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NORTHEAST EDMONTON RING ROAD
ADVANCED FUNCTIONAL PLANNING STUDY
MANNING DRIVE TO WHITEMUD DRIVE
GEOTECHNICAL INVESTIGATION
VOLUME 1 of 2

Report

to

ISL Engineering and Land Services Ltd.

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1. INTRODUCTION

This report presents the results of a preliminary geotechnical investigation that was carried out as part of the functional planning study for the Northeast Edmonton Ring Road (NEERR) in Edmonton, Alberta.

The project limits consisted of two separate highway alignments as follows:

- Along the NEERR (Hwy 216) from the intersection with Manning Drive in the northeast end of the City of Edmonton to the intersection with Whitemud Drive in the southeast part of the city in a north-south direction, and; and
- Along Hwy 16 from the intersection with Hwy 216 to Sherwood Drive, in the city's east end in an east-west direction.

The portion of Hwy 216 from Manning Drive to Hayter Road, including the North Saskatchewan River bridge crossing, was not part of the current scope of work.

The scope of work was detailed in our proposal letter to ISL Engineering and Land Services Ltd. (ISL) dated March 25, 2008. Briefly, the scope of work was to obtain soils and groundwater information along the NEERR alignment and specifically at the proposed grade separations in order to identify geotechnical issues that may impact the design and construction.

Preliminary foundation recommendations were to be provided for the bridge abutments at all major structures; geotechnical investigation and recommendations for bridge pier locations were not included in the current scope of work.

Authorization to proceed with the work was given at a meeting with ISL on May 27, 2008.

Use of this report is subject to the statement of general 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.

2. PROPOSED DEVELOPMENT

The Northeast Edmonton Ring Road (Hwy 216) will connect to the Northwest portion of Hwy 216 that is currently under construction with the previously constructed southeast section of the Anthony Henday Drive (Hwy 216).

The portion of the NEERR investigated under the current scope of work is approximately 12 km in length and spans from Hayter Road/CNR to Whitemud Drive in a north to south direction. In addition, a 4 km portion of Hwy 16, spanning east to west from Sherwood Drive to the Hwy 216 interchange was also investigated under the current scope (See Drawing Nos. 19-598-298-0 through -5 in Appendix A).

The locations and designations of bridge structures along the Hwy 216 corridor from north to south are summarized in Table 2.1. The bridge structures investigated along the Hwy 16 corridor are listed from east to west in Table 2.2.

Proposed bridge structures 9 and 10, situated at the Hwy 216/Baseline Road Interchange, and bridge structures 29 and 30, situated at the North Saskatchewan River Crossing, were not investigated under the current scope of work. The North Saskatchewan River Crossing is part of a separate scope of work undertaken by others.

TABLE 2.1
HWY 216 CORRIDOR GRADE SEPERATION/BRIDGE STRUCTURES

HWY 216 INTERSECTION	INVESTIGATION\BRIDGE NUMBER	AT BRIDGE FILE (EXISING STRUCTURES)
CNR/Hayter Road	27 & 28	BF78972-1
CPR Railway Overpass	11	BF76650 S-2
	12	New
	13	BF76650 N-1
Petroleum Way Underpass Culvert	32	BF77416-1
Sherwood Park Freeway	5	New
	6	New
	7	BF75543 W-2
	8	BF75543 E-1
Whitemud Drive	1	New
	2	New
	3	New
17 St. NW/Sherwood Park Freeway(1)	4	New

Note: (1) Bridge is over Sherwood Park Freeway not Hwy 216.

TABLE 2.2

HWY 16 CORRIDOR GRADE SEPERATION/BRIDGE STRUCTURES

HWY 16 INTERSECTION	INVESTIGATION/BRIDGE NUMBER	AT BRIDGE FILE (EXISTING STRUCTURES)
Sherwood Drive	31	New
Broadmoor Boulevard	24	BF76648-1
	23	BF76649 W-1
	22	New
CPR Railway Overpass	33	New
	21	BF76339 W-2
	20	BF76339 E-1
	19	New
Hwy 216	26	BF76651 W-1
	25	New
	14 & 15	BF76652-1
	16, 17 & 18	New

3. METHOD OF INVESTIGATION

3.1 Review of Existing Geotechnical Information

A review of available geological and geotechnical information was carried out to provide preliminary information on the soil and groundwater conditions along the alignment. Information was obtained from published geotechnical and geological reports, Alberta Transportation library, and in-house files. A list of references use in preparation of this report is presented at the end of the text.

A copy of relevant borehole logs obtained from these reports is provided in Appendix J (Volume 2).

A review of the Atlas of Coal Mine Workings of the Edmonton Area (R. Spence Taylor, 1971) was also undertaken to check for the presence of any former underground coal mines along the corridor.

3.2 Site Reconnaissance

A site reconnaissance was carried out by Mr. Shawn Russell, P.Eng. of Thurber on June 4, 2008 to visually inspect the existing conditions at the proposed bridge abutment sites. This included a visual assessment of the approach fill slopes at the existing grade separation structures. Results of the site reconnaissance are discussed in Sections 8 to 18 and selected photographs are presented in Appendix E.

3.3 Drilling Program

Forty-three (43) deep test holes (TH08-01-01 to TH08-31-02) were drilled between July 24 and November 21, 2008 to investigate the subsurface conditions at the proposed bridge abutments locations. This included six (6) deep test holes that were drilled at the revised bridge abutment locations for Bridges 5, 6, and 22. The test holes located at the bridge structure abutments were advanced to depths ranging from 10.5 m (auger refusal) to 31.7 m below existing ground surface.

In addition, twenty-one (21) shallow probe holes were drilled to depths ranging between 4.6 m to 5.3 m along the Hwy 216 and Hwy 16 corridors between November 26 and December 2, 2008 to investigate the subsurface conditions along the proposed roadway alignments.

The field drilling program was carried out under the supervision of Thurber personnel using both truck and track mounted drill rigs operated by Mobile Augers and Research Ltd. of Edmonton.

The locations of the deep test holes were chosen in conjunction with ISL prior to commencing the field program and were staked in the field by ISL prior to drilling.

The roadway shallow probe holes were drilled at approximate 500 m intervals at locations between the bridge abutment test holes. The locations of the roadway probe holes were selected by Thurber and were later surveyed by ISL for as-built elevation and location.

Standard Penetration Tests (SPT's) were carried out at selected depths in all of deep bridge abutment test holes (TH08-01-01 through TH08-32-03) and disturbed SPT samples were obtained during drilling in all test holes. In addition, Shelby tube samples were taken at select intervals during the drilling of the bridge abutment test holes.

Water levels were noted during and after completion of the drilling. Standpipe piezometers were installed in all of the test holes, (except for TH08-04-01, TH08-06-01, TH08-07-02, TH08-16-01 and TH08-32-03) to permit future monitoring of the groundwater levels. The piezometers were backfilled with cuttings above the slough level, and the upper portion of each borehole was capped with bentonite. Groundwater levels in the standpipe piezometers were measured between September 17 and December 9, 2008, approximately two to six weeks following completion of drilling.

The test hole locations are shown on the site plans, Drawing Nos. 19-598-298-1 through 19-598-298-5, in Appendix A and are summarized in Table B-1, in Appendix B.

3.4 Laboratory Testing

Laboratory testing consisted of a visual classification and determination of the natural moisture content on all the soil samples. Atterberg Limit tests and water-soluble sulphate content tests were also carried out on selected soil samples. In addition, one dimensional consolidation, direct shear and unconfined compression tests were conducted on selected undisturbed soil samples.

The results of the laboratory testing are summarized on the test hole logs in Appendix B and presented in Appendix C. A summary of Atterberg Limits tests and interpreted geotechnical properties based on AT correlations is presented in Table C.1 in Appendix C. Sulphate test results are summarized in Table C-2, Appendix C.

4. GEOLOGY

4.1 Bedrock Geology

Bedrock geology in the study area consists of Upper Cretaceous fine grained calcareous and bentonitic sandstone, bentonitic and carbonaceous clay shale and siltstone with coal layers and bentonite seams of the Edmonton Group.

Based on the published geological information (Kathol and McPherson, Figure 20 and L.D. Andriashek, NTS 83H map), the bedrock surface along the alignment varies from a high elevation of about 700 m at the southern extent of the NEERR near Whitemud Drive to an elevation of 610 m at the northern limits in the vicinity of Hayter Road. The elevation of bedrock along the Hwy 16 corridor between Sherwood Drive and 17 Street NW is expected to range from about 640 m to 645 m.

The depth to bedrock is expected to range from about 5 m to 75 m below existing ground surface.

The preglacial Beverly Channel traverses the Edmonton area to the north of the NEERR alignment. In addition, several tributary thalwegs to the Beverly Channel intersect the NEERR in an east to west direction, notably in the vicinity of Sherwood Drive and to the south of Whitemud Drive in the vicinity of Fulton Creek (also known as the Bretona Valley Channel). The locations of these preglacial thalwegs are shown on Figure 4.1, as obtained from Kathol and McPherson 1975 Geology of the Edmonton Area, Map 20.

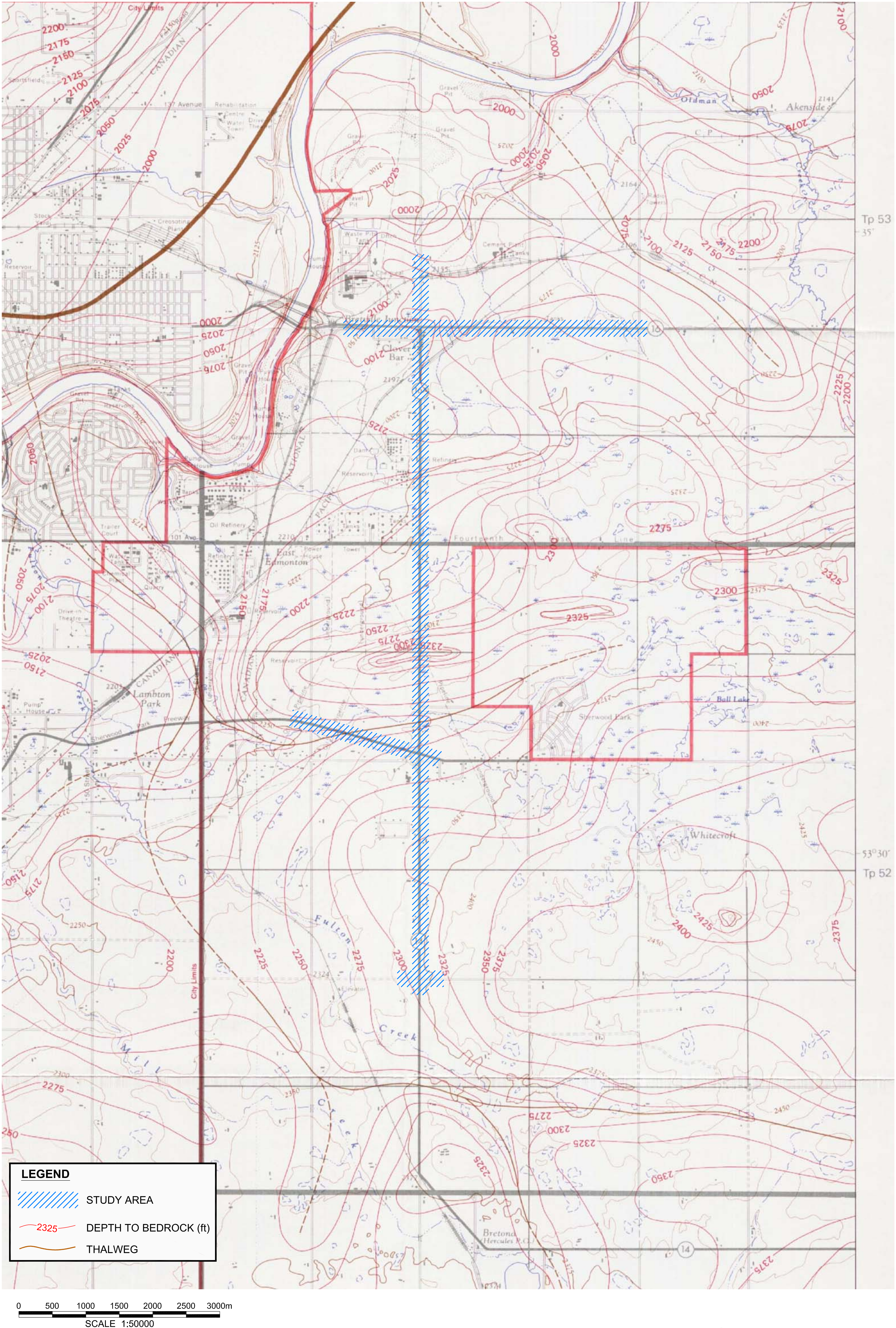
These bedrock valleys, or thalwegs, were formed during preglacial times, and preglacial sand and gravel of the Empress Formation is found in the base and terraces of these preglacial valleys. The preglacial valleys were subsequently infilled with glacial till and lake deposits in glacial and post glacial times.

4.2 Coal Mines

A review of the Atlas of Coal Mine Workings (Spence Taylor, R., 1971), the Catalogue of Coal Mines of the Alberta Plains (Campbell, J.D., 1964) and the Coal Mine Atlas, (EUB, 2004) indicated that there are possibly underground coal mines along the investigated portions of Hwy 216 and Hwy 16.

The approximate locations of these coal mine workings are shown on Figure 4.2, as obtained from EUB, Coal Mine Atlas, 2004. Table 4.1 below indicates where the proposed bridge structures may be located over the coal mine workings. It should be noted, however, that the coal mine workings are relatively deep, between 25 m and 43 m below original ground surface. Potential impacts of coal mine workings on bride structures, where present, are further addressed in Sections 9.2, 10.2, 11.2, and 18.2.

Z:\19\19-598-298\FIGURES FOR REPORT\FIGURE 4.1.dwg-Dec. 15, 2009 1:31pm

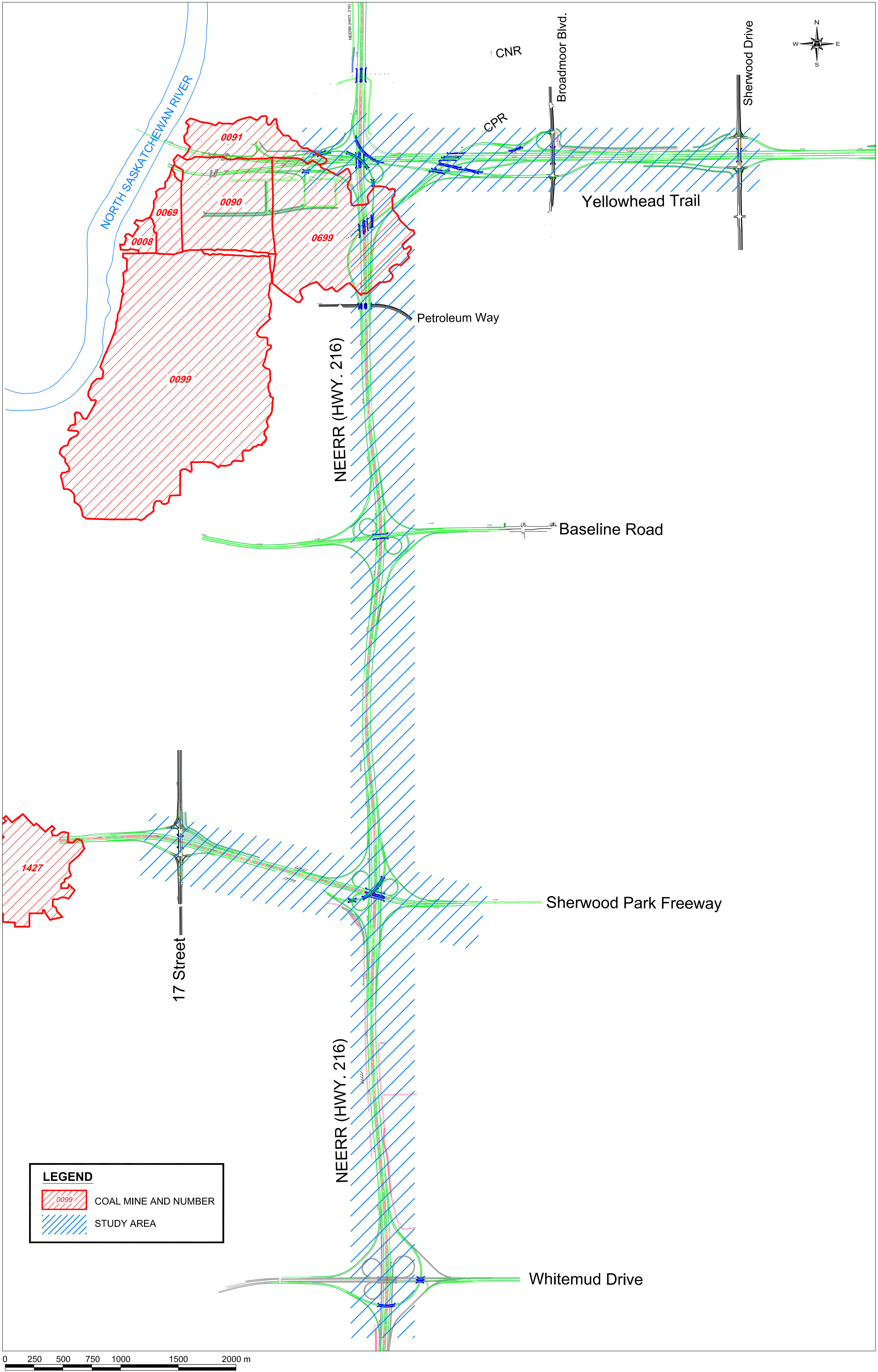


SOURCE: KATHOL AND McPHERSON
FIGURE 20 - BEDROCK TOPOGRAPHY
AND PREGLACIAL THALWEGS IN
THE EDMONTON AREA

FIGURE 4.1

THURBER PROJECT #19-598-298

Z:\19\19-598-298\FIGURES FOR REPORT\FIGURE 4.2.dwg



SOURCE: ALBERTA ENERGY AND UTILITIES BOARD
COAL MINE ATLAS
4th EDITION, VERSION 1.0, 2004

FIGURE 4.2

THURBER PROJECT #19-598-298

TABLE 4.1
LIST OF DOCUMENTED COAL MINE WORKINGS[1]

MINE NO.	TYPE OF MINE	ANTICIPATED DEPTH OF COVER (m)	LEGAL LAND DESCRIPTION (LSD of SEC-TWP-RGE-MER)	POSSIBLY AFFECTED BRIDGES
699	Underground	33 to 43	8 & 9 of 8-53-23-4	11 & 32
			15 & 16 of 8-53-23-4	25
			5, 12 & 13 of 9-53-23-4	12, 13, 16 & 32
91	Underground	25	15 of 8-53-23-4	25
			2, 3 & 4 of 17-53-23-4	26

Note: [1] Spence Taylor, R., 1971, Campbell, J.D., 1964 & EUB, 2004

4.3 Surficial Geology

The expected surficial deposits in the study area are shown on Figure 4.3 as obtained from Kathol and McPherson 1975 Geology of the Edmonton Area, Map 23. Briefly, the surficial deposits along the Hwy 216 are expected to consist of the following units, from north to south:

- From the North Saskatchewan River Valley south to Hwy 16, the surficial deposits generally consist of glaciolacustrine deposits, consisting of bedded silts and clays overlying clay till and sand deposits.

- From Hwy 16 to 82 Avenue NW, the surficial deposits generally consist of glacial till underlain by bedrock. The till consists of a clay matrix containing sand, silt, pebbles, coal fragments and occasional cobbles and boulders.

- From 82 Avenue NW to south of Sherwood Park Freeway, the surficial deposits generally consist of glaciofluvial outwash sand and gravel overlying glacial clay till.

- From south of Sherwood Park Freeway to north of Whitemud Drive, the surficial deposits generally consist of glacial till underlain by bedrock. The

SOURCE: KATHOL AND McPHERSON
FIGURE 23 - SURFICIAL GEOLOGY
OF THE EDMONTON AREA

FIGURE 4.3

THURBER PROJECT #19-598-298

till consists of a clay matrix containing sand, silt, pebbles, coal fragments and occasional cobbles and boulders.

- From north of Whitemud Drive southwards, the surficial deposits generally consists of undulating to gently rolling glacial till composed of mixed clay, silt and sand with pebbles, boulders, lenses of sand, gravel and local bedrock.
- In the vicinity of the Baseline Road Interchange, and at other select locations, lake slough deposits, consisting of silt, clay, organic muck and marl overlying clay and clay till are likely to be present.

As noted above, sand and gravel of the Empress Formation is found below the till and above the bedrock within the preglacial valleys/thalwegs. Locations and thicknesses of the Empress Sand Formation are shown on Figure 4.4, as obtained from Kathol and McPherson, 1975, *Geology of the Edmonton Area, Figure 27*.

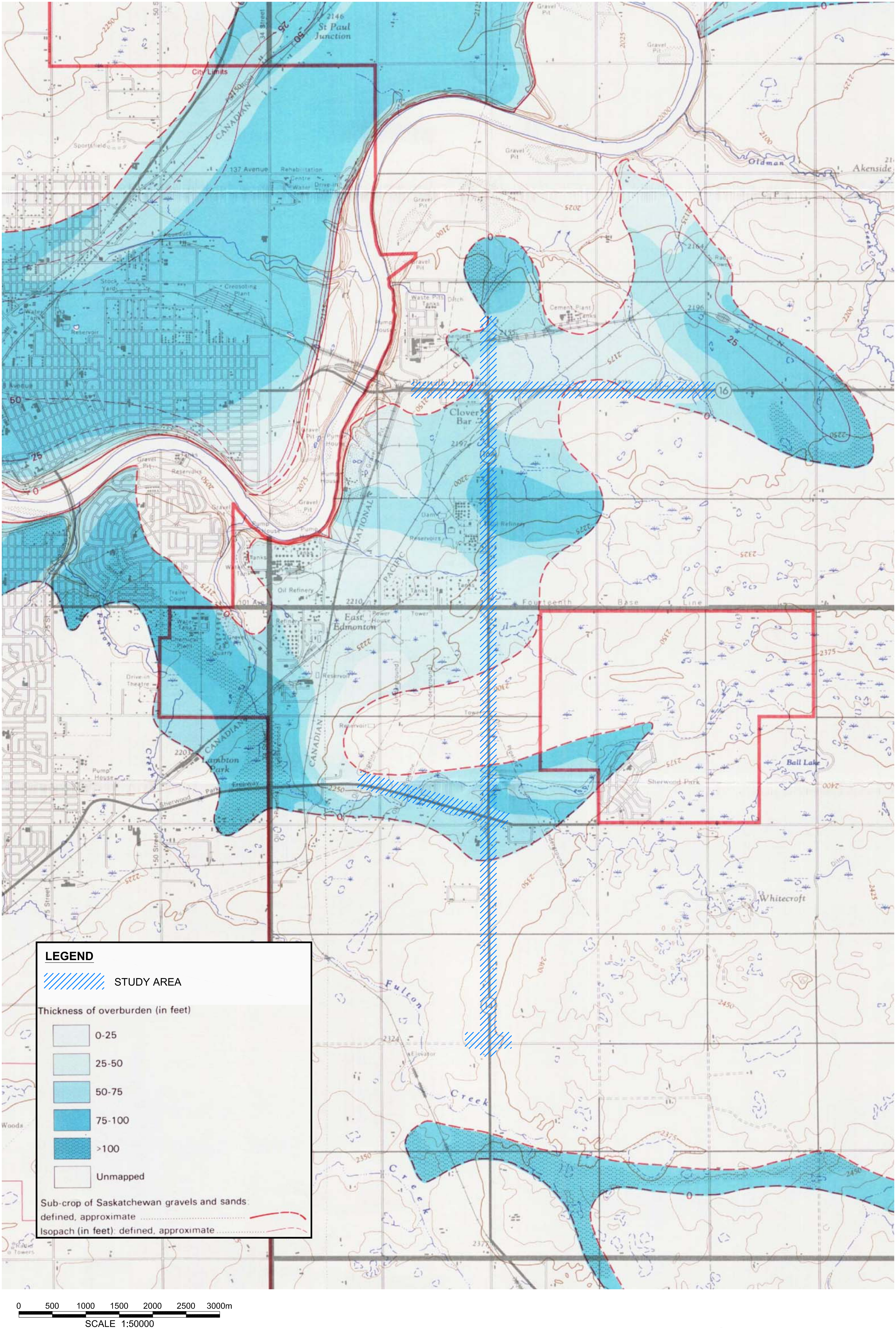
5. SITE CONDITIONS

5.1 Surface Conditions

As the proposed NEERR alignment will consist of upgrades to the existing Hwy 216 and Hwy 16 corridors, the surficial conditions are expected to consist of either existing roadway and bridge embankment structures or man-made ditches.

The topography is relatively flat to gently undulating along most of the NEERR alignment. The ground surface slopes from approximate elevation 710 m at the south end of the Hwy 216 corridor (Whitemud Drive) to about 655 m at the north end (Hayter Road/CNR) and from 675 m at the east end along the Hwy 16 corridor (Sherwood Drive) to 655 m at the west end (Hwy 216).

Surface drainage is typically towards existing sloughs, creeks and roadway ditches, as well as the North Saskatchewan River.



SOURCE: KATHOL AND McPHERSON
FIGURE 27 - THICKNESSES OF SASKATCHEWAN GRAVELS AND SANDS AND OVERBURDEN IN THE EDMONTON AREA

FIGURE 4.4

THURBER PROJECT #19-598-298

5.2 Subsurface Conditions

5.3 Stratigraphy

The following section provides a summary of the soils conditions and materials properties of the main stratigraphic units at the grade separation structures investigated along the Hwy 216 and Hwy 16 corridors investigated.

Subsurface conditions along the NEERR alignment are shown on the stratigraphic cross sections in Drawing Nos. 19-598-298-1 to 5 in Appendix A and on the test hole logs in Appendix B of Volume 1. Site specific stratigraphic and groundwater conditions at the individual grade separations are further discussed in Sections 8 to 18.

The results of the laboratory testing are summarized on the test hole logs in Appendix B and presented in Appendix C. A summary of Atterberg Limits tests and interpreted geotechnical properties based on AT correlations is presented in Table C.1 in Appendix C.

The results of the geotechnical investigation indicate that the NEERR can be subdivided into the following sections of similar stratigraphy and groundwater conditions:

- Section 1 (Hwy 216,Hayter Road/CNR to Yellowhead Trail);
- Section 2 (Hwy 216, Yellowhead Trail to Petroleum Way);
- Section 3 (Hwy 216, Petroleum Way to Sherwood Park Freeway);
- Section 4 (Hwy 216, Sherwood Park Freeway to Whitemud Drive);
- Section 5 (Hwy 216, Sherwood Park Freeway to 17 Street NW); and
- Section 6 (Hwy 16, Sherwood Drive to Hwy 216).

Following is a brief summary of the generalized stratigraphy for each of these sections:

5.3.1 Section 1 (Hwy 216, Hayter Road/CNR to Yellowhead Trail)

A stratigraphic section along the alignment between Hayter Road and Yellowhead Trail (Test Holes TH08-27-01, TH08-27-02, TH08-14-01, TH08-18-01 and previous Test Holes TH06-41 and 42) is presented in Drawing No.19-598-298-3 in Appendix A.

The soil stratigraphy is quite variable within the depth of investigation and consists of the following generalized sequence in descending order:

- Topsoil;
- Fill;
- Lacustrine Clay;
- Clay Till;
- Empress Formation (Sand & Gravel); and
- Bedrock.

The depth to bedrock along this section increases in a southerly direction from about 10 m at the Hayter Road/CNR crossing to about 20 m at the Hwy 216/Hwy 16 interchange. Empress Formation sand is present above the bedrock throughout this section and rafted bedrock is also present within the clay till layer.

5.3.2 Section 2 (Hwy 216, Yellowhead Trail to Petroleum Way)

A stratigraphic section along the section between Hwy16/Yellowhead Trail and Petroleum Way (Test Holes TH08-14-02, TH08-12-01, TH08-12-02, TH08-S19 and TH08-32-02) is provided in Drawing No. 19-598-298-3 in Appendix A.

The soil stratigraphy consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil;
- Fill;
- Lacustrine Clay;

- Clay Till;
- Empress Formation (Sand & Gravel); and
- Bedrock.

Fill consisting predominately of clay was encountered in most of the test holes along the alignment as it passes through the existing Hwy 216 corridor and bridge abutment fills.

Fill thicknesses ranging from about 11 m to 19 m, and consisting primarily of interbedded sand and clay fills, were encountered at test holes TH08-16-01, TH08-16-02 and TH08-17-02 in the vicinity of the Hwy 216/Hwy 16 interchange.

Clay shale and sandstone bedrock was encountered in the Yellowhead Trail interchange test holes at depths ranging from about 16 m to 24 m. Based on the geological maps, the clay till is anticipated to be underlain by bedrock throughout this section at depths ranging from 25 m to 17 m below existing ground, surface typically decreasing in depth in a southerly direction.

Rafted clay shale and sandstone bedrock were encountered within the clay till layer at depths ranging from 1.3 m to 11.5 m. A layer of Empress Formation sand and gravel (up to 2 m in thick) was encountered between the clay till and bedrock layers in test hole TH08-14-02 and is also expected to be encountered in thin layers between the till and bedrock throughout this section based on the geological literature.

5.3.3 Section 3 (Hwy 216, Petroleum Way to Sherwood Park Freeway)

A stratigraphic section along the section between Petroleum Way and Sherwood Park Freeway (test holes TH32-02, TH08-S18, TH08-S17, TH08-S16, TH08-S15, TH08-S14, TH08-S12, TH08-S9 and TH08-06-01) is provided in Drawing Nos. 19-598-298-2 and -3 in Appendix A.

The soil stratigraphy consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil;
- Fill;
- Clay Till; and
- Bedrock.

Fill material consisting of predominately clay was encountered in most of the test holes along the alignment as it passes through the existing Hwy 216 corridor and bridge abutment fills.

Peat layers were encountered underlying the fill in test holes TH08-S12 and TH08-S14.

Sandstone and clay shale bedrock was encountered underlying the clay till at depths ranging from about 12 m to 20 m at the Sherwood Park Freeway interchange test holes; in addition, rafted bedrock layers were encountered within the clay till at depths ranging from 6 m to 12 m at the Petroleum Way interchange test holes.

Based on the geological maps, an unnamed preglacial thalweg, which is a tributary to the Beverly preglacial channel, dissects this section in an east-west direction immediately north of Sherwood Park Freeway. The clay till is anticipated to be underlain by undulating bedrock throughout this section at depths ranging from 20 m to 30 m at Petroleum way and from 15 m to 20 m at Sherwood Park Freeway. Thin layers of Empress Formation sand and gravel are anticipated to be encountered between the till and bedrock layers throughout this section according to the same geological literature.

5.3.4 Section 4 (Hwy 216, Sherwood Park Freeway to Whitemud Drive)

A stratigraphic section along the section between Sherwood Park Freeway and Whitemud Drive (test holes TH08-08-2, TH08-SI to TH08-S8 and TH08-1-2) is provided in Drawing Nos. 19-598-298-1 and -2 in Appendix A.

The soil stratigraphy consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil,
- Fill,
- Lacustrine clay,
- Clay Till, and,
- Bedrock.

Fill material consisting of predominately clay was encountered in most of the test holes along most of the alignment as it passes through the existing Hwy 216 corridor and bridge abutment fills.

Bedrock was encountered at depths of about 12 m to 20 m in the test holes drilled at the Sherwood Park Freeway interchange and at depths of about 21 m to 30 m at the Whitemud Drive interchange. Sand layers and thin rafted bedrock lenses were encountered within the clay till layers throughout this section.

Based on the geological maps, the depth to bedrock is anticipated to vary between 6 m and 18 m through this section.

5.3.5 Section 5 (Hwy 216, Sherwood Park Freeway to 17 Street NW)

A stratigraphic section along the alignment of Hwy 216 from Sherwood Park Freeway to 17 Street NW is shown on Drawing No. 19-598-298-5 in Appendix A.

The soil stratigraphy along this section consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil;
- Fill;
- Lacustrine Clay;
- Clay Till; and
- Bedrock.

Fill consisting of predominately clay was encountered in most of the test holes along most of the alignment.

Topsoil layers ranging from about 600 mm to 1200 mm thick were encountered underlying the fill material in test holes TH08-04-02, TH08-05-01 and TH08-07-01.

Bedrock was encountered at depths of about 12 m to 20 m in the test holes drilled at the Sherwood Park Freeway interchange. Based on the geological maps, the bedrock topography is dominated by an un-named preglacial thalweg tributary to the Beverly preglacial channel, that crosses through this section in a east-west direction immediately north of Sherwood Park Freeway. The depth to bedrock is expected to vary between 15 m and 20 m, typically increasing from east to west. Thin layers of Empress Formation sand and gravel are expected to be present between the till and bedrock layers throughout this section according to the same geological literature.

5.3.6 Section 6 (Hwy 16, Sherwood Drive to Hwy 216)

A stratigraphic section along the alignment of Hwy 16 between Sherwood Drive and 17 Street NW is provided in Drawing No. 19-598-298-4 in Appendix A.

The soil stratigraphy consists of the following generalized sequence within the depth of investigation, in descending order:

- Topsoil;
- Fill;
- Lacustrine clay;
- Sand;
- Clay Till;
- Empress Formation (Sand and Gravel); and
- Bedrock.

Fill consisting of predominately clay was encountered in most of the test holes along the alignment as it passes through the existing Hwy 16 corridor and bridge abutment fills.

Bedrock was encountered at depths ranging from about 15 m to 25 m in the test holes drilled at the Hwy 216/Hwy 16 interchange and CPR railway overpass structures. Sand and rafted bedrock layers were encountered within the clay till layers throughout this section. Based on the geological maps, the depth to bedrock is expected to vary between about 8 m and 30 m through this section.

Empress Formation sand and gravel layers were encountered at depths ranging from about 10 m to 15 m. Thin layers of Empress sand and gravel are expected to be encountered between the till and bedrock layers throughout this section according to the geological literature.

Two test holes (test holes TH06-43 and 44) were also drilled along this section during Thurber's previous 2006 geotechnical investigation.

5.3.7 Material Properties

Following is a brief summary of the material properties of the various strata based on the available geotechnical data. For site specific information refer to the individual test hole logs and Sections 8 through 18 of this report.

5.3.7.1 Topsoil

Topsoil was encountered at ground surface along the NEERR alignment, either overlying fill material or native soil, except for test holes that were drilled through roadway structures and gravel surfaced embankments.

Topsoil was also encountered underlying fill layers in some test hole locations. A summary of the topsoil thicknesses observed during the field investigation is provided in Table 5.2.

The topsoil was typically brown to black, silty, and contained trace to some clay, organics, roots and rootlets. The natural moisture content of the topsoil samples ranged from 9% to 66%.

It should be noted that the depth of topsoil may vary between the locations of the test holes. Additional shallow test pits may be required if a more accurate topsoil quantity estimate is required.

5.3.7.2 Fill

An organic fill layer about 4.6 m thick was encountered at the ground surface elevation at test hole TH08-22-2.

An asphalt layer of about 50 mm to about 330 mm in thickness was encountered at ground surface at bridge abutment test holes TH08-02-02 and TH08-26-02 as well as at most of the roadway alignment test holes.

A 120 mm thick asphalt layer was also encountered underlying the fill layers at a depth of approximately 8.8 m at test hole TH08-12-02.

Sand and gravel layers ranging from 150 mm to 800 mm thick were encountered at test holes TH08-02-02, TH08-12-01, TH08-14-02, TH08-31-2 and in most of the roadway survey test holes, either underlying the asphalt layer or as embankment fill material. The sand and gravel fill was light brown to brown, fine to coarse grained, with varying quantities of silt, clay, gravel, oxides and organics.

Clay fill was encountered in several test holes, and the individual test holes should be referred to for the clay fill properties. The clay fill is generally brown to grey, silty with variable quantities of gravel with silt layers, and some organic intrusions throughout. Atterberg Limits test carried out on selected samples of the clay fill indicated it was medium to high plastic, with plastic limit values ranging from 14% to 24% and a liquid limit values ranging from 32% to 68% (Table 5.1). The corresponding field moisture contents obtained on samples of the clay fill ranged from of 5% to 37% indicating that the moisture content of the clay fill varies from dry of optimum to wet optimum moisture content SPT ‘N’ values ranged from 4 to 31 indicating a firm to very stiff consistency.

The sand fill was typically brown, fine to coarse grained with varying quantities of gravel, silt and clay. The corresponding field moisture contents obtained on samples of the sand fill ranged from of 2% to 23%. SPT ‘N’ values typically ranged from 9 to 48 indicating a loose to dense compactness.

TABLE 5.2A
SUMMARY OF TOPSOIL THICKNESS AT 2008 THURBER TEST HOLE LOCATIONS

TEST HOLE	TOPSOIL THICKNESS (m)	TEST HOLE	TOPSOIL THICKNESS (m)
TH08-01-01	-	TH08-24-01	0.18
TH08-01-02	0.8*	TH08-24-02	0.3
TH08-02-01	0.3	TH08-25-01	-
TH08-02-02	-	TH08-25-02	0.8
TH08-03-01	0.15	TH08-26-01	0.18
TH08-03-02	0.13	TH08-26-02	-
TH08-04-01	-	TH08-27-01	0.8
TH08-04-02	0.6*	TH08-27-02	0.8
TH08-05-01	1.2*	TH08-31-01	-
TH08-05-02	0.3	TH08-31-02	0.8
TH08-06-01	-	TH08-32-01	0.45
TH08-07-01	0.3 & 0.75*	TH08-32-02	0.61
TH08-07-02		TH08-32-03	0.23
TH08-08-01	-	TH08-S01	-
TH08-08-02	0.61	TH08-S02	-
TH08-12-01	0.1	TH08-S03	0.3
TH08-12-02	0.2	TH08-S04	-
TH08-14-01	-	TH08-S05	0.3
TH08-14-02	-	TH08-S06	-
TH08-15-01	0.1	TH08-S07	-
TH08-16-01	-	TH08-S08	-
TH08-17-01	0.13	TH08-S09	
TH08-17-02	-	TH08-S10	
TH08-18-01	-	TH08-S11	
TH08-18-02	0.15	TH08-S12	
TH08-19-02	0.15	TH08-S14	
TH08-20-01	0.18 & 0.45*	TH08-S15	0.46
TH08-20-02	0.28	TH08-S16	
TH08-21-02	0.13 & 0.45*	TH08-S17	0.61
TH08-22-01	0.15	TH08-S18	-
TH08-23-01	-	TH08-S20	-
TH08-23-02	0.3	TH06-S21	-

(*) Not at ground surface, underneath fill.

TABLE 5.2B
SUMMARY OF TOPSOIL THICKNESS AT 2009 THURBER TEST HOLE LOCATIONS

TEST HOLE	TOPSOIL THICKNESS (m)	TEST HOLE	TOPSOIL THICKNESS (m)
TH09-05-1A	0.15	TH09-22-1	0.15
TH09-05-2A	0.25	TH09-22-2	0.15
TH09-06-1A	0.6		
TH09-06-2A	0.1		

(*) Not at ground surface, underneath fill.

5.3.7.3 Clay

Lacustrine clay was encountered in the majority of test holes below the topsoil, and/or fill and ranged from 0.7 m to 6.4 m in thickness. The clay was typically dark brown to grey, silty, sandy and contained, trace of oxides, gravel, coal, white salts and occasional ironstone inclusions. Sand, silt and coal lenses were encountered within the clay layer in several test holes. Some organics and rootlets were also encountered near the surface.

Natural moisture contents in the clay generally ranged from 9% to 47%. Atterberg limits tests carried out on selected samples indicate that the clay was medium to high plastic, with plastic limits ranging between about 18% and 26% and liquid limits ranging between about 48% and 75% (Table 5.1).

SPT ‘N’ values typically ranged from 5 to 37 blows per 300 mm penetration indicating a firm to hard consistency.

5.3.7.4 Clay Till

Clay till was encountered below the topsoil or lacustrine clay and fill layers in the majority of deep test holes. The clay till was typically brown to grey, silty, sandy, medium to low plastic, and contained trace to some amount of gravel, clay shale and sandstone inclusions, trace coal, oxides, and gravel with occasional sand and silt lenses.

Natural moisture contents in the clay till ranged from 8% to 35%. Atterberg limit tests conducted on samples of the clay till indicated plastic limits varying between about 12% and 20% and the liquid limits varying between about 26% and 52%, indicating that the clay till is low to high plastic.

SPT ‘N’ values ranged from 6 blows per 300 mm penetration to 75 blows per 75 mm penetration, indicating firm to very hard consistency. Although not frequently encountered in the test holes, it should be noted that the clay till may contain cobbles and boulders.

Sand and gravel layers were frequently found within the clay till. These inter-till sand and gravel layers were light grey to brown, poorly graded; fine to medium grained and contained trace amounts of silt, clay, oxides, and coal. Natural moisture contents in the inter-till sand and gravel varied between 2% and 25%, with values greater than 10% typically encountered below zones of seepage. SPT ‘N’ values typically varied between 10 blows and 93 blows per 300 mm penetration, indicating a compact to very dense state.

Ice rafted (reworked) bedrock layers consisting mainly of weathered clay shale and sandstone with siltstone and coal layers were encountered within the clay till in several test holes. With respect to foundation conditions, the ice rafted bedrock can be considered similar to the clay till.

The rafted clay shale was typically grey to brown, silty, bentonitic, and contained pebbles, varying quantities of sand and occasional coal lenses. Natural moisture contents in the rafted clay shale ranged from 15% to 43%. SPT ‘N’ values ranged from 13 to 90 blows per 300 mm penetration, indicating a variable stiff to very hard consistency in soil mechanics terminology.

The rafted sandstone bedrock was typically brown to black, fine grained, bentonitic and contained trace quantities of silt and oxides. Natural moisture contents ranged from 8% to 35% and SPT ‘N’ values ranged from 13 to 87 blows per 300 mm penetration, indicating a compact to very dense state in soil mechanics terminology.

Rafted coal layers were also encountered in test holes TH08-14-01, TH08-22-02, TH08-23-01, TH08-23-02, TH08-24-01 and TH08-32-01. The rafted coal layers were black and varied in thickness from about 0.2 m to 0.8 m. Moisture contents typically ranged from 44% to 85%. One SPT ‘N’ value of 32 blows per 300 mm penetration indicates a hard consistency in soil mechanics terminology.

5.3.7.5 Empress Formation (Sand and Gravel)

Empress Formation sand and gravel deposits were found underlying the clay till in approximately half of the bridge abutment test holes drilled along the Hwy 16 corridor.

The sand was typically light grey to yellowish brown with varying quantities of gravel and contained trace oxides, occasional coal, silt lenses. The natural moisture contents of the sand varied from 2% to 27%, with values greater than 10% typically encountered below zones of seepage. SPT ‘N’ values ranged from about 8 blows per 300 mm penetration to 110 blows per 300 mm penetration indicating a compact to very dense state.

5.3.7.6 Bedrock

Bedrock consisting predominantly of clay shale and sandstone with occasional siltstone layers and coal seams was encountered either underlying the clay till, or Empress sand in most of the bridge abutment test holes.

The clay shale was typically grey to bluish grey, silty, bentonitic, high plastic and contained siltstone layers, ironstone inclusions and occasional coal layers. Natural moisture contents in the clay shale ranged from 11% to 39%. Plastic limits ranged from about 14% and 29% and liquid limits varied between about 38% and 85%, indicating that the clay shale is medium to high plastic. SPT ‘N’ values ranged from 14 blows to 91 blows per 300 mm penetration, indicating a stiff to very hard consistency in soil mechanics terminology.

The sandstone bedrock was typically brown to grey fine grained, bentonitic and contained trace quantities of silt and oxides. Natural moisture contents in the sandstone ranged from 13% to 31%. SPT ‘N’ values ranged from 18 to 97 blows per 300mm of penetration indicate a compact to very dense compactness in soil mechanics terminology.

Coal layers were encountered underlying the clay shale and sandstone bedrock in test holes TH08-18 and TH08-27. The coal layer was black and varied in thickness from about 0.2 m to 0.5 m. Moisture contents in the coal typically ranged from 37% to 47%. One SPT ‘N’ value of 50 blows per 250 mm penetration indicates a very hard consistency in soil mechanics terminology.

5.4 Groundwater Conditions

Depths of sloughing and groundwater levels encountered at the test hole locations are shown on the test hole logs in Appendix B and are summarized in Table 5.3.

Standpipe piezometers were installed in the majority of the bridge abutment test holes to allow for future monitoring of groundwater levels.

Groundwater levels were measured at the completion of drilling and after approximately two to six weeks following the completion of drilling. Groundwater levels measured in the test holes varied from 0.7 m to 22.6 m below current ground elevations.

It should be noted that the groundwater levels are relatively short term and may not represent stabilized groundwater levels in some test holes. Further, the groundwater levels may fluctuate due to seasonal variations in precipitation and other climatic factors. Hence, the actual groundwater conditions at the time of construction could vary from those recorded during this investigation.

Further groundwater level readings should be performed to provide long term stabilized water level readings.

TABLE 5.3
GROUNDWATER CONDITIONS

TEST HOLE NUMBER	DRILL DEPTH (m)	SLOUGH DEPTH (m)	GROUNDWATER LEVEL OBSERVATIONS (METRES BELOW GROUND SURFACE)				
			SEEPAGE DURING DRILLING	FIRST READING	DATE OF THE FIRST READING	LAST READING	DATE OF THE LAST READING
TH08-01-01	30.2	-	7.6	3.1	Sept. 5, 08	2.4	Sept. 19, 08
TH08-01-02	30.2	-	7.3	24.6	Sept. 4, 08	4.1	Sept. 19, 08
TH08-02-01	24.1	11.6	-	-	Aug. 29, 08	2.8	Sept. 19, 08
TH08-02-02	27.1	-	-	10.7	Aug. 28, 08	9.2	Sept. 19, 08
TH08-03-01	19.5	17.7	-	15.2	Sept. 2, 08	7.4	Sept. 19, 08
TH08-03-02	19.5	17.2	7.6	15.2	Sept. 2, 08	3.5	Sept. 19, 08
TH08-04-01B	14.9	13	5.8	N/A	N/A	N/A	N/A
TH08-04-02	22.6	18.7	2.5	15.1	Aug. 27, 08	3.0	Sept. 19, 08
TH08-05-01A	22.6	21.3	3.4	4.4	Aug. 19, 08	4.4	Sept. 19, 08
TH08-05-02	22.6	-	2.3	0.7	Aug. 19, 08	0.9	Sept. 19, 08
TH08-06-01	21.0	-	4.6	N/A	N/A	N/A	N/A
TH08-07-01B	14.9	-	8.4	-	-	7.8	Sept. 19, 08
TH08-07-02	19.5	-	2.3	N/A	N/A	N/A	N/A
TH08-08-01B	22.6	16.2	7.0	4.9	Aug. 19, 08	1.3	Sept. 19, 08
TH08-08-02	22.6	22.1	2.4	6.5	Aug. 19, 08	5.0	Sept. 19, 08
TH08-12-01	20.9	20.0	19.8	DRY	Jul. 25, 08	19.8	Sept. 19, 08
TH08-12-02	24.1	-	13	10.6	Aug. 19, 08	10.0	Nov. 14, 08
TH08-14-01B	19.5	-	0.9	-	-	0.7	Oct. 21, 08
TH08-14-02C	25.6	25.0	24.1	17.2	Sept. 29, 08	17.2	Oct. 21, 08
TH08-15-01C	19.5	9.1	1.8	-	-	1.6	Oct. 21, 08
TH08-16-01	30.2	16.5	DRY	N/A	N/A	N/A	N/A
TH08-16-02	22.1	15.2	DRY	-	-	DRY	Oct. 21, 08
TH08-17-01A	19.5	17.4	13.4	9.1	Oct. 3, 08	8.9	Oct. 21, 08
TH08-17-02A	31.7	18.3	29.7	-	-	19.8	Oct. 21, 08
TH08-18-01B	22.6	4.6	3.5	N/A	N/A	N/A	N/A
TH08-18-02B	19.5	-	3.7	-	-	8.4	Oct. 21, 08
TH08-19-02	18.0	15.2	11.3	-	-	15.9	Oct. 21, 08
TH08-20-01A	22.6	21.5	18.0	20.8	Sept. 29,08	21.3	Oct. 21, 08
TH08-20-02A	22.6	18.9	7.9	-	-	15.5	Oct. 21, 08
TH08-21-02A	19.5	-	16.8	12.7	Sept. 30, 08	11.1	Oct. 21, 08
TH08-22-01	21.0	17.4	-	-	-	6.8	Oct 21, 08
TH08-22-02	20.9	11.7	8.1	DRY	Oct. 1, 08	DRY	Oct 21, 08

TABLE 5.3
GROUNDWATER CONDITIONS (Continued)

TEST HOLE NUMBER	DRILL DEPTH (m)	SLOUGH DEPTH (m)	GROUNDWATER LEVEL OBSERVATIONS (METRES BELOW GROUND SURFACE)*				
			SEEPAGE DURING DRILLING	FIRST READING	DATE OF THE FIRST READING	LAST READING	DATE OF LAST READING
TH08-23-01A	14.5	13.6	-	14.1	Oct. 8, 08	14.1	Oct. 21, 08
TH08-23-02A	13.7	10.7	-	1.5	Oct. 8, 08	10.6	Oct. 21, 08
TH08-24-01C	14.9	14.3	4.3	12.6	Oct. 2, 08	14.0	Oct .21, 08
TH08-24-02D	18.0	9.9	-	-	-	4.3	Oct .21, 08
TH08-25-01	18.0	6.1	-	4.9	Sept. 10, 08	2.0	Oct .21, 08
TH08-25-02	19.5	16.5	-	11.4	Sept. 11, 08	18.1	Oct .21, 08
TH08-26-01A	16.5	16.3	3.1	16.2	Oct .3, 08	4.6	Oct. 21, 08
TH08-26-02A	16.5	-	-	-	-	1.9	Oct. 21, 08
TH08-27-01	16.3	-	6.9	6.7	Aug. 19, 08	6.6	Sept. 19, 08
TH08-27-02	15.5	-	13.0	10.6	Aug. 19, 08	7.4	Sept. 19, 08
TH08-31-01	22.6	21.0	21.0	22.4	Jul. 25, 08	22.6	Sept. 19, 08
TH08-31-02	19.1	-	-	N/A	N/A	N/A	N/A
TH08-32-01	21.0	18.0	7.6	-	-	7.2	Dec. 9, 08
TH08-32-02	21.0	-	10.0	-	-	6.1	Dec. 9, 08
TH08-32-03	20.6	10.8	6.9	N/A	N/A	N/A	N/A
TH09-05-01A	19.7	18.7	-	7.7	Aug. 11, 09	1.7	Aug. 20, 09
TH09-05-02A	21.0	19.5	1.8	14.6	Aug. 6, 09	3.5	Aug. 20, 09
TH09-06-01A	22.6	19.8	2.9	10.5	Aug. 5, 09	3.3	Aug. 20, 09
TH09-06-02A	18.3	17.7	1.7	1.5	Aug.7, 09		Aug. 20, 09
TH09-22-01	19.1	17.2	4.3	10.7	Sep. 9, 09	16.1	Sep. 23, 09
TH09-22-02	22.6	21.0	7.2	DRY	Sep. 10, 09	8.7	Sep. 23, 09

Note: * (N/A No Standpipe installed).

5.5 Frost Effects

Table 5.4 presents the expected depths of frost penetration for the various soil types expected along the Hwy 216 and Hwy 16 corridors. The depths of frost penetration have been estimated for the in-situ soils for both the mean annual Air Freezing Index (AFI) and the 50-year return period AFI of 1400°C days and 2200°C days, respectively.

TABLE 5.4
ESTIMATED DEPTH OF FROST PENETRATION

SOIL TYPE	MEAN ANNUAL AFI (1650°C DAYS)	50 YEAR RETURN AFI (2350°C DAYS)
Clay	1.5 m	2.2 m
Clay (Till)	2.0 m	2.8 m
Silt	2.2 m	3.2 m
Sand/ Gravel	2.4 m	3.5 m

The mean annual depth of frost penetration could be used for short-term construction cases with some risk; the 50-year return depth is usually chosen for long-term design.

These depths of frost penetration are estimated assuming no insulation cover. If the area is covered with topsoil or significant snow cover, the depth of frost penetration will be less.

6. GEOTECHNICAL EVALUATION AND RECOMMENDATIONS – NEERR AND YELLOWHEAD TRAIL ROAD ALIGNMENTS

6.1 General

The NEERR (Hwy 216) is approximately 12 km in length while the section of Yellowhead Trail (Hwy 16) under the current scope is approximately 4 km in length. The preliminary design gradeline is presented in Drawing Nos. 19-598-298-01 to 19-598-298-05 in Appendix A.

A generalized description of the soil conditions along the alignment is presented in Section 5.

Tables 6.1 and 6.2 present a summary of the estimated ranges of cuts and fills based on the preliminary ultimate grade line drawings as well as the expected soil strata. Deep cuts and high fills associated with grade separations are addressed individually in Sections 8 through 18.

TABLE 6.1
SUMMARY OF CUT AND FILL ALONG THE NEERR (HWY 216)

GRADE LINE SECTION		PROPOSED GRADE LINE		GENERAL STRATIGRAPHY BELOW ORIGINAL GROUND SURFACE	EXPECTED DISTANCE TO GWT (m)	
From	**To**	**Cut (m)**	**Fill (m)**		**Below Original Ground Surface**	**Below Proposed Grade Line**
Hayter Road/ CNR	Petroleum Way	1.0	12	**See Drawing 19-598-298-3** Up to 10 m of Fill; over 0.5 m to 6 m of Clay; over Silt/gravel/sand; over Clay till; over Empress sand, over Bedrock	6 m to 20 m	9 m to 23 m
Petroleum Way	Sherwood Park Freeway (Including 17 Street NW)	5	6	**See Drawings 19-598-298-2, 3 & 5** Up to 8 m of Fill; over 0.5 m to 4 m of Clay; over Clay till; over Empress sand, over Bedrock	2 m to 8 m	2 m to 9 m
Sherwood Park Freeway	Whitemud Drive	3	3	**See Drawings 19-598-298-1 & 2** Up to 8 m of Fill; over 0.5 m to 2 m of Clay; over Clay till; over Empress sand, over Bedrock	2 m to 9 m	2 m to 9 m

TABLE 6.2
SUMMARY OF CUT AND FILL ALONG YELLOWHEAD TRAIL (HWY 16)

GRADE LINE SECTION		PROPOSED GRADE LINE		GENERAL STRATIGRAPHY BELOW ORIGINAL GROUND SURFACE	EXPECTED DISTANCE TO GWT (m)	
From	To	Cut (m)	Fill (m)		Below Original Ground Surface	Below Proposed Grade Line
Sherwood Drive	17 Street NW	3	2	**See Drawing No. 19-598-298-4** Up to 10 m of Fill; over 0.5 to 8 m of Clay; over Clay till; over Empress sand, over Bedrock	2 m to 15 m	2 m to 23 m

NOTES:
1. All depths referred to are approximate, and are in m below existing ground surface referenced to the nearest test holes (except where noted otherwise).
2. Groundwater levels were based on November 2008, December 2008, August 2009 & September 2009 piezometer measurements, and may vary during the time of construction from the values reported herein.
3. GWT = Groundwater Table.

6.2 Stripping

All topsoil or peat and any unsuitable materials, such as soft and organic-rich soils, should be removed from under the road alignment and beneath fill areas.

As noted in Section, 5.2.3, the depths of topsoil at the test hole locations were quite variable, and the individual test hole logs should be referred to for site-specific information. An organic fill layer with a thickness of 4.5 m was encountered at test hole TH08-22-02.

Further investigation of topsoil and buried organic clay thickness should be carried out during the detailed investigation phase.

6.3 Cut Slopes

The estimated depths of cuts along the alignment are shown on the profile drawings in Appendix A and summarized in Tables 6.1 and 6.2. The available test holes indicate that the cut slopes will be through mainly firm to stiff clay and clay till, but may also extend through some sand, gravel and clay fill, depending on the cut depths and locations. Table 6.3 summarizes the cut sections based on the proposed alignment.

TABLE 6.3
SUMMARY OF CUT SLOPE SECTIONS HWY 216

STATION	LENGTH (m)	CUT DEPTH (m)	MATERIAL WITHIN CUT DEPTH
59+400 to 60+030	630	Up to 1	Clay Fill and Sand Fill
60+500 to 61+250	750	Up to 1	Clay Fill
63+000 to 63+500	500	Up to 3	Sand Fill, Clay Fill and Clay Till
63+700 to 64+500	800	Up to 5	Clay Fill, Clay and Clay Till
65+200 to 65+750	550	Up to 1	Sand Fill and Clay Fill
66+000 to 67+000	1000	Up to 0.5	Sand Fill, Clay Fill, Topsoil and Clay Till
67+000 to 67+300	300	Up to 0.5	Sand Fill and Clay Fill
67+800 to 68+200	400	Up to 0.5	Sand Fill and Clay Fill
68+800 to 68+900	100	Up to 1	Topsoil and Clay Fill

The groundwater levels are generally below the expected depths of cut, except at a few sections as follows where they encroach within about 2 m of the finished grade line:

- Along Sherwood Park Freeway (between Station 20+500 and 21+000, i.e. about 500 m in length);
- Along Hwy 216, near Whitemud Drive (between Stations 59+500 and 61+000, i.e. about 1500 m in length); and
- Along Hwy 216, near Sherwood Park Freeway (between Stations 63+000 to 64+500, i.e. 1500 m in length).

Temporary and permanent drainage may be required in the above sections along Hwy 216 and Hwy 16, as discussed in Sections 6.5 and 6.6 respectively.

Permanent cut slopes of 3H: 1V, or flatter, are recommended in view of the soil and groundwater conditions and long term slope maintenance.

Flatter slopes may be required where cuts extend into silt/sand soils below groundwater. This should be confirmed based on detailed investigations once the locations of such cuts are finalized.

6.4 Fill Slopes

The fill sections along the proposed grade line are shown on the profile drawings in Appendix A. In general, the foundation soils under embankments fills are expected to consist of firm to stiff clay and existing clay and sand fill overlying clay till or rafted clay shale and sandstone bedrock. The depths to groundwater are variable along the alignment.

It is anticipated that the fill materials will come from the cut sections along the alignment and/or from borrow pits and storm ponds adjacent to the alignment. These locations have yet to be determined and were not assessed under the current scope of work.

The on-site fill is expected to consist of mainly clay, silt and sand and clay till which may contain rafted clay shale and sandstone layers depending on the locations and depth of cut. The native clay and clay fill along the cut sections of the alignment are generally wet of Optimum Moisture Content (+2% to +10%) and will therefore require moisture conditioning and/or modification as discussed in Section 6.7.

Silt, where encountered, should be avoided as backfill material since it is frost susceptible and it is not easy to compact. It may be possible to incorporate the silt lower in the embankment cross sections where it will not be subject to frost action or surface erosion.

Permanent fill side slopes comprised of clay soils should be constructed at no steeper than 3H:1V.

Head slopes at grade separation structures constructed of common clay fill may be sloped at 2H:1V for fill heights up to about 10 m, unless specifically noted under the individual grade separations in Section 8 to 18. For fill heights greater than 10 m, the slopes should generally be flattened to 2.5 H:1V, or alternatively stronger fill (e.g. granular fill) or geogrid reinforcement should be used in the head slope area to maintain a head slope of 2H:1V. Results of stability analyses for typical slopes and fill heights are presented in Table D-2 of Appendix D.

It should be noted that high groundwater conditions, i.e. within 2 m of ground surface elevations or at the base of existing fill material, were encountered at the abutment locations for Bridges 1, 4, 5, 7, 8, 14, 15, 25, 26. These may result in the generation of high construction induced excess pore pressure that might affect the global stability of the approach fill embankments.

Installation of wick drains may be required in areas of high fills with high groundwater table to accelerate dissipation of excess construction pore pressures, and accommodate relatively fast construction schedules. Staged construction and/or installation of wick drains are also beneficial in decreasing the amount of long term settlement remaining after fill construction.

Further information on approach fill designs is provided under the individual interchange recommendations, in Sections 8 to 18 of this report. Settlement, stability and construction requirement of high fills should be checked during the detailed design stage.

Fill slopes consisting of granular fill, reinforced fill or retained fill could be constructed at steeper slope angles at specific locations where required. These slope options should be evaluated during the detailed design.

6.5 Temporary Drainage

Groundwater seepage may be encountered from cut slopes and excavations at locations of expected high groundwater, as identified in Section 6.1 and 6.3 above (refer to stratigraphic cross sections and individual test hole logs to determine expected groundwater conditions).

The seepage may occur at varying depths below the upper few meters. The rate of seepage is expected to be relatively low in the clay, clay fill, and clay till. Therefore, it is expected that the groundwater seepage during construction can be handled by conventional grading practices and temporary ditching along the toe of the cut slopes, if necessary.

However at the locations where extensive wet sand are encountered in deep cuts below the groundwater table, such as found in the test holes drilled for Bridges 14 to 18 at the Hwy216/Hwy 16 interchange, seepage rates could be greater. In such areas, greater attention to controlling drainage during construction will be required

It should be also noted that winter freezing can create icings and block slope drainage, which can trigger instability.

6.6 Permanent Drainage

It is understood that the NEERR roadway will be designed as a rural section with ditches on both sides of the alignment. Groundwater seepage is expected in several cut locations along the proposed alignments, as identified in Section 6.3. Where possible, the gradeline should be raised to avoid deep cuts below the expected groundwater table.

In general, slope seepage should be relatively slow from the clay and clay till materials encountered in the test holes within the depth of expected cut depths, and should not be a significant long-term drainage problem.

Where thick sand layers are encountered below the water table, greater seepage flow rates may be encountered and slope erosion could be a long term problem. In such areas a granular drainage blanket may be required over the lower portion of cut slopes in sand deposits, to control and minimize erosion from groundwater seepage. This may consist of a layer of coarse pit run gravel placed on a non-woven geotextile over the sand. French drains (i.e. gravel filled trenches with or without subdrain pipes) installed down the slope may also be required to control drainage locally.

In areas of high groundwater table, subdrains should also be provided on each side of the roadway near the toe of the cut slopes, where cuts extend below the groundwater table in sand deposits. Subdrains may consist of subdrain pipes placed at least 2 m below ditch level in a trench backfilled with free draining gravel and should be connected to appropriate drainage system. Based on the available roadway grading and test hole information, we anticipate that subdrains may be required in the vicinity of Bridges 4, 5, 7, 8, 14 and 15.

Requirements for permanent slope drainage should be assessed during detailed investigation, when the vertical alignment has been finalized.

6.7 Subgrade Treatment and Frost Design

In general, the subgrade conditions in the cut sections are expected to consist of firm to stiff clay and clay till. In some instances a near surface silt layer and silt lenses that may be present within clay till and are considered to be frost susceptible.

Where subgrades are close to the groundwater table (See Section 6.3) frost action may therefore be a concern for pavement structures constructed on the clay till subgrade. Methods of reducing frost heave effects include:

- raise the vertical alignment to avoid areas of high groundwater;
- subdrainage to lower the groundwater table;
- additional sub-excavation of frost susceptible soils and replacement with non-frost susceptible material in identified problem areas; and

- insulation of the subgrade.

Subgrade drainage was discussed previously and is imperative for the long term performance of the pavement subgrade.

Where the exposed subgrade consists of frost susceptible materials (i.e. silts, clayey silts and sandy silts) in areas of high groundwater, these materials should be subcut to a minimum depth of about 1.0 m below the proposed subgrade elevation. Further investigation of cut areas should be carried out during detailed design. Frost susceptible materials derived from the subcut operations should be wasted or possibly incorporated within the embankment fills elsewhere. The fill should be placed in 150 mm lifts and compacted to Alberta Transportation compaction standards, spread and cross graded to obtain the maximum soil mixing.

The subgrade should be graded with a minimum cross fall of 2% towards side ditches to promote subgrade drainage.

Insulation has been used in previous sections of Anthony Henday Drive to reduce frost effects in the subgrade. Insulation is generally not expected to be required for the NEERR except possibly in some specific areas of deep cuts in frost susceptible soils. These should be reviewed during detailed design.

6.8 Erosion

The native clay and clay till are generally erodible. Permanent cut and fill slopes should be topsoiled and revegetated as soon as possible to reduce potential slope erosion. In deep cuts, installation of erosion mats or other appropriate erosion control measures may be provided to limit erosion. Final grading above the slope should be graded to direct runoff water to areas away from the slope. In addition, water flow in roadway ditches should be evaluated and appropriate erosion protection measures should be provided.

7. GEOTECHNICAL EVALUATION AND RECOMMENDATIONS FOR BRIDGE FOUNDATIONS

7.1 General

The following sections provide general recommendations for foundation types for grade separation structures along the NEERR (Hwy 216) and Yellowhead Trail (Hwy 16) alignments. Site-specific recommendations regarding expected pile depths and basing elevations, and geotechnical capacities are provided for the individual structures in Sections 8 to 18. General recommended construction procedures for foundations are also provided in Appendix I.

Considering the size of this project and number of structures involved it is recommended that a comprehensive pile load test program should be carried out to confirm and optimize the design loads for the NEERR and Yellowhead Trail grade separation structures. A similar program was used recently for the Southeast Anthony Henday Drive and proved to be very beneficial in optimising the pile designs.

Further, the pile design recommendations given in Sections 8 to 18 should be considered preliminary and should be reviewed based on detailed site specific investigations.

The following foundation types are considered feasible for the grade separation structures along the NEERR & Yellowhead Trail, unless noted otherwise in the individual sections.

- Cast-in-Place Concrete End Bearing Piles; and
- Driven Steel Piles.

Where high groundwater conditions and sloughing soils are expected at the bridge structures, driven steel piles would generally be the preferred foundation type for ease of construction.

Cast-in-place concrete piles are generally more economical choice where competent clay till or bedrock is present at shallow depth. These have been used extensively for grade separations along the Southeast Anthony Henday Drive.

7.2 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to the following recommendations:

a) End bearing piles should be founded at the suggested minimum depths and specified soil or bedrock types for each site, as provided in Sections 8 through 18.

b) The design values assume a minimum center-to-center pile spacing of 3 pile diameters. The geotechnical resistance of the pile may need to be reduced for piles installed with a closer spacing.

c) Where sand is encountered within the depth of pile installations temporary steel casing(s) will be required to advance the pile excavations and the pile bases may have to be extended deeper into the underlying clay till in order to form the bases.

d) Piles constructed through new embankment fills should be evaluated for down drag forces during the detailed design stage, depending on the schedule of construction and details of the pile installations.

e) Straight shaft or belled piles may be used. In the case of belled piles the bell diameter to shaft diameter ratio should not exceed 3:1, and the bell should not be sloped at more than 30^o to the vertical.

f) A minimum pile depth of 2.5 times the bell diameter has been assumed in calculating the above bearing capacity. If less cover is provided, the specified bearing capacity should be reviewed.

g) A minimum pile shaft diameter of 400 mm is recommended to prevent voids from forming during pouring of the concrete.

h) As a minimum, and not including structural requirements, a nominal percentage of longitudinal reinforcement (0.5% of the sectional area of the shaft) is required for the full pile length to resist potential uplift forces on the pile due to frost action or seasonal moisture variations. If piles are designed as tension elements, longitudinal reinforcing steel should extend into the pile bells, and the piles should be designed to resist the anticipated uplift stresses.

i) Concrete should be poured immediately after the completion of drilling and inspection in order to reduce the risk of groundwater seepage and sloughing soil.

j) Casing should be used if seepage and sloughing conditions become significant during pile installation, as previously described above.

7.3 Driven Steel Piles

Driven steel piles may be designed and installed according to the following recommendations:

a) Steel piles (H-section or pipe) should be driven to specified termination set criteria in the very hard clay till, very dense sand or bedrock depending on the site specific geotechnical conditions.

b) Piles may be designed based on a combination of skin friction and end bearing resistance, using the values given for the individual structures in Sections 8 to 18. Skin friction should be neglected to a minimum depth of 1.5 m below design grade or to the depth of new fills in the calculation of shaft resistance.

c) The skin friction values should be applied to the plugged (net) perimeter of the steel section and the end bearing resistance should be applied to the plugged end area of the pile tip.

d) For preliminary design, the factored ULS geotechnical capacity should be limited to a compressive stress of 110 MPa times the cross-sectional area of the steel pile.

e) Piles constructed through new embankment fills should be evaluated for down drag forces during the detailed design stage.

f) Steel H-piles and pipe piles should be installed at a minimum pile spacing of three diameters (or flange width) center-to-center.

g) Driven steel piles should be driven with an appropriately sized hammer depending on the design loads. As a general guideline, the maximum driving energy should not exceed 630 J/cm^2 of steel cross sectional area to avoid damage to the pile section. The proposed hammers piling rig and methodology should be approved in advance of construction and set criteria should be determined by WEAP analyses.

h) Piles are expected to set up with time. Where required, selected driven steel piles should be re-driven after a specified period, to confirm set-up capacity.

i) Pile driving records should be maintained during driving of all piles and should be assessed by driving analyses to confirm the design load capacity of the piles.

j) Heave of adjacent piles is a concern for close pile spacing, and should be monitored throughout the driving. All piles indicating heave should be re-driven to at least the former embedment depth. Pile heaving may be reduced by pre-boring, but this may reduce the allowable skin friction.

k) An out-of-plumb tolerance of 2% is typically specified for driven steel piles. Care will be required in set-up and driving of the piles to meet these objectives.

l) Driving of deep steel piles may cause a void near grade surface due to pile “flutter” during driving. Voids should be grouted to maintain contact between the pile and ground resistance to vertical and lateral loads.

7.4 MSE Walls

Mechanically Stabilized Earth (MSE) walls have been used extensively for retention of abutment fills at grade separation structures along the previous sections of the Anthony Henday Drive and are also considered feasible for grade separations along the NEERR and the 5 km section of Yellowhead Trail.

In general, the stability of MSE Walls is governed by the near surface lacustrine clay that is present along most of the proposed NEERR & Yellowhead Trail alignments. This will generally require wider reinforcing zones than the typical minimum widths to satisfy global stability, and also wick drains may be required in some sections. The exception is in underpass structures, where the MSE walls will be depressed below present grade and may be founded on more competent clay till or bedrock.

The internal and global stability, bearing capacity and settlement of MSE walls should be assessed on a site specific basis during the detailed design.

7.5 Cement Type

Thirty-two (32) water soluble sulphate content tests were performed on selected soil samples obtained from the proposed interchanges/grade separation location test holes, in addition to the three from the 2007 investigation. The results of the laboratory water soluble sulphate content tests are summarized on the test hole logs in Appendix B and are presented in Table C-2 in Appendix C.

The results indicate a range in water-soluble sulphate contents from 0% to 0.71% indicating potentially high concentrations of sulphates at several grade separations structures.

Further testing will be required for individual structures during detailed design and appropriate concrete type and strength will be required in accordance with Table 3 of CSA A23. 1-04, depending on the degree of exposure and sulphate content.

8. HWY216/CNR-HAYTER ROAD (BRIDGES 27 & 28)

8.1 Project Description

Preliminary layout of the CNR and Hayter Road grade separations indicates that there will be two new bridge structures carrying Anthony Henday Drive northbound and southbound over the CNR and Hayter Road at this location. It is understood that up to 10 m high approach fills will be required.

8.2 Stratigraphy and Groundwater Conditions

The results of the field drilling program (TH08-27-1 and TH08-27-2) and information provided from previous test holes drilled during the 2007 investigation (TH06-D41 and TH06-D42) indicate that the subsurface conditions generally consist of stiff to very stiff lacustrine clay to a depth of about 2.5 m below existing ground surface over interbedded sand and gravel layers to a depth of about 11.5 m overlying clay shale and sandstone bedrock.

The groundwater table measured on September 19, 2008 was at a depth of about 6.6 m below existing ground surface.

8.3 Geotechnical Evaluation and Recommendations

8.3.1 General

Driven steel piles are expected to be the most appropriate foundations type in view of the presence of thick sand and gravel layers overlying bedrock.

Cast-in-place concrete end bearing piles founded in the underlying clay shale and sandstone bedrock could also be considered; however, these will require temporary casing to extend the piles through the thick sand and gravel into the bedrock. Recommendations for cast-in-place concrete end bearing piles can be provided upon request.

8.3.2 Driven Steel Piles

Driven steel piles may be designed and installed according to the recommendations contained in Section 6.3 and the following site specific recommendations:

a) Driven steel piles should be driven to specified termination set criteria in the very hard clay shale or very dense sandstone at expected depths of about 14 m, or greater, below existing ground surface.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Table 8.1 below.

c) Skin friction should not be included within the depth of new abutment fill.

TABLE 8.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES
FOR DRIVEN STEEL PILES
(HWY 216/CNR & HAYTER ROAD (BRIDGES 27 AND 28)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay/Clay Till	0-4	50	20	N/A	N/A
Sand/Gravel	4-12	95	38	N/A	N/A
ClayShale/Sandstone	>12	150	60	12000*	4800*

Note: * For piles founded in very hard clay shale/sandstone below 14 m depth and confirmed by pile driving records.

8.3.3 Approach Embankments

Preliminary stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses are represented on Figures 8.1 and 8.2 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 long term were assumed in the stability analyses.

Stability of the approach fill slopes will be governed by the quality of the fill material and by the existing clay underneath in the area near test holes TH08-27-01 and TH08-27-02*.* Use of better quality fill, staged construction, geogrid reinforcement or a gravel wedge at the base of the fill may be required to achieve an adequate short term factor of safety.

Based on the results of the stability analyses, and observations of existing bridge head slopes in the vicinity, approach fill head slopes and side slopes may be designed at a maximum of 2H:1V and 3H:1V, respectively.

Soil reinforcement and/or gravel wedges may be required to improve the head slope stability depending on the quality of the embankment fill, and the stability should be confirmed during detailed design.

Before fill placement, the upper 0.75 m of soil in the area near TH08-01-02 should be removed as it appears to contain organics (topsoil).

Approach fills should be built with suitable clay fill placed and compacted to AT standards.

9. HWY 216/HWY16 INTERCHANGE (BRIDGES 14 TO 18)

9.1 Project Description

The preliminary layout of the Hwy 216/Hwy 16 interchange indicates that Hwy 216 will be elevated over Hwy16 as shown in Drawing No. 19-598-298-3. The existing bridge structure (BF76652) will be replaced with individual bridge structures carrying the southbound (Bridge 14) and northbound (Bridge 15) lanes of Hwy 216. In addition, two (2) fly over bridge structures will be built to carry the Hwy 216 northbound to Hwy 16 westbound ramp (Bridge 17) and Hwy 216 southbound to Hwy 16 eastbound ramp (Bridge 18) over the Hwy 216 mainline bridges. Bridge 16 will carry the Hwy 216 northbound to Hwy 16 westbound ramp over a loop.

Approach fills up to about 17 m high will be required for the new ramps for the two-level fly over structures.

9.2 Stratigraphy and Groundwater Conditions

The results of the geotechnical investigation, supplemented by the results from previous test holes drilled in 2007 (TH06-D43 and TH06-D44) and information obtained from AT files, indicate that the subsurface conditions are quite variable and consist of mixed layers of lacustrine clay, clay till, gravel and sand and rafted bedrock, overlying Empress Sand over bedrock. The depth to bedrock ranges from about 16 m to 20 m below the original ground surface.

In addition, approach ramps have been previously constructed at the southeast portion of the interchange corresponding to the locations of Bridge 16 and the south abutment of Bridge 17. The height of these existing fills is up to about 17 m. Test holes advanced through the existing approach ramp fills (TH08-16-01, TH08-16-02 and TH08-17-02) indicate that the fill consists of layers of sand fill interbedded with clay fill.

In the southwest portion of this interchange (TH08-14-02C) the soil profile consists of clay and gravel fill to a depth of about 7m over stiff clay of about 1.5 m thickness overlying clay till to a depth 22.1 m. The clay till is underlain by a dense sand layer to a depth of 23.7 m, then clay shale to the end of the test hole at a depth of 25.6 m below existing ground level.

Test holes advanced for the north abutments of Bridges 14, 15, 17 and 18 indicate a thin layer of stiff to very stiff clay and/or clay till underlain by loose to very dense sand and gravel ranging in thickness from 2 m to 13 m overlying clay till interbedded with rafted clay shale and sandstone bedrock layers to depths of approximately 18 m to 20 m, where competent bedrock was encountered.

Where encountered, the underlying bedrock consisted of hard clay shale and very dense sandstone in soil mechanics terminology. Occasional coal layers were also present in the bedrock.

A review of the Atlas of Coal Mine Workings (Spence Taylor, R., 1971) indicated that there are possibly abandoned underground coal mine workings along the Hwy 216 corridor in the vicinity of Bridge 16. According to the literature, a coal mine, identified as No. 0699, was operated by Marcus Collieries Ltd. from 1917 to 1940, to the south of the current Hwy 216/Hwy 16 interchange and had a cover of approximately 33 m to 43 m. No definite information is available regarding the actual north extent of Mine No. 0699, but it is likely to be near the location of Bridge 16. Some cave-in activity, categorized as minor to major, was observed during the operation of Mine No. 0699. No evidence of coal mine workings was noted during the drilling of the test holes that were advanced through about 10 m to 11 m of fill to depths of 22.6 m to 30.1 m for Bridge 16.

The groundwater levels measured in the standpipes ranged from 1.6 m (el. 658 m) to 8.9 m (el. 649 m) below the existing ground surface on October 21, 2008. The groundwater level measured in test hole TH06-D43 on July 31, 2006 was at a depth of about 9.7 m (el. 651.8 m) below existing ground surface.

In the southwest portion of this intersection the groundwater level measured in TH08-14-02C on October 21, 2008 was at a depth of 17.2 m (el. 650 m).below the existing ground level.

9.3 Geotechnical Evaluation and Recommendations

9.3.1 General

Review of the existing Highway 216/Hwy 16 East Bridge drawings (AT bridge file BF76652) indicates that the existing bridges are founded on driven steel H-piles. The design pile depths are noted as being relatively shallow, with tip elevations of 650 m to 652 m, which would place the tips in the upper dense sands and gravels or the underlying clay till and rafted clay shale.

The following foundation types are considered feasible for the new structures:

- Driven Steel Piles; and
- Cast-in-Place Concrete End Bearing Piles.

Due to the variable stratigraphic conditions that include variable thickness and depths of sand layers, and the thickness of some of the abutment fills, driven steel piles are expected to be the most suitable foundation type for the new bridges.

Temporary casing will be required for cast-in-place concrete pile installations due to the presence of the relatively thick sand layers above the bedrock.

9.3.2 Driven Steel Piles

a) Steel piles should be driven to specified termination set criteria in the very hard clay shale.

b) Due to the variation in soil and bedrock conditions and the presence of existing embankment fills at some locations, the pile penetration depths will vary and the recommendations are presented for the separate bridge sites noted above.

c) Driven steel pipe and H-section piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Tables 9.1 (Bridges 14 & 15), 9.2 (Bridge 16) and 9.3 (Bridges 17 & 18).

d) Skin friction should not be included within the depth of new abutment fill.

TABLE 9.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 216/HWY 16 INTERCHANGE, BRIDGES 14 AND 15)

SOIL TYPE	AVERAGE DEPTH (ELEVATION) BELOW EXISTING GROUND SURFACE(1) (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Existing Fill	2 – 6 (664 – 660)	30(2)	12	N/A	N/A
Clay Till, Sand and rafted Clay Shale	6 – 24 (660 – 642)	60	24	1500(3)	600(3)
Clay Shale and Sandstone Bedrock	>24 (< 642)	150	60	6000(4)	2400(4)

Notes:

(1) Assumed existing average ground elevation of 666 m.

(2) Applies to existing embankment fill only; ignore skin friction in new fill.

(3) For piles based in stiff clay till at minimum embedment depth of 10 m and confirmed by pile driving analysis.

(4) For piles based in hard clay shale and sandstone bedrock at el 642 m or lower and confirmed by pile driving analysis.

TABLE 9.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 216/HWY 16 INTERCHANGE, BRIDGE 16)

SOIL TYPE	AVERAGE DEPTH (ELEVATION) BELOW EXISTING GROUND SURFACE(1) (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Existing Fill	2 – 12 (675 – 665)	40(2)	16	N/A	N/A
Clay Till, Sand and rafted Clay Shale	12 – 34 (665 – 643)	60	24	1500(3)	600(3)
Clay Shale and Sandstone Bedrock	>34 (< 643)	150	60	6000(4)	2400(4)

Notes:

(1) Assumed existing average ground elevation of 677 m.

(2) Applies to existing embankment fill only; ignore skin friction in new fill.

(3) For piles based in stiff clay till at minimum embedment depth of 15 m and confirmed by pile driving analysis.

(4) For piles based in hard clay shale and sandstone bedrock at el 643 m or lower and confirmed by pile driving analysis.

TABLE 9.3
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 216/HWY 16 INTERCHANGE, BRIDGES 17 AND 18)

SOIL TYPE	AVERAGE DEPTH (ELEVATION) BELOW EXISTING GROUND SURFACE(1) (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Embankment Fill		N/A(2)	N/A(2)	N/A	N/A
Clay Till, Sand and rafted Clay Shale	0 –19 (661 – 642)	60	24	1500(3)	600(3)
Clay Shale and Sandstone Bedrock	>19 (< 642)	150	60	6000(4)	2400(4)

Notes:

(1) Assumed existing average ground elevation of 661 m.

(2) Ignore skin friction in new fill.

(3) For piles based in stiff clay till at minimum embedment depth of 10 m below existing ground and confirmed by pile driving analysis.

(4) For piles based in hard clay shale and sandstone bedrock at el 642 m or lower and confirmed by pile driving analysis.

9.3.3 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to the general recommendations provided in Section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded in the very stiff clay till or underlying bedrock at the suggested minimum basing depths or elevations noted in Tables 9.4 to 9.6.

b) Due to the variation in soil and bedrock conditions and the presence of existing embankment fills at some locations, the pile recommendations are presented for the separate bridge sites noted above.

c) It should be noted that the piles are expected to extend through sand layers present in the clay till, and hence temporary casings will be required to extend the piles through the sand and allow basing in the underlying clay till or bedrock.

d) Drilled cast-in-place concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Tables 9.4 (Bridges 14 and 15), 9.5 (Bridge 16) and 9.6 (Bridges 17 and 18).

e) Skin friction should not be included within the depth of new abutment fill.

TABLE 9.4
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR CAST-IN-PLACE CONCRETE PILES
(HWY 216/HWY 16 INTERCHANGE, BRIDGES 14 AND 15)

SOIL TYPE	AVERAGE DEPTH (ELEVATION) BELOW EXISTING GROUND SURFACE(1) (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Existing Fill	2 – 6 (664 – 660)	30(2)	12	N/A	N/A
Clay Till, Sand and rafted Clay Shale	6 – 24 (660 – 642)	60	24	900(3)	360(3)
Clay Shale and Sandstone Bedrock	>24 (< 642)	200	80	3000(4)	1200(4)

Notes:

(1) Assumed existing average ground elevation of 666 m.

(2) Applies to existing embankment fill only; ignore skin friction in new fill.

(3) For piles founded in very stiff clay till or rafted clay shale at suggested tip elevation of 646 m.

(4) For piles founded at least 2 m into hard clay shale and sandstone bedrock at suggested base elevation of 640 m or lower.

TABLE 9.5
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR CAST-IN-PLACE CONCRETE PILES
(HWY 216/HWY 16 INTERCHANGE, BRIDGE 16)

SOIL TYPE	AVERAGE DEPTH (ELEVATION) BELOW EXISTING GROUND SURFACE$^{(1)}$ (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Existing Fill	2 – 12 (675 – 665)	40$^{(2)}$	16	N/A	N/A
Clay Till, Sand and rafted Clay Shale	12 – 34 (665 – 643)	60	24	1350$^{(3)}$	540$^{(3)}$
Clay Shale and Sandstone Bedrock	>34 (< 643)	200	80	3000$^{(4)}$	1200$^{(4)}$

Notes:

(1) Assumed existing average ground elevation of 677 m.

(2) Applies to existing embankment fill only; ignore skin friction in new fill.

(3) For piles based in very stiff clay till at suggested basing elevation of 660 m or lower (note that sand layers are present and pile bases may need to be extended to underlying clay till with temporary casings.

(4) For piles founded at least 2 m into hard clay shale and sandstone bedrock at suggested basing elevation of 640 m.

TABLE 9.6
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR CAST-IN-PLACE CONCRETE PILES (HWY 216/HWY 16 INTERCHANGE, BRIDGES 17 AND 18)

SOIL TYPE	AVERAGE DEPTH (ELEVATION) BELOW EXISTING GROUND SURFACE(1) (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Embankment Fill		N/A(2)	N/A	N/A	N/A
Clay Till, Sand and rafted Clay Shale	0 –19 (661 – 642)	60	24	900(3)	360(3)
Clay Shale and Sandstone Bedrock	>19 (< 642)	200	60	3000(4)	1200(4)

Notes:

(1) Assumed existing average ground elevation of 661 m.

(2) Ignore skin friction in new fill.

(3) For piles based in stiff clay till at a suggested tip elevation of 646 m or lower (note that sand layers are present and pile bases my need to be extended to underlying clay till or bedrock with temporary casings.

(4) For piles founded at least 2 m into hard clay shale and sandstone bedrock at suggested basing elevation of 640 m (west abutments) and 644 m (east abutments).

9.3.4 Existing Structures

The existing Hwy 216 bridge abutments, over Hwy 16 East, (AT bridge file BF76652-1) were inspected on November 14, 2008 and they appear to be in good condition, as can be seen in Photo 10 of Appendix E. No signs of slope movement or excessive settlement were observed. Some cracks were observed in the head slope concrete panels but they do not appear to be related to slope movements.

The slope angles for the northern abutment at this intersection were estimated with a clinometer and are approximately 2H:1V for the head and 3H:1V for side slopes.

The existing abutment fills in the southeast quadrant of the interchange are up to about 17 m high and have head slopes inclined at approximately 2H:1V.

9.3.5 Approach Embankments

9.3.5.1 Bridges 14 and 15

Approach fill design head slopes and side slopes will be constructed within the existing embankment fills with minor amounts of new fill. Head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments. Results of the stability analyses are represented on Figures 9.1 and 9.2 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 long term were assumed in the stability analyses.

9.3.5.2 Bridge 16

Approach embankments were constructed through the proposed Bridge 16 site during the original site construction. The existing approach fills are up to about 11 m high and the head slopes are sloped at 2H:1V. The existing embankment is within about 1.5 m of the design embankment level. The existing embankment fill will be cut down about 10 m for the new Bridge 16 head slopes.

Head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments. Results of the stability analyses are presented on Figures 9.3 and 9.4 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 long term were assumed in the stability analyses.

9.3.5.3 Bridges 17 and 18

The Bridge 17 north abutment fill will be approximately 17 m high, and may comprise of a 14 m retaining wall with a 3 m high toe slope at 2H:1V. The south abutment will be approximately 20 m high and there is an existing approach fill up to within about 2 m of final grade at this location, which is sloped at 2H:1V.

Results of the stability analyses are represented on Figures 9.5 to 9.10 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 long term were assumed in the stability analyses.

Head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments. However, the north head slope area (up to 17 m high) may have to be constructed using a combination of clay fill and granular fill, or alternatively using slope reinforcement (e.g. geogrids) to achieve the specified factor of safety. In addition, the high fill may need to be stage constructed to maintain the short term and long term stability of the head slopes. An MSE retaining wall is also considered feasible at this location, subject to satisfying global stability and bearing capacity requirements..

The Bridge 18 north abutment head slope will be approximately 9 m high and sloped at 2H:1V. The south abutment head slope will be approximately 12 m high and may comprise of a vertical MSE wall approximately 7 m high and a toe slope approximately 5 m high sloped at 2H:1V.

Head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments. An MSE wall is considered feasible for the south abutment slope.

The MSE walls will have to be founded on the stiff clay till or underlying sand and the MSE reinforcing zone dimensions should be designed to provide adequate internal and global stability and bearing capacity.

All topsoil must be removed from below the new fills. It is noted that there was up to 0.8 m of topsoil in TH08-18-01B.

10. HWY 216/CPR GRADE SEPARATION (BRIDGES 11, 12 & 13)

10.1 Project Description

The preliminary layout of the CPR grade separation indicates that the NEERR will be elevated over the CPR tracks and the westbound to southbound ramp from Hwy 16 to the NEERR, as shown in Drawing No.19-598-298-3.

The enhancements will consist of the replacement of Bridge 11 (Hwy 216 Southbound) and possible upgrades and extensions to Bridge 13 (Hwy 216 north to Hwy 16 access ramp). In addition, a new bridge, identified as Bridge 12, will carry the Hwy 16 northbound lanes.

It is understood that up to 10 m high embankments will be required at the bridge locations with up to 5 m of new fill over the existing bridge abutment fills.

10.2 Stratigraphy and Groundwater Conditions

The results of the field investigation (TH08-12-01 and TH08-12-02), and previously obtained information (AT bridge file BF76650), indicate that the subsurface conditions vary from the north side to the south side of the CPR tracks.

The soil stratigraphy encountered in test hole TH08-12-01, situated on the north side of the CPR railway, generally consisted of clay fill interbedded with sand fill layers to a depth of approximately 4 m, overlying stiff to very stiff clay till interbedded with rafted clay shale and sandstone layers to a depth of 18 m overlying very dense sand and gravel extending to the termination depth of 20.9 m.

The soil stratigraphy encountered in test hole TH08-12-02, situated on the south side of the CPR railway, consisted of a thin topsoil layer overlying clay fill interbedded with thin organic layers to a depth of 8.7 m, underlain by an asphalt layer (expected previous pavement) over stiff to very stiff lacustrine clay with organics over stiff to hard clay till to a depth of 23.8 m overlying a sand layer which extended to the test hole termination depth of 24.1 m.

Based on the available geological maps (Kathol and McPherson, 1975), the subsurface strata may be variable across this site and may include clay till overlying glacial sand and gravel and/or Empress sand overlying bedrock. The estimated depth to bedrock at this site is about 25 m below the original ground level.

A review of the Atlas of Coal Mine Workings (R. Spence Taylor, 1971) indicated that there are possibly abandoned underground coal mine workings along the NEERR corridor in the vicinity of Bridges 11, 12 and 13 at the Hwy 216/CPR overpass with the legal land description of Sections 8 and 9 of 53-23-W4M. According to this literature, a coal mine, identified as No. 0699, was operated by Marcus Collieries Ltd. from 1917 to 1940 and had a cover of approximately 33 m to 43 m. Some cave-in activity categorized as minor to major was observed during the operation of Mine No. 0699. No evidence of coal mine workings and galleries were encountered during the drilling of the test holes for Bridge 12.

Water levels measured in the standpipe piezometers in test holes TH08-12-01 and TH08-12-02 on September 19, 2008 were at depths of 19.8 m and 10.6 m respectively below the existing ground surface.

10.3 Geotechnical Evaluation and Recommendations

10.3.1 General

The following foundation types are considered feasible for the new structures:

- Cast-in-Place Concrete End Bearing Piles; and
- Driven Steel Piles.

10.3.2 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to Section 7.2 and the following site specific recommendations:

a) End bearing piles should be founded in the very stiff clay till at a suggested minimum basing depth of 16 m below existing ground level.

b) It should be noted that the piles may extend through sand layers present in the clay till, and hence temporary casings will be required to extend the piles to allow basing in the very stiff clay till.

c) Cast-in-place reinforced concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 10.1.

d) Skin friction should not be included within the depth of new abutment fill.

TABLE 10.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES
FOR DRILLED CONCRETE END BEARING PILES
(HWY 216/CPR GRADE SEPARATION; BRIDGES 11 TO 13)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay Fill/Clay, Clay Till or Rafted Bedrock	0-16	60	24	1800*	720

Note: * For piles based in clay till/rafted bedrock at a minimum basing depth of 16 m below existing ground level.

10.3.3 Driven Steel Piles

Driven steel piles may be designed and installed according to Section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to the specified termination set criteria in the very dense gravel or underlying bedrock. Bedrock was not encountered in the test holes; however based on available geological information (Kathol and McPherson, 1975, Figure 20 and L.D. Adriashek, NTS 83H map), the depth to bedrock is expected to be about 25 m below ground level at this site.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Table 12.1 following. The skin friction values should be applied to the plugged (net) perimeter of the steel section and the end bearing resistance should be applied to the plugged end area of the pile tip.

c) Skin friction should not be included within the depth of new abutment fill.

TABLE 10.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES
FOR DRIVEN STEEL PILES
(HWY 216/CPR GRADE SEPARATION; BRIDGES 11 TO 13)

SOIL TYPE	**AVERAGED EPTH BELOW EXISTING GROUND SURFACE (m)**	**VERTICAL STATIC LOADING**			
		Skin Friction (kPa)		**End Bearing (kPa)**	
		Ultimate	**ULS Factored(0.4)**	**Ultimate**	**ULS Factored (0.4)**
Clay Fill/Clay, Clay Till	0-10	30	12	N/A	N/A
Clay Till/ Rafted Bedrock	10 – 24	60	24	N/A	N/A
Very dense sand and gravel or bedrock	>24	95	38	9000*	3600*

* For piles based in sand and gravel or hard bedrock below 24 m depth and confirmed by pile driving analysis.

10.3.4 Existing Structures

The existing bridge abutments (AT bridge files BF76650 N-1 and S-2) at this location were inspected on November 14, 2008 and they appear to be in good condition, as can be seen in Photo 11 of Appendix E. No signs of movement or settlement were observed and there are no records or repairs done for this structure. However, some minor bulging was observed at the toe of the head slope at the BF 76650–S2 south abutment.

The slope angles of the south abutments at this intersection were estimated with a clinometer and are approximately 2H:1V for the head and 3H:1V for the side slopes.

10.3.5 Approach Embankments

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses are represented on Figures 10.1 and 10.2 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 long term were assumed in the stability analyses.

Approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the bridge abutments. It is assumed that the approach fills will be built with suitable clay fill placed and compacted to AT standards.

11 HWY 216/PETROLEUM WAY (BRIDGES 32, 34 & 35)

11.1 Project Description

The preliminary layout of the Hwy 216/Petroleum Way grade separation structure is shown in Drawing No.19-598-298-3.

The existing Hwy 216/Petroleum Way underpass structure (BF77416) consists of a steel arch culvert with an approximate span of 11.2 m and a rise of 6 m, supported on spread footings.

It is understood that the existing structure will be replaced by three bridges (BF77416 Structures 2, 3 & 4) that will span over the existing Petroleum Way roadway.

It is also understood that cuts of up to about 6 m in depth into the existing embankment will be required and that this may require staged construction and temporary shoring of the slopes.

Hwy 216 may also be raised by about 1 m over the existing fill at the new bridge locations.

11.2 Stratigraphy and Groundwater Conditions

The results of the field investigation indicate that the subsurface conditions in this area consist of clay fill overlying clay till containing rafted clay shale and sandstone layers interbedded with sand layers extending to the maximum depth of drilling of about 21 m.

The estimated depths of fill ranged from 6 m to 7.5 m below the top of the highway embankment at the test hole locations. The fill consisted of stiff medium to high plastic clay.

The underlying clay till was stiff to very stiff, medium plastic and the rafted bedrock layers consisted of very stiff to hard high plastic clay shale and compact to very dense sandstone in soil mechanics terminology.

Based on the available geological maps (Kathol and McPherson, 1975), the subsurface strata may be variable across the site and may include clay till overlying glacial sand overlying bedrock. The estimated depth to bedrock at this site is about 31 m below the original ground level which is at approximate elevation 677 m.

A review of the Atlas of Coal Mine Workings (Spence Taylor, R., 1971) indicated that there are possibly abandoned underground coal mine workings along the Hwy 216 corridor in the vicinity of Bridge 32. According to this literature, a coal mine, identified as No. 0699, was operated by Marcus Collieries Ltd. from 1917 to 1940, to the south of the current Hwy 216/Hwy 16 interchange and had a cover of approximately 33 m to 43 m. There is some discrepancy as to the actual southern extent of the Mine No. 0699 workings, estimated to be immediately to the north of the current Petroleum Way roadway, as it is stated that the southern limits may have been overestimated by as much as 43 m. Some cave-in activity categorized as minor to major was observed during the operation of Mine No. 0699. No evidence of coal mine workings and galleries were encountered during the drilling of the test holes drilled to depths of 20.6 m to 21 m for Bridges Nos. 32, 34 & 35.

The groundwater level measured in standpipes TH08-32-01 and TH08-32-02 on December 9, 2008 was at a depth of about 6 m and 7.7 m below existing ground surface respectively.

11.3 Geotechnical Evaluation and Recommendations

11.3.1 General

The following foundation types are considered feasible for the new structures:

- Driven Steel Piles; and
- Cast-in-Place Concrete End Bearing Piles.

Due to the variable stratigraphic conditions that include variable thicknesses and depths of sand layers, driven steel piles are expected to be the most suitable foundation type for the new bridges.

Temporary casing will be required for cast-in-place concrete pile installations due to the presence of the relatively thick sand layers within the clay till.

11.3.2 Driven Steel Piles

Driven steel piles may be designed and installed according to section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to specified termination set criteria in the very dense sand and gravel or underlying bedrock. Bedrock was not encountered in the test holes; however, based on the available geological information (Kathol and McPherson, Figure 20 and L.D. Adriashek, NTS 83H map), the depth to bedrock is expected to be at about 31 m below ground level at this site.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS end bearing and skin friction values provided in Table 11.1. Skin friction should not be included within the depth of new abutment fill.

TABLE 11.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES
FOR DRIVEN STEEL PILES
(HWY 216/PETROLEUM WAY GRADE SEPERATION, BRIDGES 32, 34 & 35)

SOIL TYPE	**AVERAGE DEPTH (ELEVATION) BELOW EXISTING GROUND SURFACE (m)**	**VERTICAL STATIC LOADING**			
		Skin Friction (kPa)		**End Bearing (kPa)**	
		Ultimate	**ULS Factored (0.4)**	**Ultimate**	**ULS Factored (0.4)**
Existing Fill	2 – 6 (675 – 671)	30	12	N/A	N/A
Clay Till/ Rafted Bedrock	6 – 10 (671 – 667)	40	16	N/A	N/A
Clay Till/ Rafted bedrock	10 – 31 (667 – 646)	60	24	1000	400
Very Dense Gravel& Bedrock	>31 (<646)	100	40	9000*	3600*

Note: * For piles based in hard bedrock below 30 m depth and confirmed by pile driving analysis.

11.3.3 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded in the very stiff clay till at a suggested minimum basing depth of 12 m below the top of the embankment. Alternatively, end bearing piles may be extended into the underlying bedrock at a suggested depth of 31 m below the top of embankment.

b) It should be noted that the soil conditions appear to be highly variable, including clay till, rafted bedrock and sand layers. Hence, piles may extend through sand layers present in the clay till, and temporary casings will be required to extend the piles to allow basing in suitable bearing soil.

c) Drilled cast-in-place reinforced concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 11.2.

d) Skin friction should not be included within the depth of new abutment fill.

TABLE 11.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRILLED CONCRETE END BEARING PILES
(HWY 216/PETROLEUM WAY GRADE SEPERATION, BRIDGES 32, 34 & 35)

SOIL TYPE	AVERAGE DEPTH (ELEVATION) BELOW EXISTING GROUND SURFACE(1) (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Existing Fill	2 – 6 (675 – 671)	30(2)	12	N/A	N/A
Clay Till, Sand & Rafted Bedrock	6 – 31 (671 – 646)	60	24	900(3)	360(3)
Clay Shale and Sandstone Bedrock	>31 (< 646)	100	40	3000(4)	1200(4)

Notes:

(1) Assumed existing average ground elevation of 677 m.

(2) Applies to existing embankment fill only; ignore skin friction in new fill.

(3) For piles founded in very stiff clay till or rafted clay shale at suggested tip elevation of 665 m.

(4) For piles founded at least 2 m into hard clay shale and sandstone bedrock at suggested base elevation of 646 m or lower.

11.3.4 Existing Structures

AT files indicate that longitudinal cracks and seams were grouted along both sides of the culvert in 2003. In addition, longitudinal cracks and seams were repaired with a concrete patch along the west half of the inner south side of the culvert. Transverse steel struts encased in concrete were also installed between the culvert support footings at 15 m intervals and the Petroleum Way roadway was repaved.

The side slope angles at both ends of the culvert were estimated with a clinometer to be at 2H:1V.

11.3.5 Embankment Slopes

Stability analyses were carried out to assess the short term and long term stability of the culvert slopes. Results of the stability analyses are represented on Figures 11.1 and 11.2 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 long term were assumed in the stability analyses.

The embankment head slopes may be designed at 2H:1V. Embankment side slopes in the existing fill should be sloped at 3H:1V. It is assumed that the fills will be built with suitable clay fill placed and compacted to AT standards.

12. HWY 216/SHERWOOD PARK. FWY (BRIDGES 5, 6, 7 AND 8)

12.1 Project Description

Preliminary layout of the Sherwood Park Freeway grade separation is shown on Drawing No. 19-598-298-2.

The existing bridges on Sherwood Park Freeway over the NEERR will be lengthened and possibly widened (Bridges 7 and 8). The existing embankment fills are about 8 m high.

There will be two new bridges (Bridges 5 & 6) that will carry the ramp from Sherwood Park Freeway eastbound to the Hwy 216/Anthony Henday Drive northbound.

Bridge 5 will pass over Hwy 216 and will involve approach fills ranging from about 8.5 m high at the west abutment to 10 m at the east abutment.

Bridge 6 will pass over the Sherwood Park Freeway and will require an approach fill heights of about 8 m.

12.2 Stratigraphy and Groundwater Conditions

The results of the field drilling program indicate that the subsurface conditions encountered at this site generally consist of clay fill and topsoil to a depth of about 1 m to 3 m below existing ground surface over clay till interbedded with thin sand layers to depths of about 12 m to 20 m over clay shale and sandstone.

Test Hole TH08-07-01 was drilled from the existing Sherwood Park Freeway level near to the west abutment and encountered approximately 7.3 m of clay fill overlying about 0.8 m of buried topsoil (original ground surface).

The bedrock surface appears to dip from east to west, ranging from about elevation 695 to 700 m on the east side of Anthony Henday Drive to 691 m on the west side. The bedrock was noted to be highly weathered and extremely weak (in rock mechanics terminology) or hard (in soils mechanics terminology), with SPT N values increasing from about 15 to 40 in the upper few metres to over 50 below about elevation 690 m.

The groundwater table as measured in September 2008 and most recently on August 20, 2009 in standpipes installed in the test holes in this area appears to be near to the top of the clay till ranging between elevations 704 m and 708 m.

12.3 Geotechnical Evaluation and Recommendations

12.3.1 General

Due to the variation in soil strata across the site, the pile design parameters and approach fill design requirements are presented separately for Bridges 5, 6 and 7 and 8 in the following sections:

12.3.2 Bridge 5

12.3.2.1 Bridge Foundations

The following foundation types are considered feasible for this structure:

- Driven Steel Piles; and
- Cast-in-Place Concrete End Bearing Piles.

Preliminary recommendations are presented in the following sections:

12.3.2.2 Driven Steel Piles

Driven steel piles may be designed and installed according to the general recommendations provided in Section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to specified termination set criteria in the hard bedrock. Based on the available information, expected depths of penetration will be greater than about 24 m to 27 m below existing ground surface, resulting in pile tip elevations of 684 m or less at both abutments.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Table 12.1 following.

c) Skin friction should not be included within the depth of new abutment fill.

TABLE 12.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 216/SHERWOOD PARK FREEWAY INTERCHANGE, BRIDGE 5)

SOIL TYPE	**AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)**	**VERTICAL STATIC LOADING**			
		Skin Friction (kPa)		**End Bearing (kPa)**	
		Ultimate	**ULS Factored (0.4)**	**Ultimate**	**ULS Factored (0.4)**
Clay/Clay Till	0-10	45	18	N/A	N/A
Clay Till	10 – 20	60	24	N/A	N/A
Clay Till/ Bedrock	> 20	100	40	6000*	2400*

Note: * For piles driven to practical refusal in hard clay shale bedrock below about 24 m to 27 m depth and confirmed by pile driving analysis.

12.3.2.3 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to the general recommendations provided in Section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded at least 3 m into hard bedrock at a suggested basing depth of about elevation 687 m. Required pile embedment depths with therefore be about 20 m to 24 m below existing ground surface (i.e. not including the depth of new abutment fills).

b) It should be noted that the piles will need to extend through sand layers present in the clay till, and hence temporary casings will be required to extend the piles to allow basing in the bedrock.

c) Drilled cast-in-place reinforced concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 12.2.

d) Skin friction should not be included within the depth of new abutment fill.

TABLE 12.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES
FOR DRILLED CONCRETE END BEARING PILES
(HWY 216/SHERWOOD PARK FREEWAY INTERCHANGE, BRIDGE 5)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay fill	0-10	50	20	N/A	N/A
Clay till	10 – 20	60	24		
Clay Till/Bedrock	> 20	100	40	1800*	720*

Note: * For piles based in very stiff clay till or hard bedrock below 20 m to 24 m depth below existing ground.

12.3.2.4 Approach Fills

Approach fills up to about 8.5 m to 12 m high are required for Bridge 5.

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses are presented on Figures 12.1 to 12.6. Target factors of safety of 1.3 for short term (end of construction) and 1.5 for long term were assumed in the stability analyses.

Based on the results of the stability analyses, and observations of existing bridge head slopes in the vicinity, approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments.

For the east abutment, with a new fill height estimated to be in the order of 12 m, the new fill will either have to be placed in staged construction, or with geogrid reinforcement or a gravel wedge in the head slope area to meet the required fill stability.

All poor quality fill and topsoil should be removed from below the approach fill head slopes.

Approach fills should be constructed with suitable clay fill placed and compacted to AT standards.

12.3.3 Bridge 6

12.3.3.1 Bridge Foundations

The following foundation types are considered feasible for this structure:

- Driven Steel Piles, and
- Cast-in-Place Concrete End Bearing Piles.

Preliminary recommendations are presented in the following sections:

12.3.3.2 Driven Steel Piles

Driven steel piles may be designed and installed according to the general recommendations provided in Section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to specified termination set criteria in the hard bedrock. Based on the available information, expected depth of penetration will be greater than about 23 m below existing ground surface, resulting in pile tip elevations of 688 m or lower.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Table 12.3 following. Skin friction should not be included within the depth of new abutment fill.

TABLE 12.3
RECOMMENDED END BEARING AND SKIN FRICTION VALUES
FOR DRIVEN STEEL PILES
(HWY216/SHERWOOD PARK FREEWAY INTERCHANGE, BRIDGE 6)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay/Clay Till	0-10	45	18	N/A	N/A
Clay Till/Bedrock	10 – 21	60	24	N/A	N/A
Bedrock	> 21	100	40	6000*	2400*

Note: * For piles driven to practical refusal in hard clay shale bedrock below 23 m depth and confirmed by pile driving analysis.

12.3.3.3 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to the general recommendations provided in Section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded in the very stiff clay till or hard clay shale bedrock at suggested basing elevation of 690 m for both abutments. Required pile embedment depths will therefore be about 21 m for both abutments, as measured below existing ground surface (i.e. not including the depth of new abutment fills).

b) It should be noted that the piles will need to extend through sand layers present in the clay till, and hence temporary casings will likely be required to extend the piles to allow basing in the bedrock.

c) Drilled cast-in-place reinforced concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 12.4.

d) Skin friction should not be included within the depth of new abutment fill.

TABLE 12.4
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRILLED CONCRETE END BEARING PILES
(HWY 216/SHERWOOD PARK FREEWAY INTERCHANGE, BRIDGE 6)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay/Clay Till	0-10	50	20	N/A	N/A
Clay Till/Bedrock	10 – 21	60	24	N/A	N/A
Bedrock	> 21	100	40	1800*	720*

Note: * For piles based in very stiff clay till or hard bedrock below 21 m below existing ground surface (Elev. 690 m).

12.3.3.4 Approach Fills

Approach fills up to about 12 m high are required for Bridge 6.

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses are presented on Figures 12.3 to 12.6. Target factors of safety of 1.3 for short term (end of construction) and 1.5 for long term were assumed in the stability analyses.

Based on the results of the stability analyses, and observations of existing bridge head slopes in the vicinity, approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments.

The fills will either have to be placed in staged construction, or with geogrid reinforcement or with a gravel wedge in the head slope are to meet the required fill stability.

All poor quality fill and topsoil should be removed from below the approach fill head slopes.

Approach fills should be constructed with suitable clay fill placed and compacted to AT standards.

12.3.4 Bridges 7 and 8

12.3.4.1 Bridge Foundations

The following foundation types are considered feasible for this structure:

- Driven Steel Piles, and
- Cast-in-Place Concrete End Bearing Piles.

Preliminary recommendations are presented in the following sections:

12.3.4.2 Driven Steel Piles

Driven steel piles may be designed and installed according to the general recommendations provided in Section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to specified termination set criteria in the hard bedrock. Based on the available information, expected tip elevations are expected to be about 685 m at the west abutment and 688 m at the east abutment, resulting in pile penetration depths of about 25 m or greater below existing underside of abutment level.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Table 12.5 following.

c) The existing fill has been in-place for a relatively long time period. Therefore, skin friction may be included within the depth of the existing abutment fill.

TABLE 12.5
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 216/SHERWOOD PARK FREEWAY INTERCHANGE, BRIDGES 7 AND 8)

SOIL TYPE	**AVERAGE DEPTH BELOW ABUTMENT LEVEL (m)**	**VERTICAL STATIC LOADING**			
		Skin Friction (kPa)		**End Bearing (kPa)**	
		Ultimate	**ULS Factored (0.4)**	**Ultimate**	**ULS Factored (0.4)**
Clay/Clay Till	0-10	45	18	N/A	N/A
Clay Till	10 – 25	60	24	N/A	N/A
Bedrock	> 25	100	40	6000*	2400*

Note: * For piles driven to practical refusal in hard clay shale bedrock at depths of about 25m depth and confirmed by pile driving analysis.

12.3.4.3 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to the general recommendations provided in Section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded in the very stiff clay till or hard clay shale bedrock at suggested basing elevation of 690 m for the west abutment and 695 m for the east abutment. Required pile embedment depths will therefore be about 22 m for the west abutment and 17 m for the east abutment, as measured below the underside of abutment pile cap.

b) It should be noted that the piles will need to extend through sand layers present in the clay till, and hence temporary casings will likely be required to extend the piles to allow basing in the bedrock.

c) Drilled cast-in-place reinforced concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 12.6.

d) The existing fill has been in-place for a relatively long time period. Therefore, skin friction may be included within the depth of the existing abutment fill

TABLE 12.6
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRILLED CONCRETE END BEARING PILES (HWY 216/SHERWOOD PARK FREEWAY INTERCHANGE, BRIDGES 7 AND 8)

SOIL TYPE	AVERAGE DEPTH BELOW ABUTMENT LEVEL (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay/Clay Till	0-10	50	20	N/A	N/A
Clay Till/Bedrock	10 – 20	60	24	N/A	N/A
Clay Till/Bedrock	> 20	100	40	1800*	720*

Note: * For piles based in very stiff clay till or hard bedrock at a maximum tip elevation of about 690 m for west abutment and el 695 m for the east abutment.

12.3.4.4 Existing Structures

The existing bridges abutments (Bridges Files at this location were inspected on November 14, 2008 and they appear to be in good condition, as can be seen in Photos 2 to 4 in Appendix E.

At the eastern abutments no signs of movement, settlement or cracks were observed. No signs of movement or settlement were observed at the western abutment as well, however, some cracks were noticed in the concrete panels that cover the head slope. Despite these cracks, which do not appear to be related to slope instability, the abutments appear to be performing well. There are also no records or repairs done for both structures.

The slope angles of the abutments at this intersection were estimated with a clinometer and they are approximately 2H:1V for the abutment head slopes. The side slopes of the east abutments are at around 5H:1V and the west abutments side slopes were estimated at around 3H:1V.

12.3.4.5 Approach Cuts

Approach cuts up to about 8.5 m high through the existing embankment fills will be required for Bridges 7 and 8.

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses re presented on Figures 12.1 and 12.2. Target factors of safety of 1.3 for short term (end of construction) and 1.5 for long term were assumed in the stability analyses.

Based on the results of the stability analyses, and observations of existing bridge head slopes in the vicinity, approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments.

13. 17 ST NW/SHERWOOD PK. FREEWAY (BRIDGE 4)

13.1 Project Description

Preliminary layout of the 17 Street/Sherwood Park Freeway grade separation indicates that a new bridge will be built to replace the existing bridge structure. (Drawing No. 19-598-298-5 in Appendix A) It is understood that up to 8.5 m high approach fill embankments will be required at the bridge location.

13.2 Stratigraphy and Groundwater Conditions

The results of the field drilling program indicate that the subsurface conditions in Test Hole 08-04-02B consist of clay fill to a depth of 2.5 m below existing ground surface over topsoil and clay to a depth of 4.6 m, overlying clay till interbedded with occasional thin sand layers to a depth of about 22.6 m. Similar subsurface conditions were encountered in TH08-04-01B; however no topsoil or clay layers were observed.

A review of available geological information (Kathol & McPherson, 1975) indicates that the anticipated depth to bedrock at this location may be at about 30 m below the existing ground surface.

The groundwater level measured on September 19, 2008 in TH08-04-02B was at a depth of 3 m below ground level.

13.3 Geotechnical Evaluation and Recommendations

13.3.1 General

Driven steel piles are considered the most feasible foundation type for this bridge. The piles may have to be extended to specified termination set criteria in the bedrock at depths of about 30 m below existing ground surface.

Cast-in-place concrete end bearing piles are not expected to be feasible as the clay till is relatively soft and is not expected to provide adequate end bearing support for cast-in-place concrete pile. In addition, the underlying bedrock is expected to be quite deep and likely not practical for extending end bearing piles to this depth.

13.3.2 Driven Steel Piles

Driven steel piles may be designed and installed according to Section 7.3 and the following site specific recommendations:

a) Steel piles (H-section or pipe) should be driven to specified termination set criteria in the bedrock at an expected depth of about 30 m below existing ground surface.

b) Driven steel piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Table 13.2 following.

c) Skin friction should not be included within the depth of new abutment fill.

TABLE 13.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(17 STREET/SHERWOOD PARK FREEWAY GRADE SEPARATION, BRIDGE 4)

SOIL TYPE	**AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)**	**VERTICAL STATIC LOADING**			
		Skin Friction (kPa)		**End Bearing (kPa)**	
		Ultimate	**ULS Factored (0.4)**	**Ultimate**	**ULS Factored (0.4)**
Clay Fill	0-2	N/A	N/A	N/A	N/A
Clay/Clay Till	2 - 10	40	16	N/A	N/A
Clay Till	10 – 20	60	24		
Clay Till/Bedrock	>20	60	24	2000*	800

Note: * For pile tips founded in hard clay till or bedrock and confirmed by pile driving records.

13.3.3 Existing Structures

The existing bridge abutments were inspected on November 14, 2008 and they appeared to be in good condition, as can be seen in Photos 5 and 6, Appendix E. No signs of movements or settlements were observed and there are no records or repairs done for this structure. Some cracks were observed in the head slope concrete panels of the north abutment but they not appear to be related to geotechnical problems.

The slope angles of the north abutment were estimated at approximately 2H: 1V for the head slopes and 3H: 1V for the side slopes.

13.3.4 Approach Embankments

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses are represented on

Figures 13.1 and 13.2 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 for long term were assumed in the stability analyses.

Based on the results of the stability analyses, and observations of existing bridge head slopes in the vicinity, approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments.

It is recommended that the upper 3 m of soil in the area near TH08-04-02 should be removed as it contains organics (topsoil) and this should be replaced with compacted clay fill meeting AT specifications.

Approach fills should be constructed with suitable clay fill placed and compacted to AT standards.

14. HWY216/WHITEMUD DRIVE INTERCHANGE (BRIDGES 1, 2 & 3)

14.1 Project Description

Preliminary layout of the Hwy 216/Whitemud Drive interchange indicates that there will be three new bridges to supplement the existing two bridges over Hwy 216.

Bridge 1 will carry the eastbound to northbound ramp from Whitemud Drive over Hwy 216 and will involve approach fills up to about 8 m to 9 m high.

Bridges 2 and 3 will carry Whitemud Drive east bound and west bound (respectively) over the EB to NB ramp. The bridge approaches will be up to 9 m high and will involve combined cut and fill.

14.2 Stratigraphy and Groundwater Conditions

The results of the field drilling program indicate that the subsurface conditions at the three new bridge sites generally consist of thin clay fill and lacustrine clay layers extending to a depth of about 2 m below the existing ground surface overlying stiff to very stiff clay till.

Clay shale and sandstone bedrock was observed in test holes TH08-01-01 (Bridge 1) at a depth of about 29.7 m below the existing ground. Clay shale and sandstone bedrock were also encountered in TH08-02-01 and -02 at about 21 m depth.

The clay shale and sandstone were very weathered and hard in soils mechanics terminology.

The groundwater levels measured on September 19, 2008 in the standpipes ranged from about 2 m to 10.7 m below ground level depending on the test hole location. Groundwater levels at the existing bridge sites were determined to be within about 2 m of the original ground surface at the time of Thurber's original 1997 investigation.

14.3 Geotechnical Evaluation and Recommendations

14.3.1 General

The following foundation types are considered feasible for support of the abutments of the three proposed bridges:

- Cast-in-Place Concrete End Bearing Piles, and
- Driven Steel Piles.

14.3.2 Cast-in-Place Concrete End Bearing Piles

The existing Whitemud Drive bridge structures over Hwy 216 are founded on cast-in-place concrete end bearing piles founded in the clay till.

Cast-in-place concrete end bearing piles founded in the clay till may be designed and installed according to the recommendations provided in Section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded in the clay till at a suggested minimum basing depth of 15 m below existing ground level.

b) Alternatively, for Bridges 2 and 3, end bearing piles may be extended into the underlying bedrock at a minimum basing depth of about 22 m below existing grade. The bedrock appears to be deeper than 30 m below the existing ground surface at Bridge site 1 and hence, end-bearing piles in bedrock are not considered feasible at this site.

c) It should be noted that the piles may extend through sand layers present in the clay till, and hence temporary casings will be required to extend the piles to allow basing in the clay till and the underlying bedrock.

d) Drilled cast-in-place concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 14.1.

e) Skin friction should not be included within the depth of new abutment fill.

TABLE 14.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRILLED CONCRETE END BEARING PILES
(HWY 216/WHITEMUD DRIVE INTERCHANGE, BRIDGES 1, 2 AND 3)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay fill/ Lacustrine clay	0-2	N/A	N/A	N/A	N/A
Clay till	2-20	60	24	800*	320*
Bedrock**	>20	100	40	1800**	720**

Note: * For pile tips in clay till at a suggested minimum basing depth of 15 m below existing ground surface.

Note: ** For pile tips in bedrock at suggested minimum depth of 22 m below existing ground surface (Bridges 2 and 3 only).

14.3.3 Driven Steel Piles

Driven steel piles (H-section or pipe) may be designed and installed according to Section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to specified termination set criteria in the hard clay shale and sandstone bedrock. Depths of pile embedment are expected to be in the order of 30 m or greater at all three bridge sites.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS end bearing and skin friction resistance values provided in Table 14.2 following.

c) Skin friction should not be included within the depth of new abutment fill.

TABLE 14.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 216/WHITEMUD DRIVE INTERCHANGE, BRIDGES 2 AND 3)

SOIL TYPE	**AVERAG DEPTH BELOW EXISTING GROUND SURFACE (m)**	**VERTICAL STATIC LOADING**			
		Skin Friction (kPa)		**End Bearing (kPa)**	
		Ultimate	**ULS Factored (0.4)**	**Ultimate**	**ULS Factored (0.4)**
Clay Fill/ Lacustrine Clay	0-2	N/A	N/A	N/A	N/A
Clay Till	2-20	60	24	N/A	N/A
Clay Till	>20	60	24	2000*	800*
Clay Shale/ Sandstone Bedrock**	>20	100	40	6000**	2400**

Notes: * For pile tips in clay till at depths of 20 m or greater below ground level and confirmed by pile driving analysis.

** For pile tips in bedrock at depths of 25 m or greater (Bridge Sites 2 and 3) and 30 m or greater (Bridge Site 1) below ground level and confirmed by pile driving analysis.

14.3.4 Existing Structures

The existing bridge abutments were inspected on November 14, 2008 and appeared to be in good condition, as can be seen in Photo 1, Appendix E. No signs of movement, settlement or cracks were observed and there are no records or repairs done for this structure.

The slope angles of the eastern abutment at this intersection were estimated with a clinometer and they are approximately 2H:1V and 3H:1V for the head and side slopes respectively.

14.3.5 Approach Embankments

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses are represented on Figures 14.1 to 14.3. Target factors of safety of 1.3 for short term (end of construction) and 1.5 for long term were assumed in the stability analyses.

Based on the results of the stability analyses, and observations of existing bridge head slopes in the vicinity, approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments.

All poor quality fill and topsoil should be removed from below the approach fill head slopes.

Approach fills should be constructed with suitable clay fill placed and compacted to AT standards.

15. HWY 16/SHERWOOD DRIVE (BRIDGE 31)

15.1 Project Description

Preliminary layout for the Hwy 16/Sherwood Drive grade separation indicates that Sherwood Drive will cross over Hwy 16 on a new bridge.

It is understood that up to 8.5 m high embankments will be required at the bridge location and that both 2H:1V head slopes or retaining walls up to 8.5 m in height are considered at this location.

15.2 Stratigraphy and Groundwater Conditions

The results of the field drilling program indicate that the subsurface conditions generally consist of gravel and clay fill to a depth of 1.2 m below existing ground surface overlying clay till to a depth of 13.7 m to 15.2 m, over dense to very dense sand and gravel to a depth of 18.3 m to 22.6 m. Clay shale was encountered in

TH08-31-02 below the lower sand layer at a depth of 22.6 m below ground level. In TH08-31-02, a topsoil layer 0.8 m thick was encountered.

The groundwater level measured in standpipe TH08-31-01 on August 19, 2008 was at a depth of about 22.6 m below existing ground surface.

15.3 Geotechnical Evaluation and Recommendations

15.3.1 General

The following foundation types are considered feasible for this structure:

- Driven Steel Piles; and
- Cast-in-place Concrete End Bearing Piles.

15.3.2 Driven Steel Piles

Driven steel piles may be designed and installed according to Section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to specified termination set criteria in the dense to very dense sand or gravel layers or underlying bedrock Based on available information, the depth to practical refusal is expected to be in the order of 20 m or greater below existing ground level.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Table 15.2 following.

c) Skin friction should not be included within the depth of new abutment fill.

TABLE 15.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 16/SHERWOOD DRIVE GRADE SEPARATION, BRIDGE 31)

SOIL TYPE	**AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)**	**VERTICAL STATIC LOADING**			
		SKIN FRICTION (kPa)		**END BEARING (kPa)**	
		Ultimate	**ULS Factored (0.4)**	**Ultimate**	**ULS Factored (0.4)**
Clay Fill/Clay Till	0-15	60	24	N/A	N/A
Dense to very dense sand/gravel	15 -22	95	38	9000*	3600*
Dense to very dense sand/gravel or hard clay shale	> 22	120	48	9000*	3600*

Note: * For pile tips founded in very dense sand/gravel or bedrock at depths greater than 15 m below existing ground level or greater, and confirmed by pile driving records.

15.3.3 Cast-in-place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to Section 7.2 and the following site specific recommendations:

a) Cast-in-place concrete end bearing piles should be founded in the clay till at a suggested minimum basing depth of 10 m below existing ground level.

b) Cast-in-place concrete end bearing piles founded in the clay till may be designed based on the factored ULS skin friction and end-bearing values provided in Table 15.1.

c) Skin friction should not be included within the depth of new abutment fill.

TABLE 15.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR CAST-IN-PLACE CONCRETE PILES (HWY 16/SHERWOOD DRIVE GRADE SEPARATION, BRIDGE 31)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		SKIN FRICTION (kPa)		END BEARING (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay Till	0 - 10	60	24	1000*	400*

Note: * For pile bell founded in very stiff clay till at a minimum depth of 10 m below existing ground level.

15.3.4 Approach Embankments

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses represented on Figures 15.1 and 15.2 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 long term were assumed in the stability analyses.

Based on the results of the stability analyses, and observations of existing bridge head slopes in the vicinity, approach fill head slopes and side slopes may be designed at a maximum of 2H:1V and 3H:1V.

Alternatively MSE retaining walls up to 10 m high are considered feasible. The MSE wall structural backfill zone should be designed to provide adequate global stability factor of safety. Results of the stability analyses are presented in Figures 15.3 and 15.4 in Appendix D.

Before fill placement, the upper 0.75 m of soil in the area near TH08-31-02 should be removed as it contains organics (topsoil).

16. HWY 16/BROADMOOR BOULEVARD (BRIDGES 23 & 24)

16.1 Project Description

The preliminary layout of the Hwy 16/Broadmoor Boulevard interchange indicates that the existing two lane bridge structure over Hwy 16 (AT bridge file BF76648-1) will be replaced with a longer wider four lane structure at this location (Bridge 24).

In addition, a new bridge structure (Bridge 23) is planned to the west of Bridge 24. Bridge 23, situated on the north side of Hwy 16, will carry the NB to WB ramp over the Hwy16/Yellowhead Trail NB to WB ramp.

The preliminary layout of the Hwy 16/Broadmoor Boulevard interchange is shown in Drawing No.19-598-298-3. It is understood that the new bridge approach fills will be approximately 8 m to 10 m high.

16.2 Stratigraphy and Groundwater Conditions

The results of the field drilling program indicate that the subsurface conditions generally consist of clay fill, topsoil and clay to depths of 0.2 m to 4.7 m below existing ground surface overlying clay till interbedded with rafted bedrock and occasional sand layers extending to depths ranging from 9.2 m to 17.7 m overlying sand and gravel layers which extended to test hole termination depth.

The groundwater level measured on October 21, 2008 in standpipes varied considerably from 4.3 m in TH08-24-02D to 14.3 in test hole TH08-23-02A. It appears that there may be two distinct water tables in this area. The upper water table appears to be perched within the upper till layer at an elevation between 664 m and 665.2 m. The lower water table was noted at an elevation between 652.4 m and 654.9 m, within the underlying sand.

16.3 Geotechnical Evaluation and Recommendations

16.3.1 General

The following foundation types are considered feasible for these structures:

- Cast-in-Place Concrete End Bearing Piles, and
- Driven Steel Piles.

16.3.2 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to the recommendations provided in Section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded in the very stiff clay till or rafted clay shale at a suggested basing elevation of about 660 m. The corresponding pile embedment lengths from the existing ground surface are therefore about 9 m to 14 m for Bridge 24, and about 6 m for Bridge 23.

b) It should be noted that the piles may extend through sand layers present in the clay till, and hence, temporary casings will be required to extend the piles to allow for basing in the very stiff clay till or rafted bedrock.

c) Drilled cast-in-place concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 16.1.

TABLE 16.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRILLED CONCRETE END BEARING PILES (HWY 16/BROADMOOR BLVD, BRIDGES 23 AND 24)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		SKIN FRICTION (kPa)		END BEARING (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay Till/ Rafted bedrock	0-10	60	24	1350* 900**	540* 360**

Notes: * Bridge 24 for pile tips in clay till/rafted bedrock at a minimum depth of 10 m below existing ground surface.
** Bridge 23 for pile tips in clay till/rafted bedrock at a minimum depth of 10 m below existing ground surface.

16.3.3 Driven Steel Piles

Driven steel piles may be designed and installed according to Section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to specified termination set criteria in the dense to very dense sand and gravel or underlying bedrock. Based on available information, piles tips are expected to extend about 20 m below existing ground surface, resulting in pile tip elevations of about 650 m.

a) Driven steel pipes and H-section piles may be designed based on the factored ULS end bearing and skin friction values provided in Table 16.2.

TABLE 16.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 16/BROADMOOR BLVD, BRIDGES 23 AND 24)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		SKIN FRICTION (kPa)		END BEARING (kPa)	
		Ultimate	UL Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay Till/ Rafted Bedrock	0-12	60	24	N/A	N/A
Sand/Gravel*	>12*	95	38	9000**	3600**

Notes: * Depth to sand and gravel layer varies, refer to nearest test holes.
** For pile tips founded in very dense sand/gravel at a minimum basing depth of about 15 m below existing ground surface and confirmed by pile driving analysis.

16.3.4 Existing Structures

The existing north and south bridge abutments over Hwy 16 (AT bridge file BF76648-1) were inspected on November 14, 2008, and they appeared to be in good condition, as can be seen in the Photos 7 to 9, in Appendix E. The bridge showed no sign of slope movement or settlement along the head and side slopes.

A concrete retaining wall was built in 2006 to accommodate an additional exit ramp traffic lane at the south abutment, and this also showed no visible signs of movement or settlement. The slope angles of both abutments at this bridge were estimated with a clinometer and they are approximately 2H:1V and 3H:1V for the head and side slopes respectively.

The existing bridge (AT bridge file BF76649), located approximately 70 meters northwest of the proposed Bridge 23, also appears to be in good condition despite the fact that some bulging and cracking in the concrete panels were observed in the lower part of the abutment head slopes. Growing vegetation was also observed in between concrete panels. The slope angles of both abutments at this bridge were estimated with a clinometer and they are approximately 2H:1V and 3H:1V for the head and side slopes respectively.

16.3.5 Approach Embankments

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Target factors of safety of 1.3 for short term (end of construction) and 1.5 long term were assumed in the stability analyses.

Approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are also considered feasible for the Bridge 23 and Bridge 24 abutments. Results of the stability analyses, represented on Figures 16.3, 16.4, 16.5 & 16.6, are included in Appendix D.

Alternatively, an MSE wall founded on clay till is considered feasible for the Bridge 24 abutments. Results of the stability analyses, represented on Figures 16.7 and 16.8, are included in Appendix D. All topsoil and poor quality fill would have to be removed from underneath the MSE structural backfill zones. In addition, the internal and global stability and bearing capacity should be checked for the designed wall configuration, to determine the width of the MSE structural backfill zone.

The approach fill for all abutments will be built with suitable clay fill placed and compacted to AT standards.

17. HWY 16/CPR GRADE SEPARATION (BRIDGES 19, 20, 21, 22 & 33)

17.1 Project Description

The preliminary layout of the Hwy 16/CPR grade separation indicates that the existing eastbound (Bridge 20) and westbound (Bridge 21) structures are elevated over the CP Rail. The existing bridges will be widened and lengthened.

In addition, new bridge structures will carry the Hwy 216 southbound to Hwy 16/YHT eastbound ramp (Bridge 19) and the Hwy16/YHT eastbound to Broadmoor Boulevard east ramp (Bridges 22 and 33) over the CPR and both the WB to SB and NB to EB ramps.

The preliminary layout of the Hwy 16/CPR grade separation is shown in Drawing No. 19-598-298-4. It is understood that the new bridge approach fills will be approximately 10 m high.

17.2 Stratigraphy and Groundwater Conditions

The results of the field drilling program indicate that the subsurface conditions encountered in this area generally consist of topsoil and clay fill to depths of 2.8 m to 8.8 m below existing ground surface overlying clay till interbedded with rafted bedrock which extended to depths of about 12.2 m to 19.1 m, overlying sand and gravel layers.

Similar soil conditions were identified in the AT drawings for the existing bridges where the sand and gravel layers extended to depths of at least 18 m below original ground level.

Based on the available geological maps (Kathol and McPherson, 1975), the subsurface strata may be variable across this site and may include clay till overlying glacial sand and gravel over bedrock. The estimated depth to bedrock is expected to range from about 15 m to greater than 20 m below original ground level at the base of the existing embankment fills.

The groundwater table measured on October 21, 2008 in the standpipes installed in the 2008 test holes in this area was at an elevation ranging between 651.5 m and 652 m in all test holes except for TH08-21-02A, where it was measured at an elevation of 663.7 m.

The groundwater table measured on September 23, 2009 in the standpipes installed in the 2009 test holes in this area was at an elevation ranging between 652.3 m and 660.3 m in test hole TH09-22-01 and TH09-22-02.

17.3 Geotechnical Evaluation and Recommendations

17.3.1 General

The following foundation types are considered feasible for this structure:

- Cast-in-Place Concrete End Bearing Piles; and
- Driven Steel Piles.

17.3.2 Cast-in-Place Concrete End Bearing Piles

Review of the existing bridge drawings indicate that the bridge structures are founded on cast-in-place concrete belled end bearing piles founded in the clay till and rafted bedrock above the underlying sand and gravel, at basing elevations of about 655 m.

Cast-in-place concrete end bearing piles may be designed and installed according to Section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded into the very stiff clay till at a suggested basing depth of about 12 m below original ground level (tip basing depth of about 655 m). The pile bases should be founded above the underlying sand/gravel layer.

b) It should be noted that the piles may extend through sand layers present in the clay till, and hence temporary casings will be required to extend the piles to allow basing in the bedrock.

c) Drilled cast-in-place reinforced concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 17.1.

d) Skin friction may be included within the depth of existing (old) fills for Bridges 20 and 21. However skin friction should not be included within the depth of new abutment fill for Bridge 19.

TABLE 17.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRILLED CONCRETE END BEARING PILES
(HWY 16/CPR GRADE SEPARATION, BRIDGES 19, 20, 21, 22& 33)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING TOP OF EMBANKMENT (m)	VERTICAL STATIC LOADING			
		SKIN FRICTION (kPa)		END BEARING (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay Fill (old)*	2-8	40	16	N/A	N/A
Clay, Clay Till/ Rafted Bedrock	8 - 18	60	24	1000**	400**

Notes: * Apply skin friction in existing fill below 2 m from top of embankment for Bridges 20 and 21. Ignore skin friction in all new fill including Bridges 19, 22 & 33.
** For pile tips in clay, clay till/rafted bedrock at depths of 12 m or greater below existing ground surface.

17.3.3 Driven Steel Piles

Driven steel piles may be designed and installed according to Section 7.3 and the following site specific recommendations:

a) Steel piles should be driven to specified termination set criteria in the very dense sand and gravel or underlying bedrock. Based on available information, depth to refusal is expected to be about 20 m or greater below original ground elevation (estimated tip elevation of about 645 m).

b) Driven steel piles may be designed based on the factored ULS geotechnical end bearing and skin friction values provided in Table 17.2 following.

c) The existing fill at Bridges 20 and 21 has been in-place for a relatively long time period. Therefore, skin friction may be included within the depth of the existing abutment fill.

d) Skin friction should however be ignored within the depth of new fills at Bridge 19.

TABLE 17.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES (HWY 16/CPR GRADE SEPARATION, BRIDGES 19, 20, 21, 22 & 33)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay fill (old)*	2 – 8	30*	12	N/A	N/A
Clay, Clay Till/ Rafted Bedrock	8 – 18	60	24	N/A	N/A
Dense to very dense Sand/Gravel	> 18	95	38	9000**	3600**

Notes: * Apply skin friction in existing fill below 2 m from top of embankment for Bridges 20 and 21. Ignore skin friction in all new fill including Bridges 19, 22 & 33.
** For pile tips driven to dense to very dense sand/gravel layer at depths of 18 m or greater below original ground level, and confirmed by pile driving analysis.

17.3.4 Existing Structures

The existing bridge abutments at this location were inspected on November 14, 2008 and they appeared to be in good condition. No signs of movement or settlement were observed. Some cracks were observed in the head slope concrete panels but they not appear to be related to geotechnical problems.

17.3.5 Approach Embankments

Stability analyses were carried out to assess the short term and long term stability of the bridge head slopes. Results of the stability analyses are represented on

Figures 17.1 to 17.6 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 for long term were assumed in the stability analyses.

Based on the results of the stability analyses, and observations of existing bridge head slopes in the vicinity, approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the new bridge abutments.

An MSE wall is also considered feasible for the Bridge 19 embankment. (Figures 17.3 and 17.4 in Appendix D) Internal and global stability as well as bearing capacity need to be checked during detailed design, and this will determine the requirements for the MSE granular zone and reinforcing dimensions.

18. HWY 16/HWY 216 INTERCHANGE RAMPS (BRIDGES 25 & 26)

18.1 Project Description

Bridges 25 and 26 are located at the Hwy 216/Hwy 16 Interchange and are shown on Drawing No. 19-598-298-4, in Appendix A.

Bridge 25 will carry the EB to NB and EB to SB ramps over a northbound eastbound ramp, connecting the 116 Avenue NW commercial area to Hwy 16, and will involve approach fills up to about 8 m high.

Bridge 26 will carry the southbound to westbound ramp over the relocated Hwy 16 westbound to 17 Street NW exit ramp and will involve approach cut/fill slopes ranging from 8 m (east abutment) to 12 m (west abutment).

18.2 Stratigraphy and Groundwater Conditions

The results of the field drilling program indicate that the subsurface conditions generally consist of clay fill, topsoil and clay to a depth of about 3.3 m below existing ground surface overlying clay till with occasional sand, clay and rafted bedrock interbedded at a depth about 14.3 m to 16 m below ground level overlying bedrock.

The bedrock consists of very hard clay shale and very dense sandstone with SPT ‘N’ values typically greater than 100 below about 2 m from the top of bedrock.

A review of the Atlas of Coal Mine Workings (R. Spence Taylor, 1971) indicated that there are possibly abandoned underground coal mine workings along the Hwy 216 and Hwy 16 corridors in the vicinity of Bridges 25 and 26. According to this literature, a coal mine, identified as No. 0699, was operated by Marcus Collieries Ltd. from 1917 to 1940, to the south of the current Hwy 216/Hwy 16 interchange and had a cover of approximately 33 m to 43 m. A second coal mine identified as No. 0091 was operated by Ottewell Coal Co. Ltd., from 1903 to 1951, under the designation of the Ottewell Clover Bar Mine, along the current Hwy 16 alignment, west of the current Hwy 216/Hwy 16 interchange and had a cover reported to be up to 24 m. These two mines were connected by a drainage way and a return airway of unknown depths. Mine No. 0091 had a history of cave-ins during its operation, notably, in 1917, along the roadway boundary of legal Sections 17 and 8 of TWP53-RGE23-W4M, which corresponds to the existing alignment of Hwy 16. Some cave-in activity categorized as minor to major was observed during the operation of Mine No. 0699. No evidence of coal mine workings and galleries were encountered during the drilling of the test holes drilled to depths of 16.5 m to 19 m for Bridges 25 and 26.

The groundwater levels measured on October 21, 2008 in the standpipes was at about 2 m to 5 m below ground surface in two of the three test holes.

18.3 Geotechnical Evaluation and Recommendations

18.3.1 General

The following foundation types are considered feasible for this structure:

- Cast-in-Place Concrete End Bearing Piles, and
- Driven Steel Piles.

18.3.2 Cast-in-Place Concrete End Bearing Piles

Cast-in-place concrete end bearing piles may be designed and installed according to the recommendations provided in Section 7.2 and the following site specific recommendations:

a) End bearing pile bases should be founded at a suggested minimum depth of about least 12 m below the existing ground elevation into the very stiff clay till. Alternatively, end bearing pile scan also be founded 2 m into the underlying bedrock at a suggested minimum depth of about 18 m below existing ground surface.

b) It should be noted that the piles may extend through sand layers present in the clay till, and hence, temporary casings will be required to extend the piles to the recommended basing depths.

c) Drilled cast-in-place reinforced concrete piles may be designed based on the factored ULS skin friction and end-bearing values provided in Table 18.1.

d) Skin friction should not be included within the depth of new abutment fill.

TABLE 18.1
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRILLED CONCRETE END BEARING PILES
(HWY 16/HWY 216 INTERCHANGE RAMPS, BRIDGES 25 AND 26)

SOIL TYPE	**AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)**	**VERTICAL STATIC LOADING**			
		Skin Friction (kPa)		**End Bearing (kPa)**	
		Ultimate	**ULS Factored (0.4)**	**Ultimate**	**ULS Factored (0.4)**
Clay Fill (Old) /Topsoil/Clay	0-2	N/A	N/A	N/A	N/A
Clay Till	2-16	60	24	1000*	400*
Bedrock	> 16	150	60	3000**	1200**

Note: * For piles installed in clay till at a minimum basing depth of 12 m below the existing ground.
** For pile tips founded at least 2 m into hard bedrock at depths of 18 m below existing ground.

18.3.3 Driven Steel Piles

Driven steel piles may be designed and installed according to Section 7.3 and the following site specific recommendations:

a) Driven steel piles should be driven to specified termination set criteria in the bedrock. Tip depths are expected to be in the order of 18 m to 20 m below existing ground level at Bridge 25 and at 16 m to 18 m at Bridge 26.

b) Driven steel pipe and H-section piles may be designed based on the factored ULS end bearing and skin friction values provided in Table 18.2.

c) Skin Friction should not be included within the depth of new abutment fill.

TABLE 18.2
RECOMMENDED END BEARING AND SKIN FRICTION VALUES FOR DRIVEN STEEL PILES
(HWY 16/HWY 216 INTERCHANGE RAMPS, BRIDGES 25 AND 26)

SOIL TYPE	AVERAGE DEPTH BELOW EXISTING GROUND SURFACE (m)	VERTICAL STATIC LOADING			
		Skin Friction (kPa)		End Bearing (kPa)	
		Ultimate	ULS Factored (0.4)	Ultimate	ULS Factored (0.4)
Clay fill/Topsoil/Clay	0-2	N/A	N/A	N/A	N/A
Clay Till	2-16	60	24	N/A	N/A
Bedrock	> 16	150	60	12000*	4800*

Note: * For piles driven to practical refusal in bedrock and confirmed by driving records.

18.3.4 Approach Embankments

Stability analyses were carried out to assess the short term and long term stability of the head slopes. Results of the stability analyses are presented on Figures 18.1 to 18.4 in Appendix D. Target factors of safety of 1.3 for short term (end of construction) and 1.5 for long term were assumed in the stability analyses.

Based on the results of the stability analyses, and observations of the existing bridge head slopes in the vicinity, approach fill design head slopes and side slopes of 2H:1V and 3H:1V, respectively, are considered feasible for the bridge abutments.

All poor quality fill and topsoil should be removed from below the approach head slopes. Approach fills should be constructed with suitable clay fill placed and compacted to AT standards.

19. PRELIMINARY SURFACING STRATEGY

19.1 Background Information

The following information and references were utilized in the determination of the pavement structures for new construction and the design of the overlay for rehabilitation:

- Alberta Transportation (AT) 2008 Traffic volume, Vehicle Class, Travel and ESAL report;
- 2008 ESAL History report;
- AT Primary Highways: 2008 PMS Highway Summary report;
- AT As-Built Cross Sections for Highways 216:04 and 16:18;
- AT 2008 Turning Movement Summary Diagrams 95510, 94460, 93465, and 94490 for the intersections on Highway 216;
- AT 2008 Turning Movement Summary Diagrams 95510, 158800, 159160, 96520 for the intersections on Highway 16;
- City of Edmonton (COE) Traffic Volumes Weekday peak Hours Monitoring 1997-2002;
- COE 2041 Estimated Truck Percentages for Anthony Henday;
- AT 2008 Falling Weight Deflectometer (FWD) data for Highway 216:02;
- TRANS IRI and Wheel Path Rutting Data Analysis;
- AT Pavement Design Manual, Edition 1 (June 1997);
- AT Guidelines for Assessing Pavement Preservation Treatments and Strategies (July 2006);
- AT Design Bulletin #13/2003, Revisions to Pavement Design Manual for Selection of ACP Mix Types and Asphalt Binder Grades;
- AT Design Bulletin #15/2003, Pavement Design Manual Revisions: Recommended Minimum Thickness First Stage Asphalt Concrete Pavement;
- Surfacing Strategy – Rehabilitation Highway 216:02 (km 2.10 to km 3.35) and Highway 216:04 (km 0 .00 to 6.41) (EBA Report dated January 2001);
- Surfacing Strategy – Rehabilitation Highway 216:02 (km 0.00 to 7.623 NBL and km 0.00 to 7.604 SBL) (EBA Report dated May 2002); and

- Surfacing Strategy – Rehabilitation Highway16:18 (EB & WB) (km 2.10 to km 3.35) (EBA Report dated March 2004).

In addition ISL provided the following information to be used in the design:

- Traffic volume flow sheets for NEERR Stage 1 (year 2041), which indicated both AM and PM peak hour flows along the routes and at each intersection along the routes. Copies of these drawings are provided in Appendix F.
- Opening of the NEERR is planned for the year 2011.
- Opening day traffic volumes are estimated by dividing the 2041 traffic by 1.6 based on the following:
  - 2011 Metro population – 1.0 million
  - 2041 Metro population - 1.6 million
  - Traffic Growth Factor – 1.6
  - Annual growth factor – 2.0 %

The AT 2008 PMS Highway summary report and as-built cross-sections indicates that the existing Highway 16 west of the west City limits was constructed between 1967 and 1973 and the existing Anthony Henday Drive south of Highway 16 was constructed between 1965 and 1973.

19.2 Pavement and Subgrade Modulus

A review was conducted on the subgrade resilient modulus determinations which were reported in the EBA surfacing strategies for Highways 216:04 and 16:18. The review was supplemented with an analysis of the 2008 FWD data for Highway 216:04 which was provided by AT. Based on our assessment of the available data, a design subgrade resilient modulus of 30,000 kPa was used.

19.3 Traffic Volumes

Traffic data was provided to Thurber that presented 2041 projected peak AM and PM traffic volumes. The AM and PM traffic volumes and the volume for each direction of travel were averaged to determine the average traffic flow per direction. The 2041 traffic flow volume data was divided by a factor of 1.6 to obtain opening day (2011) traffic volumes, and multiplied by a factor of 10 to estimate the

Average Annual Daily Traffic (AADT). The distribution of SU (single unit) and TT (tractor trailer) trucks was estimated from the turning movement diagrams and/or the truck percentages from the COE 2041 estimate for Anthony Henday Drive. Truck factors of 0.881 for SU and 2.073 for TT, respectively, were used to calculate the design traffic volumes. Lane distribution factors were then used to estimate the traffic volume in the design lane. Traffic distribution factors of 0.6, 0.7, and 0.85 were used for the 8 lane, 6 lane and 4 lane divided configurations, respectively. The growth rate provided by ISL was increased from 2 percent to 3 percent for consistency with AT design procedures.

Based on our discussions with AT, it was understood that perpetual pavement structures are required for the new pavement structures for the HWY 216 mainline and associated ramps. Conventional pavement structures are required for the portions of HWY 216 to be rehabilitated, the cross roads including HWY 16 main line, and the ramps associated with HWY 16. The design period for perpetual pavements is 50 years while the design period for conventional pavements is 20 years.

The above parameters were used to determine traffic levels for HWY 216:04 and HWY 16:18 main lines, and for each of the associated cross roads and ramps. Based on an as assessment of the traffic levels, typical design traffic levels were selected for the HWY 216 and HWY 16 main lines, low volume and high volume cross-streets, and low volume and high volume ramps as shown in Table 16.1 of the following page. The traffic levels are also presented graphically in Drawing No. 19-598-297-2 to 6 in Appendix G.

TABLE 19.1
DESIGN ESALs

ROAD ELEMENT	2011 AVERAGE DAILY ESALs IN DESIGN LANE	DESIGN PERIOD (years)	ESALs IN DESIGN LANE (3% Growth)
Main Line (HWY 216 new construction perpetual pavement)	3500	50	144 x 10^6
HWY 216 Ramps (perpetual pavement)			
Low Volume	<500	50	20.6 x 10^6
High Volume	500 – 1500	50	61.8 x 10^6
Main Line (YHT and HWY 216 rehab conventional pavement)	3500	20	34.3 x 10^6
Cross Roads (conventional pavement)			
Low Volume	<1000	20	9.81 x 10^6
High Volume	1000 –1500	20	14.7 x 10^6
YHT Ramps (conventional pavement)			
Low Volume	<500	20	4.9 x 10^6
High Volume	500 – 1500	20	14.7 x 10^6

19.4 Pavement Structure for New Construction

The 1993 AASHTO design method was used to design conventional and perpetual pavement structures for new construction. The following design input parameters were used for the design of the pavement structures:

Initial Serviceability:	4.2
Terminal Serviceability:	2.5
Reliability:	90% (5 to 10 x 10^6 ESALs) 95% (> 10 x 10^6 ESALs
Overall Standard Deviation:	0.45
High Temperature Zone:	Zone 2/3

The pavement structures in Table 19.2 were derived from the design inputs presented previously. The pavement structures are similar to other sections of Anthony Henday Drive which have already been designed and/or constructed.

TABLE 19.2
PRELIMINARY PAVEMENT STRUCTURES

ROAD ELEMENTS	STRUCTURAL NUMBER	PAVEMENT DESIGN	ACP MIX TYPE	ASPHALT CEMENT TYPE
Main Line Perpetual Pavement	220	2nd Stage ACP: 50 mm(1 lift) over 1st Stage ACP: 120 mm(2 lifts) over 1st Stage ACP: 140 mm(2 lifts) over 1st Stage ACP: 100 mm(1 lift) over GBC: 400 mm	Type H1 Type H1 Type H1 Type S3*	PG 64-37 PG 58-37 PG 58-34 PG 58-34
High Volume Ramps Perpetual Pavement	198	2nd Stage ACP: 50 mm(1 lift) over 1st Stage ACP: 100 mm(2 lifts) over 1st Stage ACP: 110 mm(2 lifts) over 1st Stage ACP: 100 mm(1 lift) over GBC: 400 mm	Type H1 Type H1 Type H1 Type S3*	PG 64-37 PG 58-37 PG 58-34 PG 58-34
Low Volume Ramps Perpetual Pavement	173	2nd Stage ACP: 50 mm(1 lift) over 1st Stage ACP: 100 mm(2 lifts) over 1st Stage ACP: 50 mm(1 lifts) over 1st Stage ACP: 100 mm(1 lift) over GBC: 400 mm	Type H1 Type H1 Type H1 Type S3*	PG 64-37 PG 58-37 PG 58-34 PG 58-34
Main Line Conventional Pavements	184	2nd Stage ACP: 50 mm(1 lift) over 1st Stage ACP: 100 mm(2 lifts) over 1st Stage ACP: 70 mm(1 lifts) over 1st Stage ACP: 100 mm(1 lift) over GBC: 400 mm	Type H1 Type H1 Type H1 Type H1**	PG 64-37 PG 58-37 PG 58-34 PG 58-34
High Volume Cross Roads and Ramps Conventional Pavements	166	2nd Stage ACP: 60 mm(1 lift) over 1st Stage ACP: 120 mm(2 lifts) over 1st Stage ACP: 100 mm(1 lift) over GBC: 400 mm	Type H1 Type H1 Type S3 Type H1**	PG 58-37 PG 58-34 PG 58-34

TABLE 19.2 (Continued)

Low Volume Cross Roads Conventional Pavement	150	2nd Stage ACP: 50 mm(1 lift) over 1st Stage ACP: 110 mm(2 lifts) over 1st Stage ACP: 100 mm(1 lift) over GBC: 350 mm	Type H1 Type H1 Type H1**	PG 58-37 PG 58-34 PG 58-34
Low Volume Ramps Conventional Pavement	131	2nd Stage ACP: 60 mm(1 lift) over 1st Stage ACP: 50 mm(2 lifts) over 1st Stage ACP: 100 mm(1 lift) over GBC: 350 mm	Type H1 Type H1 Type H1**	PG 58-37 PG 58-34 PG 58-34

Note: * - Design air voids for be selected at the lowest value within the range of 2.5 to 3.0 % such that all other mix design criteria (excluding VFT) are met.

** - Bottom lift can be S3

The final stage pavement ACP thickness should be confirmed based on FWD testing prior to placing.

19.5 Preliminary Overlay Design

19.5.1 General

Some portions of Highway 216:04 and a majority of Highway 16:18 will be incorporated into the new roadway system.

Data was not available for the loops and ramps for the intersections along Highway 216:04 and Highway 16:18, and therefore these roadways were not included in the assessment.

A detailed site reconnaissance was not included as part of the present work scope. It is assumed that a site reconnaissance will be conducted as part of the detailed surfacing design, and that the recommendations provided in Table 19.3 may be adjusted or modified based on the results of the site reconnaissance.

19.5.2 Highway 216:04

The approximate chainages of Highway 216:04 that are to be retained include the following:

- km 2. to 2.75,
- km 3.5 to 4.25, and
- km 7.5 to 9.7.

The data from the PMS summary, and the 2008 IRI and rut data are summarized in Table 19.5. The 2004 – 2006 IRI and rut data are also presented graphically in Appendix I.

TABLE 19.3
EXISTING PAVEMENT DATA

KILOMETER	EXISTING STRUCTURE	2007 IRI (mm/m) AVE (RANGE)	IRI TRIGGER	2007 RUT DEPTH, (mm) AVERAGE (RANGE)			
				Maximum		**Average**	
				Inside	**Outside**	**Inside**	**Outside**
Hwy 216:04 NBL							
2 – 2.75	Mill & Inlay (2002) 50 mm (2 outside lanes only) ACP (1990) 80 mm ACP (1975) 50 mm ACBP (1975) 250 mm	0.9(1.4-1.6)	1.9	5(4-12)	2(1-5)	11(6-21)	9(2-30)
3.5 -4.25	Mill & Inlay (2002) 50 mm (2 outside lanes only) ACP (1990) 80 mm ACP (1975) 50 mm ACBP (1975) 250 mm	0.9(0.6-1.4)	1.9	5(2-7)	4(2-7)	12(7-26)	11(3-25)
7.5-7.66	Mill & Inlay (2002) ACP (1997/98) 50 mm ACP (1986) 120 mm ACP (1973) 100 mm CTB (1972) 225	0.9(0.8-1.2)	1.9	4(3-4)	1(1-2)	12(9-17)	7(5-9)
7.66-9.7	ACP (1997/98) 50 mm ACP (1986) 100-120 mm ACP (1973) 100 mm CTB (1972) 225	1.6(0.7-1.89)	1.9	4(4-5)	2(2-4)	15(10-29)	9(7-31)

TABLE 19.3 (Continued)

KILOMETER	EXISTING STRUCTURE	2007 IRI (mm/m) AVE (RANGE)	IRI TRIGGER	2007 RUT DEPTH, (mm) AVERAGE (RANGE)			
				Maximum		Average	
				Inside	Outside	Inside	Outside
Hwy 216:04 SBL							
2 – 2.75	Mill & Inlay (2002) 50 mm (outer lane only) ACP (1990) 80 mm ACP (1975) 50 mm ACBP (1975) 250 mm	1.1(0.7-1.8)	1.9	5(2-8)	2(1-4)	10(4-24	7(4-20)
3.5 -4.0	ACP (2002) 50 mm Mill & Inlay (2002) 50 mm (outer lane only) ACP (1990) 80 mm ACP (1975) 50 mm ACBP (1975) 250 mm	1.1(0.6-1.7)	1.9	3(2-4)	4(1-8)	75-10)	8(5-14)
4.0 -4.25	Mill & Inlay (2002) 50 mm (outer lane only) ACP (1990) 80 mm ACP (1975) 50 mm ACBP (1975) 250 mm	0.8(0.7-1.0)	1.9	2(1-3)	3(2-6)	5(2-8)	6(3-11)
7.5-9.7	ACP (1997/98) 50 mm ACP (1985) 90-120 mm ACP (1973) 75 mm MC(1972) 25 mm CTB (1972) 225	1.6(1.7-2.7)	1.9	7(3-12)	2(1-5)	22(10-32)	13(6-30)

A review of the IRI data indicates that the 2008 IRI is generally below the target IRI value for the portion of Highway 216:04 to be rehabilitated. The target IRI is 1.9 mm for an AADT that exceeds 8000.

The effective subgrade resilient modulus was back-calculated from the 2008 FWD data using the DARWin 3.01 software, along with the effective pavement modulus. The results are presented graphically, using approximate 0.5 km intervals, in Appendix H. The overlay thickness was calculated using the DARWin software and the Hwy 216:04 (rehab) main line traffic loading provided in Table 19.1 (34.3 x 10^6 ESAL's). It has been assumed that a 20 year service life is required and therefore alternative treatments with lower service lives have not been considered.

Based on our analysis, preliminary recommendations for asphalt overlays of the existing pavement structure are provided in Table 19.4 below:

TABLE 19.4
ASPHALT OVERLAY OF EXISTING PAVEMENT STRUCTURES

APPROXIMATE LOCATION	PRELIMINARY OVERLAY RECOMMENDATION
NORTHBOUND LANES	
Km 2 to 2.75	100 mm Overlay
Km 3.5 to 4.25	60 mm Overlay
Km 7.5 to 9.7	60 mm overlay
SOUTHBOUND LANES	
Km 2 to 3	80 mm Overlay
Km 3.5 to 4.5	70 mm Overlay
Km 7.4 to 9.7	60 mm overlay

The asphalt concrete pavement should consist of AT Mix Type H1 with 150-200A asphalt cement. Consideration could also be given to using Performance Graded (PG) asphalt cement due the high traffic levels.

19.5.3 Highway 16:18

It is understood that the pavement structure for the portion of Highway 16:18 east of Highway 216:04 will be incorporated in the roadway system.

The EBA 2004 surfacing strategy recommended an overlay, varying in thickness from 50 mm to 70 mm, for Highway 16:18. The cross section indicated that a 70 mm overlay was placed on Highway 16:18 in 2007. Consequently, there should not be a need for major rehabilitation in the near future for this roadway and pavements strategies should focus on preventative maintenance. Future assessments of the Highway will require current FWD and IRI data to reflect the impact of the recent overlay.

20. LIMITATION AND USE OF REPORT

There is a possibility that this report may form part of the design and construction documents for information purposes. This report was issued before any final design or construction details have been prepared or issued. Therefore differences may exist between the report recommendations and the final design, in the contract documents, or during construction. In such instances, Thurber Engineering Ltd. should be contacted immediately to address these differences.

Designers and contractors undertaking or bidding the work should examine the factual results of the investigation, satisfy themselves on to the adequacy of the information for design and construction, and make their own interpretation of the data as it may affect their proposed scope of work, cost, schedules, and safety and equipment capabilities.

LIST OF REFERENCES

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STATEMENT OF GENERAL 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 . . . .)

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.

APPENDIX A

Drawings 19-598-298-0 to 5

BASE PLAN PROVIDED BY ISL ENGINEERING AND LAND SERVICES LTD.

THURBER PROJECT #19-598-298

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KEY PLAN
(SHEET 1 OF 7)

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DATE : JULY 2009	SCALE : AS SHOWN	DRAWING No. **19-598-298-0**

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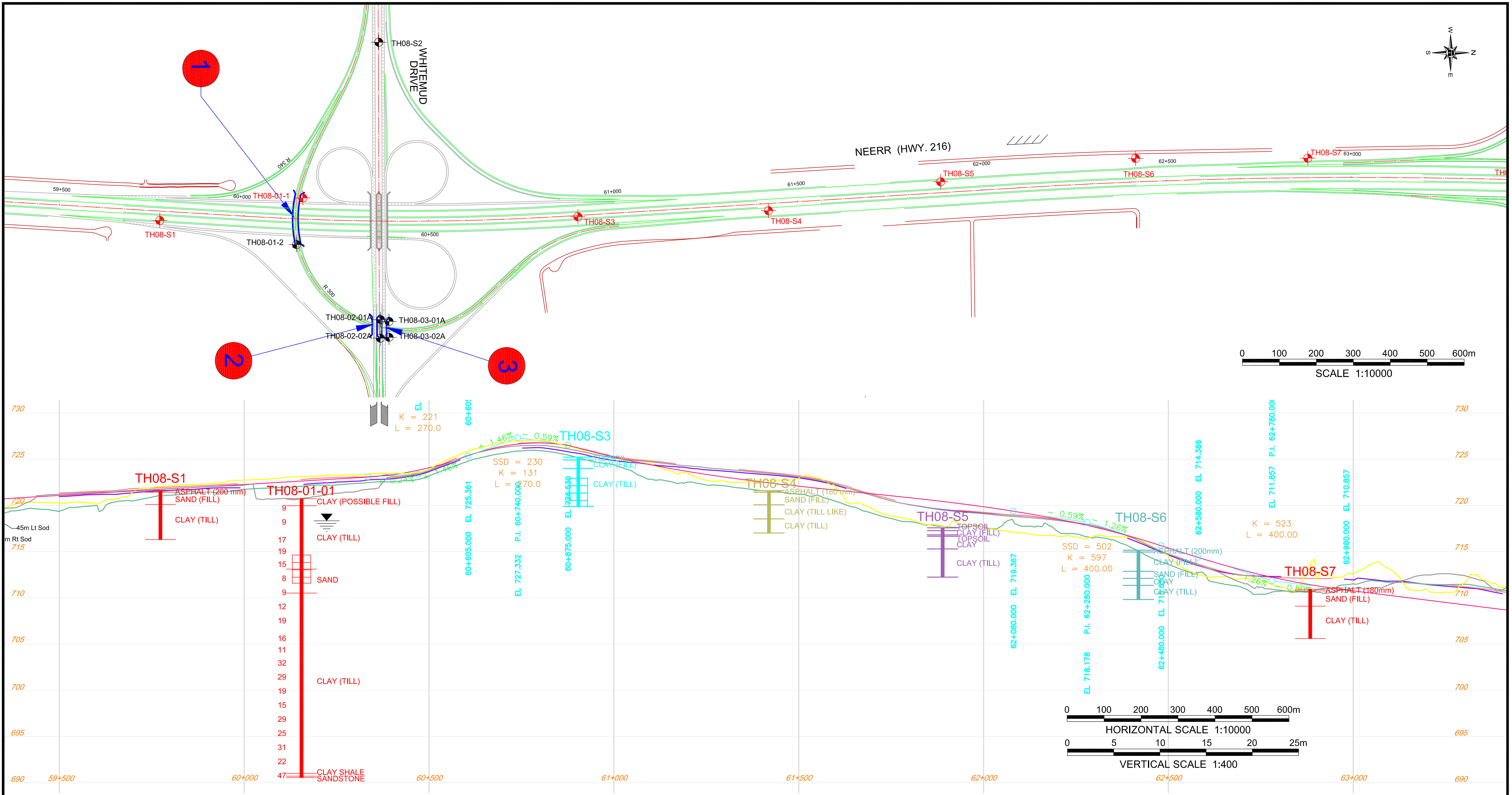

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THURBER PROJECT #19-598-298

LEGEND

- APPROXIMATE TEST HOLE LOCATIONS
- 15 SPT N VALUE
- WATER LEVEL IN PIEZOMETER,
- STANDPIPE PIEZOMETER TIP LOCATION

NOTE:

1. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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PLAN AND PROFILE SHOWING APPROXIMATE TEST HOLE LOCATIONS (SHEET 2 OF 7)

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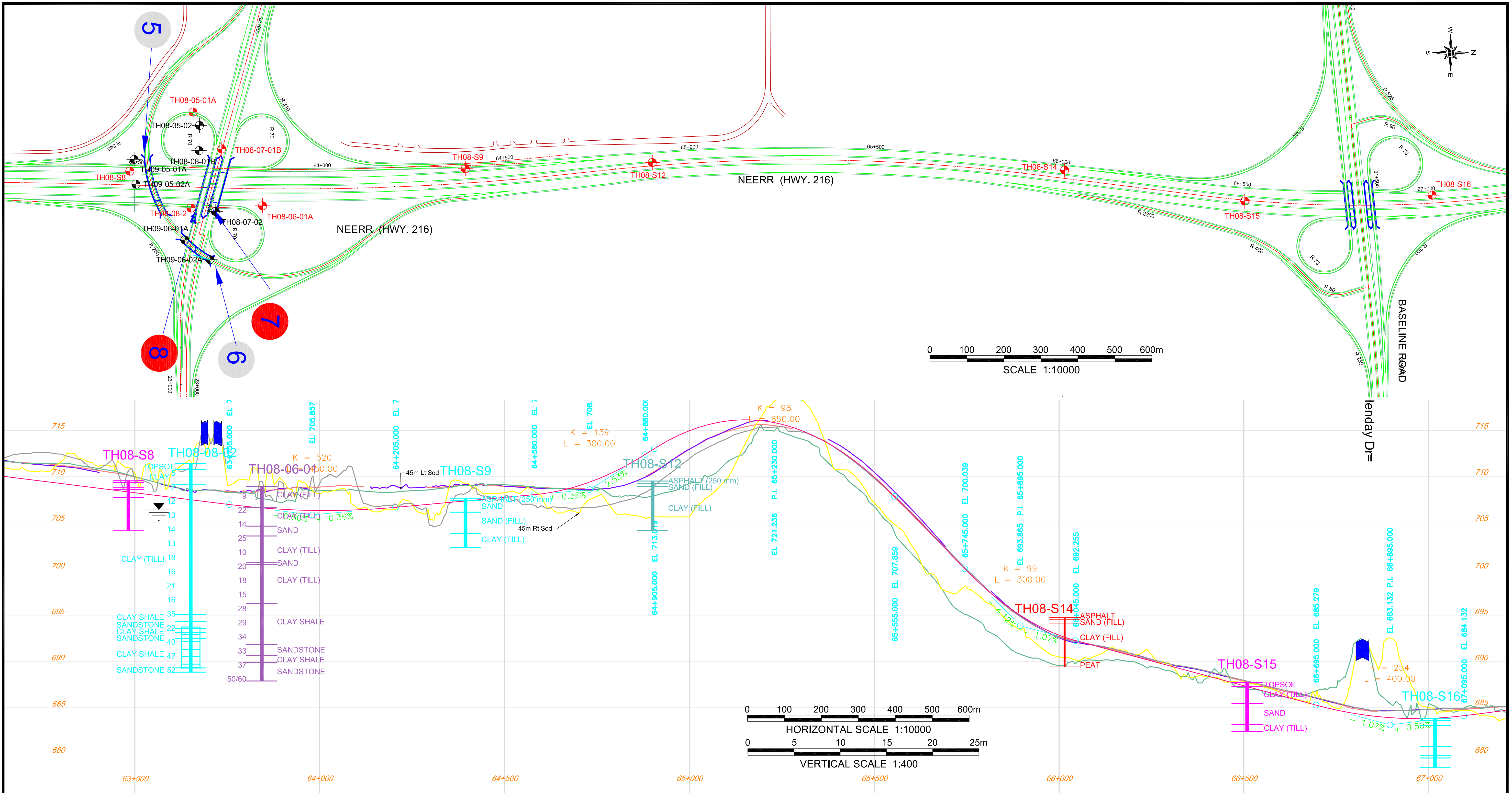

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LEGEND

⊕	APPROXIMATE TEST HOLE LOCATIONS
15 ┃	SPT N VALUE
▼	WATER LEVEL IN PIEZOMETER,
▥	STANDPIPE PIEZOMETER TIP LOCATION

NOTE:

1. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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PLAN AND PROFILE SHOWING
APPROXIMATE TEST HOLE LOCATIONS
(SHEET 3 OF 7)

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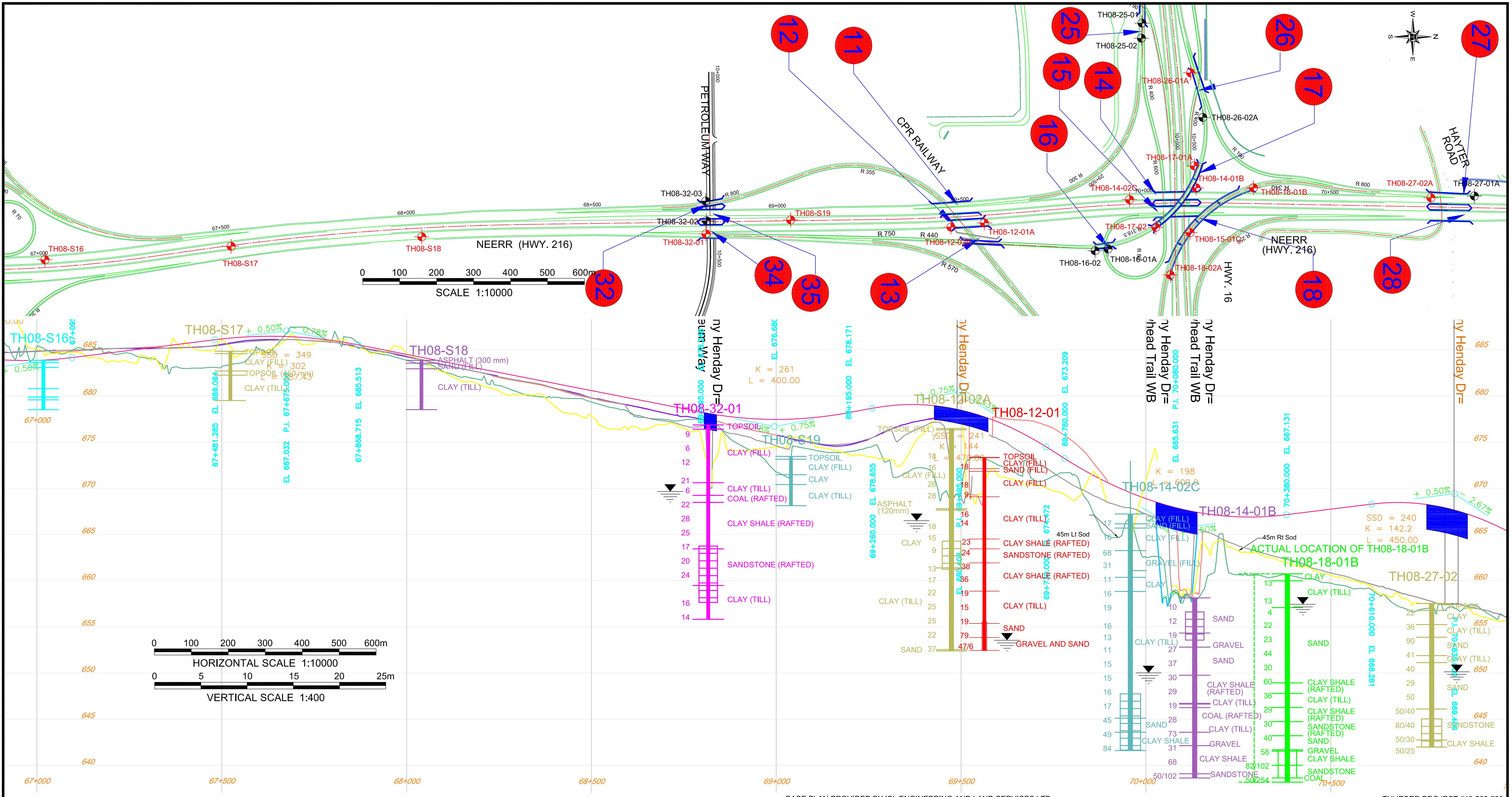

BASE PLAN PROVIDED BY ISL ENGINEERING AND LAND SERVICES LTD.

THURBER PROJECT #19-598-298

LEGEND

APPROXIMATE TEST HOLE LOCATIONS

15 SPT N VALUE

WATER LEVEL IN PIEZOMETER,

STANDPIPE PIEZOMETER
TIP LOCATION

NOTE:

1. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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PLAN AND PROFILE SHOWING APPROXIMATE TEST HOLE LOCATIONS
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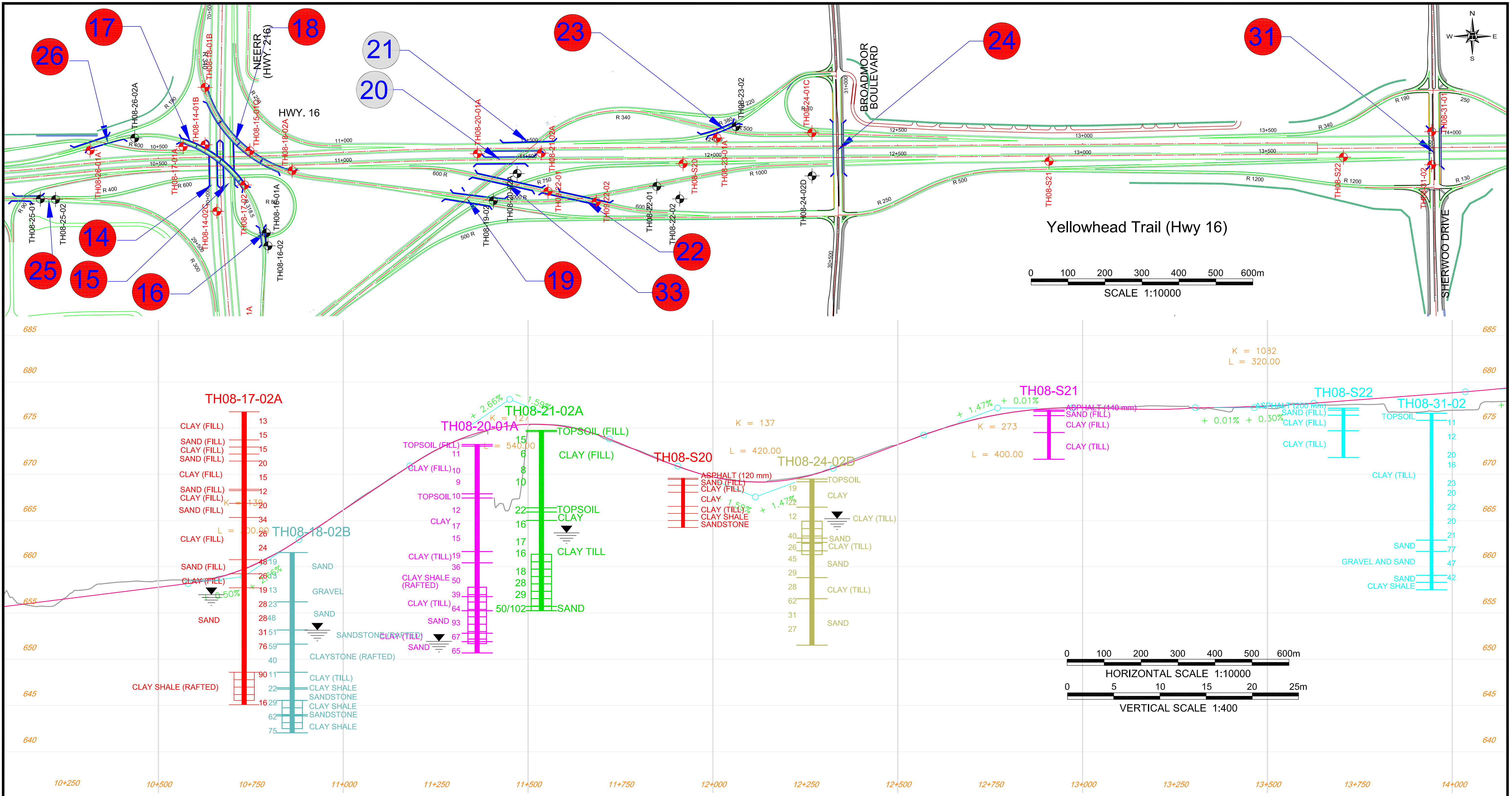

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THURBER PROJECT #19-598-298

LEGEND

⊕ APPROXIMATE TEST HOLE LOCATIONS

15 SPT N VALUE

WATER LEVEL IN PIEZOMETER,

STANDPIPE PIEZOMETER TIP LOCATION

NOTE:

1. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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PLAN AND PROFILE SHOWING
APPROXIMATE TEST HOLE LOCATIONS
(SHEET 5 OF 7)

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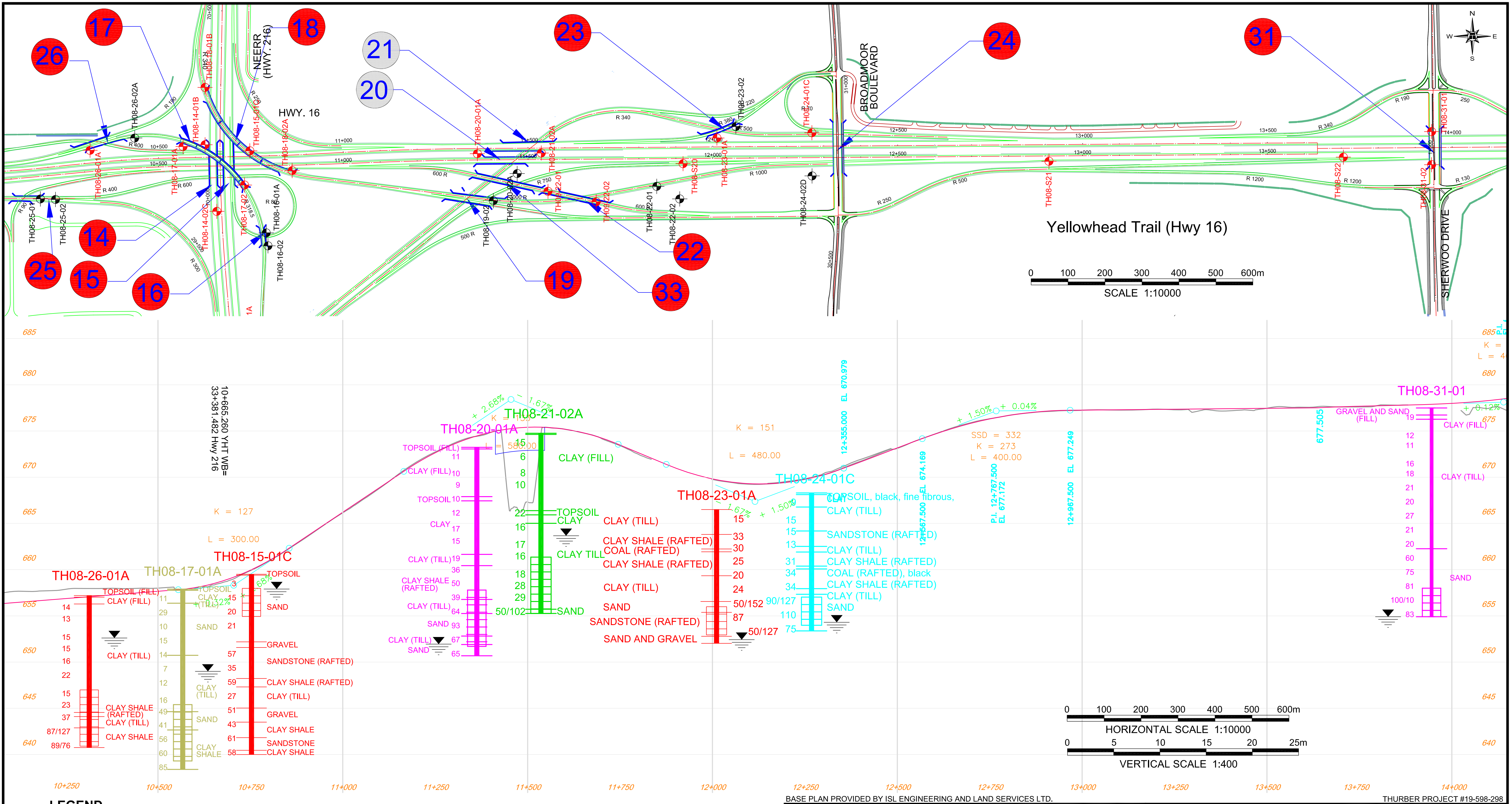

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THURBER PROJECT #19-598-298

LEGEND

⊕	APPROXIMATE TEST HOLE LOCATIONS
15 ▮	SPT N VALUE
▼	WATER LEVEL IN PIEZOMETER,
▤	STANDPIPE PIEZOMETER TIP LOCATION

NOTE:

1. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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PLAN AND PROFILE SHOWING
APPROXIMATE TEST HOLE LOCATIONS
(SHEET 6 OF 7)

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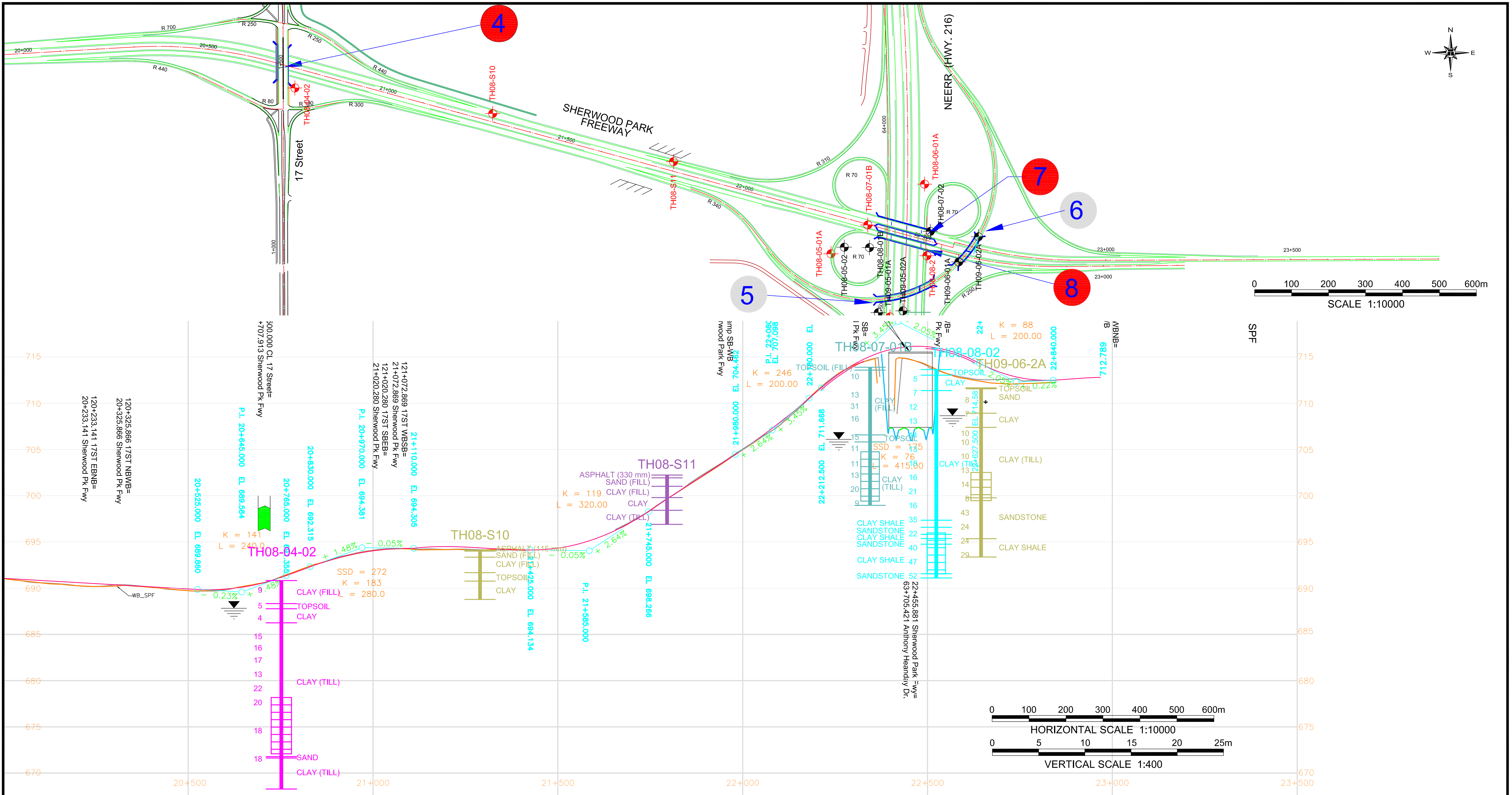

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THURBER PROJECT #19-598-298

LEGEND

⊕ APPROXIMATE TEST HOLE LOCATIONS

15 ┃ SPT N VALUE

▼ WATER LEVEL IN PIEZOMETER,

▥ STANDPIPE PIEZOMETER TIP LOCATION

NOTE:

1. DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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PLAN AND PROFILE SHOWING
APPROXIMATE TEST HOLE LOCATIONS
(SHEET 7 OF 7)

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APPENDIX B

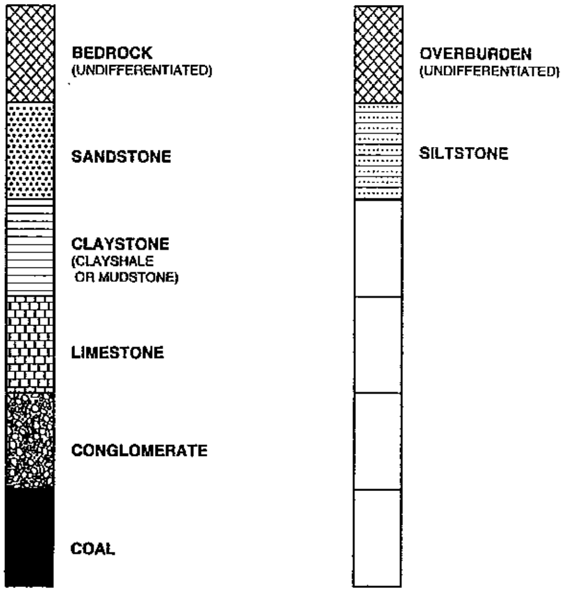
Modified Unified Soils Classification System
Symbols and Terms Used on the Test Hole Logs
Table B-1 – Summary of Test Hole Locations
Test Hole Logs

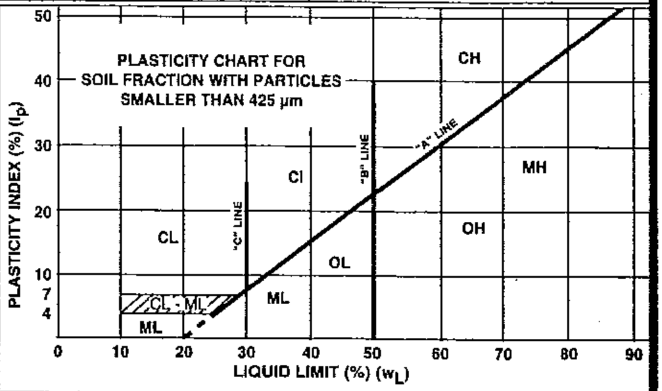
MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

(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	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ 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	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			GC	▨	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
	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		$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ 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	Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
			SC	▨	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7	
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





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GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

(MODIFIED BY PFRA, 1985)

Z:_Edmonton office\Soil_Rock classification\Symbols & Terms.dwg

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 National Building Code	15 to 30
Hard	200 - 300 kPa		Greater than 30
Very Hard	Greater than 300 kPa		

* 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 National Building Code
Dense	30 - 50	
Very Dense	Over 50	

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

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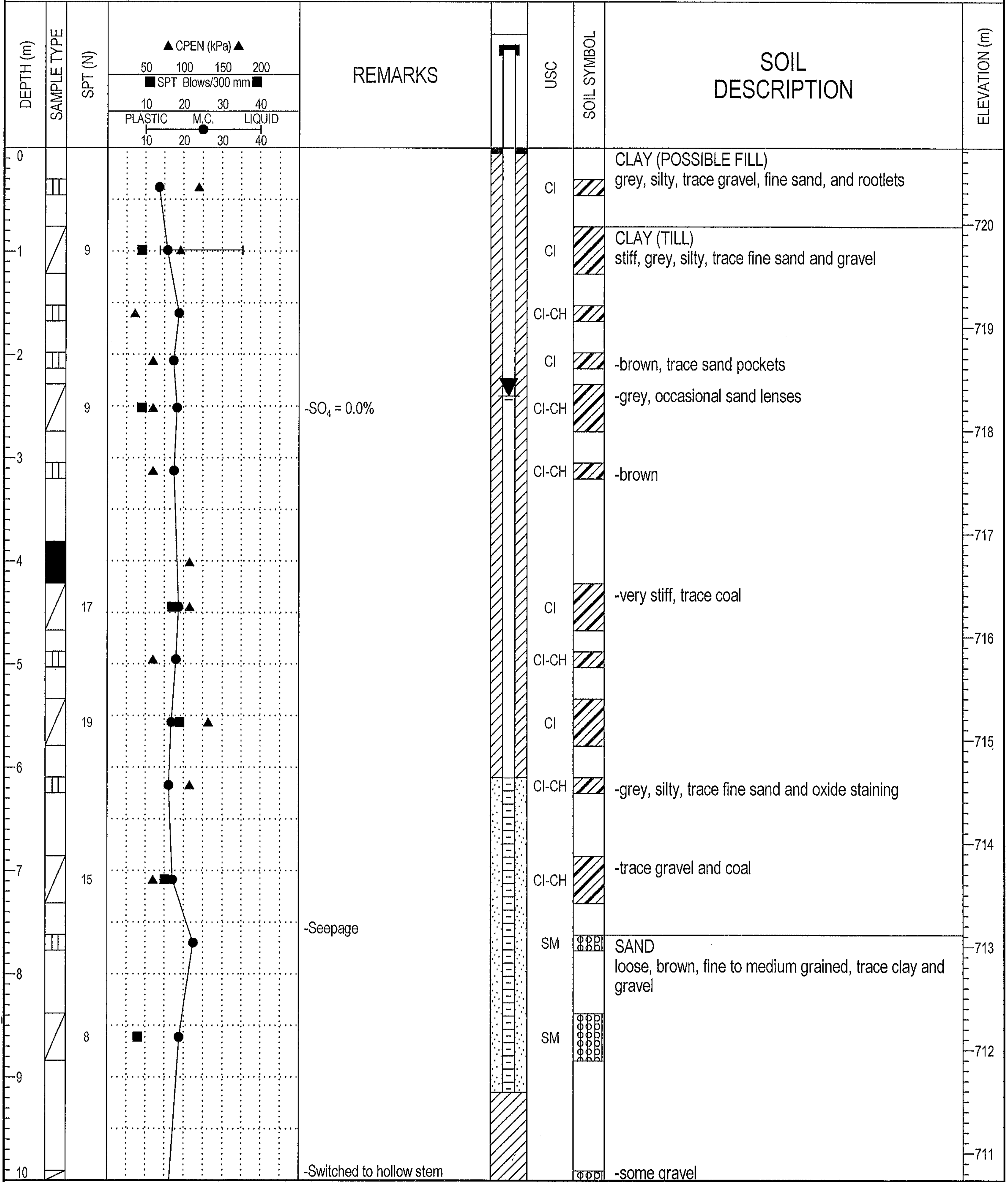
TABLE B-1
SUMMARY OF TEST HOLE LOCATIONS

TEST HOLE	LOCATION		Drilled Depth (m)	STANDPIPE PIEZOMETER		TEST HOLE	LOCATION		Drilled Depth (m)	STANDPIPE PIEZOMETER	
	Easting (m)	Northing (m)		Tip Depth (m)	Soil Type		Easting (m)	Northing (m)		Tip Depth (m)	Soil Type
TH08-01-01	43568.251	5927763.646	30.2	9.2	Sand	TH08-22-01	44575.133	5937606.871	21.0	*13.7*	*Till/Sand*
TH08-01-02	43694.193	5927746.751	30.2	30.0	Clay Till	TH08-22-02	44637.361	5937572.867	20.9	22.0	Sand
TH08-02-01	43896.991	5927973.771	24.1	6.0	Clay Till	TH08-23-01A	44737.912	5937737.508	14.5	13.5	Sandstone
TH08-02-02	43947.202	5927973.186	27.1	26.7	Clay Shale	TH08-23-02A	44743.554	5937755.554	13.7	12.3	Sand
TH08-03-01	43901.869	5927996.702	19.5	19.0	Clay Till	TH08-24-01C	44994.779	5937751.785	14.9	14.3	Sand
TH08-03-02	43945.031	5927996.904	19.5	9.2	Clay Till	TH08-24-02D	44999.871	5937662.975	18.0	8.3	Sand
TH08-04-01B	41855.749	5931787.562	14.9	N/A	N/A	TH08-25-01	42907.886	5937572.834	18.0	6.1	Sand
TH08-04-02	41862.088	5931727.95	22.6	18.7	Clay Till	TH08-25-02	42948.652	5937571.509	19.5	19.0	Clay Shale
TH08-05-01A	43322.977	5931253.169	22.6	22.0	Clay Shale	TH08-26-01A	43042.255	5937704.365	16.5	16.5	Clay Shale
TH08-05-02	43358.993	5931270.8	22.6	3.3	Clay Till	TH08-26-02A	43162.992	5937737.433	16.5	10.7	Clay Till
TH08-06-01	43576.147	5931441.238	21.0	N/A	N/A	TH08-27-01	43375.48	5938471.901	16.3	12.2	Sand
TH08-07-01B	43422.516	5931330.887	14.9	14.9	Clay Till	TH08-27-02	43380.416	5938354.543	15.5	14.7	Sandstone
TH08-07-02	43591.684	5931313.533	19.5	N/A	N/A	TH08-31-01	46671.289	5937754.992	22.6	22.6	Sand
TH08-08-01B	43427.105	5931269.695	22.6	14.9	Sand	TH08-31-02	46671.199	5937665.283	19.1	N/A	N/A
TH08-08-02	43582.458	5931247.716	22.6	22.0	Clay Shale	TH08-32-01	43477.911	5936393.224	21.0	19.0	Clay Till
TH08-12-01	43448.339	5937146.497	20.9	21.0	Gravel	TH08-32-02	43442.378	5936394.726	21.0	21.0	Clay Till
TH08-12-02A	43459.541	5937056.129	24.1	15.1	Clay	TH08-32-03	43387.443	5936393.309	20.6	N/A	N/A
TH08-14-01B	43353.315	5937719.423	19.5	4.5	Gravel						
TH08-14-02C	43385.123	5937539.242	25.6	25.5	Clay Shale						
TH08-15-01C	43474.426	5937702.93	19.5	4.5	Sand						
TH08-16-01	43518.729	5937481.02	30.2	N/A	N/A						

TABLE B-1 (Continued)

TEST HOLE	LOCATION		Drilled Depth (m)	STANDPIPE PIEZOMETER		TEST HOLE	LOCATION		Drilled Depth (m)	STANDPIPE PIEZOMETER	
	Easting (m)	Northing (m)		Tip Depth (m)	Soil Type		Easting (m)	Northing (m)		Tip Depth (m)	Soil Type
TH08-16-02	43523.511	5937446.026	22.1	15.2	Sand						
TH08-17-01A	43293.845	5937714.448	19.5	18.6	Clay Shale						
TH08-17-02A	43460.047	5937610.314	31.7	31.7	Clay Shale						
TH08-18-01B	43353.225	5937874.421	22.6	22.0	Sandstone						
TH08-18-02B	43588.914	5937649.479	19.5	19.5	Clay Shale						
TH08-19-02	44133.163	5937567.954	18.0	15.3	Sand						
TH08-20-01A	44089.827	5937695.221	22.6	21.7	Sand						
TH08-20-02A	44197.654	5937641.476	22.6	18.9	Sand						
TH08-21-02A	44262.837	5937696.989	19.5	19.5	Sand						

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-01-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 5, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 720.73 (m)
SAMPLE TYPE	▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE	
BACKFILL TYPE	■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND	



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
			CLAY (POSSIBLE FILL) grey, silty, trace gravel, fine sand, and rootlets
		CI	
9		CI	CLAY (TILL) stiff, grey, silty, trace fine sand and gravel
		CI-CH	
		CI	-brown, trace sand pockets
			-grey, occasional sand lenses
9	-SO_4 = 0.0%	CI-CH	
		CI-CH	-brown
17		CI	-very stiff, trace coal
		CI-CH	
19		CI	
		CI-CH	-grey, silty, trace fine sand and oxide staining
15		CI-CH	-trace gravel and coal
	-Seepage		
		SM	SAND loose, brown, fine to medium grained, trace clay and gravel
8		SM	
	-Switched to hollow stem		-some gravel

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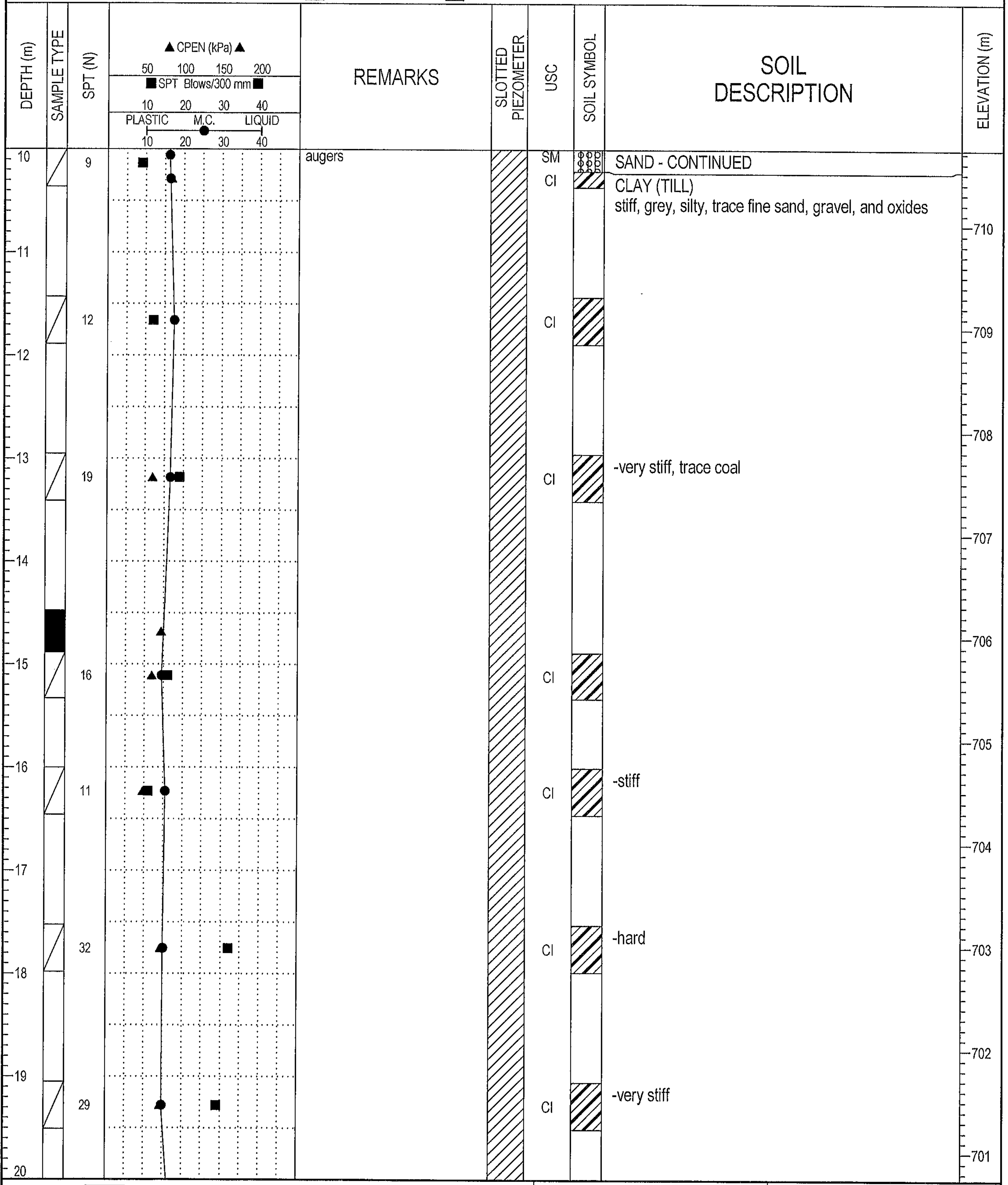
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/5/08
REVIEWED BY: RWT	Page 1 of 4

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-01-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 5, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 720.73 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND



9	SM	SAND - CONTINUED
	CI	CLAY (TILL) stiff, grey, silty, trace fine sand, gravel, and oxides
12	CI	
19	CI	-very stiff, trace coal
16	CI	
11	CI	-stiff
32	CI	-hard
29	CI	-very stiff

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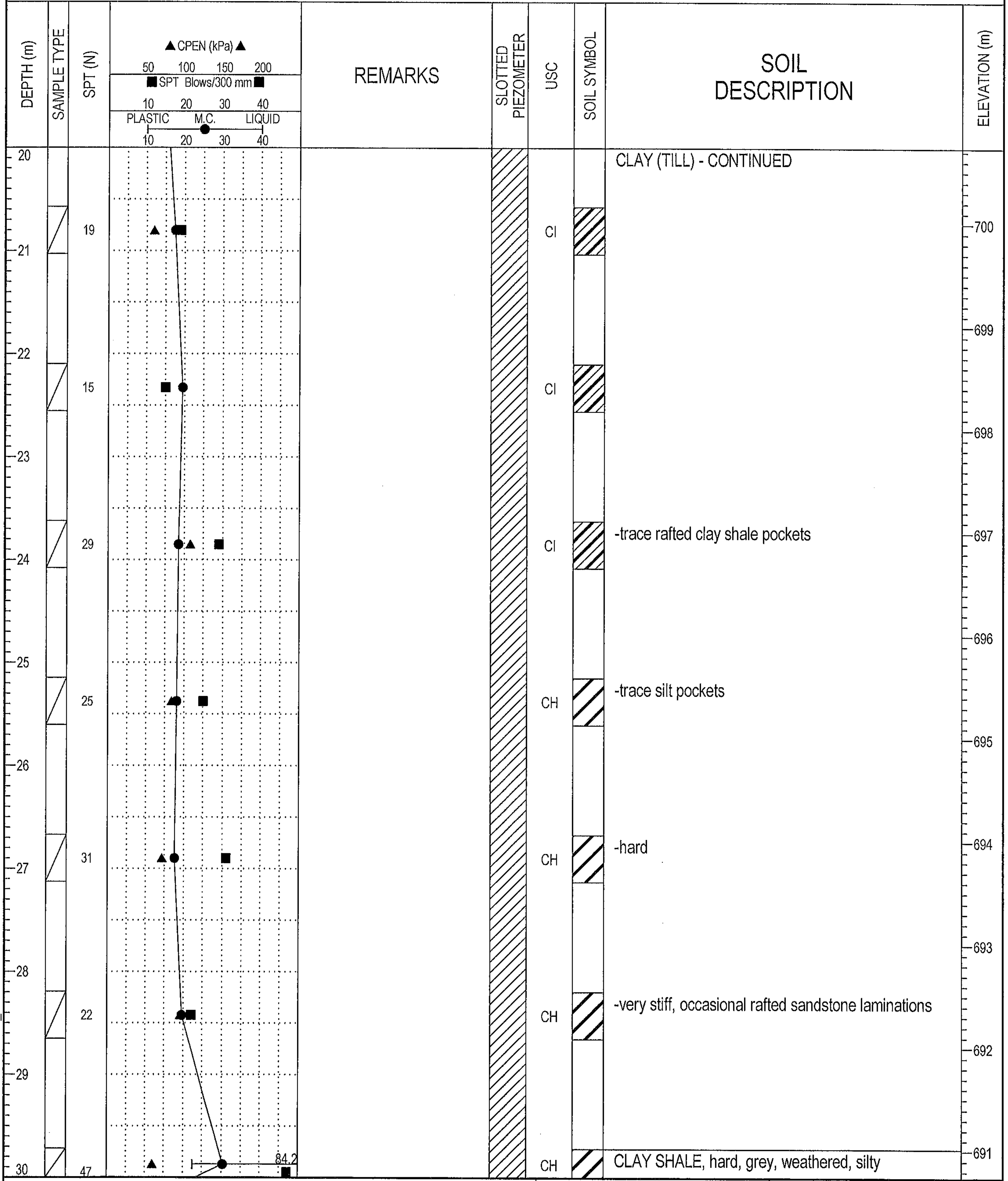
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/5/08
REVIEWED BY: RWT	Page 2 of 4

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-01-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 5, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 720.73 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND



CLAY (TILL) - CONTINUED

-trace rafted clay shale pockets

-trace silt pockets

-hard

-very stiff, occasional rafted sandstone laminations

CLAY SHALE, hard, grey, weathered, silty

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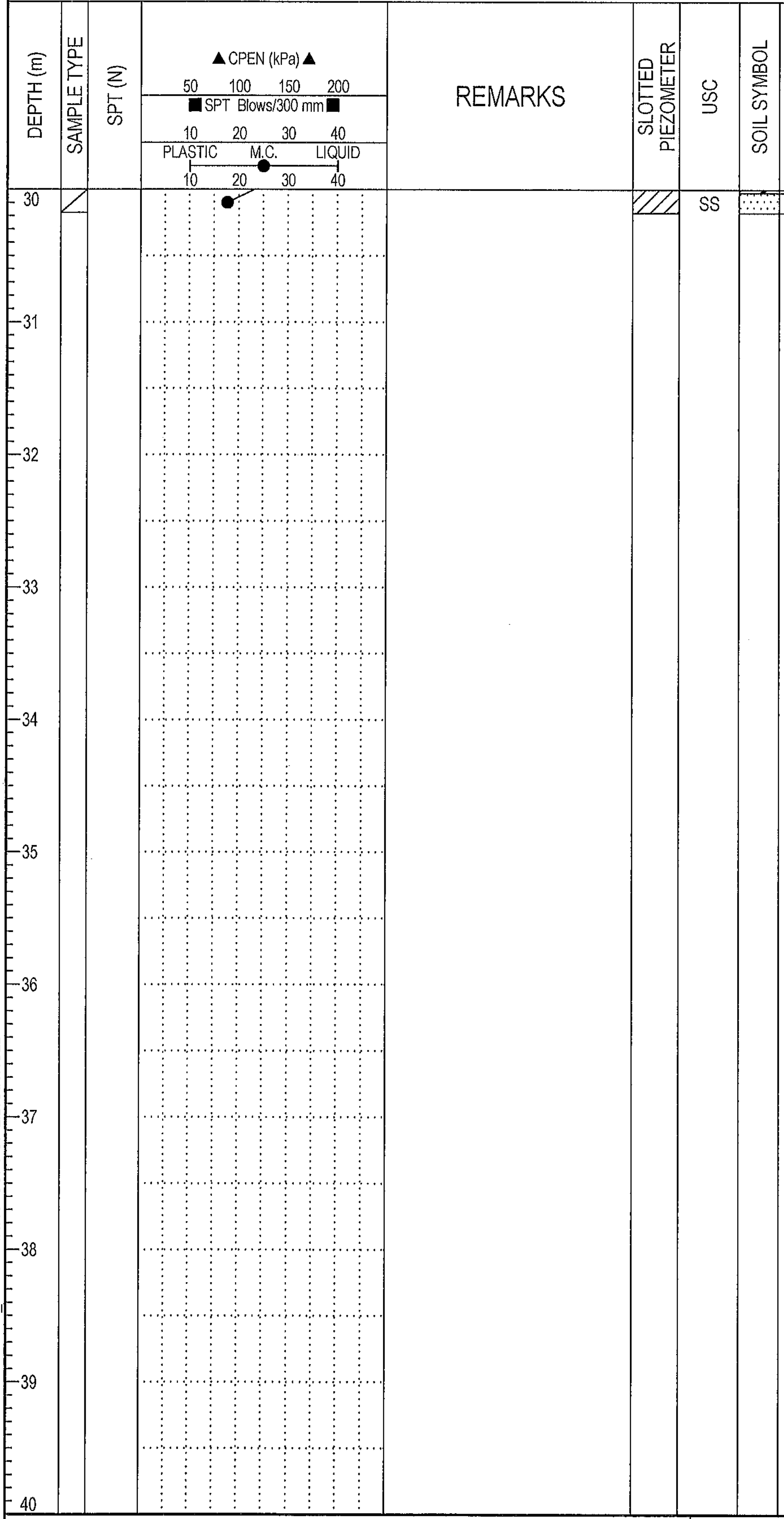
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/5/08
REVIEWED BY: RWT	Page 3 of 4

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-01-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 5, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 720.73 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ⧄ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND



SOIL DESCRIPTION

CLAY SHALE - CONTINUED
hard, grey, weathered, occasional sandstone laminations

SANDSTONE, dense, grey, fine to medium grained, weathered, oxide stained

END OF TEST HOLE AT 30.2m
UPON COMPLETION:
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 5, 2008 = 3.1m
-September 19, 2008 = 2.4m

ELEVATION (m)
690
689
688
687
686
685
684
683
682
681

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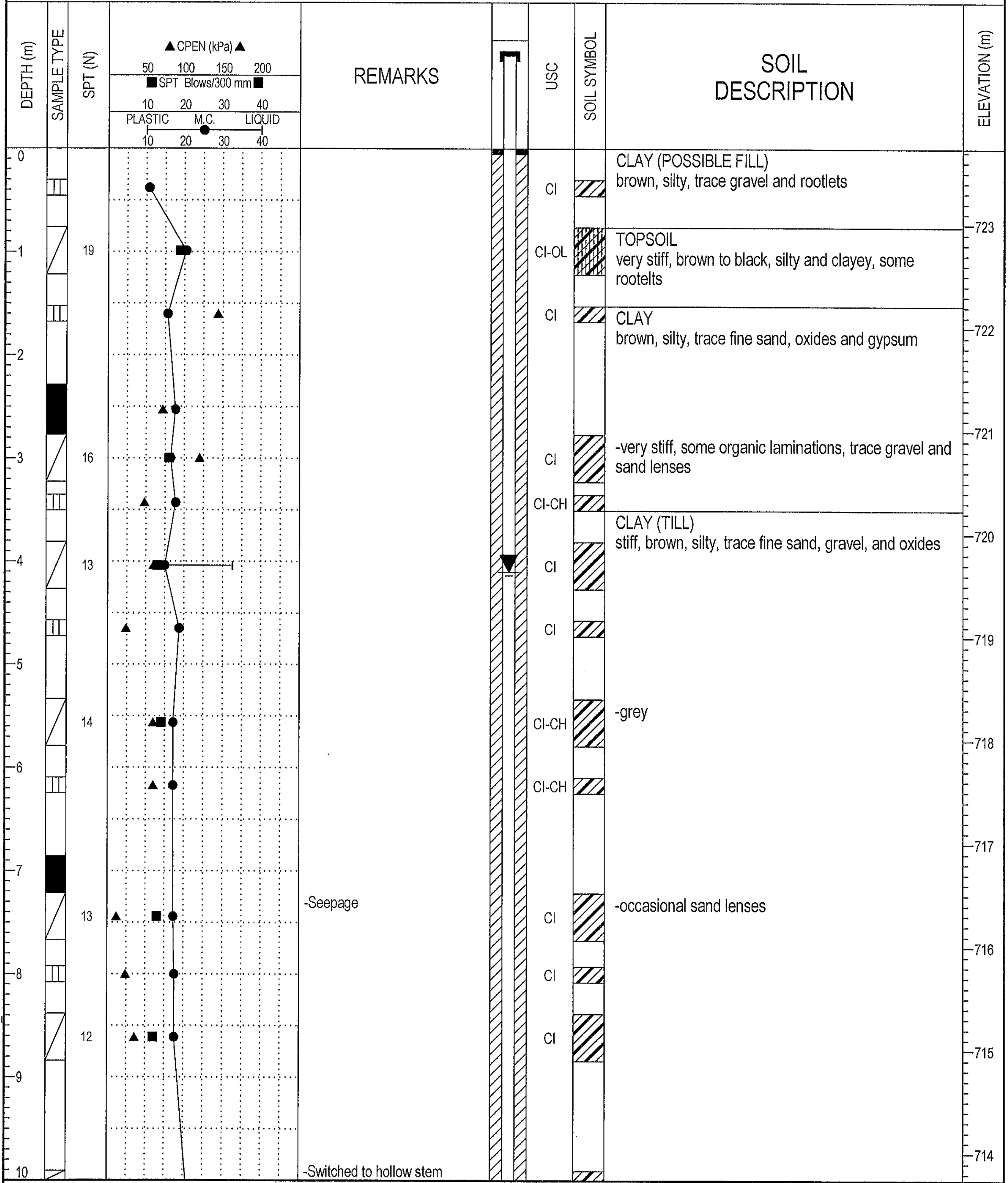
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/5/08
REVIEWED BY: RWT	Page 4 of 4

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-01-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 4, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 723.73 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND



REMARKS

-Seepage

-Switched to hollow stem

SOIL DESCRIPTION

CLAY (POSSIBLE FILL)
brown, silty, trace gravel and rootlets

TOPSOIL
very stiff, brown to black, silty and clayey, some rootelts

CLAY
brown, silty, trace fine sand, oxides and gypsum

-very stiff, some organic laminations, trace gravel and sand lenses

CLAY (TILL)
stiff, brown, silty, trace fine sand, gravel, and oxides

-grey

-occasional sand lenses

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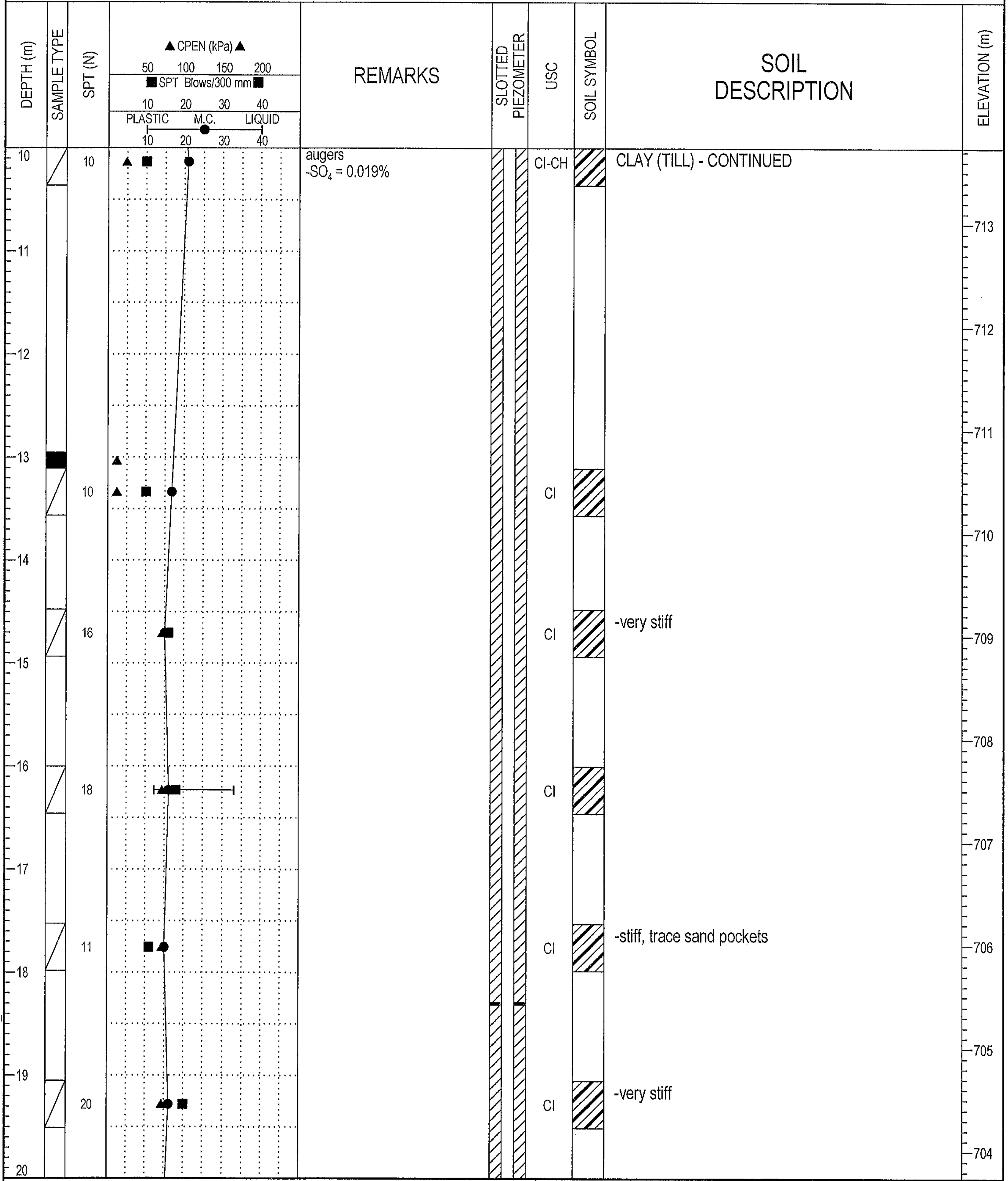
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/4/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-01-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 4, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 723.73 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁘ SAND



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
10	augers $-SO_4 = 0.019\%$	CI-CH	CLAY (TILL) - CONTINUED
10		CI	
16		CI	-very stiff
18		CI	
11		CI	-stiff, trace sand pockets
20		CI	-very stiff

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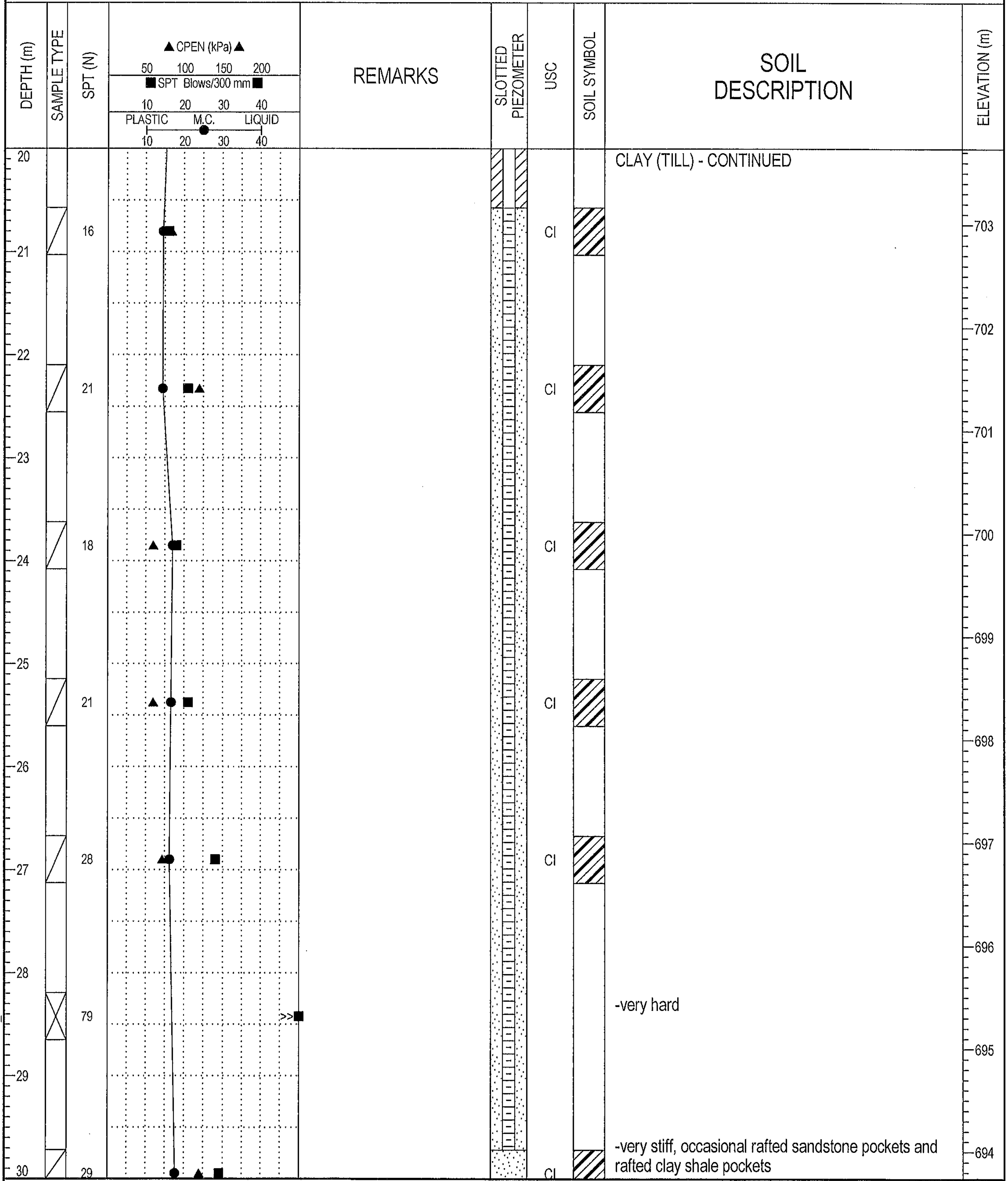
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/4/08
REVIEWED BY: RWT	Page 2 of 4

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-01-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 4, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 723.73 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND



CLAY (TILL) - CONTINUED

-very hard

-very stiff, occasional rafted sandstone pockets and rafted clay shale pockets

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FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/4/08
REVIEWED BY: RWT	Page 3 of 4

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-01-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 4, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 723.73 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ░ SAND

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)
30	◿				░		▨	END OF TEST HOLE AT 30.2m UPON COMPLETION: (Below ground surface) -No slough -Water at 24.6m Standpipe piezometer installed WATER LEVEL READINGS: -September 19, 2008 = 4.1m	
									693
31									
									692
32									
									691
33									
									690
34									
									689
35									
									688
36									
									687
37									
									686
38									
									685
39									
									684
40									

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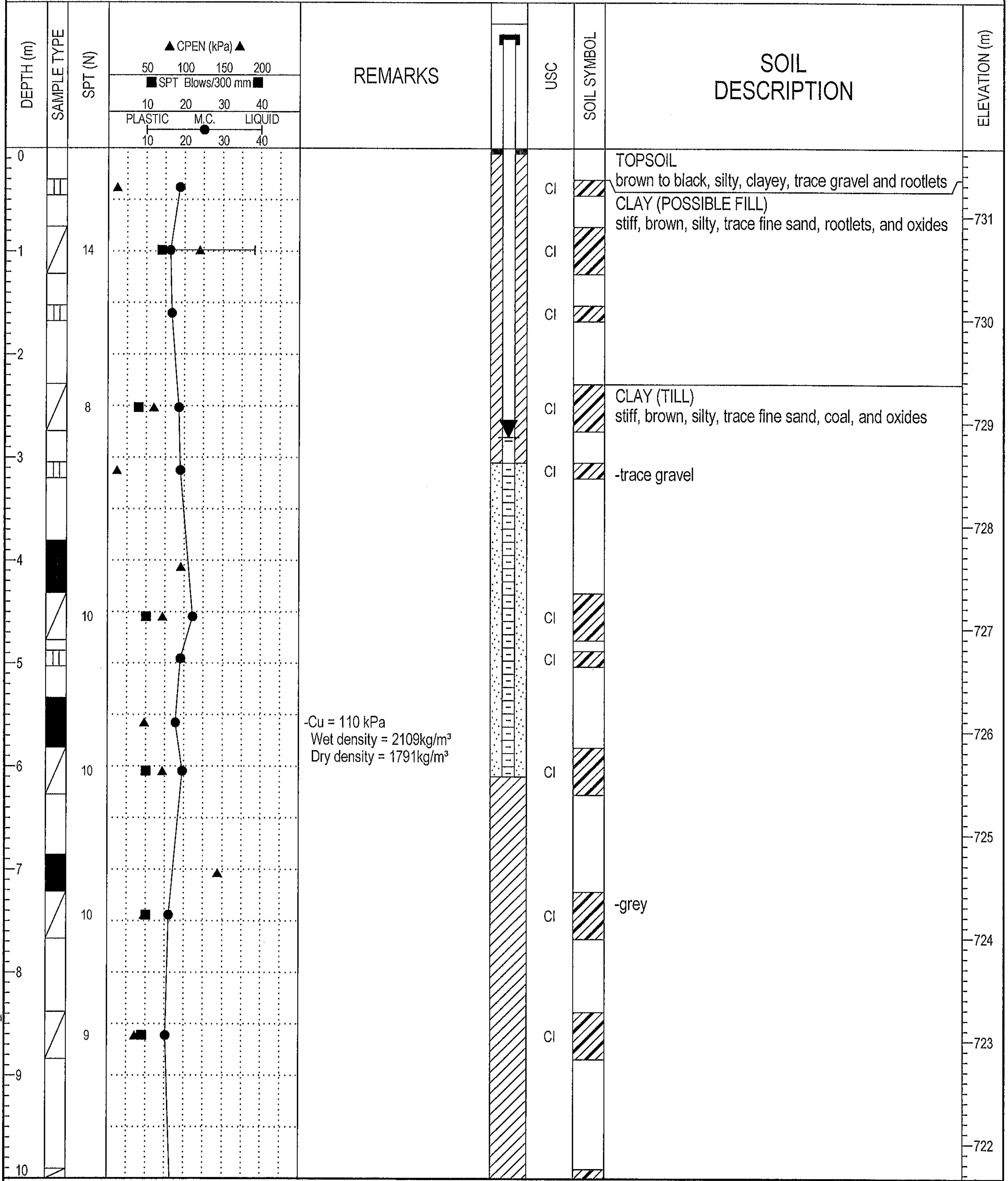
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/4/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO
BOREHOLE NO: **TH08-02-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: August 29, 2008
PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers
LOCATION: See Drawing #19-598-298-1
ELEVATION: 731.66 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE
BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



REMARKS

-Cu = 110 kPa
Wet density = 2109kg/m³
Dry density = 1791kg/m³

SOIL DESCRIPTION

TOPSOIL
brown to black, silty, clayey, trace gravel and rootlets

CLAY (POSSIBLE FILL)
stiff, brown, silty, trace fine sand, rootlets, and oxides

CLAY (TILL)
stiff, brown, silty, trace fine sand, coal, and oxides

-trace gravel

-grey

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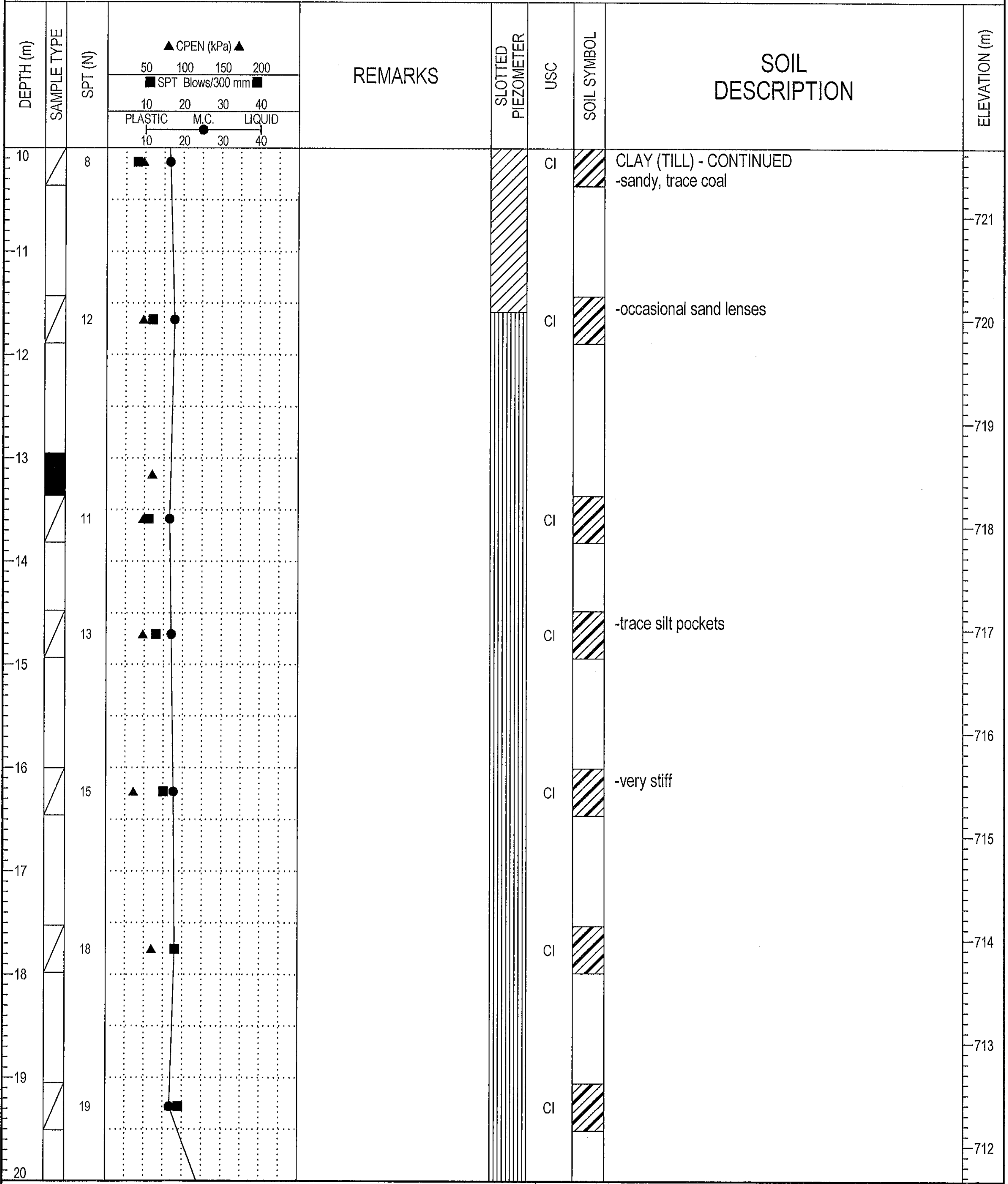
FIELD LOGGED BY: GA
COMPLETION DEPTH: 24.1 m
PREPARED BY: SGR
COMPLETION DATE: 8/29/08
REVIEWED BY: RWT

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-02-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 731.66 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛶ SAND ▥ SLOUGH



SOIL DESCRIPTION

CLAY (TILL) - CONTINUED
-sandy, trace coal

-occasional sand lenses

-trace silt pockets

-very stiff

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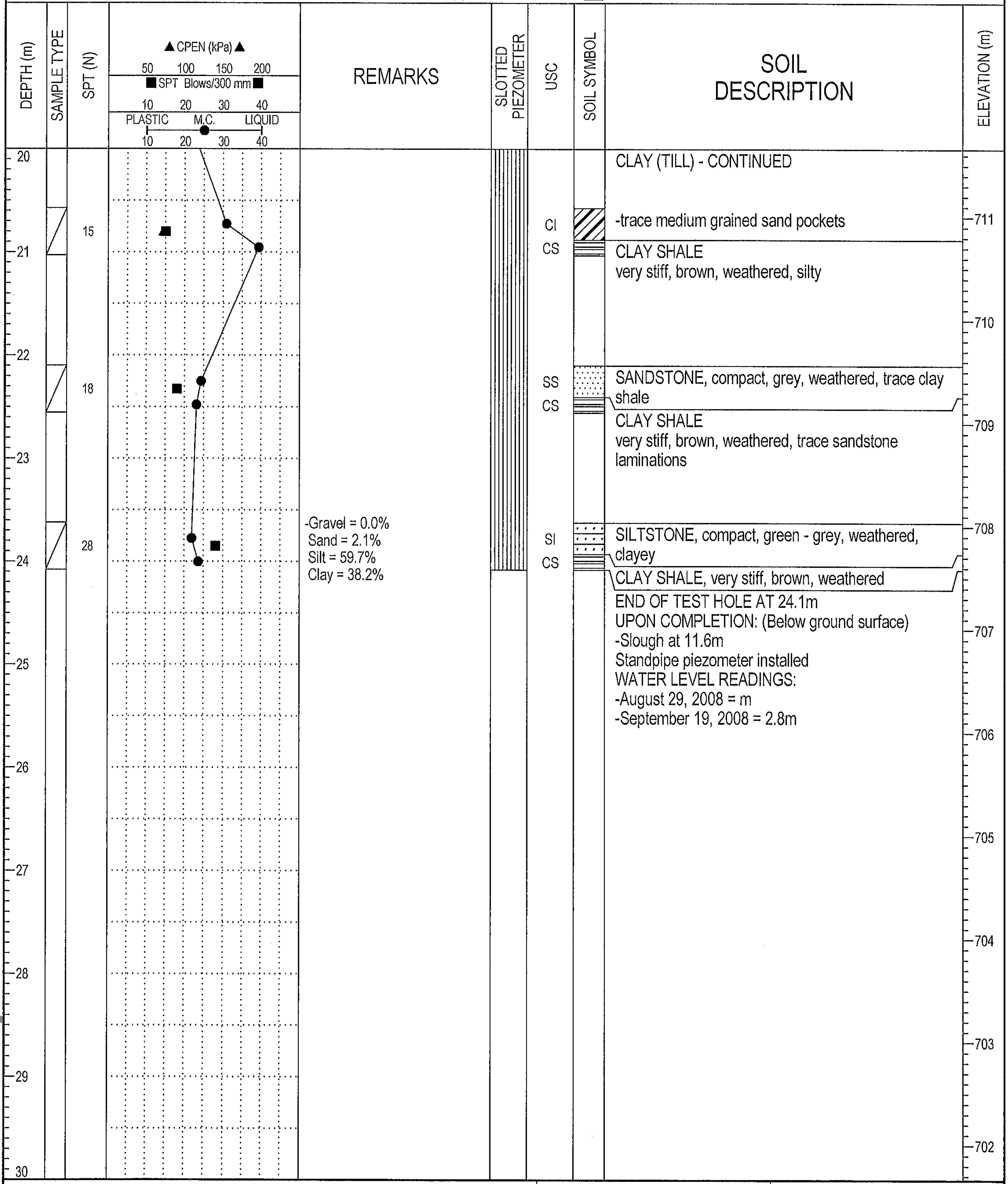
FIELD LOGGED BY: GA	COMPLETION DEPTH: 24.1 m
PREPARED BY: SGR	COMPLETION DATE: 8/29/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO
BOREHOLE NO: **TH08-02-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: August 29, 2008
PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers
LOCATION: See Drawing #19-598-298-1
ELEVATION: 731.66 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE
BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
			CLAY (TILL) - CONTINUED
15		CI	-trace medium grained sand pockets
		CS	CLAY SHALE very stiff, brown, weathered, silty
18		SS	SANDSTONE, compact, grey, weathered, trace clay shale
		CS	CLAY SHALE very stiff, brown, weathered, trace sandstone laminations
28	-Gravel = 0.0% Sand = 2.1% Silt = 59.7% Clay = 38.2%	SI	SILTSTONE, compact, green - grey, weathered, clayey
		CS	CLAY SHALE, very stiff, brown, weathered

END OF TEST HOLE AT 24.1m
UPON COMPLETION: (Below ground surface)
-Slough at 11.6m
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 29, 2008 = m
-September 19, 2008 = 2.8m

THURBER ENGINEERING LTD.
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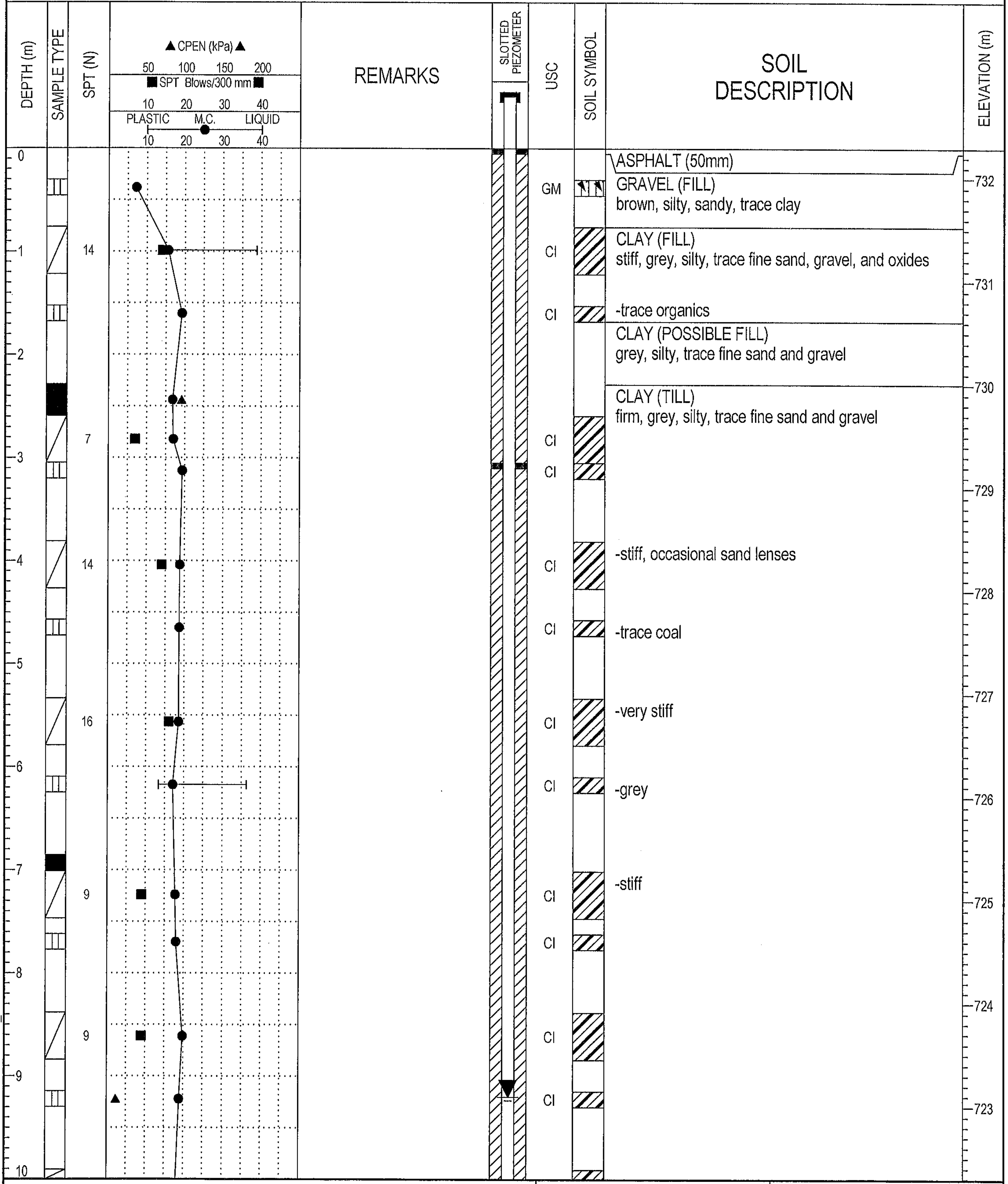
FIELD LOGGED BY: GA
COMPLETION DEPTH: 24.1 m
PREPARED BY: SGR
COMPLETION DATE: 8/29/08
REVIEWED BY: RWT

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-02-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 28, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 732.29 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND



ASPHALT (50mm)

GRAVEL (FILL)
brown, silty, sandy, trace clay

CLAY (FILL)
stiff, grey, silty, trace fine sand, gravel, and oxides

-trace organics

CLAY (POSSIBLE FILL)
grey, silty, trace fine sand and gravel

CLAY (TILL)
firm, grey, silty, trace fine sand and gravel

-stiff, occasional sand lenses

-trace coal

-very stiff

-grey

-stiff

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

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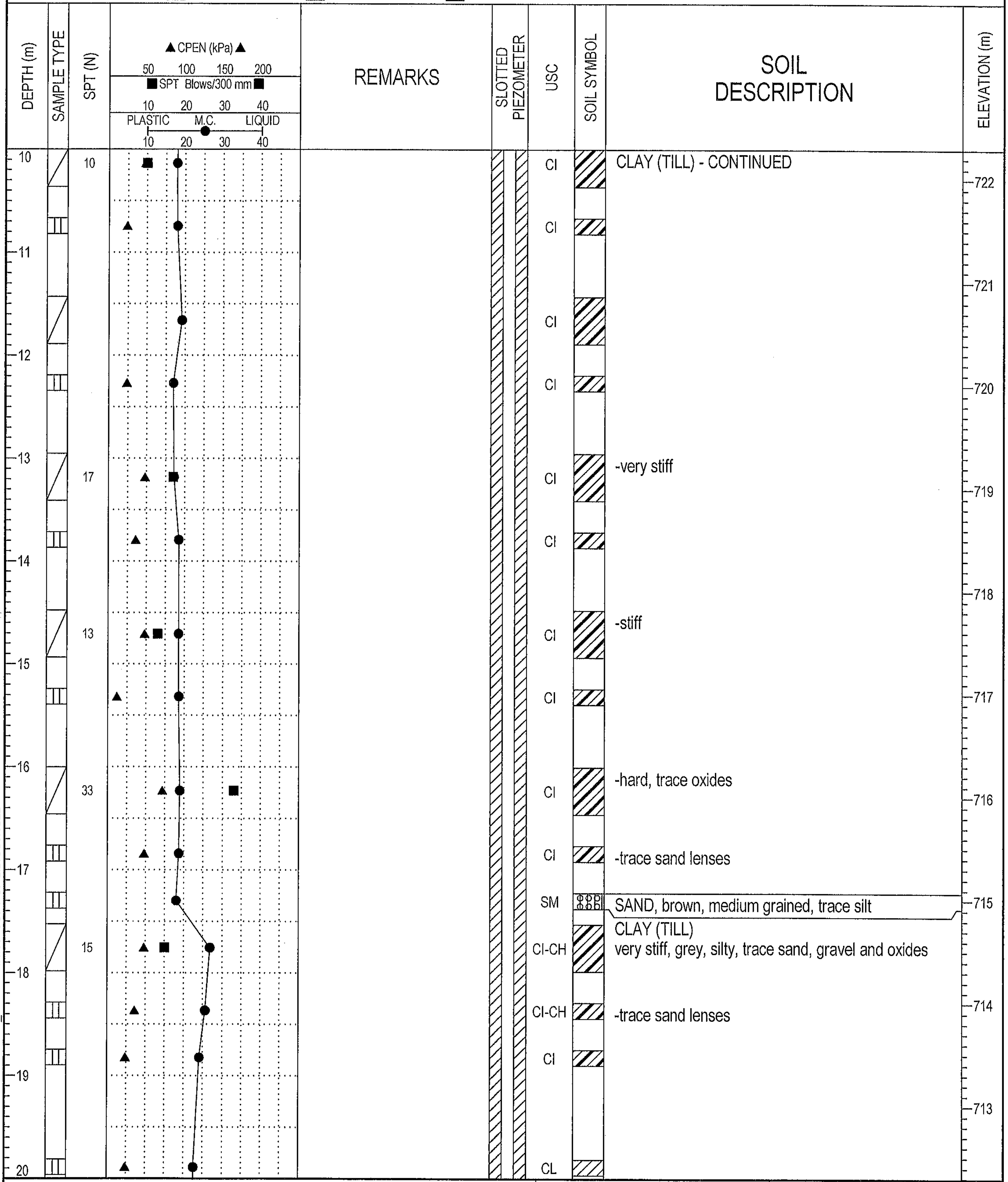
FIELD LOGGED BY: GA	COMPLETION DEPTH: 27.1 m
PREPARED BY: SGR	COMPLETION DATE: 8/28/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-02-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 28, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 732.29 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ░ SAND



CLAY (TILL) - CONTINUED

-very stiff

-stiff

-hard, trace oxides

-trace sand lenses

SAND, brown, medium grained, trace silt

CLAY (TILL)
very stiff, grey, silty, trace sand, gravel and oxides

-trace sand lenses

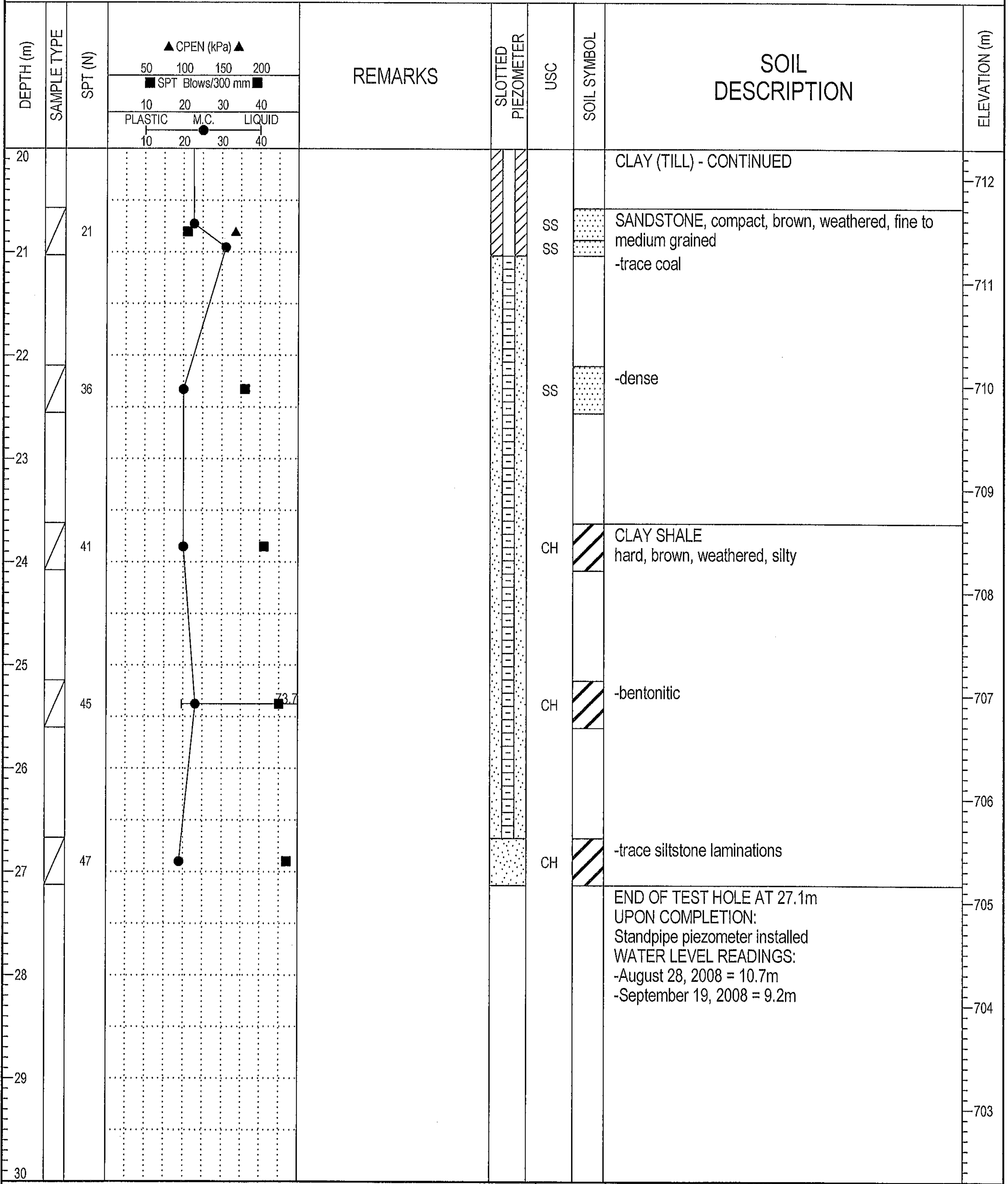
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 27.1 m
PREPARED BY: SGR	COMPLETION DATE: 8/28/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-02-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 28, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 732.29 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND



CLAY (TILL) - CONTINUED

SANDSTONE, compact, brown, weathered, fine to medium grained

-trace coal

-dense

CLAY SHALE
hard, brown, weathered, silty

-bentonitic

-trace siltstone laminations

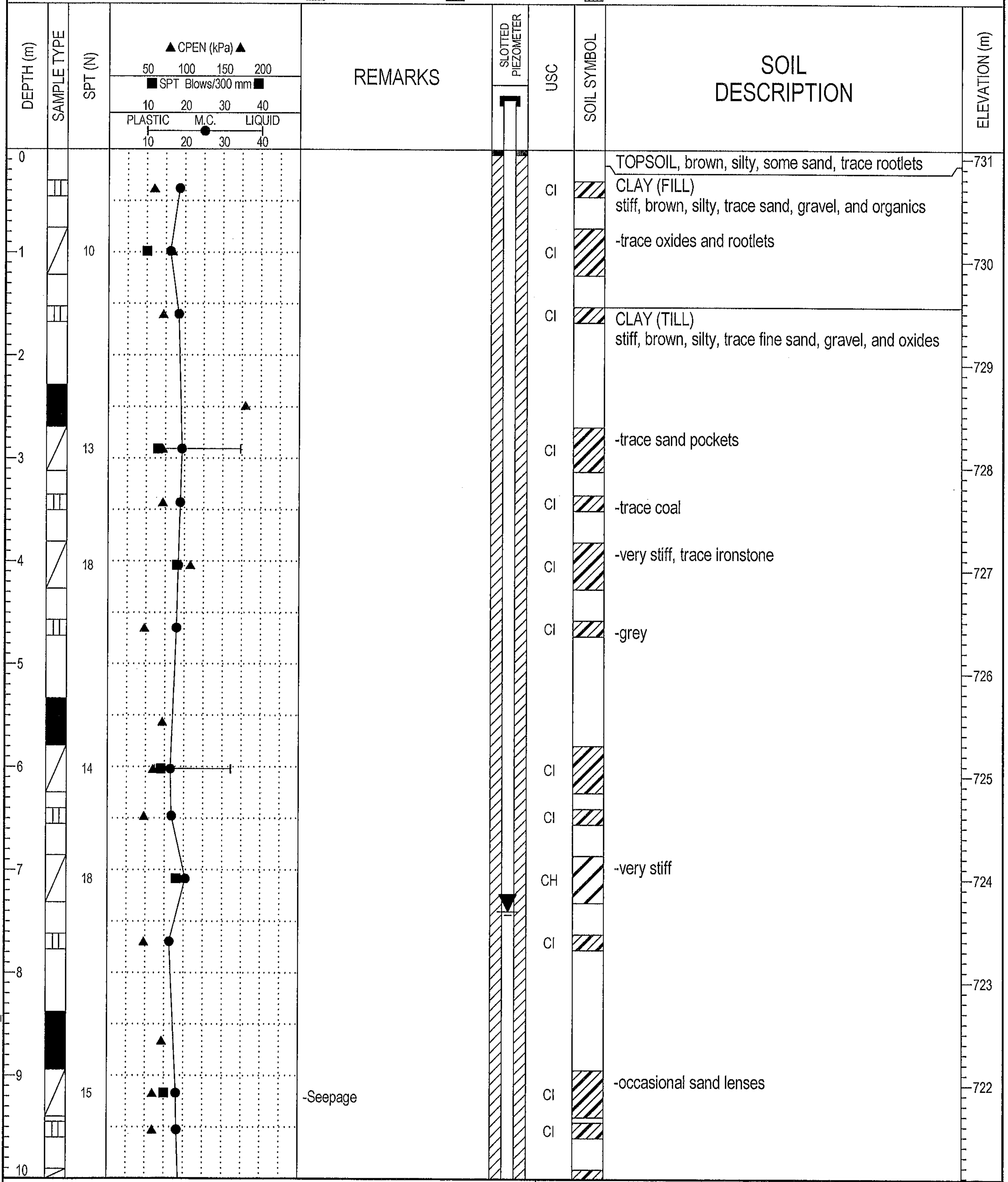
END OF TEST HOLE AT 27.1m
UPON COMPLETION:
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 28, 2008 = 10.7m
-September 19, 2008 = 9.2m

FIELD LOGGED BY: GA	COMPLETION DEPTH: 27.1 m
PREPARED BY: SGR	COMPLETION DATE: 8/28/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-03-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 2, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 731.08 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



-Seepage

TOPSOIL, brown, silty, some sand, trace rootlets

CLAY (FILL)
stiff, brown, silty, trace sand, gravel, and organics

-trace oxides and rootlets

CLAY (TILL)
stiff, brown, silty, trace fine sand, gravel, and oxides

-trace sand pockets

-trace coal

-very stiff, trace ironstone

-grey

-very stiff

-occasional sand lenses

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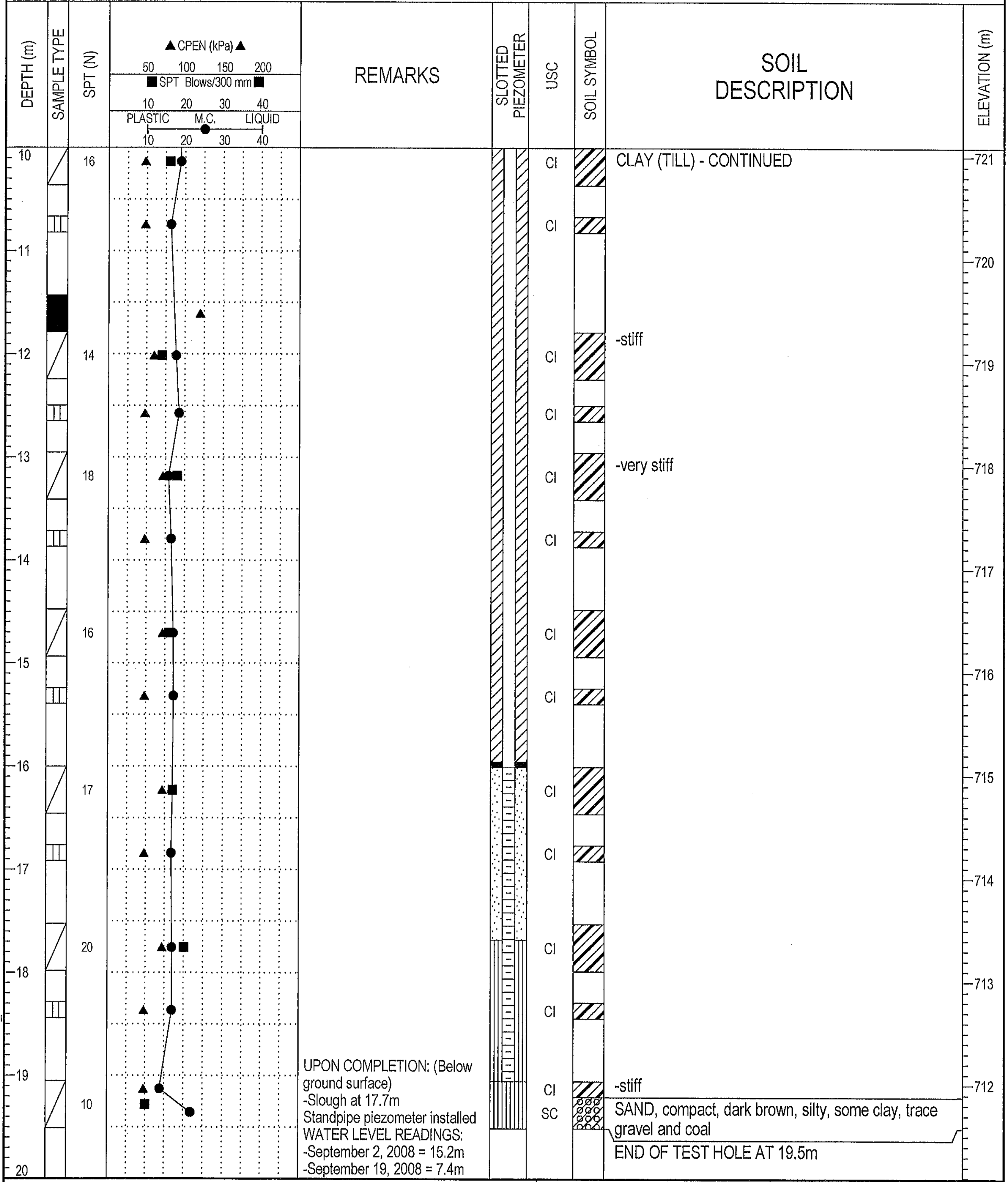
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 9/2/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO
BOREHOLE NO: **TH08-03-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: September 2, 2008
PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers
LOCATION: See Drawing #19-598-298-1
ELEVATION: 731.08 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



CLAY (TILL) - CONTINUED

-stiff

-very stiff

-stiff

SAND, compact, dark brown, silty, some clay, trace gravel and coal

END OF TEST HOLE AT 19.5m

UPON COMPLETION: (Below ground surface)
-Slough at 17.7m
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 2, 2008 = 15.2m
-September 19, 2008 = 7.4m

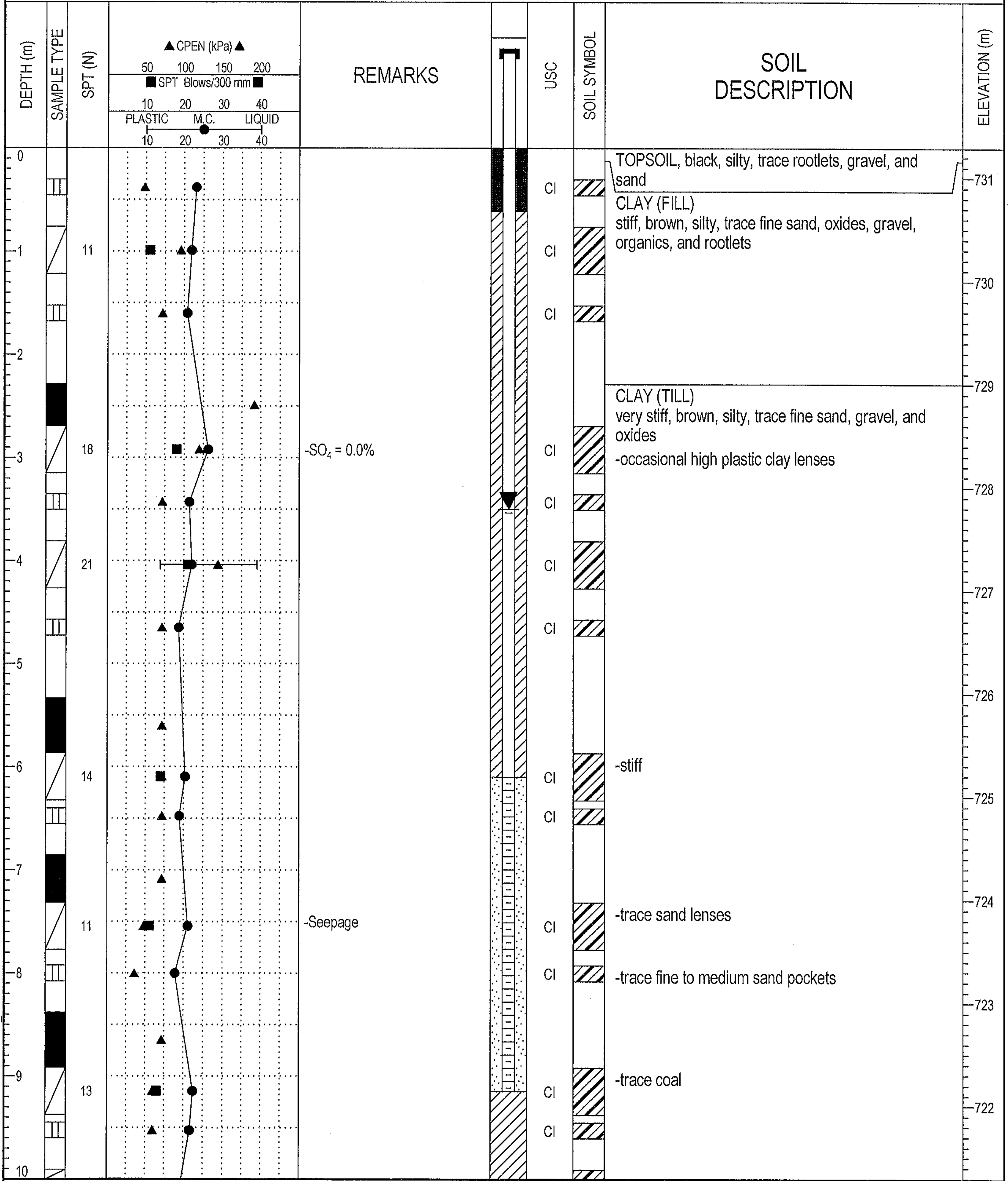
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA
COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR
COMPLETION DATE: 9/2/08
REVIEWED BY: RWT

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-03-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 2, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 731.29 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁘ SAND ▥ SLOUGH



SOIL DESCRIPTION

TOPSOIL, black, silty, trace rootlets, gravel, and sand

CLAY (FILL)
stiff, brown, silty, trace fine sand, oxides, gravel, organics, and rootlets

CLAY (TILL)
very stiff, brown, silty, trace fine sand, gravel, and oxides

-occasional high plastic clay lenses

-stiff

-trace sand lenses

-trace fine to medium sand pockets

-trace coal

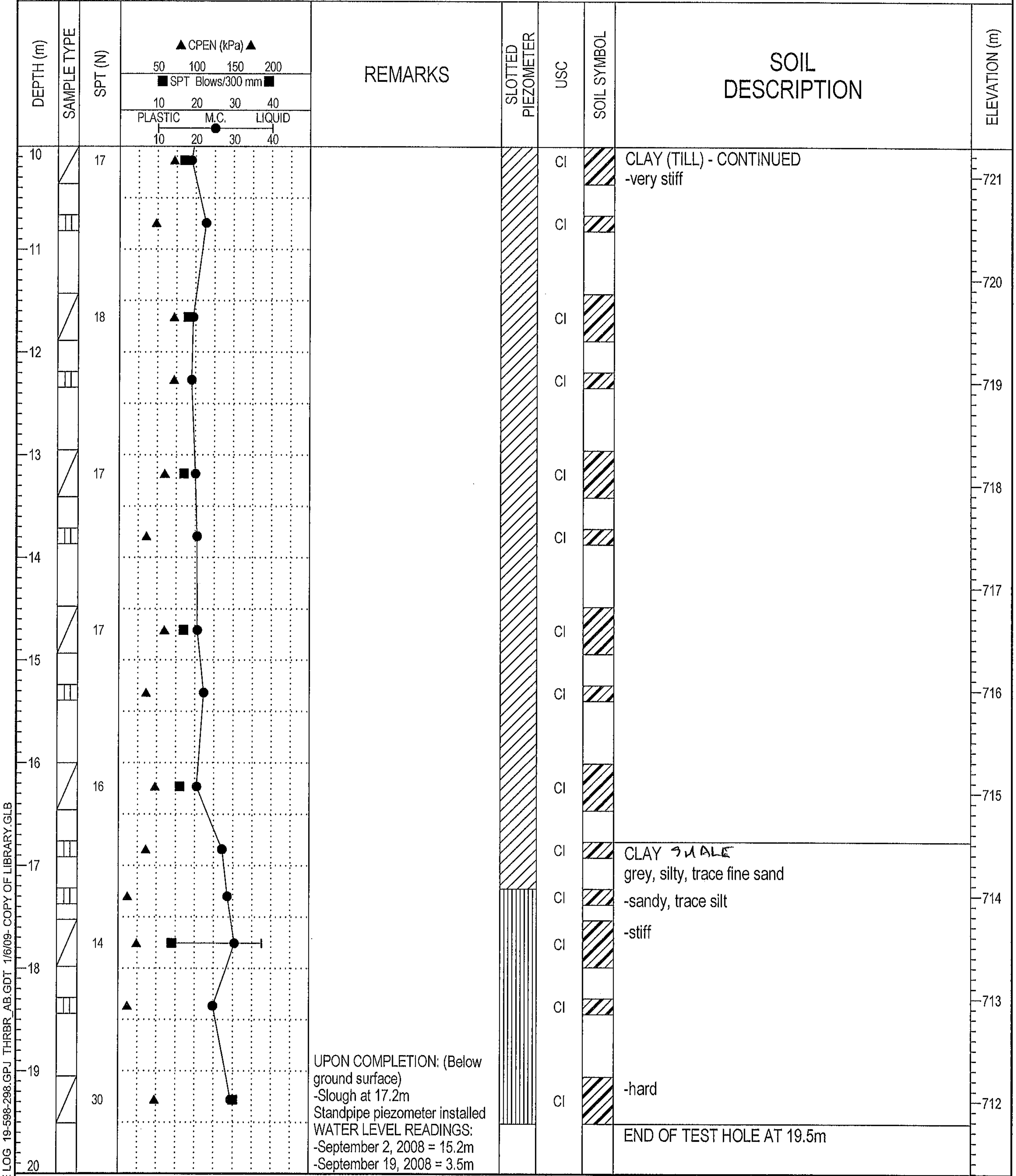
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 9/2/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-03-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 2, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 731.29 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



REMARKS

UPON COMPLETION: (Below ground surface)
-Slough at 17.2m
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 2, 2008 = 15.2m
-September 19, 2008 = 3.5m

SOIL DESCRIPTION

CLAY (TILL) - CONTINUED
-very stiff

CLAY SHALE
grey, silty, trace fine sand
-sandy, trace silt
-stiff

-hard

END OF TEST HOLE AT 19.5m

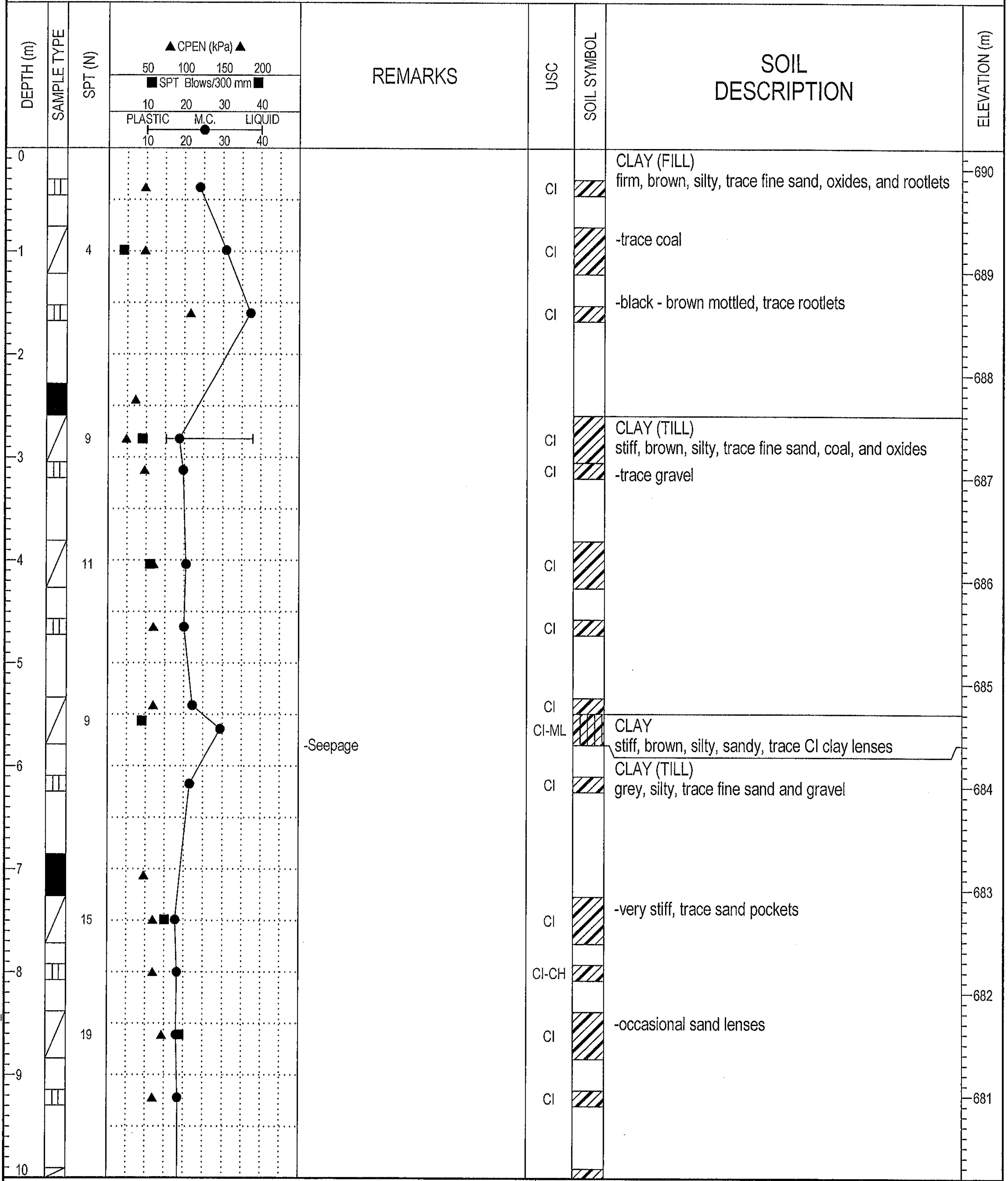
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 9/2/08
REVIEWED BY: RWT	Page 2 of 2

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-04-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 690.2 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ⧄ SPT ■ SHELBY TUBE



CLAY (FILL)
firm, brown, silty, trace fine sand, oxides, and rootlets

-trace coal

-black - brown mottled, trace rootlets

CLAY (TILL)
stiff, brown, silty, trace fine sand, coal, and oxides

-trace gravel

CLAY
stiff, brown, silty, sandy, trace CI clay lenses

CLAY (TILL)
grey, silty, trace fine sand and gravel

-very stiff, trace sand pockets

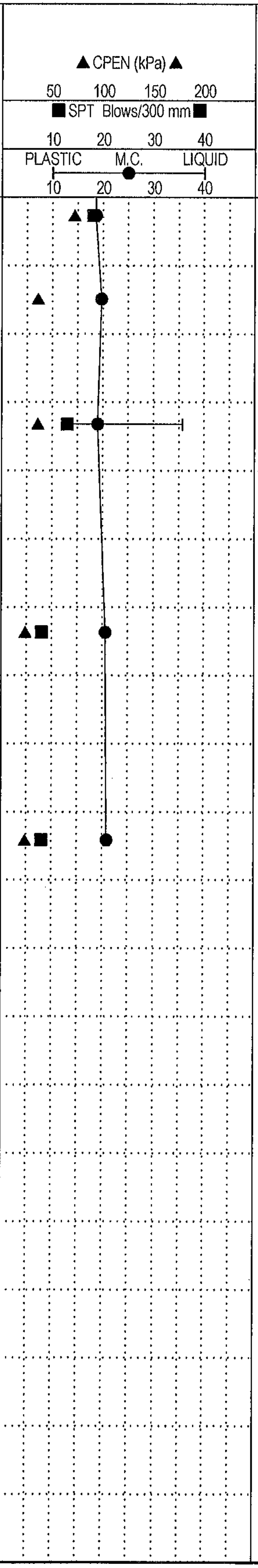
-occasional sand lenses

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 14.9 m
PREPARED BY: SGR	COMPLETION DATE: 9/3/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-04-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 690.2 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ⧄ SPT ■ SHELBY TUBE



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10	⧄	18		CI	▨	CLAY (TILL) - CONTINUED -very stiff	680
	▥			CI	▨		
11							679
	⧄	13	-Switched to hollow stem augers	CI	▨	-stiff	
12							678
13	⧄	8		CI-CH	▨		677
14							676
	⧄	8		CI-CH	▨		
15						END OF TEST HOLE AT 14.9m (B.G.S.) (Below Ground Surface) -Slough at 13m Backfilled with drill cuttings	675
16							674
17							673
18							672
19							671
20							

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

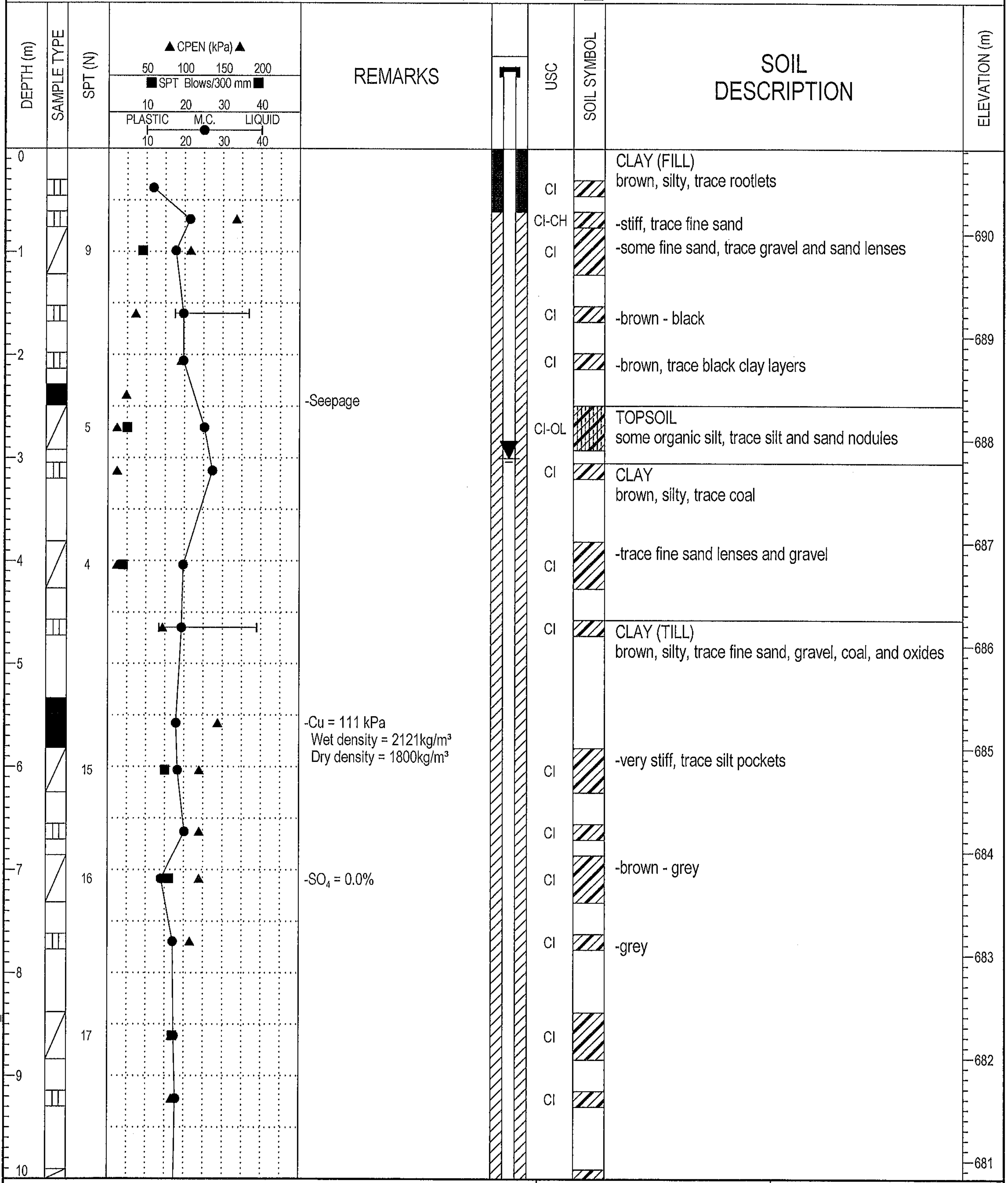
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 14.9 m
PREPARED BY: SGR	COMPLETION DATE: 9/3/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-04-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 27, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 690.82 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND ▥ SLOUGH



REMARKS

-Seepage

-Cu = 111 kPa
Wet density = 2121kg/m³
Dry density = 1800kg/m³

-SO_4 = 0.0%

SOIL DESCRIPTION

CLAY (FILL)
brown, silty, trace rootlets
-stiff, trace fine sand
-some fine sand, trace gravel and sand lenses
-brown - black
-brown, trace black clay layers

TOPSOIL
some organic silt, trace silt and sand nodules

CLAY
brown, silty, trace coal
-trace fine sand lenses and gravel

CLAY (TILL)
brown, silty, trace fine sand, gravel, coal, and oxides
-very stiff, trace silt pockets
-brown - grey
-grey

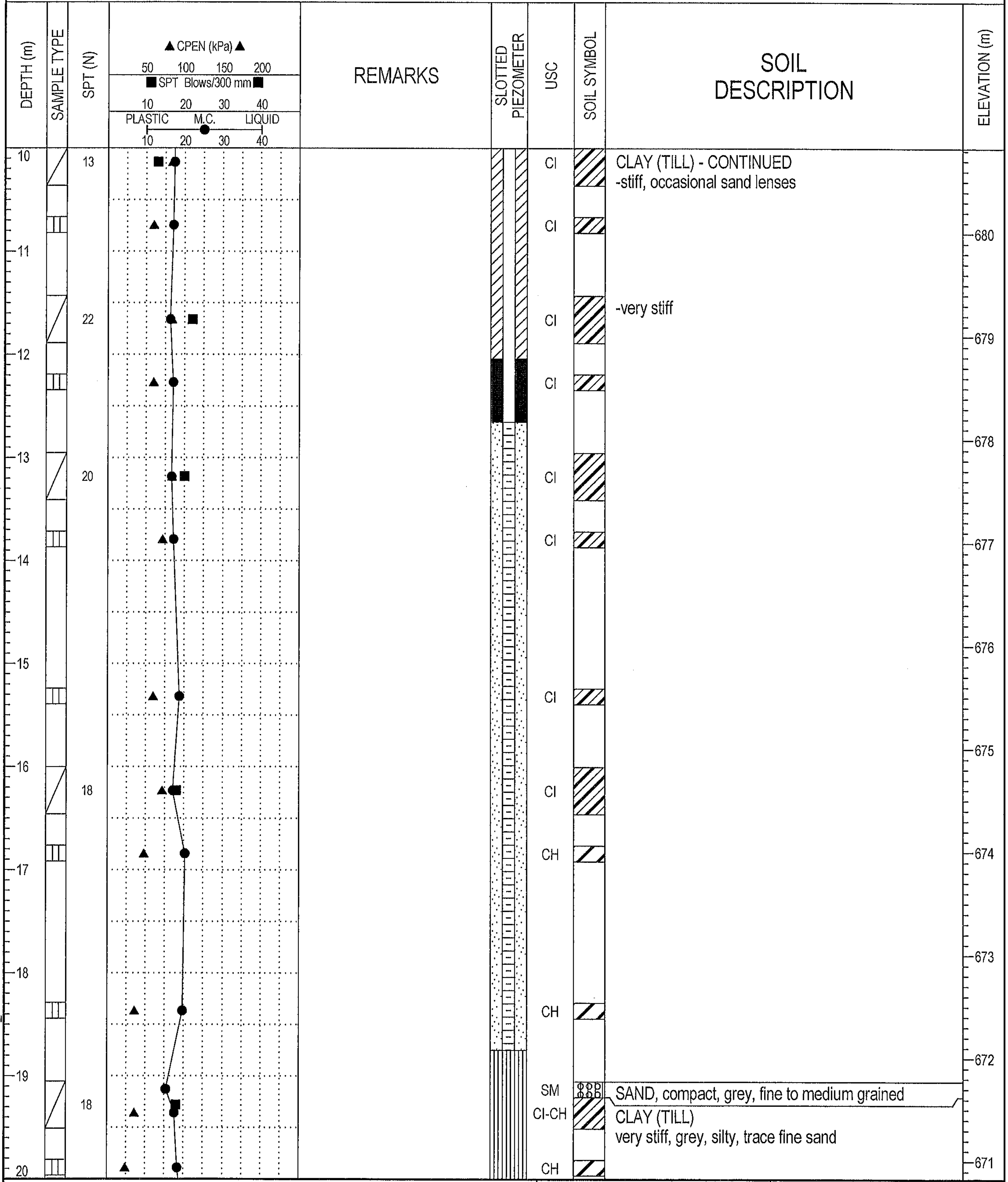
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/27/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-04-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 27, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 690.82 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



CLAY (TILL) - CONTINUED
-stiff, occasional sand lenses

-very stiff

SAND, compact, grey, fine to medium grained

CLAY (TILL)
very stiff, grey, silty, trace fine sand

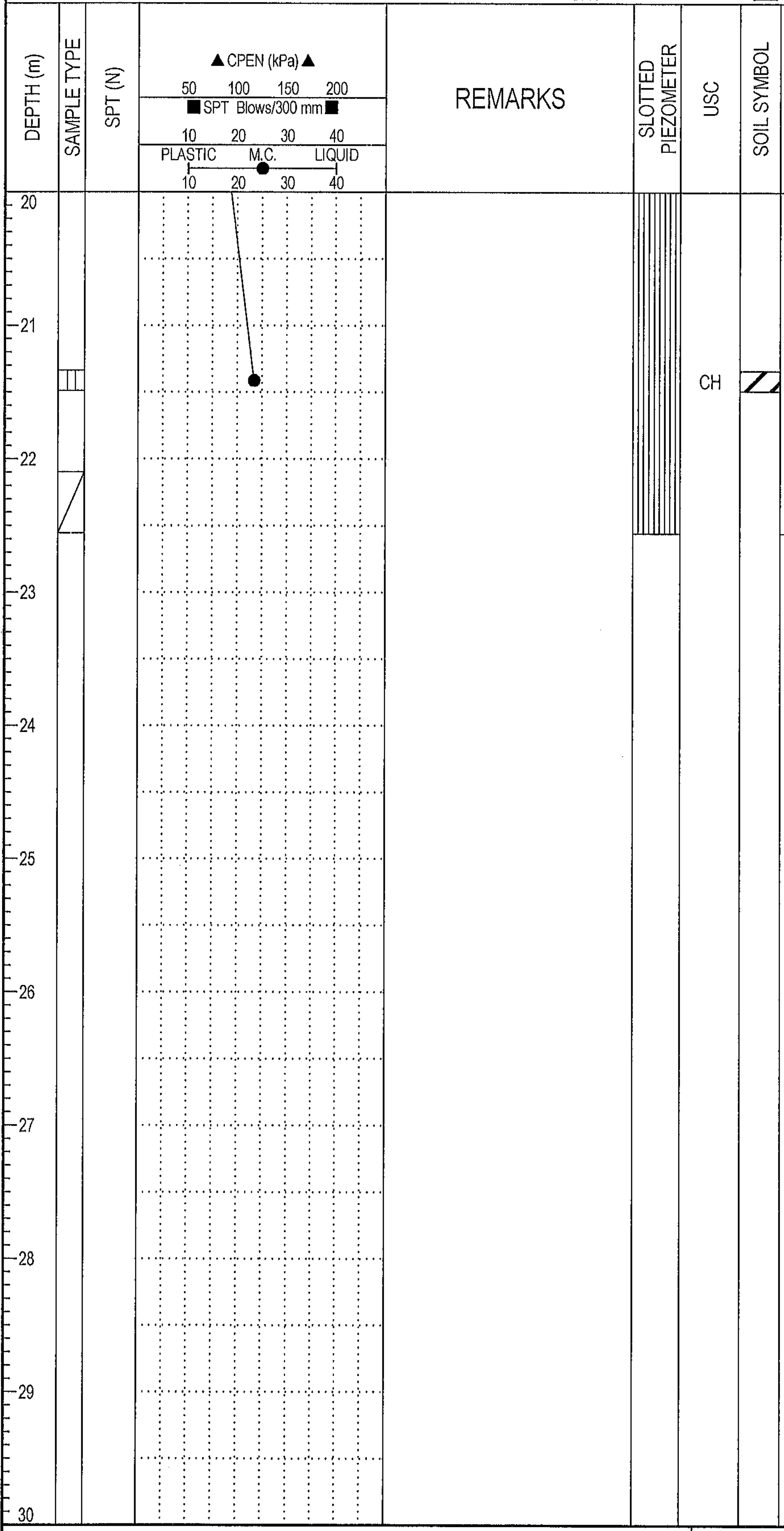
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/27/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-04-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 27, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 690.82 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



SOIL DESCRIPTION

CLAY (TILL) - CONTINUED
-trace gravel, occasional sand lenses

END OF TEST HOLE AT 22.6m
UPON COMPLETION: (Below ground surface)
-Slough at 18.7m
-Trace water at 18.7m
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 27, 2008 = 15.1m
-September 19, 2008 = 3.0m

ELEVATION (m)
670
669
668
667
666
665
664
663
662
661

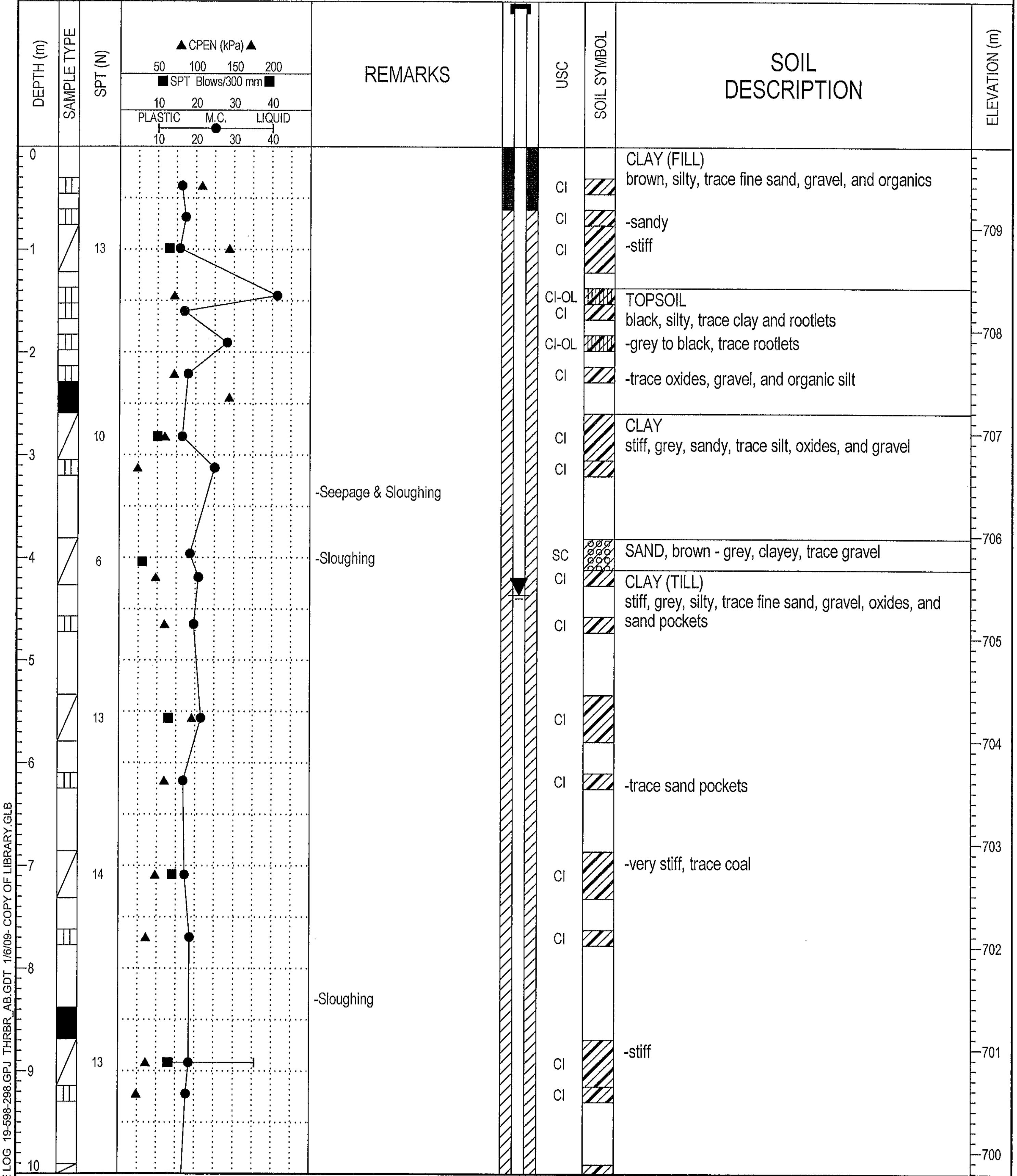
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/27/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-05-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 8 & 15, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 709.78 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



-Seepage & Sloughing

-Sloughing

-Sloughing

CLAY (FILL)
brown, silty, trace fine sand, gravel, and organics
-sandy
-stiff

TOPSOIL
black, silty, trace clay and rootlets
-grey to black, trace rootlets
-trace oxides, gravel, and organic silt

CLAY
stiff, grey, sandy, trace silt, oxides, and gravel

SAND, brown - grey, clayey, trace gravel

CLAY (TILL)
stiff, grey, silty, trace fine sand, gravel, oxides, and sand pockets
-trace sand pockets
-very stiff, trace coal
-stiff

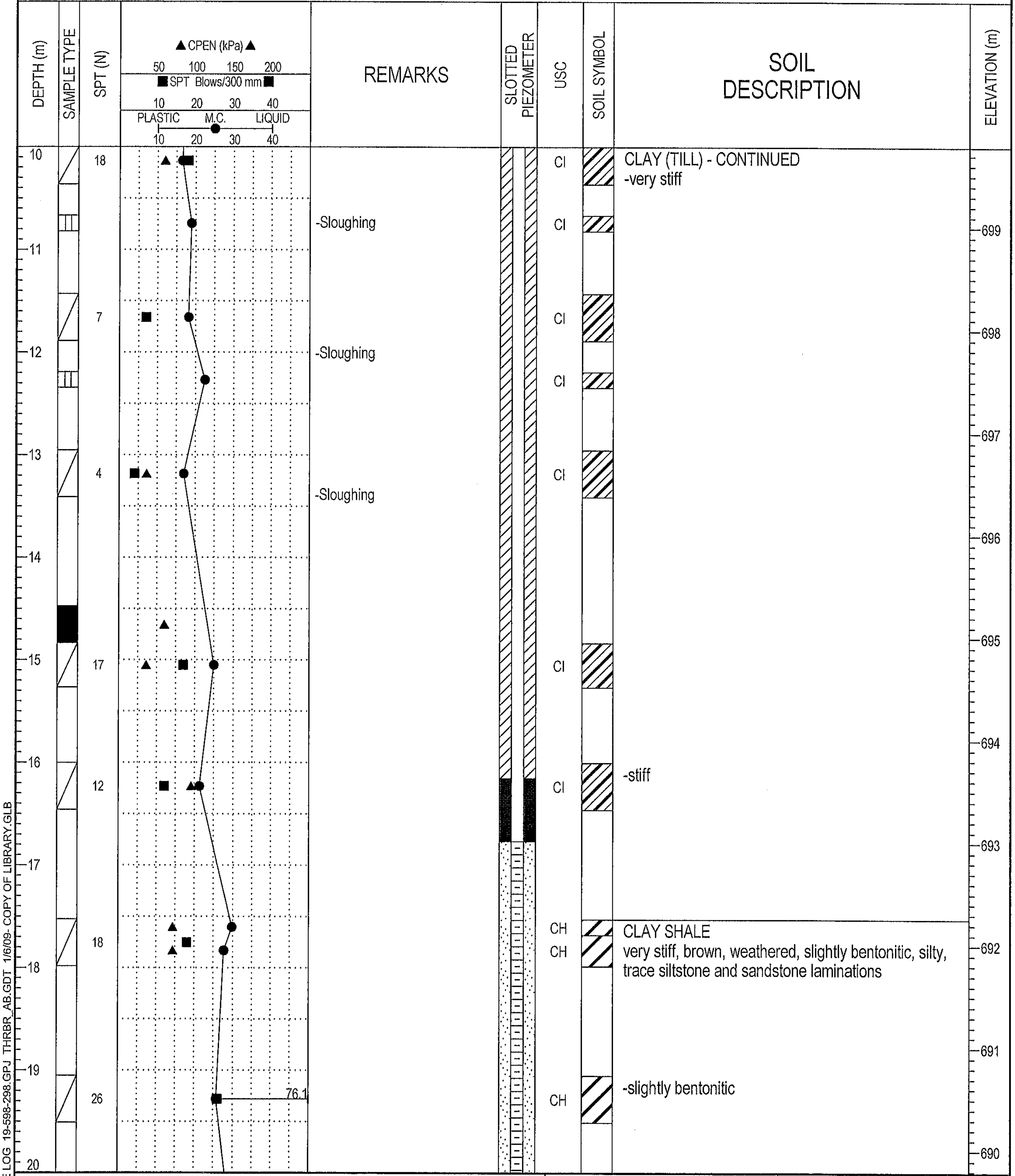
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/15/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-05-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 8 & 15, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 709.78 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁘ SAND ▥ SLOUGH



-Sloughing

-Sloughing

-Sloughing

CLAY (TILL) - CONTINUED
-very stiff

-stiff

CLAY SHALE
very stiff, brown, weathered, slightly bentonitic, silty, trace siltstone and sandstone laminations

-slightly bentonitic

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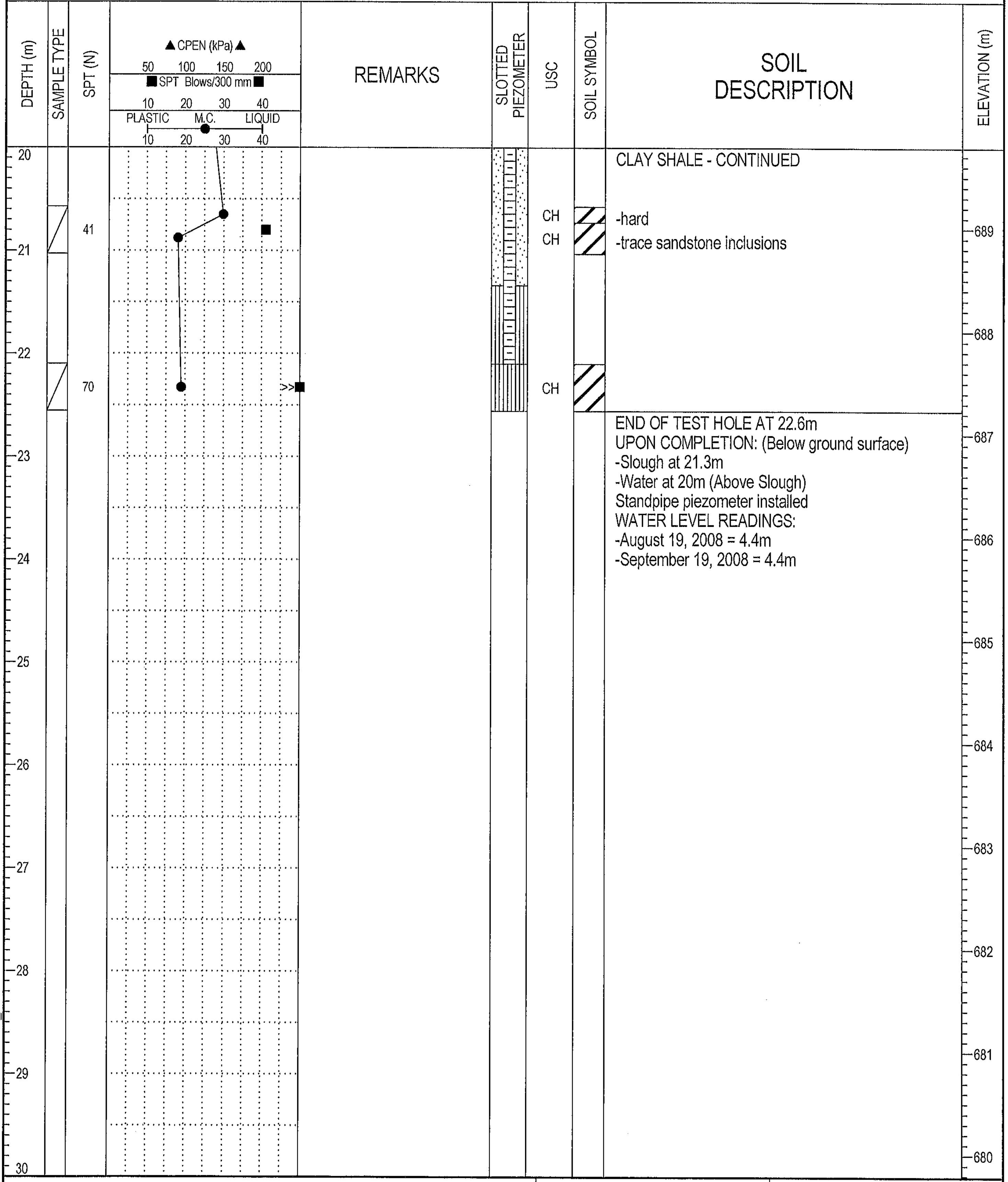
FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/15/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-05-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 8 & 15, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 709.78 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



CLAY SHALE - CONTINUED

-hard

-trace sandstone inclusions

END OF TEST HOLE AT 22.6m
UPON COMPLETION: (Below ground surface)
-Slough at 21.3m
-Water at 20m (Above Slough)
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 19, 2008 = 4.4m
-September 19, 2008 = 4.4m

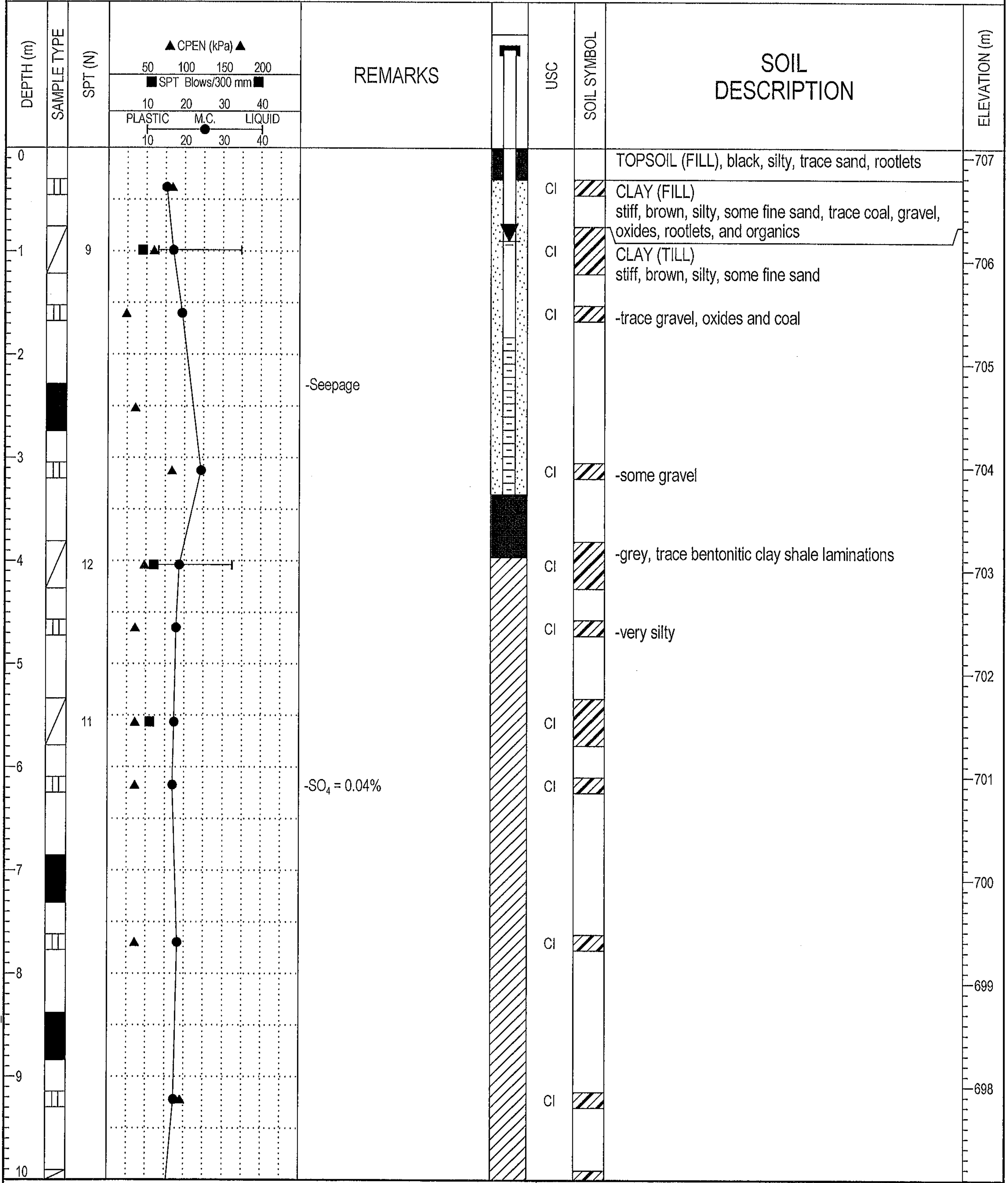
BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS	FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
	PREPARED BY: SGR	COMPLETION DATE: 8/15/08
	REVIEWED BY: RWT	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-05-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 13, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 707.09 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ⛆ SAND ▨ DRILL CUTTINGS



REMARKS	SOIL DESCRIPTION
	TOPSOIL (FILL), black, silty, trace sand, rootlets
	CLAY (FILL) stiff, brown, silty, some fine sand, trace coal, gravel, oxides, rootlets, and organics
	CLAY (TILL) stiff, brown, silty, some fine sand
	-trace gravel, oxides and coal
-Seepage	
	-some gravel
	-grey, trace bentonitic clay shale laminations
	-very silty
$-SO_4 = 0.04\%$	

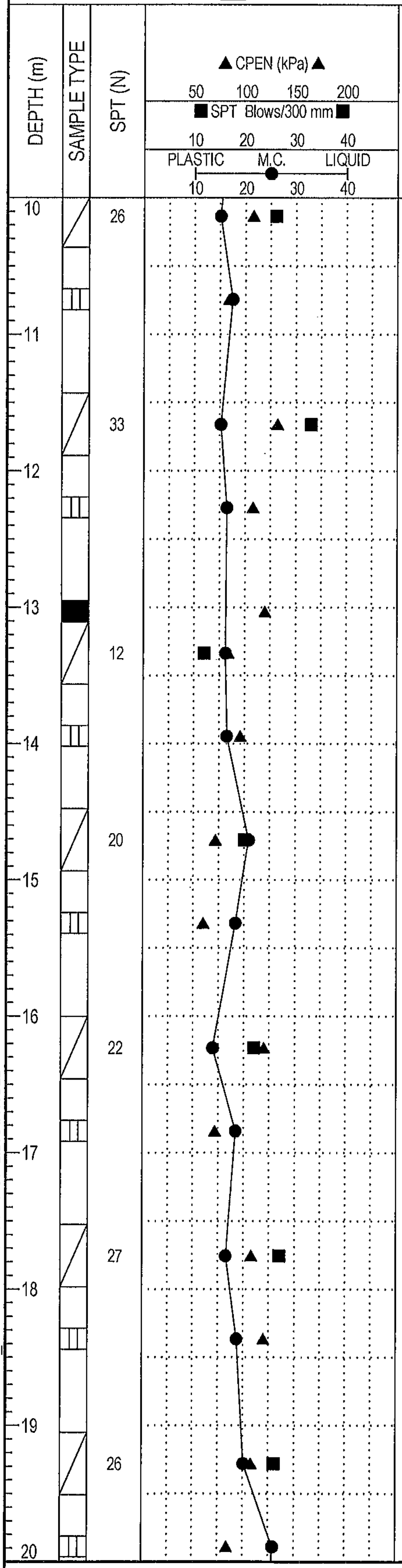
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/13/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-05-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 13, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 707.09 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ░ SAND ▨ DRILL CUTTINGS



SPT (N)	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION
26			CI		CLAY (TILL) - CONTINUED -very stiff
			CI		
33			CI		-hard
			CI		
12			CI		-stiff, trace oxides
			CI		
20			CI		-very stiff
			CI		
22			CI		
			CI		
27			CI		
			CI		
26			CI		-trace clay shale
			CI		CLAY SHALE

ELEVATION (m)
697
696
695
694
693
692
691
690
689
688

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

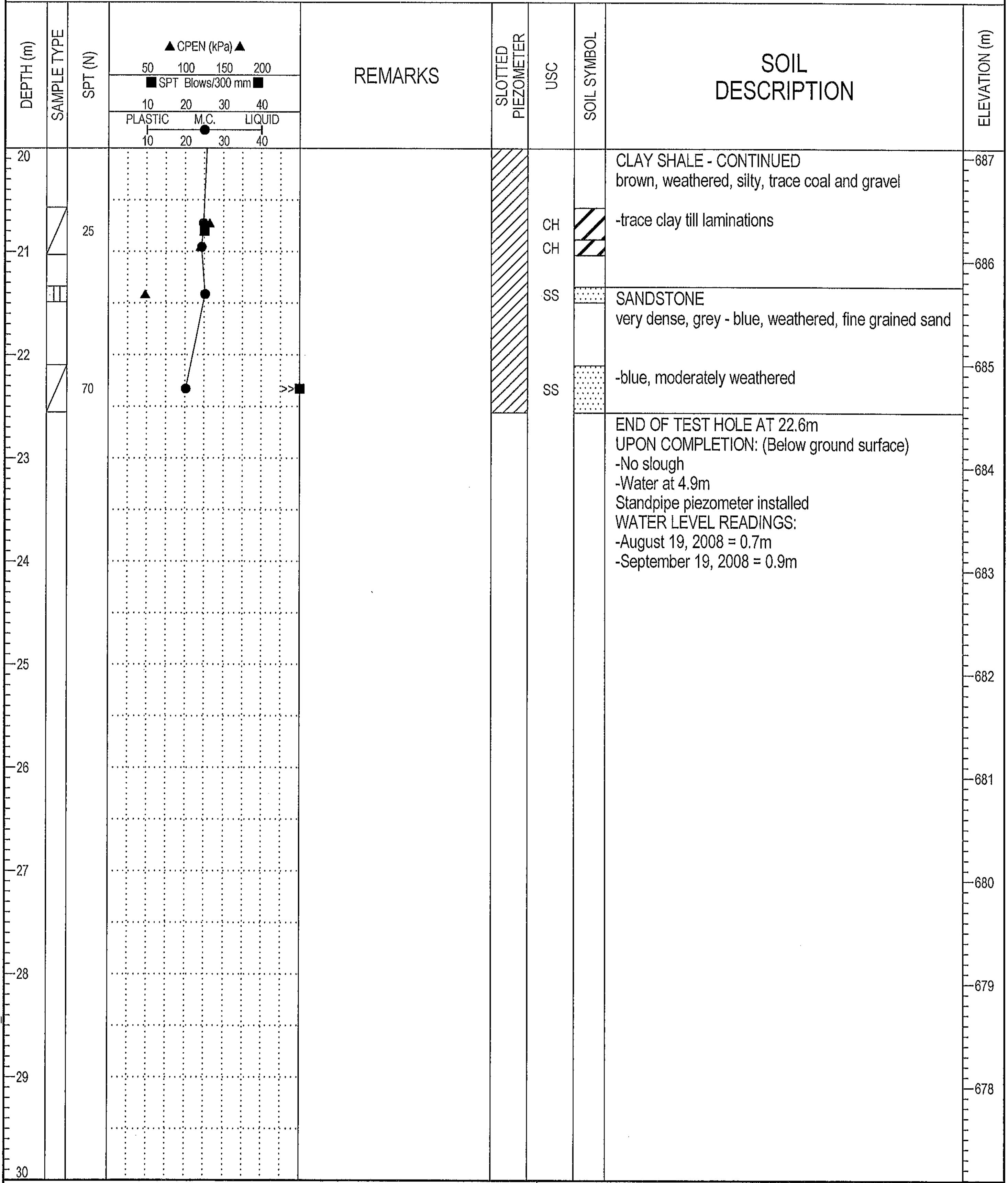
FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/13/08
REVIEWED BY: RWT	Page 2 of 3

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-05-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 13, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 707.09 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ⛆ SAND ▨ DRILL CUTTINGS



CLAY SHALE - CONTINUED
brown, weathered, silty, trace coal and gravel

-trace clay till laminations

SANDSTONE
very dense, grey - blue, weathered, fine grained sand

-blue, moderately weathered

END OF TEST HOLE AT 22.6m
UPON COMPLETION: (Below ground surface)
-No slough
-Water at 4.9m
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 19, 2008 = 0.7m
-September 19, 2008 = 0.9m

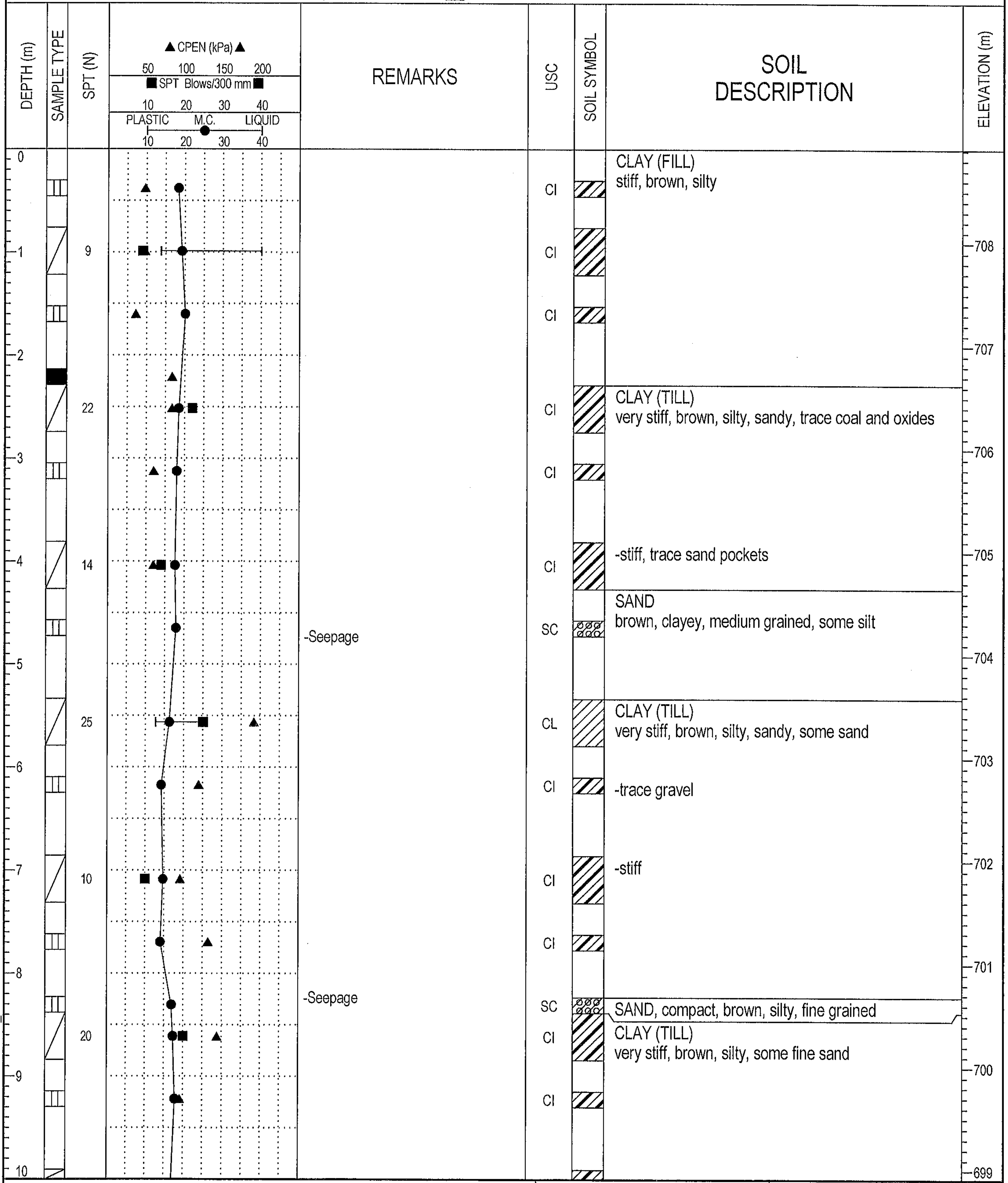
BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/13/08
REVIEWED BY: RWT	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-06-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 5, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 708.91 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE



SOIL DESCRIPTION

CLAY (FILL)
stiff, brown, silty

CLAY (TILL)
very stiff, brown, silty, sandy, trace coal and oxides

-stiff, trace sand pockets

SAND
brown, clayey, medium grained, some silt

-Seepage

CLAY (TILL)
very stiff, brown, silty, sandy, some sand

-trace gravel

-stiff

-Seepage

SAND, compact, brown, silty, fine grained

CLAY (TILL)
very stiff, brown, silty, some fine sand

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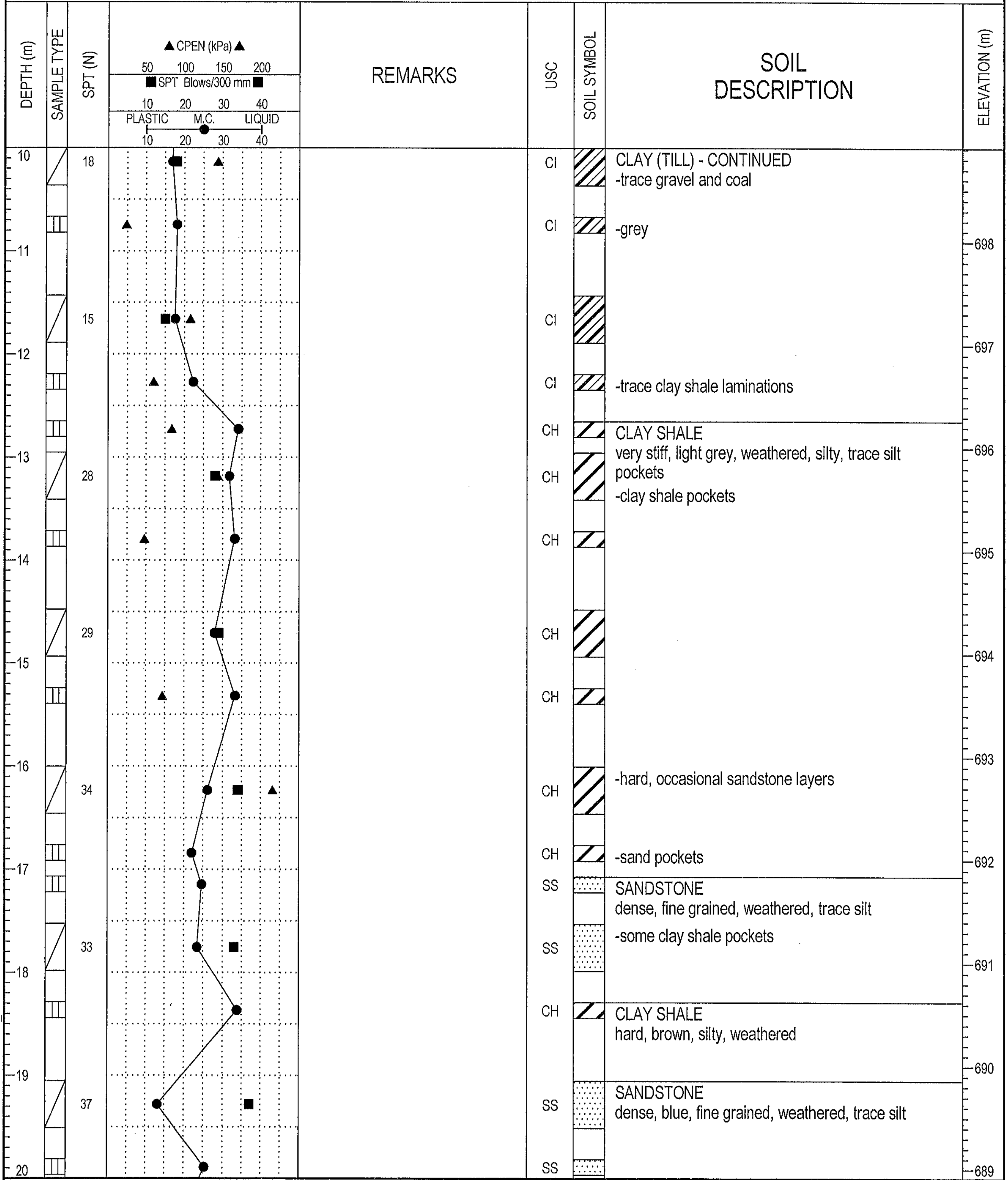
FIELD LOGGED BY: GA	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 8/5/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-06-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 5, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 708.91 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE



CLAY (TILL) - CONTINUED
-trace gravel and coal

-grey

-trace clay shale laminations

CLAY SHALE
very stiff, light grey, weathered, silty, trace silt pockets
-clay shale pockets

-hard, occasional sandstone layers

-sand pockets

SANDSTONE
dense, fine grained, weathered, trace silt
-some clay shale pockets

CLAY SHALE
hard, brown, silty, weathered

SANDSTONE
dense, blue, fine grained, weathered, trace silt

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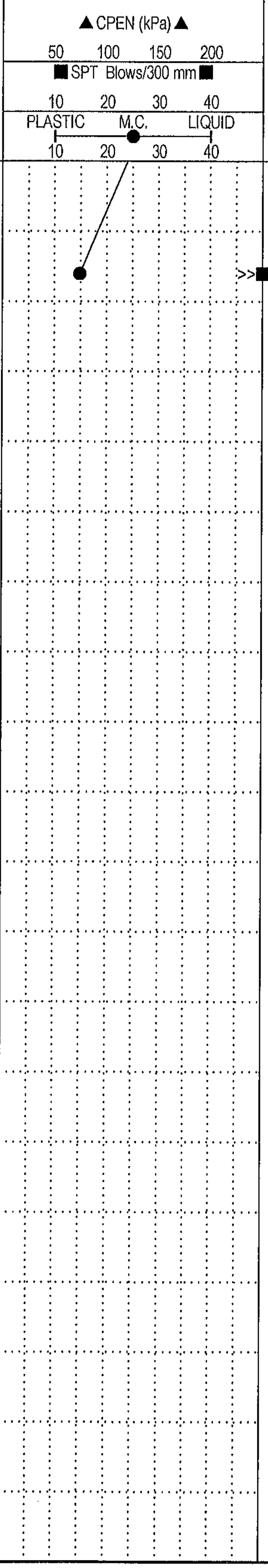
FIELD LOGGED BY: GA	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 8/5/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO
BOREHOLE NO: **TH08-06-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: August 5, 2008
PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers
LOCATION: See Drawing #19-598-298-1
ELEVATION: 708.91 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
20						SANDSTONE - CONTINUED	
	◿	50/60		SS	▒	-very dense, moderately weathered	
21						END OF TEST HOLE AT 21.0m UPON COMPLETION: (Below ground surface) -No Slough -Water at 4.6m Backfilled with drill cuttings and bentonite	688
22							687
23							686
24							685
25							684
26							683
27							682
28							681
29							680
30							679

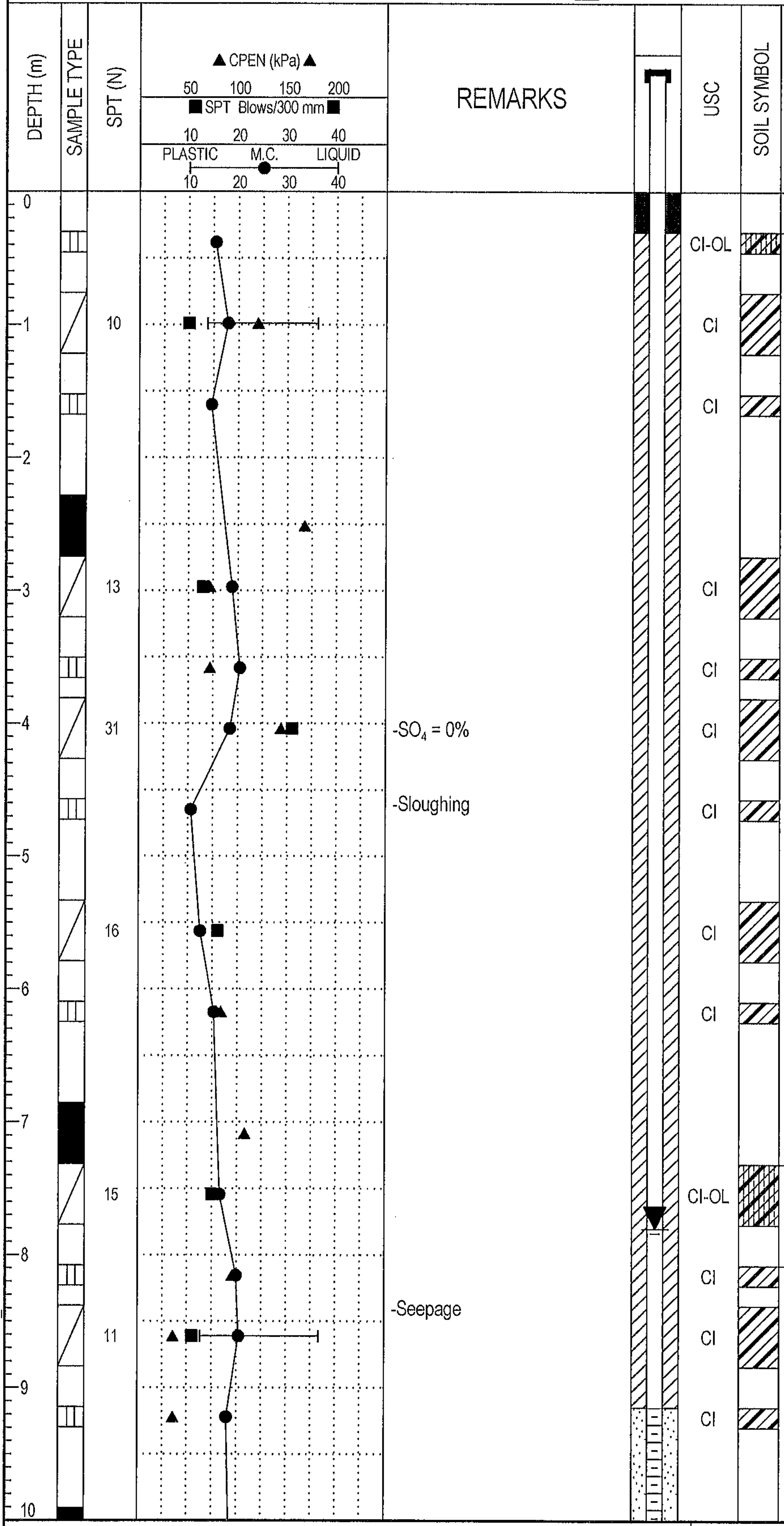
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA
PREPARED BY: SGR
REVIEWED BY: RWT
COMPLETION DEPTH: 21.0 m
COMPLETION DATE: 8/5/08

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-07-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 7, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 713.89 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND



SOIL DESCRIPTION

TOPSOIL (FILL)
black, clayey, trace gravel and sand lenses

CLAY (FILL)
stiff, brown, silty, trace fine sand and gravel
-trace coal, oxides, and sand pockets

-sandy

-trace sand and organics

-hard

-black, organic odor

-very stiff, grey, silty, some organics, trace sand, rootlets, and gravel

-trace sand pockets, coal, and oxides

TOPSOIL
very stiff, black, sandy, trace bentonitic clay lenses, fine sand lenses, and rootlets

CLAY (TILL)
stiff, greyish brown, silty, trace coal, oxides, gravel, and fine sand

-trace sand pockets

ELEVATION (m): 713, 712, 711, 710, 709, 708, 707, 706, 705, 704

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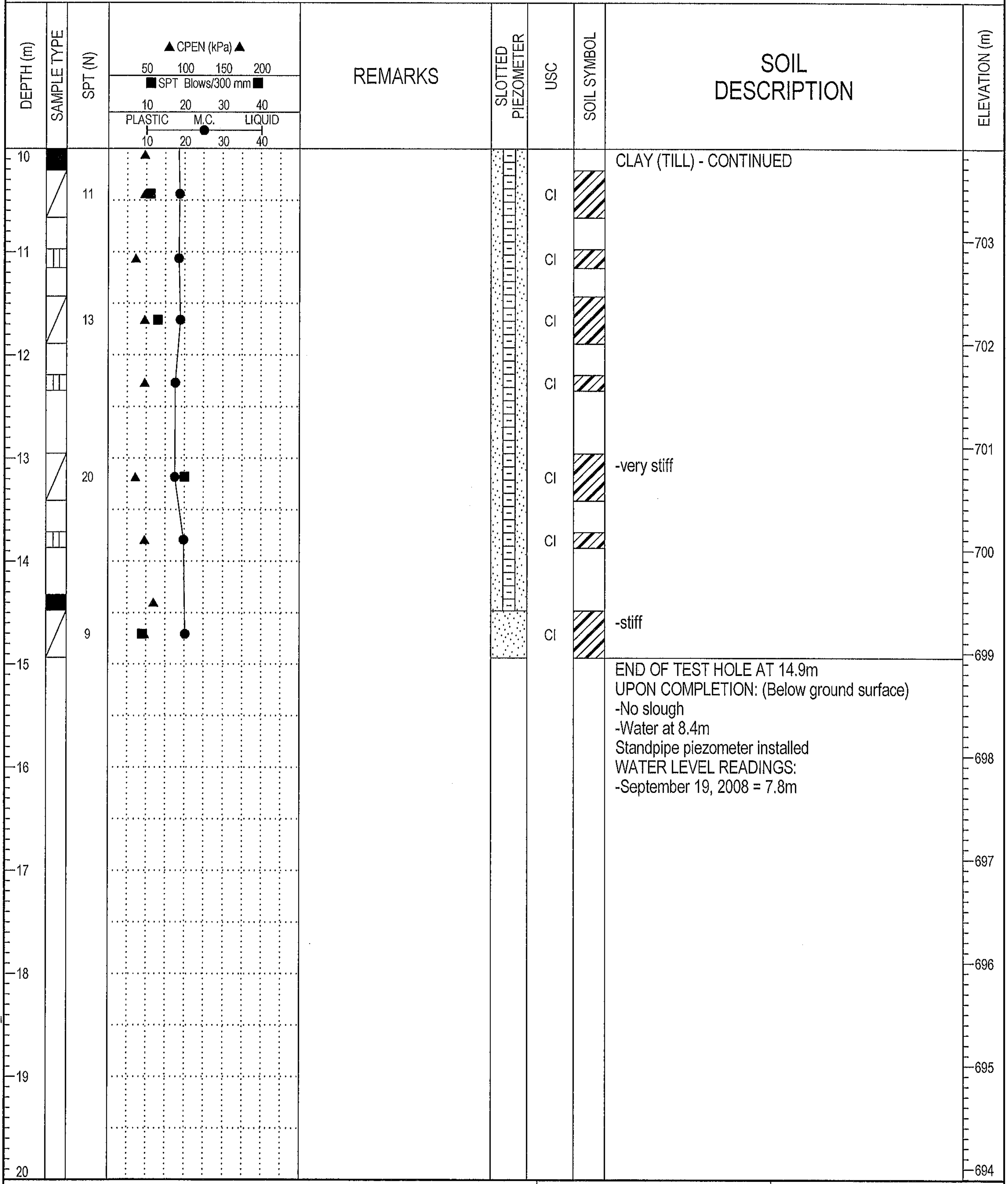
FIELD LOGGED BY: GA	COMPLETION DEPTH: 14.9 m
PREPARED BY: SGR	COMPLETION DATE: 8/7/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-07-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 7, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 713.89 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND



SOIL DESCRIPTION

CLAY (TILL) - CONTINUED

-very stiff

-stiff

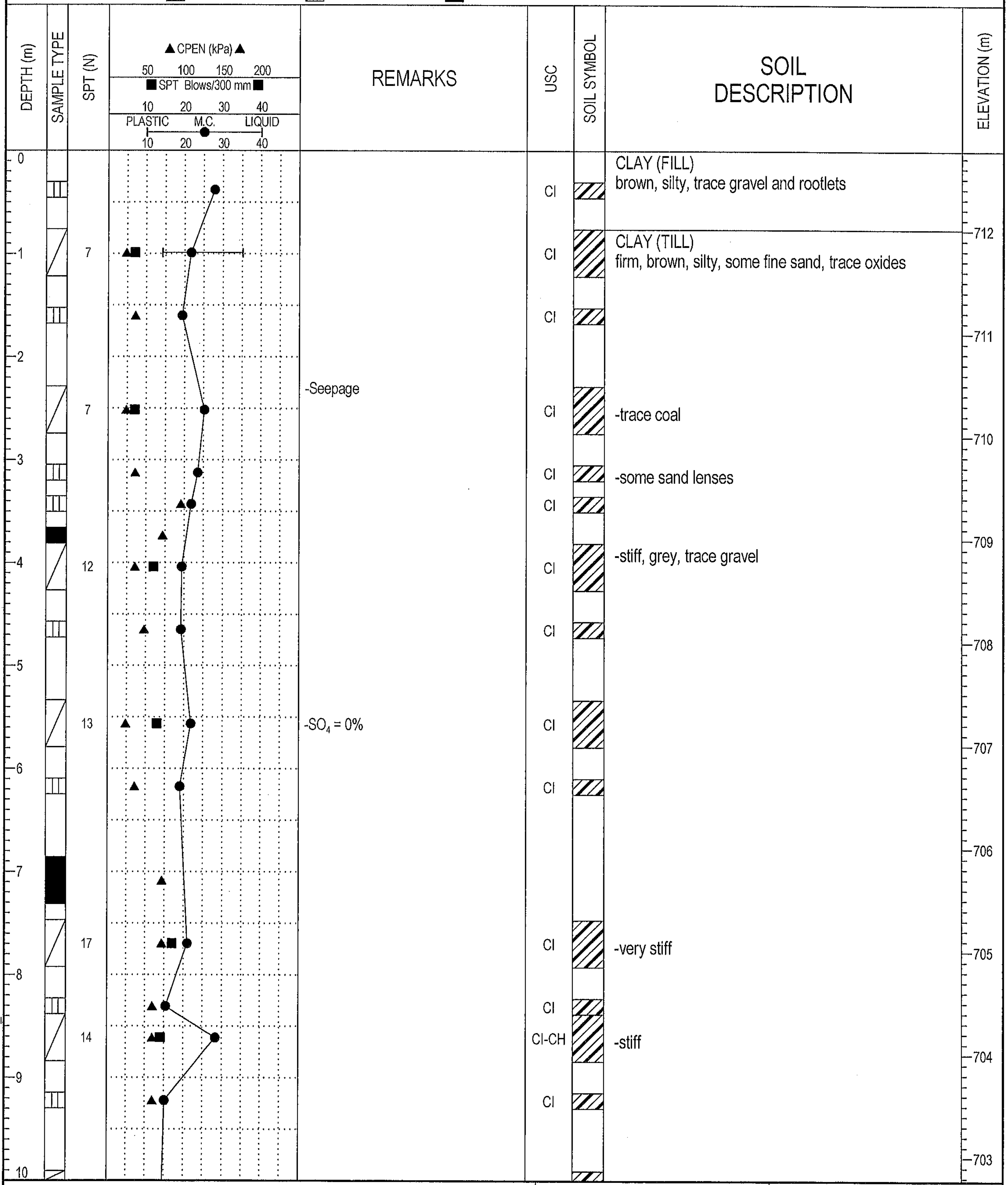
END OF TEST HOLE AT 14.9m
UPON COMPLETION: (Below ground surface)
-No slough
-Water at 8.4m
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 19, 2008 = 7.8m

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 14.9 m
PREPARED BY: SGR	COMPLETION DATE: 8/7/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-07-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 7, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 712.77 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE



-Seepage

-SO_4 = 0%

CLAY (FILL)
brown, silty, trace gravel and rootlets

CLAY (TILL)
firm, brown, silty, some fine sand, trace oxides

-trace coal

-some sand lenses

-stiff, grey, trace gravel

-very stiff

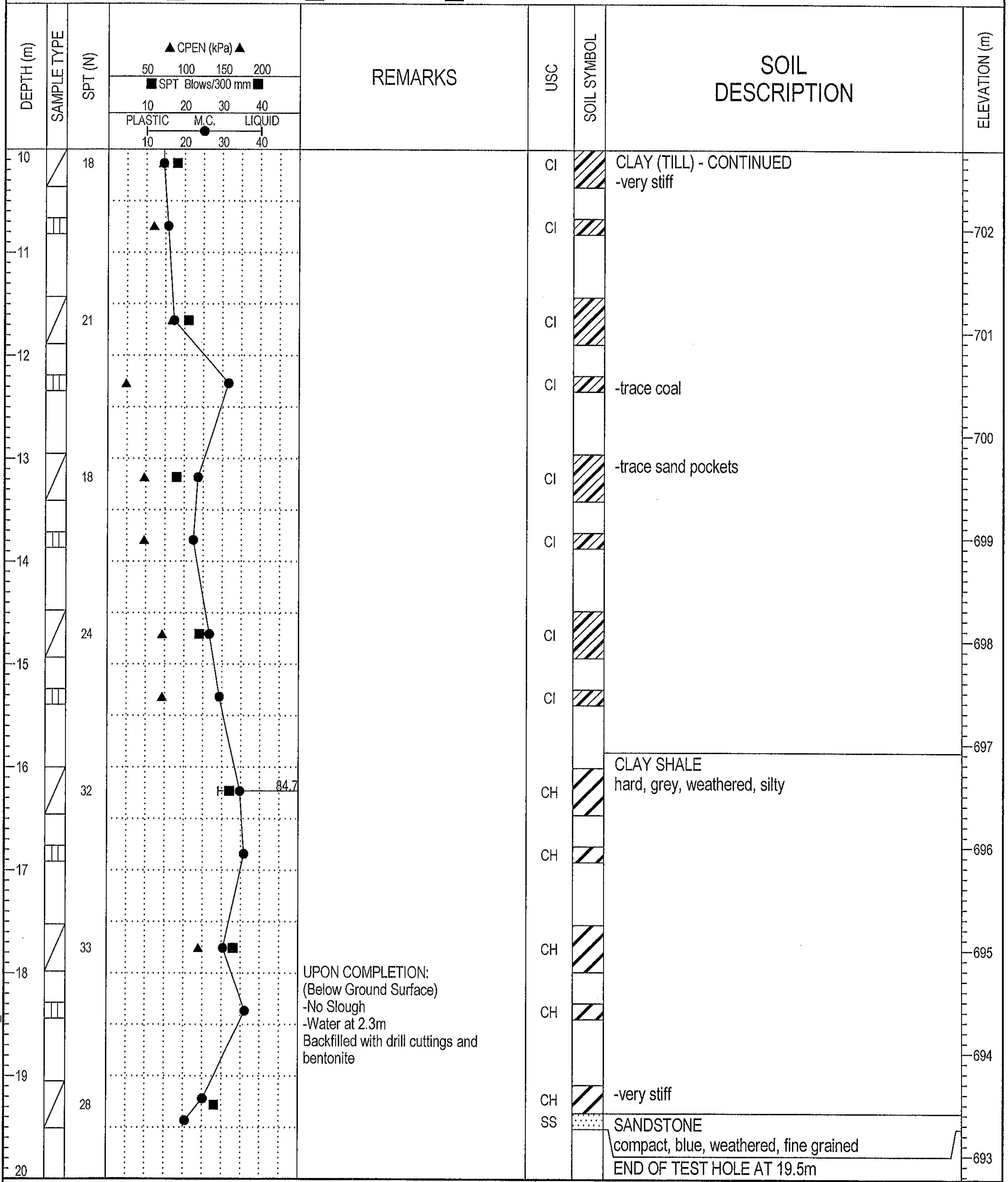
-stiff

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 8/7/08
REVIEWED BY: RWT	Page 1 of 2

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO
BOREHOLE NO: **TH08-07-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: August 7, 2008
PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers
LOCATION: See Drawing #19-598-298-1
ELEVATION: 712.77 (m)
SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE



CLAY (TILL) - CONTINUED
-very stiff

-trace coal

-trace sand pockets

CLAY SHALE
hard, grey, weathered, silty

-very stiff

SANDSTONE
compact, blue, weathered, fine grained

END OF TEST HOLE AT 19.5m

UPON COMPLETION:
(Below Ground Surface)
-No Slough
-Water at 2.3m
Backfilled with drill cuttings and bentonite

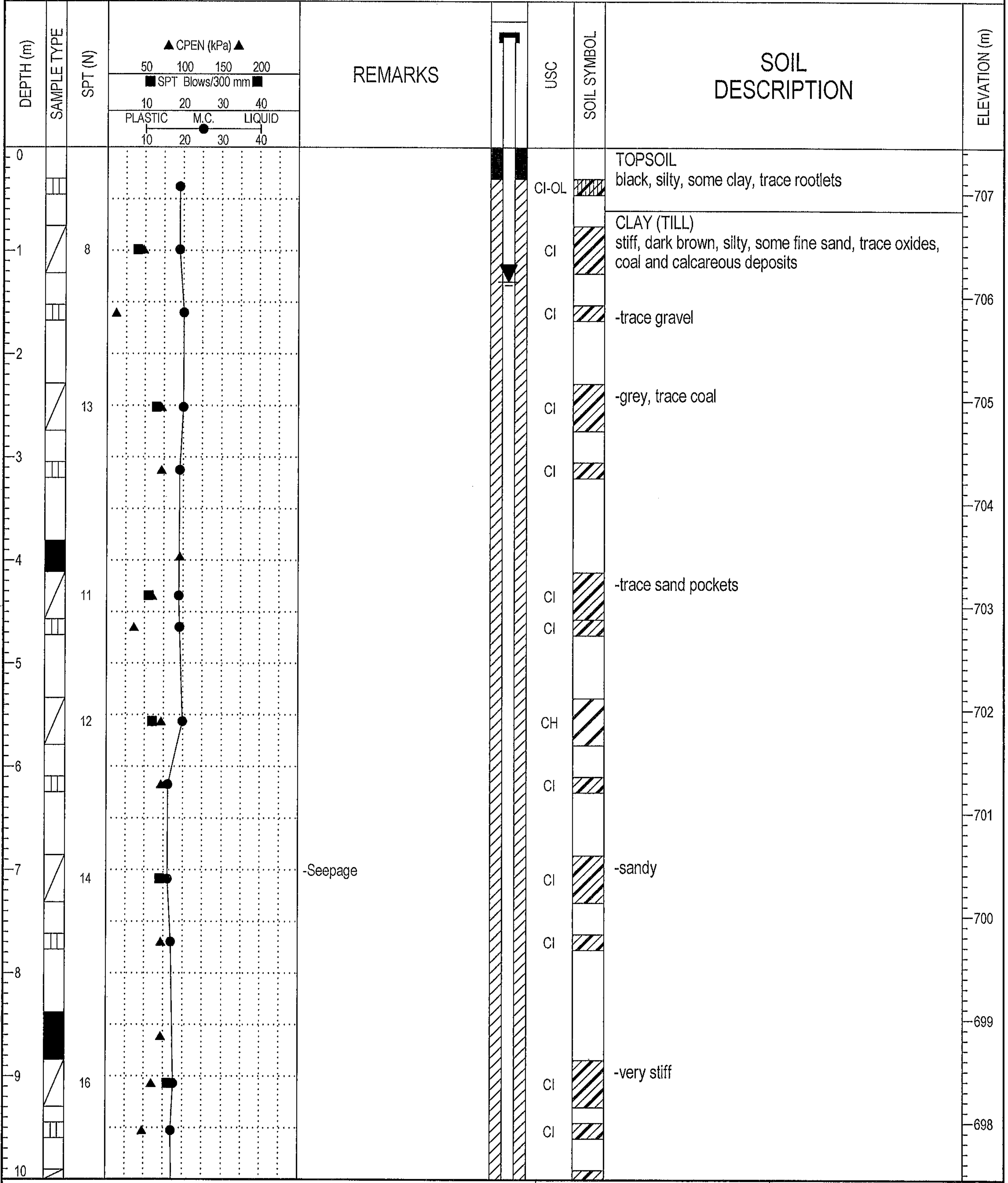
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA
COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR
COMPLETION DATE: 8/7/08
REVIEWED BY: RWT

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-08-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 707.45 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND ▥ SLOUGH



REMARKS

-Seepage

SOIL DESCRIPTION

TOPSOIL
black, silty, some clay, trace rootlets

CLAY (TILL)
stiff, dark brown, silty, some fine sand, trace oxides, coal and calcareous deposits

-trace gravel

-grey, trace coal

-trace sand pockets

-sandy

-very stiff

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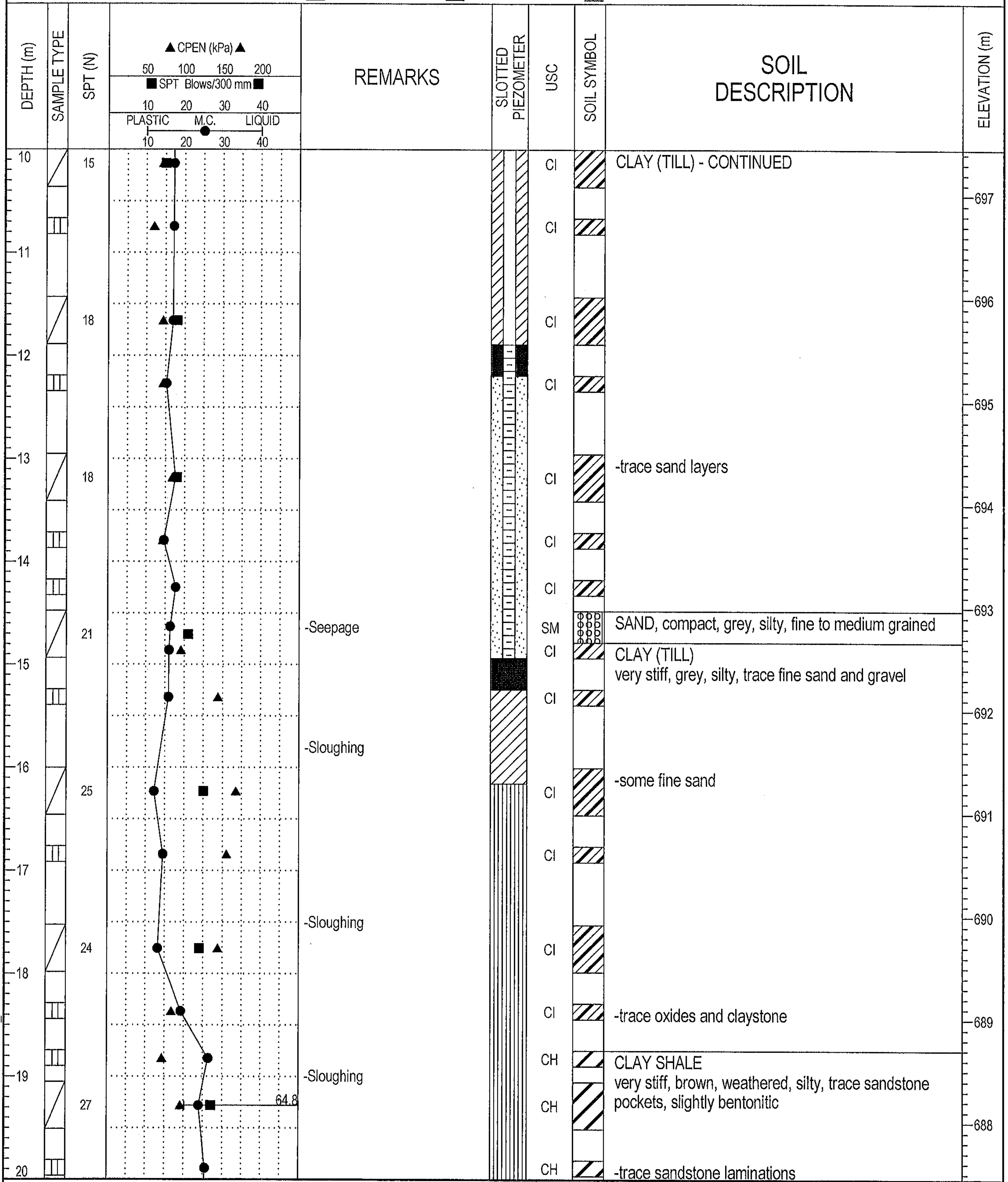
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/14/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-08-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 707.45 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



-Seepage

-Sloughing

-Sloughing

-Sloughing

CLAY (TILL) - CONTINUED

-trace sand layers

SAND, compact, grey, silty, fine to medium grained

CLAY (TILL)
very stiff, grey, silty, trace fine sand and gravel

-some fine sand

-trace oxides and claystone

CLAY SHALE
very stiff, brown, weathered, silty, trace sandstone pockets, slightly bentonitic

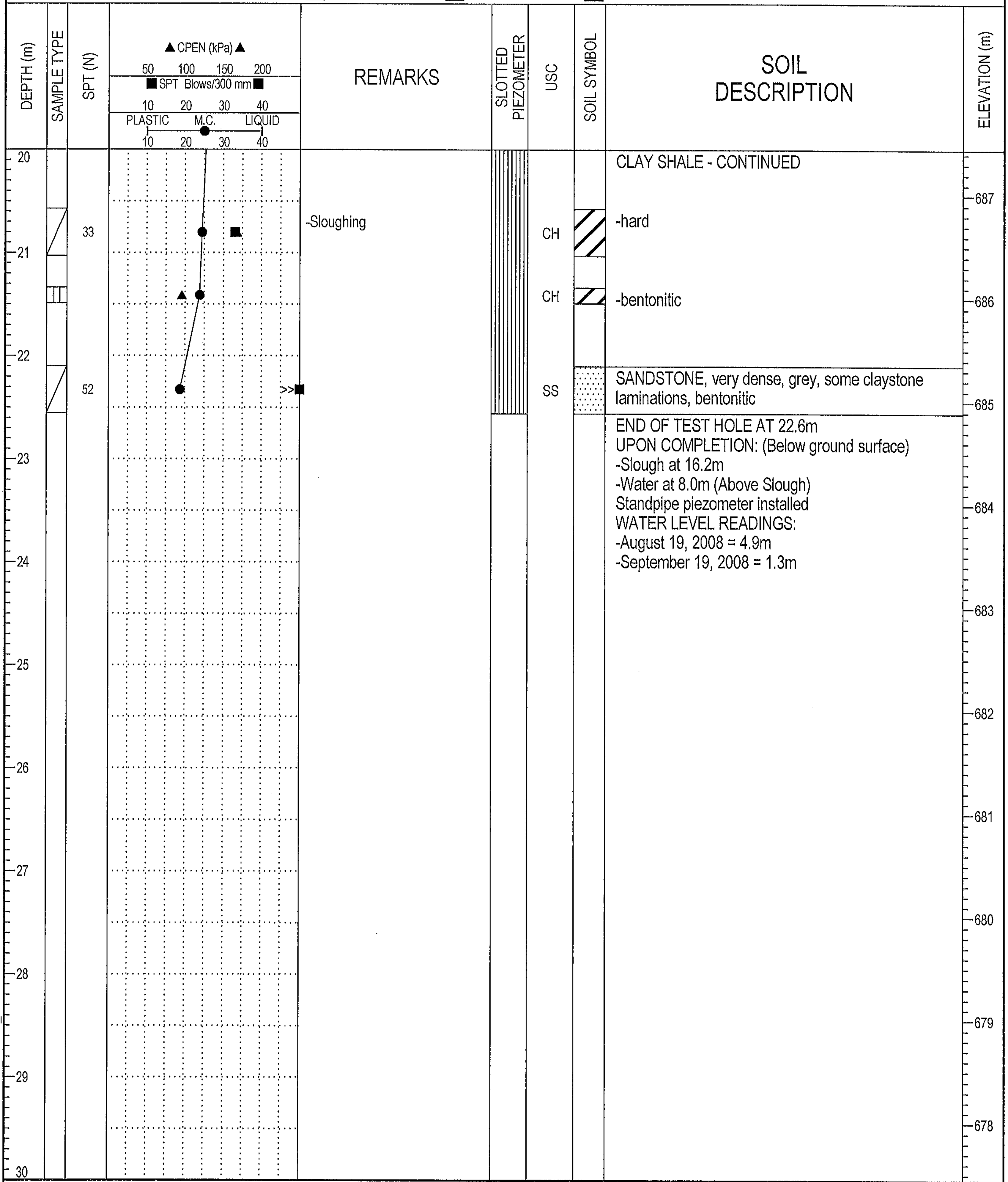
-trace sandstone laminations

THURBER ENGINEERING LTD. GEOTECHNICAL • ENVIRONMENTAL • MATERIALS	FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
	PREPARED BY: SGR	COMPLETION DATE: 8/14/08
	REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-08-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 707.45 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



-Sloughing

CLAY SHALE - CONTINUED

-hard

-bentonitic

SANDSTONE, very dense, grey, some claystone laminations, bentonitic

END OF TEST HOLE AT 22.6m
UPON COMPLETION: (Below ground surface)
-Slough at 16.2m
-Water at 8.0m (Above Slough)
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 19, 2008 = 4.9m
-September 19, 2008 = 1.3m

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

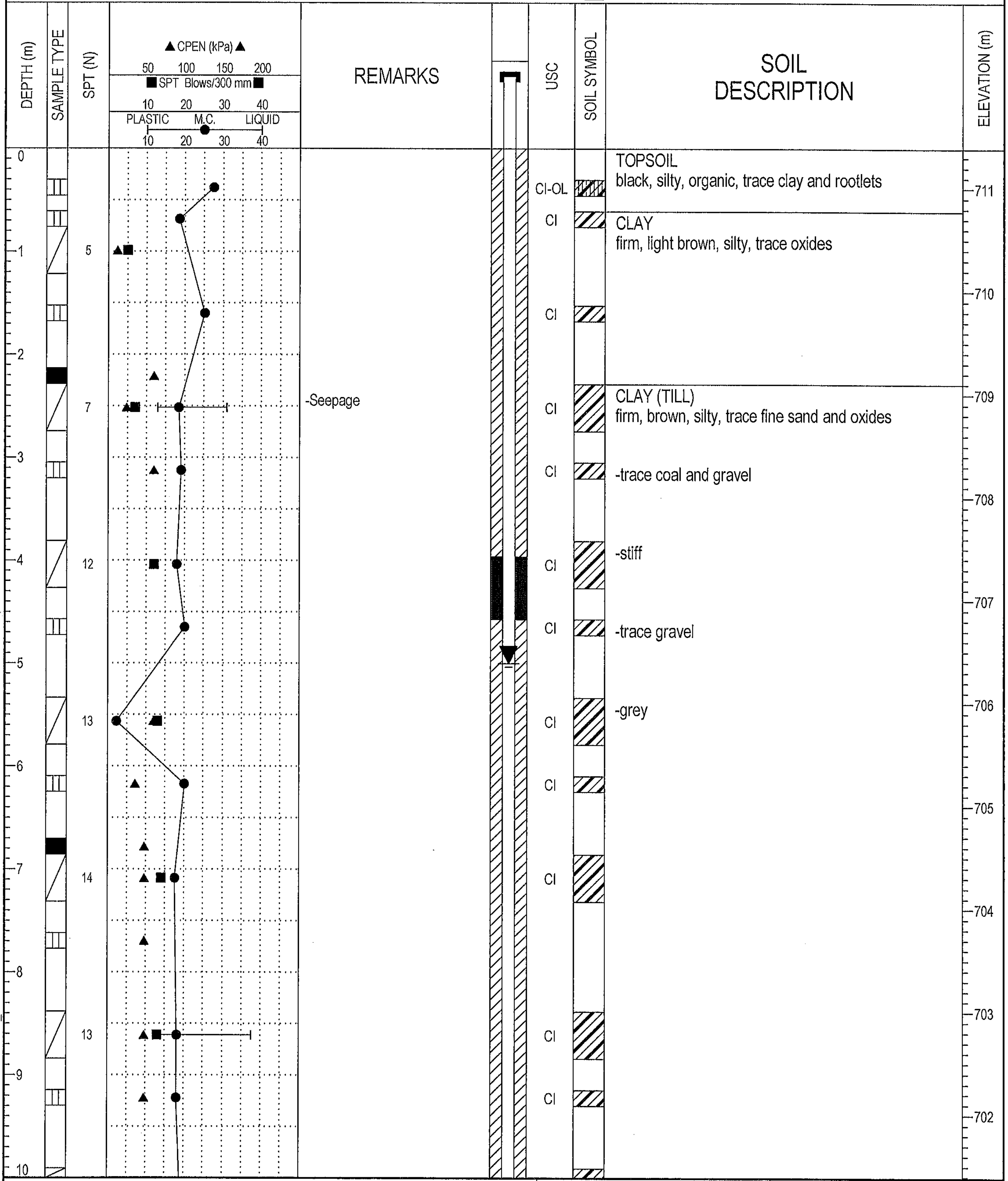
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/14/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-08-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 6, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 711.39 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ░ SAND ▥ SLOUGH



SOIL DESCRIPTION

TOPSOIL
black, silty, organic, trace clay and rootlets

CLAY
firm, light brown, silty, trace oxides

CLAY (TILL)
firm, brown, silty, trace fine sand and oxides

-trace coal and gravel

-stiff

-trace gravel

-grey

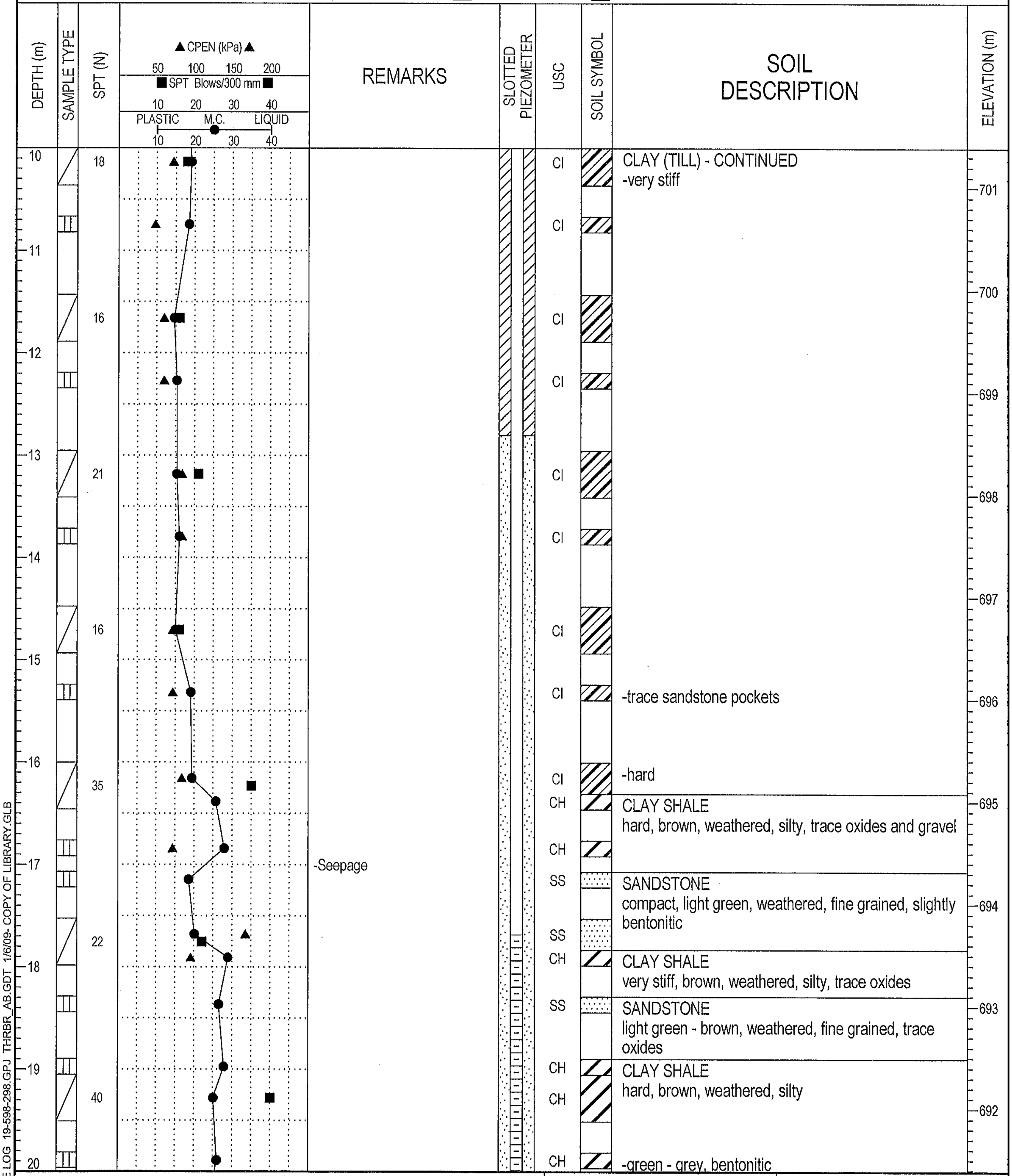
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/6/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-08-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 6, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 711.39 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ░ SAND ▥ SLOUGH



CLAY (TILL) - CONTINUED
-very stiff

-trace sandstone pockets

-hard

CLAY SHALE
hard, brown, weathered, silty, trace oxides and gravel

SANDSTONE
compact, light green, weathered, fine grained, slightly bentonitic

CLAY SHALE
very stiff, brown, weathered, silty, trace oxides

SANDSTONE
light green - brown, weathered, fine grained, trace oxides

CLAY SHALE
hard, brown, weathered, silty

-green - grey, bentonitic

THURBER ENGINEERING LTD.
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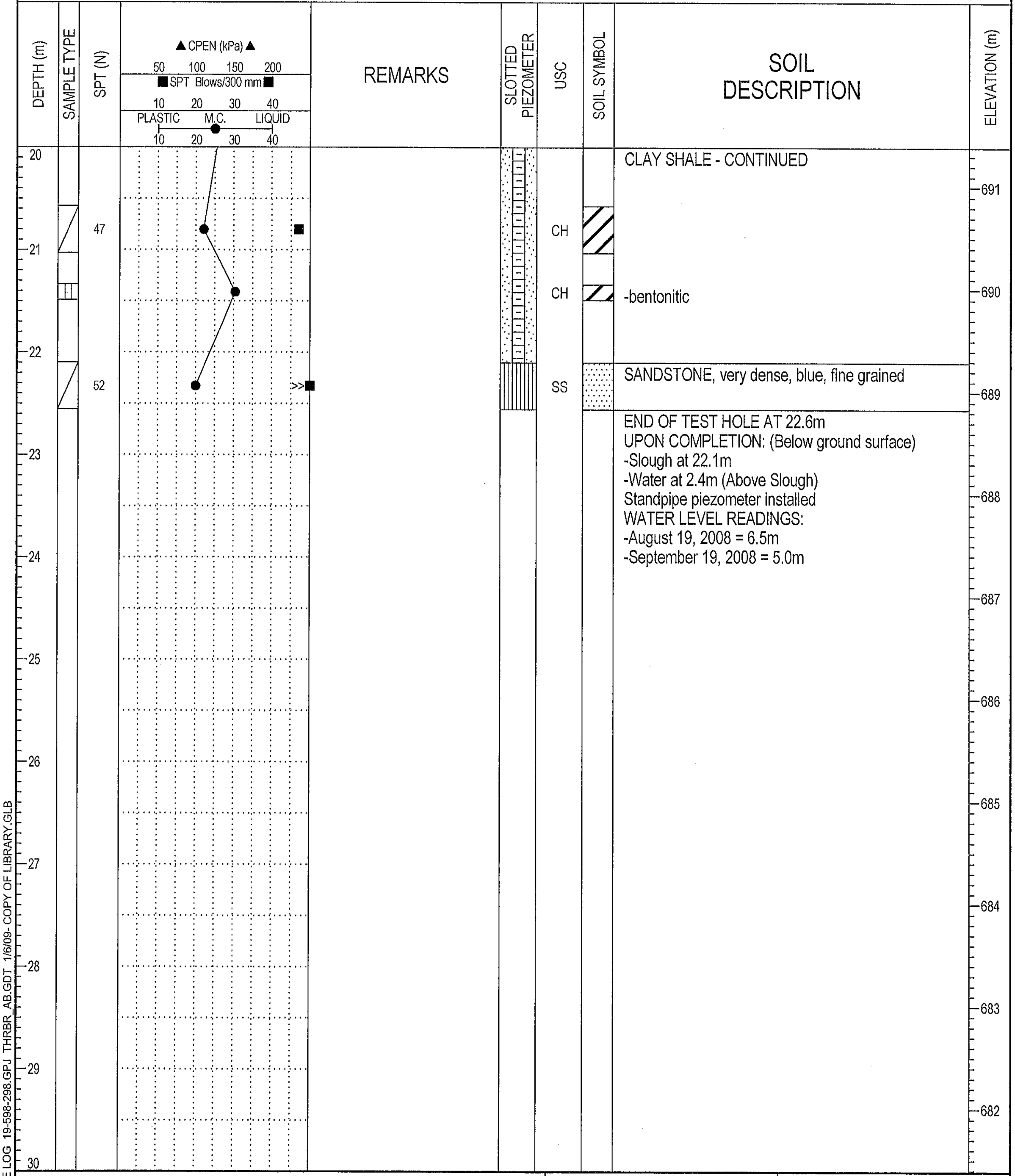
FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/6/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-08-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 6, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 711.39 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⁘ SAND ▥ SLOUGH



CLAY SHALE - CONTINUED

-bentonitic

SANDSTONE, very dense, blue, fine grained

END OF TEST HOLE AT 22.6m
UPON COMPLETION: (Below ground surface)
-Slough at 22.1m
-Water at 2.4m (Above Slough)
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 19, 2008 = 6.5m
-September 19, 2008 = 5.0m

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

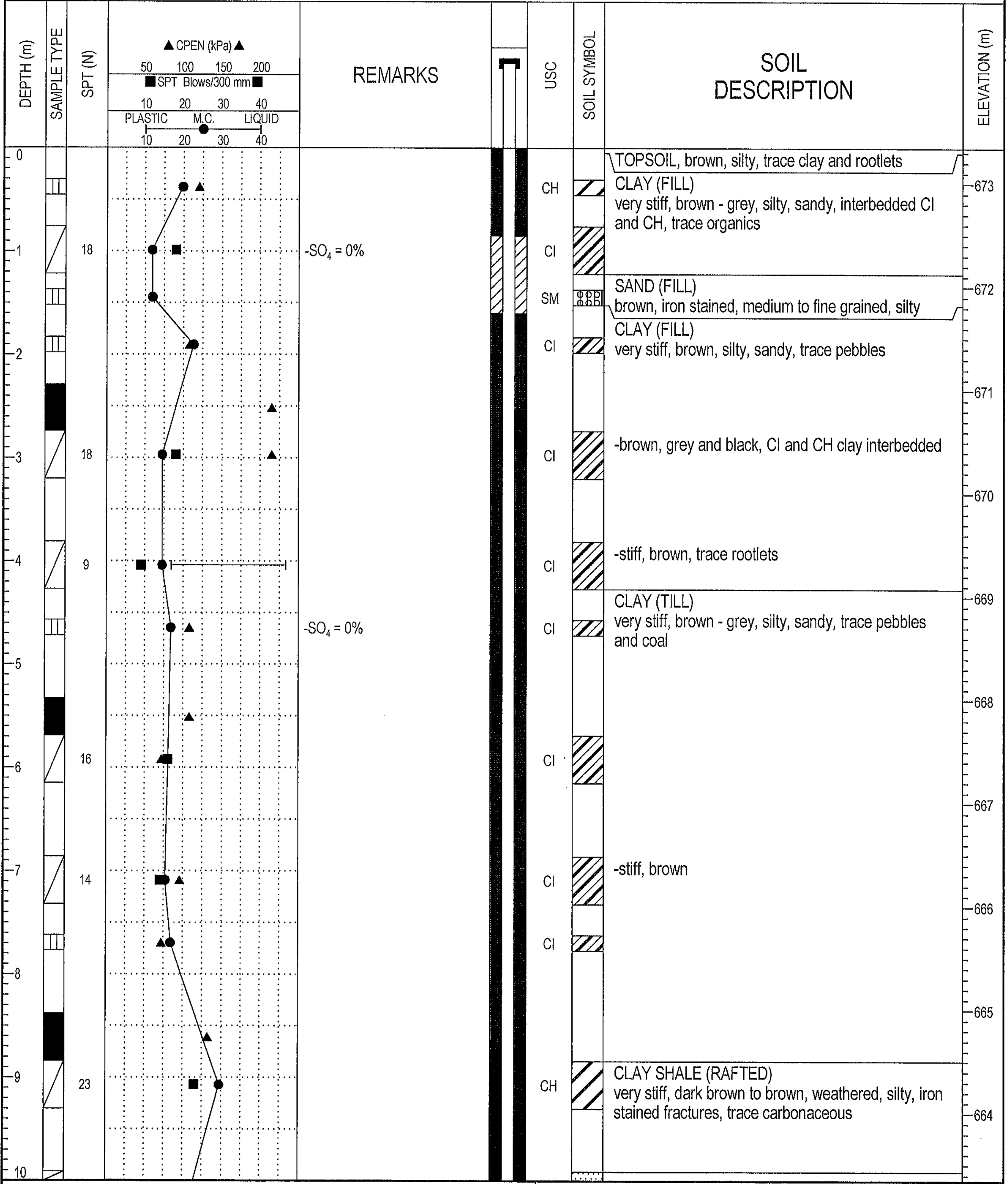
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/6/08
REVIEWED BY: RWT	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT	BOREHOLE NO: **TH08-12-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 25, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 673.34 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE

BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



REMARKS

-SO_4 = 0% (1 m)

-SO_4 = 0% (4.6 m)

SOIL DESCRIPTION

TOPSOIL, brown, silty, trace clay and rootlets

CLAY (FILL)
very stiff, brown - grey, silty, sandy, interbedded CI and CH, trace organics

SAND (FILL)
brown, iron stained, medium to fine grained, silty

CLAY (FILL)
very stiff, brown, silty, sandy, trace pebbles

-brown, grey and black, CI and CH clay interbedded

-stiff, brown, trace rootlets

CLAY (TILL)
very stiff, brown - grey, silty, sandy, trace pebbles and coal

-stiff, brown

CLAY SHALE (RAFTED)
very stiff, dark brown to brown, weathered, silty, iron stained fractures, trace carbonaceous

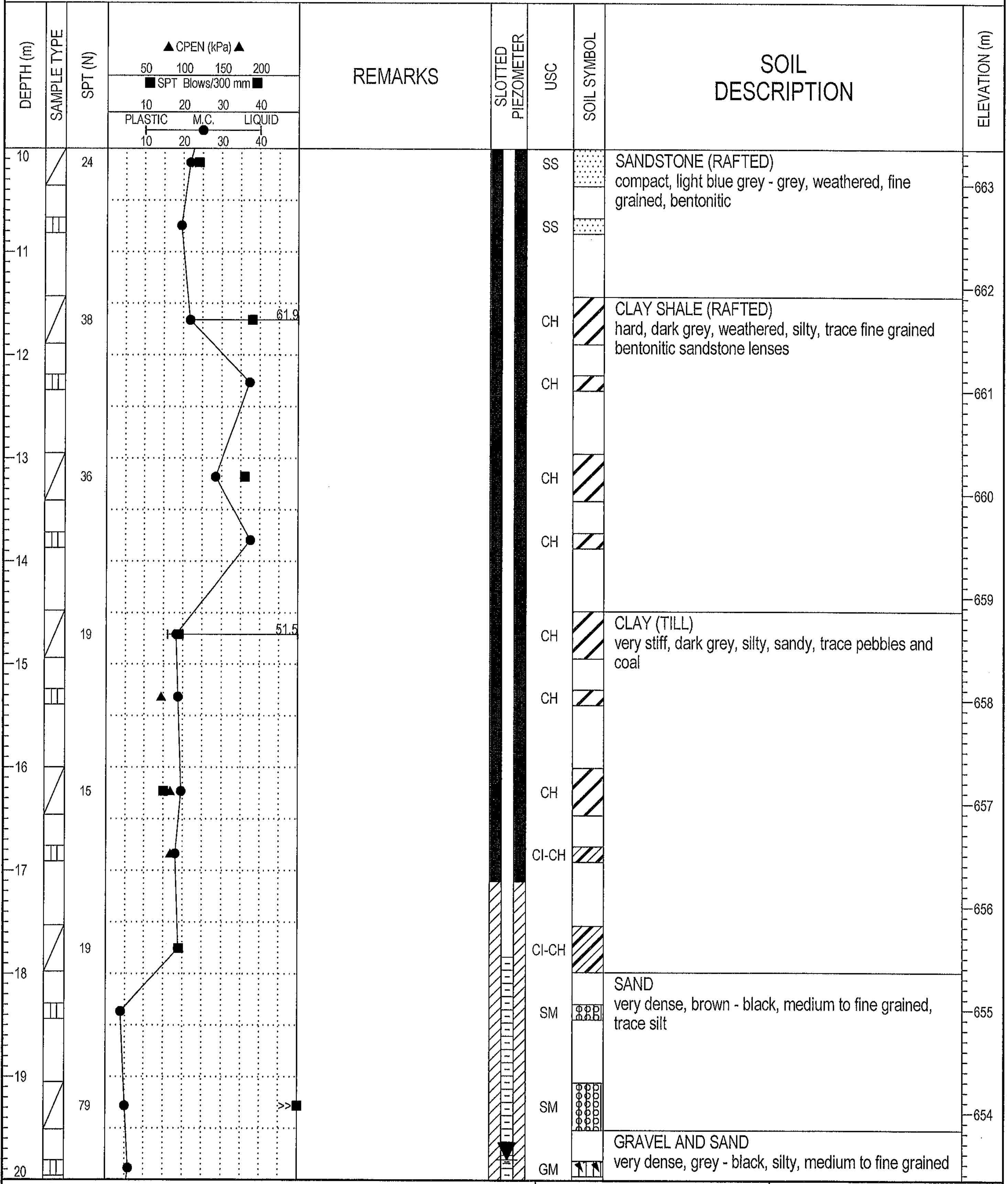
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: TDC	COMPLETION DEPTH: 20.9 m
PREPARED BY: SGR	COMPLETION DATE: 7/25/08
REVIEWED BY: DAP	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT	BOREHOLE NO: **TH08-12-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 25, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 673.34 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SANDSTONE (RAFTED)
compact, light blue grey - grey, weathered, fine grained, bentonitic

CLAY SHALE (RAFTED)
hard, dark grey, weathered, silty, trace fine grained bentonitic sandstone lenses

CLAY (TILL)
very stiff, dark grey, silty, sandy, trace pebbles and coal

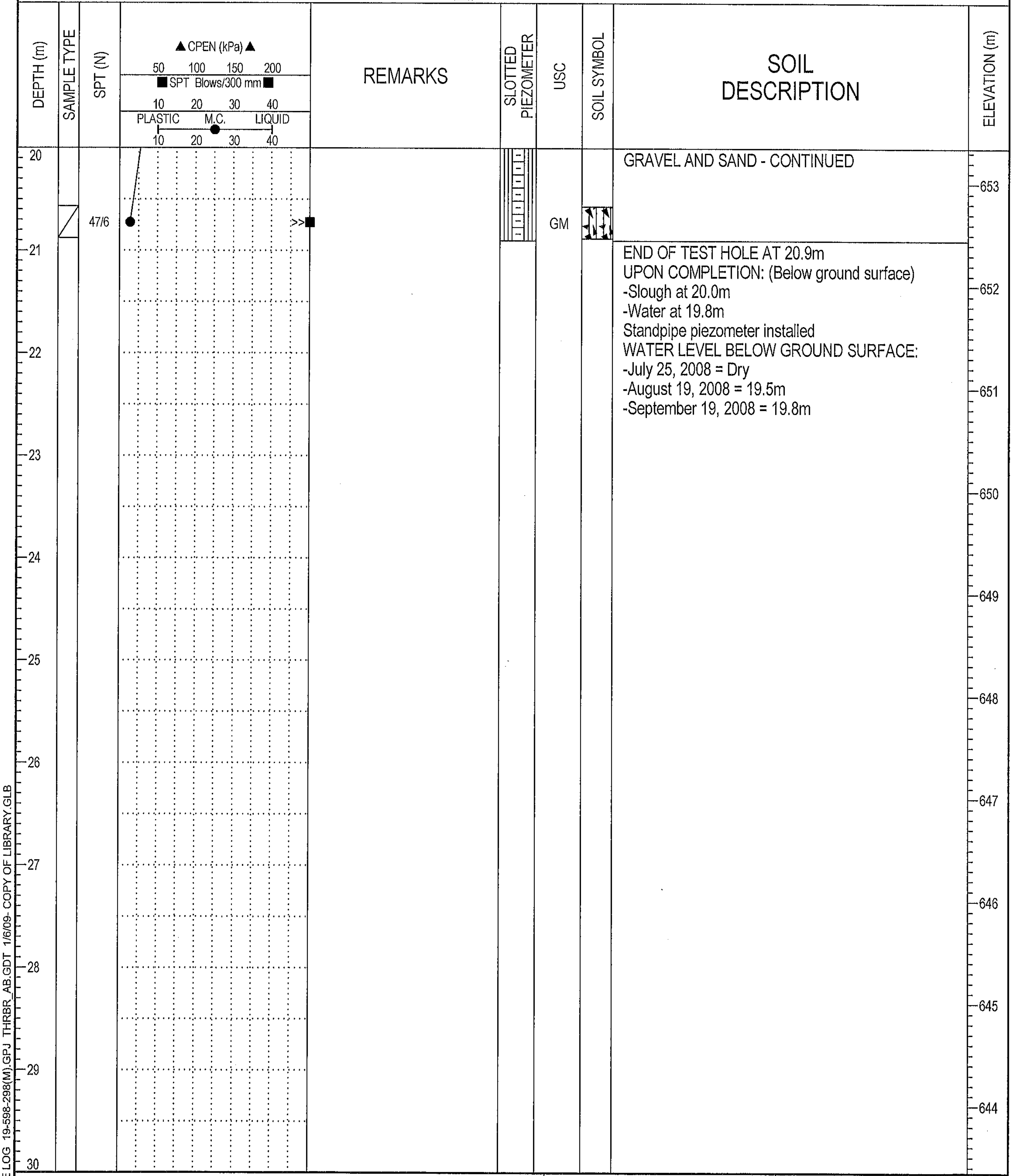
SAND
very dense, brown - black, medium to fine grained, trace silt

GRAVEL AND SAND
very dense, grey - black, silty, medium to fine grained

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: TDC	COMPLETION DEPTH: 20.9 m
PREPARED BY: SGR	COMPLETION DATE: 7/25/08
REVIEWED BY: DAP	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - BRIDGE ABUTMENT
BOREHOLE NO: **TH08-12-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: July 25, 2008
PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers
LOCATION: See Drawing #19-598-298-1
ELEVATION: 673.34 (m)
SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE
BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



GRAVEL AND SAND - CONTINUED

END OF TEST HOLE AT 20.9m
UPON COMPLETION: (Below ground surface)
-Slough at 20.0m
-Water at 19.8m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 25, 2008 = Dry
-August 19, 2008 = 19.5m
-September 19, 2008 = 19.8m

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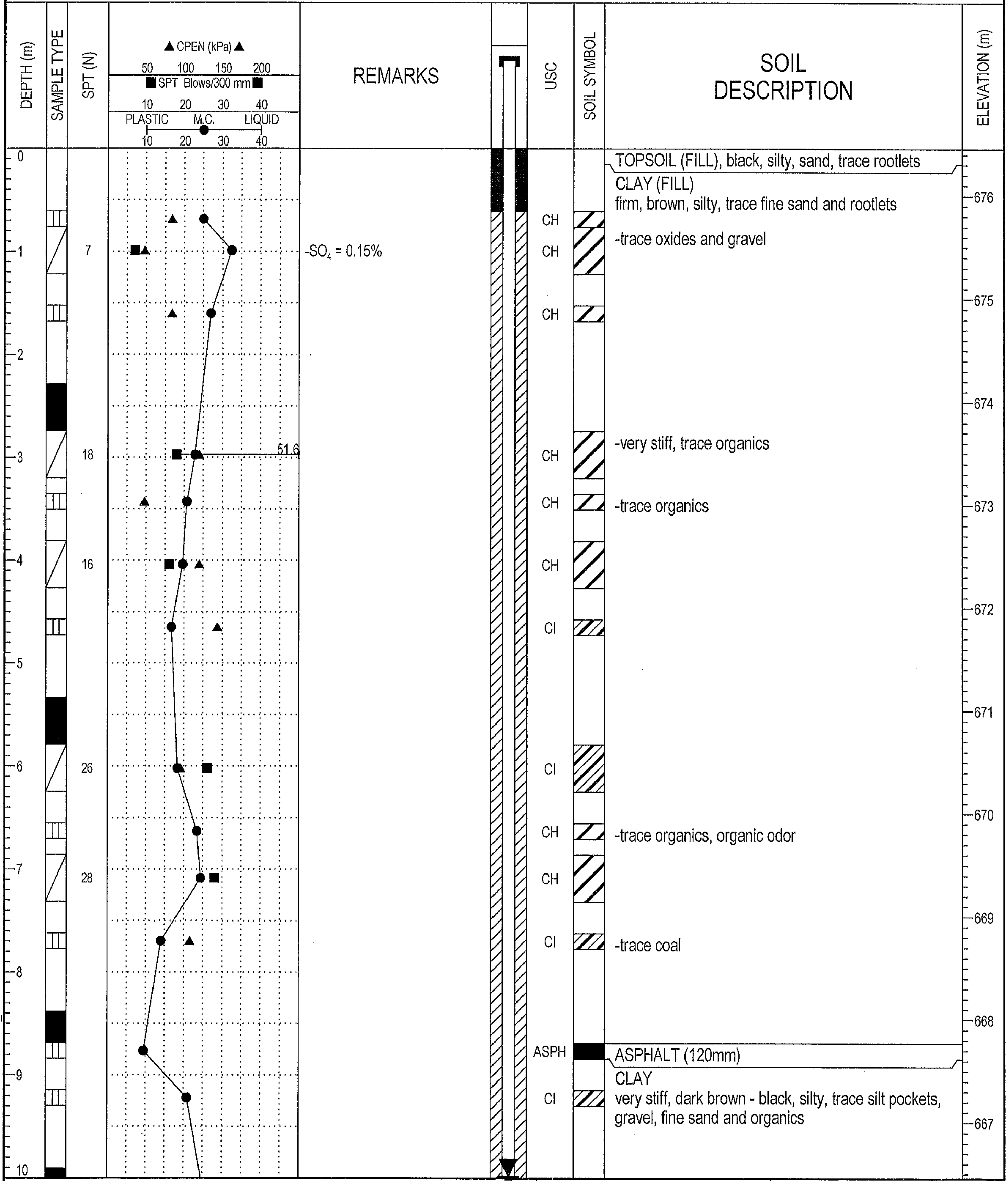
FIELD LOGGED BY: TDC
COMPLETION DEPTH: 20.9 m
PREPARED BY: SGR
COMPLETION DATE: 7/25/08
REVIEWED BY: DAP

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-12-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 28, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.46 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND



-SO$_4$ = 0.15%

TOPSOIL (FILL), black, silty, sand, trace rootlets

CLAY (FILL)
firm, brown, silty, trace fine sand and rootlets

-trace oxides and gravel

-very stiff, trace organics

-trace organics

-trace organics, organic odor

-trace coal

ASPHALT (120mm)

CLAY
very stiff, dark brown - black, silty, trace silt pockets, gravel, fine sand and organics

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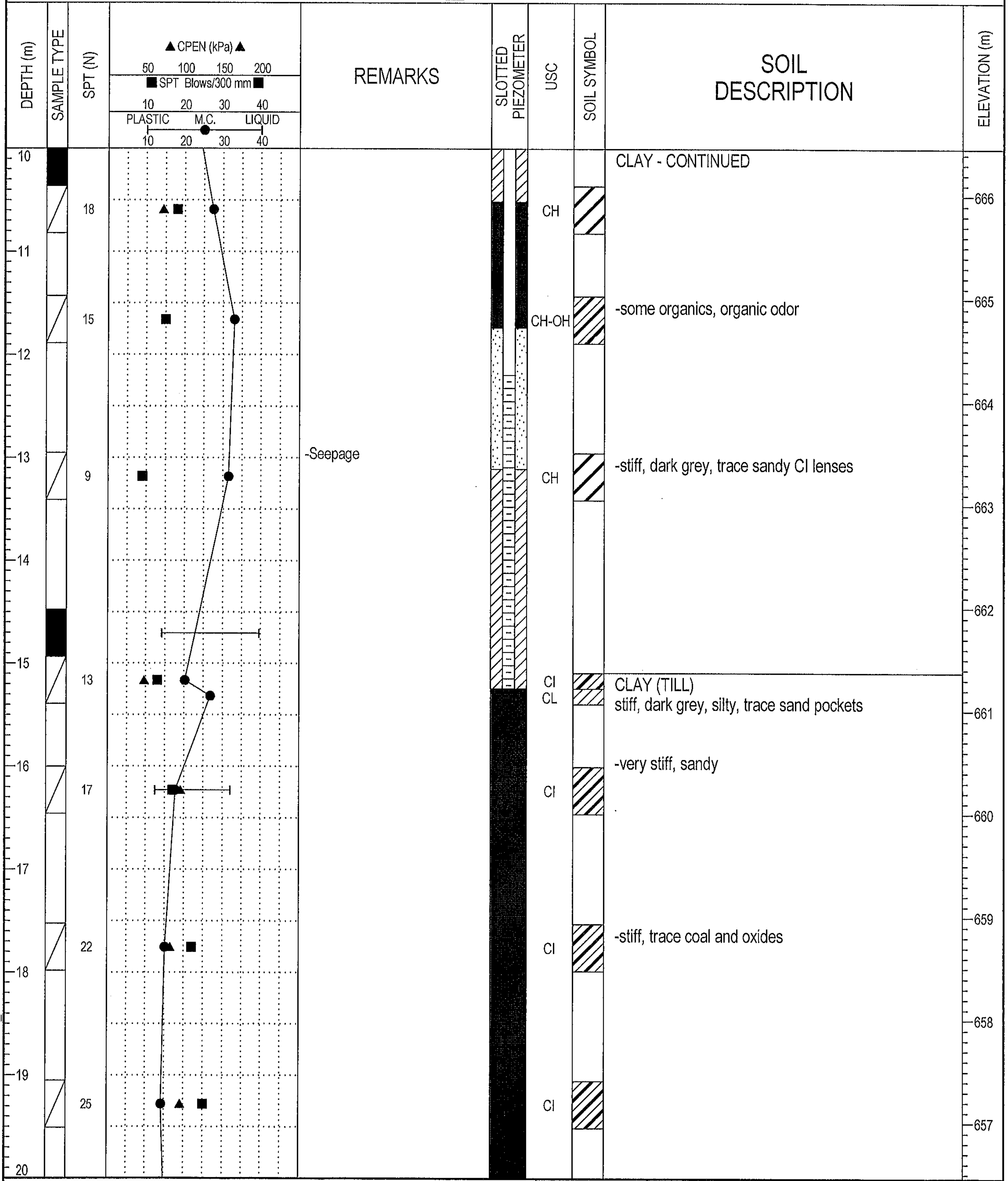
FIELD LOGGED BY: RS	COMPLETION DEPTH: 24.1 m
PREPARED BY: SGR	COMPLETION DATE: 7/28/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-12-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 28, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.46 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ░ SAND



THURBER ENGINEERING LTD.
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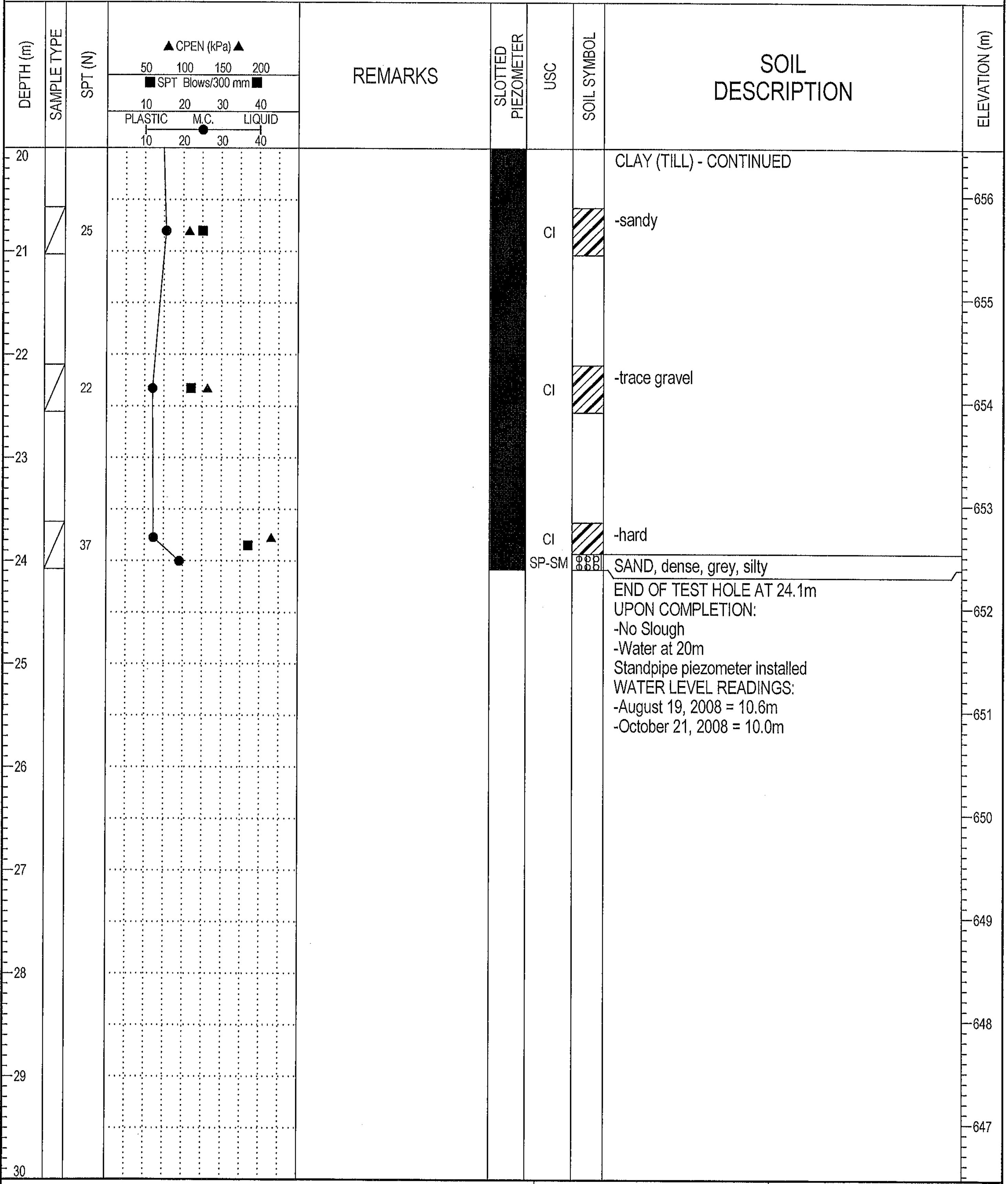
FIELD LOGGED BY: RS	COMPLETION DEPTH: 24.1 m
PREPARED BY: SGR	COMPLETION DATE: 7/28/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-12-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 28, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.46 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛶ SAND



CLAY (TILL) - CONTINUED

-sandy

-trace gravel

-hard

SAND, dense, grey, silty

END OF TEST HOLE AT 24.1m
UPON COMPLETION:
-No Slough
-Water at 20m
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 19, 2008 = 10.6m
-October 21, 2008 = 10.0m

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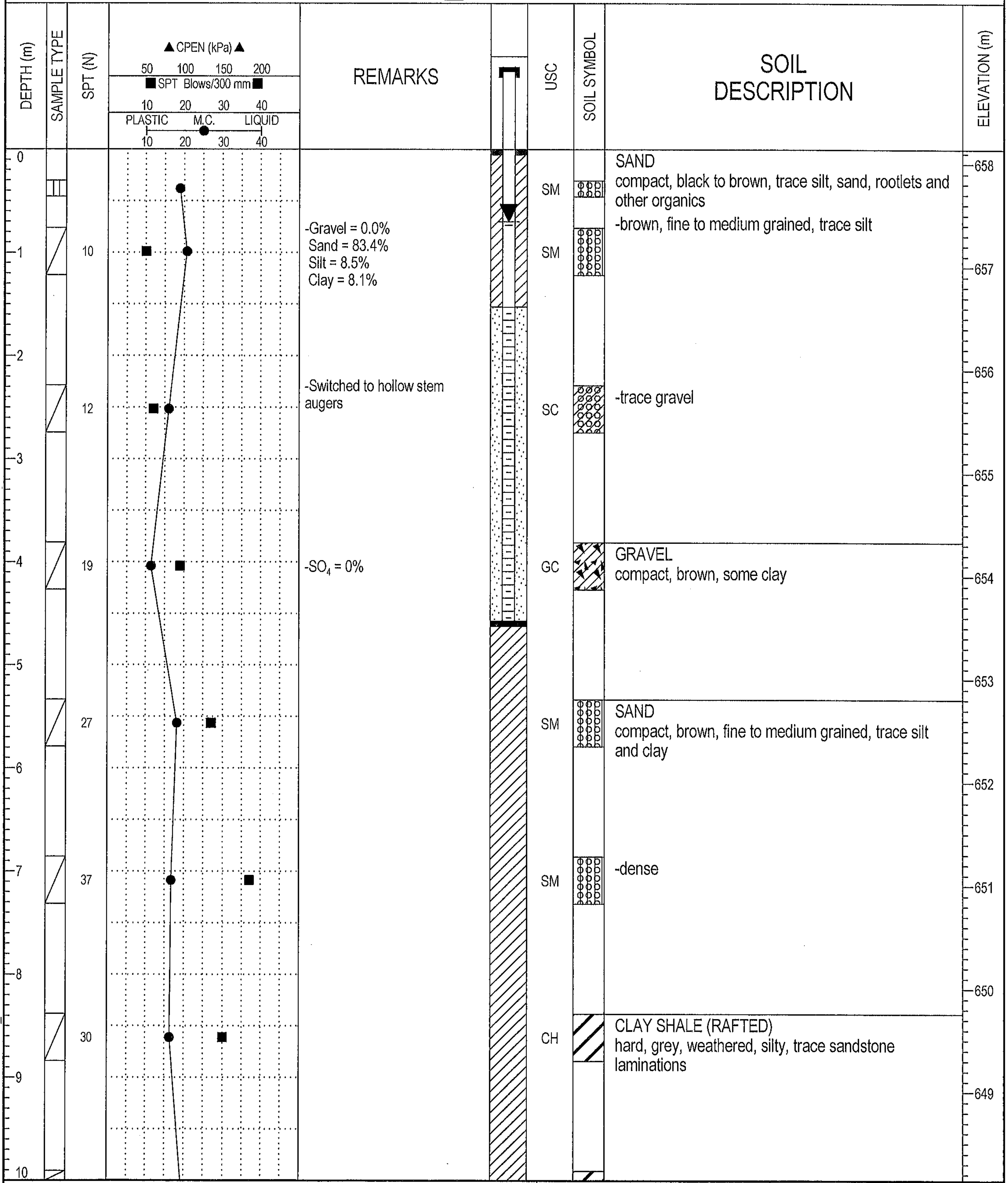
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: RS	COMPLETION DEPTH: 24.1 m
PREPARED BY: SGR	COMPLETION DATE: 7/28/08
REVIEWED BY: RWT	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-14-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 2, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 658.14 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ░ SAND



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
		SM	SAND compact, black to brown, trace silt, sand, rootlets and other organics
10	-Gravel = 0.0% Sand = 83.4% Silt = 8.5% Clay = 8.1%	SM	-brown, fine to medium grained, trace silt
12	-Switched to hollow stem augers	SC	-trace gravel
19	-SO_4 = 0%	GC	GRAVEL compact, brown, some clay
27		SM	SAND compact, brown, fine to medium grained, trace silt and clay
37		SM	-dense
30		CH	CLAY SHALE (RAFTED) hard, grey, weathered, silty, trace sandstone laminations

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

THURBER ENGINEERING LTD.
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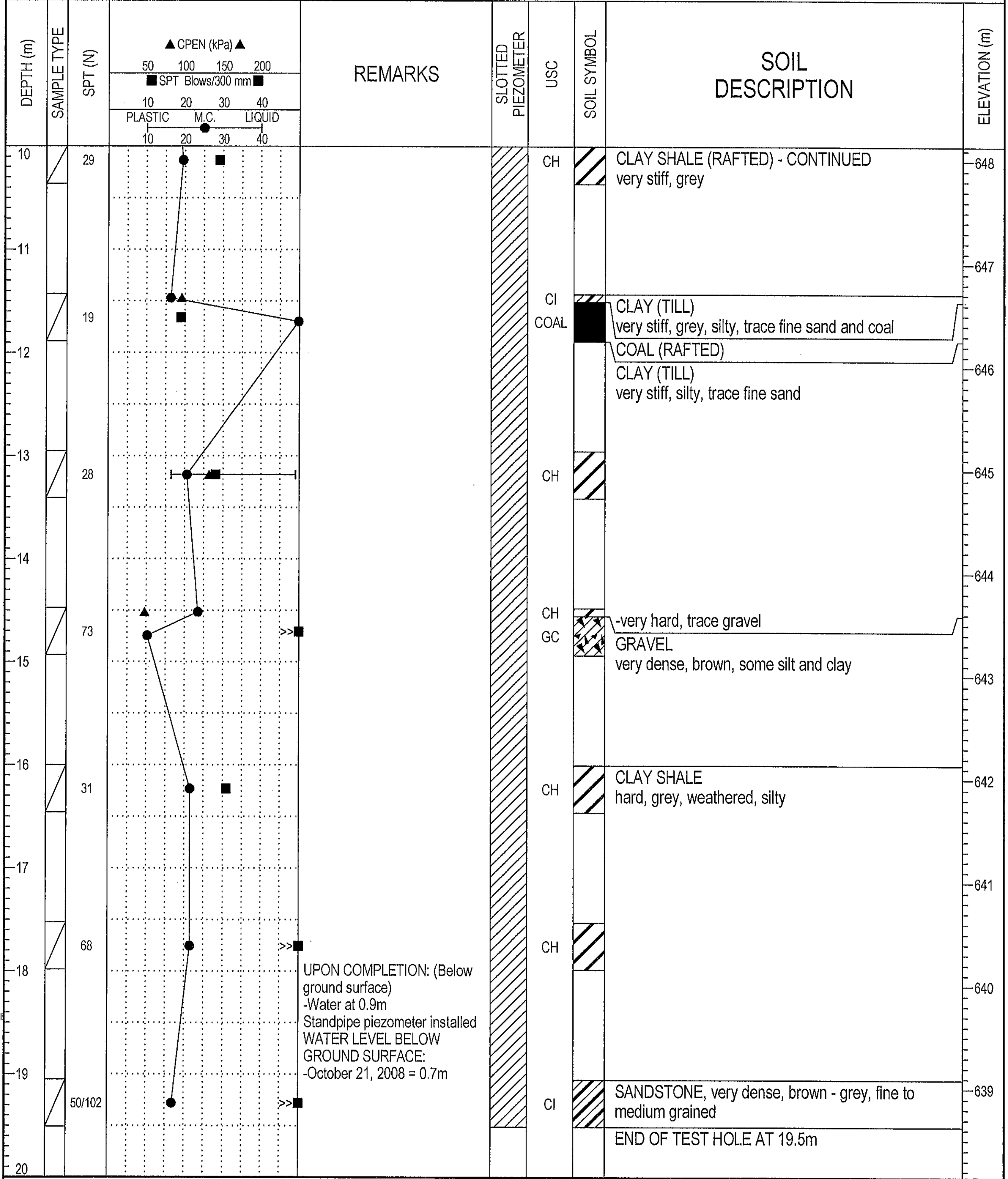
FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/2/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-14-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 2, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 658.14 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND



DEPTH (m)	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
10	29		CH	CLAY SHALE (RAFTED) - CONTINUED very stiff, grey
11.5	19		CI COAL	CLAY (TILL) very stiff, grey, silty, trace fine sand and coal COAL (RAFTED) CLAY (TILL) very stiff, silty, trace fine sand
13	28		CH	
14.5	73		CH GC	-very hard, trace gravel GRAVEL very dense, brown, some silt and clay
16	31		CH	CLAY SHALE hard, grey, weathered, silty
17.5	68	UPON COMPLETION: (Below ground surface) -Water at 0.9m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -October 21, 2008 = 0.7m	CH	
19	50/102		CI	SANDSTONE, very dense, brown - grey, fine to medium grained END OF TEST HOLE AT 19.5m

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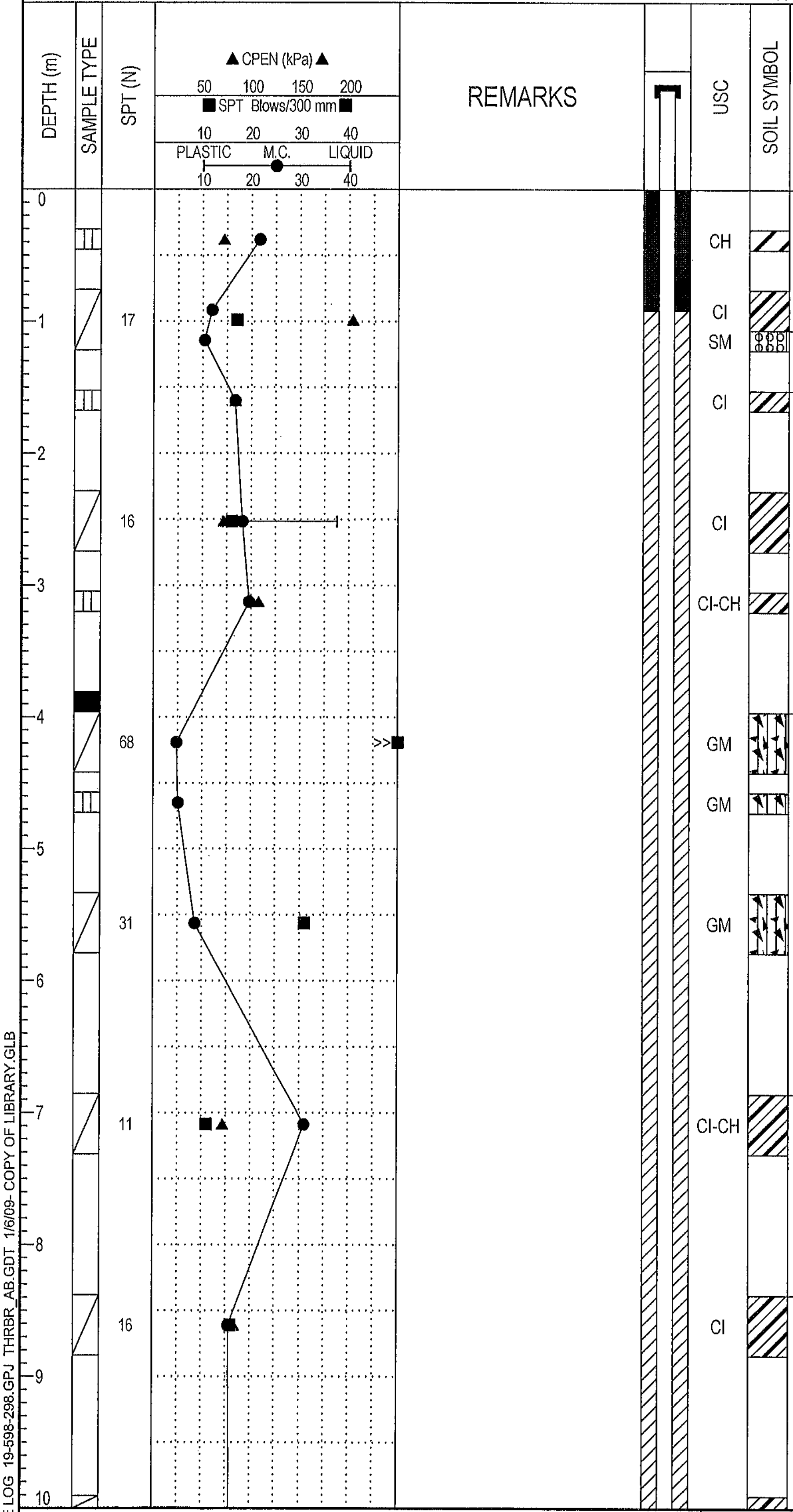
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/2/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-14-02C**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 667.21 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



SOIL DESCRIPTION

CLAY (FILL)
very stiff, grey, silty, trace fine sand, gravel, and oxides

-brown, trace rootlets

SAND (FILL)
compact, brown, fine grained, trace silt and clay

CLAY (~~FILL~~) SHALE (RAFTED)
very stiff, grey, silty, trace fine sand, gravel, and organic lenses

-trace oxides and coal

-trace oxides

GRAVEL (FILL)
very dense, dark brown, trace silt

-dense

CLAY
stiff, grey, silty, trace fine sand lenses

CLAY (TILL)
very stiff, brown, silty, trace fine sand, gravel, and oxides

ELEVATION (m)
667
666
665
664
663
662
661
660
659
658

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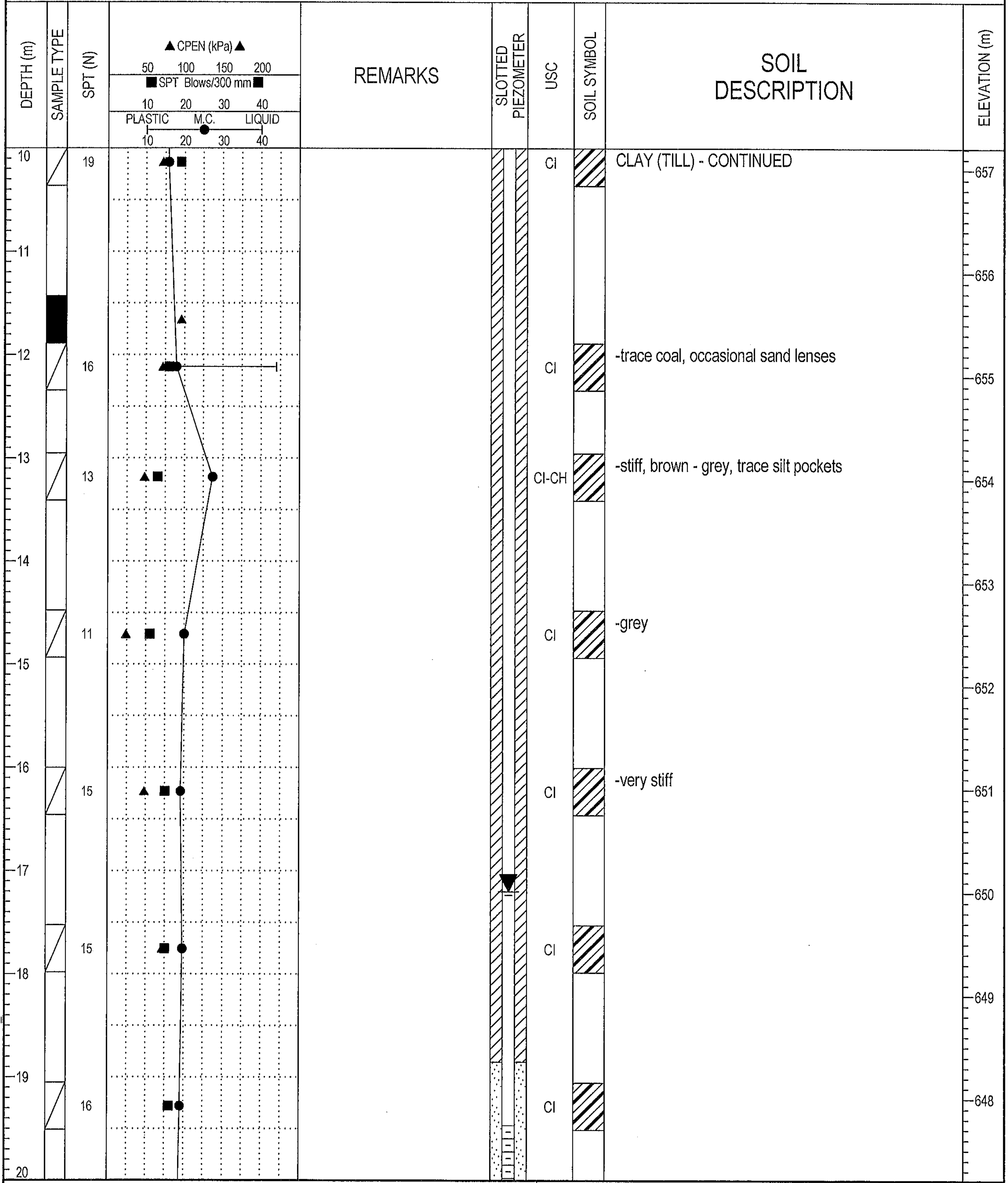
FIELD LOGGED BY: GA	COMPLETION DEPTH: 25.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-14-02C**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 667.21 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND ▥ SLOUGH



DEPTH (m)	SPT (N)	USC	SOIL DESCRIPTION
10	19	CI	CLAY (TILL) - CONTINUED
12	16	CI	-trace coal, occasional sand lenses
13	13	CI-CH	-stiff, brown - grey, trace silt pockets
14	11	CI	-grey
16	15	CI	-very stiff
17	15	CI	
19	16	CI	

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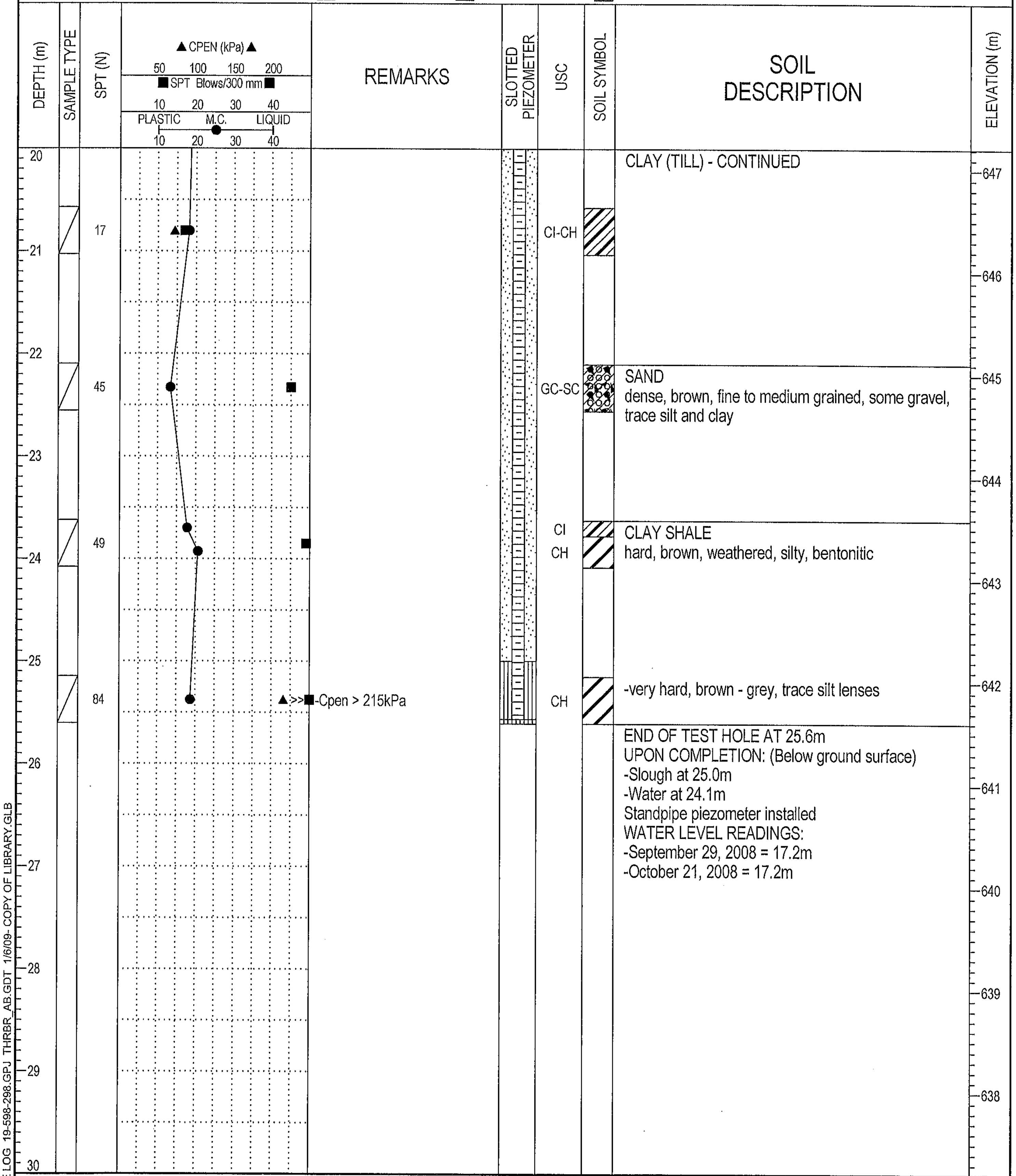
FIELD LOGGED BY: GA	COMPLETION DEPTH: 25.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-14-02C**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 667.21 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ░ SAND ▥ SLOUGH



CLAY (TILL) - CONTINUED

SAND
dense, brown, fine to medium grained, some gravel, trace silt and clay

CLAY SHALE
hard, brown, weathered, silty, bentonitic

-very hard, brown - grey, trace silt lenses

END OF TEST HOLE AT 25.6m
UPON COMPLETION: (Below ground surface)
-Slough at 25.0m
-Water at 24.1m
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 29, 2008 = 17.2m
-October 21, 2008 = 17.2m

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

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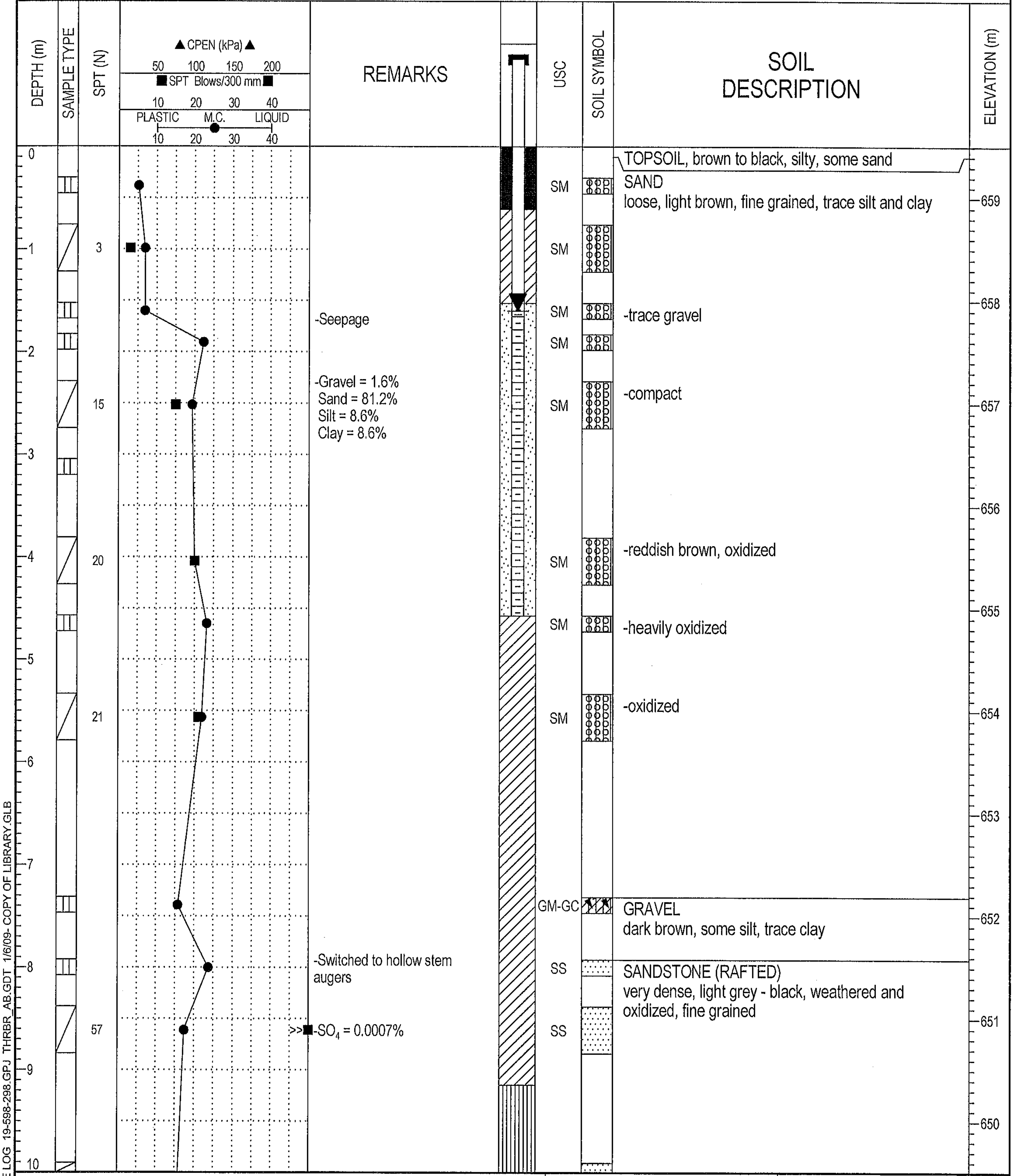
FIELD LOGGED BY: GA	COMPLETION DEPTH: 25.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-15-01C**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 3 & 7, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 659.5 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ⧄ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



REMARKS

-Seepage

-Gravel = 1.6%
Sand = 81.2%
Silt = 8.6%
Clay = 8.6%

-Switched to hollow stem augers

$-SO_4 = 0.0007\%$

SOIL DESCRIPTION

TOPSOIL, brown to black, silty, some sand

SAND
loose, light brown, fine grained, trace silt and clay

-trace gravel

-compact

-reddish brown, oxidized

-heavily oxidized

-oxidized

GRAVEL
dark brown, some silt, trace clay

SANDSTONE (RAFTED)
very dense, light grey - black, weathered and oxidized, fine grained

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THURBER ENGINEERING LTD.
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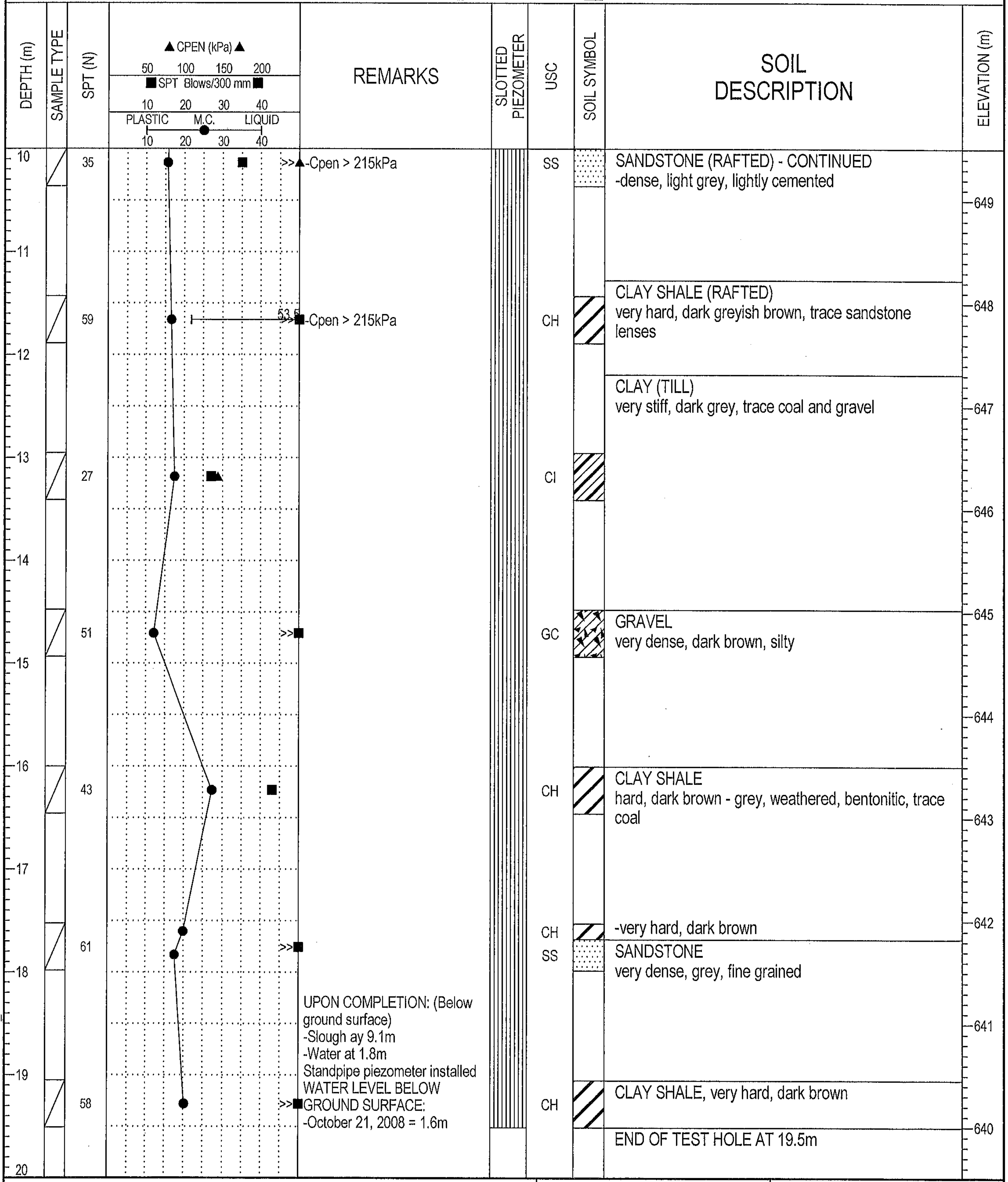
FIELD LOGGED BY: NR / GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/7/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-15-01C**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 3 & 7, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 659.5 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND ▥ SLOUGH



-Cpen > 215kPa

-Cpen > 215kPa

UPON COMPLETION: (Below ground surface)
-Slough ay 9.1m
-Water at 1.8m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-October 21, 2008 = 1.6m

SANDSTONE (RAFTED) - CONTINUED
-dense, light grey, lightly cemented

CLAY SHALE (RAFTED)
very hard, dark greyish brown, trace sandstone lenses

CLAY (TILL)
very stiff, dark grey, trace coal and gravel

GRAVEL
very dense, dark brown, silty

CLAY SHALE
hard, dark brown - grey, weathered, bentonitic, trace coal

-very hard, dark brown

SANDSTONE
very dense, grey, fine grained

CLAY SHALE, very hard, dark brown

END OF TEST HOLE AT 19.5m

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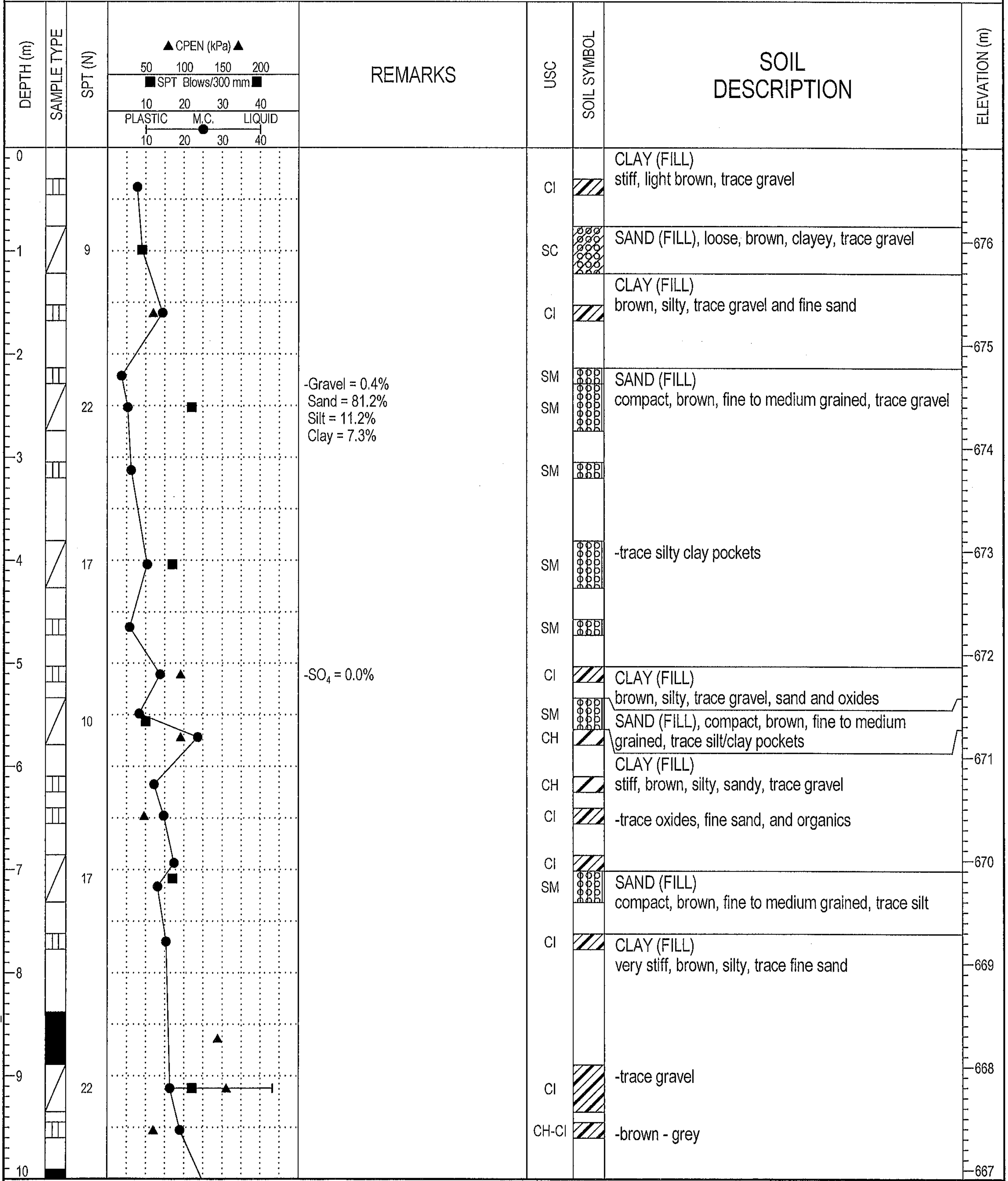
FIELD LOGGED BY: NR / GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/7/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-16-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.91 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
		CI	CLAY (FILL) stiff, light brown, trace gravel
9		SC	SAND (FILL), loose, brown, clayey, trace gravel
		CI	CLAY (FILL) brown, silty, trace gravel and fine sand
	-Gravel = 0.4% Sand = 81.2% Silt = 11.2% Clay = 7.3%	SM	SAND (FILL) compact, brown, fine to medium grained, trace gravel
22		SM	
		SM	
17		SM	-trace silty clay pockets
		SM	
	-SO_4 = 0.0%	CI	CLAY (FILL) brown, silty, trace gravel, sand and oxides
10		SM	SAND (FILL), compact, brown, fine to medium grained, trace silt/clay pockets
		CH	
		CH	CLAY (FILL) stiff, brown, silty, sandy, trace gravel
		CI	-trace oxides, fine sand, and organics
		CI	
17		SM	SAND (FILL) compact, brown, fine to medium grained, trace silt
		CI	CLAY (FILL) very stiff, brown, silty, trace fine sand
22		CI	-trace gravel
		CH-CI	-brown - grey

THURBER ENGINEERING LTD.
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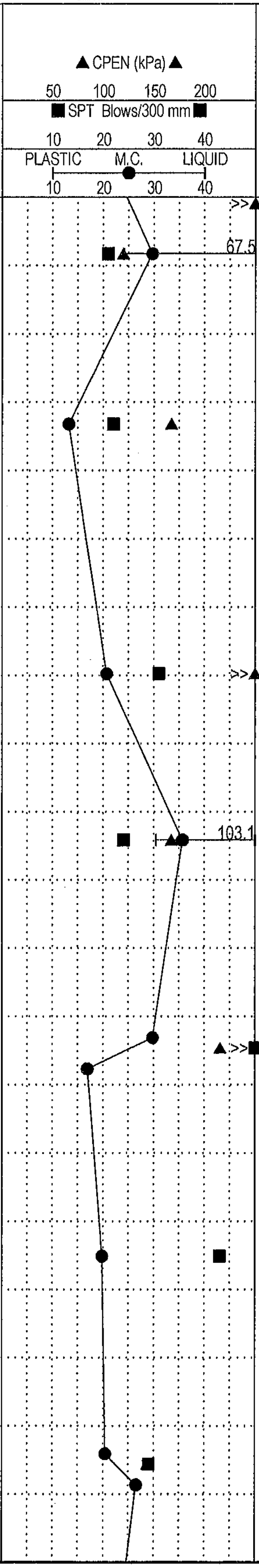
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/24/08
REVIEWED BY: RWT	Page 1 of 4

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-16-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.91 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE ☒ NO RECOVERY



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10	■		>>▲-Cpen > 215kPa			CLAY (FILL) - CONTINUED	
	◸	21		CH	▨		
11							666
	◸	22		CI	▨	CLAY (TILL) very stiff, grey, silty, trace gravel and fine sand	665
12							
13	■						664
	◸	31	>>▲-Cpen > 215kPa	CI	▨	-hard, trace oxides	
14							663
	◸	24		CH	▨	CLAY SHALE (RAFTED) very stiff, dark grey, weathered, silty, bentonitic	662
15							
16	◸	56	▲>>■	CH	▨	-very hard	661
				SC		SAND very dense, brown, fine grained, clayey	
17							660
	◸	43		SC		-dense	659
18							
19	◸	29		SC		-compact	658
				CH	▨	CLAY SHALE (RAFTED) very stiff, dark grey, weathered, bentonitic	
20							657

THURBER ENGINEERING LTD.
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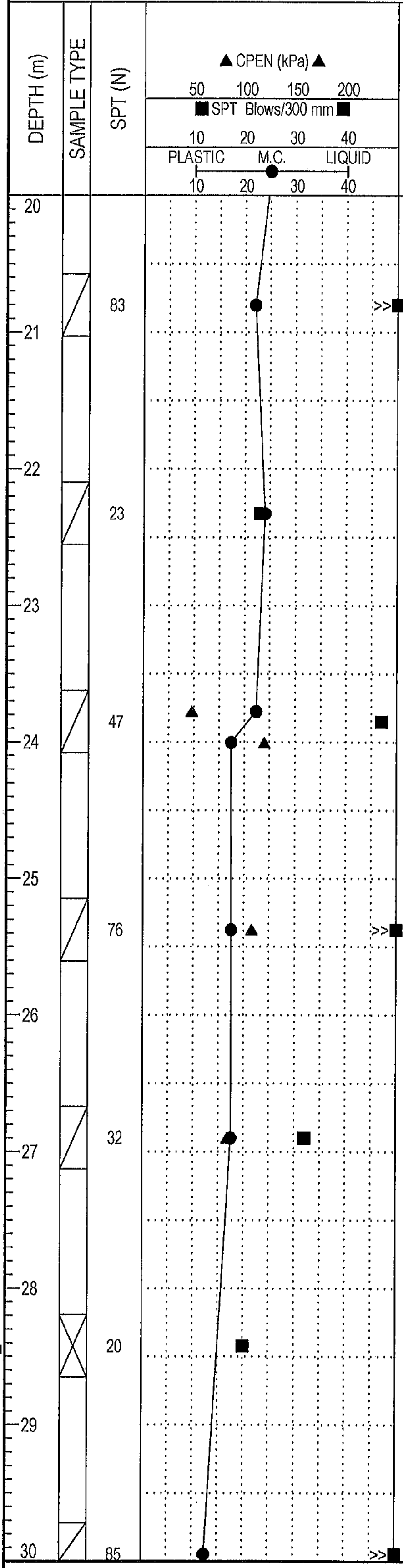
FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/24/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-16-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.91 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY



REMARKS

SPT (N)	USC	SOIL DESCRIPTION
		CLAY SHALE (RAFTED) - CONTINUED
83	SC	SAND very dense, brown, fine grained, clayey
23	SC	-compact
47	CI	CLAY SHALE (RAFTED) hard, brown, silty
	CI	CLAY (TILL) hard, brown, silty, trace fine sand and oxides
76	CI	-very hard, grey, trace gravel
32	CH	-hard
20		
85	SM	SAND

ELEVATION (m): 656, 655, 654, 653, 652, 651, 650, 649, 648, 647

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/24/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-16-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.91 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT ■ SHELBY TUBE ☒ 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)
30	◺						SAND - CONTINUED very dense, grey, fine to medium grained, trace gravel END OF TEST HOLE AT 30.2m UPON COMPLETION: (Below ground surface) -Slough at 16.5m -No water Backfilled with cuttings and bentonite	
31								646
32								645
33								644
34								643
35								642
36								641
37								640
38								639
39								638
40								637

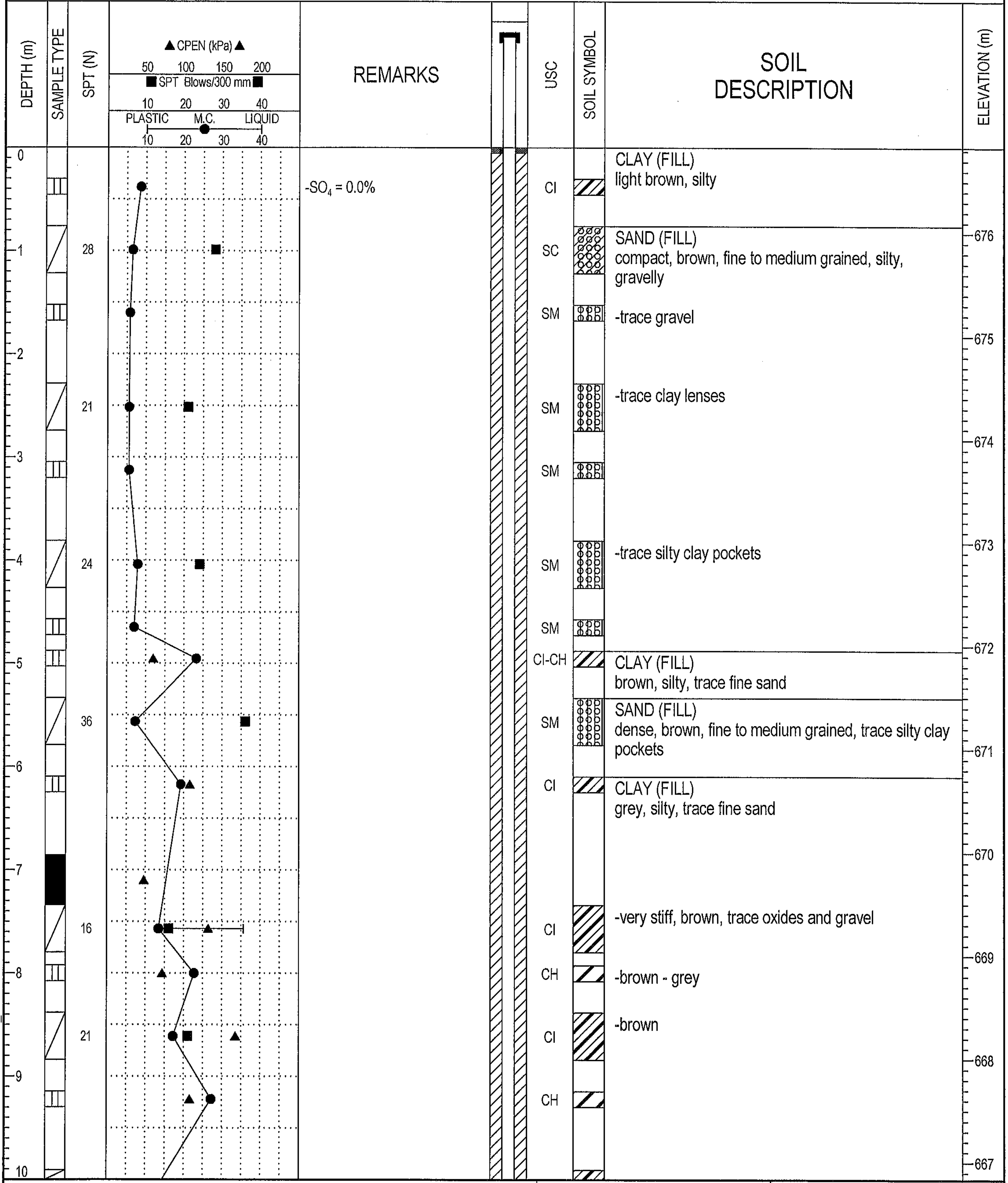
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 30.2 m
PREPARED BY: SGR	COMPLETION DATE: 9/24/08
REVIEWED BY: RWT	Page 4 of 4

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-16-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.83 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



-SO$_4$ = 0.0%

CLAY (FILL)
light brown, silty

SAND (FILL)
compact, brown, fine to medium grained, silty, gravelly

-trace gravel

-trace clay lenses

-trace silty clay pockets

CLAY (FILL)
brown, silty, trace fine sand

SAND (FILL)
dense, brown, fine to medium grained, trace silty clay pockets

CLAY (FILL)
grey, silty, trace fine sand

-very stiff, brown, trace oxides and gravel

-brown - grey

-brown

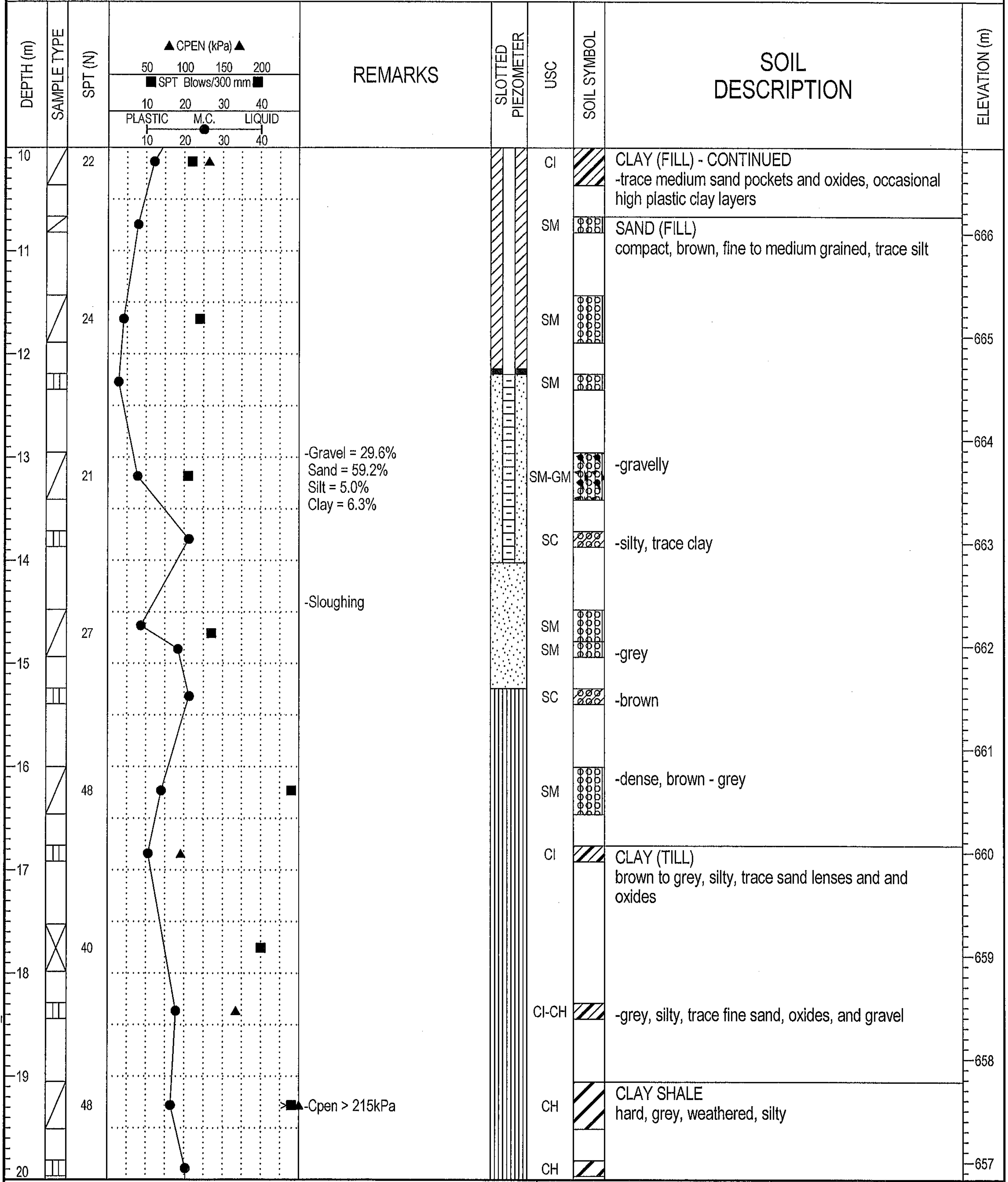
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.1 m
PREPARED BY: SGR	COMPLETION DATE: 9/24/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-16-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.83 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



-Gravel = 29.6%
Sand = 59.2%
Silt = 5.0%
Clay = 6.3%

-Sloughing

>-Cpen > 215kPa

CLAY (FILL) - CONTINUED
-trace medium sand pockets and oxides, occasional high plastic clay layers

SAND (FILL)
compact, brown, fine to medium grained, trace silt

-gravelly

-silty, trace clay

-grey

-brown

-dense, brown - grey

CLAY (TILL)
brown to grey, silty, trace sand lenses and and oxides

-grey, silty, trace fine sand, oxides, and gravel

CLAY SHALE
hard, grey, weathered, silty

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 12/15/09- COPY OF LIBRARY.GLB

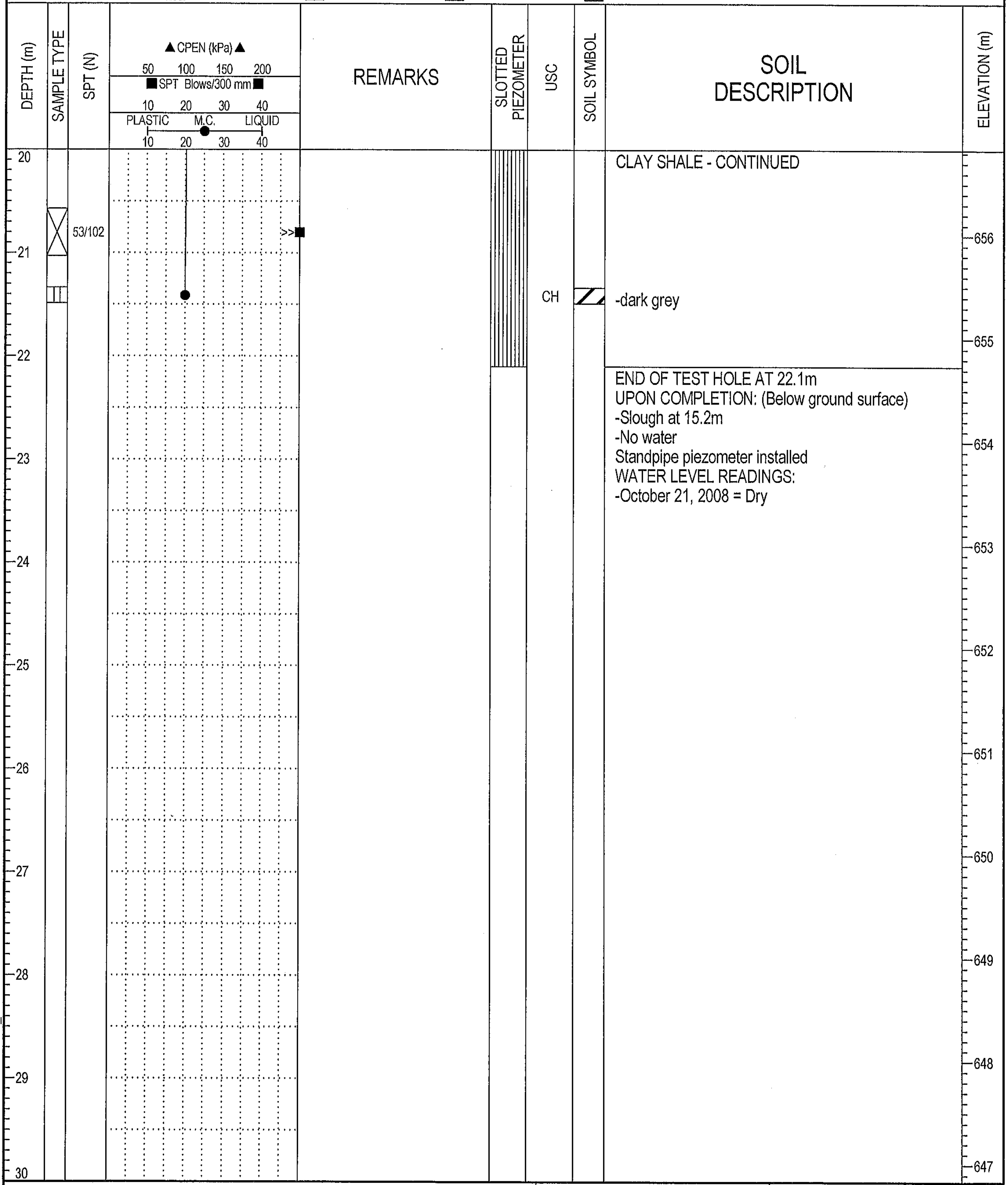
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.1 m
PREPARED BY: SGR	COMPLETION DATE: 9/24/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-16-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.83 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ◪ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



SOIL DESCRIPTION

CLAY SHALE - CONTINUED

-dark grey

END OF TEST HOLE AT 22.1m
UPON COMPLETION: (Below ground surface)
-Slough at 15.2m
-No water
Standpipe piezometer installed
WATER LEVEL READINGS:
-October 21, 2008 = Dry

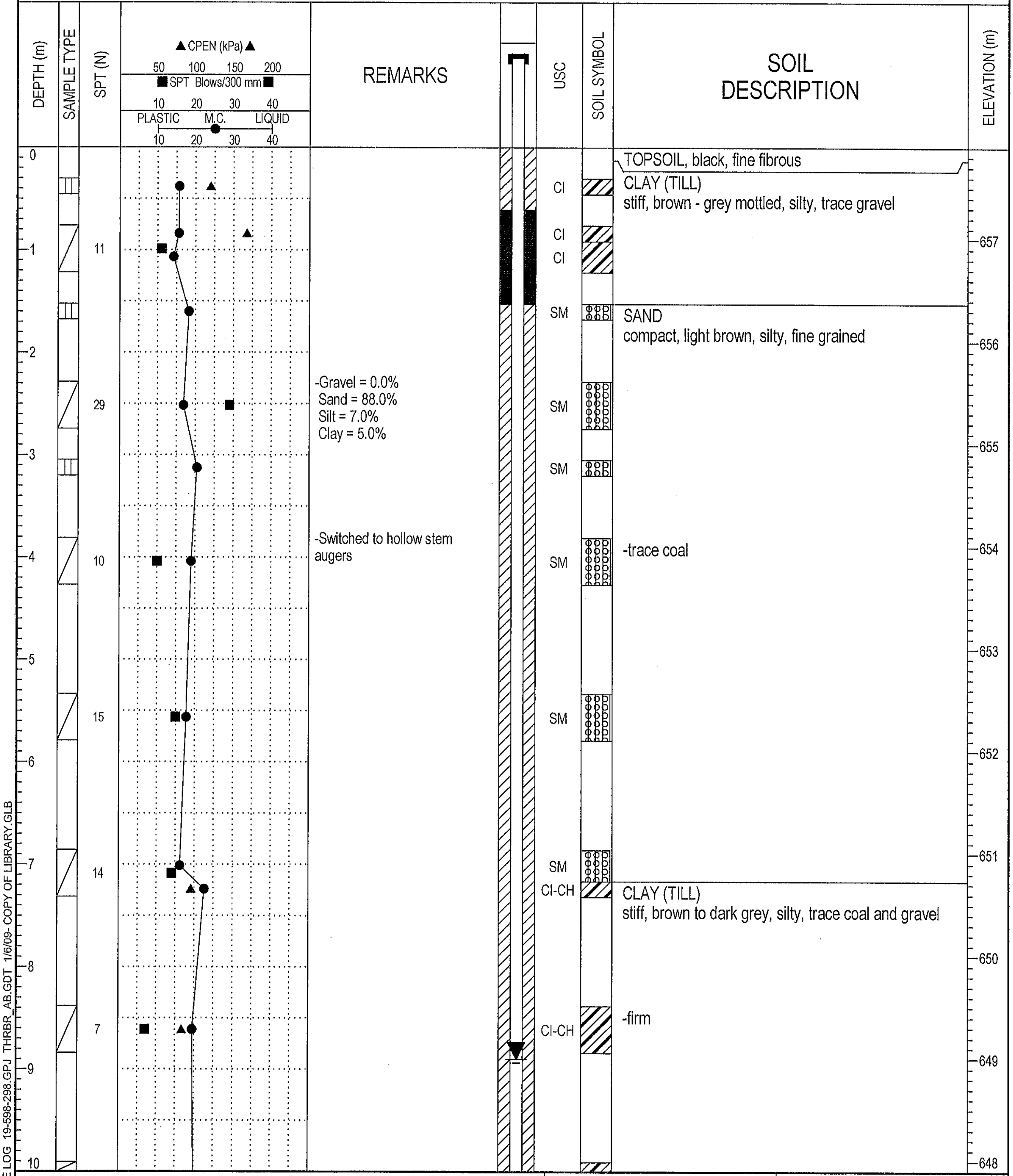
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.1 m
PREPARED BY: SGR	COMPLETION DATE: 9/24/08
REVIEWED BY: RWT	Page 3 of 3

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 12/15/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO
BOREHOLE NO: **TH08-17-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: October 2 & 3, 2008
PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers
LOCATION: See Drawing #19-598-298-1
ELEVATION: 657.89 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE ☒ NO RECOVERY
BACKFILL TYPE: ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



REMARKS

-Gravel = 0.0%
Sand = 88.0%
Silt = 7.0%
Clay = 5.0%

-Switched to hollow stem augers

SOIL DESCRIPTION

TOPSOIL, black, fine fibrous

CLAY (TILL)
stiff, brown - grey mottled, silty, trace gravel

SAND
compact, light brown, silty, fine grained

-trace coal

CLAY (TILL)
stiff, brown to dark grey, silty, trace coal and gravel

-firm

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

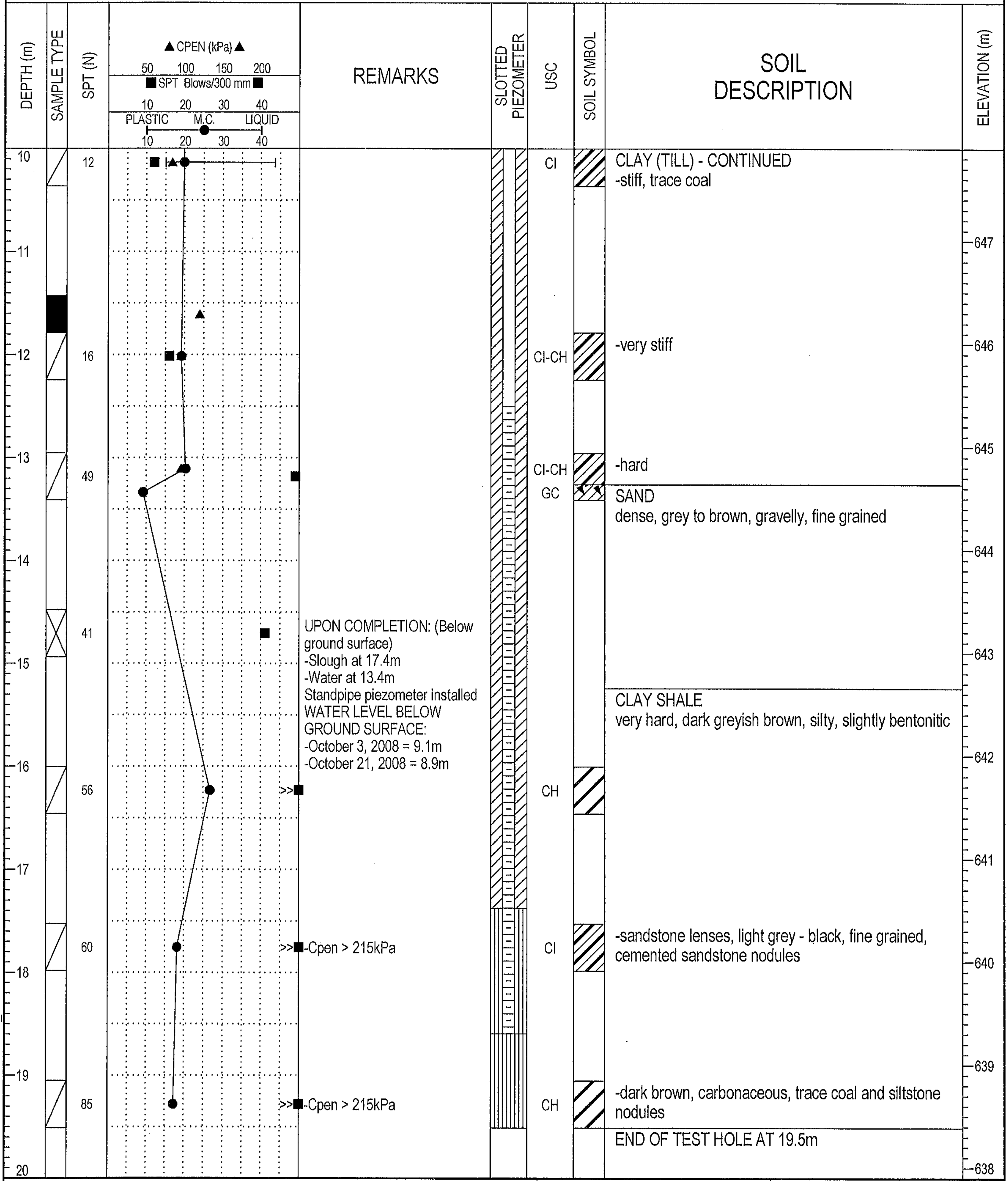
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: NR
COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR
COMPLETION DATE: 10/3/08
REVIEWED BY: RWT

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-17-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 2 & 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.89 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



12		CI	CLAY (TILL) - CONTINUED -stiff, trace coal	
16		CI-CH	-very stiff	
49		CI-CH	-hard	
		GC	SAND dense, grey to brown, gravelly, fine grained	
41				UPON COMPLETION: (Below ground surface) -Slough at 17.4m -Water at 13.4m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -October 3, 2008 = 9.1m -October 21, 2008 = 8.9m
			CLAY SHALE very hard, dark greyish brown, silty, slightly bentonitic	
56	>>	CH		
60	>>	CI	-sandstone lenses, light grey - black, fine grained, cemented sandstone nodules	-Cpen > 215kPa
85	>>	CH	-dark brown, carbonaceous, trace coal and siltstone nodules	-Cpen > 215kPa
			END OF TEST HOLE AT 19.5m	

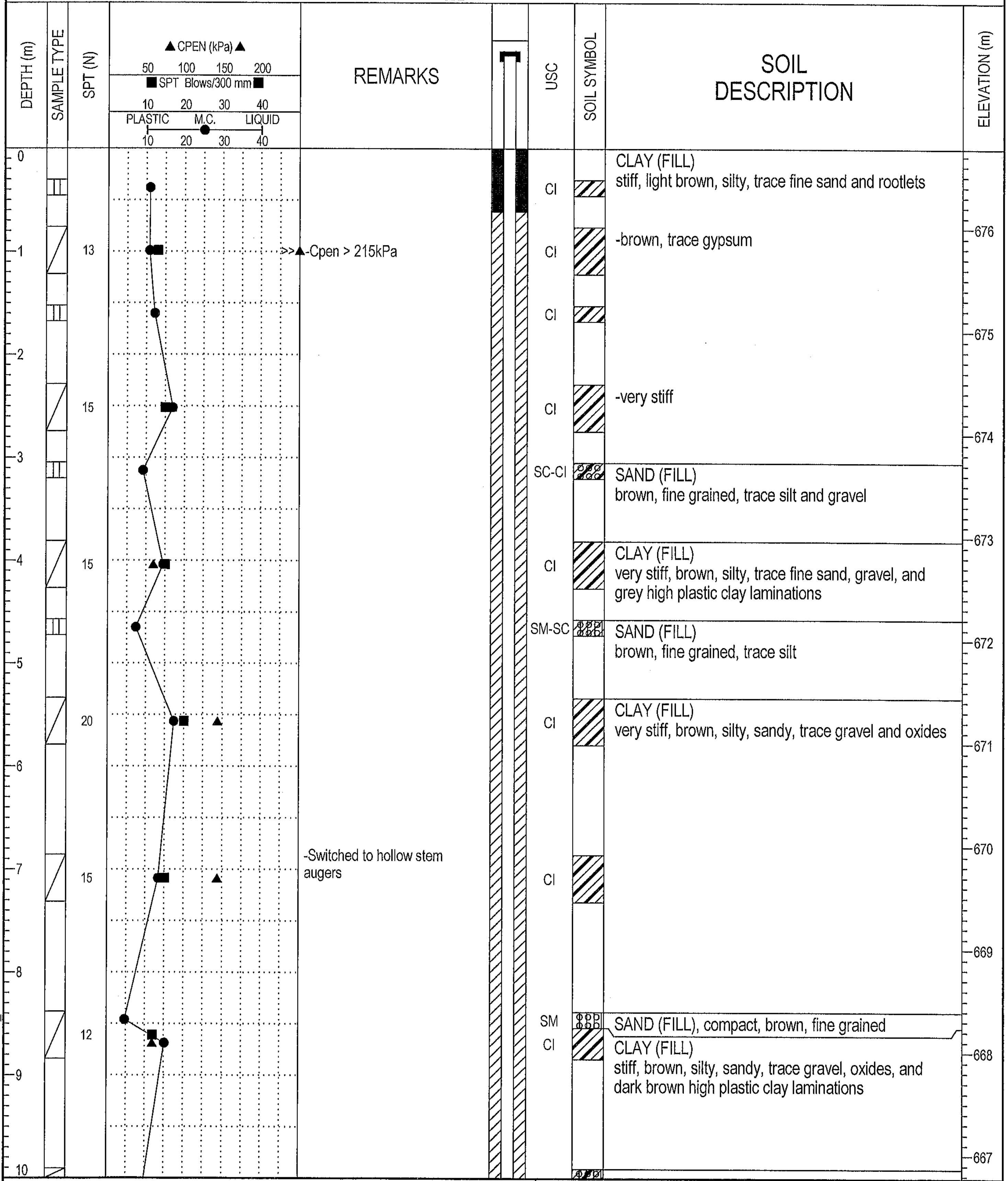
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: NR	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/3/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-17-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 10, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.77 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



Depth (m)	SPT (N)	Remarks	USC	Soil Description
0			CI	CLAY (FILL) stiff, light brown, silty, trace fine sand and rootlets
1	13	>>▲-Cpen > 215kPa	CI	-brown, trace gypsum
			CI	
2.5	15		CI	-very stiff
3			SC-CI	SAND (FILL) brown, fine grained, trace silt and gravel
4	15		CI	CLAY (FILL) very stiff, brown, silty, trace fine sand, gravel, and grey high plastic clay laminations
4.5			SM-SC	SAND (FILL) brown, fine grained, trace silt
5.5	20		CI	CLAY (FILL) very stiff, brown, silty, sandy, trace gravel and oxides
7	15	-Switched to hollow stem augers	CI	
8.5	12		SM	SAND (FILL), compact, brown, fine grained
			CI	CLAY (FILL) stiff, brown, silty, sandy, trace gravel, oxides, and dark brown high plastic clay laminations

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

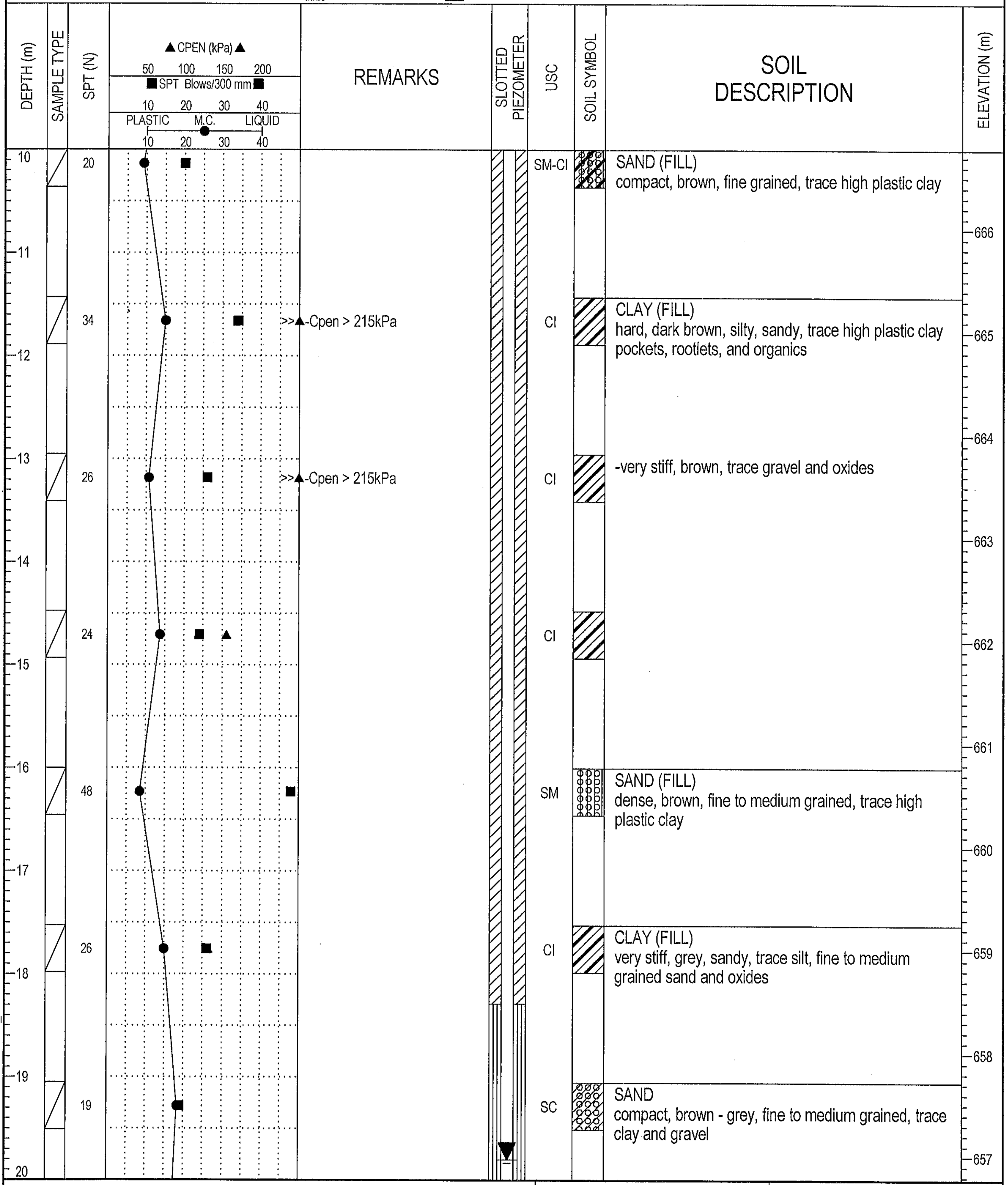
FIELD LOGGED BY: GA	COMPLETION DEPTH: 31.7 m
PREPARED BY: SGR	COMPLETION DATE: 10/10/08
REVIEWED BY: RWT	Page 1 of 4

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-17-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 10, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.77 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SAND (FILL)
compact, brown, fine grained, trace high plastic clay

CLAY (FILL)
hard, dark brown, silty, sandy, trace high plastic clay pockets, rootlets, and organics

-very stiff, brown, trace gravel and oxides

SAND (FILL)
dense, brown, fine to medium grained, trace high plastic clay

CLAY (FILL)
very stiff, grey, sandy, trace silt, fine to medium grained sand and oxides

SAND
compact, brown - grey, fine to medium grained, trace clay and gravel

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

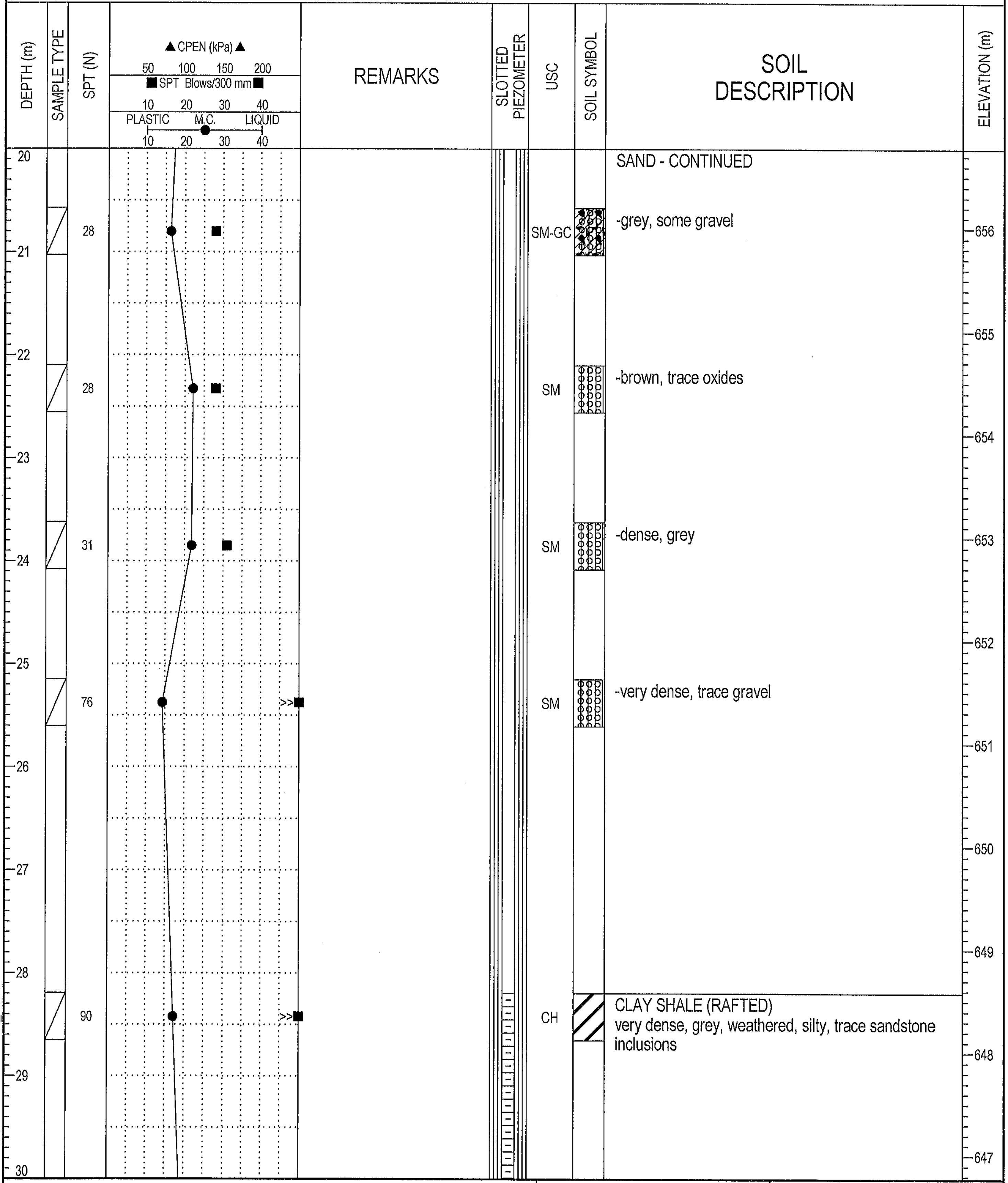
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 31.7 m
PREPARED BY: SGR	COMPLETION DATE: 10/10/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-17-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 10, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.77 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SPT (N)	USC	SOIL DESCRIPTION
		SAND - CONTINUED
28	SM-GC	-grey, some gravel
28	SM	-brown, trace oxides
31	SM	-dense, grey
76	SM	-very dense, trace gravel
90	CH	CLAY SHALE (RAFTED) very dense, grey, weathered, silty, trace sandstone inclusions

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THURBER ENGINEERING LTD.
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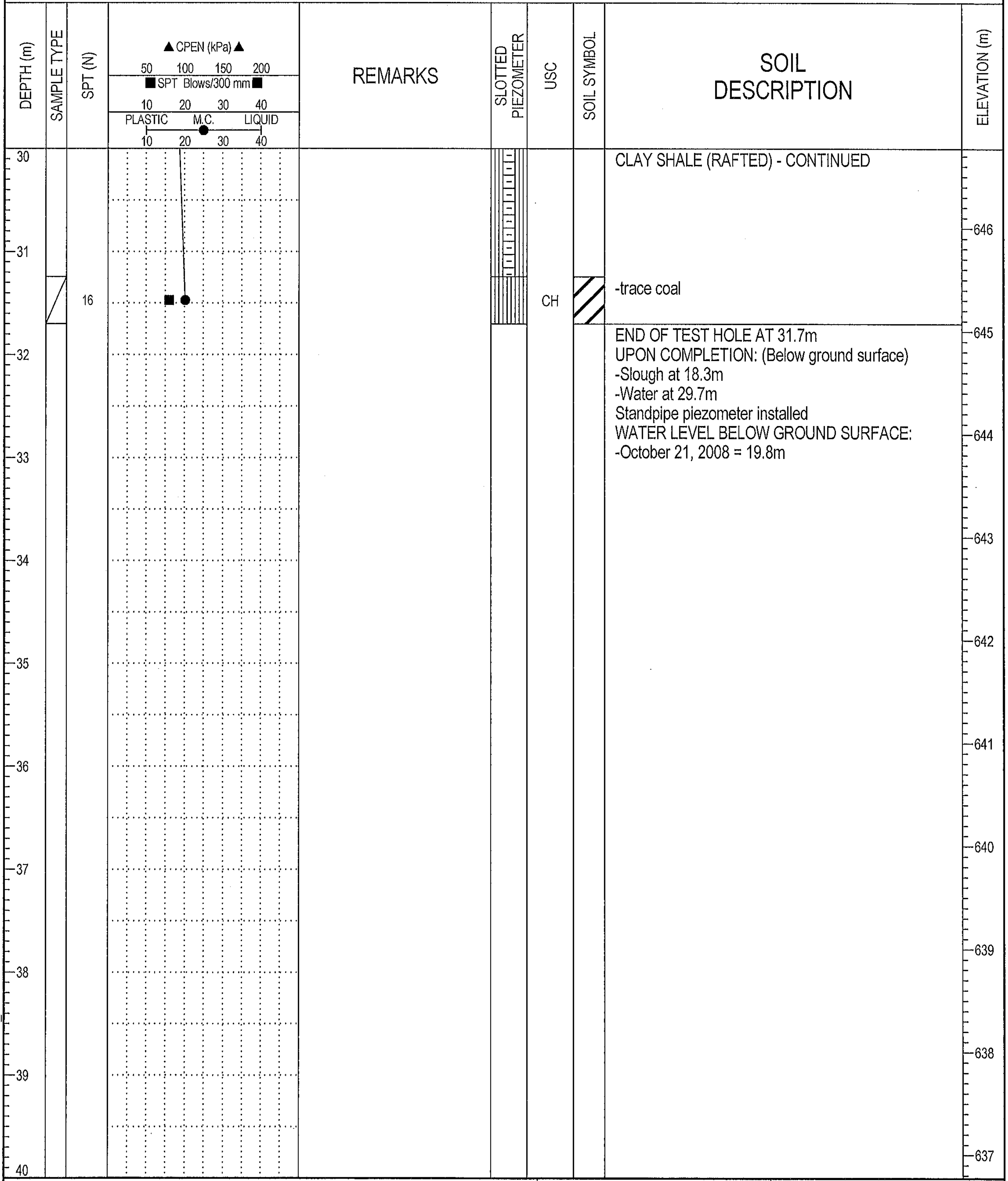
FIELD LOGGED BY: GA	COMPLETION DEPTH: 31.7 m
PREPARED BY: SGR	COMPLETION DATE: 10/10/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-17-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 10, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.77 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SOIL DESCRIPTION

CLAY SHALE (RAFTED) - CONTINUED

-trace coal

END OF TEST HOLE AT 31.7m
UPON COMPLETION: (Below ground surface)
-Slough at 18.3m
-Water at 29.7m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-October 21, 2008 = 19.8m

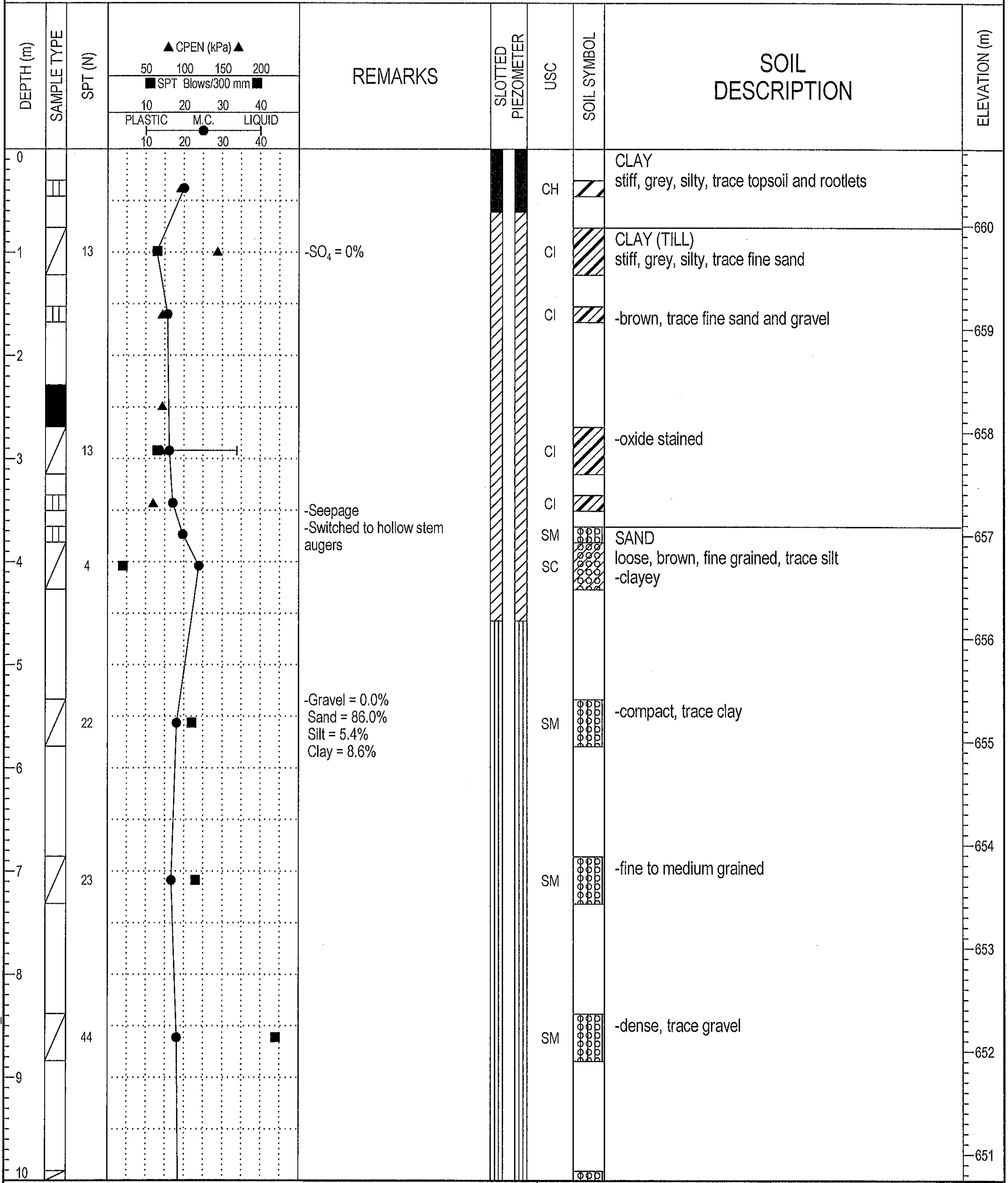
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 31.7 m
PREPARED BY: SGR	COMPLETION DATE: 10/10/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-18-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 660.74 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
		CH	CLAY stiff, grey, silty, trace topsoil and rootlets
13	-SO_4 = 0%	CI	CLAY (TILL) stiff, grey, silty, trace fine sand
		CI	-brown, trace fine sand and gravel
13		CI	-oxide stained
	-Seepage	CI	
	-Switched to hollow stem augers	SM	SAND loose, brown, fine grained, trace silt
4		SC	-clayey
22	-Gravel = 0.0% Sand = 86.0% Silt = 5.4% Clay = 8.6%	SM	-compact, trace clay
23		SM	-fine to medium grained
44		SM	-dense, trace gravel

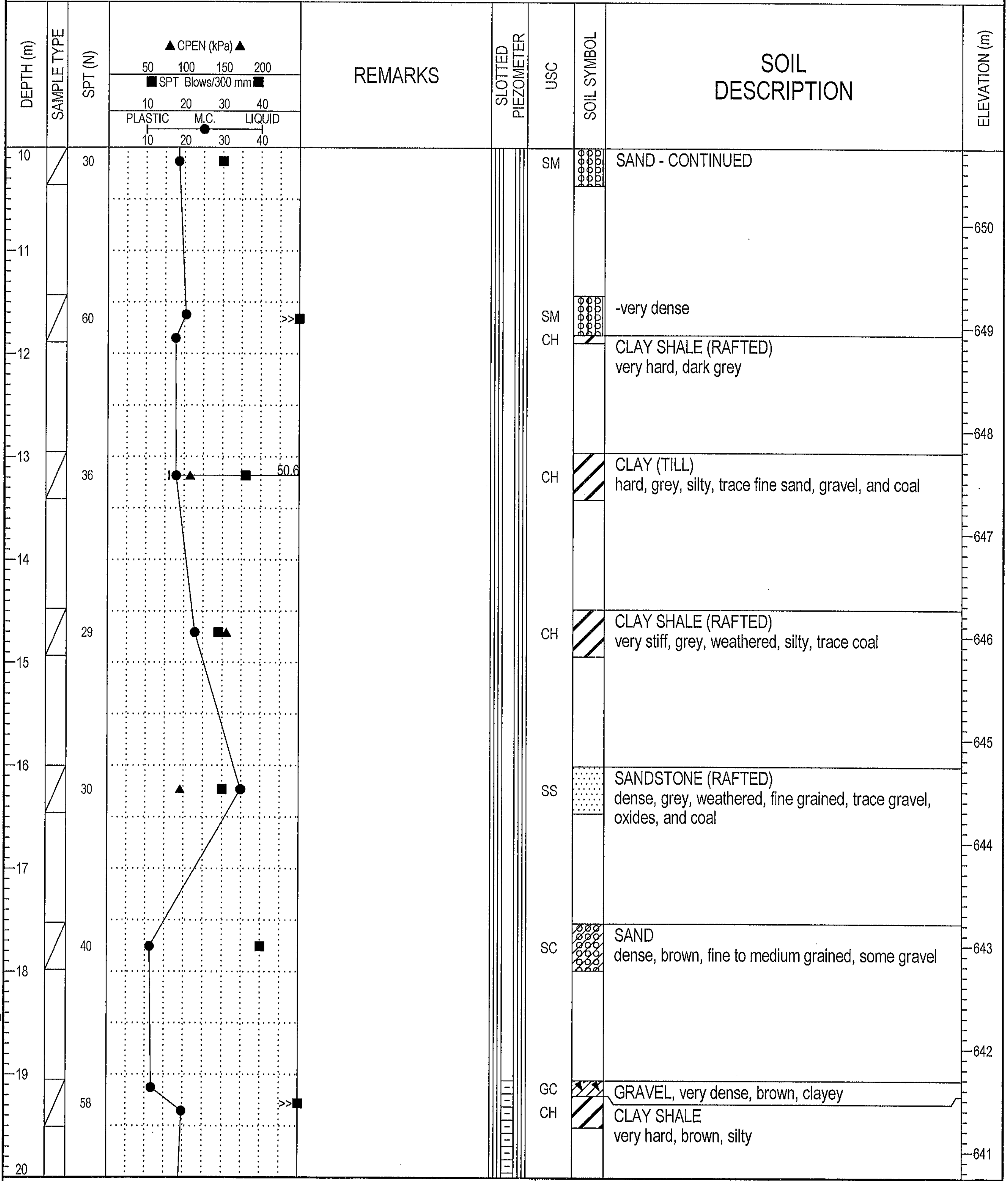
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-18-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 660.74 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SPT (N)	USC	SOIL DESCRIPTION
30	SM	SAND - CONTINUED
60	SM	-very dense
	CH	CLAY SHALE (RAFTED) very hard, dark grey
36	CH	CLAY (TILL) hard, grey, silty, trace fine sand, gravel, and coal
29	CH	CLAY SHALE (RAFTED) very stiff, grey, weathered, silty, trace coal
30	SS	SANDSTONE (RAFTED) dense, grey, weathered, fine grained, trace gravel, oxides, and coal
40	SC	SAND dense, brown, fine to medium grained, some gravel
	GC	GRAVEL, very dense, brown, clayey
58	CH	CLAY SHALE very hard, brown, silty

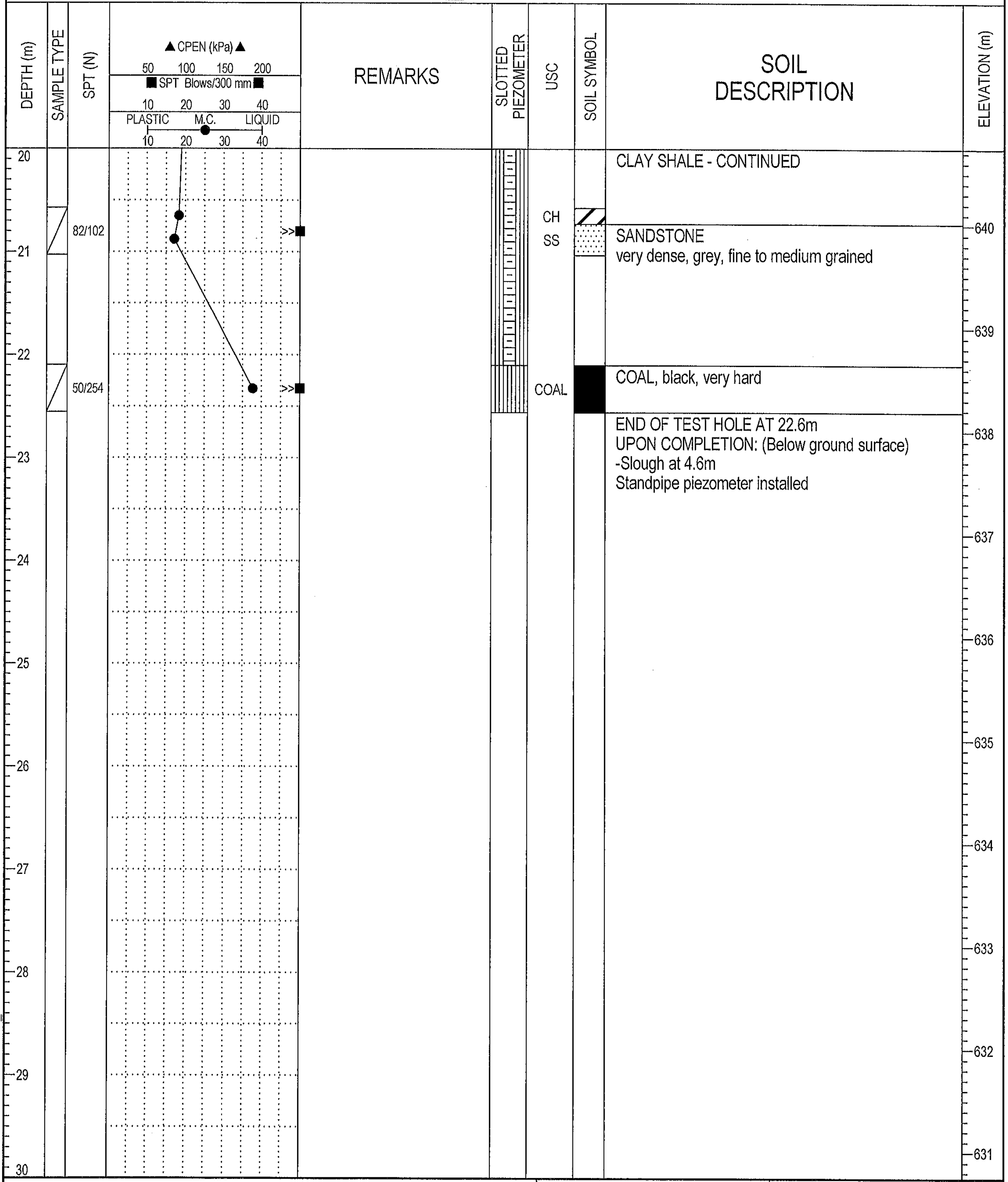
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-18-01B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 660.74 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



CLAY SHALE - CONTINUED

SANDSTONE
very dense, grey, fine to medium grained

COAL, black, very hard

END OF TEST HOLE AT 22.6m
UPON COMPLETION: (Below ground surface)
-Slough at 4.6m
Standpipe piezometer installed

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

THURBER ENGINEERING LTD.
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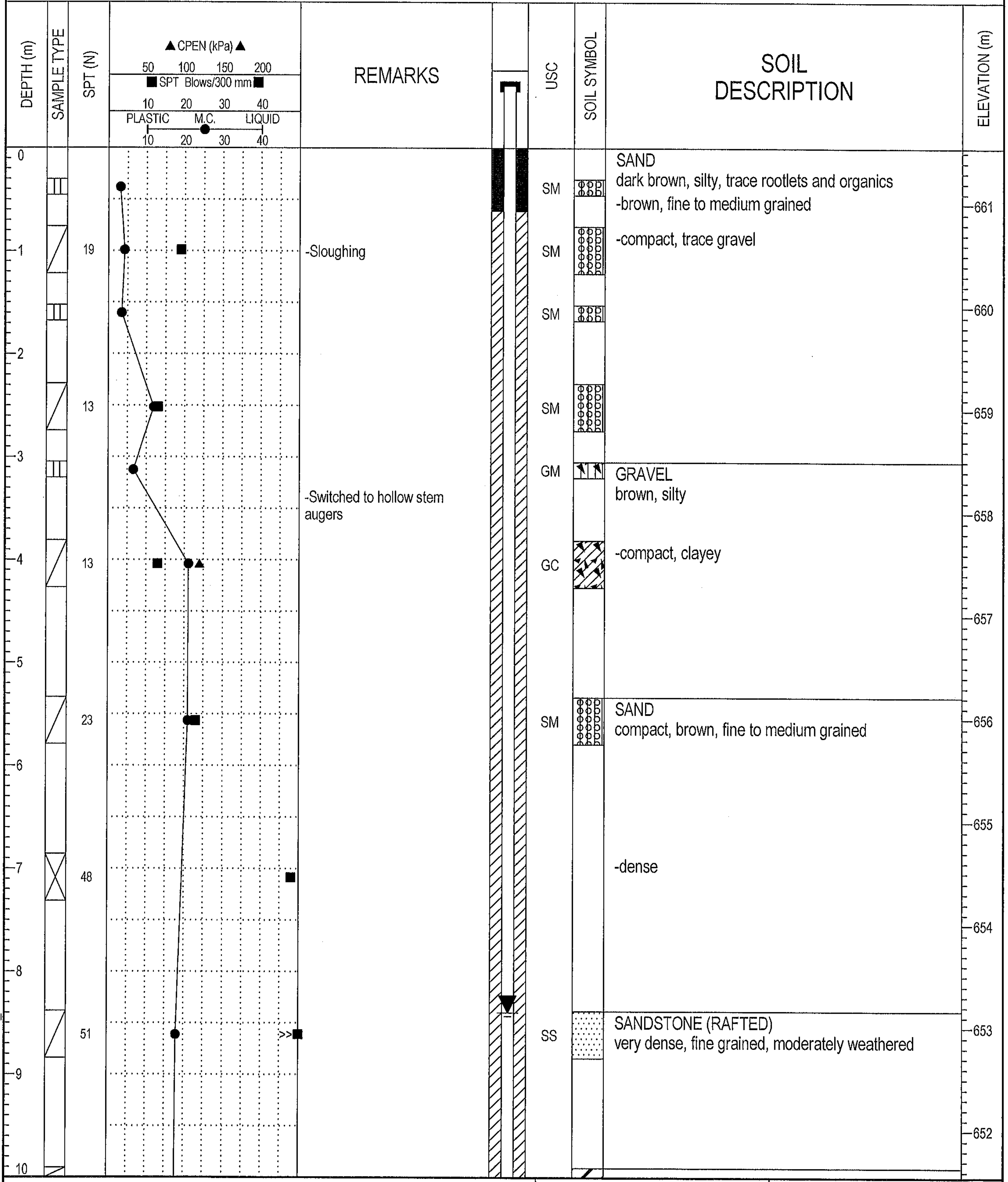
FIELD LOGGED BY: GA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-18-02B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 7, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 661.54 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◪ SPT ☒ NO RECOVERY

BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND



-Sloughing

-Switched to hollow stem augers

SAND
dark brown, silty, trace rootlets and organics
-brown, fine to medium grained
-compact, trace gravel

GRAVEL
brown, silty
-compact, clayey

SAND
compact, brown, fine to medium grained
-dense

SANDSTONE (RAFTED)
very dense, fine grained, moderately weathered

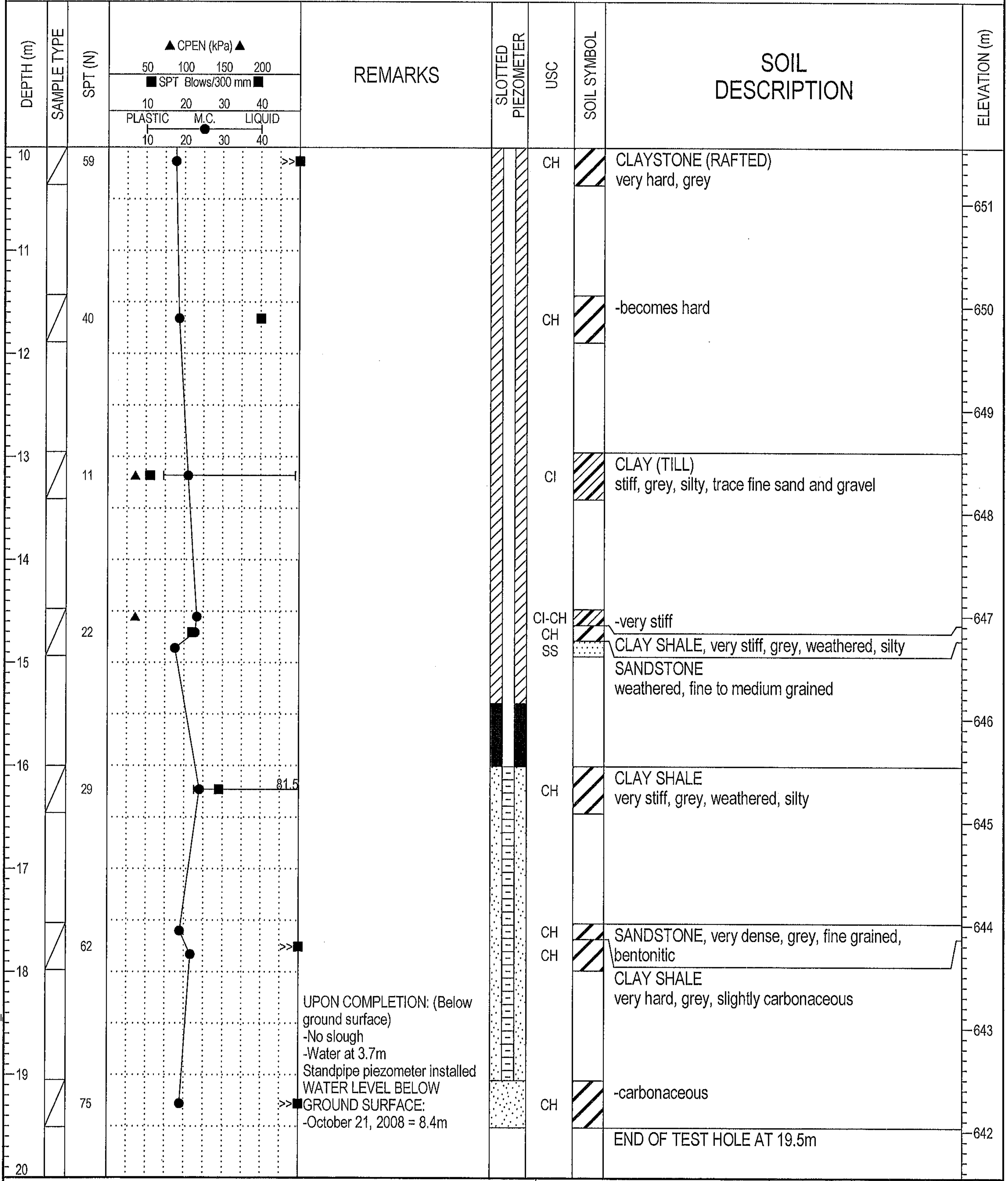
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/7/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-18-02B**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 7, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 661.54 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND



CLAYSTONE (RAFTED)
very hard, grey

-becomes hard

CLAY (TILL)
stiff, grey, silty, trace fine sand and gravel

-very stiff

CLAY SHALE, very stiff, grey, weathered, silty

SANDSTONE
weathered, fine to medium grained

CLAY SHALE
very stiff, grey, weathered, silty

SANDSTONE, very dense, grey, fine grained, bentonitic

CLAY SHALE
very hard, grey, slightly carbonaceous

-carbonaceous

END OF TEST HOLE AT 19.5m

UPON COMPLETION: (Below ground surface)
-No slough
-Water at 3.7m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-October 21, 2008 = 8.4m

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/7/08
REVIEWED BY: RWT	Page 2 of 2

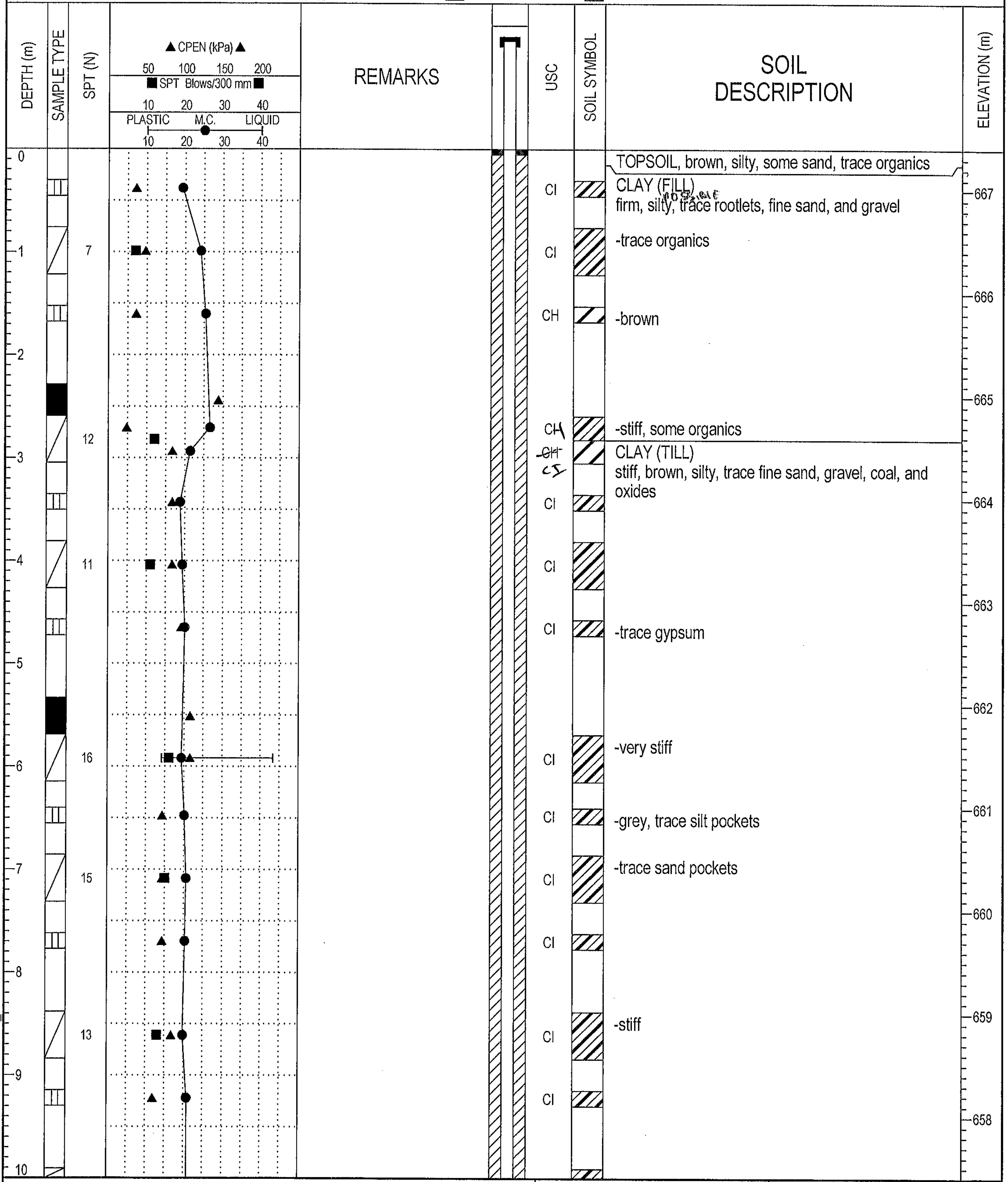
BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

FLATS

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-19-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 667.4 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ░ SAND ▥ SLOUGH



TOPSOIL, brown, silty, some sand, trace organics

CLAY (FILL) possible
firm, silty, trace rootlets, fine sand, and gravel

-trace organics

-brown

-stiff, some organics

CLAY (TILL)
stiff, brown, silty, trace fine sand, gravel, coal, and oxides

-trace gypsum

-very stiff

-grey, trace silt pockets

-trace sand pockets

-stiff

THURBER ENGINEERING LTD.
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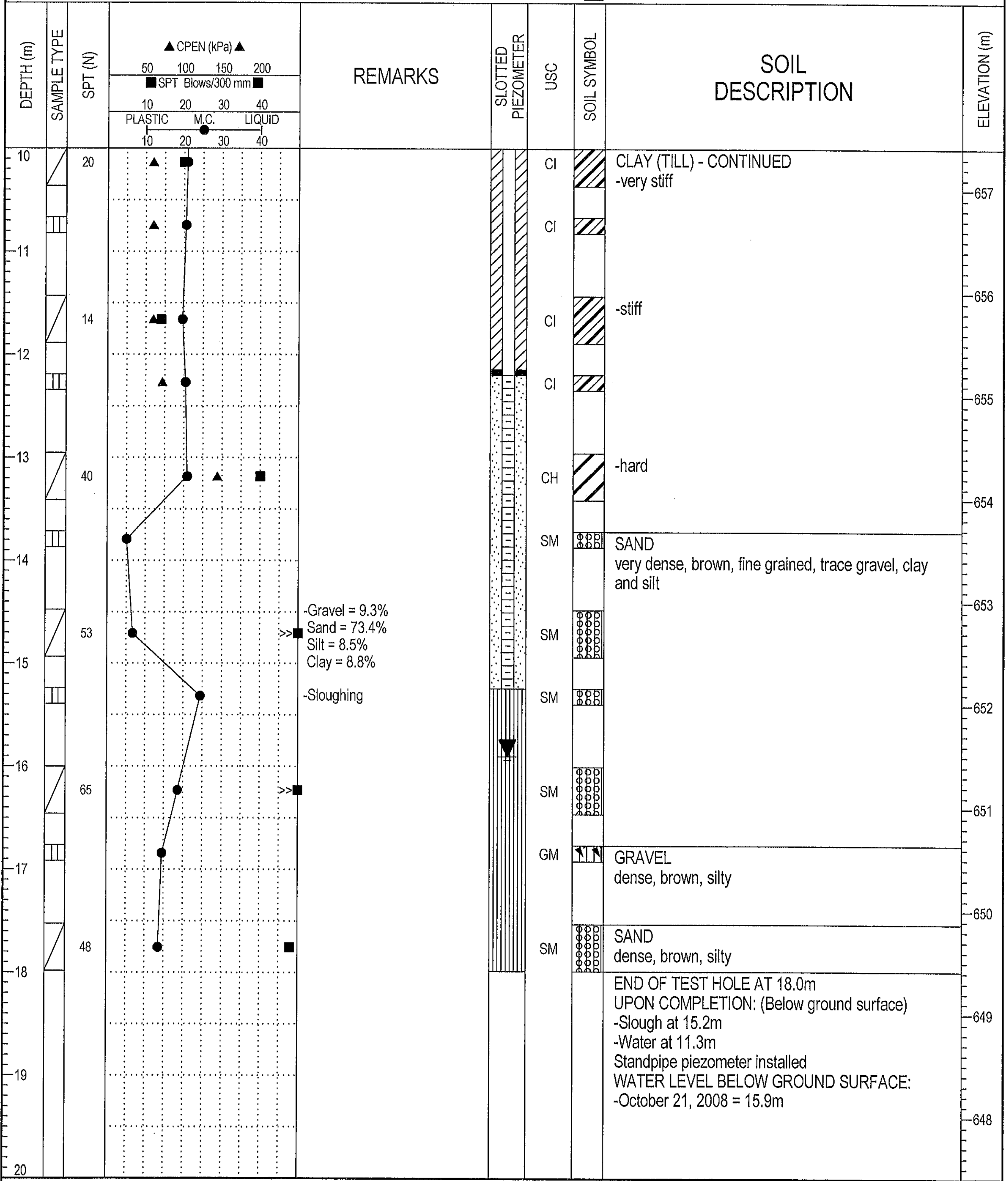
FIELD LOGGED BY: GA	COMPLETION DEPTH: 18.0 m
PREPARED BY: SGR	COMPLETION DATE: 10/3/08
REVIEWED BY: RWT	Page 1 of 2

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-19-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 667.4 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



-Gravel = 9.3%
Sand = 73.4%
Silt = 8.5%
Clay = 8.8%

-Sloughing

CLAY (TILL) - CONTINUED
-very stiff

-stiff

-hard

SAND
very dense, brown, fine grained, trace gravel, clay and silt

GRAVEL
dense, brown, silty

SAND
dense, brown, silty

END OF TEST HOLE AT 18.0m
UPON COMPLETION: (Below ground surface)
-Slough at 15.2m
-Water at 11.3m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-October 21, 2008 = 15.9m

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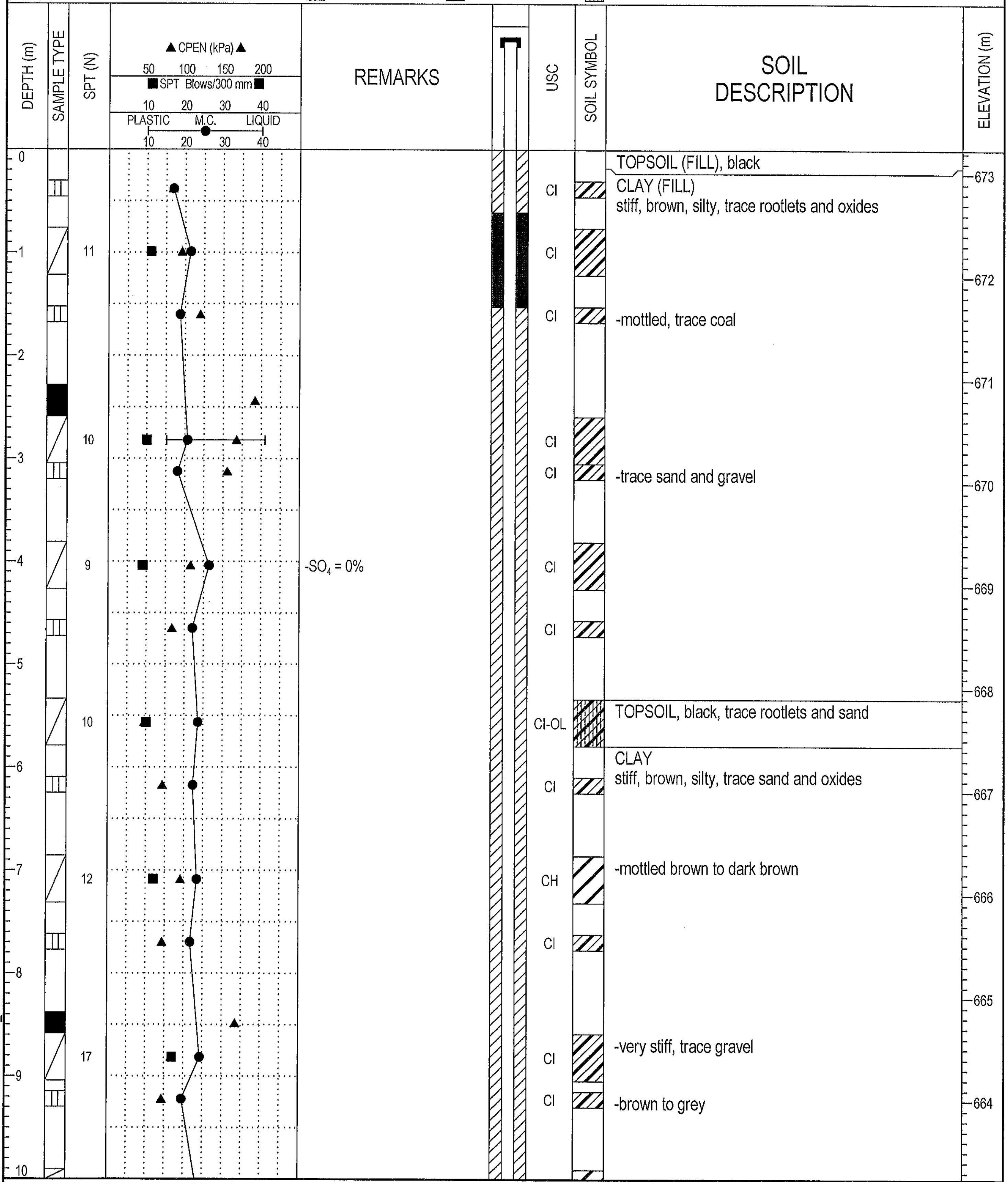
FIELD LOGGED BY: GA	COMPLETION DEPTH: 18.0 m
PREPARED BY: SGR	COMPLETION DATE: 10/3/08
REVIEWED BY: RWT	Page 2 of 2

WEST ABUTMENT

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-20-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 673.23 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE: ▨ DRILL CUTTINGS ■ BENTONITE ⬚ SAND ▥ SLOUGH



-SO$_4$ = 0%

TOPSOIL (FILL), black

CLAY (FILL)
stiff, brown, silty, trace rootlets and oxides

-mottled, trace coal

-trace sand and gravel

TOPSOIL, black, trace rootlets and sand

CLAY
stiff, brown, silty, trace sand and oxides

-mottled brown to dark brown

-very stiff, trace gravel

-brown to grey

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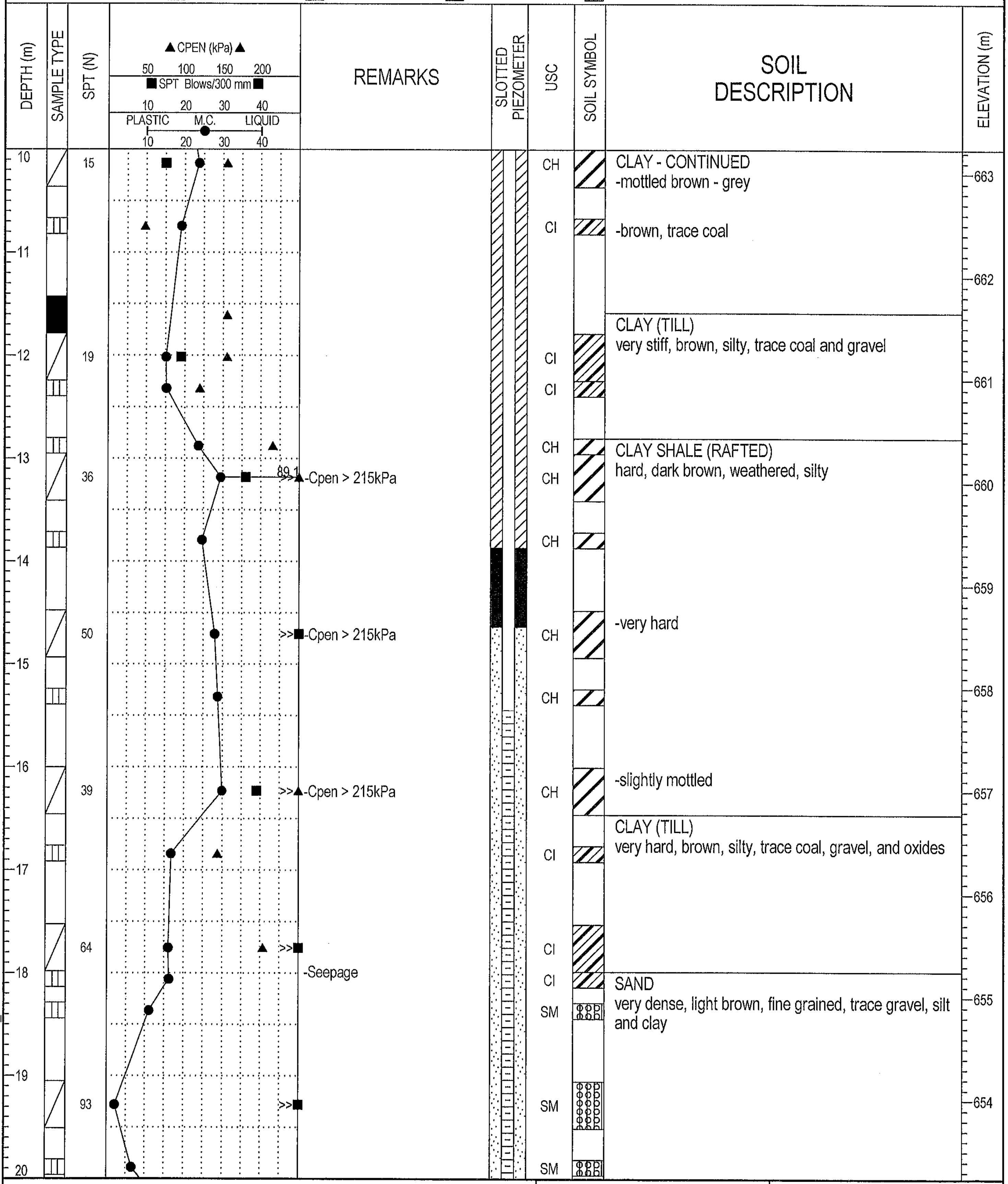
FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-20-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 673.23 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE: ▨ DRILL CUTTINGS ■ BENTONITE ░ SAND ▥ SLOUGH



CLAY - CONTINUED
-mottled brown - grey

-brown, trace coal

CLAY (TILL)
very stiff, brown, silty, trace coal and gravel

CLAY SHALE (RAFTED)
hard, dark brown, weathered, silty

-very hard

-slightly mottled

CLAY (TILL)
very hard, brown, silty, trace coal, gravel, and oxides

SAND
very dense, light brown, fine grained, trace gravel, silt and clay

Remarks:
-Cpen > 215kPa
-Cpen > 215kPa
-Cpen > 215kPa
-Seepage

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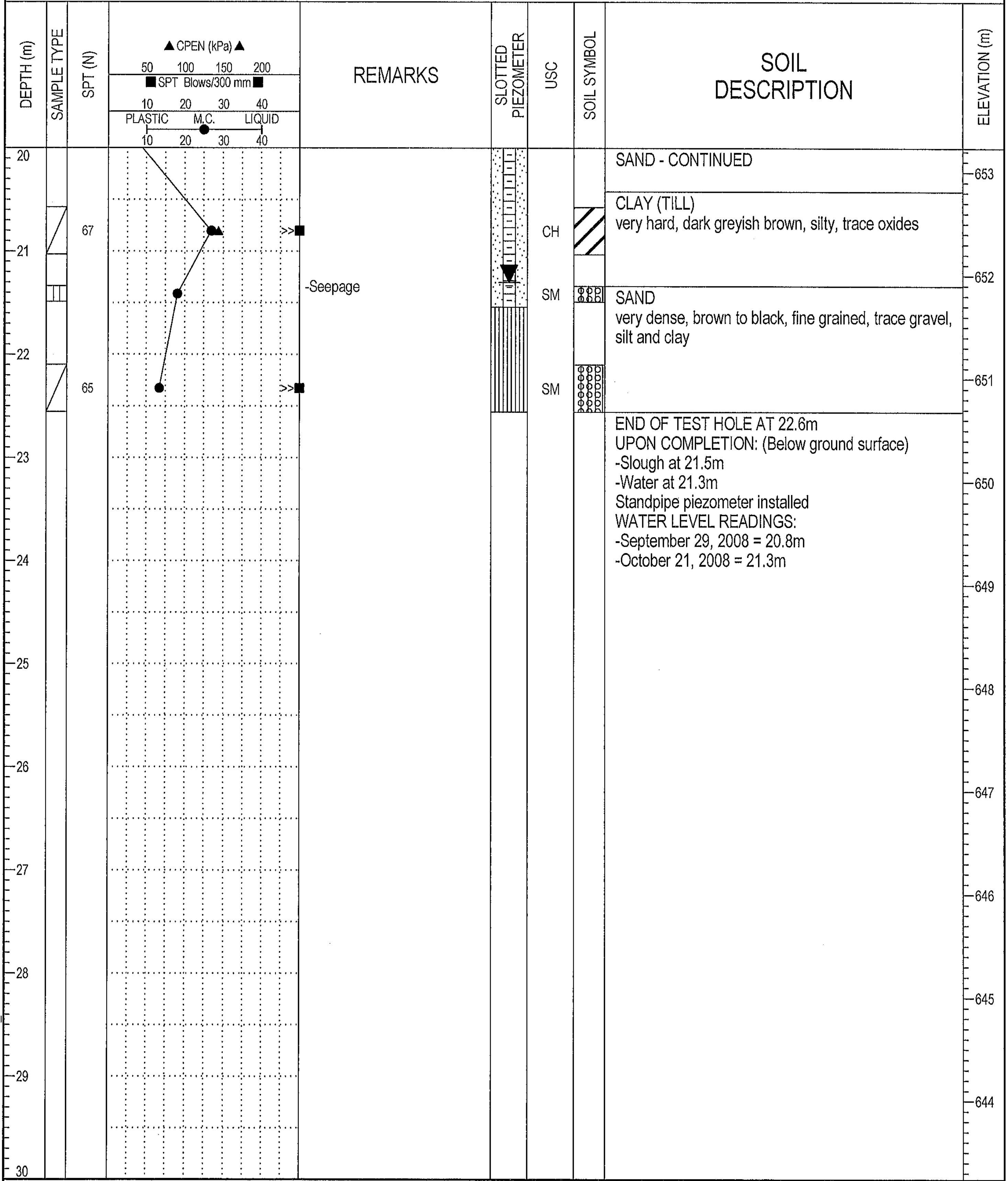
FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	Page 2 of 3

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-20-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 673.23 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⬚ SAND ▥ SLOUGH



SOIL DESCRIPTION

SAND - CONTINUED

CLAY (TILL)
very hard, dark greyish brown, silty, trace oxides

SAND
very dense, brown to black, fine grained, trace gravel, silt and clay

END OF TEST HOLE AT 22.6m
UPON COMPLETION: (Below ground surface)
-Slough at 21.5m
-Water at 21.3m
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 29, 2008 = 20.8m
-October 21, 2008 = 21.3m

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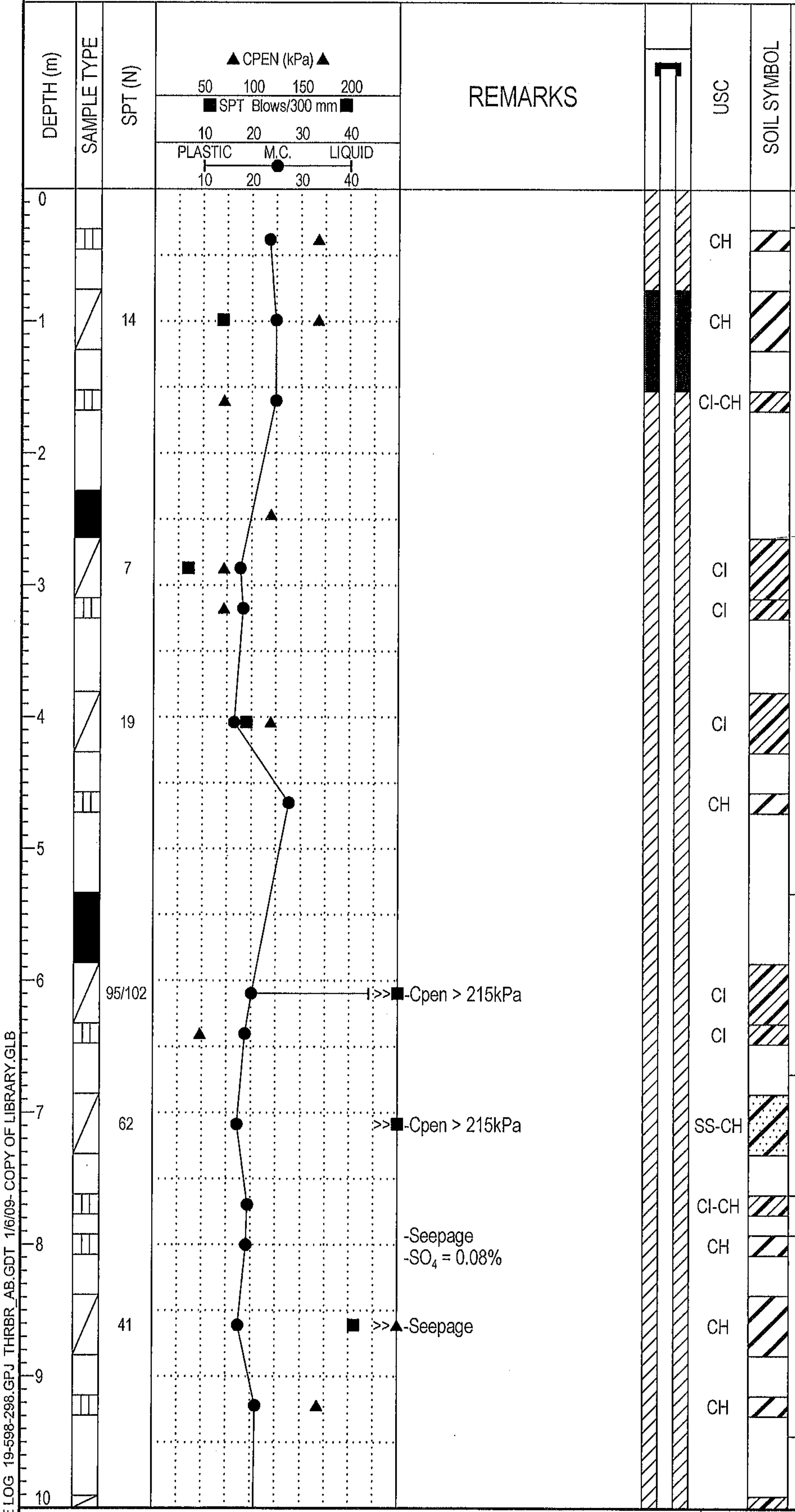
FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/29/08
REVIEWED BY: RWT	

FLATS

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-20-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 30, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 667.46 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE: ▨ DRILL CUTTINGS ■ BENTONITE ⬚ SAND ▥ SLOUGH



>>■-Cpen > 215kPa

>>■-Cpen > 215kPa

-Seepage
-SO_4 = 0.08%

>>▲-Seepage

SOIL DESCRIPTION

TOPSOIL, black, fine fibrous

CLAY ~~(FILL)~~
stiff, brown, silty, trace oxides and coal

-trace rootlets and sand

-firm CLAY NATIVE
firm, brown, silty, trace sm gravel

~~-trace gravel~~

-very stiff, mottled

CLAY (TILL)
very hard, reddish brown, heavily oxidized, silty, trace coal

-brown, trace oxides and sand

SANDSTONE (RAFTED)
very dense, light grey to black, oxidized, clayey

CLAY (TILL), brown, silty, sandy, trace oxides

CLAY SHALE (RAFTED)
hard, dark greyish brown, weathered, silty, sandy

CLAY (TILL)
stiff, dark grey, silty, trace gravel and coal

ELEVATION (m)
667
666
665
664
663
662
661
660
659
658

THURBER ENGINEERING LTD.
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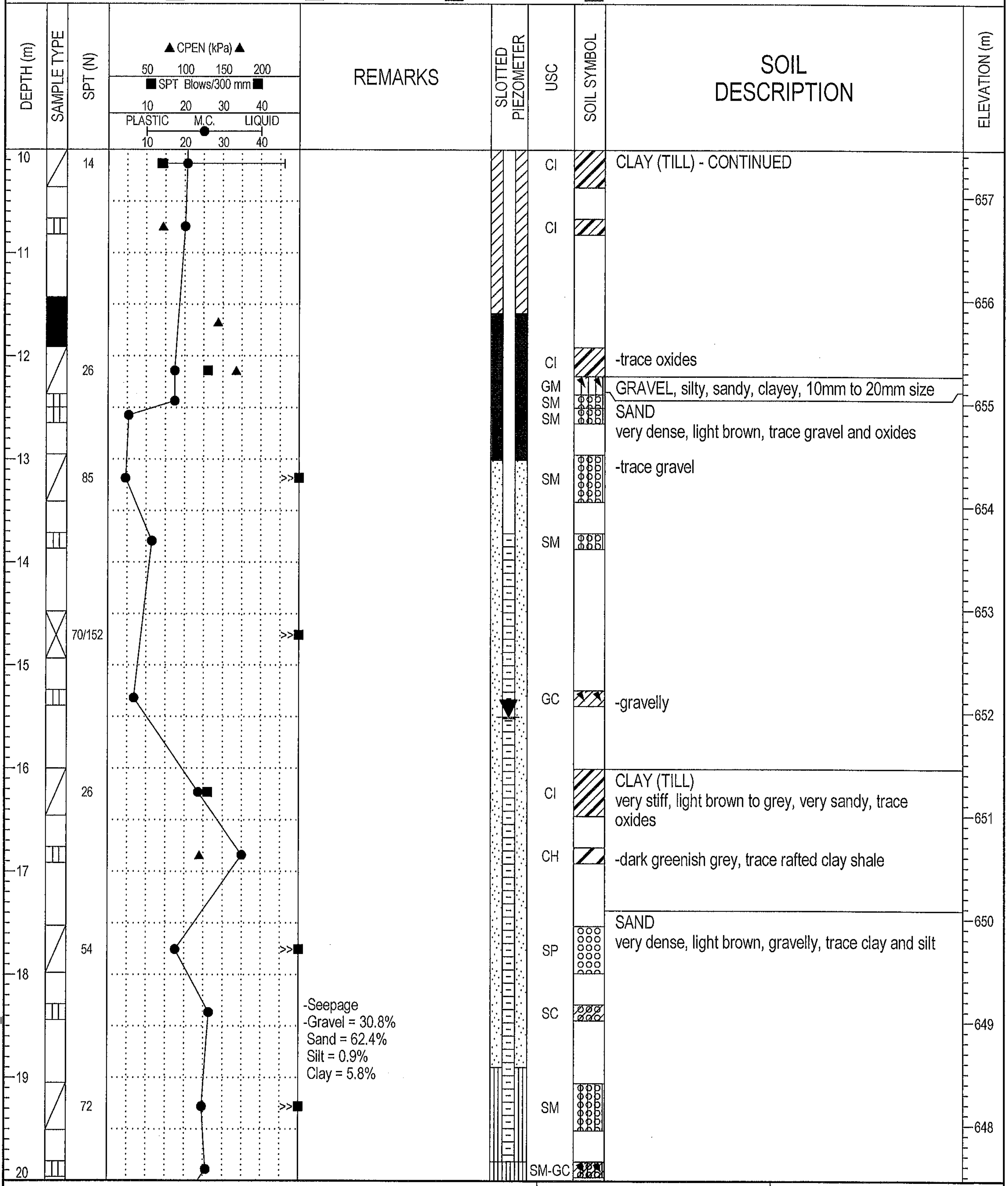
FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/30/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-20-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 30, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 667.46 (m)

SAMPLE TYPE	▥ GRAB SAMPLE	▨ SPT	■ SHELBY TUBE	☒ NO RECOVERY
BACKFILL TYPE	▨ DRILL CUTTINGS	■ BENTONITE	⁙ SAND	▥ SLOUGH



CLAY (TILL) - CONTINUED

-trace oxides

GRAVEL, silty, sandy, clayey, 10mm to 20mm size

SAND
very dense, light brown, trace gravel and oxides

-trace gravel

-gravelly

CLAY (TILL)
very stiff, light brown to grey, very sandy, trace oxides

-dark greenish grey, trace rafted clay shale

SAND
very dense, light brown, gravelly, trace clay and silt

-Seepage
-Gravel = 30.8%
Sand = 62.4%
Silt = 0.9%
Clay = 5.8%

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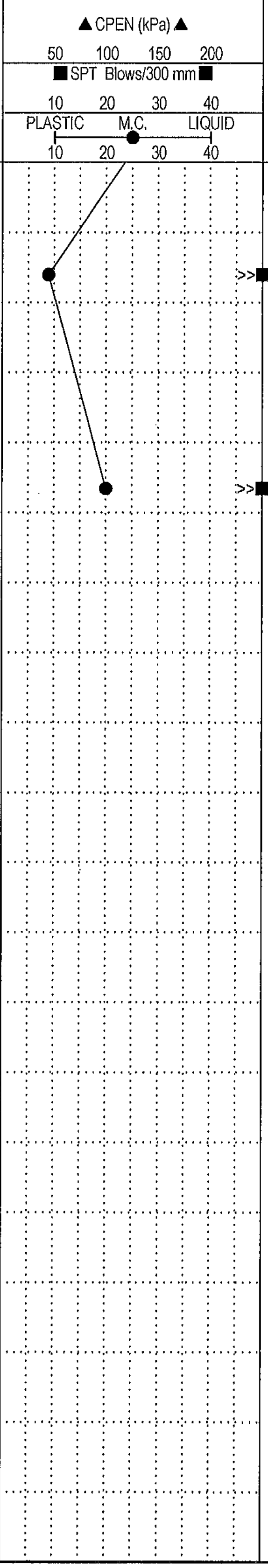
FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/30/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-20-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 30, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 667.46 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⬚ SAND ▥ SLOUGH



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
20				▥			SAND - CONTINUED	647
	◪	84		▥	GC		-some gravel	
21	☒			▥	SS	⬚	SANDSTONE very dense, light grey - black, siltstone nodules	646
22	◪	50/102		▥	CH	▨	CLAY SHALE, very hard, dark brown, silty	645
23							END OF TEST HOLE AT 22.6m UPON COMPLETION: (Below ground surface) -Slough at 18.9m -Water at 15.7m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -October 21, 2008 = 15.5m	644
24								643
25								642
26								641
27								640
28								639
29								638
30								

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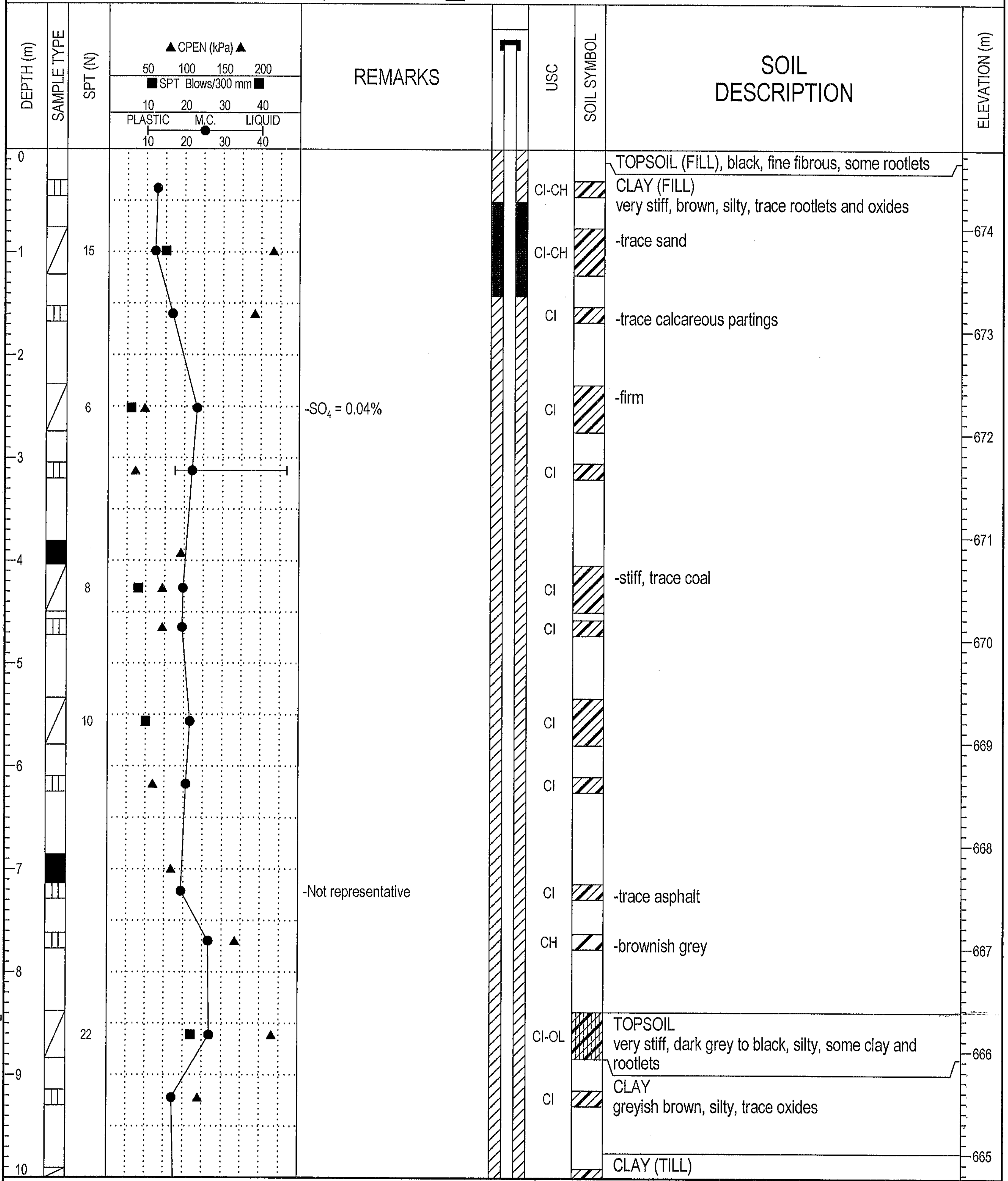
FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/30/08
REVIEWED BY: RWT	Page 3 of 3

EAST ABUTMENT

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-21-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29 & 30, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 674.76 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⬚ SAND



-SO$_4$ = 0.04%

-Not representative

TOPSOIL (FILL), black, fine fibrous, some rootlets

CLAY (FILL)
very stiff, brown, silty, trace rootlets and oxides

-trace sand

-trace calcareous partings

-firm

-stiff, trace coal

-trace asphalt

-brownish grey

TOPSOIL
very stiff, dark grey to black, silty, some clay and rootlets

CLAY
greyish brown, silty, trace oxides

CLAY (TILL)

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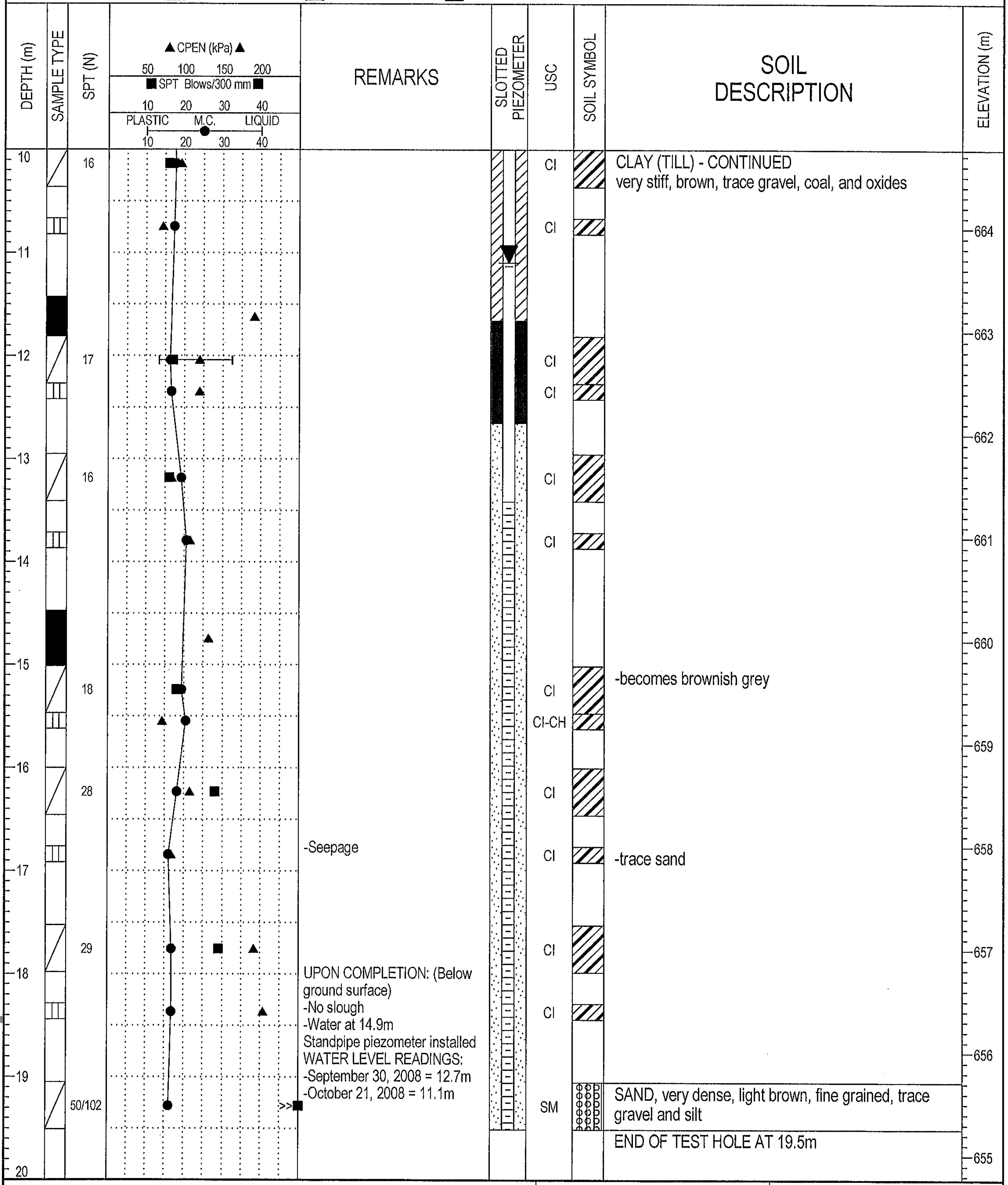
FIELD LOGGED BY: NR	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 9/30/08
REVIEWED BY: RWT	Page 1 of 2

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-21-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 29 & 30, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 674.76 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⛆ SAND



REMARKS

-Seepage

UPON COMPLETION: (Below ground surface)
-No slough
-Water at 14.9m
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 30, 2008 = 12.7m
-October 21, 2008 = 11.1m

SOIL DESCRIPTION

CLAY (TILL) - CONTINUED
very stiff, brown, trace gravel, coal, and oxides

-becomes brownish grey

-trace sand

SAND, very dense, light brown, fine grained, trace gravel and silt

END OF TEST HOLE AT 19.5m

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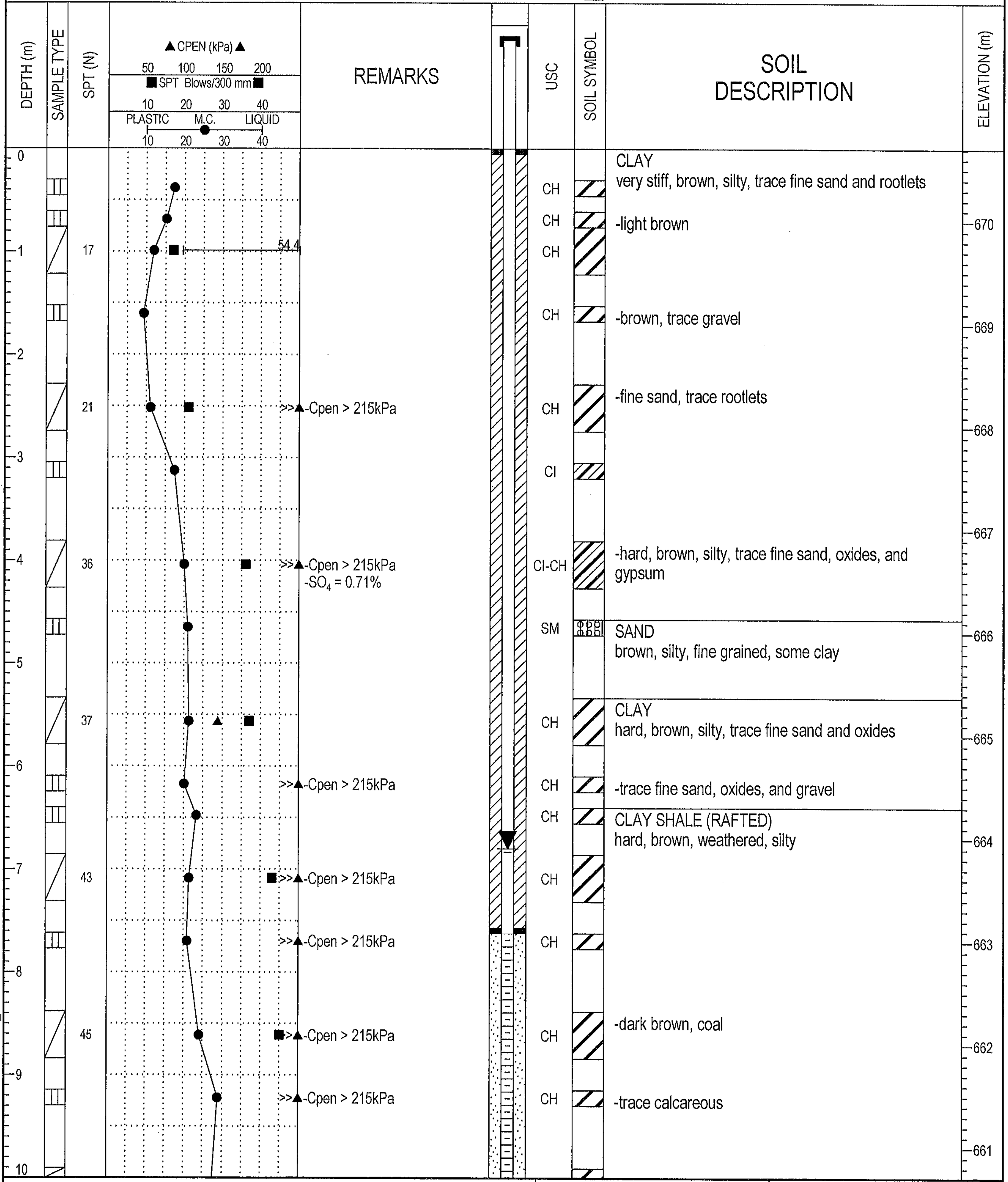
FIELD LOGGED BY: NR	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 9/30/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-22-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 670.71 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



CLAY
very stiff, brown, silty, trace fine sand and rootlets

-light brown

-brown, trace gravel

-fine sand, trace rootlets

-hard, brown, silty, trace fine sand, oxides, and gypsum

SAND
brown, silty, fine grained, some clay

CLAY
hard, brown, silty, trace fine sand and oxides

-trace fine sand, oxides, and gravel

CLAY SHALE (RAFTED)
hard, brown, weathered, silty

-dark brown, coal

-trace calcareous

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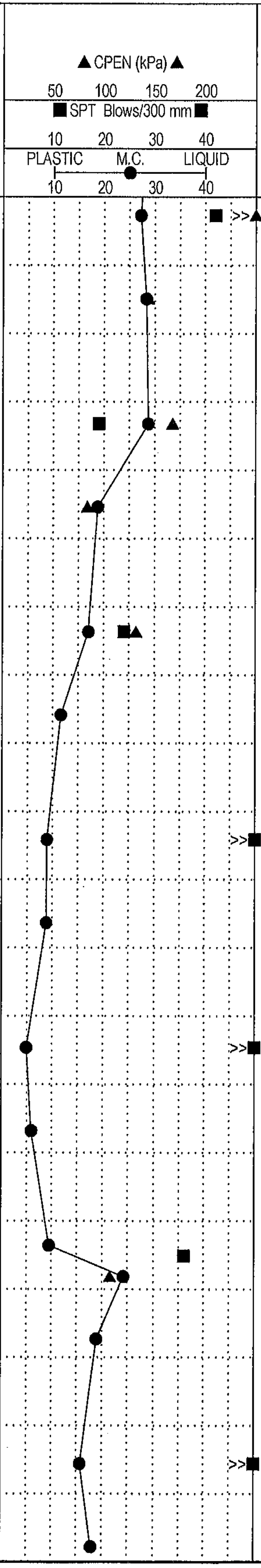
FIELD LOGGED BY: GA	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 10/1/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-22-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 670.71 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◸ SPT ☒ NO RECOVERY

BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	SLOTTED PIEZOMETER	USC	SOIL DESCRIPTION	ELEVATION (m)
10	SPT	42	-Cpen > 215kPa		CH	CLAY SHALE (RAFTED) - CONTINUED -bentonitic, weathered	
	GRAB				CH	-slightly calcareous	660
11							
	SPT	19			CH	-very stiff	659
12	GRAB				CI-CH	CLAY (TILL) very stiff, grey, silty, trace fine sand and gravel	
							658
13	SPT	24			CI	-trace oxides and sand pockets	
	GRAB				SM	SAND very dense, brown, fine to medium grained, trace silt and gravel	657
14	SPT	50/152			SM-GM	-gravelly	656
15	GRAB				SM		
							655
16	SPT	85	-Gravel = 0.0% Sand = 80.5% Silt = 12.6% Clay = 6.9%		SM	-some silt, trace clay	
	GRAB				SM		654
17	SPT	36			SM	-dense	653
18					CH	CLAY (TILL) hard, brown - grey, silty, trace coal	
	GRAB				SM	SAND very dense, brown, fine to medium grained, trace silt and gravel	652
19	SPT	89/102			SC	-trace clay	
							651
20	GRAB				SM	-some silt	

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FIELD LOGGED BY: GA	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 10/1/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-22-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 670.71 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ 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)
20					▥			SAND - CONTINUED	
	☒	50/51	>>■		▥				650
21								END OF TEST HOLE AT 21.0m UPON COMPLETION: (Below ground surface) -Slough at 17.4m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -October 21, 2008 = 6.8m	
									649
22									
									648
23									
									647
24									
									646
25									
									645
26									
									644
27									
									643
28									
									642
29									
									641
30									

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

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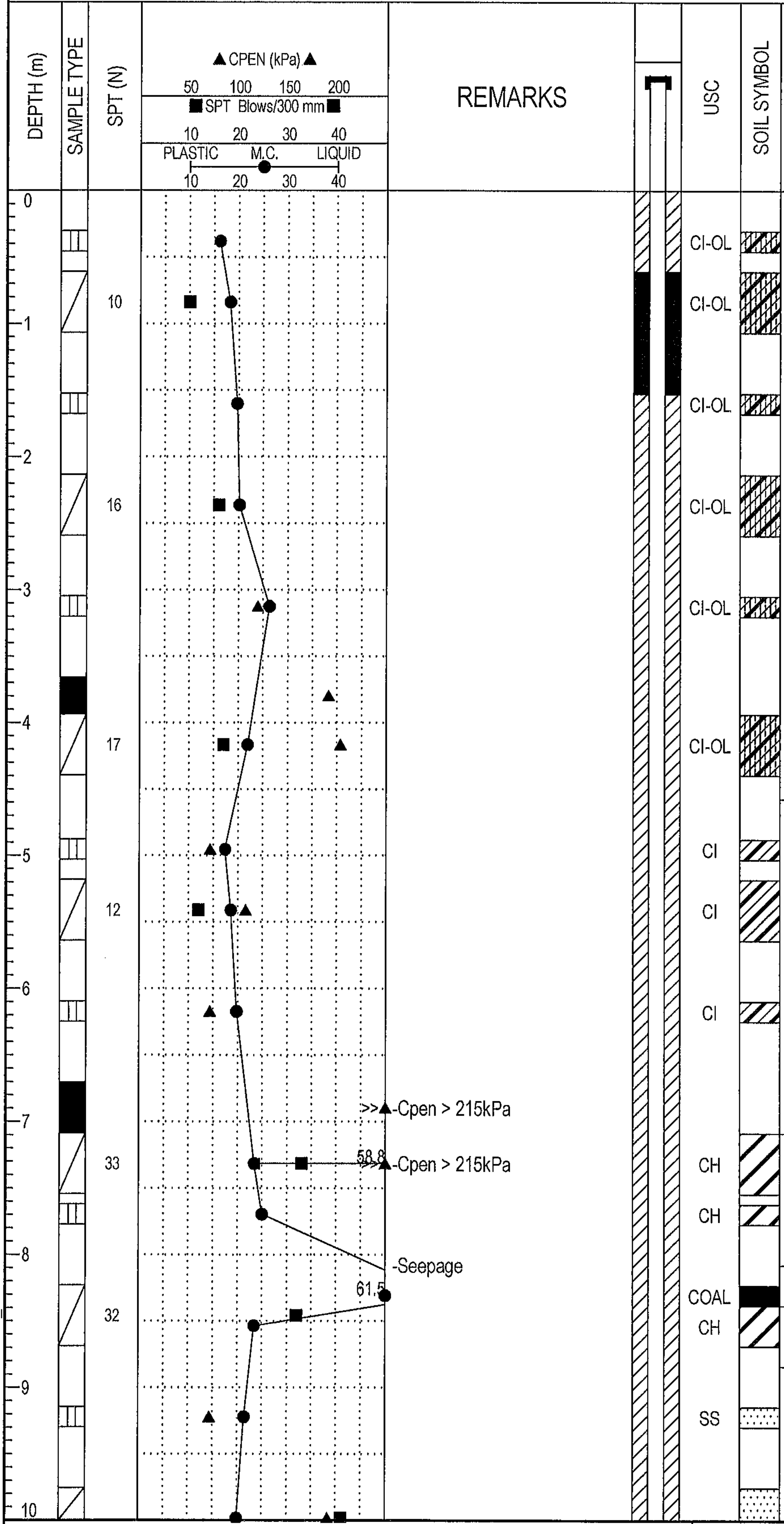
FIELD LOGGED BY: GA	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 10/1/08
REVIEWED BY: RWT	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-22-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 674.36 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⬚ SAND ▥ SLOUGH



SOIL DESCRIPTION

ORGANIC FILL, black, fine fibrous, trace rootlets
-grey, silty, some clay, trace rootlets
-stiff, black
-very stiff, some organic clay
-black, organic, trace rootlets
-mottled black to brown, trace rootlets

CLAY (TILL)
stiff, brown, silty, trace gravel and coal
-trace oxides
-mottled brown - grey

CLAY SHALE (RAFTED)
hard, brown, weathered, silty

COAL (RAFTED), hard

CLAY SHALE (RAFTED)
hard, mottled brown - grey, weathered, silty, trace oxides

SANDSTONE (RAFTED)
dense, light brown, weathered, silty, clayey, oxidized

ELEVATION (m)
674
673
672
671
670
669
668
667
666
665

THURBER ENGINEERING LTD.
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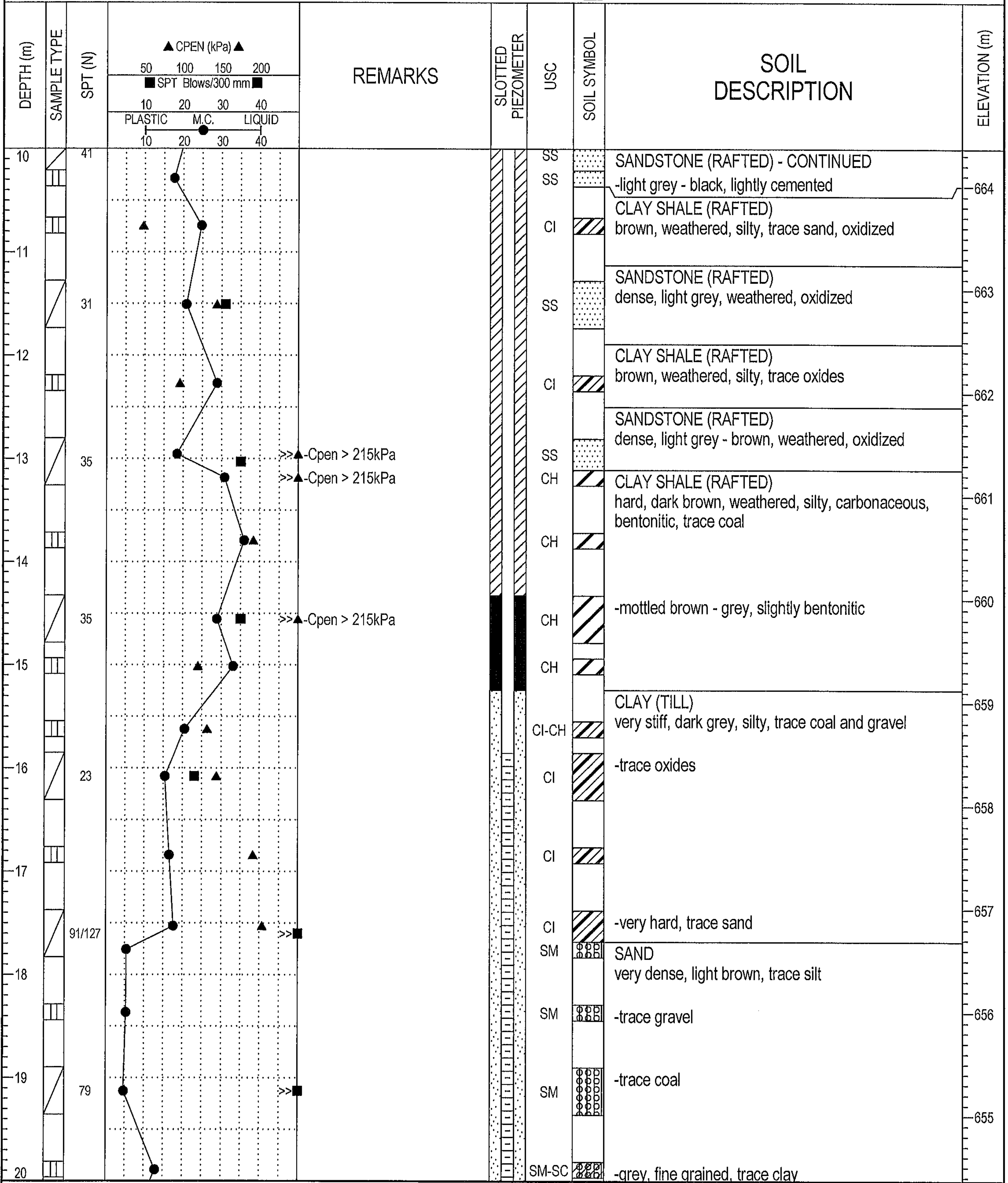
FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.4 m
PREPARED BY: SGR	COMPLETION DATE: 10/1/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-22-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 674.36 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⬚ SAND ▥ SLOUGH



SANDSTONE (RAFTED) - CONTINUED
-light grey - black, lightly cemented

CLAY SHALE (RAFTED)
brown, weathered, silty, trace sand, oxidized

SANDSTONE (RAFTED)
dense, light grey, weathered, oxidized

CLAY SHALE (RAFTED)
brown, weathered, silty, trace oxides

SANDSTONE (RAFTED)
dense, light grey - brown, weathered, oxidized

CLAY SHALE (RAFTED)
hard, dark brown, weathered, silty, carbonaceous, bentonitic, trace coal

-mottled brown - grey, slightly bentonitic

CLAY (TILL)
very stiff, dark grey, silty, trace coal and gravel

-trace oxides

-very hard, trace sand

SAND
very dense, light brown, trace silt

-trace gravel

-trace coal

-grey, fine grained, trace clay

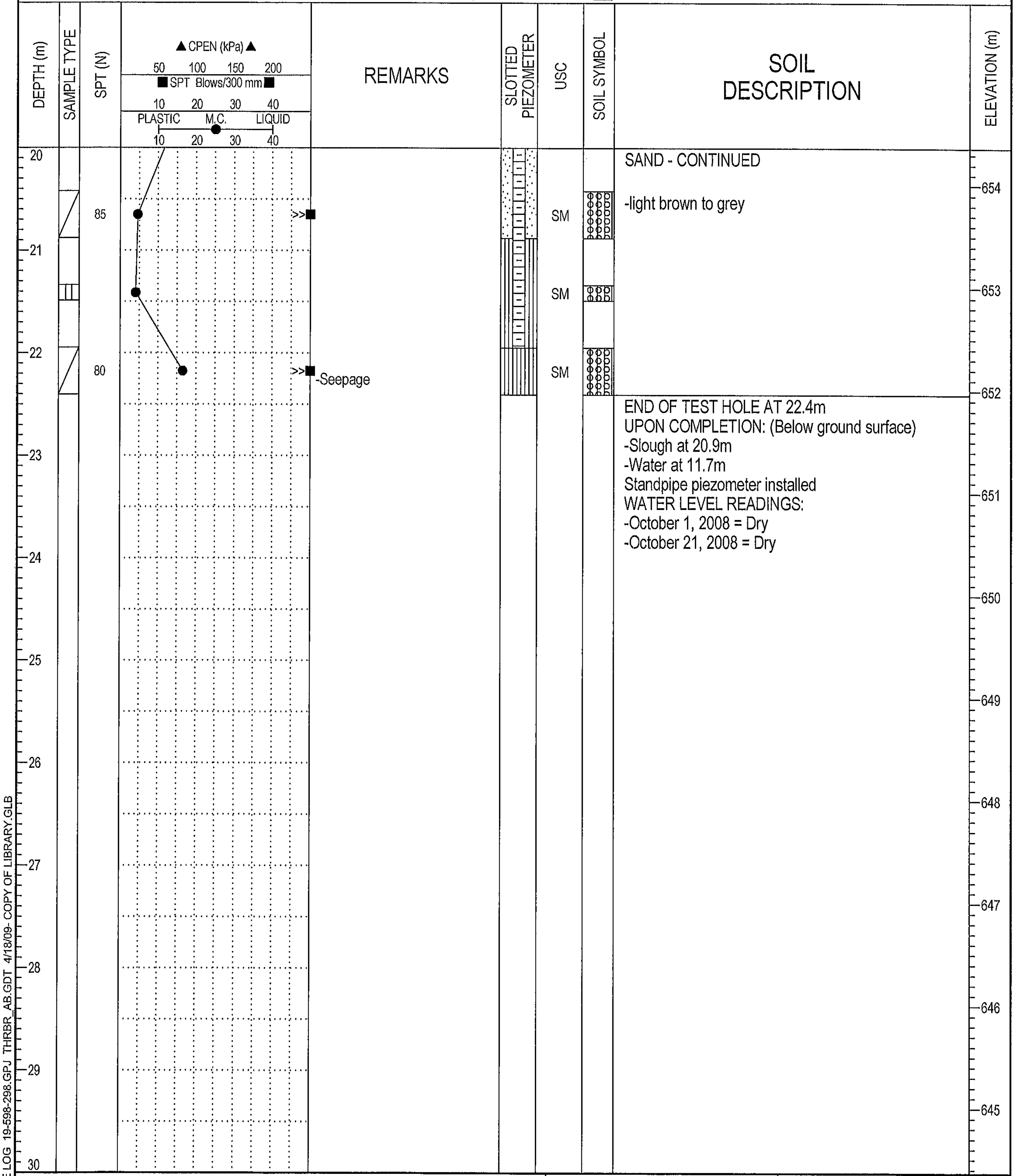
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.4 m
PREPARED BY: SGR	COMPLETION DATE: 10/1/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-22-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 674.36 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⁙ SAND ▥ SLOUGH



SAND - CONTINUED

-light brown to grey

END OF TEST HOLE AT 22.4m
UPON COMPLETION: (Below ground surface)
-Slough at 20.9m
-Water at 11.7m
Standpipe piezometer installed
WATER LEVEL READINGS:
-October 1, 2008 = Dry
-October 21, 2008 = Dry

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 4/18/09- COPY OF LIBRARY.GLB

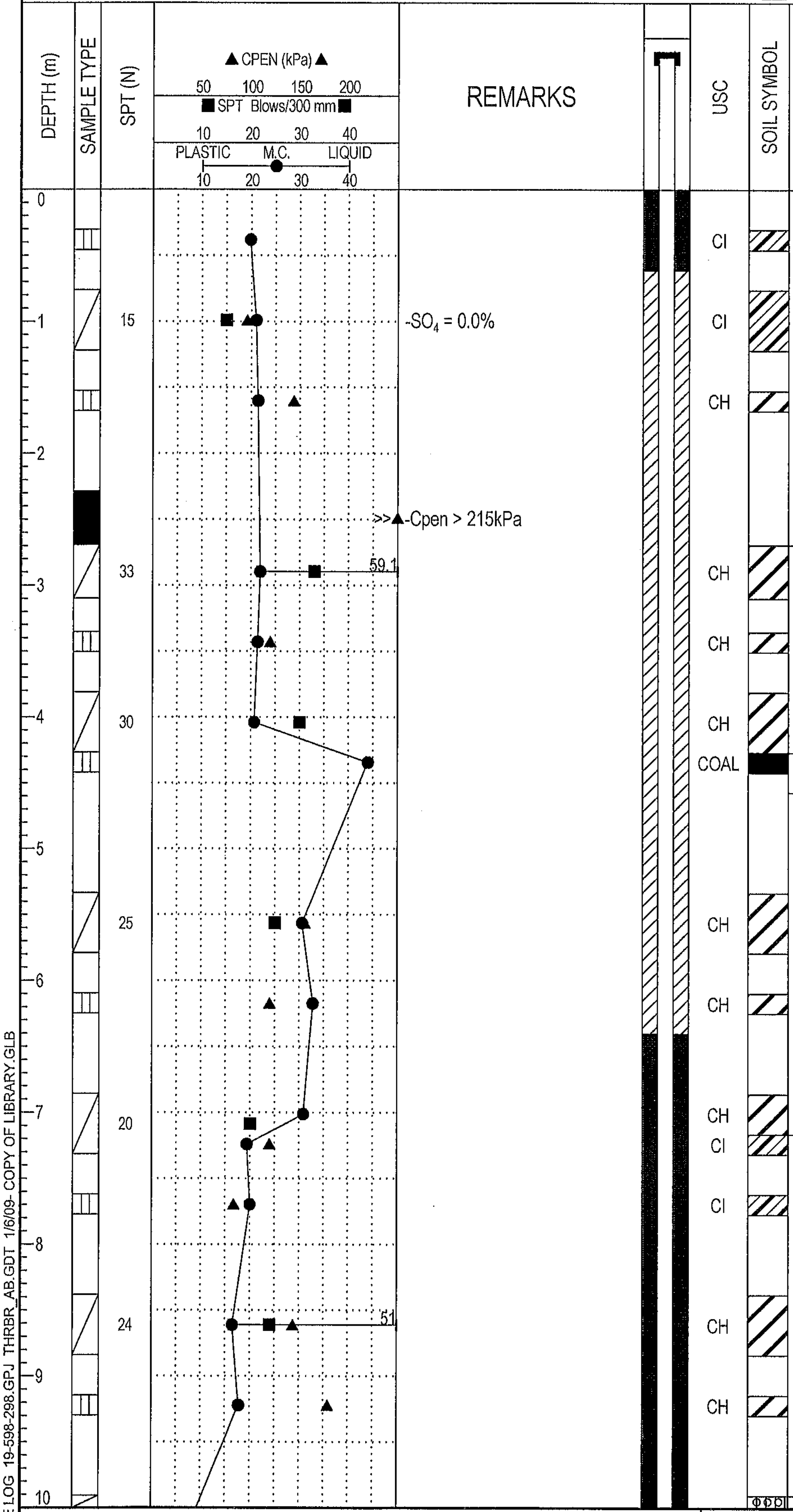
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.4 m
PREPARED BY: SGR	COMPLETION DATE: 10/1/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-23-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 8, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 666.5 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



SOIL DESCRIPTION

CLAY (TILL)
very stiff, grey, silty, trace fine sand, rootlets, and oxides

-trace gravel

CLAY SHALE (RAFTED)
hard, dark grey, weathered, silty, trace oxides

-siltstone inclusions

COAL (RAFTED)

CLAY SHALE (RAFTED)
very stiff, dark grey, weathered, silty

-bentonitic

-slightly carbonaceous

CLAY (TILL)
very stiff, grey, silty, trace fine sand and gravel

-trace coal

-trace sand pockets

-trace oxides

ELEVATION (m)

666
665
664
663
662
661
660
659
658
657

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

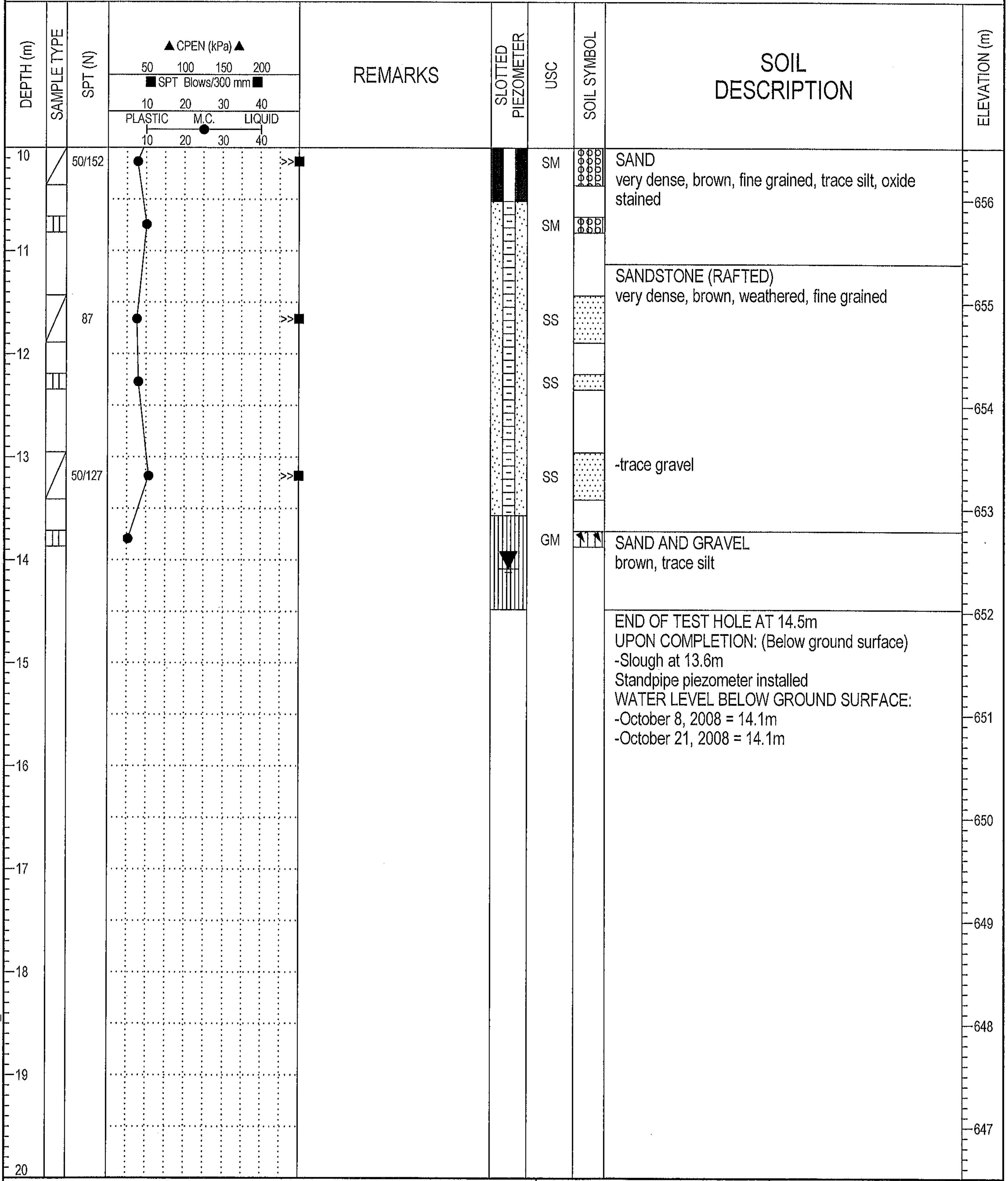
FIELD LOGGED BY: GA	COMPLETION DEPTH: 14.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/8/08
REVIEWED BY: RWT	Page 1 of 2

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-23-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 8, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 666.5 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◩ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ◩ DRILL CUTTINGS ⛆ SAND ▥ SLOUGH



SAND
very dense, brown, fine grained, trace silt, oxide stained

SANDSTONE (RAFTED)
very dense, brown, weathered, fine grained

-trace gravel

SAND AND GRAVEL
brown, trace silt

END OF TEST HOLE AT 14.5m
UPON COMPLETION: (Below ground surface)
-Slough at 13.6m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-October 8, 2008 = 14.1m
-October 21, 2008 = 14.1m

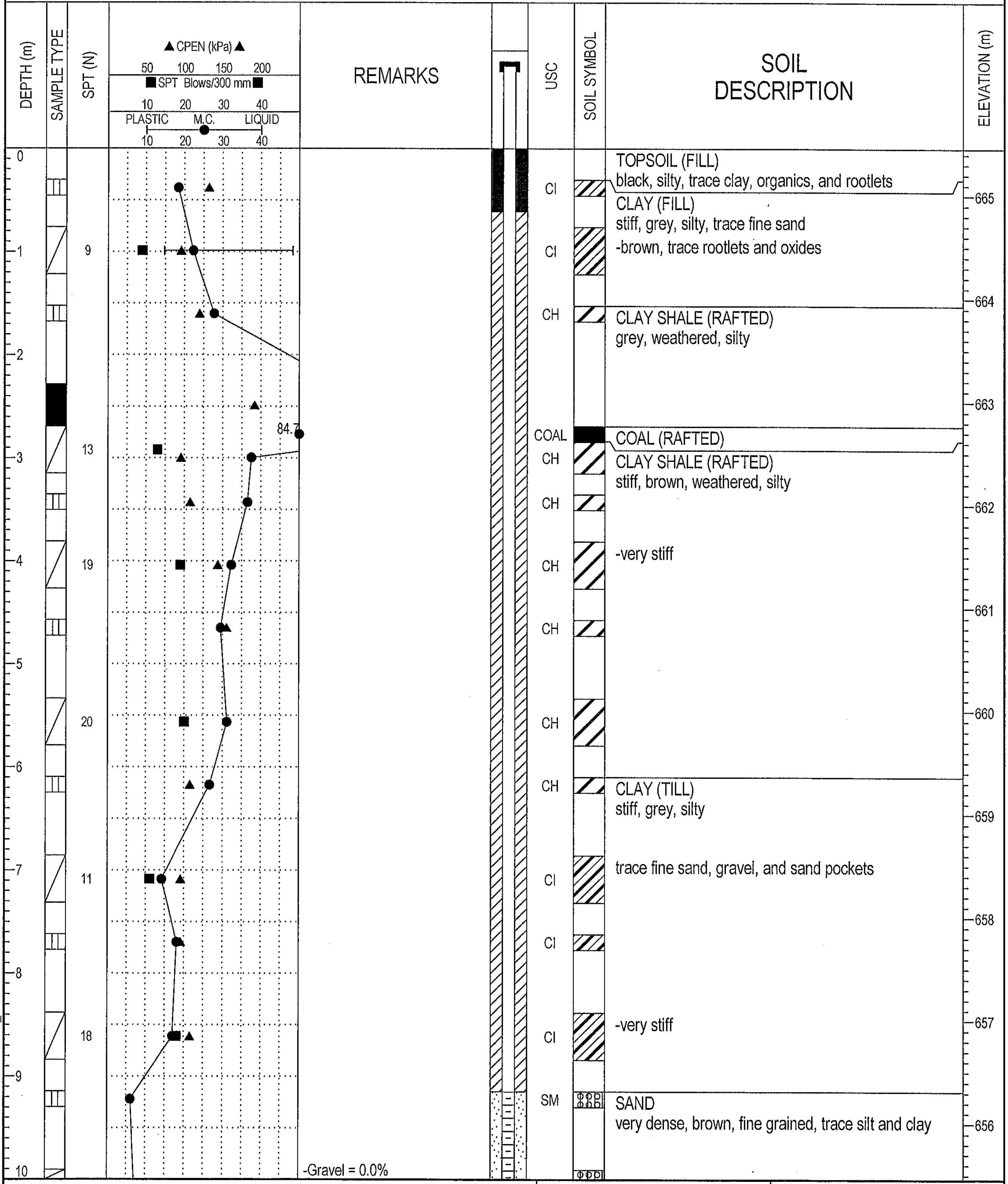
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 14.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/8/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-23-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 8, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 665.46 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



SOIL DESCRIPTION

TOPSOIL (FILL)
black, silty, trace clay, organics, and rootlets

CLAY (FILL)
stiff, grey, silty, trace fine sand
-brown, trace rootlets and oxides

CLAY SHALE (RAFTED)
grey, weathered, silty

COAL (RAFTED)

CLAY SHALE (RAFTED)
stiff, brown, weathered, silty

-very stiff

CLAY (TILL)
stiff, grey, silty

trace fine sand, gravel, and sand pockets

-very stiff

SAND
very dense, brown, fine grained, trace silt and clay

-Gravel = 0.0%

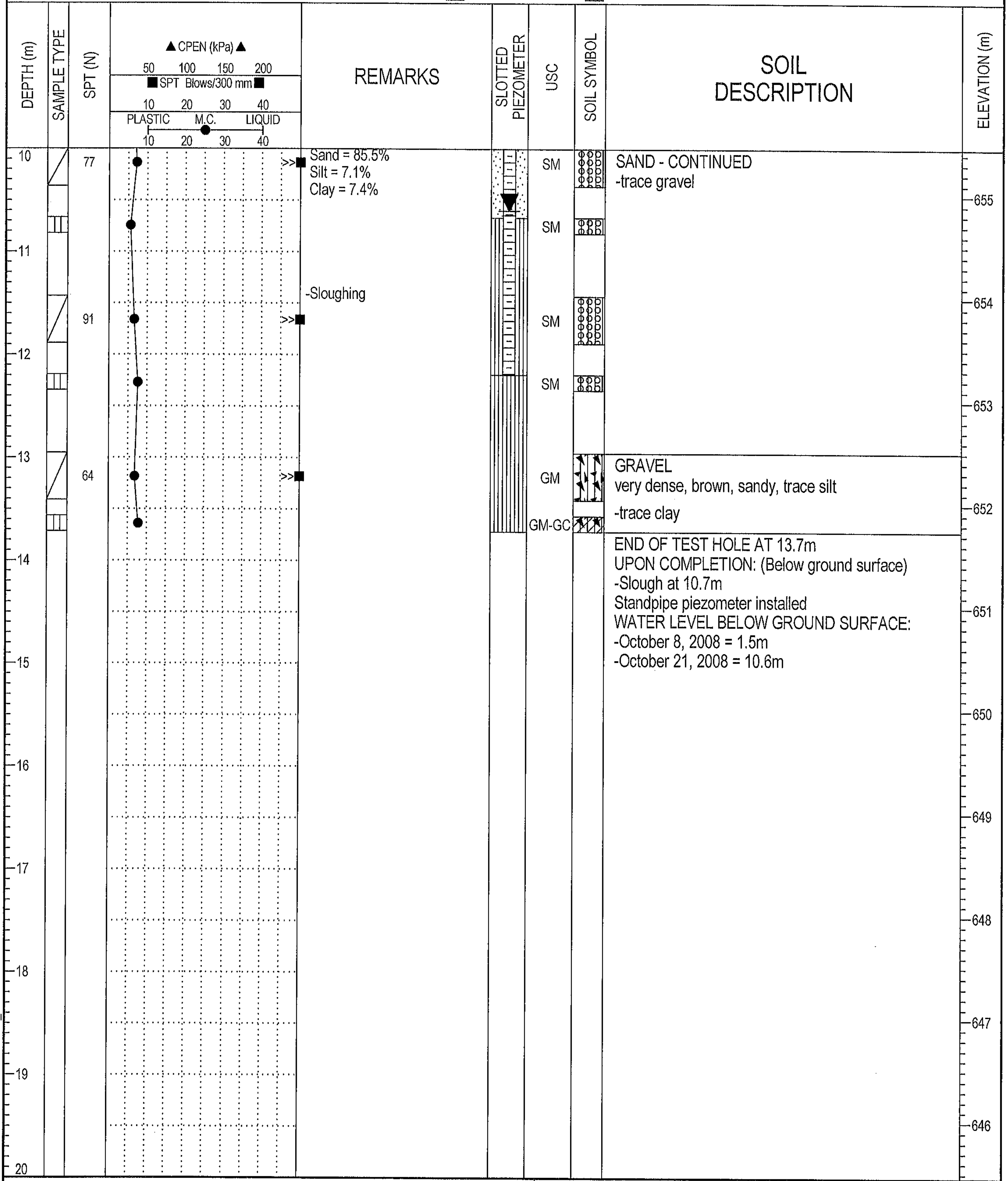
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 13.7 m
PREPARED BY: SGR	COMPLETION DATE: 10/8/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-23-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 8, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 665.46 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁚ SAND ▥ SLOUGH



Sand = 85.5%
Silt = 7.1%
Clay = 7.4%

-Sloughing

SAND - CONTINUED
-trace gravel

GRAVEL
very dense, brown, sandy, trace silt
-trace clay

END OF TEST HOLE AT 13.7m
UPON COMPLETION: (Below ground surface)
-Slough at 10.7m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-October 8, 2008 = 1.5m
-October 21, 2008 = 10.6m

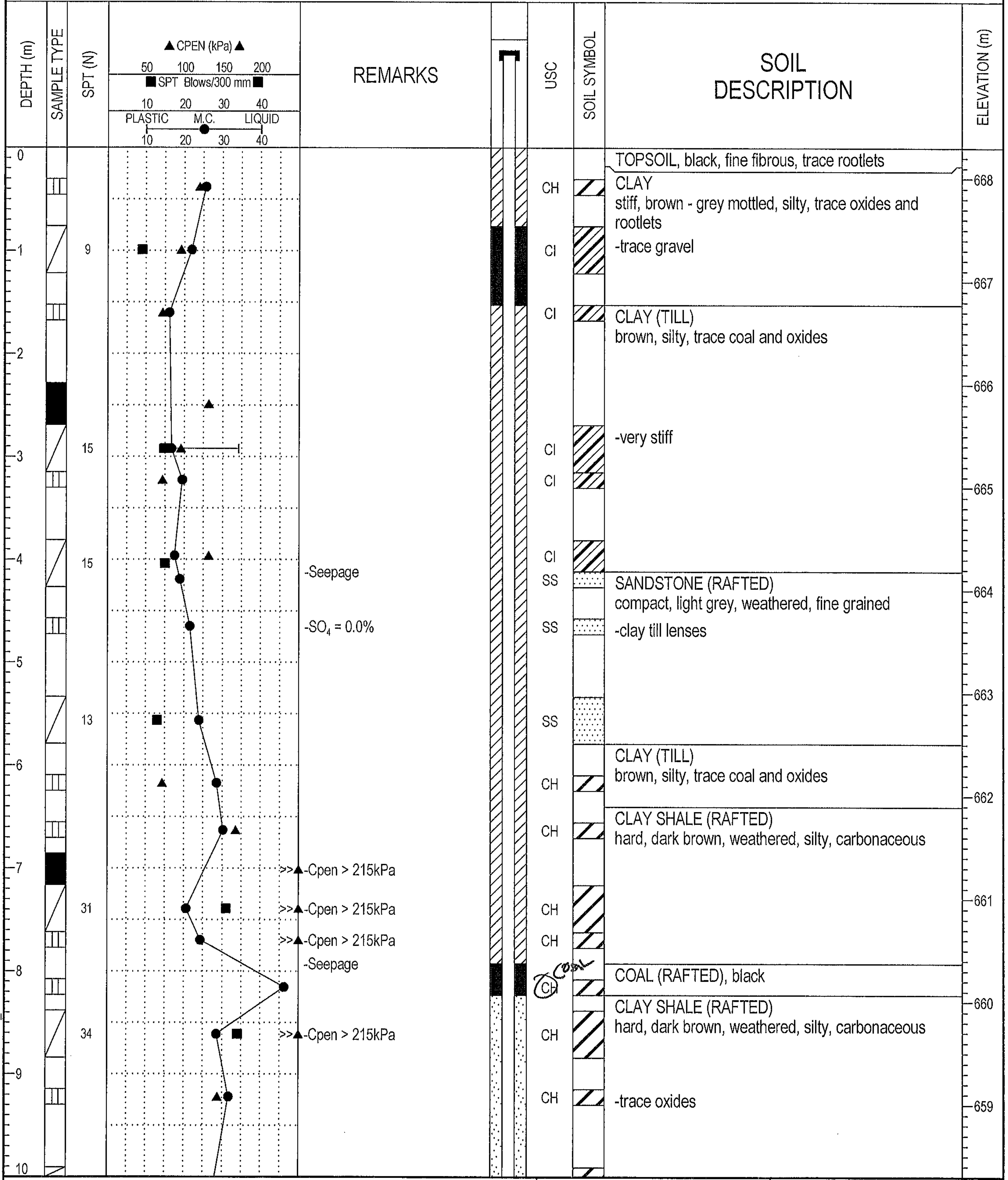
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 13.7 m
PREPARED BY: SGR	COMPLETION DATE: 10/8/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-24-01C**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1 & 2, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 668.3 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ░ SAND ▥ SLOUGH



REMARKS

-Seepage

-SO_4 = 0.0%

-Cpen > 215kPa

-Cpen > 215kPa

-Cpen > 215kPa

-Seepage

-Cpen > 215kPa

COAL

SOIL DESCRIPTION

TOPSOIL, black, fine fibrous, trace rootlets

CLAY
stiff, brown - grey mottled, silty, trace oxides and rootlets
-trace gravel

CLAY (TILL)
brown, silty, trace coal and oxides

-very stiff

SANDSTONE (RAFTED)
compact, light grey, weathered, fine grained
-clay till lenses

CLAY (TILL)
brown, silty, trace coal and oxides

CLAY SHALE (RAFTED)
hard, dark brown, weathered, silty, carbonaceous

COAL (RAFTED), black

CLAY SHALE (RAFTED)
hard, dark brown, weathered, silty, carbonaceous

-trace oxides

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

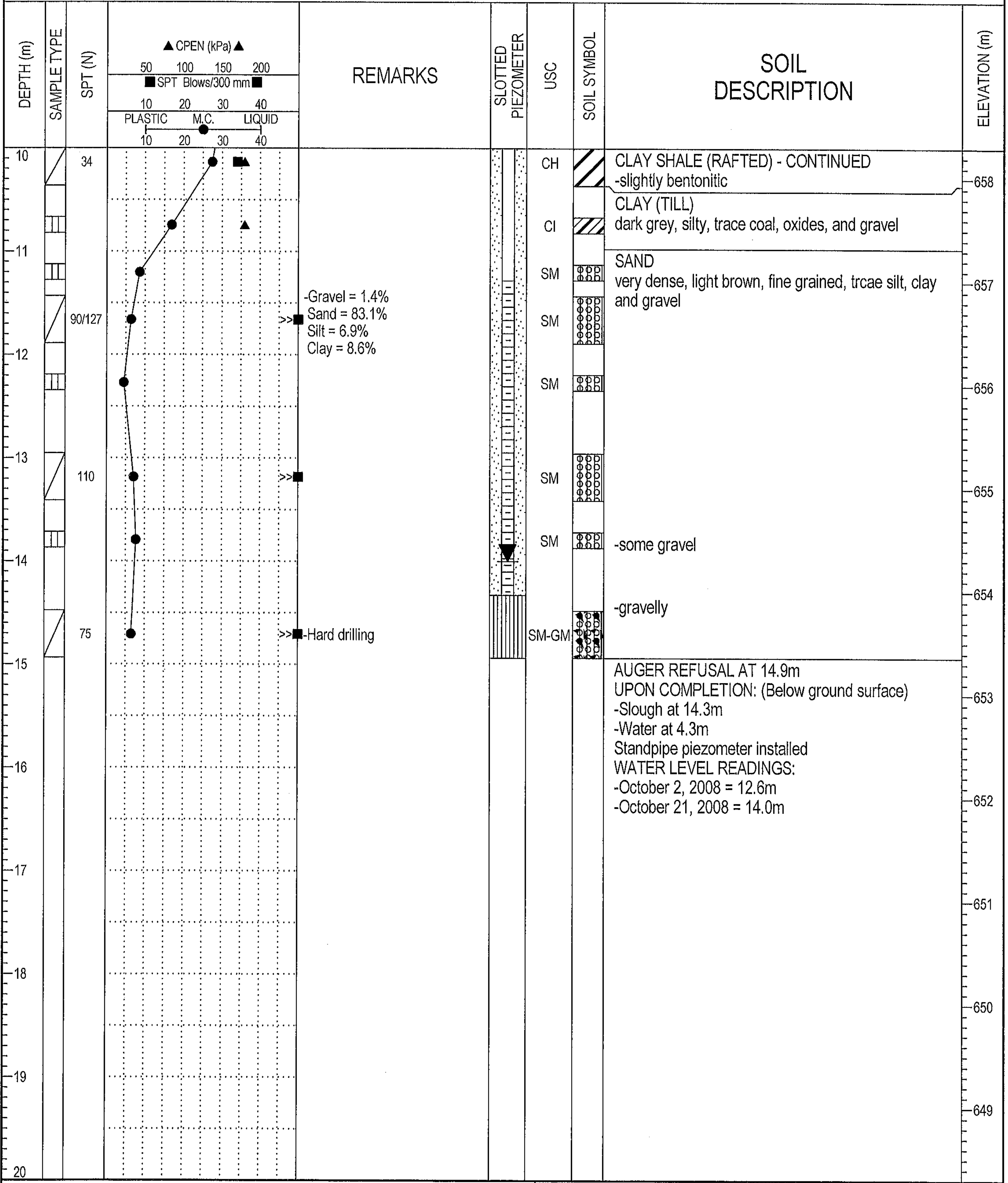
FIELD LOGGED BY: NR	COMPLETION DEPTH: 14.9 m
PREPARED BY: SGR	COMPLETION DATE: 10/2/08
REVIEWED BY: RWT	Page 1 of 2

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/7/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-24-01C**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1 & 2, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 668.3 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⛆ SAND ▥ SLOUGH



-Gravel = 1.4%
Sand = 83.1%
Silt = 6.9%
Clay = 8.6%

-Hard drilling

CLAY SHALE (RAFTED) - CONTINUED
-slightly bentonitic

CLAY (TILL)
dark grey, silty, trace coal, oxides, and gravel

SAND
very dense, light brown, fine grained, trcae silt, clay and gravel

-some gravel

-gravelly

AUGER REFUSAL AT 14.9m
UPON COMPLETION: (Below ground surface)
-Slough at 14.3m
-Water at 4.3m
Standpipe piezometer installed
WATER LEVEL READINGS:
-October 2, 2008 = 12.6m
-October 21, 2008 = 14.0m

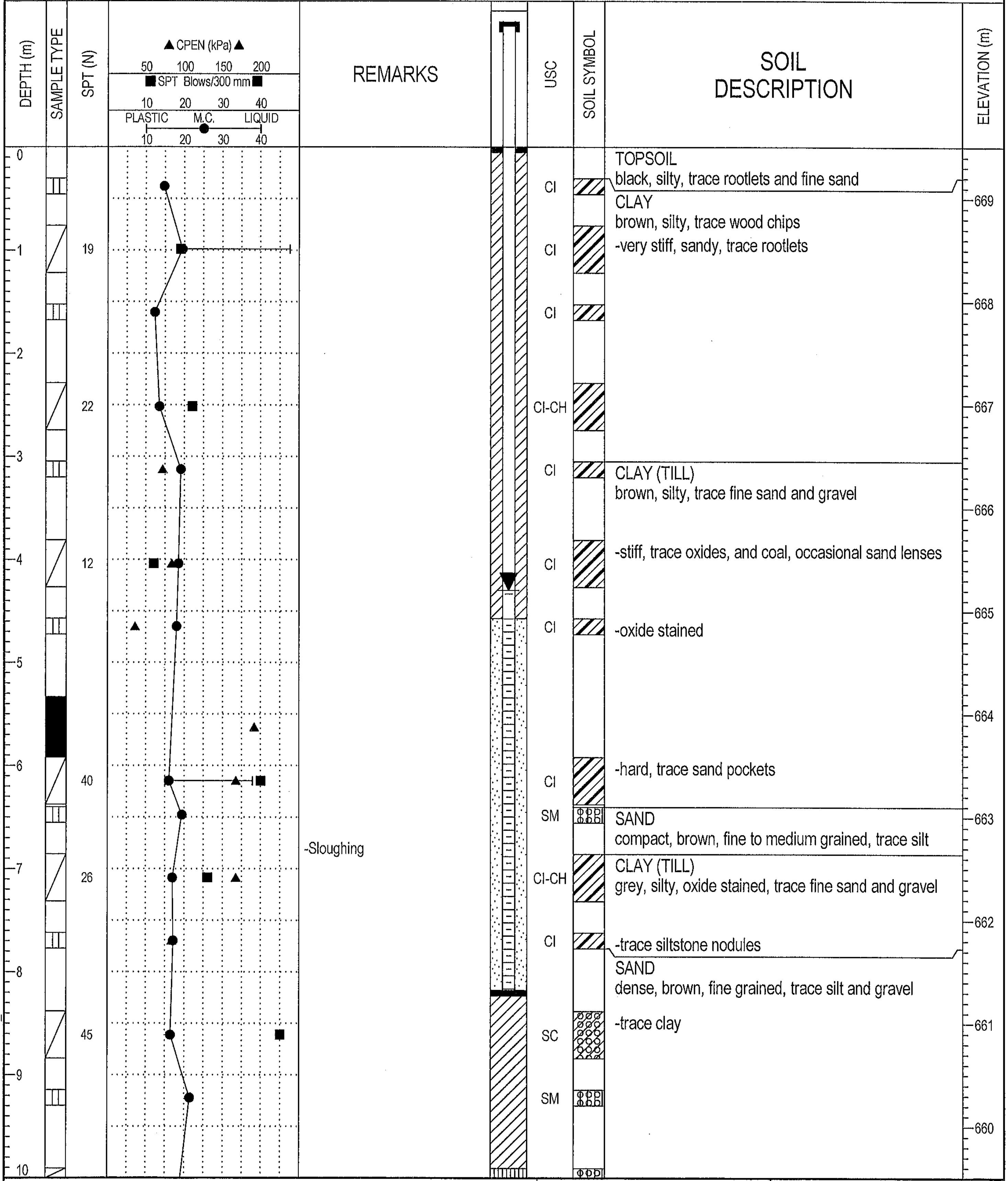
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: NR	COMPLETION DEPTH: 14.9 m
PREPARED BY: SGR	COMPLETION DATE: 10/2/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-24-02D**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 669.5 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁘ SAND ▥ SLOUGH



TOPSOIL
black, silty, trace rootlets and fine sand

CLAY
brown, silty, trace wood chips
-very stiff, sandy, trace rootlets

CLAY (TILL)
brown, silty, trace fine sand and gravel

-stiff, trace oxides, and coal, occasional sand lenses

-oxide stained

-hard, trace sand pockets

SAND
compact, brown, fine to medium grained, trace silt

CLAY (TILL)
grey, silty, oxide stained, trace fine sand and gravel

-trace siltstone nodules

SAND
dense, brown, fine grained, trace silt and gravel

-trace clay

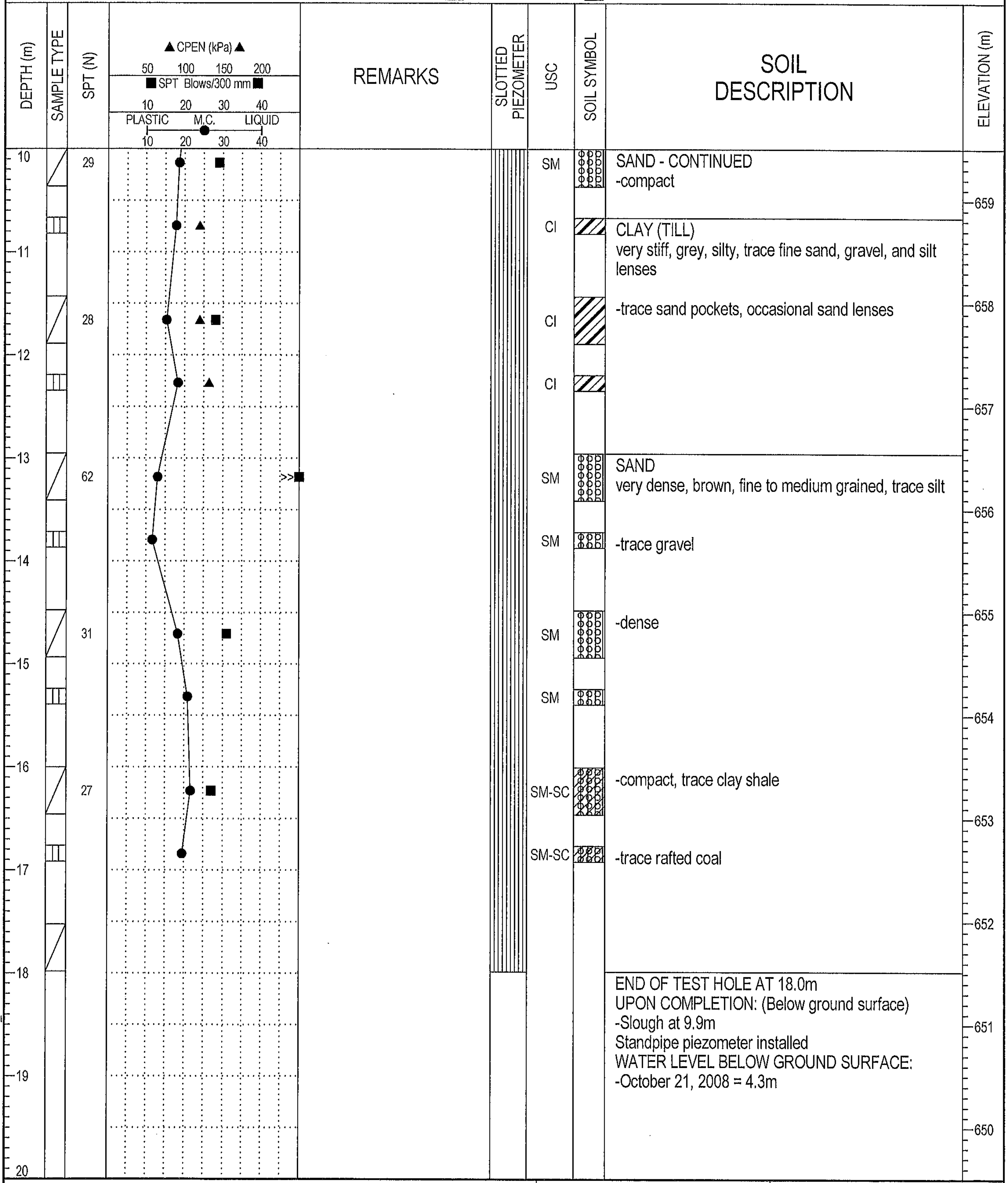
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 18.0 m
PREPARED BY: SGR	COMPLETION DATE: 10/1/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-24-02D**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 1, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 669.5 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



SAND - CONTINUED
-compact

CLAY (TILL)
very stiff, grey, silty, trace fine sand, gravel, and silt lenses

-trace sand pockets, occasional sand lenses

SAND
very dense, brown, fine to medium grained, trace silt

-trace gravel

-dense

-compact, trace clay shale

-trace rafted coal

END OF TEST HOLE AT 18.0m
UPON COMPLETION: (Below ground surface)
-Slough at 9.9m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-October 21, 2008 = 4.3m

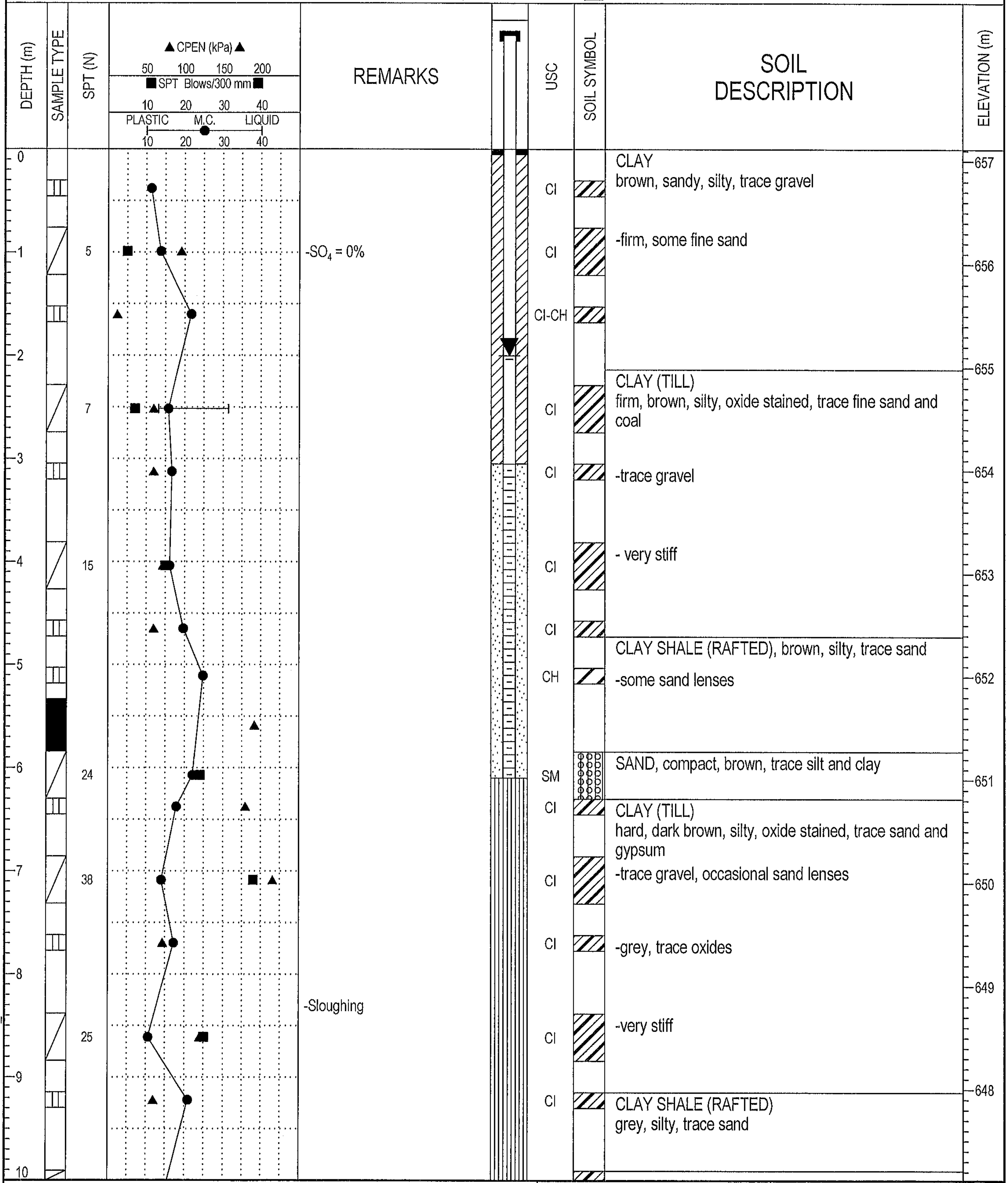
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 18.0 m
PREPARED BY: SGR	COMPLETION DATE: 10/1/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-25-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 10, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.11 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
		CI	CLAY brown, sandy, silty, trace gravel
5	-SO_4 = 0%	CI	-firm, some fine sand
		CI-CH	
7		CI	CLAY (TILL) firm, brown, silty, oxide stained, trace fine sand and coal
		CI	-trace gravel
15		CI	- very stiff
		CI	
			CLAY SHALE (RAFTED), brown, silty, trace sand
		CH	-some sand lenses
24		SM	SAND, compact, brown, trace silt and clay
		CI	CLAY (TILL) hard, dark brown, silty, oxide stained, trace sand and gypsum
38		CI	-trace gravel, occasional sand lenses
		CI	-grey, trace oxides
	-Sloughing		
25		CI	-very stiff
		CI	CLAY SHALE (RAFTED) grey, silty, trace sand

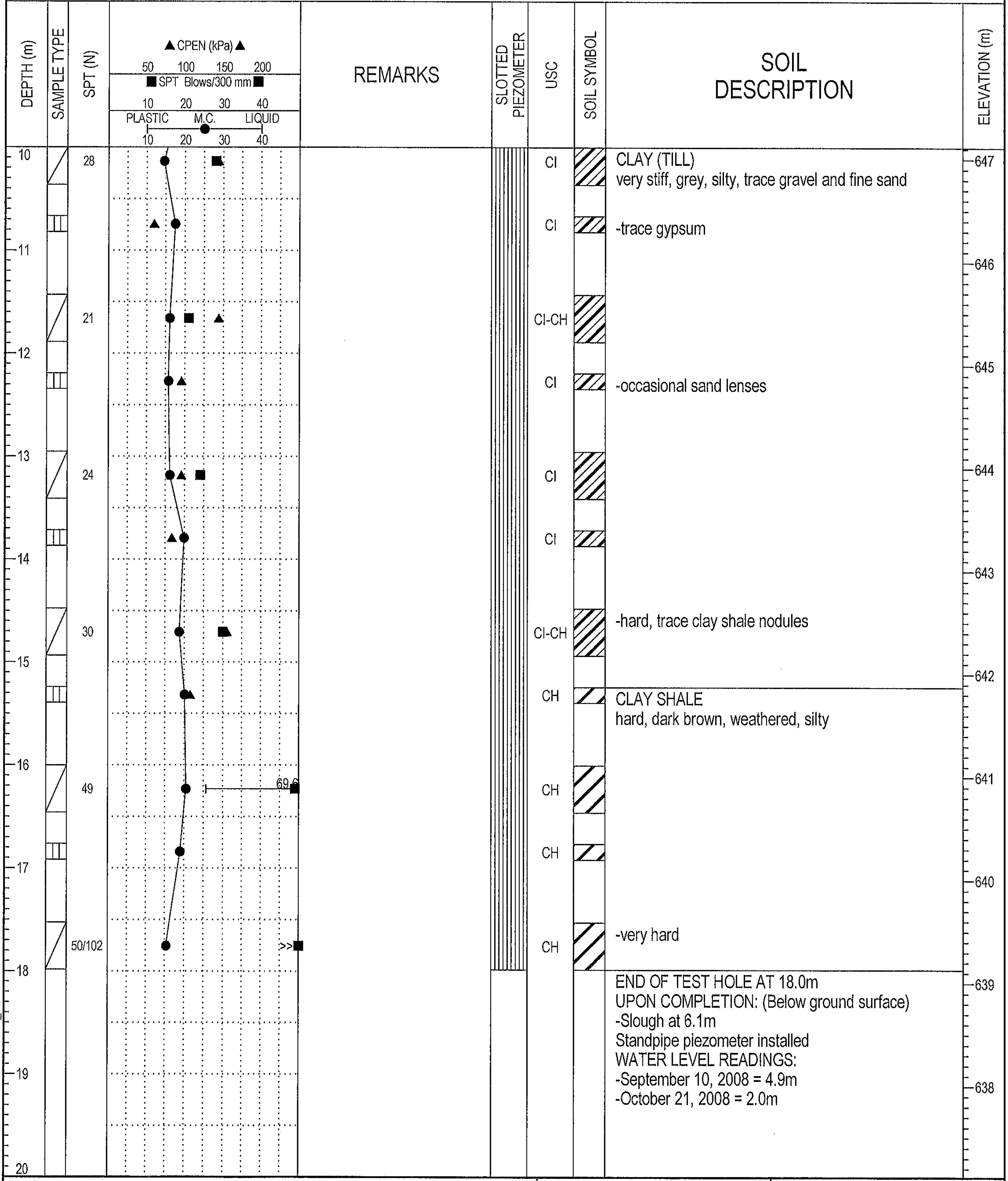
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 18.0 m
PREPARED BY: SGR	COMPLETION DATE: 9/10/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-25-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 10, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.11 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



CLAY (TILL)
very stiff, grey, silty, trace gravel and fine sand

-trace gypsum

-occasional sand lenses

-hard, trace clay shale nodules

CLAY SHALE
hard, dark brown, weathered, silty

-very hard

END OF TEST HOLE AT 18.0m
UPON COMPLETION: (Below ground surface)
-Slough at 6.1m
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 10, 2008 = 4.9m
-October 21, 2008 = 2.0m

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/7/09- COPY OF LIBRARY.GLB

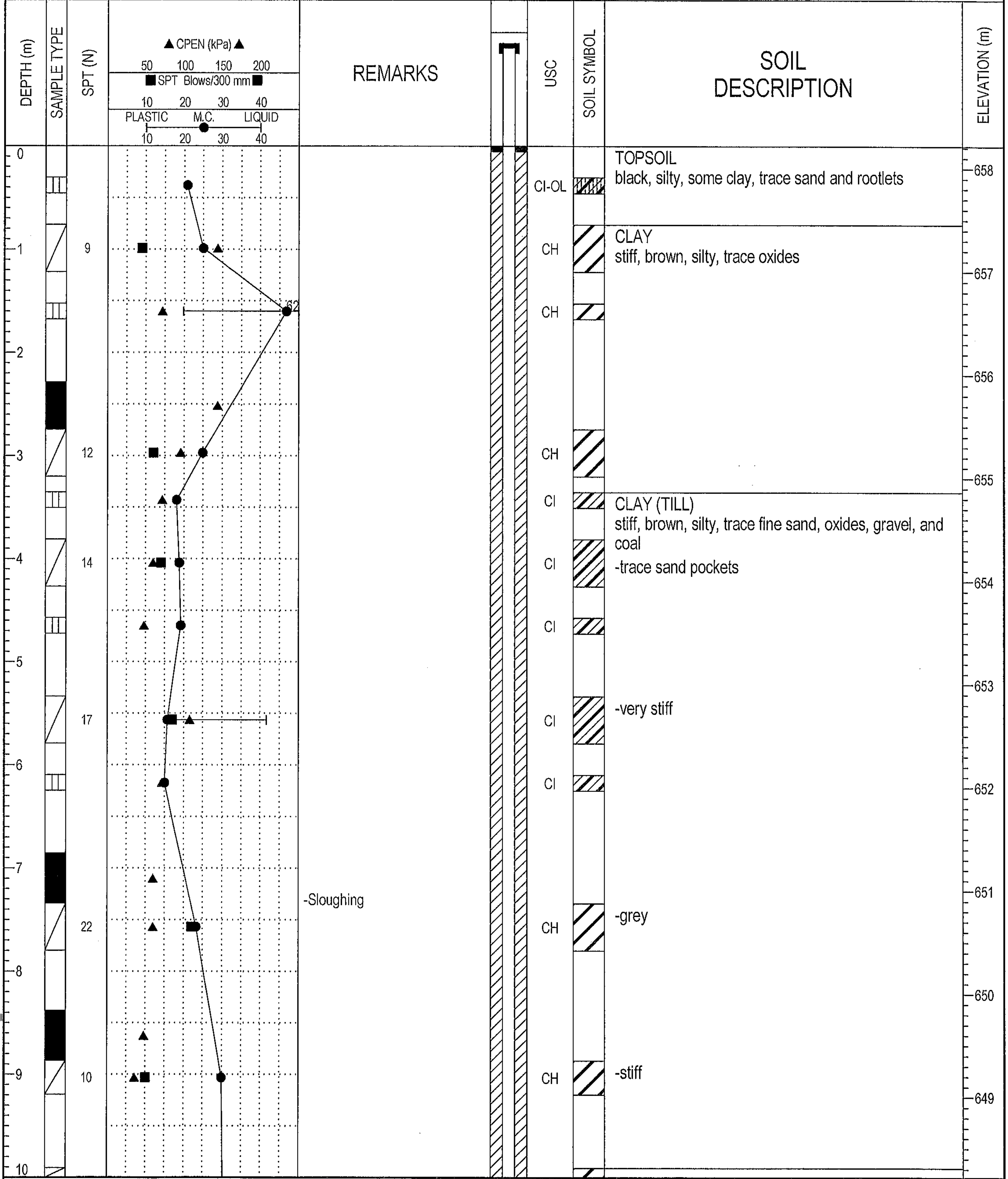
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 18.0 m
PREPARED BY: SGR	COMPLETION DATE: 9/10/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-25-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 11, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 658.22 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



-Sloughing

SOIL DESCRIPTION

TOPSOIL
black, silty, some clay, trace sand and rootlets

CLAY
stiff, brown, silty, trace oxides

CLAY (TILL)
stiff, brown, silty, trace fine sand, oxides, gravel, and coal
-trace sand pockets

-very stiff

-grey

-stiff

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/7/09- COPY OF LIBRARY.GLB

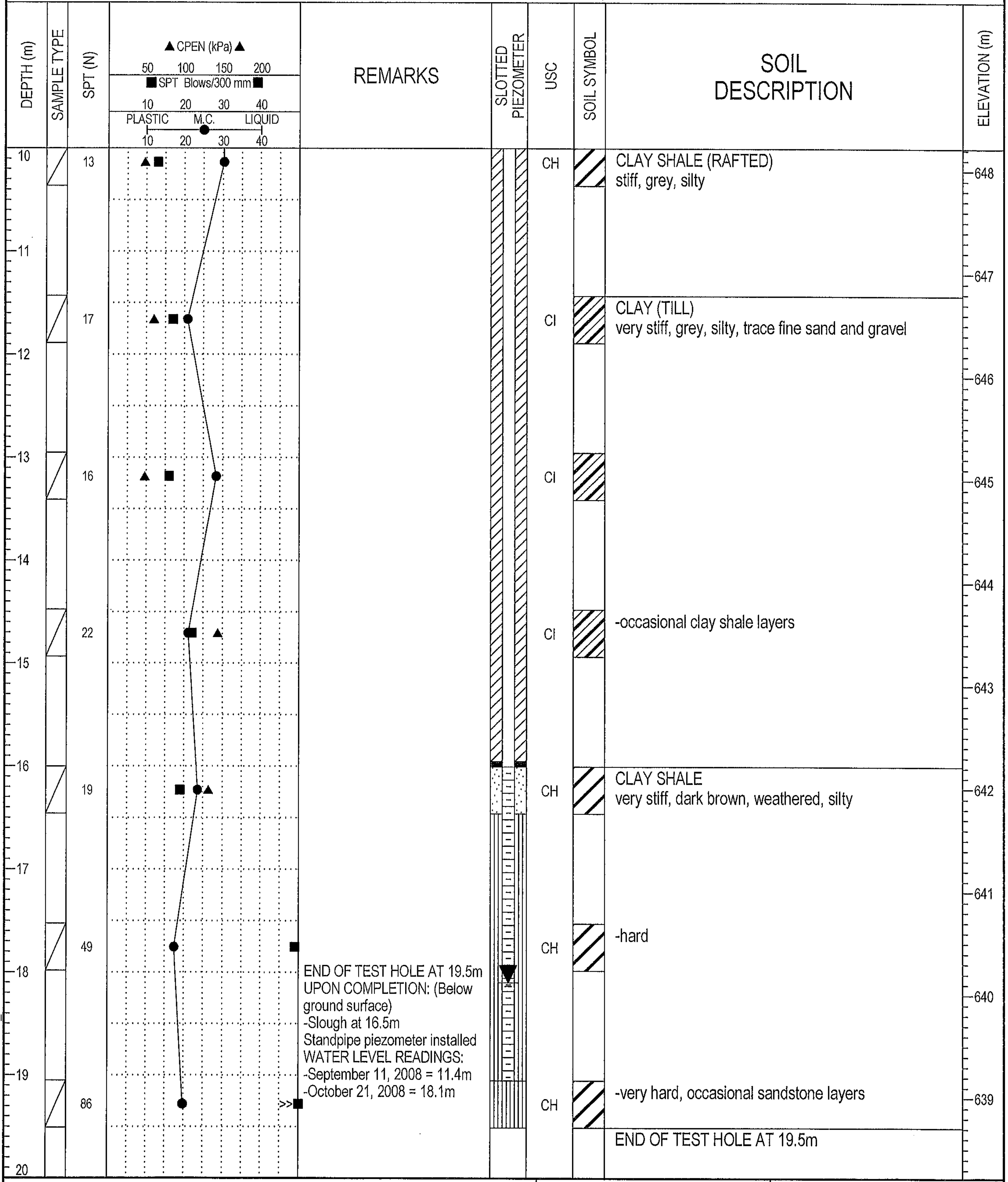
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 9/11/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-25-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 11, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: MJT / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 658.22 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND ▥ SLOUGH



SPT (N)	USC	SOIL DESCRIPTION
13	CH	CLAY SHALE (RAFTED) stiff, grey, silty
17	CI	CLAY (TILL) very stiff, grey, silty, trace fine sand and gravel
16	CI	
22	CI	-occasional clay shale layers
19	CH	CLAY SHALE very stiff, dark brown, weathered, silty
49	CH	-hard
86	CH	-very hard, occasional sandstone layers
		END OF TEST HOLE AT 19.5m

END OF TEST HOLE AT 19.5m
UPON COMPLETION: (Below ground surface)
-Slough at 16.5m
Standpipe piezometer installed
WATER LEVEL READINGS:
-September 11, 2008 = 11.4m
-October 21, 2008 = 18.1m

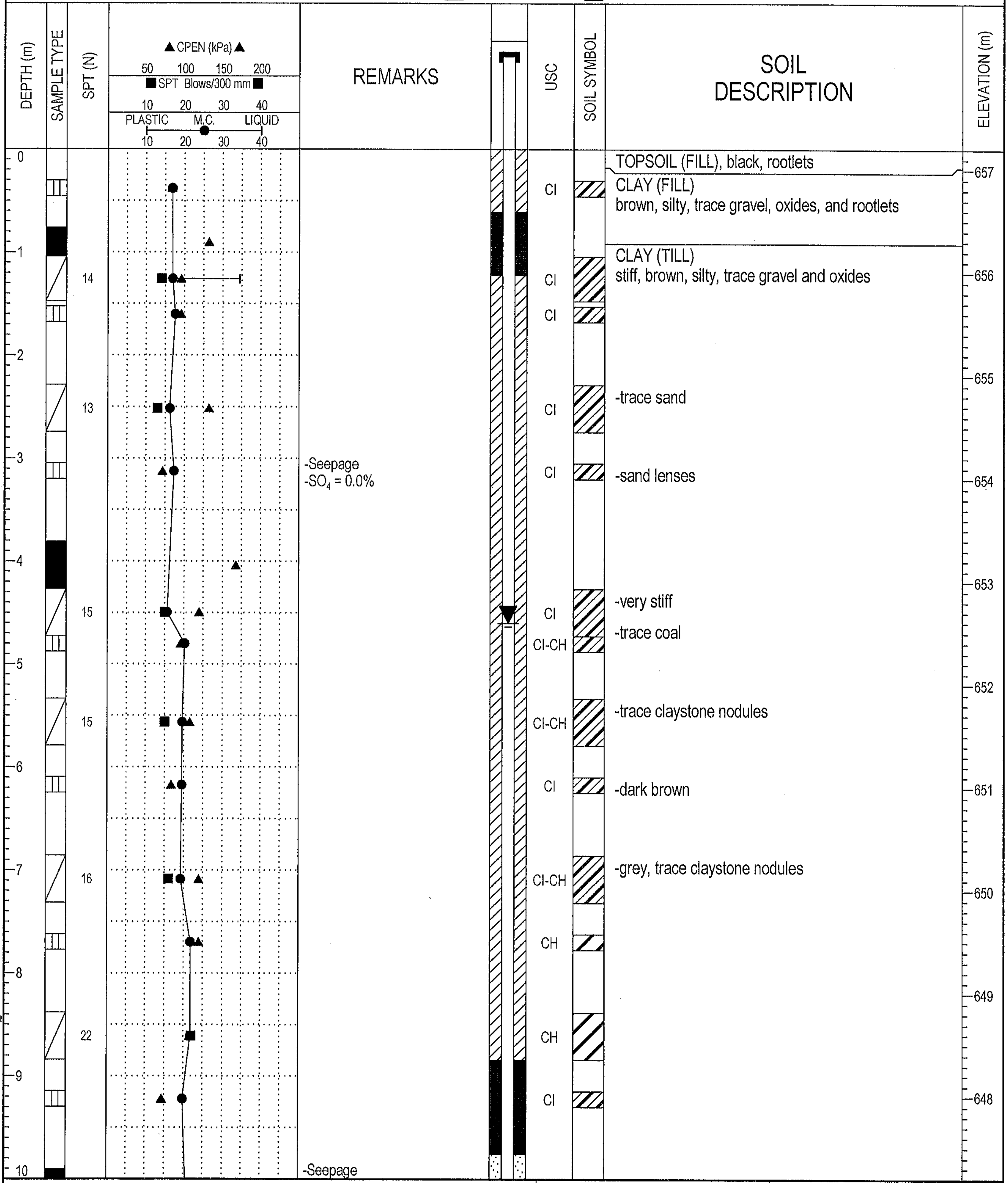
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 19.5 m
PREPARED BY: SGR	COMPLETION DATE: 9/11/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-26-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.2 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ■ SHELBY TUBE ▨ SPT

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⛆ SAND ▥ SLOUGH



TOPSOIL (FILL), black, rootlets

CLAY (FILL)
brown, silty, trace gravel, oxides, and rootlets

CLAY (TILL)
stiff, brown, silty, trace gravel and oxides
-trace sand
-sand lenses
-very stiff
-trace coal
-trace claystone nodules
-dark brown
-grey, trace claystone nodules

-Seepage
-SO_4 = 0.0%

-Seepage

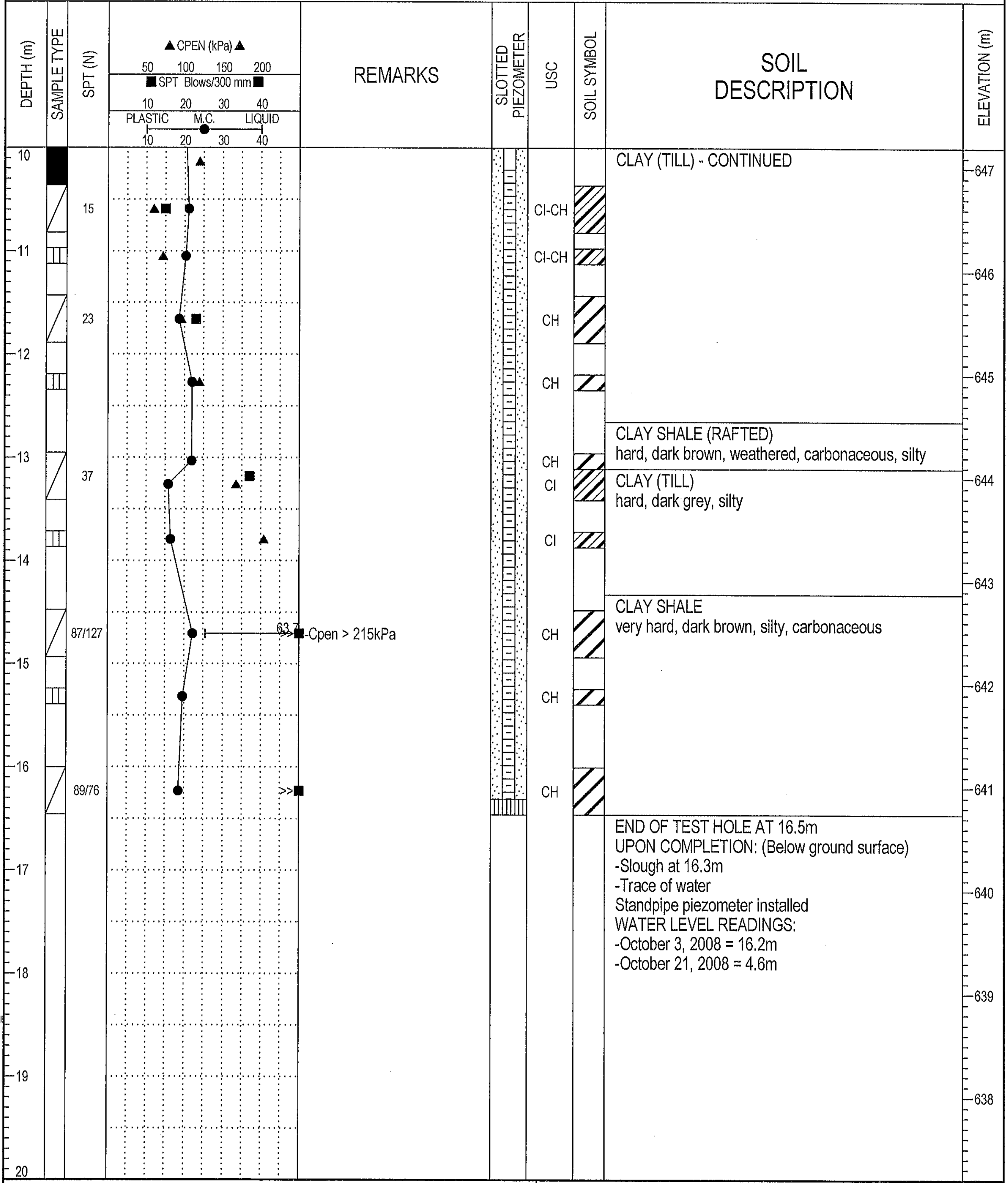
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: NR	COMPLETION DEPTH: 16.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/3/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-26-01A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.2 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ■ SHELBY TUBE ◿ SPT

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ⛶ SAND ▥ SLOUGH



CLAY (TILL) - CONTINUED

CLAY SHALE (RAFTED)
hard, dark brown, weathered, carbonaceous, silty

CLAY (TILL)
hard, dark grey, silty

CLAY SHALE
very hard, dark brown, silty, carbonaceous

END OF TEST HOLE AT 16.5m
UPON COMPLETION: (Below ground surface)
-Slough at 16.3m
-Trace of water
Standpipe piezometer installed
WATER LEVEL READINGS:
-October 3, 2008 = 16.2m
-October 21, 2008 = 4.6m

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

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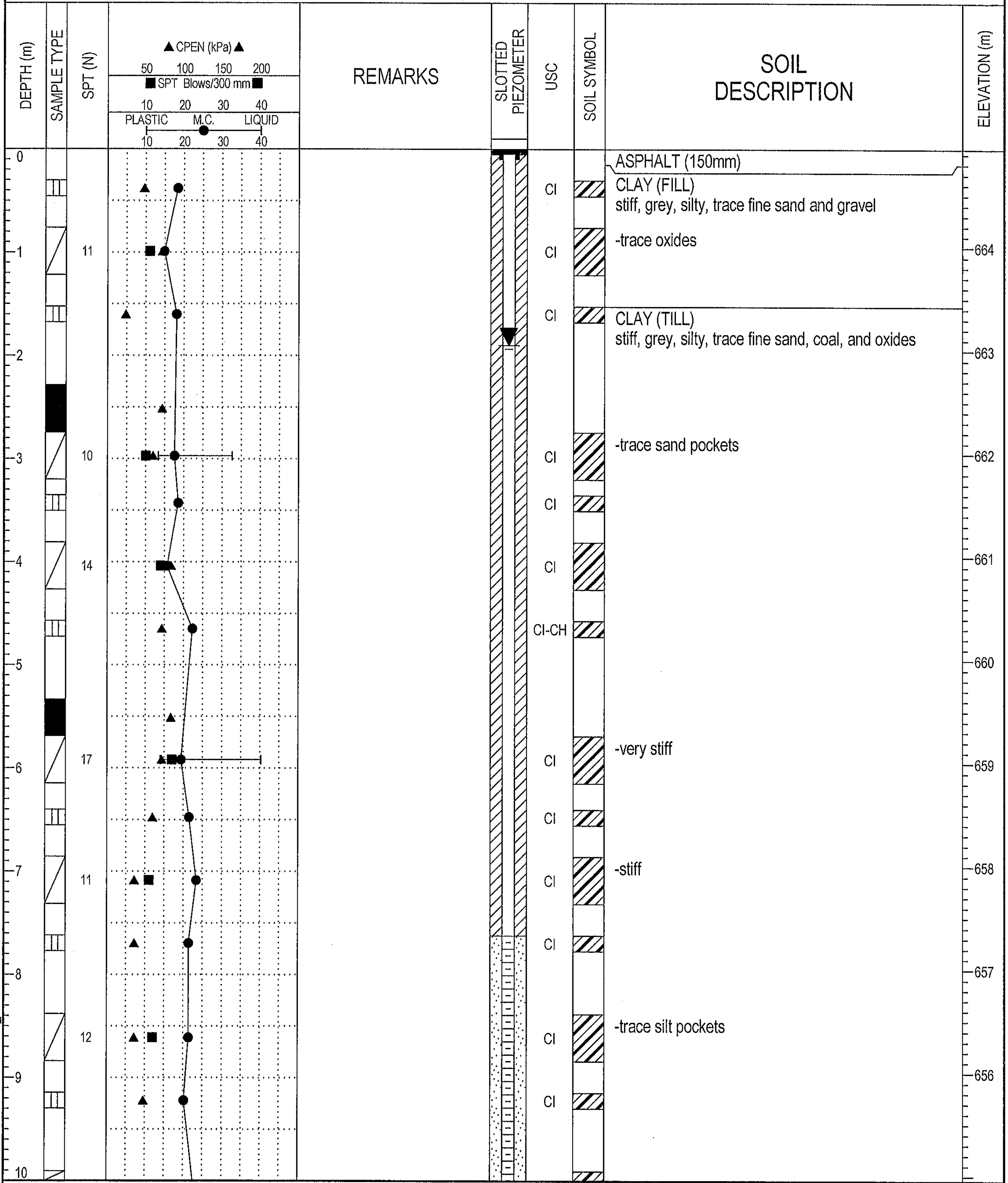
FIELD LOGGED BY: NR	COMPLETION DEPTH: 16.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/3/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-26-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 664.95 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND



ASPHALT (150mm)

CLAY (FILL)
stiff, grey, silty, trace fine sand and gravel

-trace oxides

CLAY (TILL)
stiff, grey, silty, trace fine sand, coal, and oxides

-trace sand pockets

-very stiff

-stiff

-trace silt pockets

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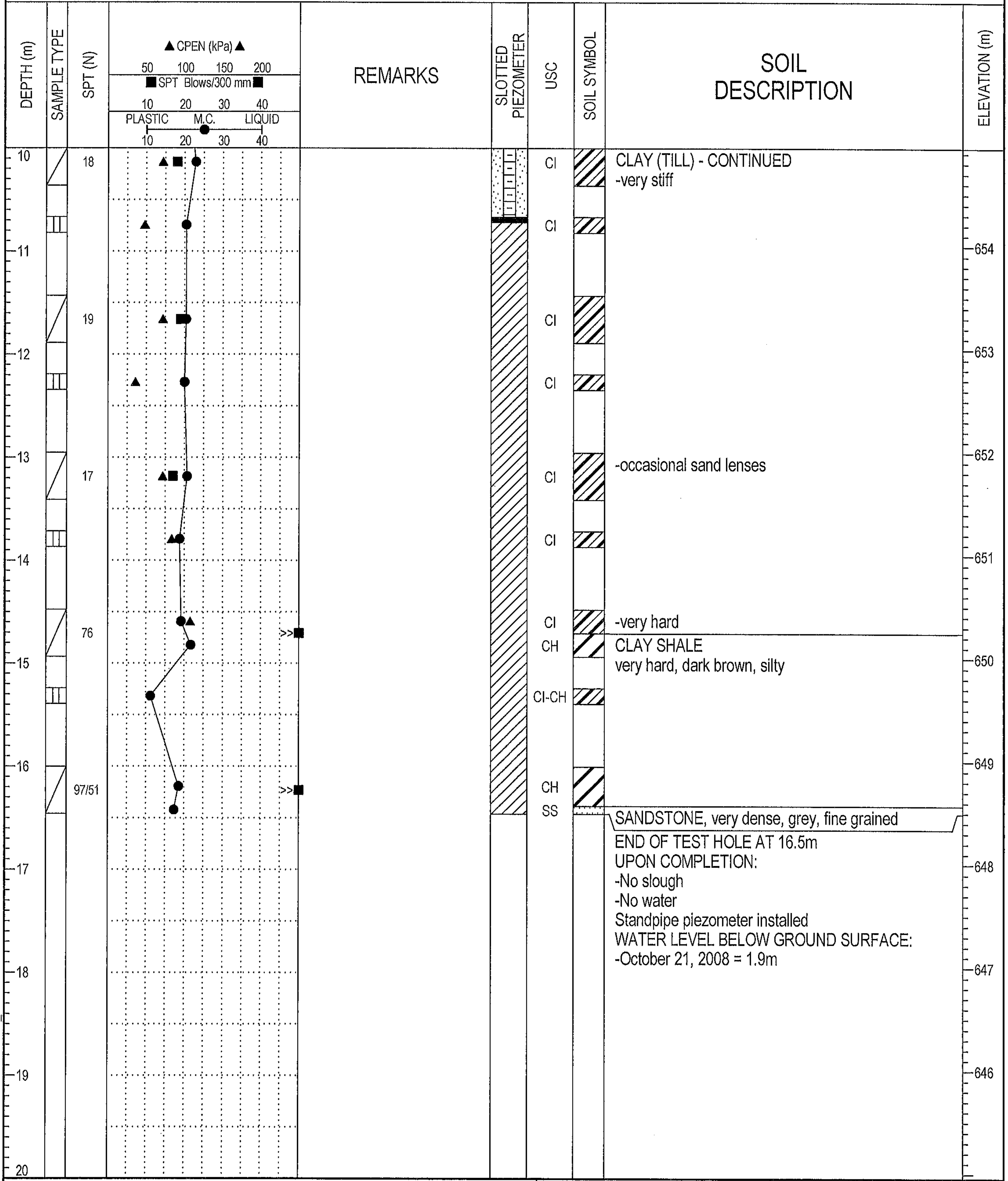
FIELD LOGGED BY: GA	COMPLETION DEPTH: 16.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/3/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-26-02A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: October 3, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 664.95 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⬚ SAND



CLAY (TILL) - CONTINUED
-very stiff

-occasional sand lenses

-very hard

CLAY SHALE
very hard, dark brown, silty

SANDSTONE, very dense, grey, fine grained

END OF TEST HOLE AT 16.5m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-October 21, 2008 = 1.9m

THURBER ENGINEERING LTD.
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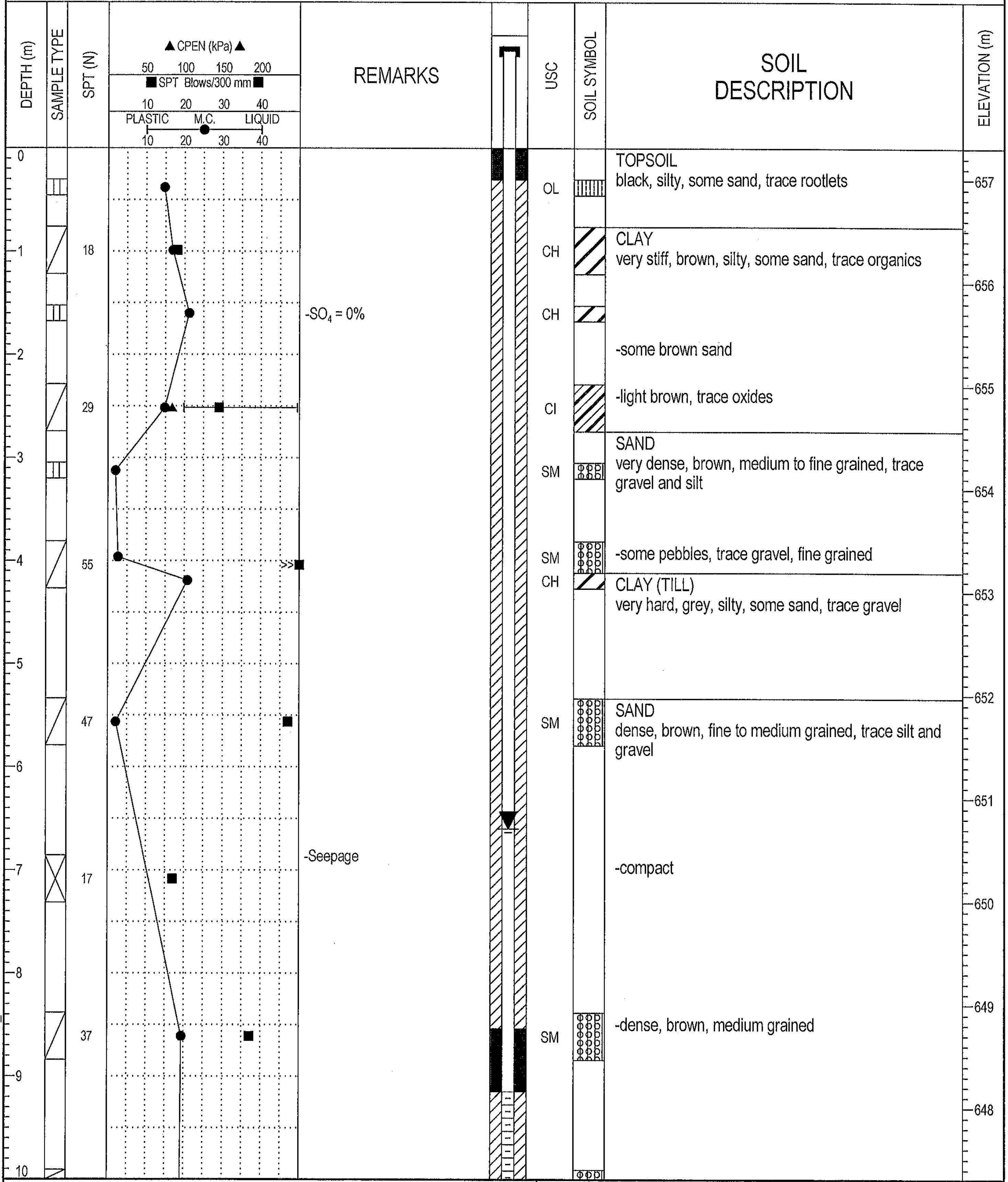
FIELD LOGGED BY: GA	COMPLETION DEPTH: 16.5 m
PREPARED BY: SGR	COMPLETION DATE: 10/3/08
REVIEWED BY: RWT	Page 2 of 2

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-27-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.3 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



-SO$_4$ = 0%

-Seepage

TOPSOIL
black, silty, some sand, trace rootlets

CLAY
very stiff, brown, silty, some sand, trace organics

-some brown sand

-light brown, trace oxides

SAND
very dense, brown, medium to fine grained, trace gravel and silt

-some pebbles, trace gravel, fine grained

CLAY (TILL)
very hard, grey, silty, some sand, trace gravel

SAND
dense, brown, fine to medium grained, trace silt and gravel

-compact

-dense, brown, medium grained

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

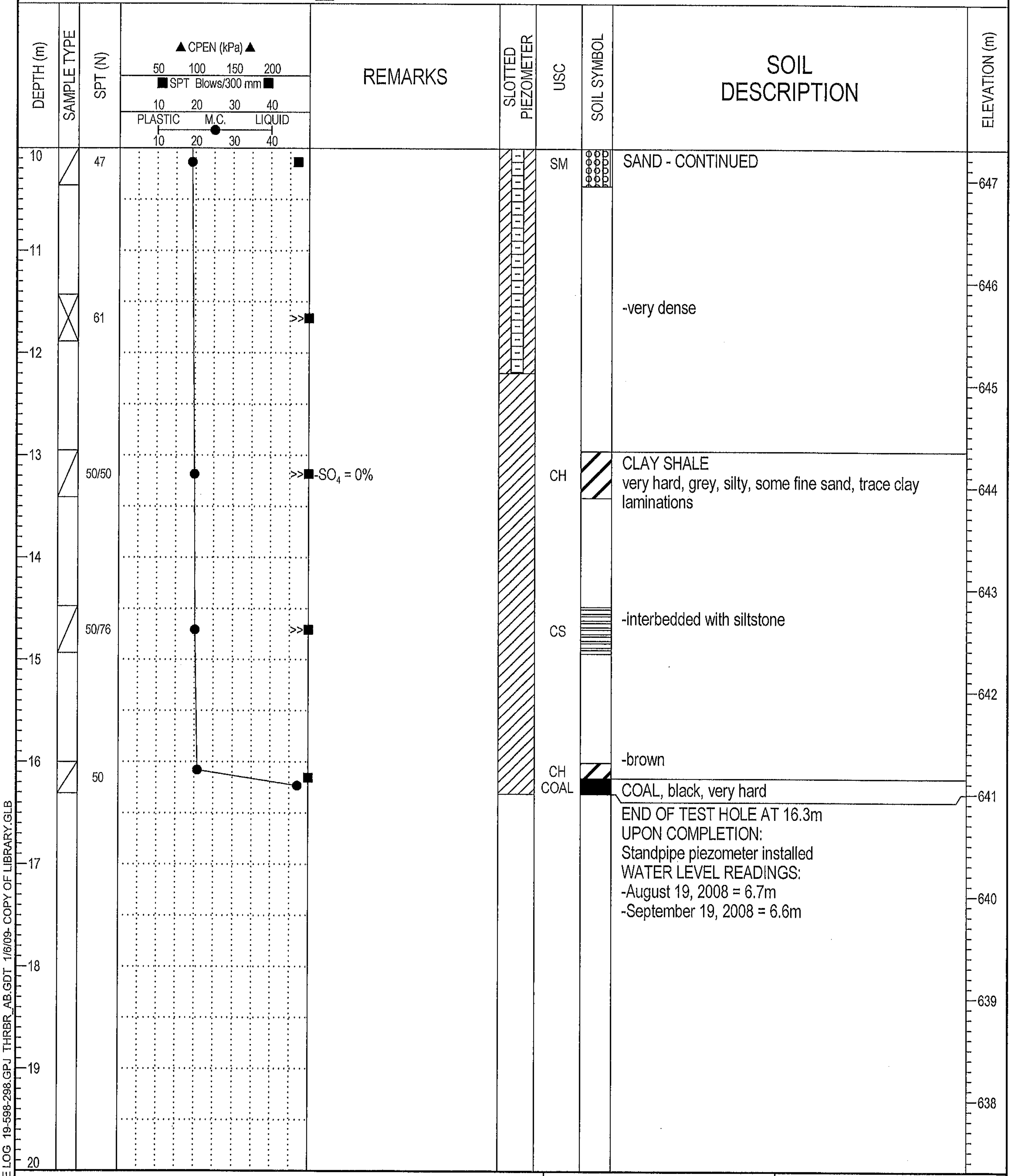
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA / RS	COMPLETION DEPTH: 16.3 m
PREPARED BY: SGR	COMPLETION DATE: 7/29/08
REVIEWED BY: RWT	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-27-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.3 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



REMARKS: -SO_4 = 0%

SAND - CONTINUED

-very dense

CLAY SHALE
very hard, grey, silty, some fine sand, trace clay laminations

-interbedded with siltstone

-brown

COAL, black, very hard

END OF TEST HOLE AT 16.3m
UPON COMPLETION:
Standpipe piezometer installed
WATER LEVEL READINGS:
-August 19, 2008 = 6.7m
-September 19, 2008 = 6.6m

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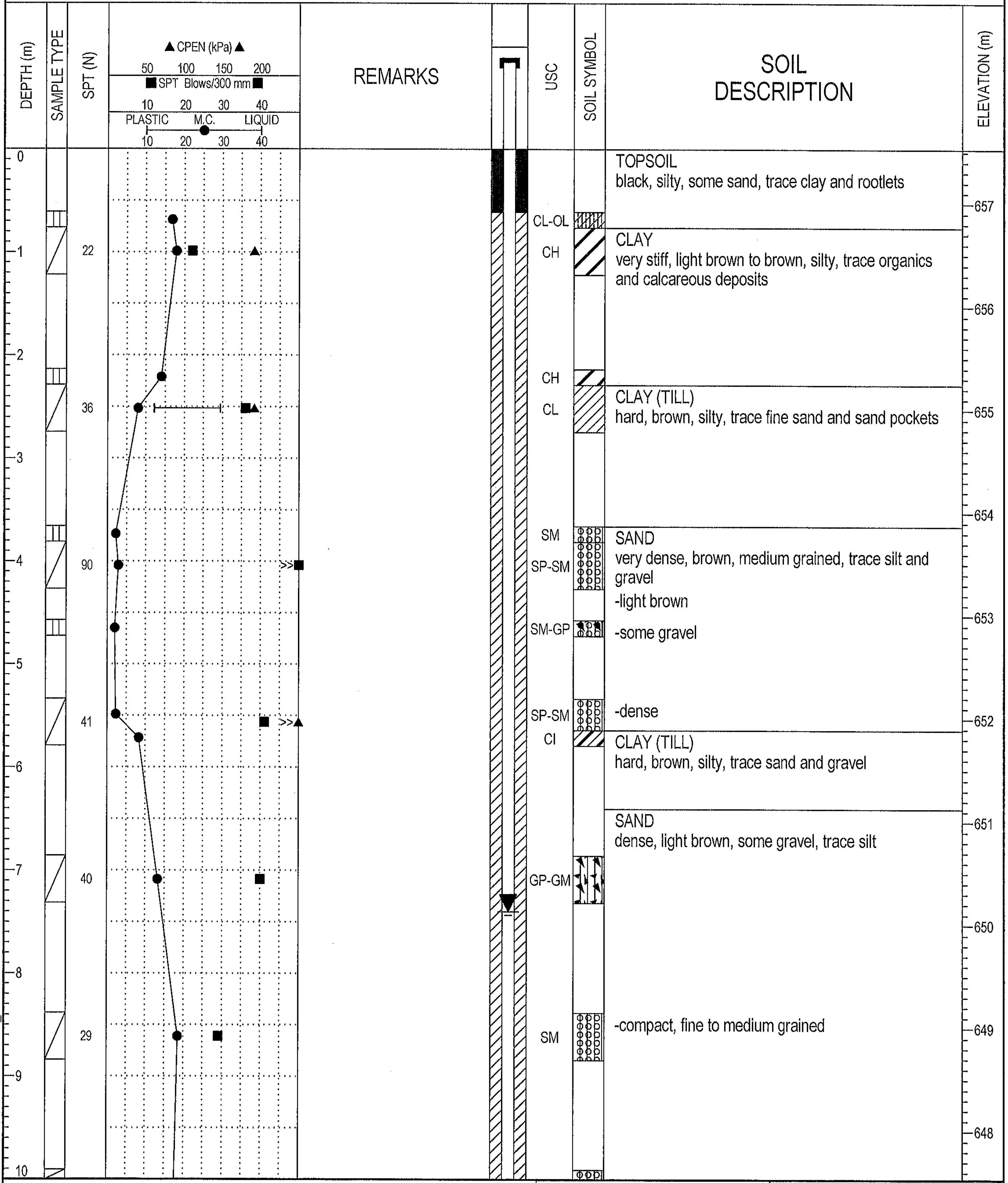
FIELD LOGGED BY: GA / RS	COMPLETION DEPTH: 16.3 m
PREPARED BY: SGR	COMPLETION DATE: 7/29/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-27-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.53 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



TOPSOIL
black, silty, some sand, trace clay and rootlets

CLAY
very stiff, light brown to brown, silty, trace organics and calcareous deposits

CLAY (TILL)
hard, brown, silty, trace fine sand and sand pockets

SAND
very dense, brown, medium grained, trace silt and gravel
-light brown
-some gravel
-dense

CLAY (TILL)
hard, brown, silty, trace sand and gravel

SAND
dense, light brown, some gravel, trace silt
-compact, fine to medium grained

THURBER ENGINEERING LTD.
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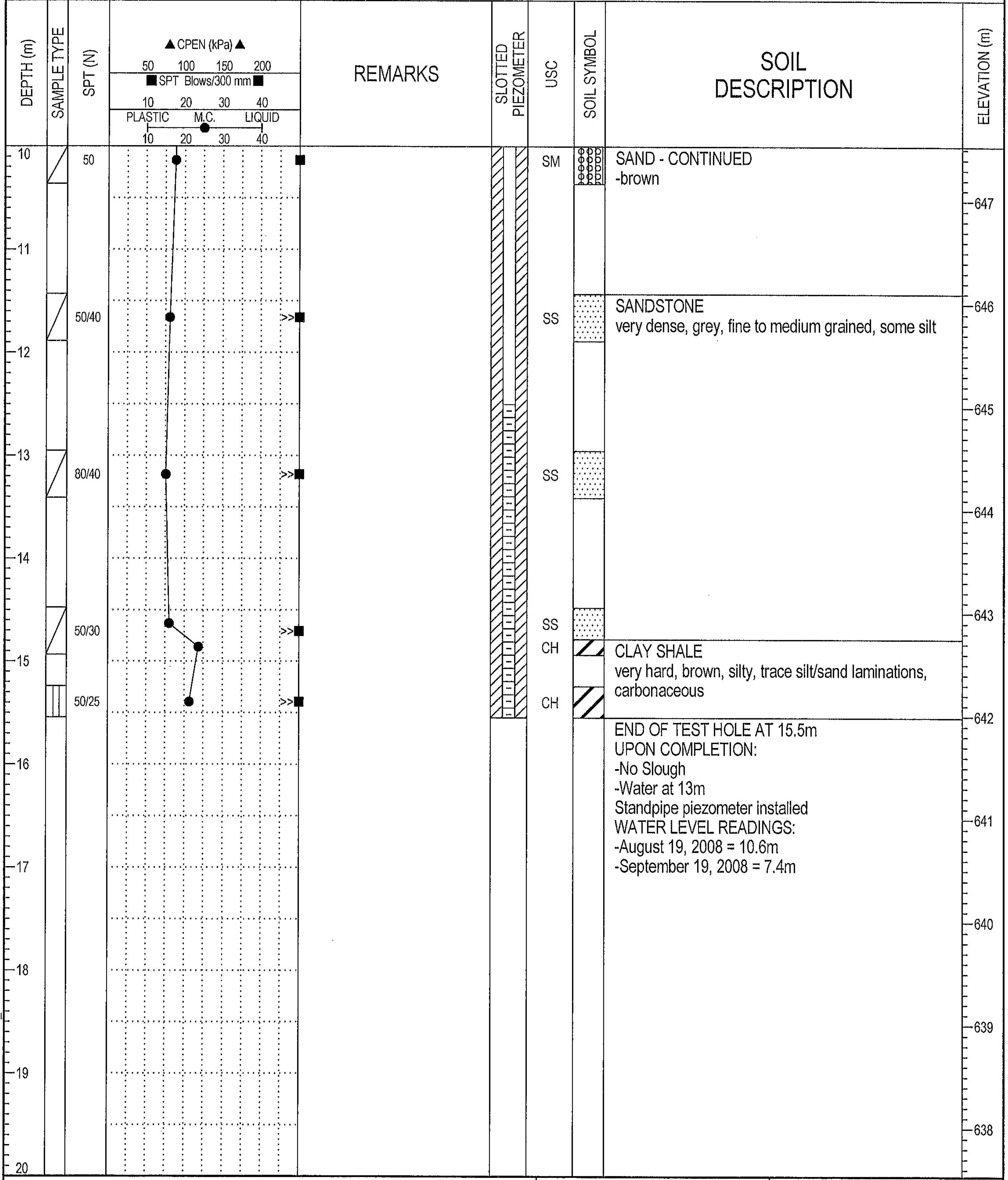
FIELD LOGGED BY: GA	COMPLETION DEPTH: 15.5 m
PREPARED BY: SGR	COMPLETION DATE: 7/29/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-27-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 29, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 657.53 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



SPT (N)	USC
50	SM
50/40	SS
80/40	SS
	SS
50/30	CH
50/25	CH

SOIL DESCRIPTION
SAND - CONTINUED -brown
SANDSTONE very dense, grey, fine to medium grained, some silt
CLAY SHALE very hard, brown, silty, trace silt/sand laminations, carbonaceous
END OF TEST HOLE AT 15.5m UPON COMPLETION: -No Slough -Water at 13m Standpipe piezometer installed WATER LEVEL READINGS: -August 19, 2008 = 10.6m -September 19, 2008 = 7.4m

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

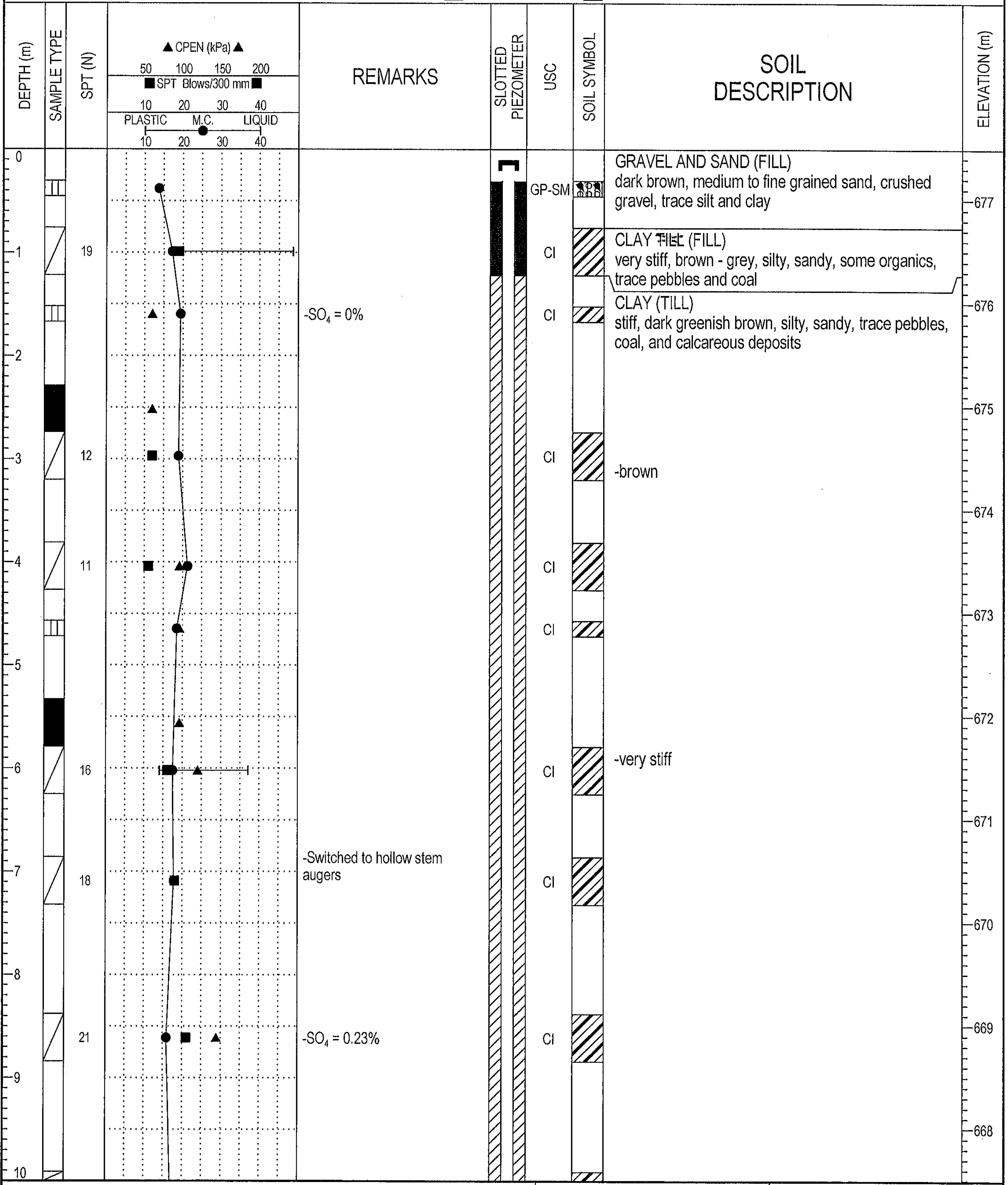
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 15.5 m
PREPARED BY: SGR	COMPLETION DATE: 7/29/08
REVIEWED BY: RWT	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT	BOREHOLE NO: **TH08-31-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 25, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 677.49 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁘ SAND ▥ SLOUGH



REMARKS

-SO_4 = 0%

-Switched to hollow stem augers

-SO_4 = 0.23%

SOIL DESCRIPTION

GRAVEL AND SAND (FILL)
dark brown, medium to fine grained sand, crushed gravel, trace silt and clay

CLAY ~~TILL~~ (FILL)
very stiff, brown - grey, silty, sandy, some organics, trace pebbles and coal

CLAY (TILL)
stiff, dark greenish brown, silty, sandy, trace pebbles, coal, and calcareous deposits

-brown

-very stiff

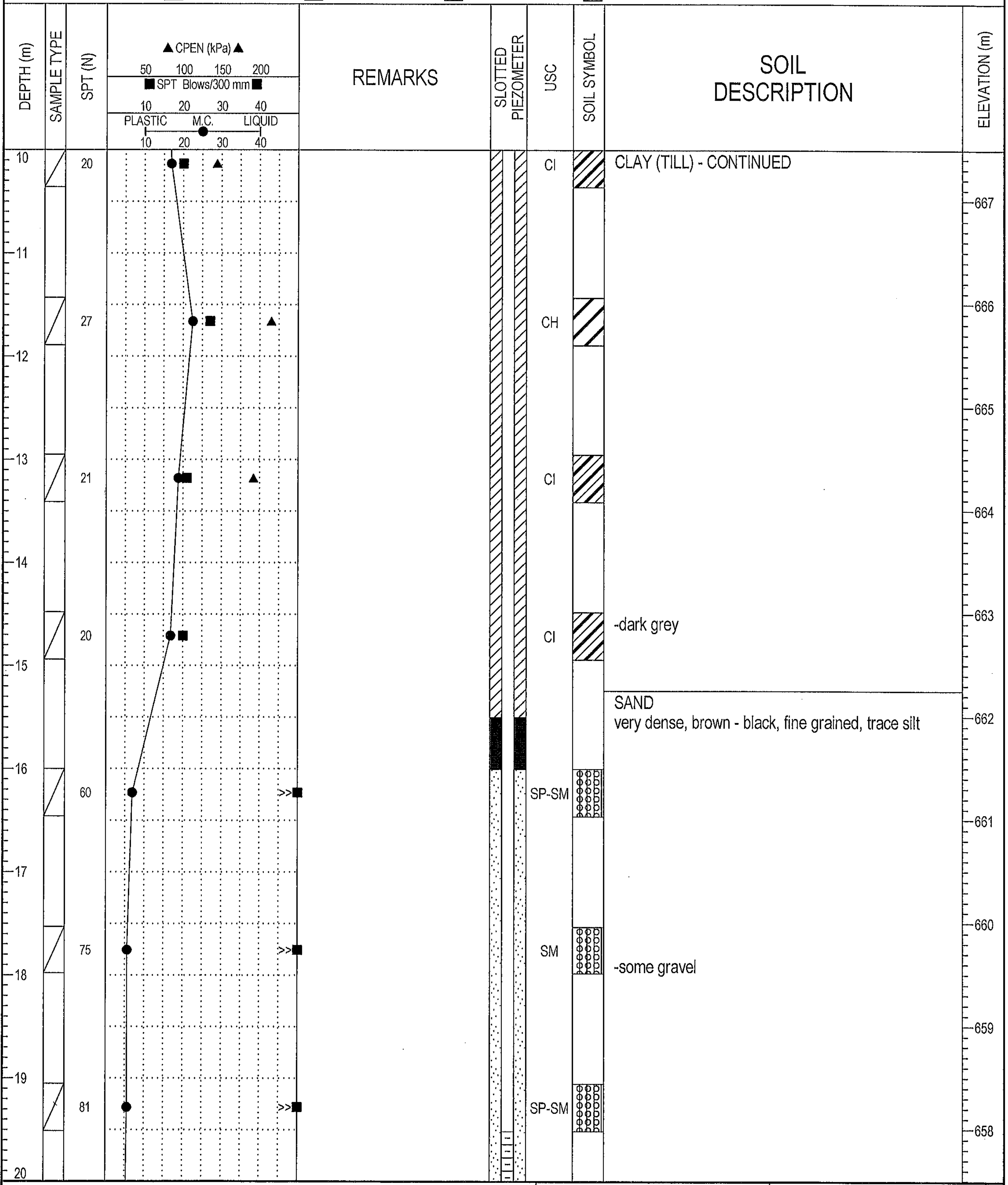
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: TDC	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 7/25/08
REVIEWED BY: DAP	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT	BOREHOLE NO: **TH08-31-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 25, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 677.49 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⁙ SAND ▥ SLOUGH



SPT (N)	USC	SOIL DESCRIPTION
20	CI	CLAY (TILL) - CONTINUED
27	CH	
21	CI	
20	CI	-dark grey
		SAND very dense, brown - black, fine grained, trace silt
60	SP-SM	
75	SM	-some gravel
81	SP-SM	

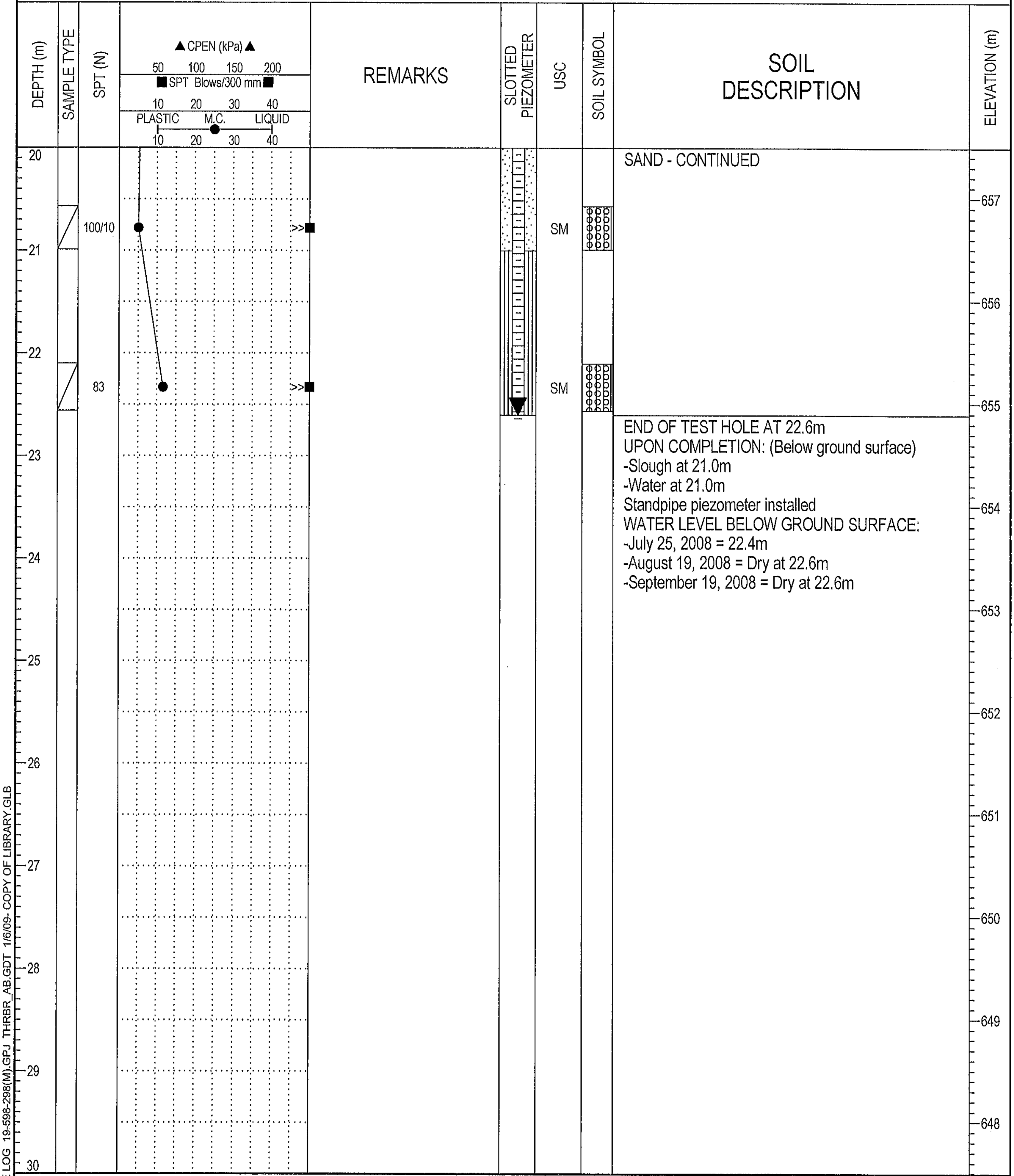
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: TDC	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 7/25/08
REVIEWED BY: DAP	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT	BOREHOLE NO: **TH08-31-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 25, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 677.49 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ⛆ SAND ▥ SLOUGH



SAND - CONTINUED

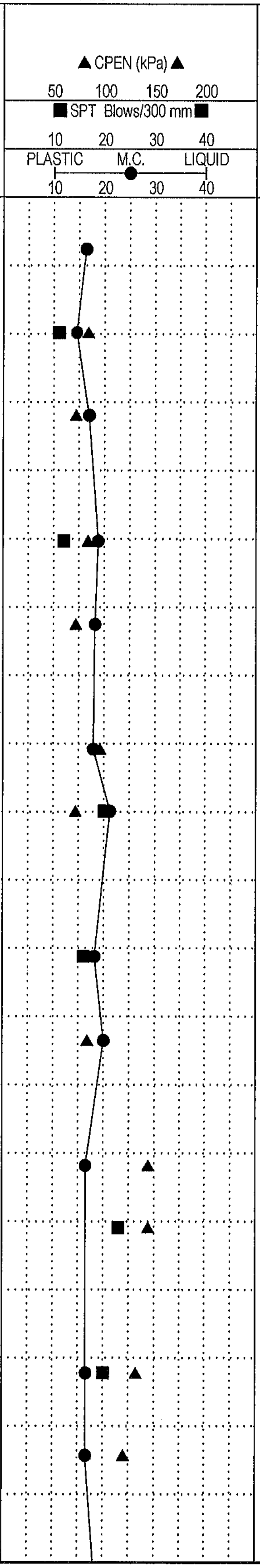
END OF TEST HOLE AT 22.6m
UPON COMPLETION: (Below ground surface)
-Slough at 21.0m
-Water at 21.0m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 25, 2008 = 22.4m
-August 19, 2008 = Dry at 22.6m
-September 19, 2008 = Dry at 22.6m

BOREHOLE LOG 19-598-298(M).GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

THURBER ENGINEERING LTD. GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS	FIELD LOGGED BY: TDC	COMPLETION DEPTH: 22.6 m
	PREPARED BY: SGR	COMPLETION DATE: 7/25/08
	REVIEWED BY: DAP	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT	BOREHOLE NO: **TH08-31-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.61 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◩ SPT ■ SHELBY TUBE



DEPTH (m)	SPT (N)	REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
0				TOPSOIL dark brown, silty, organic, trace clay, fine sand and rootlets	
			CH-OL		
					676
1	11		CI	CLAY (TILL) stiff, brown, silty, sandy, trace pebbles and coal	
			CI		675
2					
	12		CI		674
3			CI		
					673
4		-Cu = 132 kPa -Wet density = 2127kg/m³ Dry density = 1804kg/m³			
	20		CI	-very stiff, some fine sandy high plastic clay lenses	672
5					
	16		CI	-brown - grey, trace oxides	671
6			CI		
					670
7			CI		
	23				669
8					
	20		CI		668
9			CI		
					667
10					

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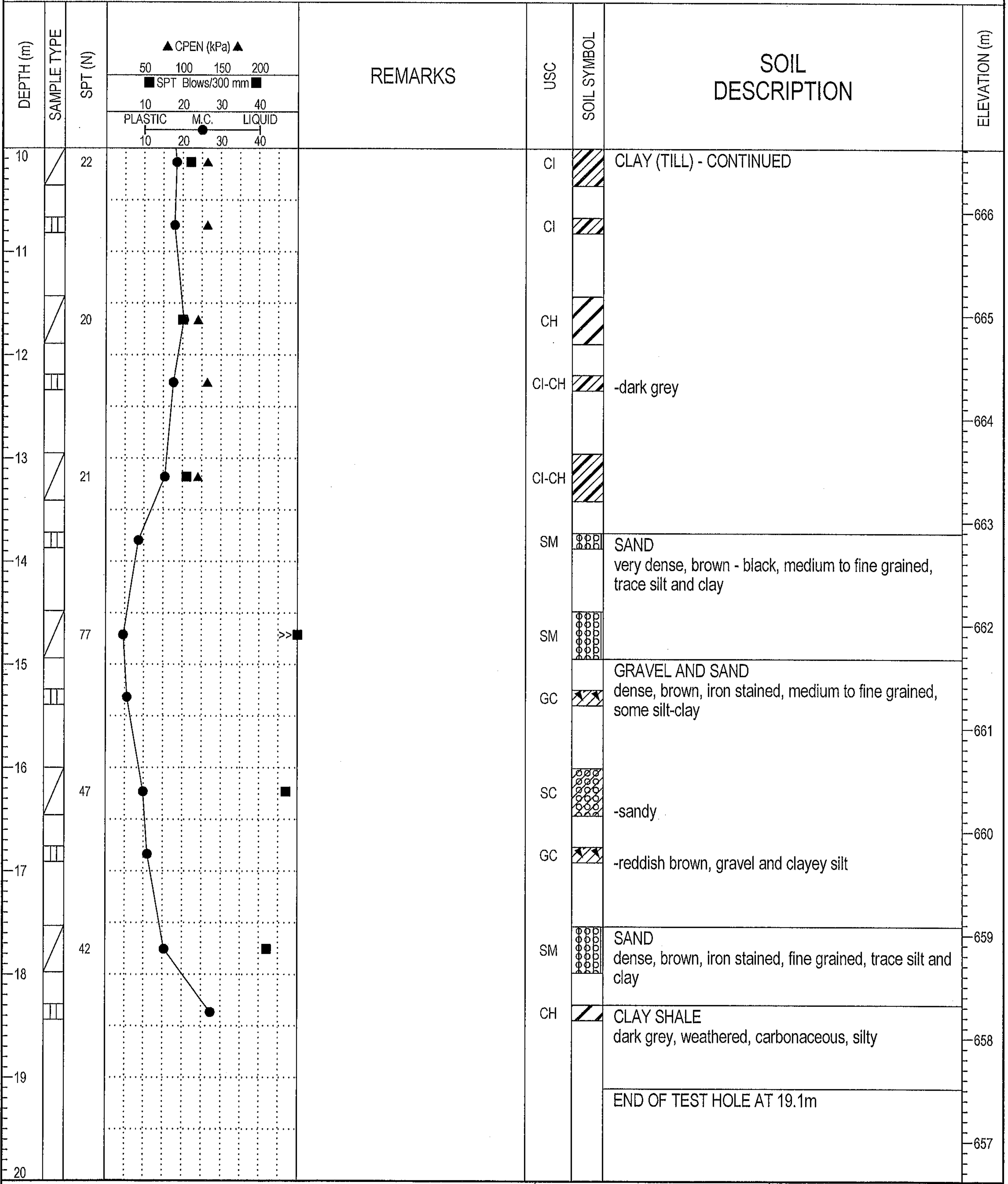
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: TDC	COMPLETION DEPTH: 19.1 m
PREPARED BY: SGR	COMPLETION DATE: 7/24/08
REVIEWED BY: DAP	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT	BOREHOLE NO: **TH08-31-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 24, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.61 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◺ SPT ■ SHELBY TUBE



SPT (N)	USC
22	CI
	CI
20	CH
	CI-CH
21	CI-CH
	SM
77	SM
	GC
47	SC
	GC
42	SM
	CH

CLAY (TILL) - CONTINUED

-dark grey

SAND
very dense, brown - black, medium to fine grained, trace silt and clay

GRAVEL AND SAND
dense, brown, iron stained, medium to fine grained, some silt-clay

-sandy

-reddish brown, gravel and clayey silt

SAND
dense, brown, iron stained, fine grained, trace silt and clay

CLAY SHALE
dark grey, weathered, carbonaceous, silty

END OF TEST HOLE AT 19.1m

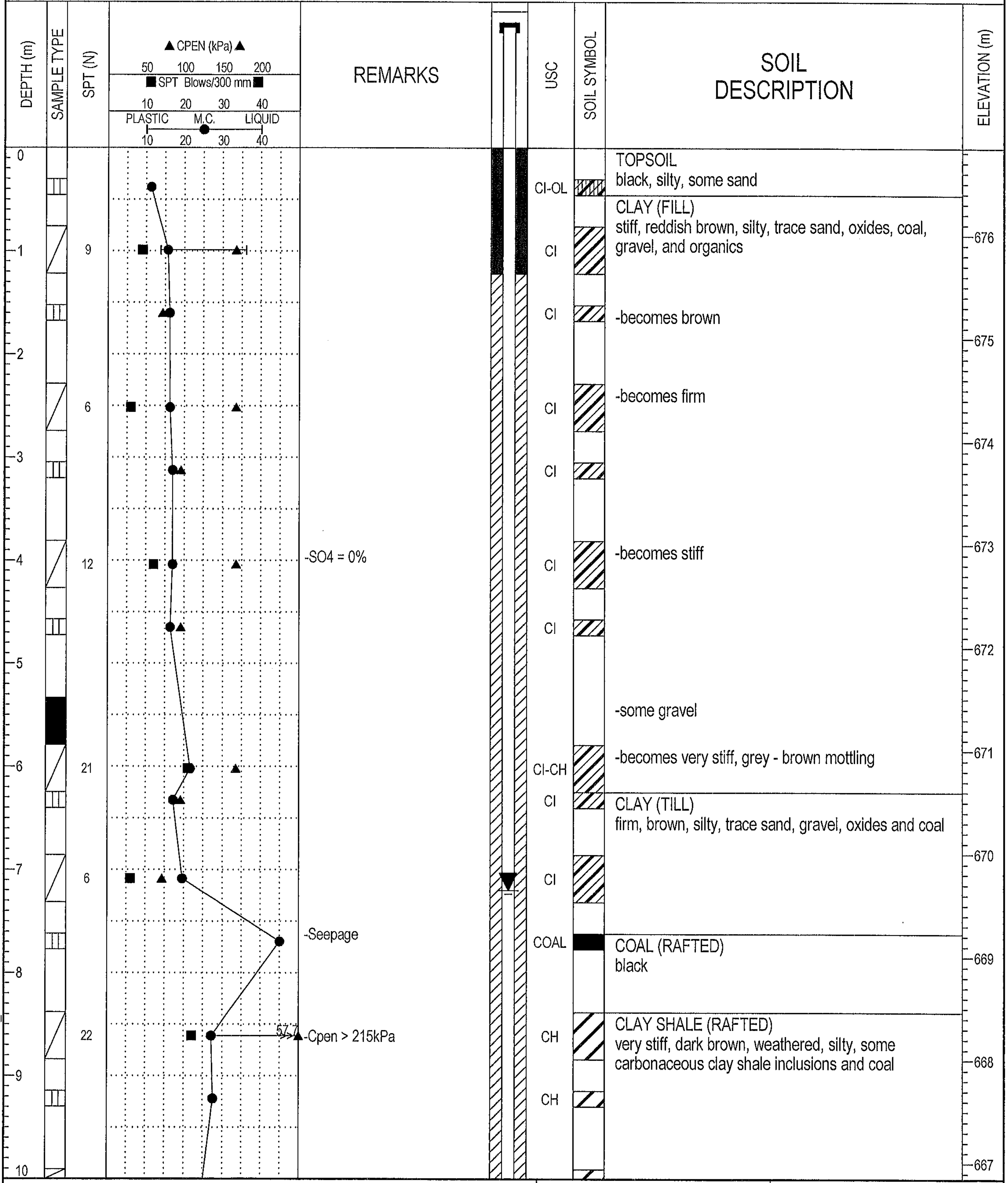
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: TDC	COMPLETION DEPTH: 19.1 m
PREPARED BY: SGR	COMPLETION DATE: 7/24/08
REVIEWED BY: DAP	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.84 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



DEPTH (m)	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
0				TOPSOIL black, silty, some sand
0.35			CI-OL	
0.45				CLAY (FILL) stiff, reddish brown, silty, trace sand, oxides, coal, gravel, and organics
1.0	9		CI	
1.6			CI	-becomes brown
2.5	6		CI	-becomes firm
3.1			CI	
4.0	12	-SO4 = 0%	CI	-becomes stiff
4.6			CI	
5.5				-some gravel
6.0	21		CI-CH	-becomes very stiff, grey - brown mottling
6.3			CI	CLAY (TILL) firm, brown, silty, trace sand, gravel, oxides and coal
7.0	6		CI	
7.6		-Seepage	COAL	COAL (RAFTED) black
8.5	22	-Cpen > 215kPa	CH	CLAY SHALE (RAFTED) very stiff, dark brown, weathered, silty, some carbonaceous clay shale inclusions and coal
9.2			CH	

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GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

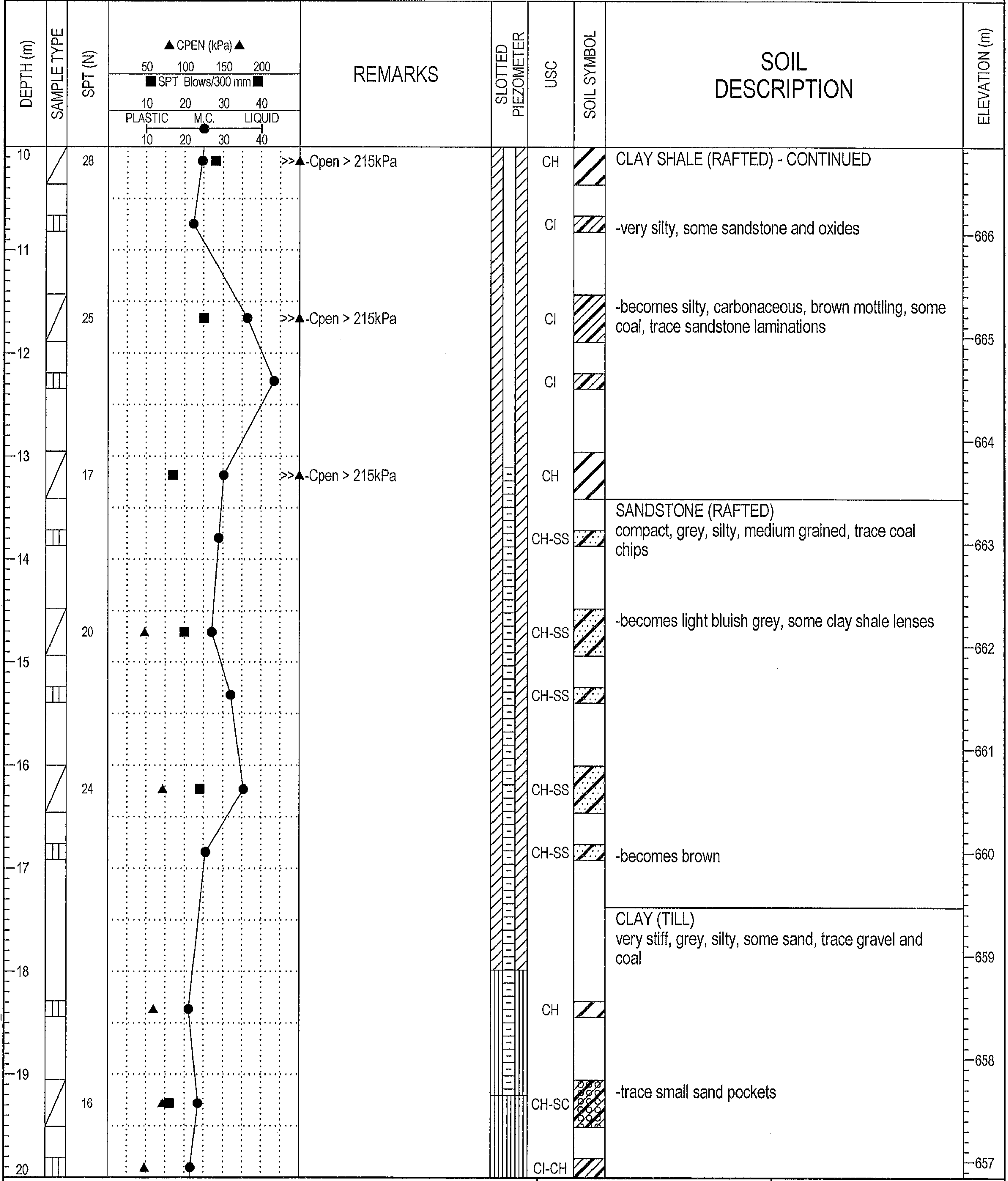
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 11/14/08
REVIEWED BY: RWT	Page 1 of 3

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 2/4/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.84 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
◿	28	>>▲-Cpen > 215kPa	CH	CLAY SHALE (RAFTED) - CONTINUED
▥			CI	-very silty, some sandstone and oxides
◿	25	>>▲-Cpen > 215kPa	CI	-becomes silty, carbonaceous, brown mottling, some coal, trace sandstone laminations
▥			CI	
◿	17	>>▲-Cpen > 215kPa	CH	
				SANDSTONE (RAFTED) compact, grey, silty, medium grained, trace coal chips
▥			CH-SS	
◿	20		CH-SS	-becomes light bluish grey, some clay shale lenses
▥			CH-SS	
◿	24		CH-SS	
▥			CH-SS	-becomes brown
				CLAY (TILL) very stiff, grey, silty, some sand, trace gravel and coal
▥			CH	
◿	16		CH-SC	-trace small sand pockets
▥			CI-CH	

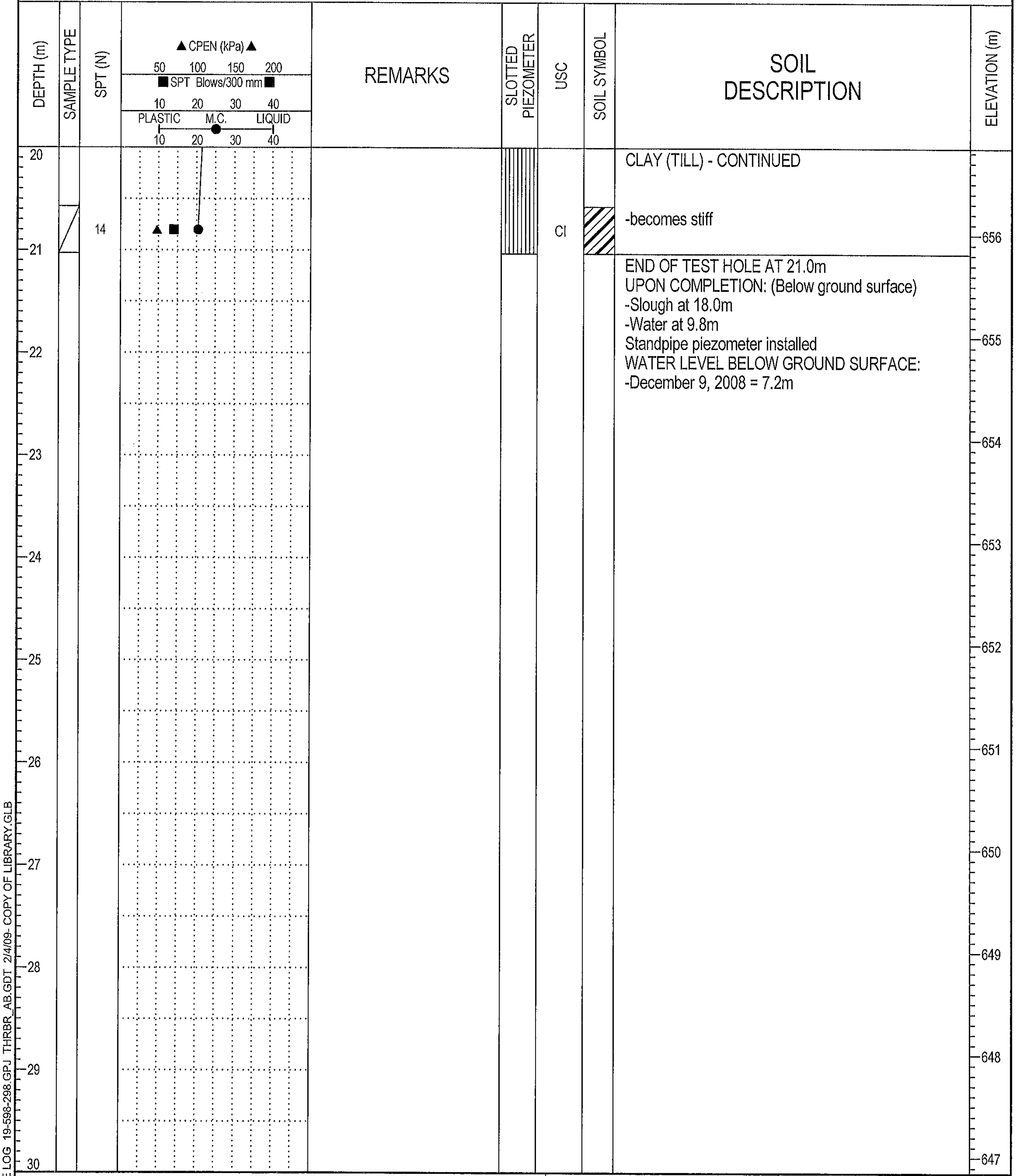
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: EMS	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 11/14/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.84 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◩ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



CLAY (TILL) - CONTINUED

-becomes stiff

END OF TEST HOLE AT 21.0m
UPON COMPLETION: (Below ground surface)
-Slough at 18.0m
-Water at 9.8m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-December 9, 2008 = 7.2m

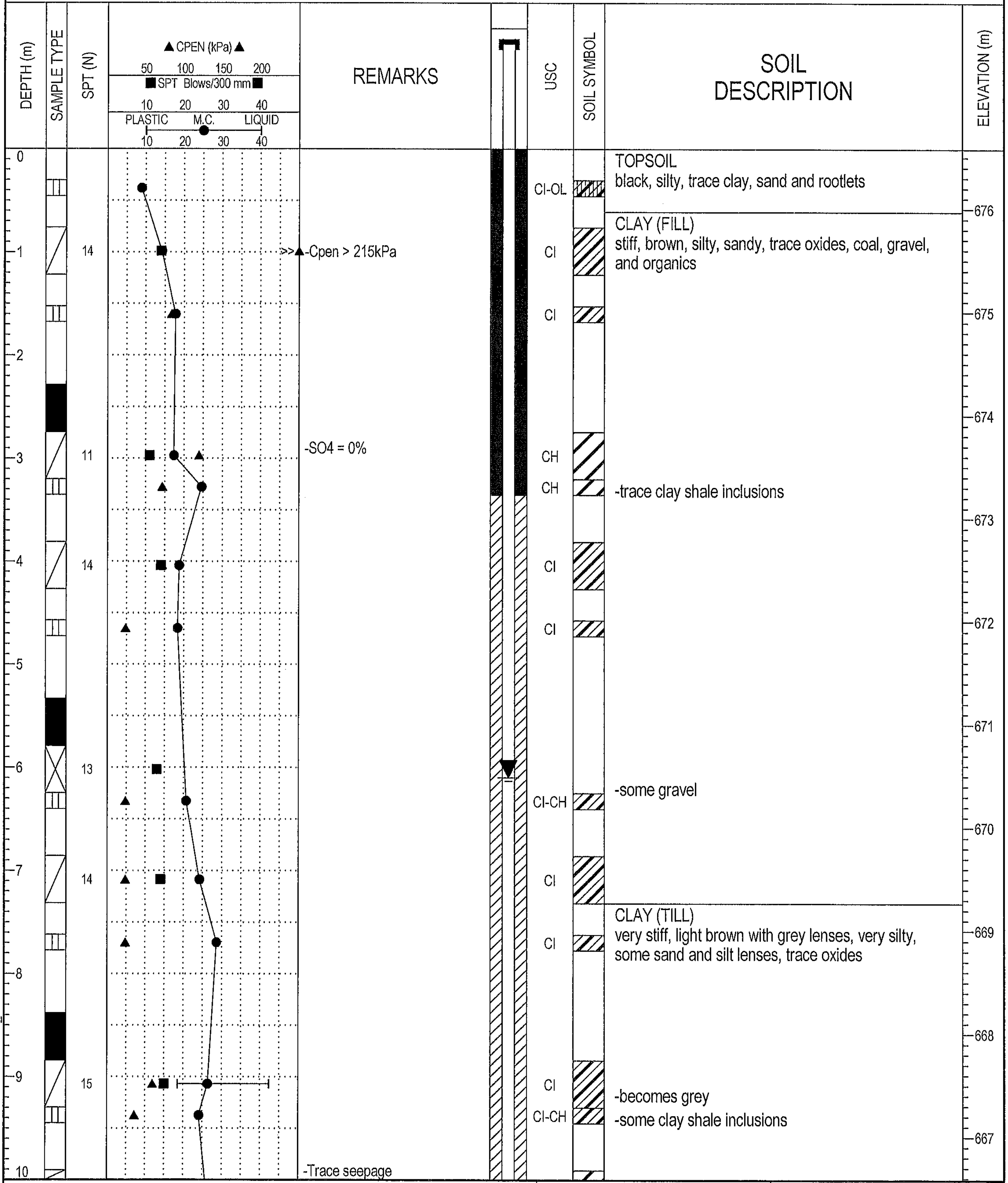
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: EMS	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 11/14/08
REVIEWED BY: RWT	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.58 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
		CI-OL	TOPSOIL black, silty, trace clay, sand and rootlets
14	-Cpen > 215kPa	CI	CLAY (FILL) stiff, brown, silty, sandy, trace oxides, coal, gravel, and organics
		CI	
11	-SO4 = 0%	CH	
		CH	-trace clay shale inclusions
14		CI	
		CI	
13			
		CI-CH	-some gravel
14		CI	
		CI	CLAY (TILL) very stiff, light brown with grey lenses, very silty, some sand and silt lenses, trace oxides
15		CI	-becomes grey
		CI-CH	-some clay shale inclusions
	-Trace seepage		

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 2/4/09- COPY OF LIBRARY.GLB

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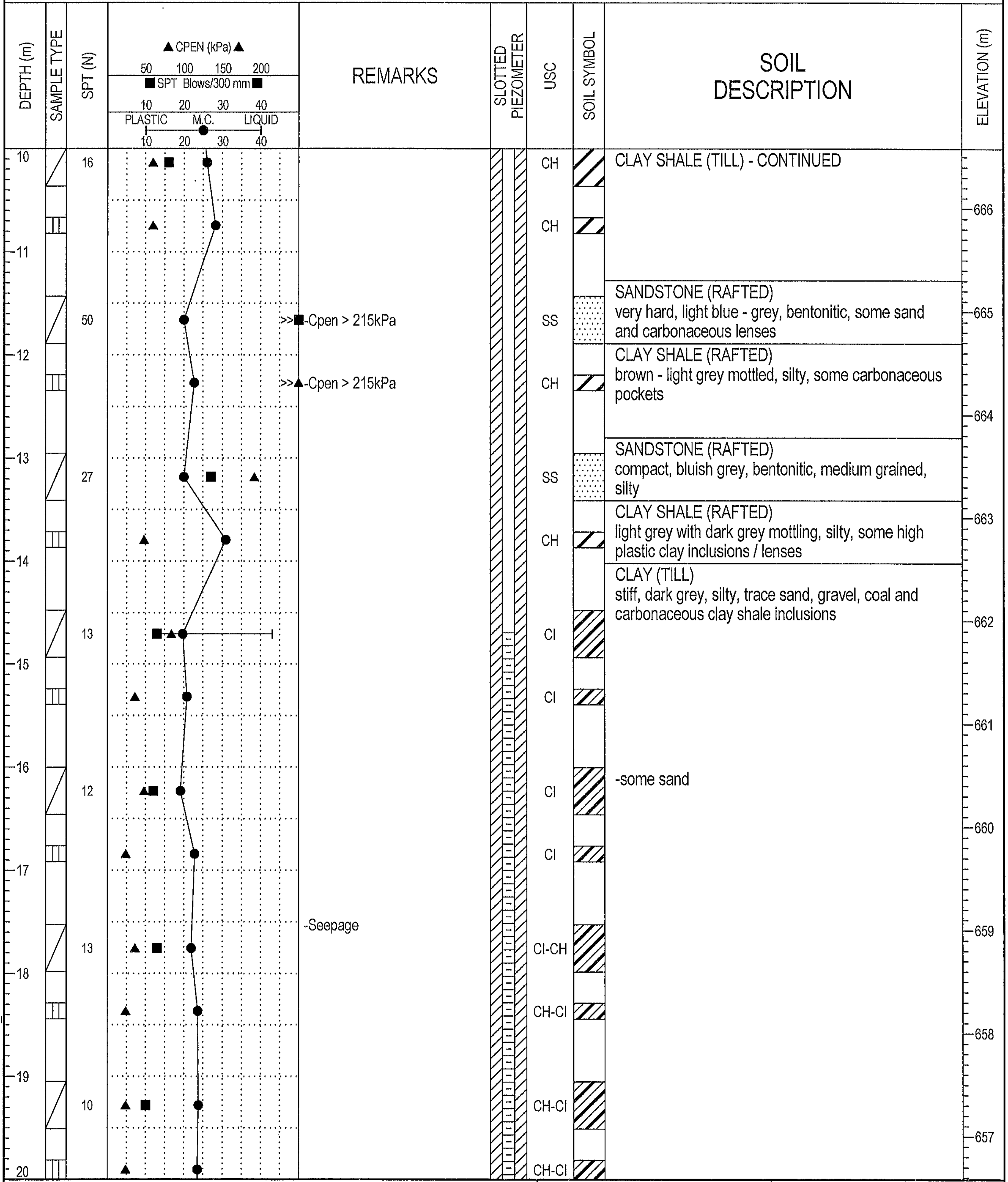
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 11/14/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.58 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◩ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



SPT (N)	REMARKS	USC	SOIL DESCRIPTION
16		CH	CLAY SHALE (TILL) - CONTINUED
		CH	
50	>>■-Cpen > 215kPa	SS	SANDSTONE (RAFTED) very hard, light blue - grey, bentonitic, some sand and carbonaceous lenses
	>>▲-Cpen > 215kPa	CH	CLAY SHALE (RAFTED) brown - light grey mottled, silty, some carbonaceous pockets
27		SS	SANDSTONE (RAFTED) compact, bluish grey, bentonitic, medium grained, silty
		CH	CLAY SHALE (RAFTED) light grey with dark grey mottling, silty, some high plastic clay inclusions / lenses
13		CI	CLAY (TILL) stiff, dark grey, silty, trace sand, gravel, coal and carbonaceous clay shale inclusions
		CI	
12		CI	-some sand
		CI	
	-Seepage		
13		CI-CH	
		CH-CI	
10		CH-CI	
		CH-CI	

THURBER ENGINEERING LTD.
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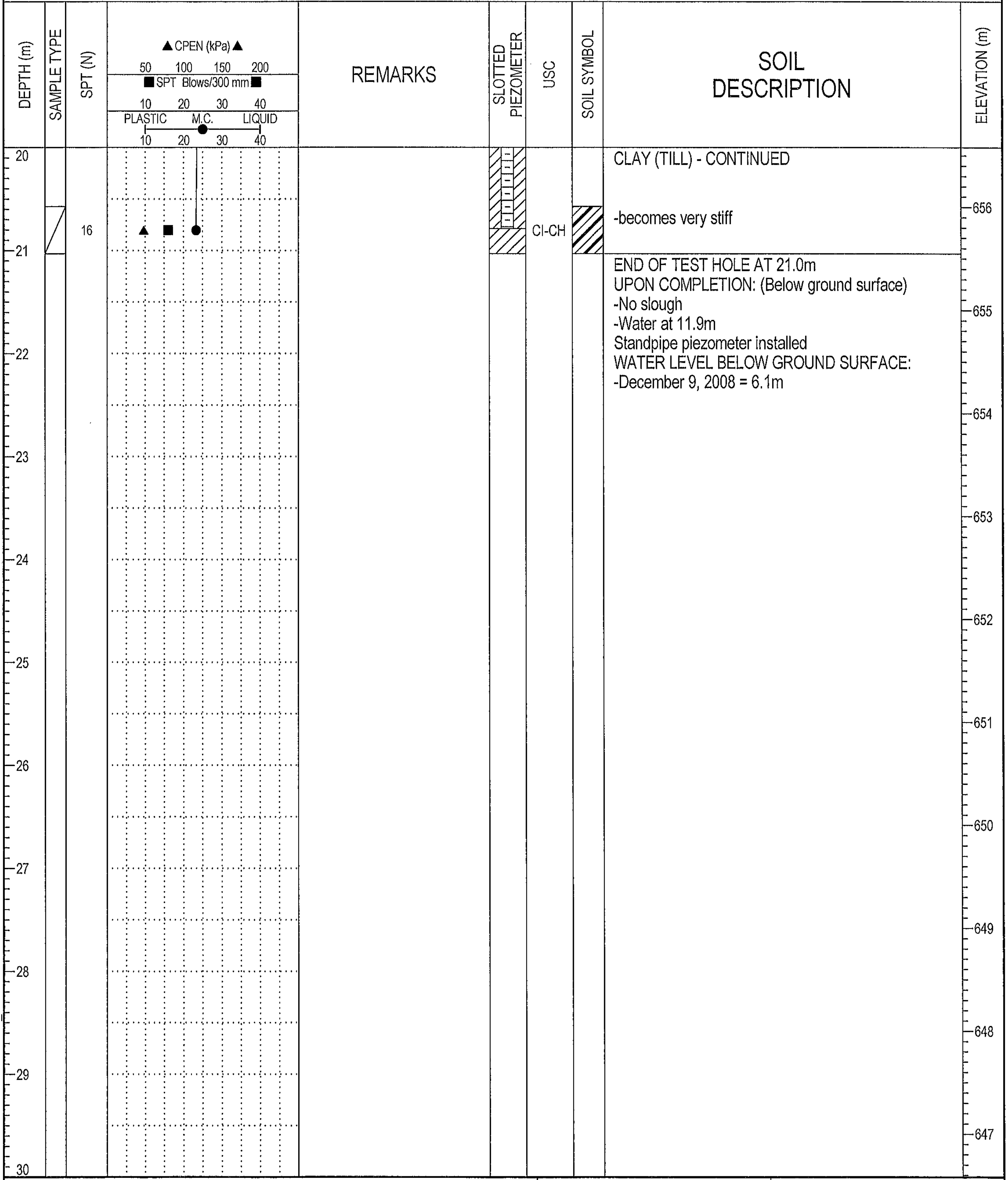
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 11/14/08
REVIEWED BY: RWT	Page 2 of 3

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 2/4/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 14, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.58 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS



SOIL DESCRIPTION

CLAY (TILL) - CONTINUED

-becomes very stiff

END OF TEST HOLE AT 21.0m
UPON COMPLETION: (Below ground surface)
-No slough
-Water at 11.9m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-December 9, 2008 = 6.1m

THURBER ENGINEERING LTD.
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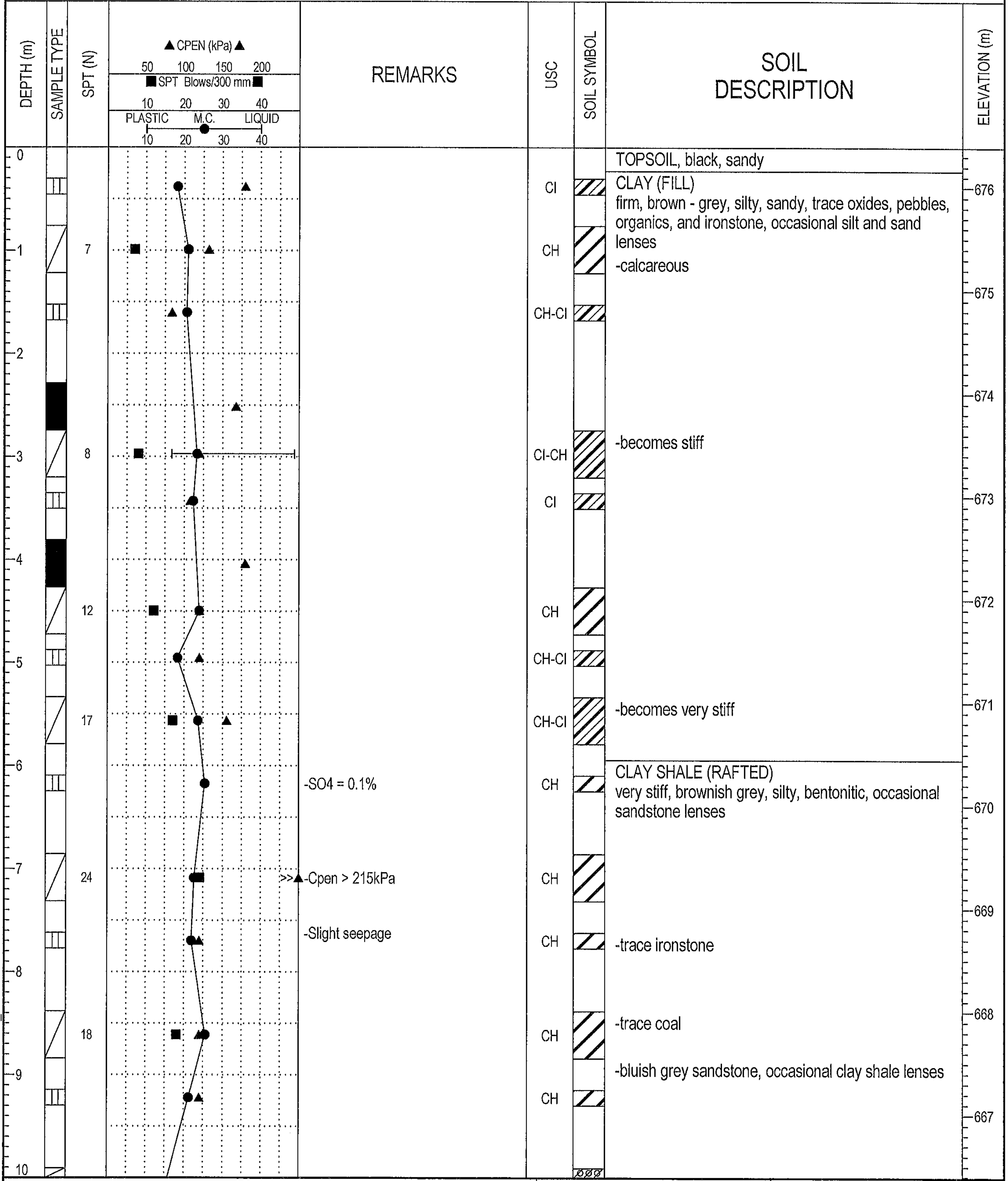
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 11/14/08
REVIEWED BY: RWT	Page 3 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-03**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 21, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.39 (m)

SAMPLE TYPE ◫ GRAB SAMPLE ◩ SPT ■ SHELBY TUBE ☒ NO RECOVERY



DEPTH (m)	SPT (N)	REMARKS	USC	SOIL DESCRIPTION
0				TOPSOIL, black, sandy
			CI	CLAY (FILL) firm, brown - grey, silty, sandy, trace oxides, pebbles, organics, and ironstone, occasional silt and sand lenses
1	7		CH	-calcareous
			CH-CI	
3	8		CI-CH	-becomes stiff
			CI	
	12		CH	
5			CH-CI	
	17		CH-CI	-becomes very stiff
6				CLAY SHALE (RAFTED) very stiff, brownish grey, silty, bentonitic, occasional sandstone lenses
		-SO4 = 0.1%	CH	
7	24	>>▲-Cpen > 215kPa	CH	
		-Slight seepage		
			CH	-trace ironstone
				-trace coal
	18		CH	
9				-bluish grey sandstone, occasional clay shale lenses
			CH	

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THURBER ENGINEERING LTD.
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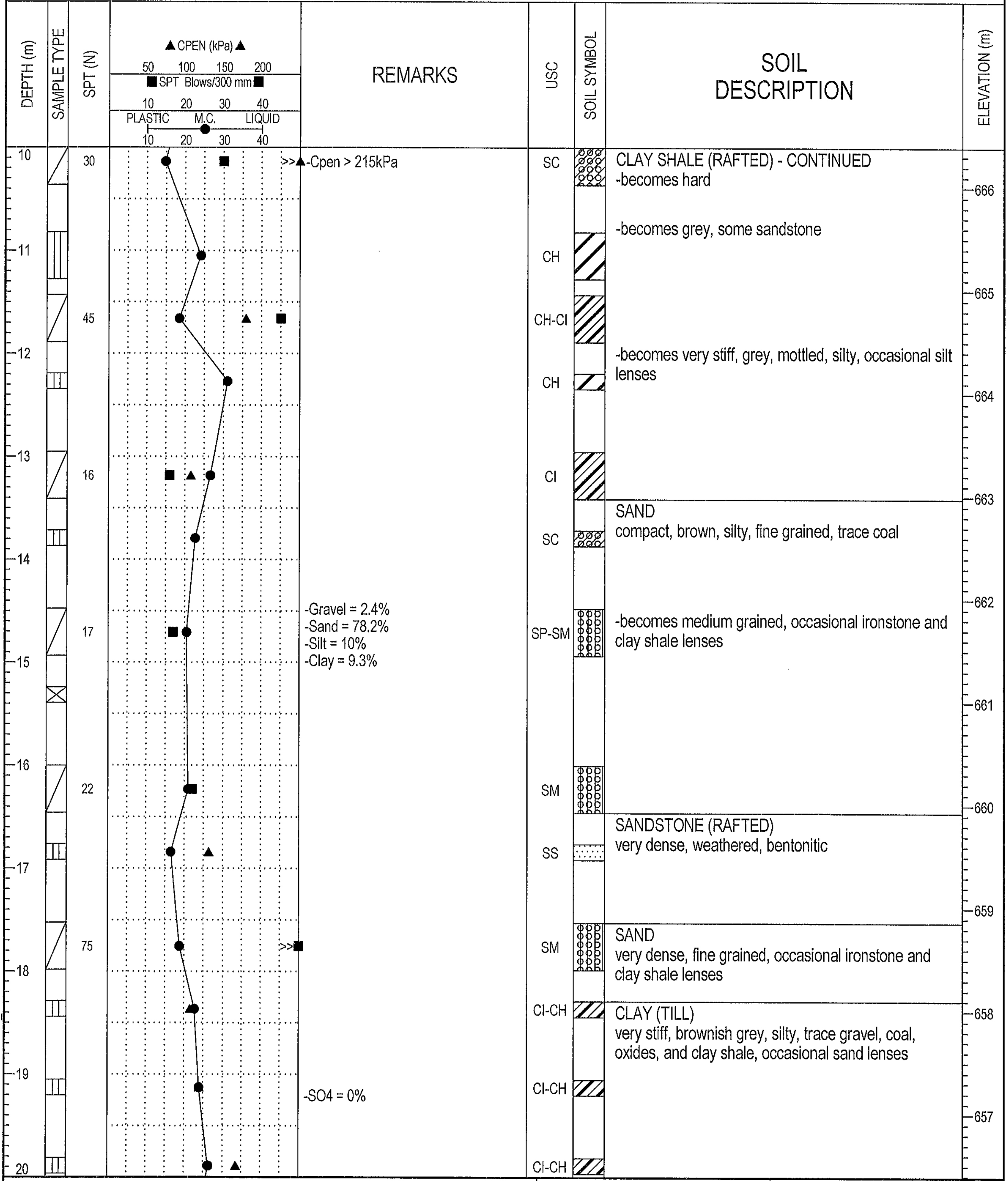
FIELD LOGGED BY: MW	COMPLETION DEPTH: 20.6 m
PREPARED BY: SGR	COMPLETION DATE: 11/21/08
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-03**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 21, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.39 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE ☒ NO RECOVERY



REMARKS

-Cpen > 215kPa

-Gravel = 2.4%
-Sand = 78.2%
-Silt = 10%
-Clay = 9.3%

-SO4 = 0%

SOIL DESCRIPTION

CLAY SHALE (RAFTED) - CONTINUED
-becomes hard

-becomes grey, some sandstone

-becomes very stiff, grey, mottled, silty, occasional silt lenses

SAND
compact, brown, silty, fine grained, trace coal

-becomes medium grained, occasional ironstone and clay shale lenses

SANDSTONE (RAFTED)
very dense, weathered, bentonitic

SAND
very dense, fine grained, occasional ironstone and clay shale lenses

CLAY (TILL)
very stiff, brownish grey, silty, trace gravel, coal, oxides, and clay shale, occasional sand lenses

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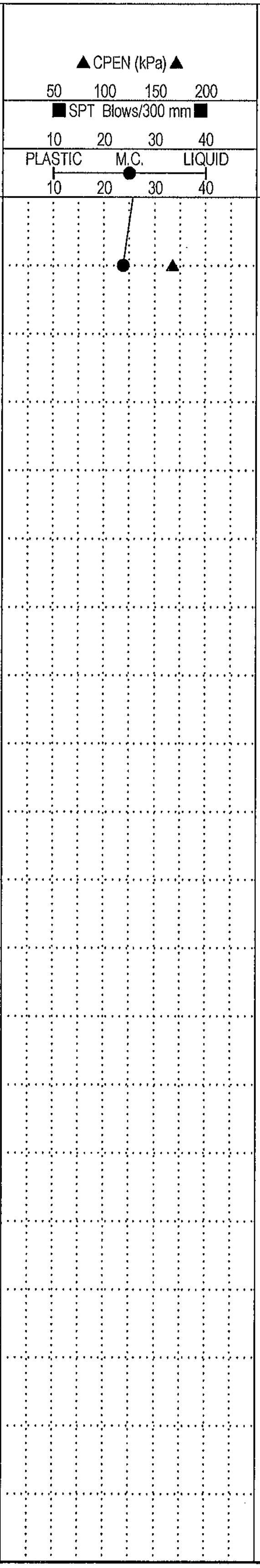
FIELD LOGGED BY: MW	COMPLETION DEPTH: 20.6 m
PREPARED BY: SGR	COMPLETION DATE: 11/21/08
REVIEWED BY: RWT	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH08-32-03**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 21, 2008	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 676.39 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◩ SPT ■ SHELBY TUBE ☒ NO RECOVERY



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
20						CLAY (TILL) - CONTINUED	
	▥			CI-CH	▨		656
						END OF TEST HOLE AT 20.6m UPON COMPLETION: (Below ground surface) -Slough at 10.8m -Water at 6.9m Backfilled with drill cuttings	
21							655
22							654
23							653
24							652
25							651
26							650
27							649
28							648
29							647
30							

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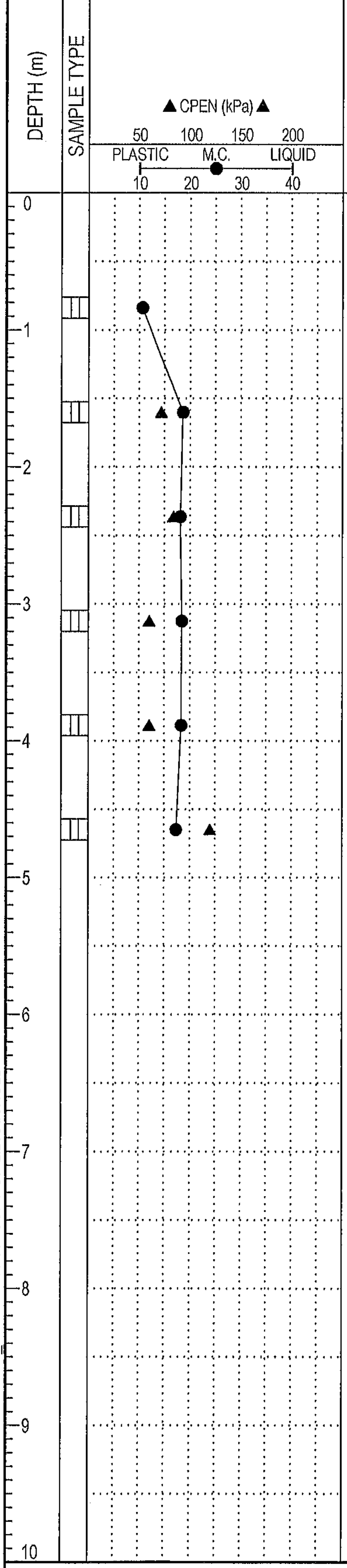
FIELD LOGGED BY: MW	COMPLETION DEPTH: 20.6 m
PREPARED BY: SGR	COMPLETION DATE: 11/21/08
REVIEWED BY: RWT	

BOREHOLE LOG 19-598-298.GPJ THRBR_AB.GDT 2/4/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 28, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION
			ASPHALT (200 mm)
-Gravel: 20.8% -Sand: 67.5% -Silt: 9.8% -Clay: 1.9%	SW-SM	▨	SAND (FILL) dark brown, fine grained, sub angular, gravelly, trace silt/clay, trace organics and claystone nodules
	CI	▨	CLAY (TILL) stiff, grey, silty, trace fine sand, coal, oxides, and gravel
	CI	▨	-stiff to very stiff
	CI	▨	-stiff
	CI	▨	
	CI	▨	-very stiff
			END OF TEST HOLE AT 5.3m UPON COMPLETION: -No Slough -No Water Backfilled with Cuttings

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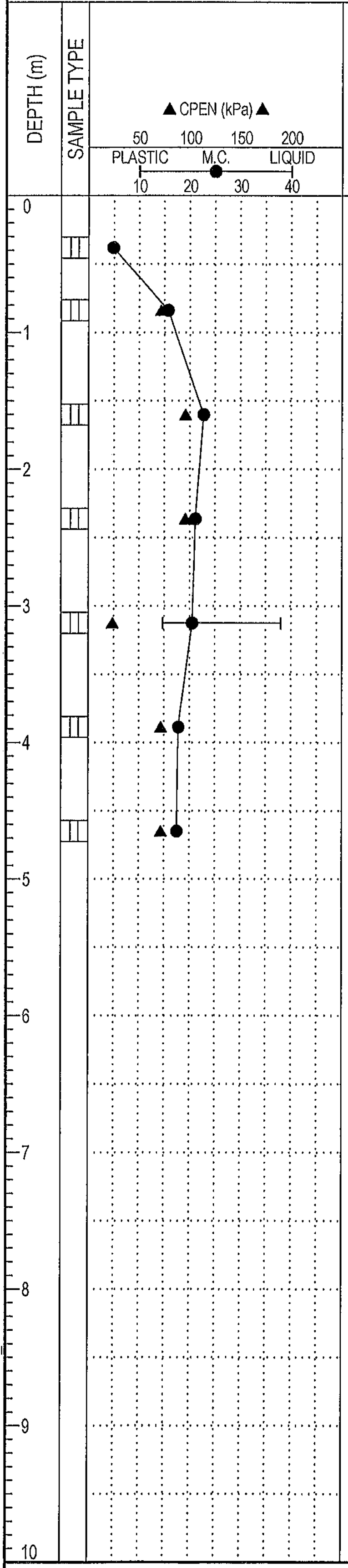
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/28/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 2, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL SYMBOL	SOIL DESCRIPTION
		ASPHALT (165 mm)
SP	○○○	SAND (FILL) brown, fine to coarse grained, silty, some gravel up to 40mm size, trace clay and coal
CI	▨	CLAY (FILL) stiff, brown, silty, trace gravel, sand, oxides and organics
CI	▨	-stiff to very stiff light brown, trace coal
CI	▨	-possible weathered bedrock layer, trace marl
CI	▨	CLAY (TILL) firm, brown, silty, some sand, trace oxides, gravel, coal, and clay shale inclusions
CI	▨	-stiff
CI	▨	-becomes greyish brown, sandy
		END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

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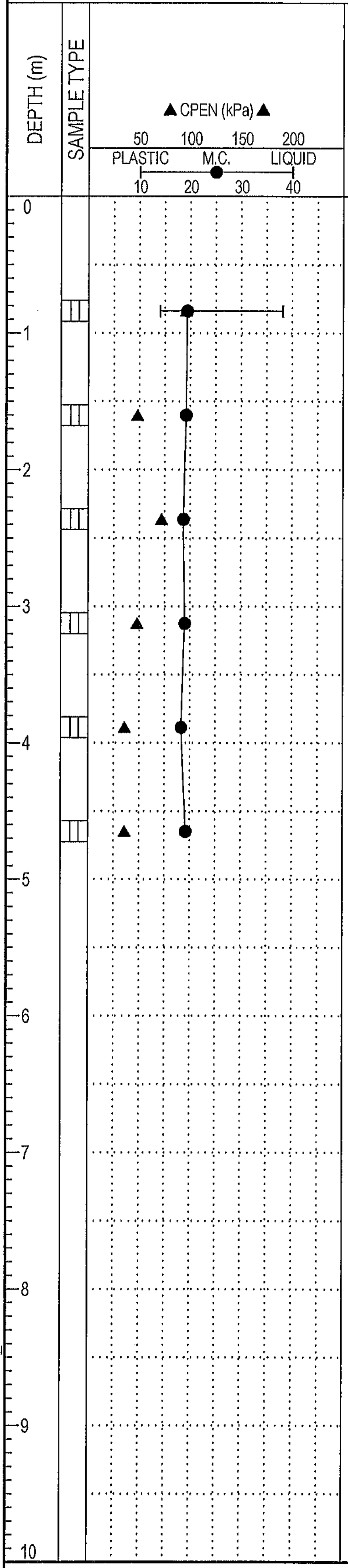
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 12/2/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S03**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 26, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION
			TOPSOIL (300 mm) black, organic, silty, trace rootlets
	CI	▨	CLAY (FILL) stiff to very stiff, grey, silty, trace oxides and gravel
	CI	▨	CLAY (TILL) firm to stiff, brown, silty, trace gravel, sand, coal and oxides
	CI	▨	-stiff, trace bentonitic shale
	CI	▨	-firm to stiff
	CI	▨	-firm
	CI	▨	-becomes grey
			END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

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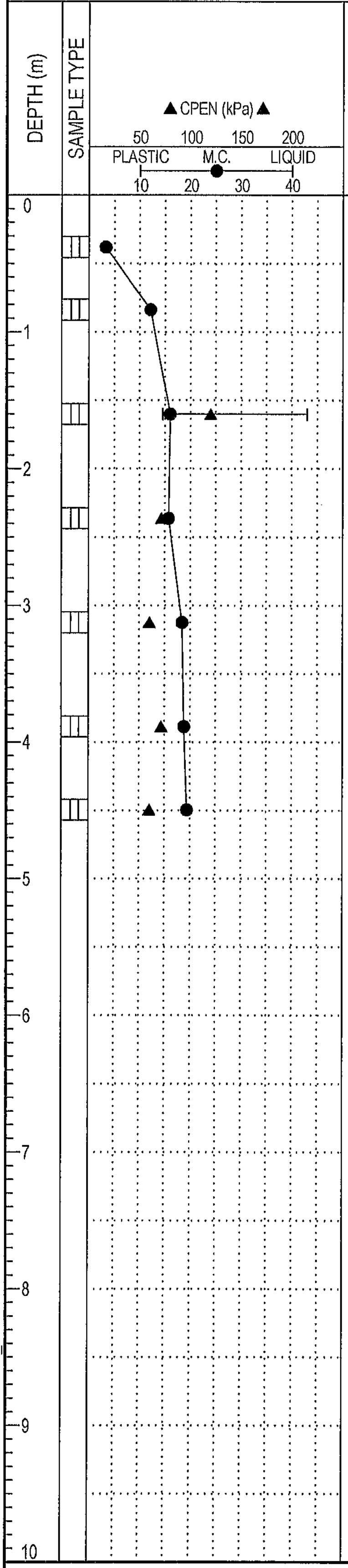
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/26/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S04**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 2, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL DESCRIPTION
	ASPHALT (180 mm)
SW-SM SW-SM	SAND (FILL) dark brown, silty, medium grained, some gravel up to 25 mm sizes, trace clay -becomes medium to coarse grained, gravel up to 40mm size, trace clay
CI CI	CLAY (TILL LIKE) very stiff, brown, silty, some sand, trace gravel, oxides and coal -stiff
CI CI CI	CLAY (TILL) stiff, brown, silty, some sand and coal, trace oxides, gravel, and clay shale

END OF TEST HOLE AT 4.6m
UPON COMPLETION:
-No slough
-No water
Backfilled with drill cuttings

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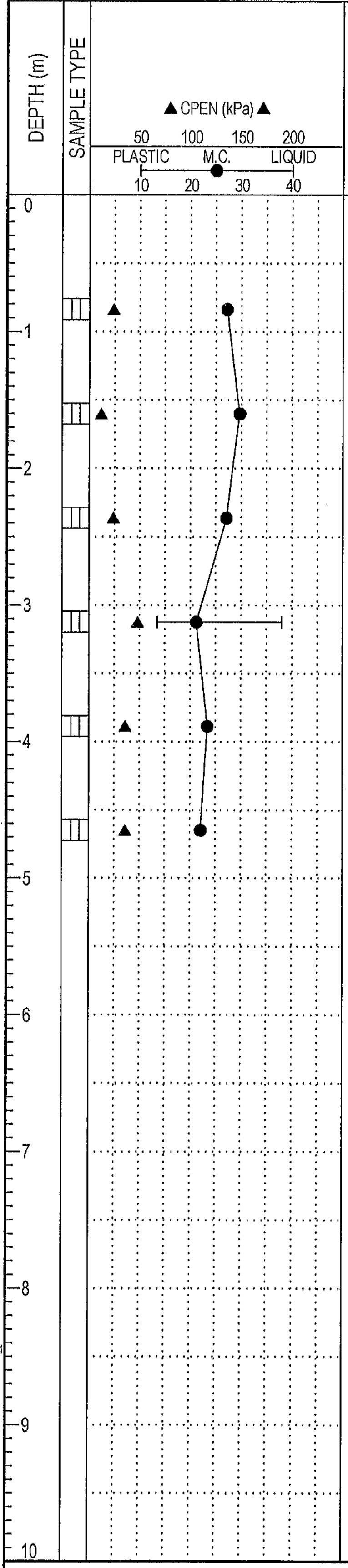
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 4.6 m
PREPARED BY: SGR	COMPLETION DATE: 12/2/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S05**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 26, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL SYMBOL
CI-OL	▨
CI	▨
CI	▨
CI	▨
CI	▨
CI	▨

SOIL DESCRIPTION

TOPSOIL (300 mm)
black, silty, organic, trace rootlets

CLAY (FILL)
brown - black, silty, trace rootlets, organics and clacareous depositis

TOPSOIL, soft to firm, black, clayey, some rootlets

CLAY
soft, light grey, silty, some fine sand

CLAY (TILL)
soft, brown, silty, trace sand. gravel, oxides and caol
-becomes grey
-firm to stiff
-firm

END OF TEST HOLE AT 5.3m
UPON COMPLETION:
-No slough
-No water
Backfilled with drill cuttings

DEPTH (m) 0 1 2 3 4 5 6 7 8 9 10

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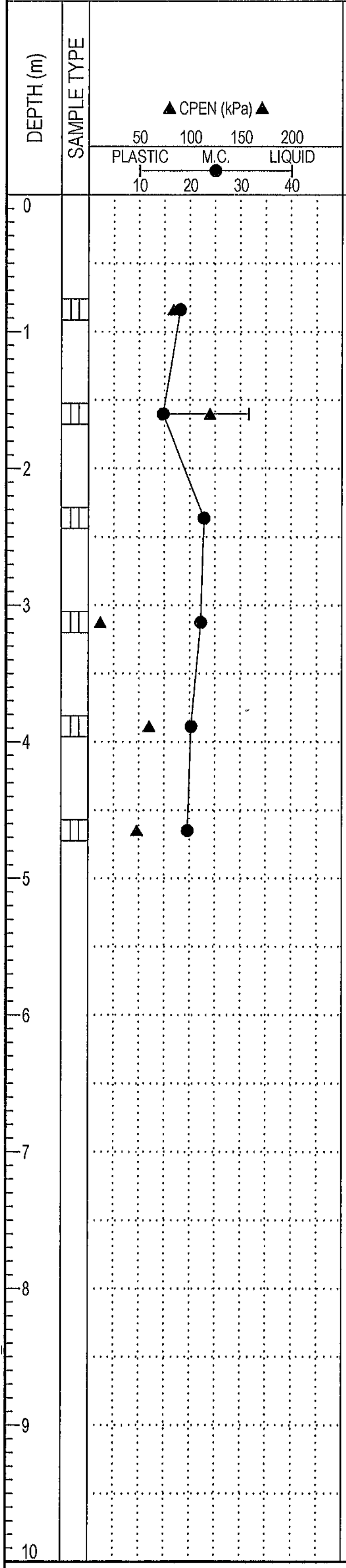
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/26/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S06**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 28, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

DEPTH (m)	USC	SOIL SYMBOL	SOIL DESCRIPTION
0			ASPHALT (200mm)
			CLAY (FILL) stiff, brown to grey, silty, trace fine sand and claystone nodules
	CI	▨	
1			
	CI	▨	-very stiff, trace oxides
2			
	SC	▩	SAND (FILL) grey, silty, fine grained
3	CI	▨	CLAY very soft to soft, grey, silty, trace oxides and claystone nodules
4	CI	▨	CLAY (TILL) stiff, brown, silty, trace fine sand, gravel, oxides, coal and claystone nodules
	CI	▨	-firm to stiff
5			
			END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings
6			
7			
8			
9			
10			

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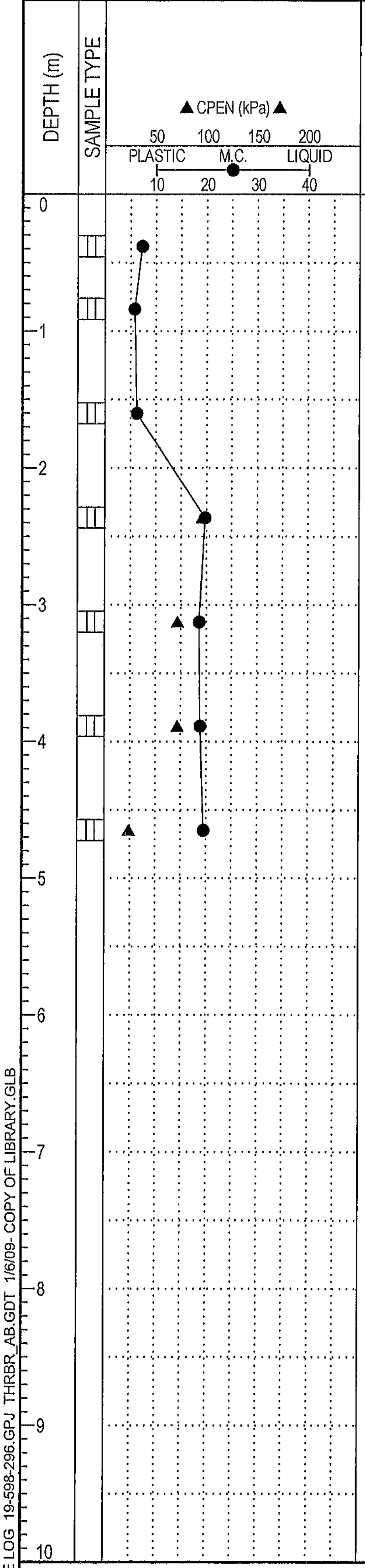
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/28/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S07**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 2, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

-Gravel = 7.4%
-Sand = 75%
-Fines = 17.6%
-Fracture = 63.5% (2 Faces)

USC	SOIL SYMBOL	SOIL DESCRIPTION
		ASPHALT (180mm)
SW-SM	▨	SAND (FILL) dark brown to black, some silt, trace gravel up to 40mm size, trace clay
SW-SM	▨	-becomes brown to dark brown, medium grained, gravel up to 25mm size
SW-SM	▨	-gravel up to 50mm size
CI	▨	CLAY (TILL) stiff to very stiff, brown, silty, some sand, trace gravel, oxides, coal, and clay shale inclusions
CI	▨	-stiff
CI	▨	
CI	▨	-firm
		END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

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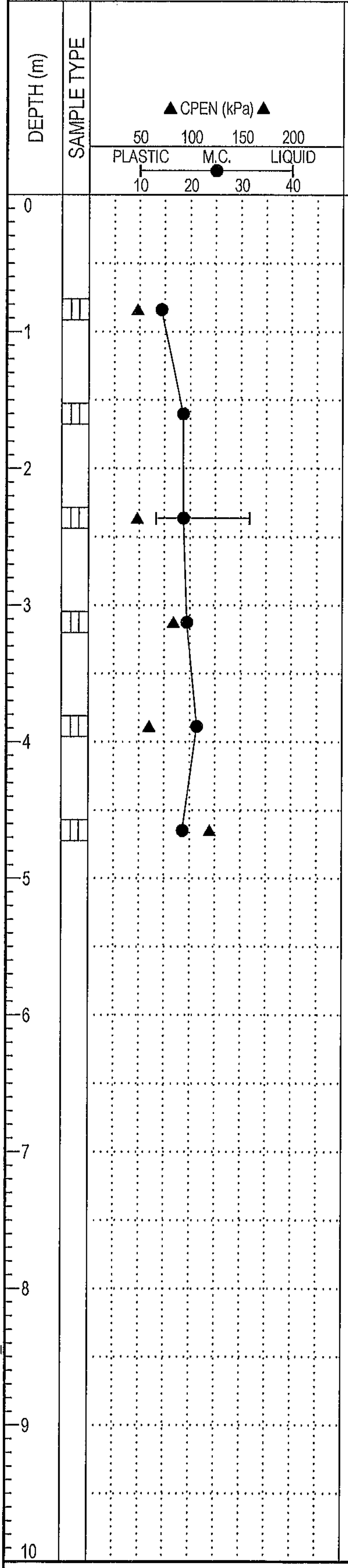
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 12/2/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S08**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 28, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



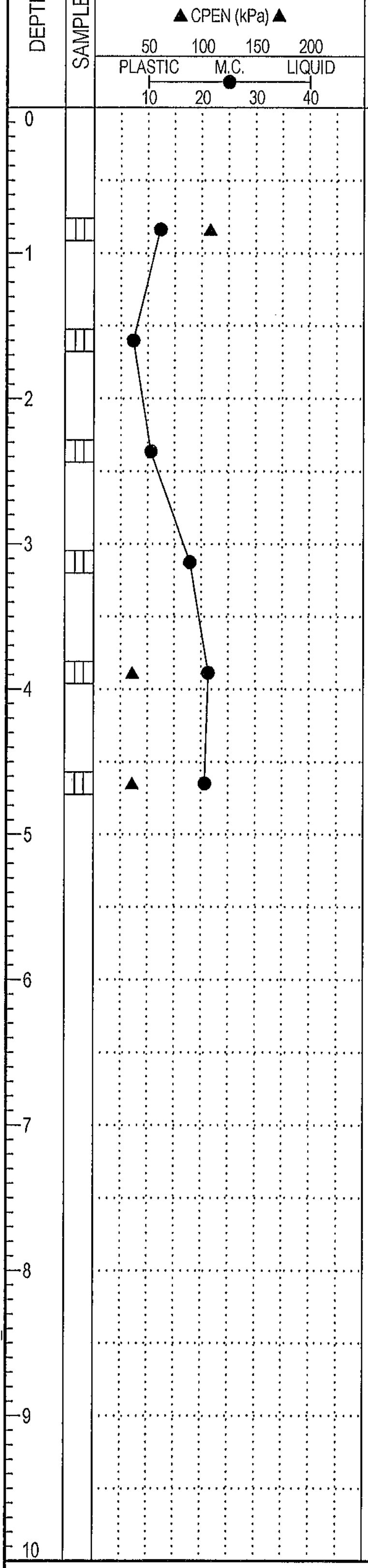
REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION
			ASPHALT (200 mm)
			SAND (FILL) brown, fine to coarse grained, silty, some gravel up to 25 mm sizes, trace clay
	CI	▨	CLAY (FILL) firm to stiff, dark brown to black, silty, some gravel trace fine sand and organics
	SM	⁙	SAND (FILL) brown, fine to medium grained, trace silt and gravel
	CI	▨	CLAY (TILL) firm, grey, silty, trace fine sand, gravel , oxides, coal, and organics
	CI	▨	-stiff
	CI	▨	
	CI	▨	-very stiff
			END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/28/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S09**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 28, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS	USC	SOIL DESCRIPTION
		ASPHALT (250 mm)
		SAND brown, fine to coarse grained, silty, some gravel up to 40 mm sizes, trace clay
	CL	CLAY (FILL) very stiff, black, silty, trace fine sand and gravel
	SW-SM	SAND (FILL) dark brown, fine to medium grained, trace gravel silt, clay and organics
-Gravel = 1.0% -Sand = 79.8% -Silt = 9.7% -Clay = 9.6%	SW-SM	-becomes brown
	SM	-some silt
	CI	CLAY (TILL) firm, brown to grey, silty, trace fine sand, gravel, oxides and coal
	CI	
		END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

BOREHOLE LOG 19-598-296.GPJ THRBR_AB.GDT 1/6/09- COPY OF LIBRARY.GLB

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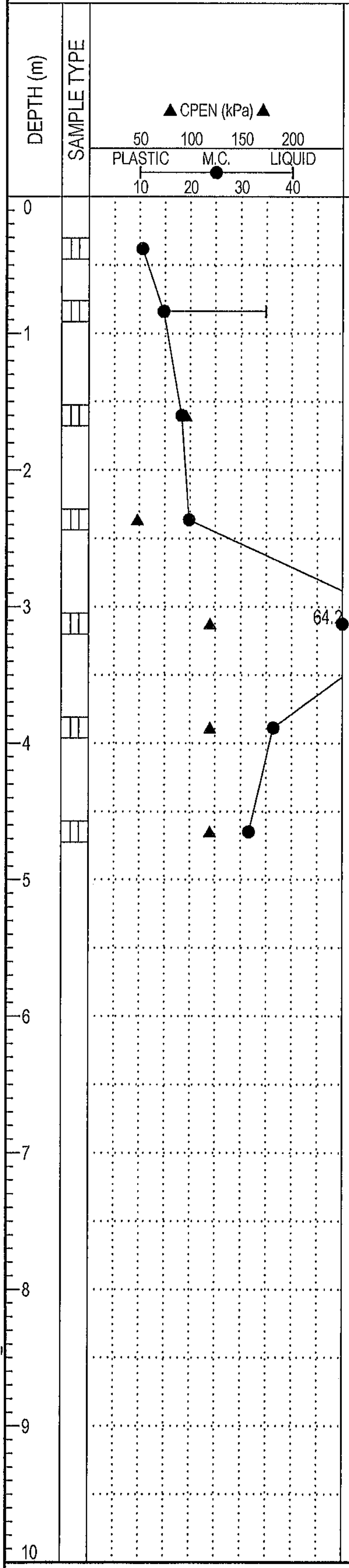
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/28/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S10**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 3, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL DESCRIPTION
	ASPHALT (115 mm)
SP	SAND (FILL) dark brown, medium grained, gravelly with gravel up to 40mm sizes, silty, trace clay
CI CI CI	CLAY (FILL) stiff, brown, silty, some sand, trace oxides, coal, and clay shale -firm
OL	ORGANIC CLAY / ORGANIC SILT very stiff, blackish brown, some sand and clay till, trace marl, shells and peat
CI CI	CLAY very stiff, brown with oxide mottling, silty, some sand lenses and oxides, trace CH pockets
	END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

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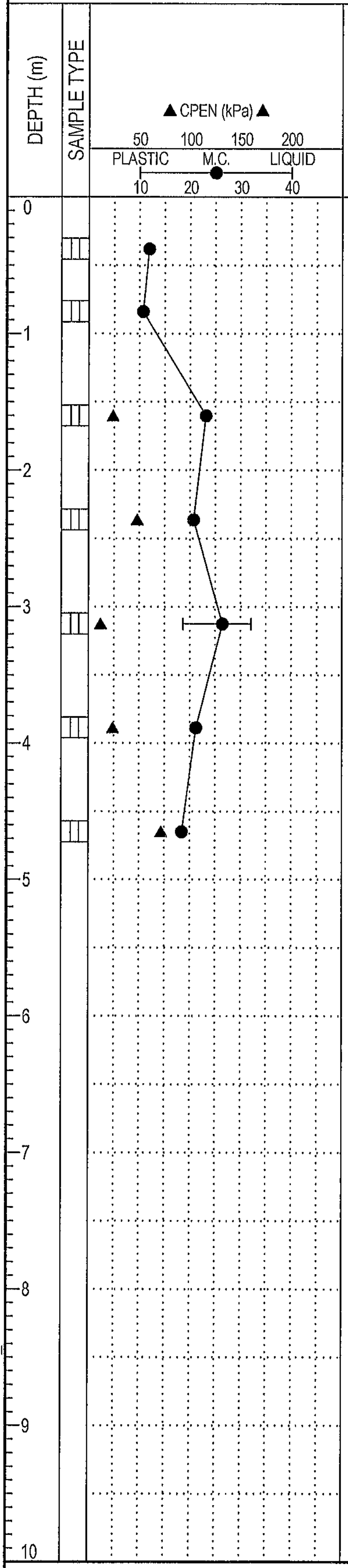
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 12/3/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S11**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 3, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION
			ASPHALT (330 mm)
	SP	⁂	SAND (FILL) dark brown to black, silty, medium grained, some gravel up to 50mm size, trace clay
	SP	⁂	
	CI	▨	CLAY (FILL) firm, brown, silty, sandy, trace oxides, coal, and clay shale inclusions
	CI	▨	-firm to stiff
			CLAY brownish grey, silty, trace oxides
	CI	▨	-soft
	CI	▨	CLAY (TILL) firm, brown to grey, silty, trace sand, gravel coal and oxides
-Seepage	CI	▨	-stiff
			END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

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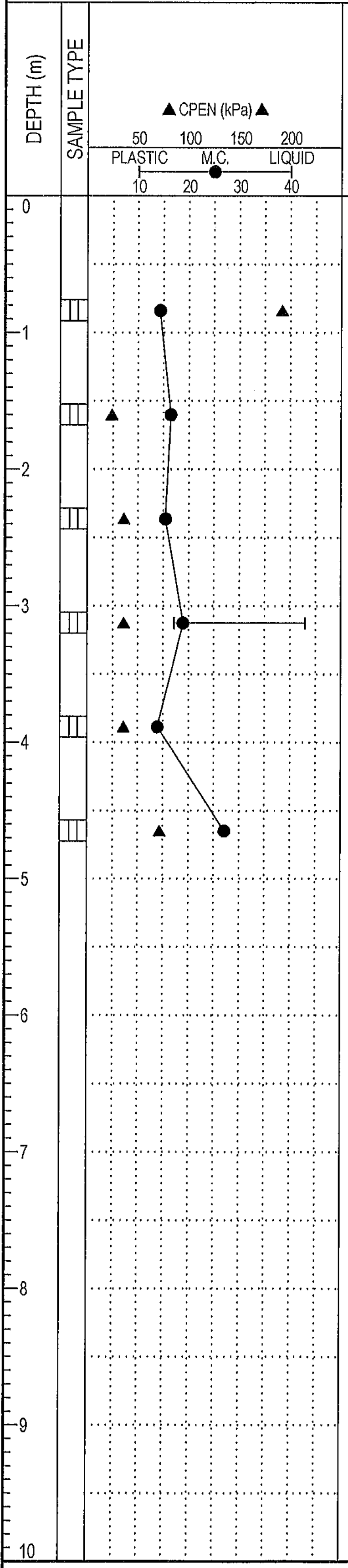
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 12/3/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S12**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 26 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
		ASPHALT (250 mm)	0
		SAND (FILL) brown, some gravel, silty, trace clay	
CI	▨	CLAY (FILL) very stiff, brown, silty, trace fine sand, oxides, and gravel	1
CI	▨	-soft to firm, dark brown	
			2
CI	▨	-firm	
CI	▨	-trace organics	3
CI	▨		4
CI-OL	▨	-stiff, grey to brown, some organics	
			5
		END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings	6
			7
			8
			9
			10

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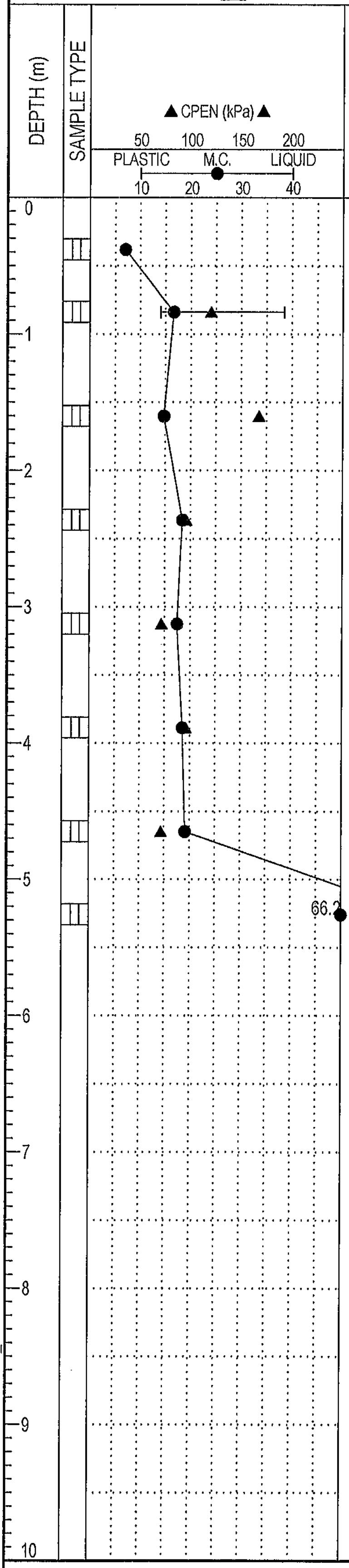
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/26/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S14**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 2, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
			ASPHALT (180 mm)	0
	SW-SM		SAND (FILL) dark brown, medium grained, some gravel up to 40mm size, some silt, trace clay	
	CI	▨	CLAY (FILL) very stiff, brown, silty, sandy, trace oxides, gravel, coal, and clay shale inclusions	1
	CI	▨		
				2
	CI	▨	-stiff to very stiff	
	CI	▨	-stiff	3
	CI	▨	-stiff to very stiff	4
	CI	▨	-stiff	
	CI-PEAT	▨	PEAT black, coarse to fine fibrous, some wood chips and gravel	5
			END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings	6
				7
				8
				9
				10

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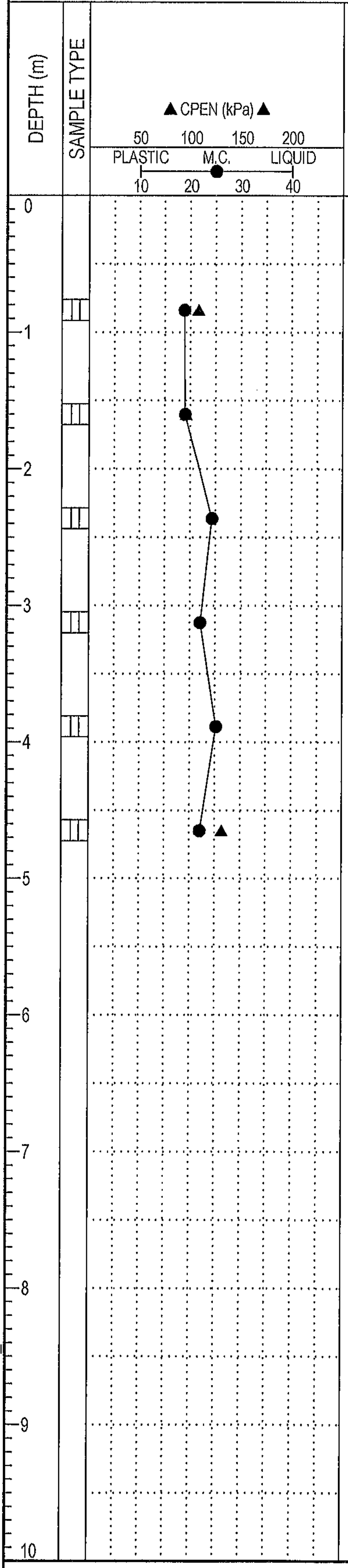
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 12/2/08
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S15**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 26, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION
			TOPSOIL ~~(450 mm)~~ black, silty, organic, trace rootlets
	CI	▨	CLAY (TILL) very stiff, brown, silty, trace fine sand, gravel, oxides and coal
	CI	▨	-stiff to very stiff
-Seepage	SW-SM	░	SAND brown, fine to medium grained, trace silt and clay
-Gravel = 0% -Sand = 82.8% -Silt = 9.8% -Clay = 7.4%	SW-SM	░	
	SM	░	-becomes grey
	CL	▨	CLAY (TILL) very stiff, grey, silt, some fine sand
			END OF TEST HOLE AT 5.3 m UPON COMPLETION: -No slough -Trace water at 5.3 m Backfilled with drill cuttings

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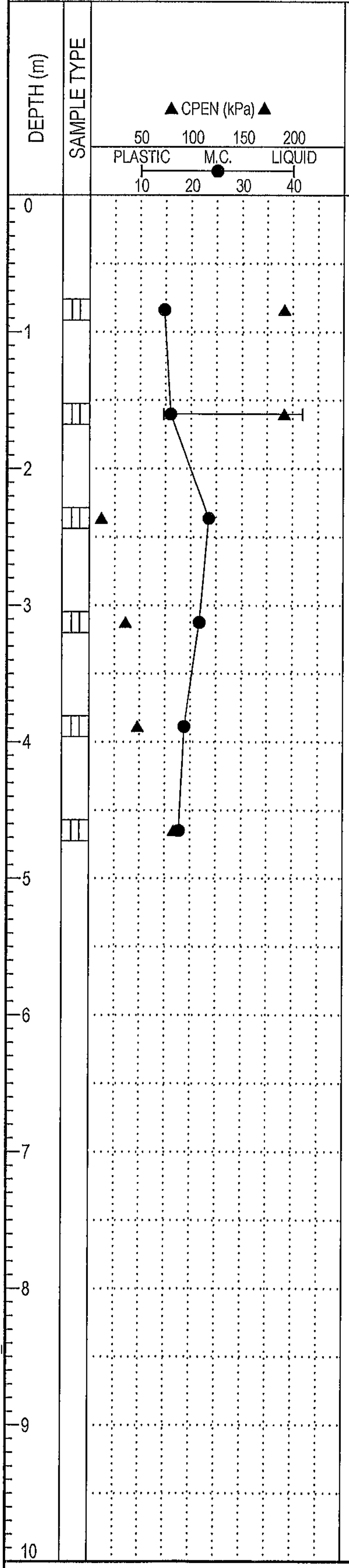
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/26/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S16**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 28, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

-trace seepage (at approx. 3.9 m)

USC: CI, CI, CI, CI, CI, CI

SOIL SYMBOL

SOIL DESCRIPTION

ASPHALT (250 mm)

SAND (FILL)
brown, fine to medium grained, silty, trace clay

CLAY (FILL)
very stiff, grey, oxide stained

CLAY (TILL)
firm, grey, silty, trace fine sand, coal, and oxides

-firm to stiff

SAND, brown, fine to medium grained

CLAY (TILL)
stiff, grey, silty, trace fine sand, coal, and gravel

END OF TEST HOLE AT 5.3 m
UPON COMPLETION:
-No slough
-Trace waterat 5.3 m
Backfilled with drill cuttings

DEPTH (m) 0 1 2 3 4 5 6 7 8 9 10

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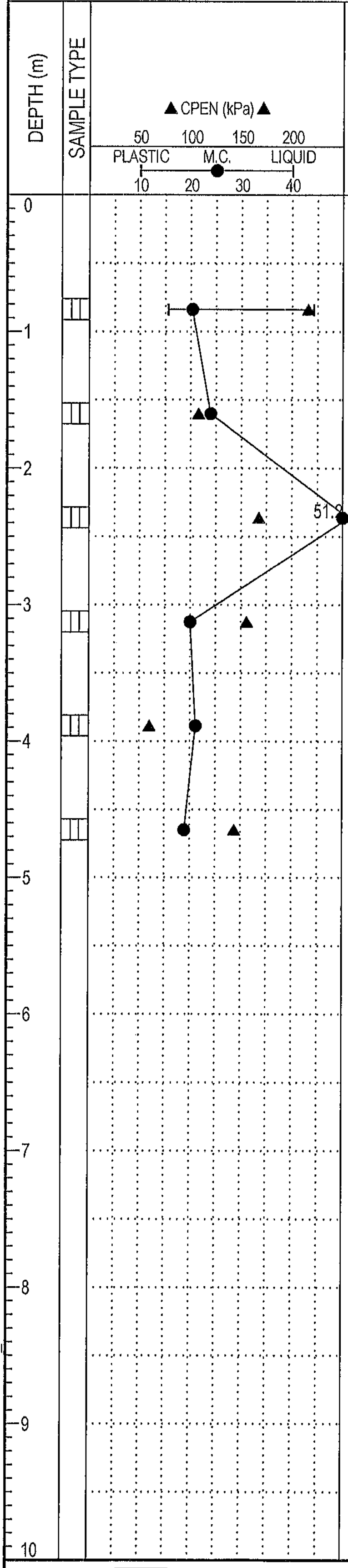
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/28/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S17**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 28, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
		TOPSOIL ~~(200 mm)~~ black, fine fibrous, some clay	0
CI	▨	CLAY (FILL) very stiff, brown, silty, trace fine sand, gravel, coal and oxides	1
CI	▨		
OL	▥	TOPSOIL ~~(450 mm)~~ very stiff, black, clayey, silty, some rootlets, trace gravel	2
CI	▨	CLAY (TILL) stiff, brown, silty, trace sand, gravel, oxides, coal and organics	3
CI	▨	-firm	4
CI	▨	-stiff	5
		END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings	6
			7
			8
			9
			10

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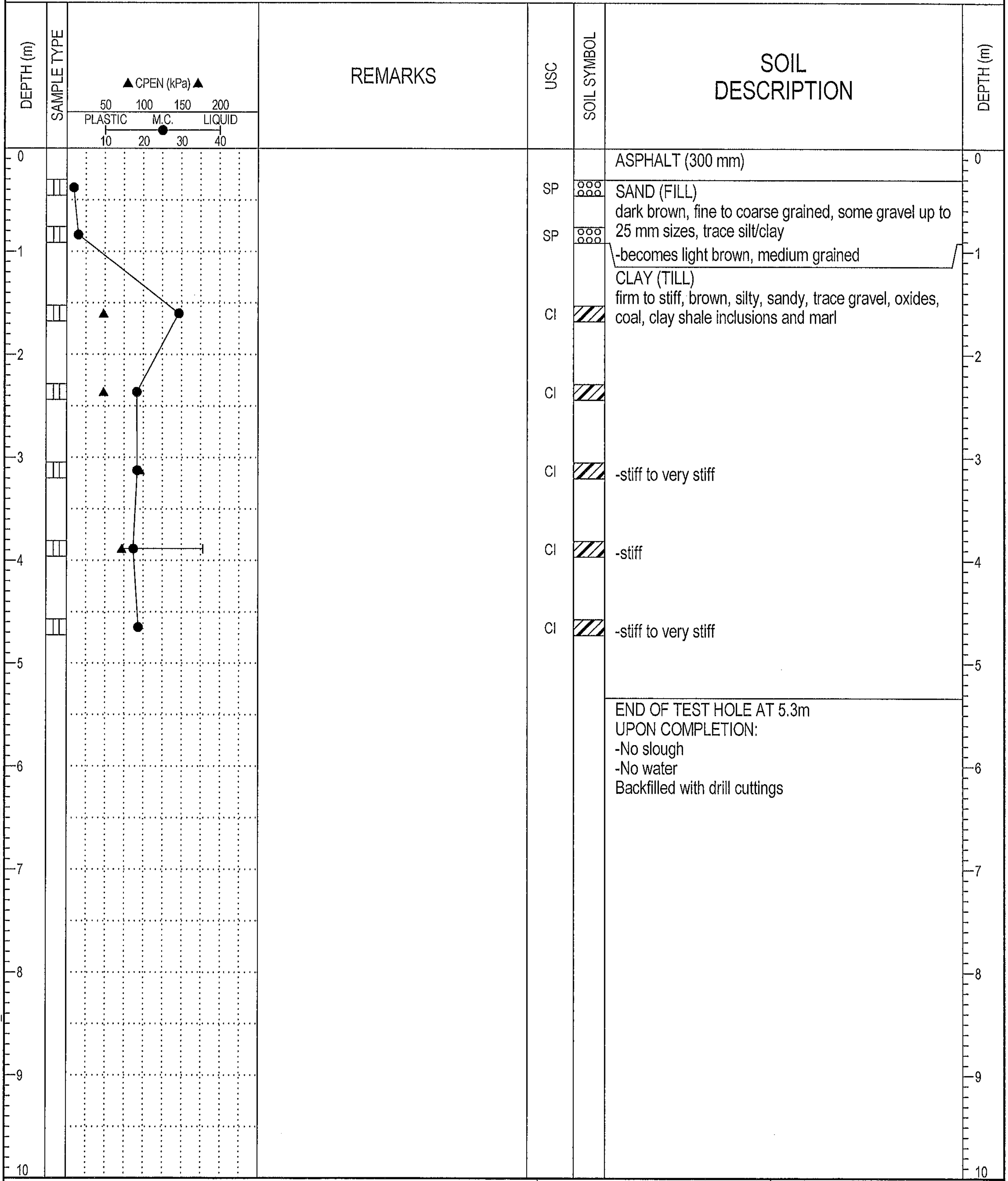
FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/28/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S18**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 2, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



SOIL DESCRIPTION

ASPHALT (300 mm)

SAND (FILL)
dark brown, fine to coarse grained, some gravel up to 25 mm sizes, trace silt/clay
-becomes light brown, medium grained

CLAY (TILL)
firm to stiff, brown, silty, sandy, trace gravel, oxides, coal, clay shale inclusions and marl

-stiff to very stiff

-stiff

-stiff to very stiff

END OF TEST HOLE AT 5.3m
UPON COMPLETION:
-No slough
-No water
Backfilled with drill cuttings

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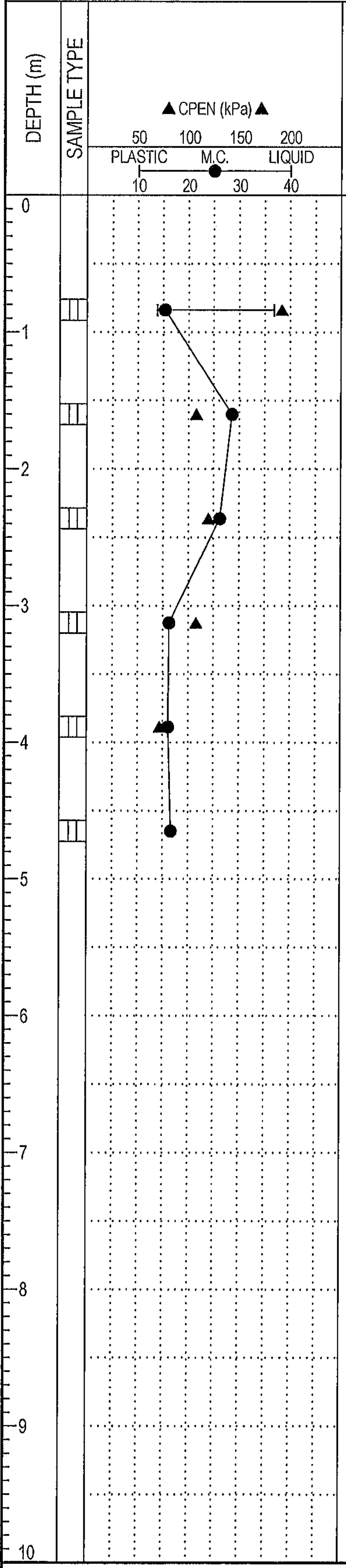
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 12/2/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - ROADWAY
BOREHOLE NO: **TH08-S19**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: November 26, 2008
PROJECT NO: 19-598-296
DRILL/METHOD: M5 Track / Solid Stem Augers
LOCATION: See Drawing #19-598-296-1
ELEVATION:
SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)
		TOPSOIL ~~(300 mm)~~ brown - black, silty, organic, trace rootlets	0
CI	▨	CLAY (FILL) very stiff, brown, silty, trace fine sand, gravel, oxides, and coal	1
CI	▨	-becomes grey - black, trace organics	
CH	▨	CLAY very stiff, brown, silty, trace sand and calcareous deposits	2
CI	▨	CLAY (TILL) very stiff, grey, silty, trace fine sand, gravel, oxides, and coal	3
CI	▨	-stiff	4
CI	▨		5
		END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings	6

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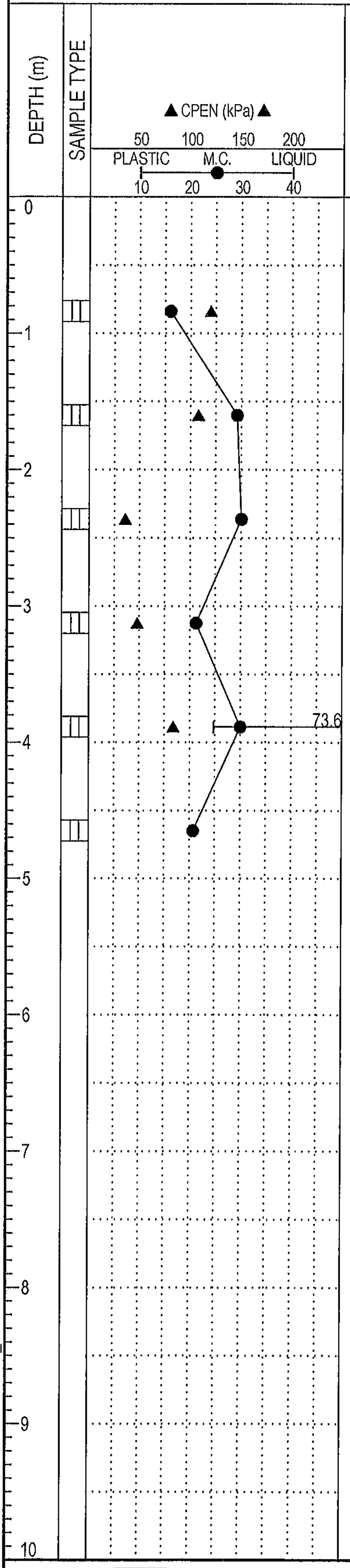
FIELD LOGGED BY: GA
PREPARED BY: SGR
REVIEWED BY: RWT
COMPLETION DEPTH: 5.3 m
COMPLETION DATE: 11/26/08

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S20**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: November 28, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL SYMBOL	SOIL DESCRIPTION
		ASPHALT (120 mm)
		SAND (FILL) brown, fine to medium grained, silty, some gravel, trace clay
CI	▨	CLAY (FILL) very stiff, grey, silty, trace fine sand and gravel
CH	▨	CLAY very stiff, grey, silty
CI	▨	-firm, trace gypsum
CI	▨	CLAY (TILL) firm to stiff, grey, silty, trace fine sand, oxides, coal, and gravel
CH	▨	CLAY SHALE stiff, grey, completely weathered, trace oxides
SS	░	SANDSTONE green - grey, fine grained, completely weathered, trace gravel and oxides
		END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

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FIELD LOGGED BY: GA	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 11/28/08
REVIEWED BY: RWT	Page 1 of 1

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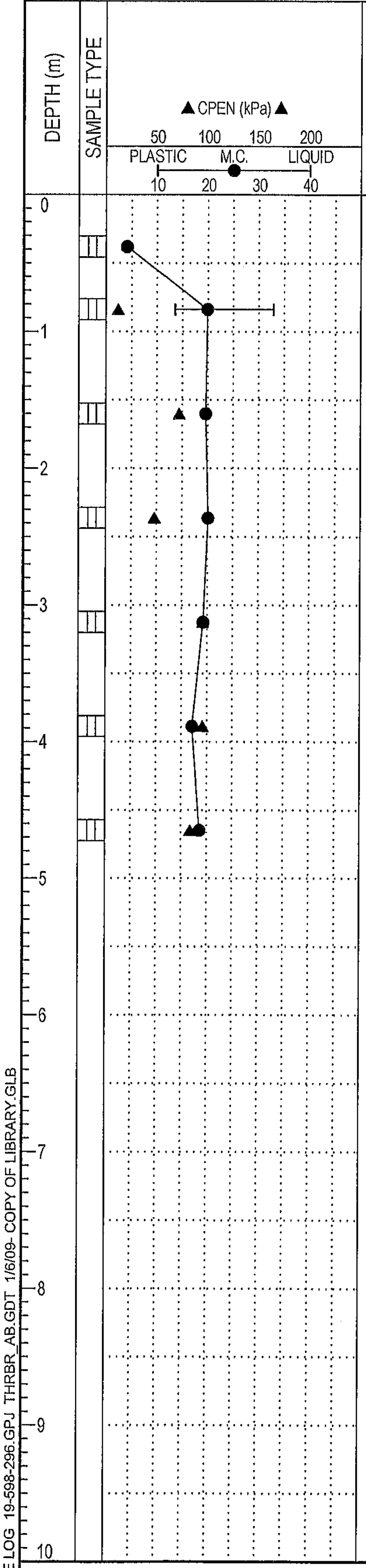
CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S21**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 2, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL SYMBOL	SOIL DESCRIPTION
		ASPHALT (140 mm)
SP	▨	SAND (FILL) light brown, well graded, silty, some gravel up to 25mm size, trace clay
CI	▨	CLAY (FILL) firm to stiff, brown, very silty, sandy, trace gravel and coal
CI	▨	-stiff, light brown, silty, some sand, trace oxides, marl, and clay shale inclusions
CI	▨	
		CLAY (TILL) stiff to very stiff, brown, silty, some sand, trace oxides, coal, and sand pockets
CI	▨	
CI	▨	-whitish brown mottling, silty, some weathered sandstone
CI	▨	-stiff

END OF TEST HOLE AT 5.3m
UPON COMPLETION:
-No slough
-No water
Backfilled with drill cuttings

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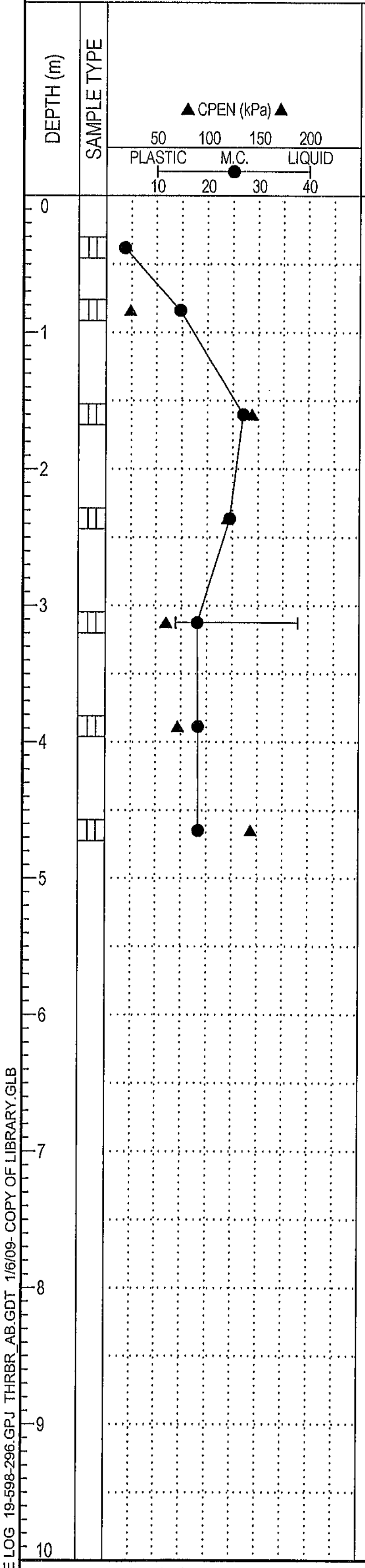
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 12/2/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - ROADWAY	BOREHOLE NO: **TH08-S22**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: December 2, 2008	PROJECT NO: 19-598-296
DRILL/METHOD: M4.5 / Solid Stem Augers	LOCATION: See Drawing #19-598-296-1	ELEVATION:

SAMPLE TYPE ▥ GRAB SAMPLE



REMARKS

USC	SOIL SYMBOL	SOIL DESCRIPTION
		ASPHALT (200 mm)
SP	⚬	SAND (FILL) light brown, medium grained, silty, some gravel up to 25mm size, trace clay
CI	▨	CLAY (FILL) firm, dark brown, some sand and gravel, trace oxides and coal
CI	▨	-very stiff, brown, silty, trace gravel and pebbles
CI	▨	
		CLAY (TILL) stiff, brown, silty, sandy, trace oxides, gravel, coal, and clay shale inclusions
CI	▨	
CI	▨	-some rafted coal
CI	▨	-very stiff
		END OF TEST HOLE AT 5.3m UPON COMPLETION: -No slough -No water Backfilled with drill cuttings

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

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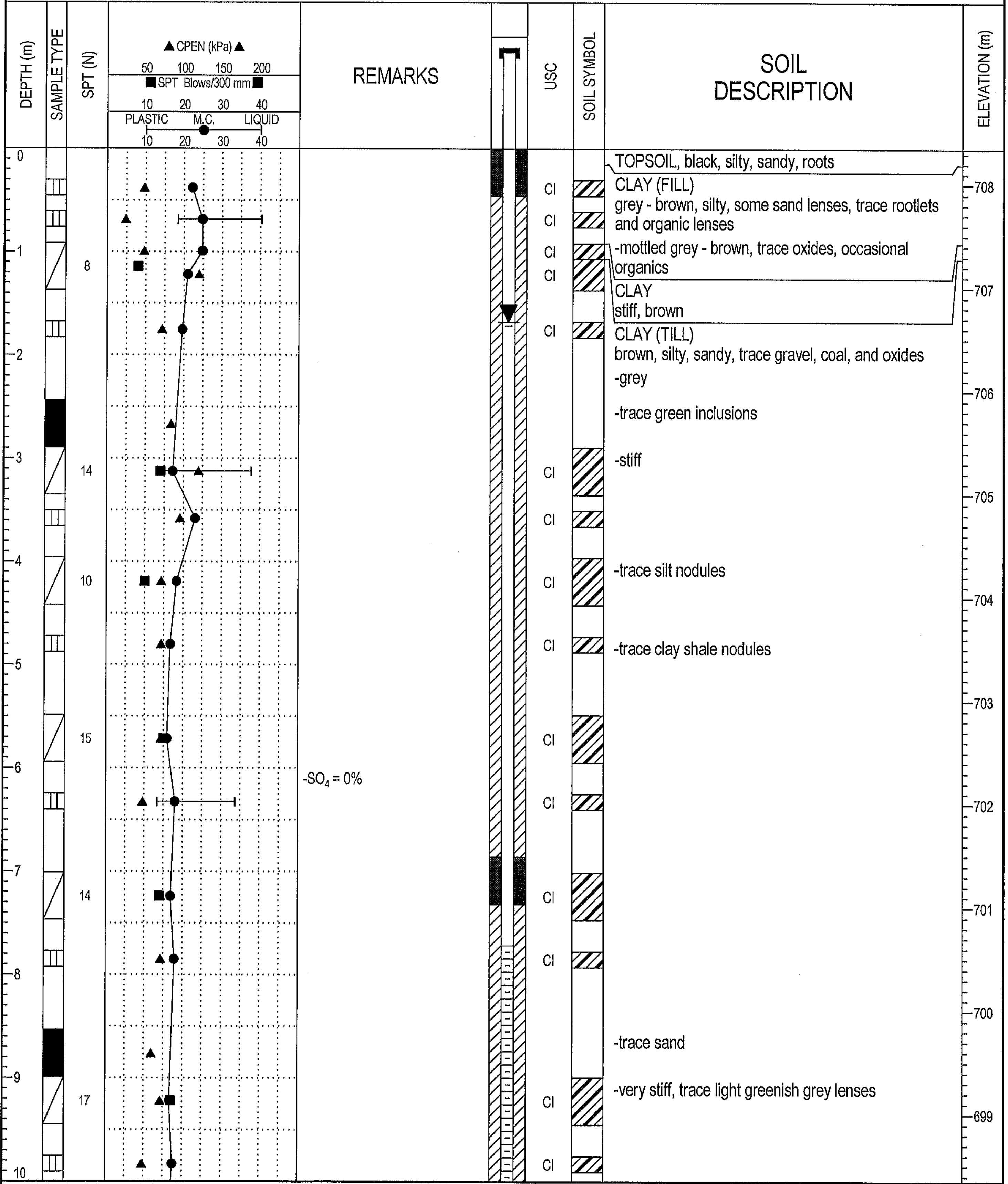
FIELD LOGGED BY: EMS	COMPLETION DEPTH: 5.3 m
PREPARED BY: SGR	COMPLETION DATE: 12/2/08
REVIEWED BY: RWT	Page 1 of 1

CLIENT: ISL ENGINEERING & LAND SERVICES LTD
PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO
BOREHOLE NO: **TH09-05-1A**
DRILLING COMPANY: Mobile Augers & Research Ltd.
DATE DRILLED: August 11, 2009
PROJECT NO: 19-598-298
DRILL/METHOD: M5 Track / Solid Stem Augers
LOCATION: See Drawing #19-598-298-1
ELEVATION: 708.35 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE
BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



TOPSOIL, black, silty, sandy, roots

CLAY (FILL)
grey - brown, silty, some sand lenses, trace rootlets and organic lenses
-mottled grey - brown, trace oxides, occasional organics

CLAY
stiff, brown

CLAY (TILL)
brown, silty, sandy, trace gravel, coal, and oxides
-grey
-trace green inclusions
-stiff
-trace silt nodules
-trace clay shale nodules
-trace sand
-very stiff, trace light greenish grey lenses

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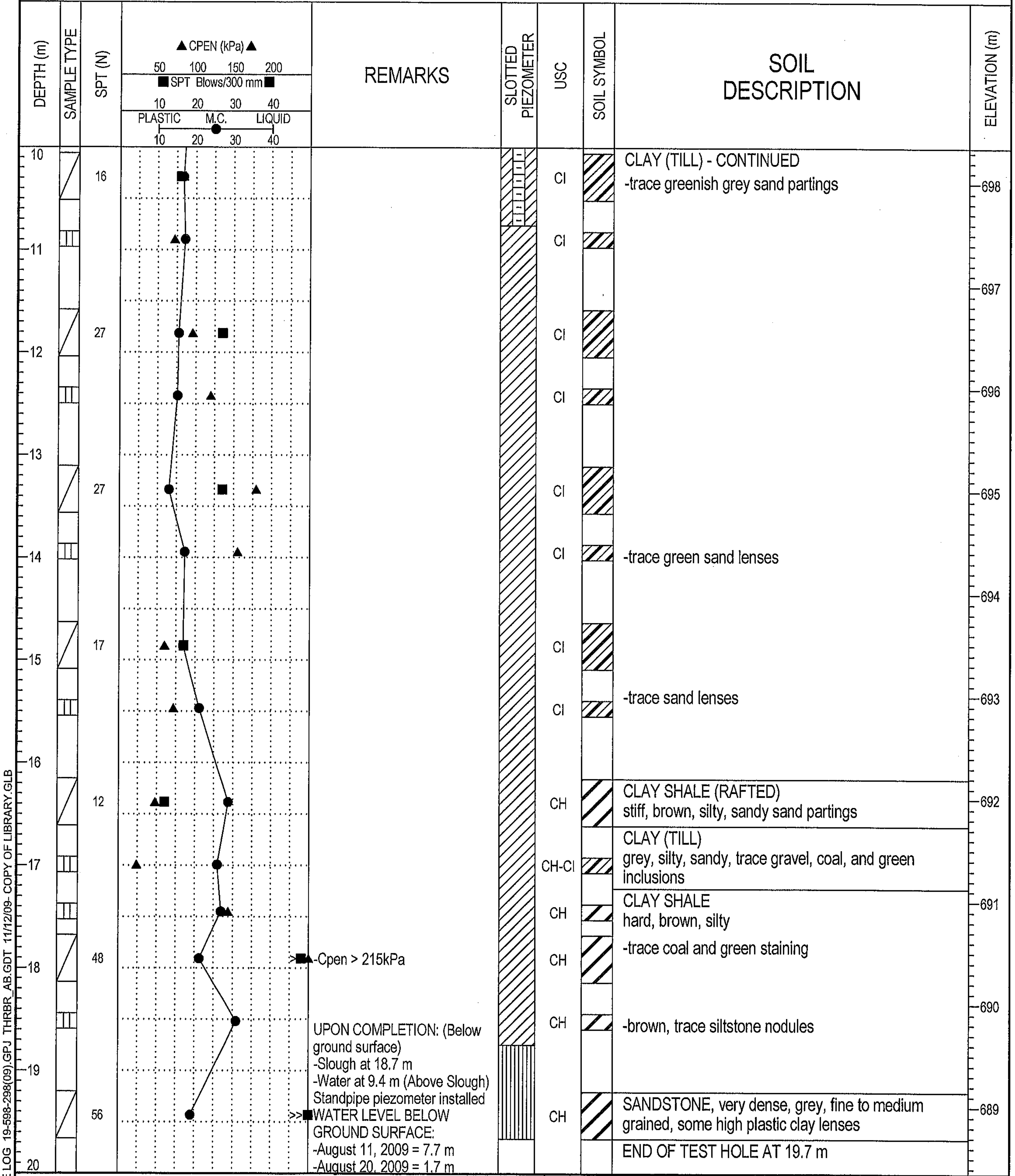
FIELD LOGGED BY: NR
COMPLETION DEPTH: 19.7 m
PREPARED BY: SGR
COMPLETION DATE: 8/11/09
REVIEWED BY: RWT

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-05-1A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 11, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 708.35 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



-Cpen > 215kPa

UPON COMPLETION: (Below ground surface)
-Slough at 18.7 m
-Water at 9.4 m (Above Slough)
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-August 11, 2009 = 7.7 m
-August 20, 2009 = 1.7 m

CLAY (TILL) - CONTINUED
-trace greenish grey sand partings

-trace green sand lenses

-trace sand lenses

CLAY SHALE (RAFTED)
stiff, brown, silty, sandy sand partings

CLAY (TILL)
grey, silty, sandy, trace gravel, coal, and green inclusions

CLAY SHALE
hard, brown, silty
-trace coal and green staining

-brown, trace siltstone nodules

SANDSTONE, very dense, grey, fine to medium grained, some high plastic clay lenses

END OF TEST HOLE AT 19.7 m

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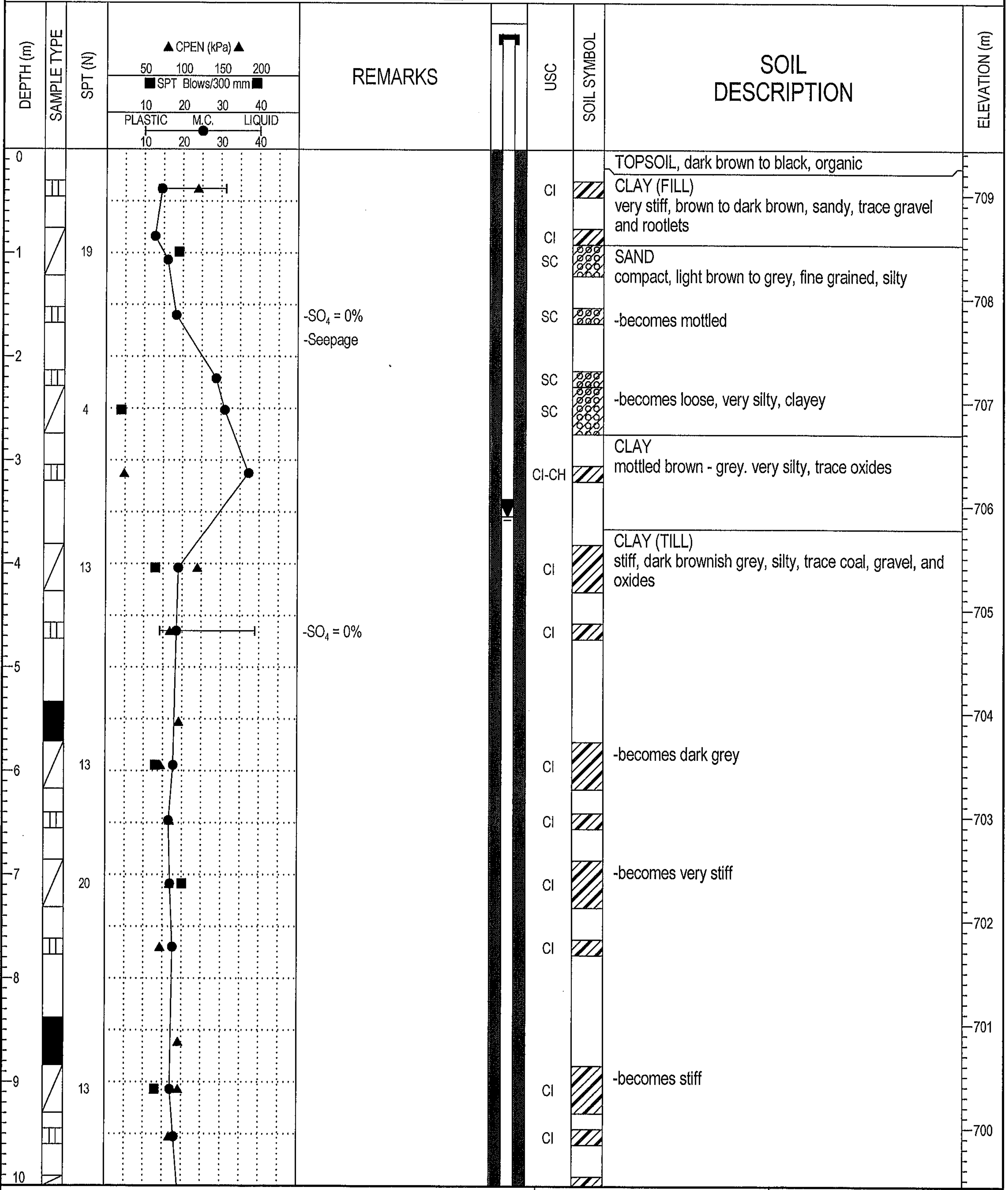
FIELD LOGGED BY: NR	COMPLETION DEPTH: 19.7 m
PREPARED BY: SGR	COMPLETION DATE: 8/11/09
REVIEWED BY: RWT	Page 2 of 2

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-05-2A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 6, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Unimog M5 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 709.44 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE

BACKFILL TYPE: ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



REMARKS:

-SO_4 = 0%
-Seepage

-SO_4 = 0%

SOIL DESCRIPTION:

TOPSOIL, dark brown to black, organic

CLAY (FILL)
very stiff, brown to dark brown, sandy, trace gravel and rootlets

SAND
compact, light brown to grey, fine grained, silty

-becomes mottled

-becomes loose, very silty, clayey

CLAY
mottled brown - grey. very silty, trace oxides

CLAY (TILL)
stiff, dark brownish grey, silty, trace coal, gravel, and oxides

-becomes dark grey

-becomes very stiff

-becomes stiff

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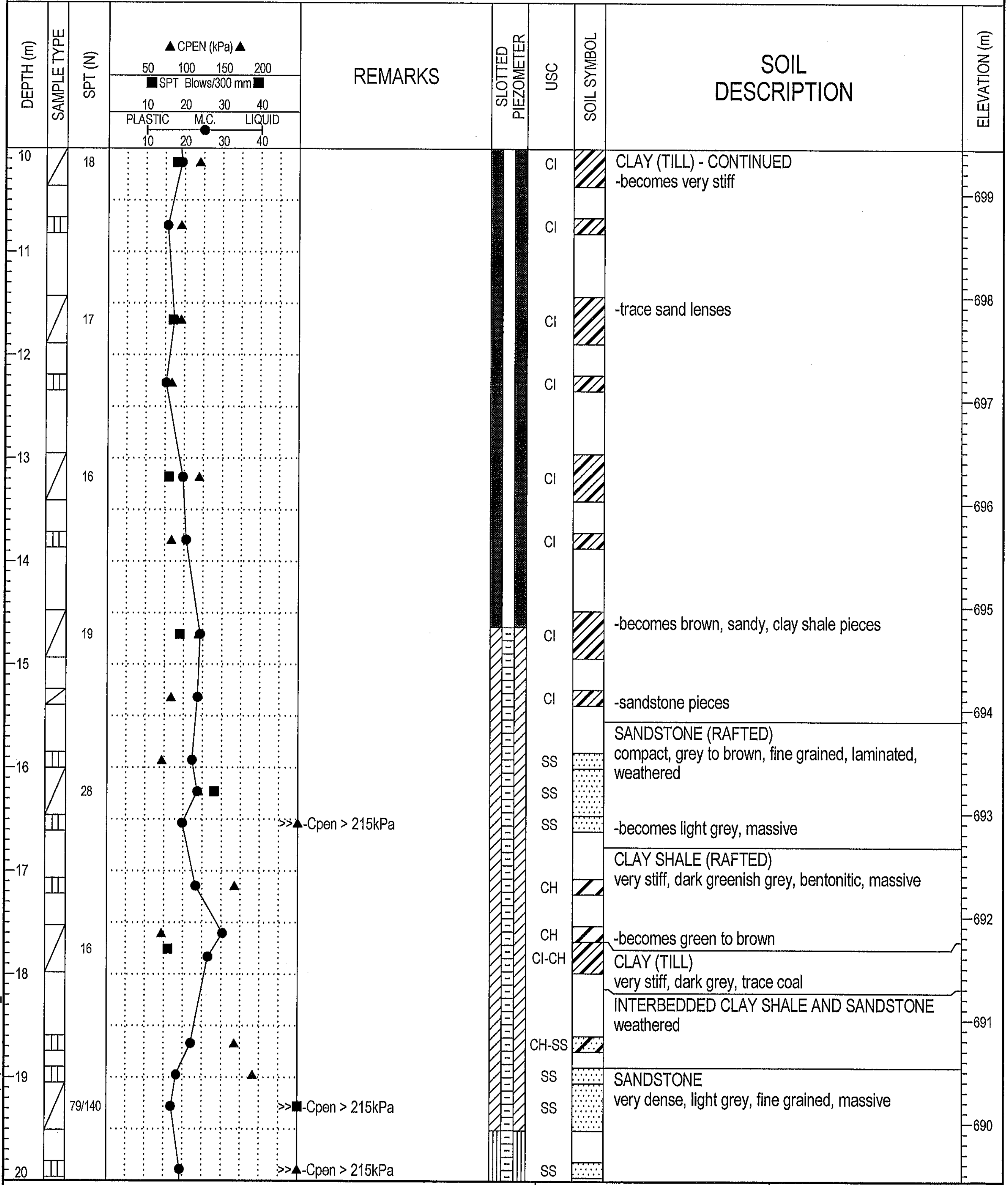
FIELD LOGGED BY: NR	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 8/6/09
REVIEWED BY: RWT	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-05-2A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 6, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Unimog M5 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 709.44 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



CLAY (TILL) - CONTINUED
-becomes very stiff

-trace sand lenses

-becomes brown, sandy, clay shale pieces

-sandstone pieces

SANDSTONE (RAFTED)
compact, grey to brown, fine grained, laminated, weathered

-becomes light grey, massive

CLAY SHALE (RAFTED)
very stiff, dark greenish grey, bentonitic, massive

-becomes green to brown

CLAY (TILL)
very stiff, dark grey, trace coal

INTERBEDDED CLAY SHALE AND SANDSTONE
weathered

SANDSTONE
very dense, light grey, fine grained, massive

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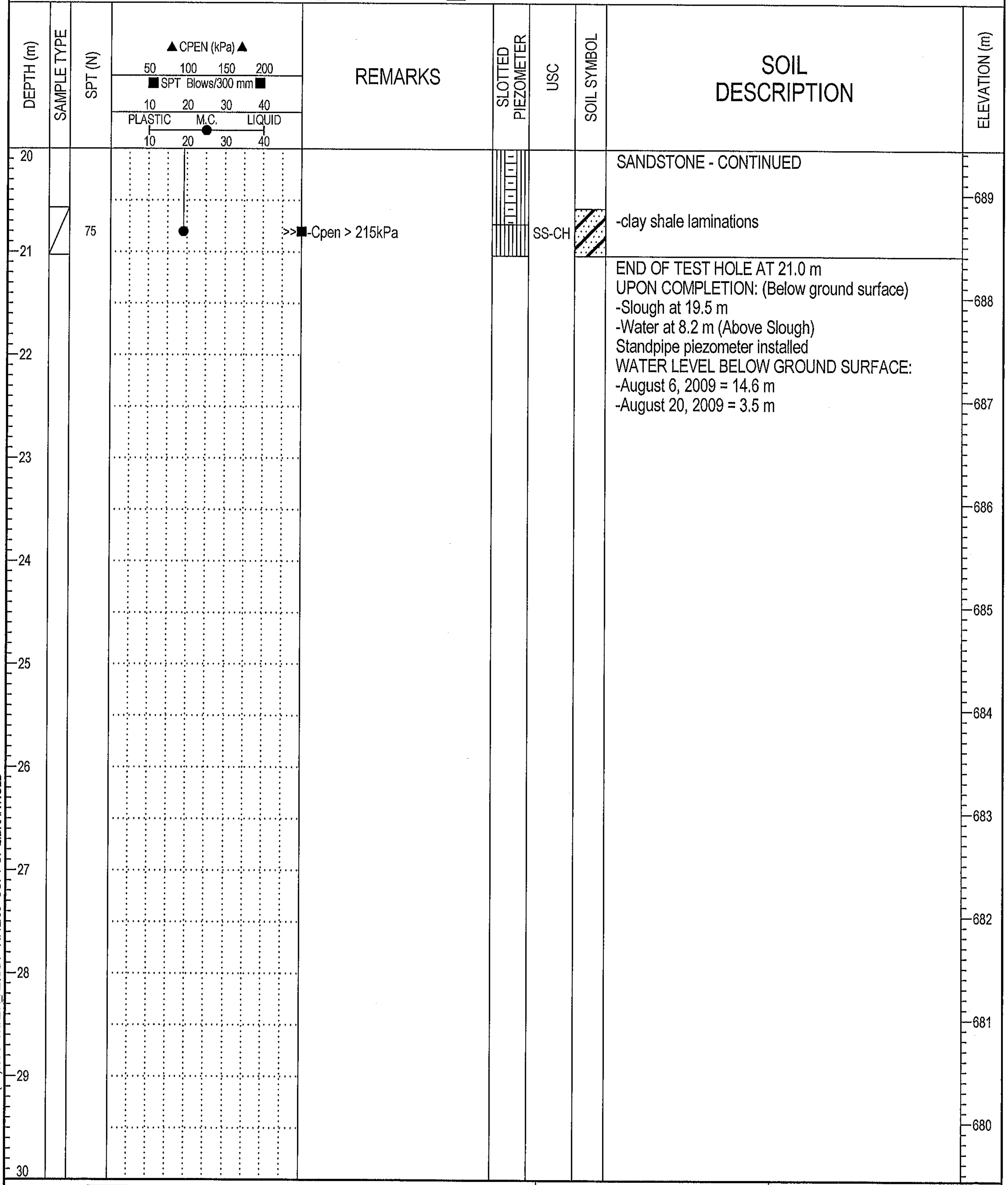
FIELD LOGGED BY: NR	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 8/6/09
REVIEWED BY: RWT	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-05-2A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 6, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Unimog M5 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 709.44 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ◪ DRILL CUTTINGS ▥ SLOUGH



SANDSTONE - CONTINUED

-clay shale laminations

END OF TEST HOLE AT 21.0 m
UPON COMPLETION: (Below ground surface)
-Slough at 19.5 m
-Water at 8.2 m (Above Slough)
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-August 6, 2009 = 14.6 m
-August 20, 2009 = 3.5 m

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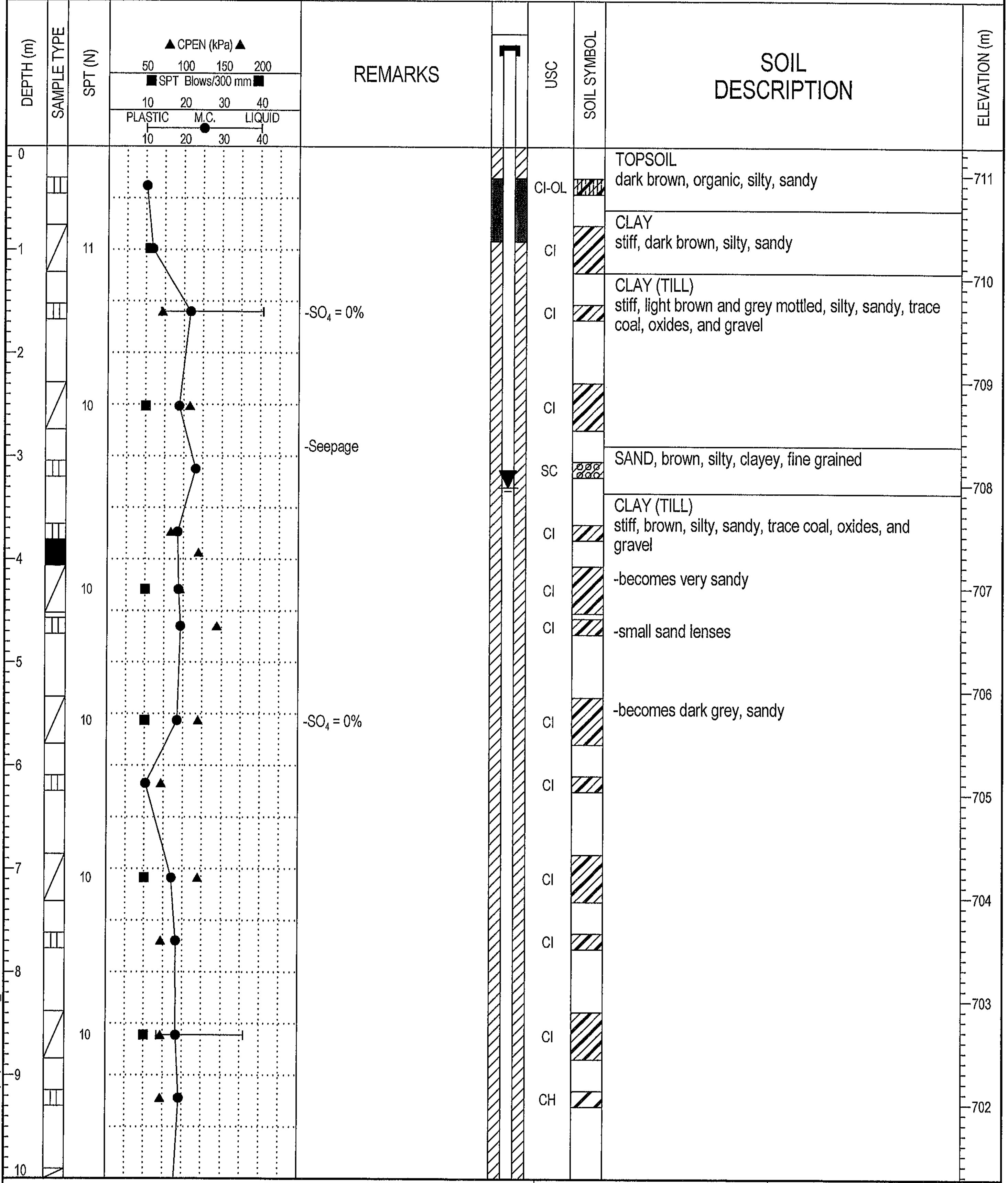
FIELD LOGGED BY: NR	COMPLETION DEPTH: 21.0 m
PREPARED BY: SGR	COMPLETION DATE: 8/6/09
REVIEWED BY: RWT	

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-06-1A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 5, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Unimog M5 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 711.27 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



-SO$_4$ = 0%

-Seepage

-SO$_4$ = 0%

TOPSOIL
dark brown, organic, silty, sandy

CLAY
stiff, dark brown, silty, sandy

CLAY (TILL)
stiff, light brown and grey mottled, silty, sandy, trace coal, oxides, and gravel

SAND, brown, silty, clayey, fine grained

CLAY (TILL)
stiff, brown, silty, sandy, trace coal, oxides, and gravel

-becomes very sandy

-small sand lenses

-becomes dark grey, sandy

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

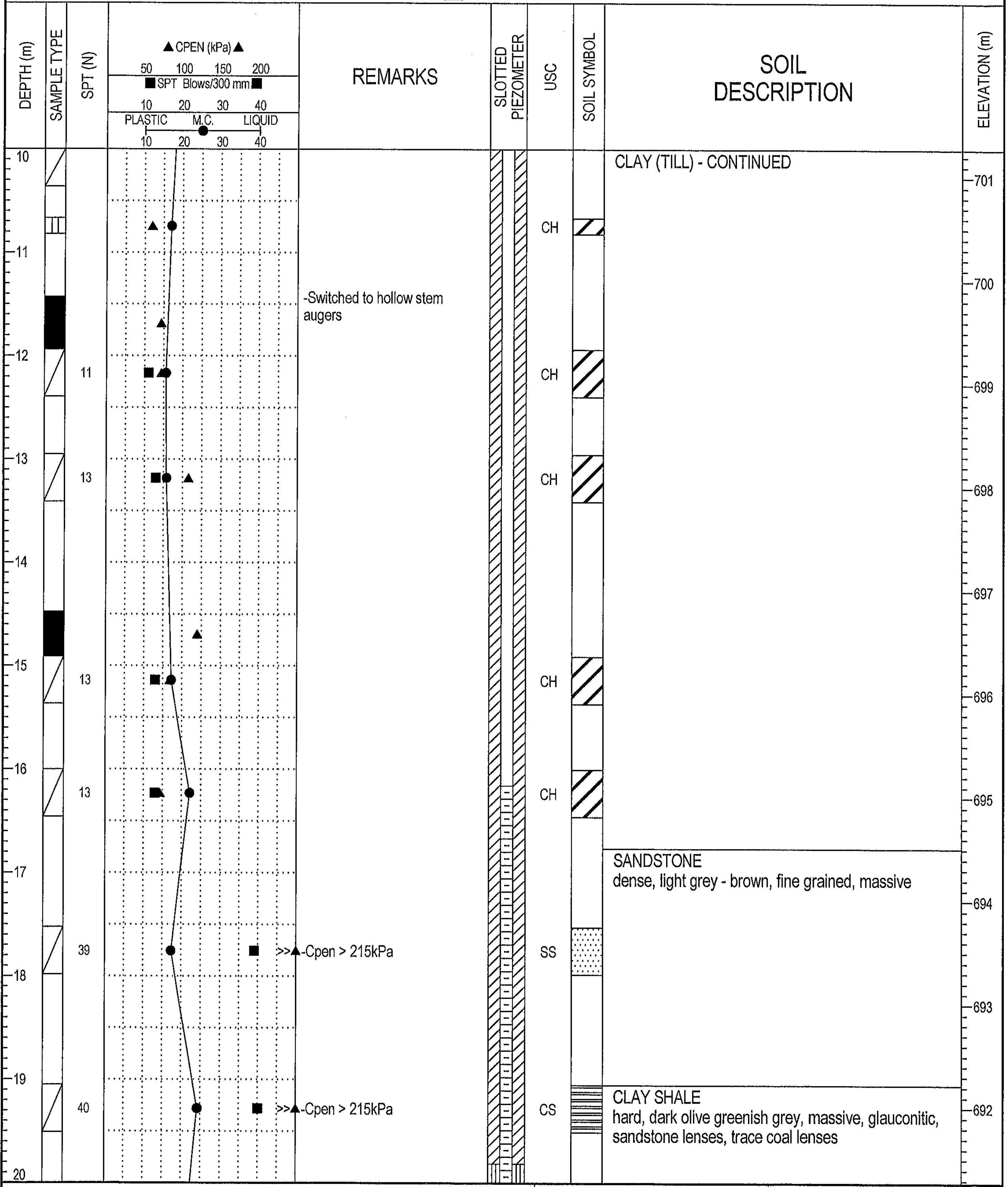
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/5/09
REVIEWED BY:	Page 1 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-06-1A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 5, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Unimog M5 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 711.27 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



-Switched to hollow stem augers

-Cpen > 215kPa

-Cpen > 215kPa

CLAY (TILL) - CONTINUED

SANDSTONE
dense, light grey - brown, fine grained, massive

CLAY SHALE
hard, dark olive greenish grey, massive, glauconitic, sandstone lenses, trace coal lenses

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

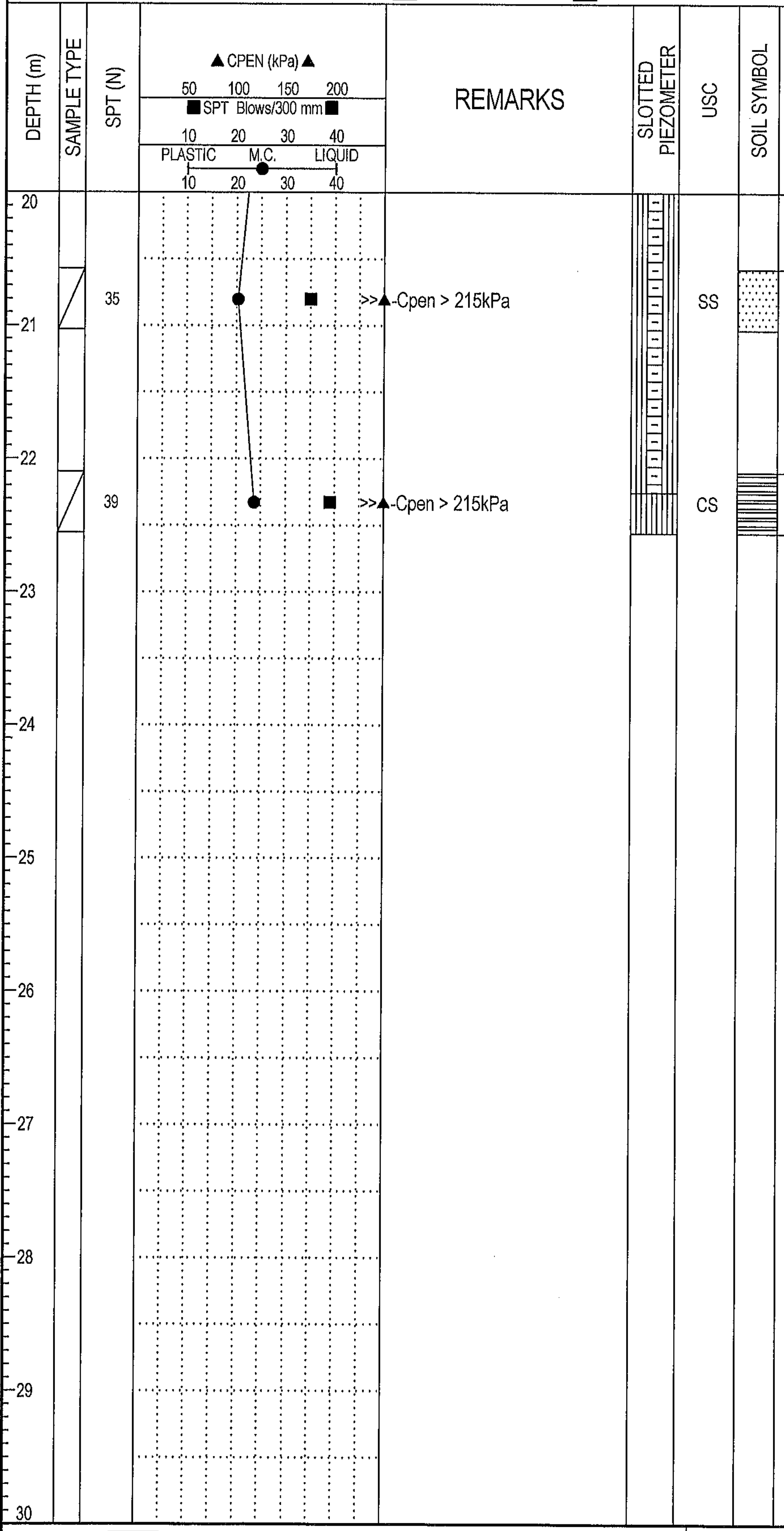
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/5/09
REVIEWED BY:	Page 2 of 3

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-06-1A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 5, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Unimog M5 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 711.27 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE

BACKFILL TYPE ◪ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



SOIL DESCRIPTION

CLAY SHALE - CONTINUED

SANDSTONE
dense, dark grey, fine grained, massive

CLAY SHALE, hard, dark brown, carbonaceous, missive, trace coal specs

END OF TEST HOLE AT 22.6 m
UPON COMPLETION: (Below ground surface)
-Slough at 19.8 m
-Water at 17.7 m (Above Slough)
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-August 5, 2009 = 10.5 m
-August 20, 2009 = 3.3 m

ELEVATION (m): 691, 690, 689, 688, 687, 686, 685, 684, 683, 682

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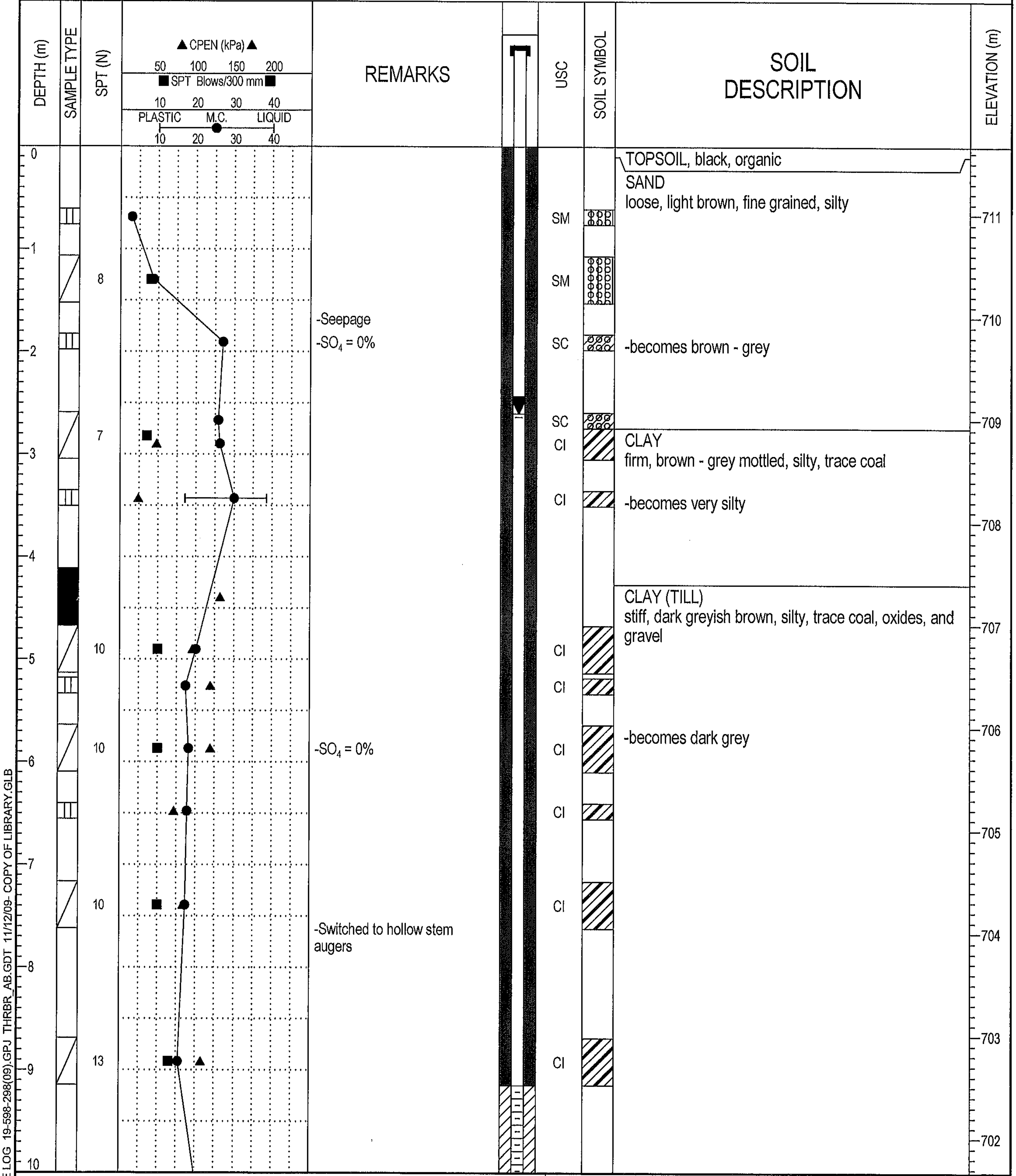
FIELD LOGGED BY: NR	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 8/5/09
REVIEWED BY:	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-06-2A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 7, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Unimog M5 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 711.66 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



REMARKS

-Seepage

-SO_4 = 0%

-SO_4 = 0%

-Switched to hollow stem augers

SOIL DESCRIPTION

TOPSOIL, black, organic

SAND
loose, light brown, fine grained, silty

-becomes brown - grey

CLAY
firm, brown - grey mottled, silty, trace coal

-becomes very silty

CLAY (TILL)
stiff, dark greyish brown, silty, trace coal, oxides, and gravel

-becomes dark grey

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

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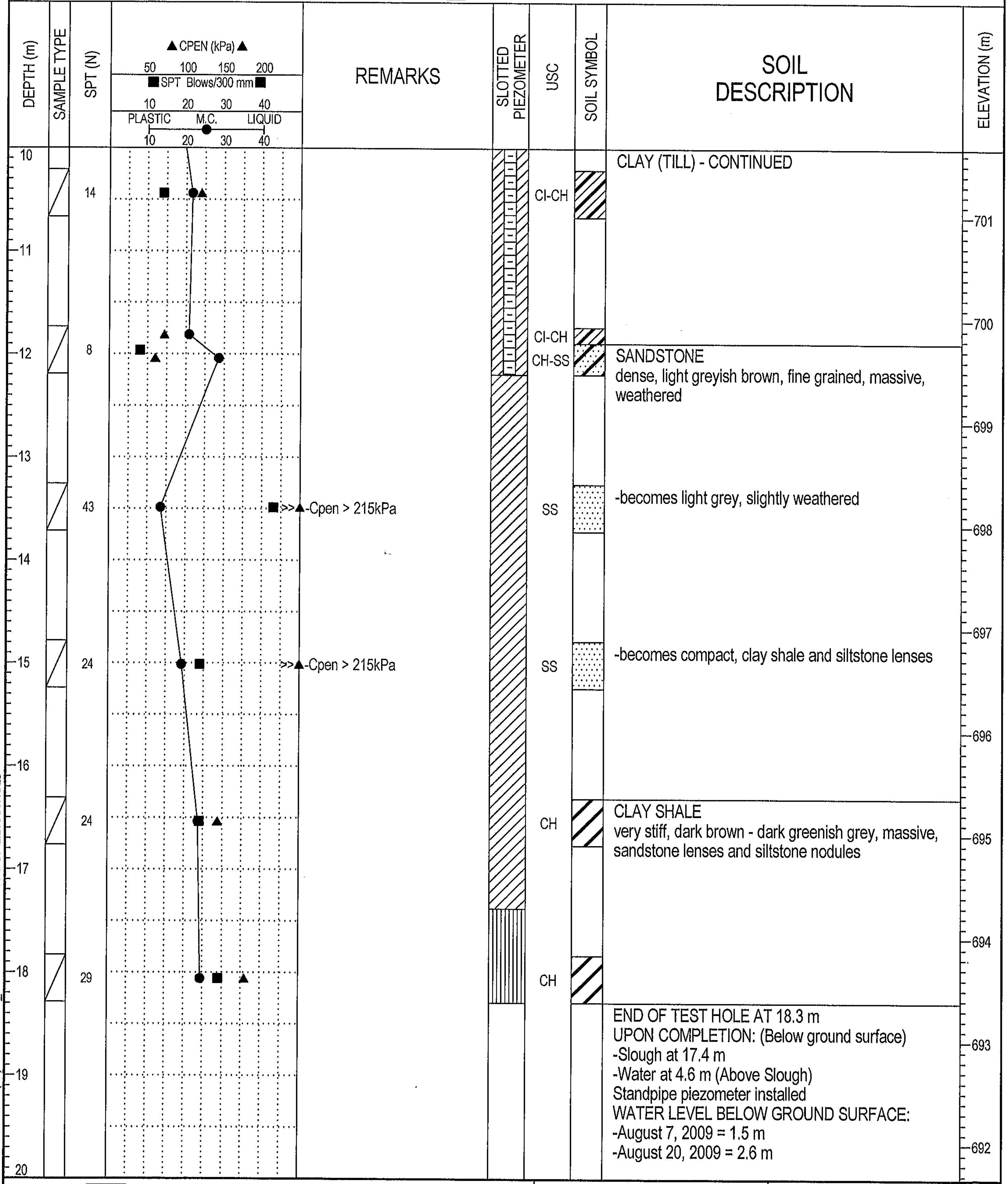
FIELD LOGGED BY: NR	COMPLETION DEPTH: 18.3 m
PREPARED BY: SGR	COMPLETION DATE: 8/7/09
REVIEWED BY:	

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-06-2A**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: August 7, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Unimog M5 / Solid & Hollow Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 711.66 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ■ SHELBY TUBE

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



CLAY (TILL) - CONTINUED

SANDSTONE
dense, light greyish brown, fine grained, massive, weathered

-becomes light grey, slightly weathered

-becomes compact, clay shale and siltstone lenses

CLAY SHALE
very stiff, dark brown - dark greenish grey, massive, sandstone lenses and siltstone nodules

END OF TEST HOLE AT 18.3 m
UPON COMPLETION: (Below ground surface)
-Slough at 17.4 m
-Water at 4.6 m (Above Slough)
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-August 7, 2009 = 1.5 m
-August 20, 2009 = 2.6 m

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

THURBER ENGINEERING LTD.
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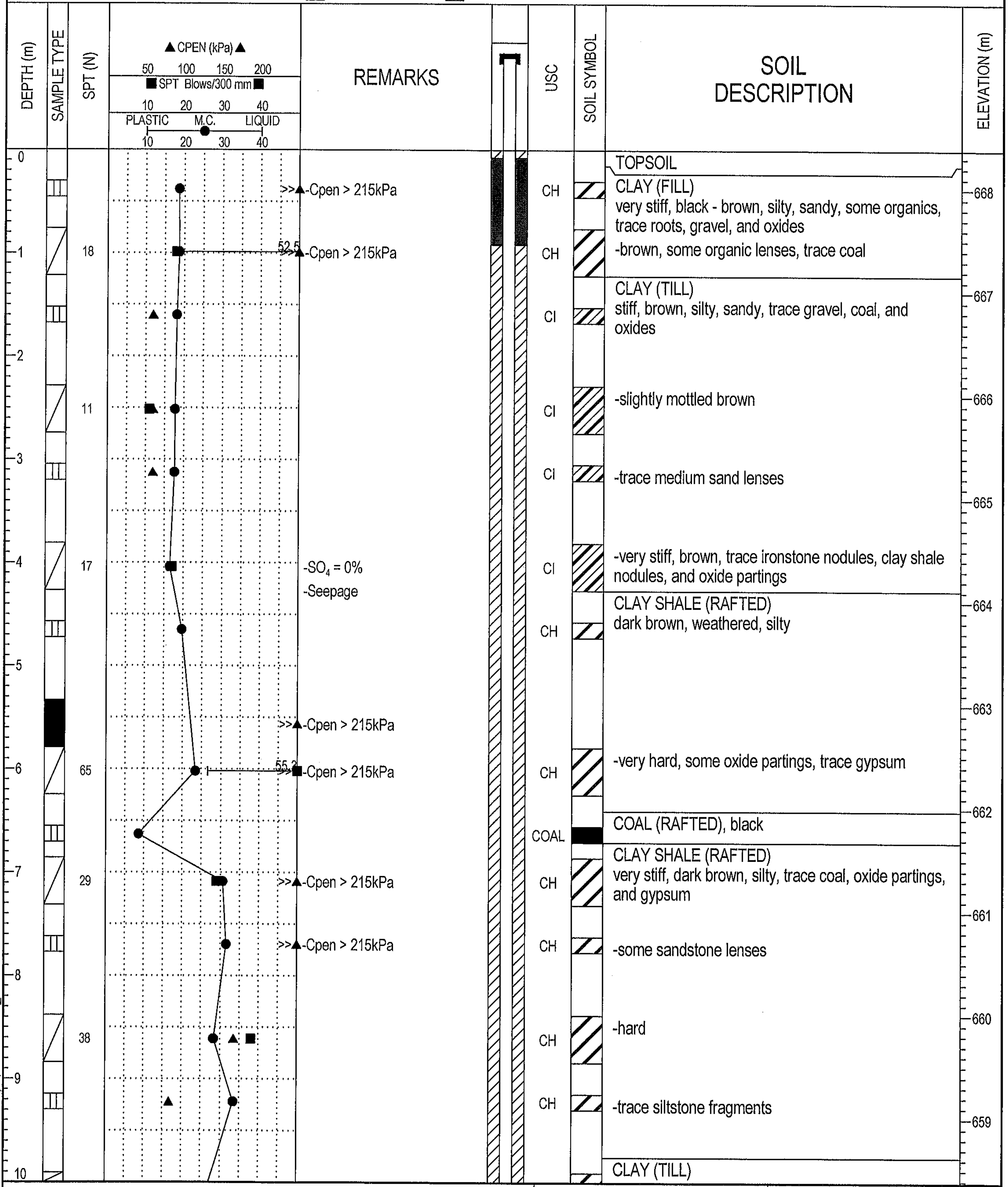
FIELD LOGGED BY: NR	COMPLETION DEPTH: 18.3 m
PREPARED BY: SGR	COMPLETION DATE: 8/7/09
REVIEWED BY:	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-22-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 9, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 668.38 (m)

SAMPLE TYPE: ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE: ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



Remarks:

- >>▲-Cpen > 215kPa (approx. 0.3 m)
- >>▲-Cpen > 215kPa (approx. 1.0 m)
- -SO$_4$ = 0% (approx. 4.0 m)
- -Seepage
- >>▲-Cpen > 215kPa (approx. 5.6 m)
- -Cpen > 215kPa (approx. 6.0 m)
- >>▲-Cpen > 215kPa (approx. 7.1 m)
- >>▲-Cpen > 215kPa (approx. 7.7 m)

Soil description:

TOPSOIL

CLAY (FILL)
very stiff, black - brown, silty, sandy, some organics, trace roots, gravel, and oxides
-brown, some organic lenses, trace coal

CLAY (TILL)
stiff, brown, silty, sandy, trace gravel, coal, and oxides
-slightly mottled brown
-trace medium sand lenses
-very stiff, brown, trace ironstone nodules, clay shale nodules, and oxide partings

CLAY SHALE (RAFTED)
dark brown, weathered, silty
-very hard, some oxide partings, trace gypsum

COAL (RAFTED), black

CLAY SHALE (RAFTED)
very stiff, dark brown, silty, trace coal, oxide partings, and gypsum
-some sandstone lenses
-hard
-trace siltstone fragments

CLAY (TILL)

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

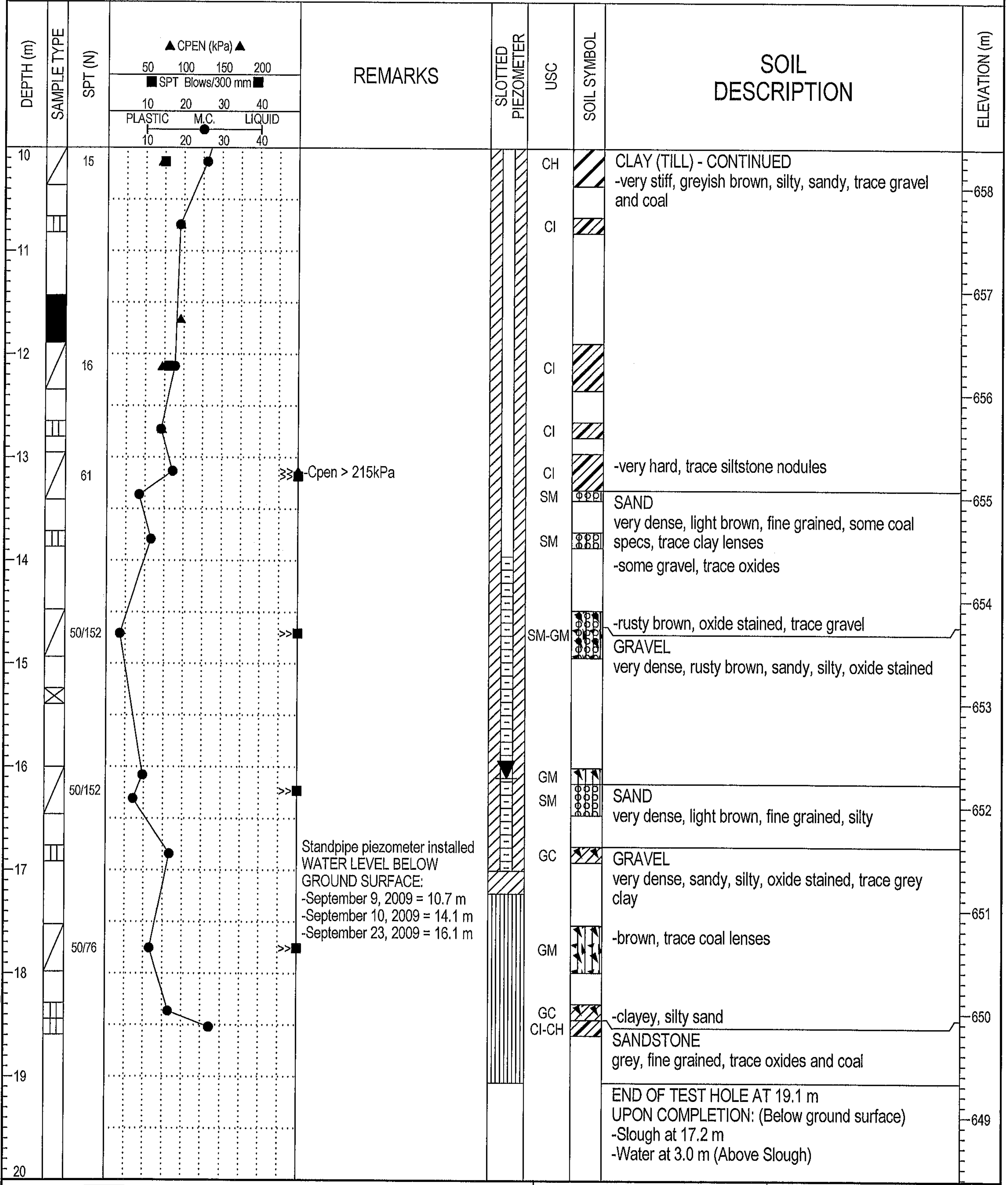
THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: JMA	COMPLETION DEPTH: 19.1 m
PREPARED BY: SGR	COMPLETION DATE: 9/9/09
REVIEWED BY:	Page 1 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-22-01**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 9, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 668.38 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◪ SPT ■ SHELBY TUBE ☒ NO RECOVERY

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



-Cpen > 215kPa

Standpipe piezometer installed
WATER LEVEL BELOW
GROUND SURFACE:
-September 9, 2009 = 10.7 m
-September 10, 2009 = 14.1 m
-September 23, 2009 = 16.1 m

CLAY (TILL) - CONTINUED
-very stiff, greyish brown, silty, sandy, trace gravel and coal

-very hard, trace siltstone nodules

SAND
very dense, light brown, fine grained, some coal specs, trace clay lenses
-some gravel, trace oxides

-rusty brown, oxide stained, trace gravel

GRAVEL
very dense, rusty brown, sandy, silty, oxide stained

SAND
very dense, light brown, fine grained, silty

GRAVEL
very dense, sandy, silty, oxide stained, trace grey clay

-brown, trace coal lenses

-clayey, silty sand

SANDSTONE
grey, fine grained, trace oxides and coal

END OF TEST HOLE AT 19.1 m
UPON COMPLETION: (Below ground surface)
-Slough at 17.2 m
-Water at 3.0 m (Above Slough)

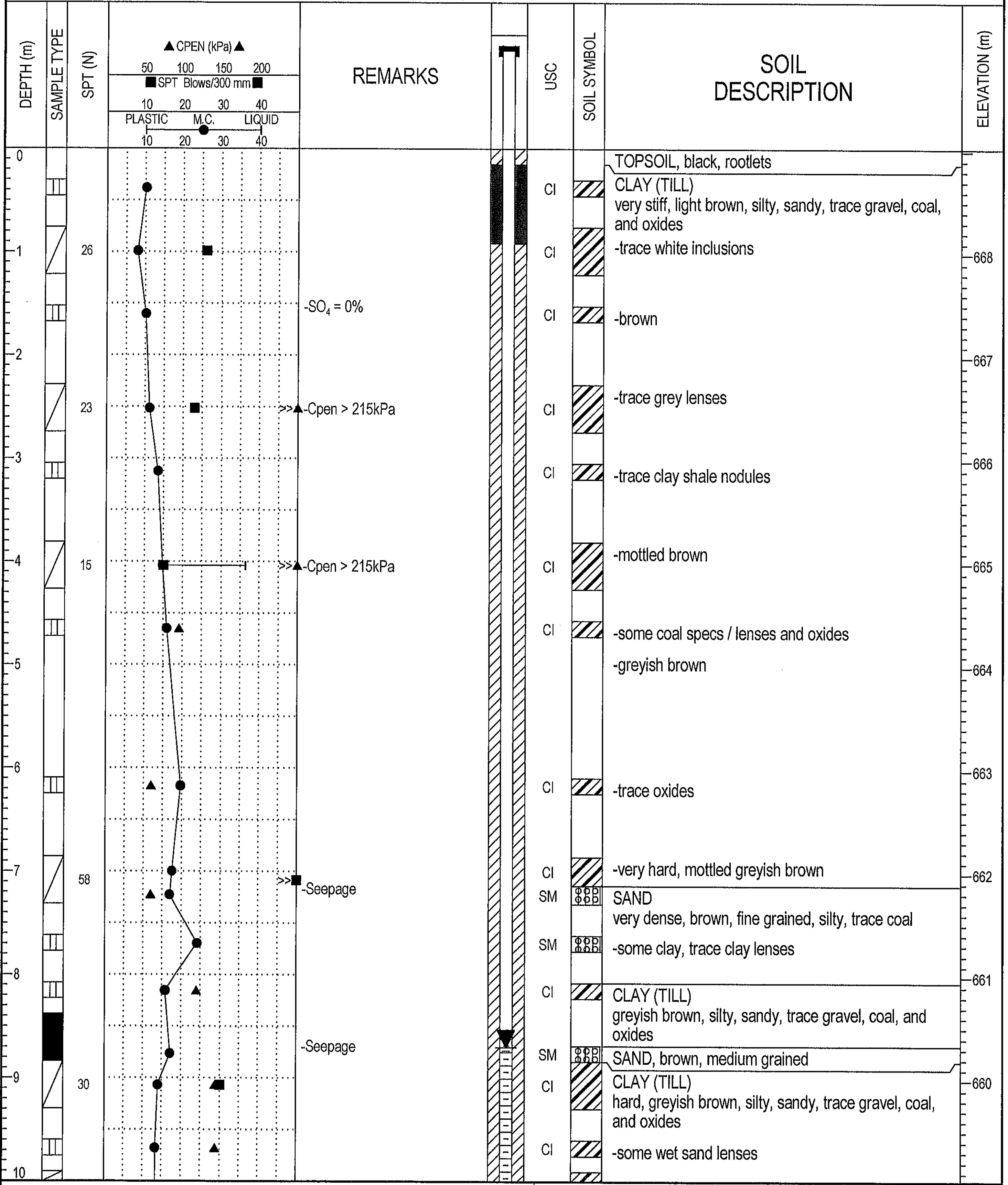
THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

FIELD LOGGED BY: JMA	COMPLETION DEPTH: 19.1 m
PREPARED BY: SGR	COMPLETION DATE: 9/9/09
REVIEWED BY:	Page 2 of 2

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-22-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 10, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 669.02 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



-SO$_4$ = 0%

-Cpen > 215kPa

-Cpen > 215kPa

-Seepage

-Seepage

TOPSOIL, black, rootlets

CLAY (TILL)
very stiff, light brown, silty, sandy, trace gravel, coal, and oxides
-trace white inclusions
-brown
-trace grey lenses
-trace clay shale nodules
-mottled brown
-some coal specs / lenses and oxides
-greyish brown
-trace oxides
-very hard, mottled greyish brown

SAND
very dense, brown, fine grained, silty, trace coal
-some clay, trace clay lenses

CLAY (TILL)
greyish brown, silty, sandy, trace gravel, coal, and oxides

SAND, brown, medium grained

CLAY (TILL)
hard, greyish brown, silty, sandy, trace gravel, coal, and oxides
-some wet sand lenses

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

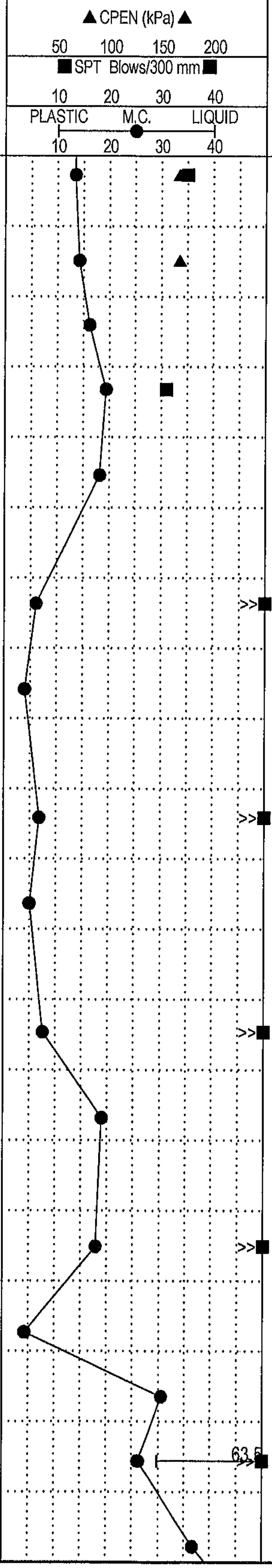
FIELD LOGGED BY: JMA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/10/09
REVIEWED BY:	Page 1 of 3

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-22-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 10, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 669.02 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◩ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
10						
	◩	35		CI	CLAY (TILL) - CONTINUED -grey, trace gypsum crystals	
	▥			CI	-sand lenses	
11						658
	▥			CI	-brown, fine grained sand lenses	
			-Seepage			
	◩	31		SM	SAND, dense, brown, fine grained, clay till lenses	
12						657
	▥			CI	CLAY (TILL) grey, silty, some sand, trace gravel, coal, oxides, green nodules, and clay shale nodules	
13						656
	◩	50/127		SC	SAND very dense, brown, fine grained, oxide stained, some gravel	
			-Hard drilling			
	▥			SM	-silty, trace coal and oxide stained colouring	
14						655
	◩	90		SM	-light brown, trace oxide staining, occasional gravel	
15						654
	▥			SM		
16						653
	◩	92		SM	-brown, trace medium grained sand lenses	
	▥			SM		
17						652
	◩	81		SM	-medium grained, trace coal partings	
18						651
	▥			GC	GRAVEL, brown, fine grained, some sand, trace coal and oxides	
	▥			CH	CLAY SHALE very hard, dark grey, weathered, trace oxides and sand lenses	
19						650
	◩	80		CH	-trace green sand lenses	
20	▥			CH		

THURBER ENGINEERING LTD.
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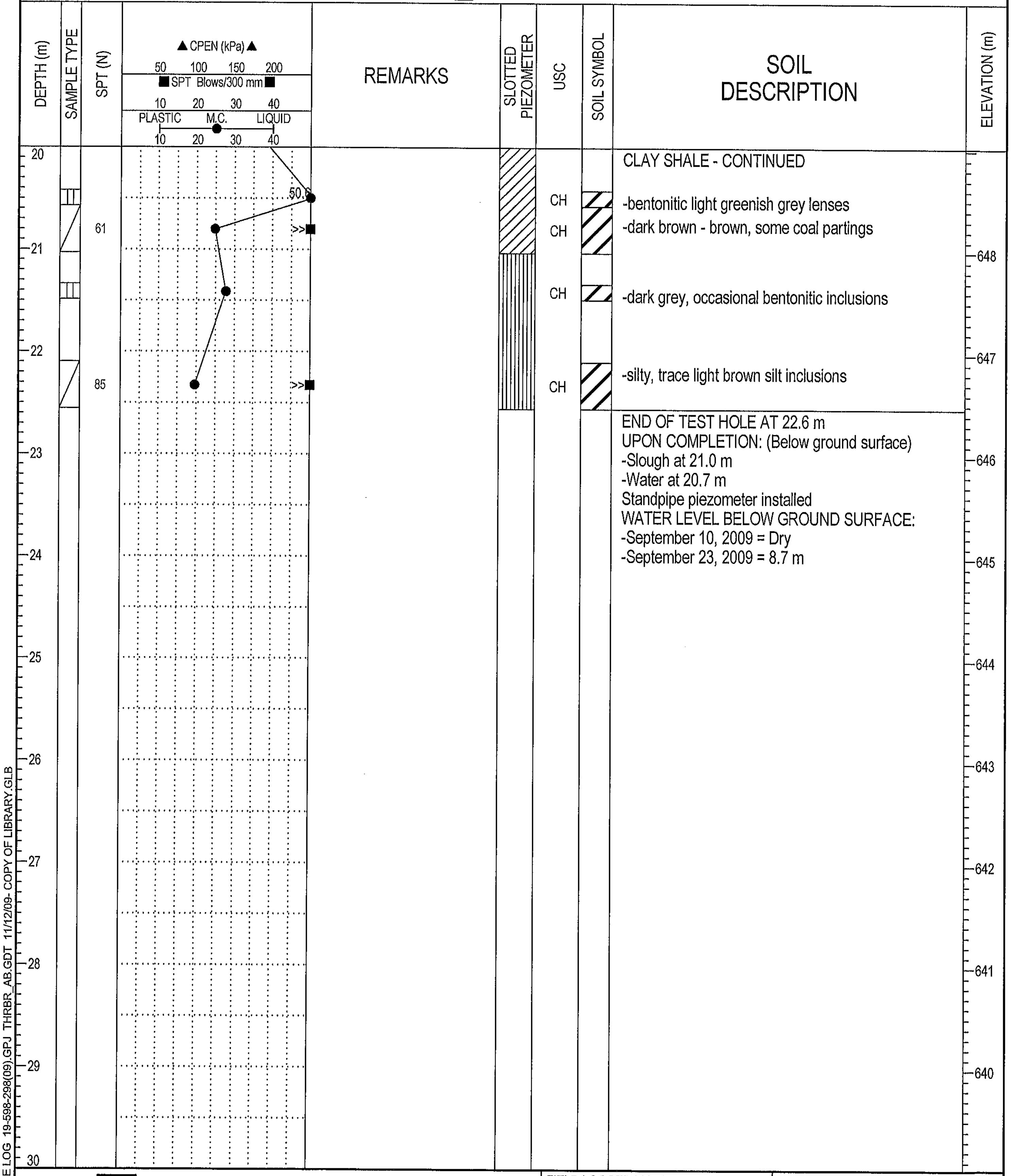
FIELD LOGGED BY: JMA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/10/09
REVIEWED BY:	Page 2 of 3

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

CLIENT: ISL ENGINEERING & LAND SERVICES LTD	PROJECT: NEERR - AFPS - BRIDGE ABUTMENT GEO	BOREHOLE NO: **TH09-22-02**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: September 10, 2009	PROJECT NO: 19-598-298
DRILL/METHOD: Nodwell M10 / Solid Stem Augers	LOCATION: See Drawing #19-598-298-1	ELEVATION: 669.02 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ■ SHELBY TUBE

BACKFILL TYPE ▨ DRILL CUTTINGS ■ BENTONITE ▥ SLOUGH



CLAY SHALE - CONTINUED

-bentonitic light greenish grey lenses

-dark brown - brown, some coal partings

-dark grey, occasional bentonitic inclusions

-silty, trace light brown silt inclusions

END OF TEST HOLE AT 22.6 m
UPON COMPLETION: (Below ground surface)
-Slough at 21.0 m
-Water at 20.7 m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-September 10, 2009 = Dry
-September 23, 2009 = 8.7 m

BOREHOLE LOG 19-598-298(09).GPJ THRBR_AB.GDT 11/12/09- COPY OF LIBRARY.GLB

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: JMA	COMPLETION DEPTH: 22.6 m
PREPARED BY: SGR	COMPLETION DATE: 9/10/09
REVIEWED BY:	

APPENDIX C

Laboratory Test Results

TABLE C-1

SUMMARY OF THE ATTERBERG LIMIT TESTS ALONG THE HWY 216 & HWY 16 CORRIDORS OF THE NEERR

TEST HOLE	DEPTH (m)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FIELD MOISTURE	M.C. ABOVE OPT.	LIQUID INDEX	EST. OPT. MOISTURE	EST. MAX DENSITY	SOIL CLASS	POTENTIAL FROST ACTION	EST. EROSION RESISTANCE
TH08-01-1	0.8	35.3	13.8	21.5	15.8	1.8	0.1	14.0	1845	CI Till	low to medium	fair to poor
TH08-01-1	29.7	84.2	22.4	61.8	30.3	6.6	0.1	23.7	1562	CH Shale	very low	fair
TH08-01-2	3.8	32.6	13.8	18.8	14.9	1.4	0.1	13.5	1859	CI Till	low to medium	fair to poor
TH08-01-2	16.0	33.0	12.3	20.7	16.1	3.6	0.2	12.5	1910	CI Till	low to medium	fair to poor
TH08-02-1	0.8	38.3	15.9	22.4	16.3	0.2	0.0	16.1	1768	CI (FILL)	low to medium	fair to poor
TH08-02-2	0.8	38.7	15.0	23.7	15.6	0.1	0.0	15.5	1794	CI (FILL)	low to medium	fair to poor
TH08-02-2	6.1	36.3	13.4	22.9	17.1	3.2	0.2	13.9	1853	CI Till	low to medium	fair to poor
TH08-02-2	25.1	73.7	19.6	54.1	23.1	1.7	0.1	21.4	1626	CH Shale	very low	fair
TH08-03-1	2.7	34.6	14.2	20.4	19.3	5.1	0.3	14.2	1835	CI Till	low to medium	fair to poor
TH08-03-1	5.8	32.2	12.4	19.8	16.5	4.1	0.2	12.4	1912	CI Till	low to medium	fair to poor
TH08-03-2	3.8	39.0	13.8	25.2	22.0	7.4	0.3	14.6	1829	CI Till	low to medium	fair to poor
TH08-03-2	17.5	37.5	13.6	23.9	30.4	16.2	0.7	14.2	1841	CH Shale	very low	fair

TABLE C-1 (Continued)

SUMMARY OF THE ATTERBERG LIMIT TESTS ALONG THE HWY 216 & HWY 16 CORRIDORS OF THE NEERR

TEST HOLE	DEPTH (m)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FIELD MOISTURE	M.C. ABOVE OPT.	LIQUID INDEX	EST. OPT. MOISTURE	EST. MAX DENSITY	SOIL CLASS	POTENTIAL FROST ACTION	EST. EROSION RESISTANCE
TH08-04-1	2.6	37.8	15.2	22.6	18.7	3.2	0.2	15.5	1790	CI Till	low to medium	fair to poor
TH08-04-1	11.4	35.7	13.9	21.8	19.0	4.8	0.2	14.2	1840	CI Till	low to medium	fair to poor
TH08-04-2	1.5	36.8	17.5	19.3	19.7	2.4	0.1	17.3	1723	CI (FILL)	low to medium	fair to poor
TH08-04-2	4.6	38.9	13.4	25.5	19.3	5.0	0.2	14.3	1841	CI Till	low to medium	fair to poor
TH08-05-01	8.7	35.6	14.3	21.3	18.5	4.1	0.2	14.4	1827	CI Till	low to medium	fair to poor
TH08-05-01	19.1	76.1	26.1	50.0	25.8	-1.0	0.0	26.8	1486	CH Shale	very low	fair
TH08-05-02	0.8	34.7	13.1	21.6	17.0	3.6	0.2	13.4	1871	CI Till	low to medium	fair to poor
TH08-05-02	3.8	32.4	12.7	19.7	18.7	6.0	0.3	12.7	1900	CI Till	low to medium	fair to poor
TH08-06-01	0.8	40.0	13.7	26.3	19.2	4.5	0.2	14.7	1828	CI (FILL)	low to medium	fair to poor
TH08-06-01	5.3	26.0	12.7	13.3	16.3	5.1	0.3	11.2	1958	CL Till	medium to very high	poor
TH08-07-01	0.8	36.1	13.7	22.4	17.9	3.8	0.2	14.1	1844	CI (FILL)	low to medium	fair to poor
TH08-07-01	8.4	36.6	12.7	23.9	20.4	7.0	0.3	13.4	1874	CI Till	low to medium	fair to poor
TH08-07-02	0.8	35.1	14.2	20.9	21.7	7.4	0.4	14.3	1833	CI Till	low to medium	fair to poor
TH08-07-02	16.0	84.7	29.0	55.7	34.7	5.1	0.1	29.6	1424	CH Shale	very low	fair

TABLE C-1 (Continued)

SUMMARY OF THE ATTERBERG LIMIT TESTS ALONG THE HWY 216 & HWY 16 CORRIDORS OF THE NEERR (CONT'D)

TEST HOLE	DEPTH (m)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FIELD MOISTURE	M.C. ABOVE OPT.	LIQUID INDEX	EST. OPT. MOISTURE	EST. MAX DENSITY	SOIL CLASS	POTENTIAL FROST ACTION	EST. EROSION RESISTANCE
TH08-08-01	19.1	64.8	20.2	44.6	23.9	2.4	0.1	21.5	1619	CH Shale	very low	fair
TH08-08-02	2.3	31.0	12.9	18.1	18.5	6.0	0.3	12.5	1902	CI Till	low to medium	fair to poor
TH08-08-02	8.4	37.5	12.8	24.7	18.2	4.5	0.2	13.7	1866	CI Till	low to medium	fair to poor
TH08-12-01	3.8	46.7	16.8	29.9	14.5	-3.3	-0.1	17.8	1723	CI (FILL)	low to medium	fair to poor
TH08-12-01	11.4	61.9	21.3	40.6	21.8	-0.5	0.0	22.3	1596	CH Shale	very low	fair
TH08-12-01	14.5	51.5	16.0	35.5	18.3	0.7	0.1	17.6	1734	CI Till	low to medium	fair to poor
TH08-12-02	2.7	51.6	17.6	34.0	22.8	4.0	0.2	18.8	1694	CH (FILL)	very low	fair
TH08-12-02	16.0	32.0	12.4	19.6	17.8	5.4	0.3	12.4	1914	CI Till	low to medium	fair to poor
TH08-14-01	13.0	49.0	16.4	32.6	20.6	2.9	0.1	17.7	1729	CH Till	very low	fair
TH08-14-02	2.3	37.5	14.1	23.4	18.2	3.6	0.2	14.6	1826	CI (FILL)	low to medium	fair to poor
TH08-14-02	11.9	44.0	15.6	28.4	17.9	1.3	0.1	16.6	1761	CI Till	low to medium	fair to poor
TH08-15-01	11.4	53.5	21.8	31.7	16.6	-5.9	-0.2	22.5	1589	CH Shale	very low	fair
TH08-16-01	8.9	43.2	15.8	27.4	16.3	-0.3	0.0	16.6	1757	CI (FILL)	low to medium	fair to poor
TH08-16-01	10.2	67.5	24.1	43.4	29.7	4.8	0.1	24.9	1530	CH (FILL)	very low	fair
TH08-16-01	14.5	103.1	30.4	72.7	35.7	5.2	0.1	30.5	1397	CH Shale	very low	fair
TH08-16-02	7.3	35.6	14.0	21.6	13.4	-0.8	0.0	14.2	1837	CI (FILL)	low to medium	fair to poor

TABLE C-1 (Continued)

SUMMARY OF THE ATTERBERG LIMIT TESTS ALONG THE HWY 216 & HWY 16 CORRIDORS OF THE NEERR

TEST HOLE	DEPTH (m)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FIELD MOISTURE	M.C. ABOVE OPT.	LIQUID INDEX	EST. OPT. MOISTURE	EST. MAX DENSITY	SOIL CLASS	POTENTIAL FROST ACTION	EST. EROSION RESISTANCE
TH08-17-01	9.9	43.6	15.0	28.6	19.9	3.8	0.2	16.1	1779	CI Till	low to medium	fair to poor
TH08-18-01	2.7	33.8	14.1	19.7	16.2	2.2	0.1	14.0	1842	CI Till	low to medium	fair to poor
TH08-18-01	13.0	50.6	16.0	34.6	17.9	0.4	0.1	17.5	1736	CH Till	very low	fair
TH08-18-02	13.0	49.0	14.5	34.5	21.0	4.7	0.2	16.3	1777	CI Till	low to medium	fair to poor
TH08-18-02	16.0	81.5	22.6	58.9	24.0	0.2	0.0	23.8	1559	CH Shale	very low	fair
TH08-19-02	5.7	43.3	14.1	29.2	19.3	3.9	0.2	15.4	1804	CI Till	low to medium	fair to poor
TH08-20-01	5.9	44.0	20.4	23.6	20.1	-0.6	0.0	20.7	1631	CI Till	low to medium	fair to poor
TH08-20-01	13.0	89.1	28.9	60.2	29.4	0.0	0.0	29.4	1426	CH Shale	very low	fair
TH08-20-02	5.9	44.0	20.4	23.6	20.1	-0.6	0.0	20.7	1631	CI Till	low to medium	fair to poor
TH08-20-02	9.9	46.1	15.3	30.8	20.7	4.1	0.2	16.6	1764	CI Till	low to medium	fair to poor
TH08-21-02	3.0	46.8	17.5	29.3	22.0	3.7	0.2	18.3	1704	CI (FILL)	low to medium	fair to poor
TH08-21-02	11.8	32.4	13.4	19.0	16.3	3.1	0.2	13.2	1874	CI Till	low to medium	fair to poor
TH08-22-01	0.8	54.4	19.5	34.9	11.9	-8.6	-0.2	20.5	1644	CH Clay	very low	fair
TH08-22-02	7.1	58.8	24.4	34.4	23.4	-1.7	0.0	25.1	1525	CH Shale	very low	fair

TABLE C-1 (Continued)

SUMMARY OF THE ATTERBERG LIMIT TESTS ALONG THE HWY 216 & HWY 16 CORRIDORS OF THE NEERR

TEST HOLE	DEPTH (m)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FIELD MOISTURE	M.C. ABOVE OPT.	LIQUID INDEX	EST. OPT. MOISTURE	EST. MAX DENSITY	SOIL CLASS	POTENTIAL FROST ACTION	EST. EROSION RESISTANCE
TH08-23-01	2.7	59.1	21.2	37.9	21.9	-0.2	0.0	22.1	1600	CH Clay Shale	very low	fair
TH08-23-01	8.4	51.0	15.8	35.2	16.5	-0.9	0.0	17.4	1740	CH Till	very low	fair
TH08-23-02	0.8	48.3	14.7	33.6	22.3	5.9	0.2	16.4	1774	CI Fill	low to medium	fair to poor
TH08-24-01	2.7	34.2	13.6	20.6	16.7	3.0	0.2	13.7	1857	CI Till	low to medium	fair to poor
TH08-24-02	0.8	47.6	18.3	29.3	19.5	0.5	0.0	19.0	1682	CI Clay	low to medium	fair to poor
TH08-24-02	5.9	37.8	15.0	22.8	16.0	0.7	0.0	15.3	1797	CI Till	low to medium	fair to poor
TH08-25-01	2.3	31.4	13.2	18.2	15.8	3.0	0.1	12.8	1888	CI Till	low to medium	fair to poor
TH08-25-01	16.0	69.6	25.6	44.0	20.5	-5.8	-0.1	26.3	1497	CH Shale	very low	fair
TH08-25-02	1.5	62.0	19.8	42.2	46.8	25.7	0.6	21.1	1630	CH Clay	very low	fair
TH08-25-02	5.3	41.6	15.5	26.1	15.7	-0.5	0.0	16.2	1770	CI Till	low to medium	fair to poor
TH08-26-01	1.0	34.5	13.8	20.7	16.9	3.0	0.1	13.9	1849	CI Till	low to medium	fair to poor
TH08-26-01	14.5	63.7	25.5	38.2	22.2	-4.1	-0.1	26.3	1500	CH Shale	very low	fair
TH08-26-02	2.7	32.6	13.3	19.3	17.6	4.4	0.2	13.2	1877	CI Till	low to medium	fair to poor
TH08-26-02	5.7	40.2	14.0	26.2	19.4	4.5	0.2	14.9	1818	CI Till	low to medium	fair to poor

TABLE C-11 (Continued)

SUMMARY OF THE ATTERBERG LIMIT TESTS ALONG THE HWY 216 & HWY 16 CORRIDORS OF THE NEERR

TEST HOLE	DEPTH (m)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	FIELD MOISTURE	M.C. ABOVE OPT.	LIQUID INDEX	EST. OPT. MOISTURE	EST. MAX DENSITY	SOIL CLASS	POTENTIAL FROST ACTION	EST. EROSION RESISTANCE
TH08-27-01	2.3	49.5	19.8	29.7	14.8	-5.7	-0.2	20.5	1641	CI Clay	low to medium	fair to poor
TH08-27-02	2.3	29.4	12.1	17.3	8.0	-3.6	-0.2	11.6	1948	CL Till	medium to very high	poor
TH08-32-01	0.8	36.1	13.8	22.3	15.7	1.6	0.1	14.1	1841	CI (FILL)	low to medium	fair to poor
TH08-32-01	8.4	57.7	27.7	30.0	27.1	-1.9	0.0	29.0	1450	CH Shale	very low	fair
TH08-32-02	8.8	42.3	18.5	23.8	26.3	7.5	0.3	18.8	1684	CI Clay	low to medium	fair to poor
TH08-32-02	14.5	43.0	13.9	29.1	19.7	4.5	0.2	15.2	1811	CI Till	low to medium	fair to poor
TH08-32-03	2.7	48.8	16.7	32.1	23.3	5.4	0.2	17.9	1721	CI (FILL)	low to medium	fair to poor
TH06-D41	12.2	74.4	22.3	52.1	22.1	-1.3	0.0	23.4	1568	CH Shale	very low	fair
TH06-D42	0.8	75.2	25.8	49.4	29.9	3.4	0.1	26.5	1492	CH Clay	very low	fair
TH06-D42	1.0	75.2	25.8	49.4	30.0	3.5	0.09	26.5	1492	CH Clay	very low	fair
TH06-D43	8.5	46.4	16.0	30.4	16.5	-0.6	0.02	17.1	1744	CI Shale	low to medium	fair to poor
TH06-D43	16.4	75.6	26.0	49.6	25.0	-1.7	-0.02	26.7	1488	CH Shale	very low	fair
TH06-D44	3.1	39.9	13.1	26.8	17.0	2.8	0.15	14.2	1846	CI Till	low to medium	fair to poor

TABLE C-2
SUMMARY OF WATER SOLUBLE SULPHATE CONTENT TESTS

TEST HOLE	**DEPTH (m)**	SO_4 CONTENT (%)
TH08-01-01	2.3	0
TH08-01-02	9.9	0.02
TH08-02-01	2.3	0
TH08-03-02	2.5	0
TH08-04-02	6.9	0
TH08-05-02	6.1	0.04
TH08-07-01	3.8	0
TH08-07-02	5.3	0
TH08-12-01	0.8	0
TH08-12-02	0.8	0.15
TH08-14-01	3.8	0
TH08-15-01	8.4	0.0007
TH08-16-01	5.0	0
TH08-16-02	0.3	0
TH08-18-01	0.8	0.004
TH08-20-01	3.8	0.019
TH08-20-02	7.9	0.077
TH08-21-02	2.3	0.04
TH08-22-01	3.8	0.71
TH08-23-01	0.8	0
TH08-24-01	4.6	0
TH08-25-01	0.8	0
TH08-26-01	3.1	0
TH08-27-01	1.5	0
TH08-27-01	13.0	0
TH08-31-01	1.5	0
TH08-31-01	2.4	0.23
TH08-32-01	4.0	0
TH08-32-02	2.7	0
TH08-32-03	6.1	0.1
TH08-32-03	19.1	0
TH06-D41	13.8	0.02
TH06-D44	4.5	0.04
TH06-D44	16.8	0.06

APPENDIX D

Slope Stability Analyses

GENERAL

Slope stability analyses have been carried out to assess the stability of the approach fills and cuts. The analyses have been carried out using Slope/W limit equilibrium stability analysis. Effective stress analyses were carried out using estimated effective strength and pore pressures. For assessing the safety factor for global stability Bishop’s method was used.

For each bridge the worst case was checked considering the local geometry and respective height of fill provided in the latest drawings provided by ISL.

Stability analyses were carried out for 2H:1V head slopes. Global stability analyses considering retaining walls were performed in a case by case basis as requested by ISL. It is worth mentioning, however, that in this project phase, internal stability, bearing capacity, sliding and settlement analysis were not performed.

The critical stability condition for loading condition, yielding the lowest estimated factor of safety, is at the end of fill construction when pore pressures generated by fill placement are greatest. Thereafter, the pore pressures dissipate with time with a corresponding increase in factor of safety.

EFFECTIVE STRENGTH PARAMETERS

Effective strength and pore pressures parameters used in the analyses represent reasonable strength values of soils based on local experience on similar materials.

The soil parameters used in the stability analysis are summarized in Table D-1 and are considered reasonable lower bound strength for the native soils and fills.

TABLE D-1
STRENGTH PARAMETERS USED IN THE STABILITY ANALYSES

				PORE PRESSURE RESPONSE	
MATERIAL DESCRIPTION	γ **(kN/m^3)**	**c' (kPa)**	**Φ' (°)**	**R$_u$**	**B $_{bar}$**
Clay fill (new)	20	5	28	0.2	-
Clay fill (old)	20	5	28	-	0.3
Clay Till	20	10	28	-	0.3
Clay (lacustrine)	18	5	23	-	0.3
Topsoil	17	5	20	-	0.3
Loose sand (native or fill)	18	0	30	-	-
Compact sand (native or fill)	19	0	32	-	-
Dense sand (native or fill)	20	0	35	-	-
Compact gravel	19	0	38	-	-

R_u = ratio of pore pressure to total overburden on pressure.
B_{bar} = ratio of change in pore pressure to change in applied vertical stress.
B_{bar} = 0.3 is considered to represent the end of construction pore pressure based on construction in one season without foundation drainage.

RESULTS OF STABILITY ANALYSIS

The results of slope stability analyses showing the slope geometry and slip circles are presented in the end of this appendix.

In these analyses, the end of construction pore pressures were estimated as the combination of initial piezometric surface and the excess pore pressure generated by fill construction.

Excess pore pressures due to fill placement were estimated as the product of B_{bar} and the increase in vertical stress. A B_{bar} value of 0.3 is considered appropriate for estimating excess pore pressure in existing (old) clay fill, clay and clay till due to new fill placement for a relative slow rate of construction over a three month period.

Following are the main observations and conclusions of the stability analyses.

- Estimated short term factors of safety of approach fill head slopes range from 1.26 to 1.49 for 2H:1V slopes with varying fill heights.
- Long term factors of safety after excess pore pressure dissipation are calculated at greater than 1.45 for 2H:1V head slopes.
- 2H:1V slopes are feasible for the majority of the head slopes without any special recommendation.
- For 2H:1V head slopes, with slope heights greater than 10 m, gravel wedges or soil reinforcement are recommended. Alternatively, the new fill construction may be staged over two construction seasons to allow for pore pressure dissipation with pore pressure monitoring.
- Fill side slopes may be constructed at 3H:1V or flatter.

Safety factors for head slopes of the bridges analyzed for the Highway 216 corridor and Hwy 16 corridors are summarized in Tables D-2 and D-3 below.

TABLE D-2
SAFETY FACTORS FOR BRIDGE STRUCTURES ALONG HWY 216/AHD

	GEOMETRY					SAFETY FACTOR	
Bridge	**Slope Type**	**Slope H:V**	**Height (m)**	**Height of Fill (m)**	**Water Below Ground (m)**	**Long Term**	**Short Term**
27	fill with Wedge	2:1	10	10.5	7.4	**1.58**	**1.37**
15	fill	2:1	8.5	1	0.7	**1.52**	**1.49**
14	fill	2:1	8.5	1	0.7	**1.52**	**1.49**
16	cut	2:1	10	Variable, 1.5m - 12m	no water	**1.49**	**1.46**
17	fill	5:1 + 14m wall	18	14	8.9	**1.69**	**1.50**
17	fill with Wedge	2:1	18	18	8.9	**1.54**	**1.29**
18	fill	2:1	9	14	3.5	**1.57**	**1.27**
11, 12 & 13	fill	2:1	9.5	4	9.1	**1.58**	**1.26**
32	cut	2:1	7	7	11.9	**1.59**	**1.27**
5 W, 7 & 8	fill	2:1	8.5	8.5	1.3	**1.52**	**1.36**
5 E & 6	fill with Wedge	2:1	12	12	0.7	**1.53**	**1.29**
4	fill	2:1	8.5	8.5	3	**1.58**	**1.27**
2 & 3	cut	2:1	8.5	0	3.5	**1.45**	**-**
1	fill	2:1	9	10.5	1.8	**1.55**	**1.26**

TABLE D-3
SAFETY FACTORS FOR BRIDGE STRUCTURES ALONG HWY 16/YHT

	GEOMETRY					**SAFETY FACTOR**	
Bridge	**Slope Type**	**Slope H:V**	**Height (m)**	**Height of Fill (m)**	**Water Below Ground (m)**	**Long Term**	**Short Term**
31	fill	2:1	8.5	8.5	no water	**1.57**	**1.27**
31	fill	wall	8.5	8.5	no water	**2.07**	**1.71**
24	fill/cut	2:1	9	6	4.3	**1.51**	**1.26**
24	fill/cut	wall	9	6	4.3	**1.56**	**1.29**
23	fill/cut	2:1	8.5	4.5	10.6	**1.74**	**1.42**
22	fill/cut	2:1	8.5	4.5	6.8	**1.59**	**1.29**
20 & 21	fill	2:1	8.5	4.25	2.5	**1.47**	**1.3**
19/33	fill	3:1 + 10.5 m wall	10	7.5	15.5	**1.8**	**1.44**
19/33	fill	2:1	10	10	15.5	**1.51**	**1.26**
26	fill/cut	2:1	10	4	1.9	**1.47**	**1.32**
25	fill/cut	2:1	8.5	7	2	**1.57**	**1.27**

FIGURE 8.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

19-598-298

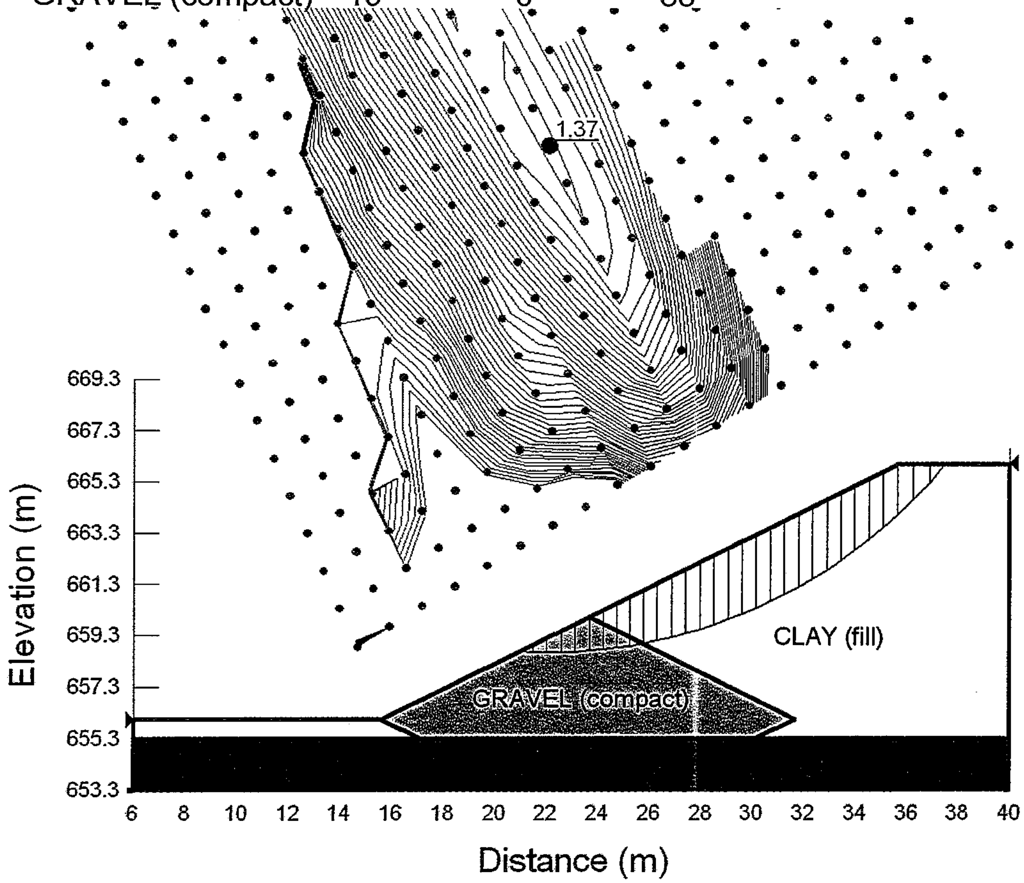
Structure 27 (Northern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V

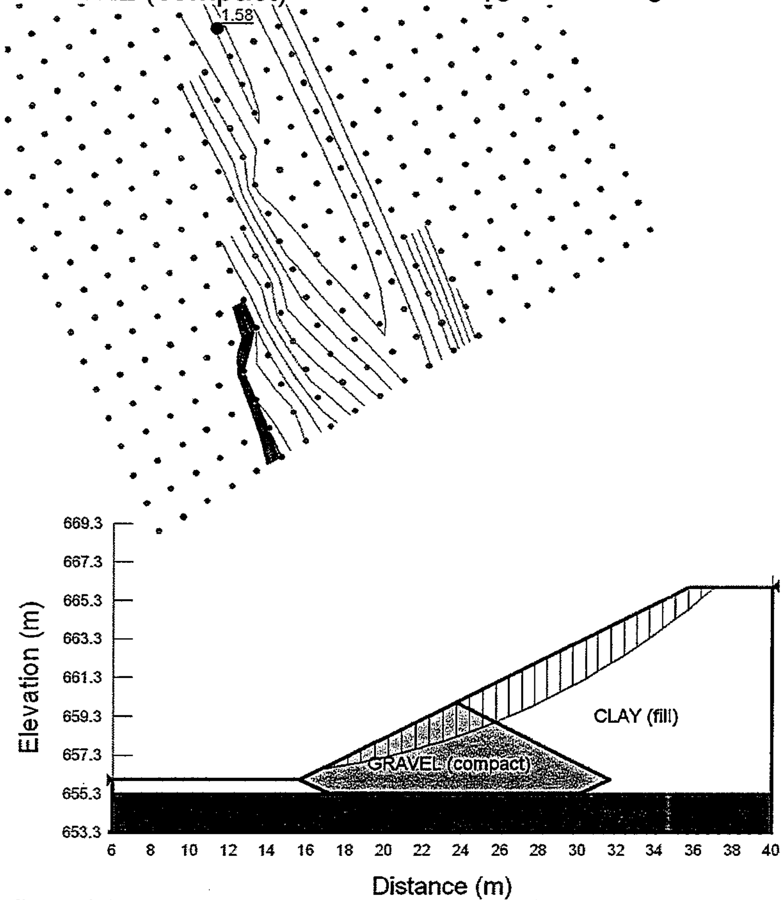
Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
TOPSOIL	17	5	20	-	0.3
SAND (loose)	18	0	30	-	-
SAND (compact)	19	0	32	-	-
SAND (dense)	20	0	35	-	-
GRAVEL (compact)	19	0	38	-	-



File: Bridge 27 ST + gravel buttress 2Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23
TOPSOIL	17	5	20
SAND (loose)	18	0	30
SAND (compact)	19	0	32
SAND (dense)	20	0	35
GRAVEL (compact)	19	0	38



File: Bridge 27 LT + gravel buttress 2Software: Slope/W

FIGURE 8.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

19-598-298

Structure 27 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28	-	0.3
SAND (compact)	19	0	32	-	-
GRAVEL (compact)	19	0	38	-	-

FIGURE 9.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

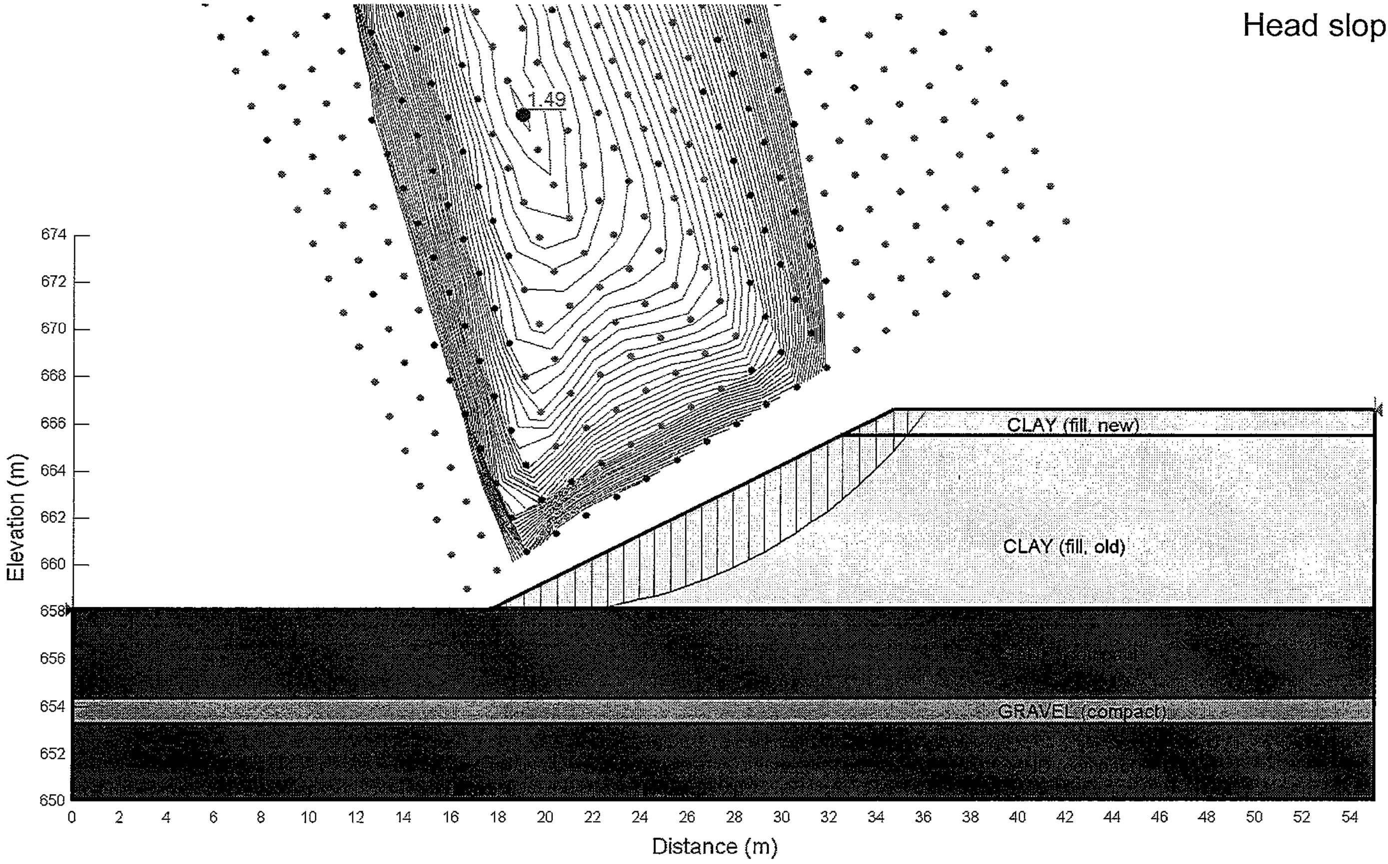
19-598-298

Structures 14 & 15 (Northern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 14 ST

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, old)	20	5	28
SAND (compact)	19	0	32
GRAVEL (compact)	19	0	38

FIGURE 9.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

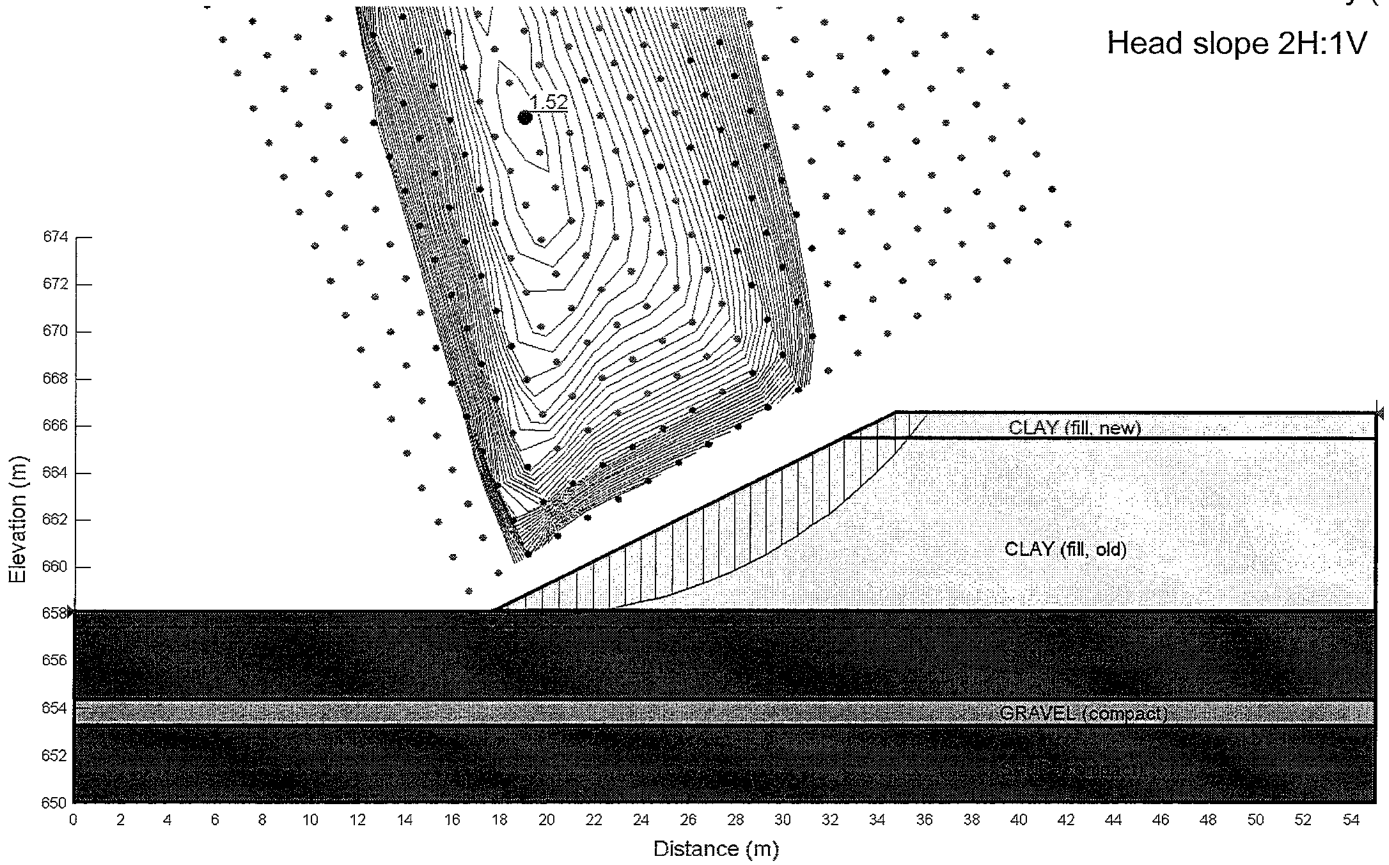
19-598-298

Structures 14 & 15 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 14 LT Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28	-	0.3
SAND (fill, loose)	18	0	30	-	-
SAND (compact)	19	0	32	-	-
CLAY (Till)	20	10	28	-	0.3

FIGURE 9.3

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

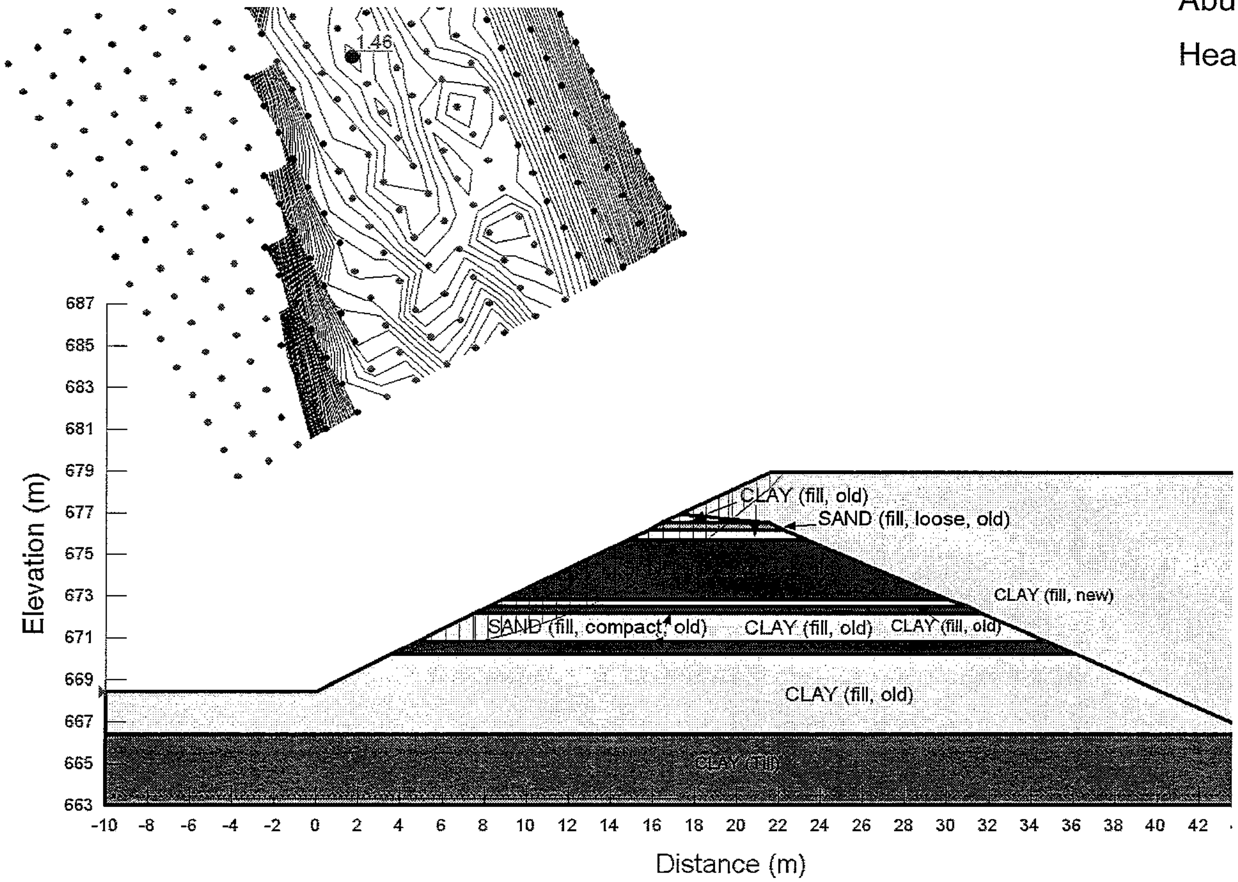
19-598-298

Structure 16 (Northern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 16 ST north abut

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, old)	20	5	28
SAND (fill, loose)	18	0	30
SAND (fill, compact)	19	0	32
CLAY (Till)	20	10	28

FIGURE 9.4

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

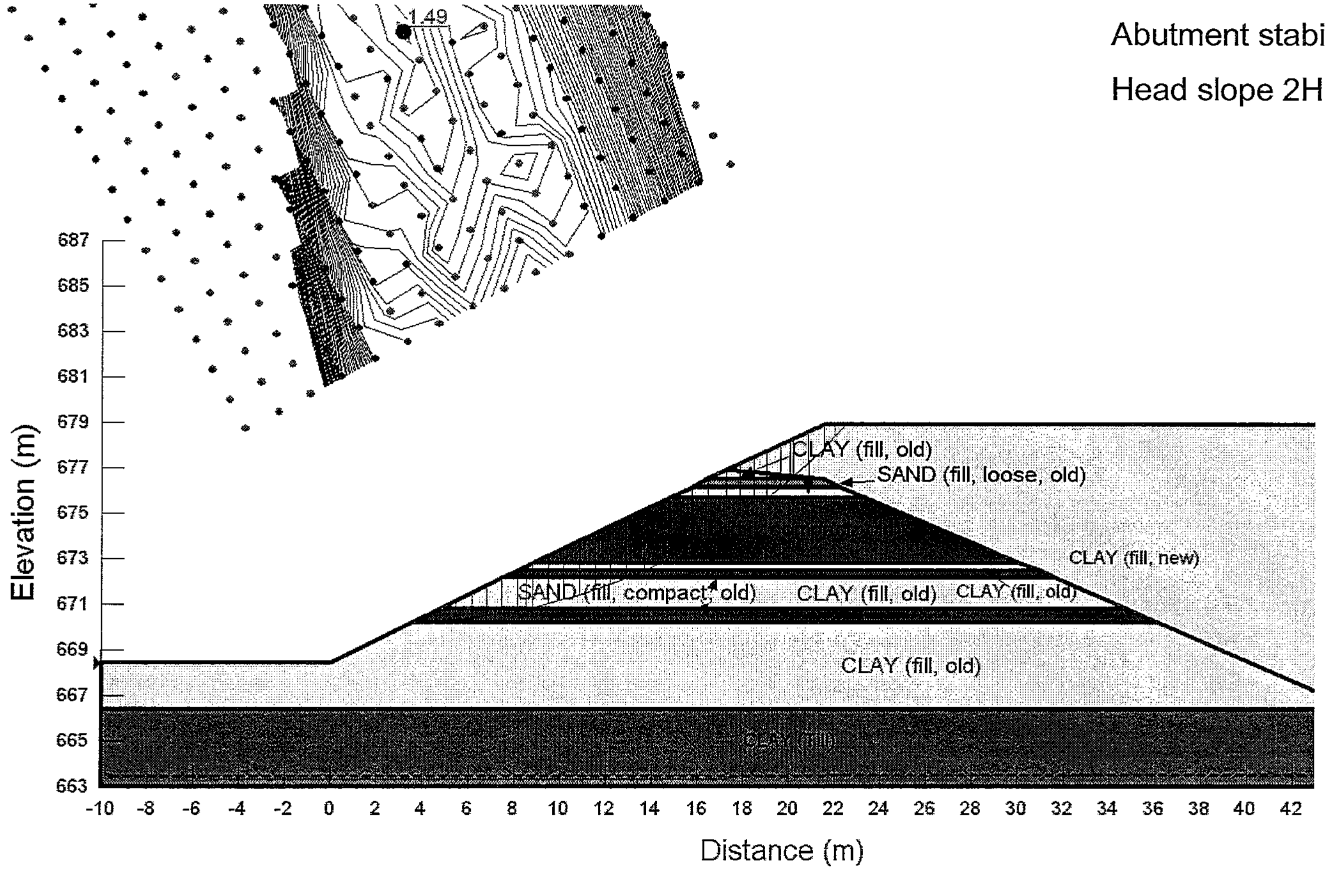
19-598-298

Structure 16 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

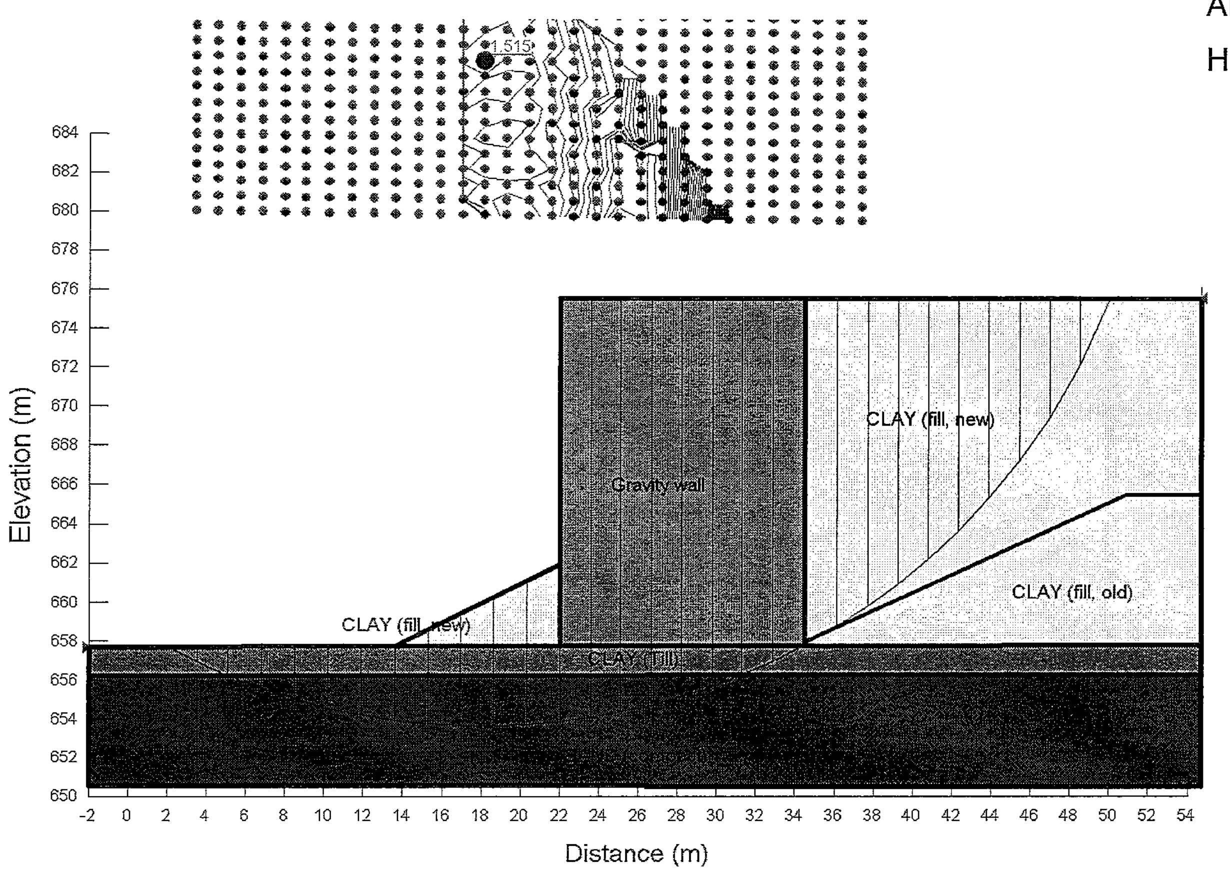
Head slope 2H:1V



File: Bridge 16 LT north abut Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28	-	0.3
CLAY (Till)	20	10	28	-	0.3
SAND (compact)	19	0	32	-	-

FIGURE 9.5
Thurber Engineering Ltd – Edmonton
NEERR – AFPS Bridge Abutment Geo Inv.
19-598-298
Structure 17 (Northern Abutment)
Dec 22, 2008
Abutment stability (short term)
Head slope 2H:1V & retaining wall



File: Bridge 17 ST ret wall 2 Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, old)	20	5	28
CLAY (Till)	20	10	28
SAND (compact)	19	0	32

FIGURE 9.6

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

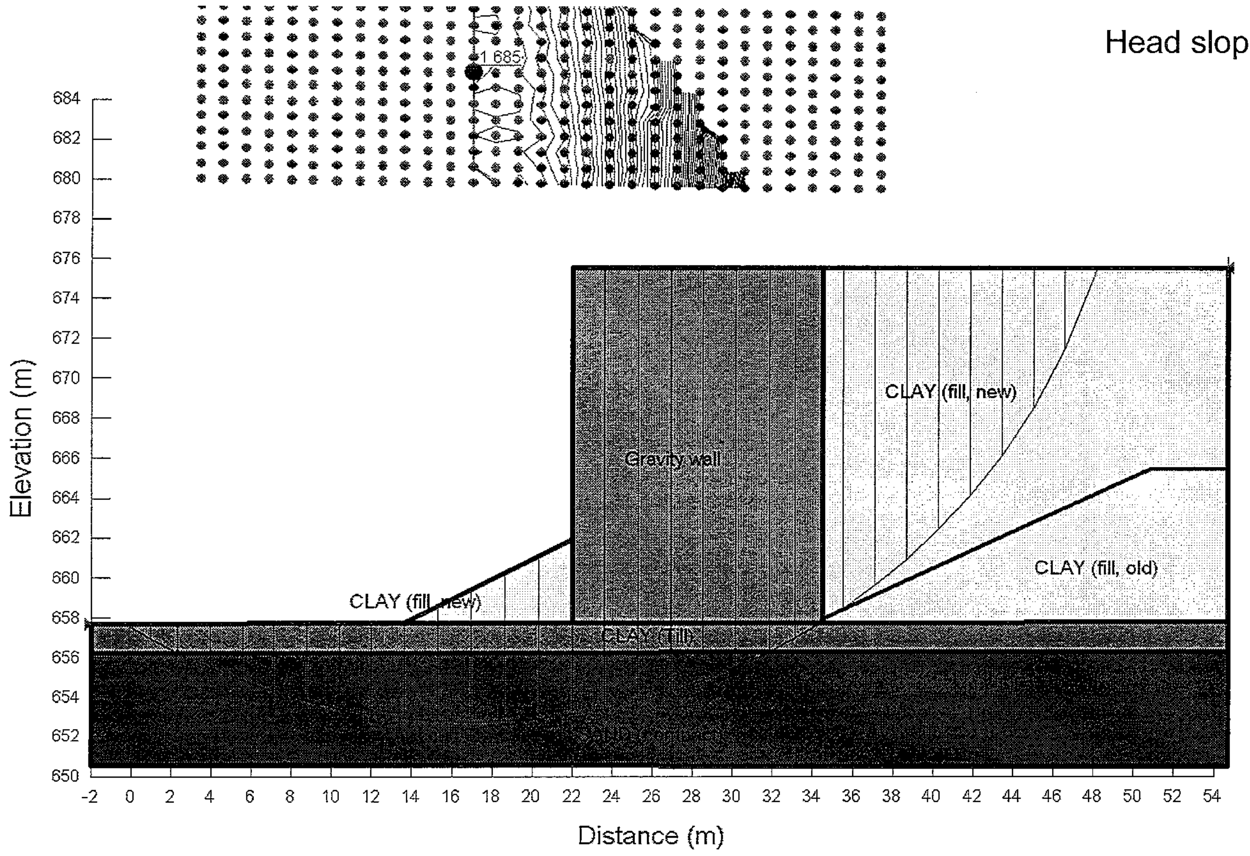
19-598-298

Structure 17 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 5H:1V & retaining wall



File: Bridge 17 LT ret wall 2 Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
GRAVEL (compact)	19	0	38	-	-
CLAY (Till)	20	10	28	-	0.3

FIGURE 9.7

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

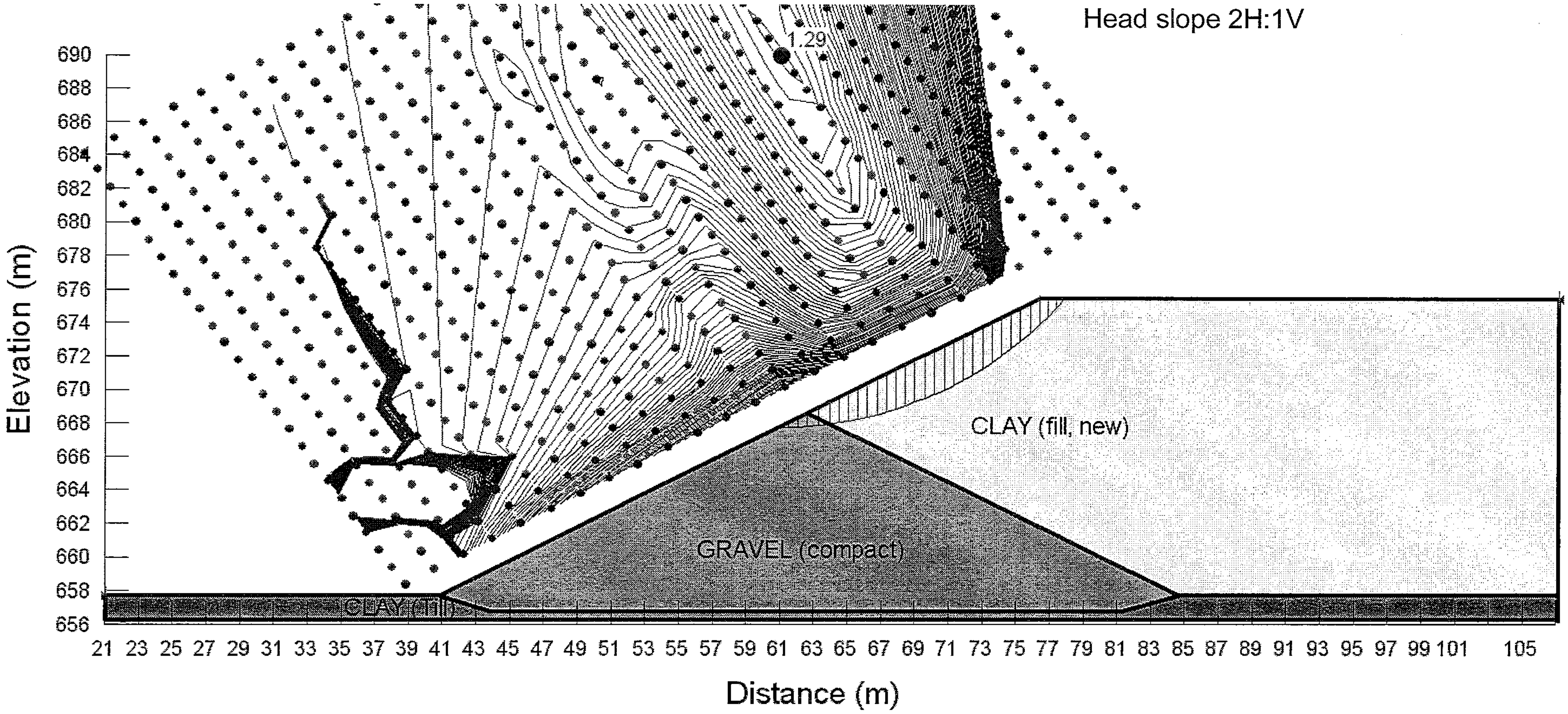
19-598-298

Structure 17 (Northern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 17 ST 2H to 1V + gravel wedge 2 Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
GRAVEL (compact)	19	0	38
CLAY (Till)	20	10	28

FIGURE 9.8

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

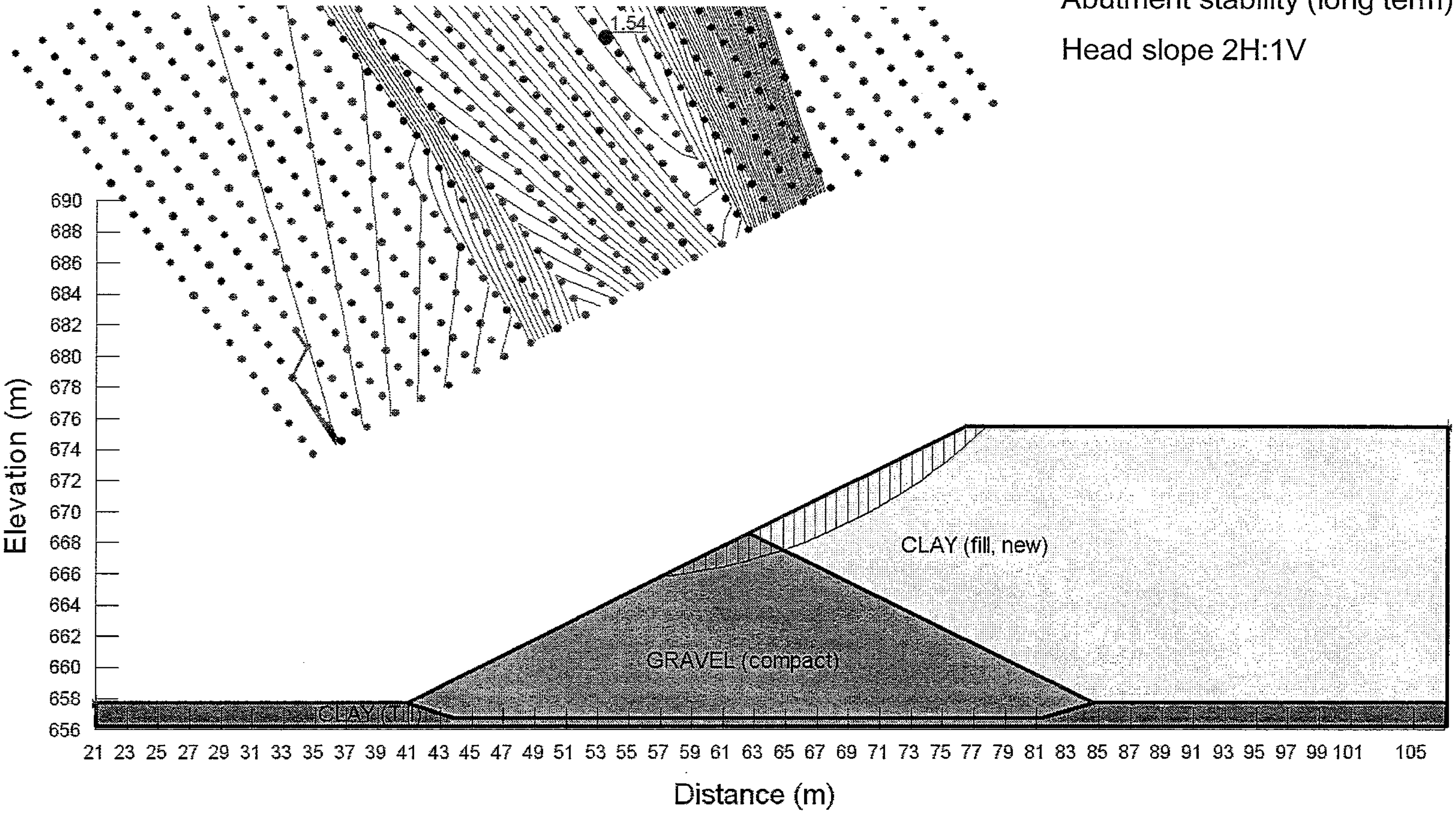
19-598-298

Structure 17 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 17 LT 2H to 1V + gravel wedge 2

Software: Slope/WVersion: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
SAND (loose)	18	0	30	-	-

FIGURE 9.9

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

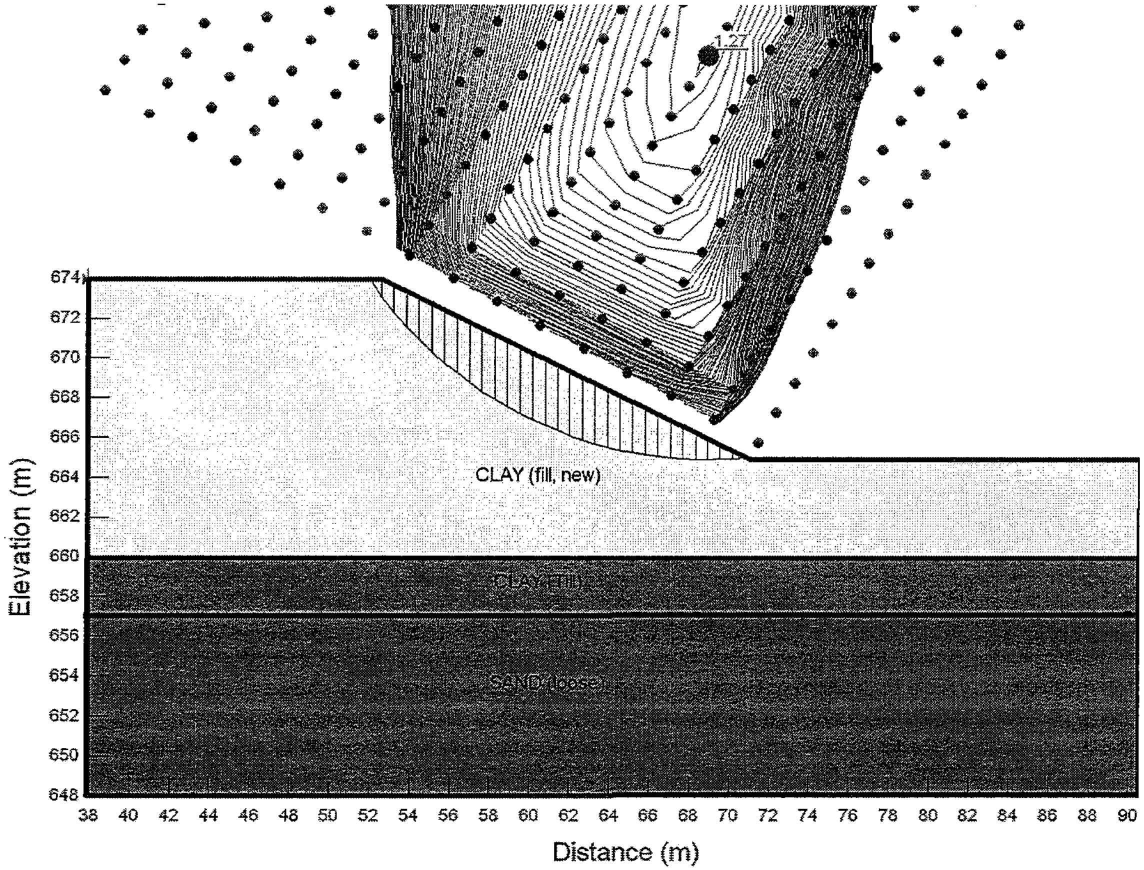
19-598-298

Structure 18 (Northern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 18 ST

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (Till)	20	10	28
SAND (loose)	18	0	30

FIGURE 9.10

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

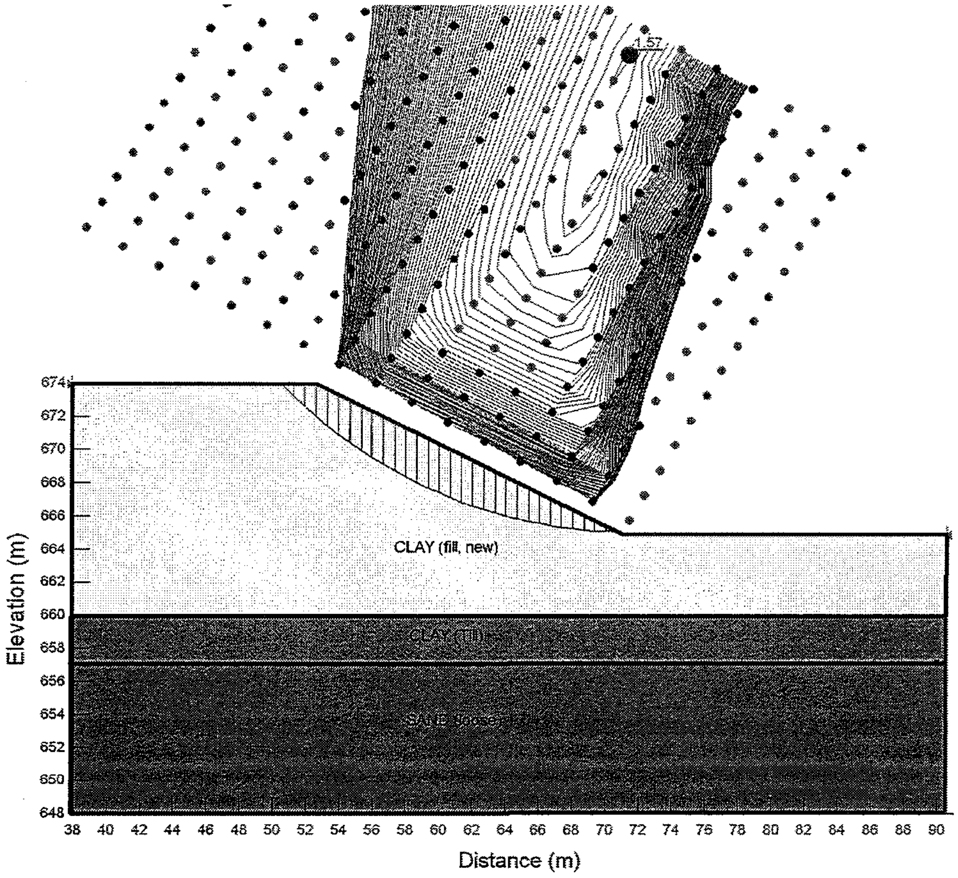
19-598-298

Structure 18 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File:Bridge 18 LT

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3

FIGURE 10.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

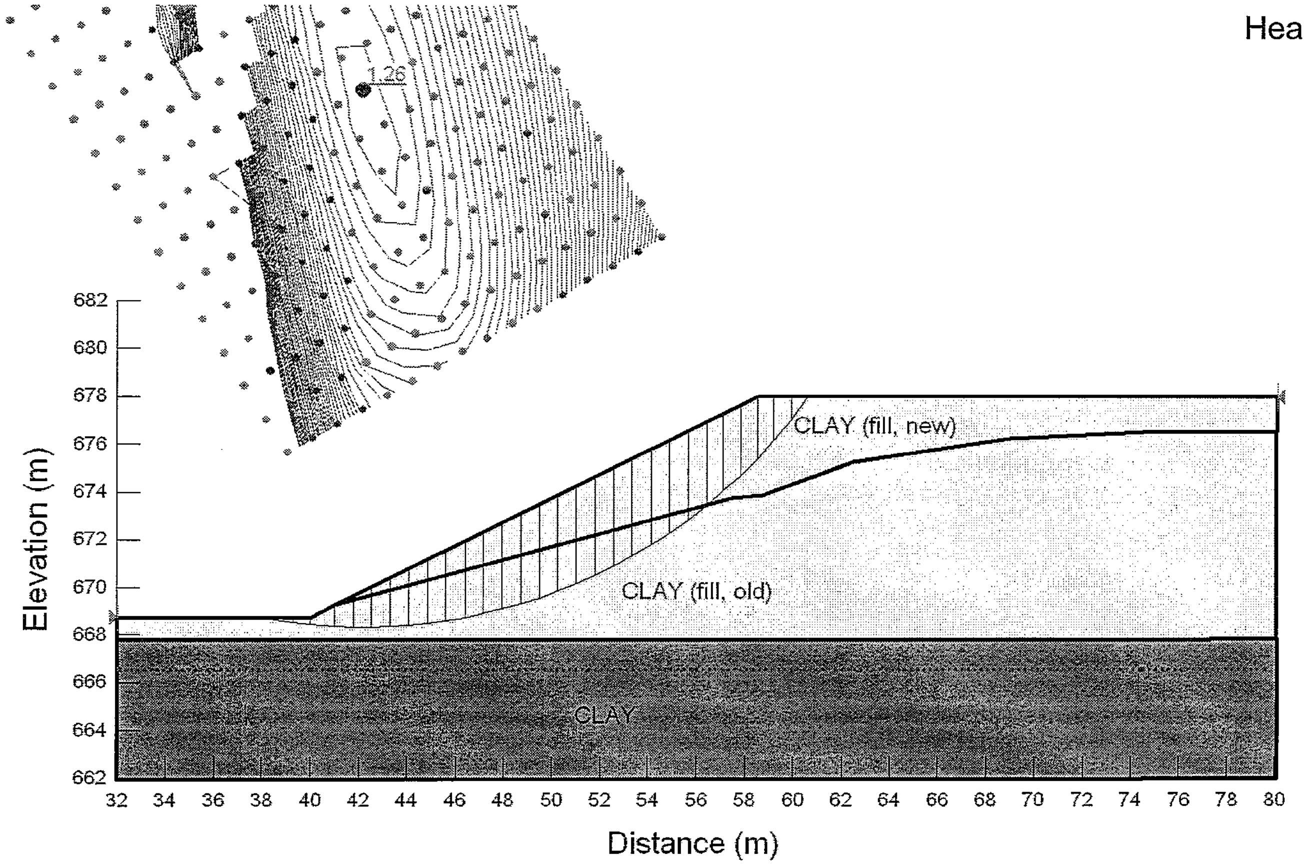
19-598-298

Structure 12

Dec 22, 2008

Abutment stability (short term)

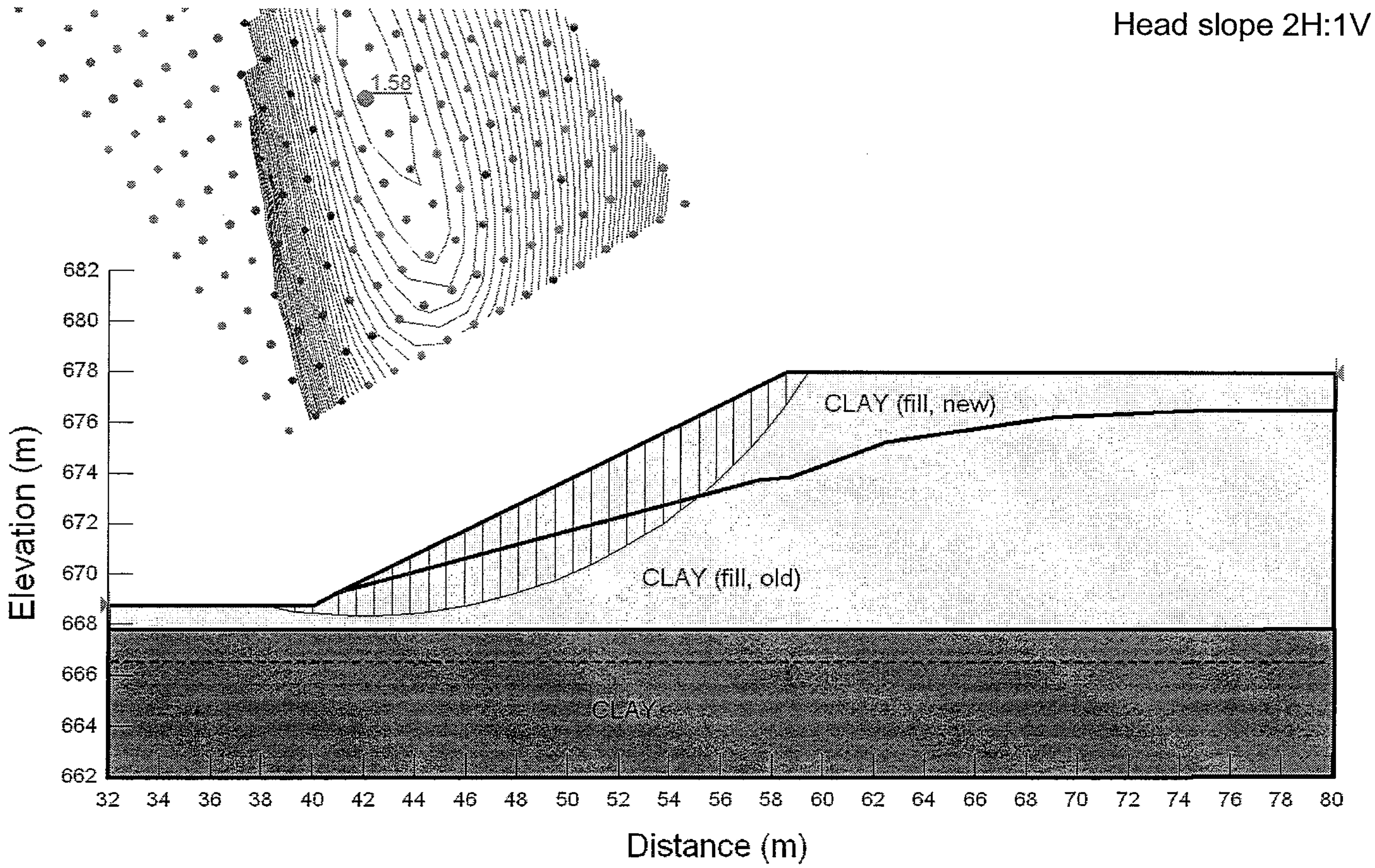
Head slope 2H:1V



File: Bridge 12 ST south abut Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, old)	20	5	28
CLAY (lacustrine)	18	5	23

FIGURE 10.2
Thurber Engineering Ltd – Edmonton
NEERR – AFPS Bridge Abutment Geo Inv.
19-598-298
Structure 12
Dec 22, 2008
Abutment stability (long term)
Head slope 2H:1V



File: Bridge 12 LT south abut   Software: Slope/W   Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (lacustrine)	18	5	23	-	0.3

FIGURE 11.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

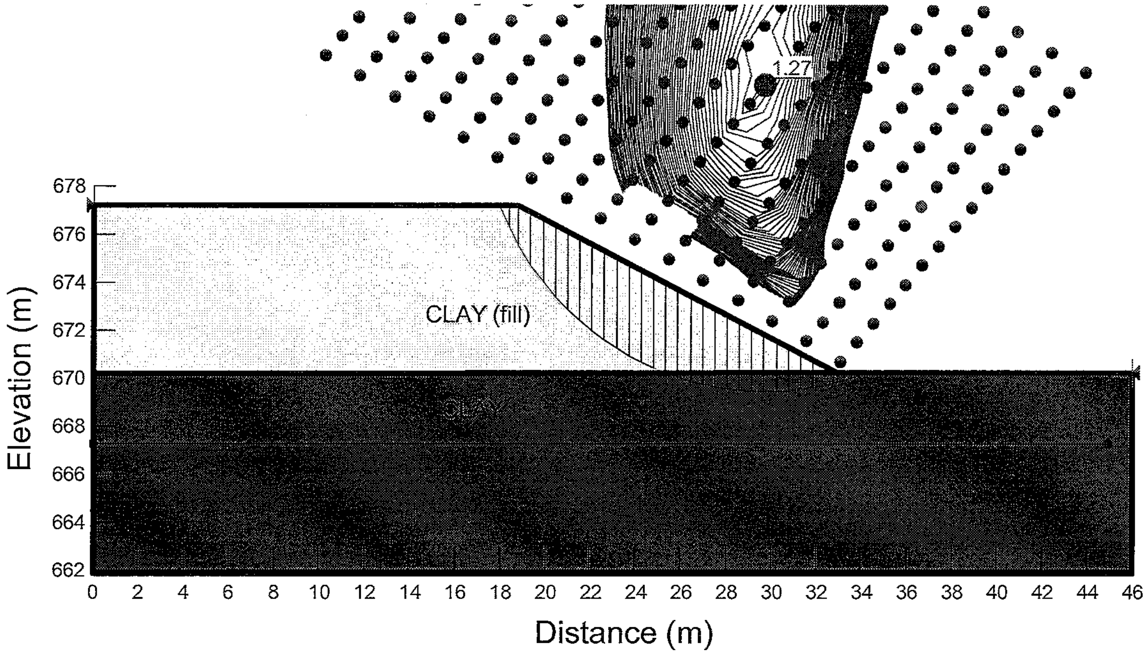
19-598-298

Structure 32

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 14 ST

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	φ' (°)
CLAY (fill, new)	20	5	28
CLAY (lacustrine)	18	5	23

FIGURE 11.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

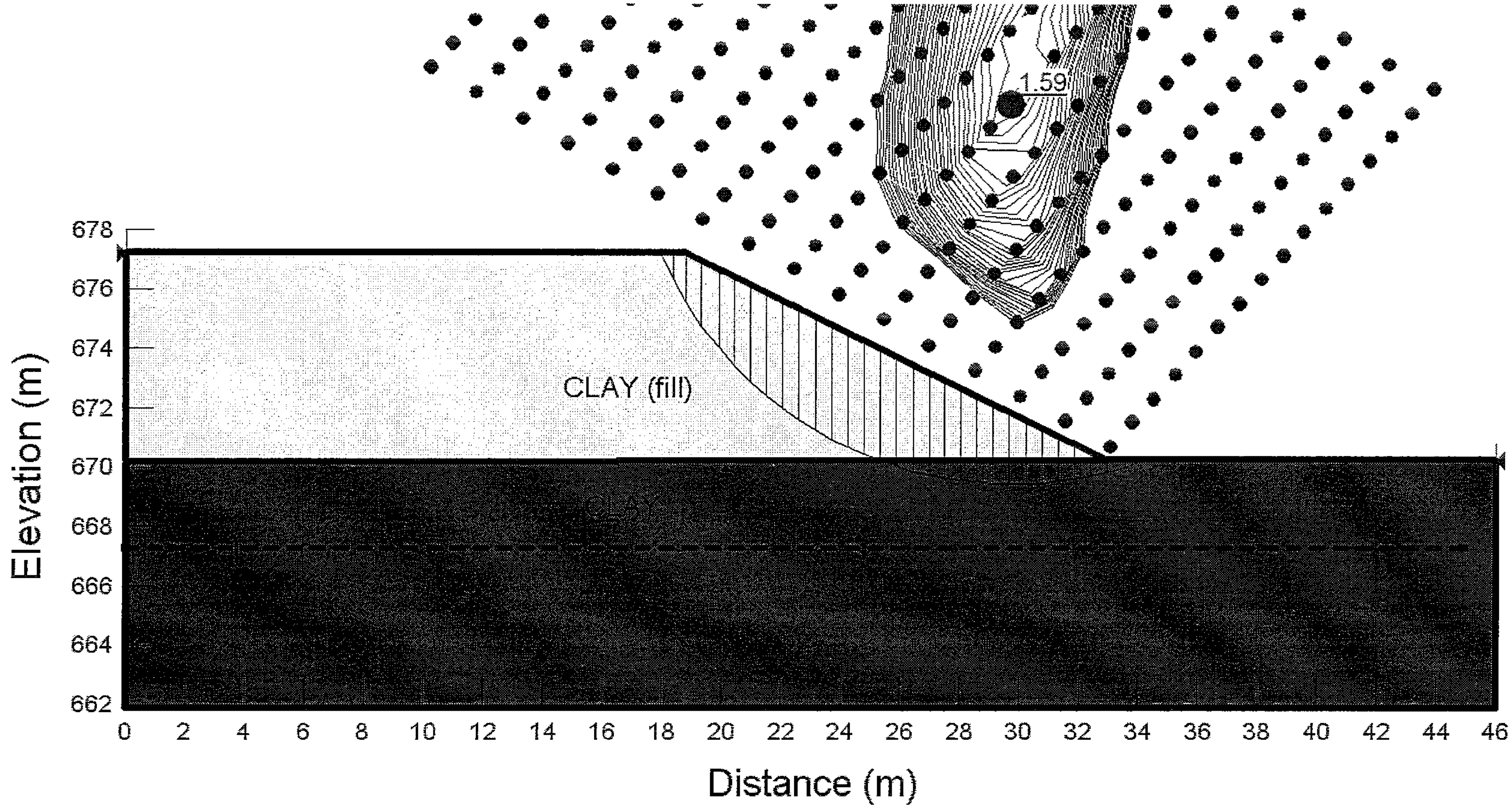
19-598-298

Structure 32

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
TOPSOIL	17	5	20	-	0.3
SAND (loose)	18	0	30	-	-
SAND (compact)	19	0	32	-	-
SAND (dense)	20	0	35	-	-
GRAVEL (compact)	19	0	38	-	-

FIGURE 12.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

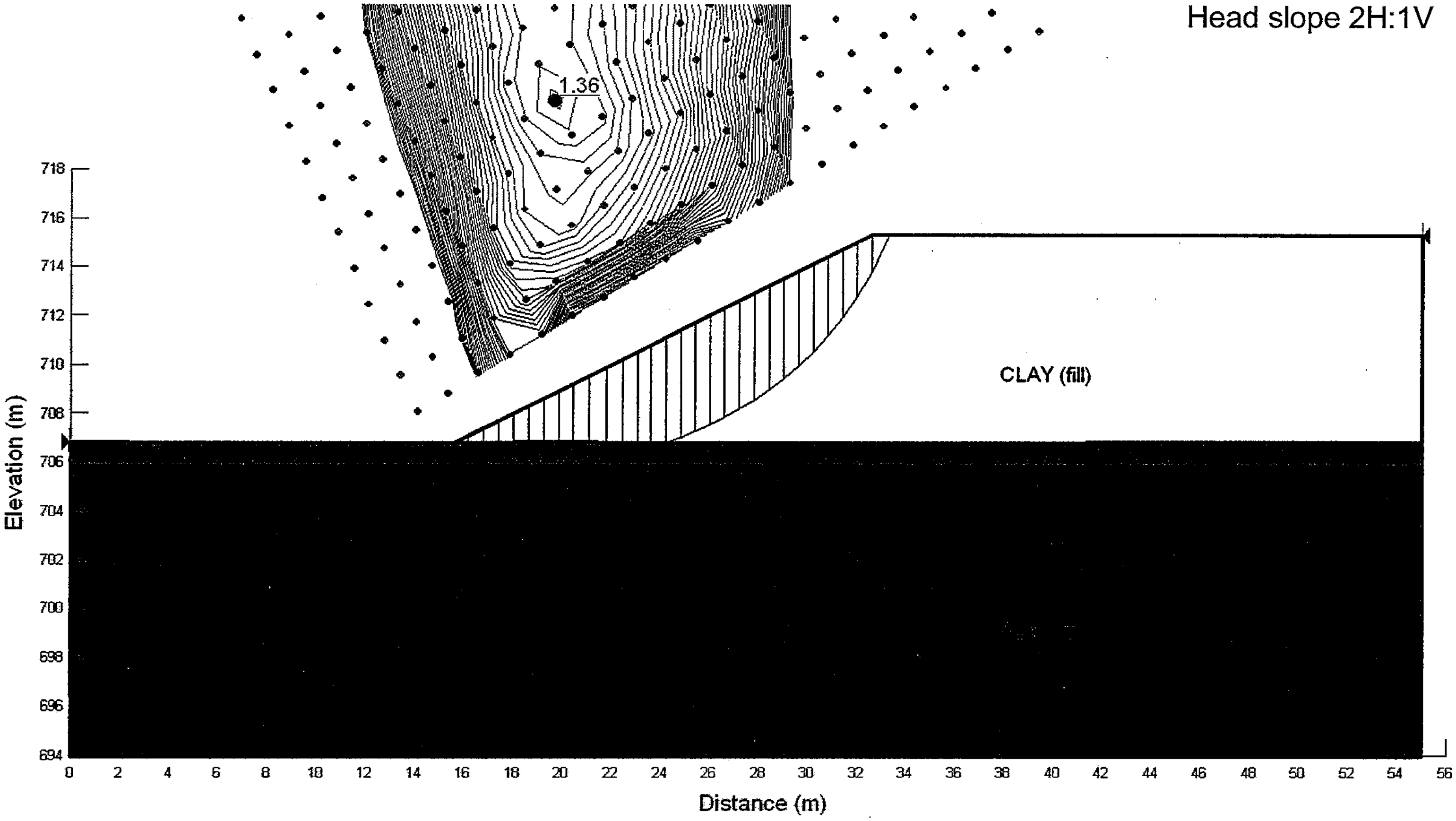
19-598-298

Structures 5 West, 7 & 8

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 5, 7 & 8 ST

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23
TOPSOIL	17	5	20
SAND (loose)	18	0	30
SAND (compact)	19	0	32
SAND (dense)	20	0	35
GRAVEL (compact)	19	0	38

FIGURE 12.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

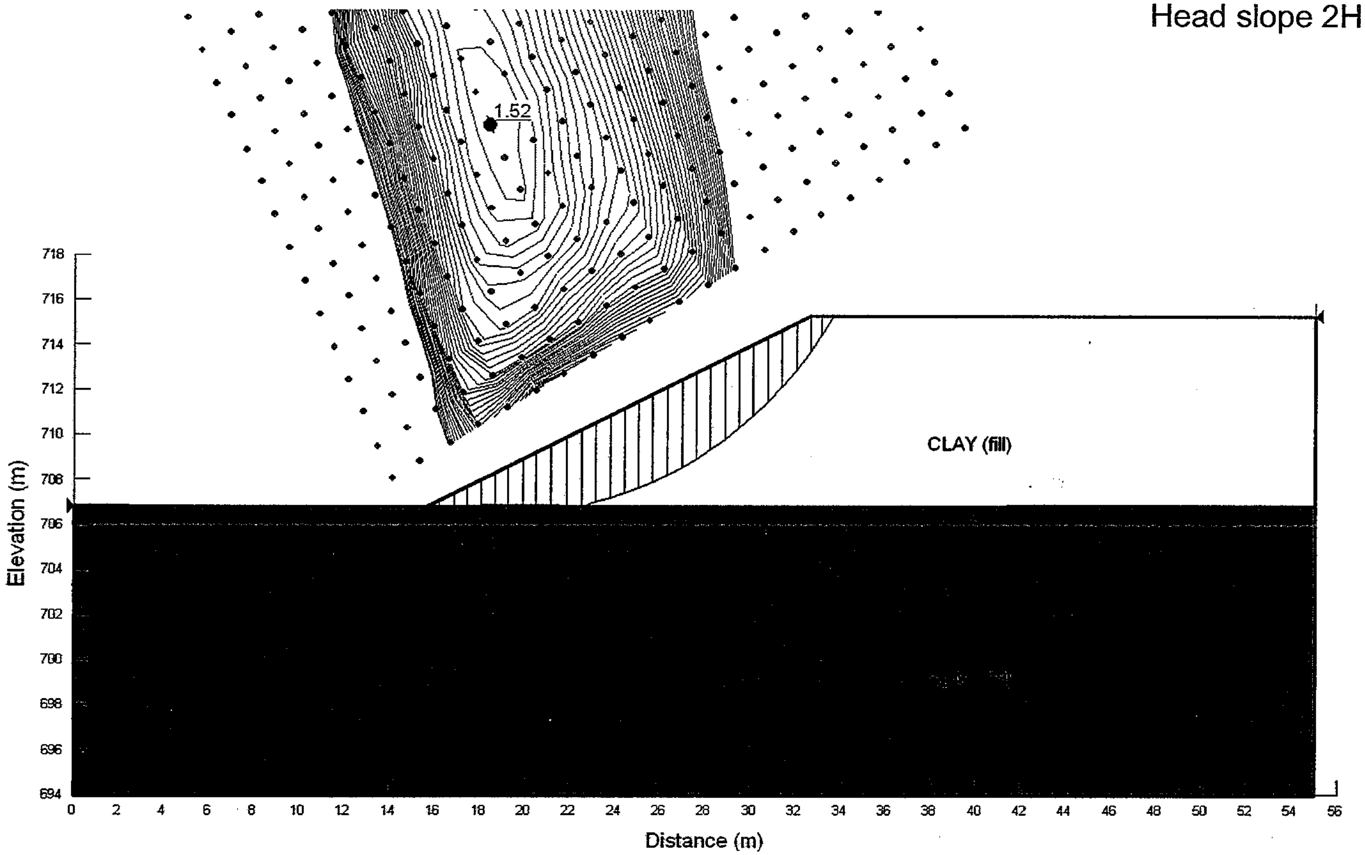
19-598-298

Structure 5 West, 7 & 8

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 5, 7 & 8 LT`   Software: Slope/W   Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3

FIGURE 12.3

Thurber Engineering Ltd – Edmonton

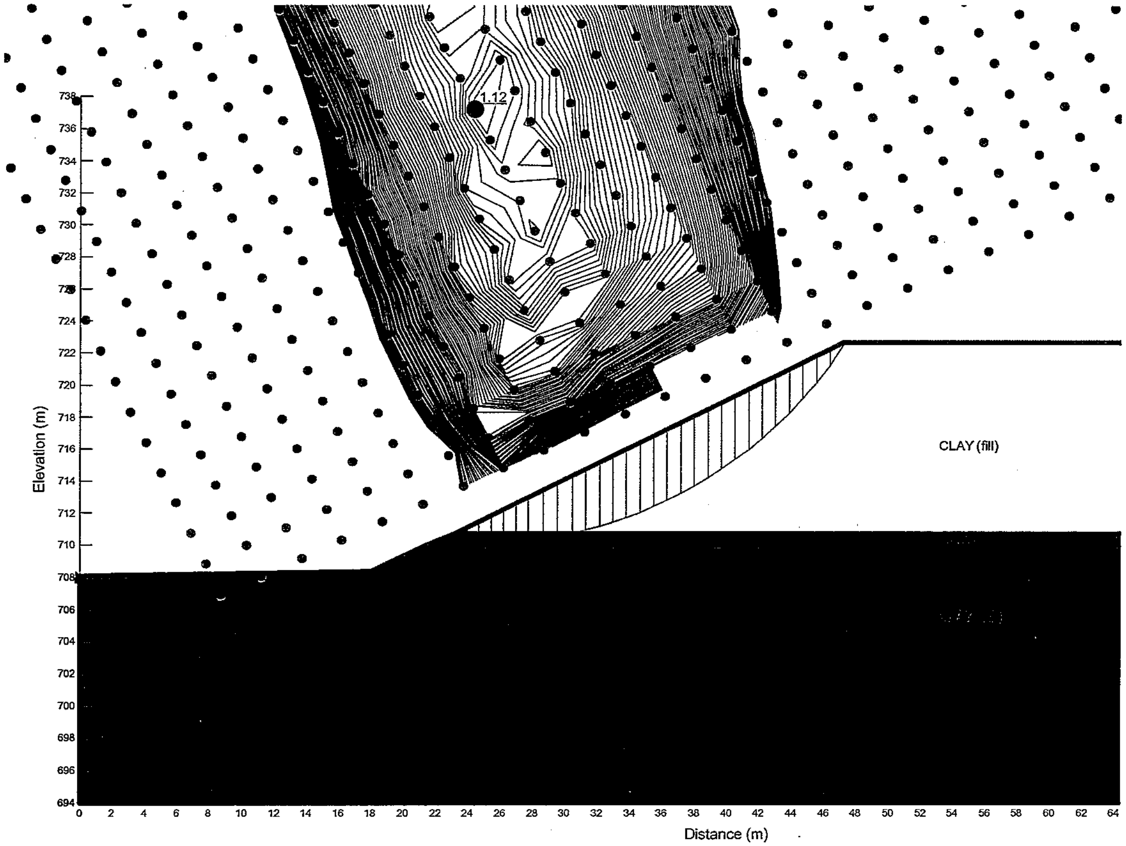
NEERR – AFPS Bridge Abutment Geo Inv.

19-598-298

Structures 5 East & 6, Dec 15, 2009

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 5, 7 & 8 ST

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23

FIGURE 12.4

Thurber Engineering Ltd – Edmonton

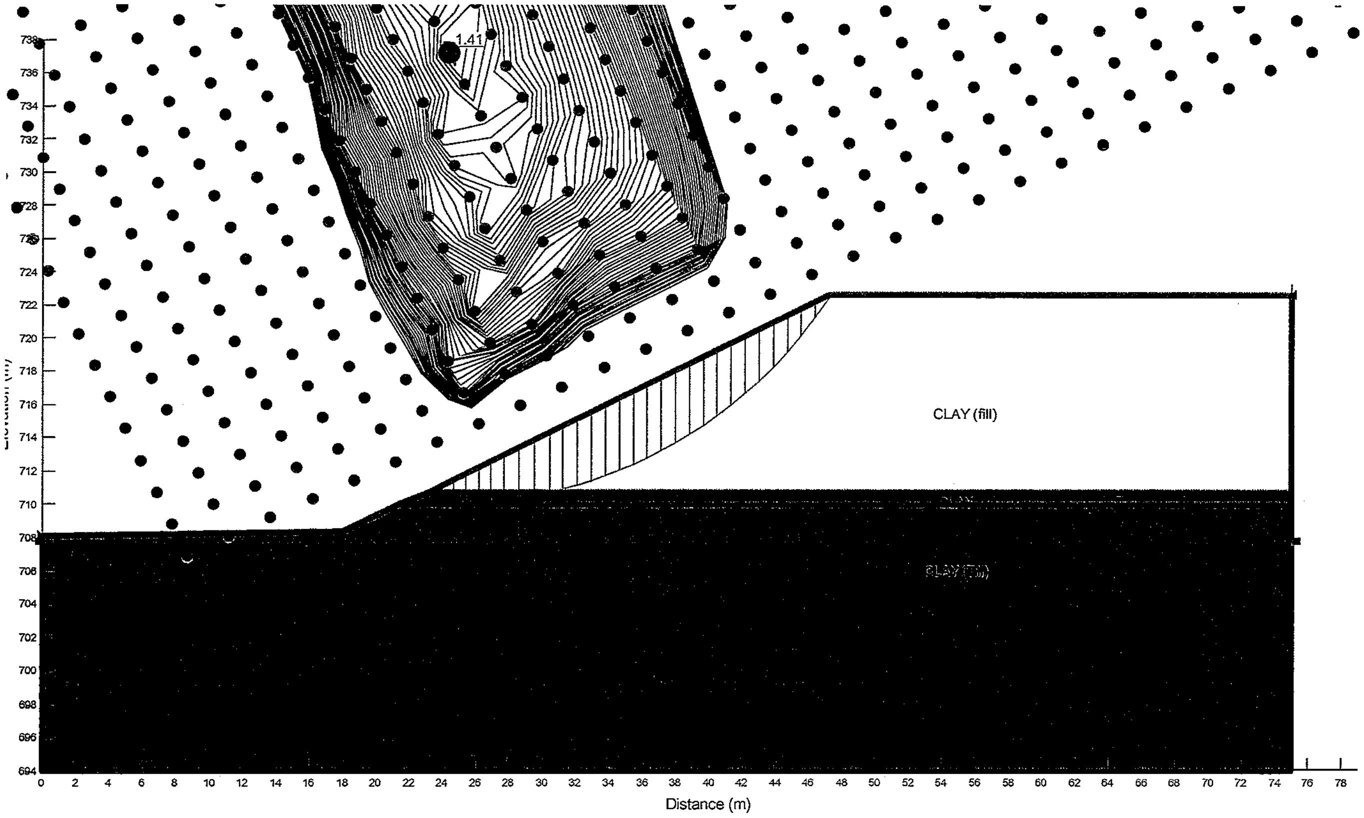
NEERR – AFPS Bridge Abutment Geo Inv.

19-598-298

Structures 5 East, 6, September, 2009

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 5 LT`　　Software: Slope/W　　Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
GRAVEL (compact)	19		38		

FIGURE 12.5

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

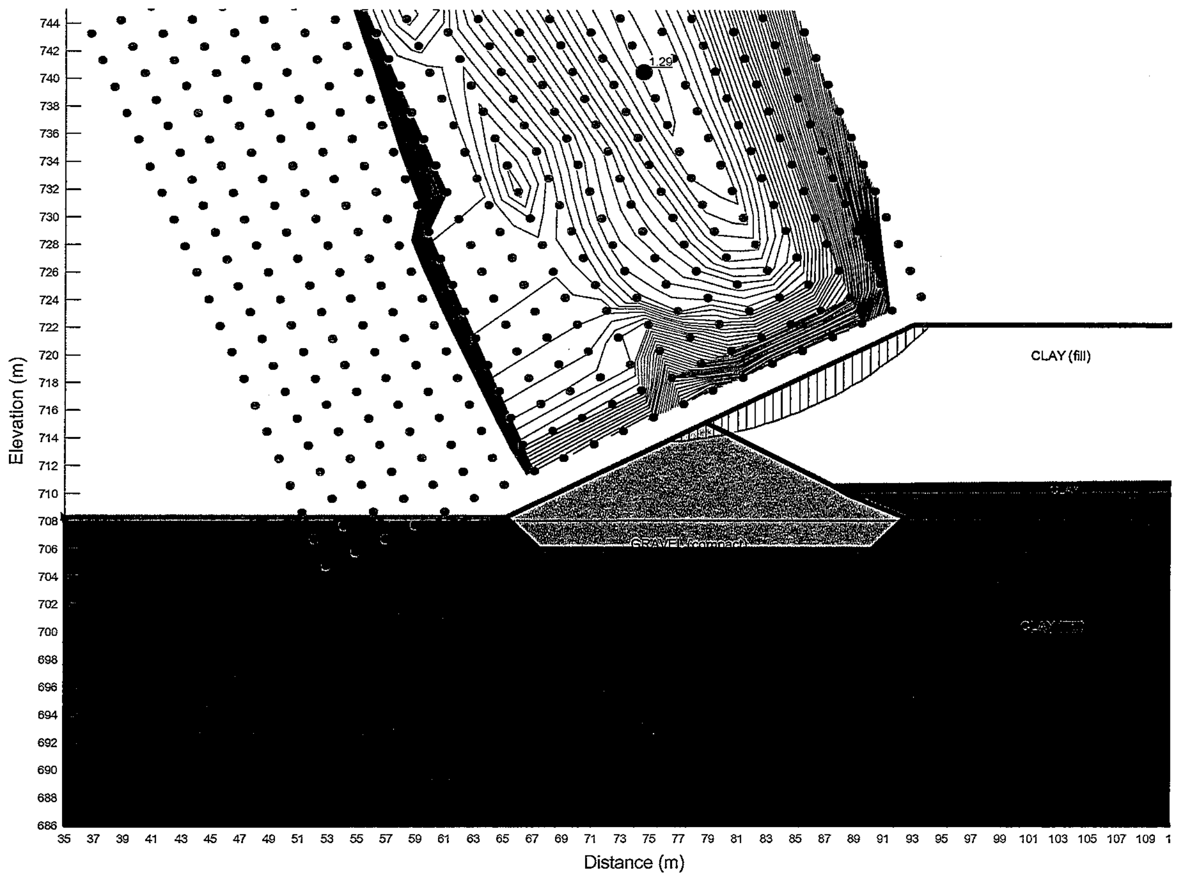
19-598-298

Structures 5 East & 6, Dec 15, 2009

Abutment stability (short term) with

Gravel Wedge

Head slope 2H:1V



File: Bridge 5, 7 & 8 ST Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23
GRAVEL (compact)	19		38

FIGURE 12.6

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

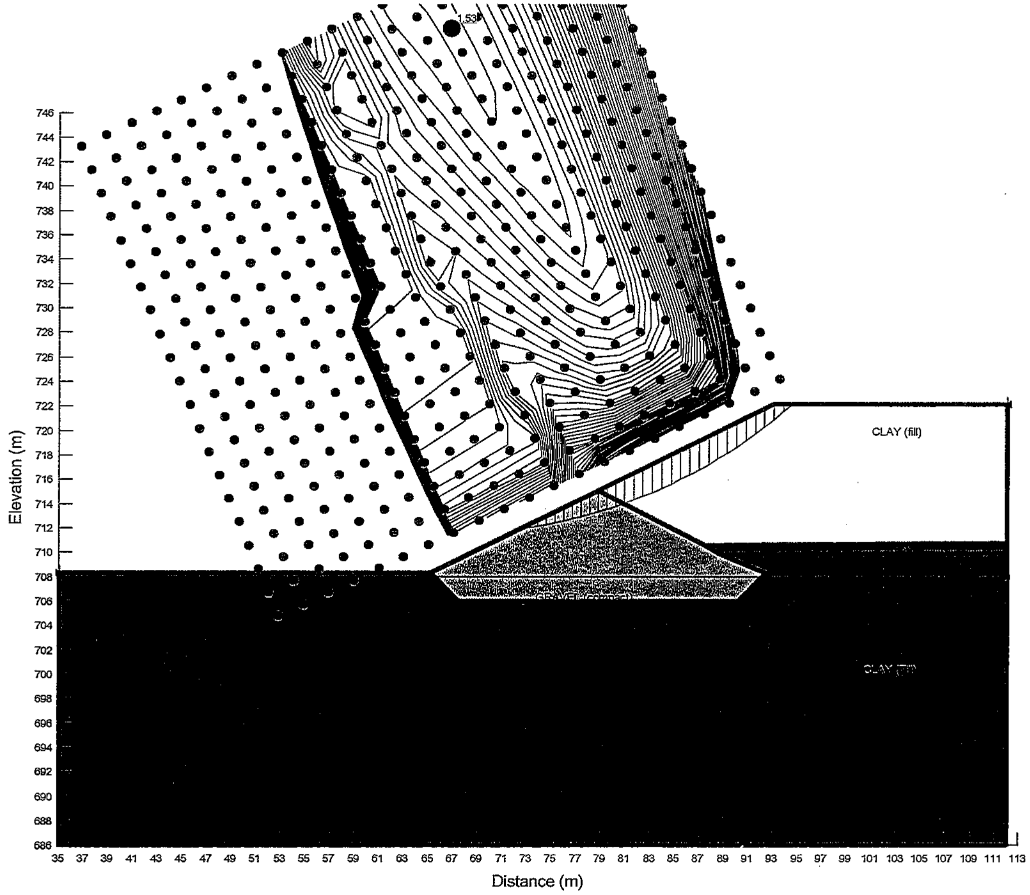
19-598-298

Structures 5 East & 6, Dec 15, 2009

Abutment stability (long term) with

Gravel Wedge

Head slope 2H:1V



File: Bridge 5 East, 6 Long Term

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R$_u$	B$_{bar}$
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
TOPSOIL	17	5	20	-	0.3
SAND (loose)	18	0	30	-	-
SAND (compact)	19	0	32	-	-
SAND (dense)	20	0	35	-	-
GRAVEL (compact)	19	0	38	-	-

FIGURE 13.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

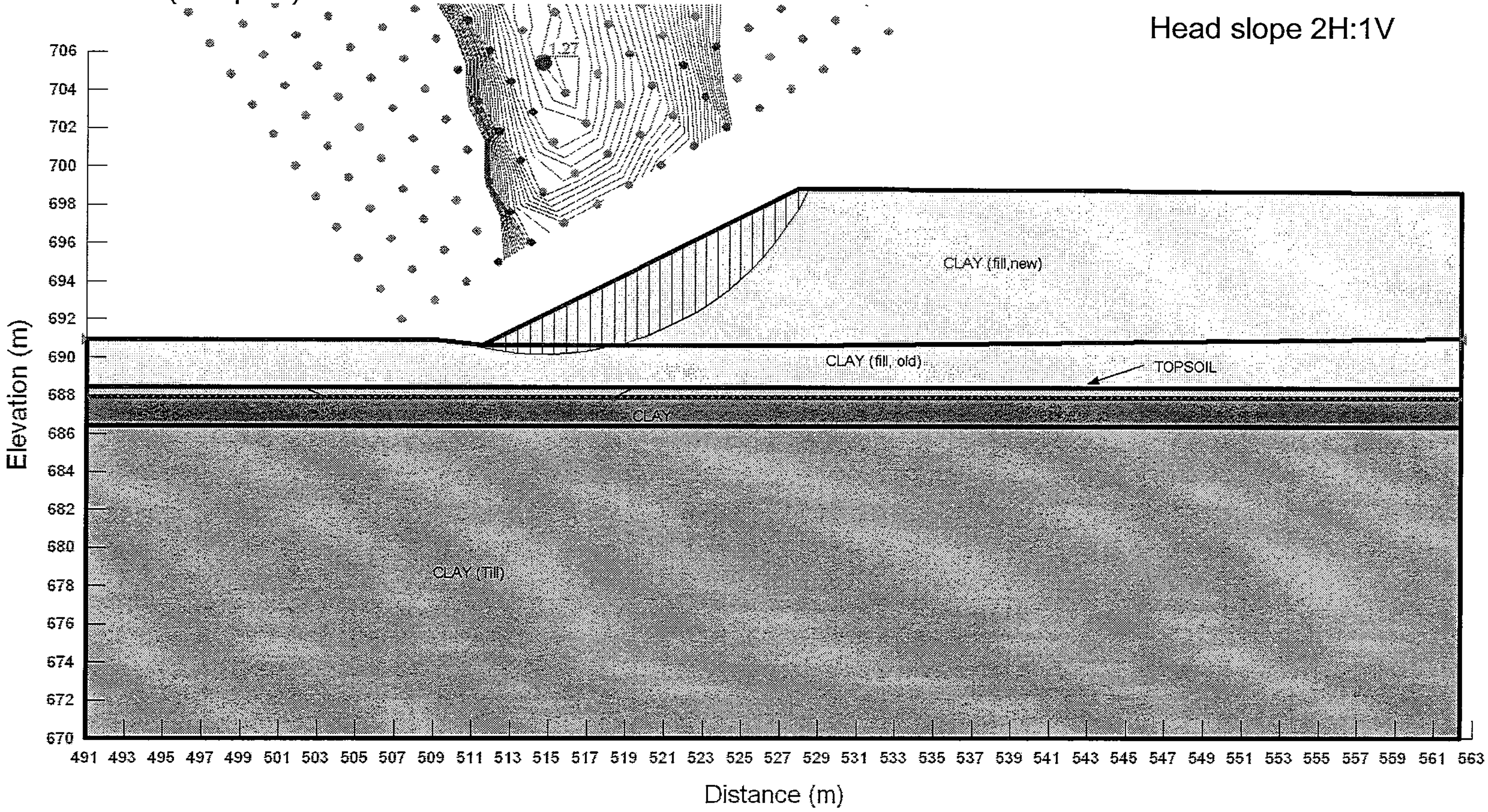
19-598-298

Structure 4 (Northern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 4 ST w rem & rep   Software: Slope/W   Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23
TOPSOIL	17	5	20
SAND (loose)	18	0	30
SAND (compact)	19	0	32
SAND (dense)	20	0	35
GRAVEL (compact)	19	0	38

FIGURE 13.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

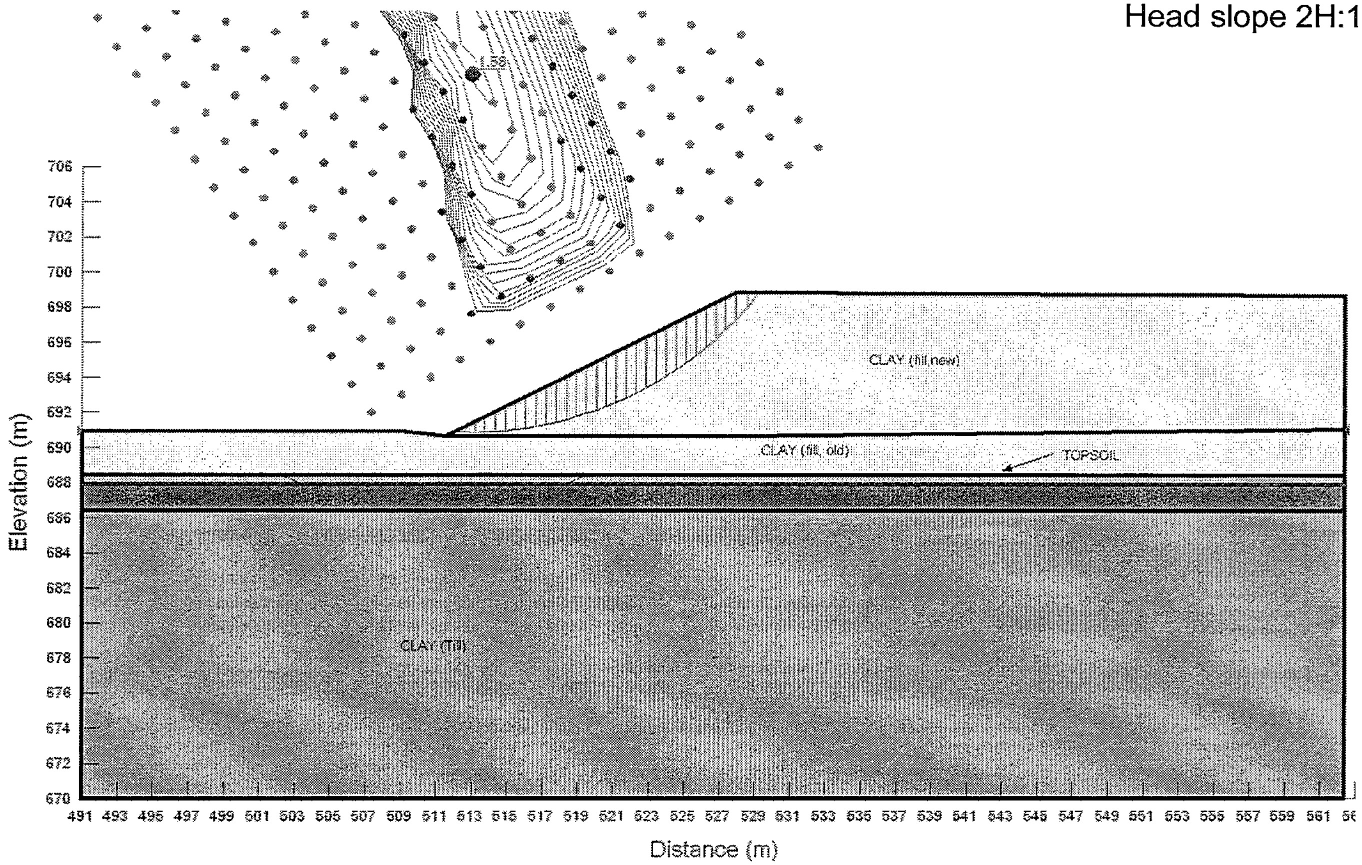
19-598-298

Structure 4 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 4 LT w rem & rep Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
TOPSOIL	17	5	20	-	0.3
SAND (loose)	18	0	30	-	-
SAND (compact)	19	0	32	-	-
SAND (dense)	20	0	35	-	-
GRAVEL (compact)	19	0	38	-	-

FIGURE 14.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

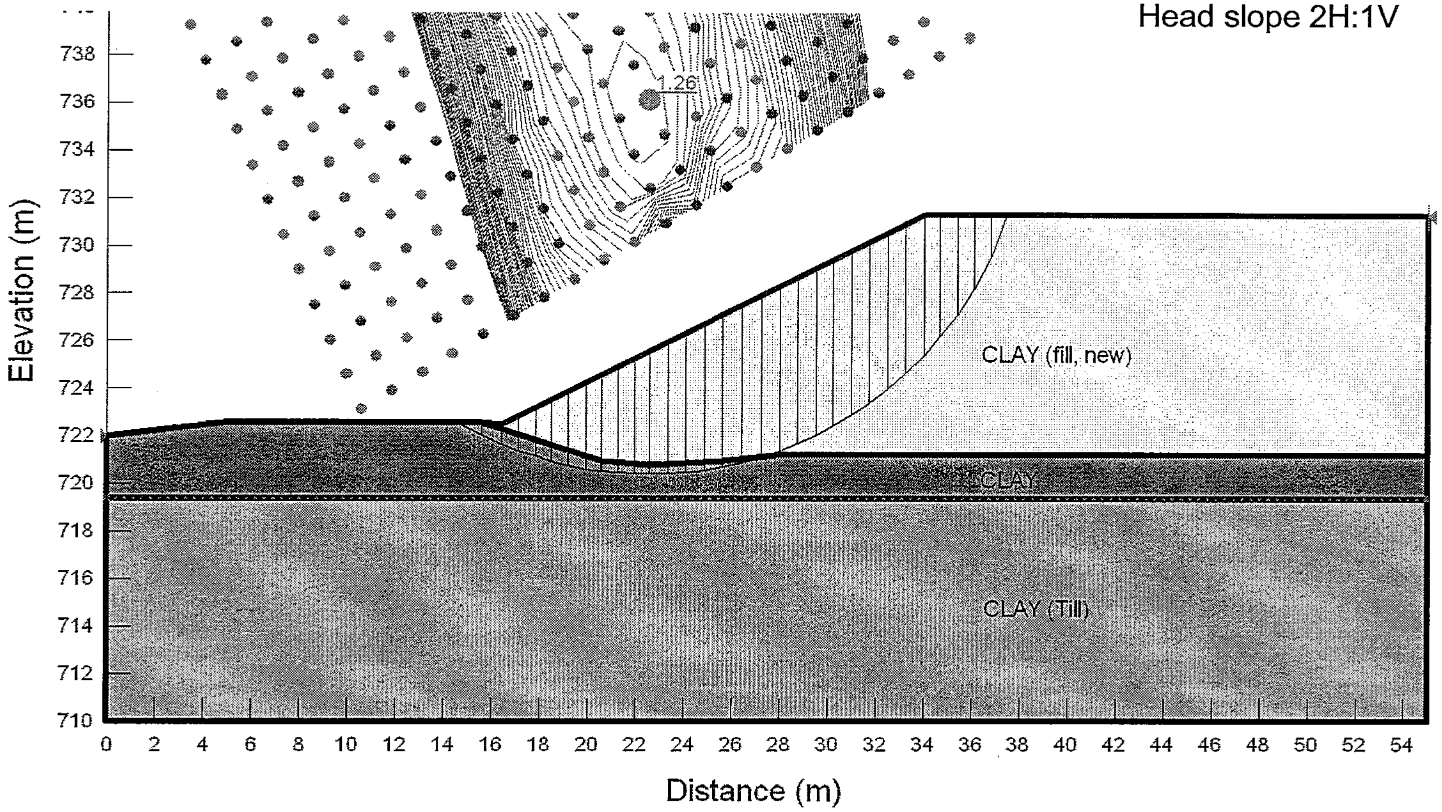
19-598-298

Structure 1 (Eastern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 1 ST Software: Slope/W Version: 7.12

FIGURE 14.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

19-598-298

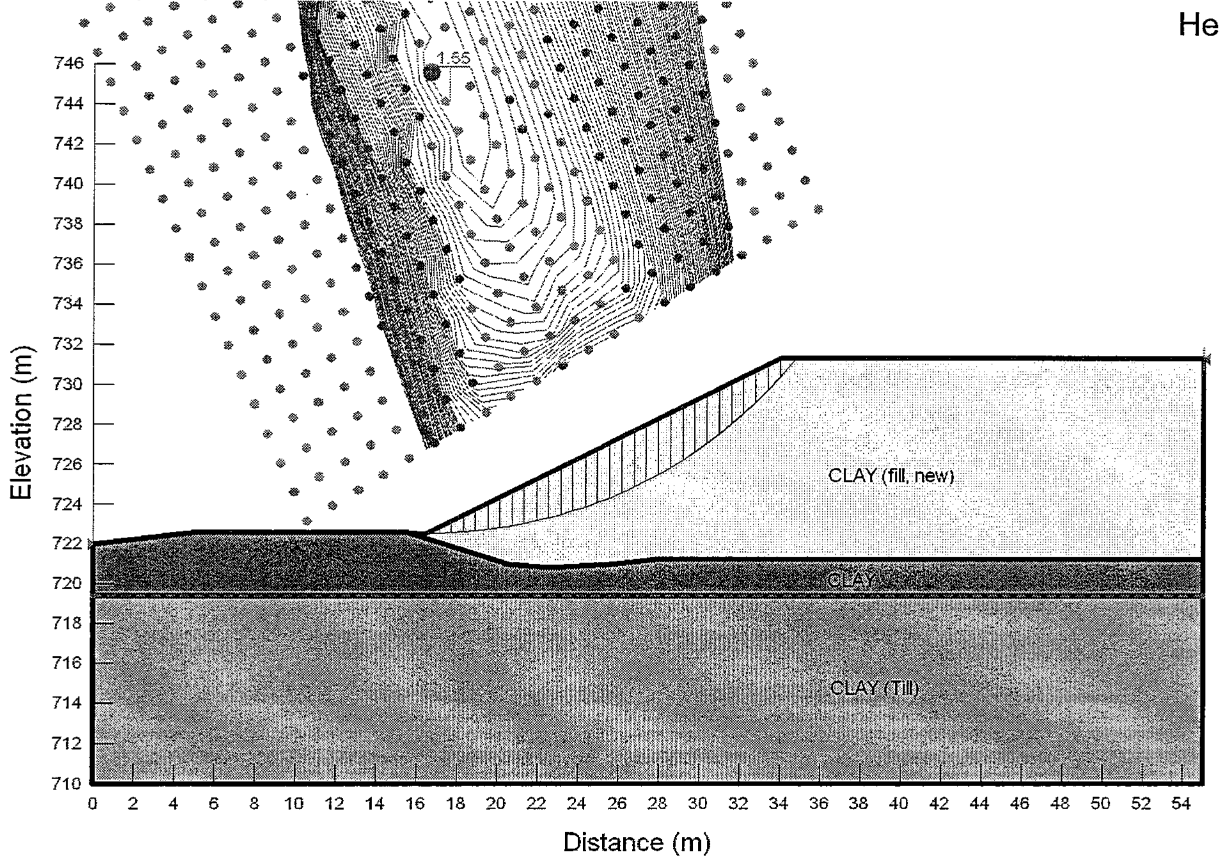
Structure 1 (Eastern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
TOPSOIL	17	5	20	-	0.3
SAND (loose)	18	0	30	-	-
SAND (compact)	19	0	32	-	-
SAND (dense)	20	0	35	-	-
GRAVEL (compact)	19	0	38	-	-



File: Bridge 1 LT

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23
TOPSOIL	17	5	20
SAND (loose)	18	0	30
SAND (compact)	19	0	32
SAND (dense)	20	0	35
GRAVEL (compact)	19	0	38

FIGURE 14.3

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

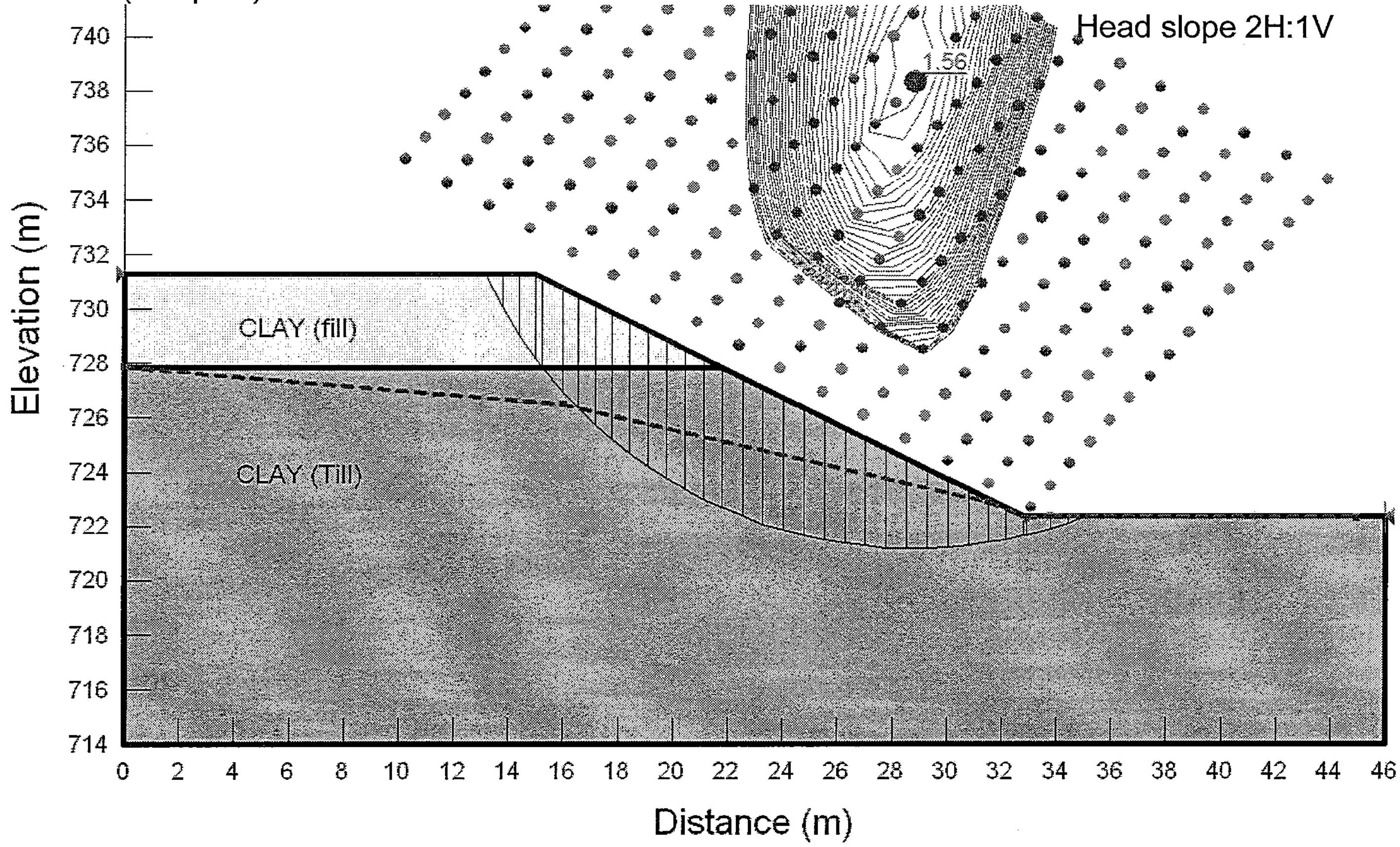
19-598-298

Structure 2 & 3

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 2&3 LT

Software: Slope/W

Version: 7.12

FIGURE 15.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

19-598-298

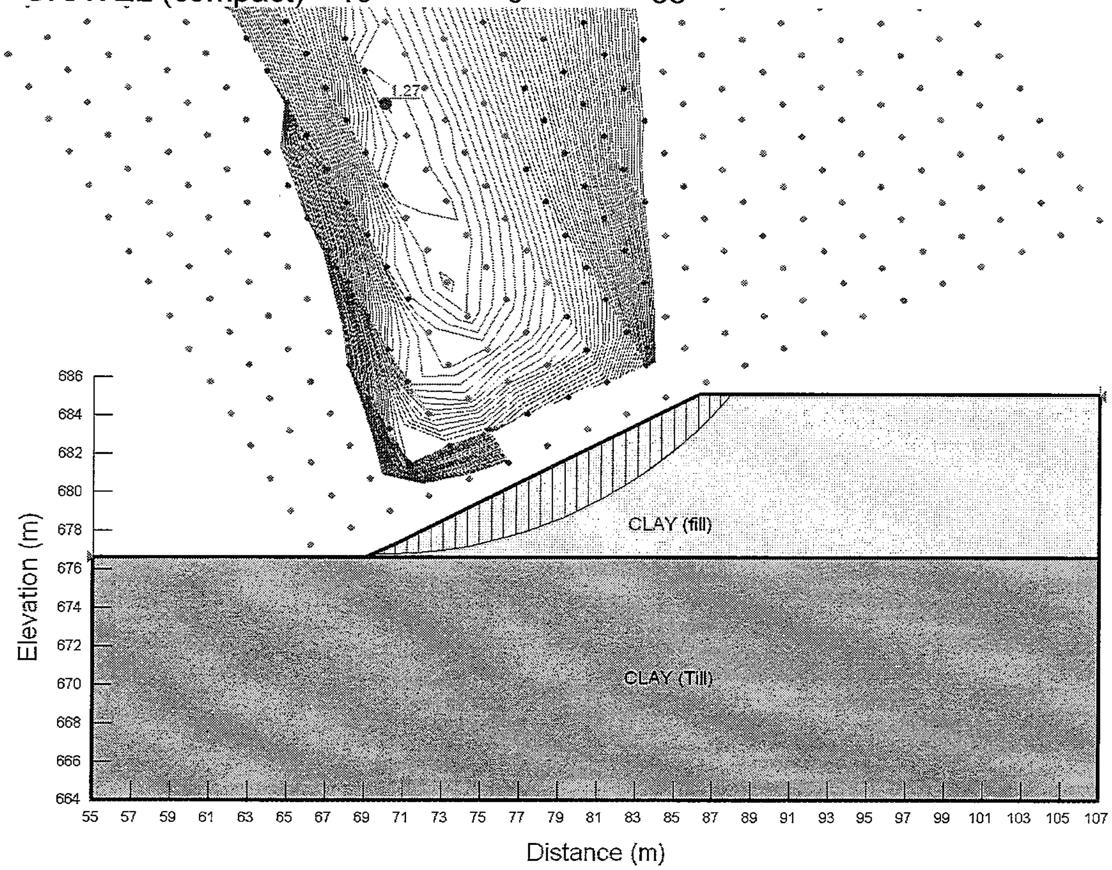
Structure 31 (Northern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
TOPSOIL	17	5	20	-	0.3
SAND (loose)	18	0	30	-	-
SAND (compact)	19	0	32	-	-
SAND (dense)	20	0	35	-	-
GRAVEL (compact)	19	0	38	-	-



File: Bridge 31 ST 2H to 1V

Software: Slope/W

Version: 7.12

Material	γ (kN/m³)	c' (kPa)	ϕ' (°)
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23
TOPSOIL	17	5	20
SAND (loose)	18	0	30
SAND (compact)	19	0	32
SAND (dense)	20	0	35
GRAVEL (compact)	19	0	38

FIGURE 15.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

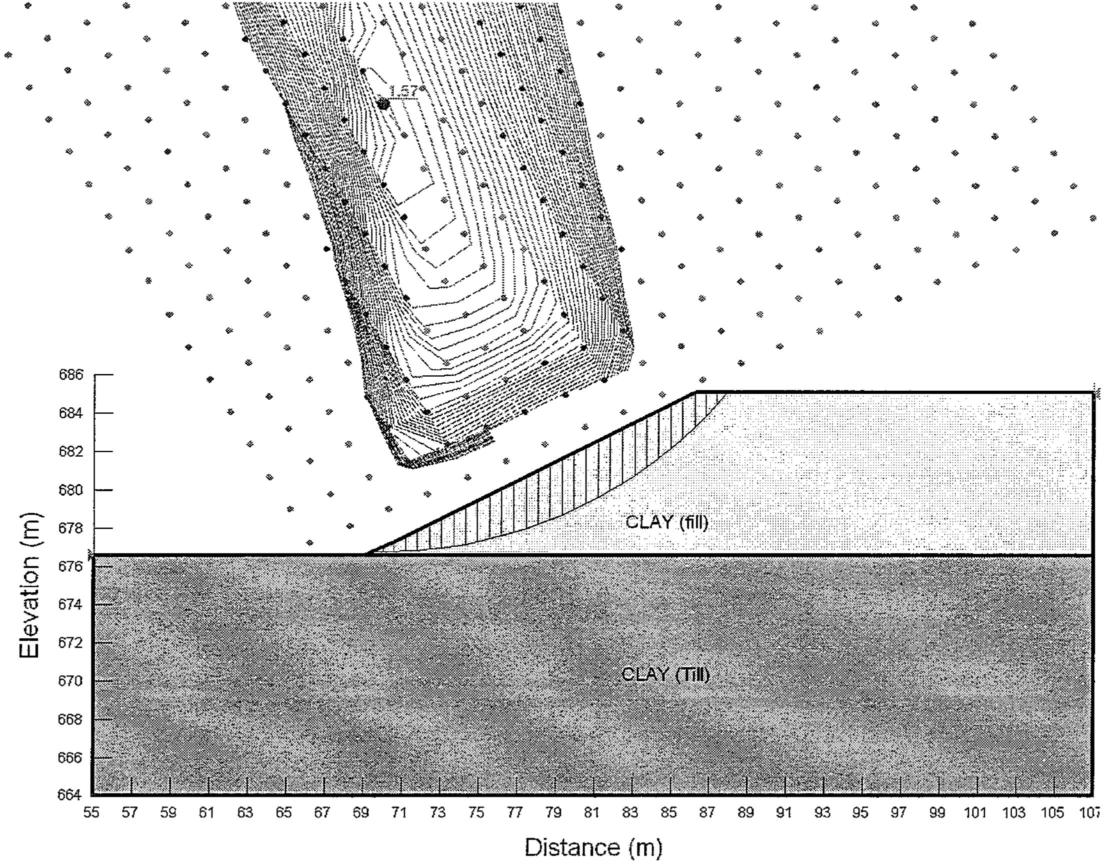
19-598-298

Structure 31 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 31 LT 2H to 1V

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3

FIGURE 15.3

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

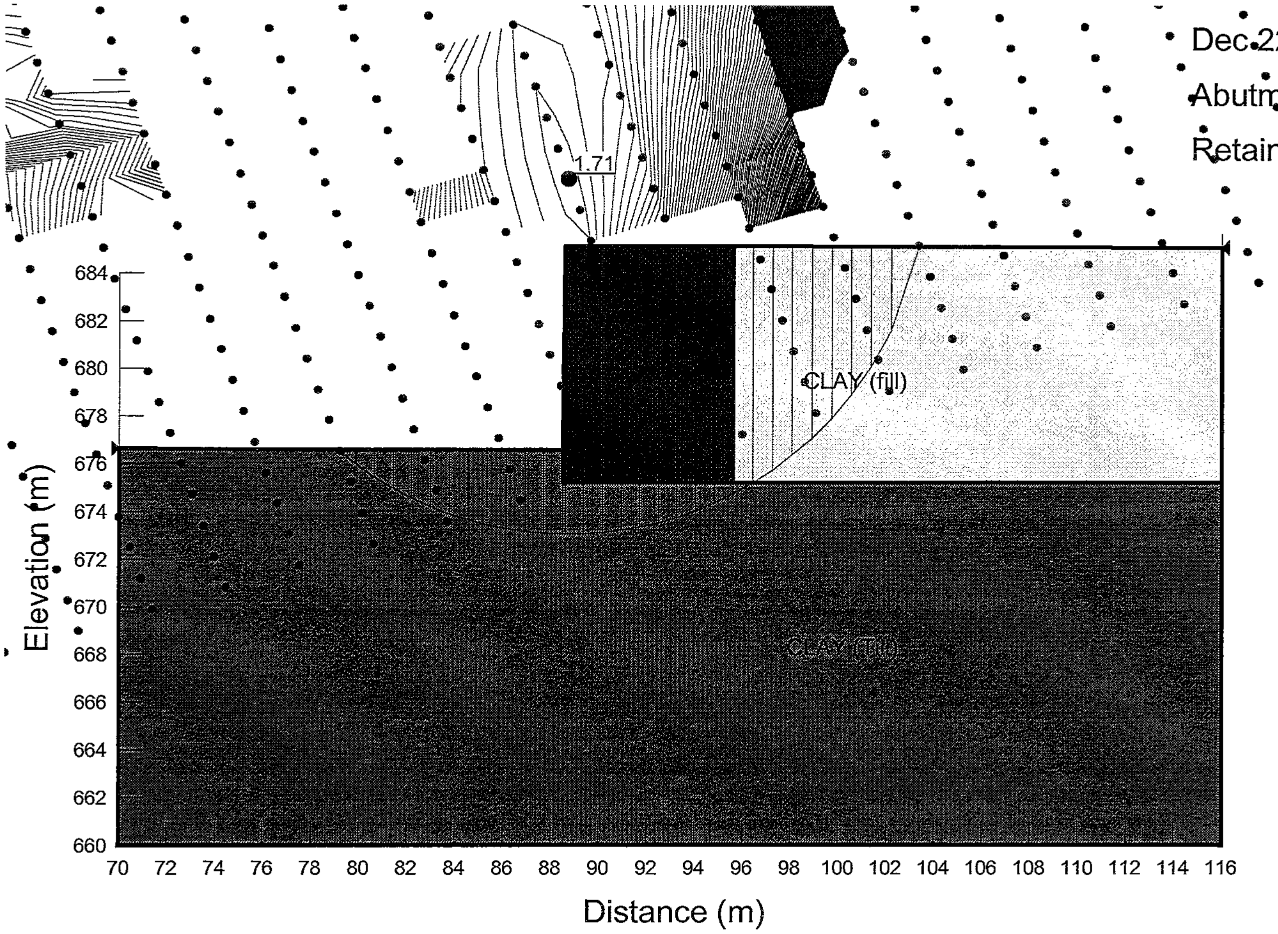
19-598-298

Structure 31 (Northern Abutment)

Dec 22, 2008

Abutment stability (short term)

Retaining wall



File: Bridge 31 ST grav vert wall

Software: Slope/W

Version: 7.12

Material	γ (kN/m³)	c' (kPa)	ϕ' (°)
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23

FIGURE 15.4

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

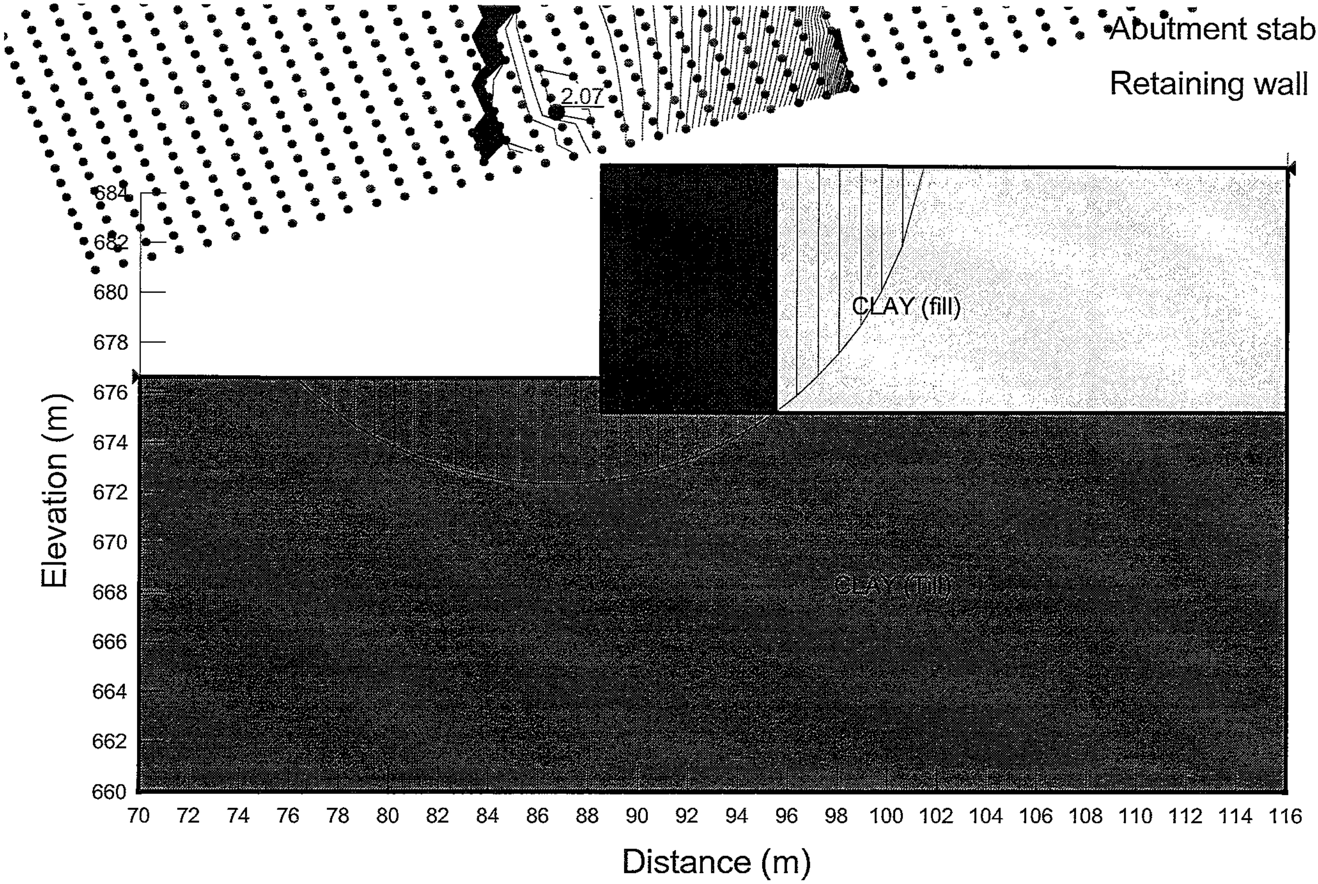
19-598-298

Structure 31 (Northern Abutment)

Dec 22, 2008

Abutment stability (long term)

Retaining wall



File: Bridge 31 LT grav vert wall

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
SAND (dense)	20	0	35	-	-
CLAY (lacustrine)	18	5	23	-	0.3
CLAY (Till)	20	10	28	-	0.3

FIGURE 16.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

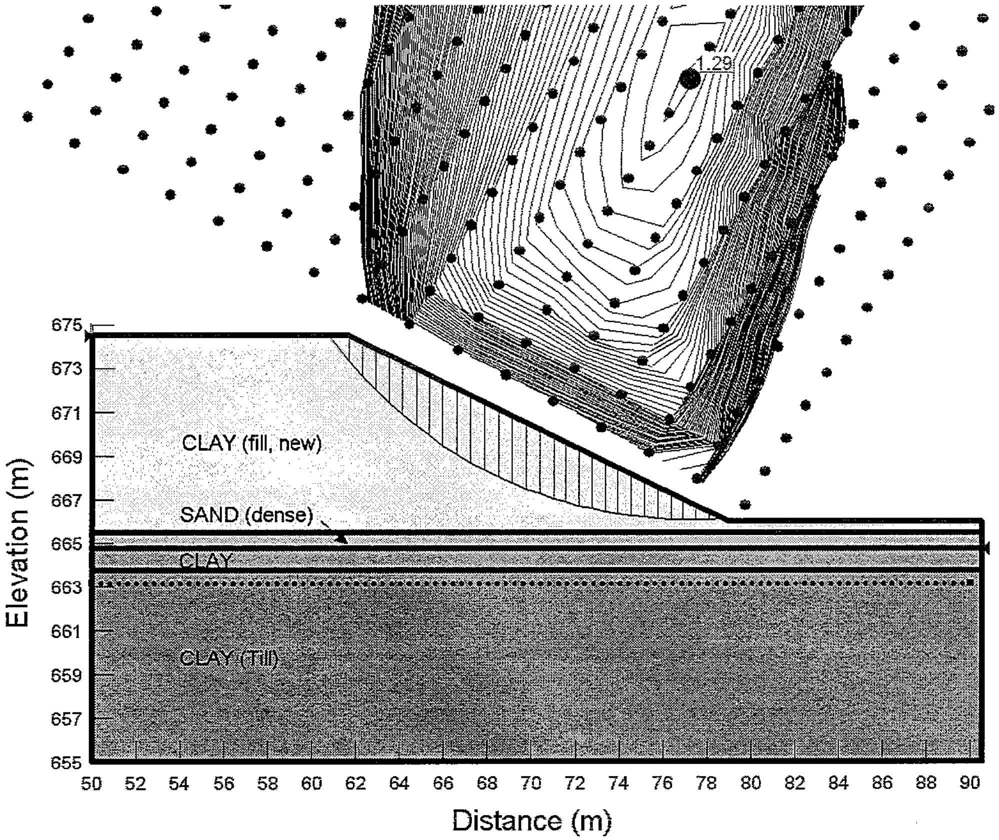
19-598-298

Structure 22 (Western Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 22 ST replacement

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
SAND (dense)	20	0	35
CLAY (lacustrine)	18	5	23
CLAY (Till)	20	10	28

FIGURE 16.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

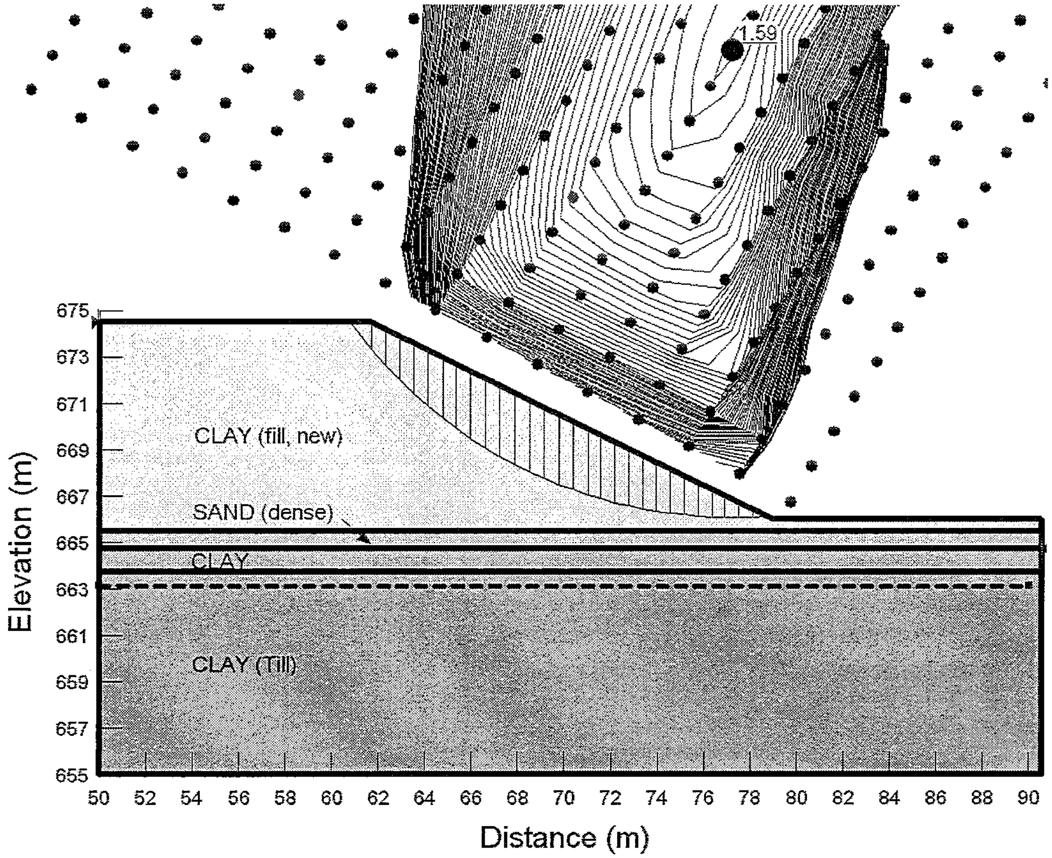
19-598-298

Structure 22 (Western Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 22 LT replacement Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28		0.3
CLAY (Till)	20	10	28	-	0.3

FIGURE 16.3

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

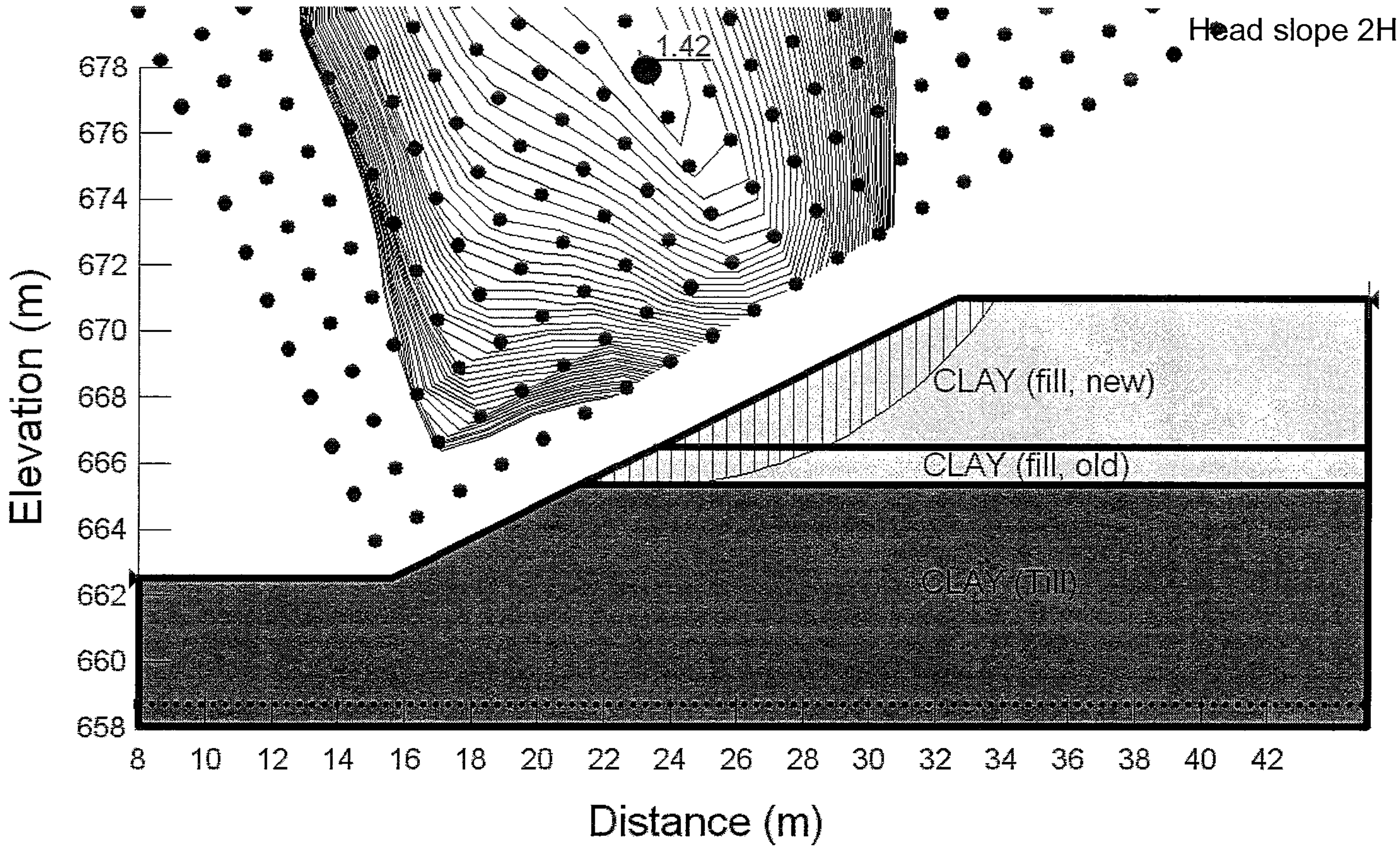
19-598-298

Structure 23 (Eastern abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 23 ST wo raft

Software: Slope/W

Version: 7.12

FIGURE 16.4

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

19-598-298

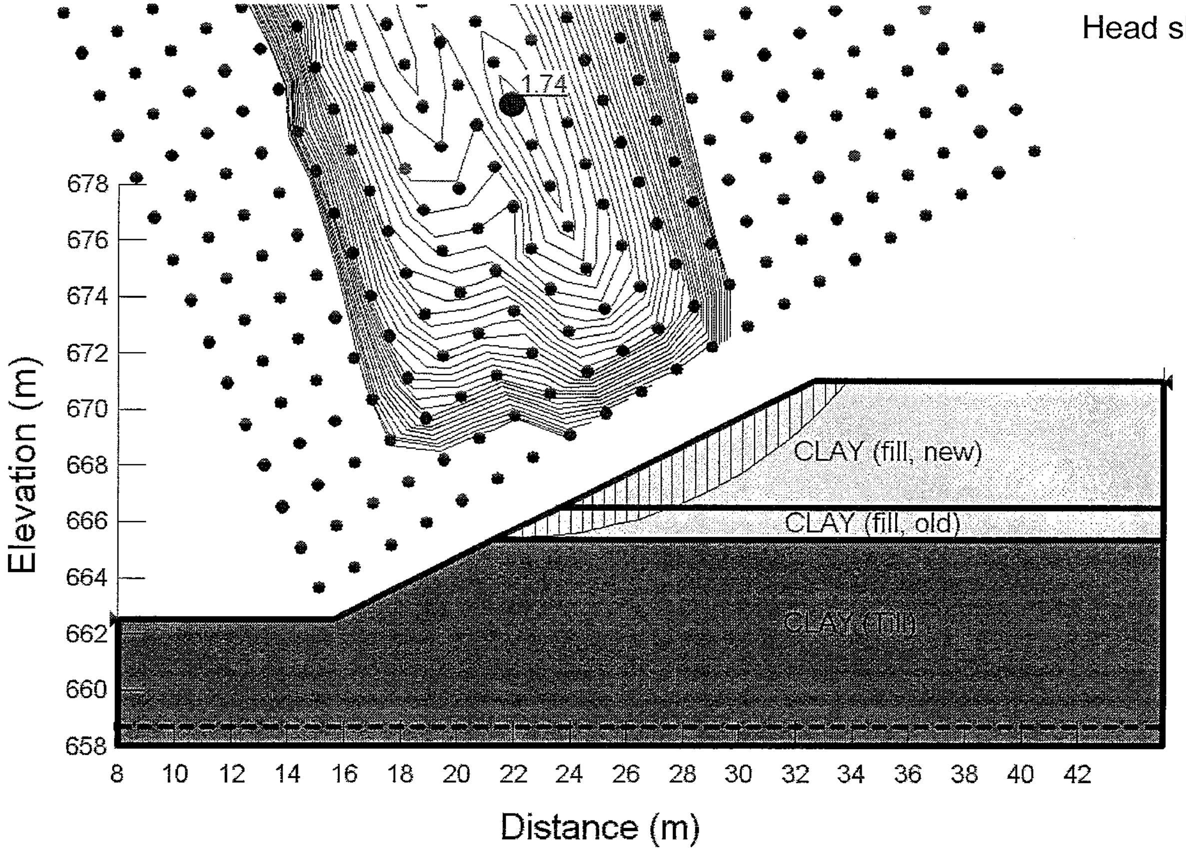
Structure 23 (Eastern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, old)	20	5	28
CLAY (Till)	20	10	28



File: Bridge 23 LT wo raft Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28		0.3
CLAY (lacustrine)	18	5	23	-	0.3
CLAY (Till)	20	10	28	-	0.3

FIGURE 16.5

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

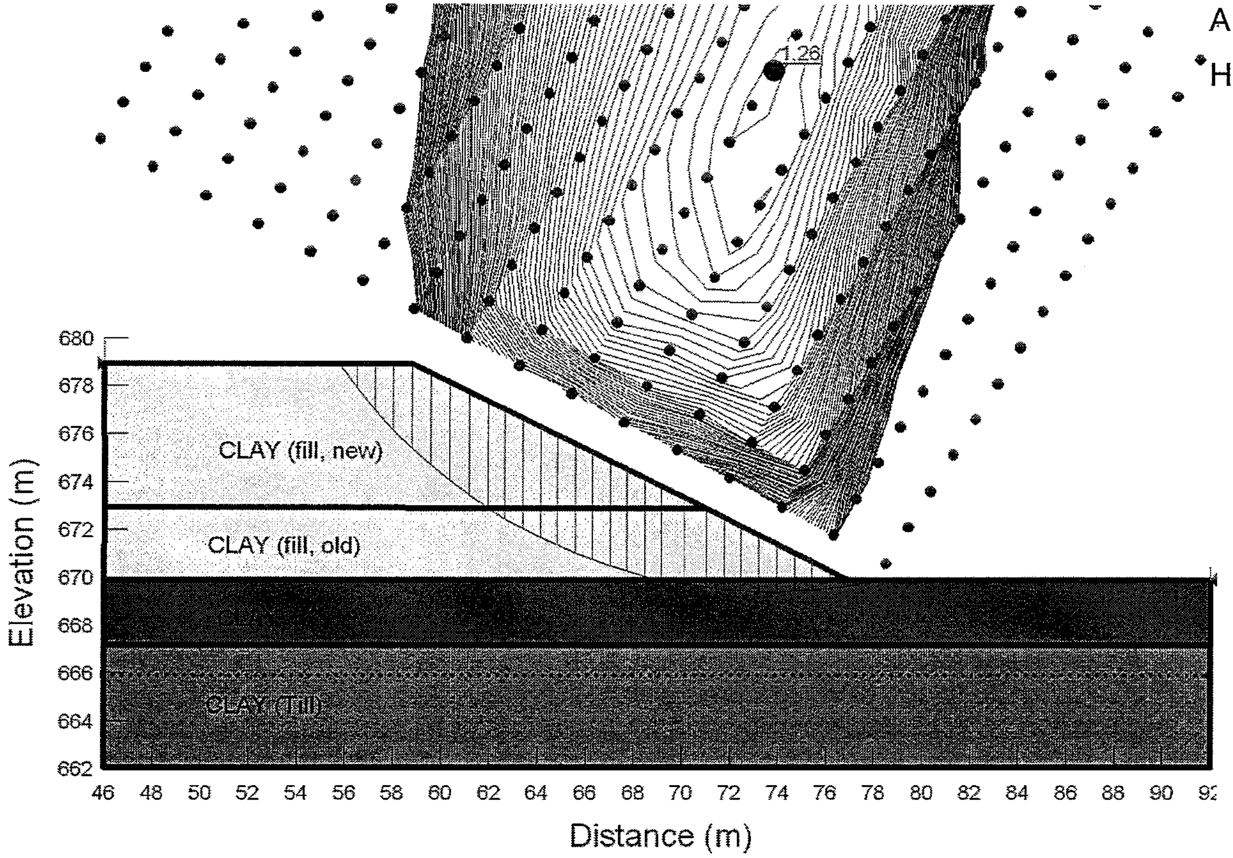
19-598-298

Structure 24 (Southern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 24 ST fill   Software: Slope/W   Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, old)	20	5	28
CLAY (lacustrine)	18	5	23
CLAY (Till)	20	10	28

FIGURE 16.6

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

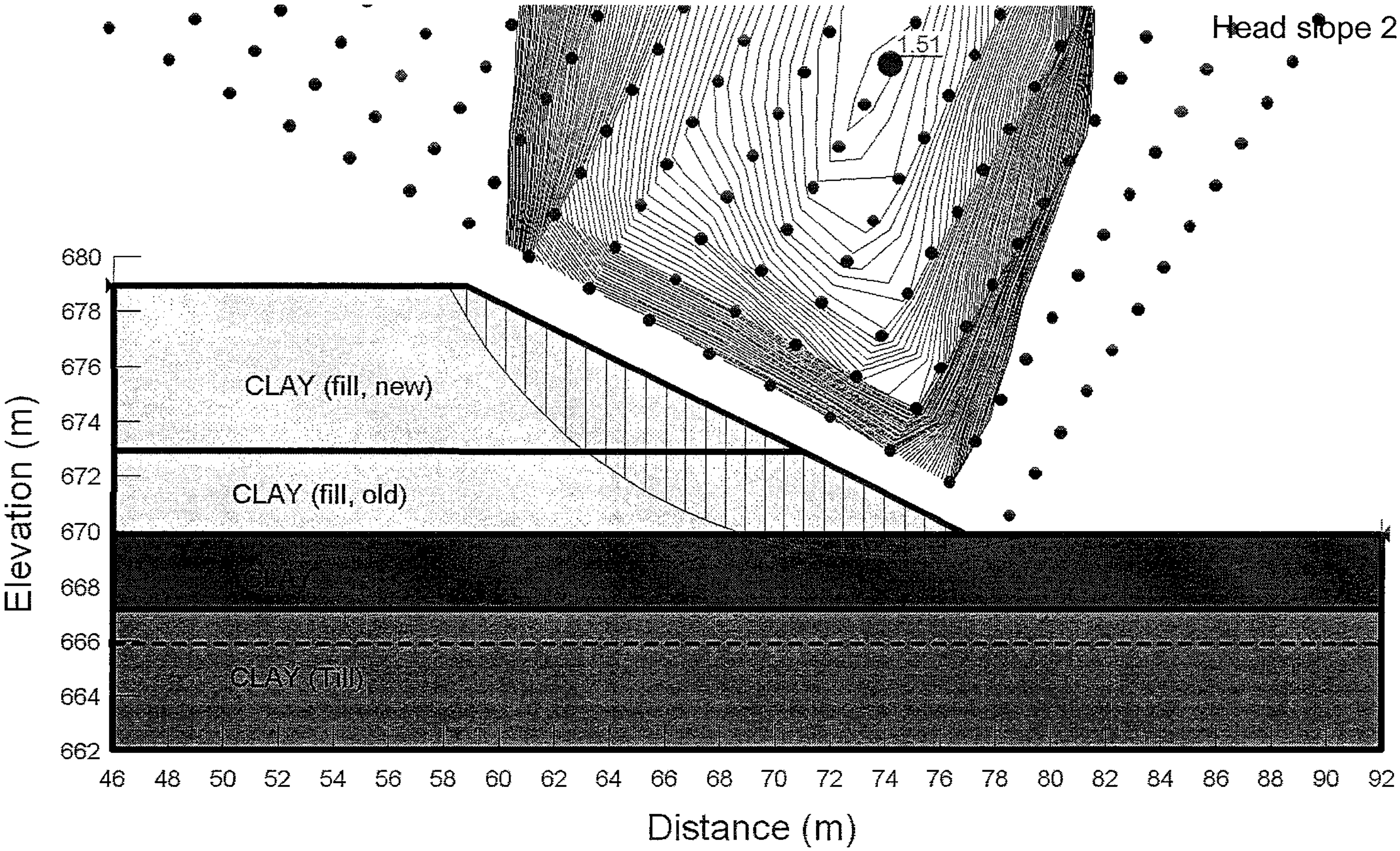
19-598-298

Structure 24 (Southern Abutment)

Dec 22, 2008

Abutment stability (long term)

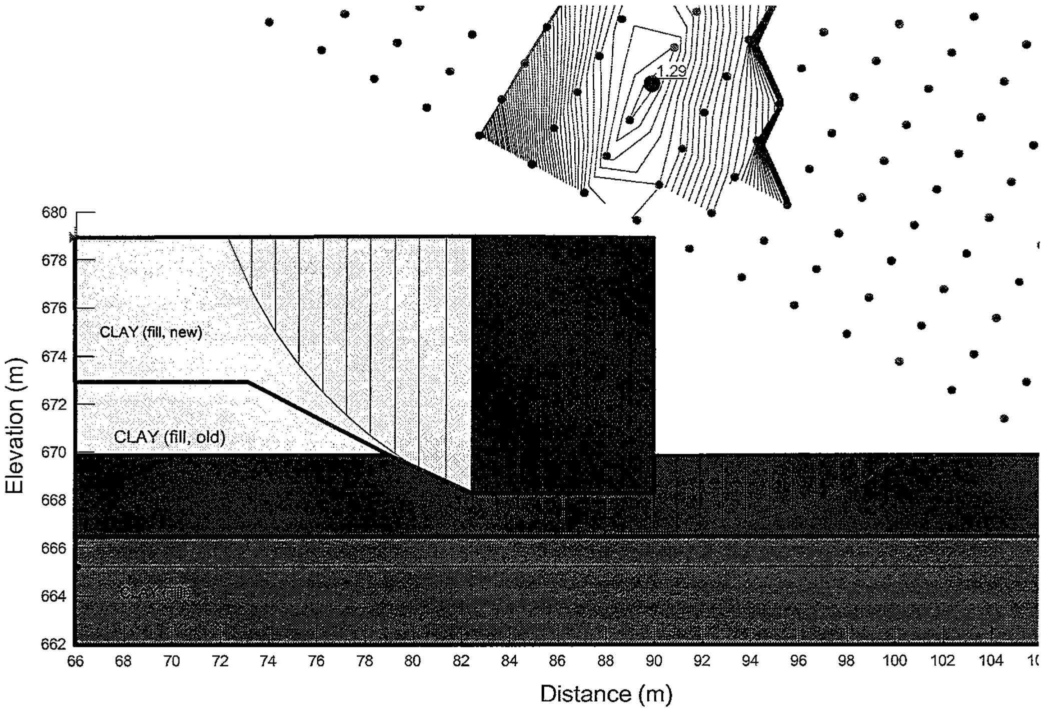
Head slope 2H:1V



File: Bridge 24 LT fill Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
TOPSOIL	17	5	20	-	0.3
SAND (loose)	18	0	30	-	-
SAND (compact)	19	0	32	-	-
SAND (dense)	20	0	35	-	-
GRAVEL (compact)	19	0	38	-	-

FIGURE 16.7
Thurber Engineering Ltd – Edmonton
NEERR – AFPS Bridge Abutment Geo Inv.
19-598-298
Structure 24 (Southern Abutment)
Dec 22, 2008
Abutment stability (short term)
Retaining wall



File: Bridge 24 ST wall

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23

FIGURE 16.8

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

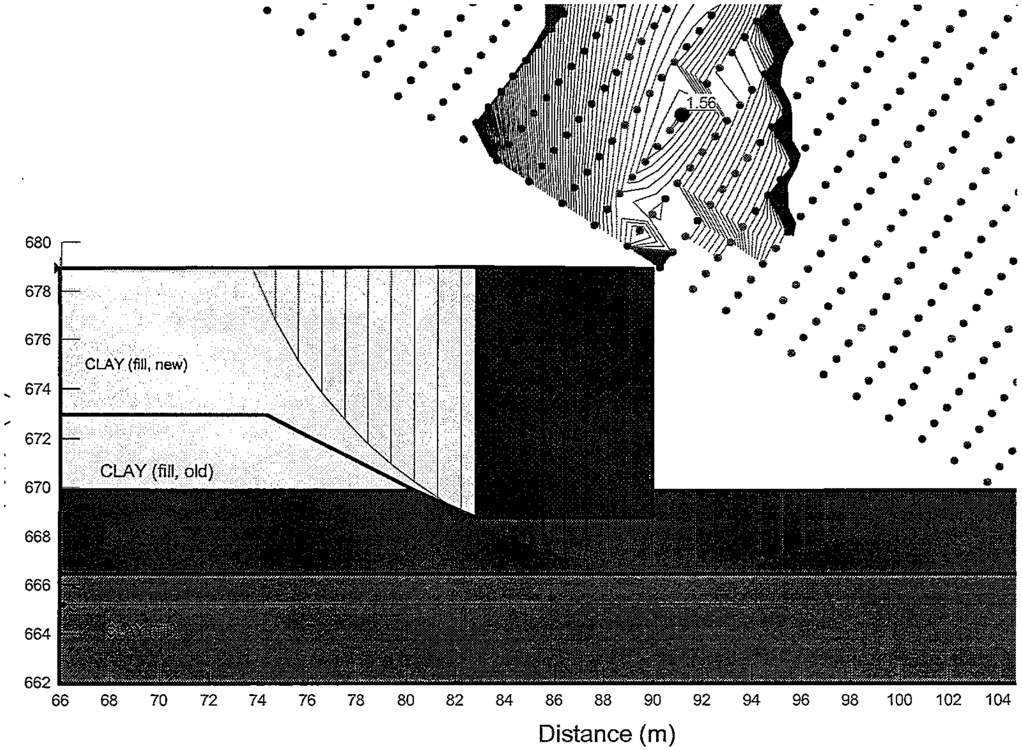
19-598-298

Structure 24 (Southern Abutment)

Dec 22, 2008

Abutment stability (long term)

Retaining wall



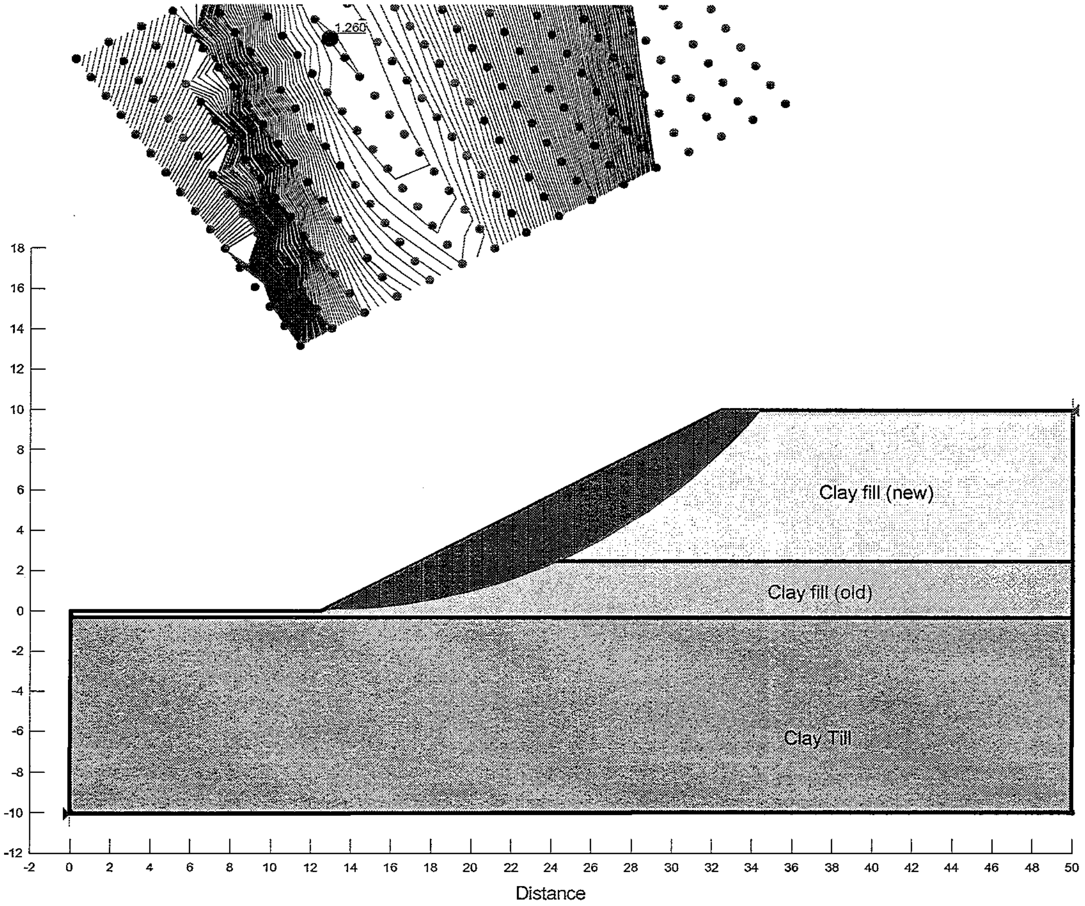
File: Bridge 24 LT wall

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28	-	0.3
CLAY (Till)	20	10	28	-	0.3

FIGURE 17.1
Thurber Engineering Ltd – Edmonton
NEERR – AFPS Bridge Abutment Geo Inv.
19-598-298
Structure 19 (Western Abutment)
Dec 22, 2008
Abutment stability (short term)
Head slope 2H:1V



File: Bridge 19 ST gravel wedge   Software: Slope/W   Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, old)	20	5	28
CLAY (Till)	20	10	28

FIGURE 17.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

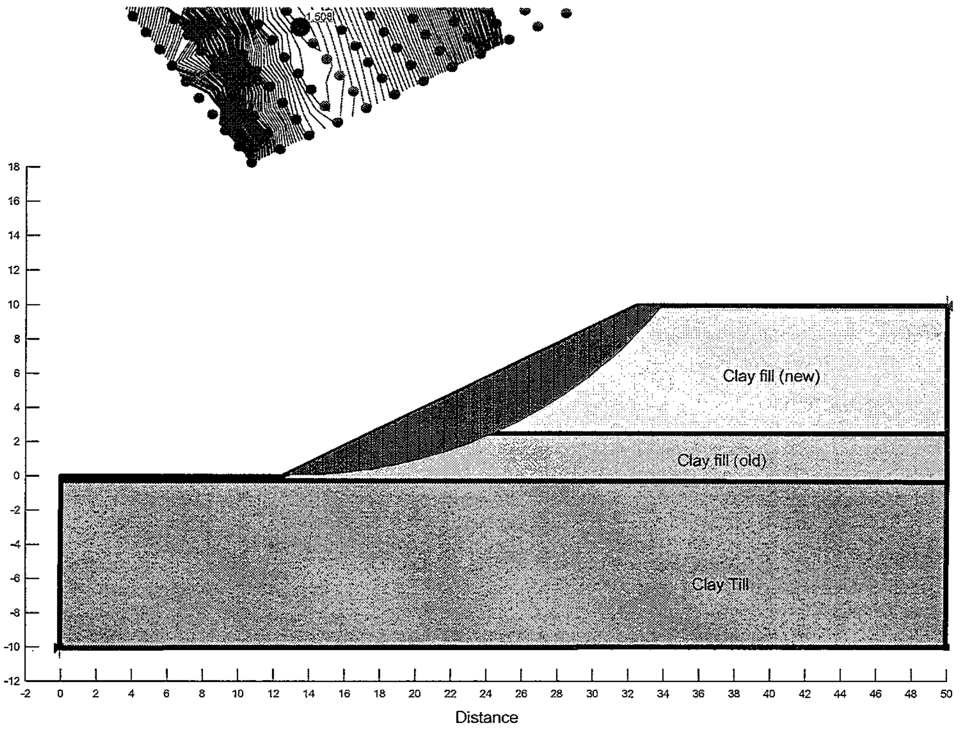
19-598-298

Structure 19 (Western Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 19 LT gravel wedge Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28	-	0.3
CLAY (Till)	20	10	28	-	0.3

FIGURE 17.3

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

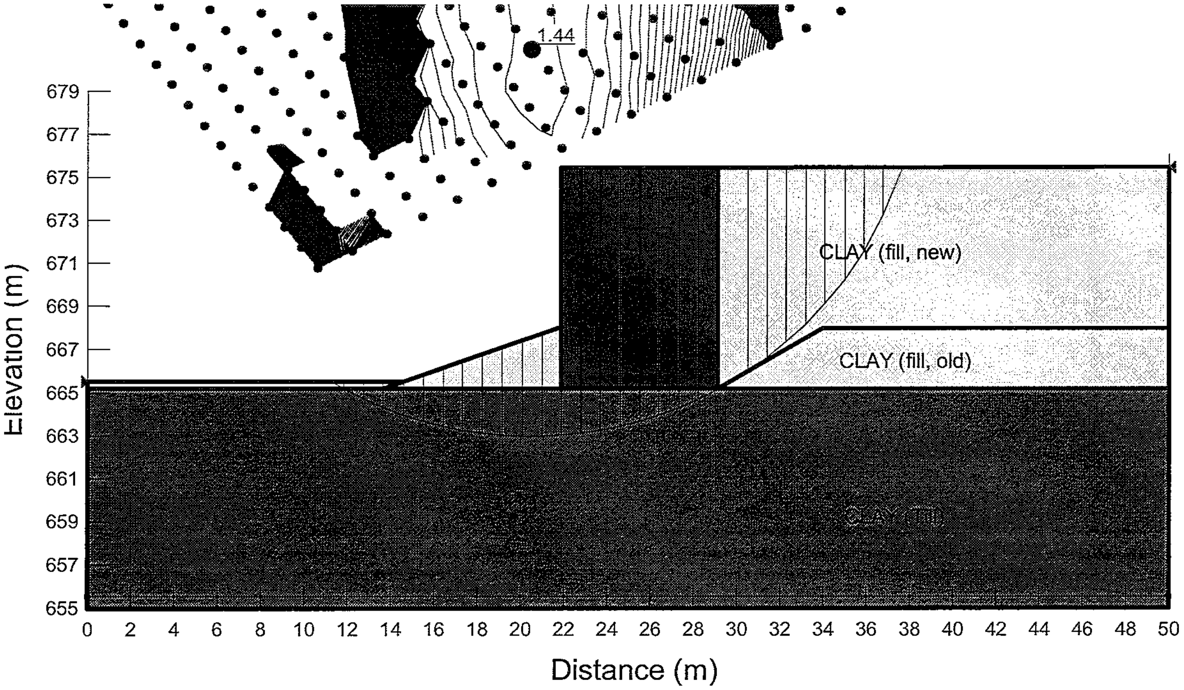
19-598-298

Structure 19 (Western Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 3H:1V & retaining wall



File: Bridge 19 ST wall Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, new)	20	5	28
CLAY (Till)	20	10	28

FIGURE 17.4

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

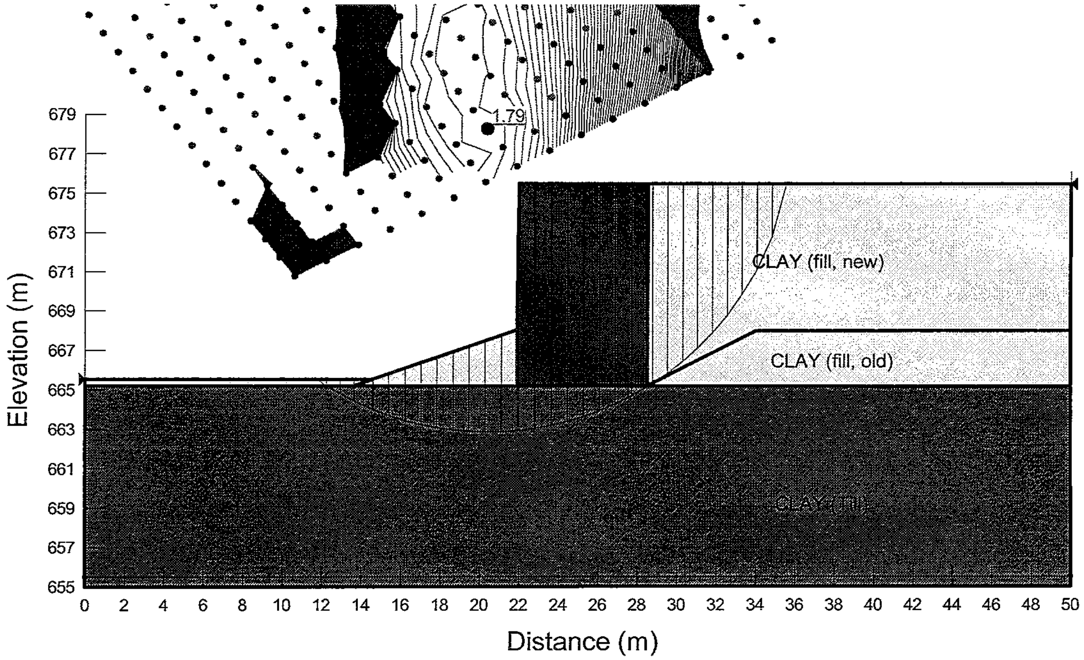
19-598-298

Structure 19 (Western Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 3H:1V & retaining wall



File: Bridge 19 LT wall

Software: Slope/W

Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	
CLAY (fill, old)	20	5	28		0.3
TOPSOIL	17	5	20	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
CLAY (Till)	20	10	28	-	0.3

FIGURE 17.5

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

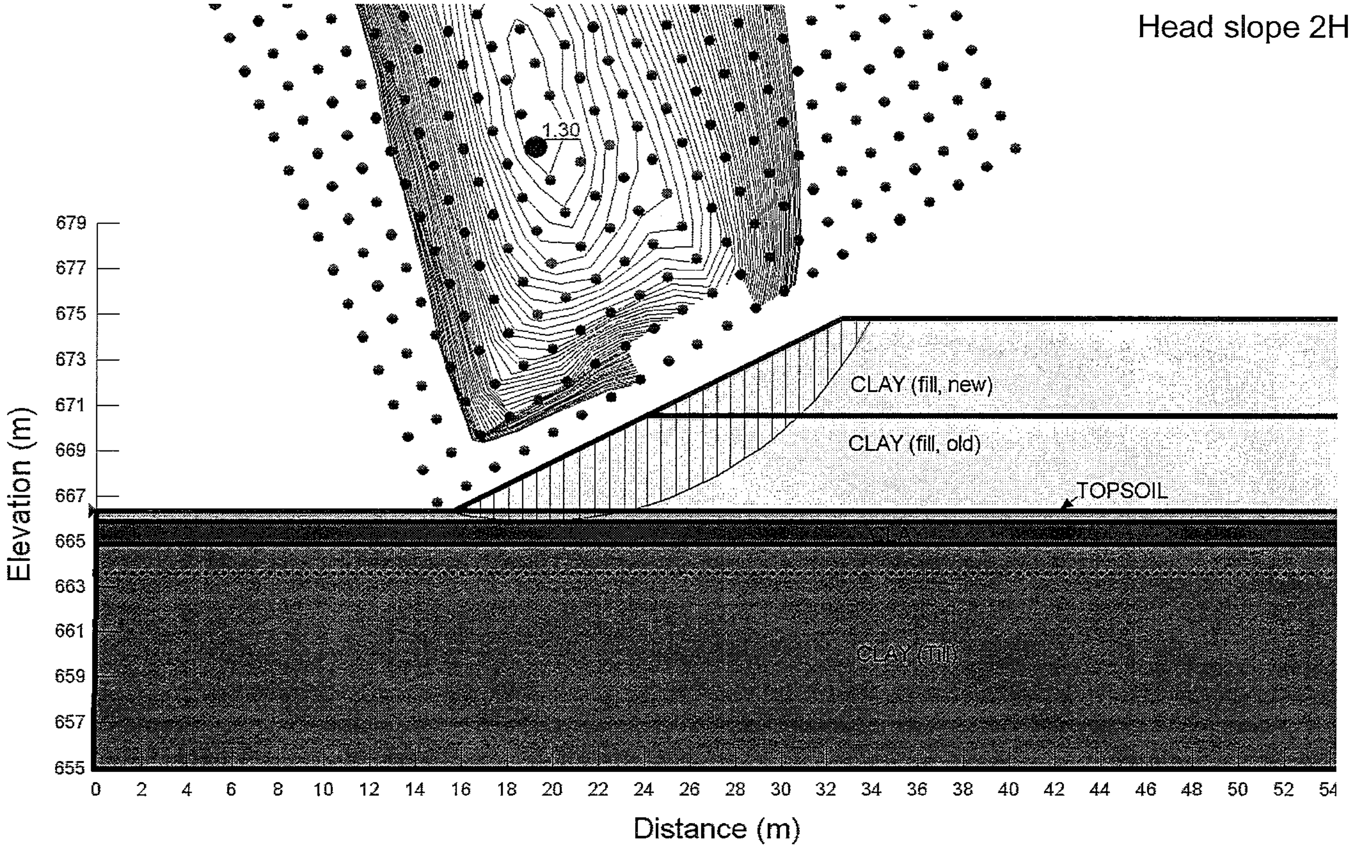
19-598-298

Structure 20 & 21 (Western Abutment)

Dec 22, 2008

Abutment stability (short term)

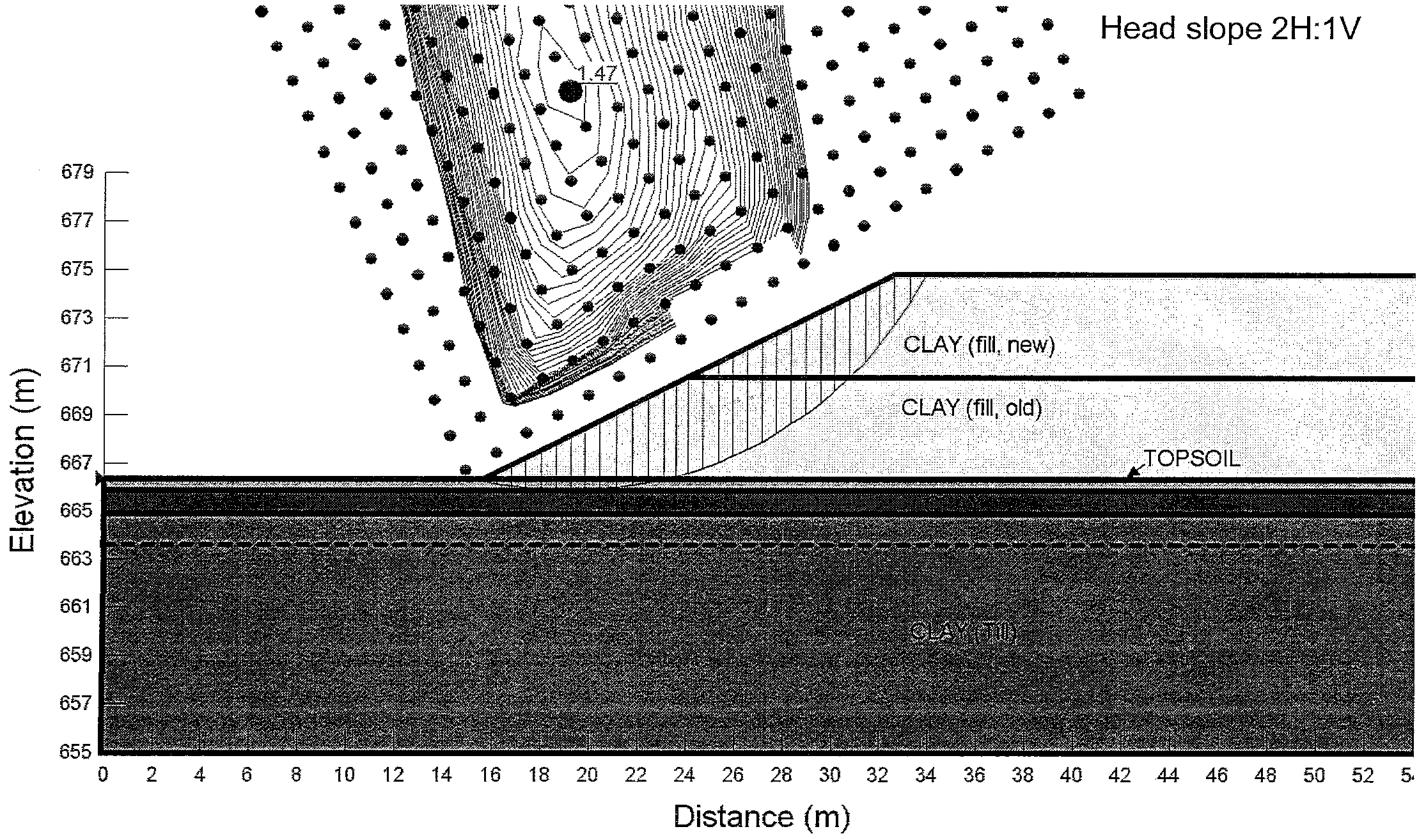
Head slope 2H:1V



File: Bridge 20 & 21 ST Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)
CLAY (fill, old)	20	5	28
CLAY (fill, new)	20	5	28
TOPSOIL	17	5	20
CLAY (lacustrine)	18	5	23
CLAY (Till)	20	10	28

FIGURE 17.6
Thurber Engineering Ltd – Edmonton
NEERR – AFPS Bridge Abutment Geo Inv.
19-598-298
Structure 20 & 21 (Western Abutment)
Dec 22, 2008
Abutment stability (long term)
Head slope 2H:1V



File: Bridge 20 & 21 LT Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (Till)	20	10	28	-	0.3
CLAY (lacustrine)	18	5	23	-	0.3
SAND (compact)	19	0	32	-	-

FIGURE 18.1

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

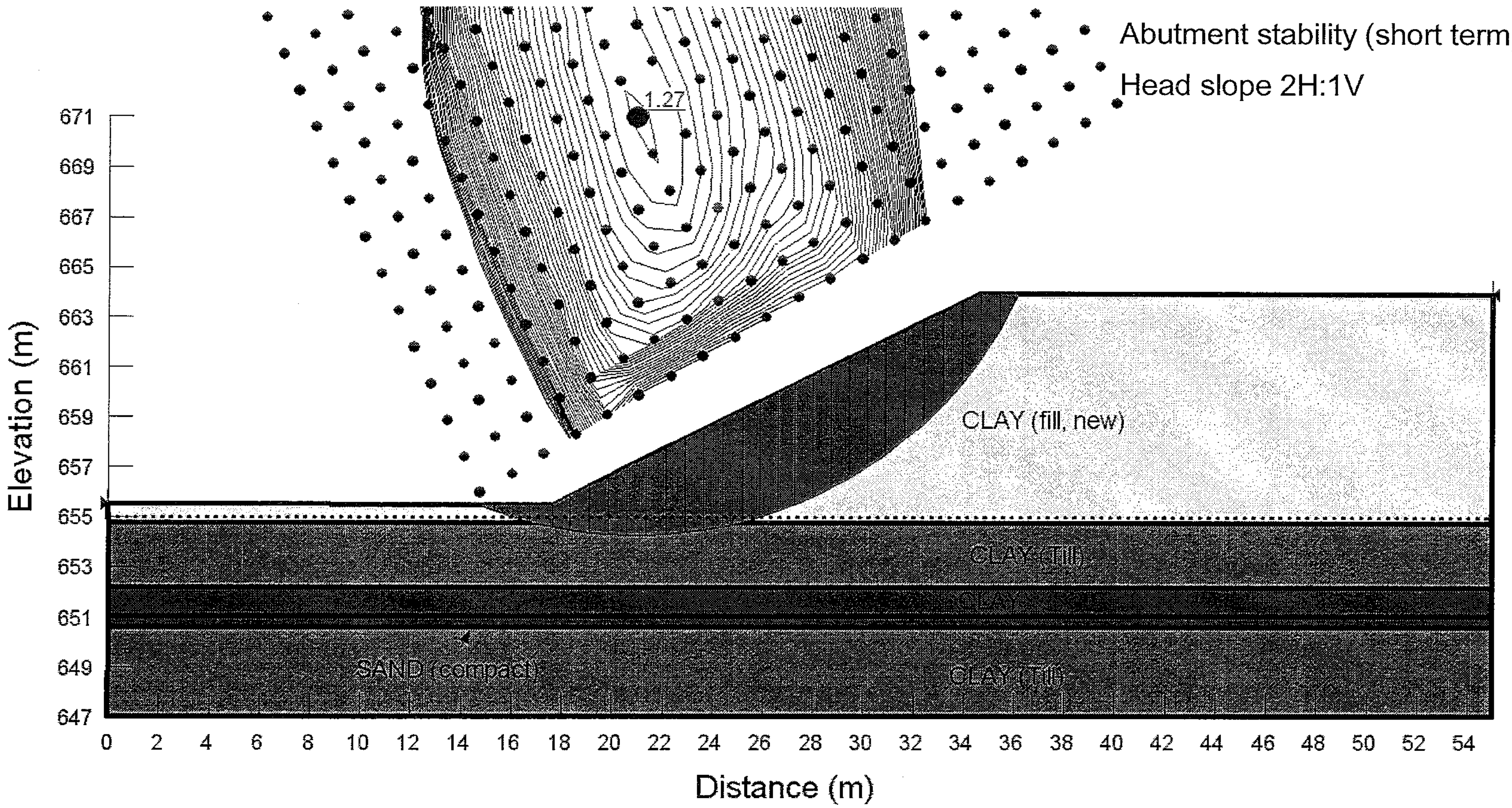
19-598-298

Structure 25 (Western Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 25 ST rem rep Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (^{o})
CLAY (fill, new)	20	5	28
CLAY (Till)	20	10	28
CLAY (lacustrine)	18	5	23
SAND (compact)	19	0	32

FIGURE 18.2

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

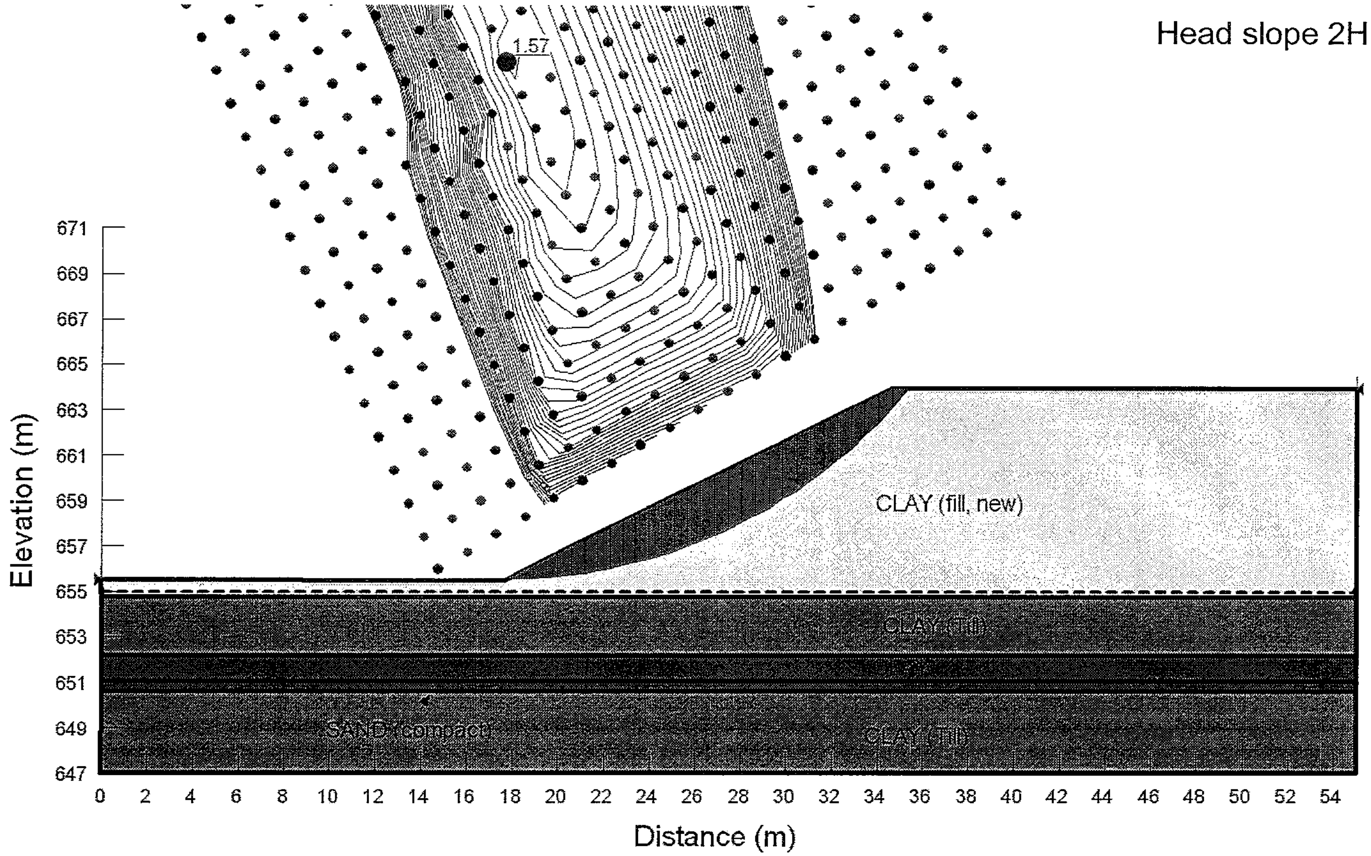
19-598-298

Structure 25 (Western Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 25 LT rem rep Software: Slope/W Version: 7.12

Material	γ (kN/m^3)	c' (kPa)	ϕ' (°)	R_u	B_{bar}
CLAY (fill, new)	20	5	28	0.2	-
CLAY (fill, old)	20	5	28	-	0.3

FIGURE 18.3

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

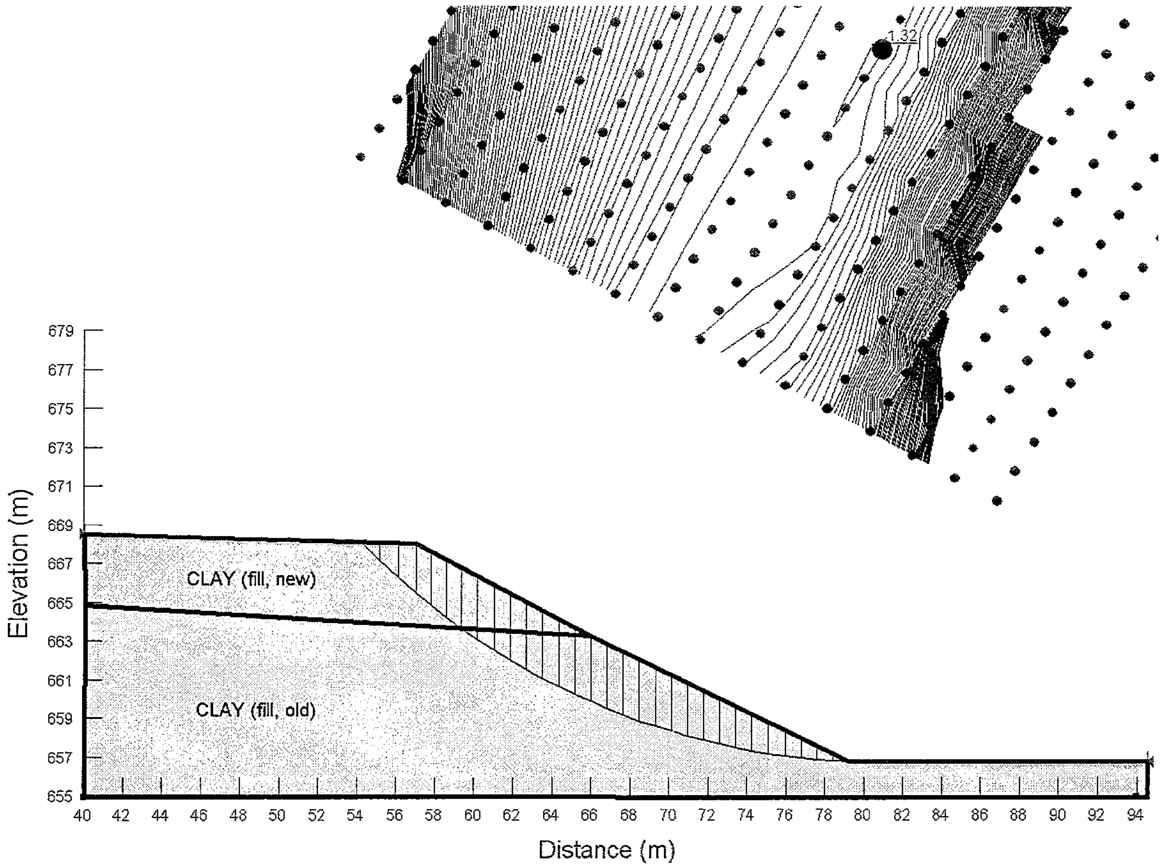
19-598-298

Structure 26 (Eastern Abutment)

Dec 22, 2008

Abutment stability (short term)

Head slope 2H:1V



File: Bridge 26 ST 2 Software: Slope/W Version: 7.12

Material	γ (kN/m³)	c' (kPa)	ϕ' (°)
CLAY (fill, new)	20	5	28
CLAY (fill, old)	20	5	28

FIGURE 18.4

Thurber Engineering Ltd – Edmonton

NEERR – AFPS Bridge Abutment Geo Inv.

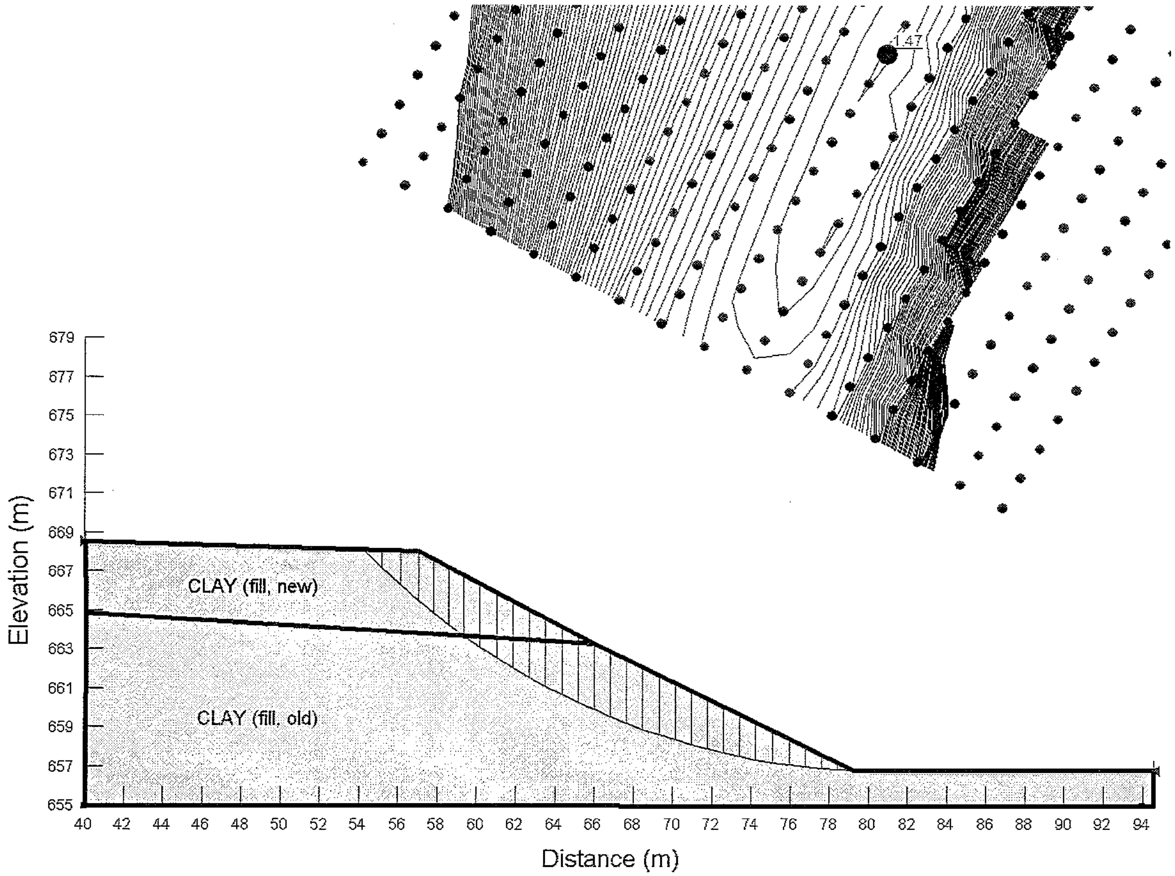
19-598-298

Structure 26 (Eastern Abutment)

Dec 22, 2008

Abutment stability (long term)

Head slope 2H:1V



File: Bridge 26 LT 2 Software: Slope/W Version: 7.12

APPENDIX E

Selected Photos

Photo 1 – Hwy 216 & Whitemud Drive interchange
- Looking north at the east abutment (BF 81157 E-1).

Photo 2 – Hwy 216 & Sherwood Park Freeway interchange
- Looking south at the east abutment (BF 75543 W-2).

Photo 3 – Hwy 216 & Sherwood Park Freeway interchange
- Looking north at the west abutment (BF75543 E-1).

Photo 4 – Hwy 216 & Sherwood Park Freeway interchange
- Looking north at the west abutment (BF75543 W-2).

Photo 5 – 17 Street – Looking west at the northern abutment.

Photo 6 – Existing 17 Street NW bridge over Sherwood Park Freeway, north abutment. Cracks in the concrete panels of the head slope.

Photo 7 – Looking east at the south abutment of the existing Broadmoor Boulevard bridge (BF76648) over Hwy 16.

Photo 8 – Bulging observed in the lower part of the head slope at existing bridge (BF76649) northwest of proposed Bridge 23.

Photo 9 – Growing vegetation between concrete panels in the head slope at existing bridge (BF76649) northwest of proposed Bridge 23.

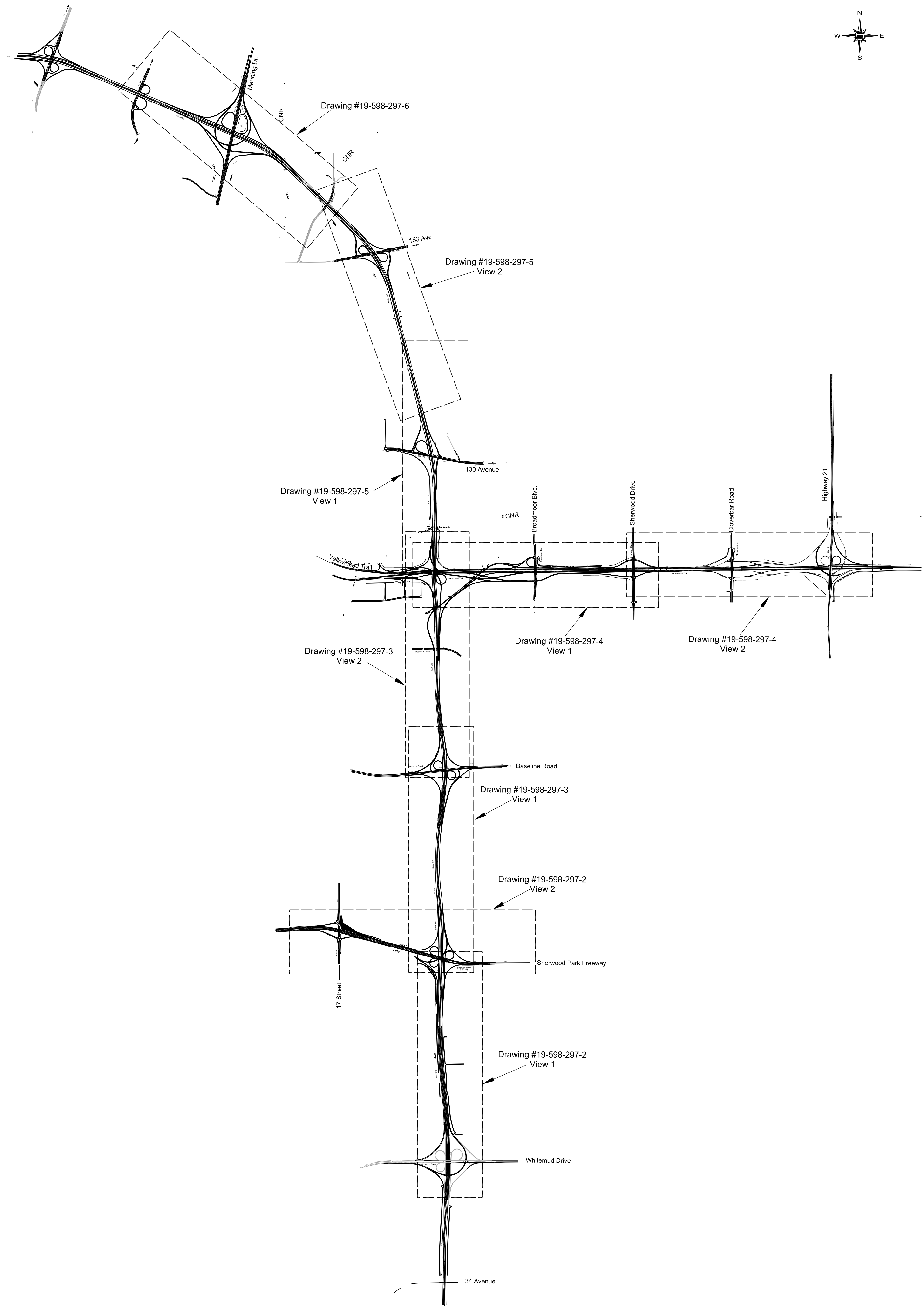
Photo 10 – Looking east at the northern abutment of the existing bridge (BF76652) near proposed Bridges 14 and 15.

Photo 11 – Existing Hwy 216 northbound bridge (BF76650 N-1) over CP rail. Looking east at the southern abutment.

APPENDIX F

Figures 19-598-297-1 to 6
Design Traffic Levels

Z:\19\19-598-297\19-598-297-1~6.dwg



BASE PLAN PROVIDED BY: ISL ENGINEERING AND LAND SERVICES LTD.

THURBER PROJECT #19-598-297

ISL ENGINEERING AND LAND SERVICES LTD.

KEY PLAN
(SHEET 1 OF 6)

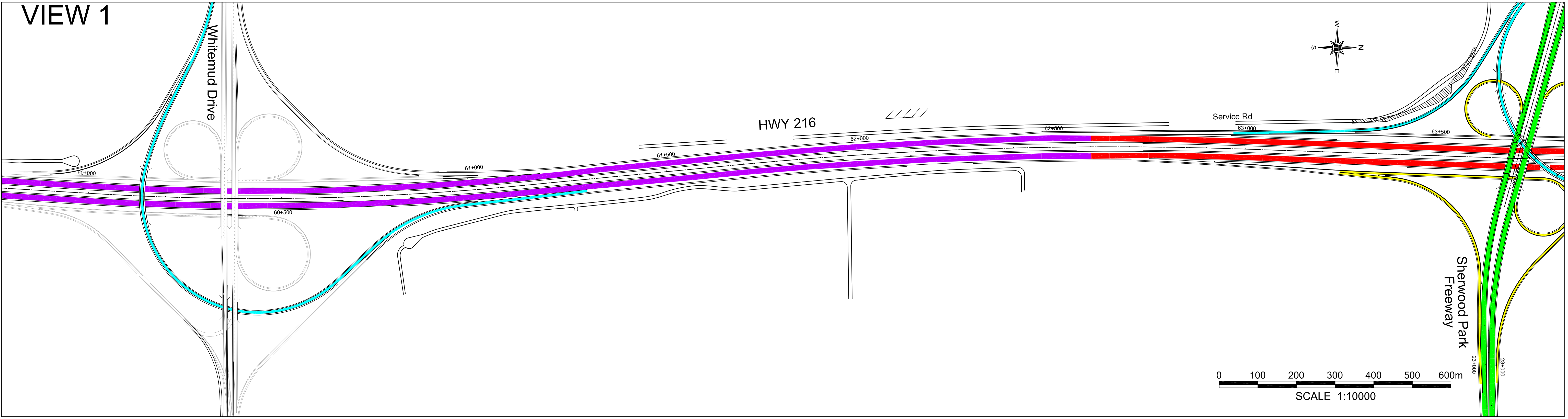
NEERR - AFPS
APPROXIMATE TRAFFIC VOLUMES

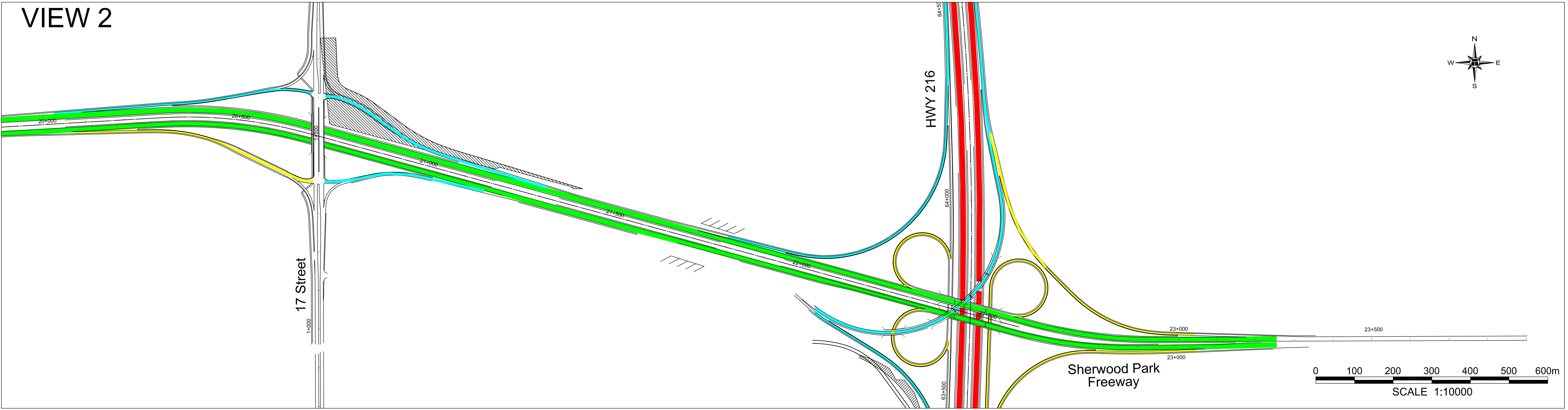
EDMONTON, AB

THU GINEERING LTD.
GEOTECHNICAL ▪ ENVIRON NTAL ▪ MATERIALS

ENGINEER : DWS	DRAWN : CMH	APPROVED : RWT
DATE : NOVEMBER, 2009	SCALE : AS SHOWN	DRAWING No. 19-598-297-1

Z:\19\19-598-297\19-598-297-1~6.dwg





BASE PLAN PROVIDED BY: ISL ENGINEERING AND LAND SERVICES LTD.

THURBER PROJECT #19-598-297

LEGEND

🟥 NEERR MAIN LINE WITH PERPETUAL PAVEMENTS (HWY 216 NEW CONSTRUCTION)

🟪 NEERR MAIN LINE WITH CONVENTIONAL PAVEMENTS (HWY 16, HWY 216 REHABILITION)

🟩 HIGH VOLUME CROSS ROADS

🟧 LOW VOLUME CROSS ROADS

🟦 HIGH VOLUME RAMP

🟨 LOW VOLUME RAMP

ISL ENGINEERING AND LAND SERVICES LTD.

PLANS OF NEERR
(SHEET 2 OF 6)

NEERR - AFPS
APPROXIMATE TRAFFIC VOLUMES
EDMONTON, AB

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER : DWS	DRAWN : HH	APPROVED : RWT
DATE : NOVEMBER, 2009	SCALE : AS SHOWN	DRAWING No. **19-598-297-2**

Z:\19\19-598-297\19-598-297-1-6.dwg

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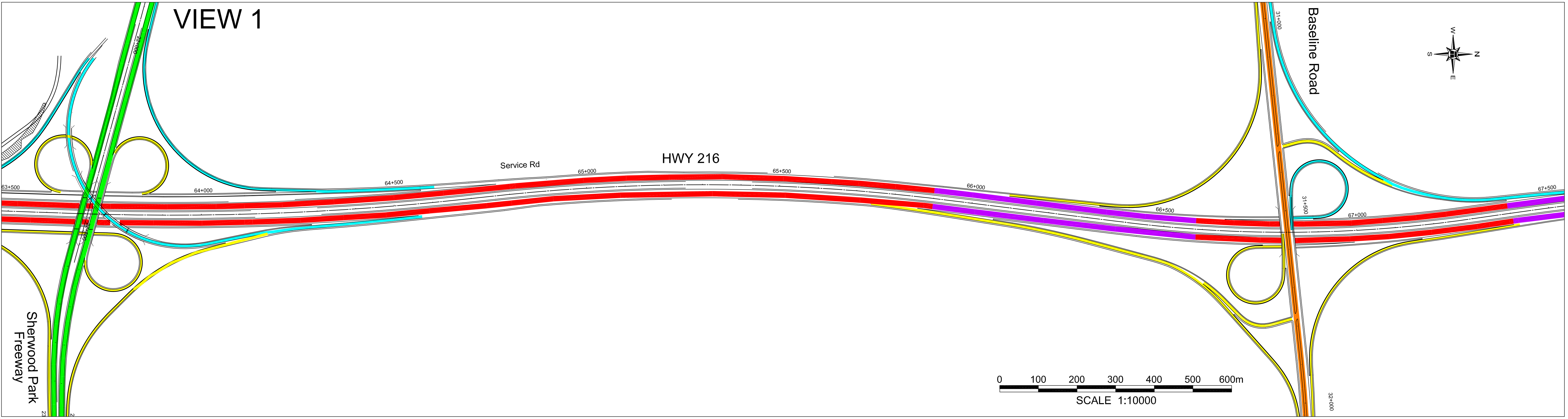

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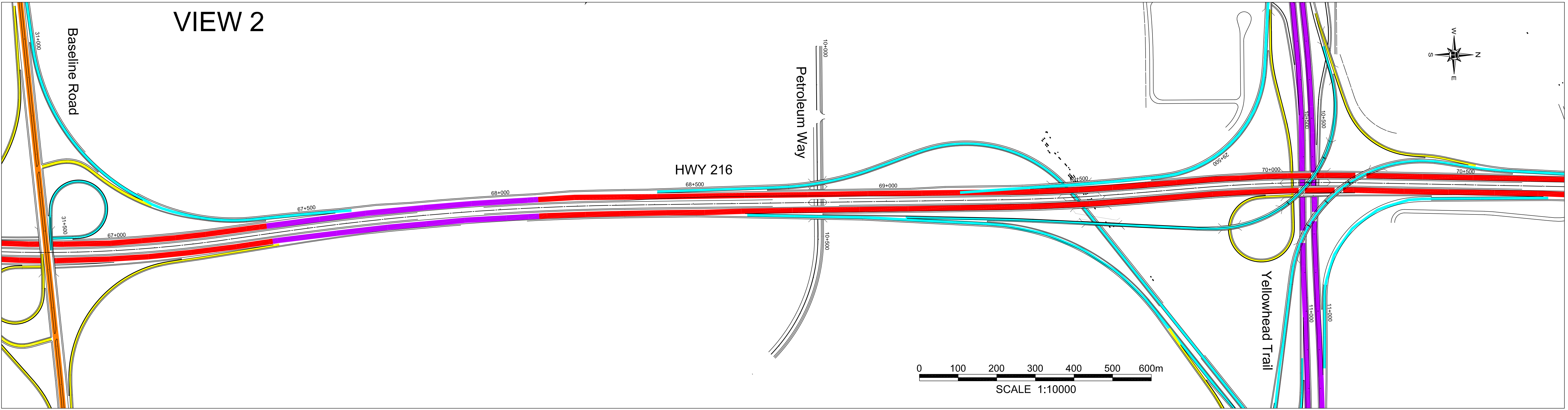

LEGEND

- 🟥 NEERR MAIN LINE WITH PERPETUAL PAVEMENTS (HWY 216 NEW CONSTRUCTION)
- 🟪 NEERR MAIN LINE WITH CONVENTIONAL PAVEMENTS (HWY 16, HWY 216 REHABILITION)
- 🟩 HIGH VOLUME CROSS ROADS
- 🟧 LOW VOLUME CROSS ROADS
- 🟦 HIGH VOLUME RAMP
- 🟨 LOW VOLUME RAMP

BASE PLAN PROVIDED BY: ISL ENGINEERING AND LAND SERVICES LTD.

THURBER PROJECT #19-598-297

ISL ENGINEERING AND LAND SERVICES LTD.

PLANS OF NEERR
(SHEET 3 OF 6)

NEERR - AFPS
APPROXIMATE TRAFFIC VOLUMES
EDMONTON, AB

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER : DWS	DRAWN : HH	APPROVED : RWT
DATE : NOVEMBER, 2009	SCALE : AS SHOWN	DRAWING No. **19-598-297-3**

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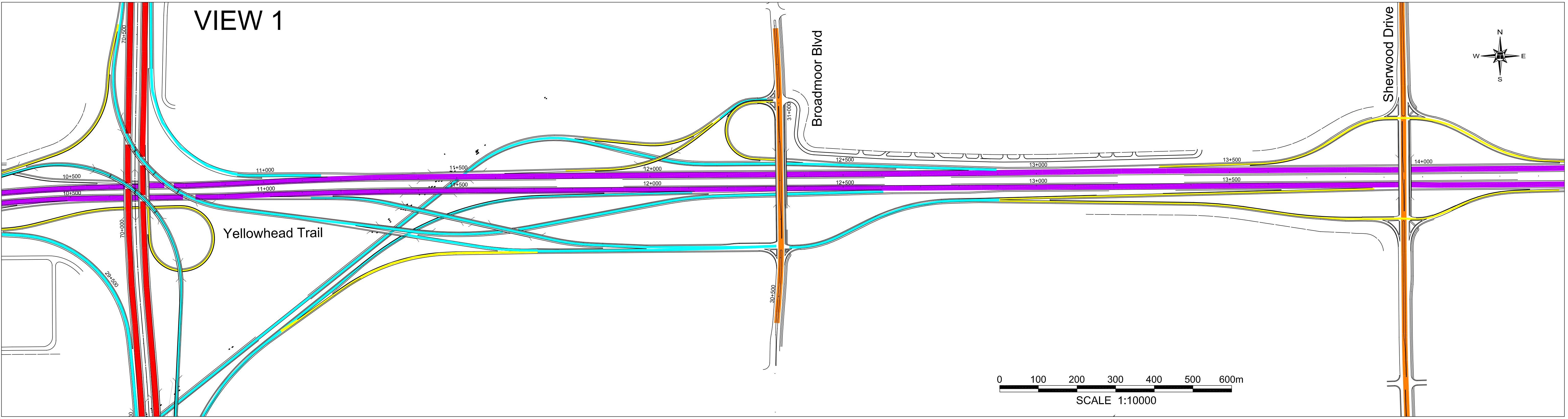
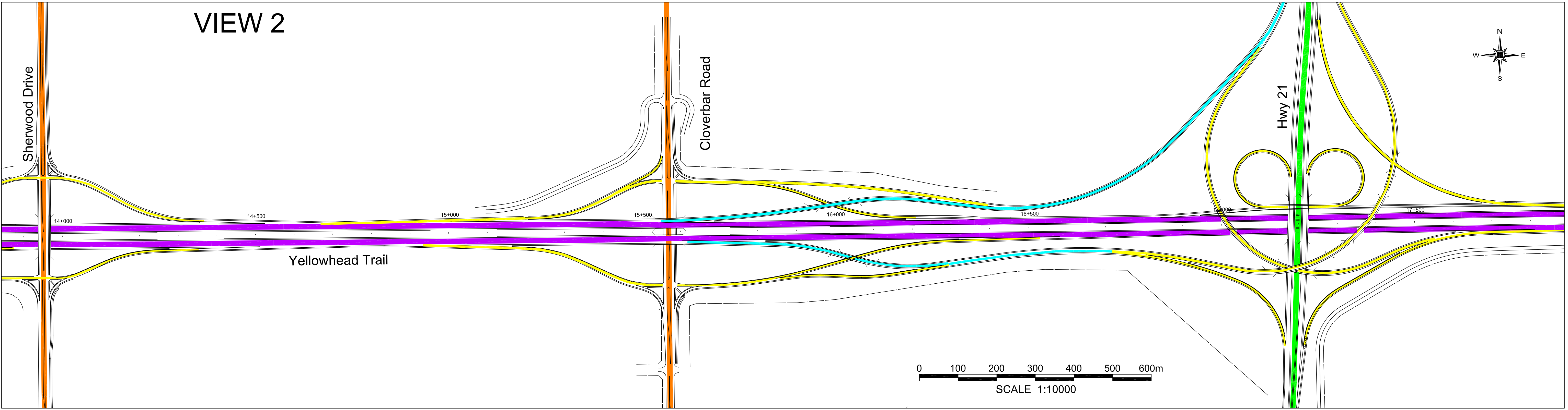


VIEW 2



BASE PLAN PROVIDED BY: ISL ENGINEERING AND LAND SERVICES LTD.

THURBER PROJECT #19-598-297

LEGEND

🟥 NEERR MAIN LINE WITH PERPETUAL PAVEMENTS (HWY 216 NEW CONSTRUCTION)

🟪 NEERR MAIN LINE WITH CONVENTIONAL PAVEMENTS (HWY 16, HWY 216 REHABILITION)

🟩 HIGH VOLUME CROSS ROADS

🟧 LOW VOLUME CROSS ROADS

🟦 HIGH VOLUME RAMP

🟨 LOW VOLUME RAMP

ISL ENGINEERING AND LAND SERVICES LTD.

PLANS OF NEERR
(SHEET 4 OF 6)

NEERR - AFPS
APPROXIMATE TRAFFIC VOLUMES
EDMONTON, AB

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER : DWS	DRAWN : HH	APPROVED : RWT
DATE : NOVEMBER, 2009	SCALE : AS SHOWN	DRAWING No. **19-598-297-4**

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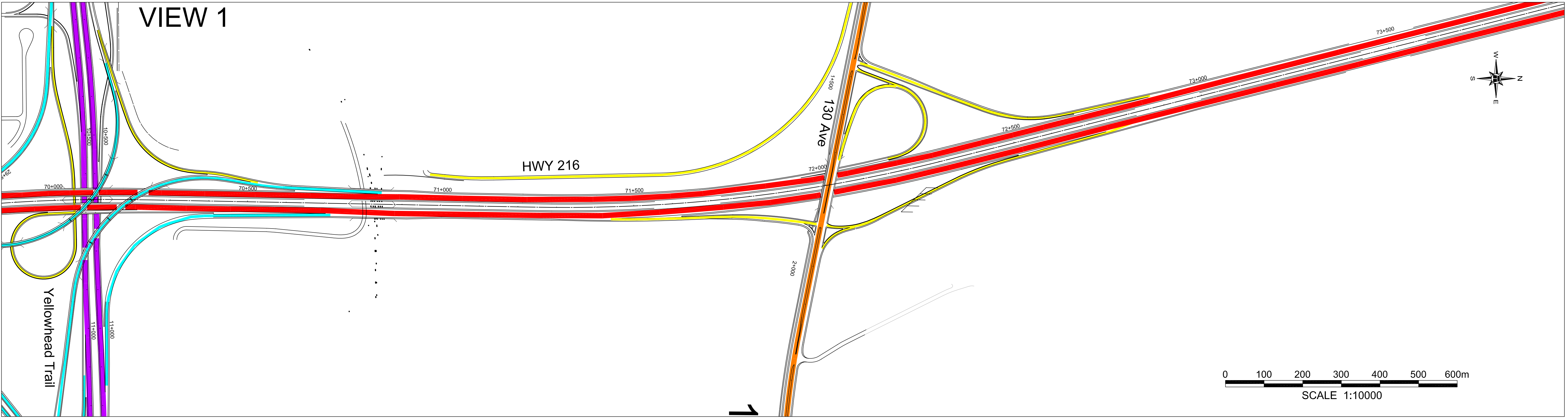

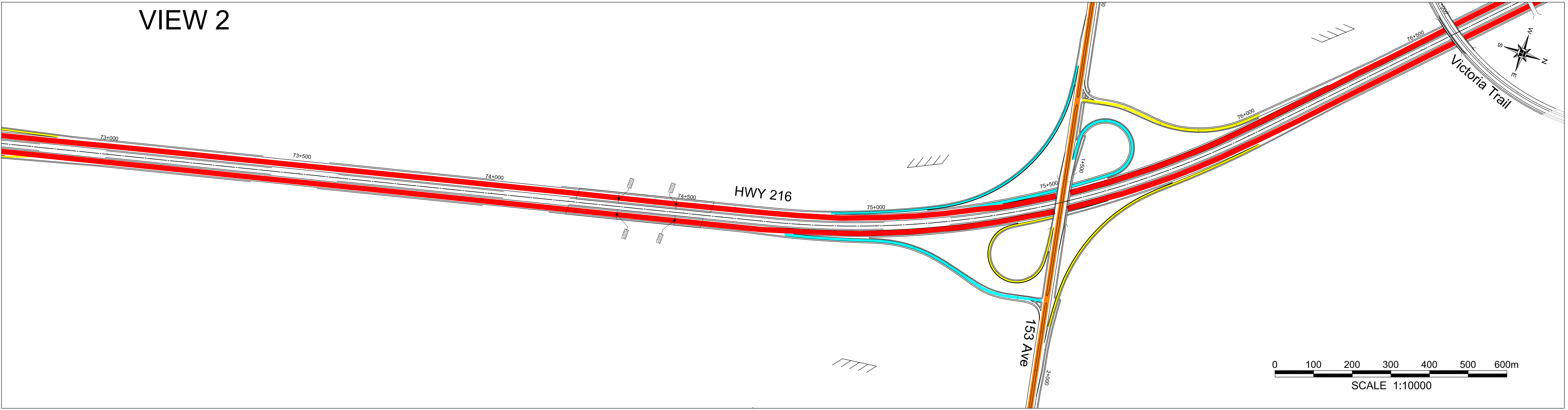

LEGEND

🟥 NEERR MAIN LINE WITH PERPETUAL PAVEMENTS (HWY 216 NEW CONSTRUCTION)

🟪 NEERR MAIN LINE WITH CONVENTIONAL PAVEMENTS (HWY 16, HWY 216 REHABILITION)

🟩 HIGH VOLUME CROSS ROADS

🟧 LOW VOLUME CROSS ROADS

🟦 HIGH VOLUME RAMP

🟨 LOW VOLUME RAMP

BASE PLAN PROVIDED BY: ISL ENGINEERING AND LAND SERVICES LTD.

THURBER PROJECT #19-598-297

ISL ENGINEERING AND LAND SERVICES LTD.

PLANS OF NEERR
(SHEET 5 OF 6)

NEERR - AFPS
APPROXIMATE TRAFFIC VOLUMES
EDMONTON, AB

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER : DWS	DRAWN : HH	APPROVED : RWT
DATE : NOVEMBER, 2009	SCALE : AS SHOWN	DRAWING No. **19-598-297-5**

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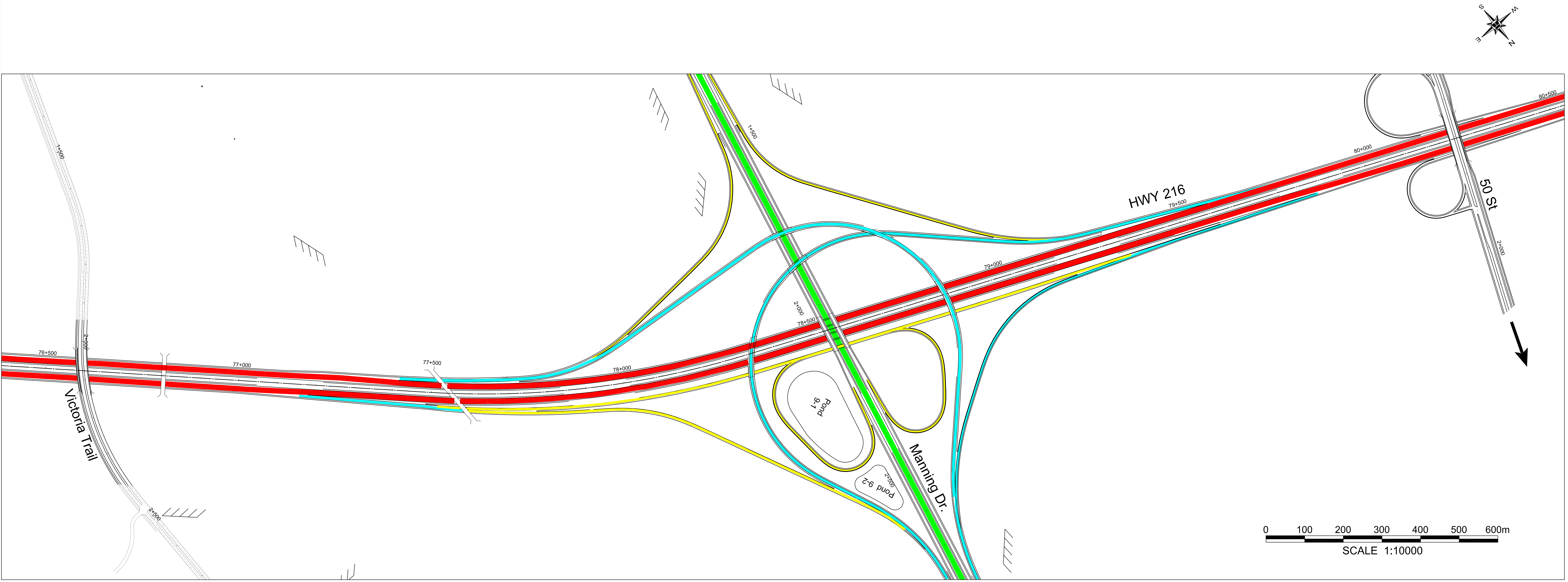


LEGEND

🟥	NEERR MAIN LINE WITH PERPETUAL PAVEMENTS (HWY 216 NEW CONSTRUCTION)
🟪	NEERR MAIN LINE WITH CONVENTIONAL PAVEMENTS (HWY 16, HWY 216 REHABILITION)
🟩	HIGH VOLUME CROSS ROADS
🟧	LOW VOLUME CROSS ROADS
🟦	HIGH VOLUME RAMP
🟨	LOW VOLUME RAMP

BASE PLAN PROVIDED BY: ISL ENGINEERING AND LAND SERVICES LTD.

THURBER PROJECT #19-598-297

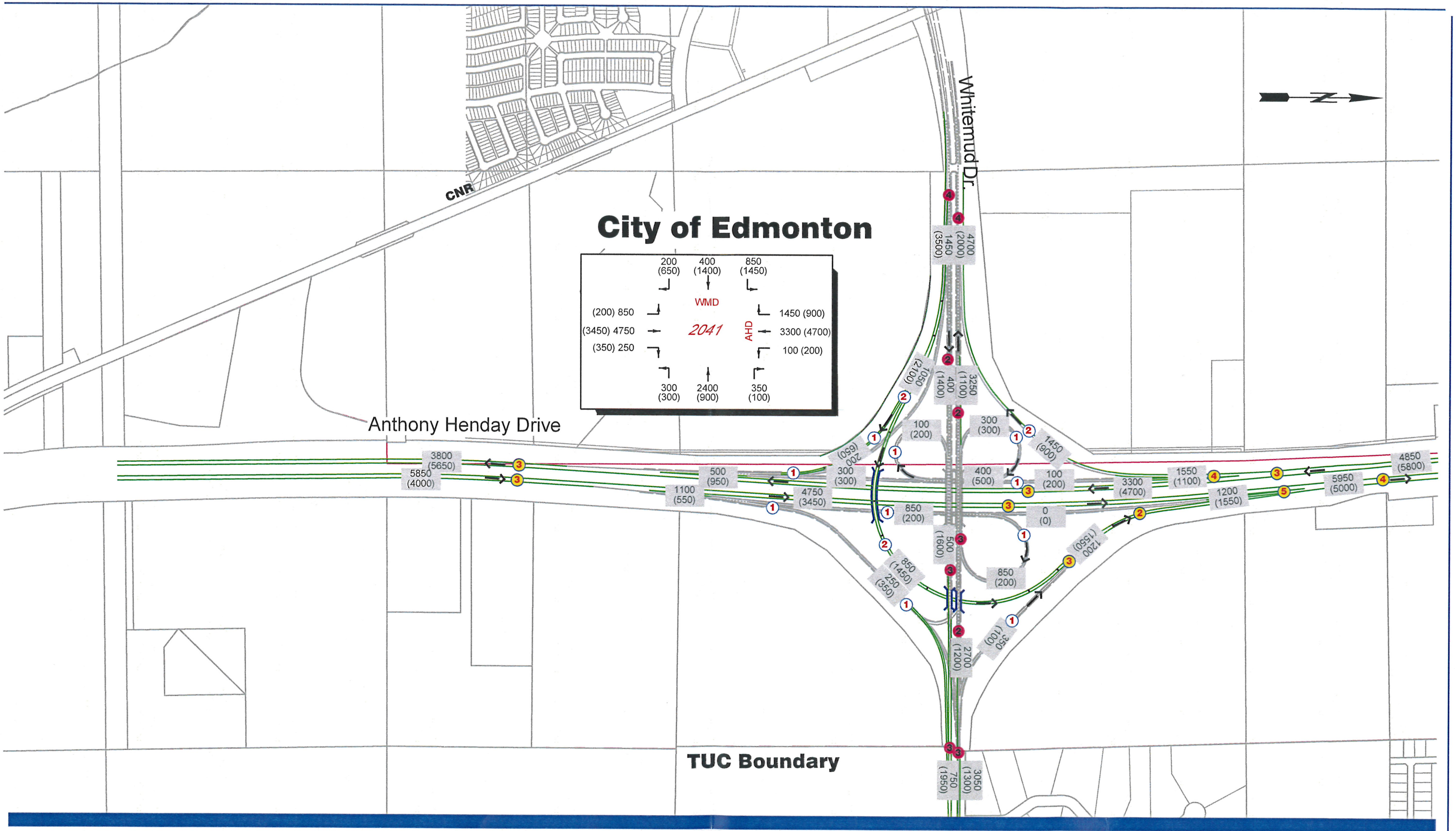
ISL ENGINEERING AND LAND SERVICES LTD.

PLANS OF NEERR
(SHEET 6 OF 6)

NEERR - AFPS
APPROXIMATE TRAFFIC VOLUMES
EDMONTON, AB

THURBER ENGINEERING LTD.
GEOTECHNICAL ▪ ENVIRONMENTAL ▪ MATERIALS

ENGINEER : DWS	DRAWN : HH	APPROVED : RWT
DATE : NOVEMBER, 2009	SCALE : AS SHOWN	DRAWING No. **19-598-297-6**



ISL Engineering and Land Services

Legend

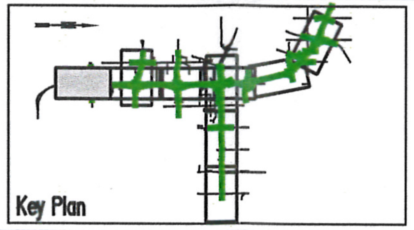
DIRECTION OF FLOW →

MORNING / AFTERNOON PEAK HOUR VOLUME 3800 (5650)

(Anthony Henday Drive) ③

(Crossing Roads) ②

(Interchange Ramps) ①



SCALE 1:10 000

75 50 0 100m 200m

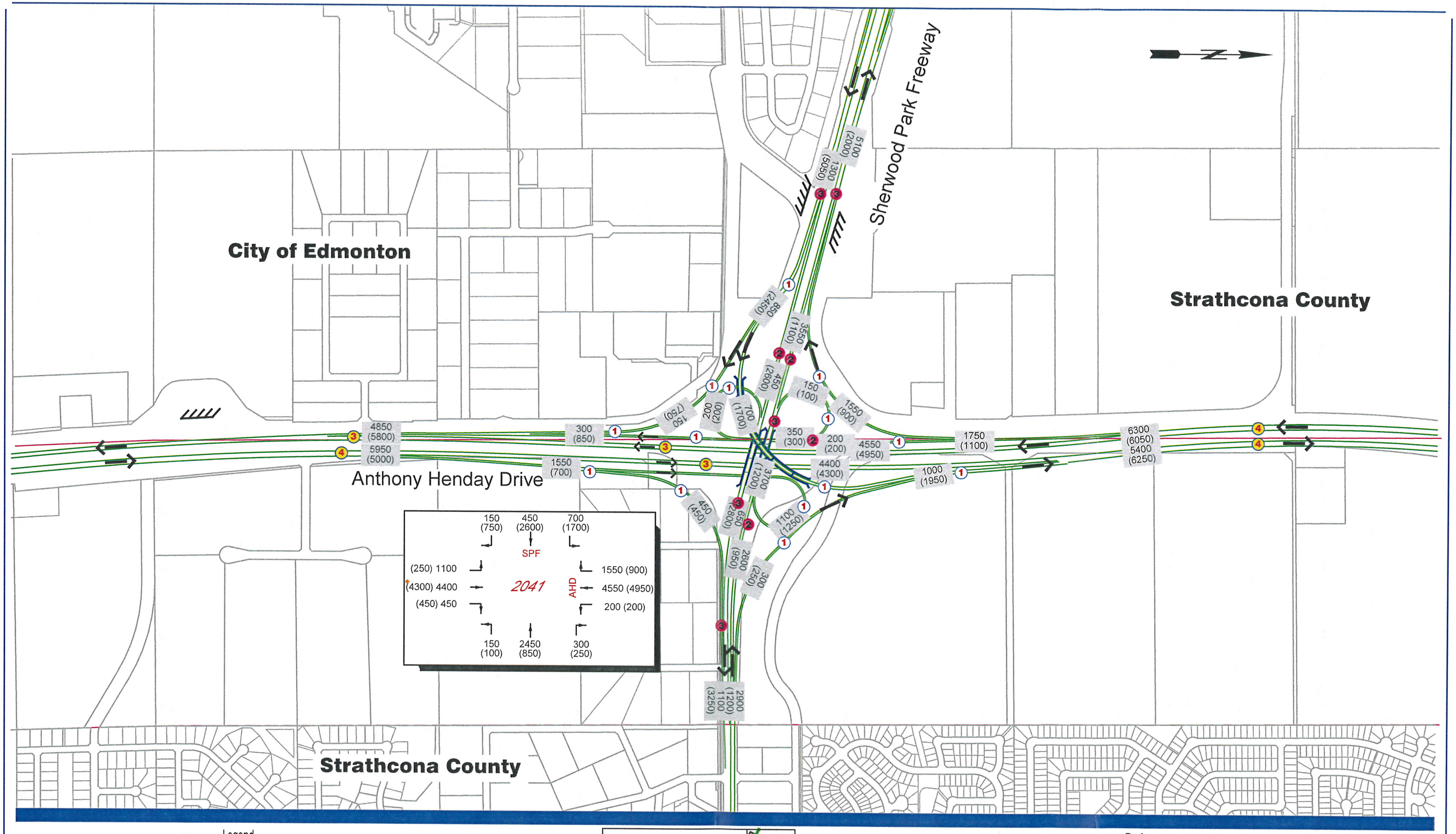
Alberta TRANSPORTATION

Project Anthony Henday Drive

Title Traffic Volumes-Stage 1
Functional Planning Study

Figure No. Traffic 01 Jan 19 2009

...\Traffic Stage 1\Traffic_01.dgn 2/27/2009 6:39:29 AM traffic.tbl



ISL Engineering and Land Services

Legend

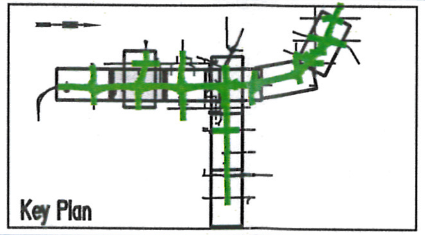
DIRECTION OF FLOW

MORNING / AFTERNOON PEAK HOUR VOLUME 3800 (5650)

(Anthony Henday Drive) ③

(Crossing Roads) ②

(Interchange Ramps) ①



SCALE 1:10 000

75 50 0 100m 200m

Alberta TRANSPORTATION

Project	Anthony Henday Drive
Title	Traffic Volumes-Stage 1 Functional Planning Study
Figure No.	Traffic 02

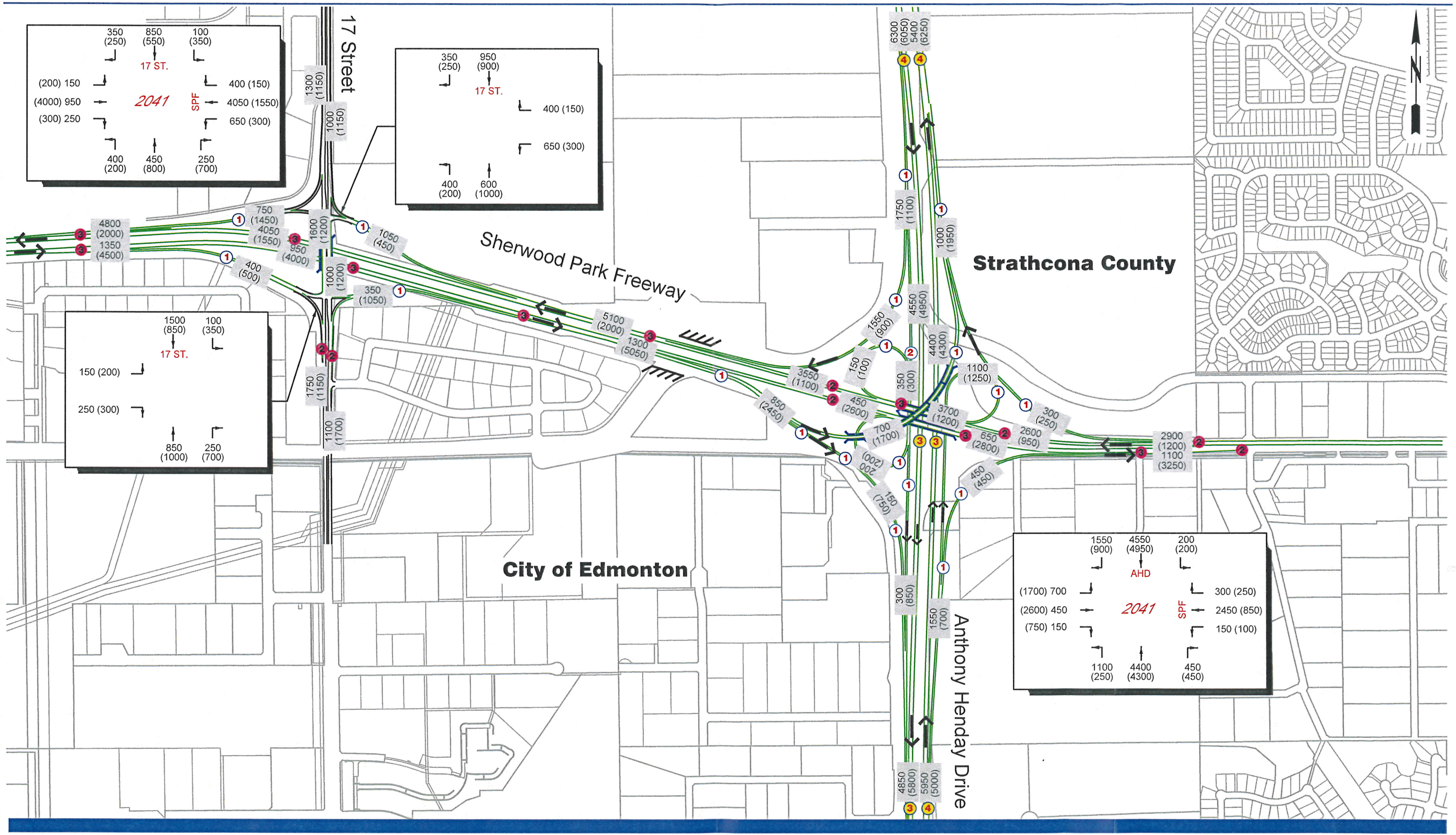
Jan 19 2009

traffic.tbl

8:58:12 AM

2/27/2009

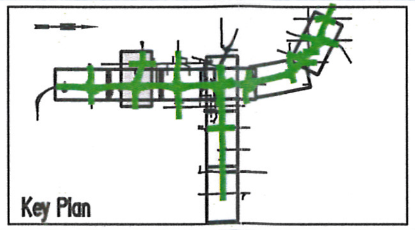
...\Traffic Stage 1\Traffic_02.dgn



ISL Engineering and Land Services

Legend

DIRECTION OF FLOW	→
MORNING / AFTERNOON PEAK HOUR VOLUME	3800 (5650)
(Anthony Henday Drive)	③
(Crossing Roads)	②
(Interchange Ramps)	①



SCALE 1:10 000
75 50 0 100m 200m

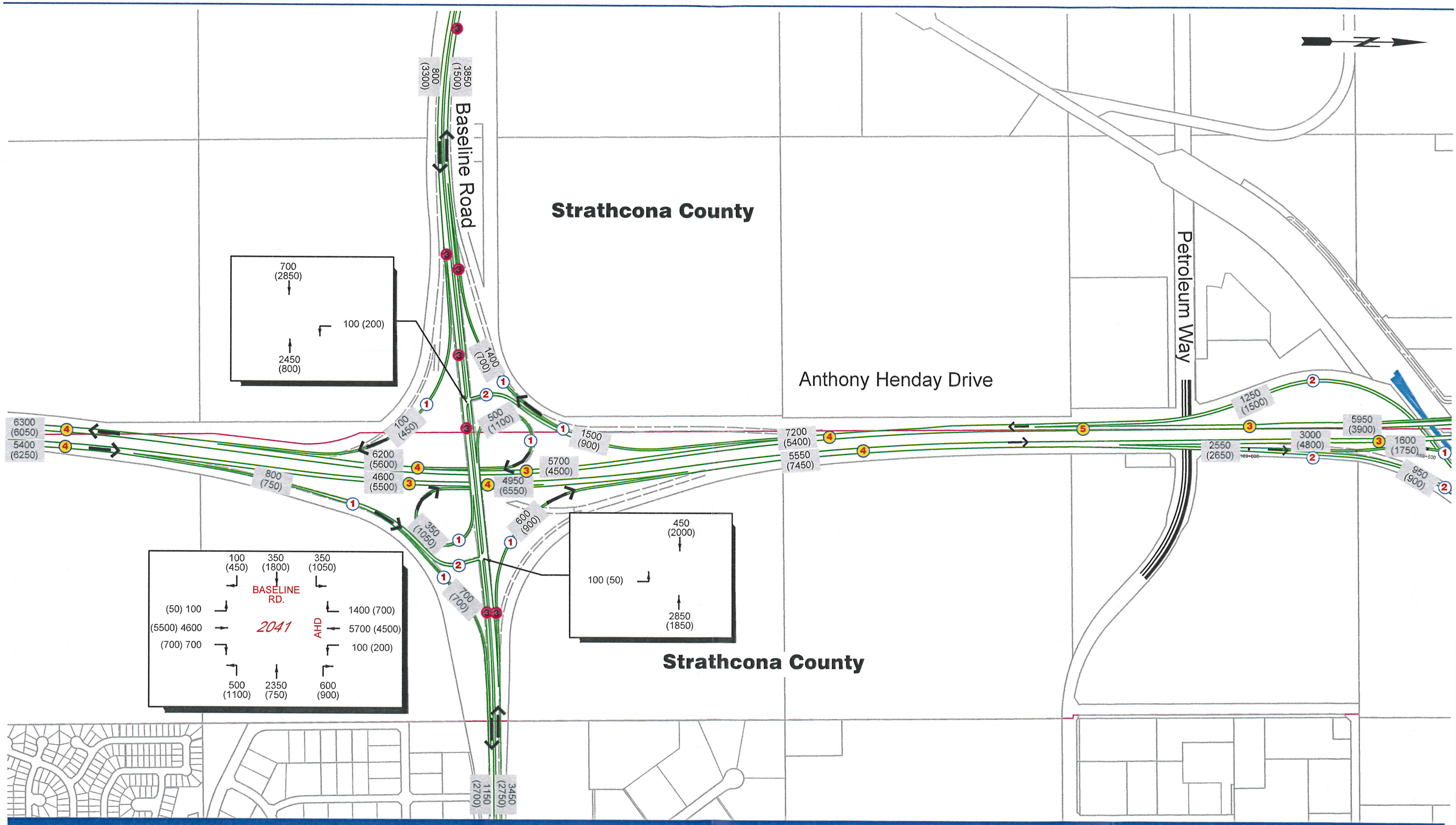
Alberta
TRANSPORTATION

Project Anthony Henday Drive

Title Traffic Volumes-Stage 1
Functional Planning Study

Figure No. Traffic 03 Jan 19 2009

...\Traffic Stage 1\Traffic_03.dgn 2/27/2009 7:30:18 AM traffic.tbl



traffic.tbl

7:44:51 AM

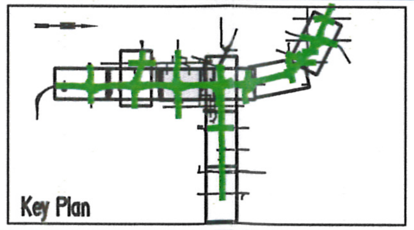
2/27/2009

...\Traffic Stage 1\Traffic_04.dgn

ISL Engineering and Land Services

Legend

DIRECTION OF FLOW	→
MORNING / AFTERNOON PEAK HOUR VOLUME	2550 (2650)
(Anthony Henday Drive)	③
(Crossing Roads)	②
(Interchange Ramps)	①



SCALE 1:10 000

75 50 0 100m 200m

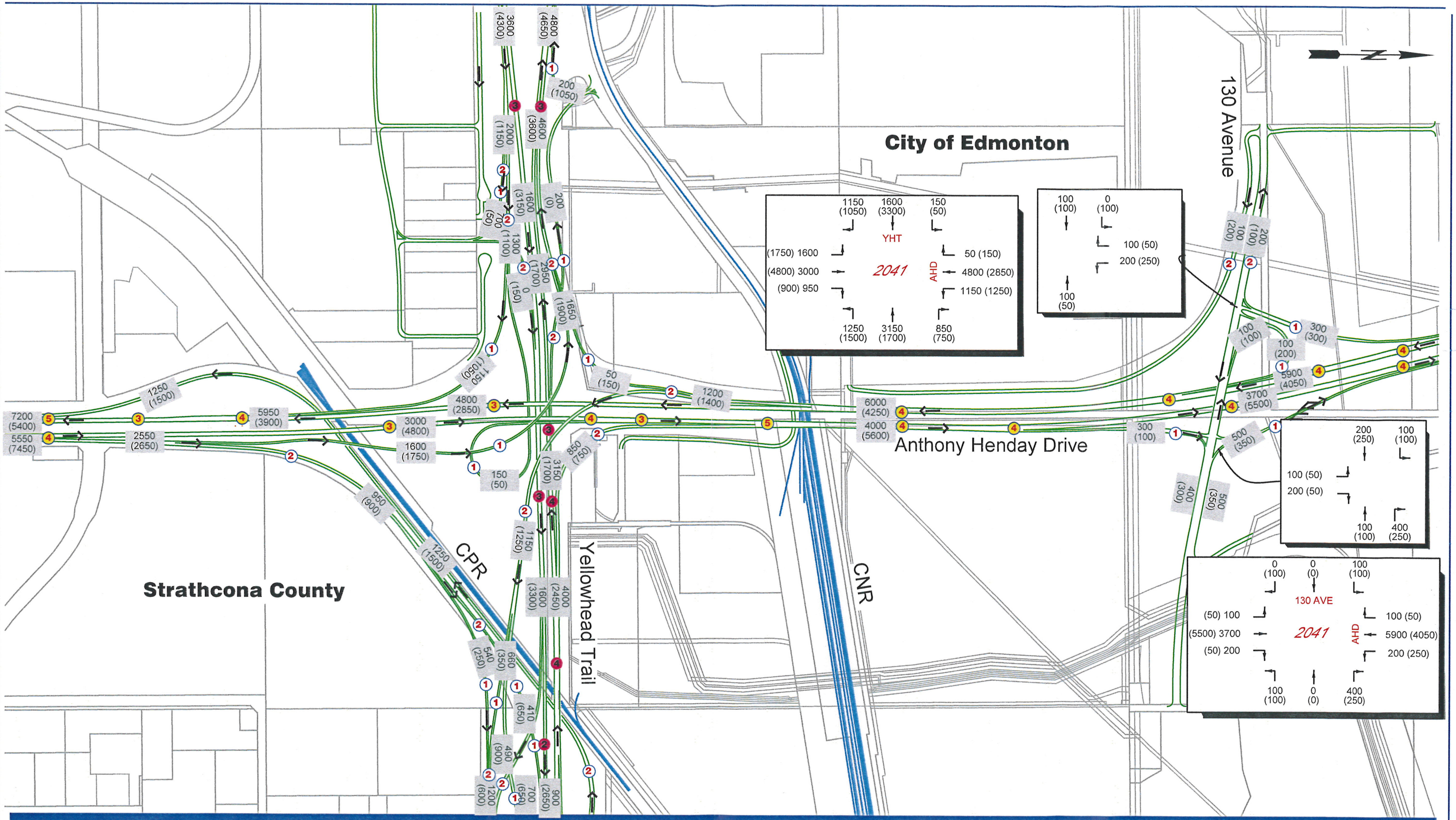
Alberta
TRANSPORTATION

Project Anthony Henday Drive

Title Traffic Volumes-Stage 1
Functional Planning Study

Figure No. Traffic 04

Jan 19 2009



![Legend]

Legend

DIRECTION OF FLOW →

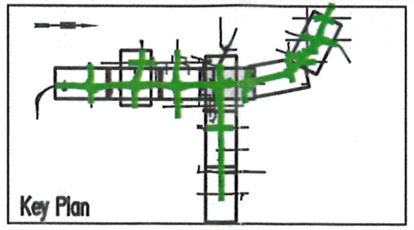
MORNING / AFTERNOON PEAK HOUR VOLUME 2550 (2650)

(Anthony Henday Drive) ③

(Crossing Roads) ②

(Interchange Ramps) ①

ISL Engineering and Land Services



SCALE 1:10 000
75 50 0 100m 200m

Alberta TRANSPORTATION

Project Anthony Henday Drive

Title Traffic Volumes-Stage 1
Functional Planning Study

Figure No. Traffic 05 Jan 19 2009

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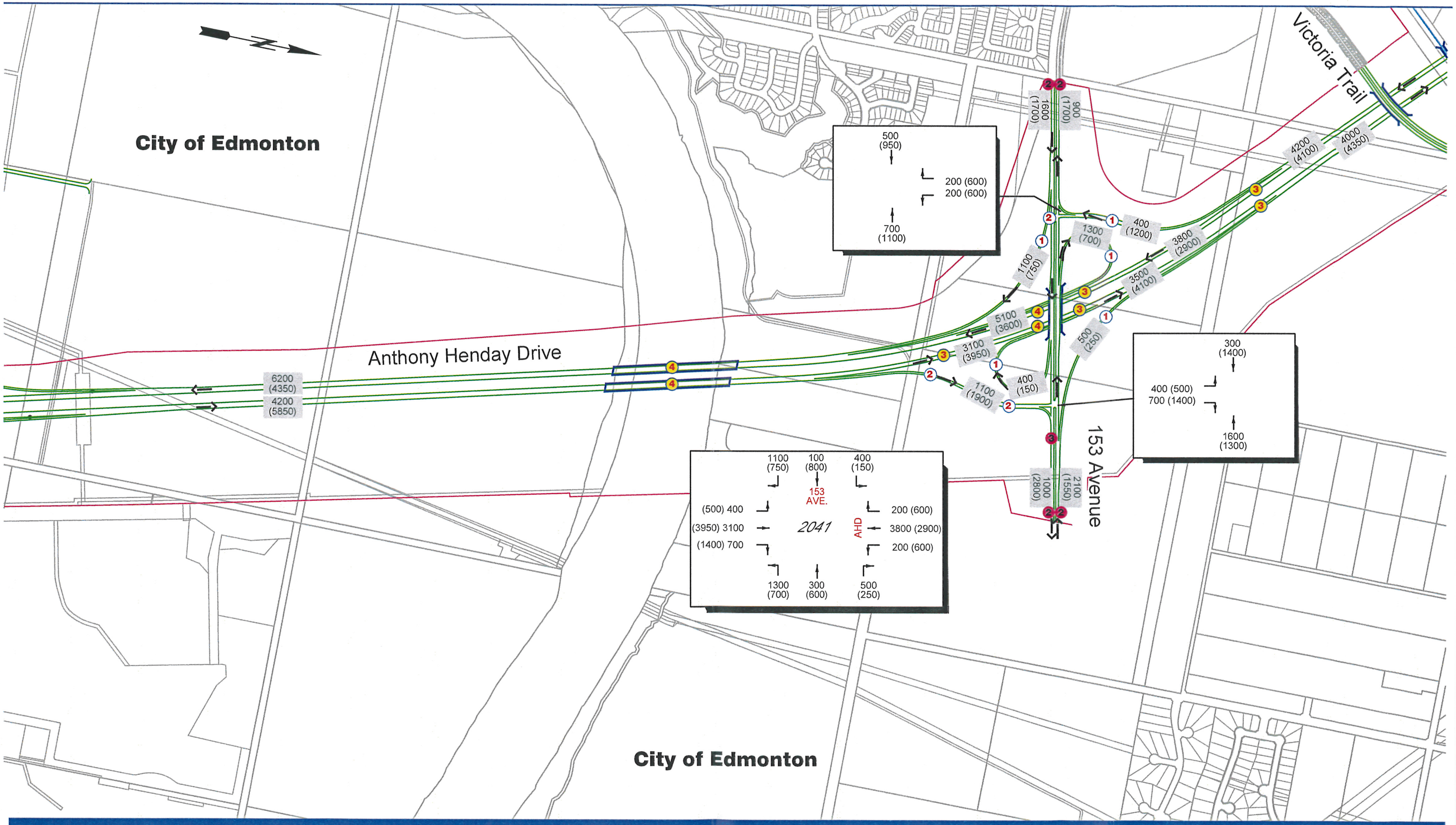
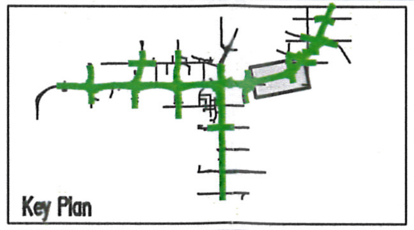
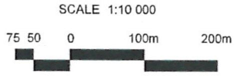


ISL Engineering and Land Services

Legend

DIRECTION OF FLOW	→
MORNING / AFTERNOON PEAK HOUR VOLUME	2550 (2650)
(Anthony Henday Drive)	③
(Crossing Roads)	②
(Interchange Ramps)	①

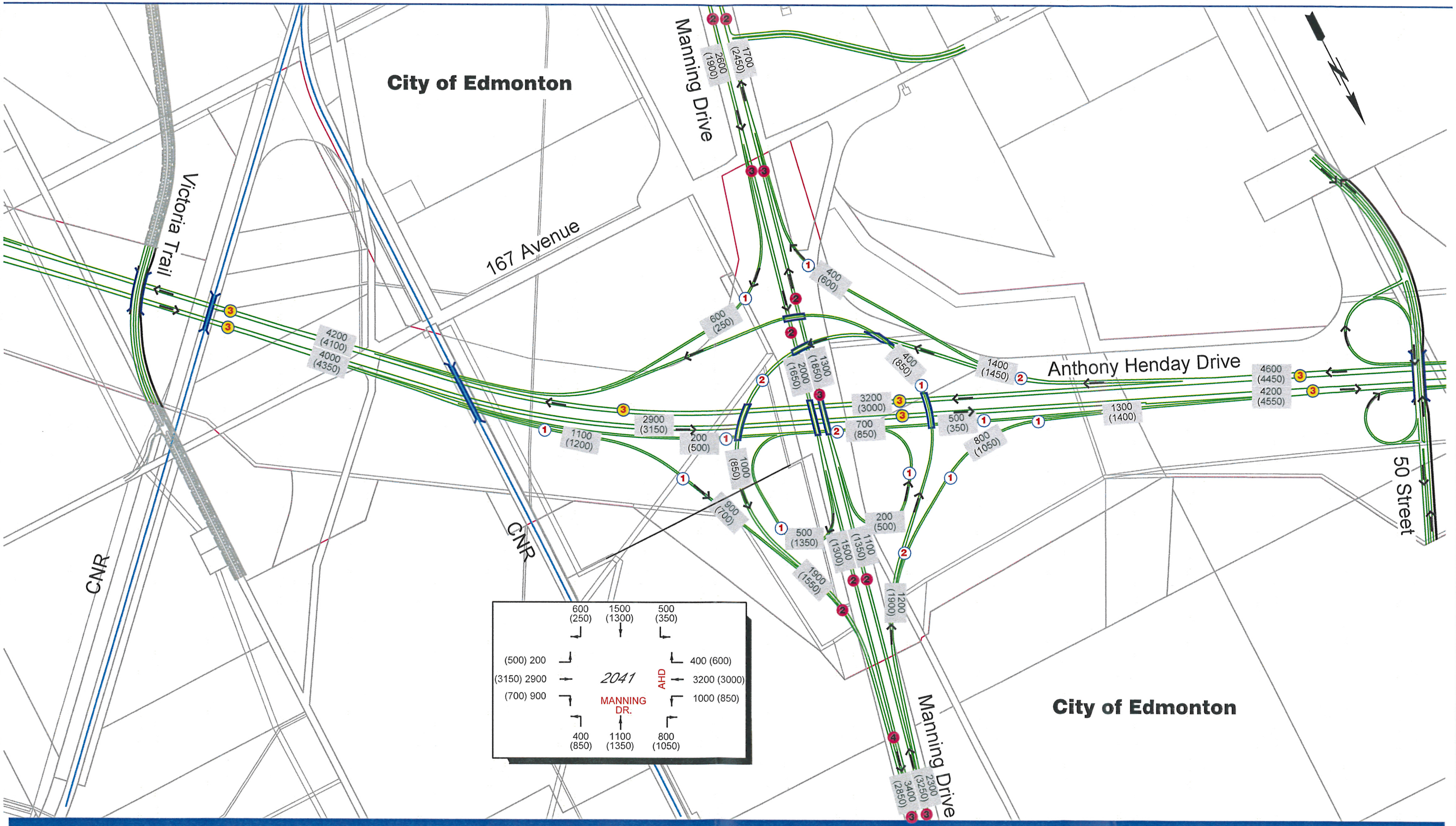




Alberta
TRANSPORTATION

Project	Anthony Henday Drive
Title	Traffic Volumes-Stage 1 Functional Planning Study
Figure No.	Traffic 06

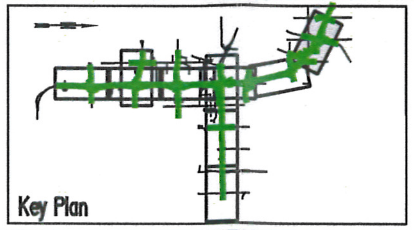
Jan 19 2009



ISL Engineering and Land Services

Legend

DIRECTION OF FLOW	→
MORNING / AFTERNOON PEAK HOUR VOLUME	2550 (2650)
(Anthony Henday Drive)	③
(Crossing Roads)	②
(Interchange Ramps)	①



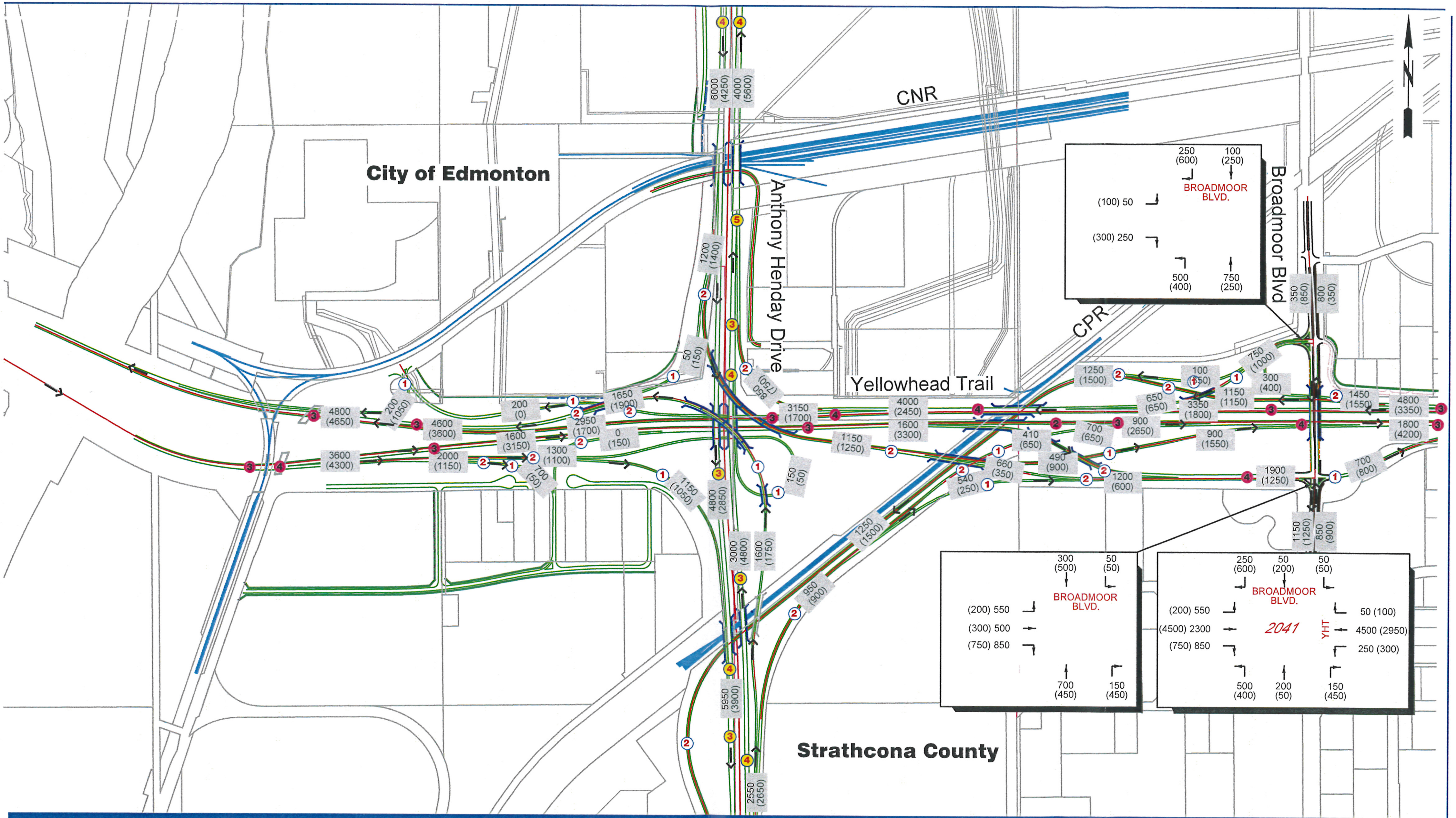
SCALE 1:10 000
75 50 0 100m 200m

Alberta TRANSPORTATION

Project	Anthony Henday Drive
Title	Traffic Volumes-Stage 1 Functional Planning Study
Figure No.	Traffic 07

Jan 19 2009

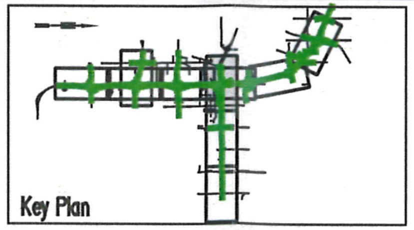
...\Traffic Stage 1\Traffic_07.dgn 2/27/2009 8:35:43 AM traffic.tbl



ISL Engineering and Land Services

Legend

DIRECTION OF FLOW	→
MORNING / AFTERNOON PEAK HOUR VOLUME	2550 (2650)
(Anthony Henday Drive)	③
(Crossing Roads)	②
(Interchange Ramps)	①



SCALE 1:10 000
75 50 0 100m 200m

Alberta TRANSPORTATION

Project	Anthony Henday Drive
Title	Traffic Volumes-Stage 1 Functional Planning Study
Figure No.	Traffic 08

Jan 19 2009

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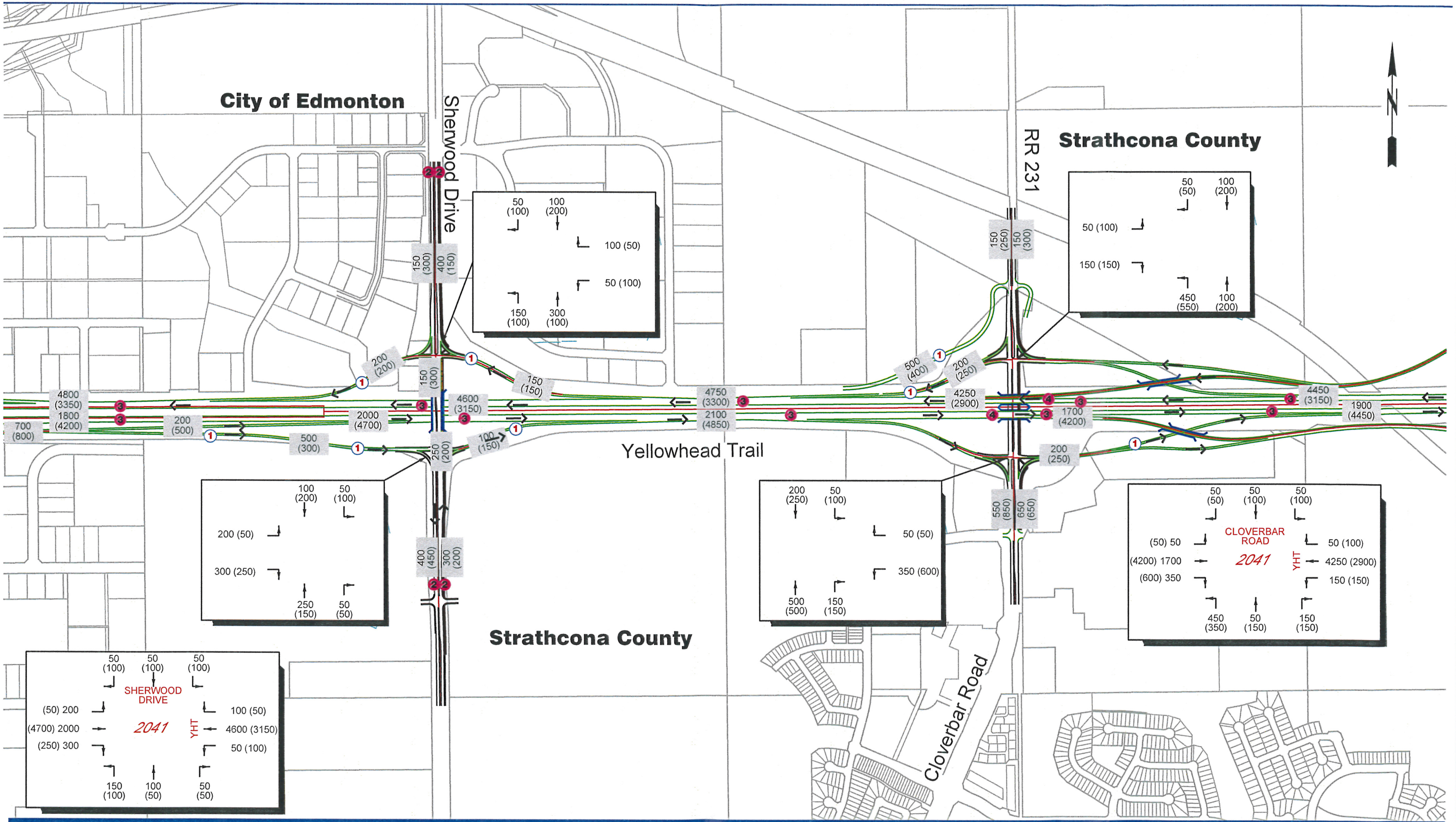
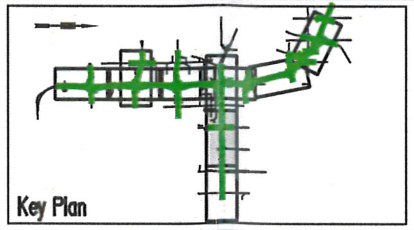


Legend

DIRECTION OF FLOW	→
MORNING / AFTERNOON PEAK HOUR VOLUME	2550 (2650)
(Anthony Henday Drive)	③
(Crossing Roads)	②
(Interchange Ramps)	①



SCALE 1:10 000

75 50 0 100m 200m

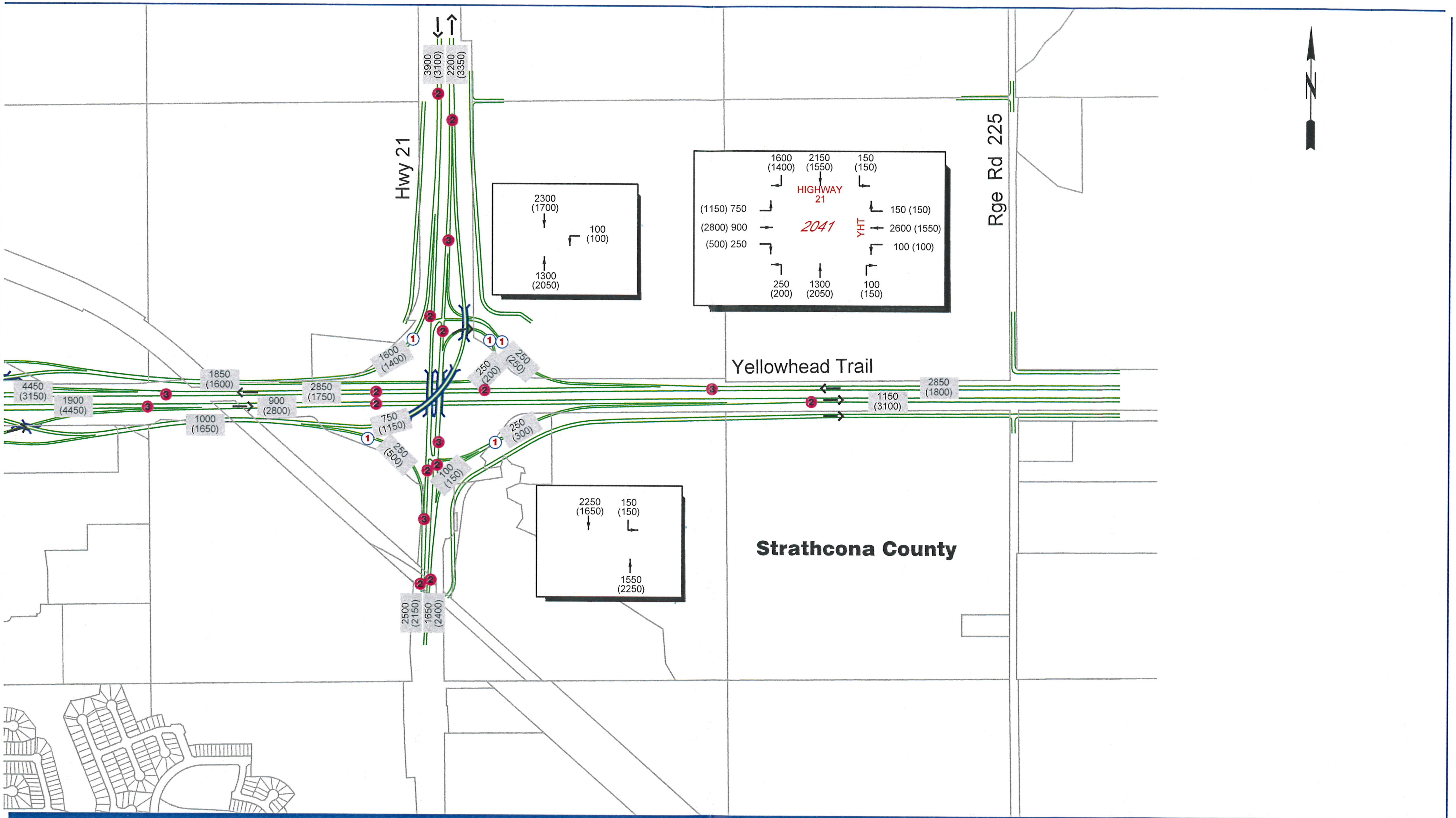
Alberta
TRANSPORTATION

Project Anthony Henday Drive

Title Traffic Volumes-Stage 1
Functional Planning Study

Figure No. Traffic 09

traffic.tbl
9:42:48 AM
2/27/2009
..\Traffic Stage 1\Traffic_09.dgn



traffic.tbl

9:59:27 AM

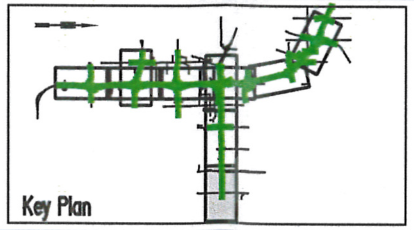
2/27/2009

...\Traffic Stage 1\Traffic_10.dgn

ISL Engineering and Land Services

Legend

DIRECTION OF FLOW	→
MORNING / AFTERNOON PEAK HOUR VOLUME	2550 (2650)
(Anthony Henday Drive)	③
(Crossing Roads)	②
(Interchange Ramps)	①


Key Plan

SCALE 1:10 000
75 50 0 100m 200m

Alberta
TRANSPORTATION

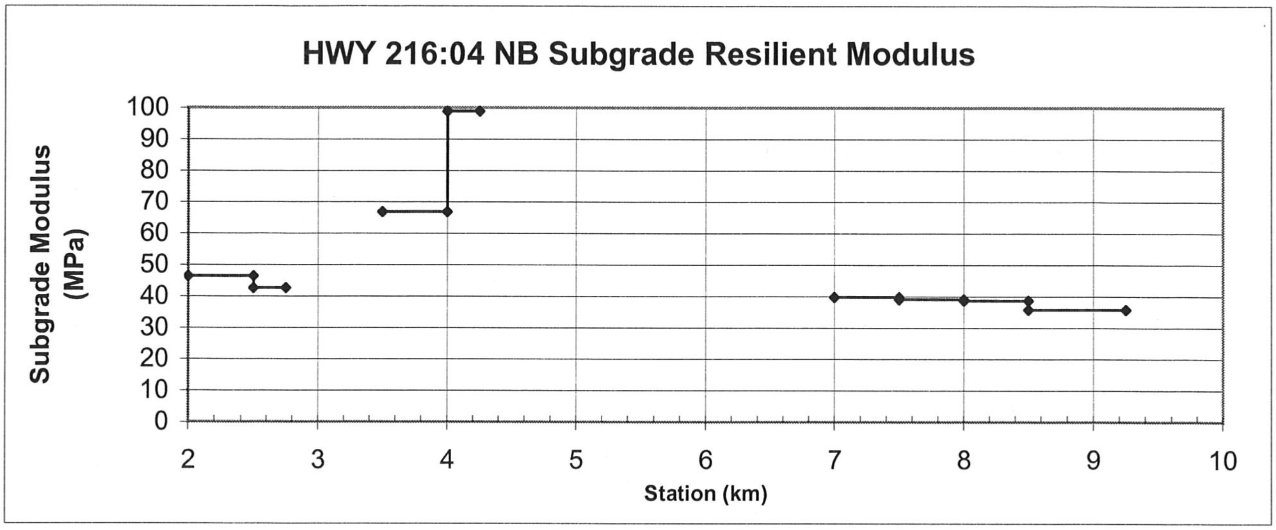
Project Anthony Henday Drive

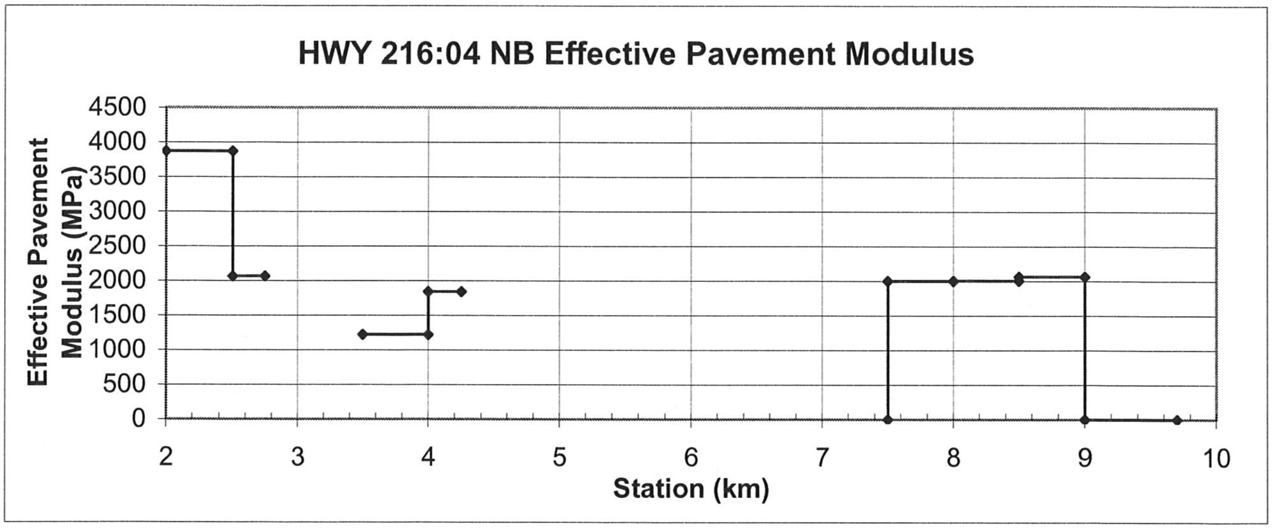
Title Traffic Volumes-Stage 1
Functional Planning Study

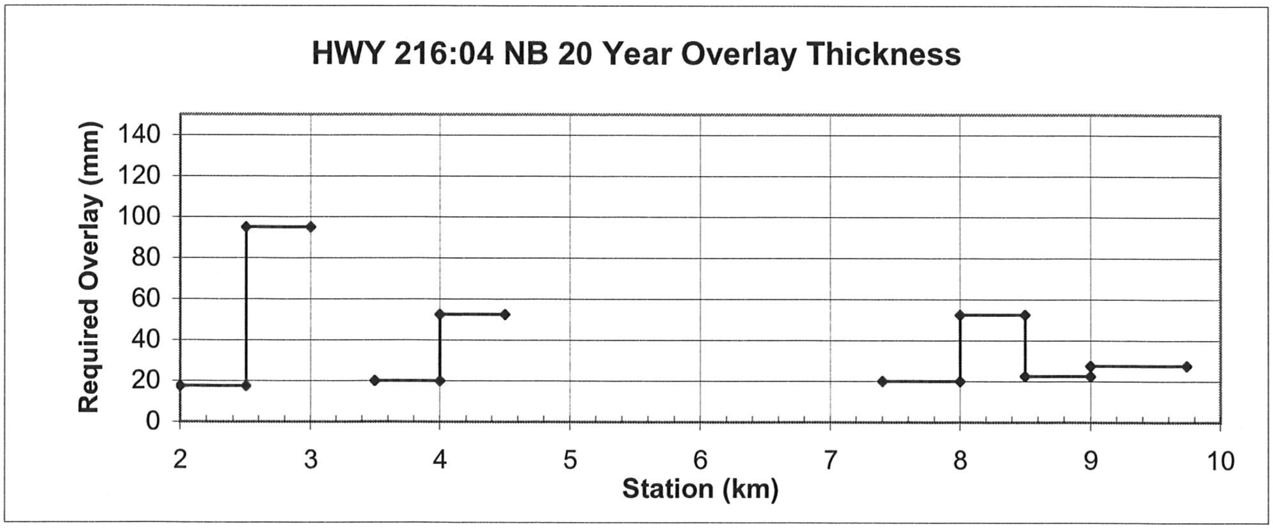
Figure No. Traffic 10 Jan 19 2009

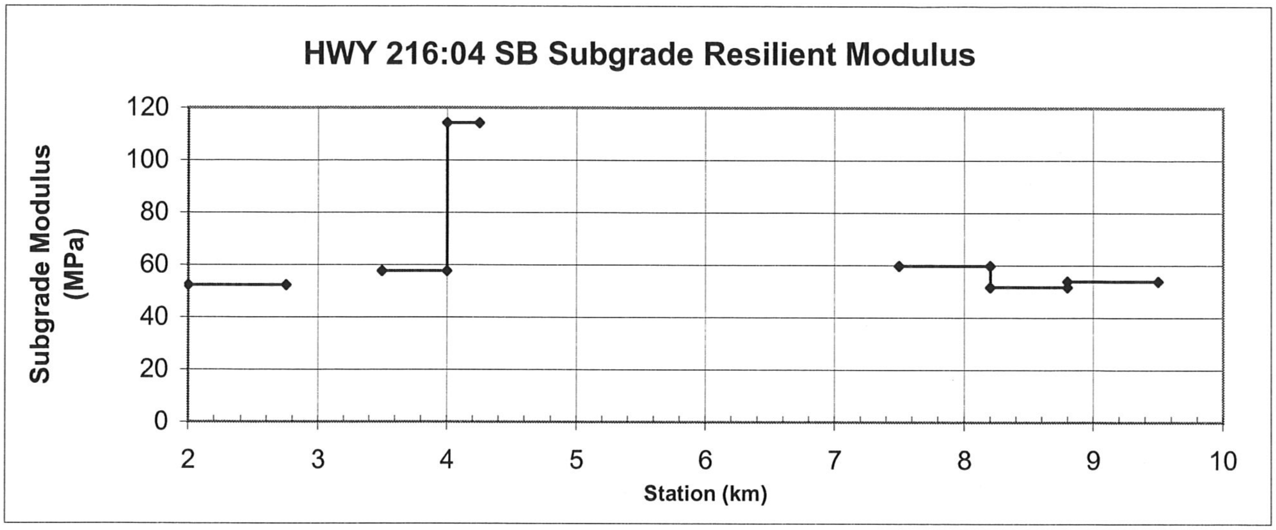
APPENDIX G

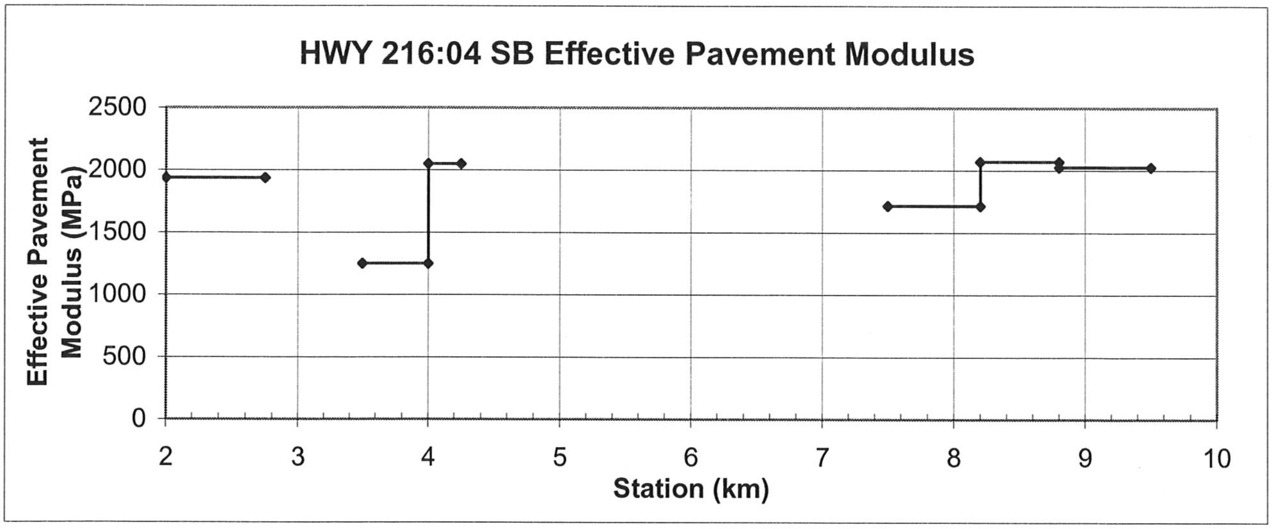
Graphs of Subgrade Resilient Modulus Pavement Resilient Modulus and Overlay Thickness
IRI Graph
Wheel Path Rutting Graph

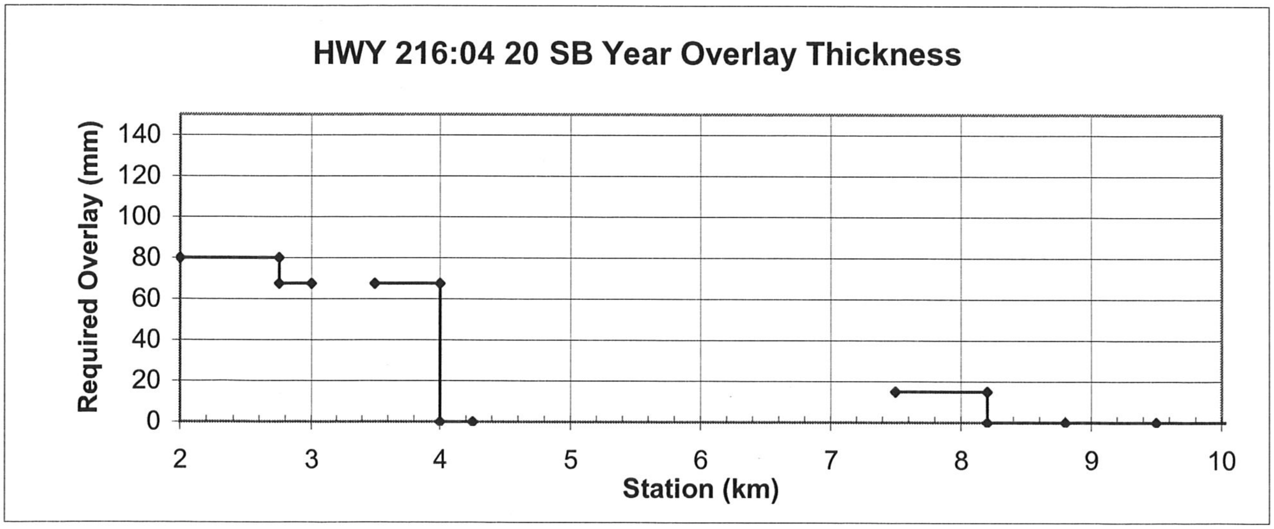

HWY 216:04 NB Subgrade Resilient Modulus


HWY 216:04 NB Effective Pavement Modulus

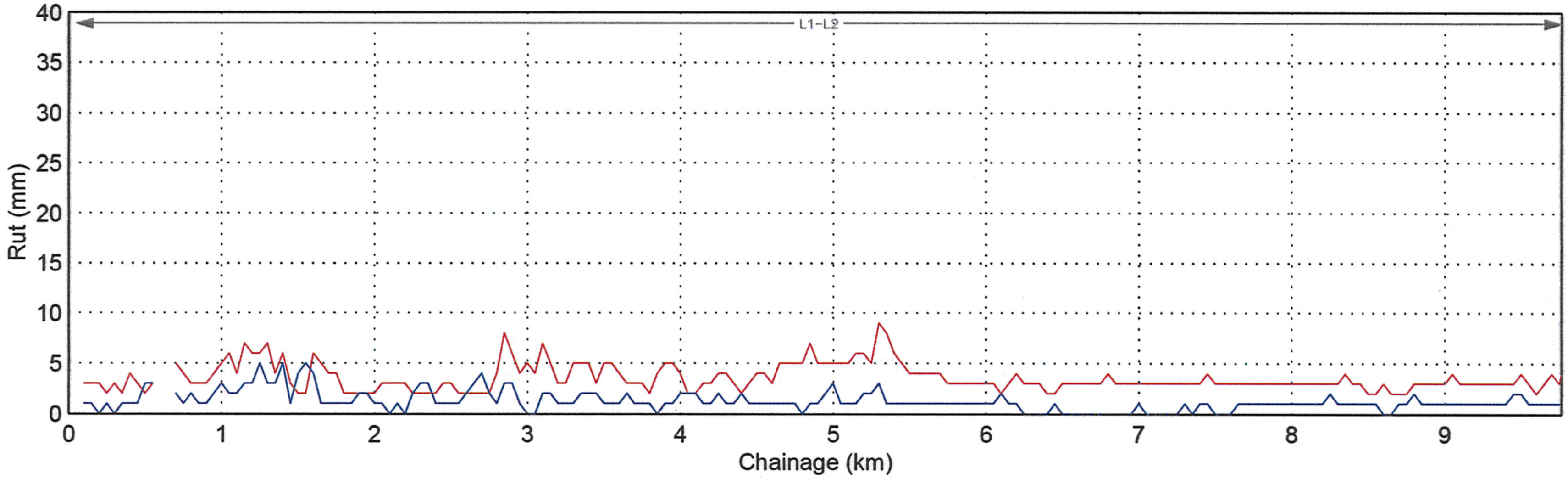

HWY 216:04 NB 20 Year Overlay Thickness


HWY 216:04 SB Subgrade Resilient Modulus

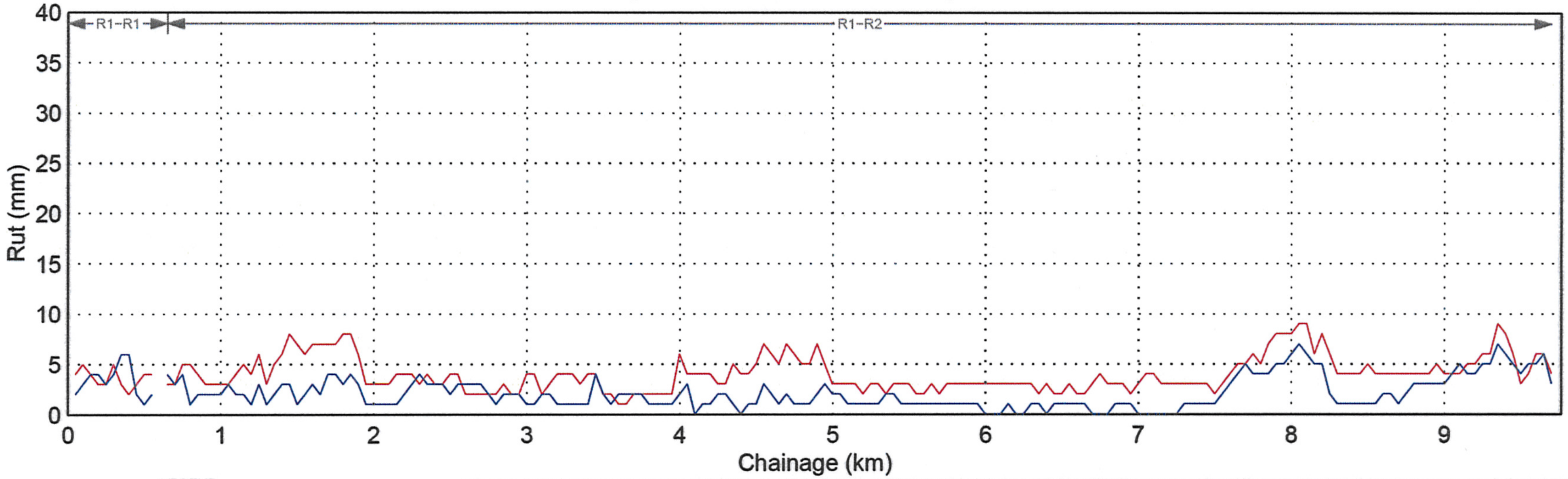

HWY 216:04 SB Effective Pavement Modulus


HWY 216:04 20 SB Year Overlay Thickness

Hwy 216:04 Wheel Path Rut – Left Lane



Hwy 216:04 Wheel Path Rut – Right Lane



LEGEND

2006 EBA – Outside Wheelpath ━━
2006 EBA – Inside Wheelpath ━━

Designations are displayed Roadway–Lane (e.g. C1–R1) and are taken from the most recent survey

Roadway Designations
R1 – Divided Hwy, Right of Centreline in Direction of Increasing Chainage
C1 – Undivided Hwy
L1 – Divided Hwy, Left of Centreline in Direction of Increasing Chainage
Lane Designations Increase From Centreline

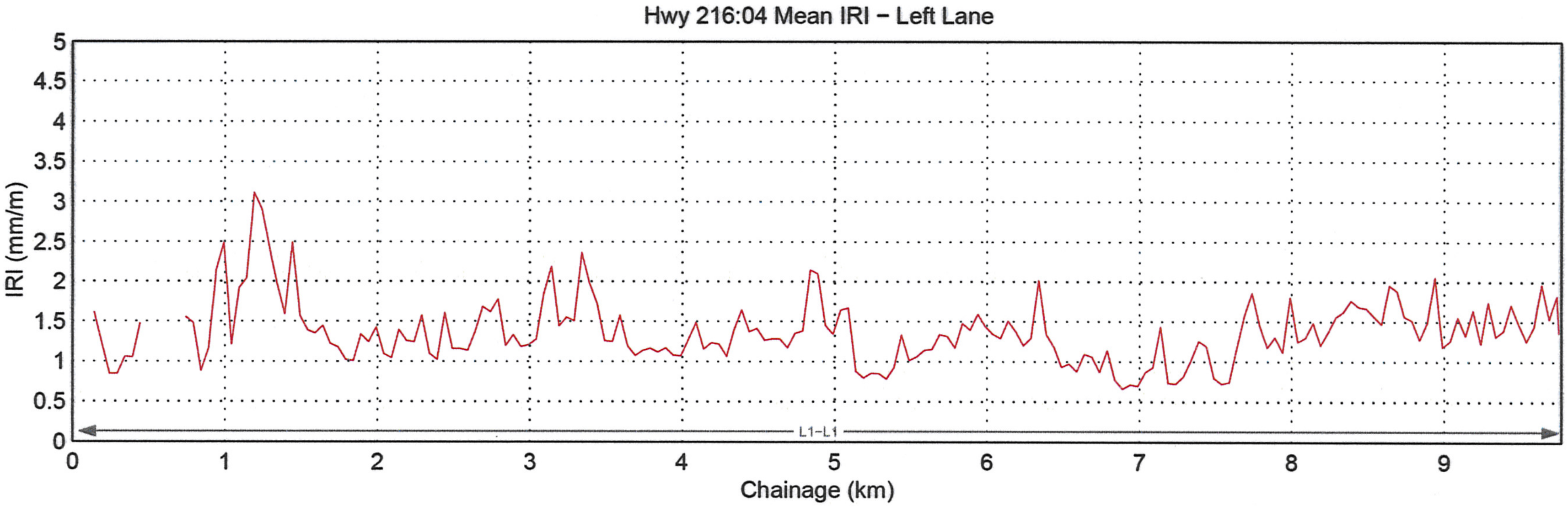
EBA Engineering Consultants Ltd.

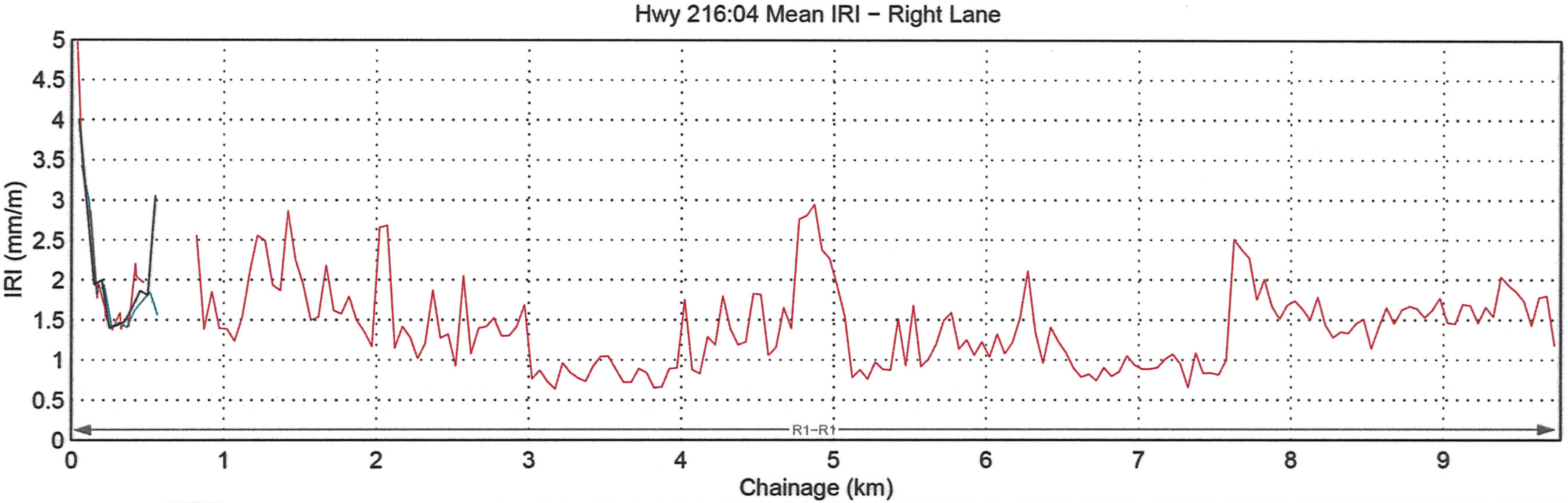
PROJECT
Rut Data Analysis 2006

CLIENT
Alberta Infrastructure and Transportation

TITLE
Highway 216:04
Divided R1–R2 / L1–L2
Mean Wheel Path Rut

DATE 2007–05–18
FILE NO. E31101019
FIGURE B.392
PAGE 1 of 1


Hwy 216:04 Mean IRI – Left Lane


Hwy 216:04 Mean IRI – Right Lane

LEGEND

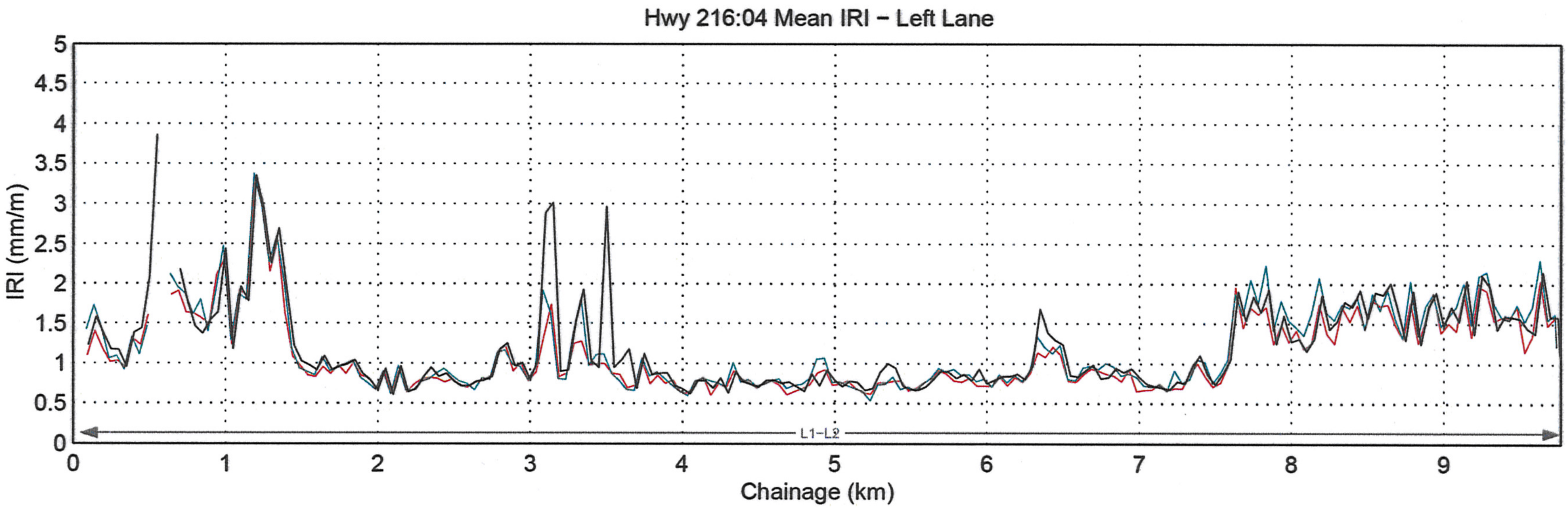
2006 EBA ━━
2004 EBA ━━
2005 EBA ━━

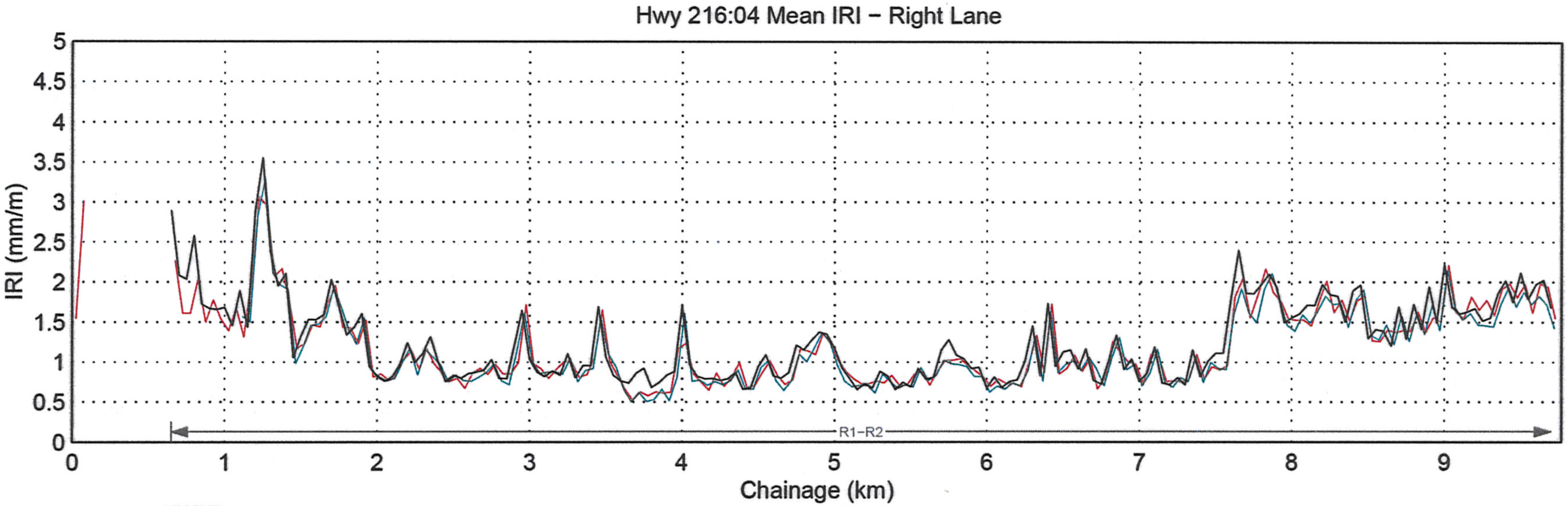
Designations are displayed Roadway–Lane (e.g. C1–R1) and are taken from the most recent survey

Roadway Designations
R1 – Divided Hwy, Right of Centreline in Direction of Increasing Chainage
C1 – Undivided Hwy
L1 – Divided Hwy, Left of Centreline in Direction of Increasing Chainage
Lane Designations Increase From Centreline

EBA Engineering Consultants Ltd.

CLIENT	Alberta Infrastructure and Transportation
PROJECT	IRI Data Analysis 2004–2006
TITLE	Highway 216:04 Divided R1–R1 / L1–L1 Mean Wheel Path IRI
DATE	2007–05–18
FILE NO.	E31101019
FIGURE	A.489
PAGE	1 of 1





LEGEND

2006 EBA ▬ 2005 EBA ▬

2004 EBA ▬

Designations are displayed Roadway–Lane (e.g. C1–R1) and are taken from the most recent survey

Roadway Designations
R1 – Divided Hwy, Right of Centreline in Direction of Increasing Chainage
C1 – Undivided Hwy
L1 – Divided Hwy, Left of Centreline in Direction of Increasing Chainage
Lane Designations Increase From Centreline

EBA Engineering Consultants Ltd.

PROJECT
IRI Data Analysis 2004–2006

CLIENT
Alberta Infrastructure and Transportation

TITLE
Highway 216:04
Divided R1–R2 / L1–L2
Mean Wheel Path IRI

DATE 2007–05–18
FILE NO. E31101019
FIGURE A.490
PAGE 1 of 1

APPENDIX H

DARWin Pavement Design Printouts

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Thurber Engineering ltd.

Flexible Structural Design Module

NEERR
AHD Main Line
Perpetual Pavement

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	144,000,000
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1
Calculated Design Structural Number	220 mm

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(mm)	Width (m)	Calculated SN (mm)
1	ACP	0.4	1	410	-	164
2	GBC	0.14	1	400	-	56
Total	-	-	-	810	-	220

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Thurber Engineering ltd.

Flexible Structural Design Module

NEERR
AHD High Volume Ramp
Perpetual Pavement

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	61,800,000
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1
Calculated Design Structural Number	198 mm

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(mm)	Width (m)	Calculated SN (mm)
1	ACP	0.4	1	360	-	120
2	GBC	0.14	1	400	-	56
Total	-	-	-	700	-	176

*Note: This value is not represented by the inputs or an error occurred in calculation.

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

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Computer Software Product

Thurber Engineering ltd.

Flexible Structural Design Module

NEERR
AHD Low Volume Ramp
Perpetual Pavement

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	20,600,000
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1
Calculated Design Structural Number	173 mm

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(mm)	Width (m)	Calculated SN (mm)
1	ACP	0.4	1	300	-	120
2	GBC	0.14	1	400	-	56
Total	-	-	-	700	-	176

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

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Computer Software Product

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Flexible Structural Design Module

NEERR
Main Line
Conventional Pavements

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	34,300,000
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1
Calculated Design Structural Number	184 mm

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(mm)	Width (m)	Calculated SN (mm)
1	ACP	0.4	1	320	-	128
2	GBC	0.14	1	400	-	56
Total	-	-	-	720	-	184

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

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Computer Software Product

Thurber Engineering ltd.

Flexible Structural Design Module

NEERR
High Volume Cross Roads and YHT Ramp
Conventional Pavements

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	14,700,000
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	95 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1
Calculated Design Structural Number	166 mm

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(mm)	Width (m)	Calculated SN (mm)
1	ACP	0.4	1	280	-	112
2	GBC	0.14	1	400	-	56
Total	-	-	-	680	-	168

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Thurber Engineering ltd.

Flexible Structural Design Module

NEERR
Low Volume Cross Roads
Conventional Pavements

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	9,800,000
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	90 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1
Calculated Design Structural Number	150 mm

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(mm)	Width (m)	Calculated SN (mm)
1	ACP	0.4	1	260	-	104
2	GBC	0.14	1	350	-	49
Total	-	-	-	610	-	153

1997 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Thurber Engineering ltd.

Flexible Structural Design Module

NEERR
Low Volume Ramps
Conventional Pavements

Flexible Structural Design

80-kN ESALs Over Initial Performance Period	4,900,000
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	85 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	30,000 kPa
Stage Construction	1
Calculated Design Structural Number	131 mm

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(mm)	Width (m)	Calculated SN (mm)
1	ACP	0.4	1	210	-	84
2	GBC	0.14	1	350	-	49
Total	-	-	-	560	-	133

APPENDIX I

Recommended Construction Procedures

RECOMMENDED CONSTRUCTION PROCEDURES

The following construction procedures are considered to represent good practice and are to be read in conjunction with the text of this report.

1. EXCAVATED FOUNDATIONS

1.1 Excavation close to foundation level should be done carefully to avoid disturbance of the soil. It is essential to prevent the soil at foundation level from deterioration due to excessive drying or becoming wet from surface or seepage water. Good drainage both during and after construction is essential.

1.2 Sumps, if required, should be located well away from the foundation area. Softened or over dried soil must be removed and replaced by lean mix concrete or by extending the foundations.

1.3 The foundation must be kept from freezing both during and after construction. Foundation concrete should not be placed on or against frozen soil.

2. BACKFILLING

2.1 Backfill around foundations should be placed in such a manner so as to prevent settlement and to be relatively impervious near the surface so that water does not pond against foundations nor be allowed to seep into the soil.

2.2 Backfill should not be placed until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction.

2.3 All backfill around grade beams, foundation walls, etc. must be carefully and uniformly compacted. The backfill should be placed in even layers and no frozen or organic material should be incorporated into the fill. All lumps of material must be broken down or squeezed together during placing and compaction.

2.4 The final grade (allowing for some settlement of the backfill) should shed water away from the structure.

2.5 During construction, precautions should be taken to prevent water ponding in grade beam excavations thereby acting as a source of water to soften the soil under the floor slab area or providing a source of water for frost action if the building is not heated during freezing weather.

3. DRIVEN STEEL PILES

3.1 Piles shall be driven by equipment having a striking weight of not less than one-third of the driven weight of the piles. The driver should be capable of delivering at least 27 kN-metres (20,000 ft-lbs) of energy.

3.2 The number of blows required to drive the pile each foot should be recorded for every pile as an indication of the satisfactory carrying capacity of the pile and as an indicator of potential tip damage.

3.3 The driving energy should be restricted to 6300 kN-metres per square metre (3,000 ft-lbs per square inch) of steel in the pile cross section to avoid over-stressing the steel during driving.

3.4 After each pile is driven to its required depth an elevation should be taken of the pile top or on a suitable mark on the side of the pile. This elevation should be checked periodically to ensure that it is not heaved by the driving of adjacent piles. Piles that are heaved must be redriven.

3.5 For piles which displace a considerable amount of soil during driving, such as closed-end piles, care must be taken that the driving does not cause damaging horizontal displacement of existing structures or foundations.

3.6 Where piles are designed to gain support by skin friction in the soil, it is essential that the pile have ends and walls free from protrusions which would cause voids or disturbance of the adjacent soil during driving.

4. BORED CAST-IN-PLACE CONCRETE PILES

4.1 If there is evidence of water bearing and/or sloughing soil, casing should be used to seal off the water or prevent the sloughing of the sides of the hole. The concrete and reinforcing steel should be on hand and placed as soon as the pile hole has been completed and approved.

4.2 Pile bells, if used, should be formed entirely in self-supporting soil and it may be necessary in some cases to extend the pile bell if caving occurs at the location of the bell.

4.3 Water should not be left ponded on the pile base and should be removed, or dried by the use of dry cement when permitted by the engineer.

4.4 Concrete should be placed without segregation and carefully vibrated throughout the full length of the pile to ensure that voids do not exist in the pile shaft. The concrete slump should be between 75 and 125 mm with a minimum compressive strength at 28 days of 21 MPa (3000 psi). Higher compressive strengths may be required for structural or durability reasons and higher slumps may be necessary for closely spaced reinforcing bars or where concrete is to be tremied under water.

4.5 Steel reinforcing should be tied into the grade beam reinforcing steel. This recommendation is important where the soil below grade beam can swell from a change in moisture content or by frost action before the building is heated.

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NORTHEAST EDMONTON RING ROAD
ADVANCED FUNCTIONAL PLANNING STUDY
MANNING DRIVE TO WHITEMUD DRIVE
GEOTECHNICAL INVESTIGATION
VOLUME 2 of 2

Report

to

ISL Engineering and Land Services Ltd.

Donald W. Stefanyk

December 15, 2009

Don W. Stefanyk, B.Sc., P.Eng.
Project Engineer

SHAWN G. RUSSELL

15/12/09

Shawn G. Russell, B.A.Sc, P.Eng.
Project Engineer

R.W. Tweedie

Rob Tweedie
Dec 15, 2009

Robin Tweedie, M.Sc., P.Eng.
Review Principal

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
Signature Rob Tweedie
Date Dec 15, 2009
PERMIT NUMBER: P 5186
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

Date: December 15, 2009
File: 19-598-298

VOLUME 2

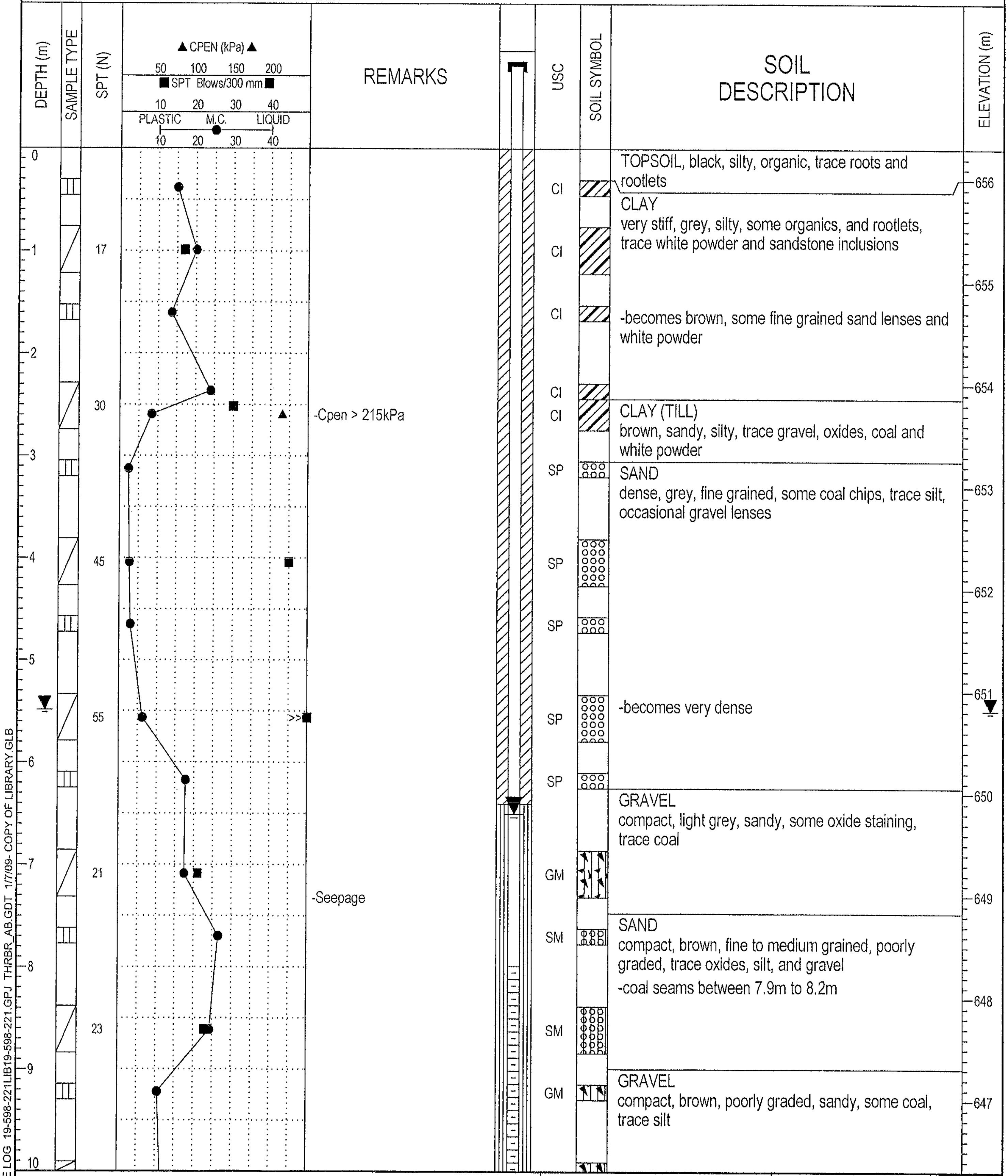
APPENDIX J

Previous Test Hole Logs
Selected Relevant Information from AT Files

CLIENT: INFRASTRUCTURE SYSTEMS LTD.	PROJECT: North Edmonton Ring Road Functional Study	BOREHOLE NO: **TH06-D41**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 6, 2006	PROJECT NO: 19-598-221
DRILL/METHOD: Truck / Solid Stem Auger	LOCATION: CN Rail and Hayter Road Crossing	ELEVATION: 656.3 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ⧄ SPT ☒ NO RECOVERY

BACKFILL TYPE ▨ DRILL CUTTINGS ▥ SLOUGH



SOIL DESCRIPTION

TOPSOIL, black, silty, organic, trace roots and rootlets

CLAY
very stiff, grey, silty, some organics, and rootlets, trace white powder and sandstone inclusions

-becomes brown, some fine grained sand lenses and white powder

CLAY (TILL)
brown, sandy, silty, trace gravel, oxides, coal and white powder

SAND
dense, grey, fine grained, some coal chips, trace silt, occasional gravel lenses

-becomes very dense

GRAVEL
compact, light grey, sandy, some oxide staining, trace coal

SAND
compact, brown, fine to medium grained, poorly graded, trace oxides, silt, and gravel
-coal seams between 7.9m to 8.2m

GRAVEL
compact, brown, poorly graded, sandy, some coal, trace silt

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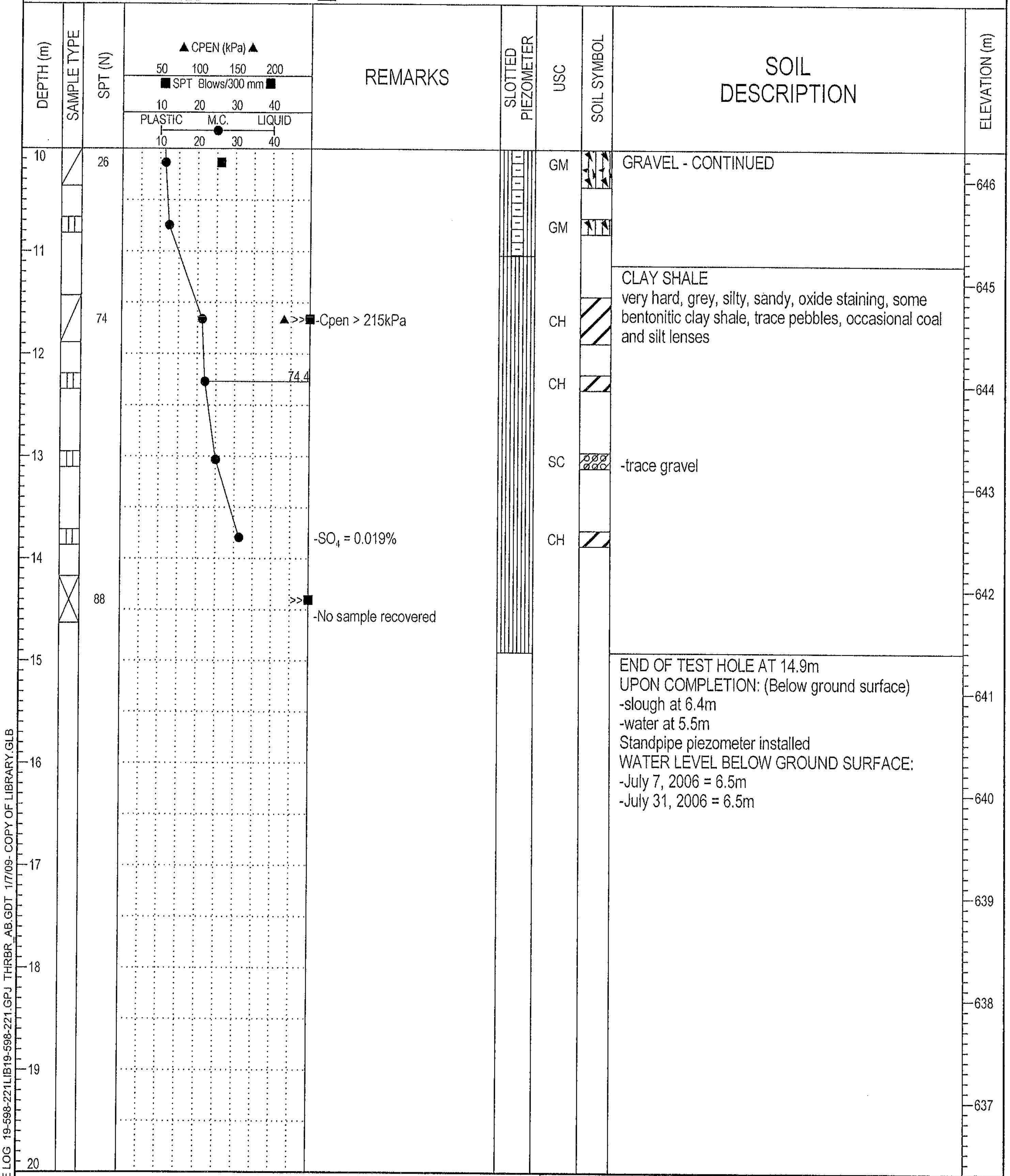
FIELD LOGGED BY: MW	COMPLETION DEPTH: 14.9 m
PREPARED BY: MMS	COMPLETION DATE: 7/6/06
REVIEWED BY:	

CLIENT: INFRASTRUCTURE SYSTEMS LTD.	PROJECT: North Edmonton Ring Road Functional Study	BOREHOLE NO: **TH06-D41**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 6, 2006	PROJECT NO: 19-598-221
DRILL/METHOD: Truck / Solid Stem Auger	LOCATION: CN Rail and Hayter Road Crossing	ELEVATION: 656.3 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT ☒ NO RECOVERY

BACKFILL TYPE ▨ DRILL CUTTINGS ▥ SLOUGH



-Cpen > 215kPa

-SO$_4$ = 0.019%

-No sample recovered

GRAVEL - CONTINUED

CLAY SHALE
very hard, grey, silty, sandy, oxide staining, some bentonitic clay shale, trace pebbles, occasional coal and silt lenses

-trace gravel

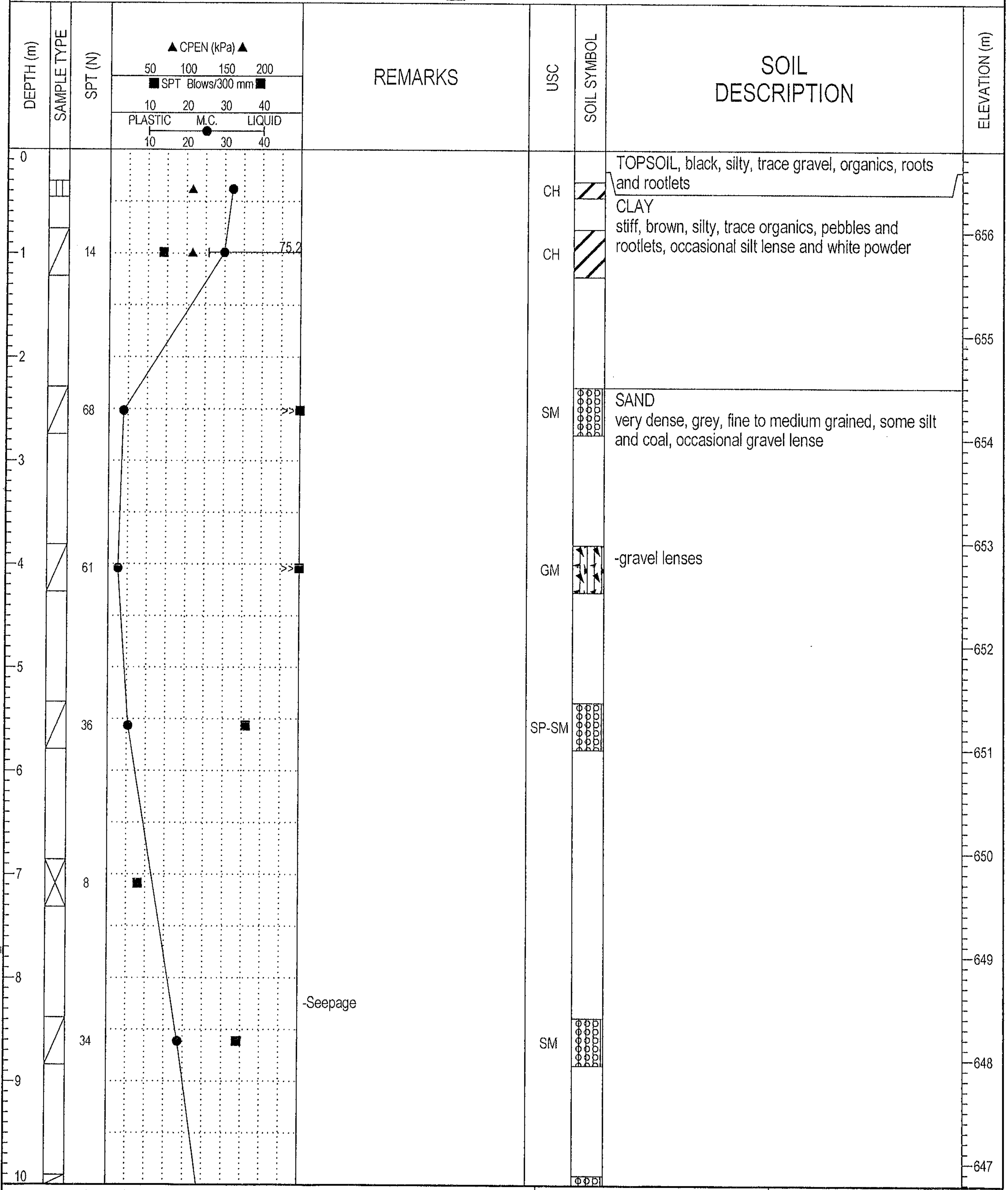
END OF TEST HOLE AT 14.9m
UPON COMPLETION: (Below ground surface)
-slough at 6.4m
-water at 5.5m
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 7, 2006 = 6.5m
-July 31, 2006 = 6.5m

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: MW	COMPLETION DEPTH: 14.9 m
PREPARED BY: MMS	COMPLETION DATE: 7/6/06
REVIEWED BY:	Page 2 of 2

CLIENT: INFRASTRUCTURE SYSTEMS LTD.	PROJECT: North Edmonton Ring Road Functional Study	BOREHOLE NO: **TH06-D42**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 7, 2006	PROJECT NO: 19-598-221
DRILL/METHOD: Truck / Hollow Stem Auger	LOCATION: CN Rail and Hayter Road Crossing	ELEVATION: 656.78 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◸ SPT ☒ NO RECOVERY



-Seepage

TOPSOIL, black, silty, trace gravel, organics, roots and rootlets

CLAY
stiff, brown, silty, trace organics, pebbles and rootlets, occasional silt lense and white powder

SAND
very dense, grey, fine to medium grained, some silt and coal, occasional gravel lense

-gravel lenses

BOREHOLE LOG 19-598-221LIB19-598-221.GPJ THRBR_AB.GDT 1/7/09- COPY OF LIBRARY.GLB

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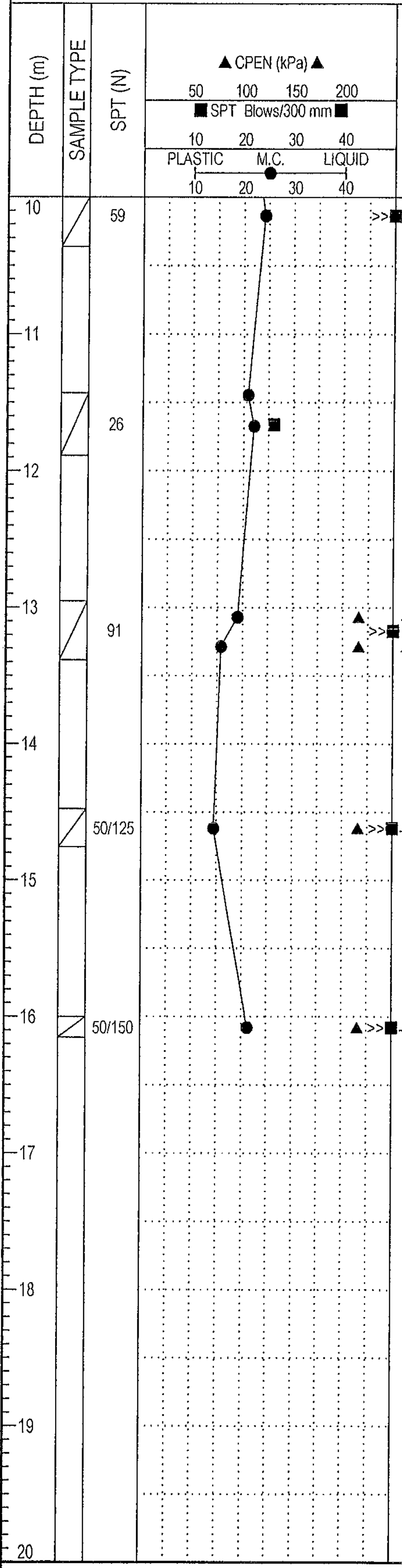
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: MW	COMPLETION DEPTH: 16.2 m
PREPARED BY: MMS	COMPLETION DATE: 7/1/06
REVIEWED BY:	Page 1 of 2

CLIENT: INFRASTRUCTURE SYSTEMS LTD.	PROJECT: North Edmonton Ring Road Functional Study	BOREHOLE NO: **TH06-D42**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 7, 2006	PROJECT NO: 19-598-221
DRILL/METHOD: Truck / Hollow Stem Auger	LOCATION: CN Rail and Hayter Road Crossing	ELEVATION: 656.78 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ◿ SPT ☒ NO RECOVERY



SPT (N)	REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
59		SP-SM	SAND - CONTINUED -becomes light grey	646
26		SM CI	CLAY SHALE very stiff, brown, gravelly, some silt, trace coal and ironstone	645 644
91	-Cpen > 215kPa -Cpen > 215kPa	CI SC	SANDSTONE very dense, light grey, bentonitic, trace gravel and ironstone, occasional silt and oxide lenses	643
50/125	-Cpen > 215kPa	SC	-trace coal, pebbles and silt lenses	642 641
50/150	-Cpen > 215kPa	CH	CLAY SHALE, hard, grey, silty, trace oxides	
			END OF TEST HOLE AT 16.2m UPON COMPLETION: (Below ground surface) -Slough at 5.3m -No water Back filled with drill cuttings	640 639 638 637

BOREHOLE LOG 19-598-221LIB19-598-221.GPJ THRBR_AB.GDT 1/7/09- COPY OF LIBRARY.GLB

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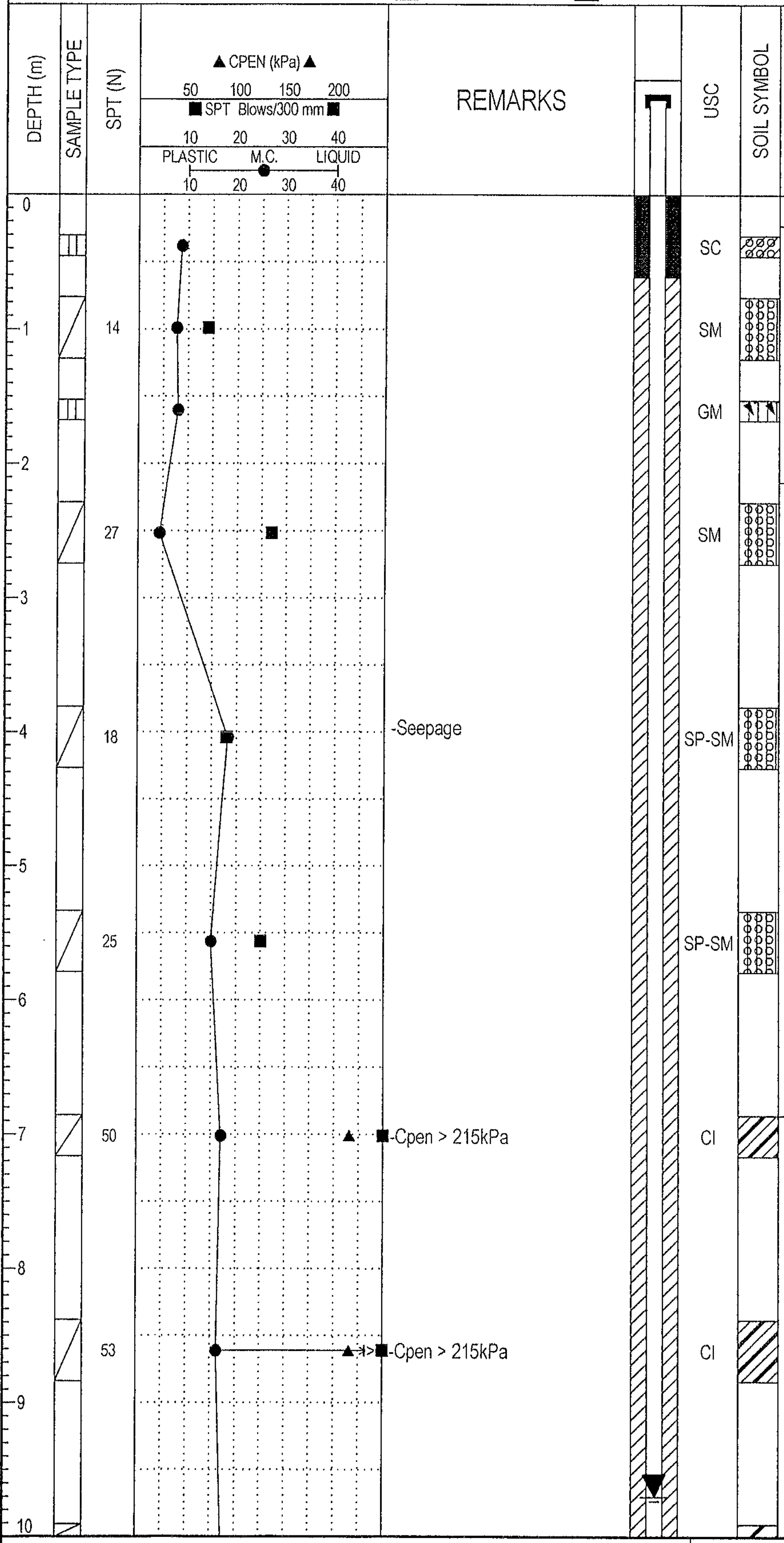
FIELD LOGGED BY: MW	COMPLETION DEPTH: 16.2 m
PREPARED BY: MMS	COMPLETION DATE: 7/1/06
REVIEWED BY:	

CLIENT: INFRASTRUCTURE SYSTEMS LTD.	PROJECT: North Edmonton Ring Road Functional Study	BOREHOLE NO: **TH06-D43**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 9, 2006	PROJECT NO: 19-598-221
DRILL/METHOD: Truck / Solid & Hollow Stem Auger	LOCATION: Maridian Street Crossing	ELEVATION: 661.49 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



SOIL DESCRIPTION

TOPSOIL, black, silty, organics, trace roots and rootlets

GRAVEL
compact, brown, poorly graded, rounded up to 80mm, sandy, trace clay, ironstone, silt, and coal
-oxide staining

-some clay lumps and coal chips

SAND
compact, brown, fine grained, poorly graded, some coal and oxide staining, trace silt

-becomes fine to medium grained

-some gravel

CLAY SHALE
very hard, bluish - grey, sandy, oxide stained, trace ironstone inclusions and bentonite, occasional silt and coal lenses

-siltstone layer

ELEVATION (m): 661, 660, 659, 658, 657, 656, 655, 654, 653, 652

BOREHOLE LOG 19-598-221LIB19-598-221.GPJ THRBR_AB.GDT 1/7/09- COPY OF LIBRARY.GLB

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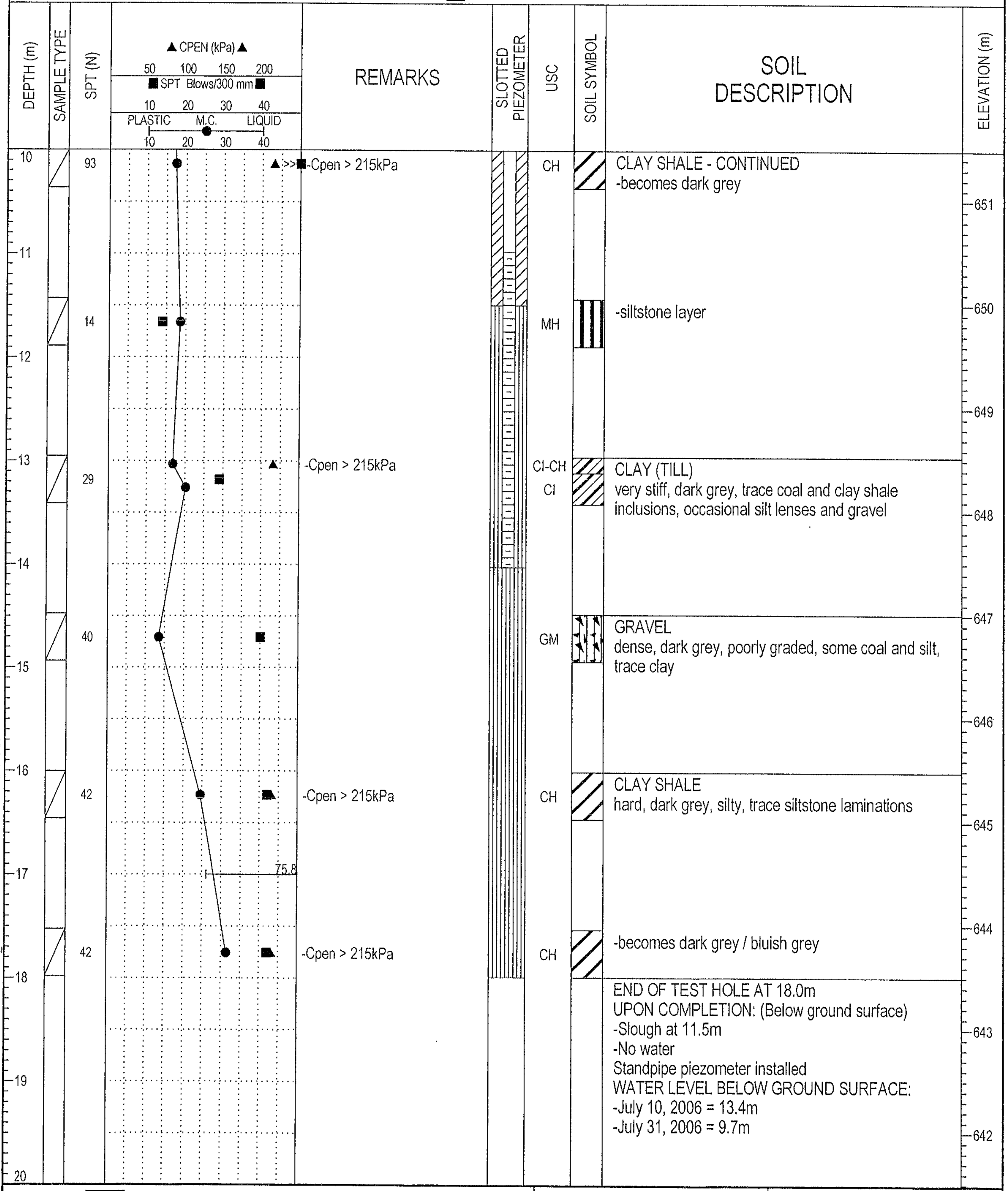
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

FIELD LOGGED BY: MW	COMPLETION DEPTH: 18.0 m
PREPARED BY: MMS	COMPLETION DATE: 7/7/06
REVIEWED BY:	

CLIENT: INFRASTRUCTURE SYSTEMS LTD.	PROJECT: North Edmonton Ring Road Functional Study	BOREHOLE NO: **TH06-D43**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 9, 2006	PROJECT NO: 19-598-221
DRILL/METHOD: Truck / Solid & Hollow Stem Auger	LOCATION: Maridian Street Crossing	ELEVATION: 661.49 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT

BACKFILL TYPE ■ BENTONITE ▨ DRILL CUTTINGS ▥ SLOUGH



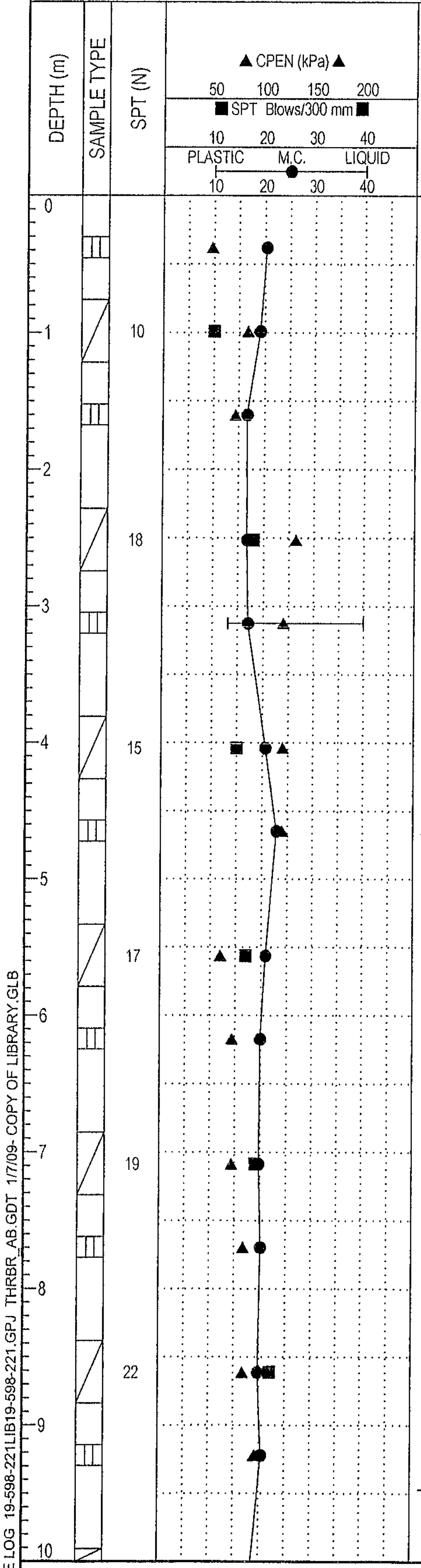
SPT (N)	REMARKS	USC	SOIL DESCRIPTION
93	>>■-Cpen > 215kPa	CH	CLAY SHALE - CONTINUED -becomes dark grey
14		MH	-siltstone layer
29	-Cpen > 215kPa	CI-CH CI	CLAY (TILL) very stiff, dark grey, trace coal and clay shale inclusions, occasional silt lenses and gravel
40		GM	GRAVEL dense, dark grey, poorly graded, some coal and silt, trace clay
42	-Cpen > 215kPa	CH	CLAY SHALE hard, dark grey, silty, trace siltstone laminations
42	-Cpen > 215kPa	CH	-becomes dark grey / bluish grey

END OF TEST HOLE AT 18.0m
UPON COMPLETION: (Below ground surface)
-Slough at 11.5m
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-July 10, 2006 = 13.4m
-July 31, 2006 = 9.7m

FIELD LOGGED BY: MW	COMPLETION DEPTH: 18.0 m
PREPARED BY: MMS	COMPLETION DATE: 7/7/06
REVIEWED BY:	

CLIENT: INFRASTRUCTURE SYSTEMS LTD.	PROJECT: North Edmonton Ring Road Functional Study	BOREHOLE NO: **TH06-D44**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 7, 2006	PROJECT NO: 19-598-221
DRILL/METHOD: Truck / Solid Stem Auger	LOCATION: Maridian Street Crossing	ELEVATION: 656.68 (m)

SAMPLE TYPE ▥ GRAB SAMPLE ▨ SPT



REMARKS	USC	SOIL DESCRIPTION
		TOPSOIL, black, organics, some roots and rootlets
	CI	CLAY (TILL) stiff, brown, sandy, silty, trace oxides, gravel, rootlets, coal, and ironstone and sand inclusions, occasional silt lense
	CI	
	CI	
	CI	-becomes very stiff, some coal, sand and oxides, trace clay shale inclusions
	CI	-becomes grey
	CI	
-SO$_4$ = 0.038%	CH	-becomes dark grey, some clay shale inclusions
	CI	
	CI	
	CH	
	CI	
	CI	
	CI	
-Seepage		

SOIL SYMBOL

ELEVATION (m): 656, 655, 654, 653, 652, 651, 650, 649, 648, 647

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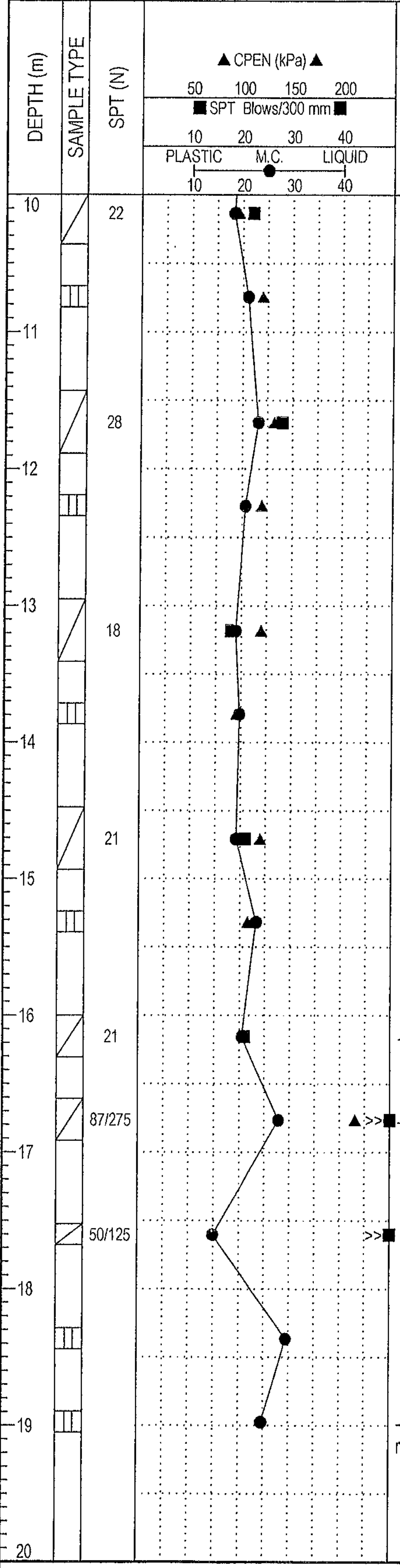
FIELD LOGGED BY: MW	COMPLETION DEPTH: 19.1 m
PREPARED BY: MMS	COMPLETION DATE: 7/7/06
REVIEWED BY:	

CLIENT: INFRASTRUCTURE SYSTEMS LTD.	PROJECT: North Edmonton Ring Road Functional Study	BOREHOLE NO: **TH06-D44**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: July 7, 2006	PROJECT NO: 19-598-221
DRILL/METHOD: Truck / Solid Stem Auger	LOCATION: Maridian Street Crossing	ELEVATION: 656.68 (m)

SAMPLE TYPE ◫ GRAB SAMPLE ⧄ SPT



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	USC	SOIL DESCRIPTION	ELEVATION (m)
10	⧄	22		CI	CLAY (TILL) CONTINUED	
	◫			CI		646
11	⧄	28		CH	-clay shale inclusions	645
12	◫			CI	-occasional silt lense	644
13	⧄	18		CI		
	◫			CI		643
14	⧄	21		CI		642
15	◫			CI	-occasional sand lenses	641
16	⧄	21	-Cpen > 215kPa	CI	CLAY SHALE. hard, dark grey, silty, some coal, dark brown staining, occasional silt lenses	
	⧄	87/275	-SO_4 = 0.06%	CH	-becomes very hard, grey, bentonitic	640
17	⧄	50/125		SC	-some coal lenses and sandstone	639
18	◫			CH	-becoming dark grey, some bentonitic clay shale	638
19	◫		-No SPT test, sample bouncing on rock	CH		
20					END OF TEST HOLE AT 19.1m UPON COMPLETION (Below ground surface) -slough at 6.6m -no water Backfilled with drill cuttings	637

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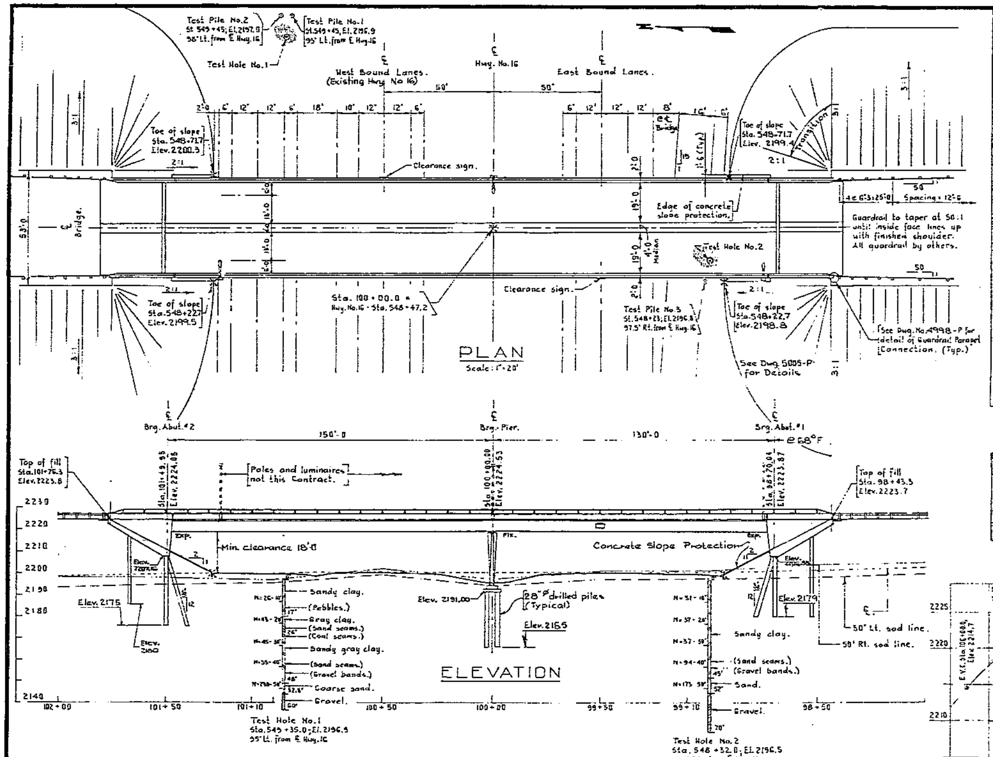
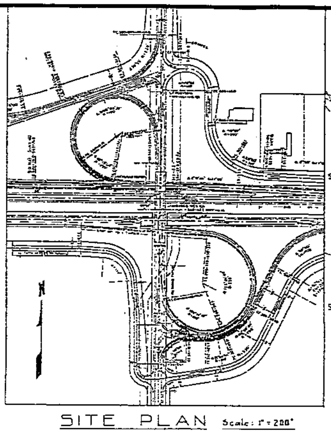
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

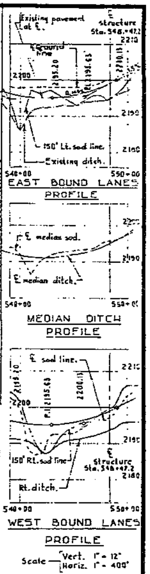
FIELD LOGGED BY: MW	COMPLETION DEPTH: 19.1 m
PREPARED BY: MMS	COMPLETION DATE: 7/7/06
REVIEWED BY:	Page 2 of 2

BF76648





SITE PLAN Scale: 1" = 200'

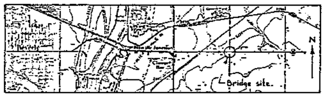


EAST BOUND LANES PROFILE

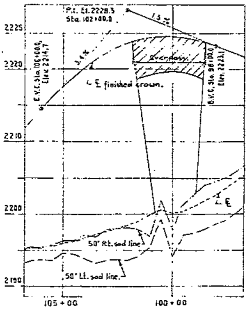
MEDIAN DITCH PROFILE

WEST BOUND LANES PROFILE

Scale — Vert. 1" = 12"; Horiz. 1" = 400'



SITE MAP Scale: 1¼" = 1 mile.



DISTRICT ROAD PROFILE

Scale. — Vert. 1" = 6"; Horiz. 1" = 200

-GENERAL NOTES-

- Foundation information shown is for the guidance only of the Contractor.
- ℄ crown elevations are given to the top of finished asphalt.
- Span lengths are measured along bottom flange and are correct at +68°F

DESIGN

- A.A.S.H.O. 1965 Specification.
- A.A.S.H.O. H.S.20-44 Loading.
- Reinforcing Steel - Intermediate Grade Reinforcing.
- Pile Loads :

Abutment D.L.	104	kips/pile	
Abutment Extreme.	143	kips/pile	= 100% basic allowable
Pier D.L.	150	kips/pile	
Pier Extreme.	202	kips/pile	= 125% basic allowable

16"⌀ Drilled Pile	Lin.ft.	145		145	
Parapet Rail	Lin.Ft.		660	660	
28"⌀ Drilled Pile	Lin.Ft.	784		784	
Reinforcing Steel	Lbs.	43,776	96,054	139,830	
Concrete Slope Protection	Sq.Yd.	281		281	
Concrete Class B	Cu.Yd.	378	373	751	
Asphaltic Wearing Surface	Sq.Yd.	256	1,121	1,377	
Excavation Common Dry	Cu.Yd.	135		135	
Backfill Compacted Granular	Cu.Yd.	518		518	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

QUANTITY ESTIMATE

Untreated Timber Test Piles Data.			
Weight of hammer 3,000 Lbs.			
Drop of hammer 10' to 12"			
Depth.	Average number of blows per ft.		
	Pile No.1	Pile No.2	Pile No.3
0'- 5'	2	2	3
5'- 10'	2	4	5
10'- 15'	6	5	9
15'- 20'	9	6	11
20'- 25'	12	12	16
25'- 30'	17	13	20
30'- 35'	17	13	27
35'- 40'	26	23	43
45'	64	150/10"	120

PILES TABLE

SHEET No.	DESCRIPTION	DWG. No.
11	Bar List.	5006-P
10	Miscellaneous Details.	5005-P
9	Parapet Rail.	5004-P
8	Girder Details # 3	5003-P
7	Girder Details # 2	5002-P
6	Girder Details # 1	5001-P
5	Deck.	5000-P
4	Pier.	4999-P
3	Abutment Details # 2	4998-P
2	Abutment Details # 1	4997-P
1	General Layout.	4996-P

INDEX

APPROVED: ___ BRIDGE BRANCH ENGINEER

NO.	DATE	DESCRIPTION	BY
△			
△			
△			
△			

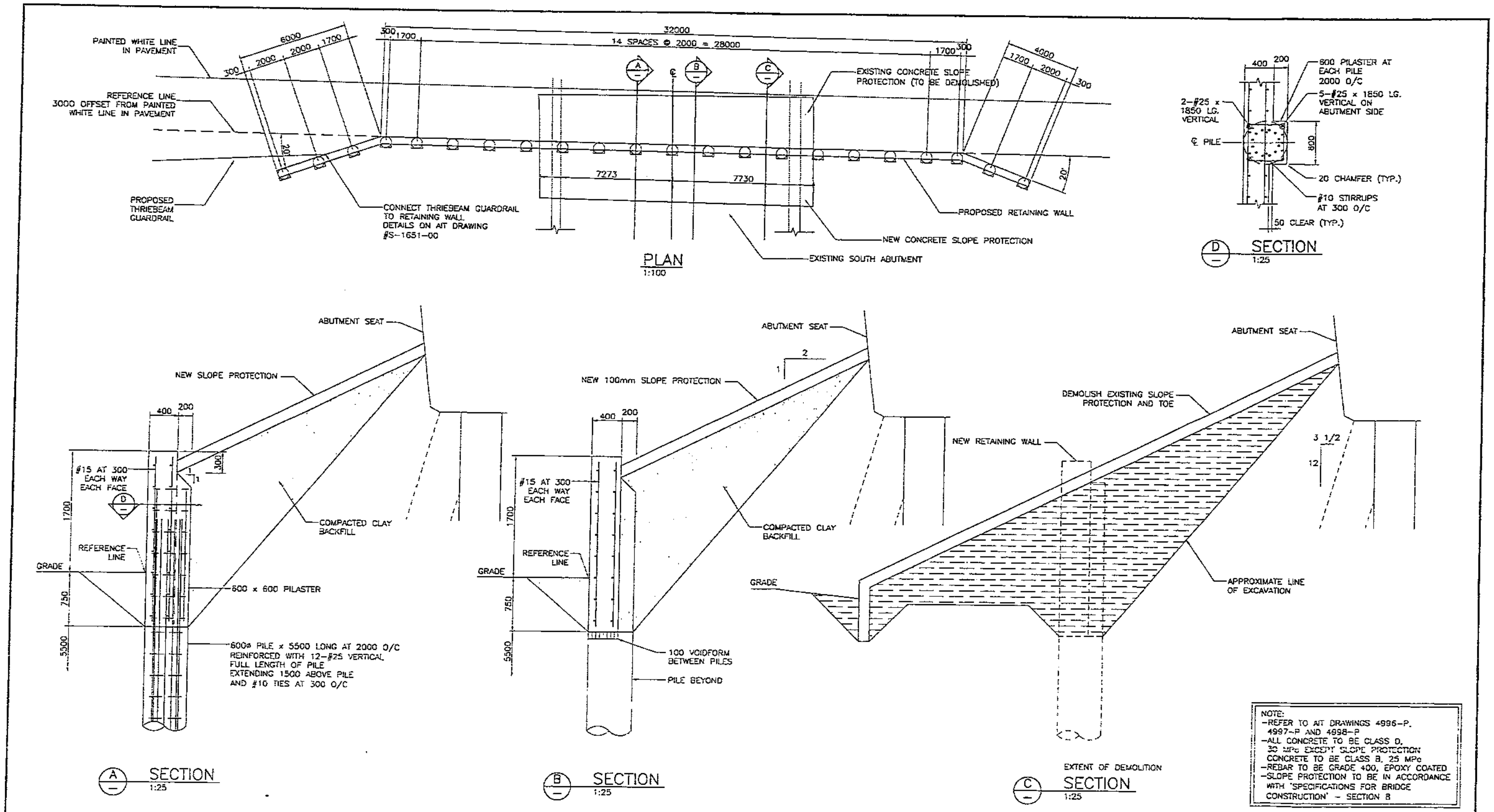
REVISIONS

DESIGNED BY T. Belke DATE June 19 68
DETAILED BY D.V. Sawicki DATE June 19 19 68
CHECKED BY DATE Nov. 19 68

CLOVER BAR STRUCTURE
NO.6
GENERAL LAYOUT

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH, EDMONTON

FILE NO. 76648 HWY. NO. District DWG. NO.
LOCATION NW 10-53-23-4 SCALE Noted. 4996-P
STREAM Hwy. No. 16 SHEET 1 OF 11



NOTE:
- REFER TO AIT DRAWINGS 4996-P, 4997-P AND 4998-P
- ALL CONCRETE TO BE CLASS D, 30 MPa EXCEPT SLOPE PROTECTION CONCRETE TO BE CLASS B, 25 MPa
- REBAR TO BE GRADE 400, EPOXY COATED
- SLOPE PROTECTION TO BE IN ACCORDANCE WITH 'SPECIFICATIONS FOR BRIDGE CONSTRUCTION' - SECTION 8

BPTEC - DNW Engineering Ltd.
Suite 200, 4320 - 99 St.
Edmonton, AB T6E 6A1
Ph: (780) 436-5376
Fax: (780) 435-4643
www.bptec-dnw.com

REV	DATE	REVISIONS	BY
	11/17/05	TENDER DRAWING	KW

PERMIT TO PRACTICE
BPTEC-DNW ENGINEERING LTD.
Signature
Date November 17 2005
PERMIT NUMBER: P0132
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

DESIGNER
DATE

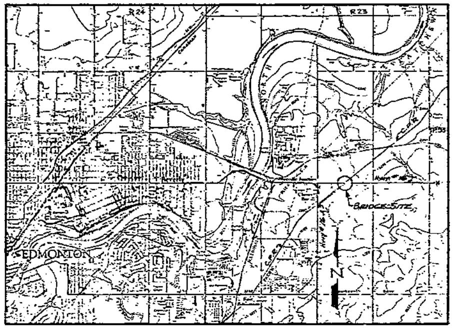
CHECKER
Nov 17/05
DATE

Alberta INFRASTRUCTURE AND TRANSPORTATION

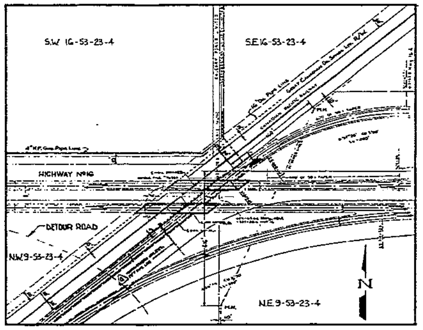
BROADMOOR BOULEVARD OVER HWY 16
GRADE SEPARATION (CLOVERBAR STR #6)
EAST BOUNDARY OF EDMONTON
RETAINING WALL

DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
2005-11-17	HWY 16	INW10-53-23-4	LOCAL	76648	37 of 40	23933-P

BF76339



SITE MAP
Scale: 1¼" = 1-Mile



SITE PLAN
Scale: 1" = 200'

QUANTITY ESTIMATE						
	ITEM	UNIT	SUBSTRUCT	SUPERSTRUCT	TOTAL EST	AS CONSTR
△3	Concrete Class "3"	Cu. yd.	754	198	952	
	Concrete Class "D"	Cu. yd.		41	41	
	Reinforcing Steel	Lbs.	135,285	20595	155,733	
	30"⌀ Drilled Concrete Brg. Pile	Lin. Ft.	1135		1135	
	16"⌀ Drilled Concrete Brg. Pile	Lin. Ft.	2111		2111	
	Excavation Common Dry	Cu. yd.	270		270	
	Backfill Compacted Gr.	Cu. yd.	194		194	
	Asphaltic Wearing Surface	Sq. yd.	346	2780	3126	
	Parapet Rail	Lin. ft.		1636	1636	
	Concrete Slope Protection	Sq. yd.	1860		1860	

	SHEET No.	DESCRIPTION	DWG. No.
△1	14	Lighting.	5093 -P
	13	Prestressed Concrete 50'-0 Type FC Girder	S - 877
	12	Prestressed Concrete 70'-0 Type FC Girder	S - 881
	11	Prestressed Concrete 85'-0 Type FC Girder	S - 884
	10	Miscellaneous Details #2	4952 -P
	9	Miscellaneous Details #1	4951 -P
	8	Bearing Details	4950 -P
	7	Deck	4949 -P
	6	Pier Details #2	4948 -P
	5	Pier Details #1	4947 -P
	4	Abutment Details #2	4946 -P
	3	Abutment Details #1	4945 -P
	2	Information Sheet	4944 -P
	1	General Layout	4943 -P

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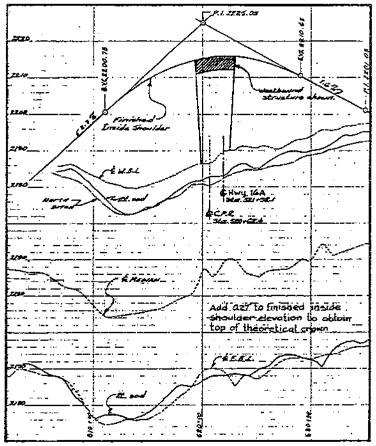
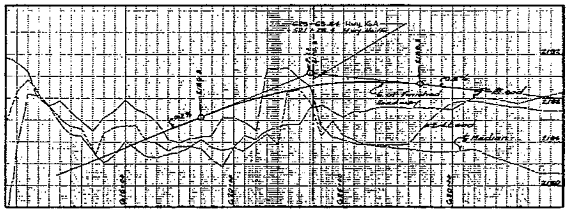


Add 0.27' to finished inside shoulder elevation to obtain top of theoretical crown

HWY. No. 16 PROFILE
Scale: Horiz. 1" = 400'
Vert. 1" = 12'



HWY. 16A
Scale: Horiz. 1" = 200'
Vert. 1" = 4'

GENERAL NOTES

- Foundation information shown is for the guidance only of the Contractor.
- ℄ crown elevations are given to top of theoretical crown. (See Crown Detail on Dwg. 4943-P) △2
- Drilling logs and laboratory test results may be reviewed in the office of the Chief Bridge Engineer in Edmonton.

DESIGN:

- A.A.S.H.O. 1965 Specification.
- A.A.S.H.O. HS 20 - 44 Loading.
- Reinforcing Steel : Intermediate Grade.
- Pile Loads:
  - Pier D.L. = 249 k @ 100% allowable stress
  - Pier Extreme = 341 k @ " " "
  - Abut D.L. = 108 k @ 100% allowable stress.
  - Abut. Extreme = 147 k @ " " "
- Drilled concrete piles shall conform to A.A.S.H.O. Specification for concrete piles (cast in place).
- Symbol W.B.S. denotes West Bound Structure
  " E.B.S. " East Bound Structure
- Unconfined strength of soil at pile ends assumed to be 3.75 tons/sq. ft. To be checked by the Engineer before pile depth is considered adequate.

CLOVER BAR STRUCTURE
NO. 8
INFORMATION SHEET

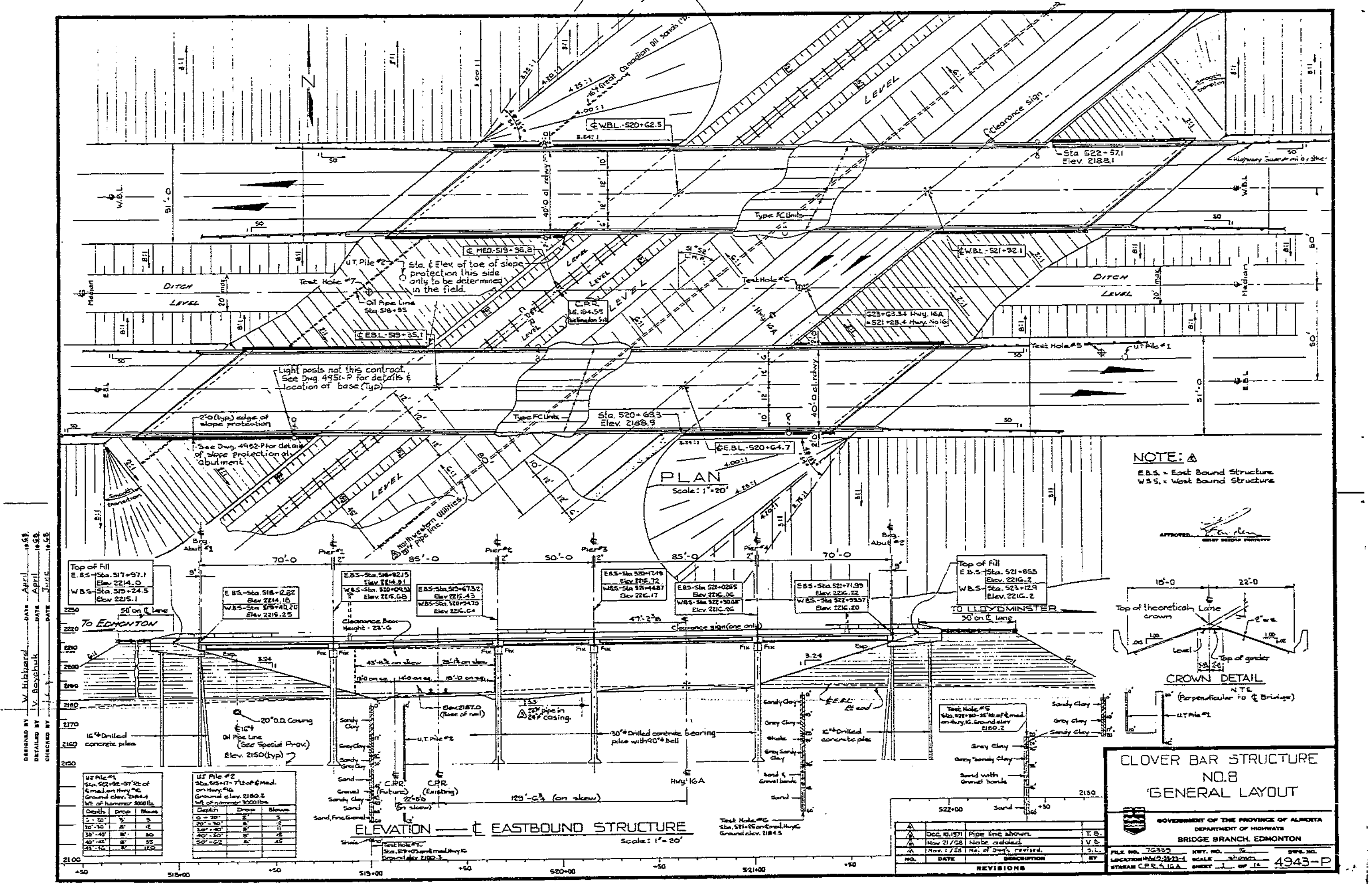
GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH, EDMONTON

FILE NO. 76339 HWY. NO. 16 DWG. NO.
LOCATION NW 9-53-23-4 SCALE shown
STREAM CPR & 16A SHEET 2 OF 14 4944-P

NO.	DATE	DESCRIPTION	BY
△4	DEC. 10. 1971	Pipeline shown.	T.B.
△3	Apr 18/69	Quantity	J.L.Y.
△2	Nov 5/68	No. corrected.	B.H.S.
△1	Nov. 1/68	Dwg. No. 14 added.	S.L.

REVISIONS

DESIGNED BY W. Hibbard DATE April 1968.
DETAILED BY Y. Boychuk DATE April 1968
CHECKED BY DATE June 1968



CLOVER BAR STRUCTURE
NO.8
GENERAL LAYOUT

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH, EDMONTON

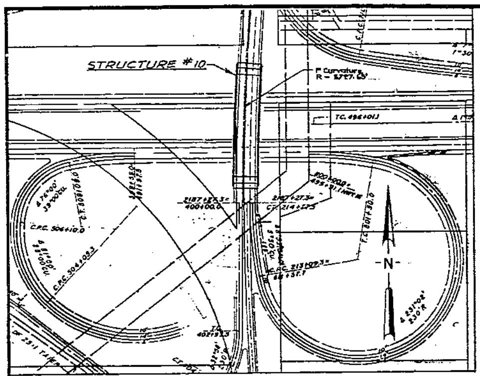
FILE NO. 76339 KEY. NO. 15 DWG. NO. 4943-P
LOCATION NW 9-53-23-4 SCALE shown
STREAM C.P.R. & 16A SHEET 1 OF 14

NO.	DATE	DESCRIPTION	BY
△			
△	Dec. 10, 1971	Pipe line shown.	T. S.
△	Nov 21/68	Note added	V. B.
△	Nov. 1/68	No. of Dwgs. revised.	S. L.

REVISIONS

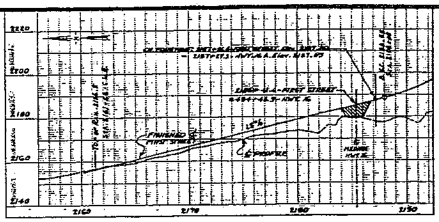
DESIGNED BY W. Hibbard DATE April 1968
DETAILED BY Y. Boychuk DATE April 1968
CHECKED BY DATE June 1968

BF76652



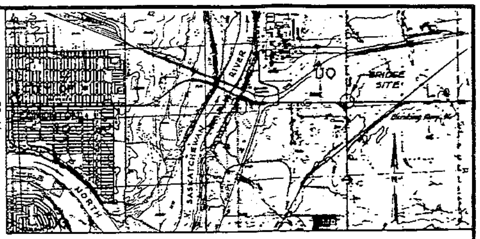
SITE PLAN

1" = 100'



FIRST STREET PROFILE

Horiz : 1" = 400'
Vert : 1" = 20'

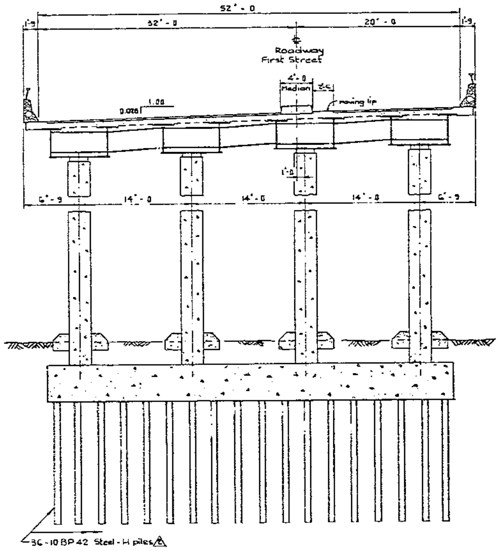


SITE MAP

2½" = 1 Mile

Painting Structural Steel.	Lump.		Lump.		
Miscellaneous Iron.	Lump.	Lump.	Lump.		
Electrical Equipment.	Lump.		Lump.		
Pile Set-ups.	Piles	48		48	
Pile Splices.	Splices	32		32	
Rip Rap-Sand Bag.	Sq. Yds.	45		45	
Bridgerail.	Lin. Ft.		544	544	
⚠ Steel H Piling.	Lin. Ft.	1673		1673	
Concrete Slope Protection	Cu. Yds.	386		386	
⚠ Asphaltic Wearing Surface.	Sq. Yds.	289	1107	1396	
Excavation-Common Dry.	Cu. Yds.	164		164	
Backfill-Compacted Granular	Cu. Yds.	138		138	
⚠ Reinforcing Steel.	Lbs.	49,148	77,610	126,758	
Concrete-Class B.	Cu. Yds.	426	325	751	
ITEM	UNIT	SUBSTRUCT	SUPERSTRUCT	TOTAL EST	AS CONST.

QUANTITY ESTIMATE



Ⓐ SECTION

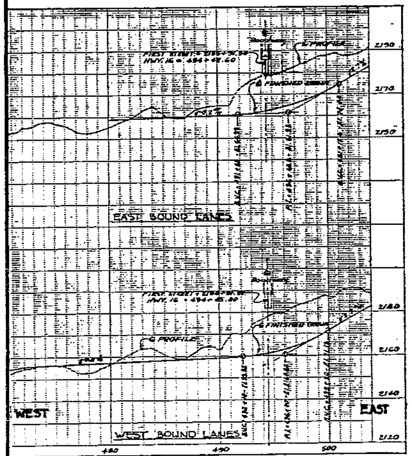
3/16" = 1'-0"
Looking south.

GENERAL NOTES

- Foundation information shown is for the guidance only of the Contractor.
- ℄ Roadway elevations are given to the top of ⚠ theoretical finished pavement under ℄ of median.
- Span lengths are measured along bottom flange and are correct at +68°F. Bearings are centred at 20°F.

DESIGN

- A.A.S.H.O. 1969 Specification.
- A.A.S.H.O. HS 20-44 Loading.
- Reinforcing Steel - Intermediate Grade Reinforcing.
- Pile Loads
  - Abuts. D.L. = 47.5 ᵏ/pile @ 100% design allowable.
  - Extreme = 61.5 ᵏ/pile @ 100% design allowable.
- ⚠ Pier Extreme = 56 ᵏ/pile D.L. = 44 ᵏ/pile
- Color Schedule:
  - Girders and Railing ; CGSB 1-GP-12C Blue 502-106.



HWY. 16 PROFILES

Horiz: 1" = 400'
Vert.: 1" = 20'

DESIGNED BY T. Belke DATE March 1970
DETAILED BY V. Boychuk DATE March 1970
CHECKED BY DATE 1970

NO.	DATE	DESCRIPTION	BY
⚠			
⚠			
⚠	Oct. 20/70	Pile foundation	T.B.
⚠	Aug. 18/70	General Note & Quantity Estimates	S.L.

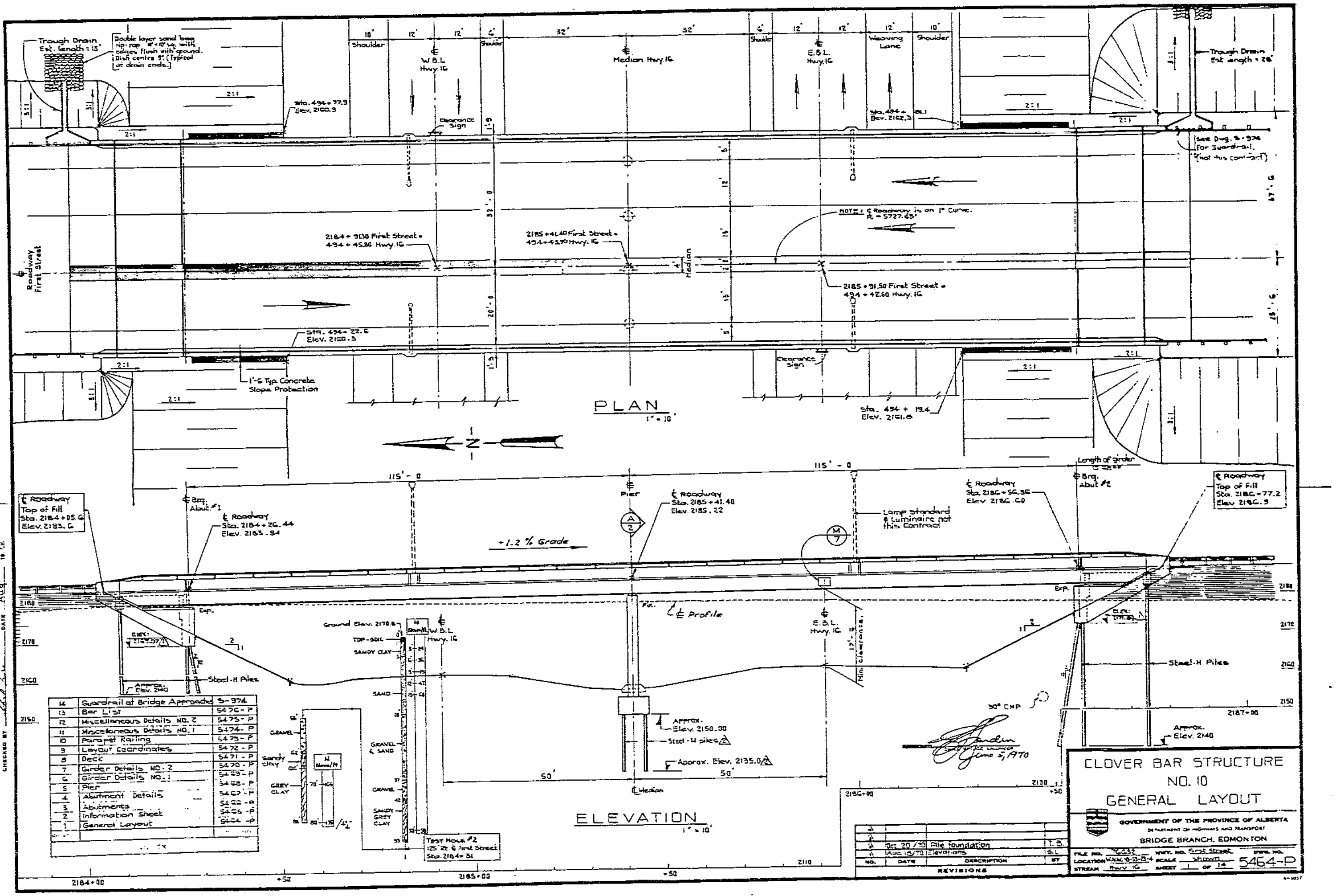
REVISIONS

CLOVER BAR STRUCTURE
NO. 10
INFORMATION SHEET

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH, EDMONTON

FILE NO. 76682 HWY. NO. First Street DWG. NO.
LOCATION NW 15-53-23-4 SCALE shown 5465-P
STREAM Hwy. 16 SHEET 2 OF 14

B-3057



14	Guardrail at Bridge Approache	S-974
13	Bar List	5476-P
12	Miscellaneous Details NO. 2	5475-P
11	Miscellaneous Details NO. 1	5474-P
10	Parapet Railing	5473-P
9	Layout Coordinates	5472-P
8	Deck	5471-P
7	Girder Details NO. 2	5470-P
6	Girder Details NO. 1	5469-P
5	Pier	5468-P
4	Abutment Details	5467-P
3	Abutments	5466-P
2	Information Sheet	5465-P
1	General Layout	5464-P

Designed by T. Belke Date March 1970
Detailed by V. Beyshuk Date March 1970
Checked by [illegible] Date Aug. 1970

J. Jardin
June 5, 1970

NO.	DATE	DESCRIPTION	BY
△			
△			
△	Oct. 20/70	Pile foundation	T.B.
△	Aug. 15/70	Elevations	S.L.

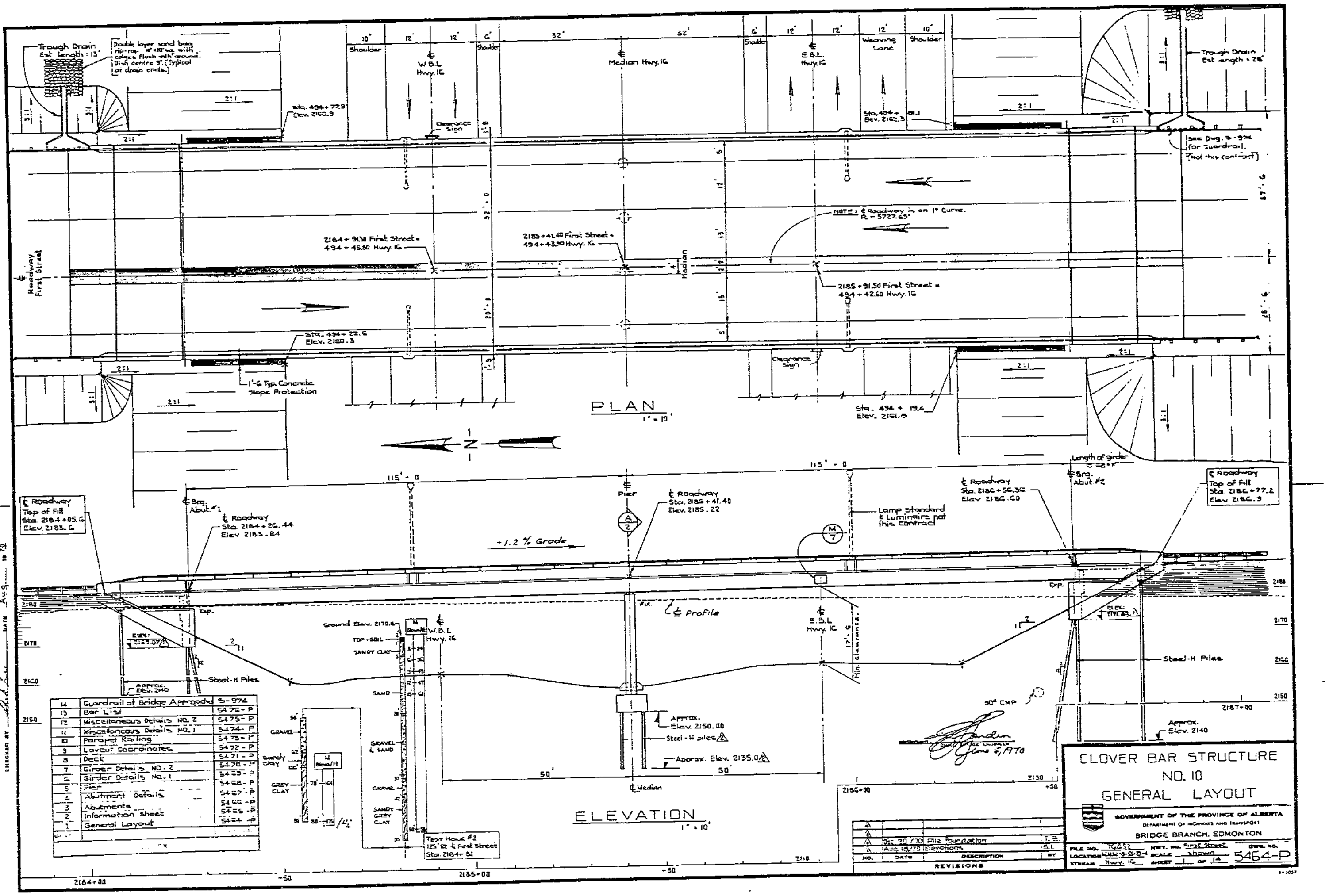
REVISIONS

CLOVER BAR STRUCTURE
NO. 10
GENERAL LAYOUT

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH, EDMONTON

FILE NO. 76652 HWY. NO. First Street DWG. NO.
LOCATION W.N.W. 6-53-23-4 SCALE shown 5464-P
STREAM Hwy 16 SHEET 1 OF 14

DESIGNED BY T. Balke DATE March 1970
DETAILED BY V. Boychuk DATE March 1972
CHECKED BY DATE Aug. 1970



14	Guardrail at Bridge Approaches	S-974
13	Bar List	5476-P
12	Miscellaneous Details NO. 2	5475-P
11	Miscellaneous Details NO. 1	5474-P
10	Parapet Railing	5473-P
9	Layout Coordinates	5472-P
8	Deck	5471-P
7	Girder Details NO. 2	5470-P
6	Girder Details NO. 1	5469-P
5	Pier	5468-P
4	Abutment Details	5467-P
3	Abutments	5466-P
2	Information Sheet	5465-P
1	General Layout	5464-P

Bridge Engineer
June 5, 1970

NO.	DATE	DESCRIPTION	BY
4			
3			
2	Oct. 20/70	Pile foundation	T.B.
1	Aug. 18/70	Elevations	S.L.

REVISIONS

CLOVER BAR STRUCTURE
NO. 10
GENERAL LAYOUT

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH, EDMONTON

FILE NO. 76652 HWY. NO. First Street DWG. NO.
LOCATION NW 6-53-23-4 SCALE Shown 5464-P
STREAM Hwy. 16 SHEET 1 OF 14

B-3057

BF76651

R.M.HARDY & ASSOCIATES LTD.

CARSWELL ENGINEERING LTD.
FOUNDATION INVESTIGATION
PROPOSED GRADE SEPARATION
HIGHWAYS 14X AND 16A
EAST EDMONTON, ALBERTA

E-2950 JUNE 21, 1974

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INTRODUCTION	1
FIELD WORK	2
SOIL CONDITIONS	3
GROUND WATER CONDITIONS	5
SOLUBLE SULPHATES	5
DISCUSSION AND RECOMMENDATIONS	5

APPENDIX A - Plates 1 to 13

APPENDIX B - Explanation Sheets

APPENDIX C - Information Sheet on Sulphated Soils

APPENDIX D - Recommended Construction Procedures

INTRODUCTION

R. M. Hardy & Associates Ltd., Edmonton were asked by Mr. Eugene Collins, P.Eng. of Carswell Engineering Ltd., on behalf of the Alberta Department of Highways Bridge Branch, to carry out a site investigation for the proposed grade separation at the intersection of Highways 14X and 16A east of Edmonton, Alberta. The purpose of the investigation was to determine the soil conditions at the site and to make recommendations for the design of the foundations for the bridge abutments and central column supports. The location of three test holes and two probe holes had been previously chosen and were indicated on Carswell Engineering Ltd. Drawing No. 1011-P1. These holes were located in the field with the assistance of a Department of Highways survey crew. The ground elevations at the location of each drill hole were also obtained from the survey crew. Copies of the preliminary bore hole logs were forwarded to Carswell Engineering Ltd. on May 15, 1974. A letter report containing preliminary recommendations was forwarded on May 21, 1974.

It is understood that the total abutment loads will be of the order of 1200 kips and the total central support load will be about 2000 kips. In addition it is understood that the east and west approach fills will be placed during this summer and that the construction of the foundations for the bridge will not take place until the fall of this year. It is expected that the maximum fill height adjacent to the bridge abutments will be of the order of 18 feet.

FIELD WORK

The field drilling program was performed on May 13 and 14, 1974. The Test Holes (1, 2 and 3) were extended to depths ranging between 39.5 feet and 44.5 feet. Disturbed and undisturbed samples were taken at regular intervals throughout the depth of each test hole. The soil stratigraphy was noted as drilling progressed and approximate unconfined compressive strengths were obtained for each undisturbed sample in the field with a pocket penetrometer. In addition to the three test holes suggested by Carswell Engineering Ltd. two extra test holes were drilled to depths of 13 feet. Test Hole 4 is located at the north edge of a slough which is indicated on Plate 1. This extra hole was an attempt to delineate the softer material in the upper level as encountered in Test Hole 1. The other extra test hole, Test Hole 5, is located at the south edge of another slough which is also indicated on Plate 1. This test hole was drilled to determine if there was a softer layer near the surface due to its proximity to the slough. The two probe holes suggested by Carswell Engineering were extended to depths of 42 feet. The soil stratigraphy was noted as these holes were drilled and samples were taken at regular intervals for moisture content determination. All samples were brought back to our laboratory for further testing. The water levels were recorded for each drill hole at completion of drilling and at least one day after drilling was completed. The locations of all test holes are shown on Plate 1 in Appendix A.

SOIL CONDITIONS

The soil stratigraphy at the site consists of a silty clay overlying a clayey till. There is a surficial layer of organic topsoil varying in thickness between 6 inches and 3 feet. In Test Hole 2 a silty clay shale was encountered between depths of 38 to 44 feet below which there is a layer of silty sand. In Probe Hole 1 a layer of silty sand was encountered between depths of 33 to 38 feet below which there is a silty clay to the depth investigated. The silty clay overlying the clay till contains sand, rust stains and salt pockets with occasional coal pockets and the odd pebble. This silty clay is medium plastic and is firm to very stiff with unconfined compressive strengths varying between 0.5 and 3.25 tons per square foot as measured with the pocket penetrometer in the field.

The clayey till is silty and sandy and contains salt, coal and sand pockets with pebbles up to ½ inch in diameter. It is medium plastic and is stiff to very stiff with unconfined compressive strengths ranging between 1.5 and 4.0 tons per square foot as measured with the pocket penetrometer in the field. The clay shale encountered in Test Hole 2 is medium to high plastic and is very stiff. The underlying sand is compact. The silty sand encountered in Probe Hole 1 appears to be compact also and the underlying silty clay is high plastic and very stiff. A detailed log of the soil stratigraphy in each drill hole is given in Plates 2 to 13 in Appendix A. Explanation sheets defining the notations used on the logs are enclosed in Appendix B.

Laboratory tests performed on the soil samples included moisture contents, Atterberg limits, soluble sulphate tests, confined compression tests and one cyclic loading test. The results of all these tests are given on the respective drill hole logs. The results of the confined compression tests performed in the laboratory generally give lower strength values for the soil than was measured in the field with the pocket penetrometer. It is expected that this discrepancy is due to sample disturbance and this is supported by the relatively large strains at failure in all of the tests.

The result of the cyclic loading test indicates an average modulus of elasticity of about 12,000 psi. for the first two stages of load cycles. During the load increase for the final cycling sequence the sample failed.

GROUND WATER CONDITIONS

In all of the drill holes free water was encountered at or below the surface of the clay till. It is expected that this water is contained in sand lenses or coal pockets. The water levels recorded in the drill holes at 1 or 2 days after the completion of drilling are recorded on each drill hole log. These water levels vary between 0 to 13 feet below the surface of the ground. It is expected that all sand, coal or salt pockets will contain excess water.

SOLUBLE SULPHATES

The results of the soluble sulphate tests are recorded on the drill hole logs. The concentrations determined in the laboratory range between 0% and 0.20% with the majority being less than 0.10%. Such concentrations of soluble sulphates are considered negligible to mild.

DISCUSSION AND RECOMMENDATIONS

The soil conditions at the site are quite consistent with the exception of the upper 10 feet in Test Hole 1 and about 5 feet in Test Hole 4. The silty clay in these two test holes is softer than the material encountered in the other test holes. It is expected that the weight of embankment fills will cause greater consolidation in the area of Test Holes 1 and 4 and this will continue during the early life of the bridge structure.

Our recommendations for the design values for different types of foundations are as follows:

1. Strip or spread footings may be designed with an allowable bearing pressure of 3000 psf when founded at 10 feet below the existing grade between Test Holes 1 and 4. Elsewhere this design value of 3000 psf may be used at 3 feet below existing grade, however all footings should be at a minimum of 8 feet below final grade for frost protection.
2. Bored cast-in-place straight shaft concrete piles may be designed using an allowable soil skin friction value of 600 psf. This design value may be utilized below a depth of 10 feet below existing grade between Test Holes 1 and 4 and elsewhere the value of 600 psf may be used below a depth of 3 feet from existing grade. At least the top 5 feet of any pile should be excluded when calculating the friction capacity.
3. It is acceptable to combine the friction capacity with the end bearing capacity of the soil.

   A straight shafted bored cast-in-place concrete pile with or without a bell formed at the base could utilize both properties of the soil. In this case an end bearing value for the base of the pile of 9000 psf is recommended at a depth of at least 25 feet below existing grade. In addition a soil skin friction value of 450 psf may be used for the straight part of the shaft. This value of 450 psf may be used below a depth of 10 feet from existing grade between Test Holes 1 and 4 and elsewhere this value may be used below a depth of 3 feet from existing grade. At least the top 5 feet of any pile should be excluded when calculating the friction capacity.

4. Another form of foundation which may be considered is driven steel piles. These piles may be either pipe sections or H sections and may be designed using an allowable soil skin friction value of 375 psf. This value of 375 psf may be used below a depth of 10 feet from existing grade between Test Holes 1 and 4 and below a depth of 3 feet from existing grade elsewhere with at least the top 5 feet of any pile being neglected for capacity calculation.

The free water observed in the test holes indicates that it may be necessary to provide casing for any bored holes at this site. If bored holes are extended into the sand encountered at 33 feet depth in Probe Hole 1 casing will almost certainly be required. For this reason it is recommended that a trial boring should be made at the site prior to final bidding for contracts.

It is expected that the bored cast-in-place concrete type pile will provide the most economical type of foundation for the central support. Since the approach fills will have been placed before the installation of the foundations it is expected that a pile type foundation will be the most practical choice for the abutment support. The installation of bored cast-in-place concrete type piles through the fill may necessitate casing to confine the fill material. The alternative of driven steel piles could probably be installed more easily through the fill material.

Based upon the results of the soluble sulphate tests performed, the concentrations are generally low. It is considered that normal Portland cement can be used for the formation of foundations. Additional information on soluble sulphate concentrations is given in Appendix C.

The placing of the approach fills prior to the installation of the foundations will facilitate some of the consolidation which will occur under the weight of the fill. This consolidation will introduce negative skin friction loads of pile foundations. It is for this reason that at least the top 5 feet below existing grade of any pile should be neglected when calculating the soil friction capacity. In the area between Test Holes 1 and 4 this depth has been increased to 10 feet below existing grade because of the softer soil encountered. In considering the negative skin friction contributed by the fill it is assumed that the fill will be compacted to at least 95% standard Proctor density.

Based upon the results of the cyclic loading test it is concluded that the initial settlement under the piles will be negligible, under the design load of 9000 psf end bearing.

There are some other general recommendations for construction procedures enclosed in Appendix D. These recommendations should be read in conjunction with this text.

THE ASSOCIATION OF
PROFESSIONAL ENGINEERS
OF ALBERTA
PERMIT NUMBER
P 226
R. M. HARDY AND
ASSOCIATES LTD.

Respectfully submitted,

R. M. HARDY & ASSOCIATES LTD.,

a. J. Hanna.

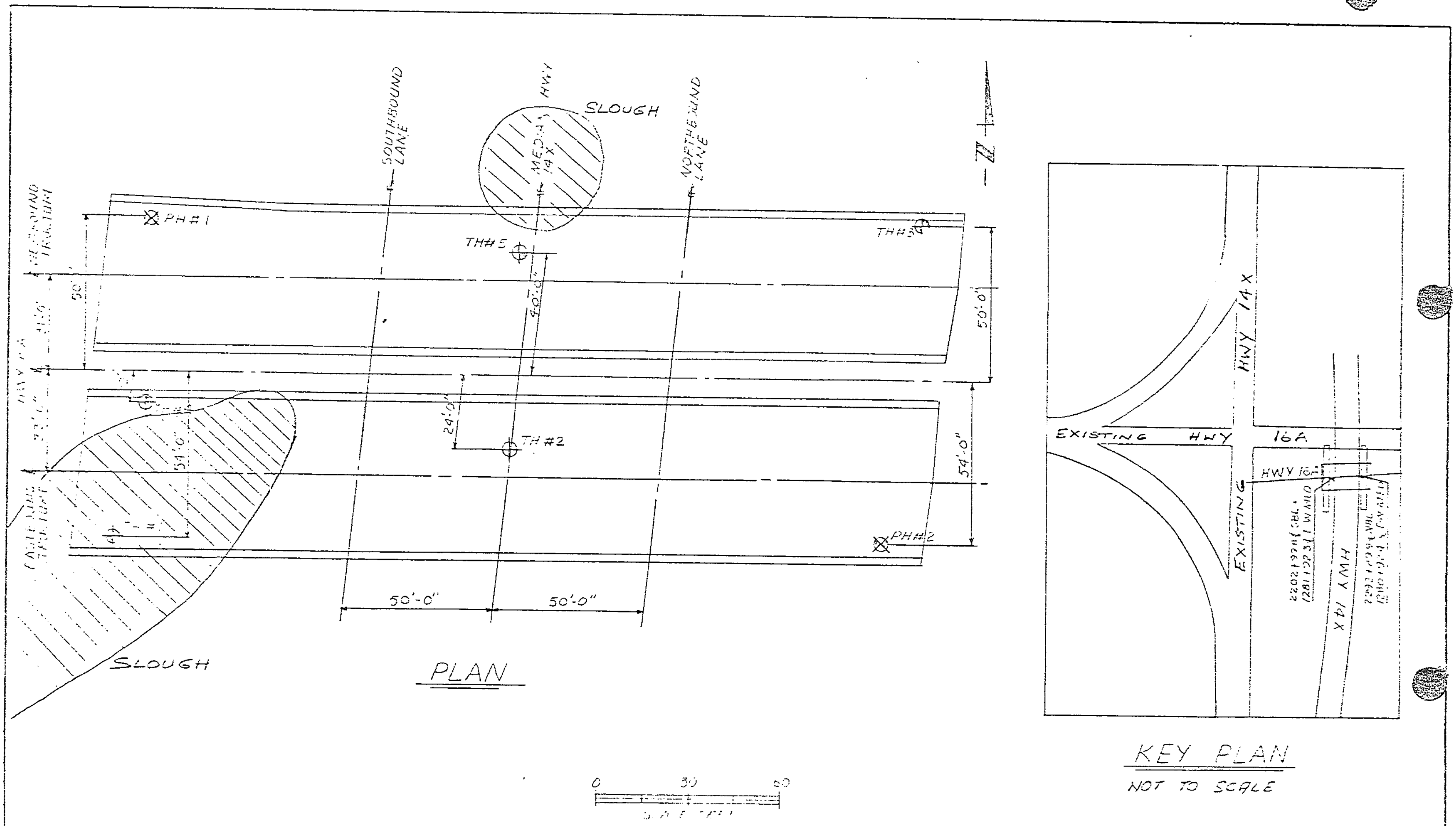
Per:

A. J. Hanna, P.Eng.

AJH/jc

APPENDIX A

Plates 1 to 13



REVISIONS

REFERENCES

SCALE

DATE

MADE A L

CHKD.

APPD.

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

PROPOSED GRADE SEPARATION
HIGHWAYS 14X - 16A
EAST EDMONTON

No. E-2950

REV.

PLATE 1

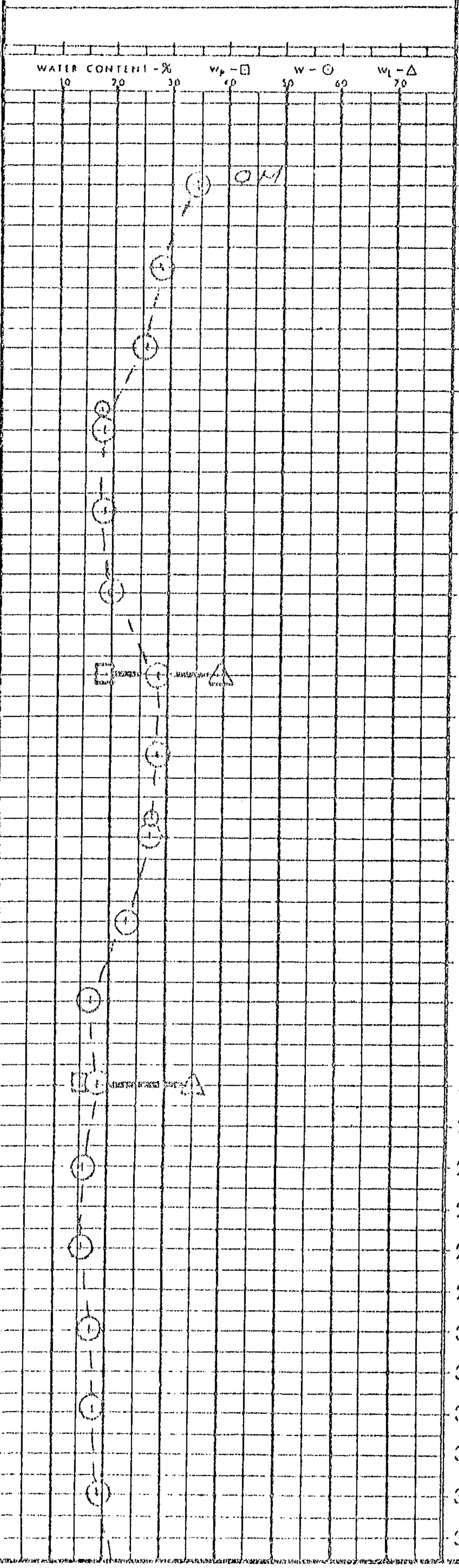
R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN Q. | CKD | DATE OF INVESTIGATION MAY 12/78 | JOB NO E2950 | HOLE 1

WATER CONTENT



SOIL PROFILE

DATUM

SURFACE ELEVATION 2251.6

DEPTH FEET	SOIL DESCRIPTION	SOIL SYMBOL	UNIFIED CLASSIF.	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
1	TOPSOIL, CLAYEY, FIRM,							
2	MEDIUM PLASTIC, BLACK, ROOTLETS				U1			
3	CLAY, SILTY, SANDY,							PP= 0.5 TSF
4	FIRM TO STIFF, NUGGETTED,				D	9		
5	MED. PLASTIC, BROWN RUST STAINS. ODD		CI					
6	SALT POCKET							γd = 110.5 PCF
7	FREE WATER CLAY (TILL),							γ = 130.4 PCF q = 2.76 KSF
8	SILTY, SANDY, STIFF, BLOCKY,				U2			εf = 20.0 % PP= 1.5 TSF
9	MEDIUM PLASTIC,				D	15		SO4 = 0 %
10	MEDIUM BROWN, RUST & COAL POCKETS							
11	OCCASIONAL SALT POCKETS.		CI					
12	PEBBLES TO 1/2"ø							
13	SAND POCKETS, GREY-BROWN				U3			PP= 2.75 TSF
14					D	15		
15								
16								γd = 94.3 PCF γ = 119.8 PCF
17					U4			q = 3.15 KSF εf = 20.0 %
18								PP= 2.75 TSF
19					D	32		PP= 1.6 TSF SO4 = 0.01 %
20								
21	SILTY, SANDY, STIFF TO VERY STIFF							
22	MEDIUM PLASTIC, DARK GREY,							
23	PEBBLES TO 1"ø,				U5			PP= 3.75 TSF
24	HARD SHALE INCLUSIONS				D	22		
25	SAND POCKETS							
26			CI					
27								
28					U6			PP= 3.75 TSF
29					D	5		
30								
31								
32								
33					U7			PP= 2.5 TSF
34					D	[illegible]		
35								

PLATE 2

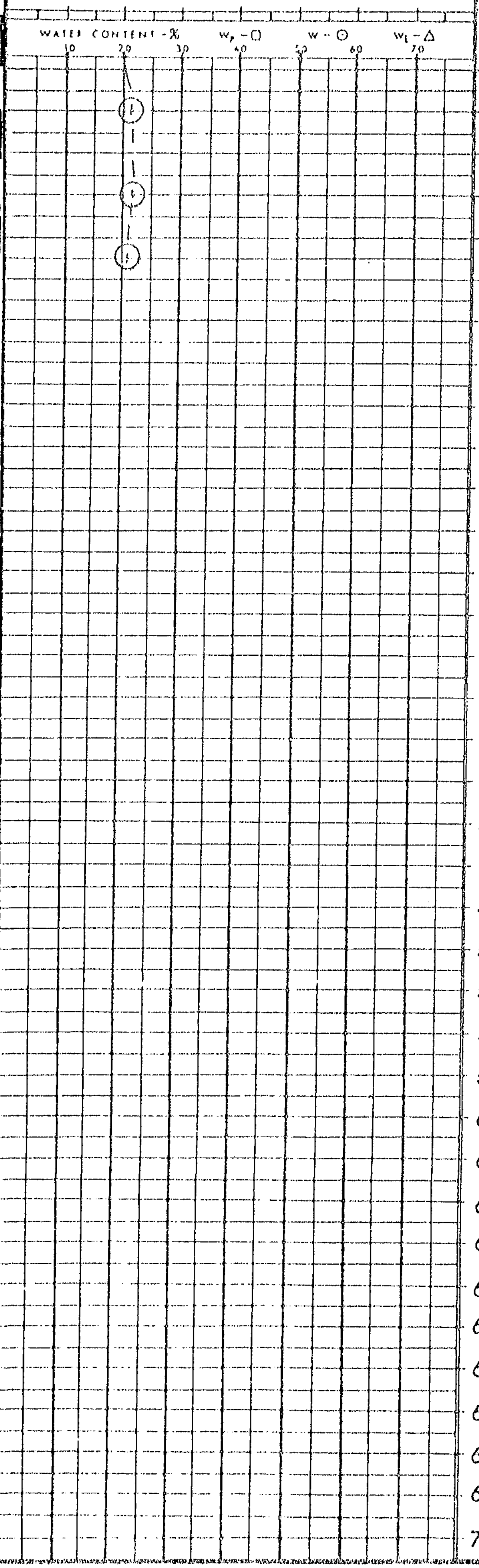
R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN Q
CKD
DATE OF INVESTIGATION MAY 12/[illegible]
JOB NO E 2950
HOLE 1 (CONT.)

WATER CONTENT



SOIL PROFILE — SOIL SAMPLES

DATUM
SURFACE ELEVATION

DEPTH FEET	SOIL DESCRIPTION	SOIL SYMBOL	UNIFIED CLASSIF	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
36	CLAY (TILL)	/						
37		/	(CI)	◭	U6			
38		/						PP = 1.5 TSF
39		/		☒	D	17		
40	END OF HOLE 39½'							
41	W.L. = 6' AT							
42	COMPLETION AND							
43	AT SURFACE AFTER 2 DAYS							
44								
45								
46								
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PLATE 5

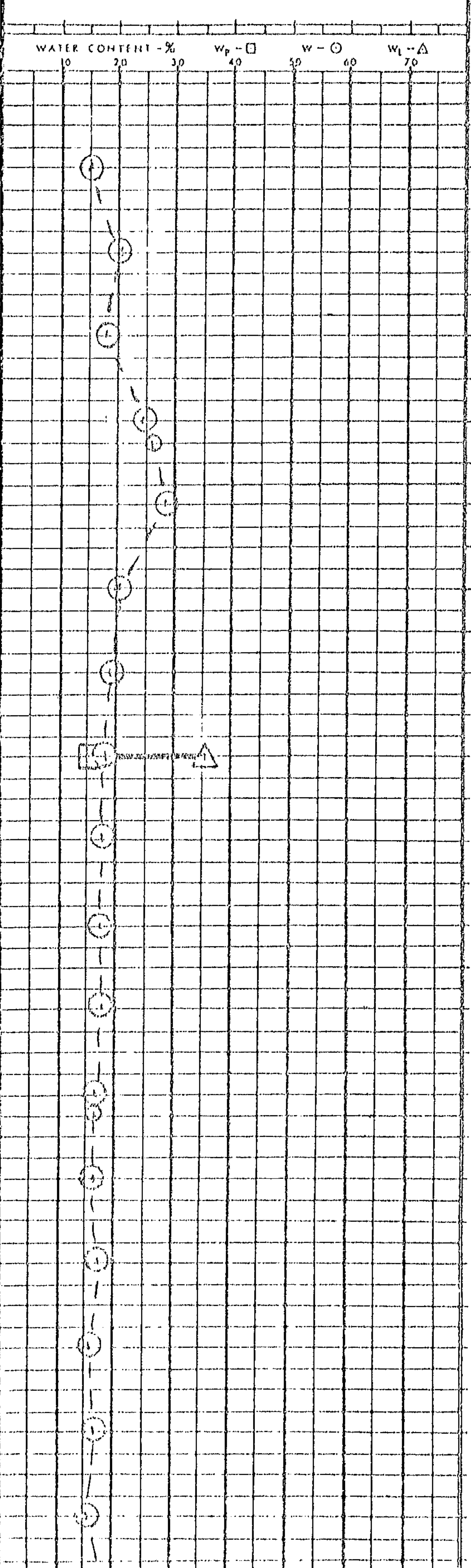
2 OF 3 (CONT.)

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN JPH | CK'D | DATE OF INVESTIGATION MAY 11/79 | JOB NO E 2750 | HOLE 2



SOIL PROFILE · SOIL SAMPLES

DATUM

SURFACE ELEVATION 2258.4

DEPTH FEET	SOIL DESCRIPTION	UNIFIED CLASSIF.	CONDITION	TYPE	PENETRATION RESISTANCE	% RECOVERY	OTHER TESTS
	TOPSOIL						
1							
2	CLAY, SILTY, SANDY, STIFF, BLOCKY,						
3	MEDIUM PLASTIC, MEDIUM BROWN,						
4	RUST STAINS,	CL					
5	SALT AND COAL POCKETS, ODD			U1			PP= 2.5 TSF
6	PEBBLE FREE WATER		☒	D	25		SO4 = 0.92 %
7	CLAY (TILL), SILTY, SANDY,						γ_d = 99.0 PCF γ = 124.4 PCF
8	STIFF, BLOCKY, MEDIUM PLASTIC,						q = 4.11 KSF Ef = 19.3 %
9	RUST STAINS, SALT POCKETS,	CL		U2			PP= 3.0 TSF PP: 2.0 TSF
10	COAL SPECKS, PEBBLES TO 1/2"Ø		☒	D	25		
11	SAND LENS AT 8'						
12	VERY STIFF, GREY,						
13	ABSENCE OF SALTS						
14							
15				U3			PP= 3.75 TSF
16		CL	☒	D	35		
17							
18							
19							
20				U4			PP= 3.75 TSF
21	SILTY, SANDY,		☒	D	28		SO4 = 0.38 %
22	STIFF TO VERY STIFF BLOCKY STRUCTURE						
23	MEDIUM PLASTIC, DARK GREY,						γ_d = 114.6 PCF γ = 135.0 PCF
24	RUST STAINS, COAL POCKETS,	CL					q = 4.55 KSF Ef = 20.0 %
25	PEBBLES TO 1"Ø			U5			PP= 3.0 TSF
26			☒	D	22		PP(AV)= 2.0 TSF
27							
28	SHALE INCLUSIONS						
29							
30				U6			PP= 3.0 TSF
31			☒	D	32		
32							
33							
34				U7			PP= 2.25 TSF
35							

PLATE 4

1 OF 2

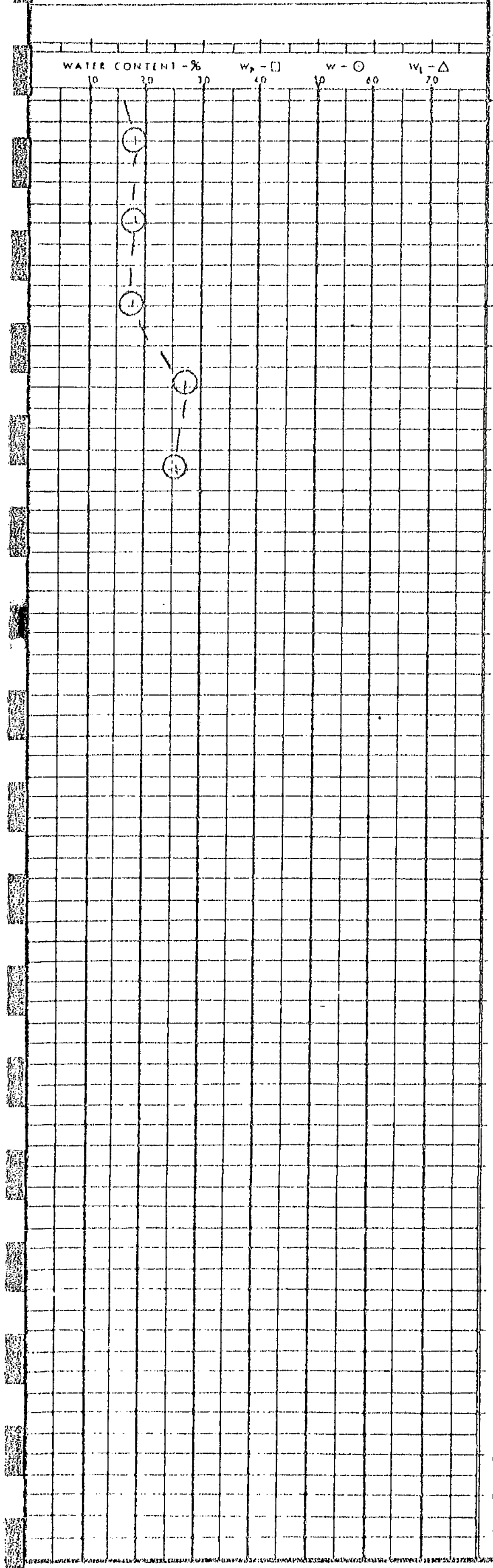
R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN A. | CKD | DATE OF INVESTIGATION NOV 13/72 | JOB NO E[illegible] | HOLE 2 (CONT.)

WATER CONTENT



SOIL PROFILE — SOIL SAMPLES

DEPTH FEET	SOIL DESCRIPTION DATUM SURFACE ELEVATION	SOIL SYMBOL	UNIFIED CLASSIF	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
36	CLAY (TILL)		(CI)		D	24		
37								
38								
39	CLAY SHALE, SILTY, VERY STIFF, MEDIUM TO HIGH PLASTIC, BLUE - GREY, HARD SHALE NODULES							
40								
41								
42					U/S			
43								PP: 3.0 TSF
44	SAND, FINE GRAINED, SILTY, COMPACT, NON PLASTIC, BLUE - GREY		(SM)		D	26		
45								
46	END OF HOLE 44½							
47	W.L. = 18' AT COMPLETION AND 4.1' AFTER 1 DAY							
48								
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PLATE 5

2 OF 2 (CONT.)

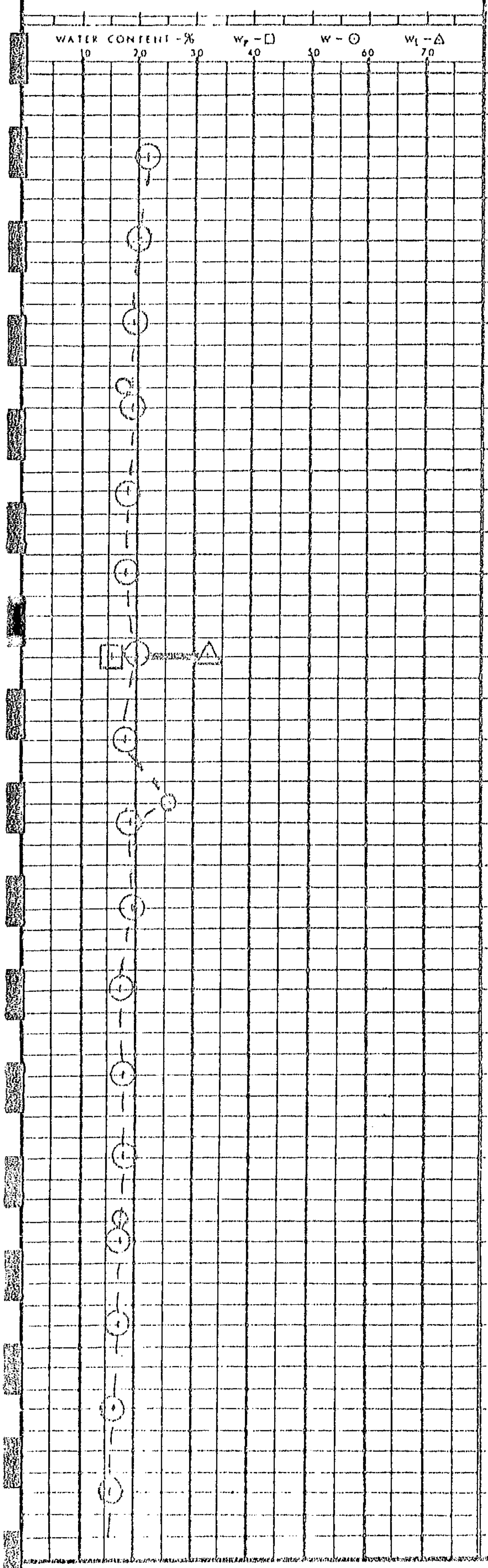
R.M.HARDY & ASSOCIATES [illegible]O.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN QFL | CKD | DATE OF INVESTIGATION MAY 13/75 | JOB NO E2950 | HOLE 3

WATER [illegible]NT



SOIL PROFILE

DATUM

SURFACE ELEVATION 2259.1

DEPTH FEET	SOIL DESCRIPTION	UNIFIED CLASSIF.	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
	TOPSOIL, CLAYEY, LOW TO MED. PLASTIC, BLACK						
1							
2	CLAY, SILTY, SANDY, STIFF TO VERY STIFF,	CL		U1			
3	BLOCKY, MED. PLASTIC, MED. BROWN, RUST AND SALT POCKETS						PP = 3.25 TSF
4	CLAY (TILL), SILTY,			D	14		SO_4 = 0.01 %
5	SANDY, STIFF TO VERY STIFF,						
6	BLOCKY STRUCTURE,						γ_d = 114.3 PCF γ = 122.8 PCF
7	MEDIUM PLASTIC, MEDIUM BROWN,						q = 5.25 KSF Sf = 19.7 %
8	RUST POCKETS,			U2			PP = 2.0 TSF
9	OCCASIONAL SALT POCKETS, PEBBLES - 1/2"			D	21		
10							
11		CL					
12	FREE WATER → SAND AND COAL POCKETS			U3			
13							PP = 2.0 TSF
14				D	22		
15	GREY - BROWN, PEBBLES TO 1"ø						
16							γ_d = 98.6 PCF
17							γ = 123.6 PCF q = 2.59 KSF
18				U4			Sf = 19.6 % PP = 2.2 TSF
19				D	22		
20	VERY STIFF, IRONSTONE INCLUSIONS						
21							
22	DARK GREY SALT CRYSTALS						
23				U5			PP = 4.0 TSF
24				D	32		SO_4 = 0.20 %
25							
26							γ_d = 112.9 PCF γ = 132.6 PCF
27							q = 3.55 KSF Sf = 20.0 %
28				U6			PP = 2.5 TSF
29	SILTY, SANDY, STIFF,			D	24		PP = 1.7 TSF
30	MEDIUM PLASTIC,						
31	PEBBLES TO 1"ø, COAL POCKETS	(CL)					
32							
33				U7			PP = 2.5 TSF
34				D	27		HITTING ON ROCK
35							

PLATE 6

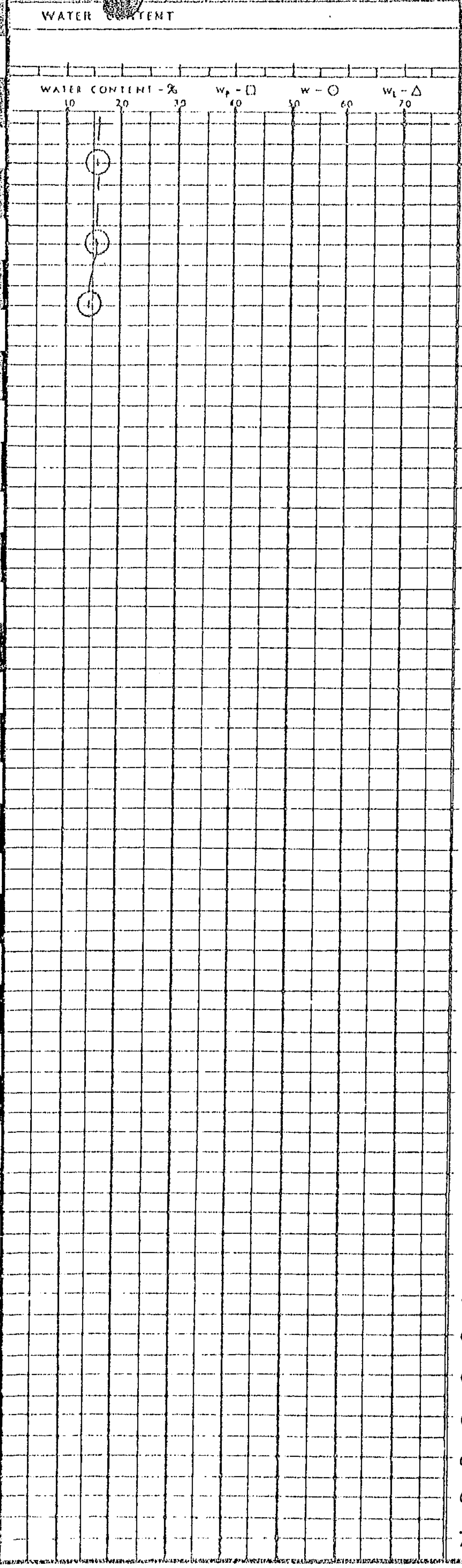
1 OF 2

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN 9
CKD
DATE OF INVESTIGATION MAY 12/73
JOB NO E2770
HOLE 3 (CONT.)



SOIL PROFILE / SOIL SAMPLES

DATUM
SURFACE ELEVATION

DEPTH FEET	SOIL DESCRIPTION	UNIFIED CLASSIF.	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
36	CLAY (TILL)						
37							
38		(CI)		U			PP= 2.25 TSF
39			☒	D	51		
40	END OF HOLE 39½						
41	W.L. = 17' AT COMPLETION AND 5.0' AFTER 2 DAYS						
42							
43							
44							
45							
46							
47							
48							
49							
50							
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PLATE 7

2 OF 2 (CONT.)

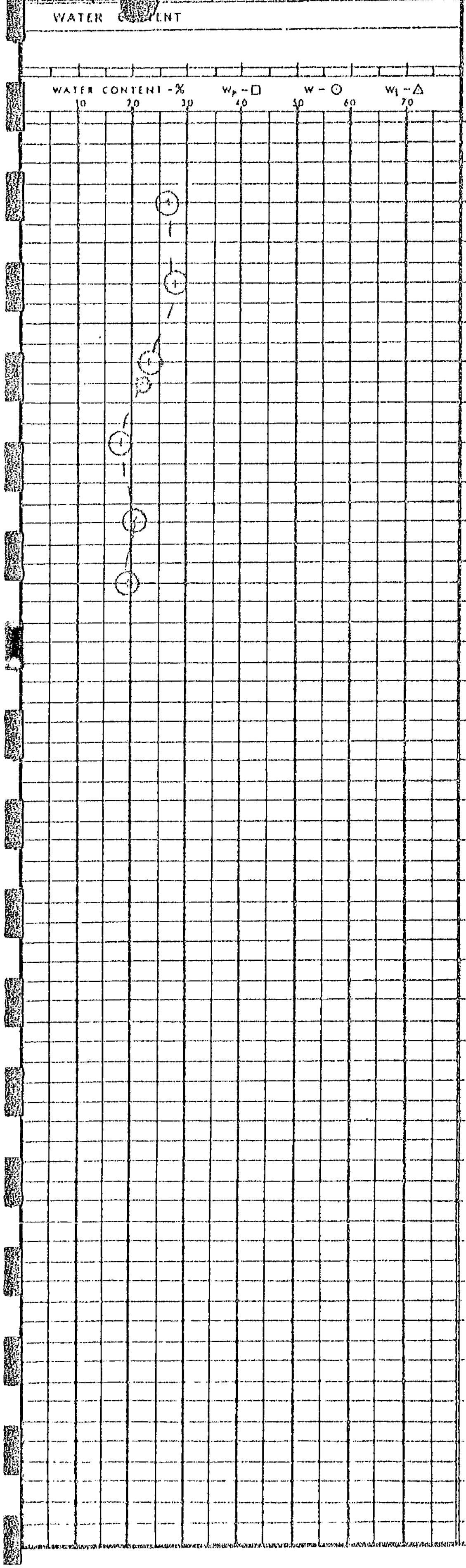
R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN ABW
CKD
DATE OF INVESTIGATION MAY 14/79
JOB NO E2950
HOLE 4

WATER CONTENT



SOIL PROFILE — SOIL SAMPLES

DATUM

SURFACE ELEVATION 2252.6

DEPTH FEET	SOIL DESCRIPTION	SOIL SYMBOL	UNIFIED CLASSIF.	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
1 2	TOPSOIL, CLAYEY, FIRM, MEDIUM PLASTIC, BLACK	~						
3 4 5	CLAY, SILTY, SANDY, FIRM TO STIFF, BLOCKY STRUCTURE MEDIUM PLASTIC, MED. BROWN, SALT POCKETS, ODD PEBBLE	/	(CI)	△	U1			PP= 1.0 TSF
6 7 8 9 10 11 12 13	FREE WATER ▽ CLAY (TILL), SILTY, SANDY, STIFF, BLOCKY STRUCTURE, MEDIUM PLASTIC, MEDIUM BROWN RUST STAINS, SALT, COAL, AND SAND POCKETS, PEBBLES TO ½"Ø WET SAND LENS VERY STIFF, DARK GREY	/	(CI)	△ △ △	U2 U3 U4			γd = 105.1 PCF γ = 127.9 PCF Q = 2.48 KSF εf = 20.0% PP = 2.0 TSF PP = 1.25 TSF SO4 = 0.05% PP= 5.0 TSF PP= 4.0 TSF
14 15 16	END OF HOLE 13' W.L. = 8' AT COMPLETION AND 0.20' AFTER 1 DAY							
17								
18								
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20								
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PLATE 5

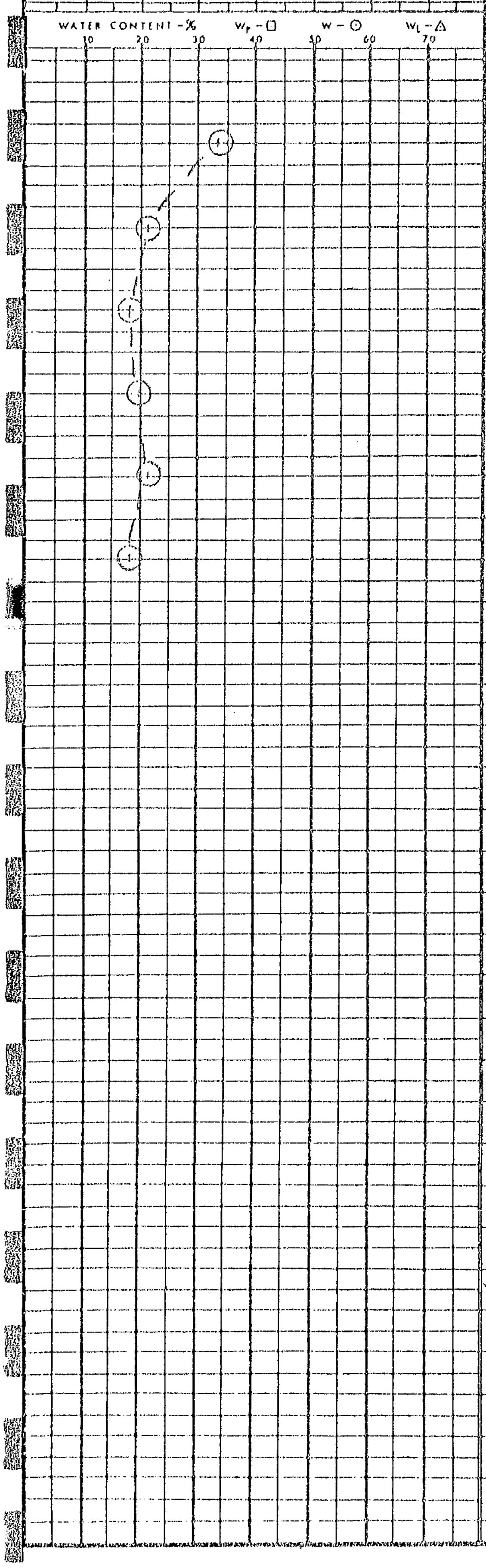
R.M.HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN [illegible] CKD DATE OF INVESTIGATION MAY 14/78 JOB NO E 2950 HOLE 2

WATER CONTENT



SOIL PROFILE — SOIL SAMPLES

DATUM

SURFACE ELEVATION 2255.9

DEPTH FEET	SOIL DESCRIPTION	SOIL SYMBOL	UNIFIED CLASSIF.	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
0–1.5	TOPSOIL, CLAYEY, FIRM, MEDIUM PLASTIC, BLACK	~						
1.5–5.5	CLAY, SILTY, SANDY, STIFF, BLOCKY, MEDIUM PLASTIC, MEDIUM BROWN, RUST STAINS, SALT AND COAL POCKETS, ODD PEBBLE	/	(CL)	◢	U1			PP=2.1 TSF
5.5–13	CLAY (TILL), SILTY, SANDY, STIFF, BLOCKY STRUCTURE MEDIUM PLASTIC, MEDIUM BROWN, RUST, SAND, SALT, AND COAL POCKETS PEBBLES TO 1/2"Ø FREE WATER SAND LENS AT 8'	/	(CL)	◢	U2			PP=3.0 TSF
				◢	U3			PP=3.0 TSF
				◢	U4			PP=3.0 TSF
13	END OF HOLE 13' W.L.=11' AT COMPLETION AND 1.0' AFTER 1 DAY							

DEPTH FEET: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35

PLATE 9

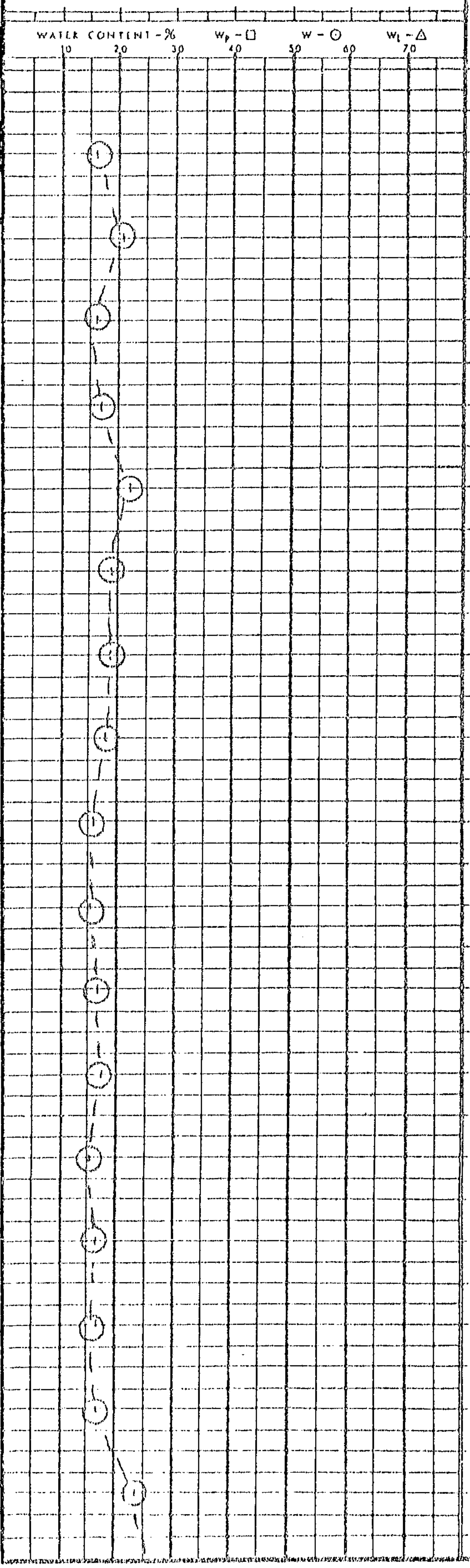
R.M.HARDY & ASSOCIATE LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN JBH | CK'D | DATE OF INVESTIGATION MAY 19/75 | JOB NO 52970 | HOLE SLOPE 1

WATER CONTENT



SOIL PROFILE — SOIL SAMPLES

DATUM

SURFACE ELEVATION 2256.6

DEPTH FEET	SOIL DESCRIPTION	SOIL SYMBOL	UNIFIED CLASSN.	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
1	TOPSOIL							
2	CLAY, SILTY, SANDY,							
3	FIRM TO STIFF, BLOCKY, MED. PLASTIC							
4	MED. BROWN,		(CI)					
5	RUST STAINS, OCCASIONAL COAL							
6	POCKETS, WET SAND POCKETS							
7	CLAY (TILL), SILTY, SANDY, STIFF,							
8	BLOCKY STRUCTURE							
9	MEDIUM PLASTIC, MEDIUM BROWN,							
10	RUST STAINS,		(CI)					
11	COAL POCKETS, PEBBLES TO 1/8" ⌀							
12								
13	TRACE OF FREE WATER →							
14								
15	GREY, SALT CRYSTALS							
16								
17								
18	— —							
19	SILTY, SANDY, STIFF,							
20	MEDIUM PLASTIC,							
21	BLOCKY STRUCTURE, DARK GREY,							
22	SHALE INCLUSIONS, OCCASIONAL							
23	PEBBLES TO 1½" ⌀		(CI)					
24								
25								
26								
27								
28								
29								
30								
31								
32								
33	SAND, SILTY, COMPACT,							
34	MED. FINE GRAINED, NON PLASTIC,		(SI)					
35	BLUE-GREY							

PLATE 10

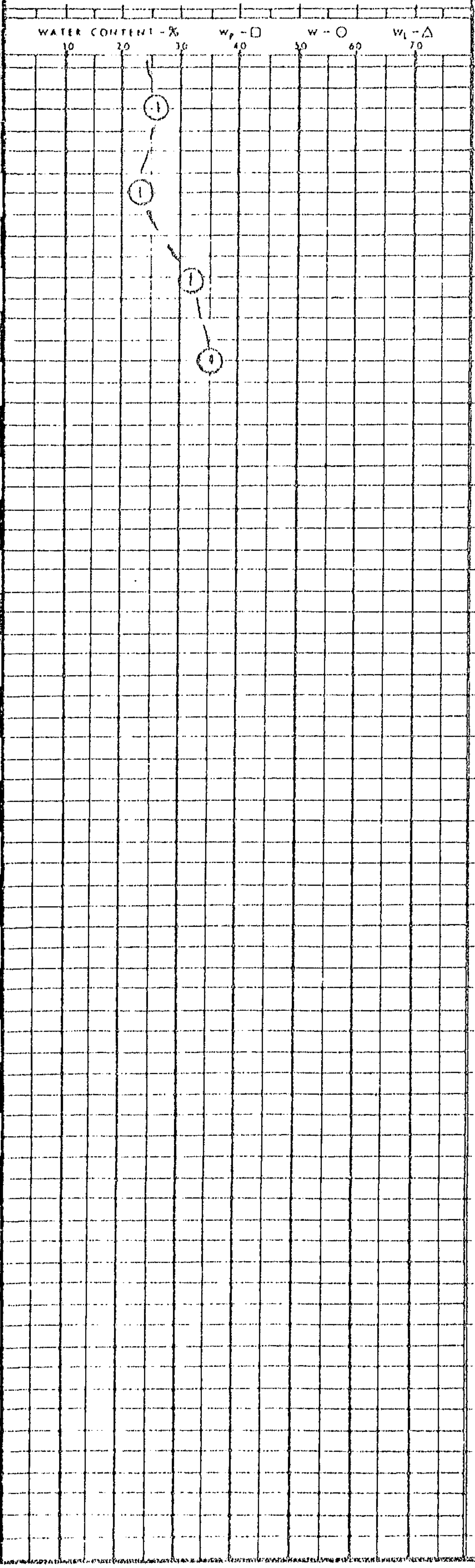
R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN [illegible] | CKD | DATE OF INVESTIGATION [illegible] | JOB NO E2750 | HOLE [illegible]

WATER CONTENT



SOIL PROFILE

SOIL SAMPLES

DEPTH FEET	SOIL DESCRIPTION DATUM SURFACE ELEVATION	SOIL SYMBOL	UNIFIED CLASSIF.	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
36	SAND, HARD SANDSTONE INCLUSIONS		(SM)					
37								
38								
39	CLAY, SILTY, VERY STIFF, HIGH PLASTIC, BLUE-GREY, OCCASIONAL PEBBLES TO 1/2" Ø							
40			(CH)					
41								
42	END OF HOLE 42'							
43	W.L. = 18' AT COMPLETION AND 3.7' AFTER 1 DAY							
44								
45								
46								
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48								
49								
50								
51								
52								
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PLATE 11

2 OF 2 (CONT.)

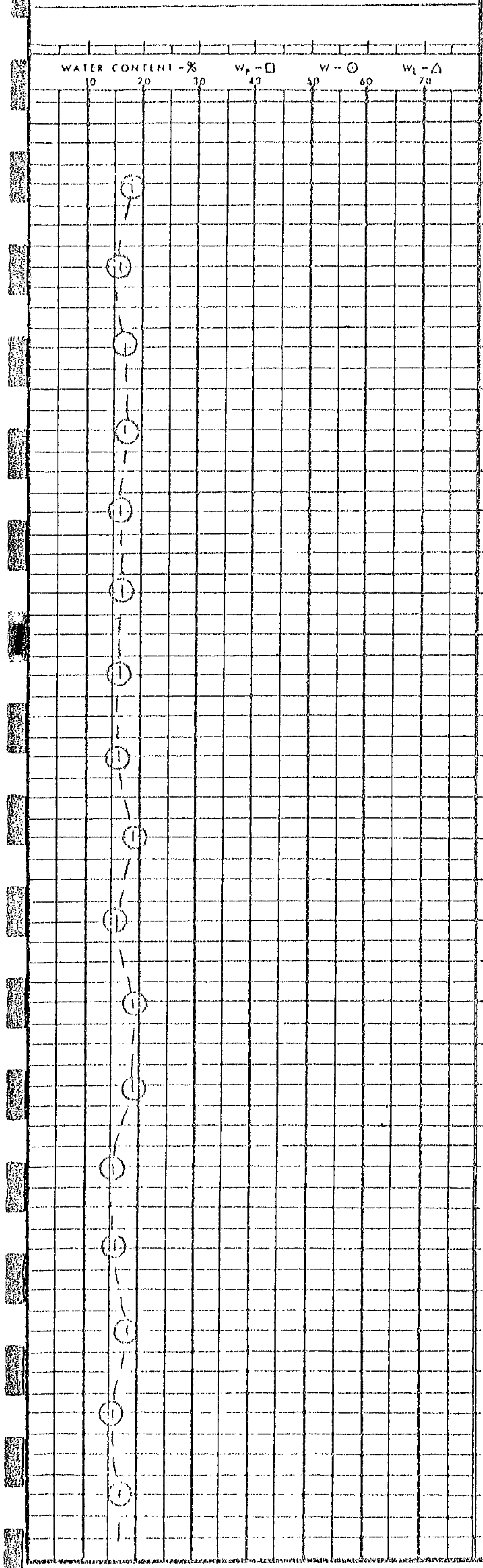
R.M.HARDY & ASSOCIATES [illegible]D.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPL[illegible]G & LABORATORY TESTS

PROJECT

DWN. [illegible] | CKD | DATE OF INVESTIGATION MAY 1968 | JOB NO E 2950 | HOLE [illegible]

WATER [illegible]ENT



SOIL PROFILE

SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 2264.8

DEPTH FEET	SOIL DESCRIPTION	UNIFIED CLASSIF.
	TOPSOIL, SILTY, FIRM	
1	CLAY, SILTY, SANDY,	
2	STIFF, BLOCKY, MED. PLASTIC,	(CI)
3	MED. BROWN, RUST STAINS, SAND POCKET SALT CRYSTALS	
4	CLAY (TILL), SILTY,	
5	SANDY, STIFF TO VERY STIFF,	
6	BLOCKY STRUCTURE,	
7	MEDIUM PLASTIC, MEDIUM BROWN,	
8	PEBBLES TO 1/2"Ø,	
9	RUST STAINS AND POCKETS.	
10	SAND, SALT, AND PYRITE POCKETS,	
11	OCCASIONAL COAL POCKETS,	
12		
13		
14		
15		(CI)
16		
17		
18		
19		
20	STIFF	
21		
22	TRACE OF	
23	FREE WATER →	
24		
25		
26		
27		
28		
29		
30		
31		
32	SILTY, SANDY, BLOCKY STRUCTURE	
33	VERY STIFF, MEDIUM PLASTIC,	
34	DARK GREY, PEBBLES TO 1"Ø,	(CI)
35	COAL AND SAND POCKETS	

SOIL SAMPLES

SOIL SYMBOL	UNIFIED CLASSIF.	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS

PLATE 15

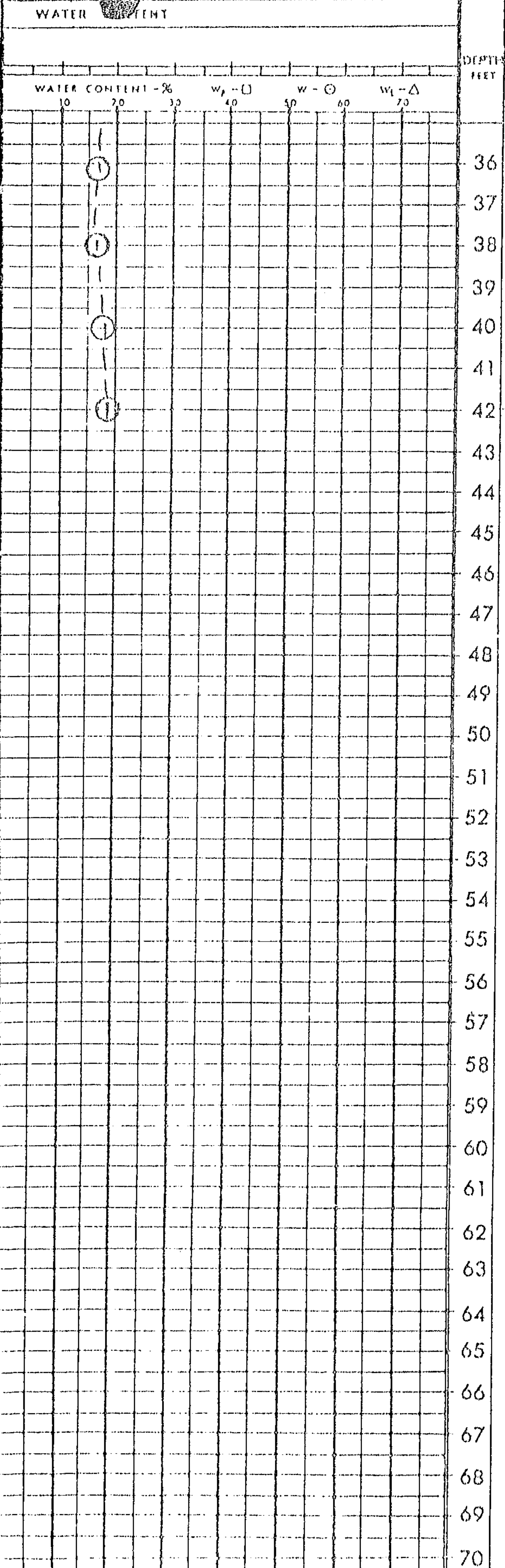
1 OF 2

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

SUMMARY OF SAMPLING & LABORATORY TESTS

PROJECT

DWN [illegible]
CKD
DATE OF INVESTIGATION MAY 19/[illegible]
JOB NO. E 2950
HOLE [illegible]



SOIL PROFILE

SOIL DESCRIPTION DATUM SURFACE ELEVATION	SOIL SYMBOL	UNIFIED CLASSIF	CONDITION	TYPE	PENETRATION RESISTANCE	RECOVERY %	OTHER TESTS
CLAY (TILL), SHALE INCLUSIONS		(CI)					
END OF HOLE 42'							
W.L. = 38' AT COMPLETION AND 15.4' AFTER 1 DAY							

PLATE 15

2 OF 2 (CONT.)

APPENDIX B

Explanation Sheets

EXPLANATION OF TERMS AND SYMBOLS

These pages present an explanation of the terms and symbols used on the log sheet entitled "Summary of Sampling and Laboratory Tests". The materials, boundaries, and conditions have been established only at the test hole locations and could differ elsewhere on the site.

WATER CONTENT AND ATTERBERG LIMITS

The natural moisture or water content of the soil at the time of drilling is plotted against depth, together with the plastic and liquid limits whenever determined in the laboratory. All water contents are expressed in terms of percentage of dry weight. The abbreviations and graphic symbols are defined as follows:

⊙	w	natural moisture content
⊡	w_P	plastic limit (ASTM, D424)
△	w_L	liquid limit (ASTM, D423)
	NP	non plastic soil
——→		seepage
—▼—		observed water level

DEPTH

This column refers to the depth below the surface. The corresponding elevations are sometimes shown with respect to the datum given.

SOIL DESCRIPTION

Soils of different engineering classification are commonly grouped generically for ease of reference. Seepage and the water level are indicated beside the graphical representation using those symbols defined under "Water Content".

SOIL PROFILE

Soil types are designated by a modified version of the Unified Soil Classification System ("The Unified Soil Classification System", Technical Memorandum No. 3-357, Vol. 1, 1953, the Waterways Research Station, U.S.A.). Page 3 of this appendix defines these terms and symbols. Letters appearing in parentheses denote visual identifications which have not been verified in the laboratory.

SOIL SAMPLES

CONDITION — This column indicates the depth and the condition of each sample attempted.

◪	undisturbed
☒	disturbed
⧅	not recovered or not retained

TYPE — The type of sample is indicated in this column as follows:

A	auger sample
B	block sample
C	rock core
D	drive sample
P	Pitcher tube sample
U	thin walled tube sample
W	wash or air return sample
O	other (see text)

PENETRATION RESISTANCE — Unless otherwise noted this column refers to the number of blows (N) of a 140 pound hammer dropping 30 inches required to drive a 2 inch O.D. open end sampler a distance of one foot from 0.5 to 1.5 feet into the soil. This is the standard penetration test referred to in ASTM, D1586.

RECOVERY — This column states the proportion in percent of the sampled length that was recovered. If nothing is shown the amount of recovery was not measured.

OTHER TESTS

In this column are tabulated results of all other laboratory tests as indicated by the following symbols:

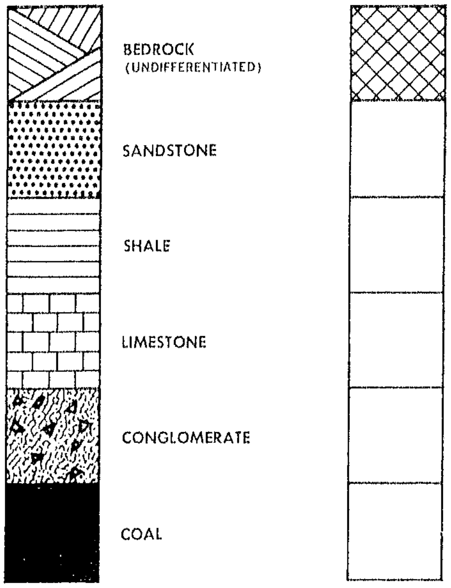
*	C	Consolidation test
	Fines	Fraction washing past #200 sieve
	G	Specific gravity
	k	Permeability coefficient
*	MA	Mechanical grain size analysis
	pp	Pocket penetrometer strength — tsf
*	q	Triaxial compression test
	qu	Unconfined compressive strength
*	SB	Shearbox test
	SO_4	Concentration of soluble sulphates
*	ST	Swelling test
	VS	Vane shear strength (undisturbed-remolded)
	ε_f	Unit strain at failure
	γ	Unit weight of soil (bulk density) — pcf
	γ_d	Unit dry weight of soil — pcf

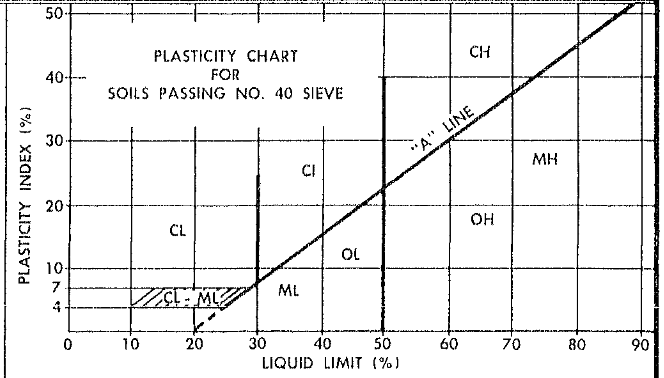
* These tests are usually summarized separately.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	COLOR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	⁘	RED	WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6 \quad C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP	⁘	RED	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM	▥	YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			GC	▨	YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-(SILT) CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW	⁘	RED	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4 \quad C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP	⁘	RED	POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM	▥	YELLOW	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			SC	▨	YELLOW	CLAYEY SANDS, SAND-(SILT) CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES 200 SIEVE)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$W_L < 50\%$	ML	▥	GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)	
		$W_L > 50\%$	MH	▥	BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS		
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLIGIBLE ORGANIC CONTENT	$W_L < 30\%$	CL	▨	GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		$30\% < W_L < 50\%$	CI	▨	GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$W_L > 50\%$	CH	▨	BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART	$W_L < 50\%$	OL	▥	GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY	
		$W_L > 50\%$	OH	▨	BLUE	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	≋	ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	

SPECIAL SYMBOLS





1. ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD, A.S.T.M. E.11.
2. BOUNDARY CLASSIFICATIONS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%.

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APPENDIX C

Information Sheet on Sulphated Soils

INFORMATION SHEET

M. HARDY & ASSOCIATES LTD.

PORTLAND CEMENT CONCRETE IN CONTACT WITH SULPHATE SOILS AND WATER

The Prairie Provinces of Western Canada contain varying amounts of sulphate salts. These are mainly found as calcium, sodium and magnesium salts. Their solubility increases in the order given, with sodium sulphate being in the order of 25 times and magnesium sulphate 130 times more soluble than calcium sulphate.

The distribution is varied with sodium sulphate being more predominant in Alberta, a mixture in Saskatchewan and magnesium sulphate more predominant in Manitoba, probably due to their solubility and the general water flow being from West to East.

They must of course be in solution and contact to react with Portland cement concrete. This reaction is a chemical one with hydrated lime and hydrated calcium aluminate in the cement paste, that results in disruptive expansion.

Protective measures may therefore be of two types:

(a) Isolation of the concrete from the salt solution by impermeable membranes (note that Dampproofing treatments do not qualify as an impermeable membrane).

(b) Use of sulphate resistant cements. (note: Type V Cements).

The severity of attack will therefore depend on the availability of salt, the potential source of water, and the flow and pressure of water solution the concrete is subject to.

In order to classify the potential severity of a particular condition, the soluble sulphate content of the soil or ground water is measured, and can be potentially classified by Table II given in CSA A23.2 Page 56 reproduced here for information.

TABLE II

ATTACK ON CONCRETE BY SOILS AND GROUND WATERS CONTAINING VARIOUS SULPHATE CONCENTRATIONS

Case	Relative Degree of Sulphate Attack	Per Cent Water Soluble Sulphate (as SO$_4$) in Soil Samples	Parts per Million Sulphate (as SO$_4$) in Ground Water Samples
a	Negligible	0.00 to 0.10	0 to 150
b	Positive (mild)	0.10 to 0.20	150 to 1,000
c	Considerable	0.20 to 0.50	1,000 to 2,000
d	Severe	Over 0.50	Over 2,000

It should be carefully noted that in alkali areas, the concentration can vary by as much as 600 times in a small area. The potential severity of attack should therefore be judged on an area rather than an isolated location test, and the flow and availability of groundwater is of considerable importance.

Please note that the resistance of concrete to sulphate attack is dependent on impermeability which is a function of the water cement ratio. For conditions (b) and (c) shown in Table II above, the water cement ratio should not exceed 0.50 and for condition (d) should not exceed 0.45, by weight.

The quality of concrete desired should therefore be chosen on the basis of impermeability as judged by water cement ratio. This means that 2500 psi concrete is not satisfactory since it has a water cement ratio in the order of 0.65 and a much higher quality concrete must be used to provide adequate resistance to sulphate attack, bearing in mind the groundwater conditions.

The following references are recommended for further information:

C.S.A. A23.2 – 1967 Section 29 & Appendix D "Performance of Concrete" by E. G. Swenson.

E. F. Holmgren, P. Eng.

APPENDIX D

Recommended Construction Procedures

RECOMMENDED CONSTRUCTION PROCEDURES

The following construction procedures are recommended to ensure the satisfactory performance of the structures. The recommendations are to be read in conjunction with the text of the report.

1. EXCAVATED FOUNDATIONS

1.1 Excavation close to foundation level should be done carefully to avoid disturbance of the soil. It is essential to prevent the soil at foundation level from deterioration due to excessive drying or becoming wet from surface or seepage water. Good drainage both during and after construction is essential.

1.2 Sumps if required should be located well away from the foundation area. Softened or overdried soil must be removed and replaced by lean mix concrete or by extending the foundations.

1.3 The foundation must be kept from freezing both during and after construction. Unless permitted by the engineer the foundation concrete should not be placed on or against frozen soil.

2. BACKFILLING

2.1 Backfill around foundations should be placed in such a manner so as to prevent settlement and to be relatively impervious near the surface so that water does not pond against foundations nor be allowed to seep into the soil.

2.2 Backfill should not be placed until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction.

2.3 All backfill around grade beams, foundation walls, etc. must be carefully and uniformly compacted. The backfill should be placed in even layers and no frozen nor organic material should be incorporated into the fill. All lumps of material must be broken down or squeezed together during placing and compaction.

2.4 The final grade (allowing for some settlement of the backfill) should shed water away from the structure.

2.5 During construction, precautions should be taken to prevent water ponding in grade beam excavations thereby acting as a source of water to soften the soil under the floor slab area or providing a source of water for frost action if the building is not heated during freezing weather.

3. BORED CAST-IN-PLACE CONCRETE PILES

3.1 Piles should be installed under full-time inspection of an experienced and competent person.

3.2 Soil may contain sand and silt lenses which are water bearing and sloughing. Casing should be on hand before drilling starts and be used if necessary to seal off water or prevent sloughing of the hole. The concrete and reinforcing steel should be on hand and placed as soon as the pile hole has been completed and approved.

3.3 Pile bells, if used, should be formed entirely in self-supporting soil and it may be necessary in some cases to extend the pile bell if caving occurs at the location of the bell.

3.4 Water should not be left ponded on the pile base and should be removed, or dried by the use of dry cement when permitted by the engineer.

3.5 Concrete should be placed without segregation and carefully vibrated throughout the full length of the pile to ensure that voids do not exist in the pile shaft. The concrete slump should be between two and five inches with a minimum compressive strength at 28 days of 3000 psi. (Note: Higher compressive strength may be required for structural or durability reasons).

3.6 Steel reinforcing should be tied into the grade beam reinforcing steel. This recommendation is important where the soil below grade beam can swell from a change in moisture content or by frost action before the building is heated.

3.7 Piles closer than 2 1/2 diameters should not be drilled and poured consecutively unless permitted by the engineer and depending upon soil conditions. Where the drilling operation might affect the concrete in the adjacent pile the drilling should not be carried out until the concrete has at least 24 hours to set, or before the concrete has reached its initial set.

4. DRIVEN STEEL PILES

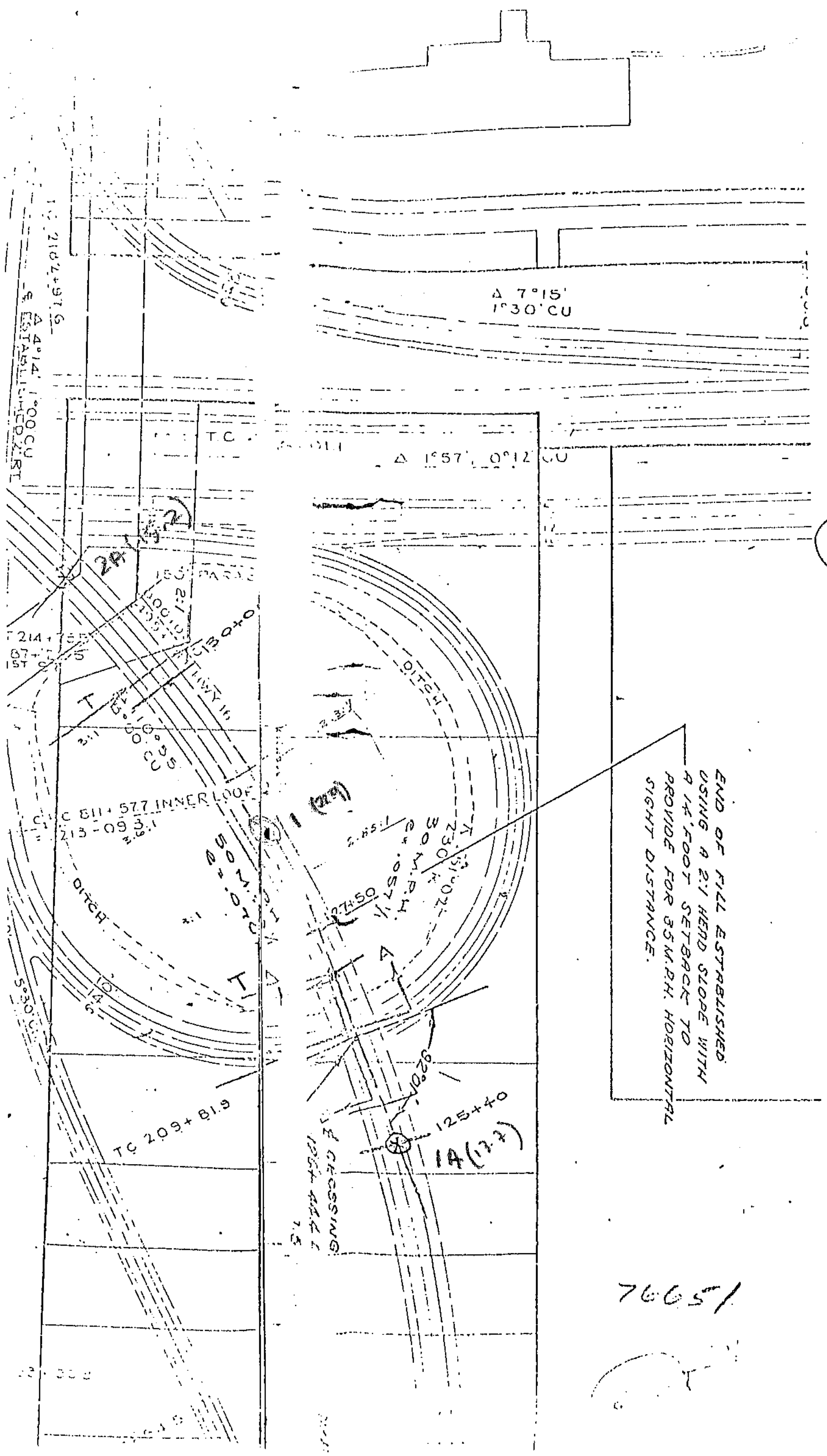
4.1 Piles shall be driven by equipment having a striking weight not less than one-third of the driven weight of the pile. The driver should be capable of delivering at least 15,000 ft. lbs. of energy.

4.2 The number of blows required to drive the pile each foot should be recorded for every pile as an indication of the satisfactory carrying capacity of the pile and as an indicator of potential tip damage.

4.3 . After each pile is driven to its required depth an elevation should be taken of the pile top or on a suitable mark on the side of the pile. This elevation should be checked periodically to ensure that it is not heaved by the driving of adjacent piles. Piles that are heaved must be redriven.

4.4 For piles which displace a considerable amount of soil during driving, such as closed-end pipe piles, care must be taken that the driving does not cause damaging horizontal displacement to existing structures or foundations.

4.5 Where piles are designed to gain support by skin friction in the soil it is essential that the pile have ends and walls free from protrusions which could cause voids or disturbance of the adjacent soil during driving.



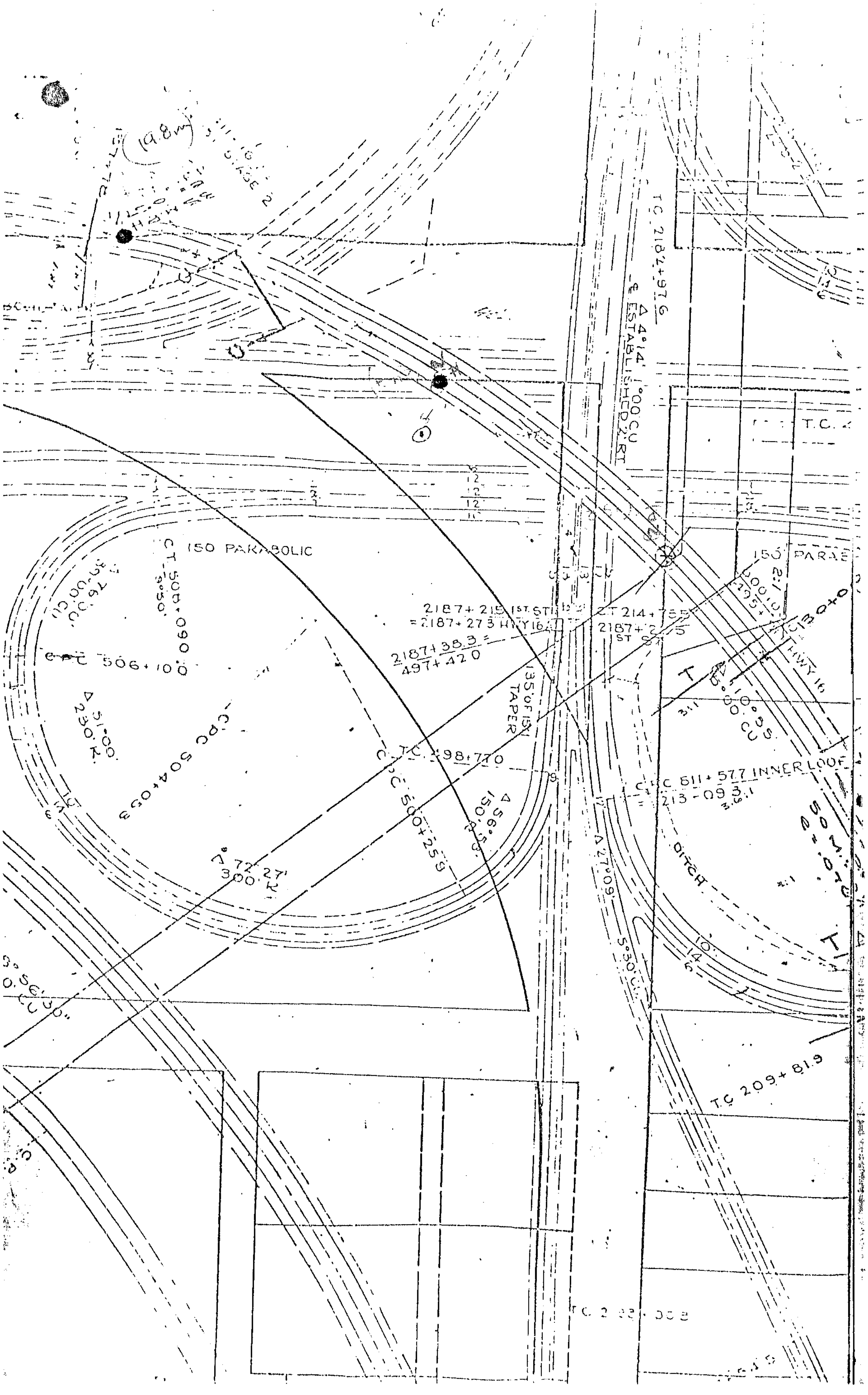
File 76651

- Existing holes

⊗ Drill new holes.

* Drill extra holes
if material is no
the same as previ
holes.

76651



(19.8m)
T.C. 2187+97.6
Δ 4°14'
1°00 CU
℄ ESTABLISHED 2 RT
T.C.
12
12
12
150 PARABOLIC
CT 500+090
3°50'
76.00
CPC 506+100
Δ 51°00'
230' R.
CPC 504+053
Δ 72°27'
300' R
2187+215 1ST ST
=2187+273 HWY16
CT 214+755
2187+215
1ST ST
2187+38.3 =
497+420
135' of 15:1 TAPER
150' PARAB
2:1
TC 130+0
HWY 16
Δ 10°35'
1°00 CU
T.C. 498+770
CPC 500+259
Δ 56°
150'
CPC 611+57.7 INNER LOOP
= 213+093.1
Δ 27°09'
5°30' CU
DITCH
T.C. 209+81.9
0.56'30"
CU
T.C. 2 33+00.8

H.R.B.F. 1025-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Bridge File: 76651
Project INTERCHANGE AT CLOVER BAR COMPLEX
Site 128 + 40
Sample
Location ℄ North- West Outer Connector.
Hole #1 Depth 75'
Technician Prelusky Date Sept. 9/69

Elevation of Ground Surface (Zero Depth) 2184.4 665 m
Elevation of Water Table
Method of Advancing Hole
Remarks 0' - 15' Dry Auger
15' - 75' Wet Drill

LEGEND
Liquid Limit .... △
Field Moisture .. ○
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ	P.P.	MOISTURE CONTENT - %
0'			0.0' - 2.5' Top-soil	kg/cm²	T/ft²	
			2.5' - 3.0 ' silty clay			
3'			Pen. @ 3' 9 26 44	35		
			6" 12" 18"	12"		
			sandy clay			
6'			Pen. @ 6' 19 43 67	48		
			6" 12" 18"	12"		
			sandy clay(sand bands)			
9'			Pen. @ 9' 17 48 78	61		
			6" 12" 18"	12"	sandy clay to 9.5'	
			@9.5' sand begins			
12'			Pen. @ 12' 21 45 93	72		
			6" 12" 18"	12"		
			sand			
15'			Pen. @ 15' 16 39 95	79		
			6" 12" 18"	12"		
18'			fine sand (brownish in color)			
	20'		Shelby @ 20'			
21'						
			fine sand			
24'						
	25'		Pen. @ 25' 24 58 100	76		
27'			6" 12" 18"	12"		
			fine sand to 28.5'			
	28.5'		@ 28.5' sand clay to 30'			
30'			Shelby @ 30'			
33'			30' - 35' gravel with sand seams			
	35'		gravel			
36'						
39'			gravel			
42'			gravel			
45'						
48'			gravel			
51'			gravel			
	52'		gravel ends at 52'			
54'			sandy clay begins at 52'			
			" "			

H.R.B.F. 1025-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Bridge File: 76651
Project INTERCHANGE AT CLOVER BAR COMPLEX
Site 128 + 40
Sample
Location ℄ North-West Outer Connector
Hole #1 Depth 75'
Technician Prelusky Date Sept. 9/69

Elevation of Ground Surface (Zero Depth)
Elevation of Water Table
Method of Advancing Hole
Remarks

LEGEND
Liquid Limit .... △
Field Moisture .. ○
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
54-0	55'		Pen. @ 55' 10 20 21	11		
			6" 12" 18"	12"		
57'			Pen. sank 11" with only 2 hammer blows.			
			sandy clay			
60'			Shelby @ 60' (bag sample)			
			sandy clay			
63'						
	65'		Pen. @ 65' 33 88 119	86		
66'			6" 12" 18"	12"		
			(no recovery)			
69'			sandy clay with pebbles			
			clay (Till)			
72'			traces of coal			
			clay			
75'			Pen. @ 75' 53 185 300	247		
			6" 12" 14.5"	8.5"		

DEPTH IN FEET

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

6 Peno. Samples

Project: 76651 Technician: WW

Site: Interchange at Clover Bar Complex Date: September 9th, 1969

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39637	1	3	3.5	M	M	N	lt.brown	below	M	silty clay	CL:CI	2.72
39638	1	6	4.0	M	M	N	lt.brown	opt.-	M	silty sandy clay	CL:CI	2.72
39639	1	9	4.5+	M	M	N	dk.brown	opt.-	M	pebbles sandy clay	CL:CI	2.72
39640	1	12	0.5	G	M	N	lt.brown	- to below	L	pebble fine uniform sand	SU	2.68
39641	1	15	3.75	G	D	N	lt.brown	opt. -	L	fine uniform sand	SU	2.68
39642	1	25	0.25	G	M	N	lt.brown	opt.-	L	uniform sand	SU	2.68

Remar

Hole #1 128+40 ℄ N.W. Outer Connector

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

2 shelby Samples

Project: 76651 Technician: W.W.

Site: Interchange Clover Bar Complex Date: Sept. 9/69.

SAMPLE Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39630	1	20	0.5	G	M	N	lt.brown	opt.-	low	uniform sand	SU	2.68
39631	1	30	2.1	M	M	N	lt.brown	opt. to +	med.	sandy clay	CI	2.72

Remarks Hole #1 128+40 ℄ NW Outer Connector

48-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

1 Shelby Samples

Project: 76651

Technician: WW.

Site: Interchange at Clover Bar Complex

Date: September 10th, 1969

Sample No. +	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39809	1	60	-	M	L	N	lt.grey	opt.+	M	sandy silty clay	CL:CI	

Remarks: Hole #1 128+40 ℄ NW Outer Connector

HRBF 948-64

Province of Alberta

Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

5 Shelby Samples

Project: 76651

Technician: W.W.

Site: Interchange at Clover Bar Complex

Date: September 10th, 1969

SAMPLE NO'S Sample No. +	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration $T/ft.^2$	Massive Stratified Nugget Granular Other	Very Loose Loose Medium Dense Extremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39688	1	70	2.75	M	M	N	dk.grey	opt.+	M	sandy clay pebbles	CI	2.72
39689	3	20	1.6	M	M	N	lt.brown	above	M	pebbles silty clay	CI	2.72
39690	3	55	4.5+	M	D	N	dk.grey	below	H	clay & shale	CH	2.75
39691	3	30	1.5	M	M	N	dk.brown	above	M	sandy clay	CL:CI	2.72
39692	3	45	1.5	M	M	N	dk.grey	above	M	sandy clay pebbles	CI	2.72

Remarks:

Hole #1 128+40 ENW Outer connector

Hole #3 137+30 30'ltE NW Outer Connector

HRBF 948-64

Province of Alberta

Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

[illegible] Samples

Project: 76051

Technician: [illegible]

Site: Interchange at Clover Bar Complex

Date: September 10th, 196[illegible]

Sample No.	Hole No.	Depth Ft.	Consistency Pocket Penetration T ft.^{2}	Structure Massive Stratified Nugget Granular Other	Relative Density Very Loose Loose Medium Dense Extremely Dense	Odor Strong Medium None	Color Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Moisture Content Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Plasticity Low Medium High	Description	Cassagrande Classification	Est. Spec. Gravity
[illegible]	[illegible]	[illegible]	4.5+	M	D	N	lt.grey	- to below	H	silt & bentonite	CH	2.75
[illegible]	2	[illegible]	1.0- [illegible]	M	M	N	lt.brown	+ to above	M	sandy clay pebbles	CL:CI	2.7[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	G	M	N	lt.brown	opt.	L	uniform sand	SU	2.68
[illegible]	[illegible]	[illegible]	[illegible]	G	M	N	lt.brown	opt.	L	uniform sand	SU	2.68
[illegible]	2	12	[illegible]	G	L	N	lt.brown	opt.	L	uniform sand	SU	2.68
[illegible]	[illegible]	15	[illegible]	G	L	N	lt.brown	opt.	L	uniform sand clay lumps	SU:SC	2.68

Remarks:

Hole #1 128+44 E N... Outer Connector

Hole #2 134+05 N'rt & N... Outer Connector

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651

DATE: September 9th, 1969

ENGINEER: A. Weber

Edmonton

REMARKS: Int. at Clover Bar Complex

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39637	PENO. TUBES	128+40	℄ N.W.Outer Connector Hole #1	3'	99.4	98.8	98	94	60.4	22.6	37.8	CH	18.7	24	96	low	clay
39638				6'	99.9	99.6	95	70	41.2	14.3	26.9	CI	12.3	15	115	low	sandy clay
39639				9'	95	91	85	57	38.8	14.2	24.6	CI	12.0	15	115	low	sandy clay
39640				12'	93	92.6	90	25			trace	SU	5.3			med.	uniform fine sand
39641				15'		100	95	23			trace	SU	7.2			med.	"
39642				25'		100	92	21			trace	SU	6.3			med.	"

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651

ENGINEER: A. Weber

DATE: September 9th, 1969

Edmonton

REMARKS: Int. at Clover Bar Complex

Sample No. 10⁵ +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
39630	Shelby Tubes	128+40	℄ NW Outer Connector Hole #1	20'	100	100	99	12			trace	SU	3.4				uniform fine sand
39631				30'	100	100	97.7	52	26.5	13.0	13.5	CL	14.7	12			sand, clay

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651

DATE: September 10th, 1969

ENGINEER: A. Weber
Edmonton

REMARKS: Int. at Clover Bar Complex

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
39809	Shelby Tube	128+40	℄ NW Outer Connector Hole #1	60'			100		48.9	19.5	29.4	CI	18.9	20	103		clay

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651

DATE: September 10th, 1969

ENGINEER: A. Weber
Edmonton

REMARKS: Int. at Clover Bar Complex

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39688	Shelby Tubes	128+40	E NW Outer Connector Hole #1	70'	99.3	98.7	96	76	46.2	14.3	31.9	Cl	17.6	16			sandy clay
39689		137+30	30' LT. N.W. OUTER CONNECTOR HOLE #3	20'	98.7	98	95	73	46.8	14.8	32.0	Cl	19.7	16			sandy clay
39690				55'	100	100	99.2	87	59.9	29.6	30.3	CH	20.5	30			silt, clay
39691				30'	100	99.3	96	70	44.3	14.8	29.5	Cl	19.8	16			sandy clay
39692				45'	99.9	99.3	96	71	43.5	14.7	28.8	Cl	18.5	15			sandy clay

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651
DATE: September 10th, 1969
ENGINEER: A. Weber
Edmonton
REMARKS: Int. at Clover Bar Complex

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39672	PENO. TUBES	128+40	℄ N.W.Outer Connector H#1	75'		100	99.9	68	58.0	17.9	40.1	CH	16.7	20	105	low	fine sand,silt bentonite
39673		134+05	10'RT ℄ N.W. OUTER CONNECTOR HOLE #2	3'	98.3	97.2	92	70	34.6	12.8	21.8	CL	16.9	13	120	med.	sandy clay
39674				6'		100	99.9	36			trace	SF	14.9			med.	fine sand
39675				9'		100	99.3	20			trace	SF	9.4			med.	fine sand
39676				12'		100	98.6	11			trace	SU	8.5			med.	uniform fine sa
39677				15'	99.9	99.8	90	19			trace	SU	7.9			med.	uniform fine sa

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

6 Peno. Samples

Project: 76651

Technician: W.W.

Site: Interchange at Clover Bar Complex

Date: September 10th, 1969

Sample No. +	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39672	1	75	4.5+	M	D	N	lt.grey	- to below	H	silt & bentonite	CH	2.75
39673	2	3	1.3-2.0	M	M	N	lt.brown	+ to above	M	sandy clay pebbles	CL:CI	2.72
39674	2	6	0.8	G	M	N	lt.brown	opt.	L	uniform sand	SU	2.68
39675	2	9	0.5	G	M	N	lt.brown	opt.	L	uniform sand	SU	2.68
39676	2	12	0.2	G	L	N	lt.brown	opt.	L	uniform sand	SU	2.68
39677	2	15	0.5	G	L	N	lt.brown	opt.	L	uniform sand clay lumps	SU:SC	2.68

Remarks:

Hole #1 128+40 ℄ N.W. Outer Connector

Hole #2 134+05 10'rt ℄ N.W. Outer Connector

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957 65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76651 LOCATION: Interchange at Clover Bar Complex

DATE: September 9 & 10, 1969 REMARKS: A. Weber Penetrometer Samples

Specific Gravities Estimated for % Saturation.

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft	TYPE OF FAILURE	REMARKS
39637	1	3	19.2	18.7	58.5	57.2	3.71	3.5	58° shear	
39638	1	6	12.5	12.3	72.6	71.1	4.53	4.0	55° shear	Vane shear - 1.90 TSF
39639	1	9	12.4	12.0	82.3	79.7	6.64	4.5+	64° cone shear	Vane shear - 2.5+ TSF
39640	1	12	No unconfine - sand					0.5		
39641	1	15	7.6	7.2	41.5	39.0	3.80	3.75	Vertical shear	
39642	1	25	No unconfine - sand					0.25		
39672	1	75	17.1	16.7	94.0	91.7	11.33	4.5+	Cone shear	
39673	2	3	17.2	16.9	94.4	92.7	1.90	1.65	52° shear	Vane shear - 1.0 TSF
39674	2	6	15.2	14.9	79.2	77.8	0.7	0.8	68° shear	
39675	2	9	No unconfine - sand					0.5		
39676	2	12	No unconfine - sand					0.2		
39677	2	15	No unconfine - sand					0.5		

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76651 LOCATION: Interchange at Clover Bar Complex

DATE: September 9 & 10, 1969 REMARKS: A. Weber. Shelby Samples

Specific gravities estimated for % saturation.

SAMPLE NO 5
10 [illegible]

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39630	1	20	no unconfine - sand					0.5		
39631	1	30	14.9	14.7	87.8	86.4	1.73	2.1	65° shear	vane shear - 1.22 TSF
39809	1	60	bag sample - no unconfine							

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF V57 65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76651

LOCATION: Int. at Clover Bar Complex

DATE: September 10th, 1969

REMARKS: A. Weber - Shelby Samples

Specific Gravities Estimated for % Saturations.

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE	MOISTURE AFTER	SATURATION BEFORE	SATURATION AFTER %	σ_1 Kg sq cm	POCKET PENETRATION T sq ft	TYPE OF FAILURE	REMARKS
39688	1	70	17.9	17.6	96.8	95.1	3.18	2.75	flow	vane shear - 1.30 TSF
39689	3	20	20.0	19.7	92.8	91.4	1.29	1.6	55° shear	vane shear - 0.62 TSF
39690	3	55	20.7	20.5	85.0	83.9	1.71	4.5+	53° shear	disturbed sample
39691	3	30	20.2	19.8	95.3	93.3	1.69	1.6	64° shear	vane shear - 0.75 TSF
39692	3	45	19.0	18.5	94.7	92.5	1.72	1.5	60° shear	vane shear - 0.75 TSF

H.R.B.F. 1025-65

Bridge File: 76651

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project INTERCHANGE AT CLOVER BAR COMPLEX.
Site 134 + 05
Sample
Location 10' Rt. ℄ North-West Outer Connector
Hole #2 Depth
Technician Prelusky Date Sept. 11/69

Elevation of Ground Surface (Zero Depth) 2170.8
Elevation of Water Table
Method of Advancing Hole
Remarks 0' - 20' Dry Auger
20' - Wet Drill

LEGEND
Liquid Limit .... △
Field Moisture .. ○
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
0'			0'- 1'0' Top-soil			
			1' - 3' sandy clay			
3'			Pen. @ 3' 5 14 29	㉔		
			6" 12" 18"	12"		
			@5' sand begins			
6'			Pen. @ 6' 10 28 46	㊱		
			6" 12" 18"	12"		
			sand			
9'			Pen. @ 9' 10 28 53	㊸		
			6" 12" 18"	12"		
			sand			
12'			Pen. @ 12' 11 28 58	㊼		
			6" 12" 18"	12"		
			sand			
15'			Pen. @ 15' 15 39 75	(60)		
			6" 12" 18"	12"		
18'			sand to 20' @ 20' sand with gravel			
20'						
21'						
			gravel & sand			
24'						
			" "			
27'						
30'						
			" "			
33'						
36'						
37'			— sand & gravel to 37'			
39'			NB			
			Drilled to 40' Sept 11/69			
			Hole completed Sept 12/69			
42'						
45'						
48'						
51'						
54'						

H.R.B.F. 1025-65

Bridge File : 76651

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project INTERCHANGE AT CLOVER BAR COMPLEX
Site 134 + 05
Sample
Location 10' Rt. C North West Outer Connector
Hole #2 Depth 80'
Technician S.P. Date Sept. 17/69

Elevation of Ground Surface (Zero Depth)
Elevation of Water Table
Method of Advancing Hole
Remarks

LEGEND
Liquid Limit .... △
Field Moisture .. ○
Plastic Limit .... *

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
40'			gravel to 42'			
42'			@42' sandy greyclay			
44'			sandy grey clay			
45'			Shelby @ 45'			
46'			sandy grey clay			
48'			sandy grey clay, sand seams			
50'			Pen. @ 50' 39 65 97 6" 12" 18"	58 12"		
			@50' sand clay			
52'			51' - 52' coal seam			
53'			@53' gravel begins			
54'			gravel			
56'			gravel			
58'			gravel			
60'						
62'			gravel ends at 62'			
64'			sandy clay			
65'			Shelby @ 65'			
66'			sand clay, sand seams			
			grey clay			
68'			grey clay			
70'			Pen. @ 70' 41 117 205 6" 12" 18"	164 12"		
72'			grey clay			
74'			grey clay			
76'						

78'

grey clay

80' Pen. @ 80' 175
4¼"

traces of coal at 80' Bag sample @80' Bag #1

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

6 Peno. Samples

Project: 76651 Technician: W.W.

Site: Interchange at Clover Bar Complex Date: September 10th, 1969

SAMPLE Sample No.^{5} +	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39672	1	75	4.5+	M	D	N	lt.grey	- to below	H	silt & bentonite	CH	2.75
39673	2	3	1.3-2.0	M	M	N	lt.brown	+ to above	M	sandy clay pebbles	CL:CI	2.72
39674	2	6	0.8	G	M	N	lt.brown	opt.	L	uniform sand	SU	2.68
39675	2	9	0.5	G	M	N	lt.brown	opt.	L	uniform sand	SU	2.68
39676	2	12	0.2	G	L	N	lt.brown	opt.	L	uniform sand	SU	2.68
39677	2	15	0.5	G	L	N	lt.brown	opt.	L	uniform sand clay lumps	SU:SC	2.68

Remarks Hole #1 128+40 ℄ N.W. Outer Connector

Hole #2 134+05 10'rt ℄ N.W. Outer Connector

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

2 Shelby Samples

Project: 76651
Technician: W.W.

Site: Int. at Clover Bar Complex
Date: September 17th, 1969

Sample No. SAMPLE NOS 10^5 +	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39922	2	45	4.5+	M	D	N	dk.grey	below	M-H	silty clay	CI:CH	2.75
39923	2	65	4.5+	M	M	N	lt.grey	- to below	M-H	silty clay W/ bentonite	CI;CH	2.75

Remarks: Hole #2 134+05 10'rt ℄ N.W. Outer Connector

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

4 Peno. Samples

Project: 76651

Technician:

Site: Interchange at Clover Bar Complex

Date: September 17th, 1969

Sample No. +	Hole No.	Depth Ft.	Consist- ency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassag- rande Classif- ication	Est. Spec. Grav- ity
			Pocket Penet- ration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39931	2	50	1.4	S	M	N	lt.grey	opt.	M	silty clay fine sand	CI	2.72
39932	2	70	4.5+	M	D	N	dk.grey	opt.-	M-H	silty clay	CI:CH	2.75
39933	2	80	4.5+	M & coal	D	N	black	- to below	M	silty clay & coal	OI	2.70
39934	2	80	no rdg.	coal	L	N	black	above	L	coal	coal	2.68

Remar Hole #2 134+05 10'rt ℄ N.W. Outer Connector

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651
ENGINEER: A. Weber
DATE: September 10th, 1969
Edmonton
REMARKS: Int. at Clover Bar Complex

Sample No. 10⁵ +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39672		128+40	℄ N.W.Outer Connector H#1	75'		100	99.9	68	58.0	17.9	40.1	CH	16.7	20	105	low	fine sand, silt bentonite
39673	PENO. TUBES	134+05	10' RT ℄ N.W. OUTER CONNECTOR HOLE #2	3'	98.3	97.2	92	70	34.6	12.8	21.8	CL	16.9	13	120	med.	sandy clay
39674				6'		100	99.9	36			trace	SF	14.9			med.	fine sand
39675				9'		100	99.3	20			trace	SF	9.4			med.	fine sand
39676				12'		100	98.6	11			trace	SU	8.5			med.	uniform fine sar
39677				15'	99.9	99.8	90	19			trace	SU	7.9			med.	uniform fine sar

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651

DATE: September 17th, 1969

ENGINEER: A. Weber
Edmonton

REMARKS: Int. at Clover Bar Complex

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39922	Shelby Tubes	134+05	10'rt ℄ N.W.Outer Connector Hole #2	45'	100	99.9	99.5	93	50.0	22.8	27.2	CH:CI	16.5	24			silty clay
39923				65'	100	99.7	99	79	60.8	23.5	36.3	CH	19.1	26			clay

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651

DATE: September 17 th, 1969

ENGINEER: A. Weber
Edmonton

REMARKS: Int. at Clover Bar Complex

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39931	Peno. Tubes	134 + 05	10' RT ℄ N.W. Outer Connector. Hole #2	50'		100	99.4	77	35.8	16.6	19.2	CI:CL	19.8	16			sandy clay, silt
39932				70'	99	98.9	98.5	97	70.3	21.6	48.7	CH	18.4	23			clay
39933				80'		100	89		65.5	34.5	31.0	OH	25.7	30+			clay, coal
39934				80'	------	------	------	------	------	COAL	------	------	------	------	------	------	------

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76651 LOCATION: Interchange at Clover Bar Complex

DATE: September 9 & 10, 1969 REMARKS: A. Weber Penetrometer Samples

Specific Gravities Estimated for % Saturation.

SAMPLE NOS SAMPLES Nos	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39637	1	3	19.2	18.7	58.5	57.2	3.71	3.5	58° shear	
39638	1	6	12.5	12.3	72.6	71.1	4.53	4.0	55° shear	Vane shear - 1.90 TSF
39639	1	9	12.4	12.0	82.3	79.7	6.64	4.5+	64° cone shear	Vane shear - 2.5+ TSF
39640	1	12	No unconfine - sand					0.5		
39641	1	15	7.6	7.2	41.5	39.0	3.80	3.75	Vertical shear	
39642	1	25	No unconfine - sand					0.25		
39672	1	75	17.1	16.7	94.0	91.7	11.33	4.5+	Cone shear	
39673	2	3	17.2	16.9	94.4	92.7	1.90	1.65	52° shear	Vane shear - 1.0 TSF
39674	2	6	15.2	14.9	79.2	77.8	0.7	0.8	68° shear	
39675	2	9	No unconfine - sand					0.5		
39676	2	12	No unconfine - sand					0.2		
39677	2	15	No unconfine - sand					0.5		

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76651
LOCATION: Int. @ Cloverbar Complex
DATE: September 17th, 1969
REMARKS: A. Weber. Shelby Samples

Specific Gravities Estimated for % Saturation.

SAMPLE No. SAMPLE NOS. 10^5 +	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39922	2	45	16.8	16.5	90.3	88.7	3.03	4.5+	70° shear	Disturbed sample
39923	2	65	No unconfine - disturbed sample					4.5+		

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76651 LOCATION: Int. at Cloverbar Complex

DATE: September 10th, 1969. REMARKS: A. Weber. Penetrometer Samples

Specific Gravities Estimated for % Saturation.

SAMPLE NOS 10^3 +

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39678	3	3	18.0	17.8	98.5	96.9	2.28	1.75	42° shear	Vane shear - 0.80 TSF
39679	3	6	17.2	16.9	97.7	96.1	2.13	1.9	59° shear	Vane shear - 1.00 TSF
39680	3	9	16.2	15.9	94.6	92.6	2.42	1.8	Flow	Vane shear - 1.00 TSF
39681	3	12	20.7	20.4	94.3	92.8	1.72	1.75	Flow	Vane shear - 0.90 TSF
39682	3	15	22.4	22.0	99.7	97.8	2.29	2.25	45° shear	Vane shear - 1.25 TSF
39683	3	25	21.5	21.2	99.9	98.5	1.97	1.7	Flow	Vane shear - 1.00 TSF
39684	3	35	20.1	19.7	97.4	95.3	1.57	1.25	Flow	Vane shear - 0.66 TSF
39685	3	40	20.2	19.8	98.9	97.2	1.49	1.25	Flow	Vane shear - 0.65 TSF
39686	3	50	22.9	22.3	95.2	92.7	6.16	4.5+	64° cone shear	
39687	3	65	22.8	22.3	83.9	82.0	5.07	4.5+	48° shear	
39931	2	50	20.2	19.8	88.7	87.1	1.52	1.4	Flow	Vane shear - 0.75 TSF
39932	2	70	18.7	18.4	91.1	89.5	9.12	4.5+	44° shear	
39933	2	80	26.3	25.7	73.1	71.6	3.46	4.5+	Shear	
39934	2	80	No unconfine -	bag sample						

50

H.R.B.F. 1025-65

Bridge File: 76651

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project INTERCHANGE AT CLOVER BAR COMPLEX
Site 137 + 30
Sample
Location 30' Lt. C North-West Outer Connector
Hole #3 Depth 65'
Technician Prelusky Date Sept. 10/69

Elevation of Ground Surface (Zero Depth) 2162.3
Elevation of Water Table
Method of Advancing Hole
Remarks 0' - 15' Dry Auger
15' - 65' Wet Drill

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
0'			0' - 2' Top-soil			
			2' - 3' sandy clay			
3'			Pen. @ 3' 7 18 32	25		
			6" 12" 18"	12"		
			sandy clay			
6'			Pen. @ 6' 7 16 32	25		
			6" 12" 18"	12"		
			sandy clay			
9'			Pen. @ 9' 11 20 55	44		
			6" 12" 18"	12"		
			sandy clay with sand	seams		
12'			Pen. @ 12' 7 17 37	30		
			6" 12" 18"	12"		
			fine sand begins @13'	(Note: sand caving in.)		
15'			Pen. @ 15' 9 20 39	30		
			6" 12" 18"	12"		
			sand ends at 15'			
18'						
			sandy clay			
	20'		Shelby @ 20'			
21'						
			sandy clay			
24'						
	25'		Pen. @ 25' 10 23 50	40		
			6" 12" 18"	12"		
27'						
			sandy clay			
30'			Shelby @ 30'			
33'			sandy clay			
	35'		Pen. @ 35' 11 24 45	34		
36'			6" 12" 18"	12"		
			clay, silty clay			
39'						
	40'		Pen. @ 40' 11 24 46	35		
			6" 12" 18"	12"		
42'						
			clay, silty clay			
45'			Shelby @ 45'			
48'			grey clay(very hard)			
	50'		Pen. @ 50' 33 83 205	172		
51'			6" 12" 18"	12"		
			clay			
54'						

DEPTH IN FEET

H.R.B.F. 1025-65

Bridge File: 76651

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project INTERCHANGE AT CLOVER BAR COMPLEX
Site 137 + 30
Sample
Location 30' Lt. ℄ North-West Outer Connector
Hole #3 Depth 65'
Technician Prelusky Date Sept. 10/69

Elevation of Ground Surface (Zero Depth) 2162.3
Elevation of Water Table
Method of Advancing Hole
Remarks

LEGEND
Liquid Limit .... △
Field Moisture .. ○
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
54'θ						
55'			Shelby @55' clay			
			@ 56' Shale ledge			
57'						
			clay			
60'			~~Pen. @~~			
			clay			
63'						
65'			Pen. @ 65' 61 239	178		
			6" 12"	12"		

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

10 Peno. Samples

Project: 76651

Technician:

Site: Interchange at Clover Bar Complex

Date: September 10th, 1969

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39678	3	3	1.75	M	M	N	lt.brown	opt.+	M	sandy clay pebbles	CL:CI	2.72
39679	3	6	1.75-2.0	M	M	N	lt.brown	opt.+	M	"	CL:CI	2.72
39680	3	9	1.8	M	M	N	lt.brown	opt.+	M	"	CL:CI	2.72
39681	3	12	1.75	M	M	N	lt.brown	above	M	"	CL:CI	2.72
39682	3	15	2.25	M	M	N	lt.brown	above	M	silty clay pebbles	CI	2.72
39683	3	25	1.7	M	M	N	lt.brown	above	M	sandy clay pebbles	CL:CI	2.72
39684	3	35	1.25	M	M	N	dk.grey	above	M	sandy clay pebbles	CL:CI	2.72
39685	3	40	1.25	M	M	N	dk.grey	above	M	sandy clay pebbles	CL:CI	2.72
39686	3	50	4.5+	M	D	N	dk.grey	- to below	H	clay and coal	CH	2.75
39687	3	65	4.5+	M	D	N	dk.grey	below	H	clay and coal	CH	2.75

Remarks: Hole #3 137+30 30'lt N.W. Outer Connector

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

5 Shelby Samples

Project: 76651
Technician: W.W.

Site: Interchange at Clover Bar Complex
Date: September 10th, 1969

SAMPLE NO.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **Dense**	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39688	1	70	2.75	M	M	N	dk.grey	opt.+	M	sandy clay pebbles	CI	2.72
39689	3	20	1.6	M	M	N	lt.brown	above	M	pebbles silty clay	CI	2.72
39690	3	55	4.5+	M	D	N	dk.grey	below	H	clay & shale	CH	2.75
39691	3	30	1.5	M	M	N	dk.brown	above	M	sandy clay	CL:CI	2.72
39692	3	45	1.5	M	M	N	dk.grey	above	M	sandy clay pebbles	CI	2.72

Remarks: Hole #1 128+40 ℄NW Outer connector

Hole #3 137+30 30' lt℄ NW Outer Connector

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651

DATE: September 10th, 1969

ENGINEER: A. Weber
Edmonton

REMARKS: Int. at Clover Bar Complex

Sample No. 10⁵ +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39678	PENO. TUBES	137 + 30	30' LT ℄ N.W. OUTER CONNECTOR HOLE #3	3'	97	96.5	91	62	35.2	13.7	21.5	CI:CL	17.8	14	118		sand, clay
39679				6'	99	98	91	60	34.0	13.1	20.9	CL:CI	16.9	13	119		sand, clay
39680				9'	99.5	99	93	60	29.9	12.8	17.1	CL	15.9	12	121		sand, clay
39681				12'		100	95.5	65	37.9	13.7	24.2	CI	20.4	14	118		sandy clay
39682				15'	99.5	99	95.5	77	49.5	15.3	34.2	CI:CH	22.0	17	110		sandy clay
39683				25'	100	99.4	96	85	44.1	17.1	27.0	CI	21.2	18	108		sandy clay
39684				35'	99.5	98.9	95	71	44.1	18.3	25.8	CI	19.7	18	108		sandy clay
39685				40'	99.9	99.8	96	71	41.8	13.8	28.0	CI	19.8	15	115		sandy clay
39686				50'	100	100	98.4	87	66.4	26.0	40.4	CH	22.3	27	92		clay,some coal
39687				65'	100	100	98.7	79	64.5	28.8	35.7	CH	22.3	30	90		clay,some coal

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76651

ENGINEER: A. Weber

DATE: September 10th, 1969

Edmonton

REMARKS: Int. at Clover Bar Complex

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
39688	Shelby Tubes	128+40	℄ NW Outer Connector Hole #1	70'	99.3	98.7	96	76	46.2	14.3	31.9	CI	17.6	16			sandy clay
39689		137+30	30' LT ℄ N.W. OUTER CONNECTOR HOLE #3	20'	98.7	98	95	73	46.8	14.8	32.0	CI	19.7	16			sandy clay
39690				55'	100	100	99.2	87	59.9	29.6	30.3	CH	20.5	30			silt, clay
39691				30'	100	99.3	96	70	44.3	14.8	29.5	CI	19.8	16			sandy clay
39692				45'	99.9	99.3	96	71	43.5	14.7	28.8	CI	18.5	15			sandy clay

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957 65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76651
LOCATION: Int. at Cloverbar Complex

DATE: September 10th, 1969.
REMARKS: A. Weber. Penetrometer Samples

Specific Gravities Estimated for % Saturation.

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE	MOISTURE AFTER	SATURATION BEFORE	SATURATION AFTER	σ	POCKET PENETRATION	TYPE OF FAILURE	REMARKS
39678	3	3	18.0	17.8	98.5	96.9	2.28	1.75	42° shear	Vane shear - 0.80 TSF
39679	3	6	17.2	16.9	97.7	96.1	2.13	1.9	59° shear	Vane shear - 1.00 TSF
39680	3	9	16.2	15.9	94.6	92.6	2.42	1.8	Flow	Vane shear - 1.00 TSF
39681	3	12	20.7	20.4	94.3	92.8	1.72	1.75	Flow	Vane shear - 0.90 TSF
39682	3	15	22.4	22.0	99.7	97.8	2.29	2.25	45° shear	Vane shear - 1.25 TSF
39683	3	25	21.5	21.2	99.9	98.5	1.97	1.7	Flow	Vane shear - 1.00 TSF
39684	3	35	20.1	19.7	97.4	95.3	1.57	1.25	Flow	Vane shear - 0.66 TSF
39685	3	40	20.2	19.8	99.0	97.8	1.40	1.25	Flow	Vane shear - 0.65 TSF
39686	3	50	22.9	22.3	95.2	92.7	6.16	4.5+	64° cone shear	
39687	3	65	22.8	22.3	83.9	82.0	5.07	4.5+	48° shear	
39931	2	50	20.2	19.8	88.7	87.1	1.52	1.4	Flow	Vane shear - 0.75 TSF
39932	2	70	18.7	18.4	91.1	89.5	9.12	4.5+	44° shear	
39933	2	80	26.3	25.7	73.1	71.6	3.46	4.5+	Shear	
39934	2	80	No unconfine - bag sample							

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76651

LOCATION: Int. at Clover Bar Complex

DATE: September 10th, 1969

REMARKS: A. Weber - Shelby Samples

Specific Gravities Estimated for % Saturations.

SAMPLE NO'S	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39688	1	70	17.9	17.6	96.8	95.1	3.18	2.75	flow	vane shear - 1.30 TSF
39689	3	20	20.0	19.7	92.8	91.4	1.29	1.6	55° shear	vane shear - 0.62 TSF
39690	3	55	20.7	20.5	85.0	83.9	1.71	4.5+	53° shear	disturbed sample
39691	3	30	20.2	19.8	95.3	93.3	1.69	1.6	64° shear	vane shear - 0.75 TSF
39692	3	45	19.0	18.5	94.7	92.5	1.72	1.5	60° shear	vane shear - 0.75 TSF

H.R.B.F. 1025-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project 76651
Site STRUCTURE 11 TOP LEVEL DIRECT RAMP @ CLOVER BAR
Sample 125 + 80
Location ℄
Hole 1 A
Depth 45'
Technician M.K
Date OCT. 15/70

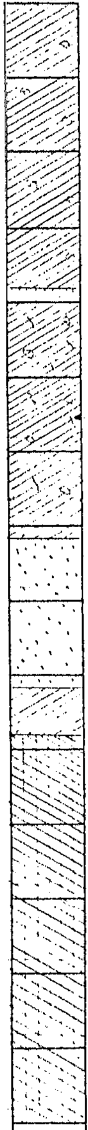
Elevation of Ground Surface (Zero Depth) 2207.0
Elevation of Water Table SLOW SEEPAGE BETWEEN 26-29' NO FREE WATER IN HOLE
Method of Advancing Hole DRY AUGER
Remarks APPROX. 11.5' FILL. CAVING BETWEEN 21.5'-27.0'
5 GALS WATER AND 50 LBS DRILLING MUD WERE USED TO STOP CAVING. PENS 343 & 244 HAVE SAME BLOW COUNT.

LEGEND

Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET

Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %



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BROWN SANDY CLAY
PEBBLES
SHELBY @ 5'

PEN. 108 @ 10' 6" 12" 18"
8 18 35

11.5
12.0
2195

BLACK ORGANIC MATERIAL

SHELBY @ 15'
BROWN SANDY CLAY (PEBBLES
FEW COAL CHIPS

PEN. 343 @ 20.5' to 21.0
PEN 244 @ 21.0 to 21.5
6" 12" 18"
18 43 66 48

21.5'

BROWN SILTY SAND
- OPT.
SHELBY @ 25'

27.5'

SAND - CLAY

29.5'

PEN. 50 @ 30'
6" 12" 18"
21 44 93

SHELBY @ 35'

BLUISH GREY SILTY CLAY
HIGHLY PLASTIC - OPT

PEN 111 @ 40'
6" 12" 18"
16 43 76

SHELBY @ 45'

45'

DEPTH IN FEET

Province of Alberta
Department of Highways
and Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

SHELBY Samples

Project: EF 76651

Technician: TK & J

Site: Top Level Direct Ramp Clover Bar, Structure

Date: Oct. 15/70

SAMPLE NO'S 10° +

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
43954	1A	5	4.5+	Massive	Dense	None	Lt. Brown	-	Med.-high	Sandy clay	CI	2.75
43955		25	4.0	"	"	"	"	Opt.	Med.	"	"	"
43956		25	0.75	G	"	"	"	Above	Low	Clayey sand	SC	2.68
43957		35	4.5+	Massive	"	"	Dk. Grey	Opt.	High	Clay	CH	2.75
43958		45	"	"	"	"	"	"	"	"	"	"

Remarks: Hole # 1 - 125 + 80 a

Province of Alberta
Department of Highways
and Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

FERO Samples

Project: BF 76651
Technician: TK

Site: Top Level Direct Ramp
- Clover Bar Structure # 11
Date: Oct. 15/76

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
SAMPLE NO'S 10⁵ +			Pocket Penetration T/ft.²	Massive Stratified Nugget Granular Other	Very Loose Loose Medium Dense Extremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
48946	1A	10	4.0	Massive	Dense	None	Med. Brown	Opt. to -	High	Silty Clay	CH	2.75
48947		20.5-21	4.5+	"	"	"	Lt. Brown	-	Med.	Sandy Clay	CI	"
* 48948		21-21.5	"	G	"	"	"	Below	Low	Clayey Sand	SC	2.[illegible]
48949		30	2.40	M	"	"	Dk. Grey	+	High	Clay	CH	2.75
48950		40	4.50	M	"	"	"	Opt.	"	"	"	2.75

Remarks: Hole # 1 - 125 + 30 - A
* Sample Disturbed - 48947 & 48, Same Blow Count

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: F 76651
DATE: Oct. 15/70
ENGINEER: [illegible]
Head Office

REMARKS: Top Level Direct Ramp Clover Bar Str. [illegible]
[illegible]

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
40954	None	125 +00	6 [illegible] 1 A	5	99.7	99.1	95	70	41.0	15.6	25.4	[illegible]	19.3	16	112	low	sandy clay
40955	"	"	"	15	99.8	99	91	56	25.5	11.8	14.7	[illegible]	12.7	11	120	med.	sand, clay
40956	"	"	"	25	100	99.8	93	18	16.7	14.1	2.6	[illegible]	10.0	10	125	low	clayey fine sand
40957	"	"	"	35		100	99.8	98	90.0	21.9	68.1	[illegible]	21.8	[illegible]	97	low	clay
40958	"	"	"	45		100	99.9	99	104.5	25.3	82.2	[illegible]	26.0			low	clay

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: F 76651

DATE: Oct. 15/70

ENGINEER: [illegible]
Head Office

REMARKS: [illegible] Level Direct [illegible] Clover Bar Br. [illegible]
[illegible]

Sample No. 10^3 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
49946	108	125+80	[illegible] 1A	10	100	99.9	99.3		68.4	25.5	42.9	CH	23.4	26	93	low	clay
49947	243	"	"	20.5-21	99.5	98	92	60	29.0	12.4	16.6	C[illegible]	10.5	12	121	mod.	[illegible], clay
49948	244	"	Sample disturbed " 1A	21-21.5	100	99.9	95				trace	F	5.2			high	silty fine sand
49949	501	"	"	30		100	99.9		93.5	22.7	70.8	CH	21.7	25	95	low	clay
49950	111	"	"	40		100	99.9		73.4	15.4	68.0	CH	20.6	[illegible]	9[illegible]	low	clay

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS and Transport
TESTING LABORATORY

PROJECT: 76651

LOCATION: Top Level Direct Ramp
Clover Bar Structure # 11

DATE: Oct. 15/70

REMARKS: A. eber - Shelby Samples

Specific Gravity Estimated for Percentage Saturation

SAMPLE NO'S 10^5 +

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
48954	1 P	5	No Unconfine - Disturbed Sample					4.5+		
48955		15	No Unconfine - Disturbed Sample					4.0		Vane Shear - 1.75 TSF
48956		25	No Unconfine - Sand					0.75		
48957		35	24.8	24.4	94.6	93.1	3.06	4.5+	61° Shear	Natural Fractures & Slide Planes
48958		45	25.0	24.6	95.7	94.2	3.80	4.5+	52° Shear	Slide Plane

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
and Transport
TESTING LABORATORY

PROJECT: 76651

LOCATION: Top Level Direct Ramp
Clover Bar Structure # 11

DATE: Oct. 15/70

REMARKS: A. Acker- Penetrometer Samples

Specific Gravity Estimated for Percentage Saturation

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
48946	1 A	10	29.4	29.1	97.8	96.7	3.78	4.0	52° Shear	Vane Shear - 2.05 TSF
48947		20.5 -21	10.3	10.2	72.5	71.4	6.53	4.5+	58° Shear	Hairline Fracture
48948		21- 21.5	No Unconfine - Disturbed Sample							
48949		30	31.7	31.4	95.6	94.8	1.65	2.40	Flow & Shear	Vane Shear - 1.37 TSF
48950		40	26.6	26.3	94.8	93.8	2.22	4.5	53° Slide Plane	Vane Shear - 2.5 TSF

H.R.B.F. 1025-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project 76651
Site TOP LEVEL DIRECT RAMP @ CLOVER BAR
Sample
Location STA. 131+00 30' LT ℄
Hole # 2 A Depth 0 - 50'
Technician KOLODYCHUK Date OCT 29,30/70

Elevation of Ground Surface (Zero Depth) 2184.0
Elevation of Water Table
Method of Advancing Hole DRY AUGER TO 32' CONTINUED WET TO 50'
Remarks HOLE CAVING @ 32' HAD TO DRILL WET & USE MUD TO CONTINUE

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

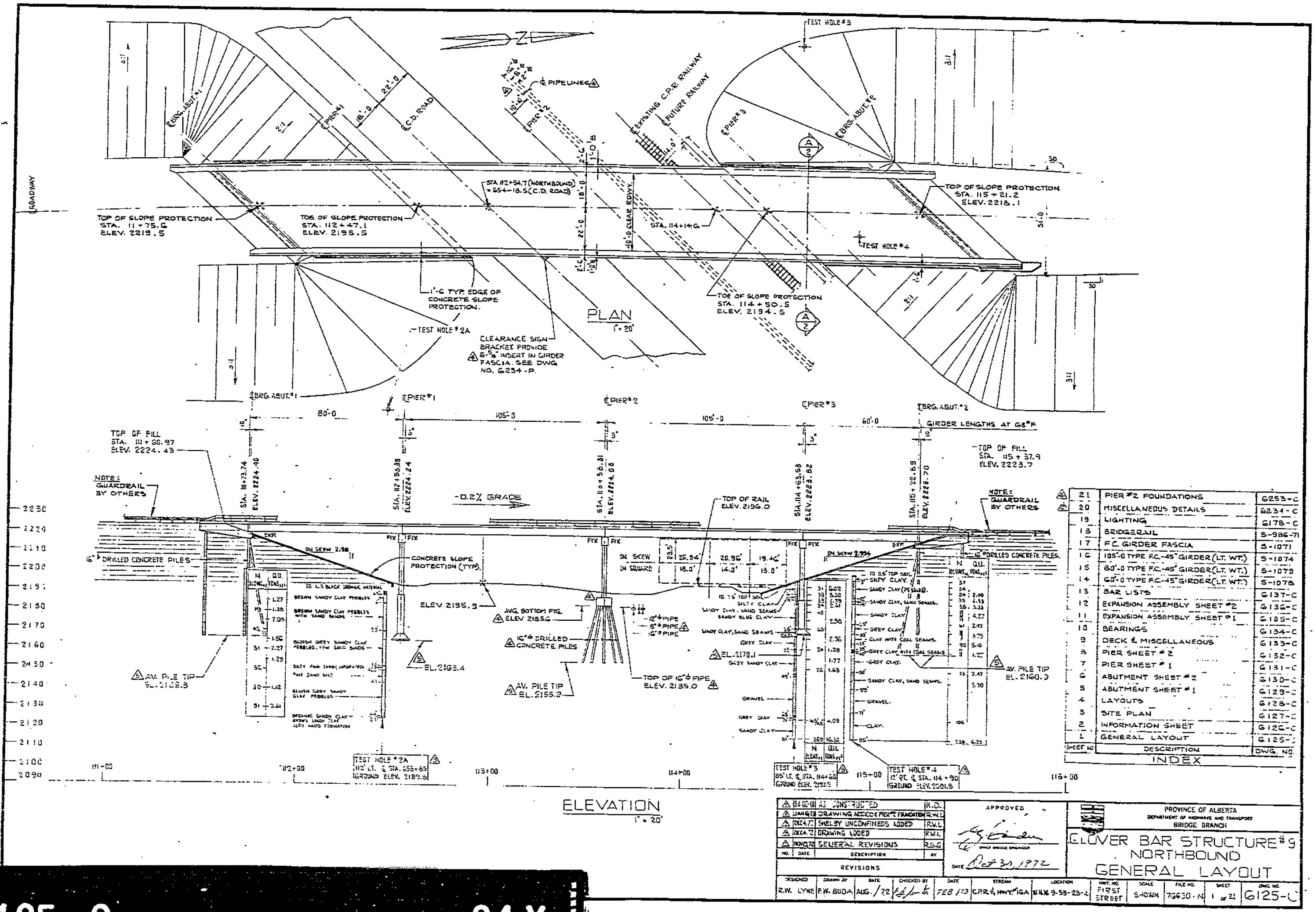
DEPTH IN FEET

DEPTH IN FEET	Blows N	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²
0				
		FILL MATERIAL BROWN CLAY/SILT		
		& STONES HELED OPT		
5		SHELBY @ 5'		
7		POOR SAMPLE SHELBY BENT.		
10	21	PEN @ 10' PEN Nº 134		
		5/6" - 14/12" - 26/18"		
		BROWN CLAY SAND & TRACES OF STONES OPT.		
15		SHELBY @ 15'		
18				
20	33	PEN @ 20' PEN Nº 522		
		15/6" - 35/12" - 53/18"		
		BROWN COARSE SAND OPT		
25		SHELBY @ 25		
		COARSE SAND WITH STONE PEBBLES		
		- OPT		
30	92	PEN. @ 30' PEN. Nº 438		
		26/6" - 59/12" 118/18"		
		COARSE SAND BEDDED WITH GRAVEL BANDS		
35		SHELBY @ 35'		
		NO SHELBY SAMPLE SHELBY		
		BENT.		
40	115	PEN @ 40' PEN. Nº 529		
		42/6" - 88/12" - 151/18"		
		SAME AS ABOVE.		
45		SHELBY COULDN'T BE TAKEN AS OF		
46		GRAVEL & SAND MIXED		
50		GREY SANDY CLAY COULDN'T		
		TAKE PEN AS HOLE CAVED IN		

MOISTURE CONTENT -%

DEPTH IN FEET

BF76650



SHEET NO.	DESCRIPTION	DWG. NO.
21	PIER #2 FOUNDATIONS	6253-C
20	MISCELLANEOUS DETAILS	6234-C
19	LIGHTING	6178-C
18	BRIDGERAIL	S-986-71
17	F.C. GIRDER FASCIA	S-1071
16	105'-0 TYPE F.C.-45" GIRDER (LT. WT.)	S-1074
15	80'-0 TYPE F.C.-45" GIRDER (LT. WT.)	S-1079
14	60'-0 TYPE F.C.-45" GIRDER (LT. WT.)	S-1078
13	BAR LISTS	6137-C
12	EXPANSION ASSEMBLY SHEET #2	6136-C
11	EXPANSION ASSEMBLY SHEET #1	6135-C
10	BEARINGS	6134-C
9	DECK & MISCELLANEOUS	6133-C
8	PIER SHEET #2	6132-C
7	PIER SHEET #1	6131-C
6	ABUTMENT SHEET #2	6130-C
5	ABUTMENT SHEET #1	6129-C
4	LAYOUTS	6128-C
3	SITE PLAN	6127-C
2	INFORMATION SHEET	6126-C
1	GENERAL LAYOUT	6125-C

INDEX

NO.	DATE	DESCRIPTION	BY
5	84-02-10	AS CONSTRUCTED	K.D.
4	JAN 6 73	DRAWING ADDED (PIER #2 FOUNDATION)	R.W.L.
3	DEC 4 72	SHELBY UNCONFINEDS ADDED	R.W.L.
2	DEC 4 72	DRAWING ADDED	R.W.L.
1	NOV 30 72	GENERAL REVISIONS	R.S.G.

REVISIONS

APPROVED

CHIEF BRIDGE ENGINEER

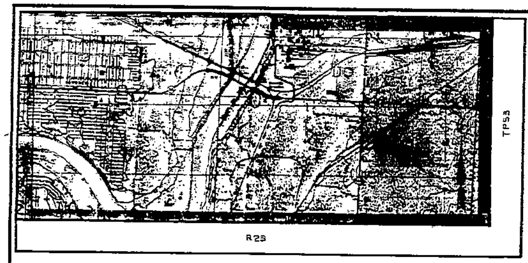
DATE Oct 30, 1972

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH

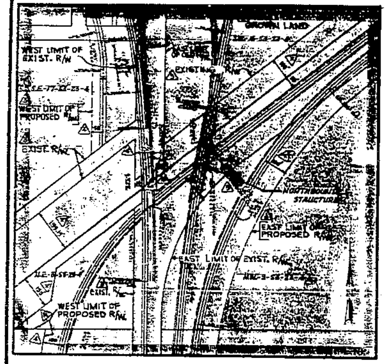
CLOVER BAR STRUCTURE #9
NORTHBOUND
GENERAL LAYOUT

DESIGNED	DRAWN BY	DATE	CHECKED BY	DATE	STREAM	LOCATION	HWY. NO.	SCALE	FILE NO.	SHEET	DWG. NO.
R.W. LYNE	F.W. BUDA	AUG./72		FEB /73	C.P.R. & HWY. 16A	W.4 9-53-23-4	FIRST STREET	SHOWN	79630-N	1 of 21	6125-C

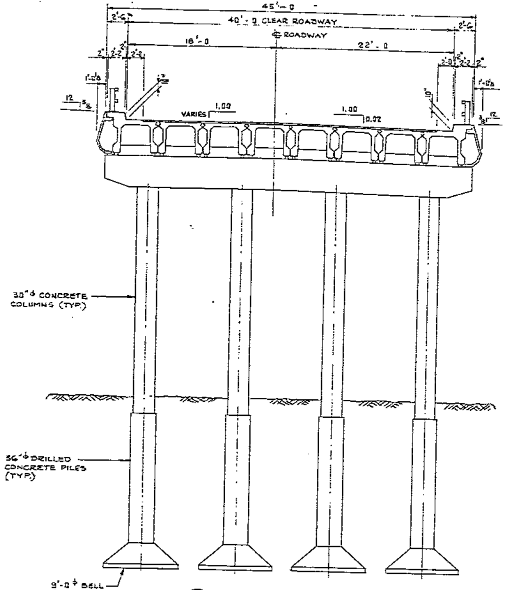
6125 C 24 X



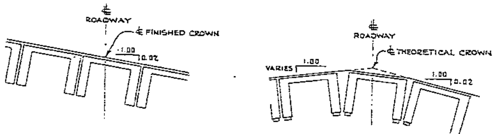
SITE MAP
APPROX 3" = 1 MILE



SITE PLAN
SCALE 1" = 200'



A/1 SECTION
3/16" = 1'-0



ABUT. #1 & PIER #1

ABUT. #2 & PIERS #2 & #3

CROWN DIAGRAMS
N.T.S.

QUANTITY ESTIMATE:

ITEM	UNIT	SUBSTRUCT	SUPERSTRUCT	TOTAL EST	AS CONST.
△ EXCAVATION STRUCTURAL	CU. YDS.	140		140	2.9
△ BACKFILL COMPACTED GRANULAR	CU. YDS.	113		113	173
△ 16"⌀ DRILLED CONCRETE PILES	LIN. FT.	1914		1914	2500.9
△ 36"⌀ DRILLED CONCRETE PILES	LIN. FT.	143		143	[illegible]
△ CONCRETE CLASS "B"	CU. YDS.	379	60	439	425.1
CONCRETE CLASS "D"	CU. YDS.		20	20	21.2
△ REINFORCING STEEL	LBS.	71,659	2,179	73,838	75635
CONCRETE SLOPE PROTECTION	SQ. YDS.			799	902.7
ASPHALTIC WEARING SURFACE	SQ. YDS.	158	1392	1550	1559.3
BRIDGERAIL	LIN. FT.		803	803	795

GENERAL NOTES:

- PILE END ELEVATIONS MAY CHANGE FROM THOSE SHOWN TO ACCOMODATE VARIATION IN SOIL PROFILE.
- THE BOTTOM OF PILE ELEVATION IS TO BE ESTABLISHED IN THE PRESENCE OF THE ENGINEER.
- THE CONTRACTOR SHALL DRILL WITH CAUTION TO ENSURE THAT THE SOFTER MATERIAL LYING BELOW THE INTENDED FOUNDING LAYER IS NOT PENETRATED.
- CASING SHALL BE SUPPLIED FOR THE DRILLING OF THE PILES AS REQUIRED.
- FOUNDATION INFORMATION SHOWN IS FOR THE GUIDANCE ONLY OF THE CONTRACTOR.
- DRILLING LOGS AND LABORATORY TEST RESULTS MAY BE REVIEWED IN THE OFFICE OF THE CHIEF BRIDGE ENGINEER IN EDMONTON.
- ELEVATIONS ARE GIVEN TO ℄ FINISHED CROWN AT ABUT. #1 AND PIER #1, AND TO ℄ THEORETICAL CROWN AT ABUT. #2 AND PIERS #2 AND #3.

DESIGN

- A.A.S.H.O. 1969 SPECIFICATION + INTERIMS
- A.A.S.H.O. HS - 20 - 44 LOADING.
- REINFORCING STEEL - INTERMEDIATE GRADE REINFORCING.
- △1 PILE LOADS:
  - ABUTMENTS - D.L. = 88 K/PILE ≠ 100 % BASIC ALLOWABLE.
  - -EXTREME = 115 K/PILE ≠ 100 % BASIC ALLOWABLE.
  - PIERS - D.L. = 302 K/PILE ≠ 100 % BASIC ALLOWABLE.
  - -EXTREME = 365 K/PILE ≠ 100 % BASIC ALLOWABLE.

△1 • UNCONFINED STRENGTH OF SOIL AT PILE ENDS ASSUMED TO BE 2.85 TONS PER SQUARE FOOT. TO BE CHECKED BY THE ENGINEER BEFORE PILE DEPTH IS CONSIDERED ADEQUATE.

NO.	DATE	DESCRIPTION	BY
△	[illegible]	AS CONSTRUCTED	K.D
△	OCT. 30/73	DIMENSION - SITE PLAN	R.W.L.
△	SEPT. 24/73	DIMENSION - SITE PLAN	R.W.L.
△	[illegible]	MILEAGE (R/W ADDED) - SITE PLAN	R.L.F.
△	16/1/73	QUANTITY ESTIMATE REVISIONS	R.W.L.
△1	5/12/72	PILE LOADS & BEARING STRENGTH	R.G.C.

REVISIONS

APPROVED

CHIEF BRIDGE ENGINEER

DATE

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH

CLOVER BAR STRUCTURE #9
NORTHBOUND
INFORMATION SHEET

DESIGNED	DRAWN BY	DATE	CHECKED BY	DATE	STREAM	LOCATION	HWY. NO.	SCALE	FILE NO.	SHEET	DWG. NO.
R.W. LYNE	M. FILIPIAK	MARCH/72		FEB /73	C.P.R. & HWY. #16A	W.N.W.-9-53-23-4	FIRST STREET	SHOWN	75630-N	2 of 21	6126-C

76650

R. H. Cronkhite
Chief Construction Engineer

E. J. Sanden
Chief Construction Engineer

November 2, 1970

Re: Additional Test Holes
Intchg. 53
CPR O'Pass @ Clover Bar.

Attached, for your information, are logs of additional holes drilled at the subject site as per your request of September 11, 1970.

R. H. Cronkhite
CHIEF CONSTRUCTION ENGINEER

Per:

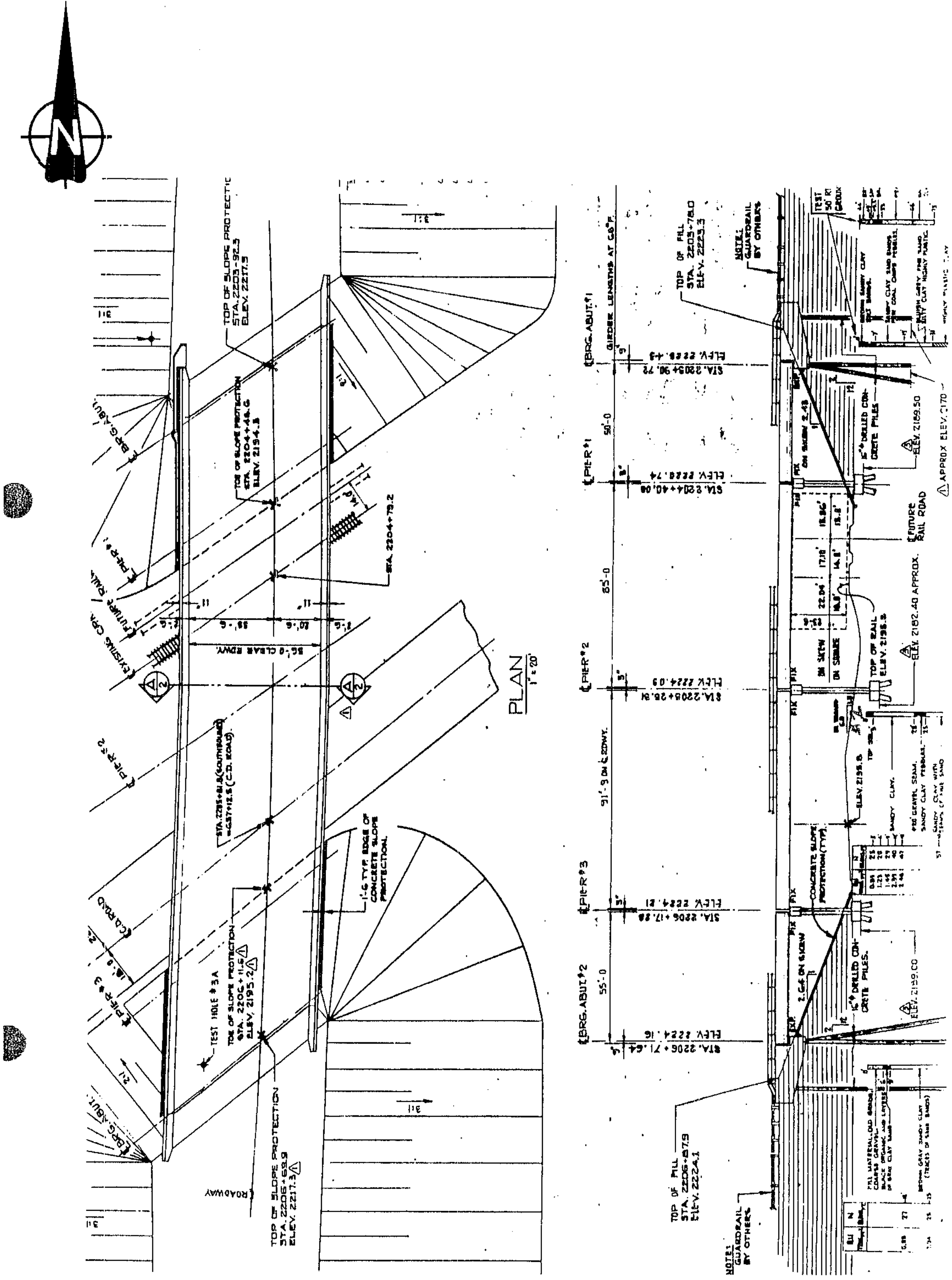
A. W. Weber
SOILS ENGINEER

AWW:jks
Att'd.

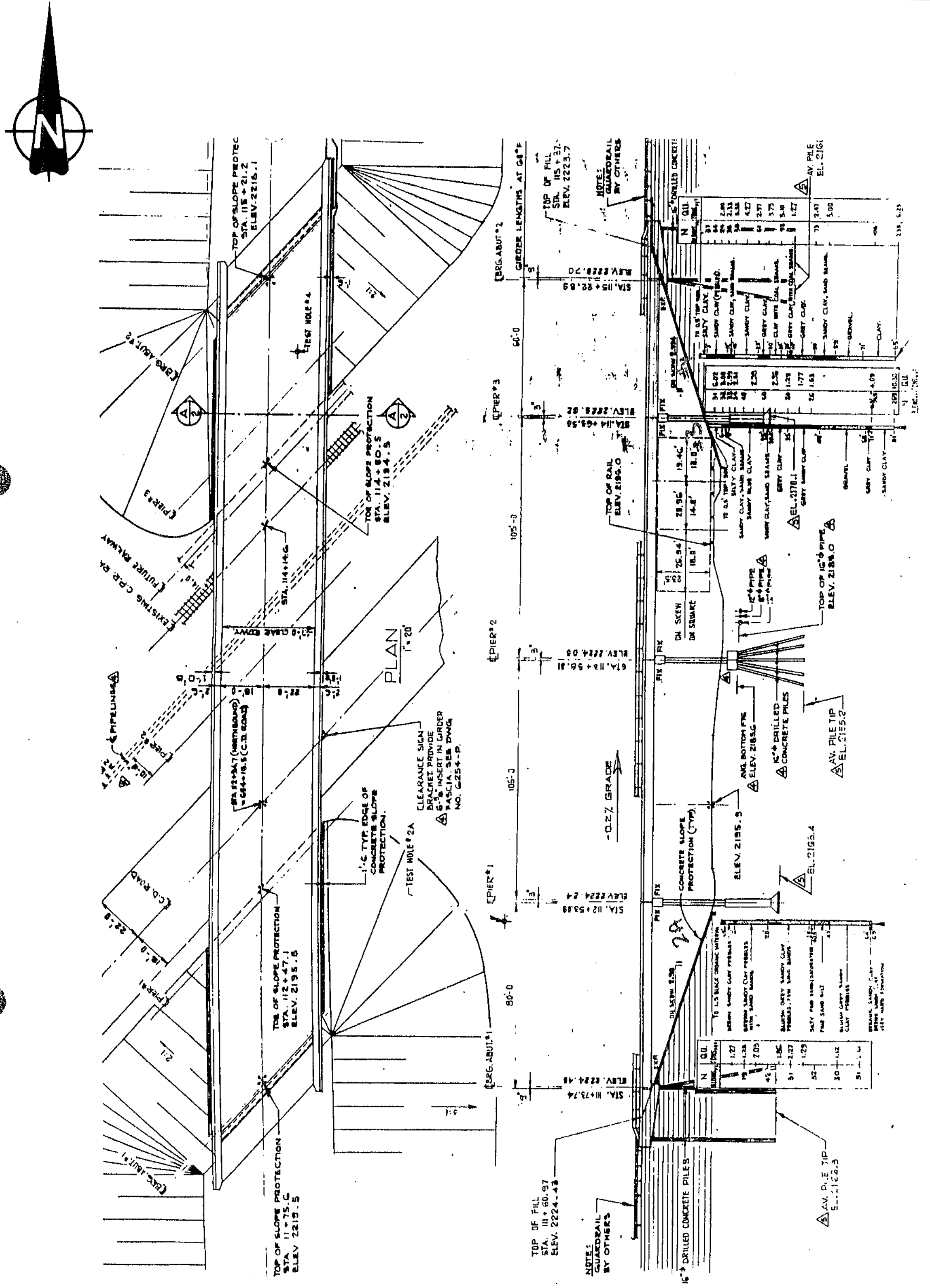
Alberta
TRANSPORTATION AND UTILITIES
Bridge Materials

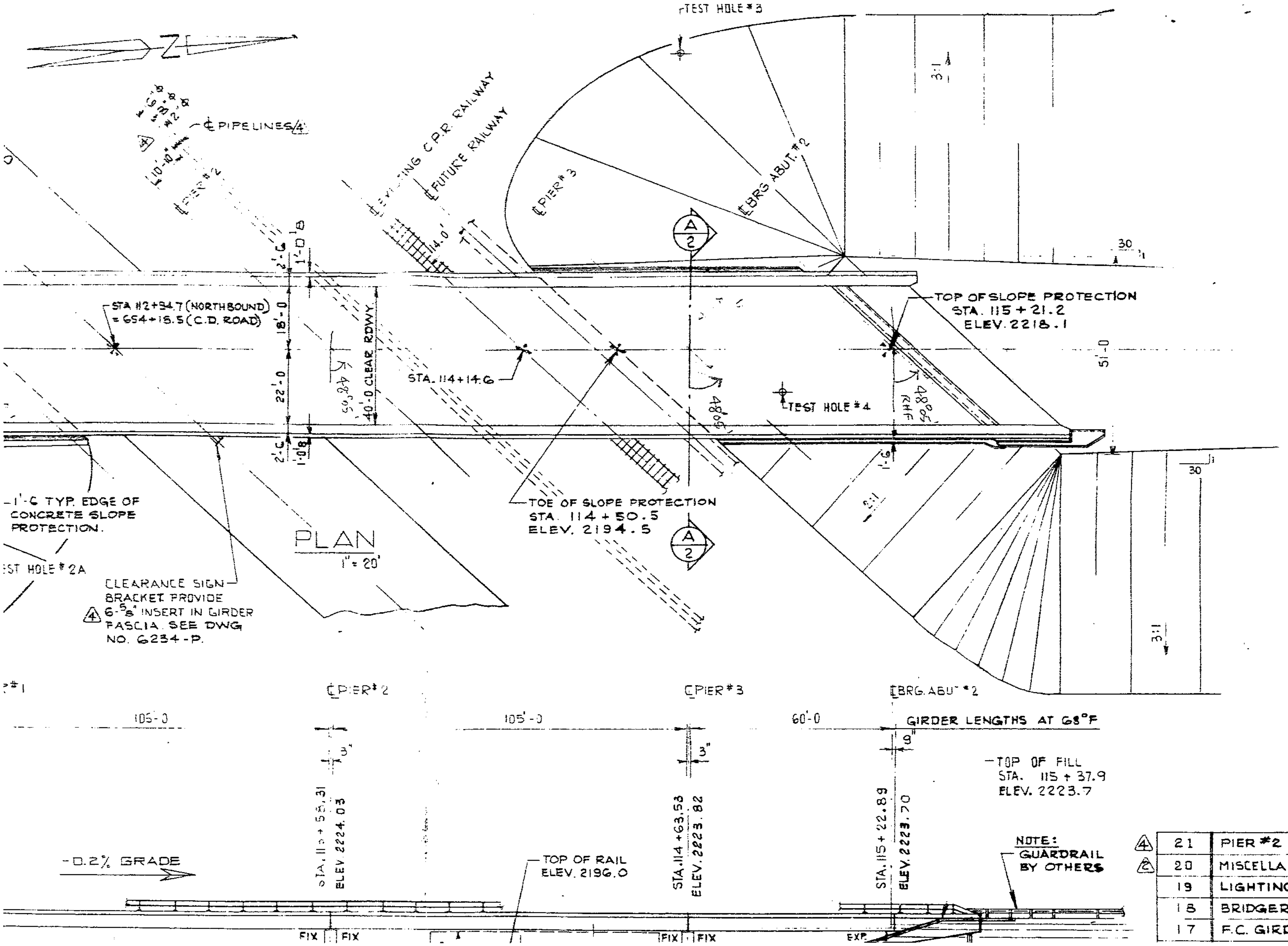
CLOVERBAR STRUCTURE NO. 9
(SOUTHBOUND STRUCTURE)

File	76650S
Date	Oct. 7, 1994
By	W. Cappellani
Page	

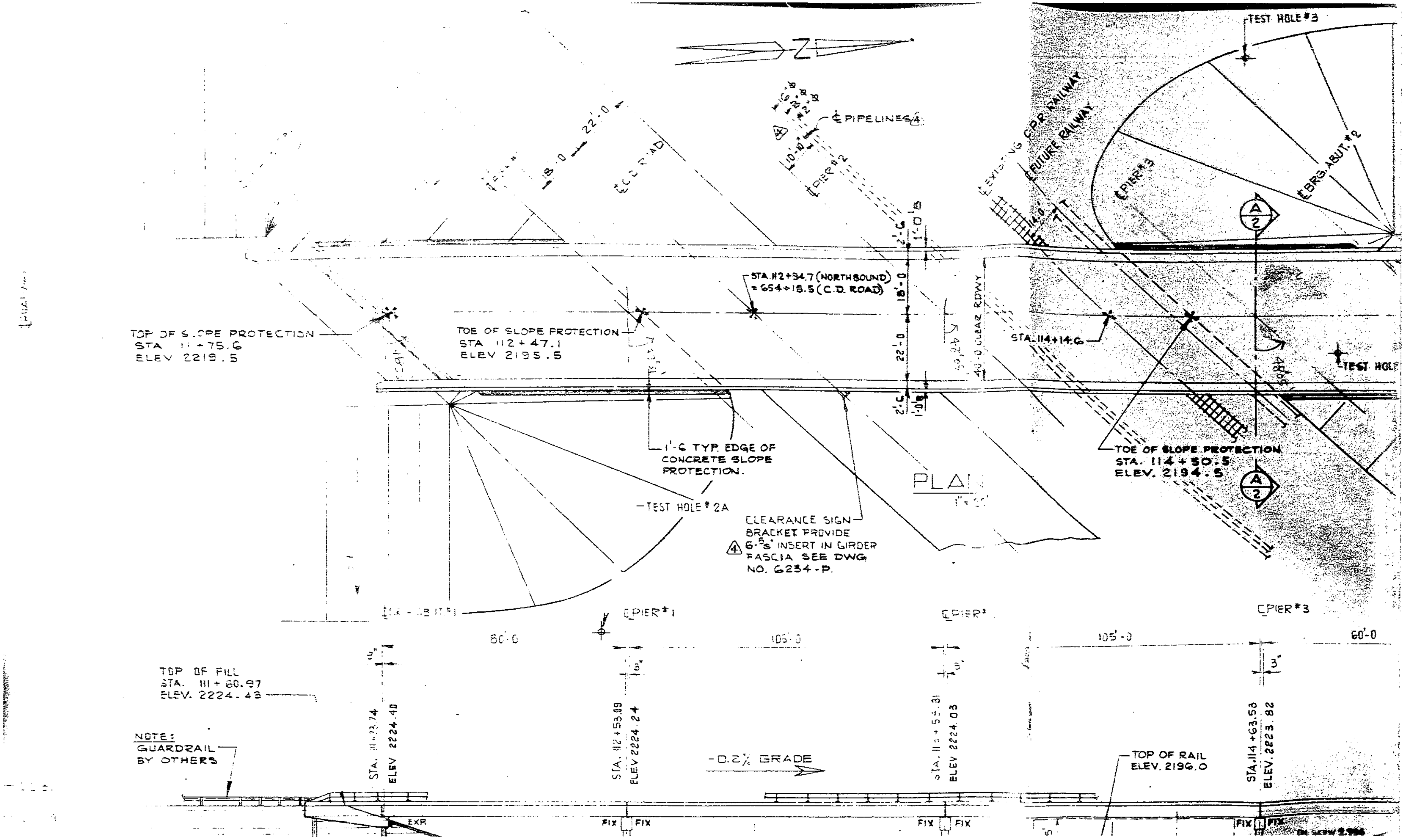


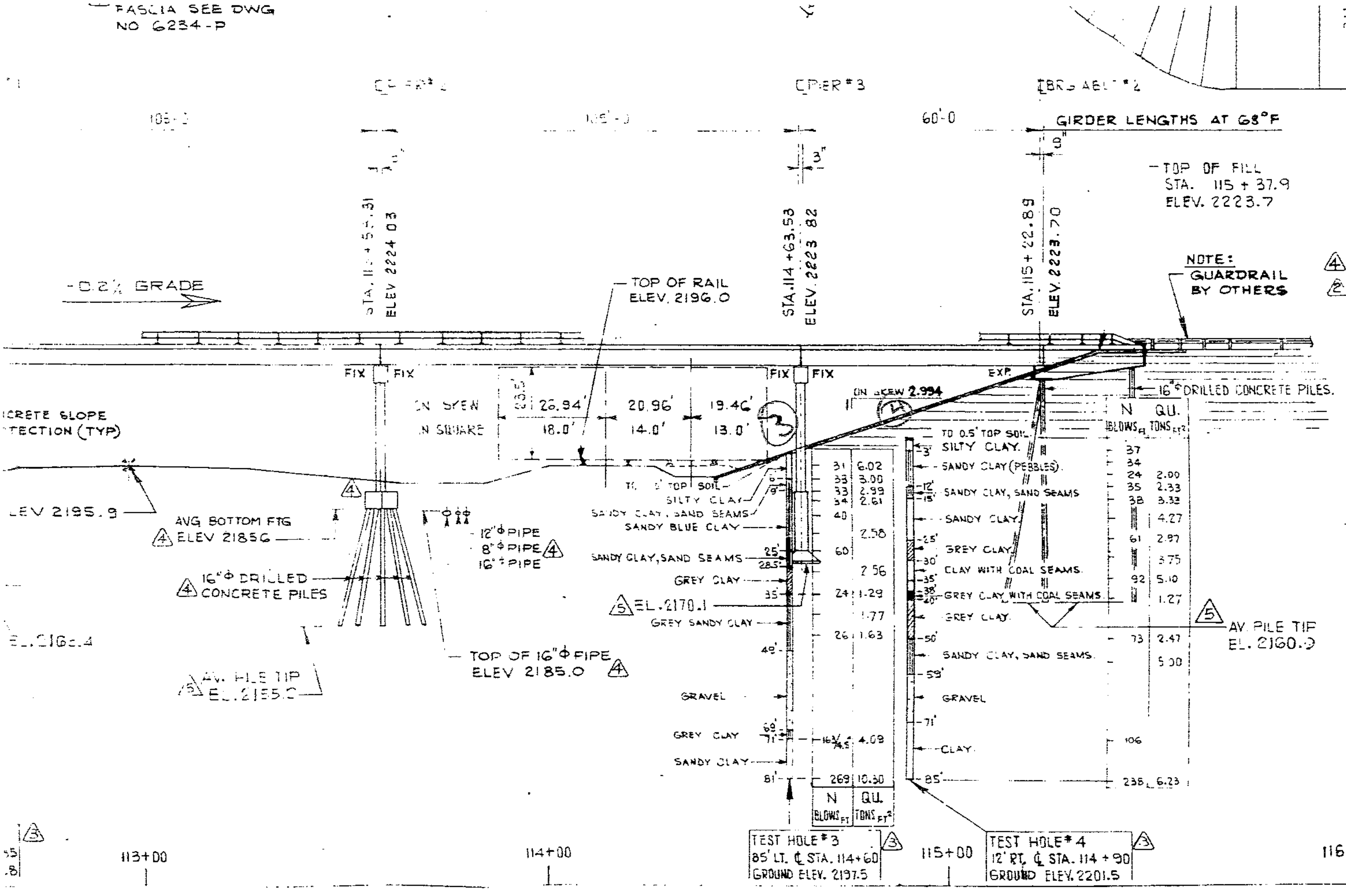
Alberta TRANSPORTATION AND UTILITIES Bridge Materials	CLOVERBAR STRUCTURE NO. 9 (NORTHBOUND STRUCTURE)	File	76650N
		Date	Oct. 7, 1994
		By	W. Cappellani
		Page	





④	21	PIER #2 FOUNDATIONS	6253-C
②	20	MISCELLANEOUS DETAILS	6234-C
	19	LIGHTING	6178-C
	18	BRIDGERAIL	S-986-71
	17	F.C. GIRDER FASCIA	S-1071


N
℄ PIPELINES ④
10'-10"
℄ PIER #2
℄ EXISTING C.P.R. RAILWAY
℄ FUTURE RAILWAY
14'-0"
TEST HOLE #3
℄ PIER #3
℄ BRG. ABUT. #2
A 2
22'-0
18'-0
℄ C.D. ROAD
2'-6
1'-0
STA. 112+34.7 (NORTHBOUND) = 654+16.5 (C.D. ROAD)
18'-0
22'-0
40'-0 CLEAR RDWY
STA. 114+14.6
TEST HOLE
TOP OF SLOPE PROTECTION
STA. 111+75.6
ELEV. 2219.5
TOE OF SLOPE PROTECTION
STA. 112+47.1
ELEV. 2195.5
1'-6 TYP. EDGE OF CONCRETE SLOPE PROTECTION.
TEST HOLE #2A
CLEARANCE SIGN BRACKET PROVIDE 6-5/8" INSERT IN GIRDER FASCIA SEE DWG. NO. 6234-P.
④
PLAN
TOE OF SLOPE PROTECTION
STA. 114+50.5
ELEV. 2194.5
℄ PIER #1
℄ PIER #2
℄ PIER #3
60'-0
105'-0
105'-0
60'-0
3"
TOP OF FILL
STA. 111+60.97
ELEV. 2224.43
STA. 111+73.74
ELEV 2224.40
STA. 112+53.09
ELEV 2224.24
STA. 113+58.31
ELEV 2224.03
STA. 114+63.58
ELEV. 2223.82
-0.2% GRADE
NOTE:
GUARDRAIL BY OTHERS
TOP OF RAIL
ELEV. 2196.0
EXR
FIX
FIX
FIX
FIX
FIX
FIX



ELEVATION
1" = 20'

	SHEET NO.	DESCRIPTION	DWG. NO.
4	21	PIER #2 FOUNDATIONS	6253-C
2	20	MISCELLANEOUS DETAILS	6234-C
	19	LIGHTING	6178-C
	18	BRIDGERAIL	S-986-71
	17	F.C. GIRDER FASCIA	S-1071
	16	105'-0 TYPE F.C.-45" GIRDER (LT. WT.)	S-1074
	15	80'-0 TYPE F.C.-45" GIRDER (LT. WT.)	S-1079
	14	60'-0 TYPE F.C.-45" GIRDER (LT. WT.)	S-1078
	13	BAR LISTS	6137-C
	12	EXPANSION ASSEMBLY SHEET #2	6136-C
	11	EXPANSION ASSEMBLY SHEET #1	6135-C
	10	BEARINGS	6134-C
	9	DECK & MISCELLANEOUS	6133-C
	8	PIER SHEET #2	6132-C
	7	PIER SHEET #1	6131-C
	6	ABUTMENT SHEET #2	6130-C
	5	ABUTMENT SHEET #1	6129-C
	4	LAYOUTS	6128-C
	3	SITE PLAN	6127-C
	2	INFORMATION SHEET	6126-C
	1	GENERAL LAYOUT	6125-C

INDEX

NO.	DATE	DESCRIPTION	BY
5	84-02-01	AS CONSTRUCTED	K.D.
4	JAN 6/73	DRAWING ADDED & PIER #2 FOUNDATION	R.W.L.
3	DEC 4,72	SHELBY UNCONFINEDS ADDED	R.W.L.
2	DEC 4,72	DRAWING ADDED	R.W.L.
1	NOV 29,72	GENERAL REVISIONS	R.G.Q.

REVISIONS

APPROVED

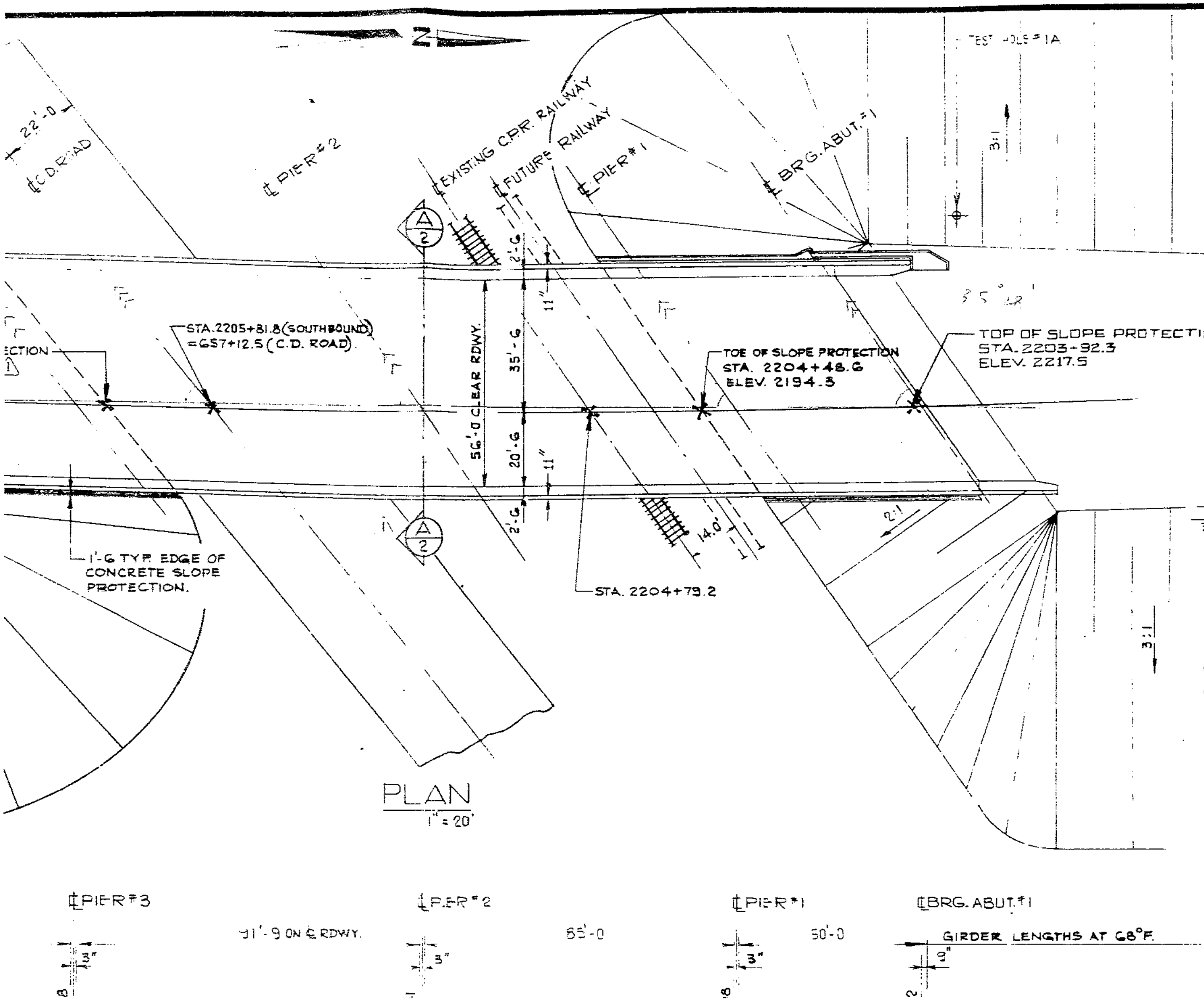
CHIEF BRIDGE ENGINEER

DATE Oct 30, 1972

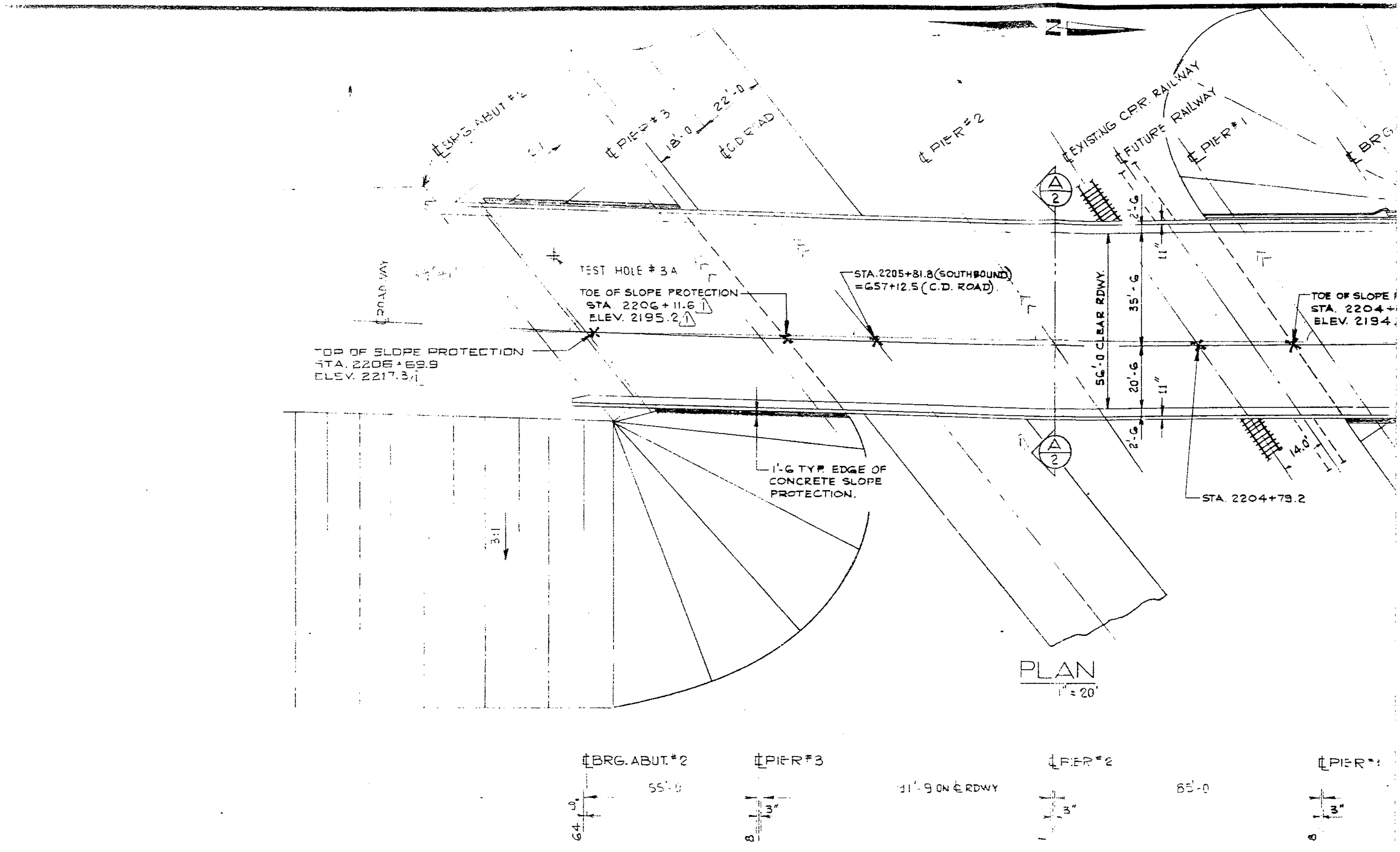
PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH

CLOVER BAR STRUCTURE #9
NORTHBOUND
GENERAL LAYOUT

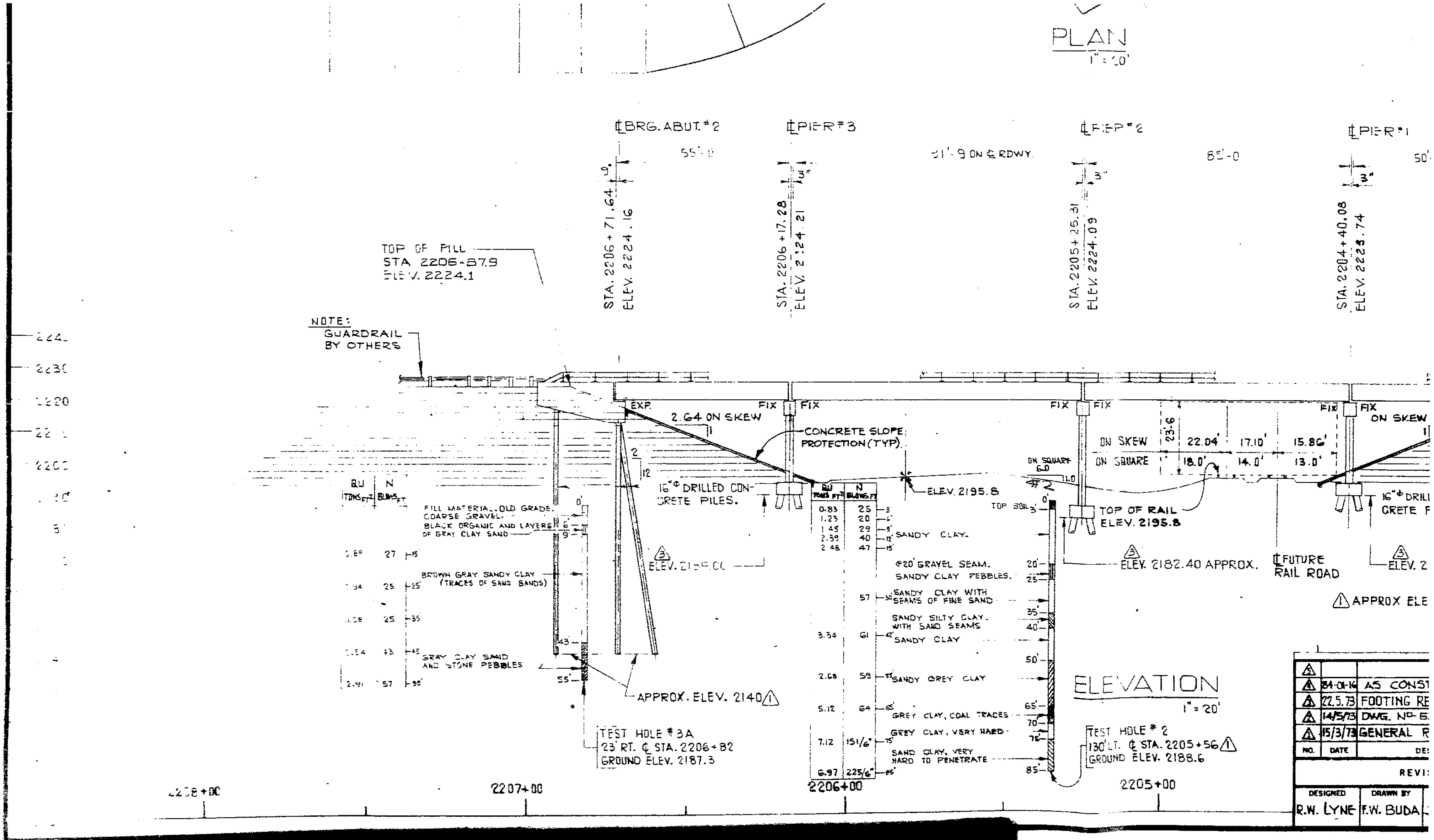
DESIGNED	DRAWN BY	DATE	CHECKED BY	DATE	STREAM	LOCATION	HWY. NO.	SCALE	FILE NO.	SHEET	DWG. NO.
R.W. LYNE	F.W. BUDA	AUG. /72		FEB /73	C.P.R. & HWY. #16A	N.W. 9-53-23-4	FIRST STREET	SHOWN	76650-N	1 of 21	6125-C

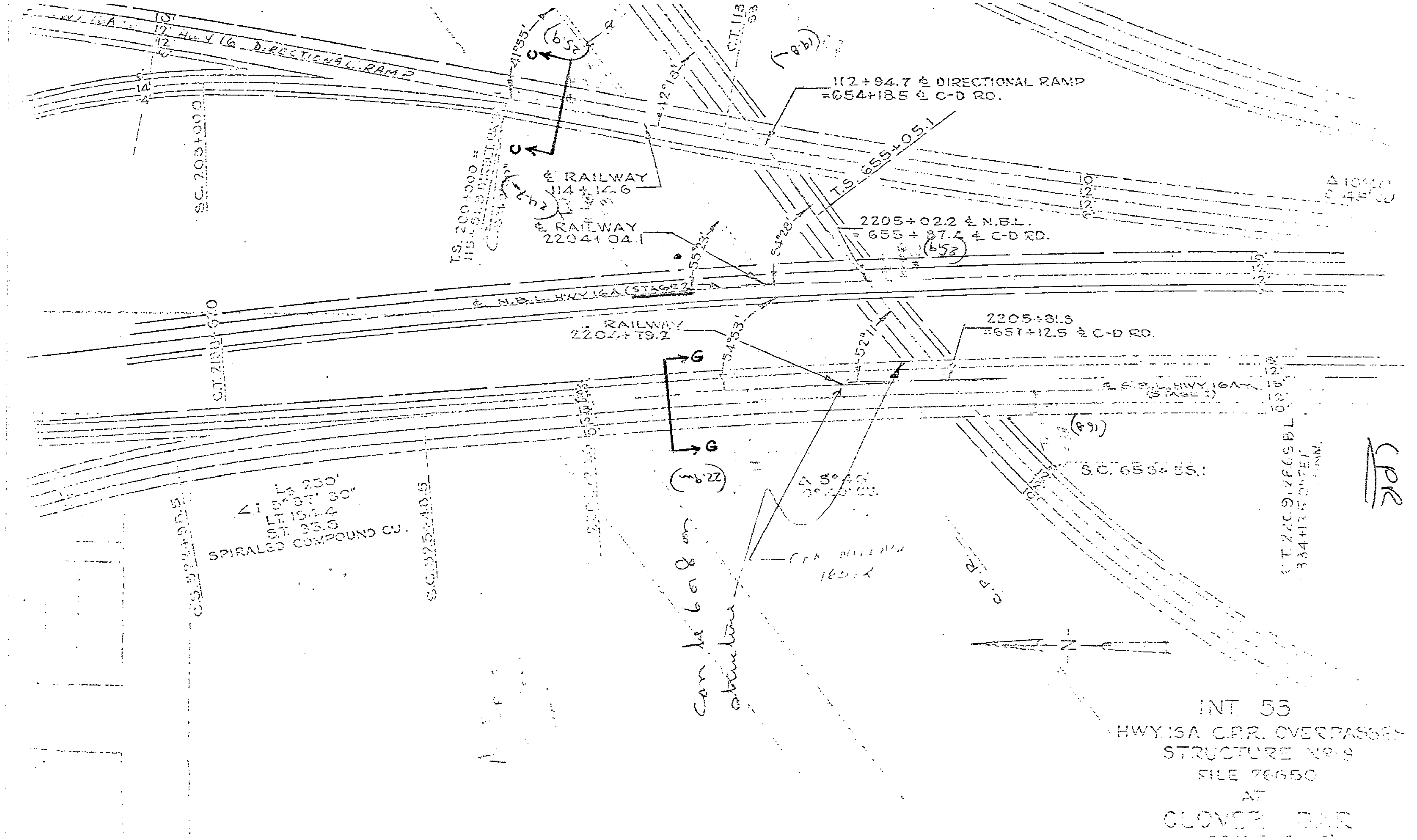


△2	23	PIER FOUNDATIONS	6306-C
△1	22	MISCELLANEOUS DETAILS	6235-C
	21	LIGHTING	6179-C
	20	BRIDGERAIL	S-986-71
	19	F.C. GIRDER FASCIA	S-1071
△1	18	95'-0 TYPE F.C.-41" GIRDER	S-922-73
△1	17	85'-0 TYPE F.C.-41" GIRDER	S-884-72
△1	16	55'-0 TYPE F.C.-41" GIRDER	S-878-72
△1	15	50'-0 TYPE F.C.-41" GIRDER	S-877-72
	14	BAR LISTS	6150-C
	13	EXPANSION ASSEMBLY SHEET #2	6149-C
	12	EXPANSION ASSEMBLY SHEET #1	6148-C
	11	BEARINGS	6147-C
	10	SPAN #3 - GIRDER PLAN	6146-C
	9	DECK & MISCELLANEOUS	6145-C
	8	PIER SHEET #2	6144-C
	7	PIER SHEET #1	6143-C
	6	ABUTMENT SHEET #2	6142-C
	5	ABUTMENT SHEET #1	6141-C
	4	LAYOUTS	6140-C


N
℄ BRG. ABUT #2
℄ PIER #3
18'-0
22'-0
℄ C.D. ROAD
℄ PIER #2
℄ EXISTING C.P.R. RAILWAY
℄ FUTURE RAILWAY
℄ PIER #1
℄ BRG.
A 2
℄ ROADWAY
TEST HOLE # 3A
TOE OF SLOPE PROTECTION
STA. 2206+11.6 1
ELEV. 2195.2 1
STA. 2205+81.8 (SOUTHBOUND) =657+12.5 (C.D. ROAD)
TOP OF SLOPE PROTECTION
STA. 2206+69.9
ELEV. 2217.3 1
2'-6
11"
35'-6
56'-0 CLEAR RDWY.
20'-6
11"
2'-6
TOE OF SLOPE
STA. 2204+
ELEV. 2194.
14.0'
STA. 2204+79.2
1'-6 TYP. EDGE OF CONCRETE SLOPE PROTECTION.
3:1
℄ BRG. ABUT. #2
℄ PIER #3
℄ PIER #2
℄ PIER #1
55'-0
81'-9 ON ℄ RDWY.
85'-0
3"
3"
3"
64'-0"
8
8

PLAN
1" = 20'


PLAN
1" = 20'
℄ BRG. ABUT. # 2
℄ PIER # 3
℄ PIER # 2
℄ PIER # 1
55'-0
81'-9 ON ℄ RDWY.
85'-0
50'
STA. 2206 + 71.64
ELEV. 2224.16
STA. 2206 + 17.28
ELEV. 2224.21
STA. 2205 + 25.31
ELEV. 2224.09
STA. 2204 + 40.08
ELEV. 2223.74
3"
TOP OF FILL
STA 2206-87.9
ELEV. 2224.1
NOTE:
GUARDRAIL
BY OTHERS
2240
2230
2220
2210
2200
EXP.
FIX
FIX
FIX
FIX
FIX
FIX
2.64 ON SKEW
1
2
12
CONCRETE SLOPE
PROTECTION (TYP)
16"Φ DRILLED CONCRETE PILES.
ELEV. 2195.8
ON SKEW
ON SQUARE
23.6
22.04'
17.10'
15.86'
18.0'
14.0'
13.0'
ON SQUARE 6.0
1.0
TOP OF RAIL
ELEV. 2195.8
ELEV. 2182.40 APPROX.
℄ FUTURE RAIL ROAD
ON SKEW
16"Φ DRILLED CONCRETE
ELEV. 2
APPROX ELE
ELEV. 2159.00
APPROX. ELEV. 2140
qu TONS FT²
N BLOWS FT
FILL MATERIAL, OLD GRADE, COARSE GRAVEL.
BLACK ORGANIC AND LAYERS OF GRAY CLAY SAND
BROWN GRAY SANDY CLAY (TRACES OF SAND BANDS)
GRAY CLAY SAND AND STONE PEBBLES
TEST HOLE # 3A
23' RT. ℄ STA. 2206 + 82
GROUND ELEV. 2187.3
SANDY CLAY.
@20' GRAVEL SEAM.
SANDY CLAY PEBBLES.
SANDY CLAY WITH SEAMS OF FINE SAND
SANDY SILTY CLAY. WITH SAND SEAMS
SANDY CLAY
SANDY GREY CLAY
GREY CLAY, COAL TRACES
GREY CLAY, VERY HARD
SAND CLAY, VERY HARD TO PENETRATE
TOP SOIL
TEST HOLE # 2
130' LT. ℄ STA. 2205 + 56
GROUND ELEV. 2188.6
0.83 25
1.23 20
1.45 29
2.39 40
2.48 47
57
3.34 61
2.68 59
5.12 64
7.12 151/6"
6.97 225/6"
ELEVATION
1" = 20'
2208+00
2207+00
2206+00
2205+00
84-01-14 AS CONST
22.5.73 FOOTING RE
14/5/73 DWG. No. 6
15/3/73 GENERAL R
NO. DATE
REVI
DESIGNED
DRAWN BY
R.W. LYNE
F.W. BUDA



INT 55

HWY 15A C.P.R. OVERPASSES

STRUCTURE No 9

FILE 79650

AT

CLOVER BAR

B.F. 1025-65

Bridge File: 76650

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project C.P.R. OVERPASS on Highway 16-2
Site 2205 + 35
Sample
Location 31' LT. ℄ North Bound Lane
Hole #2 Depth 85'
Technician Prelusky Date Sept. 8/69

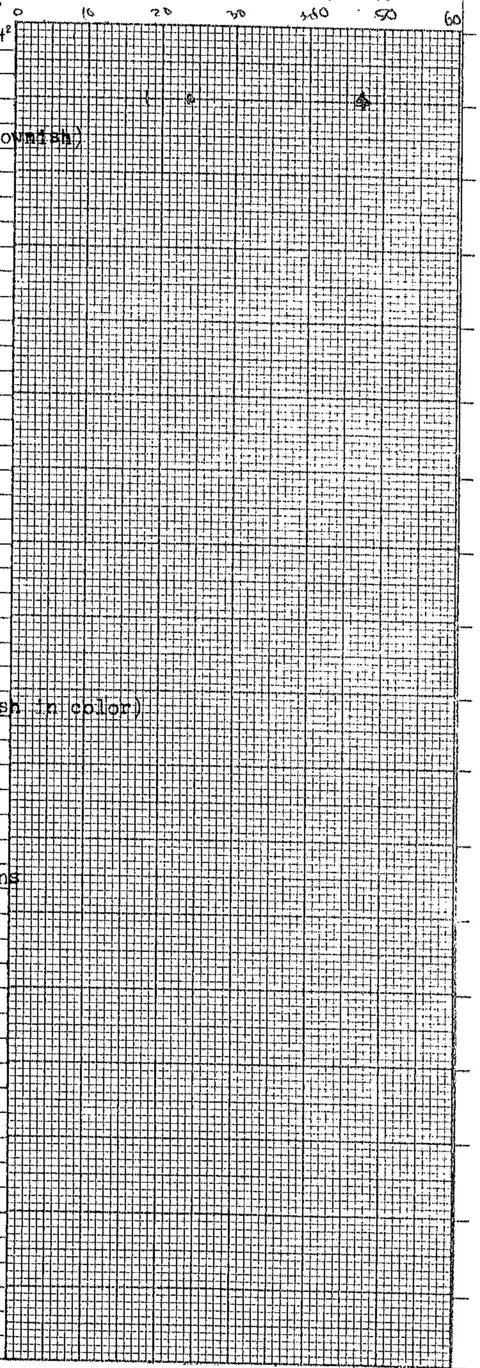
Elevation of Ground Surface (Zero Depth) 2188.6
Elevation of Water Table
Method of Advancing Hole
Remarks 0' - 9' Dry Auger
9' - 85' Wet Drill

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²
0'			0' - 2.5' Top-soil		
			2.5' - 3' sandy clay(wet)		
3'			Pen. @ 3' 6 17 31	25	
			6" 12" 18"	12"	
			sandy clay with sand seams (brownish)		
6'			Pen. @ 6' 7 14 27	20	
			6" 12" 18"	12"	
			sandy clay		
9'			Pen. @ 9' 7 17 36	29	
			6" 12" 18"	12"	
			sandy clay		
12'			Pen. @ 12' 10 30 50	40	
			6" 12" 18"	12"	
			sandy clay with sand seams		
15'			Pen. @ 15' 12 31 59	47	
			6" 12" 18"	12"	
18'			sandy clay (grey)		
	20'		@ 20' gravel seam 20' - 20.5'		
21'					
			sandy clay (pebbles)		
24'					
	25'		Shelby @ 25'		
27'					
			sandy clay (seams of sand whitish in color)		
30'			Pen. @ 30' 21 49 78	57	
			6" 12" 18"	12"	
33'			Fine sand		
	35'		Shelby @ 35' @35' sandy clay begins		
36'					
			35'-40' sandy silty clay with sands seams.		
39'					
	40'		40'-42' sand seam		
			@42' clay, sandy clay		
42'			Pen. @ 42' 14 36 75	61	
			6" 12" 18"	12"	
45'			clay, sandy clay		
48'			clay, sandy clay		
	50'		Shelby @ 50'		
51'					
54'			sandy grey clay		

MOISTURE CONTENT - %



DEPTH IN FEET

H.R.B.F. 1025-65

Bridge File: 76650

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project C.P.R. OVERPASS on Highway 16-Z
Site 2205 + 35
Sample
Location 31' Lt. C North Bound Lane
Hole #2 Depth 85'
Technician Prelusky Date Sept 8/69

Elevation of Ground Surface (Zero Depth)
Elevation of Water Table
Method of Advancing Hole
Remarks

LEGEND
Liquid Limit .... △
Field Moisture .. ○
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
56'	55'		Pen. @55' 15 37 74			
			6" 12" 18"	12"		
57'						
			sandy grey clay			
60'			Shelby @ 60'			
63'			grey clay			
	65'		Pen. @ 65' 17 42 81	64		
66'			6" 12" 18"	12"		
			grey clay (coal traces)			
69'						
	70'		Shelby @ 70'			
72'						
			grey clay (very hard)			
75'			Pen. @ 75' 59 210	151		
			6" 12"	6"		
78'			sand clay(very hard to penetrate)			
81'						
			" "			
84'						
85'			Pen. @ 85' 95 320	225		
			6" 12"	6"		

DEPTH IN FEET

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

11 Peno. Samples

Project: 76650 Hwy. 16Z

Technician: W.W.

Site: C.P.R. Overpass

Date: Sept. 8 & 9, 1969.

SAMPLE NO'S 10^5 +

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39643	2	3	0.75	M	M	N	lt.brown	above	M	silty sandy clay	CL:CI	2.72
39644	2	6	1.1	M	M	N	lt.brown	above	M	sandy clay pebbles	CL:CI	2.72
39645	2	9	1.2	M	M	N	lt.brown	above	M	"	CL:CI	2.72
39646	2	12	2.0	M	M	N	lt.brown	above	M	"	CL:CI	2.72
39647	2	15	1.75-1.9	M	M	N	dk.brown	above	M	"	CL:CI	2.72
39648	2	30	0.1	G	L	N	lt.brown	above	L	uniform sand	SU	2.68
39649	2	42	2.75	M	M	N	dk.grey	+ to above	M	sandy clay pebbles	CL:CI	2.72
39650	2	55	2.1	M	M	N	dk.grey	+ to above	M	"	CL:CI	2.72
39651	2	65	4.1	M	M	N	dk.grey	opt. +	M	"	CI	2.72
39652	2	75	4.5+	M	D	N	dk.grey	- to below	H	large pebbles clay	CH	2.75
39653	2	85	4.5+	M	D	N	lt.grey	opt. -	M	fine sandy bentonite	CI	2.72

Remarks

Hole #2 - 2205+35 3'lt ℄ N.B. Lane

HRBF. 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

5 Shelby Samples

Project: 76650 Hwy. 16Z Technician: W.W.

Site: C.P.R. Overpass Date: September 8th, 1969

Sample No. SAMPLE NOS	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39632	2	25	4.25	M	M	N	dk.grey	opt.	M	sandy clay pebbles	CI	2.72
39633	2	35	0.8	G	M	N	lt.grey	opt.+	L	clayey sand	SC	2.68
39634	2	50	2.25	M	M	N	dk.grey	above	M	pebbles sandy clay	CI	2.72
39635	2	60	3.0	M	M	N	dk.grey	opt.+	M	sandy clay pebbles	CI	2.72
39636	2	70	no rdg.	M	L	N	dk.grey	above	M-H	silty clay	CI:CH	2.75

Rema[illegible] Hole #2 2205+35 3'lt of N.B. Lane

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76650

DATE: September 8 & 9, 1969

ENGINEER: A. Weber

Edmonton

REMARKS: C.P.R. Overpass - Clover Bar

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39643	PENO. TUBES	2205+35	3'LT ℄ of N.B. LANE HOLE#2	3'	100	99.9	92	67	47.5	17.9	29.6	CI	23.7	19	106	low	sandy clay
39644				6'	99.4	99	93	59	31.6	12.8	18.8	CL	18.4	13	120	med.	sand, clay
39645				9'	100	99	93	61	32.0	12.9	19.1	CL	17.6	13	120	med.	sand, clay
39646				12'	99.9	98.7	92	58	33.5	13.3	20.2	CL	16.2	13	119	med.	sand, clay
39647				15'	93	92	86	57	33.5	13.0	20.5	CL	16.1	13	120	med.	sand, clay
39648				30'	100	99.9	81				trace	SU	17.1			med.	uniform sand
39649				42'	99.5	98	92	63	35.0	13.0	22.0	CI	13.5	13	120	med.	sandy clay
39650				55'	99	98	94	66	34.2	12.5	21.7	CL:CI	15.1	13	120	med.	sandy clay
39651				65'	99.9	99.4	95	83	47.8	14.0	33.8	CI	17.2	16	112	low	sandy clay
39652				75'	77	76.9	76		65.3	21.5	43.8	CH	19.6	23	98	low	clay
39653				85'		100	99.5	50	46.5	17.0	29.5	CI	15.9	18	108	med.	clayey sand bentonite trace

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76650

DATE: September 8th, 1969

ENGINEER: A. Weber

Edmonton

REMARKS: CPR Overpass - Clover Bar

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39632	Shelby Tubes	2205+35	3' Lt ℄ of NB Lane Hole #2	25'	97.3	97.2	90	61	33.3	14.1	19.2	CL:CI	12.7	14			sand, clay
39633				35'	100	99.7	99.4	77			trace	ML	17.9				silty fine sand
39634				50'	99.7	99	95	70	36.1	15.5	20.6	CI:CL	15.9	16			sandy clay
39635				60'	98.3	97.6	95	73	47.4	16.6	30.8	CI	19.4	17			sandy clay
39636				70'	100	99.9	98.4		56.9	26.1	30.8	CH	31.3	27			silt, clay

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76650 LOCATION: C.P.R. Overpass Hwy. 16Z

DATE: September 8 & 9, 1969 REMARKS: A. Weber. Pentrometer Samples

Specific Gravities Estimated for % Saturation

SAMPLE SAMPLE No. 10+	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39643	2	3	24.0	23.7	91.2	90.2	0.83	0.75	Flow and 50° shear	Vane shear - 0.35 TSF
39644	2	6	18.7	18.4	97.3	96.2	1.23	1.1	Flow	Vane shear - 0.55 TSF
39645	2	9	17.8	17.6	93.4	90.8	1.45	1.2	Flow	Vane shear - 0.61 TSF
39646	2	12	16.5	16.2	95.2	93.4	2.39	2.0	Flow and 47° shear	Vane shear - 1.15 TSF
39647	2	15	16.5	16.1	94.8	92.8	2.48	1.8	Flow	Vane shear - 1.10 TSF
39648	2	30	No unconfine - sand					0.1		
39649	2	42	13.8	13.5	92.7	90.8	3.34	2.75	Flow	Vane shear - 1.32 TSF
39650	2	55	15.3	15.1	96.6	95.2	2.68	2.1	Flow	Vane shear - 1.17 TSF
39651	2	65	17.9	17.2	97.1	93.3	5.12	4.1	46° shear	Vane shear - 2.25 TSF
39652	2	75	19.9	19.6	91.9	90.3	7.12	4.5+	60° shear	Vane shear - 2.5 + TSF
39653	2	85	16.3	15.9	93.1	90.9	6.97	4.5+	Cone shear	

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76650 LOCATION: C.P.R. Overpass

DATE: September 8th, 1969 REMARKS: A. Weber. Shelby Samples

Specific gravities estimated for % saturation

SAMPLE
RCS

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39632	2	25	no unconfine - pebbly					4.25		vane shear - 2.12 TSF
39633	2	35	18.2	17.9	92.6	90.8	1.04	0.8	69° shear	
39634	2	50	16.4	15.9	93.0	90.3	2.67	2.25	flow and 47° shear	vane shear - 1.30 TSF
39635	2	60	19.7	19.4	96.8	95.2	3.33	30	47° shear	vane shear - 1.55 TSF
39636	2	70	no unconfine - disturbed							

H.R.B.F. 1025-65

Bridge File: 76650

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project C.P.R. OVERPASS on Highway 16-Z
Site 114 + 60
Sample
Location 85' Lt. ℄ North Bound Lane.
Hole #3 Depth 81'
Technician S.P. Date Sept. 17/69

Elevation of Ground Surface (Zero Depth) 2197.5
Elevation of Water Table
Method of Advancing Hole
Remarks dry auger 0.0' - 30.0'
wet drill30.0' - 81.0'

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
0'			0.0' - 0.5' top-soil			
			~~0.5' - 3.0' silty clay~~			
3'			Pen. @ 3' 10 27 41	31		
			6" 12" 18"	12"		
			silty clay			
6'			Pen. @ 6' 9 23 42	33		
			6" 12" 18"	12"		
			sandy clay , sand seams			
9'			Pen. @ 9' 8 21 41	33		
			6" 12" 18"	12"		
			sandy clay			
12'			Pen. @ 12' 10 23 44	34		
			6" 12" 18"	12"		
			sandy clay			
15'			Pen. @ 15' 11 29 51	40		
			6" 12" 18"	12"		
			@ 17' sandy clay, clay blue in color			
18'						
20'			Shelby @ 20' sand clay			
21'						
			sand clay			
24'						
25'			Pen. @ 25' 14 35 74	60		
			6" 12" 18"	12"		
27'						
			sandy clay , sand seams			
			@ 28.5' grey clay			
30'			Shelby @ 30'			
33'			grey clay			
			Pen.			
35'			~~Shelby~~ @ 35' 8 18 32	24		
36'			6" 12" 18"	12"		
			grey sandy clay			
39'						
40'			Shelby @ 40'			
42'			grey sandy clay			
45'			Pen. @ 45' 9 19 35	26		
			6" 12" 18"	12"		
48'			~~grey sandy clay to 49'~~			
49'			@ 49' gravel begins			
51'						
			gravel			
			gravel			
54'						

DEPTH IN FEET

H.R.B.F. 1025-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project
Site
Sample
Location
Hole #3 Depth 81'
Technician Date Sept. 17/69

Elevation of Ground Surface (Zero Depth)
Elevation of Water Table
Method of Advancing Hole
Remarks

LEGEND
Liquid Limit .... △
Field Moisture .. ○
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
54' 0			gravel			
57'			gravel			
60'			gravel			
63'			gravel			
66'			gravel			
69'			gravel to 69' @ 69' grey clay begins			
71'			Pen. @ 71' 112 275	163		
72'			6" 10.5"	4.5"		
			sandy clay			
75'			sandy clay			
78'			sandy clay			
			sandy clay			
81'			Pen. @ 81' 91 190 360	269		
			6" 12" 18"	12"		

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

10 Peno. Samples

Project: 76650

Technician:

Site: CPR Overpass - Hwy. 16Z

Date: September 17/69

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39935	3	3	4.5+	M	M	N	lt.brown	opt.-	M	silty clay pebbles	CL:CI	2.72
39936	3	6	3.1	M	M	N	lt.brown	opt.+	M	sandy clay pebbles	CL:CI	2.72
39937	3	9	3.0	M	M	N	lt.brown	opt.+	M	"	CL:CI	2.72
39938	3	12	2.25	M	M	N	lt.brown	opt.+	M	"	CL:CI	2.72
39939	3	15	1.5	M	M	N	lt.brown	opt.+	M	"	CL:CI	2.72
39940	3	25	4.5+	M	D	N	lt.b grey	opt.+	H	silty clay & bentonite	CH	2.75
39941	3	35	1.0	M	M	N	dk.grey	above	M	sandy clay pebbles	CI	2.72
39942	3	45	1.2-1.4	M	M	N	dk.grey	above	M	"	CI	2.72
39943	3	71	4.5+	S	D	N	dk.grey black	below	M-H	silty clay & coal	coal & CI:CH	2.75
39944	3	81	4.5+	M	D	N	lt.grey	below	H	silty clay bentonite & coal	CH	2.75

Remarks

Hole #3 114+60 85'lt ℄ N. Bound Land

HRBF 948-64

Province of Alberta

Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

7 Shelby Samples

Project: 76650

Technician: W.W.

Site: C.P.R. Overpass - Hwy. 16Z

Date: September 18th, 1969

SAMPLE NOS Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39924	3	20	2.25	M	D	N	lt.grey	opt.	M-H	sandy clay & bentonite	CI:CH	2.75
39925	3	30	4.5+	M	D	N	dk.grey	below	H	silty clay	CH	2.75
39926	3	40	1.25-1.6	M	M	N	dk.grey	above	M	sandy clay pebbles	CI	2.72
39927	4	20	4.5+	M	D	N	lt.brown	opt.	M-H	silty clay	CI:CH	2.75
39928	4	30	4.2	M	D	N	dk.grey	- to below	H	silty clay	CH	2.75
39929	4	40	4.5+	M	D	N	dk.grey	- to below	H	silty clay	CH	2.75
39930	4	55	4.5+	M	D	N	dk.grey	opt. +	M	sandy clay pebbles	CI	2.72

Remark Hole #3 114+60 85'ltt N. Bound Lane

HOLE #4 114+90 12'rtt N. Bound Lane

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76650
DATE: September 17th, 1969
ENGINEER: A. Weber
Edmonton
REMARKS: C.P.R. Overpass - Hwy. 16Z

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39935	PENO. TUBES	114+60	85' LT.℄ N.B. LANE HOLE #3	3'	96	95	93		52.8	18.3	34.5	CH	17.2	19			clay
39936				6'	96.7	96.2	91	62	33.8	13.2	20.6	CL:CI	14.1	14			sand, clay
39937				9'	99.5	99	93	59	31.1	12.6	18.5	CL	15.0	12			sand, clay
39938				12'	99	97	90	57	32.2	13.2	19.0	CL	15.9	13			sand, clay
39939				15'	99.9	99.7	99.4		38.9	14.6	24.3	CI	17.1	15			sand, clay
39940				25'		100	99.9	80	62.5	21.7	40.8	CH	22.5	23			clay
39941				35'	99.9	99.8	98	76	43.0	14.3	28.7	CI	20.0	15			sandy clay
39942				45'	99.5	99	95	74	42.8	13.6	29.2	CI	19.1	15			sandy clay
39943				71'		100	96		58.9	26.1	32.8	CH	19.9	27			silty clay, coal
39944				81'		100	99.9	78	57.4	19.3	38.1	CH	18.6	20			clay

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS

& Transport

SOILS INVESTIGATION

FILE: 76650

DATE: September 18th, 1969

ENGINEER: A. Weber

Edmonton

REMARKS: C.P.R. Overpass - Hwy. 16Z

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39924	SHELBY TUBES	114+60	85' LTE N.B. LANE.HOLE#3	20'	100	99.9	99.7	42	40.5	18.0	22.5	CI	17.6	18			sand, clay
39925				30'	100	99.9	99.7	86	72.7	22.8	49.9	CH	26.6	24			clay
39926				40'	99.5	98.8	94	70	41.2	13.3	27.9	CI	17.7	15			sandy clay
39927		114+90	12' RTE N.B. LANE HOLE #4	20'	100	100	99.8	74	49.8	19.4	30.4	CI:CH	19.4	20			sandy clay
39928				30'	100	100	99.9	98	56.9	24.5	32.4	CH	20.8	25			silty clay
39929				40'	99.9	99.9	99.8	87	67.0	24.2	42.8	CH	23.6	25			clay
39930				55'	97.2	96.5	91	68	42.2	16.6	25.6	CI	14.6	17			sandy clay

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
& Transport
TESTING LABORATORY

PROJECT: 76650

LOCATION: C.P.R. Overpass - Hwy 16Z

DATE: September 17th, 1969

REMARKS: A. Weber - Penetrometer Samples

Specific gravities estimated for % saturation.

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENET-RATION T/sq ft.	TYPE OF FAILURE	REMARKS
39935	3	3	17.5	17.2	83.8	82.7	6.02	4.5+	58° shear	vane shear - 2.5+ TSF
39936	3	6	14.4	14.1	90.8	88.9	3.00	3.1	53° shear	vane shear - 0.63 TSF
39937	3	9	15.5	15.0	93.7	91.2	2.99	3.0	shear	vane shear - 1.45 TSF
39938	3	12	16.2	15.9	98.0	96.2	2.61	2.25	47° shear	Vane shear - 1.32 TSF
39939	3	15	no unconfine - short sample					1.5		Vane shear - 0.87 TSF
39940	3	25	22.9	22.5	95.4	93.5		4.5+	48° shear	Vane shear - 2.5+TSF
39941	3	35	20.3	20.0	93.8	92.1	1.29	1.0	flow	Vane shear - 0.58 TSF
39942	3	45	19.5	19.1	95.6	93.8	1.63	1.3	flow	Vane shear - 0.72 TSF
39943	3	71	20.2	19.9	74.7	73.4	4.09	4.5+	shear	Partially disturbed
39944	3	81	19.1	18.6	89.4	87.3	10.30	4.5+	52° shear	

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76650 LOCATION: C.P.R. Overpass-Hwy. 16Z

DATE: September 18/69 REMARKS: A. Weber - Shelby Samples

Specific Gravities Estimated for % Saturation.

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39924	3	20	17.9	17.6	90.8	89.5	2.58	2.25	50° shear	Vane shear - 1.25 TSF
39925	3	30	26.9	26.6	91.5	90.5	2.56	4.5+	48° shear	Dist. sample
39926	3	40	18.1	17.7	94.9	92.9	1.77	1.25- 1.6	Flow	Vane shear - 1.12 TSF
39927	4	20	19.9	19.4	94.3	91.8	4.27	4.5+	57° shear	Vane shear - 2.5+TSF
39928	4	30	21.2	20.8	94.4	92.6	3.75	4.2	55° shear	Vane shear - 2.0 TSF
39929	4	40	23.6	23.6	93.3	93.0	1.27	4.5+	55° slide plane	
39930	4	55	14.9	14.6	93.8	91.9	5.00	4.5+	51° shear	Vane shear - 2.5+ TSF

H.R.B.F. 1025-65

Bridge File: 76650

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project C.P.R. OVERPASS on Highway 16-Z
Site 114 + 90
Sample
Location 12' Rt. ℄ North Bound Lane
Hole #4 Depth 85'
Technician S.P. Date Sept. 18/69

Elevation of Ground Surface (Zero Depth) 2201.5
Elevation of Water Table
Method of Advancing Hole
Remarks 0' - 30' dry auger
30' - 85' wet drill

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
0'			0.0' - 0.5' top-soil			
			0.5' - 3.0' silty clay			
3'			Pen. @ 3' 10 27 47	37		
			6" 12" 18"	12"		
			sandy clay (pebbles)			
6'			Pen. @ 6' 14 28 48	34		
			6" 12" 18"	12"		
			sandy clay(pebbles)			
9'			Pen. @ 9' 9 16 31	24		
			6" 12" 18"	12"		
			sandy clay (pebbles)			
12'			Pen. @ 12' 11 24 46	35		
			6" 12" 18"	12"		
			sandy clay, sand seams	(water seaping into hole		
15'			Pen. @ 15' 9 21 47	38		
			6" 12" 18"	12"		
18'			sandy clay			
20'			Shelby @ 20'			
21'			sandy clay, material is opt. *			
24'			clay			
25'			Pen. @ 25' 17 44 78	61		
			6" 12" 18"	12"		
27'			grey clay			
30'			Shelby @ 30'			
33'			clay , with coal seams@ 34'			
35'			Pen. @ 35' 25 60 117	92		
36'			6" 12" 18"	12"		
			grey clay with coal seams			
39'			38'-40' coal seam.			
40'			Shelby @ 40'			
42'			grey clay			
45'						
			grey clay			
48'						
50'			Pen. @ 50' 30 65 103	73		
51'			6" 12" 18"	12"		
			sandy clay, sand seams			
54'						

H.R.B.F. 1025-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project
Site
Sample
Location
Hole #4 Depth
Technician Date

Elevation of Ground Surface (Zero Depth)
Elevation of Water Table
Method of Advancing Hole
Remarks

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET

DEPTH IN FEET	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
54'0						
55			Shelby @ 55'			
57'			sandy clay			
59'			gravel begins @ 59'			
60'						
63'			gravel			
66'			gravel			
69'						
71			gravel ends @ 71' clay begins			
72'						
75'			Pen. @ 75' 13 42 119	106		(no recovery)
			6" 12" 18"	12"		
78'			clay			
81'			clay			
84'			clay			
85'			Pen. @ 85' 48 125 286	238		
			6" 12" 18"	12"		

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

9 Peno. Samples

Project: 76650

Technician: W.W.

Site: C.P.R. Overpass - Hwy. 16Z

Date: September 18th,1969

Sample No. SAMPLE NO'S 10 +	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39945	4	3	2.25-3.7	M	D	N	lt.brown	B	M	roots sandy clay	CL:CI	2.72
39946	4	6	4.2	M	D	N	lt.brown	opt.-	M	sandy clay	CL	2.70
39947	4	9	1.9	M	M	N	lt.brown	opt.+	M	sandy clay	CL:CI	2.72
39948	4	12	2.5	M	M	N	lt.brown	opt.+	M	sandy clay	CL:CI	2.72
39949	4	15	3.0	M	M	N	lt.brown	opt.+	M	sandy clay & sandstone	CL:CI	2.72
39950	4	25	4.5+	M	D	N	dk.grey	- to below	M-H	silty clay	CI:CH	2.75
39951	4	35	4.5+	M	D	N	dk.grey	- to below	M-H	silty clay	CI:CH	2.75
39952	4	50	3.25-4.0	M	D	N	dk.grey	opt. to -	M-H	silty clay	CI:CH	2.75
39953	4	85	4.5+	M	D	N	dk.grey	below	M-H	silty clay	CI:CH	2.75

Remarks: Hole #4 114+90 12'rt ℄ N. Bound Lane

HRBF 948-64

Province of Alberta
Department of Highways & Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

7 Shelby Samples

Project: 76650

Technician: W.W.

Site: C.P.R. Overpass - Hwy. 16Z

Date: September 18th, 1969

SAMPLE NOS Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	Massive Stratified Nugget Granular Other	Very Loose Loose Medium Dense Extremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
39924	3	20	2.25	M	D	N	lt.grey	opt.	M-H	sandy clay & bentonite	CI:CH	2.75
39925	3	30	4.5+	M	D	N	dk.grey	below	H	silty clay	CH	2.75
39926	3	40	1.25-1.6	M	M	N	dk.grey	above	M	sandy clay pebbles	CI	2.72
39927	4	20	4.5+	M	D	N	lt.brown	opt.	M-H	silty clay	CI:CH	2.75
39928	4	30	4.2	M	D	N	dk.grey	- to below	H	silty clay	CH	2.75
39929	4	40	4.5+	M	D	N	dk.grey	- to below	H	silty clay	CH	2.75
39930	4	55	4.5+	M	D	N	dk.grey	opt. +	M	sandy clay pebbles	CI	2.72

Remarks

Hole #3 114+60 85'ltE N. Bound Lane

HOLE #4 114+90 12'rtE N. Bound Lane

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
& Transport

SOILS INVESTIGATION

FILE: 76650

ENGINEER: A. Weber

DATE: September 18th, 1969

Edmonton

REMARKS: C.P.R. Overpass - Hwy. 16Z

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39945	PENO. TUBES	114 + 90	12' Rt. ℄ N.B. LANE HOLE #4	3'	99.9	98	93	66	33.7	13.1	20.6	CL:CI	9.1	13			sandy clay
39946				6'	98.3	97.5	91		32.8	12.5	20.3	CL	9.7	13			sandy clay
39947				9'	98.4	97.9	93	61	32.7	13.1	19.6	CL	16.5	13			sand, clay
39948				12'	100	99.5	96	61	47.5	16.4	31.1	CI	26.1	17			sand, clay
39949				15'	99.9	99.8	99	68	39.1	14.7	24.4	CI	20.5	15			sandy clay
39950				25'	100	100	99.9	92	55.6	19.3	36.3	CH	19.6	21			clay
39951				35'	100	100	99.9	98	63.5	21.4	42.1	CH	19.8	22			clay
39952				50'	100	99.9	99.9		117.4	28.4	89.0	CH	30.0	28			clay
39953				85'	100	99.9	99.5	97	65.2	21.1	44.1	CH	17.7	22			clay

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS

& Transport

SOILS INVESTIGATION

FILE: 76650

DATE: September 18th, 1969

ENGINEER: A. Weber

Edmonton

REMARKS: C.P.R. Overpass - Hwy. 16Z

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing				L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
					4	10	40	200									
39924	SHELBY TUBES	114+60	85' LTE N.B. LANE, HOLE#3	20'	100	99.9	99.7	42	40.5	18.0	22.5	CI	17.6	18			sand, clay
39925				30'	100	99.9	99.7	86	72.7	22.8	49.9	CH	26.6	24			clay
39926				40'	99.5	98.8	94	70	41.2	13.3	27.9	CI	17.7	15			sandy clay
39927		114+90	12' RTE N.B. LANE HOLE #4	20'	100	100	99.8	74	49.8	19.4	30.4	CI:CH	19.4	20			sandy clay
39928				30'	100	100	99.9	98	56.9	24.5	32.4	CH	20.8	25			silty clay
39929				40'	99.9	99.9	99.8	87	67.0	24.2	42.8	CH	23.6	25			clay
39930				55'	97.2	96.5	91	68	42.2	16.6	25.6	CI	14.6	17			sandy clay

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76650

LOCATION: C.P.R. Overpass - Hwy. 16Z

DATE: September 18, 1969

REMARKS: A. Weber - Penetrometer Samples

Specific gravities estimated for % saturation.

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
39945	4	3	no unconfine - disturbed					2.25-3.7		
39946	4	6	no unconfine - disturbed					4.2		
39947	4	9	16.9	16.5	93.3	91.5	2.00	1.9	50° cone shear	vane shear - 0.95 TSF
39948	4	12	26.5	26.1	96.8	95.3	2.33	2.5	52° shear	vane shear - 1.20 TSF
39949	4	15	21.0	20.5	97.0	94.8	3.33	3.0	50° shear	vane shear - 1.50 TSF
39950	4	25	19.9	19.6	90.4	88.9	2.97	4.5+	35° shear	disturbed sample
39951	4	35	20.0	19.8	91.2	90.1	5.10	4.5+	55° shear	
39952	4	50	31.0	30.0	93.8	91.1	2.47	3.25-4.0	56° shear	Vane shear - 1.50 TSF
39953	4	85	18.1	17.7	93.6	91.6	6.23	4.5+	60° shear	

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS & Transport
TESTING LABORATORY

PROJECT: 76650

LOCATION: C.P.R. Overpass-Hwy. 16Z

DATE: September 18/69

REMARKS: A. Weber - Shelby Samples

Specific Gravities Estimated for % Saturation.

SAMPLE NO. S	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ Kg sq cm	POCKET PENETRATION T sq ft	TYPE OF FAILURE	REMARKS
39924	3	20	17.9	17.6	90.8	89.5	2.58	2.25	50° shear	Vane shear - 1.25 TSF
39925	3	30	26.9	26.6	91.5	90.5	2.56	4.5+	48° shear	Dist. sample
39926	3	40	18.1	17.7	94.9	92.9	1.77	1.25- 1.6	Flow	Vane shear - 1.12 TSF
39927	4	20	19.9	19.4	94.3	91.8	4.27	4.5+	57° shear	Vane shear - 2.5+TSF
39928	4	30	21.2	20.8	94.4	92.6	3.75	4.2	55° shear	Vane shear - 2.0 TSF
39929	4	40	23.6	23.6	93.3	93.0	1.27	4.5+	55° slide plane	
39930	4	55	14.9	14.6	93.8	91.9	5.00	4.5+	51° shear	Vane shear - 2.5+ TSF

H.R.B.F. 1025-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project 73650 INT. 53
Site HWY 16A C.P.R. OVERPASS @ CLOVER BAR
Sample 1203+82 50' RT. ℄
Location
Hole 1A Depth 75'
Technician M.K Date OCT. 14/70

Elevation of Ground Surface (Zero Depth) 2193.4
Elevation of Water Table SEEPAGE @ 10' THROUGH SAND BANDS. No FREE WATER IN HOLE.
Method of Advancing Hole DRY AUGER 0'-52' WET 52' To 75'
Remarks SLIGHT RECOVERY IN SHELBY @ 45'. SHELBY WOULD NOT PENETRATE FORMATION. HIGH BLOW COUNT @ 47' DUE TO PEBBLES.
CAVING BETWEEN 53'-66'

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET

Blows N	Soil Profile	FIELD CLASSIFICATION	σ, kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %

0'
BROWN SANDY CLAY
SILT BANDS

SHELBY @ 5'

7
BROWN
SANDY CLAY SAND BANDS
FEW COAL CHIPS PEBBLES

PEN. 490 @ 10'
6" 12" 18"
4 13 23

SHELBY @ 15'

15
PEN 206 @ 20'
6" 12" 18"
9 26 51

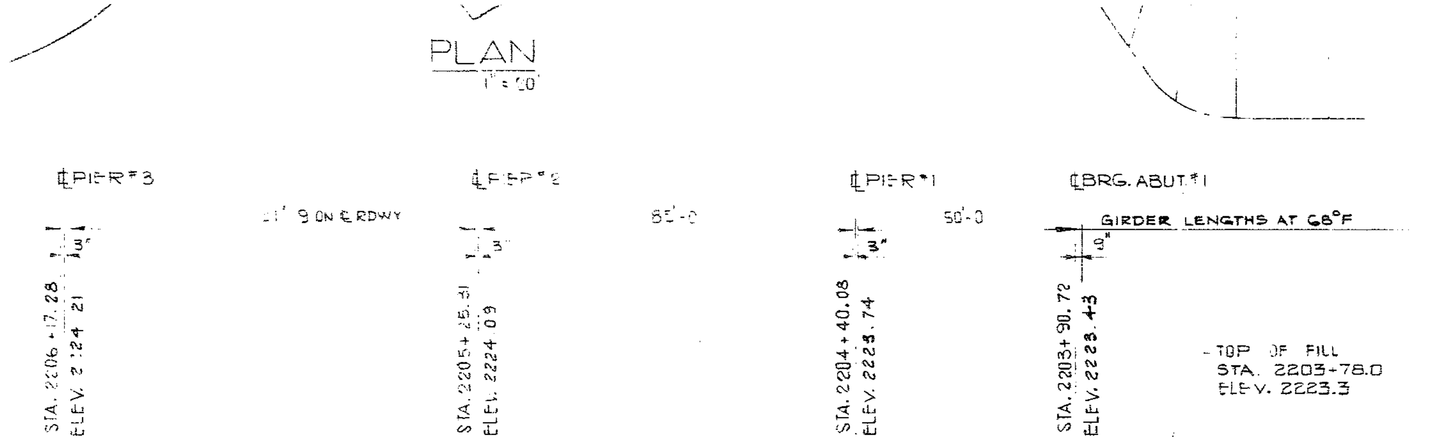
SHELBY @ 25'
BLUISH GREY FINE SAND
SILTY CLAY HIGHLY
PLASTIC

PEN. 21 @ 30'
[illegible]
[illegible]

31
[illegible]

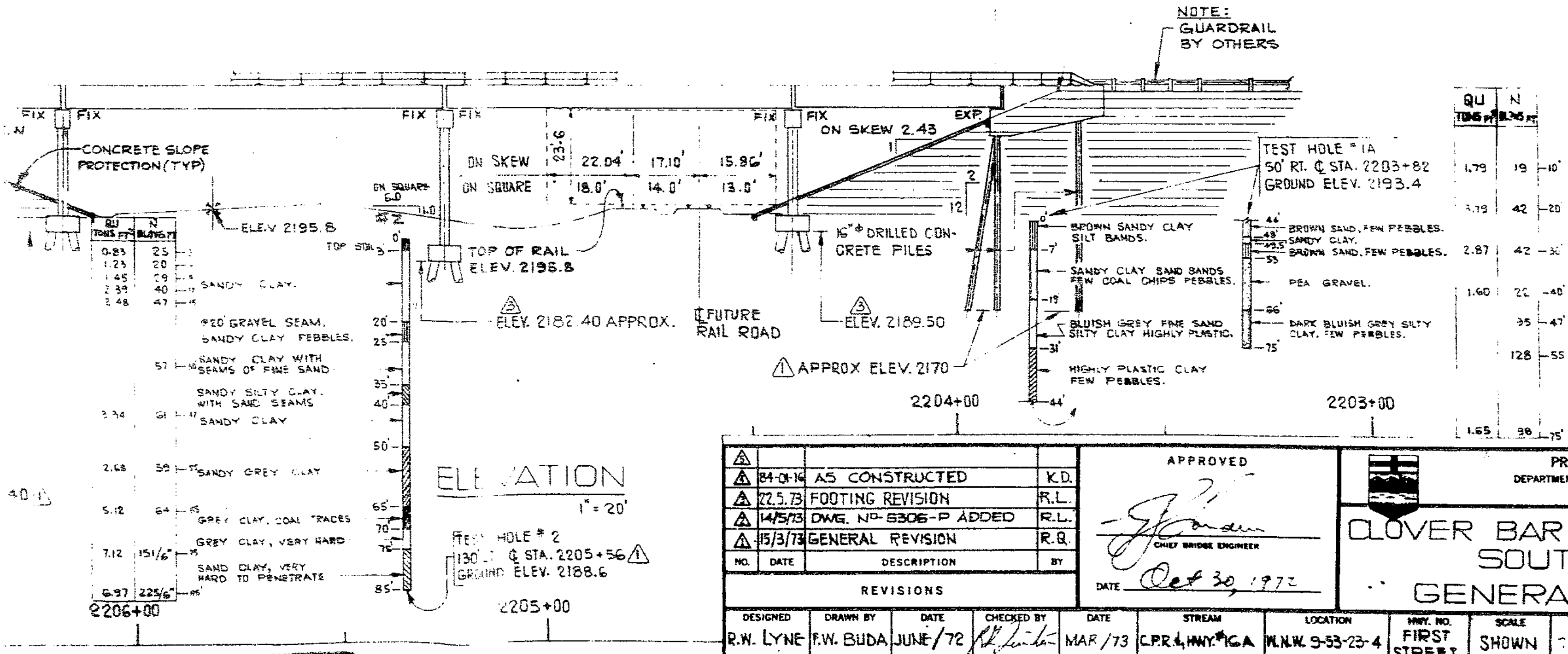
44'
[illegible]

DEPTH IN FEET



SHEET NO.	DESCRIPTION	DWG. NO.
14	BAR LISTS	6150-C
13	EXPANSION ASSEMBLY SHEET #2	6149-C
12	EXPANSION ASSEMBLY SHEET #1	6148-C
11	BEARINGS	6147-C
10	SPAN #3 - GIRDER PLAN	6146-C
9	DECK & MISCELLANEOUS	6145-C
8	PIER SHEET #2	6144-C
7	PIER SHEET #1	6143-C
6	ABUTMENT SHEET #2	6142-C
5	ABUTMENT SHEET #1	6141-C
4	LAYOUTS	6140-C
3	SITE PLAN	6127-C
2	INFORMATION SHEET	6139-C
1	GENERAL LAYOUT	6138-C

INDEX ⚠4



NO.	DATE	DESCRIPTION	BY
⚠5			
⚠4	84-01-16	AS CONSTRUCTED	K.D.
⚠3	22.5.73	FOOTING REVISION	R.L.
⚠2	14/5/73	DWG. No-5306-P ADDED	R.L.
⚠1	15/3/73	GENERAL REVISION	R.Q.

REVISIONS

APPROVED

CHIEF BRIDGE ENGINEER

DATE Oct 30, 1972

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH

CLOVER BAR STRUCTURE #9
SOUTHBOUND
GENERAL LAYOUT

DESIGNED	DRAWN BY	DATE	CHECKED BY	DATE	STREAM	LOCATION	HWY. NO.	SCALE	FILE NO.	SHEET	DWG. NO.
R.W. LYNE	F.W. BUDA	JUNE/72		MAR/73	C.P.R. & HWY. #16A	W.N.W. 9-53-23-4	FIRST STREET	SHOWN	75550-5	1 of 23	6138-C

H.R.B.F. 1025-65

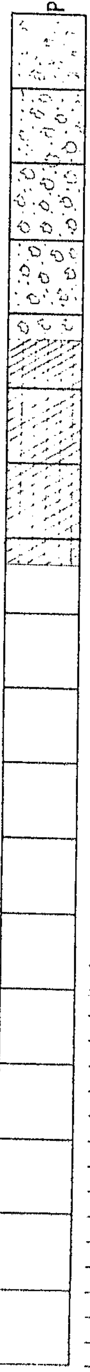
PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project 76650
Site
Sample
Location
Hole 1A Depth
Technician Date

Elevation of Ground Surface (Zero Depth)
Elevation of Water Table
Method of Advancing Hole
Remarks PEN @ 70' DISTURBED.

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET

Depth in feet	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
54 0			PEN. 32 @ 55' 6" 12" 18" 37 97 165 DENSE PEA GRAVEL			
66'			PEN. 448 @ 70' 6" 12" 16" 44 166 200 DARK BLUISH GREY SILTY CLAY FEW PEBBLES.			
75'			PEN. 183 @ 75' 6" 12" 18" 41 83 139			

Province of Alberta
Department of Highways
and Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

Shelby Samples

Project: BF 76650

Technician: TK & J

Site: Int. 53, Hwy. 16A CNR Overpass - Clover Bar

Date: Oct. 14/70

SAMPLE NO.S 10° +

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
43938	1	5	2.70	Massive	Med.	None	Lt. Brown	Opt. to +	Med.	Sandy clay	CI	2.75
43939		15	2.30	"	"	"	"	+	"	"	"	"
43940		25	4.5+	Nugget	Dense	"	Dk. Grey	-	High	Clay	CH	"
43941		35	1.70	Massive	Med.	"	"	Above	Med.	Sandy clay	CI	"
43942		45	2.00	Granular	Loose	"	Lt. Brown	-	Trace	Sand	S	2.67

Remarks: Hole # 1 - 2203 + 82 50' Rt.
Note: Shelby 45' Disturbed

HRBF 948-64

Province of Alberta

Department of Highways
and Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

[illegible] Samples

Project: 76650

Technician: TK & J

Site: Int. 53, Hwy. 16A, CPR Overpass - Clover Bar

Date: Oct. 14/70

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
SAMPLE NO'S 10° +			Pocket Penetration T/ft.^{2}	Massive Stratified Nugget Granular Other	Very Loose Loose Medium Dense Extremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
48932	1	10	2.40	Massive	M-D	N	Lt. Brown	+	Med.	Sandy clay	CI	2.75
48933		20	4.00	"	D	N	Dk. "	Opt.	Med.-high	Silty clay	CI-CH	"
48934		30	[illegible].50	"	M-D	N	"	Opt. to above	High	Clay	CH	"
48935		40	2.00	"	D	"	Dk. Grey	Above	Med.	Sandy clay	CI	"
48936		47	4.5+	[illegible]	ED	"	Lt. Brown	Below	Nil	Sand	S	2.67
48937		50	"	"	"	"	"	"	"	"	"	"

Remarks: Hole # 1 - 22.3 + 02 - 50' Lt. S

HRBF 948-64

Province of Alberta
Department of Highways
and Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

[illegible] Samples

Project: HF 76650 Technician: TK & J

Site: Int. 53, Hy. 16A C/B Overpass - Clover Bar Date: Oct. 14-15/70

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
SAMPLE NOS 1974			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
43951	1	55	-	G	D	N	Dk.Brown	Opt.+	Nil	Gravel	[illegible]	2.67
43952		70	4.5+	O	"	"	"	Opt.	High	Silty clay Coal	CH	2.75
43953		75	4.5+	M	"	"	Dk.Grey	Opt.	"	Clay	"	"

Remarks: Hole # 1, 2203 + 82 - 50' Rt 6

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: SF 70650

DATE: Oct. 14/70

ENGINEER: A. Weber

Head Office

REMARKS: Int. 53, Hwy. 16 A, CPR Overpass Clover Bar
[illegible]

Sample No. 10³ +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
48938		2203 + 82	50' Rt. [illegible] 1	5	99.8	99	93	64	31.9	11.6	20.3	CL	17.5	13	119	med.	Fine sand, clay
48939		"	"	15	99.8	99	95	64	38.5	13.9	24.6	CI	19.5	14	118	med.	"
48940		"	"	25	100	99.9	99.8	90	60.5	25.1	35.4	CH	24.1	26	93	low	Clay
48941		"	"	35	99.8	99.2	95	72	37.4	12.8	24.6	CI	19.5	13	119	med.	Sandy clay
48942	Sample Dis- turbed	"	"	45	88	85	40	6			trace	SW	5.2			low	Sand

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: HF 76650

DATE: Oct. 14/70

ENGINEER: A. Weber

Head Office

REMARKS: Int. 53, Hwy. 16A, CPR Overpass Clover Bar

Area

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
48932	400	2203 +62	30' Lt. H # 1	10	100	99.5	93	62	30.5	12.6	17.9	CL	16.9	13	121	med.	fine sand, clay
48933	206	"	"	20		100	99.9	76	58.5	19.5	39.0	CH	24.8	21	102	low	sandy clay
48934	62	"	"	30		100	99.3	96	74.6	28.1	46.5	CH	30.7	29	91	lo	clay
48935	22	"	"	40	100	99.4	95	72	40.6	12.7	27.9	CL	19.5	13	119	low	sandy clay
48936	403	"	"	47	100	99.9	88	5			trace	SU	3.3			low	uniform fine sand
48937	11	"	"	50		100	81	8			trace	SU	4.0			low	"

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: HF 76650

DATE: Oct. 14-15/70

ENGINEER: L. Ober

Head Office

REMARKS: Int.53, Hwy. 16A CNR Overpass Clover Bar
[illegible]

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
43951	50	2203 + 02	50' Rt H # 1	55	75	70	34				trace	GP	10.6			neg.	sand, gravel
43952	[illegible]	"	"	70	100	99.9	92		58.1	30.1	28.0	CH	25.2	30+	88	low	silty clay, coal
43953	73	"	"	75		100	99.9		67.0	21.9	45.1	CH	27.2	33	97	low	clay

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS and Transport
TESTING LABORATORY

PROJECT: 76650

LOCATION: Int. 53, Hwy. 16A
CPR Overpass Clover Bar

DATE: Oct. 14/70

REMARKS: 4. ober-Shelby samples

Specific Gravity Estimated for Percentage Saturation

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
43938	1	5	17.3	17.2	90.4	89.1	2.46	2.7	56° Shear	Vane Shear - 1.37 TSF
43939		15	19.5	19.3	94.7	93.7	1.72	2.3	Flow	Vane Shear - 1.25 TSF
43940		25	24.1	23.9	90.0	89.2	0.87	4.5+	67° Shear	Slide Plane and Disturbance
43941		35	19.5	19.3	94.9	93.7	1.41	1.7	Flow	Vane Shear - 1.00 TSF
43942		45	No Unconfine - Sand					2.0		

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS and Transport
TESTING LABORATORY

PROJECT: 76650

LOCATION: Int. 53, Hwy. 16A
CN Overpass Clover Bar

DATE: Oct. 14/70

REMARKS: A. Weber - Penetrometer Samples

Specific Gravity Estimated for Percentage Saturation

SAMPLE No. 10⁶ +	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg sq cm	POCKET PENET-RATION T sq ft.	TYPE OF FAILURE	REMARKS
48932	1	10	16.9	16.6	93.0	91.4	1.79	2.40	Flow	Vane Shear - .87 T.F.
48933		20	24.8	24.5	94.4	93.0	3.79	4.0	56° Shear	Vane Shear - 2.[illegible] T.F.
48934		30	30.7	30.2	98.6	97.0	[illegible].87	2.5	45° Shear	
48935		40	19.9	19.1	94.3	92.7	1.60	2.0	Flow	Vane Shear - 1.[illegible] T.F.
48936		47	No Unconfine - Sand					4.5+		
48937		50	No Unconfine - Sand					4.5+		

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
and Transport
TESTING LABORATORY

PROJECT: 76650

LOCATION: Int. 53, Hwy 16A
CPR Overpass @ Clover Bar

DATE: Oct. 14-15/70

REMARKS: A. Weber - Penetrometer Samples

Specific Gravity Estimated for Percentage Saturation

SAMPLE NOS 10° +	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
48951	1	55	No Unconfine - Gravel							
48952		70	No Unconfine - Disturbed Sample					4.5+		
48953		75	27.2	26.9	99.6	98.4	1.65	4.5+	56° Shear	Slightly Dessicated and Disturbed

H.R.B.F. 1025-65

SHEET 2 OF 2

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project 76650
Site
Sample
Location
Hole 2A Depth
Technician Date

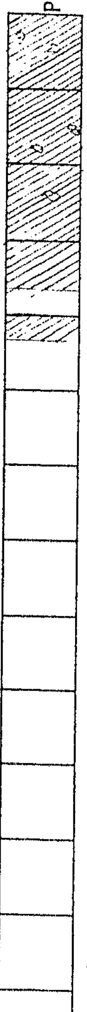
DEPTH IN FEET

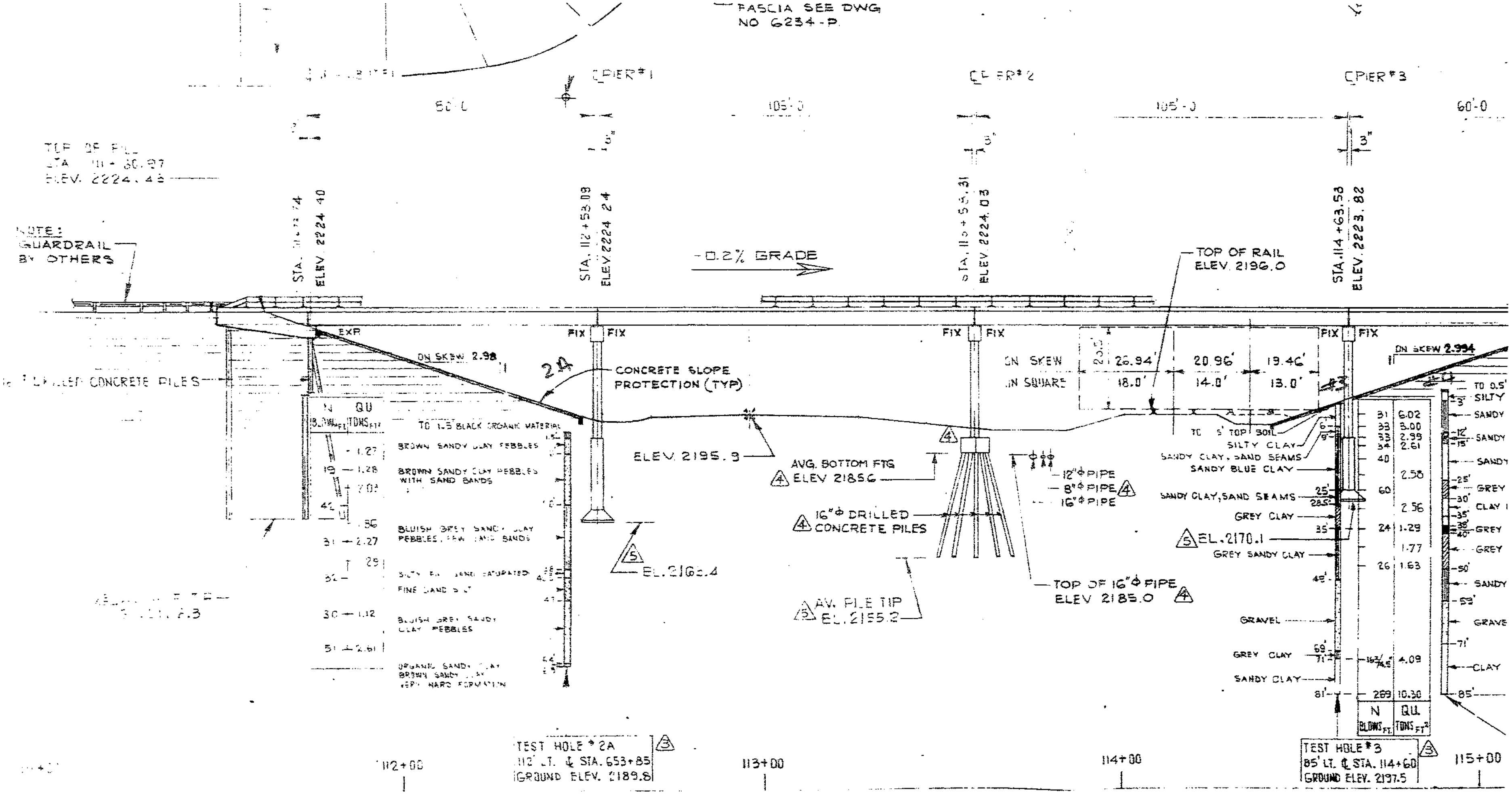
Elevation of Ground Surface (Zero Depth)
Elevation of Water Table
Method of Advancing Hole
Remarks

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET

Depth	Blows N	Soil Profile	FIELD CLASSIFICATION	σ kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
54' 0						
			SHELBY @ 55'			
			BLUISH GREY SANDY CLAY PEBBLES			
			PEN. 398 @ 60' 6" 12" 18" 17 40 68			
64			ORGANIC SANDY CLAY			
65			SHELBY @ 65'			
			BROWN SANDY CLAY · OPT			
			VERY HARD FORMATION			





ELEVATION

1" = 20'

5	84-02-0[illegible]	AS CONSTRUCTED
4	JAN[illegible]	DRAWING ADDED & P
3	DEC4,72	SHELBY UNCONFINE
2	DEC4,72	DRAWING ADDED
1	NOV[illegible]72	GENERAL REVISI
NO.	DATE	DESCRIPTIO

REVISIONS

DESIGNED	DRAWN BY	DATE
R.W. LYNE	F.W. BUDA	AUG. /

HRBF 948-64

Province of Alberta
Department of Highways
and Transport

7 [illegible] Samples

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

Project: 7650

Technician: TK

Site: Hwy. 16A O/H Overpass @ Clover Bar

Date: Oct. 16/70

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
SAMPLE NOS 10° +			Pocket Penetration T/ft.^{2}	Massive Stratified Nugget Granular Other	Very Loose Loose Medium Dense Extremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
43984	2	5	2.3	Massive	Med.	None	Lt. Brown	Opt. to +	Med.	Sandy clay	CI	2.75
43985	"	15	2.4	"	"	"	"	Opt.	"	"	"	2.73
43986	"	25	2.2	"	"	"	Med. Brown	Opt. +	"	"	"	2.75
43987	"	35	2.2	"	"	"	"	"	"	"	"	"
43988	"	44	-	"	Loose	"	Med. Grey	Wet	Low	Clayey fine sand	CL	"
43989	"	55	1.2	"	Med.	"	"	Above	Med.	Sandy clay	CI	"
43990	"	65	1.7	"	"	"	Dk. Grey	+	Med.	"	"	"

Remarks: Location: 112' [illegible] 5

HRBF 948-64

Province of Alberta
Department of Highways
and Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

5 [illegible] Samples

Project: 76650

Technician: TK

Site: Hwy. 16A CPR Overpass - Clover Bar

Date: Oct. 16/70

SAMPLE NO'S 10° +

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
48979	2	10	1.3	Massive	Med.	None	Lt. Brown	Above	Med.	Sandy clay	CI	2.75
48980	"	20	2.0	"	"	"	Med. Brn.	+	"	"	"	"
48981	"	30	2.0	"	"	"	"	+ to Above	"	"	"	"
48982	"	50	1.2	"	"	"	"	Above	"	"	"	"
48983	"	60	2.7	"	"	"	"	Opt. to +	"	"	"	"

Remarks: Location 112 ' Lt. 6

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: F 75650
DATE: Oct. 16/70
ENGINEER: A. eber
Head Office
REMARKS: Hwy. 16A CPR. Overpass Clover Bar
AUGER 3

Sample No. 10⁵ +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
43984			112°16 & [illegible] 2	5	99	98	82	62	36.4	13.9	22.5	CL-CI	18.9	14	117		sand, clay
43985			"	15	99.9	99.4	92	58	27.9	11.9	16.0	CL	16.1	11	123		fine sand, clay
43986			"	25	99.6	98.5	93	72	38.9	13.0	25.9	CI	20.6	14	118		sandy clay
43987			"	35	99.8	96.7	94	72	43.5	14.2	29.3	CI	19.6	15	115		sandy clay
43988			"	44	100	99.8	98	40	16.6		trace	SF	22.5				silty fine sand
43989			"	55	100	99	94	72	39.3	13.0	26.3	CI	22.1	14	116		sandy clay
43990			"	65	99.5	98	94	74	42.2	14.6	27.6	CI	18.9	14	115		sandy clay

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: # 76650
DATE: Oct. 16/70
ENGINEER: [illegible] eber
Head Office
REMARKS: Hwy 16A CPR Overpass Clover Bar
[illegible]

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
48979			112' Lt & H / 2	10	100	99.4	95	71	33.9	13.6	20.3	CL-CI	20.1	13	119		sandy clay
48980			"	20	78.6	78	70		29.0	11.9	17.1	CL	14.8	11	122		sand, clay gravel
48981			"	30	99.9	99.4	95	69	39.5	14.0	25.5	CI	18.5	15	116		sandy clay
48982			"	50	100	99.9	97	74	44.0	14.5	29.5	CI	22.9	15	125		sandy clay
48983			"	60	99.4	98.8	95	70	38.5	13.4	25.1	CI	16.7	14	118		sandy clay

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
and Transport
TESTING LABORATORY

PROJECT: 76650

LOCATION: Hwy 16A CPR Overpass Clover Bar

DATE: Oct. 16/70

REMARKS: A. Weber - Shelby Samples

Specific Gravity Estimated for Percentage Saturation

SAMPLE NO:S 10+

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg/sq cm	POCKET PENETRATION T/sq ft.	TYPE OF FAILURE	REMARKS
48984	2	5	18.9	18.7	91.0	89.9	1.27	2.3	68° Shear	Slightly Disturbed Vane Shear - 1.07 TSF
48985		15	16.1	15.5	92.4	89.3	2.03	2.4	Flow	Vane Shear - 0.92 TSF
48986		25	20.0	19.7	90.0	88.6	1.86	2.2	Flow	Vane Shear - 1.02 TSF
48987		35	19.6	19.5	92.9	92.1	1.29	2.2	Flow	Vane Shear - 1.07 TSF
48988		44	No Unconfine - Wet and Disturbed							
48989		55	No Unconfine - Short & Disturbed					1.2		Vane Shear - 0.50 TSF
48990		65	No Unconfine - Short & Disturbed					1.7		Vane Shear - 0.90 TSF

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

and Transport

PROJECT: 76650

LOCATION: Hwy. 16A
CPR Overpass Clover Bar

DATE: Oct. 16/70

REMARKS: A. Weber - Penetrometer Samples

Specific Gravity Estimated for Percentage Saturation

SAMPLE NO'S SAMPLE No. 10	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg sq cm	POCKET PENETRATION T sq ft.	TYPE OF FAILURE	REMARKS
48979	2	10	20.1	19.9	99.0	97.7	1.28	1.3	Flow	Vane Shear - 0.35 TSF
48980		20	No Unconfined - Short Sample					2.0		Vane Shear - 0.35 TSF
48981		30	18.5	18.1	95.4	93.4	2.27	2.0	Flow	Vane Shear - 1.05 TSF
48982		50	22.9	22.6	97.2	95.9	1.12	1.2	Flow	Vane Shear - 0.[illegible] TSF
48983		60	16.7	16.3	93.5	91.2	2.61	2.7	Flow	Vane Shear - 1.[illegible]0 TSF

AB

H.R.B.F. 1025-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TEST HOLE LOG

Project 76650
Site HWY 16A C.P.R. OVERPASS
~~Sample~~ STRUCTURE № 9 CLOVER BAR
Location STA. 2206+82 23' RT ℄
Hole # 3 (A) Depth 0 - 55'
Technician KOLODYCHUK Date OCT 30/70

Elevation of Ground Surface (Zero Depth) 2187.3
Elevation of Water Table 2175.3
Method of Advancing Hole DRY AUGER TO 55'
Remarks

LEGEND
Liquid Limit .... △
Field Moisture .. ⊙
Plastic Limit .... *

DEPTH IN FEET

Depth	Blows N	Soil Profile	FIELD CLASSIFICATION	σc kg/cm²	P.P. T/ft²	MOISTURE CONTENT - %
0						
			FILL MATERIAL			
			OLD GRADE			
			COARSE GRAVEL			
6			BLACK ORGANIC & LAYERS OF			
			GRAY CLAY SAND CPT +			
9 10			SHELBY @ 10'			
			BROWN GRAY SANDY CLAY			
			(SATURATED)			
15	27		PEN. @ 15' PEN. № 259			
			5/6" - 15/12" - 32/18"			
			BROWN GRAY SANDY CLAY & SAND BANDS			
20			SHELBY @ 20'			
			BROWN GRAY SANDY CLAY & FEW STONES			
			BELOW (SATURATED)			
25	25		PEN. @ 25' PEN. № 453			
			6/6" - 14/12" - 31/18"			
			GRAY CLAY SAND WITH STONE PEBBLES (SATURATED)			
30			SHELBY @ 30'			
			GRAY CLAY SAND WITH STONE PEBBLES &			
			TRACES OF SAND BANDS (SATURATED)			
35	25		PEN. @ 35' PEN. № 560			
			7/6" - 13/12" - 32/18"			
			GRAY SILTY FINE SAND (SATURATED)			
40			SHELBY @ 40'			
			POOR SAMPLE HOLE CAVING @ 38			
43						
45	43		PEN. @ 45' PEN. № 571			
			13/6" - 31/12" - 56/18"			
			GRAY CLAY SAND & STONE PEBBLES CPT. +			
50			SHELBY @ 50'			
55	57		PEN. @ 55' PEN. № 70			
			[illegible]" - 41/12" - [illegible]/18"			
			GRAY SANDY CLAY CPT +			

DEPTH IN FEET

HRBF 948-64

Province of Alberta
Department of Highways and Transport

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

BLOCKS Samples

Project: IF 76350

Technician: TK

Site: Hwy. 16A CPR Overpass, Str. # 9 - Clover Bar

Date: Oct. 30/70

SAMPLE NO'S 10^4 +

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	**M**assive **S**tratified **N**ugget **G**ranular **O**ther	**V**ery **L**oose **L**oose **M**edium **D**ense **E**xtremely **D**ense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
49196	3	10	1.4	Massive	Dense	None	Lt. Grey	+	Med.-High	Silty clay	CI:CH	2.75
49197		20	1.5	"	"	"	Lt. Brown	"	Med.	Sandy clay	CI	"
49198		30	4.5+	"	"	"	Dk. Grey	-	"	"	"	"
49199		40	0.9	"	Medium	"	"	Above	Med.-High	Silty clay	CI:CH	"
49200		50	0.5	"	"	"	Lt. Brown	Above-wet	Med.	Sandy clay	CI	"

Remarks: Hole # 3 2206+02 13' Lt.

HRBF 948-64

Province of Alberta
Department of Highways ~~and Transport~~

VISUAL IDENTIFICATION OF UNDISTURBED SOIL SAMPLES

[illegible] Samples

Project: F 76650 Technician: TE

Site: Hwy. 16-14 Overpass Site # 9 . Clover Bar Date: Oct. 30/70

SAMPLE NO'S 10° +

Sample No.	Hole No.	Depth Ft.	Consistency	Structure	Relative Density	Odor	Color	Moisture Content	Plasticity	Description	Cassagrande Classification	Est. Spec. Gravity
			Pocket Penetration T/ft.^{2}	Massive Stratified Nugget Granular Other	Very Loose Loose Medium Dense Extremely Dense	Strong Medium None	Lt. Brown Dk. Brown Lt. Grey Dk. Grey Black Other	Dry Below Opt. Opt. - Optimum Opt. + Above Opt. Wet	Low Medium High			
49191	3	15	1.1	Massive	Medium	None	Lt. brown	+	Medium	Sandy clay	CI	2.75
49192		25	0.8	"	"	"	Dk. grey	+ to above	"	"	"	"
49193		35	0.6	"	"	"	"	Above	Med. to H.	Silty sandy clay	CI-CH	2.75
49194		45	2.0	"	Dense	"	"	+	Medium	Sandy clay	CI	"
49195		55	3.7	"	"	"	"	+	"	"	"	"

Remarks: Hole J-3 2206 + 02 23' Lt. 5

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: F 7050

DATE: Oct. 30/70

ENGINEER: [illegible]

Head Office

REMARKS: Hwy. 16X Grd Overpass Str. 9 [illegible] Clover Bar
[illegible]

Sample No. 10⁵ +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
49196		[illegible]	23' Lt. [illegible]	10	100	99.7	95	72	49.8	15.4	34.4	[illegible]:CH	21.3	17	111		sandy clay
49197		"	"	20	99.5	98.4	91	58	33.9	12.7	21.2	CL:CL	17.6	13	120		sand, clay
49198		"	"	30	97.2	98.4	93	62	35.8	12.4	23.4	CL:CL	11.9	13	120		sand, clay
49199		"	"	40	98.4	98	96	84	32.0	15.3	16.7	CL	22.9	15	114		silty clay, fine sand
49200		"	"	50	99	97	71	60	33.3	12.8	20.5	CL:CL	20.4	13	120		sand, clay

HRBF 1178/68

PROVINCE OF ALBERTA

DEPARTMENT OF HIGHWAYS
and Transport

SOILS INVESTIGATION

FILE: T 76650
DATE: Oct. 30/70
ENGINEER: A. Eber
Head Office
REMARKS: Hwy. 16A CPR Overpass Str. # 9 Clover Bar
H2104's

Sample No. 10^5 +	Bag or Jar No	Station	Loc.	Depth Below Grade	Sieve No. % Passing 4	10	40	200	L.L.	P.L.	P.I.	Classification	Field Moist %	Est. Opt. Moist	Est. Proct. Dens.	Pot. Frost Action	Remarks
49191	259	236+82	23' Lt. H.D	15	99.5	99	94	57	30.7	13.0	17.7	CL	18.5	12	121		fine sand, clay
49192	453	"	"	25	99.5	98.4	93	63	34.6	12.7	21.9	CL:CI	19.0	13	120		fine sand, clay
49193	[illegible]	"	"	35		100	99.9	97	32.6	17.4	15.2	[illegible]	24.5	17	110		silt, sandy clay
49194	371	"	"	45	99.9	99.5	96	73	44.6	13.4	31.2	CI	18.7	15	117		sandy clay
49195	70	"	"	55	99.9	99	95	61	37.5	12.6	24.9	CI	17.2	14	119		fine sand, clay

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

PROJECT: 76650

LOCATION: Hwy 16A
C.P.R. Overpass-Site 9 - Clover Bar and Transport

DATE: Oct. 30/70

REMARKS: 4. ebar-Shelby Sample

Specific Gravity Estimated for Percentage Saturation

SAMPLE NO'S 10 +

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg sq cm	POCKET PENETRATION T sq ft.	TYPE OF FAILURE	REMARKS
49196	5	10	21.3	21.0	96.4	95.2	1.05	1.4	Flow	Vane Shear - 0.85 TSF
49197		20	17.6	17.3	91.4	90.0	1.22	1.2	Flow	Vane Shear - 0.[illegible] TSF
49198		30	11.9	11.4	84.9	81.0	0.27	4.5+	Flow	
49199		40	22.9	22.5	99.1	97.3	0.63	0.9	Flow	Vane Shear - 0.[illegible] TSF
49200		50	21.4	20.3	99.8	99.0	0.35	0.5	Flow	Vane Shear - 0.35 TSF

SUMMARY OF UNCONFINED COMPRESSION TESTS

HRBF 957-65

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
TESTING LABORATORY

PROJECT: 76650

LOCATION: Hwy 16A

and Transport

DATE: Oct. 30/70

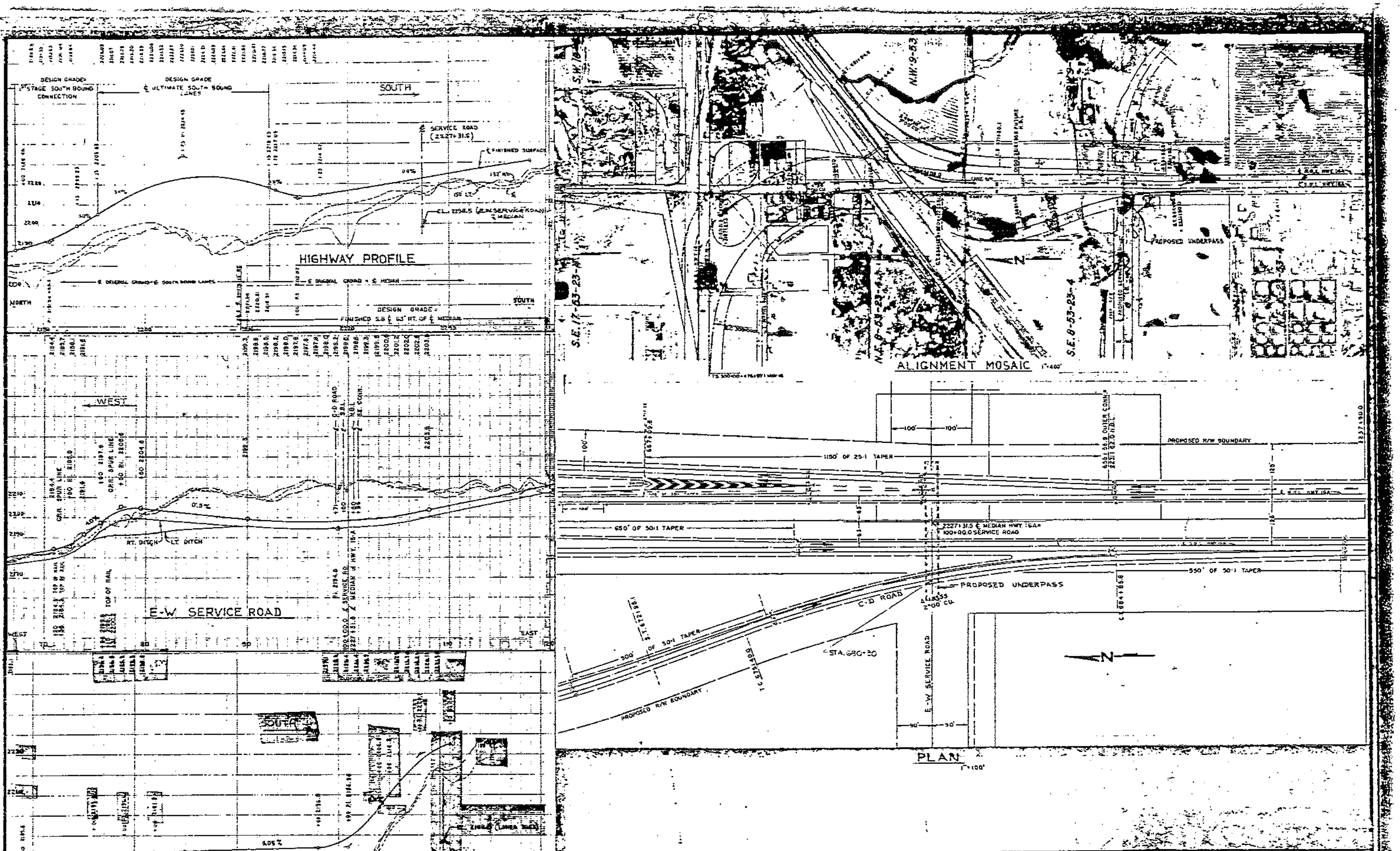
REMARKS: C.P.R. Overpass-Site # 9 Cloverbar
[illegible] ober– [illegible]trometer Samples

Specific Gravity Estimated for percentage saturation

SAMPLE No. 5
10⁵ +

SAMPLE No.	HOLE No.	DEPTH feet	MOISTURE BEFORE %	MOISTURE AFTER %	SATURATION BEFORE %	SATURATION AFTER %	σ_1 Kg sq cm	POCKET PENETRATION T sq ft.	TYPE OF FAILURE	REMARKS
49191	3	15	18.5	18.2	87.3	86.5	0.88	1.1	Flow	Vane Shear - 0.75 TSF
49192		25	19.0	18.7	98.7	97.2	0.94	[illegible]	Flow	Vane Shear - 0.45 TSF
49193		35	24.5	24.2	99.7	98.2	0.58	0.6	Flow	Vane Shear - 0.37 TSF
49194		45	18.7	18.3	99.2	96.9	1.54	2.3	Flow	Vane Shear - 1.[illegible] TSF
49195		55	17.2	16.7	97.3	94.7	2.91	3.[illegible]	Flow	Vane Shear - 1.7 TSF

BF77416



APPROVED
CHIEF BRIDGE ENGINEER
DATE Jan 29, 1973

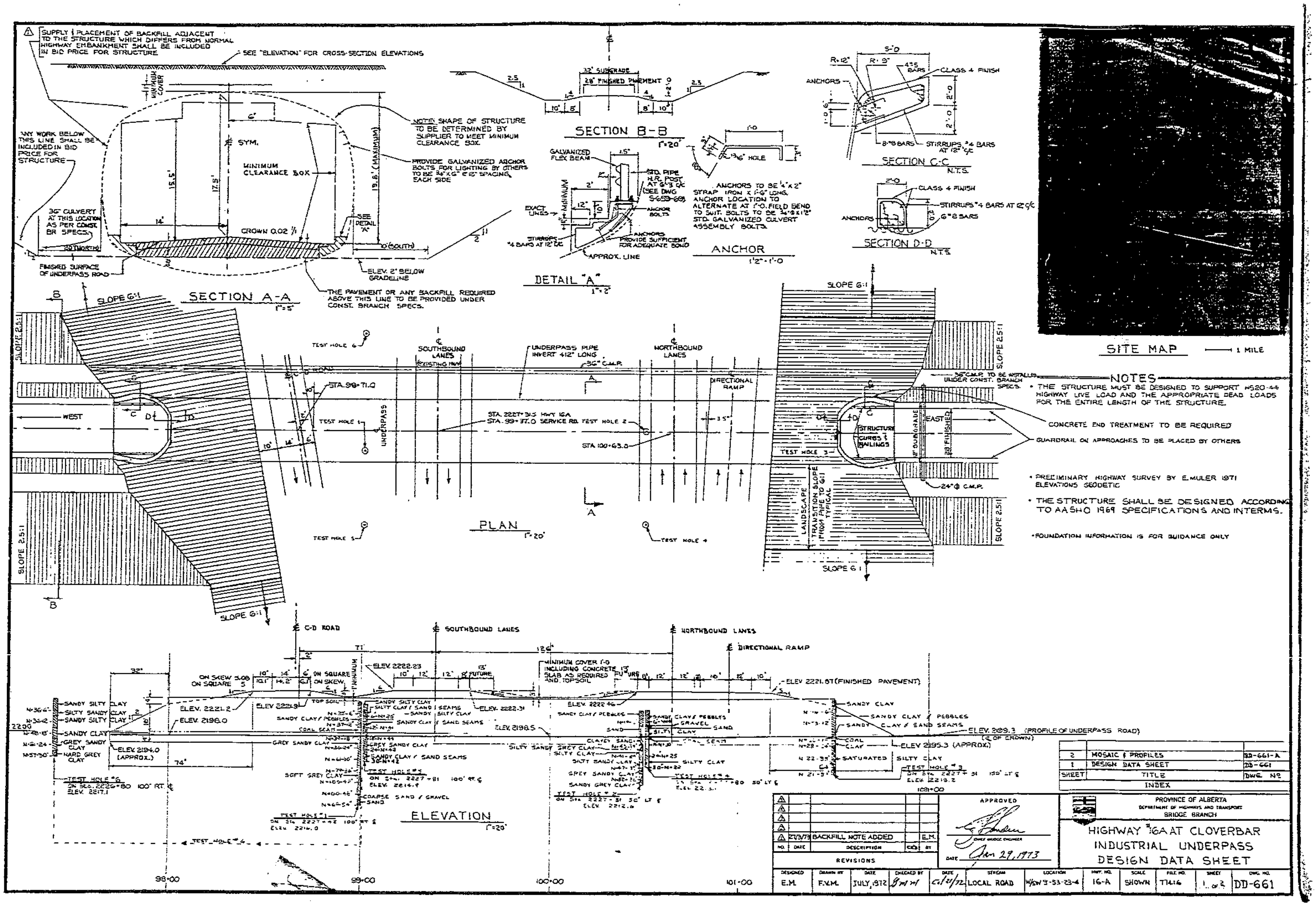
PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH

HIGHWAY 16A AT CLOVERBAR
INDUSTRIAL UNDERPASS
MOSAIC & PROFILES

NO.	DATE	DESCRIPTION	CKD.	BY
REVISIONS				

DESIGNED	DRAWN BY	DATE	CHECKED BY	DATE	STREAM	LOCATION	HWY. NO.	SCALE	FILE NO.	SHEET	DWG. NO.
E.M.	F.M.M.	JULY, 1972	[illegible]	12/7/72	LOCAL ROAD	NW 3-53-23-4	16-A	SHOWN	11416	2 of 2	DD-661A

DD-661A



NOTES

- THE STRUCTURE MUST BE DESIGNED TO SUPPORT HS20-44 HIGHWAY LIVE LOAD AND THE APPROPRIATE DEAD LOADS FOR THE ENTIRE LENGTH OF THE STRUCTURE.

CONCRETE END TREATMENT TO BE REQUIRED

GUARDRAIL ON APPROACHES TO BE PLACED BY OTHERS

- PRELIMINARY HIGHWAY SURVEY BY E. MULER 1971 ELEVATIONS GEODETIC
- THE STRUCTURE SHALL BE DESIGNED ACCORDING TO AASHO 1969 SPECIFICATIONS AND INTERMS.
- FOUNDATION INFORMATION IS FOR GUIDANCE ONLY

INDEX

SHEET	TITLE	DWG. No
1	DESIGN DATA SHEET	DD-661
2	MOSAIC & PROFILES	DD-661-A

REVISIONS

NO.	DATE	DESCRIPTION	CK'D	BY
⚠	27/3/73	BACKFILL NOTE ADDED		E.M.

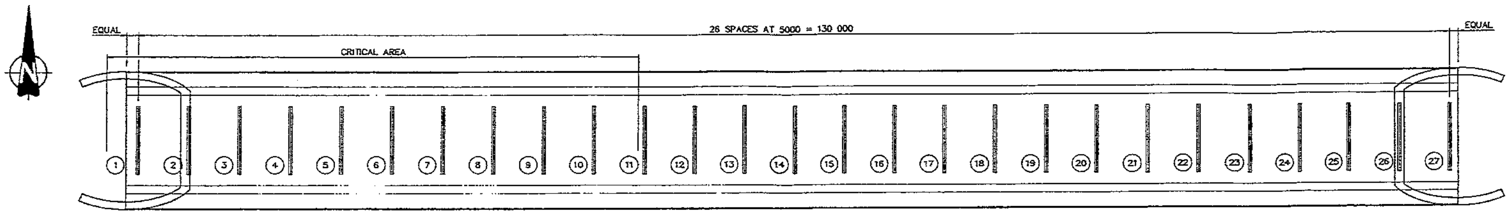
APPROVED
CHIEF BRIDGE ENGINEER
DATE Jan 29, 1973

PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS AND TRANSPORT
BRIDGE BRANCH

HIGHWAY #16A AT CLOVERBAR INDUSTRIAL UNDERPASS DESIGN DATA SHEET

DESIGNED	DRAWN BY	DATE	CHECKED BY	DATE	STREAM	LOCATION	HWY. NO.	SCALE	FILE NO.	SHEET	DWG. NO.
E.M.	F.V.M.	JULY, 1972	9m m	6/21/72	LOCAL ROAD	W/SW 3-53-23-4	16-A	SHOWN	T1416	1 of 2	DD-661

DD-661

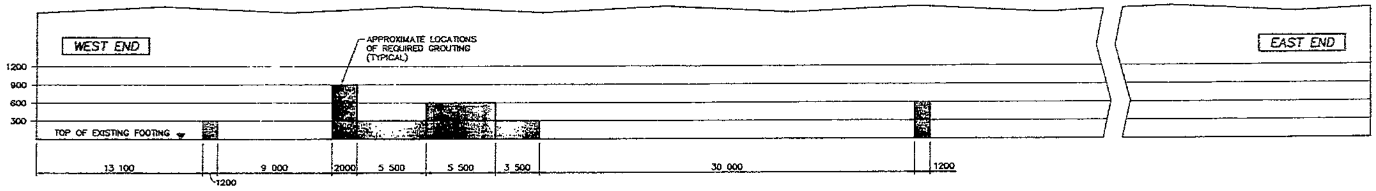


STRUTS LAYOUT

NTS

SEQUENCE OF STRUT INSTALLATION:

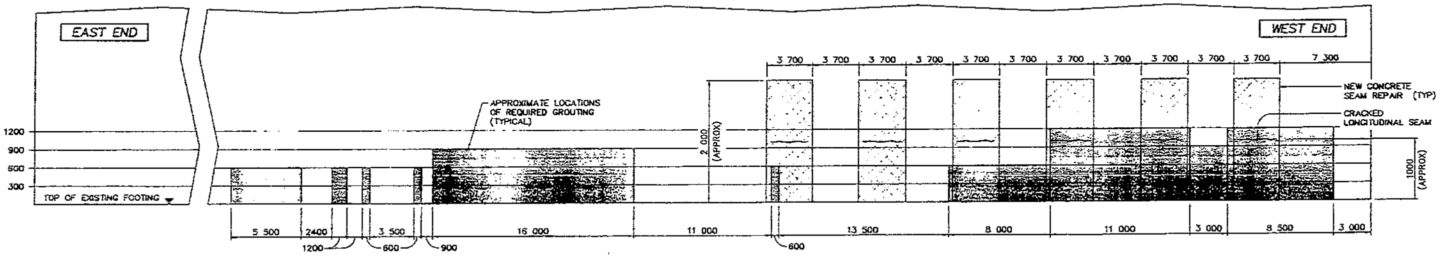
1. WITHIN CRITICAL AREA (STRUTS 1 TO 11)
   STAGE 1: 1 AND 11 STAGE 4: 4 AND 8
   STAGE 2: 2 AND 10 STAGE 5: 5 AND 7
   STAGE 3: 3 AND 9 STAGE 6: 6
2. OUTSIDE OF CRITICAL AREA (STRUTS 12 TO 27) CONTRACTOR MAY INSTALL STRUTS AT ANYTIME AS LONG AS THE TWO ADJACENT STRUTS UNDER CONSTRUCTION ARE AT LEAST 15m APART.



CULVERT ELEVATION

(INSIDE NORTH FACE, LOOKING NORTH)
HORIZONTAL 1:150
VERTICAL 1:750

NOTE:
LOCATIONS REQUIRING GROUTING ARE APPROXIMATE ONLY.
CONTRACTOR AND CONSULTANT TO VERIFY LOCATIONS IN THE FIELD.



CULVERT ELEVATION

(INSIDE SOUTH FACE, LOOKING SOUTH)
HORIZONTAL 1:150
VERTICAL 1:750

UMA Engineering Ltd.
Engineers, Planners & Surveyors
JOB NO. 0705-137-02-04

REV	DATE	REVISIONS	BY
7			
6			
5			
4			
3			
2			
1	2003.05.30	ISSUED FOR TENDER	SP

PERMIT TO PRACTICE
UMA ENGINEERING LTD.
Signature
Date May 30, 2003
PERMIT NUMBER: P329
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

DESIGNER
PROFESSIONAL ENGINEER ALBERTA
DATE May 30, 2003

CHECKER
PROFESSIONAL ENGINEER ALBERTA
DATE May 30, 2003

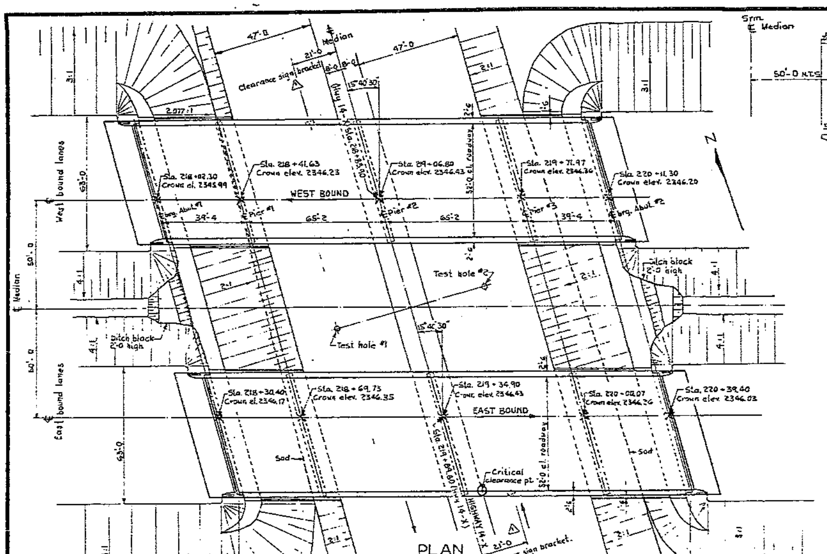
Alberta TRANSPORTATION

PETROLEUM WAY UNDERPASS
ON HWY 216, NEAR SHERWOOD PARK
CULVERT REHABILITATION-SHEET 2

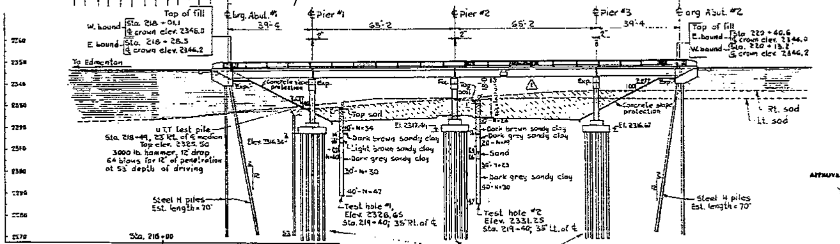
DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
2003-03-26	LOCAL RD.	SW9-053-23-4	HWY 216	77416	2 of 3	21673-P

BF75543

DESIGNED BY A.M.J. KEEN DATE March 19 64
DETAILED BY L. Kaulmann & R. Christ DATE March 19 64
CHECKED BY ____ DATE ____ 19__



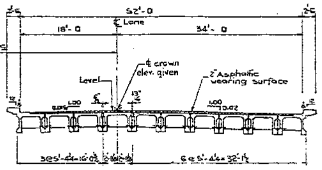
PLAN
Scale 1" = 20'



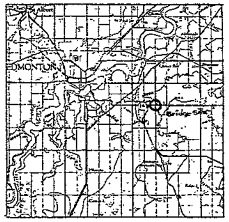
ELEVATION
Scale 1" = 20'

Item	Unit	Substruct.	Superstruct	Total Est.	As Const.
Waterproofing membrane	Sq. yds.	272	2224	2496	
Concrete Class D	Cu. yds.		31	31	
Concrete slope protection	Sq. yds.	1355		1355	
Handrail	Lin. ft.		861	861	
Asphaltic wearing surface	Sq. yds.	272	2224	2496	
Reinforcing steel	Lbs.	127558	6437	133,995	
Concrete Class B	Cu. yds.	574	73	647	
Concrete Class A	Cu. yds.	233		233	
Treated timber piling	Lin. ft.	13600		13600	
Steel H piling	Lin. ft.	4200		4200	
Backfill compacted non granular	Cu. yds.	329		329	
Backfill compacted granular	Cu. yds.	178		178	
Excavation - common dry	Cu. yds.	1118		1118	

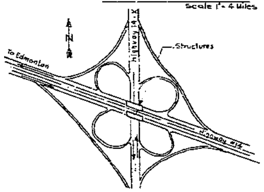
QUANTITY ESTIMATE



"DECK SECTION (on square)
Scale 3/8" = 1'-0

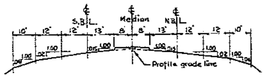


SITE MAP
Scale 1" = 4 Miles

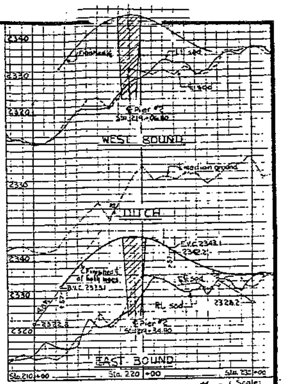


SITE PLAN (N.T.S.)

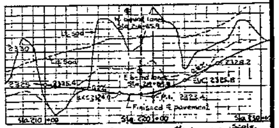
APPROVED ____ CHIEF BRIDGE ENGINEER



HWY. 14-X SECTION (on square)
N.T.S.



PROFILE - HIGHWAY #14
Scale: Hor. 1" = 400 Vert. 1" = 12'



PROFILE - HIGHWAY #14-X
Scale. Hor. 1" = 400 Vert. 1" = 6'

GENERAL NOTES

- Foundation information shown is for the guidance only of the Contractor and the Department assumes no responsibility for the accuracy of the information shown.
- € crown elevations for the overpasses are given to the theoretical finished asphalt surface at € lanes
- After the girders have been placed the Contractor shall take whatever steps necessary to prevent deck runoff water from eroding or scouring the fills at the bridge ends. He shall be responsible for this prevention until such time as the Contract is accepted as complete or paving operations by others provide accommodation for this run-off water.

DESIGN

- A.A.S.H.O. 1961 Specifications.
- A.A.S.H.O. HS 20 - 44 Loading.
- Reinforcing steel - Intermediate Grade Reinforcing.
- Pile loads - Steel H piling - D.L. = 34.5 T/pile @ 100% allow. Extreme = 57.0 T/pile @ 100% allow.
  Treated timber - D.L. = 29.0 T/pile @ 100% allow. Extreme = 40.0 T/pile @ 100% allow.

Sheet No.	Description	Dwg. No.
8	Handrail details	S-752
7	65-0 Type FC Girder	S-853
6	40-0 Type FC Girder	S-848
5	Bearing details	3837-P
4	Miscellaneous details	3836-P
3	Pier details	3835-P
2	Abutment details	3834-P
1	General layout	3822-P

INDEX

No.	Date	Description	By
4			
3			
2			
1	May 12/65	Clearance sign bracket added.	R.E.B.

REVISIONS

SALISBURY INTERCHANGE
GRADE SEPARATION
GENERAL LAYOUT

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS
BRIDGE BRANCH, EDMONTON

FILE NO. 75545 HWY. NO. 14
LOCATION NSW 20-52-23-4 SCALE as shown
STREAM Hwy. 14X SHEET 1 OF 8
DWG. NO. 3822-P

24 16 20 24

75593

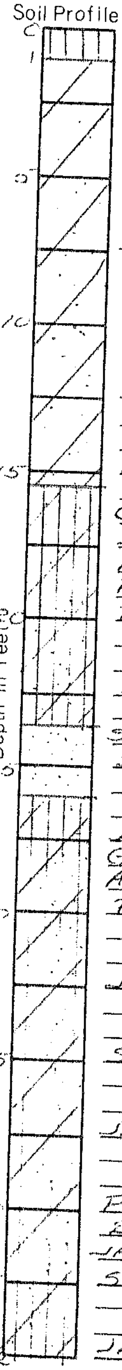
GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS

HIGHWAYS TESTING LABORATORY

TEST HOLE LOG

PROJECT SALIS[illegible]URY CORNER INTERCHANGE
SITE SW 28-22-23-4
SAMPLE INVESTIGATION HOLE
LOCATION 219+40 30' LT ℄
HOLE HOLE # 2 **DEPTH** 47½'
TECHNICIAN E PARRANTC **DATE** 2/2/64

Elevation of Ground Surface (Zero Depth) 219+40 30' LT ℄ 2312 ^{75}
Elevation of Water Table NONE POSSIBLE @ 25'
Method of Advancing Hole MAYHEW 1000 ROTARY DRILL (EUREKA)
Remarks DRILLED DRY



Soil Profile	Field Classification	Blows ~~Depth~~	Unconfined Comp Strength
0			
1	TOPSOIL		
	JAR@ 2½' 269		
	SANDY CLAY LIGHT		
	BROWN MED PLAST		
5	SHELBY@ 5'		
	JAR @ 7½' 270		
10	PT TUBE@ 10-11'	24	
	10" REC		
	JAR@ 12½' 271		
15	SHELBY@ 15'		
	GREY CLAYEY SAND		
	JAR @ 17½' 272		
	AB TO WET HIGH		
	PLAST.		
20	PT TUBE@ 20'-21'	19	
	8" REC		
	JAR@ 22½' 273		
	SAND WELL GRADED		
25	SHELBY@ 25'		
	NO REC.		
	JAR @ 27½' 279		
	GREY CLAYEY SAND		
	AB TO WET HIGH PLAST		
30	PT. TUBE@ 30'-31'	23	
	2 TBES 10" REC		
	JAR @ 32½' 275		
35	SHELBY @ 35'		
	JAR@ 37½' 2693		
40	PT TUBE@ 40'-41'	30	
	2 TBES 10" REC		
	JAR@ 42½' 2694		
45	SHELBY@ 45'		
47½	JAR@ 47½' 2695		

Depth in Feet

Depth in Feet

GOVERNMENT OF THE PROVINCE OF ALBERTA
DEPARTMENT OF HIGHWAYS

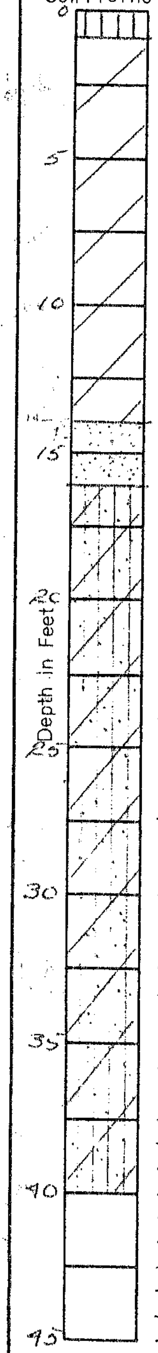
HIGHWAYS TESTING LABORATORY

TEST HOLE LOG

PROJECT [illegible]543
SITE SW 28-52-23-4 (SALISBURY)
SAMPLE INVESTIGATION HOLE
LOCATION STA 219+40 30' RTE
HOLE #1 DEPTH 40'
TECHNICIAN E FERRANTO DATE 2/29/64

Elevation of Ground Surface (Zero Depth) STA 219+40 35' RTE 2328^{65}
Elevation of Water Table 11'
Method of Advancing Hole MAYHEW 1000' ROTARY DRILL (E
Remarks DRILLED DRY

Soil Profile



Field Classification	Blows ~~Depth~~	Unconfined Comp Strength
TOPSOIL		
JAR @ 2½' 213		
CLAYEY SILT FINE SAND		
MINUS LIGHT BROWN		
SHELB @ 5'		
MED PLAST		
JAR @ 7½' 214		
PT TUBE @ 10'-11'	34	
8" REC		
JAR @ 12½' 215		
SAND CLAY LIGHT BRN		
SHELBY @ 15'		
MED PLAST - FREE WATER		
JAR @ 17½' 216		
PT TUBE @ 20'-21'	40	
6" REC		
JAR @ 22½' 265		
LIGHT BLUE CLAY FINE		
SAND HIGH PLAST.		
SHELBY @ 25'		
OAT-PLUS.		
JAR @ 27½' 266		
PT TUBE @ 30'	30	
NO REC ROCK		
JAR @ 32½' 267		
SHELBY @ 35'		
JAR @ 37½' 268		
PT TUBE @ 40'	47	
12" RE 2 TUBES		

Depth in Feet

Form B 3004

FILE NO. 75543

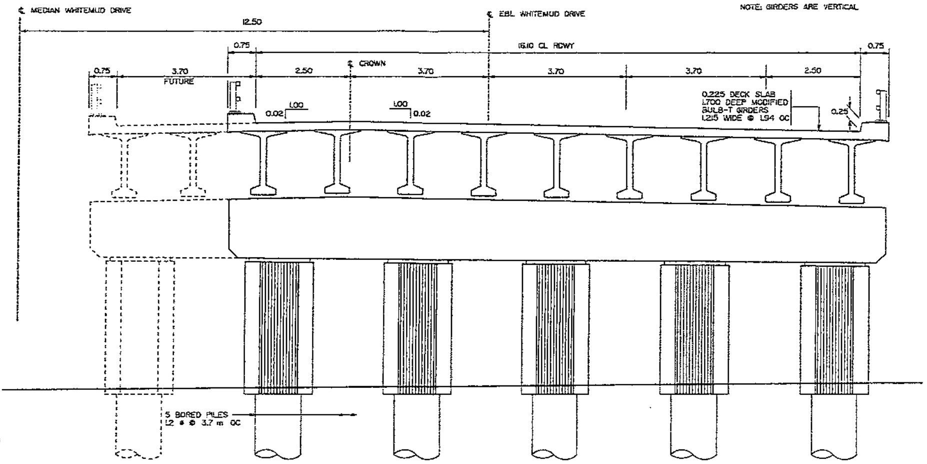
PILE DATA

STREAM Salisbury Corner
FOREMAN [illegible]
ENGINEER
PILE NO. 1
PILE TYPE HTT
PILE LENGTH 50 + 25' splice
WEIGHT OF HAMMER 3000 lbs

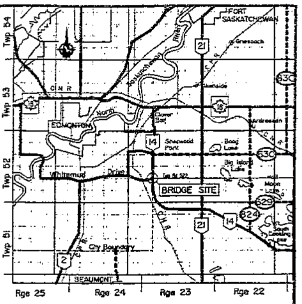
FROST DEPTH
STATION 218+49
23 FT. RIGHT/LEFT OF CENTER LINE
ICE ELEVATION
GROUND ELEVATION
WEATHER sunny warm + 50°
PIER NO. ABUT. NO.

DEPTH OF PILE IN FEET	DROP OF HAMMER IN FEET	NUMBER OF BLOWS	DEPTH OF PILE IN FEET	DROP OF HAMMER IN FEET	NUMBER OF BLOWS	REMARKS
0-1	6'	1	41-42	8'	23	
1-2		2	42-43		19	
2-3		4	43-44		25	
3-4		3½	44-45		32	
4-5		2	45-46		38	[illegible]
5-6		3	46-47		41	[illegible]
6-7		3	47-48		54	
7-8		3	48-49		62	S = [illegible] - 1
8-9		4	49-50		93	P
9-10		4	50-51	12'	41	= 2 × 3 [illegible] - 1
10-11		4	51-52		47	[illegible]
11-12		4	52-53		64	
12-13		5	53-54	~~[illegible]~~		= 1.2 - 1
13-14		5	54-55			
14-15		6	55-56			= 0.2"/b
15-16		7	56-57			
16-17		6	57-58			[illegible] = [illegible] b/1
17-18		8	58-59			
18-19		7	59-60			= 6 b/1
19-20		8	60-61			
20-21		9	61-62			
21-22		10	62-63			
22-23		10	63-64			
23-24		10	64-65			
24-25		12	65-66			
25-26		13	66-67			
26-27		13	67-68			
27-28		13	68-69			
28-29		16	69-70			
29-30		20	70-71			5 min to splice pile
30-31		24	71-72			
31-32		20	72-73			
32-33		20	73-74			
33-34		20	74-75			
34-35		20	75-76			
35-36		21	76-77			
36-37		23	77-78			
37-38		23	78-79			
38-39		25	79-80			
39-40		29	80-81			
40-41		32	81-82			

BF81157



A SECTION
1
LOOKING EAST 1:200



SITE MAP 1:125 000

- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD

SURVEY INFORMATION

- BY INFRASTRUCTURE SYSTEMS LTD. ENGINEERS & PLANNERS UNDER THE DIRECTION OF GEORGE WHITE. COMPLETED 97-02-07
- SURFACE COORDINATES = 3TM (NAD 83) × 1.0001 SCALING POINT AT ASCM = 139188
- ASCM # 278275, 5 926 808.640 N, 43 491.112 E. GEODETIC ELEVATION 719.740
- ASCM # 132449, 5 927 963.420 N, 42 232.186 E. GEODETIC ELEVATION 707.971
- ASCM # 148288, 5 927 960.749 N, 41 907.670 E. GEODETIC ELEVATION 709.720
- ASCM # 139188, 5 927 988.093 N, 43 375.185 E, STA 20+617.22 19.4 LT ℄ MEDIAN WHITEMUD DRIVE, GEODETIC ELEVATION 724.361
- IRON PIN, STA 20+755.09, 2.5 RT ℄ MEDIAN WHITEMUD DRIVE GEODETIC ELEVATION 722.367
- IRON PIN, STA 20+952.41, 18.7 RT ℄ MEDIAN WHITEMUD DRIVE GEODETIC ELEVATION 723.912
- IRON PIN, STA 20+957.19, 31.2 LT ℄ MEDIAN WHITEMUD DRIVE GEODETIC ELEVATION 722.278

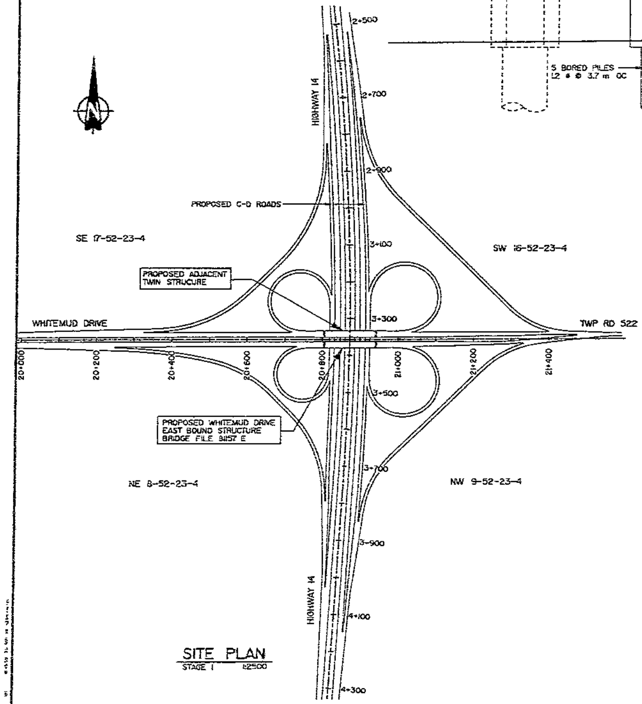
GENERAL NOTES

- ROADWAY ELEVATIONS ARE GIVEN TO TOP OF FINISHED ROADWAY ON CENTRELINE EAST BOUND LANES.
- ALL DIMENSIONS SHOWN ON GENERAL LAYOUT AND INFORMATION SHEETS ARE GIVEN IN METRES. ALL OTHER DRAWINGS ARE DIMENSIONED IN MILLIMETRES EXCEPT FOR STATIONS AND ELEVATIONS WHICH ARE EXPRESSED IN METRES.

DESIGN

- CAN/CSA-S6-88 SPECIFICATIONS
- LIVE LOAD: CS750
- WIND LOAD: q_{100} = 0.51 kPa
- ABUTMENT PILE LOADS (FACTORED)
  - DL = 469 kN
  - EXTREME = 628 kN - COMBINATION ULS 1
- PIER PILE LOADS (FACTORED)
  - DL = 3160 kN
  - EXTREME = 4260 kN - COMBINATION ULS 1

⚠ *NOTE; 5,651 kg OF THE 117,561 kg PAID FOR IN BID ITEM "ERECTION OF PRECAST GIRDERS"



SITE PLAN
STAGE 1 1:2500

ITEM		UNIT	SUBSTR	SUPERSTR	TOTAL EST	AS CONST ⚠	
BRIDGERAIL - 850 mm TUBE TYPE		m		288	288	288	
CONCRETE - SLOPE PROTECTION		m²	550		550	556.3	
CONCRETE - CLASS SF		m³	50	717	767	739.1	
CONCRETE - CLASS B (PIERS & ABUTMENTS)		m³	458		458	455.4	
PILE CONCRETE		m³	448		448	409.2	
REINFORCING STEEL - PLAIN		kg	75 198	42 399	117 597	117 661	←NOTE
REINFORCING STEEL - EPOXY		kg	4 682	41 376	46 058	46 058	
PILING - DRILLED	DRILL PILE HOLE	m	283		283	285.9	
	DRILL RIG SET-UP	PILE	15		15	15	
PILING - H PILE (HP 310 × 94)	SUPPLY & DRIVE	m	1080		1080	1164.62	
	SET-UP	PILE	36		36	36	

QUANTITY ESTIMATE

Infrastructure Systems Ltd.
ENGINEERS & PLANNERS

REV	DATE	REVISIONS	BY
⚠			
⚠			
⚠			
⚠			
⚠			
⚠	NOV 1998	AS CONSTRUCTED	P.F.
	OCT 1997	ISSUED FOR CONSTRUCTION	P.F.

PERMIT

PERMIT TO PRACTICE
Infrastructure Systems Ltd.
Signature
Date
PERMIT NUMBER: P 446
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

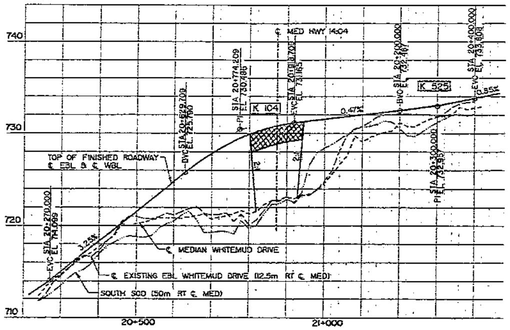
DESIGNER

CHECKER

Alberta TRANSPORTATION AND UTILITIES

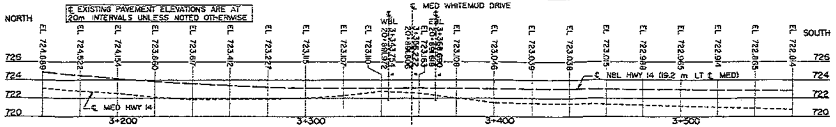
WHITEMUD DRIVE OVER HWY 14
GRADE SEPARATION -EBL
AT EAST BDY OF EDMONTON
INFORMATION SHEET - 1

CONSULTANT FILE & DRAWING	DRAWN	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
2916INIE	R.W.K.	97-07-30	HWY 14:04	SSW 16-52-23-4	WHITEMUD DRIVE	8157 E	2 of 16	16922-C

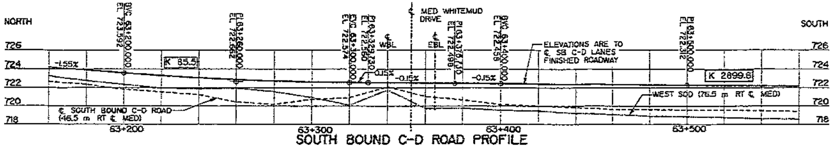


WHITEMUD DRIVE PROFILE

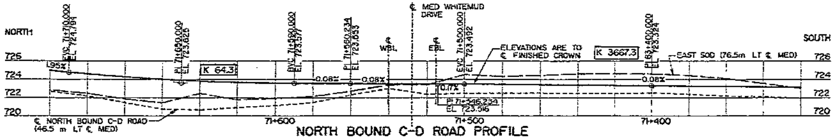
HORZ 1:5000
VERT 1:200



EXISTING NBL HWY 14:04 PROFILE



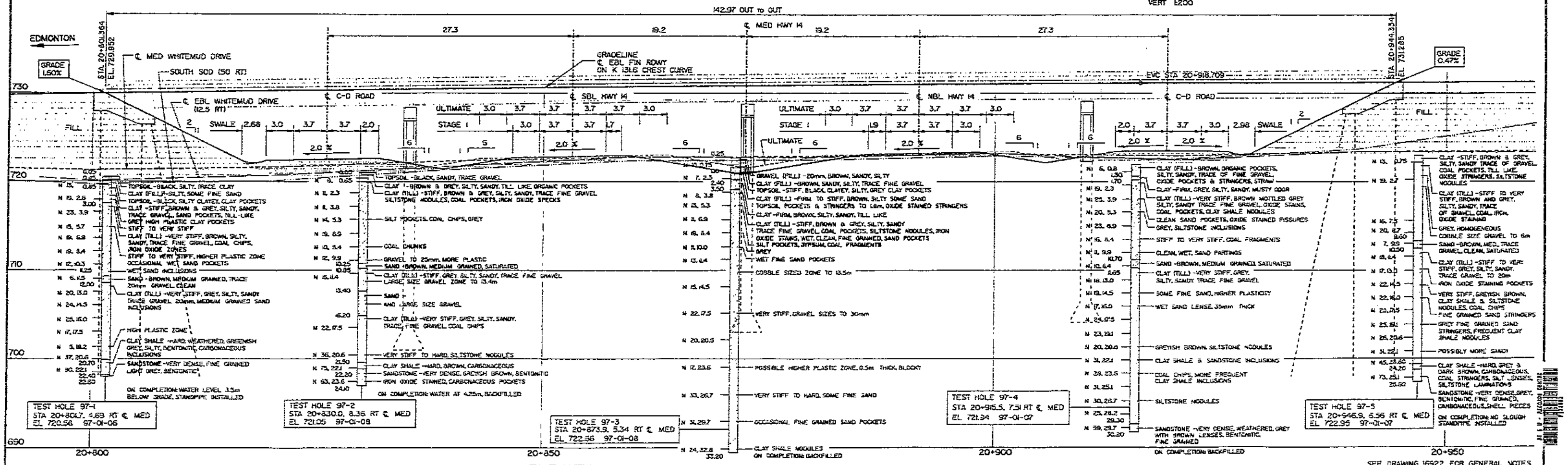
SOUTH BOUND C-D ROAD PROFILE



NORTH BOUND C-D ROAD PROFILE

HWY 14 ROAD PROFILE

HORZ 1:10 000
VERT 1:200



ELEVATION

LOOKING NORTH 1:200

SEE DRAWING 16922 FOR GENERAL NOTES

GEOTECHNICAL

- ALL GEOTECHNICAL INFORMATION PROVIDED FOR THIS PROJECT HAS BEEN COMPILED FOR DESIGN PURPOSES ONLY. WHILE IT IS BELIEVED TO CORRECTLY REPRODUCE OR SUMMARIZE OBSERVATIONS MADE DURING TESTING, IT IS VALID ONLY FOR THE PRECISE LOCATIONS SHOWN, AND IS NOT TO BE CONSTRUED AS GUARANTEEING THE ACTUAL MATERIALS AND CONDITIONS EXISTING THROUGHOUT THE SITE. THE TESTING METHODS USED MAY NOT HAVE DETERMINED THE PRESENCE, ABSENCE OR EXTENT OF BOULDERS, HARD OR SOFT FORMATIONS, WATER TABLES, ARTESIAN CONDITIONS AND OTHER VARIABLES. IT IS THE RESPONSIBILITY OF OTHERS USING THIS INFORMATION TO ENSURE THAT IT IS ADEQUATE FOR THEIR PURPOSES, OR TO SUPPLEMENT IT WITH ADDITIONAL INFORMATION.

Infrastructure Systems Ltd.
ENGINEERS & PLANNERS

REV	DATE	REVISIONS	BY
1	NOV 1998	AS CONSTRUCTED	P.F.
	OCT 1997	ISSUED FOR CONSTRUCTION	P.F.

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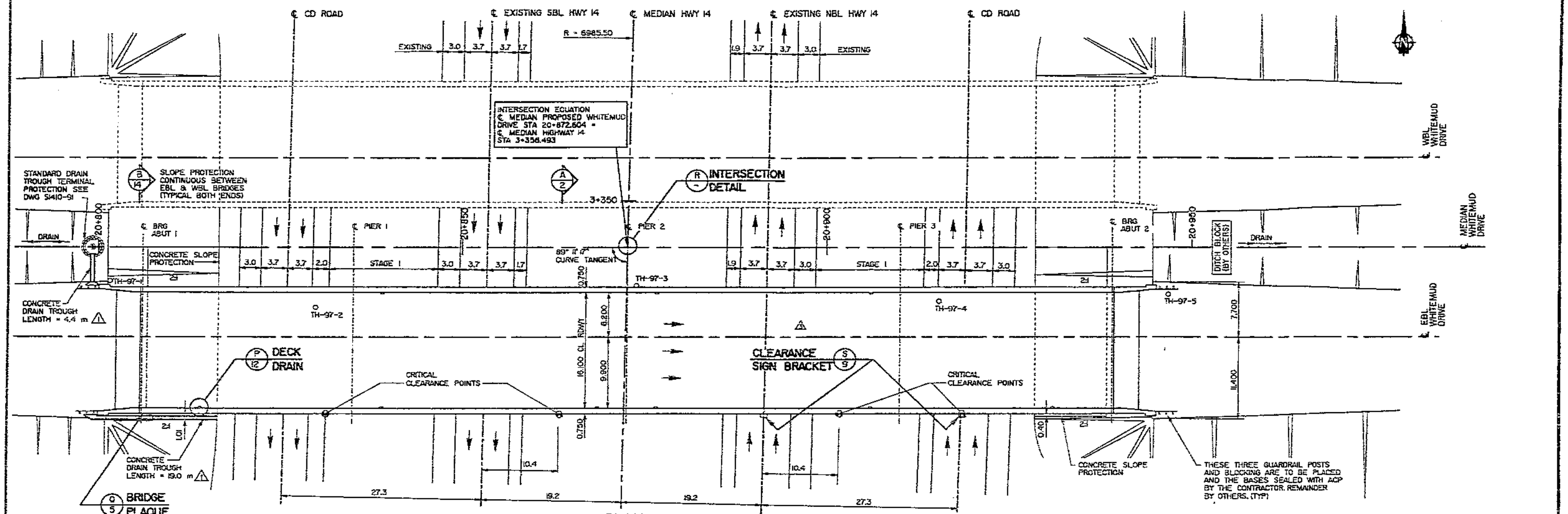
Infrastructure Systems Ltd.
PERMIT NUMBER: P 494

Alberta TRANSPORTATION AND UTILITIES

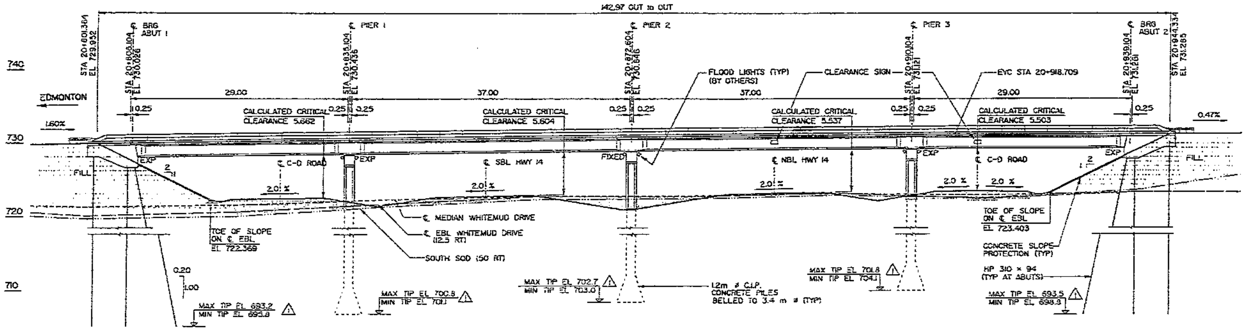
WHITEMUD DRIVE OVER HWY 14
GRADE SEPARATION - EBL
AT EAST BDY OF EDMONTON
INFORMATION SHEET - 2

CONSULTANT FILE & DRAWING	DRAWN	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
2916IN2E	R.W.K.	97-07-30	HWY 14:04	SSW 16-52-23-4	WHITEMUD DRIVE	8157 E	3 of 16	16923-C



PLAN

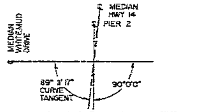
1:125



ELEVATION

LOOKING NORTH 1:125

NOTE:
CALCULATED CRITICAL CLEARANCES FOR ULTIMATE STAGE



R INTERSECTION DETAIL

N T S

SHEET	DESCRIPTION	DRAWING
16	850mm TUBE TYPE BRIDGERAIL	S-1400-95
15	BAR LIST	16935-C
14	EXPANSION ASSEMBLY - SHEET 2	16934-C
13	EXPANSION ASSEMBLY - SHEET 1	16933-C
12	DECK - SHEET 2	16932-C
11	DECK - SHEET 1	16931-C
10	POST-TENSIONING DETAILS	16930-C
9	37m MODIFIED BULB-T GIRDER	16929-C
8	29m MODIFIED BULB-T GIRDER	16928-C
7	BEARINGS	16927-C
6	PIERS	16926-C
5	ABUTMENTS - SHEET 2	16925-C
4	ABUTMENTS - SHEET 1	16924-C
3	INFORMATION SHEET - 2	16923-C
2	INFORMATION SHEET - 1	16922-C
1	GENERAL LAYOUT	16921-C

INDEX

ISL Infrastructure Systems Ltd.
ENGINEERS & PLANNERS

REV	DATE	REVISIONS	BY
6			
5			
4			
3			
2			
1	NOV 1998	AS CONSTRUCTED	P.F.
	OCT 1997	ISSUED FOR CONSTRUCTION	P.F.

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Infrastructure Systems Ltd.
Signature
Date
PERMIT NUMBER: P 4141
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

DESIGNER
CHECKER

Alberta TRANSPORTATION AND UTILITIES

WHITEMUD DRIVE OVER HWY 14
GRADE SEPARATION - EBL
AT EAST BDY OF EDMONTON
GENERAL LAYOUT

CONSULTANT FILE & DRAWING	DRAWN	DATE	STREAM	LOCATION	HIGHWAY	FILE	SHEET	DRAWING
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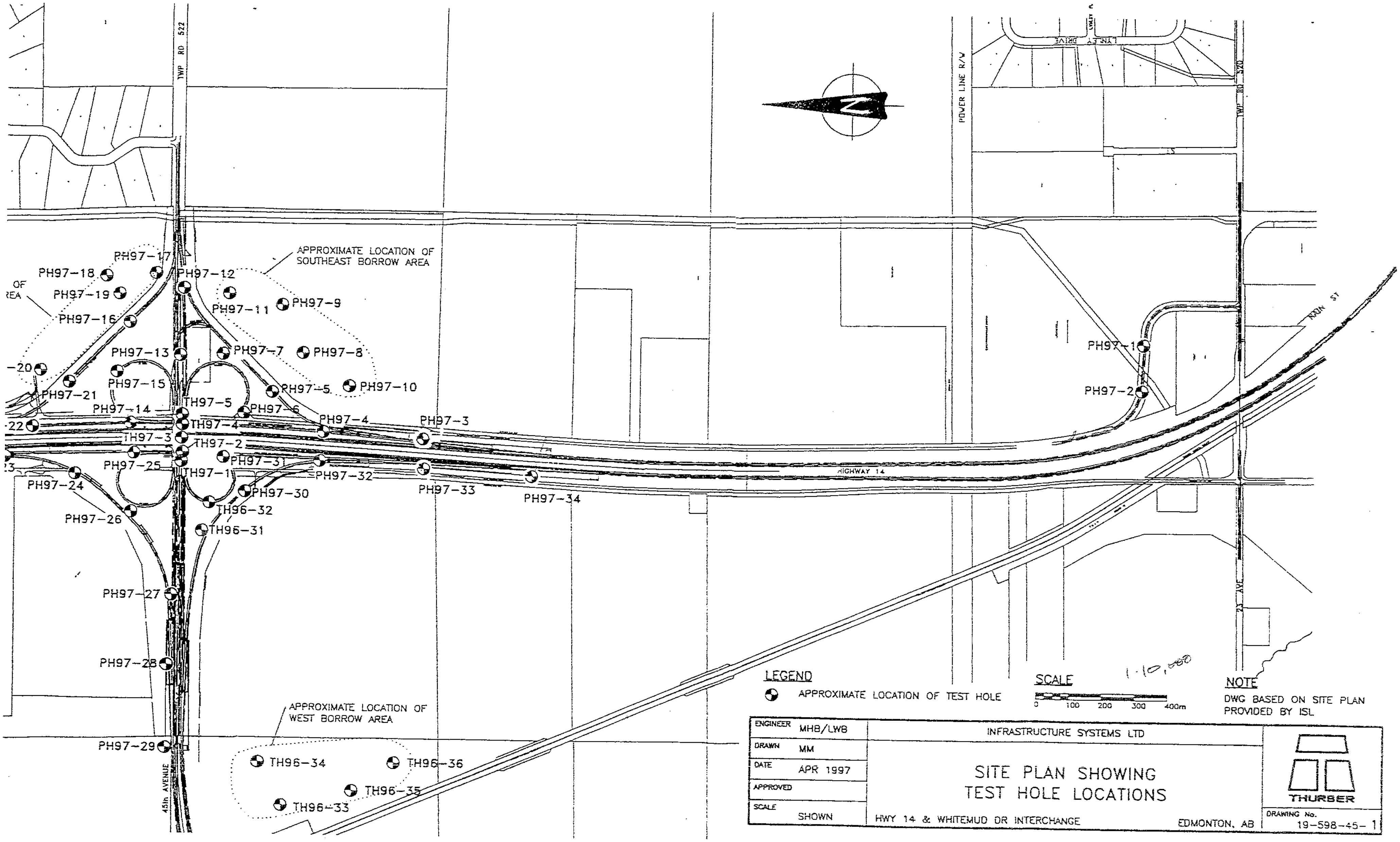


LEGEND

● APPROXIMATE LOCATION OF TEST HOLE

SCALE

0 100 200 300 400m

1:10,000

NOTE

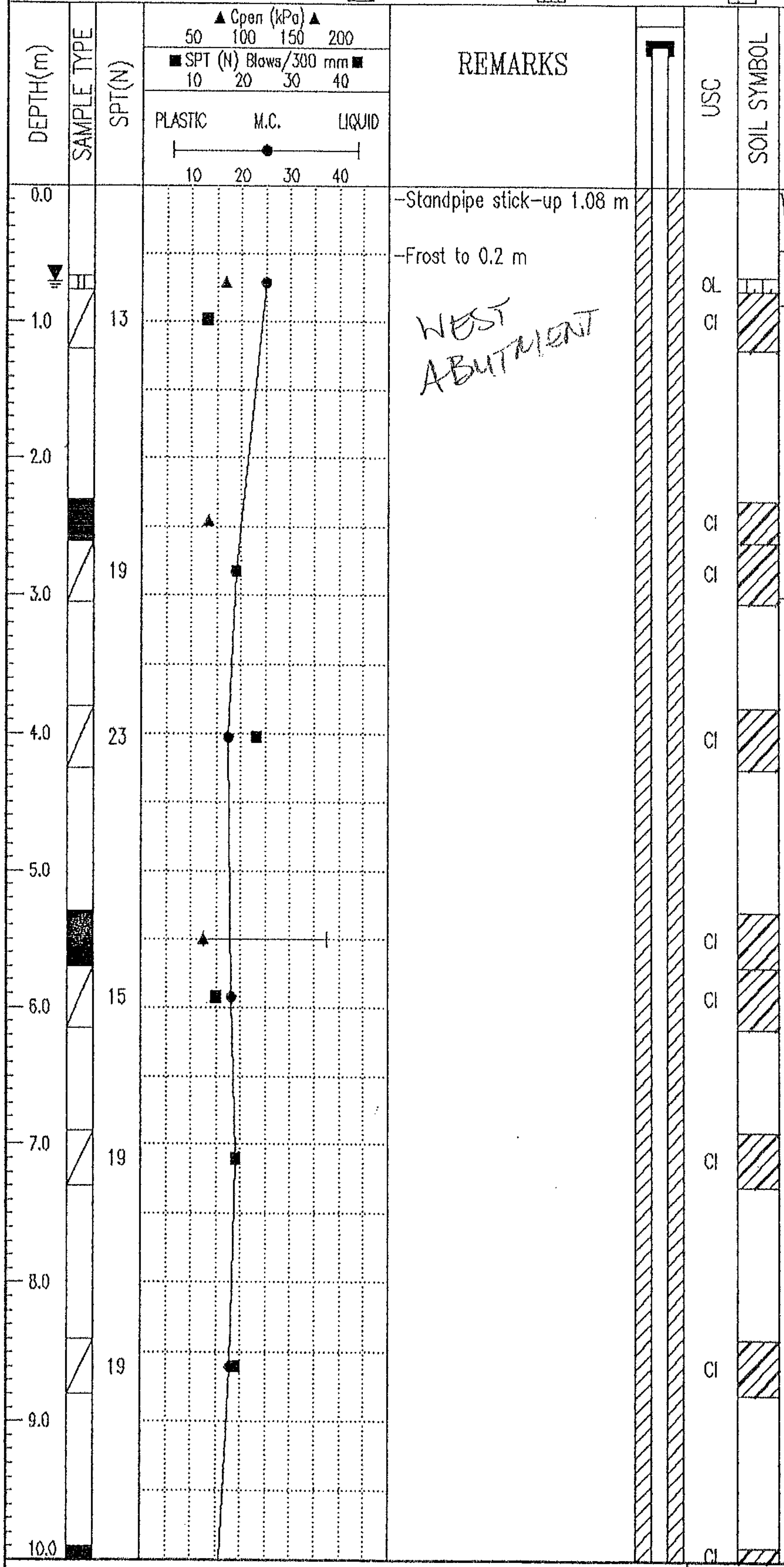
DWG BASED ON SITE PLAN PROVIDED BY ISL

ENGINEER MHB/LWB	INFRASTRUCTURE SYSTEMS LTD		THURBER
DRAWN MM	SITE PLAN SHOWING TEST HOLE LOCATIONS		
DATE APR 1997			
APPROVED			
SCALE SHOWN	HWY 14 & WHITEMUD DR INTERCHANGE	EDMONTON, AB	DRAWING No. 19-598-45- 1

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-1
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 6 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/SOLID STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 720.578 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ☒ NO RECOVERY ☰ A-CASING ▥ GRAB SAMPLE ▮ CORE SAMPLE

BACKFILL TYPE ■ BENTONITE ⁚ PEA GRAVEL ▥ SLOUGH ▨ GROUT ▨ DRILL CUTTINGS ▒ SAND



REMARKS

-Standpipe stick-up 1.08 m

-Frost to 0.2 m

WEST ABUTMENT

SOIL DESCRIPTION

0.0 TOPSOIL, black, silty, trace clay

CLAY (FILL), silty, some fine sand

TOPSOIL, black, silty clayey, clay pockets

1.0 CLAY
trace gravel, sand pockets, till-like
stiff, brown and grey, silty, sandy,

2.0 -grey high plastic clay pockets

-stiff to very stiff

3.0 CLAY (TILL)
very stiff, brown, silty, sandy, trace
fine gravel, coal chips, iron oxide zones

4.0 -grey, ironstone concretions

5.0 -siltstone nodules

-stiff to very stiff
-higher plastic zone, occasional wet sand
pockets

6.0

7.0 -very stiff

8.0

9.0

-stiff

10.0

LOGGED BY: HJH	COMPLETION DEPTH: 22.6 m
REVIEWED BY: MHB	COMPLETE: 06/01/97
Fig. No:	Page 1 of 3

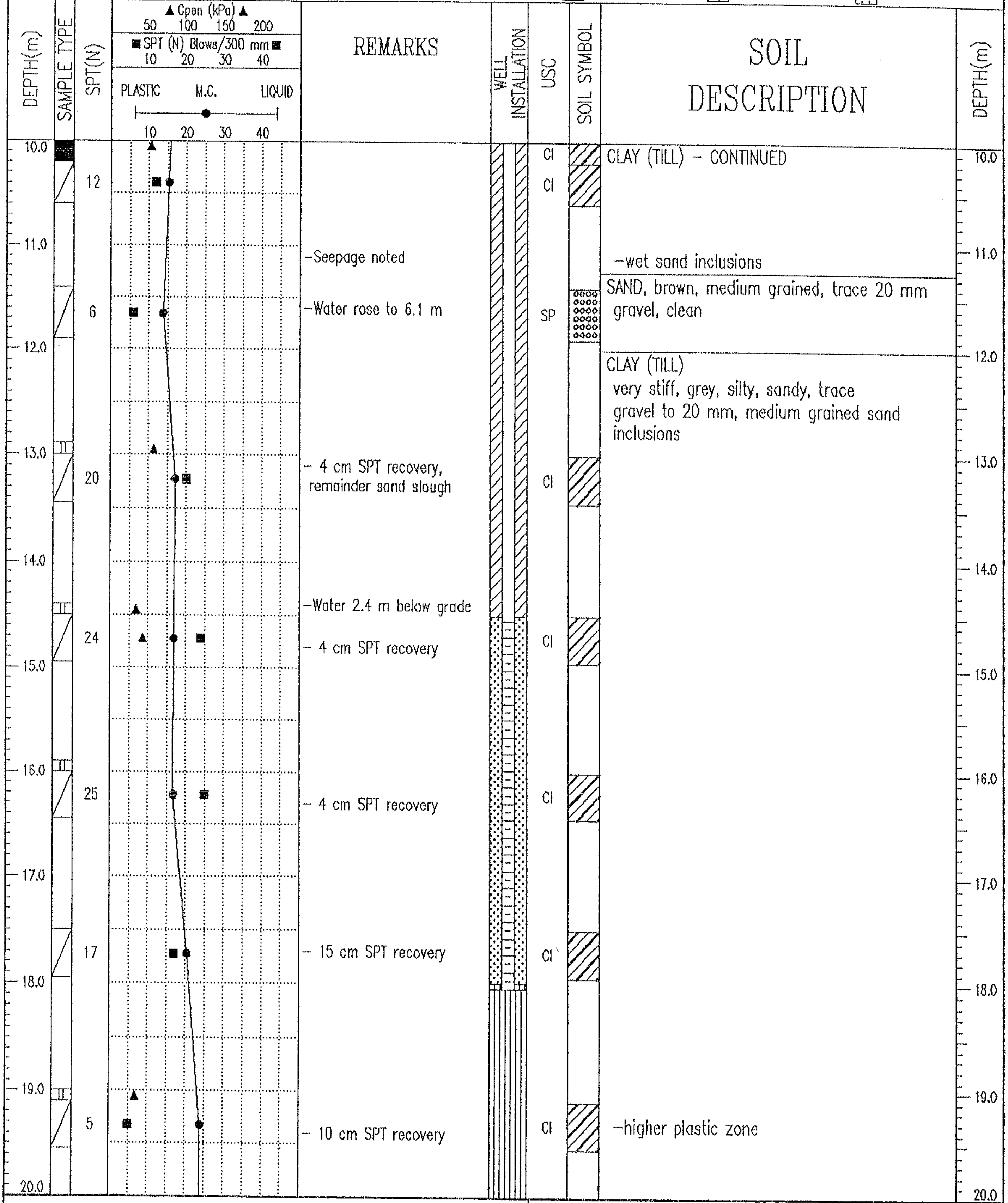
Thurber Engineering Ltd.
Edmonton, Alberta.

97/04/25 09:22AM (THURPIEZ)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-1
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 6 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/SOLID STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 720.578 (m)

SAMPLE TYPE ■ SHELBY TUBE ⧄ SPT ☒ NO RECOVERY ☰ A-CASING ▥ GRAB SAMPLE ▮ CORE SAMPLE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁖ GROUT ▨ DRILL CUTTINGS ▩ SAND



REMARKS

-Seepage noted

-Water rose to 6.1 m

- 4 cm SPT recovery, remainder sand slough

-Water 2.4 m below grade

- 4 cm SPT recovery

- 4 cm SPT recovery

- 15 cm SPT recovery

- 10 cm SPT recovery

SOIL DESCRIPTION

CLAY (TILL) - CONTINUED

-wet sand inclusions

SAND, brown, medium grained, trace 20 mm gravel, clean

CLAY (TILL)
very stiff, grey, silty, sandy, trace gravel to 20 mm, medium grained sand inclusions

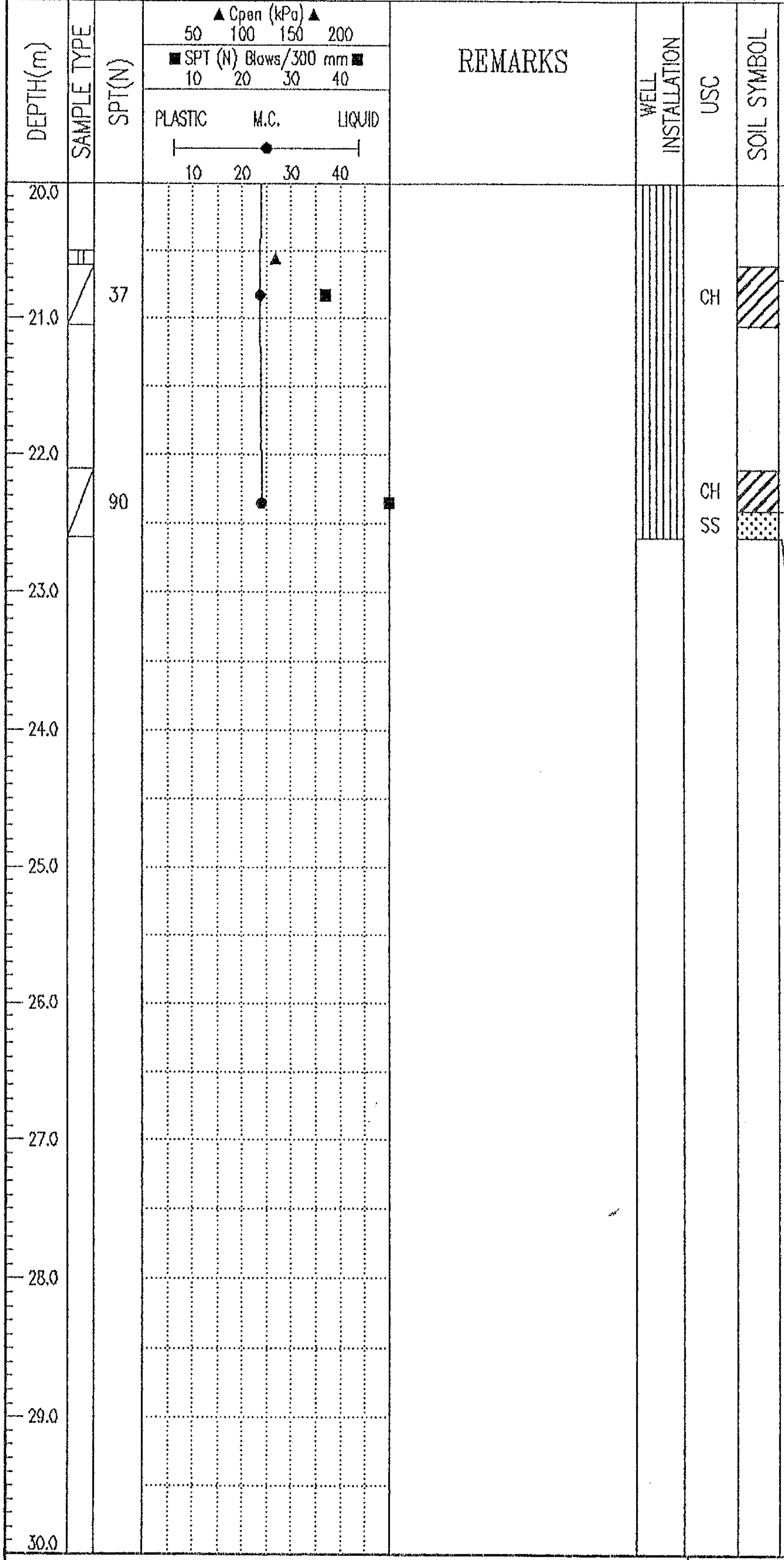
-higher plastic zone

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: HJH	COMPLETION DEPTH: 22.6 m
	REVIEWED BY: MHB	COMPLETE: 06/01/97
	Fig. No:	Page 2 of 3

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-1
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 6 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/SOLID STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 720.578 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ☒ NO RECOVERY ☰ A-CASING ▥ GRAB SAMPLE ▮ CORE SAMPLE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ▩ GROUT ▨ DRILL CUTTINGS ░ SAND



SOIL DESCRIPTION

CLAY (TILL) - CONTINUED

699.87

CLAY SHALE
hard, weathered, greenish grey, silty, bentonitic, carbonaceous inclusions

~ 1.5m into Rk.

698.78

-carbonaceous

SANDSTONE, very dense, light grey, fine grained, bentonitic

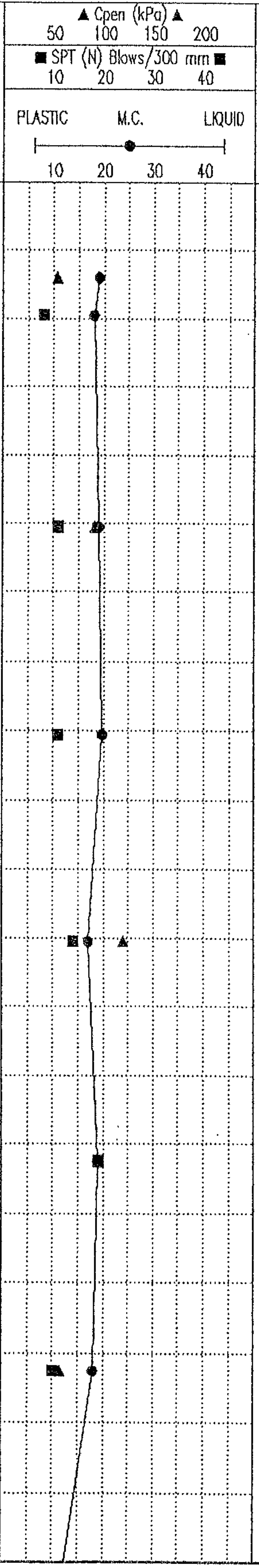
END OF TEST HOLE 22.6m
ON COMPLETION:
-WATER LEVEL 3.5m BELOW GRADE
STANDPIPE INSTALLED
-WATER LEVEL 0.7m MARCH 27, 1997

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: HJH	COMPLETION DEPTH: 22.6 m
	REVIEWED BY: MHB	COMPLETE: 06/01/97
	Fig. No:	Page 3 of 3

97/01/25 09:23AM (THURPIEZ)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-2
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 8 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 721.052 (m)

SAMPLE TYPE ■ SHELBY TUBE ◿ SPT ☒ NO RECOVERY ▤ A-CASING ▥ GRAB SAMPLE ▮ CORE SAMPLE



DEPTH(m)	SPT(N)	REMARKS	USC	SOIL DESCRIPTION	DEPTH(m)
0.0				TOPSOIL, black, sandy, silty, trace gravel	0.0
		-Frost to 0.5 m		CLAY, brown and grey, silty, sandy, till-like, organic pockets	
		-Top portion of test hole drilled with solid augers		CLAY (TILL)	
1.0	8		CI	stiff, brown and grey, silty, sandy, trace fine gravel, siltstone nodules, coal pockets, iron oxide specks	1.0
2.0					2.0
		-Swiched to hollow augers			
	11		CI		
3.0					3.0
		-Poor SPT recovery – sampler pushing rock			
4.0	11		CI		4.0
▽					▽
5.0					5.0
	14		CI	-silt pockets, coal chips	
				-grey	
6.0					6.0
7.0	19		CI		7.0
8.0					8.0
	10		CI	-coal chunks	
9.0					9.0
10.0	12		CI	-gravel to 25 mm, more plastic	10.0

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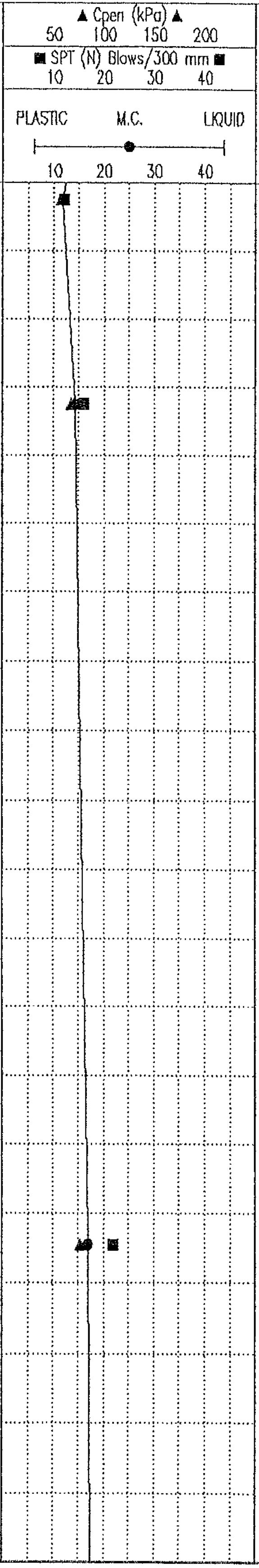
Edmonton, Alberta.

LOGGED BY: HJH	COMPLETION DEPTH: 24.1 m
REVIEWED BY: MHB	COMPLETE: 08/01/97
Fig. No:	Page 1 of 3

97/04/25 09:24AM (THURBER)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-2
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 8 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 721.052 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ☒ NO RECOVERY ☰ A-CASING ▯ GRAB SAMPLE ▮ CORE SAMPLE



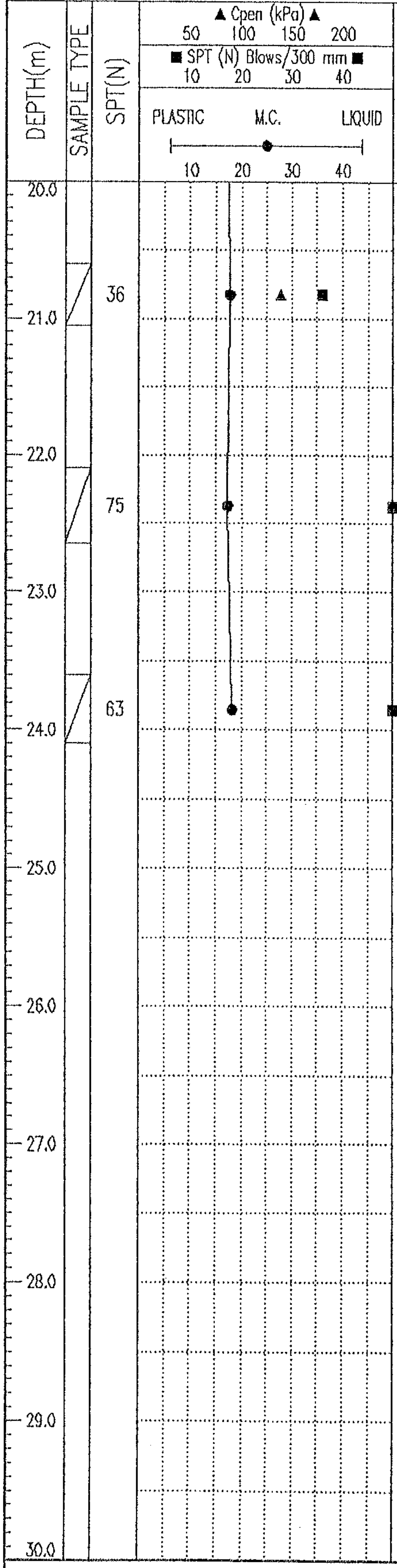
DEPTH(m)	SAMPLE TYPE	SPT(N)	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION
10.0	▨	12	-groundwater seepage noted	CI	▨	CLAY (TILL) - CONTINUED
						SAND, brown, medium grained, saturated
11.0						CLAY (TILL) stiff, grey, silty, sandy, trace fine gravel
	▨	16	-Rock caused SPT refusal - N-value estimated	CI	▨	
12.0						-large size gravel zone to 13.4
13.0						SAND
14.0			-No SPT - 2 m of sand inside augers, water rose 7.5 m inside augers -Augers raised to expel sand			-and large size gravel
15.0						
16.0						CLAY (TILL) very stiff, grey, silty, sandy, trace fine gravel, coal chips,
17.0						
	▨	22		CI	▨	
18.0						
19.0						
20.0						

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: HJH	COMPLETION DEPTH: 24.1 m
	REVIEWED BY: MHB	COMPLETE: 08/01/97
	Fig. No:	Page 2 of 3

97/04/25 09:24AM (THURBER)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-2
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 8 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 721.052 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ☒ NO RECOVERY ☰ A-CASING ▯ GRAB SAMPLE ▮ CORE SAMPLE



REMARKS

USC	SOIL DESCRIPTION	DEPTH(m)
	CLAY (TILL) - CONTINUED	20.0
CI	-very stiff to hard, siltstone nodules	21.0
	CLAY SHALE hard, brown, carbonaceous	22.0
SS	SANDSTONE very dense, greyish brown, bentonitic	23.0
SS	-iron oxide stained, carbonaceous pockets	24.0
	END OF TEST HOLE 24.1 m ON COMPLETION: WATER AT 4.25 m BACKFILLED	25.0
		26.0
		27.0
		28.0
		29.0
		30.0

Thurber Engineering Ltd.
Edmonton, Alberta.

LOGGED BY: HJH	COMPLETION DEPTH: 24.1 m
REVIEWED BY: MHB	COMPLETE: 08/01/97
Fig. No:	Page 3 of 3

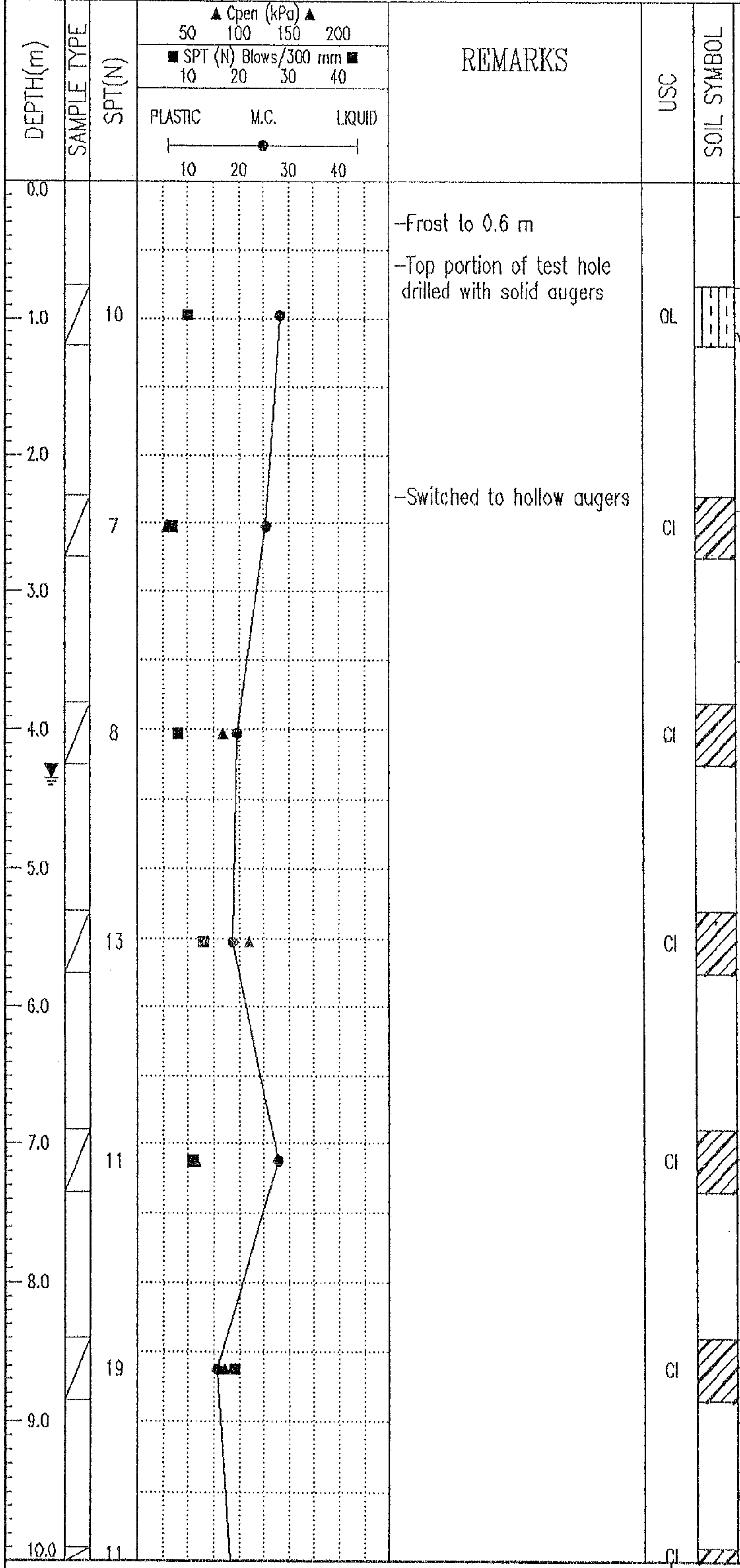
97/04/25 09:24AM (THURBER)

CLIENT: INFRASTRUCTURE SYSTEMS LTD
DRILL CO: MOBILE AUGERS AND RESEARCH LTD
RIG/METHOD: B61/HOLLOW STEM AUGERS

PROJECT: HWY 14/WHITEMUD DR INTERCHANGE
DRILL DATE: 8 JANUARY 1997
LOCATION: SEE DRAWING 19-598-45-1

HOLE NO: TH97-3
PROJECT NO: 19-598-45
ELEVATION: 722.66 (m)

SAMPLE TYPE ■ SHELBY TUBE ⧄ SPT ☒ NO RECOVERY ☰ A-CASING ▯ GRAB SAMPLE ▮ CORE SAMPLE



REMARKS

-Frost to 0.6 m

-Top portion of test hole drilled with solid augers

-Switched to hollow augers

SOIL DESCRIPTION

GRAVEL (FILL), 20 mm, brown, sandy, silty

CLAY (FILL), brown, silty, sandy, trace fine gravel

TOPSOIL, stiff, black, clayey, silty, grey clay pockets

CLAY (FILL)
firm to stiff, brown, silty, some sand, topsoil pockets and stringers to 1.8 m
-sandy, trace gravel, silt pockets, oxide stained stringers

CLAY
firm, brown, silty, sandy, till-like

CLAY (TILL)
stiff, brown and grey, silty, sandy, trace fine gravel, coal pockets, siltstone nodules, iron oxide stains
-wet, clean, fine grained, sand pockets

-oxide stains, silt pockets, gypsum
-coal fragments

-wet fine sand pockets

-grey

-wet fine sand pockets

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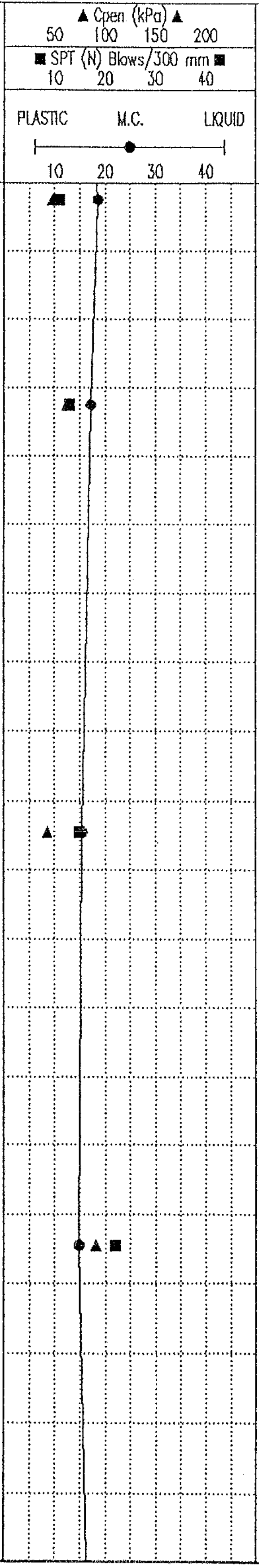
Edmonton, Alberta.

LOGGED BY: HJH
REVIEWED BY: MHB
Fig. No:

COMPLETION DEPTH: 33.2 m
COMPLETE: 08/01/97

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-3
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 8 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 722.66 (m)

SAMPLE TYPE ■ SHELBY TUBE ⧄ SPT ☒ NO RECOVERY ☰ A-CASING ▯ GRAB SAMPLE ▮ CORE SAMPLE



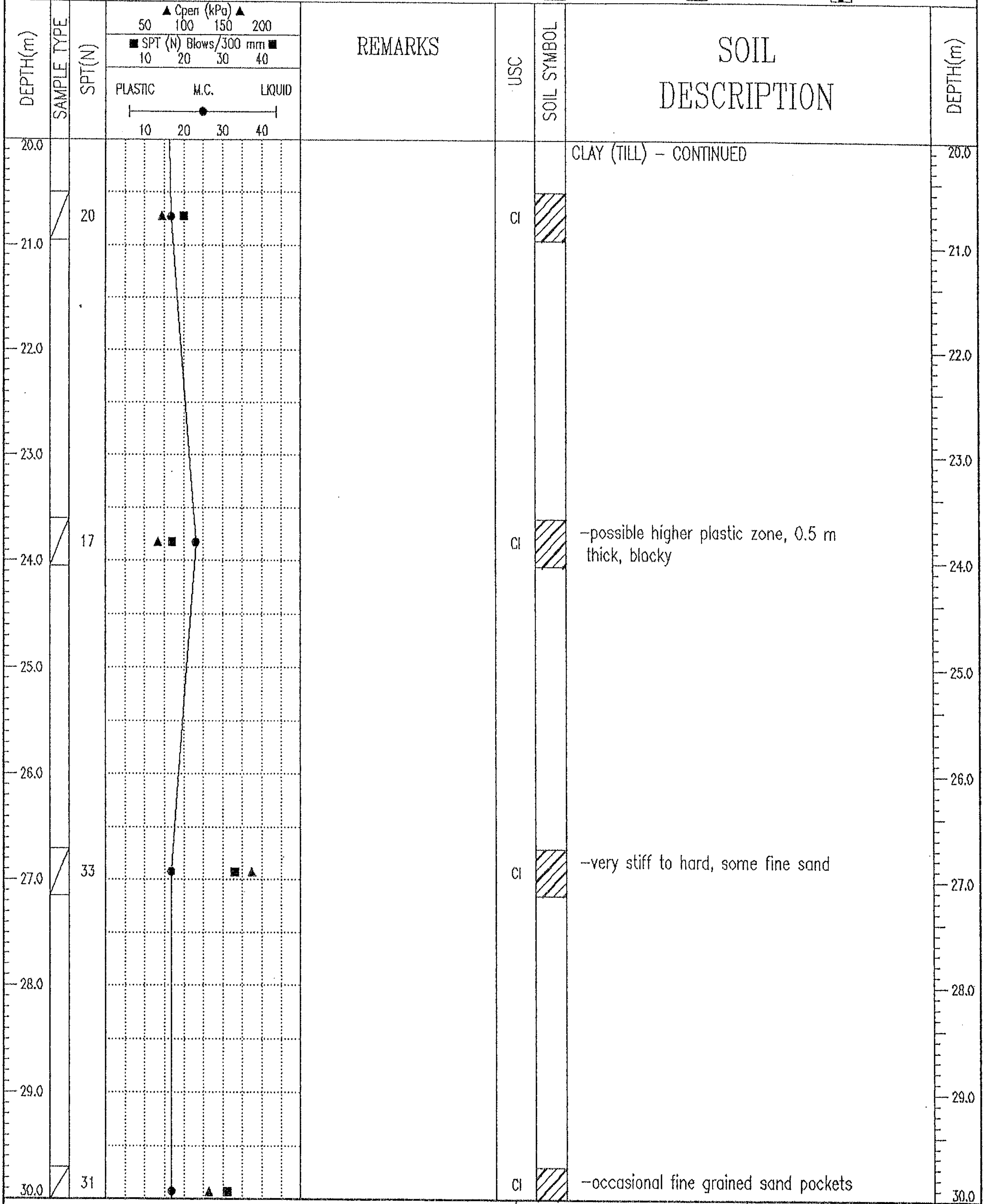
DEPTH(m)	SAMPLE TYPE	SPT(N)	REMARKS	USC	SOIL DESCRIPTION	DEPTH(m)
10.0	⧄	11		CI	CLAY (TILL) – CONTINUED	10.0
11.0						11.0
	⧄	13		CI		
12.0						12.0
			–No SPT taken		–cobble sized zone to 13.5 m	
13.0						13.0
14.0						14.0
	⧄	15		CI		
15.0						15.0
16.0						16.0
17.0						17.0
	⧄	22		CI	–very stiff, gravel sizes to 30 mm	
18.0						18.0
19.0						19.0
20.0						20.0

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: HJH	COMPLETION DEPTH: 33.2 m
	REVIEWED BY: MHB	COMPLETE: 08/01/97
	Fig. No:	Page 2 of 4

07/04/25 09:25AM (THURBER)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-3
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 8 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 722.66 (m)

SAMPLE TYPE ■ SHELBY TUBE ◿ SPT ☒ NO RECOVERY ☰ A-CASING ▯ GRAB SAMPLE ▮ CORE SAMPLE



CLAY (TILL) – CONTINUED

–possible higher plastic zone, 0.5 m thick, blocky

–very stiff to hard, some fine sand

–occasional fine grained sand pockets

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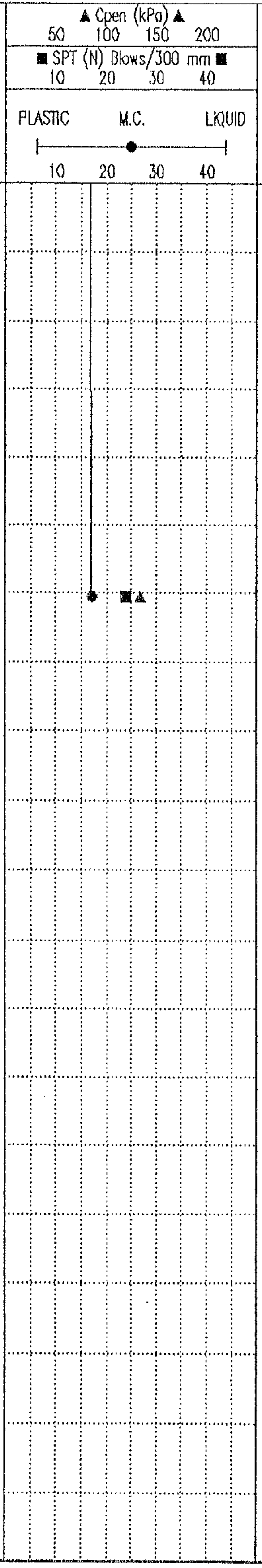
	Fig. No:

COMPLETION DEPTH: 33.2 m
COMPLETE: 08/01/97

CLIENT: INFRASTRUCTURE SYSTEMS LTD
PROJECT: HWY 14/WHITEMUD DR INTERCHANGE
HOLE NO: TH97-3
DRILL CO: MOBILE AUGERS AND RESEARCH LTD
DRILL DATE: 8 JANUARY 1997
PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS
LOCATION: SEE DRAWING 19-598-45-1
ELEVATION: 722.66 (m)

SAMPLE TYPE ■ SHELBY TUBE ⧄ SPT ☒ NO RECOVERY ☰ A-CASING ◫ GRAB SAMPLE ◨ CORE SAMPLE



DEPTH(m)	SAMPLE TYPE	SPT(N)	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH(m)
30.0	⧄	31		CI	▨	CLAY (TILL) – CONTINUED	30.0
31.0							31.0
32.0							32.0
33.0	⧄	24	–Test hole terminated – ran out of hollow stem augers	CI	▨	–clay shale nodules	33.0
						END OF TESTHOLE 33.2 m ON COMPLETION: BACKFILLED	
34.0							34.0
35.0							35.0
36.0							36.0
37.0							37.0
38.0							38.0
39.0							39.0
40.0							40.0

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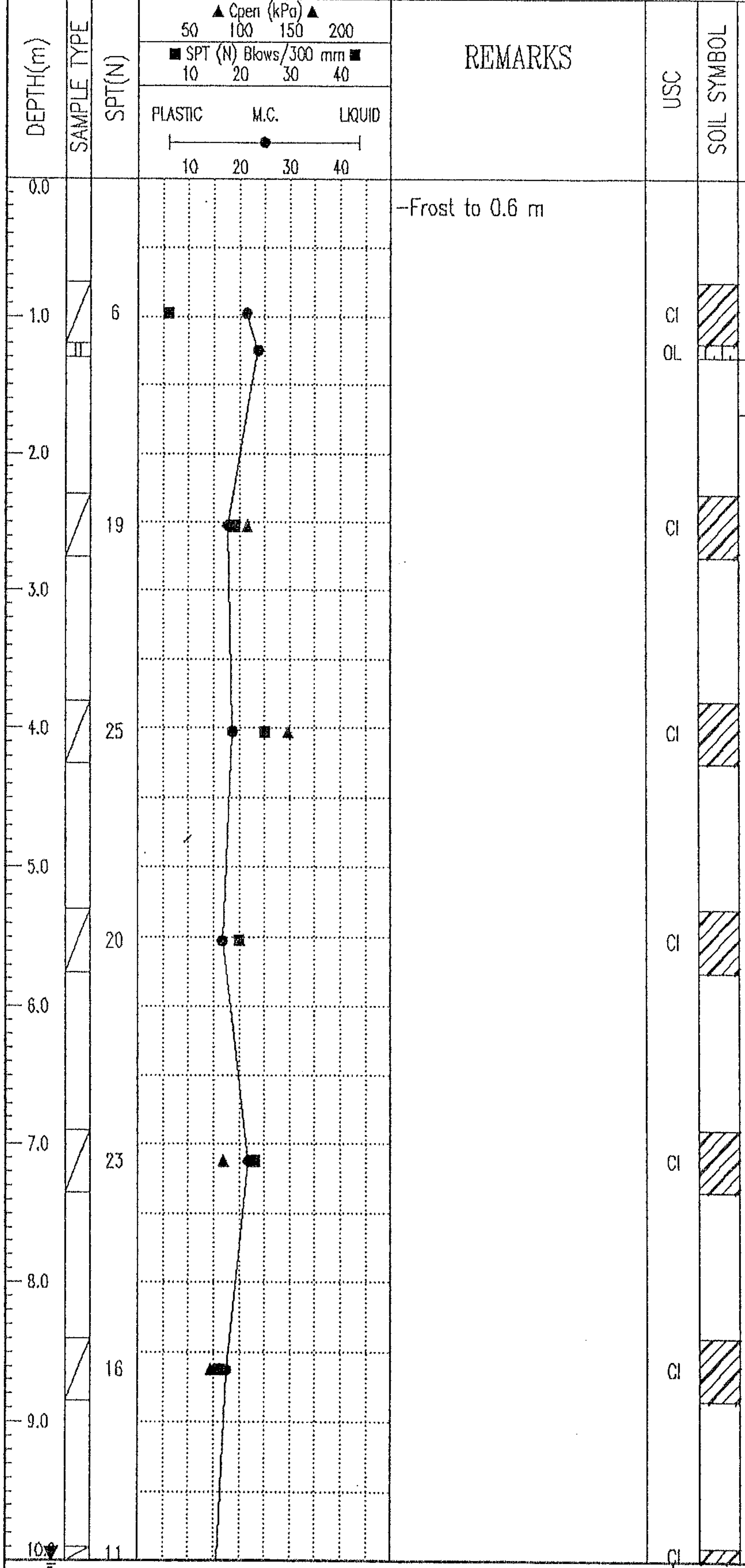
Fig. No:
COMPLETION DEPTH: 33.2 m
COMPLETE: 08/01/97

97/04/25 09:26AM (THURBER)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-4
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 7 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 721.938 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ☒ NO RECOVERY ☰ A-CASING ◫ GRAB SAMPLE ▮ CORE SAMPLE



REMARKS

-Frost to 0.6 m

SOIL DESCRIPTION

CLAY (FILL), brown, silty, sandy, organic pockets, trace fine gravel, oxide pockets and stringers, straw

-firm, brown mottled grey

CLAY, firm, grey, silty, sandy, musty odor

CLAY (TILL)
very stiff, brown mottled grey, silty, sandy, trace fine gravel, oxide stains, coal pockets, clay shale nodules
-sandstone inclusions

-zone with clean sand pockets, oxide stained fissures

-grey, siltstone inclusions

-stiff to very stiff, coal fragments

-clean, wet, sand partings

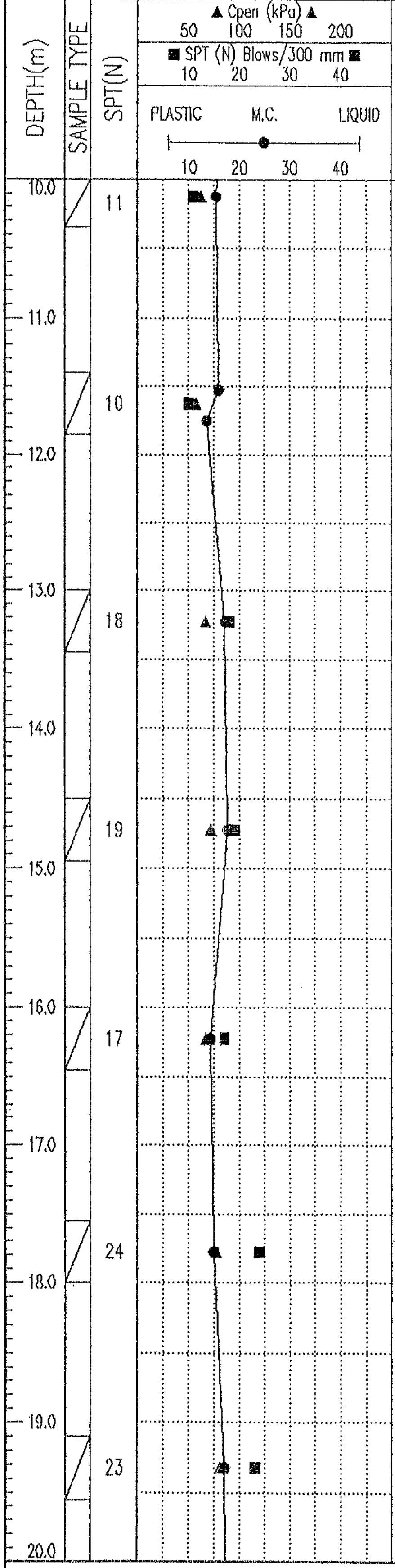
DEPTH(m) 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: HJH	COMPLETION DEPTH: 30.2 m
	REVIEWED BY: MHB	COMPLETE: 07/01/97
	Fig. No:	Page 1 of 4

97/04/25 09:27AM (THURBER)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-4
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 7 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 721.938 (m)

SAMPLE TYPE ■ SHELBY TUBE ◸ SPT ☒ NO RECOVERY ☰ A-CASING ▯ GRAB SAMPLE ▮ CORE SAMPLE



SPT(N)	REMARKS	USC	SOIL DESCRIPTION
11		CI	CLAY (TILL) – CONTINUED
			SAND, brown, medium grained, saturated
	–Seepage noted		
10		SP CI	CLAY (TILL) very stiff, grey, silty, sandy, trace fine gravel
18		CI	
19		CI	–some fine sand, higher plasticity
17		CI	–wet sand lense, 35 mm thick
24		CI	
23		CI	

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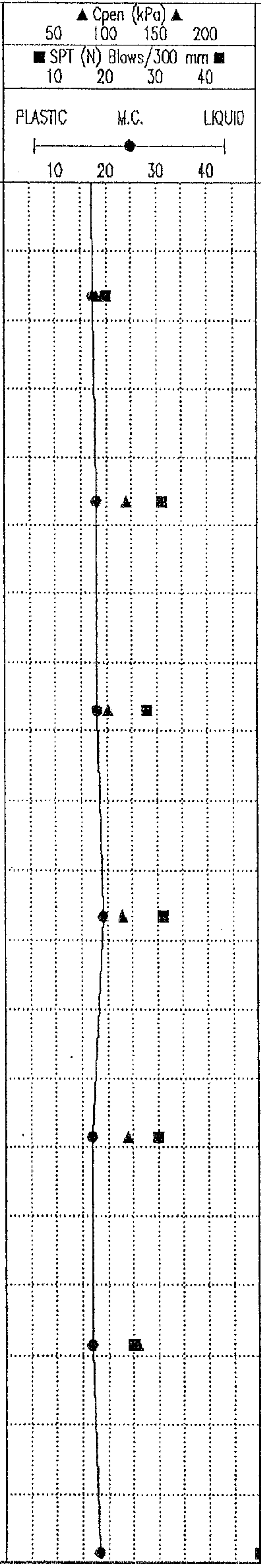
LOGGED BY: HJH	COMPLETION DEPTH: 30.2 m
REVIEWED BY: MHB	COMPLETE: 07/01/97
Fig. No:	Page 2 of 4

97/04/25 09:27AM (THURBER)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-4
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 7 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 721.938 (m)

SAMPLE TYPE ■ SHELBY TUBE ⧄ SPT ☒ NO RECOVERY ☰ A-CASING ▯ GRAB SAMPLE ▮ CORE SAMPLE



DEPTH(m)	SAMPLE TYPE	SPT(N)	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH(m)
20.0						CLAY (TILL) - CONTINUED	20.0
	⧄	20		CI	▨	-greyish brown, siltstone nodules	
21.0							21.0
22.0							22.0
	⧄	31		CI	▨	-clay shale and sandstone inclusions	
23.0							23.0
	⧄	28		CI	▨	-coal chips, more frequent clay shale nodules	
24.0							24.0
25.0							25.0
	⧄	31		CI	▨		
26.0							26.0
	⧄	30		CI	▨	-siltstone nodules	
27.0							27.0
28.0							28.0
	⧄	25		CI	▨		
29.0							29.0
						SANDSTONE, very dense, weathered, grey with brown lenses, bentonitic, fine grained	
	⧄	59		SS	░		
30.0							30.0

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	REVIEWED BY: MHB	COMPLETE: 07/01/97
	Fig. No:	Page 3 of 4

97/04/25 09:27AM (THURBER)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-4
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 7 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 721.938 (m)

SAMPLE TYPE ■ SHELBY TUBE ⧄ SPT ☒ NO RECOVERY ☰ A-CASING ◫ GRAB SAMPLE ▮ CORE SAMPLE

DEPTH(m)	SAMPLE TYPE	SPT(N)	▲ Cpen (kPa) ▲ 50 100 150 200 ■ SPT (N) Blows/300 mm ■ 10 20 30 40 PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH(m)
30.0	⧄	59			SS	▨		30.0
							END OF TEST HOLE 30.2 m ON COMPLETION: BACKFILLED	
31.0								31.0
32.0								32.0
33.0								33.0
34.0								34.0
35.0								35.0
36.0								36.0
37.0								37.0
38.0								38.0
39.0								39.0
40.0								40.0

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: HJH	COMPLETION DEPTH: 30.2 m
	REVIEWED BY: MHB	COMPLETE: 07/01/97
	Fig. No:	Page 4 of 4

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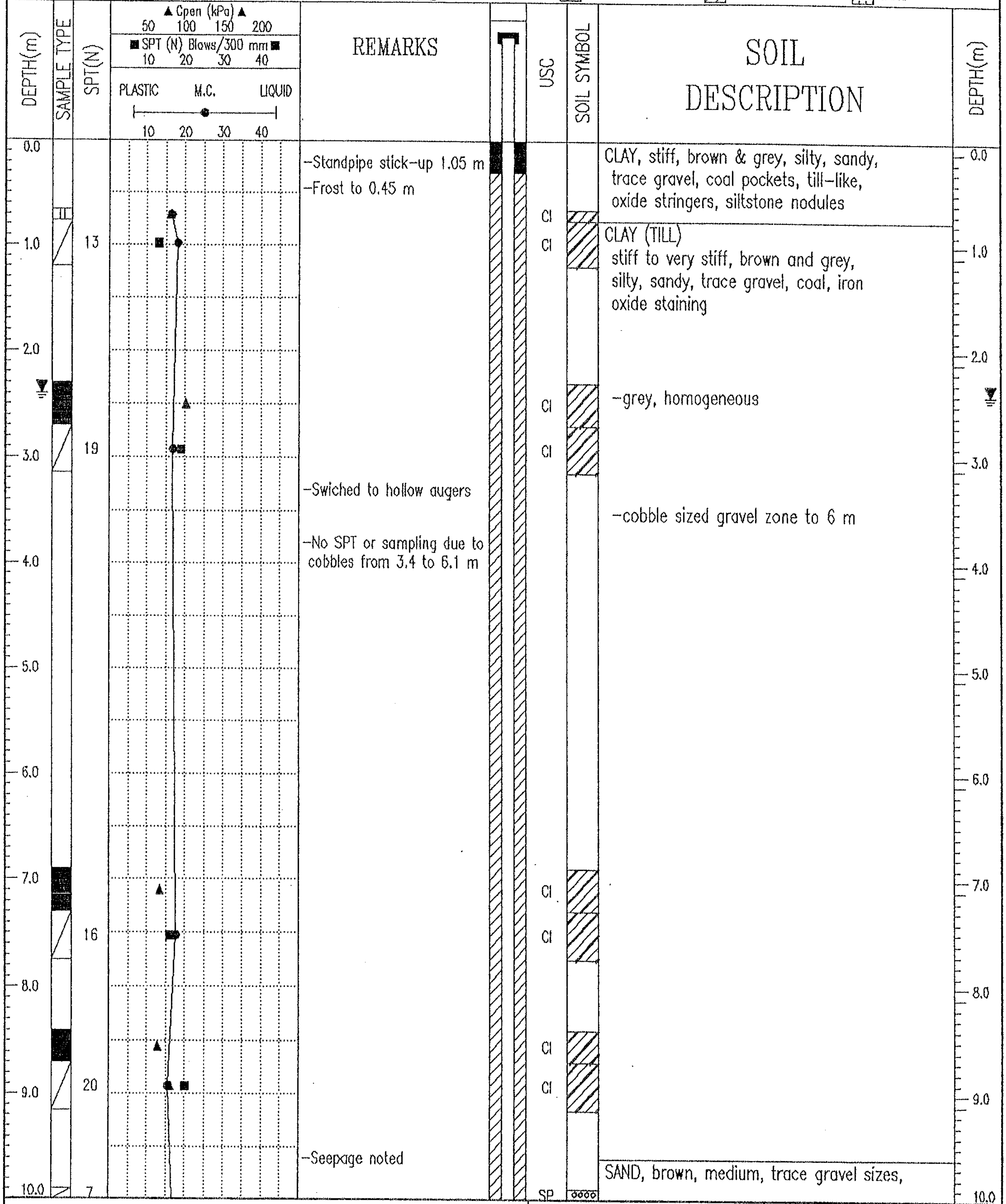
CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-5
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 7 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 722.951 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ☒ NO RECOVERY ☰ A-CASING ▥ GRAB SAMPLE ▮ CORE SAMPLE

BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ⁘ GROUT ▨ DRILL CUTTINGS ⁘ SAND



REMARKS

-Standpipe stick-up 1.05 m

-Frost to 0.45 m

-Swiched to hollow augers

-No SPT or sampling due to cobbles from 3.4 to 6.1 m

-Seepage noted

SOIL DESCRIPTION

CLAY, stiff, brown & grey, silty, sandy, trace gravel, coal pockets, till-like, oxide stringers, siltstone nodules

CLAY (TILL)
stiff to very stiff, brown and grey, silty, sandy, trace gravel, coal, iron oxide staining

-grey, homogeneous

-cobble sized gravel zone to 6 m

SAND, brown, medium, trace gravel sizes,

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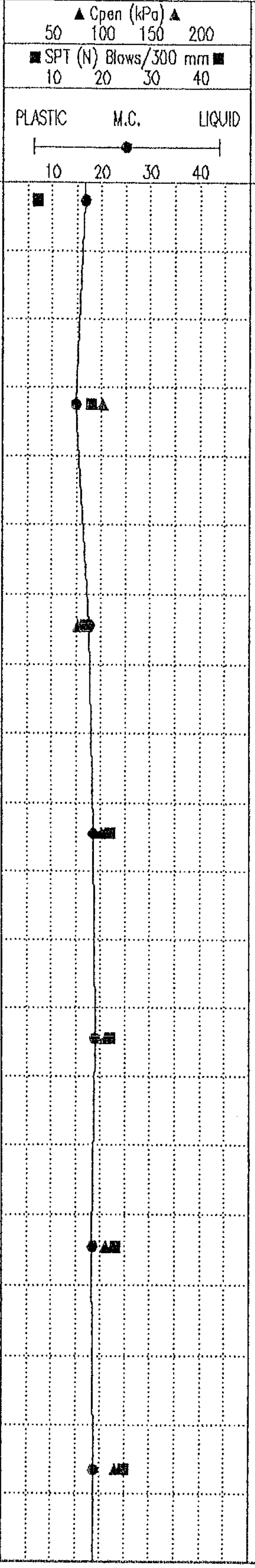
	REVIEWED BY: MHB	COMPLETE: 07/01/97
	Fig. No:	Page 1 of 3

97/04/25 09:21AM (THURPIEZ)

CLIENT: INFRASTRUCTURE SYSTEMS LTD	PROJECT: HWY 14/WHITEMUD DR INTERCHANGE	HOLE NO: TH97-5
DRILL CO: MOBILE AUGERS AND RESEARCH LTD	DRILL DATE: 7 JANUARY 1997	PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS	LOCATION: SEE DRAWING 19-598-45-1	ELEVATION: 722.951 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ SPT ☒ NO RECOVERY ▤ A-CASING ▥ GRAB SAMPLE ▮ CORE SAMPLE

BACKFILL TYPE ■ BENTONITE ☐ PEA GRAVEL ▥ SLOUGH ☐ GROUT ▨ DRILL CUTTINGS ▩ SAND



DEPTH(m)	SPT(N)	REMARKS	USC	SOIL DESCRIPTION
10.0	7		SP	SAND – CONTINUED clean, saturated
				CLAY (TILL) stiff to very stiff, grey, silty, sandy, trace gravel to 20 mm
11.0				
	18		CI	
12.0				
13.0	17		CI	–iron oxide stained pockets
14.0				
	22		CI	–very stiff, greyish brown, clay shale and siltstone nodules, coal chips
15.0				
16.0	22		CI	–fine grained sand stringers
17.0				
	23		CI	
18.0				
19.0	25		CI	–grey fine grained sand stringers, frequent clay shale nodules
20.0				

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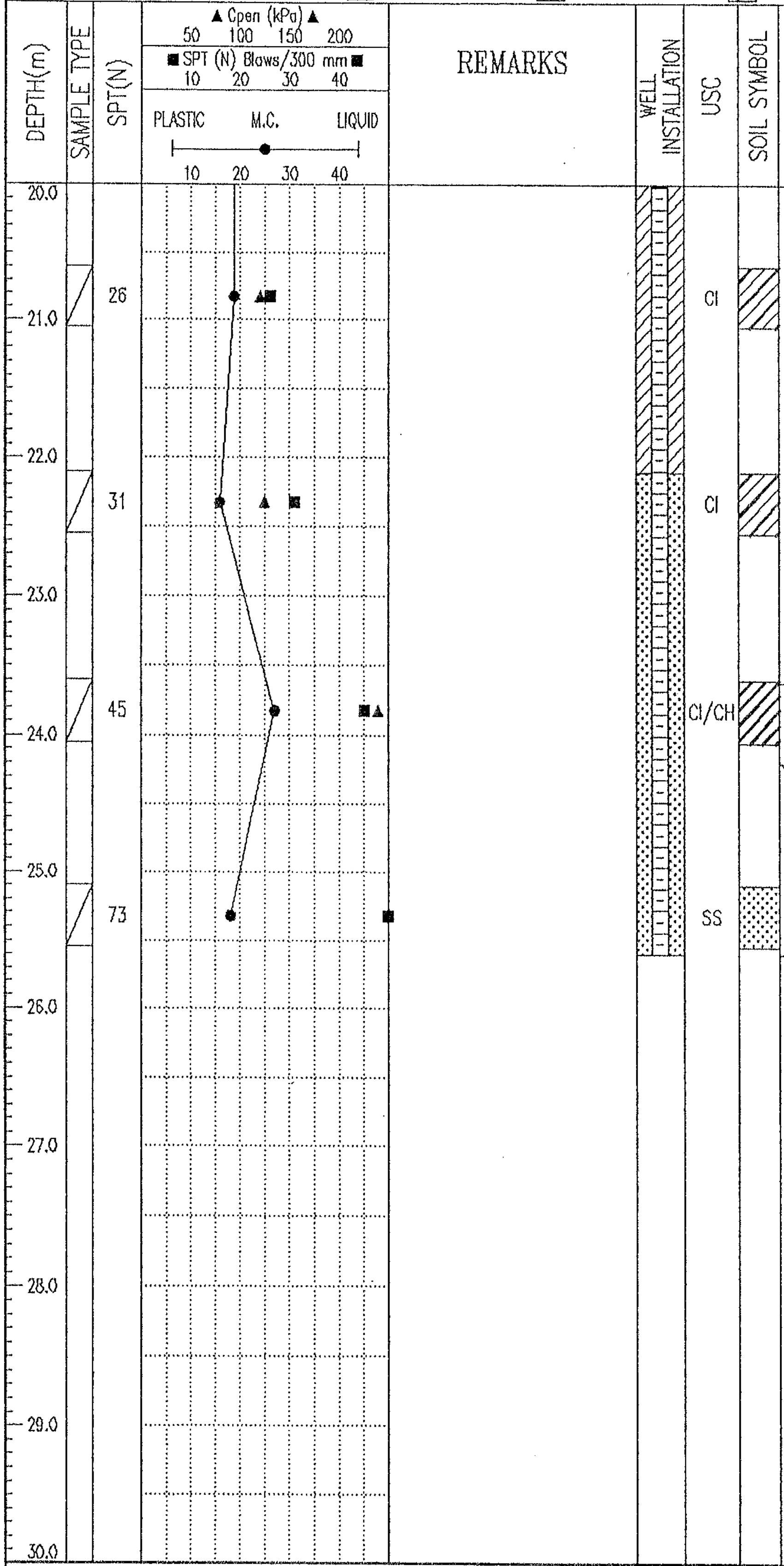
REVIEWED BY: MHB
Fig. No:

COMPLETION DEPTH: 25.6 m
COMPLETE: 07/01/97

CLIENT: INFRASTRUCTURE SYSTEMS LTD
PROJECT: HWY 14/WHITEMUD DR INTERCHANGE
HOLE NO: TH97-5
DRILL CO: MOBILE AUGERS AND RESEARCH LTD
DRILL DATE: 7 JANUARY 1997
PROJECT NO: 19-598-45
RIG/METHOD: B61/HOLLOW STEM AUGERS
LOCATION: SEE DRAWING 19-598-45-1
ELEVATION: 722.951 (m)

SAMPLE TYPE ■ SHELBY TUBE ◪ SPT ☒ NO RECOVERY ☰ A-CASING ▯ GRAB SAMPLE ▮ CORE SAMPLE
BACKFILL TYPE ■ BENTONITE ⁘ PEA GRAVEL ▥ SLOUGH ∴ GROUT ▨ DRILL CUTTINGS ░ SAND



SOIL DESCRIPTION

DEPTH(m)

20.0

CLAY (TILL) – CONTINUED

21.0

22.0

-possibly more sandy

23.0

23.6

CLAY SHALE, hard, grey and dark brown, carbonaceous, coal stringers, silt lenses
-siltstone laminations

24.0

SANDSTONE, very dense, grey, bentonitic, fine grained, carbonaceous, shell pieces

25.1m @ 697.85m.

25.0

END OF TEST HOLE 25.6m
ON COMPLETION:
-NO SLOUGH
STANDPIPE INSTALLED
-WATER AT 2.4m MARCH 27, 1997

26.0

27.0

28.0

29.0

30.0

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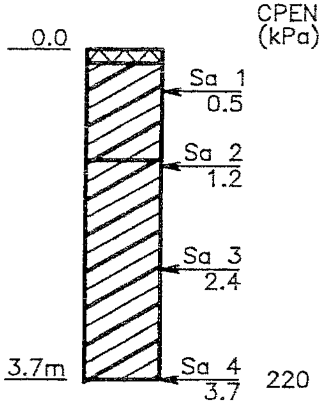
LOGGED BY: HJH
REVIEWED BY: MHB
Fig. No:
COMPLETION DEPTH: 25.6 m
COMPLETE: 07/01/97

97/04/25 09:22AM (THURPIEZ)

TEST HOLE PH97-1
LOCATION N 925 038
E 43 998
DATE MARCH 21, 1997
ELEVATION 732.679
DEPTH 3.7m



TOPSOIL, 150mm thick
CLAY
light brown, silty, sandy, desiccated, friable

CLAY (TILL)
brown, silty, sandy, desiccated, friable

-salts

LABORATORY ANALYSIS 1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI-CL	CI-CL	CI-CL	CI-CL	–	–	–
3	11.6	10.4	11.0	13.9	–	–	–

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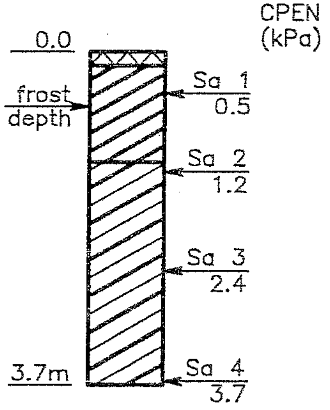
THURBER PROJECT # 19-598-45
CLIENT – INFRASTRUCTURE SYSTEMS LTD

TEST HOLE PH97-2
LOCATION N 925 049
E 43 819
DATE MARCH 21, 1997
ELEVATION 730.450
DEPTH 3.7m



TOPSOIL, 150mm thick
CLAY
light brown, silty, sandy, desiccated, friable

CLAY (TILL)
brown, silty, sandy, desiccated, friable

-salts

LABORATORY ANALYSIS
1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	19-50	–	–	–	–	–	–
2	CI/CH	CI	CI	CI	–	–	–
3	15.6	11.1	9.8	13.6	–	–	–
4	19.6	–	–	–	–	–	–
5	1666	–	–	–	–	–	–

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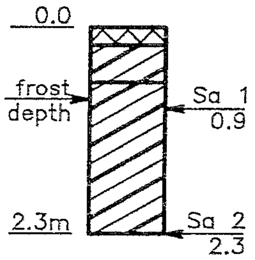
TEST HOLE PH97-3 DATE MARCH 20, 1997

LOCATION N 927 234
E 43 639

ELEVATION 720.166

DEPTH 2.3m



CPEN (kPa)

TOPSOIL, 200mm thick

CLAY
brown & grey, silty, sandy

70

CLAY (TILL)
stiff, grey & brown, silty, sandy, trace of gravel to 15mm dia

60 —water bearing sand partings

LABORATORY ANALYSIS 1 = PL—LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	—	—	—	—	—	—	—
2	CI	CI	—	—	—	—	—
3	20.0	20.2	—	—	—	—	—

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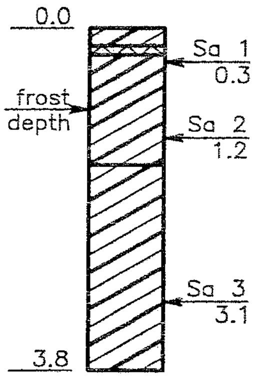
THURBER PROJECT # 19—598—45
CLIENT — INFRASTRUCTURE SYSTEMS LTD

TEST HOLE PH97—4 DATE MARCH 20, 1997

LOCATION N 927 536
E 43 658

ELEVATION 721.468

DEPTH 3.8m



CPEN (kPa)

CLAY (FILL), medium plastic, 200mm thk

TOPSOIL, black, silty, 100mm thick

CLAY, brown & grey, silty, sandy, oxide stains

110 —oxide concretions

80

CLAY (TILL)
brown & grey, silty, sandy, trace of gravel to 25mm dia

70

80 —fine grained sand lenses

70

LABORATORY ANALYSIS 1 = PL—LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	—	—	—	—	—	—	—
2	CI—CH	CI	CI	—	—	—	—
3	20.7	18.4	19.4	—	—	—	—

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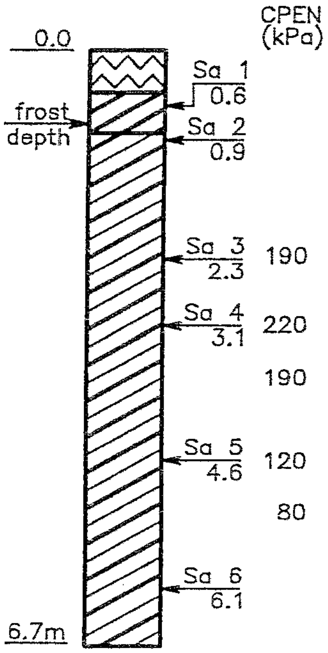
THURBER PROJECT # 19—598—45
CLIENT — INFRASTRUCTURE SYSTEMS LTD

TEST HOLE PH97-5   DATE MARCH 20, 1997

LOCATION N 927 693   ELEVATION 724.796
E 43 779

DEPTH 6.1m



TOPSOIL, dark brown, very silty, 460mm

CLAY, light brown, very silty, sandy, very friable, desiccated

CLAY (TILL)
light brown, very silty, sandy, white salts, friable, desiccated, oxide stains

—becomes grey & brown

—becomes grey, trace of gravel to 15mm

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI–CH	CI	CI	CI	CI	CI	–
3	15.6	11.8	12.6	13.7	17.2	17.5	–

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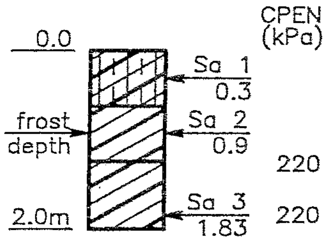
THURBER PROJECT # 19–598–45
CLIENT – INFRASTRUCTURE SYSTEMS LTD

THURBER

TEST HOLE PH97-6   DATE MARCH 20, 1997

LOCATION N 927 835   ELEVATION 725.120
E 43 676

DEPTH 2.0m



TOPSOIL, black, silty, 600mm thick

CLAY, light brown, very silty, some fine sand, white salts, desiccated, friable

CLAY (TILL), brown, very silty, sandy, oxide stains, desiccated

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	OL–CI	CI	CI	–	–	–	–
3	17.1	10.5	11.7	–	–	–	–

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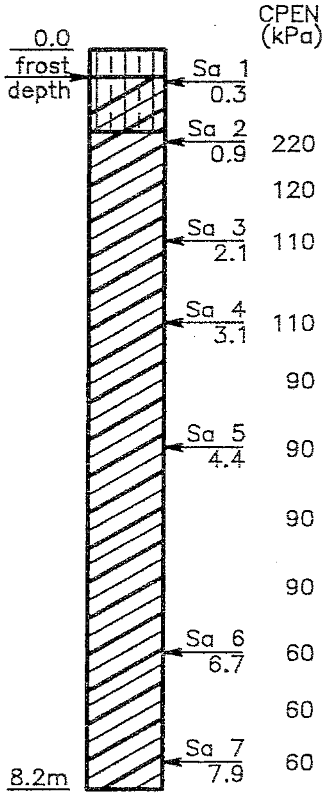
GEOTECHNICAL AND GEOLOGICAL ENGINEERS
THURBER PROJECT # 19–598–45
CLIENT – INFRASTRUCTURE SYSTEMS LTD

THURBER

TEST HOLE PH97-7
DATE MARCH 20, 1997
LOCATION N 927 842
E 43 892
ELEVATION 729.540
DEPTH 8.2m



TOPSOIL, dark brown, 300mm thick

CLAY, light brown, very silty, friable, dessicated
CLAY (TILL), very silty, sandy, oxide stains, trace of fine gravel, white salts, desiccated
—becomes grey & brown

—gravel to 25mm dia

—becomes grey, shale nodules

LABORATORY ANALYSIS 1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	—	—	—	—	—	—	—
2	CI-OL	CI	CI	CI	CI	CI	CI
3	13.6	12.9	17.2	17.4	18.5	18.1	18.3

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THURBER PROJECT # 19-598-45
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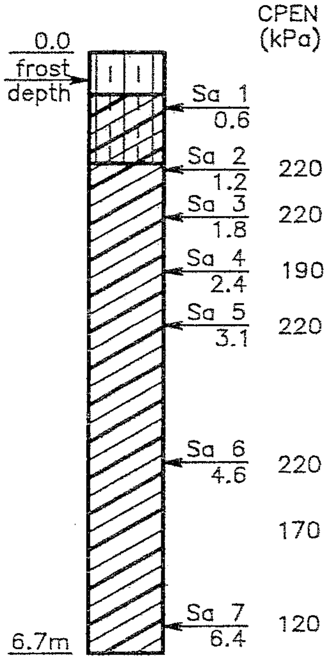
TEST HOLE PH97-8
DATE MARCH 20, 1997
LOCATION N 927 484
E 43 903
ELEVATION 732.002
DEPTH 6.7m



TOPSOIL, dark brown, silty, desiccated, 460mm thick
CLAY, light brown, very silty, sandy, dessicated, friable

CLAY (TILL), light brown, very silty, sandy, trace of fine gravel, desiccated, salts, oxide stains, friable
—becomes brown, coal
—gravel to 30mm dia

—becomes grey

LABORATORY ANALYSIS 1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	—	—	—	—	—	—	—
2	OL-CI	CI-CL	CI	CI	CI	CI	CI
3	13.7	10.0	11.6	11.8	13.1	14.7	14.8

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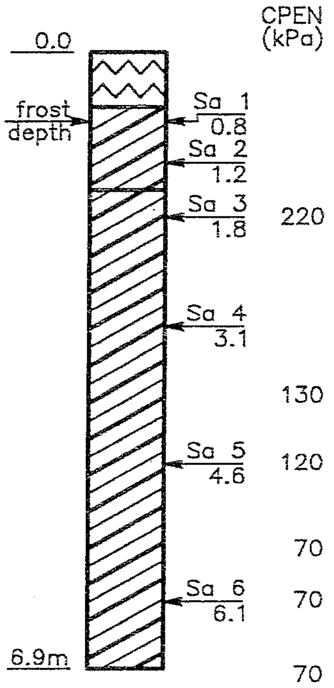
TEST HOLE PH97-9
DATE MARCH 20, 1997
LOCATION N 927 486
E 44 133
ELEVATION 732.957
DEPTH 6.9m



TOPSOIL, dark brown, silty, dessicated 600mm thick

CLAY, brown, silty, sandy, desiccated, friable

CLAY (TILL), brown, silty, sandy, trace of gravel, oxide stains, coal chips, friable, desiccated

–gravelly sand layers

–becomes grey

LABORATORY ANALYSIS

1 = PL–LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	15–37	–	–	–	–	–
2	CI–CL	CI	CI	CI	CI	CI	–
3	14.1	9.3	10.6	7.4	17.9	15.1	–
4	–	15.0	–	–	–	–	–
5	–	1810	–	–	–	–	–

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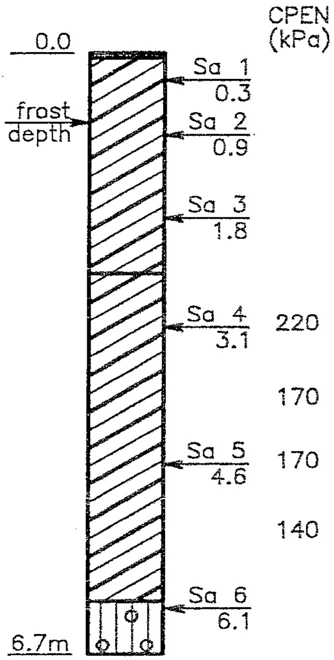
TEST HOLE PH97-10
DATE MARCH 20, 1997
LOCATION N 927 311
E 43 825
ELEVATION 729.517
DEPTH 6.7m



TOPSOIL, dark brown, 50mm thick

CLAY, light brown, very silty, sandy, desiccated, salts, friable

CLAY (TILL), light brown & mottled grey, silty, sandy, gravel to 15mm dia, oxide stains, coal chips, salts

becomes grey & brown, gravel to 30mm dia

SAND, brown, fine grained, silty

LABORATORY ANALYSIS

1 = PL–LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	–	16–41	–	–	–	–
2	CL–CI	CL–CI	CI	CI	CI	SM	–
3	16.0	11.3	12.9	13.6	15.8	13.0	–
4	–	–	16.2	–	–	–	–
5	–	–	1767	–	–	–	–

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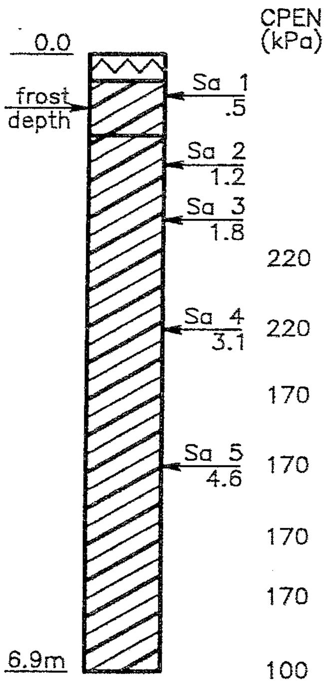
TEST HOLE PH97-11 DATE MARCH 20, 1997

LOCATION N 927 682 ELEVATION 734.772
E 44 086

DEPTH 6.9m



TOPSOIL, dark brown, silty, 300mm thick

CLAY, light brown, very silty,sandy, dessicated, friable

CLAY (TILL), light brown, silty, sandy, oxide stains, coal chips, dessicated, friable
–salts

–becomes grey

LABORATORY ANALYSIS

1 = PL–LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	–	14–36	–	–	–	–
2	CI–CL	CI	CI	CI	CI	–	–
3	14.3	10.2	10.4	11.4	15.5	–	–
4	–	–	14.3	–	–	–	–
5	–	–	1834	–	–	–	–

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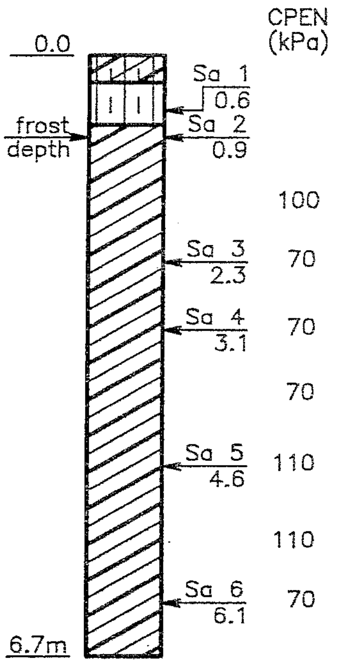
TEST HOLE PH97-12 DATE MARCH 20, 1997

LOCATION N 927 961 ELEVATION 732.863
E 44 093

DEPTH 6.7m



TOPSOIL & CLAY (FILL), 300mm thick

TOPSOIL, 460mm thick

CLAY (TILL), light brown, silty, sandy, trace of gravel to 25mm dia

–becomes grey & brown, salts, sand partings, coal pockets

–coal pockets

–becomes brown

–shale nodules

–brown sand pockets

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	OL	CI	CI	CI	CI	CI	–
3	29.1	18.5	20.4	19.0	17.8	17.8	–

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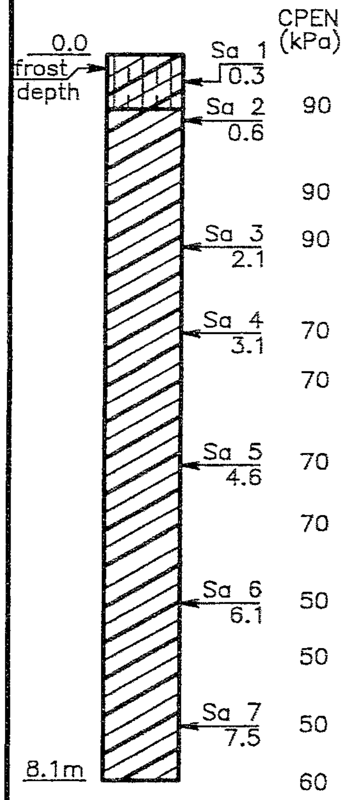
TEST HOLE PH97-13
DATE MARCH 20, 1997
LOCATION N 927 970
E 43 886
ELEVATION 729.681
DEPTH 8.1m



CLAY & TOPSOIL (FILL), 600mm thick

CLAY (TILL), light brown, silty, sandy, trace of fine gravel, oxide stains, coal chips

–coal pockets, gravel to 25mm dia

–becomes grey

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI–OL	CI	CI	CI	CI	CI	CI
3	22.5	19.3	18.8	18.6	19.0	18.3	18.1

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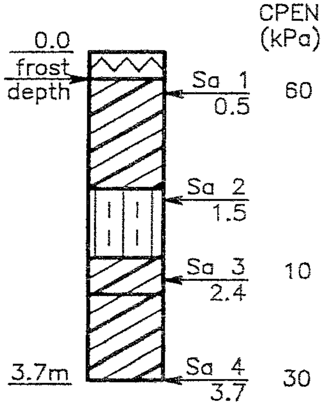
TEST HOLE PH97-14
DATE MARCH 20, 1997
LOCATION N 928 116
E 43 679
ELEVATION 721.594
DEPTH 3.7m



TOPSOIL, black, silty, 300mm thick

CLAY (FILL), brown, silty, sandy, trace of gravel

PEAT, black, amorphous

CLAY, grey, organic,

CLAY (TILL), brown & grey, silty, sandy

LABORATORY ANALYSIS
1 = PL–LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	14–38	–	–	–	–	–	–
2	CI	OL	CI	CI	–	–	–
3	21.9	203.0	29.7	20.7	–	–	–
4	14.5	–	–	–	–	–	–
5	1831	–	–	–	–	–	–

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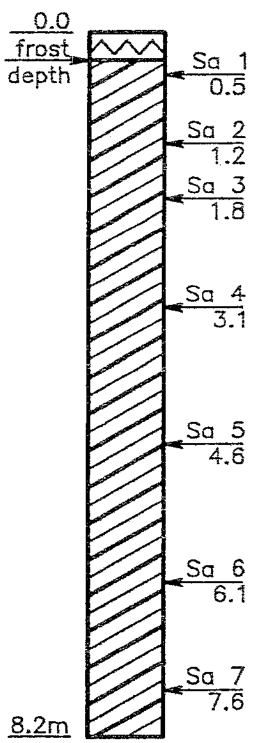
TEST HOLE PH97-15
DATE MARCH 20, 1997
LOCATION N 928 148
E 43 838
ELEVATION 723.995
DEPTH 8.2m



CPEN (kPa)	
	TOPSOIL, black, silty, 300mm thick
	CLAY (TILL), brown, silty, sandy, trace of fine gravel, oxide stains, sand partings
70	
100	—becomes grey & brown
	—zone of water bearing sand lenses
80	—becomes brown
80	
110	—becomes grey
100	—shale nodules
120	
120	
120	

LABORATORY ANALYSIS
1 = PL–LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	14–42	–	–	–	–	–	–
2	CI	CI	CI	CI	CI	CI	CI
3	20.2	18.3	18.5	18.2	16.1	16.1	16.6
4	15.2	–	–	–	–	–	–
5	1811	–	–	–	–	–	–

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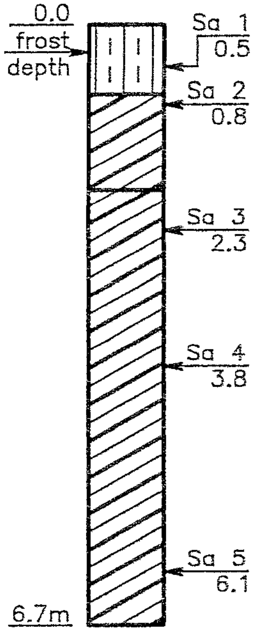
TEST HOLE PH97-16
DATE MARCH 20, 1997
LOCATION N 928 122
E 43 986
ELEVATION 727.658
DEPTH 6.7m



CPEN (kPa)	
	TOPSOIL, black, peaty, 750mm thick
30	CLAY, greyish–light brown, silty
30	
60	CLAY (TILL), grey & brown, silty, sandy, trace of gravel to 15mm dia, coal chips, oxide stains
60	
70	—becomes olive brown
80	—becomes grey & brown grading to grey, gravel to 25mm dia
80	
60	
60	

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	OL	CI	CI	CI	CI	–	–
3	34.2	24.7	19.5	17.9	18.6	–	–

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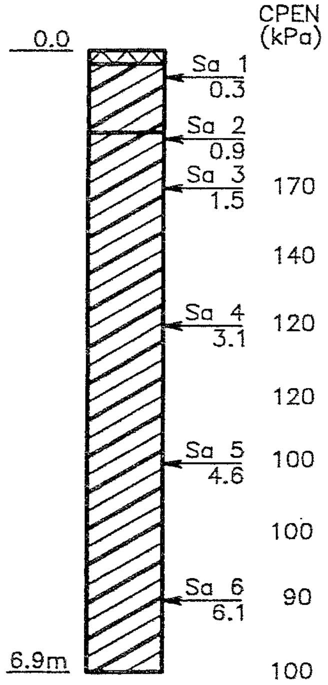
TEST HOLE PH97-17 **DATE** MARCH 20, 1997

LOCATION N 928 113 E 44 138 **ELEVATION** 735.633

DEPTH 6.9m



TOPSOIL, black, silty, 150mm thick
CLAY, light brown, silty, sandy

CLAY (TILL), brown, silty, sandy, trace of fine gravel, oxide stains

—iron oxides

—becomes brown & mottled grey

—becomes grey

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	–	14–37	–	–	–	–
2	CI	CI	CI	CI	CI	–	–
3	17.3	17.4	15.5	16.6	17.5	–	–
4	–	–	14.3	–	–	–	–
5	–	–	1834	–	–	–	–

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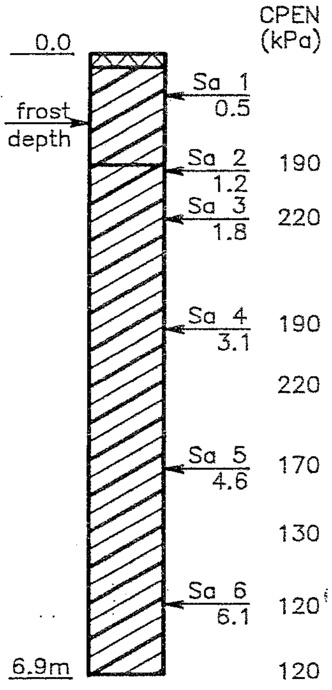
TEST HOLE PH97-18 **DATE** MARCH 20, 1997

LOCATION N 928 313 E 44 128 **ELEVATION** 732.460

DEPTH 6.9m



TOPSOIL, dark brown, silty, 150mm thick
CLAY, light brown, silty, sandy

CLAY (TILL), brown, silty, sandy, trace of fine gravel, oxide stains, salts

—coal chips

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	14–40	–	–	–	–	–
2	CI	CI	CI	CI	CI	CI	–
3	24.7	15.4	11.9	16.9	15.0	17.1	–
4	–	15.1	–	–	–	–	–
5	–	1812	–	–	–	–	–

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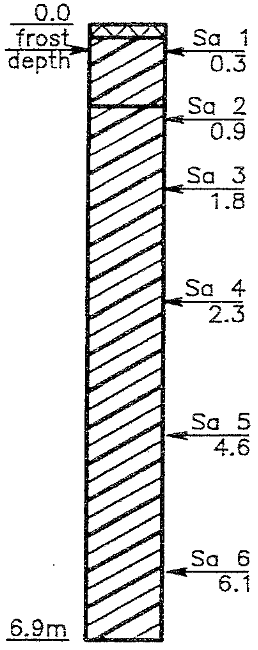
TEST HOLE PH97-19
DATE MARCH 20, 1997
LOCATION N 928 230
E 44 029
ELEVATION 732.152
DEPTH 6.9m



CPEN (kPa)	
	TOPSOIL, dark brown, silty, 150mm thick CLAY, light brown, silty, sandy
190	CLAY (TILL), brown, silty, sandy, trace of gravel to 50mm dia, oxide stains
140	—salts
170	
190	—coal chips
220	—gravel to 75mm dia
120	
110	
80	—becomes grey & brown —becomes grey
80	

LABORATORY ANALYSIS 1 = PL—LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	—	—	—	—	—	—	—
2	CI	CI	CI	CI	CI	CI	—
3	18.1	16.8	16.4	13.6	16.5	17.2	—

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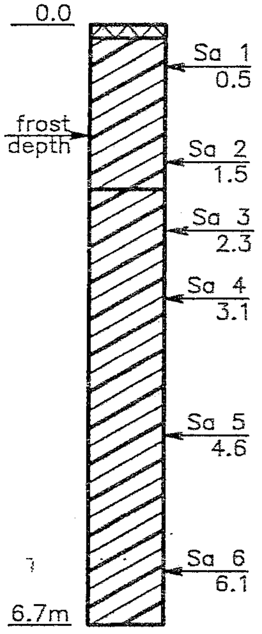
TEST HOLE PH97-20
DATE MARCH 21, 1997
LOCATION N 928 394
E 43 837
ELEVATION 731.336
DEPTH 6.7m



CPEN (kPa)	
	TOPSOIL, dark brown, silty, 150mm thick CLAY, lightbrown, silty, sandy, salts
110	
100	CLAY (TILL), brown—mottled grey, silty, sandy, trace of gravel to 15mm dia, oxide stains
100	
110	—becomes brown
130	—gravel to 50mm dia —becomes grey
80	
90	
90	

LABORATORY ANALYSIS
1 = PL—LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	—	—	14—37	—	—	—	—
2	CI	CI	CI	CI	CI	CI	—
3	17.5	21.0	19.2	18.6	17.5	16.4	—
4	—	—	14.6	—	—	—	—
5	—	—	1826	—	—	—	—

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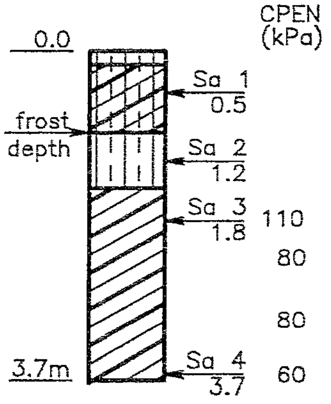
TEST HOLE PH97-21
DATE MARCH 21, 1997
LOCATION N 928 305
E 43 801
ELEVATION 727.288
DEPTH 3.7m



TOPSOIL, 150mm thick
CLAY (FILL), light brown, silty, sandy, marbled with black organic soil

TOPSOIL, black, silty, 620mm thick

CLAY (TILL), brown & grey, silty, sandy
-gravel to 25mm dia, oxide stains

LABORATORY ANALYSIS 1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI-OL	OL	CI	CI	–	–	–
3	29.6	28.5	18.6	19.3	–	–	–

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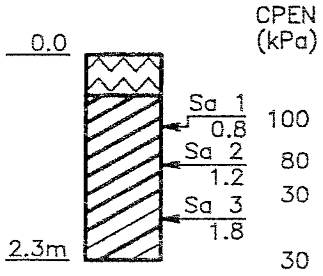
TEST HOLE PH97-22
DATE MARCH 21, 1997
LOCATION N 928 417
E 43 663
ELEVATION 725.916
DEPTH 2.3m



TOPSOIL, black, silty, 450mm thick

CLAY, brown & grey, silty, some sand, rootlets

LABORATORY ANALYSIS
1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	18-56	–	–	–	–	–	–
2	CH	CH	CI	–	–	–	–
3	22.1	24.5	26.1	–	–	–	–
4	19.2	–	–	–	–	–	–
5	1683	–	–	–	–	–	–

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THURBER PROJECT # 19-598-45
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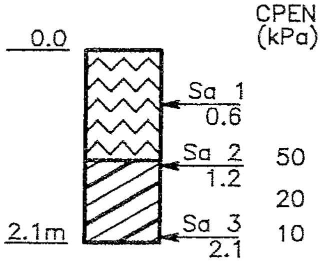
TEST HOLE PH97-23
DATE MARCH 21, 1997
LOCATION N 928 499
E 43 567
ELEVATION 724.229
DEPTH 2.1m



TOPSOIL, black, silty, some peat, 1.22m thick

CLAY, light grey, silty, some sand, oxide stains
—becomes light brown
—becomes sandy

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	13–37	–	–	–	–	–
2	–	CI	CI	–	–	–	–
3	152.0	20.4	22.5	–	–	–	–
4	–	13.7	–	–	–	–	–
5	–	1865	–	–	–	–	–

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THURBER PROJECT # 19–598–45
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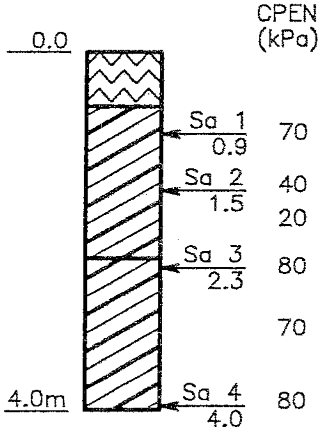
THURBER

TEST HOLE PH97-24
DATE MARCH 19, 1997
LOCATION N 928 285
E 43 515
ELEVATION 723.882
DEPTH 4.0m



TOPSOIL, black, silty, 600mm thick

CLAY, brown, silty, sandy

—trace of gravel to 25mm dia

CLAY (TILL), brown, silty, sandy, trace of fine gravel, oxide stains, coal chips

—becomes olive brown

LABORATORY ANALYSIS 1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI	CI	CI	–	–	–
3	20.5	21.2	19.3	19.8	–	–	–

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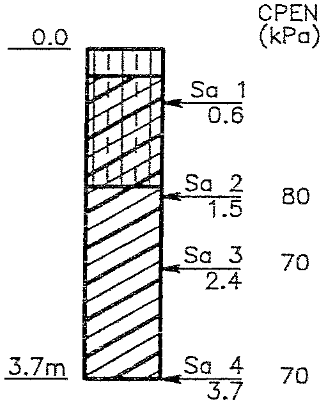
THURBER PROJECT # 19–598–45
CLIENT – INFRASTRUCTURE SYSTEMS LTD
THURBER

TEST HOLE PH97-25
DATE MARCH 21, 1997
LOCATION N 928 106
E 43 583
ELEVATION 721.633
DEPTH 3.7m



TOPSOIL (FILL), some clay, 300mm thick

TOPSOIL, black, silty

CLAY (TILL), grey &brown, silty, sandy, trace of gravel to 25mm dia, oxide stains, coal chips

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	14–37	–	–	–	–	–
2	CI–OL	CI	CI	CI	–	–	–
3	37.0	19.0	19.7	17.3	–	–	–
4	–	14.7	–	–	–	–	–
5	–	1820	–	–	–	–	–

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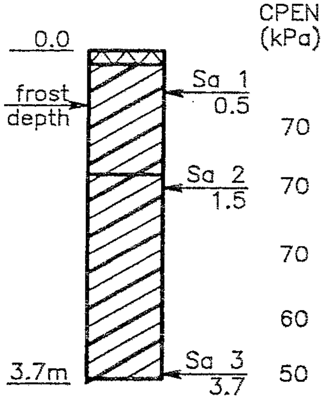
TEST HOLE PH97-26
DATE MARCH 19, 1997
LOCATION N 928 113
E 43 402
ELEVATION 723.176
DEPTH 3.7m



TOPSOIL, dark brown, silty, sandy, 150mm

CLAY, dark brown, grading to light brown, silty, sandy, friable

CLAY (TILL), brown, silty, sandy, trace of fine gravel, oxide stains, coal chips

–becomes light brown

–gravel to 35mm dia

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI	CI	–	–	–	–
3	19.4	17.7	19.5	–	–	–	–

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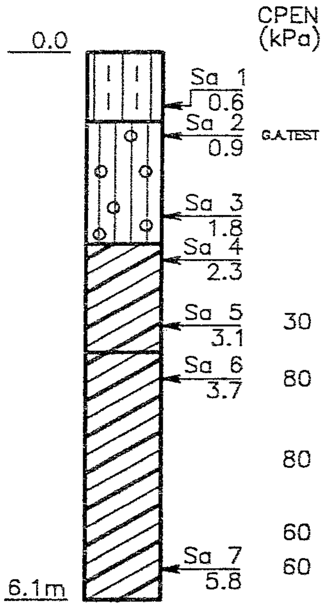
TEST HOLE PH97-27

DATE MARCH 21, 1997

LOCATION N 927 989
E 43 149

ELEVATION 717.932

DEPTH 6.1m



TOPSOIL, black, silty, sandy, 760mm thick

SAND, black & brown, medium grained, some silt, trace of clay to 1.2m
—some silt, brown, fine grained
—becomes very silty

CLAY, very silty, trace of fine sand

CLAY (TILL), brown, silty, sandy, gravel to 25mm dia, shale nodules
—becomes grey

—some clayey zones with no sand constituent

LABORATORY ANALYSIS 1 = PL—LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	—	—	—	—	—	—	—
2	OL	SM	SM	CL—CI	CI	CI	CI
3	12.6	11.3	20.1	23.0	32.3	17.4	18.6

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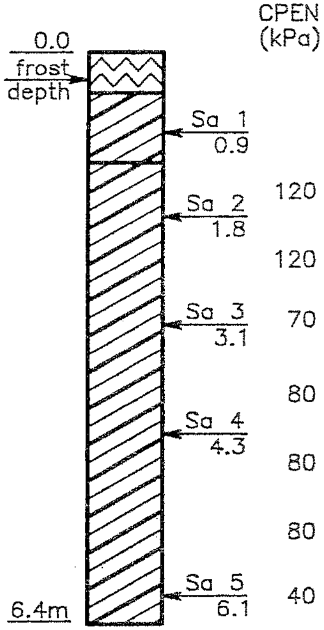
TEST HOLE PH97-28

DATE MARCH 19, 1997

LOCATION N 928 001
E 42 935

ELEVATION 709.684

DEPTH 6.4m



TOPSOIL, black, silty, 450mm thick

CLAY, light brown, silty, very sandy, trace to some fine gravel, friable

CLAY (TILL), light brown—mottled grey, silty, sandy, trace of fine gravel, oxide stains, salts

—gravel to 30mm dia
—some gravel to 4.6m

—becomes grey

LABORATORY ANALYSIS
1 = PL—LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	13—33	—	—	—	—	—	—
2	CL—CI	CL—CI	CI	CI	CI	—	—
3	10.7	15.3	19.3	19.2	19.4	—	—
4	13.0	—	—	—	—	—	—
5	1884	—	—	—	—	—	—

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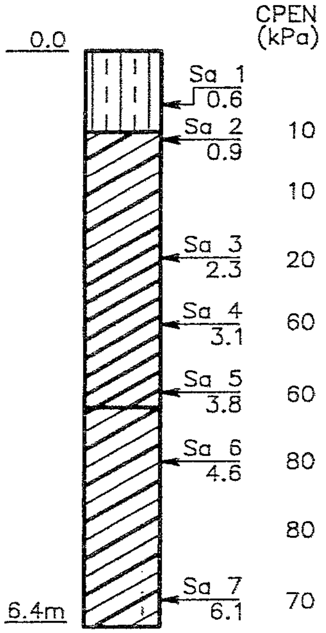
TEST HOLE	PH97-29	DATE	MARCH 21, 1997
LOCATION	N 928 003 E 42 681	ELEVATION	707.286
		DEPTH	6.4m



TOPSOIL, black, silty, 900mm thick

CLAY, light grey, silty, sandy, oxide concretion
—becomes brown & grey

—sand lenses

—trace of fine gravel to 3.4m

—becomes very sandy

CLAY (TILL), grey, silty, sandy, trace of fine gravel

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	14–44	–	–	–	–	–
2	OL	CI	CH	CH	CH	CI	CI
3	101.9	25.5	20.5	19.7	19.5	15.1	17.6
4	–	15.7	–	–	–	–	–
5	–	1794	–	–	–	–	–

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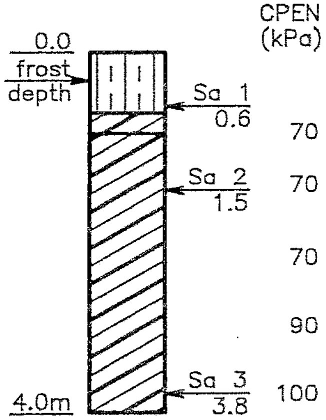
TEST HOLE	PH97-30	DATE	MARCH 19, 1997
LOCATION	N 927 771 E 43 469	ELEVATION	718.612
		DEPTH	4.0m



TOPSOIL, black, silty, some sand, 670mm thick

CLAY, light brown, silty, sandy

CLAY (TILL), brown silty, sandy, trace of gravel to 15mm dia, oxide stains, coal chips

—trace of gravel to 25mm dia

LABORATORY ANALYSIS 1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	OL	CI	CI	–	–	–	–
3	22.7	18.6	18.1	–	–	–	–

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THURBER PROJECT # 19–598–45
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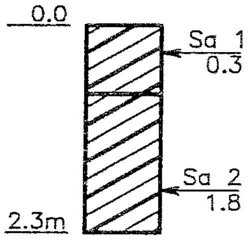
TEST HOLE PH97-31 DATE MARCH 19, 1997

LOCATION N 927 838
E 43 574

ELEVATION 719.499

DEPTH 2.3m



CPEN (kPa)

30
80
90
90
120

CLAY, brown & mottled grey, silty, sandy, oxide stains & concretions

CLAY (TILL), brown, silty, sandy, trace of gravel to 15mm dia, oxide stains, coal chips

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI	–	–	–	–	–
3	18.8	17.9	–	–	–	–	–

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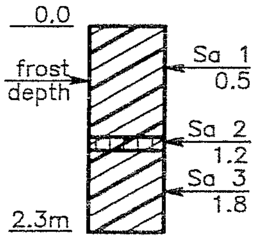
THURBER PROJECT # 19–598–45
CLIENT – INFRASTRUCTURE SYSTEMS LTD

TEST HOLE PH97-32 DATE MARCH 19, 1997

LOCATION N 927 546
E 43 568

ELEVATION 718.558

DEPTH 2.3m



CPEN (kPa)

60
20
20

TOPSOIL & CLAY (FILL), silty, black topsoil mixed with clay till, 1.22m thick

TOPSOIL, black, 150mm thick
CLAY, black stained to 1.7m turning to light brown & mottled grey, silty, sandy, sand partings, oxide stains

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI–OL	CI	–	–	–	–
3	19.4	39.4	25.6	–	–	–	–

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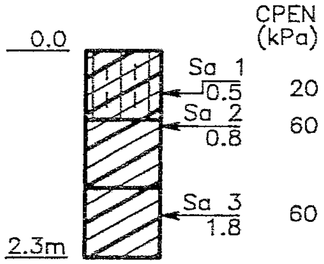
TEST HOLE PH97-33
DATE MARCH 19, 1997
LOCATION N 927 231
E 43 546
ELEVATION 719.130
DEPTH 2.3m



TOPSOIL (FILL), black & brown, silty, mixed with clay till, 760mm thick

CLAY, light brown mottled with light grey, silty, sandy, sand seams, oxide stains, rootlets, salt deposits

CLAY (TILL), brown & grey, silty, sandy, sand lenses, oxide stains,

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	19–47	–	–	–	–	–
2	CI–OL	CI	CI	–	–	–	–
3	23.3	25.9	25.1	–	–	–	–
4	–	19.2	–	–	–	–	–
5	–	1675	–	–	–	–	–

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THURBER PROJECT # 19-598-45
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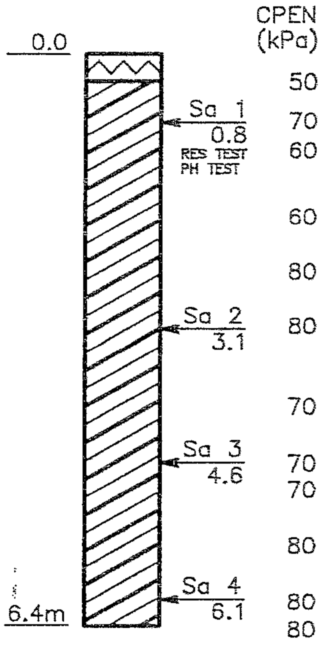
TEST HOLE PH97-34
DATE MARCH 19, 1997
LOCATION N 926 898
E 43 522
ELEVATION 717.008
DEPTH 6.4m



TOPSOIL, black, peaty, 300mm thick

CLAY (TILL), brown, silty, sandy, occasional gravel to 15mm dia, oxide stains

–becomes olive brown, coal chips
–becomes grey

–shale nodules

LABORATORY ANALYSIS 1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI	CI	CI	–	–	–
3	17.9	19.6	17.3	16.8	–	–	–

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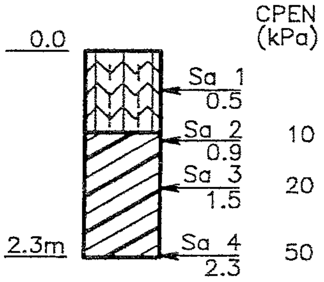
TEST HOLE PH97-35

DATE MARCH 21, 1997

LOCATION N 929 438
E 44 987

ELEVATION 735.782

DEPTH 32.3m



PEAT, black, fibrous over amorphous 900mm thick

CLAY, light grey, silty, sandy, trace of organics to 1.5m
—becomes brown & grey

LABORATORY ANALYSIS
1 = PL–LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	17–41	–	–	–	–	–
2	PT–OL	CI	CI	CI	–	–	–
3	99.7	33.0	26.3	23.2	–	–	–
4	–	17.6	–	–	–	–	–
5	–	1720	–	–	–	–	–

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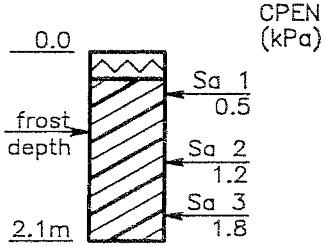
TEST HOLE PH97-36

DATE MARCH 21, 1997

LOCATION N 929 435
E 44 629

ELEVATION 737.658

DEPTH 2.1m



TOPSOIL, dark brown, silty, 300mm thick

CLAY, light brown, very silty, sandy

—salts, friable

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI	CI	–	–	–	–
3	18.4	13.3	11.5	–	–	–	–

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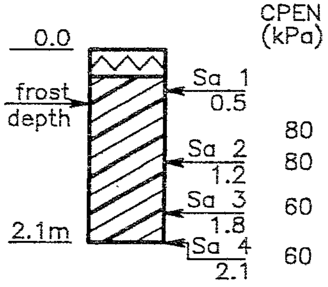
TEST HOLE PH97–37 DATE MARCH 21, 1997

LOCATION N 929 435
E 44 209

ELEVATION 728.385

DEPTH 2.1m



TOPSOIL, black, silty, 300mm thick

CLAY (TILL), light brown, silty, sandy, trace of gravel to 15mm dia, oxide stains, sand lenses

– becomes brown & grey

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI	CI	–	–	–	–
3	17.4	19.0	19.5	–	–	–	–

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THURBER PROJECT # 19–598–45
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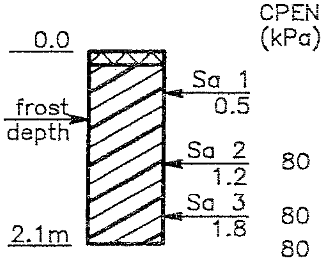
TEST HOLE PH97–38 DATE MARCH 19, 1997

LOCATION N 929 568
E 43 776

ELEVATION 720.493

DEPTH 2.1m



TOPSOIL, black, silty, 150mm thick
CLAY (TILL), brown & mottled grey, silty, sandy, trace of fine gravel

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI	CI	–	–	–	–
3	20.2	18.8	18.8	–	–	–	–

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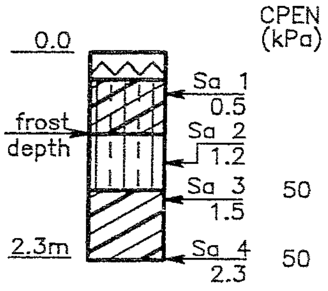
TEST HOLE PH97-39 DATE MARCH 21, 1997

LOCATION N 929 583
E 43 475
ELEVATION 717.301

DEPTH 2.3m



TOPSOIL, black, silty, 300mm thick
CLAY (FILL), light brown, silty, sandy, oxide stains

TOPSOIL, black, silty

CLAY, grey & brown, silty, sandy

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	–	15–41	–	–	–	–
2	CI–OL	OL	CI	CH	–	–	–
3	23.5	90.8	21.5	28.7	–	–	–
4	–	–	15.5	–	–	–	–
5	–	–	1797	–	–	–	–

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TEST HOLE PH97-40 DATE

LOCATION N 929 732
E 43 326
ELEVATION

DEPTH

NO PERMISSION TO DRILL

LABORATORY ANALYSIS 1 = PL-LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–

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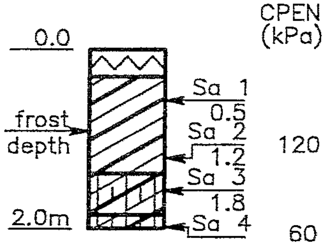
TEST HOLE PH97-41
DATE MARCH 21, 1997
LOCATION N 929 867
E 43 461
ELEVATION 717.026
DEPTH 2.0m



TOPSOIL, black, silty, 300mm thick

CLAY (FILL), brown, silty, sandy, trace of gravel

TOPSOIL, black, silty

CLAY, grey, silty, sandy, organic stained

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CI	CI	CI–OL	CI–OL	–	–	–
3	16.4	24.0	70.5	25.0	–	–	–

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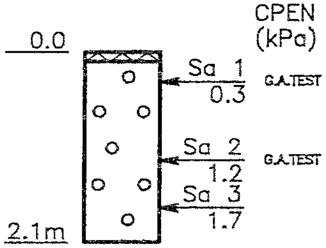
TEST HOLE PH97-42
DATE MARCH 19, 1997
LOCATION N 931 065
E 43 381
ELEVATION 710.922
DEPTH 2.1m



TOPSOIL, 100mm thick

SAND, fine, brown with oxide stained streaks, trace of silt, desiccated

–coal stained layer

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	SP	SP	SP	–	–	–	–
3	3.7	10.5	24.2	–	–	–	–

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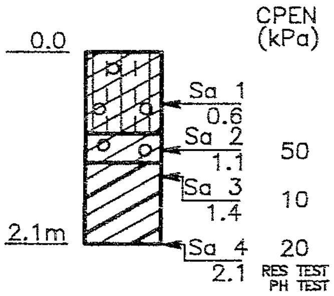
THURBER PROJECT # 19–598–45
CLIENT – INFRASTRUCTURE SYSTEMS LTD

TEST HOLE PH97-43
DATE MARCH 21, 1997
LOCATION N 931 039
E 43 647
ELEVATION 710.827
DEPTH 2.1m



TOPSOIL (FILL), black, sandy, 900mm thk

CLAY (FILL), very sandy

CLAY, light grey, silty, sandy, salts

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	–	–	17–35	–	–	–	–
2	SC–OL	SC	CI	CI–CL	–	–	–
3	12.9	11.1	23.5	27.4	–	–	–
4	–	–	16.9	–	–	–	–
5	–	–	1734	–	–	–	–

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THURBER PROJECT # 19-598-45
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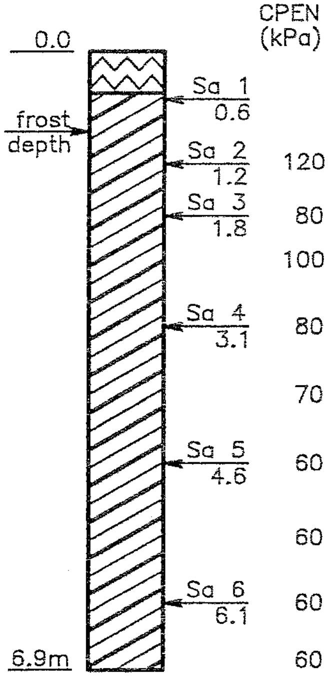
THURBER

TEST HOLE PH97-44
DATE MARCH 19, 1997
LOCATION N 929 265
E 44 169
ELEVATION 728.138
DEPTH 6.9m



TOPSOIL, black, silty, sandy, 460mm thick

CLAY (TILL), brown, silty, sandy, trace of fine gravel

–becomes grey

–bedrock nodules

LABORATORY ANALYSIS

1 = PL-LL, 2= CLASS, 3 = MC, 4 = OPT MC, 5 = MAX DD

	S1	S2	S3	S4	S5	S6	S7
1	16–47	–	16–39	–	–	–	–
2	CI	CI	CI	CI	CI	CI	–
3	21.0	18.6	18.5	17.9	18.2	18.3	–
4	17.3	–	16.1	–	–	–	–
5	1740	–	1770	–	–	–	–

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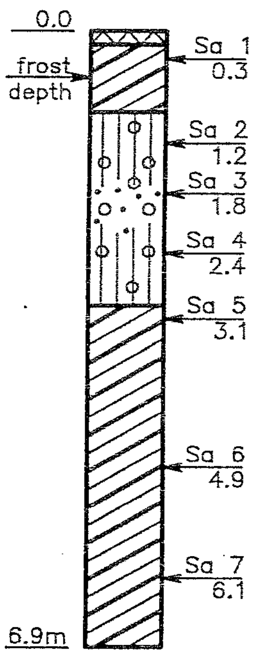
CLIENT – INFRASTRUCTURE SYSTEMS LTD

THURBER

TEST HOLE PH97–45
DATE MARCH 21, 1997
LOCATION N 929 265
E 44 098
ELEVATION 729.323
DEPTH 6.9m



CPEN (kPa)

TOPSOIL, dark brown, silty, 150mm thick
CLAY, light brown, very silty, sandy, desicated, friable

G.A.TEST SAND, light brown, fine grained, silty to 1.5m
G.A.TEST –well graded zone, some silt, trace of gravel to 10mm dia

–becomes fine grained

190 CLAY (TILL), brown & mottled grey, silty, sandy, trace of fine gravel, oxide stains

170

120 –gravel to 25mm dia, coal chips

110

–becomes grey

70

70

LABORATORY ANALYSIS 1 = PL–LL, 2= CLASS, 3 = MC

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	CL–CI	SM	SW	SM	CI	CI	CI
3	12.2	5.1	4.7	4.1	14.2	16.5	17.3

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TEST HOLE
DATE
LOCATION
ELEVATION
DEPTH

LABORATORY ANALYSIS

	S1	S2	S3	S4	S5	S6	S7
1	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–

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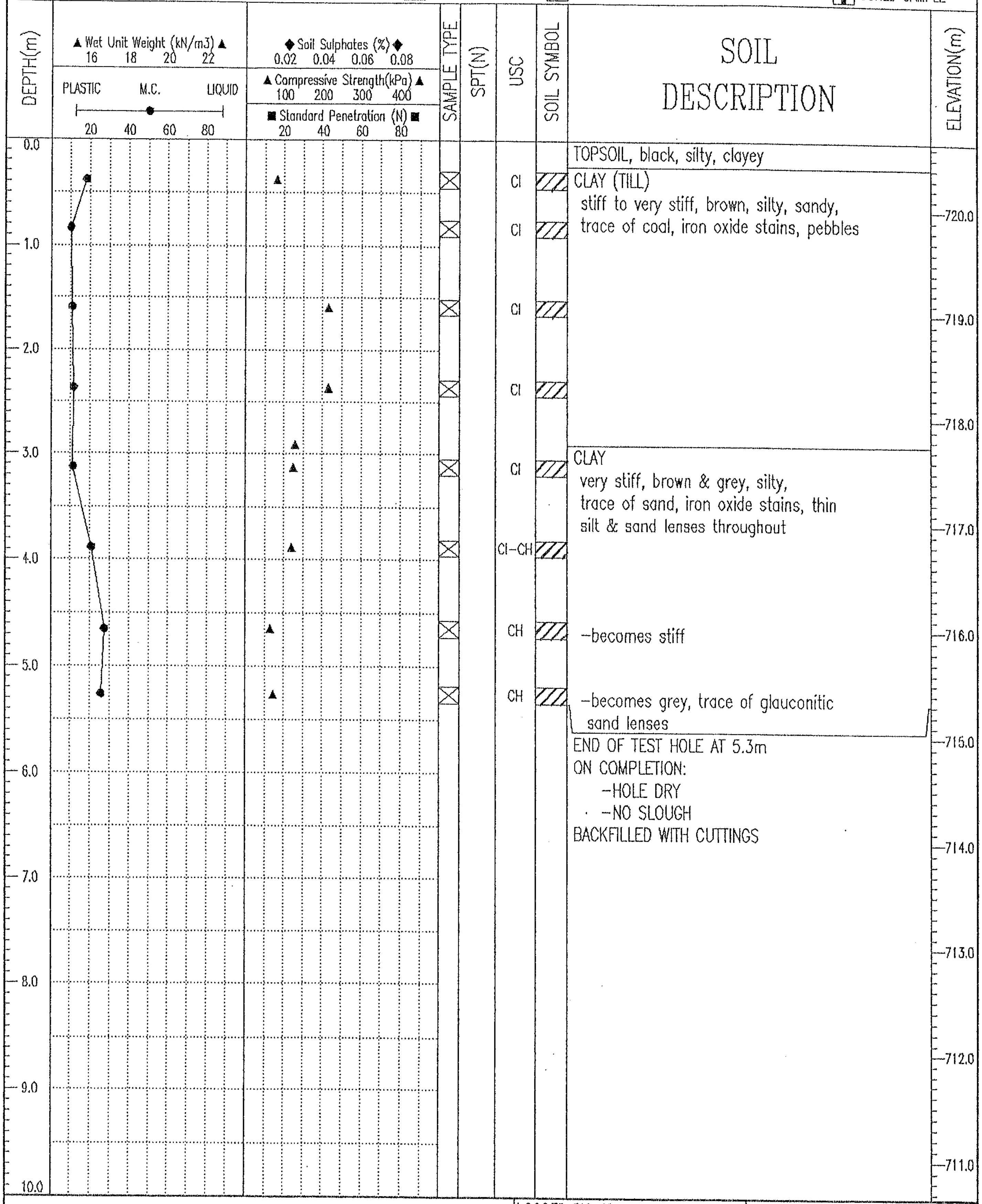
THURBER PROJECT # 19–598–45
CLIENT – INFRASTRUCTURE SYSTEMS LTD

PROJECT: WHITEMUD DRIVE 34 ST to HWY 14	LOCATION: WHITEMUD DR & HWY 14	BOREHOLE NO: TH96-31
CLIENT: CITY OF EDMONTON	UTM ZONE: - N5927900.38 E43345.97	PROJECT NO: 14-31-119
DATE DRILLED: 28 APRIL 1996	925 + 44 + 21	ELEVATION: 720.652 (m)

SAMPLE TYPE ■ SHELBY TUBE ▨ DRIVE SAMPLE ☒ AUGER SAMPLE ☰ NO RECOVERY ▮ CORED SAMPLE



SOIL DESCRIPTION

TOPSOIL, black, silty, clayey

CLAY (TILL)
stiff to very stiff, brown, silty, sandy, trace of coal, iron oxide stains, pebbles

CLAY
very stiff, brown & grey, silty, trace of sand, iron oxide stains, thin silt & sand lenses throughout

-becomes stiff

-becomes grey, trace of glauconitic sand lenses

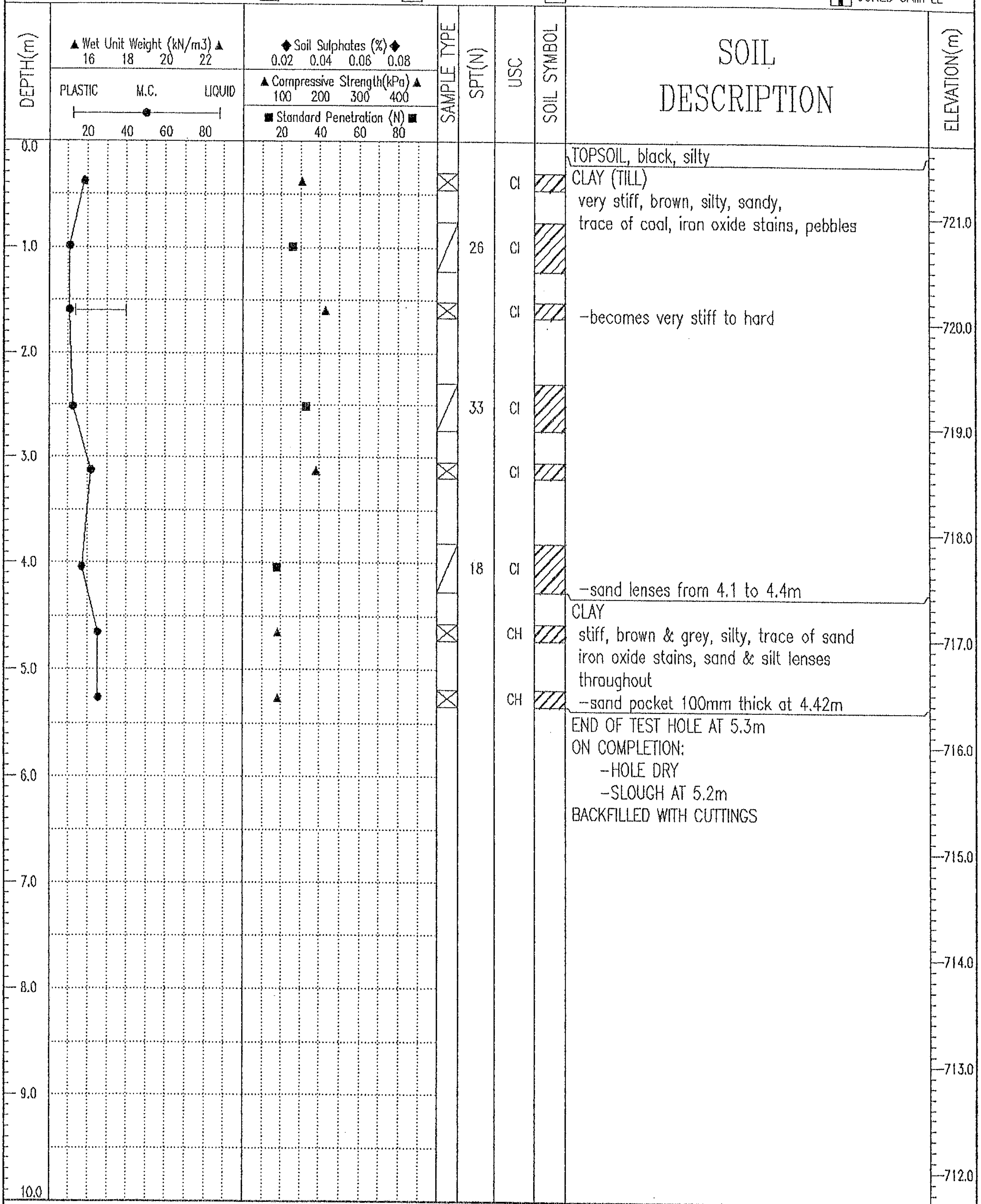
END OF TEST HOLE AT 5.3m
ON COMPLETION:
-HOLE DRY
-NO SLOUGH
BACKFILLED WITH CUTTINGS

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: JS	COMPLETION DEPTH: 5.3 m
	REVIEWED BY: LWB	COMPLETE: 96/04/28
	Fig. No:	Page 1 of 1

97/04/28 03:42PM (CITYOFED)

PROJECT: WHITEMUD DRIVE 34 ST to HWY 14	LOCATION: WHITEMUD DR & HWY 14	BOREHOLE NO: TH96-32
CLIENT: CITY OF EDMONTON	UTM ZONE: - N5927874.4 E43651.44	PROJECT NO: 14-31-119
DATE DRILLED: 28 APRIL 1996	925 + 44 + 21	ELEVATION: 721.705 (m)

SAMPLE TYPE ■ SHELBY TUBE ▱ DRIVE SAMPLE ☒ AUGER SAMPLE ☰ NO RECOVERY ▮ CORED SAMPLE



SOIL DESCRIPTION

TOPSOIL, black, silty

CLAY (TILL)
very stiff, brown, silty, sandy,
trace of coal, iron oxide stains, pebbles

-becomes very stiff to hard

-sand lenses from 4.1 to 4.4m

CLAY
stiff, brown & grey, silty, trace of sand
iron oxide stains, sand & silt lenses
throughout
-sand pocket 100mm thick at 4.42m

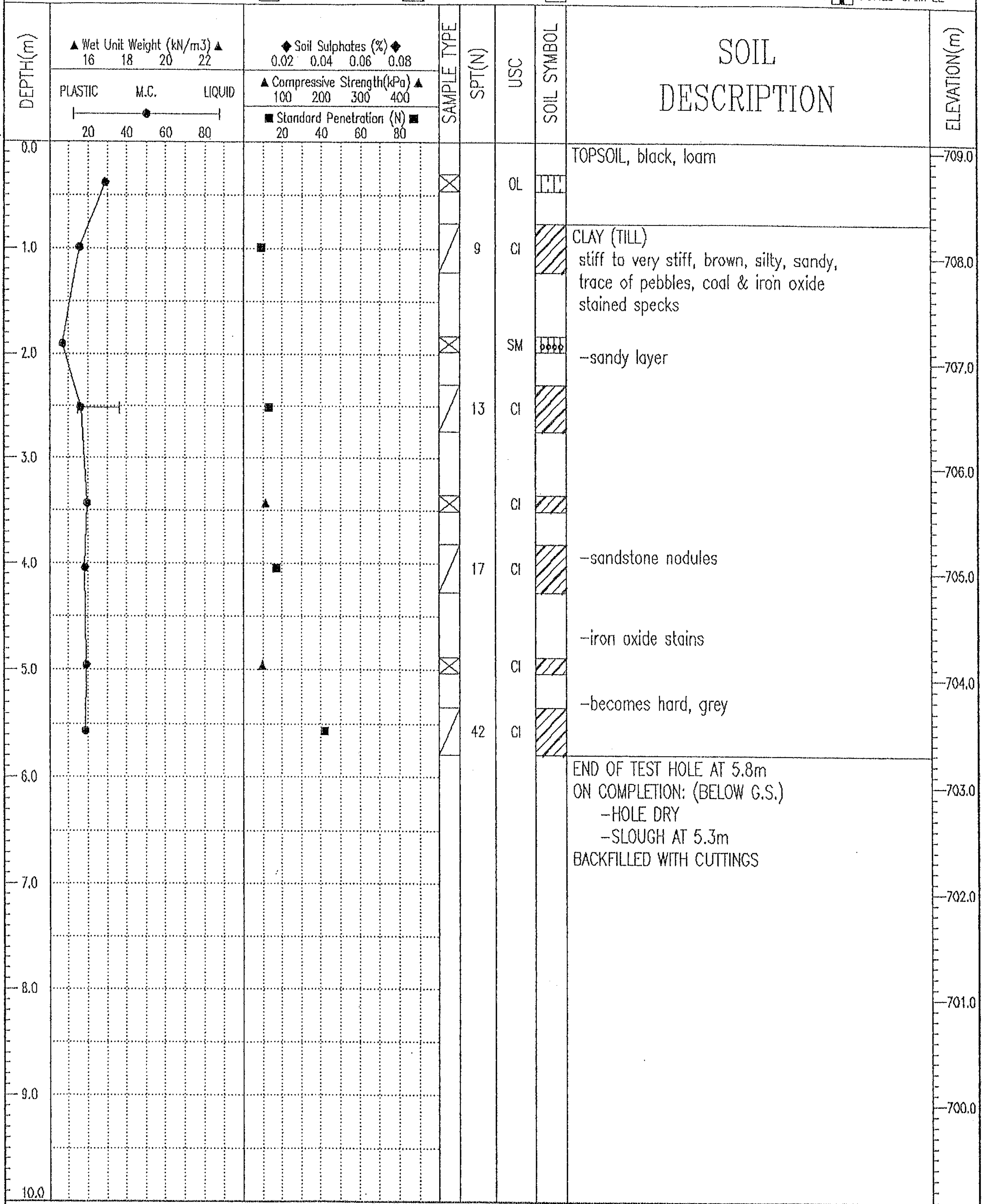
END OF TEST HOLE AT 5.3m
ON COMPLETION:
-HOLE DRY
-SLOUGH AT 5.2m
BACKFILLED WITH CUTTINGS

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: JS	COMPLETION DEPTH: 5.3 m
	REVIEWED BY: LWB	COMPLETE: 96/04/28
	Fig. No:	Page 1 of 1

97/04/28 03:43PM (CITYOFED)

PROJECT: WHITEMUD DRIVE 34 ST to HWY 14	LOCATION: WHITEMUD DR & CNR	BOREHOLE NO: TH96-33
CLIENT: CITY OF EDMONTON	UTM ZONE: - N5927647.59 E42507.48	PROJECT NO: 14-31-119
DATE DRILLED: 29 JULY 1996	925 + 44 + 19	ELEVATION: 709.083 (m)

SAMPLE TYPE ■ SHELBY TUBE ◿ DRIVE SAMPLE ☒ AUGER SAMPLE ☰ NO RECOVERY ▯ CORED SAMPLE



SOIL DESCRIPTION

TOPSOIL, black, loam

CLAY (TILL)
stiff to very stiff, brown, silty, sandy, trace of pebbles, coal & iron oxide stained specks

-sandy layer

-sandstone nodules

-iron oxide stains

-becomes hard, grey

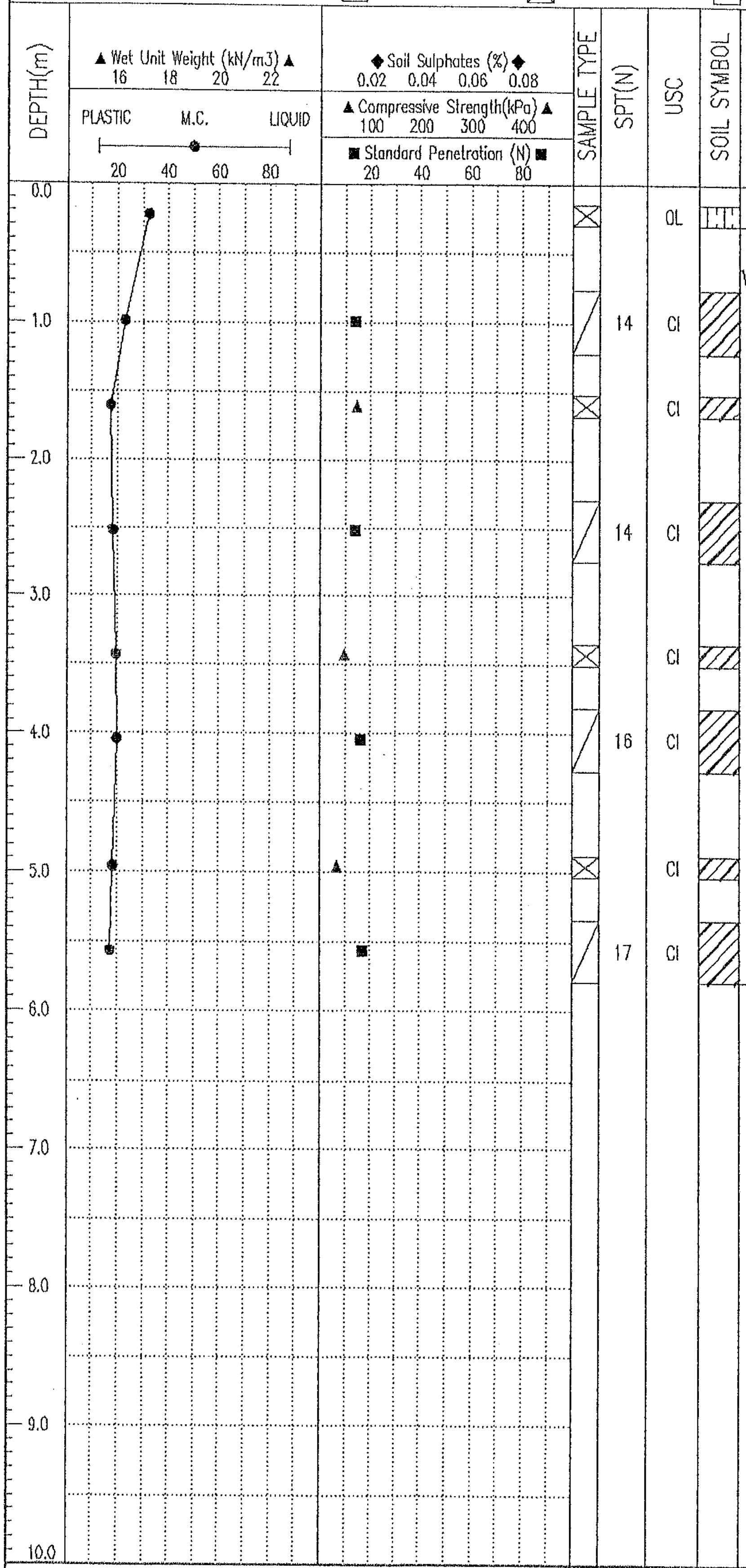
END OF TEST HOLE AT 5.8m
ON COMPLETION: (BELOW G.S.)
-HOLE DRY
-SLOUGH AT 5.3m
BACKFILLED WITH CUTTINGS

Thurber Engineering Ltd. Edmonton, Alberta.	LOGGED BY: AJ	COMPLETION DEPTH: 5.8 m
	REVIEWED BY: LWB	COMPLETE: 96/07/29
	Fig. No:	Page 1 of 1

97/01/28 03:43PM (CITYOFED)

PROJECT: WHITEMUD DRIVE 34 ST to HWY 14	LOCATION: WHITEMUD DR & CNR	BOREHOLE NO: TH96-34
CLIENT: CITY OF EDMONTON	UTM ZONE: – N5927719.02 E42639.3	PROJECT NO: 14-31-119
DATE DRILLED: 29 JULY 1996	925 + 44 + 19	ELEVATION: 708.38 (m)

SAMPLE TYPE ■ SHELBY TUBE ▱ DRIVE SAMPLE ☒ AUGER SAMPLE ☰ NO RECOVERY ▯ CORED SAMPLE



SOIL DESCRIPTION

TOPSOIL, black, loam

CLAY
stiff, light brown

CLAY (TILL)
stiff, brown, silty, some sand, trace of pebbles, claystone nodules, coal nuggets & sand pockets

–very stiff zones at 3.8 & 5.3m

–becomes grey

END OF TEST HOLE AT 5.8m
ON COMPLETION: (BELOW G.S.)
–HOLE DRY
–SLOUGH AT 5.3m
BACKFILLED WITH CUTTINGS

ELEVATION(m)
708.0
707.0
706.0
705.0
704.0
703.0
702.0
701.0
700.0
699.0

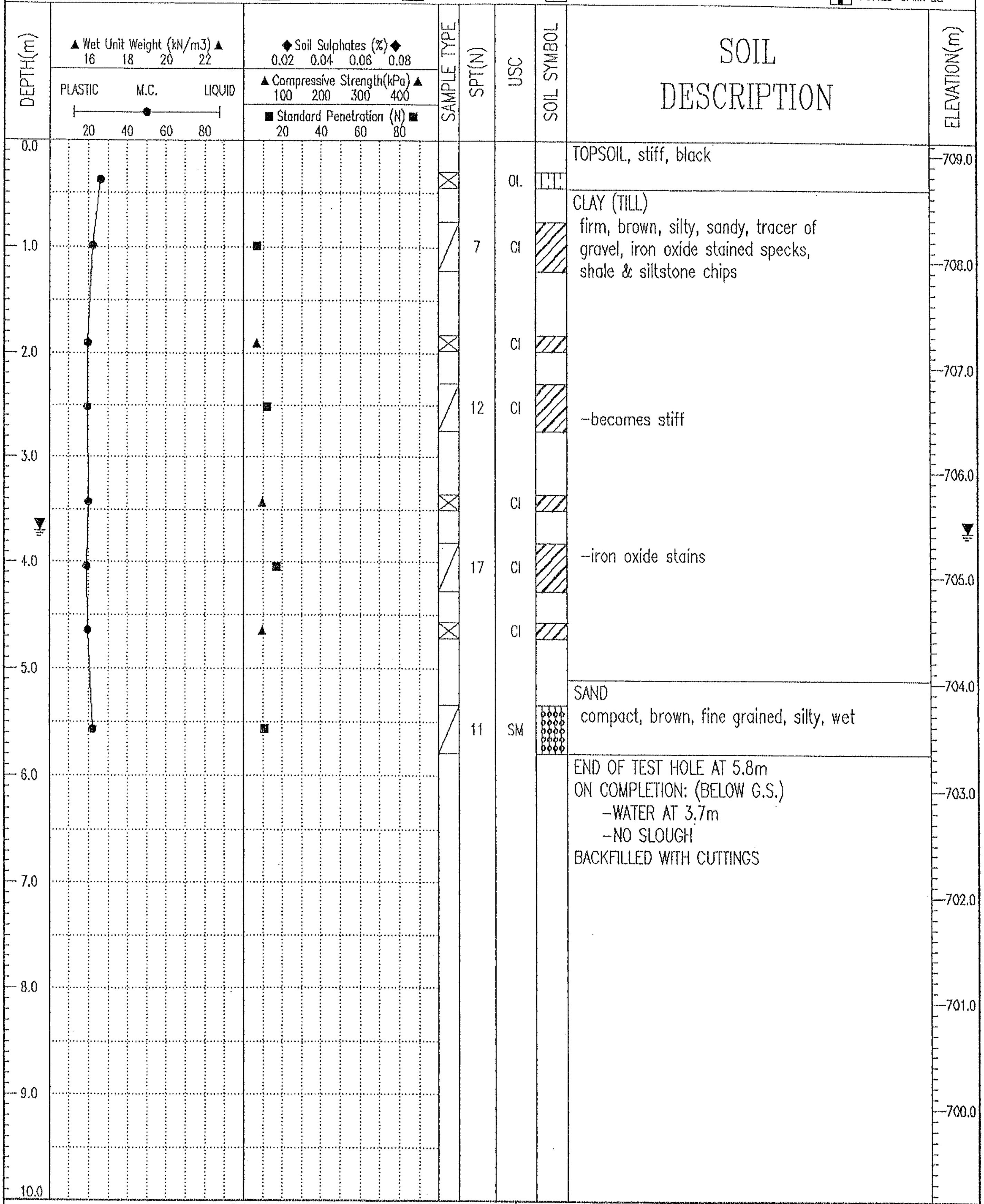
Thurber Engineering Ltd.
Edmonton, Alberta.

LOGGED BY: AJ	COMPLETION DEPTH: 5.8 m
REVIEWED BY: LWB	COMPLETE: 96/07/29
Fig. No:	Page 1 of 1

97/04/28 03:44PM (CITYOFED)

PROJECT: WHITEMUD DRIVE 34 ST to HWY 14	LOCATION: WHITEMUD DR & CNR	BOREHOLE NO: TH96-35
CLIENT: CITY OF EDMONTON	UTM ZONE: - N5927434.82 E42554.74	PROJECT NO: 14-31-119
DATE DRILLED: 29 JULY 1996	925 + 44 + 19	ELEVATION: 709.133 (m)

SAMPLE TYPE ■ SHELBY TUBE ▱ DRIVE SAMPLE ☒ AUGER SAMPLE ☰ NO RECOVERY ▮ CORED SAMPLE



SAMPLE TYPE	SPT(N)	USC
☒		OL
▱	7	CI
☒		CI
▱	12	CI
☒		CI
▱	17	CI
☒		CI
▱	11	SM

SOIL DESCRIPTION

TOPSOIL, stiff, black

CLAY (TILL)
firm, brown, silty, sandy, tracer of gravel, iron oxide stained specks, shale & siltstone chips

-becomes stiff

-iron oxide stains

SAND
compact, brown, fine grained, silty, wet

END OF TEST HOLE AT 5.8m
ON COMPLETION: (BELOW G.S.)
-WATER AT 3.7m
-NO SLOUGH
BACKFILLED WITH CUTTINGS

Thurber Engineering Ltd.
Edmonton, Alberta.

LOGGED BY: AJ	COMPLETION DEPTH: 5.8 m
REVIEWED BY: LWB	COMPLETE: 96/07/29
Fig. No:	Page 1 of 1

97/04/28 03:44PM (CITYOFED)