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Factual Geotechnical Report

Geotechnical Assessment of Sediments in the St. Mary's River Area of Concern
Sault Ste. Marie, Ontario

May 14, 2012
MRW Project G11297

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Sault Ste. Marie, Ontario

Prepared for:

Sault Ste. Marie Innovation Centre
Attn: Dr. Paula Antunes
1520 Queen Street East, Room NW 307
Sault Ste. Marie, Ontario
P6A 2G4

Prepared by:

M.R. Wright and Associates Co. Ltd.
Consulting Engineers
Sault Ste. Marie, Ontario
P6B 0A3

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1.0 Introduction and Scope

The Consulting Engineering firm of M. R. Wright and Associates Co. Ltd. (MRW) has been retained by the Sault Ste. Marie Innovation Centre (SSMIC) to perform a geotechnical assessment of sediments within the St. Mary's River in Sault Ste. Marie, Ontario. The area of investigation is shown on Figure 1. The overall assessment site is located southeast of Bellevue Marine Park and east of Topsail Island, herein referred to as the 'Site', and is shown on Figure 2. This Site has been identified as an "Area of Concern". The Canada-Ontario sediment decision making framework (EC/MOE 2007) indicated management actions are required at 7 specific locations at the Site (SSMIC 2011). Previous gravity coring efforts at the 7 locations did not yield penetration down to the native till (SSMIC 2011). The purpose of this geotechnical assessment was to obtain additional sediment data to augment the information available to date. The additional data will be used in the assessment of future sediment management options.

The geotechnical field investigation included Cone Penetration Test (CPT) soundings in conjunction with an ultra violet induced fluorescence (UVIF) module, as well as advancing a continuous steel split-barrel to retrieve depth stratified sediment samples at the Site to delineate the following:

- Sediment behaviour and physical engineering properties;
- A vertical profile of hydrocarbon contamination;
- Sediment types; and,
- The sediment thickness above the native glacial till.

The CPT, UVIF, and sediment sample locations are shown on Figure 2. Photographic records of the geotechnical assessment is included in Appendix D.

This factual report documents the field investigation methodology, results, and provides a summary of the sediment data based on the investigation and MRW's engineering review, as well as our understanding of the project scope.

Abbreviations, terminology and principal symbols commonly used throughout the report are enclosed in Appendix F.

2.0 Geological Setting

Data obtained from the Northern Ontario Geological Survey Map 5012, as published by the Ministry of Natural Resources in 1979, indicate the north shore of the St. Mary's River at the Site location is situated on a glaciolacustrine plain that is mainly comprised of sandy material, deposited from former glacial Lake Algonquin.

The underlying bedrock at this Site is within the Paleozoic era and the subgroup is of the lower and middle Cambrian. The bedrock is of the Jacobsville formation consisting of sandstone, siltstone, shale and conglomerate (Ontario Geological Survey Map 2419, published 1979).

The sediment deposition below the more recent river (alluvial) sediment deposits consist of glacial lacustrine deposits of the Pleistocene period (Trow 1977). The lacustrine deposits in the immediate vicinity of the Site predominantly consist of varying phases of clay and silt, which is often varved and interlayered. This deposition was a result of numerous glacial lakes forming during the end of the Wisconsinan stage (approximately 14,000 years ago) reaching a maximum extent during the Lake Nipissing phase, when one large lake filled the present, Superior, Huron and Michigan basins (Hay, 1963). During significant stagnant periods, varved clays were deposited in deeper water overlying the existing glacial till (Trow 1977).

3.0 General Site Description & Background

The St. Mary's River is a 120 km channel connecting Lake Superior and Lake Huron. The river is bound by both Canada and the United States of America (USA), with most of the river being USA waters. The specific geotechnical assessment site is located southeast of Bellevue Marine Park and east of Topsail Island in Sault Ste. Marie, Ontario. The area of investigation is shown on Figure 1. The surrounding land masses create a sheltered bay in which the Site takes up approximately 90,000 m^2 of sheltered water. The protection from the bay diverts the current away from the site, making the surface water conditions mostly calm. Based on a modelling study performed in 2011 there is a vortex/back eddy created due to Topsail Island that results in a gyre in the study area. Sediment is retained due to low energy. There has to be a transport in (flux) for sediment to be accumulated. It is also possible that much of the material was deposited before the causeway was constructed between the mainland and Topsail Island (Krishnappen 2011).

Since the early 1900's, the river has received industrial and municipal wastewater, which has resulted in sediment contamination with petroleum hydrocarbons, polycyclic aromatic hydrocarbons, oils/grease, and trace metals (SSMIC 2011). Due to the extensive contamination, the St. Mary's River was designated as one of the 43 Areas of Concern (AOC) under Annex 2 of the 1987 Canada-US Great Lakes Water Quality Agreement (SSMIC 2011). A commitment to developing a contaminated sediment management plan was made by the Canadian Government in 2007 as part of the Canada-Ontario Agreement (SSMIC 2011).

During past sampling events, woody debris, and gas bubble generation with oil sheen were observed. In 2007 and in 2011, core samples were taken from these areas to a maximum depth of approximately 50 cm below sediment surface. Chemical analysis of core slices from different depth intervals indicate higher levels of organics and metals at depth (Debbie Burniston, personal communication).

4.0 Geotechnical Field Investigation and Methodology

The geotechnical field investigation was carried out from December 6 to 10, 2011. The field investigation consisted of advancing a total of 7 Cone Penetration Test (CPT) soundings in conjunction with an ultra violet induced fluorescence (UVIF) module and one sampled borehole at the geotechnical stations identified by the SSMIC. The CPT soundings were advanced until the maximum safe capacity of the equipment was reached (i.e. refusal). The sampled borehole at geotechnical station EC34 was advanced to a refusal depth of approximately 8.6 m below the river bottom.

The CPT soundings, UVIF module, and sampled borehole were advanced with a high torque CME 850 track-mounted auger/rotary core drill rig mounted on a 100 tonne capacity barge. Portable CPT equipment was supplied and operated by our subcontractor ConeTec Inc. (ConeTec) and the drill rig was operated by our drilling subcontractor Marathon Drilling Co. Ltd. (Marathon). The barge was supplied and operated by our subcontractor Purvis Marine Limited (Purvis).

The CPT soundings and UVIF module were continuously pushed via hydraulic equipment on the drill rig under the direct guidance of ConeTec. Prior to advancing the CPT soundings, a 100 mm diameter steel casing was set either partially or fully into the water column to prevent the piezocones steel rods from bending and breaking.

To obtain sediment samples, the drill rig was equipped with 250 mm diameter continuous flight hollow stem augers and a 130 mm inside diameter split-barrel sampler lined with acrylic sleeves. The split-barrel head has a one-way ball bearing check valve to create suction and hold the sample in. MRW notes that the Request For Proposal (RFP), dated November 9, 2012, required a 100 mm inside diameter sampler. Since the timing to start the project was critical, and given the relatively short time frame to retain a drilling contractor, the closest inside diameter soil sampler that was available to 100 mm was 130 mm inside diameter.

The original intent of the investigation was to collect sediment samples beside each CPT sounding to corroborate the CPT data and perform geotechnical and geochemical laboratory testing to estimate sediment types and contaminants. However, despite the best efforts of our drilling subcontractor (Marathon Drilling Co. Ltd.) very few sediment samples were retrieved. As such, limited sediment quantities were collected at one geotechnical station, identified by the SSMIC as station EC34. The collection of limited sediment quantities is likely in our opinion due to the relatively large cross sectional area of the sediment within the sample, a strong enough cohesive bond was not formed between the sediment and the walls of the acrylic liner, as well, sufficient suction was not created by the sampling head to retain the sediment within the sampler. The experience gained from this investigation indicates that the sampling equipment used is not appropriate for the sediments encountered. It may be more appropriate to use smaller diameter sampling equipment, such as a conventional 51 mm outside diameter split spoon barrel. Whatever method is chosen, MRW would recommend testing different sampling methods to obtain sediment, prior to any additional significant investigation programs being implemented.

The CPT soundings in conjunction with the UVIF were advanced as close as reasonably possible to the 7 geotechnical stations identified by the SSMIC. The approximate location of each geotechnical station are indicated on Figure 2. A Trimble^{TM} survey-grade differential global positioning system (DGPS) was used to position the CPT probe over the geotechnical stations. The following table outlines the UTM coordinates (NAD 83, Zone 16) identified by the SSMIC and the UTM coordinates where the CPT probe was actually advanced:

Station	**UTM Coordinates Proposed by SSMIC**		**Actual UTM Coordinates at CPT Probe/borehole**	
	Easting	**Northing**	**Easting**	**Northing**
CS10	708025.9	5152649.5	708016.7	5152647.3
EC30	707762.2	5152733.5	707765.6	5152733.6
EC31	707747.4	5152547.5	707754.5	5152550.2
EC32	707915.8	5152668.0	707923.0	5152670.8
EC34	708018.0	5152742.0	708018.0	5152742.0
EC35	707925.56	5152584.0	707928.6	5152583.2
EC64	707709.7	5152635.5	707708.0	5152628.8

Note: The GPS real-time differential correction is accurate to within 1 metre, as indicated on the handheld unit, and is presented in UTM NAD 83, Zone 16.

During the positioning of the barge, the GPS equipment kept losing satellites signals, and coupled with 20 to 30 km winds, accurate positioning was extremely difficult. As such, the CPT soundings were not as precise as MRW would have liked. The approximate locations of each station are indicated on Figure 2.

Sediment sampling near EC34 was conducted approximately 0.5 m west of the CPT sounding.

Cone Penetration Testing was performed with a portable integrated electronic piezocone manufactured by ConeTec. The piezocone used was a compression model cone with a 15 cm^2 tip and a 225 cm^2 friction sleeve. The piezocone dimensions and operating procedure were in accordance with ASTM D-5578-95.

ConeTec's portable CPT System takes data readings of tip resistance (q_t), sleeve friction (f_s) and dynamic pore pressure (u_t) and records the results on magnetic media every 25 mm as the cone penetrates the sediment. The combination of q_t, friction ratio ($R_f = f_s/q_t$) and u_t is used to differentiate between sediment behaviour types. An Ultra Violet Induced Fluorescence (UVIF) module was added to the piezocone to detect a response to hydrocarbons in the sediment. The UVIF module directs high intensity ultra violet light into the surrounding sediment causing fluorescence of hydrocarbon contaminants located in the sediment and water. The intensity of the fluorescence is measured in the module and hydrocarbon contaminant characteristics are recorded electronically. For additional information regarding CPT data interpretation, reference should be made to ConeTec's Field Report in Appendix C.

River sediment samples were obtained at geotechnical station EC34 by advancing 250 mm diameter continuous flight hollow stem auger and a 130 mm inside diameter split-barrel sampler lined with acrylic sleeves. The 130 mm inside diameter split-barrel sampler was assembled in 1.5 m sections and advanced inside the hollow stem augers. The sampling head has a one-way ball bearing check valve on the inside which allows the release of water and air pressure above the sediment sample and also creates suction during retrieval to prevent the sample from washing out. The sampling end (tip) of the split-barrel was fitted with a metal "sand trap" to hold sediment samples in the split-barrel sampler. Although this is a standard method used to "trap" sediment samples, the sediment at this site was not staying contained inside the split-barrel and recovery was minimal. As such, when present, cohesive sediment samples were obtained from the outside of the hollow stem augers.

Marathon Drilling Co. Ltd. (Marathon) implemented extensive efforts by modifying the standard sediment sampling equipment and made several attempts to collect the sediment samples. Despite best efforts, Marathon was unable to collect any significant amount, in part due to the very soft and fluid sediment consistency at depths between 0 and 5.3 m. Due to time constraints of the project, EC34 was the site for which sampling efforts were sucessful.

The sediment assessment field operations were completed under the full time review of an MRW technical team, made up of 4 members. During the field operations, MRW's technical team logged the drilling operations and identified the sediment samples as they were retrieved. Recovered sediment samples (from site EC34 only) were sealed in plastic bags and carefully transported to our laboratory for detailed examination and testing. All sediment samples were classified according to visual and index properties by the project engineer.

5.0 Site Operations and Observations

The following sub-sections summarize investigative operations and observations at each geotechnical station from December 6 to 10, 2011.

When reading the following sub-sections, reference should be made to the computed tabulations of the interpreted sediment types included in Appendix A of ConeTec's Field Report, which is included in Appendix C of this report.

All soil descriptions interpreted from the CPT data are based on experience and comparison of similar soil deposits in the local area.

When referring to ConeTec's data plot CPT-EC34, advanced at geotechnical station EC34, the actual water surface is located 1.37 m lower than indicated on the plot. The 1.37 m discrepancy is the height of the steel platform above the water. We also note that they identified Station "EC 30 as "CS" 30.

All discussions referencing sediment depths have been adjusted throughout the report to account for the 1.37 m discrepancy at geotechnical station EC34.

5.1 Geotechnical Station EC34

Instead of presenting the information in alphanumeric order, we are starting the discussion at the first investigative geotechnical station, which is considered a vital part of the geotechnical investigation and set the platform for the remaining investigation work at each station.

The geotechnical field investigation at station EC34 commenced on the morning of December 6, 2011 and was completed in the evening of December 7, 2011.

The investigation consisted of advancing one CPT sounding to a refusal depth of approximately 8.6 m below the river bottom. The CPT sounding was advanced through approximately 2.3 m of very soft organic silt (sensitive fines), 0.8 m of silty sand, 3.4 m of interlayered silt and silty clay, and 0.7 m of glacial till that predominantly comprises silt. The CPT sounding was completed on the evening of December 6, 2011.

Attempts to collect sediment samples with the 130 mm inside diameter split-barrel sampler lined with acrylic sleeves proved very difficult and limited samples were collected, likely due to the fluidity of the river sediment, see attached photograph #9 of collected sediment sample in Appendix D. Sampling attempts started at 8:30 am and were ceased at 5:00 pm on December 7, 2011.

Some conventional modifications and unconventional modifications to the sampling equipment were performed in an attempt to collect sediment samples. They typically included the following:

- Advancing and retrieving the sampling equipment at an approximate rate of 1 cm/sec or less;
- Inserting a metal "sand trap" at the tip of the split-barrel sampler to hold sediment samples in;

- Adding a second one-way check valve on the exterior of the sediment sampling head to generate additional suction during retrieval and mitigate the sample from washing out;

Despite the above noted modifications, only minimal quantities of the very soft river bottom sediments were collected within the split-barrel. The most rational reason for this, at least for the uppermost sediment profile consisting of very soft and fluid organic silt (i.e., 0 to 5.3 m), is that the sample was too fluid to be retained by the sampling device. Although the underlying sediments of silty sand, silt, and silty clay exhibited a less fluid like behaviour than the upper organic silt, minimal quantities were collected. The size of the split barrel, coupled with the relatively smooth acrylic liners and insufficient suction were the most likely reasons in our opinion for not being able to retrieve samples from these deeper horizons. Due to the difficulty of retrieving sediment samples and time constraints, it was decided to move on to the next geotechnical station and advance the CPT sounding.

During the sampling attempts, the 250 mm diameter continuous flight hollow stem augers were advanced to refusal on glacial till approximately 8.6 m below the river bottom and when present additional cohesive samples were retrieved off the outside of the augers.

The following table outlines the approximate sediment sampling attempt intervals and the approximate thickness of material retrieved from each sampling attempt:

Sample Identification	Approximate Sampling Interval from River Bottom (m)	Sample Thickness (mm)	Sediment Type
SB-1	0.0 – 1.5	75	Organic Silt
SB-2	1.5 – 2.1	100	Organic Silt
SB-3	2.1 – 2.3	130	Organic Silt
SB-4*	2.1 – 2.4	100	Organic Silt/Silt
SB-5	3.0 – 4.6	200	Silty Clay
SB-6	4.6 – 6.1	200	Silty Clay
SB-7	6.1 – 7.6	15	Silty Clay/Silt
SB-8	7.6 – 8.0	100	Till - Silt

Notes:

- The thickness of sediment collected was measured within the acrylic liner in a vertical position. All sediment thicknesses are approximate and the tolerance is approximately ± 10 mm;

- Sample SB4 was a second attempt to retrieve additional sediment at approximately the same sampling interval.

- The following table outlines the approximate depth of sediment samples collected from the outside of the augers below the river bottom and sediment type:

Sample Identification	Approximate Auger Depth Below River Bottom (m)	Sediment Type
AS-1	3.0 – 3.6	Silty Clay
AS-2	4.6 – 4.9	Silty Clay
AS-3	6.1 – 6.7	Silty Clay
AS-4	6.7 – 7.0	Till - Silt

Note: It is noted that the sediment information in the preceding two tables may not be fully representative of the actual in-situ sediment stratigraphy but it presents the factual information documented during the geotechnical investigation. We also note that it compares well with the interpreted sediment profile from the CPT sounding advanced at geotechnical station EC34.

5.2 Geotechnical Station CS10

The geotechnical field investigation at station CS10 commenced on the morning of December 8, 2011 and was completed in the afternoon of December 9, 2011.

The investigation consisted of advancing one CPT sounding to a refusal depth of approximately 7.4 m below the river bottom.

Previous experience and calibration, infers that the CPT sounding was advanced through approximately 4.3 m of very soft organic silt (sensitive fines), 1.8 m of interlayered silty clay, silty sand, and silt, which overlaid 1.3 m of glacial till predominantly comprised of sand.

During the advancement of the piezocone through the 100 mm diameter steel casing it became "sand locked". As such, the casing and cone were removed from the river and flushed with water. When the casing was removed the end was plugged with silt and sand. Because of the 'false' readings of resistivity obtained due to the plug in the casing, the entire CPT test was re-done for this site upon removal of the silt and sand within the casing.

5.3 Geotechnical Station EC30

The geotechnical field investigation at station EC30 was started and completed on December 9, 2011.

The investigation consisted of advancing one CPT sounding to a refusal depth of 2.7 m below the river bottom. Previous experience and calibration, infers that the CPT sounding was advanced through approximately 2.5 m of organic silt (organics/sensitive fines), and 0.2 m of glacial till predominantly comprised of silt.

5.4 Geotechnical Station EC31

The geotechnical field investigation at station EC31 commenced late in the afternoon on December 9, 2011 and was completed in the afternoon on December 10, 2011.

The investigation consisted of advancing one CPT sounding to a refusal depth of 4.4 m below the river bottom. Previous experience and calibration, infers that the CPT sounding was advanced through approximately 4.1 m of organic silt (sensitive fines), and 0.3 m of glacial till predominantly comprised of silty clay.

The 100 mm diameter steel casing was frozen prior to starting and needed to be thawed in order to advance the CPT sounding.

5.5 Geotechnical Station EC32

The geotechnical field investigation at station EC32 was started and completed on December 10, 2011.

The investigation consisted of advancing one CPT sounding to a refusal depth of 5.5 m below the river bottom. Previous experience and calibration, infers that the CPT sounding was advanced through approximately 5.3 m of organic silt (sensitive fines), and 0.2 m of possible till.

5.6 Geotechnical Station EC35

The geotechnical field investigation at station EC35 was started and completed on December 10, 2011.

The investigation consisted of advancing one CPT sounding to a refusal depth of 11.0 m below the river bottom. Previous experience and calibration, infers that the CPT sounding was advanced through approximately 3.1 m of organic silt (sensitive fines), and 7.9 m of silty clay where it encountered refusal on possible till.

5.7 Geotechnical Station EC64

The geotechnical field investigation at station EC64 was started and completed on December 9, 2011.

The investigation consisted of advancing one CPT sounding to a refusal depth of 3.2 m below the river bottom. Previous experience and calibration, infers that the CPT sounding was advanced through approximately 2.9 m of organic silt (sensitive fines), and 0.3 m of glacial till predominantly comprised of silt.

6.0 Laboratory Testing

Sediment samples collected from the split-barrel and outside of the augers were submitted to MRW's Materials Testing Laboratory and tested in accordance with the applicable ASTM and CSA Standards to determine the following:

- Water content;
- Grain size distribution;
- Atterberg limits; and,
- Unit weight.

The water content, grain size distribution, Atterberg limits and unit weight of the materials tested are summarized on the interpreted borehole logs/CPT soundings in Appendix A, and our laboratory analytical reports in Appendix B. The laboratory testing was utilized to compare with sediments that are the same/similar in composition. We note that the testing was performed on disturbed sediment samples and accordingly is subject to a degree of error. As such, all geotechnical data requires interpretation by MRW, experienced geotechnical engineering consultants who are familiar with the local sediment types and conditions. It is noted that due to the difficulties of retrieving the sediment samples, the grain size distribution results may not fully represent the in-situ sediment matrix. The collected samples and CPT data were compared to previous geotechnical information from the area, for comparison purposes.

7.0 Geophysical Logging of Subsurface Conditions

Details of the sediment conditions encountered at each CPT sounding are included in Appendix A, "Interpreted Borehole Logs/CPT Soundings". The interpreted borehole logs/CPT soundings include textural descriptions of the sediment in accordance with an expanded Unified Soil Classification System (USCS). The results also show the sediment boundaries, as interpreted from ConeTec's CPT results and observations during the geotechnical investigation. These boundaries reflect approximate transition zones and should not be interpreted as exact planes of geological change. We note that in some instances, the CPT soundings indicate relatively thin seams of different material behaviour within a predominant material type. These relatively thin seams have been ignored within the subsurface profile description on the interpreted borehole/CPT sounding since they have a negligible influence on the overall sediment type and behaviour. The expanded USCS classification is explained in further detail in Appendix F.

The interpreted borehole logs/CPT soundings also include a profile of the piezocone's tip resistance every 300 mm, as well as the interpreted equivalent Standard Penetration Tests ("N_{60}" values) at 300 mm intervals, to provide an indication of the sediment strength characteristics with depth. The "N_{60}" values have been included because it is a standard in-situ testing method in Canada (and most of the world) for evaluating the qualitative compactness of cohesionless soils and as an approximation to estimate the consistency of cohesive soils (and sediments).

When referring to ConeTec's data plot CPT-EC34, advanced at geotechnical station EC34, the actual water surface is located 1.37 m lower than indicated on the plot. The 1.37 m discrepancy is the height of the steel working platform above the water. We also note that they identified Station "EC" 30 as "CS" 30.

7.1 Interpreted Sediment Stratigraphy and Physical Properties

7.1.1 Interpreted General Sediment Stratigraphy

The following section provides a summary of the interpreted general sediment stratigraphy.

The sediment samples obtained at geotechnical station EC34 were used to refine the sediment type estimated by the ConeTec's CPT sediment data. This information was also utilized to refine the sediment types for the remaining CPT soundings, and is indicated on the attached interpreted borehole logs/CPT soundings in Appendix A. Although limited sediment samples were obtained to corroborate the CPT testing, the information obtained bodes well since the sediment profile determined from CPT soundings is usually in agreement with the sediment profile obtained from conventional sediment sampling, grain size distribution and visual and tactile observations. The following is a summary of the sediment stratigraphy encountered within the CPT soundings at the time of the geotechnical investigation. We note that sediment depths are reference from the river bottom in the following discussion.

Based on the subsurface information obtained at each geotechnical station, the interpreted sediment range in thickness can be summarized as follows:

- 2.3 to 5.3 m of organic silt;
- 0.0 to 7.9 m of silty sand, silt and silty clay (silty and clayey phases of sediment);

- 0.0 to greater than or equal to 1.3 m of glacial till or possible glacial till.

At stations EC30, EC31 and EC64 the organic silt was inferred to directly overly the glacial till/possible glacial till deposit.

At station EC32, EC35 and EC64, the CPT soundings did not extend far enough into the potential glacial till layer to interpret a sediment type.

All CPT soundings were advanced through the very soft organic silt until the maximum safe capacity of the CPT equipment was reached (i.e. refusal). The following table outlines the estimated water elevation above mean sea level (amsl) and depth, river bottom elevation (amsl), thickness of the organic silt, and refusal depths from the river bottom at each geotechnical station:

Station	Water Depth (m)	Organic Silt Thickness (m)	CPT Refusal Depth (m)	Elevation (amsl)	
				Water Elevation (m)	River Bottom Elevation (m)
CS10	8.5	4.3	7.4	176.4	167.9
EC30	4.5	2.5	2.7	176.4	171.9
EC31	5.8	4.1	4.4	176.4	170.6
EC32	7.7	5.3	5.5	176.4	168.7
EC34	5	2.3	8.6	176.4	171.4
EC35	4.2	3.1	11	176.4	172.2
EC64	4.4	2.9	3.2	176.4	172

Note: The water elevation was obtained from the Great Lakes Information Network's website: http://www.great-lakes.net/envt/water/levels/levels-cur/stmarywlc.html

7.1.2 Sediment Description and Engineering Properties

The following section provides additional information on the sediments encountered and their engineering properties based on the CPT sediment data interpreted by ConeTec, which was corroborated by the sediment information obtained within geotechnical station EC34, and compared against previous geotechnical information from the area, for consistency and calibration of results.

Organic Silt (Encountered at all Geotechnical Stations)

The organic silt encountered within each CPT sounding is interpreted to comprise trace sand and trace clay. The material is classified as being saturated, dark brown to black in colour, very soft, and also as exhibiting a fluid behaviour.

Based on the CPT data, the material behaviour was mainly classified as sensitive fines with the exception of station EC35, where the material behaviour was classified as a combination of organics and sensitive fines.

Grain size distribution analysis indicates that the organic silt material was comprised of 7% sand, 88% silt and 5% clay size particles by weight. A grain size distribution curve is included in Appendix B. The water content ranged from 220.9 to 264.4%. A summary of the water contents is included in Appendix B. Near the interface of the organic silt material and the non-organic material, the water content decreased to between 88.6 to 90.3%, which tends to indicate that the organic content is decreasing and the non-organic content is increasing.

The organic silt sediment samples retrieved from station EC34 had a strong Petroleum Hydrocarbon odour.

The typical range of estimated sediment information and engineering properties based on CPT sediment data interpreted by ConeTec, laboratory test results and geotechnical information in the vicinity are provided in the following table:

Station	Tip Resistance q_t (MPa)	Unit Weight γ (kN/m^3)	Effective Unit Weight γ' (kN/m^3)	N_{60} Blows per 300 mm	Effective Angle of Internal Friction ø'	Undrained Shear Strength S_u (kPa)
CS10	2 – 3.5	12.5	2.7	1 - 2	5 - 10°	0 - 11
EC30	1 – 3.5	12.5	2.7	1 – 1.5	5 - 8°	0 - 7
EC31	1 – 3.5	12.5	2.7	1 – 1.5	5 - 8°	0 - 12
EC32	1.5 – 4	12.5	2.7	1 - 2	5 - 10°	0 - 11
EC34	1.5 – 3	12.5	2.7	1 – 3.5	5 - 11°	0 - 11
EC35	1 – 2.5	12.5	2.7	1 – 1.5	5 - 8°	0 - 8
EC64	1.5 – 3	12.5	2.7	1 – 1.5	5 - 8°	0 - 7

Notes:

- The above ranges do not include any outliers;

- N_{60} is the standard penetration resistance normalized to a rod energy of 60%;

- It is noted that there was an initial increase in tip resistance within EC34 just prior to exiting the steel casing. This was due to the end of the casing being slightly plugged with sediment;

- The piezocone tip resistance and N_{60} blows per 300 mm generally increases with depth.

Silty Clay – CS10, EC34 and EC35

The silty clay encountered within CPT soundings CS10, EC34 and EC35 is interpreted to comprise trace sand. The material is classified as wet, very soft to firm in consistency, low to high plasticity and varved. The silty clay within EC34 is inferred to alternate with layers of silt.

Based on the CPT data, the material behaviour was mainly classified as silty clay to clayey silt.

Atterberg limit testing was conducted on the following samples obtained from geotechnical station EC34:

- AS-1 collected from approximately 3.0 to 3.3 m below the river bottom. The plastic limit of the material tested is 18.1% and the liquid limit is 36.9%. The natural water content was 40.4% indicating that the material is in excess of its liquid limit, which means it will have a fluid behaviour. The material is classified as a low plastic silty clay (CL);

- AS-2 collected from approximately 4.6 to 4.9 m below the river bottom. The plastic limit of the material tested is 21.1% and the liquid limit is 46.1%. The natural water content was 45.4% indicating that the material is approaching its liquid limit. The material is classified as a medium plastic silty clay (CI);

- AS-3 collected from approximately 6.1 to 6.7 m below the river bottom. The plastic limit of the material tested is 27.9% and the liquid limit is 49.9%. The natural water content was 48.4% indicating that the material is approaching its liquid limit. The material is classified as a medium to high plastic silty clay (CI to CH).

The above Atterberg limits are included on a plasticity chart in Appendix B.

A sample of the silty clay material from 3.0 to 3.6 m below the river bottom was tested for unit weight. The laboratory test results indicate that the silty clay has a unit weight of approximately 18.2 kN/m^3. This test correlates well with the unit weight interpreted by ConeTec.

The typical range of sediment information and engineering properties based on CPT sediment data interpreted by ConeTec, laboratory test results and geotechnical information in the vicinity are provided in the following table:

Station	Tip Resistance q_t (MPa)	Unit Weight γ (kN/m^3)	Effective Unit Weight γ' (kN/m^3)	N_{60} Blows per 300 mm	Effective Angle of Internal Friction ø'	Undrained Shear Strength S_u (kPa)
CS10	5.6 – 8.3	18	8.2	3 - 4	20 - 22°	20 – 30
EC34	9 - 11	18	8.2	4.5 - 5	20 - 22°	20 - 30
EC35	6 - 10	18	8.2	3.5 - 5	20 - 22°	20 - 30

Notes:

- The above ranges do not include any outliers;
- N_{60} is the standard penetration resistance normalized to a rod energy of 60%.

Silty Sand – CS10 and EC34

The silty sand encountered within CPT soundings CS10 and EC34 is classified as wet and compact.

Based on the CPT data, the material behaviour was mainly classified as sandy silt to silty sand.

The typical range of estimated sediment information and engineering properties based on CPT sediment data interpreted by ConeTec, laboratory test results and geotechnical information in the vicinity are provided in the following table:

Station	Tip Resistance q_t (MPa)	Unit Weight γ (kN/m^3)	Effective Unit Weight γ' (kN/m^3)	N_{60} Blows per 300 mm	Effective Angle of Internal Friction ø'	Undrained Shear Strength S_u (kPa)
CS10	40 – 100	19	9.2	13 - 20	28 - 30°	Not Applicable
EC34	40 - 130	19	9.2	12 - 26	28 - 30°	Not Applicable

Notes:

- The above ranges do not include any outliers;
- N_{60} is the standard penetration resistance normalized to a rod energy of 60%.

Silt –EC34

The silt encountered within CPT sounding EC34 is classified as wet and loose. The silt within EC34 is inferred to alternate with layers of silty clay.

Based on the CPT data, the material behaviour was mainly classified as silt.

The typical range of estimated sediment information and engineering properties based on CPT sediment data interpreted by ConeTec, laboratory test results and geotechnical information in the vicinity are provided in the following table:

Station	**Tip Resistance q_t (MPa)**	**Unit Weight γ (kN/m^3)**	**Effective Unit Weight γ' (kN/m^3)**	**N_{60} Blows per 300 mm**	**Effective Angle of Internal Friction ø'**	**Undrained Shear Strength S_u (kPa)**
EC34	9 - 11	18	8.2	4 - 5	26 - 28°	Not Applicable

Notes:

- The above ranges do not include any outliers;
- N_{60} is the standard penetration resistance normalized to a rod energy of 60%.

Glacial Till (Possibly Encountered at all Geotechnical Stations)

The glacial till encountered within each CPT sounding is interpreted to predominantly comprise silt or sand and inferred silty clay at station EC31.

The predominant silt till is interpreted to comprise trace to some clay, trace to some sand, and trace to some gravel. The material is classified as wet and compact to dense. The silt till is inferred to be encountered at geotechnical stations EC30 and EC34.

The predominant sand till is interpreted to comprise trace to some silt, trace to some gravel, and trace clay. The material is classified as wet and compact to dense. The sand till is inferred to be encountered at geotechnical station CS10.

The predominant silty clay till is interpreted to comprise trace to some sand, and trace gravel. The material is classified as wet and firm to stiff in consistency. The silty clay till is inferred to be encountered at geotechnical station EC31.

Within EC32, EC35 and EC64 the possible till material cannot be classified due to insufficient data.

Based on the CPT data, the material behaviour varied from clay to sand.

The glacial till deposit was interpreted to be encountered between 2.5 to 10.7 m below the bottom of the river. The CPT began to reach practical refusal within the till layer due to the combination of high tip resistance and high frictional resistance from the cone rods. Based on the data from the CPT soundings, we would anticipate a dense till underlying the fine grained sediments.

The typical range of sediment information and engineering properties based on CPT sediment data interpreted by ConeTec, laboratory test results and geotechnical information in the vicinity are provided in the following table:

Station	**Tip Resistance q_t (MPa)**	**Unit Weight γ (kN/m^3)**	**Effective Unit Weight γ' (kN/m^3)**	**N_{60} Blows per 300 mm**	**Effective Angle of Internal Friction ø'**	**Undrained Shear Strength S_u (kPa)**
CS10	48 - 148	19	9.2	10 – 30	34 - 38°	Not Applicable
EC30	15 - 56	18.5	8.7	10 – 30	28 - 32°	Not Applicable
EC31	27.5 - 50	18.5	8.7	10 – 20	28 - 30°	30
EC32	27.5 - 33	18.5	8.7	Undefined	Undefined	Undefined
EC34	60 - 119	19	9.2	17 - 30	32 - 36°	Not Applicable
EC35	43	18.5	8.7	Undefined	Undefined	Undefined
EC64	64 - 76	18.5	8.7	20 - 30	Undefined	Undefined

Notes:

- The above ranges do not include any outliers;
- N_{60} is the standard penetration resistance normalized to a rod energy of 60%;
- The piezocone tip resistance and N_{60} blows per 300 mm generally increases with depth.

7.1.3 Summary of Sediment Conditions

In general, based on the information encountered within the CPT soundings and comparison with collected sediment samples, there is approximately 2.3 to 5.3 m of very soft organic silt material, overlying denser non-organic sediment consisting of interlayered material predominantly comprising silty sand, silt, and silty clay (silty and clayey phases of sediment), as well as compact to dense glacial till deposit that varies in matrix. The glacial till material typically increased from compact to dense with depth. The non-organic stratum ranges from approximately 0.0 to 7.9 m in thickness and overlies compact to dense glacial till deposits that vary in matrix. The glacial till deposit varied in matrix from clay to gravel sized particles.

7.2 Ultra Violet Induced Fluorescence Interpretation

In an effort to vertically delineate the distribution of potential petroleum hydrocarbon (PHC) concentrations within the sediment at each geotechnical station, the cone penetrometer was coupled with an ultra violet induced fluorescence (UVIF) module. The module was advanced downwards through the casing and into the undisturbed sediment below. Readings were collected by the module at 1.0 cm intervals, in an effort to identify the distribution of potential petroleum hydrocarbon (PHC) concentrations within the sediment at each location, thus creating a vertical profile of PHC concentrations within the sediment horizons. The vertical profiles of the data collected by the UVIF module are included in Appendix C.

The amalgamation of the UVIF module and the cone penetrometer with pore pressure measurement produces a powerful site characterization tool for sediment investigations. The UVIF module contains a high energy ultra- violet light which is directed through a sapphire window into the surrounding sediments being penetrated. The ultra- violet light causes fluorescence of PHC contaminants contained within the surrounding sediment strata. The intensity of the fluorescence is detected via a sensor within the UVIF module. The intensity of the fluorescence is dependent on a variety of factors such as concentration and type of contaminant, as well as scale of decomposition of the petroleum hydrocarbon contamination within the sediment structure. Therefore the UVIF module is ultimately a screening tool which is 'relative', and also is dependent on actual laboratory analyses for any fluorescence – contamination relationship within sediments.

Based on the data provided by ConeTec, PHCs were detected within each CPT sounding ranging in depths from 0.9 to approximately 1.7 metres below the river bottom. The UVIF results as well as a plot of voltage versus depth for each sounding can be found in Appendix A of ConeTec's Field Report which is included in Appendix C of this report. Further investigation of the plotted results would indicate the straight line portions of the graphs are not indicative of PHC's being present in the lower sediment layers (i.e. less than a maximum depth of 1.7 metres below the river bottom). The following table outlines the estimated PHC detection depths and elevation above mean sea level (amsl) ignoring the straight line portions:

Station	Interpreted PHC Thickness	Elevations (amsl)	
		Upper PHC Elevation (m)	Lower PHC Elevation (m)
CS10	1.2	167.9	166.7
EC30	1.2	171.9	170.7
EC31	1.2	170.6	169.4
EC32	1.7	168	167
EC34	0.9	171.4	170.5
EC35	1.2	172.2	171
EC64	0.9	172	171.1

The above data estimates that hydrocarbons are confined within the upper 0.9 to 1.7 m of organic silt material (i.e. sensitive fines). Additionally, elevated PHC detections were observed in fines above the river bottom in the water and may be indicative of hydrocarbon impacted suspended solids. The vertical distribution of the impacted suspended solids was observed to start consistently at approximately 4.0 metres below the surface of the water, and continued to a depth at the river bottom where PHC detections decreased significantly.

Therefore, there is a high potential that the impacted suspended solids are elevation dependent and are 'pooling' in lower elevation areas on the river bottom at or below 4.0 metres below the water surface.

7.3 Additional Contamination Observations

Based on information obtained from the Request For Proposal (RFP), entitled "Geotechnical Assessment of Sediments in St. Mary's River Area of Concern", previous investigations encountered woody debris. However, during our investigation we did not encounter woody debris material.

The organic sediment samples retrieved from station EC34 were black and had a strong PHC odour.

To hold the barge in place over each geotechnical station, spuds were lowered down into the river sediment. Shortly after the spuds were set in place, a petroleum sheen was visible on the water surface at all geotechnical stations.

8.0 Limitations

We have prepared this report for the exclusive use of the Sault Ste. Marie Innovation Centre and their authorized agents.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering, for the Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern, in Sault Ste. Marie, Ontario. Classification and identification of sediments, and geologic units have been based upon commonly accepted methods employed in professional geotechnical practice. No warranty or other conditions, expressed or implied, should be understood.

Regardless how exhaustive a geotechnical investigation is performed, the investigation cannot identify all the subsurface conditions. In addition, subsurface conditions between test holes may differ from the conditions encountered during our geotechnical investigation. Therefore, no warranty is expressed or implied that the entire site is representative of the subsurface information obtained at the specific test hole locations.

Please refer to Appendix E, Report Limitations and Guidelines for Use, which pertains to this report.

9.0 Closure

We trust that the factual information in this report will be found to be complete and adequate for your consideration. Should further elaboration be required for any portion of this project, we would be pleased to provide assistance.

Respectfully submitted,

Maurice Corriveau, P. Eng.
Geotechnical Engineer

Greg Saunders, P.Eng.
Senior Engineer

LICENSED PROFESSIONAL ENGINEER
MAY/14/12
M. L. CORRIVEAU
100085875
MLC
PROVINCE OF ONTARIO

References

Sault Ste. Marie Innovation Centre, 2011. REQUEST FOR PROPOSALS, Geotechnical Assessment of Sediments in St. Mary's River Area of Concern.

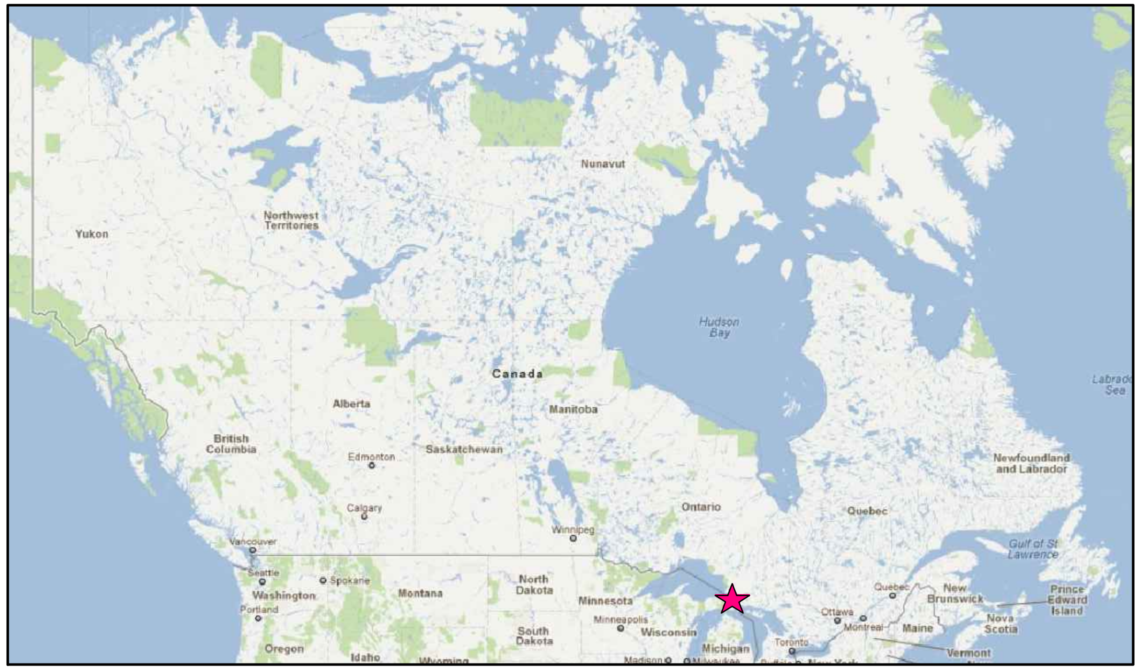
The TROW GROUP, 1977. Geotechnical Study, City of Sault Ste. Marie.

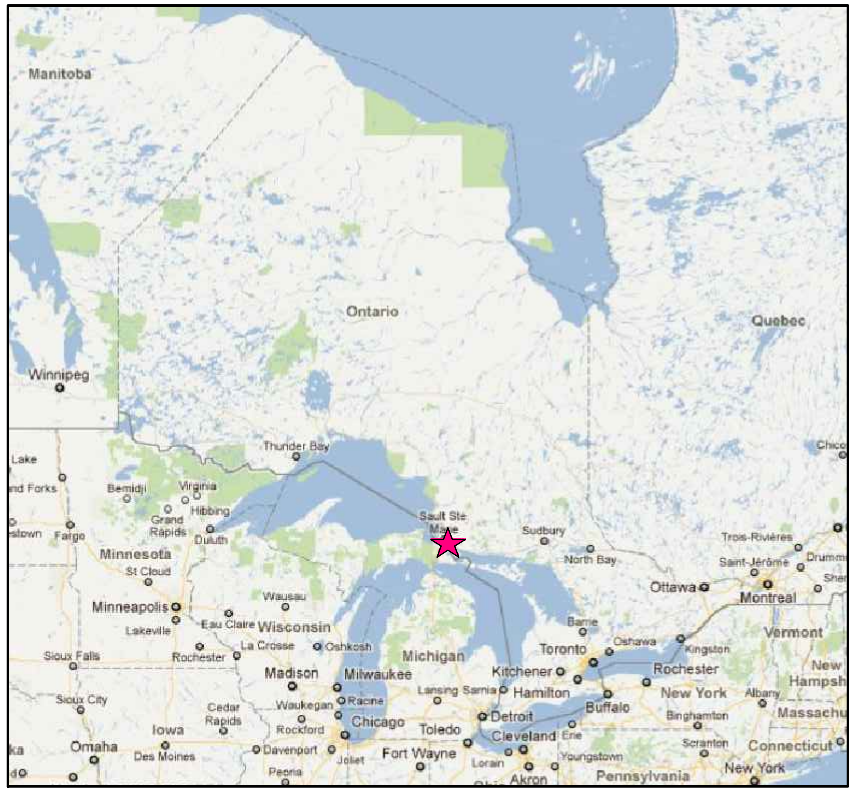
Hay, 1963. The geology of Sault Ste. Marie Map Area. PhD Thesis, McGill University, Montreal.

Great Lakes Information Network's website: http://www.great-lakes.net/envt/water/levels/levels-cur/stmarywlc.html

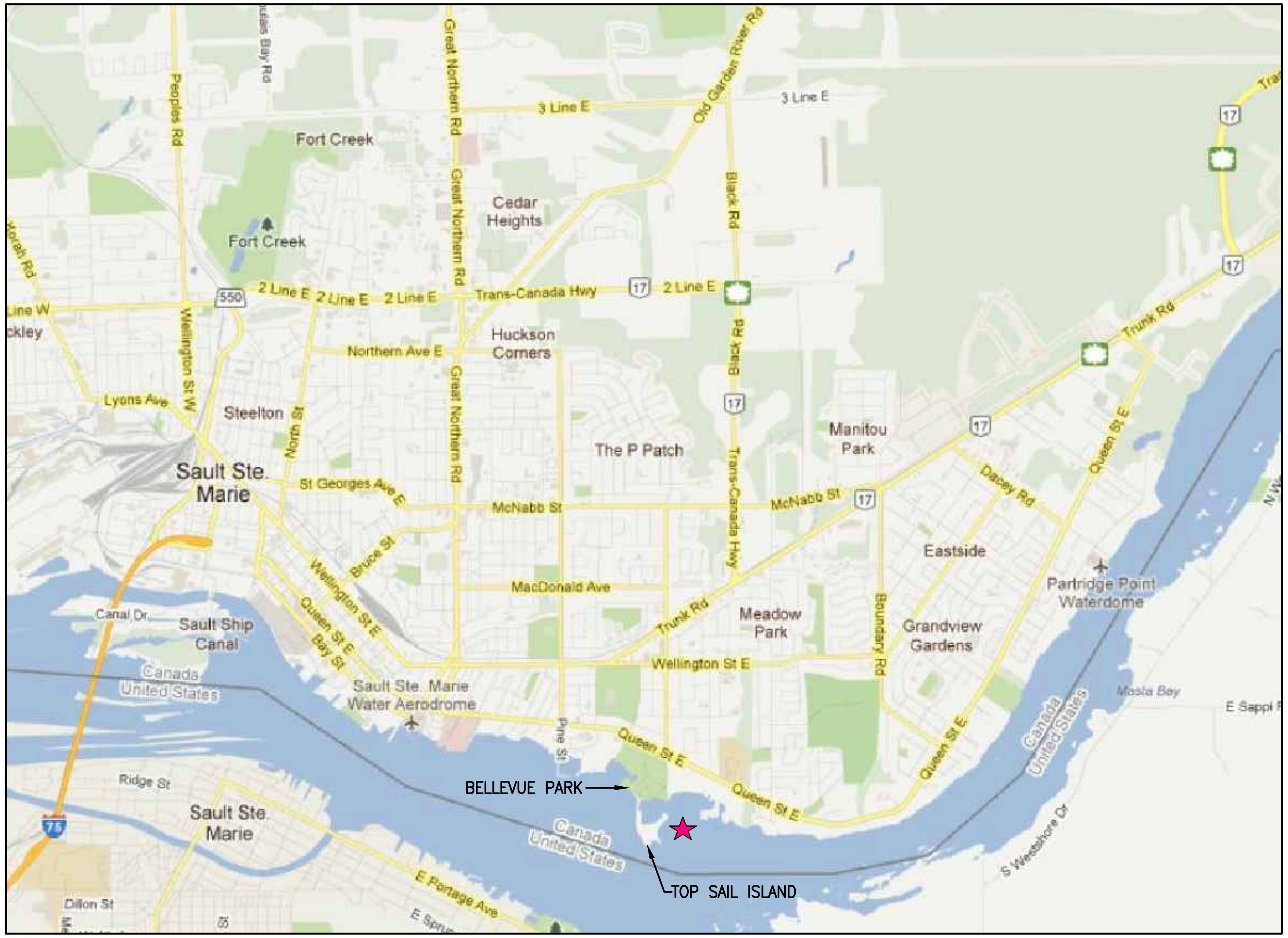
Krishnappen, B. 2011. Modelling flow and sediment transport in the St. Marys River near Sault Ste. Marie, Ontario, Canada. A report prepared for Environment Canada and the Ministry of Environment.

Figure 1 - Site Location Maps





PROJECT NORTH



★ IDENTIFIES SITE LOCATION

NOTE: MAPS OBTAINED FROM GOOGLE MAPS ®

DRAWN BY:	D.A.Mousseau
APPROVED BY:	M.Corriveau
DATE CREATED:	Feb 10/12
REVISION #:	#
REVISION DATE:	mm/dd/yy

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FIGURE 1: GENERAL LOCATION PLAN

GEOTECHNICAL ASSESSMENT OF SEDIMENTS IN THE ST. MARY'S RIVER AREA OF CONCERN
ST. MARY'S RIVER
SAULT STE. MARIE, ONTARIO
G11297

CLIENT:
SAULT STE. MARIE INNOVATION CENTRE

Figure 2 – Geotechnical Station Location Map

PROJECT NORTH

NOTES

EBMP – SOUTH EAST OF BELLEVUE MARINE PARK

EC34 – IDENTIFIES APPROXIMATE GEOTECHNICAL STATION WHERE CPT/BOREHOLE WAS ADVANCED

WL=5.0M – APPROXIMATE WATER LEVEL AT TIME OF INVESTIGATION

TO=3.7M – APPROXIMATE THICKNESS OF ORGANIC SILT (SENSITIVE FINES)

R=8.6M – APPROXIMATE CPT REFUSAL DEPTH FROM RIVER BOTTOM

ALL DEPTHS/THICKNESS IN METRES (M)

Station	UTM Coordinates Proposed by SSMIC		Actual UTM Coordinates at CPT Probe/borehole	
	Easting	Northing	Easting	Northing
CS10	708025.9	5152649.5	708016.7	5152647.3
EC30	707762.2	5152733.5	707765.6	5152733.6
EC31	707747.4	5152547.5	707754.5	5152550.2
EC32	707915.8	5152668.0	707923.0	5152670.8
EC34	708018.0	5152742.0	708018.0	5152742.0
EC35	707925.56	5152584.0	707928.6	5152583.2
EC64	707709.7	5152635.5	707708.0	5152628.8

NOTE: THE GPS REAL–TIME DIFFERENTIAL CORRECTION IS ACCURATE TO WITHIN 1 METRE, AS INDICATED ON THE HAND HELD UNIT, AND IS PRESENTED IN UTM NAD83, ZONE 16.

DRAWN BY:	D.A.Mousseau
APPROVED BY:	M.Corriveau
DATE CREATED:	Feb 10/12
REVISION #:	# 1
REVISION DATE:	Mar 29/12

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FIGURE 2: GEOTECHNICAL STATIONS

GEOTECHNICAL ASSESSMENT OF SEDIMENTS IN THE ST. MARY'S RIVER AREA OF CONCERN
ST. MARY'S RIVER
SAULT STE. MARIE, ONTARIO
G11297

CLIENT:
SAULT STE. MARIE INNOVATION CENTRE

Appendix A Interpreted Borehole / CPT Soundings

Project No: G11297

Interpreted Borehole / CPT Sounding: CS10

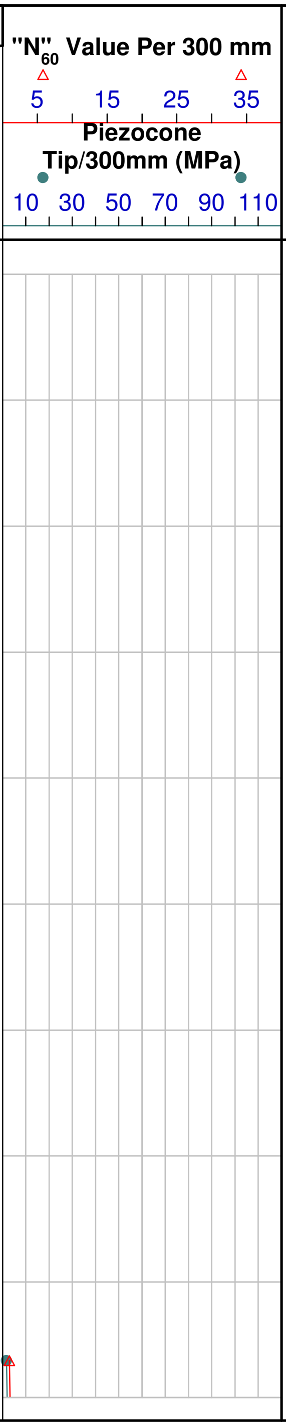
Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan & M. Corriveau

SUBSURFACE PROFILE				SAMPLE					
Depth ft / m	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery	"N60" Value Per 300 mm / Piezocone Tip/300mm (MPa)	Remarks
0 / 0		Water Surface	176.4						
0–28 ft	▨	Water							
28 ft		Organic silt, trace sand, trace clay, saturated, dark brown to black, very soft (fluid)	167.9						



Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 8, 2011

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Datum: Geodetic
The geodetic elevation is approximate and fluctuates

Sheet: 1 of 2

Project No: G11297

Interpreted Borehole / CPT Sounding: CS10

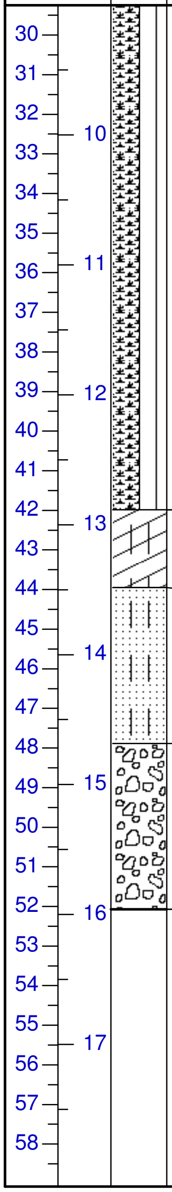
Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

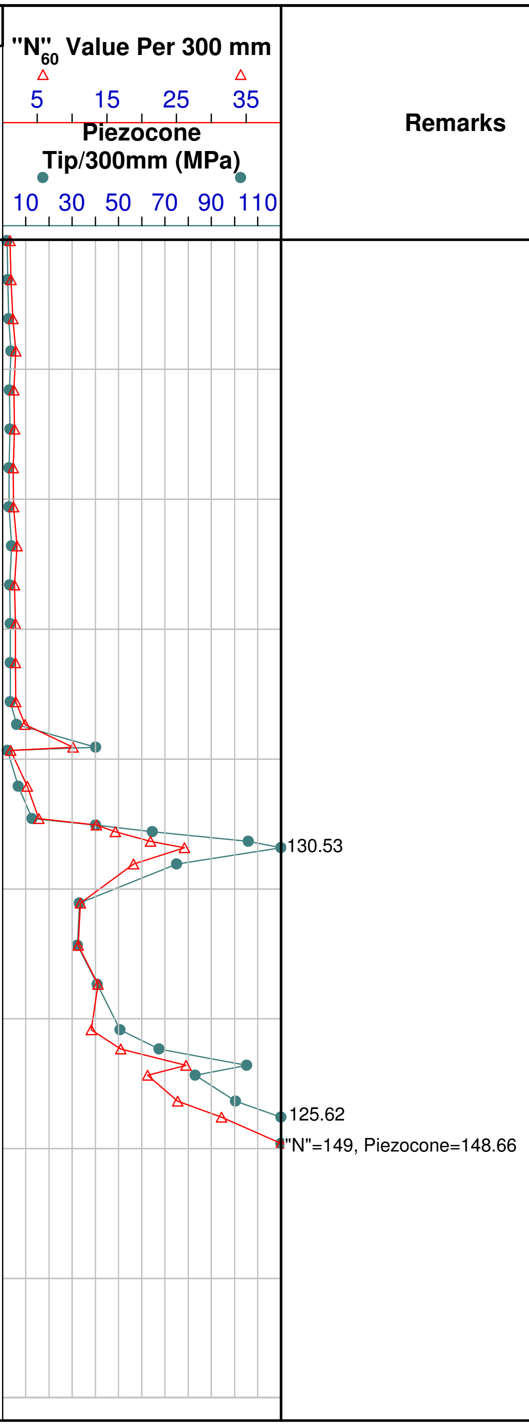
Inspector(s): D. Cavan & M. Corriveau

SUBSURFACE PROFILE



Description	Elevation (m)	Number	Method	"N" Value	% Recovery
Organic silt, trace sand, trace clay, saturated, dark brown to black, very soft (fluid)	163.6				
Silty clay, trace sand, wet, light brown, very soft, low plasticity, varved	163.0				
Silty sand, wet, light brown, compact	161.8				
Till - Sand, trace to some silt, trace to some gravel, trace clay, wet, brownish grey, compact to dense	160.5				
CPT Refusal					

SAMPLE



Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 8, 2011

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Datum: Geodetic

The geodetic elevation is approximate and fluctuates

Project No: G11297

Interpreted Borehole / CPT Sounding: EC30

Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

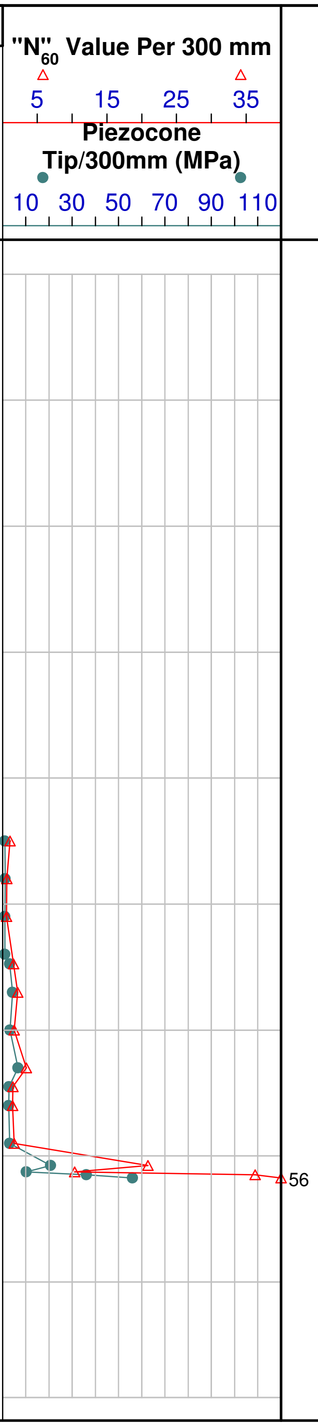
Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan & D. Griffa

SUBSURFACE PROFILE				SAMPLE					
Depth	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery	"N60" Value Per 300 mm Piezocone Tip/300mm (MPa)	Remarks
ft m		Water Surface	176.4						
		Water							
		Organic silt, trace sand, trace clay, saturated, dark brown to black, very soft (fluid)	171.9						
		Till - Silt, some clay, trace to some sand, trace to some gravel, wet, brownish grey, compact to dense	169.4						
		CPT Refusal							

Depth (ft): 0 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

Depth (m): 0 1 2 3 4 5 6 7 8



Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 9, 2011

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Datum: Geodetic
The geodetic elevation is approximate and fluctuates

Sheet: 1 of 1

Project No: **G11297**

Interpreted Borehole / CPT Sounding: EC31

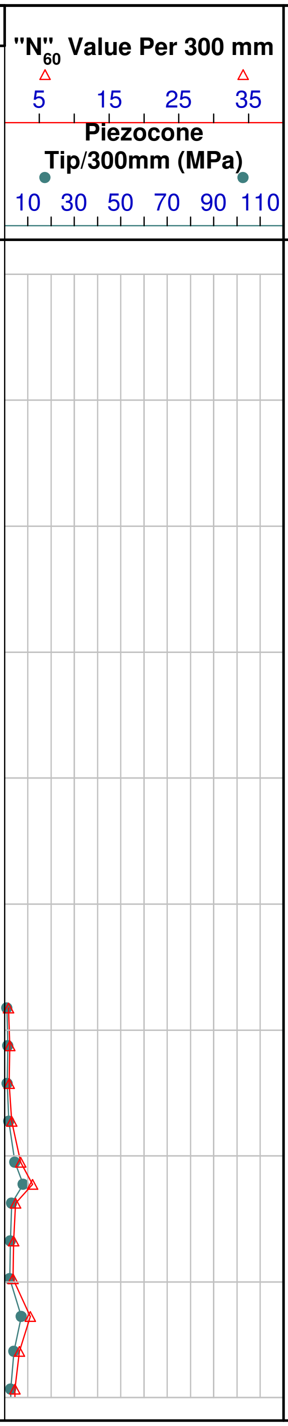
Project: **Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern**

Site Location: **St. Mary's River, East of Topsail Island**

Client: **Sault Ste. Marie Innovation Centre**

Inspector(s): **D. Cavan & D. Griffa**

SUBSURFACE PROFILE				SAMPLE					
Depth	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery	"N₆₀" Value Per 300 mm / Piezocone Tip/300mm (MPa)	Remarks
ft 0 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 m 0 1 2 3 4 5 6 7 8		Water Surface	176.4						
		Water							
		Organic silt, trace sand, trace clay, saturated, dark brown to black, very soft (fluid)	170.6						



Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 10, 2011

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Datum: Geodetic

The geodetic elevation is approximate and fluctuates

Sheet: 1 of 2

Project No: G11297

Interpreted Borehole / CPT Sounding: EC31

Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

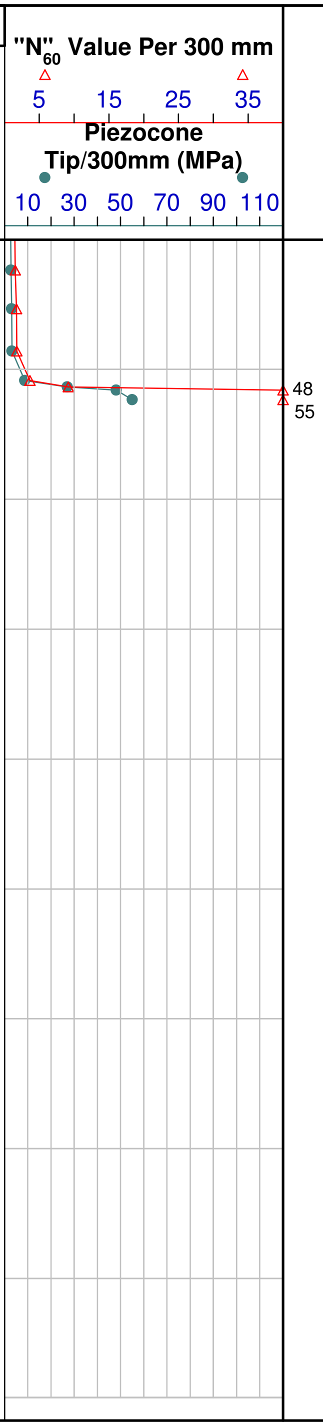
Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan & D. Griffa

SUBSURFACE PROFILE				SAMPLE			
Depth	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery
		Organic silt, trace sand, trace clay, saturated, dark brown to black, very soft (fluid)	166.5				
		Till - Silty clay, trace to some sand, trace gravel, wet, brownish grey, firm to stiff	166.2				
		CPT Refusal					

Depth: 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58 (ft); 10, 11, 12, 13, 14, 15, 16, 17 (m)



Remarks

Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 10, 2011

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Datum: Geodetic

The geodetic elevation is approximate and fluctuates

Sheet: 2 of 2

Project No: G11297

Interpreted Borehole / CPT Sounding: EC32

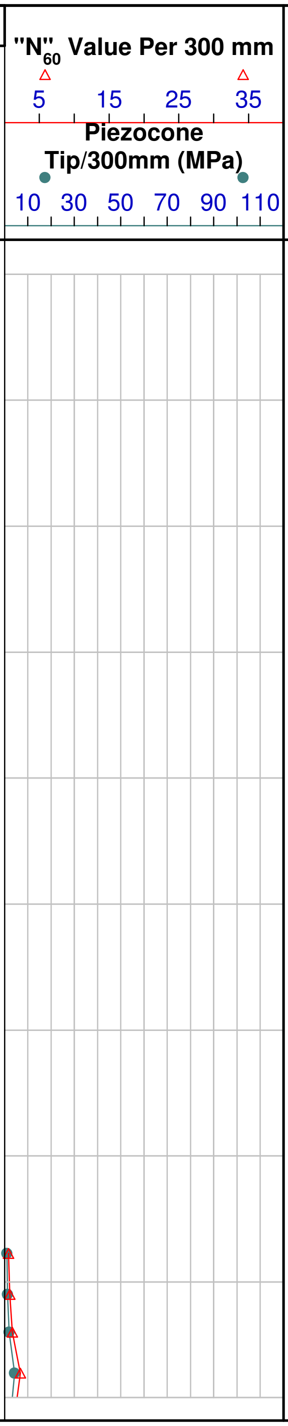
Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan & D. Griffa

SUBSURFACE PROFILE				SAMPLE					
Depth	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery	"N_{60}" Value Per 300 mm / Piezocone Tip/300mm (MPa)	Remarks
0 ft / 0 m		Water Surface	176.4						
	▨	Water							
25 ft		Organic silt, trace sand, trace to some clay, saturated, dark brown to black, very soft (fluid)	168.7						



Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 10, 2011

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Datum: Geodetic
The geodetic elevation is approximate and fluctuates

Project No: G11297

Interpreted Borehole / CPT Sounding: EC32

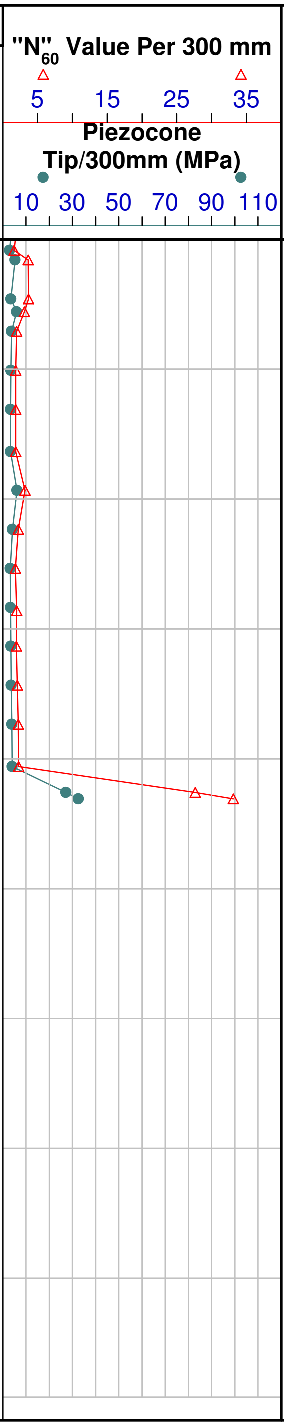
Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan & D. Griffa

SUBSURFACE PROFILE				SAMPLE					
Depth	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery	"N60" Value Per 300 mm / Piezocone Tip/300mm (MPa)	Remarks
30 31 32 10 33 34 35 11 36 37 38 39 12 40 41 42 13		Organic silt, trace sand, trace to some clay, saturated, dark brown to black, very soft (fluid)	163.4						
43 44		Possible till, not enough data to interpret a soil type	163.2						
45 14 46 47 48 49 15 50 51 52 16 53 54 55 17 56 57 58		CPT Refusal							



Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 10, 2011

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Datum: Geodetic
The geodetic elevation is approximate and fluctuates

Sheet: 2 of 2

Project No: G11297

Interpreted Borehole / CPT Sounding: EC34

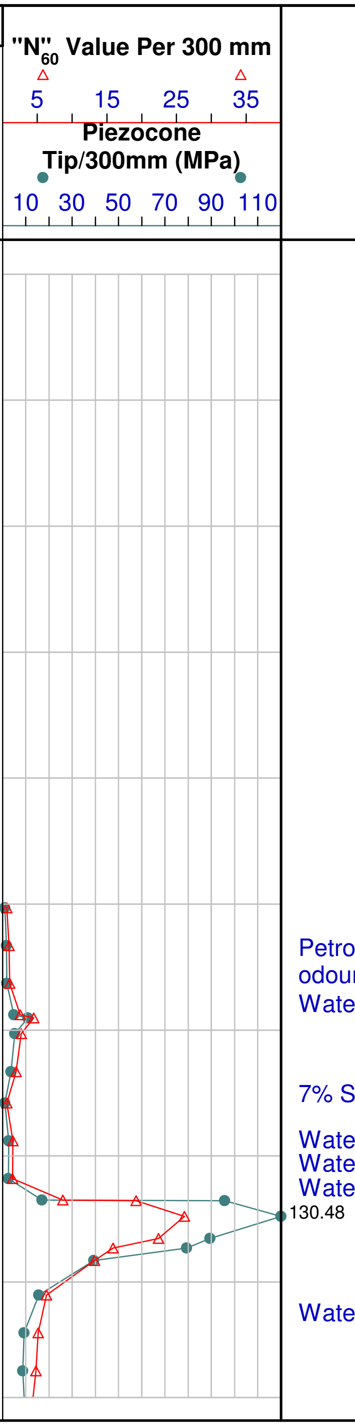
Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan, M. Corriveau & J. Raymer

SUBSURFACE PROFILE				SAMPLE					
Depth ft / m	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery		Remarks
0 / 0		Water Surface	176.4						
0–16 ft 0–5 m		Water							
17–23 ft 5–7 m		Organic silt, trace sand, trace clay, saturated, dark brown to black, very soft	171.4	SB-1	SB				Petroleum Hydrocarbon odour from 5 to 6 m Water Content: 264.4% 7% Sand, 88% Silt, 5% Clay
				SB-2 SB-3 SB-4	SB SB SB				Water Content: 220.9% Water Content: 88.6% Water Content: 90.3%
24–26 ft 8 m		Silty sand, trace clay, wet, light brown, compact	169.1						
27–29 ft		Interlayered silt and silty clay (Silt, wet, light brown, loose)	168.3	AS-1	AS				Water Content: 40.4%



Drilled By: Marathon Drilling

Drill Method: CPT Sounding & Hollow Stem

Drill Date: December 6 and 7, 2011

Consulting Engineers
MRW
M.R. WRIGHT & ASSOCIATES CO. LTD.
SAULT STE. MARIE • ONTARIO

Datum: Geodetic
The geodetic elevation is approximate and fluctuates

Project No: G11297

Interpreted Borehole / CPT Sounding: EC34

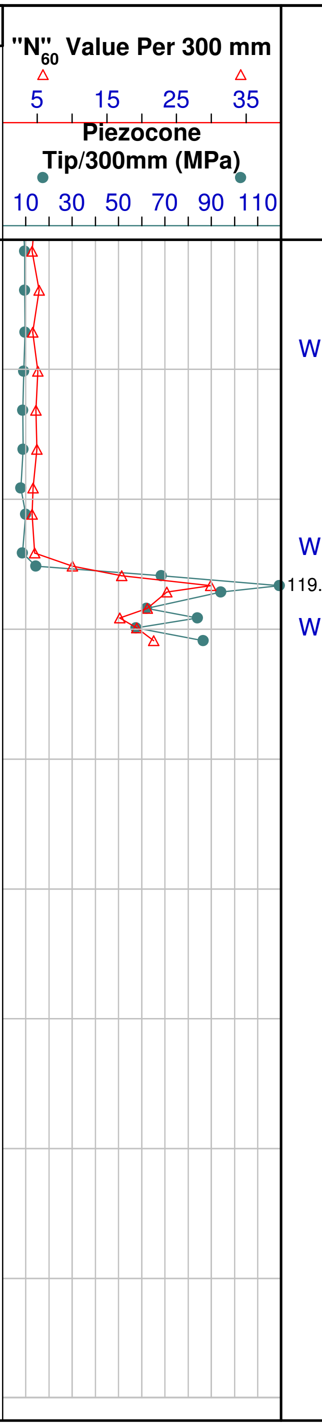
Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan, M. Corriveau & J. Raymer

SUBSURFACE PROFILE				SAMPLE					
Depth	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery		Remarks
30		(Silty clay, wet, light brown, very soft, mediumto high plasticity, varved)							
31									
32 10		(Silt, wet, light brown, very loose)		AS-2	AS				Water Content: 45.4%
33									
34									
35 11									
36									
37			164.9	AS-3	AS				Water Content: 48.4%
38		Till - Silt, some sand, trace to some gravel, trace clay, wet, light brown to grey, compact to dense							
39 12				AS-4	AS				Water Content: 28.4%
40			164.2						
41		CPT Refusal							
42 13									
43									
44									
45 14									
46									
47									
48 15									
49									
50									
51									
52 16									
53									
54									
55 17									
56									
57									
58									



Drilled By: Marathon Drilling

Drill Method: CPT Sounding & Hollow Stem

Drill Date: December 6 and 7, 2011

Consulting Engineers
MRW
M.R. WRIGHT & ASSOCIATES CO. LTD.
SAULT STE. MARIE • ONTARIO

Datum: Geodetic

The geodetic elevation is approximate and fluctuates

Sheet: 2 of 2

Project No: G11297

Interpreted Borehole / CPT Sounding: EC35

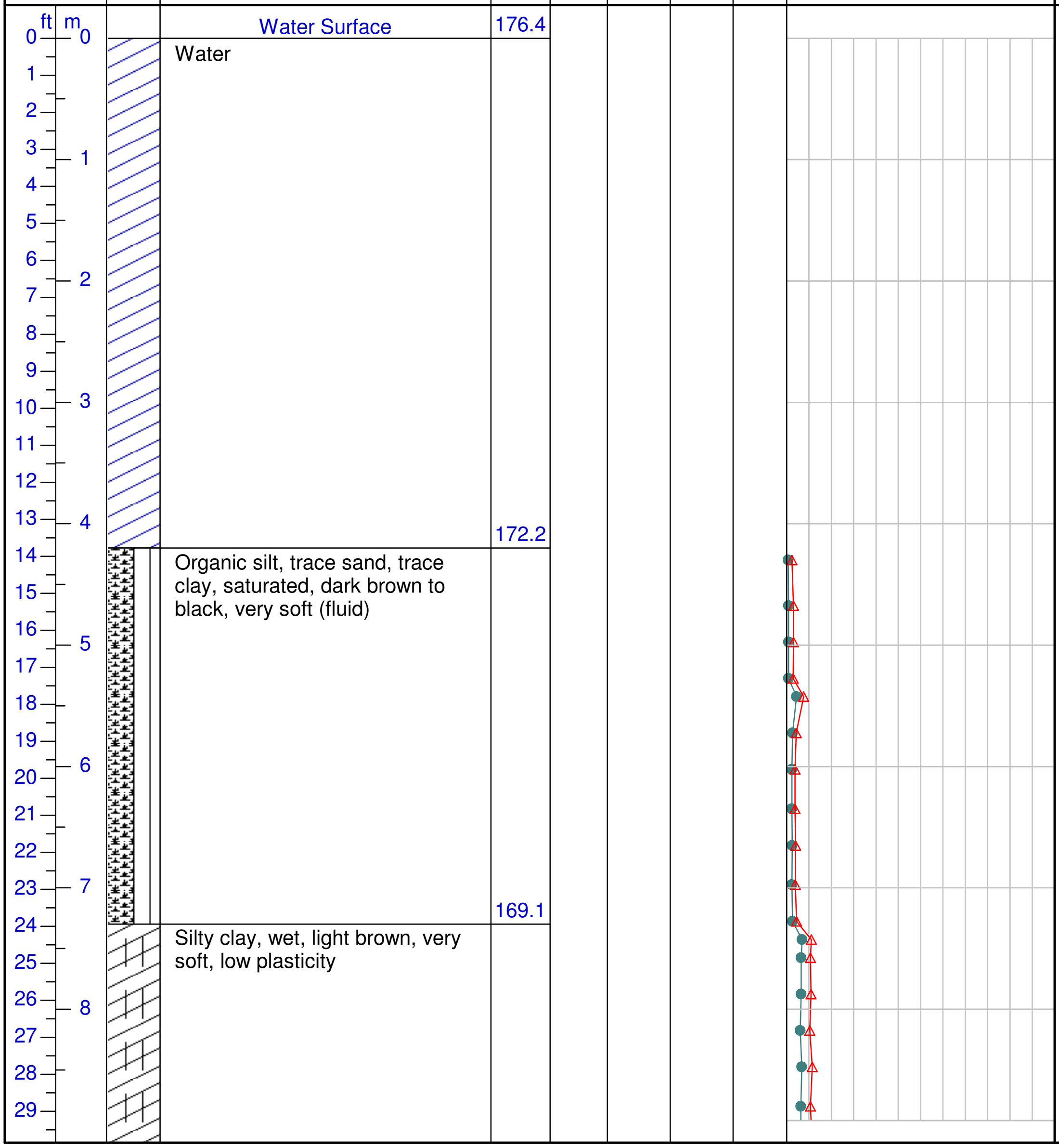
Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan & D. Griffa

SUBSURFACE PROFILE				SAMPLE					
Depth	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery	"N_{60}" Value Per 300 mm / Piezocone Tip/300mm (MPa)	Remarks
ft 0 / m 0		Water Surface	176.4						
	▨	Water	172.2						
	▦	Organic silt, trace sand, trace clay, saturated, dark brown to black, very soft (fluid)	169.1						
	▤	Silty clay, wet, light brown, very soft, low plasticity							



Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 10, 2011

Consulting Engineers
MRW
M.R. WRIGHT & ASSOCIATES CO. LTD.
SAULT STE. MARIE • ONTARIO

Datum: Geodetic
The geodetic elevation is approximate and fluctuates

Sheet: 1 of 2

Project No: G11297

Interpreted Borehole / CPT Sounding: EC35

Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

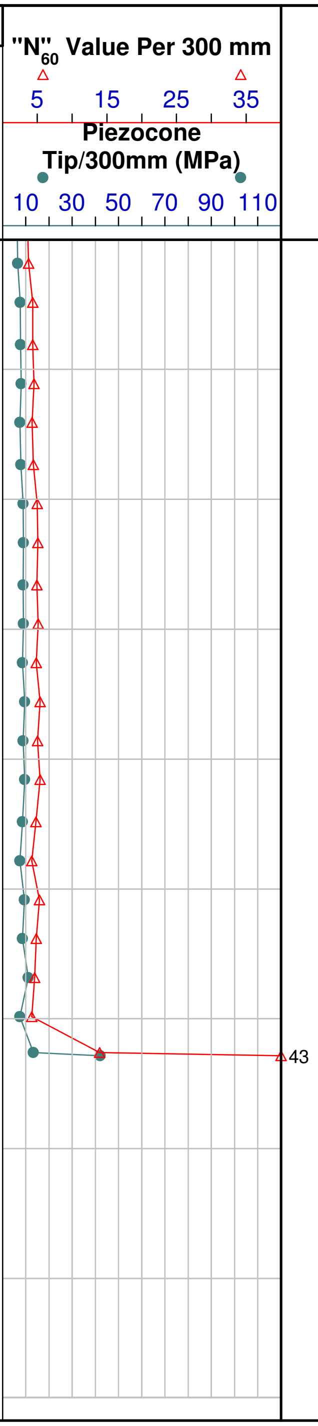
Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan & D. Griffa

SUBSURFACE PROFILE				SAMPLE					
Depth	Legend	Description	Elevation (m)	Number	Method	"N" Value	% Recovery	"N_{60}" Value Per 300 mm / Piezocone Tip/300mm (MPa)	Remarks
30–49 (ft) / 10–15 (m)	▨	Silty clay, wet, light brown, very soft, medium to high plasticity	161.5						
49–50 (ft) / 15 (m)	∘	Possible till, not enought data to interpret a soil type	161.2						
		CPT Refusal							

Depth (ft): 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58

Depth (m): 10, 11, 12, 13, 14, 15, 16, 17



Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 10, 2011

Consulting Engineers
MRW
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SAULT STE. MARIE • ONTARIO

Datum: Geodetic
The geodetic elevation is approximate and fluctuates

Project No: G11297

Interpreted Borehole / CPT Sounding: EC64

Project: Geotechnical Assessment of Sediment in the St. Mary's River Area of Concern

Site Location: St. Mary's River, East of Topsail Island

Client: Sault Ste. Marie Innovation Centre

Inspector(s): D. Cavan & D. Griffa

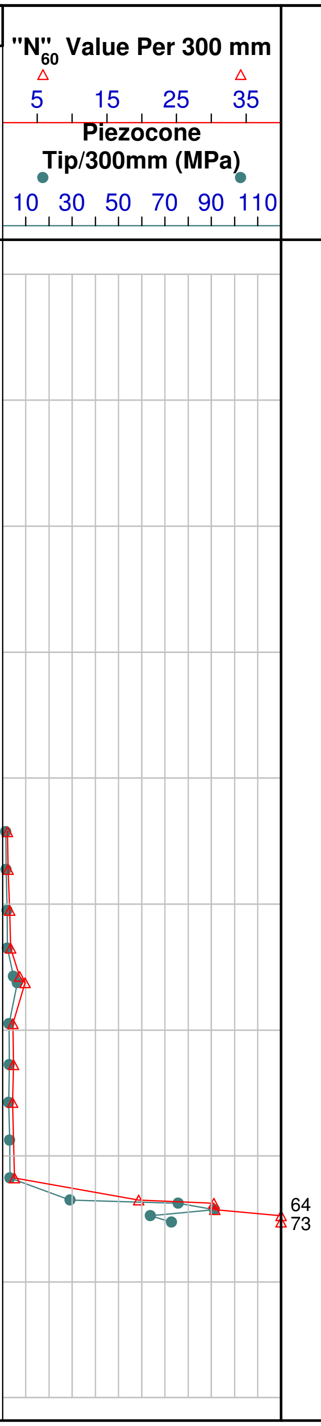
SUBSURFACE PROFILE

Depth ft / m	Legend	Description	Elevation (m)
0 / 0		Water Surface	176.4
	▨	Water	
		Organic silt, trace clay, saturated, dark brown to black, very soft (fluid)	172.0
		Possible till, not enough data to interpret a soil type	169.1
		CPT Refusal	168.8

SAMPLE

Number	Method	"N" Value	% Recovery

Remarks



Depth scale: ft 0, 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; m 0, 1, 2, 3, 4, 5, 6, 7, 8

Drilled By: Marathon Drilling

Drill Method: CPT Sounding

Drill Date: December 9, 2011

Consulting Engineers
MRW
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SAULT STE. MARIE • ONTARIO

Datum: Geodetic
The Geodetic elevation is approximate and fluctuates

Sheet: 1 of 1

Appendix B MRW's Laboratory Analytical Reports of Sediment Samples

Consulting Engineers
MRW
M.R. WRIGHT & ASSOCIATES CO. LTD.
SAULT STE. MARIE • ONTARIO

Testing Lab

71 Black Road - Unit 3
Sault Ste. Marie, ON
P6B 0A3
Phone: (705) 945-5090
Fax: (705) 945-5092
Email: d.stadnisky@mrweng.ca

MOISTURE CONTENT TEST

CONTRACT NO: G11297

DATE SAMPLED: December 7, 2011

PROJECT: St. Mary's River Geotechnical Sediment Assessment

SOURCE: St. Mary's River

Test Location	SA #	Wet Weight	Dry Weight	TARE	Moisture Content	
SS-1 0'-5'		793.4	499.9	388.9	264.4%	
SS-2 5'-7'		1126.7	627.1	400.9	220.9%	
SS-3 @ 7'		1166.2	866.4	528.1	88.6%	
SS-4 7'-8'		2315.7	1392.2	369.9	90.3%	
AS-1 31'-32'		2376.1	1805.0	389.9	40.4%	
AS-2 36'-37'		1349.3	1089.8	518.6	45.4%	
AS-3 41'-42'		3643.0	2632.8	545.9	48.4%	
AS-4 43'-44'		1121.8	936.6	284.2	28.4%	

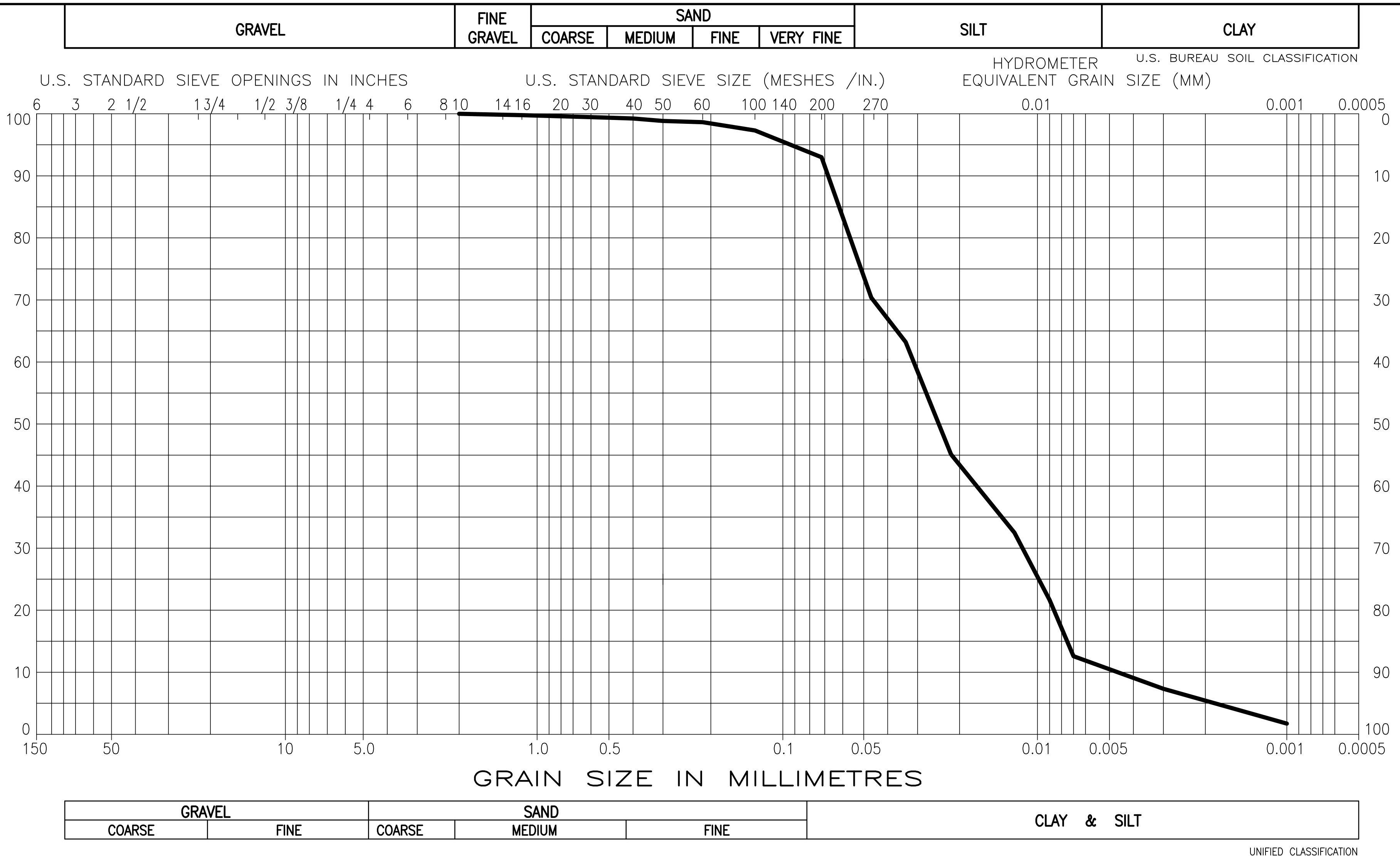
REMARKS:

CLIENT:
COPIES TO:

DATE TESTED: January 2, 2012

Technician T. Edmonds

WE HEREBY CERTIFY TESTING PROCEDURES IN ACCORDANCE WITH ASTM D 2216 FOR THAT PORTION OF TESTING PERFORMED BY THIS COMPANY.



GRAIN SIZE DISTRIBUTION

MRW Consulting Engineers
M. R. WRIGHT & ASSOCIATES CO. LTD.
SAULT STE. MARIE, ONTARIO

TESTING LAB

71 Black Road – Unit 3
Sault Ste. Marie, Ontario P6B 0A3
Phone: 1–(705)–945–5090
Fax: 1–(705)–945–5092
email: d.stadnisky@mrweng.ca

PROJECT: St. Mary's River Geotechnical Sediment Assessment

GRAIN SIZE DISTRIBUTION No. SA 5913

SAMPLED FROM: EC34 SB–2, 1.5 to 2.1 m From River Bottom

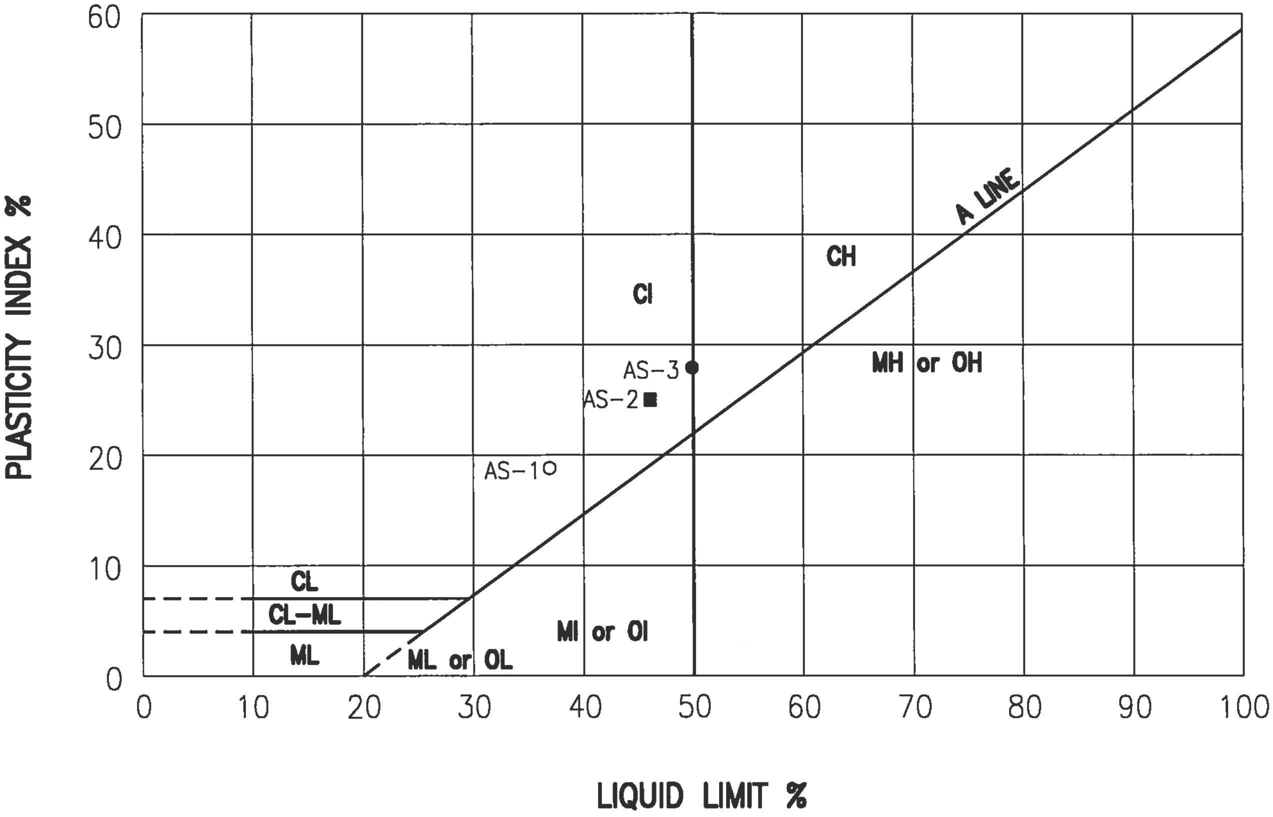
SAMPLED BY: M. Corriveau

OF: M.R. Wright & Associates

TESTED BY: T. Edmonds

DATE: January 5, 2012

CONTRACT No: G11297



SYMBOL	SAMPLE LOCATION	SAMPLE NUMBER	DEPTH RANGE (m)	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	MOISTURE CONTENT (%)
○	CPT-EC34	AS-1	9.45-9.75	36.9	18.1	18.8	40.4
■	CPT-EC34	AS-2	10.97-11.28	46.1	21.1	25.0	45.4
●	CPT-EC34	AS-3	12.5-12.8	49.9	22.0	27.9	48.4

TECHNICIAN:	W.TABACZUK
DRAWN BY:	W.TABACZUK
DATE CREATED:	01/25/2012
REVISION #:	
REVISION DATE:	

Consulting Engineers
MRW
M. R. WRIGHT & ASSOCIATES CO. LTD.
SAULT STE. MARIE, ONTARIO

ATTERBERG PLASTICITY CHART

GEOTECHNICAL ASSESSMENT OF SEDIMENTS IN THE ST. MARY'S RIVER
AREA OF CONCERN
SAULT STE. MARIE, ONTARIO
G11297

CLIENT:
SAULT STE. MARIE INNOVATION CENTRE

UNIT WEIGHT TEST

M.R. WRIGHT AND ASSOCIATES CO. LTD.

CONSULTING ENGINEERS

LABORATORY - 71 BLACK ROAD - UNIT #3 - SAULT STE. MARIE, ONTARIO

CONTRACT NO: G11297

DATE SAMPLED December 7, 2011

PROJECT: St. Mary's River Geot. Sediment Assessment

SOURCE: AS 1, 31'to 32'

SAMPLE IDENTIFICATION:	PROCEDURE USED	CALIBRATION FACTOR
AS 1, 31' to 32'	Compact	1/3597 m3

EIGHT OF SAMPLE & TARE Kg	TARE WEIGHT Kgs.	WEIGHT OF SAMPLE Kgs.
0.69109	0.1765	0.51459
0.69179	0.1765	0.51529
0.69323	0.1765	0.51673

AVERAGE WEIGHT = 0.5155 Kgs.

UNIT WEIGHT = 1854.39 Kgs/m3

REMARKS:

Material tested in its natural moisture content of 40.4%.

CLIENT:

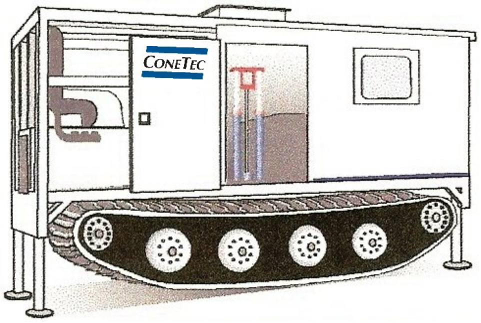
COPIES TO:

DATE TESTED: January 5, 2012

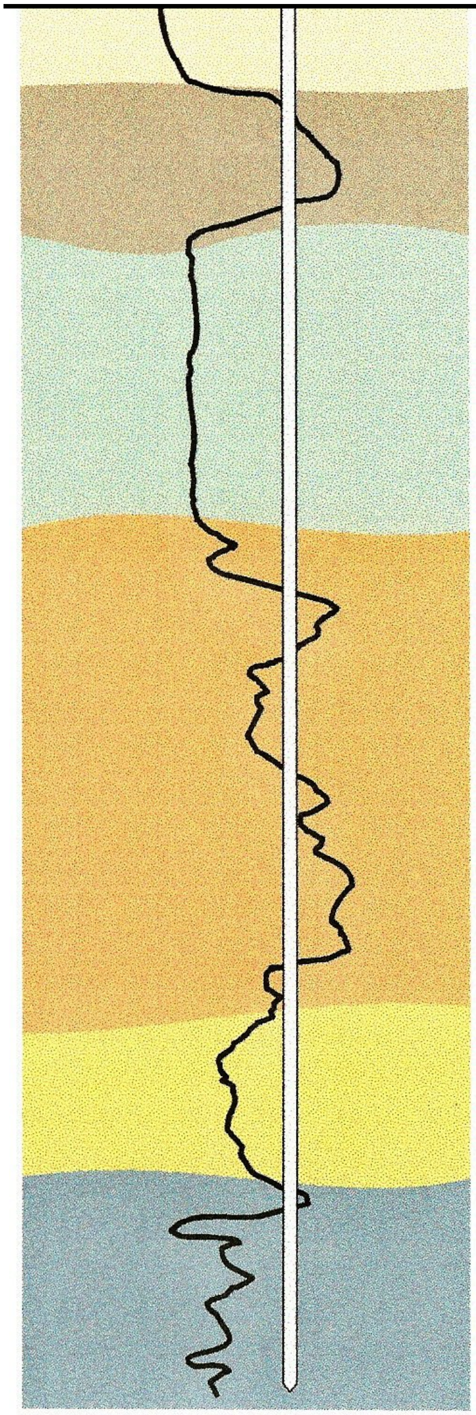
TECHNICIAN: D.Stadnisky

WE HEREBY CERTIFY TESTING PROCEDURES IN ACCORDANCE WITH CAN/CSA-A23.2-M94 FOR THAT PORTION OF TESTING PERFORMED BY THIS COMPANY.

Appendix C ConeTec's Field Report



Geotechnical and Environmental In Situ Testing Contractors



ConeTec Field Report

Presentation of In Situ Test Results for:

St. Mary's River Sediment Assessment Site
Sault Ste. Marie, Ontario

Presented to: M. R. Wright Associates

Date: December 15th, 2011

Presented by: ConeTec, Inc.
436 Commerce Lane, Unit C
West Berlin, NJ 08091
(856) 767-8600

Vancouver, BC • Edmonton, AB • Salt Lake City, UT • West Berlin, NJ • Charles City, VA

PRESENTATION OF IN SITU TESTING PROGRAM RESULTS

Ste. Mary's Sediment Assessment Program
St. Mary's River – Sault Ste. Marie, Ontario

December 6th through 10th, 2011

Prepared for:

W. R. Wright Associates
Sault Ste. Marie, Ontario

Prepared by:

ConeTec Inc.
West Berlin, NJ

December 15th, 2011

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents the results of a piezocone penetrometer testing (CPTU) program carried out at the St. Mary's River Sediment Assessment Site located near Sault Ste. Marie, Ontario. The work was performed under subcontract to M. R. Wright Associates of Sault Ste. Marie, Ontario. The CPTU program took place from December 6th through December 10th, 2011.

A total of seven soundings were completed at seven different sounding locations. The CPT testing was performed to evaluate insitu geotechnical criteria of the soils.

CPT sounding locations were selected and numbered under the direction and supervision of MRW personnel.

2.0 FIELD EQUIPMENT AND PROCEDURES

2.1 CONE PENETRATION TESTING

The cone penetrometer tests were carried out using an integrated electronic piezocone manufactured by ConeTec in Vancouver, Canada. The piezocone used was a compression model cone penetrometer with a 15 cm^2 tip and a 225 cm^2 friction sleeve. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.80. The piezocone dimensions and the operating procedure were in accordance with ASTM Standard D-5778-95. A diagram of the cone penetrometer used for this project is shown as Figure 1.

Pore pressure filter elements, made of porous plastic, were saturated under a vacuum using silicone as the saturating fluid. The pore pressure element was six millimeters thick and was located immediately behind the tip (the u_2 location) for all soundings.

The cone was advanced using a barge mounted drill rig and ConeTec's portable CPT System. The following data were recorded onto magnetic media every two and a half centimeters (approximately every inch) as the cone was advanced into the ground:

- Tip Resistance (qc)
- Sleeve Friction (fs)
- Dynamic Pore Pressure (u_t)

Before each sounding a complete set of analog baseline readings are taken with a multimeter and compared with the digitized value on the computer screen. This provides a check on the analog to digital conversion board.

Evaluation of the analog baselines is key to consistent readings. The baseline data should be stable and should not wander excessively during the course of a sounding. Baseline data can be used to apply corrections to the cone data where necessary. For this project, the baseline shift from sounding to sounding was small, typically less than 0.1% of full scale, and no data corrections were applied.

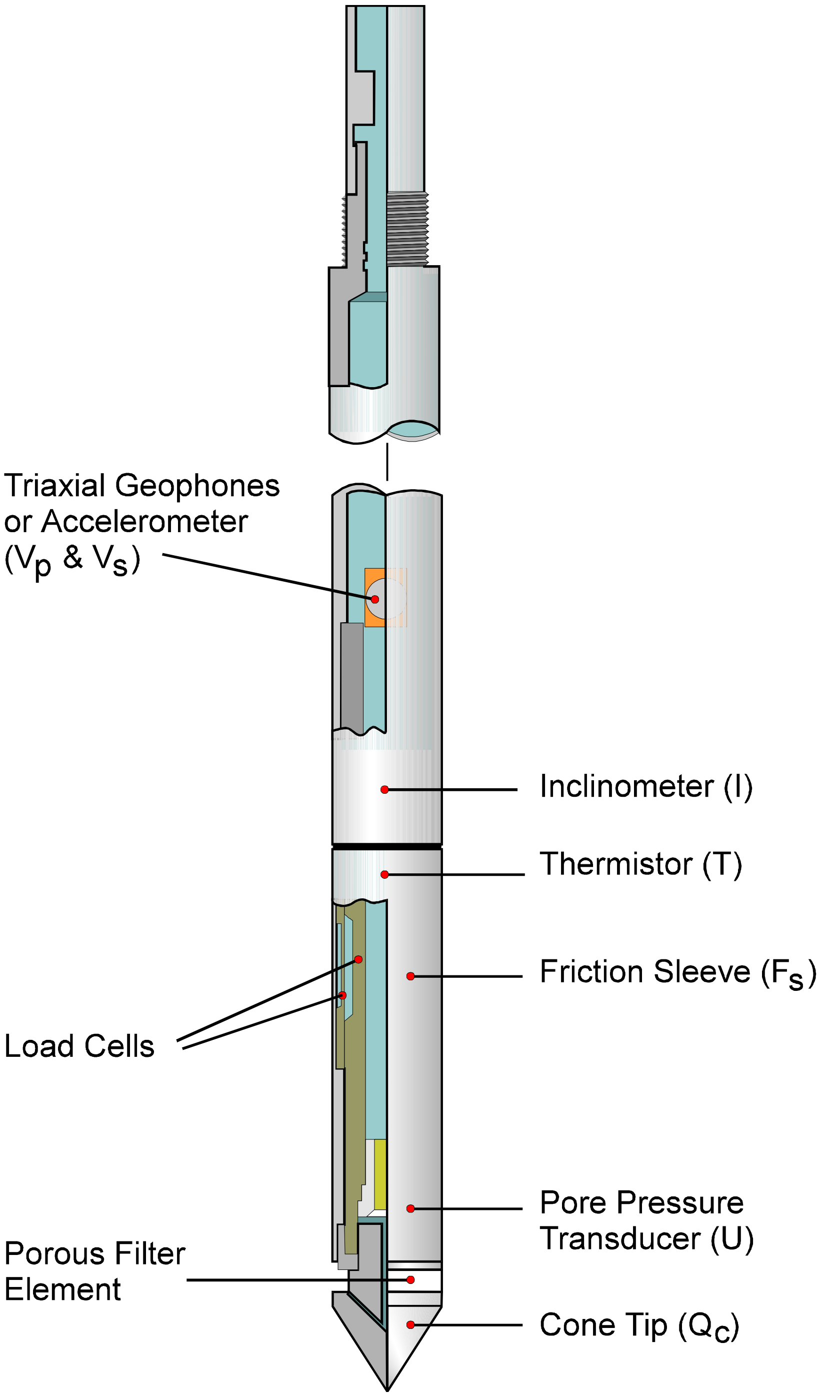


FIGURE 1 - TYPICAL CONE PENETROMETER

2.2 PORE PRESSURE DISSIPATION TESTS

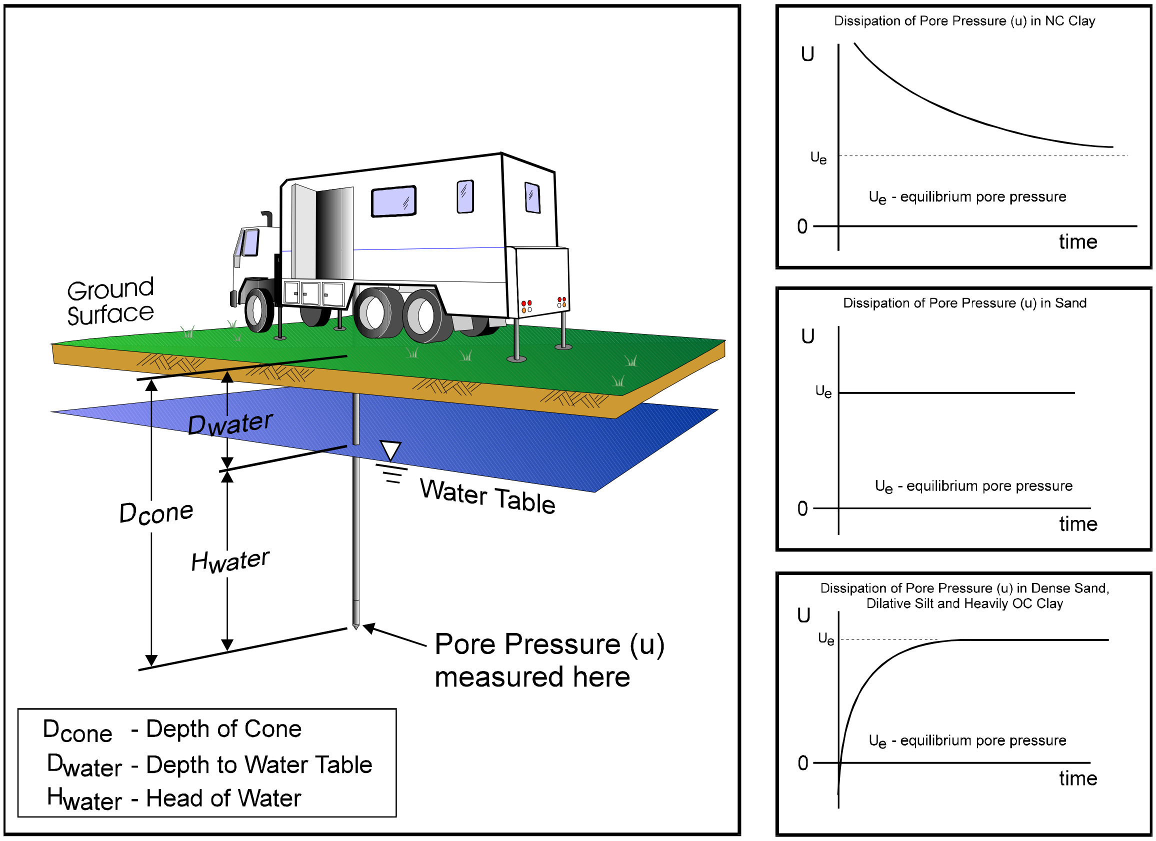
When cone penetration is stopped, the piezocone essentially becomes a piezometer. While stopped, pore water pressures are automatically recorded at five-second intervals and the readings are stored in a dissipation file (.ppd). Dissipation data can then be plotted onto a dissipation curve consisting of pore water pressure (u) verses time (t). The shapes of dissipation curves are very useful in evaluating soil type, drainage and in situ static water level.

A flat curve that stabilizes quickly (i.e. less than 30 seconds) is typical of a free draining sand. In this case, the final measured pore water pressure is the static in situ water pressure.

Soils that generate excess dynamic pore water pressure during penetration will dissipate this excess pressure when penetration stops. The shape of the dissipation curve and the time of dissipation can be used to estimate C_h, the coefficient of consolidation that can in turn be used to calculate K_h, the horizontal permeability.

Figure 2 shows some idealized shapes of various pore water pressure dissipation curves. The reader is referred Robertson et. al., 1990 to reference dissipation test data analytical techniques.

Estimation of Ground Water Table from CPT Dissipation Tests



Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors: 1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

FIGURE 2 - TYPICAL DISSIPATION TESTS

3.0 CONE PENETRATION TEST DATA AND INTERPRETATION

3.1 ANALYSIS OF PIEZOCONE DATA - GENERAL

A total of seven CPT soundings, involving 271.41 feet of testing, were completed.

The interpretation of cone data is based on the relationship between cone bearing, qc, sleeve friction, fs, and penetration pore water pressure, u. The friction ratio, Rf , (sleeve friction divided by cone bearing) is a calculated parameter which is used to infer soil behavior type. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

The interpretation of soils encountered on this project was carried out using correlations developed by Robertson et al., 1992. It should be noted that it is not always possible to clearly identify a soil type based on qc, fs and u. Occasionally soils will fall within different soil categories on the classification charts. In these situations, experience and judgment and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type. Computer tabulations of the interpreted soil types along with certain other geotechnical parameters for each cone hole is presented in Appendix B.

Each of the parameters measured in the sounding is discussed briefly below. A detailed explanation of CPTU testing and interpretation of the results can be found in Robertson, 1989.

TIP RESISTANCE (q_c): The resistance to penetration, measured at the cone tip, provides an accurate profile of subsurface strata. The recorded tip resistance is a composite of the penetration resistance of the soils located five to ten cone diameters (7 to 14 inches) in front of and behind the tip. The actual resistance "sensed" by the tip depends on the soil properties and on the relative stiffness of the layers encountered. Tip resistance is often corrected for pore pressure effects when testing in soft saturated cohesive soils.

For this project the correction was made and the tip resistance shown, q_t is the corrected tip resistance.

The correction used is: $q_t = q_c + (1-a)u$

Where:
q_t = corrected tip resistance
q_c = measured tip resistance
a = net area ratio for cone (0.80 for this project)
u = dynamic pore water pressure measured behind tip

SLEEVE FRICTION (f_s) The resistance recorded on the friction sleeve, is a measure of the remolded strength of the soil. Values of sleeve friction in very soft soils (such as peat) may fluctuate due to the measured force being small relative to the capacity of the measuring load cell.

FRICTION RATIO (R_f) The ratio of sleeve friction to tip resistance expressed as a percentage, is an indicator of soil type. Cohesive soils generally have friction ratios that are greater than two, while sands and non-plastic silts have friction ratios that are lower than two.

PORE PRESSURE (u*)* Dynamic pore water pressure is measured during penetration. (dynamic pore water pressure data can be found in the .cor, and .xls files. Static pore water pressure is measured when cone penetration is stopped (static pore water pressure data can be found in the .ppd files). The measured dynamic pore water pressure changes with the location of the porous filter and negative readings are possible when the filter is located behind the tip.

It is important to note that the CPT classifies soil by physical behavior, not by grain size; therefore, the CPT classification should be verified against samples obtained from a conventional drilling program. While the CPT soil classification may not always be accurate in terms of the actual label it applies to a particular soil, it is very accurate in grouping soils with similar mechanical properties.

3.2 CONE PLOTS

The data from each sounding was plotted using the computer program SCREENzW. The plots are included in Appendix A. SCREENzW was developed by ConeTec Inc. and it incorporates soil behavior type (SBT) classification as part of the plot. The soil classification is based on the classification chart reproduced chart in Appendix B.

3.3 PORE PRESSURE DISSIPATION TEST RESULTS

Pore water pressure dissipation data are collected and automatically recorded during pauses in penetration. The pore water pressure data is recorded at five second intervals. A few pore water pressure dissipation tests were performed on this project. Those plots can be found in Appendix C.

3.4 CPT DATA PROCESSING

The electronic data files were processed using the program SCREENzW. SCREENzW is a program developed by ConeTec to calculate common engineering parameters from CPT data. The processed data file summery sheet is attached in Appendix B. The files (IFI.xls) are included in the electronic data package. The calculations used are summarized in the table at the front of the Appendix. Each calculation is derived according to the referenced article.

For this project, the piezometric surface used was determined to be the water surface and confirmed from the dynamic pore water pressure responses recorded during the CPT. The exact depth used can be found in the headers of the ifi.xls files.

3.5 ELECTRONIC DATA FILES

Along with the report, all of the project data can be downloaded from ConeTec's "ConeTec Data Services" (CDS) website (www.conetecdataservices.com) using a secure, project-specific user name and password. These electronic files contain all important project information including tabular data (.xls and ASCII formats), GPS coordinates of approximate sounding locations, dynamic and static pore water pressure and some basic interpretation files in Microsoft™ Excel format (.xls). Information regarding the digital file formats of the electronic files is included in Appendix D.

5.0 REFERENCES

Robertson, P.K., 1989, “Soil Classification using the Cone Penetration Test”, Canadian Geotechnical Journal, vol. 27, pages 151-158.

Robertson, P.K., Sully, J., Woeller, D.G., Lunne, T., Powell, J.M., and Gillespie, D.J., 1992, “Estimating Coefficient of Consolidation from Piezocone Tests”, Canadian Geotechnical Journal, vol. 29, pages 539-550.

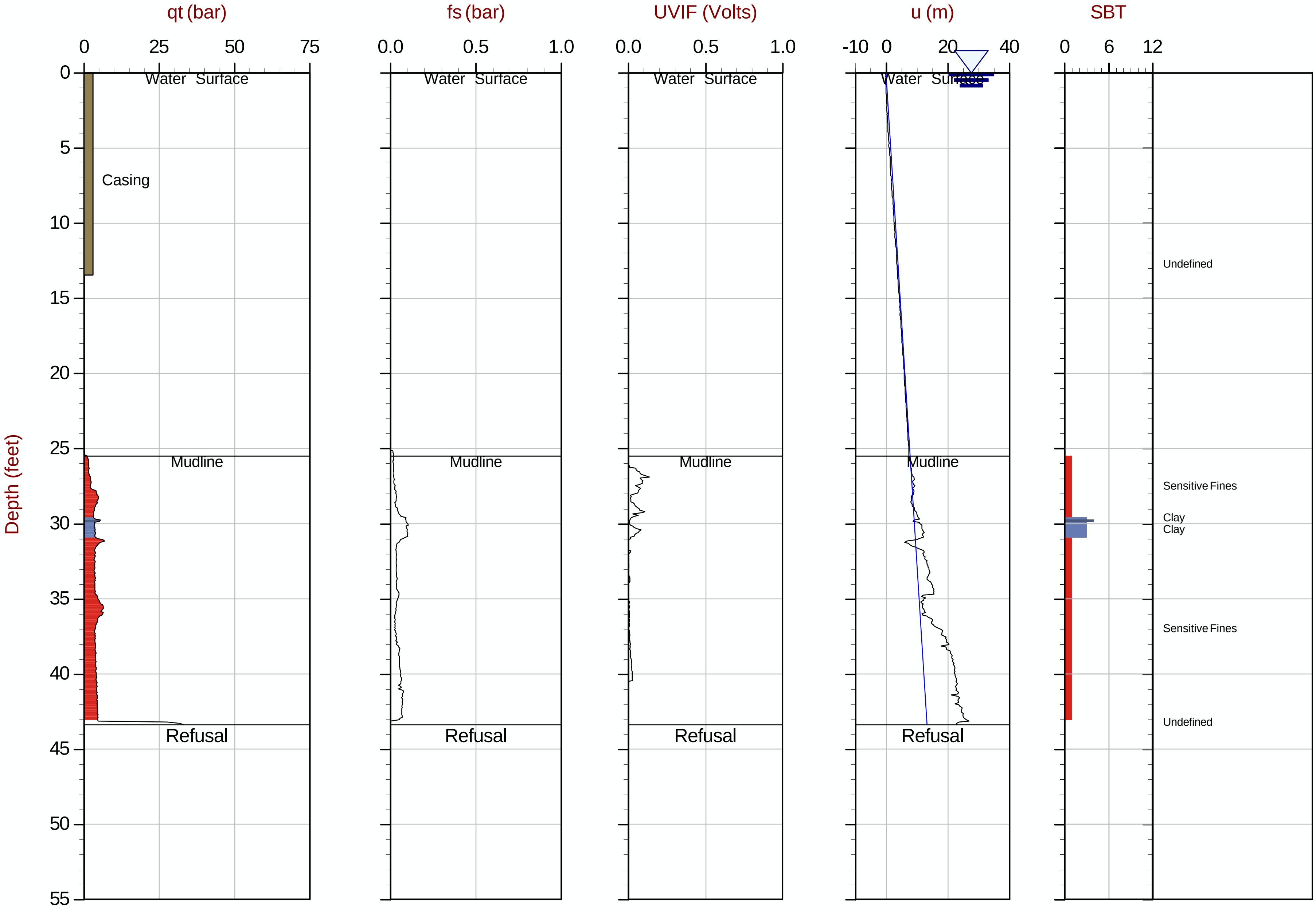
Appendix A

CONETEC

M. R. Wright & Associates

Job No: 11-610
Date: 12:10:11 16:07
Site: Ste. Marys Sediment

Sounding: CPT-EC32
Cone: 308:T1500F15U500



Max Depth: 13.225 m / 43.39 ft
Depth Inc: 0.025 m / 0.082 ft

File: 610EC32.COR

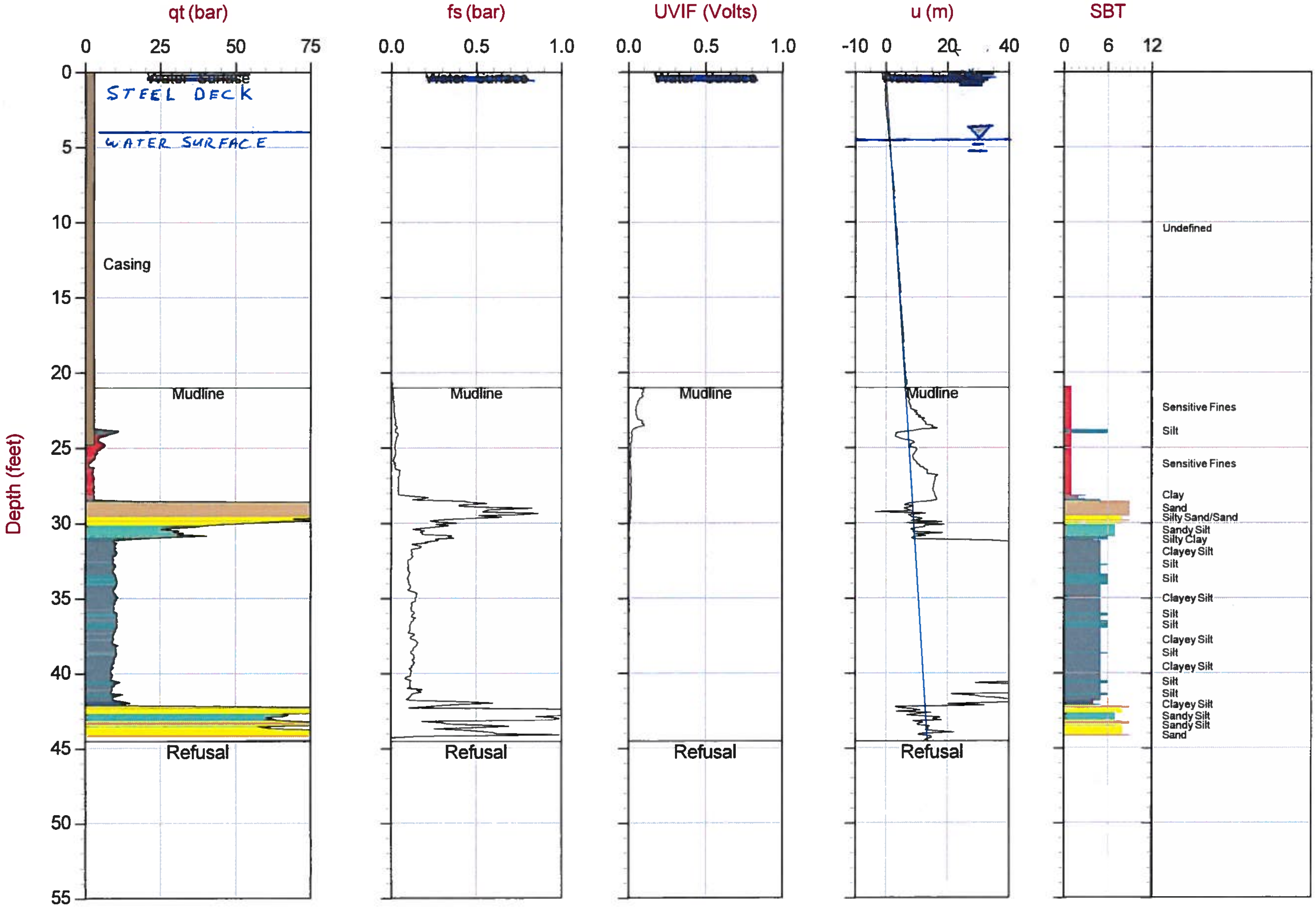
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 16 N: 5152670.790 E: 707922.950

CONETEC

M. R. Wright & Associates

Job No: 11-610
Date: 12:06:11 12:30
Site: Ste. Marys Sediment

Sounding: CPT-EC34
Cone: 308:T1500F15U500



Max Depth: 13.575 m / 44.54 ft
Depth Inc: 0.025 m / 0.082 ft

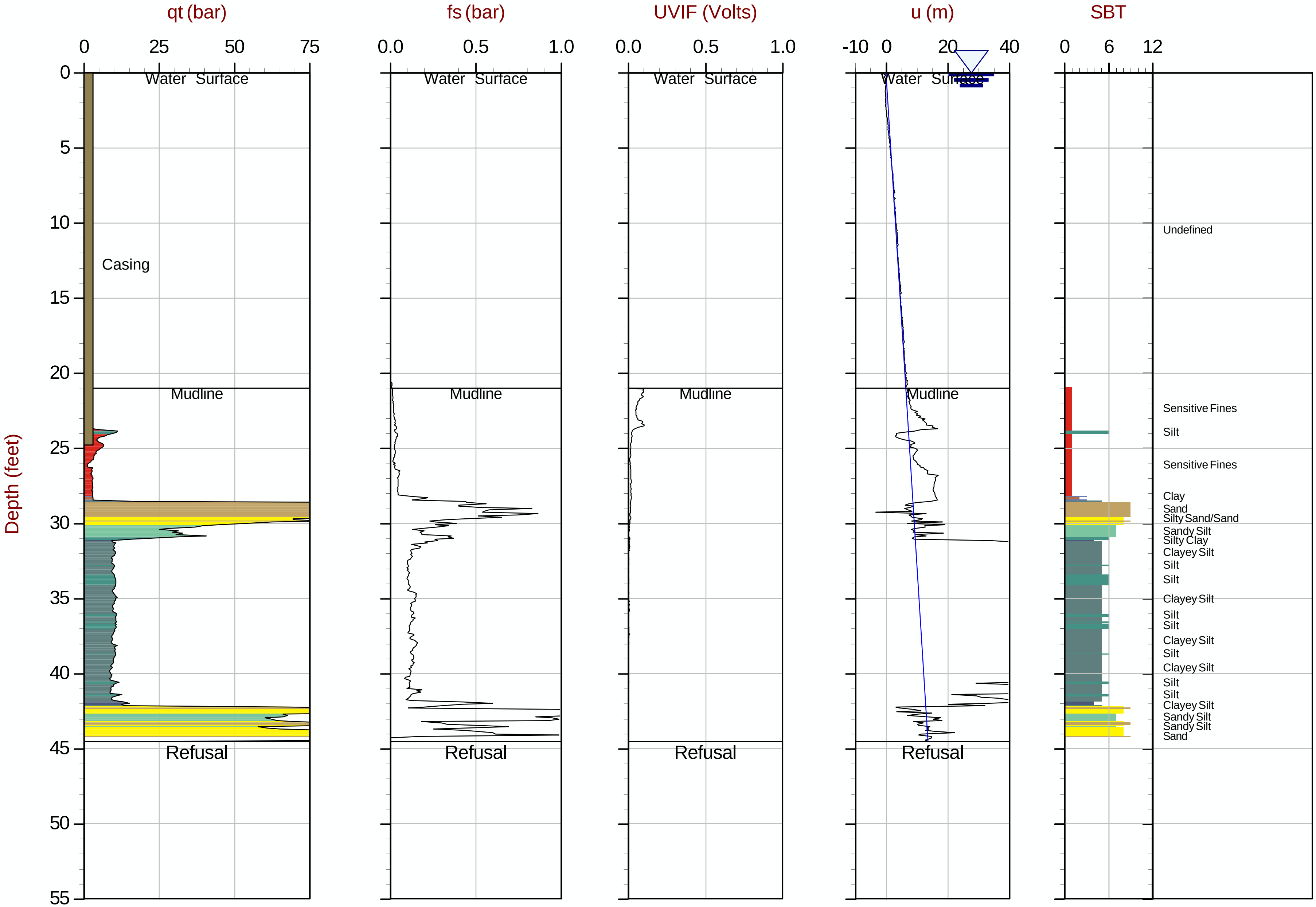
File: 610EC34.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 16 N: 5152742.000 E: 708018.000

M. R. Wright & Associates

Job No: 11-610
Date: 12:06:11 12:30
Site: Ste. Marys Sediment

Sounding: CPT-EC34
Cone: 308:T1500F15U500



Max Depth: 13.575 m / 44.54 ft
Depth Inc: 0.025 m / 0.082 ft

File: 610EC34.COR

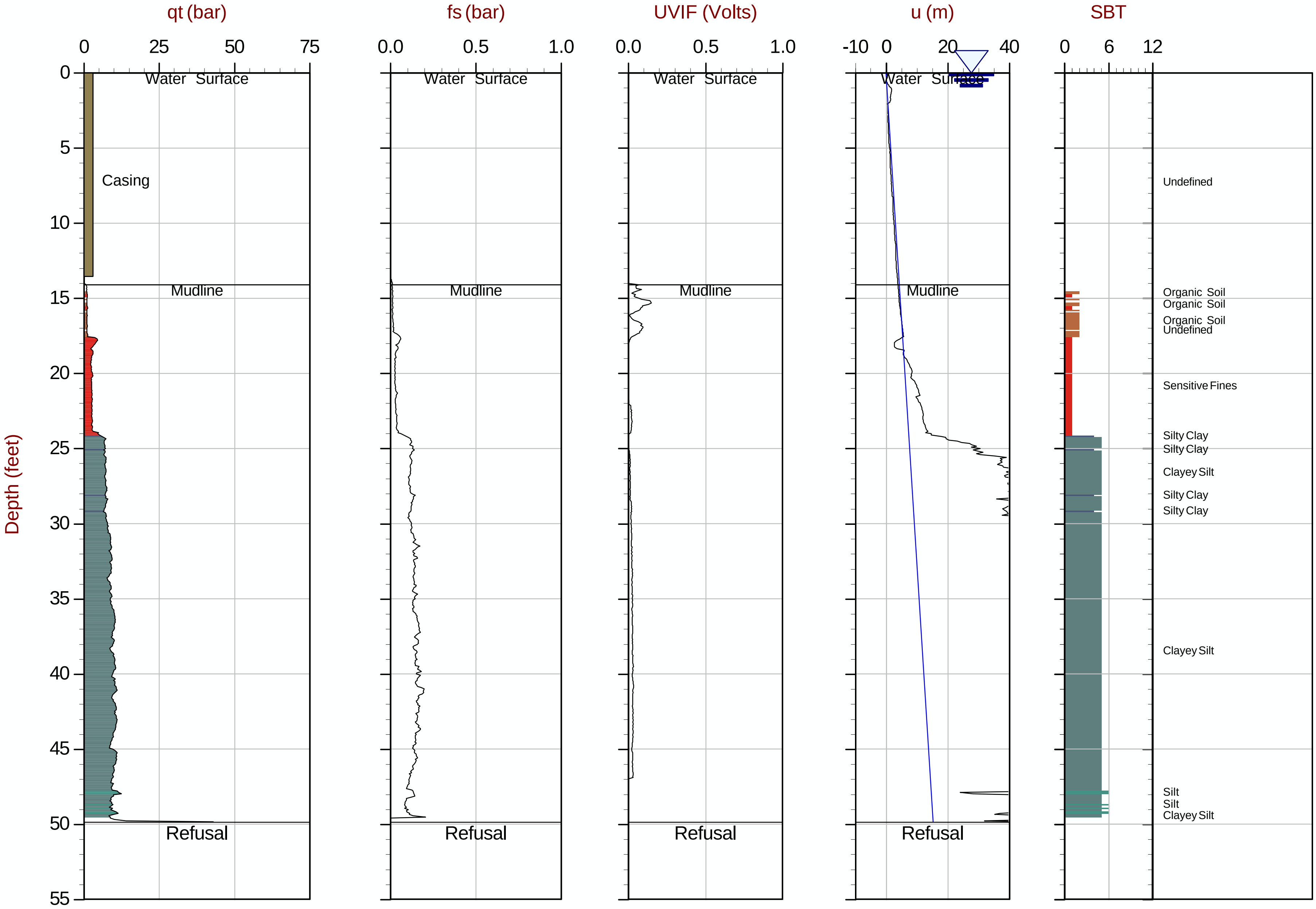
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 16 N: 5152742.000 E: 708018.000

CONETEC

M. R. Wright & Associates

Job No: 11-610
Date: 12:10:11 13:54
Site: Ste. Marys Sediment

Sounding: CPT-EC35
Cone: 308:T1500F15U500



Max Depth: 15.200 m / 49.87 ft
Depth Inc: 0.025 m / 0.082 ft

File: 610EC35.COR

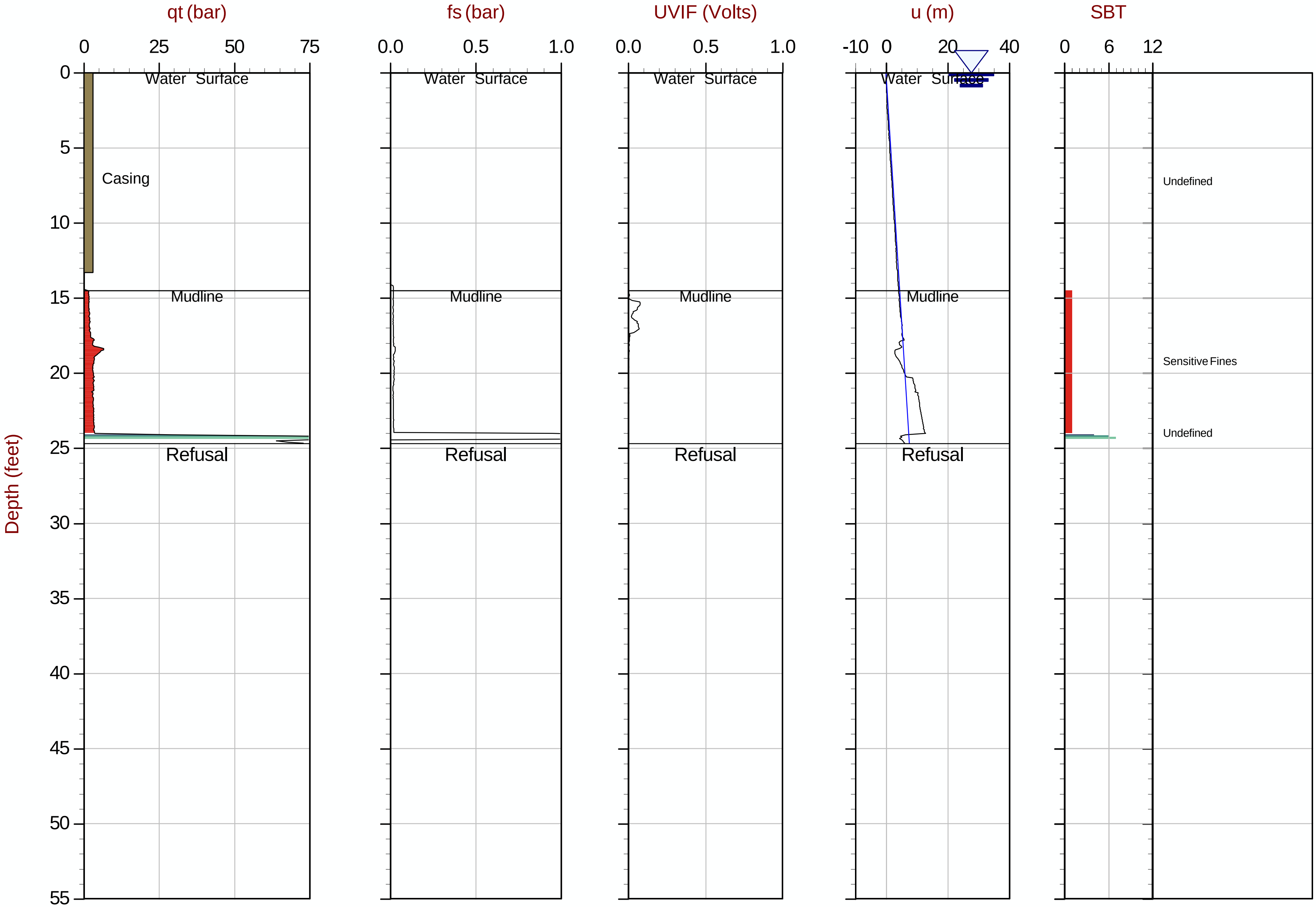
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 16 N: 5152583.180 E: 707928.550

CONETEC

M. R. Wright & Associates

Job No: 11-610
Date: 12:09:11 12:38
Site: Ste. Marys Sediment

Sounding: CPT-EC64
Cone: 308:T1500F15U500



Max Depth: 7.525 m / 24.69 ft
Depth Inc: 0.025 m / 0.082 ft

File: 610EC64.COR

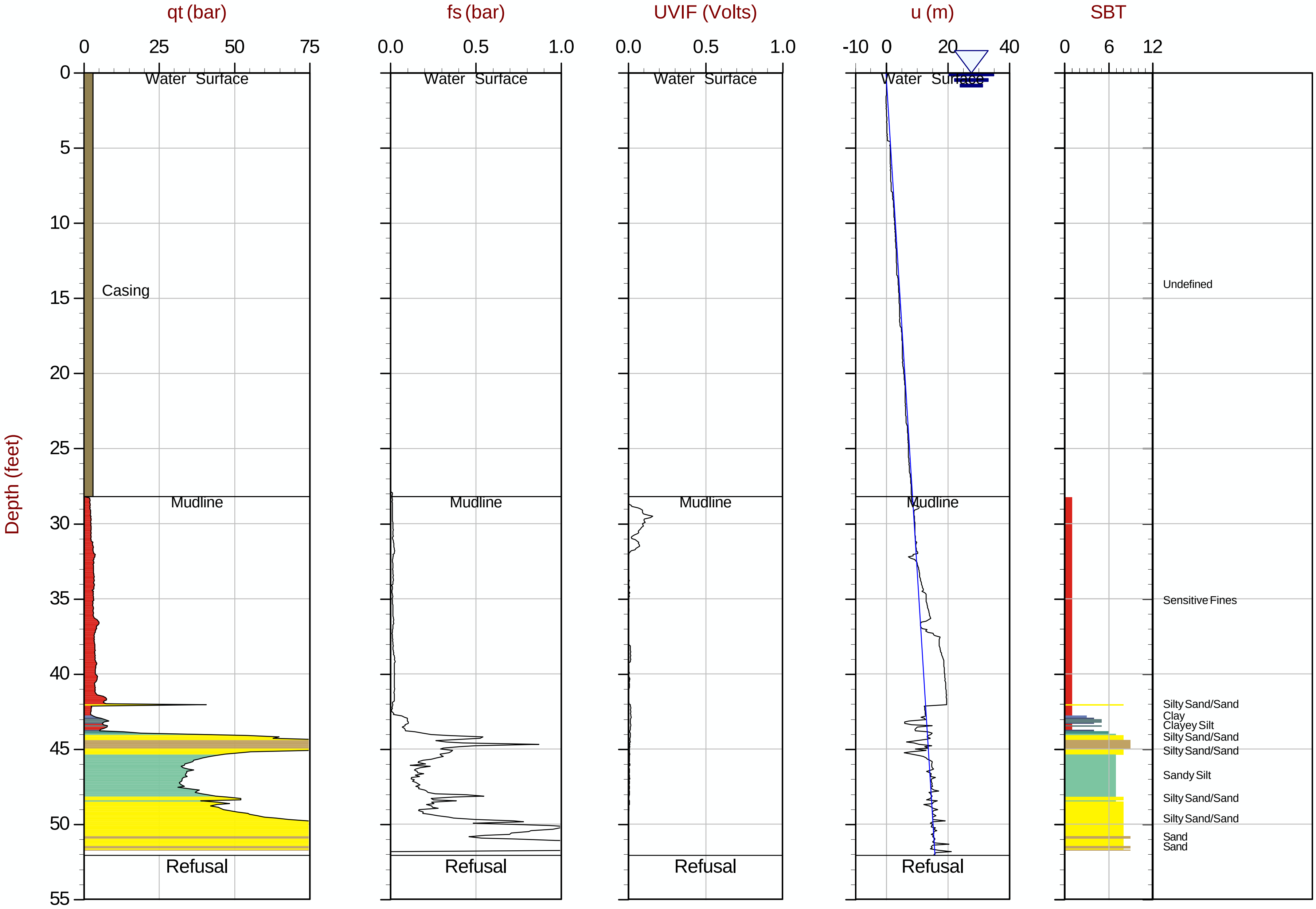
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 16 N: 5152628.790 E: 707707.960

CONETEC

M. R. Wright & Associates

Job No: 11-610
Date: 12:08:11 10:06
Site: Ste. Marys Sediment

Sounding: CPT-CS10
Cone: 308:T1500F15U500



Max Depth: 15.875 m / 52.08 ft
Depth Inc: 0.025 m / 0.082 ft

File: 610SC10.COR

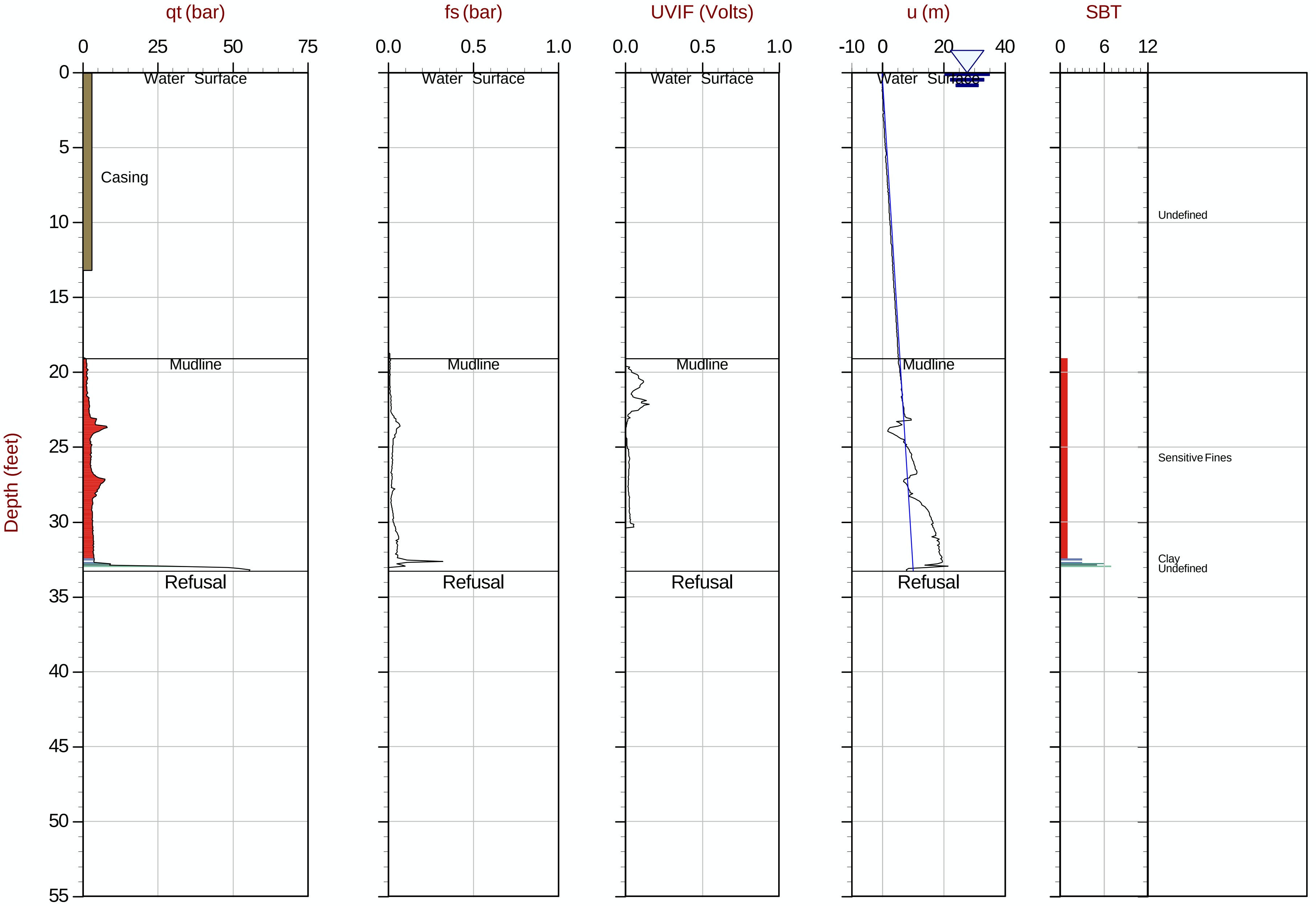
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 16 N: 5152647.310 E: 708016.710

CONETEC

M. R. Wright & Associates

Job No: 11-610
Date: 12:10:11 09:21
Site: Ste. Marys Sediment

Sounding: CPT-EC31
Cone: 308:T1500F15U500



Max Depth: 10.150 m / 33.30 ft
Depth Inc: 0.025 m / 0.082 ft

File: 610EC31.COR

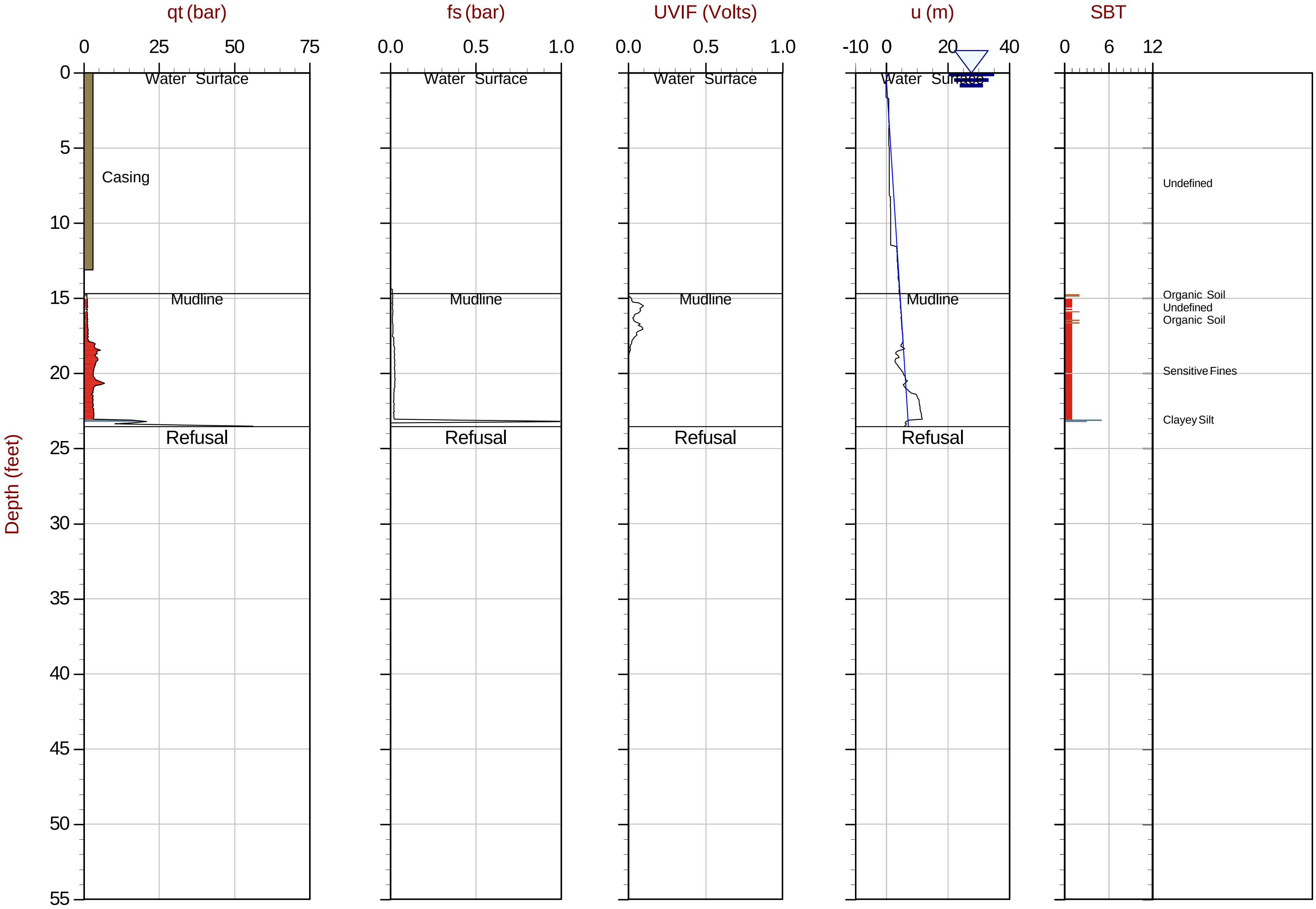
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 16 N: 5152550.220 E: 707754.500

CONETEC

M. R. Wright & Associates

Job No: 11-610
Date: 12:09:11 13:59
Site: Ste. Marys Sediment

Sounding: CPT-CS30
Cone: 308:T1500F15U500



Max Depth: 7.175 m / 23.54 ft
Depth Inc: 0.025 m / 0.082 ft

File: 610EC30.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 16 N: 5152733.560 E: 707765.560

TABLE 1 - SUMMARY OF CPT SOUNDINGS

Job No.: 11-610
Location: Ste. Mary's Sediment - Sault Ste. Marie, Ontario
Client: M. R. Wright Associates
Date: December 6, 7, 8, 9 & 10, 2011

Date	CPTU Sounding	Filename	Total Depth From Water Surface (ft)	Northing UTM Zone 16 (m)	Easting UTM Zone 16 (m)	Comments
11/7/2011	CPT-CS10	610SC10.COR	52.08	5152647.310	708016.710	
11/8/2011	CPT-CS30	610EC30.COR	23.54	5152733.560	707765.560	
11/8/2011	CPT-EC31	610EC31.COR	33.30	5152550.220	707754.500	
11/8/2011	CPT-EC32	610EC32.COR	43.39	5152670.790	707922.950	
11/9/2011	CPT-EC34	610EC34.COR	44.54	5152742.000	708018.000	
11/9/2011	CPT-EC35	610EC35.COR	49.87	5152583.180	707928.550	
11/9/2011	CPT-EC64	610EC64.COR	24.69	5152628.790	707707.960	
Totals:		7	271.41			

Note: Coordinates are in UTM-NAD83 (meters) Zone 16.

Appendix B

CONETEC INTERPRETATION METHODS

A Detailed Description of the Methods Used in ConeTec's CPT Interpretation and Plotting Software

Revision SZW-Rev 05
January 16, 2011

Prepared by Jim Greig

ConeTec

ConeTec Interpretations as of January 16, 2011

ConeTec's interpretation routine provides a tabular output of geotechnical parameters based on current published CPT correlations and is subject to change to reflect the current state of practice. The interpreted values are not considered valid for all soil types. The interpretations are presented only as a guide for geotechnical use and should be carefully scrutinized for consideration in any geotechnical design. Reference to current literature is strongly recommended. ConeTec does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the program and does not assume liability for any use of the results in any design or review. Representative hand calculations should be made for any parameter that is critical for design purposes. The end user of the interpreted output should also be fully aware of the techniques and the limitations of any method used in this program. The purpose of this document is to inform the user as to which methods were used and what the appropriate papers and/or publications are for further reference.

The CPT interpretations are based on values of tip, sleeve friction and pore pressure averaged over a user specified interval (e.g. 0.20m). Note that q_t is the tip resistance corrected for pore pressure effects and q_c is the recorded tip resistance. Since all ConeTec cones have equal end area friction sleeves, pore pressure corrections to sleeve friction, f_s, are not required.

The tip correction is: $q_t = q_c + (1-a) \cdot u_2$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the cone (typically 0.80 for ConeTec cones)

The total stress calculations are based on soil unit weights that have been assigned to the Soil Behavior Type zones, from a user defined unit weight profile or by using a single value throughout the profile.

Effective vertical overburden stresses are calculated based on a hydrostatic distribution of equilibrium pore pressures below the water table or from a user defined equilibrium pore pressure profile (this can be obtained from CPT dissipation tests). For over water projects the effects of the column of water have been taken into account as has the appropriate unit weight of water. How this is done depends on where the instruments were zeroed (i.e. on deck or at mud line).

Details regarding the interpretation methods for all of the interpreted parameters are provided in Table 1. The appropriate references cited in Table 1 are listed in Table 2. Where methods are based on charts or techniques that are too complex to describe in this summary the user should refer to the cited material.

The estimated Soil Behavior Types (normalized and non-normalized) are based on the charts developed by Robertson and Campanella shown in Figures 1 and 2. Alternate classification charts, such as the Bq SBTcharts, are shown in Figure 3.

Where the results of a calculation/interpretation are declared *'invalid'* the value will be represented by the text strings "-9999" or "-9999.0". In some cases the value 0 will be used. Invalid results will occur because of (and not limited to) one or a combination of:

1. Invalid or undefined CPT data (e.g. drilled out section or data gap).
2. Where the interpretation method is inappropriate, for example, drained parameters in an undrained material (and vice versa).
3. Where interpretation input values are beyond the range of the referenced charts or specified limitations of the interpretation method.
4. Where pre-requisite or intermediate interpretation calculations are invalid.

The parameters selected for output from the program are often specific to a particular project. As such, not all of the interpreted parameters listed in Table 1 may be included in the output files delivered with this report.

The output files are provided in Microsoft Excel XLS format. The ConeTec software has several options for output depending on the number or types of interpreted parameters desired. Each output file will be named using the original COR file basename followed by a three or four letter indicator of the interpretation set selected (e.g. BSC, TBL, NLI or IFI) and possibly followed by an operator selected suffix identifying the characteristics of the particular interpretation run.

Table 1
CPT Interpretation Methods

Interpreted Parameter	Description	Equation	Ref
Depth	Mid Layer Depth *(where interpretations are done at each point then Mid Layer Depth = Recorded Depth)*	*Depth (Layer Top) + Depth (Layer Bottom) / 2.0*	
Elevation	Elevation of Mid Layer based on sounding collar elevation supplied by client	Elevation = Collar Elevation - Depth	
Avgqc	Averaged recorded tip value (q_c)	$Avgqc = \frac{1}{n}\sum_{i=1}^{n} q_c$ *n=1 when interpretations are done at each point*	
Avgqt	Averaged corrected tip (q_t) where: $q_t = q_c + (1-a) \bullet u$	$Avgqt = \frac{1}{n}\sum_{i=1}^{n} q_t$ *n=1 when interpretations are done at each point*	
Avgfs	Averaged sleeve friction (f_s)	$Avgfs = \frac{1}{n}\sum_{i=1}^{n} fs$ *n=1 when interpretations are done at each point*	
AvgRf	Averaged friction ratio (Rf) where friction ratio is defined as: $Rf = 100\% \bullet \frac{fs}{qt}$	$AvgRf = 100\% \cdot \frac{Avgfs}{Avgqt}$ *n=1 when interpretations are done at each point*	
Avgu	Averaged dynamic pore pressure *(u)*	$Avgu = \frac{1}{n}\sum_{i=1}^{n} u_i$ *n=1 when interpretations are done at each point*	
AvgRes	Averaged Resistivity (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} RESISTIVITY_i$ *n=1 when interpretations are done at each point*	
AvgUVIF	Averaged UVIF ultra-violet induced fluorescence (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} UVIF_i$ *n=1 when interpretations are done at each point*	
AvgTemp	Averaged Temperature (this data is not always available since it is a specialized test)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} TEMPERATURE_i$ *n=1 when interpretations are done at each point*	
AvgGamma	Averaged Gamma Counts (this data is not always available since it is a specialized test requiring an additional module)	$Avgu = \frac{1}{n}\sum_{i=1}^{n} GAMMA_i$ *n=1 when interpretations are done at each point*	
SBT	Soil Behavior Type as defined by Robertson and Campanella	See Figure 1	2, 5

Interpreted Parameter	Description	Equation	Ref
U.Wt.	Unit Weight of soil determined from one of the following user selectable options: 1) uniform value 2) value assigned to each SBT zone 3) user supplied unit weight profile	See references	5
T. Stress σ_v	Total vertical overburden stress at Mid Layer Depth. *A layer is defined as the averaging interval specified by the user. For data interpreted at each point the Mid Layer Depth is the same as the recorded depth.*	$TStress = \sum_{i=1}^{n} \gamma_i h_i$ *where* γ_i is layer unit weight h_i is layer thickness	
E. Stress σ_v'	Effective vertical overburden stress at Mid Layer Depth	*Estress = Tstress -* u_{eq}	
Ueq	Equilibrium pore pressure determined from one of the following user selectable options: 1) hydrostatic from water table depth 2) user supplied profile	For hydrostatic option: $u_{eq} = \gamma_w \cdot (D - D_{wt})$ where u_{eq} is equilibrium pore pressure γ_w is unit weight of water D is the current depth D_{wt} is the depth to the water table	
Cn	SPT N_{60} overburden correction factor	$Cn=(\sigma_v')^{-0.5}$ where σ_v' *is in tsf* $0.5 < C_n < 2.0$	
N_{60}	SPT N value at 60% energy calculated from qt/N ratios assigned to each SBT zone. This method has abrupt N value changes at zone boundaries.	*See Figure 1*	4, 5
$(N_1)_{60}$	SPT N_{60} value corrected for overburden pressure	$(N_1)_{60} = Cn \cdot N_{60}$	4
$N_{60}I_c$	SPT N_{60} values based on the Ic parameter	$(qt/pa)/ N_{60} = 8.5 (1 – Ic/4.6)$	5
$(N_1)_{60}Ic$	SPT N_{60} value corrected for overburden pressure (using N_{60} $I_{c).}$ User has 2 options.	1) $(N_1)_{60}Ic= Cn \cdot (N_{60}\, Ic)$ 2) $q_{c1n}/ (N_1)_{60}Ic = 8.5 (1 – Ic/4.6)$	4 5
$(N_1)_{60cs}Ic$	Clean sand equivalent SPT $(N_1)_{60}Ic$. User has 3 options.	1) $(N_1)_{60cs}Ic = \alpha + \beta((N_1)_{60}Ic)$ 2) $(N_1)_{60cs}Ic = K_{SPT} * ((N_1)_{60}Ic)$ 3) $q_{c1ncs})/ (N_1)_{60cs}Ic = 8.5 (1 – Ic/4.6)$ FC ≤ 5%: $\alpha = 0$, $\beta=1.0$ FC ≥ 35% $\alpha = 5.0$, $\beta=1.2$ 5% < FC < 35% $\alpha = \exp[1.76 – (190/FC^2)]$ $\beta = [0.99 + (FC^{1.5}/1000)]$	10 10 5
Su	Undrained shear strength based on q_t Su factor N_{kt} is user selectable	$Su = \frac{qt - \sigma_v}{N_{kt}}$	1, 5
Su	Undrained shear strength based on pore pressure Su factor $N_{\Delta u}$ is user selectable	$Su = \frac{u_2 - u_{eq}}{N_{\Delta u}}$	1, 5
k	Coefficient of permeability (assigned to each SBT zone)		5
Bq	Pore pressure parameter	$Bq = \frac{\Delta u}{qt - \sigma_v}$ *where:* $\Delta u = u - u_{eq}$ *and u = dynamic pore pressure* u_{eq} *= equilibrium pore pressure*	1, 5

Interpreted Parameter	Description	Equation	Ref
Q_t	Normalized q_t for Soil Behavior Type classification as defined by Robertson, 1990	$Qt = \frac{qt - \sigma_v}{\sigma'_v}$	2, 5
F_r	Normalized Friction Ratio for Soil Behavior Type classification as defined by Robertson, 1990	$Fr = 100\% \cdot \frac{fs}{qt - \sigma_v}$	2, 5
Net qt	Net tip resistance	$qt - \sigma_v$	
qe	Effective tip resistance	$qt - u_2$	
qeNorm	Normalized effective tip resistance	$\frac{qt - u_2}{\sigma'_v}$	
SBTn	Normalized Soil Behavior Type as defined by Robertson and Campanella	See Figure 2	2, 5
SBT-BQ	Non-normalized Soil Behavior type based on the Bq parameter	See Figure 3	2, 5
SBT-BQn	Normalized Soil Behavior based on the Bq parameter	See Figure 3	2, 5
SBT-JandD	Soil Behaviour Type as defined by Jeffries and Davies	See Figure 3	7
SBT-BQn	Normalized Soil Behavior base on the Bq parameter	See Figure 3	2, 5
I_c	Soil index for estimating grain characteristics	$Ic = [(3.47 - \log_{10}Q)^2 + (\log_{10} Fr + 1.22)^2]^{0.5}$ *Where:* $Q = \left(\frac{qt - \sigma_v}{P_{a2}}\right)\left(\frac{P_a}{\sigma'_v}\right)^n$ *And* *Fr is in percent* P_a *= atmospheric pressure* P_{a2} *= atmospheric pressure* *n varies from 0.5 to 1.0 and is selected in an iterative manner based on the resulting* I_c	3, 8
FC	Apparent fines content (%)	$FC=1.75(Ic^{3.25}) - 3.7$ $FC=100$ *for* $Ic > 3.5$ $FC=0$ *for* $Ic < 1.26$ $FC = 5\%$ *if* $1.64 < Ic < 2.6$ *AND* $F_r<0.5$	3
Ic Zone	This parameter is the Soil Behavior Type zone based on the Ic parameter (valid for zones 2 through 7 on SBTn chart)	Ic < 1.31 Zone = 7 1.31 < Ic < 2.05 Zone = 6 2.05 < Ic < 2.60 Zone = 5 2.60 < Ic < 2.95 Zone = 4 2.95 < Ic < 3.60 Zone = 3 Ic > 3.60 Zone = 2	3
PHI ϕ	Friction Angle determined from one of the following user selectable options: a) Campanella and Robertson b) Durgunoglu and Mitchel c) Janbu d) Kulhawy and Mayne	See reference	5 5 5 11
Dr	Relative Density determined from one of the following user selectable options: a) Ticino Sand b) Hokksund Sand c) Schmertmann 1976 d) Jamiolkowski - All Sands	See reference	5

Interpreted Parameter	Description	Equation	Ref
OCR	Over Consolidation Ratio	a) Based on Schmertmann's method involving a plot of $S_u/\sigma_v' / (S_u/\sigma_v')_{NC}$ and OCR where the Su/p' ratio for NC clay is user selectable	9
State Parameter	The state parameter is used to describe whether a soil is contractive (SP is positive) or dilative (SP is negative) at large strains based on the work by Been and Jefferies	See reference	8, 6, 5
Es/qt	Intermediate parameter for calculating Young's Modulus, E, in sands. It is the Y axis of the reference chart.	Based on Figure 5.59 in the reference	5
Young's Modulus E	Young's Modulus based on the work done in Italy. There are three types of sands considered in this technique. The user selects the appropriate type for the site from: a) OC Sands b) Aged NC Sands c) Recent NC Sands Each sand type has a family of curves that depend on mean normal stress. The program calculates mean normal stress and linearly interpolates between the two extremes provided in the Es/qt chart.	Mean normal stress is evaluated from: $\sigma_m' = \frac{1}{3}\left(\sigma_v' + \sigma_h' + \sigma_h'\right)^3$ where σ_v'= vertical effective stress σ_h'= horizontal effective stress and $\sigma_h = K_o \cdot \sigma_v'$ with Ko assumed to be 0.5	5
q_{c1}	q_t normalized for overburden stress used for seismic analysis	$q_{c1} = q_t \cdot (Pa/\sigma_v')^{0.5}$ where: Pa = atm. Pressure q_t is in MPa	3
q_{c1n}	q_{c1} in dimensionless form used for seismic analysis	$q_{c1n} = (q_{c1} / Pa)(Pa/\sigma_v')^n$ where: Pa = atm. Pressure and n ranges from 0.5 to 0.75 based on Ic.	3
K_{SPT}	Equivalent clean sand factor for $(N_1)60$	$K_{SPT} = 1 + ((0.75/30) \cdot (FC - 5))$	10
K_{CPT}	Equivalent clean sand correction for q_{c1N}	$K_{cpt} = 1.0$ for $I_c \leq 1.64$ $K_{cpt} = f(I_c)$ for $I_c > 1.64$ (see reference)	10
q_{c1ncs}	Clean sand equivalent q_{c1n}	$q_{c1ncs} = q_{c1n} \cdot K_{cpt}$	3
CRR	Cyclic Resistance Ratio (for Magnitude 7.5)	$q_{c1ncs} < 50$: $CRR_{7.5} = 0.833\ [(q_{c1ncs}/1000] + 0.05$ $50 \leq q_{c1ncs} < 160$: $CRR_{7.5} = 93\ [(q_{c1ncs}/1000]^3 + 0.08$	10
CSR	Cyclic Stress Ratio	$CSR = (\tau_{av}/\sigma_v') = 0.65\ (a_{max} / g)\ (\sigma_v/ \sigma_v')\ r_d$ $r_d = 1.0 - 0.00765\ z$ $z \leq 9.15m$ $r_d = 1.174 - 0.0267\ z$ $9.15 < z \leq 23m$ $r_d = 0.744 - 0.008\ z$ $23 < z \leq 30m$ $r_d = 0.50$ $z > 30m$	10

Interpreted Parameter	Description	Equation	Ref
MSF	Magnitude Scaling Factor	See Reference	10
FofS	Factor of Safety against Liquefaction	FS = $(CRR_{7.5} / CSR)$ MSF	10
Liquefaction Status	Statement indicating possible liquefaction	Takes into account FofS and limitations based on I_c and q_{c1ncs}.	10
Cont/Dilat Tip	Contractive / Dilative qc1 Boundary based on $(N_1)_{60}$	$(\sigma_v')_{boundary} = 9.58 \times 10^{-4} [(N_1)_{60}]^{-4.79}$ qc1 is calculated from specified qt(MPa)/N ratio	11
Su(Liq)/s'v	Liquefied Shear Strength Ratio	$\frac{Su(Liq)}{\sigma_v'} = 0.03 + 0.0143(q_{c1})$	12

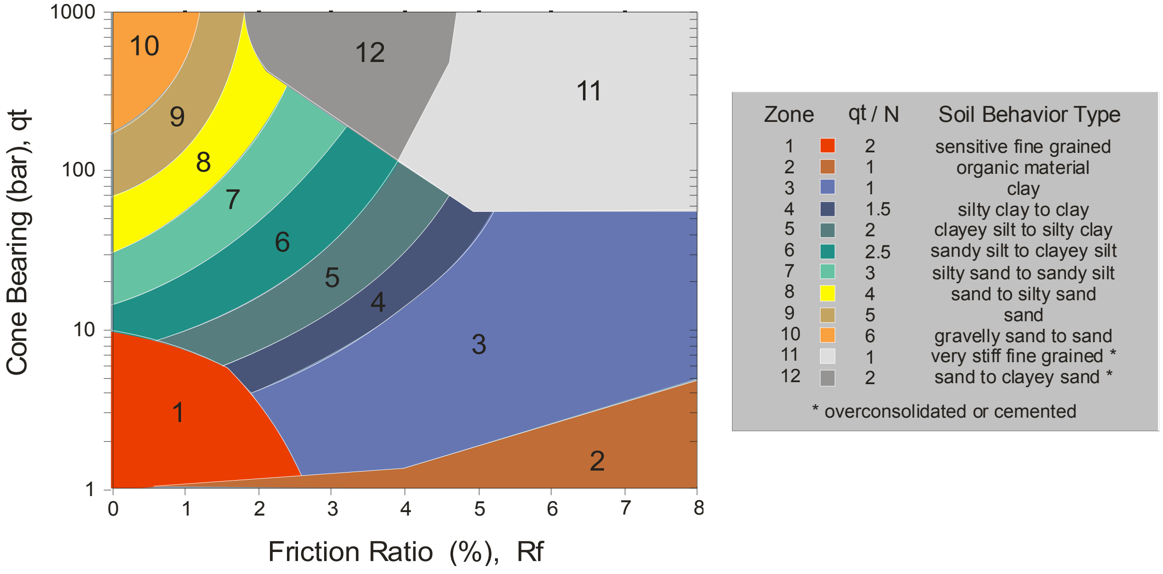


Figure 1 Non-Normalized Behavior Type Classification Chart

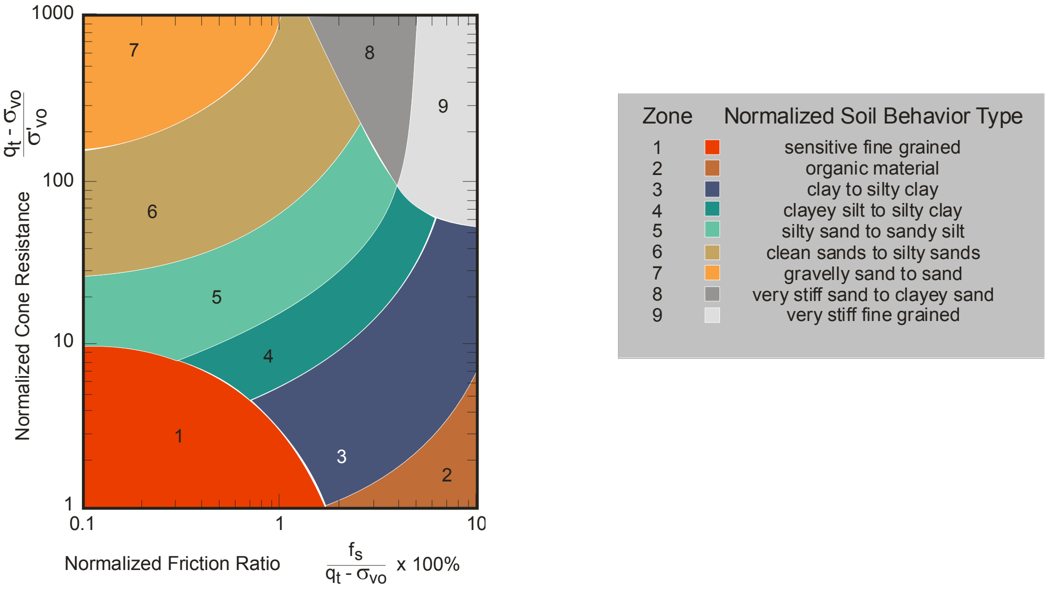


Figure 2 Normalized Behavior Type Classification Chart

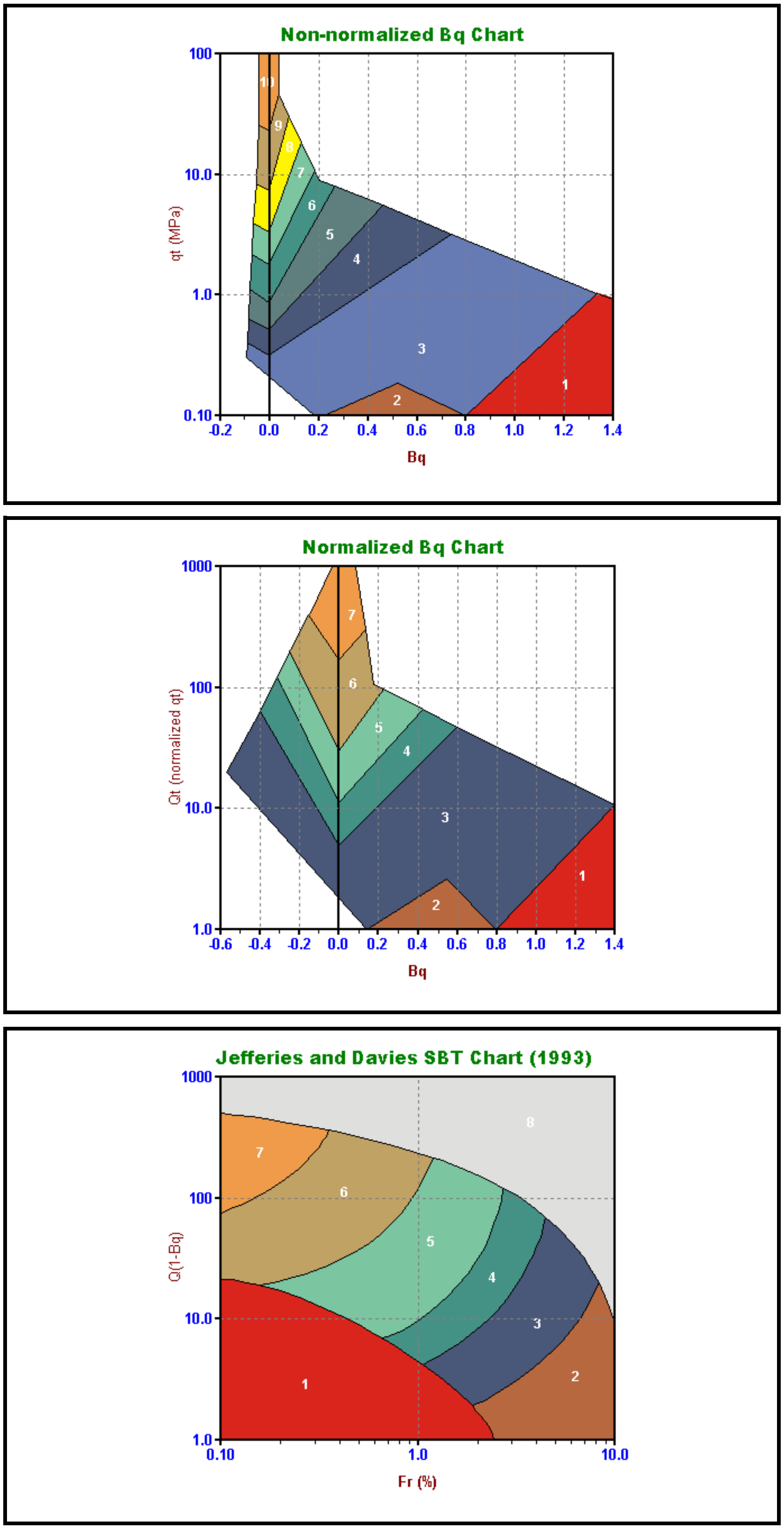


Figure 3 – Alternate Soil Behaviour Type Charts

Table 2 References

No.	References
1	Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, "Use of Piezometer Cone Data", Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.
2	Robertson, P.K., 1990, "Soil Classification Using the Cone Penetration Test", Canadian Geotechnical Journal, Volume 27.
3	Robertson, P.K. and Fear, C.E., 1998, "Evaluating cyclic liquefaction potential using the cone penetration test", Canadian Geotechnical Journal, 35: 442-459.
4	Robertson, P.K. and Wride, C.E., 1998, "Cyclic Liquefaction and its Evaluation Based on SPT and CPT", NCEER Workshop Paper, January 22, 1997
5	Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, " Cone Penetration Testing in Geotechnical Practice," Blackie Academic and Professional.
6	Plewes, H.D., Davies, M.P. and Jefferies, M.G., 1992, "CPT Based Screening Procedure for Evaluating Liquefaction Susceptibility", 45th Canadian Geotechnical Conference, Toronto, Ontario, October 1992.
7	Jefferies, M.G. and Davies, M.P., 1993. "Use of CPTu to Estimate equivalent N_{60}", Geotechnical Testing Journal, 16(4): 458-467.
8	Been, K. and Jefferies, M.P., 1985, "A state parameter for sands", Geotechnique, 35(2), 99-112.
9	Schmertmann, 1977, "Guidelines for Cone Penetration Test Performance and Design", Federal Highway Administration Report FHWA-TS-78-209, U.S. Department of Transportation
10	Proceedings of theNCEER Workshop on Evaluation of Liquefaction Resistance of Soils, Salt LakeCity, 1996. Chaired by Leslie Youd. 11
11	Kulhawy, F.H. and Mayne, P.W. ,1990, "Manual on Estimating Soil Properties for Foundation Design, *Report No. EL-6800"*, Electric Power Research Institute, Palo Alto, CA, August 1990, 306 p.
12	Oslon, Scott M. and Stark, Timothy D., 2003, "Yield Strength Ratio and Liquefaction Analysis of Slopes and Embankments", Journal of Geotechnical and Geoenvironmental Engineering, ASCE, August 2003.

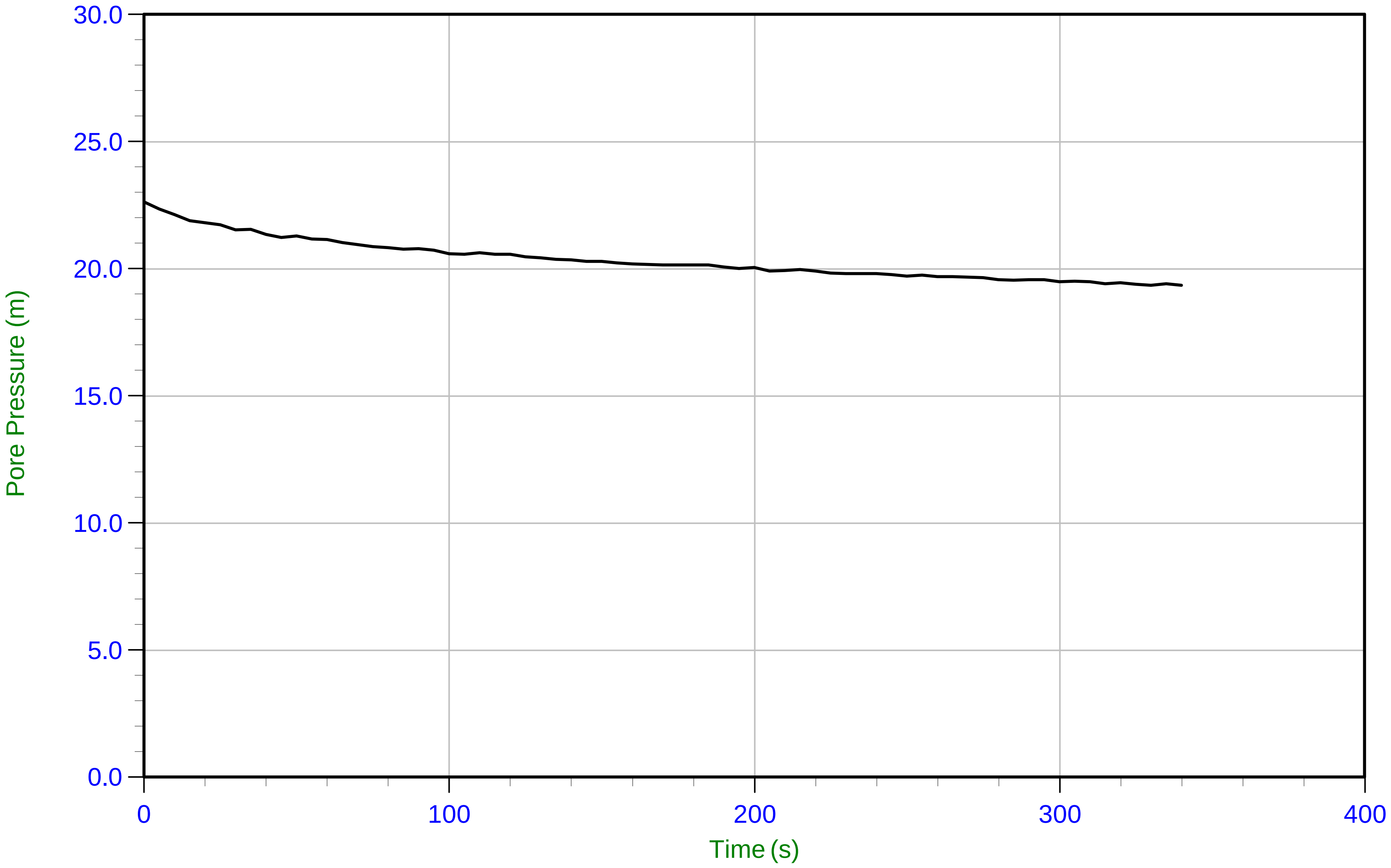
Appendix C

CONETEC

M. R. Wright Associates

Job No: 11-610
Date: 12/08/2011 10:06
Site: Ste. Marys Sedi

Sounding: CPT-CS10
Cone: 308:T1500F15U500
Cone Area: 15 sq cm

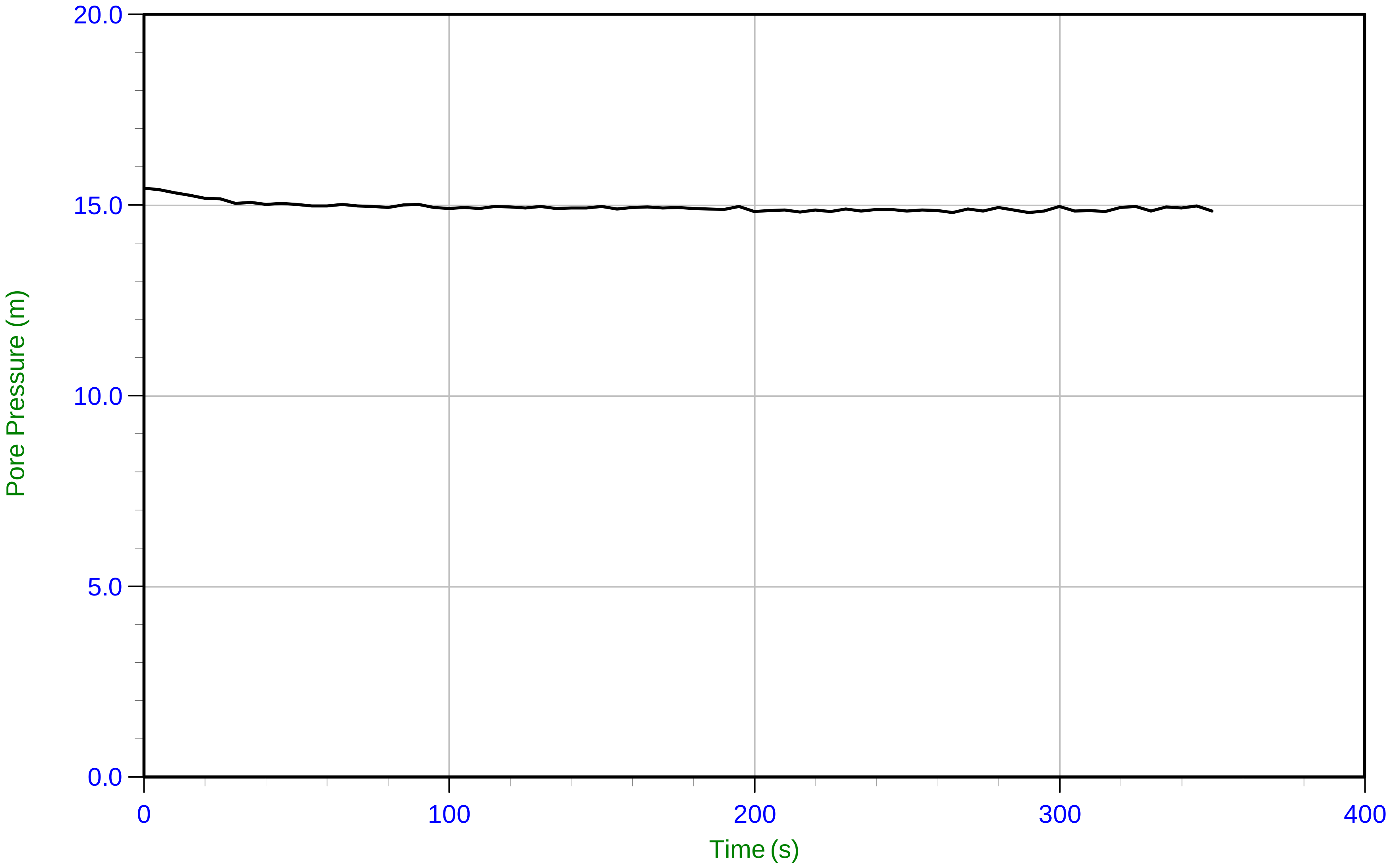


Trace Summary:

Filename: 610CS10.PPD
Depth: 12.850 m / 42.158 ft
Duration: 340.0 s

U Min: 19.4 m
U Max: 22.6 m

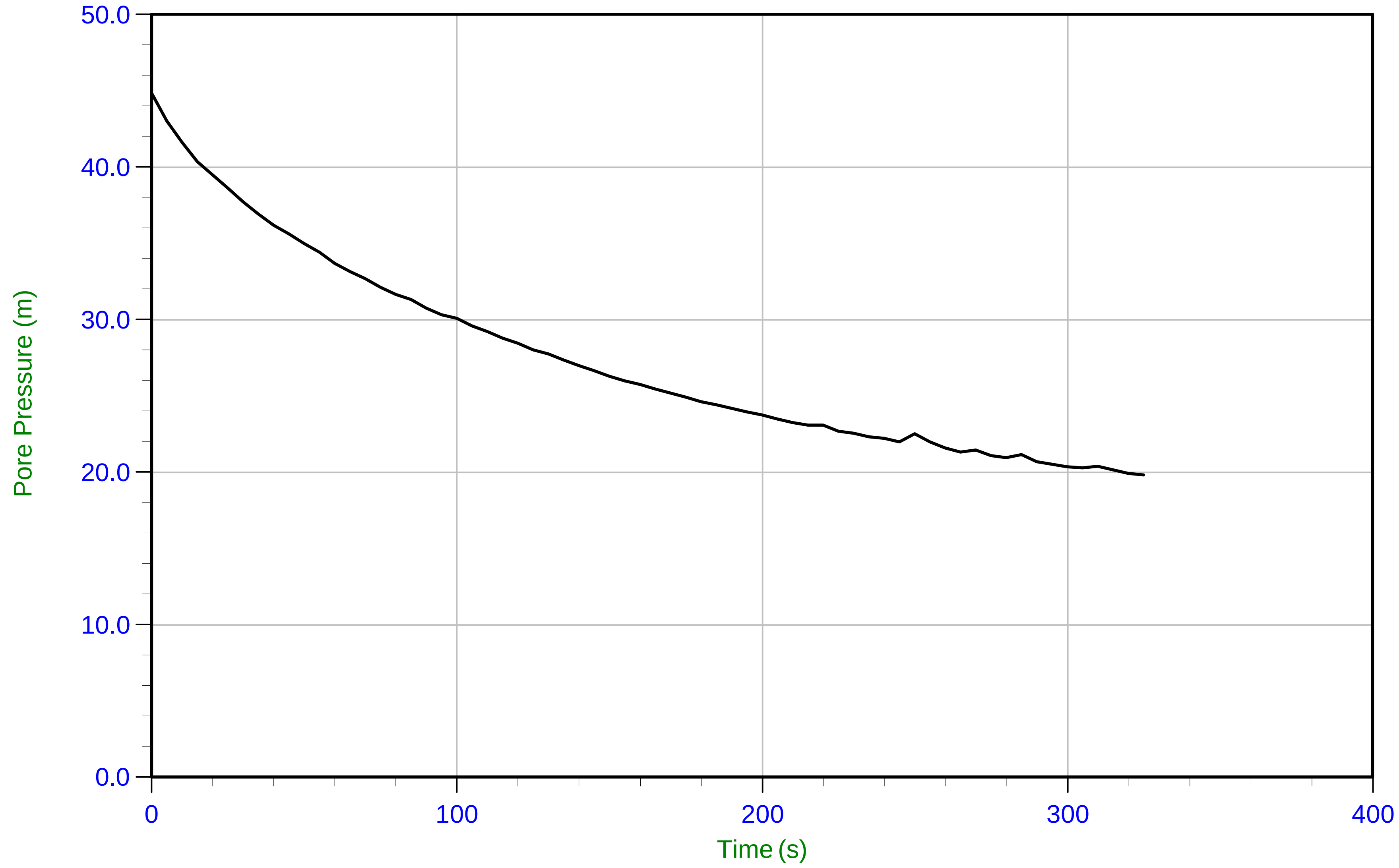
WT: 0.000 m / 0.000 ft
Ueq: 12.8 m



Trace Summary:

Filename: 610CS10.PPD
Depth: 15.900 m / 52.165 ft
Duration: 350.0 s

U Min: 14.8 m
U Max: 15.5 m



Trace Summary:

Filename: 610EC34.PPD
Depth: 12.600 m / 41.338 ft
Duration: 325.0 s

U Min: 19.8 m
U Max: 44.9 m

Appendix D

Electronic Data Files

The released data contains the following folders:

1. CPT Data - .cor files in ASCII format, and or .xls files.
2. Pore Pressure Dissipation Data - .ppd files in Excel format
3. CPT Plots - .pdf files
4. Data Interpretation - .xls files contain common engineering values

ConeTec Digital File Formats

CPT Data Files (COR Extension)

ConeTec data files are stored in ASCII text files that are readable by almost any text editor. ConeTec CPT data files are named such that the first 3 characters contain the job number, the next two characters are CP followed by two characters indicating the sounding number. The last 8th character position is reserved for the letters a, b, c, d etc to uniquely identify multiple soundings at the same location. The CPT sounding file has the extension COR, and pore pressure dissipation files have the extension PPD or PPF. As an example, for job number 06-127 the first sounding will have file names 127CP01.COR and 127CP01.PPD.

The sounding (COR) file consists of the following components:

1. Two lines of header information
2. Data records
3. End of data marker
4. Units information

Header Lines

Line 1: Columns 1-6 may be blank or may indicate the version number of the recording software
Columns 7-21 contain the sounding Date and Time
Columns 22-36 contain the sounding Operator

Line 2: Columns 1-16 contain the Job Location
Columns 17-31 contain the Cone ID
Columns 32-47 contain the sounding number

Data Records

The data records contain 4 or more columns of data in floating point format. A comma (and spaces) separates each data item:

Column 1:	Sounding Depth (meters)
Column 2:	Tip (q_c) data uncorrected for pore pressure effects. Recorded in units selected by the operator.
Column 3:	Sleeve (f_s) data. Recorded in units selected by the operator
Column 4:	Dynamic pore pressure readings. Recorded in units selected by the operator
Column 5:	Empty, Resistivity, UVIF or Gamma data

End of Data Marker

After the last line of data there will be a line containing ASCII 26 (CTL-Z) and a newline (carriage return/ line feed) character. This is used to mark the end of data.

Units Information

The last section of the file contains information about the units that were selected for the sounding. A separator bar makes up the first line. The second line contains the type of units used for depth, q_c, f_s and u. The third line contains the conversion values required for ConeTec's software to convert the recorded data to an internal set of base units (bar for q_c, bar for f_s and meters for u).

CPT Dissipation Files (PPx Extension)

CPT Dissipation files have the same naming convention as the CPT sounding files and have the extension PPD, PPF or PPM. PPF (PPM and PPD) files consist of the following components:

1. Two lines of header information
2. Data records

Header Lines (same as COR file):

Line 1: Columns 1-6 may be blank or may indicate the version number of the recording software
Columns 7-21 contain the sounding Date and Time
Columns 22-36 contain the sounding Operator

Line 2: Columns 1-16 contain the Job Location
Columns 17-31 contain the Cone ID
Columns 32-47 contain the sounding number

Data Records

The data records immediately follow the header lines. Each data record can occupy several lines in the file and is a complete record of a dissipation test at a particular depth. Each data record starts with a line containing two values separated by spaces; the first value being an index number (not currently used by the Software) and the second being the dissipation test depth in meters. Following this line are the dissipation pore pressure values stored at 5 second intervals with a maximum of 12 entries per line. The last line of the dissipation record may not contain a full 12 entries. The data record is terminated with an ASCII 30 character (appears as a triangle in some editors).

This sequence is repeated for every dissipation test in the sounding. No marker is used to indicate end of file. Units information is not stored in this file. Users need to check the CPT file for the units that were used.

CPT Basic Interpretations (TBL Extension)

ConeTec’s basic CPT interpretation output files are generally delivered in text files with a TBL extension. The root file name is the same as the COR files. A number of calculated geotechnical parameters are presented in these files. The files are stored as ASCII text files that can be viewed using any text editor such as Notepad or Wordpad. The files do not contain any page formatting. These files are not distributed if the enhanced interpretation files are provided.

CPT Enhanced Interpretations (IFI, IFP, XLS Extension)

ConeTec’s enhanced CPT interpretation output files are delivered in several formats, each file type containing the exact same information but formatted slightly differently. The files typically have any of the following file extensions:

1. IFI an importable TAB delimited ASCII text file containing approximately 47 data columns of geotechnical interpretations. The file is designed for easy import to Excel. A companion document describes the techniques used for the interpretations (usually reproduced at the beginning of the Interpretation Appendix). Text editors can be used to view the file contents, however, they may remove the tabs or replace the tabs with spaces upon saving the file destroying the feature that makes them easy to import into Excel.

   Because Excel imports the data as text and the sheet is protected two steps may be necessary to modify the data or use the values in certain Excel functions:

   a) Under Tools (Excel 2000) Select the Protection Option and then Unprotect the sheet
   b) Select the entire sheet, copy and then use Paste Special to paste as values to a second sheet.

   Future versions of our interpretation routine will address these inconveniences.

2. IFP a printable ASCII text file containing the same 47 columns of geotechnical interpretations as the IFI file. This file type has been formatted as a multi-page document with up to 132 characters per line and up to 68 lines per page. Each page has been separated into multiple sections to accommodate all the data fields. Each physical page has a header section and a page/section number. The file is designed for direct printing to laser printers set into compressed font mode. This output is typically provided in the Interpretation Appendix.

   An abbreviated set of interpretations (containing 36 columns of output) may be generated instead. These files usually have the extensions NLI and NLP. XLS files can be generated from these as well.

3. XLS an Excel format file that has been generated directly from the corresponding IFI file. IFI and IFP files are not distributed if the XLS files are generated. The XLS files may have been generated from abbreviated NLI interpretation files.

In each case root file name is the same as the COR files.

CPT Interpretations (Excel Format)

ConeTec's latest software (September 2007) outputs CPT interpretations directly to Excel format (XLS extension) without creating intermediate ASCII files. Because of the desires of various clients, there are several different configurations of output parameters in ConeTec's interpretation files. Since the Excel format file must have the XLS extension a suffix is used after the basename of the source CPT data file (COR) to identify the format of the file. The configurations still follow the formats described above and use the same extensions but now as suffixes. To allow for various runs (e.g. using a different water table, or user supplied equilibrium profile, or different methods for a particular parameter) of the same data an additional suffix may be specified by the engineer post processing the data to identify each particular run. This suffix will follow the one used to identify the format of the file.

For example:

If the selected format is ConeTec's TBL configuration and each run is identified by a run number. The resultant files generated for 278CP01.COR would be:

78CP01-TBL-RUN01.XLS
78CP01-TBL-RUN02.XLS
78CP01-TBL-RUN03.XLS

CPT Data in Excel Format

ConeTec can now provide the equivalent of the ASCII COR files in Excel Format. These files will have the same basename as the COR files and an XLS extension.

Pore Pressure Dissipation Data in Excel Format

ConeTec can now provide the equivalent of the ASCII PPD format files in Excel format. These files will contain each dissipation trace that exceeds a minimum duration (selected by the engineer during post-processing) in a particular Excel spreadsheet column. The first column (Column A) will contain the time in seconds and the second column (Column B) will contain the time in minutes. Subsequent columns will contain dissipation trace data. The time columns will extend to the longest trace of the data set.

Detailed header information is provided at the top of the spreadsheet. The test depth in meters and feet, the number of points in the trace and the particular units are identified at the top of each trace column.

The Excel format file names will have the same basename as the original PPD format file followed by the suffix -PPD and then followed by a second suffix that the engineer doing the post processing can specify. Because the engineer can select various types of units for the dissipation data output (which can be different from the units used in the original recording) the secondary suffix is often used to identify the units in the XLS file, however, the original recorded units and the output units are clearly identified within the XLS spreadsheet file.

Appendix D Photographic Records

Photograph #1 – 100 tonne capacity barge with drill rig mounted on it

Photograph #2 – CME 850 drill rig mounted to 100 tonne capacity barge

Photograph #3 – Driller's work platform off the edge of the barge

Photograph #4 – Advancing borehole

Photograph #5 – Advancing CPT sounding

Photograph #6 – 250 mm ø hollow stem augers and 51 mm ø drill rods

Photograph #7 – 130 mm inside ø split-barrel sampler with acrylic sleeves, and sampling head

Photograph #8 – Electronic piezocone c/w Ultra Violet Induced Fluorescence (UVIF) module

Photograph #9 – Organic silt samples obtained at geotechnical station EC34

Appendix E Report Limitations and Guidelines for Use

REPORT LIMITATIONS AND GUIDELINES FOR USE

This information has been provided to help manage risks with respect to the use of this report.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This geotechnical report has been prepared for the exclusive use of the client, their authorized agents, and other members of the design team. It is not intended for use by others, and the information contained herein is not applicable to other Sites, or for purposes other than those specified in the report.

M.R. Wright & Associates Company Limited (MRW) cannot be held responsible for reliance on the information contained in this report, by persons other than the client or 'authorized' agent without prior written approval.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical investigation report is based on existing conditions at the time the study was performed, and our opinion of sediment conditions are strictly based on sediment samples collected at specific test hole locations. The findings and conclusions of our reports may be affected by the passage of time, by manmade events such as construction on or adjacent to the Site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations.

LIMITATIONS TO PROFESSIONAL OPINIONS

Interpretations of subsurface conditions are based on field observations from test holes that were spaced to capture a 'representative' snap shot of subsurface conditions. Site exploration identifies subsurface conditions only at points of sampling. MRW reviews field and laboratory data and then applies our professional judgment to formulate an opinion of subsurface conditions throughout the Site. Actual subsurface conditions may differ, between sampling locations, from those indicated in this report.

LIMITATIONS OF RECOMMENDATIONS

Subsurface sediment conditions should be verified by a qualified geotechnical engineer during construction. MRW should be notified if any discrepancies to this report or unusual conditions are found during construction.

Sufficient monitoring, testing and consultation should be provided by MRW during construction and/or excavation activities, to confirm that the conditions encountered are consistent with those indicated by the investigation, and to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated. In addition, monitoring, testing and consultation by MRW should be completed to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining MRW for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions. However, please be advised that any construction/excavation observations by MRW is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

MISINTERPRETATION OF GEOTECHNICAL ENGINEERING REPORT

Misinterpretation of our report by other design team members can result in costly problems. You could lower that risk by having MRW confer with appropriate members of the design team after submitting the report. Also retain MRW to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having MRW participate in pre-bid and preconstruction conferences, and by providing construction observation. Please be advised that retaining MRW to participation in any 'other' activities associated with this project is over and above the mandate of this geotechnical investigation and therefore, additional fees would apply.

CONTRACTORS RESPONSIBILITY FOR SITE SAFETY

This geotechnical report is not intended to direct the contractor's procedures, methods, schedule or management of the work Site. The contractor is solely responsible for job Site safety and for managing construction operations to minimize risks to on-Site personnel and to adjacent properties. It is ultimately the contractor's responsibility that the Ontario Occupational Health and Safety Act is adhered to, and Site conditions satisfy all 'other' acts, regulations and/or legislation that may be mandated by federal, provincial and/or municipal authorities.

SUBSURFACE SEDIMENT AND/OR GROUNDWATER CONTAMINATION

This report is geotechnical in nature and was not performed in accordance with any environmental guidelines. As such, any environmental comments are very preliminary in nature and based solely on field observations. Accordingly, the scope of services do not include any interpretations, recommendations, findings, or conclusions regarding the, assessment, prevention or abatement of contaminants, and no conclusions or inferences should be drawn regarding contamination, as they may relate to this project. The term "contamination" includes, but is not limited to, molds, fungi, spores, bacteria, viruses, PCBs, petroleum hydrocarbons, inorganics, pesticides/insecticides, volatile organic compounds, polycyclic aromatic hydrocarbons and/or any of their byproducts.

The total amount of all claims the Client may have against MRW or any present or former partners, executive officers, directors, stockholders or employees thereof under this engagement, including but not limited to claims for negligence, negligent misrepresentation and breach of contract, shall be strictly limited to the amount of MRW's professional fees for this assignment. No claim may be brought against MRW in contract or in tort more than two (2) years after the Services were completed or terminated under this agreement. Completion of services shall be deemed to be the last date on any invoice issued by MRW for services provided and as such will constitute the stature of limitations.

Appendix F Abbreviations, Terminology and Principal Symbols used in Report and Test Hole Log

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ABBREVIATIONS, TERMINOLOGY & PRINCIPAL SYMBOLS USED IN REPORT AND TEST HOLE LOGS

Borehole & Test Pit Logs

Sampling Method

AS	Auger Sample	**w**	Washed Sample
SB	Split-Barrel Sample	**HQ**	Rock Core (63.5 mm diam.)
ST	Thin Walled Shelby Tube	**NQ**	Rock Core (47.5 mm diam.)
BS	Block Sample	**BQ**	Rock Core (36.5 mm diam.)

In-Situ Soil Testing

Standard Penetration Test (SPT), “N” value is the number of blows required to drive a 51 mm outside diameter spilt barrel sampler into the soil a distance of 300 mm with a 63.5 kg weight free falling a distance of 760 mm after an initial penetration of 150 mm has been achieved. The SPT, “N” value is a qualitative term used to interpret the compactness condition of cohesionless soils and is used only as a very approximation to estimate the consistency and undrained shear strength of cohesive soils.

Dynamic Cone Penetration Test (DCPT) is the number of blows required to drive a cone with a 60 degree apex attached to “A” size drill rods continuously into the soil for each 300 mm penetration with a 63.5 kg weight free falling a distance of 760 mm.

Field Vane Test (FVT) consists of a vane blade, a set of rods and torque measuring apparatus used to determine the undrained shear strength of cohesive soils.

Soil Descriptions

The soil descriptions and classifications are based on an expanded Unified Soil Classification System (USCS). The USCS classifies soils on the basis of engineering properties. The system divides soils into three major categories; coarse grained, fine grained and highly organic soils. The soil is then subdivided based on either gradation or plasticity characteristics. The classification excludes particles larger than 75 mm. To aid in quantifying material amounts by weight within the respective grain size fractions the following terms have been included to expand the USCS:

Soil Classification		Terminology	Proportion
Clay	<0.002 mm		
Silt	0.002 to 0.06 mm	"trace", trace sand, etc.	1% to 10%
Sand	0.075 to 4.75 mm	"some", some sand, etc.	10% to 20%
Gravel	4.75 to 75 mm	adjective, sandy, gravelly, etc.	20% to 35%
Cobbles	75 to 200 mm	and, and gravel, and silt, etc.	>35%
Boulders	>200 mm	noun, Sand, Gravel, Silt, etc.	>35% and main fraction

Notes:

- Soil properties, such as strength, gradation, plasticity, structure, etcetera, dictate the soils engineering behaviour over grain size fractions;

- With the exception of soil samples tested for grain size distribution or plasticity, all soil samples have been classified based on visual and tactile observations. The accuracy of visual and tactile observation is not sufficient to differentiate between changes in soil classification or precise grain size and is therefore an approximate description.

The following table outlines the qualitative terms used to describe the compactness condition of cohesionless soil:

Cohesionless Soil	
Compactness Condition	**SPT N-Index (blows per 300 mm)**
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

The following table outlines the qualitative terms used to describe the consistency of cohesive soils related to undrained shear strength and SPT, N-Index:

Cohesive Soil		
Consistency	**Undrained Shear Strength (kPa)**	**SPT N-Index (blows per 300 mm)**
Very soft	<12	<2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

Note: Utilizing the SPT, N-Index value to correlate the consistency and undrained shear strength of cohesive soils is only very approximate and needs to be used with caution.

Soil & Rock Physical Properties

General

W	Natural water content or moisture content within soil sample
γ	Unit weight
γ'	Effective unit weight
γ_d	Dry unit weight
γ_{sat}	Saturated unit weight
ρ	Density
ρ_s	Density of solid particles
ρ_w	Density of Water
ρ_d	Dry density
ρ_{sat}	Saturated density
e	Void ratio
n	Porosity
S_r	Degree of saturation
E_{50}	Strain at 50% maximum stress (cohesive soil)

Consistency

w_L	Liquid limit
w_P	Plastic limit
I_P	Plasticity index
w_s	Shrinkage limit
I_L	Liquidity index
I_c	Consistency index
e_{max}	Void ratio in loosest state
e_{min}	Void ratio in densest state
I_D	Density index (formerly relative density)

Shear Strength

c_u, s_u	Undrained shear strength parameter (total stress)
c'_d	Drained shear strength parameter (effective stress)
r	Remolded shear strength
τ_p	Peak residual shear strength
τ_r	Residual shear strength
ø'	Angle of interface friction, coefficient of friction = tan ø'

Consolidation (One Dimensional)

C_c	Compression index (normally consolidated range)
C_r	Recompression index (over consolidated range)
C_s	Swelling index
m_v	Coefficient of volume change
c_v	Coefficient of consolidation
T_v	Time factor (vertical direction)
U	Degree of consolidation
σ'_o	Overburden pressure
σ'_p	Preconsolidation pressure (most probable)
OCR	Overconsolidation ratio

Permeability

The following table outlines the terms used to describe the degree of permeability of soil and common soil types associated with the permeability rates:

Permeability (k cm/s)	Degree of Permeability	Common Associated Soil Type
$>10^{-1}$	Very High	Clean Gravel
10^{-1} to 10^{-3}	High	Clean Sand, Clean Sand and Gravel
10^{-3} to 10^{-5}	Medium	Fine Sand to Silty Sand
10^{-5} to 10^{-7}	Low	Silt and Clayey Silt (low plasticity)
$<10^{-7}$	Practically Impermeable	Silty Clay (medium to high plasticity)

Rock Coring

Rock Quality Designation (RQD) is an indirect measure of the number of fractures within a rock mass, Deere et al. (1967). It is the sum of sound pieces of rock core equal to or greater than 100 mm recovered from the core run, divided by the total length of the core run, expressed as a percentage. If the core section is broken due to mechanical or handling, the pieces are fitted together and if 100 mm or greater included in the total sum.

RQD is calculated as follows:

$$\text{RQD (\%)} = \frac{\Sigma \text{ Length of core pieces} > 100 \text{ mm x } 100}{\text{Total length of core run}}$$

The following is the Classification of Rock with Respect to RQD Value:

RQD Classification	RQD Value (%)
Very poor quality	<25
Poor quality	25 to 50
Fair quality	50 to 75
Good quality	75 to 90
Excellent quality	90 to 100

Consulting Engineers

MRW

M.R. WRIGHT & ASSOCIATES CO. LTD.

Since being established in 1961, MRW has earned a reputation for providing quality engineering services through a teamwork approach with our clients and staff. MRW is an employee owned firm providing engineering consulting services in the civil, environmental, structural and geotechnical disciplines. MRW also operates a Canadian Standards Association certified materials testing laboratory to service specific needs of the construction industry for quality control of soils, aggregates, concrete and asphalt.

Head Office

71 Black Road, Unit #8
Sault Ste. Marie, ON
P6B 0A3
T. (705) 945-5090
F. (705) 949-3026
mrw@mrweng.ca

Kingston Office

190 Binnington Ct, Ste 200
Kingston, ON
K7M 8R6
T. (613) 536-5090
F. (613) 536-5094
kingston@mrweng.ca

www.mrweng.ca

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