APPENDIX A

SEDIMENT CONSOLIDATION AREA (SCA) CIVIL AND GEOTECHNICAL TECHNICAL MEMORANDUM

MEMORANDUM

August 11, 2009

To: Tim Larson, NYSDEC

From: Ed Glaza, Parsons

Subject: Sediment Consolidation Area (SCA) Civil and Geotechnical Technical Memorandum

---

This Sediment Consolidation Area (SCA) Civil and Geotechnical Technical Memorandum (Technical Memorandum) has been prepared on behalf of Honeywell International Inc. in accordance with the Remedial Design Work Plan (RDWP) for the Onondaga Lake Bottom Subsite (Parsons, 2009). The RDWP presents the activities necessary to complete design of the remedy selected in the Record of Decision issued by the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency Region 2 in 2005, and as set forth in the Consent Decree (United States District Court, Northern District of New York, 2007) (89-CV-815).

This Technical Memorandum is being submitted in advance of the SCA Civil and Geotechnical Initial Design Submittal (IDS) to facilitate NYSDEC's review of the IDS and achievement of the overall project schedule. Preparation and submission of this Technical Memorandum allows NYSDEC the opportunity to review and provide comments on the following documents prior to their inclusion in the IDS:

- Attachment A – Basis of Design
- Attachment B – Subsurface Stratigraphy Model of Wastebed 13 for the Design of Sediment Consolidation Area (i.e., the Data Package).

To further facilitate NYSDEC's IDS Review, the SCA Dewatering Evaluation Report will be submitted in advance of the IDS. The content and submittal schedule for the IDS will be in accordance with the RDWP.

REFERENCES

NYSDEC and USEPA. 2005. Record of Decision Onondaga Lake Bottom Subsite of the Onondaga Lake Superfund Site. Town of Geddes and Salina, Villages of Solvay and Liverpool, and City of Syracuse, Onondaga County, New York.

Parsons, 2009. Remedial Design Work Plan for the Onondaga Lake Bottom Subsite Prepared for Honeywell. March 2009.

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. Order Number 89-CV-815. Syracuse, New York.

ATTACHMENT A

CIVIL AND GEOTECHNICAL BASIS OF DESIGN

ONONDAGA LAKE
SEDIMENT CONSOLIDATION AREA

CIVIL AND GEOTECHNICAL
BASIS OF DESIGN

Prepared For:

Honeywell

5000 Brittonfield Parkway
Suite 700
East Syracuse, NY 13057

Prepared By:

PARSONS

301 Plainfield Road, Suite 350
Syracuse, New York 13212
Phone: (315) 451-9560
Fax: (315) 451-9570

AUGUST 2009

TABLE OF CONTENTS

Page

ONONDAGA LAKE SEDIMENT CONSOLIDATION AREA

CIVIL AND GEOTECHNICAL BASIS OF DESIGN

1.0 PURPOSE AND ORGANIZATION

This Basis of Design (BOD) has been prepared on behalf of Honeywell International Inc. (Honeywell). The purpose of this document is to define the requirements and criteria under which the civil and geotechnical aspects of the Onondaga Lake Sediment Consolidation Area (SCA) will be designed. Additionally, the SCA design will incorporate criteria from the dredging, SCA operations, and water treatment designs. As additional information is gained or project requirements change, this BOD will be revised accordingly.

The remainder of this document is organized as follows:

- Section 2: Regulatory Requirements
- Section 3: Design Objectives
- Section 4: Design Criteria
- Section 5: References

2.0 REGULATORY REQUIREMENTS

The remedial design of the SCA will be executed in accordance with the Record of Decision (ROD) issued by the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) Region 2 in 2005 for the Onondaga Lake Bottom subsite. The design requirements for the SCA are further set forth in the Consent Decree - United States District Court, Northern District of New York, 89-CV-815 (CD). Additional design considerations will be selected based on relevant guidance documents from the United States Army Corp of Engineers (USACE) and the USEPA.

The CD states, "Honeywell shall design, operate and maintain the SCA in accordance with the substantive requirements of NYSDEC Regulations Part 360, Section 2.14(a), (industrial monofills)". In addition, the SCA will meet the requirements of NYSDEC Regulations Part 373-2.19 as set forth herein. The ROD identifies NAPL as the Principal Threat Waste and therefore any pooled NAPL encountered or collected as part of the water treatment process would be treated to meet the minimum treatment requirements defined in Part 373-2.19 or disposed at an off-site permitted facility. The CD and ROD state the following additional requirements related to the SCA design:

- "The SCA shall be constructed on Solvay Wastebed 13, located south of Ninemile Creek and west of Geddes Brook."
- "*Impermeable Liner* – Honeywell shall design and install an impermeable liner system. The grading design for the SCA shall utilize the existing surface topography of Wastebed 13 as much as possible so as to limit wastebed cut and fill requirements and the associated need for a large volume of imported soil fill. Preloading and stabilization of the wastebed shall only be required to the extent necessary to ensure the integrity of the SCA components and underlying Solvay waste foundations, based upon the remedial design."
- "*Leachate Collection* – The impermeable liner shall be overlain by a leachate collection system. The type of system will be determined during Remedial Design. A laterally-transmissive sand or geosynthetic liquid collection layer may be considered by DEC for inclusion in the system. The system shall convey leachate by gravity drainage to collection sumps where the leachate will be pumped via force main to a water treatment plant."
- "*SCA Cover* – The SCA cover shall be designed pursuant to applicable regulations and guidance including the U.S. EPA Alternative Cover Assessment Program ("ACAP"). If appropriate based upon the Remedial Design, the SCA cover may utilize a soil layer and ecological plant community to produce evapotranspiration rates sufficient to reduce precipitation infiltration rates to acceptably low levels."

3.0 DESIGN OBJECTIVES

The SCA design objectives are:

- Design the SCA for the efficient and secure containment of sediments dredged as part of the Onondaga Lake remedy in a manner protective of human health and the environment and consistent with applicable regulations and codes.
- Incorporate dredging, SCA operations, and water treatment into the SCA civil and geotechnical design.
- Incorporate stakeholder (i.e., regulatory agencies and the community) input in the process to identify design criteria (e.g., odor mitigation, groundwater monitoring, redundancy of operations, leachate containment, dewatering, traffic, beneficial use, etc.).
- Incorporate value engineering and constructability into the design process from the earliest stages to assure overall value in the facility.

4.0 DESIGN CRITERIA

This section presents the criteria for the major aspects of the SCA civil and geotechnical design. Design criteria for the SCA operations are addressed in a separate document.

SCA Purpose

The purpose of the SCA is to receive dredged sediment from the Onondaga Lake remedial action. In addition to settling basins, alternate methods of dewatering were evaluated during the conceptual design of the SCA. As discussed in the Remedial Design Work Plan (RDWP), this evaluation included "the feasibility of using Geotube™ technology as both structural and containment elements in basin layout development." Based on the evaluation presented in the SCA Dewatering Evaluation Report (Parsons, 2009), geotextile tubes were selected as the dewatering method for the dredged sediment within the SCA.

Location

The Onondaga Lake SCA Siting Evaluation (Parsons, 2006) was prepared to describe and evaluate potential locations for building and operating a SCA, which included Honeywell's Wastebed B and Wastebeds 1 through 15. Based on that evaluation, Wastebed 13 was selected as the SCA location. Wastebed 13 occupies approximately 163 acres and is bordered to the north by Ninemile Creek and CSX Railroad tracks; to the west by an Onondaga County Garage property, a former gravel excavation owned by Honeywell, and residential properties; and to the east and south by Wastebeds 12 and 14, respectively. Because of off-site public access areas and residences, a 500-ft buffer between active SCA operations and the western limit of existing Wastebed 13 will be considered during SCA design.

Capacity

The required capacity of the SCA has not been determined yet. For preliminary design purposes, it is assumed that the SCA will contain up to 2,653,000 cubic yards (in-lake volume) of sediment. This may be revised as the design progresses and final dredge volumes are established. Capacity will be determined based on the following design assumptions:

- Dredged slurry will be 10% solids by weight on average.
- Sediment will achieve a 1.0 bulking factor following self-weight consolidation.

Phased Construction

The SCA design will consider the potential for phased construction to facilitate the dredging schedule, odor mitigation, underlying Solvay waste consolidation, and/or enhanced final closure. The SCA design will incorporate the construction schedule necessary to meet the remedial action timing requirements of the CD.

Geotechnical Stability

Static slope stability analyses will be performed as part of the SCA design. A series of analyses will be performed to evaluate the stability of the SCA and its components (e.g., stacked geotextile tubes, perimeter dikes, final cover) for interim (i.e., during SCA construction and operation) and long-term (i.e., post-closure) conditions. The degree of stability of a slope is reported in geotechnical engineering in terms of the slope stability factor of safety. A factor of safety of at least 1.0 is required for a slope to be stable. Due to the inherent variability in the engineering properties of soils, slopes are typically designed with a factor of safety greater than 1.0. Minimum acceptable factors of safety for a given set of conditions were developed for the SCA considering the criticality of the facility, the consequences of failure, and guidance provided by:

- U.S. Army Engineer Waterways Experiment Station Technical Report D-77-9 (Hammer and Blackburn, 1977); and
- U.S. Army Corps of Engineers Engineering Manual EM 1110-2-1902 (USACE, 2003).

Based on these guidance documents, a minimum acceptable factor of safety of 1.3 will be used for interim conditions (i.e., during construction and operation). In addition, a minimum acceptable factor of safety of 1.5 will be used for long-term conditions (i.e., post-closure). This factor of safety for long-term conditions is consistent with NYSDEC Regulations Section 360-2.7(b)(6), which indicates a minimum factor of safety of 1.50 for the final cover system under long-term conditions. The site is not located in a seismic impact zone; therefore, a seismic slope stability analysis is not necessary.

In terms of the dike stability analyses, both interim and long-term conditions will be evaluated using Spencer's Method (Spencer, 1973). The critical case (e.g., cross section, water level, etc.) will be defined for each cross section, and the guidance provided in Holtz and Kovacs (1981), Duncan et al. (1987), and Kulhawy and Mayne (1990) will be followed when selecting between total-stress and effective-stress analysis approaches and between unconsolidated-undrained (UU), consolidated-undrained (CU), and consolidated-drained (CD) shear strength parameters. In establishing shear strength parameters for geosynthetic interfaces, the differences between peak and large-displacement shear strength values will be considered using proven approaches that are consistent with the requirements of NYSDEC and USEPA standards and guidelines. The resulting factors of safety from these analyses will be compared with the minimum acceptable values indicated previously. If the calculated values are not acceptable, the design will be modified as necessary to achieve the required factors of safety.

Settlement

Calculations will be performed to evaluate the magnitude of SCA foundation soil settlement. Dredged sediment loadings for these calculations will be developed based on sediment characteristics established from the pre-design investigation data. Since the consolidation of the compressible foundation soils (i.e., Solvay waste) may require significant periods to reach completion, the time rate of primary consolidation settlement will also be considered.

Conventional one-dimensional (1-D) small strain primary consolidation settlement and secondary compression settlement calculation methods, such as those presented by Holtz and

Kovacs (1981), will be used to estimate settlement due to liner construction, geotextile tube placement and filling, and final cover installation in the SCA. Secondary settlement will be calculated for 30 years after closure of the SCA.

The time rate of primary consolidation settlement will be calculated using Terzaghi's 1-D consolidation theory, as presented in Holtz and Kovacs (1981). The parameters required to perform these calculations will be established from laboratory 1-D consolidation tests, the settlement pilot study, and/or appropriate empirical correlations.

The primary settlement as a function of time and the secondary compression will be estimated. In addition, based on those settlements, the tensile strain in the geomembrane liner will be estimated and compared to the maximum recommended tensile strain of 5% (Berg and Bonaparte, 1993). If necessary, the design, construction schedule, construction methods, SCA operations, etc. will be adjusted to accommodate the settlement.

Liquids Management and Liner System

The SCA design will include a liner and a liquids management system to collect and convey liquids draining from the dredged sediment. This liner and liquids management system will be designed in accordance with the requirements of NYSDEC Regulations Part 360, Section 2.14(a).

The bottom of the SCA (i.e., bottom of the liner system) will overlie existing Solvay waste ranging in thickness from approximately 35 ft to 90 ft. Existing site topography indicates elevation changes of up to 10 ft within the Wastebed 13 limits (i.e., the SCA site). The SCA design will use the existing site topography, to the extent possible, in designing the liner and liquid management systems. The bottom of the SCA will be designed to maintain a positive post-settlement slope toward the liquid withdrawal sumps so that liquid may be effectively removed from the SCA during and following active operations.

Following the requirements of the NYSDEC regulations and the specific conditions encountered in the SCA, the liner and liquids collection system for the SCA will be designed with the following general considerations:

- The liner system will include a geomembrane compatible with the materials to be contained within the SCA. A 24-inch (on average) gravel layer will be used for drainage and geotextile tube bedding.
- Consistent with Part 360, Section 2.14a, the intent of the design is to achieve a head no greater than 1 ft in the liquids management system; however, the facility design may allow for heads greater than 1 ft for some interim periods if it can be demonstrated that the overall performance objectives are met.
- The liner system will include a low permeability soil component immediately underlying the geomembrane. This soil component will vary in thickness to achieve

appropriate bottom slopes with the existing topography of the site, but it will not be less than 12 inches at any location and will be a minimum of 18 inches in critical areas such as sumps and drainage corridors. The soil component will exhibit a maximum hydraulic conductivity of 1 x 10^{-6} cm/sec in its uppermost layer (i.e., top 6 inches).

- If necessary, preloading will be used to establish or maintain positive drainage toward the sump areas. Preloading requirements will be developed using the results of the settlement evaluations.

The quantity and rate of liquids generated will be estimated for each representative step in the filling of the SCA cell, and each representative phase of the SCA development (i.e., construction, operation, closure, and post-closure). In addition, surface water run-off from active portions of the facility for the 25-year, 24-hour storm event will be considered in the liquids generation analysis. These estimates will be used to design the liquids collection system and the liquids transmission system.

Surface Water Management

Surface water management for the SCA includes the management of surface water flow over and around the SCA during construction, during operation, and after closure. The "New York State Standards and Specifications for Erosion and Sediment Control" (NYSDEC, 2005) shall be used as a guidance document for surface water design activities. Specifically, surface water management will include controlling runon, runoff, and wastewater (i.e., waters that must be contained, collected, and conveyed to the water treatment plant), as follows:

- route surface water to designated locations where it can be appropriately managed;
- protect the SCA from damage caused by precipitation and surface water runon and runoff;
- discharge surface water to existing watercourses in accordance with applicable regulatory requirements; and
- collect and route wastewater to the water treatment plant.

A surface water management system will be designed to meet the project requirements for both temporary conditions (i.e., during construction, filling, and closure of the SCA) and long-term conditions (i.e., after closure of the SCA). Design calculations for temporary and permanent surface water control structures will be performed using the 25-year, 24-hour storm event, as indicated in NYSDEC Regulations Section 360-2.7(b)(8)(ii). The system will be designed to control surface water runon to the SCA and uncontrolled surface water and wastewater runoff from the SCA, and will be integrated, to the extent possible, with existing topographic features and facilities.

Runon will be controlled and diverted away from and around the SCA using channels or diversion berms. If needed, calculations will be performed to size temporary sediment basins for each contributing drainage area during each representative phase of SCA development. As per the "New York State Standards and Specifications for Erosion and Sediment Control", runoff shall be computed by the method outlined in:

- Chapter 2, Estimating Runoff, "Engineering Field Handbook" available in the Natural Resources Conservation Service offices, or
- TR-55, "Urban Hydrology for Small Watersheds" (USDA-SCS, 1986).

Runoff computations will be based upon the worst soil cover conditions expected to prevail in the contributing drainage area during the anticipated effective life of the structure. An acceptable tool for performing these calculations is the computer program "*HydroCAD™ Stormwater Modeling System*" (1998).

Final Cover System

The final cover system will accommodate the final height of the dewatered dredged material in the SCA. Changes in dredged material volume and actual SCA layout will determine the final height of the SCA. The final cover system components and slopes will be designed to account for settlement of the subgrade material, to promote positive drainage, and to minimize erosion.

The SCA cover may utilize a soil layer and ecological plant community to reduce precipitation infiltration rates to acceptably low levels. The design of the final cover system will balance the infiltration rates with the hydraulic conductivity of the contained sediment and the liquid management system.

5.0 REFERENCES

Berg, R.R. and Bonaparte, R., Long-Term Allowable Tensile Stresses for Polyethylene Geomembranes, Geotextiles and Geomembranes, Vol. 12, 1993, pp. 287-306.

Bonaparte, R. and Giroud, J.P., Waste Containment Systems for Pollution Control: Part II-Hydraulic Design and Performance, Proceedings, NATO Advanced Study Institute, Recent Advances in Ground-Water Pollution Control and Remediation, Springer-Verlag, New York, 1995.

Duncan, J.M., Buchignani, A.L., and DeWet, M., An Engineering Manual for Slope Stability Studies, Department of Civil Engineering, Virginia Polytechnic Institute and State University, March 1987.

Hammer, D.P., and Blackburn, E.D., Design and Construction of Retaining Dikes for Containment of Dredged Material, Technical Report D-77-9, U.S. Army Engineer Water Experiment Station, Vicksburg, Mississippi, August 1977, pp. 93.

Holtz, R.D., and Kovacs, W.D., An Introduction to Geotechnical Engineering, Prentice-Hall Inc., Englewood Cliffs, N.J., 1981.

HydroCAD. *HydroCAD™:* Stormwater Modeling System, Version 6, Applied Microcomputer Systems, Chocorua, New Hampshire, 1998.

Kulhawy, F.H., and Mayne, P.W., Manual on Estimating Soil Properties for Foundation Design, Report No. EL-6800 Electric Power Research Institute, Palo Alto, California, 1990.

NYSDEC and USEPA. 2005. Record of Decision Onondaga Lake Bottom Subsite of the Onondaga Lake Superfund Site. Town of Geddes and Salina, Villages of Solvay and Liverpool, and City of Syracuse, Onondaga County, New York.

NYSDEC, 2005. New York State Standards and Specifications for Erosion and Sediment Control.

Parsons, 2006. Onondaga Lake Sediment Consolidation Area (SCA) Siting Evaluation. Prepared for Honeywell.

Parsons, 2009. Remedial Design Work Plan for the Onondaga Lake Bottom Subsite Prepared for Honeywell.

Parsons, 2009. Onondaga Lake Sediment Consolidation Area (SCA) Dewatering Evaluation. Prepared for Honeywell.

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. Order Number 89-CV-815. Syracuse, New York.

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

U.S. Army Corps of Engineers, Settlement Analysis, Engineer Manual 1110-1-1904, Washington, DC, September 1990.

U.S. Department of Agriculture-Soil Conservation Service (USDA-SCS), Urban Hydrology for Small Watersheds, Technical Release 55 (TR55), U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C., 2nd Edition, 1986.

ATTACHMENT B

SUBSURFACE STRATIGRAPHY MODEL OF WASTEBED 13 FOR THE DESIGN OF SEDIMENT CONSOLIDATION AREA

SUBSURFACE STRATIGRAPHY MODEL OF WASTEBED 13 FOR THE DESIGN OF SEDIMENT CONSOLIDATION AREA

1. INTRODUCTION

This Subsurface Stratigraphy Model of Wastebed 13 for the Design of Sediment Consolidation Area (SCA) (referred to as the Data Package) was prepared in support of the design of the SCA for the Onondaga Lake Bottom Site, which will be constructed on Honeywell's Solvay Wastebed 13 (WB-13). Specifically, the purpose of the package is to provide:

- a summary of the site investigation activities conducted in WB-13 to date;
- interpretation of material characteristics and subsurface stratigraphy in WB-13 based on the results of the site investigations;
- interpretation of material properties (i.e., index properties, shear strength, and compressibility) based on the results of the laboratory tests, the field test, and the empirical correlations;
- recommendation on material properties to be used for the SCA design; and
- verification of the interpreted subsurface model and compressibility of Solvay waste (SOLW) using the field settlement test results.

2. SITE INVESTIGATIONS

Historical information indicates that three large pits (i.e., Pits A, C, and D as shown in Figure 1) were excavated in the WB-13 area. These pits, along with the entire WB-13 area contained within constructed berms, were filled with Solvay waste during the period from 1973 to 1985. Numerous site investigations were conducted at WB-13 from 1985 to 2007. This section provides a brief summary of the recent site investigations between 2004 and 2007.

2.1 <u>2004 Investigation Program</u>

The 2004 investigation was performed in June and July 2004 to characterize the geotechnical properties of the subsurface materials within and surrounding WB-12 and WB-13. Activities relevant to WB-13 included 20 cone penetration tests (CPTs) and 17 borings with standard penetration tests (SPTs). Samples were taken during the investigation for laboratory testing of material properties (see Section 5). The locations of the CPTs and borings are shown in Figure 2. A detailed description of the investigation was presented in *Appendix A – Data Summary Report Geotechnical Characterization of*

Wastebed 13 of "*Onondaga Lake Pre-Design Investigation: Wastebed 13 Settlement Pilot Study Data Summary Report*" [Parsons and Geosyntec, 2008a]. For the remainder of this data package, this investigation will be referred to as the 2004 Investigation.

2.2 Phase I Investigation Program

The Phase I investigation was performed between August and October 2005 as a part of the pre-design investigation (PDI) program to support the WB-13 settlement pilot study. The purpose of the pilot study was to evaluate the settlement of SOLW under a constructed test fill. Activities performed during this investigation included 18 CPTs, 30 borings (10 of them with SPTs), and 2 test pits. Samples were taken during the investigation for laboratory testing of material properties (see Section 5). The locations of the CPTs and borings are shown in Figures 2 and 3. A detailed description of the investigation was presented in the report titled "*Onondaga Lake Pre-Design Investigation: Wastebed 13 Settlement Pilot Study Data Summary Report*, *Onondaga County, New York*" [Parsons and Geosyntec, 2008a]. Monitoring data for 2007 is provided in "*Wastebed 13 Settlement Pilot Study Monitoring Data – Year 2*" [Parsons, 2008b]. For the remainder of this data package, this investigation will be referred to as the Phase I Investigation.

2.3 Phase II Investigation Program

The Phase II investigation was performed between September and November 2006 as a part of the PDI program to further characterize the geotechnical properties of the subsurface materials at WB-13. Activities performed during this investigation included 113 CPTs and 30 borings with SPTs. Samples were taken during the investigation for laboratory testing of material properties (see Section 5). The locations of the CPTs and borings are shown in Figure 4. A detailed description of the investigation was presented in the report titled "*Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report*" [Parsons, 2008c]. For the remainder of this data package, this investigation will be referred to as the Phase II Investigation.

2.4 Phase III Investigation Program

The Phase III investigation was performed in October 2007 as a part of the PDI program to further investigate the buried berms between Pits A, C, and D and to characterize the geotechnical properties of SOLW at WB-13. Activities performed during this investigation included 28 CPTs and 23 borings with SPTs. Samples were taken during the investigation for laboratory testing of material properties (see Section 5). The locations of the CPTs and borings are shown in Figure 5. A detailed description of the investigation was presented in *Appendix E – Phase III SCA Data Summary Report* of the "*Onondaga Lake Pre-Design Investigation Phase III Data Summary Report*" [Parsons, 2009]. For the remainder of this data package, this investigation will be referred to as the Phase III Investigation.

3. SUBSURFACE STRATIGRAPHY

Schematics of the subsurface profiles at four cross sections in WB-13 were developed based on the previous site investigation results. The locations of these cross sections are shown in Figure 6 and the subsurface profiles are illustrated in Figures 7, 8, 9, and 10. The subsurface stratigraphy consists primarily of three types of material: SOLW, the dike soil, and the foundation soil. The dike was determined to be approximately 40 ft high based on topographic contours for dikes and surrounding areas outside the dikes on the north and west sides. The eastern and southern dikes of WB-13 are also the northwestern and northern dikes of Wastebeds 12 and 14, respectively. The natural soil beneath the dike and the SOLW was considered as the foundation soil.

3.1 SOLW

SOLW is a by-product of sodium carbonate (soda ash) production via the Solvay process (i.e., process by which soda ash is formed from salt, limestone, carbon dioxide, and ammonia). It is a combination of process residuals, unreacted material, and mineral salts that was deposited in slurry exhibiting a very high pH. The thickness of SOLW varies across WB-13 and is related to the shape of the three original pits. The native materials that were left in place between the pits formed “berms” that were buried during wastebed filling activities. Figure 11 shows the bottom elevation contours of SOLW that were developed based on the estimated SOLW thickness from CPTs and borings presented in Attachment 1, as well as the additional information regarding the buried berms obtained from the Phase III investigation. The SOLW thickness ranges between approximately 50 ft and 90 ft in the central areas of the three original pits.

SOLW in WB-13 can be divided into three zones based on different characteristics indicated by the results of CPTs (Figures 12, 13, and 14) and SPT blow counts (N values) (Figure 15) in different areas of WB-13:

- Zone 1 is defined as the “ring” area that is within approximately 150 ft from the inner edge of the WB-13 dike. SOLW in Zone 1 was generally described in the boring logs as gray, soft to medium dense, silt- and sand-sized particles in paste-like or semi-cemented matrix. CPT profiles of SOLW in Zone 1 show relatively high tip resistance, high sleeve friction, and small excess porewater pressure, which are characteristics of dense coarse grained material (Figure 12). Results of borings show much larger SPT N values for SOLW in Zone 1 than SOLW in the other two zones (Figure 15). During the operation of WB-13, SOLW was placed mainly from pipes placed along the dikes. The coarser particles of SOLW would have settled out first which can explain the observed matrix in Zone 1.

- Zone 2 is defined as the original Pit D area and the top 40 ft of the original Pit A and Pit C areas that are beyond the limit of Zone 1. The depth of 40 ft is selected as the boundary of

Zone 2 in the Pit A and Pit C areas because the profiles of CPT (Figure 14) and SPT N values (Figure 15) generally show sudden increase at this depth. SOLW in Zone 2 was generally described in the boring logs as white to gray, very soft to soft, silt-sized particles in paste-like matrix. CPT profiles of SOLW in Zone 2 generally show relatively low tip resistance, low sleeve friction, and large excess porewater pressure, which are characteristics of soft fine grained material (Figures 13 and 14). Results of borings indicate zero to very small SPT N values for SOLW in Zone 2 (Figure 15).

- Zone 3 is defined as the area from 40 ft below ground surface (bgs) to the top of foundation soil in the original Pit A and Pit C areas that are beyond the limit of Zone 1. Unlike SOLW in Zone 2 that is relatively uniform, SOLW in Zone 3 varied from very soft to dense silt-sized particles according to the boring logs. Inter-layered soft and hard layers of SOLW in Zone 3 result in a wider range of the tip resistance and the sleeve friction (Figure 14) and the SPT N values (Figure 15) than SOLW in Zone 2. The reason for the apparent absence of Zone 3 in Pit D is currently unknown. It is also unknown why Zone 3 material has unique characteristics as compared to Zone 2 material.

A summary of the SPT N values of SOLW in the three zones obtained from the site investigations between 2004 and 2007 is presented in Table 1. As indicated in the table, the SPT N value of SOLW in Zone 1 ranges from 0 to 74 with an average value of 17; the SPT N value of SOLW in Zone 2 ranges from 0 to 18 with an average value of 1; and the SPT N value of SOLW in Zone 3 ranges from 0 to 68 with an average value of 8. The SPT N values of SOLW in the three zones are also plotted in Figure 16 as a function of depth.

Using the correlations between the SPT N values and the consistency for cohesive soils shown in Table 2, SOLW in Zone 1, Zone 2, and Zone 3 can be classified as “very stiff”, “very soft”, and “medium stiff”, respectively, based on the calculated average SPT N values. The classification is consistent with the observations from the CPTs and the borings.

3.2 Dike Soil

Based on the observations during previous investigations, it appears that native material underneath the footprint of WB-13 was used to construct the dikes. Results of borings indicate that the dike soil consists of a mixture of clay, silt, sand, and gravel. Borings in the exterior dike of WB-13 indicate no SOLW underneath the dike. However, SOLW was encountered in borings drilled in the inter-cell dike between WB-13 and Wastebeds 12 and 14 at depths of approximately between 15 ft and 50 ft bgs as shown in Figure 17. It appears that part of the inter-cell dike was constructed on top of SOLW filled in Wastebeds 12 and 14.

A summary of the SPT N values of the dike soil (not including the SOLW under the inter-cell dike between WB-13 and Wastebeds 12 and 14) obtained from the site investigations between 2004 and 2007 is presented in Table 1. As indicated in the table, the SPT N value of the dike soil ranges from 5 to 127 with an average value of 36. The SPT N values of the dike soil are also plotted in Figure 18 as a function of depth.

Using the correlations between the SPT N values and the relative density for granular soils shown in Table 3, the dike soil can be classified as "dense" based on the calculated average SPT N value. The classification is consistent with the observations from the borings.

3.3 Foundation Soil

The foundation soil is the native material underneath the footprint of WB-13. Results of borings indicate that the foundation soil consists primarily of dense sand and gravel. A summary of the SPT N values of the foundation soil obtained from the site investigations between 2004 and 2007 is presented in Table 1. As indicated in the table, the SPT N value of the foundation soil ranges from 2 to 120 with an average value of 40, which is very similar to the value of the dike soil. The SPT N values of the foundation soil are plotted in Figure 18 as a function of depth along with the dike soil.

Using the same correlations shown in Table 3, the foundation soil can also be classified as "dense" based on the calculated average SPT N value. The classification is consistent with the observations from the borings.

4. GROUNDWATER TABLE

Information about the groundwater table (GWT) in WB-13 is available from: (i) piezometer measurements; (ii) CPT porewater dissipation tests, and (iii) borings.

4.1 GWT From Piezometers

The GWT has been monitored by the piezometers installed in November 2006. Figure 19 shows the locations of these piezometers. The data collected between November 30, 2006 and December 28, 2007 was provided to Geosyntec by Parsons and is presented in Attachment 2. The average GWT elevations and the average GWT depths during the monitoring period were calculated for each piezometer and the results are presented in Table 4. It is noted that the piezometers installed in the test pad area in September 2005 were not included in this evaluation, because the measured GWT has been affected by the excess water pressure generated due to the load of the test fill.

There are six locations inside WB-13 where the GWT has been monitored. At each location, 3 or

4 piezometers were installed and were screened at different depths ranging approximately from 15 ft to 64 ft bgs. Among these piezometers, 5 piezometers (i.e., SB915-PZ13-01N, -02N, -04N, -05N, and -06N) were screened in the natural soil underneath SOLW. The data collected from the piezometers indicate both shallow water levels recorded by the piezometers screened in SOLW and deep water levels recorded by the piezometers screened in the natural soil. Figure 20 presents the average measured groundwater table elevations with respect to the piezometer tip elevations. The average measured groundwater elevations along two cross sections shown on Figure 21 are plotted in Figures 22 and 23.

The results imply that "perched" groundwater exists in SOLW above the "real" GWT. The "perched" GWT is affected by precipitation and therefore fluctuates seasonally. In general, the seasonal high "perched" GWT occurs in April or May with depths of about 6 to 11 ft below the ground, except at the lowest point of WB-13 where the seasonal high "perched" GWT can be as high as 0.4 ft below the ground.

Three of the five piezometers screened in the natural soil indicate that the "real" GWT elevation in WB-13 is around 375 ft, while the other two (i.e., SB915-PZ13-02N and -05N, which are located near the WB-13 perimeter dike) indicate a relatively higher GWT elevation around 385 ft. A further review of the data from these two piezometers found that the measured groundwater levels by these two piezometers have experienced more fluctuation than the other three piezometers that were screened in the natural soil (See Table 4). Recently, the groundwater level at SB915-PZ13-02N has been below the piezometer tip elevation at 380.34 ft (Table 5) and the groundwater level at SB915-PZ13-05N has been below or very close to the piezometer tip elevation at 376.94 ft (Table 6). Based on the observations discussed above, the GWT in WB-13 was interpreted to be at the elevation of 375 ft. As compared to the interpreted GWT in WB-13, the water table in the adjacent Ninemile Creek is at approximately 372 ft.

The GWT in WB-13 has also been monitored by ten piezometers installed in or outside the WB-13 dike. However, the tip elevations of these piezometers are higher than the anticipated GWT elevation except for piezometer SB915-PZ13-10, which is located outside the WB-13 perimeter dike. The average GWT elevation measured by SB915-PZ13-10 is 373.2 ft, which confirms the interpretation of GWT presented in the preceding paragraph.

4.2 GWT From CPT Porewater Dissipation Tests

The GWT in WB-13 was estimated from the CPT porewater dissipation tests during the 2004, Phase I, and Phase II investigations. The test results are presented in Tables 7, 8, and 9. The GWT depth was estimated from the 2004 tests to range from 41.4 ft to 52.6 ft with an average depth of 50 ft bgs (excluding the test results at shallow depths of two CPT locations, PW-13A and PW-119). The

GWT depth was estimated from the Phase I tests to range from 41.2 ft to 59.4 ft with an average depth of 55 ft bgs (excluding the test results at shallow depths of one CPT location, SB915-CPT-A3). In the Phase II tests, only the tests with depth greater than 45 ft were considered for the estimation of the GWT. The GWT depth was estimated from the Phase II tests to range from 33.1 ft to 65.9 ft with an average depth of 51.8 ft bgs. The results of the CPT porewater dissipation tests are in general consistent with the monitoring data from the piezometers. A 50 to 55 ft depth corresponds to a GWT elevation of approximately 370 to 375 ft.

4.3 GWT From Borings

The GWT was measured during boring activities in the 2004 Investigation and the results are summarized in Table 10. Because of the existence of the "perched" groundwater in SOLW, some of the borings inside WB-13 and near the crest of WB-13 dike recorded shallow GWTs or several different GWTs. The GWTs measured in the borings at the toe of the WB-13 dike range from 44.5 ft to 63.3 ft below the WB-13 ground surface. The deep GWTs measured in the borings inside WB-13 and near the crest of WB-13 dike range between 38 ft and 73.5 ft bgs. The results are consistent with the GWTs estimated from the piezometers and the CPT pore water dissipation tests.

Based on the data collected from the piezometers, the results of the CPT porewater dissipation tests, and the measurements during borings, the "real" GWT was estimated to be at the elevation of approximately 375 ft in WB-13, which is equivalent to approximately 50 ft bgs assuming that the average elevation of the existing WB-13 ground is 425 ft, for the purpose of geotechnical analyses. The piezometer data indicates there are zones of perched water within the wastebed.

5. MATERIAL PROPERTIES

Material properties were obtained from laboratory tests or empirical correlations. Laboratory tests were performed on samples taken during the site investigations.

Laboratory tests include:

- Index property tests (i.e., water content, grain size, 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, one-dimensional consolidation tests, and hydraulic conductivity tests).

Summary tables of the lab test results were provided to Geosyntec by Parsons and are presented in Attachment 3.

5.1 Index Properties

5.1.1 Water Content

Water contents were measured for the index property tests performed during the 2004, Phase I, Phase II, and Phase III investigations, and for the UU tests, and the CU tests performed during the 2004, Phase I, and Phase II investigations. The data is plotted with respect to depth in Figure 24 for SOLW in three zones and in Figure 25 for the dike soil and the foundation soil. The results of the measured water contents are summarized in Table 11. As indicated in the table, the water content of SOLW covers a wide range between 5% and 912%. The average water content was calculated to be 166%, 227%, and 172% for SOLW in Zone 1, Zone 2, and Zone 3, respectively. The dike soil and the foundation soil, which consist primarily of sand and gravel, have much lower water contents than SOLW. The average water content was calculated to be 13% and 16% for the dike soil and the foundation soil, respectively. The calculated average water content for each material is recommended to be used for design.

5.1.2 Grain Size

The fine size particle content (i.e., clay size and silt size particles) was measured as part of the laboratory index property tests during all four investigations. Hydrometer tests were performed during the Phase II and Phase III investigations to further measure the clay size particle content (i.e., particle size less than 0.002 mm). Based on the lab results, the average fine size particle content was calculated to be 50.5%, 83.6%, and 65.7% for SOLW in Zone 1, Zone 2, and Zone 3, respectively. The average clay size particle content was calculated to be 4.9%, 15.9%, and 8.7% for SOLW in Zone 1, Zone 2, and Zone 3, respectively. The average fine size particle content was calculated to be 63.1% and 33.3% for the dike soil and the foundation soil, respectively. The average clay size particles content was calculated to be 21.8% and 7.7% for the dike soil and the foundation soil, respectively.

5.1.3 Atterberg Limits

The Atterberg limits were measured from the index property tests performed during all four investigations. The results of the plastic limit, the liquid limit, and the plasticity index are summarized in Table 12.

As indicated in Table 12, the plastic limit of SOLW ranges from 62 to 245. The average plastic limit was calculated to be 109, 139, and 130 for SOLW in Zone 1, Zone 2, and Zone 3, respectively.

The plastic limit of the dike soil ranges from 11 to 49 with a calculated average value of 20. The plastic limit of the foundation soil ranges from 10 to 53 with a calculated average value of 26.

The liquid limit of SOLW ranges from 80 to 241. The average liquid limit was calculated to be 145, 168, and 150 for SOLW in Zone 1, Zone 2, and Zone 3, respectively. The liquid limit of the dike soil ranges from 10 to 66 with a calculated average value of 19. The liquid limit of the foundation soil ranges from 13 to 57 with a calculated average value of 29.

The results of the plasticity index (i.e., the difference between the liquid limit and the plastic limit) are plotted with respect to depth in Figure 26 for SOLW in three zones and in Figure 27 for the dike soil and the foundation soil. The plasticity index of SOLW ranges from 12 to 138. The average plasticity index was calculated to be 36, 55, and 69 for SOLW in Zone 1, Zone 2, and Zone 3, respectively. The dike soil and the foundation soil, which consist primarily of sand and gravel, have much lower plasticity indices than SOLW. The plasticity index of the dike soil ranges from 6 to17 with a calculated average of 10. The plasticity index of the foundation soil ranges from 3 to 30 with a calculated average of 11.

The calculated average plastic limit, liquid limit, and plasticity index for each material are recommended to be used for design.

5.1.4 Specific Gravity

The specific gravity was measured as part of the index property tests performed during all four investigations. The average specific gravity was calculated to be 2.57, 2.50, and 2.47 for SOLW in Zone 1, Zone 2, and Zone 3, respectively. Because these three average values are very close, a uniform specific gravity of 2.51 is recommended for design, which represents the average specific gravity of SOLW in all three zones. The average specific gravity was calculated to be 2.71 and 2.65 for the dike soil and the foundation soil, respectively. It is noted that the unit weights of the materials were measured from bulk density tests or calculated using measured water content and dry density. Therefore, the specific gravity values were not used to estimate any design parameters.

5.1.5 Unit Weight

The total unit weight of SOLW was measured from the index property tests performed during the 2004, Phase I, Phase II, and Phase III investigations or calculated using the initial water content and the dry density measured from the UU and CU tests performed during the 2004, Phase I, and Phase II investigations. The data is plotted with respect to depth in Figure 28. The results of the measured total unit weight are summarized in Table 13. As indicated in the table, the total unit weight of SOLW ranges from 55 pcf to 139 pcf. The average total unit weight was calculated to be 84 pcf, 82 pcf, and 82 pcf for SOLW in Zone 1, Zone 2, and Zone 3, respectively. Because these three average values are very close, a uniform total unit weight of 82 pcf is recommended for design, which represents the average total unit weight of SOLW in all three zones.

The total unit weight of the foundation soil was calculated using the initial water content and the dry density measured from the Phase II CU tests. The results are presented in Table 13 and also plotted in Figure 28. The total unit weight of the foundation soil ranges from 118 to 124 with a calculated average of 121. A value of 120 pcf is recommended for design.

Since undisturbed samples of dike material could not be collected in the field, the total unit weight of the dike soil could not be measured in the lab. The total unit weight of the dike soil is assumed to be 120 pcf.

5.2 Compressibility Parameters

5.2.1 Preconsolidation Pressure and Overconsolidation Ratio

The preconsolidation pressure ($p_c^{'}$) of SOLW was estimated from the 2004, Phase I, Phase II, and Phase III one-dimensional consolidation test results. The results of $p_c^{'}$ (see Attachment 3) are plotted with respect to depth in Figure 29. The profile of the in-situ vertical effective stress is also plotted in the same figure using the total unit weight of 82 pcf for SOLW and the GWT at 50 ft bgs as discussed in the previous sections. Figure 29 shows a wide scatter of $p_c^{'}$ values. However, the profiles of $p_c^{'}$ and the in-situ vertical effective stress are consistent with overconsolidation of soil in shallow depths by desiccation.

The overconsolidation ratio (OCR), which is the ratio of $p_c^{'}$ to the in-situ vertical effective stress, was calculated and is plotted in Figure 30 as a function of depth. Based on the plot, SOLW above 20 ft is considered to be overconsolidated and SOLW below 20 ft is considered to be normally consolidated. The average OCR above 10 ft was calculated to be 4.5. The average OCR between 10 ft and 20 ft was calculated to be 2.0. The OCR for the normally consolidated SOLW below 20 ft is 1.0. The recommended OCR for design is also plotted in Figure 30.

5.2.2 Modified Compression Index

The modified compression index ($C_{c\varepsilon}$) of SOLW was measured from the 2004, Phase I, Phase II and Phase III one-dimensional consolidation test results. The results of $C_{c\varepsilon}$ are plotted with respect to depth in Figure 31. A summary of the test results are presented in Table 14.

The $C_{c\varepsilon}$ for SOLW in Zone 1 ranges between 0.15 and 0.50 with an average value of 0.34 based on seven consolidation tests. The $C_{c\varepsilon}$ for SOLW in Zone 2 ranges between 0.21 and 0.71 with an average value of 0.46 based on twenty-five consolidation tests. The $C_{c\varepsilon}$ for SOLW in Zone 3 ranges between 0.21 and 0.46 with an average value of 0.38 based on five consolidation tests. The results indicate the compressibility of SOLW in Zone 2 is in general greater than the compressibility of SOLW in Zone 1 and Zone 3.

The calculated average $C_{c\varepsilon}$ of SOLW in each zone is recommended to be used for design.

5.2.3 Modified Recompression Index

The modified recompression index ($C_{r\varepsilon}$) of SOLW was measured from the 2004, Phase I, Phase II, and Phase III one-dimensional consolidation tests. The results of $C_{r\varepsilon}$ are plotted with respect to depth in Figure 32. A summary of the test results are presented in Table 15.

The $C_{r\varepsilon}$ for SOLW in Zone 1 ranges between 0.01 and 0.02 with an average value of 0.015 based on seven consolidation tests. The $C_{r\varepsilon}$ for SOLW in Zone 2 ranges between 0.004 and 0.025 with an average value of 0.014 based on twenty-five consolidation tests. The $C_{r\varepsilon}$ for SOLW in Zone 3 ranges between 0.003 and 0.034 with an average value of 0.021 based on five consolidation tests.

The calculated average $C_{r\varepsilon}$ of SOLW in each zone is recommended for SCA design.

5.2.4 Modified Secondary Compression Index

The modified secondary compression index ($C_{a\varepsilon}$) of SOLW was interpreted from the 2004, Phase I, Phase II, and Phase III one-dimensional consolidation tests. The results of $C_{a\varepsilon}$ are plotted as a function of the stress ratio $\sigma_v^{'}/P_c^{'}$, where $\sigma_v^{'}$ is the vertical effective stress, in Figures 33, 34, and 35 for SOLW in Zone 1, Zone 2, and Zone 3, respectively. The plots indicate that the values of $C_{a\varepsilon}$ are affected by the stress history. Larger values of $C_{a\varepsilon}$ were obtained for stress levels greater than $p_c^{'}$ (i.e., at stresses corresponding to virgin compression).

The average value of $C_{a\varepsilon}$ for SOLW in Zone 1 was calculated to be 0.13% for $\sigma_v^{'}/P_c^{'}$ less than or equal to 1 and 0.83% for $\sigma_v^{'}/P_c^{'}$ greater than 1 based on seven consolidation tests. The average value of $C_{a\varepsilon}$ for SOLW in Zone 2 was calculated to be 0.11% for $\sigma_v^{'}/P_c^{'}$ less than or equal to 1 and 0.91%

for $\sigma_v^{'}/P_c^{'}$ greater than 1 based on twenty-five consolidation tests. The average value of $C_{a\varepsilon}$ for SOLW in Zone 3 was calculated to be 0.07% for $\sigma_v^{'}/P_c^{'}$ less than or equal to 1 and 0.70% for $\sigma_v^{'}/P_c^{'}$ greater than 1 based on five consolidation tests.

The calculated average value of $C_{a\varepsilon}$ for SOLW in each zone is recommended to be used for design. The final effective stress in SOLW after primary consolidation is completed should be evaluated in order to assess the value of $C_{a\varepsilon}$, because the $C_{a\varepsilon}$ is dependent on the stress level.

5.2.5 Coefficient of Consolidation

The coefficient of consolidation (c_v) of SOLW was interpreted from the 2004, Phase I, Phase II, and Phase III laboratory one-dimensional consolidation tests as well as the Phase I field settlement test.

c_v from Laboratory Tests

The coefficient of consolidation (c_v) of SOLW was interpreted from the 2004, Phase I, Phase II, and Phase III one-dimensional consolidation tests. The results of c_v are plotted as a function of the stress ratio $\sigma_v^{'}/P_c^{'}$ in Figures 36, 37, and 38 for SOLW in Zone 1, Zone 2, and Zone 3, respectively. Similar to the $C_{a\varepsilon}$, the plots indicate that the values of c_v are also affected by the stress history. Larger values of c_v were obtained for stress levels smaller than $p_c^{'}$ (i.e., at stresses corresponding to recompression).

The average value of c_v for SOLW in Zone 1 was calculated to be 0.047 cm^2/s for $\sigma_v^{'}/P_c^{'}$ less than or equal to 1 and 0.029 cm^2/s for $\sigma_v^{'}/P_c^{'}$ greater than 1 based on seven consolidation tests. The average value of c_v for SOLW in Zone 2 was calculated to be 0.046 cm^2/s for $\sigma_v^{'}/P_c^{'}$ less than or equal to 1 and 0.009 cm^2/s for $\sigma_v^{'}/P_c^{'}$ greater than 1 based on twenty-five consolidation tests. The average value of c_v for SOLW in Zone 3 was calculated to be 0.024 cm^2/s for $\sigma_v^{'}/P_c^{'}$ less than or equal to 1 and 0.008 cm^2/s for $\sigma_v^{'}/P_c^{'}$ greater than 1 based on five consolidation tests.

The calculated average value of c_v for SOLW in each zone is recommended to represent the c_v from the lab test. The final effective stress in SOLW under the load should be evaluated in order to assess the value of c_v, because the c_v is dependent on the stress level.

c_v from Field Settlement Test

The WB-13 settlement pilot study was conducted in 2005 to evaluate the settlement of SOLW under the constructed test fill. Field monitoring data collected by the piezometers and the settlement plates installed in the test pad were interpreted, and the results are presented in Attachment 4 of this package. The c_v of SOLW obtained from the field settlement test is plotted in Figure 39 as a function of time. The results indicate that the c_v of SOLW decreases with time from an upper range of 0.2 to 0.76 cm^2/s to a lower range of 0.06 to 0.13 cm^2/s. The average value of the c_v after 40 days, i.e., the relatively flat portion of the curve in Figure 39, was calculated to be 0.14 cm^2/s and is recommended to represent the c_v for SOLW in all three zones based on the field settlement test.

Comparison of c_v from Field Settlement Test and Lab Test

The results of c_v of SOLW from the field settlement test are about an order of magnitude higher than the lab values. The difference may be attributed to the fact that in the field test the drainage of water from SOLW may have been in both vertical and horizontal directions, while in the lab test the water was only allowed to drain vertically. The quicker the water was drained, the larger the value of c_v. Therefore, use of the c_v from the field test or the lab test in design depends on the actual loading condition. If the footprint of the load is relatively large and the consolidation of SOLW under the load can be considered one-dimensional (i.e., vertical drainage only), the c_v from the lab test is recommended for use in design. On the other hand, if the load is applied to a relatively small footprint and the drainage of water from SOLW can take place both vertically and horizontally, the c_v from the field test is recommended for use in design.

5.3 <u>Shear Strength Parameters</u>

5.3.1 Undrained Shear Strength Ratio

The undrained shear strength ratio (S_u/σ_3'), where σ_3' is the effective confining stress, was calculated based on the 2004, Phase I, and Phase II CU tests for SOLW. The results of S_u/σ_3' are plotted with respect to σ_3' measured from the lab in Figure 40. The lower bound of the S_u/σ_3' is estimated to be approximately 0.3 and the upper bound is estimated to be approximately 0.8 for SOLW in the three zones.

5.3.2 Undrained Shear Strength

The undrained shear strength (S_u) of SOLW was measured from the 2004, Phase I, and Phase II UU tests. The measured S_u is plotted with respect to depth in Figure 41 for SOLW in the three zones. The results are summarized in Table 16.

The S_u varies with depth. As indicated in Table 16, the average S_u was calculated to be 592 psf and 633 psf for SOLW in Zone 1 and Zone 2, respectively, at depths above 20 ft. The average S_u was calculated to be 1113 psf and 780 psf for SOLW in Zone 1 and Zone 2, respectively, at depths between 20 ft and 40 ft. The average S_u was calculated to be 719 psf and 899 psf for SOLW in Zone 2 and Zone 3, respectively, at depths below 40 ft. It is noted that the S_u values greater than 2000 psf were conservatively not included in the calculation of the average values.

An empirical correlation was also used to estimate the S_u. The equation of this empirical correlation [Kulhawy and Mayne, 1990] can be written as:

$$S_u = \left(\frac{S_u}{\sigma_v'}\right)_{NC} \cdot OCR^{0.8} \cdot \sigma_v'$$

where, $\left(\frac{S_u}{\sigma_v'}\right)_{NC}$ is the undrained shear strength ratio for normally consolidated soil. Using the OCR recommended in the previous section and $\left(\frac{S_u}{\sigma_v'}\right)_{NC}$ equal to 0.3, it appears that this empirical correlation predicts the measured S_u well for SOLW above approximately 45 ft, but it over-predicts the S_u below 45 ft.

Based on the measured S_u from the UU tests and the estimated S_u from the empirical correlation, the S_u for design (as shown in Figure 41) is recommend to be 600 psf for SOLW above 20 ft and 700 psf for SOLW between 20 ft and 30 ft. The S_u increases linearly to 1200 psf at a depth of 50 ft and 1400 psf at a depth of 80 ft.

5.3.3 Effective Stress Friction Angle

The effective stress friction angle (ϕ') was measured from the 2004, Phase I, and Phase II CU tests for SOLW. The calculated average ϕ' based on the lab test results is presented in Table 17. The effective stress cohesion c' was conservatively considered to be zero for SOLW. Based on the calculated average ϕ', a uniform value of ϕ' equal to 34° is conservatively recommended for design for SOLW in all three zones.

Only one CU test was performed on the foundation soil. The ϕ' was reported to be 18° and the c' was reported to be 1420 psf as shown in Table 17. As an alternative method, the empirical relationship between the ϕ' and the SPT N value shown in Table 18 [Kulhawy and Mayne, 1990] was used to estimate the ϕ'. Using an average SPT N value of 40 recommended in the previous section, the ϕ' of the foundation soil was estimated to be approximately 37°.

The ϕ' for the dike soil was also estimated by the same empirical relationship shown in Table 18. Using an average SPT N value of 36 recommended in the previous section, the ϕ' of the dike soil was estimated to be approximately 37°.

5.4 Hydraulic Conductivity

Five laboratory hydraulic conductivity tests were performed on SOLW samples during the 2004 investigation. In addition, four in-situ permeability tests (slug tests) were conducted in WB-13 during the 2004 investigation. The lab and field test results are presented together in Table 19.

The measured hydraulic conductivities for SOLW in Zone 2 and Zone 3 vary from 1.30×10^{-6} cm/s to 1.83×10^{-5} cm/s and the values are within the typical range of hydraulic conductivity for silt and silty clay materials (i.e., 10^{-7} to 10^{-9} m/s or 10^{-5} to 10^{-7} cm/s) as shown in Table 20. The average hydraulic conductivity was calculated to be 4.3×10^{-6} cm/s and 2.2×10^{-6} cm/s for SOLW in Zone 2 and Zone 3, respectively, based on the test results. The hydraulic conductivity of SOLW in Zone 1 is not available. Based on the observation that SOLW in Zone 1 consists of coarse particles and the excess water pressure dissipates relatively quickly during CPT, its hydraulic conductivity was estimated to be 10^{-5} cm/s, which is the lower bound for the silty sand material as shown in Table 20.

5.5 Recommended Material Properties For Design

Based on the discussion of material properties presented above, the recommended index properties, compressibility parameters, shear strength parameters, and hydraulic conductivity of SOLW, the dike soil, and the foundation soil for the SCA design are summarized in Table 21.

6. VERIFICATION OF SUBSURFACE MODEL AND DESIGN PARAMETERS

The subsurface model and the design material properties (i.e., unit weight and compressibility parameters) of SOLW were verified using the results of the WB-13 settlement pilot test performed in 2005.

The predicted primary consolidation settlement is plotted in Figure 42 with respect to the settlement measured on January 10, 2008 (i.e., approximately 2.3 years after the placement of the test fill) from the field test as presented in Attachment 4. The plotted data points are in general close to the 45 degree line, indicating a good agreement between the predicted settlement and the settlement from the field test. In addition, the time rate of the consolidation settlement was also evaluated using the average c_v value from the field measurements. It is noted that this value is an order of magnitude higher than the c_v values from lab tests. The results of the predicted primary settlement are plotted with respect to time and compared with the field monitoring data in Figures 43, 44, 45, and 46 at four different locations. The comparison also shows a good agreement between the predicted and field measured time rate of the consolidation settlement. Detailed descriptions of the methodology and the engineering calculation of the primary consolidation settlement and the time rate consolidation are presented in Attachment 4.

7. REFERENCE

AASHTO (1988). “Manual on Subsurface Investigations”, Washington, D.C., American Association of State Highway Transportation Officials.

Kulhawy, F.H. and Mayne, P.W. (1990). “Manual on Estimating Soil Properties for Foundation Design”, EPRI EL-6800, Project 1493-6, August 1990.

Parsons and Geosyntec (2008a). “Onondaga Lake Pre-Design Investigation: Wastebed 13 Settlement Pilot Study Data Summary Report”, Onondaga County, New York.

Parsons (2008b). “Wastebed 13 Settlement Pilot Study Monitoring Data – Year 2”.

Parsons (2008c). “Draft Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report”.

Parsons (2009). “Draft Onondaga Lake Pre-Design Investigation Phase III Data Summary Report”.

Tables

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

Table 1. Summary of SPT N Values

Material		SPT N Values		
		Range	Average	Standard Deviatio n
SOLW	Zone 1	0 - 74	17	16
	Zone 2	0 - 18	1	2
	Zone 3	0 - 68	8	11
Dike Soil		5 - 127	36	22
Foundation Soil		2 - 120	40	23

Table 2. Correlation of Consistency for Cohesive Soils [AASHTO, 1988]

SPT N Value	Consistency
0~1	Very soft
2~4	Soft
5~8	Medium Stiff
9~15	Stiff
16~30	Very Stiff
31~60	Hard
>60	Very hard

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

Table 3. Correlation of Relative Density for Granular Soils [AASHTO, 1988]

SPT N Value	Relative Density
0~4	Very loose
5~10	Loose
11~24	Medium Dense
25~50	Dense
>50	Very dense

Table 4. Summary of GWT Data from Piezometers
[Based on data provided in Attachment 2]

Piezometer Location	Serial Number	Date Installed	Depth to Piezometer Tip from Ground Surface (ft)	Initial Ground Surface Elevation (ft)	Piezometer Tip Elevation (ft)	Type	Average GWT Depth (ft, bgs)	Average GWT Elevation (ft)	GWT Variation (ft)
Wastebed Piezometers									
SB915-PZ13-01S	06-20309	11/10/2006	19.5	430.89	411.39	Typ VW	16.4	414.5	>9.5
SB915-PZ13-01D	06-19784	11/10/2006	39.5	430.89	391.39	Typ VW	30.8	400.1	N/A
SB915-PZ13-01N	06-19773	11/9/2006	63.5	430.89	367.39	Typ VW	57.4	373.5	3.6
SB915-PZ13-02I	06-20310	11/8/2006	19.9	430.34	410.44	Typ VW	16.4	414.0	>11.4
SB915-PZ13-02D	06-20305	11/8/2006	36.5	430.34	393.84	Typ VW	35.7	394.7	>1.5
SB915-PZ13-02N	06-19778	11/7/2006	50	430.34	380.34	Typ VW	44.3	386.0	>10.6
SB915-PZ13-03S	06-20308	11/14/2006	20.5	429.17	408.67	Typ VW	11.1	418.1	>12.3
SB915-PZ13-03I	06-19786	11/13/2006	40.2	429.17	388.97	Typ VW	24.8	404.3	23.8
SB915-PZ13-03D	06-19775	11/13/2006	59.5	429.17	369.67	Typ VW	28.8	400.3	29.2
SB915-PZ13-04S	06-19781	11/20/2006	15.5	419.10	403.60	Typ VW	6.1	413.0	>14.1
SB915-PZ13-04I	06-19774	11/20/2006	35.5	419.10	383.60	Typ VW	11.8	407.3	25.4
SB915-PZ13-04D	06-19776	11/17/2006	52.5	419.10	366.60	Typ VW	14.2	404.9	24.6
SB915-PZ13-04N	NA	11/16/2006	113	418.6	305.6	SP	44.2	374.4	3.1
SB915-PZ13-05S	06-20311	11/6/2006	14.8	432.94	418.14	Typ VW	11.8	421.1	N/A
SB915-PZ13-05I	06-19785	11/3/2006	35	432.94	397.94	Typ VW	30.8	402.1	>6.8
SB915-PZ13-05N	06-19772	11/3/2006	56	432.94	376.94	Typ VW	47.4	385.5	>13.4
SB915-PZ13-06S	06-20307	11/7/2006	19.5	428.67	410.5	Typ VW	13.4	415.2	>9.1
SB915-PZ13-06I	06-20306	11/6/2006	34.5	428.67	395.5	Typ VW	19.7	409.0	>10.7
SB915-PZ13-06D	06-19771	11/6/2006	49.5	428.67	380.5	Typ VW	28.6	400.1	29.7
SB915-PZ13-06N	06-19769	11/3/2006	64	428.67	366	Typ VW	53.8	374.8	4.6
Dike Piezometers									
SB915-PZ13-07	06-19782	11/14/2006	54	438.23	384.23	Typ VW	53.1	385.1	0.8
SB915-PZ13-08	NA	11/27/2006	40	431.35	391.35	SP	39.8	391.5	>0.0
SB915-PZ13-09	06-19783	11/16/2006	36.5	432.48	395.98	Typ VW	36.1	396.4	>0.8
SB915-PZ13-10	NA	11/29/2006	32	397.45	365.45	SP	24.3	373.2	4.0
SB915-PZ13-11	06-19787	11/17/2006	41	432.44	391.44	Typ VW	40.7	391.7	>0.4
SB915-PZ13-12	NA	11/28/2006	25	431.51	406.51	SP	22.9	408.7	>9.9
SB915-PZ13-13	06-19779	11/21/2006	30	434.26	404.26	Typ VW	26.2	408.0	5.2
SB915-PZ13-14	06-19780	11/27/2006	30	443.67	413.67	Typ VW	19.8	423.9	15.1
SB915-PZ13-15	06-19770	11/29/2006	30	446.56	416.56	Typ VW	22.6	423.9	13.1
SB915-PZ13-16	NA	11/22/2006	30	441.08	411.08	SP	17.1	424.0	10.4

Notes:
Typ VW = Typical Vibrating Wire Piezometer (GeoKon model 4500S)
SP = Standpipe
NA = Not Applicable

Notes:

1. Piezometers inside WB-13 that were screened in natural soil underneath SOLW are highlighted in the table.
2. Piezometers inside WB-13 with S (shallow), I (intermediate), and D (deep) at the end of their names were screened in SOLW and with N (native) at the end of their names were screened in the natural soil underneath SOLW.
3. Results of GWT depths and elevations presented in this table were calculated based on the piezometer data as of December 28, 2007.

Table 5. Record of Groundwater Level Elevations Measured at Piezometer SB915-PZ13-02N

SB915-PZ13-02N Serial # 06-19778

Typical Vibrating Wire Piezometer

Date Installed: 11/7/2006

Bentonite Seal =	0 to 48.1	ft
Sandpack =	48.1 to 50.5	ft
Depth to Piezometer Tip from Ground Surface =	50	ft
Ro =	8954.3	
To =	11.6	degrees Celsius
Linear Gage Factor (psi) =	0.01583	psi/digit
Thermal Factor =	0.00182	psi/°C
Unit Weight of Water =	62.4	pcf
Initial Ground Surface Elevation =	430.34	ft
Piezometer Tip Elevation =	380.34	ft

Note:

A blank entry in the piezometric elevation column indicates the calculated elevation is below the piezometer tip.

Date and Time	R	T (°C)	Pressure (psi)	ft- water	Piezometric Level as Depth Below Original Ground Surface (ft)	Piezometric Elevation (ft)
12/7/06 13:16	8921	11.9	0.5	1.2	48.8	381.6
12/14/06 11:21	8900	11.9	0.9	2.0	48.0	382.3
12/21/06 12:01	8863.5	11.9	1.4	3.3	46.7	383.7
12/28/06 11:56	8839.3	11.9	1.8	4.2	45.8	384.5
1/11/07 13:08	8786.6	11.9	2.7	6.1	43.9	386.5
2/8/07 11:49	8807.4	11.9	2.3	5.4	44.6	385.7
3/9/07 9:48	8811.7	11.8	2.3	5.2	44.8	385.5
4/12/07 10:26	8643.3	11.8	4.9	11.4	38.6	391.7
5/10/07 14:41	8630.8	11.7	5.1	11.8	38.2	392.2
6/21/07 11:43	8755	11.7	3.2	7.3	42.7	387.6
7/12/07 11:24	8769.5	11.7	2.9	6.8	43.2	387.1
8/15/07 11:46	8847.2	11.7	1.7	3.9	46.1	384.2
9/21/07 11:31	8977.5	11.7	-0.4	-0.8	>=50 ft	
10/26/07 11:55	8981.5	11.7	-0.4	-1.0	>=50 ft	
11/28/07 10:16	8982.7	11.7	-0.4	-1.0	>=50 ft	
12/28/07 11:30	8966.1	11.7	-0.2	-0.4	>=50 ft	

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

Table 6. Record of Groundwater Level Elevations Measured at Piezometer SB915-PZ13-05N

SB915-PZ13-05N Serial # 06-19772

Typical Vibrating Wire Piezometer

Date Installed: 11/3/2006

Bentonite Seal =	0 to 54	ft
Sandpack =	54 to 56.5	ft
Depth to Piezometer Tip from Ground Surface =	56	ft
Ro =	9073.3	
To =	6	degrees Celsius
Linear Gage Factor (psi) =	0.01666	psi/digit
Thermal Factor =	0.01085	psi/°C
Unit Weight of Water =	62.4	pcf
Initial Ground Surface Elevation =	432.94	ft
Piezometer Tip Elevation =	376.94	ft

Note:

A blank entry in the piezometric elevation column indicates the calculated elevation is below the piezometer tip.

Date and Time	R	T (°C)	Pressure (psi)	ft- water	Piezometric Level as Depth Below Original Ground Surface (ft)	Piezometric Elevation (ft)
12/7/06 14:03	8837.8	11.3	4.0	9.2	46.8	386.1
12/14/06 11:53	8814.6	11.3	4.4	10.1	45.9	387.0
12/21/06 12:44	8818.3	11.3	4.3	9.9	46.1	386.9
12/28/06 12:24	8797.6	11.3	4.7	10.7	45.3	387.7
1/11/07 13:42	8696	11.5	6.3	14.6	41.4	391.6
2/8/07 12:03	8713.2	11.3	6.1	14.0	42.0	390.9
3/9/07 10:04	9034.3	11.3	0.7	1.6	54.4	378.6
4/12/07 10:46	8735.7	11.3	5.7	13.1	42.9	390.1
5/10/07 15:05	8733	11.3	5.7	13.2	42.8	390.2
6/21/07 12:32	8978.9	11.3	1.6	3.8	52.2	380.7
7/12/07 12:27	9044.4	11.3	0.5	1.2	54.8	378.2
8/15/07 12:36	9118.5	11.3	-0.7	-1.6	>=56 ft	
9/21/07 12:02	9117	11.3	-0.7	-1.5	>=56 ft	
10/26/07 12:23	9121.3	11.1	-0.7	-1.7	>=56 ft	
11/28/07 10:46	9126.1	11.1	-0.8	-1.9	>=56 ft	
12/28/07 10:55	9034.2	11.1	0.7	1.6	54.4	378.6

Table 7. Summary of 2004 CPT Porewater Dissipation Tests [Parsons and Geosyntec, 2008a]

ESTIMATED WATER TABLE ELEVATIONS FROM PORE WATER DISSIPATION TESTS

CPT Location	Measurement Depth (ft below waste surface)	Estimated Water Table Depth (ft below waste surface)	CPT Location	Measurement Depth (ft below waste surface)	Estimated Water Table Depth (ft below waste surface)
PW-128	68.9	49.6	**PW-13D**	86.5	49.6
PW-107	67.1	49.6	**PW-12B**	66.4	49.6
PW-140	49.4	49.6	**PW-131**	79.4	49.6
PW-13A	14.3 35.3 80.2	8 18.1 52.6	**PW-12E**	61.7	49.6
PW-11D	78.7	49.6	**PW-113**	Not Available	Not Available
PW-10B	Not Available	Not Available	**PW-119**	20.5 36.6 50.0 56.0	9.3 15.6 46.2 48.5
PW-122	52.8	41.4	**PW-10A**	64.0	52.1
PW-11F	64.6	50.4	**PW-11C**	Not Available	Not Available
PW-134	44.3	49.6	**PW-125**	75.1	50.8
PW-116	Not Available	Not Available	**PW-137**	80.2	51.9

Note: The water table depths listed were estimated by ConeTec, and at many locations the depth to water represents perched water, and not the regional water table.

Table 8. Summary of Phase I CPT Porewater Dissipation Tests [Parsons and Geosyntec, 2008a)]

Phase I Pre-Design Investigation
Estimated Water Table Levels from CPT Pore Water Pressure Dissipation Tests

CPTu Location	Measurement Depth (ft below waste surface)	Estimated Water Table Depth (ft below waste surface)
SB915-CPT-2	80.05	58.59
SB915-CPT-3	80.05	58.96
SB915-CPT-A3	15.09	16.58
	27.07	21.93
	30.02	26.54
	79.4	58.98
SB915-CPT-A4	80.05	59.04
SB915-CPT-A5	45.44	41.27
SB915-CPT-A7	73.82	59.37
SB915-CPT-A8	80.05	57.69
SB915-CPT-A9	80.05	58.56
SB915-CPT-A11	46.42	41.22

Note:
The water table depths listed were estimated by ConeTec, and at many locations the depth to water represents perched water, and not the regional water table.

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

Table 9. Summary of Phase II CPT Porewater Dissipation Tests [Parsons, 2008c]

Phase II Pre-Design Investigation
Estimated Water Table Elevations from Pore Water Pressure Dissipation Tests

Location	Dissipation Test Depth (ft)	Estimated Water Head at Equilibrium (ft)	Estimated Water Table Depth (ft)[1]
SB915-CPT-17	15.42	0.00	15.42
SB915-CPT-17	30.68	0.00	30.68
SB915-CPT-17	40.52	0.00	40.52
SB915-CPT-22	15.09	0.83	14.26
SB915-CPT-22	30.02	0.60	29.42
SB915-CPT-22	45.11	4.73	40.38
SB915-CPT-22	54.79	7.37	47.42
SB915-CPT-27	15.09	0.61	14.48
SB915-CPT-27	30.02	2.42	27.6
SB915-CPT-27	41.5	NA[2]	NA[2]
SB915-CPT-28	16.57	0.00	16.57
SB915-CPT-28	27.89	0.00	27.89
SB915-CPT-33	15.09	0.00	15.09
SB915-CPT-33	30.02	0.72	29.3
SB915-CPT-33	45.11	NA[2]	NA[2]
SB915-CPT-33	54.63	0.30	54.33
SB915-CPT-40	15.09	0.00	15.09
SB915-CPT-40	30.02	NA[2]	NA[2]
SB915-CPT-40	46.1	NA[2]	NA[2]
SB915-CPT-45	15.09	NA[2]	NA[2]
SB915-CPT-45	30.02	1.06	28.96
SB915-CPT-45	45.11	5.00	40.11
SB915-CPT-45	65.29	3.60	61.69
SB915-CPT-49	15.09	1.21	13.88
SB915-CPT-49	30.02	4.00	26.02
SB915-CPT-49	45.11	9.00	36.11
SB915-CPT-49	73.98	16.06	57.92
SB915-CPT-50	78.25	18.20	60.05
SB915-CPT-51	15.58	NA[2]	NA[2]
SB915-CPT-51	31.17	1.05	30.12
SB915-CPT-51	49.21	0.00	49.21
SB915-CPT-51	55.77	NA[2]	NA[2]
SB915-CPT-51	65.62	7.58	58.04
SB915-CPT-53	73.82	17.00	56.82
SB915-CPT-55	91.86	32.76	59.1
SB915-CPT-59	25.43	2.63	22.8
SB915-CPT-59	40.35	6.00	34.35
SB915-CPT-59	55.94	6.67	49.27
SB915-CPT-59	89.73	24.09	65.64
SB915-CPT-59A	93.5	27.58	65.92
SB915-CPT-64	15.09	0.60	14.49
SB915-CPT-64	30.18	10.00	20.18
SB915-CPT-64	45.11	12.00	33.11
SB915-CPT-64	73.65	21.52	52.13
SB915-CPT-71	15.09	0.00	15.09
SB915-CPT-71	30.02	10.00	20.02
SB915-CPT-71	45.11	NA[2]	NA[2]
SB915-CPT-71	67.42	21.82	45.6
SB915-CPT-74	80.54	22.42	58.12
SB915-CPT-78	15.09	1.43	13.66
SB915-CPT-78	30.02	3.00	27.02
SB915-CPT-78	45.11	8.00	37.11
SB915-CPT-78	75.79	21.25	54.54
SB915-CPT-80	63.16	13.75	49.41
SB915-CPT-81	55.12	0.00	55.12
SB915-CPT-82	15.09	NA[2]	NA[2]
SB915-CPT-82	30.02	1.52	28.5
SB915-CPT-82	45.6	0.00	45.6
SB915-CPT-82	62.01	8.40	53.61
SB915-CPT-86	64.3	8.03	56.27
SB915-CPT-87	74.31	17.27	57.04

Notes:

1. The water table depths were estimated from the water heads at equilibrium, which were interpreted from the pore water dissipation tests. It should be noted that in many cases a perched water zone, not the regional water table, is identified through this interpretation process.
2. NA indicates the water table depth is not available because the pore water pressure did not reach equilibrium within a reasonable timeframe (i.e., by the end of the test) or the water head at equilibrium was negative (i.e., the probe was above the water table).

Table 10. Summary of GWT Data Measured from Borings in WB-13 during 2004 Investigation

Boring ID	Boring Location	Boring Depth (ft, bgs)	GWT Depth (ft, bgs)[1]
SB915-SB-01	Toe of WB-13 dike	30	4.5
SB915-SB-02	Crest of WB-13 dike	50	18, 28, 36, 38
SB915-SB-03	Toe of WB-13 dike	30	23.3
SB915-SB-04	Crest of WB-13 dike	66	4, 54
SB915-SB-05	Toe of WB-13 dike	62	N/A
SB915-SB-06	Crest of WB-13 dike	68	38, 56
SB915-SB-07	Toe of WB-13 dike	30	6, 20
SB915-SB-08	Crest of WB-13 dike	68	28, 56.6
SB915-SB-09	Toe of WB-13 dike	30	18
SB915-SB-10	Crest of WB-13 dike	68	60
SB915-SB-21	In WB-13	52.4	N/A
SB915-SB-22	In WB-13	76	1
SB915-SB-23	Crest of WB-13 dike	50	N/A
SB915-SB-24	Crest of WB-13 dike	46	N/A
SB915-SB-25	Crest of WB-13 dike	50	N/A
SB915-PZ-01	In WB-13	60	10
SB915-PZ-02	In WB-13	86	10, 73.5

Note:

[1]. The GWT depth at the toe of WB-13 dike is measured with respect to the ground surface at the toe, which is approximately 40 ft lower than the ground surface at the crest of WB-13 and in WB-13. Therefore, for an example, the GWT depth measured at Boring SB915-SB-01 (i.e., 4.5 ft) would become 44.5 ft with respect to ground surface in WB-13.

Table 11. Summary of Water Content

Material		Water Content (%)		
		Range	Average	Standard Deviation
SOLW	Zone 1	64 - 367	166	80
	Zone 2	10 - 912	227	103
	Zone 3	5 - 294	172	63
	All 3 Zones	5 - 912	212	99
Dike Soil		3 - 83	13	10
Foundation Soil		4 - 66	16	12

Note:

The water contents in this table include the water contents from the index property tests, the UU tests, and the CU tests.

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

Table 12. Summary of Atterberg Limits

Material		Plastic Limit			Liquid Limit			Plasticity Index		
		Range	Average	Standard Deviation	Range	Average	Standard Deviation	Range	Average	Standard Deviation
SOLW	Zone 1	68 - 167	109	27	80 - 241	145	41	12 -74	36	16
	Zone 2	62 - 245	139	36	89 - 227	168	35	27 - 127	55	20
	Zone 3	89 - 199	130	38	91 - 234	150	53	22 - 138	69	41
	All 3 Zones	62 - 245	131	36	80 - 241	160	40	12 - 138	53	26
Dike Soil		11 - 49	20	8	10 - 66	19	11	6 - 17	10	3
Foundation Soil		10 - 53	26	11	13 - 57	29	15	3 - 30	11	7

Table 13. Summary of Total Unit Weight from Lab Tests

Soil		Total Unit Weight (pcf)		
		Range	Average	Standard Deviation
SOLW	Zone 1	69 - 108	84	10
	Zone 2	55 - 139	82	13
	Zone 3	68 - 101	82	8
	All 3 Zones	55 - 139	82	12
Foundation Soil		118 - 124	121	3

Table 14. Summary of Modified Compression Index of SOLW ($C_{c\varepsilon}$)

SOLW	Modified Compression Index		
	Number of tests	Range	Average
Zone 1	7	0.15~0.50	0.34
Zone 2	25	0.21~0.71	0.46
Zone 3	5	0.21~0.46	0.38

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

Table 15. Summary of Modified Recompression Index of SOLW ($C_{r\varepsilon}$)

SOLW	Modified Recompression Index		
	Number of tests	Range	Average
Zone 1	7	0.010~0.020	0.015
Zone 2	25	0.004~0.025	0.014
Zone 3	5	0.003~0.034	0.021

Table 16. Summary of Undrained Shear Strength of SOLW from UU Tests

Depth	Undrained Shear Strength of SOLW (psf)					
	Zone 1		Zone 2		Zone 3	
	Range	Average	Range	Average	Range	Average
0~20 ft	444~767	592	527~748	633	N/A	
20~40 ft	916~1431	1113	419~1353	780	N/A	
>40 ft	N/A		719	719	320~1479	899

Note:

Undrained shear strength values that are greater than 2000 psf are not included in this table.

Table 17. Summary of Average Effective Stress Friction Angles

Material		Effective Stress Friction Angle (degree)	Effective Stress Cohesion (psf)
SOLW (Lab Tests)	Zone 1	34	0
	Zone 2	42	0
	Zone 3	46	0
Foundation Soil	Lab (one test)	18	1420
	Correlation (SPT N)	37 (N=40)	0
Dike Soil	Correlation (SPT N)	37 (N=36)	0

Table 18. Empirical Relationship Between ϕ' and SPT N value [Kulhawy and Mayne, 1990]

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.

Table 19. Hydraulic Conductivity of SOLW [Parsons and Geosyntec, 2008a]

		Boring Location	Sample Depth (ft)	Hydraulic Conductivity (cm/s)	Average Hydraulic Conductivity[1] (cm/s)
Zone 2	Lab Test	PZ-01	10 - 12	1.54E-05	4.3E-06
		PZ-02	56 - 58	3.34E-06	
		SB-21	10 - 12	8.58E-06	
		SB-22	20 - 22	1.83E-05	
	Field Test	PZ-02 I	N/A	1.30E-06	
		PZ-02 D	N/A	1.30E-06	
		PZ-13 P3-1	N/A	1.40E-06	
		PZ-13 C-1	N/A	6.30E-06	
Zone 3	Lab Test	PZ-01	44 - 46	2.24E-06	2.2E-06

Note:
[1]. Logarithmic average value was calculated.

Table 20. Typical Value of Hydraulic Conductivity [Kulhawy and Mayne, 1990]

COEFFICIENT OF PERMEABILITY

Soil	Coefficient of Permeability, k (m/sec)	Relative Permeability
gravel	$> 10^{-3}$	high
sandy gravel, clean sand, fine sand	10^{-3} to 10^{-5}	medium
sand, dirty sand, silty sand	10^{-5} to 10^{-7}	low
silt, silty clay	10^{-7} to 10^{-9}	very low
clay	$< 10^{-9}$	practically impermeable

Source: Based on Terzaghi and Peck (1).

Note: The unit of hydraulic conductivity in this table is m/s.

Table 21. Recommended Material Properties for SCA Design

Material		Index Property						Shear Strength		Compressibility						SPT N Value	Hydraulic Conductivity (cm/s)
		Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Specific Gravity	Total Unit Weight (pcf)	Effective Stress Friction Angle (degree)	Undrained Shear Strength (psf)	Overconsolidation Ratio	Modified Compression Index	Modified Recompression Index	Coefficient of Secondary Compression	Coefficient of Consolidation (cm^2/s) [1]			
														From Lab Tests	From Field Test		
SOLW	Zone 1	166	145	109	36	2.51	82	34	600 for $D \le 20$ ft 700 for D=20-30 ft Increases linearly to 1,200 at D=50 ft and 1,400 at D=80 ft	4.5 for D=0~10 ft 2.0 for D=10~20 ft 1.0 for D>20 ft	0.34	0.015	0.13% for $\sigma'_v/P'_c \le 1.0$ 0.83% for $\sigma'_v/P'_c > 1.0$	0.047 for $\sigma'_v/P'_c \le 1.0$ 0.029 for $\sigma'_v/P'_c > 1.0$	N/A	17	1.0x10^{-5} [2]
	Zone 2	227	168	139	55						0.46	0.014	0.11% for $\sigma'_v/P'_c \le 1.0$ 0.91% for $\sigma'_v/P'_c > 1.0$	0.046 for $\sigma'_v/P'_c \le 1.0$ 0.009 for $\sigma'_v/P'_c > 1.0$	0.14	1	4.3x10^{-6}
	Zone 3	172	150	130	69						0.38	0.021	0.07% for $\sigma'_v/P'_c \le 1.0$ 0.70% for $\sigma'_v/P'_c > 1.0$	0.024 for $\sigma'_v/P'_c \le 1.0$ 0.008 for $\sigma'_v/P'_c > 1.0$		8	2.2x10^{-6}
Dike Soil		13	19	20	10	2.71	120	37	N/A	N/A	N/A	N/A	N/A	N/A		36	N/A
Foundation Soil		16	29	26	11	2.65	120	37	N/A	N/A	N/A	N/A	N/A	N/A		40	N/A

Notes:

[1]. Coefficient of consolidation obtained from the lab tests are recommended to be used for loading with relatively large footprint compared to the thickness of SOLW, where consolidation of SOLW can be considered as one-dimensional (for example, under dredged material placed across the wastebed); Coefficient of consolidation obtained from the field tests are recommended to be used for loading with relatively small footprint compared to the thickness of SOLW, where consolidation of SOLW can be considered to take place in both vertical and horizontal directions (for examples, under berms and pre-load areas).

[2]. No test results are available for the hydraulic conductivity of SOLW in Zone 1. This value was estimated based on typical range of hydraulic conductivity for silty sand.

Figures

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

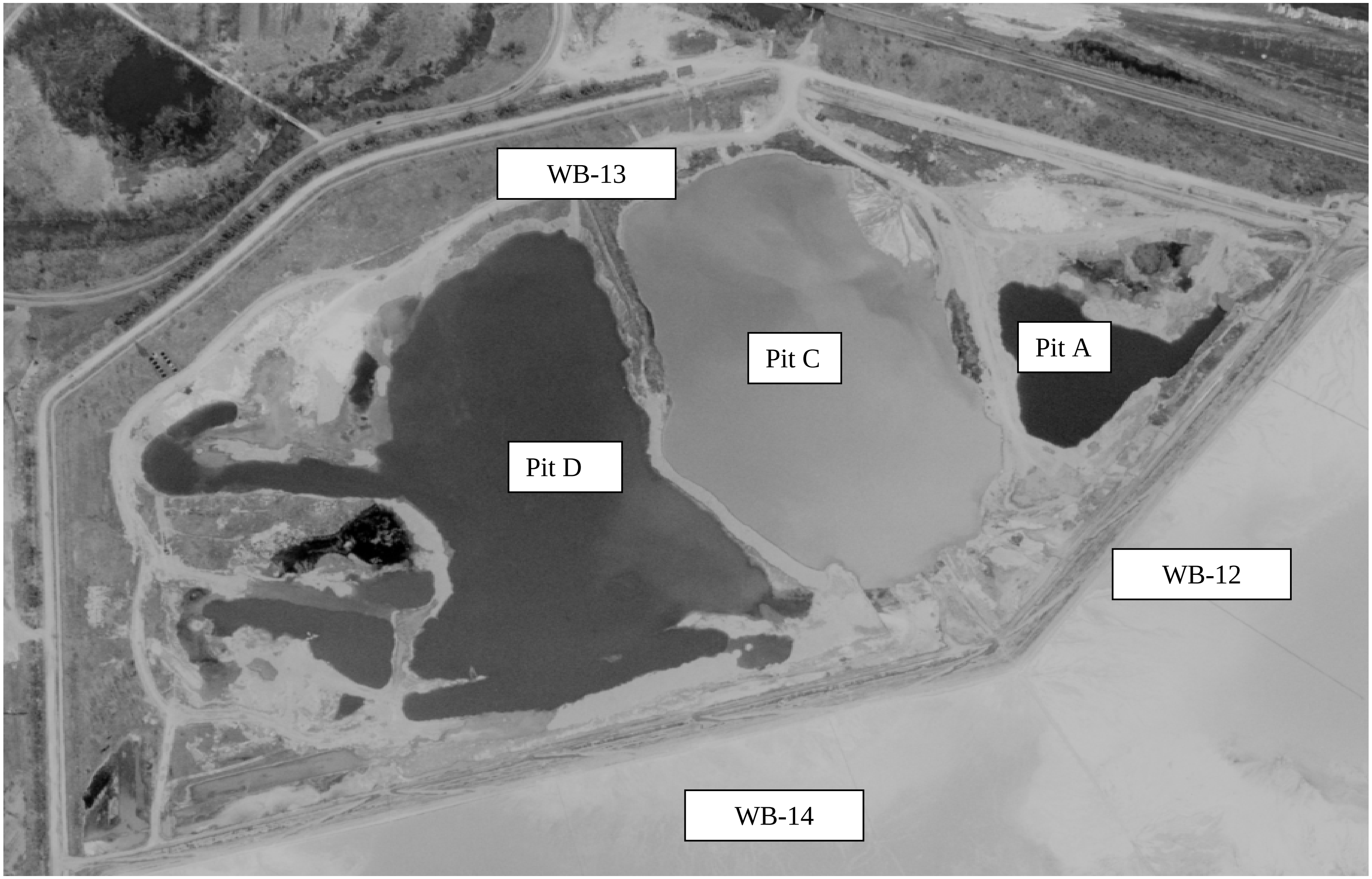


Figure 1. 1972 Aerial Photo Showing Three Pits

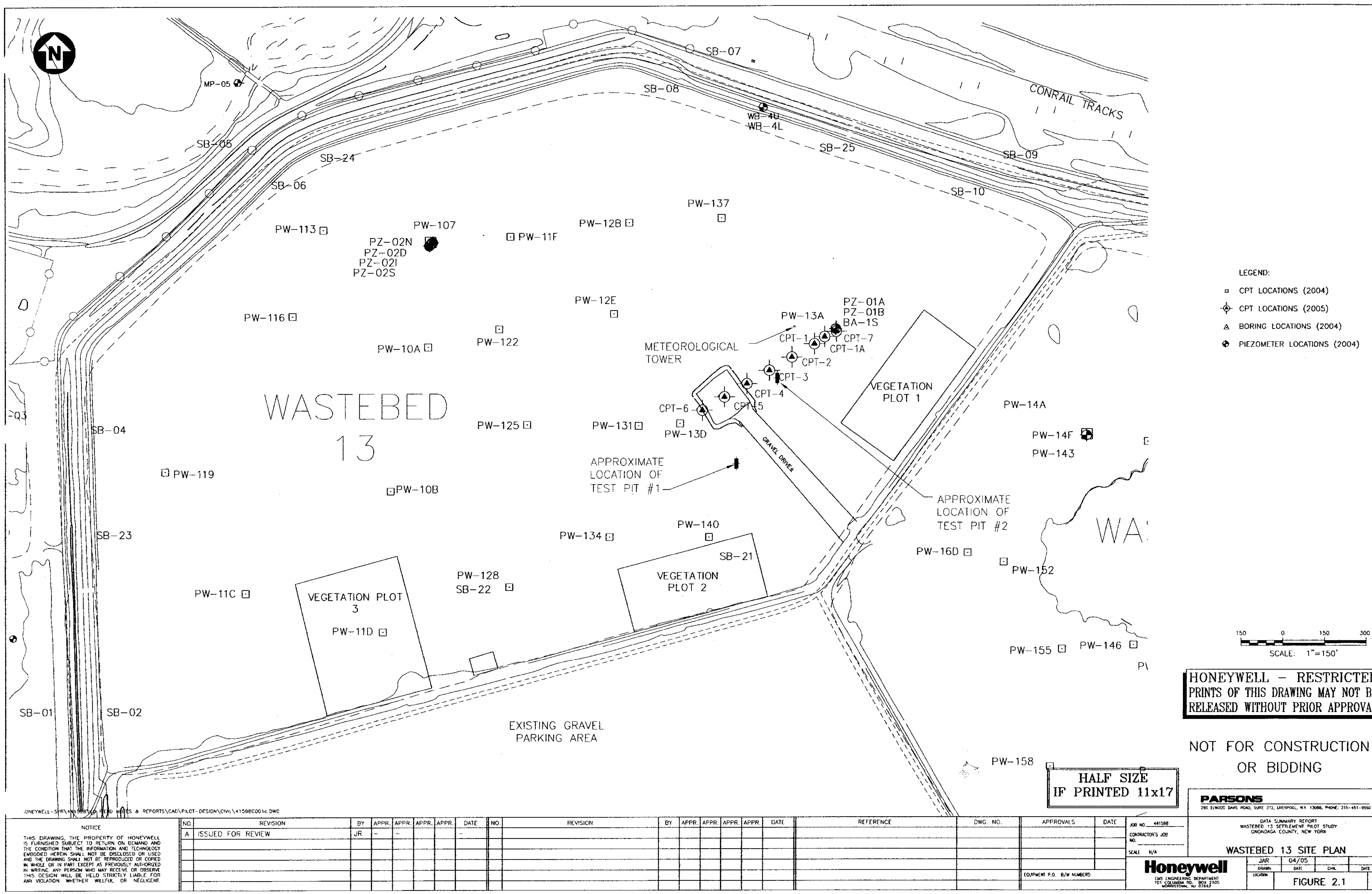
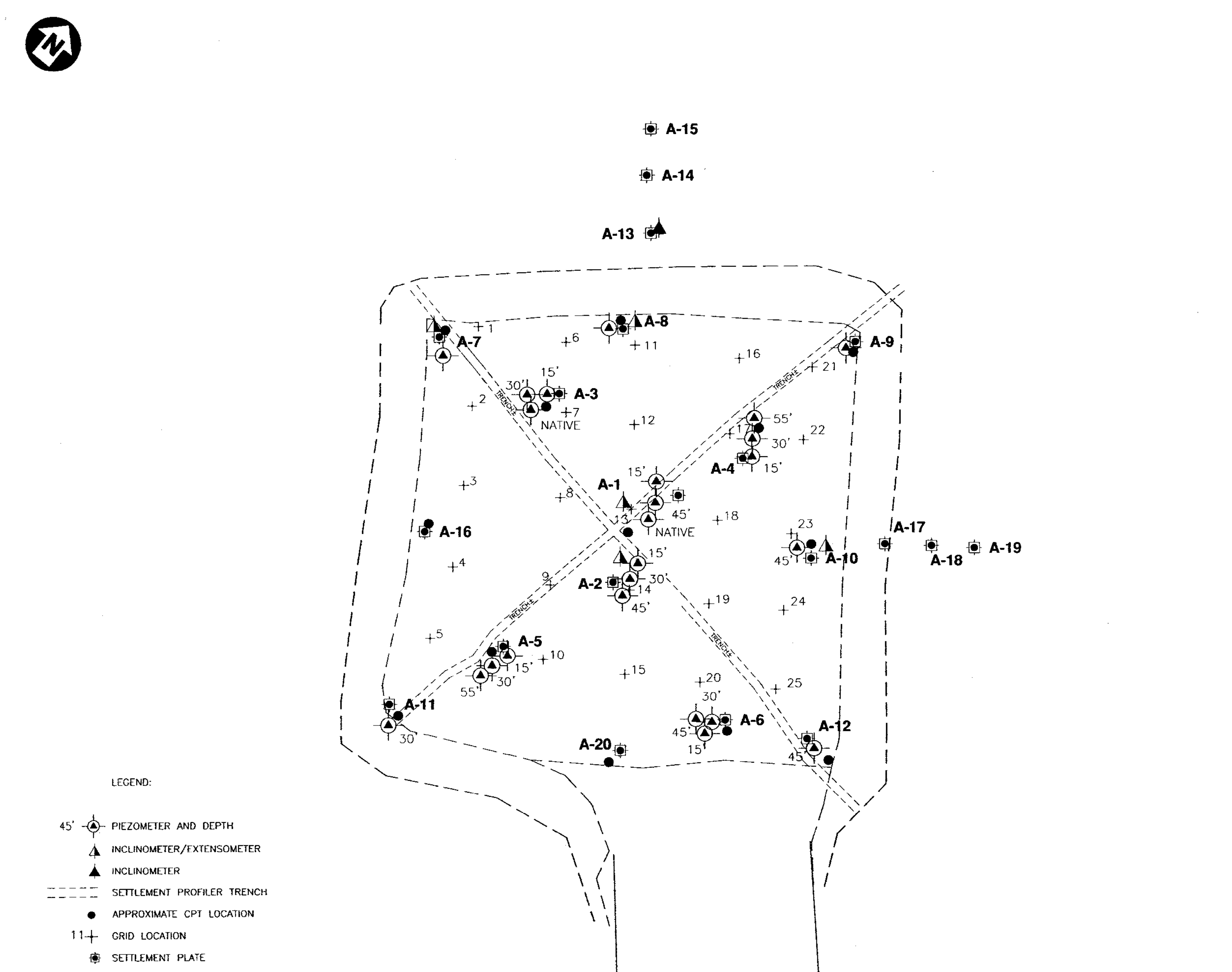


Figure 2. Locations of CPTs and Borings in 2004 and Phase I Site Investigations [Parsons and Geosyntec, 2008a]



LOCATION	CPT ID	INCLINOMETER/ EXTENSOMETER ID	PIEZOMETER ID [2]	SETTLEMENT PLATE
A-1	SB915-CPT-5	SB915-INEX-A1	SB915-PZ-A1(15') SB915-PZ-A1(45') SB915-PZ-A1(NATIVE)	SP-1
A-2		SB915-INEX-A2	SB915-PZ-A2(15') SB915-PZ-A2(30') SB915-PZ-A2(45')	SP-2
A-3	SB915-CPT-A3		SB915-PZ-A3(15') SB915-PZ-A3(30') SB915-PZ-A3(NATIVE)	SP-3
A-4	SB915-CPT-A4		SB915-PZ-A4(15') SB915-PZ-A4(30') SB915-PZ-A4(55')	SP-4
A-5	SB915-CPT-A5		SB915-PZ-A5(15') SB915-PZ-A5(30') SB915-PZ-A5(55')	SP-5
A-6	SB915-CPT-A6		SB915-PZ-A6(15') SB915-PZ-A6(30') SB915-PZ-A6(45')	SP-6
A-7	SB915-CPT-A7	SB915-INEX-A7	SB915-PZ-A7(15')	SP-7
A-8	SB915-CPT-A8	SB915-INEX-A8	SB915-PZ-A8(30')	SP-8
A-9	SB915-CPT-A9		SB915-PZ-A9(15')	SP-9
A-10	CB-915-CPT-4	SB915-INEX-A10	SB915-PZ-A10(45')	SP-10
A-11	SB915-CPT-A11		SB915-PZ-A11(30')	SP-11
A-12	SB915-CPT-A12		SB915-PZ-A12(45')	SP-12
A-13		SB915-IN-A13 [1]		SP-13
A-14				SP-14
A-15				SP-15
A-16	SB915-CPT-6			SP-16
A-17				SP-17
A-18				SP-18
A-19				SP-19
A-20	S915-CPT-A20			SP-20

NOTES:

1. ONLY AN INCLINOMETER WAS INSTALLED AT THIS LOCATION.

2. NUMBERS IN PARENTHESES AFTER IDs INDICATE THE PIEZOMETER TIP INSTALLATION DEPTH (i.e., FEET BELOW INITIAL GROUND SURFACE). NATIVE INDICATES PIEZOMETERS WERE INSTALLED IN THE NATIVE SOIL BENEATH THE SOLVAY WASTE.

SCALE: 1"=20'

HONEYWELL – RESTRICTED
PRINTS OF THIS DRAWING MAY NOT BE RELEASED WITHOUT PRIOR APPROVAL

NOT FOR CONSTRUCTION OR BIDDING

HALF SIZE IF PRINTED 11x17

PARSONS

TEST PLOT INSTRUMENTATION LAYOUT

Honeywell

FIGURE 2.2

Figure 3. Locations of CPTs and Borings in Test Pad in Phase I Site Investigation [Parsons and Geosyntec, 2008a]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

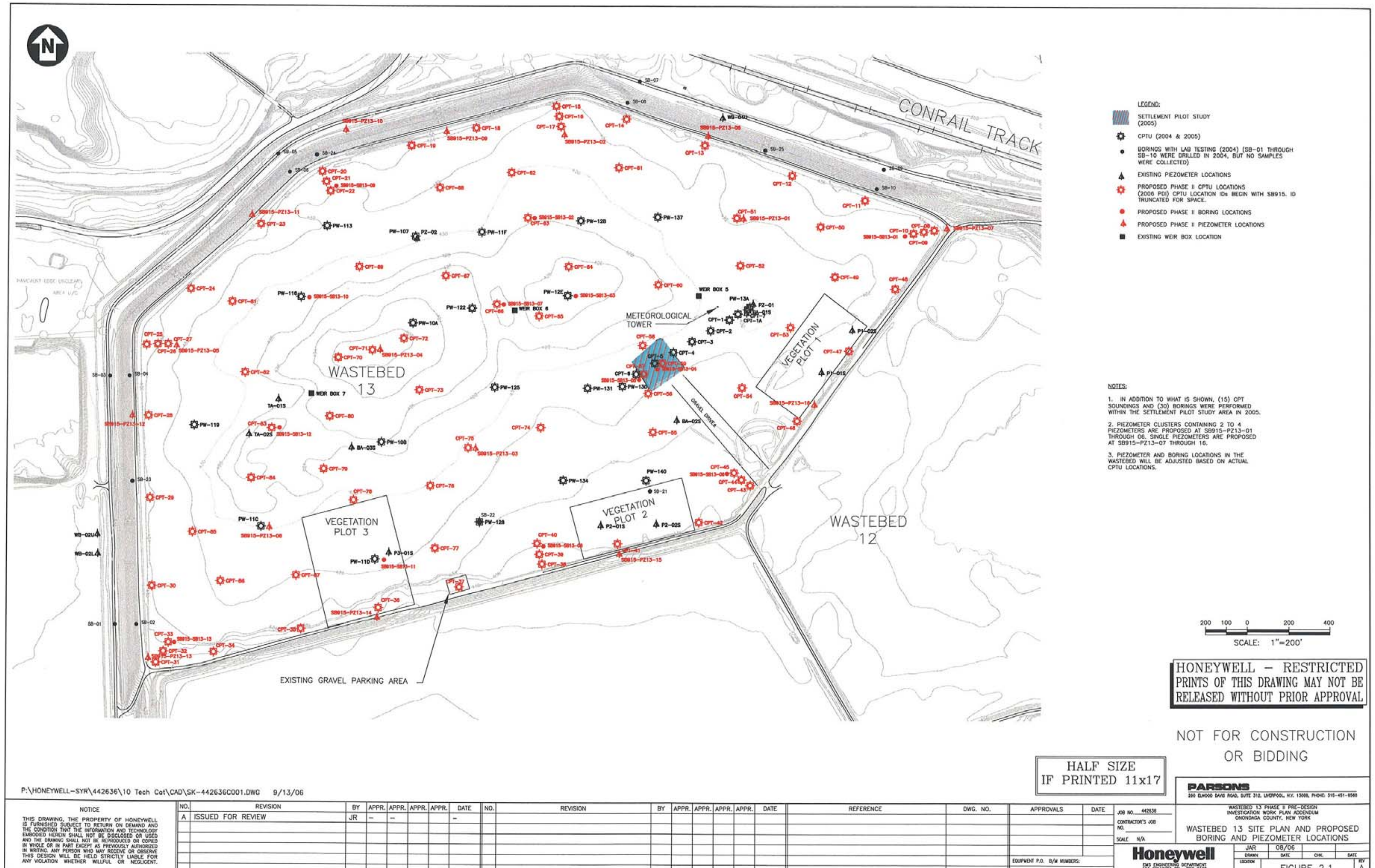


Figure 4. Locations of CPTs and Borings in Phase II Investigation [Parsons, 2008c]

Written by: Ming Zhu Date: 03/06/2008 Reviewed by: R. Kulasingam/Jay Beech Date: 03/06/2008

Client: Honeywell Project: Onondaga Lake SCA IDS Project/ Proposal No.: GD3944 Task No.: 04

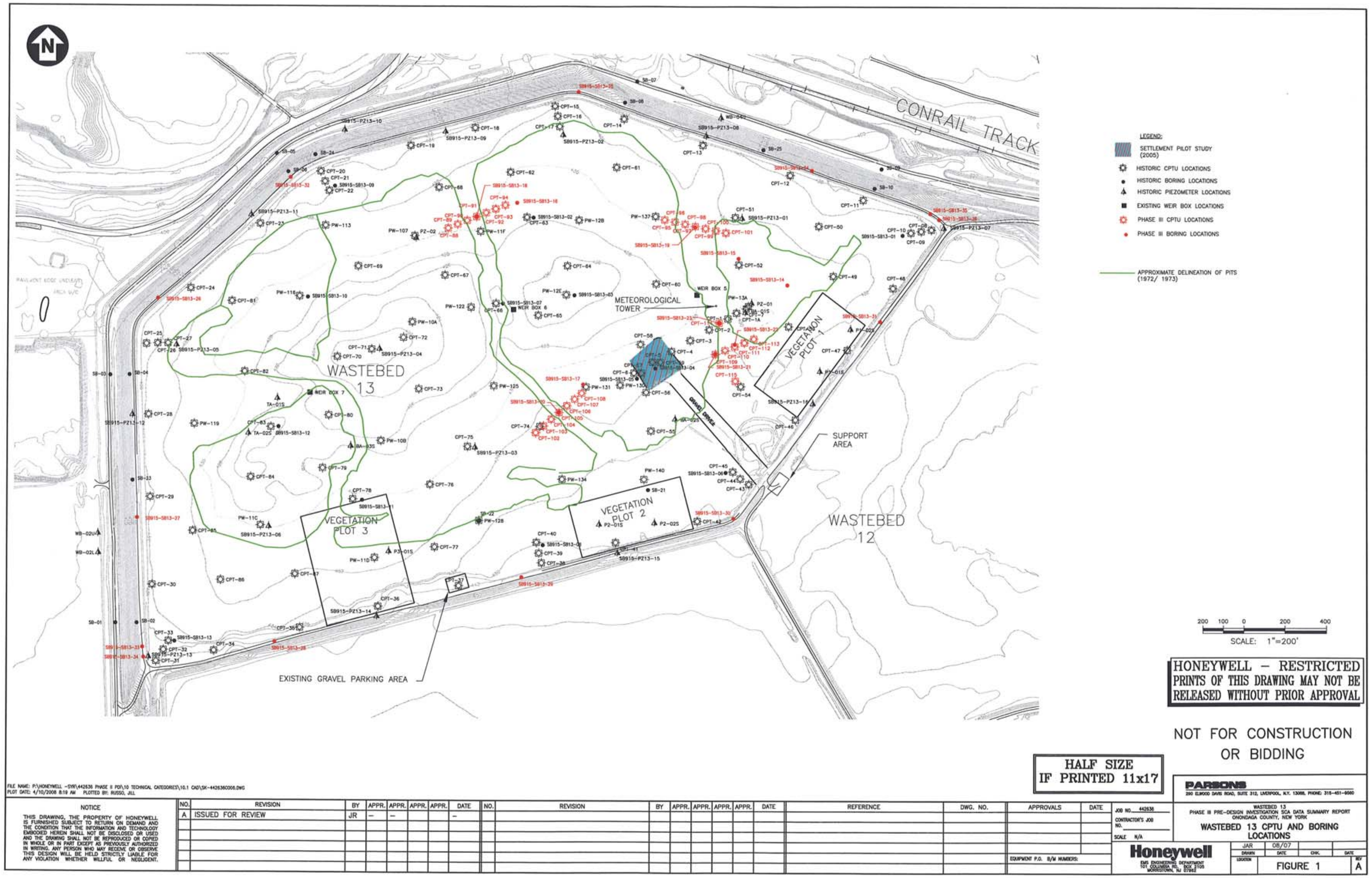


Figure 5. Locations of CPTs and Borings in Phase III Site Investigation
(in addition to the CPTs and borings from Phase I and II site investigations) [Parsons, 2009]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

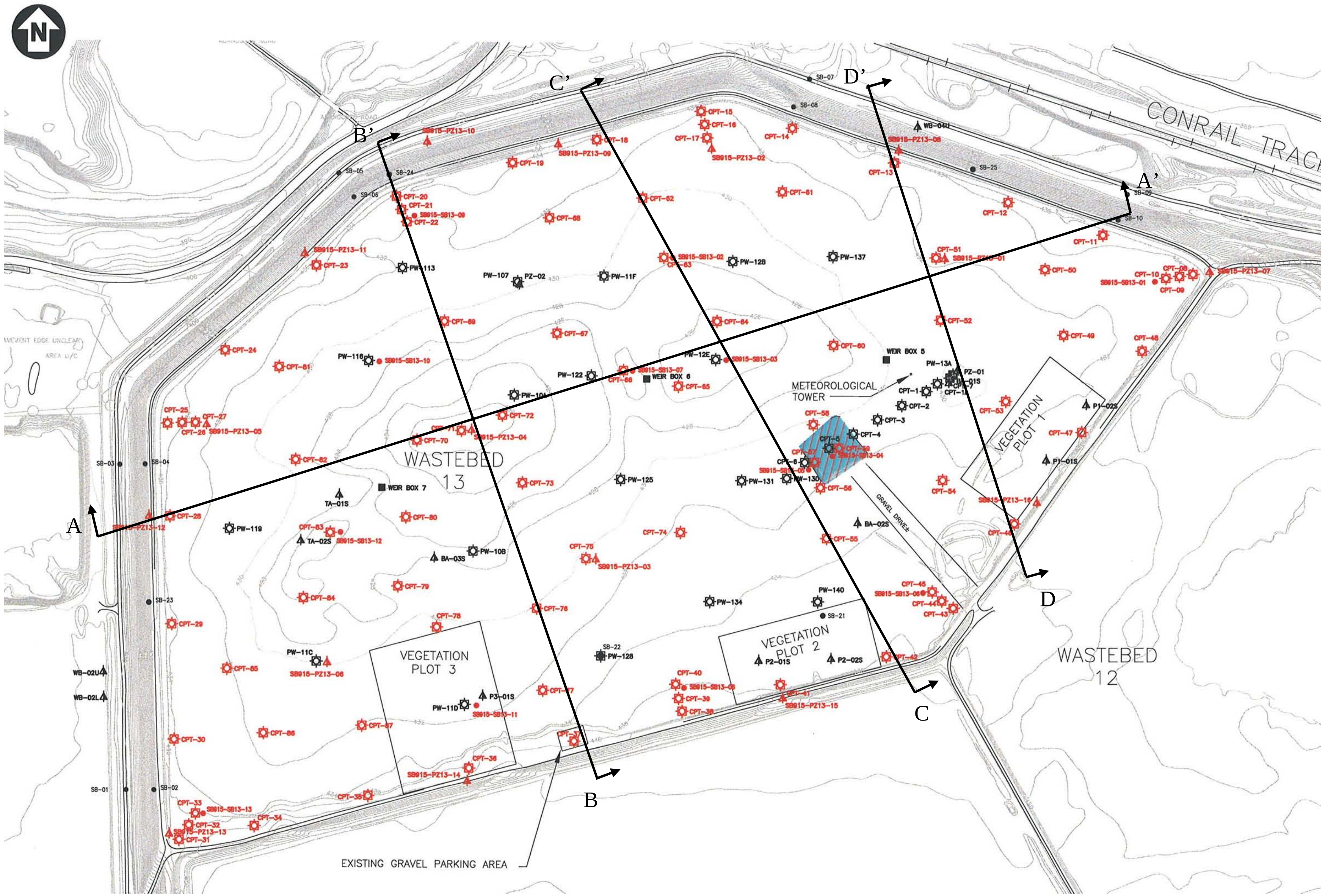


Figure 6. Locations of Cross Sections A-A' to D-D'

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

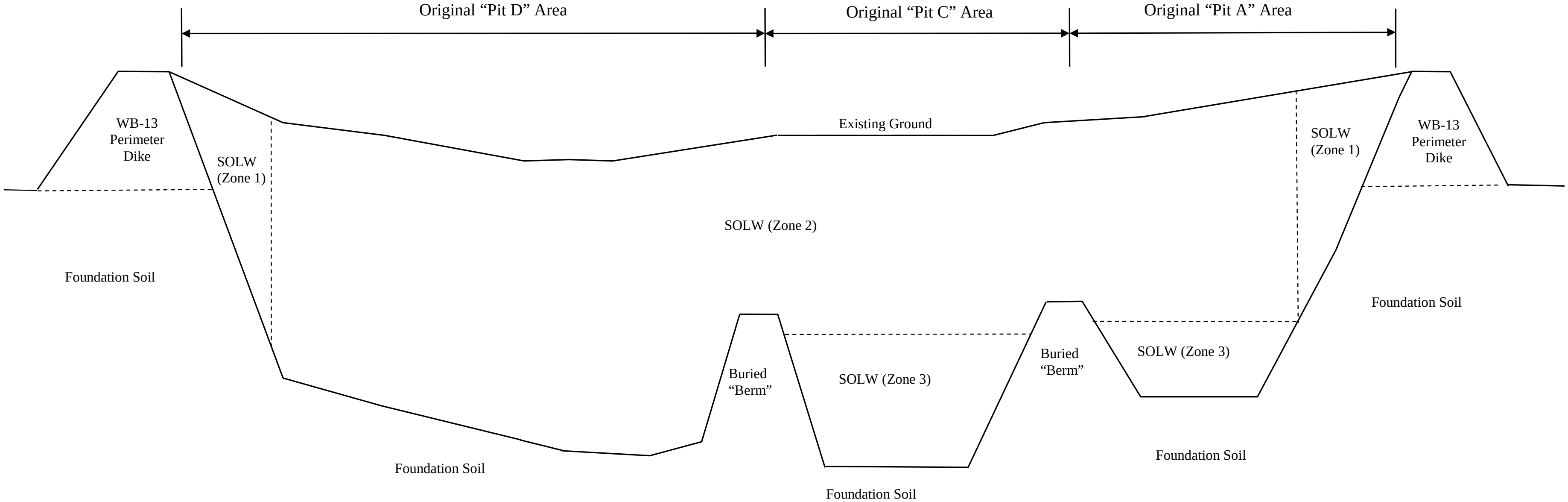


Figure 7. Schematic of Subsurface Profile at Cross Section A-A'

[Not to scale; for purpose of showing subsurface stratigraphy only]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

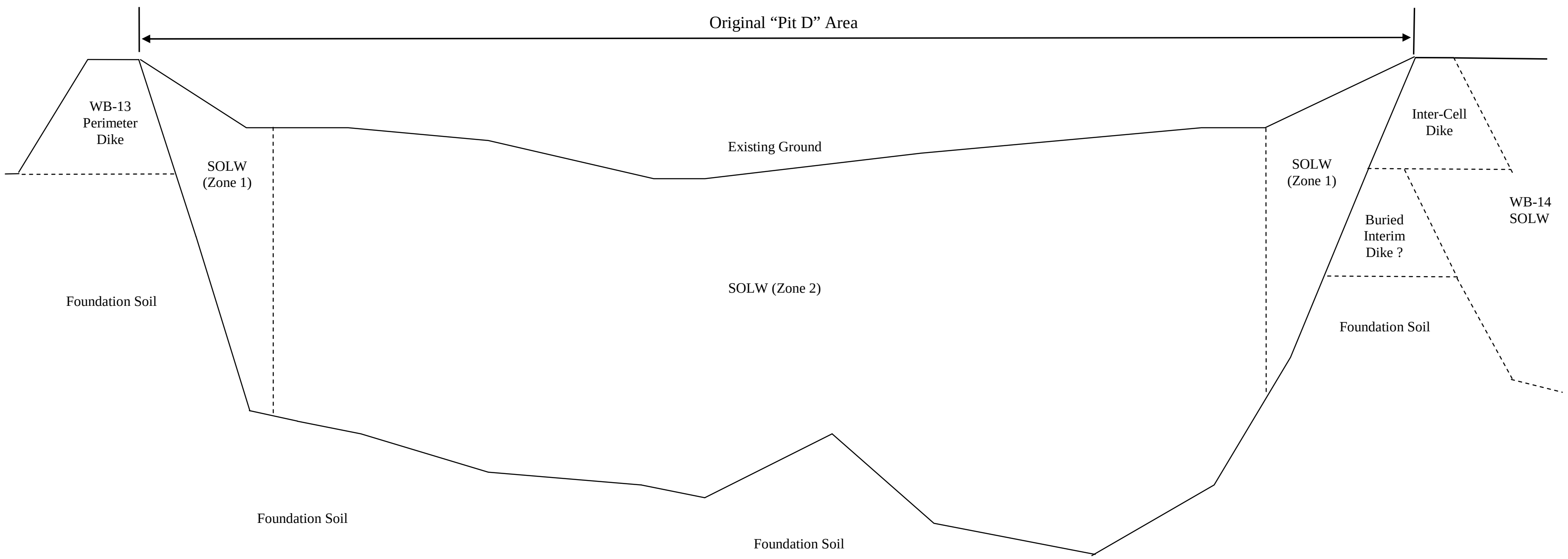


Figure 8. Schematic of Subsurface Profile at Cross Section B-B'

[Not to scale; for purpose of showing subsurface stratigraphy only]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

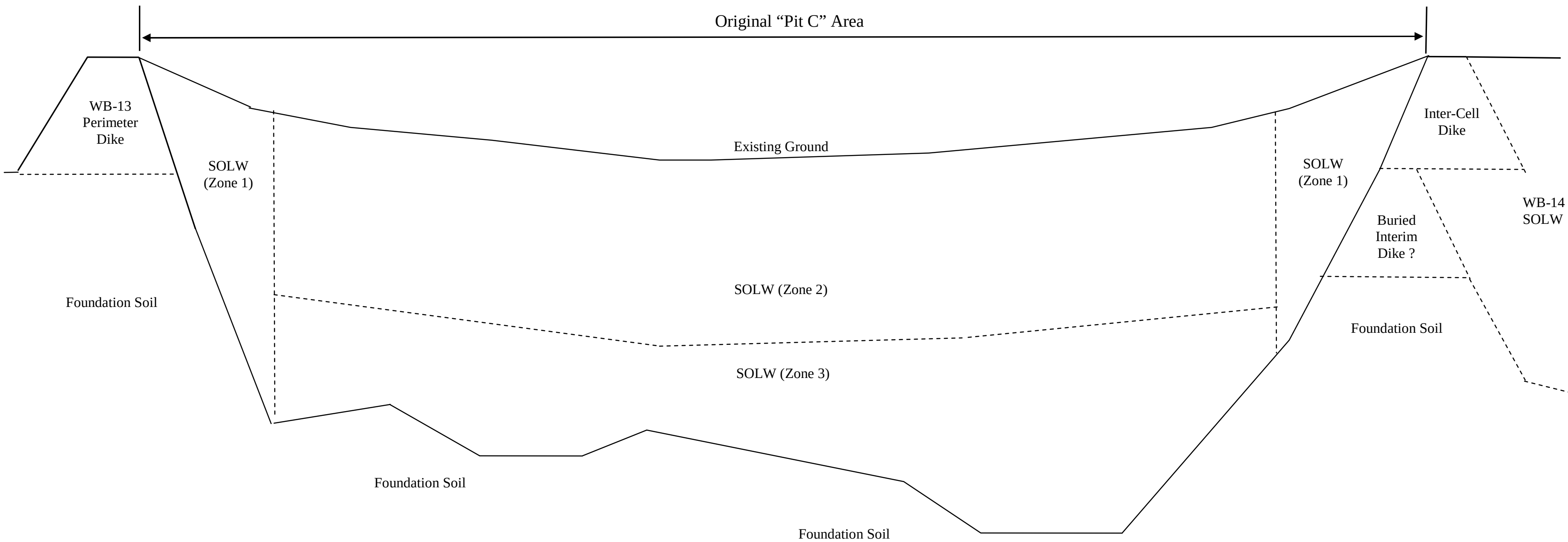


Figure 9. Schematic of Subsurface Profile at Cross Section C-C'

[Not to scale; for purpose of showing subsurface stratigraphy only]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

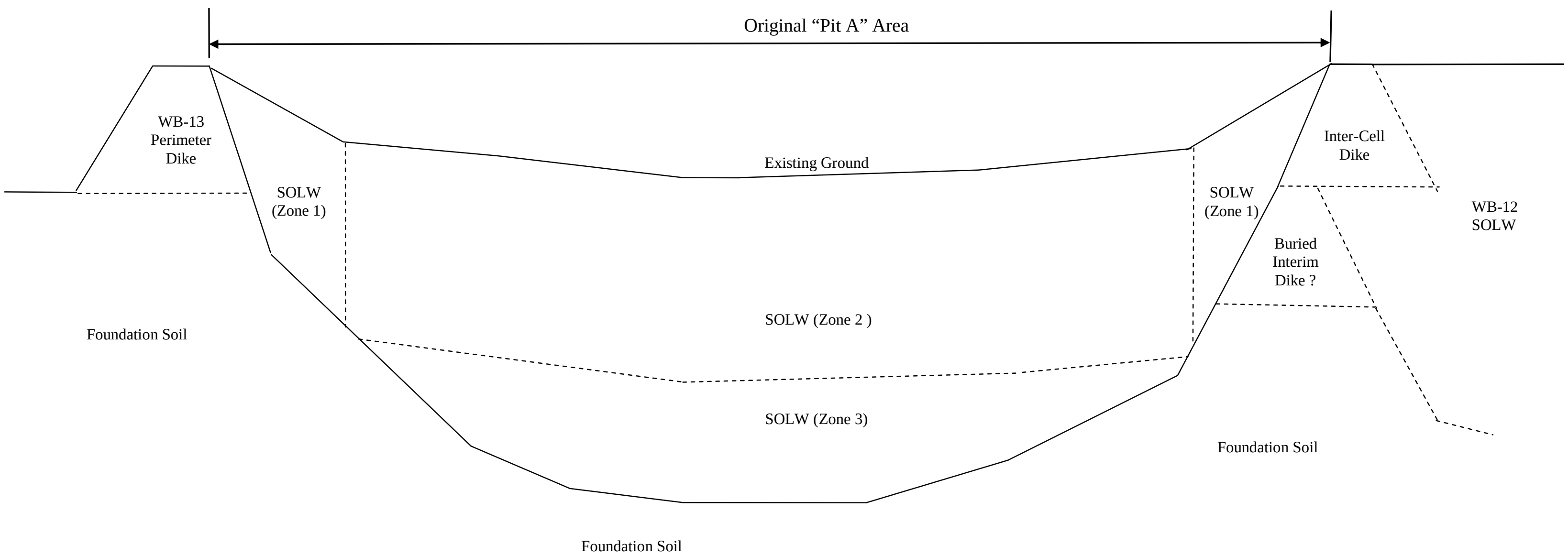


Figure 10. Schematic of Subsurface Profile at Cross Section D-D'

[Not to scale; for purpose of showing subsurface stratigraphy only]

Geosyntec consultants

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

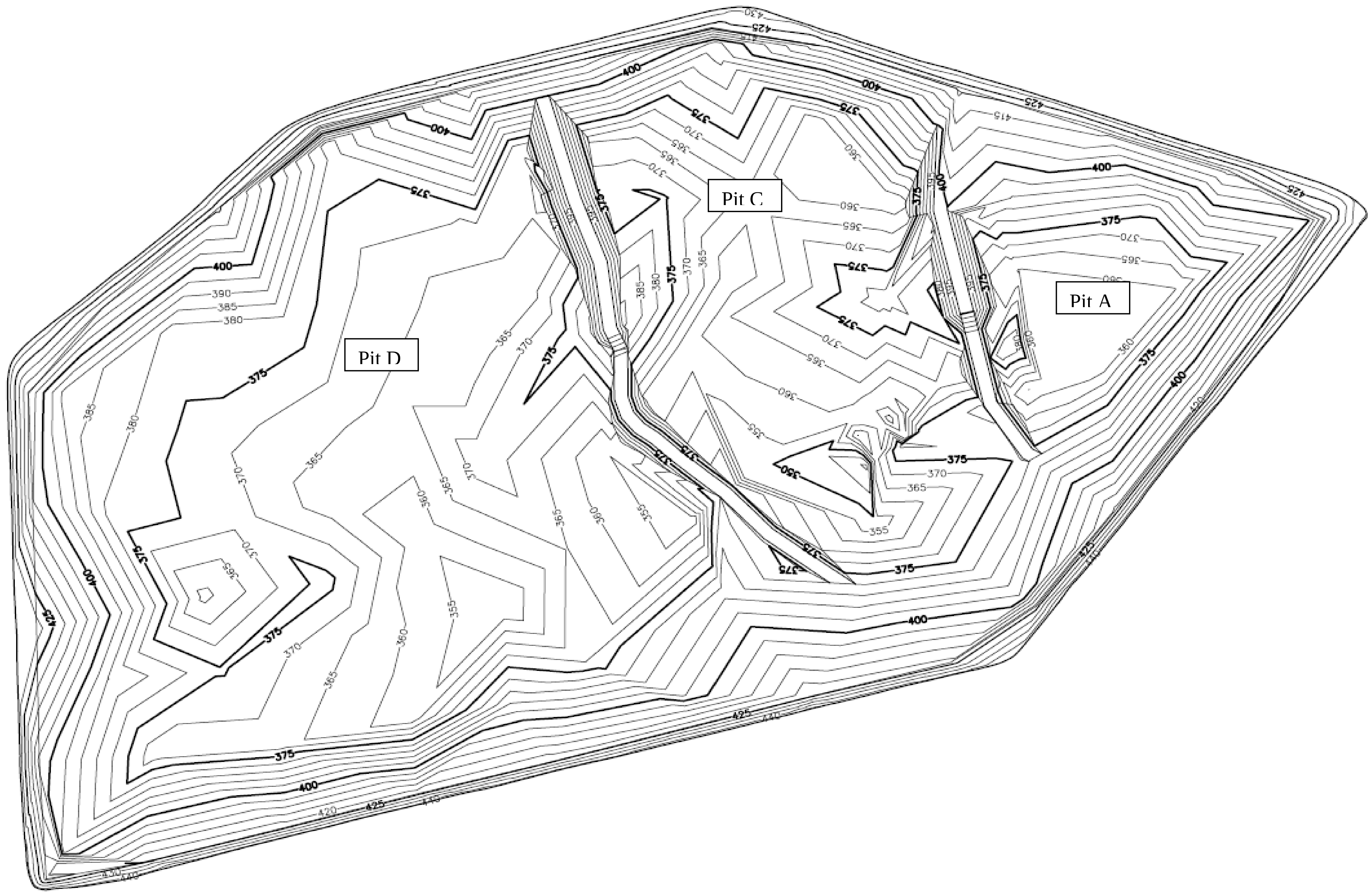


Figure 11. Bottom Elevation Contours of SOLW in WB-13

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

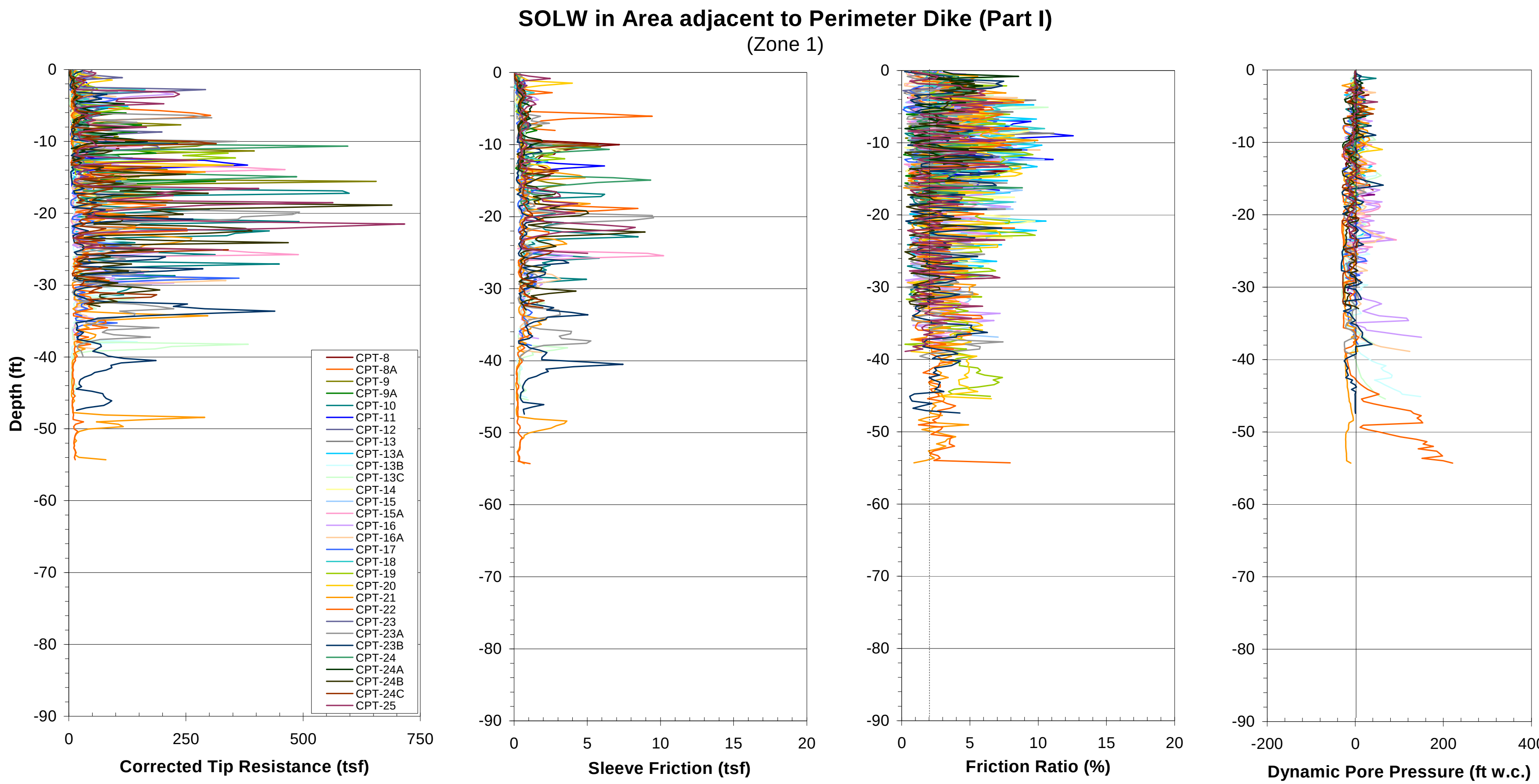


Figure 12. CPT Profiles of SOLW in Areas adjacent to the Perimeter Dikes of WB-13
[Based on CPT data provided in Parsons and Geosyntec (2008a), Parsons (2008c), and Parsons (2009)]

SOLW in Area adjacent to Perimeter Dike (Part II)
(Zone 1)

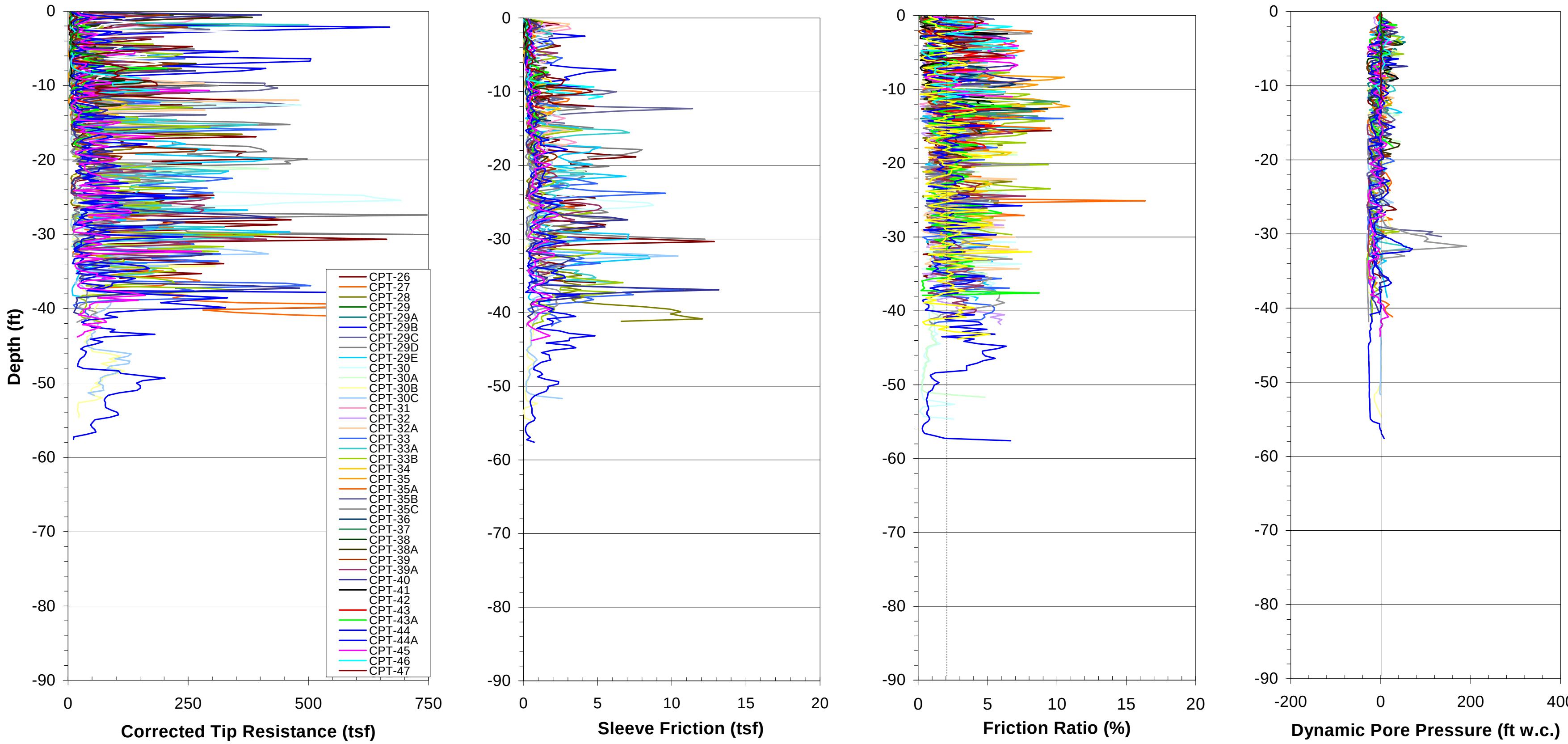


Figure 12. CPT Profiles of SOLW in Areas adjacent to the Perimeter Dikes of WB-13 (continued)
[Based on CPT data provided in Parsons and Geosyntec (2008a), Parsons (2008c), Parsons (2009)]

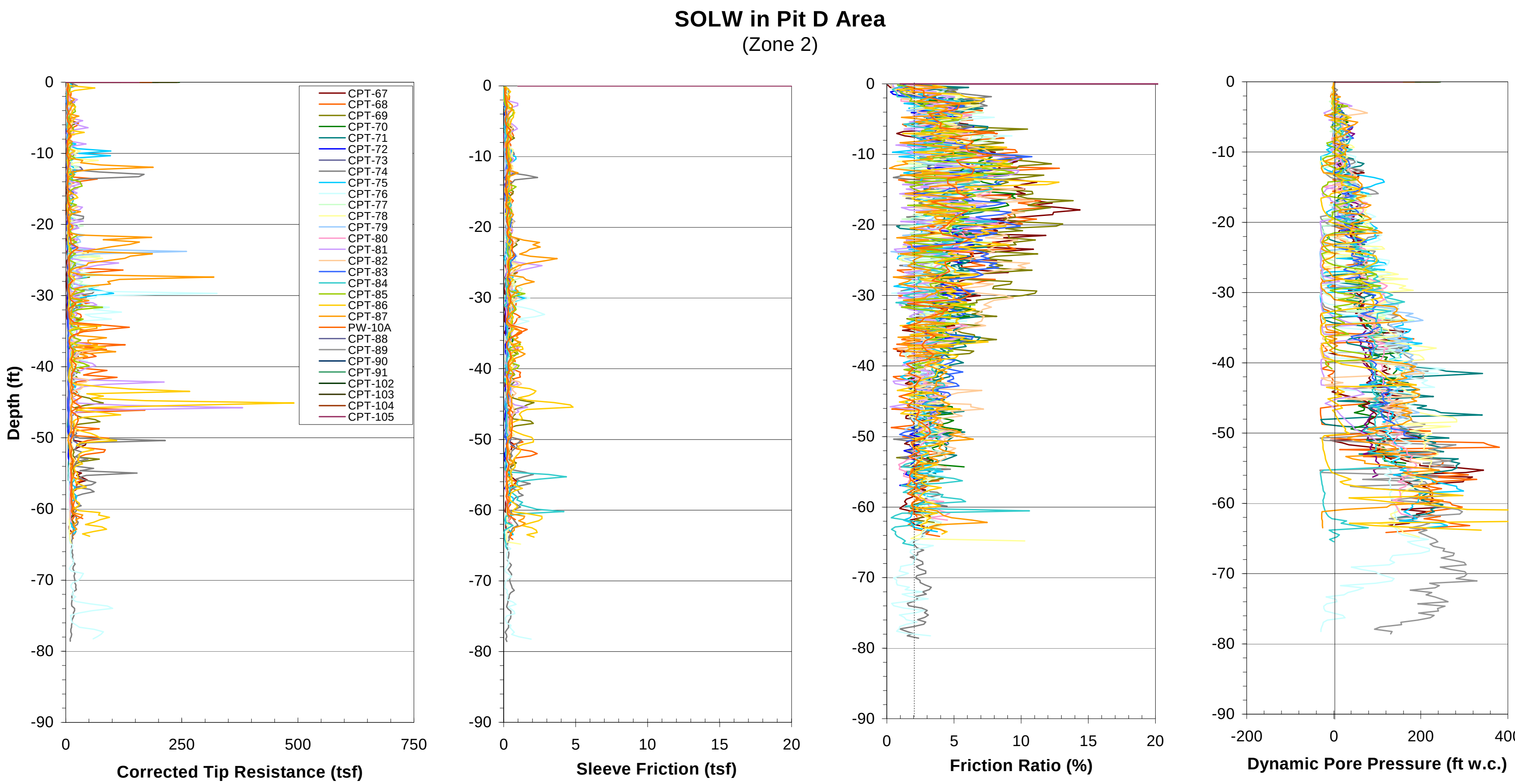


Figure 13. CPT Profiles of SOLW in Pit D Area of WB-13
[Based on CPT data provided in Parsons and Geosyntec (2008a), Parsons (2008c), and Parsons (2009)]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

SOLW in Pit A and Pit C Areas

(Above 40 ft, Zone 2; Below 40 ft, Zone 3)

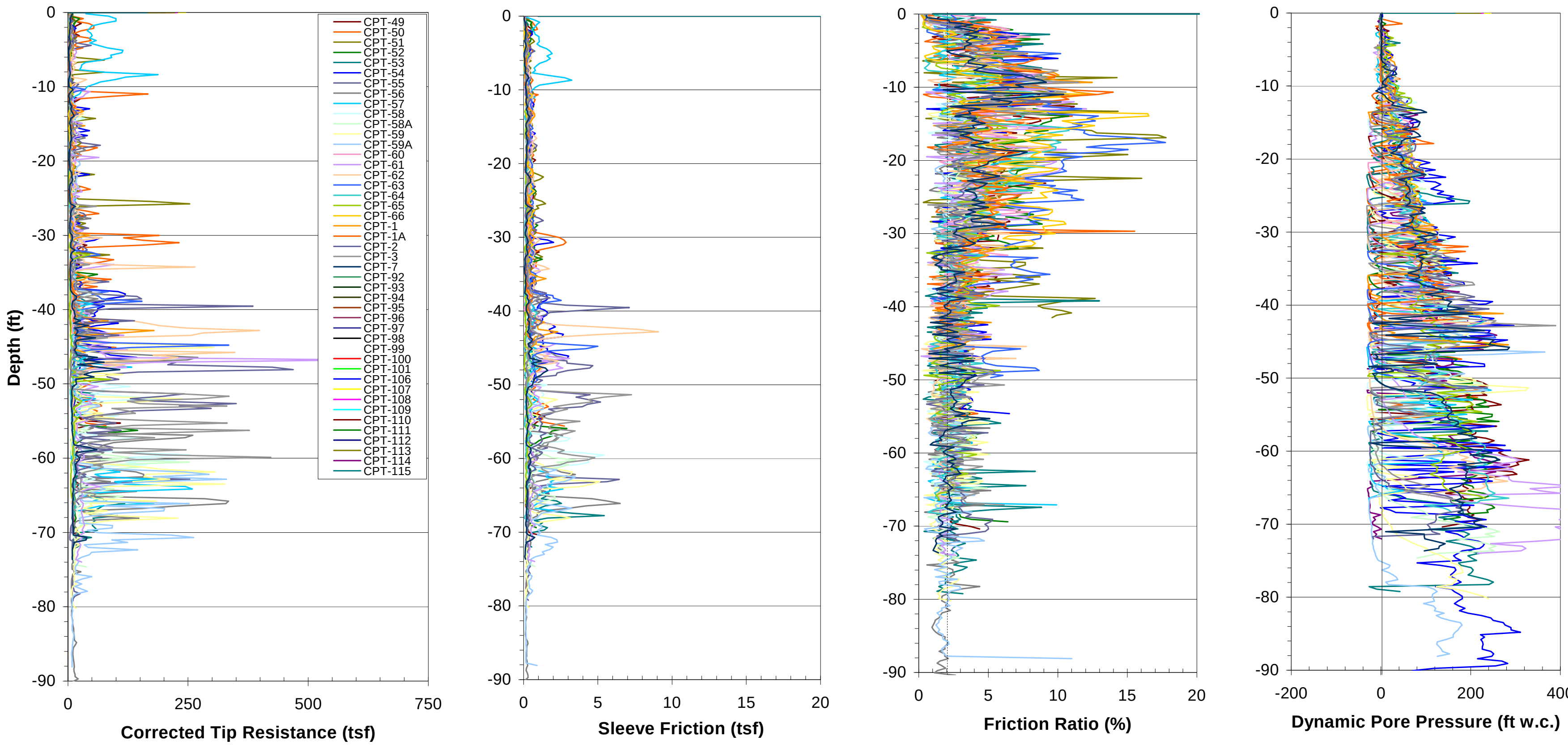


Figure 14. CPT Profiles of SOLW in Pit A and Pit C Areas of WB-13
[Based on CPT data provided in Parsons and Geosyntec (2008a), Parsons (2008c), and Parsons (2009)]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

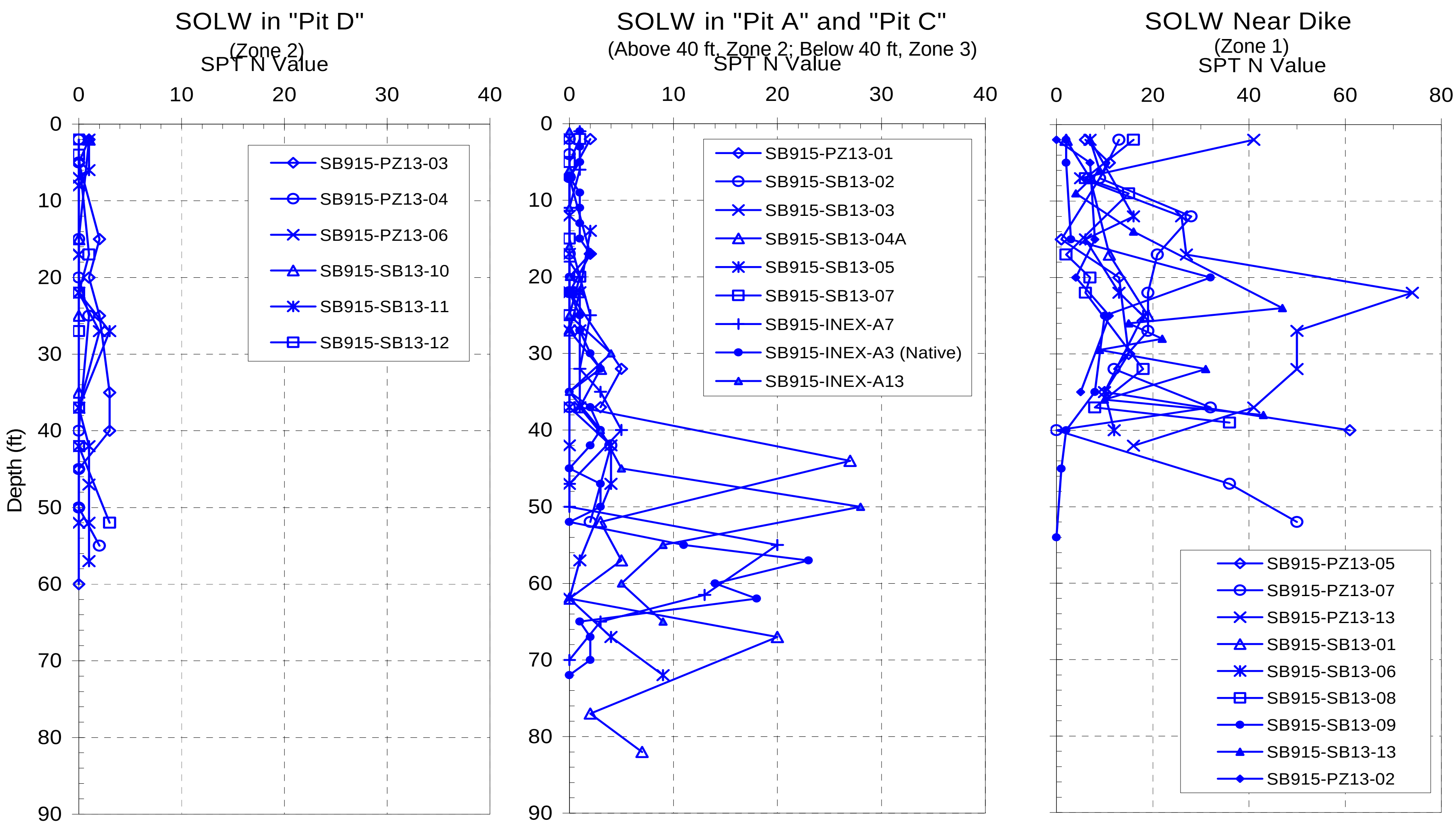
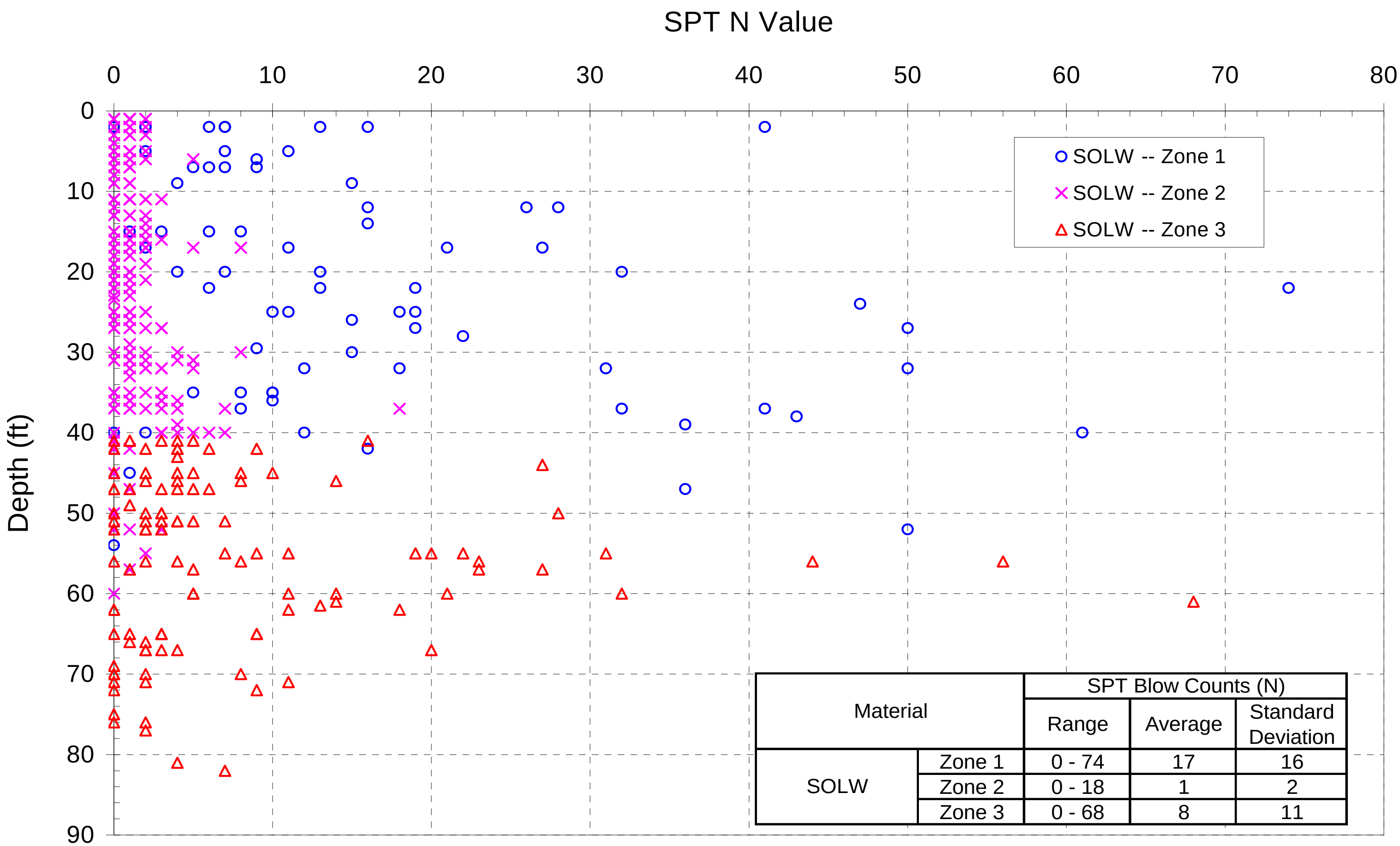


Figure 15. SPT N Value Profiles of SOLW at Selected Locations in WB-13



Material		SPT Blow Counts (N)		
		Range	Average	Standard Deviation
SOLW	Zone 1	0 - 74	17	16
	Zone 2	0 - 18	1	2
	Zone 3	0 - 68	8	11

Figure 16. SPT N Value Versus Depth of SOLW
[based on boring logs presented in Parsons and Geosyntec (2008a), Parsons (2008c), and Parsons (2009)]

Geosyntec consultants

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

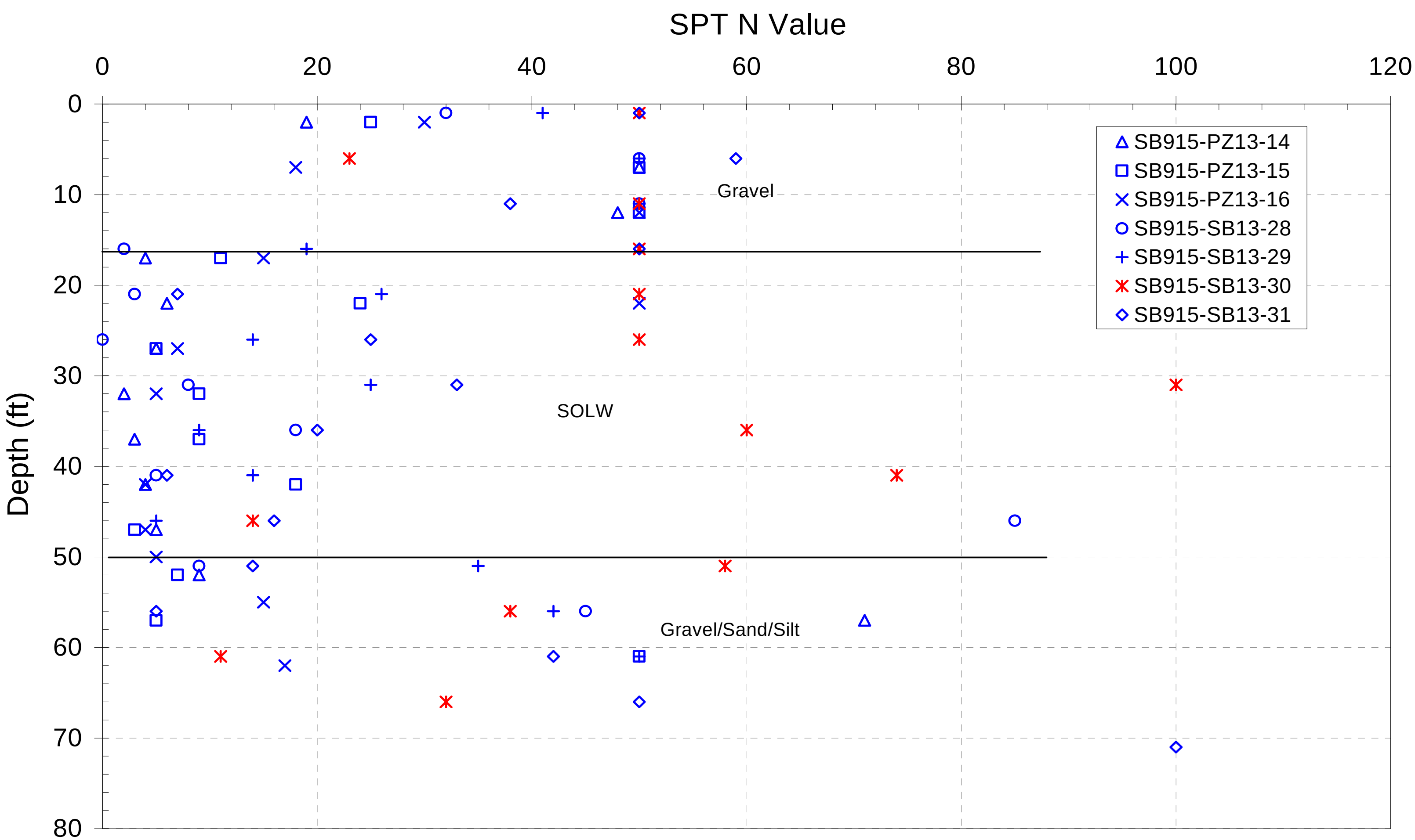
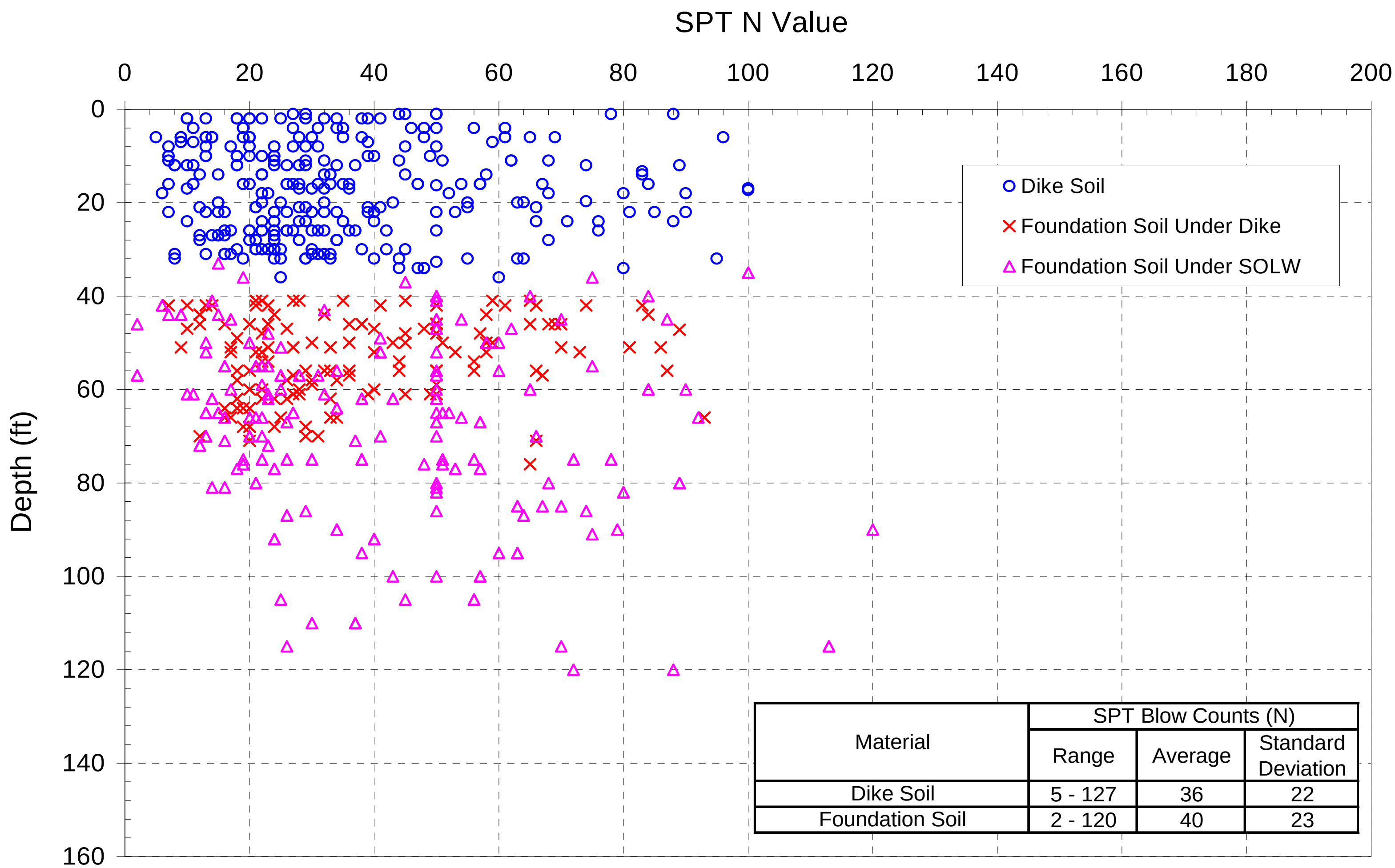


Figure 17. SPT N Values from Borings in Inter-cell Dike between WB-13 and Wastebeds 12 and 14 [based on boring logs presented in Parsons (2008c) and Parsons (2009)]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04



Material	SPT Blow Counts (N)		
	Range	Average	Standard Deviation
Dike Soil	5 - 127	36	22
Foundation Soil	2 - 120	40	23

Figure 18. SPT N Values for Dike Soil and Foundation Soil
[based on boring logs presented in Parsons and Geosyntec (2008a), Parsons (2008c), Parsons (2009)]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

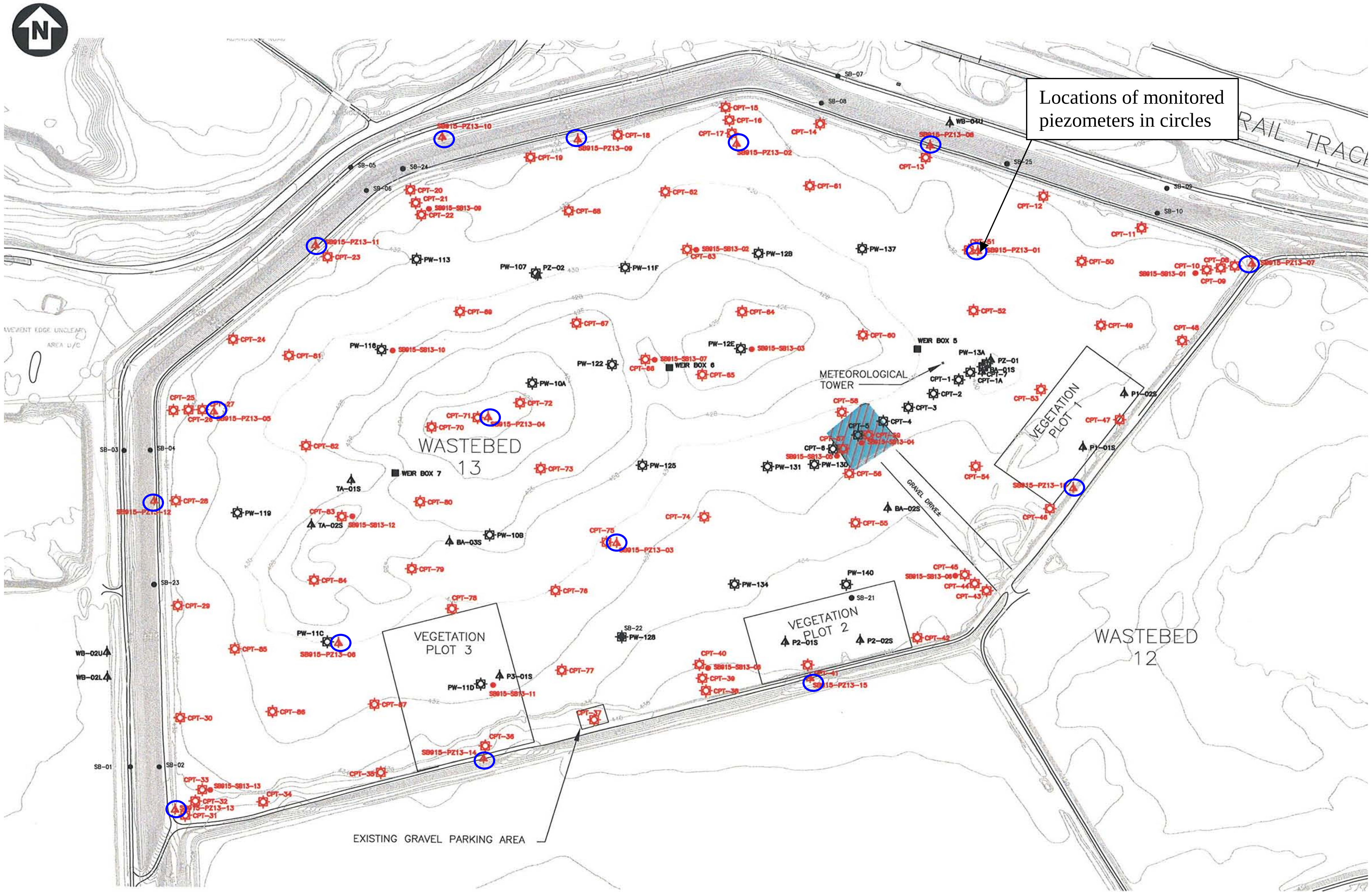


Figure 19. Locations of Piezometers Monitored Since November 2006

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

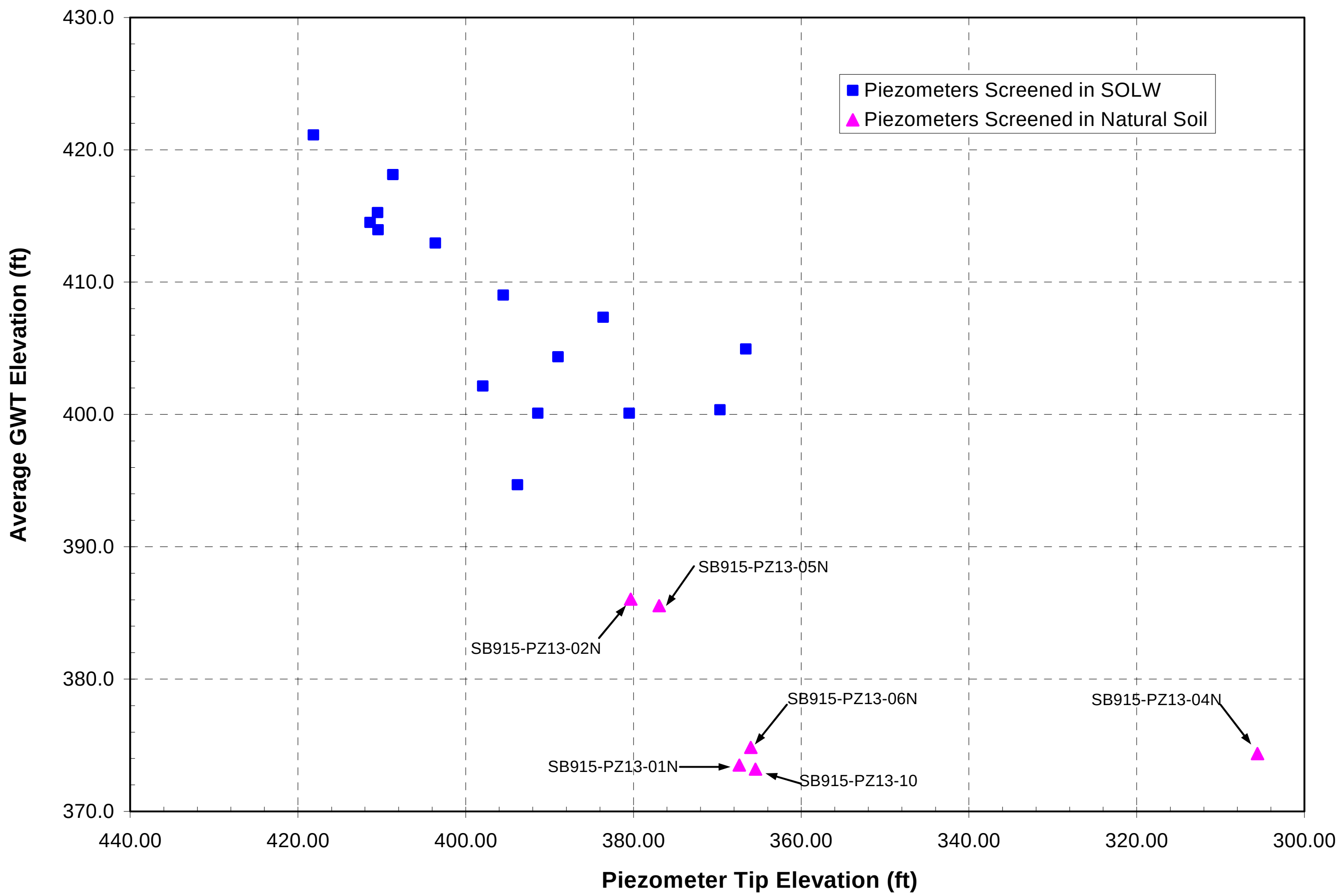


Figure 20. Average GWT Elevation vs. Piezometer Tip Elevation

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

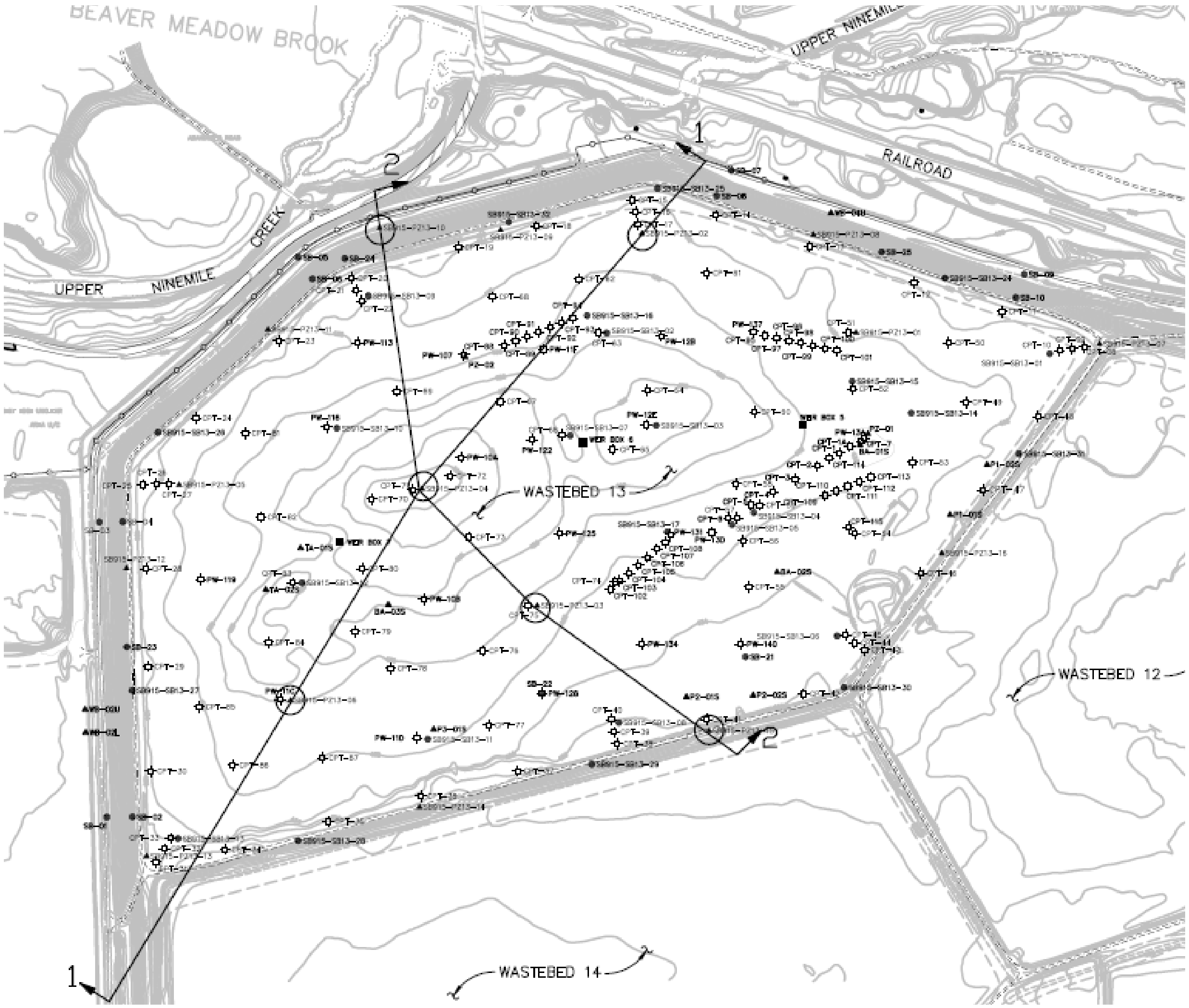


Figure 21. Locations of Cross Sections Showing Measured Groundwater Table Elevations

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

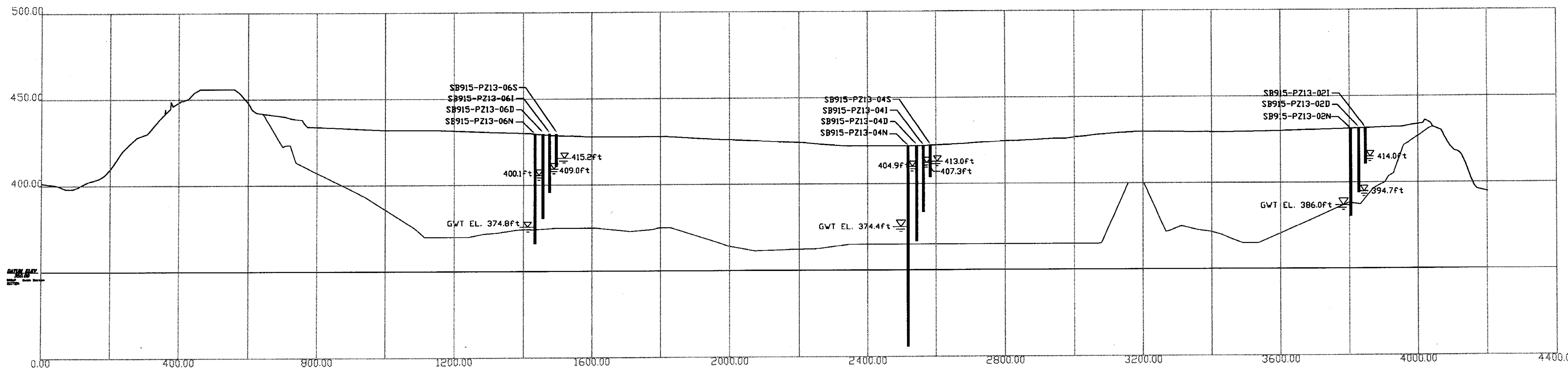


Figure 22. Measured Groundwater Table Elevations on Cross Section 1

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

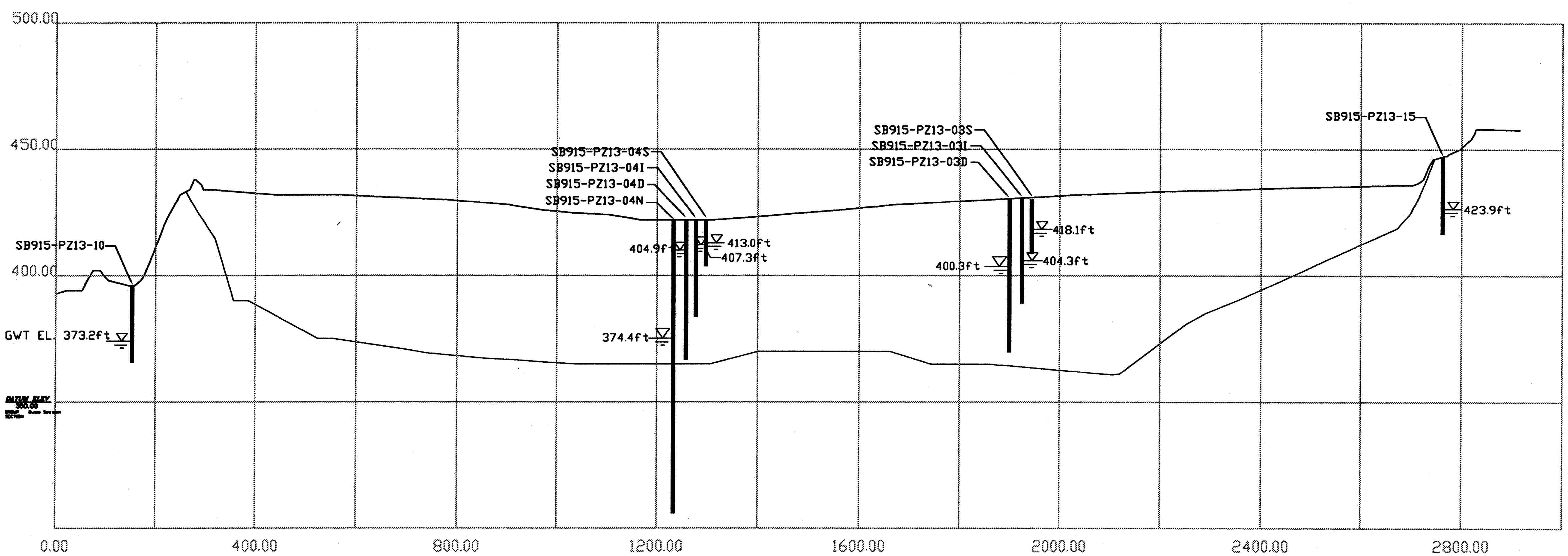
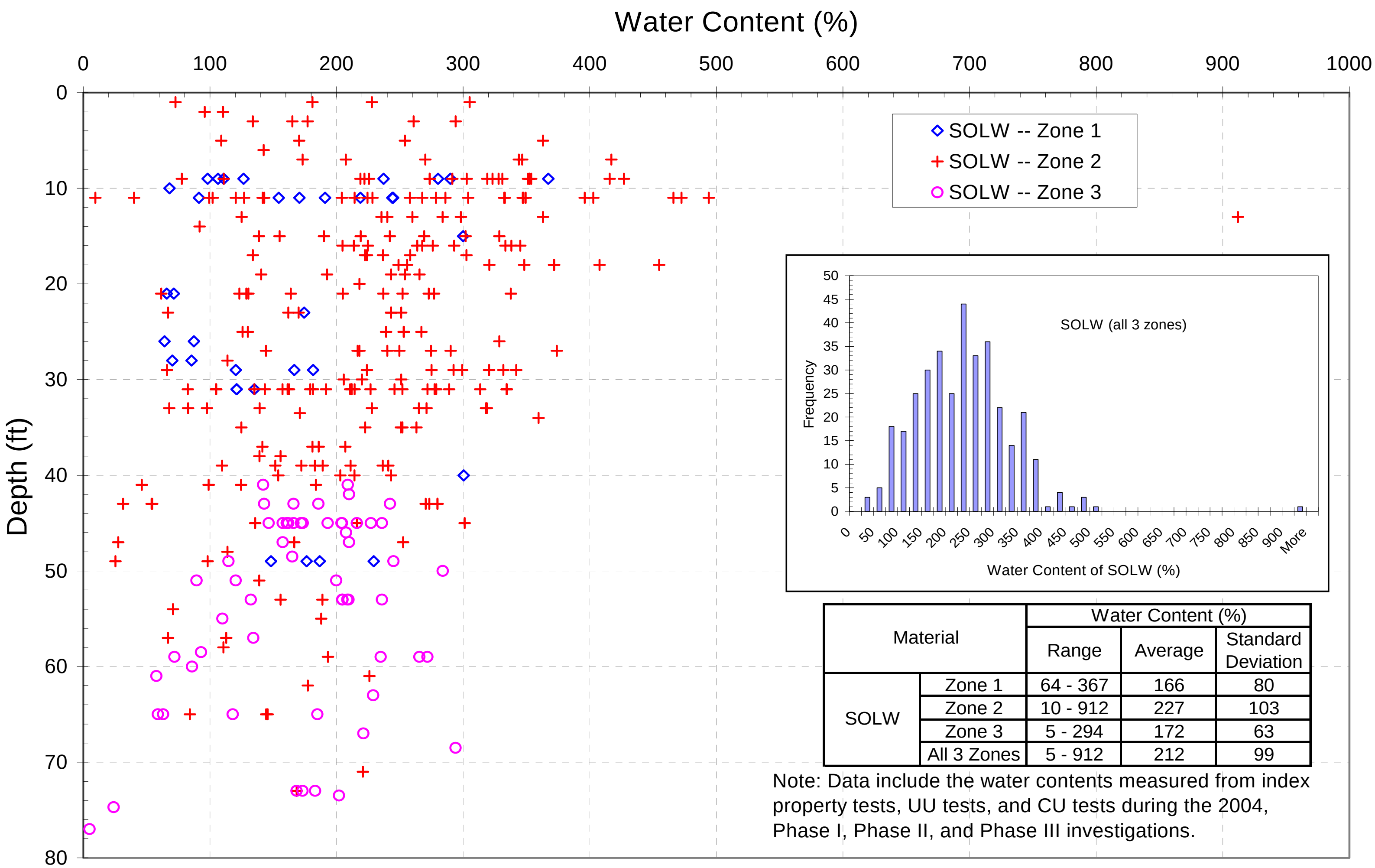


Figure 23. Measured Groundwater Table Elevations on Cross Section 2

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

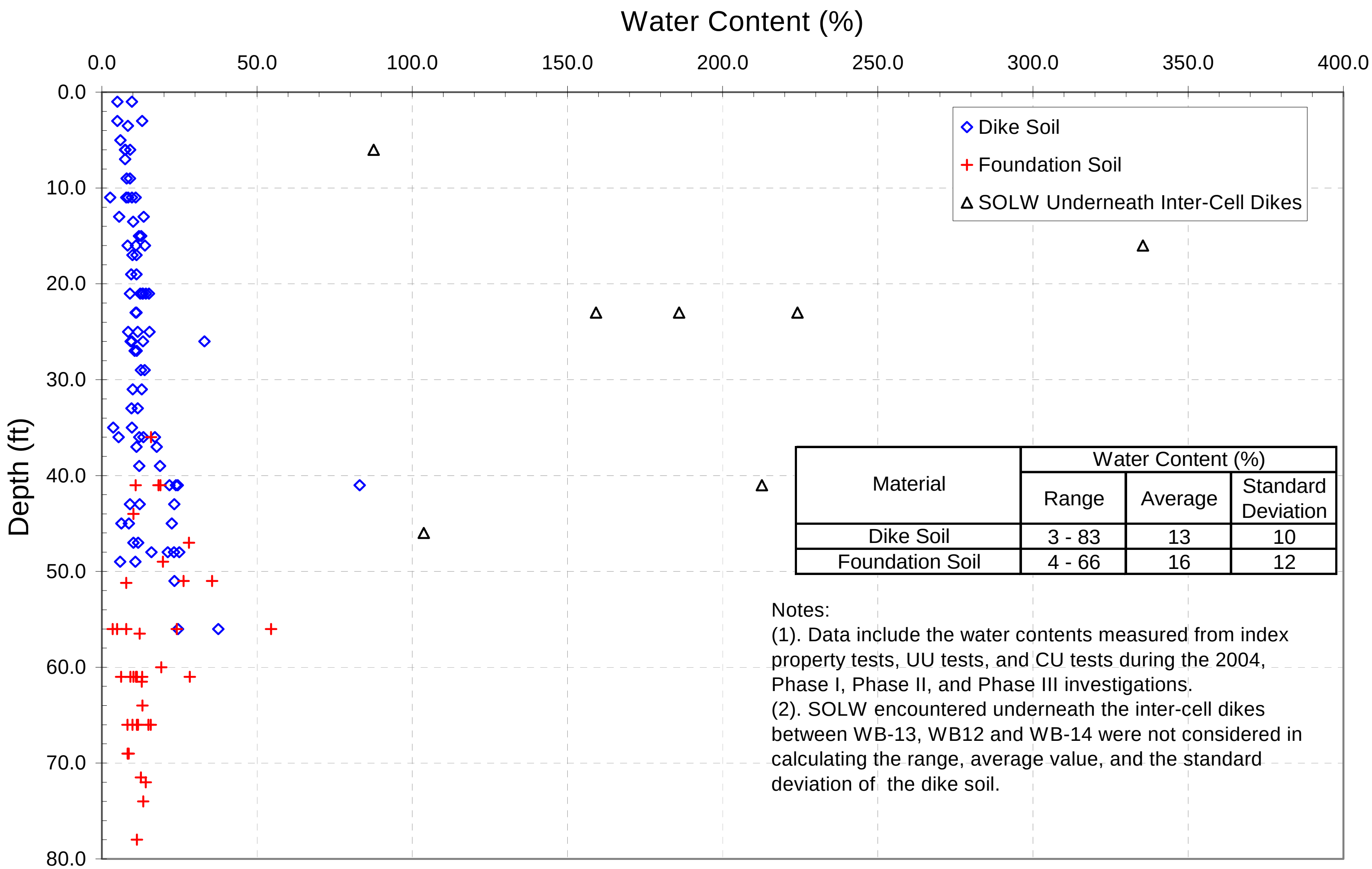


Material		Water Content (%)		
		Range	Average	Standard Deviation
SOLW	Zone 1	64 - 367	166	80
	Zone 2	10 - 912	227	103
	Zone 3	5 - 294	172	63
	All 3 Zones	5 - 912	212	99

Note: Data include the water contents measured from index property tests, UU tests, and CU tests during the 2004, Phase I, Phase II, and Phase III investigations.

Figure 24. Water Content of SOLW
[Data from the summary tables provided in Attachment 3]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

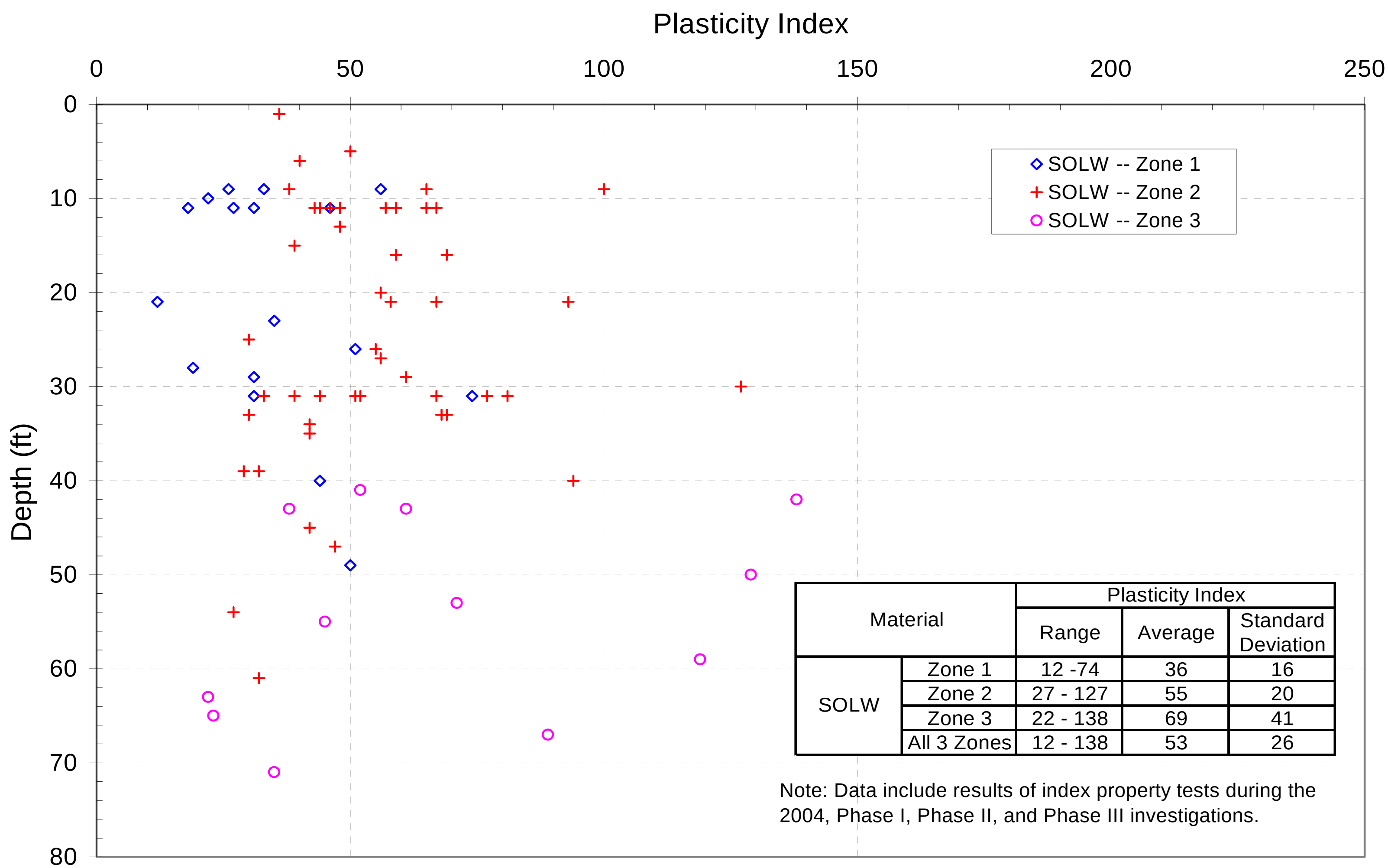


Material	Water Content (%)		
	Range	Average	Standard Deviation
Dike Soil	3 - 83	13	10
Foundation Soil	4 - 66	16	12

Notes:
(1). Data include the water contents measured from index property tests, UU tests, and CU tests during the 2004, Phase I, Phase II, and Phase III investigations.
(2). SOLW encountered underneath the inter-cell dikes between WB-13, WB12 and WB-14 were not considered in calculating the range, average value, and the standard deviation of the dike soil.

Figure 25. Water Content of Dike Soil and Foundation Soil
[Data from the summary tables provided in Attachment 3]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

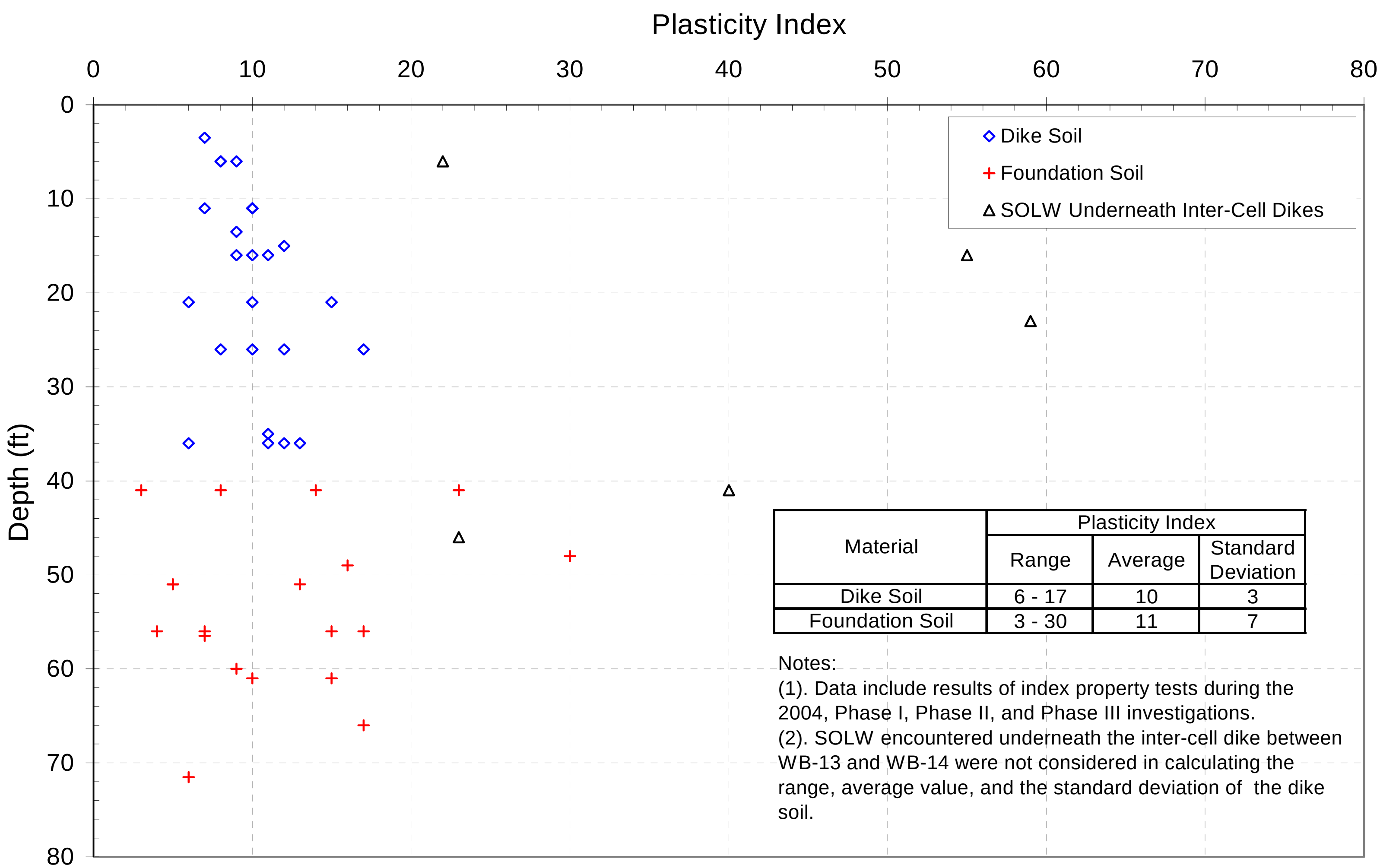


Material		Plasticity Index		
		Range	Average	Standard Deviation
SOLW	Zone 1	12 -74	36	16
	Zone 2	27 - 127	55	20
	Zone 3	22 - 138	69	41
	All 3 Zones	12 - 138	53	26

Note: Data include results of index property tests during the 2004, Phase I, Phase II, and Phase III investigations.

Figure 26. Plasticity Index of SOLW
[Data from the summary tables provided in Attachment 3]

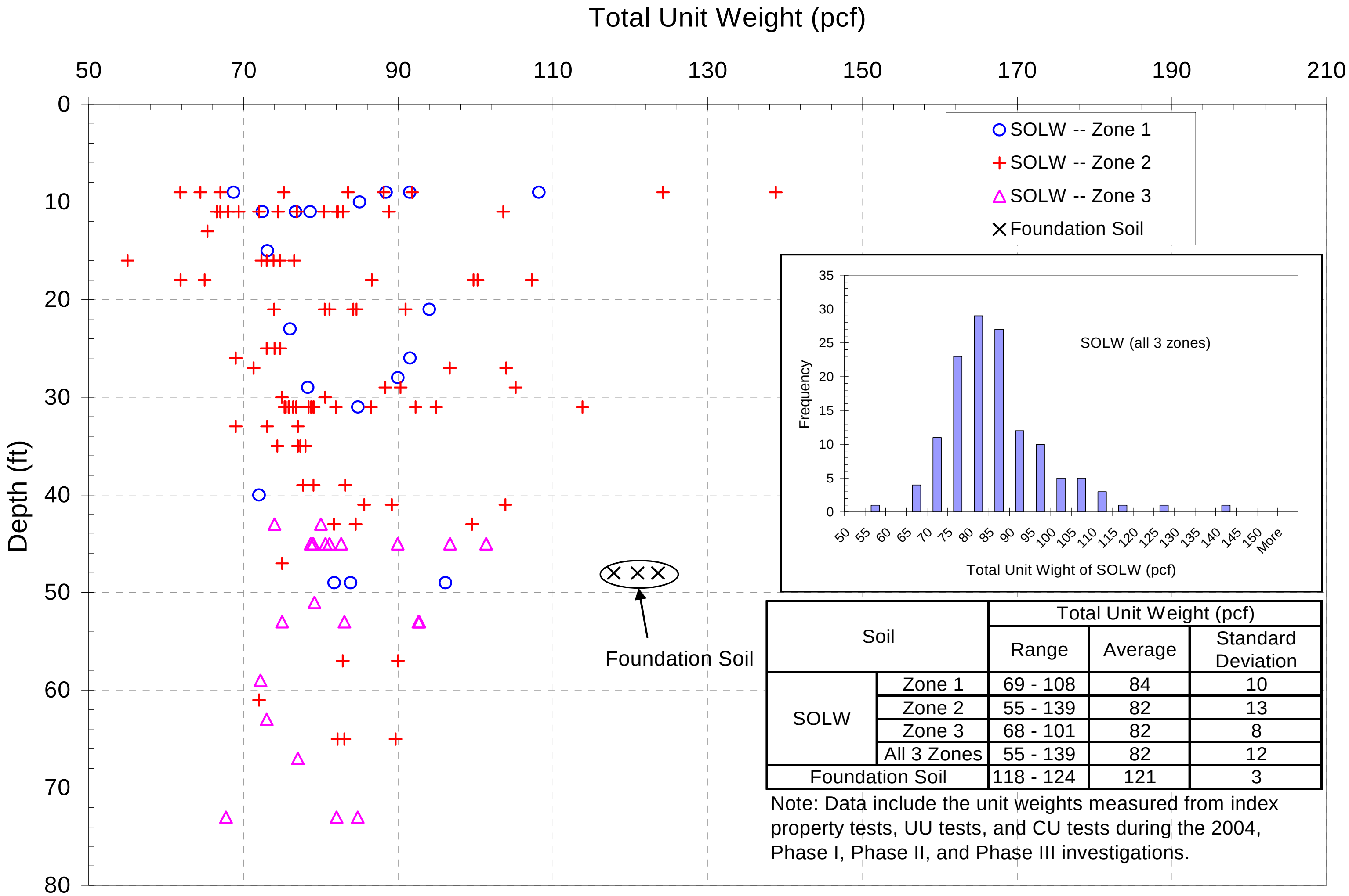
Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**



Material	Plasticity Index		
	Range	Average	Standard Deviation
Dike Soil	6 - 17	10	3
Foundation Soil	3 - 30	11	7

Figure 27. Plasticity Index of Dike Soil and Foundation Soil
[Data from the summary tables provided in Attachment 3]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04



Soil		Total Unit Weight (pcf)		
		Range	Average	Standard Deviation
SOLW	Zone 1	69 - 108	84	10
	Zone 2	55 - 139	82	13
	Zone 3	68 - 101	82	8
	All 3 Zones	55 - 139	82	12
Foundation Soil		118 - 124	121	3

Note: Data include the unit weights measured from index property tests, UU tests, and CU tests during the 2004, Phase I, Phase II, and Phase III investigations.

Figure 28. Total Unit Weight of SOLW and Foundation Soil
[Data from the summary tables provided in Attachment 3]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

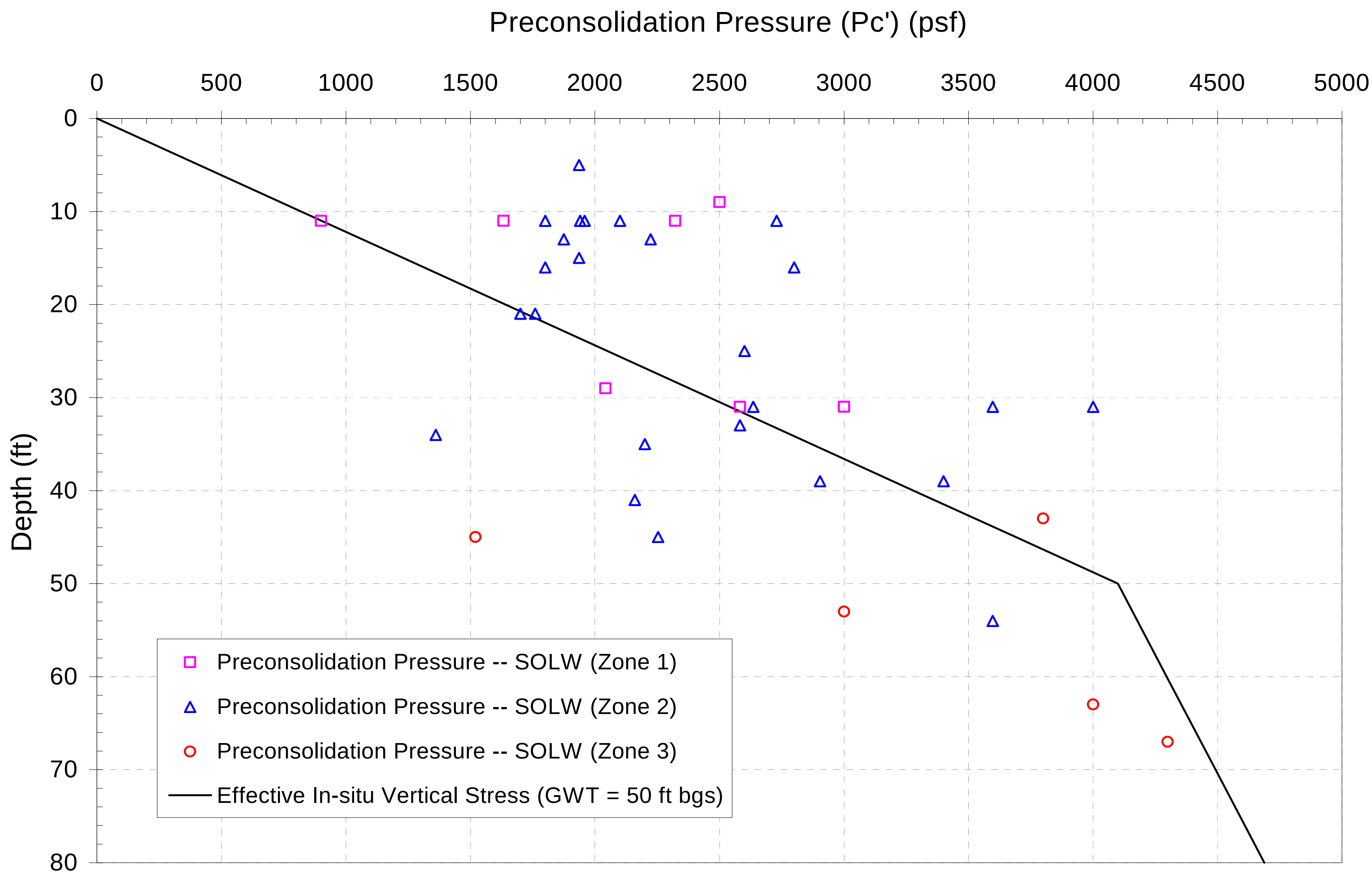


Figure 29. Preconsolidation Pressure of SOLW
[Data from the summary tables provided in Attachment 3]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

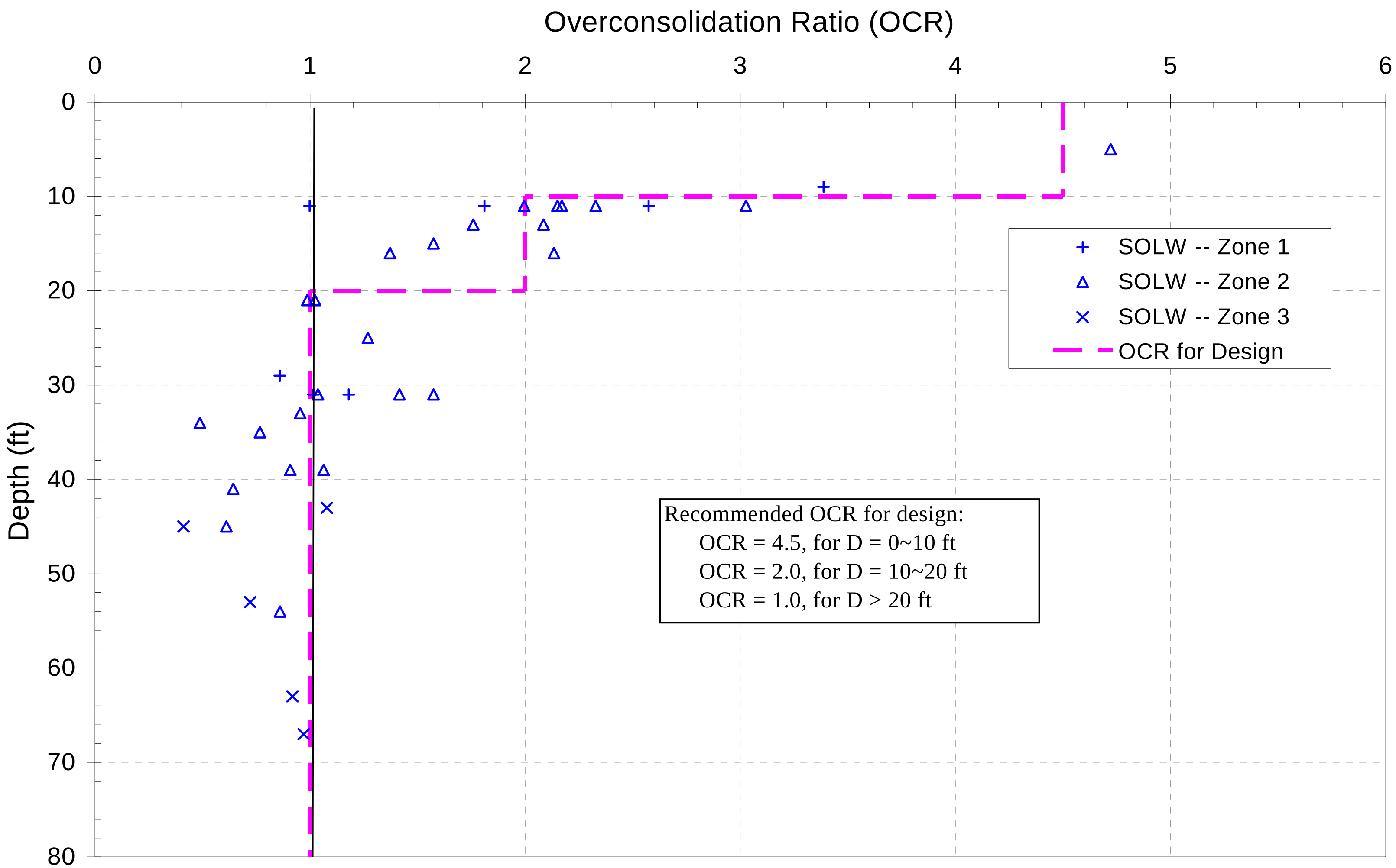
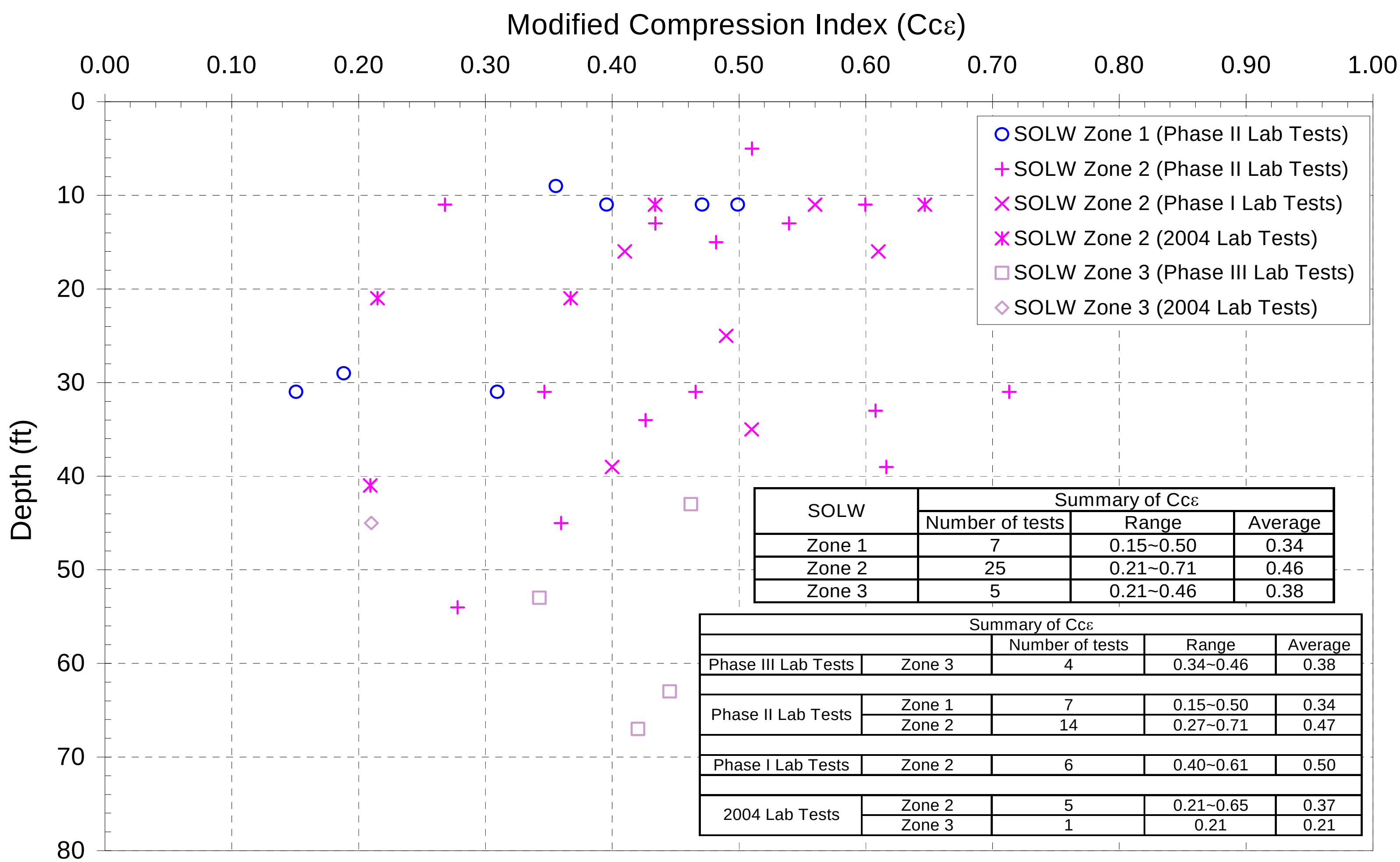


Figure 30. Overconsolidation Ratio of SOLW

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

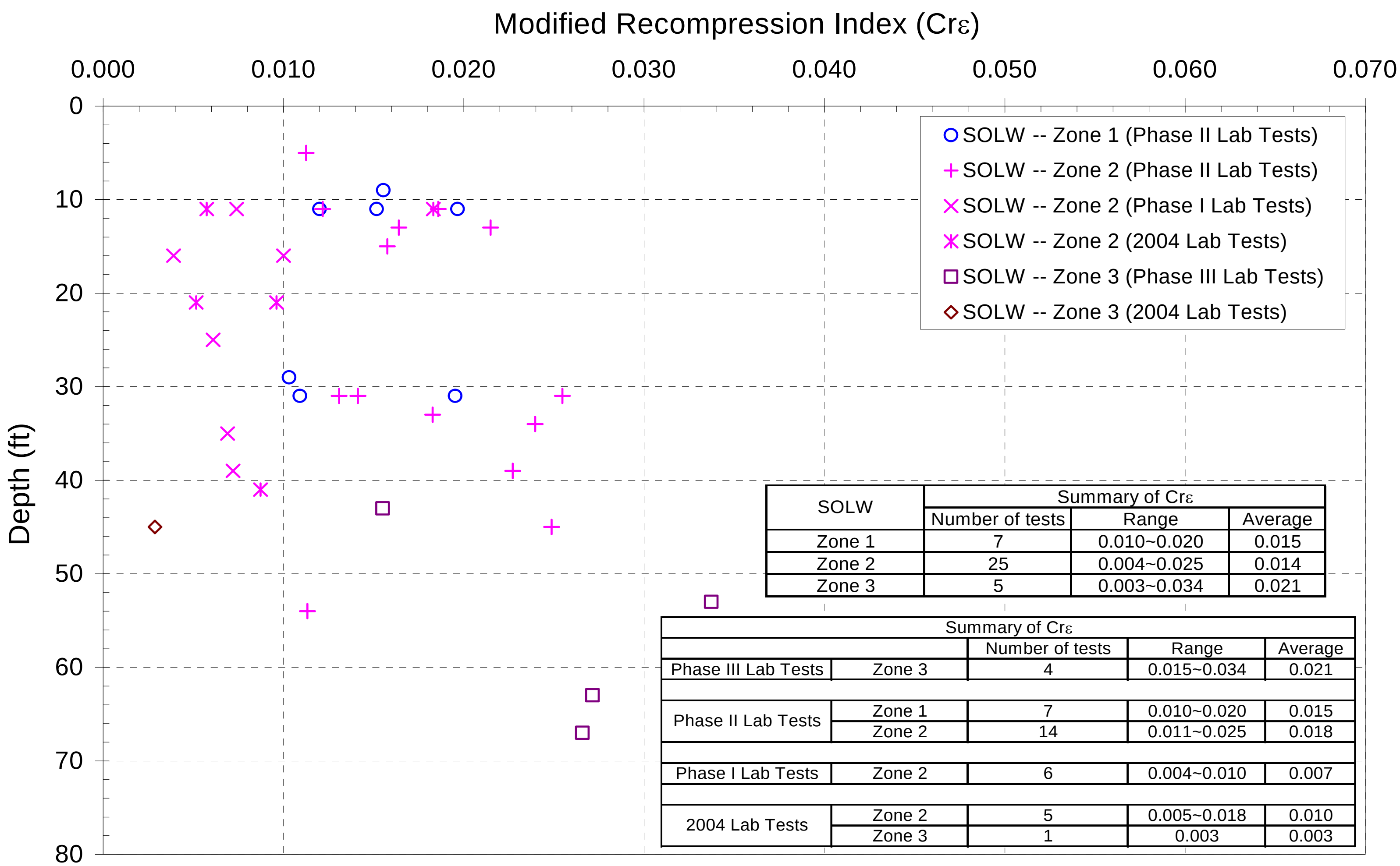


SOLW	Summary of Ccε		
	Number of tests	Range	Average
Zone 1	7	0.15~0.50	0.34
Zone 2	25	0.21~0.71	0.46
Zone 3	5	0.21~0.46	0.38

Summary of Ccε				
		Number of tests	Range	Average
Phase III Lab Tests	Zone 3	4	0.34~0.46	0.38
Phase II Lab Tests	Zone 1	7	0.15~0.50	0.34
	Zone 2	14	0.27~0.71	0.47
Phase I Lab Tests	Zone 2	6	0.40~0.61	0.50
2004 Lab Tests	Zone 2	5	0.21~0.65	0.37
	Zone 3	1	0.21	0.21

Figure 31. Modified Compression Index of SOLW
[Data from the summary tables provided in Attachment 3]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**



SOLW	Summary of Crε		
	Number of tests	Range	Average
Zone 1	7	0.010~0.020	0.015
Zone 2	25	0.004~0.025	0.014
Zone 3	5	0.003~0.034	0.021

Summary of Crε				
		Number of tests	Range	Average
Phase III Lab Tests	Zone 3	4	0.015~0.034	0.021
Phase II Lab Tests	Zone 1	7	0.010~0.020	0.015
	Zone 2	14	0.011~0.025	0.018
Phase I Lab Tests	Zone 2	6	0.004~0.010	0.007
2004 Lab Tests	Zone 2	5	0.005~0.018	0.010
	Zone 3	1	0.003	0.003

Figure 32. Modified Recompression Index of SOLW
[Data from the summary tables provided in Attachment 3]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

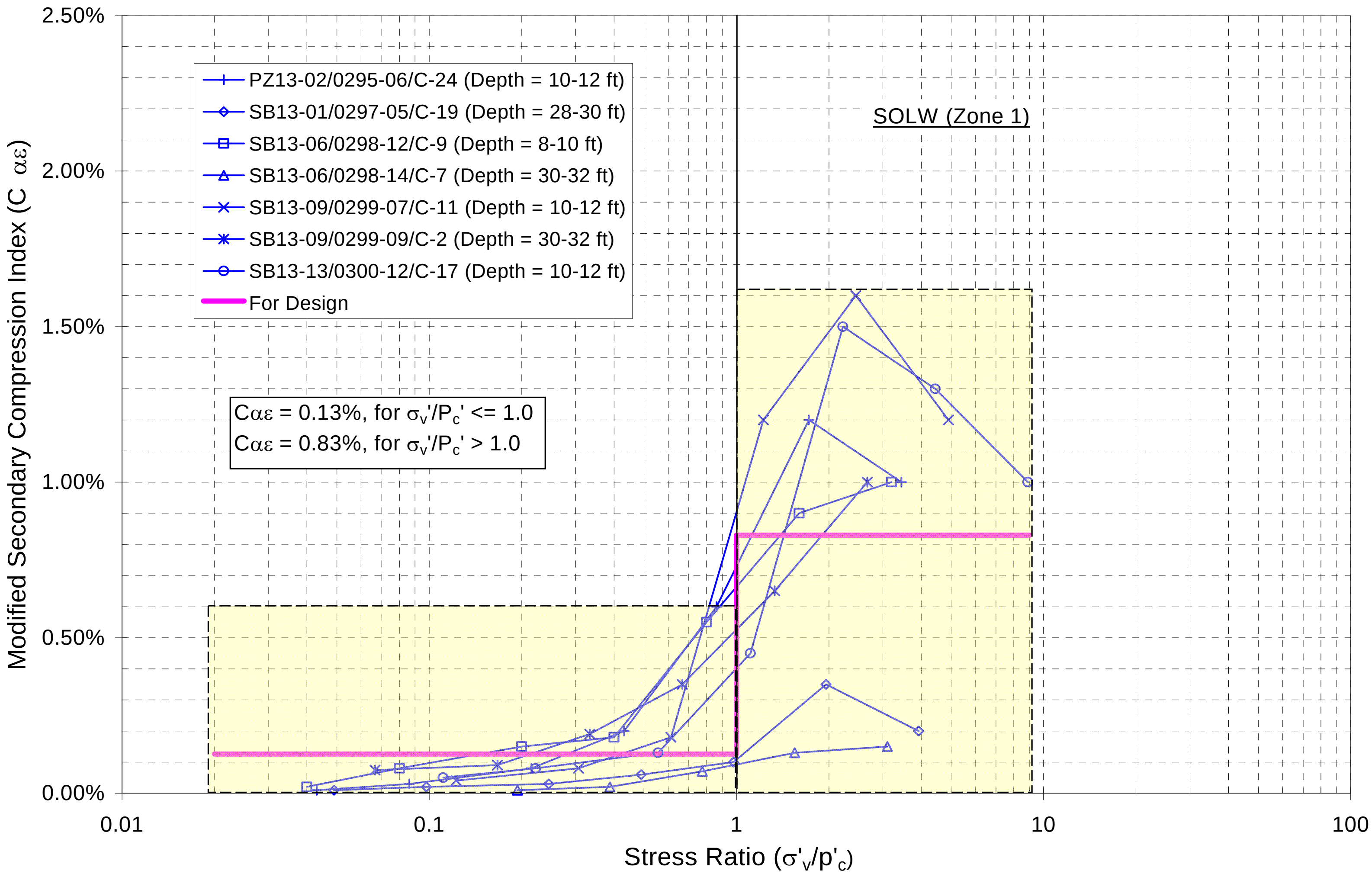


Figure 33. Modified Secondary Compression Index for SOLW in Zone 1
[based on 1-D consolidation test reports provided in Parsons and Geosyntec (2008a) and Parsons (2008c)]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

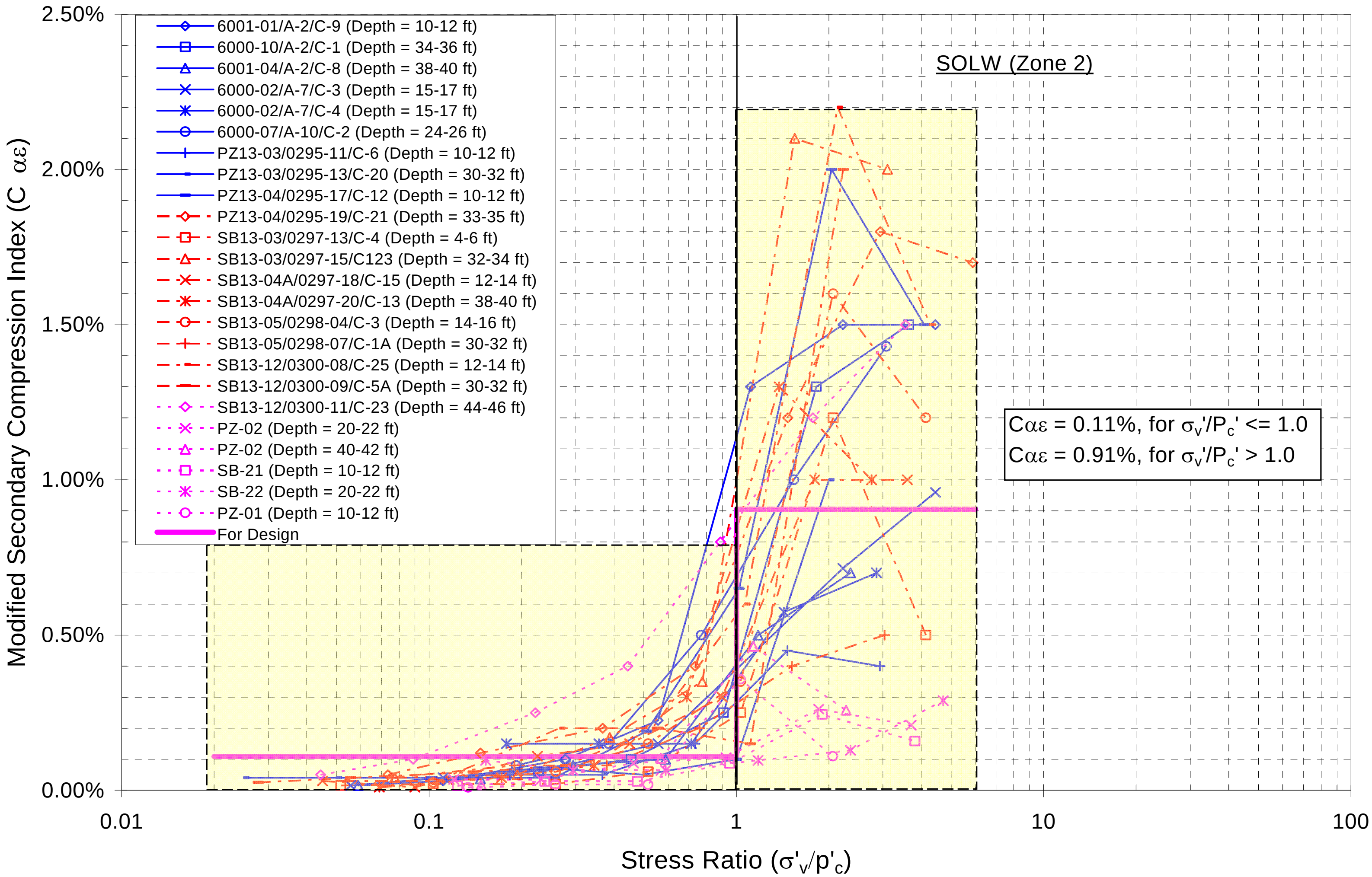


Figure 34. Modified Secondary Compression Index for SOLW in Zone 2
[based on 1-D consolidation test reports provided in Parsons and Geosyntec (2008a) and Parsons (2008c)]

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

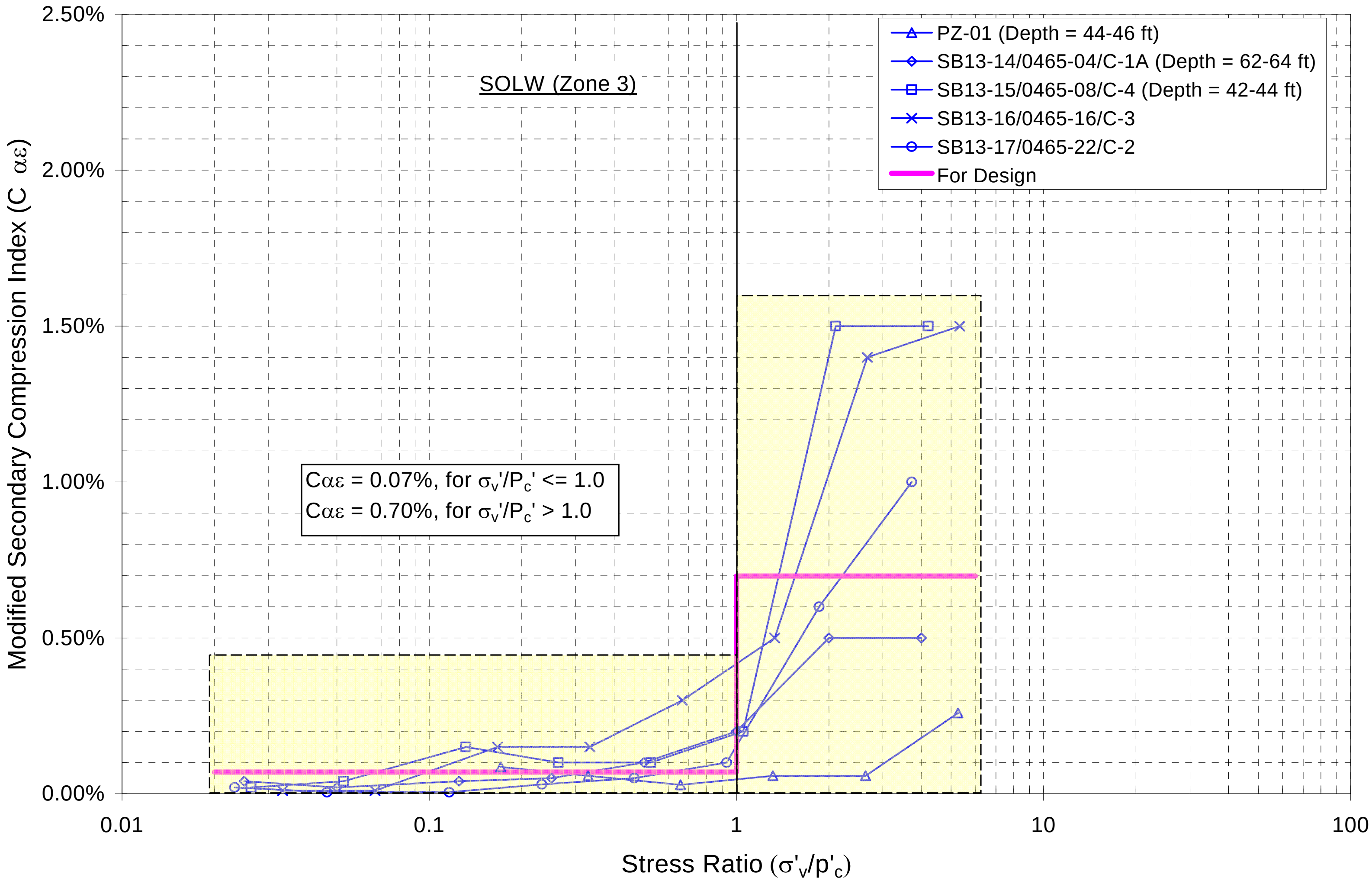


Figure 35. Modified Secondary Compression Index for SOLW in Zone 3
[based on 1-D consolidation test reports provided in Parsons and Geosyntec (2008a), Parsons (2008c;2009)]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

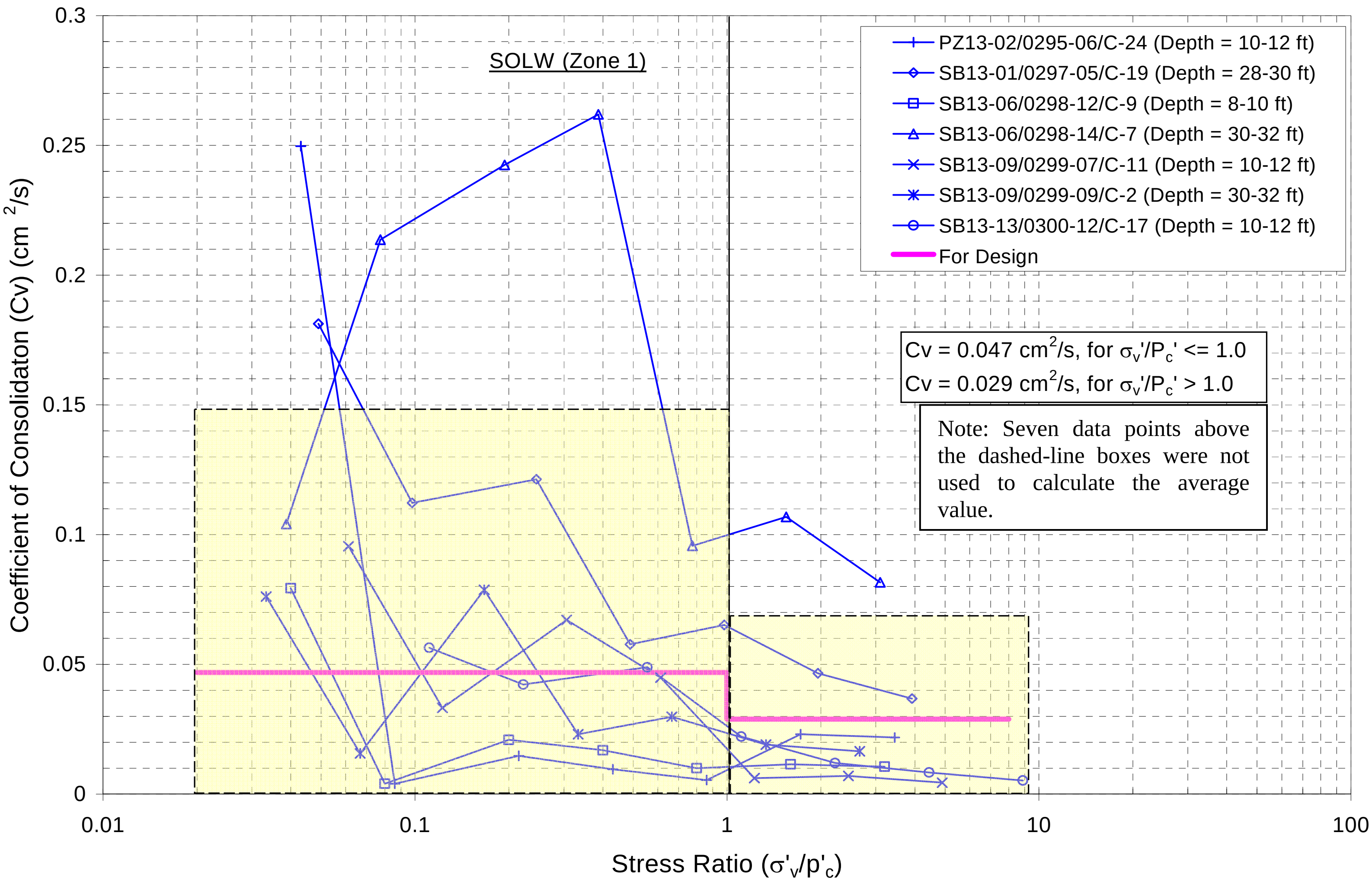


Figure 36. Coefficient of Consolidation for SOLW in Zone 1

[based on 1-D consolidation test reports provided in Parsons and Geosyntec (2008a) and Parsons (2008c)]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

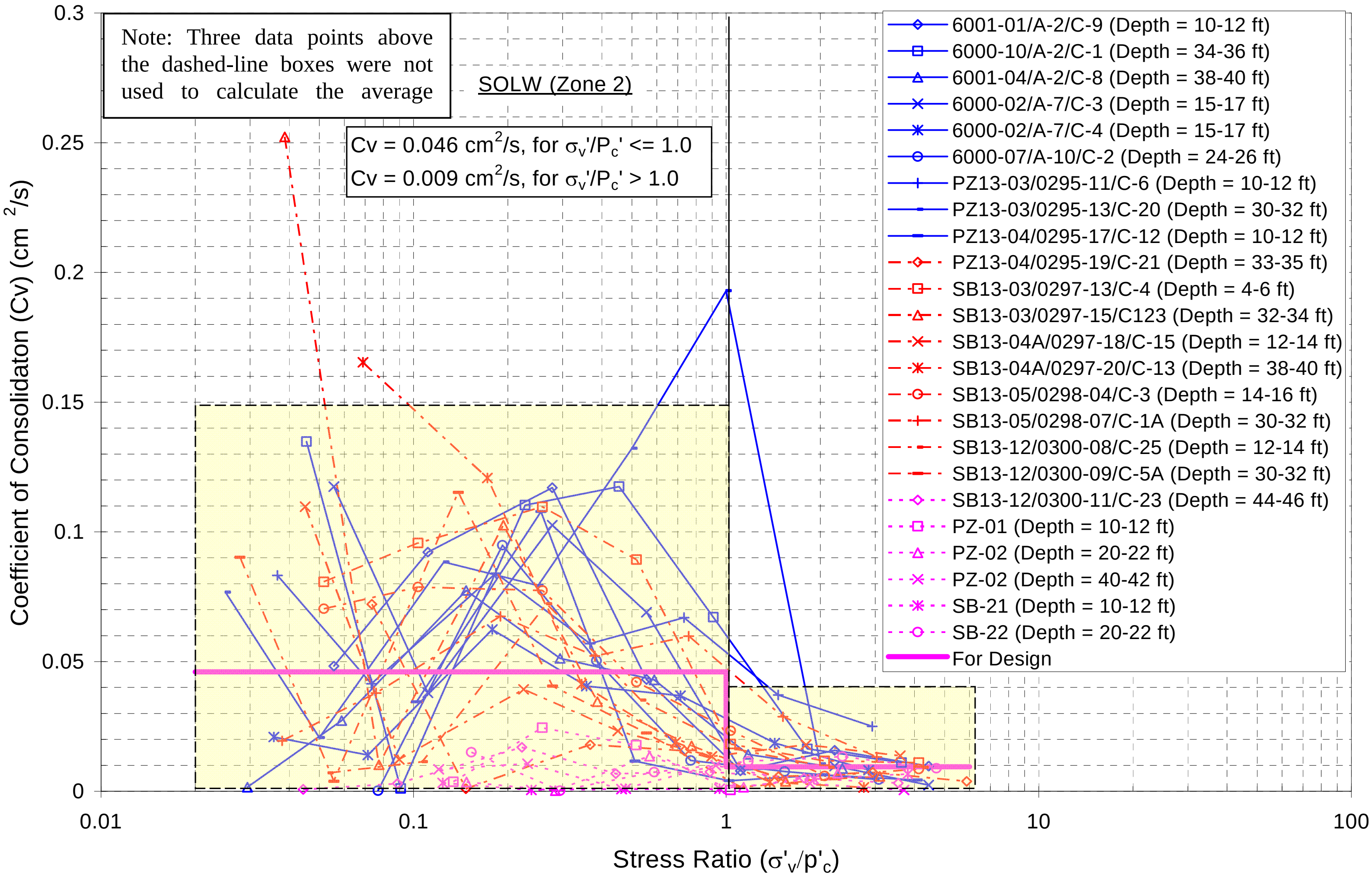


Figure 37. Coefficient of Consolidation for SOLW in Zone 2
[based on 1-D consolidation test reports provided in Parsons and Geosyntec (2008a) and Parsons (2008c)]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

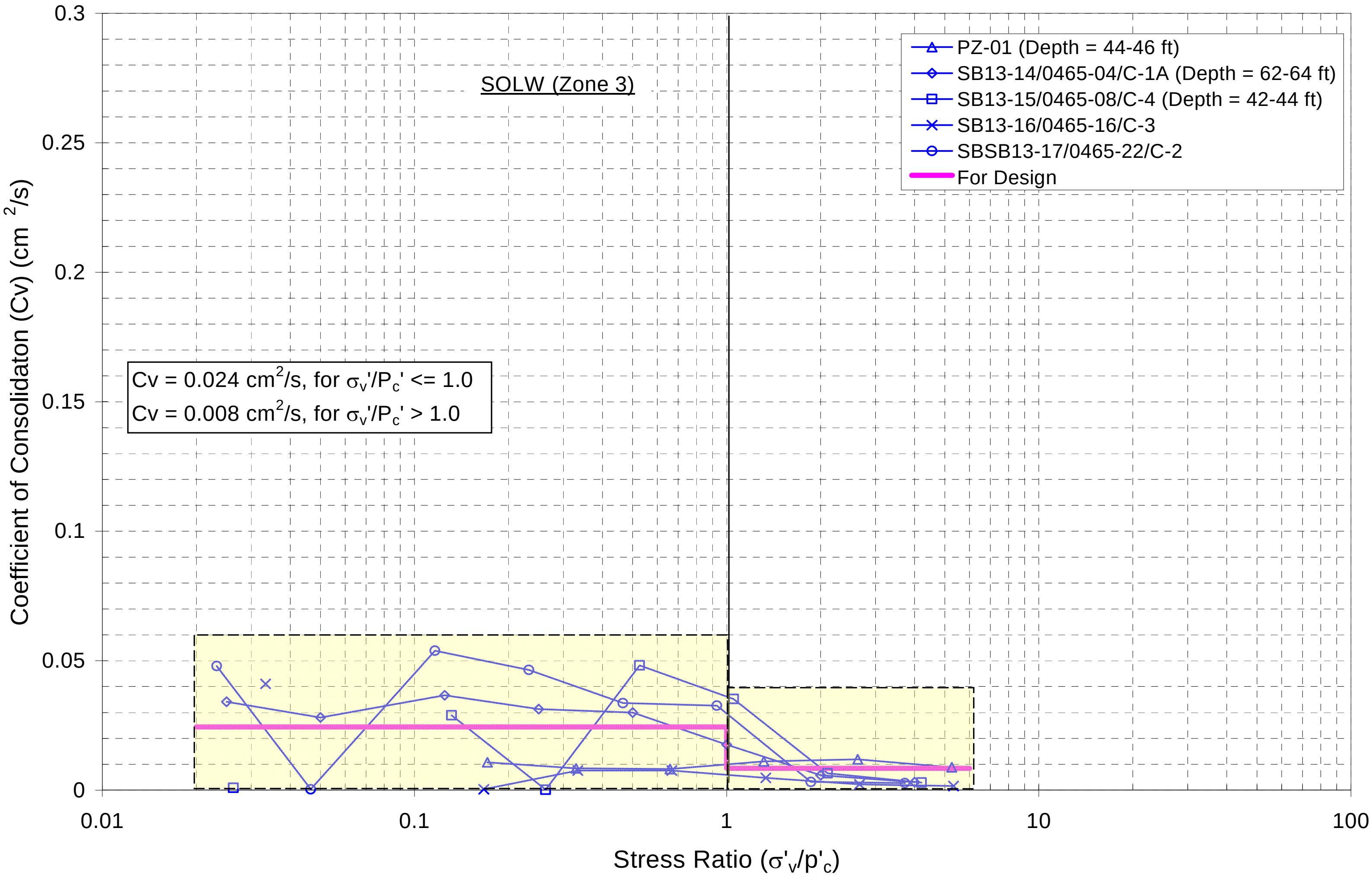


Figure 38. Coefficient of Consolidation for SOLW in Zone 3
[based on 1-D consolidation test reports provided in Parsons and Geosyntec (2008a) and Parsons (2008c;2009)]

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

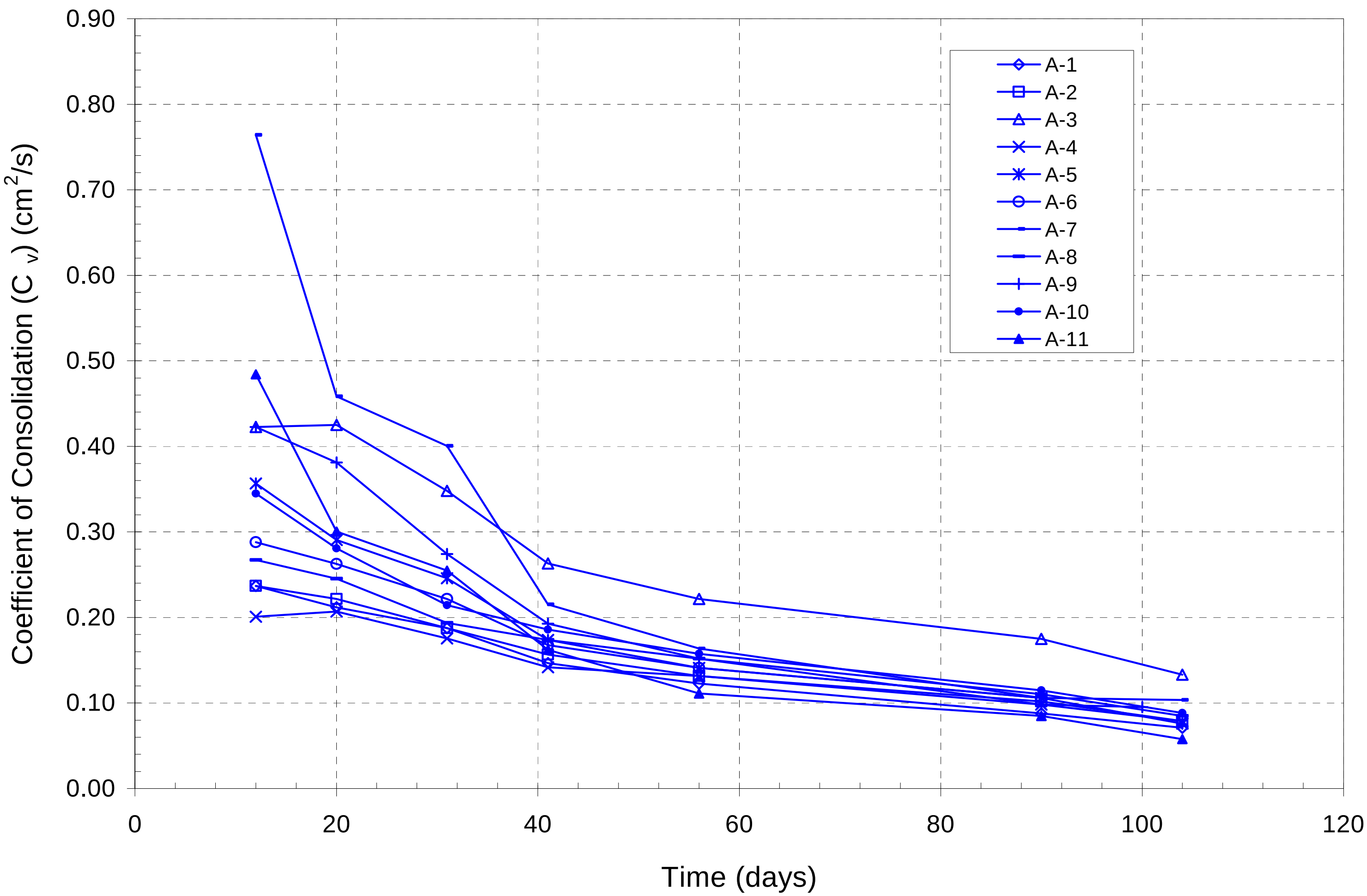


Figure 39. Coefficient of Consolidation from Phase I Pilot Study

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

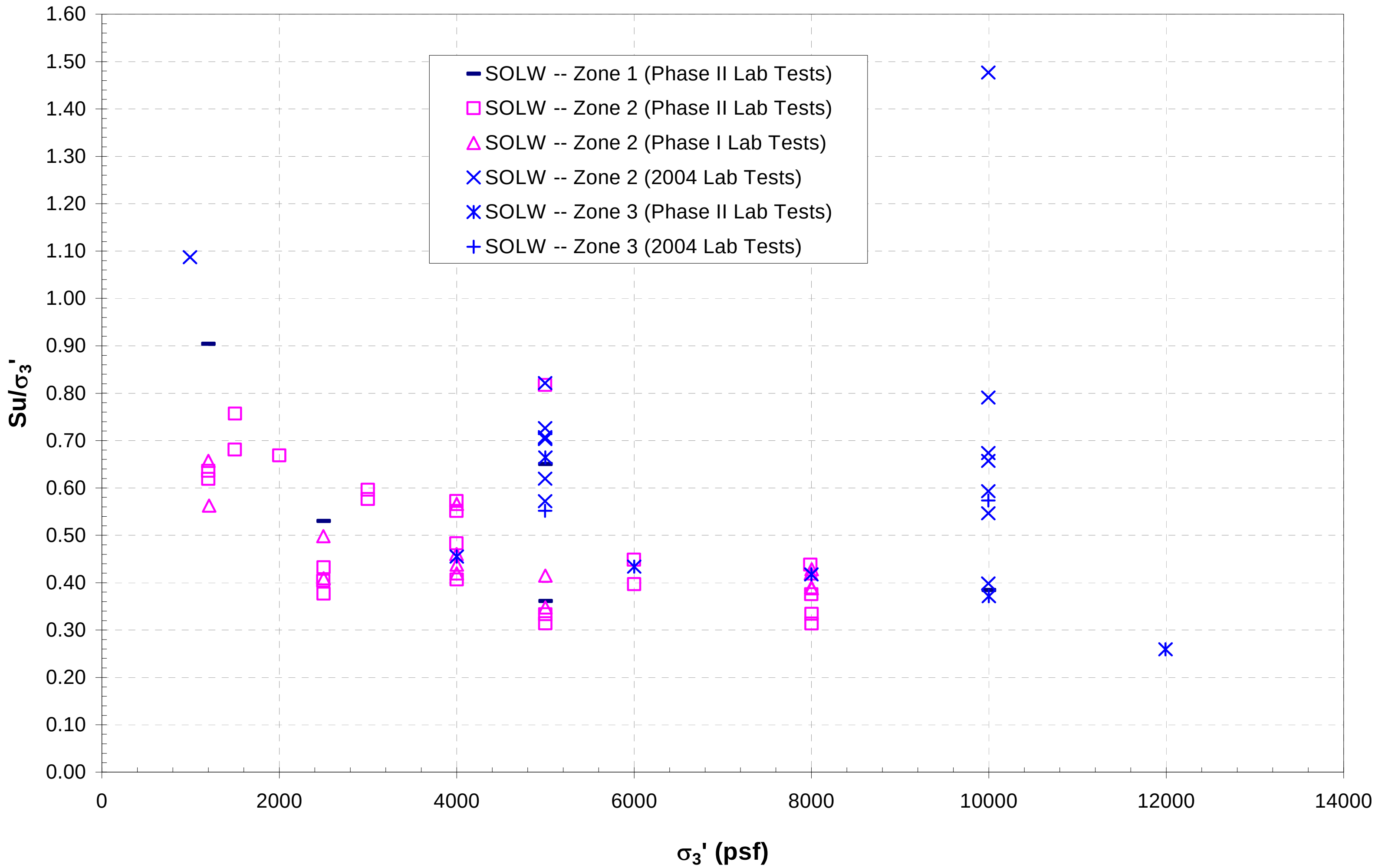
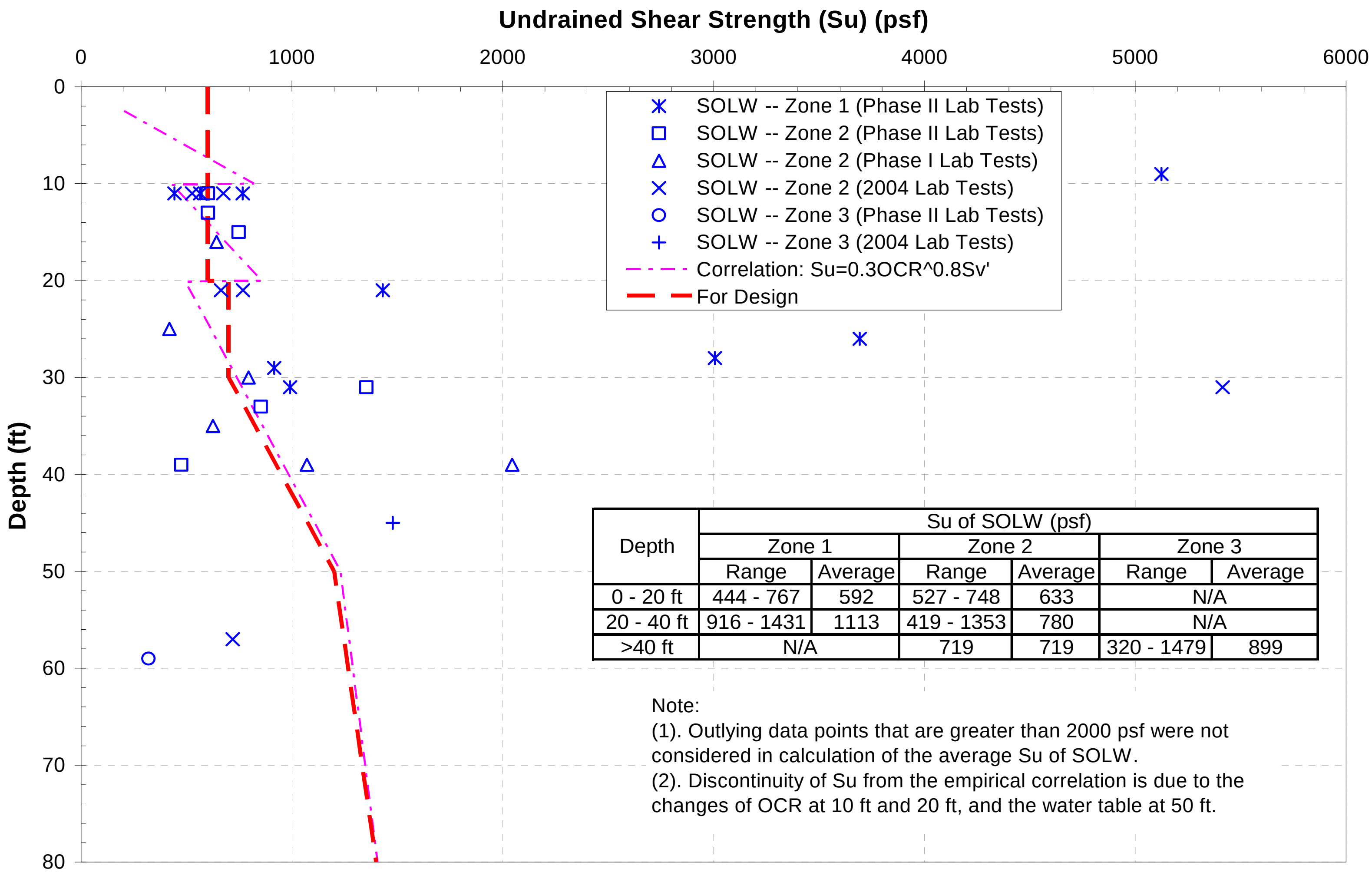


Figure 40. Undrained Strength Ratio of SOLW
[Data from the summary tables provided in Attachment 3]

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04



Depth	Su of SOLW (psf)					
	Zone 1		Zone 2		Zone 3	
	Range	Average	Range	Average	Range	Average
0 - 20 ft	444 - 767	592	527 - 748	633	N/A	
20 - 40 ft	916 - 1431	1113	419 - 1353	780	N/A	
>40 ft	N/A		719	719	320 - 1479	899

Note:
(1). Outlying data points that are greater than 2000 psf were not considered in calculation of the average Su of SOLW.
(2). Discontinuity of Su from the empirical correlation is due to the changes of OCR at 10 ft and 20 ft, and the water table at 50 ft.

Figure 41. Undrained Shear Strength of SOLW
[Data from the summary tables provided in Attachment 3]

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

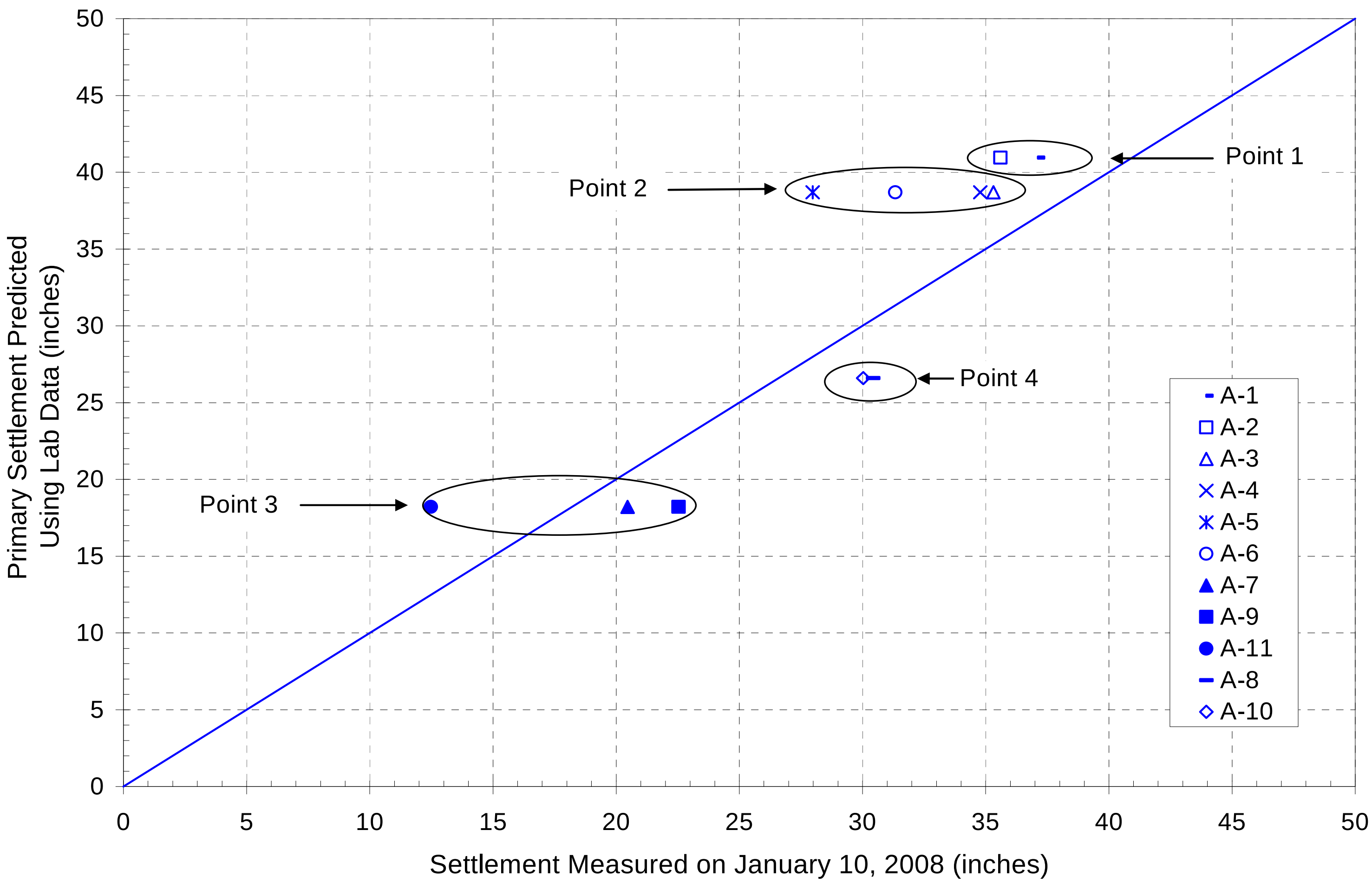


Figure 42. Comparison of Predicted Settlement with Settlement from Phase I Pilot Study

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

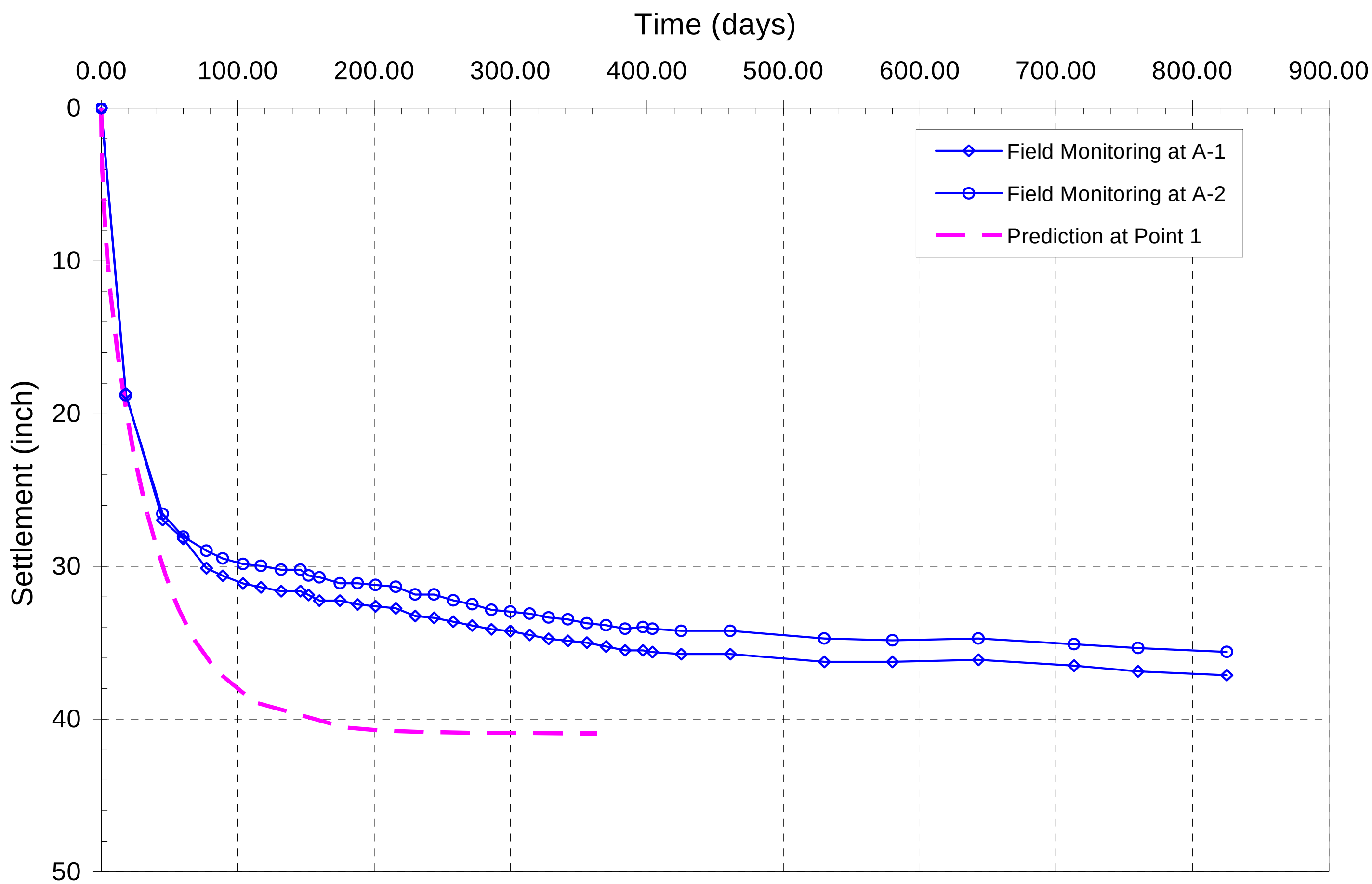


Figure 43. Prediction of Time Rate of Consolidation at Point 1

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

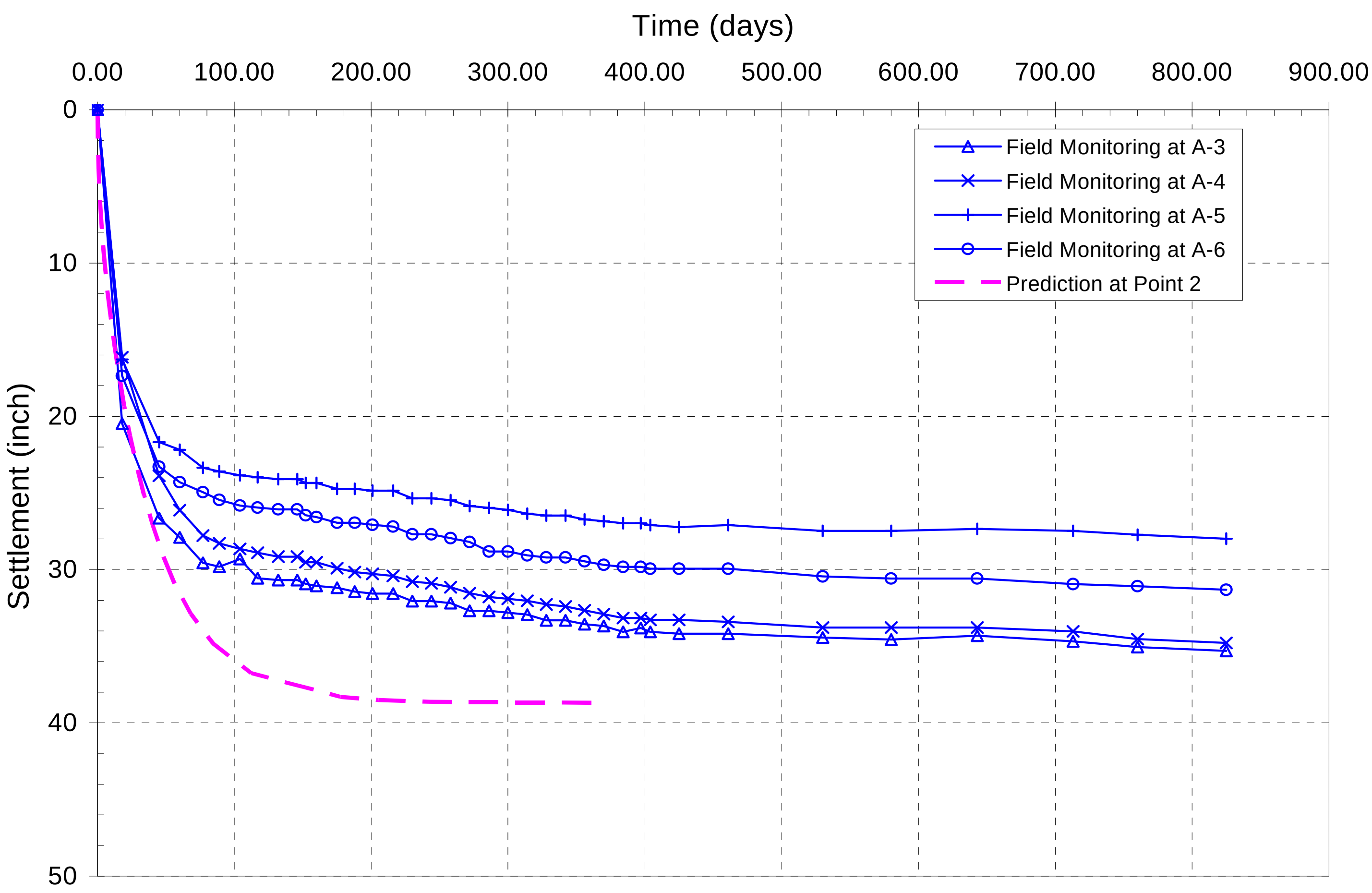


Figure 44. Prediction of Time Rate of Consolidation at Point 2

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

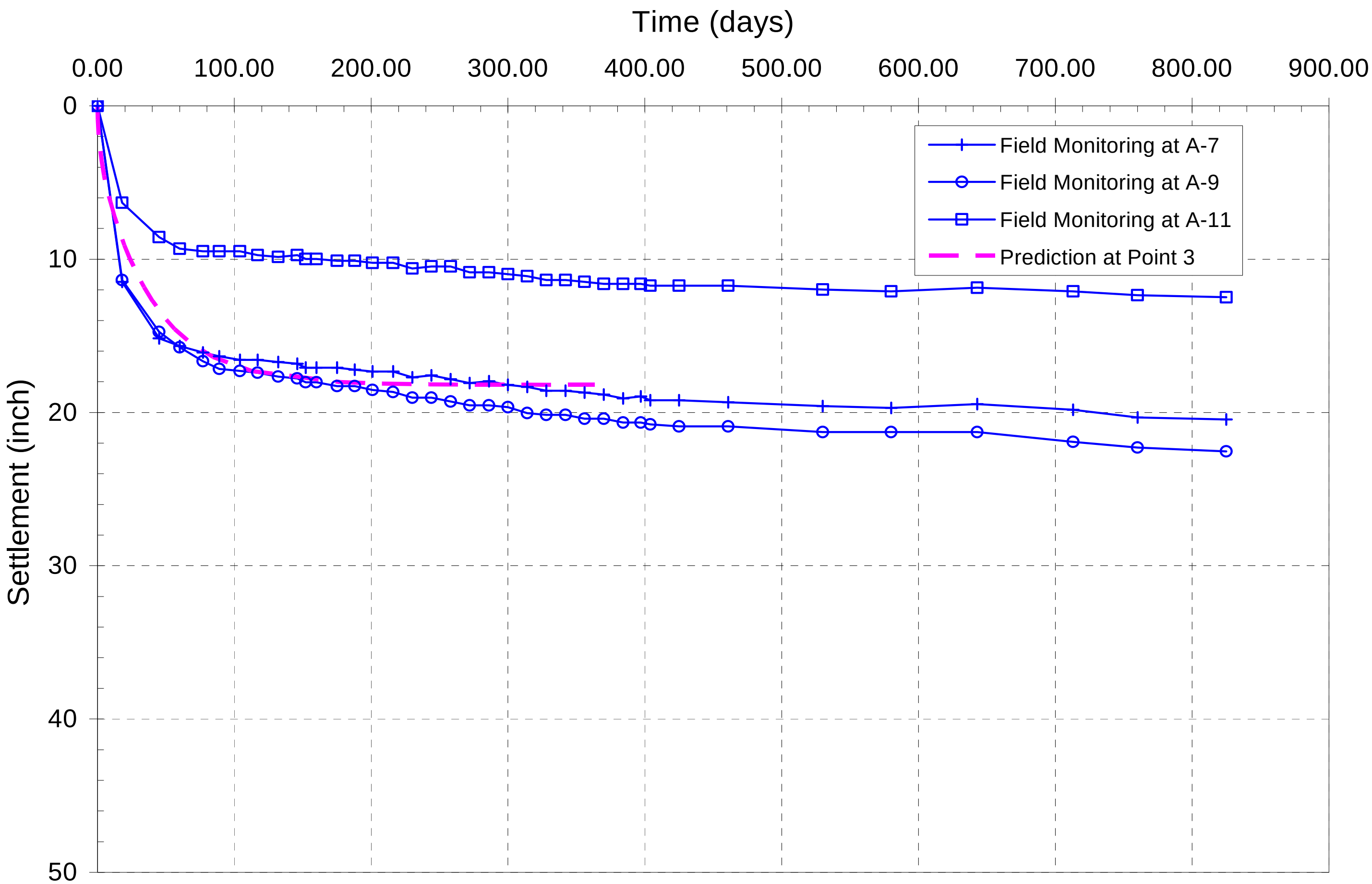


Figure 45. Prediction of Time Rate of Consolidation at Point 3

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

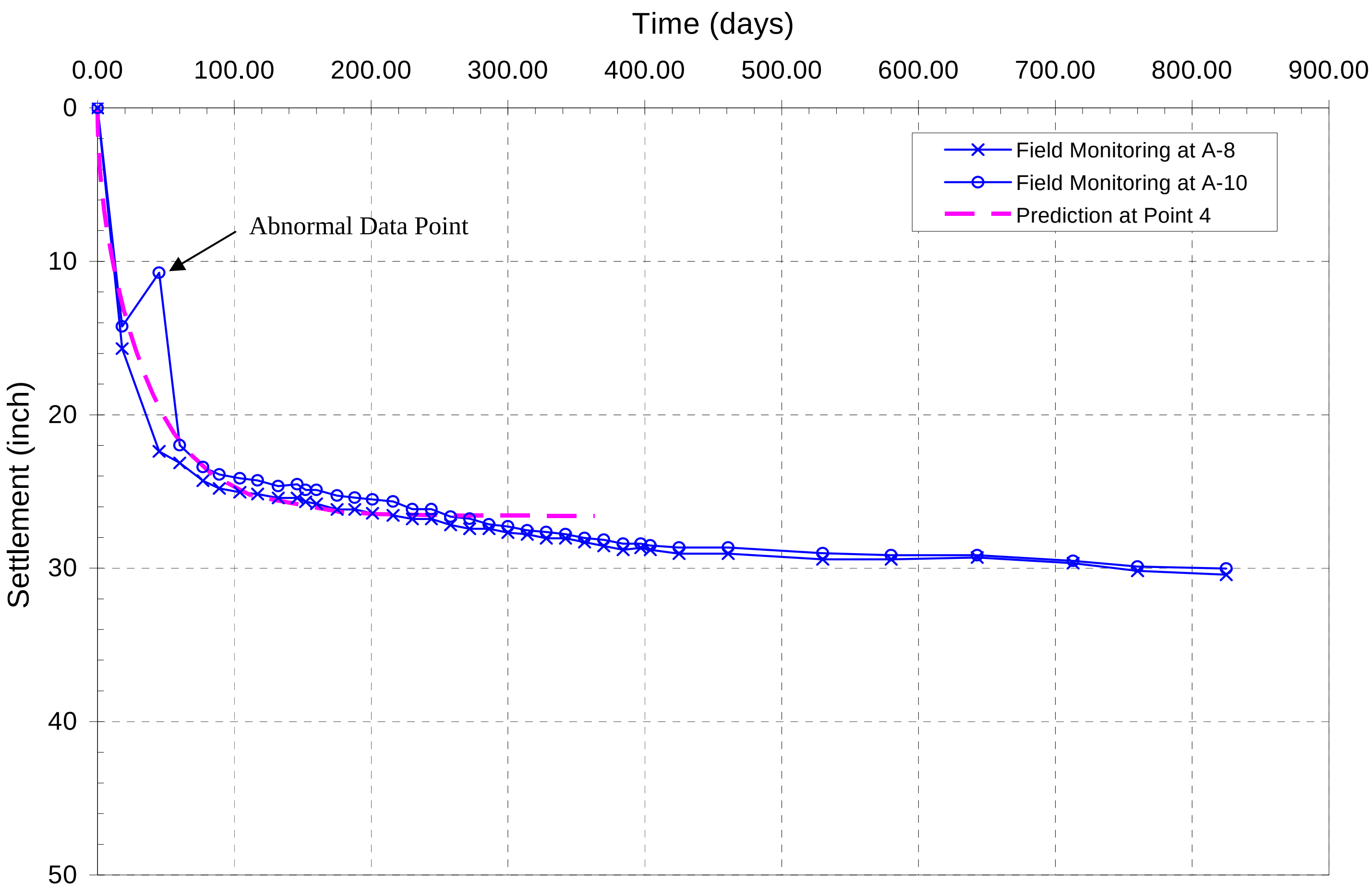


Figure 46. Prediction of Time Rate of Consolidation at Point 4

Attachment 1

Estimated Solvay Waste Thickness

(Provided to Geosyntec by Parsons; Phase III Thicknesses were added by Geosyntec)

Attachment 2

Piezometer Data Collected Between November 2006 and December 2007

(Provided to Geosyntec by Parsons)

Attachment 3

Summary Tables of Lab Test Results

2004 Lab Results

(Presented in Appendix A of the report titled "*Onondaga Lake Pre-Design Investigation: Wastebed 13 Settlement Pilot Study Data Summary Report*" prepared by Parsons and Geosyntec 2008a)

Phase I Lab Results

(Presented in the report titled "*Onondaga Lake Pre-Design Investigation: Wastebed 13 Settlement Pilot Study Data Summary Report, Onondaga County, New York*" prepared by Parsons and Geosyntec [2008a])

Phase II Lab Results

(Provided to Geosyntec by Parsons and included in the report "*Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report*" prepared by Parsons [2008c])

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

Phase III Lab Results

(Provided to Geosyntec by Parsons and included in Appendix E of "*Onondaga Lake Pre-Design Investigation Phase III Data Summary Report*" prepared by Parsons in 2008)

Attachment 4

Verification of Subsurface Model and Compressibility of SOLW Based on Test Pad Results

Part I: Prediction of Primary Consolidation Settlement Based on Field Test Data

Introduction

Terzaghi's one dimensional (1-D) consolidation theory was used to interpret the field test results from the Phase I Settlement Pilot Study and to predict the primary consolidation settlement. The initial excess pore water pressure was assumed to be constant throughout the SOLW layer and two-way drainage was assumed (i.e., at top and bottom of the waste). The average thickness of the SOLW layer under the test fill is calculated to be 72 ft. Hence, the longest drainage path H_{dr} is equal to one-half of the layer thickness (i.e., 36 ft). The major calculation steps included the following.

1. Use the excess pore water pressure measured in the field to develop the excess pore water pressure profile at each piezometer location for each time period that piezometers were monitored. The location of piezometers A-1 through A-11 are presented in Figure 4-1 of this attachment.
2. Use the excess pore water pressure profile at each piezometer to calculate the average degree of consolidation for the entire depth of the compressible SOLW layer at each monitoring time period.
3. Use the calculated average degree of consolidation for the SOLW layer at each monitoring time period to calculate the coefficient of consolidation.
4. Use the measured settlements and the calculated average degree of consolidation at each time period for each piezometer location to predict the primary consolidation settlement at that location.

Piezometer and settlement data that was recorded during the time period between October 15, 2005 and January 5, 2006 (i.e., approximately 100 days after the placement of test fill) was considered in prediction of the primary consolidation settlement. The predicted primary settlement is compared to field data measured on January 10, 2008 (i.e., approximately 2.3 years after the placement of test fill) in Part III of this attachment.

Calculation of Degree of consolidation

The degree of consolidation at any depth was calculated by

$$U(z,t) = 1 - \frac{u_z}{u_0}$$

where

u_z = excess pore water pressure at any depth at a given time *t*.

u_0 = initial excess pore water pressure

Measured excess pore water pressures were recorded in the field by Parsons as the equivalent water pressure (i.e., piezometric) head. Based on the fill loading process and the stress distribution below the test fill (see Part II of this attachment for discussion regarding stress distribution), the initial excess pore water pressure head used in subsequent analyses was assumed to be the measured excess pore water pressure after the end of fill placement. Based on the data provided by Parsons, these values were assumed to be: (i) 18 ft for locations A-1 through A-6; and (ii) 14.4 ft for locations A-7 through A-11. The typical piezometer response to loading that shows these initial excess pore water pressure heads after the end of fill placement as well as the excess pore water pressures at other monitoring periods is presented in Figure 4-2. Using these field monitoring results and the referenced equation, the degree of consolidation for each piezometer at selected monitoring time periods was calculated. Results from each piezometer location are presented in Figure 4-3. It is noted that rainfall and snowmelt in late December 2005 and early January 2006 combined to locally increase the water levels in most piezometers, resulting in a decrease in the calculated degree of consolidation in the SOLW layer relative to the previous time period.

Calculation of Average Degree of Consolidation

The average degree of consolidation for the entire depth of the compressible waste layer at any time can be determined by the following equation and shown schematically in Figure 4-4.

$$\overline{U}(t) = \frac{1}{2H_{dr}}\int_0^{2H_{dr}} U(t,z)dz = \frac{Area1}{Total\ \ Area}$$

Using the data plotted in Figure 4-3 explicitly, the area "Area 1" was calculated, and the average degree of consolidation at the selected monitoring time periods was evaluated. Results are shown in Figure 4-5.

Calculation of Coefficient of consolidation

The coefficient of consolidation was calculated by

$$C_v = \frac{T_v H_{dr}^2}{t}$$

where, H_{dr} is the longest drainage path and was assumed to be 36 ft for the SOLW under the test fill. T_v is the time factor and was determined according to the calculated average degree of consolidation ($\overline{U}$). The tabulated values of the time factors and their corresponding average degrees of consolidation can be found in most geotechnical engineering textbooks, or they may be approximated by the following relationship:

$$T_v = \frac{\pi}{4}\overline{U}^2 \qquad \text{for } \overline{U} = 0 \text{ to } 0.60$$

$$T_v = 1.781 - 0.933\log(100 - 100\overline{U}) \qquad \text{for } \overline{U} > 0.6$$

The calculated C_v are plotted in Figure 4-6 as a function of time.

Prediction of Primary Consolidation Settlement

The primary consolidation settlement (S) was calculated by

$$S = \frac{S_t}{\overline{U}}$$

where, S_t is the settlement measured by the settlement plates in the field at time t. $\overline{U}$ is the corresponding average degree of consolidation at that time. The calculation results for the primary consolidation settlement are presented in Table 4-1 and are plotted in Figure 4-7. The average of the values presented in column 3 (i.e., S at time t = 45 days) to column 7 (i.e., S at time t = 104 days) was calculated and recorded in the last column of Table 4-1. The values presented in the last column are subsequently referenced as the predicted primary consolidation settlement based on the field monitoring data at each piezometer location.

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

Part II. Prediction of Primary Consolidation Settlement Based on Laboratory Test Data

Introduction

The ultimate primary consolidation settlement was calculated based on the compression parameters derived from laboratory testing results. The calculation steps included the following:

1. Use the laboratory test results to derive the waste compression properties.
2. Calculate the initial stress distribution in the waste.
3. Apply the Boussinesq solution for elastic stress distribution to calculate the vertical stress increase caused by the loading from the test fill.
4. Break the waste profile into sub-layers and calculate the primary consolidation settlement of each sub-layer.
5. Add the calculated settlement of each sub-layer to obtain the total primary consolidation settlement.

The predicted primary settlement is compared to measurement on January 2008 in Part III of this attachment.

Material Properties

The recommended design parameters summarized in Table 21 in this package were used to calculate the primary consolidation settlement of SOLW under the load from the test fill.

Subsurface Geometry

As mentioned before, the average thickness of SOLW under the test fill was calculated to be 72 ft. The groundwater table was considered to be 50 ft bgs as discussed in this package.

Locations of Selected Calculation Points

Four locations were selected for the settlement calculation as shown in Figure 4-8. These four points coincide with the relative locations of settlement plates in the test fill. The calculation Point 1 represents the settlement plates A-1 and A-2; Point 2 represents A-3 to A-6; Point 3 represents A-7, A-9, and A-11; and Point 4 represents A-8 and A-10.

Loading

Loading from the 10-ft high test fill was simplified to be rectangular as shown in Figure 4-9. According to the Boussinesq solution for a rectangular loading, the vertical stress increase at depth z below the corner of a rectangular area is

$$\Delta\sigma = qI_3$$

where

$$I_3 = \frac{1}{4\pi}\left[\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2+m^2n^2+1}\left(\frac{m^2+n^2+2}{m^2+n^2+1}\right)+\tan^{-1}\left(\frac{2mn\sqrt{m^2+n^2+1}}{m^2+n^2-m^2n^2+1}\right)\right]$$

$$m = \frac{B}{z},\ n = \frac{L}{z}$$

The calculated stress increases at these four locations are plotted in Figure 4-10 with respect of depth.

Calculation of Primary Consolidation Settlement

The primary consolidation settlement was calculated using the conventional 1-D consolidation theory as expressed in the following equations (Figure 4-11):

$$S = C_{r\varepsilon} H \log\frac{\sigma_0' + \Delta\sigma'}{\sigma_0'} \qquad \text{for } \sigma_0' + \Delta\sigma' < p_c'$$

$$S = C_{r\varepsilon} H \log\frac{p_c'}{\sigma_0'} + C_{c\varepsilon} H \log\frac{\sigma_0' + \Delta\sigma'}{p_c'} \qquad \text{for } \sigma_0' < p_c' \text{ and } \sigma_0' + \Delta\sigma' > p_c'$$

$$S = C_{c\varepsilon} H \log\frac{\sigma_0' + \Delta\sigma'}{\sigma_0'} \qquad \text{for } \sigma_0' > p_c'$$

where,

S = primary consolidation settlement
H = thickness of compressible layer
σ_0' = initial effective stress
$\Delta\sigma'$ = effective stress increase due to fill placement
p_c' = pre-consolidation pressure
$C_{r\varepsilon}$ = modified recompression index
$C_{c\varepsilon}$ = modified compression index

The primary settlement was calculated using the Excel spreadsheet as presented in Table 4-2 at the four selected locations.

Part III. Comparison of Predicted Settlement with Measured Settlement on January 10, 2008

Table 4-3 summarizes the predicted primary consolidation settlement based on the field monitoring data and the laboratory testing data discussed in Part I and Part II, respectively, of this attachment. The settlement measured on January 10, 2008 is also presented in this table.

The predicted settlements are compared to the measured settlements as shown in Figures 4-12 and 4-13. The plotted data points are in general close to the 45 degree line, indicating a good agreement between the predicted settlement and the settlement measured from the field test on January 10, 2008.

There are several factors that may contribute to the slight difference between the predicted settlement and the measured settlement:

1. The shape of the test fill: The constructed test fill has an irregular shape (Figure 4-14); while in the stress distribution calculation it was idealized to have a 200 ft by 200 ft square footprint.
2. The thickness of SOLW: Under the footprint of the test fill, the thickness of SOLW varies slightly as presented in Table 4-4; while in the prediction calculation a uniform thickness of 72 ft was used.
3. Material properties: The SOLW beneath the test fill is heterogeneous with inter-layered hard and soft zones; while in the prediction calculation the SOLW was divided into two zones and within each zone the SOLW was assumed homogeneous.
4. Secondary consolidation settlement: The predicted settlement includes only the primary settlement; while the measured settlement on January 10, 2008 includes the primary settlement and part of the secondary consolidation settlement. The total secondary consolidation settlement was estimated to be about 10 inches over 30 years based on the lab consolidation test data.
5. Limitation of the 1-D consolidation theory: Consolidation of the SOLW material under the test fill is a 3-D process; while the 1-D consolidation theory, which has been widely accepted in typical engineering practice, was used to predict the consolidation settlement.

Part IV. Calculation of Time Rate of Consolidation for Test Pad

Methodology

Terzaghi's 1-D consolidation theory was used to calculate the time rate of the consolidation. The consolidation time *t* can be calculated using

$$t = \frac{T_v H_{dr}^2}{c_v}$$

where, H_{dr} is the longest drainage path and equals 36 ft for SOLW in the test pad area (assuming two-way drainage). T_v is the time factor and determined according to the degree of consolidation (*U*) using the following relationship

$$T_v = \frac{\pi}{4}U^2 \qquad \text{for } U = 0 \text{ to } 60\%$$

$$T_v = 1.781 - 0.933\log(100 - 100U) \qquad \text{for } U > 60\%$$

c_v is the coefficient of consolidation. The recommended value of c_v is presented in Table 21 of this package. Using the above equations, the time *t* corresponding to a certain degree of consolidation *U(t)* can be calculated.

The settlement at the time *t*, i.e., *S(t)*, can be calculated using

$$S(t) = U(t) \cdot S_p$$

where, the S_p is the predicted primary consolidation settlement as presented in Part I of this attachment.

Results of Time Rate of Consolidation

The time rate of consolidation was calculated using the Excel spreadsheet as presented in Table 4-5 at the four selected locations. It is noted that the value of c_v interpreted from the field piezometer data was used in the calculation. The calculated consolidation settlement is plotted with respect to time in Figures 4-15 to 4-18 together with the field monitoring data at the four selected locations, respectively. The results indicate a good agreement between the predicted and measured time rate of consolidation.

Part V. Summary

The subsurface model and the design material properties (i.e., unit weight and compressibility parameters) of SOLW were verified using the results of the WB-13 settlement pilot test performed in 2005. The results indicate a good agreement between the prediction and the measurement for both the primary consolidation settlement and the time rate of settlement.

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

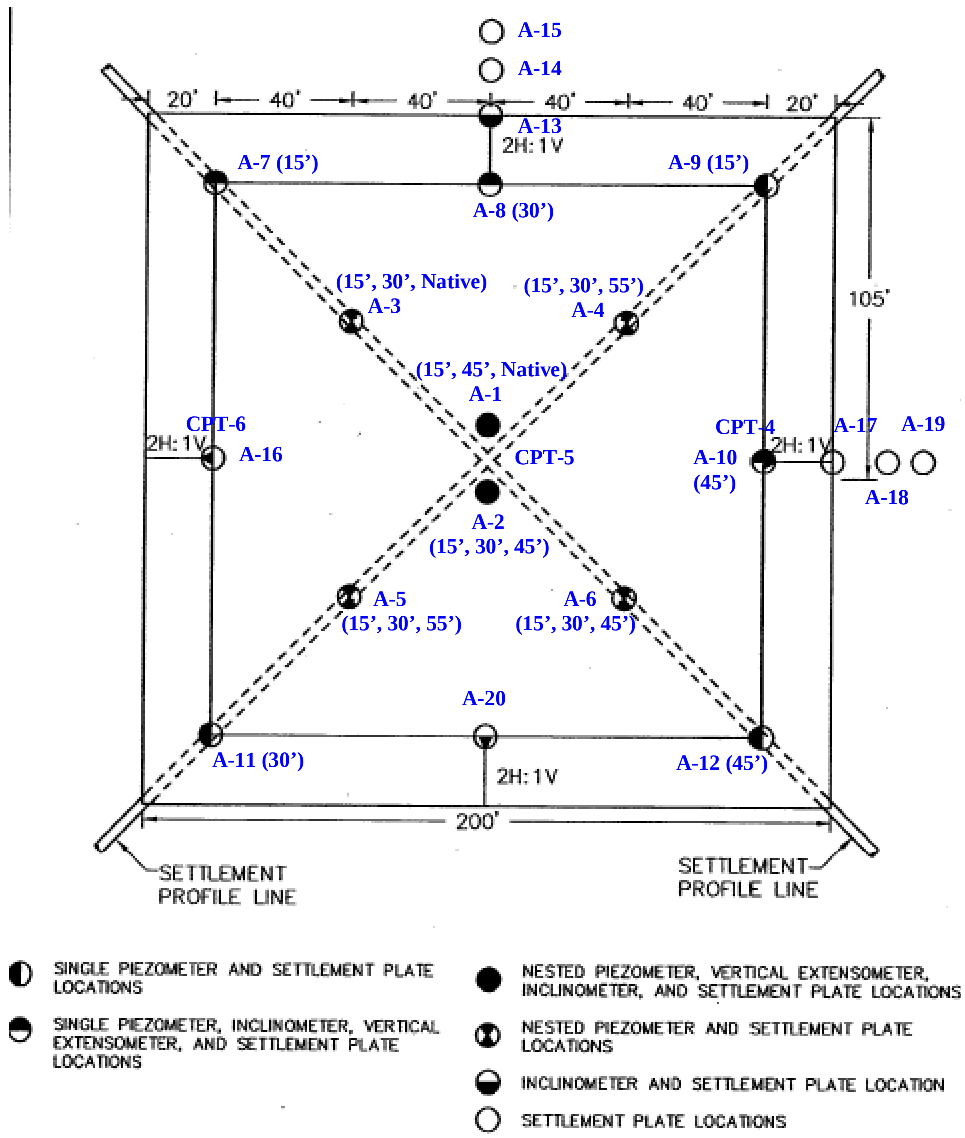


Figure 4-1. Locations of Monitoring Instruments Across Test Fill

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

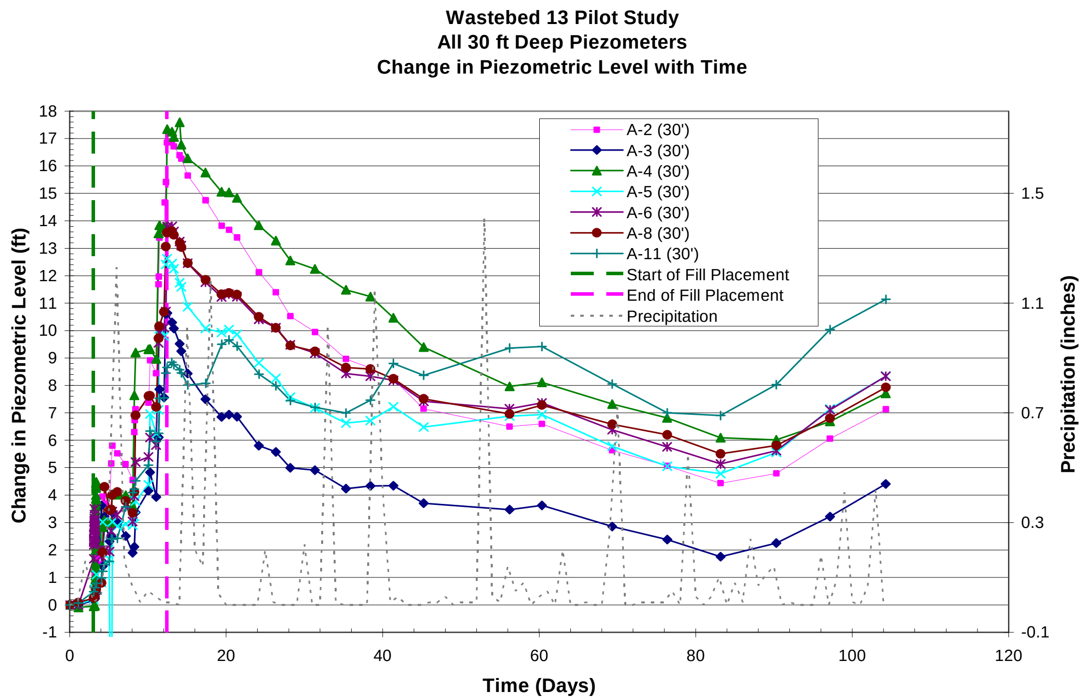


Figure 4-2. Typical Piezometer Response
(Data provided electronically by Parsons)

Note: Fill placement began at time t=0 (October 7, 2005)

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

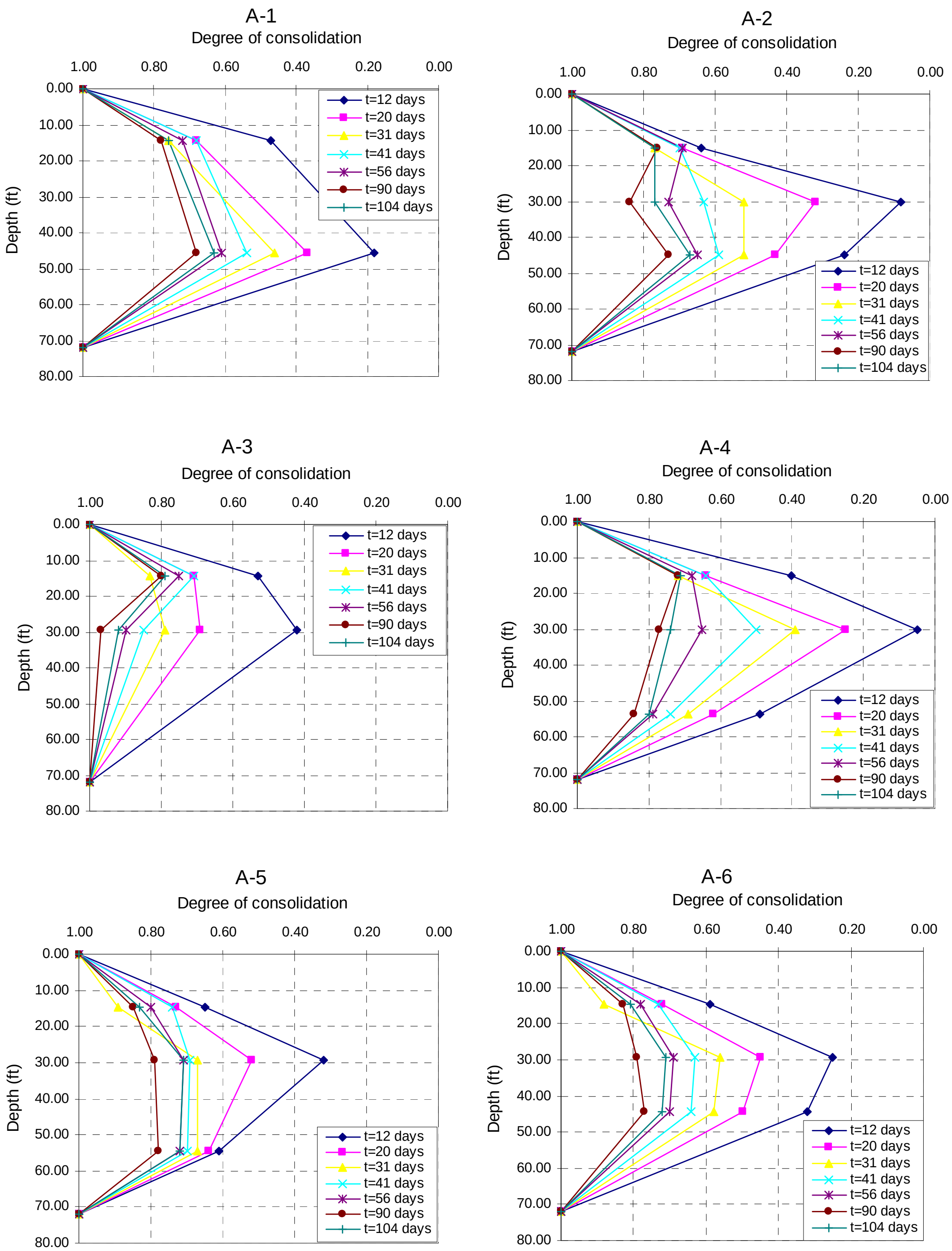


Figure 4-3. Calculation Results for Degree of Consolidation

Written by: Ming Zhu Date: 03/06/2008 Reviewed by: R. Kulasingam/Jay Beech Date: 03/06/2008

Client: Honeywell Project: Onondaga Lake SCA IDS Project/ Proposal No.: GD3944 Task No.: 04

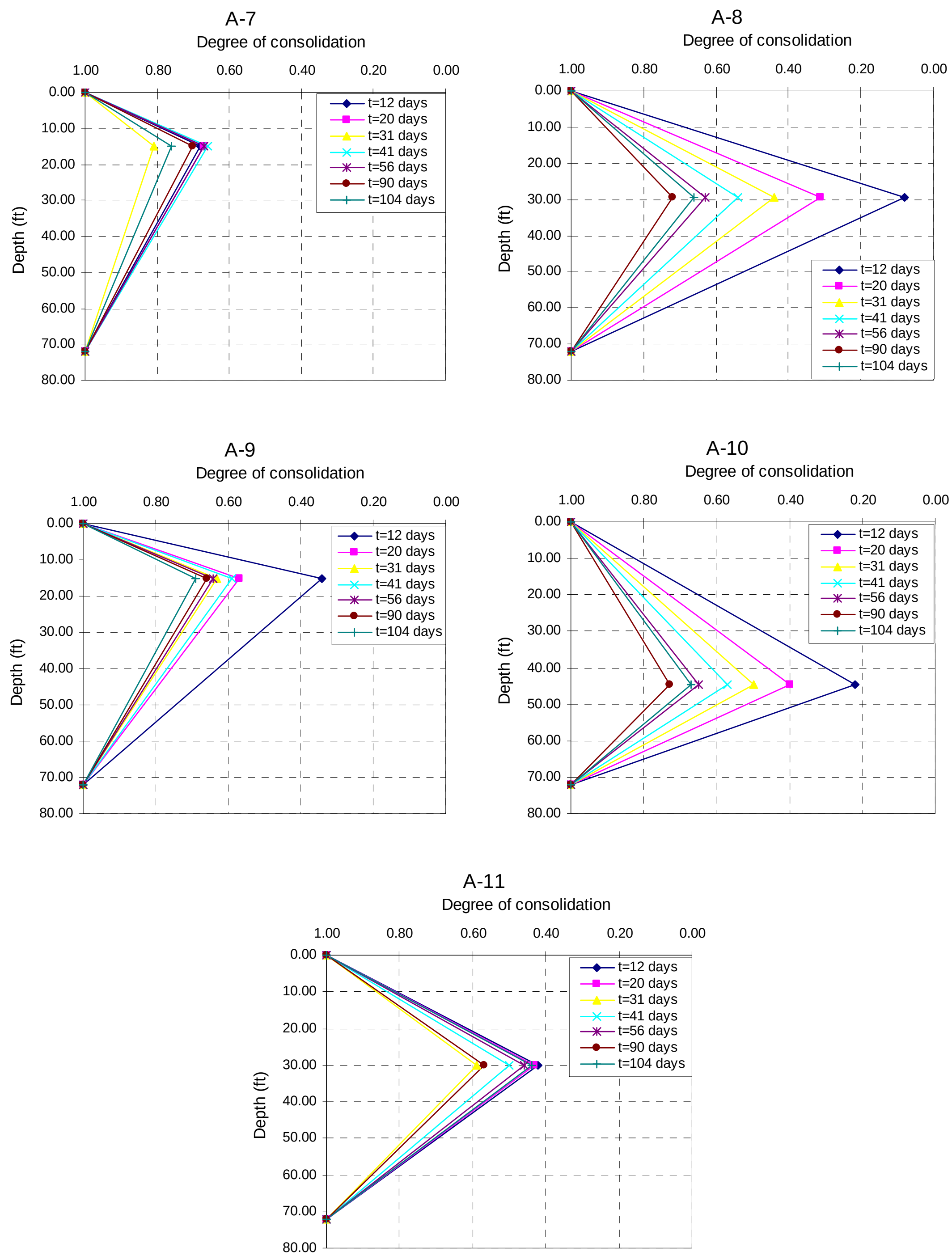


Figure 4-3. Calculation Results for Degree of Consolidation (Continued)

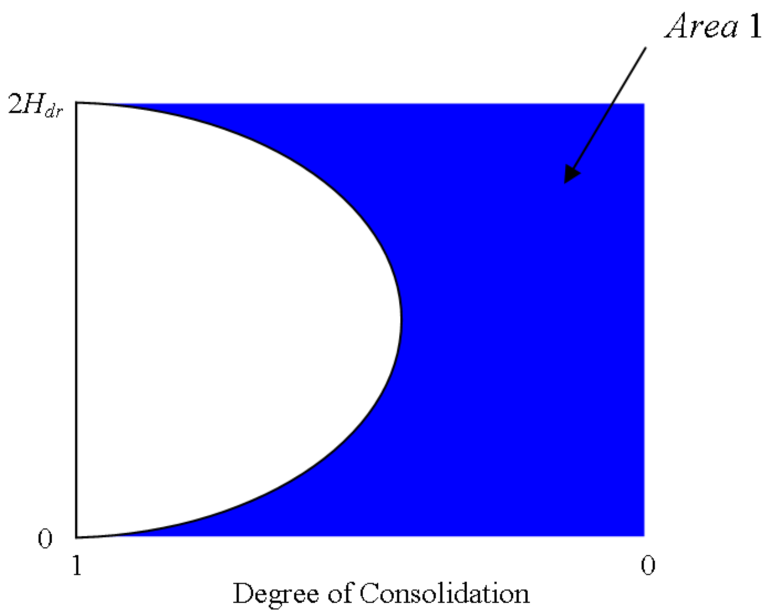
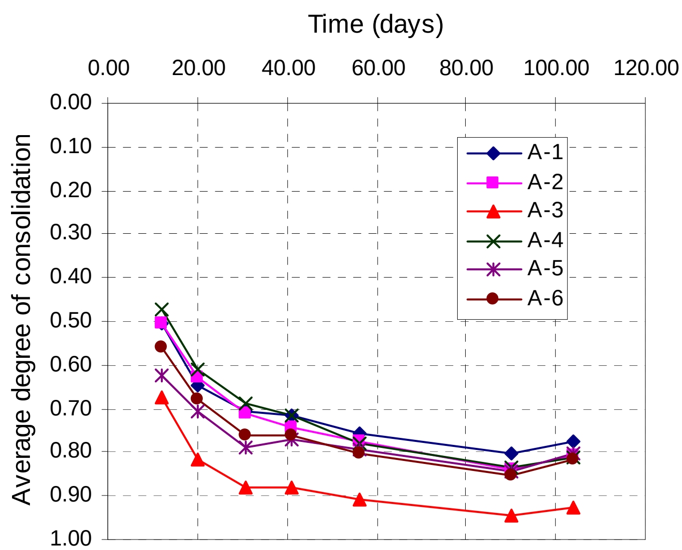


Figure 4-4. Calculation of Average Degree of Consolidation

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**



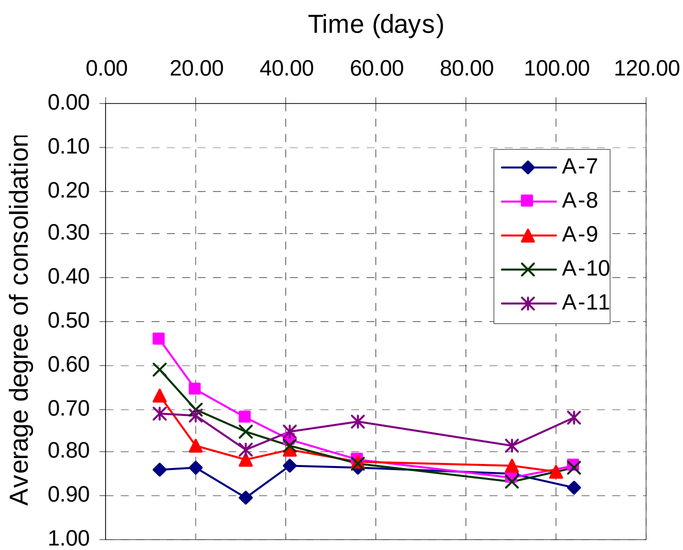


Figure 4-5. Calculated Average Degree of Consolidation

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

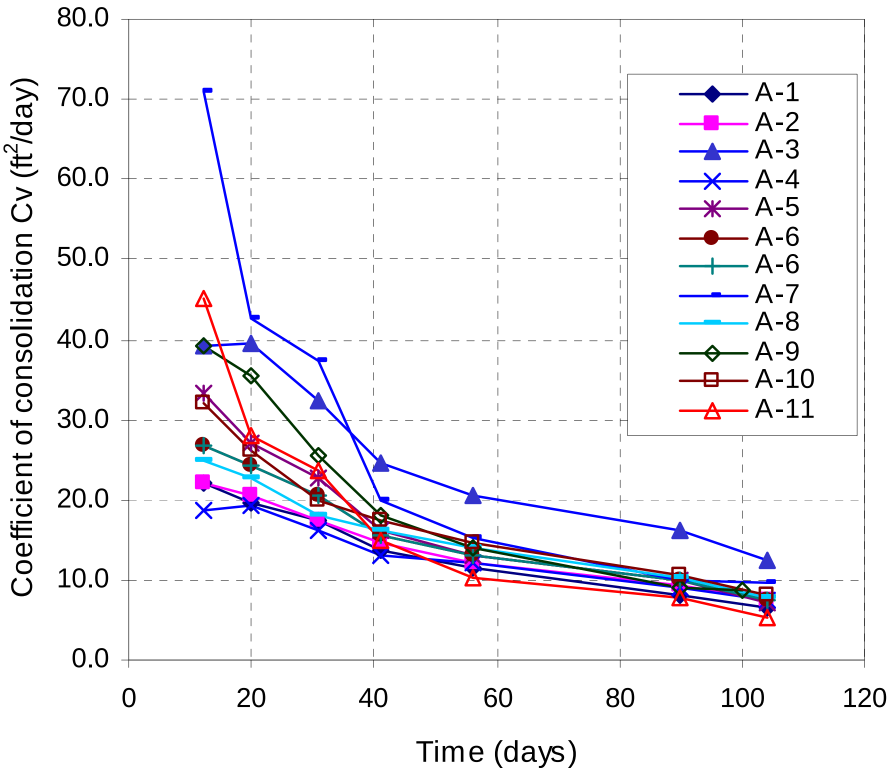


Figure 4-6. Calculated Coefficient of Consolidation

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

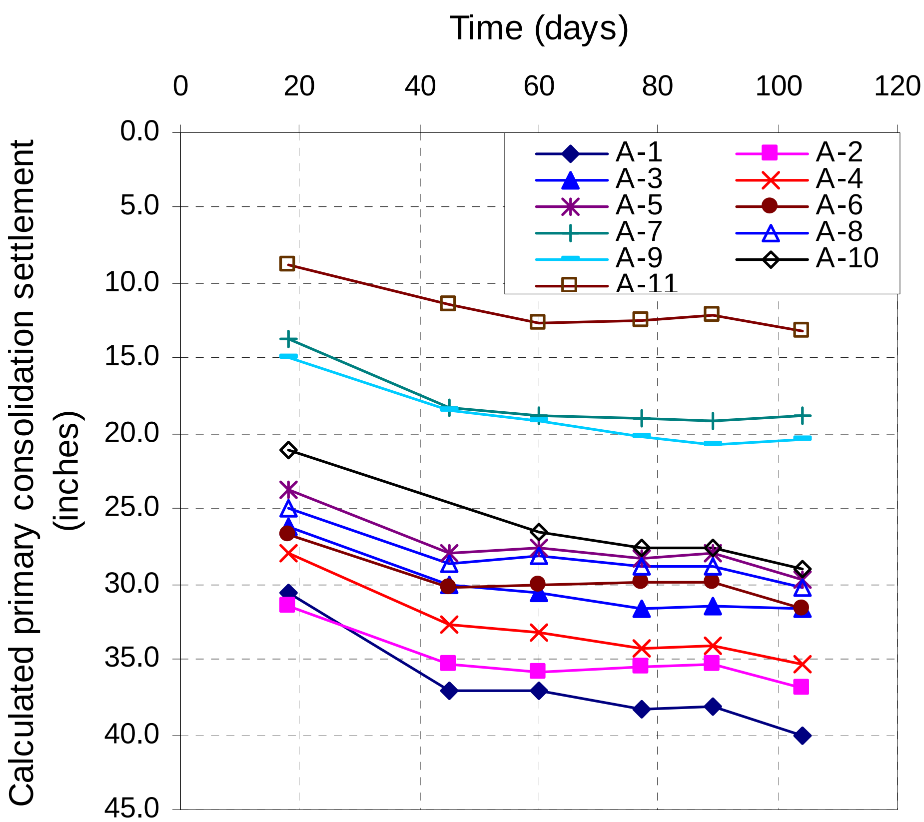


Figure 4-7. Predicted Primary Consolidation Settlement

Note: This figure shows the predicted primary consolidation settlement at a given time using the measured settlement and the corresponding calculated average degree of consolidation at this time.

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

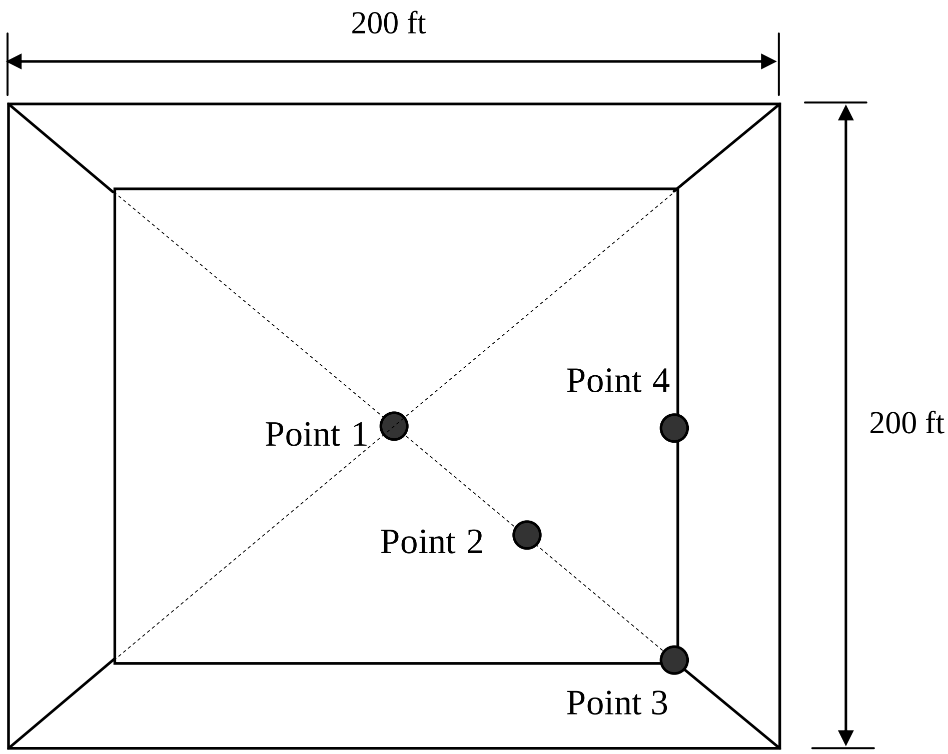
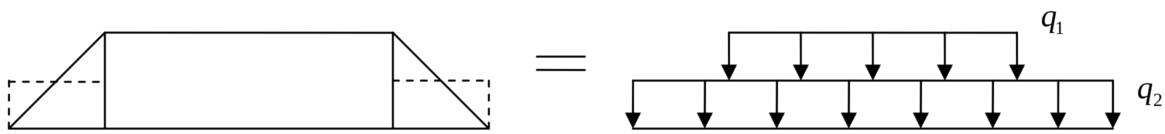


Figure 4-8. Location of Calculation Points



Height of test fill = 10 ft; Side length of bottom surface =200 ft;
Side length of top surface = 160 ft;
Sideslope = 2H:1V;
Total unit weight of test fill = 120 pcf

$q = q_1 + q_2 = 120 \times 10 = 1200\,\text{psf}$

Total volume = $\frac{1}{3} \times 10 \times \left(160 \times 160 + 200 \times 200 + \sqrt{160 \times 160 \times 200 \times 200}\right) = 325333\,\text{ft}^3$

$q_2 = 120 \times \frac{325333 - 160 \times 160 \times 10}{200 \times 200 - 160 \times 160} = 578\,\text{psf}$

$q_1 = q - q_2 = 1200 - 578 = 622\,\text{psf}$

Figure 4-9. Calculation of Test Fill Loading

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

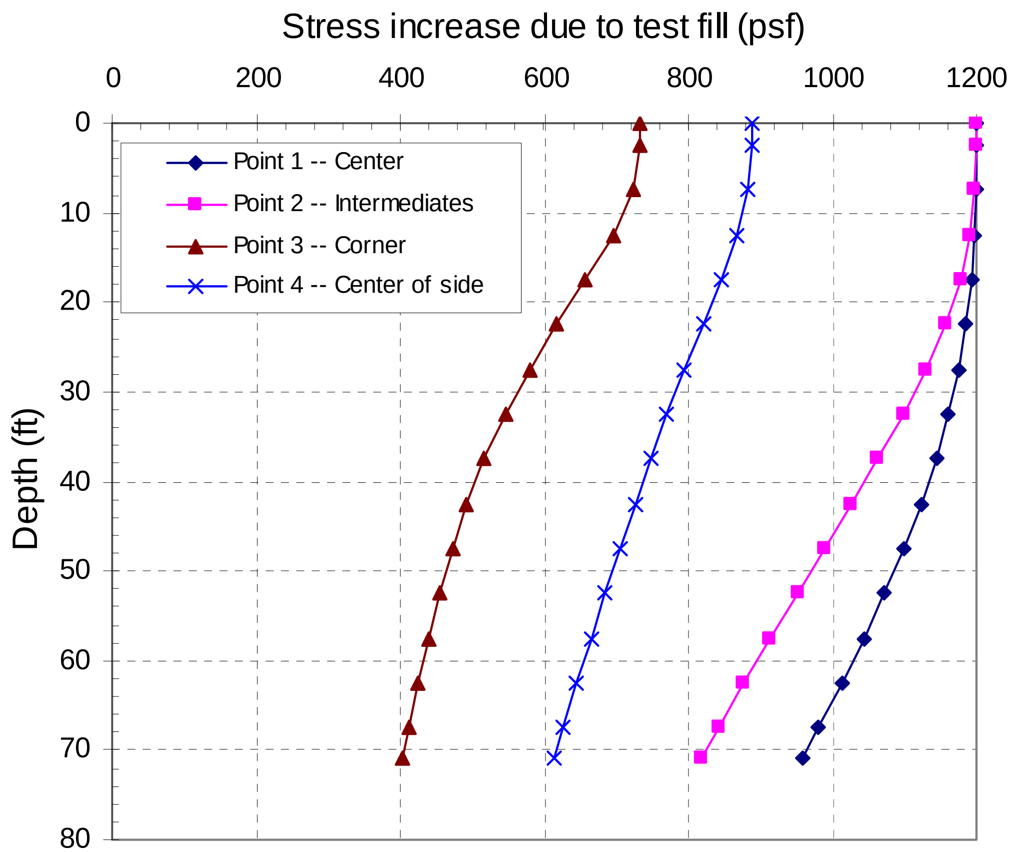


Figure 4-10. Calculated Stress Increase with Depth due to Loading from Test Fill

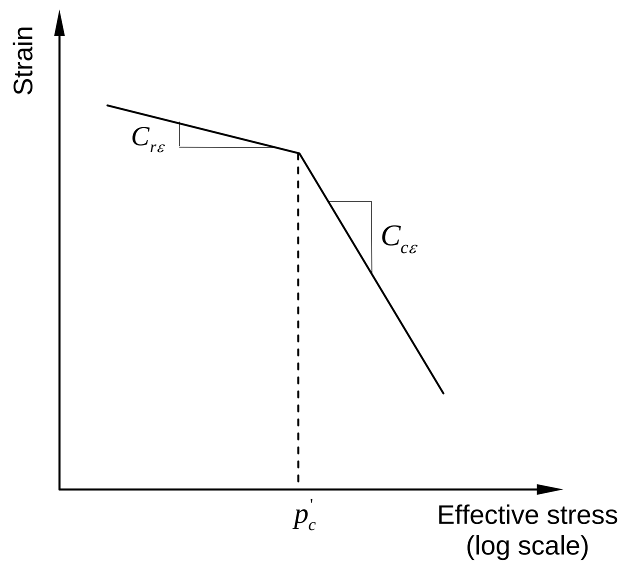


Figure 4-11. 1-D consolidation curve

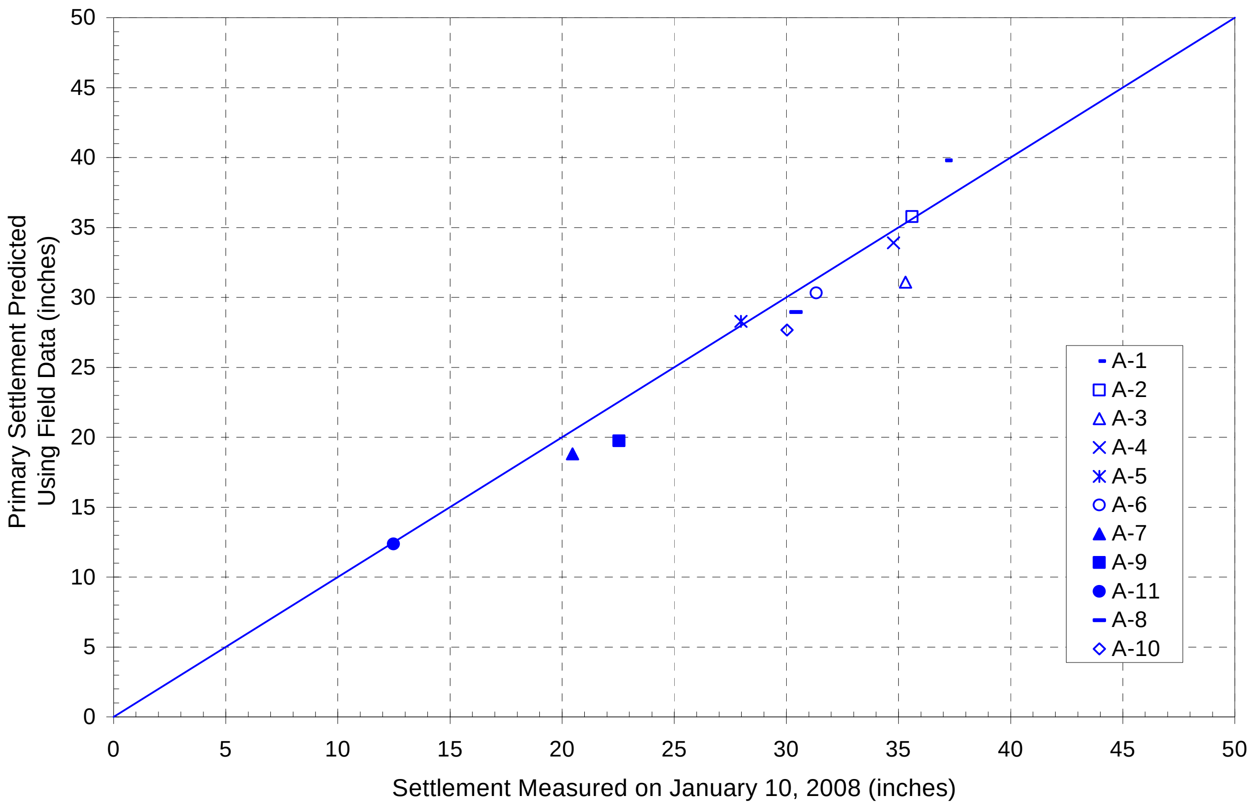


Figure 4-12. Comparison of Predicted Primary Settlement Based on Field Data with Measured Settlement

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

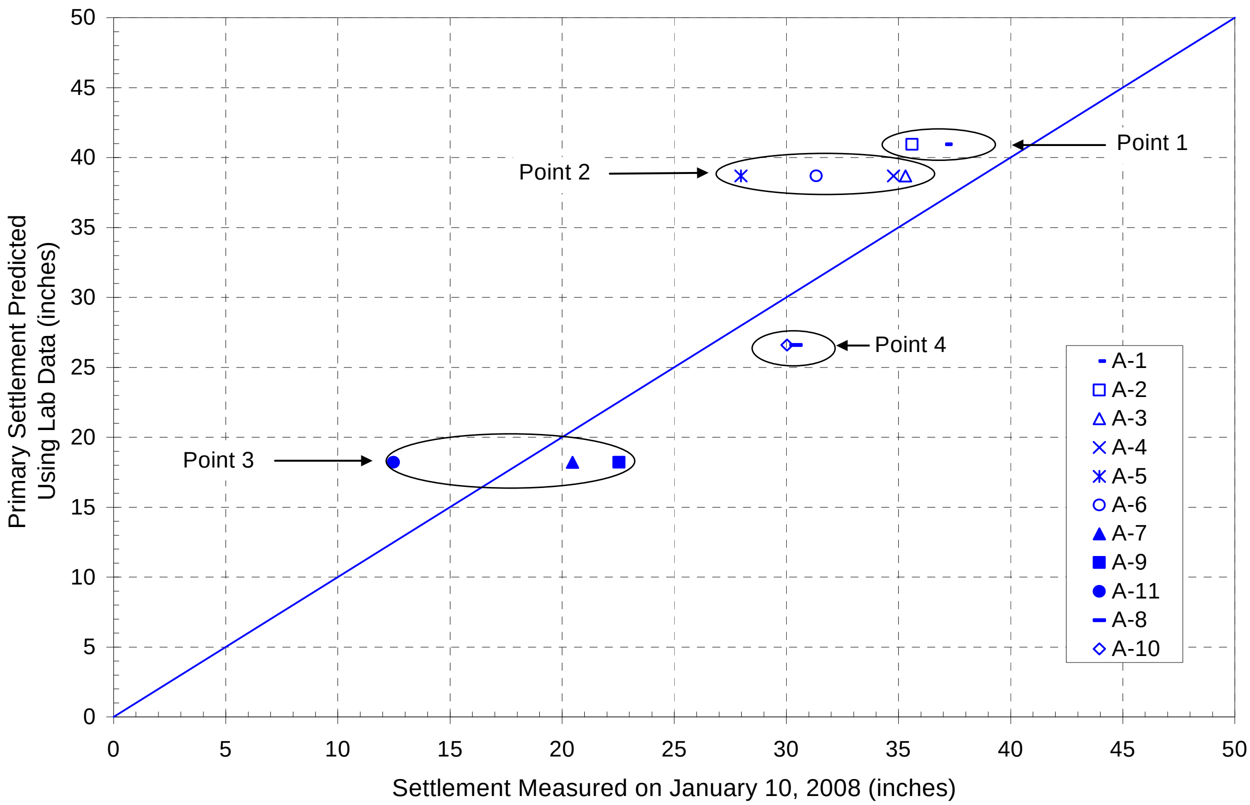


Figure 4-13. Comparison of Predicted Primary Settlement Based on Lab Data with Measured Settlement

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

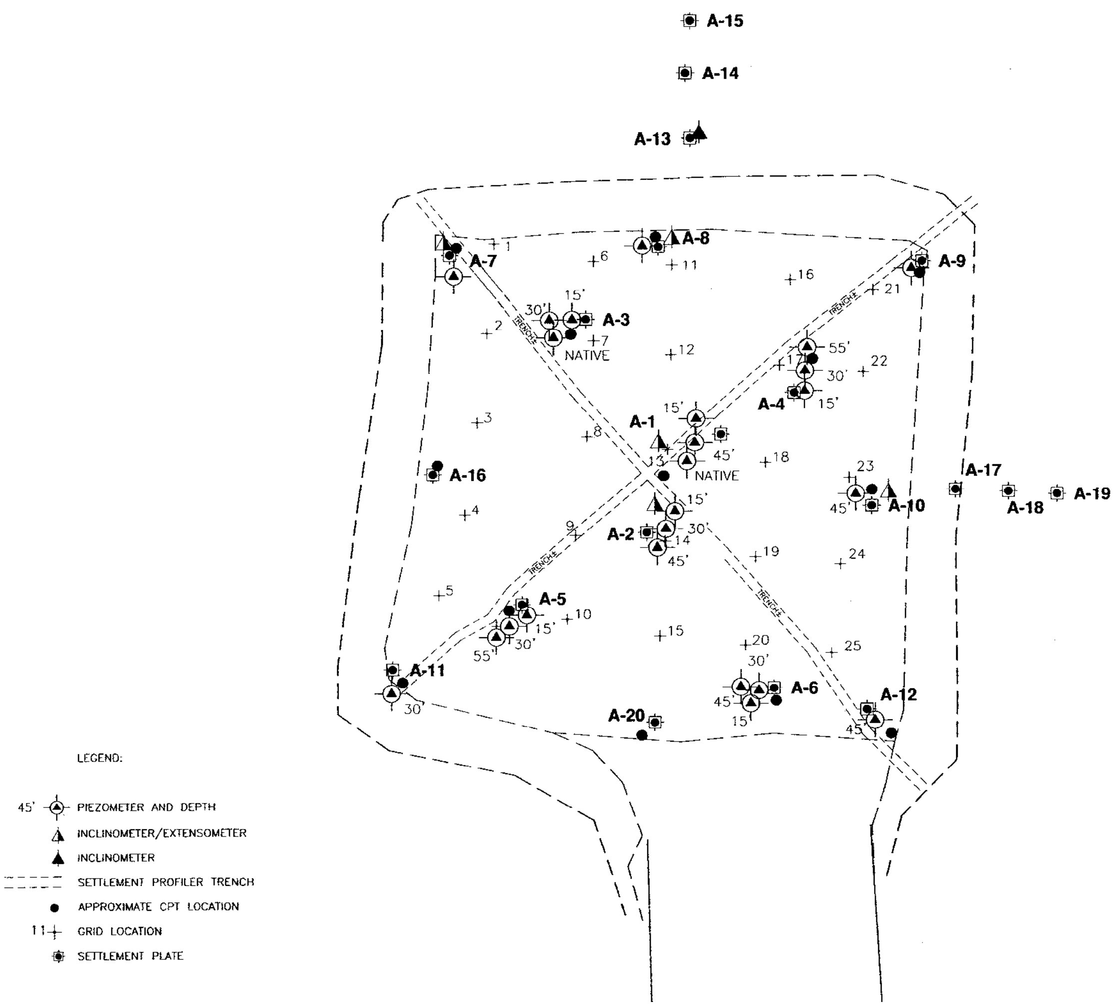


Figure 4-14. Constructed Test Fill

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

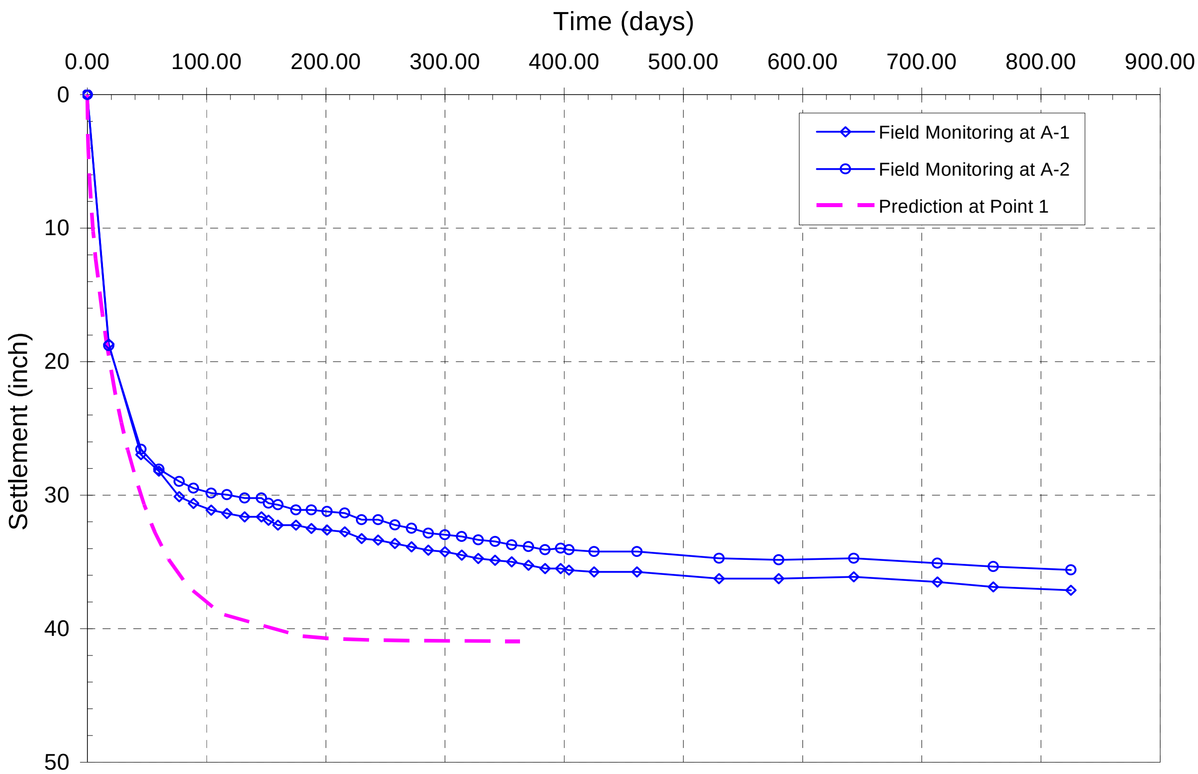


Figure 4-15. Calculation of Time Rate of Consolidation at Point 1

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

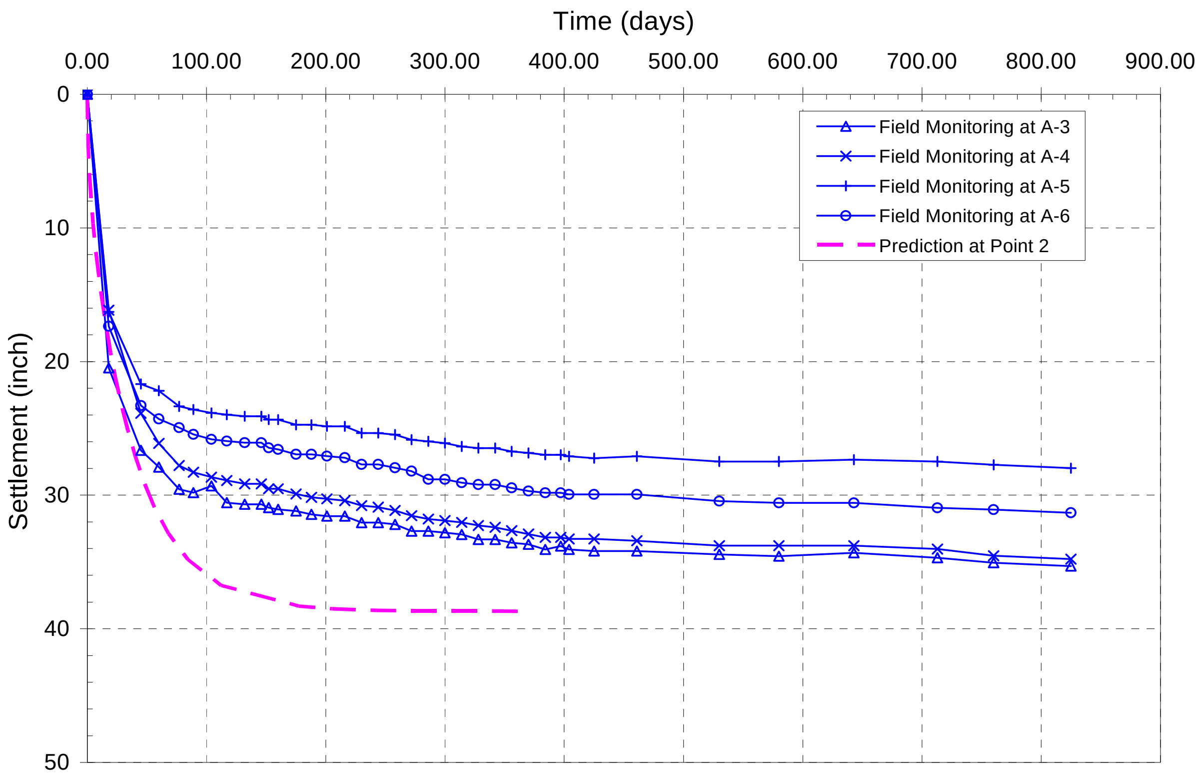


Figure 4-16. Calculation of Time Rate of Consolidation at Point 2

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

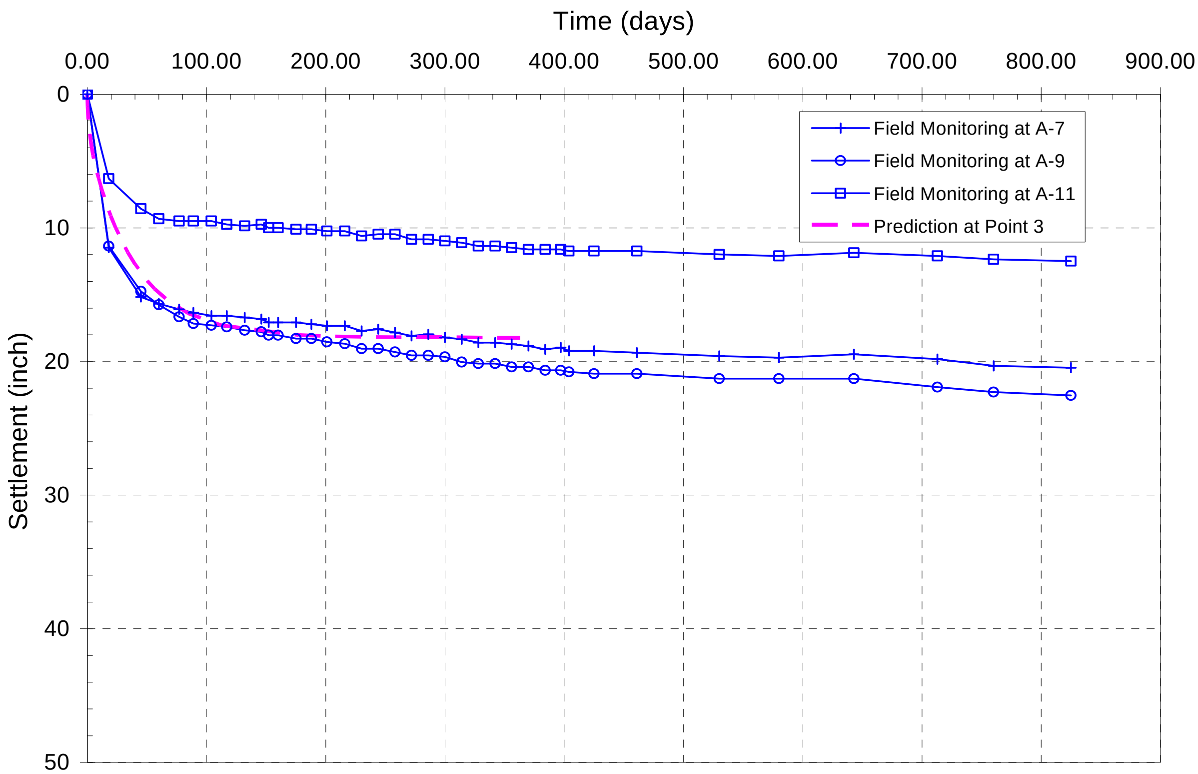


Figure 4-17. Calculation of Time Rate of Consolidation at Point 3

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

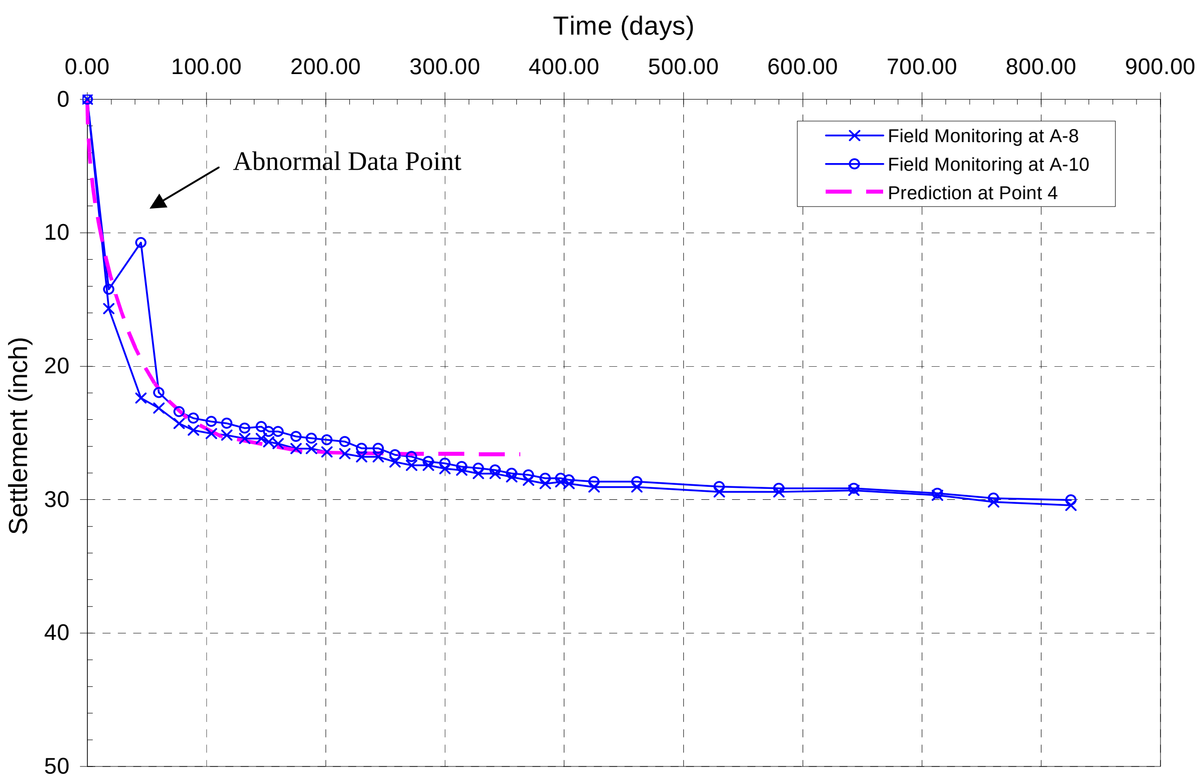


Figure 4-18. Calculation of Time Rate of Consolidation at Point 4

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

Table 4-1. Predicted Primary Consolidation Settlement Based on Calculated Average Degree of Consolidation

Piezometer ID	Time (days)						Average Settlement [1](ft)
	18	45	60	77	89	104	
A-1	30.5	37.1	37.1	38.4	38.2	40.1	38.2
A-2	31.4	35.4	35.8	35.6	35.2	36.9	35.8
A-3	26.2	30.0	30.5	31.7	31.5	31.7	31.1
A-4	28.0	32.6	33.3	34.2	34.0	35.3	33.9
A-5	23.8	27.9	27.7	28.2	27.9	29.7	28.3
A-6	26.7	30.2	30.1	29.9	29.9	31.6	30.3
A-7	13.7	18.2	18.7	19.0	19.2	18.8	18.8
A-8	25.0	28.6	28.2	28.8	28.9	30.2	28.9
A-9	15.0	18.4	19.2	20.2	20.7	20.3	19.7
A-10	21.0	---	26.5	27.5	27.7	28.9	27.7
A-11	8.9	11.5	12.7	12.4	12.1	13.2	12.4

Note:

[1]. The predicted primary consolidation settlements at time = 18 days were not considered in calculating the average settlement.

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

Table 4-2. Calculation of Primary Consolidation Settlement

SOLW Density (pcf)	82			
Ccε	Zone 2	0.46	Zone 3	0.38
Crε	Zone 2	0.014	Zone 3	0.021

Point 1

	Depth (ft)	Mid-point	S_initial	S_increment	S_final	water_pressure	effective_ini	Effective_final	OCR	Pc' (psf)	a1	a2	Strain	Settlement(ft)
Zone 2	0	2.5	205.00	1199.98	1404.98	0	205.00	1404.98	4.5	923	0.653213	0.182703	0.093189	0.47
	5	7.5	615.00	1199.44	1814.44	0	615.00	1814.44	4.5	2768	0.469867	0	0.006578	0.03
	10	12.5	1025.00	1197.44	2222.44	0	1025.00	2222.44	2.0	2050	0.30103	0.035077	0.02035	0.10
	15	17.5	1435.00	1193.17	2628.17	0	1435.00	2628.17	2.0	2870	0.262801	0	0.003679	0.02
	20	22.5	1845.00	1185.96	3030.96	0	1845.00	3030.96	1.0	1845	0	0.215584	0.099168	0.50
	25	27.5	2255.00	1175.39	3430.39	0	2255.00	3430.39	1.0	2255	0	0.182197	0.083811	0.42
	30	32.5	2665.00	1161.27	3826.27	0	2665.00	3826.27	1.0	2665	0	0.157078	0.072256	0.36
	35	37.5	3075.00	1143.60	4218.60	0	3075.00	4218.60	1.0	3075	0	0.137323	0.063169	0.32
Zone 3	40	42.5	3485.00	1122.57	4607.57	0	3485.00	4607.57	1.0	3485	0	0.121269	0.046082	0.23
	45	47.5	3895.00	1098.49	4993.49	0	3895.00	4993.49	1.0	3895	0	0.107897	0.041001	0.21
	50	52.5	4305.00	1071.79	5376.79	0	4305.00	5376.79	1.0	4305	0	0.09655	0.036689	0.18
	55	57.5	4715.00	1042.91	5757.91	468	4247.00	5289.91	1.0	4247	0	0.095366	0.036239	0.18
	60	62.5	5125.00	1012.32	6137.32	780	4345.00	5357.32	1.0	4345	0	0.090958	0.034564	0.17
	65	67.5	5535.00	980.50	6515.50	1092	4443.00	5423.50	1.0	4443	0	0.086603	0.032909	0.16
	70	71	5822.00	957.71	6779.71	1310	4511.60	5469.31	1.0	4512	0	0.083602	0.031769	0.06
	72													

Total =	**3.4**	ft
	40.9	in

Point 2

	Depth (ft)	Mid-point	S_initial	S_increment	S_final	water_pressure	effective_ini	Effective_final	OCR	Pc' (psf)	a1	a2	Strain	Settlement(ft)
Zone 2	0	2.5	205.00	1199.92	1404.92	0	205.00	1404.92	4.5	923	0.653213	0.182685	0.09318	0.47
	5	7.5	615.00	1197.92	1812.92	0	615.00	1812.92	4.5	2768	0.469504	0	0.006573	0.03
	10	12.5	1025.00	1190.97	2215.97	0	1025.00	2215.97	2.0	2050	0.30103	0.033809	0.019767	0.10
	15	17.5	1435.00	1177.29	2612.29	0	1435.00	2612.29	2.0	2870	0.260169	0	0.003642	0.02
	20	22.5	1845.00	1156.63	3001.63	0	1845.00	3001.63	1.0	1845	0	0.211361	0.097226	0.49
	25	27.5	2255.00	1129.83	3384.83	0	2255.00	3384.83	1.0	2255	0	0.176391	0.08114	0.41
	30	32.5	2665.00	1098.28	3763.28	0	2665.00	3763.28	1.0	2665	0	0.149869	0.06894	0.34
	35	37.5	3075.00	1063.46	4138.46	0	3075.00	4138.46	1.0	3075	0	0.128994	0.059337	0.30
Zone 3	40	42.5	3485.00	1026.70	4511.70	0	3485.00	4511.70	1.0	3485	0	0.112137	0.042612	0.21
	45	47.5	3895.00	989.06	4884.06	0	3895.00	4884.06	1.0	3895	0	0.098274	0.037344	0.19
	50	52.5	4305.00	951.34	5256.34	0	4305.00	5256.34	1.0	4305	0	0.08671	0.03295	0.16
	55	57.5	4715.00	914.11	5629.11	468	4247.00	5161.11	1.0	4247	0	0.08466	0.032171	0.16
	60	62.5	5125.00	877.74	6002.74	780	4345.00	5222.74	1.0	4345	0	0.079908	0.030365	0.15
	65	67.5	5535.00	842.48	6377.48	1092	4443.00	5285.48	1.0	4443	0	0.075408	0.028655	0.14
	70	71	5822.00	818.53	6640.53	1310	4511.60	5330.13	1.0	4512	0	0.072407	0.027515	0.06
	72													

Total =	**3.2**	ft
	38.7	in

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

Table 4-2. Calculation of Primary Consolidation Settlement (Continued)

Point 3

	Depth (ft)	Mid-point	S_initial	S_increment	S_final	water_pressure	effective_ini	Effective_final	OCR	Pc' (psf)	a1	a2	Strain	Settlement(ft)
	0	2.5	205.00	733.06	938.06	0	205.00	938.06	4.5	923	0.653213	0.007263	0.012486	0.06
	5	7.5	615.00	723.14	1338.14	0	615.00	1338.14	4.5	2768	0.337626	0	0.004727	0.02
	10	12.5	1025.00	696.12	1721.12	0	1025.00	1721.12	2.0	2050	0.225088	0	0.003151	0.02
Zone 2	15	17.5	1435.00	657.88	2092.88	0	1435.00	2092.88	2.0	2870	0.163892	0	0.002294	0.01
	20	22.5	1845.00	617.10	2462.10	0	1845.00	2462.10	1.0	1845	0	0.12531	0.057642	0.29
	25	27.5	2255.00	579.07	2834.07	0	2255.00	2834.07	1.0	2255	0	0.099264	0.045662	0.23
	30	32.5	2665.00	545.71	3210.71	0	2665.00	3210.71	1.0	2665	0	0.080904	0.037216	0.19
	35	37.5	3075.00	517.15	3592.15	0	3075.00	3592.15	1.0	3075	0	0.067509	0.031054	0.16
	40	42.5	3485.00	492.83	3977.83	0	3485.00	3977.83	1.0	3485	0	0.057444	0.021829	0.11
	45	47.5	3895.00	472.02	4367.02	0	3895.00	4367.02	1.0	3895	0	0.049678	0.018878	0.09
	50	52.5	4305.00	454.03	4759.03	0	4305.00	4759.03	1.0	4305	0	0.043545	0.016547	0.08
Zone 3	55	57.5	4715.00	438.27	5153.27	468	4247.00	4685.27	1.0	4247	0	0.042653	0.016208	0.08
	60	62.5	5125.00	424.29	5549.29	780	4345.00	4769.29	1.0	4345	0	0.040464	0.015376	0.08
	65	67.5	5535.00	411.69	5946.69	1092	4443.00	4854.69	1.0	4443	0	0.038485	0.014624	0.07
	70	71	5822.00	403.55	6225.55	1310	4511.60	4915.15	1.0	4512	0	0.037206	0.014138	0.03
	72													

Total =	1.5	ft
	18.2	in

Point 4

	Depth (ft)	Mid-point	S_initial	S_increment	S_final	water_pressure	effective_ini	Effective_final	OCR	Pc' (psf)	a1	a2	Strain	Settlement(ft)
	0	2.5	205.00	888.76	1093.76	0	205.00	1093.76	4.5	923	0.653213	0.073955	0.043164	0.22
	5	7.5	615.00	883.30	1498.30	0	615.00	1498.30	4.5	2768	0.386723	0	0.005414	0.03
	10	12.5	1025.00	868.09	1893.09	0	1025.00	1893.09	2.0	2050	0.266447	0	0.00373	0.02
Zone 2	15	17.5	1435.00	845.70	2280.70	0	1435.00	2280.70	2.0	2870	0.201217	0	0.002817	0.01
	20	22.5	1845.00	820.46	2665.46	0	1845.00	2665.46	1.0	1845	0	0.159777	0.073497	0.37
	25	27.5	2255.00	795.14	3050.14	0	2255.00	3050.14	1.0	2255	0	0.131173	0.060339	0.30
	30	32.5	2665.00	770.85	3435.85	0	2665.00	3435.85	1.0	2665	0	0.110337	0.050755	0.25
	35	37.5	3075.00	747.84	3822.84	0	3075.00	3822.84	1.0	3075	0	0.094541	0.043489	0.22
	40	42.5	3485.00	725.97	4210.97	0	3485.00	4210.97	1.0	3485	0	0.082179	0.031228	0.16
	45	47.5	3895.00	705.01	4600.01	0	3895.00	4600.01	1.0	3895	0	0.072251	0.027455	0.14
	50	52.5	4305.00	684.75	4989.75	0	4305.00	4989.75	1.0	4305	0	0.064106	0.02436	0.12
Zone 3	55	57.5	4715.00	665.05	5380.05	468	4247.00	4912.05	1.0	4247	0	0.06318	0.024009	0.12
	60	62.5	5125.00	645.79	5770.79	780	4345.00	4990.79	1.0	4345	0	0.06018	0.022868	0.11
	65	67.5	5535.00	626.91	6161.91	1092	4443.00	5069.91	1.0	4443	0	0.057324	0.021783	0.11
	70	71	5822.00	613.91	6435.91	1310	4511.60	5125.51	1.0	4512	0	0.055407	0.021055	0.04
	72													

Total =	2.2	ft
	26.6	in

Written by: **Ming Zhu** Date: **03/06/2008** Reviewed by: **R. Kulasingam/Jay Beech** Date: **03/06/2008**

Client: **Honeywell** Project: **Onondaga Lake SCA IDS** Project/ Proposal No.: **GD3944** Task No.: **04**

Table 4-3. Summary of Predicted and Measured Consolidation Settlement

	Consolidation Settlement (inches)										
	Point 1		Point 2				Point 3			Point 4	
	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-9	A-11	A-8	A-10
Prediction based on field data	39.79	35.78	31.09	33.9	28.29	30.32	18.82	19.75	12.37	28.95	27.66
Prediction based on lab data	40.94		38.69				18.20			26.60	
Measurement on 1/10/2008	37.12	35.6	35.31	34.78	27.98	31.33	20.46	22.54	12.48	30.43	30.03

Written by:	**Ming Zhu**	Date:	**03/06/2008**	Reviewed by:	**R. Kulasingam/Jay Beech**	Date:	**03/06/2008**
Client:	**Honeywell**	Project:	**Onondaga Lake SCA IDS**	Project/ Proposal No.:	**GD3944**	Task No.:	**04**

Table 4-4. Thickness of SOLW Beneath Test Fill

Piezometer Location	Thickness of SOLW (ft)
A-1	74
A-2	74
A-3	73
A-4	70
A-5	71
A-6	75
A-7	74
A-8	74
A-9	74
A-10	76
A-11	67

Written by:	Ming Zhu	Date:	03/06/2008	Reviewed by:	R. Kulasingam/Jay Beech	Date:	03/06/2008
Client:	Honeywell	Project:	Onondaga Lake SCA IDS	Project/ Proposal No.:	GD3944	Task No.:	04

Table 4-5. Summary of Consolidation Settlement

Thickness of SOLW	72	ft
Drainage distance	36	ft
Cv of SOLW	0.14	cm^2/s
Predicted settlement		
Point 1	40.9	inch
Point 2	38.7	inch
Point 3	18.2	inch
Point 4	26.6	inch

$$t = \frac{T_v H_{dr}^2}{C_v}$$

Degree of Consolidation (U(t))	Time Factor (Tv)	Time (t, days)	Predicted Settlement (S(t), ft)			
			Point 1	Point 2	Point 3	Point 4
0%	0.0000	0	0.00	0.00	0.00	0.00
5%	0.0020	0	2.05	1.93	0.91	1.33
10%	0.0079	1	4.09	3.87	1.82	2.66
15%	0.0177	2	6.14	5.80	2.73	3.99
20%	0.0314	3	8.19	7.74	3.64	5.32
25%	0.0491	5	10.24	9.67	4.55	6.65
30%	0.0707	7	12.28	11.61	5.46	7.98
35%	0.0962	10	14.33	13.54	6.37	9.31
40%	0.126	13	16.38	15.48	7.28	10.64
45%	0.159	16	18.42	17.41	8.19	11.97
50%	0.196	20	20.47	19.35	9.10	13.30
55%	0.238	24	22.52	21.28	10.01	14.63
60%	0.286	28	24.57	23.22	10.92	15.96
65%	0.340	34	26.61	25.15	11.83	17.29
70%	0.403	40	28.66	27.09	12.74	18.62
75%	0.477	47	30.71	29.02	13.65	19.95
80%	0.567	56	32.75	30.96	14.56	21.28
85%	0.684	68	34.80	32.89	15.47	22.61
90%	0.848	84	36.85	34.83	16.38	23.94
95%	1.129	112	38.90	36.76	17.29	25.27
99%	1.781	177	40.53	38.31	18.02	26.33
99.5%	2.062	205	40.74	38.50	18.11	26.47
99.8%	2.433	242	40.86	38.62	18.16	26.55
99.9%	2.714	270	40.90	38.66	18.18	26.57
99.99%	3.647	363	40.94	38.69	18.20	26.60

APPENDIX B

SEDIMENT CONSOLIDATION AREA (SCA) DEWATERING EVALUATION

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau D
625 Broadway, Albany, New York 12233-7013
Phone: (518) 402-9676 • **FAX:** (518) 402-9020
Website: www.dec.state.ny.us

443519

Alexander B. Grannis
Commissioner

March 7, 2009

Mr. John P. McAuliffe, P.E.
Program Director, Syracuse
Honeywell
5000 Brittonfield Parkway, Suite 700
East Syracuse, NY 13057

Re: Onondaga Lake Sediment Consolidation Area (SCA) Dewatering Evaluation, Dated February 2009 (734030) (SCA-14b)

Dear Mr. McAuliffe:

We have received and reviewed the above-referenced document, which was transmitted by your March 2, 2009 letter to my attention, and find that the revised document has satisfactorily addressed our previous comments. Therefore, the February 2009 version of the Onondaga Lake Sediment Consolidation Area (SCA) Dewatering Evaluation, is approved.

Please distribute copies of the document to the various document repositories as discussed in the governing consent decree.

Sincerely,

Timothy J. Larson, P.E.
Project Manager

cc: T. Milch, Esq, - Arnold & Porter
ecc: R. Nunes - USEPA, NYC
J. Davis - NYSDOL, Albany
M. Sergott - NYSDOH, Troy
J. Heath, Esq.
G. Jamieson, HETF/Onondaga Nation

ONONDAGA LAKE

SEDIMENT CONSOLIDATION AREA (SCA) DEWATERING EVALUATION
Syracuse, New York

Prepared For:

Honeywell

5000 Brittonfield Parkway
Suite 700
East Syracuse, NY 13057

Prepared By:

PARSONS

290 Elwood Davis Road, Suite 312
Liverpool, New York 13088
Phone: (315) 451-9560
Fax: (315) 451-9570

FEBRUARY 2009

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF TABLES

SEDIMENT CONSOLIDATION AREA DEWATERING EVALUATION

EXECUTIVE SUMMARY

This report summarizes the activities and conclusions of a study conducted by Parsons to compare methods for dewatering up to 2.65 million cubic yards of dredged Onondaga Lake sediment. Settling basins and geotextile tubes were the methods considered, and the study included bench-scale testing, case study reviews, a comparative analysis of each technology's ability to meet established objectives, and a cost comparison.

Bench-scale testing for settling basins was performed during the Phase I and II Pre-Design Investigations (PDIs), and bench-scale tests for geotextile tubes were conducted during the Phase III PDI. Based on this testing, both settling basins and geotextile tubes were considered feasible methods for dewatering Onondaga Lake sediment. The following ten objectives were developed as a basis for the comparative analysis of the two dewatering methods:

- Protect the Public and Wildlife during SCA Operations;
- Facilitate Efficient Emissions and Odor Management;
- Protect Workers during SCA Operations;
- Maintain Geotechnical Stability and SCA Liner System Integrity;
- Meet Operations Requirements;
- Select a Method Acceptable to the Public;
- Meet Cell Closure Requirements;
- Minimize Dewatering Area;
- Enhance the Water Treatment Process; and
- Minimize Imported Material Quantities.

In addition, comparative cost estimates supported by conceptual designs for each method were prepared. This study indicated that, although higher in cost, geotextile tubes were considered to be more effective than settling basins at meeting project objectives, particularly in their ability to mitigate offsite odor potential. Based on these results, Honeywell selected geotextile tubes as the preferred dewatering method.

1.0 INTRODUCTION

This Report has been prepared on behalf of Honeywell International, Inc. (Honeywell) in accordance with the Draft Remedial Design Work Plan (RDWP) for the Onondaga Lake Bottom Subsite (Parsons, 2008a). The Draft RDWP presents the activities necessary to complete design of the remedy selected in the Record of Decision (ROD) issued by the New York State Department of Environmental Conservation (NYSDEC) and the United States Environmental Protection Agency (USEPA) Region 2 in 2005 (NYSDEC and USEPA, 2005), and as set forth in the Consent Decree (CD) (United States District Court, Northern District of New York, 2007) (89-CV-815). The purpose of this Report is to present the evaluation performed to select the method for dewatering the dredged sediment generated during the Onondaga Lake remedial action, consistent with the requirements and objectives of the ROD and CD, thus facilitating the advancement of the remedial design of the Sediment Consolidation Area (SCA). For both methods evaluated, the final location for the sediment is the SCA on Settling Basin 13.

The Report is organized as follows:

- Section 2 provides a general description of the potentially applicable dewatering methods (i.e., settling basins and geotextile tubes).
- Section 3 summarizes the technical feasibility evaluation for each method, including a review of bench-scale test results and case studies.
- Section 4 presents the conceptual design assumptions for each dewatering method.
- Section 5 presents a comparative evaluation of the effectiveness of the two dewatering methods using objectives that were developed for this purpose.
- Section 6 provides a summary of the evaluation and conclusions, including the selection of geotextile tubes as the preferred dewatering method.

2.0 DEWATERING METHOD ALTERNATIVES

General descriptions of the settling basin and geotextile tube dewatering methods and a discussion of how these methods could be incorporated into this project are provided in the subsections that follow. Both methods assume that Onondaga Lake sediments will be hydraulically transported as a slurry to the SCA.

2.1 Settling Basin Description

For the settling basin approach, the sediment slurry would be discharged continuously into a basin at the SCA that would be constructed using earthen berms. Figure 1 shows an aerial view of an active settling basin. The basin would be designed to provide the slurry adequate time for clarification, thus allowing the formation of a thickened slurry layer at the bottom of the basin and supernatant at the top. The thickened slurry layer would be left in place within the basin, and the supernatant would be decanted from the basin, treated, and returned to the lake. After allowing time for dewatering and consolidation, a final cover would be constructed over the dewatered sediment.

2.2 Geotextile Tubes Description

Geotextile tubes are fabricated in a variety of circumferences and lengths using high strength permeable geotextiles. For dewatering the Onondaga Lake sediment, it is anticipated that geotextile tubes 80 to 90 ft in circumference and 200 to 300 ft in length would be used. Slurry would be pumped into the tubes via ports along the top of the tubes, and the filtrate would drain through the openings of the geotextile. Solids would be retained within the geotextile tubes. The basic steps in the geotextile tube dewatering process are as follows:

- Step 1: A pre-conditioner (e.g., polymer) is added to the dredged slurry to enhance solids-liquid separation and dewatering. Single or multiple dosages of pre-conditioner may be used. Depending on the specific design, the slurry may be thickened in a clarifier.
- Step 2: The pre-conditioned slurry (underflow if a clarifier is used) is pumped into the tubes, which are located in a dewatering cell.
- Step 3: The filtrate is allowed to seep out of the tubes while the solids remain in the tube and consolidate. The filtrate would be collected, treated, and returned to the lake.

Once dewatering has occurred, the tubes (with the solids inside) would be left in place at the SCA and covered. Figure 2 shows geotextile tubes during operation.

3.0 TECHNICAL FEASIBILITY

To evaluate the technical feasibility of each method for dewatering Onondaga Lake sediment and to obtain sufficient data for a conceptual level design, bench-scale testing was performed. In addition, case studies were reviewed. The following assumptions were made for purposes of assessing technical feasibility:

- The sediments from Sediment Management Units (SMUs) 1 and 6 are representative of the majority of sediment to be dredged (i.e., they represent approximately 70% of the total dredge volume);
- The sediment slurry pumped from the lake will average approximately 10% solids by weight, but it may vary widely due to variability in dredge head, preprocessing, and transport operation conditions;
- The selected dewatering system will be capable of handling up to an estimated 2.65 million cubic yards of sediment over four years; and
- The entire area of Settling Basin 13 can be utilized, if necessary, for the SCA (approximately 160 acres).

3.1 Settling Basin

To evaluate the settling basin approach, column settling tests (CST) and column consolidation tests were performed by Geotesting Express in Boxborough, Massachusetts on multiple sediment samples. Details of these testing efforts are described in the Phase I Pre-Design Investigation (PDI) Work Plan (Parsons, 2005) and Phase II PDI Work Plan – Addendum 5 (Parsons and O'Brien & Gere, 2006). These tests were performed to evaluate the sedimentation and consolidation behaviors of the Onondaga Lake sediment slurry. The CST provides data on the sedimentation characteristics of the slurry. Using these data, a settling basin can be designed to meet effluent total suspended solids (TSS) concentration, clarification, and initial storage requirements. The column consolidation tests provide data to predict long-term volume reduction of settled solids due to consolidation. The test results are provided in the Phase I and Phase II Summary Reports (Parsons, 2007; Parsons, 2008b).

In most of the column settling tests, a distinct interface formed between the settled slurry and the supernatant water; thus, the sediments exhibited zone settling behavior in the column settling tests. In addition, the tests generally show relatively little change in total suspended solids or interface height after four days of testing. The test results also show differences between sedimentation and consolidation characteristics of the sediment from different SMUs; however, these differences can be quantified, and the full-scale design could account for them. Therefore, the CST and consolidation test results indicate that it is feasible to use a settling basin to retain and dewater the sediment from Onondaga Lake.

In addition to bench-scale testing that indicated the use of settling basins was feasible, case study reviews showed that settling basins have been effectively used at numerous contaminated sediment sites (e.g., Port of Tacoma Remediation in Washington, Indiana Harbor and Shipping Canal in Indiana), and the assumptions listed previously were compatible with an effective settling basin design.

3.2 Geotextile Tubes

Bench-scale tests were performed by Waste Stream Technology, Inc. (WST) in Buffalo, New York to evaluate the feasibility of using geotextile tubes to dewater the dredged sediment. The procedure used for the bench-scale hanging bag tests is described in the Phase III PDI Work Plan – Addendum 1 (Parsons, 2007). The detailed results of the bench-scale testing of samples collected from SMUs 1 and 6 are provided in the Phase III Summary Report (Parsons, 2008c).

For all the tests in this study, an approximately 10% solids by weight slurry was prepared from a SMU 1 or SMU 6 sediment sample that had been screened through a 1-inch sieve. After slurry preparation, half of the slurry samples were pumped directly into the hanging bag as prepared; whereas, the other half were mixed with a pre-conditioner (i.e., Hychem 824 polymer) prior to pumping into the hanging bag. The selection of Hychem 824 polymer was based on jar testing. After the hanging bags were filled, the slurry was allowed to dewater for approximately 24 hours. The results from this testing are summarized as follows:

- During sample preparation to replicate anticipated slurry conditioning (i.e., screening through a 1-inch sieve), significant oversize material was observed in the samples from SMU 1.
- The addition of Hychem 824 polymer to the slurry prior to pumping it into the hanging bag significantly increased the dewatering rate; however, the total filtrate volumes collected over the 24-hour test period were very similar whether or not polymer was used.
- In general, the turbidity and TSS of the filtrate from the hanging bag tests was significantly less (i.e., by at least a factor of two in most cases) when Hychem 824 polymer was added to the slurry prior to pumping it into the hanging bag as compared to the tests without polymer. One of the SMU 1 samples (i.e., one of the In-Lake Waste Deposit [ILWD] samples) was an exception to this because the filtrate from both with and without polymer hanging bag tests had similar TSS and turbidity.
- A comparison of the with and without polymer addition hanging bag tests for the SMU 6 samples indicates that the addition of Hychem 824 polymer to the slurry significantly increased the solids content of the material that was retained in the hanging bag after 24 hours of dewatering. However, this effect was not apparent for the SMU 1 hanging bag tests.
- In addition to increasing the dewatering rate, the Hychem 824 polymer addition to the slurry also affected the consistency of the material that was retained in the hanging bag after the 24-hour dewatering period. This was particularly the case for the SMU 1 samples. Specifically, the material strength after 24 hours of dewatering in the hanging bag was measurable in the polymer treated samples (i.e., it was approximately 50 psf); whereas, the untreated samples were too weak/soft for measurements to be taken with a mini-vane shear device. In addition, when polymer was not used on the SMU 1 tests, the material stuck to the sides of the bag and blinded the geotextile.

In general, the bench-scale test results indicate that the use of geotextile tubes is feasible for dewatering the Onondaga Lake sediment; however, polymer addition would likely be required. Based on this study, Hychem 824 is an effective polymer for the SMU 6 material, but additional polymer and bag testing is required to determine the most effective polymer(s) for all the anticipated dredged sediments.

As with the settling basin, case study reviews (e.g., Ashtabula River Site in Ohio) occurred as part of this technical feasibility evaluation. Site visits (e.g., Fox River in Wisconsin, confidential site in Alabama) were also a major component of this review. As with the settling basin, the development of an effective design given the previously listed assumptions was considered feasible. Therefore, based on the case study review and the bench-scale test results presented above, the use of geotextile tubes to dewater Onondaga Lake sediment was considered technically feasible.

4.0 CONCEPTUAL DESIGN ASSUMPTIONS

To more fully evaluate settling basins and geotextile tubes, a conceptual design was developed for each method. Assumptions for each method were established so that comparable conceptual designs could be developed. Therefore, the intent was to make parallel assumptions whenever possible. For both dewatering options, it was assumed that up to an estimated 2.65 million cubic yards of sediment would be dredged over a four year period. The assumptions for the conceptual designs are presented in the following subsections.

4.1 Settling Basin Assumptions

Multiple geometries were explored to optimize the settling basin layout that would be used for the conceptual design. The conceptual design developed for the settling basin layout is provided in Figure 3 and was based on the following assumptions:

- Two dewatering cells would be required with the possibility to subdivide into four cells to enhance operations, including potential odor mitigation.
- A minimum 500-ft buffer zone between the western edge of Settling Basin 13 and the settling basins for sediment dewatering is required based on a request from residents in the Town of Camillus.
- Two (2) ft minimum water depth would be required over settled solids to facilitate settling and to maintain a water blanket over the sediments.
- Two (2) ft minimum freeboard would be required between top of perimeter dikes and water surface to protect against overtopping due to precipitation and wave action.
- Based on capacity, water depth, and freeboard criteria, the settling basin footprint within Settling Basin 13 would be approximately 100 acres with constructed dike heights up to 33 ft.
- Particles sand-size and greater would be removed from the slurry prior to pumping into the settling basin to prevent mounding of sediments near the discharge.

4.2 Geotextile Tube Assumptions

The conceptual design developed for the geotextile tube dewatering area is provided in Figure 4, and the assumptions were as follows:

- Tubes would be stacked up to a height of 30 ft.
- Based on required capacity and stacked tube height constraints, the geotextile dewatering area would be approximately 100 acres.
- Constructed dikes would be 5-ft high.
- A minimum 500-ft buffer zone between the western edge of Settling Basin 13 and the geotextile tube dewatering area is required based on a request from residents in the Town of Camillus.

- Particles sand size and greater would be removed from the slurry prior to pumping into the geotextile tubes to prevent mounding near the filling ports of the tube.
- Slurry would require pre-conditioner addition and gravity thickening prior to pumping it into the geotextile tubes based on bench-scale test results.

5.0 DETAILED COMPARISON

For purposes of the comparative evaluation, ten objectives were developed by which the two dewatering methods could be compared. Those objectives are as follows:

- Objective 1: Protect the Public and Wildlife during SCA Operations
- Objective 2: Facilitate Efficient Emissions and Odor Management
- Objective 3: Protect Workers during SCA Operations
- Objective 4: Maintain Geotechnical Stability and SCA Liner System Integrity
- Objective 5: Meet Operations Requirements
- Objective 6: Select a Method Acceptable to the Public
- Objective 7: Meet Cell Closure Requirements
- Objective 8: Minimize Dewatering Area
- Objective 9: Enhance the Water Treatment Process
- Objective 10: Minimize Imported Material Quantities

Of these objectives, the first four were considered the most important, with decreasing importance from Objective 6 to Objective 10. In addition to the ten objectives listed above, cost effectiveness was also considered. Using the conceptual designs developed based on the assumptions presented in Section 4, the two methods were compared. A summary of those comparisons is provided in the following subsections.

5.1 Objective 1 – Public and Wildlife Protection During SCA Operations

Public and wildlife protection is considered to be of utmost importance. Whether settling basins or geotextile tubes are used, security will be in place around the entire perimeter to prevent the public from entering the project area. If the public and/or wildlife do enter the area, however, there is a drowning hazard for an open settling basin that does not exist for the geotextile tube dewatering area. Specifically, for geotextile tubes, the liquid generated from dewatering would be contained in the gravel drainage layer beneath the tubes; whereas, for the settling basin the liquid would accumulate on top of the dewatering sediment. In addition, the open settling basin has more potential than the tubes for attracting birds and other wildlife. The geotextile tubes, as compared to the basin, also provide additional containment of the sediment during operations. For these reasons, the geotextile tubes are considered to be more effective at protecting the public and wildlife.

5.2 Objective 2 – Emission and Odor Management

Minimizing volatile emissions and odors is also of utmost importance. Whether the slurry is discharged into a basin or a tube, the potential sources of odor and volatile emissions during operations are the water and the consolidating sediments. Based on the conceptual design, it was determined either method of dewatering could be utilized without offsite health impacts from emissions. Odor mitigation strategies for both methods were evaluated based on their effectiveness at meeting this important objective and their potential operational impacts.

Based on case studies, geotextile tubes have been shown to effectively control odors when used to dewater sludges (e.g., sludges from water treatment plants). In addition, minimizing the volume and movement of filtrate, minimizing the active dewatering area, and covering the tubes (if necessary) were considered to be effective and implementable odor mitigation strategies during tube operations.

For the settling basins, it was determined that floating covers could be needed to control odors. Floating covers would be more difficult and expensive to implement than the mitigation efforts for the tubes. In addition, the effectiveness of the floating covers may be impacted by the need to remove them due to operational requirements (e.g., moving the discharge). Therefore, the use of geotextile tubes was considered to be more effective at meeting the objective.

5.3 Objective 3 – Worker Protection During SCA Operations

As with the previous objectives, worker protection is also considered to be of utmost importance. In addition to the typical worker protection issues during construction, each dewatering method has unique risks to workers associated with it. Operating geotextile tubes requires workers to walk across the tubes to connect and disconnect hoses; therefore, trip and fall hazards are more significant than with the basins. For the basins, the risk of drowning is an example of a unique hazard as compared to the tubes. A hazard analysis for each dewatering method was performed to identify the worker risk mitigations that would be employed. Since the unique hazards for both methods can be adequately mitigated using the appropriate personal protective equipment (PPE) and/or operating procedures, both methods were considered to be similar with respect to worker protection.

5.4 Objective 4 – Geotechnical Stability and SCA Liner System Integrity

Maintaining geotechnical and SCA liner system integrity is also of utmost importance regardless of the dewatering method selected. Because the SCA will be built on compressible Solvay waste material for both methods, settlement (including total and differential settlement) and porewater pressures will be monitored during construction and operation; however, the geotextile tube method provides the flexibility to adjust the placement configuration if more or less settlement occurs in certain areas. If necessary, strategic tube placement could be used to maintain liner system integrity and/or positive grades to the areas for liquid removal. Conversely, once the berms for the settling basin are constructed and the slurry is discharged into the basin, it is difficult to monitor settlement or to adjust the loading to control settlement. In addition, the lower hydraulic head associated with the geotextile tubes as compared to the settling basin is considered preferable in terms of maintaining liner system integrity during operation. Because of the lower hydraulic head and the flexibility related to tube placement, geotextile tubes are considered more effective than a settling basin at meeting this objective.

5.5 Objective 5 – Operations

The operations objective includes consideration of sediment dewatering as it relates to the overall remedial process such that it enhances, or at a minimum does not impede, the implementation of the remedial action (i.e., schedule). This includes evaluating the option in regards to maintaining planned dredging rates, receiving and handling material, dewatering of sediment (during and following dredging), and managing water.

The results of the bench testing for the geotextile tubes indicate that varying or multiple pre-conditioners may be required for different sediment types. Operational controls will be required to properly dose the feed slurry with pre-conditioner so that it will dewater effectively and maintain the necessary dredge rate.

For the settling basin option, pre-conditioner is not required; therefore, the process of discharging the slurry into the basin is much simpler than discharging it into the tubes. However, discharge pipe movement will be required to control load distribution, which is more operationally challenging than adjusting tube placement, especially if a floating cover is required to control odors. In addition, access to liquid removal areas, which would be in the low spots of the SCA, would be more difficult for settling basins than tubes.

Since a similar level of operational challenges exists for both settling basins and geotextile tubes, especially when the challenges associate with odor control are taken into account, both methods were considered similarly effective at meeting this objective.

5.6 Objective 6 – Public Acceptance

Although the dewatering method selection process was not specifically discussed with the public, comments during previous phases of this project indicated that odor and security were the two major concerns. During the public comment period for the CD, the Town of Camillus, where the SCA is sited, formally requested a 500-ft buffer zone on the western boundary of the site to address these concerns. As indicated previously, both options provide positive odor control measures, security, and the requested buffer zone. However, the geotextile tubes have an advantage over the settling basins because the tubes provide additional containment of the dredged sediment during operations. In addition, they are more effective at mitigating odors, protecting the public and wildlife during operations, and maintaining geotechnical and SCA liner system integrity. Therefore, geotextile tubes are considered more effective at meeting this objective.

5.7 Objective 7 – Cell Closure

The cell closure objective includes consideration of potential reuse, consistency with the planned overall settling basin program, opportunities for closure enhancement, and time required for closure. Geotextile tubes provide reinforcement within the dredged sediment, which would allow for equipment to place a cover over the area relatively quickly after the tubes are filled; however, options are also available for the settling basin which could reduce time to closure. The conceptual design developed for the settling basin included a plan to slurry and place sand on the dredged sediment and/or use a reinforcement geotextile or geogrid to provide strength for cover placement. The geotextile tubes would also provide the ability to shape the area to facilitate drainage after filling; however, placement of dredge material within the settling basin could also be implemented in such a way as to facilitate drainage. For either option, designs could be developed that would address each of the cell closure issues (including reasonable time to closure); therefore, they were both considered similarly effective at achieving the final closure objective.

5.8 Objective 8 – Dewatering Area

Minimizing the dewatering area was included as an objective because reducing the footprint allows for greater buffer areas between local residents and the contained dredged materials. Although the goal of this objective was to minimize the required dewatering area for each method, the conceptual designs indicate that a similarly sized dewatering area is required for both the geotextile tubes and the settling basin for two reasons. First, because of the potential for large settlements and/or differential settlement, certain locations within Settling Basin 13 are preferred for berm construction and geotextile tube placement. Since the constraints are similar regardless of the selected dewatering method, the dewatering area size/configuration is assumed to be the same for both methods. Second, and as mentioned previously, the optimized size for the settling basin (approximately 100 acres including four cells) is fairly consistent with what would be required with a stacked geotextile tube arrangement. Since the same area is considered appropriate for both dewatering methods, they were both considered similarly effective at achieving this objective.

5.9 Objective 9 – Water Treatment

Since water treatment is an important component of the design, the potential for enhancing water treatment was a consideration in dewatering method selection. As discussed in the results of the bench-scale testing, the hanging bag tests indicate the filtrate has significantly less TSS, turbidity, and mercury concentrations as compared to the slurry; however, the CST results indicated that the slurries settled out quickly. Therefore, it was concluded that the same benefits could be accomplished using either method. Since the test results did not indicate there would be a significant advantage in terms of water treatment, both methods were considered relatively similar in terms of potential for enhancing water treatment.

5.10 Objective 10 – Imported Material Quantities

Minimizing imported material quantities is considered an objective because transporting materials to the site has the potential to disturb local residents, and the potential time period of disturbance increases with greater material quantities. Conceptual designs indicated that approximately 600,000 cubic yards less material would be required to construct the geotextile tube dewatering area as compared to the settling basin. Even though geotextile tubes and pre-conditioner would need to be delivered to the site, the geotextile tubes were judged to be more effective overall at minimizing the required imported material quantities; therefore, the geotextile tubes were considered slightly more effective at achieving this objective.

5.11 Cost Effectiveness

In addition to the ten objectives discussed previously, cost effectiveness was also considered in this evaluation. The cost comparisons were prepared based on the conceptual designs that were developed using the assumptions presented in Section 4. This comparison focused on evaluating the cost differentials between the two methods. When the cost implications and potential risks associated with achieving the project-specific requirements (e.g., odor management and soft subgrade) were evaluated for the entire process, the geotextile tube option was estimated to be more costly than the settling basin option.

5.12 Comparison Summary

As summarized in Table 1, the geotextile tubes were considered more effective than the settling basins at meeting the following objectives:

- Objectives 1 – Protect the Public and Wildlife during SCA Operations
- Objective 2 – Facilitate Efficient Emissions and Odor Management
- Objective 4 – Maintain Geotechnical Stability and SCA Liner System Integrity
- Objective 6 – Select a Method Acceptable to the Public
- Objective 10 – Minimize Imported Material Quantities

For the remaining objectives, the two methods were considered to be similarly effective.

6.0 CONCLUSION

The dewatering method selection process described in this Report includes bench-scale testing, case study reviews, a feasibility evaluation, a detailed cost comparison, and a comparative analysis of each technology's ability to meet established objectives. Using the bench-scale testing and preliminary design assumptions, conceptual-level designs were developed for the settling basin and geotextile tube options. Ten objectives by which the two methods could be compared were identified and evaluated for each method, and a cost comparison was prepared. Although geotextile tubes are considered to be more expensive than settling basins, they are the selected dewatering method for the Onondaga Lake remedial action because they are considered to be more effective at meeting project objectives, particularly with regard to their ability to mitigate offsite odor potential.

7.0 REFERENCES

NYSDEC and USEPA. 2005. Record of Decision Onondaga Lake Bottom Subsite of the Onondaga Lake Superfund Site. Town of Geddes and Salina, Villages of Solvay and Liverpool, and City of Syracuse, Onondaga County, New York.

Parsons, 2005. *Onondaga Lake Pre-Design Investigation: Phase I Work Plan.*

Parsons and O'Brien & Gere, 2006. *Onondaga Lake Pre-Design Investigation: Phase II Work Plan – Addendum 5 Water Treatability, Effluent Elutriate, Odors and Column Settling Testing.*

Parsons, 2007. *Onondaga Lake Pre-Design Investigation: Phase I Data Summary Report.*

Parsons, 2007. *Onondaga Lake Pre-Design Investigation: Phase III Work Plan – Addendum 1 Geotextile Tube Evaluation – Bench-Scale Testing.*

Parsons, 2008a. *Draft Remedial Design Work Plan for the Onondaga Lake Bottom Subsite.*

Parsons, 2008b. *Onondaga Lake Pre-Design Investigation: Phase II Data Summary Report.*

Parsons, 2008c. *Draft Onondaga Lake Pre-Design Investigation: Phase III Data Summary Report.*

United States District Court, Northern District of New York. 2007. Consent Decree between the State of New York and Honeywell International, Inc. Senior Judge Scullin. Dated October 11, 2006. Filed January 4, 2007. Order Number 89-CV-815. Syracuse, New York.

FIGURES

Figure 1 Example Site – Settling Basin

Figure 2 Example Site – Geotextile Tube Dewatering

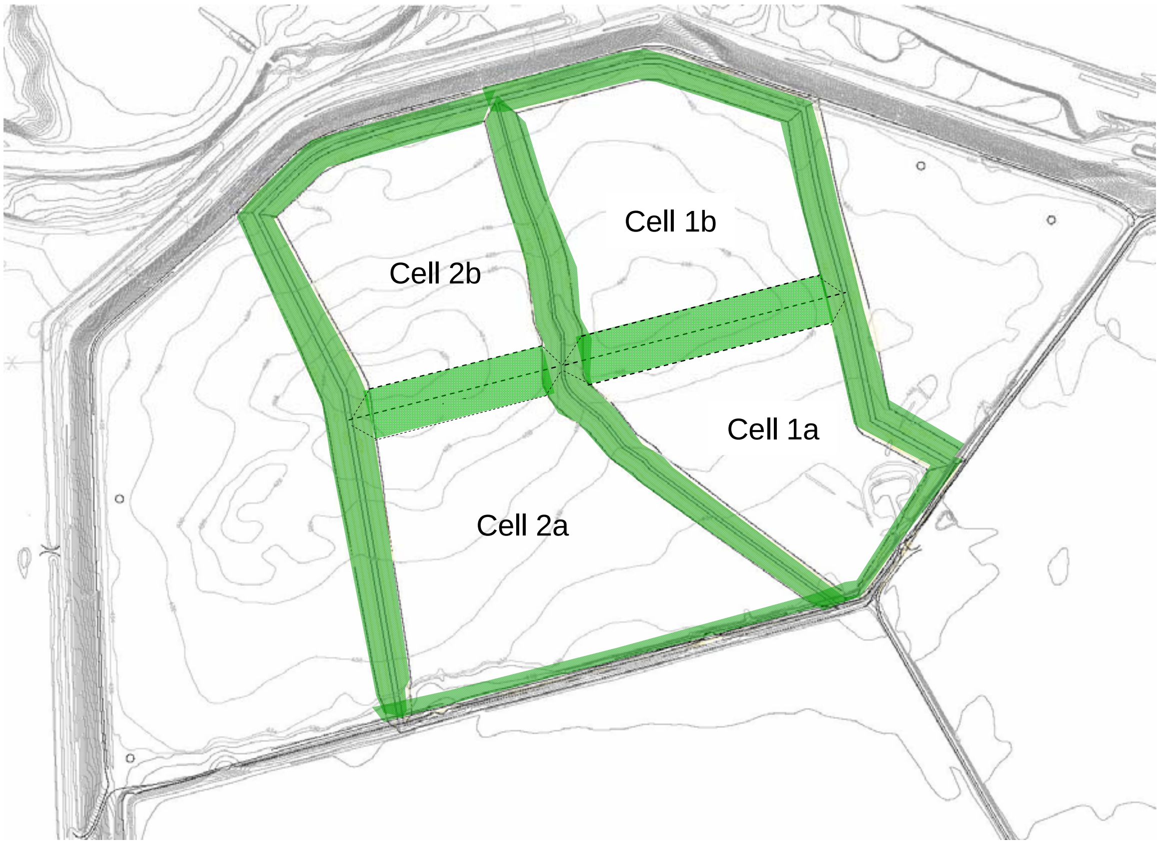


Figure 3 Settling Basin Conceptual Design

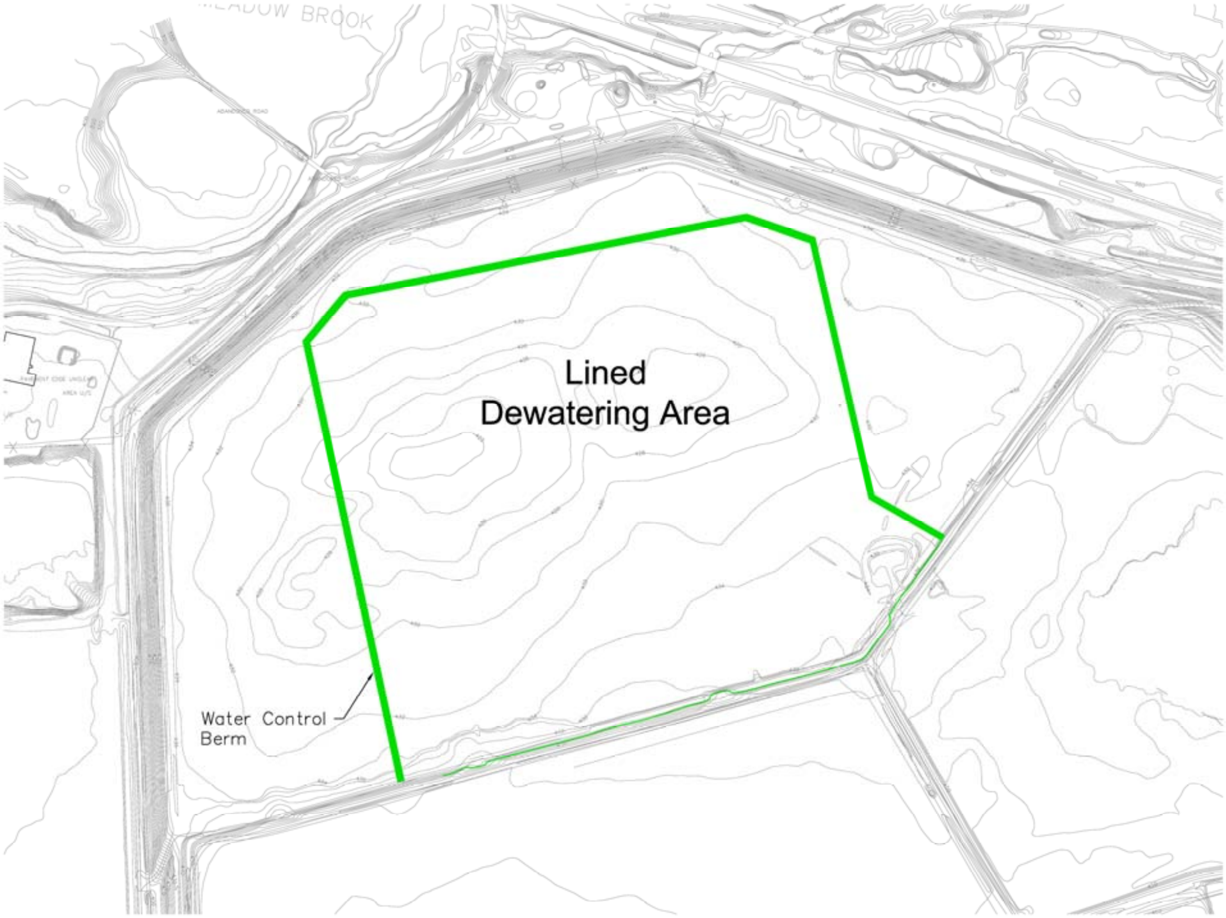


Figure 4 Geotextile Tubes Conceptual Design

TABLES

TABLE 1

SETTLING BASIN VERSUS GEOTEXTILE TUBES

Objectives	Settling Basin	Geotextile Tubes
1. Protect the Public and Wildlife during SCA Operations	--	+
2. Facilitate Efficient Emissions and Odor Management	--	+
3. Protect Workers during SCA Operations	o	o
4. Maintain Geotechnical Stability and SCA Liner System Integrity	--	+
5. Meet Operations Requirements	o	o
6. Select a Method Acceptable to the Public	--	+
7. Meet Cell Closure Requirements	o	o
8. Minimize Dewatering Area	o	o
9. Enhance the Water Treatment Process	o	o
10. Minimize Imported Material Quantities	--	+

Note: For a given objective, an "o" for both methods indicates that they are similarly effective at meeting the objective; whereas, a "+" for one method and a "--" for the other method indicates that the "+" method is considered to be more effective than the "--" method at meeting the objective.

APPENDIX C

COMPATIBILITY TEST RESULTS

JLT LABORATORIES, INC.
GEOTECHNICAL, GEOSYNTHETIC AND MATERIALS TESTING AND RESEARCH

June 29, 2009
09LR1826.01

Parsons
290 Elwood Davis Road
Suite 312
Liverpool, NY 13088

Attn: David Steele

**RE: COMPATIBILITY TEST RESULTS
GEOMEMBRANE SAMPLES WITH SOLVAY WASTE
HONEYWELL PROJECT
PO NO. 444853.00001.00**

Dear Mr. Steele:

Submitted herein is our report of 120 day compatibility testing performed on four (4) types of geomembrane identified as follows:

40 mil Smooth HDPE	Supplier: GSE
40 mil Smooth LLDPE	Supplier: GSE
40 mil Polypropylene	Supplier: Not Provided
40 mil EPDM	Supplier: Not Provided

Coupons of the materials were cut and tested for baseline properties as described herein. The remaining coupons were submerged in separate tanks containing Solvay waste. One set of sealed tanks were encased in a Styrofoam housing and maintained at $23 \pm 1^{\circ}C$. The other set of tanks were placed on steel shelving, encased in Styrofoam walls and maintained at $50 \pm 1^{\circ}C$.

After 30, 60, 90 and 120 days of continuous submergence in the Solvay waste, coupons were removed and tested for the following properties:

Dimensional Properties

The Width, Length, Thickness and Weight of the coupons were tested before exposure for baseline testing. They were then submerged in the tanks at 23°C and 50°C. At 30, 60, 90 and 120 days the coupons were removed, cleaned and retested for the same properties.

Puncture (ASTM D-4833)

Virgin material of each geomembrane type were tested for Puncture to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Puncture.

Density (ASTM D-1505)

Virgin material of each geomembrane type were tested for Density to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Density.

Hardness (ASTM D-2240)

Virgin material of each geomembrane type were tested for Hardness to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Hardness.

2% Secant Modulus (ASTM D-5323)

Virgin material of each geomembrane type were tested for Modulus to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Modulus.

Tear Resistance (ASTM D-1004)

Virgin material of each geomembrane type were tested for Tear Resistance to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Tear Resistance.

Volatiles (EPA-SW870)

Virgin material of each geomembrane type were tested for Volatiles to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Volatiles.

Extractables (EPA-SW870)

Virgin material of each geomembrane type were tested for Extractables to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Extractables.

Tensile Properties (ASTM D-669)

Virgin material of each geomembrane type were tested for Tensile Properties to develop baseline properties. At 30, 60, 90 and 120 days, coupons were removed from each tank and tested for Tensile Properties.

Test Results

The average value for each baseline test was computed and used as a reference for the subsequent immersion tests. As each test was performed after the 30, 60, 90 and 120 day immersion periods, the average result was computed. This value was compared to the average baseline value and the percent change computed as shown on the attached data sheets. The data was plotted as percent change vs immersion period at 23°C and 50°C as shown on the tables.

Testing Comments

It is noted the specified tests for this work were based on ASTM D-5747 criteria for HDPE geomembranes. Thus, many of the tests do not apply to LLDPE, Polypropylene and EPDM. However, for comparison purposes, it was decided to run the same tests regardless of the material types as a common baseline.

Summary of HDPE Results

HDPE Dimensional Properties
The values varied only slightly with less then 1% difference over the 120 day period. Thus, Solvay waste had little effect on these properties.

HDPE Puncture
The results varied with less then 10% decrease in strength over the 120 day period. This is well within the statistical variability of the material itself.

HDPE Density
The variation in Density was less then 1% over 120 days indicating the Solvay waste has little effect on the density.

HDPE Hardness
The Hardness decreased by 2.78% at 23°C and 8.33% at 50°C. With immersion, the material tends to soften slightly with greater softening at higher temperatures. However, this softening was quite minimal.

HDPE 2% Secant Modulus
At 23°C the Modulus decreased by 22.41% and 11.38% at 50°C. This is as expected. A softening of the material always decreases the Modulus value.

HDPE Tear Resistance
Tear strength decreased by 10.5% at 23°C and 8.0% at 50°C. These values are well within the statistical variation of the material itself.

HDPE Volatiles
For these tests, Volatiles varied the most. However, Volatiles evaporate very quickly. Once a sample is removed from the tank, volatiles begin to evaporate. The variation can easily be accounted to the time between the sample was extracted, washed and weighed for the test. These tests are not valid for evaluation unless other tests correlate with these results.

HDPE Extractables
At 23°C, the Extractables gradually increased over time with a maximum of 19.1% increase. Similarly, at 50°C the Extractables increased through 60 days but decreased at 90 and 120 days. It is difficult to explain this decrease but it does not appear to have an effect on the engineering properties of strength.

HDPE Tensile Properties
Although the properties varied vs exposure time, the statistical variations were well within the statistical variations of the material's virgin properties. The plots show no significant and consistent decrease with exposure time vs temperature to indicate degradation of the material.

<u>Summary of LLDPE Results</u>

LLDPE Dimensional Properties
The Length, Width, Thickness and Weight all varied by less then 1% indicating that swelling and absorption was very minimal.

LLDPE Puncture
Puncture strength did decrease by 15.7% at 23°C and 12.81% at 50°C indicating a slight and expected softening of the geomembrane.

LLDPE Density
The Density change was minimal (<1%) indicating a very slight swelling of the geomembrane.

LLDPE Hardness
Hardness increased somewhat. However, this test method is not applicable to LLDPE.

LLDPE 2% Secant Modulus
This value decreased by 23.00% at 23°C and 27.18% at 50°C. Although this test is not applicable to a LLDPE membrane, the results suggests a softening of the material.

LLDPE Tear Resistance
Tear strength varied by +2.94% at 23°C and 12.5% at 50°C. This variation is well within the statistical variation of the material itself.

LLDPE Volatiles
Volatiles increased significantly indicating the LLDPE absorbed the Volatile components in the Solvay waste. However a relationship between Volatiles and engineering properties is not evident.

LLDPE Extractables
This value also varied increasing at 23°C and decreasing at 50°C. Again these changes do not correlate well with any engineering properties.

LLDPE Tensile Properties
Yield stress and yield strain are not applicable to LLDPE. With respect to the Peak Stress and Peak Strain, the change was less then 8% over 120 days and well within the statistical variation of the material itself.

Summary of Polypropylene Results

Polypropylene Dimensional Properties
Length, Width, Thickness and Weight changes exhibition less then 2% change over the 120 days immersion period. This data does not suggest any significant degradation of the material.

Polypropylene Puncture
Over 120 days, Puncture strength decreased by 13.97% at 23°C and 21.89% at 50°C.

Polypropylene Density
The Density change was on the order of 0.5% which was insignificant at both 23°C and 50°C.

Polypropylene Hardness
Since Hardness does not apply to Polypropylene, no meaningful conclusions can be made.

Polypropylene 2% Secant Modulus
This test does not apply to Polypropylene. However, using the graphical procedure of the Standard indicated a 61% decrease after 120 days at 23°C and 50°C.

Polypropylene Tear Resistance
At 23^{O}C the Tear strength decreased by 13% after 120 days and 21.95% after 120 days at 50^{O}C. This suggests a softening of the material.

Polypropylene Volatiles
At both 23^{O}C and 50^{O}C after 120 days, the Polypropylene significantly absorbs Volatiles from the Solvay waste.

Polypropylene Extractables
Conversely after 120 days, the Polypropylene exhibited a significant decrease in Extractables.

Polypropylene Tensile Properties
Similar to LLDPE, yield stress and yield strain are not applicable to Polypropylene. Peak values did not change significantly and were well within the statistical variations of the material itself.

Summary of EPDM Results

EPDM Dimensional Properties
Length, Width, Thickness and Weight changes were all less then 2% after 120 days. These values are insignificant.

EPDM Puncture
After 120 days of exposure, the average values decreased by 18.66% at 23^{O}C and 14.71 at 50^{O}C. These values are not that significant in that the values can vary by +20% on virgin materials.

EPDM Density
At both 23^{O}C and 50^{O}C, the Density decreased by less then 1% which is insignificant but does suggest some slight absorption of liquid.

EPDM Hardness
The Hardness values decreased due to softening and corresponds with the decrease in Density.

EPDM 2% Secant Modulus
Although this test does not apply to EPDM, we used graphical procedure of the Standard. The data indicates a 40 ± % loss over 120 days. This suggests a softening of the material similar to Puncture.

EPDM Tear Resistance
Tear strength varied by +12.5% at 23^{O}C and +4.17% at 50^{O}C after 120 days of exposure. These values are within the statistical variation of the material itself.

EPDM Volatiles
After 120 days of exposure, Volatiles increased by 130% at 23°C and 216% at 50°C. This suggests the EPDM did absorb Volatiles from the Solvay waste.

EPDM Extractables
Similar to Volatiles, the Extractables also increased by about 60 ± % at 23°C and 50°C. This indicates the EPDM does absorb liquids from the Solvay waste.

EPDM Tensile Properties
Since yield stress and yield strain does not apply to EPDM, these results were not evaluated. Peak Stress after 120 days of exposure increase by about 15+% with a slight decrease in Peak Strain. This suggests a stiffening of the material which increases Strength but decreases Strain. However, these values are still within the statistical variation of the material itself.

Summary

All four (4) geomembrane types performed well. The HDPE and LLDPE geomembrane performed the best considering all of the properties were relatively consistent. With respect to the Polypropylene and EPDM, they both absorbed the most extractables and volatiles with more strength variations then the HDPE and LLDPE due to the absorption and softening of the materials.

We appreciate the opportunity to provide our services and look forward to working with you again. Should you have any questions, comments or require additional information, please do not hesitate to call. Thank you.

Sincerely,

JLT LABORATORIES, INC.

John Boschuk, Jr., P.E.
President

cc: Martin A. Switzer

Enclosures
JB/mlb
\wp10\letter\09121
Inv# 3827

Summary of Test Results

PROPERTY CHANGE (ASTM D-5747)

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	GSE 40 mil Smooth	Tested By:	RL/AM/MLB
Sample ID:	101130132 - HDPE	Checked By:	JB

23° Celcius

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Weight, gr	9.5917	9.5931	0.01	9.61	0.20	9.62	0.25	9.60	0.09
Length, in	5.5443	5.6135	1.25	5.56	0.22	5.54	-0.14	5.54	-0.02
Width, in	2.6255	2.6153	-0.39	2.62	-0.34	2.61	-0.61	2.61	-0.49
Thickness, mils	41	41	0.00	41.33	0.00	41.33	0.00	41.33	0.00

50° Celcius

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Weight, gr	9.1289	9.1593	0.33	9.18	0.52	9.17	0.49	9.15	0.24
Length, in	5.2642	5.2664	0.04	5.26	-0.05	5.26	-0.01	5.28	0.22
Width, in	2.7485	2.7465	-0.07	2.75	0.00	2.76	0.24	2.75	0.13
Thickness, mils	41	41	0.00	41.00	0.00	41.00	0.00	41.00	0.00

JLT Laboratories, Inc.

Property Change
ASTM D-5747, paragraphs 11.1 & 11.2

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	GSE 40 mil Smooth	Tested By:	RL/AM/MLB
Sample ID:	101130132 - HDPE	Checked By:	JB
	120 Day Testing		

23° C

PROPERTY ID	UNIT	REPLICATE 1	REPLICATE 2	REPLICATE 3	AVERAGE	STANDARD DEVIATION
Weight	grams	9.0441	9.8676	9.8882	9.6000	0.3931
Length	in	5.5875	5.5690	5.4725	5.5430	0.0504
Width	in	2.4030	2.6915	2.7435	2.6127	0.1498
Thickness	mils	42	40	42	41.3	0.9428

50° C

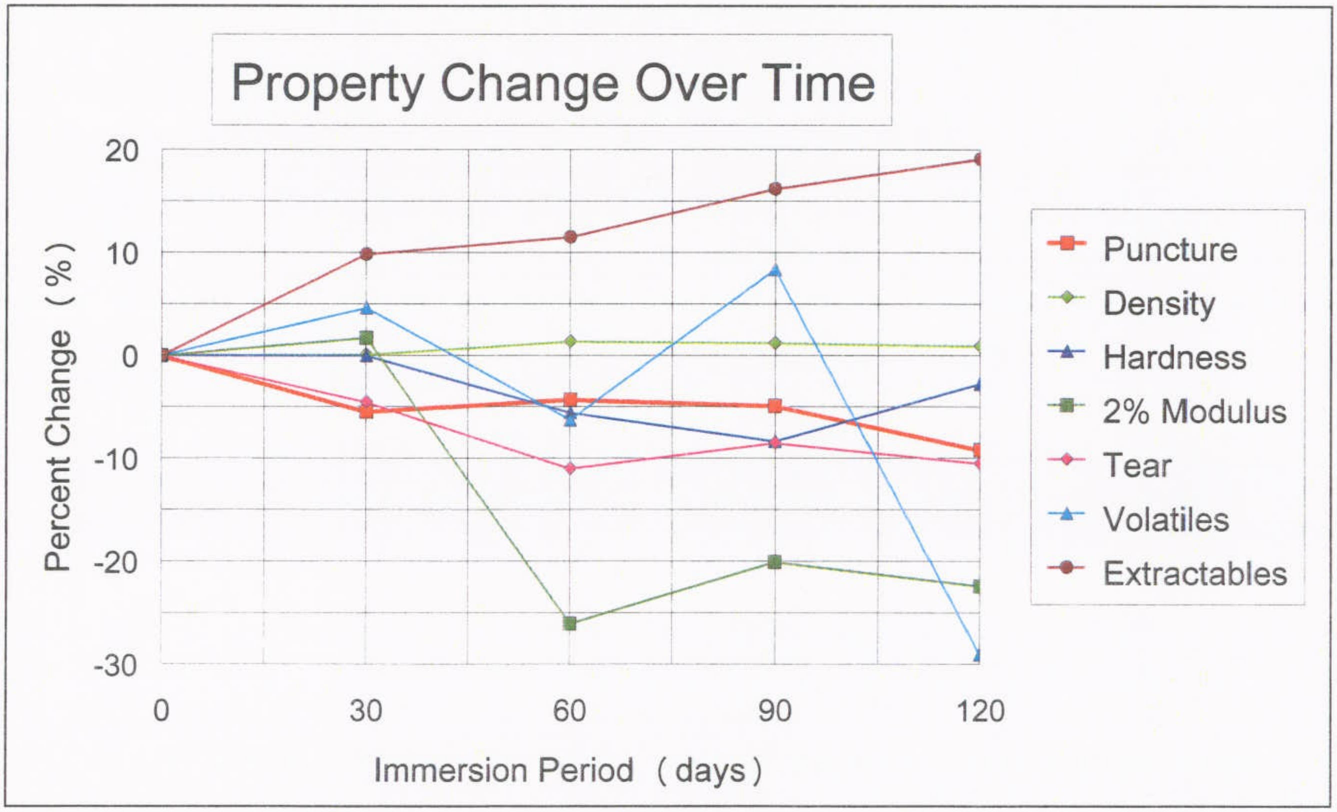
PROPERTY ID	UNIT	REPLICATE 1	REPLICATE 2	REPLICATE 3	AVERAGE	STANDARD DEVIATION
Weight	grams	8.7853	9.4372	9.2310	9.1512	0.2721
Length	in	5.1890	5.3900	5.2475	5.2755	0.0844
Width	in	2.6835	2.7645	2.8080	2.7520	0.0516
Thickness	mils	41	41	41	41.0	0.0000

JLT Laboratories, Inc.

Summary of Test Results
HDPE - 23° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	GSE 40 mil Smooth	Tested By:	RL/AM/MLB
Sample ID:	101130132 - HDPE	Checked By:	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture	108.4	102.5	-5.44	103.8	-4.28	103.1	-4.89	98.5	-9.17
Density	0.931	0.932	0.07	0.944	1.36	0.943	1.22	0.940	0.89
Hardness	12	12	0.00	11	-5.56	11	-8.33	12	-2.78
2% Modulus	49750	50600	1.71	36800	-26.03	39768	-20.06	38602	-22.41
Tear	40.0	38.2	-4.50	35.6	-11.00	36.6	-8.50	35.8	-10.50
Volatiles	0.6637	0.6943	4.61	0.6221	-6.27	0.7194	8.38	0.4710	-29.04
Extractables	0.3410	0.3746	9.85	0.3803	11.52	0.3963	16.21	0.4061	19.10



JLT Laboratories, Inc.

Geomembrane Conformance Test Results

HDPE - 23° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	120 Day Testing		

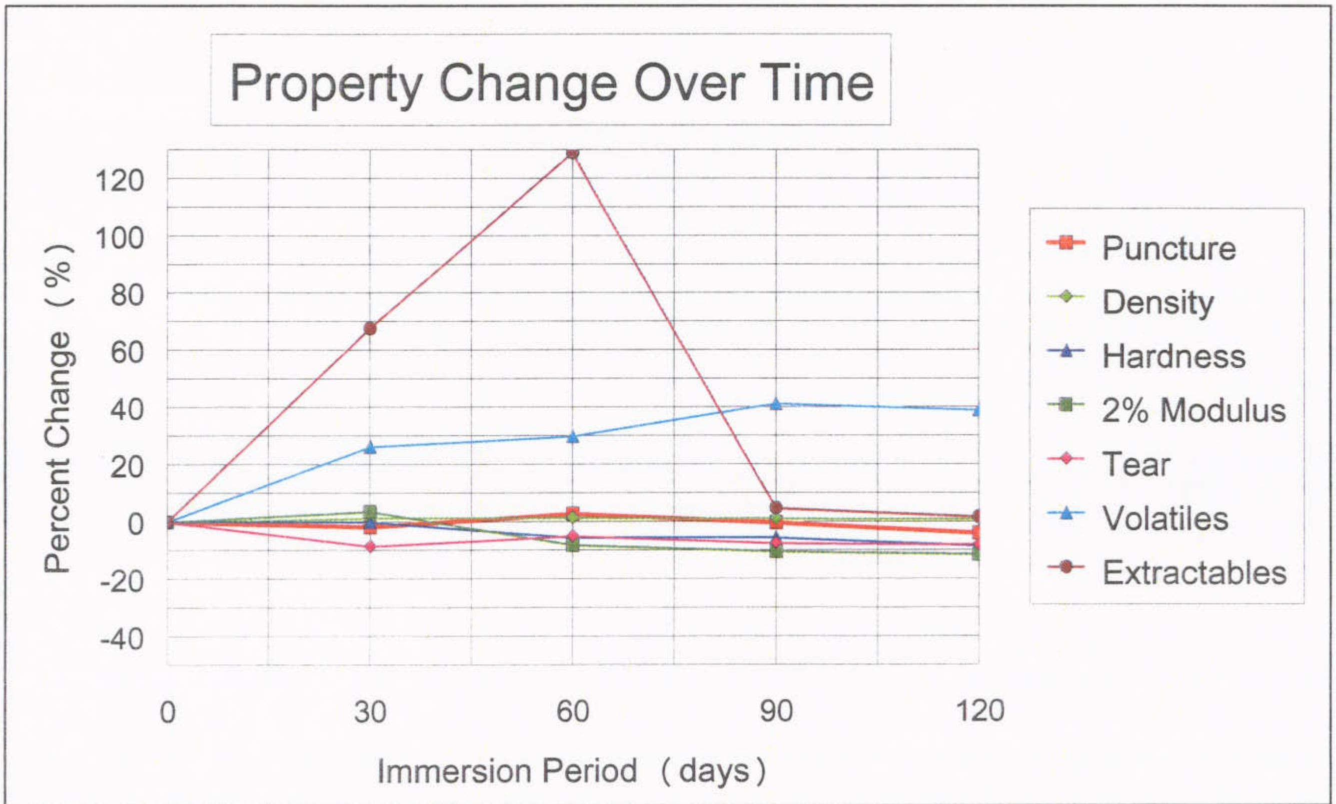
PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture Resistance	lbs	102.8	97.0	97.6	97.6	97.3	98.5	2.1814
Density	gr/cucm	0.94	0.94	0.94			0.94	0.0005
Hardness		11	12	12			12	0.4714
2% Secant Modulus	psi	38500	37850	38640	39140	38880	38602	434.5
Tear (MD Only)	lbs	37	35	32	38	37	35.8	2.1354
Volatiles	%	0.4372	0.5048				0.4710	0.0338
Extractables	%	0.3997	0.4125				0.4061	0.0064

JLT Laboratories, Inc.

Summary of Test Results
HDPE - 50° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture	108.4	106.5	-1.73	111.4	2.73	108.1	-0.24	104.1	-4.00
Density	0.931	0.944	1.32	0.945	1.43	0.942	1.11	0.939	0.86
Hardness	12	12	0.00	11	-5.56	11	-5.56	11	-8.33
2% Modulus	49750	51500	3.52	45700	-8.14	44582	-10.39	44088	-11.38
Tear	40.0	36.6	-8.50	38.0	-5.00	37.0	-7.50	36.8	-8.00
Volatiles	0.6637	0.8376	26.20	0.8614	29.78	0.9374	41.23	0.9218	38.88
Extractables	0.3410	0.5713	67.55	0.7804	128.88	0.3568	4.64	0.3466	1.65



JLT *Laboratories, Inc.*

Geomembrane Conformance Test Results

HDPE - 50° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	120 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture Resistance	lbs	103.7	104.5	105.3	106.6	100.2	104.1	2.1546
Density	gr/cucm	0.94	0.94	0.94			0.94	0.0005
Hardness		11	12	10			11	0.8165
2% Secant Modulus	psi	43670	43260	44120	45100	44290	44088	620.7
Tear (MD Only)	lbs	39	39	35	35	36	36.8	1.8330
Volatiles	%	0.9321	0.9114				0.9218	0.0103
Extractables	%	0.2355	0.4577				0.3466	0.1111

JLT Laboratories, Inc.

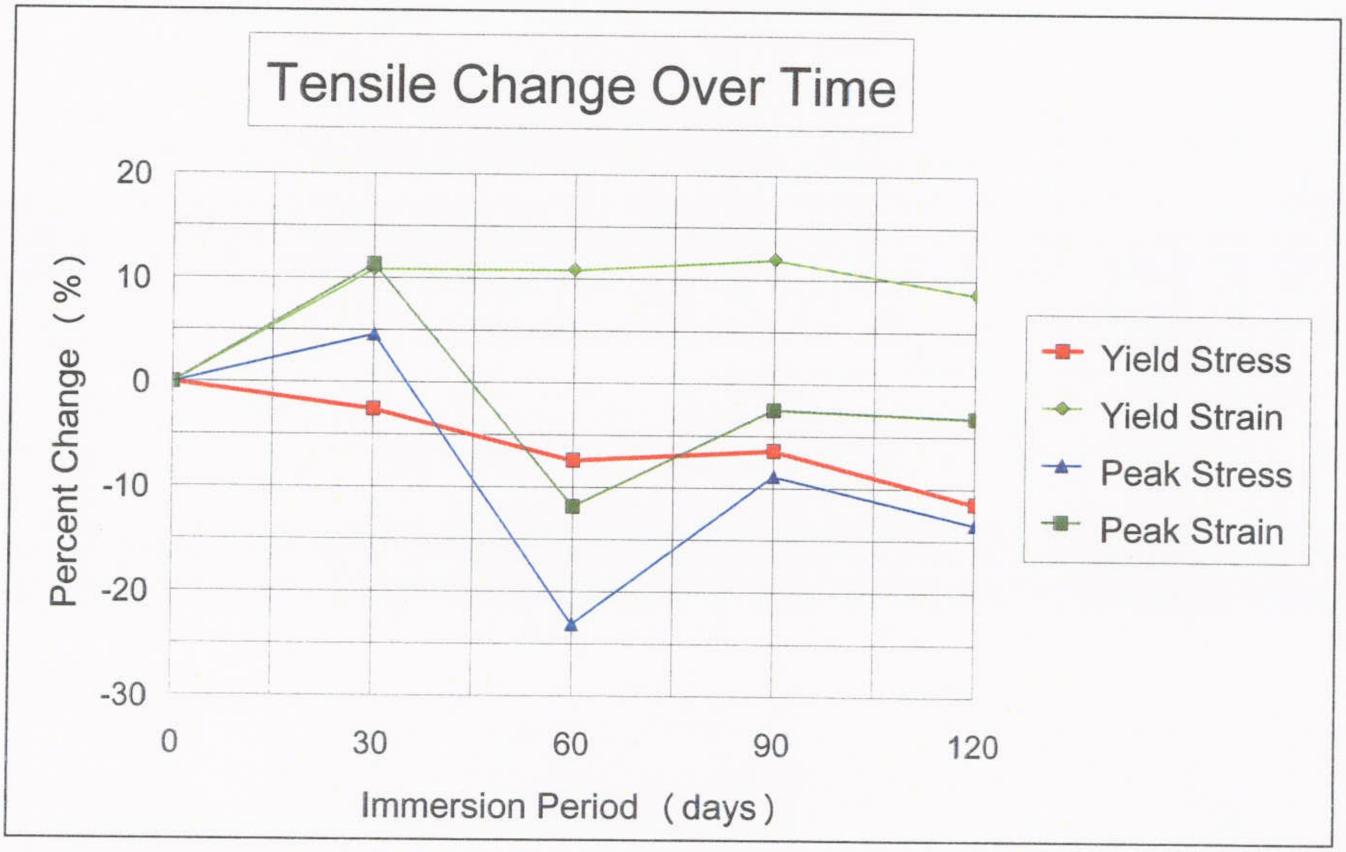
Summary of Test Results

HDPE - 23° Celcius

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	GSE 40 mil Smooth	Tested By:	RL/AM/MLB
Sample ID:	101130132 - HDPE	Checked By:	JB

TEST READING	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Yield Stress	103.2	100.6	-2.52	95.6	-7.36	96.6	-6.40	91.4	-11.43
Yield Strain	18.4	20.4	10.87	20.4	10.87	20.6	11.96	20.0	8.70
Peak Stress	190.4	199.2	4.62	146.4	-23.11	173.6	-8.82	164.8	-13.45
Peak Strain	532.2	592.6	11.35	469.2	-11.84	519.0	-2.48	515.0	-3.23



JLT Laboratories, Inc.

Tensile Test Results

HDPE - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	Baseline Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	102	102	105	103	104	103.2	1.17
Yield Strain	%	18	18	19	19	18	18.4	0.49
Peak Stress	lb/in	168	220	176	192	196	190.4	22.86
Peak Strain	%	184	683	557	613	624	532.2	178.64

JLT *Laboratories, Inc.*

Tensile Test Results

HDPE - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	30 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	99	102	100	98	104	100.6	2.15
Yield Strain	%	21	19	21	19	22	20.4	1.20
Peak Stress	lb/in	164	220	216	204	192	199.2	25.51
Peak Strain	%	506	641	642	615	559	592.6	52.75

JLT *Laboratories, Inc.*

Tensile Test Results
HDPE - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	03/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	60 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	99	94	96	98	91	95.6	2.87
Yield Strain	%	22	22	19	19	20	20.4	1.36
Peak Stress	lb/in	220	140	96	136	140	146.4	51.33
Peak Strain	%	598	445	450	403	450	469.2	66.78

JLT *Laboratories, Inc.*

Tensile Test Results

HDPE - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	04/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	90 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	100	95	98	93	97	96.6	2.42
Yield Strain	%	20	21	21	21	20	20.6	0.49
Peak Stress	lb/in	192	144	164	184	184	173.6	19.69
Peak Strain	%	568	441	491	535	560	519.0	47.34

JLT *Laboratories, Inc.*

Tensile Test Results
HDPE - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	120 Day Testing		

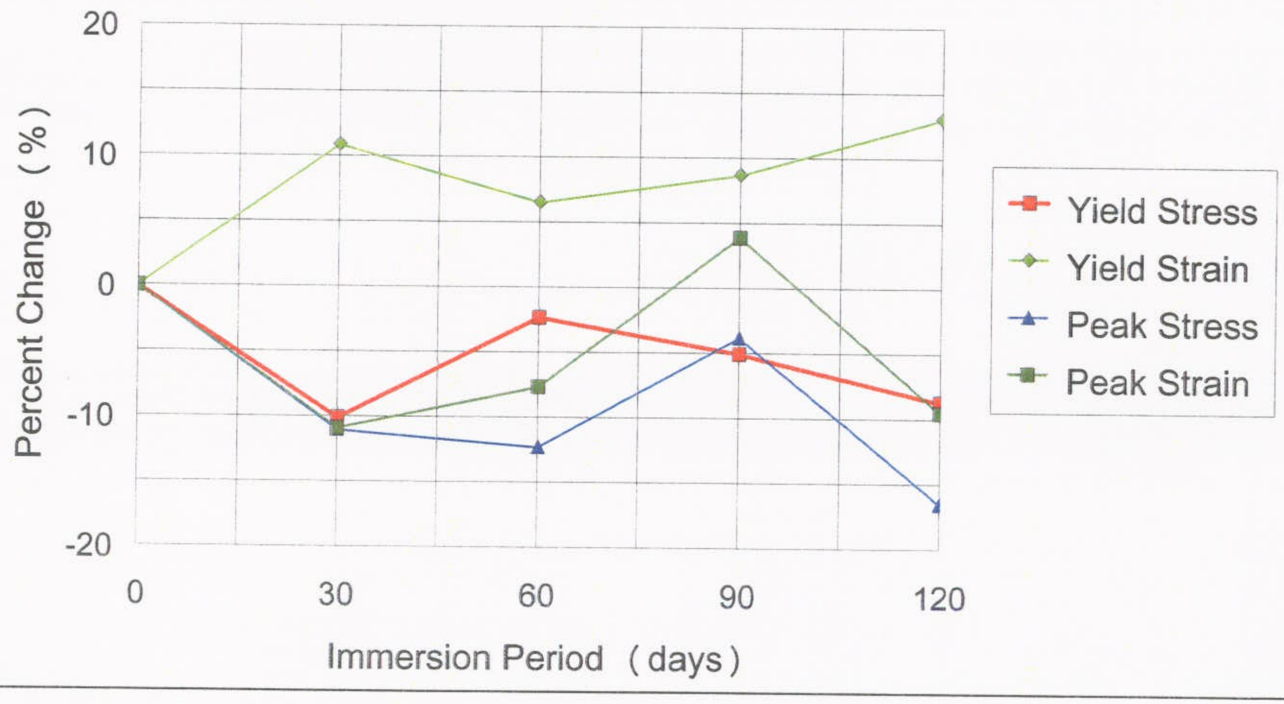
PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	93	97	88	93	86	91.4	3.93
Yield Strain	%	18	19	18	23	22	20.0	2.10
Peak Stress	lb/in	148	136	188	200	152	164.8	24.71
Peak Strain	%	462	410	596	611	496	515.0	77.42

JLT *Laboratories, Inc.*

Summary of Test Results
HDPE - 50° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	GSE 40 mil Smooth	Tested By:	RL/AM/MLB
Sample ID:	101130132 - HDPE	Checked By:	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Yield Stress	103.2	92.8	-10.08	100.8	-2.33	98.0	-5.04	94.2	-8.72
Yield Strain	18.4	20.4	10.87	19.6	6.52	20.0	8.70	20.8	13.04
Peak Stress	188.8	168.0	-11.02	165.6	-12.29	181.6	-3.81	157.6	-16.53
Peak Strain	532.2	474.2	-10.90	491.4	-7.67	552.8	3.87	481.4	-9.55



JLT Laboratories, Inc.

Tensile Test Results

HDPE - 50° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	Baseline Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	102	102	105	103	104	103.2	1.17
Yield Strain	%	18	18	19	19	18	18.4	0.49
Peak Stress	lb/in	160	220	176	192	196	188.8	25.37
Peak Strain	%	184	683	557	613	624	532.2	178.64

JLT Laboratories, Inc.

Tensile Test Results

HDPE - 50° Celcius

JLT

Client: Parsons
Project: Honeywell
Material: GSE 40 mil Smooth
Sample ID: 101130132 - HDPE
30 Day Testing

Job No.: 09LR1826.01
Date: 02/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	97	94	93	91	89	92.8	2.71
Yield Strain	%	21	19	21	19	22	20.4	1.20
Peak Stress	lb/in	164	192	168	168	148	168.0	12.36
Peak Strain	%	331	576	513	505	446	474.2	82.61

JLT *Laboratories, Inc.*

Tensile Test Results

HDPE - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	03/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	101130132 - HDPE	**Checked By:**	JB
	60 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	98	101	101	101	103	100.8	1.60
Yield Strain	%	21	20	18	19	20	19.6	1.02
Peak Stress	lb/in	140	120	176	196	196	165.6	23.17
Peak Strain	%	443	351	528	574	561	491.4	83.74

JLT *Laboratories, Inc.*

Tensile Test Results
HDPE - 50° Celcius

JLT

Client:	Parsons
Project:	Honeywell
Material:	GSE 40 mil Smooth
Sample ID:	101130132 - HDPE
	90 Day Testing

Job No.:	09LR1826.01
Date:	04/15/2009
Tested By:	RL/AM/MLB
Checked By:	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	97	100	97	98	98	98.0	1.10
Yield Strain	%	20	18	21	21	20	20.0	1.10
Peak Stress	lb/in	216	172	168	164	188	181.6	21.75
Peak Strain	%	663	522	516	502	561	552.8	58.47

JLT *Laboratories, Inc.*

Tensile Test Results

HDPE - 50° Celcius

JLT

Client: Parsons
Project: Honeywell
Material: GSE 40 mil Smooth
Sample ID: 101130132 - HDPE
120 Day Testing

Job No.: 09LR1826.01
Date: 05/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	95	96	97	89	94	94.2	2.79
Yield Strain	%	22	20	21	21	20	20.8	0.75
Peak Stress	lb/in	188	168	148	144	140	157.6	16.33
Peak Strain	%	572	501	448	464	422	481.4	52.04

JLT Laboratories, Inc.

Summary of Test Results

PROPERTY CHANGE (ASTM D-5747)

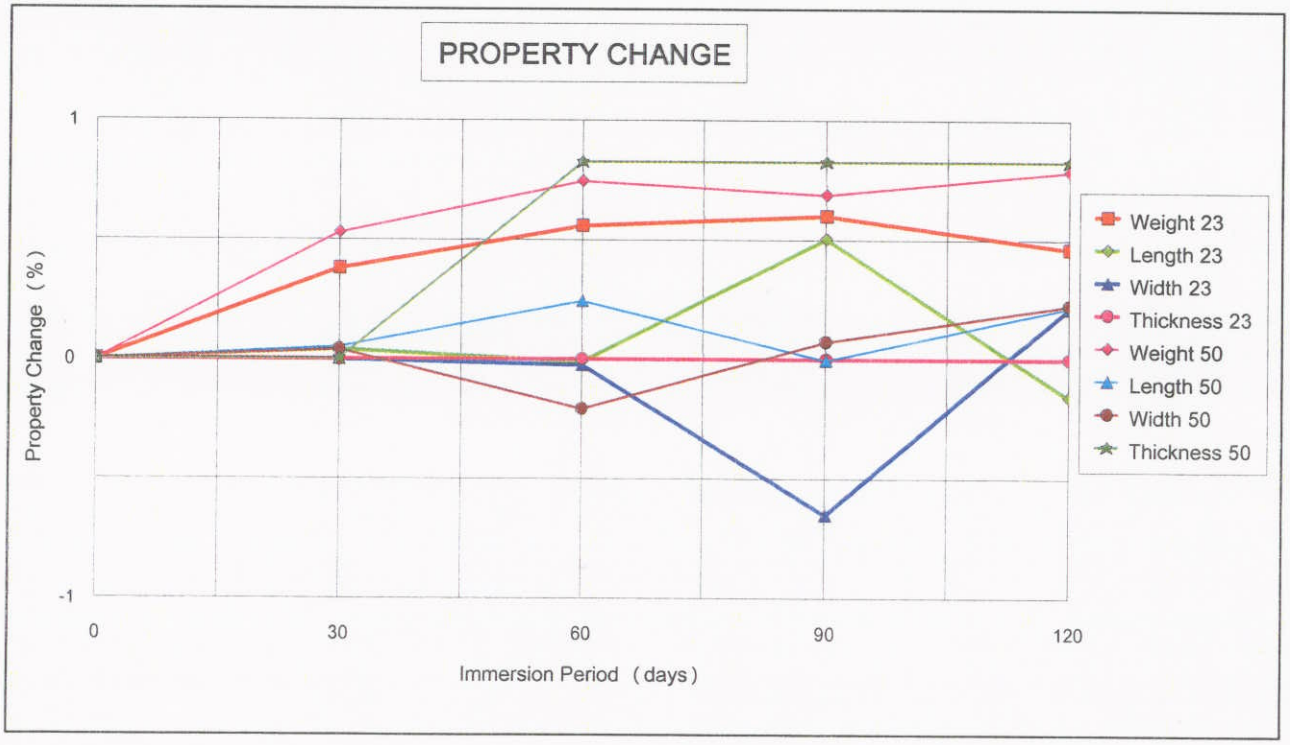
Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB

23° Celcius

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Weight, gr	8.5775	8.6102	0.38	8.63	0.56	8.63	0.60	8.62	0.46
Length, in	4.8562	4.8577	0.03	4.86	-0.01	4.88	0.50	4.85	-0.16
Width, in	2.8250	2.8262	0.04	2.82	-0.02	2.81	-0.65	2.83	0.21
Thickness, mils	41	41	0.00	40.67	0.00	40.67	0.00	40.67	0.00

50° Celcius

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Weight, gr	7.6216	7.6620	0.53	7.68	0.75	7.67	0.69	7.68	0.79
Length, in	4.8562	4.8587	0.05	4.87	0.24	4.86	-0.00	4.87	0.22
Width, in	2.5017	2.5027	0.04	2.50	-0.21	2.50	0.07	2.51	0.23
Thickness, mils	40	40	0.00	40.67	0.83	40.67	0.83	40.67	0.83



JLT Laboratories, Inc.

Property Change

ASTM D-5747, paragraphs 11.1 & 11.2

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	120 Day Testing		

23° C

PROPERTY ID	UNIT	REPLICATE			AVERAGE	STANDARD DEVIATION
		1	2	3		
Weight	grams	7.7665	9.0903	8.9948	8.6172	0.6028
Length	in	4.6190	4.9805	4.9460	4.8485	0.1629
Width	in	2.6690	2.9130	2.9110	2.8310	0.1146
Thickness	mils	40	41	41	40.7	0.4714

50° C

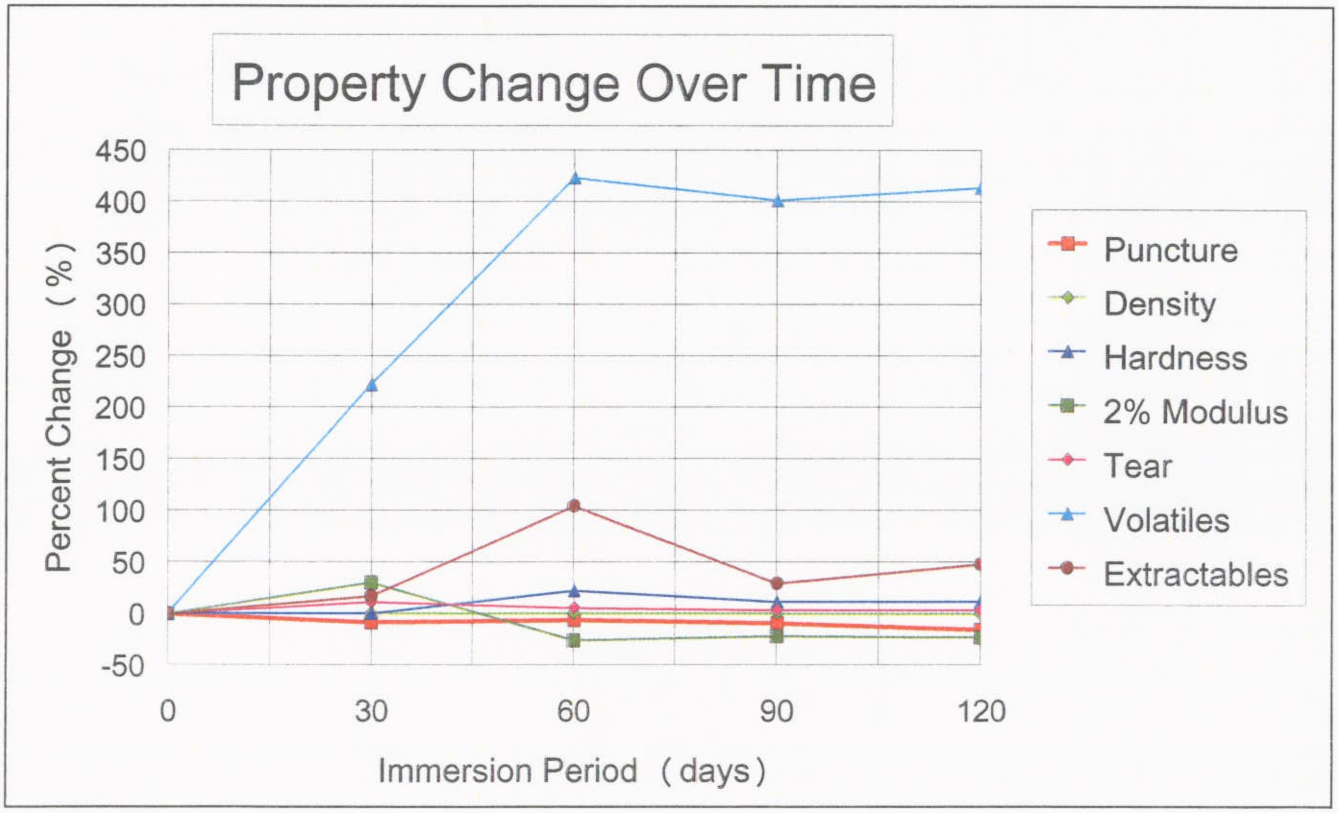
PROPERTY ID	UNIT	REPLICATE			AVERAGE	STANDARD DEVIATION
		1	2	3		
Weight	grams	8.4800	7.5752	6.9893	7.6815	0.6132
Length	in	5.2615	4.8345	4.5040	4.8667	0.3101
Width	in	2.5355	2.4930	2.4935	2.5073	0.0199
Thickness	mils	41	41	40	40.7	0.4714

JLT Laboratories, Inc.

Summary of Test Results
LLDPE - 23° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture	94.5	86.5	-8.43	88.6	-6.22	85.6	-9.40	79.6	-15.71
Density	0.931	0.932	0.07	0.931	-0.04	0.931	0.00	0.928	-0.32
Hardness	9	9	0.00	11	22.22	10	11.11	10	11.11
2% Modulus	22000	28600	30.00	16300	-25.91	17138	-22.10	16896	-23.20
Tear	27.2	30.2	11.03	28.6	5.15	28.0	2.94	28.0	2.94
Volatiles	0.1340	0.4315	221.89	0.7014	423.31	0.6719	401.23	0.6885	413.66
Extractables	0.3461	0.4045	16.87	0.7062	104.05	0.4468	29.09	0.5117	47.85



Laboratories, Inc.

Geomembrane Conformance Test Results
LLDPE - 23° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	GSE 40 mil Smooth	Tested By:	RL/AM/MLB
Sample ID:	104143221 - LLDPE 120 Day Testing	Checked By:	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture Resistance	lbs	78.6	80.3	80.1	81.2	78.0	79.6	1.1706
Density	gr/cucm	0.93	0.93	0.93			0.93	0.0005
Hardness		9	10	11			10	0.8165
2% Secant Modulus	psi	16920	16850	17160	16540	17010	16896	206.0
Tear (MD Only)	lbs	29	28	28	30	25	28.0	1.6733
Volatiles	%	0.6311	0.7459				0.6885	0.0574
Extractables	%	0.5355	0.4879				0.5117	0.0238

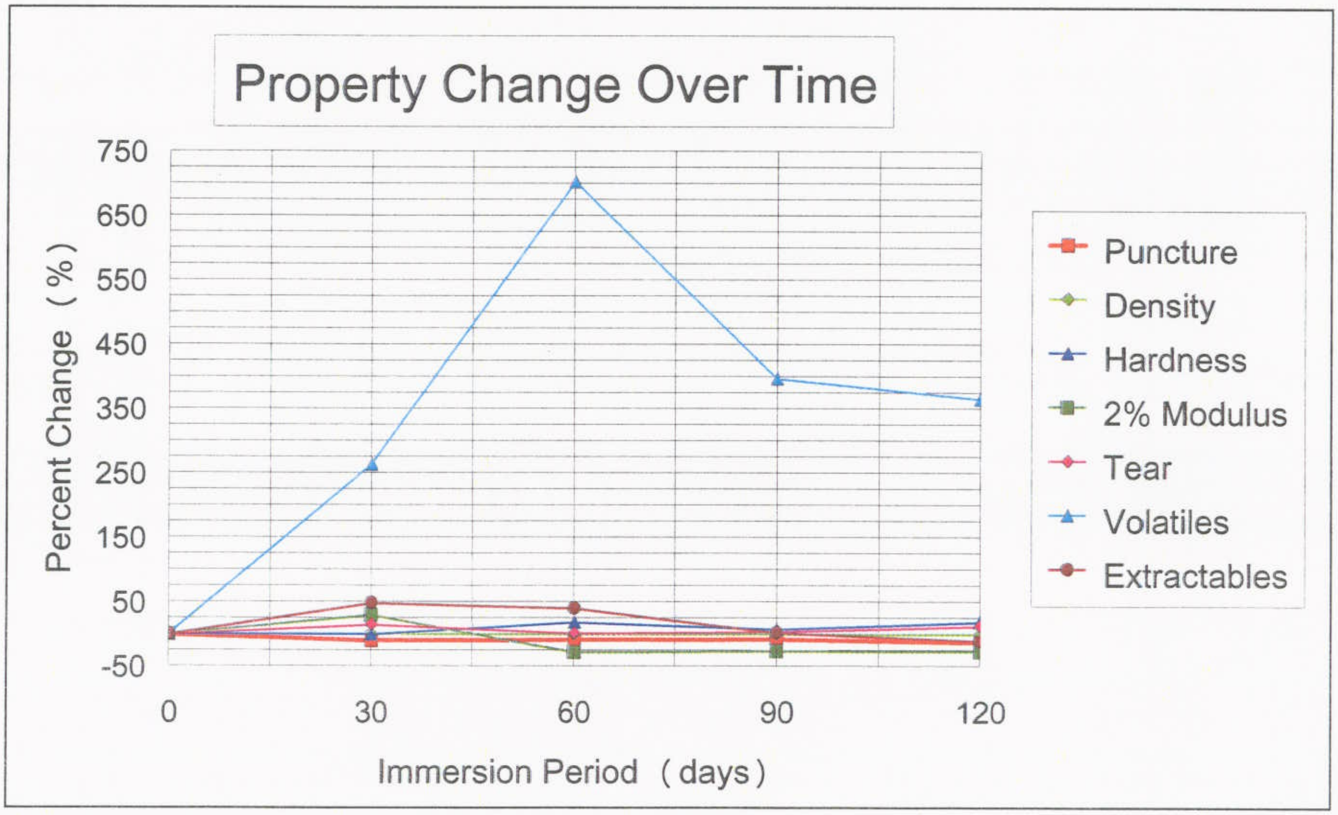
JLT Laboratories, Inc.

Summary of Test Results

LLDPE - 50° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	GSE 40 mil Smooth	Tested By:	RL/AM/MLB
Sample ID:	104143221 - LLDPE	Checked By:	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture	94.5	85.3	-9.72	86.2	-8.81	87.1	-7.77	82.4	-12.81
Density	0.931	0.932	0.07	0.931	0.00	0.931	-0.07	0.927	-0.47
Hardness	9	9	0.00	11	18.52	10	7.41	11	18.52
2% Modulus	22000	28500	29.55	15800	-28.18	16188	-26.42	16020	-27.18
Tear	27.2	31.2	14.71	27.6	1.47	28.2	3.68	30.6	12.50
Volatiles	0.1340	0.4870	263.29	1.0762	702.87	0.6659	396.76	0.6229	364.68
Extractables	0.3461	0.5112	47.70	0.4840	39.85	0.3527	1.91	0.3077	-11.11



Laboratories, Inc.

Geomembrane Conformance Test Results

LLDPE - 50° Celcius

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	GSE 40 mil Smooth	Tested By:	RL/AM/MLB
Sample ID:	104143221 - LLDPE	Checked By:	JB
	120 Day Testing		

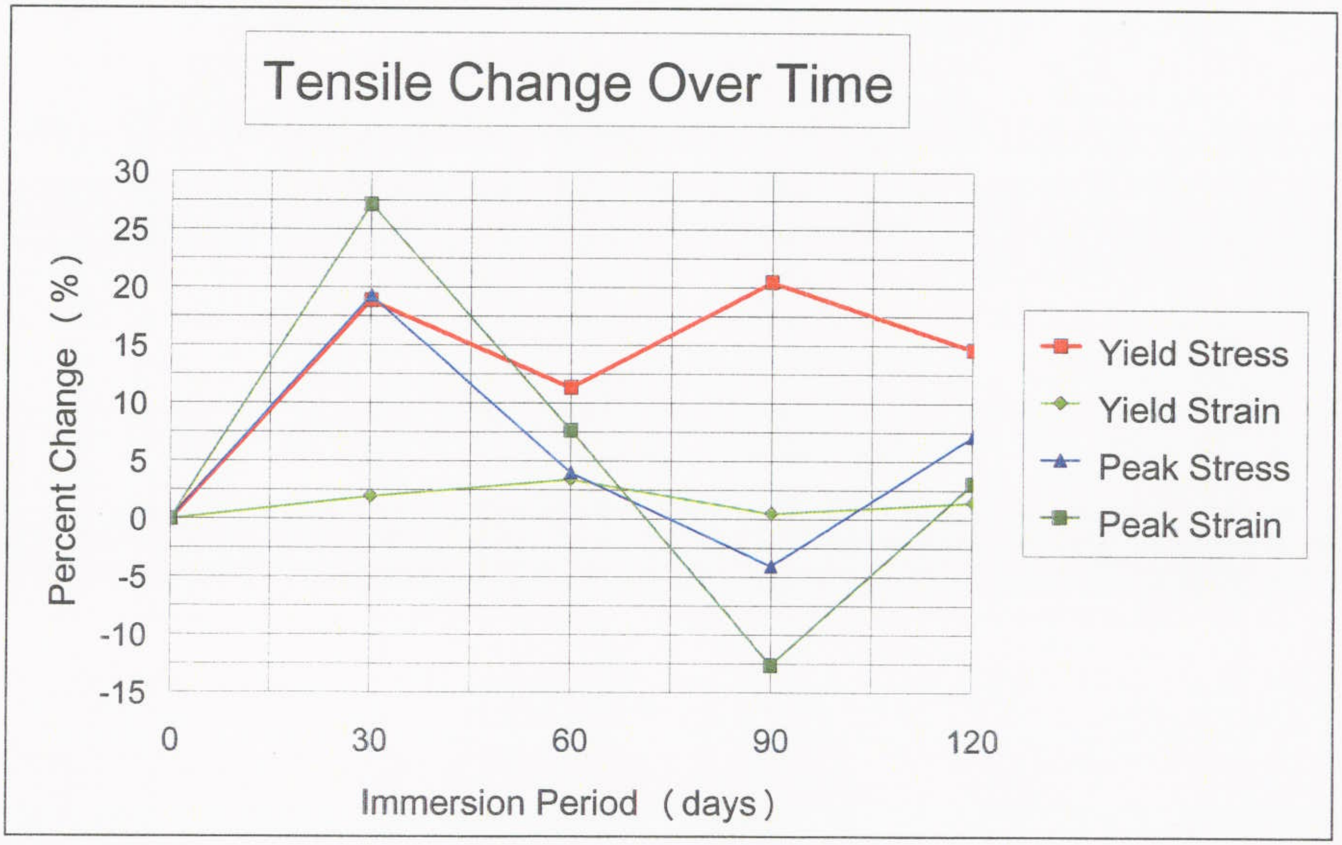
PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture Resistance	lbs	79.5	83.6	85.0	80.5	83.3	82.4	2.0508
Density	gr/cucm	0.93	0.93	0.93			0.93	0.0000
Hardness		11	10	11			11	0.4714
2% Secant Modulus	psi	15640	16210	16360	16110	15780	16020	269.0
Tear (MD Only)	lbs	31	31	32	32	27	30.6	1.8547
Volatiles	%	0.6609	0.5848				0.6229	0.0381
Extractables	%	0.2754	0.3399				0.3077	0.0323

JLT Laboratories, Inc.

Summary of Test Results
LLDPE - 23° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB

TEST READING	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Yield Stress	61.4	73.0	18.89	68.4	11.40	74.0	20.52	70.4	14.66
Yield Strain	40.8	41.6	1.96	42.2	3.43	41.0	0.49	41.4	1.47
Peak Stress	178.4	212.8	19.28	185.6	4.04	171.2	-4.04	191.2	7.17
Peak Strain	703.6	894.8	27.17	757.6	7.67	614.8	-12.62	725.2	3.07



Laboratories, Inc.

Tensile Test Results

LLDPE - 23° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	Baseline Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	62	63	61	62	59	61.4	1.36
Yield Strain	%	42	41	43	40	38	40.8	1.72
Peak Stress	lb/in	180	152	200	164	196	178.4	19.69
Peak Strain	%	747	516	899	567	789	703.6	142.28

JLT Laboratories, Inc.

Tensile Test Results

LLDPE - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	30 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	74	74	72	72	73	73.0	0.89
Yield Strain	%	44	44	41	41	38	41.6	2.24
Peak Stress	lb/in	164	252	216	212	220	212.8	36.12
Peak Strain	%	592	979	995	984	924	894.8	153.38

JLT *Laboratories, Inc.*

Tensile Test Results
LLDPE - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	03/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	60 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	69	70	68	68	67	68.4	1.02
Yield Strain	%	41	44	41	41	44	42.2	1.47
Peak Stress	lb/in	192	196	184	176	180	185.6	4.99
Peak Strain	%	795	794	724	735	740	757.6	30.57

JLT *Laboratories, Inc.*

Tensile Test Results

LLDPE - 23° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	04/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	90 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	75	75	72	75	73	74.0	1.26
Yield Strain	%	41	41	41	41	41	41.0	0.00
Peak Stress	lb/in	192	196	128	172	168	171.2	31.16
Peak Strain	%	685	708	484	601	596	614.8	79.08

Laboratories, Inc.

Tensile Test Results
LLDPE - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	120 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	75	70	69	70	68	70.4	2.42
Yield Strain	%	44	44	41	40	38	41.4	2.33
Peak Stress	lb/in	184	208	200	192	172	191.2	12.50
Peak Strain	%	695	749	777	733	672	725.2	37.56

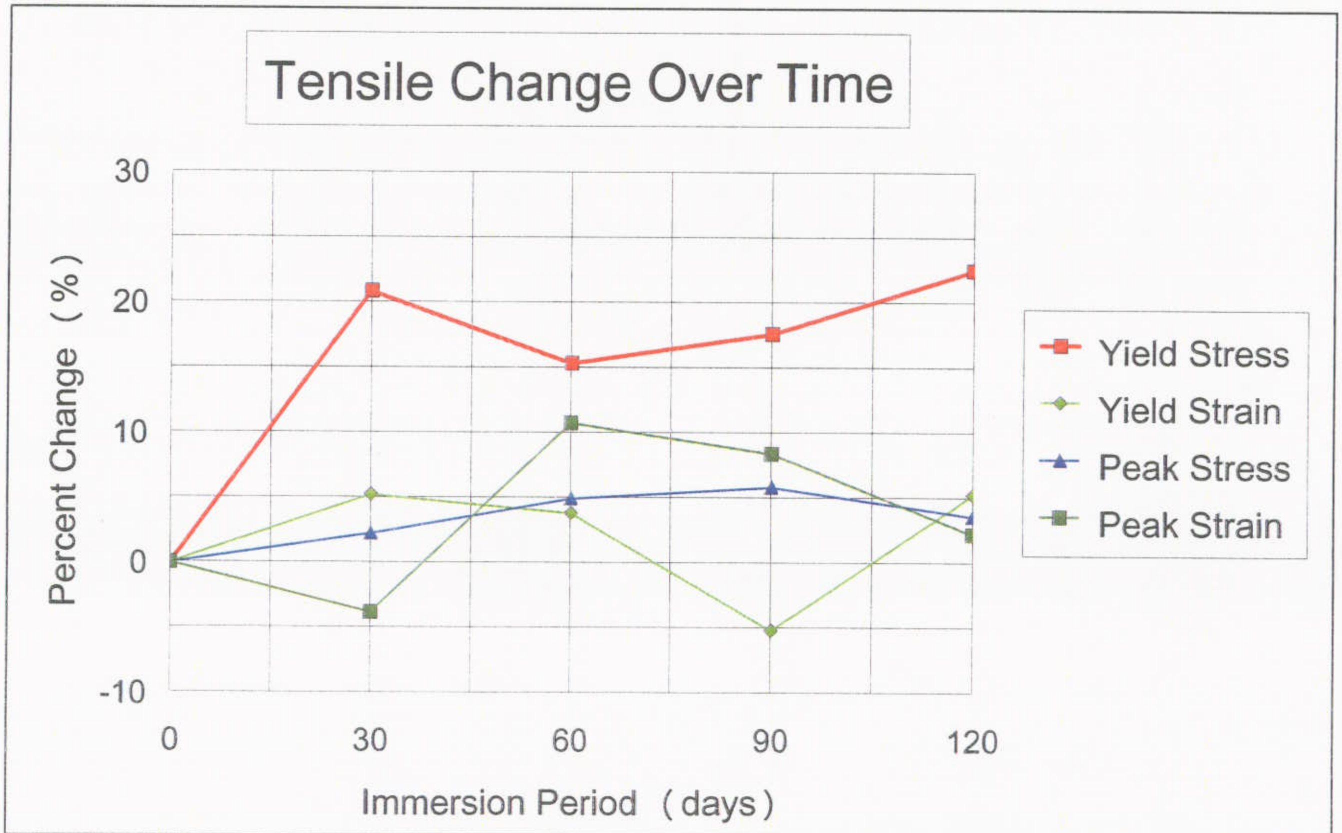
JLT Laboratories, Inc.

Summary of Test Results

LLDPE - 50° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Yield Stress	61.4	74.2	20.85	70.8	15.31	72.2	17.59	75.2	22.48
Yield Strain	42.2	44.4	5.21	43.8	3.79	40.0	-5.21	44.4	5.21
Peak Stress	178.4	182.4	2.24	187.2	4.93	188.8	5.83	184.8	3.59
Peak Strain	703.6	676.6	-3.84	779.0	10.72	762.4	8.36	719.0	2.19



JLT Laboratories, Inc.

Tensile Test Results

LLDPE - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	Baseline Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	62	63	61	62	59	61.4	1.36
Yield Strain	%	42	43	41	42	43	42.2	0.75
Peak Stress	lb/in	180	152	200	164	196	178.4	19.69
Peak Strain	%	747	516	899	567	789	703.6	142.28

JLT Laboratories, Inc.

Tensile Test Results
LLDPE - 50° Celcius

Client: Parsons
Project: Honeywell
Material: GSE 40 mil Smooth
Sample ID: 104143221 - LLDPE
30 Day Testing

Job No.: 09LR1826.01
Date: 02/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	74	75	74	74	74	74.2	0.40
Yield Strain	%	46	44	44	44	44	44.4	0.80
Peak Stress	lb/in	168	212	120	200	212	182.4	37.57
Peak Strain	%	613	772	467	732	799	676.6	122.58

JLT Laboratories, Inc.

Tensile Test Results
LLDPE - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	03/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	60 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	72	71	71	70	70	70.8	0.75
Yield Strain	%	46	44	41	44	44	43.8	1.60
Peak Stress	lb/in	176	200	208	168	184	187.2	13.60
Peak Strain	%	695	888	1012	624	676	779.0	146.87

JLT Laboratories, Inc.

Tensile Test Results
LLDPE - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	04/15/2009
Material:	GSE 40 mil Smooth	**Tested By:**	RL/AM/MLB
Sample ID:	104143221 - LLDPE	**Checked By:**	JB
	90 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	73	73	72	72	71	72.2	0.75
Yield Strain	%	39	38	41	41	41	40.0	1.26
Peak Stress	lb/in	188	200	176	200	180	188.8	9.80
Peak Strain	%	729	812	680	816	775	762.4	51.76

JLT Laboratories, Inc.

Tensile Test Results
LLDPE - 50° Celcius

Client: Parsons
Project: Honeywell
Material: GSE 40 mil Smooth
Sample ID: 104143221 - LLDPE
120 Day Testing

Job No.: 09LR1826.01
Date: 05/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	84	80	72	71	69	75.2	5.78
Yield Strain	%	38	46	46	46	46	44.4	3.20
Peak Stress	lb/in	204	192	148	196	184	184.8	19.50
Peak Strain	%	863	719	563	757	693	719.0	97.15

JLT Laboratories, Inc.

Summary of Test Results

PROPERTY CHANGE (ASTM D-5747)

JLT

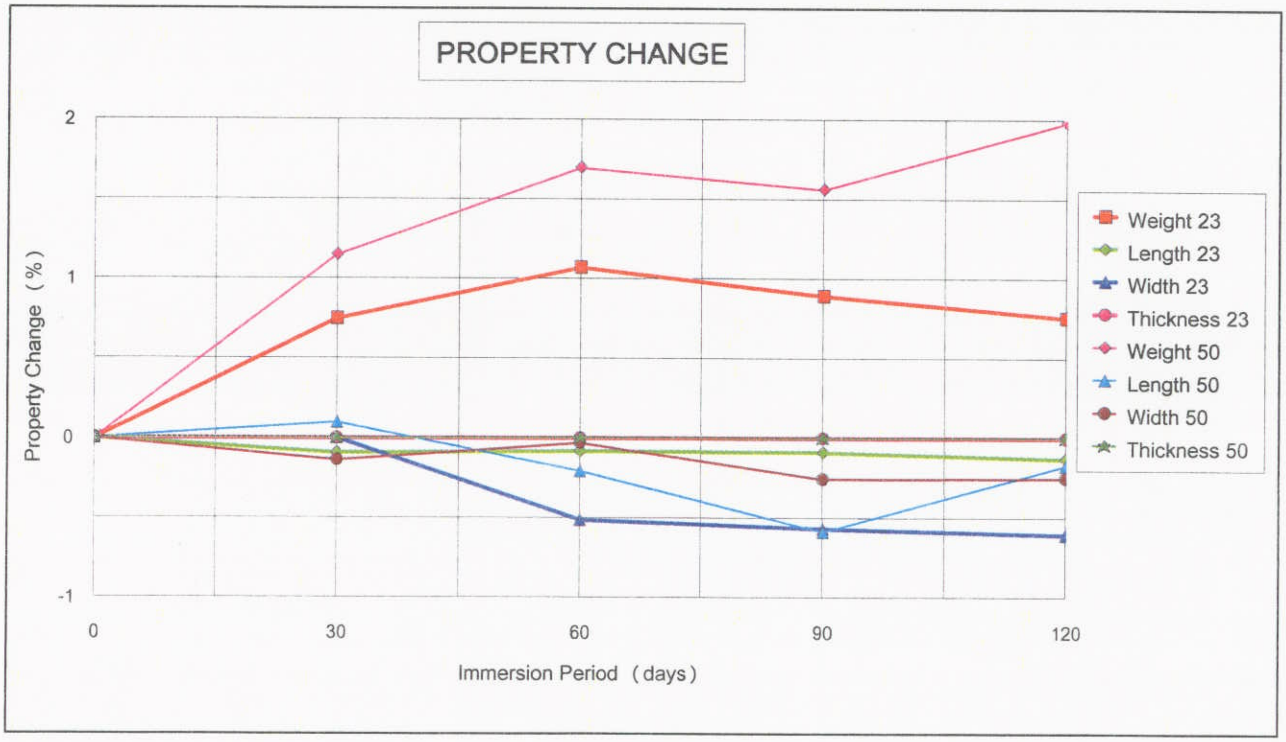
Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	Polypropylene	Tested By:	RL/AM/MLB
Sample ID:	Polypropylene	Checked By:	JB

23° Celcius

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Weight, gr	11.1493	11.2330	0.75	11.27	1.07	11.25	0.89	11.23	0.76
Length, in	5.3462	5.3507	0.08	5.34	-0.08	5.34	-0.09	5.34	-0.13
Width, in	2.8922	2.8895	-0.09	2.88	-0.51	2.88	-0.57	2.87	-0.61
Thickness, mils	44	44	0.00	44.33	0.00	44.33	0.00	44.33	0.00

50° Celcius

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Weight, gr	10.4059	10.5256	1.15	10.58	1.70	10.57	1.56	10.61	1.99
Length, in	5.3895	5.3948	0.10	5.38	-0.21	5.36	-0.59	5.38	-0.17
Width, in	2.9427	2.9387	-0.14	2.94	-0.03	2.94	-0.25	2.94	-0.25
Thickness, mils	40	40	0.00	40.33	0.00	40.33	0.00	40.33	0.00



JLT Laboratories, Inc.

Property Change
ASTM D-5747, paragraphs 11.1 & 11.2

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	Polypropylene	Tested By:	RL/AM/MLB
Sample ID:	Polypropylene 120 Day Testing	Checked By:	JB

23° C

PROPERTY ID	UNIT	REPLICATE 1	REPLICATE 2	REPLICATE 3	AVERAGE	STANDARD DEVIATION
Weight	grams	11.0203	11.6313	11.0494	11.2337	0.2814
Length	in	5.2635	5.4075	5.3470	5.3393	0.0590
Width	in	2.8675	2.8985	2.8580	2.8747	0.0173
Thickness	mils	44	45	44	44.3	0.4714

50° C

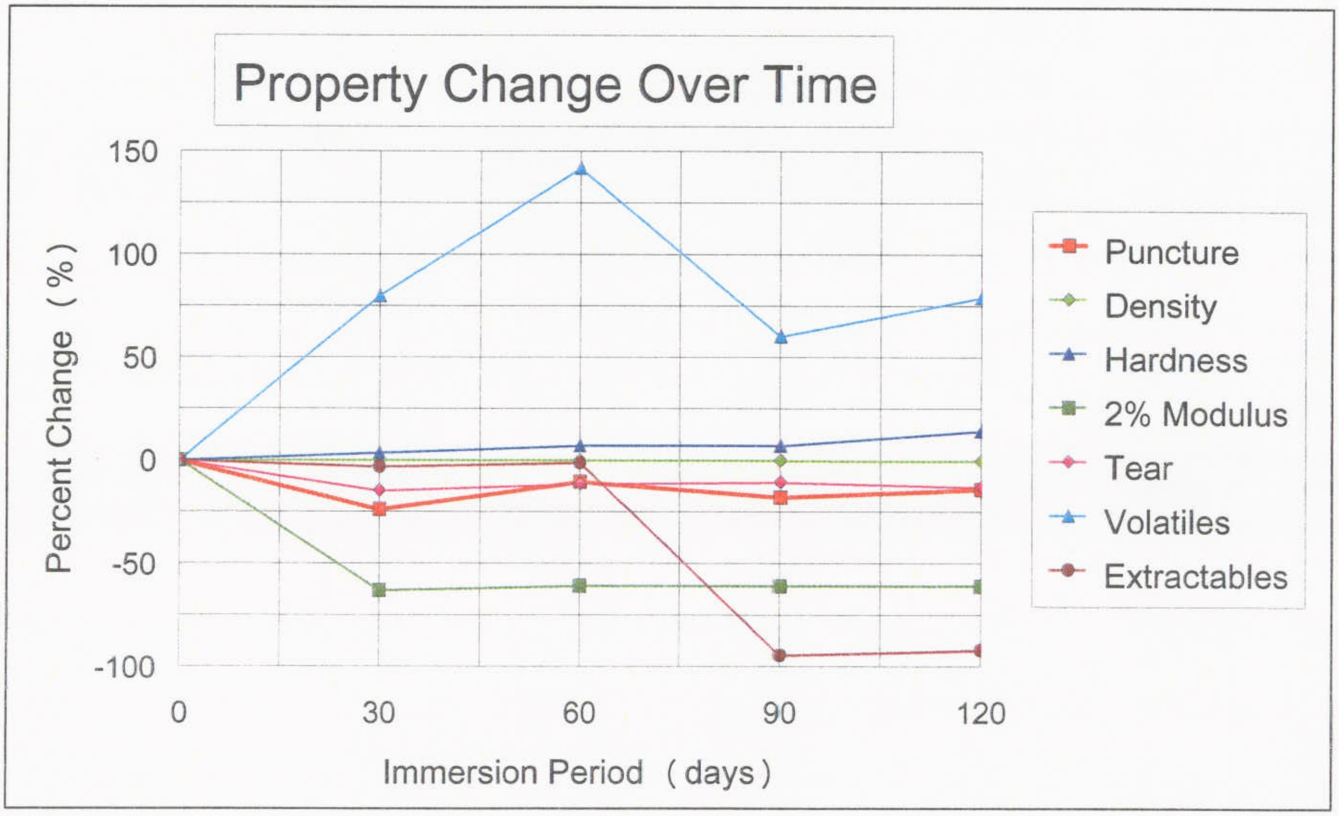
PROPERTY ID	UNIT	REPLICATE 1	REPLICATE 2	REPLICATE 3	AVERAGE	STANDARD DEVIATION
Weight	grams	11.0615	10.3916	10.3843	10.6125	0.3175
Length	in	5.4455	5.3705	5.3250	5.3803	0.0497
Width	in	2.8975	2.9885	2.9200	2.9353	0.0387
Thickness	mils	43	39	39	40.3	1.8856

JLT *Laboratories, Inc.*

Summary of Test Results
Polypropylene - 23° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene	**Checked By:**	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture	73.7	56.3	-23.66	66.0	-10.50	60.5	-17.91	63.4	-13.97
Density	0.910	0.911	0.11	0.910	0.07	0.908	-0.18	0.906	-0.44
Hardness	9	10	3.57	10	7.14	10	7.14	11	14.29
2% Modulus	27000	10000	-62.96	10600	-60.74	10558	-60.90	10524	-61.02
Tear	24.6	21.0	-14.63	21.8	-11.38	22.0	-10.57	21.4	-13.01
Volatiles	0.3802	0.6838	79.88	0.9197	141.94	0.6089	60.16	0.6806	79.03
Extractables	24.2593	23.5016	-3.12	23.9529	-1.26	1.3578	-94.40	1.9722	-91.87



Laboratories, Inc.

Geomembrane Conformance Test Results
Polypropylene - 23° Celcius

Client: Parsons
Project: Honeywell
Material: Polypropylene
Sample ID: Polypropylene
120 Day Testing

Job No.: 09LR1826.01
Date: 05/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture Resistance	lbs	59.6	67.7	61.5	65.1	63.2	63.4	2.8096
Density	gr/cucm	0.91	0.91	0.91			0.91	0.0005
Hardness		11	11	10			11	0.4714
2% Secant Modulus	psi	10490	10520	10480	10520	10610	10524	45.9
Tear (MD Only)	lbs	21	22	21	22	21	21.4	0.4899
Volatiles	%	0.6599	0.7013				0.6806	0.0207
Extractables	%	2.0262	1.9182				1.9722	0.0540

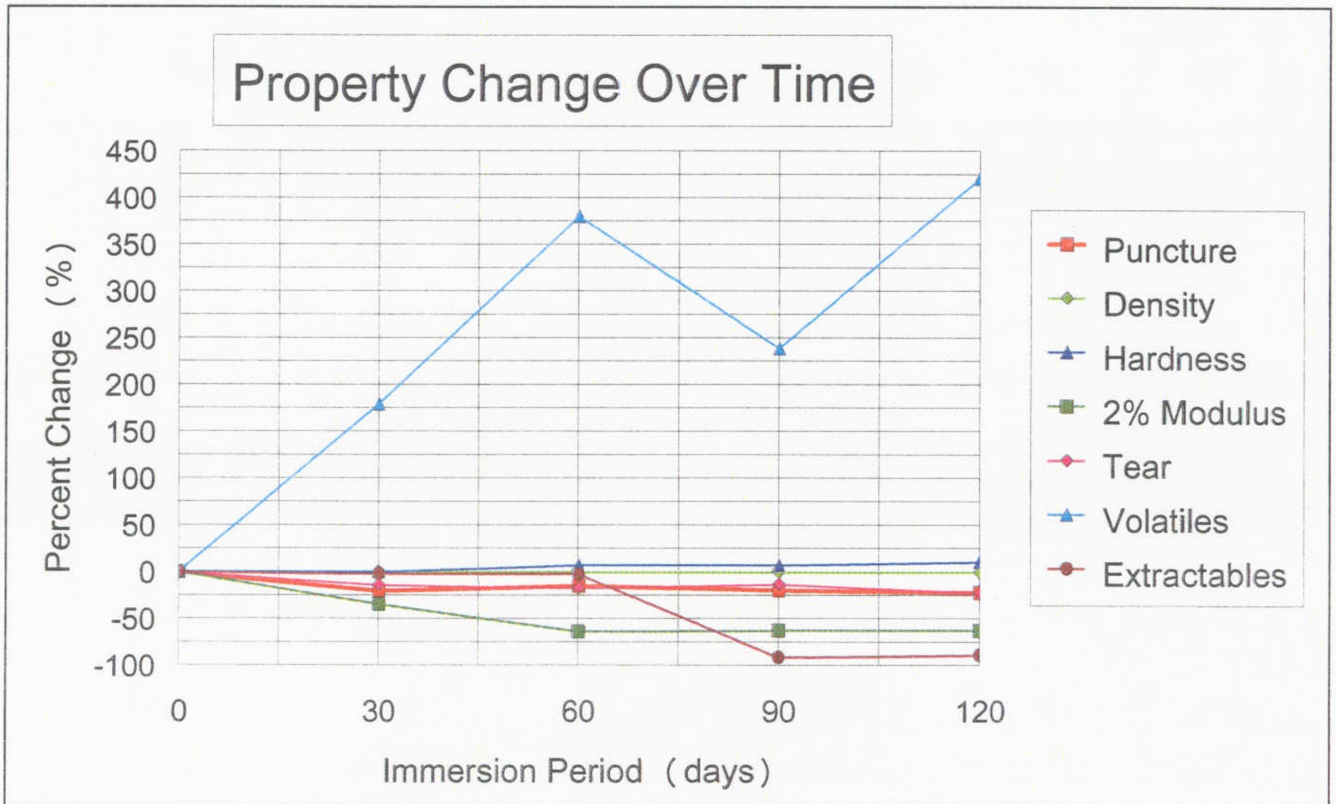
JLT Laboratories, Inc.

Summary of Test Results

Polypropylene - 50° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	Polypropylene	Tested By:	RL/AM/MLB
Sample ID:	Polypropylene	Checked By:	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture	73.7	59.1	-19.83	62.8	-14.81	59.5	-19.29	57.6	-21.89
Density	0.910	0.910	0.00	0.910	0.00	0.907	-0.29	0.905	-0.51
Hardness	9	9	0.00	10	7.14	10	7.14	10	10.71
2% Modulus	27000	17700	-34.44	9800	-63.70	10068	-62.71	10042	-62.81
Tear	24.6	21.2	-13.82	20.4	-17.07	21.4	-13.01	19.2	-21.95
Volatiles	0.3802	1.0608	179.04	1.8251	380.09	1.2863	238.34	1.9792	420.62
Extractables	24.2593	23.7521	-2.09	23.6336	-2.58	2.1139	-91.29	2.7495	-88.67



JLT Laboratories, Inc.

Geomembrane Conformance Test Results

Polypropylene - 50° Celcius

Client: Parsons
Project: Honeywell
Material: Polypropylene
Sample ID: Polypropylene
120 Day Testing

Job No.: 09LR1826.01
Date: 05/15/2009
Tested By: RL/AM/MLB
Checked By: JB

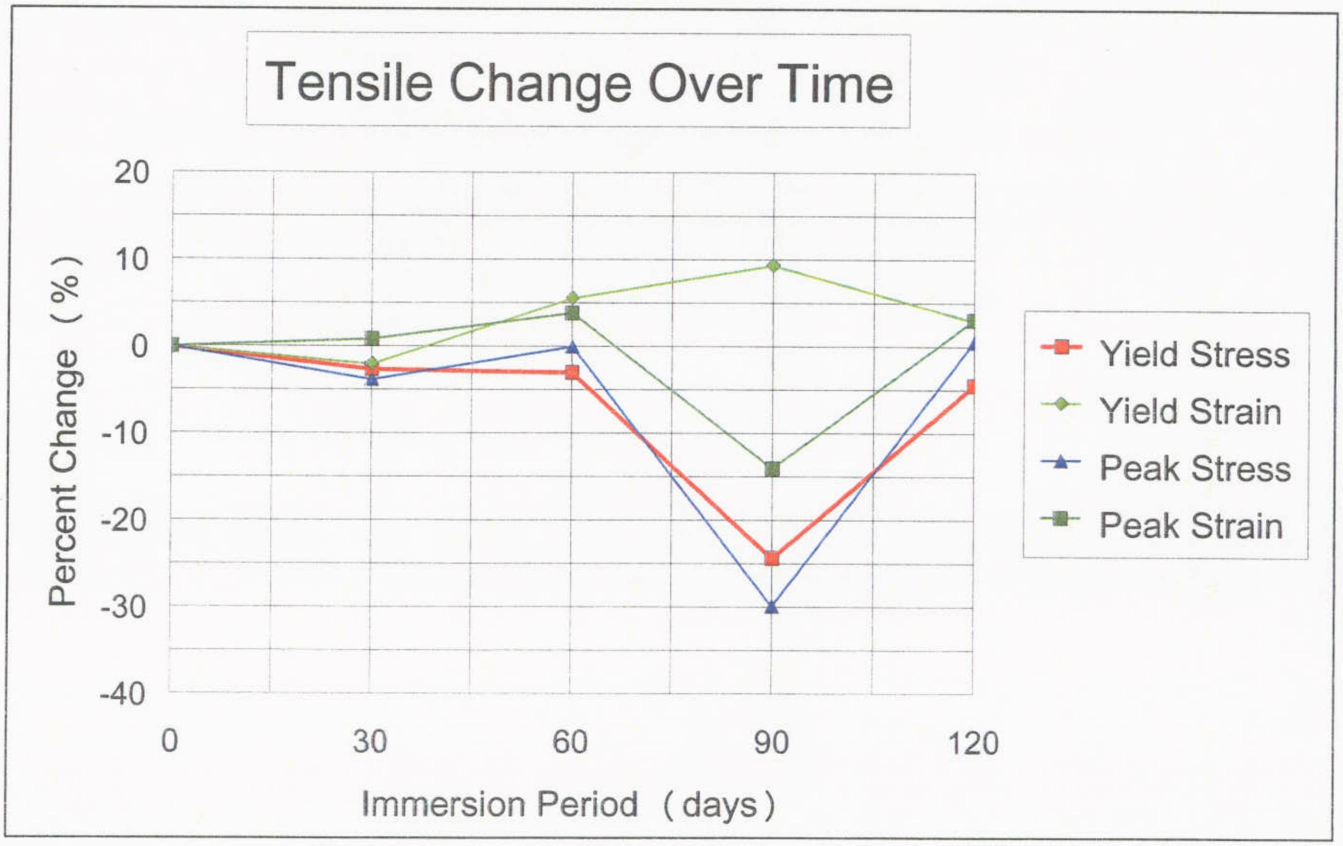
PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture Resistance	lbs	63.3	61.6	57.3	48.0	57.7	57.6	5.3056
Density	gr/cucm	0.91	0.91	0.91			0.91	0.0000
Hardness		10	11	10			10	0.4714
2% Secant Modulus	psi	10060	10130	10210	9890	9920	10042	121.9
Tear (MD Only)	lbs	20	19	18	19	20	19.2	0.7483
Volatiles	%	1.7454	2.2130				1.9792	0.2338
Extractables	%	2.5277	2.9713				2.7495	0.2218

JLT Laboratories, Inc.

Summary of Test Results
Polypropylene - 23° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	Polypropylene	Tested By:	RL/AM/MLB
Sample ID:	Polypropylene	Checked By:	JB

TEST READING	Baseline Average	30-Day Immersion Average	30-Day Immersion % Change	60-Day Immersion Average	60-Day Immersion % Change	90-Day Immersion Average	90-Day Immersion % Change	120-Day Immersion Average	120-Day Immersion % Change
Yield Stress	53.4	52.0	-2.62	51.8	-3.00	40.4	-24.34	51.0	-4.49
Yield Strain	68.4	67.0	-2.05	72.2	5.56	74.8	9.36	70.4	2.92
Peak Stress	147.2	141.6	-3.80	147.2	0.00	103.2	-29.89	148.0	0.54
Peak Strain	688.6	694.4	0.84	715.2	3.86	591.8	-14.06	709.8	3.08



JLT Laboratories, Inc.

Tensile Test Results

Polypropylene - 23° Celcius

JLT

Client: Parsons
Project: Honeywell
Material: Polypropylene
Sample ID: Polypropylene
Baseline Testing

Job No.: 09LR1826.01
Date: 02/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	55	56	53	53	50	53.4	2.06
Yield Strain	%	72	72	64	72	62	68.4	4.45
Peak Stress	lb/in	152	144	160	144	136	147.2	6.53
Peak Strain	%	748	644	737	671	643	688.6	45.28

JLT Laboratories, Inc.

Tensile Test Results

Polypropylene - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene	**Checked By:**	JB
	30 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	52	52	53	51	52	52.0	0.63
Yield Strain	%	67	69	66	66	67	67.0	1.10
Peak Stress	lb/in	140	148	144	132	144	141.6	3.27
Peak Strain	%	688	713	704	652	715	694.4	23.24

JLT Laboratories, Inc.

Tensile Test Results

Polypropylene - 23° Celcius

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	03/15/2009
Material:	Polypropylene	Tested By:	RL/AM/MLB
Sample ID:	Polypropylene	Checked By:	JB
	60 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	52	52	52	52	51	51.8	0.40
Yield Strain	%	77	77	64	74	69	72.2	5.04
Peak Stress	lb/in	148	152	136	144	156	147.2	6.80
Peak Strain	%	711	756	659	695	755	715.2	36.97

JLT Laboratories, Inc.

Tensile Test Results

Polypropylene - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	04/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene	**Checked By:**	JB
	90 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	41	41	40	40	40	40.4	0.49
Yield Strain	%	79	79	67	77	72	74.8	4.66
Peak Stress	lb/in	100	104	104	104	104	103.2	1.89
Peak Strain	%	577	587	608	595	592	591.8	10.15

JLT Laboratories, Inc.

Tensile Test Results

Polypropylene - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene 120 Day Testing	**Checked By:**	JB

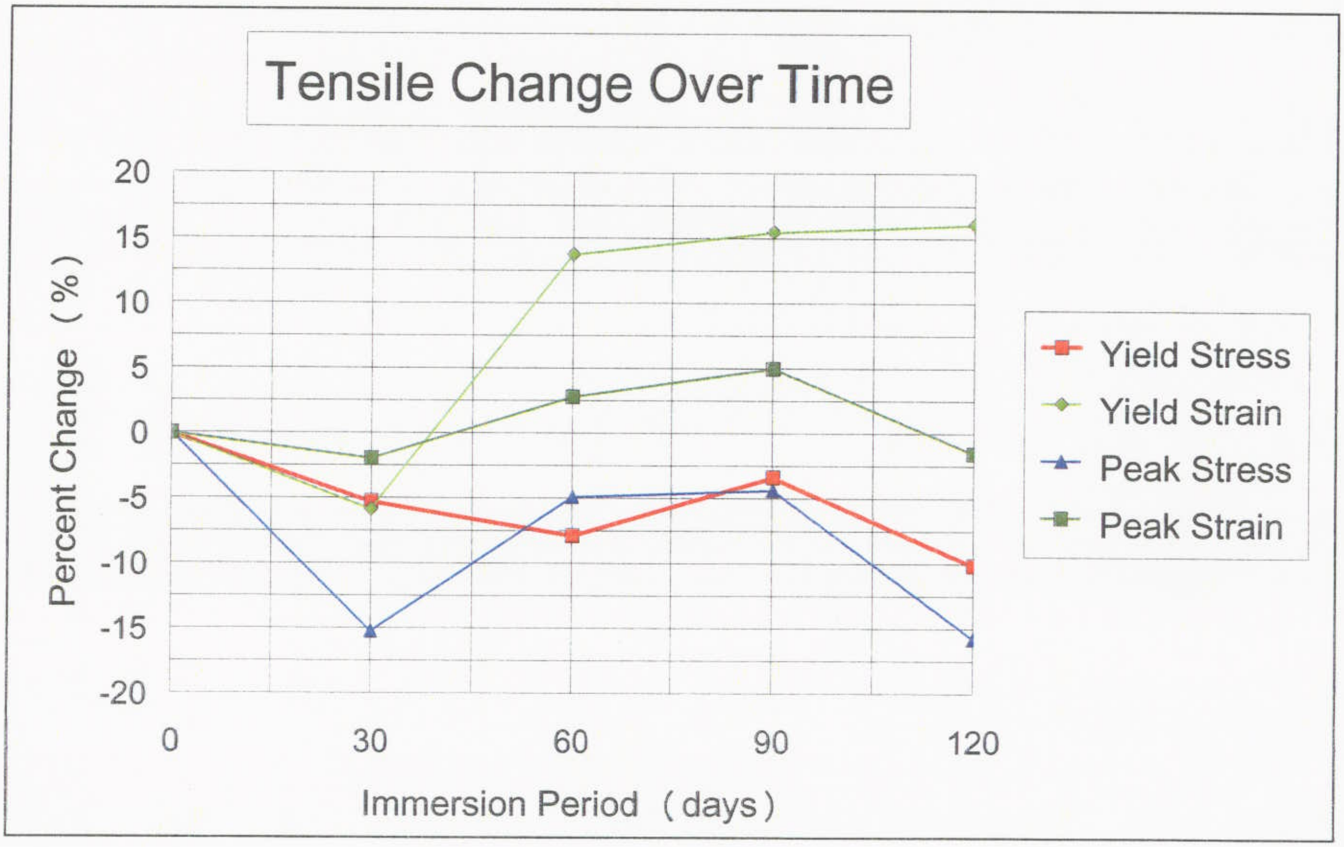
PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	51	51	54	49	50	51.0	1.67
Yield Strain	%	67	72	72	77	64	70.4	4.50
Peak Stress	lb/in	148	152	124	164	152	148.0	13.15
Peak Strain	%	756	741	604	687	761	709.8	59.06

JLT Laboratories, Inc.

Summary of Test Results
Polypropylene - 50° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	Polypropylene	Tested By:	RL/AM/MLB
Sample ID:	Polypropylene	Checked By:	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Yield Stress	53.4	50.6	-5.24	49.2	-7.87	51.6	-3.37	48.0	-10.11
Yield Strain	68.4	64.4	-5.85	77.8	13.74	79.0	15.50	79.4	16.08
Peak Stress	147.2	124.8	-15.22	140.0	-4.89	140.8	-4.35	124.0	-15.76
Peak Strain	688.6	675.2	-1.95	707.8	2.79	723.0	5.00	678.0	-1.54



JLT Laboratories, Inc.

Tensile Test Results

Polypropylene - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene **Baseline Testing**	**Checked By:**	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	55	56	53	53	50	53.4	2.06
Yield Strain	%	72	72	64	72	62	68.4	4.45
Peak Stress	lb/in	152	144	160	144	136	147.2	6.53
Peak Strain	%	748	644	737	671	643	688.6	45.28

JLT *Laboratories, Inc.*

Tensile Test Results

Polypropylene - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene **30 Day Testing**	**Checked By:**	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	51	51	50	52	49	50.6	1.02
Yield Strain	%	67	66	62	63	64	64.4	1.85
Peak Stress	lb/in	120	132	124	128	120	124.8	4.99
Peak Strain	%	607	645	728	781	615	675.2	68.07

JLT *Laboratories, Inc.*

Tensile Test Results

Polypropylene - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	03/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene **60 Day Testing**	**Checked By:**	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	48	49	51	50	48	49.2	1.17
Yield Strain	%	77	74	78	81	79	77.8	2.32
Peak Stress	lb/in	140	144	136	128	152	140.0	3.27
Peak Strain	%	736	739	671	641	752	707.8	43.68

JLT Laboratories, Inc.

Tensile Test Results

Polypropylene - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	04/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene 90 Day Testing	**Checked By:**	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	52	52	52	51	51	51.6	0.49
Yield Strain	%	77	79	72	80	87	79.0	4.86
Peak Stress	lb/in	136	152	136	136	144	140.8	7.54
Peak Strain	%	775	781	689	665	705	723.0	46.72

JLT *Laboratories, Inc.*

Tensile Test Results
Polypropylene - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	Polypropylene	**Tested By:**	RL/AM/MLB
Sample ID:	Polypropylene 120 Day Testing	**Checked By:**	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	53	46	47	47	47	48.0	2.53
Yield Strain	%	90	79	74	85	69	79.4	7.50
Peak Stress	lb/in	140	112	124	124	120	124.0	9.12
Peak Strain	%	688	643	701	695	663	678.0	21.76

JLT *Laboratories, Inc.*

Summary of Test Results

PROPERTY CHANGE (ASTM D-5747)

JLT

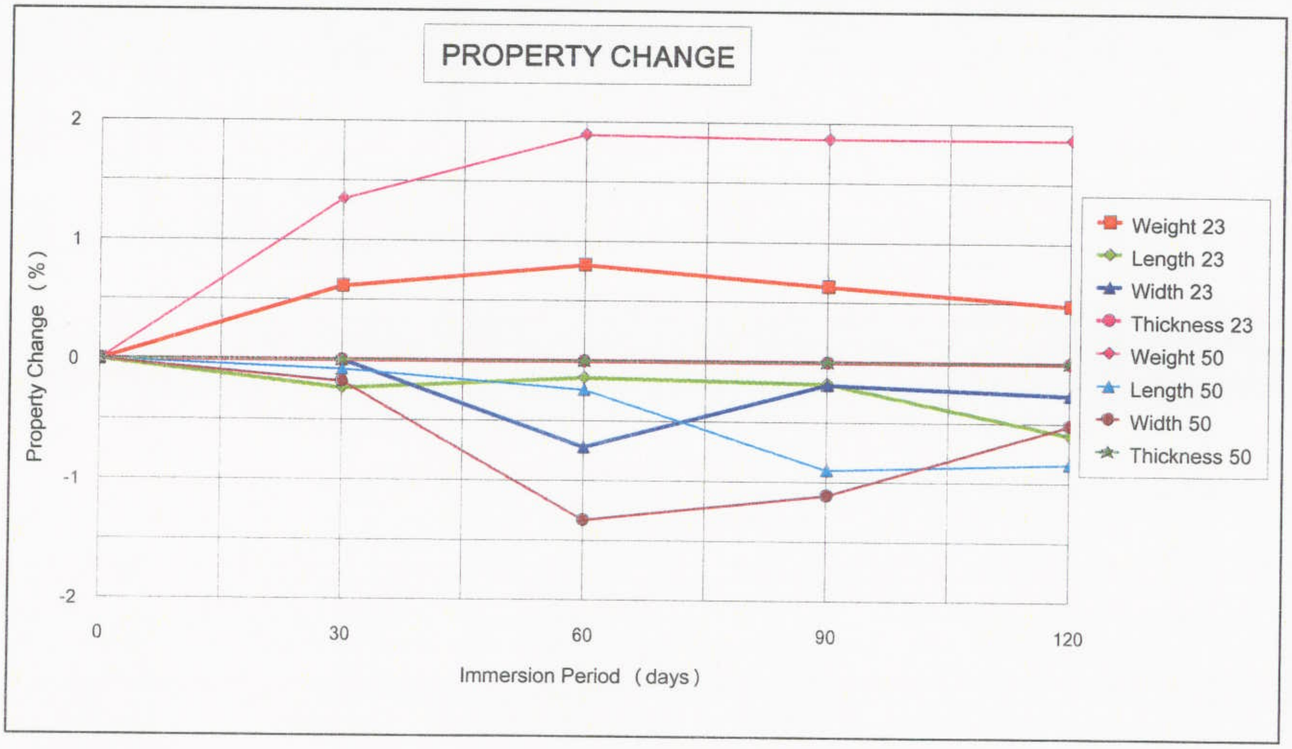
Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	EPDM	Tested By:	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	Checked By:	JB

23° Celcius

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Weight, gr	11.8718	11.9453	0.62	11.97	0.81	11.95	0.63	11.93	0.48
Length, in	5.2212	5.2223	0.02	5.21	-0.14	5.21	-0.18	5.19	-0.60
Width, in	2.5860	2.5800	-0.23	2.57	-0.72	2.58	-0.19	2.58	-0.26
Thickness, mils	43	43	0.00	42.67	0.00	42.67	0.00	42.67	0.00

50° Celcius

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Weight, gr	14.7763	14.9759	1.35	15.06	1.90	15.05	1.87	15.05	1.87
Length, in	5.5427	5.5385	-0.08	5.53	-0.24	5.49	-0.90	5.50	-0.84
Width, in	3.0300	3.0246	-0.18	2.99	-1.33	3.00	-1.11	3.01	-0.52
Thickness, mils	42	42	0.00	42.00	0.00	42.00	0.00	42.00	0.00



JLT Laboratories, Inc.

Property Change

ASTM D-5747, paragraphs 11.1 & 11.2

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	EPDM	Tested By:	RL/AM/MLB
Sample ID:	AZ12347 - EPDM 120 Day Testing	Checked By:	JB

23° C

PROPERTY ID	UNIT	REPLICATE 1	REPLICATE 2	REPLICATE 3	AVERAGE	STANDARD DEVIATION
Weight	grams	11.3564	11.0042	13.4263	11.9290	1.0685
Length	in	4.9310	5.1425	5.4965	5.1900	0.2333
Width	in	2.5655	2.4440	2.7280	2.5792	0.1163
Thickness	mils	42	43	43	42.7	0.4714

50° C

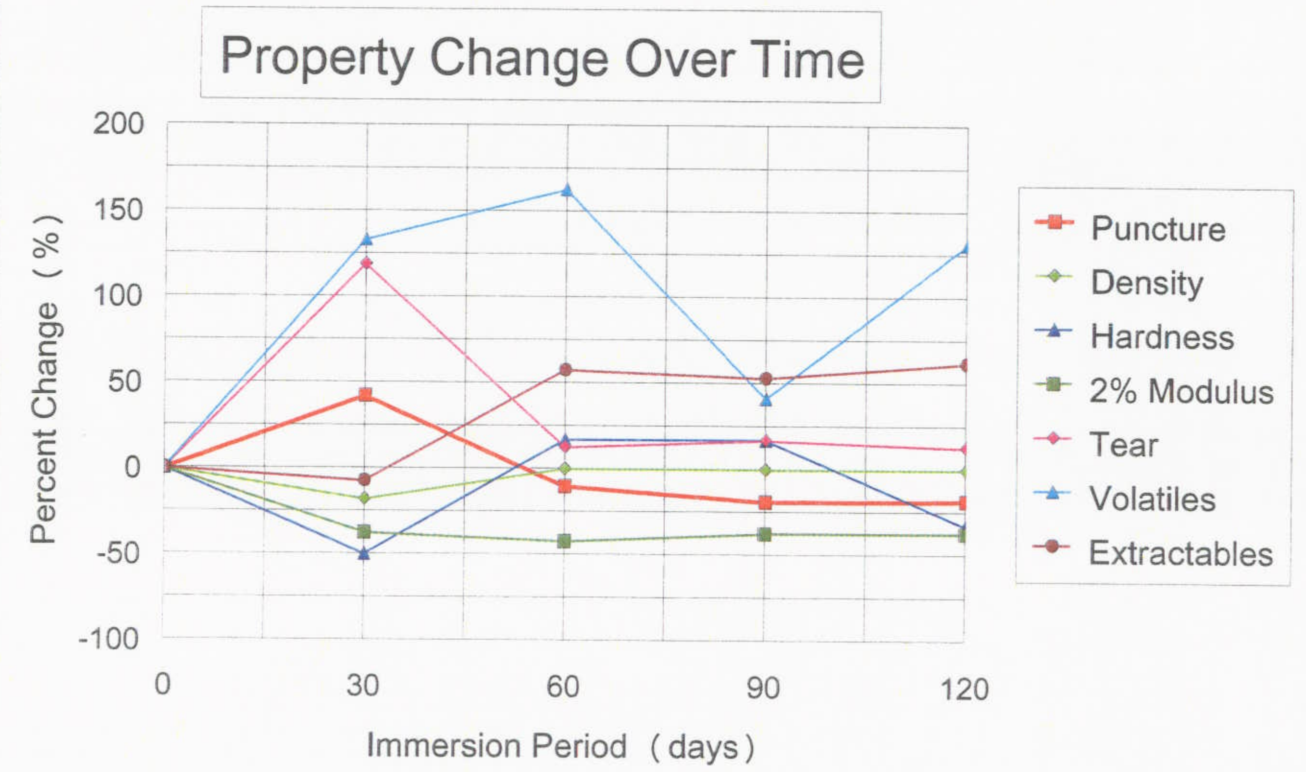
PROPERTY ID	UNIT	REPLICATE 1	REPLICATE 2	REPLICATE 3	AVERAGE	STANDARD DEVIATION
Weight	grams	14.7860	15.2103	15.1628	15.0530	0.1898
Length	in	5.4550	5.5380	5.4955	5.4962	0.0339
Width	in	2.9865	3.0230	3.0335	3.0143	0.0201
Thickness	mils	42	42	42	42.0	0.0000

JLT Laboratories, Inc.

Summary of Test Results
EPDM - 23° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	EPDM	Tested By:	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	Checked By:	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture	39.6	56.3	42.26	35.4	-10.41	32.0	-19.11	32.2	-18.66
Density	1.112	0.911	-18.08	1.110	-0.18	1.107	-0.39	1.105	-0.57
Hardness	2	1	-50.00	2	16.67	2	16.67	1	-33.33
2% Modulus	16000	10000	-37.50	9200	-42.50	9970	-37.69	9994	-37.54
Tear	9.6	21.0	118.75	10.8	12.50	11.2	16.67	10.8	12.50
Volatiles	0.4929	1.1493	133.15	1.2931	162.33	0.6942	40.83	1.1374	130.74
Extractables	1.5058	1.3953	-7.34	2.3699	57.38	2.3017	52.85	2.4331	61.58



JLT Laboratories, Inc.

Geomembrane Conformance Test Results

EPDM - 23° Celcius

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	EPDM	Tested By:	RL/AM/MLB
Sample ID:	AZ12347 - EPDM 120 Day Testing	Checked By:	JB

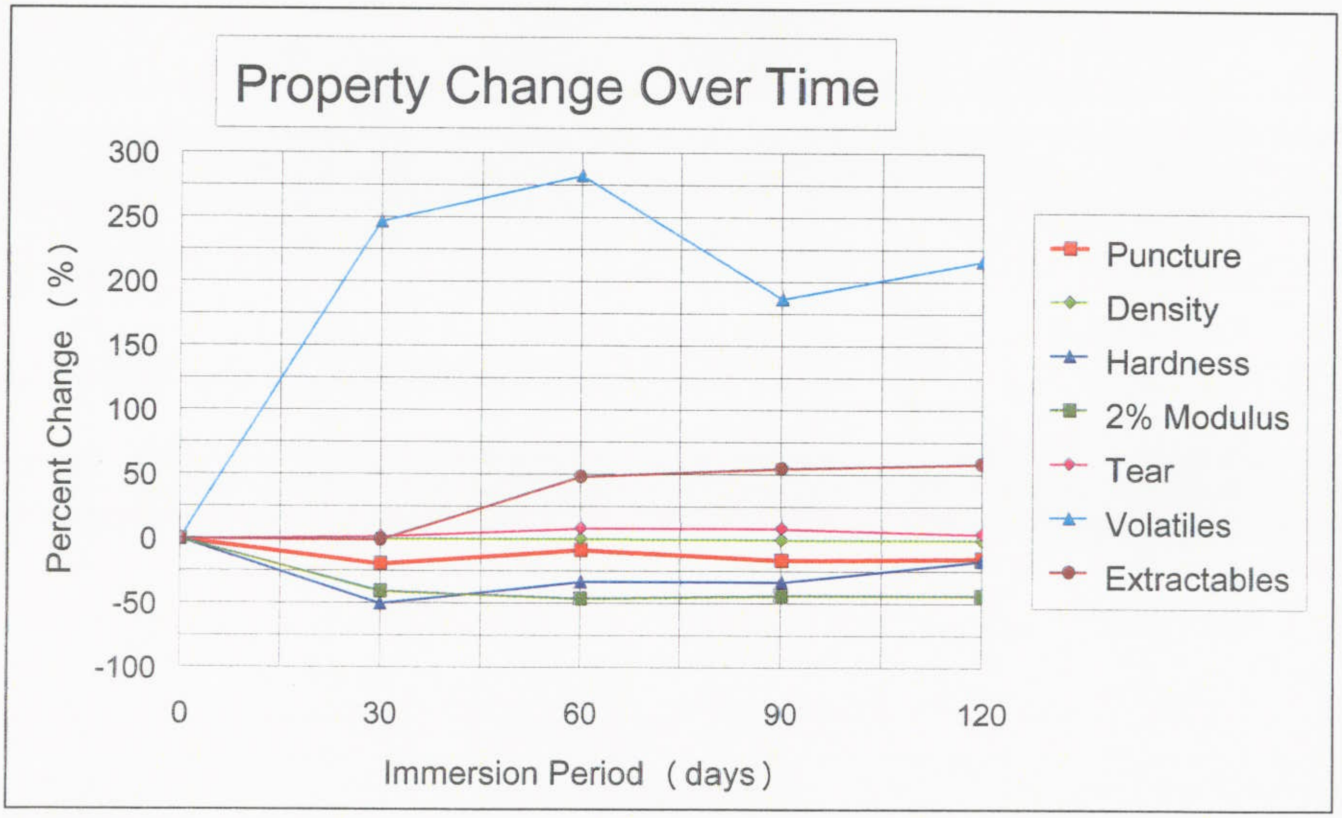
PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture Resistance	lbs	32.7	30.7	31.6	32.5	33.4	32.2	0.9368
Density	gr/cucm	1.11	1.11	1.11			1.11	0.0005
Hardness		1	2	1			1	0.4714
2% Secant Modulus	psi	10200	9980	9920	9850	10020	9994	117.9
Tear (MD Only)	lbs	11	11	10	11	11	10.8	0.4000
Volatiles	%	1.2873	0.9875				1.1374	0.1499
Extractables	%	2.4551	2.4110				2.4331	0.0221

JLT Laboratories, Inc.

Summary of Test Results
EPDM - 50° Celcius

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	EPDM	Tested By:	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	Checked By:	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture	39.6	31.9	-19.31	36.2	-8.49	33.1	-16.23	33.7	-14.71
Density	1.112	1.110	-0.15	1.110	-0.12	1.107	-0.39	1.104	-0.72
Hardness	2	1	-50.00	1	-33.33	1	-33.33	2	-16.67
2% Modulus	1600	950	-40.63	860	-46.25	898	-43.88	898	-43.88
Tear	9.6	9.8	2.08	10.4	8.33	10.4	8.33	10.0	4.17
Volatiles	0.6279	2.1780	246.85	2.4	282.57	1.8011	186.82	1.9855	216.19
Extractables	1.5058	1.4933	-0.83	2.2334	48.31	2.3321	54.87	2.3891	58.66



JLT Laboratories, Inc.

Geomembrane Conformance Test Results

EPDM - 50° Celcius

Client: Parsons
Project: Honeywell
Material: EPDM
Sample ID: AZ12347 - EPDM
120 Day Testing

Job No.: 09LR1826.01
Date: 05/15/2009
Tested By: RL/AM/MLB
Checked By: JB

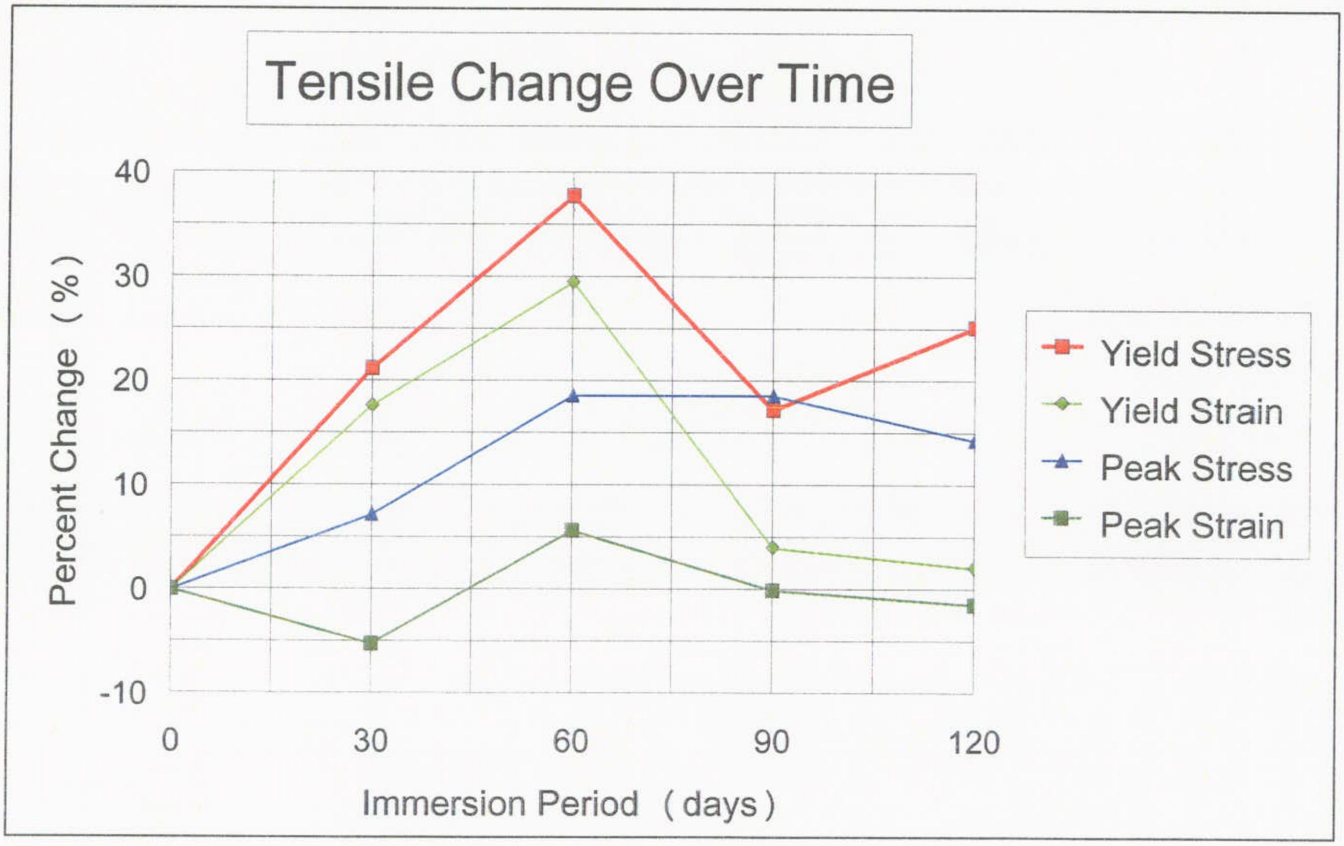
PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture Resistance	lbs	33.2	32.5	32.7	34.3	36.0	33.7	1.2909
Density	gr/cucm	1.10	1.10	1.10			1.10	0.0005
Hardness		2	1	2			2	0.4714
2% Secant Modulus	psi	910	880	910	920	870	898	19.4
Tear (MD Only)	lbs	10	10	10	10	10	10.0	0.0000
Volatiles	%	1.9570	2.0140				1.9855	0.0285
Extractables	%	2.3807	2.3975				2.3891	0.0084

JLT Laboratories, Inc.

Summary of Test Results
EPDM - 23° Celcius

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	EPDM	**Tested By:**	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	**Checked By:**	JB

TEST READING	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Yield Stress	30.2	36.6	21.19	41.6	37.75	35.4	17.22	37.8	25.17
Yield Strain	348.8	410.2	17.60	451.6	29.47	362.8	4.01	356.0	2.06
Peak Stress	56.0	60.0	7.14	66.4	18.57	66.4	18.57	64.0	14.29
Peak Strain	433.2	410.4	-5.26	457.6	5.63	432.8	-0.09	426.8	-1.48



JLT Laboratories, Inc.

Tensile Test Results

EPDM - 23° Celcius

Client: Parsons
Project: Honeywell
Material: EPDM
Sample ID: AZ12347 - EPDM
Baseline Testing

Job No.: 09LR1826.01
Date: 02/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	30	30	27	29	35	30.2	2.64
Yield Strain	%	328	327	330	351	408	348.8	30.89
Peak Stress	lb/in	56	56	56	56	56	56.0	0.00
Peak Strain	%	427	434	447	456	402	433.2	18.56

JLT Laboratories, Inc.

Tensile Test Results

EPDM - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	EPDM	**Tested By:**	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	**Checked By:**	JB
	30 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	38	37	38	35	35	36.6	1.36
Yield Strain	%	418	413	413	392	415	410.2	9.28
Peak Stress	lb/in	60	64	60	60	56	60.0	1.89
Peak Strain	%	441	391	316	465	439	410.4	52.96

JLT *Laboratories, Inc.*

Tensile Test Results
EPDM - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	03/15/2009
Material:	EPDM	**Tested By:**	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	**Checked By:**	JB
	60 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	41	44	46	39	38	41.6	3.01
Yield Strain	%	440	446	420	475	477	451.6	21.71
Peak Stress	lb/in	68	64	68	64	68	66.4	1.89
Peak Strain	%	471	455	444	427	491	457.6	22.01

JLT *Laboratories, Inc.*

Tensile Test Results

EPDM - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	04/15/2009
Material:	EPDM	**Tested By:**	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	**Checked By:**	JB
	90 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	33	38	36	37	33	35.4	2.06
Yield Strain	%	333	387	377	355	362	362.8	18.64
Peak Stress	lb/in	64	64	68	68	68	66.4	1.96
Peak Strain	%	467	341	460	455	441	432.8	46.68

JLT *Laboratories, Inc.*

Tensile Test Results
EPDM - 23° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	EPDM	**Tested By:**	RL/AM/MLB
Sample ID:	AZ12347 - EPDM 120 Day Testing	**Checked By:**	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	48	49	30	30	32	37.8	8.77
Yield Strain	%	492	315	290	308	375	356.0	73.75
Peak Stress	lb/in	68	64	64	60	64	64.0	2.53
Peak Strain	%	433	399	469	428	405	426.8	24.77

JLT *Laboratories, Inc.*

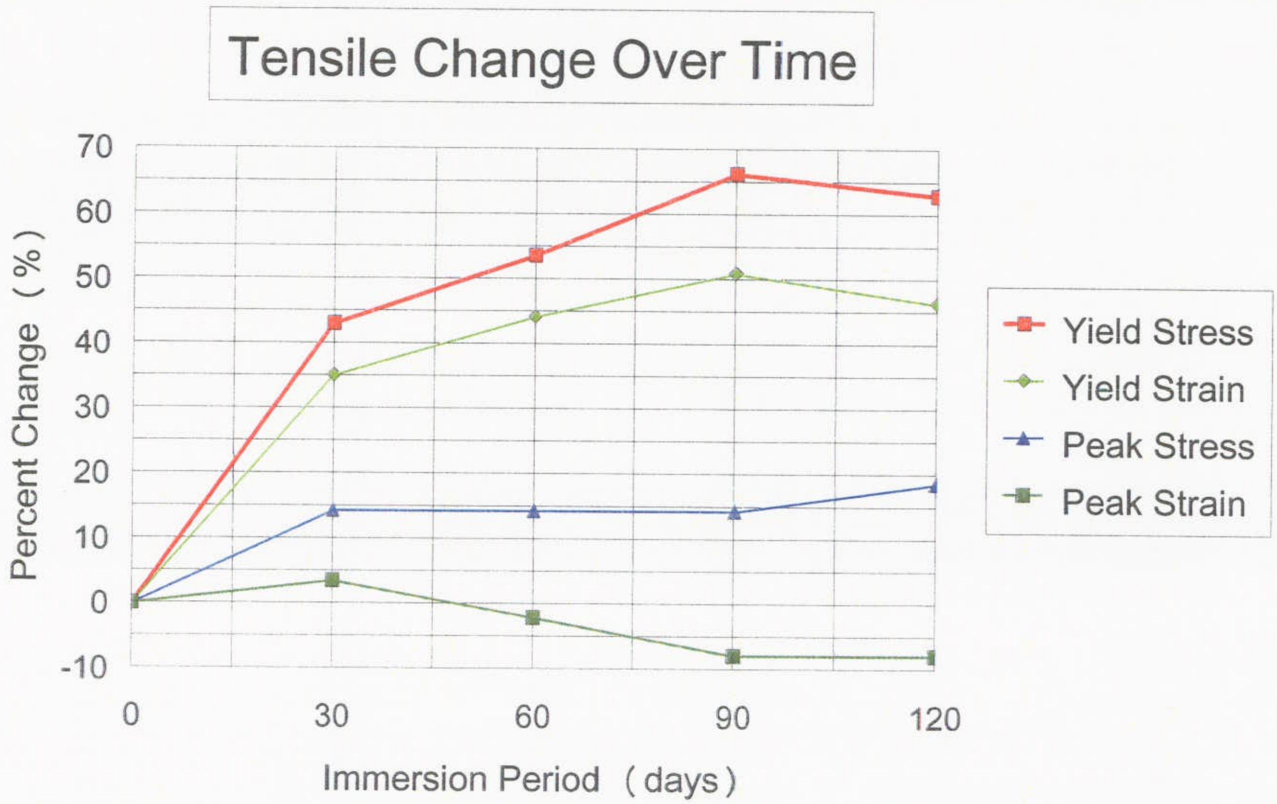
Summary of Test Results

EPDM - 50° Celcius

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	05/15/2009
Material:	EPDM	Tested By:	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	Checked By:	JB

TEST READING	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Yield Stress	30.2	43.2	43.05	46.4	53.64	50.2	66.23	49.2	62.91
Yield Strain	348.8	471.0	35.03	502.8	44.15	526.4	50.92	510.4	46.33
Peak Stress	56.0	64.0	14.29	64.0	14.29	64.0	14.29	66.4	18.57
Peak Strain	433.2	448.4	3.51	424.0	-2.12	399.0	-7.89	399.0	-7.89



JLT *Laboratories, Inc.*

Tensile Test Results

EPDM - 50° Celcius

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	02/15/2009
Material:	EPDM	**Tested By:**	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	**Checked By:**	JB
	Baseline Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	30	30	27	29	35	30.2	2.64
Yield Strain	%	328	327	330	351	408	348.8	30.89
Peak Stress	lb/in	56	56	56	56	56	56.0	0.00
Peak Strain	%	427	434	447	456	402	433.2	18.56

JLT Laboratories, Inc.

Tensile Test Results

EPDM - 50° Celcius

JLT

Client: Parsons
Project: Honeywell
Material: EPDM
Sample ID: AZ12347 - EPDM
30 Day Testing

Job No.: 09LR1826.01
Date: 02/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	42	44	45	45	40	43.2	1.94
Yield Strain	%	477	462	481	480	455	471.0	10.53
Peak Stress	lb/in	64	64	64	64	64	64.0	0.00
Peak Strain	%	441	411	467	463	460	448.4	20.72

JLT *Laboratories, Inc.*

Tensile Test Results

EPDM - 50° Celcius

JLT

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	03/15/2009
Material:	EPDM	Tested By:	RL/AM/MLB
Sample ID:	AZ12347 - EPDM	Checked By:	JB
	60 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	45	51	44	47	45	46.4	2.50
Yield Strain	%	469	564	477	489	515	502.8	34.33
Peak Stress	lb/in	64	64	68	64	60	64.0	1.89
Peak Strain	%	435	433	444	408	400	424.0	16.94

JLT Laboratories, Inc.

Tensile Test Results
EPDM - 50° Celcius

Client:	Parsons
Project:	Honeywell
Material:	EPDM
Sample ID:	AZ12347 - EPDM
	90 Day Testing

Job No.:	09LR1826.01
Date:	04/15/2009
Tested By:	RL/AM/MLB
Checked By:	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	47	52	50	53	49	50.2	2.14
Yield Strain	%	498	554	515	577	488	526.4	33.86
Peak Stress	lb/in	68	60	64	60	68	64.0	3.58
Peak Strain	%	448	369	387	376	415	399.0	29.09

JLT *Laboratories, Inc.*

Tensile Test Results
EPDM - 50° Celcius

JLT

Client: Parsons
Project: Honeywell
Material: EPDM
Sample ID: AZ12347 - EPDM
120 Day Testing

Job No.: 09LR1826.01
Date: 05/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Yield Stress	lb/in	44	55	47	46	54	49.2	4.45
Yield Strain	%	431	579	482	522	538	510.4	50.42
Peak Stress	lb/in	72	68	64	68	60	66.4	4.08
Peak Strain	%	420	389	403	415	368	399.0	18.84

JLT *Laboratories, Inc.*

JLT LABORATORIES, INC.
GEOTECHNICAL, GEOSYNTHETIC AND MATERIALS TESTING AND RESEARCH

June 29, 2009
09LR1826.01

Parsons
290 Elwood Davis Road
Suite 312
Liverpool, NY 13088

Attn: David Steele

RE: COMPATIBILITY TEST RESULTS
GEOTUBE FABRIC & SEWING THREAD WITH SOLVAY WASTE
HONEYWELL PROJECT
PO NO. 444853.00001.00

Dear Mr. Steele:

Similar to the geomembrane samples, the TenCate Geotube fabric and the sewing thread used to sew the fabric were also subject to immersion testing in the Solvay waste. A virgin sample of each material was taken from the samples and subject to the following baseline tests:

Fabric -	Puncture	ASTM D-4833
	Trap Tear	ASTM D-4533
	Grab Strength	ASTM D-4632
	AOS	ASTM D-4751
	Permittivity	ASTM D-4491
Thread -	Tensile Strength	ASTM D-5446

Samples of the material were then placed in two tanks of Solvay waste at 23°C and 50°C, respectively. At 30, 60, 90 and 120 days, coupons were removed, cleaned and tested for the same properties as the baseline tests. The average results were compared to the average baseline test results and the percent change computed. The percent change vs immersion time was plotted as shown on the attached data sheets. An evaluation of the results are described herein.

938 South Central Avenue • Canonsburg, Pennsylvania 15317 Tel: (724) 746-4441 Fax: (724) 745-4261

TenCate Geotube

Prior to testing, the immersed coupons were washed to remove the excess Solvay waste and rinsed to clean the holes in the fabric. If there holes were not cleaned, AOS and Permittivity testing would not yield any meaningful results since the holes would be completely blocked. The ends of the thread were simply wiped with a moist towel to fit in the clamps.

Puncture

Puncture results varied from +34% to -26%. This is typical with a coarse woven fabric because it depends on where the puncture needle is seated on the fabric. If the needle aligns with a strand, the results are higher. If the needle aligns at a woven junction, the results are lower. Per the test procedure, the alignment is random in the test unit.

Trap Tear

Trap Tear values generally decreased by about 25% and remained relatively consistent after 30 days.

Grab Strength

Grab Strength decreased by about 10+% and remained essentially consistent after 30 days.

AOS

This value ranged from an AOS of 40 to an AOS of 50. Essentially, there was no significant change in AOS over the 120 day period. Prior to testing, the fabric was washed to remove the encrusted Solvay waste that blocked the holes.

Permittivity

The baseline values average was 0.4 sec^{-1}. Over the 120 day test period, the value varied for 0.4 sec^{-1} to 0.3 sec^{-1} terminating at about 0.35 sec^{-1}. Essentially, there was no meaningful change in Permittivity.

TenCate Fabric Summary

The results indicate no significant deterioration of the fabric. In fact, AOS and Permittivity values were essentially the same throughout the test period.

TenCate Sewing Thread

Since the most important property is the Tensile Strength of the thread used to sew the geotubes, we only performed Tensile Strength per ASTM D-5446. This test was designed to determine the Tensile Strength of thread used for inflatable materials. Since the Geotubes will be filled or inflated with waste, we deemed this an appropriate test.

Again, a sample of the virgin thread was tested for Strength and the average computed as the baseline value. Samples of the thread were immersed in the Solvay waste in 23°C and 50°C tanks. At 30, 60, 60 and 120 days, samples were removed and tested. The average value was computed and the percent difference plotted vs exposure time.

The data plot shows a general increase in Strength vs Time. This is mostly likely attributed to the fact that the thread was encased in Solvay waste when it was tested.

TenCate Sewing Thread Summary

Both the TenCate fabric and sewing thread performed well when exposed to the Solvay waste for 120 days. There is no evidence in these tests to suggest the waste adversely effected the fabric or the thread.

We appreciate the opportunity to provide our services and look forward to working with you again. Should you have any questions, comments or require additional information, please do not hesitate to call. Thank you.

Sincerely,

JLT LABORATORIES, INC.

John Boschuk, Jr., P.E.
President

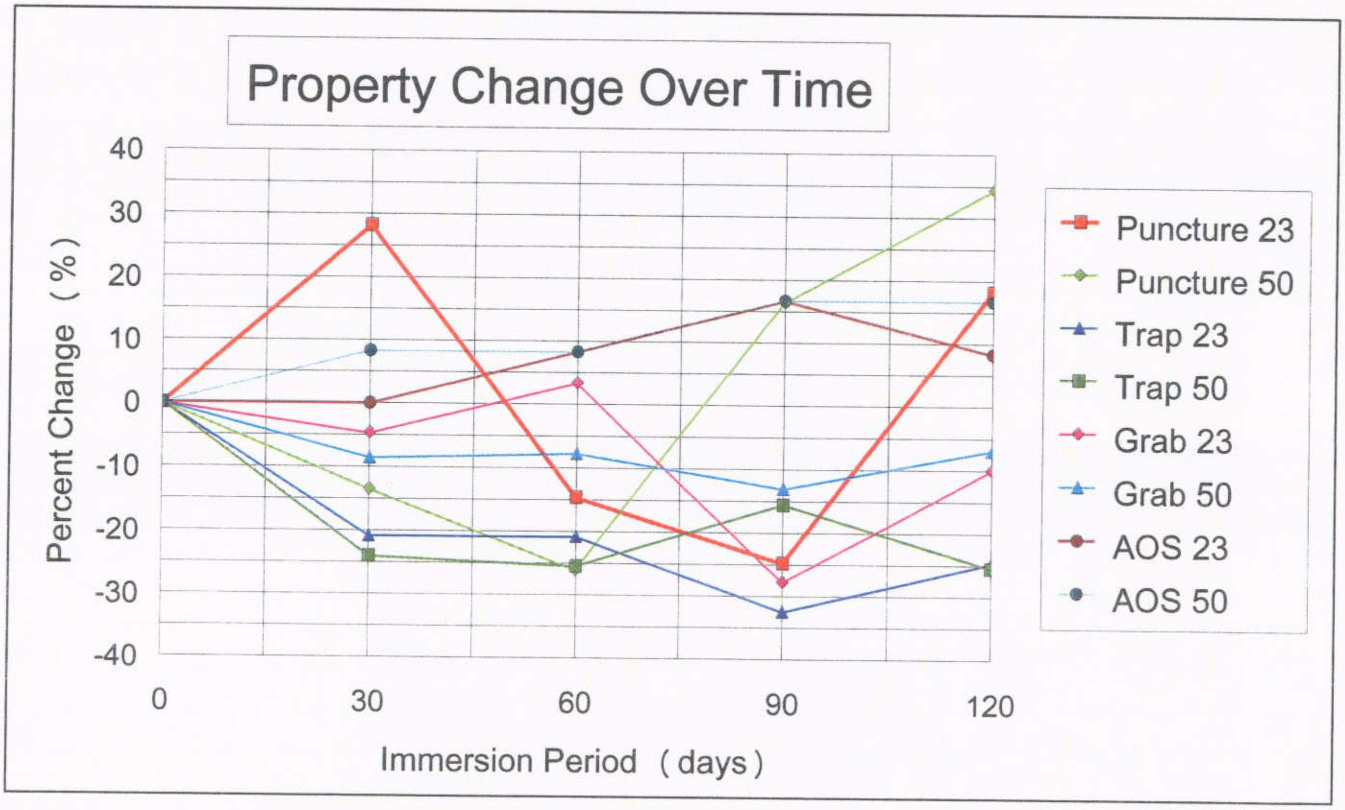
cc: Martin A. Switzer

Enclosures
JB/mlb
\wp10\letter\09122
Inv# 3828

Summary of Test Results
TenCate GeoTube

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GT 500 Woven Geotextile	**Tested By:**	RL/AM/MLB
Sample ID:	Geotextile - GeoTube	**Checked By:**	JB

TEST READING	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Puncture 23°C	159.8	204.9	28.23	136.6	-14.55	120.4	-24.70	189.0	18.26
Puncture 50°C	159.8	138.4	-13.40	118.2	-26.02	186.1	16.44	214.8	34.40
Trap Tear 23°C	312.1	247.2	-20.79	247.4	-20.73	211.0	-32.38	235.1	-24.66
Trap Tear 50°C	312.1	237.2	-23.99	232.8	-25.40	263.7	-15.51	232.8	-25.40
Grab 23°C	307	292	-4.63	317	3.39	222	-27.70	276	-9.98
Grab 50°C	307	280	-8.55	283	-7.70	267	-13.02	286	-6.88
AOS 23°C	40	40	0.00	43	8.33	47	16.67	43	8.33
AOS 50°C	40	43	8.33	43	8.33	47	16.67	47	16.67



JLT Laboratories, Inc.

GeoTube Conformance Test Results

TenCate GeoTube

Client:	Parsons	Job No.:	09LR1826.01
Project:	Honeywell	Date:	03/31/2009
Material:	GT 500 Woven Geotextile	Tested By:	RL/AM/MLB
Sample ID:	Geotextile - GeoTube	Checked By:	JB
	Baseline Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture 23°C	lbs	158.2	157.8	151.7	167.2	164.2	159.8	5.4090
Puncture 50°C	lbs	158.2	157.8	151.7	167.2	164.2	159.8	5.4090
Trap Tear 23°C	lbs	308.1	297.5	286.2	347.5	321.2	312.1	21.1468
Trap Tear 50°C	lbs	308.1	297.5	286.2	347.5	321.2	312.1	21.1468
Grab 23°C	lbs	332	321	299	287	294	307	17.0482
Grab 50°C	lbs	332	321	299	287	294	307	17.0482
AOS 23°C		40	40	40			40	0.0000
AOS 50°C		40	40	40			40	0.0000

JLT Laboratories, Inc.

GeoTube Conformance Test Results

TenCate GeoTube

Client: Parsons
Project: Honeywell
Material: GT 500 Woven Geotextile
Sample ID: Geotextile - GeoTube
30 Day Testing

Job No.: 09LR1826.01
Date: 03/31/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture 23°C	lbs	146.2	458.5	128.7	154.3	137.0	204.9	127.0715
Puncture 50°C	lbs	127.0	132.0	155.0	142.7	135.3	138.4	9.7425
Trap Tear 23°C	lbs	296.8	295.0	213.1	230.6	200.6	247.2	40.8777
Trap Tear 50°C	lbs	203.1	222.5	294.3	230.6	235.6	237.2	30.6119
Grab 23°C	lbs	322	300	272	288	280	292	17.4539
Grab 50°C	lbs	278	231	295	304	294	280	26.0814
AOS 23°C		40	40	40			40	0.0000
AOS 50°C		40	50	40			43	4.7140

JLT Laboratories, Inc.

GeoTube Conformance Test Results

TenCate GeoTube

JLT

Client:	Parsons
Project:	Honeywell
Material:	GT 500 Woven Geotextile
Sample ID:	Geotextile - GeoTube
	60 Day Testing

Job No.:	09LR1826.01
Date:	03/31/2009
Tested By:	RL/AM/MLB
Checked By:	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture 23°C	lbs	126.5	149.3	133.9			136.6	9.4971
Puncture 50°C	lbs	112.6	110.5	131.6			118.2	9.4905
Trap Tear 23°C	lbs	240.6	250.4	251.2			247.4	4.8194
Trap Tear 50°C	lbs	225.6	233.1	239.8			232.8	5.8002
Grab 23°C	lbs	332	329	290			317	19.1311
Grab 50°C	lbs	268	294	287			283	10.9848
AOS 23°C		40	40	50			43	4.7140
AOS 50°C		40	50	40			43	4.7140

JLT *Laboratories, Inc.*

GeoTube Conformance Test Results
TenCate GeoTube

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	04/28/2009
Material:	GT 500 Woven Geotextile	**Tested By:**	RL/AM/MLB
Sample ID:	Geotextile - GeoTube	**Checked By:**	JB
	90 Day Testing		

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture 23°C	lbs	122.1	118.6				120.4	1.7500
Puncture 50°C	lbs	146.1	226.1				186.1	40.0000
Trap Tear 23°C	lbs	177.5	238.1	217.5			211.0	25.1589
Trap Tear 50°C	lbs	224.3	215.0	351.8			263.7	62.4117
Grab 23°C	lbs	264	192	209			222	30.7282
Grab 50°C	lbs	337	229	234			267	49.7750
AOS 23°C		40	50	50			47	4.7140
AOS 50°C		40	50	50			47	4.7140

JLT *Laboratories, Inc.*

GeoTube Conformance Test Results

TenCate GeoTube

Client:	Parsons
Project:	Honeywell
Material:	GT 500 Woven Geotextile
Sample ID:	Geotextile - GeoTube
	120 Day Testing

Job No.:	09LR1826.01
Date:	05/15/2009
Tested By:	RL/AM/MLB
Checked By:	JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Puncture 23°C	lbs	160.5	175.8	231.7	188.0		189.0	30.6020
Puncture 50°C	229.8	240.1	149.1	255.2			214.8	46.8641
Trap Tear 23°C	lbs	244.3	256.8	204.3			235.1	22.3917
Trap Tear 50°C	lbs	256.7	213.7	228.1			232.8	17.8709
Grab 23°C	lbs	272	280				276	4.0000
Grab 50°C	lbs	241	330				286	44.5000
AOS 23°C		40	50	40			43	4.7140
AOS 50°C		40	50	50			47	4.7140

JLT Laboratories, Inc.

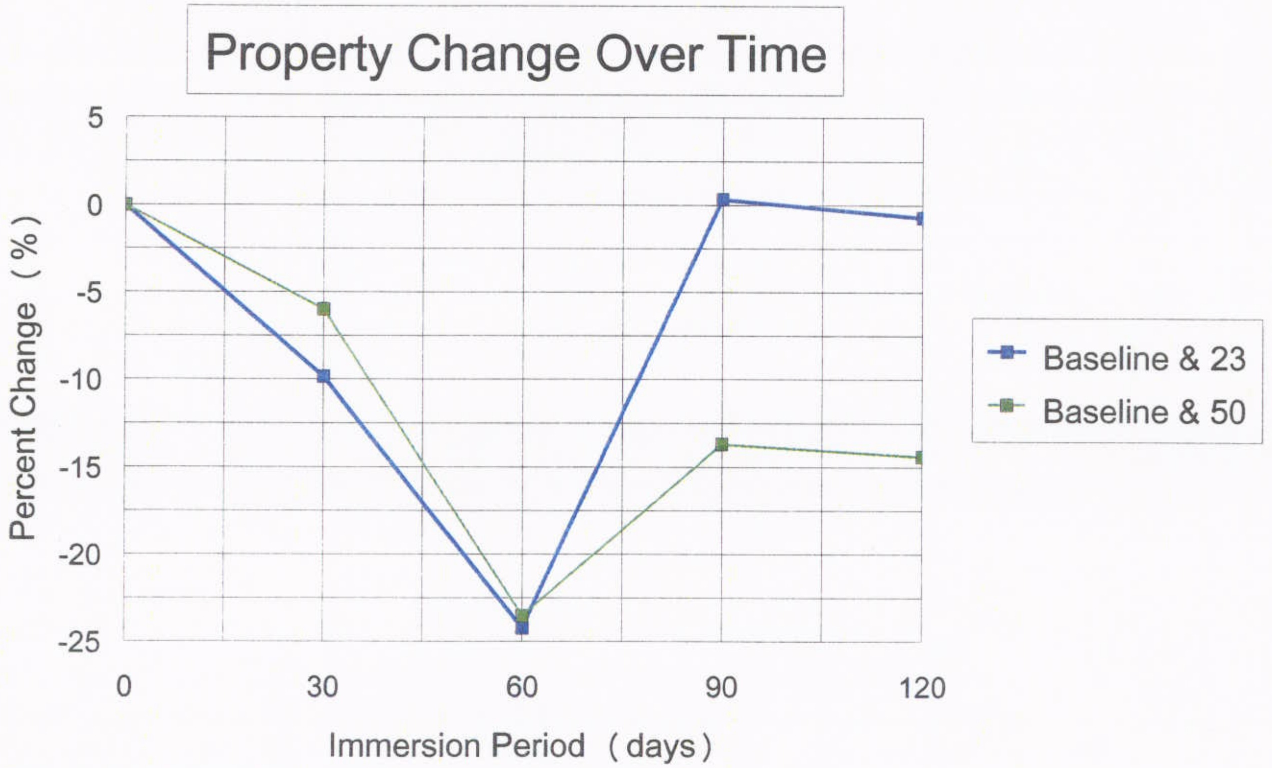
Summary Permittivity of Test Results

TenCate GeoTube

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	05/15/2009
Material:	GT 500 Woven Geotextile	**Tested By:**	RL/AM/MLB
Sample ID:	Geotextile - GeoTube	**Checked By:**	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Baseline & 23°C	28.5	25.7	-9.82	21.6	-24.21	28.6	0.35	28.3	-0.70
Baseline & 50°C	28.5	26.8	-5.96	21.8	-23.51	24.6	-13.68	24.4	-14.39

Note: At 60 days, the coupons were only soaked and rinsed but not cleaned with a soft brush, like the other samples.



JLT Laboratories, Inc.

PERMITTIVITY OF GEOTEXTILES

CONSTANT HEAD METHOD

ASTM D-4491 (Also meets D2434 Criteria for permeability)

JLT

Client: Parsons
Project: Honeywell Site
Material: Geotextile - GT500
Sample ID: Supplied Sample
Manufacturer: TenCate
Spec Value: 20 gpm/sq ft

BASLEINE

Job No.: 09LR1826.01
Report Date : 03/30/09
Technician: RL
Machine: JLT-CHPTV-1
Chk'd By : JB

HEAD ACROSS SPECIMEN: **5.08 cm**
WATER TEMPERATURE: **18.0** **Degrees C**

SAMP. AREA: **44.096 cm^2**
TEMP CORR. **1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
Baseline	1	1305.6	15.31	28.5	0.400
	2	1324.6	15.50	28.6	0.401
	3	1311.6	15.32	28.6	0.402
	4	1320.6	15.50	28.5	0.400
	5	1313.7	15.41	28.5	0.400

Average : 28.5 0.400

PERMITTIVITY OF GEOTEXTILES

CONSTANT HEAD METHOD

ASTM D-4491 (Also meets D2434 Criteria for permeability)

Client: Parsons
Project: Honeywell Site
Material: Geotextile - GT500
Sample ID: Supplied Sample
Manufacturer: TenCate 30 DAYS
Spec Value: 20 gpm/sq ft MARV

Job No.: 09LR1826.01
Report Date : 03/30/09
Technician: RL
Machine: JLT-CHPTV-1
Chk'd By : JB

HEAD ACROSS SPECIMEN: **5.08 cm**
WATER TEMPERATURE: **18.0** **Degrees C**

SAMP. AREA: **44.096 cm^2**
TEMP CORR. **1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
23 Degrees C Replicate 1	1	1124.2	15.40	24.4	0.343
	2	1127.9	15.47	24.4	0.342
	3	1130.7	15.44	24.5	0.344
	4	1132.1	15.59	24.3	0.341
	5	1125.0	15.46	24.3	0.341
23 Degrees C Replicate 2	1	1256.6	15.47	27.1	0.381
	2	1272.8	15.72	27.1	0.380
	3	1244.2	15.37	27.0	0.380
	4	1250.2	15.43	27.1	0.380
	4	1252.3	15.50	27.0	0.379

Average : 25.7 0.361

JLT Laboratories, Inc.
938 S. Central Avenue, Canonsburg, PA 15317 * Tel: (724) 746-4441 / Fax: (724) 745-4261

PERMITTIVITY OF GEOTEXTILES

CONSTANT HEAD METHOD

ASTM D-4491 (Also meets D2434 Criteria for permeability)

JLT

Client: Parsons
Project: Honeywell Site
Material: Geotextile - GT500
Sample ID: Supplied Sample
Manufacturer: TenCate 30 DAYS
Spec Value: 20 gpm/sq ft MARV

Job No.: 09LR1826.01
Report Date : 03/30/09
Technician: RL
Machine: JLT-CHPTV-1
Chk'd By : JB

HEAD ACROSS SPECIMEN: **5.08 cm**
WATER TEMPERATURE: **18.0** **Degrees C**

SAMP. AREA: **44.096 cm^2**
TEMP CORR. **1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
50 Degrees C Replicate 1	1	1141.5	15.25	25.0	0.351
	2	1150.1	15.35	25.0	0.352
	3	1159.0	15.32	25.3	0.355
	4	1157.8	15.34	25.2	0.354
	5	1162.0	15.47	25.1	0.352
50 Degrees C Replicate 2	1	1305.6	15.31	28.5	0.400
	2	1324.6	15.50	28.6	0.401
	3	1311.6	15.32	28.6	0.402
	4	1312.2	15.50	28.3	0.397
	4	1313.4	15.41	28.5	0.400

Average : 26.8 0.376

JLT *Laboratories, Inc.*

938 S. Central Avenue, Canonsburg, PA 15317 * Tel: (724) 746-4441 / Fax: (724) 745-4261

PERMITTIVITY OF GEOTEXTILES

CONSTANT HEAD METHOD

ASTM D-4491 (Also meets D2434 Criteria for permeability)

JLT

Client: Parsons
Project: Honeywell Site
Material: Geotextile - GT500
Sample ID: Supplied Sample
Manufacturer: TenCate 60 DAYS
Spec Value: 20 gpm/sq ft MARV

Job No.: 09LR1826.01
Report Date : 03/30/09
Technician: RL
Machine: JLT-CHPTV-1
Chk'd By : JB

HEAD ACROSS SPECIMEN: **5.08 cm**
WATER TEMPERATURE: **18.0** **Degrees C**

SAMP. AREA: **44.096 cm^2**
TEMP CORR. **1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
23 Degrees C Replicate 1	1	1205.5	18.50	21.8	0.306
	2	1208.0	18.46	21.9	0.307
	3	1196.7	18.50	21.6	0.303
	4	1203.3	18.60	21.6	0.304
	5	1196.4	18.43	21.7	0.305
23 Degrees C Replicate 2	1	1060.2	16.44	21.5	0.303
	2	1181.2	18.32	21.5	0.303
	3	1061.2	16.50	21.5	0.302
	4	1054.7	16.47	21.4	0.300
	4	1073.4	16.56	21.7	0.304

Average : 21.6 0.304

JLT Laboratories, Inc.

938 S. Central Avenue, Canonsburg, PA 15317 * Tel: (724) 746-4441 / Fax: (724) 745-4261

PERMITTIVITY OF GEOTEXTILES
CONSTANT HEAD METHOD
ASTM D-4491 (Also meets D2434 Criteria for permeability)

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell Site	**Report Date :**	03/30/09
Material:	Geotextile - GT500	**Technician:**	RL
Sample ID:	Supplied Sample	**Machine:**	JLT-CHPTV-1
Manufacturer:	TenCate 60 DAYS	**Chk'd By :**	JB
Spec Value:	20 gpm/sq ft MARV		

HEAD ACROSS SPECIMEN:	**5.08 cm**	**SAMP. AREA:**	**44.096 cm^2**
WATER TEMPERATURE:	**18.0 Degrees C**	**TEMP CORR.**	**1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
50 Degrees C Replicate 1	1	1287.1	19.38	22.2	0.312
	2	1310.2	19.47	22.5	0.316
	3	1301.2	19.43	22.4	0.314
	4	1300.8	19.38	22.4	0.315
	5	1306.5	19.34	22.6	0.317
50 Degrees C Replicate 2	1	1230.0	19.34	21.2	0.298
	2	1233.3	19.44	21.2	0.298
	3	1239.3	19.50	21.2	0.298
	4	1226.8	19.28	21.3	0.299
	4	1230.7	19.28	21.3	0.299
			Average :	21.8	0.307

JLT Laboratories, Inc.

938 S. Central Avenue, Canonsburg, PA 15317 * Tel: (724) 746-4441 / Fax: (724) 745-4261

PERMITTIVITY OF GEOTEXTILES

CONSTANT HEAD METHOD

ASTM D-4491 (Also meets D2434 Criteria for permeability)

JLT

Client: Parsons
Project: Honeywell Site
Material: Geotextile - GT500
Sample ID: Supplied Sample
Manufacturer: TenCate 90 DAYS
Spec Value: 20 gpm/sq ft MARV

Job No.: 09LR1826.01
Report Date : 06/29/09
Technician: RL
Machine: JLT-CHPTV-1
Chk'd By : JB

HEAD ACROSS SPECIMEN: **5.08 cm**
WATER TEMPERATURE: **18.0** **Degrees C**

SAMP. AREA: **44.096 cm^2**
TEMP CORR. **1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
23 Degrees C Replicate 1	1	1314.0	15.26	28.8	0.404
	2	1319.0	15.31	28.8	0.404
	3	1318.0	15.29	28.8	0.404
	4	1321.0	15.33	28.8	0.404
	5	1323.0	15.37	28.8	0.404
23 Degrees C Replicate 2	1	1312.0	15.46	28.4	0.398
	2	1309.0	15.39	28.4	0.399
	3	1312.0	15.42	28.4	0.399
	4	1315.0	15.47	28.4	0.399
	4	1319.0	15.57	28.3	0.397
			Average :	28.6	0.401

JLT Laboratories, Inc.
938 S. Central Avenue, Canonsburg, PA 15317 * Tel: (724) 746-4441 / Fax: (724) 745-4261

PERMITTIVITY OF GEOTEXTILES

CONSTANT HEAD METHOD

ASTM D-4491 (Also meets D2434 Criteria for permeability)

Client: Parsons
Project: Honeywell Site
Material: Geotextile - GT500
Sample ID: Supplied Sample
Manufacturer: TenCate 90 DAYS
Spec Value: 20 gpm/sq ft MARV

Job No.: 09LR1826.01
Report Date : 06/29/09
Technician: RL
Machine: JLT-CHPTV-1
Chk'd By : JB

HEAD ACROSS SPECIMEN: **5.08 cm**
WATER TEMPERATURE: **18.0** **Degrees C**

SAMP. AREA: **44.096 cm^2**
TEMP CORR. **1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
50 Degrees C Replicate 1	1	1277.0	17.44	24.5	0.344
	2	1279.0	17.45	24.5	0.344
	3	1275.0	17.41	24.5	0.344
	4	1281.0	17.52	24.4	0.343
	5	1282.0	17.53	24.4	0.343
50 Degrees C Replicate 2	1	1288.0	17.39	24.7	0.348
	2	1294.0	17.42	24.8	0.349
	3	1295.0	17.43	24.8	0.349
	4	1289.0	17.39	24.8	0.348
	4	1297.0	17.44	24.8	0.349
			Average :	24.6	0.346

JLT Laboratories, Inc.
938 S. Central Avenue, Canonsburg, PA 15317 * Tel: (724) 746-4441 / Fax: (724) 745-4261

PERMITTIVITY OF GEOTEXTILES

CONSTANT HEAD METHOD

ASTM D-4491 (Also meets D2434 Criteria for permeability)

JLT

Client: Parsons
Project: Honeywell Site
Material: Geotextile - GT500
Sample ID: Supplied Sample
Manufacturer: TenCate 120 DAYS
Spec Value: 20 gpm/sq ft MARV

Job No.: 09LR1826.01
Report Date : 06/29/09
Technician: RL
Machine: JLT-CHPTV-1
Chk'd By : JB

HEAD ACROSS SPECIMEN: **5.08 cm**
WATER TEMPERATURE: **18.0** **Degrees C**

SAMP. AREA: **44.096 cm^2**
TEMP CORR. **1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
23 Degrees C Replicate 1	1	1314.0	15.45	28.4	0.399
	2	1316.0	15.51	28.3	0.398
	3	1315.0	15.49	28.4	0.398
	4	1315.0	15.47	28.4	0.399
	5	1317.0	15.51	28.4	0.398
23 Degrees C Replicate 2	1	1312.0	15.52	28.2	0.397
	2	1312.0	15.51	28.3	0.397
	3	1309.0	15.44	28.3	0.398
	4	1313.0	15.53	28.2	0.397
	4	1312.0	15.49	28.3	0.397

Average : 28.3 0.398

JLT *Laboratories, Inc.*

938 S. Central Avenue, Canonsburg, PA 15317 * Tel: (724) 746-4441 / Fax: (724) 745-4261

PERMITTIVITY OF GEOTEXTILES
CONSTANT HEAD METHOD
ASTM D-4491 (Also meets D2434 Criteria for permeability)

Client: Parsons
Project: Honeywell Site
Material: Geotextile - GT500
Sample ID: Supplied Sample
Manufacturer: TenCate 120 DAYS
Spec Value: 20 gpm/sq ft MARV

Job No.: 09LR1826.01
Report Date : 06/29/09
Technician: RL
Machine: JLT-CHPTV-1
Chk'd By : JB

HEAD ACROSS SPECIMEN: **5.08 cm**
WATER TEMPERATURE: **18.0** **Degrees C**
SAMP. AREA: **44.096 cm^2**
TEMP CORR. **1.0510**

COUPON	REPLICATE	FLOW cm^3	TIME sec	FLOW gal/min/ft^2	PERMITTIVITY sec-1
50 Degrees C Replicate 1	1	1246.0	17.54	23.7	0.333
	2	1241.0	17.50	23.7	0.333
	3	1235.0	17.49	23.6	0.331
	4	1251.0	17.56	23.8	0.334
	5	1250.0	17.55	23.8	0.334
50 Degrees C Replicate 2	1	1301.0	17.39	25.0	0.351
	2	1305.0	17.42	25.0	0.351
	3	1318.0	17.46	25.2	0.354
	4	1311.0	17.53	25.0	0.351
	4	1310.0	17.49	25.0	0.351

Average : 24.4 0.342

JLT Laboratories, Inc.
938 S. Central Avenue, Canonsburg, PA 15317 * Tel: (724) 746-4441 / Fax: (724) 745-4261

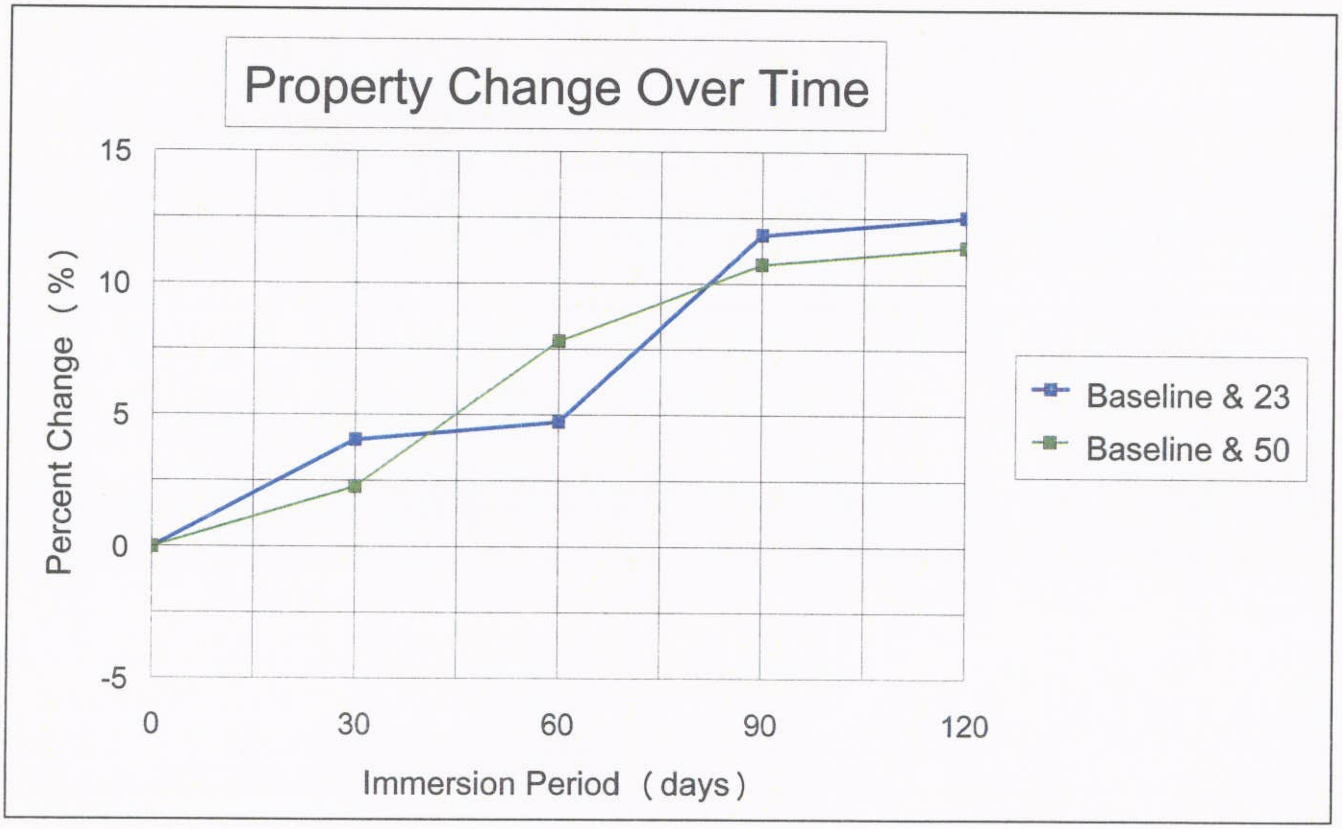
Summary of Test Results

Sewing Thread

JLT

Client:	Parsons	**Job No.:**	09LR1826.01
Project:	Honeywell	**Date:**	06/15/2009
Material:	Sewing Thread	**Tested By:**	RL/AM/MLB
Sample ID:	TenCate Sewing Thread	**Checked By:**	JB

TEST	Baseline	30-Day Immersion		60-Day Immersion		90-Day Immersion		120-Day Immersion	
READING	Average	Average	% Change	Average	% Change	Average	% Change	Average	% Change
Baseline & 23°C	59.0	61.4	4.07	61.8	4.75	66.0	11.86	66.4	12.54
Baseline & 50°C	61.4	62.8	2.28	66.2	7.82	68.0	10.75	68.4	11.40



JLT *Laboratories, Inc.*

Sewing Thread Test Results

Client: Parsons
Project: Honeywell
Material: Sewing Thread
Sample ID: TenCate Sewing Thread

Job No.: 09LR1826.01
Date: 06/15/2009
Tested By: RL/AM/MLB
Checked By: JB

PARAMETER	UNITS	REPLICATE No.					AVERAGE	STANDARD DEVIATION
		1	2	3	4	5		
Baseline	lbs	58	56	62	59	60	59.0	2.0000
30 Days 23°C	lbs	58	69	61	64	55	61.4	4.8415
30 Days 50°C	lbs	69	69	58	55	63	62.8	5.6710
60 Days 23°C	lbs	66	60	61	60	62	61.8	2.2271
60 Days 50°C	lbs	70	60	66	66	69	66.2	3.4871
90 Days 23°C	lbs	65	67	69	65	64	66.0	1.7889
90 Days 50°C	lbs	68	68	70	69	65	68.0	1.6733
120 Days 23°C	lbs	65	67	67	65	68	66.4	1.2000
120 Days 50°C	lbs	66	68	69	69	70	68.4	1.3565

JLT Laboratories, Inc.