Prepared for

Parsons
301 Plainfield Road, Suite 350
Syracuse, New York 13212

STABILITY EVALUATION OF REMEDIATION AREA D ONONDAGA LAKE BOTTOM SUBSITE

ONONDAGA LAKE SYRACUSE, NEW YORK

Prepared by

Geosyntec consultants

engineers | scientists | innovators
1255 Roberts Boulevard, Suite 200
Kennesaw, Georgia 30144

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1. INTRODUCTION

This appendix provides the methods and results of a stability evaluation for Remediation Area D, which was performed as part of the *Capping, Dredging, and Habitat Design*. Remediation Area D, which is also referred to as the In Lake Waste Deposit (ILWD), is shown in Figure 1 and consists predominantly of Sediment Management Unit (SMU) 1 with limited portions of SMUs 2 and 7. Consistent with the Statement of Work (SOW) in the Consent Decree for Onondaga Lake [United States District Court, Northern District of New York, 2007] [89-CV-815], this evaluation includes a stability analysis under both static and seismic conditions.

Guidelines for the stability evaluations are provided below, along with a summary of the following analyses: (i) subsurface geotechnical conditions (Appendix H.1); (ii) liquefaction potential (Appendix H.2); (iii) static slope stability after dredging, during capping, and after capping (Appendix H.3); and (iv) seismic slope stability after capping (Appendix H.4). Lastly, conclusions based on the results of the evaluations are provided.

2. GUIDELINES FOR STABILITY EVALUATION

The SOW provided guidelines for evaluating the stability of the ILWD as follows:

"The determination of geotechnical stability shall consider both static and seismic stability of the ILWD. The determination of seismic stability shall be based on an analysis of cap stability during an operating level event (i.e., a seismic event with a 50 percent chance of exceedance in 50 years) and a contingency level event (i.e., a seismic event with a 10 percent chance of exceedance in 50 years). If analysis of geotechnical stability demonstrates that the remediated slope would have an operating and/or contingency seismic slope stability factor of less than 1.1, Honeywell shall evaluate deformation of the cap and the ILWD under the seismic event. If the analysis of the geotechnical stability demonstrates that the remediated slope would have a static slope stability factor of less than 1.5 or if the predicted operating and/or contingency seismic deformation would compromise the performance of the isolation cap, Honeywell shall dredge sufficient material from the ILWD to ensure the geotechnical stability of the Isolation Cap, provided, however, that Honeywell may propose alternative engineering measures to ensure the ILWD is not exposed."

An evaluation approach, consistent with the SOW, was developed and is presented as a flowchart in Figure 2. Since a contingency level event is more severe than an operating level event, the analysis was only performed for the contingency level event. If the calculated factor of safety (FS) for the contingency level event is greater than 1.1, the calculated FS for an operating level event would also be greater than 1.1. In addition, as part of this evaluation, the potential for sensitivity and flow-type behavior in the ILWD was analyzed and is presented herein.

3. SUBSURFACE GEOTECHNICAL CONDITIONS

A detailed description of the development of the subsurface model and geotechnical parameters used in the analyses is presented in Appendix H.1 titled "Summary of Subsurface Stratigraphy and Material Properties". As indicated in this appendix, it has been established that the subsurface soils in Remediation Area D consist primarily of seven strata (from top to bottom): (i) Solvay waste (SOLW); (ii) Marl; (iii) Silt and Clay; (iv) Silt and Sand; (v) Sand and Gravel; (vi) Till; and (vii) Shale. In addition, thin silt layers (up to 10-ft thick) are present on top of the SOLW in isolated areas. Geotechnical parameters of these subsurface soils were selected based on laboratory performance test data or empirical correlations using in situ and/or index test data.

4. LIQUEFACTION POTENTIAL ANALYSES

Liquefaction potential analyses are presented in Appendix H.2 in a calculation package titled "Liquefaction Potential Analyses". These analyses include an evaluation of the potential for flow (or true) liquefaction, cyclic mobility (or cyclic liquefaction), and flow-type behavior due to sensitivity. As shown on Figure 2, the result of this evaluation is the basis for whether or not strength parameters need to be reduced for the seismic stability analyses.

The liquefaction analyses indicate that the SOLW and underlying soil layers in Remediation Area D are not considered susceptible to potential liquefaction or cyclic softening during a contingency level seismic event. In addition, the materials are not considered susceptible to sensitive behavior or loss of shear strength. Therefore, the original strength parameters developed in Appendix H.1 can be used for the seismic slope stability analyses. Liquefaction potential of the cap material and the impact of the cap on the liquefaction potential of underlying materials are addressed in an addendum to Appendix H.2. Since the site is not in a seismic impact zone, monitoring and maintenance will be performed, as necessary, to address the potential for cap liquefaction during a seismic event.

5. STATIC SLOPE STABILITY ANALYSES

Static slope stability analyses are presented in Appendix H.3 in a calculation package titled "Static Slope Stability Analyses". The purpose of these analyses is to establish stability of Remediation Area D after dredging, during capping, and after capping. Static stability was evaluated for five overall general slopes (i.e., Cross Sections 1 through 5) and three localized steep slopes (i.e., Cross Sections A through C), as shown on Figure 3. These analyses were performed using Spencer's [1973] method, which is a generally accepted slope stability analysis method in engineering practice. The results indicate that the selected cross sections have acceptable calculated FSs for static slope stability after dredging, during capping, and after capping.

6. SEISMIC SLOPE STABILITY ANALYSES

Seismic slope stability analyses are presented in Appendix H.4 in a calculation package titled "Seismic Slope Stability Analyses". As indicated in Figure 2, the results of the liquefaction potential evaluation may impact the seismic stability evaluation. Specifically, because it was established that the SOLW, Marl, Silt and Clay, Silt and Sand, and Sand and Gravel are not susceptible to liquefaction, the original material strengths (as opposed to reduced strengths) can be used in the seismic stability evaluation.

The seismic slope stability of Remediation Area D after capping was evaluated for five overall general slope cross sections (i.e., Cross Sections 1 through 5) and three localized steep slope cross sections (i.e., Cross Sections A through C), as shown on Figure 3. As with the static stability analyses, Spencer's [1973] method was used. The results indicate that the selected cross sections have acceptable calculated FSs after capping for the case of a contingency level seismic event.

The seismic slope stability analysis results are based on representative shear strength parameters selected by the geotechnical engineers for this project. A sensitivity analysis with lower shear strength parameters is included as Attachment 1 to this appendix; however, this sensitivity analysis does not change the main conclusions described herein, which are based on the representative parameters selected for this project.

7. CONCLUSIONS

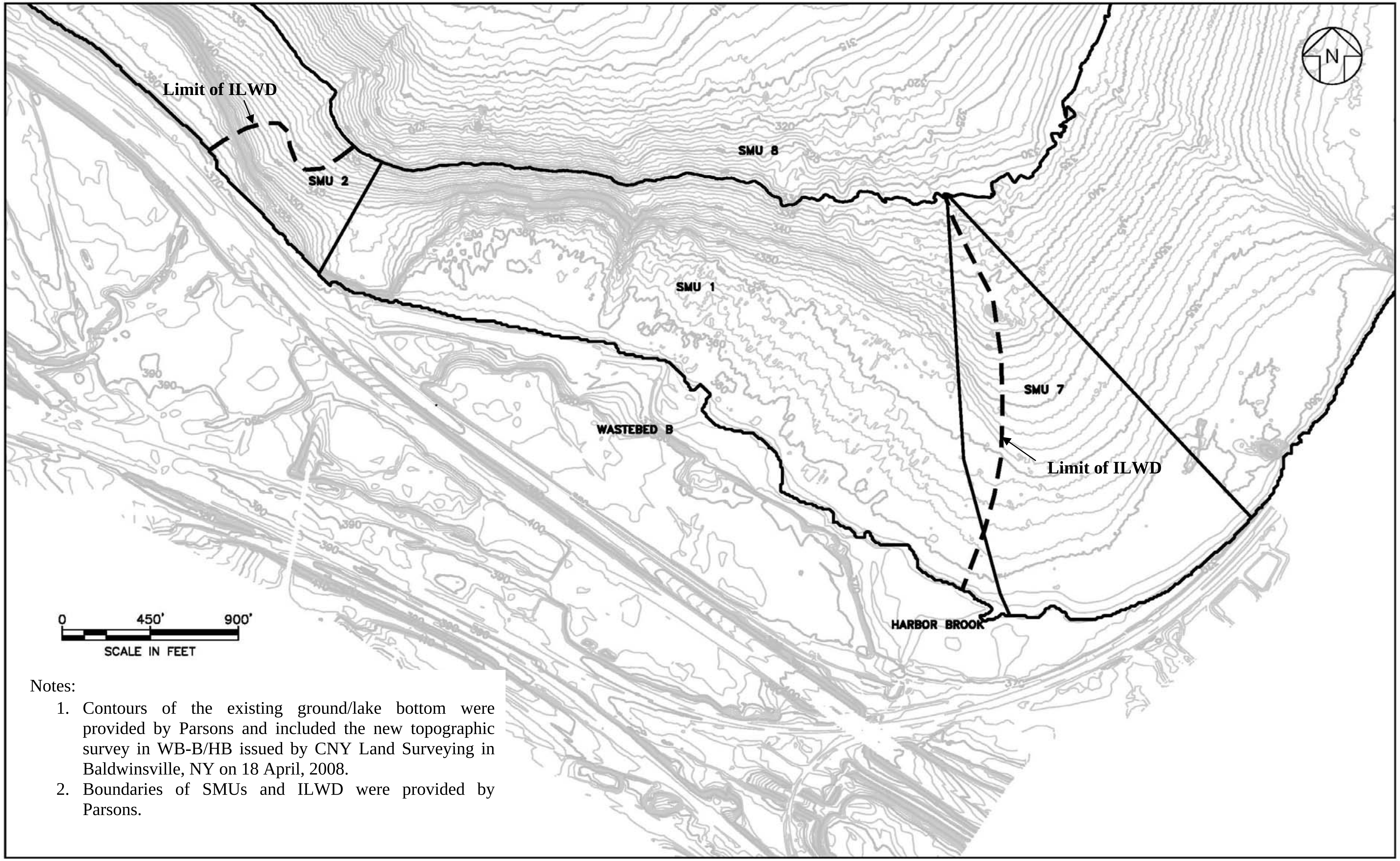
Geotechnical stability of Remediation Area D under static conditions (after dredging, during capping, and after capping) and during a contingency level earthquake (after capping) was evaluated. Based on the analyses, the SOLW and underlying soils do not have the potential for liquefaction or cyclic softening during an operating or contingency level seismic event. The materials in Remediation Area D also do not appear to have the potential for sensitive behavior or loss of shear strength. Since the site is not in a seismic impact zone, the potential for cap liquefaction during a seismic event will be addressed through a monitoring and maintenance program, as needed. In addition, calculated static and seismic FSs for the five overall general slope cross sections (i.e., Cross Sections 1 through 5) and three localized steep slope cross sections (i.e., Cross Sections A through C) in Remediation Area D have adequate FSs.

REFERENCES

Spencer, E., "The Thrust Line Criterion in Embankment Stability Analysis," Géotechnique, Vol. 23, No. 1, pp. 85-100, March 1973.

United States District Court, Northern District of New York. 2006. State of New York and Denise M. Sheehan against Honeywell International, Inc. Consent Decree Between the State of New York and Honeywell International, Inc. Senior Judge Scullin. Dated October 11, 2006. Filed January 4, 2007.

FIGURES



Notes:

1. Contours of the existing ground/lake bottom were provided by Parsons and included the new topographic survey in WB-B/HB issued by CNY Land Surveying in Baldwinsville, NY on 18 April, 2008.
2. Boundaries of SMUs and ILWD were provided by Parsons.

Figure 1. ILWD layout.

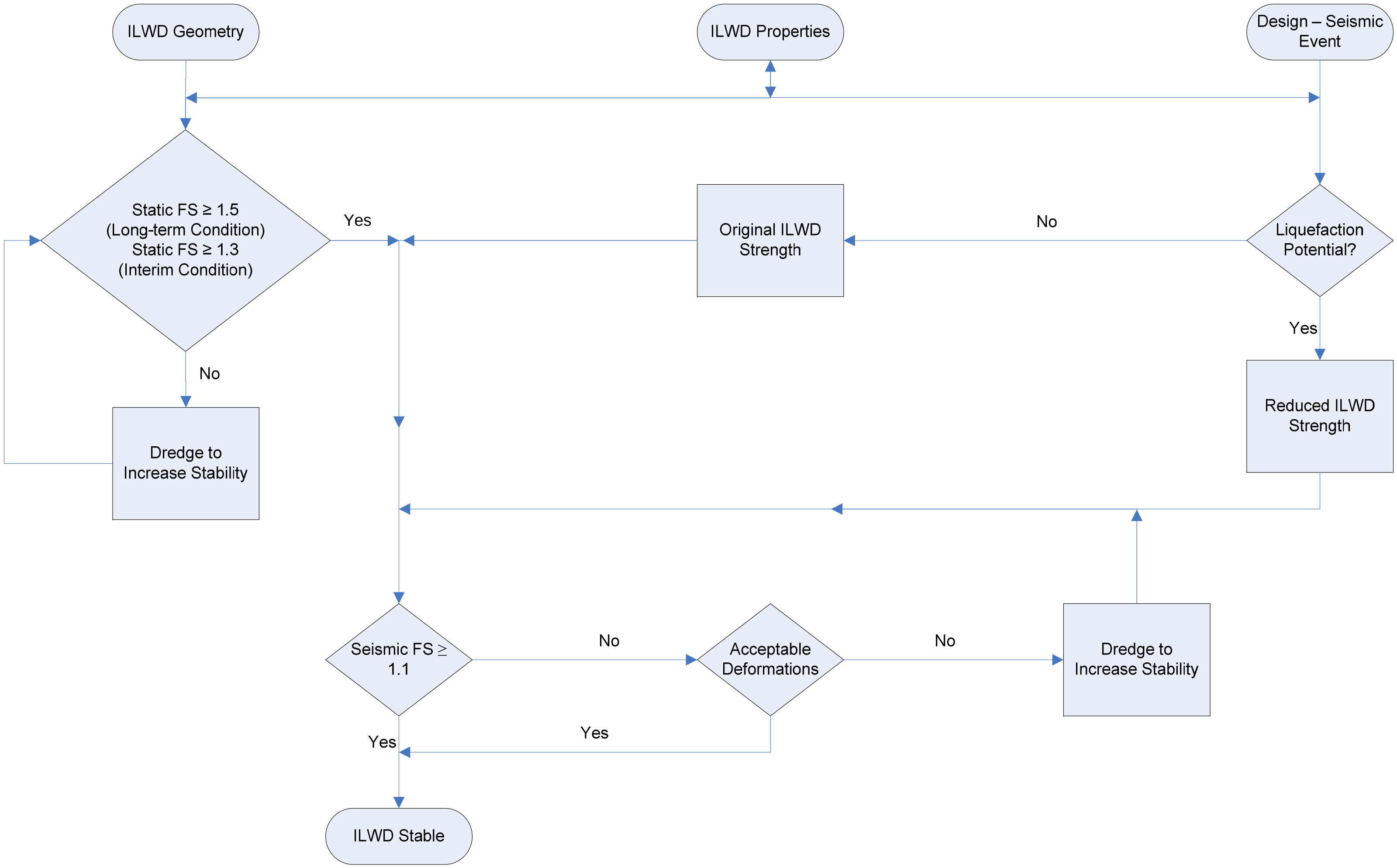
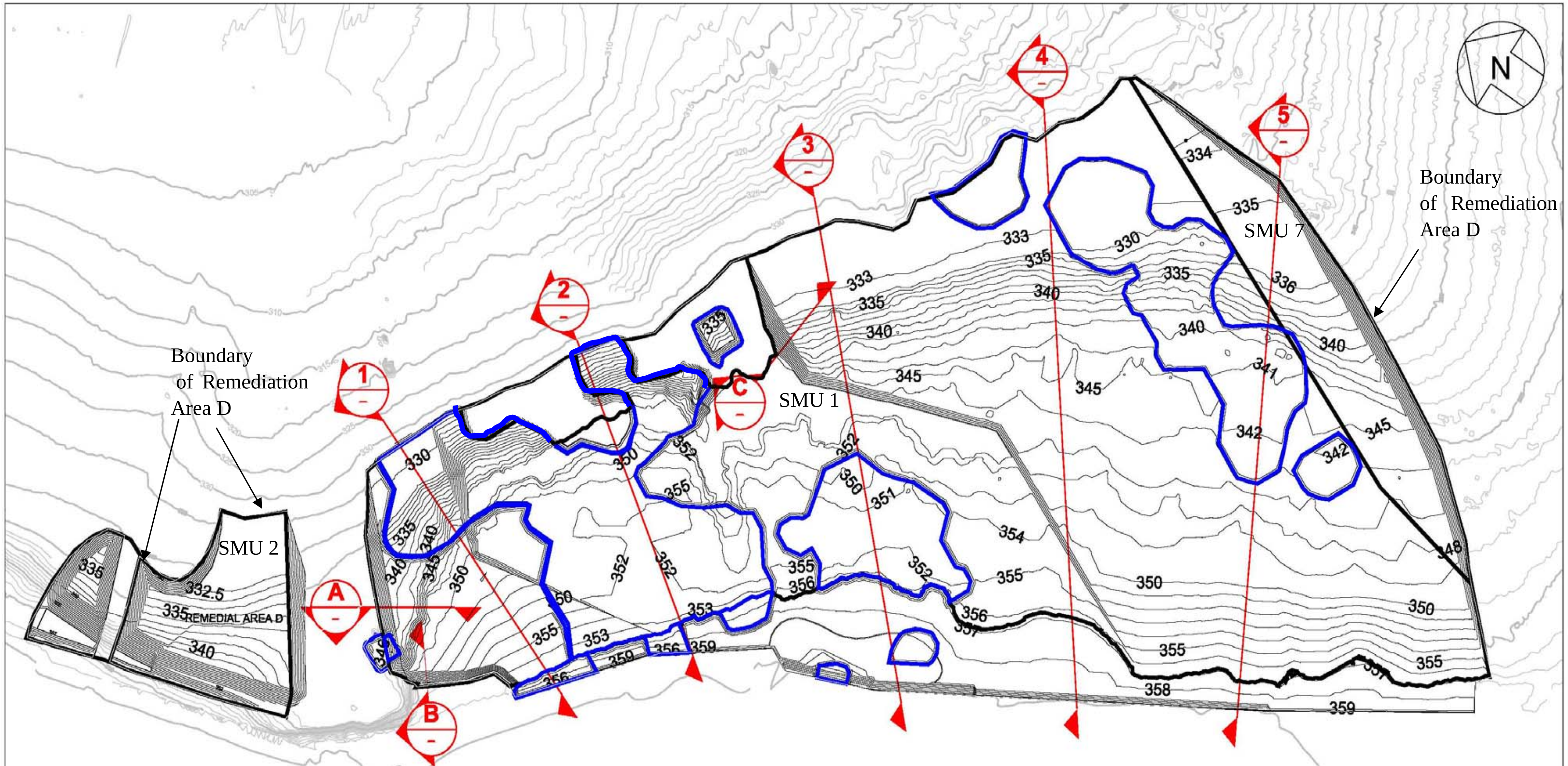


Figure 2. Flow chart of geotechnical stability evaluation strategy (note that this approach is applicable for soils underlying the Solvay waste as well).



Notes:

1. Contours of the existing ground/lake bottom were provided by Parsons.
2. Dredging plan was prepared by Anchor Environmental and provided to Geosyntec by Parsons.

Hot spot dredge area

Figure 3. Locations of borings and selected cross sections.

APPENDIX H.1

SUMMARY OF SUBSURFACE STRATIGRAPHY AND MATERIAL PROPERTIES

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Honeywell **Project:** Onondaga Lake ILWD Stability **Project/Proposal #:** GJ4204 **Task #:** 01

TITLE OF COMPUTATIONS **SUMMARY OF SUBSURFACE STRATIGRAPHY AND MATERIAL PROPERTIES**

COMPUTATIONS BY:

Signature 12-2-2009
DATE

Printed Name and Title: Ming Zhu/Raja Madhyannapu, Engineer/Senior Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)

Signature R. Kulasingam 12-2-2009
DATE

Printed Name and Title: R. Kulasingam, Senior Engineer

COMPUTATIONS CHECKED BY:

Signature 12-2-2009
DATE

Printed Name and Title: Ming Zhu, Engineer

COMPUTATIONS BACKCHECKED BY:
(Originator)

Signature 12-2-2009
DATE

Printed Name and Title: Ming Zhu/Raja Madhyannapu, Engineer/Senior Staff Engineer

STATE OF NEW YORK
JOHN F. BEECH
No. 066337
LICENSED PROFESSIONAL
7 MAR 2012

APPROVED BY:
(PM or Designate)

Signature J. F. Beech 2 Dec 2009
DATE

Printed Name and Title: Jay Beech, Principal

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

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Written by:	**Ming Zhu**	Date:	**08/20/2008**	Reviewed by:	**R. Kulasingam/J. Beech**	Date:	**08/20/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GJ4204**	Task No.:	**01**

SUMMARY OF SUBSURFACE STRATIGRAPHY AND MATERIAL PROPERTIES

1. INTRODUCTION

This "*Summary of Subsurface Stratigraphy and Material Properties*" package (referred to as the Data Package) was prepared in support of the stability evaluation of the In-Lake Waste Deposit (ILWD). Specifically, the purpose of the package is to provide:

- a summary of the site investigation activities conducted in the ILWD area to date;
- interpretation of subsurface stratigraphy in the ILWD area;
- interpretation of material properties (i.e., index properties, shear strength, and compressibility); and
- recommendation on material properties to be used for the stability evaluation of the ILWD area.

2. SITE INVESTIGATIONS

The ILWD area, which is adjacent to Wastebed B (WB-B), consists mainly of the area identified as Sediment Management Unit 1 (SMU 1) with limited portions of SMU 2, SMU 7, and SMU 8 (Figure 1). Extensive pre-design investigations (PDIs) were conducted in the ILWD area to characterize the subsurface conditions. These investigations included the Phase I PDI in 2005, the Phase II PDI in 2006, the Phase III PDI in 2007, and the DNAPL investigation in 2006 and 2007. Figure 2 shows the locations of soil borings drilled during the investigations. Details of the investigations were presented in the data summary reports prepared by Parsons [Parsons, 2007a, 2007b, 2009a, and 2009b].

3. SUBSURFACE STRATIGRAPHY

The subsurface stratigraphy in the ILWD area was developed based on the geotechnical information interpreted from the boring logs. Subsurface profiles at eight selected cross sections (Figure 2) are shown in Figures 3 through 10. Sections 1 through 5 represent the overall general cross sections with average slopes of about 3 to 5 degrees (i.e., 19 horizontal to 1 vertical [19H:1V] to 11H:1V) and Sections 6 through 8 represent the steeper localized cross sections with average slopes of about 20 to 27 degrees (i.e., 2.7H:1V to 2H:1V). Attachment 1 of this package provides a detailed description of how the subsurface profiles were developed.

As shown in the above cross sections, the subsurface soil in the ILWD area consists primarily of seven strata:

- Stratum I – Solvay Waste (SOLW): SOLW encountered in the ILWD area was described in the boring logs as wet, very soft, gray to dark gray, silt-like grains with mothball odor. The reported standard penetration test (SPT) N value of SOLW in the ILWD area ranges mainly from 0 to 7 (with most of the values being 0). The thickness of SOLW ranges between approximately 15 ft and 55 ft in the ILWD area.
- Stratum II – Marl: Marl encountered in the ILWD area was described in the boring logs as wet, very soft, dark gray or brown silt with shells. The reported SPT N value of Marl in the ILWD area ranges mainly from 0 to 4 (with most of the values being 0). The thickness of Marl varies from 0 ft to approximately 50 ft in the ILWD area.
- Stratum III – Silt and Clay: Silt and Clay encountered in the ILWD area was described in the boring logs as wet, very soft, dark gray or brown mixture of silt and clay. The reported SPT N value of Silt and Clay in the ILWD area is mainly 0. Only a limited number of deep borings in the ILWD area penetrated the bottom of Silt and Clay layer and the thickness of Silt and Clay was reported to be about 20 ft to 80 ft. Based on available information from the deep borings and the other relatively shallow borings, it was estimated that the thickness of Silt and Clay in the ILWD area is at least 15 ft.
- Stratum IV – Silt and Sand: Silt and Sand were encountered in several deep borings in the ILWD area. The SPT N value of Silt and Sand ranges typically from approximately 20 to 80 as reported in the boring logs.
- Stratum V – Sand and Gravel: Sand and Gravel were encountered in several deep borings in the ILWD area. The typical SPT N value for Sand and Gravel ranges from approximately 20 to greater than 100 as reported in the boring logs.
- Stratum VI – Till: Till was encountered in several deep borings in the ILWD area. The SPT N value for Till is typically greater than 100.
- Stratum VII – Shale: Shale was encountered in several deep borings in the ILWD area. The SPT N value for Shale is typically greater than 100.

In addition to the above seven strata, isolated pockets of thin layers of silt were also noticed on top of SOLW in the ILWD area.

Figure 11 shows the historic lake water level. The lake water level was estimated to be at Elevation 363 ft above mean sea level for the purpose of the ILWD stability evaluation.

4. MATERIAL PROPERTIES

Properties of the subsurface soils were selected based on laboratory data or empirical correlations using in-situ test data when laboratory data were not available. Samples of SOLW, Marl, and Silt and Clay were collected during the investigations for laboratory testing, which included:

- Index property tests (i.e., water content, grain size, organic content, carbonate content, Atterberg limits, specific gravity, and density); and
- Performance tests (i.e., unconsolidated undrained (UU) triaxial compression tests, consolidated undrained (CU) triaxial compression tests with porewater pressure measurement, and one-dimensional consolidation tests).

Summary tables of the laboratory test results for Phase I, Phase II, Phase III, and DNAPL investigations were provided to Geosyntec by Parsons and are presented in Attachment 2 of this package. It is noted that the summary tables include data from SMU 1, SMU 2, and SMU 8. However, only the data from SMU 1 (unless specified otherwise) were considered for the ILWD stability evaluation because: (i) the ILWD area consists of only a small portion of SMU 2; and (ii) the stability evaluation is mainly focused on SMU 1 where the lake bottom slope is steeper than in SMU 8.

4.1 INDEX PROPERTIES

The fines (including clay and silt) content was measured in the laboratory index property tests during all four investigations. The carbonate and organic contents were also measured in the laboratory index property tests except during the Phase II investigation. The fines, carbonate, and organic contents were plotted together as a function of depth in Figure 12. Hydrometer tests were performed during the Phase I, Phase II, Phase III, and DNAPL investigations to further measure the clay content (particle size less than 0.002 mm). Based on the lab results, the clay content typically ranges from 5% to 30% for SOLW, from 20% to 43% for Marl, and from 14% to 50% for Silt and Clay. The average clay content was calculated to be 14%, 30%, and 30% for SOLW, Marl, and Silt and Clay, respectively.

The water content and Atterberg limits (i.e., plastic limit and liquid limit) were measured in the laboratory index property tests and were plotted together as a function of depth in Figure 13. Based on the measured water content and Atterberg limits, the plasticity index and liquidity index were calculated and plotted with respect to depth in Figures 14 and 15, respectively. The laboratory data were also plotted in Casagrande's plasticity chart shown in Figure 16.

The unit weights of SOLW, Marl, and Silt and Clay were measured in the laboratory index property tests except during the Phase II investigation when only disturbed sampling was performed. The results are summarized in Table 1 and also plotted in Figure 17 as a function of depth. The calculated average total unit weights recommended for the ILWD stability analysis are 81 pcf, 98 pcf, and 108 pcf for SOLW, Marl, and Silt and Clay, respectively. The unit weight of the isolated silt pockets was assumed to be the same as Marl. The unit weights of the other subsurface soils (i.e., Silt and Sand, Sand and Gravel, Till, and Shale) were assumed to be 120 pcf.

4.2 CONSOLIDATION PARAMETERS

One-dimensional consolidation tests were performed during Phase I and Phase II investigations. The results of the preconsolidation pressures ($p_c^{'}$) of SOLW, Marl, and Silt and Clay were plotted with respect to depth in Figure 18. As a comparison, data from adjacent SMU 2 were also plotted in the figure. The profile of the in-situ vertical effective stress was calculated and plotted in the same figure. The assumed representative subsurface profile in the ILWD area shown in Figure 19 was used in the calculation of the in-situ vertical effective stress. It was assumed in the representative subsurface profile that the thickness of SOLW, Marl, and Silt and Clay is 30 ft, 10 ft, and 30 ft, respectively.

The overconsolidation ratio (*OCR*), which is the ratio of $p_c^{'}$ to the in-situ vertical effective stress, was calculated and plotted in Figure 20 as a function of depth. Figure 20 includes both SMU 1 and SMU 2 data. Based on the plot, material above 30 ft, which consists mainly of SOLW, was considered to be overconsolidated and material below 30 ft, which consists mainly of Marl and Silt and Clay, was considered to be normally consolidated. The *OCR* of SOLW was observed to vary from 1.6 to 8.2, with an average of about 4.7. An OCR value of 2.0 was selected, which is slightly higher than the lower bound of 1.6 but well below the average value of 4.7, to conservatively estimate undrained shear strengths from CU test results, as presented in the next section.

4.3 UNDRAINED SHEAR STRENGTH

Undrained shear strength (S_u) properties of SOLW, Marl, and Silt and Clay were interpreted from UU and CU tests performed as part of the Phase I, Phase III, and DNAPL investigations.

4.3.1 Interpretation of Undrained Shear Strength from UU Tests

The S_u values of SOLW, Marl, and Silt and Clay measured from the UU tests were plotted with respect to depth in Figure 21. The mean and standard deviation of the S_u were calculated and summarized in Table 2 for SOLW, Marl, and Silt and Clay. As presented in the table, the calculated average S_u of SOLW, Marl, and Silt and Clay is 247 psf, 354 psf, and 350 psf, respectively.

4.3.2 Interpretation of Undrained Shear Strength from CU Tests

During CU tests, a soil sample is usually trimmed into three specimens, and each specimen is tested under a different initial confining stress. The initial effective confining stress applied in each test should be greater than the effective overburden stress in the ground where the sample was collected to compensate for the effect of any disturbance. The S_u measured in each CU test corresponds to the initial effective confining stress applied to the specimens rather than the in-situ effective overburden stress the specimens were subjected to in the field. Therefore, the measured S_u from each CU test can not be used directly in analysis. However, a relationship between the S_u in the field and the S_u established from the CU test results can be used to calculate the "in-situ" S_u as explained below:

- Approach 1 – The undrained shear strength ratio defined as s_u / σ'_{ci} can be calculated from CU test results, where S_u is the undrained shear strength measured in the laboratory and is equal to one half of the peak deviator stress, and σ'_{ci} is the initial effective confining stress applied in the CU test. The calculated s_u / σ'_{ci} is then corrected for the overconsolidation effect by multiplying by a factor of $OCR^{0.8}$, if the sample is overconsolidated [Kulhawy and Mayne, 1990]. The s_u / σ'_{ci}, or the corrected s_u / σ'_{ci} if soil is overconsolidated, can be applied directly to a slope stability analysis program. The program will calculate the effective stress for each slice and then assign appropriate S_u based on the undrained shear strength ratio.
- Approach 2 – A best-fit straight line that passes through the origin can be developed to represent the relationship between S_u and σ'_{ci} for each specimen based on the CU tests, as illustrated in Figure 22. In this example using this best-fit line, the "in-situ" S_u for the sample can be established as the strength that corresponds to the in-situ overburden effective stress, $\sigma'_{v,in-situ}$ (see Figure 22), which is calculated according to the subsurface profile where the sample was collected. The calculated S_u is then corrected for the overconsolidation effect by multiplying by a factor of $OCR^{0.8}$, if the sample is overconsolidated [Kulhawy and Mayne, 1990].

The undrained shear strengths were interpreted from the CU test results using both approaches:

Approach 1 -- Undrained Shear Strength Ratio

The undrained shear strength ratio was calculated for each test based on the summary tables of the CU test results provided by Parsons. Figures 23, 24, and 25 present the plots of the undrained shear strength ratio versus the effective confining stress for SOLW, Marl, and Silt and Clay, respectively. The undrained shear strength ratios of SOLW presented in Figure 23 were not corrected for the overconsolidation effect (i.e., the factor of $OCR^{0.8}$ was not applied). The undrained shear strength ratio ranges mainly from 0.2 to 1.2 for SOLW, 0.25 to 0.65 for Marl, and 0.25 to 0.6 for Silt and Clay.

It should be noted that specimens that were tested in an overconsolidated stress state (i.e., the initial effective confining stress in the laboratory is less than the in-situ effective overburden stress) and specimens with abnormal results (i.e., laboratory test report shows abnormal behavior of the stress-strain relation) were removed from the plots for SOLW, Marl, and Silt and Clay. The intent of removing data for specimens that were tested in an overconsolidated stress state is to remove data for which overconsolidation was artificially created in the lab, rather than limiting the data to normally consolidated samples. An example of this situation is shown in Figure 26 for the Silt and Clay samples, where the test results removed from the data set are circled. The in-situ effective overburden stresses were calculated based on the assumed representative subsurface profiles in the ILWD area illustrated in Figure 19. The calculated in-situ effective stress was compared to the initial effective confining stress in the laboratory to identify the overconsolidated samples.

Approach 2 -- Undrained Shear Strength as a Function of Depth

Using Approach 2 described before and illustrated in Figure 22, the in-situ effective overburden stress calculated using the assumed representative subsurface profile in Figure 19 was used to establish the "in-situ" S_u for each sample. The resulting S_u is plotted with respect to the sample depth in Figure 27. The mean and standard deviation of the interpreted S_u from the CU tests are summarized in Table 2. As presented in the table, the calculated average S_u is 140 psf, 492 psf, and 612 psf for SOLW, Marl, and Silt and Clay, respectively. Because SOLW is overconsolidated, the average S_u of SOLW was adjusted by a factor of $OCR^{0.8}$ with OCR being 2.0 as discussed before. The adjusted S_u for SOLW was calculated to be approximately 240 psf. It is noticed that the S_u of Marl and Silt and Clay increases with depth. A line with $s_u / \sigma_v^{'} = 0.35$ was found to fit the S_u data well for Marl and Silt and Clay.

4.3.3 Recommended Undrained Shear Strength for Design

Comparison of S_u interpreted from UU and CU test results is shown in Figure 28. In general, S_u from CU tests are close to S_u from UU tests for SOLW and Marl at shallow depths, and S_u from CU tests are greater than S_u from UU tests for Marl and Silt and Clay at deep depths. This observation is consistent with the evidence found in literature [e.g., Sabatini et al., 2002], where UU tests tend to underestimate the actual shear strength for samples collected at depths greater than 6 m (or 18 ft) for normally consolidated samples and greater than 12 m (or 36 ft) for overconsolidated soils.

Based on the interpretation results, it is recommended that the adjusted average S_u of SOLW from the CU tests, which was calculated to be 240 psf, be used for the ILWD stability analysis. It is also recommended that the undrained shear strength ratio of 0.35 be used for Marl and Silt and Clay because their S_u appears to increase with depth. For the liquefaction analysis, an undrained shear strength ratio of 0.35 is recommended for the SOLW and this value will be adjusted to account for overconsolidation as needed.

4.4 DRAINED SHEAR STRENGTH

The effective stress friction angles (ϕ') of SOLW, Marl, and Silt and Clay were estimated based on the CU test results. The ϕ' was calculated using the effective stress Mohr circle at failure for each CU test as illustrated in Figure 29. The calculated ϕ' is plotted in Figure 30 as a function of the effective normal stress for SOLW, Marl, and Silt and Clay. The mean value and the standard deviation of the ϕ' for SOLW, Marl, and Silt and Clay are summarized in Table 3. As shown in Figure 30, there is considerable scatter in the data for the near surface material (i.e., at low effective normal stress). It is unknown if the scatter is due to material variability or difficulty in testing at low normal stresses. For this reason, it is recommended that the "Mean minus one standard deviation or slightly lower" values of the ϕ' be used at low effective normal stresses for SOLW in the ILWD stability analysis, which was calculated to be 37 degrees. It is noted that the standard deviation for the deeper materials, primarily Marl and Silt and Clay layers, indicates less scatter than for the near surface materials. While it may be appropriate to use the mean value, the mean minus standard deviation was used for consistency, which was calculated to be 32 degrees and 30 degrees for Marl and Silt and Clay, respectively.

Initial slope stability analyses were performed using mean and standard deviation values calculated from the initial data that was available. When more data (i.e., Phase III data) became available, the values were recalculated. Since the recalculated mean values were greater than or equal to the initial values and the standard deviations were less than or equal to the initial values, the slope stability analyses were not updated because the original strength values were considered to be conservative. This is the rationale behind the term *"Mean minus one standard deviation or slightly lower"*.

An empirical relation between $\phi^{'}$ and SPT N value, as shown in Table 4 [Kulhawy and Mayne, 1990], was used to estimate $\phi^{'}$ of Silt and Sand, Sand and Gravel, Till, and Shale. Using an estimated average SPT N value of 30 for Silt and Sand and Sand and Gravel, their $\phi^{'}$ was conservatively estimated to be 32 degrees. The $\phi^{'}$ of Till and Shale was estimated to be 40 degrees as their SPT N values are typically greater than 100.

4.5 SUMMARY OF RECOMMENDED MATERIAL PROPERTIES

The material properties (i.e., unit weight and undrained and drained shear strengths) recommended for the ILWD stability analysis are summarized in Table 5.

5. REFERENCES

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Sabatini P.J., Bachus, R.C., Mayne, P.W., Schneider, J.A., and Zettler, T.E. (2002). " Geotechnical Engineering Circular No. 5: Evaluation of Soil and Rock Properties", FHWA-IF-02-034, Federal Highway Administration, Washington, DC, April 2002.

TABLES

Table 1. Summary of measured total unit weight

Material	Average value (pcf)	Standard Deviation (pcf)
SOLW	81	6
Marl	98	9
Silt and Clay	108	9

Note:
See Table 5 for the final recommended material properties to be used for the ILWD stability analysis.

Table 2. Summary of measured/interpreted undrained shear strength

Material	Based on UU tests		Based on CU tests		
	Mean	Standard Deviation	Mean	Standard Deviation	Mean adjusted for overconsolidation
SOLW	247	149	140	44	244
Marl	354	127	492	166	$S_u/\sigma_v' = 0.35$
Silt and Clay	350	136	612	183	$S_u/\sigma_v' = 0.35$

Note:
See Table 5 for the final recommended material properties to be used for the ILWD stability analysis.

Table 3. Summary of interpreted effective friction angle from CU tests

Material	Mean (degrees)	Standard deviation (degrees)	Mean – Standard deviation (degrees)
SOLW	48	8	40
Marl	39	6	33
Silt & Clay	36	6	30

Note:
See Table 5 for the final recommended material properties to be used for the ILWD stability analysis.

Table 4. Empirical relation between friction angle and SPT N value

N Value (blows/ft or 305 mm)	Relative Density	Approximate $\bar{\phi}_{tc}$ (degrees) (a)	(b)
0 to 4	very loose	< 28	< 30
4 to 10	loose	28 to 30	30 to 35
10 to 30	medium	30 to 36	35 to 40
30 to 50	dense	36 to 41	40 to 45
> 50	very dense	> 41	> 45

a - Source: Peck, Hanson, and Thornburn (12), p. 310.
b - Source: Meyerhof (13), p. 17.

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Table 5. Material properties recommended for the ILWD slope stability analysis

Material	Total Unit Weight (pcf)	Drained Shear Strength		Undrained Shear Strength[1] (psf)	
		c'	ϕ'	From UU	From CU
Silt[2]	98	0	32	N/A[3]	N/A
SOLW	81	0	37[4]	245	240[5]
Marl	98	0	32[6]	350	$S_u/\sigma'_v = 0.35$[7]
Silt and Clay	108	0	30	350	$S_u/\sigma'_v = 0.35$[7]
Silt and Sand	120	0	32	N/A	N/A
Sand and Gravel	120	0	32	N/A	N/A
Till	120	0	40	N/A	N/A
Shale	120	0	40	N/A	N/A

Notes:

1. Undrained shear strength obtained from CU tests is recommended to be used for the ILWD stability analysis for undrained loading conditions. Values of the undrained shear strength were rounded down to the nearest 5 or 10.
2. Properties of Marl were used for the isolated Silt on top of SOLW.
3. N/A = Not Applicable
4. As presented in Table 3, the "mean minus one standard deviation" value for SOLW is 40 degrees. However, based on initially available data, a value of 37 degrees was calculated and used in slope stability analyses. Because it is conservative, the recommended shear strength value was not changed to 40 degrees after the new data became available.
5. Undrained shear strength of SOLW from CU tests has been adjusted by multiplying a factor of $OCR^{0.8}$ (with OCR being 2.0) to account for the overconsolidation effect.
6. As presented in Table 3, the "mean minus one standard deviation" value for Marl is 33 degrees. However, based on initially available data, a value of 32 degrees was calculated and used in slope stability analyses. Because it is conservative, the recommended shear strength value was not changed to 33 degrees after the new data became available.
7. The laboratory undrained shear strength data of Marl and Silt and Clay shows a trend of increase with depth. An undrained shear strength ratio of 0.35 was found to fit the data well.

FIGURES

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

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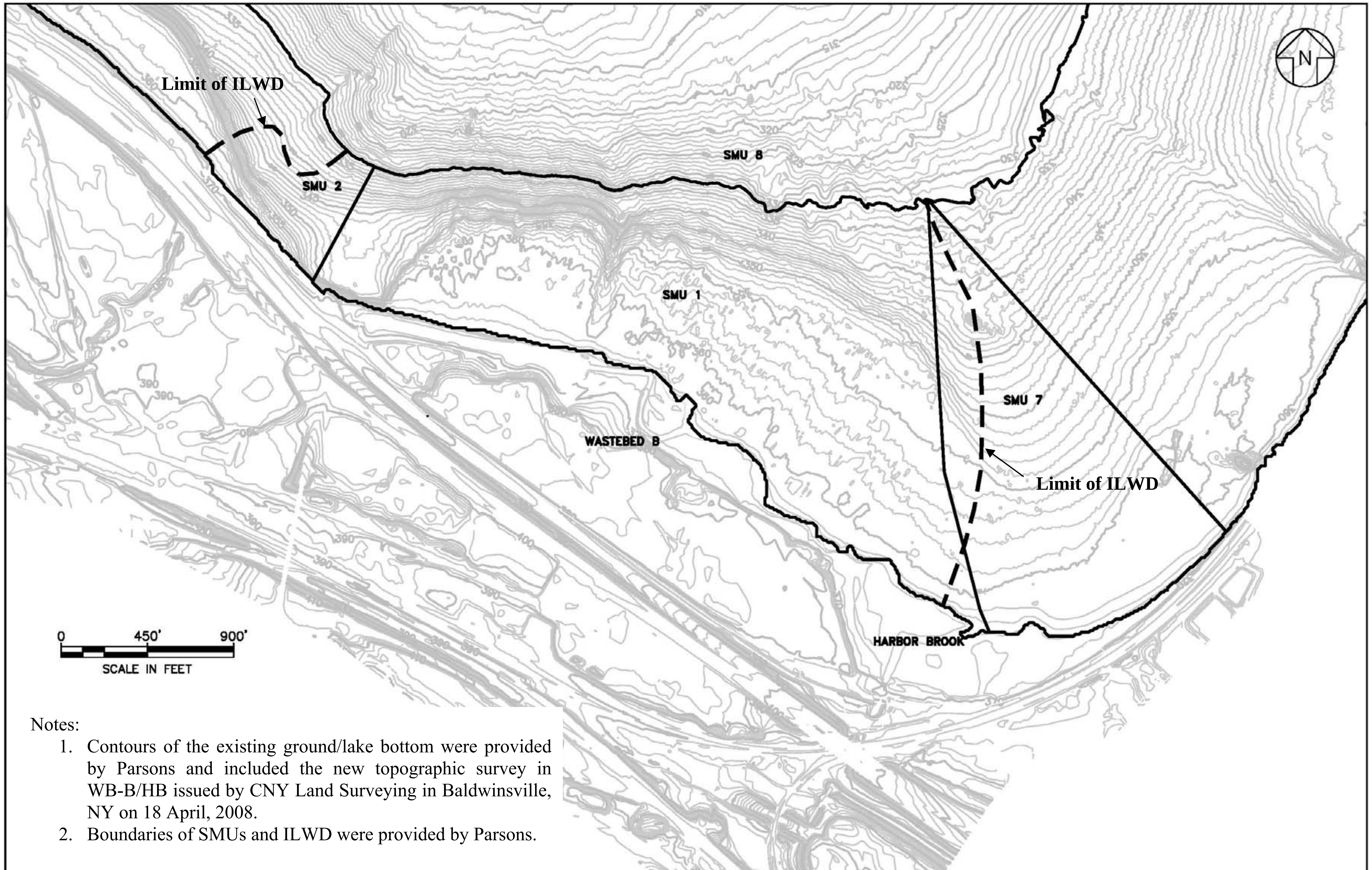

Notes:

1. Contours of the existing ground/lake bottom were provided by Parsons and included the new topographic survey in WB-B/HB issued by CNY Land Surveying in Baldwinsville, NY on 18 April, 2008.
2. Boundaries of SMUs and ILWD were provided by Parsons.

Figure 1. ILWD site layout

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

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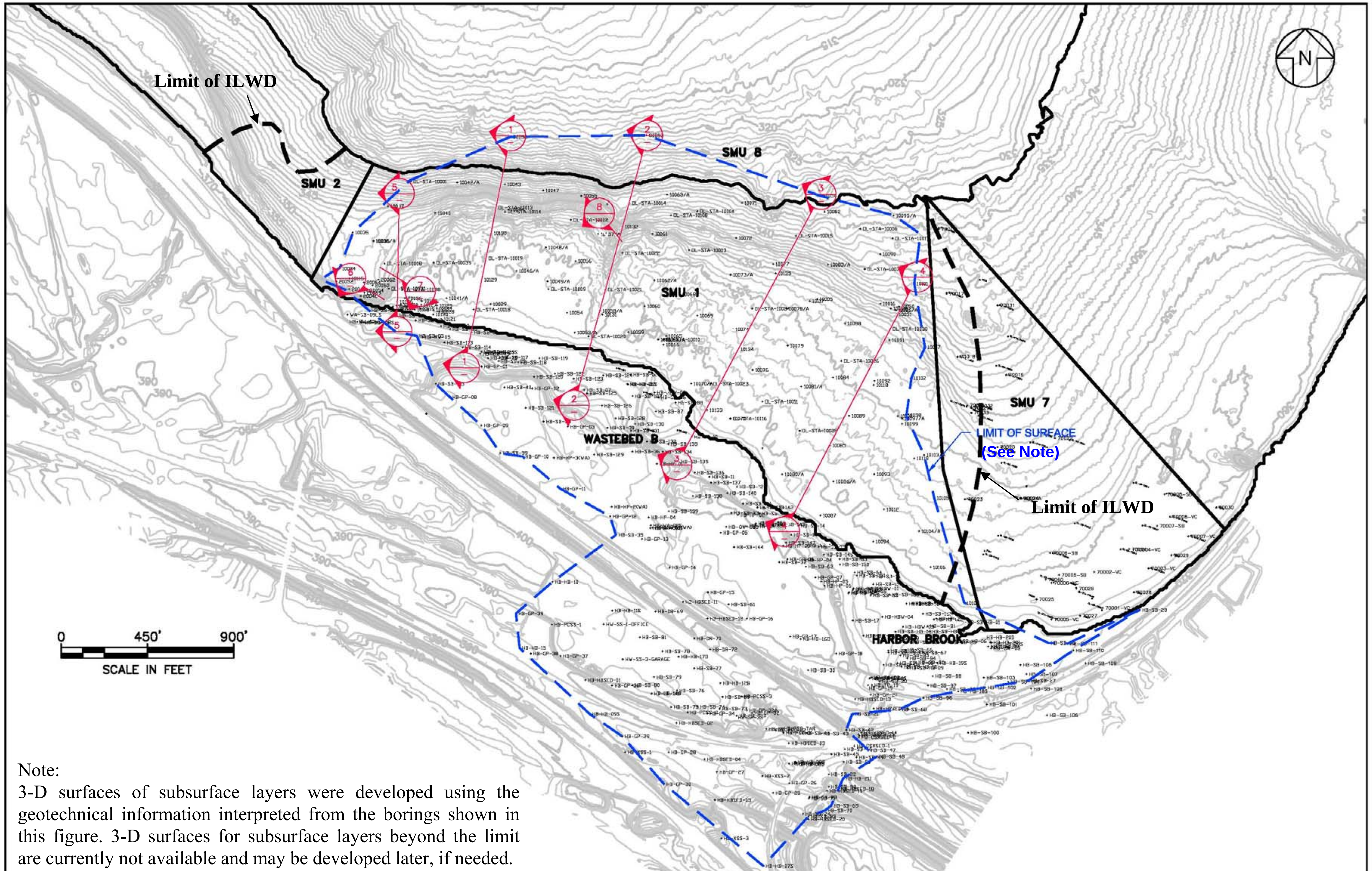

Note:
3-D surfaces of subsurface layers were developed using the geotechnical information interpreted from the borings shown in this figure. 3-D surfaces for subsurface layers beyond the limit are currently not available and may be developed later, if needed.

Figure 2. Locations of borings and selected cross sections

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

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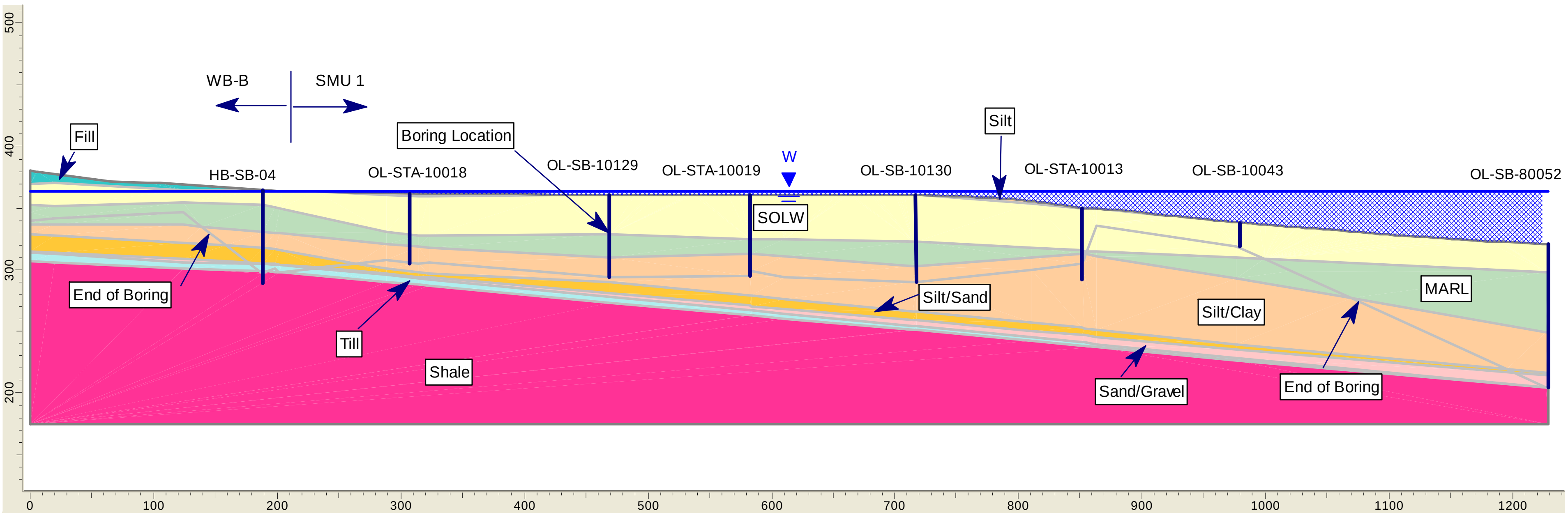

Figure 3. Geometry of cross section 1

Notes:

1. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings and may not represent the true field stratigraphy. See Attachment 1 for details.
2. Borings HB-SB-04 and OL-STA-10013 are offset from the cross section line. Therefore, the end of the boring shown in the figure does not match the line of end of boring for these two borings.
3. Subsurface layer elevations above the end of boring at the boring locations shown in the figure were checked and found to match well with the available elevations reported in the boring logs.

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

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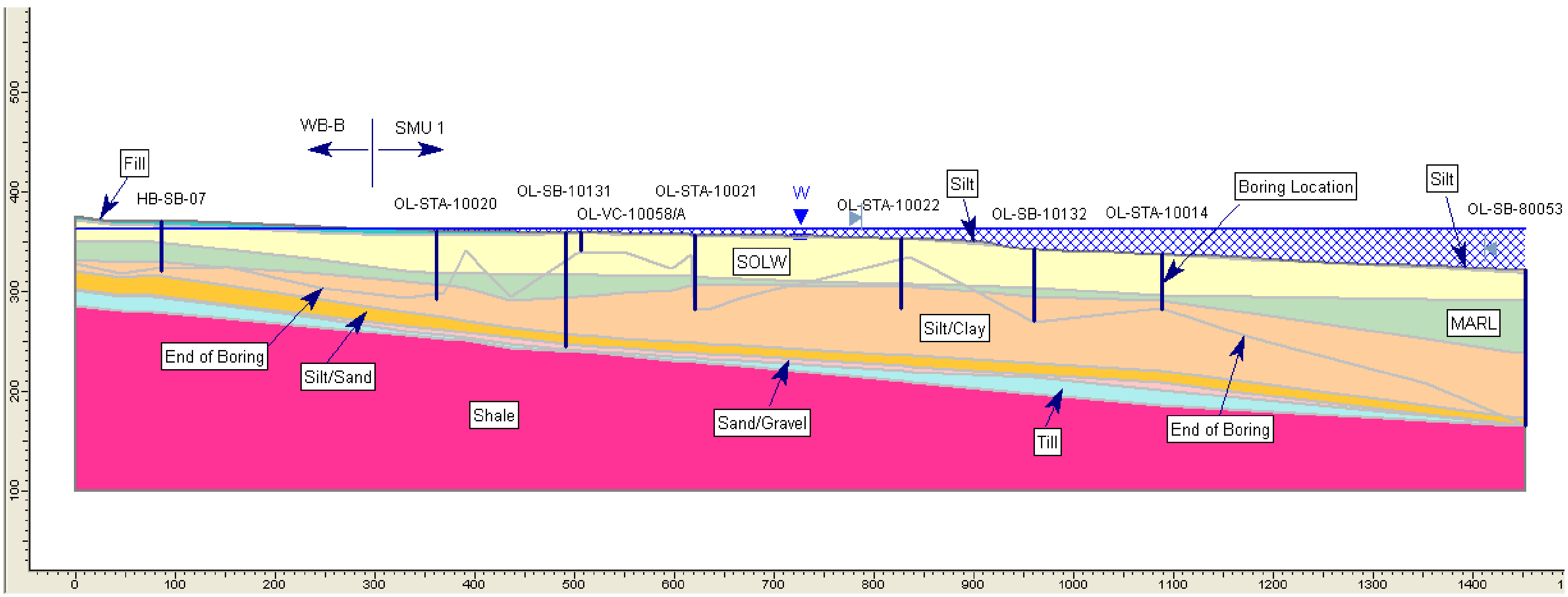

Figure 4. Geometry of cross section 2

Notes:

1. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings and may not represent the true field stratigraphy. See Attachment 1 for details.
2. Borings OL-SB-10131 and OL-STA-10022 are offset from the cross section line. Therefore, the end of the boring shown in the figure does not match the line of end of boring for these two borings.
3. Subsurface layer elevations above the end of boring at the boring locations shown in the figure were checked and found to match well with the available elevations reported in the boring logs.

Written by:	**Ming Zhu**	Date:	**08/20/2008**	Reviewed by:	**R. Kulasingam/J. Beech**	Date:	**08/20/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GJ4204**	Task No.:	**01**

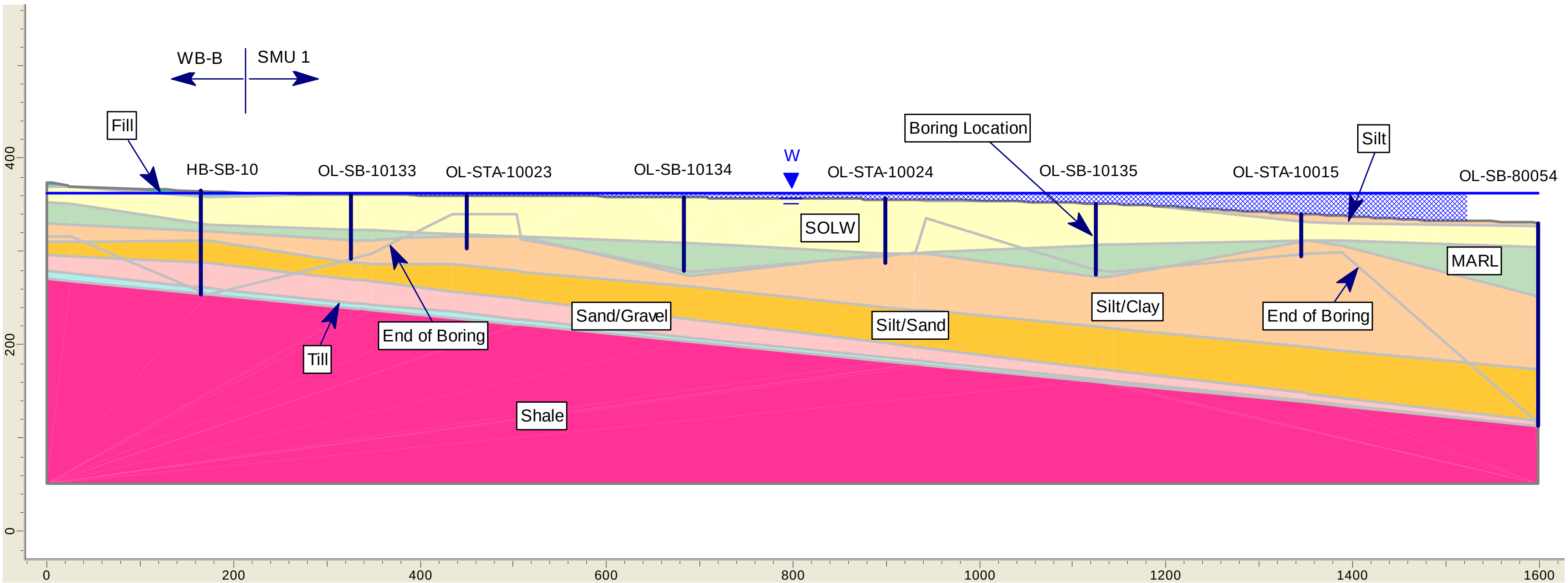

Figure 5. Geometry of cross section 3

Notes:

1. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings and may not represent the true field stratigraphy. See Attachment 1 for details.
2. Boring OL-STA-10023 is offset from the cross section line. Therefore, the end of the boring shown in the figure does not match the line of end of boring for this boring.
3. Subsurface layer elevations above the end of boring at the boring locations shown in the figure were checked and found to match well with the available elevations reported in the boring logs.

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

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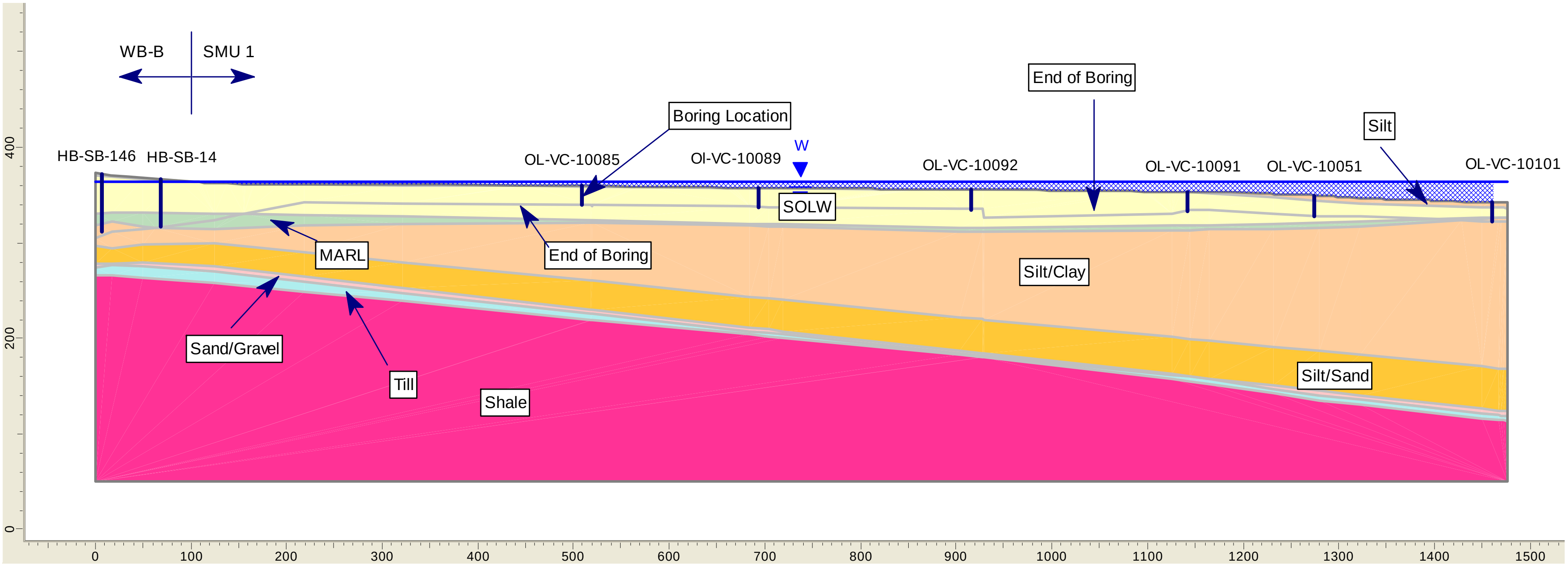

Figure 6. Geometry of cross section 4

Notes:

1. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings and may not represent the true field stratigraphy. See Attachment 1 for details.
2. Subsurface layer elevations above the end of boring at the boring locations shown in the figure were checked and found to match well with the available elevations reported in the boring logs.

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

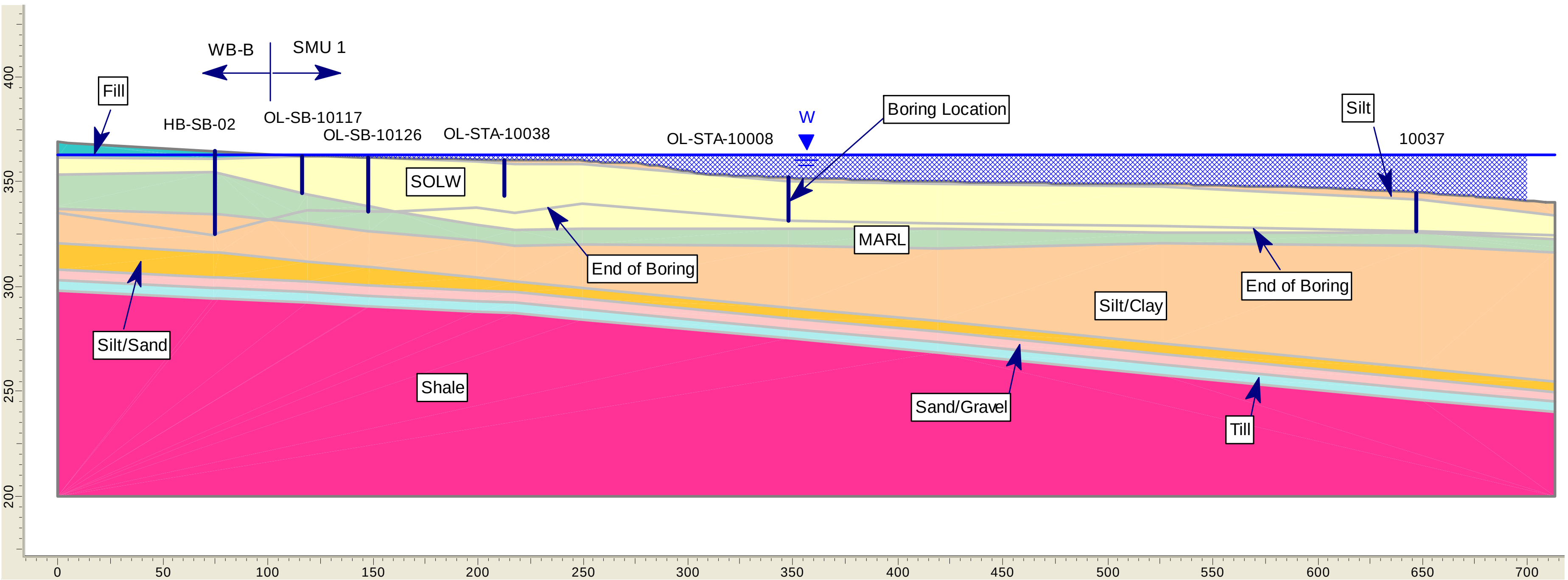

Figure 7. Geometry of cross section 5

Notes:

1. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings and may not represent the true field stratigraphy. See Attachment 1 for details.
2. Borings OL-SB-10117 and OL-STA-10038 are offset from the cross section line. Therefore, the end of the boring shown in the figure does not match the line of end of boring for these two borings.
3. Subsurface layer elevations above the end of boring at the boring locations shown in the figure were checked and found to match well with the available elevations reported in the boring logs.

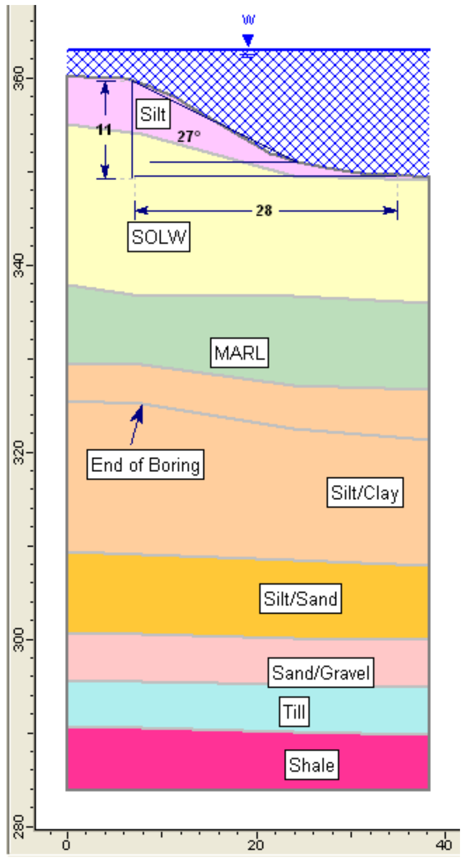

Figure 8. Geometry of cross section 6

Notes:

1. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings and may not represent the true field stratigraphy. See Attachment 1 for details.
2. The average slope is about 27 degrees and the maximum slope is about 32 degrees.

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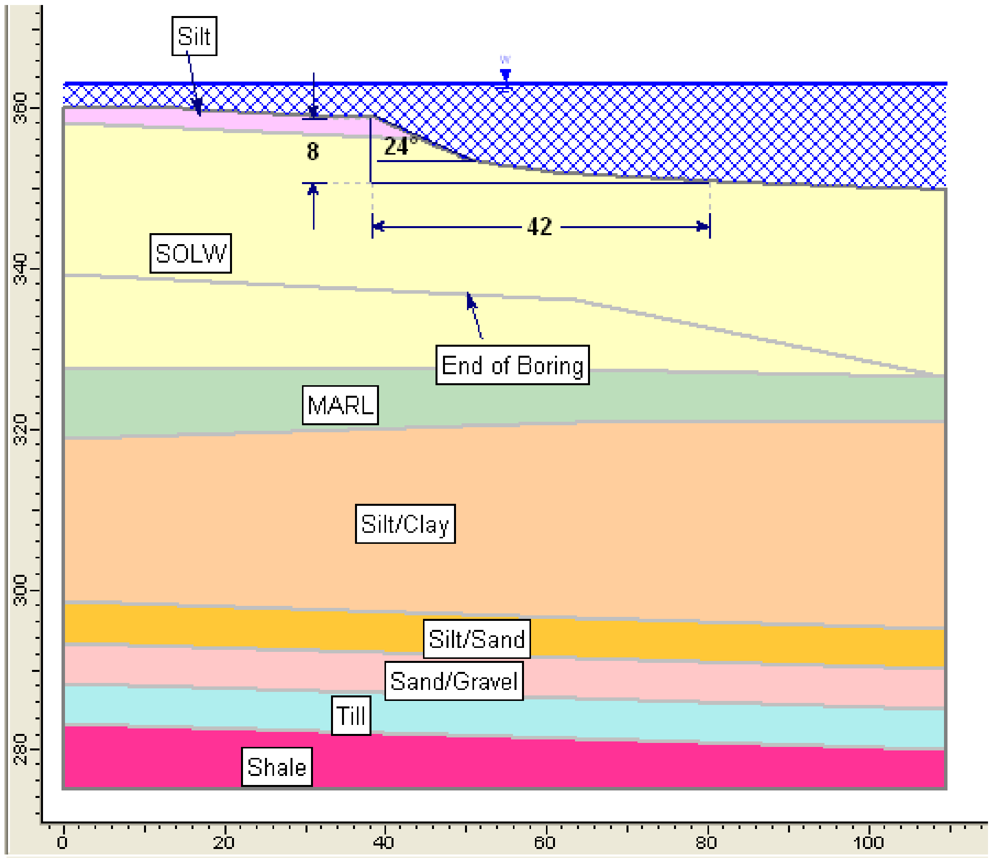

Figure 9. Geometry of cross section 7

Notes:

1. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings and may not represent the true field stratigraphy. See Attachment 1 for details.
2. The average slope is about 24 degrees and the maximum slope is about 28 degrees.

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

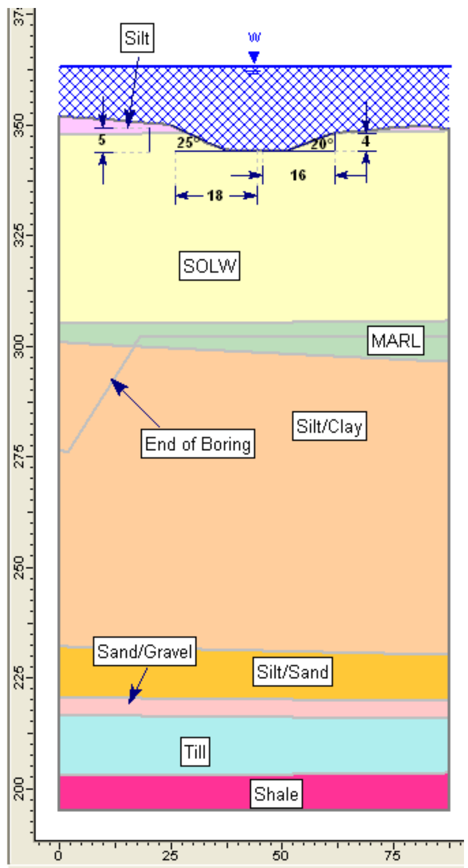

Figure 10. Geometry of cross section 8

Notes:

1. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings and may not represent the true field stratigraphy. See Attachment 1 for details.
2. The average slope is about 25 degrees and the maximum slope is about 28 degrees for the steeper left-side slope.

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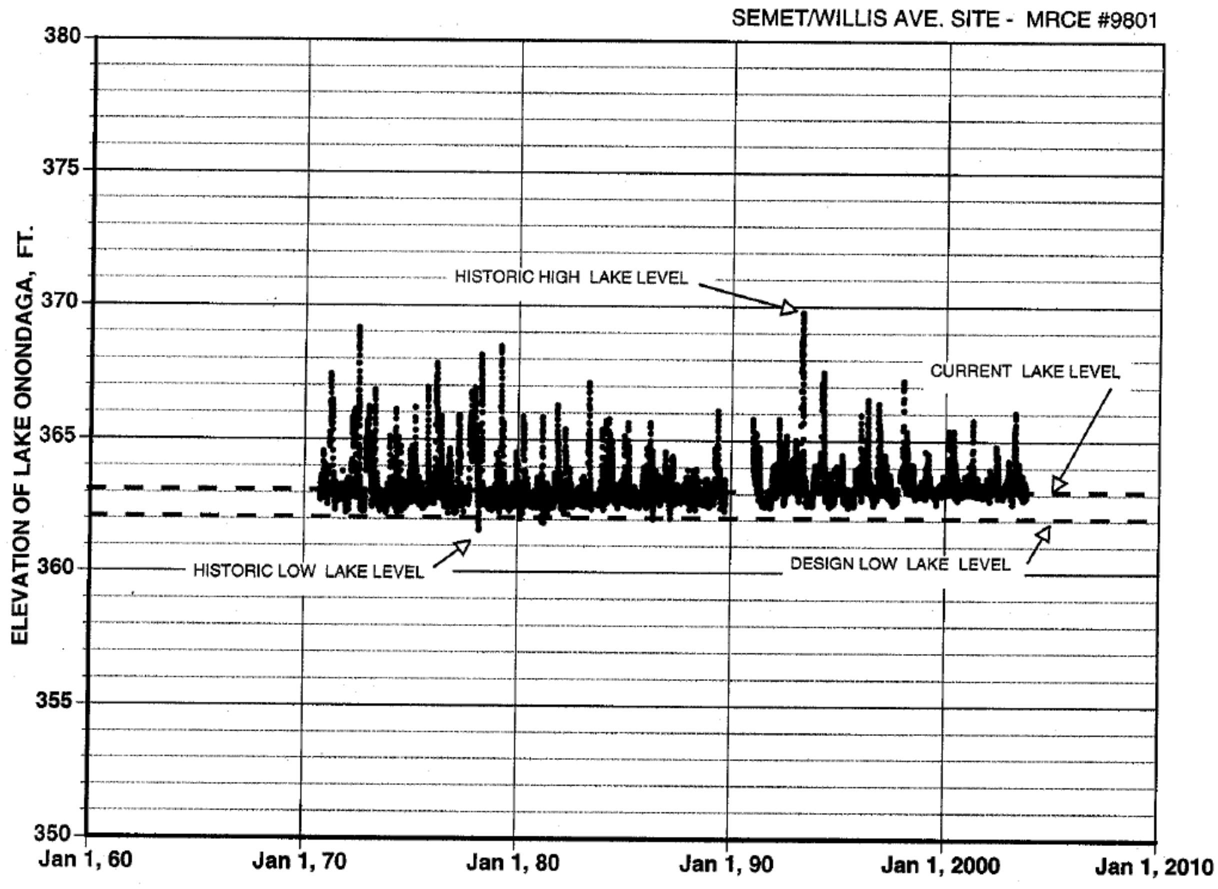

Figure 11. Onondaga Lake water level
(Figure provided to Geosyntec by Parsons)

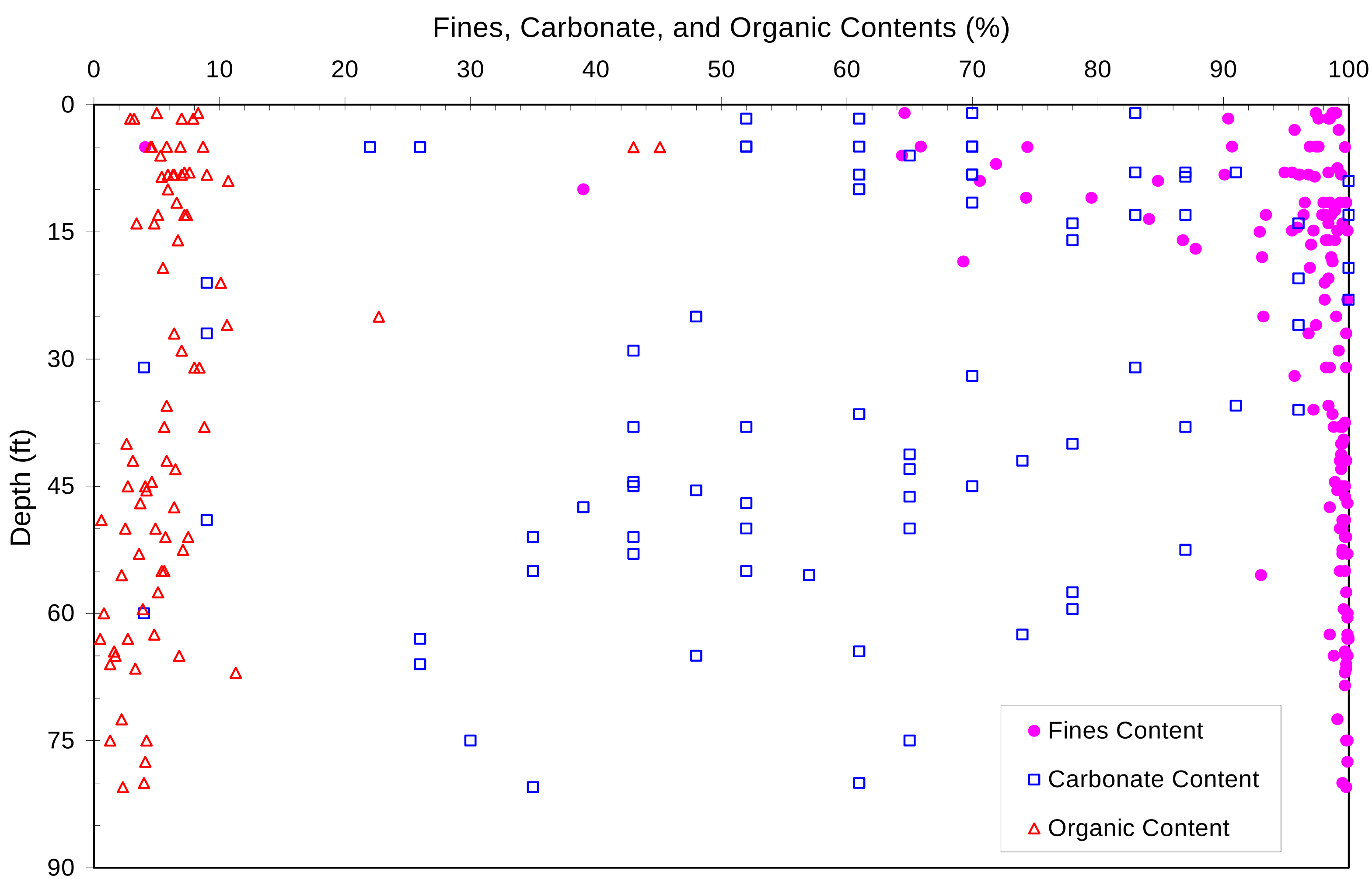

Figure 12. Plot of fines, carbonate, and organic contents versus depth

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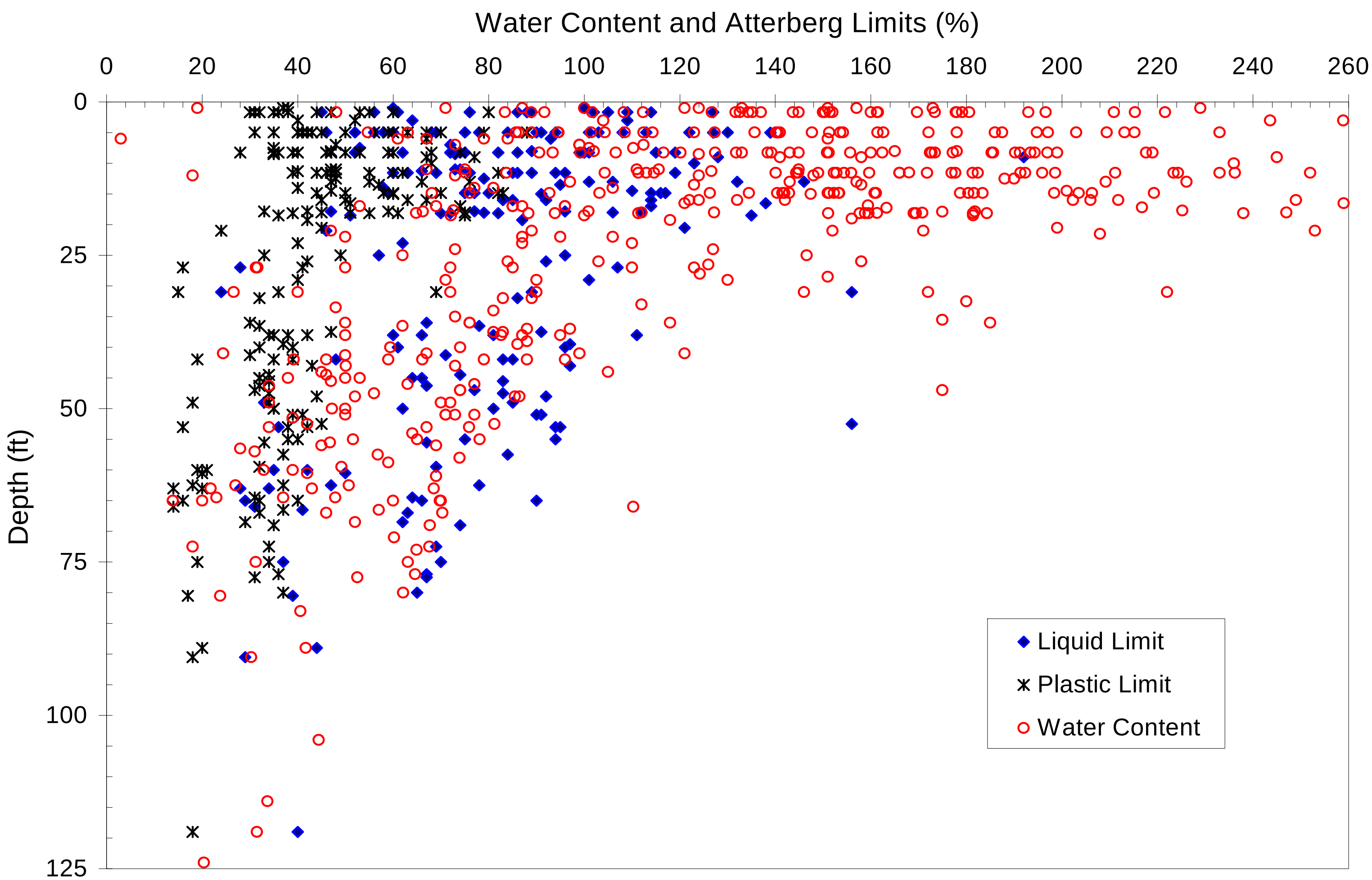

Figure 13. Plot of water content and Atterberg limits versus depth

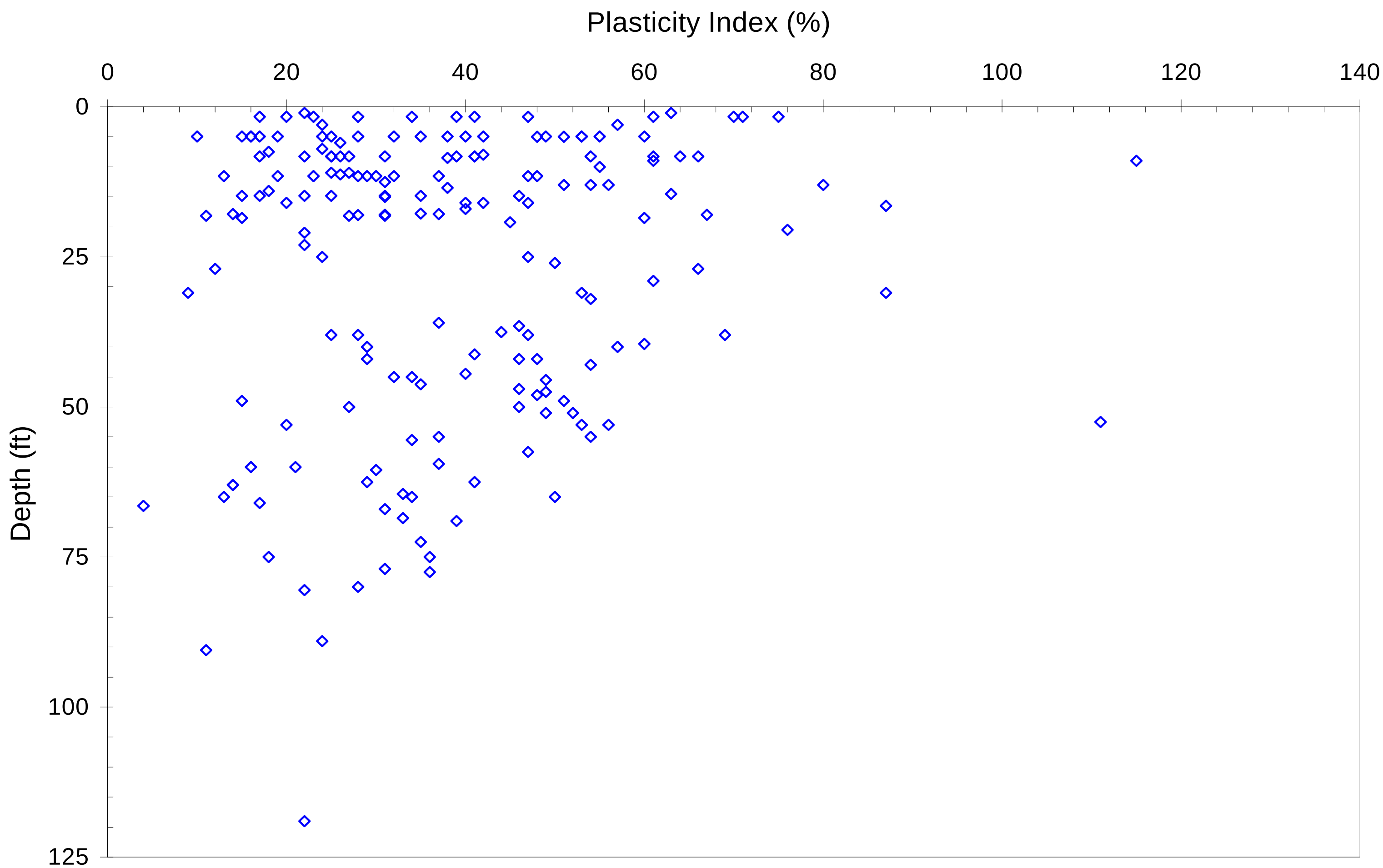

Figure 14. Plot of plasticity index versus depth

Written by:	**Ming Zhu**	Date:	**08/20/2008**	Reviewed by:	**R. Kulasingam/J. Beech**	Date:	**08/20/2008**

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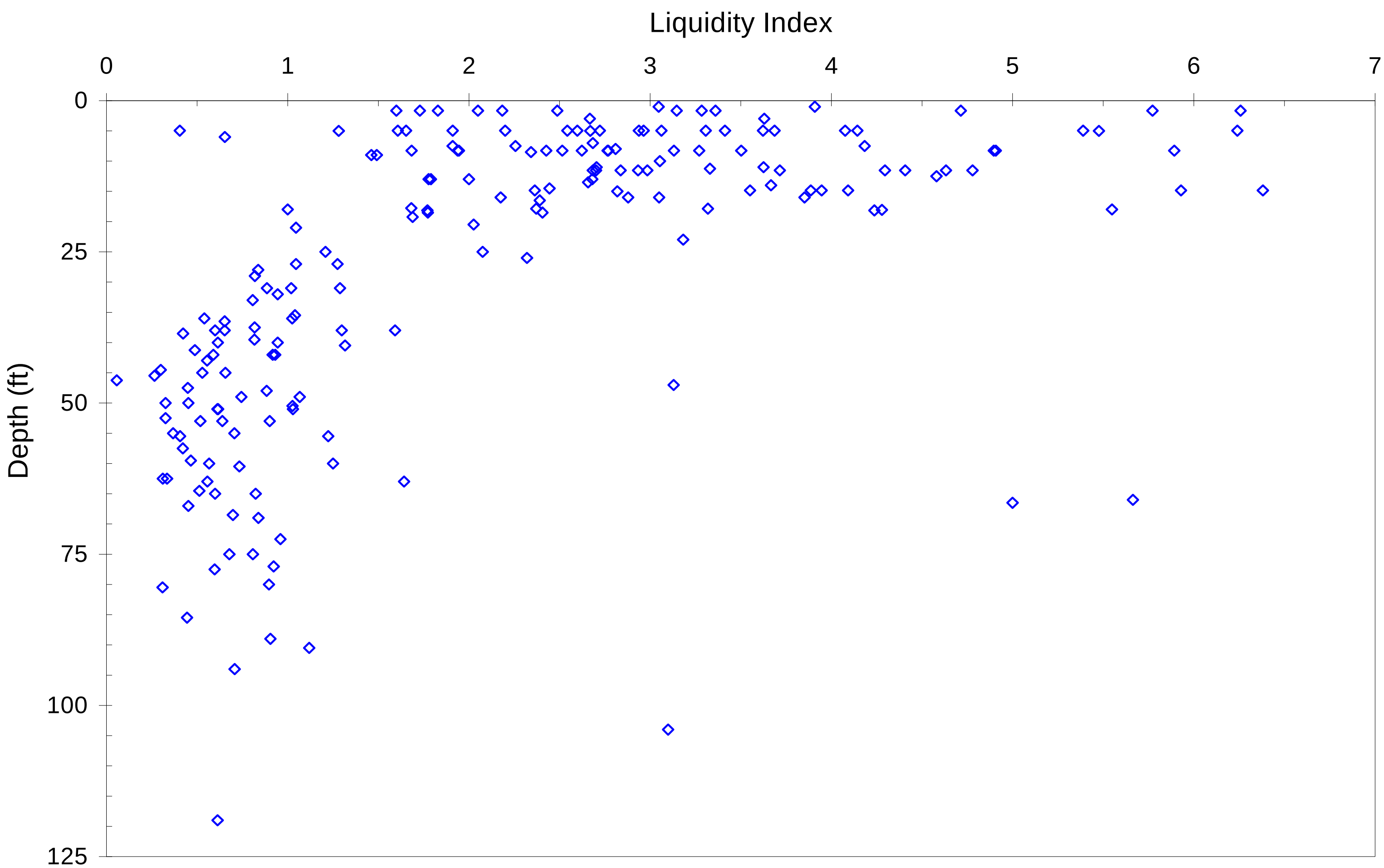

Figure 15. Plot of liquidity index versus depth

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

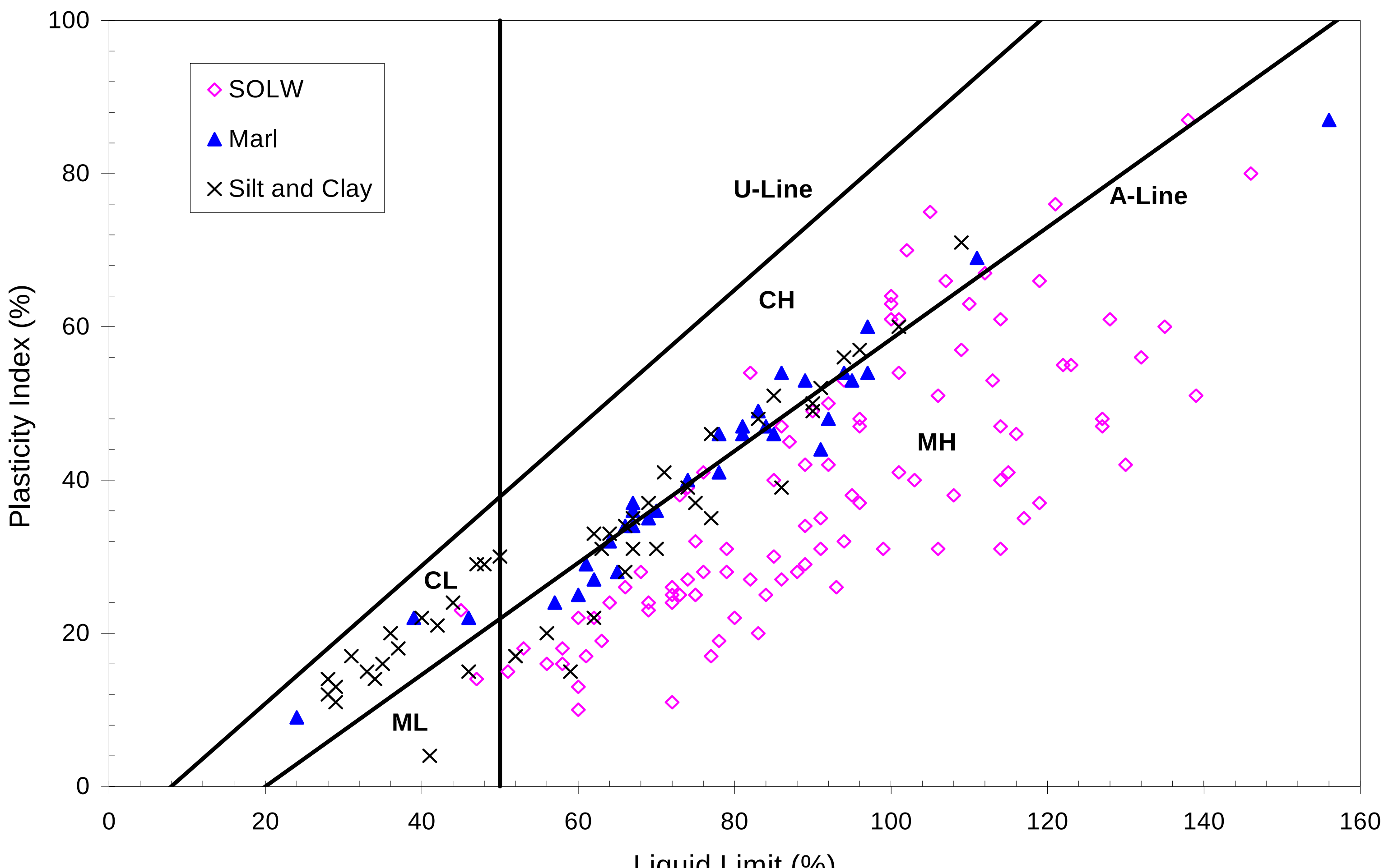

Figure 16. Casagrande's plasticity chart

Written by:	Ming Zhu	Date:	08/20/2008	Reviewed by:	R. Kulasingam/J. Beech	Date:	08/20/2008
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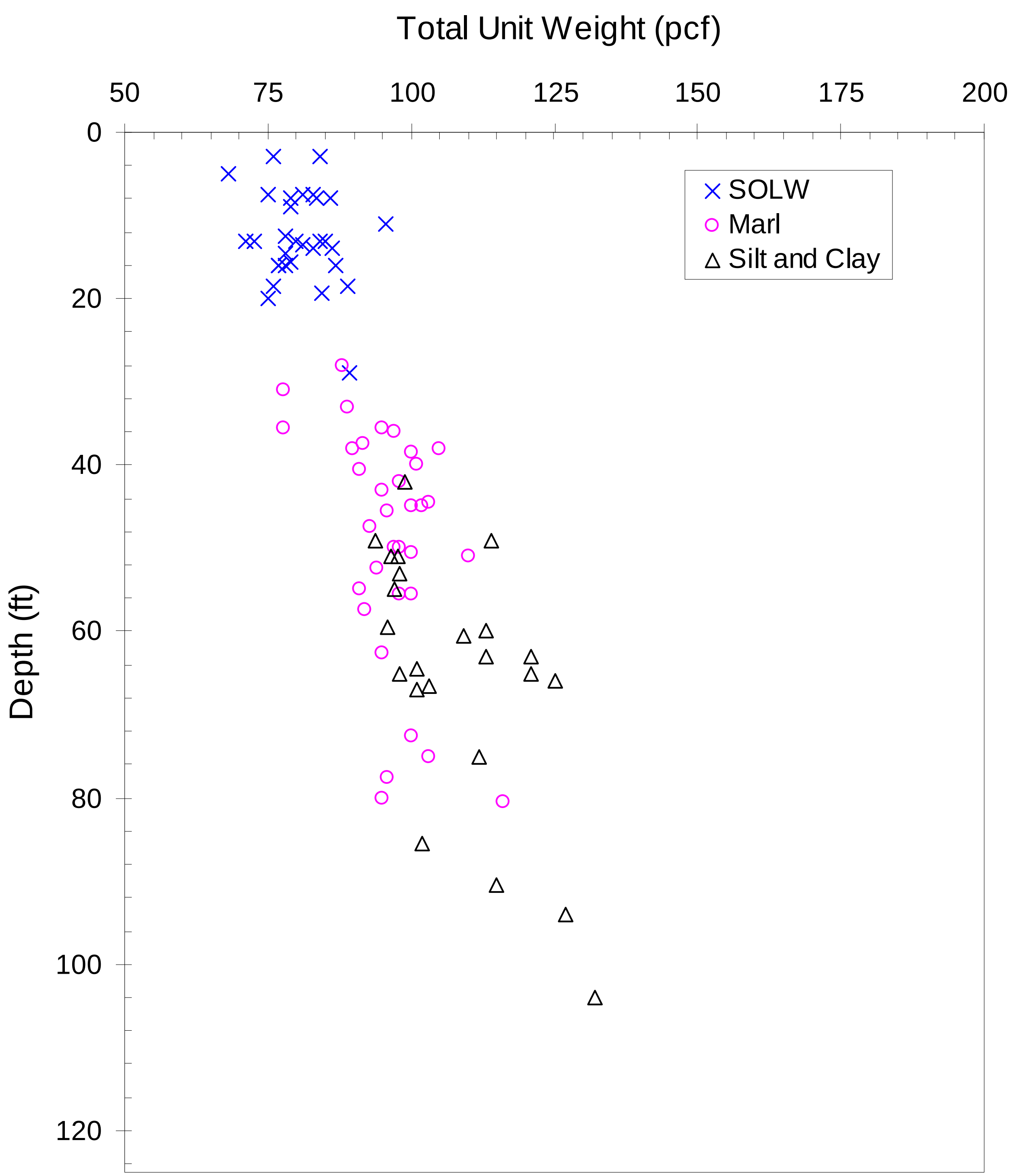

Figure 17. Plot of total unit weight versus depth

Written by:	Ming Zhu	Date:	08/20/2008	Reviewed by:	R. Kulasingam/J. Beech	Date:	08/20/2008

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	01

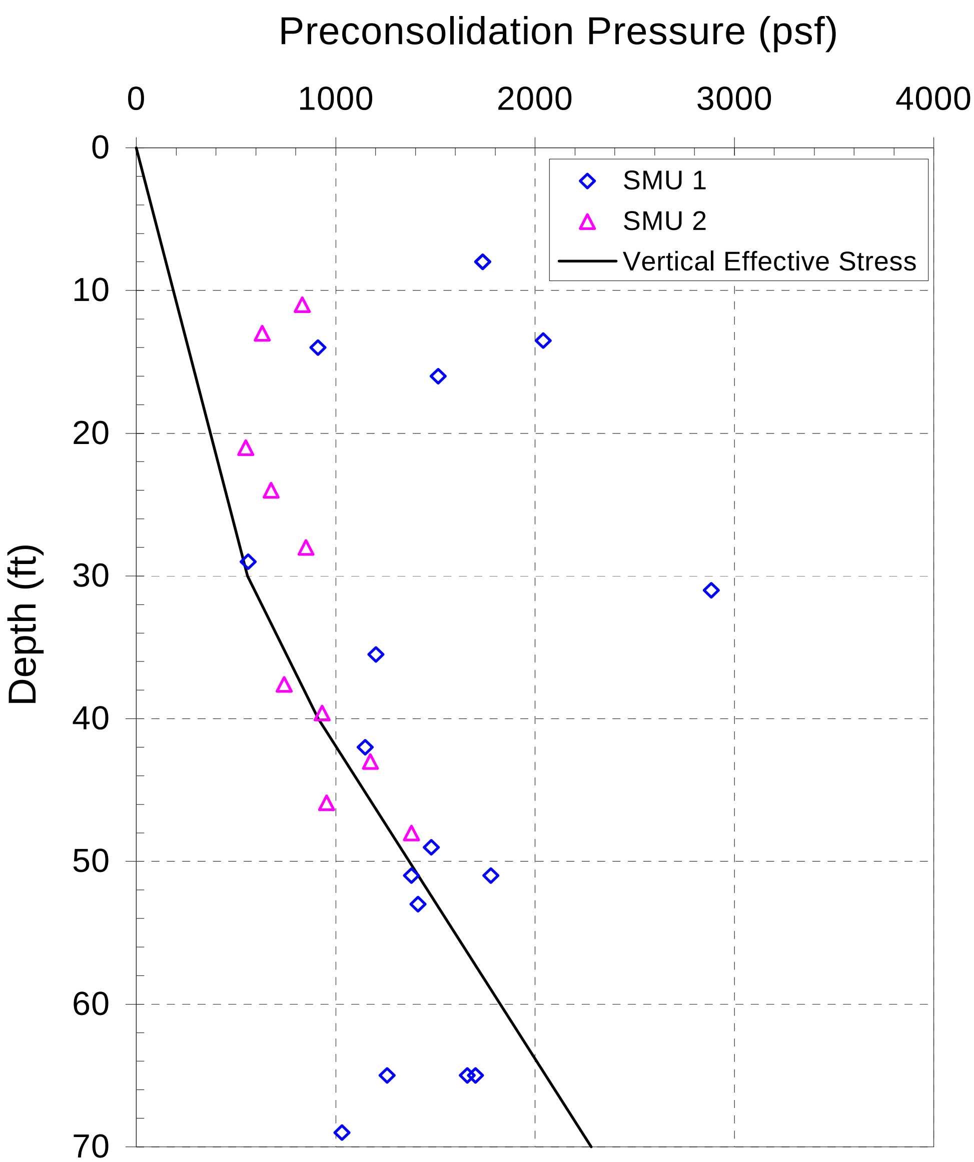

Figure 18. Profile of preconsolidation pressure
(Note: data from SMU 2 were included for comparison)

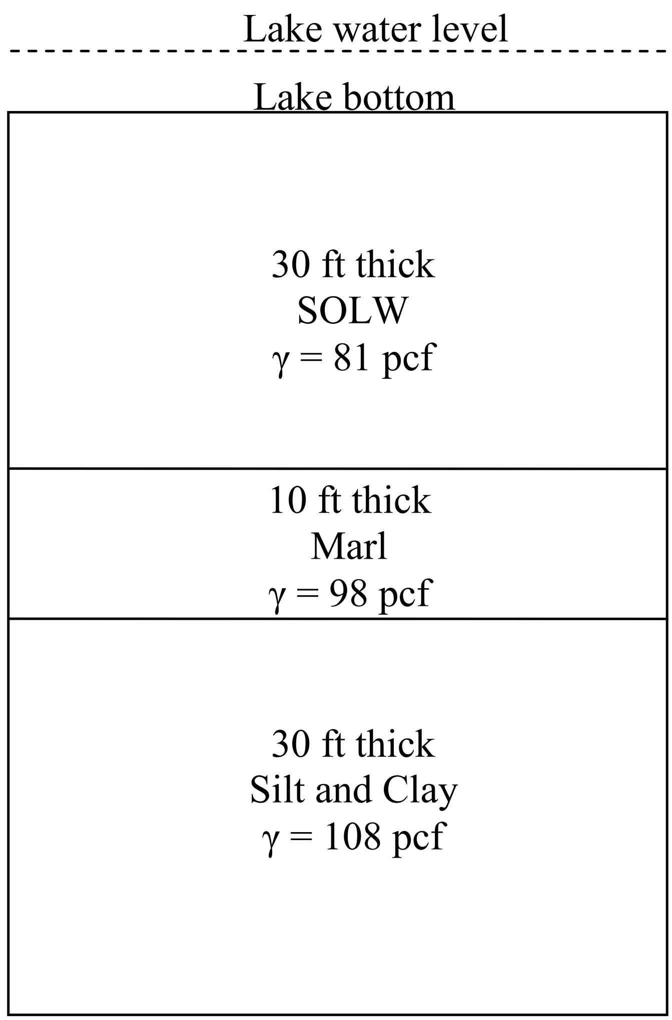

Figure 19. Assumed representative subsurface profile in the ILWD area for in-situ effective overburden stress calculation

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

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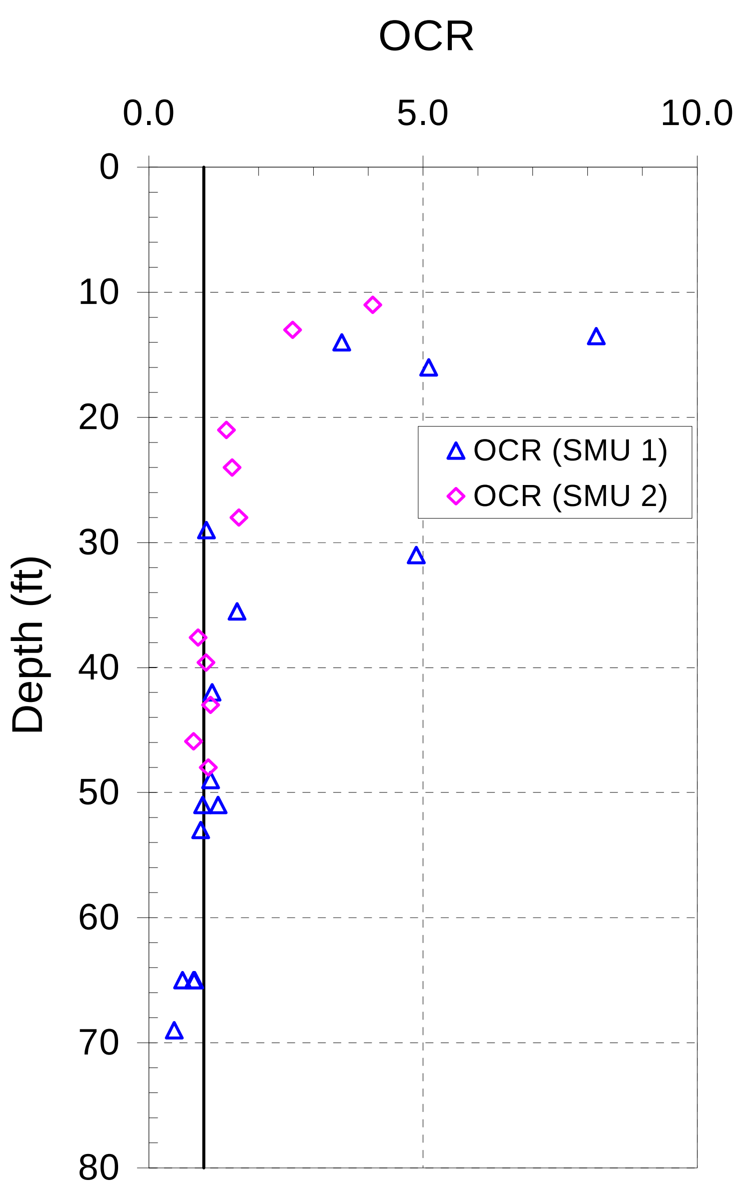

Figure 20. Profile of overconsolidation ratio
(Note: data from SMU 2 were included for comparison)

Geosyntec consultants

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SMU 1 (UU Results)

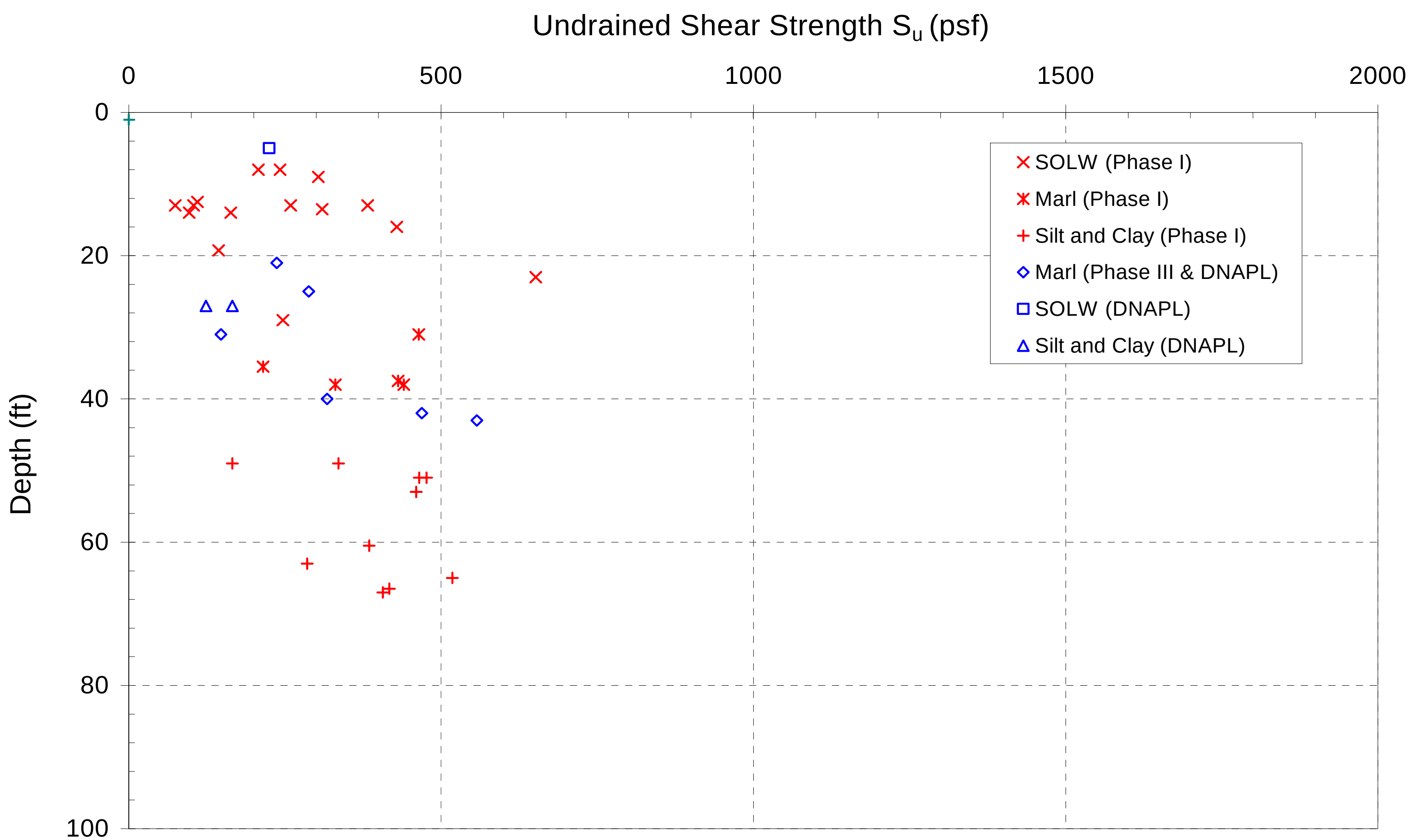

Figure 21. Undrained shear strength from UU tests

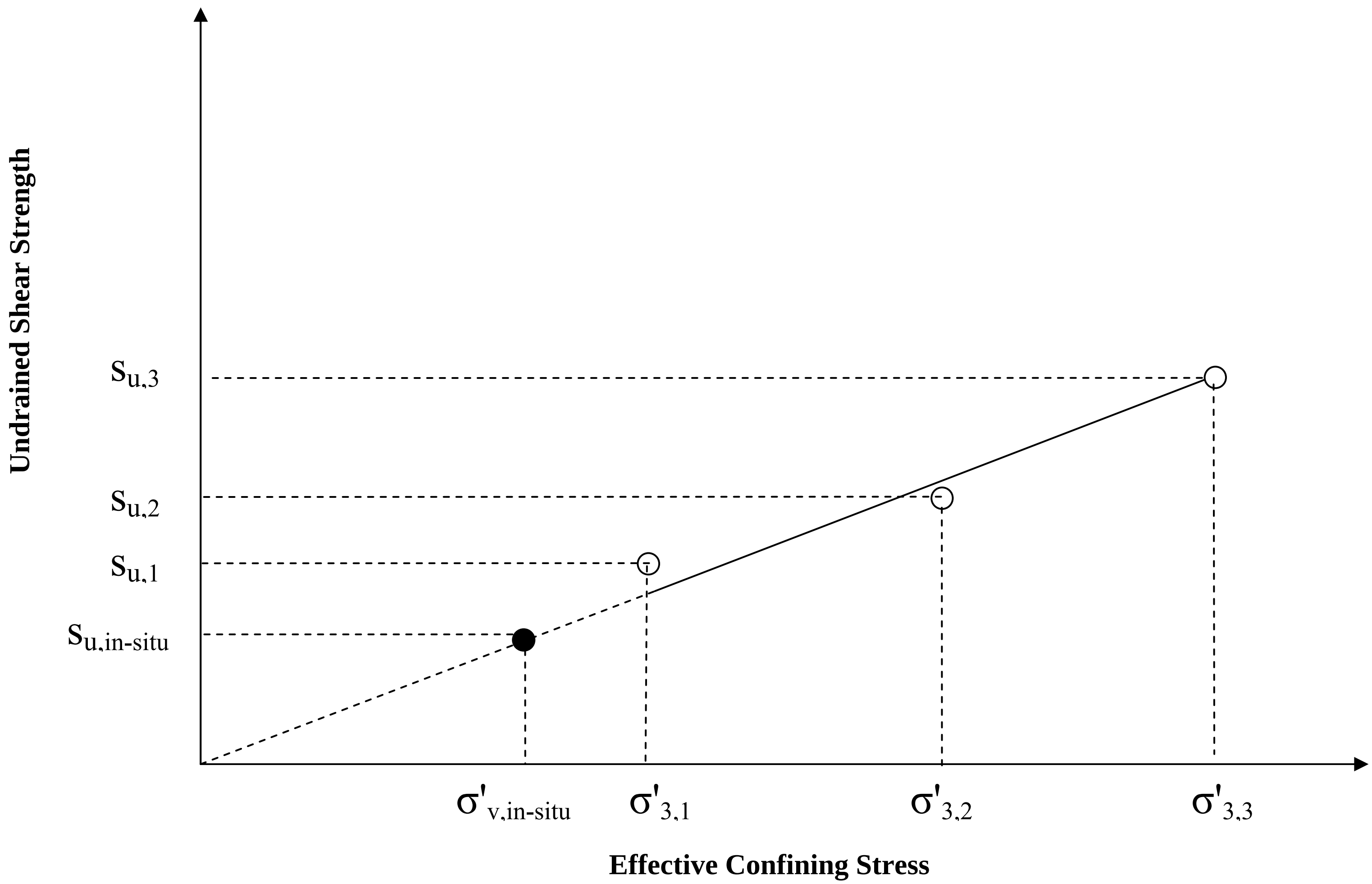

Figure 22. Obtaining S_u corresponding to the in-situ vertical stress from CU tests (Approach 2).

Written by:	**Ming Zhu**	Date:	**08/20/2008**	Reviewed by:	**R. Kulasingam/J. Beech**	Date:	**08/20/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GJ4204**	Task No.:	**01**

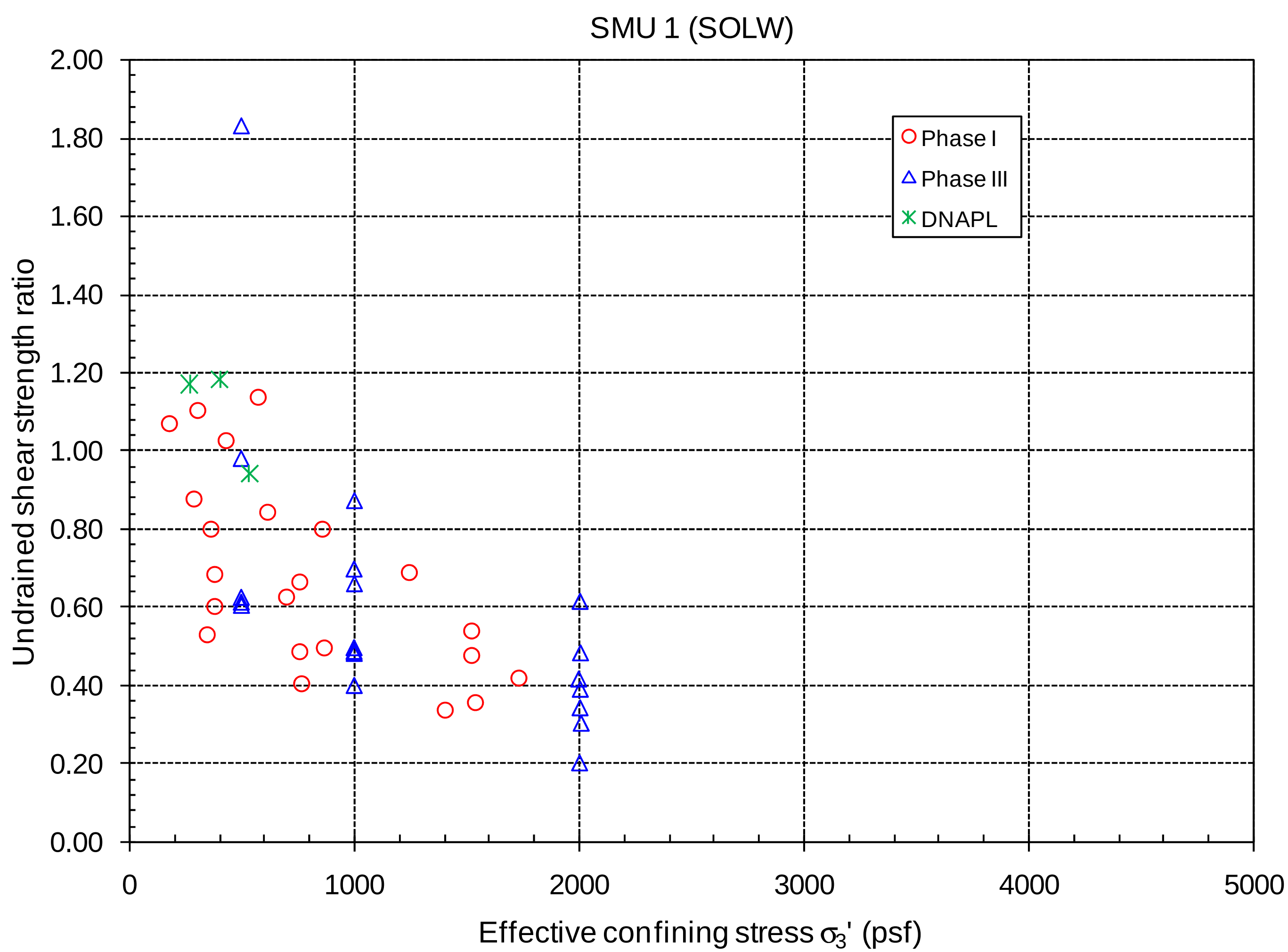

Figure 23. Undrained shear strength ratio for SOLW from CU tests

Written by: **Ming Zhu** Date: **08/20/2008** Reviewed by: **R. Kulasingam/J. Beech** Date: **08/20/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

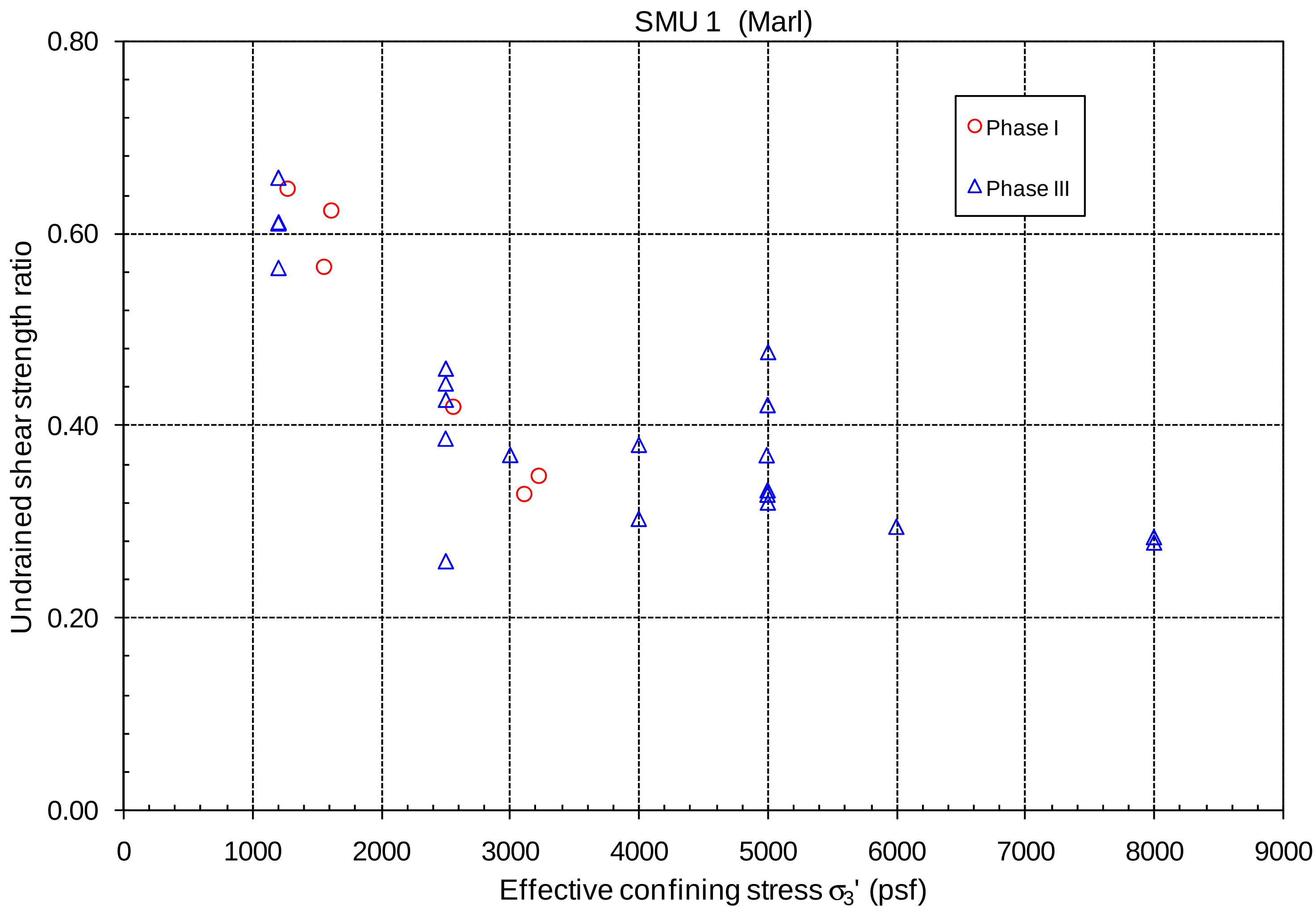

Figure 24. Undrained shear strength ratio for Marl from CU tests

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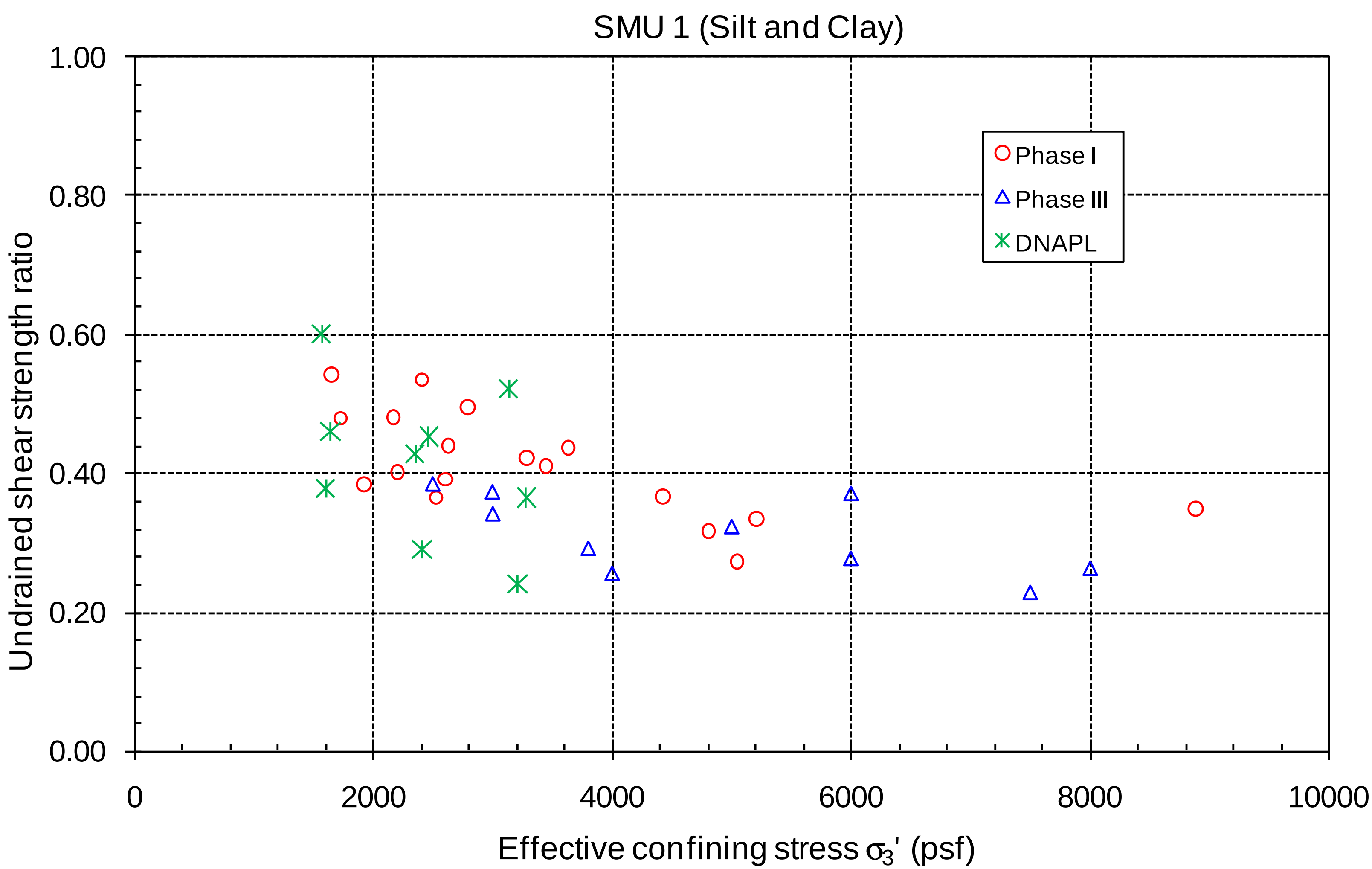

Figure 25. Undrained shear strength ratio for Silt and Clay from CU tests

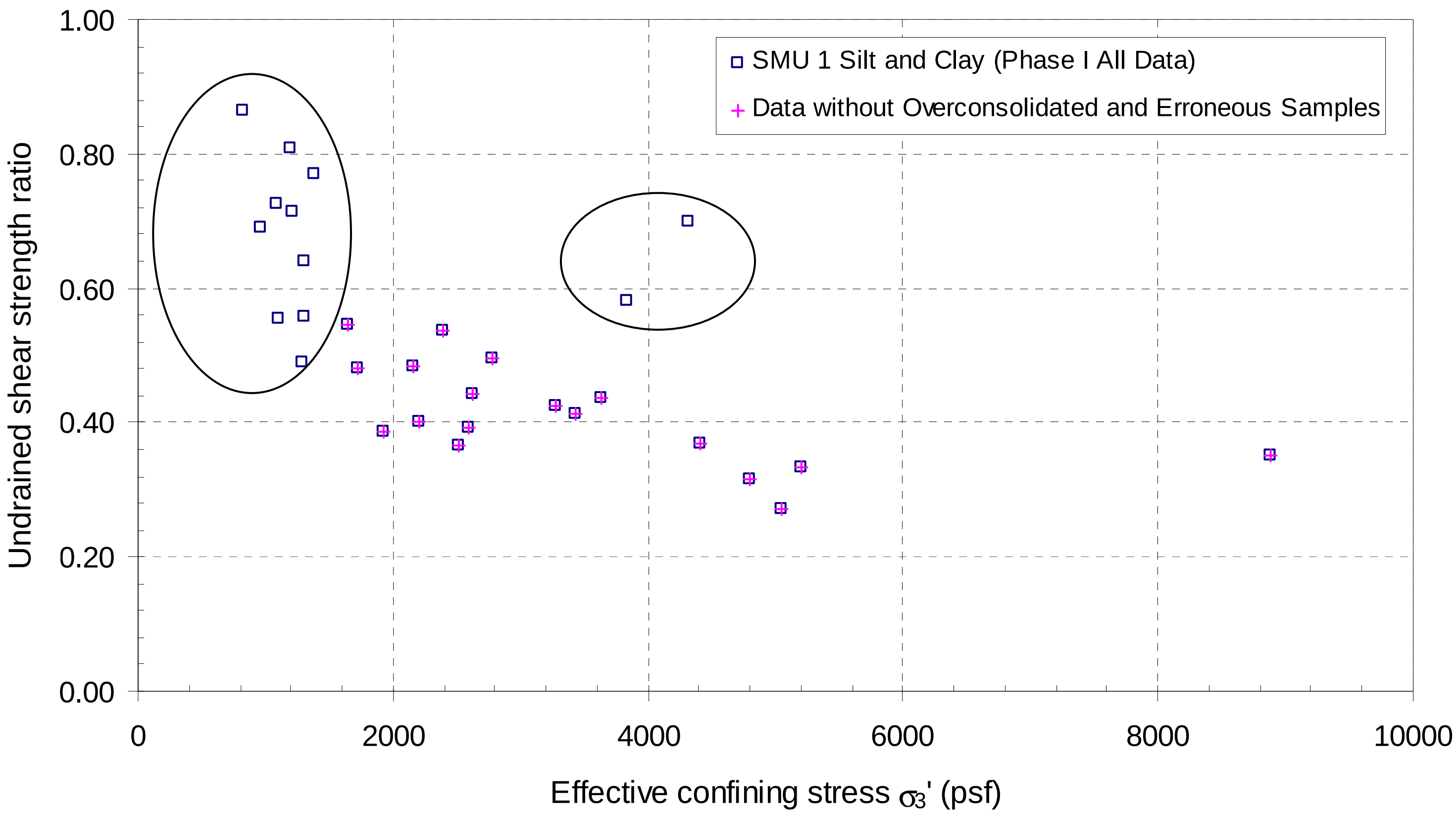

Figure 26. Example of removed samples from CU tests

Notes:
1. Data obtained from a confining stress lower than the in-situ vertical stress were removed.
2. Two data points showing erroneous behavior were removed based on the observation of stress-strain curves.

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Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	01

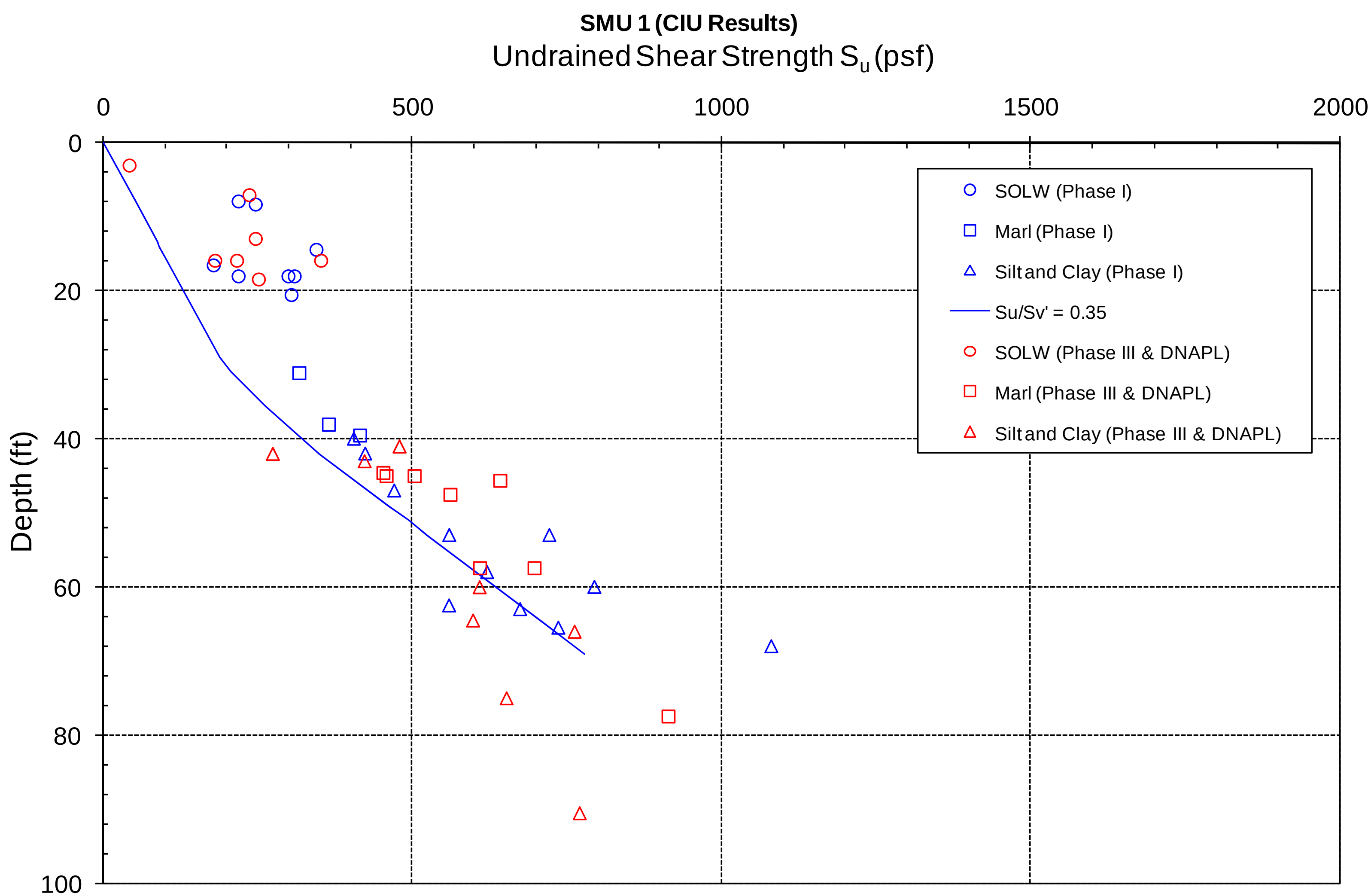

Figure 27. Interpreted undrained shear strength from CU tests

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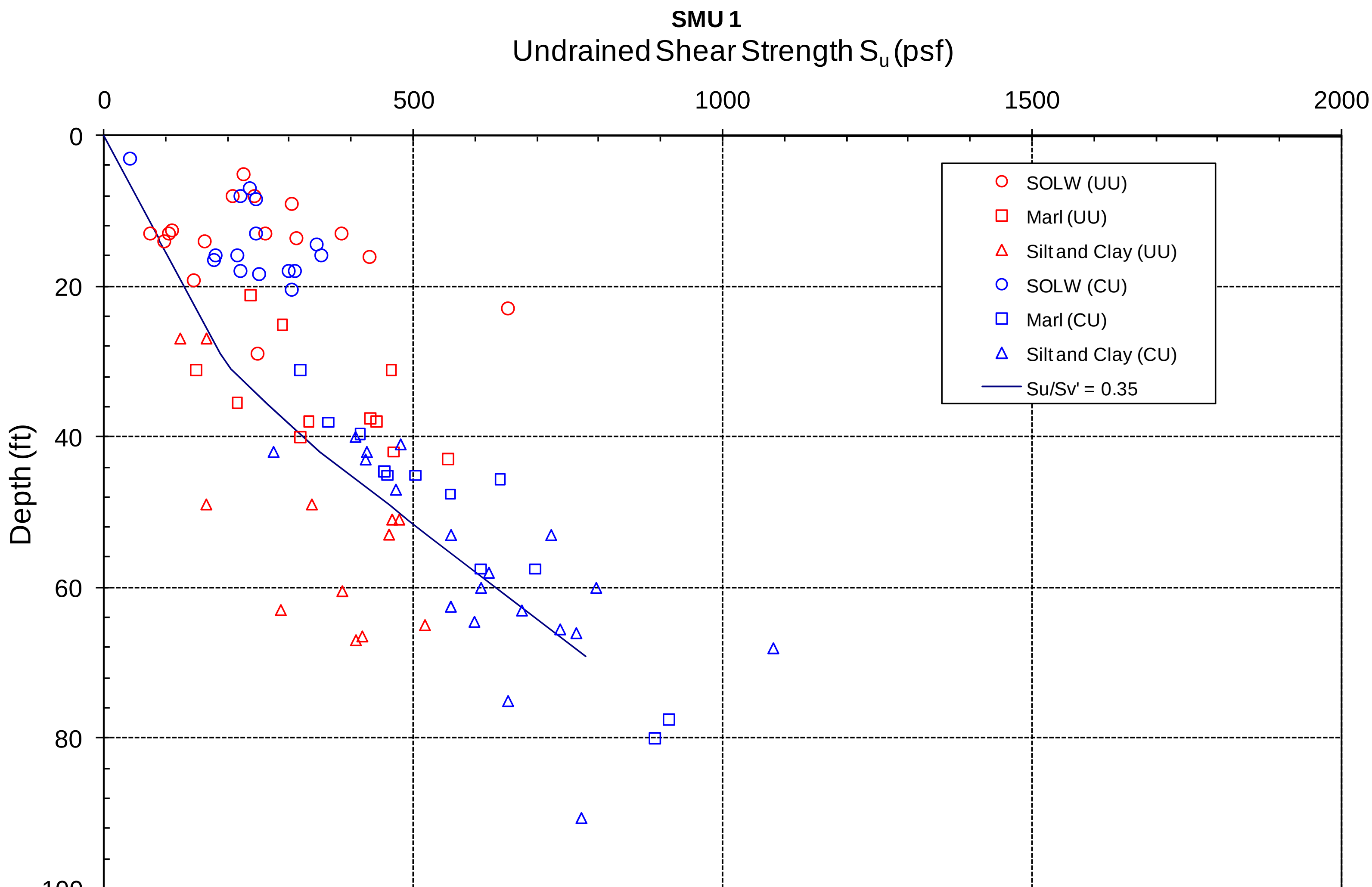


Figure 28. Comparison of undrained shear strength from UU and CU tests

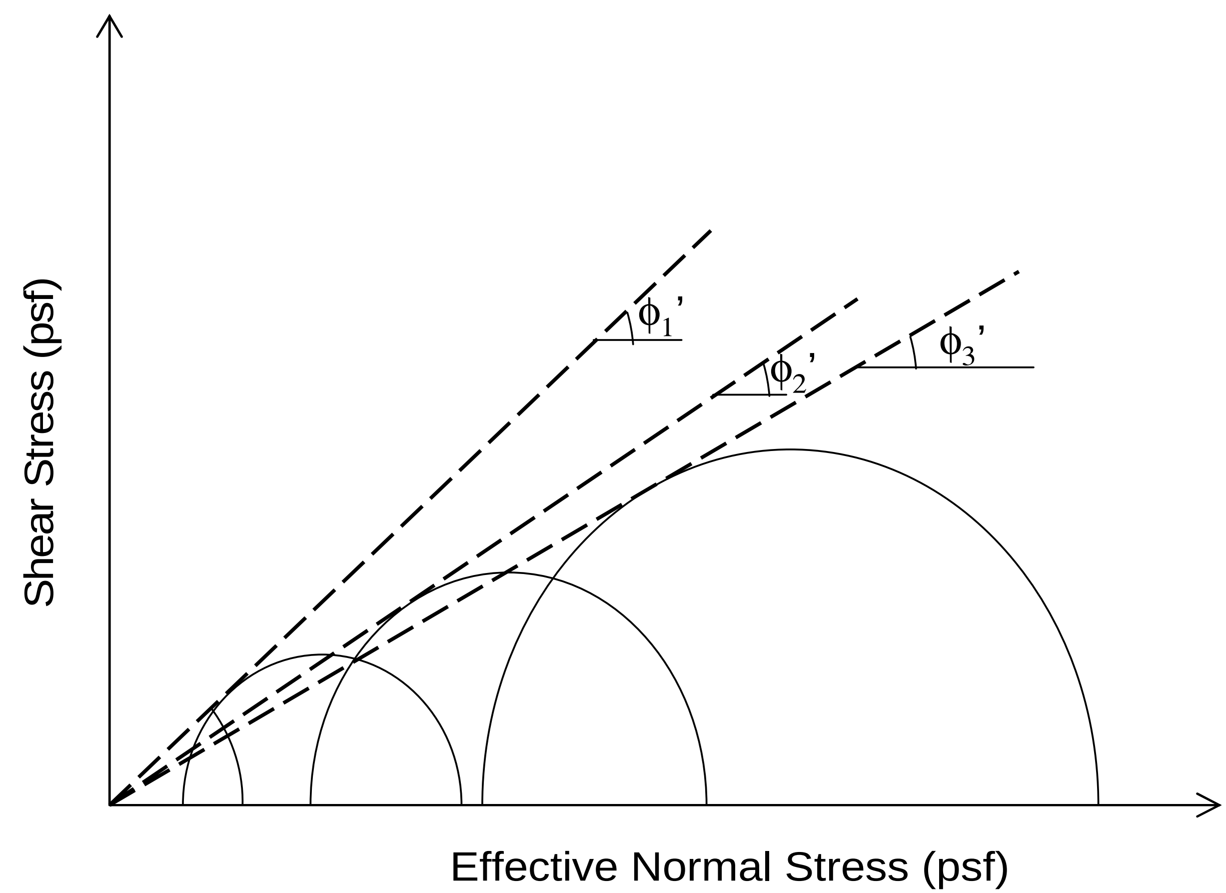


Figure 29. Obtaining effective stress friction angle using effective stress Mohr circles from CU tests

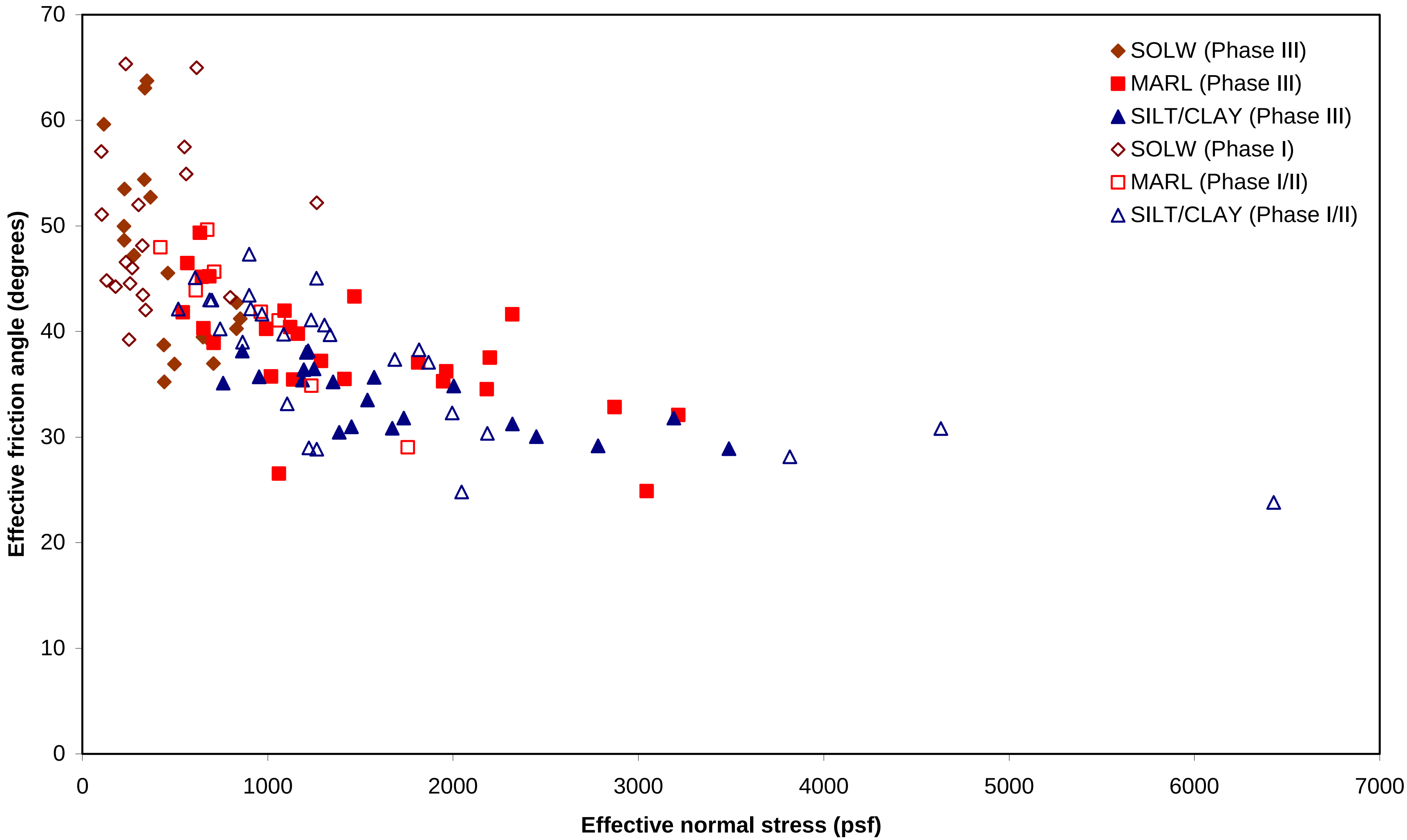


Figure 30. Effective stress friction angle versus effective normal stress for SOLW, Marl, and Silt and Clay

ATTACHMENT 1

Development of Subsurface Profiles in the ILWD area

Subsurface profiles were developed for the ILWD area and the Wastebed B (WB-B) and Harbor Brook (HB) areas using the geotechnical information interpreted from borings conducted during the site investigations. Table 1-1 summarizes the coordinates (i.e., northing and easting), the elevation of existing ground or lake bottom, and the elevations of the bottoms of subsurface layers at each boring location. A 3-D surface was created for each subsurface soil layer using the information provided in the table.

The procedure of creating the surfaces included the following steps (using the surface of bottom of Silt and Clay as an example):

- Step 1: divide the borings into two groups: one group included the relatively deep borings where the elevations of the bottom of Silt and Clay are known; the other group included the relatively shallow borings where the borings ended above the bottom of Silt and Clay and therefore, the elevations were unknown but were expected to be lower than or equal to the end of boring.
- Step 2: create the 3-D surface of bottom of Silt and Clay using the known elevations: a 3-D surface (i.e., Triangular Irregular Network (TIN) surface) was created using the Kriging method imbedded in the program Autodesk Land Desktop 2007. The input data were the known elevations of bottom of Silt and Clay and corresponding coordinates of the borings.
- Step 3: extract the elevations from the 3-D surface at locations where the elevations were originally unknown: The extracted elevations must meet two criteria: first, they can not be higher than the end of boring; second, they can not be higher than the bottom of the overlying layer, which is Marl for this example. If both of the criteria were satisfied, the extracted elevation was considered acceptable, although the true elevation was unknown at this location. However, if either of the two criteria was not satisfied, the extracted elevation was then manually adjusted to be 5 ft below the end of boring or the bottom of Marl, whichever was lower. The 5 ft was selected arbitrarily to provide an estimate of the elevation, since the true elevation is unknown.
- Step 4: re-create the 3-D surface in Step 2 using the known elevations and the adjusted elevations at locations where the elevations were originally unknown.
- Step 5: repeat Steps 1 to 4 for other subsurface layers.

The contours of the existing ground/lake bottom and the bottoms of seven subsurface layers (i.e., Fill (in land)/Silt (in lake), SOLW, Marl, Silt and Clay, Silt and Sand, Sand and Gravel, and Till) are shown in Figures 1-1 through 1-8. The surface of bottom of Shale was not created because of insufficient data. The limit of the 3-D surfaces is shown in Figure 1-1. 3-D surfaces for subsurface layers beyond this limit are currently not available and may be developed later, if needed. In addition, the contours of the surface of the end of boring were also created and are shown in Figure 1-9. The surface of the end of the borings was used to identify the areas where the created 3-D surfaces for subsurface layers were below the surface of the end of boring, which are shown in Figures 1-3 through 1-8 as the shaded areas.

It is noted that: (i) the Kriging method used the known elevations from boring logs to interpolate or extrapolate the surface elevations between or outside the boring locations; and (ii) because of the uncertainty associated with the shallow borings, Step 3 in the above-mentioned procedure only provides an estimated elevation. As a result, surfaces that are below the end of boring may not represent the true in-situ stratigraphy.

Based on the created 3-D surfaces, subsurface profiles of eight selected cross sections in the ILWD area were developed and are shown in Figures 3 through 10 in the main text of this package. It is recommended that engineering judgment be applied in the ILWD stability analysis if the most critical slip surface goes below the line of the end of boring shown in these cross sections.

Written by: Ming Zhu Date: 06/18/2008 Reviewed by: Raja Madhyannapu Date: 06/19/2008

Client: Honeywell Project: Onondaga Lake ILWD Stability Project/ Proposal No.: GJ4204 Task No.: 01

Table 1-1. Summary of subsurface layer elevations from boring logs

Boring ID	Northing	Easting	Mudline Elevation (ft)	Bottom of Silt Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Silt (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
PHASE I																					
OL-STA-10001-VC	1118517.76	923452.28	336.22	326.22	<323.02	<323.02	<323.02	<323.02	<323.02	<323.02	<323.02	323.02	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10002-VC	1118311.97	924291.63	353.54	353.54	<340.34	<340.34	<340.34	<340.34	<340.34	<340.34	<340.34	340.34	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10003-VC	1118153.61	924907.56	351.23	351.23	<338.03	<338.03	<338.03	<338.03	<338.03	<338.03	<338.03	338.03	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10004-VC	1118356.41	924950.90	340.87	340.87	<327.67	<327.67	<327.67	<327.67	<327.67	<327.67	<327.67	327.67	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10005-VC	1117898.15	925576.04	352.85	352.85	<339.65	<339.65	<339.65	<339.65	<339.65	<339.65	<339.65	339.65	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10006-VC	1118267.11	925796.04	336.89	324.39	<323.69	<323.69	<323.69	<323.69	<323.69	<323.69	<323.69	323.69	12.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10007-VC	1117646.82	926138.49	349.12	349.12	<335.92	<335.92	<335.92	<335.92	<335.92	<335.92	<335.92	335.92	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10008-VC	1118082.96	923319.57	349.76	349.76	<330.36	<330.36	<330.36	<330.36	<330.36	<330.36	<330.36	330.36	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.4
OL-STA-10009-VC	1117950.72	924174.44	361.40	361.40	<342.7	<342.7	<342.7	<342.7	<342.7	<342.7	<342.7	342.70	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.7
OL-STA-10010-VC	1117686.08	924773.69	359.70	359.70	<340.2	<340.2	<340.2	<340.2	<340.2	<340.2	<340.2	340.20	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.5
OL-STA-10011-VC	1117369.90	925301.95	359.41	359.41	<340.11	<340.11	<340.11	<340.11	<340.11	<340.11	<340.11	340.11	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.3
OL-STA-10012-VC	1116800.55	925924.34	359.24	359.24	342.74	<339.54	<339.54	<339.54	<339.54	<339.54	<339.54	339.54	0	16.5	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-STA-10013-SB	1118375.53	923900.19	349.52	349.52	315.02	312.52	<304.52	<304.52	<304.52	<304.52	<304.52	304.52	0	34.5	37	N/A	N/A	N/A	N/A	N/A	45
OL-STA-10013-VC	1118383.60	923909.42	349.19	349.19	<335.99	<335.99	<335.99	<335.99	<335.99	<335.99	<335.99	335.99	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10014-SB	1118398.91	924596.38	336.85	336.85	295.35	290.85	<282.85	<282.85	<282.85	<282.85	<282.85	282.85	0	41.5	46	N/A	N/A	N/A	N/A	N/A	54
OL-STA-10014-VC	1118398.61	924609.04	337.62	337.62	<324.42	<324.42	<324.42	<324.42	<324.42	<324.42	<324.42	324.42	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10015-SB	1118228.76	925464.84	337.90	329.90	311.90	311.90	<295.4	<295.4	<295.4	<295.4	<295.4	295.40	8	26	26	N/A	N/A	N/A	N/A	N/A	42.5
OL-STA-10015-VC	1118225.72	925443.60	340.11	335.11	<326.91	<326.91	<326.91	<326.91	<326.91	<326.91	<326.91	326.91	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10016-SB	1117874.32	925905.77	344.22	342.22	314.22	314.22	<303.22	<303.22	<303.22	<303.22	<303.22	303.22	2	30	30	N/A	N/A	N/A	N/A	N/A	41
OL-STA-10016-VC	1117871.97	925898.56	346.58	337.58	<333.38	<333.38	<333.38	<333.38	<333.38	<333.38	<333.38	333.38	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13.2
OL-STA-10017-SB	1118233.61	926113.93	335.91	323.91	314.91	314.91	<299.91	<299.91	<299.91	<299.91	<299.91	299.91	12	21	21	N/A	N/A	N/A	N/A	N/A	36
OL-STA-10017-VC	1118245.60	926104.00	336.78	330.28	<324.18	<324.18	<324.18	<324.18	<324.18	<324.18	<324.18	324.18	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.6
OL-STA-10018-SB	1117844.21	923783.99	359.30	359.30	327.80	318.30	<303.3	<303.3	<303.3	<303.3	<303.3	303.30	0	31.5	41	N/A	N/A	N/A	N/A	N/A	56
OL-STA-10018-VC	1117842.07	923779.99	360.82	360.82	<341.62	<341.62	<341.62	<341.62	<341.62	<341.62	<341.62	341.62	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.2
OL-STA-10019-SB	1118111.61	923847.96	360.16	360.16	324.66	312.66	<294.66	<294.66	<294.66	<294.66	<294.66	294.66	0	35.5	47.5	N/A	N/A	N/A	N/A	N/A	65.5
OL-STA-10019-VC	1118120.13	923856.72	360.58	360.58	<341.48	<341.48	<341.48	<341.48	<341.48	<341.48	<341.48	341.48	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.1
OL-STA-10020-SB	1117703.29	924383.28	358.44	355.44	318.44	308.44	<292.44	<292.44	<292.44	<292.44	<292.44	292.44	3	40	50	N/A	N/A	N/A	N/A	N/A	66
OL-STA-10020-VC	1117726.18	924394.20	359.89	355.89	<340.09	<340.09	<340.09	<340.09	<340.09	<340.09	<340.09	340.09	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-STA-10021-SB	1117948.41	924469.86	355.65	355.15	314.65	305.65	<282.15	<282.15	<282.15	<282.15	<282.15	282.15	0.5	41	50	N/A	N/A	N/A	N/A	N/A	73.5
OL-STA-10021-VC	1117945.12	924467.87	356.41	356.41	<337.11	<337.11	<337.11	<337.11	<337.11	<337.11	<337.11	337.11	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.3
OL-STA-10022-SB	1118138.66	924560.00	351.72	351.22	306.22	306.22	<281.72	<281.72	<281.72	<281.72	<281.72	281.72	0.5	45.5	45.5	N/A	N/A	N/A	N/A	N/A	70
OL-STA-10022-VC	1118152.34	924536.07	352.49	352.49	<332.79	<332.79	<332.79	<332.79	<332.79	<332.79	<332.79	332.79	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-STA-10023-SB	1117456.65	925020.02	359.62	359.62	317.62	317.62	<303.62	<303.62	<303.62	<303.62	<303.62	303.62	0	42	42	N/A	N/A	N/A	N/A	N/A	56
OL-STA-10023-VC	1117452.38	925019.68	359.78	359.78	<340.08	<340.08	<340.08	<340.08	<340.08	<340.08	<340.08	340.08	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-STA-10024-SB	1117848.61	925237.17	356.19	356.19	296.19	296.19	<288.19	<288.19	<288.19	<288.19	<288.19	288.19	0	60	60	N/A	N/A	N/A	N/A	N/A	68
OL-STA-10024-VC	1117861.90	925237.66	355.70	355.70	<335.9	<335.9	<335.9	<335.9	<335.9	<335.9	<335.9	335.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-STA-10025-SB	1117210.54	925484.56	358.33	358.33	315.33	315.33	<286.33	<286.33	<286.33	<286.33	<286.33	286.33	0	43	43	N/A	N/A	N/A	N/A	N/A	72
OL-STA-10025-VC	1117211.28	925488.14	359.05	359.05	<340.55	<340.55	<340.55	<340.55	<340.55	<340.55	<340.55	340.55	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.5
OL-STA-10026-SB	1117575.40	925701.69	354.85	354.85	307.85	307.85	<296.85	<296.85	<296.85	<296.85	<296.85	296.85	0	47	47	N/A	N/A	N/A	N/A	N/A	58
OL-STA-10026-VC	1117571.58	925702.21	355.08	355.08	<335.38	<335.38	<335.38	<335.38	<335.38	<335.38	<335.38	335.38	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.7

Note: Depths are measured from mudline elevation (NAVD 88).

Geosyntec consultants

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Boring ID	Northing	Easting	Mudline Elevation (ft)	Bottom of Silt Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Silt (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
PHASE II																					
OL-VC-10034	1118059.79	923085.68	347.90	347.90	329.90	<328.2	<328.2	<328.2	<328.2	<328.2	<328.2	328.20	0	18	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-VC-10035	1118249.10	923155.90	347.00	347.00	327.50	<327.2	<327.2	<327.2	<327.2	<327.2	<327.2	327.20	0	19.5	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10036	1118201.60	923262.90	347.40	347.40	327.90	<327.6	<327.6	<327.6	<327.6	<327.6	<327.6	327.60	0	19.5	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10036A	1118202.50	923260.40	347.40	347.40	327.90	<327.6	<327.6	<327.6	<327.6	<327.6	<327.6	327.60	0	19.5	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10037	1118398.60	923321.20	344.30	338.80	326.30	<324.5	<324.5	<324.5	<324.5	<324.5	<324.5	324.50	5.5	18	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10038	1117947.64	923415.06	361.90	361.90	<343	<343	<343	<343	<343	<343	<343	343.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.9
OL-VC-10039	1118088.40	923575.40	351.00	351.00	<333	<333	<333	<333	<333	<333	<333	333.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18
OL-VC-10040	1118351.90	923587.30	349.70	347.70	<329.9	<329.9	<329.9	<329.9	<329.9	<329.9	<329.9	329.90	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10041	1117900.70	923642.10	361.30	361.30	<341.6	<341.6	<341.6	<341.6	<341.6	<341.6	<341.6	341.60	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-VC-10041A	1117900.00	923643.90	361.30	361.30	<341.5	<341.5	<341.5	<341.5	<341.5	<341.5	<341.5	341.50	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10042	1118505.00	923697.10	338.70	338.70	<318.9	<318.9	<318.9	<318.9	<318.9	<318.9	<318.9	318.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10042A	1118507.20	923698.10	338.20	335.20	<318.4	<318.4	<318.4	<318.4	<318.4	<318.4	<318.4	318.40	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10043	1118496.60	923946.70	338.60	338.60	<318.8	<318.8	<318.8	<318.8	<318.8	<318.8	<318.8	318.80	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10044	1118365.50	923964.80	349.80	349.80	<330.8	<330.8	<330.8	<330.8	<330.8	<330.8	<330.8	330.80	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19
OL-VC-10046	1118047.30	924008.60	359.60	359.60	<340.4	<340.4	<340.4	<340.4	<340.4	<340.4	<340.4	340.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.2
OL-VC-10046A	1118045.00	924010.70	360.00	360.00	<341.9	<341.9	<341.9	<341.9	<341.9	<341.9	<341.9	341.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.1
OL-VC-10047	1118465.20	924146.40	339.70	339.70	<319.9	<319.9	<319.9	<319.9	<319.9	<319.9	<319.9	319.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10048	1118168.80	924158.40	360.00	360.00	<340.3	<340.3	<340.3	<340.3	<340.3	<340.3	<340.3	340.30	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-VC-10048A	1118168.30	924160.50	360.00	360.00	<342.1	<342.1	<342.1	<342.1	<342.1	<342.1	<342.1	342.10	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.9
OL-VC-10049	1117989.70	924167.40	360.70	360.70	<340.9	<340.9	<340.9	<340.9	<340.9	<340.9	<340.9	340.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10049A	1117991.00	924167.80	360.70	360.70	<340.9	<340.9	<340.9	<340.9	<340.9	<340.9	<340.9	340.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10050	1117816.40	925985.10	346.60	343.60	<327.2	<327.2	<327.2	<327.2	<327.2	<327.2	<327.2	327.20	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.4
OL-VC-10051	1117854.70	926006.90	346.20	339.70	<326.4	<326.4	<326.4	<326.4	<326.4	<326.4	<326.4	326.40	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10052	1117852.60	925963.80	346.60	341.60	<326.8	<326.8	<326.8	<326.8	<326.8	<326.8	<326.8	326.80	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10053	1117722.00	924313.00	361.00	361.00	<341.8	<341.8	<341.8	<341.8	<341.8	<341.8	<341.8	341.80	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.2
OL-VC-10053A	1117723.80	924313.30	361.00	361.00	<341.2	<341.2	<341.2	<341.2	<341.2	<341.2	<341.2	341.20	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10054	1117823.80	924273.20	361.20	361.20	<342.4	<342.4	<342.4	<342.4	<342.4	<342.4	<342.4	342.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.8
OL-VC-10055	1118435.40	924347.90	341.40	341.40	<322.5	<322.5	<322.5	<322.5	<322.5	<322.5	<322.5	322.50	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.9
OL-VC-10056	1118096.50	924315.80	359.60	359.60	<340.4	<340.4	<340.4	<340.4	<340.4	<340.4	<340.4	340.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.2
OL-VC-10057	1118236.30	924432.40	353.90	353.90	<334.4	<334.4	<334.4	<334.4	<334.4	<334.4	<334.4	334.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.5
OL-VC-10057A	1118237.80	924433.90	353.90	353.90	<334.2	<334.2	<334.2	<334.2	<334.2	<334.2	<334.2	334.20	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-VC-10058	1117838.00	924442.80	358.30	358.30	<338.5	<338.5	<338.5	<338.5	<338.5	<338.5	<338.5	338.50	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10058A	1117839.50	924444.60	358.30	356.30	<340.9	<340.9	<340.9	<340.9	<340.9	<340.9	<340.9	340.90	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.4
OL-VC-10059	1117726.60	924590.40	359.80	359.80	<340.5	<340.5	<340.5	<340.5	<340.5	<340.5	<340.5	340.50	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.3
OL-VC-10060	1117861.40	924676.30	359.90	358.90	<341.9	<341.9	<341.9	<341.9	<341.9	<341.9	<341.9	341.90	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18
OL-VC-10061	1118238.80	924717.30	350.70	350.70	<331	<331	<331	<331	<331	<331	<331	331.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-VC-10062	1117993.70	924727.10	358.00	358.00	<338.8	<338.8	<338.8	<338.8	<338.8	<338.8	<338.8	338.80	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.2
OL-VC-10062A	1117996.10	924727.20	358.10	358.10	<339.1	<339.1	<339.1	<339.1	<339.1	<339.1	<339.1	339.10	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19
OL-VC-10063	1118434.80	924795.40	338.00	338.00	<318.2	<318.2	<318.2	<318.2	<318.2	<318.2	<318.2	318.20	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10063A	1118435.40	924793.40	338.00	338.00	<320.5	<320.5	<320.5	<320.5	<320.5	<320.5	<320.5	320.50	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.5
OL-VC-10064	1117684.30	924771.70	359.80	359.80	<340	<340	<340	<340	<340	<340	<340	340.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10064A	1117684.70	924774.20	359.80	359.80	<340	<340	<340	<340	<340	<340	<340	340.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10065	1117697.10	924792.20	360.40	360.40	<340.6	<340.6	<340.6	<340.6	<340.6	<340.6	<340.6	340.60	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10066	1117659.00	924773.40	360.80	360.80	<341	<341	<341	<341	<341	<341	<341	341.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10067	1117697.50	924750.20	360.90	360.90	<341.8	<341.8	<341.8	<341.8	<341.8	<341.8	<341.8	341.80	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.1
OL-VC-10068	1117921.70	924860.70	356.90	356.90	<337.3	<337.3	<337.3	<337.3	<337.3	<337.3	<337.3	337.30	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.6
OL-VC-10069	1117812.20	924950.90	357.70	353.70	<337.9	<337.9	<337.9	<337.9	<337.9	<337.9	<337.9	337.90	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10070	1117455.20	924919.90	360.30	360.30	<341.2	<341.2	<341.2	<341.2	<341.2	<341.2	<341.2	341.20	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.1
OL-VC-10070A	1117457.00	924918.50	360.30	360.30	<341.1	<341.1	<341.1	<341.1	<341.1	<341.1	<341.1	341.10	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.2

Note: Depths are measured from mudline elevation (NAVD 88).

Geosyntec consultants

Written by: Ming Zhu Date: 06/18/2008 Reviewed by: Raja Madhyannapu Date: 06/19/2008

Client: Honeywell Project: Onondaga Lake ILWD Stability Project/ Proposal No.: GJ4204 Task No.: 01

Boring ID	Northing	Easting	Mudline Elevation (ft)	Bottom of Silt Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Silt (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
OL-VC-10071	1118398.90	925183.70	335.20	332.20	<315.4	<315.4	<315.4	<315.4	<315.4	<315.4	<315.4	315.40	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10072	1118217.60	925154.10	344.10	344.10	<324.3	<324.3	<324.3	<324.3	<324.3	<324.3	<324.3	324.30	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10073	1118025.10	925124.40	353.20	353.20	<333.4	<333.4	<333.4	<333.4	<333.4	<333.4	<333.4	333.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10073A	1118024.80	925112.80	353.20	353.20	<333.4	<333.4	<333.4	<333.4	<333.4	<333.4	<333.4	333.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10074	1117740.60	925137.10	356.90	356.90	<337.1	<337.1	<337.1	<337.1	<337.1	<337.1	<337.1	337.10	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10075	1117274.00	925124.10	360.30	360.30	<341.4	<341.4	<341.4	<341.4	<341.4	<341.4	<341.4	341.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.9
OL-VC-10076	1117526.40	925240.30	357.80	357.80	<338	<338	<338	<338	<338	<338	<338	338.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10077	1118080.00	925345.50	349.50	349.50	<331.6	<331.6	<331.6	<331.6	<331.6	<331.6	<331.6	331.60	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.9
OL-VC-10078	1117846.00	925415.90	354.20	351.20	<334.4	<334.4	<334.4	<334.4	<334.4	<334.4	<334.4	334.40	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10078A	1117845.20	925416.60	354.30	353.30	<334.5	<334.5	<334.5	<334.5	<334.5	<334.5	<334.5	334.50	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10079	1117654.20	925420.70	355.90	355.90	<337	<337	<337	<337	<337	<337	<337	337.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.9
OL-VC-10080	1116980.60	925396.30	360.60	360.60	<341.3	<341.3	<341.3	<341.3	<341.3	<341.3	<341.3	341.30	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.3
OL-VC-10080A	1116982.20	925394.20	360.60	354.60	<341.3	<341.3	<341.3	<341.3	<341.3	<341.3	<341.3	341.30	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.3
OL-VC-10081	1117441.00	925496.00	357.60	357.60	<337.8	<337.8	<337.8	<337.8	<337.8	<337.8	<337.8	337.80	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10081A	1117443.50	925496.80	357.70	357.70	<338.1	<338.1	<338.1	<338.1	<338.1	<338.1	<338.1	338.10	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.6
OL-VC-10082	1118354.30	925614.90	333.60	326.60	<313.8	<313.8	<313.8	<313.8	<313.8	<313.8	<313.8	313.80	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10083	1118077.40	925633.80	344.10	344.10	<324.3	<324.3	<324.3	<324.3	<324.3	<324.3	<324.3	324.30	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10083A	1118076.40	925631.90	344.10	342.10	<324.3	<324.3	<324.3	<324.3	<324.3	<324.3	<324.3	324.30	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10084	1117489.50	925660.70	355.40	355.40	<335.6	<335.6	<335.6	<335.6	<335.6	<335.6	<335.6	335.60	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10085	1117135.00	925641.90	358.50	358.50	<338.7	<338.7	<338.7	<338.7	<338.7	<338.7	<338.7	338.70	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10086	1116945.80	925660.60	359.40	359.40	<341.4	<341.4	<341.4	<341.4	<341.4	<341.4	<341.4	341.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18
OL-VC-10086A	1116944.40	925659.40	359.40	359.40	<340.6	<340.6	<340.6	<340.6	<340.6	<340.6	<340.6	340.60	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.8
OL-VC-10087	1116769.10	925592.60	360.40	360.40	<341.4	<341.4	<341.4	<341.4	<341.4	<341.4	<341.4	341.40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19
OL-VC-10088	1117764.50	925722.10	353.10	353.10	<333.3	<333.3	<333.3	<333.3	<333.3	<333.3	<333.3	333.30	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10089	1117288.40	925742.90	356.60	356.60	<336.9	<336.9	<336.9	<336.9	<336.9	<336.9	<336.9	336.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.7
OL-VC-10090	1118132.30	925905.20	338.80	332.30	<319	<319	<319	<319	<319	<319	<319	319.00	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10091	1117683.10	925945.20	352.90	352.90	<333.3	<333.3	<333.3	<333.3	<333.3	<333.3	<333.3	333.30	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.6
OL-VC-10092	1117470.80	925874.70	354.60	354.60	<335.6	<335.6	<335.6	<335.6	<335.6	<335.6	<335.6	335.60	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19
OL-VC-10093	1116983.50	925873.50	358.50	358.50	<338.7	<338.7	<338.7	<338.7	<338.7	<338.7	<338.7	338.70	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10094	1116632.30	925868.40	360.40	360.40	<340.6	<340.6	<340.6	<340.6	<340.6	<340.6	<340.6	340.60	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10095	1118333.90	925972.70	334.10	325.10	317.60	317.60	<314.5	<314.5	<314.5	<314.5	<314.5	314.50	9	16.5	16.5	N/A	N/A	N/A	N/A	N/A	19.6
OL-VC-10095A	1118335.50	925974.70	334.10	325.60	321.10	321.10	<315	<315	<315	<315	<315	315.00	8.5	13	13	N/A	N/A	N/A	N/A	N/A	19.1
OL-VC-10096	1117842.40	925984.70	347.00	344.00	<327.2	<327.2	<327.2	<327.2	<327.2	<327.2	<327.2	327.20	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10096A	1117840.70	925983.80	347.00	344.00	<329.6	<329.6	<329.6	<329.6	<329.6	<329.6	<329.6	329.60	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.4
OL-VC-10097	1117273.40	926020.40	355.20	355.20	<336.8	<336.8	<336.8	<336.8	<336.8	<336.8	<336.8	336.80	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.4
OL-VC-10097A	1117275.10	926019.50	355.20	355.20	<336.7	<336.7	<336.7	<336.7	<336.7	<336.7	<336.7	336.70	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18.5
OL-VC-10098	1117287.00	926041.70	354.90	354.90	<335.1	<335.1	<335.1	<335.1	<335.1	<335.1	<335.1	335.10	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10099	1117250.50	926020.20	355.30	355.30	<335.5	<335.5	<335.5	<335.5	<335.5	<335.5	<335.5	335.50	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10100	1117287.30	925996.80	355.10	355.10	<336	<336	<336	<336	<336	<336	<336	336.00	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	19.1
OL-VC-10101	1117979.00	926082.60	341.40	335.90	325.90	325.90	<321.6	<321.6	<321.6	<321.6	<321.6	321.60	5.5	15.5	15.5	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10102	1117485.00	926067.60	353.90	353.90	<336.7	<336.7	<336.7	<336.7	<336.7	<336.7	<336.7	336.70	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	17.2
OL-VC-10103	1117084.30	926131.80	354.90	354.90	<336.9	<336.9	<336.9	<336.9	<336.9	<336.9	<336.9	336.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18
OL-VC-10103A	1117084.40	926133.50	354.90	354.90	<336.9	<336.9	<336.9	<336.9	<336.9	<336.9	<336.9	336.90	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18
OL-VC-10104	1116687.10	926107.60	359.10	359.10	346.10	346.10	<339.3	<339.3	<339.3	<339.3	<339.3	339.30	0	13	13	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10104A	1116685.60	926107.10	359.10	359.10	347.60	347.60	<340.9	<340.9	<340.9	<340.9	<340.9	340.90	0	11.5	11.5	N/A	N/A	N/A	N/A	N/A	18.2
OL-VC-10105	1116859.40	926187.20	356.80	356.80	338.80	338.80	<337	<337	<337	<337	<337	337.00	0	18	18	N/A	N/A	N/A	N/A	N/A	19.8
OL-VC-10106	1116498.40	926169.90	359.80	357.80	354.80	354.80	<342.3	<342.3	<342.3	<342.3	<342.3	342.30	2	5	5	N/A	N/A	N/A	N/A	N/A	17.5
OL-VC-10107	1116313.70	926342.70	360.70	360.70	360.70	360.70	<343.2	<343.2	<343.2	<343.2	<343.2	343.20	0	0	0	N/A	N/A	N/A	N/A	N/A	17.5
OL-STA-10108	1118335.70	924813.40	342.81	342.81	295.81	280.81	218.31	202.81	194.31	173.81	<163.81	163.81	0	47	62	124.5	140	148.5	169	N/A	179

Note: Depths are measured from mudline elevation (NAVD 88).

Written by: Ming Zhu Date: 06/18/2008 Reviewed by: Raja Madhyannapu Date: 06/19/2008

Client: Honeywell Project: Onondaga Lake ILWD Stability Project/ Proposal No.: GJ4204 Task No.: 01

Boring ID	Northing	Easting	Mudline Elevation (ft)	Bottom of Silt Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Silt (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
2007 DNAPL Addendum (Mudline elevations in pink not presented in boroing logs; estimated from the boring plan)																					
OL-SB-10115	1118004.96	923135.01	347.24	347.24	336.54	324.94	<321.24	<321.24	<321.24	<321.24	<321.24	321.24	0	10.7	22.3	N/A	N/A	N/A	N/A	N/A	26
OL-SB-10116	1117858.77	923362.77	362.41	362.41	348.41	330.41	<328.41	<328.41	<328.41	<328.41	<328.41	328.41	0	14	32	N/A	N/A	N/A	N/A	N/A	34
OL-SB-10117	1117851.31	923409.20	362.44	362.44	<344.44	<344.44	<344.44	<344.44	<344.44	<344.44	<344.44	344.44	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18
OL-SB-10117A	1117868.78	923403.94	361.91	Incomplete boring logs									Incomplete boring logs								
OL-SB-10117B	1117852.93	923384.42	362.4																		
OL-SB-10118	1117843.24	923476.58	362.26	362.26	348.26	<334.26	<334.26	<334.26	<334.26	<334.26	<334.26	334.26	0	14	N/A	N/A	N/A	N/A	N/A	N/A	28
OL-SB-10119	1117847.79	923504.34	361.99	361.99	341.99	<331.99	<331.99	<331.99	<331.99	<331.99	<331.99	331.99	0	20	N/A	N/A	N/A	N/A	N/A	N/A	30
OL-SB-10120	1117818.00	923573.00	362.32	362.32	342.32	328.32	<326.32	<326.32	<326.32	<326.32	<326.32	326.32	0	20	34	N/A	N/A	N/A	N/A	N/A	36
OL-SB-10121	1117794.13	923614.32	362.58	362.58	344.08	328.58	<320.58	<320.58	<320.58	<320.58	<320.58	320.58	0	18.5	34	N/A	N/A	N/A	N/A	N/A	42
OL-SB-10122	1117840.64	923574.97	361.97	361.97	342.97	<333.97	<333.97	<333.97	<333.97	<333.97	<333.97	333.97	0	19	N/A	N/A	N/A	N/A	N/A	N/A	28
OL-SB-10123	1117890.13	923515.16	361.06	361.06	331.56	321.06	<319.06	<319.06	<319.06	<319.06	<319.06	319.06	0	29.5	40	N/A	N/A	N/A	N/A	N/A	42
OL-SB-10124	1117850.92	923591.26	361.69	361.69	332.49	321.69	<319.69	<319.69	<319.69	<319.69	<319.69	319.69	0	29.2	40	N/A	N/A	N/A	N/A	N/A	42
OL-SB-10125	1117864.09	923592.56	361.45	361.45	331.45	323.15	<321.45	<321.45	<321.45	<321.45	<321.45	321.45	0	30	38.3	N/A	N/A	N/A	N/A	N/A	40
OL-SB-10126	1117884.17	923386.19	361.52	361.52	338.02	<335.52	<335.52	<335.52	<335.52	<335.52	<335.52	335.52	0	23.5	N/A	N/A	N/A	N/A	N/A	N/A	26
OL-SB-10127	1117868.23	923510.67	361.49	361.49	332.79	323.79	<321.49	<321.49	<321.49	<321.49	<321.49	321.49	0	28.7	37.7	N/A	N/A	N/A	N/A	N/A	40
OL-SB-10128	1117832.55	923602.76	361.99	361.99	338.09	327.29	<323.99	<323.99	<323.99	<323.99	<323.99	323.99	0	23.9	34.7	N/A	N/A	N/A	N/A	N/A	38
Phase III SMU 1 and 8																					
OL-SB-10129	1117999.55	923826.20	360.95	360.95	327.95	309.45	<293.95	<293.95	<293.95	<293.95	<293.95	293.95	0	33	51.5	N/A	N/A	N/A	N/A	N/A	67
OL-SB-10130	1118242.42	923877.19	360.1	360.10	322.10	302.60	<289.1	<289.1	<289.1	<289.1	<289.1	289.10	0	38	57.5	N/A	N/A	N/A	N/A	N/A	71
OL-SB-10131	1117817.76	924455.93	357.39	357.39	315.39	273.39	255.89	245.89	<243.89	<243.89	<243.89	243.89	0	42	84	101.5	111.5	N/A	N/A	N/A	113.5
OL-SB-10132	1118276.19	924561.43	345.24	343.24	303.74	294.24	<269.24	<269.24	<269.24	<269.24	<269.24	269.24	2	41.5	51	N/A	N/A	N/A	N/A	N/A	76
OL-SB-10133	1117318.06	925001.70	362.49	362.49	322.99	311.49	<291.99	<291.99	<291.99	<291.99	<291.99	291.99	0	39.5	51	N/A	N/A	N/A	N/A	N/A	70.5
OL-SB-10134	1117635.90	925164.52	359.29	359.29	309.29	<278.29	<278.29	<278.29	<278.29	<278.29	<278.29	278.29	0	50	N/A	N/A	N/A	N/A	N/A	N/A	81
OL-SB-10135	1118032.66	925359.40	353.57	353.57	306.57	<275.07	<275.07	<275.07	<275.07	<275.07	<275.07	275.07	0	47	N/A	N/A	N/A	N/A	N/A	N/A	78.5
OL-SB-80052	1118745.12	923974.90	323.85	322.25	297.85	248.85	215.85	213.85	204.45	204.45	<203.85	203.85	1.6	26	75	108	110	119.4	119.4	N/A	120
OL-SB-80053	1118753.14	924685.38	322.03	318.03	290.03	237.53	172.03	165.03	165.03	165.03	<164.03	164.03	4	32	84.5	150	157	157	157	N/A	158
OL-SB-80054	1118437.57	925589.90	330.44	326.94	304.44	250.94	173.44	117.44	112.74	112.74	<112.44	112.44	3.5	26	79.5	157	213	217.7	217.7	N/A	218
2006 DNAPL (In the overlapping area of SMU 1 and SMU 2)																					
OL-VC-20024	1117946.41	923116.47	351.3	346.90	335.30	324.80	<317.3	<317.3	<317.3	<317.3	<317.3	317.30	4.4	16	26.5	N/A	N/A	N/A	N/A	N/A	34
OL-VC-20039	1117999.12	922986.03	356.4	352.10	332.40	322.40	<321.4	<321.4	<321.4	<321.4	<321.4	321.40	4.3	24	34	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20043	1118001.70	923003.90	350.5	339.80	328.30	321.30	<317.9	<317.9	<317.9	<317.9	<317.9	317.90	10.7	22.2	29.2	N/A	N/A	N/A	N/A	N/A	32.6
OL-VC-20044	1117950.40	923134.10	349.3	347.00	329.70	323.20	<314.3	<314.3	<314.3	<314.3	<314.3	314.30	2.3	19.6	26.1	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20045	1118013.70	923017.50	348.8	346.50	329.10	324.20	<313.8	<313.8	<313.8	<313.8	<313.8	313.80	2.3	19.7	24.6	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20046	1117914.10	923194.50	348.8	344.80	329.00	323.80	<314	<314	<314	<314	<314	314.00	4	19.8	25	N/A	N/A	N/A	N/A	N/A	34.8
OL-VC-20047	1118026.20	923030.30	348.3	344.10	327.00	320.00	<313.3	<313.3	<313.3	<313.3	<313.3	313.30	4.2	21.3	28.3	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20048	1117880.20	923290.40	356.8	351.80	344.10	332.20	<327.9	<327.9	<327.9	<327.9	<327.9	327.90	5	12.7	24.6	N/A	N/A	N/A	N/A	N/A	28.9
OL-VC-20049	1117931.70	923213.50	348.6	347.10	329.40	324.10	<313.6	<313.6	<313.6	<313.6	<313.6	313.60	1.5	19.2	24.5	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20050	1118038.50	923044.30	348	344.20	327.00	321.00	<313	<313	<313	<313	<313	313.00	3.8	21	27	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20052	1117989.90	923067.30	348.1	346.00	328.00	319.80	<313.1	<313.1	<313.1	<313.1	<313.1	313.10	2.1	20.1	28.3	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20054	1117943.40	923227.40	348.1	342.30	329.90	324.40	<313.1	<313.1	<313.1	<313.1	<313.1	313.10	5.8	18.2	23.7	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20055	1117906.80	923320.20	356.3	354.80	334.20	328.50	<324.3	<324.3	<324.3	<324.3	<324.3	324.30	1.5	22.1	27.8	N/A	N/A	N/A	N/A	N/A	32
OL-STA-20056	1117902.85	923425.95		This boring seems to be a continuation to OL-VC-20056 based on coordiantes; Soil profile here is combined into OL-VC-200056																	
OL-VC-20056	1117905.90	923418.40	361.5	360.00	326.50	322.50	<316.5	<316.5	<316.5	<316.5	<316.5	316.50	1.5	35	39	N/A	N/A	N/A	N/A	N/A	45
OL-VC-20060	1117970.30	923256.90	347.8	345.50	326.80	320.80	<312.8	<312.8	<312.8	<312.8	<312.8	312.80	2.3	21	27	N/A	N/A	N/A	N/A	N/A	35
OL-STA-20061				Boring log N/A									Boring log N/A								
OL-VC-20062	1117999.20	923286.50	348.9	345.90	324.10	316.90	<313.9	<313.9	<313.9	<313.9	<313.9	313.90	3	24.8	32	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20063	1117950.50	923312.30	350	346.30	326.30	320.00	<315	<315	<315	<315	<315	315.00	3.7	23.7	30	N/A	N/A	N/A	N/A	N/A	35
OL-VC-20064	1117985.30	923211.00	347.9	345.80	327.10	320.00	<316.7	<316.7	<316.7	<316.7	<316.7	316.70	2.1	20.8	27.9	N/A	N/A	N/A	N/A	N/A	31.2
OL-VC-20065	1117968.50	923322.80	351.2	349.50	325.30	318.80	<317.3	<317.3	<317.3	<317.3	<317.3	317.30	1.7	25.9	32.4	N/A	N/A	N/A	N/A	N/A	33.9

Note: Depths are measured from mudline elevation (NAVD 88).

Written by: Ming Zhu Date: 06/18/2008 Reviewed by: Raja Madhyannapu Date: 06/19/2008

Client: Honeywell Project: Onondaga Lake ILWD Stability Project/ Proposal No.: GJ4204 Task No.: 01

Boring ID	Northing	Easting	Ground Elevation (ft)	Bottom of Fill Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Fill (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
HB-SB-01	1117840.27	923237.44	368.14	357.14	351.94	326.34	<320.14	<320.14	<320.14	<320.14	<320.14	320.14	11	16.2	41.8	N/A	N/A	N/A	N/A	N/A	48
HB-SB-02	1117811.12	923383.93	368.48	360.98	354.48	334.68	<324.48	<324.48	<324.48	<324.48	<324.48	324.48	7.5	14	33.8	N/A	N/A	N/A	N/A	N/A	44
HB-SB-03	1117705.90	923488.10	369.7	362.70	355.70	340.20	<333.7	<333.7	<333.7	<333.7	<333.7	333.70	7	14	29.5	N/A	N/A	N/A	N/A	N/A	36
HB-SB-04	1117723.70	923772.70	368.5	364.50	352.50	330.50	317.50	304.90	304.90	298.50	<296.3	296.30	4	16	38	51	63.6	63.6	70	N/A	72.2
HB-SB-05	1117574.23	923914.63	370.04	364.54	356.04	342.54	<332.04	<332.04	<332.04	<332.04	<332.04	332.04	5.5	14	27.5	N/A	N/A	N/A	N/A	N/A	38
HB-SB-07	1117424.12	924360.13	369.17	364.17	349.17	328.67	<319.17	<319.17	<319.17	<319.17	<319.17	319.17	5	20	40.5	N/A	N/A	N/A	N/A	N/A	50
HB-SB-08	1117503.70	924603.38	366.14	361.14	321.14	311.64	<308.14	<308.14	<308.14	<308.14	<308.14	308.14	5	45	54.5	N/A	N/A	N/A	N/A	N/A	58
HB-SB-09	1117225.96	924481.57	376.47	369.47	353.77	342.97	<332.47	<332.47	<332.47	<332.47	<332.47	332.47	7	22.7	33.5	N/A	N/A	N/A	N/A	N/A	44
HB-SB-10	1117179.20	924921.40	363.7	357.70	328.20	321.70	311.90	288.20	260.20	253.70	<253.5	253.50	6	35.5	42	51.8	75.5	103.5	110	N/A	110.2
HB-SB-11	1116969.99	925013.38	365.49	364.49	349.49	327.49	<317.49	<317.49	<317.49	<317.49	<317.49	317.49	1	16	38	N/A	N/A	N/A	N/A	N/A	48
HB-SB-12	1116918.09	925157.85	363.51	363.51	333.51	317.51	<315.51	<315.51	<315.51	<315.51	<315.51	315.51	0	30	46	N/A	N/A	N/A	N/A	N/A	48
HB-SB-13	1116810.14	925264.09	364.94	364.94	332.94	318.94	<314.94	<314.94	<314.94	<314.94	<314.94	314.94	0	32	46	N/A	N/A	N/A	N/A	N/A	50
HB-SB-14	1116715.05	925479.87	365	363.00	331.10	<317	<317	<317	<317	<317	<317	317.00	2	33.9	N/A	N/A	N/A	N/A	N/A	N/A	48
HB-SB-15	1116604.07	925584.66	365.41	363.41	347.41	316.41	302.41	279.91	279.91	266.01	<265.71	265.71	2	18	49	63	85.5	85.5	99.4	N/A	99.7
HB-SB-16	1116450.95	925872.47	363.6	357.60	346.60	<317.6	<317.6	<317.6	<317.6	<317.6	<317.6	317.60	6	17	N/A	N/A	N/A	N/A	N/A	N/A	46
HB-SB-17	1116219.81	925761.67	364.88	363.18	354.88	<320.88	<320.88	<320.88	<320.88	<320.88	<320.88	320.88	1.7	10	N/A	N/A	N/A	N/A	N/A	N/A	44
HB-SB-18	1116307.90	926076.11	363.4	361.40	348.40	313.40	280.20	271.90	270.00	267.90	<265.4	265.40	2	15	50	83.2	91.5	93.4	95.5	N/A	98
HB-SB-19	1116127.48	925969.59	363.61	357.01	353.81	<317.61	<317.61	<317.61	<317.61	<317.61	<317.61	317.61	6.6	9.8	N/A	N/A	N/A	N/A	N/A	N/A	46
HB-SB-20	1115903.03	925902.66	368.12	351.12	351.12	334.37	<324.12	<324.12	<324.12	<324.12	<324.12	324.12	17	17	33.75	N/A	N/A	N/A	N/A	N/A	44
HB-SB-21	1115732.02	925758.87	373.38	363.38	356.88	331.38	300.38	284.58	284.58	282.68	<282.48	282.48	10	16.5	42	73	88.8	88.8	90.7	N/A	90.9
HB-SB-22	1115416.91	925636.34	374.83	370.03	359.73	339.03	<328.83	<328.83	<328.83	<328.83	<328.83	328.83	4.8	15.1	35.8	N/A	N/A	N/A	N/A	N/A	46
HB-SB-23	1115297.76	925536.59	370.03	361.23	361.23	342.03	<334.03	<334.03	<334.03	<334.03	<334.03	334.03	8.8	8.8	28	N/A	N/A	N/A	N/A	N/A	36
HB-SB-24	1115210.68	925502.23	371.03	360.53	360.53	347.63	335.03	335.03	335.03	331.53	<331.23	331.23	10.5	10.5	23.4	36	36	36	39.5	N/A	39.8
HB-SB-25	1116106.10	926261.77	363.78	357.08	357.08	310.28	<299.78	<299.78	<299.78	<299.78	<299.78	299.78	6.7	6.7	53.5	N/A	N/A	N/A	N/A	N/A	64
HB-SB-26	1116103.01	926781.14	363.64	355.94	355.94	312.44	<301.64	<301.64	<301.64	<301.64	<301.64	301.64	7.7	7.7	51.2	N/A	N/A	N/A	N/A	N/A	62
HB-SB-27	1115906.21	926677.66	363.42	353.92	353.92	<299.42	<299.42	<299.42	<299.42	<299.42	<299.42	299.42	9.5	9.5	N/A	N/A	N/A	N/A	N/A	N/A	64
HB-SB-28	1116276.11	927258.43	365.29	347.09	347.09	<303.29	<303.29	<303.29	<303.29	<303.29	<303.29	303.29	18.2	18.2	N/A	N/A	N/A	N/A	N/A	N/A	62
HB-SB-30	1115961.00	925528.80	379.19	377.19	356.19	339.19	<337.188	<337.188	<337.188	<337.188	<337.188	337.19	2	23	40	N/A	N/A	N/A	N/A	N/A	42
HB-SB-32	1116524.40	925378.40	380.07	378.07	348.67	326.07	300.07	269.57	<264.268	<264.268	<264.268	264.27	2	31.4	54	80	110.5	N/A	N/A	N/A	115.8
HB-SB-32A	1115751.05	925209.52	389.54	375.54	359.54	337.54	310.54	310.54	310.54	<305.54	<305.54	305.54	14	30	52	79	79	79	N/A	N/A	84
HB-SB-33	1116781.30	925128.50	379.98	377.98	346.28	<325.984	<325.984	<325.984	<325.984	<325.984	<325.984	325.98	2	33.7	N/A	N/A	N/A	N/A	N/A	N/A	54
HB-SB-35	1116667.00	924526.50	380.10	378.10	356.10	343.60	343.60	<340.097	<340.097	<340.097	<340.097	340.10	2	24	36.5	36.5	N/A	N/A	N/A	N/A	40
HB-SB-36	1117102.80	924612.20	380.17	378.17	352.17	338.17	<334.165	<334.165	<334.165	<334.165	<334.165	334.17	2	28	42	N/A	N/A	N/A	N/A	N/A	46
HB-SB-38	1117259.00	924148.50	380.53	378.53	349.53	334.53	<313.526	<313.526	<313.526	<313.526	<313.526	313.53	2	31	46	N/A	N/A	N/A	N/A	N/A	67
HB-SB-39	1117094.20	923923.20	380.79	378.79	352.79	340.79	<338.789	<338.789	<338.789	<338.789	<338.789	338.79	2	28	40	N/A	N/A	N/A	N/A	N/A	42
HB-SB-40	1117438.10	923944.30	383.25	381.25	351.25	344.25	<341.249	<341.249	<341.249	<341.249	<341.249	341.25	2	32	39	N/A	N/A	N/A	N/A	N/A	42
HB-SB-42	1115649.20	925728.20	379.99	373.29	363.29	340.99	<337.991	<337.991	<337.991	<337.991	<337.991	337.99	6.7	16.7	39	N/A	N/A	N/A	N/A	N/A	42
HB-SB-43	1115629.50	925596.80	394.72	374.02	370.92	<356.716	<356.716	<356.716	<356.716	<356.716	<356.716	356.72	20.7	23.8	N/A	N/A	N/A	N/A	N/A	N/A	38
HB-SB-44	1115632.10	925499.50	386.00	375.80	364.80	351.40	351.40	351.40	<346.004	<346.004	<346.004	346.00	10.2	21.2	34.6	34.6	34.6	N/A	N/A	N/A	40
HB-SB-45	1115522.30	925650.20	376.65	372.75	363.85	353.85	353.85	<348.651	<348.651	<348.651	<348.651	348.65	3.9	12.8	22.8	22.8	N/A	N/A	N/A	N/A	28
HB-SB-46	1115548.60	925720.70	379.49	374.49	365.49	354.49	354.49	<351.492	<351.492	<351.492	<351.492	351.49	5	14	25	25	N/A	N/A	N/A	N/A	28
HB-SB-47	1115544.10	925842.50	375.58	364.78	357.88	348.58	348.58	<345.576	<345.576	<345.576	<345.576	345.58	10.8	17.7	27	27	N/A	N/A	N/A	N/A	30
HB-SB-48	1115511.10	925889.20	378.51	373.71	360.31	349.81	349.81	<346.507	<346.507	<346.507	<346.507	346.51	4.8	18.2	28.7	28.7	N/A	N/A	N/A	N/A	32
HB-SB-49	1115506.00	925780.60	381.50	375.60	366.70	353.50	353.50	<349.497	<349.497	<349.497	<349.497	349.50	5.9	14.8	28	28	N/A	N/A	N/A	N/A	32
HB-SB-50	1115482.20	925714.10	379.38	358.98	358.98	348.58	348.58	<345.381	<345.381	<345.381	<345.381	345.38	20.4	20.4	30.8	30.8	N/A	N/A	N/A	N/A	34

Note: Depths are measured from mudline elevation (NAVD 88).

Geosyntec
consultants

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Boring ID	Northing	Easting	Ground Elevation (ft)	Bottom of Fill Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Fill (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
HB-SB-61	1116304.87	925113.83	380.58	376.58	356.58	334.58	<328.58	<328.58	<328.58	<328.58	<328.58	328.58	4	24	46	N/A	N/A	N/A	N/A	N/A	52
HB-SB-62	1116501.67	925517.11	380.05	379.05	351.30	322.55	<318.05	<318.05	<318.05	<318.05	<318.05	318.05	1	28.75	57.5	N/A	N/A	N/A	N/A	N/A	62
HB-SB-63	1116540.82	925693.98	366.21	361.71	355.21	322.21	<318.212	<318.212	<318.212	<318.212	<318.212	318.21	4.5	11	44	N/A	N/A	N/A	N/A	N/A	48
HB-SB-64	1116471.45	925771.95	365.61	363.61	352.61	326.61	<319.608	<319.608	<319.608	<319.608	<319.608	319.61	2	13	39	N/A	N/A	N/A	N/A	N/A	46
HB-SB-65	1116351.48	925855.65	364.91	363.91	353.91	319.91	<316.909	<316.909	<316.909	<316.909	<316.909	316.91	1	11	45	N/A	N/A	N/A	N/A	N/A	48
HB-SB-66	1116066.72	926035.35	367.11	362.61	362.61	324.11	<321.108	<321.108	<321.108	<321.108	<321.108	321.11	4.5	4.5	43	N/A	N/A	N/A	N/A	N/A	46
HB-SB-67	1116052.25	926108.94	366.40	360.40	360.40	321.40	<318.395	<318.395	<318.395	<318.395	<318.395	318.40	6	6	45	N/A	N/A	N/A	N/A	N/A	48
HB-SB-68	1115755.21	926004.30	371.05	364.05	356.05	322.05	273.05	273.05	273.05	<272.448	<272.448	272.45	7	15	49	98	98	98	N/A	N/A	98.6
HB-SB-69	1115253.82	925648.84	382.00	360.00	360.00	348.00	<344	<344	<344	<344	<344	344.00	22	22	34	N/A	N/A	N/A	N/A	N/A	38
HB-SB-70	1115228.86	925618.42	381.43	357.43	357.43	343.43	<339.425	<339.425	<339.425	<339.425	<339.425	339.43	24	24	38	N/A	N/A	N/A	N/A	N/A	42
HB-SB-71	1115291.27	925532.57	373.06	365.06	365.06	353.06	353.06	<347.06	<347.06	<347.06	<347.06	347.06	8	8	20	20	N/A	N/A	N/A	N/A	26
HB-SB-72	1115653.88	925310.27	381.90	381.90	364.90	354.90	314.90	314.90	314.90	<309.901	<309.901	309.90	0	17	27	67	67	67	N/A	N/A	72
HB-SB-73	1115759.44	925067.40	390.35	377.35	361.35	351.35	317.35	317.35	317.35	<314.345	<314.345	314.35	13	29	39	73	73	73	N/A	N/A	76
HB-SB-74	1115769.22	924952.42	390.17	353.17	353.17	346.17	346.17	346.17	346.17	<339.365	<339.365	339.37	37	37	44	44	44	44	N/A	N/A	50.8
HB-SB-75	1115768.21	924814.40	390.23	370.23	358.23	353.23	353.23	353.23	353.23	<350.029	<350.029	350.03	20	32	37	37	37	37	N/A	N/A	40.2
HB-SB-76	1115854.33	924845.17	391.89	358.89	358.89	350.89	350.89	350.89	350.89	<345.786	<345.786	345.79	33	33	41	41	41	41	N/A	N/A	46.1
HB-SB-77	1115970.97	924934.51	390.88	384.88	357.88	343.88	313.88	313.88	313.88	<307.982	<307.982	307.98	6	33	47	77	77	77	N/A	N/A	82.9
HB-SB-78	1116058.98	924769.02	393.27	387.27	360.27	346.27	324.27	324.27	324.27	<321.267	<321.267	321.27	6	33	47	69	69	69	N/A	N/A	72
HB-SB-79	1115924.80	924724.58	393.52	359.52	359.52	351.52	<346.219	<346.219	<346.219	<346.219	<346.219	346.22	34	34	42	N/A	N/A	N/A	N/A	N/A	47.3
HB-SB-80	1115883.00	924613.65	390.90	371.90	360.90	352.90	352.90	352.90	352.90	<348.097	<348.097	348.10	19	30	38	38	38	38	N/A	N/A	42.8
HB-SB-81	1116132.67	924651.71	394.87	387.87	359.87	330.87	326.87	326.87	326.87	<319.668	<319.668	319.67	7	35	64	68	68	68	N/A	N/A	75.2
HB-SB-82	1115351.77	925637.20	369.97	362.97	362.97	355.97	<352.971	<352.971	<352.971	<352.971	<352.971	352.97	7	7	14	N/A	N/A	N/A	N/A	N/A	17
HB-SB-83	1115197.03	925530.50	370.32	364.32	364.32	356.32	<353.322	<353.322	<353.322	<353.322	<353.322	353.32	6	6	14	N/A	N/A	N/A	N/A	N/A	17
HB-SB-84	1117787.26	923482.10	364.75	362.75	352.75	<330.751	<330.751	<330.751	<330.751	<330.751	<330.751	330.75	2	12	N/A	N/A	N/A	N/A	N/A	N/A	34
HB-SB-85	1117741.78	923661.10	364.27	360.27	352.27	334.27	<330.272	<330.272	<330.272	<330.272	<330.272	330.27	4	12	30	N/A	N/A	N/A	N/A	N/A	34
HB-SB-86	1117385.76	924748.55	364.93	364.93	323.43	<320.931	<320.931	<320.931	<320.931	<320.931	<320.931	320.93	0	41.5	N/A	N/A	N/A	N/A	N/A	N/A	44
HB-SB-87	1117311.43	924734.59	365.21	365.21	329.71	<327.209	<327.209	<327.209	<327.209	<327.209	<327.209	327.21	0	35.5	N/A	N/A	N/A	N/A	N/A	N/A	38
HB-SB-88	1117357.89	924837.61	363.14	363.14	322.14	<318.144	<318.144	<318.144	<318.144	<318.144	<318.144	318.14	0	41	N/A	N/A	N/A	N/A	N/A	N/A	45
HB-SB-89	1115820.44	925082.35	390.42	382.42	358.42	337.22	312.42	312.42	312.42	<302.418	<302.418	302.42	8	32	53.2	78	78	78	N/A	N/A	88
HB-SB-90	1115197.10	925530.50											4	4	15	N/A	N/A	N/A	N/A	N/A	17
HB-SB-91	1116191.13	926151.56	363.80	362.80	351.80	321.80	<299.8	<299.8	<299.8	<299.8	<299.8	299.80	1	12	42	N/A	N/A	N/A	N/A	N/A	64
HB-SB-92	1116061.891	925947.596	363.174	356.17	356.17	325.17	<303.174	<303.174	<303.174	<303.174	<303.174	303.17	7	7	38	N/A	N/A	N/A	N/A	N/A	60
HB-SB-93	1116038.491	926009.791	363.624	349.62	349.62	321.62	<301.624	<301.624	<301.624	<301.624	<301.624	301.62	14	14	42	N/A	N/A	N/A	N/A	N/A	62
HB-SB-94	1116023.418	926045.208	363.447	347.45	347.45	317.95	<293.447	<293.447	<293.447	<293.447	<293.447	293.45	16	16	45.5	N/A	N/A	N/A	N/A	N/A	70
HB-SB-95	1116002.604	926091.248	363.213	351.21	351.21	324.21	<297.213	<297.213	<297.213	<297.213	<297.213	297.21	12	12	39	N/A	N/A	N/A	N/A	N/A	66
HB-SB-96	1115815.69	926130.29	369.24	350.74	344.24	317.24	<285.24	<285.24	<285.24	<285.24	<285.24	285.24	18.5	25	52	N/A	N/A	N/A	N/A	N/A	84
HB-SB-97	1115881.17	926153.24	364.79	355.79	355.79	320.79	<278.79	<278.79	<278.79	<278.79	<278.79	278.79	9	9	44	N/A	N/A	N/A	N/A	N/A	86
HB-SB-98	1115929.83	926178.56	363.96	355.96	355.96	317.96	<297.96	<297.96	<297.96	<297.96	<297.96	297.96	8	8	46	N/A	N/A	N/A	N/A	N/A	66
HB-SB-99	1115862.329	926252.789	363.442	337.44	337.44	315.44	<287.442	<287.442	<287.442	<287.442	<287.442	287.44	26	26	48	N/A	N/A	N/A	N/A	N/A	76
HB-SB-100	1115634.97	926363.29	373.62																		
HB-SB-101	1115781.84	926461.01	370.43																		
HB-SB-102	1115870.171	926452.403	362.891	337.89	337.89	309.89	<288.891	<288.891	<288.891	<288.891	<288.891	288.89	25	25	53	N/A	N/A	N/A	N/A	N/A	74
HB-SB-103	1115922.201	926445.291	363.215	336.72	336.72	311.22	<291.215	<291.215	<291.215	<291.215	<291.215	291.22	26.5	26.5	52	N/A	N/A	N/A	N/A	N/A	72
HB-SB-104	1115900.44	926572.74	364.00	357.00	357.00	308.00	<264	<264	<264	<264	<264	264.00	7	7	56	N/A	N/A	N/A	N/A	N/A	100
HB-SB-105	1115725.41	926774.37	372.00																		
HB-SB-106	1115863.94	926692.41	370.62																		
HB-SB-107	1115940.23	926668.13	364.00	352.00	352.00	304.00	<249	<249	<249	<249	<249	249.00	12	12	60	N/A	N/A	N/A	N/A	N/A	115
HB-SB-108	1115988.571	926637.101	362.816	356.82	356.82	287.82	<268.816	<268.816	<268.816	<268.816	<268.816	268.82	6	6	75	N/A	N/A	N/A	N/A	N/A	94

Note: Depths are measured from mudline elevation (NAVD 88).

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Boring ID	Northing	Easting	Ground Elevation (ft)	Bottom of Fill Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Fill (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
HB-SB-109	1115996.13	926976.00	371.29																		
HB-SB-110	1116064.121	926912.382	364.613	355.11	355.11	314.61	<294.613	<294.613	<294.613	<294.613	<294.613	294.61	9.5	9.5	50	N/A	N/A	N/A	N/A	N/A	70
HB-SB-111	1116099.924	926883.08	364.083	350.08	350.08	314.08	<294.083	<294.083	<294.083	<294.083	<294.083	294.08	14	14	50	N/A	N/A	N/A	N/A	N/A	70
HB-SB-112	1117756.71	923614.03	364.28	358.28	340.28	326.28	317.28	<312.278	<312.278	<312.278	<312.278	312.28	6	24	38	47	N/A	N/A	N/A	N/A	52
HB-SB-113	1117671.01	923630.99	369.99																		
HB-SB-114	1117646.40	923727.04	370.17																		
HB-SB-115	1117456.02	923586.02	380.06	378.06	346.06	334.06	334.06	319.56	319.56	<314.055	<314.055	314.06	2	34	46	46	60.5	60.5	N/A	N/A	66
HB-SB-116	1117621.96	923824.64	370.06																		
HB-SB-117	1117593.85	923920.16	370.00																		
HB-SB-118	1117567.69	924016.40	369.00																		
HB-SB-119	1117589.64	924127.64	367.32																		
HB-SB-120	1117492.80	924099.45	379.53																		
HB-SB-121	1117330.23	924055.77	383.33	382.33	345.83	341.33	341.33	321.33	319.33	<317.333	<317.333	317.33	1	37.5	42	42	62	64	N/A	N/A	66
HB-SB-122	1117508.37	924207.80	369.02																		
HB-SB-123	1117482.28	924305.80	369.32																		
HB-SB-124	1117500.43	924459.74	366.72	360.72	326.72	314.72	300.72	<294.724	<294.724	<294.724	<294.724	294.72	6	40	52	66	N/A	N/A	N/A	N/A	72
HB-SB-125	1117406.64	924375.62	369.95	359.95	347.95	327.95	316.95	<313.95	<313.95	<313.95	<313.95	313.95	10	22	42	53	N/A	N/A	N/A	N/A	56
HB-SB-126	1117341.67	924453.60	374.15	373.65	348.15	327.65	320.15	<306.145	<306.145	<306.145	<306.145	306.15	0.5	26	46.5	54	N/A	N/A	N/A	N/A	68
HB-SB-127	1117391.78	924613.12	368.34	366.84	329.34	320.34	<298.34	<298.34	<298.34	<298.34	<298.34	298.34	1.5	39	48	N/A	N/A	N/A	N/A	N/A	70
HB-SB-128	1117276.18	924524.86	373.65	371.65	346.65	337.65	<327.653	<327.653	<327.653	<327.653	<327.653	327.65	2	27	36	N/A	N/A	N/A	N/A	N/A	46
HB-SB-129	1117086.68	924413.11	384.51	382.51	358.51	342.51	336.51	329.51	326.51	<324.509	<324.509	324.51	2	26	42	48	55	58	N/A	N/A	60
HB-SB-130	1117245.71	924625.51	367.98																		
HB-SB-131	1117211.16	924604.00	370.12	368.62	354.62	341.12	<330.119	<330.119	<330.119	<330.119	<330.119	330.12	1.5	15.5	29	N/A	N/A	N/A	N/A	N/A	40
HB-SB-132	1117154.70	924688.15	372.03																		
HB-SB-133	1117141.46	924799.17	368.33																		
HB-SB-134	1117101.12	924770.27	371.14	368.64	351.14	329.14	<317.137	<317.137	<317.137	<317.137	<317.137	317.14	2.5	20	42	N/A	N/A	N/A	N/A	N/A	54
HB-SB-135	1117049.96	924854.26	369.93																		
HB-SB-136	1116992.14	924937.68	369.67	369.17	351.67	326.67	<315.67	<315.67	<315.67	<315.67	<315.67	315.67	0.5	18	43	N/A	N/A	N/A	N/A	N/A	54
HB-SB-137	1116939.76	925022.82	369.77																		
HB-SB-138	1116869.90	924927.53	375.69	375.19	355.69	328.69	<305.687	<305.687	<305.687	<305.687	<305.687	305.69	0.5	20	47	N/A	N/A	N/A	N/A	N/A	70
HB-SB-139	1116790.85	924801.87	380.04	378.04	355.54	340.04	<310.037	<310.037	<310.037	<310.037	<310.037	310.04	2	24.5	40	N/A	N/A	N/A	N/A	N/A	70
HB-SB-140	1116884.92	925107.07	370.01	369.51	344.01	324.01	<314.005	<314.005	<314.005	<314.005	<314.005	314.01	0.5	26	46	N/A	N/A	N/A	N/A	N/A	56
HB-SB-141	1116830.68	925189.67	369.46	367.96	329.46	319.46	<309.46	<309.46	<309.46	<309.46	<309.46	309.46	1.5	40	50	N/A	N/A	N/A	N/A	N/A	60
HB-SB-142	1116809.91	925297.84	365.38																		
HB-SB-143	1116778.49	925274.31	369.96																		
HB-SB-144	1116603.18	925142.66	380.96	379.96	353.96	320.96	306.96	<288.961	<288.961	<288.961	<288.961	288.96	1	27	60	74	N/A	N/A	N/A	N/A	92
HB-SB-145	1116723.16	925359.88	370.61	369.61	330.61	320.61	<310.606	<310.606	<310.606	<310.606	<310.606	310.61	1	40	50	N/A	N/A	N/A	N/A	N/A	60
HB-SB-146	1116667.87	925440.24	369.60	367.10	330.60	321.60	<311.6	<311.6	<311.6	<311.6	<311.6	311.60	2.5	39	48	N/A	N/A	N/A	N/A	N/A	58
HB-SB-147	1116626.54	925413.21	374.72	373.72	326.72	312.72	302.72	<290.721	<290.721	<290.721	<290.721	290.72	1	48	62	72	N/A	N/A	N/A	N/A	84
HB-SB-148	1116612.43	925526.13	371.86	370.36	350.86	325.86	<315.863	<315.863	<315.863	<315.863	<315.863	315.86	1.5	21	46	N/A	N/A	N/A	N/A	N/A	56
HB-SB-149	1116563.94	925610.82	369.34																		
HB-SB-150	1116512.68	925695.44	367.41	367.41	349.41	326.41	<315.409	<315.409	<315.409	<315.409	<315.409	315.41	0	18	41	N/A	N/A	N/A	N/A	N/A	52
HB-SB-151	1116455.45	925782.99	365.91																		
HB-SB-152	1116409.78	925868.27	364.83																		
HB-SB-153	1116355.56	925954.03	364.04																		
HB-SB-154	1116308.54	926041.69	363.91																		
HB-SB-155	1116254.74	926128.18	364.10																		

Note: Depths are measured from mudline elevation (NAVD 88).

Geosyntec consultants

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Boring ID	Northing	Easting	Ground Elevation (ft)	Bottom of Fill Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Fill (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
GP series borings in WB-B (coordinates and ground elevations were obtained from the topo shown on the boring location plan)																					
HB-GP-01	1117546.60	923825.10	371.94	361.94	355.94	<349.94	<349.94	<349.94	<349.94	<349.94	<349.94	349.94	10	16	N/A	N/A	N/A	N/A	N/A	N/A	22
HB-GP-02	1117431.50	924089.30	384.07	382.07	350.07	<348.07	<348.07	<348.07	<348.07	<348.07	<348.07	348.07	2	34	N/A	N/A	N/A	N/A	N/A	N/A	36
HB-GP-03	1117231.90	924275.20	385.27	383.27	357.27	<351.27	<351.27	<351.27	<351.27	<351.27	<351.27	351.27	2	28	N/A	N/A	N/A	N/A	N/A	N/A	34
HB-GP-04	1117154.80	924481.70	378.00	376.00	354.00	<350	<350	<350	<350	<350	<350	350.00	2	24	N/A	N/A	N/A	N/A	N/A	N/A	28
HB-GP-05	1116678.80	925073.00	379.97	377.97	352.17	<349.97	<349.97	<349.97	<349.97	<349.97	<349.97	349.97	2	27.8	N/A	N/A	N/A	N/A	N/A	N/A	30
HB-GP-06	1116540.30	925420.70	378.99	376.99	347.29	<344.99	<344.99	<344.99	<344.99	<344.99	<344.99	344.99	2	31.7	N/A	N/A	N/A	N/A	N/A	N/A	34
HB-GP-07	1116445.00	925566.60	378.00	376.00	350.00	<346	<346	<346	<346	<346	<346	346.00	2	28	N/A	N/A	N/A	N/A	N/A	N/A	32
HB-GP-08	1117386.40	923660.00	387.46	385.46	353.66	<349.46	<349.46	<349.46	<349.46	<349.46	<349.46	349.46	2	33.8	N/A	N/A	N/A	N/A	N/A	N/A	38
HB-GP-09	1117238.48	923824.48	387.53	387.53	357.53	<353.53	<353.53	<353.53	<353.53	<353.53	<353.53	353.53	0	30	N/A	N/A	N/A	N/A	N/A	N/A	34
HB-GP-10	1117076.40	924040.00	384.78	382.78	356.78	<350.78	<350.78	<350.78	<350.78	<350.78	<350.78	350.78	2	28	N/A	N/A	N/A	N/A	N/A	N/A	34
HB-GP-11	1116908.10	924236.30	382.64	380.64	356.64	<352.64	<352.64	<352.64	<352.64	<352.64	<352.64	352.64	2	26	N/A	N/A	N/A	N/A	N/A	N/A	30
HB-GP-11B	1116908.08	924236.28			Boring log not available																
HB-GP-12	1116763.90	924496.10	382.00	378.00	358.00	<356	<356	<356	<356	<356	<356	356.00	4	24	N/A	N/A	N/A	N/A	N/A	N/A	26
HB-GP-13	1116646.00	924662.40	380.37	378.37	360.37	<342.37	<342.37	<342.37	<342.37	<342.37	<342.37	342.37	2	20	N/A	N/A	N/A	N/A	N/A	N/A	38
HB-GP-14	1116497.70	924806.30	380.54	378.54	358.54	<352.54	<352.54	<352.54	<352.54	<352.54	<352.54	352.54	2	22	N/A	N/A	N/A	N/A	N/A	N/A	28
HB-GP-15	1116367.40	925005.80	380.00	376.00	356.00	<350	<350	<350	<350	<350	<350	350.00	4	24	N/A	N/A	N/A	N/A	N/A	N/A	30
HB-GP-16	1116230.20	925209.50	380.00	378.00	356.00	<352	<352	<352	<352	<352	<352	352.00	2	24	N/A	N/A	N/A	N/A	N/A	N/A	28
HB-GP-17	1116136.40	925435.30	379.11	377.11	351.11	<349.11	<349.11	<349.11	<349.11	<349.11	<349.11	349.11	2	28	N/A	N/A	N/A	N/A	N/A	N/A	30
HB-GP-18	1116047.90	925675.10	378.19	376.19	350.19	<346.19	<346.19	<346.19	<346.19	<346.19	<346.19	346.19	2	28	N/A	N/A	N/A	N/A	N/A	N/A	32
HB-GP-19	1115882.90	925841.30	369.91	361.91	357.91	<353.41	<353.41	<353.41	<353.41	<353.41	<353.41	353.41	8	12	N/A	N/A	N/A	N/A	N/A	N/A	16.5
HB-GP-20	1115832.20	925855.20	372.00	362.00	358.00	<342	<342	<342	<342	<342	<342	342.00	10	14	N/A	N/A	N/A	N/A	N/A	N/A	30
HB-GP-25	1115320.40	925345.70	372.00	362.50	362.50	357.00	<352	<352	<352	<352	<352	352.00	9.5	9.5	15	N/A	N/A	N/A	N/A	N/A	20
HB-GP-26	1115371.72	925430.32	372.20	363.20	363.20	344.70	<338.2	<338.2	<338.2	<338.2	<338.2	338.20	9	9	27.5	N/A	N/A	N/A	N/A	N/A	34
HB-GP-27	1115428.90	925052.50	376.96	374.96	365.06	362.96	362.96	362.96	362.96	<362.56	<362.56	362.56	2	11.9	14	14	14	14	N/A	N/A	14.4
HB-GP-28	1115531.88	924801.30	380.00	378.00	364.30	364.30	364.30	364.30	364.30	<363.7	<363.7	363.70	2	15.7	15.7	15.7	15.7	15.7	N/A	N/A	16.3
HB-GP-29	1115615.60	924558.80	378.94	373.34	364.44	364.44	364.44	364.44	364.44	<361.44	<361.44	361.44	5.6	14.5	14.5	14.5	14.5	14.5	N/A	N/A	17.5
HB-GP-30	1115365.70	924777.60	380.00	380.00	380.00	380.00	380.00	370.60	367.00	<365.6	<365.6	365.60	0	0	0	0	9.4	13	N/A	N/A	14.4
HB-GP-32	1115738.40	925235.80	390.00	372.00	363.00	344.00	<340	<340	<340	<340	<340	340.00	18	27	46	N/A	N/A	N/A	N/A	N/A	50
HB-GP-32A	1115751.05	925209.52	390.00	376.00	360.00	344.00	311.00	311.00	311.00	<306	<306	306.00	14	30	46	79	79	79	N/A	N/A	84
HB-GP-33	1115721.90	925156.00	390.00	371.40	362.10	347.00	306.90	306.90	304.90	<304	<304	304.00	18.6	27.9	43	83.1	83.1	85.1	N/A	N/A	86
HB-GP-34	1115734.10	925002.70	390.00	372.00	372.00	346.10	<344	<344	<344	<344	<344	344.00	18	18	43.9	N/A	N/A	N/A	N/A	N/A	46
HB-GP-35	1115838.32	924712.28	391.14	373.54	365.54	356.04	356.04	352.14	352.14	<351.14	<351.14	351.14	17.6	25.6	35.1	35.1	39	39	N/A	N/A	40
HB-GP-36	1115880.70	924505.80	392.23	374.63	360.63	<354.23	<354.23	<354.23	<354.23	<354.23	<354.23	354.23	17.6	31.6	N/A	N/A	N/A	N/A	N/A	N/A	38
HB-GP-37	1116034.70	924237.80	391.85	367.85	361.85	<351.85	<351.85	<351.85	<351.85	<351.85	<351.85	351.85	24	30	N/A	N/A	N/A	N/A	N/A	N/A	40
HB-GP-38	1116047.18	924082.70	390.00	382.40	380.50	380.50	379.50	379.50	379.50	<378	<378	378.00	7.6	9.5	9.5	10.5	10.5	10.5	N/A	N/A	12
HB-GP-39	1116256.93	924005.15	390.00	388.00	366.10	366.10	366.10	366.10	366.10	<366	<366	366.00	2	23.9	23.9	23.9	23.9	23.9	N/A	N/A	24

Note: Depths are measured from mudline elevation (NAVD 88).

Geosyntec consultants

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Boring ID	Northing	Easting	Ground Elevation (ft)	Bottom of Fill Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Fill (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
HB-RISB-1	Coordinates NA																				
HB-RISB-2																					
HB-RISB-4																					
HB-RISB-5																					
HB-RISB-6																					
HB-RISB-7																					
HB-RISB-11																					
HB-RISB-16																					
(coordinates and ground elevations for OW series were provided by Parsons)																					
HB-OW-1S	1117590.143	923859.617	369.9	365.90	<355.9	<355.9	<355.9	<355.9	<355.9	<355.9	<355.9	355.90	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14
HB-OW-2S	1116387.435	925765.841	364.1	364.10	352.60	<350.1	<350.1	<350.1	<350.1	<350.1	<350.1	350.10	0	11.5	N/A	N/A	N/A	N/A	N/A	N/A	14
HB-OW-3S	1115918.426	925849.318	369.2	359.70	<355.2	<355.2	<355.2	<355.2	<355.2	<355.2	<355.2	355.20	9.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14
HB-OW-4S	1117612.594	923818.011	370	366.00	<356	<356	<356	<356	<356	<356	<356	356.00	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14
HB-OW-5S	1116372.665	925784.796	363.9	361.90	352.20	<349.9	<349.9	<349.9	<349.9	<349.9	<349.9	349.90	2	11.7	N/A	N/A	N/A	N/A	N/A	N/A	14
HB-OW-6S	1116074.1	926482.9	363.1	348.20	<347.1	<347.1	<347.1	<347.1	<347.1	<347.1	<347.1	347.10	14.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16
HB-OW-7S	1116083.8	926467.8	362.8	<346.8	<346.8	<346.8	<346.8	<346.8	<346.8	<346.8	<346.8	346.80	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16
HB-OW-8D	1116709.3	925101.4	378.4	374.60	348.60	322.40	289.40	279.20	278.70	<274.4	<274.4	274.40	3.8	29.8	56	89	99.2	99.7	N/A	N/A	104
(coordinates and ground elevations for TW series were provided by Parsons)																					
HB-TW-1	1117618.28	923847.26	369.8	364.30	<355.8	<355.8	<355.8	<355.8	<355.8	<355.8	<355.8	355.80	5.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	14
HB-TW-2	1116379.93	925761.80	364.3	364.30	352.50	<350.3	<350.3	<350.3	<350.3	<350.3	<350.3	350.30	0	11.8	N/A	N/A	N/A	N/A	N/A	N/A	14
HB-TW-3	1115922.90	925858.25	369	361.00	357.00	<355	<355	<355	<355	<355	<355	355.00	8	12	N/A	N/A	N/A	N/A	N/A	N/A	14
HB-TW-4	1116712.70	925208.53	378.6	Incomplete Boring, data missing for top 80 ft. This boring location is close to HB-OW-08D																	
HB-TW-5	1116083.20	926486.80	363	349.30	<347	<347	<347	<347	<347	<347	<347	347.00	13.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	16
BFMW-01S	Coordinates NA/Borings are on OBG's Fig. 1																				
BFMW-01I																					
BFMW-01D																					
BFMW-02B																					
BFMW-03S																					
BFMW-03I																					
BFMW-03D																					
BFMW-04S																					
BFMW-04I																					
BFMW-04D																					
BFMW-05S																					
BFMW-05I																					
BFMW-05D																					
BFMW-06S																					
BFMW-06I																					
BFMW-06D																					
BFMW-07																					
(coordinates and ground elevations in blue were obtained from the topo shown on the boring location plan)																					
HB-HB-01D	1117455.00	924585.12	368.00	356.00	320.00	316.00	282.00	277.00	277.00	<276.5	<276.5	276.50	12	48	52	86	91	91	N/A	N/A	91.5
HB-HB-01S	1117453.46	924589.21	368.00										Boring information is included in HB-HB-01D (a deep boring at approximately the same location)								
HB-HB-02D	1116367.30	925743.10	365.77	364.77	351.77	327.77	<293.77	<293.77	<293.77	<293.77	<293.77	293.77	1	14	38	N/A	N/A	N/A	N/A	N/A	72

Note: Depths are measured from mudline elevation (NAVD 88).

Geosyntec
consultants

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Boring ID	Northing	Easting	Ground Elevation (ft)	Bottom of Fill Elevation (ft)	Bottom of SOLW Elevation (ft)	Bottom of Marl Elevation (ft)	Bottom of Silt and Clay Elevation (ft)	Bottom of Silt and Sand Elevation (ft)	Bottom of Sand and Gravel Elevation (ft)	Bottom of Till Elevatioin (ft)	Bottom of Shale Elevation (ft)	End of Boring Elevation (ft)	Depth to Bottom of Fill (ft)	Depth to Bottom of SOLW (ft)	Depth to Bottom of Marl (ft)	Depth to Bottom of Silt and Clay (ft)	Depth to Bottom of Silt and Sand (ft)	Depth to Bottom of Sand and Gravel (ft)	Depth to Bottom of Till (ft)	Depth to Bottom of Shale (ft)	Depth to End of Boring (ft)
HB-HB-02I	1116367.30	925743.10	365.77										Boring information is included in HB-HB-02D (a deep boring at approximately the same location)								
HB-HB-02S	1116363.20	925739.20	365.91										Boring information is included in HB-HB-02D (a deep boring at approximately the same location)								
HB-HB-03S	1117620.07	923856.38	370.00	366.00	354.00	<352	<352	<352	<352	<352	<352	352.00	4	16	N/A	N/A	N/A	N/A	N/A	N/A	18
HB-HB-04D	1115915.01	925879.18	368.36	352.36	352.36	328.36	280.36	272.06	<270.86	<270.86	<270.86	270.86	16	16	40	88	96.3	N/A	N/A	N/A	97.5
HB-HB-04S	1115920.24	925886.19	368.09							**Boring N/A**											
HB-HB-05D	1116715.20	925256.30	378.00	378.00	327.00	314.00	278.00	274.00	274.00	<268	<268	268.00	0	51	64	100	104	104	N/A	N/A	110
HB-HB-05I	1116728.20	925256.10	378.00										Boring information is included in HB-HB-05D (a deep boring at approximately the same location)								
HB-HB-05S	1116724.20	925255.20	378.00										Boring information is included in HB-HB-05D (a deep boring at approximately the same location)								
HB-HB-06S	1116225.60	926185.00	363.90	351.90	337.90	<329.9	<329.9	<329.9	<329.9	<329.9	<329.9	329.90	12	26	N/A	N/A	N/A	N/A	N/A	N/A	34
HB-HB-07S	1114938.87	925295.14	377.66	377.66	377.66	377.66	377.66	372.76	372.76	<369.66	<369.66	369.66	0	0	0	0	4.9	4.9	N/A	N/A	8
HB-HB-08D	1115476.36	925459.35	373.23	367.33	359.73	351.63	309.23	308.63	308.63	306.23	<305.73	305.73	5.9	13.5	21.6	64	64.6	64.6	67	N/A	67.5
HB-HB-08I	1115476.52	925464.86	373.17										Boring information is included in HB-HB-08D (a deep boring at approximately the same location)								
HB-HB-08S	1115482.95	925460.32	373.28										Boring information is included in HB-HB-08D (a deep boring at approximately the same location)								
HB-HB-09S	1115732.37	924388.96	382.92	373.92	369.42	369.42	369.42	364.92	363.42	<361.12	<361.12	361.12	9	13.5	13.5	13.5	18	19.5	N/A	N/A	21.8
HB-HB-10	1116421.43	924195.32	394.74	388.24	359.74	<348.74	<348.74	<348.74	<348.74	<348.74	<348.74	348.74	6.5	35	N/A	N/A	N/A	N/A	N/A	N/A	46
HB-HB-11I										**Boring N/A**											
HB-HB-11D	1116271.90	924507.40	392.12	386.12	356.52	347.12	331.02	331.02	328.12	<326.12	<326.12	326.12	6	35.6	45	61.1	61.1	64	N/A	N/A	66
HB-HB-11S										**Boring N/A**											
HB-HB-12D	1115893.40	925070.80	390.00	384.90	354.40	339.40	302.00	302.00	302.00	<300.2	<300.2	300.20	5.1	35.6	50.6	88	88	88	N/A	N/A	89.8
HB-HB-12I	1115893.40	925070.80	390.00										Boring information is included in HB-HB-12D (a deep boring at approximately the same location)								
HB-HB-12S	1115893.40	925070.80	390.00										Boring information is included in HB-HB-12D (a deep boring at approximately the same location)								
HB-HB-13D	1115722.90	925156.00	390.00	371.40	362.10	347.00	306.90	306.90	304.90	<304	<304	304.00	18.6	27.9	43	83.1	83.1	85.1	N/A	N/A	86
HB-HB-14D	1115838.59	924711.95	391.15										This boring is same as HB-GP-35.								
HB-HB-14S	1115839.37	924712.73	391.18										Boring information is included in HB-HB-14D (a deep boring at approximately the same location)								
HB-HB-15	1116076.70	924023.90	390.00	385.00	378.00	378.00	378.00	378.00	378.00	<376.6	<376.6	376.60	5	12	12	12	12	12	N/A	N/A	13.4
HB-HB-16D	1116123.40	925489.60	379.05	377.05	351.05	337.25	288.05	275.05	272.45	<271.05	<271.05	271.05	2	28	41.8	91	104	106.6	N/A	N/A	108
HB-HB-17D	1116031.40	924853.10	391.83	389.83	354.03	336.33	316.13	316.13	316.13	<314.33	<314.33	314.33	2	37.8	55.5	75.7	75.7	75.7	N/A	N/A	77.5
HB-HB-18S	1115851.02	926311.70	363.99	354.99	354.99	<325.99	<325.99	<325.99	<325.99	<325.99	<325.99	325.99	9	9	N/A	N/A	N/A	N/A	N/A	N/A	38
HB-HB-19S	1115997.80	926203.30	363.82	352.32	347.82	328.02	<327.82	<327.82	<327.82	<327.82	<327.82	327.82	11.5	16	35.8	N/A	N/A	N/A	N/A	N/A	36
HB-HB-20D	1116106.00	926478.30	363.28	347.78	347.78	317.28	241.28	237.78	229.78	<227.78	<227.78	227.78	15.5	15.5	46	122	125.5	133.5	N/A	N/A	135.5
HB-HB-20I	1116105.10	926483.40	363.33										Boring information is included in HB-HB-20D (a deep boring at approximately the same location)								
HB-HB-20S	1116104.20	926488.40	363.37										Boring information is included in HB-HB-20D (a deep boring at approximately the same location)								
HB-HB-21I	1115395.66	925711.82	376.61	357.61	357.61	341.11	<340.61	<340.61	<340.61	<340.61	<340.61	340.61	19	19	35.5	N/A	N/A	N/A	N/A	N/A	36
HB-WA-08S	1116716.90	924708.10	381.28										Boring information is included in HB-WA-08D (a deep boring at approximately the same location)								
HB-WA-08D	1116702.90	924706.30	381.06	381.06	355.26	337.06	321.06	307.06	303.56	<301.06	<301.06	301.06	0	25.8	44	60	74	77.5	N/A	N/A	80
HB-WA-08I	1116705.10	924717.30	381.03										Boring information is included in HB-WA-08D (a deep boring at approximately the same location)								
HB-WA-1D	Coordinates NA/Borings are on OBG's Fig. 1																				
HB-WA-3S																					
HB-WA-3D																					
HB-WA-3I																					
HB-HBW-01	1116387.01	925845.23	364.00	360.00	354.00	<334	<334	<334	<334	<334	<334	334.00	4	10	N/A	N/A	N/A	N/A	N/A	N/A	30
HB-HBW-02	1116140.61	925817.26	365.12	361.12	349.12	<333.12	<333.12	<333.12	<333.12	<333.12	<333.12	333.12	4	16	N/A	N/A	N/A	N/A	N/A	N/A	32
HB-HBW-03	1116186.50	926023.60	363.65	359.65	353.65	<331.65	<331.65	<331.65	<331.65	<331.65	<331.65	331.65	4	10	N/A	N/A	N/A	N/A	N/A	N/A	32
HB-HBW-04	1116238.97	925915.78	363.88	357.88	350.88	<331.88	<331.88	<331.88	<331.88	<331.88	<331.88	331.88	6	13	N/A	N/A	N/A	N/A	N/A	N/A	32
HB-HBW-06	1117410.13	924727.74	365.50	363.50	323.50	<319.5	<319.5	<319.5	<319.5	<319.5	<319.5	319.50	2	42	N/A	N/A	N/A	N/A	N/A	N/A	46
WA-SB-29	1117727.41	923377.10	369.3	361.30	353.30	338.30	<336.3	<336.3	<336.3	<336.3	<336.3	336.30	8	16	31	N/A	N/A	N/A	N/A	N/A	33

Note: Depths are measured from mudline elevation (NAVD 88).

Figure 1-1. Existing topography and limit of 3-D surfaces

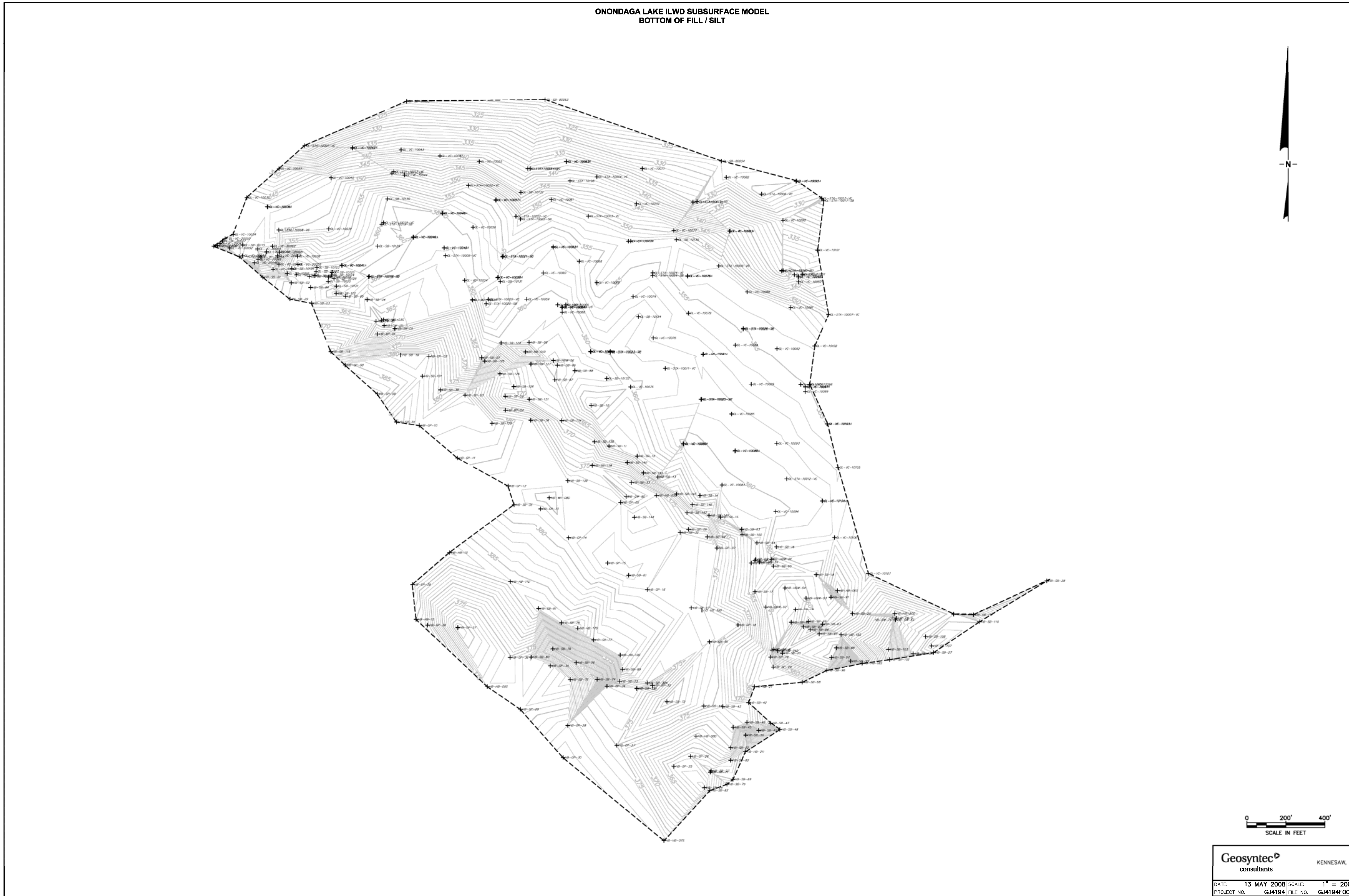


Figure 1-2. Contours of bottom of Fill (in WB-B) and Silt (in lake)

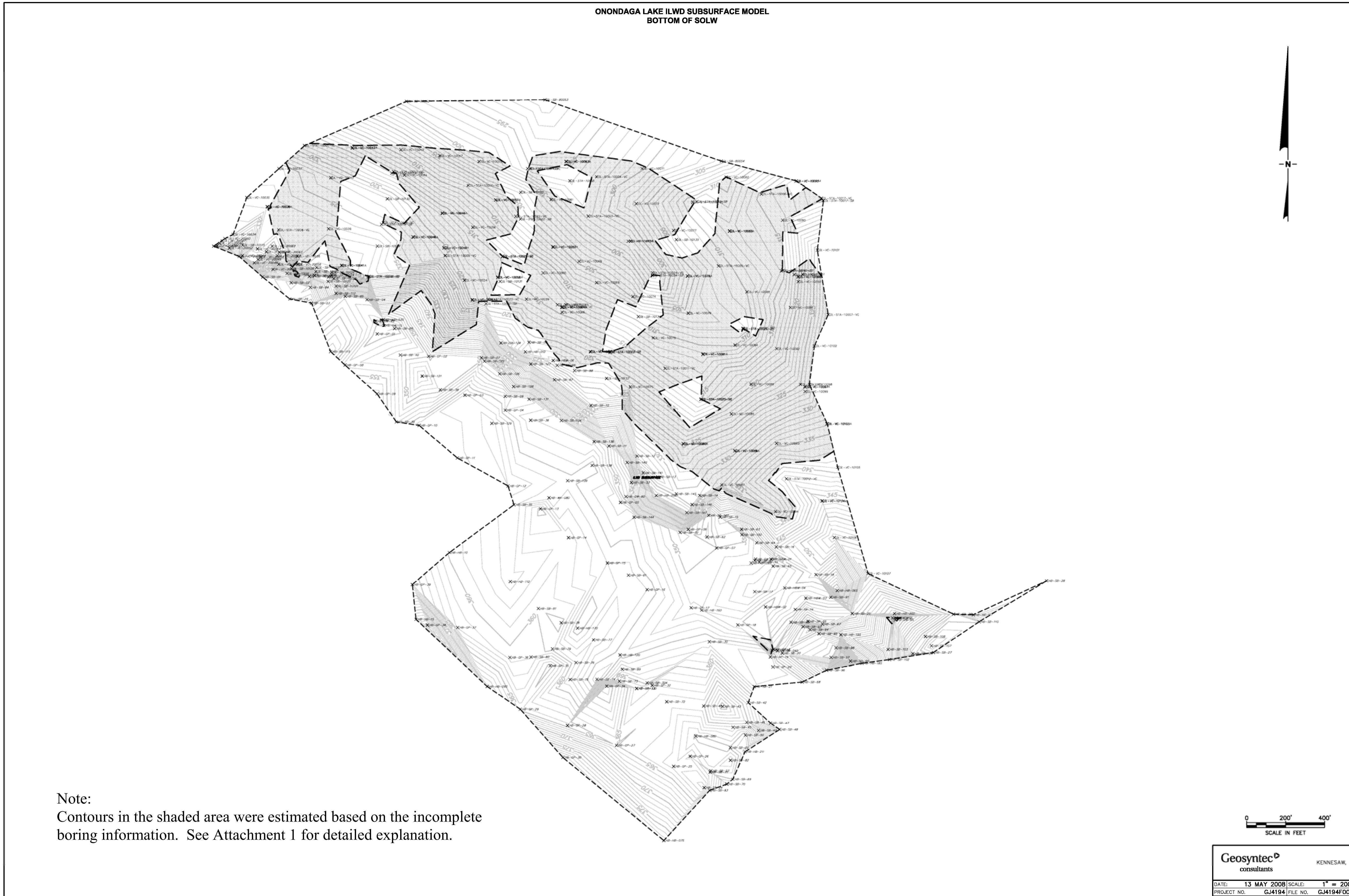
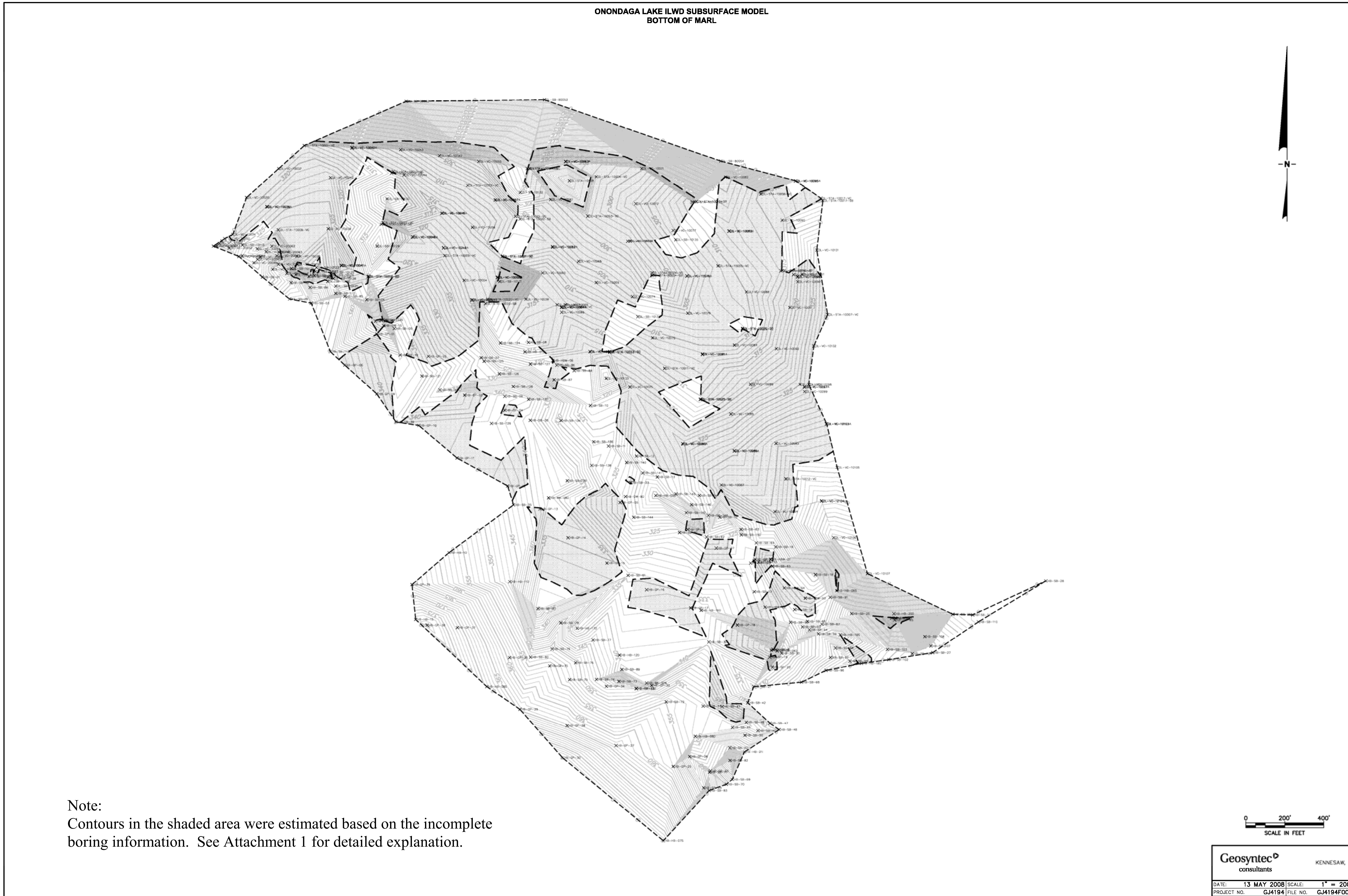


Figure 1-3. Contours of bottom of SOLW



Note:
Contours in the shaded area were estimated based on the incomplete boring information. See Attachment 1 for detailed explanation.

Figure 1-4. Contours of bottom of Marl

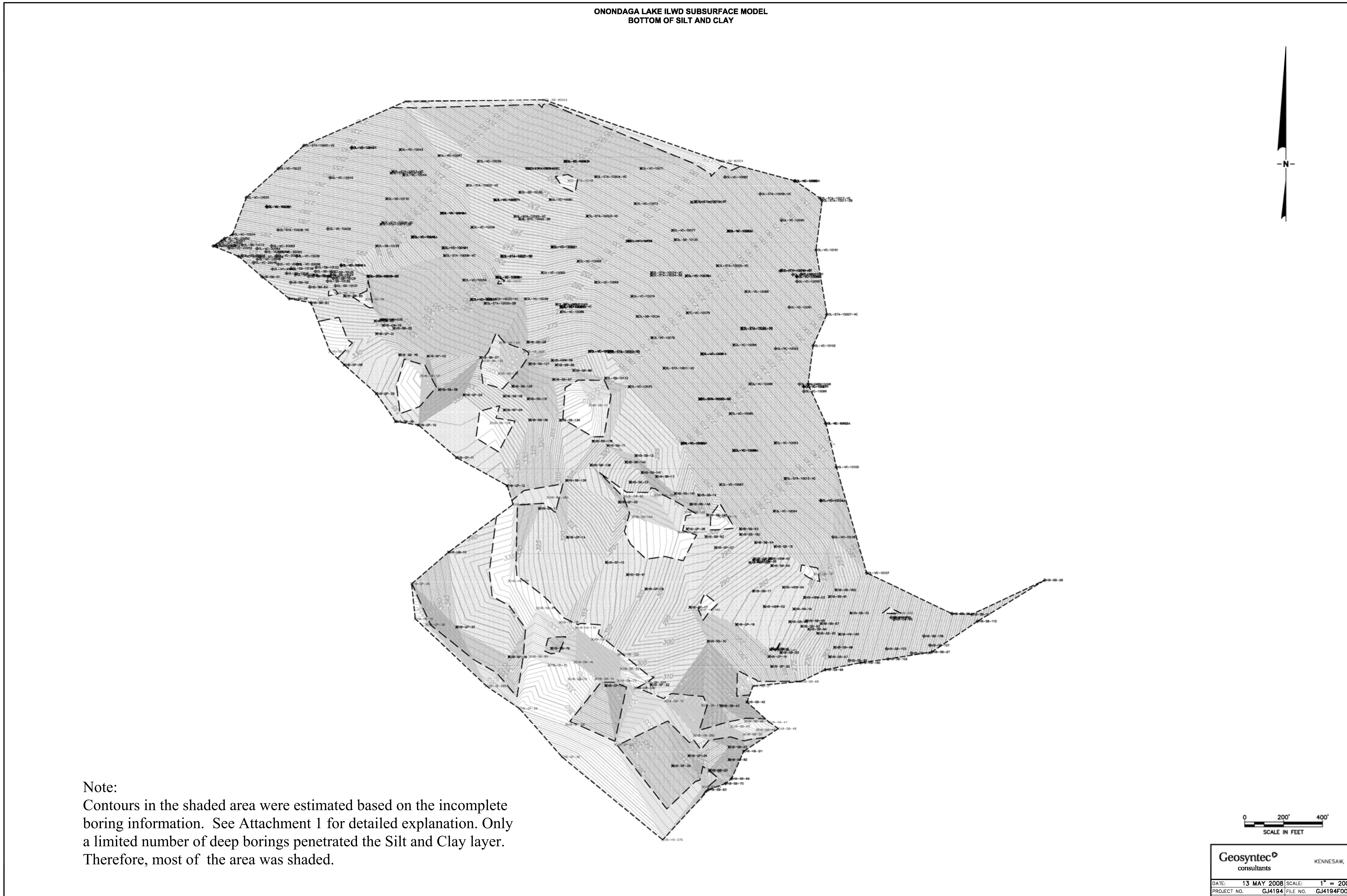


Figure 1-5. Contours of bottom of Silt and Clay

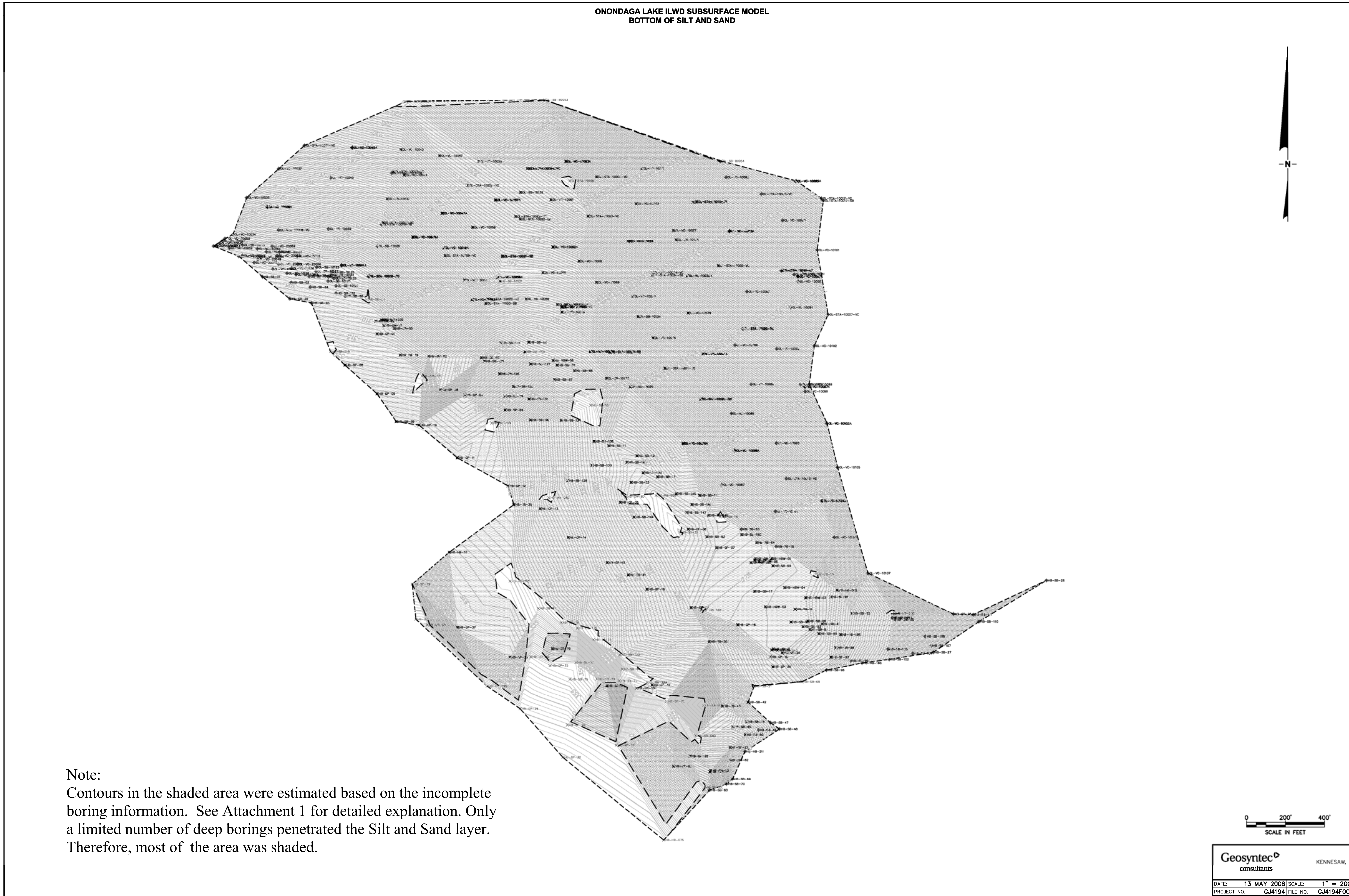


Figure 1-6. Contours of bottom of Silt and Sand

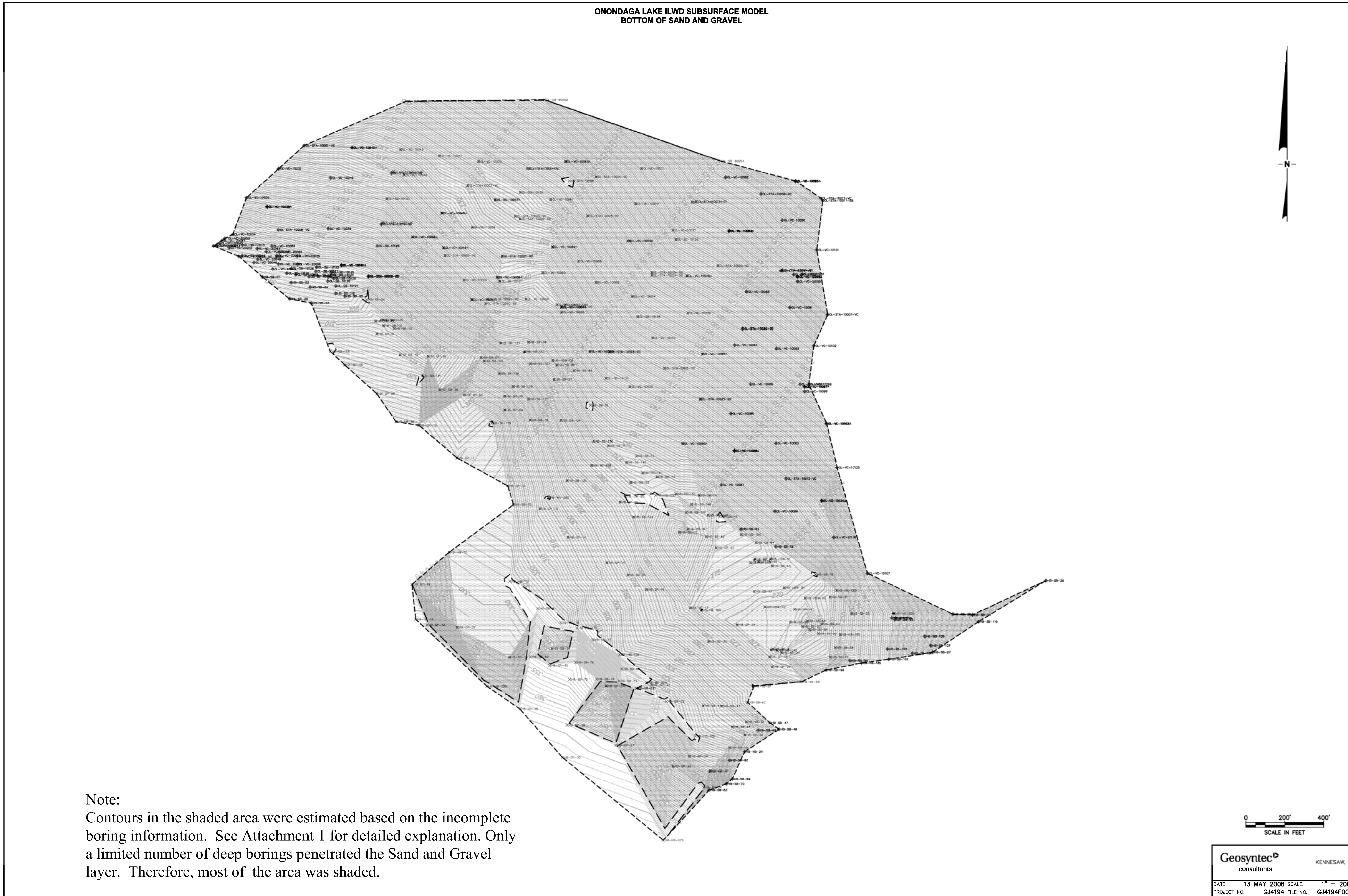
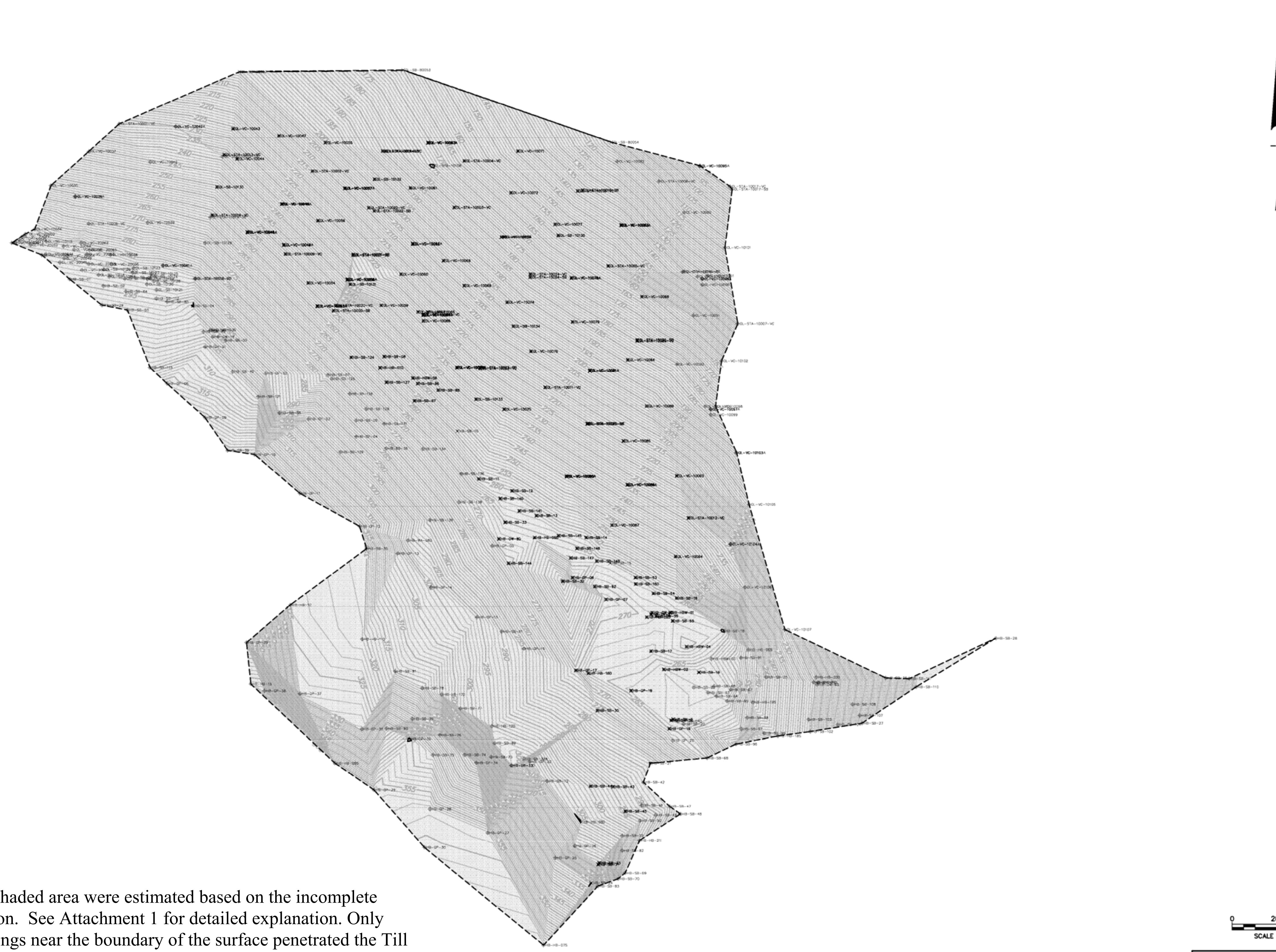


Figure 1-7. Contours of bottom of Sand and Gravel

ONONDAGA LAKE ILWD SUBSURFACE MODEL
BOTTOM OF TILL

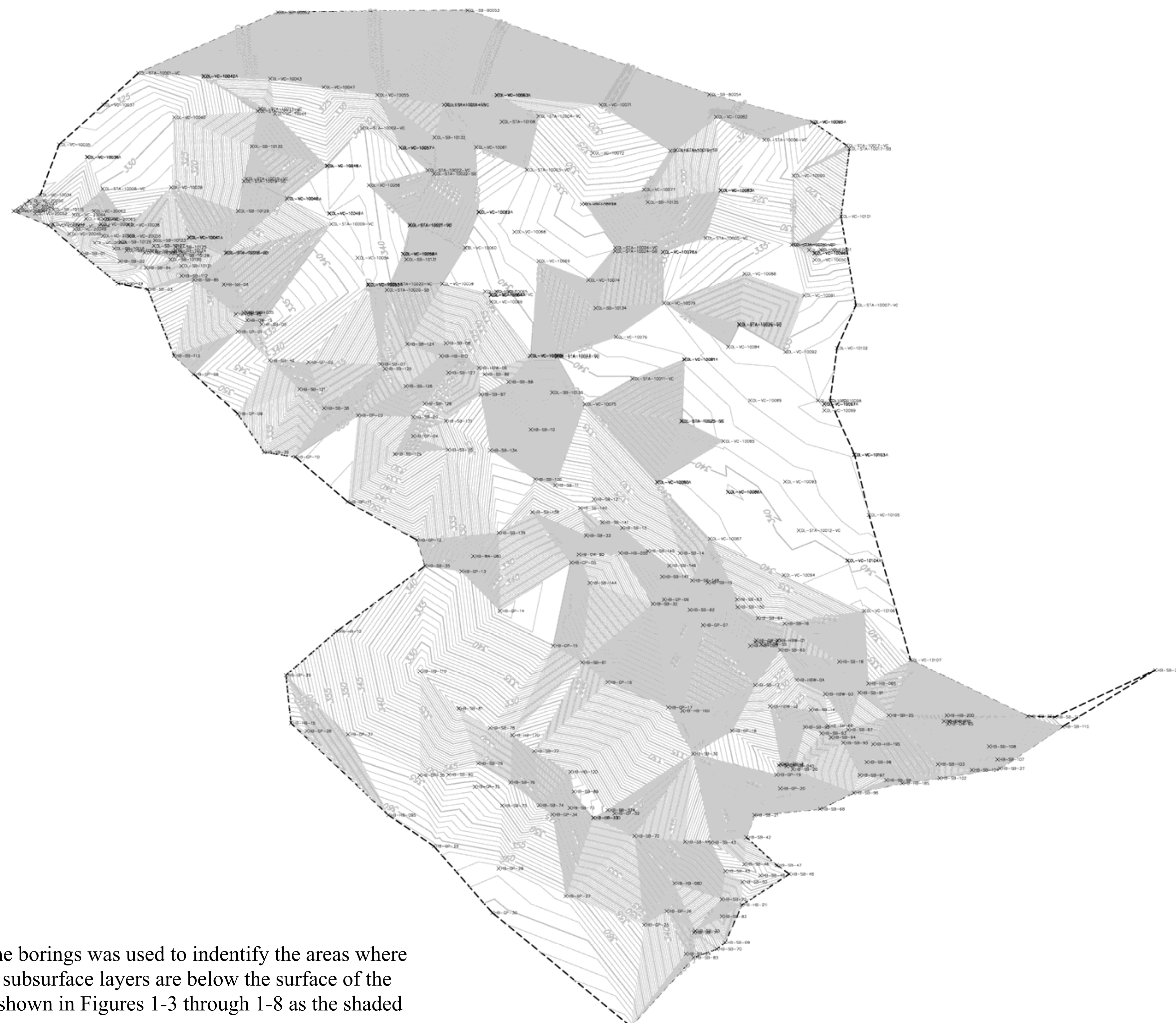


Note:
Contours in the shaded area were estimated based on the incomplete boring information. See Attachment 1 for detailed explanation. Only several deep borings near the boundary of the surface penetrated the Till layer. Therefore, almost all of the area was shaded.

Geosyntec consultants		KENNESAW, GA	
DATE:	13 MAY 2008	SCALE:	1" = 200'
PROJECT NO.	GJ4194	FILE NO.	GJ4194F0008
DOCUMENT NO.		FIGURE NO.	7

Figure 1-8. Contours of bottom of Till

ONONDAGA LAKE ILWD SUBSURFACE MODEL
END OF BORINGS



Note:
The surface of the end of the borings was used to indentify the areas where the created 3-D surfaces of subsurface layers are below the surface of the end of boring, which were shown in Figures 1-3 through 1-8 as the shaded areas.

N

0 200' 400'
SCALE IN FEET

Geosyntec consultants
KENNESAW, GA

DATE:	13 MAY 2008	SCALE:	1" = 200'
PROJECT NO.	GJ4194	FILE NO.	GJ4194F0009
DOCUMENT NO.		FIGURE NO.	8

Figure 1-9. Contours of End of Boring

ATTACHMENT 2

Summary Tables of Lab Testing Results for ILWD

(Provided to Geosyntec by Parsons)

Phase I Investigation

Written by:	Ming Zhu	Date:	06/18/2008	Reviewed by:	Raja Madhyannapu	Date:	06/19/2008
Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	01

Onondaga Lake Pre-Design Investigation
Phase I Geotechnical Data Summary - Table Index
Syracuse, New York

Table Number	Content
Table 1	Index Test Results
Table 2	Bulk Density Results
Table 3	Consolidation Test Results
Table 4	Unconsolidated Undrained Test Results
Table 5	Consolidated Undrained Test Results

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Table 1

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Water Content (ASTM D 2216) (%)	Grain Size (ASTM D 422) Percent Gravel (%)	Percent Sand (%)	Percent Fines (clay & silt) (%)	Clay-sized Particle Content (0.005 mm) (%)	Clay-sized Particle Content (0.002 mm) (%)	Atterberg Limits (ASTM D 4318) Liquid Limit	Plastic Limit	Plasticity Index	Organic Content (ASTM D 2974) (%)	Specific Gravity (ASTM D 854)	Carbonate Content (ASTM D 4373) (%)
OL-STA-10001-VC	OL-0118-14	0-3.3 Ft	1.65	160	0.1	1.4	98.5	14	9	102	32	70	7	2.37	
OL-STA-10001-VC	OL-0118-15	6.6-9.9 Ft	8.25	133	0	3.9	96.1	24	17	82	28	54	9	2.72	
OL-STA-10002-VC	OL-0118-09	3.3-6.6 Ft	4.95	203	0	3.1	96.9	39	16	90	41	49	8.7	2.5	52
OL-STA-10003-VC	OL-0118-16	0-3.3 Ft	1.65	137	0	1.6	98.4	25	11	76	35	41	3.2	2.75	61
OL-STA-10003-VC	OL-0118-17	9.9-13.2 Ft	11.55	166	0	2	98	29	10	86	39	47	6.6	2.59	70
OL-STA-10004-VC	OL-0118-18	3.3-6.6 Ft	4.95	233	0.1	2.3	97.6	12	9	94	41	53	4.5	2.53	70
OL-STA-10004-VC	OL-0118-19	9.9-13.2 Ft	11.55		0.1	1.4	98.5	9	6						
OL-STA-10005-VC	OL-0118-20	0-3.3 Ft	1.65	178	0	2.4	97.6	17	11	114	53	61	2.9	2.38	52
OL-STA-10005-VC	OL-0118-21	9.9-13.2 Ft	11.55		0	0.2	99.8	38	16						
OL-STA-10006-VC	OL-0118-22	0-3.3 Ft	1.65	150	0	9.6	90.4	25	17	105	30	75	7.9	2.59	
OL-STA-10006-VC	OL-0118-23	6.6-9.9 Ft	8.25	160	0	3.2	96.8	19	10	100	36	64	7	2.71	
OL-STA-10007-VC	OL-0118-07	3.3-6.6 Ft	4.95	141	0	2.6	97.4	13	7	75	43	32	5.8	2.62	70
OL-STA-10007-VC	OL-0118-08	9.9-13.2 Ft	11.55		0	0.7	99.3	18	7						
OL-STA-10008-VC	OL-0118-01	6.6-9.9 Ft	8.25	219	0.1	0.5	99.4	43	21	119	53	66	6.4	2.52	70
OL-STA-10008-VC	OL-0118-02	13.2-16.5 Ft	14.85		0	0.1	99.9	48	24						
OL-STA-10009-VC	OL-0118-10	6.6-9.9 Ft	8.25	143	0	9.9	90.1	24	8	74	35	39	5.9	2.47	70
OL-STA-10009-VC	OL-0118-11	13.2-16.5 Ft	14.85		0	2.8	97.2	36	13						
OL-STA-10010-VC	OL-0118-12	3.3-6.6 Ft	4.95	89	0.2	33.9	65.9	16	8	58	42	16	6.9	2.41	61
OL-STA-10010-VC	OL-0118-13	9.9-13.2 Ft	11.55		0.1	3.4	96.5	24	10						
OL-STA-10011-VC	OL-0118-03	6.6-9.9 Ft	8.25	199	0	4	96	21	9	100	39	61	6.3	2.39	61
OL-STA-10011-VC	OL-0118-04	13.2-16.5 Ft	14.85		0	4.5	95.5	37	15						
OL-STA-10012-VC	OL-0118-05	3.3-6.6 Ft	4.95	123	0	9.3	90.7	13	6	68	40	28	4.6	2.43	52
OL-STA-10012-VC	OL-0118-06	13.2-16.5 Ft	14.85		0.1	0.8	99.1	17	7						
OL-STA-10013-SB	OL-0111-01	5-7 Ft	6	79											
OL-STA-10013-SB	OL-0110-01	7-9 Ft	8	165	0	1.6	98.4	36	17	89	47	42			91
OL-STA-10013-SB	OL-0111-02	10-12 Ft	11	67											
OL-STA-10013-SB	OL-0110-02	12-14 Ft	13	278	0	2.1	97.9	51	22		NP		7.2	2.58	83
OL-STA-10013-SB	OL-0111-03	15-17 Ft	16	142											
OL-STA-10013-SB	OL-0111-04	20-22 Ft	21	89											
OL-STA-10013-SB	OL-0111-05	25-27 Ft	26	158	0	2.6	97.4	21	12	92	42	50	10.6	2.57	96
OL-STA-10013-SB	OL-0111-06	30-32 Ft	31	40											
OL-STA-10013-SB	OL-0111-07	35-37 Ft	36	76											
OL-STA-10013-SB	OL-0110-04	37-39 Ft	38	95	0	0.5	99.5	60	41	81	34	47			52
OL-STA-10013-SB	OL-0110-05	41-43 Ft	42	79	0	0.3	99.7	55	35	83	35	48	3.1	2.61	
OL-STA-10013-SB	OL-0111-08	43-45 Ft	44	45											
OL-STA-10014-SB	OL-0111-09	0-2 Ft	1	87											
OL-STA-10014-SB	OL-0111-10	8-10 Ft	9	141											
OL-STA-10014-SB	OL-0111-11	12.5-14.5 Ft	13.5	123											
OL-STA-10014-SB	OL-0111-12	17.5-19.5 Ft	18.5	100											
OL-STA-10014-SB	OL-0110-07	19.5-21.5 Ft	20.5	199	0	1.6	98.4	30	15	121	45	76			96
OL-STA-10014-SB	OL-0111-13	23-25 Ft	24	73											
OL-STA-10014-SB	OL-0111-14	28-30 Ft	29	71											
OL-STA-10014-SB	OL-0111-15	32.5-34.5 Ft	33.5	48											
OL-STA-10014-SB	OL-0110-08	34.5-36.5 Ft	35.5	175	0	1.6	98.4	40	22		NP		5.8	2.65	91
OL-STA-10014-SB	OL-0111-16	40-42 Ft	41	99											
OL-STA-10014-SB	OL-0111-17	44-46 Ft	45	38											

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

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OL-STA-10014-SB	OL-0110-09	46-48 Ft	47	175	0	0.1	99.9	48	30	77	31	46	3.7	2.7	52
OL-STA-10014-SB	OL-0110-10	48-50 Ft	49	72	0	0.3	99.7	53	40	85	34	51		2.73	
OL-STA-10014-SB	OL-0111-18	50-52 Ft	51	73											
OL-STA-10015-SB	OL-0110-64	11.5-13.5 Ft	12.5	190	0.1	1	98.9	11	5	79	48	31		2.54	
OL-STA-10015-SB	OL-0110-65	15.5-17.5 Ft	16.5	259	0	3	97	28	15	138	51	87			
OL-STA-10015-SB	OL-0110-68	36.5-38.5 Ft	37.5	83	0	0.3	99.7	41	23	91	47	44		2.6	
OL-STA-10015-SB	OL-0110-69	38.5-40.5 Ft	39.5	86	0	0.4	99.6	47	30	97	37	60			
OL-STA-10016-SB	OL-0111-20	0-2 Ft	1	124	0	1	99	27	10	60	38	22		2.34	
OL-STA-10016-SB	OL-0111-21	5-7 Ft	6	61											
OL-STA-10016-SB	OL-0111-22	10-12 Ft	11	75											
OL-STA-10016-SB	OL-0110-12	12-14 Ft	13	143	0	1.4	98.6	19	11	101	47	54		2.56	100
OL-STA-10016-SB	OL-0111-23	15-17 Ft	16	122											
OL-STA-10016-SB	OL-0111-24	20-22 Ft	21	171											
OL-STA-10016-SB	OL-0110-14	22-24 Ft	23	110	0	1.9	98.1	15	6	62	40	22			100
OL-STA-10016-SB	OL-0111-25	25-27 Ft	26	84											
OL-STA-10016-SB	OL-0111-26	30-32 Ft	31	72											
OL-STA-10016-SB	OL-0111-27	35-37 Ft	36	76											
OL-STA-10016-SB	OL-0110-15	37-39 Ft	38	87	0	1.2	98.8	47	31	111	42	69	8.8	2.6	43
OL-STA-10016-SB	OL-0110-16	39-41 Ft	40	74	0	0.6	99.4	53	33	96	39	57			
OL-STA-10017-SB	OL-0111-28	0-2 Ft	1	229	0	1.3	98.7	30	23	100	37	63		2.38	
OL-STA-10017-SB	OL-0111-29	6-8 Ft	7	99											
OL-STA-10017-SB	OL-0111-30	11-13 Ft	12	148											
OL-STA-10017-SB	OL-0110-17	13-15 Ft	14	106	0	1.6	98.4	32	12	58	40	18	3.4	2.54	96
OL-STA-10017-SB	OL-0111-31	16-18 Ft	17	69											
OL-STA-10017-SB	OL-0111-32	21-23 Ft	22	87											
OL-STA-10017-SB	OL-0111-33	26-28 Ft	27	110	0.4	2.8	96.8	45	29	107	41	66		2.64	
OL-STA-10017-SB	OL-0110-20	28-30 Ft	29	90	0	0.8	99.2	44	29	101	40	61	7	2.63	43
OL-STA-10017-SB	OL-0110-21	30-32 Ft	31	90	0	1.5	98.5	51	32	89	36	53			
OL-STA-10017-SB	OL-0111-34	34-36 Ft	35	73											
OL-STA-10018-SB	OL-0111-35	0-2 Ft	1	121											
OL-STA-10018-SB	OL-0111-36	6-8 Ft	7	73											
OL-STA-10018-SB	OL-0110-23	8-10 Ft	9	158	0	15.2	84.8	32	16	128	67	61	10.7		100
OL-STA-10018-SB	OL-0111-37	11-13 Ft	12	124											
OL-STA-10018-SB	OL-0111-38	16-18 Ft	17	87											
OL-STA-10018-SB	OL-0111-39	21-23 Ft	22	50											
OL-STA-10018-SB	OL-0111-40	26-28 Ft	27	50											
OL-STA-10018-SB	OL-0111-41	31-33 Ft	32	83	0	4.3	95.7	35	24	86	32	54			70
OL-STA-10018-SB	OL-0111-42	35-37 Ft	36	50	0	2.8	97.2	64	43	67	30	37			96
OL-STA-10018-SB	OL-0110-26	37-39 Ft	38	50	0	0.7	99.3	67	40	60	35	25	5.6	2.68	87
OL-STA-10018-SB	OL-0118-26	41-43 Ft	42	46	0	0.2	99.8	59	39	48	19	29			
OL-STA-10018-SB	OL-0110-27	48-50 Ft	49	34	0	0.5	99.5	51	32	33	18	15	0.6	2.79	9
OL-STA-10018-SB	OL-0110-28	52-54 Ft	53	34	0	0.1	99.9	66	48	36	16	20			
OL-STA-10019-SB	OL-0111-45	0-2 Ft	1	71											
OL-STA-10019-SB	OL-0111-46	5-7 Ft	6	151											
OL-STA-10019-SB	OL-0110-29	7.5-9.5 Ft	8.5	124	0	2.7	97.3	31	14	73	35	38	5.4	2.42	87
OL-STA-10019-SB	OL-0111-47	10.5-12.5 Ft	11.5	168											

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

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OL-STA-10019-SB	OL-0110-30	12.5-14.5 Ft	13.5	158	0.2	15.7	84.1	31	10	95	57	38			
OL-STA-10019-SB	OL-0111-48	15.5-17.5 Ft	16.5	121											
OL-STA-10019-SB	OL-0111-49	20.5-22.5 Ft	21.5	208											
OL-STA-10019-SB	OL-0111-50	25.5-27.5 Ft	26.5	126											
OL-STA-10019-SB	OL-0111-98	27.5-29.5 Ft	28.5	151											
OL-STA-10019-SB	OL-0111-51	35.5-37.5 Ft	36.5	62	0	1.3	98.7	52	33	78	32	46			61
OL-STA-10019-SB	OL-0111-52	40.5-42 Ft	41.25	50	0	0.6	99.4	64	42	71	30	41			65
OL-STA-10019-SB	OL-0111-53	45.5-47 Ft	46.25	34	0	0.3	99.7	56	26	67	32	35			65
OL-STA-10019-SB	OL-0111-54	50.5-52.5 Ft	51.5	39											
OL-STA-10019-SB	OL-0111-55	55.5-57.5 Ft	56.5	28											
OL-STA-10019-SB	OL-0110-32	59.5-61.5 Ft	60.5	42	0	0.1	99.9	62	43	50	20	30		2.78	
OL-STA-10019-SB	OL-0110-33	61.5-63.5 Ft	62.5	27	0	0.1	99.9	54	40	47	18	29			
OL-STA-10019-SB	OL-0111-56	63.5-65.5 Ft	64.5	23											
OL-STA-10020-SB	OL-0111-57	0-2 Ft	1	19											
OL-STA-10020-SB	OL-0111-58	5-7 Ft	6	3											
OL-STA-10020-SB	OL-0111-59	10-12 Ft	11	111											
OL-STA-10020-SB	OL-0110-34	12-14 Ft	13	330	0	6.6	93.4	16	9		NP		7.4	2.64	
OL-STA-10020-SB	OL-0111-60	15-17 Ft	16	249											
OL-STA-10020-SB	OL-0110-35	17-19 Ft	18	247	0	1.4	98.6	36	13	106	75	31			
OL-STA-10020-SB	OL-0111-61	20-22 Ft	21	253											
OL-STA-10020-SB	OL-0110-36	22-24 Ft	23	441	0	0.1	99.9	74	41		NP				
OL-STA-10020-SB	OL-0111-62	25-27 Ft	26	452											
OL-STA-10020-SB	OL-0111-63	30-32 Ft	31	172											
OL-STA-10020-SB	OL-0111-64	35-37 Ft	36	118											
OL-STA-10020-SB	OL-0111-65	40-42 Ft	41	67											
OL-STA-10020-SB	OL-0111-66	45-47 Ft	46	63											
OL-STA-10020-SB	OL-0111-67	50-52 Ft	51	50											
OL-STA-10020-SB	OL-0111-68	55-57 Ft	56	45											
OL-STA-10020-SB	OL-0110-38	59-61 Ft	60	39	0	0.1	99.9	59	38	35	19	16			
OL-STA-10020-SB	OL-0110-39	62-64 Ft	63	43	0	0.1	99.9	69	50	34	20	14	2.7	2.76	
OL-STA-10020-SB	OL-0111-69	64-66 Ft	65	20											
OL-STA-10021-SB	OL-0111-70	0-2 Ft	1	133											
OL-STA-10021-SB	OL-0111-71	6.5-8.5 Ft	7.5	101											
OL-STA-10021-SB	OL-0111-72	11.5-13.5 Ft	12.5	188											
OL-STA-10021-SB	OL-0110-40	13.5-15.5 Ft	14.5	201	0	4.1	95.9	38	20	110	47	63			
OL-STA-10021-SB	OL-0111-73	16-18 Ft	17	96											
OL-STA-10021-SB	OL-0110-41	18-20.5 Ft	19.25	118	0	3.1	96.9	29	9	87	42	45	5.5	2.53	100
OL-STA-10021-SB	OL-0111-74	22-24 Ft	23	87											
OL-STA-10021-SB	OL-0111-75	26-28 Ft	27	85											
OL-STA-10021-SB	OL-0111-76	31.5-33.5 Ft	32.5	180											
OL-STA-10021-SB	OL-0111-77	36.5-38.5 Ft	37.5	81											
OL-STA-10021-SB	OL-0111-78	41-43 Ft	42	59											
OL-STA-10021-SB	OL-0111-79	47-49 Ft	48	52											
OL-STA-10021-SB	OL-0111-80	51.5-53.5 Ft	52.5	42											
OL-STA-10021-SB	OL-0111-81	56-58 Ft	57	31											
OL-STA-10021-SB	OL-0111-82	63.5-65.5 Ft	64.5	37											
OL-STA-10021-SB	OL-0110-43	65.5-67.5 Ft	66.5	57	0	0.2	99.8	59	43	41	37	4	3.3	2.73	
OL-STA-10021-SB	OL-0110-44	67.5-69.5 Ft	68.5	52	0	0.3	99.7	70	50	62	29	33			
OL-STA-10021-SB	OL-0111-83	71.5-73.5 Ft	72.5	18											
OL-STA-10022-SB	OL-0111-84	0-2 Ft	1	151											
OL-STA-10022-SB	OL-0110-45	12-14 Ft	13	157	0.1	1.7	98.2	36	15	106	55	51	5.1	2.58	87
OL-STA-10022-SB	OL-0110-46	17-19 Ft	18	112	0	6.9	93.1	33	13	112	45	67			
OL-STA-10022-SB	OL-0110-49	64-66 Ft	65	60	0	0.1	99.9	62	42	66	32	34			

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OL-STA-10022-SB	OL-0110-50	66-68 Ft	67	46	0	0.3	99.7	55	33	63	32	31	11.3	2.67	
OL-STA-10023-SB	OL-0071-54	0-2 Ft	1	173	0	35.4	64.6	17	7		NP		8.3	2.61	70
OL-STA-10023-SB	OL-0071-55	6-8 Ft	7	99											
OL-STA-10023-SB	OL-0071-56	11-13 Ft	12	73											
OL-STA-10023-SB	OL-0052-06	13-15 Ft	14	81	0	0.5	99.5	17	6		NP		4.8	2.34	78
OL-STA-10023-SB	OL-0071-57	16-18 Ft	17	85											
OL-STA-10023-SB	OL-0071-58	21-23 Ft	22	106											
OL-STA-10023-SB	OL-0071-59	26-28 Ft	27	72											
OL-STA-10023-SB	OL-0071-60	36-38 Ft	37	88											
OL-STA-10023-SB	OL-0071-61	41-43 Ft	42	88											
OL-STA-10023-SB	OL-0071-62	46-48 Ft	47	74											
OL-STA-10023-SB	OL-0052-04	50-52 Ft	51	71	0	0.2	99.8	31	21	91	39	52	7.5	2.65	35
OL-STA-10023-SB	OL-0071-65	54-56 Ft	55	65											
OL-STA-10024-SB	OL-0071-66	0-2 Ft	1	100											
OL-STA-10024-SB	OL-0071-67	5-7 Ft	6	67											
OL-STA-10024-SB	OL-0071-68	9-11 Ft	10	236	0	61	39	12	7	123	68	55	5.9	2.54	61
OL-STA-10024-SB	OL-0071-69	13-15 Ft	14	77											
OL-STA-10024-SB	OL-0052-07	15-17 Ft	16	124	0	13.2	86.8	24	11	83	63	20	6.7	2.48	78
OL-STA-10024-SB	OL-0071-70	18-20 Ft	19	156											
OL-STA-10024-SB	OL-0071-71	23-25 Ft	24	127											
OL-STA-10024-SB	OL-0071-72	28-30 Ft	29	130											
OL-STA-10024-SB	OL-0052-09	30-32 Ft	31	146	0	0.2	99.8	30	8	156	69	87	8	2.52	83
OL-STA-10024-SB	OL-0071-73	33-35 Ft	34	81											
OL-STA-10024-SB	OL-0071-74	38-40 Ft	39	88											
OL-STA-10024-SB	OL-0071-75	43-45 Ft	44	105											
OL-STA-10024-SB	OL-0071-76	48-50 Ft	49	70											
OL-STA-10024-SB	OL-0071-77	53-55 Ft	54	64											
OL-STA-10024-SB	OL-0071-78	58-59.5 Ft	58.75	59											
OL-STA-10024-SB	OL-0052-12	64-66 Ft	65	70	0	1.2	98.8	39	26	90	40	50	6.8	2.66	48
OL-STA-10025-SB	OL-0071-31	0-2 Ft	1	157	0	2.6	97.4	21	10		NP		5	2.39	83
OL-STA-10025-SB	OL-0052-13	7-9 Ft	8	178	0	4.5	95.5	26	8		NP		7.6	2.43	87
OL-STA-10025-SB	OL-0071-32	15-17 Ft	16	206											
OL-STA-10025-SB	OL-0071-33	20-22 Ft	21	152											
OL-STA-10025-SB	OL-0071-34	25-27 Ft	26	103											
OL-STA-10025-SB	OL-0071-35	30-32 Ft	31	222											
OL-STA-10025-SB	OL-0071-36	35-37 Ft	36	185											
OL-STA-10025-SB	OL-0071-37	40-42 Ft	41	121											
OL-STA-10025-SB	OL-0071-38	45-47 Ft	46	77											
OL-STA-10025-SB	OL-0071-39	50-52 Ft	51	77											
OL-STA-10025-SB	OL-0052-16	52-54 Ft	53	67	0	0.5	99.5	36	24	94	38	56	3.6	2.61	43
OL-STA-10025-SB	OL-0071-40	55-57 Ft	56	69											
OL-STA-10025-SB	OL-0071-41	60-62 Ft	61	69											
OL-STA-10026-SB	OL-0071-79	5-7 Ft	6	84	21.7	13.9	64.4	15	7	93	67	26	5.3	2.42	65
OL-STA-10026-SB	OL-0052-19	7-9 Ft	8	102	0	5.1	94.9	19	6		NP		7.2	2.64	83
OL-STA-10026-SB	OL-0071-80	11-13 Ft	12	18											
OL-STA-10026-SB	OL-0071-81	16-18 Ft	17	85											
OL-STA-10026-SB	OL-0071-82	21-23 Ft	22	95											
OL-STA-10026-SB	OL-0071-83	26-28 Ft	27	123											
OL-STA-10026-SB	OL-0071-84	31-33 Ft	32	89											
OL-STA-10026-SB	OL-0071-85	36-38 Ft	37	97											
OL-STA-10026-SB	OL-0071-86	41-43 Ft	42	96											
OL-STA-10026-SB	OL-0071-87	46-48 Ft	47	74											
OL-STA-10026-SB	OL-0052-22	50-52 Ft	51	71	0	0.3	99.7	40	25	90	41	49	5.7	2.59	43

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OL-STA-20001-SB	OL-0072-07	20-22 Ft	21	68	0	34.5	65.5	28	20	60	37	23	2.3		9
OL-STA-20001-SB	OL-0072-09	44.9-46.9 Ft	45.9	29	0	0.1	99.9	50	35	27	16	11	1		78
OL-STA-20001-VC	OL-0071-01	0-3.3 Ft	1.65	62	0	35.3	64.7	20	12				2	2.65	
OL-STA-20001-VC	OL-0071-02	13.2-16.5 Ft	14.85	65	0	19.1	80.9	26	17				1.5		
OL-STA-20002-VC	OL-0071-03	3.3-6.6 Ft	4.95	89	0	12.8	87.2	10	5	65	41	24	4.4	2.36	
OL-STA-20002-VC	OL-0071-04	13.2-16.5 Ft	14.85	104	0	11.3	88.7	18	12	88	39	49	14.6	2.36	
OL-STA-20002-VC	OL-0095-01	20.3-23.6 Ft	21.95	61	0	3	97	52	33	53	41	12	7.2		96
OL-STA-20002-VC	OL-0095-02	33.5-36.8 Ft	35.15	26	0	2.9	97.1	23	19		NP		1.2		13
OL-STA-20003-VC	OL-0071-05	6.6-9.9 Ft	8.25	107	0	5.5	94.5	18	8	88	39	49	9.2	2.34	
OL-STA-20003-VC	OL-0071-06	13.2-16.5 Ft	14.85	78	0	28.6	71.4	17	9		NP		3.6	2.62	30
OL-STA-20003-VC	OL-0071-07	16.5-17.5 Ft	17	96	0	3.4	96.6	12	10	83	34	39	1.4		78
OL-STA-20003-VC	OL-0095-03	26.9-30.2 Ft	28.55	52	0	1.4	98.6	63	39	56	42	14	6.4		
OL-STA-20003-VC	OL-0095-04	36.8-40.2 Ft	38.5	16	0	0.5	99.5	27	20	24	15	9	1		
OL-STA-20004-SB	OL-0072-01	12-14 Ft	13	108	0	2.6	97.4	43	30	77	51	26	4.8		87
OL-STA-20004-SB	OL-0072-02	36.6-38.6 Ft	37.6	27	0	0.6	99.4	46	34	26	14	12	1.3		78
OL-STA-20004-VC	OL-0071-08	0-3.3 Ft	1.65	136	0	27	73	22	13	85	44	41	13.9		
OL-STA-20004-VC	OL-0071-09	23.5-26.7 Ft	25.1	64	0.6	10.6	88.8	30	19	76	35	41	4.7		78
OL-STA-20004-VC	OL-0071-10	33.3-36.6 Ft	34.95	61	0.7	1.5	97.8	60	32	63	34	29	1.8	2.69	70
OL-STA-20004-VC	OL-0118-25	0-3.3 Ft	1.65											2.69	
OL-STA-20005-VC	OL-0071-11	6.6-9.9 Ft	8.25	127	0	1.6	98.4	17	12	98	43	55	9.5		
OL-STA-20005-VC	OL-0071-12	23.2-26.6 Ft	24.9	68	0	0.9	99.1	60	31	72	37	35	3.3	2.66	70
OL-STA-20005-VC	OL-0071-13	33.3-36.6 Ft	34.95	40	0	0.3	99.7	59	38	52	23	29	2.1		17
OL-STA-20006-VC	OL-0071-14	6.6-9.9 Ft	8.25	253	0	2.5	97.5	36	20	0	0	0	6		
OL-STA-20006-VC	OL-0071-15	23.6-27 Ft	25.3	61	0	1.1	98.9	53	31	72	28	44	1.6		61
OL-STA-20006-VC	OL-0071-16	36.9-40.2 Ft	38.55	27	0	0.1	99.9	44	31	25	14	11	1.3		9
OL-STA-20007-SB	OL-0072-04	23-25 Ft	24	67	0	1.4	98.6	64	33	67	38	29	2.5		9
OL-STA-20007-SB	OL-0072-05	38.6-40.6 Ft	39.6	43	0	0.2	99.8	58	39	45	19	26	1.8		61
OL-STA-20007-VC	OL-0071-17	3.3-6.6 Ft	4.95	113	0	7.5	92.5	13	11	110	39	71	15.7		
OL-STA-20007-VC	OL-0071-18	9.9-13.2 Ft	11.55	185	0	0.8	99.2	32	25		NP		5.2		
OL-STA-20008-VC	OL-0071-19	9.9-13.2 Ft	11.55	173	0	0.2	99.8	43	20		NP		3.8		
OL-STA-20009-VC	OL-0071-20	6.6-9.9 Ft	8.25	90	0	72.3	27.7	7	4				2.1	2.59	
OL-STA-20009-VC	OL-0071-21	16.5-19.8 Ft	18.15	73	0	23.5	76.5	15	6	73	43	30	2.7	2.61	100
OL-STA-20009-VC	OL-0095-06	23.6-26.9 Ft	25.25	79	0	66.3	33.7	10	7		NP		2.2		
OL-STA-20009-VC	OL-0095-07	36.8-40.1 Ft	38.45	21	0	0.9	99.1	19	14	45	25	20	0.6		
OL-STA-20010-VC	OL-0071-22	3.3-6.6 Ft	4.95	78	0	73.9	26.1	9	7				1.2	2.65	
OL-STA-20010-VC	OL-0071-23	13.2-16.5 Ft	14.85	73	0	46.1	53.9	15	12				3.7	2.63	87
OL-STA-20010-VC	OL-0095-08	26.9-30.2 Ft	28.55	58	0	8	92	42	27	64	48	16	3.3		96
OL-STA-20010-VC	OL-0095-09	36.8-40.1 Ft	38.45	38	0	0.9	99.1	51	34	32	20	12	0.6		26
OL-STA-20011-VC	OL-0071-24	16.5-19.8 Ft	18.15	64	0	1.9	98.1	44	27	83	35	48	5.7	2.63	78
OL-STA-20011-VC	OL-0101-01	33.5-36.8 Ft	35.15	47	0	0.2	99.8	68	49	46	20	26	9.8	2.74	26
OL-STA-20012-VC	OL-0071-25	3.3-6.6 Ft	4.95	128	0	10.9	89.1	7	3	109	46	63	13.4		
OL-STA-20012-VC	OL-0071-26	33.3-36.6 Ft	34.95	36	0	0.1	99.9	67	43	48	24	24	23.3	2.47	17
OL-STA-20012-VC	OL-0118-24	26.6-30 Ft	28.3	66	0	1.1	98.9	63	34	65	30	35	3		70
OL-STA-20013-VC	OL-0071-27	13.2-16.5 Ft	14.85	138	0.1	0.7	99.2	32	16		NP		6.3		
OL-STA-20013-VC	OL-0095-10	33-36 Ft	34.5	48	0	5.7	94.3	33	21	65	40	25	7.4		87
OL-STA-20013-VC	OL-0095-11	39-42.2 Ft	40.6	30	0	0.6	99.4	46	30	31	15	16	7.5		17
OL-STA-20014-VC	OL-0071-28	0-3.3 Ft	1.65	132	0	1.6	98.4	15	6	71	46	25	7		
OL-STA-20014-VC	OL-0071-29	13.2-16.5 Ft	14.85	116	0	3.9	96.1	33	16	84	56	28	4.8		

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OL-STA-20014-VC	OL-0101-02	23.3-26.9 Ft	25.1	62	0	0.7	99.3	69	50	64	31	33	3.1	2.69	91
OL-STA-20014-VC	OL-0101-03	30.1-33.4 Ft	31.75	38	0	0.5	99.5	46	23	66	31	35	4.7	2.68	96
OL-STA-20015-VC	OL-0071-30	3.3-6.6 Ft	4.95	178	0	0.5	99.5	39	18	127	63	64	6.5		
OL-STA-20015-VC	OL-0095-12	23.6-26.9 Ft	25.25	35	0	0.8	99.2	60	28	61	42	19	3.3		
OL-STA-20015-VC	OL-0095-13	30.2-33.5 Ft	31.85	24	0	0.3	99.7	44	30	32	22	10	5.3		
OL-STA-20016-SB	OL-0110-51	14-16 Ft	15	28	0	8.9	91.1	35	24	25	15	10	0.9	2.7	9
OL-STA-20016-SB	OL-0110-52	27-29 Ft	28	29	0.1	0.2	99.7	11	8		NP			2.75	
OL-STA-20016-SB	OL-0110-53	57-59 Ft	58		0	9.3	90.7	7	6		NP			2.71	
OL-STA-20017-SB	OL-0110-57	10-12 Ft	11	79	0	15.7	84.3	14	10		NP		3	2.67	
OL-STA-20017-SB	OL-0110-58	37-39 Ft	38	79	0	0.2	99.8	66	53	40	16	24	9	2.57	
OL-STA-20017-SB	OL-0110-59	42-44 Ft	43	28	0	0.1	99.9	50	35	23	13	10			
OL-STA-20018-SB	OL-0110-54	10-12 Ft	11	68	0	19.5	80.5	18	11	41	29	12	2	2.68	61
OL-STA-20018-SB	OL-0110-55	47-49 Ft	48	33	0.1	0.3	99.6	53	36	35	16	19			
OL-STA-20018-SB	OL-0110-56	51-53 Ft	52	27	0	0	100	65	46	32	18	14			
OL-STA-20019-VC	OL-0101-04	23.6-26.9 Ft	25.25	71	0.1	14.7	85.2	32	20	64	33	31	2.4	2.68	96
OL-STA-20019-VC	OL-0101-05	33.5-36.8 Ft	35.15	44	0.1	0.9	99	66	45	46	22	24	1.1	2.78	35
OL-STA-20020-VC	OL-0101-06	20.3-23.6 Ft	21.95	65	0.4	10.3	89.3	35	23	74	36	38	4.7	2.62	87
OL-STA-20020-VC	OL-0101-07	36.8-40.1 Ft	38.45	29	0	1.2	98.8	41	29	31	14	17	1.8	2.7	17
OL-STA-20021-VC	OL-0101-08	17-20.3 Ft	18.65	226	0.3	1.8	97.9	39	30	138	89	49	8.9	2.7	57
OL-STA-20021-VC	OL-0101-09	26.9-30.2 Ft	28.55	56	0.2	2.4	97.4	63	40	63	29	34	8.4	2.7	87
OL-STA-20021-VC	OL-0101-10	33.5-36.8 Ft	35.15	53	0.1	0.6	99.3	63	44	48	20	28	3.3	2.75	26
OL-STA-20022-VC	OL-0101-11	17-20.3 Ft	18.65	248	0	1	99	39	28	129	79	50	8	2.54	65
OL-STA-20022-VC	OL-0101-12	23.6-26.9 Ft	25.25	51	0	2.8	97.2	51	36	74	30	44	13.3	2.68	78
OL-STA-20022-VC	OL-0101-13	33.5-36.8 Ft	35.15	41	0	0.4	99.6	61	41	48	19	29	6.6	2.45	13
OL-STA-20023-VC	OL-0101-14	17-20.3 Ft	18.65	204	0	2.3	97.7	4	4	112	69	43	2.6	2.7	57
OL-STA-20023-VC	OL-0101-15	20.3-21.3 Ft	20.8	72	0	4.6	95.4	48	38	80	34	46	5	2.6	87
OL-STA-20023-VC	OL-0101-16	30.2-33.5 Ft	31.85	47	0	0.7	99.3	53	36	35	17	18	5	2.77	30

Note:
NP indicates non-plastic.

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Table 2

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Bulk Density (pcf)	Water Content (%)	Dry Density (pcf)
OL-STA-10013-SB	OL-0110-01	7-9	8	83.4	123	37.4
OL-STA-10013-SB	OL-0110-02	12-14	13	72.6	245	21.0
OL-STA-10013-SB	OL-0110-05	41-43	42	99	58	62.8
OL-STA-10014-SB	OL-0110-06	14.5-16.5	15.5	79	259	22.0
OL-STA-10014-SB	OL-0110-08	34.5-36.5	35.5	77.7	173	28.4
OL-STA-10014-SB	OL-0110-10	48-50	49	93.9	39	67.8
OL-STA-10015-SB	OL-0110-64	11.5-13.5	12.5	78.2	180	27.9
OL-STA-10015-SB	OL-0110-68	36.5-38.5	37.5	91.8	81	50.6
OL-STA-10016-SB	OL-0110-12	12-14	13	84.2	136	35.8
OL-STA-10016-SB	OL-0110-15	37-39	38	89.9	86	48.3
OL-STA-10017-SB	OL-0110-17	13-15	14	83	112	39.1
OL-STA-10017-SB	OL-0110-20	28-30	29	89.1	91	46.6
OL-STA-10018-SB	OL-0110-23	8-10	9	79	153	31.3
OL-STA-10018-SB	OL-0110-26	37-39	38	105	56	67.2
OL-STA-10018-SB	OL-0110-27	48-50	49	114	29	88.7
OL-STA-10019-SB	OL-0110-30	12.5-14.5	13.5	81.1	155	31.8
OL-STA-10019-SB	OL-0110-32	59.5-61.5	60.5	109.2	46	74.9
OL-STA-10020-SB	OL-0110-34	12-14	13	71	334	16.4
OL-STA-10020-SB	OL-0110-39	62-64	63	113	42	79.7
OL-STA-10021-SB	OL-0110-40	13.5-15.5	14.5	78.2	154	30.8
OL-STA-10021-SB	OL-0110-41	18-20.5	19.25	84.3	113	39.5
OL-STA-10021-SB	OL-0110-43	65.5-67.5	66.5	103	59	65.0
OL-STA-10022-SB	OL-0110-45	12-14	13	80	165	30.2
OL-STA-10022-SB	OL-0110-50	66-68	67	101	64	62.0
OL-STA-10023-SB	OL-0052-06	13-15	14	86.2	107	41.6
OL-STA-10023-SB	OL-0052-04	50-52	51	97.7	71	57.1
OL-STA-10024-SB	OL-0052-07	15-17	16	86.9	99	43.6
OL-STA-10024-SB	OL-0052-09	30-32	31	77.8	177	28.1
OL-STA-10024-SB	OL-0052-12	64-66	65	97.9	69	57.9
OL-STA-10025-SB	OL-0052-13	7-9	8	78.9	140	32.9
OL-STA-10025-SB	OL-0052-16	52-54	53	98	69	58.0
OL-STA-10026-SB	OL-0052-19	7-9	8	85.9	125	38.3
OL-STA-10026-SB	OL-0052-22	50-52	51	96.4	72	56.1
OL-STA-20001-SB	OL-0072-07	20-22	21	98.2	70	57.7
OL-STA-20001-SB	OL-0072-09	45-47	46	122	29	93.9
OL-STA-20004-SB	OL-0072-01	12-14	13	89.4	102	44.3
OL-STA-20004-SB	OL-0072-02	36.6-38.6	37.6	121	30	93.6
OL-STA-20007-SB	OL-0072-04	23-25	24	102	50	68.3
OL-STA-20007-SB	OL-0072-05	38.6-40.6	39.6	106	48	71.2
OL-STA-20016-SB	OL-0110-51	14-16	15	131	16	113.0
OL-STA-20017-SB	OL-0110-59	42-44	43	127	23	104.0
OL-STA-20018-SB	OL-0110-54	10-12	11	95.7	69	56.6
OL-STA-20018-SB	OL-0110-56	51-53	52	115	36	84.6

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Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Table 3

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Compression Index (Cc)	Recompression Index (Cr)	Initial Void Ratio (e_o)	Initial Water Content (%)	Preconsolidation Pressure (tsf)
OL-STA-10013	OL-0110-05	41-43	42	0.51	0.06	1.60	57.6	0.6
OL-STA-10014	OL-0110-08	34.5-36.5	35.5	0.94	0.01	3.05	113.1	0.6
OL-STA-10017	OL-0110-20	28-30	29	0.94	0.13	2.74	103.7	0.3
OL-STA-10018	OL-0110-27	48-50	49	0.36	0.03	1.06	36.5	0.7
OL-STA-10019	OL-0110-30	12.5-14.5	13.5	0.08	0.01	4.24	148.7	1.0
OL-STA-10022	OL-0110-49	64-66	65	0.70	0.06	1.85	67.2	0.8
OL-STA-10023	OL-0052-06	13-15	14	1.59	0.02	3.38	142.2	0.5
OL-STA-10023	OL-0052-04	50-52	51	0.73	0.07	1.94	72.5	0.9
OL-STA-10024	OL-0052-07	15-17	16	1.18	0.02	3.08	120.9	0.8
OL-STA-10024	OL-0052-09	30-32	31	2.84	0.03	4.93	180.0	1.4
OL-STA-10024	OL-0052-12	64-66	65	0.57	0.09	1.81	63.4	0.6
OL-STA-10025	OL-0052-13	7-9	8	2.04	0.02	4.53	183.6	0.9
OL-STA-10025	OL-0052-16	52-54	53	0.65	0.08	1.88	70.3	0.7
OL-STA-10026	OL-0052-19	7-9	8	1.22	0.03	3.17	105.7	0.9
OL-STA-10026	OL-0052-22	50-52	51	0.69	0.09	1.99	76.5	0.7
OL-STA-20001	OL-0072-07	20-22	21	0.37	0.02	1.87	64.2	0.3
OL-STA-20001	OL-0072-09	44.9-46.9	45.9	0.26	0.04	0.95	32.7	0.5
OL-STA-20004	OL-0072-01	12-14	13	0.72	0.01	2.91	102.3	0.3
OL-STA-20004	OL-0072-02	36.6-38.6	37.6	0.16	0.02	0.90	31.4	0.4
OL-STA-20007	OL-0072-04	23-25	24	0.41	0.03	1.89	65.8	0.3
OL-STA-20007	OL-0072-05	38.6-40.6	39.6	0.49	0.05	1.33	48.6	0.5
OL-STA-20016	OL-0110-52	27-29	28	0.19	0.04	0.89	30.9	0.4
OL-STA-20017	OL-0110-57	10-12	11	0.51	0.01	1.42	37.2	0.4
OL-STA-20017	OL-0110-59	42-44	43	0.22	0.03	0.87	31.1	0.6
OL-STA-20018	OL-0110-55	47-49	48	0.23	0.02	0.91	32.7	0.7

Note:
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Table 4

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Water Content (%)	Dry Density (pcf)	Undrained Strength (psf)	Strain at Failure (%)
OL-STA-10013	OL-0110-02	12.0-14.0	13	245.2	21.0	382.3	2.6
OL-STA-10014	OL-0110-08	34.5-36.5	35.5	173.1	28.4	215.2	9.4
OL-STA-10014	OL-0110-10	48.0-50.0	49	38.5	67.8	165.6	14.3
OL-STA-10015	OL-0110-64	11.5-13.5	12.5	179.9	27.9	109.9	4.0
OL-STA-10015	OL-0110-68	36.5-38.5	37.5	81.3	50.6	431.3	6.6
OL-STA-10016	OL-0110-12	12.0-14.0	13	135.5	35.8	103.6	12.6
OL-STA-10016	OL-0110-15	37.0-39.0	38	86.2	48.3	330.9	10.8
OL-STA-10017	OL-0110-17	13.0-15.0	14	112.3	39.1	96.7	5.8
OL-STA-10017	OL-0110-20	28.0-30.0	29	91.2	46.6	247.0	9.0
OL-STA-10018	OL-0110-26	37.0-39.0	38	55.6	67.2	440.3	9.5
OL-STA-10018	OL-0110-27	48.0-50.0	49	28.7	88.7	335.8	7.8
OL-STA-10018	OL-0110-23	8.0-10.0	9	152.5	31.3	303.5	12.1
OL-STA-10019	OL-0110-30	12.5-14.5	13.5	154.6	31.8	309.8	15.0
OL-STA-10019	OL-0110-32	59.5-61.5	60.5	45.8	74.9	384.9	5.7
OL-STA-10020	OL-0110-34	12.0-14.0	13	333.8	16.4	74.4	6.0
OL-STA-10020	OL-0110-36	22.0-24.0	23	440.2	13.0	651.6	6.7
OL-STA-10020	OL-0110-39	62.0-64.0	63	41.6	79.7	285.7	13.9
OL-STA-10021	OL-0110-41	18-20.5	19.25	113.1	39.5	144.0	15.0
OL-STA-10021	OL-0110-43	65.5-67.5	66.5	59.0	65.0	417.1	9.8
OL-STA-10022	OL-0110-45	12.0-14.0	13	164.7	30.2	259.3	15.0
OL-STA-10022	OL-0110-50	66.0-68.0	67	63.6	62.0	406.8	8.7
OL-STA-10023	OL-0052-06	13.0-15.0	14	107.1	41.6	163.3	8.9
OL-STA-10023	OL-0052-04	50.0-52.0	51	71.2	57.1	465.2	6.4
OL-STA-10024	OL-0052-07	15.0-17.0	16	99.3	43.6	429.2	18.3
OL-STA-10024	OL-0052-09	30.0-32.0	31	176.9	28.1	464.5	11.7
OL-STA-10024	OL-0052-12	64.0-66.0	65	69.2	57.9	518.1	9.5
OL-STA-10025	OL-0052-16	52.0-54.0	53	68.8	58.0	460.3	8.2
OL-STA-10025	OL-0052-13	7.0-9.0	8	139.6	32.9	242.4	15.0
OL-STA-10026	OL-0052-22	50.0-52.0	51	71.7	56.1	476.7	9.6
OL-STA-10026	OL-0052-19	7.0-9.0	8	124.5	38.3	207.7	8.1
OL-STA-20001	OL-0072-07	20.0-22.0	21	70.2	57.7	99.8	11.7
OL-STA-20001	OL-0072-09	44.9-46.9	45.9	29.4	93.9	200.5	12.5
OL-STA-20004	OL-0072-01	12.0-14.0	13	101.9	44.3	63.2	10.8
OL-STA-20004	OL-0072-02	36.6-38.6	37.6	29.7	93.6	203.4	15.0
OL-STA-20007	OL-0072-04	23.0-25.0	24	49.9	68.3	247.6	10.5
OL-STA-20007	OL-0072-05	38.6-40.6	39.6	48.3	71.2	316.5	5.9
OL-STA-20016	OL-0110-51	14.0-16.0	15	15.6	113.4	3051.0	1.8
OL-STA-20016	OL-0110-52	27.0-29.0	28	26.8	98.1	229.5	4.0
OL-STA-20016	OL-0110-53	57.0-59.0	58	16.8	115.8	2240.0	9.8
OL-STA-20017	OL-0110-57	10.0-12.0	11	82.4	51.2	312.6	6.1
OL-STA-20017	OL-0110-58	37.0-39.0	38	29.2	95.7	576.4	5.5
OL-STA-20017	OL-0110-59	42.0-44.0	43	22.7	103.8	402.0	15.0
OL-STA-20018	OL-0110-54	10.0-12.0	11	62.7	58.8	222.5	12.5
OL-STA-20018	OL-0110-55	47.0-49.0	48	35.3	85.2	391.4	9.9
OL-STA-20018	OL-0110-56	51.0-53.0	52	35.9	84.6	357.7	9.8

Note:
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Table 5

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Initial Water Content (%)	Dry Density (pcf)	Initial Confining Stress (psf)	Peak Deviator Stress (psf)	Strain at Failure (%)	CU Total Stress Cohesion (psf)	CU Total Stress Friction Angle (degrees)	CU Effective Stress Cohesion (psf)	CU Effective Stress Friction Angle (degrees)
OL-STA-10013	OL-0110-01	7.0-9.0	8	123.4	37.4	180.4	385.6	7.5	67.6	20.4	54.5	37.3
				100.6	41.8	360.2	574.4	10.4				
OL-STA-10013	OL-0110-04	37.0-39.0	38	70.4	58.1	780.7	1120.2	15.0	436	9	349	20.4
				72.2	57.2	1561	1765.4	13.2				
				86.8	50.4	3121	2050	15.0				
OL-STA-10013	OL-0110-05	41.0-43.0	42	65.9	59.2	1720	1654.4	14.0	178	14.9	0	40.5
				60	60.0	3438	2830	15.0				
OL-STA-10014	OL-0110-07	19.5-21.5	20.5	156.3	30.7	432.6	887.6	8.8	298	7.8	201	30.3
				127.1	36.2	864.9	854.4	15.0				
				117.5	39.4	1727	1440.4	10.0				
OL-STA-10014	OL-0110-09	46.0-48.0	47	67.1	59.9	959.3	1324	15.0	280	12.2	227	24.3
				69.5	58.1	1921	1479.2	15.0				
				67.6	59.7	3836	4468	15.0				
OL-STA-10015	OL-0110-69	38.5-40.5	39.5	75.8	55.3	807.1	1197	12.5	446	9.8	152	39.9
				85.2	51.1	1614	2010	15.0				
				81.6	52.6	3227	2246	11.4				
OL-STA-10015	OL-0110-65	44.0-46.0	45	206.5	24.2	348.9	368.0	9.5	121	12	30.3	44.3
				224.4	22.6	699.9	875.6	6.5				
				171.4	27.8	1400	939.8	12.9				
OL-STA-10016	OL-0110-13	170.-19.0	18	134.1	32.7	379.2	454.8	15.0	21.8	19.8	16.4	44.8
				133.8	34.5	759.7	737.4	15.0				
				135	33.7	1519	1635.6	11.9				
OL-STA-10016	OL-0110-16	39.0-41.0	40	75.2	52.9	819	1415	13.0	374	12.7	230	37.8
				80	52.7	1640	1786.4	15.0				
				79.3	53.4	3283	2782	15.0				
OL-STA-10017	OL-0110-21	30.0-32.0	31	88.5	49.7	1279	1652.2	11.3	387	10.9	258	32.5
				95.6	47.1	2562	2150	15.0				
OL-STA-10018	OL-0110-28	52.0-54.0	53	30.3	90.2	1081.3	1568.2	15.0	0	21.6	273.6	24.8
				25.6	96.4	2161.4	2085.1	15.0				
				21.5	97.5	4318.6	6042.2	15.0				
OL-STA-10019	OL-0110-29	7.5-9.5	8.5	110.9	41.0	288.3	504.8	15.0	33.4	27.5	96.2	44.2
				115.8	39.7	575.4	1307.6	15.0				
				104.4	42.5	860.9	1377.4	15.0				
OL-STA-10019	OL-0110-33	61.5-63.5	62.5	46.9	73.4	1296.0	1269.2	15.0	355	9.2	358	22.6
				49	72.6	2519.0	1839.0	10.7				
				52.9	68.8	5041.0	2742.0	11.6				
OL-STA-10020	OL-0110-35	17.0-19.0	18	388.2	14.7	760.0	1008.6	13.6	61	20.7	NA	
				307.9	17.6	1514.9	1446.6	15.0				
OL-STA-10020	OL-0110-38	59.0-61.0	60	24.9	94.0	1208.0	1725.2	15.0	419	13.2	100	36
				21.4	98.1	3630.0	3180.0	15.0				

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OL-STA-10021	OL-0110-40	13.5-15.5	14.5	154.3	30.8	309.0	680.4	15.0	137	20.2	NA	
				199.9	26.1	618.7	1041.2	4.7				
				160	30.2	1239.0	1701.2	12.9				
OL-STA-10021	OL-0110-44	67.5-68.5	68	43.8	70.0	1389.0	2136.0	15.0	627	10.6	110	36.7
				50.1	71.6	2781.0	2760.0	15.0				
OL-STA-10022	OL-0110-46	17.0-19.0	18	116.5	39.9	383.3	523.6	10.5	119	11.6	70.1	34.2
				118.9	39.5	766.7	619.2	12.1				
				118.1	39.8	1531.0	1080.8	2.5				
OL-STA-10022	OL-0110-49	65.0-66.0	65.5	65.7	60.8	1311	1676.8	9.4	441	10.8	428	24
				66	60.6	2620	2312	15.0				
				63.4	62.2	8885	6212	6.4				
OL-STA-10023	OL-0052-05	52.0-54.0	53	61.8	62.3	1099	1218.4	11.5	159	16.1	58.4	39.9
				64.4	59.3	2198	1768.8	13.5				
				63.8	59.6	4414	3244	15.0				
OL-STA-10024	OL-0052-11	62.0-64.0	63	68.2	57.7	1298	1448	12.8	294	12	187	34.8
				68.8	58.6	2597	2038	12.3				
				67.9	58.9	5203	3480	14.7				
OL-STA-10025	OL-0052-17	57.0-59.0	58	56.9	63.6	1199	1936	12.1	749	7.3	504	25.5
				66.5	60.3	2398	2572	14.9				
				67.4	59.8	4801	3042	15.3				
OL-STA-20001	OL-0072-08	38.9-40.9	39.9	22.4	101.6	788.4	2652	15.0	158	18.6	0.86	37.9
				23.3	101.3	1601	4546	15.0				
OL-STA-20004	OL-0072-03	38.6-40.6	39.6	26.5	86.8	1600	1528.8	15.0	13	19.7	75.8	32.5
				23.8	101.7	3200	3180	15.0				
OL-STA-20007	OL-0072-06	36.6-38.6	37.6	25.4	93.3	746.4	770.4	8.8	0	25.1	123	29.3
				25.7	99.1	3001	4356	15.0				
OL-STA-20016	OL-0110-54	10.0-12.0	11	69.3	56.6	241.2	613.2	1.5	172	17.4	0	38
						479.1	972.3	1.3				
						945.4	1240.4	1.1				
OL-STA-20016	OL-0110-51	14.0-16.0	15	40.6	80.0	639.9	1738.4	15.0	159	27.8	46.9	34.5
				15.2	111.3	1281	8642	15.0				
OL-STA-20017	OL-0110-58	37.0-39.0	38	25.4	97.0	780.2	1089.8	4.5	280	8.7	0	36.5
				36.2	83.1	1559	997.6	2.1				
				31.4	88.8	3123	1827.8	2.3				

Note:
1. These parameters are provided to show general material behavior for informational purposes only, additional interpretation will be required for design.
2. NA indicates not applicable. Additional interpretation is required to use these test results.

Phase II Investigation

SMU 1 Index Test Results Summary

Location ID	Field Sample ID	Depth	Average Depth	Water Content	Atterberg Limits (ASTM D4318)			Grain Size (ASTM D422)					Specific
				(ASTM D2216)	Liquid Limit	Plastic Limit	Plasticity Index	Percent Gravel	Percent Sand	Percent Fines (clay & silt)	Clay-sized Particle Content (0.005 mm)	Clay-sized Particle Content (0.002 mm)	Gravity (ASTM D854)
		(ft)	(ft)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	
SICT Index Tests													
OL-STA-10015-VC	OL-0119-05	9.9-13.2	11.55	233									
OL-STA-10016-VC	OL-0119-02	0-3.3	1.65	108.3	45	31	23	0	1.5	98.5	32	12	
OL-STA-10017-VC	OL-0119-06	0-3.3	1.65	152									
OL-STA-10017-VC	OL-0119-07	9.9-12.6	11.25	126.6	66	40	26	0.5	4.7	94.8	35	14	
OL-STA-10018-VC	OL-0119-04	6.6-9.9	8.25	217.6	115	74	41	0.4	8.6	91	33	11	2.54
OL-STA-10022-VC	OL-0119-01	9.9-13.2	11.55	171.8									
OL-STA-10024-VC	OL-0119-08	6.6-9.9	8.25	120.2	99	68	31	0	25.3	74.7	32	17	
OL-STA-10026-VC	OL-0119-03	3.3-6.6	4.95	54.7	69	45	24	0	55.3	44.7	18	11	
Phase II Index Tests													
OL-VC-10034	OL-0236-08	0-3.3	1.65	180.6									
OL-VC-10034	OL-0236-07	3.3-6.6	4.95	213.1									
OL-VC-10034	OL-0236-09	6.6-9.9	8.25	277.7									
OL-VC-10034	OL-0236-10	9.9-13.2	11.55	263.5									
OL-VC-10034	OL-0236-11	13.2-16.5	14.85	260.9									
OL-VC-10034	OL-0236-12	16.5-19.7	18.1	64.8									
OL-VC-10037	OL-0236-13	0-3.3	1.65	112.3									
OL-VC-10037	OL-0256-01	3.3-6.6	4.95	161.4	78	59	19	0	1.6	98.4	44	18	2.45
OL-VC-10037	OL-0256-02	6.6-9.9	8.25	191.2	86	59	27	0	3.2	96.8	53	27	
OL-VC-10037	OL-0236-14	9.9-13.2	11.55	166									
OL-VC-10037	OL-0296-01	9.9-13.2	11.55	191.3	96	48	48	0	4.8	95.2	55	28	2.52
OL-VC-10037	OL-0236-15	13.2-16.5	14.85	219.3									
OL-VC-10037	OL-0236-16	16.5-19.8	18.15	88.3									
OL-VC-10038	OL-0250-19	0-3.3	1.65	161.3	127	80	47	3	35.6	61.4	34	17	
OL-VC-10038	OL-0236-17	3.3-6.6	4.95	215.2									
OL-VC-10038	OL-0236-18	6.6-9.9	8.25	144.9									
OL-VC-10038	OL-0236-19	9.9-13.2	11.55	236.2									
OL-VC-10038	OL-0296-02	9.9-13.2	11.55	223.4									
OL-VC-10038	OL-0250-20	13.2-16.5	14.85	160.8	77	60	17	0	3.4	96.6	48	18	
OL-VC-10038	OL-0236-20	16.5-18.9	17.7	225.2									
OL-VC-10040	OL-0237-01	0-3.3	1.65	88.9									
OL-VC-10040	OL-0237-02	3.3-6.6	4.95	114.3									
OL-VC-10040	OL-0250-17	6.6-9.9	8.25	127.4	72	46	26	0	2.2	97.8	28	9	
OL-VC-10040	OL-0250-18	9.9-13.2	11.55	155.9	94	62	32	0	4.4	95.6	30	10	
OL-VC-10046	OL-0237-03	0-3.3	1.65	173.4									
OL-VC-10046	OL-0250-15	3.3-6.6	4.95	153.6	108	70	38	0	4.2	95.8	29	6	2.67
OL-VC-10046	OL-0237-04	6.6-9.9	8.25	131.8									
OL-VC-10046	OL-0237-05	9.9-13.2	11.55	111.3									
OL-VC-10046	OL-0237-06	13.2-16.5	14.85	68.1									

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OL-VC-10046	OL-0250-16	16.5-19.2	17.85	66.2	47	33	14	0	0.8	99.2	29	13	
OL-VC-10047	OL-0237-07	0-3.3	1.65	144.9									
OL-VC-10047	OL-0250-13	3.3-6.6	4.95	151.3	91	56	35	0	4	96	32	16	2.63
OL-VC-10047	OL-0250-14	6.6-9.9	8.25	173.4	101	60	41	0.3	4.9	94.8	35	13	
OL-VC-10047	OL-0237-08	9.9-13.2	11.55	113									
OL-VC-10047	OL-0237-09	13.2-16.5	14.85	92.7									
OL-VC-10047	OL-0237-10	16.5-19.8	18.15	111.3									
OL-VC-10054	OL-0237-15	0-3.3	1.65	134.3									
OL-VC-10054	OL-0250-11	6.6-9.9	8.25	93.4	62	40	22	0	14.7	85.3	33	12	
OL-VC-10054	OL-0250-12	9.9-13.2	11.55	114.6	63	44	19	0	1.5	98.5	36	11	
OL-VC-10054	OL-0237-17	13.2-16.5	14.85	76									
OL-VC-10054	OL-0237-18	16.5-18.8	17.65	72.6									
OL-VC-10057	OL-0237-11	0-3.3	1.65	143.7									
OL-VC-10057	OL-0250-09	3.3-6.6	4.95	197.1	130	88	42	0	27.6	72.4	27	13	
OL-VC-10057	OL-0237-12	6.6-9.9	8.25	193.4									
OL-VC-10057	OL-0250-10	9.9-13.2	11.55	140.1	85	55	30	0	1.3	98.7	28	12	
OL-VC-10057	OL-0237-14	13.2-16.5	14.85	141.9									
OL-VC-10057	OL-0237-13	16.5-19.5	18	127.2									
OL-VC-10062	OL-0237-19	0-3.3	1.65	177.8									
OL-VC-10062	OL-0250-07	3.3-6.6	4.95	127.3	103	63	40	0	7.6	92.4	33	11	
OL-VC-10062	OL-0237-20	6.6-9.9	8.25	185.3									
OL-VC-10062	OL-0238-01	9.9-13.2	11.55	144.4									
OL-VC-10062	OL-0238-02	13.2-16.5	14.85	181.6									
OL-VC-10062	OL-0250-08	16.5-19.2	17.85	181.8	96	59	37	0	3	97	36	14	2.7
OL-VC-10062A	OL-0296-03	3.3- 6.6	4.95	194.8	113	60	53	0	4.3	95.7	43	22	2.54
OL-VC-10063	OL-0250-05	0-3.3	1.65	221.6	88	60	28	0	1.2	98.8	30	12	
OL-VC-10063	OL-0238-03	3.3-6.6	4.95	209.4									
OL-VC-10063	OL-0238-04	6.6-9.9	8.25	172.4									
OL-VC-10063	OL-0238-05	9.9-13.2	11.55	154.4									
OL-VC-10063	OL-0238-06	13.2-16.5	14.85	180.4									
OL-VC-10063	OL-0250-06	16.5-19.8	18.15	169.4	82	55	27	0	2.2	97.8	30	13	
OL-VC-10066	OL-0238-07	0-3.3	1.65	131.7									
OL-VC-10066	OL-0249-12	3.3-6.6	4.95	112.4	60	50	10	0	30.3	69.7	17	7	
OL-VC-10066	OL-0238-08	6.6-9.9	8.25	99.2									
OL-VC-10066	OL-0249-13	9.9-13.2	11.55	104.3	60	47	13	0	23.5	76.5	20	9	
OL-VC-10066	OL-0238-09	13.2-16.5	14.85	134.5									
OL-VC-10066	OL-0238-10	16.5-19.8	18.15	238									
OL-VC-10071	OL-0249-14	0-3.3	1.65	169.7	86	47	39	0	1.1	98.9	42	32	
OL-VC-10071	OL-0238-11	3.3-6.6	4.95	186									
OL-VC-10071	OL-0238-12	6.6-9.9	8.25	155.7									
OL-VC-10071	OL-0249-15	9.9-13.2	11.55	198.6	89	60	29	0	1.4	98.6	29	13	
OL-VC-10071	OL-0238-13	13.2-16.5	14.85	153.3									
OL-VC-10071	OL-0238-14	16.5-19.8	18.15	157.7									
OL-VC-10073	OL-0245-01	0-3.3	1.65	196.6									
OL-VC-10073	OL-0245-02	3.3-6.6	4.95	147.7									

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OL-VC-10073	OL-0249-16	6.6-9.9	8.25	194.3	72	47	25	0	1.7	98.3	30	11	
OL-VC-10073	OL-0245-03	9.9-13.2	11.55	152.3									
OL-VC-10073	OL-0245-05	13.2-16.5	14.85	151									
OL-VC-10073	OL-0245-04	16.5-19.8	18.15	159.5									
OL-VC-10076	OL-0245-06	0-3.3	1.65	151.4									
OL-VC-10076	OL-0245-07	3.3-6.6	4.95	154.2									
OL-VC-10076	OL-0245-08	9.9-13.2	11.55	192.3									
OL-VC-10076	OL-0249-17	13.2-16.5	14.85	178.7	116	70	46	0.1	7.2	92.7	38	17	
OL-VC-10076	OL-0245-09	16.5-19.8	18.15	169									
OL-VC-10077	OL-0249-18	0-3.3	1.65	150.4	61	44	17	0	0.4	99.6	31	15	
OL-VC-10077	OL-0245-10	3.3-6.6	4.95	187.5									
OL-VC-10077	OL-0245-11	6.6-9.9	8.25	138.4									
OL-VC-10077	OL-0249-19	9.9-13.2	11.55	177.7	76	48	28	0	1.4	98.6	38	18	
OL-VC-10077	OL-0245-12	13.2-16.5	14.85	151.1									
OL-VC-10077	OL-0245-13	16.5-17.9	17.2	216.8									
OL-VC-10078	OL-0248-05	0-3.3	1.65	48.1									
OL-VC-10078	OL-0248-06	3.3-6.6	4.95	108.5									
OL-VC-10078	OL-0248-07	6.6-9.9	8.25	150.8									
OL-VC-10078	OL-0249-20	9.9-13.2	11.55	181.3	119	82	37	0	10.3	89.7	14	11	
OL-VC-10078	OL-0248-08	13.2-16.5	14.85	153.4									
OL-VC-10078	OL-0248-09	16.5-19.8	18.15	181.4									
OL-VC-10080	OL-0245-14	0-3.3	1.65	135.2									
OL-VC-10080	OL-0250-01	3.3-6.6	4.95	94.6	56	40	16	0	9.2	90.8	26	10	
OL-VC-10080	OL-0245-15	6.6-9.9	8.25	185.6									
OL-VC-10080	OL-0245-16	9.9-13.2	11.55	252									
OL-VC-10080	OL-0296-04	9.9-13.2	11.55	224.3									
OL-VC-10080	OL-0250-02	13.2-16.5	14.85	203.5	114	83	31	0	2.5	97.5	8	2	
OL-VC-10080	OL-0245-17	16.5-19.3	17.9	175									
OL-VC-10081A	OL-0248-01	0-3.3	1.65	132.6									
OL-VC-10081A	OL-0250-03	3.3-6.6	4.95	172.1	122	67	55	0	3	97	38	19	2.69
OL-VC-10081A	OL-0248-02	6.6-9.9	8.25	197									
OL-VC-10081A	OL-0248-03	9.9-13.2	11.55	149									
OL-VC-10081A	OL-0248-04	13.2-16.5	14.85	183.4									
OL-VC-10081A	OL-0296-05	13.2-16.5	14.85	206.3	117	82	35	4.8	7.1	88.1	40	22	2.58
OL-VC-10081A	OL-0250-04	16.5-19.6	18.05	170.8	79	51	28	0	1.1	98.9	39	17	
OL-VC-10089	OL-0248-10	0-3.3	1.65	91.7									
OL-VC-10089	OL-0248-11	3.3-6.6	4.95	135.7									
OL-VC-10089	OL-0248-12	6.6-9.9	8.25	162.4									
OL-VC-10089	OL-0248-13	9.9-13.2	11.55	176.9									
OL-VC-10089	OL-0256-08	13.2-16.5	14.85	198.4	80	58	22	0	0.9	99.1	36	17	2.43
OL-VC-10089	OL-0248-14	16.5-19.7	18.1	161.3									
OL-VC-10090	OL-0248-15	0-3.3	1.65	179.1									
OL-VC-10090	OL-0256-09	3.3-6.6	4.95	104.3	52	35	17	0	1.7	98.3	20	8	
OL-VC-10090	OL-0248-16	6.6-9.9	8.25	116.6									
OL-VC-10090	OL-0248-17	9.9-13.2	11.55	83.7									

OL-VC-10090	OL-0248-18	13.2-16.5	14.85	141.5									
OL-VC-10090	OL-0248-19	16.5-19.8	18.15	151.1									
OL-VC-10094	OL-0248-20	0-3.3	1.65	126.7									
OL-VC-10094	OL-0249-11	3.3-6.6	4.95	86.3	46	31	15	0	11	89	16	8	2.58
OL-VC-10094	OL-0249-01	6.6-9.9	8.25	106.6									
OL-VC-10094	OL-0249-02	9.9-13.2	11.55	195.9									
OL-VC-10094	OL-0249-03	13.2-16.5	14.85	161.1									
OL-VC-10094	OL-0249-04	16.5-19.8	18.15	184.3	72	61	11	0	1	99	13	8	
OL-VC-10095A	OL-0256-05	0-3.3	1.65	193	109	38	71	0	2.7	97.3	24	16	
OL-VC-10095A	OL-0256-06	3.3-6.6	4.95	140.2	101	41	60	0	1.9	98.1	19	12	
OL-VC-10095A	OL-0244-05	6.6-9.9	8.25	139.2									
OL-VC-10095A	OL-0244-06	9.9-13.2	11.55	211.2									
OL-VC-10095A	OL-0244-07	13.2-16.5	14.85	126.3									
OL-VC-10095A	OL-0256-07	16.5-19.1	17.8	100.9	77	42	35	0	1.5	98.5	12	8	
OL-VC-10096	OL-0256-03	0-3.3	1.65	101.7	56	36	20	0	3.2	96.8	23	8	
OL-VC-10096	OL-0244-08	3.3-6.6	4.95	94.5									
OL-VC-10096	OL-0244-09	6.6-9.9	8.25	177.2									
OL-VC-10096	OL-0244-10	9.9-13.2	11.55	159.7									
OL-VC-10096	OL-0256-04	13.2-16.5	14.85	152.3	75	50	25	0	1	99	31	11	
OL-VC-10096	OL-0244-11	16.5-19.8	18.15	158.8									
OL-VC-10102	OL-0244-12	3.3-6.6	4.95	101.4									
OL-VC-10102	OL-0244-13	6.6-9.9	8.25	190.2									
OL-VC-10102	OL-0256-11	9.9-13.2	11.55	144.8	69	46	23	0	0.8	99.2	27	8	2.63
OL-VC-10102	OL-0244-14	13.2-16.5	14.85	140.4									
OL-VC-10102	OL-0244-15	16.5-17.2	16.85	159.4									
OL-VC-10103	OL-0244-16	0-3.3	1.65	161.5									
OL-VC-10103	OL-0244-17	3.3-6.6	4.95	178									
OL-VC-10103	OL-0256-10	6.6-9.9	8.25	172.7	75	50	25	0	0.9	99.1	30	13	
OL-VC-10103	OL-0244-18	9.9-13.2	11.55	152.8									
OL-VC-10103	OL-0244-19	13.2-16.5	14.85	142.9									
OL-VC-10103	OL-0244-20	16.5-18	17.25	163.3									
OL-VC-10105	OL-0244-01	0-3.3	1.65	210.9									
OL-VC-10105	OL-0296-06	0-3.3	1.65	215.3	89	55	34	0	11.7	88.3	35	20	2.6
OL-VC-10105	OL-0256-12	3.3-6.6	4.95	162.6	84	59	25	0	27	73	26	13	
OL-VC-10105	OL-0244-02	6.6-9.9	8.25	151.2									
OL-VC-10105	OL-0244-03	9.9-13.2	11.55	182.4									
OL-VC-10105	OL-0244-04	13.2-16.5	14.85	151.3									
OL-VC-10105	OL-0256-13	16.5-19.8	18.15	93.9	70	39	31	0	2.3	97.7	19	11	
OL-VC-10107	OL-0249-06	0-3.3	1.65	83.4									
OL-VC-10107	OL-0249-07	3.3-6.6	4.95	85.7									
OL-VC-10107	OL-0249-10	6.6-9.9	8.25	90.6	52	35	17	0	5.9	94.1	17	9	2.65
OL-VC-10107	OL-0249-08	9.9-13.2	11.55	75.1									
OL-VC-10107	OL-0249-05	13.2-16.5	14.85	103.2	59	44	15	0	5.5	94.5	17	8	2.71
OL-VC-10107	OL-0249-09	16.5-17.5	17	96									
OL-STA-10108	OL-0299-01	2-4	3	243.6									

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OL-STA-10108	OL-0299-02	12-14	13	226.1	132	76	56	0	4.1	95.9	42	20	2.59
OL-STA-10108	OL-0299-03	27-29	28	124.2									
OL-STA-10108	OL-0299-04	32-34	33	112									
OL-STA-10108	OL-0299-08	37-39	38	82.6	66	38	28	0.1	3.7	96.2	39	19	2.52
OL-STA-10108	OL-0299-05	42-44	43	270.5									
OL-STA-10108	OL-0299-06	47-49	48	85.5									
OL-STA-10108	OL-0298-05	47-49	48	86.43	92	44	48	0	3.6	96.4	34	27	2.57
OL-STA-10108	OL-0299-09	52-54	53	75.9	95	42	53	0.2	2.3	97.5	26	19	2.69
OL-STA-10108	OL-0299-07	57-59	58	73.9									
OL-STA-10108	OL-0299-10	62-64	63	68.5									
OL-STA-10108	OL-0267-01	64-66	65	69.8									
OL-STA-10108	OL-0299-11	66-68	67	70.3									
OL-STA-10108	OL-0267-02	68-70	69	67.7	74	35	39	0	0.1	99.9	23	17	2.77
OL-STA-10108	OL-0299-12	70-72	71	60.2									
OL-STA-10108	OL-0299-13	72-74	73	64.9									
OL-STA-10108	OL-0301-10	76-78	77	64.6	67	36	31	0	0.4	99.6	47	29	
OL-STA-10108	OL-0299-14	82-84	83	40.6									
OL-STA-10108	OL-0301-11	88-90	89	41.7	44	20	24	0	0	100	33	27	
OL-STA-10108	OL-0299-15	103-105	104	44.4									
OL-STA-10108	OL-0301-13	113-115	114	33.7									
OL-STA-10108	OL-0301-12	118-120	119	31.5	40	18	22	0	0	100	55	41	
OL-STA-10108	OL-0299-16	123-125	124	20.4									
OL-STA-10108	OL-0299-17	128-130	129	18.6									
OL-STA-10108	OL-0301-14	134-136	135	17.2	17	15	2	0	8.1	91.9	17	13	2.79
OL-STA-10108	OL-0299-18	141-143	142	17.2									
OL-STA-10108	OL-0301-15	147-149	148	10	26	15	11	63.3	24	12.7	6	5	
OL-STA-10108	OL-0299-19	149-151	150	7.9									
OL-STA-10108	OL-0301-16	153-155	154	7.6	14	10	4	5.9	53.7	40.4	13	10	
OL-STA-10108	OL-0301-17	155-157	156	9.3	20	10	10	9.6	38	52.4	29	20	2.8
OL-STA-10108	OL-0299-20	165-167	166	11.2									

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SMU 8 Index Test Results Summary

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Water Content (ASTM D2216) (%)	Atterberg Limits (ASTM D 4318)			Grain Size (ASTM D 422)					Specific Gravity (ASTM D 854)
					Liquid Limit	Plastic Limit	Plasticity Index	Percent Gravel (%)	Percent Sand (%)	Percent Fines (clay & silt) (%)	Clay-sized Particle Content (0.005 mm) (%)	Clay-sized Particle Content (0.002 mm) (%)	
OL-VC-80028	OL-0281-07	0.5-3.3	1.9	206.4	105	48	57	0	0.5	99.5	31	20	2.65
OL-VC-80028	OL-0271-15	3.3-6.6	4.95	143.1									
OL-VC-80028	OL-0303-06	3.3-6.6	4.95	109	64	37	27	0	0.8	99.2	17	11	
OL-VC-80028	OL-0304-04	6.6-9.9	8.25	161.1									
OL-VC-80028	OL-0271-16	9.9-13.2	11.55	93.4									
OL-VC-80028	OL-0271-17	13.2-16.5	14.85	85.2									
OL-VC-80028	OL-0271-18	16.5-17.2	16.85	80.1									
OL-VC-80029	OL-0281-08	3.3-6.6	4.95	123.3	79	55	24	0	6	94	27	10	2.57
OL-VC-80029	OL-0271-11	6.6-9.9	8.25	227.9									
OL-VC-80029	OL-0271-12	9.9-13.2	11.55	103.4									
OL-VC-80029	OL-0271-13	13.2-16.5	14.85	134									
OL-VC-80029	OL-0271-14	16.5-20	18.25	171.3									
OL-VC-80030	OL-0281-17	3.3-6.6	4.95	232	99	61	38	0	1.5	98.5	29	11	
OL-VC-80030	OL-0272-03	6.6-9.9	8.25	172									
OL-VC-80030	OL-0272-04	9.9-13.2	11.55	176.8									
OL-VC-80030	OL-0303-04	9.9-13.2	11.55	176	95	61	34	0.1	1.3	98.6	41	17	2.6
OL-VC-80030	OL-0272-05	13.2-16.5	14.85	159.3									
OL-VC-80030	OL-0272-06	16.5-20	18.25	150.1									
OL-VC-80031	OL-0272-07	0-0.5	0.25	161.3									
OL-VC-80031	OL-0272-08	0.5-3.3	1.9	238.1									
OL-VC-80031	OL-0272-09	3.3-6.6	4.95	185.6									
OL-VC-80031	OL-0303-05	3.3-6.6	4.95	179.4	80	45	35	0.4	1.3	98.3	34	13	2.55
OL-VC-80031	OL-0272-10	6.6-9.9	8.25	141.2									
OL-VC-80031	OL-0272-11	9.9-13.2	11.55	168.4									
OL-VC-80031	OL-0272-12	13.2-16.5	14.85	140.1									
OL-VC-80031	OL-0272-13	16.5-20	18.25	148.5									
OL-VC-80032	OL-0281-04	0.5-3.3	1.9	186.2	120	45	75	0	1.2	98.8	20	13	2.5
OL-VC-80032	OL-0272-14	6.6-9.9	8.25	163.4									
OL-VC-80032	OL-0272-15	9.9-13.2	11.55	143.4									
OL-VC-80032	OL-0272-16	13.2-16.5	14.85	99.3									
OL-VC-80032	OL-0272-17	16.5-18.4	17.45	106									
OL-VC-80033	OL-0281-09	0-0.5	0.25	211.2	115	47	68	0	0.8	99.2	33	22	2.62
OL-VC-80033	OL-0271-01	3.3-6.6	4.95	147.9									
OL-VC-80033	OL-0271-02	6.6-9.9	8.25	49.1									
OL-VC-80033	OL-0271-03	9.9-13.2	11.55	199.2									
OL-VC-80033	OL-0271-04	13.2-16.5	14.85	115.4									
OL-VC-80033	OL-0271-05	16.5-19.7	18.1	139.1									
OL-VC-80034	OL-0281-10	0-0.5	0.25	215.6	113	49	64	0	0.7	99.3	25	17	
OL-VC-80034	OL-0304-08	0.5-3.3	1.9	232.5	161	49	112	0	1.4	98.6	8	7	

OL-VC-80034	OL-0271-06	3.3-6.6	4.95	181.4									
OL-VC-80034	OL-0271-07	6.6-9.9	8.25	174.4									
OL-VC-80034	OL-0271-08	9.9-13.2	11.55	113.1									
OL-VC-80034	OL-0271-09	13.2-16.5	14.85	198.4									
OL-VC-80034	OL-0271-10	16.5-19.6	18.05	9.1									
OL-VC-80035	OL-0281-18	0-0.5	0.25	219.2	103	48	55	0	2.1	97.9	25	19	2.73
OL-VC-80035	OL-0273-11	3.3-6.6	4.95	186.6									
OL-VC-80035	OL-0273-12	6.6-9.9	8.25	179.7									
OL-VC-80035	OL-0273-13	9.9-13.2	11.55	122.5									
OL-VC-80035	OL-0273-14	13.2-16.5	14.85	102.4									
OL-VC-80035	OL-0273-15	16.5-19	17.75	88.5									
OL-VC-80036	OL-0281-19	0-0.5	0.25	269.4	113	52	61	0	0.8	99.2	13	10	
OL-VC-80036	OL-0273-07	3.3-6.6	4.95	140.7									
OL-VC-80036	OL-0281-20	6.6-9.9	8.25	137	69	44	25	0	1.1	98.9	16	9	
OL-VC-80036	OL-0273-08	9.9-13.2	11.55	101.8									
OL-VC-80036	OL-0273-09	13.2-16.5	14.85	89.4									
OL-VC-80036	OL-0304-09	13.2-16.5	14.85		78	37	41	0.1	0.7	99.2	7	6	
OL-VC-80036	OL-0273-10	16.5-18.5	17.5	104.4									
OL-VC-80041	OL-0271-20	0.5-3.3	1.9	210									
OL-VC-80041	OL-0303-03	0-3.3	1.65	219.6	143	45	98	0	0.9	99.1	12	9	2.49
OL-VC-80049	OL-0272-01	0-0.5	0.25	248.1									
OL-VC-80049	OL-0272-02	0.5-3.3	1.9	234.5									
OL-VC-80050	OL-0273-04	0-0.5	0.25	176.9									
OL-VC-80050	OL-0273-05	0.5-3.3	1.9	167.8									
OL-VC-80050	OL-0282-01	3.3-6.6	4.95	56.7	84	48	36	0	0.6	99.4	10	5	
OL-VC-80050	OL-0273-06	6.6-9.9	8.25	131.4									
OL-VC-80050	OL-0282-02	13.2-16.5	14.85	119.9	117	51	66	0	1.1	98.9	31	22	
OL-VC-80050	OL-0304-02	16.5-17	16.75	91.4									
OL-VC-80051	OL-0304-01	0.5-3.3	1.9	189.1	126	44	82	0	0.8	99.2	13	10	
OL-VC-80051	OL-0304-03	3.3-6.6	4.95	169.3									

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Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Consolidation Test Results Summary

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Compression Index (C_c)	Recompression Index (C_r)	Modified Compression Index (C_{ce})	Modified Recompression Index (C_{re})	Initial Void Ratio (e_o)	Initial Water Content (%)	Preconsolidation Pressure (psf)
OL-STA-10108	OL-0267-01	64-66	65	0.74	0.06	0.25	0.02	1.91	70.8	1702
OL-STA-10108	OL-0267-02	68-70	69	0.58	0.05	0.20	0.02	1.86	65.3	1032 (disturbed sample)

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Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	01

DNAPL Investigation

Geosyntec consultants

Written by: **Ming Zhu** Date: **06/18/2008** Reviewed by: **Raja Madhyannapu** Date: **06/19/2008**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Index Test Results Summary

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Atterberg Limits (ASTM D4318) Liquid Limit (%)	Atterberg Limits (ASTM D4318) Plastic Limit (%)	Atterberg Limits (ASTM D4318) Plasticity Index (%)	Bulk Density (EM-1110-2-1906) Bulk Density (pcf)	Bulk Density (EM-1110-2-1906) Dry Density (pcf)	Carbonate Content ASTM D4373	Organic Content ASTM D2974	Water Content ASTM D2216	Specific Gravity ASTM D854	Grain Size (ASTM D422) Percent Gravel (%)	Grain Size (ASTM D422) Percent Sand (%)	Grain Size (ASTM D422) Percent Fines (clay & silt) (%)	Grain Size (ASTM D422) Clay-sized Particle Content (0.005 mm) (%)	Grain Size (ASTM D422) Clay-sized Particle Content (0.002 mm) (%)
OL-SB-10115	OL-0317-01	26-28	27				116	88			31.6	2.7					
OL-SB-10121	OL-0317-02	40-42	41				118	92			24.4	2.73					
OL-SB-10124	OL-0317-03	42-44	43				109	72			50.1	2.7					
OL-STA-20056	OL-0317-04	41-43	42				110	79			39.2	2.72					
OL-STA-20056	OL-0317-05	43-45	44														
OL-STA-20052	OL-0318-06	4-6	5	139	88	51	74	16	26	45.1	367.3	2.76	0	0.3	99.7	82	72
OL-STA-20052	OL-0318-07	6-8	7														
OL-STA-20052	OL-0318-08	22-24	23														
OL-STA-20052	OL-0318-09	24-26	25	57	33	24	101	62	48	22.7	62	2.68	0	1	99	52	24
OL-STA-20052	OL-0318-10	30-32	31	24	15	9	124	97	4	8.4	26.6	2.7	0	1.8	98.2	40	27
OL-STA-20052	OL-0318-11	32-34	33														
OL-STA-20054	OL-0318-12	2-4	3														
OL-STA-20054	OL-0318-13	4-6	5	127	79	48	77	23	22	43	140.5	2.58	0	25.6	74.4	28	15
OL-STA-20054	OL-0318-14	20-22	21	46	24	22	103	70	9	10.1	47	2.82	0.3	1.6	98.1	70	48
OL-STA-20054	OL-0318-15	26-28	27	28	16	12	114	86	9	6.4	31.3	2.77	0	0.2	99.8	46	28
OL-SB-10118	OL-0333-01	10-12	11	73	48	25					115.6	2.62	0	25.7	74.3	22	10
OL-SB-10120	OL-0333-02	6-8	7	72	48	24					112.4	2.7	0.7	27.4	71.9	29	14
OL-SB-10126	OL-0333-03	12-14	13	146	66	80					209.2	2.43	0	3.6	96.4	1	0
OL-SB-10121	OL-0333-04	8-10	9	192	77	115					245	2.33	0	29.4	70.6	15	9
OL-SB-10121	OL-0333-05	14-16	15	91	60	31					147.4	2.53	0	7.1	92.9	24	8
OL-SB-10121	OL-0333-06	16-18	17	114	74	40					53	2.52	0.5	11.7	87.8	18	9
OL-SB-10124	OL-0333-07	4-6	5	Non-Plastic							63.1	2.7	0	95.9	4.1		
OL-SB-10124	OL-0333-08	10-12	11	74	47	27					144.9	2.52	0	20.5	79.5	22	4
OL-SB-10124	OL-0333-09	24-26	25	96	49	47					146.6	2.51	0	6.8	93.2	4	2

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Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

CIU Test Results Summary

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Initial Water Content (%)	Initial Confining Stress (psf)	Peak Deviator Stress (psf)	Undrained Strength (psf)	Strain at Failure (%)	CIU Total Stress		CIU Effective Stress	
									Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)
OL-SB-10121	OL-0317-02	40-42	41	29.2	1561	1872.6	936.3	15	57.8	18.7	41.7	29.5
				25	2343	2002	1001	14.4				
				28.4	3123	3256	1628	15				
OL-SB-10124	OL-0317-03	42-44	43	49.4	1636	1502.8	751.4	11.5	319	10.7	195	26.4
				47.6	2455	2220	1110	15				
				31.6	3271	2388	1194	14.2				
OL-STA-20056	OL-0317-04	41-43	42	34.1	1597	1205.4	602.7	13.4	401	5	335	15.1
				29.9	2399	1390	695	10.2				
				39.2	3198	1540.8	770.4	8.46				
OL-STA-20052	OL-0318-07	6-8	7	297.3	267.2	624.2	312.1	3.4	79.1	25.5	200	46
				194.3	400	943.8	471.9	6.66				
				231.8	532.4	1002.8	501.4	7.92				
OL-STA-20054	OL-0318-13	4-6	5	230.6	295.5	744.6	372.3	8.1				

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Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

UU Test Results Summary

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Water Content (%)	Dry Density (pcf)	Confining Stress (psf)	Undrained Strength (psf)	Strain at Failure (%)
OL-SB-10115	OL-0317-01	26-28	27	32.7	87.4	1028	165.9	8.1
OL-STA-20052	OL-0318-06	4-6	5	211.1	23.82	190	225.1	23.1
OL-STA-20052	OL-0318-09	24-26	25	53.5	65.59	952	288.1	10.3
OL-STA-20052	OL-0318-10	30-32	31	27.8	95.6	1180	147.7	12.7
OL-STA-20054	OL-0318-14	20-22	21	62.9	63.21	800	236.9	10
OL-STA-20054	OL-0318-15	26-28	27	32	86.1	1028	123.6	11.9

Phase III investigation

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Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

Index Test Results Summary

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Sediment Type	Water Content (ASTM D2216) (%)	Atterberg Limits (ASTM D4318) Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Grain Size (ASTM D422) Percent Gravel (%)	Percent Sand (%)	Percent Fines (clay & silt) (%)	Clay-sized Particle Content (0.005 mm) (%)	Clay-sized Particle Content (0.002 mm) (%)	Organic Content (ASTM D2974)	Specific Gravity (ASTM D854)	Carbonate Content (ASTM D4373)	Bulk Density (ASTM D2937)
OL-SB-10129	OL-0414-02	6.5-8.5	7.5	SOLW	110.3	53	35	18	0	0.9	99.1	36	12		2.53		83
OL-SB-10129	OL-0414-03	12-14	13	SOLW	97												85
OL-SB-10129	OL-0414-06	39-41	40	Marl	59.4	61	32	29	0	0.5	99.5	65	36	2.6		78	101
OL-SB-10129	OL-0414-08	44-46	45	Marl	53	64	32	32	0	0.3	99.7	32	14	2.7	2.69	70	100
OL-SB-10129	OL-0414-11	62-64	63	Silt/Clay	21.8	28	14	14	0	0	100	63	43	0.5		26	121
OL-SB-10129	OL-0414-12	65-67	66	Silt/Clay	110.3	31	14	17	0	0.2	99.8	45	33	1.3	2.76	26	125
OL-SB-10130	OL-0414-13	15-17	16	SOLW	202.3	114	67	47	0	1.8	98.2	45	18		2.57		78
OL-SB-10130	OL-0414-16	44-46	45	Marl	50	66	32	34	0	0.5	99.5	30	15	4.1	2.74	43	102
OL-SB-10130	OL-0414-18	49-51	50	Marl	47.2	62	35	27	0	0.5	99.5	74	48	2.5		52	98
OL-SB-10130	OL-0414-20	59-61	60	Silt/Clay	32.9	42	21	21	0	0.1	99.9	72	47	0.8	2.75	4	113
OL-SB-10130	OL-0414-21	64-66	65	Silt/Clay	13.9	29	16	13	0	0.2	99.8	54	36	1.7		0	121
OL-SB-10131	OL-0414-23	2-4	3	SOLW	104	64	40	24	0	4.3	95.7	32	13		2.58		84
OL-SB-10131	OL-0414-27	17.5-19.5	18.5	SOLW	72.1	51	36	15	0	1.3	98.7	34	13		2.51		89
OL-SB-10131	OL-0414-28	42-44	43	Marl	73	97	43	54	0	0.6	99.4	43	29	6.5		65	95
OL-SB-10131	OL-0414-29	44.5-46.5	45.5	Marl	47	83	34	49	0	0.9	99.1	45	34	4.2	2.68	48	96
OL-SB-10131	OL-0414-32	54.5-56.5	55.5	Marl	46.8	67	33	34	0	7	93	52	35	2.2	2.67	57	98
OL-SB-10131	OL-0414-36	79.5-81.5	80.5	Marl?	23.8	39	17	22	0	0.2	99.8	40	27	2.3		35	116
OL-SB-10131	OL-0414-37	89.5-91.5	90.5	Silt/Clay	30.3	29	18	11	0	0.3	99.7	72	50	0.8	2.76	9	115
OL-SB-10132	OL-0414-38	15-17	16	SOLW	132	85	45	40	0	1.6	98.4	27	12		2.5		77
OL-SB-10132	OL-0414-40	46.5-48.5	47.5	Marl	56	83	34	49	0	1.5	98.5	41	26	6.4	2.67	39	93
OL-SB-10132	OL-0414-41	49-51	50	Marl	50	81	35	46	0	0.7	99.3	48	31	4.9		65	97
OL-SB-10132	OL-0414-43	54-56	55	Silt/Clay	51.6	75	38	37	0	0.3	99.7	30	20	5.6		52	97
OL-SB-10132	OL-0414-47	74-76	75	Silt/Clay	31.2	37	19	18	0	0.1	99.9	61	39	1.3	2.68	30	112
OL-SB-10133	OL-0414-48	2-4	3	SOLW	258.9	109	52	57	0	0.8	99.2	33	13		2.58		76
OL-SB-10133	OL-0414-51	19-21	20	SOLW	299.1												75
OL-SB-10133	OL-0414-52	41-43	42	Marl	66.1	85	39	46	0	0.7	99.3	43	29	5.8		74	98
OL-SB-10133	OL-0414-53	43.5-45.5	44.5	Marl	46	74	34	40	0	1.1	98.9	47	29	4.6	2.58	43	103
OL-SB-10133	OL-0414-57	58.5-60.5	59.5	Silt/Clay	49.2	69	32	37	0	0.4	99.6	26	20	3.9		78	96
OL-SB-10133	OL-0414-58	63.5-65.5	64.5	Silt/Clay	47.9	64	31	33	0	0.3	99.7	39	24	1.6	2.77	61	101
OL-SB-10134	OL-0414-61	17.5-19.5	18.5	SOLW	181.4	135	75	60	0	30.7	69.3	32	15		2.52		76
OL-SB-10134	OL-0414-62	51.5-53.5	52.5	Marl	81.2	156	45	111	0	0.5	99.5	53	33	7.1	2.64	87	94
OL-SB-10134	OL-0414-63	54-56	55	Marl	78.1	94	40	54	0	0.7	99.3	32	24	5.4		35	91
OL-SB-10134	OL-0414-68	74-76	75	Marl	63.1	70	34	36	0	0.2	99.8	32	24	4.2		65	103
OL-SB-10134	OL-0414-69	79-81	80	Marl	62.1	65	37	28	0	0.5	99.5	43	30	4	2.73	61	95
OL-SB-10135	OL-0414-70	15-17	16	SOLW	211.8	92	50	42	0	1.1	98.9	40	20		2.57		77
OL-SB-10135	OL-0414-75	56.5-58.5	57.5	Marl	56.8	84	37	47	0	0.2	99.8	46	27	5.1	2.68	78	92
OL-SB-10135	OL-0414-76	61.5-63.5	62.5	Marl	50.7	78	37	41	0	1.5	98.5	19	15	4.8		74	95
OL-SB-10135	OL-0414-78	71.5-73.5	72.5	Marl	67.6	69	34	35	0	0.9	99.1	34	23	2.2		74	100
OL-SB-10135	OL-0414-79	76.5-78.5	77.5	Marl	52.5	67	31	36	0	0.1	99.9	28	20	4.1	2.66	74	96
OL-SB-80052	OL-0414-81	6.5-8.5	7.5	SOLW	128.4	92	52	40	0.1	0.7	99.2	45	20		2.54		75
OL-SB-80052	OL-0414-83	35-37	36	Marl	66.8	66	34	32	0	0.3	99.7	50	32	3.3		61	97
OL-SB-80052	OL-0414-84	37.5-39.5	38.5	Marl	48.2	69	33	36	0	0.5	99.5	35	23	2	2.46	91	100
OL-SB-80052	OL-0414-87	50-52	51	Marl	40.6	40	19	21	0	0	100	69	48	0.8	2.74	9	110
OL-SB-80052	OL-0414-92	93-95	94	Silt/Clay	23.2	27	14	13	0	0	100	59	41	0.8		9	127
OL-SB-80052	OL-0414-93	103-105	104	Silt/Clay	19.1	17	16	1	0	12.6	87.4	13	11	0.4	2.79	9	132
OL-SB-80053	OL-0414-94	4-6	5	SOLW	148.8	87	50	37	0	0.8	99.2	39	22		2.58		68
OL-SB-80053	OL-0414-96	32-34	33	Marl	86.6	98	39	59	0	1	99	54	31	3.7		48	89
OL-SB-80053	OL-0414-97	34.5-36.5	35.5	Marl	84.7	83	40	43	0	0.4	99.6	37	27	4.5	2.58	61	95
OL-SB-80053	OL-0414-101	54.5-56.5	55.5	Marl	68.7	62	32	30	0	0.2	99.8	55	36	2.9	2.71	74	100
OL-SB-80053	OL-0414-108	129-131	130	Silt/Clay	29.7	41	17	24	0	0	100	84	63	1.9		26	121
OL-SB-80053	OL-0414-109	139-141	140	Silt/Clay	25.2	32	15	17	0	0.1	99.9	63	43	1.2	2.79	30	127
OL-SB-80054	OL-0414-111	6.5-8.5	7.5	SOLW	100.2	65	37	28	0	1.5	98.5	33	16		2.59		81
OL-SB-80054	OL-0414-112	27-29	28	Marl	90.1	100	39	61	0	1	99	35	25	6.8	2.65	61	88
OL-SB-80054	OL-0414-117	39.5-41.5	40.5	Marl	78.8	69	38	31	0	0.6	99.4	52	35	5.1		78	91
OL-SB-80054	OL-0414-119	49.5-51.5	50.5	Marl	64.7	64	37	27	0	0.2	99.8	35	19	1.5	2.56	96	100
OL-SB-80054	OL-0414-123	84.5-86.5	85.5	Silt/Clay	35.8	53	22	31	0	0.1	99.9	70	53	2.9		9	102
OL-SB-80054	OL-0414-128	134.5-136.5	135.5	Silt/Clay	32.7	46	18	28	0	0	100	73	56	1.4	2.72	30	125

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Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **01**

UU Test Results Summary

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Sediment Type	Water Content (%)	Dry Density (pcf)	Confining Stress (psf)	Undrained Strength (psf)	Strain at Failure (%)
OL-SB-10129	OL-0414-06	39-41	40	Marl	59.9	63.1	3442	318	11.4
OL-SB-10131	OL-0414-28	42-44	43	Marl	71.4	55.7	3701	557	9.41
OL-SB-10133	OL-0414-52	41-43	42	Marl	67.7	58.2	3572	469	9.43
OL-SB-80052	OL-0414-83	35-37	36	Marl	51.9	64.0	5528	312	8.65
OL-SB-80053	OL-0414-96	32-34	33	Marl	89.5	46.9	4959	125	15
OL-SB-80054	OL-0414-112	27-29	28	Marl	89.7	46.5	4247	150	15
OL-SB-80054	OL-0414-117	39.5-41.5	40.5	Marl	74.4	52.0	5372	216	12.5

Note:

1. These parameters are provided to show general material behavior for informational purposes only. Additional interpretation will be required for design.

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CIU Test Results Summary

Location ID	Field Sample ID	Depth (ft)	Average Depth (ft)	Sediment Type	Initial Water Content (%)	Initial Confining Stress (psf)	Peak Deviator Stress (psf)	Undrained Strength (psf)	Strain at Failure (%)	CIU Total Stress [1] Cohesion (psf)	CIU Total Stress [1] Friction Angle (degrees)	CIU Effective Stress [1] Cohesion (psf)	CIU Effective Stress [1] Friction Angle (degrees)	Test Type
OL-SB-10129	OL-0414-02	6.5-8.5	7.5	SOLW	150.1	1999	1144	572	9.18	0	12.2	0	34	1-Point CIU
OL-SB-10129	OL-0414-03	12-14	13	SOLW	73.9	500.3	1829.8	914.9	12.9	682	5.1	54.8	39.7	3-Point CIU
					88.4	999.3	1394.8	697.4	12.8					
					97.3	2002	1938	969	15					
OL-SB-10129	OL-0414-08	44-46	45	Marl	60	1199	1576.4	788.2	12.9	365	12.5	97.9	41.3	3-Point CIU [2]
					60.5	4993	3682	1841	14.2					
OL-SB-10129	OL-0414-11	62-64	63	Silt/Clay	27.7	6001	3870	1935	14.8					1-Point CIU
OL-SB-10129	OL-0414-12	65-67	66	Silt/Clay	24	2000	2518	1259	15	347	13	292	27.7	3-Point CIU
					19.3	3001	2052	1026	15					
					21.8	5999	4456	2228	12.8					
OL-SB-10130	OL-0414-13	15-17	16	SOLW	173.3	499.8	979.6	489.8	9.46	217	19	0	58	3-Point CIU
					247.2	1001	1746.8	873.4	5.72					
					205.6	2000	2462	1231	15					
OL-SB-10130	OL-0414-16	44-46	45	Marl	62.6	1200	1352.6	676.3	14.4	287	11.7	101	32.9	3-Point CIU
					57	2498	1928.4	964.2	9.68					
					57.4	4999	3276	1638	14.5					
OL-SB-10130	OL-0414-18	49-51	50	Marl	54.8	5000	3178	1589	14.7					1-Point CIU
OL-SB-10130	OL-0414-20	59-61	60	Silt/Clay	34.8	1200	1218.4	609.2	12.4	239	12.1	130	29.5	3-Point CIU
					38.5	2499	1925	962.5	13.3					
					31.1	5000	3232	1616	15					
OL-SB-10130	OL-0414-21	64-66	65	Silt/Clay	29	6000	4652	2326	15					1-Point CIU
OL-SB-10131	OL-0414-23	2-4	3	SOLW	127.8	999.3	993.8	496.9	8.51	124	14.6	191	28.3	3-Point CIU [2]
					106.3	1994	1664.4	832.2	3.8					
OL-SB-10131	OL-0414-27	17.5-19.5	18.5	SOLW	87.7	2000	1148	574	11.6					1-Point CIU
OL-SB-10131	OL-0414-29	44.5-46.5	45.5	Marl	63.4	1201	1467.8	733.9	15	210	16	261	32.1	3-Point CIU
					69.4	2500	2294	1147	12.2					
					70.1	5004	4764	2382	15					
OL-SB-10131	OL-0414-32	54.5-56.5	55.5	Marl	62.4	5000	3776	1888	15					1-Point CIU
OL-SB-10131	OL-0414-36	79.5-81.5	80.5	Marl?	36.7	6001	3486	1743	10					1-Point CIU
OL-SB-10131	OL-0414-37	89.5-91.5	90.5	Silt/Clay	41.3	2499	1893.6	946.8	9.72	474	7.7	292	25.1	3-Point CIU
					38.7	3800	2218	1109	13.9					
					31.9	7498	3420	1710	8.13					
OL-SB-10132	OL-0414-38	15-17	16	SOLW	152.4	499.8	613	306.5	3.78	170	9.7	118	30.3	3-Point CIU
					143.5	1000	801.6	400.8	5.61					
					189.9	2005	1221	610.5	9.56					

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OL-SB-10132	OL-0414-40	46.5-48.5	47.5	Marl	81.4	1200	1200.4	600.2	15	0	16	46.3	36.6	3-Point CIU
					81.7	2500	1292.4	646.2	14.4					
					72.2	5000	4208	2104	15					
OL-SB-10132	OL-0414-41	49-51	50	Marl	70.6	4999	3150	1575	11.9					1-Point CIU
OL-SB-10132	OL-0414-43	54-56	55	Silt/Clay	65.5	5001	3180	1590	9.31					1-Point CIU
OL-SB-10132	OL-0414-47	74-76	75	Silt/Clay	32.4	1999	2018	1009	12.6	383	9.5	341	24.3	3-Point CIU
					35.1	4000	2046	1023	12					
					24.5	8000	4208	2104	15					
OL-SB-10133	OL-0414-48	2-4	3	SOLW	122	999.2	974.8	487.4	4.95	NA [3]		0	40.2	3-Point CIU [2]
					85	1998	812.6	406.3	9.82					
OL-SB-10133	OL-0414-51	19-21	20	SOLW	282.3	1999	1533.6	766.8	5.59					1-Point CIU
OL-SB-10133	OL-0414-53	43.5-45.5	44.5	Marl	68.6	1199	1462.4	731.2	13.1	267	13.6	290	28.2	3-Point CIU
					63.1	2500	2132	1066	10					
					56.1	5002	3196	1598	5.49					
OL-SB-10133	OL-0414-57	58.5-60.5	59.5	Silt/Clay	64.8	4999	3244	1622	15					1-Point CIU
OL-SB-10133	OL-0414-58	63.5-65.5	64.5	Silt/Clay	59.3	1997	1605.8	802.9	10.7	366	9.9	129	33	3-Point CIU
					60.4	2998	2240	1120	11.9					
					58.1	5997	3324	1662	12.6					
OL-SB-10134	OL-0414-61	17.5-19.5	18.5	SOLW	196.2	499.8	625.6	312.8	4.06	128	13.7	0.362	52	3-Point CIU
					125.3	1000	965.6	482.8	5.91					
					201.2	2001	1565.4	782.7	8.56					
OL-SB-10134	OL-0414-63	54-56	55	Marl	76.2	4999	3742	1871	13.6					1-Point CIU
OL-SB-10134	OL-0414-64	56.5-58.5	57.5		72.8	1200	1571.8	785.9	11.2	432	10.7	295	30.7	3-Point CIU
					73	2499	2216	1108	13.9					
					74	5000	3322	1661	9.71					
OL-SB-10134	OL-0414-68	74-76	75	Marl	60.4	6006	7554	3777	15					1-Point CIU
OL-SB-10134	OL-0414-69	79-81	80	Marl	67.7	2001	1757	878.5	12.2	306	10.7	78.9	33.6	3-Point CIU
					60.1	3999	2420	1210	13.1					
					54.9	8003	4448	2224	15					
OL-SB-10135	OL-0414-70	15-17	16	SOLW	216.8	500.7	606	303	2.96	214	11.5	150	36.1	3-Point CIU
					227.3	1001	1322.2	661.1	4.28					
					188.4	2000	1375.8	687.9	9.58					
OL-SB-10135	OL-0414-75	56.5-58.5	57.5	Marl	77.9	1501	1285.4	642.7	10.6	255	11.4	188	31.9	3-Point CIU
					76.8	3000	2214	1107	15					
					69.6	6000	3532	1766	15					
OL-SB-10135	OL-0414-76	61.5-63.5	62.5	Marl	72.9	5998	3984	1992	14.6					1-Point CIU
OL-SB-10135	OL-0414-78	71.5-73.5	72.5	Marl	65.1	6000	3542	1771	7.5					1-Point CIU

Geosyntec consultants

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OL-SB-10135	OL-0414-79	76.5-78.5	77.5	Marl	65.9	2002	1832.2	916.1	12.8	448	10.4	331	27.7	3-Point CIU
					66.1	4000	3036	1518	14.6					
					66.8	8002	4538	2269	9.49					
OL-SB-80052	OL-0414-81	6.5-8.5	7.5	SOLW	192	500	370.2	185.1	5.35	44.5	11.8	53.3	31.8	3-Point CIU
					222.7	999.4	616.4	308.2	10.7					
					217.7	2001	1137.2	568.6	8.92					
OL-SB-80052	OL-0414-84	37.5-39.5	38.5	Marl	60.1	999.2	941.2	470.6	13.3	17.5	15.9	7.79	37.5	3-Point CIU
					66.7	2000	1356.6	678.3	11.9					
					58.7	4000	3124	1562	15					
OL-SB-80052	OL-0414-87	50-52	51	Marl	36.5	4999	6654	3327	15					1-Point CIU
OL-SB-80052	OL-0414-92	93-95	94	Silt/Clay	21.5	6000	5620	2810	15					1-Point CIU
OL-SB-80052	OL-0414-93	103-105	104	Silt/Clay	19.4	2999	9822	4911	15	0	50	0.192	36.6	3-Point CIU
					19.3	4503	49700	24850	11.8					
					18.8	8998	47160	23580	15					
OL-SB-80053	OL-0414-94	4-6	5	SOLW	257.9	499.8	396.8	198.4	5.95	86.5	9.5	41.1	33.1	3-Point CIU
					306.4	1009	604.8	302.4	7.18					
					196.1	1999	990.4	495.2	10.2					
OL-SB-80053	OL-0414-97	34.5-36.5	35.5	Marl	79.6	1000	1380.4	690.2	15	320	13.2	262	30.1	3-Point CIU
					82.9	2002	2020	1010	14.9					
					85.5	3997	3164	1582	15					
OL-SB-80053	OL-0414-101	54.5-56.5	55.5	Marl	66.5	4997	2888	1444	5.47					1-Point CIU
OL-SB-80053	OL-0414-108	129-131	130	Silt/Clay	30.6	5999	2784	1392	14					1-Point CIU
OL-SB-80053	OL-0414-109	139-141	140	Silt/Clay	25.3	4005	4462	2231	14.2	1530	8.5	236	30.1	3-Point CIU
					24.9	6002	6370	3185	15					
					25.4	12000	7522	3761	33.3					
OL-SB-80054	OL-0414-111	6.5-8.5	7.5	SOLW	125.6	998.6	660.4	330.2	12.4	0	15	0	45	3-Point CIU [2]
					122.6	1998	1373.4	686.7	15					
OL-SB-80054	OL-0414-119	49.5-51.5	50.5	Marl	64.6	1503	1564.2	782.1	13.4	389	10.1	192	30.7	3-Point CIU
					61.8	2999	2210	1105	15					
					64.9	6000	3486	1743	15					
OL-SB-80054	OL-0414-123	84.5-86.5	85.5	Silt/Clay	56.6	5999	2276	1138	4.63					1-Point CIU
OL-SB-80054	OL-0414-128	134.5-136.5	135.5	Silt/Clay	26.8	4001	2424	1212	15	686	6.7	36	31.6	3-Point CIU
					15.3	6000	3348	1674	4.09					
					25.2	12000	4630	2315	3.56					

Notes:
1. Cohesion and friction angle are not determined for the 1-point CIU tests.
2. Only a 2-point CIU test could be performed at this interval.
3. NA indicates not applicable. Additional interpretation is required to use these test results.
4. These parameters are provided to show general material behavior for informational purposes only. Additional interpretation will be required for design.

APPENDIX H.2

LIQUEFACTION POTENTIAL ANALYSES

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Honeywell **Project:** Onondaga Lake ILWD Stability **Project/Proposal #:** GD4014 **Task #:** 02

TITLE OF COMPUTATIONS **LIQUEFACTION POTENTIAL ANALYSES AND THE ADDENDUM**

COMPUTATIONS BY: Signature R. Kulasingam 1/14/2011 DATE

Printed Name and Title: R. Kulasingam, Senior Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY: (Peer Reviewer) Signature Ming Zhu / J. F. Beech 1/14/2011 DATE

Printed Name and Title: Ming Zhu/Jay Beech, Project Engineer/Principal

COMPUTATIONS CHECKED BY: Signature Ming Zhu 1/14/2011 DATE

Printed Name and Title: Ming Zhu, Project Engineer

COMPUTATIONS BACKCHECKED BY: (Originator) Signature R. Kulasingam 1/14/2011 DATE

Printed Name and Title: R. Kulasingam, Senior Engineer

STATE OF NEW YORK JOHN F. BEECH No. 066337 LICENSED PROFESSIONAL ENGINEER

APPROVED BY: (PM or Designate) Signature J. F. Beech 1/14/2011 DATE

Printed Name and Title: Jay Beech, Principal

APPROVAL NOTES:

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

Written by:	**R. Kulasingam**	Date:	**12/17/2010**	Reviewed by:	**Ming Zhu/Jay Beech**	Date:	**12/17/2010**
Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GD4014**	Task No.:	**02**

LIQUEFACTION POTENTIAL ANALYSES

INTRODUCTION

This calculation package was prepared as part of the In-Lake Waste Deposit (ILWD) geotechnical stability evaluation for the Onondaga Lake Bottom Site. Specifically, the purpose of this package is to present liquefaction potential analyses for the ILWD area. The ILWD area consists of Sediment Management Unit (SMU) 1 and limited portions of SMUs 2, 7, and 8. Liquefaction potential of the Solvay Waste (SOLW) and the underlying soils was evaluated for existing conditions.

The evaluation of the capped condition is not explicitly included herein because the evaluation of the existing SOLW and underlying soils will not be affected by the installation of a cap (anticipated to be approximately 3 to 5.5-ft thick) at slopes that are similar to existing conditions. However, for completeness, the effect of cap weight on the liquefaction potential of the existing SOLW and underlying soils and the liquefaction potential of the cap itself are addressed in an addendum to this calculation package.

The remainder of this calculation package presents: (i) technical framework; (ii) subsurface stratigraphy and material properties; (iii) methodology; (iv) results; and (v) conclusions.

TECHNICAL FRAMEWORK

A technical framework for the proposed liquefaction evaluation is presented in this section. Defining a framework is important because the term "liquefaction" is used to describe a variety of phenomena in the literature. A description of the different liquefaction mechanisms and liquefaction potential evaluation procedures are presented in the following sections.

Liquefaction Mechanisms

Kramer [1996] writes the following about the term "liquefaction":

"*The term liquefaction……has historically been used in conjunction with a variety of phenomena that involve soil deformations caused by monotonic, transient, or repeated* *disturbance of saturated cohesionless soils under undrained loading conditions. The generation of excess pore pressure under undrained loading conditions is a hallmark of all liquefaction phenomena*".

Generally liquefaction phenomena can be divided into two main groups: (i) flow liquefaction (or true liquefaction); and (ii) cyclic mobility (or cyclic liquefaction). These two types of "liquefaction" phenomena are illustrated in Figure 1 and explained in the following paragraphs.

Flow liquefaction can occur when the shear stress required for static equilibrium of a soil mass (static shear stress, τ_d in Figure 1) is greater than the shear strength of the soil in its liquefied state (S_{us} in Figure 1). The shear strength of the soil in its liquefied state is also referred to as the undrained steady state shear strength or residual undrained shear strength in the literature. This shear strength is less than the peak shear strength for strain softening soils and is the same as the peak shear strength for strain hardening soils. Deformations produced by flow liquefaction are driven by static shear stresses and can be very large [Kramer 1996]. Flow liquefaction can be initiated by seismic loading, vibrations such as pile driving, geophysical exploration, blasting, and/or monotonic loading (static liquefaction). Flow liquefaction stress paths due to monotonic loading and cyclic loading are illustrated in Figure 1(a). The above discussion about flow liquefaction is generally applicable to cohesionless soils and soils with low plasticity. The term liquefaction is not generally used for cohesive soils that show "clay-like" behavior. However, undrained shear strength of sensitive clays or cemented soils can reduce from their undisturbed undrained shear strength to remolded undrained shear strength when disturbed and show a "flow liquefaction"-like behavior.

Cyclic mobility can be initiated by cyclic loading (i.e., seismic or periodic wave loading) resulting in the development of incremental deformations during loading [Kramer 1996]. It can occur when the static shear stress is less than the shear strength of the liquefied soil, and it will not result in flow liquefaction, which is discussed in the previous paragraph. However, if the static shear stress is greater than the shear strength of the liquefied soil, cyclic mobility can act as a trigger to push the stress path past the peak shear strength and lead to flow liquefaction. Conversely, if cyclic loading is not strong enough to trigger cyclic mobility, flow liquefaction is not likely to occur under that same loading. Cyclic mobility stress path due to cyclic loading is illustrated in Figure 1(b). Monotonic loading stress paths for the same soil are also provided in this figure to illustrate that the soil deforming due to cyclic mobility still has shear strength to resist shear stresses.

While the term cyclic mobility or cyclic liquefaction is generally used for cohesionless soils and soils with low plasticity, the term cyclic softening is used to describe the behavior of silty and clayey soils during earthquakes [Boulanger and Idriss, 2007].

Liquefaction Potential Evaluation Procedures

The state-of-practice for evaluating the liquefaction potential does not explicitly account for different liquefaction mechanisms. State-of-practice procedures are mainly based on case histories of occurrences and non-occurrences of liquefaction due to past earthquakes. Occurrences (or non-occurrences) of liquefaction are determined by presence (or absence) of surface manifestations of liquefaction such as sand boils, ground cracking, slope movements, and/or flow failures. Surface manifestations are generally present if high pore pressures are generated due to seismic loading and “liquefaction” is triggered. Therefore, if soils at a particular site are deemed to be not susceptible to liquefaction based on methods used in state-of-practice, further analyses such as post-liquefaction slope stability or flow liquefaction are not needed for seismic loading.

An initial step in performing a liquefaction potential evaluation is application of screening criteria based on geotechnical properties to evaluate whether subsurface materials are potentially liquefiable. Seismic loading is not considered in this screening evaluation. In general, soils that show “clay-like” behavior are not susceptible to liquefaction. Boulanger and Idriss [2007] proposed a procedure to evaluate the potential for cyclic softening of silty and clayey soils based on undrained static shear strengths and seismic loading. The screening criteria and the Boulanger and Idriss [2007] procedure to evaluate cyclic softening basically evaluate the potential for significant pore pressure increase due to seismic loading, and therefore cover all forms of “liquefaction” due to seismic loading.

The state-of-practice for liquefaction analysis for cohesionless soils is based on empirical correlations based on insitu soil tests such as Standard Penetration Tests (SPT) or Cone Penetration Tests (CPT). The effect of seismic loading is considered in this approach. This procedure was developed based on field case histories where evidence of liquefaction was or was not observed after earthquakes, and, therefore, covers all forms of “liquefaction” due to seismic loading.

In addition to the state-of-practice based methods, potential for flow liquefaction or sensitivity for loss of shear strength can be directly evaluated for soils based on stress-strain behavior during laboratory tests such as undrained triaxial tests. A pronounced strain softening behavior where the shear strength peaks at relatively low strains and then drops significantly to reach a steady state or residual value may be an indication of the potential to liquefy under certain conditions. On the other hand, a strain hardening behavior where the shear strength keeps increasing as the soil is strained or a limited strain softening behavior where the shear strength peaks and then drops slightly to reach a steady value indicates that flow liquefaction or sensitivity is not an issue. These three types of soil behavior are illustrated in Figure 2. It is noted that liquefaction due to cyclic mobility may still be triggered in a strain hardening soil depending on the acceleration and magnitude of the seismic loading.

SUBSURFACE STRATIGRAPHY AND MATERIAL PROPERTIES

Subsurface soils in the ILWD area consist of primarily seven strata (from top to bottom): (i) SOLW; (ii) marl; (iii) silt and clay; (iv) silt and sand; (v) sand and gravel; (vi) till; and (vii) shale. Standard Penetration Tests (SPT) were conducted in most of the borings to measure the SPT blow count values. Samples of SOLW, marl, and silt and clay were collected during the investigations for laboratory testing of index properties, shear strength, and compressibility. A detailed description of the development of the subsurface model and geotechnical parameters is presented in Appendix A titled "Summary of Subsurface Stratigraphy and Material Properties".

SOLW, marl, and silt and clay units can be classified as mainly MH, MH and CH, and CL and CH type material based on the Unified Soil Classification System (USCS). SPT values for SOLW, marl, and silt and clay mainly ranged from 0 to 7 (with most of the reported blow counts being 0). Plasticity index values for SOLW mainly ranged from 10 to 80. Most of the SOLW samples had water contents that were higher than their liquid limits. However, under laboratory undrained shearing, 12 out of 17 SOLW samples (two to three specimens were tested for each sample) showed strain hardening ductile behavior. Out of the remaining five samples, three showed limited strain-softening behavior and two showed gradual strain softening behavior. Based on laboratory triaxial test results, an undrained shear strength ratio of 0.35 for SOLW, marl, and silt and clay were selected to model the shear strength under undrained conditions. The undrained shear strength ratio of 0.35 for SOLW was subsequently adjusted to account for overconsolidation, corresponding to an overconsolidation ratio (OCR) of 2. SPT values for the deeper soil layers mainly ranged from 20 to 100. Table 1 summarizes the material properties of each subsurface layer (i.e., SOLW and soils).

METHODOLOGY

The liquefaction potential evaluation methodology used for the ILWD area is presented in this section. Screening criteria, Boulanger and Idriss [2007] evaluation procedure for "cohesive" soils, and Seed and Idriss [1971] evaluation procedure for "cohesionless" soils are applied to evaluate the potential for triggering liquefaction. In addition, the potential for flow liquefaction and/or sensitive behavior is directly evaluated for SOLW using stress paths observed in static triaxial tests. This evaluation is described in the following five steps:

1. A general screening is conducted to assess the liquefaction potential of the ILWD. Several screening criteria are used in state-of-practice for evaluating the liquefaction potential of cohesive soils (generally soils that can be classified as ML, CL, MH, CH or combinations of these). These screening criteria are developed from actual field evidence of both liquefaction and no liquefaction in different soil types and supplemental laboratory studies. These criteria cover both flow and cyclic liquefaction due to seismic loading. The following three criteria were used in the screening evaluation presented in this calculation package:

   a. Chinese criteria [Wang 1979] has been widely used for the past two decades in US engineering practice to screen liquefaction potential of soils. Soil is considered susceptible if all three of the following conditions are met:

      - percent finer than 0.005 mm $\leq$ 15%

      - Liquid Limit $\leq$ 35%

      - Water Content $\geq$ 0.9 x Liquid Limit

      Figure 3 presents these criteria in a chart format.

   b. Andrews and Martin [2000] presented screening criteria to evaluate the liquefaction susceptibility of silty and clayey sands. These criteria are based on clay fraction (minus 0.002 mm) and Liquid Limit of soils. Figure 4 presents these criteria in a tabular form.

c. Bray and Sancio [2006] evaluated several case histories and performed laboratory cyclic triaxial tests to develop screening criteria based on water content, Liquid Limit, and Plasticity Index. These criteria and the data used to develop them are shown in Figure 5.

2. Cyclic stresses caused by seismic loading within soil units need to be evaluated for liquefaction analyses. The cyclic stresses on the soils are calculated as follows to evaluate the liquefaction potential for "cohesive" soils and "cohesionless" soils described below in steps 3 and 4, respectively.

   a. Design bedrock acceleration for a contingency level seismic event (i.e., a seismic event with a 10 percent chance of exceedance in 50 years) was established using United States Geological Survey (USGS) seismic hazard maps [USGS, 2008].

   b. The design earthquake magnitude was established using deaggregated seismic hazard provided by USGS. Deaggregation is done to identify the earthquake that is contributing the most to the total hazard at the site.

   c. Maximum ground surface acceleration for the contingency level seismic event was estimated by considering potential for amplification using the chart proposed by Idriss [1990] for soft soil sites. This chart is presented in Figure 6. Application of this chart in lieu of site response analyses based on time histories is generally considered to be conservative.

   d. Cyclic Stress Ratio (CSR) was evaluated using the simplified procedure proposed by Seed and Idriss [1971]. The steps involved and equations used are described below.

$$CSR_M = 0.65 r_d \frac{a_{\max}}{g} \frac{\sigma_{v0}}{\sigma_{v0}'}$$

Where:

CSR_M = Cyclic Stress Ratio due to an earthquake with magnitude M;

r_d = stress reduction factor;

a_{max} = maximum ground surface acceleration;

g = gravitational acceleration;

σ_{v0} = total vertical stress; and

σ_{v0}' = effective vertical stress.

The r_d value was calculated using the following equation presented in NCEER [1997] to approximate the mean values of the possible range of r_d.

$$r_d = \frac{\left(1.000 - 0.4113z^{0.5} + 0.04052z + 0.001753z^{1.5}\right)}{\left(1.000 - 0.4177z^{0.5} + 0.05729z - 0.006205z^{1.5} + 0.001210z^{2}\right)}$$

Where:

z = depth below ground surface in meters.

3. Cyclic softening potential was evaluated for cohesive soils using the procedure proposed by Boulanger and Idriss [2007]. This procedure is similar to the Seed and Idriss [1971] simplified procedure used for liquefaction evaluation of cohesionless soils, with some modifications for application to cohesive soils. Because this procedure evaluates the potential for significant pore pressure increase due to seismic loading, it covers all forms of "liquefaction" due to seismic loading. The steps involved and equations used are described below.

$$CRR_M = 0.8 \frac{S_U}{\sigma_{v0}'} K_\alpha MSF$$

Where:

CRR_M = Cyclic Resistance Ratio for an earthquake with magnitude M;

S_U = static undrained shear strength;

k_α = correction factor for driving static shear stresses; and

MSF = Magnitude Scaling Factor.

The k_α is a function of the driving static shear stresses or slope angle. For the mild overall slopes of the ILWD area ranging from three to five degrees, k_α can be assumed to be one.

The MSF for clay type soils can be calculated using the equation proposed by Boulanger and Idriss [2007] as illustrated in Figure 7.

$$MSF = 1.12\exp\left(\frac{-M}{4}\right) + 0.828, \text{ and MSF} \leq 1.13 \text{ (for clay)}$$

Factor of safety against liquefaction (FS_{liq}) can be calculated as follows:

$$FS_{liq} = \frac{CRR_M}{CSR_M}$$

4. Liquefaction potential was evaluated for cohesionless soils using the simplified procedure proposed by Seed and Idriss [1971]. Because this procedure evaluates the potential for significant pore pressure increase due to seismic loading, it covers all forms of "liquefaction" due to seismic loading. The steps involved in this SPT based procedure and equations used are described below.

   Figure 8 presents the relationship between SPT blow counts and $CRR_{7.5}$ based on case histories [NCEER, 1997]. The corrected normalized SPT blow count, $(N_1)_{60}$ can be calculated by the following equation presented by NCEER [1997].

$$(N_1)_{60} = N_m C_N C_E C_B C_R C_S$$

   Where:

   N_m = measured SPT blow count;

C_N = correction for overburden pressure;

C_E = correction for energy ratio;

C_B = correction for borehole diameter;

C_R = correction for rod length; and

C_S = correction for sampler.

C_N can be calculated as follows:

$$C_N = \sqrt{\frac{P_a}{\sigma'_{vo}}}$$

Where:

P_a = atmospheric pressure (2117 psf).

The other corrections will be applied based on NCEER [1997] procedures as needed.

The MSF for cohesionless soils can be calculated using the equation proposed by Idriss [2007], as illustrated in Figure 7.

$$MSF = 6.9\exp\left(\frac{-M}{4}\right) - 0.058\text{, and MSF} \leq 1.8 \text{ (for sand)}$$

CRR_M is calculated by multiplying $CRR_{7.5}$ by the MSF.

FS_{liq} can be calculated as presented in step 3 above.

5. The potential for flow liquefaction or sensitivity for loss of shear strength can be directly evaluated for soils based on stress-strain behavior during laboratory tests such as undrained triaxial tests, as discussed in the technical framework section. Stress-strain plots for SOLW were compared with standard stress-strain plots for strain hardening, limited strain softening, and strain softening soil behavior. These three types of soil behavior were illustrated in Figure 2. It is noted that

liquefaction due to cyclic mobility cannot be evaluated with this procedure; however, it will be evaluated in the steps described previously.

RESULTS

The liquefaction potential evaluation results are presented in this section, and the steps in this section directly correspond to the steps in the methodology section.

1. Application of screening criteria used in state-of-practice for evaluating the liquefaction potential of cohesive soils indicates that SOLW, marl, and silt and clay units in the ILWD area are not susceptible to liquefaction.

    a. Figure 9 presents the application of the Chinese Criteria for SOLW, marl, and silt and clay. Based on these criteria these soils can be considered not susceptible to liquefaction.

    b. Liquid limits for SOLW, marl, and silt and clay are greater than 32. Based on the lab results, the clay content (particle size less than 0.002 mm) typically ranges from 5% to 30% for SOLW, from 20% to 43% for marl, and from 14% to 50% for silt and clay. The average clay content was calculated to be 14%, 30%, and 30% for SOLW, marl, and silt and clay, respectively. Per the screening criteria proposed by Andrews and Martin [2000] if clay content is greater than or equal to 10% and liquid limit greater than or equal to 32, soils can be considered not susceptible to liquefaction. If clay content is less than 10% or liquid limit is less than 32, further studies are required. Therefore, in general SOLW, marl, and silt and clay are not considered susceptible to liquefaction based on these criteria.

    c. Figure 10 presents the application of the criteria proposed by Bray and Sancio [2006] to SOLW, marl, and silt and clay. Values of water content, liquid limit, and plasticity index were used to classify samples as susceptible, moderately susceptible, and not susceptible to liquefaction. Out of a total of 101 SOLW samples, 3, 11, and 87 samples were classified as susceptible, moderately susceptible, and not susceptible to liquefaction, respectively. Out of a total of 35 marl samples, 1, 0, and 34 were classified as susceptible, moderately susceptible, and not susceptible to liquefaction, respectively. Out of a total of 47 silt and clay samples, 3, 9, and 35 were classified as susceptible, moderately susceptible, and not susceptible to liquefaction, respectively. A few samples being classified as susceptible to liquefaction are not likely to cause overall liquefaction of the ILWD. Therefore, based on these criteria, these soils are not considered susceptible to liquefaction.

2. The cyclic stresses on the soils are calculated using the following steps:

    a. Figure 11 presents the peak ground acceleration with a 10% probability of exceedance in 50 years [USGS, 2008]. A latitude of 43° 04' N and a longitude of 76° 11' W were used for the ILWD area to obtain a PGA value of 0.025g (0.02478g) using the interactive maps from the USGS website. Attachment 1 presents the deaggregated seismic hazard for the 10% probability of exceedance in 50 year event. It is noted that the deaggregated hazard was based on the 2002 USGS hazard maps because deaggregated data for 2008 maps are not yet available. Based on the deaggregated hazard, a 5.3 moment magnitude was selected for use in liquefaction analyses as explained in Attachment 1.

    b. Maximum ground surface acceleration of 0.09g was estimated for this seismic event by considering potential for amplification using the recommended mean relation in the chart presented in Figure 6. Application of this chart in lieu of site response analyses based on time histories is generally considered to be conservative.

    c. Table 2 presents the CSR values calculated using the simplified procedure proposed by Seed and Idriss [1971]. The calculated CSR values are plotted with depth in Figure 12. The calculated CSR values generally ranged from 0.10 at 70 feet depth in the silt and clay unit to 0.25 near the top of the SOLW.

3. Table 2 presents the CRR values for cohesive soils calculated using the procedure proposed by Boulanger and Idriss [2007]. A normalized static strength ratio of 0.35 was used for SOLW, marl, and silt and clay as presented in Table 1 and Appendix A titled "Summary of Subsurface Stratigraphy and Material

Properties". The undrained shear strength ratio of 0.35 for SOLW was subsequently adjusted to account for overconsolidation, corresponding to an OCR of 2. For the mild overall slopes of the ILWD area ranging from three to five degrees, k_α was assumed to be one. A MSF value of 1.13 was calculated. The calculated CRR values are plotted with depth in Figure 12. The calculated CRR values generally ranged from 0.32 for the marl and the silt and clay units to 0.55 for the SOLW. Calculated factors of safety against liquefaction are plotted in Figure 13. Calculated factors of safety against liquefaction ranged from about 2.2 to 2.3 for SOLW, 1.5 to 1.7 for marl, and 1.9 to 3.1 for silt and clay units. In liquefaction analyses, calculated factors of safety of 1.0 to 1.2 are considered adequate to conclude that adverse effects due to pore pressure buildup are unlikely. Therefore, based on this analysis, SOLW, marl, and silt and clay units in the ILWD area are not considered to be susceptible to liquefaction during the design seismic event established in step 2.

4. Uncorrected SPT blow counts for deeper soil units such as silt and sand, and sand and gravel ranged from 20 to 100 or more. An uncorrected SPT blow count of 20 is very conservatively assumed for demonstration purposes. It is assumed that energy correction is not required because SPT testing was done per standard US practice. After the application of overburden correction, which depends on the effective stress at a particular depth, one can calculate corrected blow count values ($N_{1,60}$) of about 13 to 20 for depths of 70 feet to 120 feet. Based on Figure 8, and assuming a fine content of less than 5%, these correspond to $CRR_{7.5}$ values of about 0.14 to 0.22. An MSF value of 1.7 can be calculated for cohesionless soils based on Figure 7. Therefore, calculated CRR_M values range from about 0.24 to 0.37. These values are much greater than the CSR_M value of 0.10 calculated for 70 feet. CSR_M values below 70 feet will be even smaller. Therefore, based on this simple analysis, the silt and sand, and sand and gravel units are not considered susceptible to liquefaction during the design seismic event established in step 2.

5. Figures 14 and 15 present the stress-strain and q-p' paths, respectively, for SOLW under laboratory consolidated undrained monotonic triaxial tests. These tests were conducted with applied effective confining stresses that are in the general range of insitu effective vertical stresses. Under laboratory undrained shearing,

12 out of 17 SOLW samples (two to three specimens were tested for each sample) showed strain-hardening ductile behavior. Out of the remaining five samples, three showed limited strain-softening behavior (OL-STA-20052, OL-STA-20038, and OL-SB-10131 in Figure 14) and two showed gradual strain softening behavior (OL-SB-10133 and OL-SB-10135 in Figure 14). This gradual softening appears different from the sudden strength loss that is typical of soils susceptible to flow liquefaction or sensitive behavior. Therefore, based on these tests one can conclude that SOLW in the ILWD area is not likely to be susceptible to flow liquefaction or show sensitive behavior.

CONCLUSIONS

Liquefaction potential of the Solvay Waste (SOLW) and the underlying soils was evaluated for existing conditions. Based on the results summarized herein, the ILWD and underlying soils are not considered to have the potential for liquefaction or cyclic softening during the contingency level seismic event. In addition, the SOLW does not appear to have the potential for sensitive behavior or loss of shear strength.

As indicated previously, the evaluation of the capped condition is not explicitly included herein because the liquefaction potential evaluation of the existing SOLW and underlying soils will not be affected by the installation of a cap (anticipated to be approximately 3 to 5.5-ft thick) at slopes that are similar to existing conditions. However, for completeness, the effect of cap weight on the liquefaction potential of the existing SOLW and underlying soils and the liquefaction potential of the cap itself are addressed in an addendum to this calculation package.

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Tables

Table 1. Summary of material properties

Material	General Classification	Typical Range of Liquid Limit (%)	Typical Range of Plastic Limit (%)	Typical Range of Water Content (%)	Typical Range of Plasticity Index	Typical Range of Liquidity Index	Typical Range of Fines Content	Typical Range of SPT N value	Total Unit Weight (pcf)	Undrained Shear Strength[1]	
										From UU (psf)	From CU (psf)
Silt[2]	NA	NA	NA	NA	NA	NA	NA	NA[1]	98	NA	NA
SOLW	MH	40 – 146	30 – 80	40 – 260	10 – 80	1.0 – 6.4	65 – 100	0 – 7[3]	81	245	$S_u/\sigma'_v = 0.35$[4]
Marl	MH and CH	60 – 80	25 – 45	35 – 85	20 – 50	0.4 – 1.1	96 – 100	0 – 4[3]	98	350	$S_u/\sigma'_v = 0.35$
Silt/Clay	CL and CH	32 – 70	20 – 45	20 – 80	15 – 40	0.4 – 1.0	93 - 100	0[3]	108	350	$S_u/\sigma'_v = 0.35$
Silt/Sand	NA	NA	NA	NA	NA	NA	NA	20 - 80	120	NA	NA
Sand/Gravel	NA	NA	NA	NA	NA	NA	NA	20 to > 100	120	NA	NA
Till	NA	NA	NA		NA	NA	NA	> 100	120	NA	NA
Shale	NA	NA	NA	NA	NA	NA	NA	> 100	120	NA	NA

Notes:

1 NA – Not Applicable

2 Properties of marl are also considered applicable for the silt overlying the Solvay waste in certain areas of the ILWD.

3 SPT N values are zero at most of the depths within the SOLW, marl, and silt/clay layers.

4 The undrained shear strength ratio of normally consolidated SOLW was estimated to be 0.35 as presented in the Data Package [The value of 240 psf for shear strength of the SOLW reported in Table 5 of the Data Package accounts for the insitu overconsolidation of SOLW. The shear strength ratio of 0.35 used herein conservatively assumes normally consolidated conditions and is used only to simplify the calculations].

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Table 2. Calculation of CSR, CRR, and factor of safety against liquefaction

Unit weight of water =	62.4 pcf
Maximum surface acceleration =	0.09 g
K-alpha =	1
OCR model parameter, m =	0.8
Earthquake magnitude =	5.3
Magnitude scaling factor for cohesive soils =	1.13

Depth (ft)	Depth (m)	Idealized Soil Type	Unit Weight (pcf)	Vertical Effective Stress (psf)	Vertical Total Stress (psf)	Stress Reduction Factor	Equivalent Cyclic Shear Stress (psf)	CSR_M	Cu/Sigv' - NC	OCR	Cu/Sigv' - OC	$CRR_{7.5}$	CRR_M	FSliq
0	0.0	SOLW	81	0	0	1.00	0		0.35	2.0	0.61	0.49	0.55	
5	1.5	SOLW	81	93	405	0.99	23	0.25	0.35	2.0	0.61	0.49	0.55	2.18
10	3.0	SOLW	81	186	810	0.98	46	0.25	0.35	2.0	0.61	0.49	0.55	2.20
15	4.6	SOLW	81	279	1,215	0.97	69	0.25	0.35	2.0	0.61	0.49	0.55	2.22
20	6.1	SOLW	81	372	1,620	0.96	91	0.24	0.35	2.0	0.61	0.49	0.55	2.25
25	7.6	SOLW	81	465	2,025	0.94	112	0.24	0.35	2.0	0.61	0.49	0.55	2.29
30	9.1	SOLW	81	558	2,430	0.92	131	0.23	0.35	2.0	0.61	0.49	0.55	2.34
35	10.7	Marl	98	736	2,920	0.89	152	0.21	0.35	1.0	0.35	0.28	0.32	1.52
40	12.2	Marl	98	914	3,410	0.85	170	0.19	0.35	1.0	0.35	0.28	0.32	1.70
45	13.7	Silt and Clay	108	1,142	3,950	0.80	186	0.16	0.35	1.0	0.35	0.28	0.32	1.94
50	15.2	Silt and Clay	108	1,370	4,490	0.75	198	0.14	0.35	1.0	0.35	0.28	0.32	2.18
55	16.8	Silt and Clay	108	1,598	5,030	0.70	207	0.13	0.35	1.0	0.35	0.28	0.32	2.43
60	18.3	Silt and Clay	108	1,826	5,570	0.66	215	0.12	0.35	1.0	0.35	0.28	0.32	2.68
65	19.8	Silt and Clay	108	2,054	6,110	0.62	222	0.11	0.35	1.0	0.35	0.28	0.32	2.91
70	21.3	Silt and Clay	108	2,282	6,650	0.59	230	0.10	0.35	1.0	0.35	0.28	0.32	3.12

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Figures

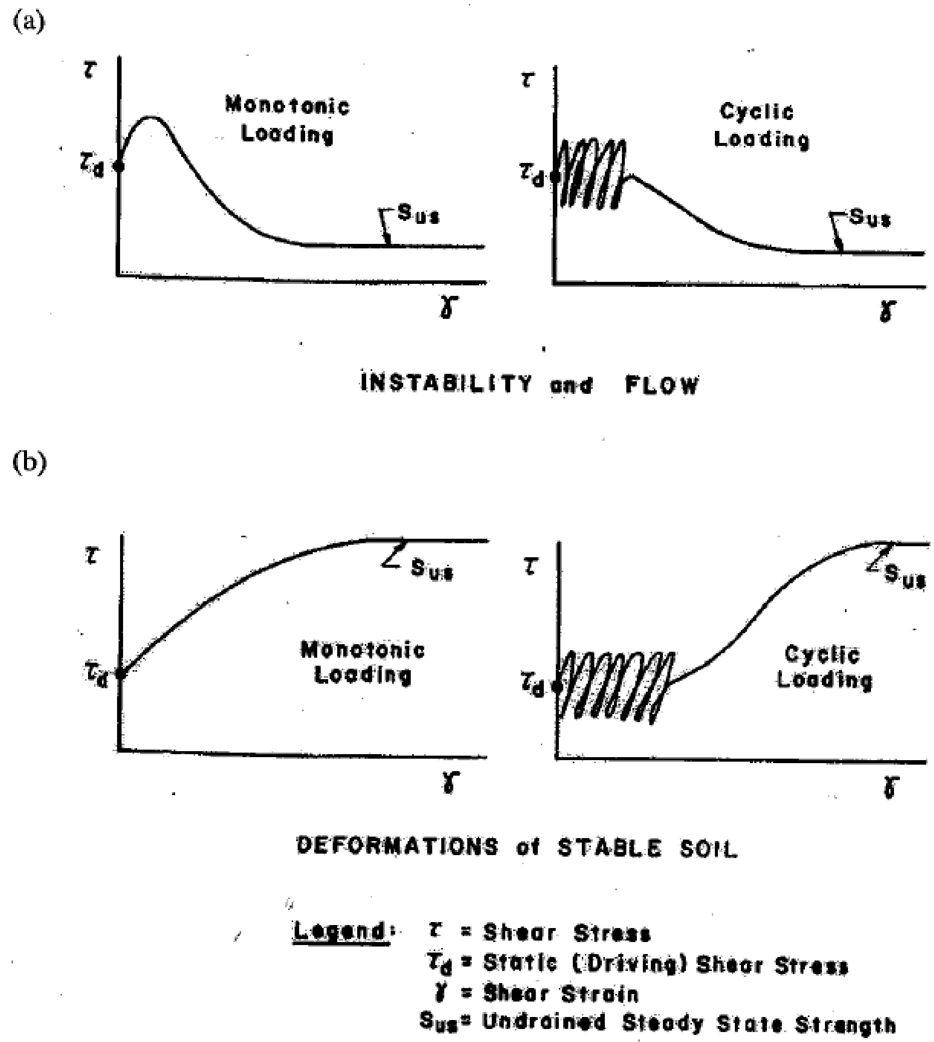

Figure 1. Monotonic and cyclic soil behaviors leading to different liquefaction mechanisms [Castro, 1976].

Notes: the following is noted in regards to the terminology used in this figure and the text:

1. The terms static loading and monotonic loading are used to describe similar loading.
2. Cyclic loading may include seismic (earthquake) or periodic wave loading.
3. "Instability and flow" corresponds to flow liquefaction behavior.
4. "Deformations of stable soil" corresponds to cyclic mobility (or cyclic softening).

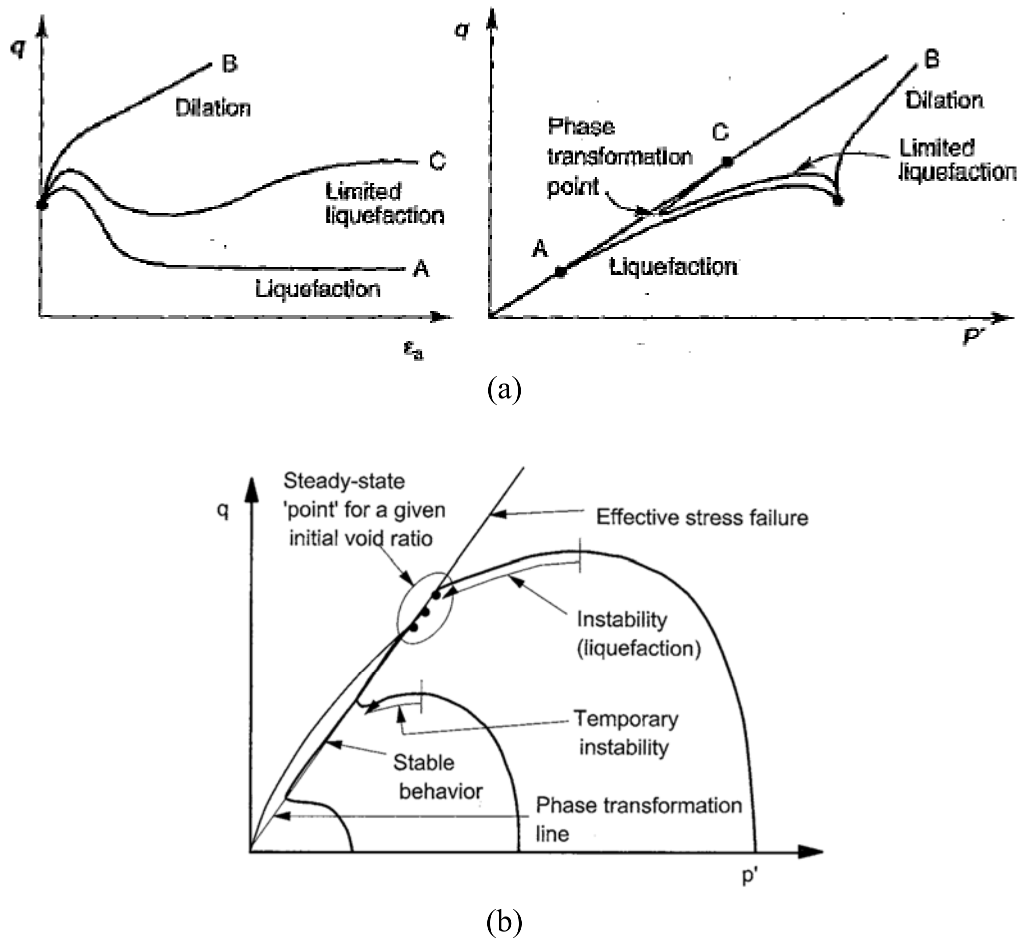

Figure 2. Undrained stress-strain behavior of soils. (Figures from: (a) Kramer [1996]; and (b) Yamamuro & Covert [2001]).

Notes: the following is noted in regards to the terminology used in this figure and the text:

1. The term dilation in the figure corresponds to the strain hardening behavior described in the text.
2. The term limited liquefaction in the figure corresponds to the limited strain softening behavior described in the text.
3. The term liquefaction in the figure corresponds to the strain softening behavior described in the text.

1.	Percent Finer than 0.005 mm	≤ 15%
2.	Liquid Limit (LL)	≤ 35%
3.	Water Content	≥ 0.9 x LL

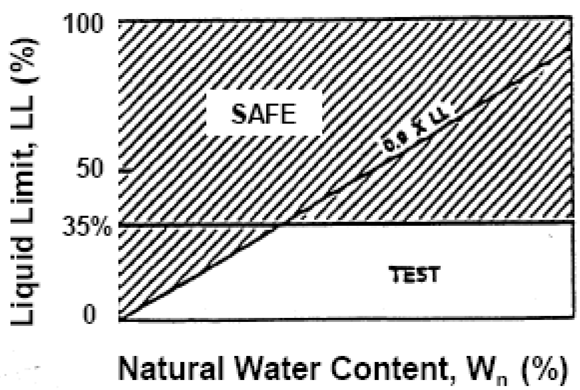

Figure 3. Modified Chinese criteria for screening liquefaction potential [Finn et al., 1994] (figure taken from Seed et al., 2001).

	Liquid Limit[1] < 32	Liquid Limit ≥ 32
Clay Content[2] < 10%	Susceptible	Further Studies Required *(Considering plastic non-clay sized grains – such as Mica)*
Clay Content[2] ≥ 10%	Further Studies Required *(Considering non-plastic clay sized grains – such as mine and quarry tailings)*	Not Susceptible

Notes:

1. Liquid limit determined by Casagrande-type percussion apparatus.
2. Clay defined as grains finer than 0.002 mm.

Figure 4. Liquefaction susceptibility of silty and clayey sands [Andrews and Martin, 2000] (figure taken from Seed et al., 2001).

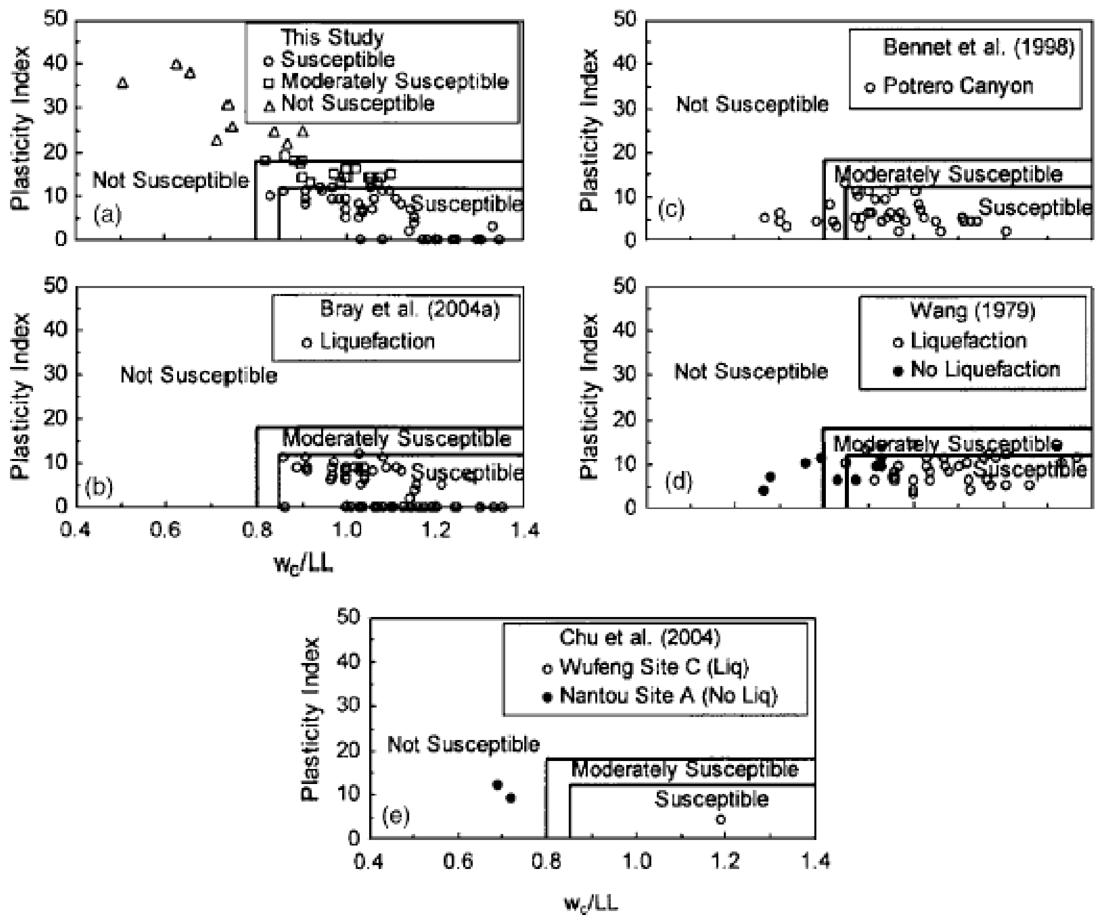

Figure 5. Liquefaction susceptibility criteria with data plotted from: (a) laboratory cyclic triaxial testing; (b) field data from Turkey (Kocaeli) earthquake; (c) field data from Northridge earthquake; (d) field data used for developing Chinese criteria; and (e) field data from Taiwan (Chi-Chi) earthquake [Bray and Sancio, 2006].

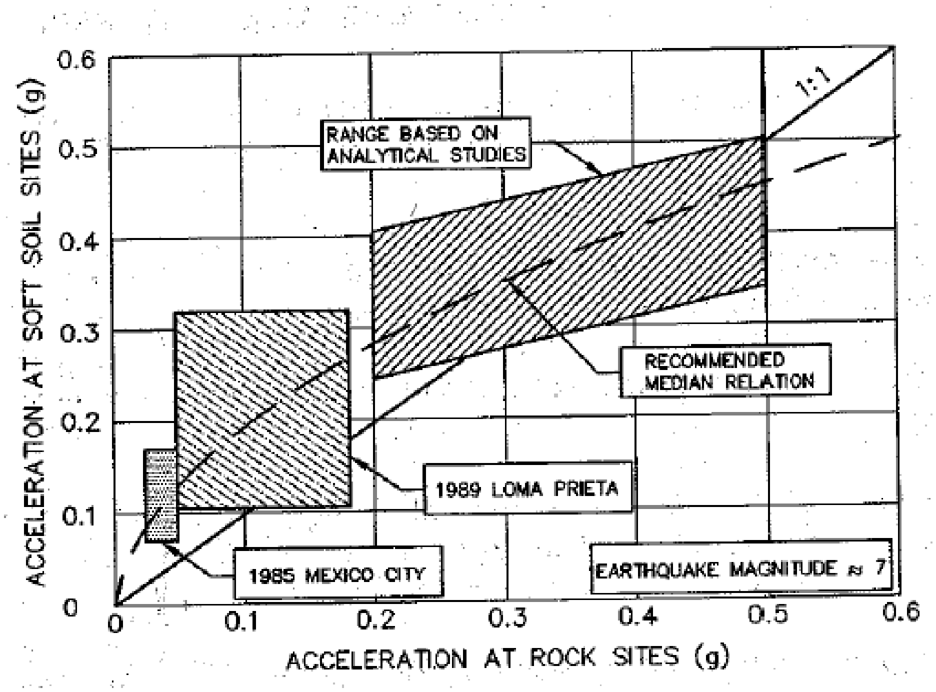

Figure 6. Relationship between peak acceleration on rock and soft soil sites [Idriss, 1990].

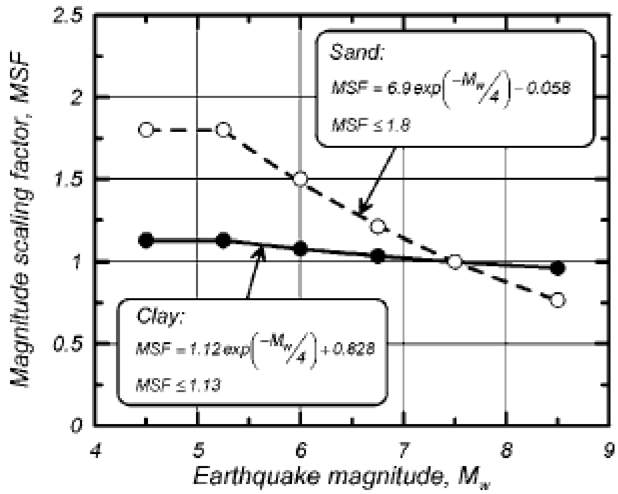

Figure 7. MSF correlations proposed by Boulanger and Idriss for clayey and sandy soils [2007].

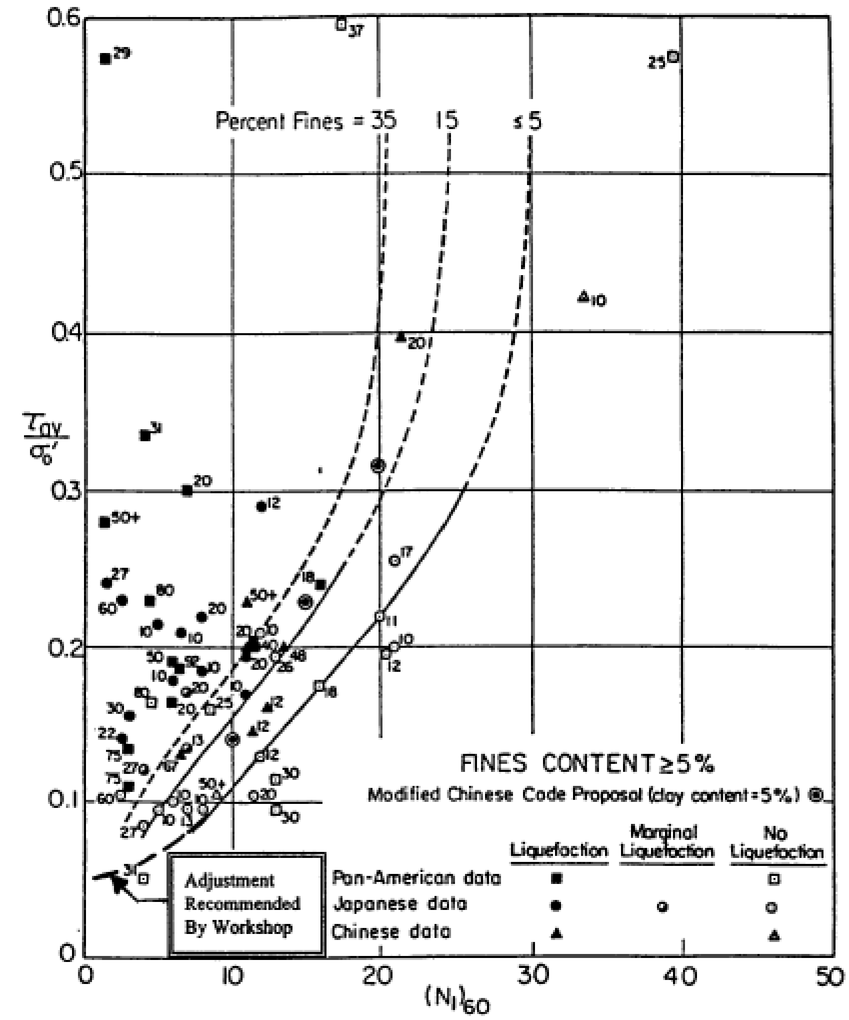

Figure 8. Relationship between SPT blow counts and CRR based on case histories [NCEER, 1997].

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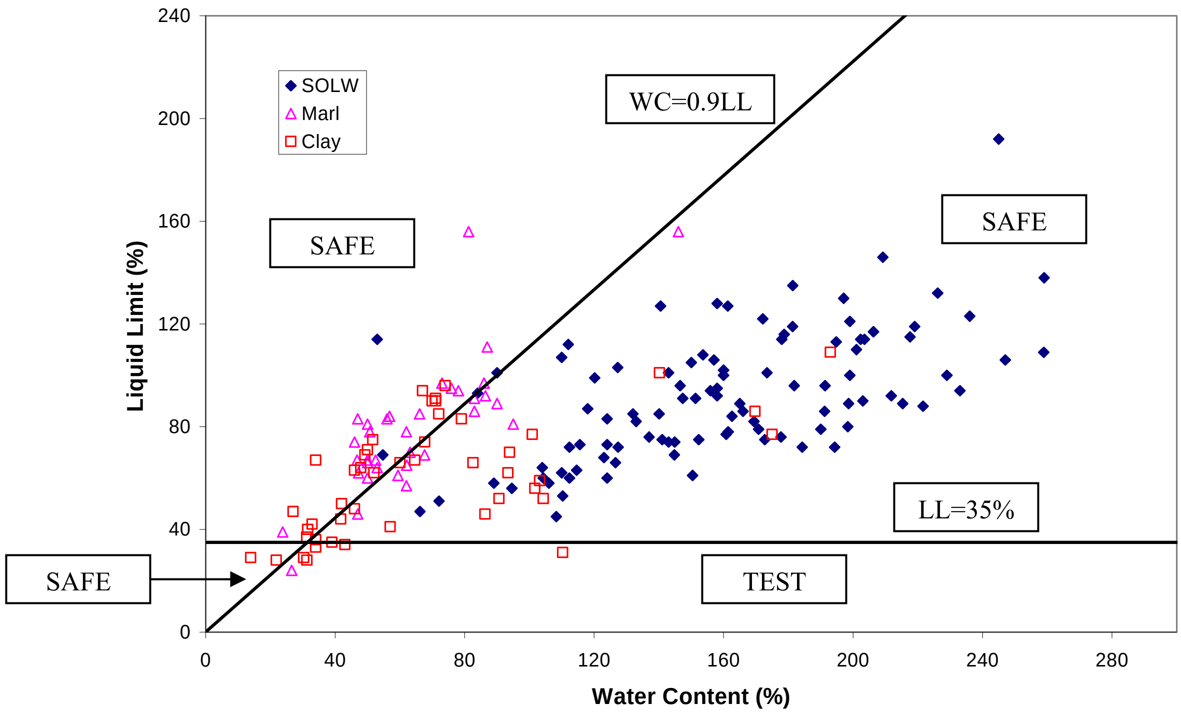

Figure 9. Application of Chinese criteria for SOLW, marl, and silt and clay.

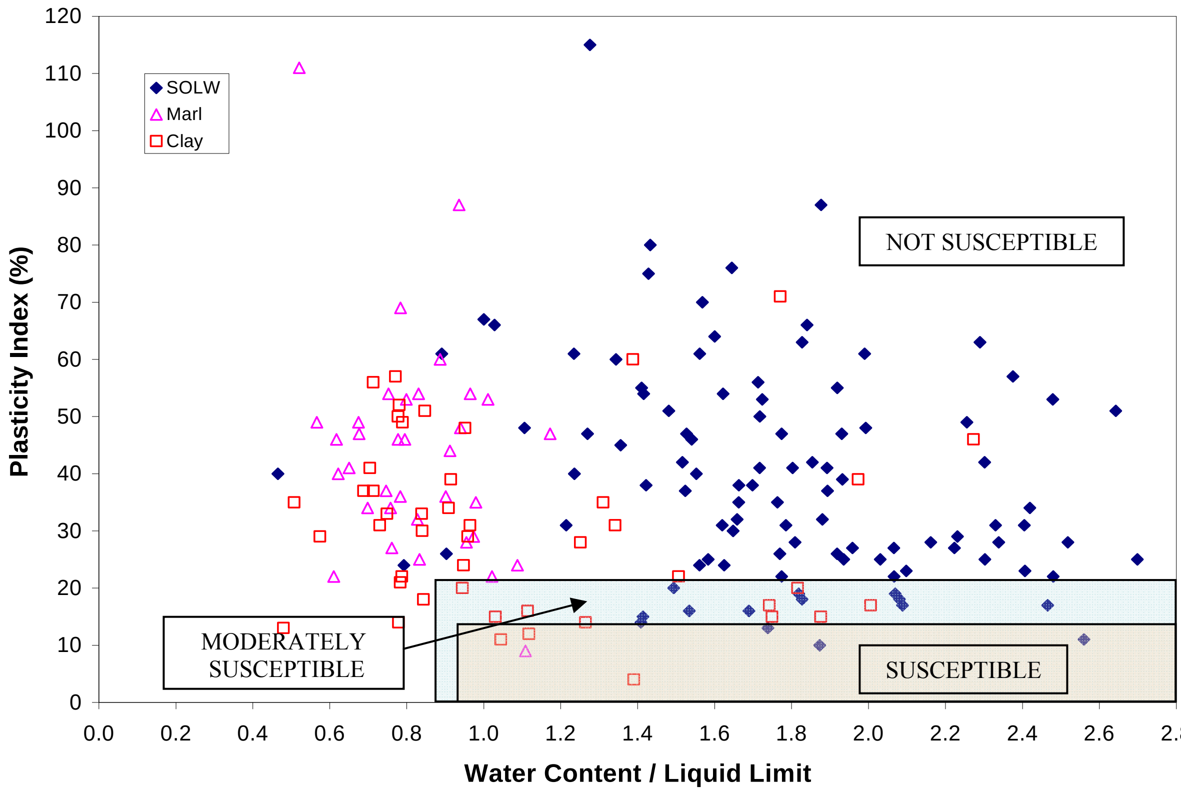

Figure 10. Application of the criteria proposed by Bray and Sancio [2006] for SOLW, marl, and silt and clay.

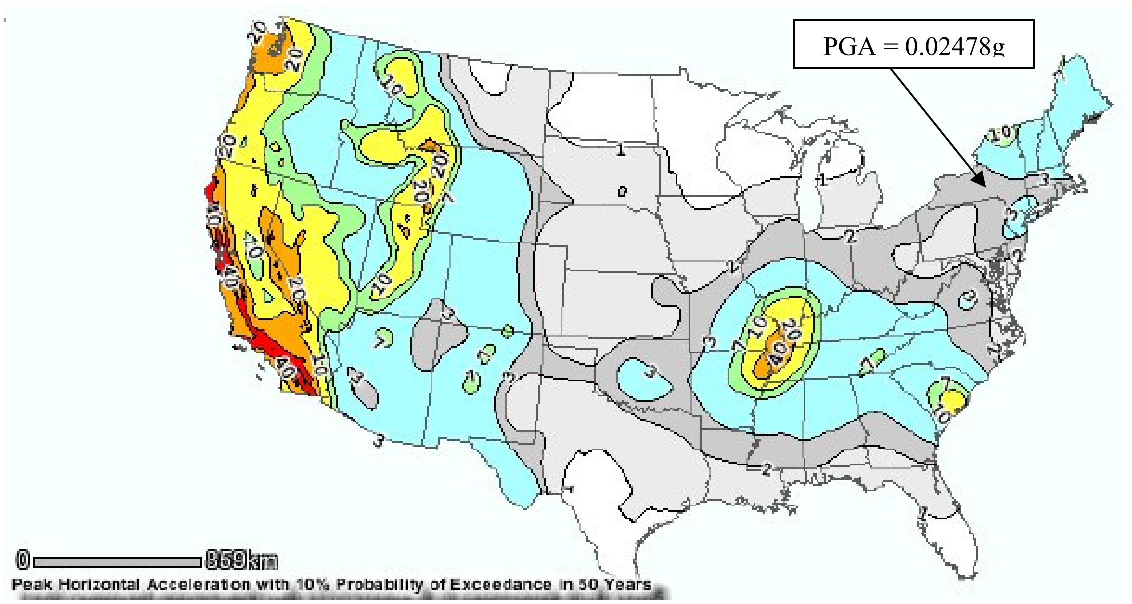

Figure 11. Peak ground acceleration with a 10% probability of exceedance in 50 years [USGS, 2008]. A latitude of 43° 04' N and a longitude of 76° 11' W were used to obtain the PGA value using the interactive maps from the USGS website.

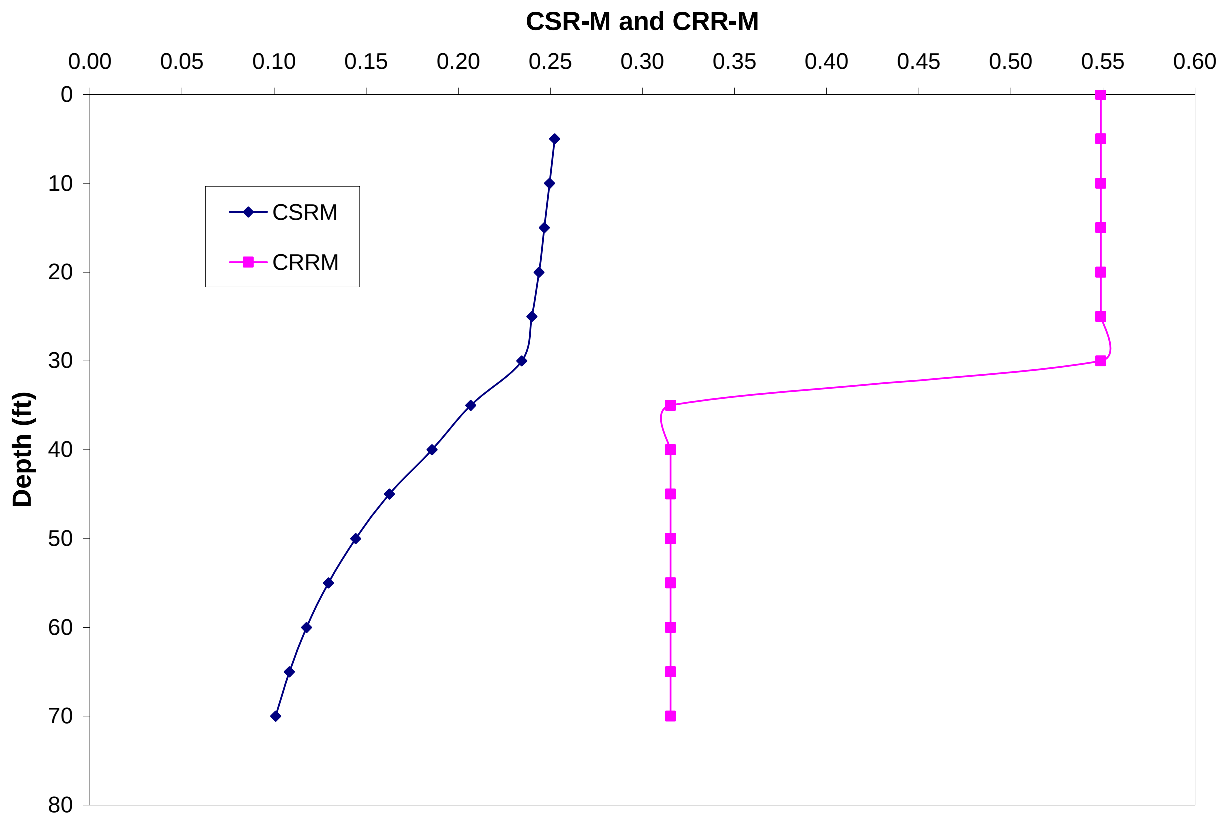

Figure 12. Calculated CSR and CRR values for SOLW marl, and silt and clay.

Note: ***The discontinuity in CRR_M values occurred at 30 ft because it is the interface between Solvay waste and Marl. Solvay waste shear strengths were modeled with an OCR of 2, and Marl was modeled with an OCR of 1. These OCR values are conservative.***

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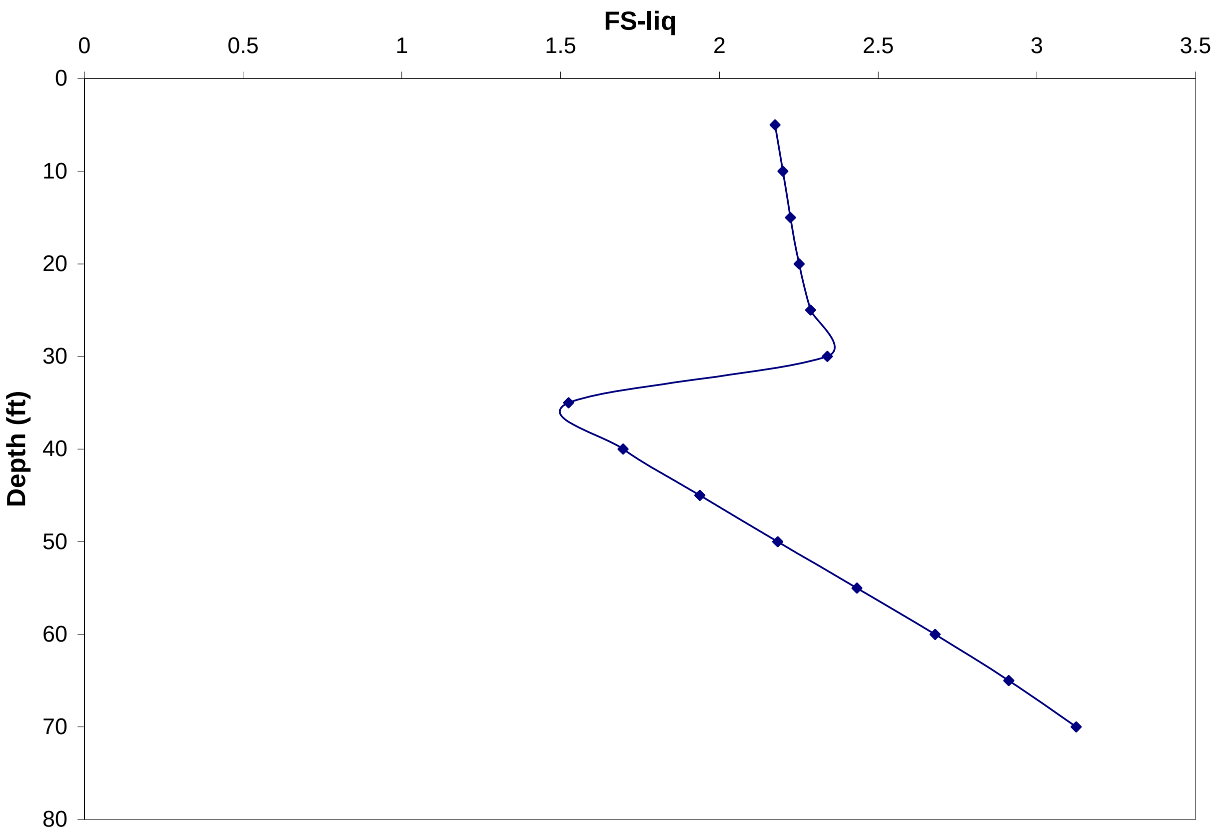

Figure 13. Calculated FS_{liq} values for SOLW marl, and silt and clay.

Note: ***The discontinuity in FS-liq values occurred at 30 ft because it is the interface between Solvay waste and Marl. Solvay waste shear strengths were modeled with an OCR of 2, and Marl was modeled with an OCR of 1. These OCR values are conservative.***

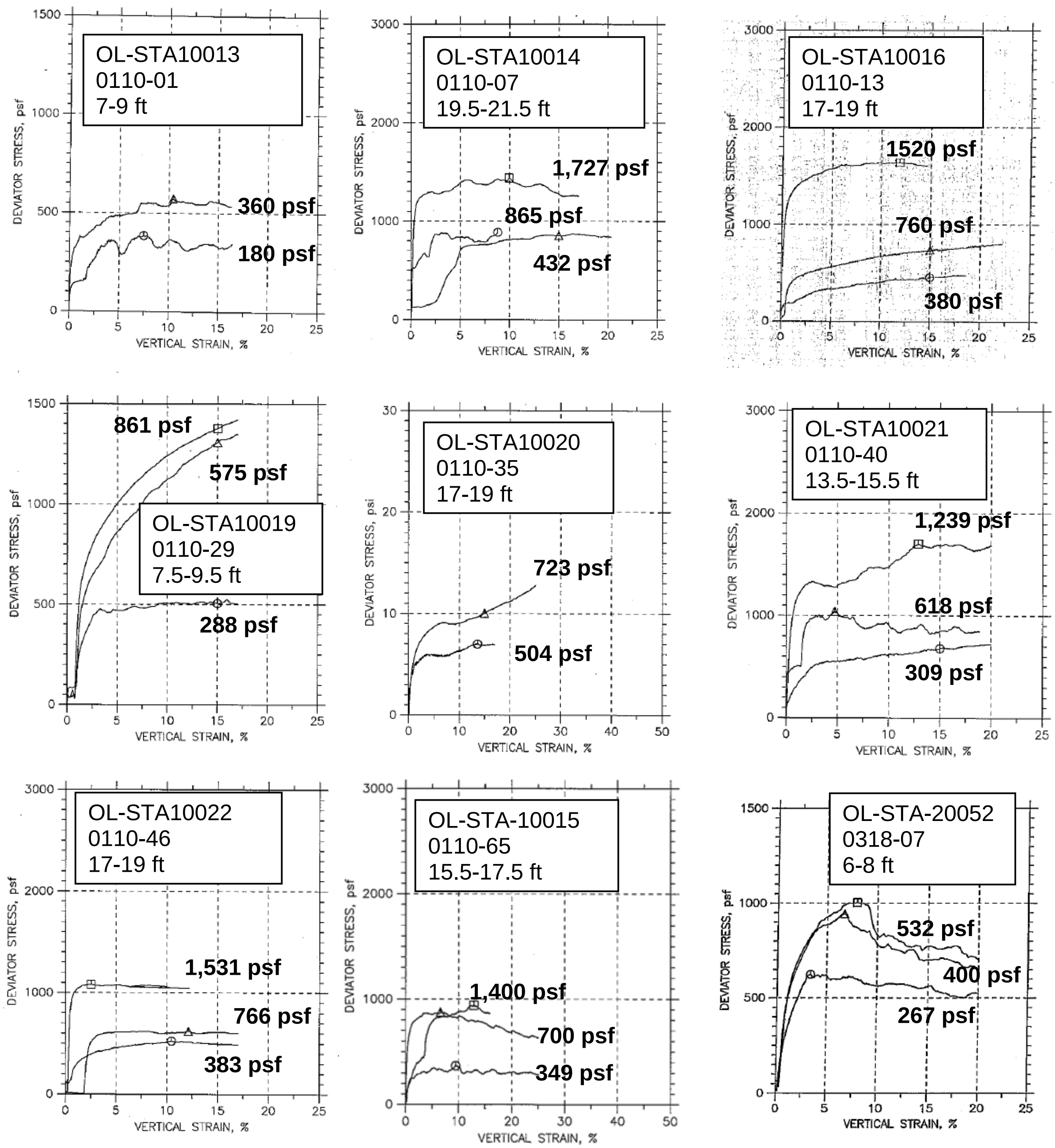

Figure 14. Consolidated undrained monotonic triaxial test stress-strain paths for SOLW (note that effective confining stresses applied in the lab are marked for each test).

Written by:	**R. Kulasingam**	Date:	**12/17/2010**	Reviewed by:	**Ming Zhu/Jay Beech**	Date:	**12/17/2010**

Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GD4014**	Task No.:	**02**

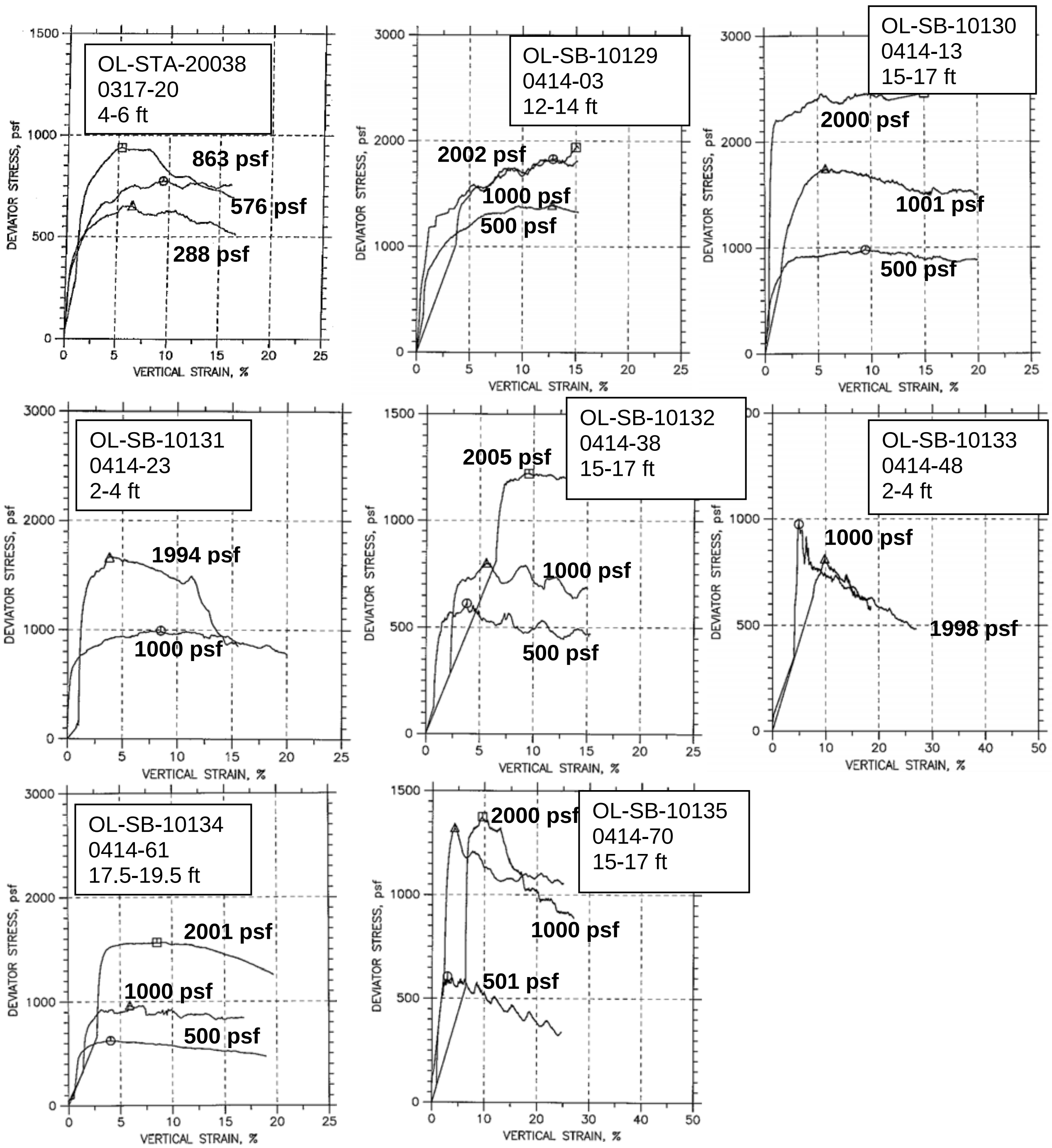

Figure 14. Consolidated undrained monotonic triaxial test stress-strain paths for SOLW (note that effective confining stresses applied in the lab are marked for each test) (continued).

Written by: **R. Kulasingam** Date: **12/17/2010** Reviewed by: **Ming Zhu/Jay Beech** Date: **12/17/2010**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GD4014** Task No.: **02**

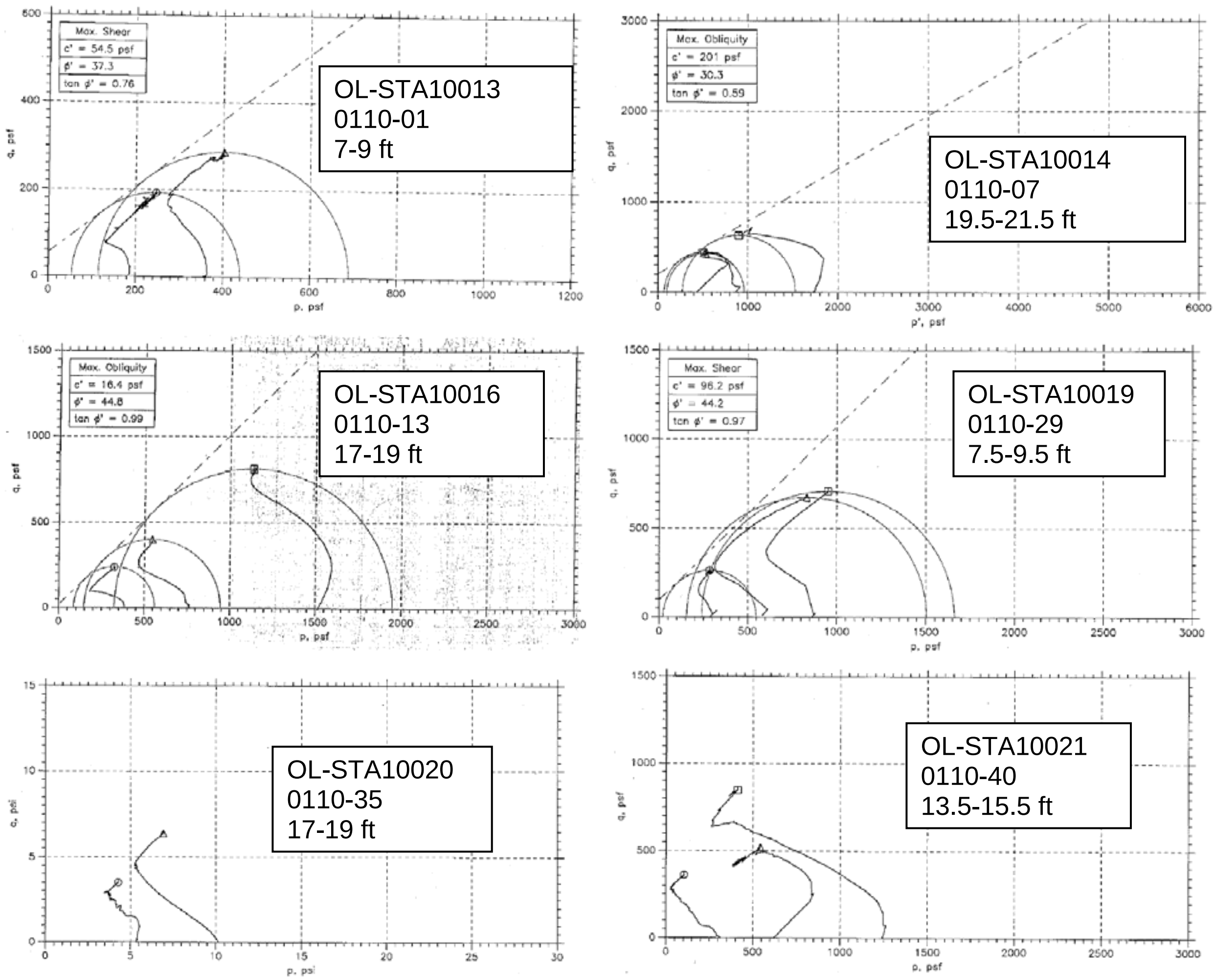

Figure 15. Consolidated undrained monotonic triaxial test q-p' stress paths for SOLW.

Written by: R. Kulasingam Date: 12/17/2010 Reviewed by: Ming Zhu/Jay Beech Date: 12/17/2010

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GD4014** Task No.: **02**

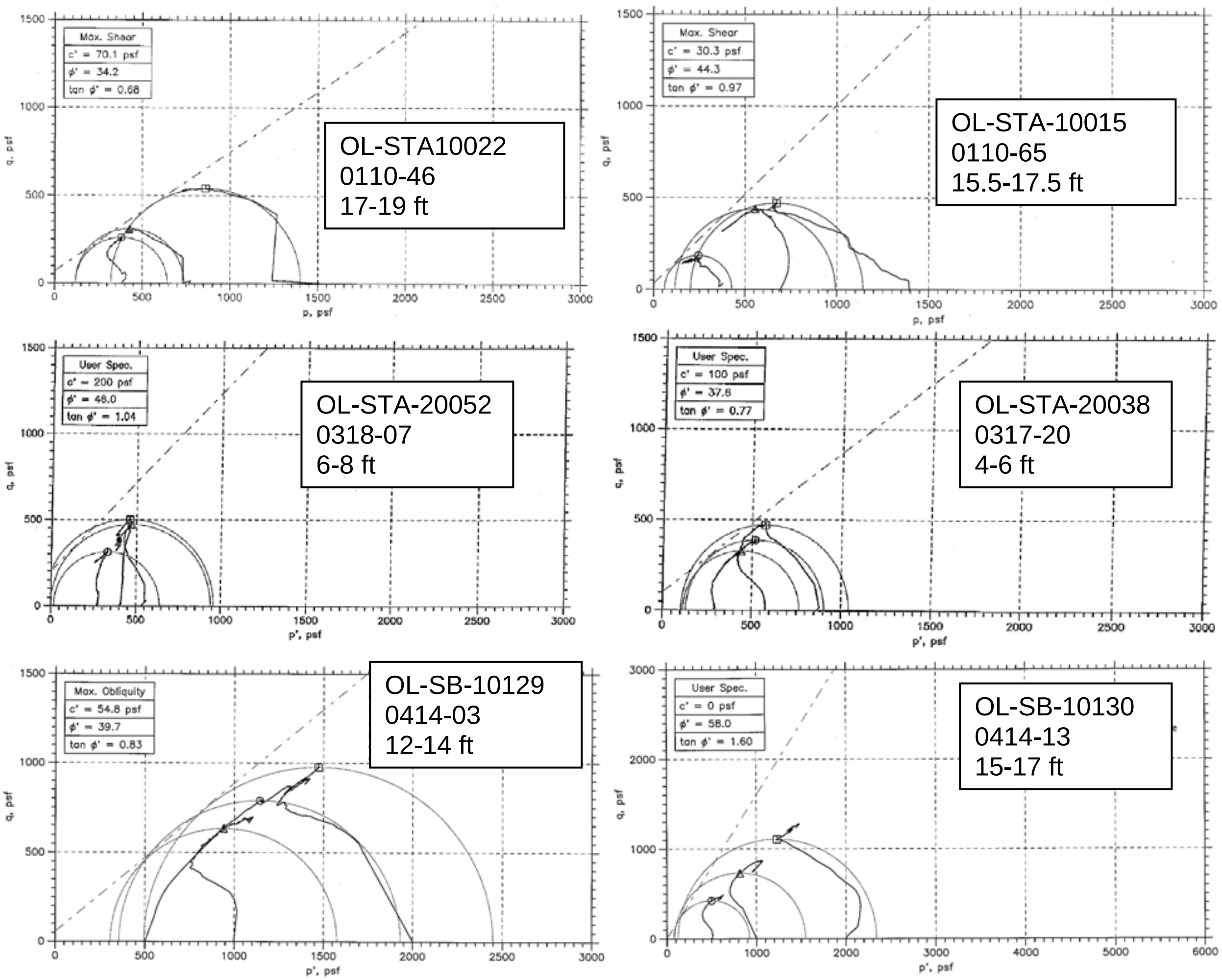

Figure 15. Consolidated undrained monotonic triaxial test q-p' stress paths for SOLW (continued).

Written by:	R. Kulasingam	Date:	12/17/2010	Reviewed by:	Ming Zhu/Jay Beech	Date:	12/17/2010

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GD4014	Task No.:	02

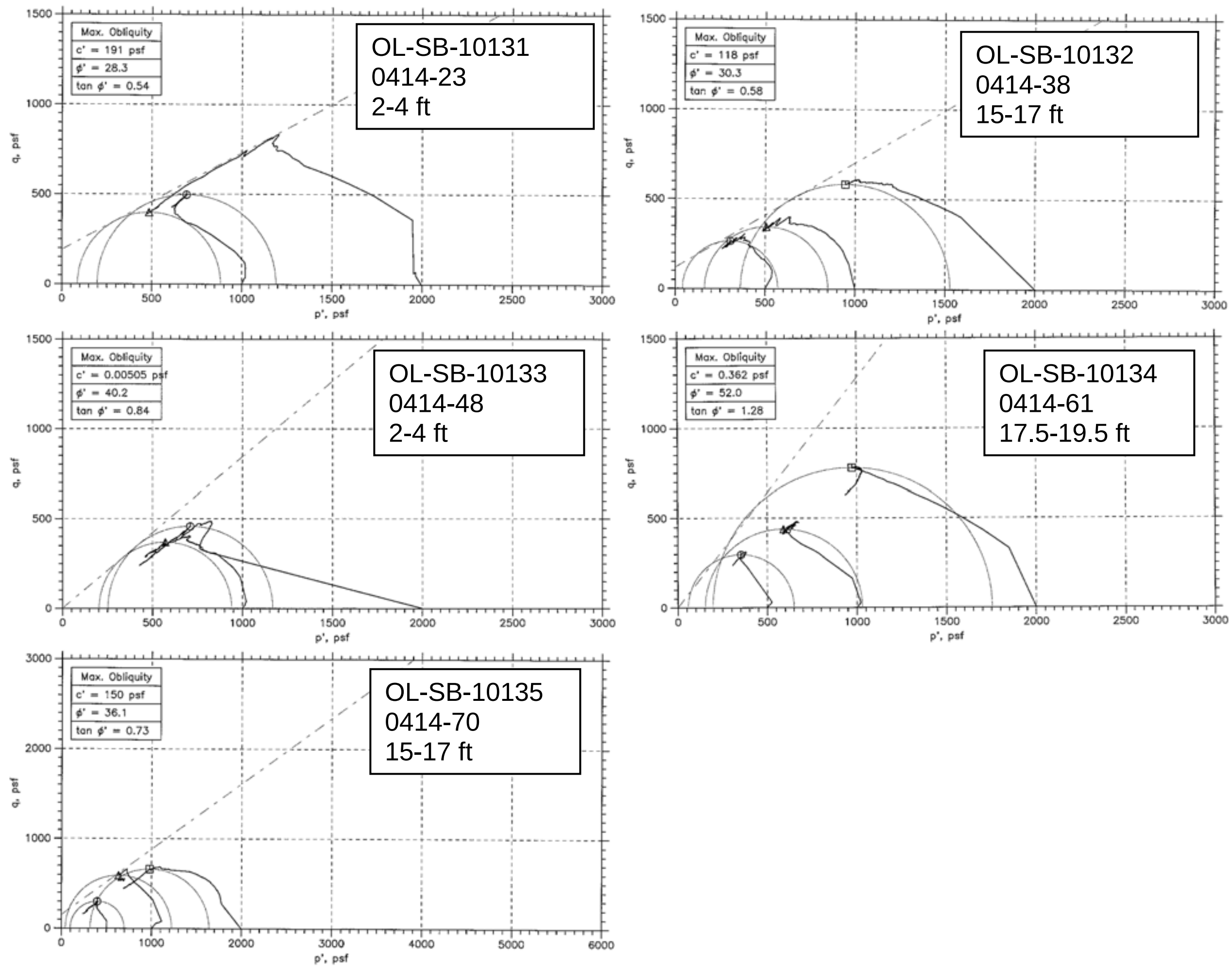

Figure 15. Consolidated undrained monotonic triaxial test q-p' stress paths for SOLW (continued).

Attachment 1

Deaggregated Seismic Hazard

This attachment presents the deaggregated seismic hazard for the 10% probability of exceedance in a 50-year event, which is based on the 2002 United States Geological Survey (USGS) maps. The following paragraphs describe how a 5.3 moment magnitude was selected for the liquefaction analyses based on the deaggregation.

Conventional engineering methods for evaluation of soil liquefaction potential are deterministic. Required (deterministic) input parameters for evaluation of soil liquefaction include design earthquake magnitude, M (which is a proxy for duration of strong ground shaking) and free-field (zero-period) maximum ground surface acceleration (a_{max}).

In the Central and Eastern U.S., seismic hazard (and therefore a_{max}) is typically governed by multiple seismic sources at various distances. Probabilistic seismic hazard analysis is conducted in order to account for these multiple seismic source – distance pairs. The result of the probabilistic seismic hazard analysis is the a_{max} for a given return period. The contribution of each seismic source in evaluation of the a_{max} in a probabilistic seismic hazard analysis can be assessed by a process called deaggregation.

Deaggregation does not result in a single earthquake magnitude–distance pair. The result of deaggregation is a series of seismic hazard matrices (usually 3 to 5 matrices, each for a different period of oscillation, as available at the United States Geological Survey, USGS web site). For an evaluation of soil liquefaction potential, a_{max} is required. The value of a_{max} can be defined as the peak spectral acceleration (PSA) corresponding to a period of zero seconds. The PSA corresponding to a period of zero seconds is very close to the PSA corresponding to a period of 0.1 seconds. Hence, a 0.1-second matrix (matrix with the lowest period available from the USGS web page) is considered for this site. This is consistent with standard practice in seismic hazard evaluation.

A review of the 0.1-second matrix reveals the following three candidate magnitude-distance pairs:

M 4.81 at 36.3 km (Epsilon = 4.53)
M 5.25 at 115.3 km (Epsilon = 3.39)
M 5.72 at 164.7 km (Epsilon = 3.27)

These above-listed magnitude-distance pairs have the largest Epsilon and hence, dominate the a_{max} estimate for this site (zero Epsilon corresponds to the median motion; Epsilon = 2 corresponds to median plus one standard deviation motion; larger Epsilon=larger a_{max}).

An inspection of the above-listed candidate events indicates that the a_{max} evaluated for this site corresponds to M 4.81. However, M 4.81 at 36.3 km pair is associated with a relatively low duration of strong ground shaking (5.9 seconds as opposed to 18.5 seconds from the M 5.25 event at a distance of 115.3 km). Therefore, Geosyntec selected the highest evaluated a_{max} (i.e., a_{max} that corresponds to an M 4.81 event at 36.3 km) and duration (i.e., duration that corresponds to M 5.25 event) for an evaluation of soil liquefaction at this site. This is a conservative approach.

*** Deaggregation of Seismic Hazard at Three Periods of Spectral Accel. ***
*** Data from U.S.G.S. National Seismic Hazards Mapping Project, 1996 version ***
PSHA Deaggregation. %contributions. site: Lake_Onondaga long: 76.20000 W., lat: 43.0600 N.
Return period: 475yrs. 2.00 s. PSA =0.0127989g. Computed annual rate=.21076E-02

DIST(KM)	MAG(MW)	ALL-EPS	EPSILON>2	1<EPS<2	0<EPS<1	-1<EPS<0	-2<EPS<-1	EPS<-2
13.1	4.87	0.121	0.037	0.065	0.019	0.001	0.000	0.000
13.7	5.27	0.250	0.022	0.091	0.106	0.029	0.001	0.000
35.4	5.30	0.262	0.044	0.134	0.082	0.002	0.000	0.000
64.1	5.33	0.163	0.062	0.094	0.007	0.000	0.000	0.000
89.6	5.34	0.090	0.054	0.036	0.000	0.000	0.000	0.000
114.5	5.35	0.115	0.087	0.028	0.000	0.000	0.000	0.000
138.7	5.35	0.101	0.090	0.011	0.000	0.000	0.000	0.000
164.8	5.36	0.133	0.130	0.003	0.000	0.000	0.000	0.000
190.1	5.36	0.082	0.082	0.000	0.000	0.000	0.000	0.000
210.1	5.36	0.076	0.076	0.000	0.000	0.000	0.000	0.000
234.6	5.37	0.093	0.093	0.000	0.000	0.000	0.000	0.000
259.7	5.37	0.057	0.057	0.000	0.000	0.000	0.000	0.000
284.5	5.37	0.067	0.067	0.000	0.000	0.000	0.000	0.000
13.6	5.71	0.212	0.006	0.037	0.091	0.067	0.010	0.000
36.1	5.74	0.522	0.027	0.155	0.255	0.082	0.002	0.000
65.2	5.76	0.514	0.051	0.226	0.219	0.018	0.000	0.000
90.0	5.77	0.418	0.060	0.233	0.125	0.000	0.000	0.000
110.3	5.78	0.474	0.083	0.292	0.099	0.000	0.000	0.000
135.6	5.78	0.974	0.210	0.633	0.130	0.000	0.000	0.000
165.3	5.79	1.135	0.311	0.760	0.064	0.000	0.000	0.000
190.3	5.79	0.816	0.275	0.521	0.021	0.000	0.000	0.000
210.3	5.80	0.841	0.330	0.510	0.002	0.000	0.000	0.000
234.9	5.80	1.164	0.525	0.639	0.000	0.000	0.000	0.000
259.8	5.81	0.805	0.413	0.392	0.000	0.000	0.000	0.000
284.8	5.81	1.048	0.621	0.427	0.000	0.000	0.000	0.000
309.9	5.81	0.662	0.434	0.228	0.000	0.000	0.000	0.000
334.7	5.82	0.828	0.593	0.235	0.000	0.000	0.000	0.000
364.3	5.82	0.662	0.536	0.126	0.000	0.000	0.000	0.000
389.7	5.82	0.361	0.318	0.043	0.000	0.000	0.000	0.000
410.0	5.82	0.278	0.251	0.026	0.000	0.000	0.000	0.000
434.5	5.83	0.315	0.296	0.019	0.000	0.000	0.000	0.000
464.3	5.83	0.207	0.204	0.002	0.000	0.000	0.000	0.000
489.2	5.83	0.102	0.102	0.000	0.000	0.000	0.000	0.000
509.7	5.84	0.072	0.072	0.000	0.000	0.000	0.000	0.000
534.1	5.84	0.073	0.073	0.000	0.000	0.000	0.000	0.000
13.9	6.21	0.111	0.003	0.016	0.039	0.039	0.014	0.001
37.2	6.23	0.414	0.011	0.068	0.170	0.142	0.022	0.000
65.9	6.24	0.596	0.021	0.127	0.297	0.145	0.005	0.000
90.3	6.25	0.608	0.025	0.150	0.331	0.102	0.000	0.000
110.4	6.25	0.777	0.035	0.207	0.439	0.096	0.000	0.000

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136.0	6.25	1.791	0.089	0.529	1.026	0.147	0.000	0.000
165.6	6.26	2.422	0.140	0.835	1.348	0.100	0.000	0.000
190.4	6.26	1.960	0.129	0.768	1.030	0.033	0.000	0.000
210.4	6.27	2.199	0.160	0.959	1.074	0.007	0.000	0.000
235.2	6.27	3.347	0.280	1.626	1.442	0.000	0.000	0.000
259.9	6.27	2.536	0.242	1.358	0.937	0.000	0.000	0.000
285.1	6.28	3.612	0.394	2.098	1.119	0.000	0.000	0.000
309.9	6.28	2.485	0.309	1.527	0.650	0.000	0.000	0.000
334.9	6.29	3.373	0.480	2.182	0.712	0.000	0.000	0.000
364.5	6.29	2.964	0.495	2.012	0.458	0.000	0.000	0.000
389.8	6.29	1.748	0.334	1.215	0.199	0.000	0.000	0.000
410.1	6.30	1.434	0.306	1.009	0.119	0.000	0.000	0.000
434.7	6.30	1.757	0.429	1.236	0.092	0.000	0.000	0.000
464.5	6.30	1.264	0.362	0.884	0.018	0.000	0.000	0.000
489.3	6.30	0.670	0.218	0.452	0.000	0.000	0.000	0.000
509.8	6.31	0.500	0.178	0.323	0.000	0.000	0.000	0.000
534.3	6.31	0.541	0.214	0.327	0.000	0.000	0.000	0.000
559.8	6.31	0.299	0.132	0.167	0.000	0.000	0.000	0.000
584.9	6.31	0.410	0.199	0.210	0.000	0.000	0.000	0.000
37.6	6.72	0.167	0.004	0.023	0.059	0.059	0.021	0.001
66.3	6.72	0.289	0.007	0.044	0.110	0.108	0.020	0.000
90.4	6.72	0.324	0.009	0.052	0.130	0.122	0.012	0.000
110.5	6.72	0.435	0.012	0.071	0.179	0.164	0.009	0.000
136.2	6.73	1.060	0.030	0.181	0.454	0.386	0.009	0.000
165.5	6.73	1.360	0.042	0.248	0.623	0.447	0.000	0.000
190.5	6.73	1.127	0.037	0.218	0.548	0.324	0.000	0.000
210.5	6.73	1.348	0.046	0.275	0.691	0.336	0.000	0.000
235.5	6.73	2.217	0.081	0.486	1.220	0.430	0.000	0.000
260.0	6.73	1.857	0.073	0.436	1.087	0.260	0.000	0.000
285.4	6.73	2.937	0.124	0.743	1.771	0.299	0.000	0.000
310.1	6.74	2.182	0.099	0.593	1.346	0.143	0.000	0.000
333.9	6.74	2.479	0.122	0.726	1.533	0.099	0.000	0.000
364.3	6.74	1.834	0.099	0.591	1.113	0.031	0.000	0.000
389.9	6.74	1.049	0.061	0.367	0.620	0.001	0.000	0.000
414.4	6.74	1.174	0.074	0.444	0.655	0.000	0.000	0.000
439.8	6.74	0.693	0.048	0.285	0.360	0.000	0.000	0.000
464.8	6.75	0.874	0.066	0.391	0.418	0.000	0.000	0.000
489.8	6.75	0.500	0.041	0.243	0.216	0.000	0.000	0.000
509.7	6.75	0.387	0.034	0.201	0.152	0.000	0.000	0.000
534.3	6.75	0.409	0.039	0.233	0.136	0.000	0.000	0.000
559.9	6.75	0.248	0.026	0.154	0.068	0.000	0.000	0.000
585.3	6.75	0.354	0.041	0.232	0.082	0.000	0.000	0.000
37.7	7.20	0.100	0.002	0.014	0.034	0.034	0.014	0.002
66.4	7.21	0.184	0.004	0.026	0.064	0.064	0.024	0.001
90.4	7.21	0.214	0.005	0.030	0.076	0.076	0.026	0.000

110.5	7.21	0.291	0.007	0.042	0.105	0.105	0.033	0.000
136.3	7.21	0.729	0.018	0.106	0.266	0.266	0.074	0.000
165.5	7.21	0.975	0.024	0.145	0.365	0.365	0.076	0.000
190.6	7.21	0.836	0.021	0.128	0.321	0.320	0.046	0.000
210.6	7.21	1.031	0.027	0.161	0.405	0.395	0.042	0.000
235.6	7.21	1.764	0.048	0.284	0.714	0.671	0.047	0.000
260.0	7.22	1.535	0.043	0.255	0.641	0.569	0.026	0.000
285.5	7.22	2.524	0.073	0.435	1.093	0.897	0.026	0.000
310.1	7.22	1.945	0.058	0.347	0.872	0.656	0.011	0.000
334.0	7.22	2.292	0.071	0.425	1.067	0.722	0.007	0.000
364.4	7.22	1.776	0.058	0.346	0.869	0.502	0.001	0.000
390.0	7.22	1.043	0.036	0.212	0.533	0.262	0.000	0.000
414.5	7.22	1.202	0.043	0.256	0.642	0.261	0.000	0.000
439.9	7.23	0.741	0.028	0.165	0.415	0.134	0.000	0.000
464.9	7.23	0.976	0.038	0.228	0.564	0.145	0.000	0.000
489.8	7.23	0.579	0.024	0.142	0.342	0.071	0.000	0.000
509.6	7.23	0.454	0.019	0.116	0.271	0.047	0.000	0.000
534.3	7.22	0.470	0.021	0.127	0.285	0.037	0.000	0.000
560.0	7.22	0.296	0.014	0.085	0.180	0.017	0.000	0.000
585.5	7.23	0.459	0.023	0.139	0.274	0.023	0.000	0.000

Summary statistics for above 2.0s PSA deaggregation, R=distance, e=epsilon:
Mean src-site R= 289.7 km; M= 6.53; e0= 0.26; e= 1.05 for all sources.
Modal src-site R= 285.1 km; M= 6.28; e0= 0.71 from peak (R,M) bin
Primary distance metric: EPICENTRAL
MODE R*= 335.0km; M*= 6.29; EPS.INTERVAL: 1 to 2 sigma % CONTRIB.= 2.182

Principal sources (faults, subduction, random seismicity having >10% contribution)

Source:	% contr.	R(km)	M	epsilon0 (mean values)
CEUS gridded seismicity,Frankel	57.12	295.0	6.58	0.18
CEUS gridded seismicity,Toro att	42.88	282.7	6.45	0.36

****

PSHA Deaggregation. %contributions. site: Lake_Onondaga long: 76.20000 W., lat: 43.0600 N.
Return period: 475yrs. 0.50 s. PSA =0.0482607g. Computed annual rate=.21104E-02

DIST(KM)	MAG(MW)	ALL-EPS	EPSILON>2	1<EPS<2	0<EPS<1	-1<EPS<0	-2<EPS<-1	EPS<-2
12.9	4.83	0.834	0.034	0.205	0.429	0.161	0.005	0.000
34.1	4.85	1.073	0.150	0.614	0.305	0.005	0.000	0.000
63.5	4.87	0.444	0.224	0.220	0.000	0.000	0.000	0.000
89.6	4.88	0.219	0.178	0.041	0.000	0.000	0.000	0.000
115.1	4.89	0.296	0.279	0.017	0.000	0.000	0.000	0.000
139.9	4.89	0.185	0.185	0.000	0.000	0.000	0.000	0.000
164.1	4.90	0.217	0.217	0.000	0.000	0.000	0.000	0.000
189.8	4.90	0.105	0.105	0.000	0.000	0.000	0.000	0.000
209.8	4.90	0.079	0.079	0.000	0.000	0.000	0.000	0.000
233.8	4.91	0.073	0.073	0.000	0.000	0.000	0.000	0.000

13.7	5.22	0.575	0.015	0.089	0.224	0.211	0.035	0.000
35.8	5.24	1.420	0.065	0.390	0.780	0.184	0.001	0.000
64.6	5.26	1.108	0.123	0.642	0.342	0.001	0.000	0.000
89.9	5.27	0.768	0.145	0.552	0.072	0.000	0.000	0.000
112.3	5.28	0.923	0.254	0.650	0.020	0.000	0.000	0.000
136.3	5.28	1.225	0.442	0.783	0.000	0.000	0.000	0.000
164.6	5.29	1.264	0.691	0.573	0.000	0.000	0.000	0.000
190.0	5.29	0.730	0.525	0.205	0.000	0.000	0.000	0.000
210.0	5.30	0.627	0.528	0.099	0.000	0.000	0.000	0.000
234.3	5.30	0.691	0.655	0.036	0.000	0.000	0.000	0.000
260.8	5.31	0.414	0.414	0.000	0.000	0.000	0.000	0.000
285.1	5.31	0.345	0.345	0.000	0.000	0.000	0.000	0.000
309.5	5.31	0.188	0.188	0.000	0.000	0.000	0.000	0.000
333.9	5.32	0.184	0.184	0.000	0.000	0.000	0.000	0.000
363.6	5.32	0.109	0.109	0.000	0.000	0.000	0.000	0.000
13.9	5.70	0.268	0.006	0.037	0.093	0.093	0.035	0.002
37.0	5.70	0.955	0.027	0.162	0.408	0.328	0.029	0.000
65.4	5.72	1.170	0.051	0.305	0.672	0.142	0.000	0.000
90.1	5.73	1.029	0.060	0.360	0.590	0.019	0.000	0.000
110.2	5.73	1.184	0.083	0.495	0.606	0.000	0.000	0.000
135.6	5.73	2.368	0.212	1.248	0.908	0.000	0.000	0.000
165.1	5.74	2.650	0.335	1.736	0.579	0.000	0.000	0.000
190.2	5.75	1.781	0.308	1.287	0.186	0.000	0.000	0.000
210.2	5.75	1.717	0.384	1.270	0.063	0.000	0.000	0.000
234.6	5.75	2.164	0.670	1.490	0.004	0.000	0.000	0.000
259.6	5.76	1.349	0.571	0.779	0.000	0.000	0.000	0.000
284.5	5.76	1.564	0.865	0.699	0.000	0.000	0.000	0.000
309.7	5.77	0.877	0.594	0.283	0.000	0.000	0.000	0.000
334.2	5.77	0.956	0.764	0.192	0.000	0.000	0.000	0.000
363.9	5.77	0.640	0.594	0.046	0.000	0.000	0.000	0.000
389.5	5.78	0.299	0.297	0.001	0.000	0.000	0.000	0.000
409.8	5.78	0.202	0.202	0.000	0.000	0.000	0.000	0.000
434.1	5.78	0.195	0.195	0.000	0.000	0.000	0.000	0.000
463.9	5.79	0.105	0.105	0.000	0.000	0.000	0.000	0.000
14.0	6.21	0.114	0.003	0.015	0.039	0.039	0.015	0.002
37.5	6.22	0.471	0.011	0.068	0.170	0.170	0.051	0.001
66.0	6.22	0.749	0.021	0.127	0.319	0.265	0.016	0.000
90.3	6.23	0.774	0.025	0.150	0.377	0.221	0.001	0.000
110.4	6.23	0.974	0.035	0.206	0.518	0.214	0.000	0.000
135.9	6.23	2.181	0.088	0.529	1.274	0.291	0.000	0.000
165.5	6.24	2.808	0.140	0.833	1.693	0.142	0.000	0.000
190.3	6.24	2.146	0.128	0.767	1.226	0.025	0.000	0.000
210.3	6.25	2.286	0.160	0.957	1.168	0.001	0.000	0.000
235.0	6.25	3.243	0.279	1.663	1.300	0.000	0.000	0.000
259.8	6.25	2.269	0.242	1.384	0.644	0.000	0.000	0.000

284.8	6.26	2.944	0.394	2.012	0.539	0.000	0.000	0.000
309.8	6.26	1.837	0.308	1.339	0.190	0.000	0.000	0.000
334.6	6.27	2.229	0.479	1.658	0.092	0.000	0.000	0.000
364.1	6.27	1.696	0.495	1.195	0.007	0.000	0.000	0.000
389.6	6.28	0.880	0.333	0.547	0.000	0.000	0.000	0.000
409.9	6.28	0.646	0.298	0.348	0.000	0.000	0.000	0.000
434.3	6.28	0.686	0.393	0.294	0.000	0.000	0.000	0.000
464.1	6.29	0.414	0.289	0.125	0.000	0.000	0.000	0.000
489.2	6.29	0.189	0.149	0.040	0.000	0.000	0.000	0.000
509.6	6.29	0.124	0.107	0.016	0.000	0.000	0.000	0.000
533.8	6.29	0.113	0.105	0.008	0.000	0.000	0.000	0.000
560.9	6.30	0.057	0.057	0.001	0.000	0.000	0.000	0.000
585.2	6.30	0.055	0.055	0.000	0.000	0.000	0.000	0.000
37.7	6.72	0.169	0.004	0.023	0.059	0.058	0.023	0.002
66.3	6.72	0.301	0.007	0.044	0.110	0.110	0.030	0.000
90.4	6.72	0.337	0.009	0.052	0.130	0.129	0.018	0.000
110.5	6.72	0.446	0.012	0.071	0.178	0.173	0.012	0.000
136.1	6.72	1.065	0.030	0.181	0.454	0.393	0.008	0.000
165.4	6.73	1.321	0.042	0.248	0.622	0.410	0.000	0.000
190.4	6.73	1.048	0.036	0.218	0.548	0.246	0.000	0.000
210.5	6.73	1.207	0.046	0.275	0.687	0.199	0.000	0.000
235.4	6.73	1.890	0.081	0.485	1.156	0.168	0.000	0.000
264.7	6.73	2.197	0.110	0.660	1.356	0.071	0.000	0.000
290.0	6.73	1.484	0.087	0.518	0.869	0.010	0.000	0.000
310.0	6.74	1.499	0.099	0.592	0.807	0.000	0.000	0.000
333.7	6.74	1.562	0.121	0.725	0.715	0.000	0.000	0.000
363.9	6.74	1.025	0.099	0.583	0.343	0.000	0.000	0.000
389.8	6.74	0.527	0.061	0.347	0.118	0.000	0.000	0.000
414.1	6.74	0.528	0.074	0.378	0.075	0.000	0.000	0.000
439.7	6.75	0.276	0.048	0.208	0.020	0.000	0.000	0.000
464.5	6.75	0.307	0.065	0.232	0.010	0.000	0.000	0.000
489.6	6.75	0.155	0.041	0.114	0.000	0.000	0.000	0.000
509.5	6.74	0.108	0.034	0.074	0.000	0.000	0.000	0.000
533.9	6.75	0.099	0.039	0.060	0.000	0.000	0.000	0.000
559.7	6.75	0.052	0.025	0.027	0.000	0.000	0.000	0.000
584.8	6.75	0.064	0.037	0.026	0.000	0.000	0.000	0.000
37.7	7.20	0.100	0.002	0.014	0.034	0.034	0.014	0.002
66.4	7.21	0.185	0.004	0.026	0.064	0.064	0.025	0.001
90.4	7.21	0.214	0.005	0.030	0.076	0.076	0.027	0.000
110.5	7.21	0.290	0.007	0.042	0.104	0.104	0.033	0.000
136.2	7.21	0.718	0.018	0.106	0.266	0.266	0.063	0.000
165.5	7.21	0.942	0.024	0.145	0.364	0.359	0.049	0.000
190.5	7.21	0.789	0.021	0.128	0.321	0.297	0.022	0.000
210.5	7.21	0.949	0.027	0.161	0.404	0.341	0.016	0.000
235.5	7.22	1.568	0.048	0.284	0.713	0.511	0.011	0.000

261.9	7.22	1.501	0.050	0.301	0.755	0.393	0.002	0.000
286.4	7.22	1.859	0.065	0.389	0.969	0.436	0.000	0.000
310.0	7.22	1.498	0.058	0.347	0.840	0.253	0.000	0.000
333.8	7.23	1.663	0.071	0.424	0.969	0.199	0.000	0.000
364.2	7.23	1.184	0.058	0.346	0.692	0.089	0.000	0.000
389.9	7.23	0.645	0.035	0.212	0.367	0.031	0.000	0.000
414.3	7.24	0.687	0.043	0.255	0.372	0.017	0.000	0.000
439.8	7.24	0.388	0.028	0.165	0.192	0.003	0.000	0.000
464.7	7.24	0.467	0.038	0.223	0.207	0.000	0.000	0.000
489.7	7.25	0.253	0.024	0.132	0.097	0.000	0.000	0.000
509.5	7.25	0.184	0.019	0.103	0.061	0.000	0.000	0.000
533.9	7.25	0.171	0.021	0.105	0.045	0.000	0.000	0.000
559.8	7.25	0.096	0.014	0.063	0.020	0.000	0.000	0.000
585.2	7.26	0.132	0.023	0.089	0.020	0.000	0.000	0.000

Summary statistics for above 0.5s PSA deaggregation, R=distance, e=epsilon:
Mean src-site R= 229.7 km; M= 6.23; e0= 0.49; e= 1.22 for all sources.
Modal src-site R= 235.0 km; M= 6.25; e0= 0.58 from peak (R,M) bin
Primary distance metric: EPICENTRAL
MODE R*= 285.1km; M*= 6.26; EPS.INTERVAL: 1 to 2 sigma % CONTRIB.= 2.012

Principal sources (faults, subduction, random seismicity having >10% contribution)

Source:	% contr.	R(km)	M	epsilon0 (mean values)
CEUS gridded seismicity,Frankel	66.19	237.1	6.24	0.47
CEUS gridded seismicity,Toro att	33.81	215.3	6.22	0.53

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PSHA Deaggregation. %contributions. site: Lake_Onondaga long: 76.20000 W., lat: 43.0600 N.
Return period: 475yrs. 0.10 s. PSA =0.0709094g. Computed annual rate=.21080E-02

DIST(KM)	MAG(MW)	ALL-EPS	EPSILON>2	1<EPS<2	0<EPS<1	-1<EPS<0	-2<EPS<-1	EPS<-2
13.9	4.81	1.461	0.034	0.206	0.516	0.516	0.180	0.009
36.3	4.81	4.513	0.150	0.898	2.228	1.182	0.055	0.000
64.4	4.82	3.813	0.282	1.679	1.826	0.026	0.000	0.000
89.6	4.83	2.239	0.333	1.618	0.288	0.000	0.000	0.000
114.6	4.84	2.696	0.774	1.903	0.020	0.000	0.000	0.000
139.7	4.85	1.451	0.733	0.719	0.000	0.000	0.000	0.000
163.5	4.86	1.444	1.142	0.302	0.000	0.000	0.000	0.000
189.5	4.86	0.555	0.552	0.003	0.000	0.000	0.000	0.000
209.4	4.87	0.339	0.339	0.000	0.000	0.000	0.000	0.000
233.0	4.87	0.242	0.242	0.000	0.000	0.000	0.000	0.000
262.2	4.88	0.103	0.103	0.000	0.000	0.000	0.000	0.000
14.0	5.22	0.653	0.015	0.089	0.224	0.224	0.089	0.011
37.1	5.22	2.464	0.065	0.390	0.980	0.902	0.126	0.001
65.2	5.23	2.919	0.123	0.733	1.686	0.377	0.000	0.000
89.9	5.24	2.241	0.145	0.864	1.229	0.004	0.000	0.000
115.2	5.25	3.397	0.339	1.960	1.098	0.000	0.000	0.000

Written by: **R. Kulasingam** Date: **12/17/2010** Reviewed by: **Ming Zhu/Jay Beech** Date: **12/17/2010**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GD4014** Task No.: **02**

140.0	5.25	2.241	0.370	1.643	0.229	0.000	0.000	0.000
164.1	5.26	2.694	0.802	1.863	0.028	0.000	0.000	0.000
189.8	5.26	1.277	0.693	0.584	0.000	0.000	0.000	0.000
209.7	5.27	0.910	0.699	0.211	0.000	0.000	0.000	0.000
233.5	5.28	0.774	0.734	0.040	0.000	0.000	0.000	0.000
262.7	5.28	0.407	0.407	0.000	0.000	0.000	0.000	0.000
289.0	5.29	0.132	0.132	0.000	0.000	0.000	0.000	0.000
309.0	5.29	0.077	0.077	0.000	0.000	0.000	0.000	0.000
332.7	5.30	0.051	0.051	0.000	0.000	0.000	0.000	0.000
14.0	5.70	0.274	0.006	0.037	0.093	0.093	0.037	0.006
37.5	5.70	1.141	0.027	0.163	0.408	0.408	0.130	0.004
65.8	5.70	1.728	0.051	0.305	0.767	0.585	0.020	0.000
90.1	5.71	1.613	0.060	0.360	0.901	0.291	0.000	0.000
112.6	5.72	2.169	0.106	0.633	1.303	0.128	0.000	0.000
136.5	5.71	3.005	0.190	1.132	1.642	0.041	0.000	0.000
164.7	5.72	3.267	0.335	1.881	1.052	0.000	0.000	0.000
189.9	5.73	1.872	0.308	1.348	0.217	0.000	0.000	0.000
209.9	5.73	1.549	0.385	1.125	0.039	0.000	0.000	0.000
234.0	5.74	1.578	0.650	0.929	0.000	0.000	0.000	0.000
263.2	5.75	1.025	0.694	0.331	0.000	0.000	0.000	0.000
289.3	5.75	0.399	0.352	0.046	0.000	0.000	0.000	0.000
309.2	5.76	0.268	0.264	0.004	0.000	0.000	0.000	0.000
333.2	5.76	0.208	0.208	0.000	0.000	0.000	0.000	0.000
362.8	5.77	0.089	0.089	0.000	0.000	0.000	0.000	0.000
14.0	6.21	0.114	0.003	0.016	0.039	0.039	0.016	0.003
37.7	6.21	0.493	0.011	0.068	0.170	0.170	0.067	0.006
66.2	6.22	0.859	0.021	0.127	0.320	0.319	0.071	0.000
90.3	6.22	0.913	0.025	0.150	0.377	0.344	0.017	0.000
110.3	6.22	1.133	0.035	0.207	0.519	0.369	0.004	0.000
135.8	6.23	2.414	0.089	0.529	1.296	0.500	0.000	0.000
165.2	6.23	2.835	0.140	0.834	1.666	0.195	0.000	0.000
190.2	6.24	1.938	0.128	0.768	1.022	0.020	0.000	0.000
210.1	6.24	1.842	0.160	0.925	0.757	0.000	0.000	0.000
234.5	6.25	2.210	0.280	1.398	0.532	0.000	0.000	0.000
260.6	6.26	1.372	0.290	0.952	0.130	0.000	0.000	0.000
284.9	6.25	1.198	0.342	0.833	0.023	0.000	0.000	0.000
309.5	6.26	0.629	0.283	0.346	0.000	0.000	0.000	0.000
333.7	6.27	0.579	0.371	0.208	0.000	0.000	0.000	0.000
363.3	6.28	0.309	0.259	0.050	0.000	0.000	0.000	0.000
389.2	6.29	0.117	0.114	0.003	0.000	0.000	0.000	0.000
409.5	6.29	0.066	0.066	0.000	0.000	0.000	0.000	0.000
433.4	6.30	0.051	0.051	0.000	0.000	0.000	0.000	0.000
37.7	6.72	0.171	0.004	0.023	0.059	0.059	0.023	0.004
66.4	6.72	0.315	0.007	0.044	0.110	0.110	0.042	0.002
90.4	6.72	0.358	0.009	0.052	0.130	0.130	0.038	0.000

110.4	6.72	0.470	0.012	0.071	0.179	0.177	0.031	0.000
136.0	6.72	1.092	0.030	0.181	0.454	0.400	0.027	0.000
165.2	6.72	1.281	0.042	0.248	0.622	0.367	0.002	0.000
190.3	6.73	0.945	0.037	0.218	0.518	0.172	0.000	0.000
210.3	6.73	1.004	0.046	0.275	0.581	0.102	0.000	0.000
235.0	6.73	1.385	0.081	0.486	0.779	0.039	0.000	0.000
264.2	6.73	1.345	0.111	0.636	0.599	0.000	0.000	0.000
289.8	6.73	0.758	0.087	0.442	0.230	0.000	0.000	0.000
309.8	6.73	0.656	0.099	0.439	0.118	0.000	0.000	0.000
333.0	6.74	0.557	0.121	0.400	0.035	0.000	0.000	0.000
363.3	6.74	0.274	0.094	0.180	0.000	0.000	0.000	0.000
389.5	6.75	0.109	0.051	0.058	0.000	0.000	0.000	0.000
413.3	6.75	0.084	0.054	0.031	0.000	0.000	0.000	0.000
37.7	7.20	0.100	0.002	0.014	0.034	0.034	0.014	0.002
66.4	7.20	0.188	0.004	0.026	0.064	0.064	0.026	0.003
90.4	7.21	0.219	0.005	0.030	0.076	0.076	0.030	0.001
110.5	7.21	0.296	0.007	0.042	0.105	0.105	0.037	0.001
136.2	7.21	0.723	0.018	0.106	0.266	0.265	0.068	0.000
165.4	7.21	0.919	0.024	0.145	0.365	0.336	0.049	0.000
190.5	7.21	0.738	0.021	0.128	0.321	0.250	0.017	0.000
210.4	7.22	0.846	0.027	0.161	0.403	0.248	0.007	0.000
235.3	7.22	1.291	0.048	0.284	0.664	0.295	0.001	0.000
264.5	7.23	1.431	0.065	0.387	0.780	0.200	0.000	0.000
289.9	7.23	0.914	0.051	0.304	0.499	0.061	0.000	0.000
309.9	7.24	0.874	0.058	0.338	0.454	0.023	0.000	0.000
333.4	7.24	0.838	0.071	0.377	0.388	0.002	0.000	0.000
363.6	7.25	0.485	0.058	0.265	0.161	0.000	0.000	0.000
389.6	7.26	0.219	0.036	0.138	0.045	0.000	0.000	0.000
413.7	7.26	0.192	0.041	0.131	0.020	0.000	0.000	0.000
439.5	7.27	0.087	0.024	0.061	0.002	0.000	0.000	0.000
464.1	7.28	0.085	0.030	0.055	0.000	0.000	0.000	0.000

Summary statistics for above 0.1s PSA deaggregation, R=distance, e=epsilon:
Mean src-site R= 158.8 km; M= 5.82; e0= 0.29; e= 1.13 for all sources.
Modal src-site R= 36.3 km; M= 4.81; e0= -0.61 from peak (R,M) bin
Primary distance metric: EPICENTRAL
MODE R*= 37.5km; M*= 4.81; EPS.INTERVAL: 0 to 1 sigma % CONTRIB.= 2.228

Principal sources (faults, subduction, random seismicity having >10% contribution)

Source:	% contr.	R(km)	M	epsilon0 (mean values)
CEUS gridded seismicity,Frankel	67.06	171.9	5.90	0.30
CEUS gridded seismicity,Toro att	32.95	132.0	5.68	0.29

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APPENDIX H.2

ADDENDUM

ADDENDUM TO THE PACKAGE TITLED "LIQUEFACTION POTENTIAL ANALYSES"

INTRODUCTION

The purpose of this addendum is to supplement the calculation package titled "*Liquefaction Potential Analyses*" (original calculation package) by presenting the liquefaction potential analyses for the ILWD area subsurface materials that include the weight of the cap. Only the existing conditions were analyzed in the original calculation package because that was considered to be a conservative approach. The methodology used in this addendum is the same as what was used in the original calculation package. A 5-ft thick sediment cap with an estimated average unit weight of 120 pcf was modeled to evaluate the influence of the cap on the liquefaction potential of the subsurface materials. An evaluation of the cap liquefaction potential is also included in this addendum as Attachment 1.

ANALYSIS RESULTS AND CONCLUSION

Table 1 presents the Cyclic Stress Ratio (CSR) values calculated using the simplified procedure proposed by Seed and Idriss [1971], as described in the original calculation package. The calculated CSR values are plotted with depth in Figure 1. The calculated CSR values generally ranged from 0.09 at a depth of 75 ft (same as the 70-ft deep location for the existing conditions) in the silt and clay unit to 0.15 near the top of the Solvay waste (SOLW), with a maximum CSR value of 0.19 at a depth of 25 to 35 ft below the top of the cap. For existing conditions, the calculated CSR values generally ranged from 0.10 at a depth of 70 ft in the silt and clay unit to 0.25 near the top of the SOLW, as presented in the original calculation package. The difference in the calculated CSR values and distribution with depth was caused by the addition of the cap with a significantly higher unit weight than the subsurface materials. The calculated CSR values for the subsurface materials are less for the case including the cap than for the existing conditions, indicating that the addition of the cap decreases the severity of the seismic loading conditions.

Table 1 also presents the Cyclic Resistance Ratio (CRR) values for cohesive soils calculated using the procedure proposed by Boulanger and Idriss [2007], as described in the original calculation package. Figure 1 shows the distribution of CRR with depth graphically. The same shear strength ratios were used in both this addendum and the original calculation package. The results indicate that the calculated CRR values for the case including the cap are the same as those for the existing conditions. Because the calculated CSR values for the case including the cap are smaller than those for the existing conditions (as discussed in the previous section), the calculated factor of safety against liquefaction (FS_{liq}), which is the ratio between CRR and CSR, increases when considering the cap. As presented in Table 1 and Figure 2, the calculated factors of safety against liquefaction ranged from about 2.9 to 3.6 for the SOLW unit, 1.8 to 2.0 for the marl unit, and 2.3 to 3.4 for the silt and clay unit for the case including the cap analyzed herein. In liquefaction analyses, a calculated factor of safety of 1.0 to 1.2 is generally considered adequate to conclude that adverse effects due to pore pressure buildup are unlikely. Therefore, based on this analysis, the SOLW, marl, and silt and clay units in the ILWD area are not considered to be susceptible to liquefaction during the design seismic event.

The above analyses clearly show that the calculated CSR values decreased in the subsurface materials due to the addition of the cap, thereby indicating less severe seismic loading conditions. It is expected that the calculated CSR values for the deeper soil units such as silt and sand, and sand and gravel will decrease too. The strength of these soil units, expressed as corrected SPT blow counts for the purposes of liquefaction potential evaluation, are not expected to change due to the addition of a few feet thick cap. In addition, the calculations for the existing conditions presented in the original calculation package indicate significantly higher calculated CRR values compared to CSR values for these deeper soil units. Due to the above reasons, the deeper soils units (such as silt and sand, and sand and gravel) are not considered susceptible to liquefaction during the design seismic event.

All other additional evaluations and discussions presented in the original calculation package (e.g. screening criteria, triaxial test stress paths etc.) that contributed to the conclusion that subsurface materials are not considered susceptible to liquefaction during the design seismic event are not affected by the addition of a few feet thick cap, and therefore are not repeated herein.

An evaluation of the potential for cap liquefaction was also performed, as described in Attachment 1. Based on this evaluation, a monitoring and maintenance (as needed) approach is recommended. Additional details will be provided in the Cap Monitoring and Maintenance Plan.

REFERENCES

Boulanger, R.W. and Idriss, I.M. (2007), "Evaluation of Cyclic Softening in Silts and Clays", Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Volume 133, No. 6, June 2007, pp. 641 - 652.

Seed, H.B. and Idriss, I.M. (1971). "Simplified Procedure for Evaluating Soil Liquefaction Potential", Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 107, No. SM9, pp. 1249 - 1274.

Tables

Written by: R. Kulasingam Date: 01/04/2011 Reviewed by: Ming Zhu/Jay Beech Date: 01/04/2011

Client: Honeywell Project: Onondaga Lake ILWD Stability Project/ Proposal No.: GD4014 Task No.: 02

Table 1. Calculation of CSR, CRR, and factor of safety against liquefaction

Unit weight of water =	62.4 pcf
Maximum surface acceleration =	0.09 g
K-alpha =	1
OCR model parameter, m =	0.8
Earthquake magnitude =	5.3
Magnitude scaling factor for cohesive soils =	1.13

Depth (ft)	Depth (m)	Idealized Soil Type	Unit Weight (pcf)	Vertical Effective Stress (psf)	Vertical Total Stress (psf)	Stress Reduction Factor	Equivalent Cyclic Shear Stress (psf)	CSR_M	Cu/Sigv' - NC	OCR	Cu/Sigv' - OC	$CRR_{7.5}$	CRR_M	FSliq
0	0.0	Cap	120	0	0	1.00	0							
5	1.5	Cap	120	288	600	0.99	35							
10	3.0	SOLW	81	381	1,005	0.98	58	0.15	0.35	2.0	0.61	0.49	0.55	3.63
15	4.6	SOLW	81	474	1,410	0.97	80	0.17	0.35	2.0	0.61	0.49	0.55	3.26
20	6.1	SOLW	81	567	1,815	0.96	102	0.18	0.35	2.0	0.61	0.49	0.55	3.06
25	7.6	SOLW	81	660	2,220	0.94	122	0.19	0.35	2.0	0.61	0.49	0.55	2.96
30	9.1	SOLW	81	753	2,625	0.92	141	0.19	0.35	2.0	0.61	0.49	0.55	2.92
35	10.7	SOLW	81	846	3,030	0.89	158	0.19	0.35	2.0	0.61	0.49	0.55	2.94
40	12.2	Marl	98	1,024	3,520	0.85	175	0.17	0.35	1.0	0.35	0.28	0.32	1.84
45	13.7	Marl	98	1,202	4,010	0.80	189	0.16	0.35	1.0	0.35	0.28	0.32	2.01
50	15.2	Silt and Clay	108	1,430	4,550	0.75	200	0.14	0.35	1.0	0.35	0.28	0.32	2.25
55	16.8	Silt and Clay	108	1,658	5,090	0.70	209	0.13	0.35	1.0	0.35	0.28	0.32	2.50
60	18.3	Silt and Clay	108	1,886	5,630	0.66	217	0.12	0.35	1.0	0.35	0.28	0.32	2.74
65	19.8	Silt and Clay	108	2,114	6,170	0.62	225	0.11	0.35	1.0	0.35	0.28	0.32	2.97
70	21.3	Silt and Clay	108	2,342	6,710	0.59	232	0.10	0.35	1.0	0.35	0.28	0.32	3.18
75	22.9	Silt and Clay	108	2,570	7,250	0.57	241	0.09	0.35	1.0	0.35	0.28	0.32	3.36

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Figures

Written by:	R. Kulasingam	Date:	01/04/2011	Reviewed by:	Ming Zhu/Jay Beech	Date:	01/04/2011
Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GD4014	Task No.:	02

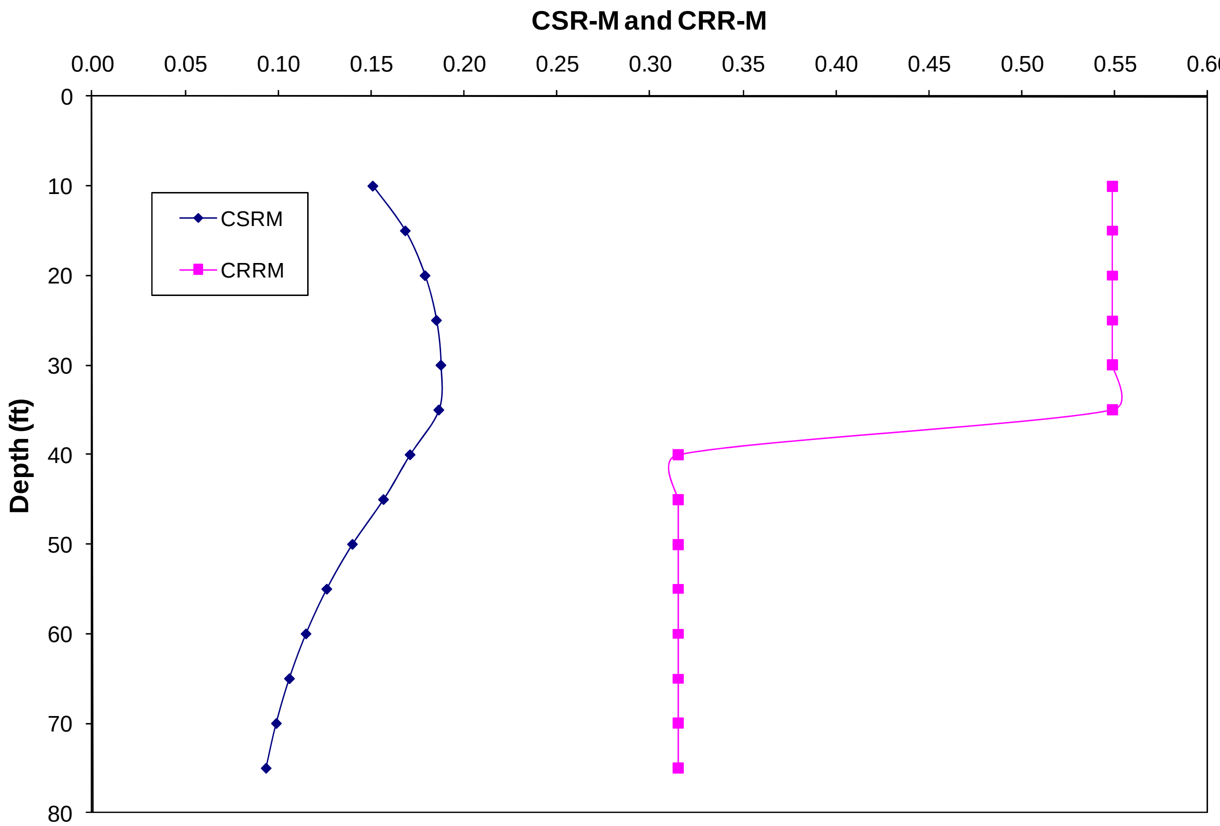

Figure 1. Calculated CSR and CRR values for SOLW, marl, and silt and clay.

Note: ***The discontinuity in CRR_M values occurred at 35 ft below the top of cap because it is the interface between Solvay waste and Marl. Solvay waste shear strengths were modeled with an OCR of 2, and Marl was modeled with an OCR of 1. These OCR values are conservative. The top 5 ft consists of the cap material.***

Written by:	**R. Kulasingam**	Date:	**01/04/2011**	Reviewed by:	**Ming Zhu/Jay Beech**	Date:	**01/04/2011**
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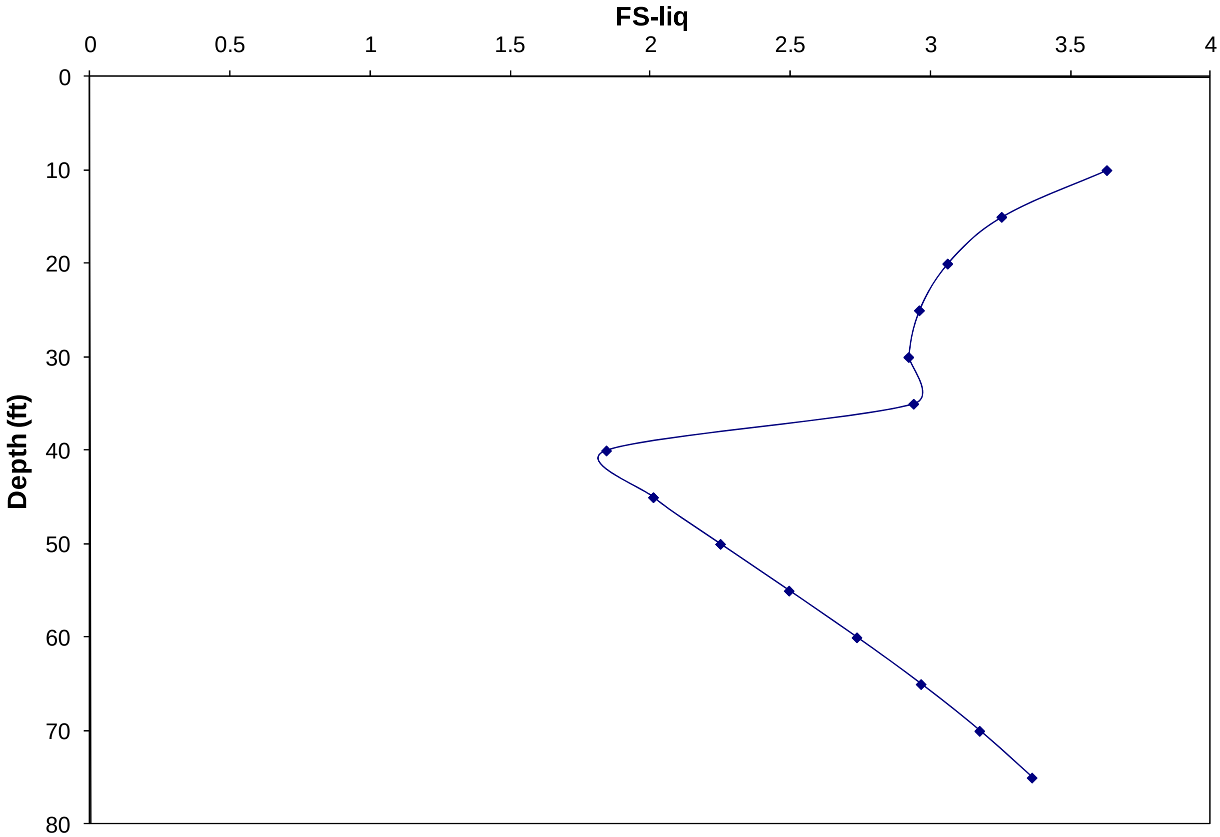

Figure 2. Calculated FS_{liq} values for SOLW, marl, and silt and clay.

Note: ***The discontinuity in FS-liq values occurred at 35 ft below the top of cap because it is the interface between Solvay waste and Marl. Solvay waste shear strengths were modeled with an OCR of 2, and Marl was modeled with an OCR of 1. These OCR values are conservative. The top 5 ft consists of the cap material.***

Written by:	**R. Kulasingam**	Date:	**01/04/2011**	Reviewed by:	**Ming Zhu/Jay Beech**	Date:	**01/04/2011**
Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GD4014**	Task No.:	**02**

Attachment 1

LIQUEFACTION POTENTIAL OF THE PROPOSED SEDIMENT CAP

As documented in the main text of the *Capping, Dredging, and Habitat Design*, the sediment cap design for Onondaga Lake consists primarily of medium sand and gravel layers. Mean cap thicknesses will vary depending on water depth, remediation area, and over placement. The sand cap materials will be placed using a hydraulic spreading system, except for in shallow areas near the shoreline where mechanical placement will be necessary. All the coarse gravel materials will be placed mechanically. It is anticipated that the sand placed hydraulically will have a low relative density because of the placement method. Based on experience, low density sand materials typically have more potential for liquefaction than coarser materials; therefore, it is the sand material that is considered in the evaluation presented below.

General screening criteria (e.g., the Chinese criteria [Wang, 1979] or Andrews and Martin [2000], as described in Appendix H.2) were considered to evaluate the liquefaction potential of the sand in the cap. Since the sand will likely have less than 10% clay content and a liquid limit less than 32, these criteria indicate that the capping layer may be susceptible to liquefaction. Other liquefaction evaluation methods that are used in standard practice to estimate liquefaction susceptibility and potential displacements were considered. For a variety of reasons, they were not considered appropriate for this application. Because of this, a more practical approach, as described in the paragraphs that follow, was selected. For completeness, a brief discussion of these other evaluation methods and why they are not considered applicable is provided following the references section below.

Onondaga Lake is not in a seismic impact zone, as defined in RCRA Subtitle D(258) Seismic Guidance for Municipal Solid Waste Landfill Facilities (Richardson et al, 1995), which means there is a less than 10 percent probability that the maximum horizontal acceleration in lithified earth material, as expressed as a percentage of the earth’s gravitational pull, will exceed 0.10g in 250 years. As such, the risk and frequency of earthquakes is low. Liquefaction evaluations of the Solvay waste and underlying Marl and Silt and Clay [see Appendix H.2] resulted in acceptable factor of safety values. Therefore, if the sand layer in the cap does liquefy, the effects are expected to be limited to within the cap itself and not affect the underlying materials. These effects (if any) are generally expected to be manifested at the cap surface in the form of cracking, slumping, and/or displacements. In the event of liquefaction impacts from an unlikely seismic event, the cap can be readily repaired as part of the long-term monitoring and maintenance program. The extent of these potential effects has not been estimated because of the large uncertainties inherent in that type of calculation. The potential effects are strongly related to slope and seismic event, with steeper slopes and stronger seismic events showing greater potential for localized displacements. The slopes of the cap are generally very flat (i.e., three to five degrees), therefore, the extent of impact, if any, is expected to be limited. In addition, the steeper slope areas are primarily near the shoreline and are surrounded by flatter slopes.

Monitoring and maintenance (as needed) approaches have already been successfully used for caps installed at sites that are in seismic impact zones (i.e., the Western United States) [Waukeganweb, 2002]. For the Onondaga lake site, cap monitoring is recommended to be performed after: (i) indication of significant damage to structures in the Syracuse metropolitan area due to an earthquake; or (ii) occurrence of a 5.5 or greater magnitude on the Richter scale earthquake within 30 miles. Based on these monitoring events, cap maintenance would be performed, if required. Additional details will be provided in the Cap Monitoring and Maintenance Plan.

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OTHER LIQUEFACTION EVALUATION METHODS

As indicated above, liquefaction evaluation methods other than the general screening criteria approach were considered and then determined to be inapplicable for the sand cap. Specifically, methods used in standard engineering practice for evaluating liquefaction potential in sands (e.g., Seed and Idriss, 1971; NCEER, 1997) were considered. These methods are based on *in situ* soil testing, such as standard penetration tests (SPTs) and cone penetrometer tests (CPTs), and comparison to case history databases. Since the case histories do not include sand layers placed under water to shallow depths, as is the case for the proposed Onondaga Lake sediment cap, these methods were not considered applicable.

Liquefaction evaluation approaches using laboratory testing were also considered. These approaches have been used in cases of thick sand deposits placed under water (e.g., hydraulic fill dams) and are based on either: (i) undrained cyclic triaxial testing of sand samples prepared in the laboratory; or (ii) determination of the *in situ* void ratio of the hydraulically placed sand and comparing it to the critical state or steady state line obtained in the laboratory. Both these approaches suffer from limitations in terms of measuring or recreating the *in situ* void ratio and structure of the sand, as well as having to assume that fully undrained conditions would prevail during the design earthquake. Small changes in void ratio can have a large effect on the undrained behavior of sand in these tests, and estimating and recreating the *in situ* void ratio can be difficult. The void ratio can also vary with time (i.e., a freshly deposited sand will have a higher void ratio than a sand cap that has been in place for several years). This can lead to under or overestimation of the liquefaction potential. In addition, partial drainage (i.e., free draining boundary conditions above or below the deposit) will likely occur for a thin sand cap; however, this type of testing, which evaluates fully undrained conditions, is more applicable to a fully undrained thick sand deposit. Since this testing cannot take partial drainage into consideration, it will potentially overestimate susceptibility to liquefaction. Because of these limitations, laboratory testing approaches were not considered appropriate to evaluate the liquefaction potential of the proposed sediment cap.

In addition, hybrid approaches for evaluating the liquefaction potential that combine past experience with laboratory testing and case histories were considered. These approaches include estimating relative densities from past laboratory tests and correlating them to SPT blow counts, estimating undrained residual shear strengths from SPT blow counts using case histories, and performing deformation analyses. Typically, the deformation analyses result in large uncertainty in calculated cap displacements over a range of possible relative density values because of the numerous assumptions that are required as part of the analysis. In addition, all the limitations that were mentioned for the laboratory testing and case histories apply to this hybrid approach. From a practical standpoint, calculating a wide range in deformations is not considered useful because it would not influence how potential liquefaction will be addressed in the design; therefore, additional calculations are not recommended. Instead, low earthquake risk for the site, flat slopes, and underlying materials that are not susceptible to liquefaction were considered in developing a monitoring and maintenance, if required, approach for the cap, as discussed above.

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Seed, H.B. and Idriss, I.M. (1971). "Simplified Procedure for Evaluating Soil Liquefaction Potential", Journal of the Soil Mechanics and Foundations Division, ASCE, Vol. 107, No. SM9, pp. 1249 - 1274.

APPENDIX H.3

STATIC SLOPE STABILITY ANALYSES

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Honeywell **Project:** Onondaga Lake ILWD Stability **Project/Proposal #:** GJ4204 **Task #:** 14-05

TITLE OF COMPUTATIONS **STATIC SLOPE STABILITY ANALYSES**

COMPUTATIONS BY:
Signature Fan Zhu
1/17/2011
DATE
Printed Name and Title: Fan Zhu, Senior Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY:
(Peer Reviewer)
Signature R. Kulasingam
1/17/2011
DATE
Printed Name and Title: Ming Zhu/R. Kulasingam, Project Engineer/Senior Engineer

COMPUTATIONS CHECKED BY:
Signature
1/17/2011
DATE
Printed Name and Title: Joseph Sura, Senior Staff Engineer

COMPUTATIONS BACKCHECKED BY:
(Originator)
Signature Fan Zhu
1/17/2011
DATE
Printed Name and Title: Fan Zhu, Senior Staff Engineer

STATE OF NEW YORK
JOHN F. BEECH
LICENSED PROFESSIONAL ENGINEER
MAR 2012

APPROVED BY:
(PM or Designate)
Signature J. F. Beech
17 JAN 2011
DATE
Printed Name and Title: Jay Beech, Principal

APPROVAL NOTES: Figure 1 was changed on August 13, 2011. M.Z.

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

STATIC SLOPE STABILITY ANALYSES

INTRODUCTION

This calculation package was prepared as part of the Remediation Area D geotechnical stability analysis for the Onondaga Lake Bottom Site. Specifically, the purpose of this package is to present static slope stability analyses for Remediation Area D after dredging, during capping, and after capping. Remediation Area D, which is also referred to as the In-Lake Waste Deposit (ILWD), is shown in Figure 1. Remediation Area D consists predominantly of Sediment Management Unit (SMU) 1 with limited portions of SMUs 2 and 7. The static slope stability was evaluated for (i) overall general cross sections along the ILWD slope, and (ii) localized areas that have relatively steep slopes. Analyses were performed for both undrained and drained cases under the interim condition after dredging, the interim condition during the potential phases of capping, and the final condition after capping.

It should be noted that the cap configurations used in the analyses presented herein are consistent with the mean cap thickness, as documented in the main text of the *Capping, Dredging, and Habitat Design.* For the purpose of the analyses presented herein, the maximum potential difference in cap thickness during the capping phases was assumed, as described later in this package.

Seismic slope stability analyses for the Remediation Area D after capping were performed and are presented in a separate calculation package titled "*Seismic Slope Stability Analyses*" in Appendix H.4 of the *Capping, Dredging, and Habitat Design*.

METHODOLOGY

Static Slope Stability

Static slope stability analyses were performed using Spencer's method [Spencer, 1973], as implemented in the computer program SLIDE, version 5.0 [Rocscience, 2006]. Spencer's method, which satisfies both vertical and horizontal force equilibrium and moment equilibrium, is considered to be more rigorous than other methods, such as the simplified Janbu method [Janbu, 1973] and the simplified Bishop method [Bishop, 1955].

In general, selection of a slope stability method depends on the accuracy of the analytical derivation of the method as well as the numerical implementation in a slope stability program. SLIDE 5.0 offers nine separate methods to analyze slope stability. Ordinary or Fellenius and

Simplified Bishop methods satisfy only force equilibrium in one direction and moment equilibrium. Janbu's simplified, Corps of Engineers' (#1 and #2), and Lowe-Karafiath methods satisfy only force equilibrium in two directions. Janbu's corrected method as implemented in SLIDE uses a modification factor to correct the factor of safety to indirectly account for moment equilibrium. Spencer's, General Limit Equilibrium (GLE), and Morgenstern-Price methods satisfy force equilibrium in two directions and moment equilibrium. The implementation of GLE method in SLIDE is essentially the same as Morgenstern-Price method. Based on the number of equilibrium equations satisfied, Spencer's and GLE/Morgenstern-Price methods are the most rigorous methods available. GLE/Morgenstern-Price method is generally not available in many slope stability programs due to the complexity of numerical implementation, and therefore the experience of applying this method in general practice is significantly less than that for Spencer's method. For this reason, Spencer's method is the preferred method in standard practice for analyzing general circular slip surfaces. Therefore, Spencer's method was chosen as the standard method for performing slope stability analyses for potential circular failure surfaces.

Rotational type failure mode (i.e., circular slip surfaces) was considered to assess the slope stability factor of safety (FS) at the selected cross sections. The SLIDE program generated several potential circular slip surfaces, calculated the FS for each of these surfaces, and identified the most critical slip surface (i.e., the slip surface with the lowest FS). Wedge type slip surfaces were not considered applicable for Remediation Area D because they generally only apply when known weak layers or interfaces are present. Regardless, an independent analysis was performed assuming wedge type slip surfaces. The results indicated that the FSs calculated using the wedge type slip surfaces were greater than those calculated using the circular slip surfaces. Therefore, only circular slip surfaces were evaluated and presented in this package.

Information required for the analyses included:

- geometry of the slope;
- subsurface soil stratigraphy;
- water table;
- properties of subsurface materials; and
- external loading and support conditions, if any.

Target Factor of Safety

The Statement of Work (SOW) attachment of the Consent Decree (CD) provided guidelines for evaluating the stability of the ILWD. A FS of 1.5 is required for the long-term static condition. This is consistent with target FS values used in general engineering practice for the long-term condition [Hammer and Blackburn, 1977; USACE, 2003]. A minimum required FS of 1.3 was selected for the interim condition [USACE, 2003].

SUBSURFACE STRATIGRAPHY

Detailed information regarding the subsurface stratigraphy is presented in Appendix H.1 of the *Capping, Dredging, and Habitat Design* in a calculation package titled "*Summary of Subsurface Stratigraphy and Material Properties*" (referred to as the Data Package). In summary, the subsurface stratigraphy primarily consists of the following materials: Solvay Waste (SOLW), Marl, Silt and Clay, Silt and Sand, Sand and Gravel, Till, and Shale. In isolated areas of the ILWD, thin silt layers are present over the SOLW. The elevation of the lake water surface in the ILWD was assumed to be El. 363 feet above mean sea level (NAVD88), as presented in the Data Package.

The subsurface profile of the ILWD was developed based on the elevation of each layer from the boring logs provided by Parsons. As explained in the Data Package, the deeper surfaces (e.g., bottom of Silt and Clay, bottom of Silt and Sand) that were below the depth of the shallow borings were developed based on a limited number of deeper borings in the ILWD. Since critical slip surfaces identified in the analyses are generally located within depths that were covered by the shallower borings (i.e., borings that terminated in or above the Silt and Clay layer), this is not expected to affect the static slope stability evaluation.

ANALYZED CROSS SECTIONS

As shown on the proposed dredging plan in Figure 1, eight cross sections were selected for the stability analyses. The dredging plan was developed by Anchor QEA and provided to Geosyntec by Parsons. Cross Sections 1 through 5 were selected to represent the overall general slope of the ILWD bottom. Cross Sections A to C were selected to represent potentially critical localized steep slopes. The geometries of Cross Sections 1 through 5 and Cross Sections A through C after dredging are presented in Figures 2 to 9.

As documented in the main text of the *Capping, Dredging, and Habitat Design*, the total cap thickness varies with the water depth. The minimum and mean thicknesses of each cap component correspond to several ranges in water depths. The following potentially critical conditions during and after capping were analyzed:

- Overall General Slopes during Capping: The potential condition where only the cap in 0 to 3 ft of water near the shoreline is constructed and the cap has a mean (with overplacement) total thickness of 4.4 ft was considered to be the most critical condition based on a preliminary analysis. As an example, the analyzed geometry of Cross Section 1 during capping is shown in Figure 10.
- Localized Steep Slopes during Capping: The potential condition where only the cap in the shallower water zone (i.e., upslope side of the cross section) is constructed and the cap has the mean (with overplacement) total thickness corresponding to the water depth was considered to be the most critical condition based on a preliminary analysis. As an example, the analyzed geometry of Cross Section A during capping is shown in Figure 11.
- Overall General Slopes and Localized Steep Slopes after Capping of Remediation Area D: The potential condition where the cap in 10 to 30 ft of water has the minimum total thickness, while the caps in other areas have the mean (with overplacement) total thicknesses was considered to be the most critical condition based on a preliminary analysis. The same cap configuration for the overall general slopes was applied to the localized steep slopes. As examples, the analyzed geometry of Cross Sections 1 and A after capping are shown in Figures 12 and 13, respectively.

MATERIAL PROPERTIES

Detailed information related to the selection of subsurface material properties was presented in the Data Package. Table 1 summarizes the properties (i.e., unit weights, undrained and drained shear strengths) of each subsurface material and the cap material (i.e., the sand) used in the slope stability analyses.

It should be noted that to model the condition immediately after capping when the excess pore water pressure due to the cap has not yet dissipated and no shear strength gain has yet been achieved, the undrained shear strength ratios of the Marl and the Silt and Clay were manually adjusted (i.e., reduced as compared to the ratios used for the other conditions) in the slope stability program (i.e., SLIDE). This adjustment was necessary because the program automatically adds the effective cap loading to the vertical effective stress before calculating the undrained shear strength values. The reduced undrained shear strength ratios were selected so that the calculated undrained shear strengths are approximately the same before and immediately after cap placement. The calculation of the reduced undrained shear strength ratios for Marl and Silt and Clay are presented in Attachment 1 of this package. For the condition during dredging, the program automatically considers the reduction of undrained shear strength of the Marl and the Silt and Clay due to the reduction in vertical effective stress caused by dredging.

RESULTS AND CONCLUSIONS

The static slope stability of Remediation Area D after dredging, during capping and after capping was evaluated for five overall general slopes (i.e., Cross Sections 1 through 5) and three localized steep slopes (i.e., Cross Sections A through C). The results of the static slope stability analyses are summarized in Table 2. As examples, the critical circular slip surfaces for Cross Sections 4 and C are shown in Figures 14 through 25.

Under the interim condition after dredging, the calculated FSs for the selected eight cross sections range from 2.6 to 9.0 for the undrained case and 2.2 to 3.9 for the drained case. Under the interim condition during capping, the calculated FSs for the eight selected cross sections range from 2.1 to 2.5 for both the undrained and the drained cases. Under the final condition after capping, the calculated FSs for the eight selected cross sections range from 2.1 to 2.9 for both the undrained and the drained cases. The results indicate that the selected cross sections have acceptable calculated FSs.

Additional analyses were performed to evaluate the sensitivity of slope stability to the undrained and drained shear strengths of SOLW. One of the critical cross sections, i.e., Cross Section 3, was selected for the sensitivity analyses. In the sensitivity analyses, the SOLW shear strength values were reduced to represent the mean minus one standard deviation (i.e., 165 psf for the undrained shear strength) or lower value (i.e., 29 degrees for the drained friction angle), which were calculated based on the laboratory tests. The sensitivity analysis results indicate that (i) for the interim condition after dredging, the calculated FS is 2.4 for the undrained case and 1.6 for the drained case; (ii) for the interim condition during capping, the calculated FS is 1.8 for the undrained case and 2.5 for the drained case; and (iii) for the final condition after capping, the calculated FS is 1.8 for the undrained case and 2.5 for the drained case. Therefore, the calculated FSs are greater than the target FSs for the critical cross section using the reduced shear strengths for SOLW.

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Spencer, E., “The Thrust Line Criterion in Embankment Stability Analysis,” *Géotechnique*, Vol. 23, No. 1, pp. 85-100, March 1973.

U.S. Army Corps of Engineers (USACE), “Engineering and Design – Slope Stability”, Engineering Manual EM 1110-2-1902, October 2003, pp. 3-2.

Tables

Table 1. Summary of Material Properties for Slope Stability Analyses

Material	Unit Weight (pcf)	Drained Shear Strength, ϕ' (degrees)	Undrained Shear Strength used for analysis after dredging	Undrained Shear Strength used for analysis during and after capping
Cap-Sand[1]	120	32	N/A	N/A
Silt[2]	98	32	N/A	N/A
SOLW	81	37	240 psf	240 psf
Marl	98	32	$S_u/\sigma_v'=0.35$	$S_u/\sigma_v'=0.24$[3],[4]
Silt and Clay	108	30	$S_u/\sigma_v'=0.35$	$S_u/\sigma_v'=0.26$[3],[4]
Silt and Sand	120	32	N/A	N/A
Sand and Gravel	120	32	N/A	N/A
Till	120	40	N/A	N/A
Shale	120	40	N/A	N/A

Notes:

[1]. For the purpose of the slope stability analysis, the relatively thin layer of gravel in the proposed cap was not modeled. The gravel material is expected to have a larger friction angle than the sand. Therefore, not modeling the gravel component of the cap in the slope stability analysis was considered to be conservative.

[2]. The unit weight and the drained shear strength of Marl were used for Silt overlying the SOLW in certain areas of the ILWD.

[3]. The undrained shear strength ratios of Marl and Silt and Clay below the cap were manually reduced in the SLIDE program to avoid the increase of undrained shear strengths of Marl and Silt and Clay due to the additional load from cap. For the portion of cross section without cap, the original ratio of 0.35 was applied to Marl and Silt and Clay.

[4]. The reduced undrained shear strength ratios were calculated as described in Attachment 1.

Table 2. Summary of Static Slope Stability Analysis Results

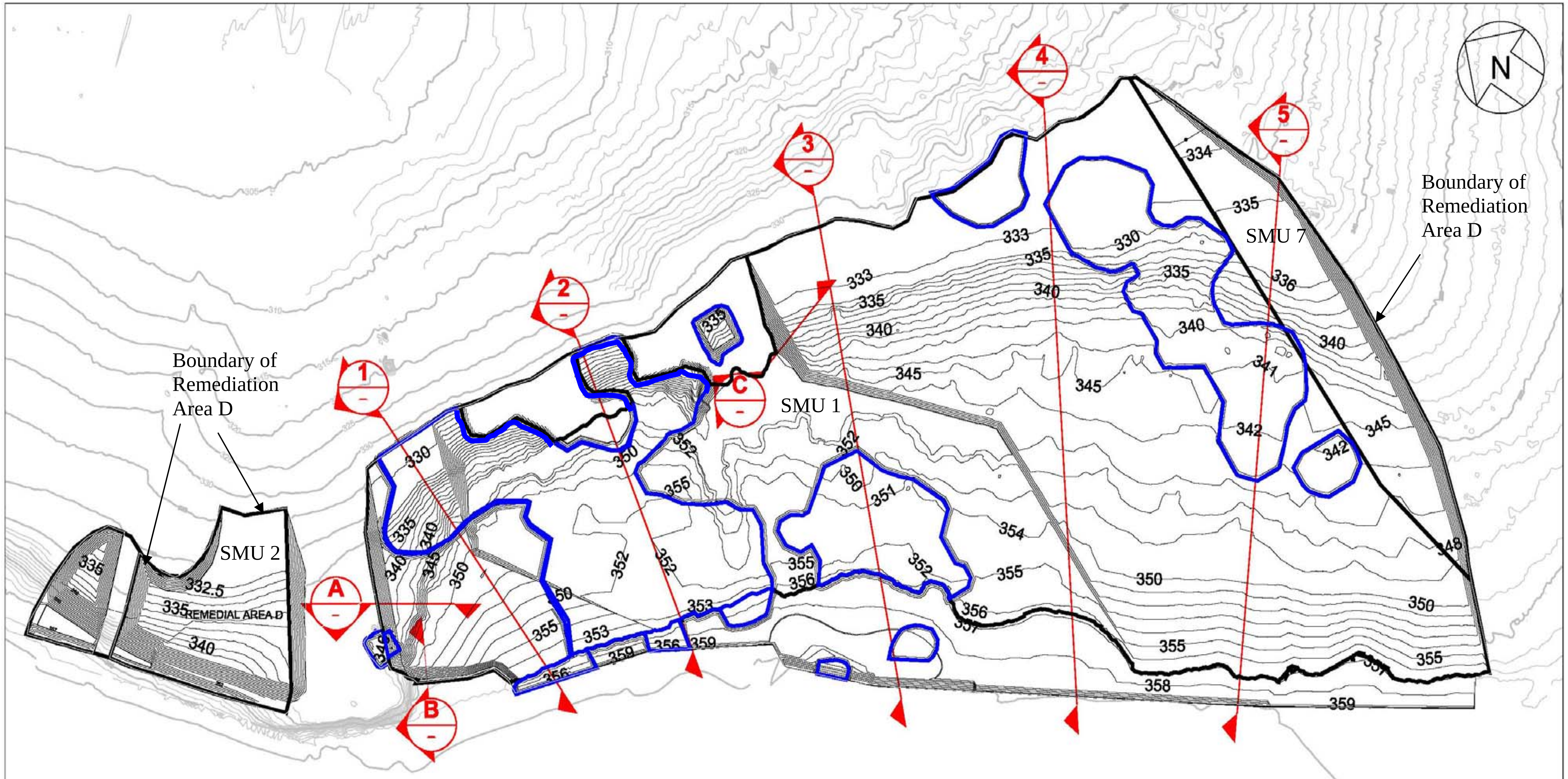
Analyzed Scenario	Cross Section	Interim-Condition (after dredging)			Interim-Condition (during capping)			Final-Condition (after capping)			Note
		Calculated Minimum FS	Target FS	Is FS OK?	Calculated Minimum FS	Target FS	Is FS OK?	Calculated Minimum FS	Target FS	Is FS OK?	
Undrained	1	7.09	1.3	Yes	2.50	1.3	Yes	2.63[1]	1.5	Yes	
	2	2.64	1.3	Yes	2.50	1.3	Yes	2.64[1]	1.5	Yes	
	3	2.64	1.3	Yes	2.40	1.3	Yes	2.40[1]	1.5	Yes	
	4	7.30	1.3	Yes	2.51	1.3	Yes	2.86[1]	1.5	Yes	Results shown in Figures 14, 16 and 18
	5	7.16	1.3	Yes	2.33	1.3	Yes	2.33[1]	1.5	Yes	
	A	9.01	1.3	Yes	2.50	1.3	Yes	2.58[1]	1.5	Yes	
	B	4.63	1.3	Yes	2.12	1.3	Yes	2.12[1]	1.5	Yes	
	C	2.94	1.3	Yes	2.50	1.3	Yes	2.58[1]	1.5	Yes	Results shown in Figures 20, 22 and 24
Drained	1	3.23	1.3	Yes	2.50	1.3	Yes	2.63	1.5	Yes	
	2	2.64	1.3	Yes	2.32	1.3	Yes	2.64	1.5	Yes	
	3	2.15	1.3	Yes	2.50	1.3	Yes	2.50	1.5	Yes	
	4	2.16	1.3	Yes	2.51	1.3	Yes	2.86	1.5	Yes	Results shown in Figures 15, 17 and 19
	5	2.18	1.3	Yes	2.50	1.3	Yes	2.50	1.5	Yes	
	A	3.85	1.3	Yes	2.39	1.3	Yes	2.58	1.5	Yes	
	B	2.78	1.3	Yes	2.12	1.3	Yes	2.12	1.5	Yes	
	C	2.94	1.3	Yes	2.50	1.3	Yes	2.58	1.5	Yes	Results shown in Figures 21, 23 and 25

Note:

[1].The FSs were calculated using the reduced undrained shear strength ratios of Marl and Silt and Clay.

Figures

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011
Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05



Notes:
1. Contours of the existing ground/lake bottom were provided by Parsons.
2. Dredging plan was prepared by Anchor QEA and provided to Geosyntec by Parsons.

Hot spot dredge area

Figure 1. Locations of Selected Cross Sections on Dredging Plan
(Dredging plan was prepared by Anchor QEA and provided to Geosyntec by Parsons)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

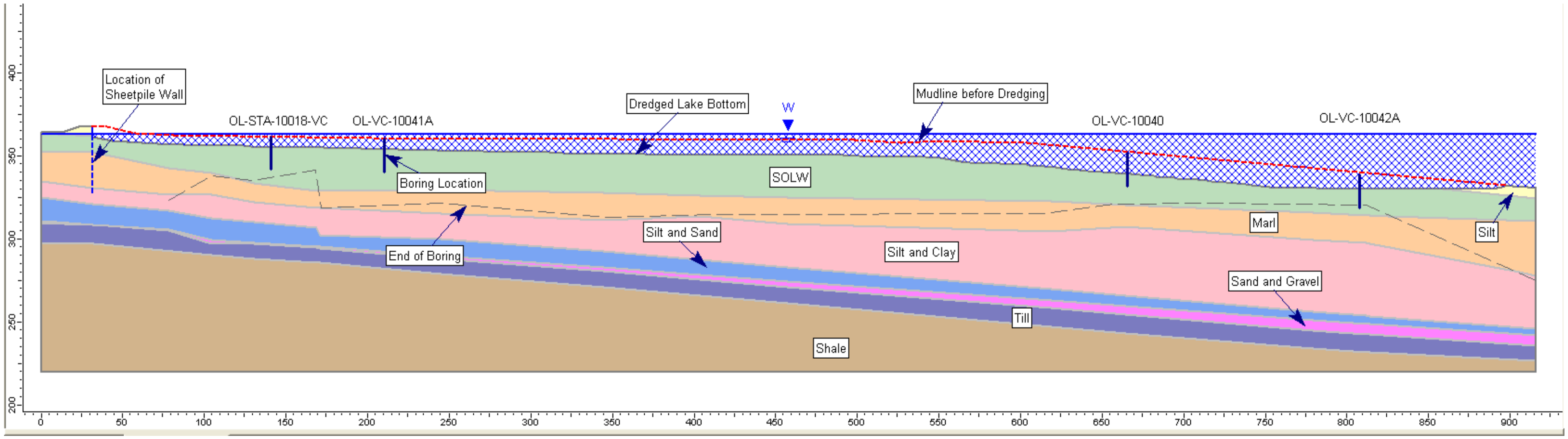


Figure 2. Geometry of Cross Section 1

Notes:
1. Axes show distances and elevations in feet.
2. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings located elsewhere in Remediation Area D.
3. At several locations, the borings shown in the figure are offset from the cross section line. As a result, the end of the boring at these locations does not match exactly the line of end of boring.
4. The above notes apply to Figures 3 through 6.

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

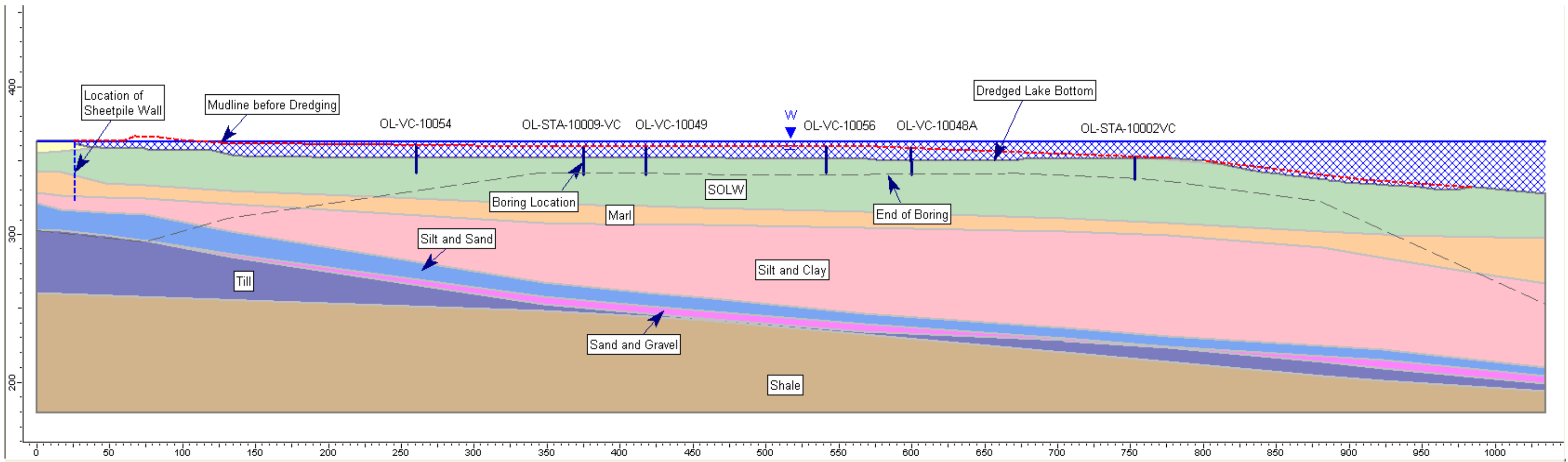


Figure 3. Geometry of Cross Section 2

Notes:
1. See notes for Figure 2.

Written by: **Fan Zhu** Date: **1/14/2011** Reviewed by: **Ming Zhu/R. Kulasingam/Jay Beech** Date: **1/14/2011**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **14-05**

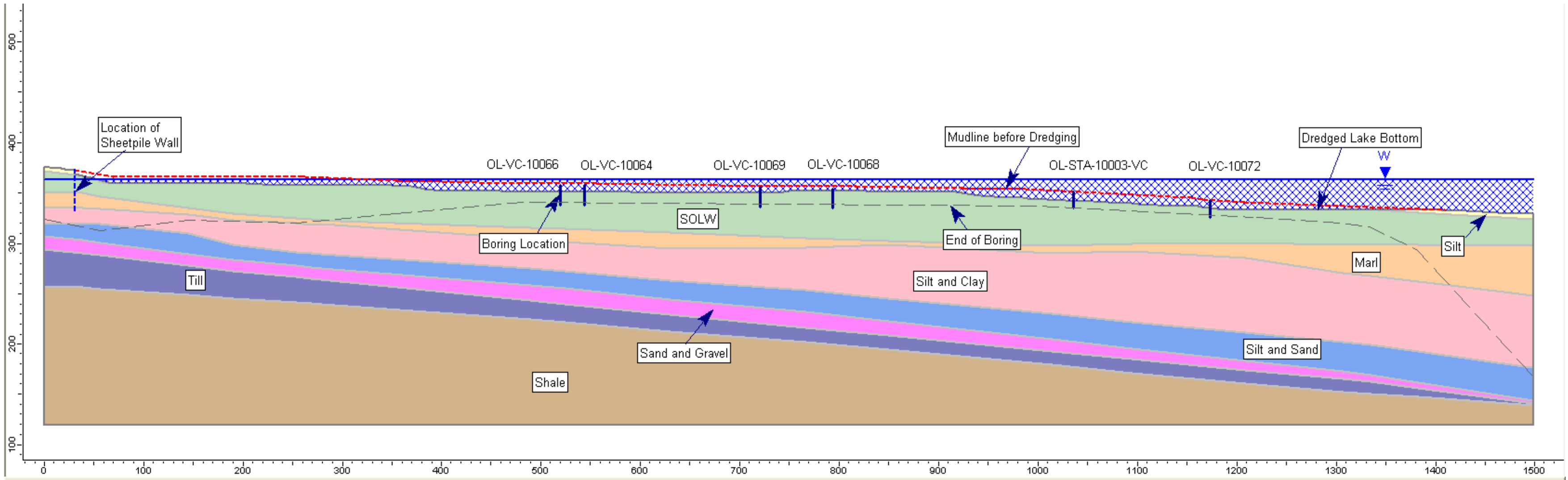


Figure 4. Geometry of Cross Section 3

Notes:

1. See notes for Figure 2.

Written by:	**Fan Zhu**	Date:	**1/14/2011**	Reviewed by:	**Ming Zhu/R. Kulasingam/Jay Beech**	Date:	**1/14/2011**
Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GJ4204**	Task No.:	**14-05**

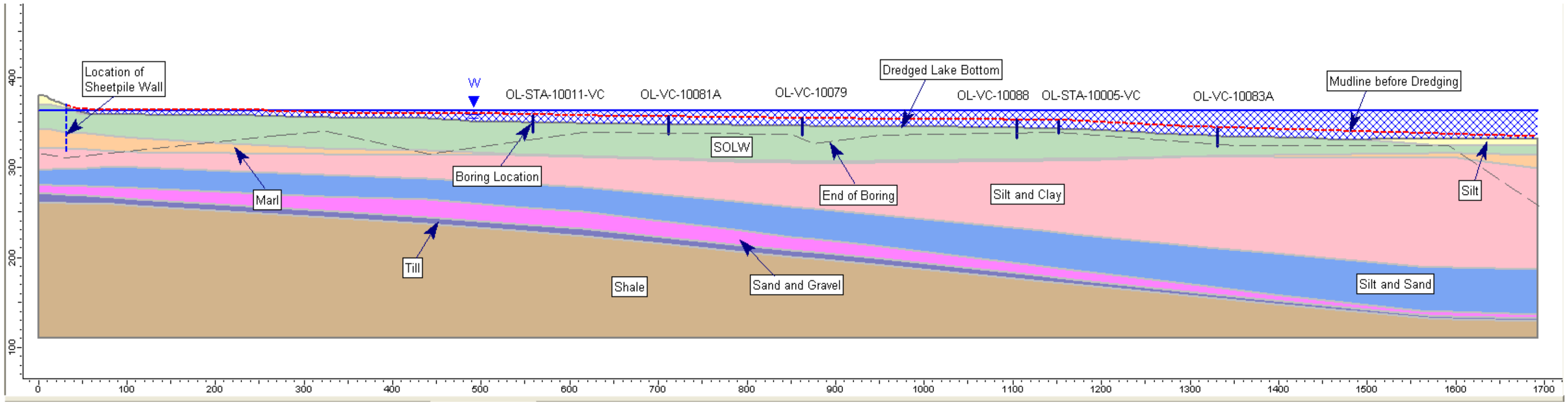


Figure 5. Geometry of Cross Section 4

Notes:

1. See notes for Figure 2.

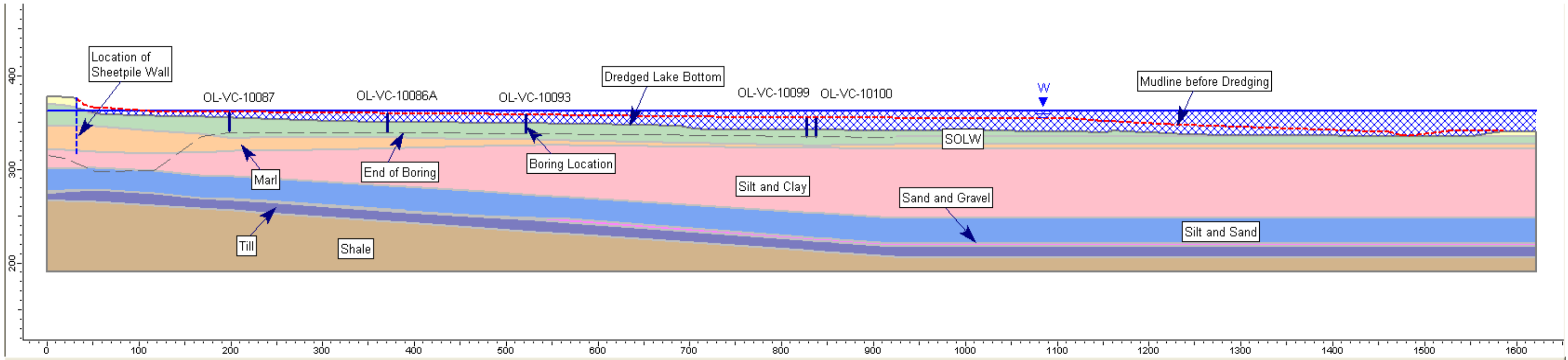


Figure 6. Geometry of Cross Section 5

Notes:

1. See notes for Figure 2.
2. The subsurface layer boundaries (i.e., the boundaries below the original mudline and the dredged lake bottom) were extended horizontally beyond the station of 850 ft for the purpose of slope stability analysis.

Written by:	**Fan Zhu**	Date:	**1/14/2011**	Reviewed by:	**Ming Zhu/R. Kulasingam/Jay Beech**	Date:	**1/14/2011**

Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GJ4204**	Task No.:	**14-05**

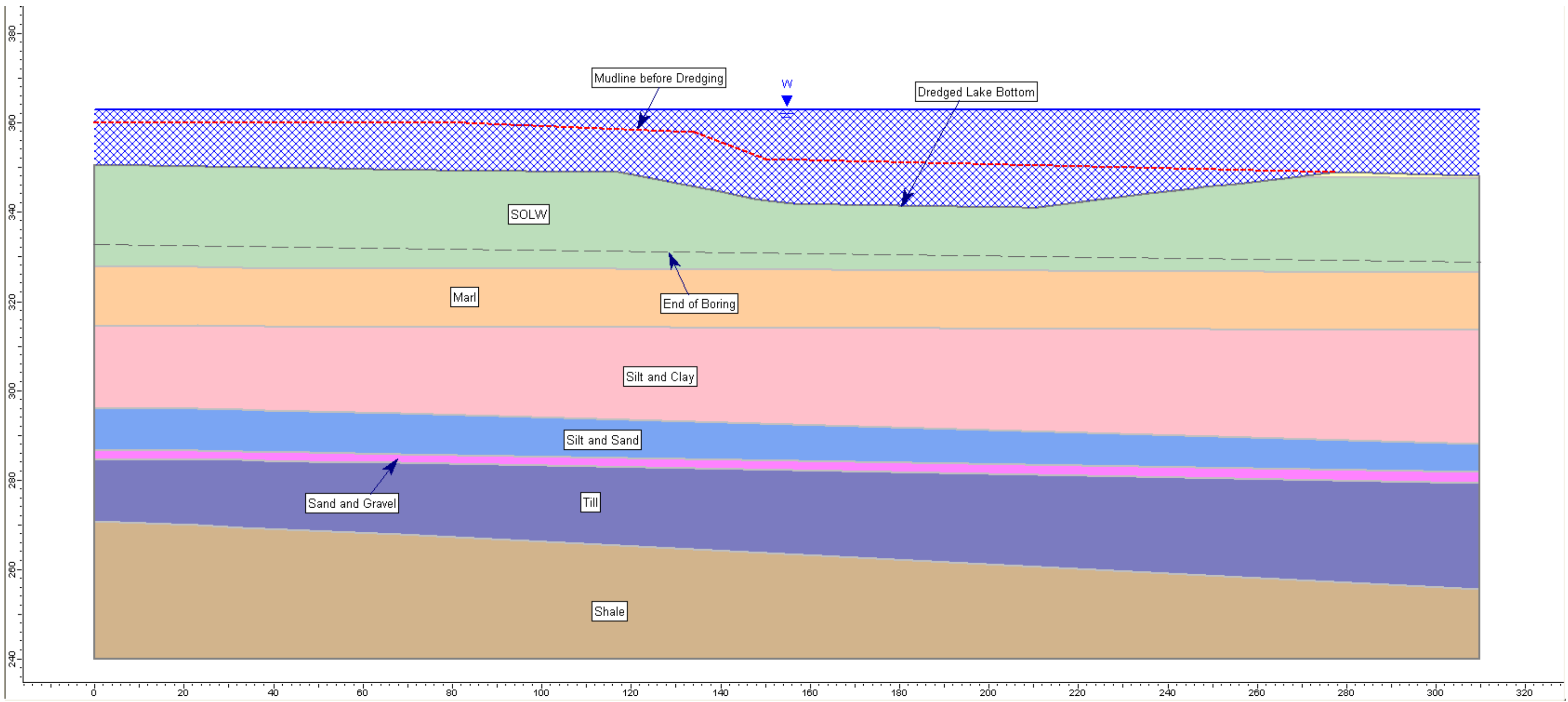


Figure 7. Geometry of Cross Section A

Notes:

1. Axes show distances and elevations in feet.
2. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings.
3. The above notes apply to Figures 8 and 9.

Written by:	**Fan Zhu**	Date:	**1/14/2011**	Reviewed by:	**Ming Zhu/R. Kulasingam/Jay Beech**	Date:	**1/14/2011**

Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GJ4204**	Task No.:	**14-05**

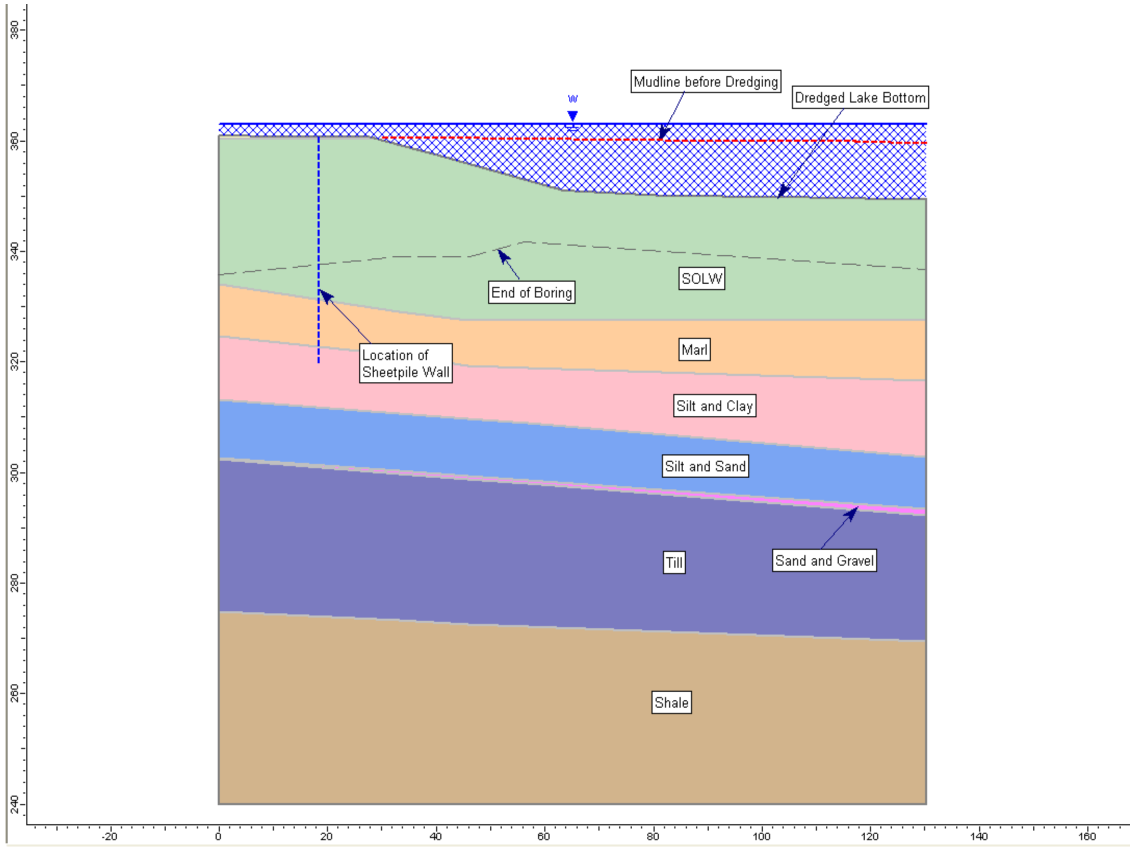


Figure 8. Geometry of Cross Section B

Notes:

1. See notes for Figure 7.

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **14-05**

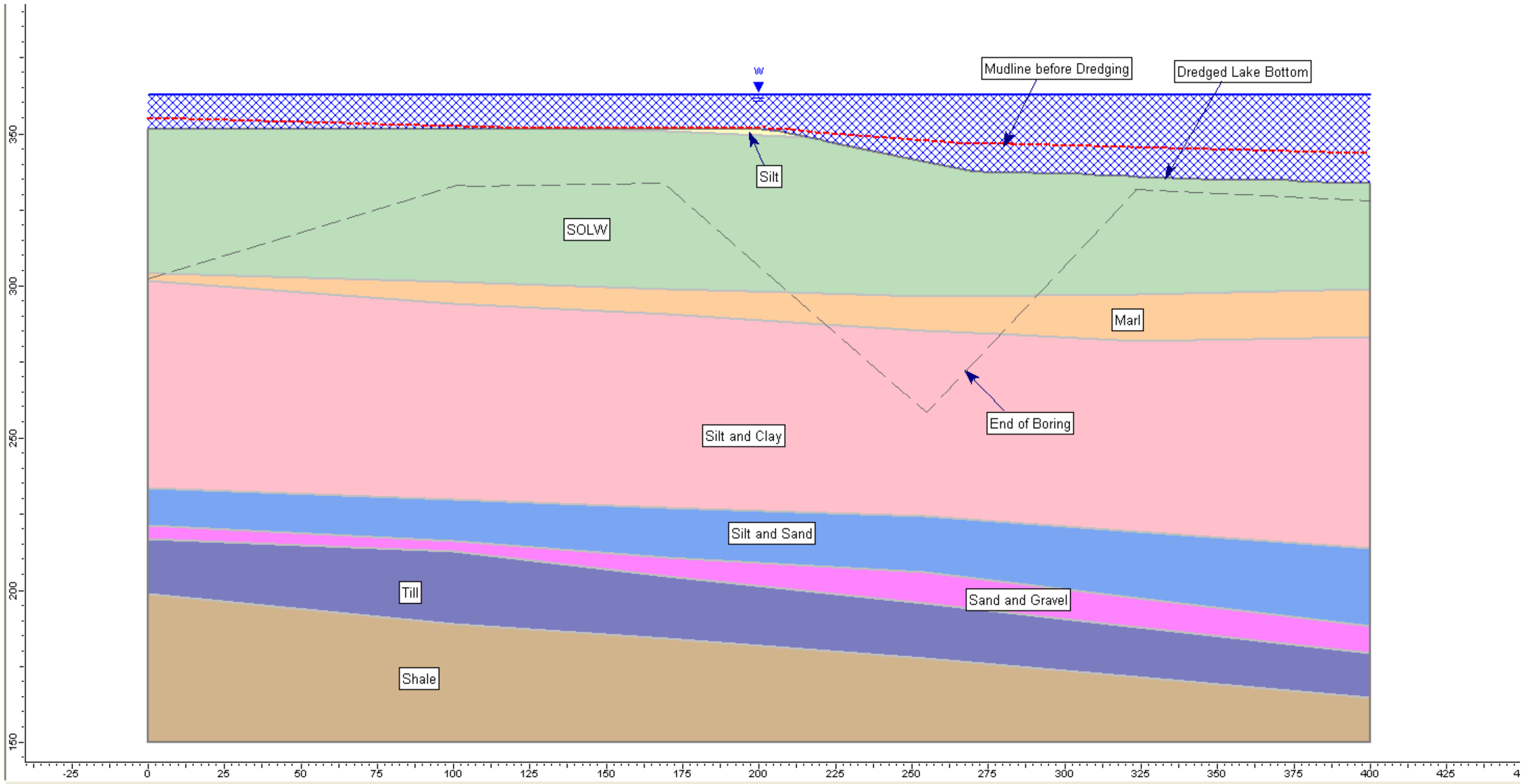


Figure 9. Geometry of Cross Section C

Notes:

1. See notes for Figure 7.

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011
Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

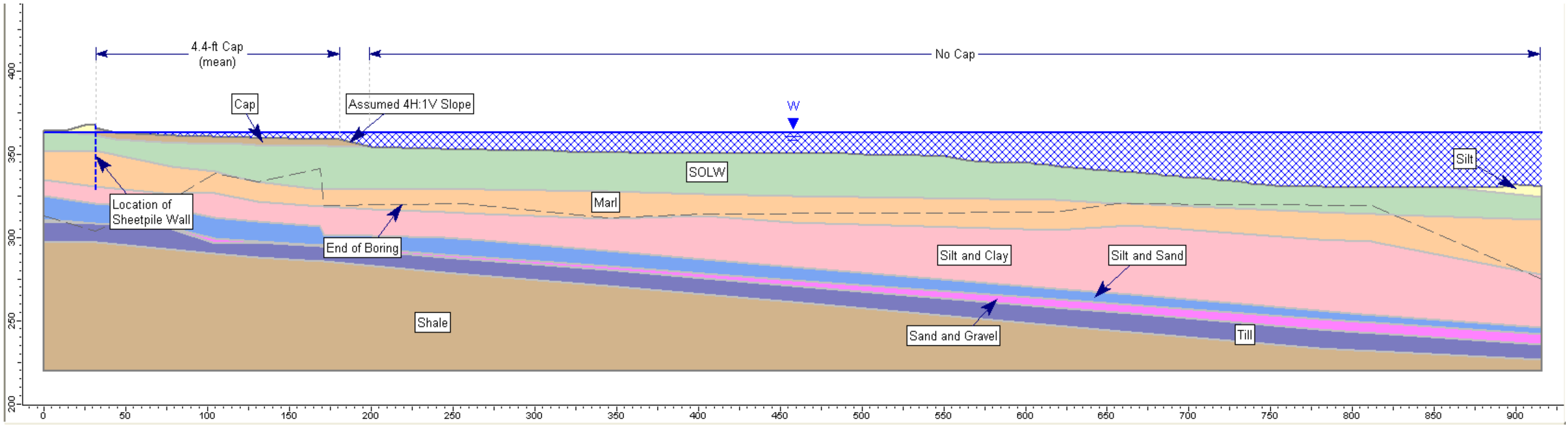


Figure 10. Analyzed Geometry of Cross Section 1 during Capping

Written by: **Fan Zhu** Date: **1/14/2011** Reviewed by: **Ming Zhu/R. Kulasingam/Jay Beech** Date: **1/14/2011**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **14-05**

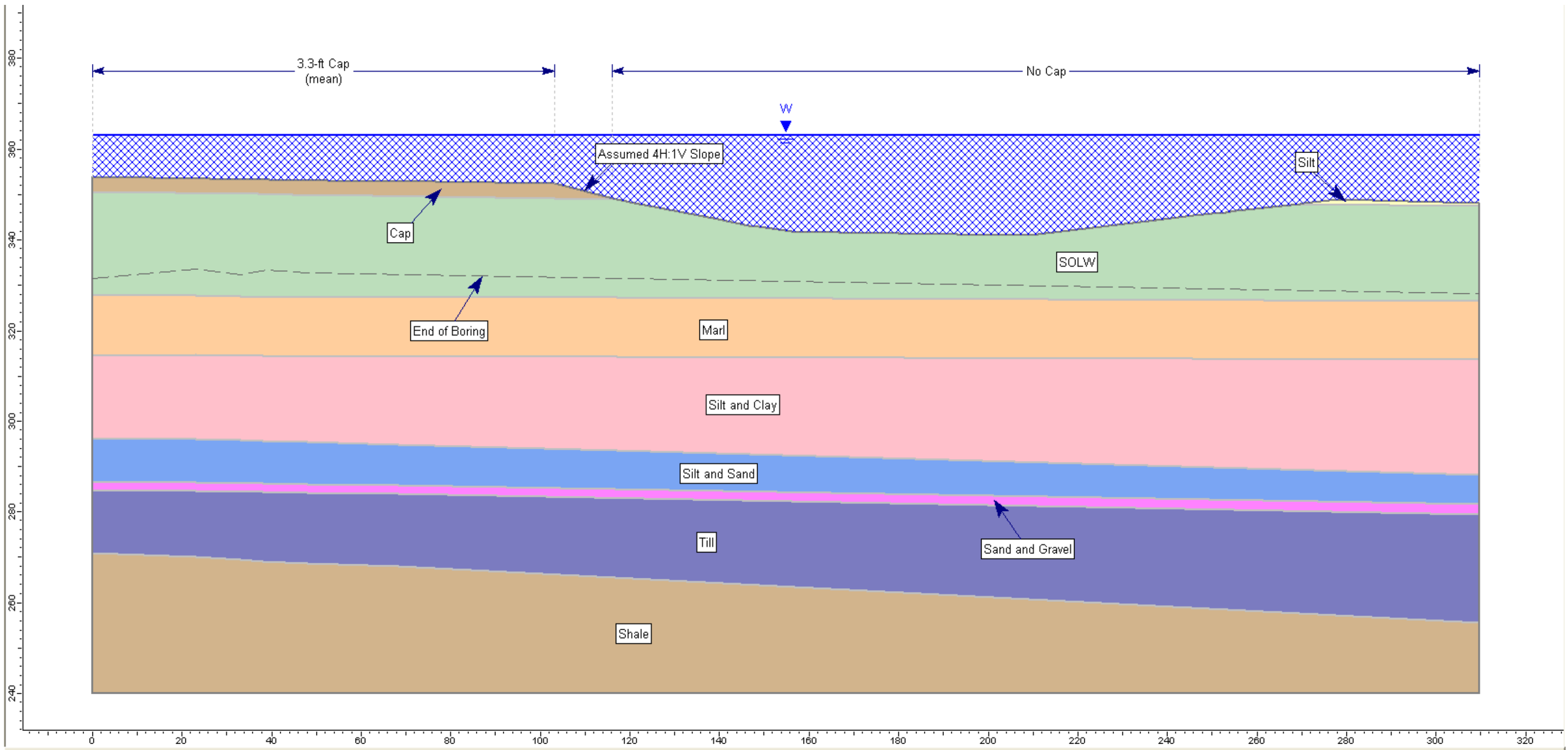


Figure 11. Analyzed Geometry of Cross Section A during Capping

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

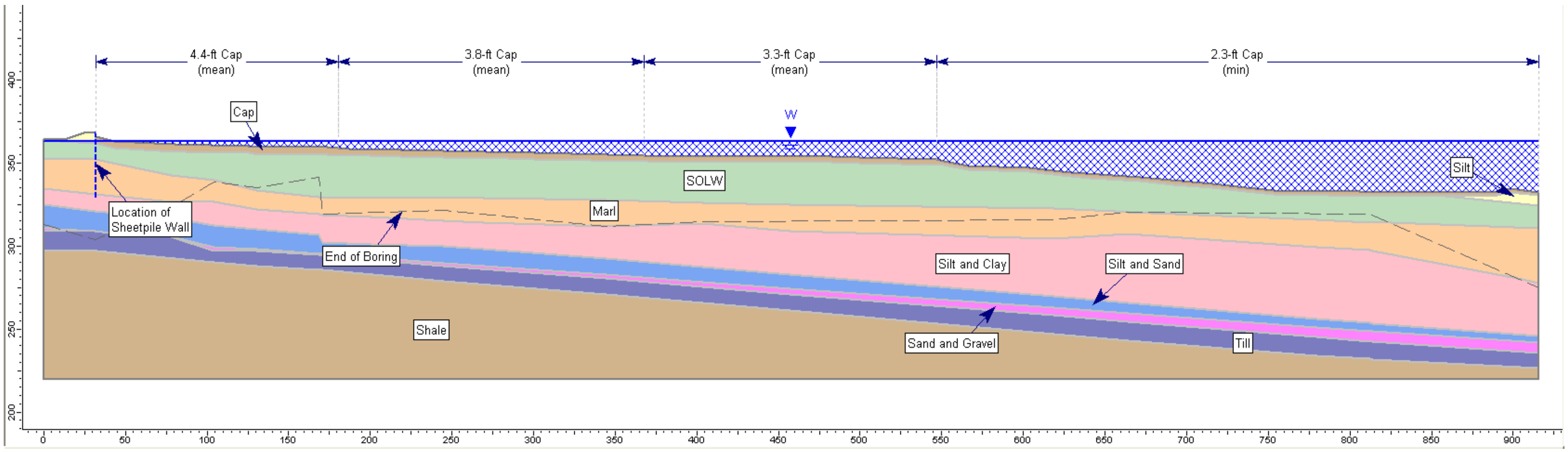


Figure 12. Analyzed Geometry of Cross Section 1 after Capping

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

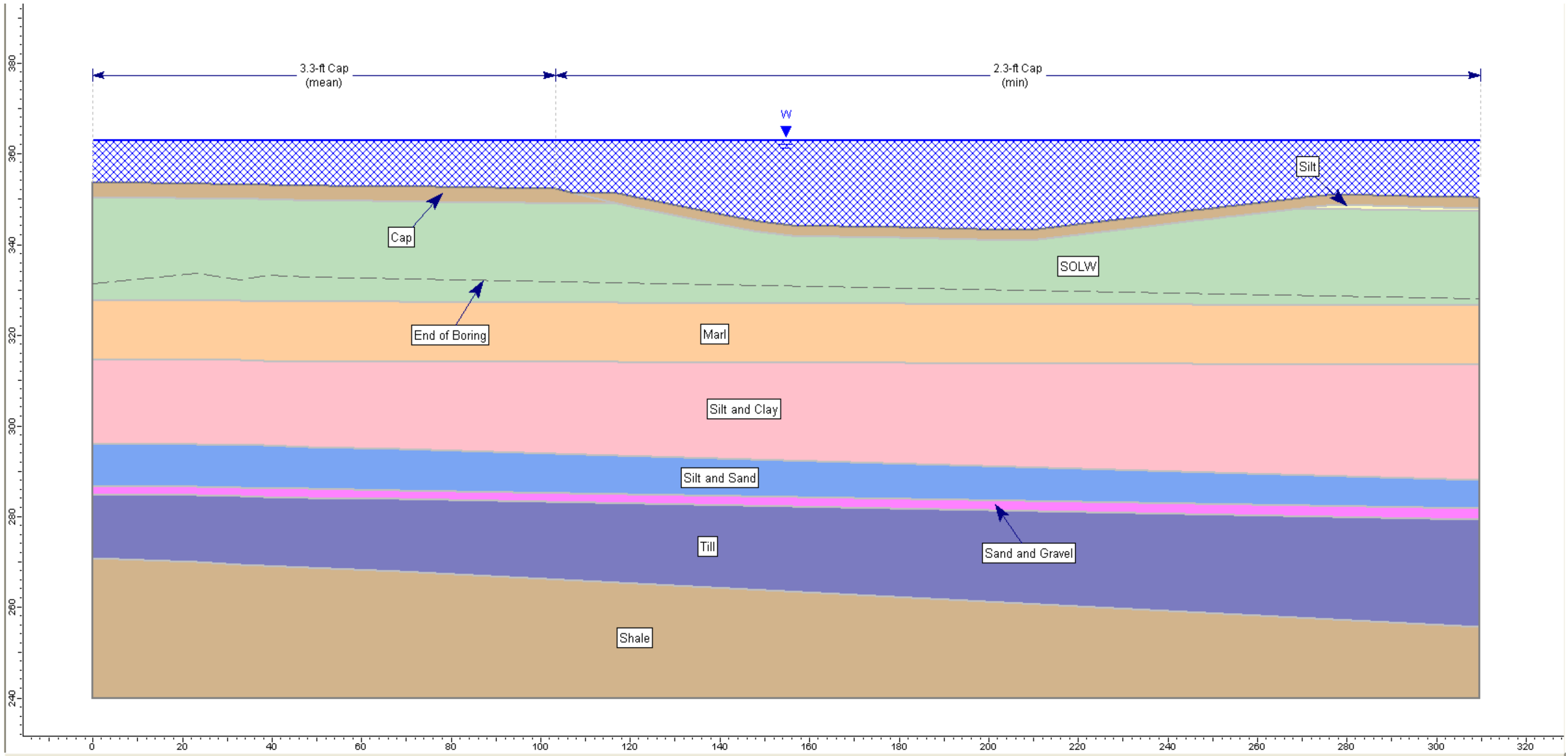


Figure 13. Analyzed Geometry of Cross Section A after Capping

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011
Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

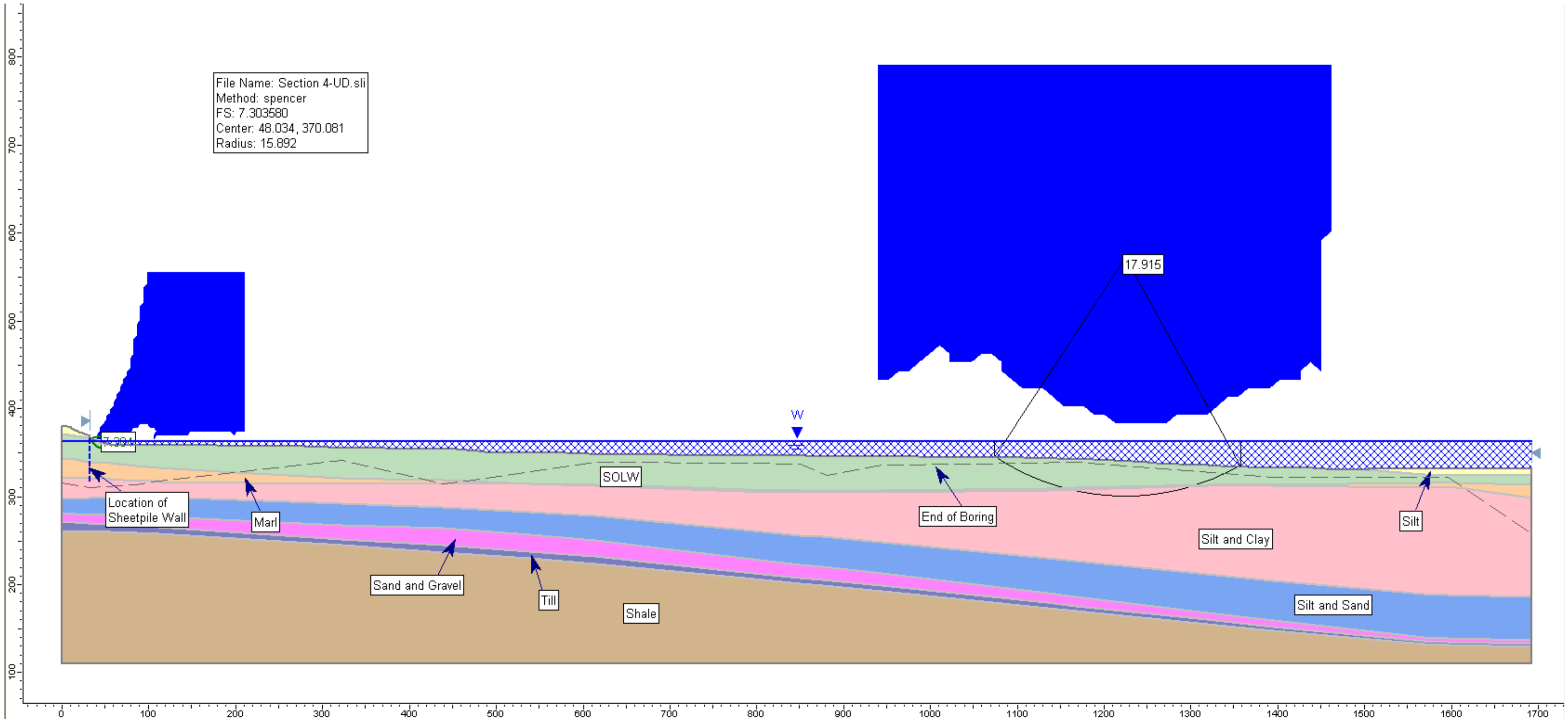


Figure 14. Slope Stability Analysis Result for Cross Section 4 under Interim Condition after Dredging (Undrained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

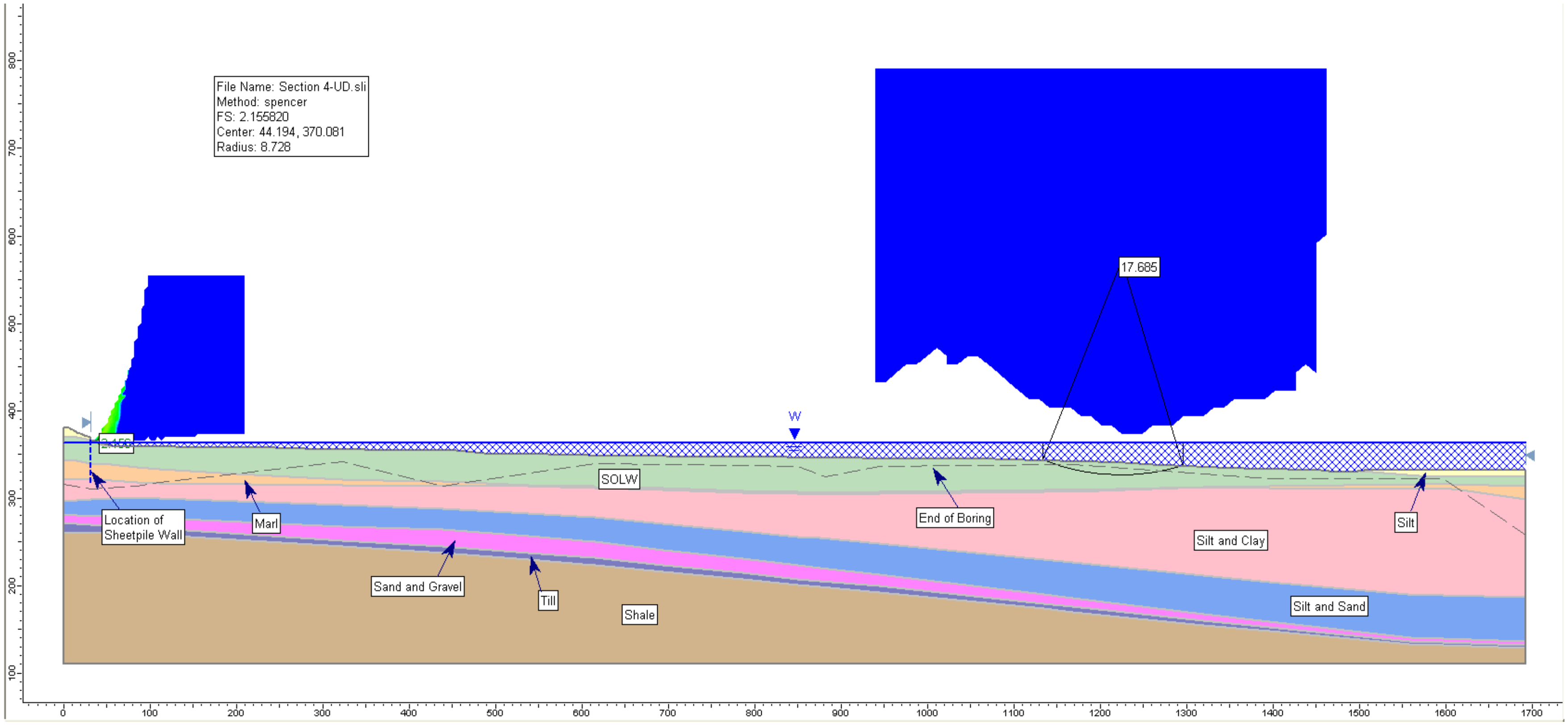


Figure 15. Slope Stability Analysis Result for Cross Section 4 under Interim Condition after Dredging (Drained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

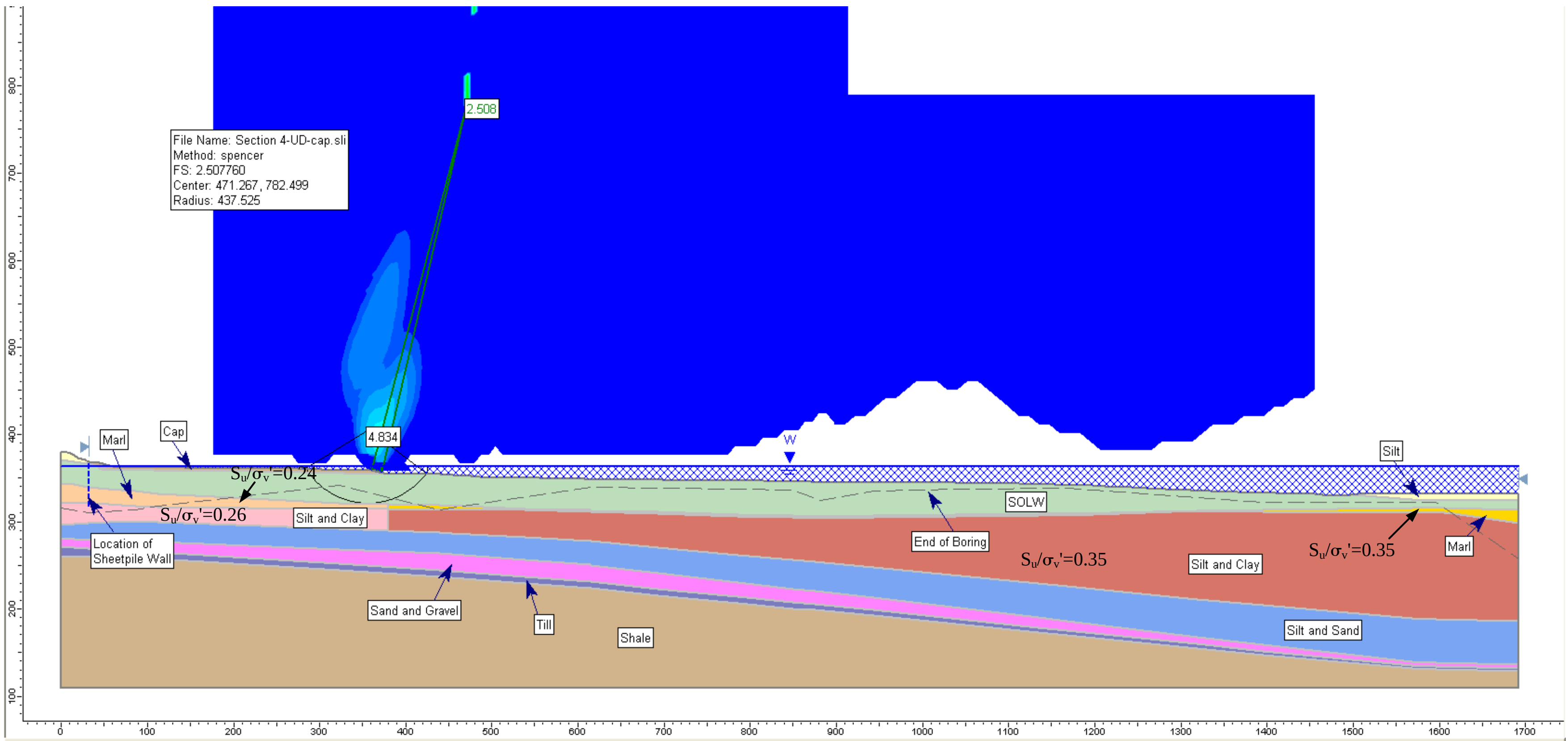


Figure 16. Slope Stability Analysis Result for Cross Section 4 under Interim Condition during Capping (Undrained)

Written by:	**Fan Zhu**	Date:	**1/14/2011**	Reviewed by:	**Ming Zhu/R. Kulasingam/Jay Beech**	Date:	**1/14/2011**

Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GJ4204**	Task No.:	**14-05**

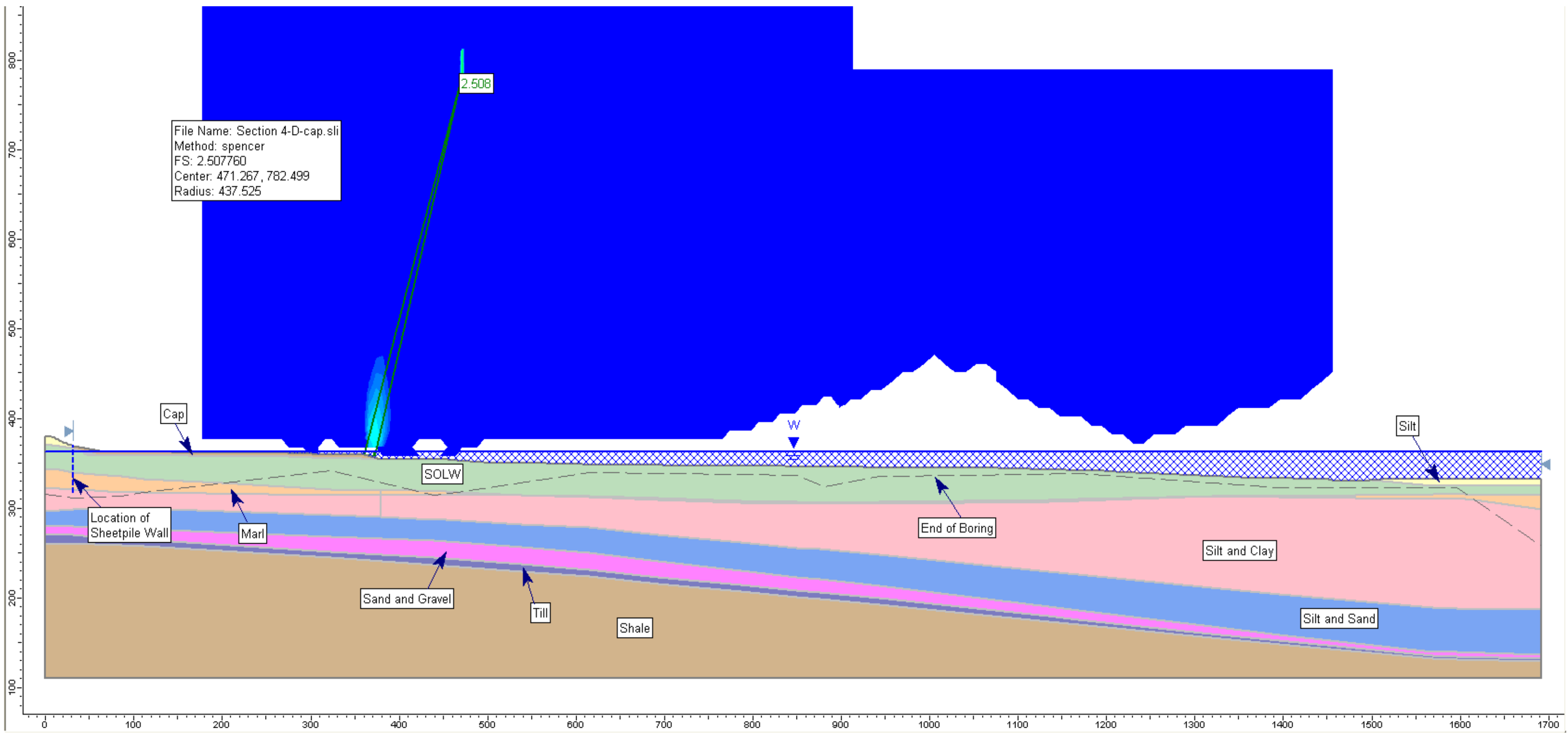


Figure 17. Slope Stability Analysis Result for Cross Section 4 under Interim Condition during Capping (Drained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

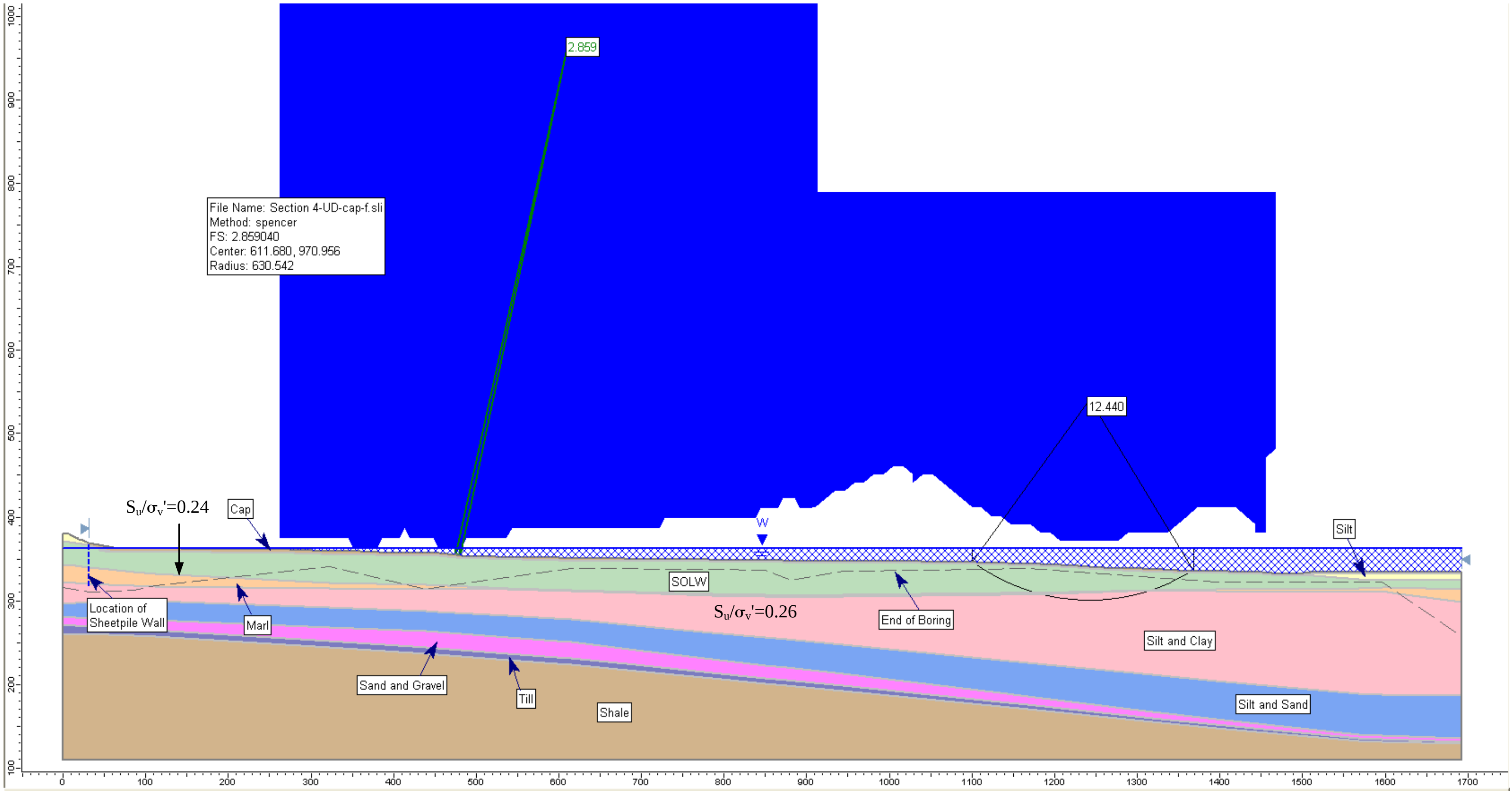


Figure 18. Slope Stability Analysis Result for Cross Section 4 under Final Condition after Capping (Undrained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

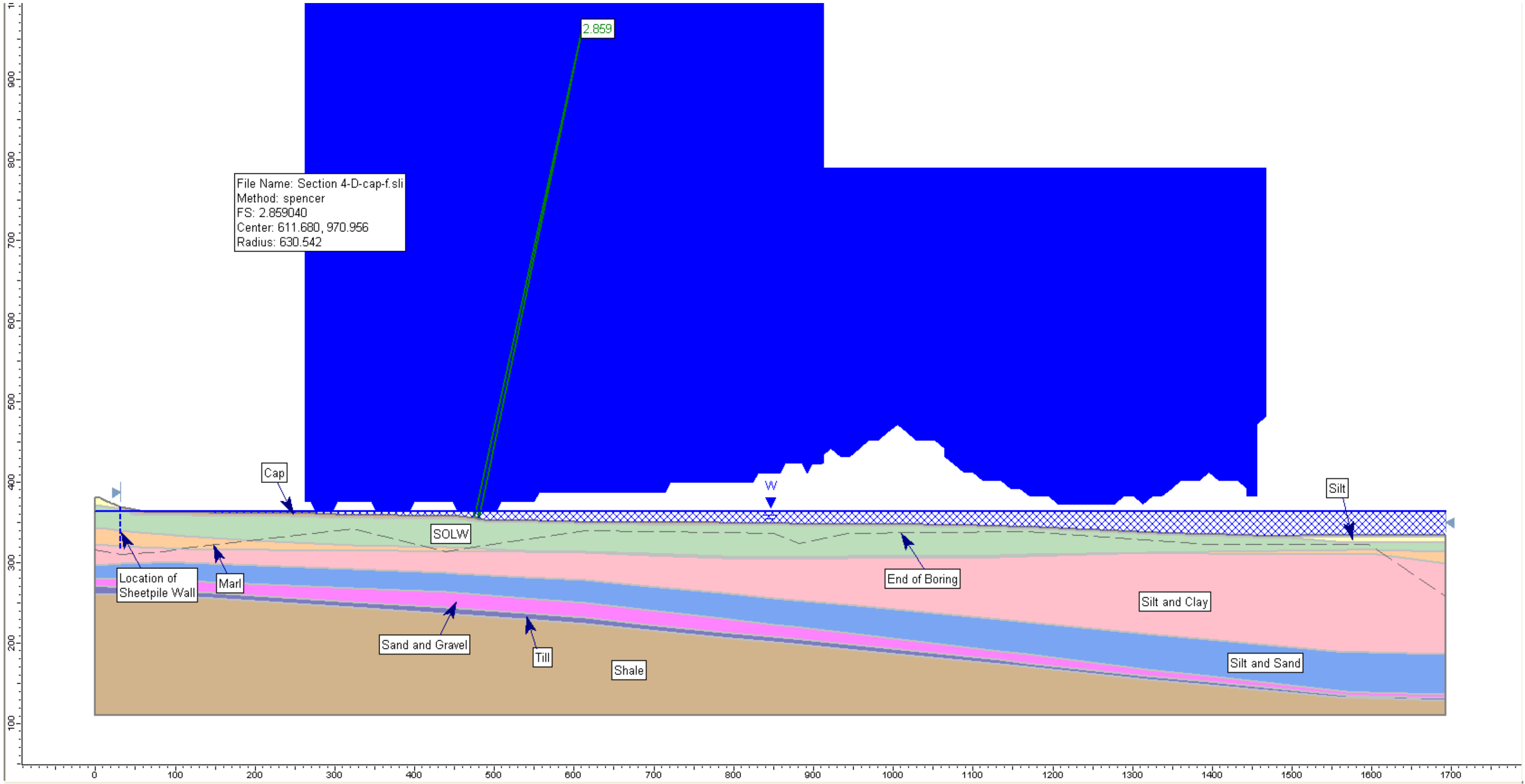


Figure 19. Slope Stability Analysis Result for Cross Section 4 under Final Condition after Capping (Drained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

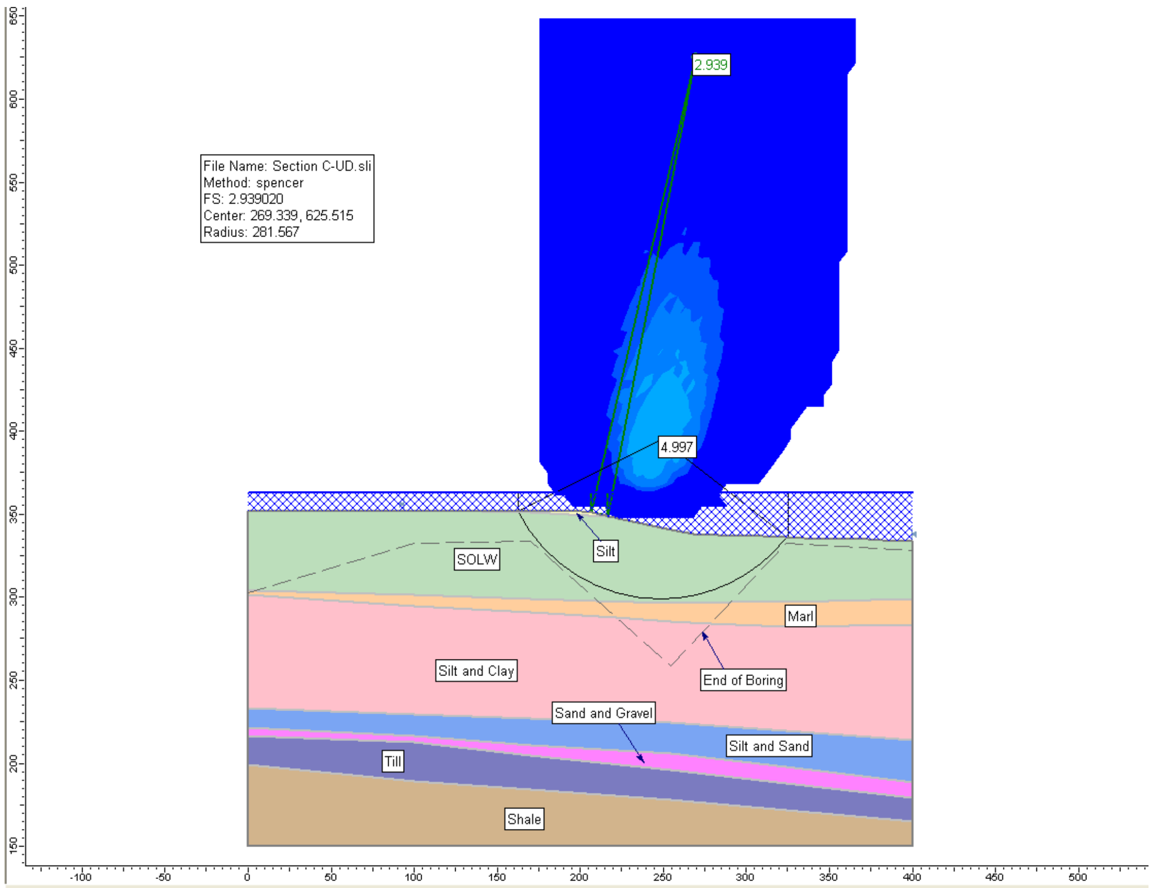


Figure 20. Slope Stability Analysis Result for Cross Section C under Interim Condition after Dredging (Undrained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

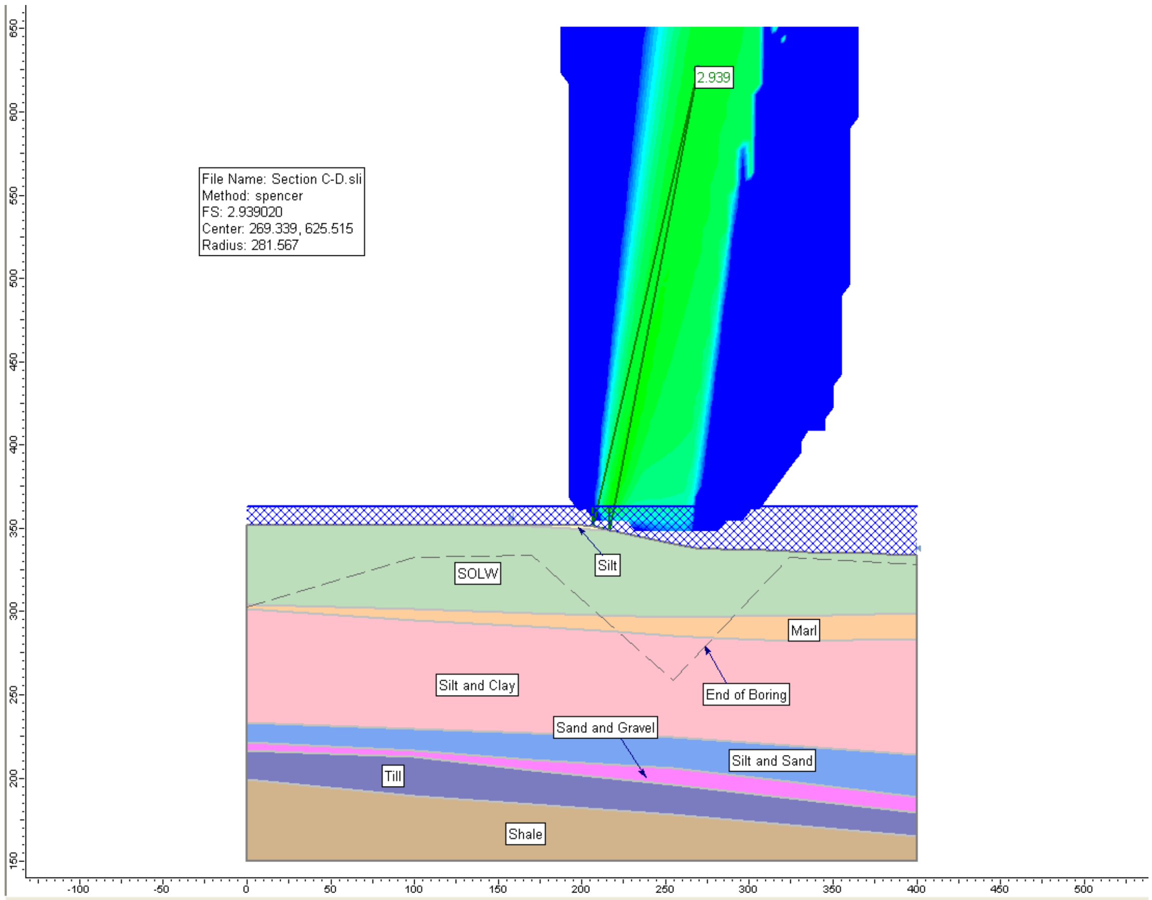


Figure 21. Slope Stability Analysis Result for Cross Section C under Interim Condition after Dredging (Drained)

Written by: **Fan Zhu** Date: **1/14/2011** Reviewed by: **Ming Zhu/R. Kulasingam/Jay Beech** Date: **1/14/2011**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **14-05**

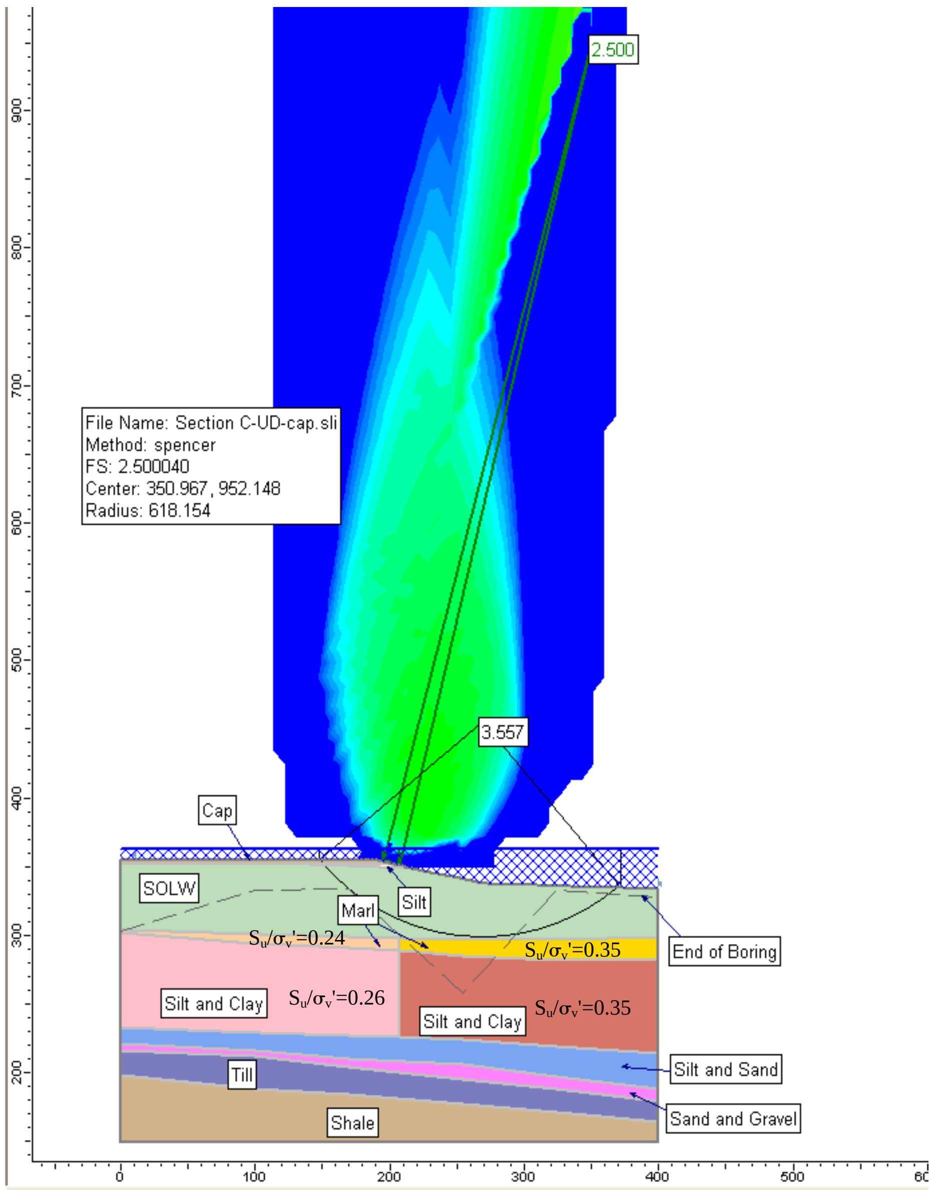


Figure 22. Slope Stability Analysis Result for Cross Section C under Interim Condition during Capping (Undrained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

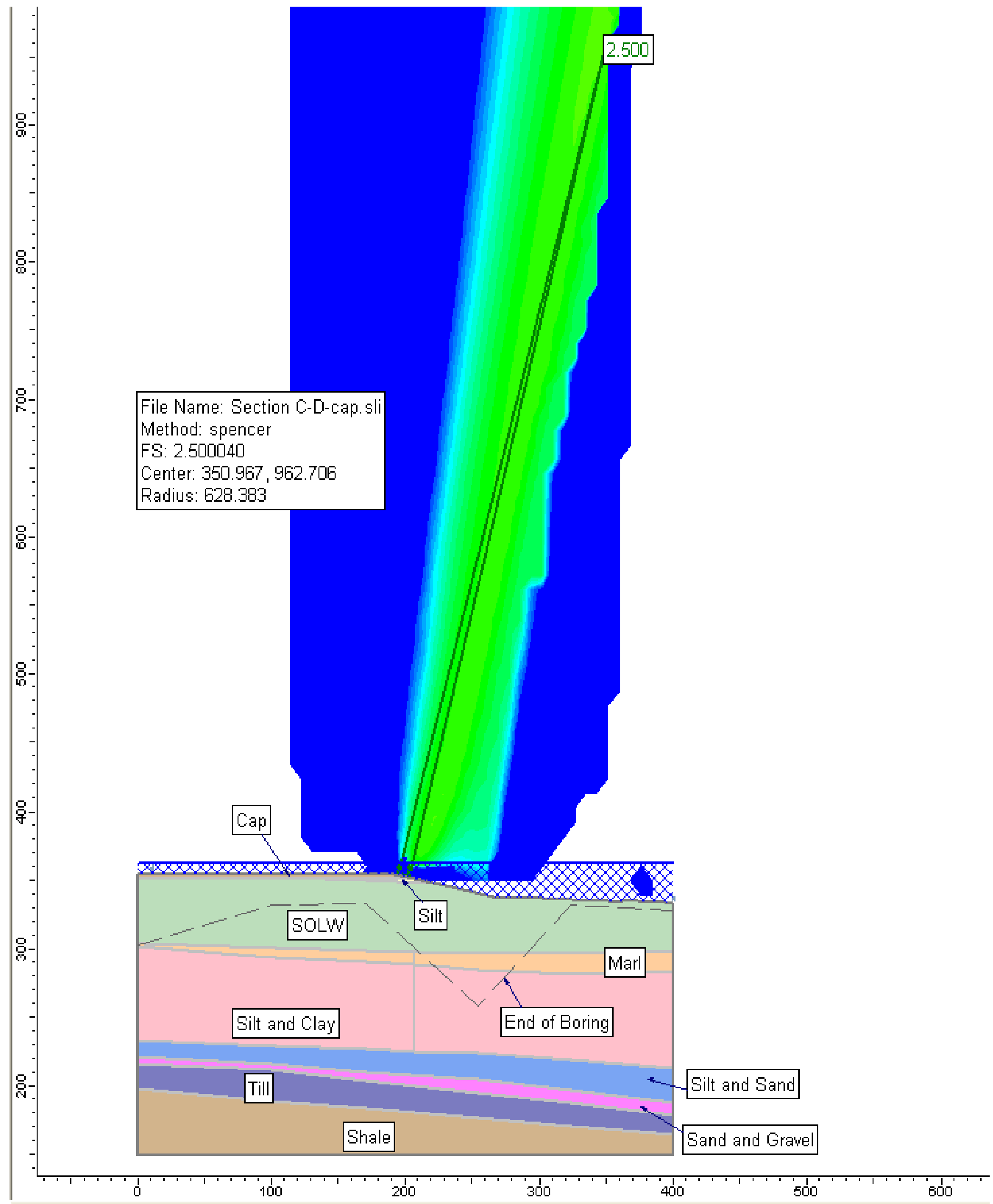


Figure 23. Slope Stability Analysis Result for Cross Section C under Interim Condition during Capping (Drained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

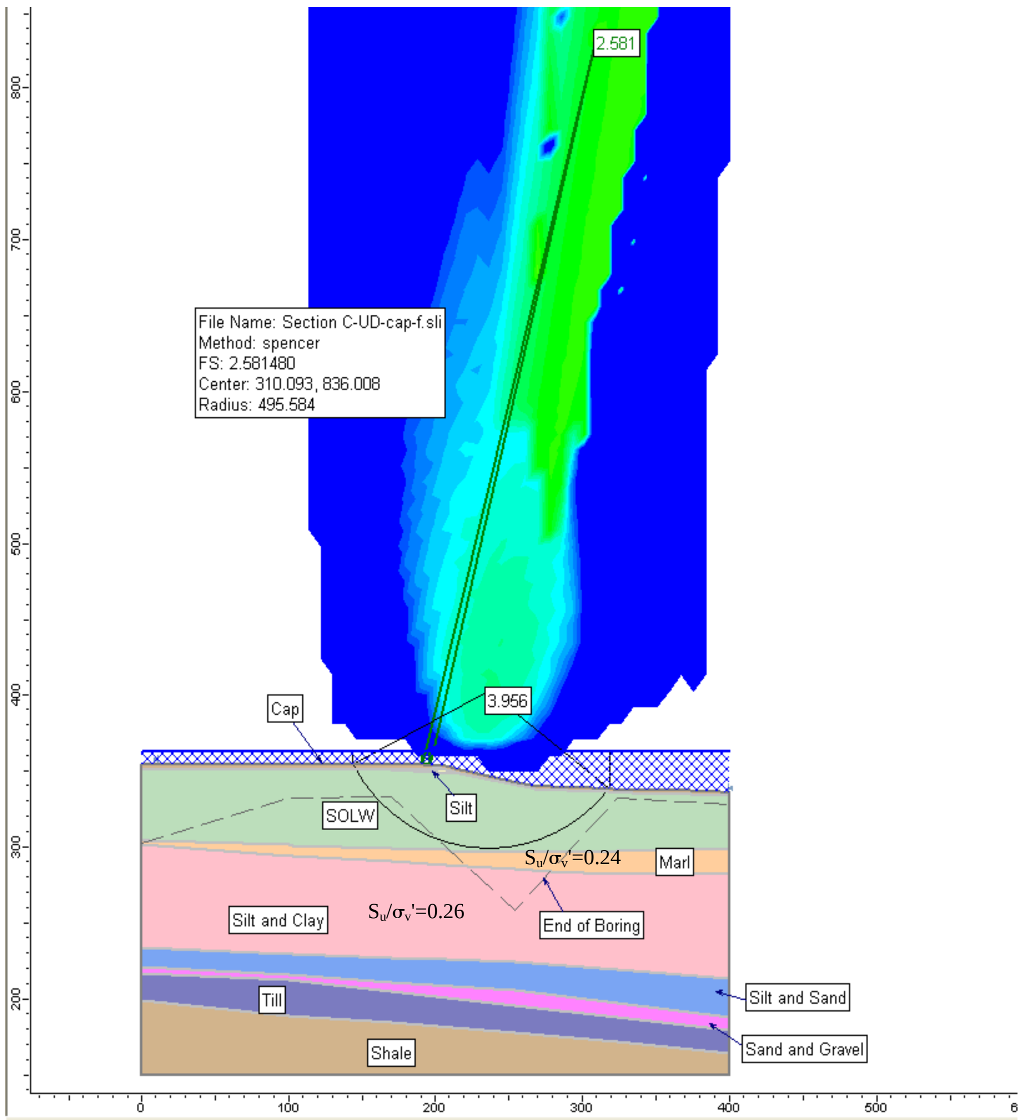


Figure 24. Slope Stability Analysis Result for Cross Section C under Final Condition after Capping (Undrained)

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011

Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

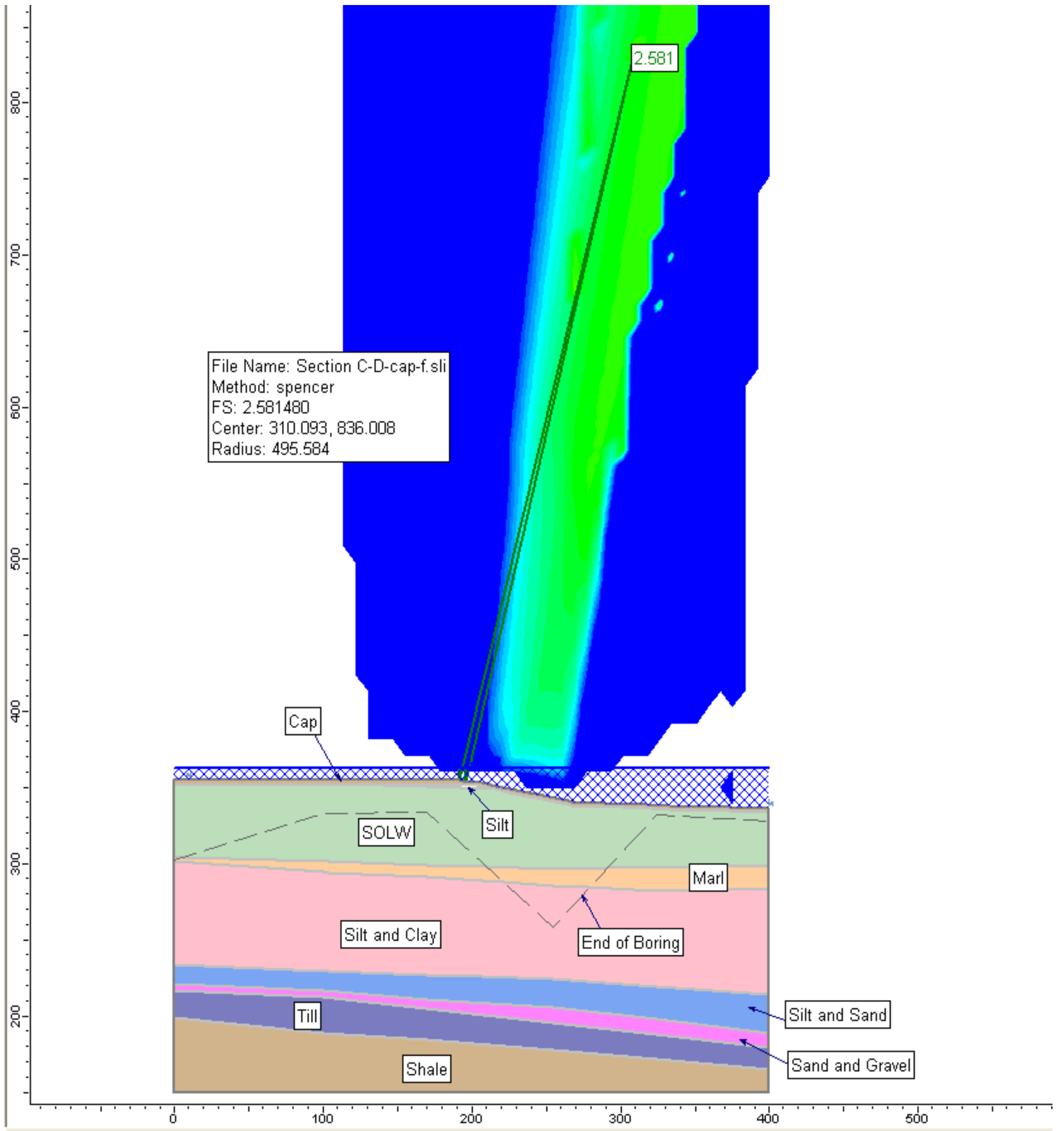


Figure 25. Slope Stability Analysis Result for Cross Section C under Final Condition after Capping (Drained)

Written by:	**Fan Zhu**	Date:	**1/14/2011**	Reviewed by:	**Ming Zhu/R. Kulasingam/Jay Beech**	Date:	**1/14/2011**

Client:	**Honeywell**	Project:	**Onondaga Lake ILWD Stability**	Project/ Proposal No.:	**GJ4204**	Task No.:	**14-05**

Attachment 1

Calculation of Reduced Undrained Shear Strength Ratios

The reduced undrained shear strength ratios of Marl and Silt and Clay were calculated as follows:

a) Assume a representative subsurface profile for ILWD: As presented in Figure 19 in the Data Package, the thicknesses of SOLW and Marl were assumed to be 30 ft and 10 ft, respectively. The unit weights of SOLW and Marl are 81 pcf and 98 pcf, respectively.

b) Select the point at the middle of Marl and the point at the top of Silt and Clay: The undrained shear strength at the middle of Marl before capping is:

$$S_{u1} = 0.35\sigma_v' = 0.35\times[30\times(81-62.4)+5\times(98-62.4)] = 258 \text{ psf}$$

The undrained shear strength at the top of Silt and Clay before capping is:

$$S_{u2} = 0.35\sigma_v' = 0.35\times[30\times(81-62.4)+10\times(98-62.4)] = 320 \text{ psf}$$

c) The vertical effective stresses at the selected points after capping (assuming a 5.5-ft thick cap consisting of 3.2 ft gravel and 2.3 ft sand) are:

$$\sigma_{v1}' = 3.2\times(125-62.4)+2.3\times(120-62.4)+30\times(81-62.4)+5\times(98-62.4) = 1069 \text{ psf}$$

$$\sigma_{v2}' = 3.2\times(125-62.4)+2.3\times(120-62.4)+30\times(81-62.4)+10\times(98-62.4) = 1247 \text{ psf}$$

d) To consider the condition immediately after capping, the undrained shear strength ratios of Marl and Silt and Clay below cap were selected to be:

$$S_u/\sigma_v'\,_{\text{(Marl)}} = 258/1069 = 0.24$$

$$S_u/\sigma_v'\,_{\text{(Silt and Clay)}} = 320/1247 = 0.26$$

It is noted that the above undrained strength ratios were calculated assuming that the maximum cap thickness is 5.5 ft. If the actual cap thickness is less than 5.5 ft, the calculated undrained shear strength ratios will be greater. Therefore, it is conservative to use the above calculated undrained shear strength corresponding to a 5.5 ft cap in the slope stability analyses for cases with thinner caps.

APPENDIX H.4

SEISMIC SLOPE STABILITY ANALYSES

GEOSYNTEC CONSULTANTS

COMPUTATION COVER SHEET

Client: Honeywell **Project:** Onondaga Lake ILWD Stability **Project/Proposal #:** GJ4204 **Task #:** 14-05

TITLE OF COMPUTATIONS **SEISMIC SLOPE STABILITY ANALYSES**

COMPUTATIONS BY:

Signature Fan Zhu — 1/17/2011 DATE

Printed Name and Title: Fan Zhu, Senior Staff Engineer

ASSUMPTIONS AND PROCEDURES CHECKED BY: (Peer Reviewer)

Signature Ming Zhu R. Kulasingam — 1/17/2011 DATE

Printed Name and Title: Ming Zhu/R. Kulasingam, Project Engineer/Senior Engineer

COMPUTATIONS CHECKED BY:

Signature Joseph Sura — 1/17/2011 DATE

Printed Name and Title: Joseph Sura, Senior Staff Engineer

COMPUTATIONS BACKCHECKED BY: (Originator)

Signature Fan Zhu — 1/17/2011 DATE

Printed Name and Title: Fan Zhu, Senior Staff Engineer

APPROVED BY: (PM or Designate)

STATE OF NEW YORK · JOHN F. BEECH · No. 066337 · LICENSED PROFESSIONAL ENGINEER

1/17/2012

Signature J. Beech — 17 JAN 2011 DATE

Printed Name and Title: Jay Beech, Principal

APPROVAL NOTES: Figure 1 was changed on August 13, 2011. M.Z.

REVISIONS (Number and initial all revisions)

NO.	SHEET	DATE	BY	CHECKED BY	APPROVAL

Written by:	Fan Zhu	Date:	1/14/2011	Reviewed by:	Ming Zhu/R. Kulasingam/Jay Beech	Date:	1/14/2011
Client:	Honeywell	Project:	Onondaga Lake ILWD Stability	Project/ Proposal No.:	GJ4204	Task No.:	14-05

SEISMIC SLOPE STABILITY ANALYSES

INTRODUCTION

This calculation package was prepared as part of the Remediation Area D geotechnical stability analysis for the Onondaga Lake Bottom Site. Specifically, the purpose of this package is to present seismic slope stability analyses for Remediation Area D after capping. Remediation Area D, which is also referred to as the In-Lake Waste Deposit (ILWD), is shown in Figure 1. Remediation Area D consists predominantly of Sediment Management Unit (SMU) 1 with limited portions of SMUs 2 and 7. The seismic slope stability of both (i) overall general cross sections along the ILWD slope and (ii) localized areas that have relatively steep slopes was evaluated for the condition after capping.

It should be noted that the cap configurations used in the analyses presented herein are consistent with the mean cap thickness, as documented in the main text of the *Capping, Dredging, and Habitat Design.* For the purpose of the analyses presented herein, the expected potentially critical condition with the maximum potential difference in cap thickness was assumed, as described later in this package. The liquefaction evaluation of the cap is presented in Appendix H.2 of the *Capping, Dredging, and Habitat Design* in a calculation package titled "*Liquefaction Potential Analysis*" (referred to as the Liquefaction Package).

METHODOLOGY

Seismic Slope Stability

Seismic slope stability analyses were performed using Spencer's method [Spencer, 1973], as implemented in the computer program SLIDE, version 5.0 [Rocscience, 2006]. Rotational type failure mode, i.e. circular slip surface, was considered to assess the pseudostatic slope stability factor of safety (FS) of the selected cross sections. Wedge type slip surfaces were not considered applicable for Remediation Area D because they generally only apply when known weak layers or interfaces are present. Regardless, an independent analysis was performed assuming wedge type slip surfaces. The results indicated that the FSs calculated using the wedge type slip surfaces were greater than those calculated using the circular slip surfaces. Therefore, only circular slip surfaces were evaluated. Detailed discussion regarding Spencer's method and the SLIDE program is presented in Appendix H.3 of the *Capping, Dredging, and Habitat Design* in a calculation package titled "*Static Slope Stability Analyses*" (referred to as the Static Stability Package). The procedure for the seismic slope stability analysis presented herein is summarized as follows:

- Select a pseudostatic coefficient to reduce the maximum horizontal acceleration for use in slope stability analyses. This is done in recognition that maximum acceleration exists only for a very short time [Kramer, 1996]. Based on the discussions presented in the Federal Highway Administration's seismic design guidance document [Kavazanjian et al., 1997], a pseudostatic coefficient of 0.5 was conservatively selected for this seismic slope stability evaluation.
- Calculate the horizontal seismic coefficient (k) by multiplying the maximum horizontal acceleration by the pseudostatic coefficient. A maximum horizontal acceleration of 0.09g was selected for a contingency level event (i.e., a seismic event with a 10 percent chance of exceedance in 50 years) at the site, as required in the Statement of Work of the Consent Decree for the Onondaga Lake Bottom Subsite (United States District Court, 2007) and as presented in the Liquefaction Package. Using this maximum horizontal acceleration of 0.09g and a pseudostatic coefficient of 0.5, a horizontal seismic coefficient (k) of 0.045g was calculated for the seismic analysis.
- Perform pseudostatic slope stability analyses by applying a horizontal seismic coefficient to the same procedures used for static slope stability analyses. If the calculated pseudostatic FS is greater than 1.1, the slope is considered to have an acceptable FS under the contingency level seismic event (i.e., a seismic event of 10 percent chance of exceedance in 50 years). If the calculated pseudostatic FS is less than 1.1, calculate permanent seismic displacements by performing deformation analysis and compare the calculated displacement to allowable displacements. Calculate the yield acceleration (i.e., the horizontal seismic coefficient that results in a calculated FS of 1.0) and estimate permanent displacements using the Hynes and Franklin [1984] chart (Figure 2).

SUBSURFACE STRATIGRAPHY

Detailed information regarding the subsurface stratigraphy is presented in Appendix H.1 of the *Capping, Dredging, and Habitat Design* in a calculation package titled "*Summary of Subsurface Stratigraphy and Material Properties*" (referred to as the Data

Package). In summary, the subsurface stratigraphy primarily consists of the following materials: Solvay Waste (SOLW), Marl, Silt and Clay, Silt and Sand, Sand and Gravel, Till, and Shale. In isolated areas of the ILWD, thin silt layers are present over the SOLW. The elevation of the lake water surface in the ILWD was assumed to be El. 363 feet above mean sea level (NAVD88), as presented in the Data Package.

The subsurface profile of the ILWD was developed based on the elevation of each layer from the boring logs provided by Parsons. As explained in the Data Package, the deeper surfaces (e.g., bottom of Silt and Clay, bottom of Silt and Sand) that were below the depth of shallow borings were developed based on a limited number of deeper borings in the ILWD. Since critical slip surfaces identified in the analyses are generally located within depths that were covered by the shallower borings (i.e., borings that terminated in or above the Silt and Clay layer), this is not expected to affect the seismic slope stability evaluation.

ANALYZED CROSS SECTIONS

As shown on the proposed dredging plan in Figure 1, eight cross sections were selected for the stability analyses. The dredging plan was developed by Anchor QEA and provided to Geosyntec by Parsons. Cross Sections 1 through 5 were selected to represent the overall general slope of the ILWD. Cross Sections A to C were selected to represent potentially critical localized steep slopes. As documented in the main text of the *Capping, Dredging, and Habitat Design*, the total cap thickness varies with the water depth. The minimum and mean thicknesses of each cap component correspond to several ranges in water depths.

For the overall general slopes after the entire Remediation Area D is capped, the condition where the cap in 10 to 30 ft of water has the minimum total thickness, while the caps in other areas have the mean (with overplacement) total thicknesses was found to be the potentially critical condition based on a preliminary analysis. The same cap configuration for the overall general slopes was applied to the localized steep slopes. The analyzed geometries of Cross Sections 1 through 5 and Cross Sections A through C after capping are presented in Figures 3 to 10.

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MATERIAL PROPERTIES

Detailed information related to the selection of subsurface material properties was presented in the Data Package. Table 1 summarizes the material properties (i.e., unit weights and shear strengths) of each subsurface material and the cap material (i.e., the sand) used in the slope stability analyses.

Based on the material type, the appropriate undrained and drained material properties were used in the analyses. Specifically, drained shear strength properties were used for Silt and Sand, Sand and Gravel, Till, and Shale. The drained properties of Marl were used for the silt in isolated areas of the ILWD. The sand material in the proposed cap was modeled with drained strength parameters. Undrained shear strength properties were used for SOLW, Marl, and Silt and Clay, as they are fine grained materials and take a relatively long time to dissipate pore pressures generated under seismic loading conditions. As described for the after-capping condition in the Static Stability Package (see Material Properties section and Attachment 1 of that package), the undrained shear strength ratios of Marl and Silt and Clay were also manually reduced for the analyses presented herein.

RESULTS AND CONCLUSIONS

The seismic slope stability of Remediation Area D after capping was evaluated for five overall general slope cross sections (i.e., Cross Sections 1 through 5) and three localized steep slope cross sections (i.e., Cross Sections A through C). The results of seismic slope stability analyses are summarized in Table 2. As examples, the critical circular slip surfaces for Cross Sections 2, 3, and C are shown in Figures 11 through 13.

Under the after-capping condition, the calculated seismic slope stability FSs for the selected eight cross sections range from 1.4 to 1.9. The results indicate that the selected cross sections have acceptable calculated FSs after capping in case of a contingency level seismic event.

Additional analyses were performed to evaluate the sensitivity of the seismic slope stability to the undrained shear strength of SOLW. The three most critical cross sections, i.e., Cross Sections 2, 3, and C, were selected for the sensitivity analysis. In the sensitivity analysis, the SOLW shear strength value was reduced to represent the mean minus one standard deviation (i.e., 165 psf for the undrained shear strength), which was calculated based on the laboratory tests. The FSs for these three cross sections were calculated to be

1.10, 1.06, and 1.02, respectively, for the seismic condition after capping using the reduced undrained shear strength of SOLW. Because the calculated FS is less than the target FS of 1.1 for Cross Sections 3 and C, a deformation analysis was performed for these cross sections. The seismic displacements were estimated to range from 0.2 to 0.6 inches for Cross Sections 3 and C, which were considered to be acceptable. The analysis results are presented in Attachment 1.

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Tables

Table 1. Summary of Material Properties for Slope Stability Analyses

Material	Total Unit Weight (pcf)	Drained Shear Strength ϕ' (degrees)	Undrained Shear Strength
Cap – Sand[1]	120	32	N/A
Silt[2]	98	32	N/A
SOLW	81	N/A	240 psf
Marl	98	N/A	$S_u/\sigma_v' = 0.24$[3],[4]
Silt and Clay	108	N/A	$S_u/\sigma_v' = 0.26$[3],[4]
Silt and Sand	120	32	N/A
Sand and Gravel	120	32	N/A
Till	120	40	N/A
Shale	120	40	N/A

Notes:

[1]. For the purpose of the slope stability analysis, the relatively thin layer of gravel in the proposed cap was not modeled. The gravel material is expected to have a larger friction angle than the sand. Therefore, not modeling the gravel component of the cap in the slope stability analysis was considered to be conservative.

[2]. Unit weight and drained shear strength of Marl were used for Silt overlying the SOLW in certain areas of the ILWD.

[3]. The undrained shear strength ratios of Marl and Silt and Clay below the cap were manually reduced in the SLIDE program to avoid the increase of undrained shear strengths of Marl and Silt and Clay due to the additional load from cap.

[4]. The reduced undrained shear strength ratios were calculated as described in Attachment 1 of the Static Stability Package.

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Table 2. Summary of Seismic Slope Stability Analysis Results

Cross Section	Horizontal Seismic Coefficient (K_h)	Calculated Minimum FS	Target FS	Is FS OK?	Deformation Analysis Necessary?	Note
1	0.045	1.56	1.1	Yes	No	
2	0.045	1.44	1.1	Yes	No	Results shown in Figure 11
3	0.045	1.45	1.1	Yes	No	Results shown in Figure 12
4	0.045	1.72	1.1	Yes	No	
5	0.045	1.80	1.1	Yes	No	
A	0.045	1.86	1.1	Yes	No	
B	0.045	1.69	1.1	Yes	No	
C	0.045	1.48	1.1	Yes	No	Results shown in Figure 13

Figures

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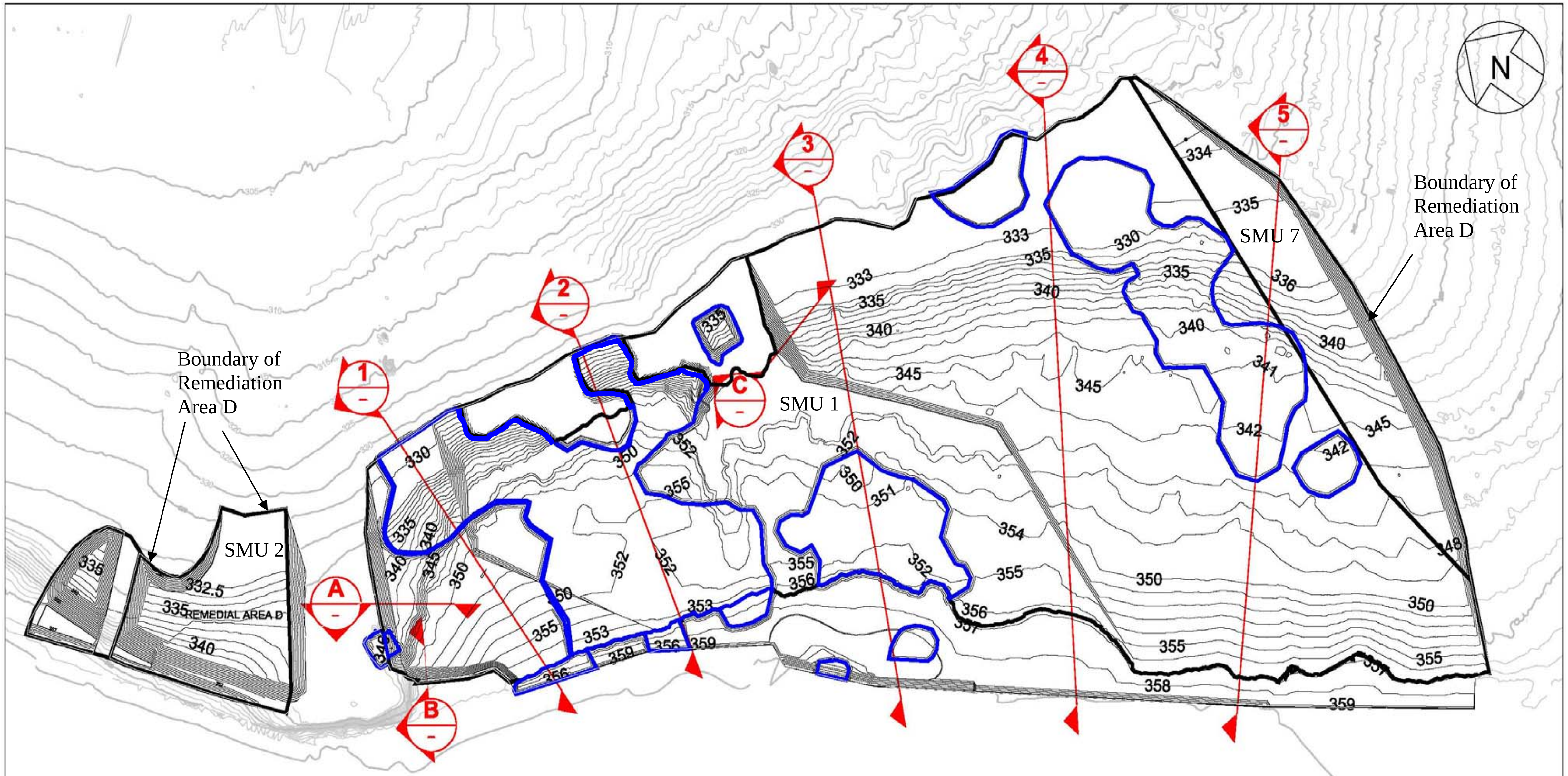

Notes:
1. Contours of the existing ground/lake bottom were provided by Parsons.
2. Dredging plan was prepared by Anchor QEA and provided to Geosyntec by Parsons.

Hot spot dredge area

Figure 1. Locations of Selected Cross Sections on Dredging Plan

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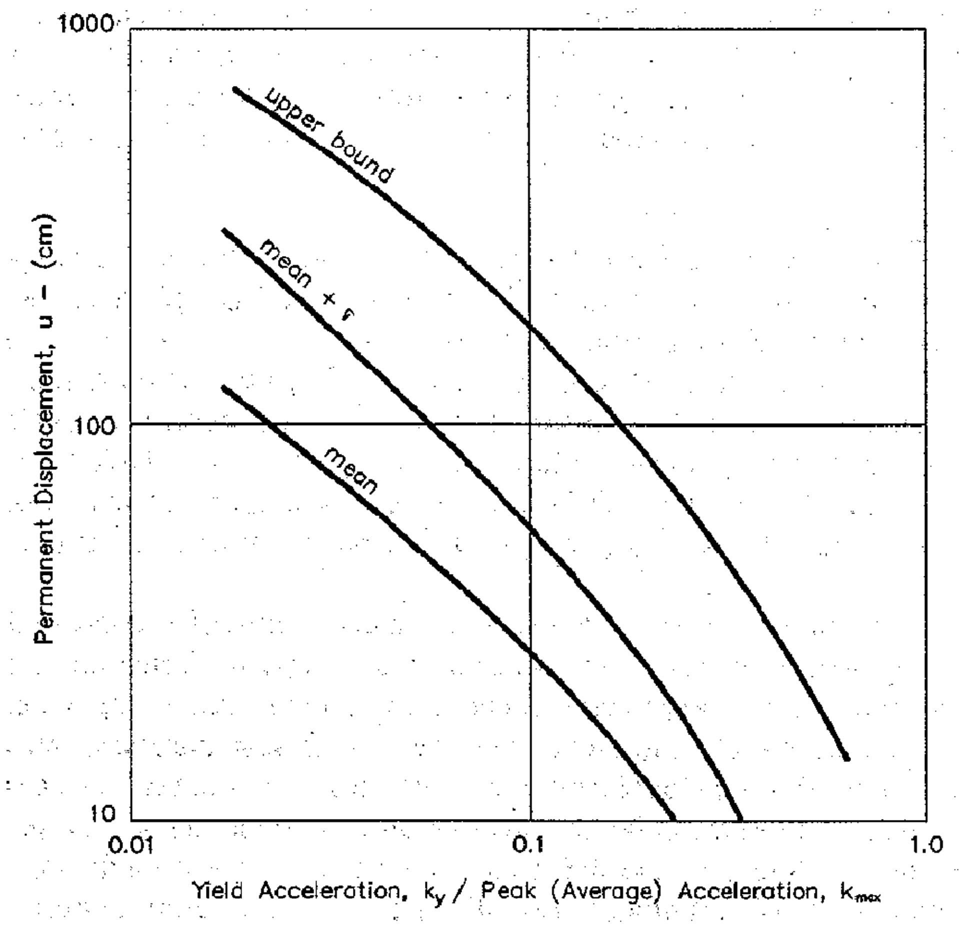

Figure 2. Permanent Seismic Deformation Chart (Hynes and Franklin, 1984)

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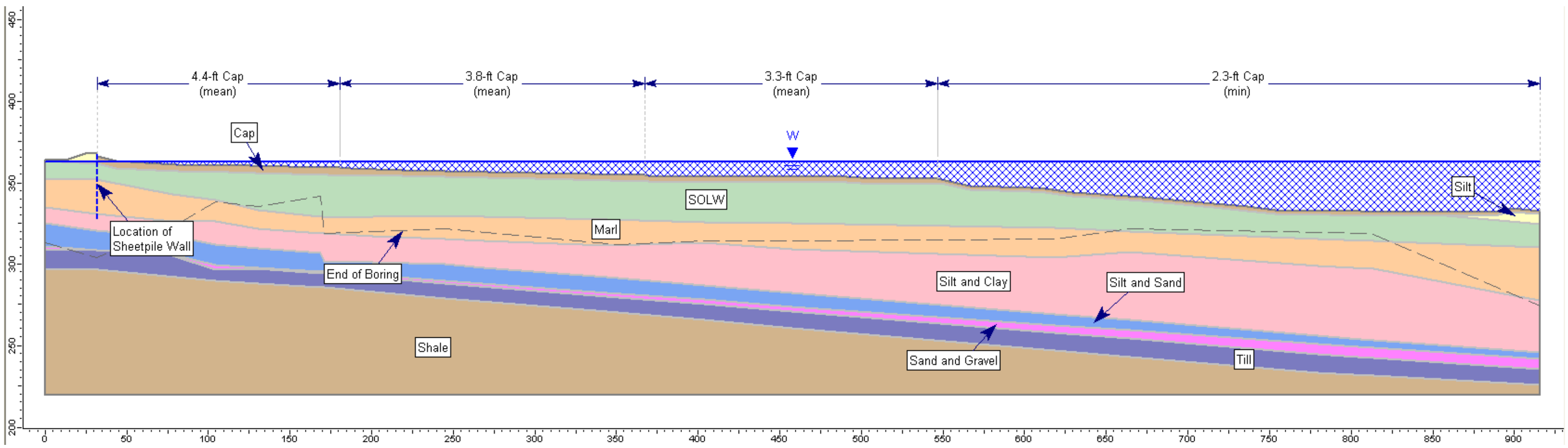

Figure 3. Geometry of Cross Section 1

Notes:

1. Axes show distances and elevations in feet.
2. Subsurface profiles below the line of end of boring were estimated based on information from deeper borings located elsewhere in Remediation Area D.
3. Above notes also apply to Figures 4 through 10.

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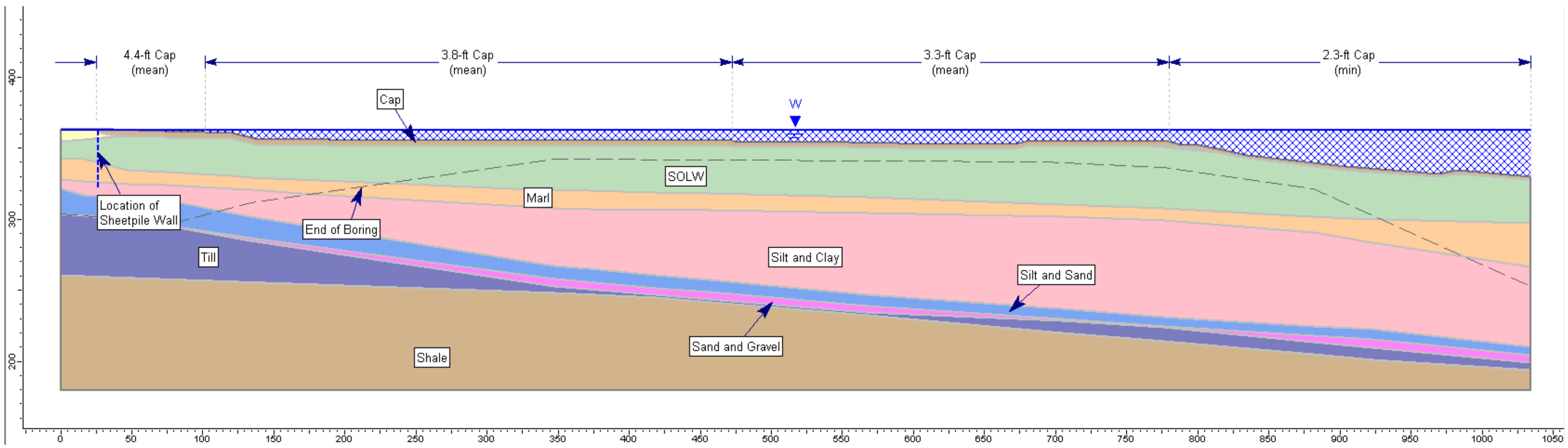

Figure 4. Geometry of Cross Section 2

Note:

1. See notes for Figure 3.

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Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **14-05**

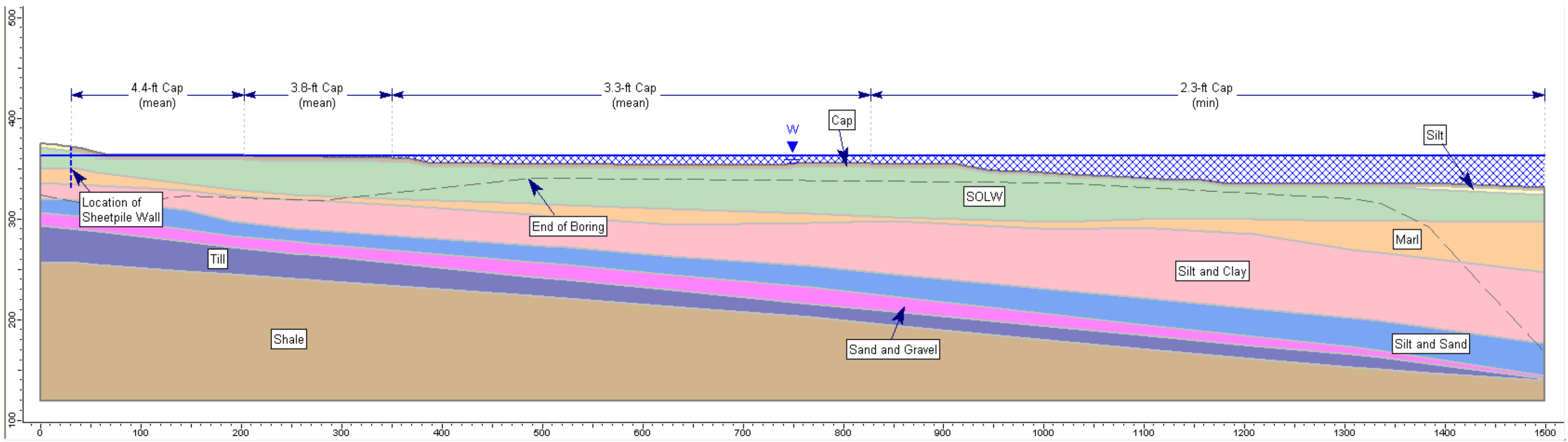

Figure 5. Geometry of Cross Section 3

Note:

1. See notes for Figure 3.

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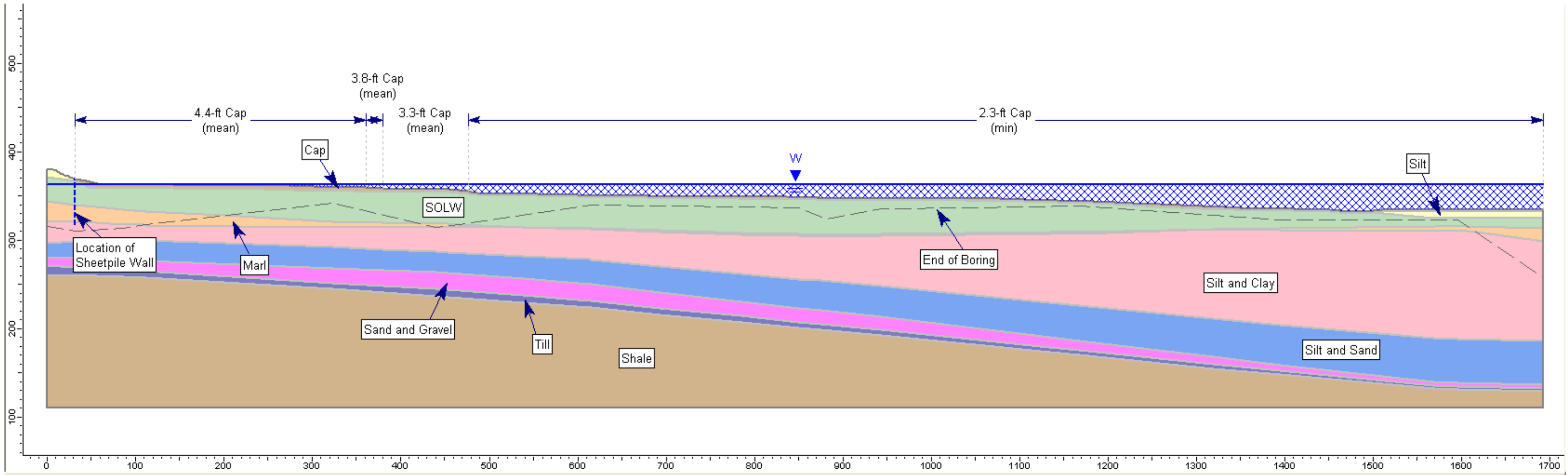

Figure 6. Geometry of Cross Section 4

Note:

1. See notes for Figure 3.

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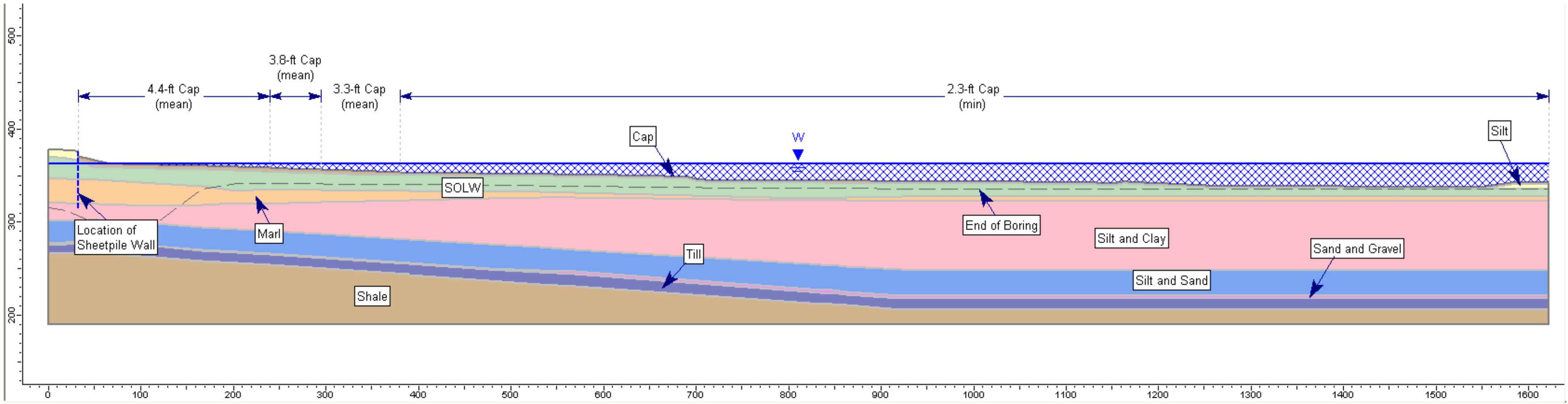

Figure 7. Geometry of Cross Section 5

Notes:
1. See notes for Figure 3.
2. The subsurface layer boundaries were extended horizontally beyond the station of 850 ft for the purpose of slope stability analysis.

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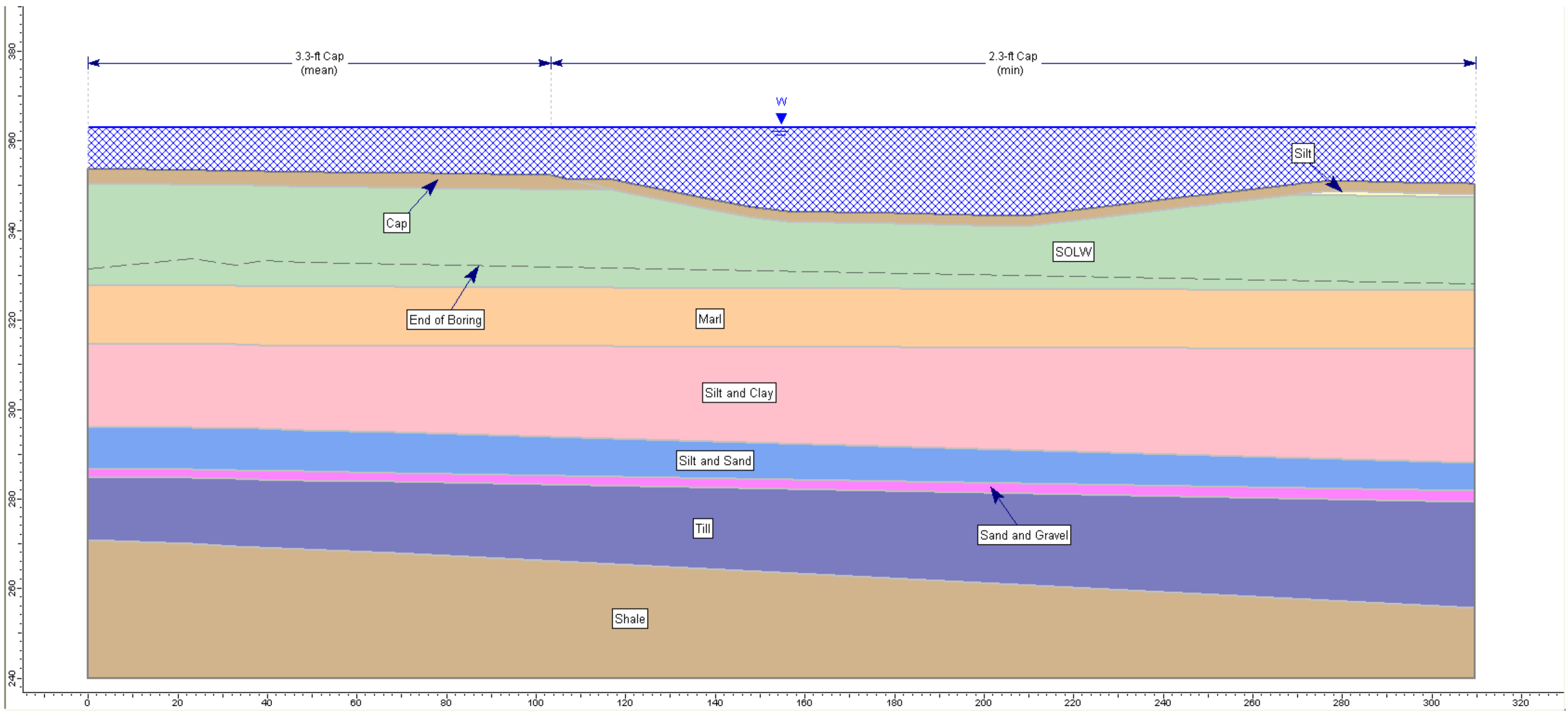

Figure 8. Geometry of Cross Section A

Note:

1. See notes for Figure 3.

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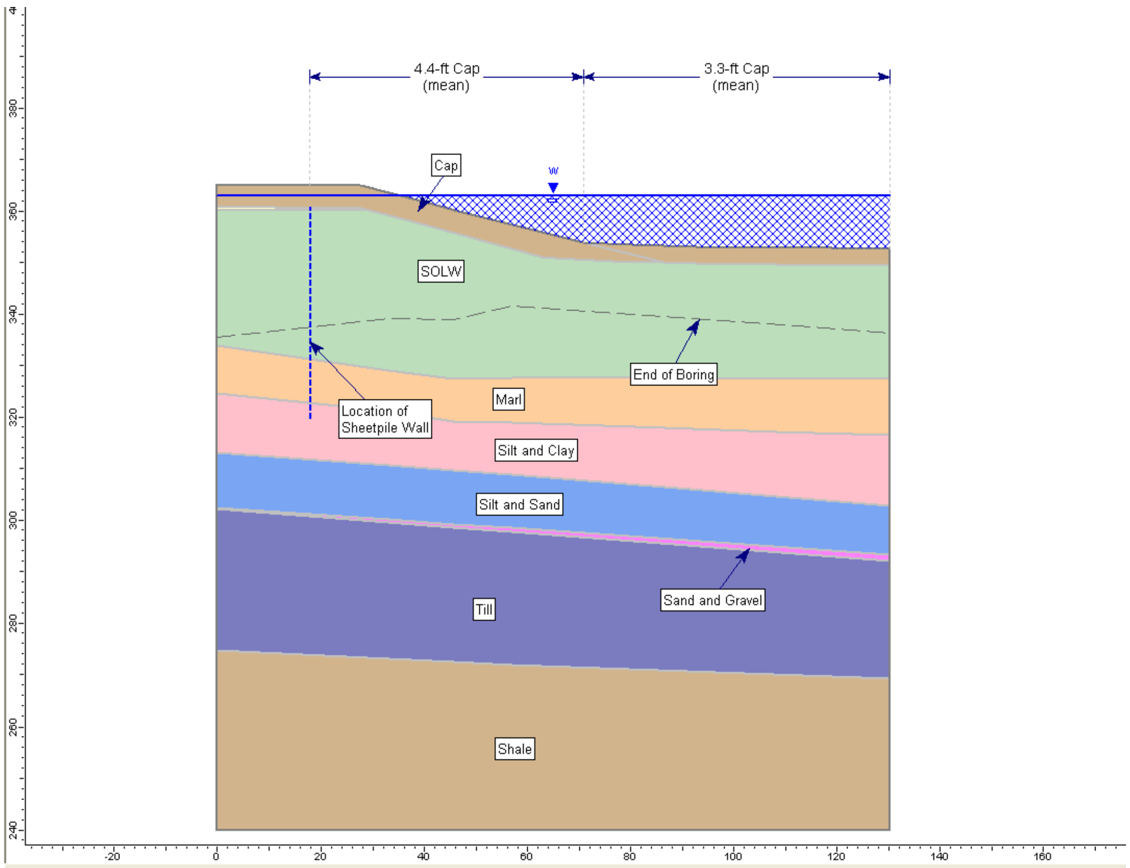

Figure 9. Geometry of Cross Section B

Note:

1. See notes for Figure 3.

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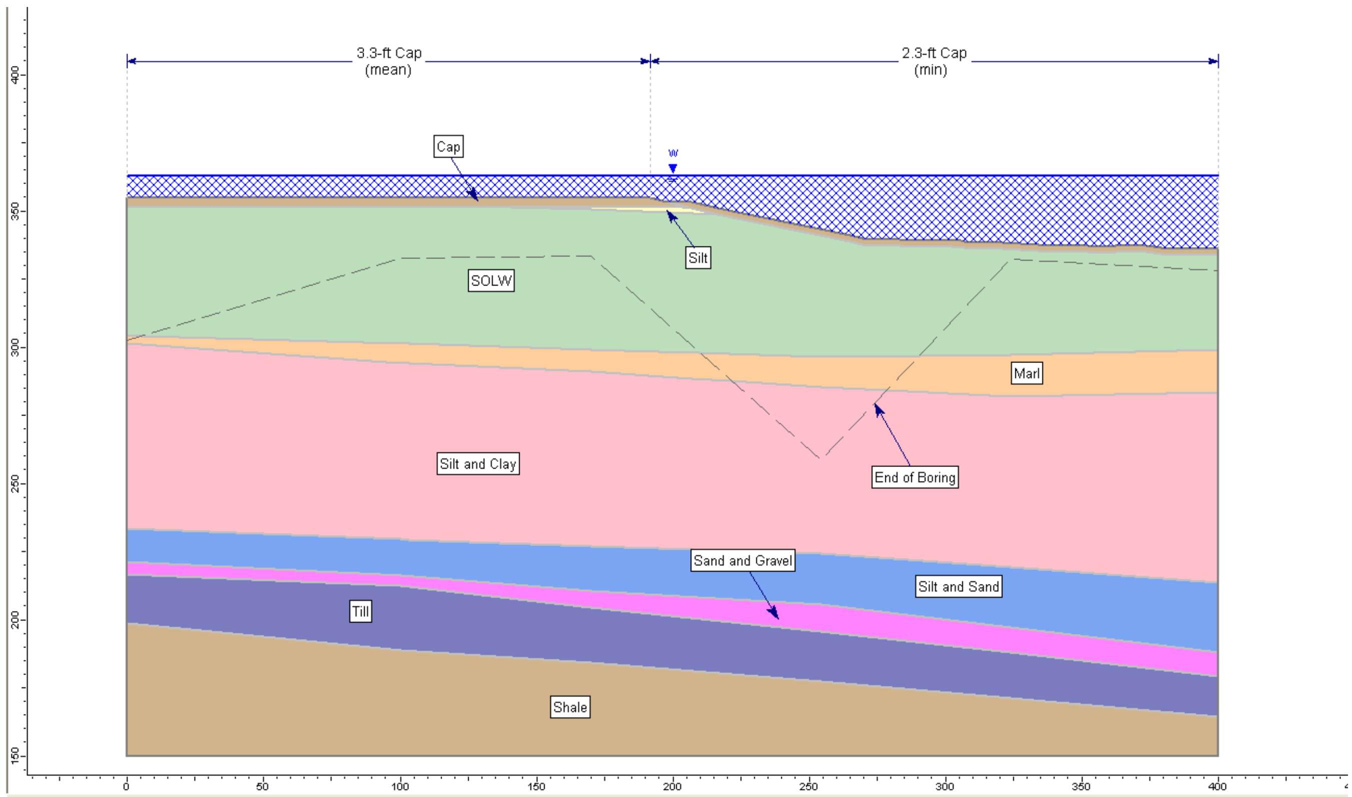

Figure 10. Geometry of Cross Section C

Note:

1. See notes for Figure 3.

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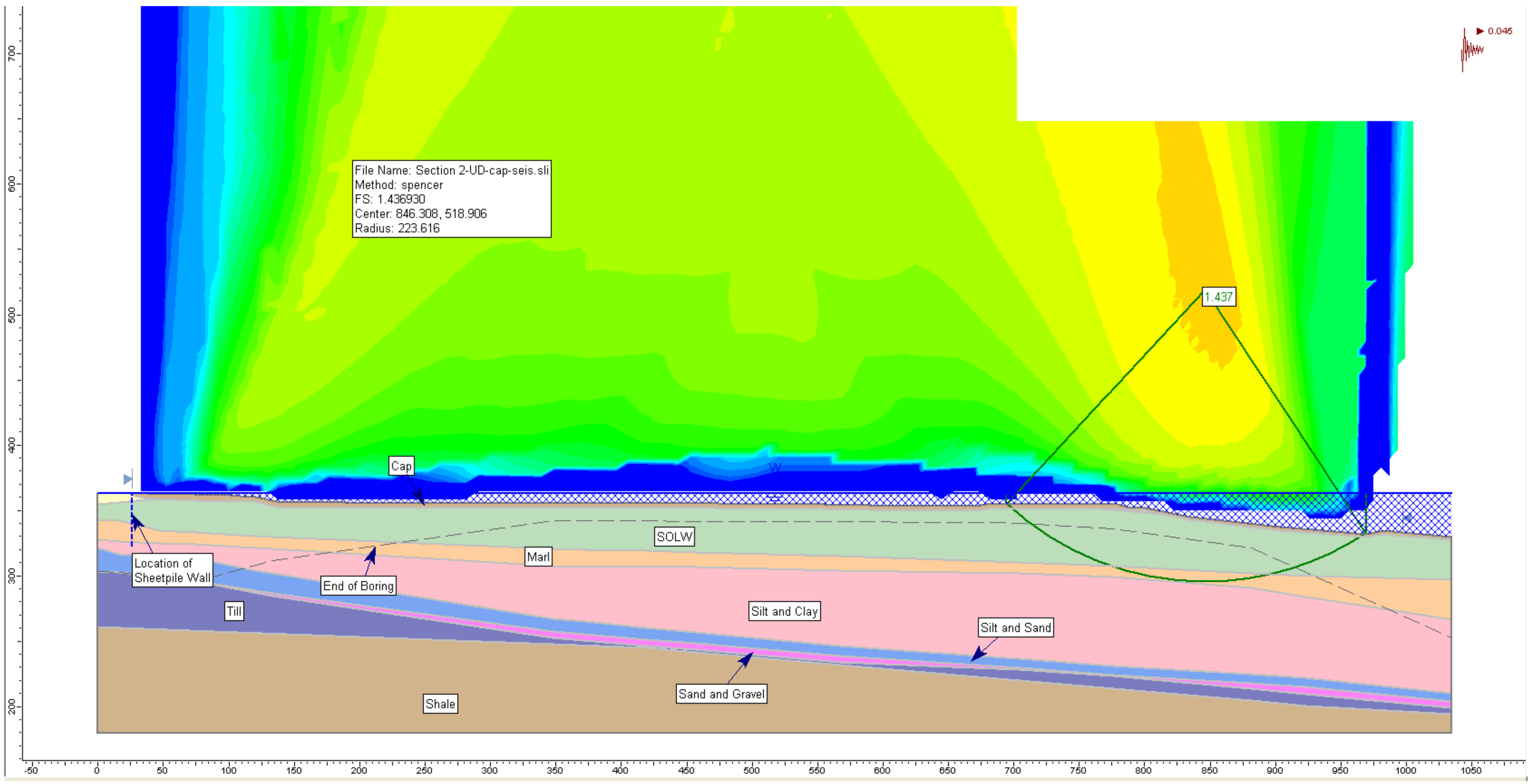

Figure 11. Slope Stability Analysis Result for Cross Section 2

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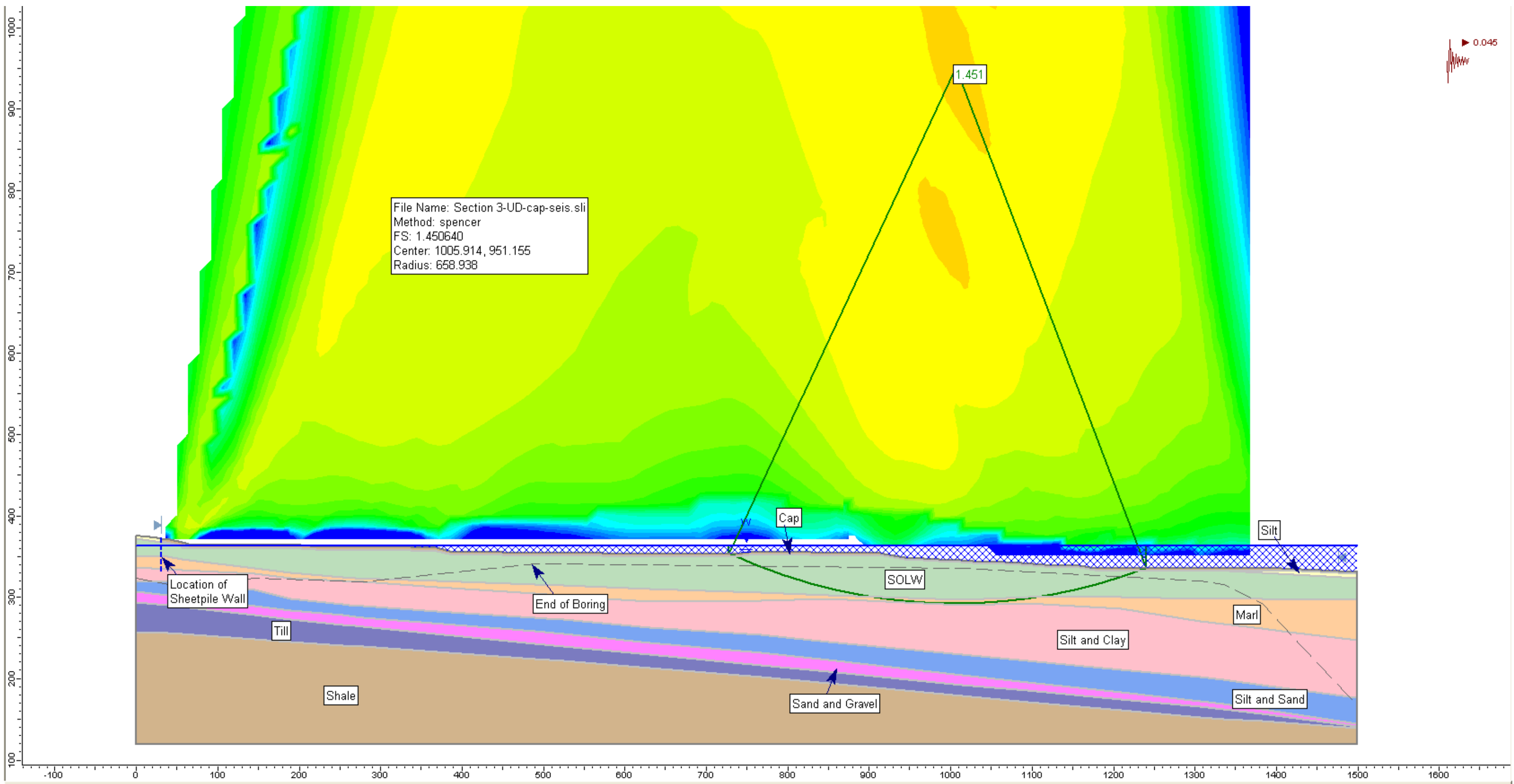

Figure 12. Slope Stability Analysis Result for Cross Section 3

Written by:	**Fan Zhu**	Date:	**1/14/2011**	Reviewed by:	**Ming Zhu/R. Kulasingam/Jay Beech**	Date:	**1/14/2011**

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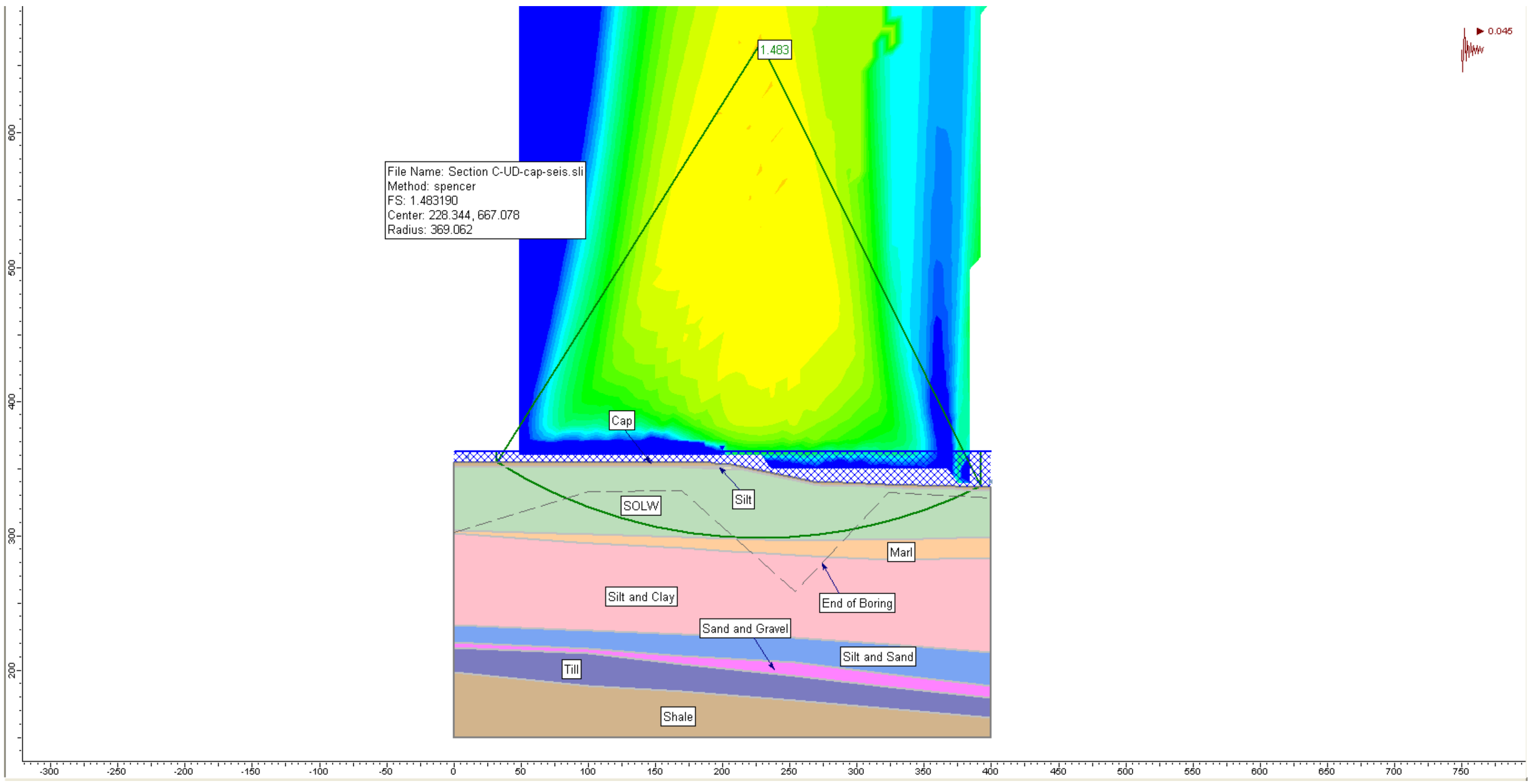

Figure 13. Slope Stability Analysis Result for Cross Section C

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Attachment 1
Sensitivity Analysis

Written by: **Fan Zhu** Date: **1/14/2011** Reviewed by: **Ming Zhu/R. Kulasingam/Jay Beech** Date: **1/14/2011**

Client: **Honeywell** Project: **Onondaga Lake ILWD Stability** Project/ Proposal No.: **GJ4204** Task No.: **14-05**

Table 1-1. Summary of Seismic Slope Stability Sensitivity Analysis Results

Cross Section	Calculated Minimum FS using Reduced Strength of SOLW	Yield Acceleration, a_y [1] (g)	Maximum Horizontal Acceleration, a_{max} (g)	a_y/a_{max}	Interpolated Displacement Range [2] (in)
3	1.06	0.048	0.09	0.53	0.2~0.6
C	1.02	0.047	0.09	0.52	0.2~0.6

Notes:
1. The yield acceleration corresponds to the horizontal seismic coefficient that results in a calculated FS of 1.0.
2. The displacement range was interpolated using the mean and mean + standard deviation curves presented in Figure 1-1.

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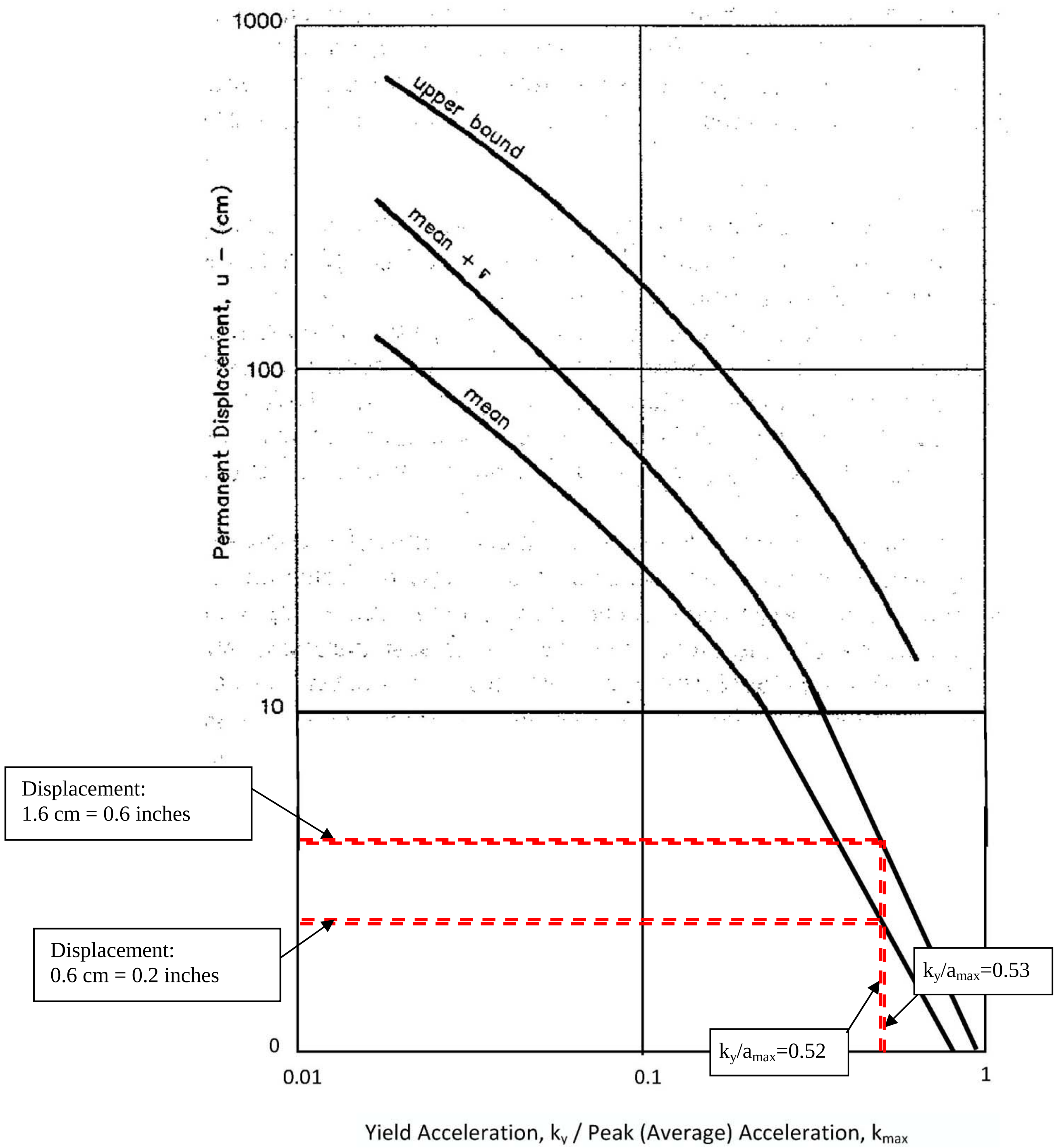

Figure 1-1. Interpolation of Displacement

APPENDIX H SLIDE FILES