SOUTHEAST COUNTY LANDFILL

HILLSBOROUGH COUNTY
SOLID WASTE MANAGEMENT DEPT
ARDAMAN REPORTS

2009

JONES EDMUNDS

May 18, 2009

Susan J. Pelz, P.E.
Solid Waste Program Manager
Department of Environmental Protection - Southwest District
13051 North Telecom Parkway
Temple Terrace, Florida 33637-0926

RE: Hillsborough County Southeast County Landfill
Phase I Landfill Slope Stability
FDEP Permit No. 35435-014-SO/01
Jones Edmunds Project No.: 08449-030-03-1160

Dear Ms. Pelz:

On behalf of the Hillsborough County Solid Waste Management Department (SWMD), Jones Edmunds has performed a slope stability evaluation for the Phase I area at the Southeast County Landfill (SCLF) Class I Landfill (see Site Plan provided in Attachment 1). The evaluation was based on the most recent phosphatic clay field and laboratory shear strength results reported by Ardaman & Associates, Inc. The Ardaman report is provided in Attachment 2.

The phosphatic clay is the bottom barrier layer for the Phase I – VI Class I Landfill. Since the initial permitting of Phases I-VI, the strength of the phosphatic clays has been a critical design and operational condition. As part of the Florida Department of Environmental Protection operations permit, procedures were established for determining whether a specific phase was ready for the next lift of waste placement and possibly for final build-out based on stability models using the undrained shear strength of the phosphatic clay. According to the current operations fill sequence plans, the Phase I area is the next area scheduled to be filled.

A Conceptual Environmental Resource Permit (CERP), FDEP Permit No. 29-0270881-004, was recently issued to include modifications to the SCLF stormwater management systems. As part of the proposed modifications, stormwater ponds A-1, A-2, A-3, and B will be excavated and regraded. As part of this overall evaluation letter to the FDEP for approval of filling the Phase I area, the proposed configurations of these stormwater management ponds were included in the slope stability evaluations.

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To determine if the current in-situ shear strength of the phosphatic clay beneath the Phase I area is sufficient to support the additional load resulting from the next lift of waste and final build out elevation conditions, the SWMD contracted Jones Edmunds to collect in-situ phosphatic clay samples at several locations. Laboratory shear strength testing was performed on the samples to provide undrained shear strengths for use in analyzing the slope stability of the waste mass.

The Phase I waste is currently at a maximum elevation of approximately 200 feet (see cross sections provided in Attachment 1). The proposed side slope break (4 to 1 horizontal to vertical slope) elevation in the Phase I area is approximately 220 feet (NGVD 1929) and the proposed peak elevation for the Phase I waste at final build-out is approximately 240 feet (NGVD 1929) in accordance with the operational fill sequence plans dated November 2006, specifically Drawing No. 12 and Drawing No. 14. Please refer to the cross sections provided in Attachment 1.

<u>CURRENT WASTE PHOSPHATIC CLAY STRENGTHS FOR PHASE I</u>

In March 2007 and June 2008, Jones Edmunds subcontracted with Ardaman to perform the field and laboratory work necessary to collect and test the phosphatic clay samples from the Phase I area. The laboratory reports submitted to Jones Edmunds from Ardaman for the 2007 and 2008 waste phosphatic clays are provided in Attachment 2 and are summarized in Table 1.

Table 1 Ardaman Phase I Field and Laboratory Test Results

Date Sampled	Boring Number	Sample Number	Sample Depth (ft)	Test Type [4]	Undrained Shear Strength (s_u) (psf)	Normal Load [1] (σ_1) (psf)	Cell Pressure[1] (σ_3) (psf)	Estimated Clay Thickness (ft)
May 2007	TH-1O[2]	US-2	70.5-72.5	Retested – see TH-1BS3				8.5
	TH-1O[2]	US-4	77.5-79.5					
	TH-1P	US-1	70.5-72.5	UU	1,350	7,700	5,000	4.5
August 2008	TH-1Q1	US-1	56 - 58	UC	1,630	3,260	-	5.5
	TH-1Q1	US-2	58 - 60	UU	1,140	5,240	2,960	
	TH-1Q1	US-3[2]	60 - 62	Retested – see TH-1Q6				
	TH-1Q2	US-1	56 - 58	UC	1,500	3,000	-	4.0
	TH-1Q2	US-2	58 - 60	UU	1,750	9,400	5,900	
	TH-1Q2	US-3[3]	60 - 62	Incomplete Sample				
November 2008	TH-1Q6	US-1	61.5 - 63.5	UU	1,340	7,080	4,400	4.0
	TH-1Q6	US-2	63.6 - 71.6	DSS	2,160	13,040	-	
	TH-1B-S3[2]	US-1	69.6 – 71.6	UU	1,030	7,060	5,000	4.5
	TH-1B-S3	US-1	69.6 – 71.6	DSS	2,320	14,660	-	

(1) Normal Load is the test load in psf. Cell pressure is zero for UC and DSS tests. Normal Load at Failure for the UU tests are plotted in Figure 1 as $(\sigma_1 + \sigma_3)/2$.
(2) TH-1BS3 is a retest of TH-1O performed in 2007. TH-1Q6 is a retest of TH-1Q1 US-3 – Retested due to sample disturbance.
(3) TH-1Q2 US-3 – Incomplete sample; sample not suitable for testing due to intrusion of debris/or insufficient clay to sample.
(4) UC = Unconfined Compression Test; UU = Unconsolidated Undrained Test, DSS = Direct Simple Shear Test

The laboratory strength tests included unconfined compression tests (UC), unconsolidated-undrained triaxial tests (UU), and direct simple shear tests (DSS). The following is a brief description of each of these laboratory tests:

- Unconfined Compression Test (UC) – A simple compression test that applies a normal load (σ_1) to a cylindrical sample but does not load the sample axially with a confining stress ($\sigma_3 = 0$). This test tends to yield a conservative estimate of the samples shear strength since in-situ the sample would have surrounding material to confine and limit movement of the failure plane. The speed of the shearing and permeability of the sample will affect whether the failure occurs under drained or undrained conditions. However, measuring pore-pressure during testing is not possible with this test.
- Unconsolidated - Undrained Test (UU) – A tri-axial testing method that involves loading a cylindrical sample with axial stresses ($\sigma_3 > 0$) around the entire sample and applying a normal load (σ_1) until failure. The uniform loading is representative of in-situ conditions. A valve is closed to prevent dissipation of pore-pressures representing undrained conditions. This test would be representative of low-permeability clay, such as phosphatic clay, under a relatively rapid loading condition, such as placement of a lift of waste.
- Direct Simple Shear (DSS) Test – A shear test that evaluates a sample using a normal load (σ_1) acting perpendicular to the failure surface. The shearing plane is forced horizontally through the sample. The speed of the shearing and permeability of the sample will effect whether the failure occurs under drained or undrained conditions. However, pore-pressure measurements are not recorded during testing.

The UU and UC tests were performed at loads bracketing the anticipated maximum load due to the waste mass of approximately 7,400 psf (based on approximately 100 ft of waste at elevation 240 ft NGVD 1929) at final build out in Phase I with a waste density of 74 pcf. The DSS tests were performed at loads much higher than the anticipated load to overcome the effects of sample disturbance.

Figure 1 shows the undrained shear strength versus the normal load at failure measured in the laboratory tests (UC, UU, and DSS).

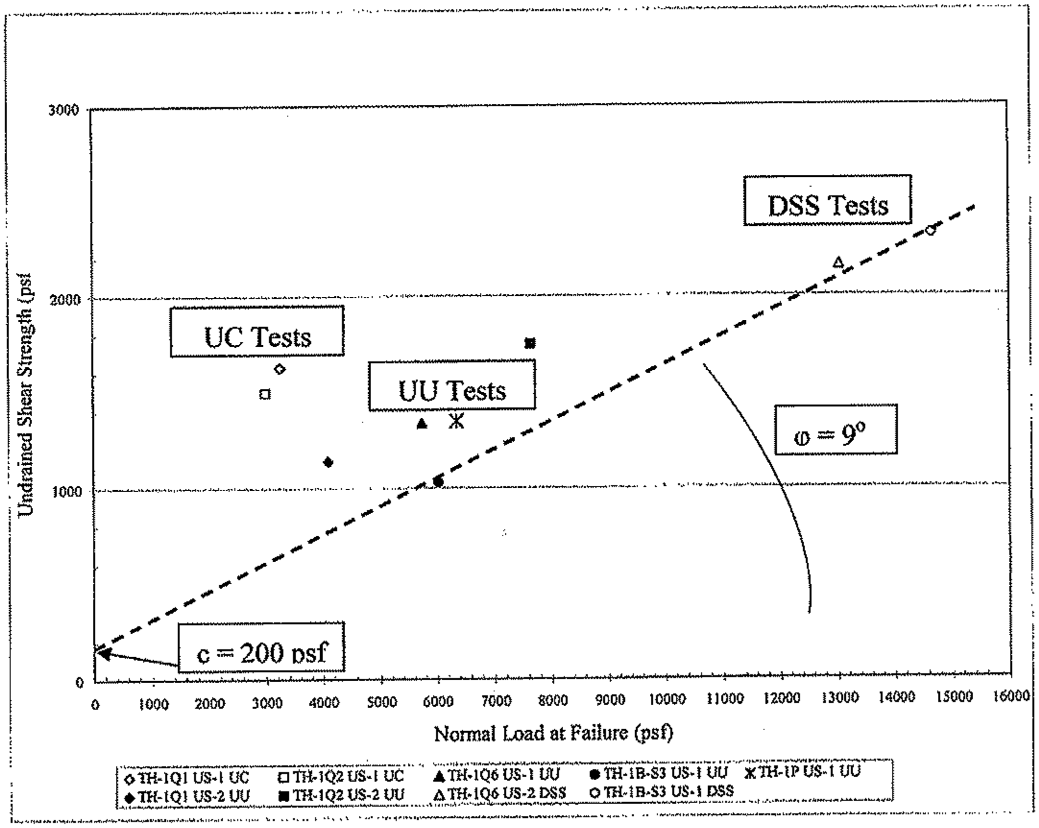

Figure 1: Relationship Between Laboratory Undrained Shear Strength and Normal Load

This graph is used to determine the linear undrained shear strength as a function of normal load through the lowest values reported in the laboratory testing. Thus, for the slope stability models the phosphatic clay was estimated to have an equivalent slope angle (φ) of 9° and an intercept (c) of 200 psf. These values are used to represent the undrained shear strength of the phosphatic clay in the slope stability models.

SLOPE STABILITY ANALYSES

The slope stability analyses were performed using SLOPE/W software. The FDEP-proposed rule requires a Factor of Safety of 1.5 based on peak shear strength values.

Jones Edmunds modeled the landfill using worst-case slope stability conditions including:

1. Waste elevations at final grade plus final cover soil simulating the highest load condition.

2. Sliding block failure surface simulating a horizontal continuous failure through the phosphatic clay.
3. Waste shear strength with a friction angle of 28°, which is 15% lower than the lower-bound shear strength determined based on large-scale direct shear tests (*Soil Strength and Slope Stability*, Duncan and Wright, 2005 provided in Attachment 3).
4. Current undrained laboratory tested clay shear strength for viable samples of the waste phosphatic clays to generate a φ and c value to use in the slope stability models based on a linear relationship through the lowest shear strength values (refer to Figure 1).

The critical cross sections for Phase I were chosen through the proposed modified stormwater ponds permitted in the recent CERP application and the peak elevation of the landfill as shown in the Site Plan provided in Attachment 1 (see Sections C, D, E, F, and G). The resulting factor of safety for each section, as reported in the Slope/W models provided in Attachment 4, are all greater than 1.5.

CONCLUSIONS AND RECOMMENDATIONS

The slope stability models indicate that the phosphatic clay sampled under current Phase I conditions meets the FDEP-proposed requirement for the minimum Factor of Safety of 1.5. Therefore, additional phosphatic clay laboratory and field testing is not necessary for waste mass stability in Phase I through the final build-out elevation. Jones Edmunds recommends that the current clay strengths in Phase I, as tested in 2007 and 2008, be seen as providing reasonable assurance that waste filling operations in Phase I may continue at any time.

The SWMD intends to continue waste filling operations in Phase I by August 1, 2009 in accordance with the permitted Phases I-VI fill sequence plans.

Future phosphatic clay sampling and testing will be performed for the Phase II through VI areas before the next lift of waste is placed. Jones Edmunds recommends obtaining intact samples of the phosphatic clay for laboratory testing as permitted in the SCLF Operations Permit. Based on the results of the Phase I sampling and testing, the UU tests had the most consistent determination of the undrained shear strength. In addition, as discussed in the Ardaman correspondence provided in Attachment 2, the laminated samples used in the DSS resulted in lower strengths that were not representative of actual conditions. The UC tests resulted in higher shear strengths at lower normal loads and were not consistent with the UU tests. Therefore, we recommend the UU tests for future undrained shear strength testing.

If you have any questions or comments, please contact me at 813/258-0703.

Sincerely,

Jason J. Timmons, P.E.
Project Engineer
Florida PE No. 65869

5/18/09
Don Hullings, P.E.
Discipline Director
Florida PE No. 65058

Jones Edmunds Certificate of Authorization No. 1841

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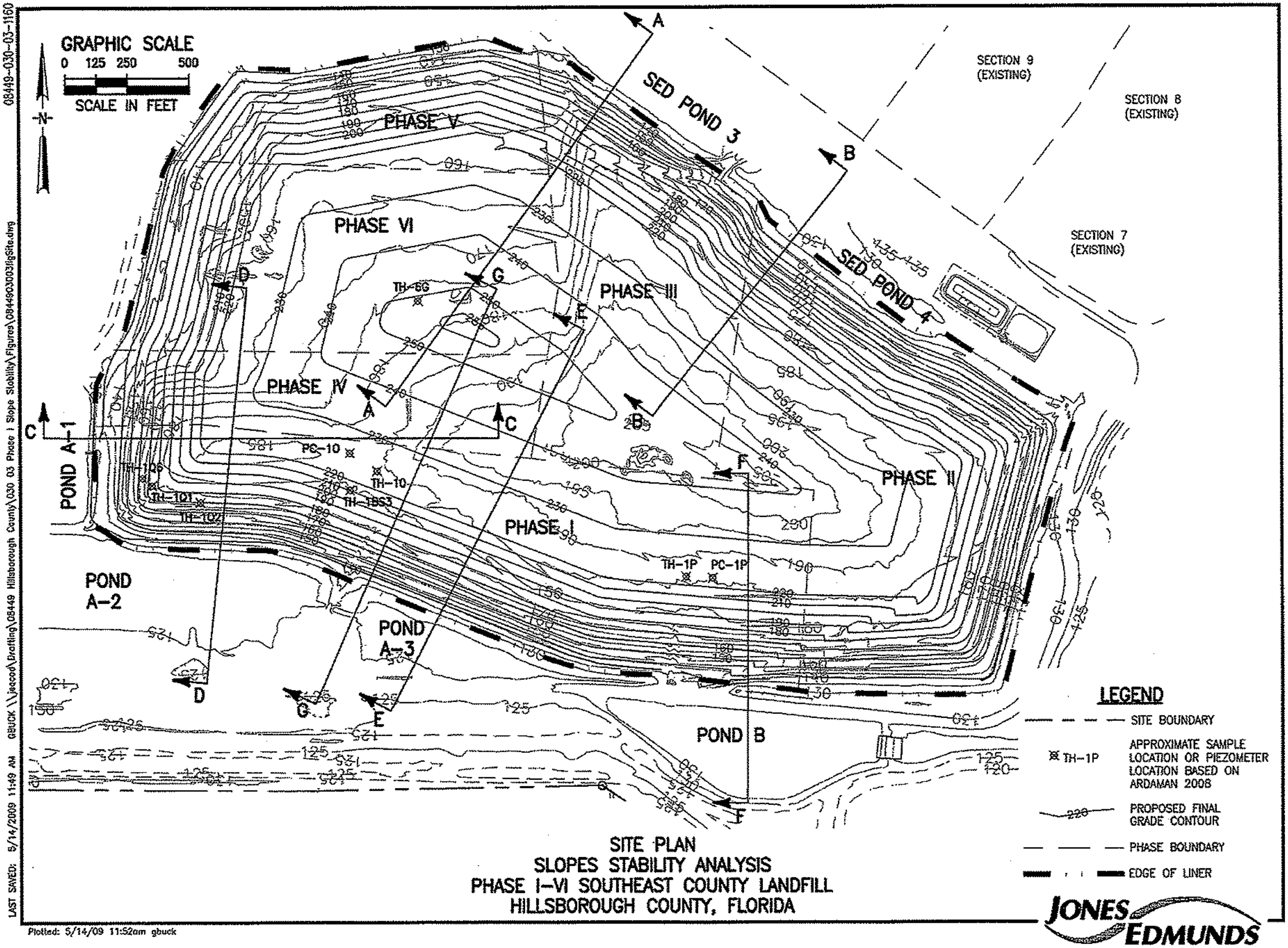
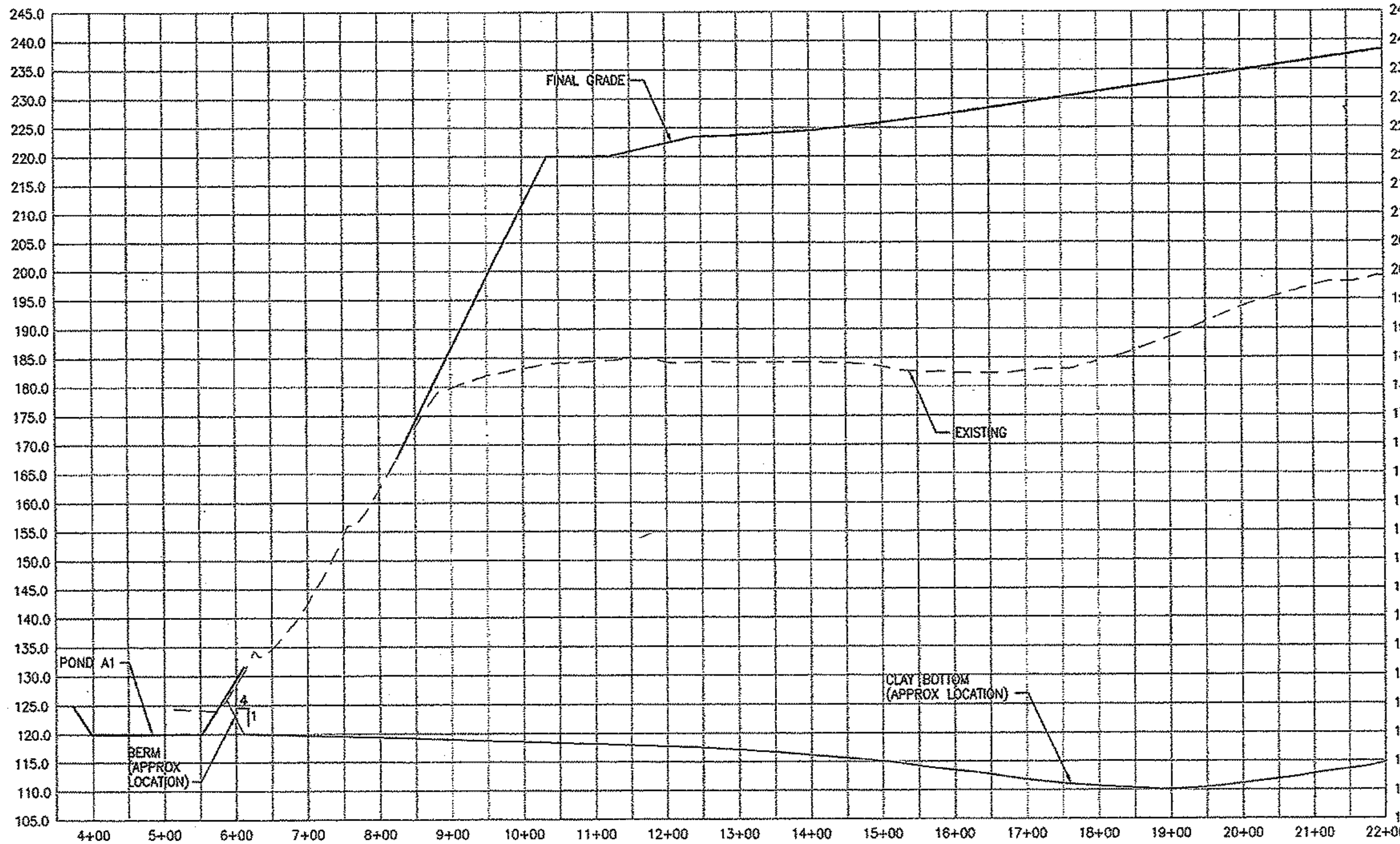
xc: Patricia Berry, Hillsborough County
Larry Ruiz, Hillsborough County
Megan Miller, Hillsborough County
Ron Cope, EPC
Joseph O'Neill, CES
Francis Cheung, Ardaman
Don Hullings, Jones Edmunds
Mickey Pollman, Jones Edmunds

ATTACHMENT 1

FIGURES



SITE PLAN
SLOPES STABILITY ANALYSIS
PHASE I-VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA



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SECTION C
SLOPE STABILITY ANALYSES
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH, COUNTY FLORIDA

JONES EDMUNDS

08449-030-03-1160

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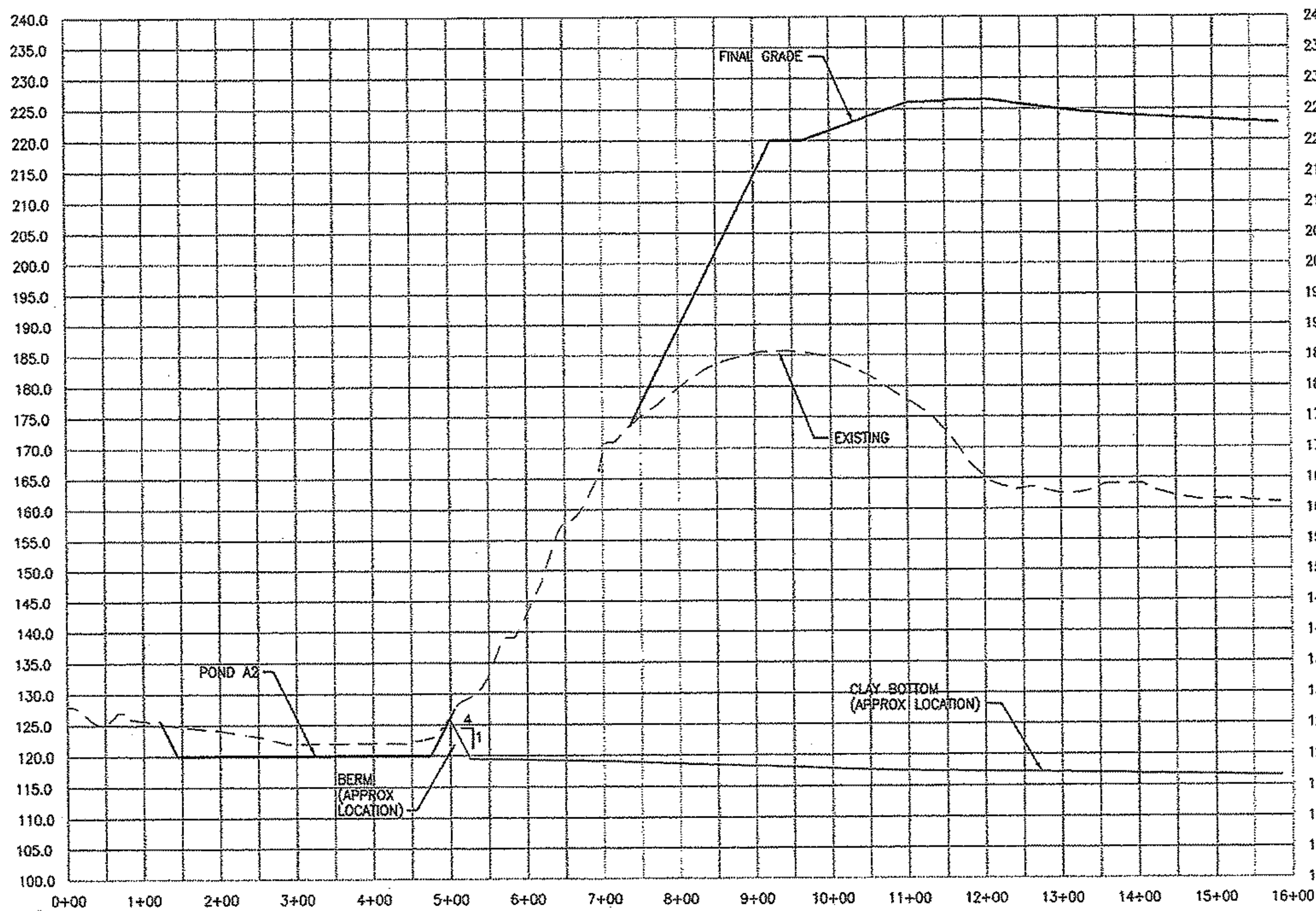

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SECTION D
SLOPE STABILITY ANALYSES
PHASE I—VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH, COUNTY FLORIDA

JONES EDMUNDS

08449-030-03-1160

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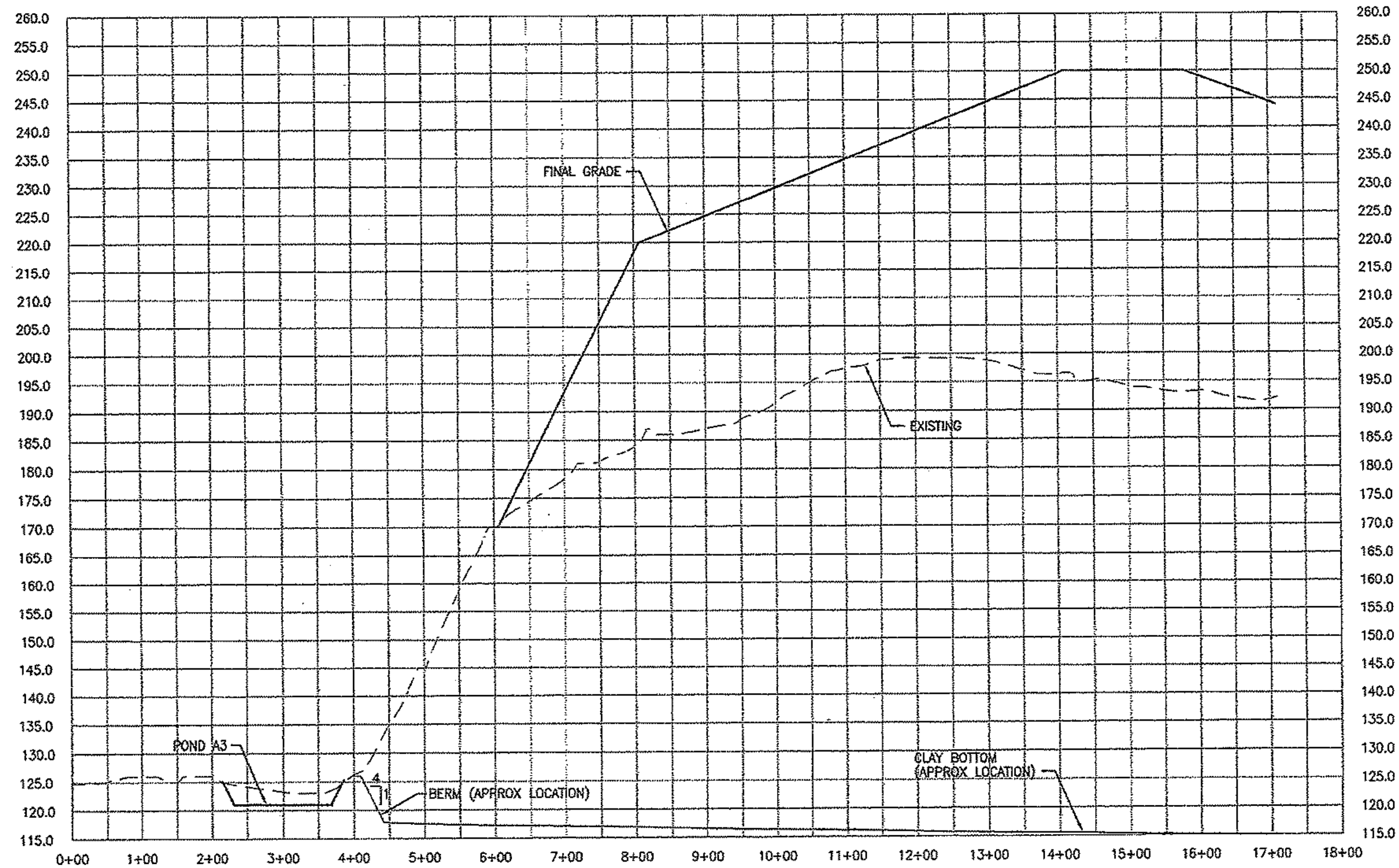

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SECTION E
SLOPE STABILITY ANALYSES
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH, COUNTY FLORIDA

JONES EDMUNDS

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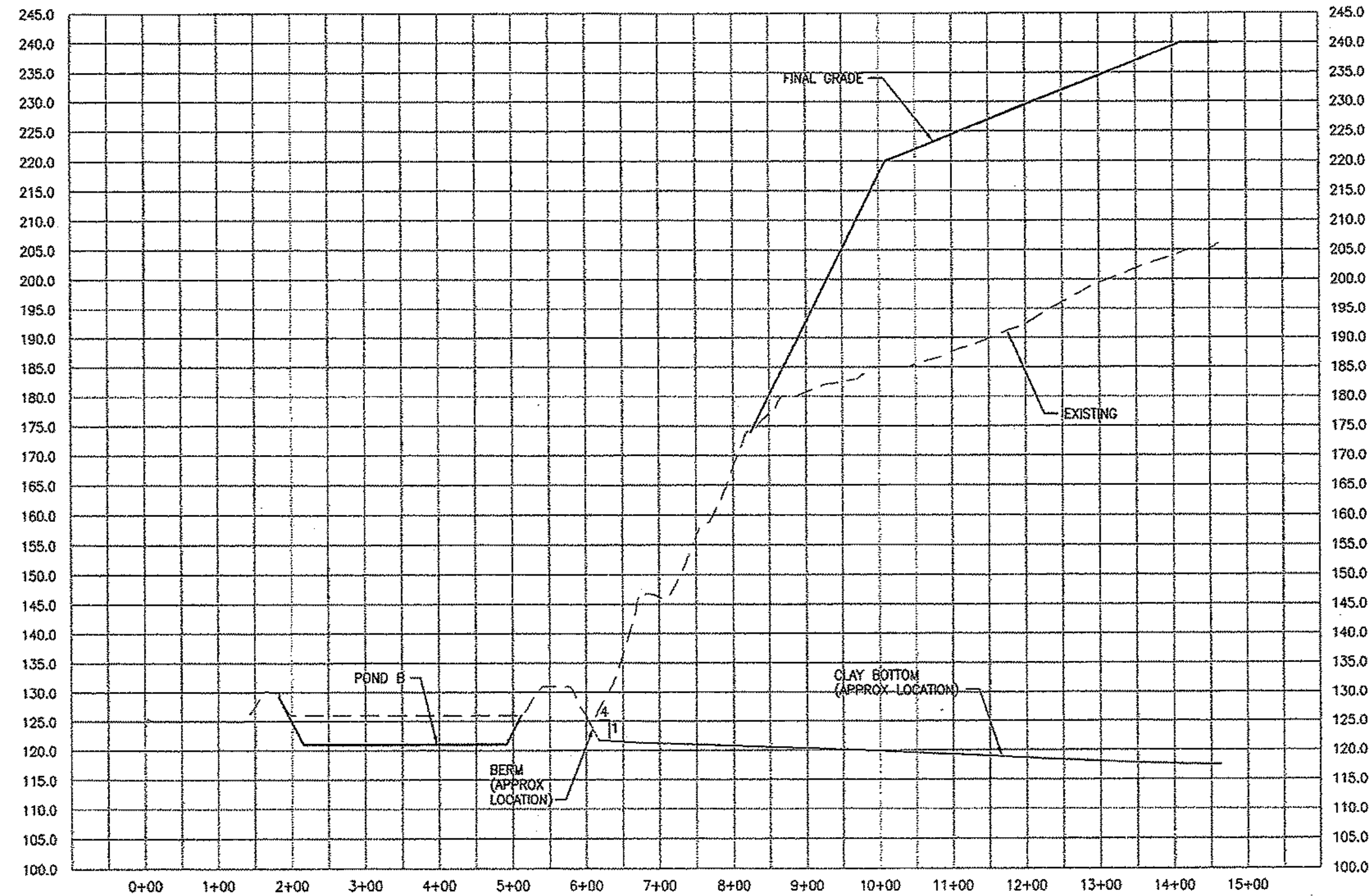

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SECTION F
SLOPE STABILITY ANALYSES
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH, COUNTY FLORIDA

JONES EDMUNDS

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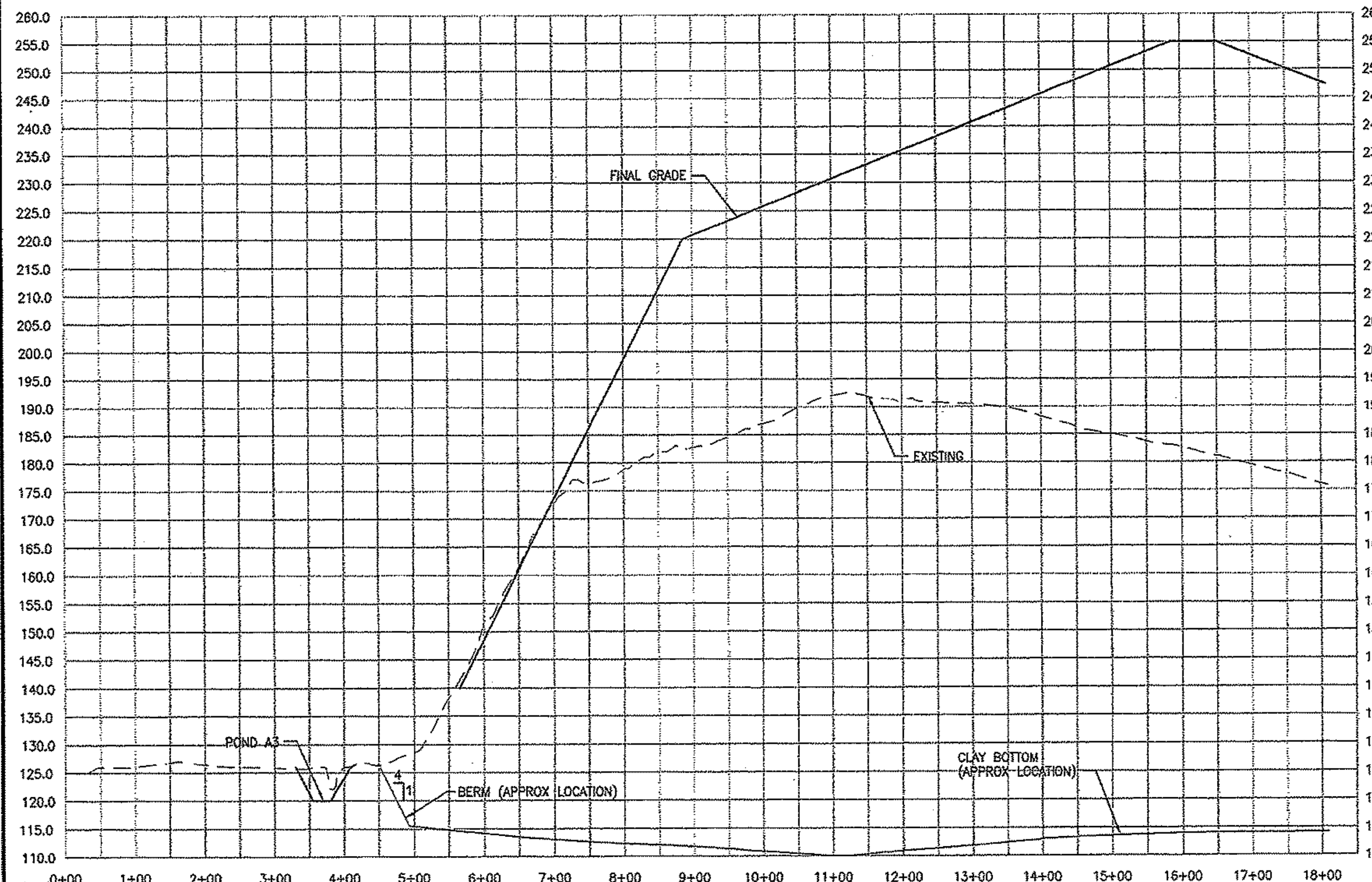

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GRAPHIC SCALE
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SCALE IN FEET
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SECTION G
SLOPE STABILITY ANALYSIS
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

JONES EDMUNDS

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ATTACHMENT 2

ARDAMAN & ASSOCIATES, INC. FIELD AND LABORATORY REPORT DATED MAY 8, 2009

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

May 7, 2009
File Number 08-032

Jones Edmunds & Associates, Inc.
324 South Hyde Park Avenue
Suite 250
Tampa, FL 33606-4110

Attention: Mr. Jason Timmons, P.E.
Project Engineer

Subject: Results of Laboratory Strength Testing of Waste Phosphatic Clay Samples from Phase I Area of Southeast County Landfill, Hillsborough County, Florida

Gentlemen/Ladies:

As requested by Jones Edmunds & Associates, Inc. (Jones Edmunds), Ardaman & Associates, Inc. (Ardaman) is pleased to submit this report to present results of laboratory strength testing for waste phosphatic clay samples recovered from the Phase I Area of the Southeast County Landfill Facility in 2007 and 2008.

Sampling and Testing in 2007

Two soil borings, designated TH-1O and TH-1P, were performed by Ardaman in 2007 in the Phase I area at the locations shown on the boring location map in Appendix A. TH-1O was drilled within the western half near the north side of the Phase I area, adjacent to the piezocone test site designated PC-1O, which was performed as part of the 2007 annual monitoring program. TH-1P was advanced near the eastern end of the Phase I area, adjacent to the piezocone test site designated PC-1P, also performed as part of the 2007 annual monitoring program. The soil borings were advanced through the entire depths of refuse/ash and drainage sand layer to recover samples of the underlying waste phosphatic clay for laboratory testing. A total of three undisturbed samples were recovered, with two samples from TH-1O and one sample from TH-1P.

In TH-1O and TH-1P, the top of waste phosphatic clay was encountered at depths of 71 and 70 feet below landfill surface, and the waste phosphatic clay thicknesses were documented to be 8.5 and 4.5 feet, respectively. The original waste phosphatic clay deposit was thinnest (4 to 8 feet) along the south side of the Phase I area where TH-1P was drilled. Along the west side of the Phase I area where TH-1O was drilled, the original phosphatic clay thickness could have been as much as 8 to 10 feet.

Ardaman performed unconfined compression tests, unconsolidated-undrained triaxial tests, and direct simple shear tests on the recovered undisturbed waste phosphatic clay samples. Results of these undrained shear strength measurements are presented in the laboratory reports in Appendix B and are summarized in the following table.

8008 South Orange Avenue (32809), Post Office Box 593003. Orlando, Florida 32859-3003 Phone (407) 855-3860 FAX (407) 859-8121
Offices in: Bartow, Cocoa, Fort Myers, Miami, Orlando, Port Charlotte, Port St. Lucie, Sarasota, Tallahassee, Tampa, W. Palm Beach

Test Hole	Sample	Depth (feet)	Test Type*	Undrained Shear Strength (psf)
TH-1O	US-2	73.5 – 75.5	UU	530
TH-1O	US-4	77.5 – 79.5	UU	640
TH-1P	US-1	70.5 – 72.5	UU	1,350
* Unconsolidated-undrained triaxial tests.				

As shown, the laboratory measurements indicated that the west side of the Phase I area, with an overburden load of approximately 70 feet and a waste phosphatic clay thickness of approximately 8 feet, had undrained shear strengths of 530 to 640 psf, characteristic of a medium stiff clay. The south side of the Phase I area, with a refuse/ash overburden load of approximately 70 feet and a waste phosphatic clay thickness of approximately 4 feet, had a higher undrained shear strength of 1,350 psf, characteristic of a stiff clay. The moisture contents of the undisturbed samples recovered from TH-1O were generally higher than those recovered from TH-1P, which confirmed that the undrained shear strengths of the waste phosphatic clay were higher at TH-1P than at TH-1O.

For comparisons, an undisturbed sample obtained at a depth of 42 feet below the landfill surface from the Phase I area in 1994 yielded an undrained shear strength of 460 psf. In its original state, the phosphatic clay below the desiccated crust had an undrained shear strength on the order of 70 psf.

Sampling and Testing in 2008

Four soil borings, designated TH-1Q1, TH-1Q2, TH-1Q6, and TH-1B-S3, were performed by Ardaman in 2008 in the Phase I area to recover undisturbed samples of the waste phosphatic clay for laboratory testing. TH-1Q1 and TH-1Q2 were drilled in July 2008, and TH-1Q6 and TH-1B-S3 were drilled in November 2008. These soil borings were performed within the western half of the Phase I area. TH-1Q1, TH-1Q2, and TH-1Q6 were located close to the crest of the existing landfill slope, whereas TH-1B-S3 was drilled at a greater distance from the existing landfill slope crest (i.e., towards the interior of the landfill), as shown on the boring location plan in Appendix A.

The soil borings were advanced through the entire depths of refuse/ash and the drainage sand layer to allow recovery of undisturbed samples of the waste phosphatic clay using a Shelby tube sampler. The approximate depths and thicknesses of the waste phosphatic clay layer encountered in the soil borings are summarized in the following table.

Test Hole	Approx Depth to Waste Phosphatic Clay Layer Below Land Surface (feet)	Approx Thickness of Waste Phosphatic Clay Layer (feet)
TH-1Q1	56.0	5.5
TH-1Q2	56.0	4.0
TH-1Q6	61.5	4.0
TH-1B-S3	70.0	4.5

As shown in the table above, the waste phosphatic clay was encountered at a depth ranging from 56 to 70 feet below land surface, and had a thickness of 4.0 to 5.5 feet at the soil boring locations.

To characterize the undrained shear strengths of the waste phosphatic clay, Ardaman performed unconfined compression tests, unconsolidated-undrained triaxial tests, and direct simple shear tests on selected samples of the waste phosphatic clay recovered from the four soil borings. Results of the laboratory strength tests are presented in the laboratory reports in Appendix B and are summarized in the following table.

Test Hole	Sample Number	Depth (feet)	Test Type*	Undrained Shear Strength (psf)	Estimated Overburden Pressure (psf)	Applied Normal Load Prior to Shear (psf)
TH-1Q1	US-1	56-58	UC	1,630	4,320	-
TH-1Q1	US-2	58-60	UU	1,140	4,520	-
TH-1Q1	US-3	60-62	UC	540***	4,720	-
TH-1Q2	US-1	56-58	UC	1,500	4,320	-
TH-1Q2	US-2	58-60	UU	1,750	4,520	-
TH-1Q6	US-1	61.6-63.6	UU	1,340	4,400	-
TH-1Q6	US-2	63.5-65.5	DSS	2,160**	4,840	13,040
TH-1B-S3	US-1	69.6-71.6	UU	1,030	4,880	-
TH-1B-S3	US-1	69.6-71.6	DSS	2,320**	4,880	14,660

* UC = Unconfined Compression Test. UU = Unconsolidated-Undrained Triaxial Test. DSS = Direct Simple Shear Test.
** Undrained shear strength obtained using a normal load greater than the existing overburden pressure. The measured strengths are lower than expected because of laminations.
*** Sample may have been disturbed as a result of intrusion from natural ground soils below.

The unconfined compression tests and unconsolidated-undrained triaxial tests were conducted to provide estimates of undrained shear strengths of the waste phosphatic clay under existing condition. For the direct simple shear tests, a normal load exceeding the existing overburden pressure was used to "mask" any effect of sample disturbance, which could potentially result in lower measured strength values. Therefore, the measured undrained shear strengths from the direct simple shear tests do not represent the *in situ* undrained shear strengths under existing condition.

With the exception of the sample designated US-3 obtained from a depth of 60 to 62 feet below land surface in TH-1Q1, results of the unconfined compression tests and unconsolidated-undrained triaxial tests yielded undrained shear strength values that ranged from 1,030 to 1,750 psf, and averaged approximately 1,400 psf from six measurements. The low undrained shear strength measured in US-3 from TH-1Q1 could be attributed to sample disturbance due to intrusion of natural ground soils into the waste phosphatic clay when the Shelby tube sampler was pushed below the bottom of the waste phosphatic clay.

The two direct simple shear tests were performed using applied normal loads that were approximately 2.5 to 3.0 times greater than the existing overburden pressure. Under the existing overburden pressures at the boring locations, the undrained shear strengths of the waste phosphatic clay were estimated to on the order of 700 to 800 psf, which were lower than expected. Visual examinations of the tested specimens revealed the presence of thin laminations or varves (≤ 2mm thick) that would be expected to produce lower undrained shear strengths in the horizontal shearing mode of a direct simple shear test where the failure surface could occur along one or more horizontal laminations. Waste phosphatic clays typically do not occur as laminated (varved) clays and, hence, the lower undrained shear strengths measured on the two specimens are not considered representative of site condition.

Ardaman appreciates the opportunity to provide services to Jones Edmunds and Hillsborough County. If you have any questions or need additional information, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

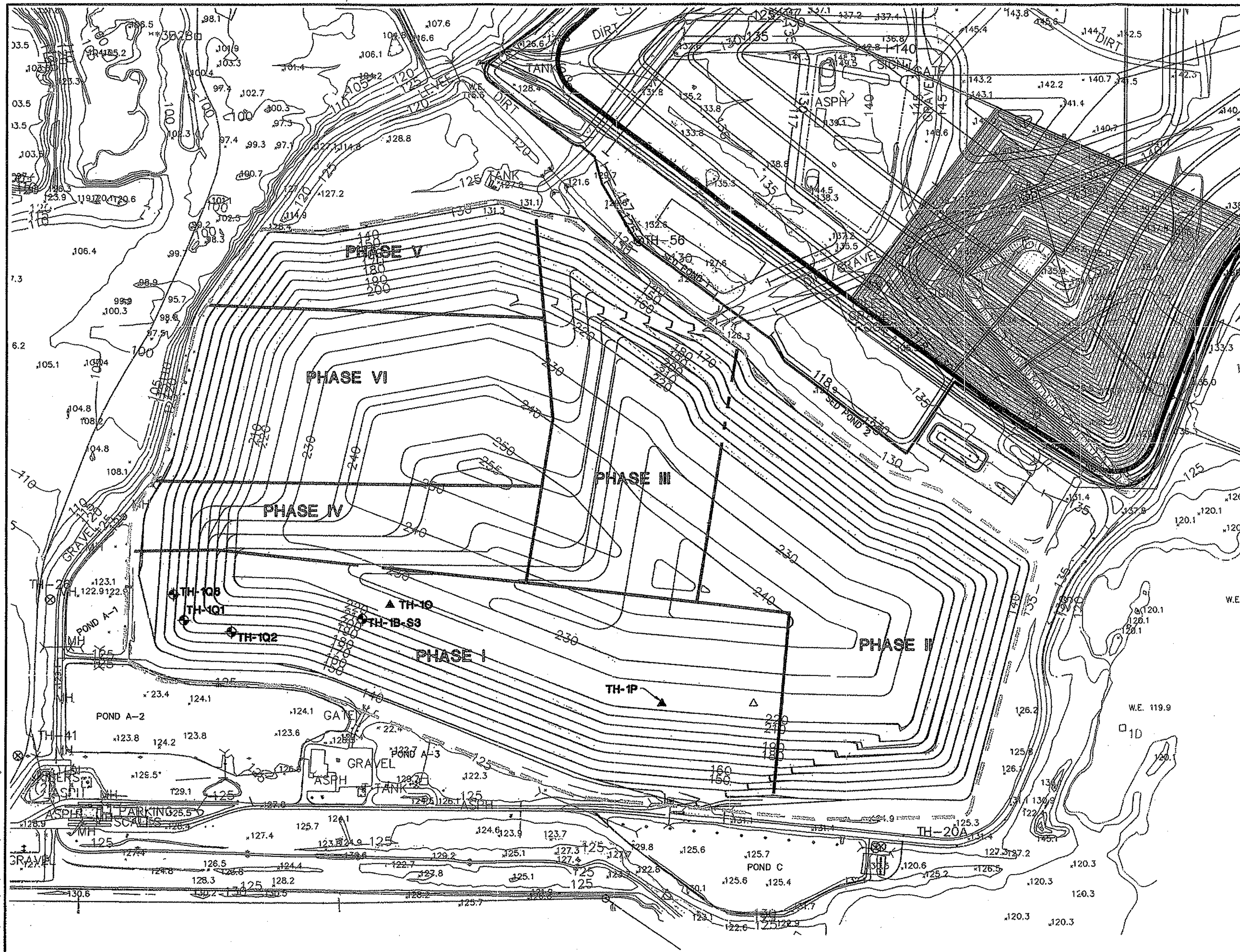
Jeyisanker Mathiyaparanam, E.I.
Assistant Project Engineer

Francis K. Cheung, P.E.
Senior Project Engineer 05/07/09
Florida License No. 36382

Enclosures

Appendix A

Boring Location Plan



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LEGEND

▲ 2007 SAMPLING LOCATION

⊕ 2008 SAMPLING LOCATION

SOIL BORING LOCATION MAP			
Ardaman & Associates, Inc. Geotechnical, Environmental and Materials Consultants			
SOUTHEAST COUNTY LANDFILL HILLSBOROUGH COUNTY, FLORIDA			
DRAWN BY: SDS	CHECKED BY: MCC	DATE: 05/06/09	
FILE NO. 08-032	APPROVED BY: MCC		FIGURE: A-1

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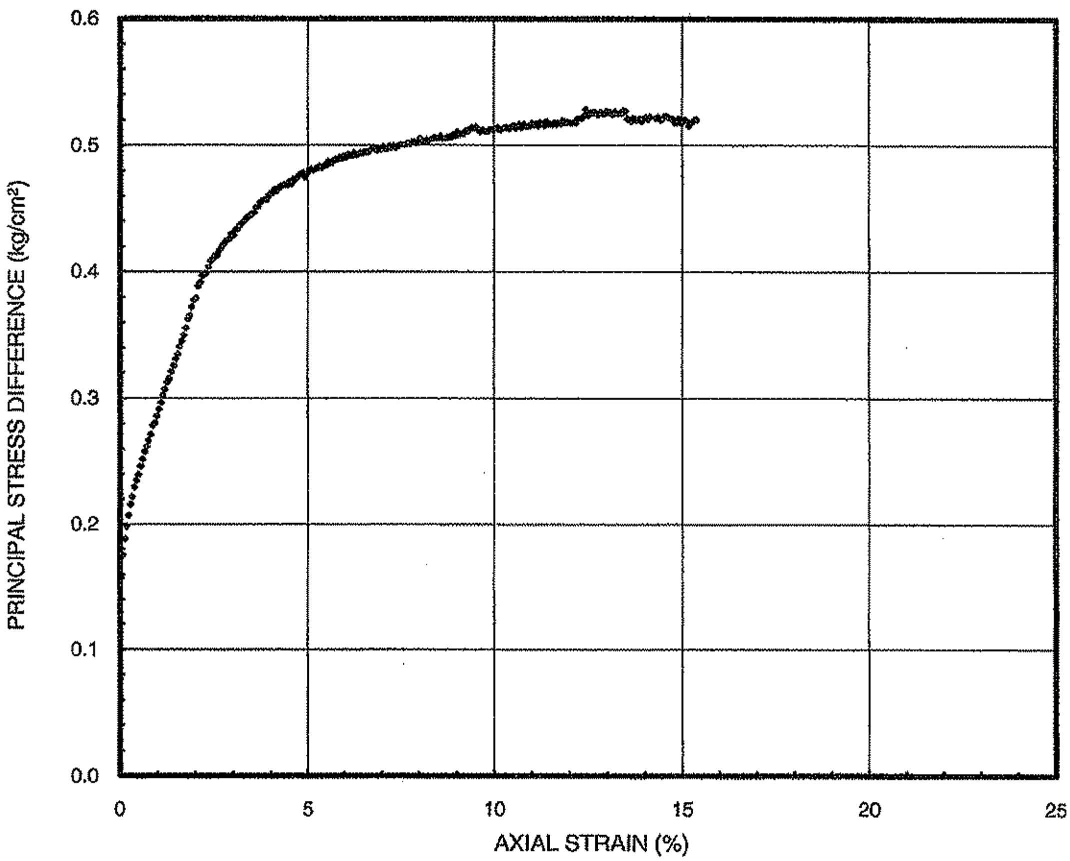
Appendix B

Laboratory Test Data

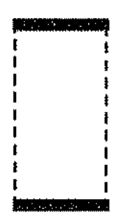
Project Name	HCLF
Project Number	06-212
Sample Name	PC-10 US2 B3
Depth	73.5-75.5
Cell Pressure	2.75 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM PC-1O-B3

Description Gray clay

Initial Height	7.125 cm
Initial Diameter	3.544 cm
Dry Density	51.6 pcf
Water Content	86.1 %
Saturation	102 %



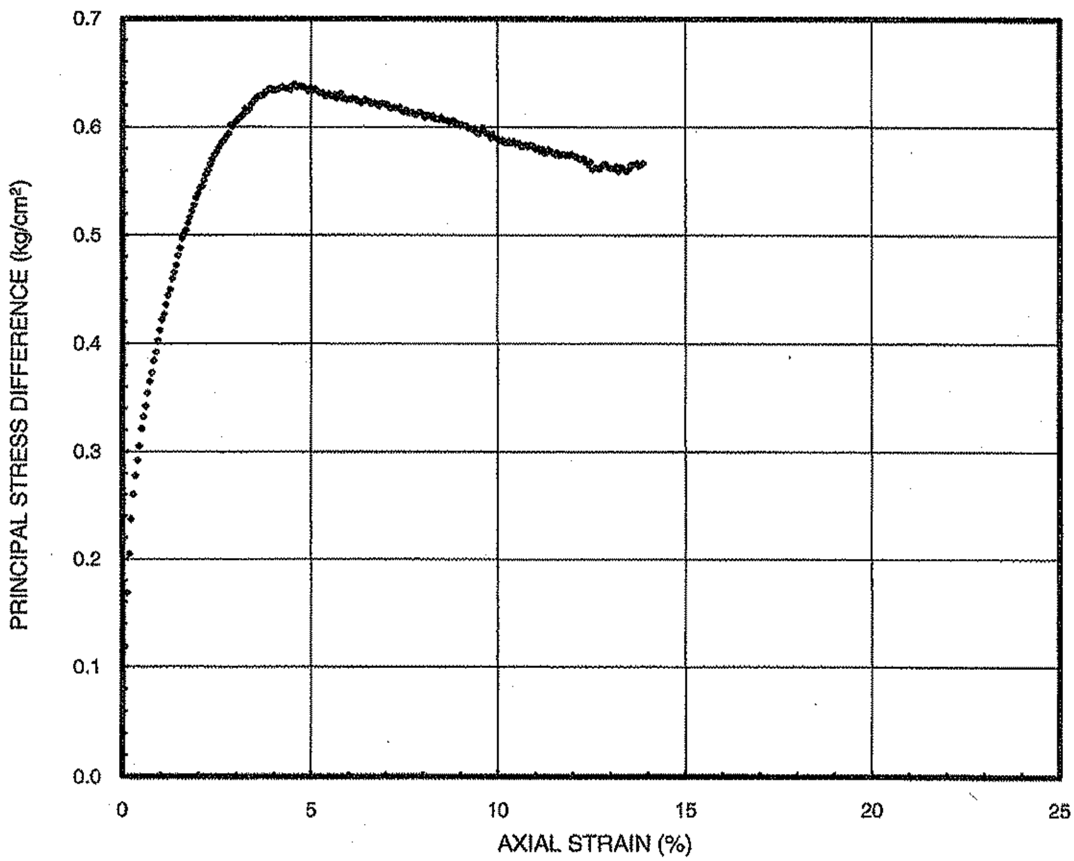
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

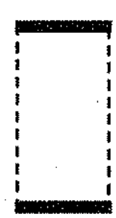
DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 1

Project Name	06-212
Project Number	HCLF
Sample Name	PC10 US4 B2
Depth	77.5-79.5
Cell Pressure	2.75 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-4 FROM PC-10-B2

Description	Gray clay
Initial Height	7.106 cm
Initial Diameter	3.558 cm
Dry Density	55.0 pcf
Water Content	77.2 %
Saturation	100 %



TYPE OF FAILURE

Ardaman & Associates, Inc.
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SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

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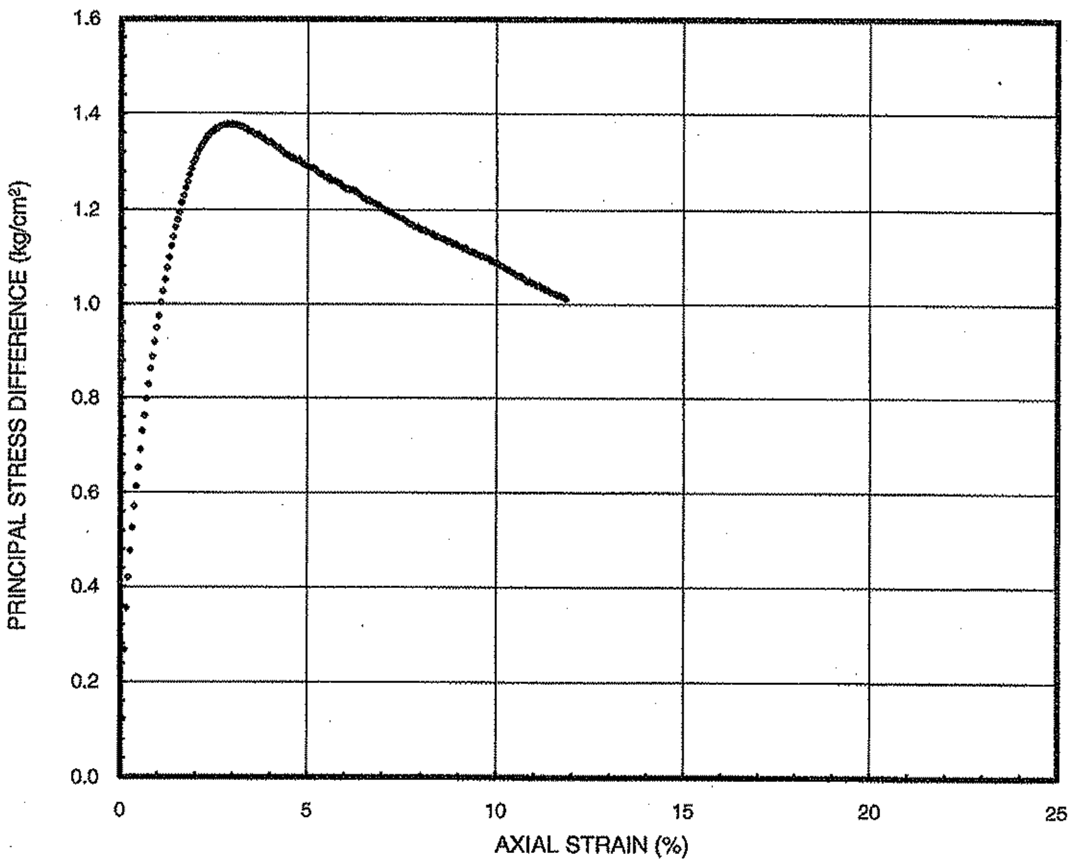
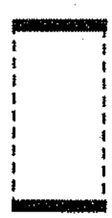
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 2

Project Name	HCLF
Project Number	06-212
Sample Name	THPC1P US1 B4
Depth	70.5-72.5
Cell Pressure	2.50 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-1 FROM PC-1P-B4

Description	Gray Clay	
Initial Height	7.12	cm
Initial Diameter	3.58	cm
Dry Density	53.5	pcf
Water Content	80.9	%
Saturation	100	%



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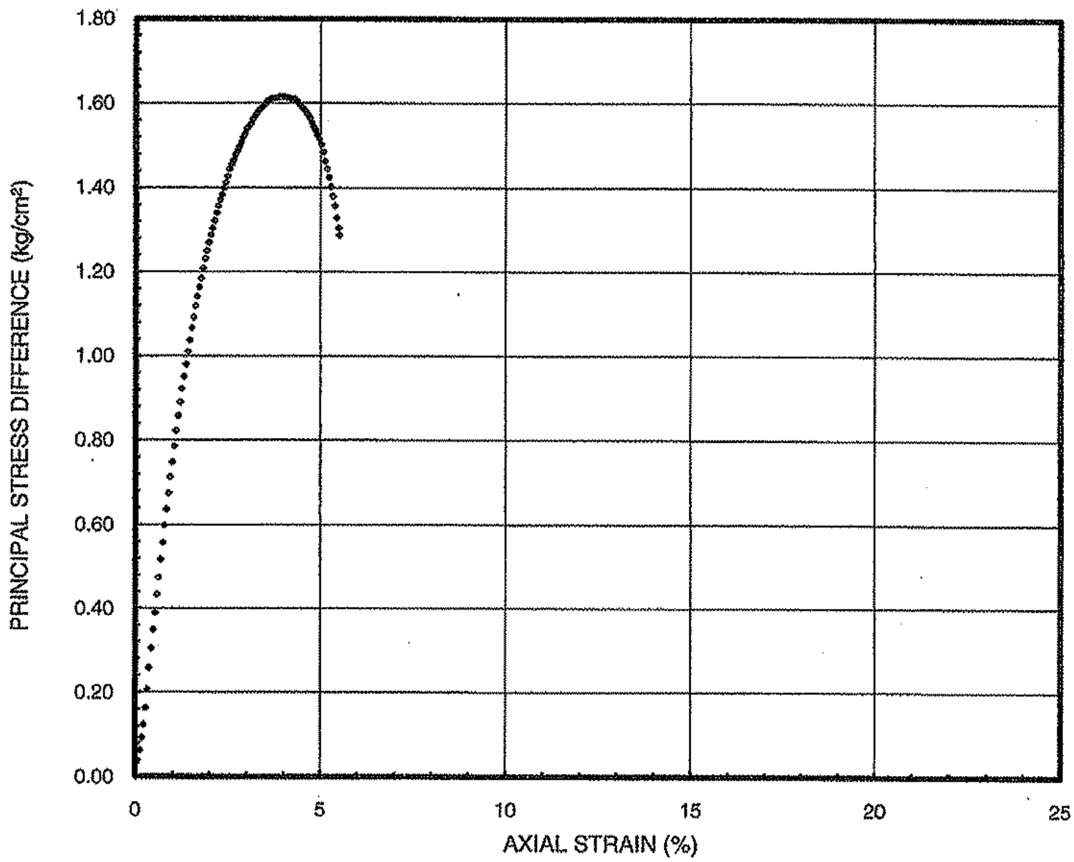
FILE NO.: 08-032	APPROVED BY: FKC		FIGURE: 3

Project Name SELF
Project Number 08-032
Sample Name TH1Q1 US1 B2
Depth 56-58 ft

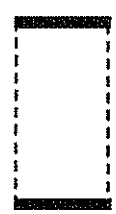
Strain Rate 1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-1 FROM TH-1Q1-B2

Description Gray clay

Initial Height	7.103	cm
Initial Diameter	3.561	cm
Dry Density	45.0	pcf
Water Content	103.0	%
Saturation	99	%



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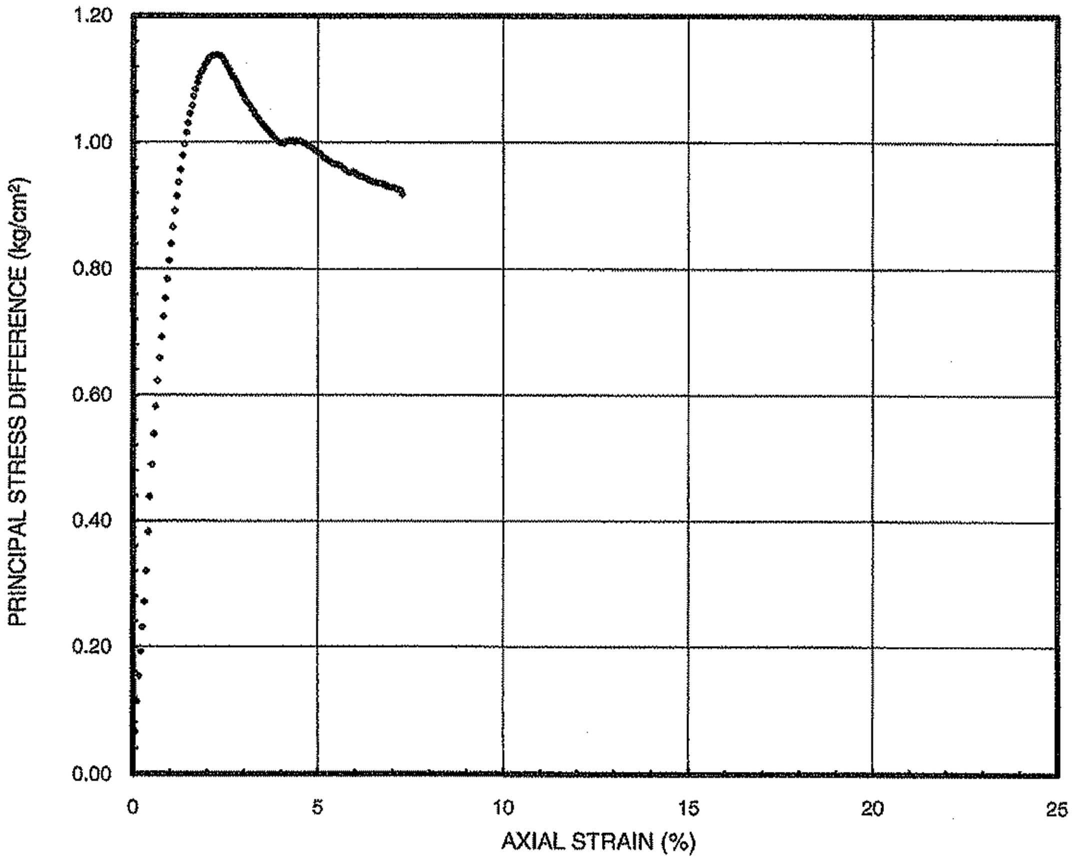
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 4	

Project Name	SELF
Project Number	08-032
Sample Name	TH-1Q1 US2 B2
Depth	58-60 ft
Cell Pressure	1.48 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM TH-1Q1-B2

Description	Gray clay
Initial Height	7.104 cm
Initial Diameter	3.559 cm
Dry Density	52.6 pcf
Water Content	83.9 %
Saturation	100 %

TYPE OF FAILURE

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Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

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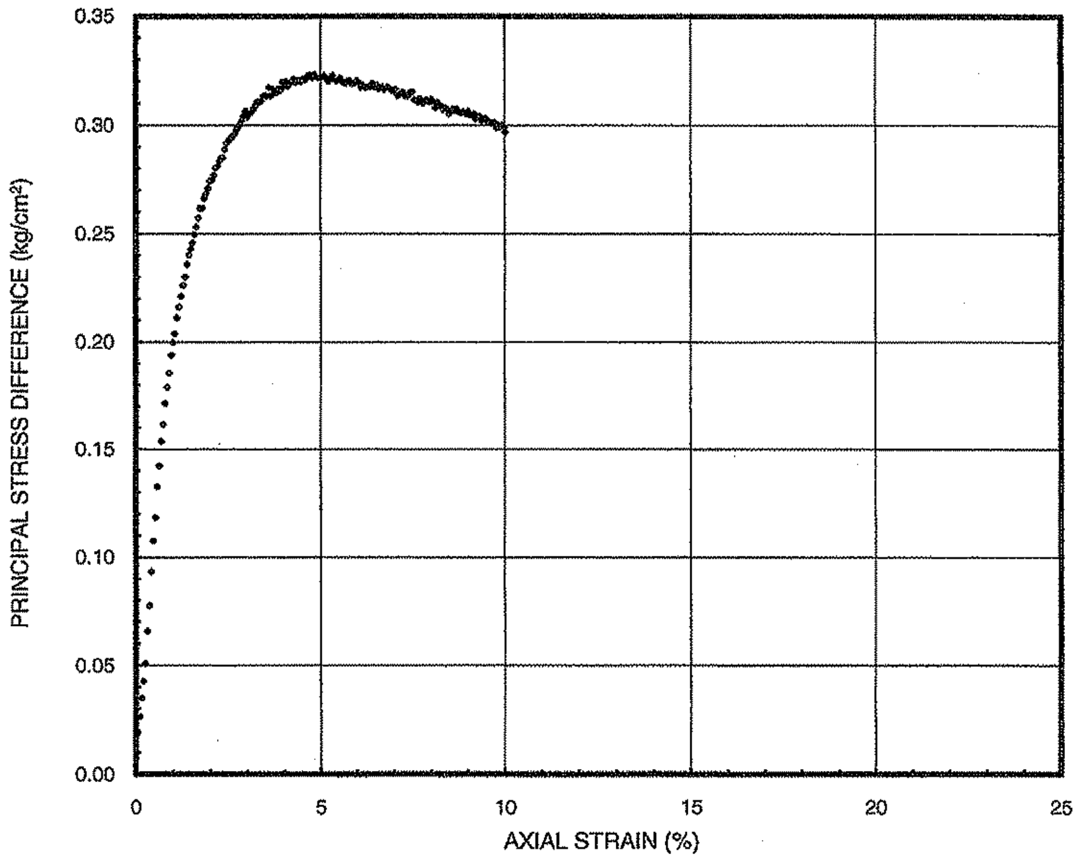
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 5

Project Name SE LANDFILL
Project Number 08-032
Sample Name TH1Q1 US3 B1
Depth 60-62 ft

Strain Rate 1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-3 FROM TH-1Q1-B1

Description Gray clay

Initial Height	7.089	cm
Initial Diameter	3.554	cm
Dry Density	49.1	pcf
Water Content	91.6	%
Saturation	100	%

TYPE OF FAILURE

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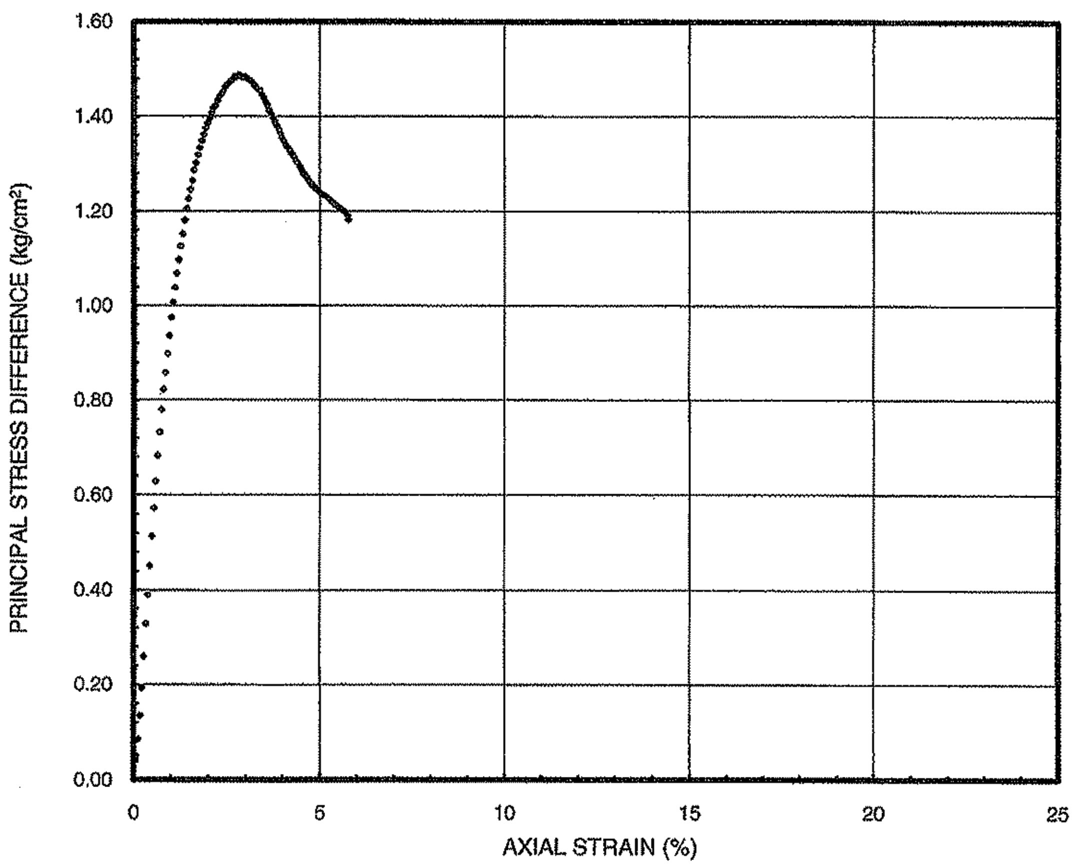
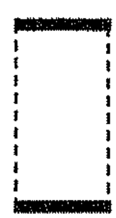
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 6

Project Name	SELF
Project Number	08-032
Sample Name	TH1Q2 US1 B2
Depth	56-58 ft
Strain Rate	1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-1 FROM TH-1Q2-B2

Description	Gray clay	
Initial Height	7.097	cm
Initial Diameter	3.563	cm
Dry Density	48.0	pcf
Water Content	94.1	%
Saturation	99	%



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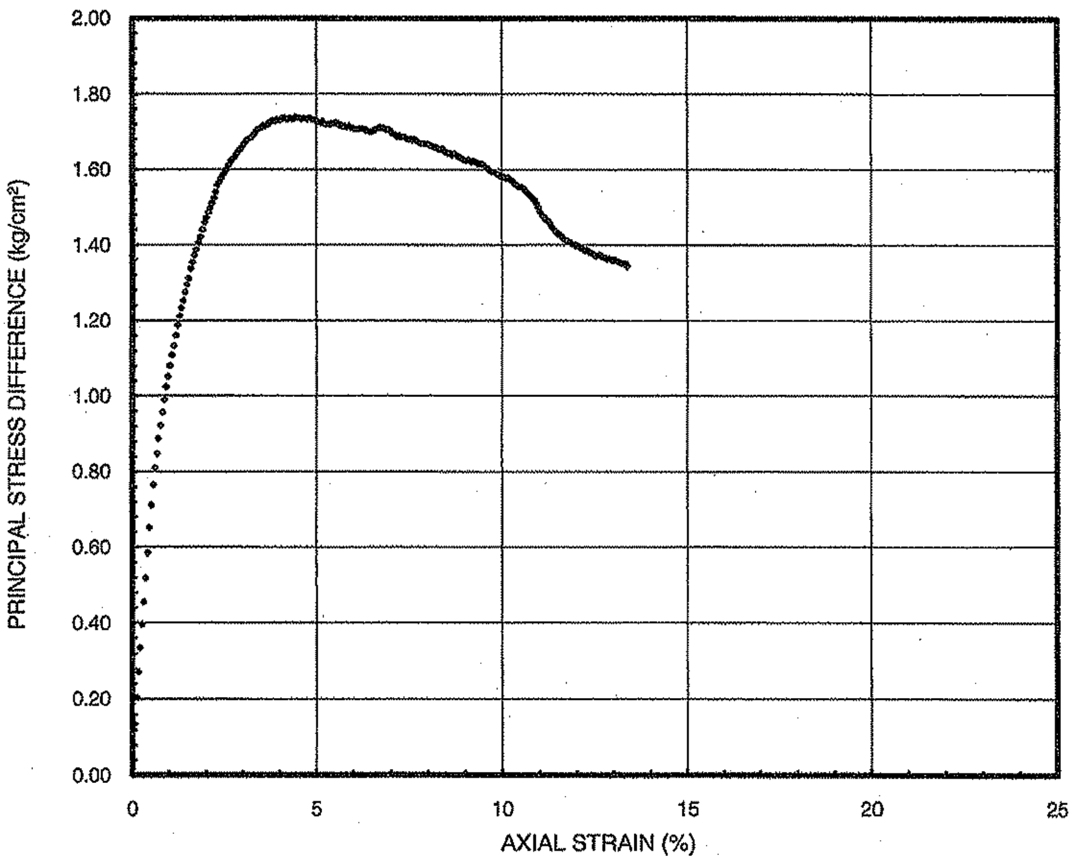
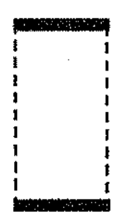
FILE NO.: 08-032	APPROVED BY: FKC		FIGURE: 7

Project Name	SELF	
Project Number	08-032	
Sample Name	TH1Q2 US2 B2	
Depth	58-60	ft
Cell Pressure	2.95	kg/cm²
Strain Rate	1.0	%/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM TH-1Q2-B2

Description	Gray clay	
Initial Height	7.094	cm
Initial Diameter	3.563	cm
Dry Density	47.6	pcf
Water Content	95.9	%
Saturation	100	%



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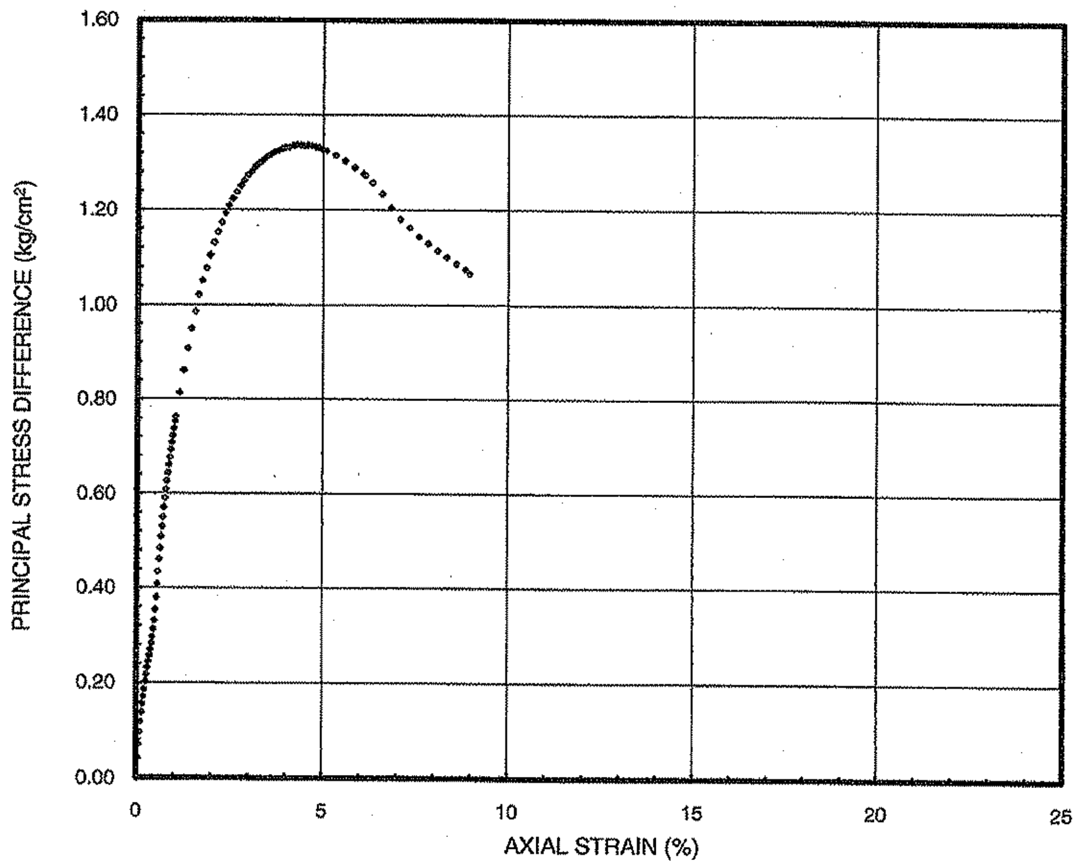
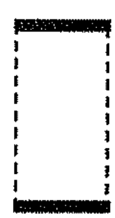
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 8	

Project Name	SELF
Project Number	08-032
Sample Name	TH1Q6 US1
Depth	61.6-63.6 ft
Cell Pressure	2.20 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST FOR SAMPLE US-1 FROM TH-1Q6

Description	Gray clay
Initial Height	7.078 cm
Initial Diameter	3.569 cm
Dry Density	47.5 pcf
Water Content	95.6 %
Saturation	100 %



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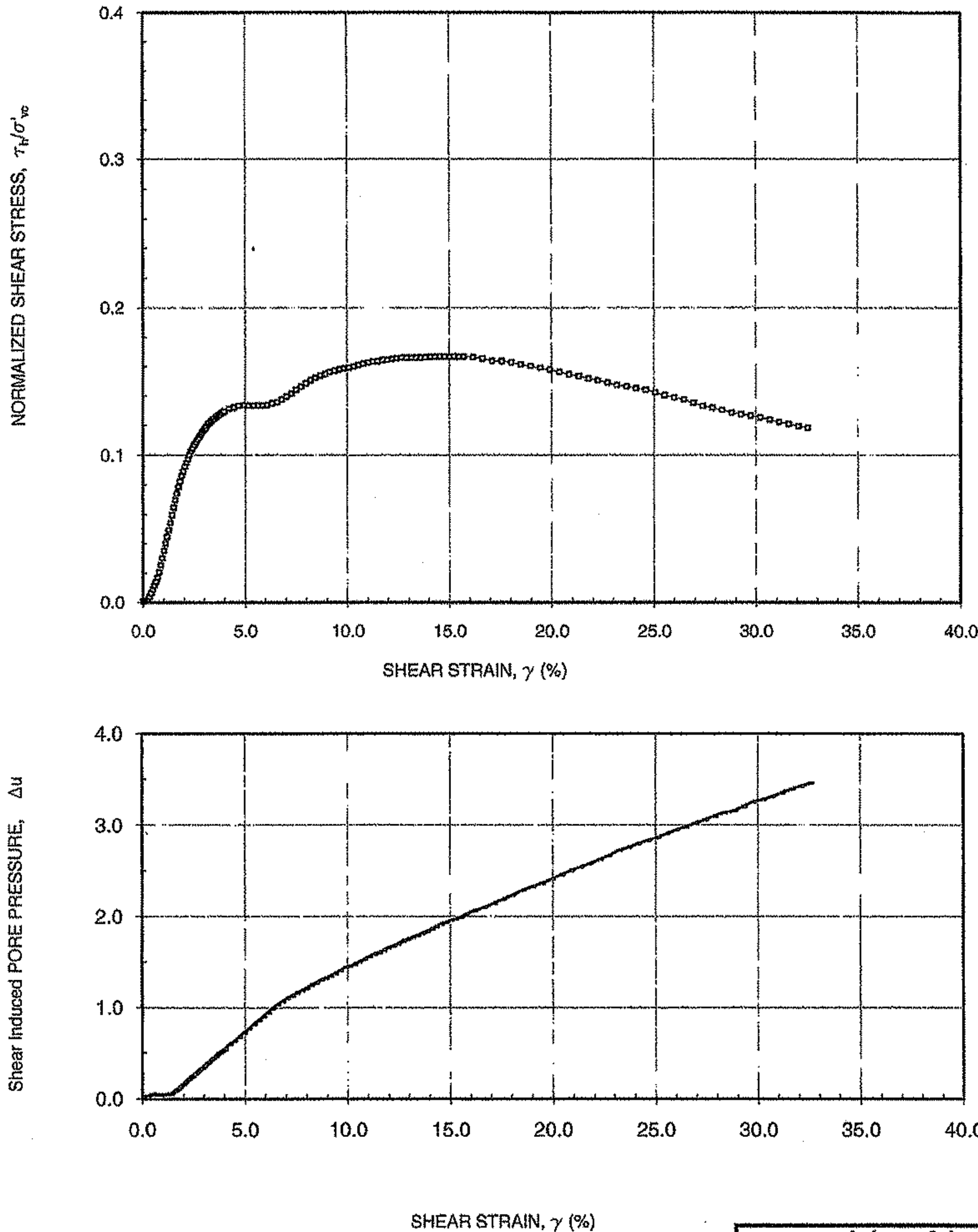
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 9



RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-2 FROM TH-1Q6

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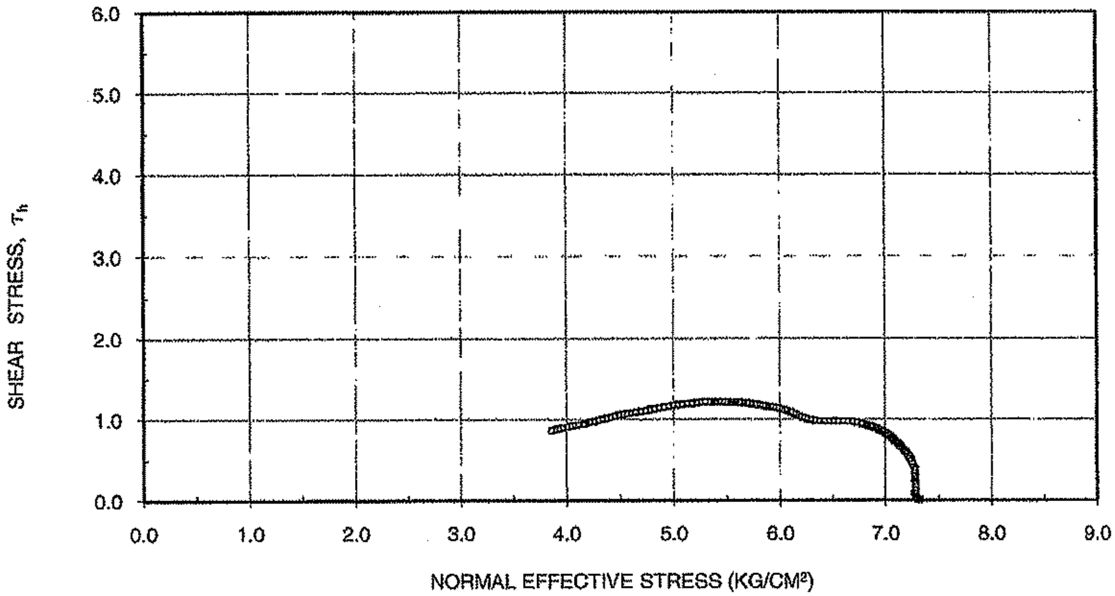
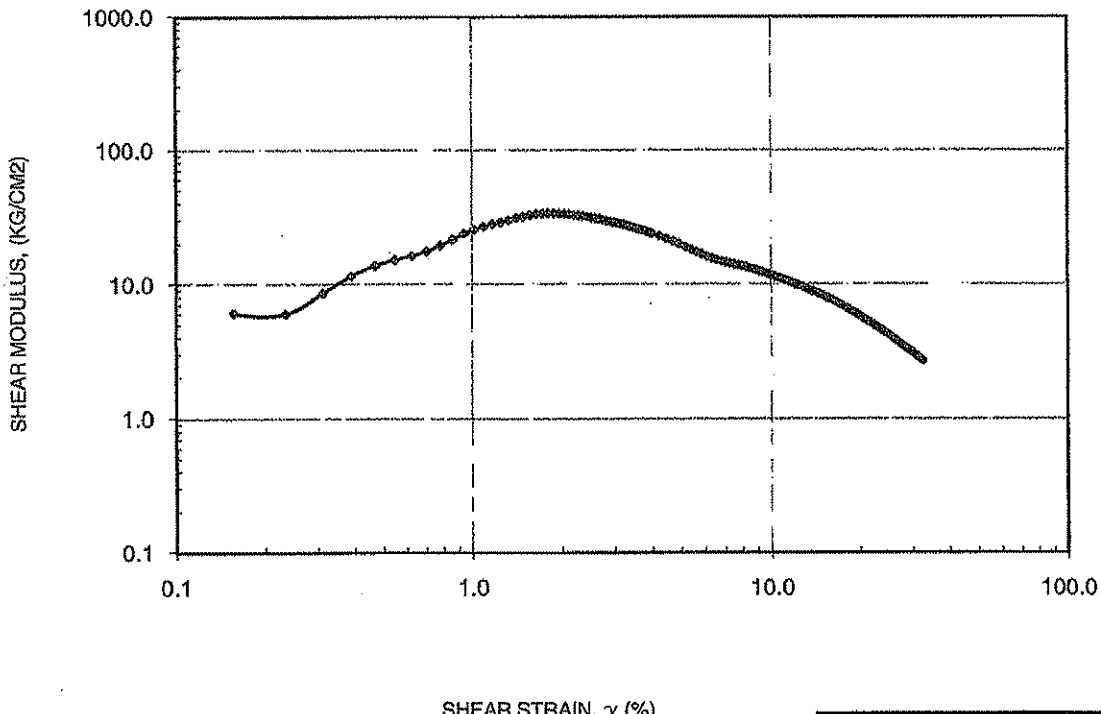
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 10-1





RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-2 FROM TH-1Q6

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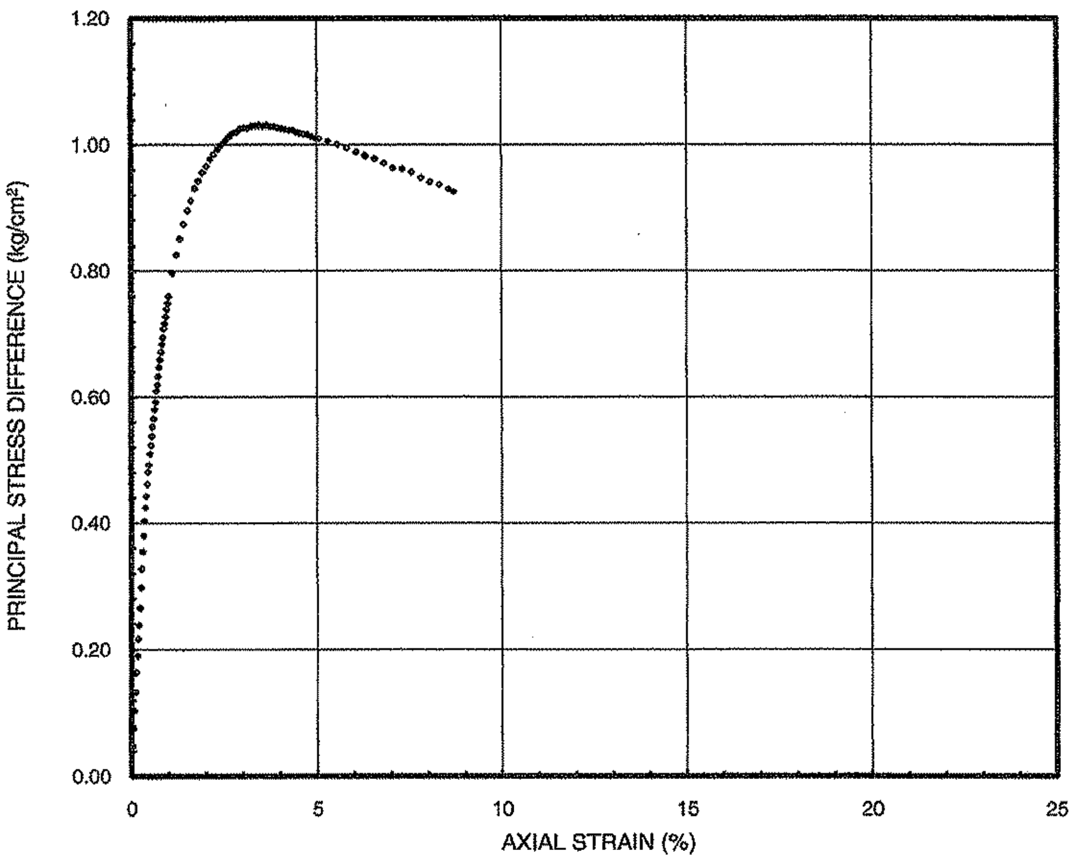
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 10-2

Project Name	SELF
Project Number	08-032
Sample Name	PC-1BS3 US1
Depth	69.6-71.6 ft
Cell Pressure	2.44 kg/cm²
Strain Rate	1.0 %/minute



**RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
FOR SAMPLE US-1 FROM TH-1B-S3**

Description	Lt gray clay
Initial Height	7.083 cm
Initial Diameter	3.569 cm
Dry Density	54.8 pcf
Water Content	79.2 %
Saturation	100 %

TYPE OF FAILURE

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**SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA**

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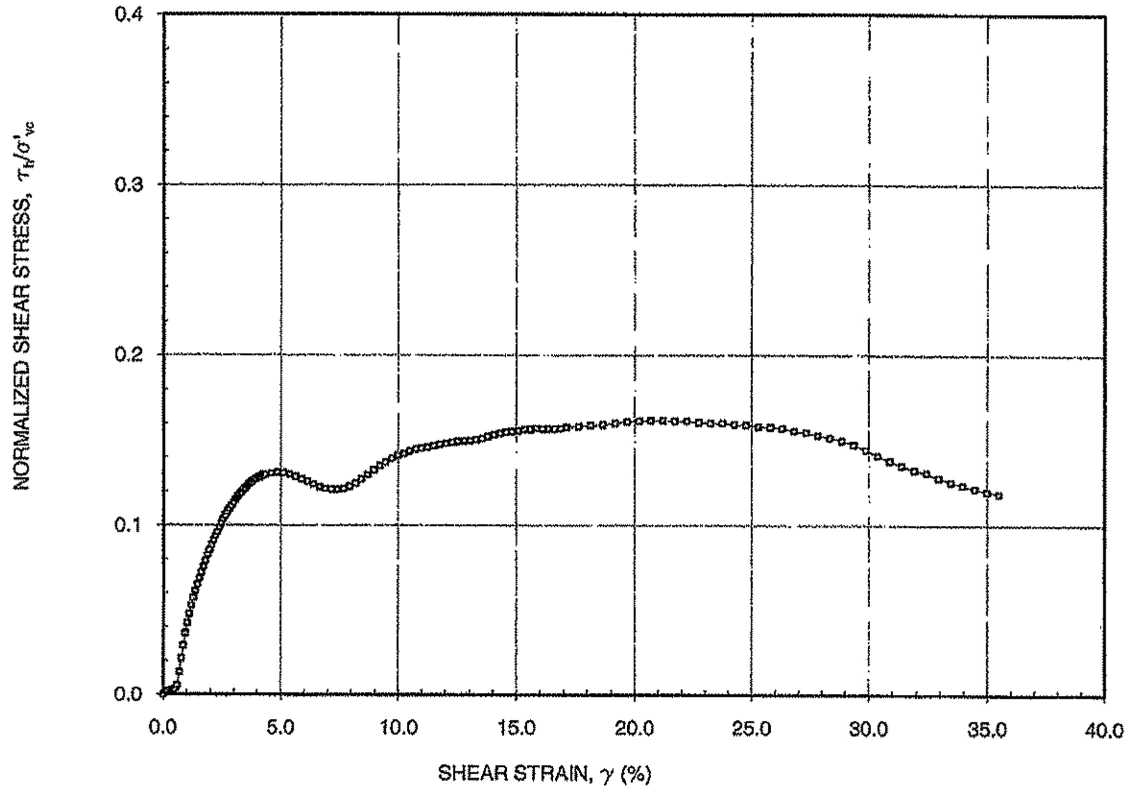
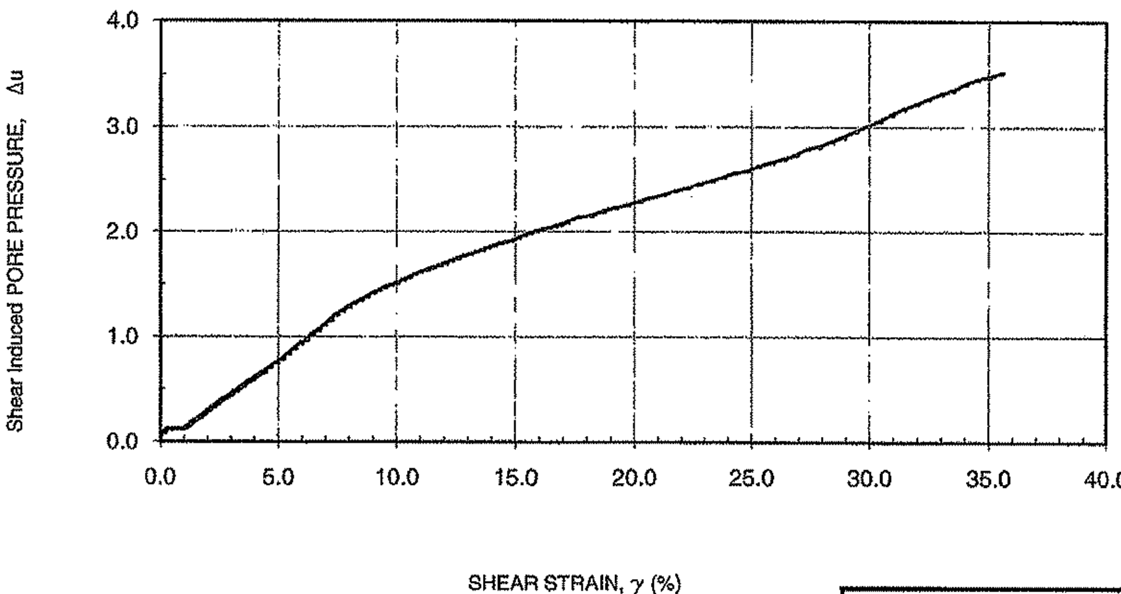
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 11





RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-1 FROM TH-1B-S3

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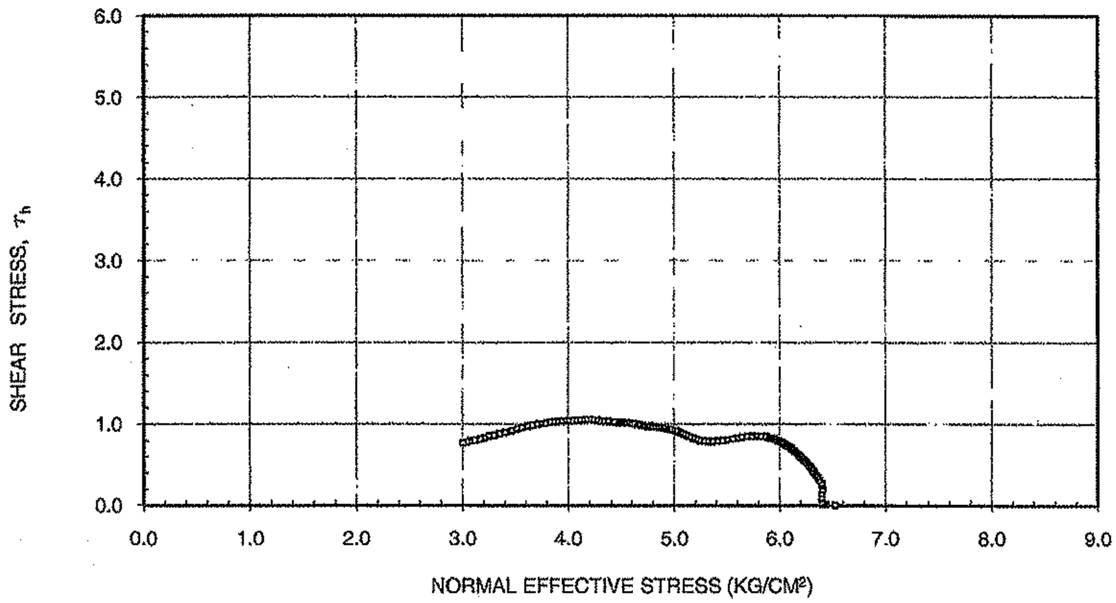
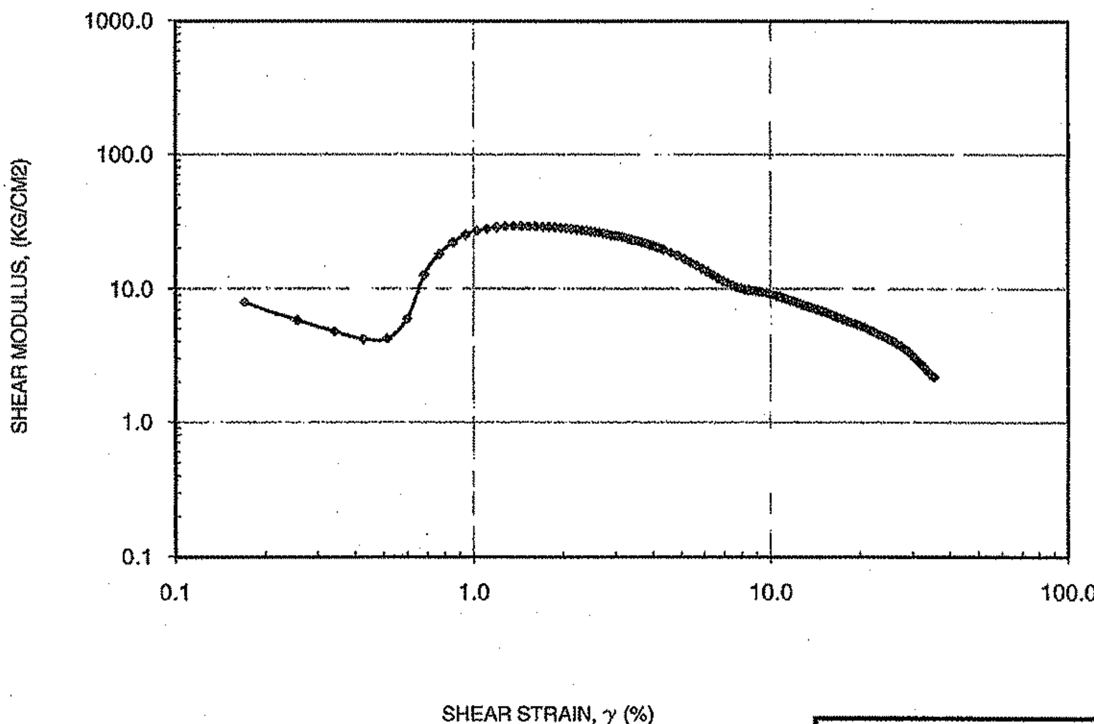
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 12-1





RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-1 FROM TH-1B-S3

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FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 12-2

ATTACHMENT 3

REFERENCES

Source: Soil Strength and Slope Stability 2005
Duncan and Wright
John Wiley & Sons, Inc. New Jersey

major principal stress at failure is vertical, and the shear surface is oriented about 60° from horizontal. In the middle part of the shear surface, where the shear surface is horizontal, the major principal stress at failure is oriented about 30° from horizontal. At the toe of the slope, sometimes called the *passive zone*, the major principal stress at failure is horizontal, and the shear surface is inclined about 30° past horizontal. As a result of these differences in orientation, the undrained strength ratio (s_u/σ'_v) varies from point to point around the shear surface. Variations of undrained strengths with orientation of the applied stress in the laboratory are shown in Figure 5.12*b* for two normally consolidated clays and two heavily overconsolidated clay shales.

Ideally, laboratory tests to measure the undrained strength of clay would be performed on completely undisturbed plane strain test specimens, tested under unconsolidated–undrained conditions, or consolidated and sheared with stress orientations that simulate those in the field. However, equipment that can apply and reorient stresses to simulate these effects is highly complex and has been used only for research purposes. For practical applications, tests must be performed with equipment that is easier to use, even though it may not replicate all the various aspects of the field conditions.

Triaxial compression (TC) tests, often used to simulate conditions at the top of the slip surface, have been found to result in strengths that are 5 to 10% lower than vertical compression plane strain tests. Triaxial extension (TE) tests, often used to simulate conditions at the bottom of the slip surface, have been found to result in strengths that are significantly less (at least 20% less) than strengths measured in horizontal compression plane strain tests. Direct simple shear (DSS) tests, often used to simulate the condition in the central portion of the shear surface, underestimate the undrained shear strength on the horizontal plane. As a result of these biases, the practice of using TC, TE, and DSS tests to measure the undrained strengths of normally consolidated clays results in strengths that are lower than the strengths that would be measured in ideally oriented plane strain tests.

Strain rate. Laboratory tests involve higher rates of strain than are typical for most field conditions. UU test specimens are loaded to failure in 10 to 20 minutes, and the duration of CU tests is usually 2 or 3 hours. Field vane shear tests are conducted in 15 minutes or less. Loading in the field, on the other hand, typically involves a period of weeks or months. The difference in these loading times is on the order of 1000. Slower loading results in lower undrained shear strengths of saturated clays. As shown in Figure 5.13, the strength of San Francisco Bay mud decreases by about 30% as the time to failure increases from 10 minutes to 1 week. It appears that there is no further decrease in undrained strength for longer times to failure.

In conventional practice, laboratory tests are not corrected for strain rate effects or disturbance effects. Because high strain rates increase strengths measured in UU tests and disturbance reduces them, these effects tend to cancel each other when UU laboratory tests are used to evaluate undrained strengths of natural deposits of clay.

Methods of Evaluating Undrained Strengths of Intact Clays

Alternatives for measuring or estimating undrained strengths of normally consolidated and moderately ov-

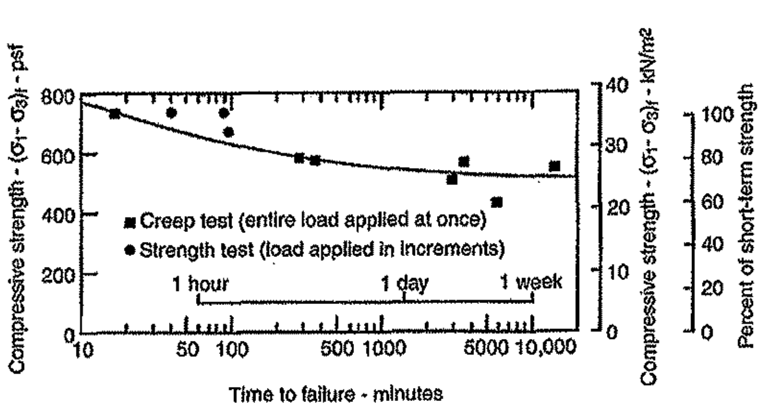


Figure 5.13 Strength loss due to sustained loading.

Source: Soil Strength and Slope Stability - 2005
Duncan and Wright
John Wiley & Sons, Inc., New Jersey

Undrained strengths of compacted clays. Values of c and ϕ (total stress shear strength parameters) for the as-compacted condition can be determined by performing UU triaxial tests on specimens at their compaction water contents. Undrained strength envelopes for compacted, partially saturated clays tested are curved, as discussed in Chapter 3. Over a given range of stresses, however, a curved strength envelope can be approximated by a straight line and can be characterized in terms of c and ϕ. When this is done, it is especially important that the range of pressures used in the tests correspond to the range of pressures in the field conditions being evaluated. Alternatively, if the computer program used accommodates nonlinear strength envelopes, the strength test data can be represented directly.

Values of total stress c and ϕ for compacted clays vary with compaction water content and density. An example is shown in Figure 5.20 for compacted Pittsburgh sandy clay. The range of confining pressures used in these tests was 1.0 to 6.0 tons/ft^2. The value of c, the total stress cohesion intercept from UU tests, increases with dry density but is not much affected by compaction water content. The value of ϕ, the total stress friction angle, decreases as compaction water content increases, but is not so strongly affected by dry density.

If compacted clays are allowed to age prior to testing, they become stronger, apparently due to thixotropic effects. Therefore, undrained strengths measured using freshly compacted laboratory test specimens provide a conservative estimate of the strength of the fill a few weeks or months after compaction.

MUNICIPAL SOLID WASTE

Waste materials have strengths comparable to the strengths of soils. Strengths of waste materials vary depending on the amounts of soil and sludge in the waste, as compared to the amounts of plastic and other materials that tend to interlock and provide tensile strength (Eid et al., 2000). Larger amounts of materials that interlock increase the strength of the waste. Although solid waste tends to decompose or degrade with time, Kavazanjian (2001) indicates that the strength after degradation is similar to the strength before degradation.

Kavazanjian et al. (1995) used laboratory test data and back analysis of stable slopes to develop the lower-bound strength envelope for municipal solid waste shown in Figure 5.21. The envelope is horizontal with a constant strength c = 24 kPa, ϕ = 0 at normal pressures less than 37 kPa. At pressures greater than 37 kPa, the envelope is inclined at ϕ = 33° with c = 0.

Eid et al. (2000) used results of large-scale direct shear tests (300 to 1500 mm shear boxes) and back analysis of failed slopes in waste to develop the range of strength envelopes show in Figure 5.22. All three envelopes (lower bound, average, and upper bound) are inclined at ϕ = 35°. The average envelope shown in Figure 5.22 corresponds to c = 25 kPa, and the lowest of the envelopes corresponds to c = 0.

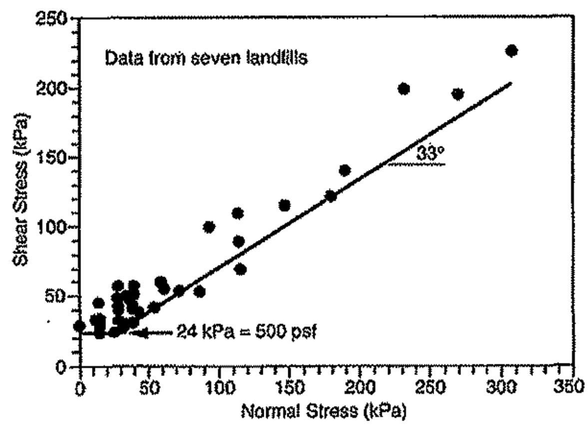


Figure 5.21 Shear strength envelope for municipal solid waste based on large-scale direct shear tests and back analysis of stable slopes. (After Kavazanjian et al., 1995.)

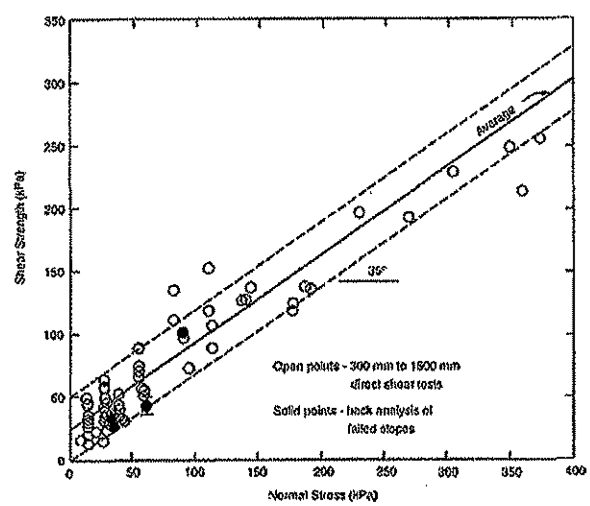


Figure 5.22 Range of shear strength envelopes for municipal solid waste based on large-scale direct shear tests and back analysis of failed slopes. (After Eid et al., 2000.)

Source: Soil Mechanics in Engineering Practice, 3rd Edition
Terzaghi, Peck, and Mesri
John Wiley & Sons, Inc. New York
1996

below almost level ground are subjected to high confining pressures, and contractive shear soil conditions exist. The undrained yield strength, which determines stability for this condition, cannot be easily computed with the aid of Eq. 20.3, and an alternative approach must be used.

20.4 Measurement of Undrained Shear Strength

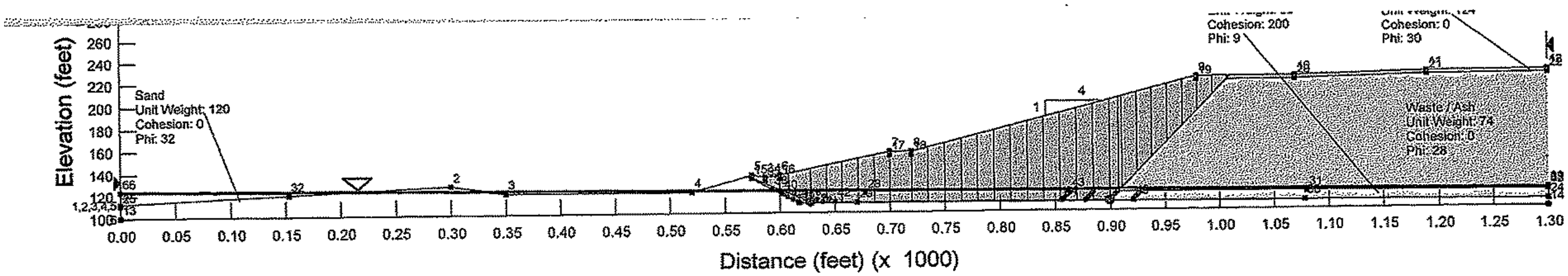
For many contractive-shear soil conditions, it is not possible to express the undrained shear strength in terms of the strength parameters c'_m and ϕ'_m and the effective-stress state at failure. The alternative is to measure the undrained shear strength directly. However, the undrained shear strength of an element of soil is not a unique value; it depends on the way in which the soil is brought to failure. Modes of shear that take full advantage of the resistance of the natural soil structure and that minimize progressive yielding mobilize the highest undrained shear strength. The more rapidly the shear stress is applied, the greater the measured undrained shear strength. Thus, different *in situ* or laboratory testing devices and procedures that subject soil to different modes and rates of shear and that involve different degrees of progressive yielding measure different values of undrained shear strength. The most common methods of obtaining or directly measuring the undrained shear strength are field vane (*FV*) shear tests and laboratory unconfined compression (*UC*), triaxial compression (*TC*), triaxial extension (*TE*), and direct simple shear (*DSS*) tests. The vane device (Article 11.5.2) is inserted into the ground and then rotated to measure the undrained shear strength. Laboratory shear tests require that samples of *in situ* soil be obtained. Although most *in situ* and laboratory shear devices test a relatively small element of soil, this limitation is rarely a serious problem in the measurement of the undrained shear strength of soft clays, silts, and loose sands.

The measurement of undrained shear strength, perhaps more than any other soil property, is affected by soil disturbance before shearing. Disturbance is involved in both *in situ* testing and in sampling and laboratory testing, although it may be easier to minimize or at least to standardize the effect of disturbance for *in situ* tests than for sampling and testing in laboratory devices. Because of disturbance, the undrained shear strength measured *in situ* or on specimens in the laboratory is usually smaller than the undrained shear strength of a truly undisturbed soil. The magnitude of the reduction varies considerably with the type of soil. The effect of disturbance is generally greater in brittle silty clays of relatively high permeability than in ductile plastic clays of low permeability. Moreover, it depends on the mode of shear used to measure the undrained shear strength. Its significance is greater in modes of shear that cause little disruption of soil structure before yield, and is less in modes that damage soil structure before yield is reached.

The *in situ* vane shear device (Article 11.5.2) tests soil in its natural environment. Insertion of the vane into soft clays and silts, however, causes displacements and changes in stress that disrupt the natural structure of the soil around the vane. Moreover, the undrained shear strength measured 1 day after inserting the vane can be more than 20% higher than that obtained from a standard test carried out about 5 min after insertion. Consolidation increases the strength of the soil around the vane and also increases the adhesion between the blades of the vane and the soil; this minimizes progressive yielding during rotation of the vane. The increase in undrained shear strength s_{uo} (*FV*) with time confirms that the natural soil structure is disturbed during the penetration of the vane. Although this disturbance cannot be eliminated completely, its adverse effect on the applicability of the test results can be minimized by standardization of equipment (e.g., vane stem diameter and blade thickness) and operation (e.g., delay time between penetration and rotation).

All specimens of natural soil deposits tested in laboratory shear devices experience disturbance. The disturbance may have occurred during sampling and handling in the field, during transit to the laboratory, and during laboratory storage and trimming of specimens for the tests. The most serious mechanism of disturbance is shear distortion of the natural soil structure produced by displacement of the soil during conventional tube sampling (Article 11.3.3) and careless handling of the sample thereafter. Other mechanisms of disturbance, which operate especially during long storage periods, are redistribution of water from the outside to the relatively less disturbed inside of the sample that is eventually tested, and chemical changes including oxidation. Because considerable handling of the soil takes place after sampling and there is variable opportunity for additional sample disturbance, it is not practicable to quantify the quality of specimens in terms of sampling devices and procedures. However, a good indicator of the quality of a shear specimen is the specimen quality designation (SQD) (Article 11.3.8) (Table 11.2). Soft clay and silt block samples of A quality can be obtained from excavations or test pits. The Sherbrooke and Laval sampling devices (Article 11.3.7) can take samples of *A* quality down to depths of 15 to 20 m. However, for most projects soft clay and silt samples of *B* quality are adequate. They can be obtained by using 54- to 95-mm fixed-piston, thin-walled tube samplers with area ratios not exceeding about 10% (Article 11.3.4). The sampler must be pushed, not driven, into the ground.

Although Table 11.2 is a good indicator of the quality of shear specimens, it does not offer a unique assessment of the effect of disturbance on the undrained shear strength of every type of soil. The same magnitude of volumetric strain may imply a smaller disturbance-related reduction in undrained shear strength for plastic soft clays than for



\\Gnv-projects\projects\08449-Hillsborough\030-02-APLFEngSvc2008\Stability Analysis Ph1-6 with Ponds\Attachment3-SlopeStabilityAnalysesPrint-outs

May 18, 2009

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13051 North Telecom Parkway
Temple Terrace, Florida 33637-0926

RE: Hillsborough County Southeast County Landfill
Phase I Landfill Slope Stability
FDEP Permit No. 35435-014-SO/01
Jones Edmunds Project No.: 08449-030-03-1160

Dear Ms. Pelz,

On behalf of the Hillsborough County Solid Waste Management Department (SWMD), Jones Edmunds has performed a slope stability evaluation for the Phase I area located at the Southeast County Landfill (SCLF) Class I Landfill (see Site Plan provided in Attachment 1). The evaluation was based on the most recent phosphatic clay field and laboratory shear strength results reported by Ardaman & Associates, Inc. (Ardaman). The Ardaman report is provided in Attachment 2.

The phosphatic clay is the bottom barrier layer for the Phase I – VI Class I Landfill. Since the initial permitting of Phases I-VI, the strength of the phosphatic clays has been a critical design and operational condition. As part of the Florida Department of Environmental Protection (FDEP) operations permit, procedures were established for determining whether a specific phase was ready for the next lift of waste placement and possibly for final build-out based on stability models using the undrained shear strength of the phosphatic clay. According to the current operations fill sequence plans, the Phase I area is the next area scheduled to be filled.

A Conceptual Environmental Resource Permit (CERP), FDEP Permit No. 29-0270881-004, was recently issued to include modifications to the SCLF stormwater management systems. As part of the proposed modifications, stormwater ponds A-1, A-2, A-3, and B, will be excavated and regraded. As part of this overall evaluation letter to the FDEP for approval of filling the Phase I area, the proposed configurations of these stormwater management ponds were included in the slope stability evaluations.

To determine if the current in-situ shear strength of the phosphatic clay beneath the Phase I area is sufficient to support the additional load resulting from the next lift of waste and final build out elevation conditions, the SWMD contracted Jones Edmunds to collect in-situ phosphatic clay samples at several locations. Laboratory shear strength testing was performed on the samples, to provide undrained shear strengths, for use in an analysis of the slope stability of the waste mass.

The Phase I waste is currently at a maximum elevation of approximately 200 feet (see cross-sections provided in Attachment 1). The proposed side slope break (4 to 1 horizontal to vertical slope) elevation in the Phase I area is approximately 220 feet (NGVD 1929) and the proposed peak elevation for the Phase I waste at final build-out is approximately 240 feet (NGVD 1929) in accordance with the operational fill sequence plans dated November 2006, specifically Drawing No. 12 and Drawing No. 14. Please refer to the cross sections provided in Attachment 1.

CURRENT WASTE PHOSPHATIC CLAY STRENGTHS FOR PHASE I

In March 2007 and June 2008, Jones Edmunds subcontracted with Ardaman to perform the field and laboratory work necessary to collect and test the phosphatic clay samples from the Phase I area. The laboratory reports submitted to Jones Edmunds from Ardaman for the 2007 and 2008 waste phosphatic clays are provided in Attachment 2 and are summarized in Table 1.

Table 1 – Ardaman Phase I Field and Laboratory Test Results

Date Sampled	Boring Number	Sample Number	Sample Depth (ft)	Test Type [4]	Undrained Shear Strength (s_u) (psf)	Normal Load [1] (σ_1) (psf)	Cell Pressure[1] (σ_3) (psf)	Estimated Clay Thickness (ft)
May 2007	TH-1O[2]	US-2	70.5-72.5	Retested – see TH-1BS3				8.5
	TH-1O[2]	US-4	77.5-79.5					
	TH-1P	US-1	70.5-72.5	UU	1,350	7,700	5,000	4.5
August 2008	TH-1Q1	US-1	56 - 58	UC	1,630	3,260	-	5.5
	TH-1Q1	US-2	58 - 60	UU	1,140	5,240	2,960	
	TH-1Q1	US-3[2]	60 - 62	Retested – see TH-1Q6				
	TH-1Q2	US-1	56 - 58	UC	1,500	3,000	-	4.0
	TH-1Q2	US-2	58 - 60	UU	1,750	9,400	5,900	
	TH-1Q2	US-3[3]	60 - 62	Incomplete Sample				
November 2008	TH-1Q6	US-1	61.5 - 63.5	UU	1,340	7,080	4,400	4.0
	TH-1Q6	US-2	63.6 - 71.6	DSS	2,160	13,040	-	
	TH-1B-S3[2]	US-1	69.6 – 71.6	UU	1,030	7,060	5,000	4.5
	TH-1B-S3	US-1	69.6 – 71.6	DSS	2,320	14,660	-	

(1) Normal Load is the test load in psf. Cell pressure is zero for UC and DSS tests. Normal Load at Failure for the UU tests are plotted in Figure 1 as $(\sigma_1 + \sigma_3)/2$.
(2) TH-1BS3 is a retest of TH-1O performed in 2007. TH-1Q6 is a retest of TH-1Q1 US-3 – Retested due to sample disturbance.
(3) TH-1Q2 US-3 – Incomplete sample; sample not suitable for testing due to intrusion of debris/or insufficient clay to sample.
(4) UC = Unconfined Compression Test; UU = Unconsolidated Undrained Test, DSS = Direct Simple Shear Test

The laboratory strength tests included unconfined compression tests (UC), unconsolidated-undrained triaxial tests (UU), and direct simple shear tests (DSS). The following is a brief description of each of these laboratory tests:

- Unconfined Compression Test (UC) – A simple compression test that applies a normal load (σ_1) to a cylindrical sample but does not load the sample axially with a confining stress (σ_3 = 0). This test tends to yield a conservative estimate of the samples shear strength since in-situ the sample would have surrounding material to confine and limit movement of the failure plane. The speed of the shearing and permeability of the sample will affect whether the failure occurs under drained or undrained conditions. However, measuring pore-pressure during testing is not possible with this test.

- Unconsolidated - Undrained Test (UU) – A tri-axial testing method that involves loading a cylindrical sample with axial stresses ($\sigma_3 > 0$) around the entire sample and applying a normal load (σ_1) until failure. The uniform loading is representative of in-situ conditions. A valve is closed to prevent dissipation of pore-pressures representing undrained conditions. This test would be representative of low-permeability clay, such as phosphatic clay, under a relatively rapid loading condition, such as placement of a lift of waste.

- Direct Simple Shear (DSS) Test – A shear test that evaluates a sample using a normal load (σ_1) acting perpendicular to the failure surface. The shearing plane is forced horizontally through the sample. The speed of the shearing and permeability of the sample will effect whether the failure occurs under drained or undrained conditions. However, pore-pressure measurements are not recorded during testing.

The UU and UC tests were performed at loads bracketing the anticipated maximum load due to the waste mass of approximately 7,400 psf (based on approximately 100 ft of waste at elevation 240 ft NGVD 1929) at final build out in Phase I with a waste density of 74 pcf. The DSS tests were performed at loads much higher than the anticipated load to overcome the effects of sample disturbance.

Figure 1 shows the undrained shear strength versus the normal load at failure measured in the laboratory tests (UC, UU, and DSS).

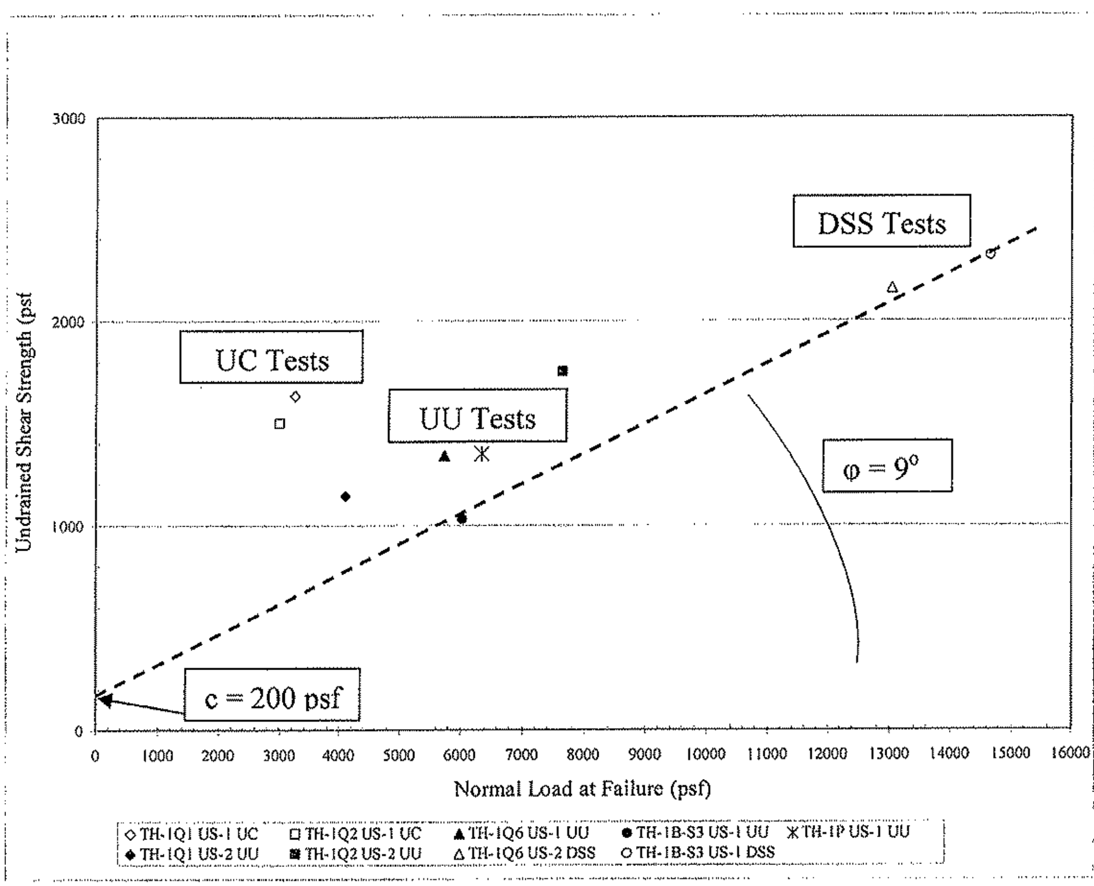

Figure 1: Relationship Between Laboratory Undrained Shear Strength and Normal Load

This graph is used to determine the linear undrained shear strength as a function of normal load through the lowest values reported in the laboratory testing. Thus, for the slope stability models, the phosphatic clay was estimated to have an equivalent slope angle (φ) of 9° and an intercept (c) of 200 psf. These values are used to represent the undrained shear strength of the phosphatic clay in the slope stability models.

SLOPE STABILITY ANALYSES

The slope stability analyses were performed using SLOPE/W software. The FDEP-proposed rule requires a Factor of Safety of 1.5 based on peak shear strength values.

Jones Edmunds modeled the landfill using worst-case slope stability conditions including:

1. Waste elevations at final grade plus final cover soil simulating the highest load condition.

2. Sliding block failure surface simulating a horizontal continuous failure through the phosphatic clay.

3. Waste shear strength with a friction angle of 28°, which is 15% lower than the lower-bound shear strength determined based on large-scale direct shear tests (*Soil Strength and Slope Stability*, Duncan and Wright, 2005 provided in Attachment 3).

4. Current undrained laboratory tested clay shear strength for viable samples of the waste phosphatic clays to generate a φ and c value to use in the slope stability models based on a linear relationship through the lowest shear strength values (refer to Figure 1).

The critical cross-sections for Phase I were chosen through the proposed modified stormwater ponds permitted in the recent CERP application and the peak elevation of the landfill as shown in the Site Plan provided in Attachment 1 (see Sections C, D, E, F, and G). The resulting factor of safety for each section, as reported in the Slope/W models provided in Attachment 4, are all greater than 1.5.

CONCLUSIONS AND RECOMMENDATIONS

The slope stability models indicate that the phosphatic clay sampled under current Phase I conditions meets the FDEP proposed rule requirement for the minimum Factor of Safety of 1.5. Therefore, additional phosphatic clay laboratory and field testing is not necessary for waste mass stability in Phase I through the final build-out elevation. It is Jones Edmunds recommendation that the current clay strengths in Phase I, as tested in 2007 and 2008, provides reasonable assurance that waste filling operations in Phase I may continue at any time.

The SWMD intends to continue waste filling operations in Phase I by August 1, 2009 in accordance with the permitted Phases I-VI fill sequence plans.

Future phosphatic clay sampling and testing will be performed for the Phase II through VI areas before placement of the next lift of waste. Jones Edmunds recommends obtaining intact samples of the phosphatic clay for laboratory testing as permitted in the SCLF Operations Permit. Based on the results of the Phase I sampling and testing, the UU tests had the most consistent determination of the undrained shear strength. In addition, as discussed in the Ardaman correspondence provided in Attachment 2, the laminated samples used in the DSS resulted in lower strengths that were not representative of actual conditions. The UC tests resulted in higher shear strengths at lower normal loads and were not consistent with the UU tests. Therefore, the UU tests are recommended for future undrained shear strength testing.

If you have any questions or comments, please contact me at 813/258-0703.

Sincerely,

Jason. Timmons, P.E.
Project Engineer
Florida PE No. 65869

Don Hullings, P.E.
Discipline Director
Florida PE No. 65058

Jones Edmunds Certificate of Authorization No. 1841

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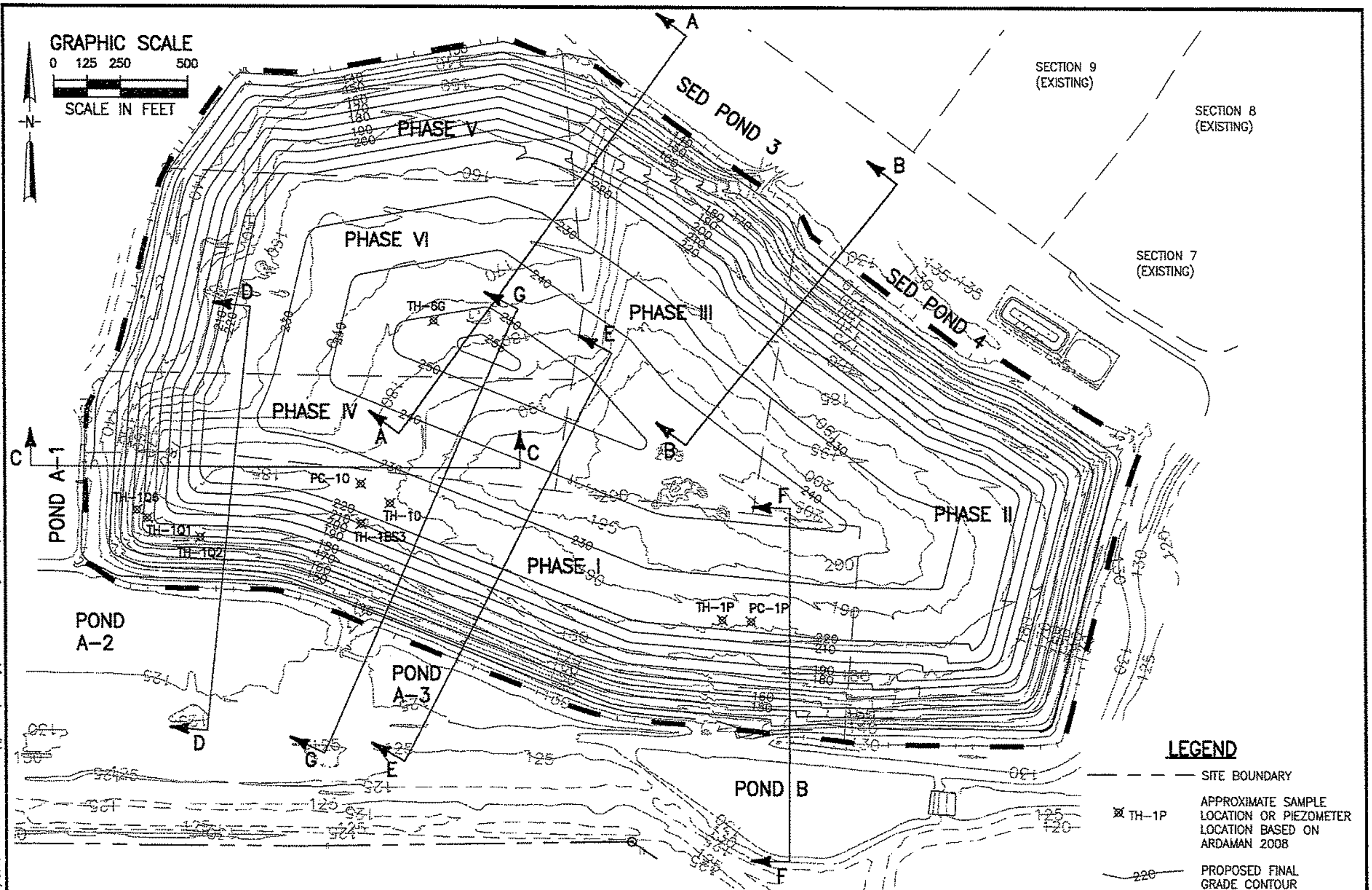
xc: Patricia Berry, Hillsborough County
Larry Ruiz, Hillsborough County
Megan Miller, Hillsborough County
Ron Cope, EPC
Joseph O'Neill, CES
Francis Cheung, Ardaman
Don Hullings, Jones Edmunds
Mickey Pollman, Jones Edmunds

ATTACHMENT 1

FIGURES



SITE PLAN
SLOPES STABILITY ANALYSIS
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

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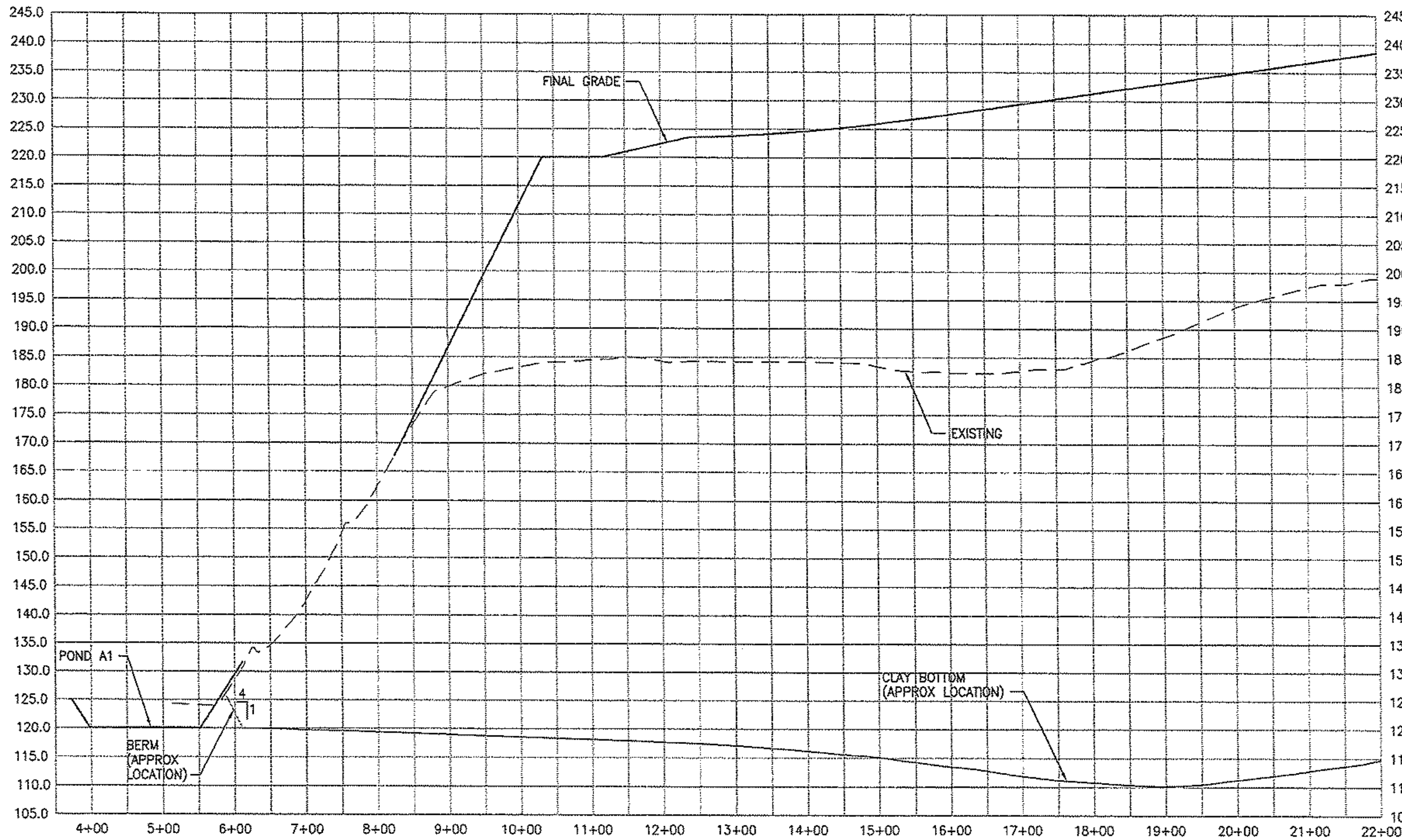

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SECTION C
SLOPE STABILITY ANALYSES
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH, COUNTY FLORIDA

JONES EDMUNDS

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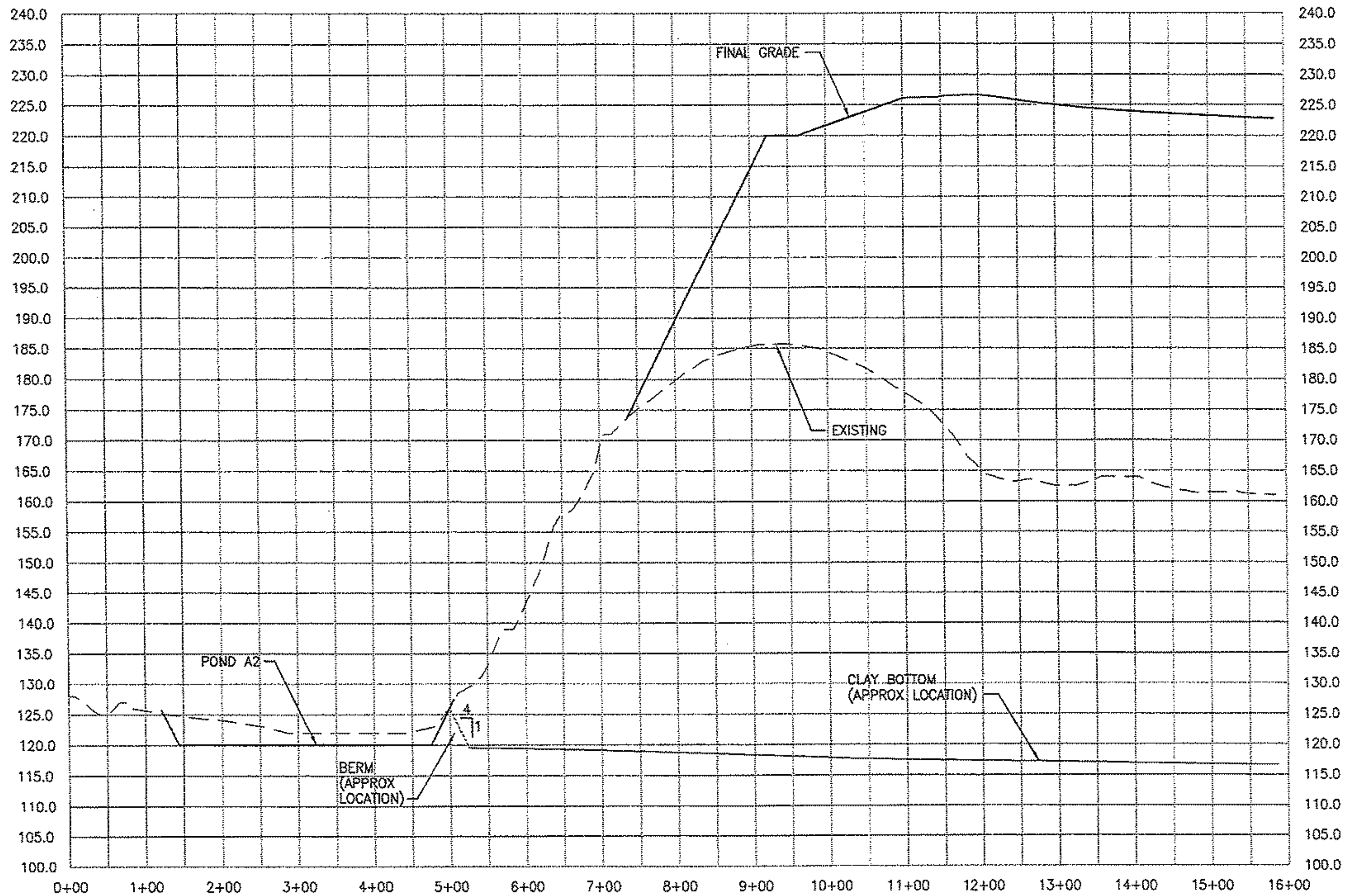

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SECTION D
SLOPE STABILITY ANALYSES
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH, COUNTY FLORIDA

JONES EDMUNDS

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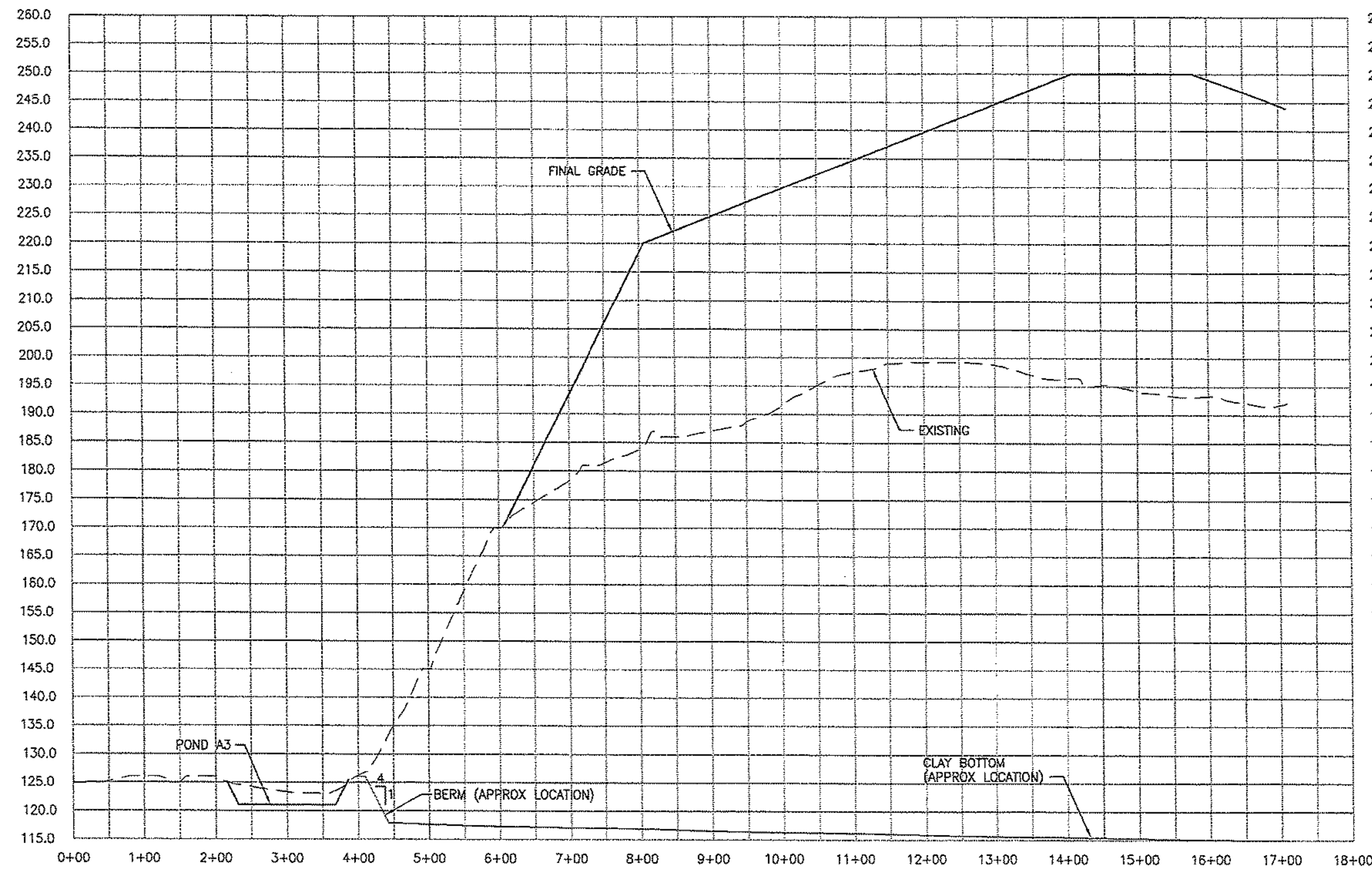

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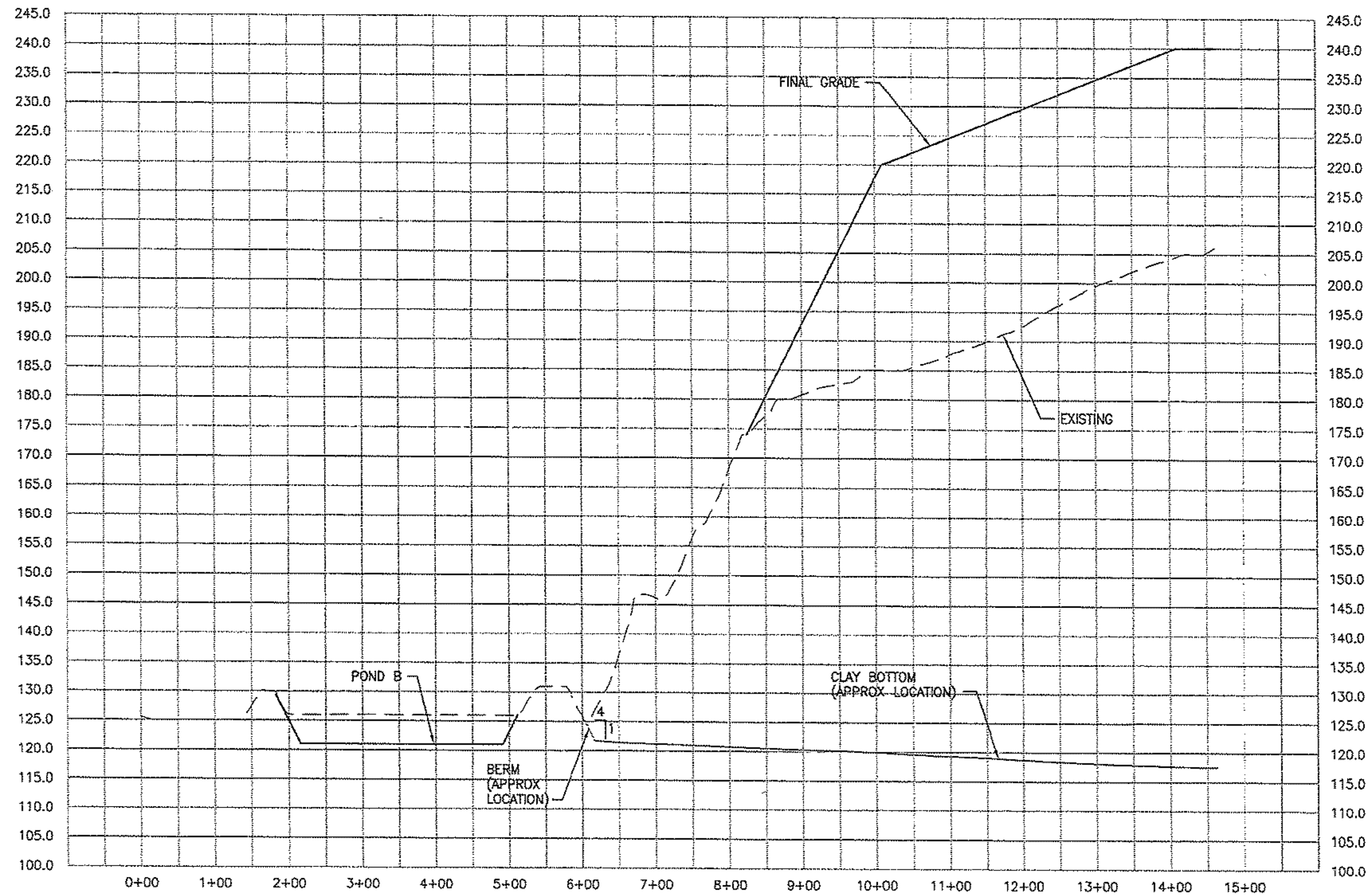
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH, COUNTY FLORIDA

JONES EDMUNDS



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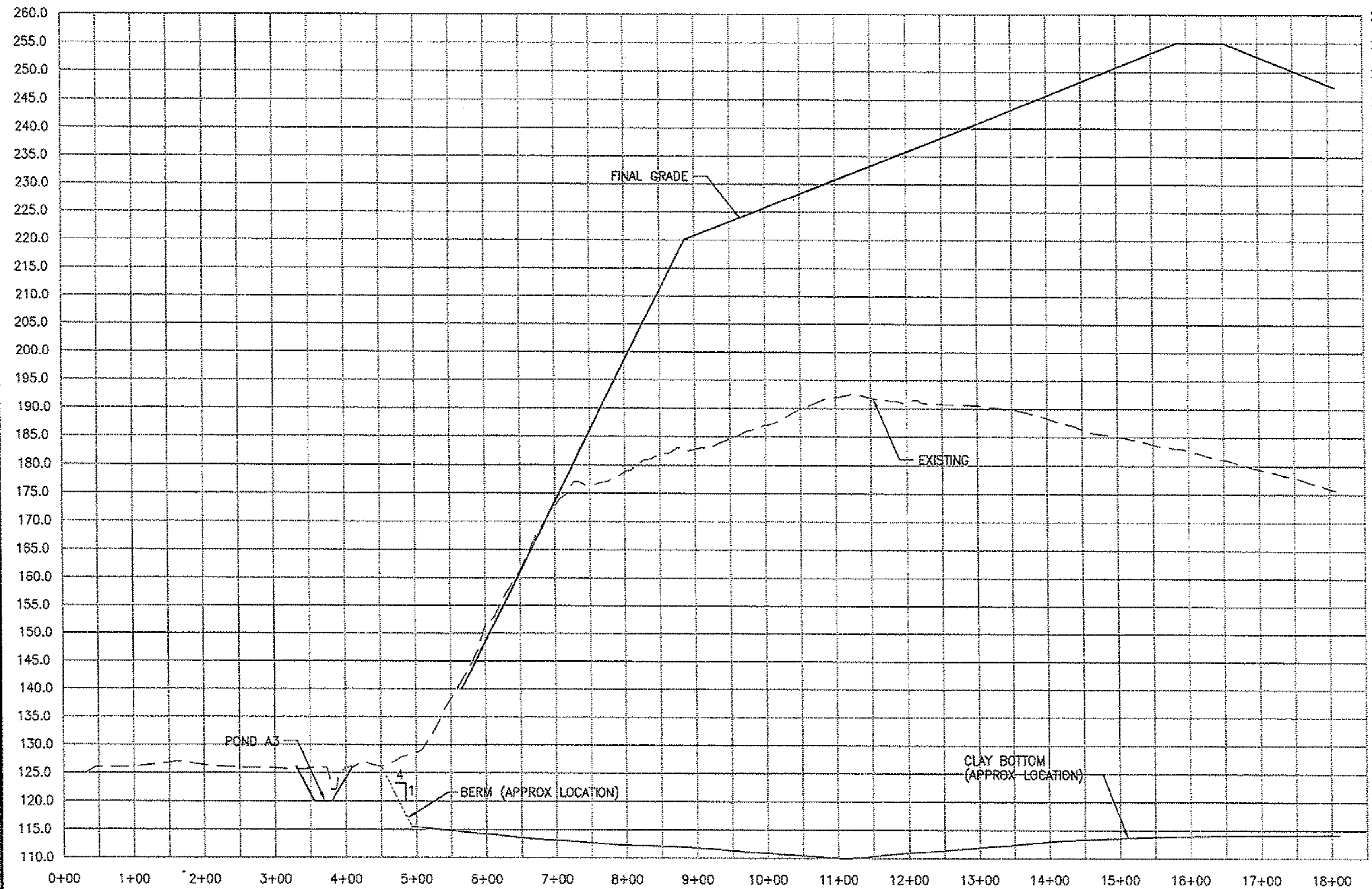
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH, COUNTY FLORIDA

JONES EDMUNDS



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SECTION G
SLOPE STABILITY ANALYSIS
PHASE I–VI SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

JONES EDMUNDS

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ATTACHMENT 2

ARDAMAN & ASSOCIATES, INC. FIELD AND LABORATORY REPORT DATED MAY 8, 2009

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

MAY 0 8 2009

May 7, 2009
File Number 08-032

Jones Edmunds & Associates, Inc.
324 South Hyde Park Avenue
Suite 250
Tampa, FL 33606-4110

Attention: Mr. Jason Timmons, P.E.
Project Engineer

Subject: Results of Laboratory Strength Testing of Waste Phosphatic Clay Samples from Phase I Area of Southeast County Landfill, Hillsborough County, Florida

Gentlemen/Ladies:

As requested by Jones Edmunds & Associates, Inc. (Jones Edmunds), Ardaman & Associates, Inc. (Ardaman) is pleased to submit this report to present results of laboratory strength testing for waste phosphatic clay samples recovered from the Phase I Area of the Southeast County Landfill Facility in 2007 and 2008.

Sampling and Testing in 2007

Two soil borings, designated TH-1O and TH-1P, were performed by Ardaman in 2007 in the Phase I area at the locations shown on the boring location map in Appendix A. TH-1O was drilled within the western half near the north side of the Phase I area, adjacent to the piezocone test site designated PC-1O, which was performed as part of the 2007 annual monitoring program. TH-1P was advanced near the eastern end of the Phase I area, adjacent to the piezocone test site designated PC-1P, also performed as part of the 2007 annual monitoring program. The soil borings were advanced through the entire depths of refuse/ash and drainage sand layer to recover samples of the underlying waste phosphatic clay for laboratory testing. A total of three undisturbed samples were recovered, with two samples from TH-1O and one sample from TH-1P.

In TH-1O and TH-1P, the top of waste phosphatic clay was encountered at depths of 71 and 70 feet below landfill surface, and the waste phosphatic clay thicknesses were documented to be 8.5 and 4.5 feet, respectively. The original waste phosphatic clay deposit was thinnest (4 to 8 feet) along the south side of the Phase I area where TH-1P was drilled. Along the west side of the Phase I area where TH-1O was drilled, the original phosphatic clay thickness could have been as much as 8 to 10 feet.

Ardaman performed unconfined compression tests, unconsolidated-undrained triaxial tests, and direct simple shear tests on the recovered undisturbed waste phosphatic clay samples. Results of these undrained shear strength measurements are presented in the laboratory reports in Appendix B and are summarized in the following table.

Test Hole	Sample	Depth (feet)	Test Type*	Undrained Shear Strength (psf)
TH-1O	US-2	73.5 – 75.5	UU	530
TH-1O	US-4	77.5 – 79.5	UU	640
TH-1P	US-1	70.5 – 72.5	UU	1,350
* Unconsolidated-undrained triaxial tests.				

As shown, the laboratory measurements indicated that the west side of the Phase I area, with an overburden load of approximately 70 feet and a waste phosphatic clay thickness of approximately 8 feet, had undrained shear strengths of 530 to 640 psf, characteristic of a medium stiff clay. The south side of the Phase I area, with a refuse/ash overburden load of approximately 70 feet and a waste phosphatic clay thickness of approximately 4 feet, had a higher undrained shear strength of 1,350 psf, characteristic of a stiff clay. The moisture contents of the undisturbed samples recovered from TH-1O were generally higher than those recovered from TH-1P, which confirmed that the undrained shear strengths of the waste phosphatic clay were higher at TH-1P than at TH-1O.

For comparisons, an undisturbed sample obtained at a depth of 42 feet below the landfill surface from the Phase I area in 1994 yielded an undrained shear strength of 460 psf. In its original state, the phosphatic clay below the desiccated crust had an undrained shear strength on the order of 70 psf.

Sampling and Testing in 2008

Four soil borings, designated TH-1Q1, TH-1Q2, TH-1Q6, and TH-1B-S3, were performed by Ardaman in 2008 in the Phase I area to recover undisturbed samples of the waste phosphatic clay for laboratory testing. TH-1Q1 and TH-1Q2 were drilled in July 2008, and TH-1Q6 and TH-1B-S3 were drilled in November 2008. These soil borings were performed within the western half of the Phase I area. TH-1Q1, TH-1Q2, and TH-1Q6 were located close to the crest of the existing landfill slope, whereas TH-1B-S3 was drilled at a greater distance from the existing landfill slope crest (i.e., towards the interior of the landfill), as shown on the boring location plan in Appendix A.

The soil borings were advanced through the entire depths of refuse/ash and the drainage sand layer to allow recovery of undisturbed samples of the waste phosphatic clay using a Shelby tube sampler. The approximate depths and thicknesses of the waste phosphatic clay layer encountered in the soil borings are summarized in the following table.

Test Hole	Approx Depth to Waste Phosphatic Clay Layer Below Land Surface (feet)	Approx Thickness of Waste Phosphatic Clay Layer (feet)
TH-1Q1	56.0	5.5
TH-1Q2	56.0	4.0
TH-1Q6	61.5	4.0
TH-1B-S3	70.0	4.5

As shown in the table above, the waste phosphatic clay was encountered at a depth ranging from 56 to 70 feet below land surface, and had a thickness of 4.0 to 5.5 feet at the soil boring locations.

To characterize the undrained shear strengths of the waste phosphatic clay, Ardaman performed unconfined compression tests, unconsolidated-undrained triaxial tests, and direct simple shear tests on selected samples of the waste phosphatic clay recovered from the four soil borings. Results of the laboratory strength tests are presented in the laboratory reports in Appendix B and are summarized in the following table.

Test Hole	Sample Number	Depth (feet)	Test Type*	Undrained Shear Strength (psf)	Estimated Overburden Pressure (psf)	Applied Normal Load Prior to Shear (psf)
TH-1Q1	US-1	56-58	UC	1,630	4,320	-
TH-1Q1	US-2	58-60	UU	1,140	4,520	-
TH-1Q1	US-3	60-62	UC	540***	4,720	-
TH-1Q2	US-1	56-58	UC	1,500	4,320	-
TH-1Q2	US-2	58-60	UU	1,750	4,520	-
TH-1Q6	US-1	61.6-63.6	UU	1,340	4,400	-
TH-1Q6	US-2	63.5-65.5	DSS	2,160**	4,840	13,040
TH-1B-S3	US-1	69.6-71.6	UU	1,030	4,880	-
TH-1B-S3	US-1	69.6-71.6	DSS	2,320**	4,880	14,660

* UC = Unconfined Compression Test, UU = Unconsolidated-Undrained Triaxial Test, DSS = Direct Simple Shear Test.
** Undrained shear strength obtained using a normal load greater than the existing overburden pressure. The measured strengths are lower than expected because of laminations.
*** Sample may have been disturbed as a result of intrusion from natural ground soils below.

The unconfined compression tests and unconsolidated-undrained triaxial tests were conducted to provide estimates of undrained shear strengths of the waste phosphatic clay under existing condition. For the direct simple shear tests, a normal load exceeding the existing overburden pressure was used to "mask" any effect of sample disturbance, which could potentially result in lower measured strength values. Therefore, the measured undrained shear strengths from the direct simple shear tests do not represent the *in situ* undrained shear strengths under existing condition.

With the exception of the sample designated US-3 obtained from a depth of 60 to 62 feet below land surface in TH-1Q1, results of the unconfined compression tests and unconsolidated-undrained triaxial tests yielded undrained shear strength values that ranged from 1,030 to 1,750 psf, and averaged approximately 1,400 psf from six measurements. The low undrained shear strength measured in US-3 from TH-1Q1 could be attributed to sample disturbance due to intrusion of natural ground soils into the waste phosphatic clay when the Shelby tube sampler was pushed below the bottom of the waste phosphatic clay.

The two direct simple shear tests were performed using applied normal loads that were approximately 2.5 to 3.0 times greater than the existing overburden pressure. Under the existing overburden pressures at the boring locations, the undrained shear strengths of the waste phosphatic clay were estimated to on the order of 700 to 800 psf, which were lower than expected. Visual examinations of the tested specimens revealed the presence of thin laminations or varves (≤ 2mm thick) that would be expected to produce lower undrained shear strengths in the horizontal shearing mode of a direct simple shear test where the failure surface could occur along one or more horizontal laminations. Waste phosphatic clays typically do not occur as laminated (varved) clays and, hence, the lower undrained shear strengths measured on the two specimens are not considered representative of site condition.

Ardaman appreciates the opportunity to provide services to Jones Edmunds and Hillsborough County. If you have any questions or need additional information, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

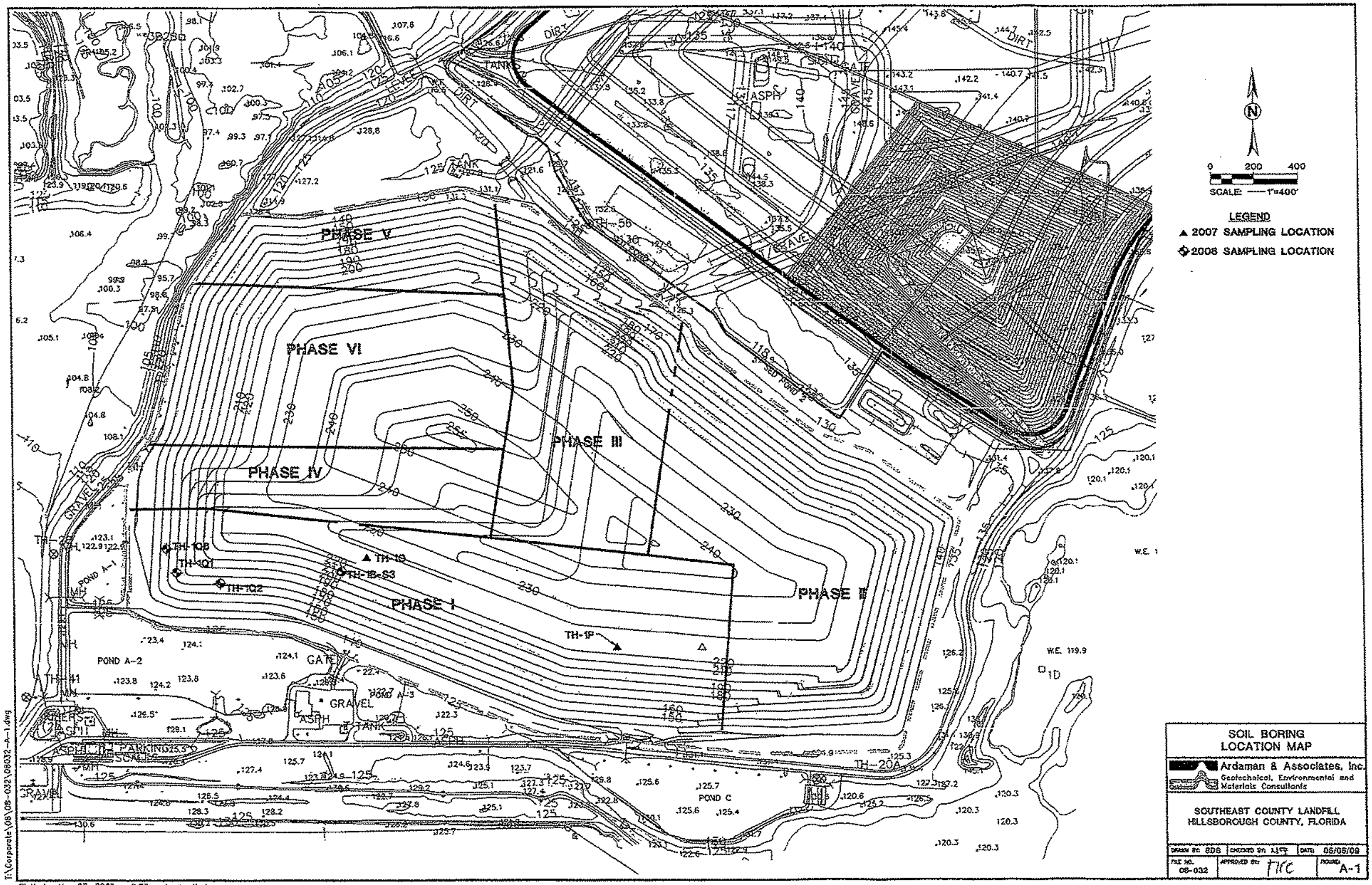
Jeyisanker Mathiyaparanam, E.I.
Assistant Project Engineer

Francis K. Cheung, P.E.
Senior Project Engineer 03/07/09
Florida License No. 36382

Enclosures

Appendix A

Boring Location Plan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PHASE VI
PHASE IV
PHASE III
PHASE I
PHASE II
TH-108
TH-101
TH-102
TH-1G
TH-1B-S3
TH-1P
TH-20A
TH-41
POND A-1
POND A-2
POND A-3
POND C
SED POND 2
GATE
GRAVEL
ASPH
TANK
DIRT
PARKING
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N
LEGEND
2007 SAMPLING LOCATION
2008 SAMPLING LOCATION
SOIL BORING LOCATION MAP
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants
SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA
DRAWN BY: SDS
DATE: 05/06/09
FILE NO. 08-032
FIGURE A-1
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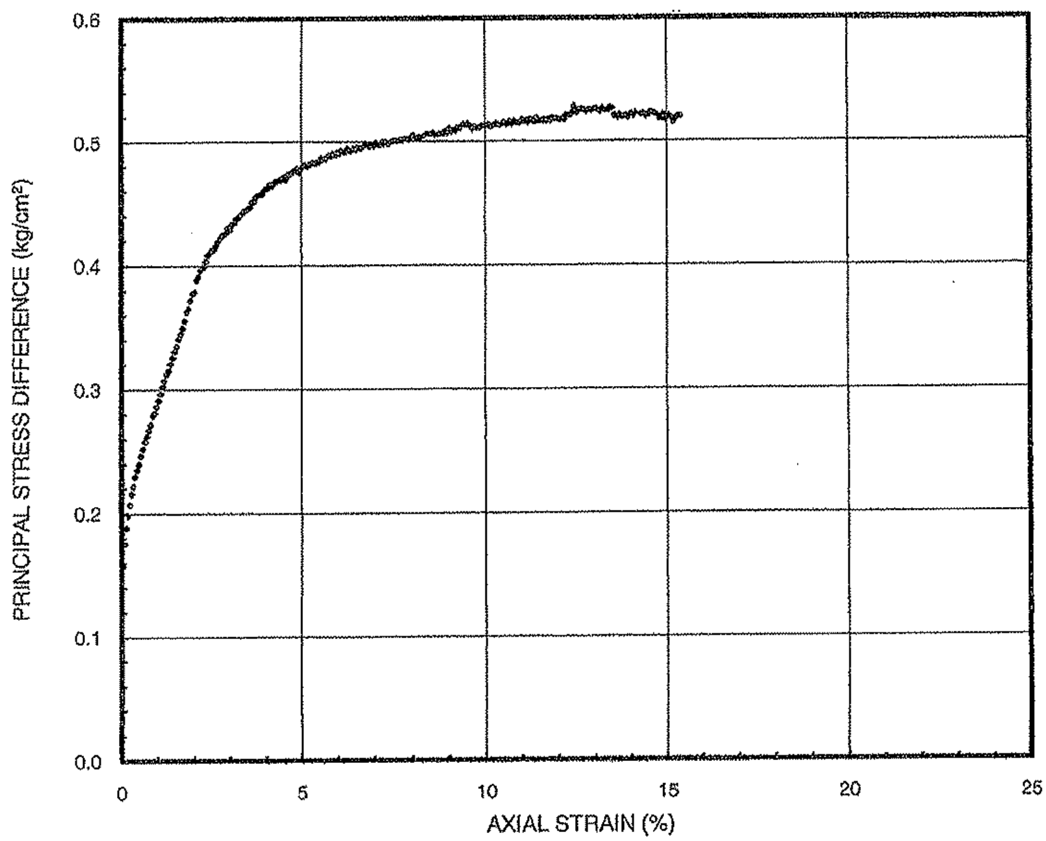
Appendix B

Laboratory Test Data

Project Name	HCLF
Project Number	06-212
Sample Name	PC-10 US2 B3
Depth	73.5-75.5
Cell Pressure	2.75 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM PC-1O-B3

Description	Gray clay
Initial Height	7.125 cm
Initial Diameter	3.544 cm
Dry Density	51.6 pcf
Water Content	86.1 %
Saturation	102 %

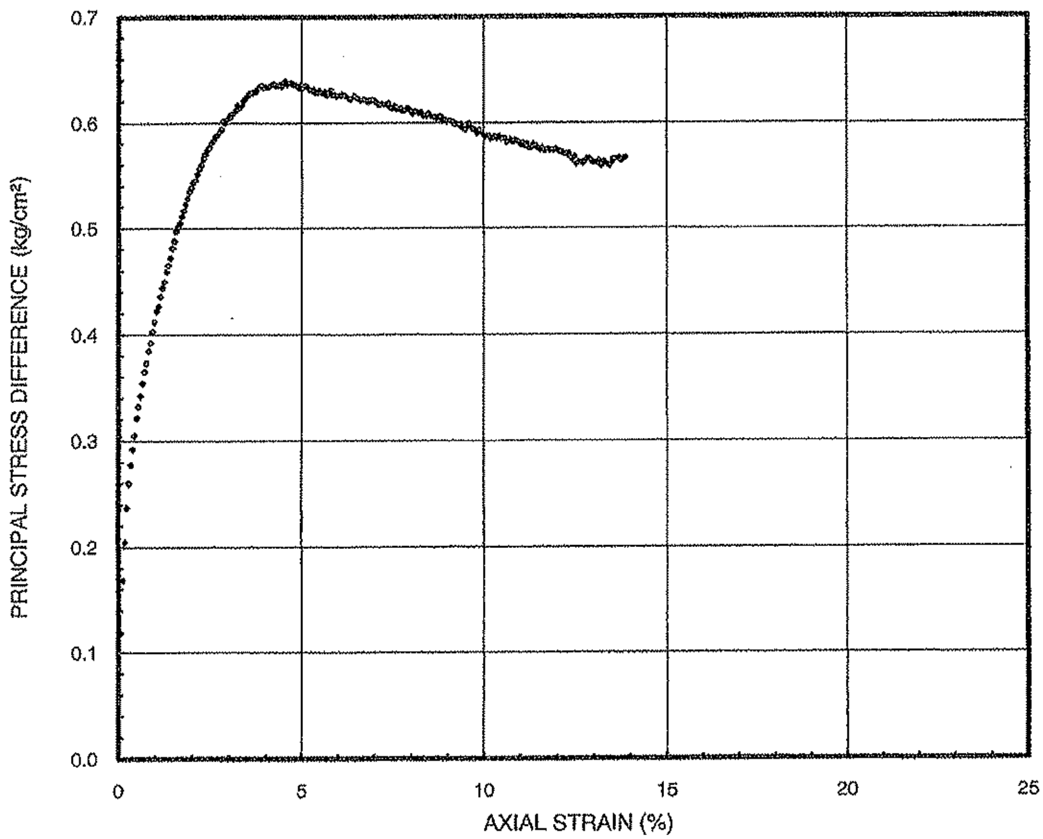
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 1

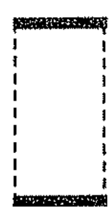
Project Name 06-212
Project Number HCLF
Sample Name PC10 US4 B2
Depth 77.5-79.5
Cell Pressure 2.75 kg/cm²
Strain Rate 1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-4 FROM PC-1O-B2

Description Gray clay

Initial Height	7.106 cm
Initial Diameter	3.558 cm
Dry Density	55.0 pcf
Water Content	77.2 %
Saturation	100 %



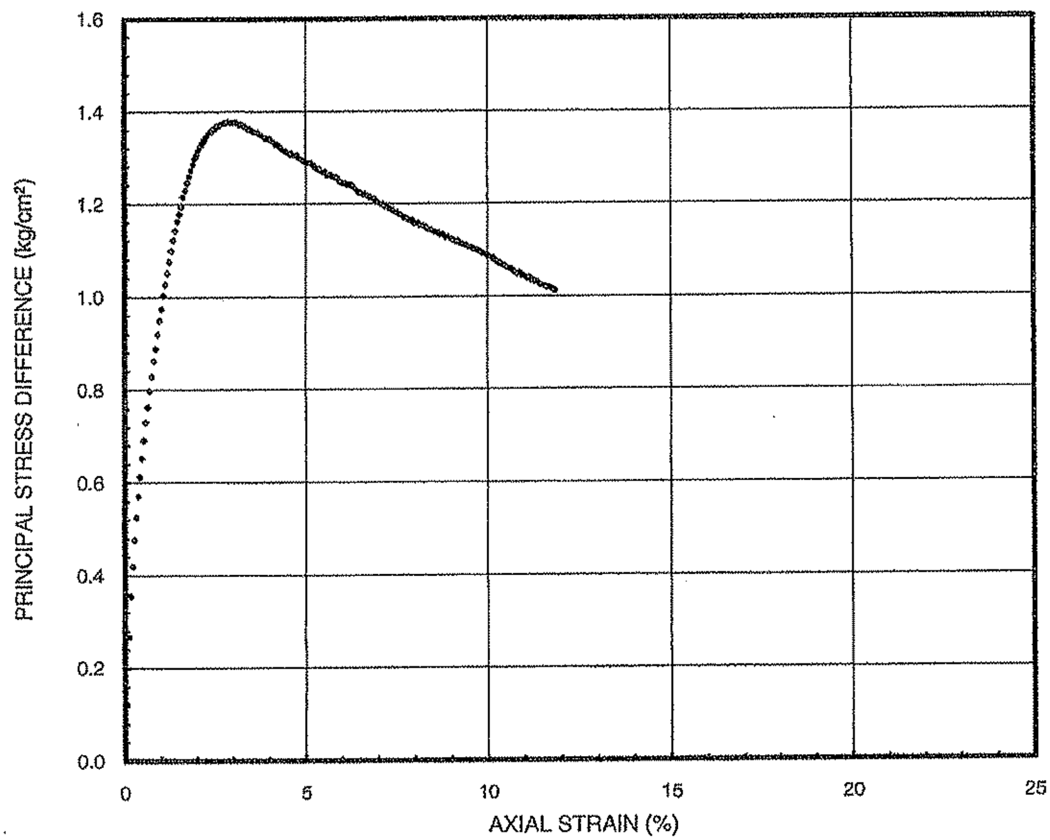
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 2

Project Name	HCLF
Project Number	06-212
Sample Name	THPC1P US1 B4
Depth	70.5-72.5
Cell Pressure	2.50 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-1 FROM PC-1P-B4

Description	Gray Clay	
Initial Height	7.12	cm
Initial Diameter	3.58	cm
Dry Density	53.5	pcf
Water Content	80.9	%
Saturation	100	%

TYPE OF FAILURE

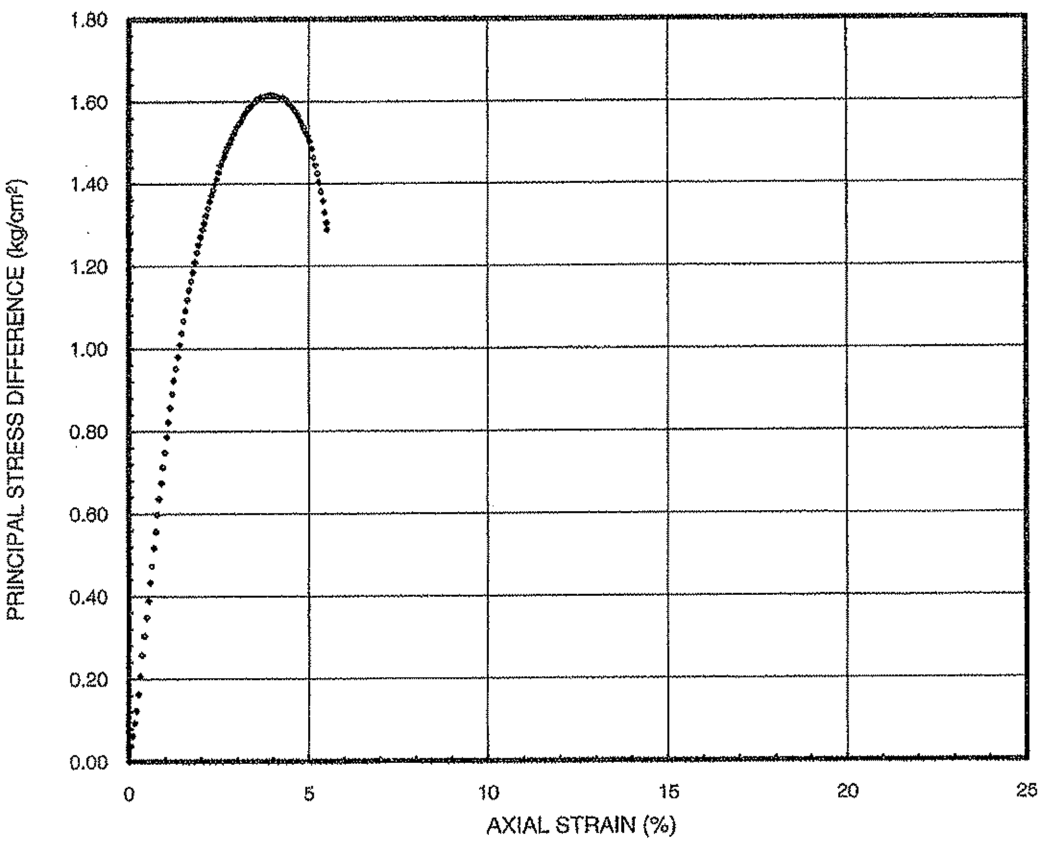
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09	
FILE NO.: 09-032	APPROVED BY: FKC	FIGURE: 3	

Project Name SELF
Project Number 08-032
Sample Name TH1Q1 US1 B2
Depth 56-58 ft

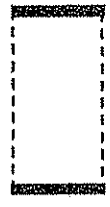
Strain Rate 1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-1 FROM TH-1Q1-B2

Description Gray clay

Initial Height	7.103	cm
Initial Diameter	3.561	cm
Dry Density	45.0	pcf
Water Content	103.0	%
Saturation	99	%



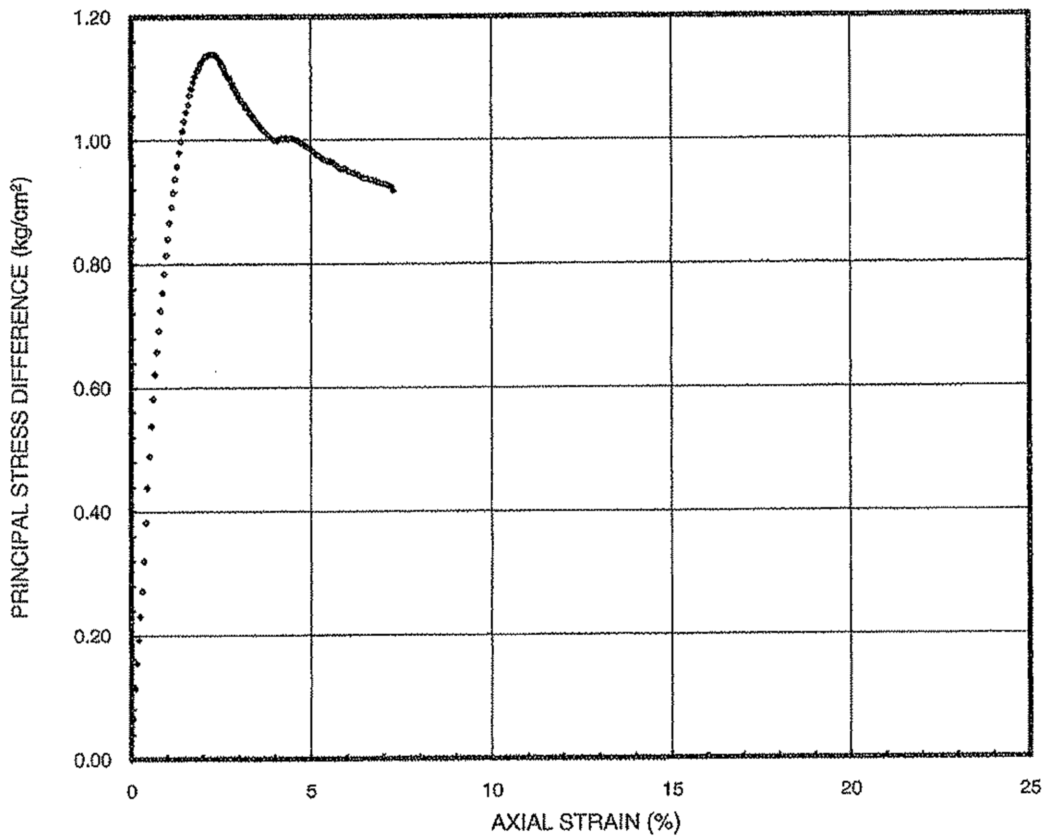
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

**SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA**

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09	
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 4	

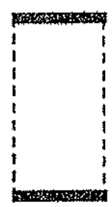
Project Name SELF
Project Number 08-032
Sample Name TH-1Q1 US2 B2
Depth 58-60 ft
Cell Pressure 1.48 kg/om²
Strain Rate 1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM TH-1Q1-B2

Description Gray clay

Initial Height	7.104	cm
Initial Diameter	3.559	cm
Dry Density	52.6	pcf
Water Content	83.9	%
Saturation	100	%



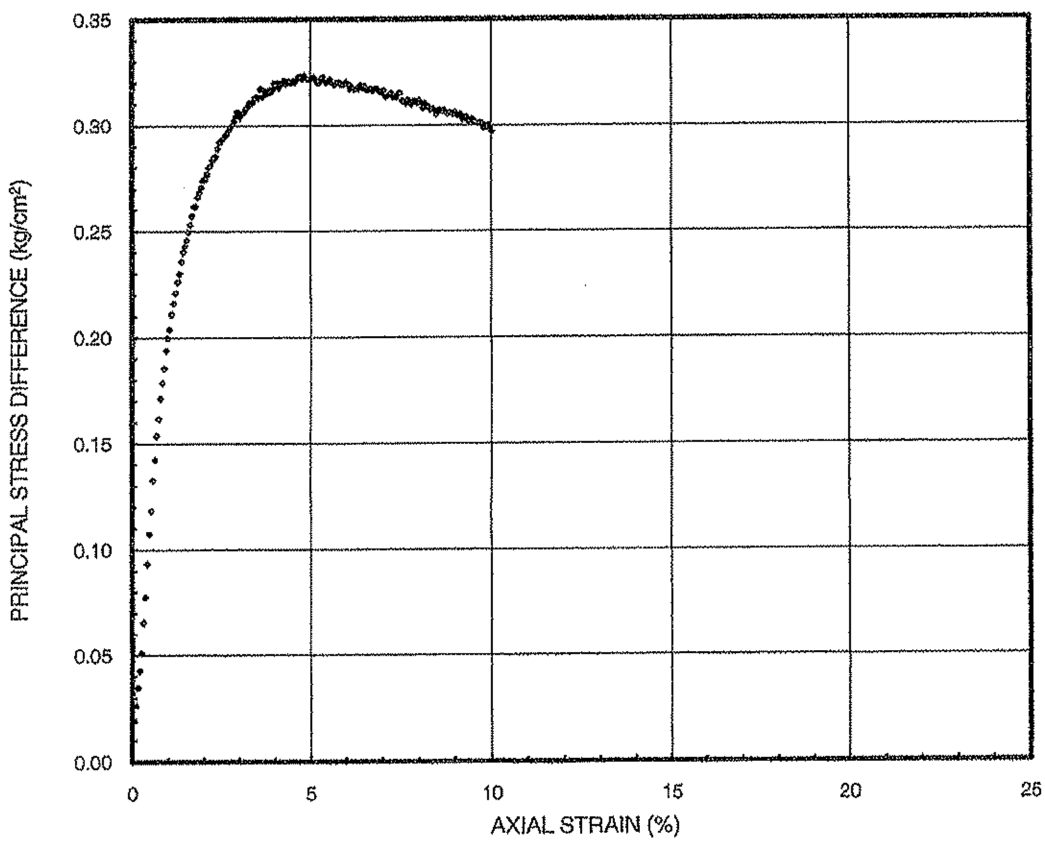
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 5

Project Name	SE LANDFILL
Project Number	08-032
Sample Name	TH1Q1 US3 B1
Depth	60-62 ft
Strain Rate	1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-3 FROM TH-1Q1-B1

Description	Gray clay	
Initial Height	7.089	cm
Initial Diameter	3.554	cm
Dry Density	49.1	pcf
Water Content	91.6	%
Saturation	100	%

TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

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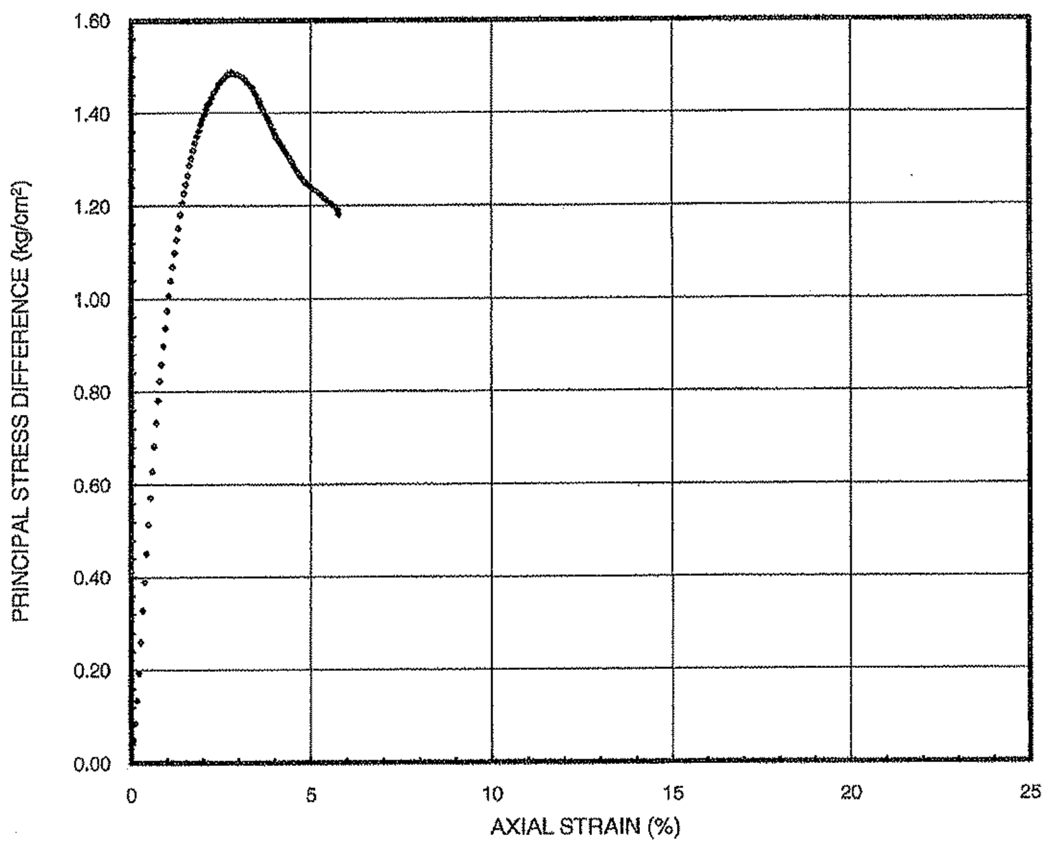
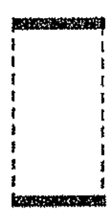
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 6

Project Name	SELF
Project Number	08-032
Sample Name	TH1Q2 US1 B2
Depth	56-58 ft
Strain Rate	1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-1 FROM TH-1Q2-B2

Description	Gray clay	
Initial Height	7.097	cm
Initial Diameter	3.563	cm
Dry Density	48.0	pcf
Water Content	94.1	%
Saturation	99	%



TYPE OF FAILURE

Ardaman & Associates, Inc.
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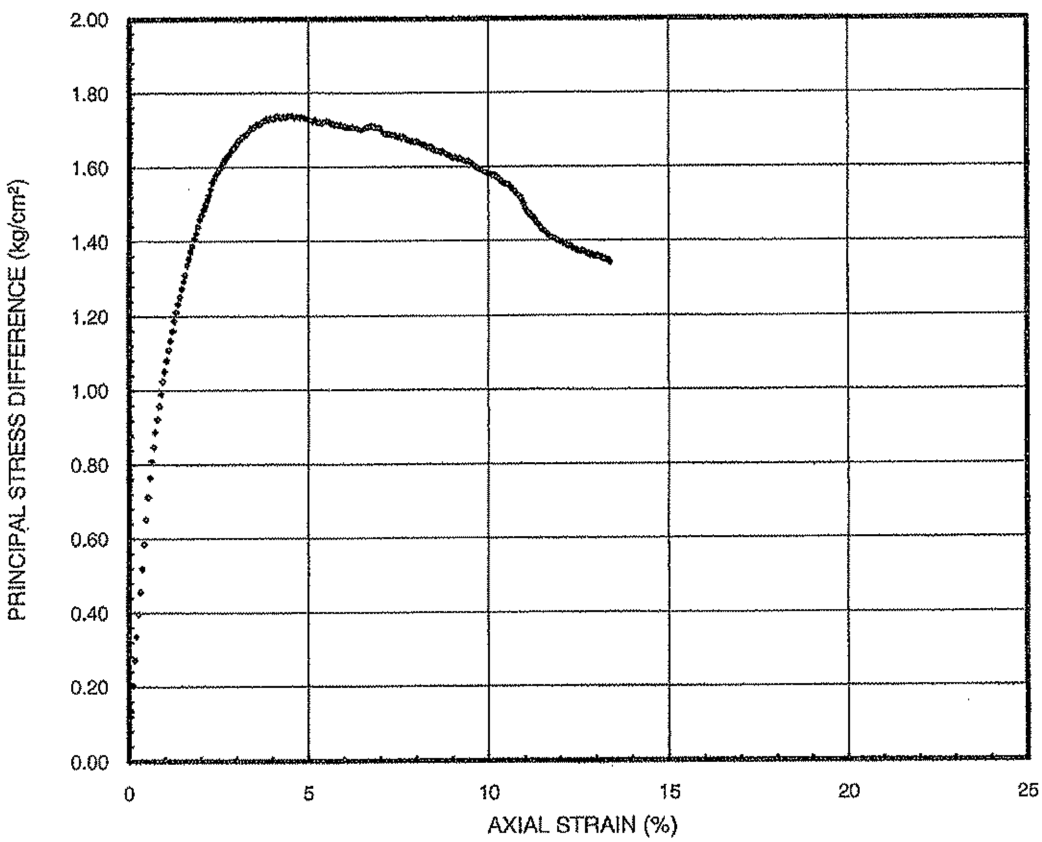
SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 7

Project Name	SELF
Project Number	08-032
Sample Name	TH1Q2 US2 B2
Depth	58-60 ft
Cell Pressure	2.95 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM TH-1Q2-B2

Description	Gray clay	
Initial Height	7.094	cm
Initial Diameter	3.563	cm
Dry Density	47.6	pcf
Water Content	95.9	%
Saturation	100	%

TYPE OF FAILURE

Ardaman & Associates, Inc.
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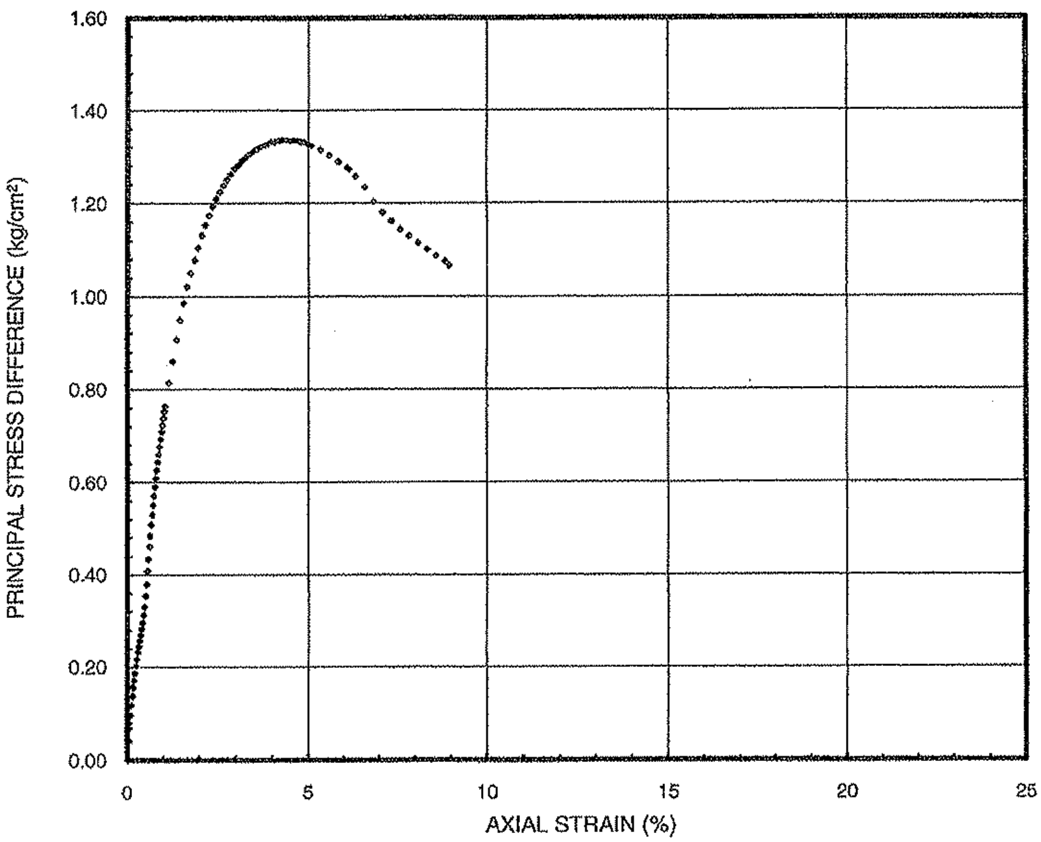
SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09	
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 8	

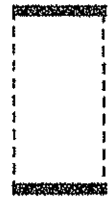
Project Name	SELF
Project Number	08-032
Sample Name	TH1Q6 US1
Depth	61.6-63.6 ft
Cell Pressure	2.20 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST FOR SAMPLE US-1 FROM TH-1Q6

Description Gray clay

Initial Height	7.078 cm
Initial Diameter	3.569 cm
Dry Density	47.5 pcf
Water Content	95.6 %
Saturation	100 %

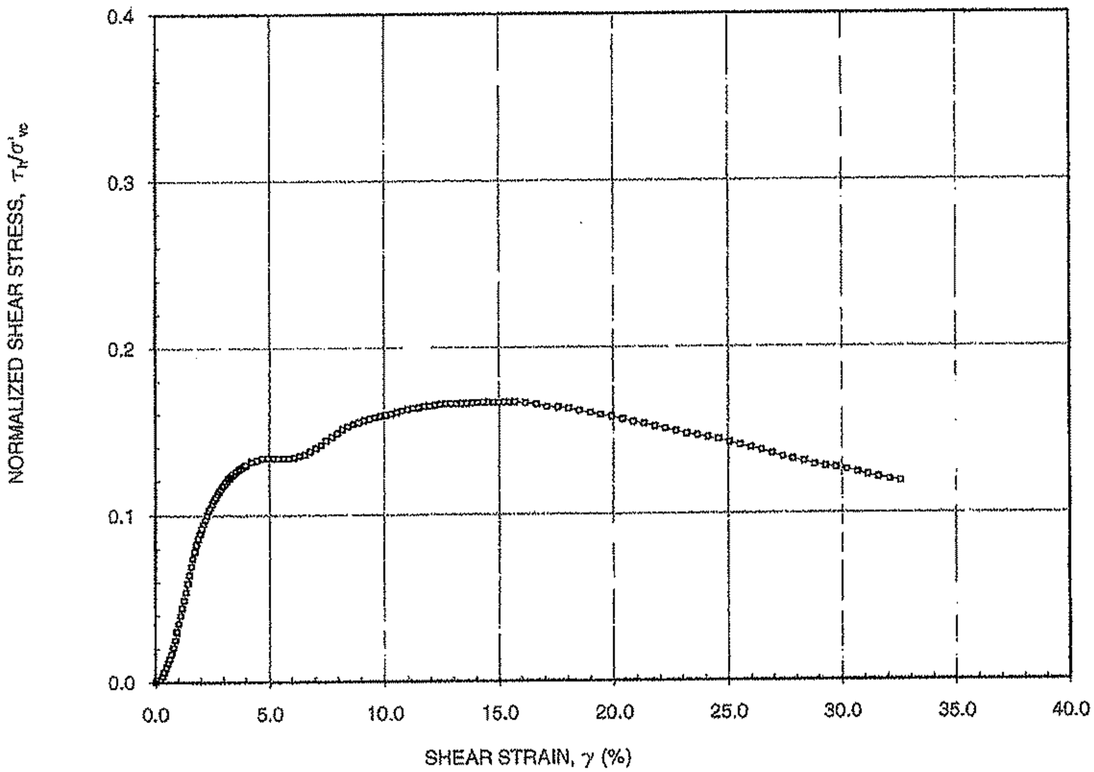


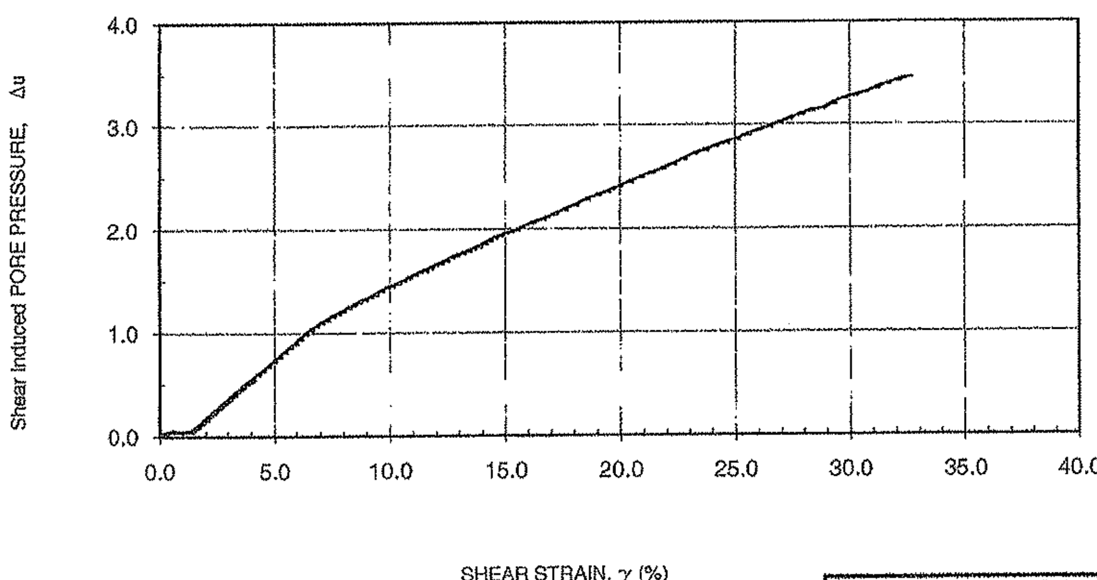
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 08-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 9



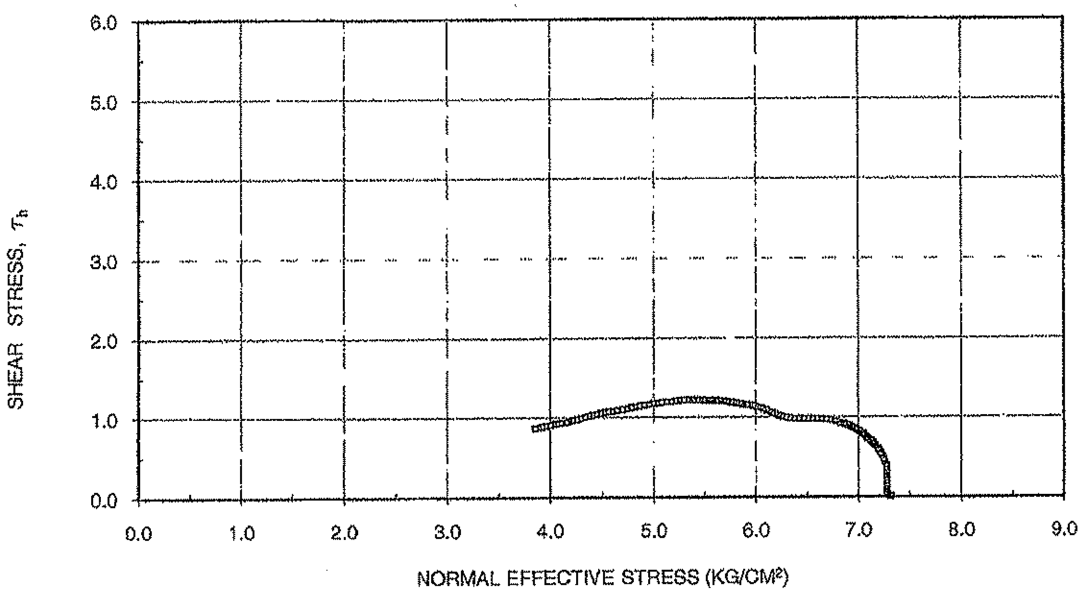


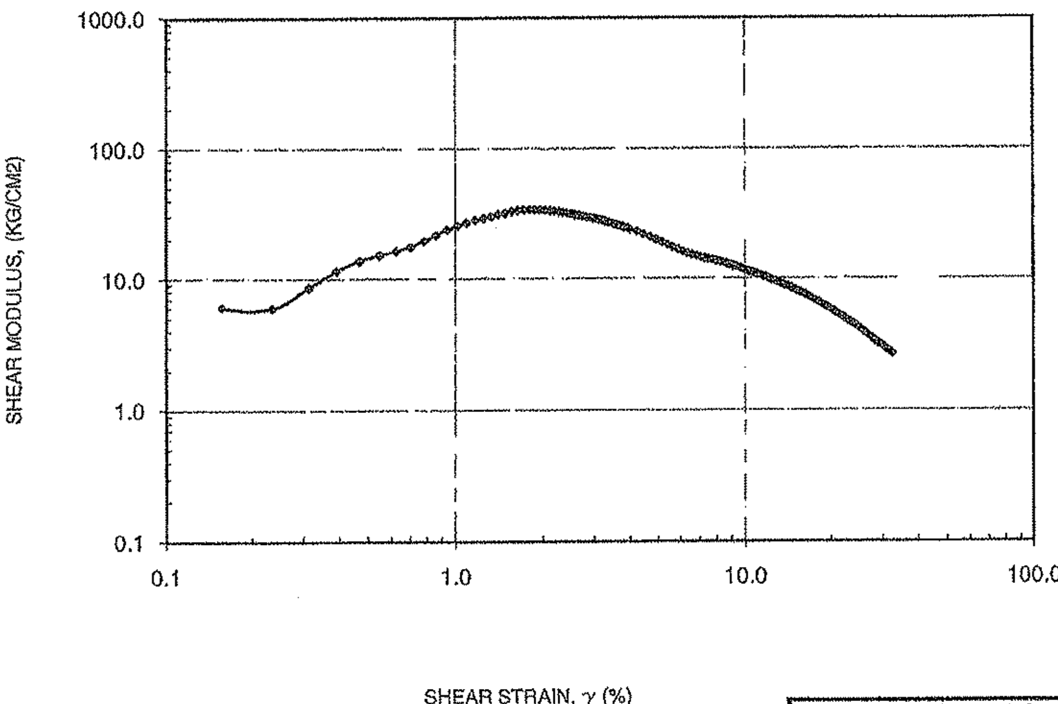
RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-2 FROM TH-1Q6

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 10-1





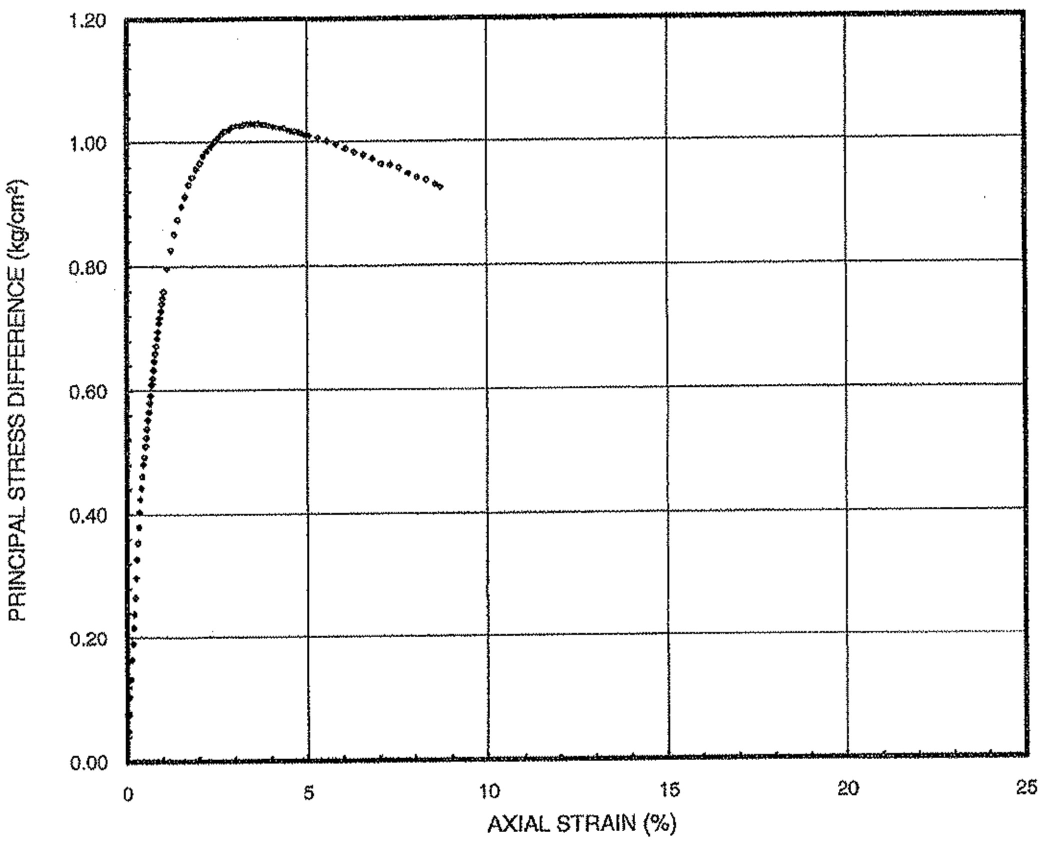
RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-2 FROM TH-1Q6

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 10-2

Project Name SELF
Project Number 08-032
Sample Name PC-1BS3 US1
Depth 69.6-71.6 ft
Cell Pressure 2.44 kg/cm²
Strain Rate 1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
FOR SAMPLE US-1 FROM TH-1B-S3

Description Lt gray clay

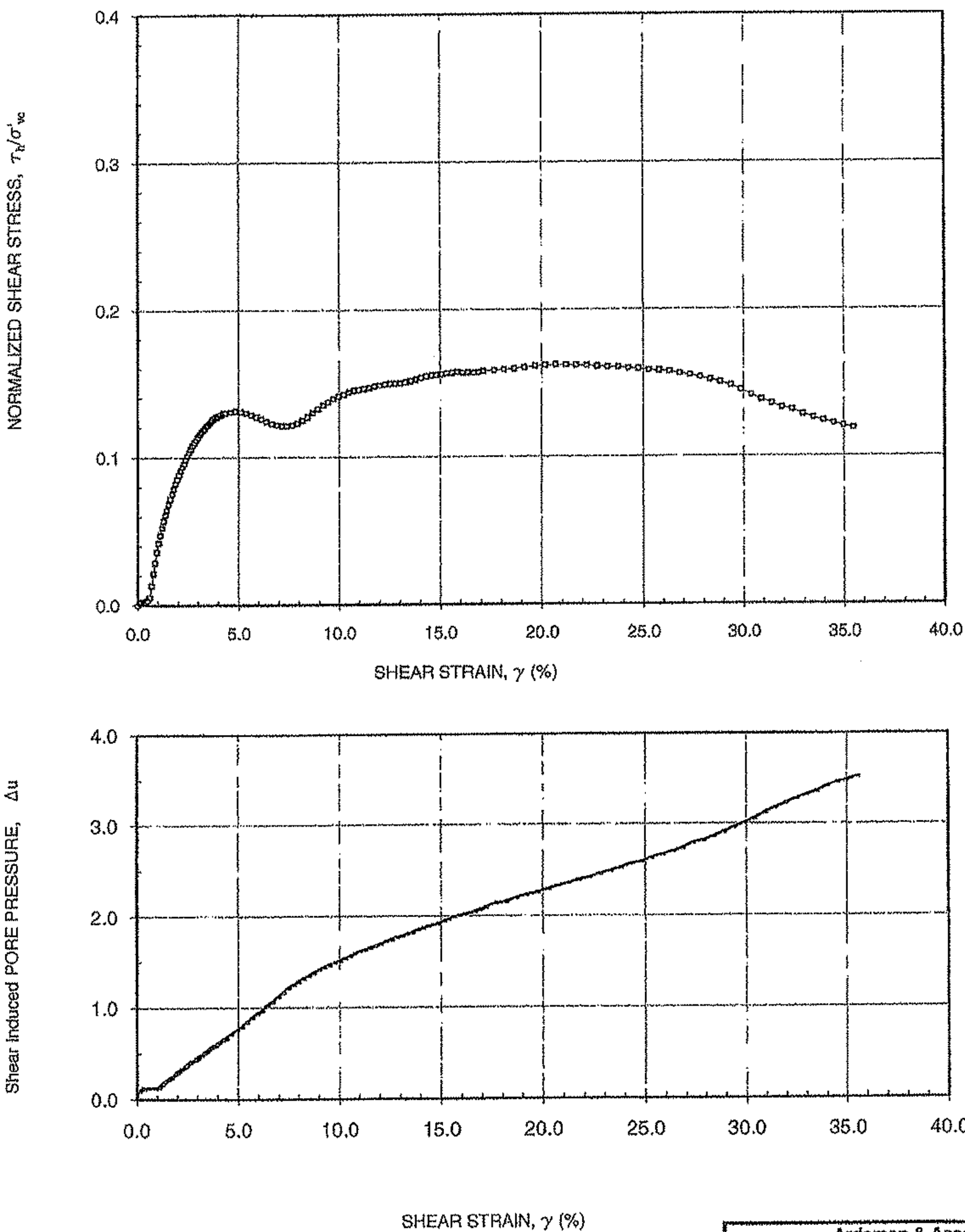
Initial Height	7.083 cm
Initial Diameter	3.569 cm
Dry Density	54.8 pcf
Water Content	79.2 %
Saturation	100 %

TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 11



RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-1 FROM TH-1B-S3

Ardaman & Associates, Inc.
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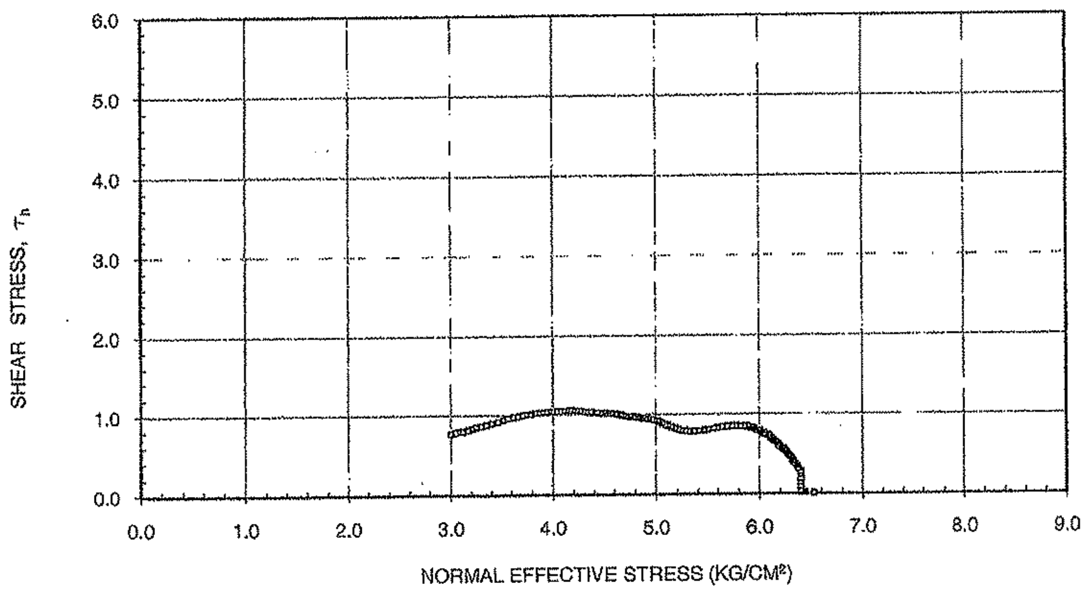
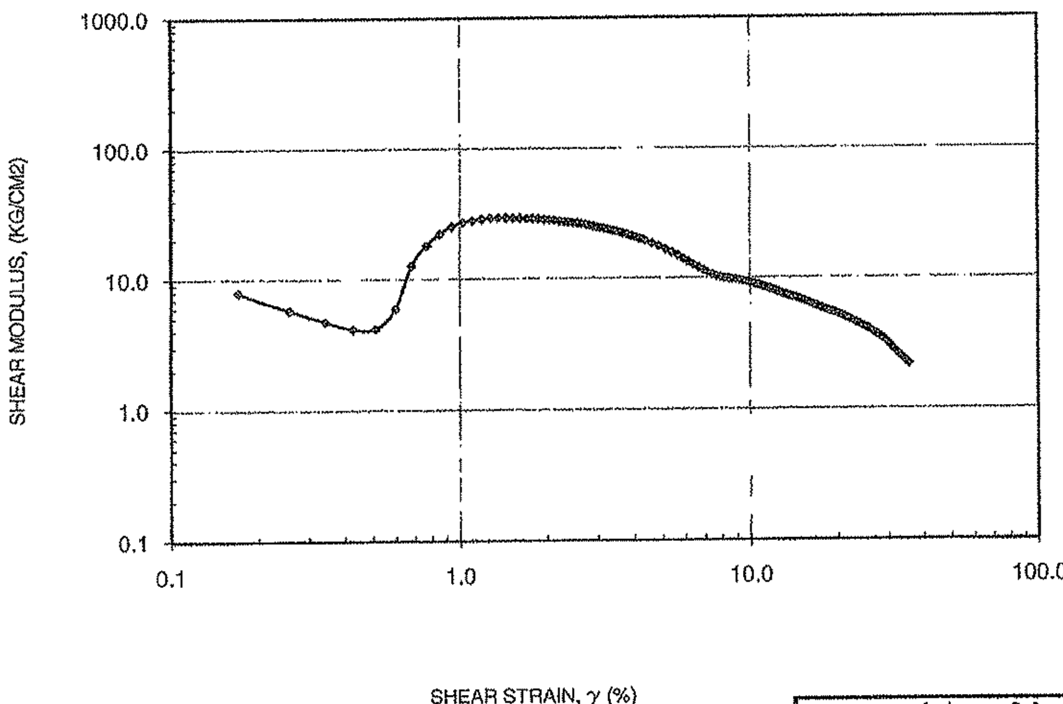
SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: MJ	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 12-1





RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-1 FROM TH-1B-S3

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 12-2

ATTACHMENT 3

REFERENCES

Source: Soil Strength and Slope Stability 2005
Duncan and Wright
John Wiley & Sons, Inc. New Jersey

major principal stress at failure is vertical, and the shear surface is oriented about 60° from horizontal. In the middle part of the shear surface, where the shear surface is horizontal, the major principal stress at failure is oriented about 30° from horizontal. At the toe of the slope, sometimes called the *passive zone,* the major principal stress at failure is horizontal, and the shear surface is inclined about 30° past horizontal. As a result of these differences in orientation, the undrained strength ratio (s_u/σ'_v) varies from point to point around the shear surface. Variations of undrained strengths with orientation of the applied stress in the laboratory are shown in Figure 5.12*b* for two normally consolidated clays and two heavily overconsolidated clay shales.

Ideally, laboratory tests to measure the undrained strength of clay would be performed on completely undisturbed plane strain test specimens, tested under unconsolidated–undrained conditions, or consolidated and sheared with stress orientations that simulate those in the field. However, equipment that can apply and reorient stresses to simulate these effects is highly complex and has been used only for research purposes. For practical applications, tests must be performed with equipment that is easier to use, even though it may not replicate all the various aspects of the field conditions.

Triaxial compression (TC) tests, often used to simulate conditions at the top of the slip surface, have been found to result in strengths that are 5 to 10% lower than vertical compression plane strain tests. Triaxial extension (TE) tests, often used to simulate conditions at the bottom of the slip surface, have been found to result in strengths that are significantly less (at least 20% less) than strengths measured in horizontal compression plane strain tests. Direct simple shear (DSS) tests, often used to simulate the condition in the central portion of the shear surface, underestimate the undrained shear strength on the horizontal plane. As a result of these biases, the practice of using TC, TE, and DSS tests to measure the undrained strengths of normally consolidated clays results in strengths that are lower than the strengths that would be measured in ideally oriented plane strain tests.

Strain rate. Laboratory tests involve higher rates of strain than are typical for most field conditions. UU test specimens are loaded to failure in 10 to 20 minutes, and the duration of CU tests is usually 2 or 3 hours. Field vane shear tests are conducted in 15 minutes or less. Loading in the field, on the other hand, typically involves a period of weeks or months. The difference in these loading times is on the order of 1000. Slower loading results in lower undrained shear strengths of saturated clays. As shown in Figure 5.13, the strength of San Francisco Bay mud decreases by about 30% as the time to failure increases from 10 minutes to 1 week. It appears that there is no further decrease in undrained strength for longer times to failure.

In conventional practice, laboratory tests are not corrected for strain rate effects or disturbance effects. Because high strain rates increase strengths measured in UU tests and disturbance reduces them, these effects tend to cancel each other when UU laboratory tests are used to evaluate undrained strengths of natural deposits of clay.

Methods of Evaluating Undrained Strengths of Intact Clays

Alternatives for measuring or estimating undrained strengths of normally consolidated and moderately ov-

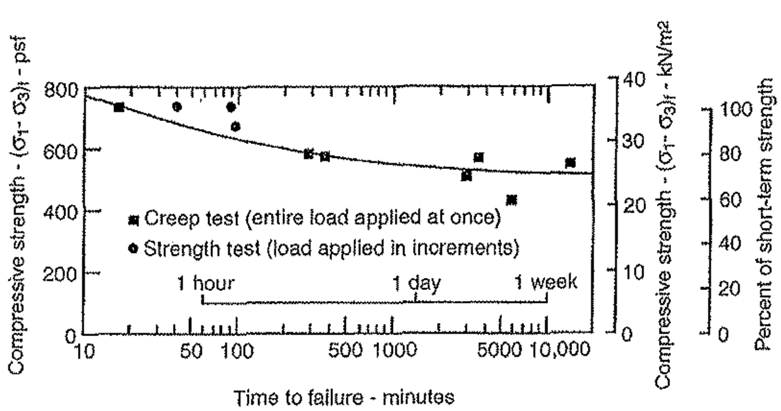


Figure 5.13 Strength loss due to sustained loading.

Source: Soil Strength and Slope Stability - 2005
Duncan and Wright
John Wiley & Sons, Inc., New Jersey

Undrained strengths of compacted clays. Values of c and ϕ (total stress shear strength parameters) for the as-compacted condition can be determined by performing UU triaxial tests on specimens at their compaction water contents. Undrained strength envelopes for compacted, partially saturated clays tested are curved, as discussed in Chapter 3. Over a given range of stresses, however, a curved strength envelope can be approximated by a straight line and can be characterized in terms of c and ϕ. When this is done, it is especially important that the range of pressures used in the tests correspond to the range of pressures in the field conditions being evaluated. Alternatively, if the computer program used accommodates nonlinear strength envelopes, the strength test data can be represented directly.

Values of total stress c and ϕ for compacted clays vary with compaction water content and density. An example is shown in Figure 5.20 for compacted Pittsburgh sandy clay. The range of confining pressures used in these tests was 1.0 to 6.0 tons/ft^2. The value of c, the total stress cohesion intercept from UU tests, increases with dry density but is not much affected by compaction water content. The value of ϕ, the total stress friction angle, decreases as compaction water content increases, but is not so strongly affected by dry density.

If compacted clays are allowed to age prior to testing, they become stronger, apparently due to thixotropic effects. Therefore, undrained strengths measured using freshly compacted laboratory test specimens provide a conservative estimate of the strength of the fill a few weeks or months after compaction.

MUNICIPAL SOLID WASTE

Waste materials have strengths comparable to the strengths of soils. Strengths of waste materials vary depending on the amounts of soil and sludge in the waste, as compared to the amounts of plastic and other materials that tend to interlock and provide tensile strength (Eid et al., 2000). Larger amounts of materials that interlock increase the strength of the waste. Although solid waste tends to decompose or degrade with time, Kavazanjian (2001) indicates that the strength after degradation is similar to the strength before degradation.

Kavazanjian et al. (1995) used laboratory test data and back analysis of stable slopes to develop the lower-bound strength envelope for municipal solid waste shown in Figure 5.21. The envelope is horizontal with a constant strength c = 24 kPa, ϕ = 0 at normal pressures less than 37 kPa. At pressures greater than 37 kPa, the envelope is inclined at $\phi = 33°$ with $c = 0$.

Eid et al. (2000) used results of large-scale direct shear tests (300 to 1500 mm shear boxes) and back analysis of failed slopes in waste to develop the range of strength envelopes show in Figure 5.22. All three envelopes (lower bound, average, and upper bound) are inclined at $\phi = 35°$. The average envelope shown in Figure 5.22 corresponds to c = 25 kPa, and the lowest of the envelopes corresponds to c = 0.

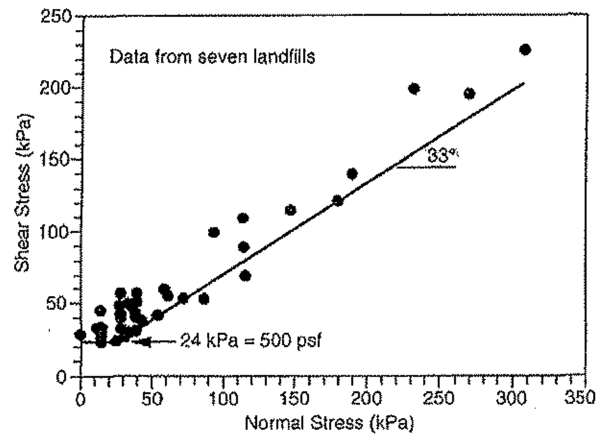


Figure 5.21 Shear strength envelope for municipal solid waste based on large-scale direct shear tests and back analysis of stable slopes. (After Kavazanjian et al., 1995.)

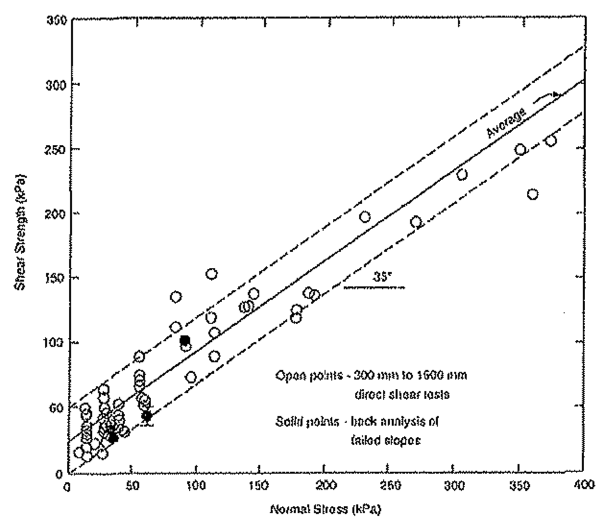


Figure 5.22 Range of shear strength envelopes for municipal solid waste based on large-scale direct shear tests and back analysis of failed slopes. (After Eid et al., 2000.)

Source: Soil Mechanics in Engineering Practice, 3rd Edition
Terzaghi, Peck, and Mesri
John Wiley & Sons, Inc. New York
1996

below almost level ground are subjected to high confining pressures, and contractive shear soil conditions exist. The undrained yield strength, which determines stability for this condition, cannot be easily computed with the aid of Eq. 20.3, and an alternative approach must be used.

20.4 Measurement of Undrained Shear Strength

For many contractive-shear soil conditions, it is not possible to express the undrained shear strength in terms of the strength parameters c'_m and ϕ'_m and the effective-stress state at failure. The alternative is to measure the undrained shear strength directly. However, the undrained shear strength of an element of soil is not a unique value; it depends on the way in which the soil is brought to failure. Modes of shear that take full advantage of the resistance of the natural soil structure and that minimize progressive yielding mobilize the highest undrained shear strength. The more rapidly the shear stress is applied, the greater the measured undrained shear strength. Thus, different *in situ* or laboratory testing devices and procedures that subject soil to different modes and rates of shear and that involve different degrees of progressive yielding measure different values of undrained shear strength. The most common methods of obtaining or directly measuring the undrained shear strength are field vane (*FV*) shear tests and laboratory unconfined compression (*UC*), triaxial compression (*TC*), triaxial extension (*TE*), and direct simple shear (*DSS*) tests. The vane device (Article 11.5.2) is inserted into the ground and then rotated to measure the undrained shear strength. Laboratory shear tests require that samples of *in situ* soil be obtained. Although most *in situ* and laboratory shear devices test a relatively small element of soil, this limitation is rarely a serious problem in the measurement of the undrained shear strength of soft clays, silts, and loose sands.

The measurement of undrained shear strength, perhaps more than any other soil property, is affected by soil disturbance before shearing. Disturbance is involved in both *in situ* testing and in sampling and laboratory testing, although it may be easier to minimize or at least to standardize the effect of disturbance for *in situ* tests than for sampling and testing in laboratory devices. Because of disturbance, the undrained shear strength measured *in situ* or on specimens in the laboratory is usually smaller than the undrained shear strength of a truly undisturbed soil. The magnitude of the reduction varies considerably with the type of soil. The effect of disturbance is generally greater in brittle silty clays of relatively high permeability than in ductile plastic clays of low permeability. Moreover, it depends on the mode of shear used to measure the undrained shear strength. Its significance is greater in modes of shear that cause little disruption of soil structure before yield, and is less in modes that damage soil structure before yield is reached.

The *in situ* vane shear device (Article 11.5.2) tests soil in its natural environment. Insertion of the vane into soft clays and silts, however, causes displacements and changes in stress that disrupt the natural structure of the soil around the vane. Moreover, the undrained shear strength measured 1 day after inserting the vane can be more than 20% higher than that obtained from a standard test carried out about 5 min after insertion. Consolidation increases the strength of the soil around the vane and also increases the adhesion between the blades of the vane and the soil; this minimizes progressive yielding during rotation of the vane. The increase in undrained shear strength s_{uo} (*FV*) with time confirms that the natural soil structure is disturbed during the penetration of the vane. Although this disturbance cannot be eliminated completely, its adverse effect on the applicability of the test results can be minimized by standardization of equipment (e.g., vane stem diameter and blade thickness) and operation (e.g., delay time between penetration and rotation).

All specimens of natural soil deposits tested in laboratory shear devices experience disturbance. The disturbance may have occurred during sampling and handling in the field, during transit to the laboratory, and during laboratory storage and trimming of specimens for the tests. The most serious mechanism of disturbance is shear distortion of the natural soil structure produced by displacement of the soil during conventional tube sampling (Article 11.3.3) and careless handling of the sample thereafter. Other mechanisms of disturbance, which operate especially during long storage periods, are redistribution of water from the outside to the relatively less disturbed inside of the sample that is eventually tested, and chemical changes including oxidation. Because considerable handling of the soil takes place after sampling and there is variable opportunity for additional sample disturbance, it is not practicable to quantify the quality of specimens in terms of sampling devices and procedures. However, a good indicator of the quality of a shear specimen is the specimen quality designation (SQD) (Article 11.3.8) (Table 11.2). Soft clay and silt block samples of A quality can be obtained from excavations or test pits. The Sherbrooke and Laval sampling devices (Article 11.3.7) can take samples of *A* quality down to depths of 15 to 20 m. However, for most projects soft clay and silt samples of *B* quality are adequate. They can be obtained by using 54- to 95-mm fixed-piston, thin-walled tube samplers with area ratios not exceeding about 10% (Article 11.3.4). The sampler must be pushed, not driven, into the ground.

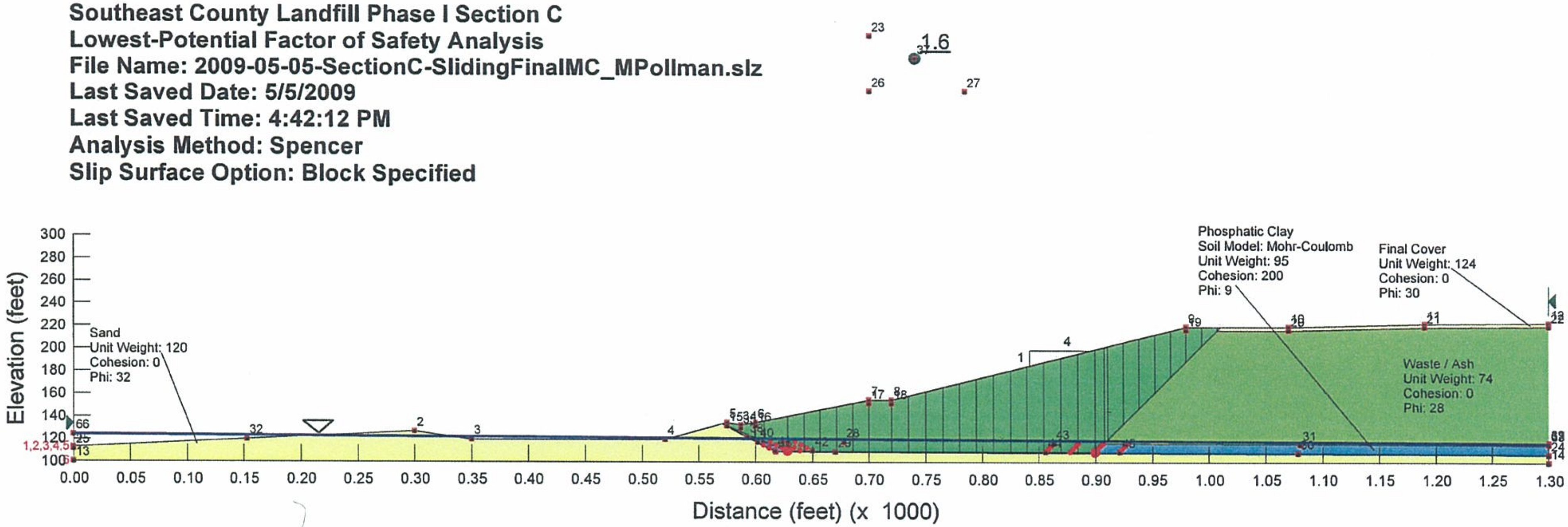
Although Table 11.2 is a good indicator of the quality of shear specimens, it does not offer a unique assessment of the effect of disturbance on the undrained shear strength of every type of soil. The same magnitude of volumetric strain may imply a smaller disturbance-related reduction in undrained shear strength for plastic soft clays than for

ATTACHMENT 4

SLOPE STABILITY ANALYSIS PRINTOUTS

Section C Factor of Safety Against Sliding Block Failure = 1.6

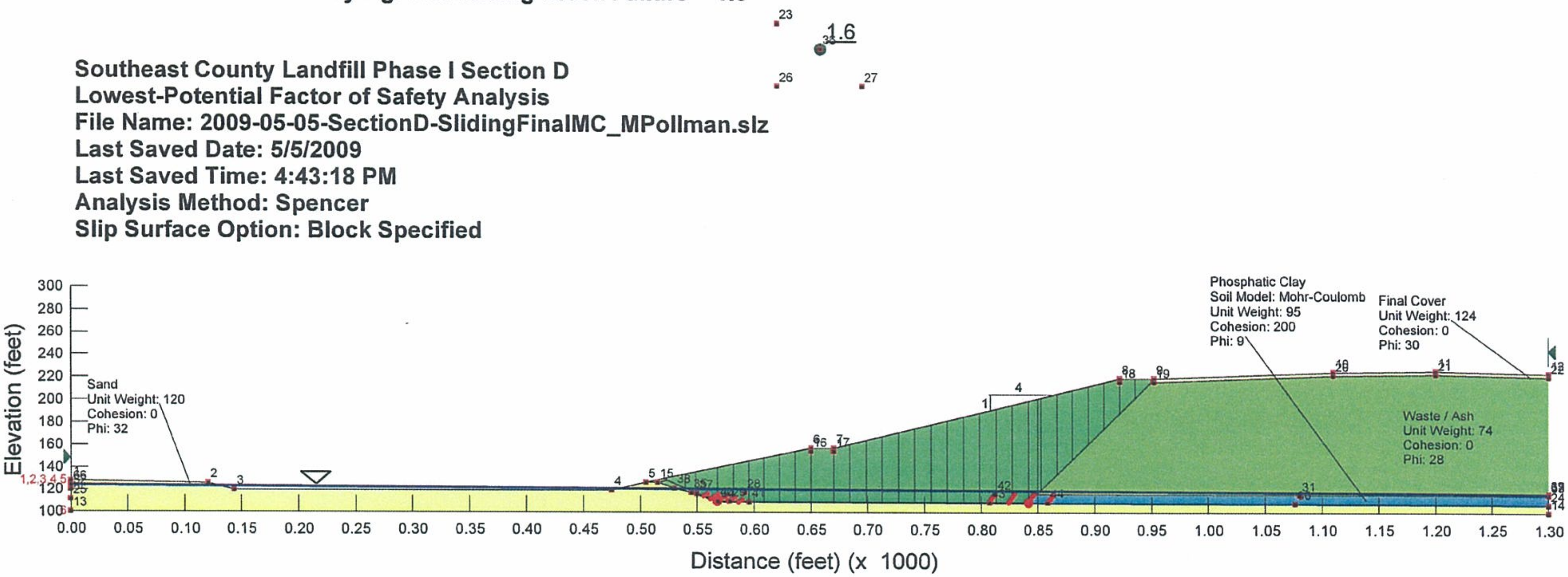
Southeast County Landfill Phase I Section C
Lowest-Potential Factor of Safety Analysis
File Name: 2009-05-05-SectionC-SlidingFinalMC_MPollman.slz
Last Saved Date: 5/5/2009
Last Saved Time: 4:42:12 PM
Analysis Method: Spencer
Slip Surface Option: Block Specified



\\Gnv-projects\projects\08449-Hillsborough\030-02-APLFEngSvc2008\Stability Analysis Ph1-6 with Ponds\Attachment3-SlopeStabilityAnalysesPrint-outs

Section D Factor of Safety Against Sliding Block Failure = 1.6

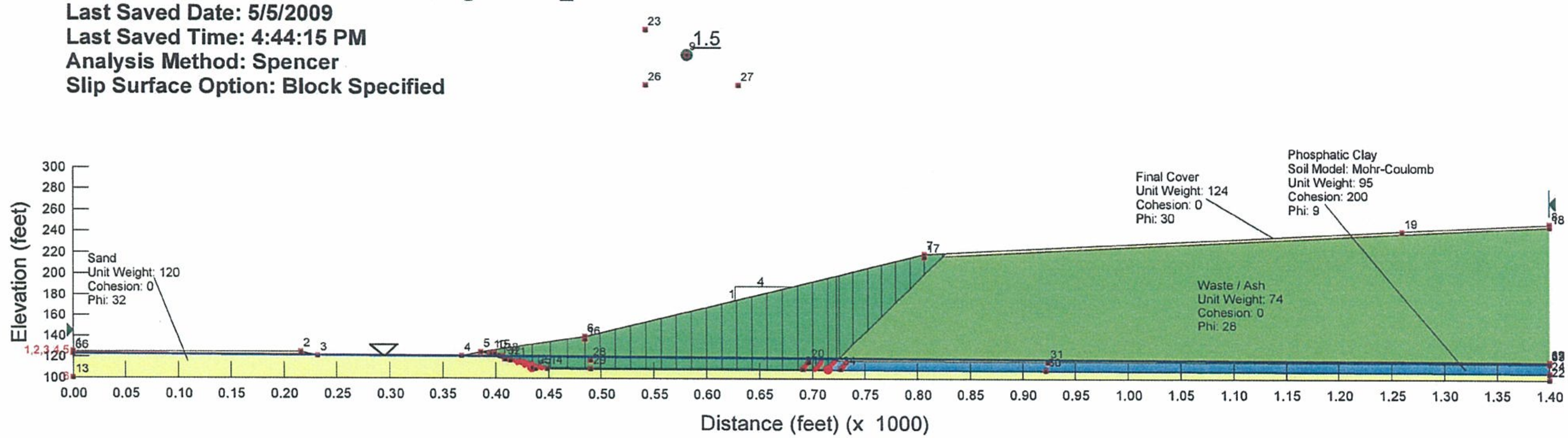
Southeast County Landfill Phase I Section D
Lowest-Potential Factor of Safety Analysis
File Name: 2009-05-05-SectionD-SlidingFinalMC_MPollman.slz
Last Saved Date: 5/5/2009
Last Saved Time: 4:43:18 PM
Analysis Method: Spencer
Slip Surface Option: Block Specified



\\Gnv-projects\projects\08449-Hillsborough\030-02-APLFEngSvc2008\Stability Analysis Ph1-6 with Ponds\Attachment3-SlopeStabilityAnalysesPrint-outs

Section E Factor of Safety Against Sliding Block Failure = 1.5

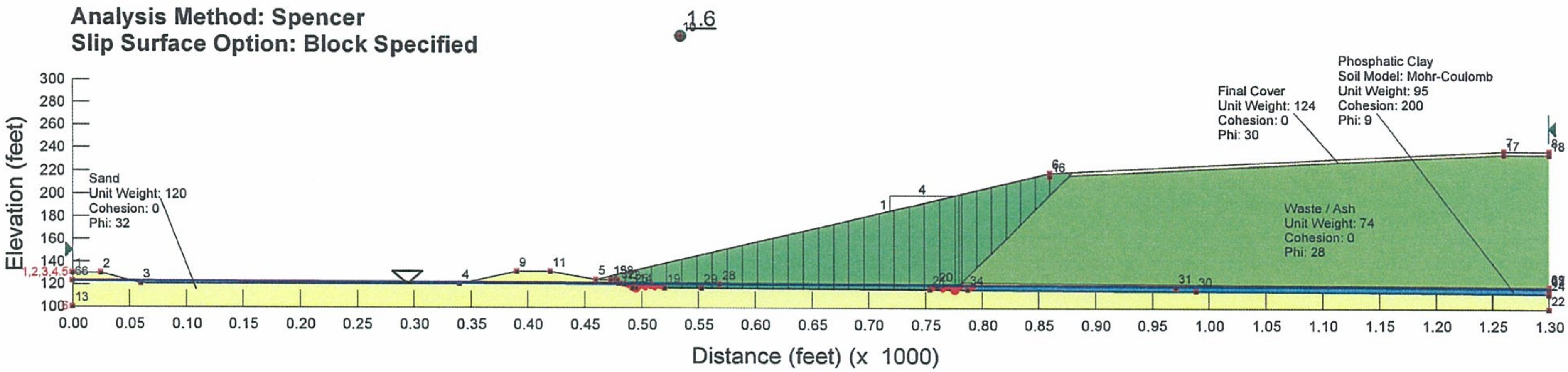
Southeast County Landfill Phase I-VI Section E - Final Grade
Lowest-Potential Factor of Safety Analysis
File Name: 2009-05-05-SectionE-SlidingFinalMC_MPollman.slz
Last Saved Date: 5/5/2009
Last Saved Time: 4:44:15 PM
Analysis Method: Spencer
Slip Surface Option: Block Specified



\\Gnv-projects\projects\08449-Hillsborough\030-02-APLFEngSvc2008\Stability Analysis Ph1-6 with Ponds\Attachment3-SlopeStabilityAnalysesPrint-outs

Section F- Factor of Safety Against Sliding Block Failure = 1.6

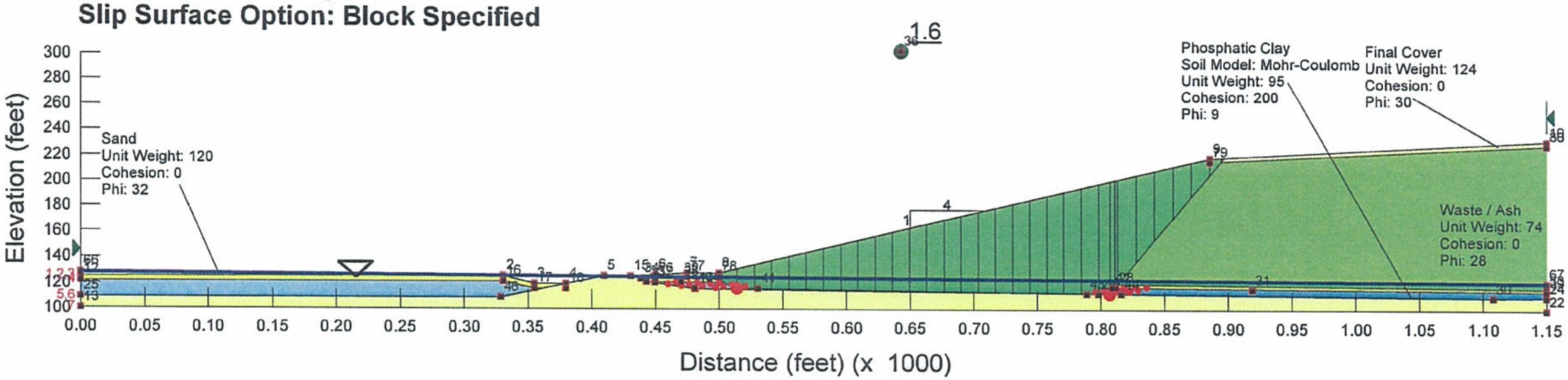
Southeast County Landfill Phase I Section F
Lowest-Potential Factor of Safety Analysis
File Name: 2009-05-05-SectionF-SlidingFinalMC_MPollman.slz
Last Saved Date: 5/5/2009
Last Saved Time: 4:38:31 PM
Analysis Method: Spencer
Slip Surface Option: Block Specified



\\Gnv-projects\projects\08449-Hillsborough\030-02-APLFEngSvc2008\Stability Analysis Ph1-6 with Ponds\Attachment3-SlopeStabilityAnalysesPrint-outs

Section G Factor of Safety Against Sliding Block Failure = 1.6

Southeast County Landfill Phase I Section G - Final Grade
Lowest-Potential Factor of Safety Analysis
File Name: 2009-05-05-SectionG-SlidingFinalMC_MPollman.slz
Last Saved Date: 5/5/2009
Last Saved Time: 4:47:13 PM
Analysis Method: Spencer
Slip Surface Option: Block Specified



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Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

MAY 08 2009

May 7, 2009
File Number 08-032

Jones Edmunds & Associates, Inc.
324 South Hyde Park Avenue
Suite 250
Tampa, FL 33606-4110

#2 -
Complete
Phase I - Clay Rep.

Attention: Mr. Jason Timmons, P.E.
Project Engineer

Subject: Results of Laboratory Strength Testing of Waste Phosphatic Clay Samples from Phase I Area of Southeast County Landfill, Hillsborough County, Florida

Gentlemen/Ladies:

As requested by Jones Edmunds & Associates, Inc. (Jones Edmunds), Ardaman & Associates, Inc. (Ardaman) is pleased to submit this report to present results of laboratory strength testing for waste phosphatic clay samples recovered from the Phase I Area of the Southeast County Landfill Facility in 2007 and 2008.

Sampling and Testing in 2007

Two soil borings, designated TH-1O and TH-1P, were performed by Ardaman in 2007 in the Phase I area at the locations shown on the boring location map in Appendix A. TH-1O was drilled within the western half near the north side of the Phase I area, adjacent to the piezocone test site designated PC-1O, which was performed as part of the 2007 annual monitoring program. TH-1P was advanced near the eastern end of the Phase I area, adjacent to the piezocone test site designated PC-1P, also performed as part of the 2007 annual monitoring program. The soil borings were advanced through the entire depths of refuse/ash and drainage sand layer to recover samples of the underlying waste phosphatic clay for laboratory testing. A total of three undisturbed samples were recovered, with two samples from TH-1O and one sample from TH-1P.

In TH-1O and TH-1P, the top of waste phosphatic clay was encountered at depths of 71 and 70 feet below landfill surface, and the waste phosphatic clay thicknesses were documented to be 8.5 and 4.5 feet, respectively. The original waste phosphatic clay deposit was thinnest (4 to 8 feet) along the south side of the Phase I area where TH-1P was drilled. Along the west side of the Phase I area where TH-1O was drilled, the original phosphatic clay thickness could have been as much as 8 to 10 feet.

Ardaman performed unconfined compression tests, unconsolidated-undrained triaxial tests, and direct simple shear tests on the recovered undisturbed waste phosphatic clay samples. Results of these undrained shear strength measurements are presented in the laboratory reports in Appendix B and are summarized in the following table.

Test Hole	Sample	Depth (feet)	Test Type*	Undrained Shear Strength (psf)
TH-1O	US-2	73.5 – 75.5	UU	530
TH-1O	US-4	77.5 – 79.5	UU	640
TH-1P	US-1	70.5 – 72.5	UU	1,350
* Unconsolidated-undrained triaxial tests.				

As shown, the laboratory measurements indicated that the west side of the Phase I area, with an overburden load of approximately 70 feet and a waste phosphatic clay thickness of approximately 8 feet, had undrained shear strengths of 530 to 640 psf, characteristic of a medium stiff clay. The south side of the Phase I area, with a refuse/ash overburden load of approximately 70 feet and a waste phosphatic clay thickness of approximately 4 feet, had a higher undrained shear strength of 1,350 psf, characteristic of a stiff clay. The moisture contents of the undisturbed samples recovered from TH-1O were generally higher than those recovered from TH-1P, which confirmed that the undrained shear strengths of the waste phosphatic clay were higher at TH-1P than at TH-1O.

For comparisons, an undisturbed sample obtained at a depth of 42 feet below the landfill surface from the Phase I area in 1994 yielded an undrained shear strength of 460 psf. In its original state, the phosphatic clay below the desiccated crust had an undrained shear strength on the order of 70 psf.

Sampling and Testing in 2008

Four soil borings, designated TH-1Q1, TH-1Q2, TH-1Q6, and TH-1B-S3, were performed by Ardaman in 2008 in the Phase I area to recover undisturbed samples of the waste phosphatic clay for laboratory testing. TH-1Q1 and TH-1Q2 were drilled in July 2008, and TH-1Q6 and TH-1B-S3 were drilled in November 2008. These soil borings were performed within the western half of the Phase I area. TH-1Q1, TH-1Q2, and TH-1Q6 were located close to the crest of the existing landfill slope, whereas TH-1B-S3 was drilled at a greater distance from the existing landfill slope crest (i.e., towards the interior of the landfill), as shown on the boring location plan in Appendix A.

The soil borings were advanced through the entire depths of refuse/ash and the drainage sand layer to allow recovery of undisturbed samples of the waste phosphatic clay using a Shelby tube sampler. The approximate depths and thicknesses of the waste phosphatic clay layer encountered in the soil borings are summarized in the following table.

Test Hole	Approx Depth to Waste Phosphatic Clay Layer Below Land Surface (feet)	Approx Thickness of Waste Phosphatic Clay Layer (feet)
TH-1Q1	56.0	5.5
TH-1Q2	56.0	4.0
TH-1Q6	61.5	4.0
TH-1B-S3	70.0	4.5

As shown in the table above, the waste phosphatic clay was encountered at a depth ranging from 56 to 70 feet below land surface, and had a thickness of 4.0 to 5.5 feet at the soil boring locations.

To characterize the undrained shear strengths of the waste phosphatic clay, Ardaman performed unconfined compression tests, unconsolidated-undrained triaxial tests, and direct simple shear tests on selected samples of the waste phosphatic clay recovered from the four soil borings. Results of the laboratory strength tests are presented in the laboratory reports in Appendix B and are summarized in the following table.

Test Hole	Sample Number	Depth (feet)	Test Type*	Undrained Shear Strength (psf)	Estimated Overburden Pressure (psf)	Applied Normal Load Prior to Shear (psf)
TH-1Q1	US-1	56-58	UC	1,630	4,320	-
TH-1Q1	US-2	58-60	UU	1,140	4,520	-
TH-1Q1	US-3	60-62	UC	540***	4,720	-
TH-1Q2	US-1	56-58	UC	1,500	4,320	-
TH-1Q2	US-2	58-60	UU	1,750	4,520	-
TH-1Q6	US-1	61.6-63.6	UU	1,340	4,400	-
TH-1Q6	US-2	63.5-65.5	DSS	2,160**	4,840	13,040
TH-1B-S3	US-1	69.6-71.6	UU	1,030	4,880	-
TH-1B-S3	US-1	69.6-71.6	DSS	2,320**	4,880	14,660

* UC = Unconfined Compression Test. UU = Unconsolidated-Undrained Triaxial Test. DSS = Direct Simple Shear Test.
** Undrained shear strength obtained using a normal load greater than the existing overburden pressure. The measured strengths are lower than expected because of laminations.
*** Sample may have been disturbed as a result of intrusion from natural ground soils below.

The unconfined compression tests and unconsolidated-undrained triaxial tests were conducted to provide estimates of undrained shear strengths of the waste phosphatic clay under existing condition. For the direct simple shear tests, a normal load exceeding the existing overburden pressure was used to "mask" any effect of sample disturbance, which could potentially result in lower measured strength values. Therefore, the measured undrained shear strengths from the direct simple shear tests do not represent the *in situ* undrained shear strengths under existing condition.

With the exception of the sample designated US-3 obtained from a depth of 60 to 62 feet below land surface in TH-1Q1, results of the unconfined compression tests and unconsolidated-undrained triaxial tests yielded undrained shear strength values that ranged from 1,030 to 1,750 psf, and averaged approximately 1,400 psf from six measurements. The low undrained shear strength measured in US-3 from TH-1Q1 could be attributed to sample disturbance due to intrusion of natural ground soils into the waste phosphatic clay when the Shelby tube sampler was pushed below the bottom of the waste phosphatic clay.

The two direct simple shear tests were performed using applied normal loads that were approximately 2.5 to 3.0 times greater than the existing overburden pressure. Under the existing overburden pressures at the boring locations, the undrained shear strengths of the waste phosphatic clay were estimated to on the order of 700 to 800 psf, which were lower than expected. Visual examinations of the tested specimens revealed the presence of thin laminations or varves (≤ 2mm thick) that would be expected to produce lower undrained shear strengths in the horizontal shearing mode of a direct simple shear test where the failure surface could occur along one or more horizontal laminations. Waste phosphatic clays typically do not occur as laminated (varved) clays and, hence, the lower undrained shear strengths measured on the two specimens are not considered representative of site condition.

Ardaman appreciates the opportunity to provide services to Jones Edmunds and Hillsborough County. If you have any questions or need additional information, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

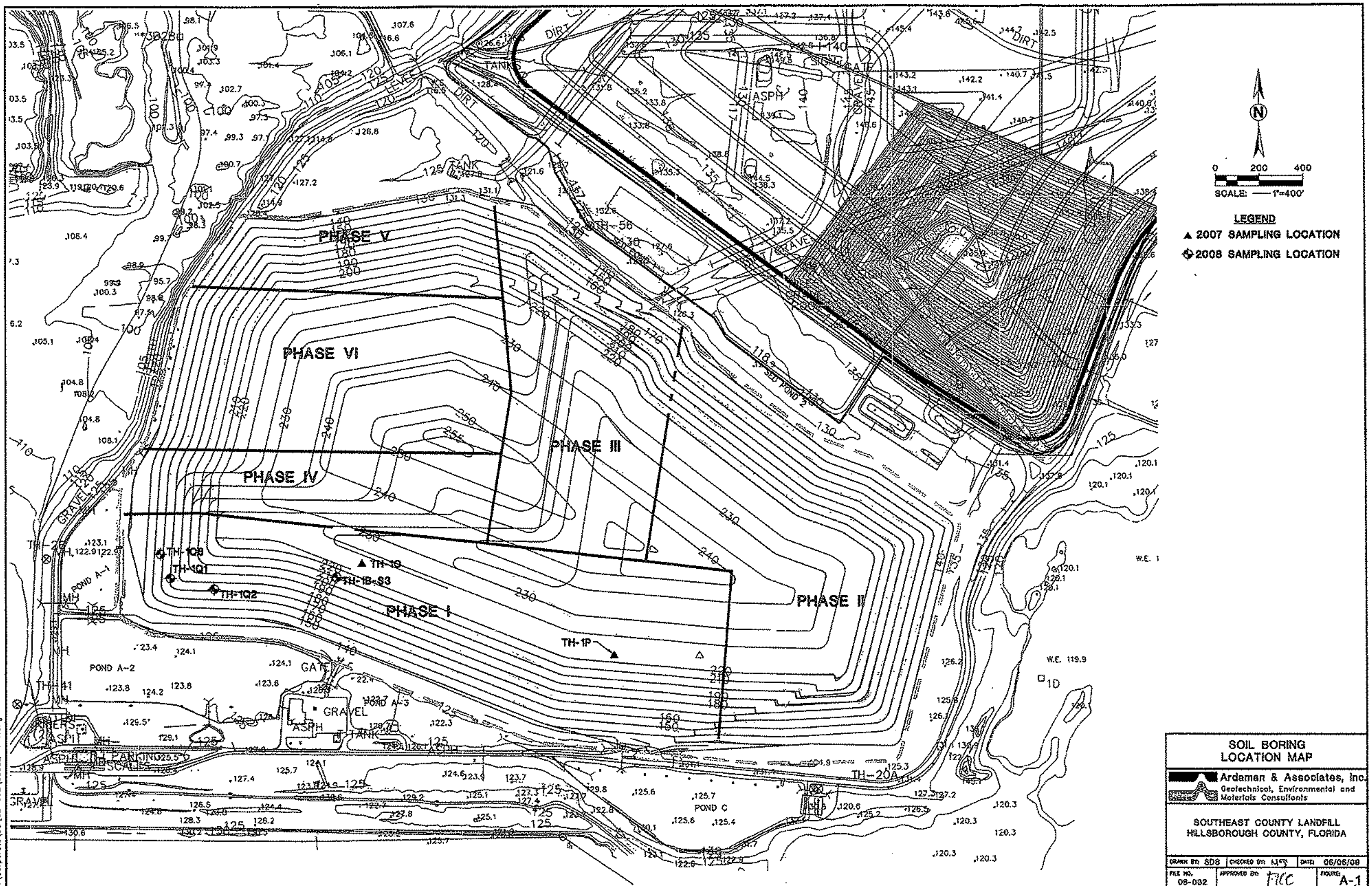
Jeyisanker Mathiyaparanam, E.I.
Assistant Project Engineer

Francis K. Cheung, P.E. 03/07/09
Senior Project Engineer
Florida License No. 36382

Enclosures

Appendix A

Boring Location Plan



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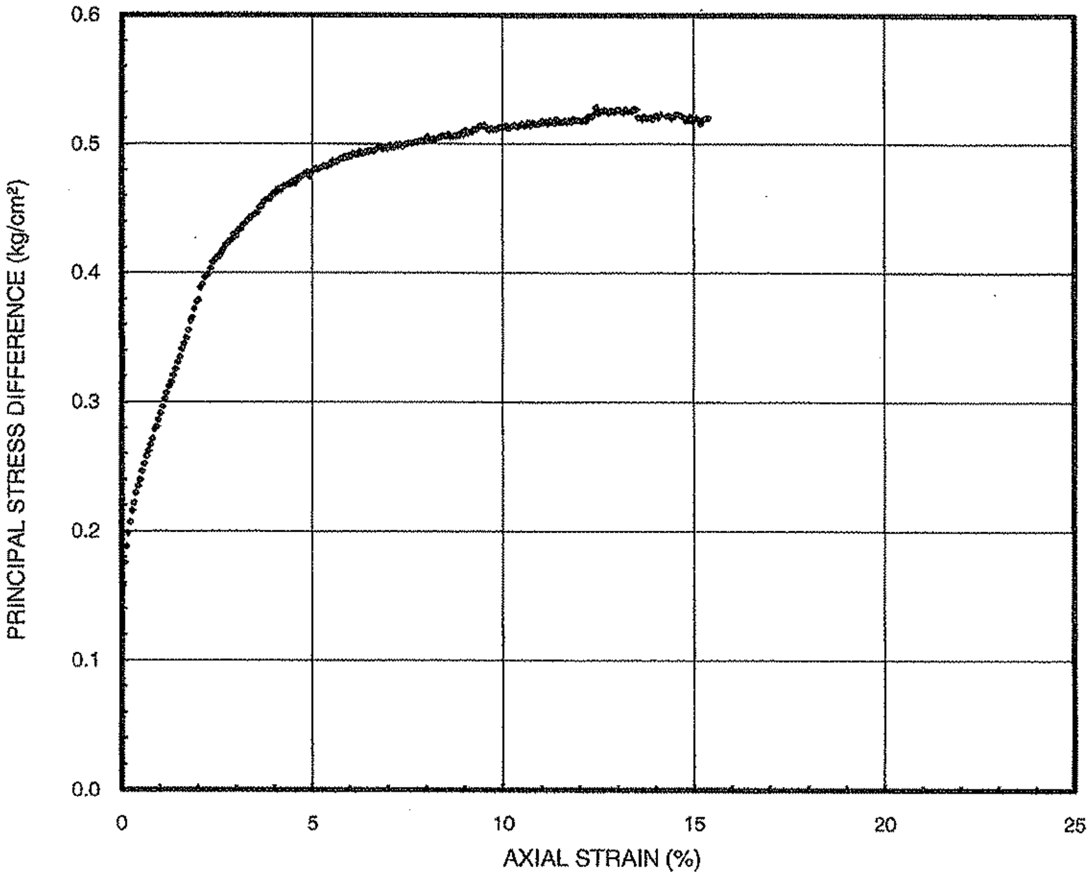
Plotted: May 07, 2009 - 9:27am by scott.stevenson

Appendix B

Laboratory Test Data

Project Name	HCLF
Project Number	06-212
Sample Name	PC-10 US2 B3
Depth	73.5-75.5
Cell Pressure	2.75 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM PC-10-B3

Description	Gray clay
Initial Height	7.125 cm
Initial Diameter	3.544 cm
Dry Density	51.6 pcf
Water Content	86.1 %
Saturation	102 %

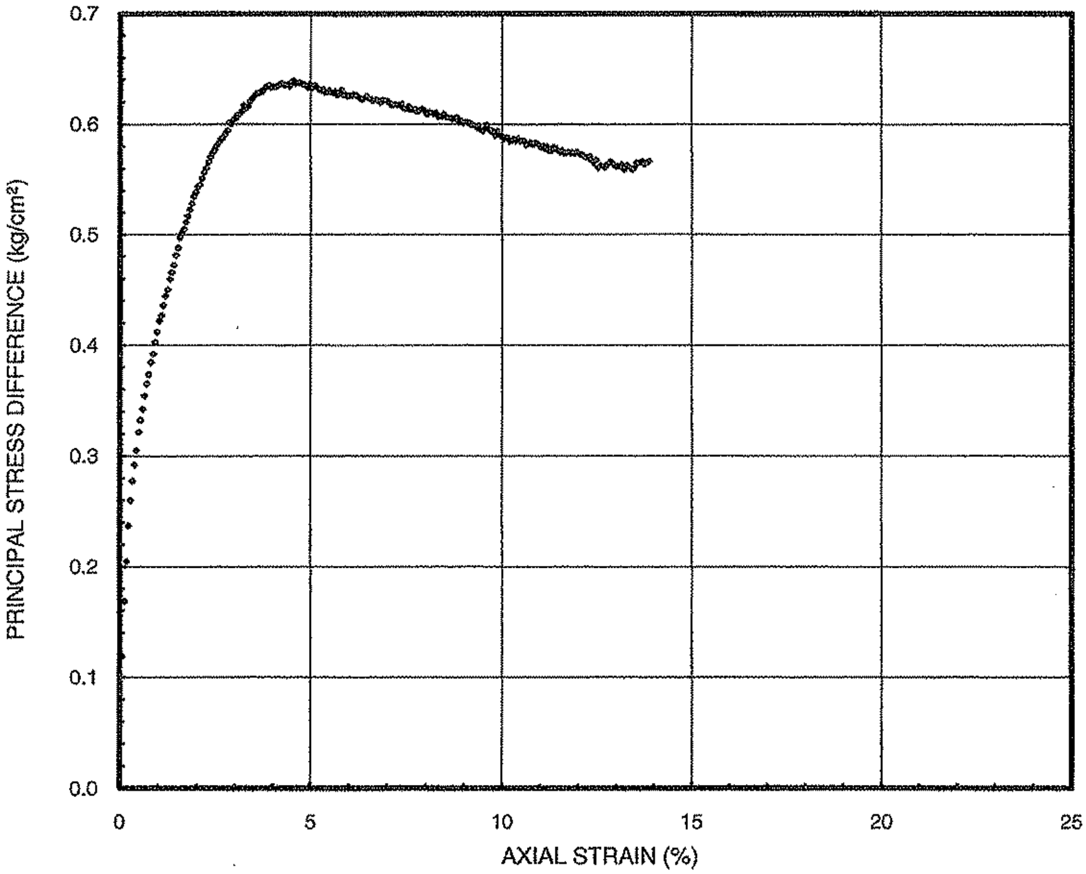
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09	
FILE NO.: 08-032	APPROVED BY: FKC		FIGURE: 1

Project Name	06-212
Project Number	HCLF
Sample Name	PC10 US4 B2
Depth	77.5-79.5
Cell Pressure	2.75 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-4 FROM PC-1O-B2

Description	Gray clay
Initial Height	7.106 cm
Initial Diameter	3.558 cm
Dry Density	55.0 pcf
Water Content	77.2 %
Saturation	100 %

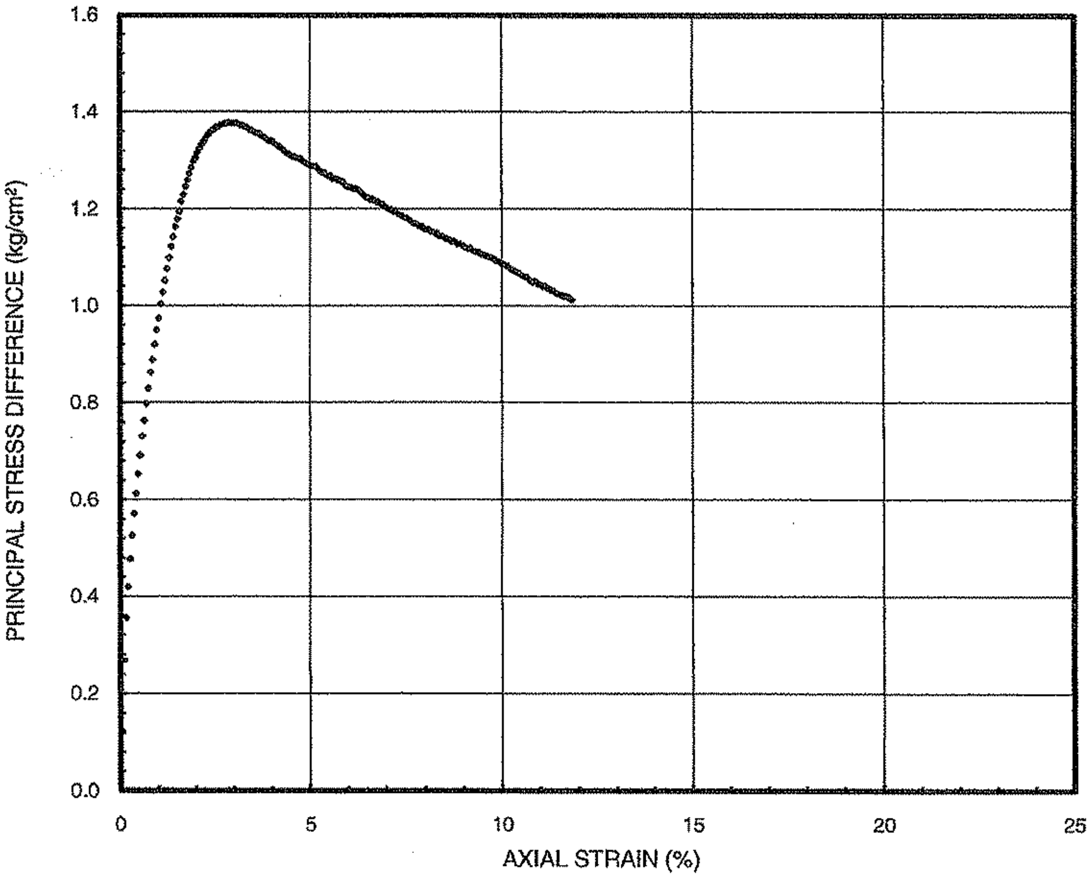
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 2

Project Name HCLF
Project Number 06-212
Sample Name THPC1P US1 B4
Depth 70.5-72.5
Cell Pressure 2.50 kg/cm²
Strain Rate 1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-1 FROM PC-1P-B4

Description Gray Clay

Initial Height	7.12	cm
Initial Diameter	3.58	cm
Dry Density	53.5	pcf
Water Content	80.9	%
Saturation	100	%

TYPE OF FAILURE

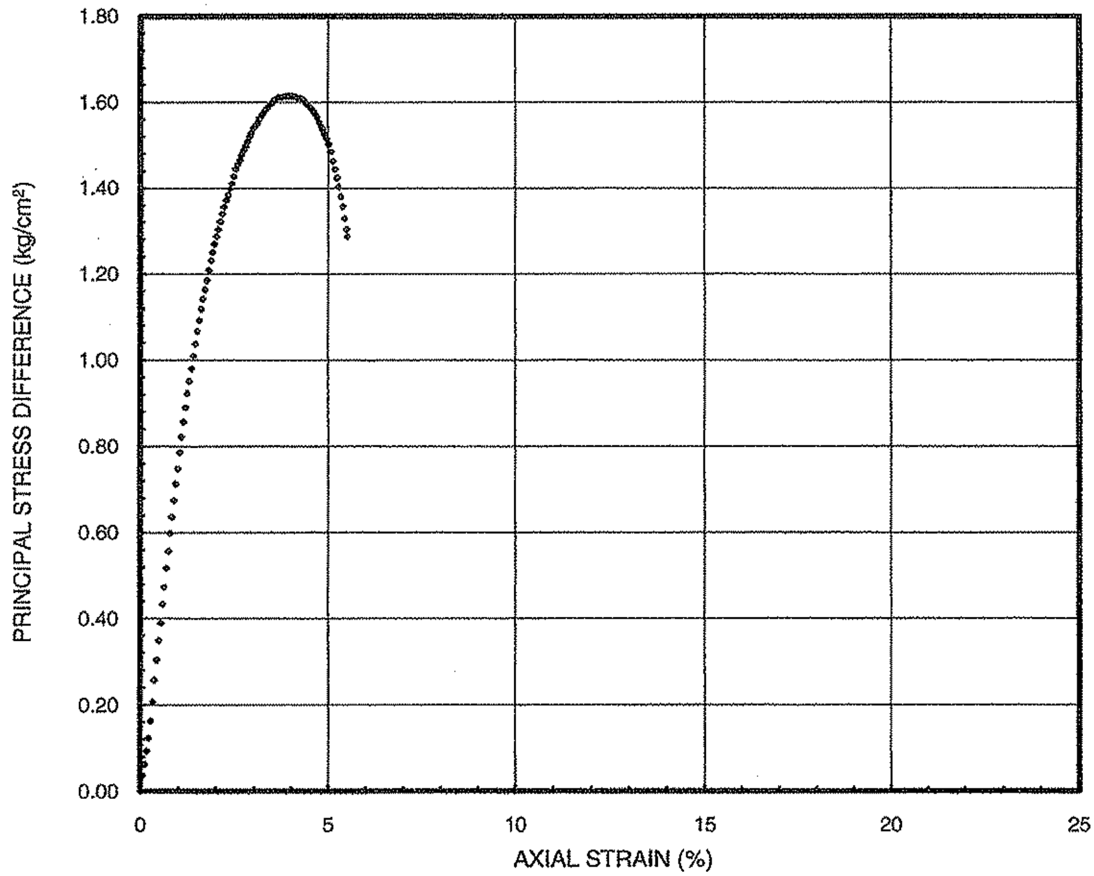
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 3

Project Name SELF
Project Number 08-032
Sample Name TH1Q1 US1 B2
Depth 56-58 ft

Strain Rate 1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-1 FROM TH-1Q1-B2

Description Gray clay

Initial Height	7.103	cm
Initial Diameter	3.561	cm
Dry Density	45.0	pcf
Water Content	103.0	%
Saturation	99	%

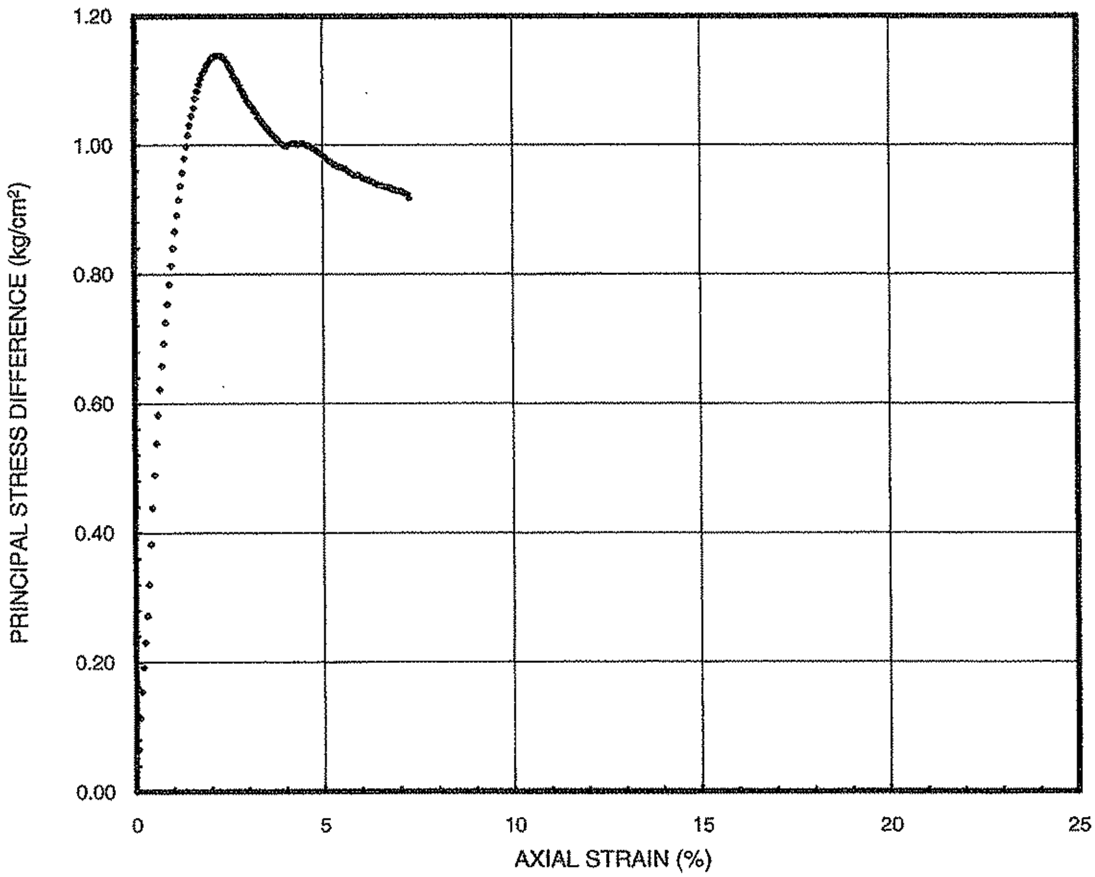
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 4

Project Name	SELF
Project Number	08-032
Sample Name	TH-1Q1 US2 B2
Depth	58-60 ft
Cell Pressure	1.48 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM TH-1Q1-B2

Description	Gray clay	
Initial Height	7.104	cm
Initial Diameter	3.559	cm
Dry Density	52.6	pcf
Water Content	83.9	%
Saturation	100	%

TYPE OF FAILURE

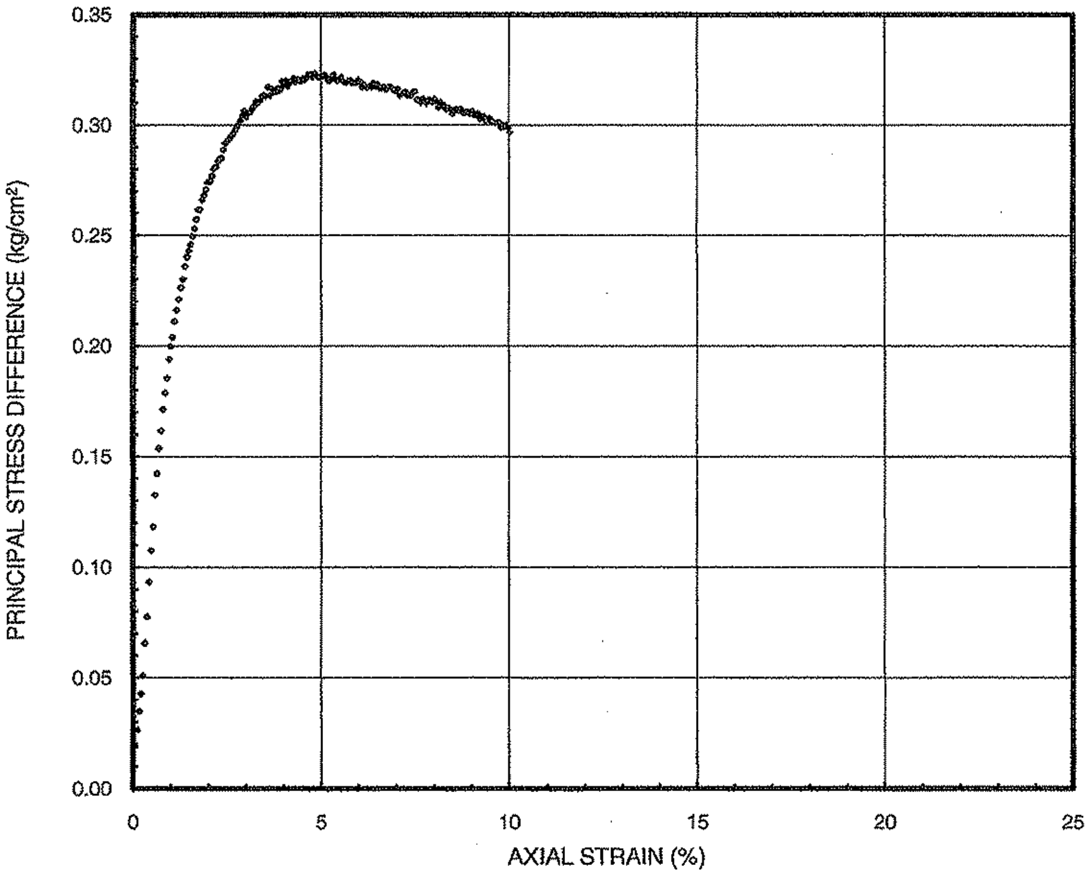
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 5

Project Name SE LANDFILL
Project Number 08-032
Sample Name TH1Q1 US3 B1
Depth 60-62 ft

Strain Rate 1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-3 FROM TH-1Q1-B1

Description	Gray clay
Initial Height	7.089 cm
Initial Diameter	3.554 cm
Dry Density	49.1 pcf
Water Content	91.6 %
Saturation	100 %

TYPE OF FAILURE

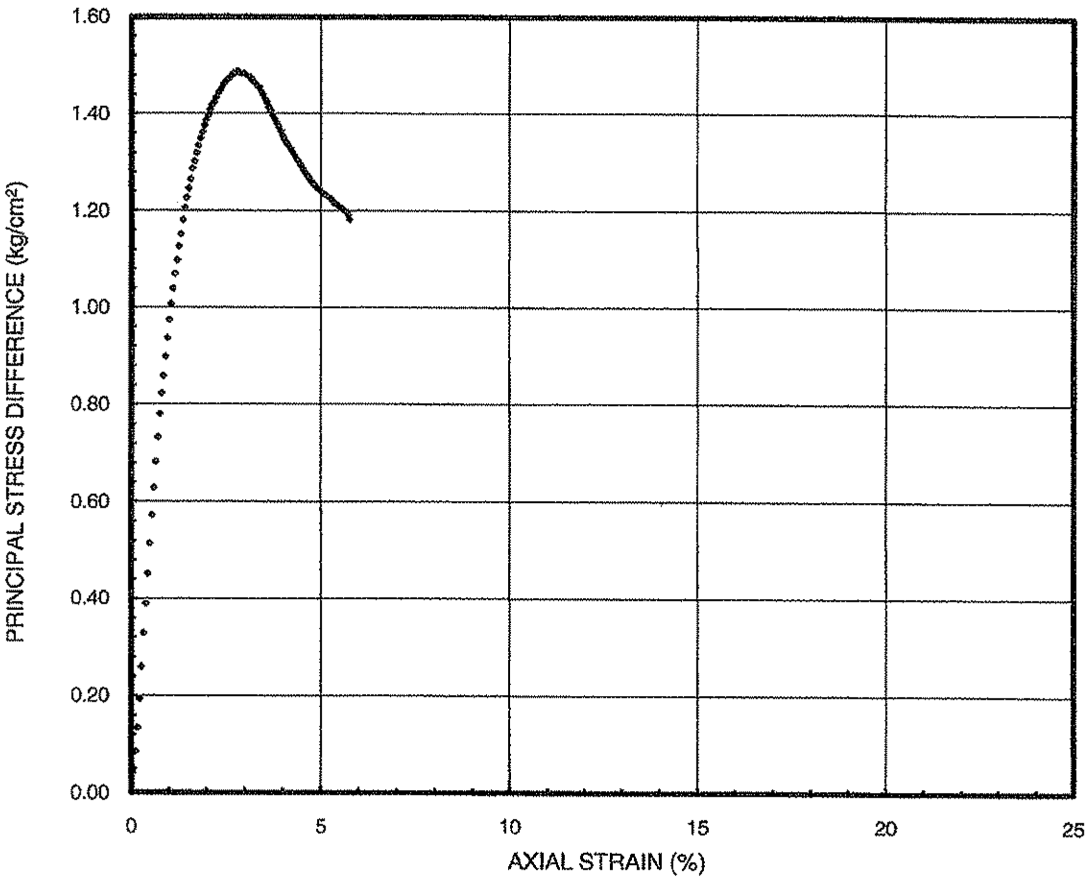
Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 6

Project Name SELF
Project Number 08-032
Sample Name TH1Q2 US1 B2
Depth 56-58 ft

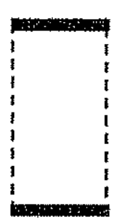
Strain Rate 1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-1 FROM TH-1Q2-B2

Description Gray clay

Initial Height 7.097 cm
Initial Diameter 3.563 cm
Dry Density 48.0 pcf
Water Content 94.1 %
Saturation 99 %



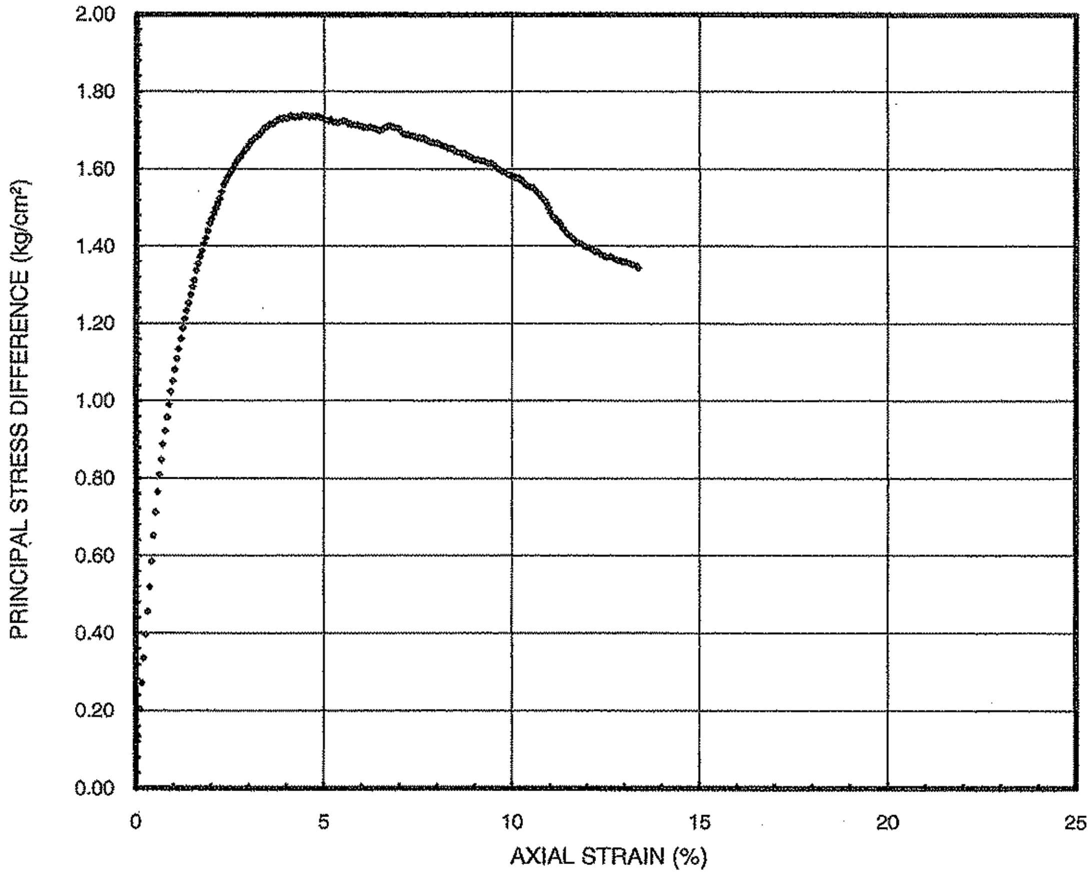
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

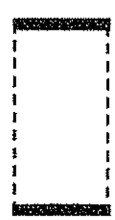
DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 7

Project Name	SELF
Project Number	08-032
Sample Name	TH1Q2 US2 B2
Depth	58-60 ft
Cell Pressure	2.95 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
FOR SAMPLE US-2 FROM TH-1Q2-B2

Description	Gray clay
Initial Height	7.094 cm
Initial Diameter	3.563 cm
Dry Density	47.6 pcf
Water Content	95.9 %
Saturation	100 %



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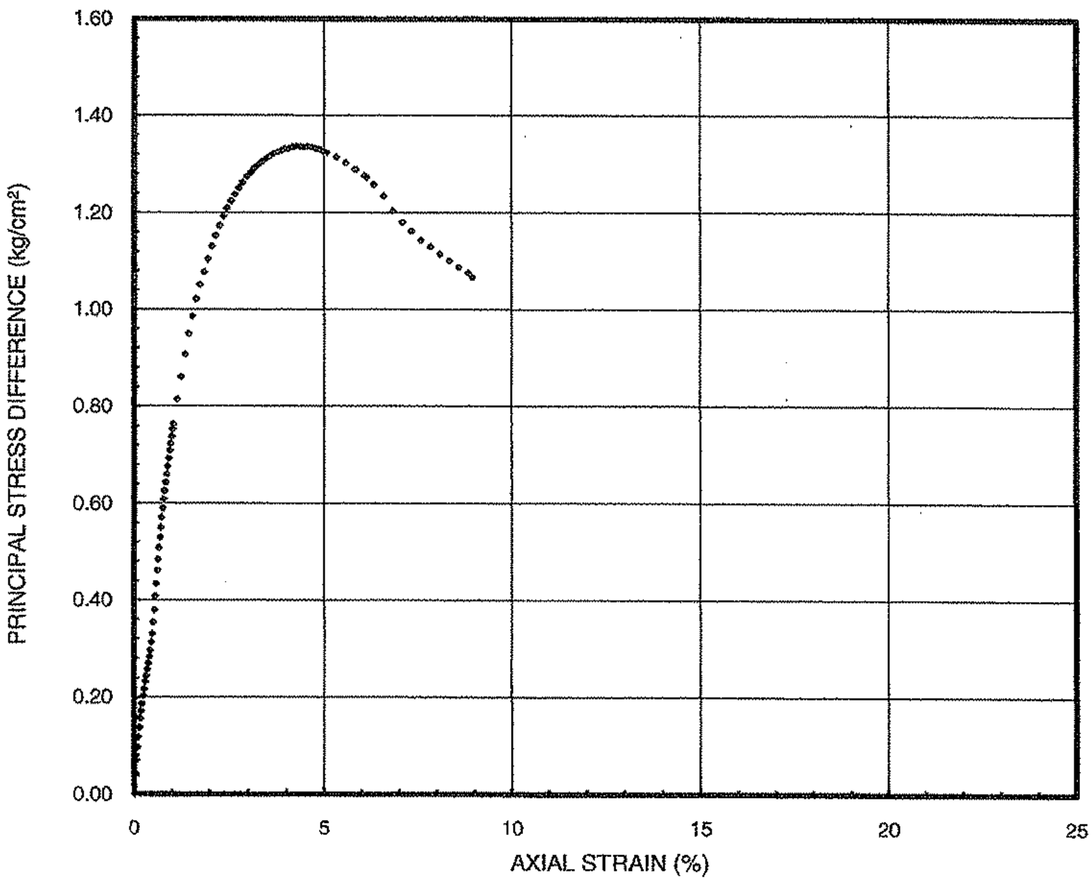
SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 8

Project Name	SELF
Project Number	08-032
Sample Name	TH1Q6 US1
Depth	61.6-63.6 ft
Cell Pressure	2.20 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST FOR SAMPLE US-1 FROM TH-1Q6

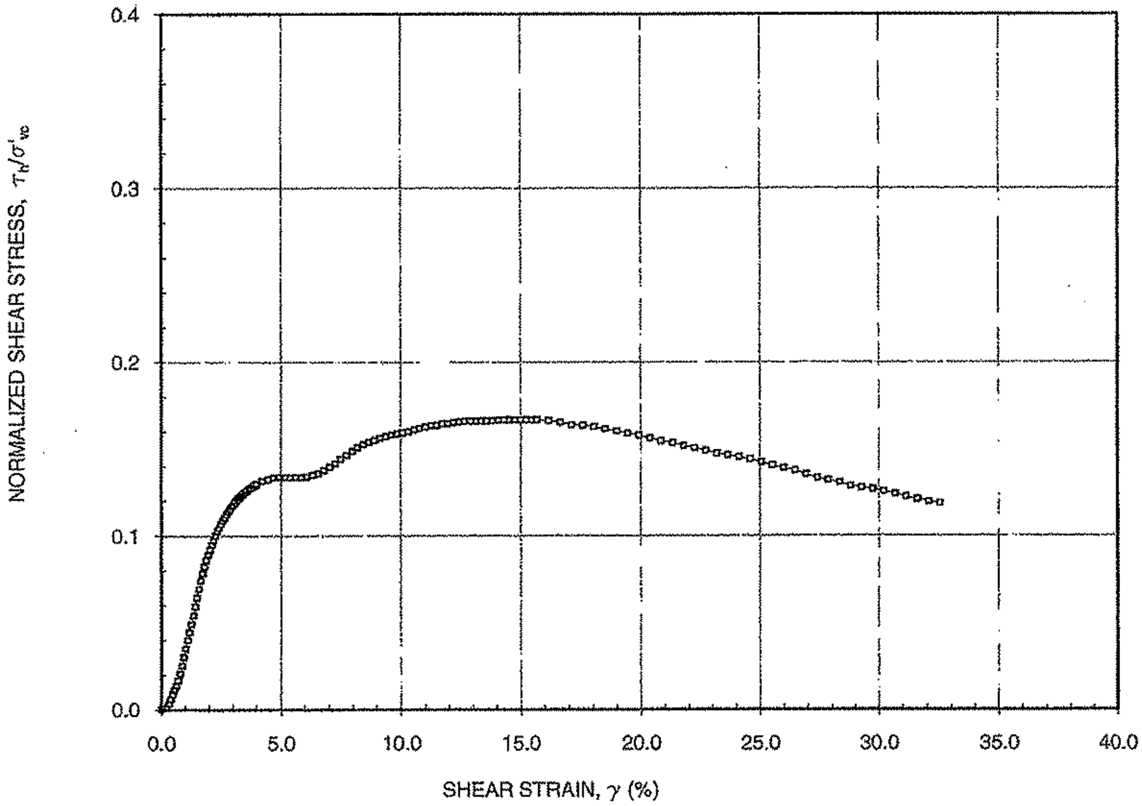
Description	Gray clay
Initial Height	7.078 cm
Initial Diameter	3.569 cm
Dry Density	47.5 pcf
Water Content	95.6 %
Saturation	100 %

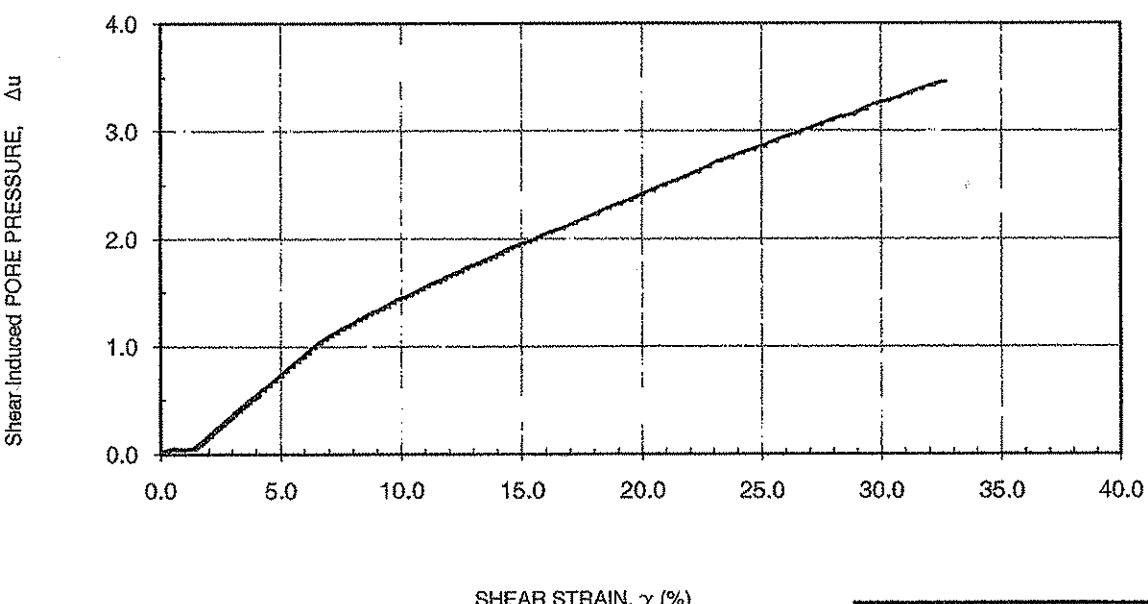
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 9





RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-2 FROM TH-1Q6

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SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

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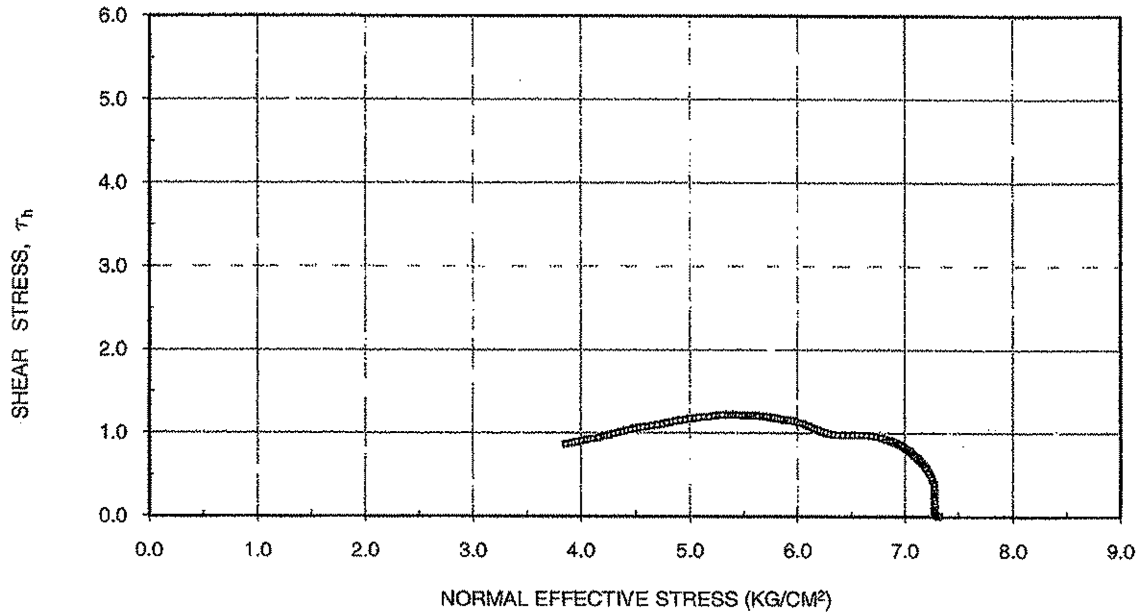
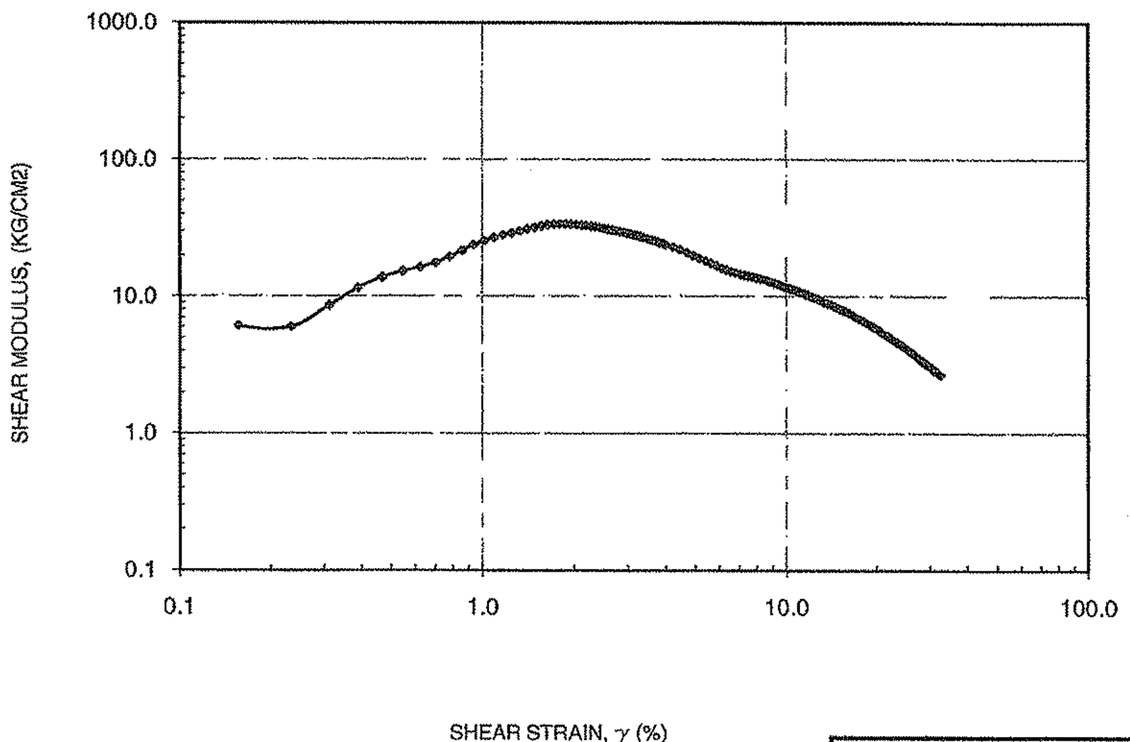
FILE NO.: 08-032	APPROVED BY: FKC		FIGURE: 10-1





RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-2 FROM TH-1Q6

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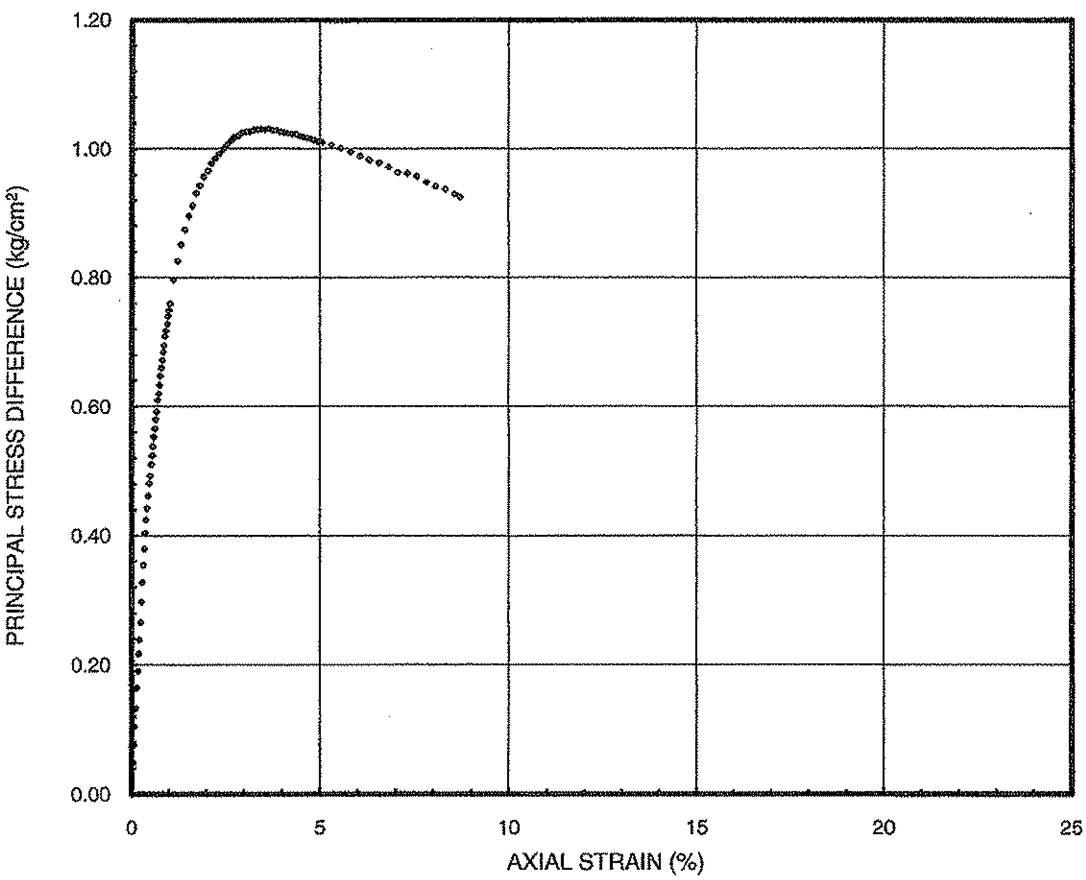
SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 10-2

Project Name	SELF
Project Number	08-032
Sample Name	PC-1BS3 US1
Depth	69.6-71.6 ft
Cell Pressure	2.44 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
FOR SAMPLE US-1 FROM TH-1B-S3

Description Lt gray clay

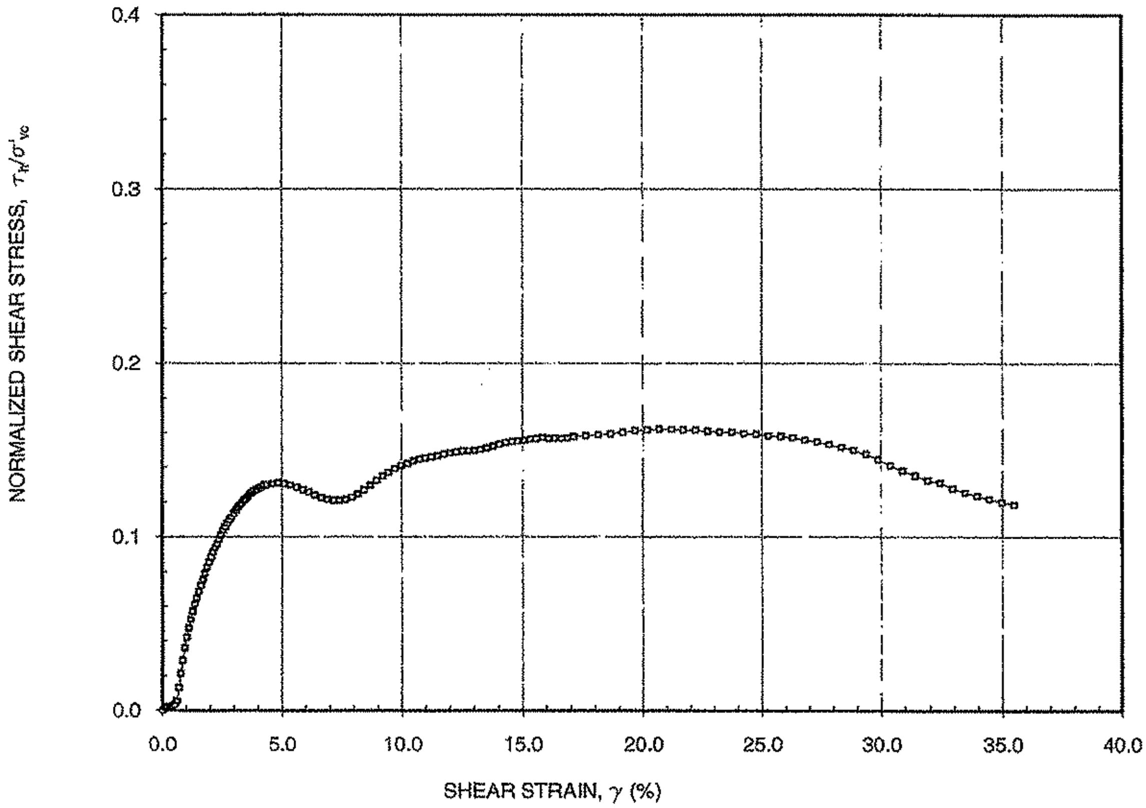
Initial Height	7.083 cm
Initial Diameter	3.569 cm
Dry Density	54.8 pcf
Water Content	79.2 %
Saturation	100 %

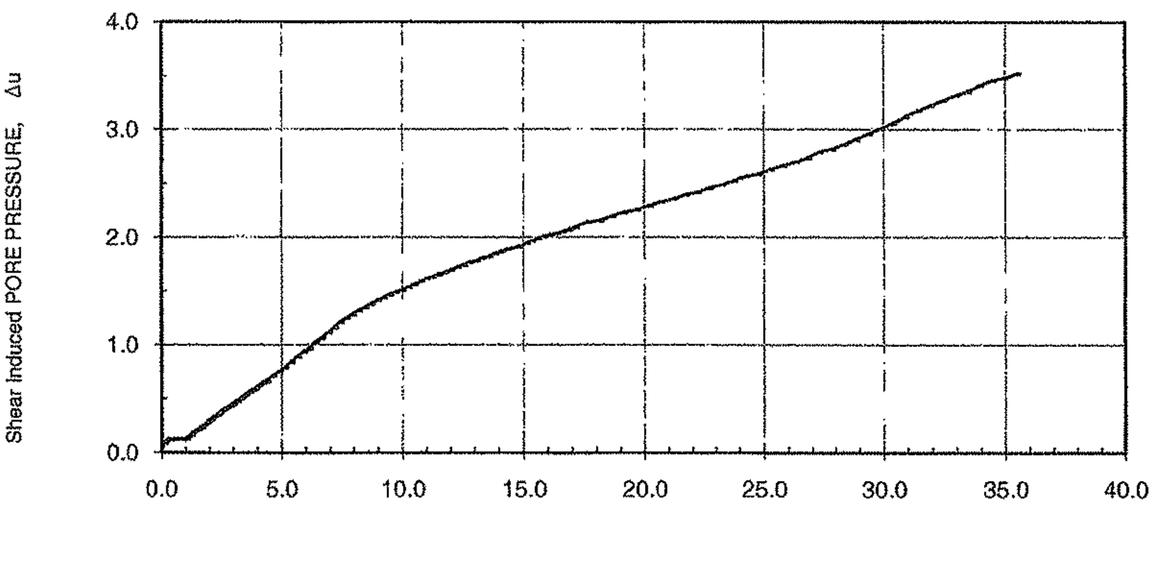
TYPE OF FAILURE

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 11



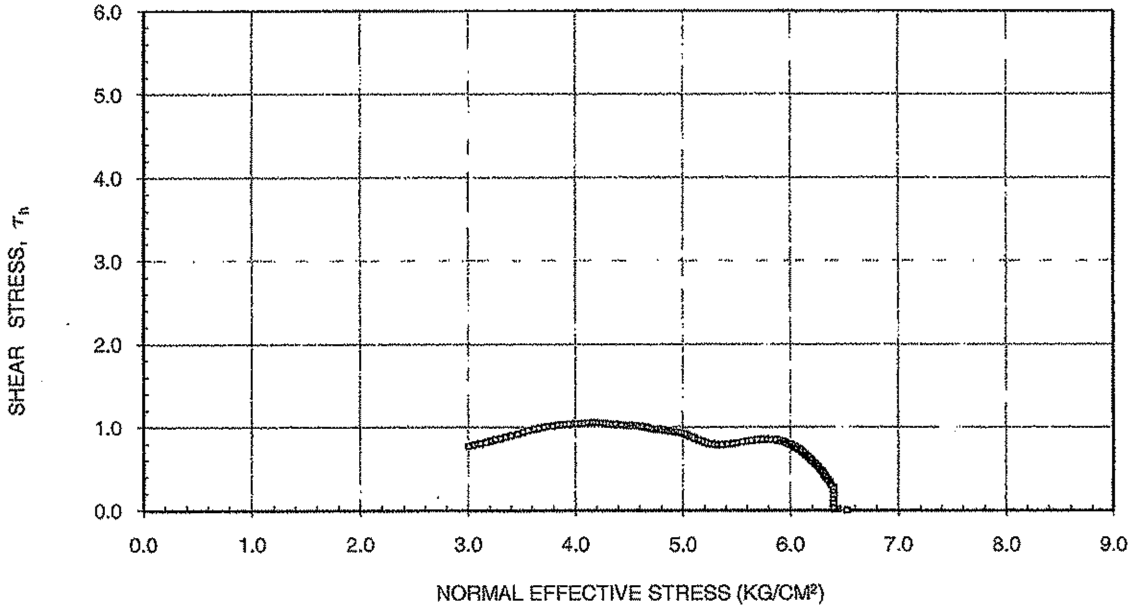


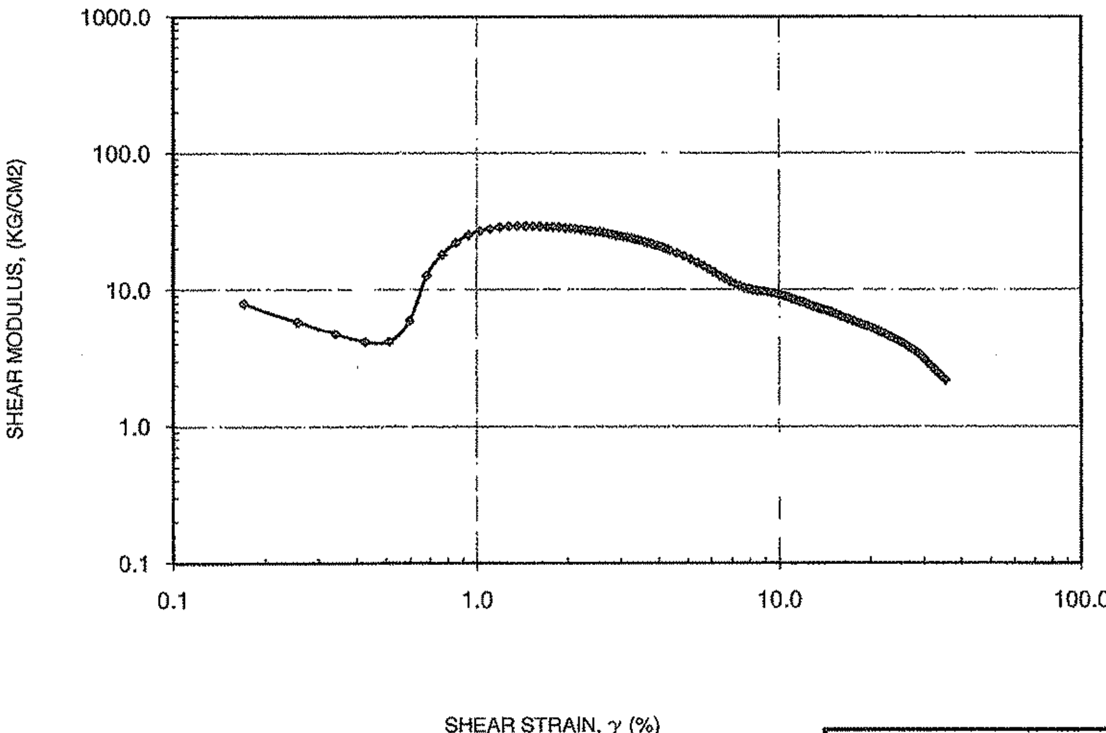
RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-1 FROM TH-1B-S3

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: MJ	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 12-1





RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-1 FROM TH-1B-S3

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Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 12-2

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

May 7, 2009
File Number 08-032

Jones Edmunds & Associates, Inc.
324 South Hyde Park Avenue
Suite 250
Tampa, FL 33606-4110

Attention: Mr. Jason Timmons, P.E.
Project Engineer

Subject: Results of Laboratory Strength Testing of Waste Phosphatic Clay Samples from Phase I Area of Southeast County Landfill, Hillsborough County, Florida

Gentlemen/Ladies:

As requested by Jones Edmunds & Associates, Inc. (Jones Edmunds), Ardaman & Associates, Inc. (Ardaman) is pleased to submit this report to present results of laboratory strength testing for waste phosphatic clay samples recovered from the Phase I Area of the Southeast County Landfill Facility in 2007 and 2008.

Sampling and Testing in 2007

Two soil borings, designated TH-1O and TH-1P, were performed by Ardaman in 2007 in the Phase I area at the locations shown on the boring location map in Appendix A. TH-1O was drilled within the western half near the north side of the Phase I area, adjacent to the piezocone test site designated PC-1O, which was performed as part of the 2007 annual monitoring program. TH-1P was advanced near the eastern end of the Phase I area, adjacent to the piezocone test site designated PC-1P, also performed as part of the 2007 annual monitoring program. The soil borings were advanced through the entire depths of refuse/ash and drainage sand layer to recover samples of the underlying waste phosphatic clay for laboratory testing. A total of three undisturbed samples were recovered, with two samples from TH-1O and one sample from TH-1P.

In TH-1O and TH-1P, the top of waste phosphatic clay was encountered at depths of 71 and 70 feet below landfill surface, and the waste phosphatic clay thicknesses were documented to be 8.5 and 4.5 feet, respectively. The original waste phosphatic clay deposit was thinnest (4 to 8 feet) along the south side of the Phase I area where TH-1P was drilled. Along the west side of the Phase I area where TH-1O was drilled, the original phosphatic clay thickness could have been as much as 8 to 10 feet.

Ardaman performed unconfined compression tests, unconsolidated-undrained triaxial tests, and direct simple shear tests on the recovered undisturbed waste phosphatic clay samples. Results of these undrained shear strength measurements are presented in the laboratory reports in Appendix B and are summarized in the following table.

Test Hole	Sample	Depth (feet)	Test Type*	Undrained Shear Strength (psf)
TH-1O	US-2	73.5 – 75.5	UU	530
TH-1O	US-4	77.5 – 79.5	UU	640
TH-1P	US-1	70.5 – 72.5	UU	1,350
* Unconsolidated-undrained triaxial tests.				

As shown, the laboratory measurements indicated that the west side of the Phase I area, with an overburden load of approximately 70 feet and a waste phosphatic clay thickness of approximately 8 feet, had undrained shear strengths of 530 to 640 psf, characteristic of a medium stiff clay. The south side of the Phase I area, with a refuse/ash overburden load of approximately 70 feet and a waste phosphatic clay thickness of approximately 4 feet, had a higher undrained shear strength of 1,350 psf, characteristic of a stiff clay. The moisture contents of the undisturbed samples recovered from TH-1O were generally higher than those recovered from TH-1P, which confirmed that the undrained shear strengths of the waste phosphatic clay were higher at TH-1P than at TH-1O.

For comparisons, an undisturbed sample obtained at a depth of 42 feet below the landfill surface from the Phase I area in 1994 yielded an undrained shear strength of 460 psf. In its original state, the phosphatic clay below the desiccated crust had an undrained shear strength on the order of 70 psf.

Sampling and Testing in 2008

Four soil borings, designated TH-1Q1, TH-1Q2, TH-1Q6, and TH-1B-S3, were performed by Ardaman in 2008 in the Phase I area to recover undisturbed samples of the waste phosphatic clay for laboratory testing. TH-1Q1 and TH-1Q2 were drilled in July 2008, and TH-1Q6 and TH-1B-S3 were drilled in November 2008. These soil borings were performed within the western half of the Phase I area. TH-1Q1, TH-1Q2, and TH-1Q6 were located close to the crest of the existing landfill slope, whereas TH-1B-S3 was drilled at a greater distance from the existing landfill slope crest (i.e., towards the interior of the landfill), as shown on the boring location plan in Appendix A.

The soil borings were advanced through the entire depths of refuse/ash and the drainage sand layer to allow recovery of undisturbed samples of the waste phosphatic clay using a Shelby tube sampler. The approximate depths and thicknesses of the waste phosphatic clay layer encountered in the soil borings are summarized in the following table.

Test Hole	Approx Depth to Waste Phosphatic Clay Layer Below Land Surface (feet)	Approx Thickness of Waste Phosphatic Clay Layer (feet)
TH-1Q1	56.0	5.5
TH-1Q2	56.0	4.0
TH-1Q6	61.5	4.0
TH-1B-S3	70.0	4.5

As shown in the table above, the waste phosphatic clay was encountered at a depth ranging from 56 to 70 feet below land surface, and had a thickness of 4.0 to 5.5 feet at the soil boring locations.

To characterize the undrained shear strengths of the waste phosphatic clay, Ardaman performed unconfined compression tests, unconsolidated-undrained triaxial tests, and direct simple shear tests on selected samples of the waste phosphatic clay recovered from the four soil borings. Results of the laboratory strength tests are presented in the laboratory reports in Appendix B and are summarized in the following table.

Test Hole	Sample Number	Depth (feet)	Test Type*	Undrained Shear Strength (psf)	Estimated Overburden Pressure (psf)	Applied Normal Load Prior to Shear (psf)
TH-1Q1	US-1	56-58	UC	1,630	4,320	-
TH-1Q1	US-2	58-60	UU	1,140	4,520	-
TH-1Q1	US-3	60-62	UC	540***	4,720	-
TH-1Q2	US-1	56-58	UC	1,500	4,320	-
TH-1Q2	US-2	58-60	UU	1,750	4,520	-
TH-1Q6	US-1	61.6-63.6	UU	1,340	4,400	-
TH-1Q6	US-2	63.5-65.5	DSS	2,160**	4,840	13,040
TH-1B-S3	US-1	69.6-71.6	UU	1,030	4,880	-
TH-1B-S3	US-1	69.6-71.6	DSS	2,320**	4,880	14,660

* UC = Unconfined Compression Test. UU = Unconsolidated-Undrained Triaxial Test. DSS = Direct Simple Shear Test.
** Undrained shear strength obtained using a normal load greater than the existing overburden pressure. The measured strengths are lower than expected because of laminations.
*** Sample may have been disturbed as a result of intrusion from natural ground soils below.

The unconfined compression tests and unconsolidated-undrained triaxial tests were conducted to provide estimates of undrained shear strengths of the waste phosphatic clay under existing condition. For the direct simple shear tests, a normal load exceeding the existing overburden pressure was used to "mask" any effect of sample disturbance, which could potentially result in lower measured strength values. Therefore, the measured undrained shear strengths from the direct simple shear tests do not represent the *in situ* undrained shear strengths under existing condition.

With the exception of the sample designated US-3 obtained from a depth of 60 to 62 feet below land surface in TH-1Q1, results of the unconfined compression tests and unconsolidated-undrained triaxial tests yielded undrained shear strength values that ranged from 1,030 to 1,750 psf, and averaged approximately 1,400 psf from six measurements. The low undrained shear strength measured in US-3 from TH-1Q1 could be attributed to sample disturbance due to intrusion of natural ground soils into the waste phosphatic clay when the Shelby tube sampler was pushed below the bottom of the waste phosphatic clay.

The two direct simple shear tests were performed using applied normal loads that were approximately 2.5 to 3.0 times greater than the existing overburden pressure. Under the existing overburden pressures at the boring locations, the undrained shear strengths of the waste phosphatic clay were estimated to on the order of 700 to 800 psf, which were lower than expected. Visual examinations of the tested specimens revealed the presence of thin laminations or varves (≤ 2mm thick) that would be expected to produce lower undrained shear strengths in the horizontal shearing mode of a direct simple shear test where the failure surface could occur along one or more horizontal laminations. Waste phosphatic clays typically do not occur as laminated (varved) clays and, hence, the lower undrained shear strengths measured on the two specimens are not considered representative of site condition.

Ardaman appreciates the opportunity to provide services to Jones Edmunds and Hillsborough County. If you have any questions or need additional information, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.
Certificate of Authorization No. 5950

M. J.

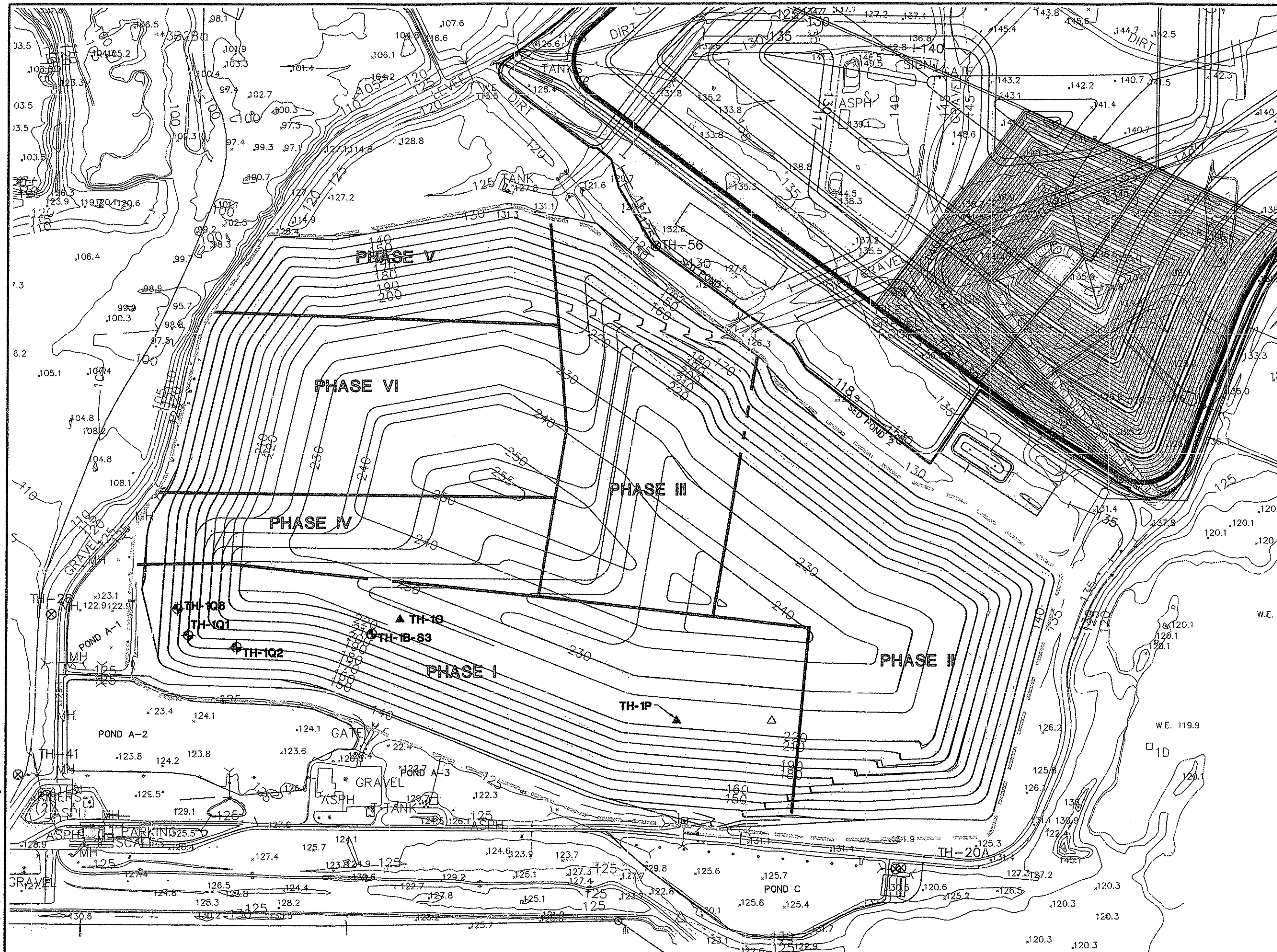
Jeyisanker Mathiyaparanam, E.I.
Assistant Project Engineer

Francis K. Cheung, P.E. 02/07/09
Senior Project Engineer
Florida License No. 36382

Enclosures

Appendix A

Boring Location Plan



N

0 200 400

SCALE: 1"=400'

LEGEND

▲ 2007 SAMPLING LOCATION

⊕ 2008 SAMPLING LOCATION

SOIL BORING LOCATION MAP

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HILLSBOROUGH COUNTY, FLORIDA

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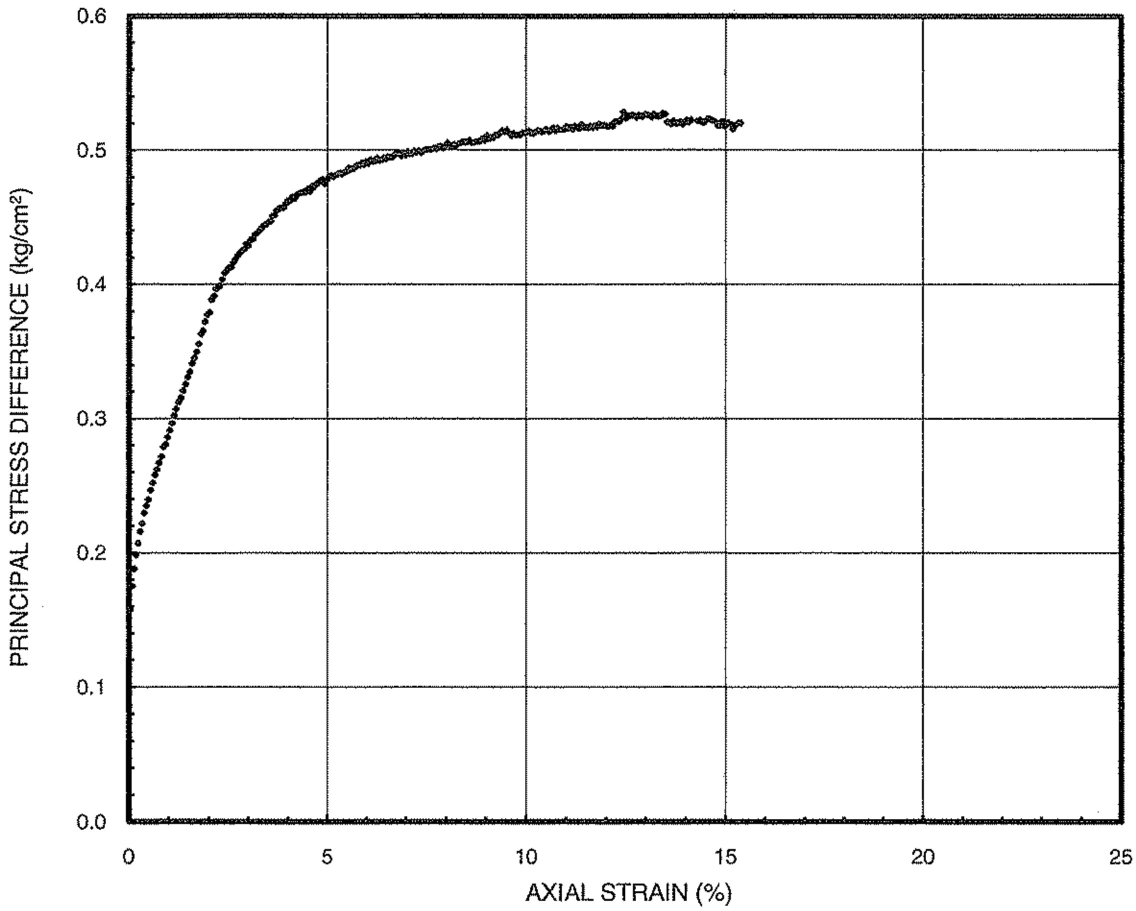
Plotted: May 07, 2009 - 9:27am by scott.stevenson

Appendix B

Laboratory Test Data

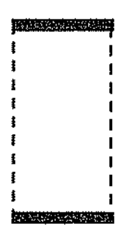
Project Name HCLF
Project Number 06-212
Sample Name PC-10 US2 B3
Depth 73.5-75.5
Cell Pressure 2.75 kg/cm²
Strain Rate 1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM PC-1O-B3

Description Gray clay

Initial Height	7.125 cm
Initial Diameter	3.544 cm
Dry Density	51.6 pcf
Water Content	86.1 %
Saturation	102 %



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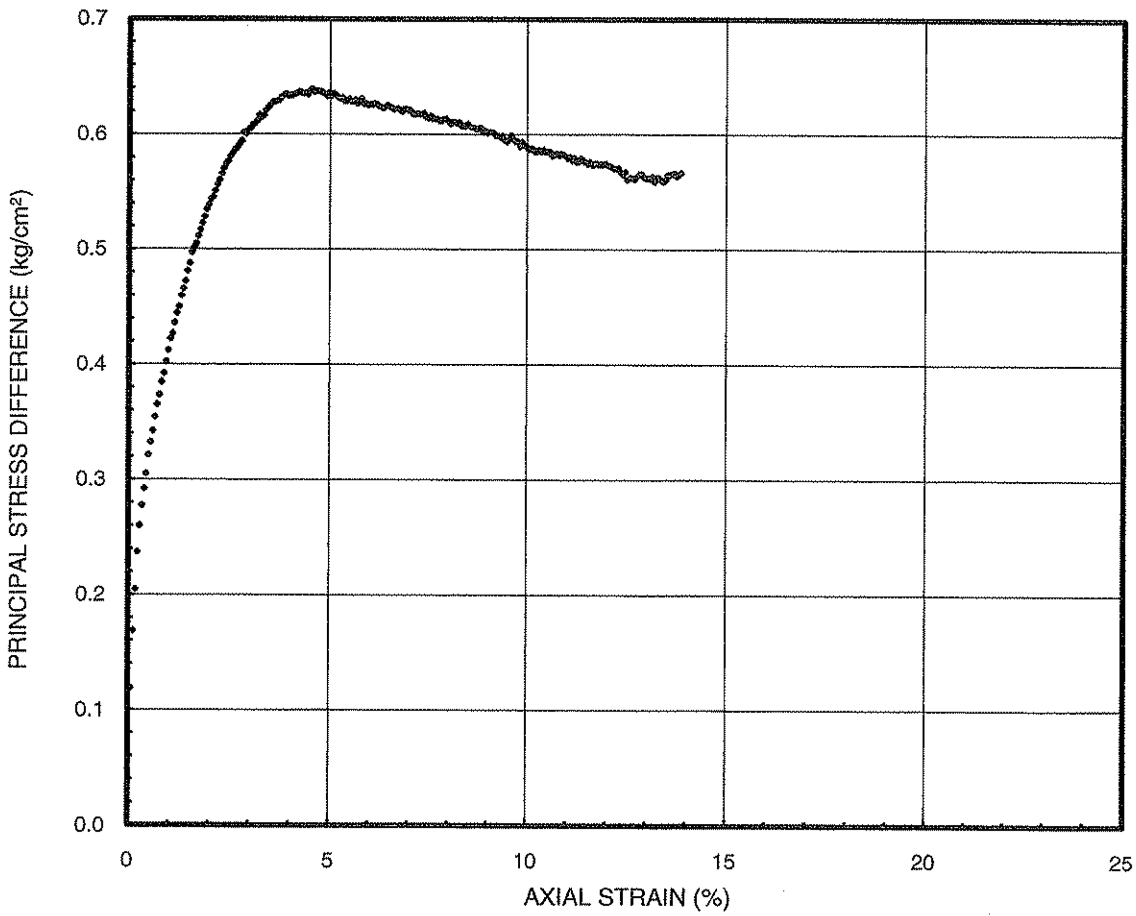
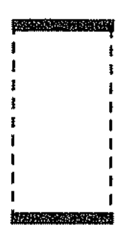
Project Name 06-212
Project Number HCLF
Sample Name PC10 US4 B2
Depth 77.5-79.5
Cell Pressure 2.75 kg/cm²
Strain Rate 1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-4 FROM PC-1O-B2

Description Gray clay

Initial Height	7.106 cm
Initial Diameter	3.558 cm
Dry Density	55.0 pcf
Water Content	77.2 %
Saturation	100 %



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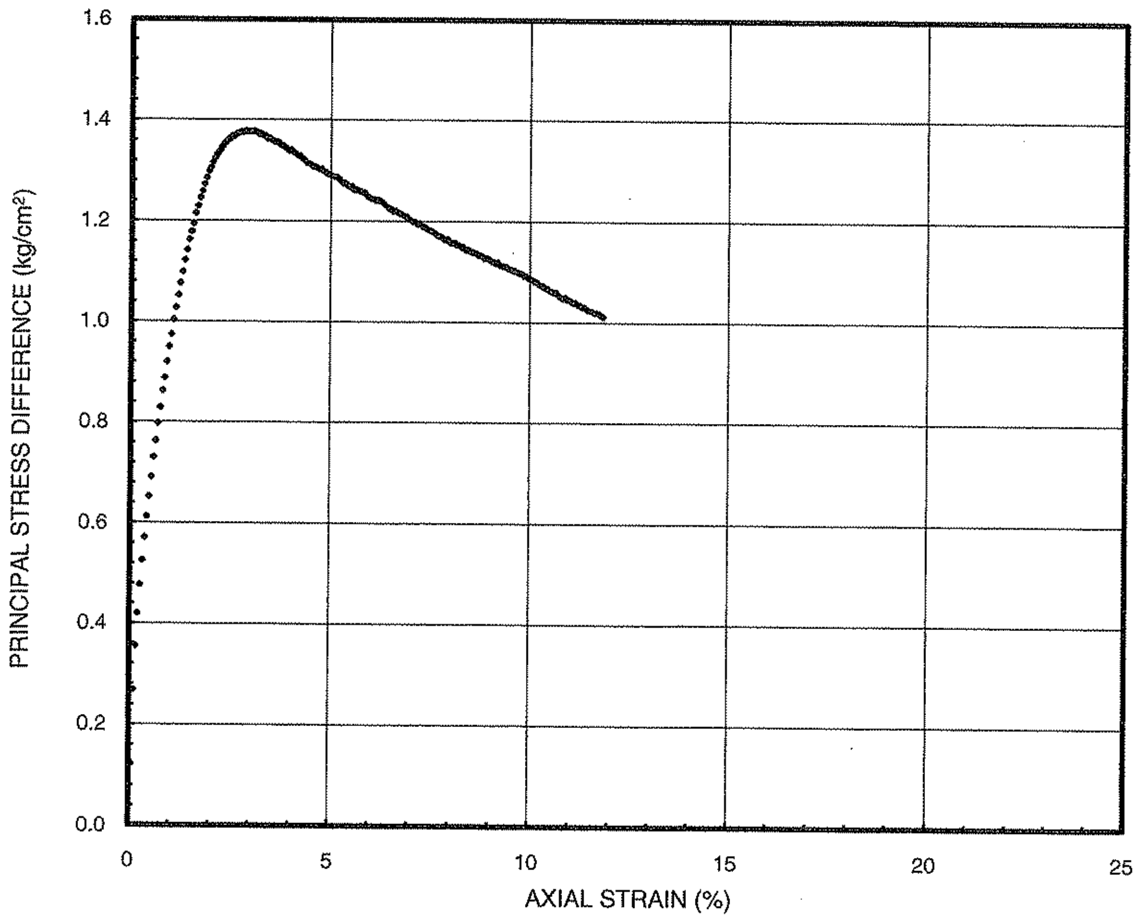
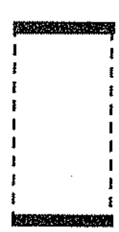
Project Name HCLF
Project Number 06-212
Sample Name THPC1P US1 B4
Depth 70.5-72.5
Cell Pressure 2.50 kg/cm²
Strain Rate 1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-1 FROM PC-1P-B4

Description Gray Clay

Initial Height	7.12	cm
Initial Diameter	3.58	cm
Dry Density	53.5	pcf
Water Content	80.9	%
Saturation	100	%



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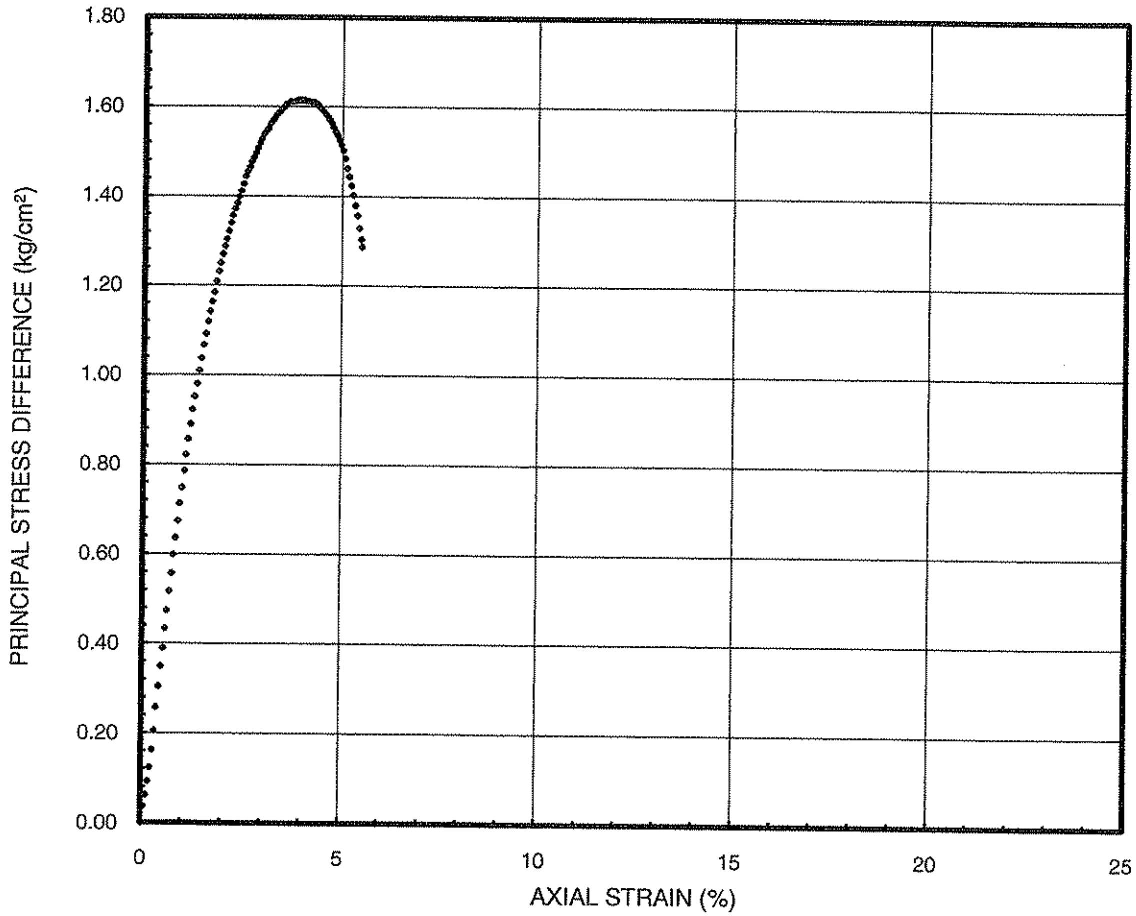
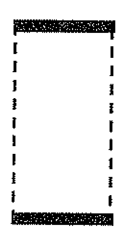
Project Name SELF
Project Number 08-032
Sample Name TH1Q1 US1 B2
Depth 56-58 ft

Strain Rate 1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-1 FROM TH-1Q1-B2

Description	Gray clay	
Initial Height	7.103	cm
Initial Diameter	3.561	cm
Dry Density	45.0	pcf
Water Content	103.0	%
Saturation	99	%



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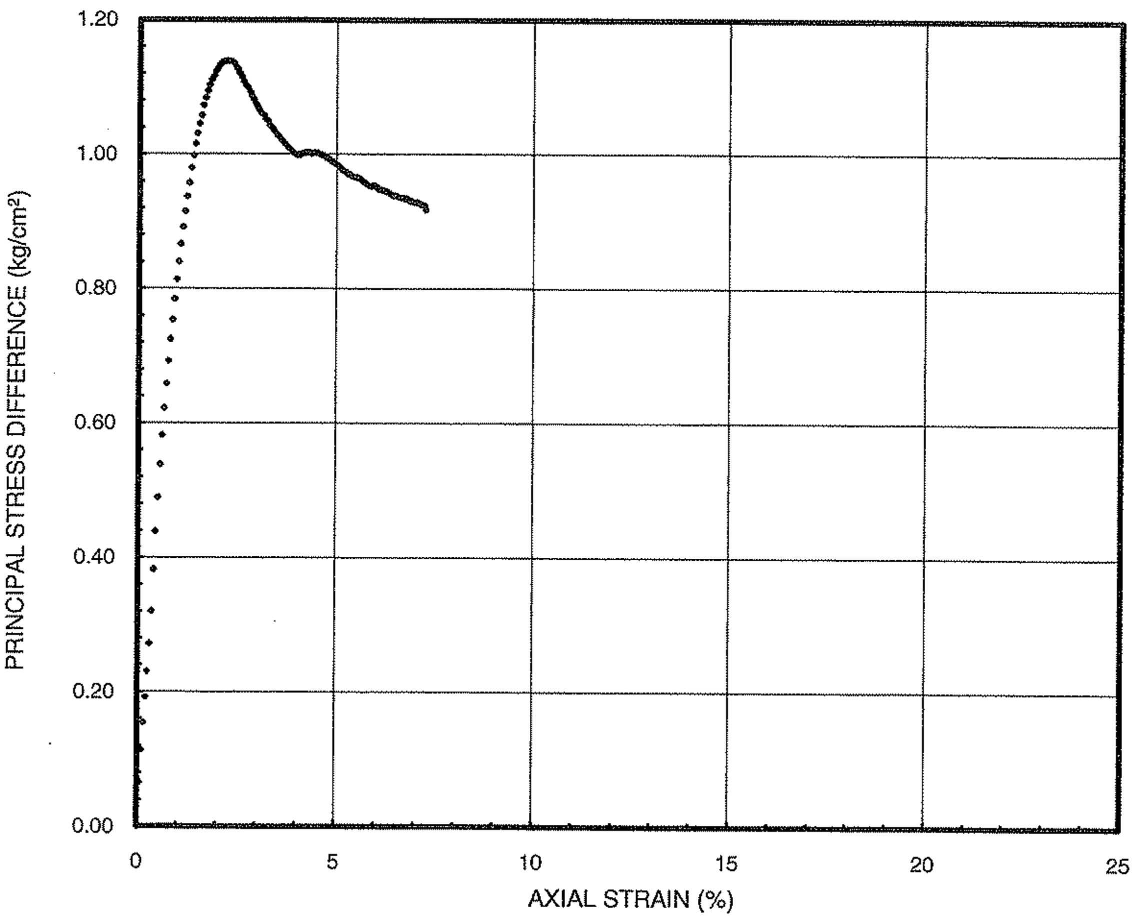
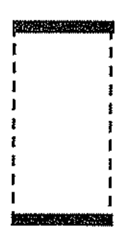
Project Name	SELF
Project Number	08-032
Sample Name	TH-1Q1 US2 B2
Depth	58-60 ft
Cell Pressure	1.48 kg/cm^2
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDARAINED TRIAXIAL TEST FOR SAMPLE US-2 FROM TH-1Q1-B2

Description	Gray clay	
Initial Height	7.104	cm
Initial Diameter	3.559	cm
Dry Density	52.6	pcf
Water Content	83.9	%
Saturation	100	%



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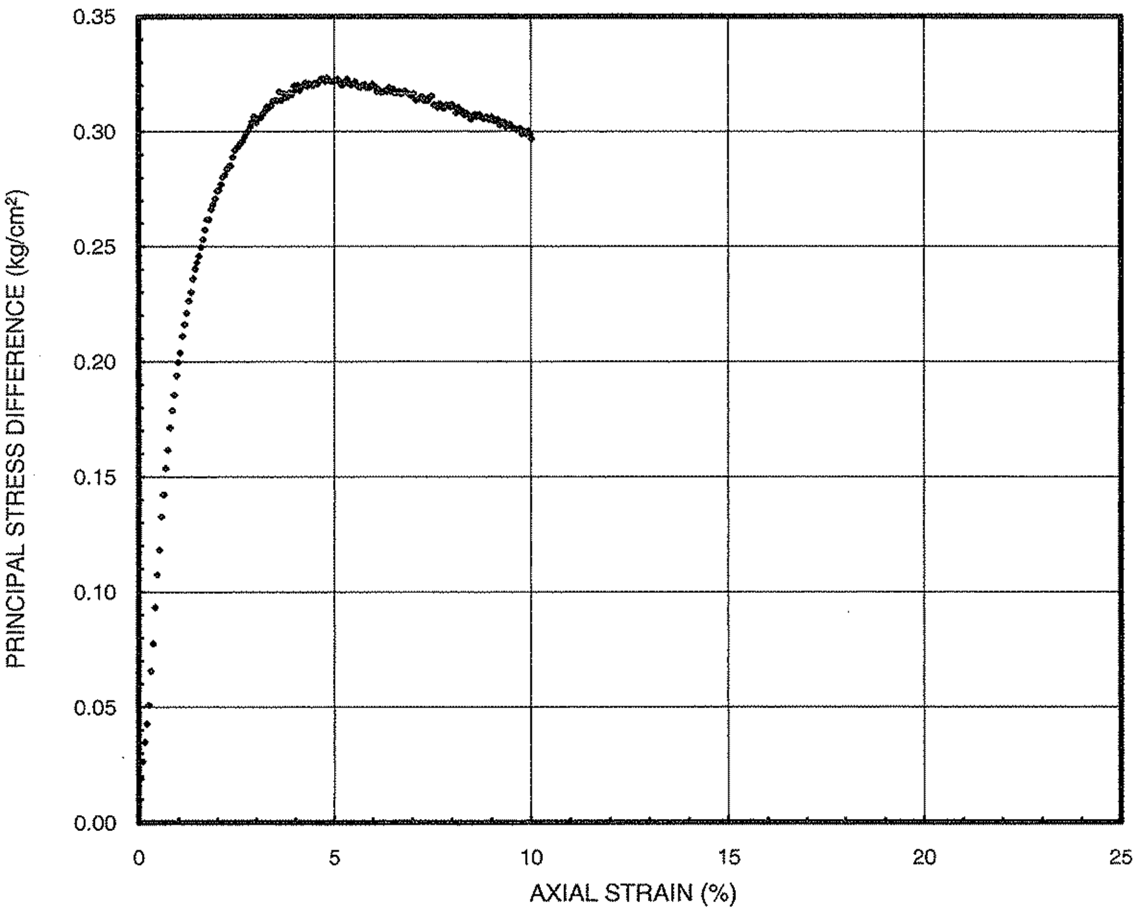
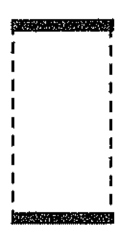
Project Name	SE LANDFILL
Project Number	08-032
Sample Name	TH1Q1 US3 B1
Depth	60-62 ft
Strain Rate	1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-3 FROM TH-1Q1-B1

Description	Gray clay	
Initial Height	7.089	cm
Initial Diameter	3.554	cm
Dry Density	49.1	pcf
Water Content	91.6	%
Saturation	100	%



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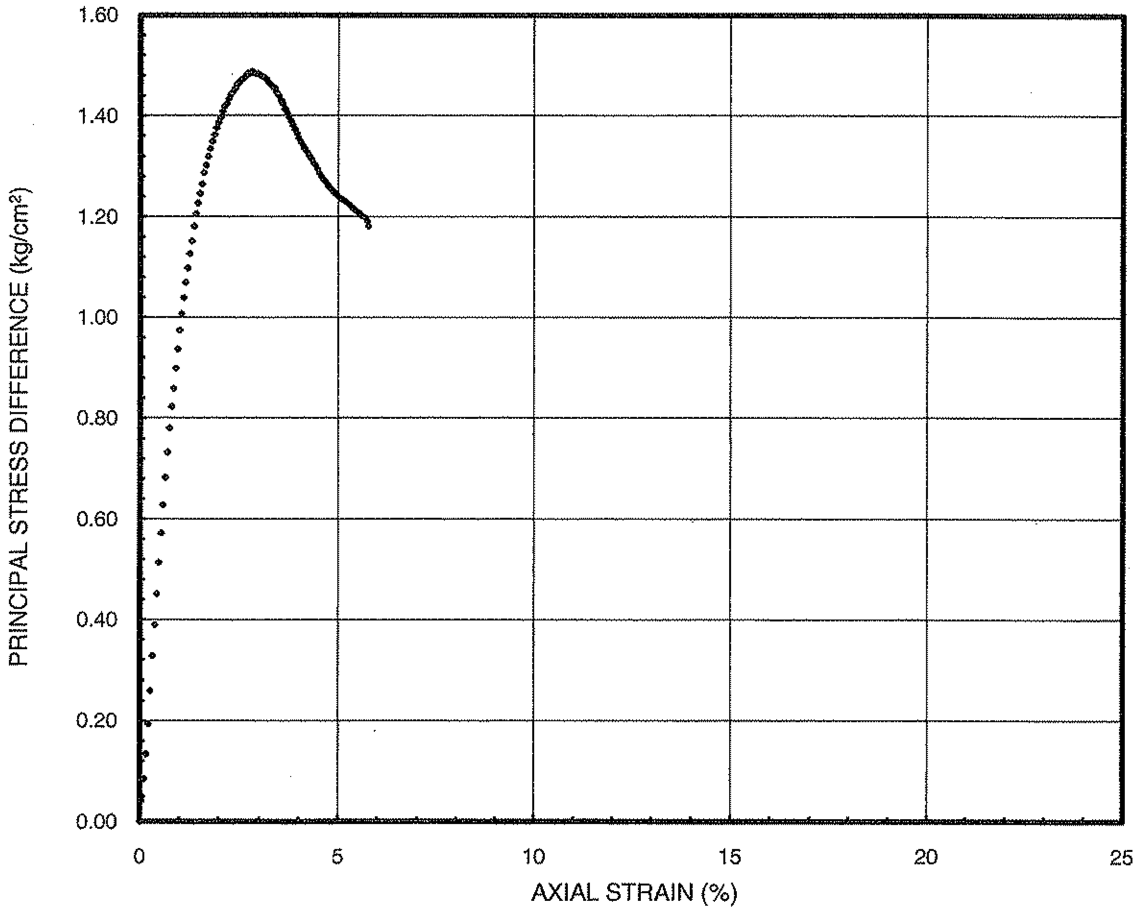
Project Name SELF
Project Number 08-032
Sample Name TH1Q2 US1 B2
Depth 56-58 ft

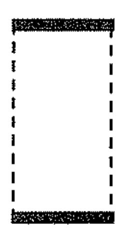
Strain Rate 1.0 %/minute



RESULTS OF UNCONFINED COMPRESSION TEST FOR SAMPLE US-1 FROM TH-1Q2-B2

Description Gray clay

Initial Height 7.097 cm
Initial Diameter 3.563 cm
Dry Density 48.0 pcf
Water Content 94.1 %
Saturation 99 %



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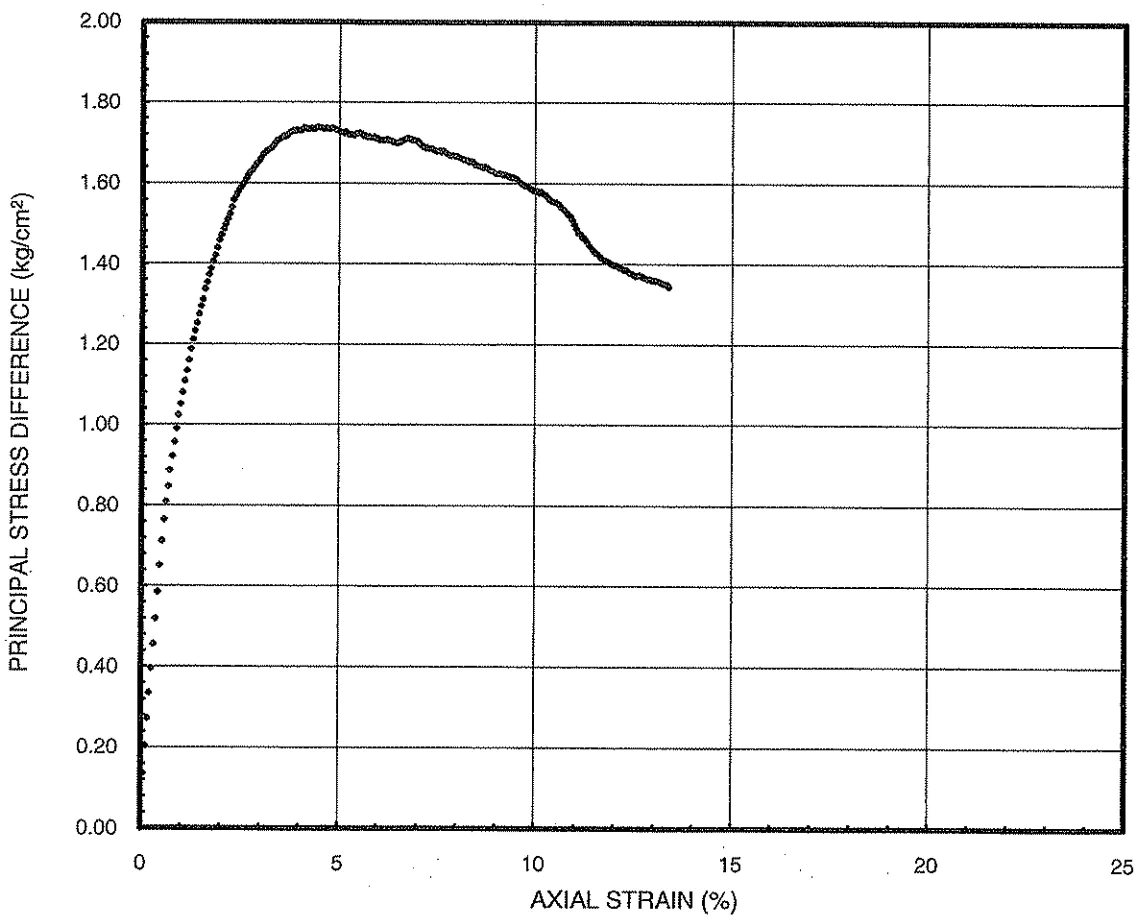
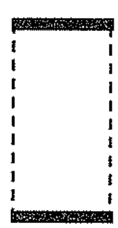
Project Name	SELF
Project Number	08-032
Sample Name	TH1Q2 US2 B2
Depth	58-60 ft
Cell Pressure	2.95 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
FOR SAMPLE US-2 FROM TH-1Q2-B2

Description	Gray clay	
Initial Height	7.094	cm
Initial Diameter	3.563	cm
Dry Density	47.6	pcf
Water Content	95.9	%
Saturation	100	%



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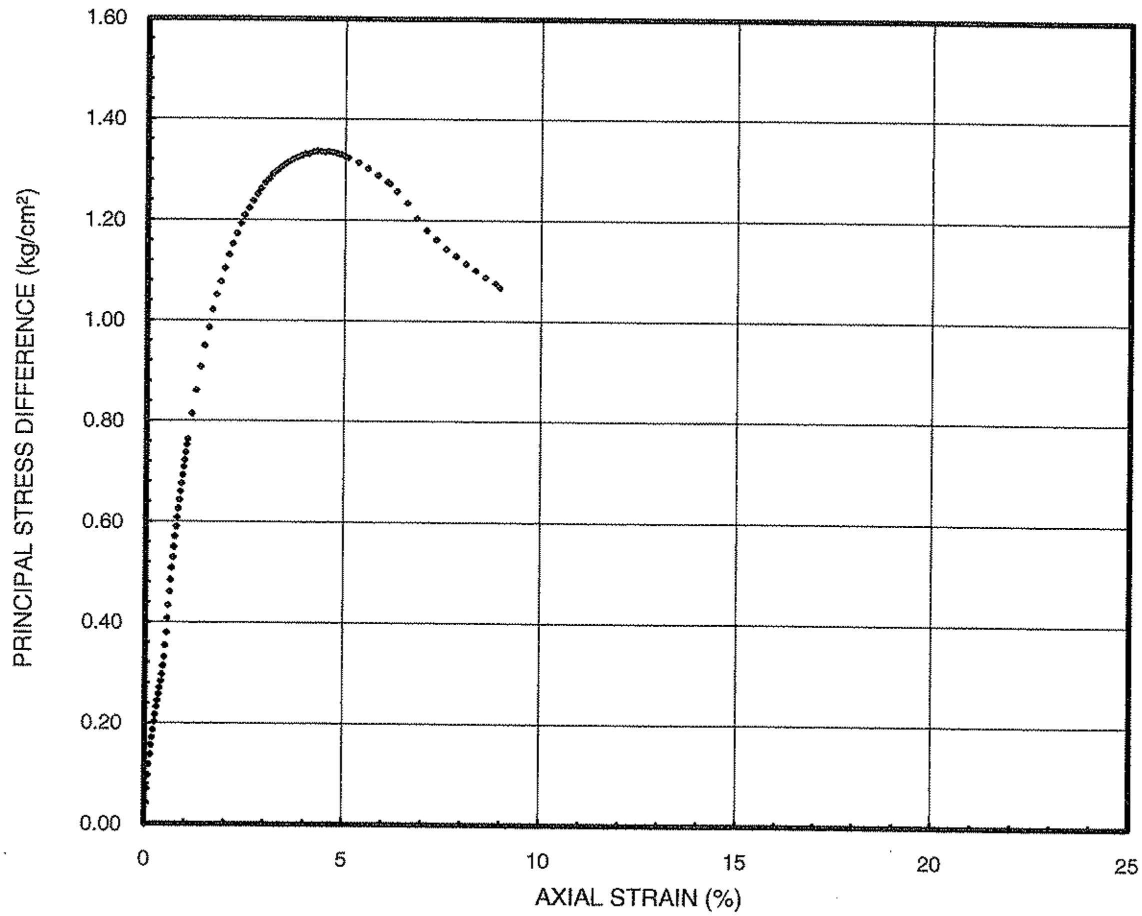
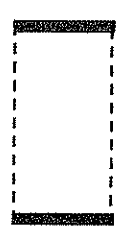
Project Name	SELF
Project Number	08-032
Sample Name	TH1Q6 US1
Depth	61.6-63.6 ft
Cell Pressure	2.20 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
FOR SAMPLE US-1 FROM TH-1Q6

Description Gray clay

Initial Height	7.078 cm
Initial Diameter	3.569 cm
Dry Density	47.5 pcf
Water Content	95.6 %
Saturation	100 %



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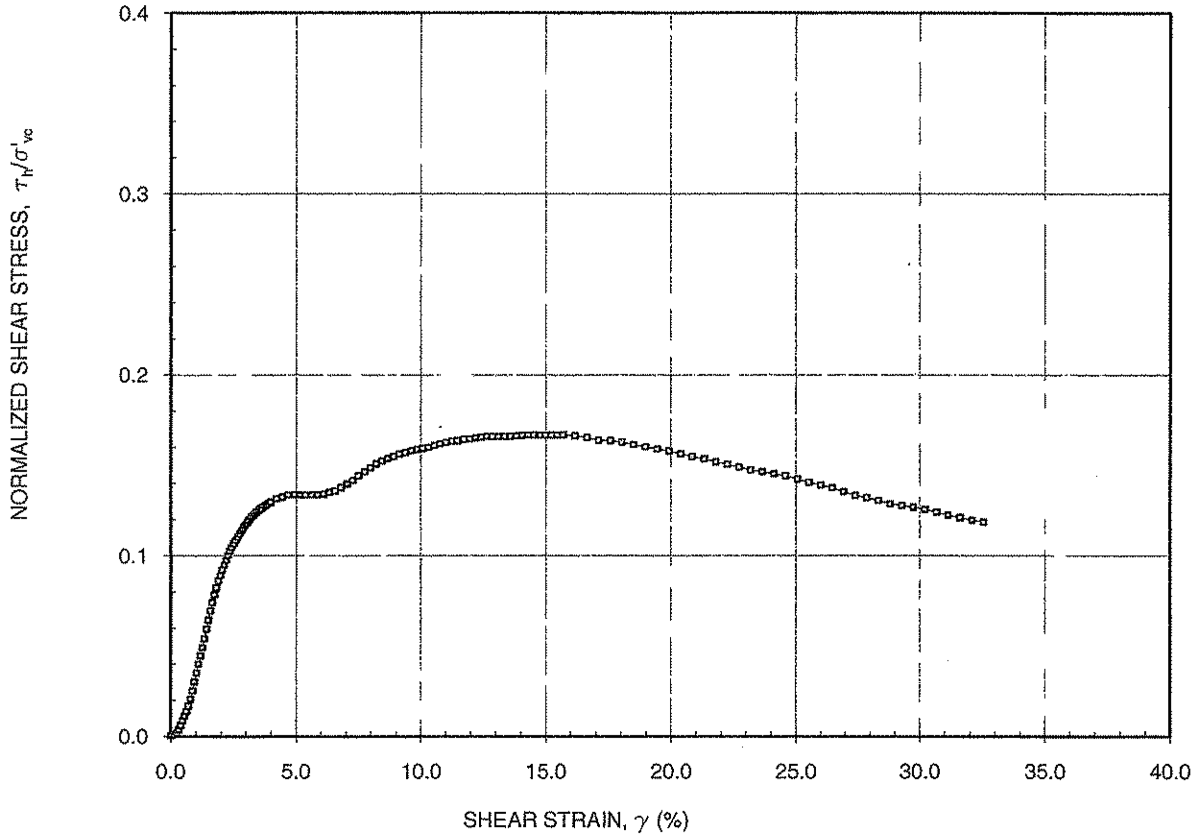

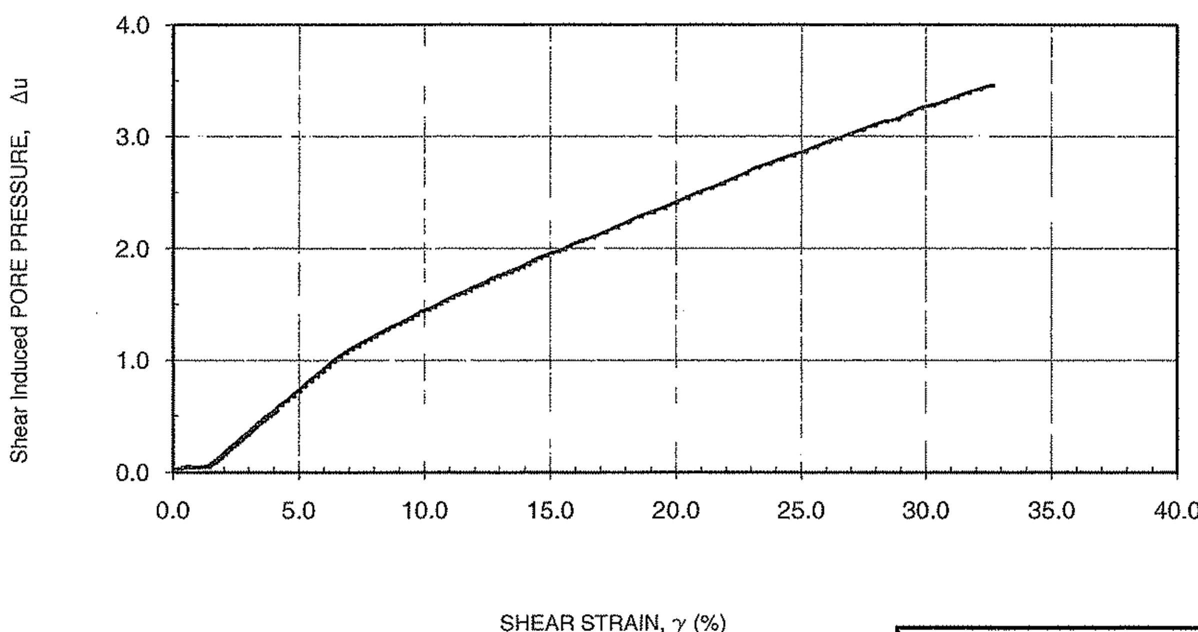

RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-2 FROM TH-1Q6

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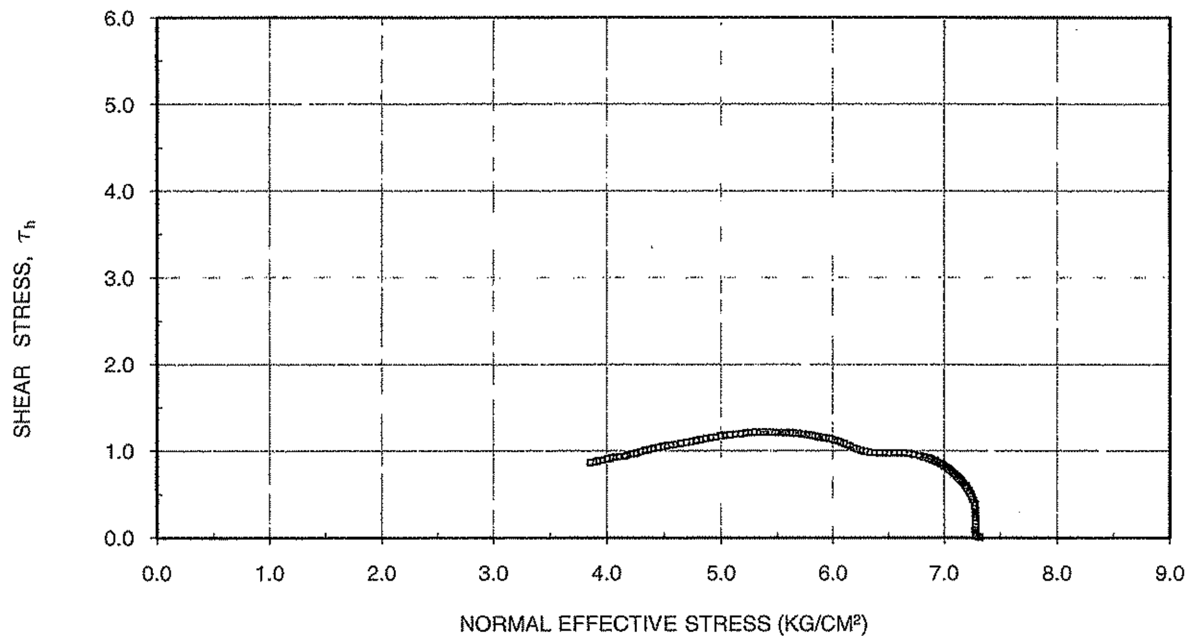

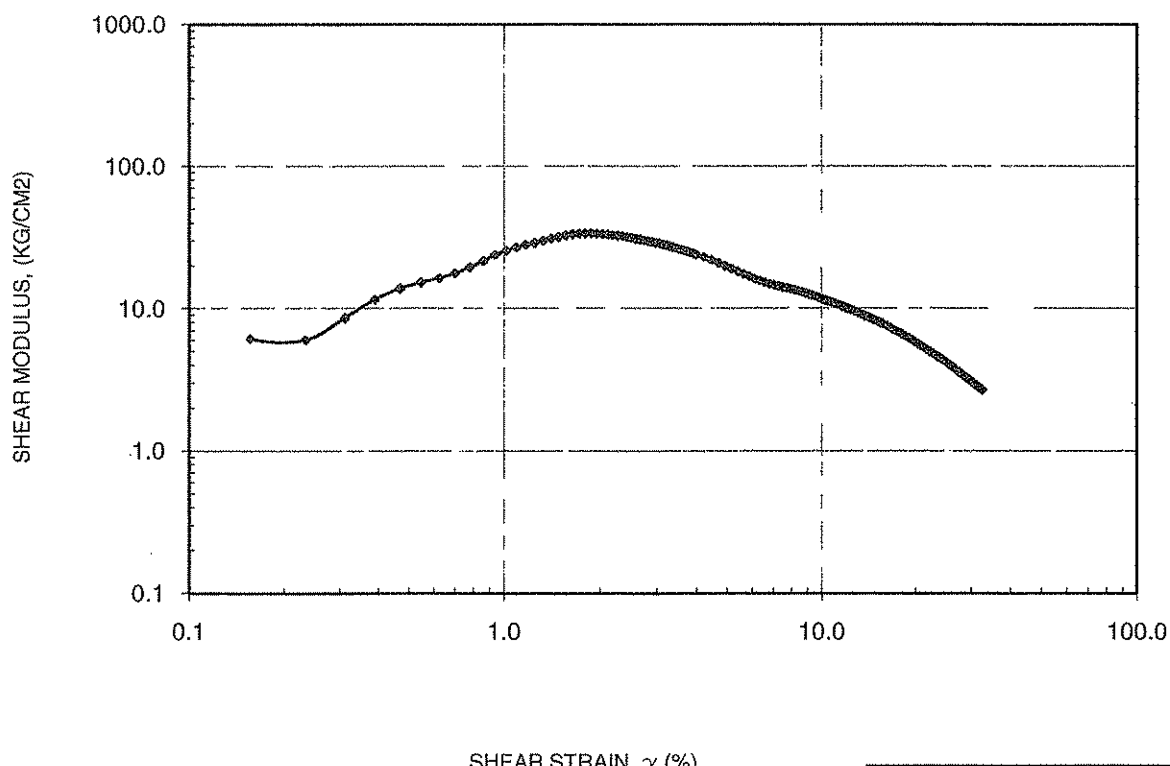

RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-2 FROM TH-1Q6

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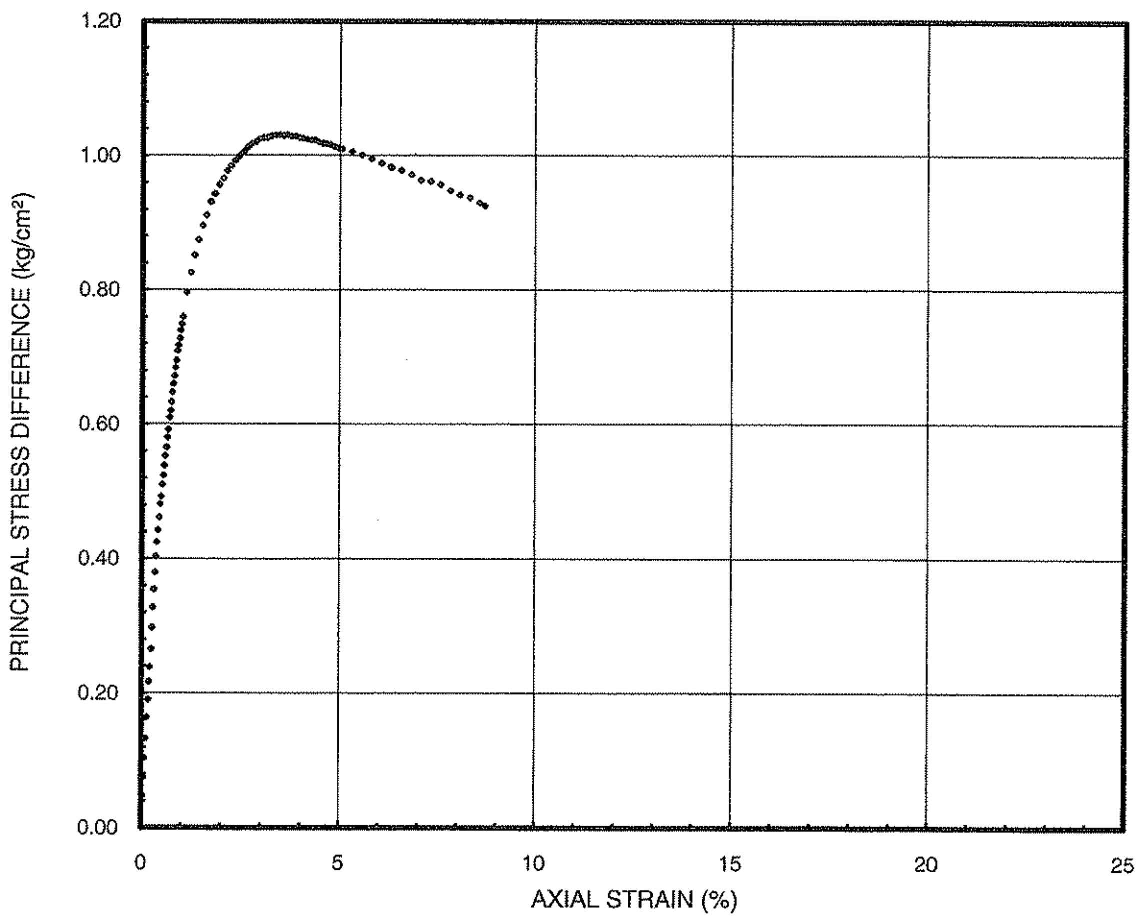
Project Name	SELF
Project Number	08-032
Sample Name	PC-1BS3 US1
Depth	69.6-71.6 ft
Cell Pressure	2.44 kg/cm²
Strain Rate	1.0 %/minute



RESULTS OF UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
FOR SAMPLE US-1 FROM TH-1B-S3

Description	Lt gray clay
Initial Height	7.083 cm
Initial Diameter	3.569 cm
Dry Density	54.8 pcf
Water Content	79.2 %
Saturation	100 %

TYPE OF FAILURE

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HILLSBOROUGH COUNTY, FLORIDA

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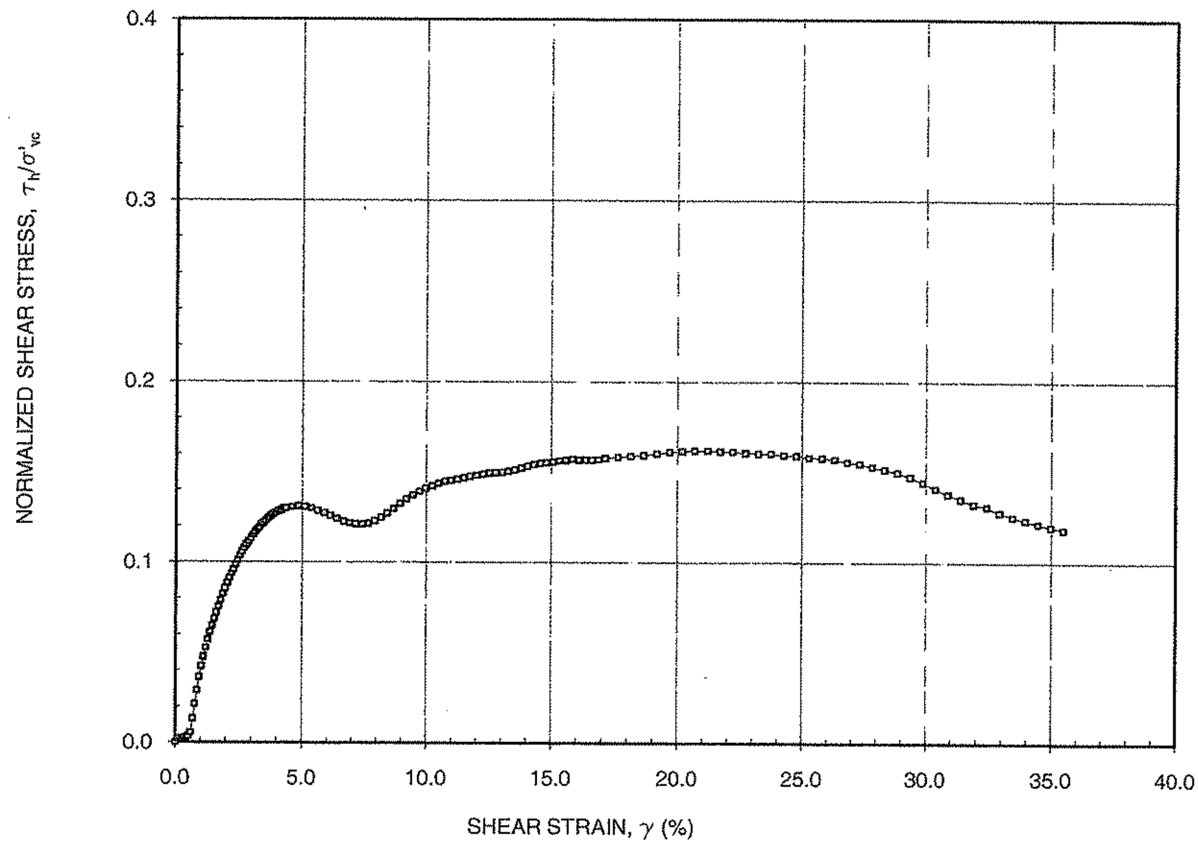

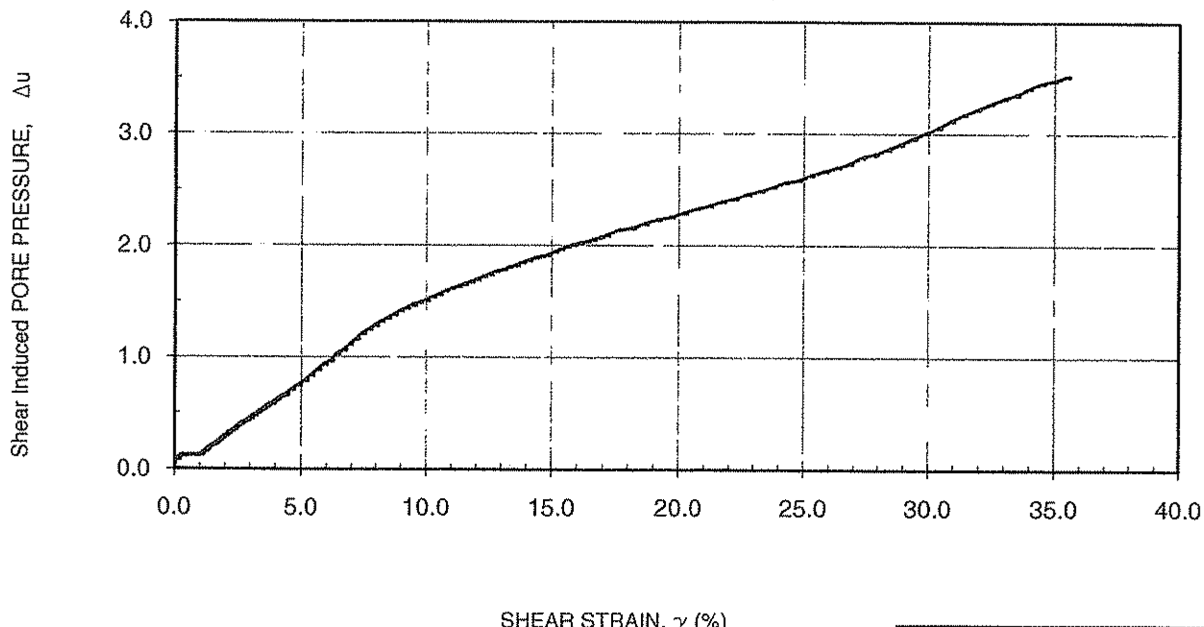

RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-1 FROM TH-1B-S3

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HILLSBOROUGH COUNTY, FLORIDA

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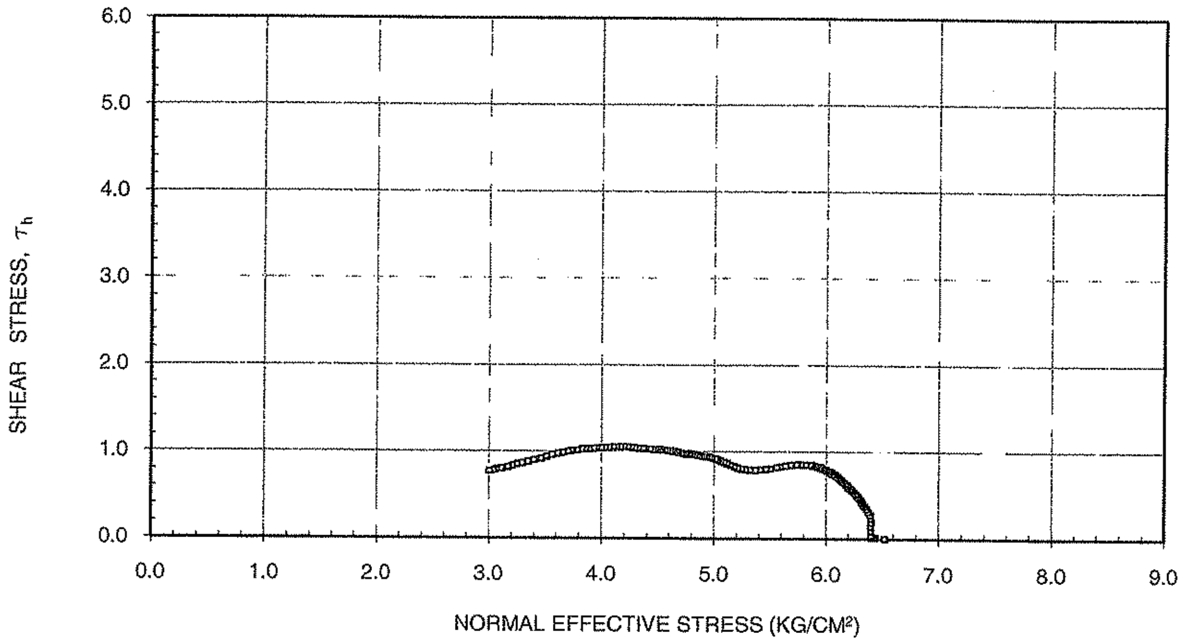
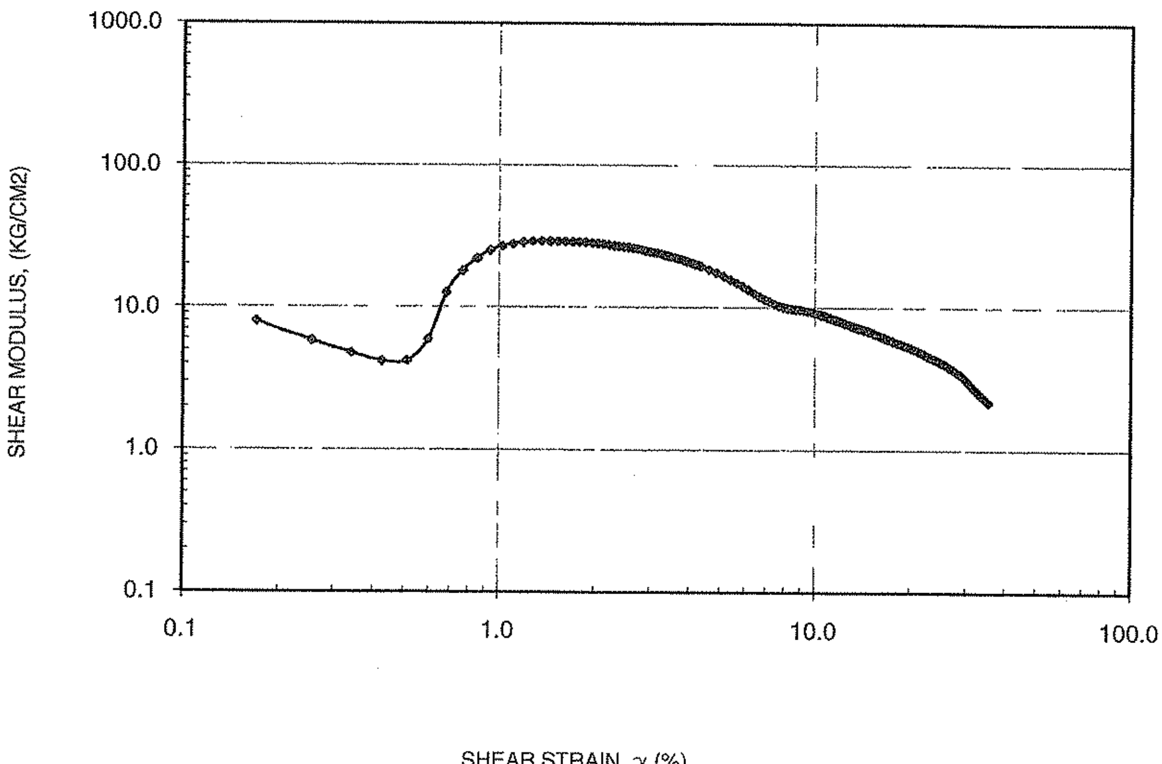
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 12-1





RESULTS OF DIRECT SIMPLE SHEAR TEST FOR SAMPLE US-1 FROM TH-1B-S3

Ardaman & Associates, Inc.
Geotechnical, Environmental and Materials Consultants

SOUTHEAST COUNTY LANDFILL
HILLSBOROUGH COUNTY, FLORIDA

DRAWN BY: JM	CHECKED BY: FKC	DATE: 05-07-09
FILE NO.: 08-032	APPROVED BY: FKC	FIGURE: 12-2