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ENGINEERING CORP.

GEOTECHNICAL INVESTIGATION

SHAWNEE ROAD OVER HCFCD UNIT NO. C106-03-00
BRIDGE REPLACEMENT
WBS NO. N-00445N-0030-3
HOUSTON, TEXAS

Reported to:
Entech Civil Engineers, Inc.
Houston, Texas

by

Aviles Engineering Corporation
5790 Windfern
Houston, Texas 77041
713-895-7645

REPORT NO. G164-11

November 2011

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1.0 INTRODUCTION

1.1 Project Description

Aviles Engineering Corporation (AEC) performed a geotechnical investigation for a proposed replacement bridge along Shawnee Road for the City of Houston (COH), located near the intersection of Shawnee Road and the I-45 northbound frontage road, in Houston, Texas (Houston Key Map 576E). A vicinity map is presented on Plate A-1, in Appendix A. According to information provided to AEC, the existing wooden bridge along Shawnee Road crossing over Harris County Flood Control District (HCFCD) drainage channel C106-03-00 will be replaced with a new concrete bridge. The proposed 2-lane concrete replacement bridge will be a single span that is 35 feet long and 38 feet wide. The drainage channel at the bridge crossing is approximately 8 feet deep, with a proposed channel slope inclination at H:V = 3:1. The channel slopes at the bridge crossing will be protected with a concrete liner. The bridge profile drawing prepared by Aguirre & Fields is presented on Plate B-7, in Appendix B.

1.2 Authorization

The notice to proceed for the investigation was provided by Mr. Mike Spiegel, P.E., of Entech Civil Engineers via email on July 21, 2011, based upon AEC Proposal No. G2011-05-06, dated May 18, 2011.

1.3 Purpose and Scope

The purpose of this geotechnical investigation is to evaluate the subsurface soil conditions at the project site and develop geotechnical engineering recommendations for the proposed bridge replacement. The scope of this geotechnical investigation is summarized as below:

1. Drilling and sampling two soil borings to 90 feet below existing grade;
2. Soil laboratory testing for selected soil samples;
3. Engineering analyses and recommendations for bridge foundations, including foundation type and axial capacity;
4. Slope stability analysis for the drainage channel;
5. Construction recommendations for the bridge foundations and channel.

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2.0 SUBSURFACE EXPLORATION

Subsurface conditions for the bridge crossing were investigated by drilling two soil borings to a depth of 90 feet below grade; Borings B-1 and B-2 were drilled adjacent to the west and east abutments, respectively. The total drilling footage was 180 feet. Borings were performed in accordance with the 2011 COH Infrastructure Design Manual, as well as 2010 HCFCD Geotechnical Guidelines. The boring locations are shown on the attached Boring Location Plan on Plate A-2, in Appendix A. Boring locations were surveyed by others and the survey data is included on our boring logs. Boring logs were prepared in HCFCD format using the gINT v5.1 computer program.

Prior to drilling, existing pavement at the boring locations was cored with a core barrel. After pavement coring was completed, drilling was conducted using a truck-mounted drilling rig initially using dry auger method and then using wet rotary method once groundwater was encountered. Undisturbed samples of cohesive soils were obtained from the boring by pushing 3-inch diameter thin-wall, seamless steel Shelby tube samplers in accordance with ASTM D 1587. Granular soils were sampled with a 2-inch split-barrel sampler in accordance with ASTM D 1586. Standard Penetration Test resistance (N) values were recorded for the granular soils as "Blows per Foot" and are shown on the boring logs. Strength of the cohesive soils was estimated in the field using a hand penetrometer. The undisturbed samples of cohesive soils were extruded mechanically from the core barrels in the field and wrapped in aluminum foil; all samples were sealed in plastic bags to reduce moisture loss and disturbance. The samples were then placed in core boxes and transported to the AEC laboratory for testing and further study. After completion of drilling, Boring B-2 was left open for a period of approximately 24 hours to obtain an additional water reading. The borings were grouted with cement-bentonite and the pavement patched with lean concrete. Details of the soils encountered in the borings are presented on Plates A-3 and A-4, in Appendix A.

3.0 LABORATORY TESTING

Soil laboratory testing was performed by AEC personnel. Samples from the borings were examined and classified in the laboratory by a technician under supervision of a geotechnical engineer. Laboratory tests were performed on selected soil samples in order to evaluate the engineering properties of the foundation soils in accordance with applicable ASTM Standards. Atterberg limits, moisture contents, percent passing a No. 200 sieve, sieve analysis, and dry unit weight tests were performed on typical samples to establish the index properties and confirm field classification of the subsurface soils. Strength properties of cohesive soils were determined by means of

unconfined compression (UC) and unconsolidated-undrained (UU) tri-axial tests performed on undisturbed samples. The test results are presented on their representative boring logs. A key to the boring logs, classification of soils for engineering purposes, terms used on boring logs, and reference ASTM Standards for laboratory testing are presented on Plates A-5 through A-8, in Appendix A. Sieve analysis results are presented on Plate A-9, in Appendix A.

A crumb test was performed to evaluate the dispersive potential of clayey soils in the drainage channel. The crumb test results indicate that the soil sample from Boring B-2, 4 to 6 feet, had no sign of cloudy water caused by colloidal suspension. The crumb test results are presented on Plate A-10, in Appendix A.

Two consolidated-undrained (CU) triaxial shear tests were performed to determine shear strength parameters for slope stability analyses. The results of the CU tests are included on Plates A-11 through A-14, in Appendix A. The shear strength parameters obtained from the CU tests are summarized below in Table 1.

Table 1. Summary of Shear Strength Parameters from CU Triaxial Tests

Sample ID and Description	Cu (psf)	Effective Stress		Total Stress	
		c′ (psf)	φ′ (deg)	c_{cu} (psf)	φ_{cu} (deg)
B-1, 4'-6', Fat Clay (CH)	1,500	460	19.1	520	12.9
B-2, 8'-10', Lean Clay w/Sand (CL)	1,400	330	26.1	450	19.1

Notes: (1) Cu = cohesion, obtained from UC and UU tests;
(2) c' = effective cohesion, φ' =effective friction angle, obtained from CU tests with pore pressure measurements;
(3) c_{cu} = cohesion in total stress, φ_{cu} = friction angle in total stress, obtained from CU tests.

4.0 SITE CONDITIONS

4.1 Subsurface Conditions

The soil strata encountered in our borings are summarized below. A cross-section profile of the borings has been included on the bridge plan and profile drawing provided to AEC, and is presented on Plate B-7, in Appendix B.

Boring	Depth (ft)	Description of Stratum
B-1	0 - 1.4	Pavement: 9" concrete, 1" asphalt, 6" stabilized base, 1" stabilized sand
	1.4 - 30	Stiff to hard, Fat Clay (CH), with slickensides
	30 - 33	Silty clay layer
	33 - 67	Very stiff to hard, Fat Clay (CH), with slickensides
	67 - 77	Dense, Well Graded Sand w/Silt (SW-SM)

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Boring	Depth (ft)	Description of Stratum
B-1 (cont.)	77 - 87	Very stiff to hard, Fat Clay (CH)
	87 - 90	Medium dense, Silt (ML), with clay partings
B-2	0 - 0.8	Pavement: 10" concrete
	0.8 - 2	Fill: Silty Sand (SM), with clay pockets
	2 - 8	Stiff to very stiff, Fat Clay (CH), with slickensides
	8 - 10	Very stiff, Lean Clay w/Sand (CL)
	10 - 52	Stiff to very stiff, Fat Clay (CH), with slickensides
	52 - 57	Very stiff, Lean Clay w/Sand (CL), with silt partings
	57 - 58	Gravel layer
	58 - 66	Very stiff, Fat Clay (CH), with slickensides
	66 - 71	Dense, Poorly Graded Sand w/Silt (SP-SM), with gravel
	71 - 76	Dense, Silty Sand (SM), with clay pockets
	76 - 81	Stiff, Lean Clay w/Sand (CL), with silt partings
	81 - 86	Medium dense, Silt (ML)
	86 - 90	Hard, Fat Clay (CH)

The natural cohesive soils have Liquid Limits (LL) that varied from 32 to 99 and Plasticity Indices (PI) that varied from 17 to 58. This indicates that the cohesive soils at the site have medium to very high plasticity. The cohesive soils encountered are classified as "CL" and "CH" type soils and the granular soils are classified as "SW-SM", "SP-SM", "SM", and "ML" type soils in accordance with the Unified Soil Classification System (USCS). "CH" soils undergo significant volume changes due to seasonal changes in soil moisture contents. "CL" type soils with lower LL (less than 40) and PI (less than 20) generally do not undergo significant volume changes with changes in moisture content. However, "CL" soils with LL approaching 50 and PI greater than 20 essentially behave as "CH" soils and could undergo significant volume changes.

Details of the soils encountered during drilling are presented in the boring logs. Ground water was encountered in both borings at a depth of 27 to 30 feet below grade during drilling and subsequently rose to a depth of 15.4 to 21.6 feet below grade approximately 15 minutes after the initial encounter; ground water was also observed at a depth of 18 feet below grade in Boring B-2 approximately 24 hours after drilling was complete. This indicates that the groundwater at the site could be pressurized. The information in this report summarizes conditions found on the date the borings were drilled. It should be noted that our ground water observations are short-term; ground water depths and subsurface soil moisture contents will vary with environmental variations such as frequency and magnitude of rainfall and the time of year when construction is in progress.

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4.2 Geologic Faults

AEC performed a preliminary fault investigation, which included a review of available literature, aerial photographs, public maps and limited field observations. According to the published maps "*Principal Active Faults of the Houston Area (after O'Neill and Van Siclen, May 1984)*", and "*Principal Surface Faults in the Central Houston Metropolitan Area (after O' Neill, Van Siclen, with additions by C. Norman, May 13, 2004)*", no documented faults are located at the project site. An overlay of a street map of Houston over the fault map shows that the closest fault to the project area is an unnamed fault which crosses I-45 near Edgebrook Drive approximately 0.4 miles southeast of the project site. Another nearby unnamed fault crosses I-45 near Airport Boulevard approximately 0.5 miles to the northwest of the project site. Both of these faults are associated with the South Houston salt dome.

Limited field observations were made at the project site by AEC Senior Geologist for evidences of faulting. No evidences of faulting were observed. Based on the limited field observations, AEC does not recommend any further fault studies for the project area.

Limitations: The preliminary fault investigation provided in this report is limited to a review of literature, aerial photographs and maps and our limited field observations, and distances are scaled from maps. Faults may exist in the project area or surrounding area due to the following reasons: not observed during the reconnaissance due to limitations of the scope of work and cost; the presence of obscuring vegetation and environmental features; modification of the land surface by human activities; and lack of documentation in the literature. Faults may also be present below ground but do not currently have surface expressions. Identification of these faults is beyond the scope of work for this project.

4.3 Subsurface Variations

It should be emphasized that: (i) at any given time, ground water depths can vary from location to location, and (ii) at any given location, ground water depths can change with time. Ground water depths will vary with seasonal rainfall and other climatic/environmental events. Subsurface conditions may vary away from and in between the boring locations.

Clay soils in the Greater Houston area typically have secondary features such as slickensides and contain sand/silt seams/lenses/layers/pockets. It should be noted that the information in the boring log is based on 3-inch diameter

soil samples which were generally continuously obtained at intervals of 2 feet in the top 20 feet of the borings and then at 5 foot intervals thereafter to the boring termination depths of 90 feet. A detailed description of the soil secondary features may not have been obtained due to the small sample size and sampling interval between the samples. Therefore, while some of AEC's logs show the soil secondary features, it should not be assumed that the features are absent where not indicated on the logs.

5.0 ENGINEERING ANALYSIS AND RECOMMENDATIONS

According to information provided to AEC, the existing wooden bridge along Shawnee Road crossing over Harris County Flood Control District (HCFCD) drainage channel C106-03-00 will be replaced with a new concrete bridge. The proposed 2-lane concrete replacement bridge will be a single span that is 35 feet long and 38 feet wide. The drainage channel at the bridge crossing is approximately 8 feet deep, with a proposed channel slope inclination at H:V = 3:1. The channel slopes at the bridge crossing will be protected with a concrete liner.

5.1 Shawnee Road Bridge Crossing

Based on the provided bridge plan and profile drawing, the bridge will be supported on five 24-inch diameter by 43 foot long straight-sided drilled shafts at each of the abutments. Each drilled shaft on the west and east abutments will support a load of 55 and 60 tons, respectively.

5.1.1 Straight Sided Drilled Shafts

We selected soil parameters based on Borings B-1 and B-2, and performed drilled shaft analyses using O'Neill and Reese's method, "Drilled Shaft Design and Construction" (1999). In the analyses, we neglected skin friction from the existing ground surface to 10 feet below the top of shaft (the top of shaft elevation is at approximately 31 feet above Mean Sea Level for both abutments), considering the shafts are located at a wet crossing. We did not consider scour depth, since the provided drawings indicate that the ditch slopes will be protected with a concrete liner. We used a Factor of Safety (FS) of 2 and 3 for skin friction and end bearing, respectively.

The total allowable compressive axial bearing capacity of a straight-sided drilled shaft is the sum of the allowable skin friction (obtained by multiplying the shaft perimeter by the allowable unit cumulative skin friction beginning from 20 feet below existing grade to the design depth) and the allowable end bearing (obtained by multiplying the shaft cross-sectional area by the allowable unit end bearing at the design depth). The allowable accumulative unit

skin friction capacity vs. depth curve, allowable unit end bearing vs. depth curve, and allowable compressive load vs. depth curve for 24-, 30-, 36-, 42-, and 48-inch diameter straight sided drilled shafts for the east and west abutments of the bridge are presented on Plates B-1 through B-6, in Appendix B.

When a shaft tip is terminated in a strong layer underlain by a weak layer and the thickness between the shaft tip and the top of the weak layer is less than 2 shaft diameters (feet), we recommend the use of the design end bearing of the lower weak layer.

Drilled Shaft Spacing: To reduce the influence of adjacent drilled shafts and group effects, the minimum center-to-center spacing between adjacent shafts should be at least 3 times the diameter of the larger shafts; the minimum edge-to-edge spacing between adjacent shafts should not be less than 3 feet. The minimum spacing must include proper allowances for cantilever tolerance of alignment and possible oversizing of the drilled hole.

Foundation Settlements: Based on the soil conditions encountered, we estimate that straight sided drilled shafts designed and constructed as recommended will experience total settlements within 1 inch.

Drilled Shaft Construction: Drilled shaft foundations should be constructed in accordance with the latest City of Houston Standard Construction Specifications (COHSCS). Based on our borings, drilled shaft excavations will most likely encounter ground water and granular soils (if the shafts extend to approximately 65 to 67 feet below grade), which could cause sidewall sloughing or collapse during shaft excavation. To maintain integrity of the shaft excavations, we recommend the use of steel casing and/or bentonite slurry for drilled shaft construction. AEC does not recommend the use of polymer slurry for shaft construction.

For slurry method, the bentonite slurry should be used prior to encountering ground water or granular soils and the slurry head should be maintained at least 5 feet higher than the ground water at the site during construction. The concrete should be placed using a tremie to displace the lower density slurry. Care must be taken to ensure that tremie is positioned and maintained at the bottom of excavation until a height of 5 feet of concrete has been poured. As more concrete is added, the tremie should be maintained at a minimum distance of 5 feet below the top of the concrete pour.

New drilled shafts should not be excavated within 3 shaft diameters (edge to edge) of an open shaft excavation, or one in which concrete has been placed in the preceding 24 hours, to prevent movement of fresh concrete from the recently filled footing to an adjacent unfilled footing. Placement of concrete should be accomplished as soon

as possible after excavation to reduce changes in the state of stress and possible sloughing in the foundation soils. No shafts should be left open overnight or poured without the prior approval of the Owner's Representative.

In addition, each footing excavation should be inspected by a qualified Owner's Representative prior to placing concrete, to check that (1) the footing excavation has been constructed to the specified dimensions at the recommended depth and formation, (2) excessive cuttings and any soft-compressible materials have been removed from the bottom of the excavation.

5.1.2 Slope Stability

Based on our borings, AEC selected the west bank of the channel to perform slope stability analyses using the soil conditions encountered in Boring B-1. Based on the provided plan and profile drawing, the existing channel is approximately 8 feet deep, and the channel slopes will be H:V = 3:1. The channel slopes will be protected with a concrete liner. According to the bridge plan and profile drawing, the proposed 100 year flood elevation is at 36.54 feet above Mean Sea Level (MSL). AEC assumes that the channel will typically remain dry in most conditions. The slope stability analyses consider three different conditions: the short-term condition, long-term condition and rapid drawdown condition. AEC performed the stability analyses in accordance with Harris County Flood Control (HCFCD) requirements.

Design Soil Parameters and Profiles: Soil parameters used in the analyses include wet unit weights, unconsolidated-undrained (UU) shear strengths, consolidated-drained (CD) shear strengths, and consolidated-undrained (CU) shear strengths. The channel cross section provided on the plan and profile drawings was used to perform slope stability analyses. High to very high plasticity fat clay was encountered in our borings. Exposing these fat clays to the atmosphere and cycles of wetting-drying from seasonal moisture changes will result in desiccation, cracking, and progressive movement of these clays, and a reduction in their shear strengths. We considered the desiccation zone for fat clay to be about 8 feet below the top of bank and the slope surface. For fat clay within the desiccation zone, we used effective stress residual shear strengths of c'_r = 65 psf and ϕ'_r = 21 degrees to evaluate slope stability for both the long-term condition and rapid drawdown condition. We also reduced the c' and c_{cu} of clay soils (with a PI greater than 20) within the non-desiccated zone based on our experience with HCFCD projects.

Conditions Analyzed for Slope Stability: AEC used the Simplified Bishop Method of Slices option in the SLOPE/W computer program to analyze slope stability for 2-dimensional limiting equilibrium. The program has

the capability to compute pore water pressures based on a defined piezometric surface. For rapid drawdown conditions, we considered that the water level drops from the 100 year flood elevation to the channel bottom; this models the condition where a 100-year flood event occurs and then the water level drops down quickly. Based on our water readings in the borings, we considered the ground water level to be approximately 15 feet deep for both short-term and long-term conditions.

HCFCD requires a minimum safety factor (SF) of 1.3 for short-term conditions, 1.5 for long-term conditions, and 1.25 for rapid drawdown conditions. Stability analyses for the slopes were conducted for the short-term (end-of-construction), long-term, and rapid drawdown conditions. A brief description of these conditions is presented below:

1. End-of-Construction Condition - This condition models rapid construction loading taking place, so that there is no time for the induced excess pore water pressure to dissipate or for consolidation to occur during the loading period. Unconsolidated-undrained shear strength parameters were used for this analysis.

2. Long-Term Condition - This condition models long-term steady seepage through embankments and the long-term stability of slopes in stiff clays. Consolidated-drained effective stress shear strength parameters (obtained from CU triaxial tests with pore water pressure measurements) were used for this analysis.

3. Rapid Drawdown Condition - The majority of slope failures in the Harris County/Houston area occur under rapid drawdown conditions. This condition models when the slope becomes fully saturated and consolidated and is at equilibrium with the existing stress system, then encounters rapid drawdown and simultaneously allows no drainage to occur. Consolidated-undrained total stress shear strength with pore pressures parameters modeling rapid drawdown conditions were used for this analysis.

Slope Stability Analysis at Shawnee Road Bridge Crossing: We performed slope stability analyses for the west bank of the Shawnee Road Bridge crossing, using soil information encountered in Boring B-1. Design soil parameters for the analysis are presented on Plate C-1, in Appendix C. A 240 psf construction/traffic surcharge was added to the top of the slope for both the short- and long-term condition. The results of the slope stability analyses for the channel slopes under the short-term, long-term, and rapid drawdown conditions are presented on Plates C-2 through C-4, in Appendix C. The safety factors for the channel slopes at the bridge crossing under short term, long term, and rapid drawdown conditions are summarized in Table 2.

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Table 2. Shawnee Road West Bank Slope Stability Analysis Results (Based on Boring B-1)

Slope Analyzed	Minimum Factor of Safety		
	Short-Term	Long-Term	Rapid Drawdown
West Bank, H:V = 3:1	7.10 (Plate C-2)	2.30 (Plate C-3)	2.06 (Global Slide, Plate C-4) 1.49 (Local Slide, Plate C-4a)

Based on the summary in Table 2, the SF's for the channel at the Shawnee Road Bridge meets HCFCD guidelines under short-term, long-term, and rapid drawdown conditions.

5.2 Select Fill

If required, select fill should consist of uniform, non-active inorganic lean clays with a PI between 10 and 20 percent, and more than 50 percent passing a No. 200 sieve. Excavated material delivered to the site for use as select fill shall not have clay clods with PI greater than 20, clay clods greater than 2 inches in diameter, or contain sands/silts with PI less than 10. Prior to construction, the Contractor should determine if he or she can obtain qualified select fill meeting the above select fill criteria.

As an alternative to imported fill, on-site soils excavated during foundation construction can be stabilized with a minimum of 7 percent hydrated lime (by dry soil weight) determined by lime-series curve or pH method in a laboratory prior to construction. Lime stabilization should be done in general accordance with the latest COHSCS. AEC prefers using stabilized on-site clay as select fill since compacted lime-stabilized clay generally has high shear strength, low compressibility, and relatively low permeability. Blended or mixed soils (sand and clay) should not be used as select fill.

All material intended for use as select fill should be tested prior to use to confirm that it meets select fill criteria. The fill should be placed in loose lifts not exceeding 8 inches in thickness. Backfill within 3 feet of walls or columns should be placed in loose lifts no more than 4-inches thick and compacted using hand tampers, or small self-propelled compactors. The lime-stabilized onsite soils or select fill should be compacted to a minimum of 95 percent of the ASTM D 698 (Standard Proctor) maximum dry unit weight at a moisture content ranging between optimum and 3 percent above optimum.

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5.3 Site Preparation and Grading

To mitigate site problems that may develop following prolonged periods of rainfall, it is essential to have adequate drainage to maintain a relatively dry and firm surface prior to starting any work at the site. Adequate drainage should be maintained throughout the construction period. Methods for controlling surface runoff and ponding include proper site grading, berm construction around exposed areas, and installation of sump pits with pumps.

6.0 CONSTRUCTION MONITORING

Site preparation (including clearing and proof-rolling), foundation construction, and earthwork operations should be monitored by qualified geotechnical professionals to check for compliance with project documents and changed conditions, if encountered.

7.0 GENERAL

The information contained in this report summarizes conditions found on the date the borings were drilled. The attached boring logs are true representations of the soils encountered at the specific boring locations on the date of drilling. Due to variations encountered in the subsurface conditions across the site, changes in soil conditions from those presented in this report should be anticipated. AEC should be notified immediately when conditions encountered during construction are significantly different from those presented in this report. AEC should be allowed to review the design and construction plans and specifications prior to release to check that the geotechnical recommendations and design criteria presented herein are properly interpreted.

8.0 LIMITATIONS

The investigation was performed using the standard level of care and diligence normally practiced by recognized geotechnical engineering firms in this area, presently performing similar services under similar circumstances. This report has been prepared exclusively for the project and location described in this report, and is intended to be used in its entirety. If pertinent project details change or otherwise differ from those described herein, AEC should be notified immediately and retained to evaluate the effect of the changes on the recommendations presented in this report, and revise the recommendations if necessary. The scope of services does not include a fault investigation. The recommendations presented in this report should not be used for other structures located at this site or similar structures located at other sites, without additional evaluation and/or investigation.

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9.0 CLOSING REMARKS

AEC appreciates the opportunity to be of service on this project and looks forward to our continuing association during the construction phase of this project and on future projects.

AVILES ENGINEERING CORPORATION
(TBPE Firm Registration No. F-42)

11/15/11
STATE OF TEXAS
WILBER L. WANG
99226
LICENSED
PROFESSIONAL ENGINEER

Wilber L. Wang, M.Eng., P.E.
Project Engineer

Shou Ting Hu, M.S.C.E., P.E.
Principal Engineer

November 15, 2011

Reports Submitted: 4 Entech Civil Engineers, Inc.
1 Electronic (CD)

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APPENDIX A

Plate A-1	Vicinity Map
Plate A-2	Boring Location Plan
Plates A-3 and A-4	Boring Logs
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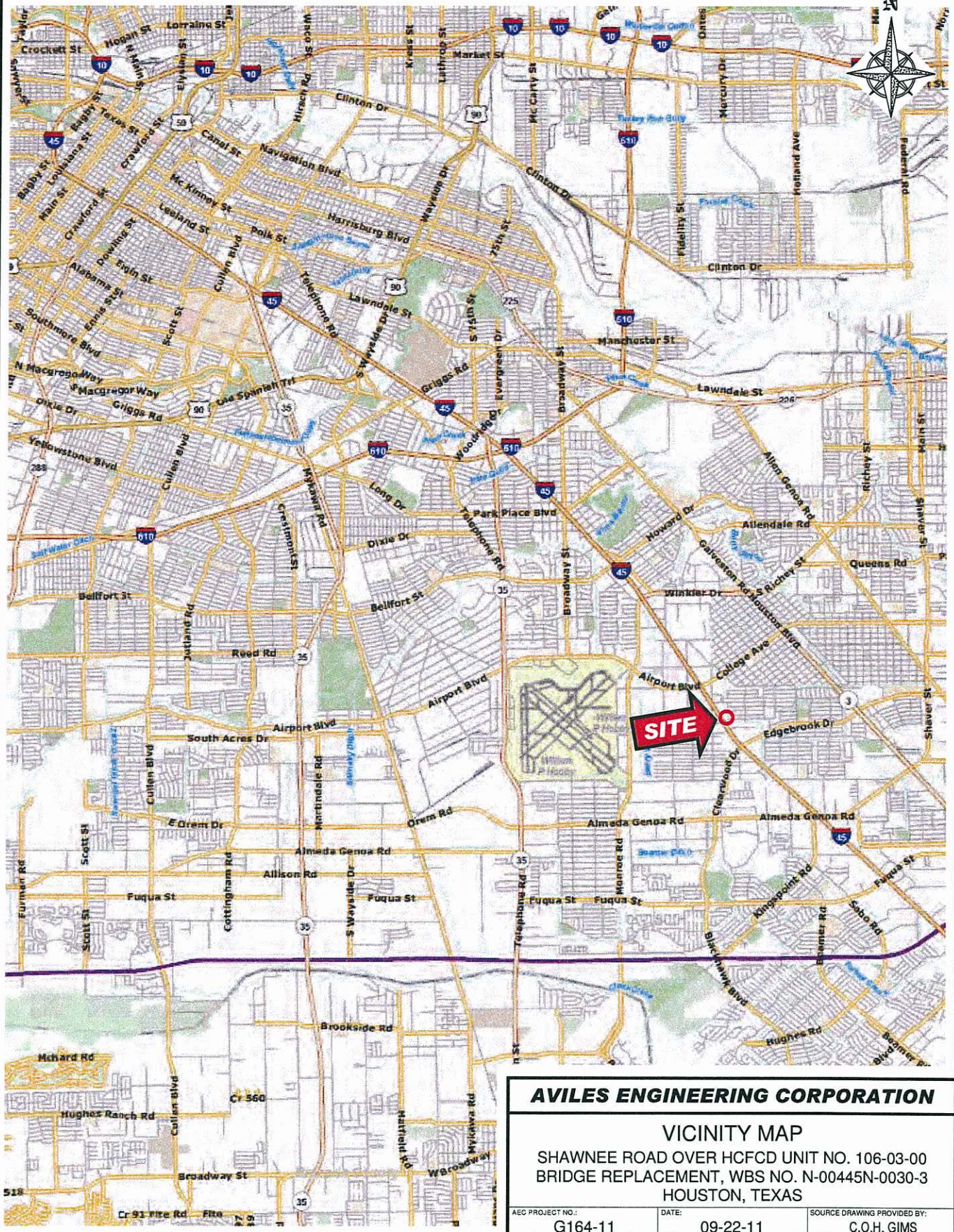
Plate A-6	Classification of Soils for Engineering Purposes
Plate A-7	Terms Used on Boring Logs
Plate A-8	ASTM & TXDOT Designation for Soil Laboratory Tests
Plate A-9	Sieve Analysis Results
Plate A-10	Crumb Test Results
Plates A-11 to A-14	CU Test Results



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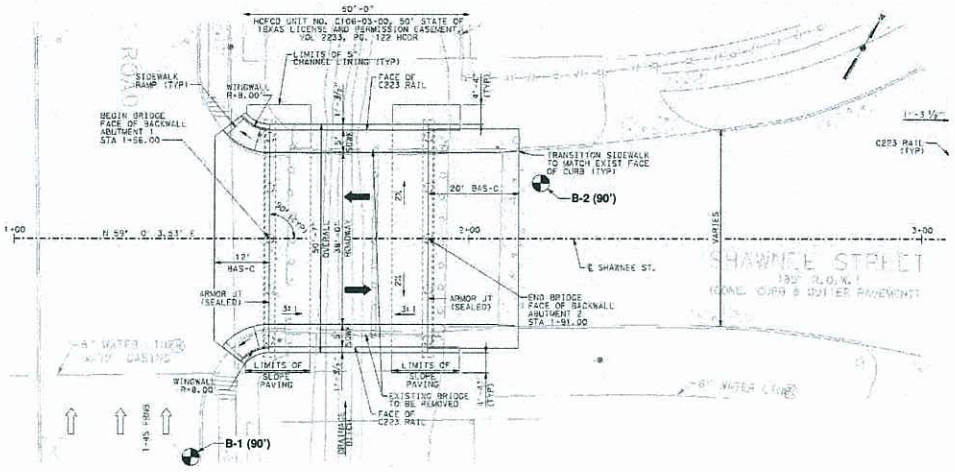
VICINITY MAP

SHAWNEE ROAD OVER HCFCD UNIT NO. 106-03-00
BRIDGE REPLACEMENT, WBS NO. N-00445N-0030-3
HOUSTON, TEXAS

AEC PROJECT NO.:	DATE:	SOURCE DRAWING PROVIDED BY:
G164-11	09-22-11	C.O.H. GIMS
APPROX. SCALE:	DRAFTED BY:	PLATE NO.:
N.T.S.	BpJ	PLATE A-1



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BORING LOCATION PLAN

SHAWNEE ROAD OVER HCFCD UNIT NO. 106-03-00
BRIDGE REPLACEMENT, WBS NO. N-00445N-0030-3
HOUSTON, TEXAS

A/E PROJECT NO.:	DATE:	SOURCE DRAWING PREPARED BY:
G164-11	11-15-11	ENTECH
APPROX. SCALE:	DRAFTED BY:	PLATE NO.:
1" = 20'	BpJ	PLATE A-2

HCFCD_G164-11_LOGS.GPJ HCFCD.GDT 11/15/11

AVILES ENGINEERING CORP.
5790 Windfern
Houston, Texas
Telephone: (713) 895-7645
Fax: (713) 895-7943

LOG OF BORING B-1

PROJECT: Shawnee Road Over HCFCD Unit No. 106-03-00
Bridge Replacement, WBS No. N-00445N-0030-3
Houston, Texas

PROJECT NO.: G164-11 BORING TYPE: 4" DRY AUGER / WET ROTARY

DATE: 8/17/11

SURFACE ELEVATION (FT.): 34.52

LOCATION

Northing: 13803160.63
Easting: 3160938.09
Station: 1+36.00, Offset: 51.14' R

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	UU / UC SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		CH		PAVEMENT: 9" concrete + 1" asphalt + 6" cement-stabilized base + 1" stabilized sand FAT CLAY (CH), stiff to hard, high to very high plasticity, dark gray, with slickensides and ferrous stains, moist	P=2.0 P=2.25	91	0.75	7.7	0	30 28	79	25	54	94	
5				-tan, light gray and brown 4'-10', with calcareous nodules 4'-12' -with silt seams 6'-8' -with sand partings 8'-10'	P=2.5 P=2.75 P=2.5	95 105	1.08	4.9	6	28 29 22	75	24	51	98	4'-6' CU: C'=460psf ϕ'=19.1° C_{cu}=520psf ϕ_{cu}=12.9°
10				-reddish brown and light gray 10'-18'	P=1.25 P=2.75 P=3.25	90	0.89	2.8	10	31 33 30	66	27	39	99	
15				-with silt seams 16'-18'	P=2.5					33	80	32	48	99	
20				-tan and light gray 18'-20'	P=4.25					24					
25				-tan, brown and light gray, with sand partings 23'-25'	P=2.75	105	1.21	14.8	15	22					
30		CL ML		-reddish brown, with silty clay seams 28'-30' Silty Clay layer 30'-33'	P=3.5					27	71	31	40	100	
35		CH		FAT CLAY (CH), very stiff to hard, high to very high plasticity, reddish brown and light gray, with slickensides and ferrous stains, moist -with silt pockets 33'-35' -brown and tan 38'-55'	P=4.25	94	1.08	4.9	18	29					
40					P=4.25					28	75	30	45	99	
45					P=4.25					26					

FIELD STRENGTH DATA: ● BLOW COUNT ● (20 40 60 80); ▲ C_u (tsf) ▲ (1.0 2.0 3.0 4.0); ■ SS (tsf) ■ (1.0 2.0 3.0 4.0); ◆ Torvane (psf) ◆ (200 400 600 800)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼
Water Observations: Water encountered at 30' during drilling.
Measured water at 21.6' approx 15 minutes after initial encounter.

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed (Auger)

Key to Abbreviations:
N -SPT Data (blows/ft)
P -Pocket Penetrometer (tsf)
T -Torvane
C_u -Undrained Cohesion (tsf)
SS-Shear Strength (P/2, tsf)

Notes:
(1) Borehole caved in at 28.9' during drilling. (2) Wet rotary started at 30'.
(3) Northing/Easting is Texas State Plane, South Central Zone No. 4204, Grid Coordinates, NAD83. Surface elevation is NAVD88, 2001 Adj.

PLATE A-3

HCFCD_G164-11_LOGS.GPJ HCFCD.GDT 11/15/11

AVLES ENGINEERING CORP.
5790 Windfern
Houston, Texas
Telephone: (713) 895-7645
Fax: (713) 895-7943

LOG OF BORING B-1

PROJECT: Shawnee Road Over HCFCD Unit No. 106-03-00
Bridge Replacement, WBS No. N-00445N-0030-3
Houston, Texas

PROJECT NO.: G164-11 BORING TYPE: 4" DRY AUGER / WET ROTARY

DATE: 8/17/11

SURFACE ELEVATION (FT.): 34.52

LOCATION

Northing: 13803160.63
Easting: 3160938.09
Station: 1+36.00, Offset: 51.14' R

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	UU / UC SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
50		CH		FAT CLAY (CH), stiff to hard, high to very high plasticity, brown and tan, with slickensides and ferrous stains, moist *(continued)* -with sand partings 48'-52', and silt pockets 48'-55' with silt partings 52'-58'	P=3.75	98	1.40	3.8	23	24					
					P=4.5					26	56	25	31	100	
55															
60				-dark brown and dark gray 58'-65'	P=3.0	80	1.19	7.1	27	39					
					P=3.0					45	94	33	61	99	
65															
70		SW SM		WELL-GRADED SAND WITH SILT (SW-SM), dense, no plasticity, tan, wet	N=34					11				7	
					N=31					14					
75															
80		CH		FAT CLAY (CH), very stiff to hard, high plasticity, reddish brown and light gray, moist -with silt pockets 78'-80'	P=4.5	108	1.55	7.6	33	19					
					P=4.5					24	66	26	40	100	
85															
		ML		SILT (ML), medium dense, no plasticity, reddish brown, with clay partings, wet	N=29					21				93	
90				Termination depth = 90 feet.											

FIELD STRENGTH DATA: ● BLOW COUNT ● (20 40 60 80); ▲ C_u (tsf) ▲ (1.0 2.0 3.0 4.0); ■ SS (tsf) ■ (1.0 2.0 3.0 4.0); ◆ Torvane (psf) ◆ (200 400 600 800)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼
Water Observations: Water encountered at 30' during drilling.
Measured water at 21.6' approx 15 minutes after initial encounter.

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed (Auger)

Key to Abbreviations:
N -SPT Data (blows/ft)
P -Pocket Penetrometer (tsf)
T -Torvane
C_u -Undrained Cohesion (tsf)
SS-Shear Strength (P/2, tsf)

Notes:
(1) Borehole caved in at 28.9' during drilling. (2) Wet rotary started at 30'.
(3) Northing/Easting is Texas State Plane, South Central Zone No. 4204, Grid Coordinates, NAD83. Surface elevation is NAVD88, 2001 Adj.

PLATE A-3

HCFCD_G164-11_LOGS.GPJ_HCFCD.GDT_11/15/11

AVLES ENGINEERING CORP.
5790 Windfern
Houston, Texas
Telephone: (713) 895-7645
Fax: (713) 895-7943

LOG OF BORING B-2

PROJECT: Shawnee Road Over HCFCD Unit No. 106-03-00
Bridge Replacement, WBS No. N-00445N-0030-3
Houston, Texas

PROJECT NO.: G164-11 BORING TYPE: 4" DRY AUGER / WET ROTARY

DATE: 8/17/11

SURFACE ELEVATION (FT.): 34.71

LOCATION

Northing: 13803256.12
Easting: 3160972.35
Station: 2+14.56, Offset: 13.07' L

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	UU / UC SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				PAVEMENT: 10" concrete	n/a					16				34	
		CH		FILL: SILTY SAND (SM), no plasticity, tan, with clay pockets, moist	n/a P=2.5					29	85	27	58	95	
				FAT CLAY (CH), stiff to very stiff, very high plasticity, gray and tan, with slickensides and ferrous stains, moist	P=3.25					29					
5					P=2.0	93	0.69	4.9	5	28					
		CL		-with calcareous nodules 6'-8'	P=3.5	107				22	44	19	25	80	8'-10' CU: C'=330psf ϕ'=26.1° C_{cu}=450psf ϕ_{cu}=19.1°
10		CH		LEAN CLAY WITH SAND (CL), very stiff, high plasticity, tan and brown, with calcareous nodules, moist	P=3.25					28					
				FAT CLAY (CH), stiff to very stiff, high to very high plasticity, reddish brown and light gray, with slickensides and ferrous stains, moist	P=3.5	95	1.08	5.8	9	29				
15					P=1.5					33	73	28	45	100	
					P=3.0					31					
				-with calcareous nodules 10'-12'	P=3.0	103	1.52	11.8	11	23					
20				-with sand partings 18'-25'											
				-tan and gray 23'-25'	P=3.5					23	65	24	41	95	
25					P=4.0	98	1.14	9.8	15	27					
30					P=4.0					30	66	26	40	99	
35															
				-brown 38'-40'	P=3.75	95	1.33	4.9	18	28					
40					P=3.5					28	79	29	50	99	
45															

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼
Water Observations: Water encountered at 27' during drilling. Measured water at 15.4' approx 15 minutes after initial encounter, and at 18' approx 24 hours after drilling.
Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed (Auger)

Key to Abbreviations:
N -SPT Data (blows/ft)
P -Pocket Penetrometer (tsf)
T -Torvane
C_u -Undrained Cohesion (tsf)
SS-Shear Strength (P/2, tsf)

Notes:
(1) Wet rotary started at 27'.
(2) Northing/Easting is Texas State Plane, South Central Zone No. 4204, Grid Coordinates, NAD83. Surface elevation is NAVD88, 2001 Adj.

PLATE A-4

AYLES ENGINEERING CORP.
5790 Windfern
Houston, Texas
Telephone: (713) 895-7645
Fax: (713) 895-7943

LOG OF BORING B-2

PROJECT: Shawnee Road Over HCFCD Unit No. 106-03-00
Bridge Replacement, WBS No. N-00445N-0030-3
Houston, Texas

PROJECT NO.: G164-11 BORING TYPE: 4" DRY AUGER / WET ROTARY

DATE: 8/17/11

SURFACE ELEVATION (FT.): 34.71

LOCATION

Northing: 13803256.12
Easting: 3160972.35
Station: 2+14.56, Offset: 13.07' L

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	UU / UC SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits (Plastic Limit – Moisture Content – Liquid Limit)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
50		CH		FAT CLAY (CH), stiff to very stiff, high to very high plasticity, reddish brown and light gray, with slickensides and ferrous stains, moist *(continued)*	P=3.5	97	0.86	6.8	21		28					
				-with silt pockets and silty clay seams 48'-50'												
55		CL		LEAN CLAY WITH SAND (CL), very stiff, dark brown, with silt partings, moist	P=3.5						26					
		GP		Gravel layer 57'-58'												
60		CH		FAT CLAY (CH), very stiff, very high plasticity, brown and gray, with slickensides, moist	P=4.0						36	82	31	51	100	
				-dark brown 63'-65'	P=3.75	87	1.06	2.2	26		34					
65		SP SM		POORLY GRADED SAND WITH SILT (SP-SM), dense, no plasticity, tan, with gravel, wet	N=48						14				11	
70		SM		SILTY SAND (SM), dense, no plasticity, tan, with clay pockets, wet	N=50						21					
75		CL		LEAN CLAY WITH SAND (CL), stiff, medium plasticity, light gray, with silt partings, moist	n/a	117	0.82	6.8	31		14	32	15	17	78	
80		ML		SILT (ML), medium dense, no plasticity, reddish brown and tan, wet	N=28						23				85	
85		CH		FAT CLAY (CH), hard, reddish brown and light gray, with calcareous nodules, moist	P=4.5						23					
90				Termination depth = 90 feet.												

Water Level Est.: ▽ Measured: ▼ Perched: ▼
Water Observations: Water encountered at 27' during drilling. Measured water at 15.4' approx 15 minutes after initial encounter, and at 18' approx 24 hours after drilling.
Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed (Auger)

Key to Abbreviations:
N -SPT Data (blows/ft) T -Torvane
P -Pocket Penetrometer (tsf) C_u -Undrained Cohesion (tsf)
SS-Shear Strength (P/2, tsf)

Notes:
(1) Wet rotary started at 27'.
(2) Northing/Easting is Texas State Plane, South Central Zone No. 4204, Grid Coordinates, NAD83. Surface elevation is NAVD88, 2001 Adj.

LEGEND

LITHOLOGY SYMBOLS

 Concrete

 USCS High Plasticity Fat Clay

 USCS Low Plasticity Silty Clay

 USCS Well-graded Sand with Silt

 USCS Silt

 Fill (made ground)

 USCS Low Plasticity Lean Clay

 USCS Poorly-graded Sandy Gravel

 USCS Poorly-graded Sand with Silt

 USCS Silty Sand

SAMPLER TYPES

 Rock Core

 Harris County Flood Control District: Shelby Tube

 Harris County Flood Control District: Standard Penetration Test

 Harris County Flood Control District: Disturbed Sample (Auger)

AYLES ENGINEERING CORP.

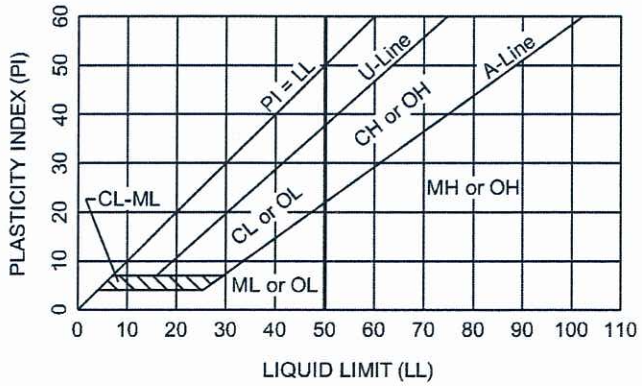
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM Designation D-2487

MAJOR DIVISIONS				GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (Less than 50% of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)		GW	Well-graded gravel, well-graded gravel with sand
				GP	Poorly-graded gravel, poorly-graded gravel with sand
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart	GM	Silty gravel, silty gravel with sand
			Limits plot above "A" line & hatched zone on plasticity chart	GC	Clayey gravel, clayey gravel with sand
	SANDS (50% or more of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)		SW	Well-graded sand, well-graded sand with gravel
				SP	Poorly-graded sand, poorly-graded sand with gravel
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart	SM	Silty sand, silty sand with gravel
			Limits plot above "A" line & hatched zone on plasticity chart	SC	Clayey sand, clayey sand with gravel
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)		SILTS AND CLAYS (Liquid Limit Less Than 50%)		ML	Silt, silt with sand, silt with gravel, sandy silt, gravelly silt
				CL	Lean clay, lean clay with sand, lean clay with gravel, sandy lean clay, gravelly lean clay
				OL	Organic clay, organic clay with sand, sandy organic clay, organic silt, sandy organic silt
		SILTS AND CLAYS (Liquid Limit 50% or More)		MH	Elastic silt, elastic silt with sand, sandy elastic silt, gravelly elastic silt
				CH	Fat clay, fat clay with sand, fat clay with gravel, sandy fat clay, gravelly fat clay
				OH	Organic clay, organic clay with sand, sandy organic clay, organic silt, sandy organic silt

NOTE: Coarse soils between 5% and 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone of the plasticity chart are to have dual symbols.

PLASTICITY CHART



Equation of A-Line: Horizontal at PI=4 to LL=25.5, then PI=0.73(LL-20)

Equation of U-Line: Vertical at LL=16 to PI=7, then PI=0.9(LL-8)

DEGREE OF PLASTICITY OF COHESIVE SOILS

Degree of Plasticity	Plasticity Index
None	0 - 4
Slight	5 - 10
Medium	11 - 20
High	21 - 40
Very High	>40

SOIL SYMBOLS

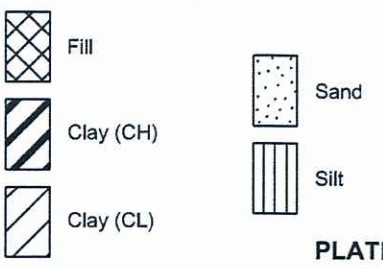


PLATE A-6

AYLES ENGINEERING CORP.

TERMS USED ON BORING LOGS

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

6"	3"	3/4"	#4	#10	#40	#200	
BOULDERS	COBBLES	GRAVEL		SAND			SILT / CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
152	76.2	19.1	4.76	2.00	0.420	0.074	0.002

SOIL GRAIN SIZE IN MILLIMETERS

STRENGTH OF COHESIVE SOILS

Consistency	Undrained Shear Strength, Kips per Sq. ft.
Very Soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

RELATIVE DENSITY OF COHESIONLESS SOILS FROM STANDARD PENETRATION TEST

Very Loose	<4 bpf
Loose	5-10 bpf
Medium Dense	11-30 bpf
Dense	31-50 bpf
Very Dense	>50 bpf

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows per Foot	Description
25	25 blows driving sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows driving sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows driving sampler 3 inches, during initial 6-inches seating interval.

NOTE: To avoid change to sampling tools, driving is limited to 50 blows during or after seating interval.

DRY STRENGTH ASTM D2488

None	Dry specimen crumbles into powder with mere pressure of handling
Low	Dry specimen crumbles into powder with some finger pressure
Medium	Dry specimen breaks into pieces or crumbles with considerable pressure
High	Dry specimen cannot be broken with finger pressure, it can be broken between thumb and hard surface
Very High	Dry specimen cannot be broken between thumb and hard surface

MOISTURE CONDITION ASTM D2488

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the easiness of breaking along these planes.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil types.
Interlayered	Soil sample composed of alternating layers of different soil types.
Intermixed	Soil sample composed of pockets of different soil types and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of calcium material.

AVILES
ENGINEERING CORP.

ASTM & TXDOT DESIGNATION FOR SOIL LABORATORY TESTS

NAME OF TEST	ASTM TEST DESIGNATION	TXDOT TEST DESIGNATION
Moisture Content	D 2216	Tex-103-E
Specific Gravity	D 854	Tex-108-E
Sieve Analysis	D 421 D 422	Tex-110-E (Part 1)
Hydrometer Analysis	D 422	Tex-110-E (Part 2)
Minus No. 200 Sieve	D 1140	Tex-111-E
Liquid Limit	D 4318	Tex-104-E
Plastic Limit	D 4318	Tex-105-E
Shrinkage Limit	D 427	Tex-107-E
Standard Proctor Compaction	D 698	Tex-114-E
Modified Proctor Compaction	D 1557	Tex-113-E
Permeability (constant head)	D 2434	-
Consolidation	D 2435	-
Direct Shear	D 3080	-
Unconfined Compression	D 2166	-
Unconsolidated-Undrained Triaxial	D 2850	Tex-118-E
Consolidated-Undrained Triaxial	D 4767	Tex-131-E
Pinhole Test	D 4647	-
California Bearing Ratio	D 1883	-
Unified Soil Classification System	D 2487	Tex-142-E

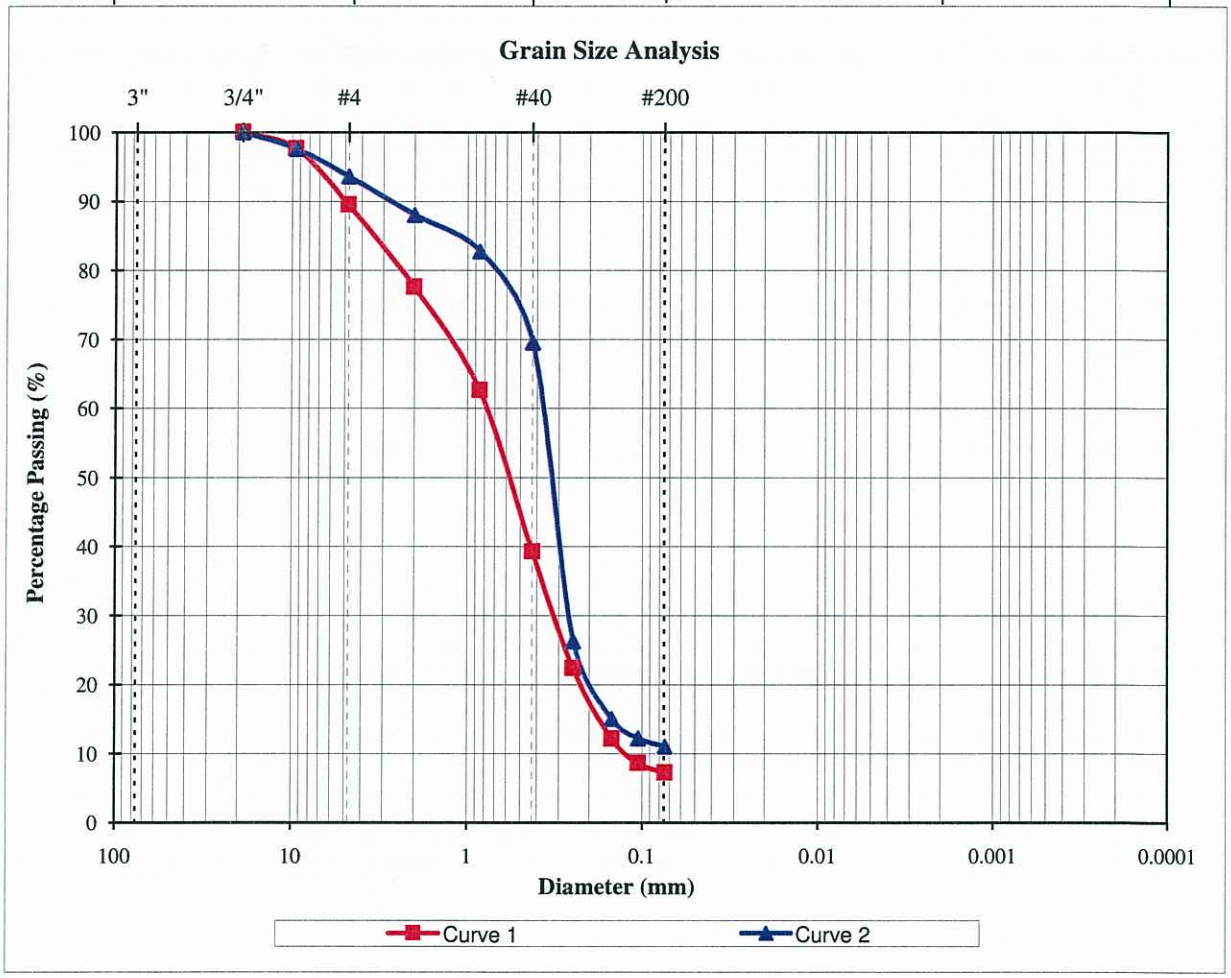
AVILES ENGINEERING CORPORATION

Consulting Engineers - Geotechnical, Construction Materials Testing, Environmental

GRAIN SIZE ANALYSIS - SIEVE

Project : Shawnee Bridge Replacement **Job No.:** G164-11
Location of Project: Houston, Texas **Date of Testing:** 8/25/2011

Gravel	Sand		Silt	Clay
	Coarse to Medium	Fine		



Curve	Boring	Depth (ft)	Soil Description	Cu	Cc
1	B-1	68-70	Well Graded Sand w/Silt (SW-SM)	6.47	1.06
2	B-2	68-70	Poorly Graded Sand w/Silt (SP-SM)	N/A	N/A

PLATE A-9

AVILES ENGINEERING CORPORATION

Consulting Engineers - Geotechnical, Construction Materials Testing, Environmental

RESULTS OF CRUMB TESTS

Project Name: Shawnee Bridge Replacement
Project No.: G164-11 Test Date: 8/30/2011

Boring Number	Depth, feet	Crumbling Characteristics				Crumb Test Classification	
		Soil Crumbles? (Y/N)	If soil crumbles, rate of crumbling			@10 minutes	@30 minutes
			Minor	Moderate	Immediate		
B-2	4-6	Y	•			1	1

Results interpretation:

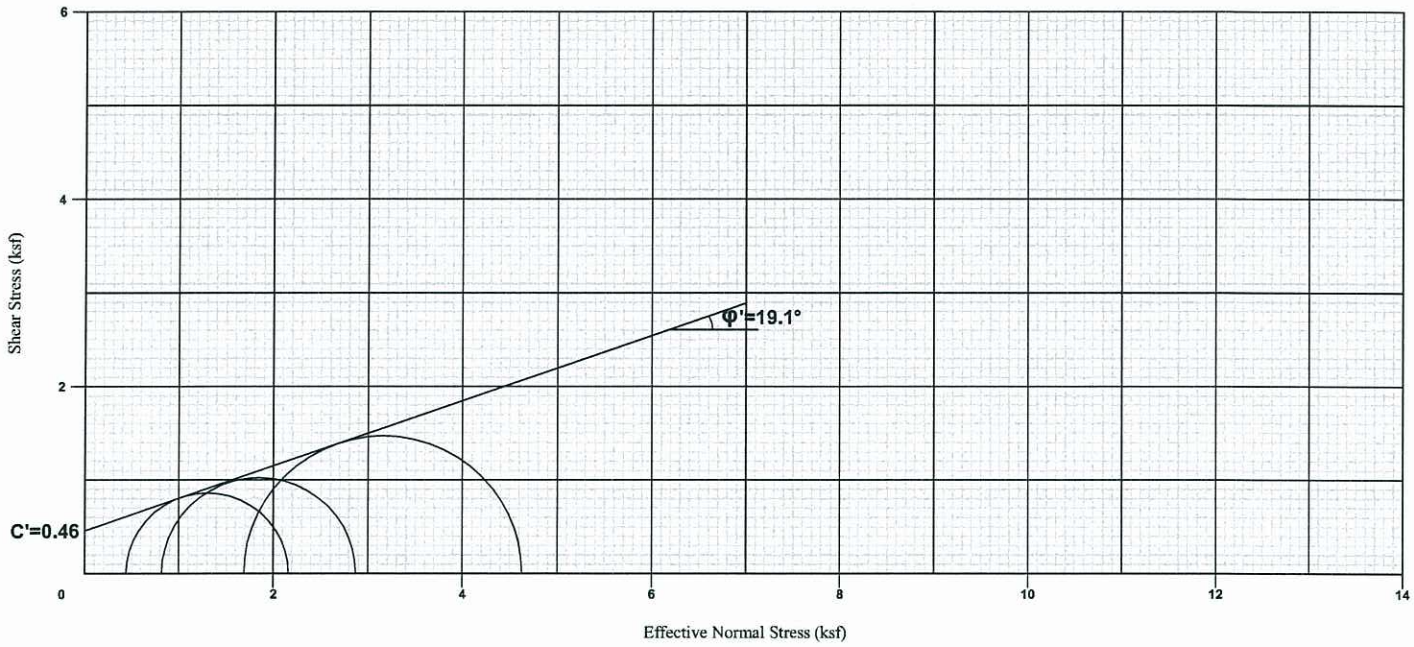
1	No sign of cloudy water caused by colloidal suspension
2	Bare hint of colloidal cloud formation at surface or soil crumb
3	Easily recognized colloidal cloud covering at least 1/4 to 1/2 of the bottom of the glass container
4	Strong reaction with colloidal cloud covering most of the bottom of the glass container

AVLES
ENGINEERING CORP.

Brown FAT CLAY (CH)

LL = 75, PL = 24, PI = 51

W_n = 27.99%, r_d = 94.8 pcf, e_o = 0.811



TRIAXIAL CU TESTS
MOHR'S CIRCLES
Effective Stress
G164-11 Boring B-1, 4'-6'

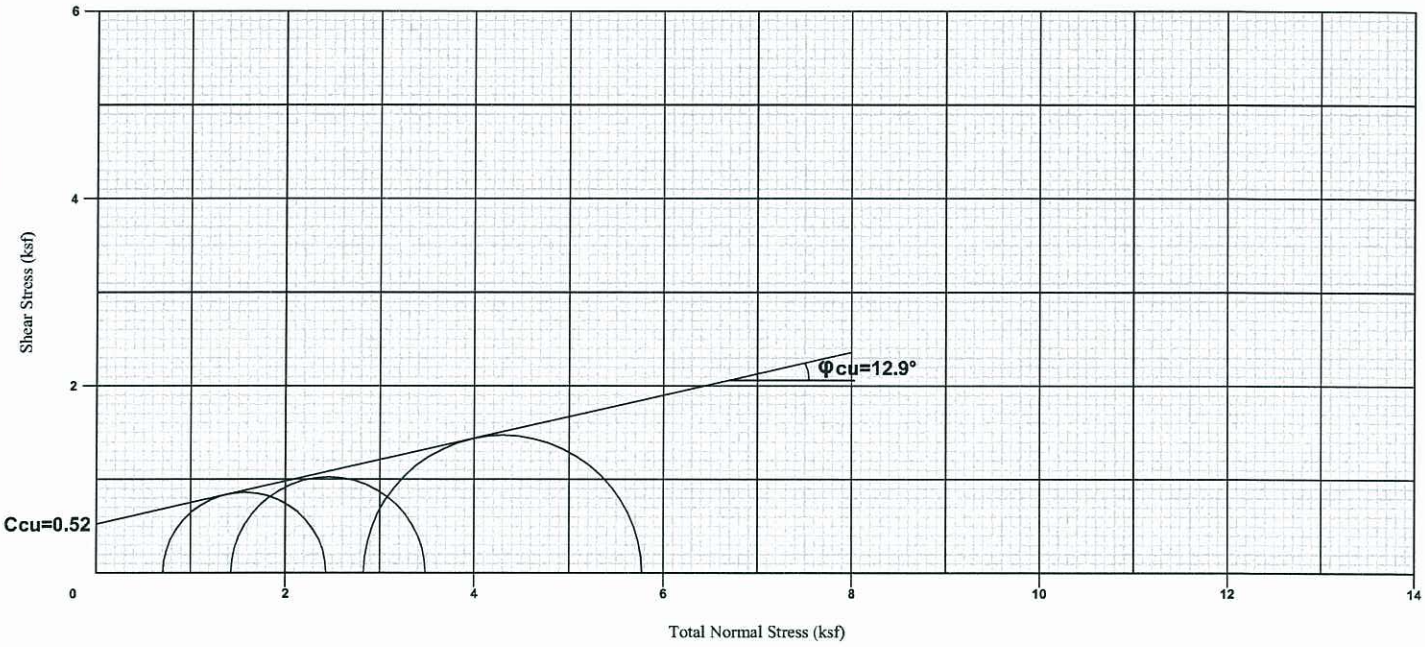
PLATE A-11

AYLES
ENGINEERING CORP.

Brown FAT CLAY (CH)

LL = 75, PL = 24, PI = 51

W_n = 27.99%, r_d = 94.8 pcf, e_o = 0.811



TRIAXIAL CU TESTS
MOHR'S CIRCLES
Total Stress
G164-11 Boring B-1, 4'-6'

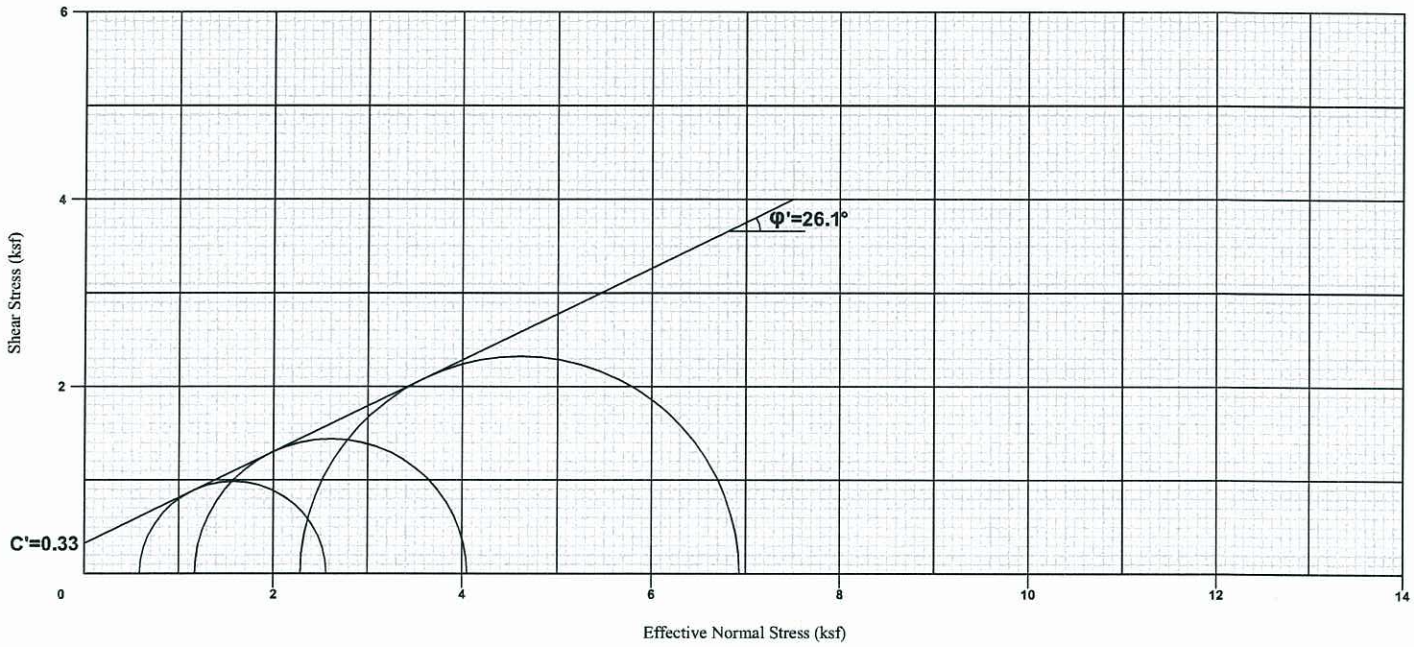
PLATE A-12

AVLES
ENGINEERING CORP.

Brown and gray LEAN CLAY WITH SAND (CL)

LL = 44, PL = 19, PI = 25

W_n = 22.00%, r_d = 107.2 pcf, e_o = 0.572



TRIAXIAL CU TESTS
MOHR'S CIRCLES
Effective Stress
G164-11 Boring B-2, 8'-10'

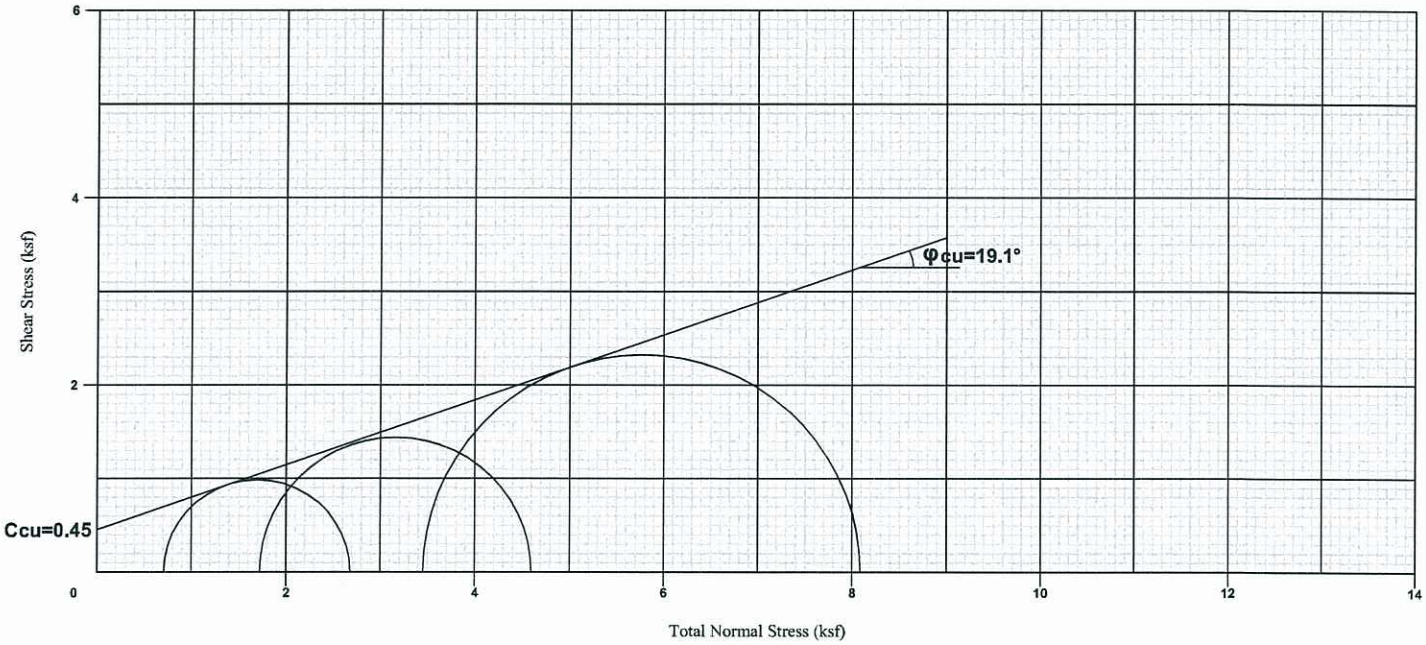
PLATE A-13

AVLES
ENGINEERING CORP.

Brown and gray LEAN CLAY WITH SAND (CL)

LL = 44, PL = 19, PI = 25

W_n = 22.00%, r_d = 107.2 pcf, e_o = 0.572



TRIAXIAL CU TESTS
MOHR'S CIRCLES
Total Stress
G164-11 Boring B-2, 8'-10'

PLATE A-14

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ENGINEERING CORP.

APPENDIX B

Plates B-1 to B-6	Straight Sided Drilled Shaft Capacity Curves
Plate B-7	Aguirre & Fields, LP, Drawing: "Shawnee St. Bridge Replacement", dated November 3, 2011.

G164-11 Shawnee Road Over Drainage Ditch
West Abutment Straight Sided Drilled Shafts (Boring B-1)

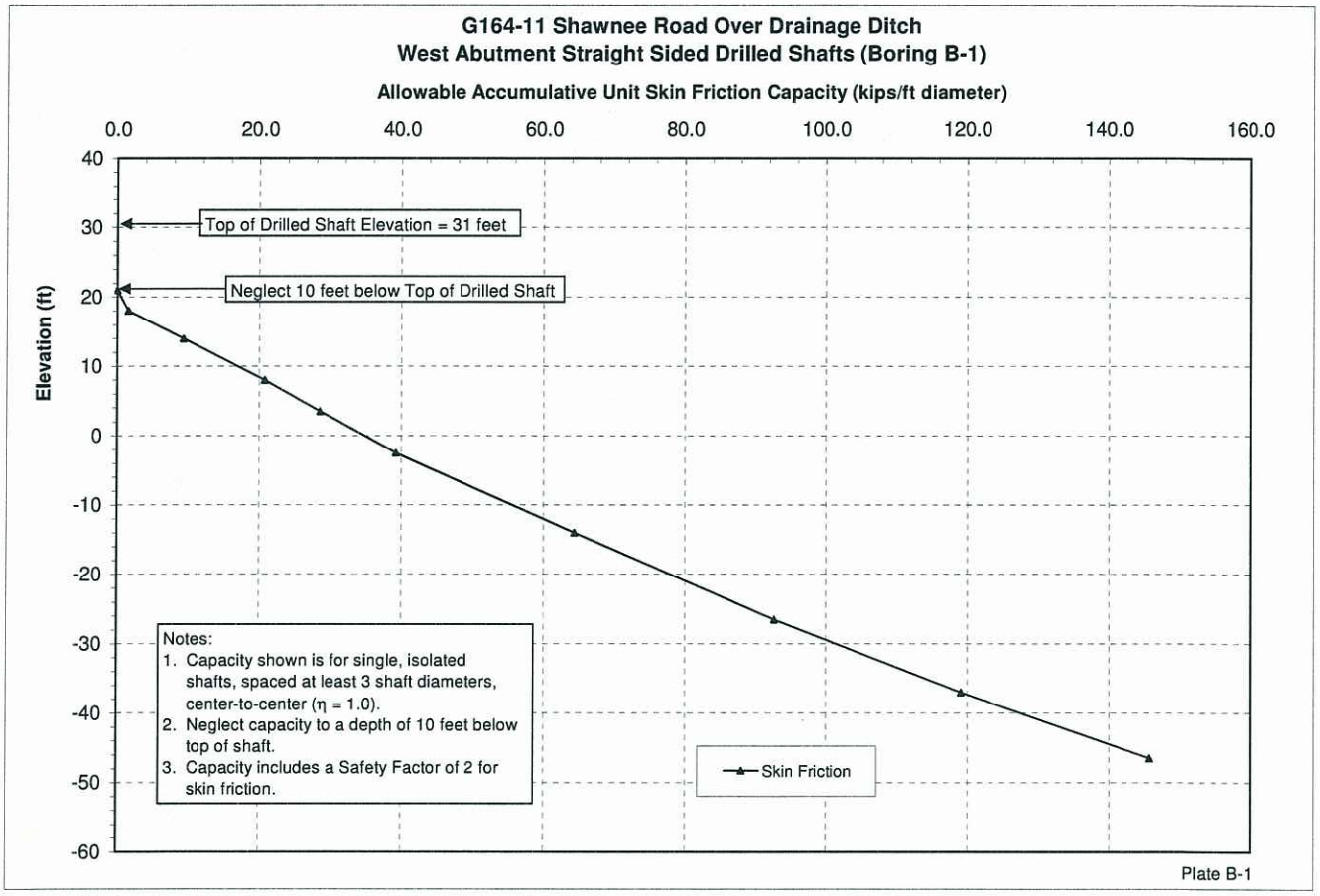
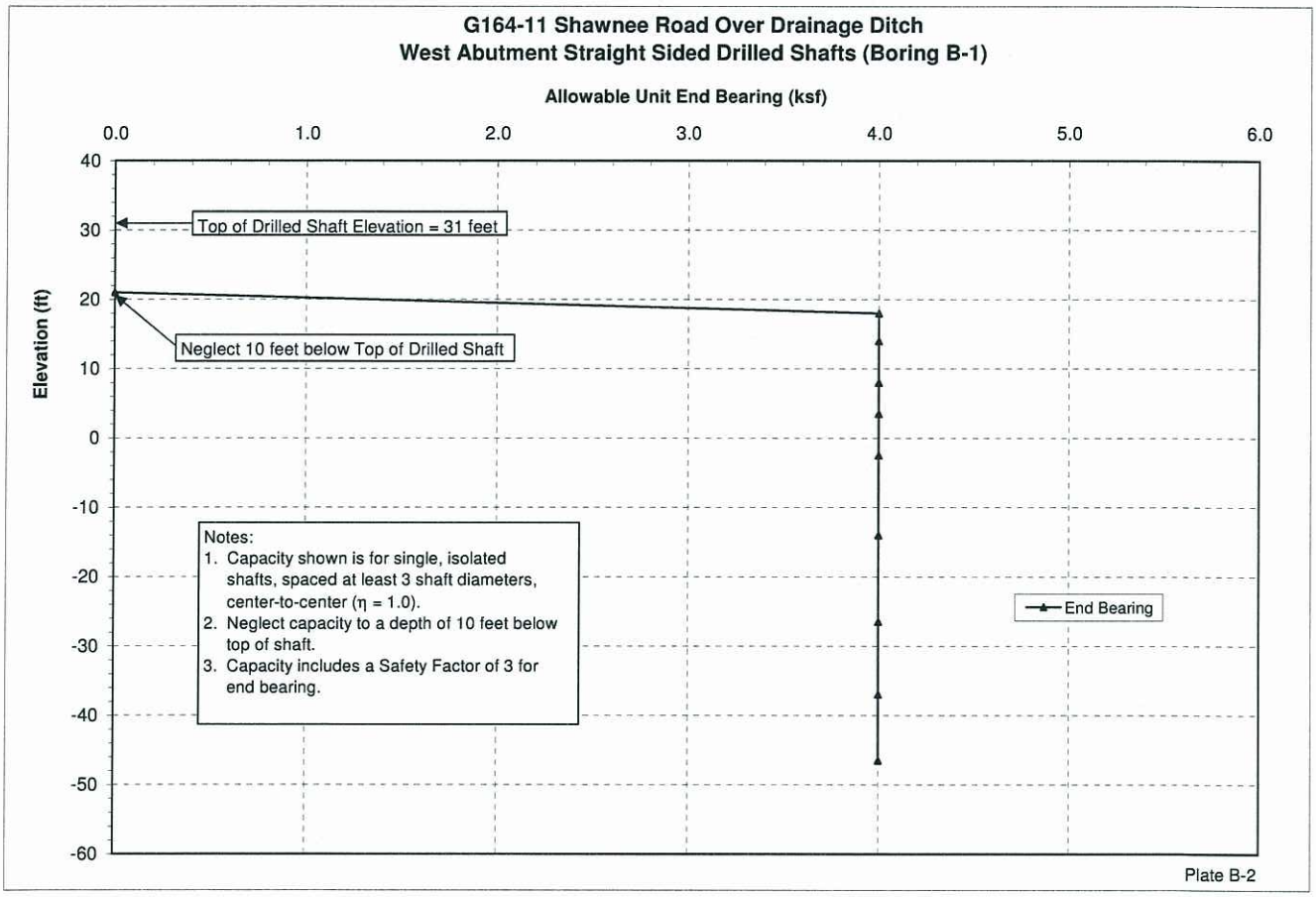
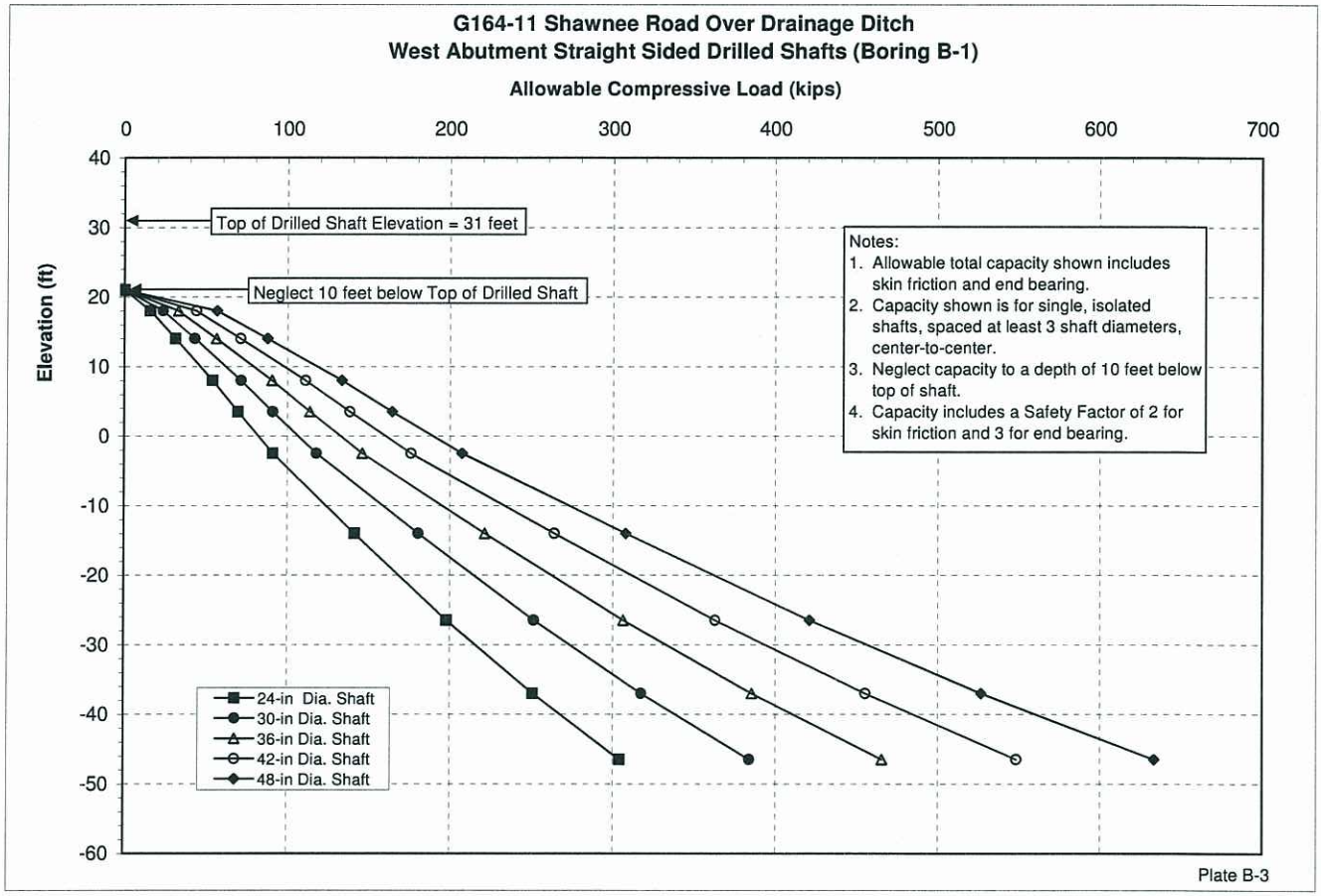


Plate B-1


G164-11 Shawnee Road Over Drainage Ditch
West Abutment Straight Sided Drilled Shafts (Boring B-1)
Allowable Unit End Bearing (ksf)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Elevation (ft)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
Top of Drilled Shaft Elevation = 31 feet
Neglect 10 feet below Top of Drilled Shaft
Notes:
1. Capacity shown is for single, isolated shafts, spaced at least 3 shaft diameters, center-to-center (η = 1.0).
2. Neglect capacity to a depth of 10 feet below top of shaft.
3. Capacity includes a Safety Factor of 3 for end bearing.
End Bearing
Plate B-2


G164-11 Shawnee Road Over Drainage Ditch
West Abutment Straight Sided Drilled Shafts (Boring B-1)
Allowable Compressive Load (kips)
0
100
200
300
400
500
600
700
40
30
20
10
0
-10
-20
-30
-40
-50
-60
Elevation (ft)
Top of Drilled Shaft Elevation = 31 feet
Neglect 10 feet below Top of Drilled Shaft
Notes:
1. Allowable total capacity shown includes skin friction and end bearing.
2. Capacity shown is for single, isolated shafts, spaced at least 3 shaft diameters, center-to-center.
3. Neglect capacity to a depth of 10 feet below top of shaft.
4. Capacity includes a Safety Factor of 2 for skin friction and 3 for end bearing.
24-in Dia. Shaft
30-in Dia. Shaft
36-in Dia. Shaft
42-in Dia. Shaft
48-in Dia. Shaft
Plate B-3

G164-11 Shawnee Road Over Drainage Ditch
East Abutment Straight Sided Drilled Shafts (Boring B-2)

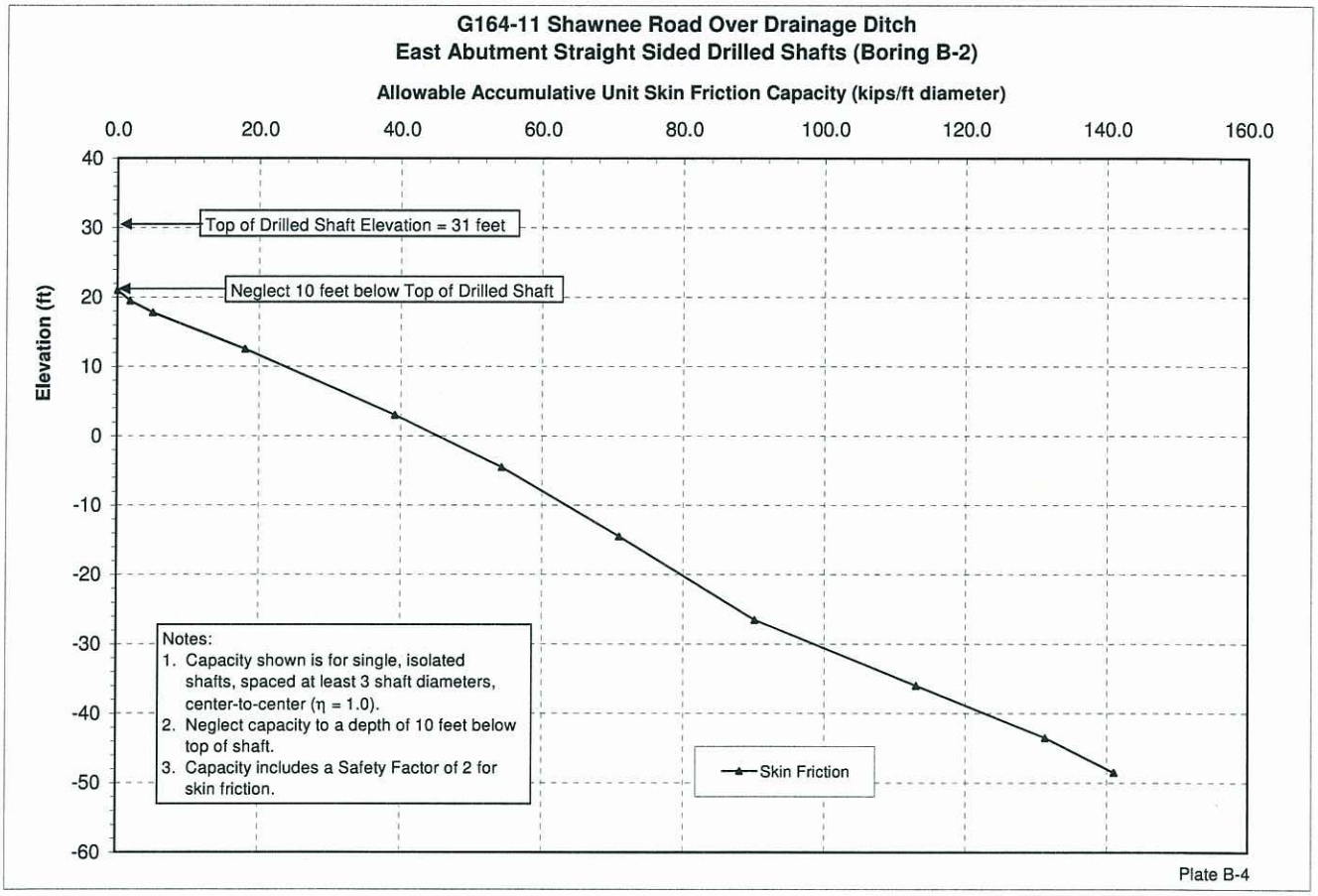
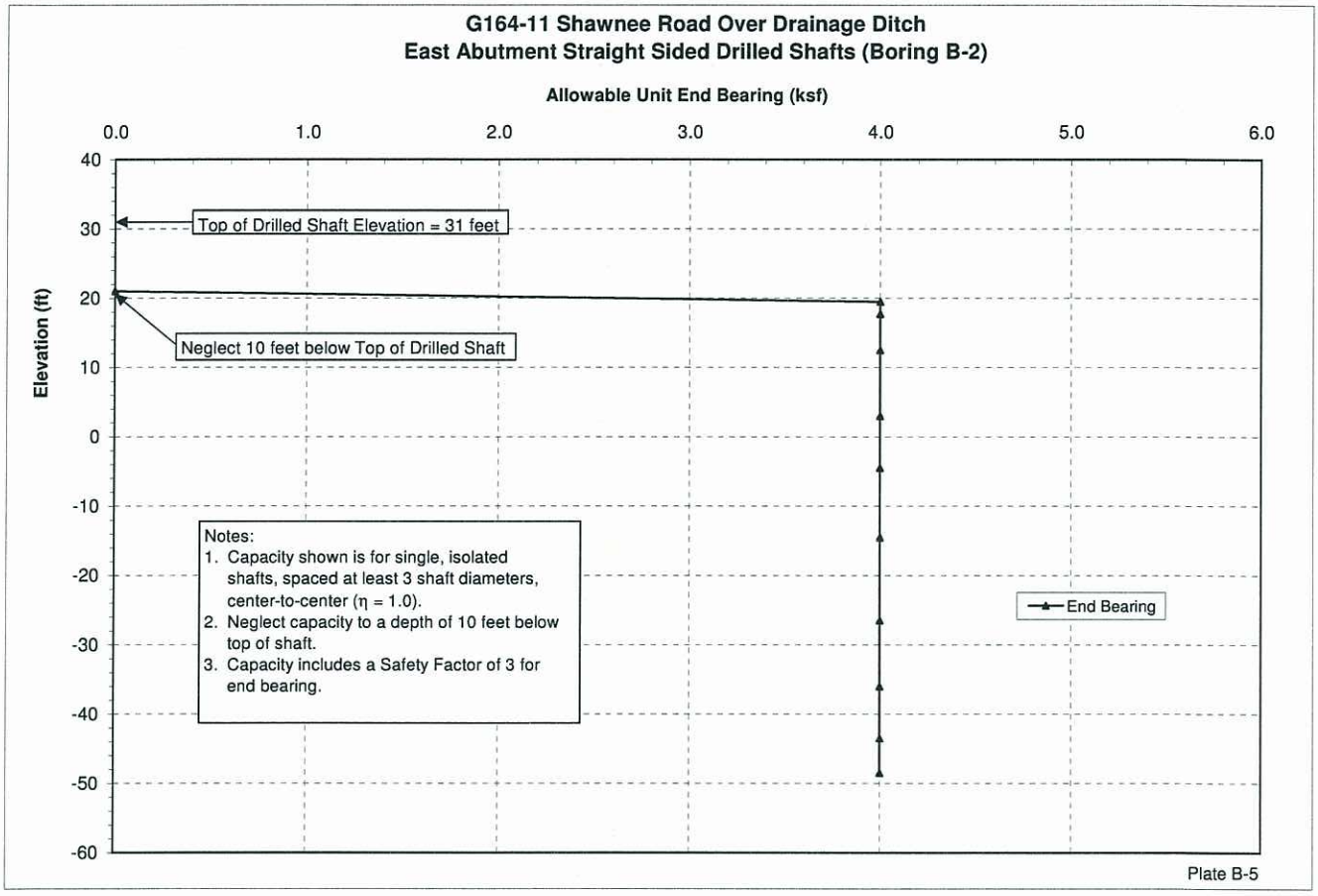
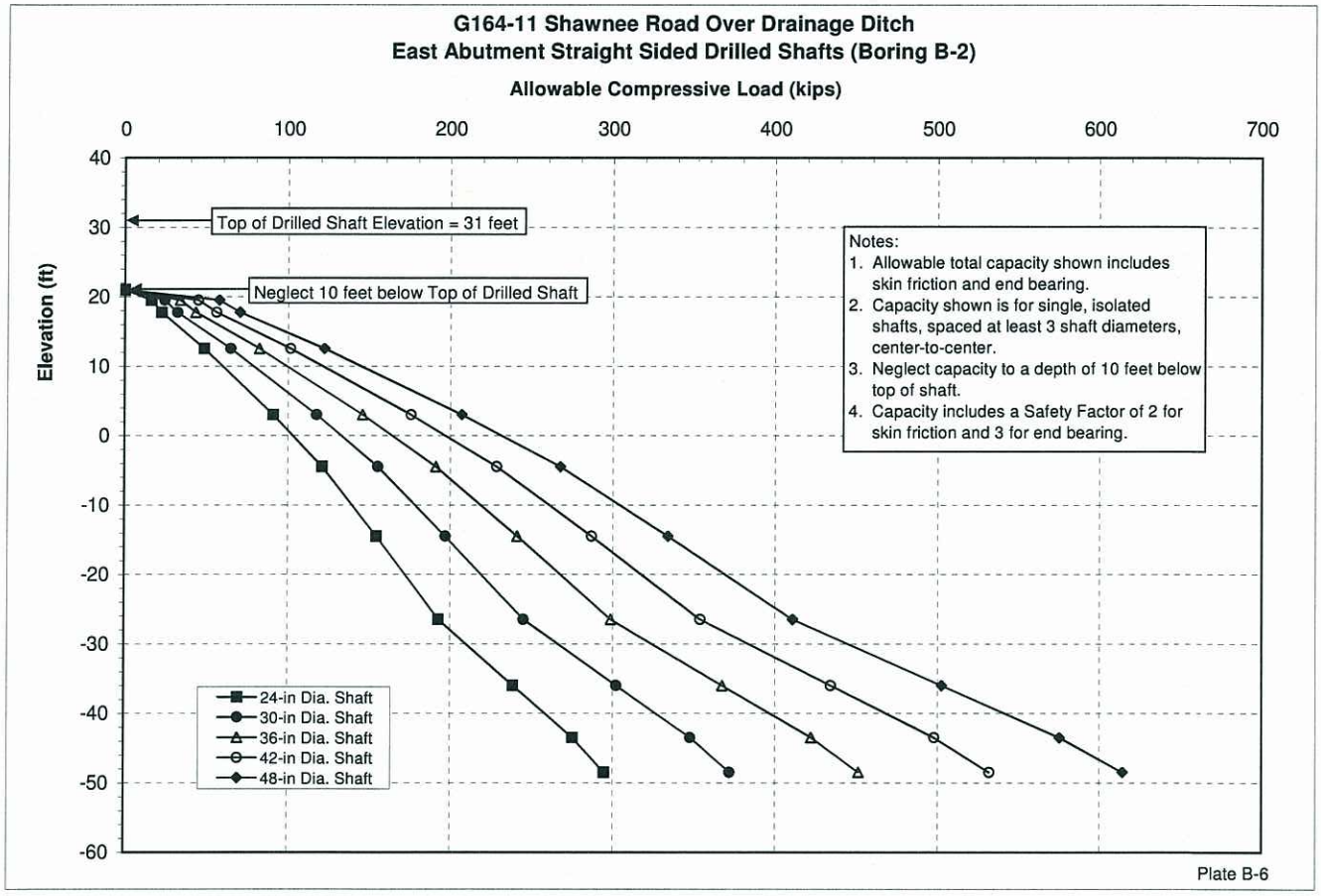
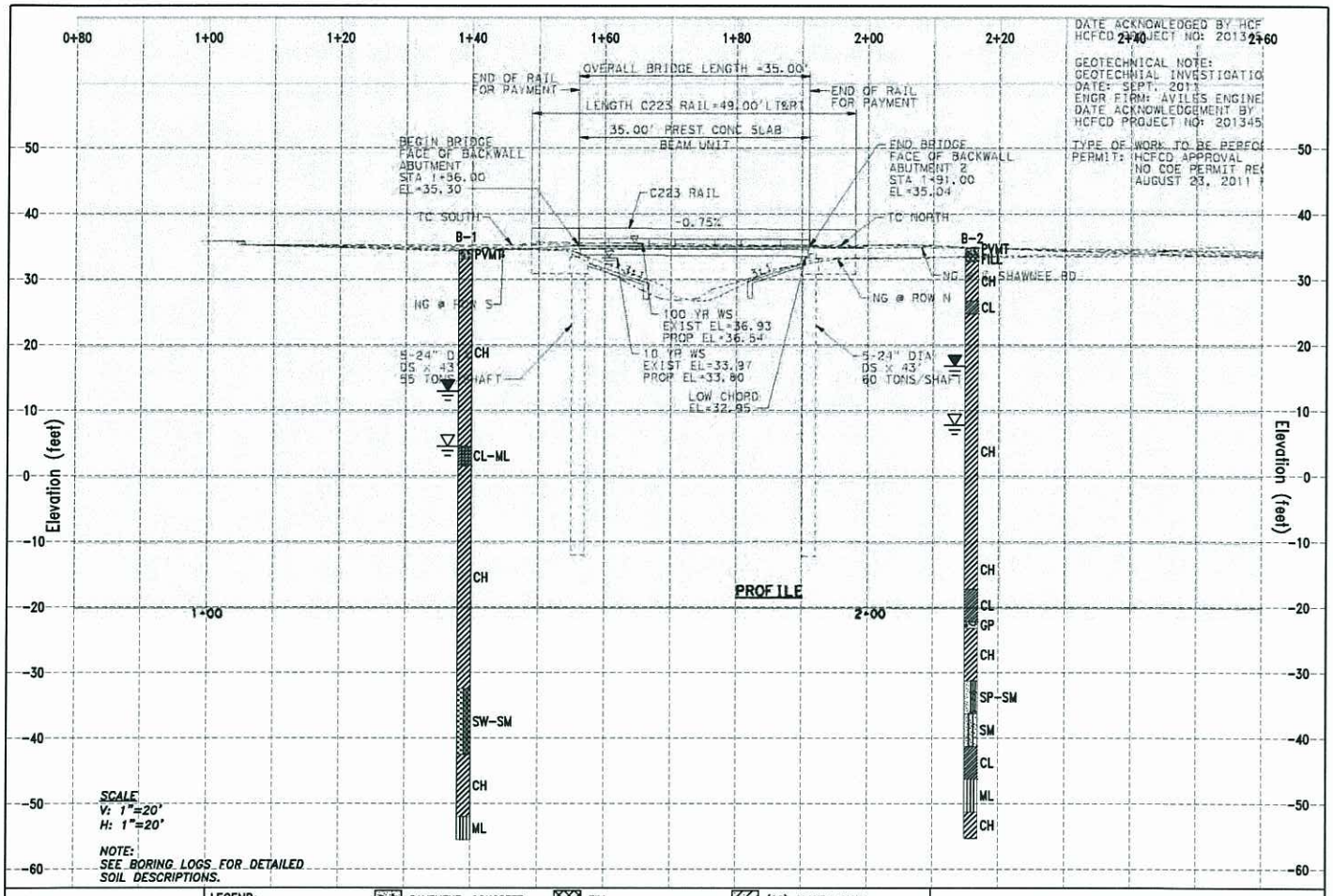


Plate B-4


G164-11 Shawnee Road Over Drainage Ditch
East Abutment Straight Sided Drilled Shafts (Boring B-2)
Allowable Unit End Bearing (ksf)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Elevation (ft)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
Top of Drilled Shaft Elevation = 31 feet
Neglect 10 feet below Top of Drilled Shaft
Notes:
1. Capacity shown is for single, isolated shafts, spaced at least 3 shaft diameters, center-to-center (η = 1.0).
2. Neglect capacity to a depth of 10 feet below top of shaft.
3. Capacity includes a Safety Factor of 3 for end bearing.
End Bearing
Plate B-5


G164-11 Shawnee Road Over Drainage Ditch
East Abutment Straight Sided Drilled Shafts (Boring B-2)
Allowable Compressive Load (kips)
0
100
200
300
400
500
600
700
40
30
20
10
0
-10
-20
-30
-40
-50
-60
Elevation (ft)
Top of Drilled Shaft Elevation = 31 feet
Neglect 10 feet below Top of Drilled Shaft
Notes:
1. Allowable total capacity shown includes skin friction and end bearing.
2. Capacity shown is for single, isolated shafts, spaced at least 3 shaft diameters, center-to-center.
3. Neglect capacity to a depth of 10 feet below top of shaft.
4. Capacity includes a Safety Factor of 2 for skin friction and 3 for end bearing.
24-in Dia. Shaft
30-in Dia. Shaft
36-in Dia. Shaft
42-in Dia. Shaft
48-in Dia. Shaft
Plate B-6



AVILES ENGINEERING CORP.

LEGEND:

- PAVEMENT, CONCRETE
- (SW-SM) WELL-GRADED SAND W/SILT
- (GP) POORLY GRADED SANDY GRAVEL
- INITIAL WATER LEVEL DURING DRILLING
- WATER LEVEL MEASURED AFTER INITIAL ENCOUNTER
- FILL
- (CH) FAT CLAY
- (CL) LEAN CLAY
- (CL) SANDY LEAN CLAY
- (CL-ML) SILTY CLAY
- (SC) CLAYEY SAND
- (SP-SM) POORLY GRADED SAND W/SILT
- (ML) SILT
- (ML) SANDY SILT
- (SM) SILTY SAND

GENERALIZED SOIL PROFILE
SHAWNEE ROAD OVER HCFCD UNIT NO. 106-03-00, BRIDGE REPLACEMENT
WBS NO. N-00445N-0030-3
HOUSTON, TEXAS

G164-11

PLATE B-7

AVLES
ENGINEERING CORP.

APPENDIX C

Plate C-1	Design Soil Parameters for Slope Stability Analysis
Plates C-2 to C-4a	Slope Stability Analysis for Shawnee Road Bridge

AVLES
ENGINEERING CORP.

Table 1. Soil Profile Parameters for Slope Stability Analyses (Based on Boring B-1)

Depth (ft)	Elevation (ft)	Soil Type	γ (pcf)	Short-Term (UU)		Long-Term (CD)		Rapid Drawdown (CU)	
				C_u (psf)	ϕ_u (deg)	C' (psf)	ϕ' (deg)	C_{cu} (psf)	ϕ_{cu} (deg)
0 to 8	35 to 27	Stiff to very stiff CH	118	1,500	0	230 (C_r=65)	19 (ϕ_r=21)	260 (C_r=65)	13 (ϕ_r=21)
8 to 10	27 to 25	Very stiff CL	128	2,000	0	260	26	360	19
10 to 14	25 to 21	Very stiff CH	117	1,200	0	240 (C_r=65)	19 (ϕ_r=21)	270 (C_r=65)	13 (ϕ_r=21)
14 to 18	21 to 17	Very stiff to hard CH	117	1,800	0	230	19	260	13
18 to 30	17 to 5	Very stiff CH	128	2,200	0	240	19	270	13

Notes:
(1) γ = wet unit weight of soil;
(2) C_u =undrained cohesion, ϕ_u = angle of internal friction, under short term conditions. UU = strength parameters that were determined from Unconsolidated-Undrained triaxial tests;
(3) C' =effective cohesion, ϕ' =effective friction angle, under long term condition; CD = Consolidated-Drained strength parameters that were determined from CU triaxial tests with pore pressure measurements;
(4) C_r = cohesion for desiccated fat clay, ϕ_r = friction angle for desiccated fat clay;
(5) C_{cu} = cohesion, ϕ_{cu} = friction angle, under rapid drawdown condition; CU = strength parameters developed from Consolidated-Undrained triaxial tests;
(6) CH = Fat Clay, CL = Lean Clay.

G164-11 SHAWNEE ROAD OVER DRAINAGE DITCH
SLOPE STABILITY ANALYSIS, BASED ON BORING B-1
SHORT TERM CONDITION

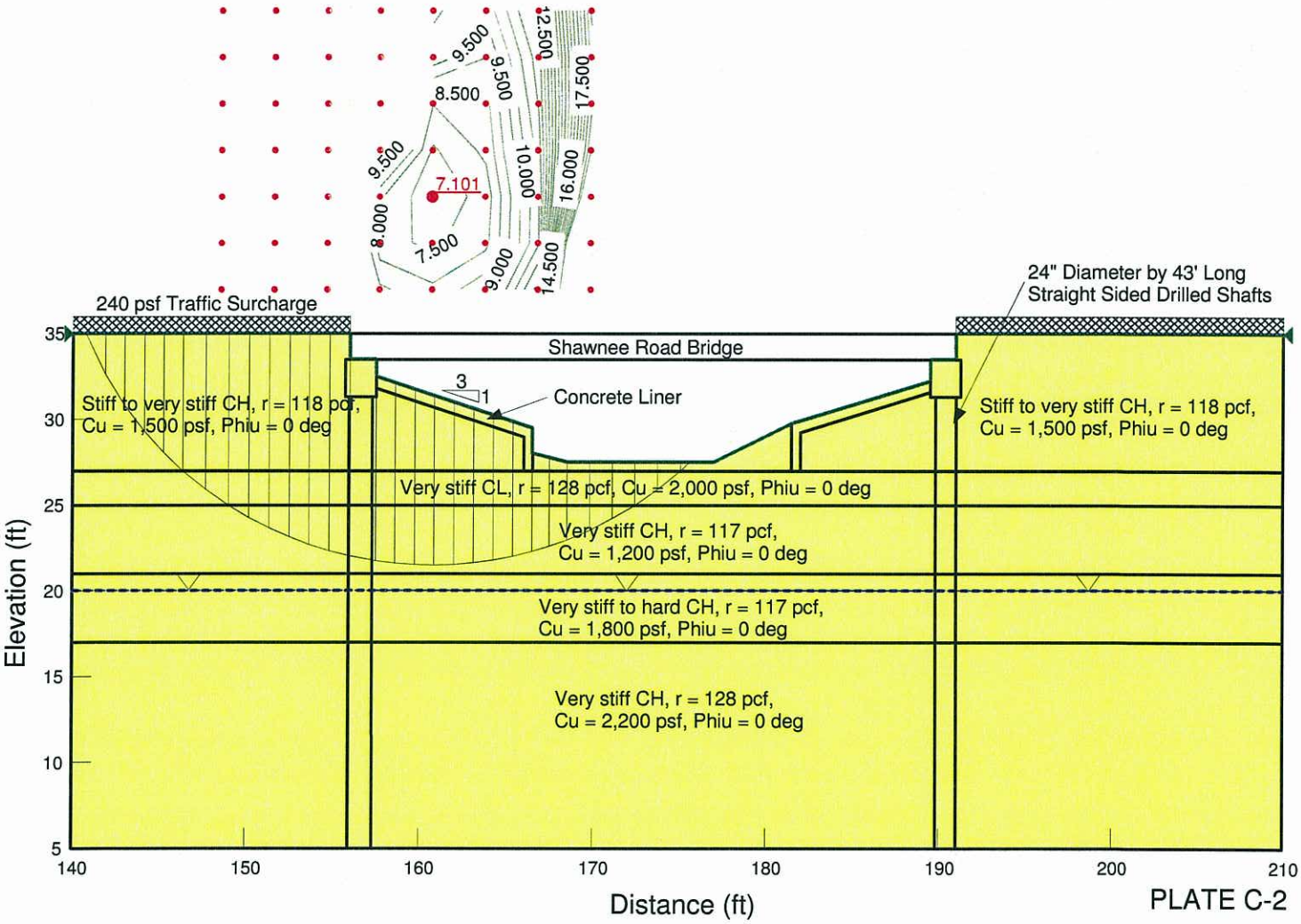


PLATE C-2

G164-11 SHAWNEE ROAD OVER DRAINAGE DITCH
SLOPE STABILITY ANALYSIS, BASED ON BORING B-1
LONG TERM CONDITION

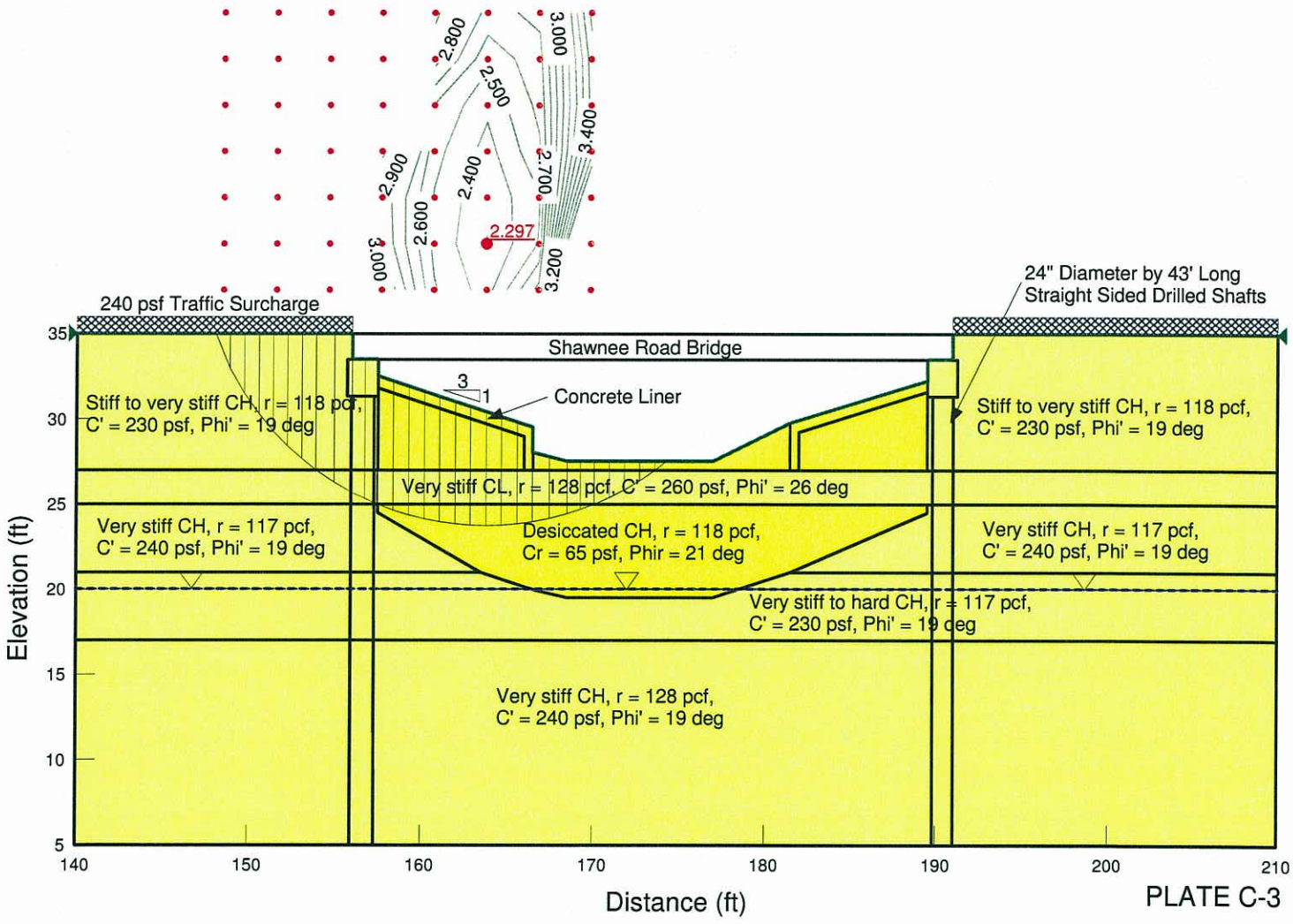


PLATE C-3

G164-11 SHAWNEE ROAD OVER DRAINAGE DITCH
SLOPE STABILITY ANALYSIS, BASED ON BORING B-1
RAPID DRAWDOWN CONDITION - GLOBAL SLIDE

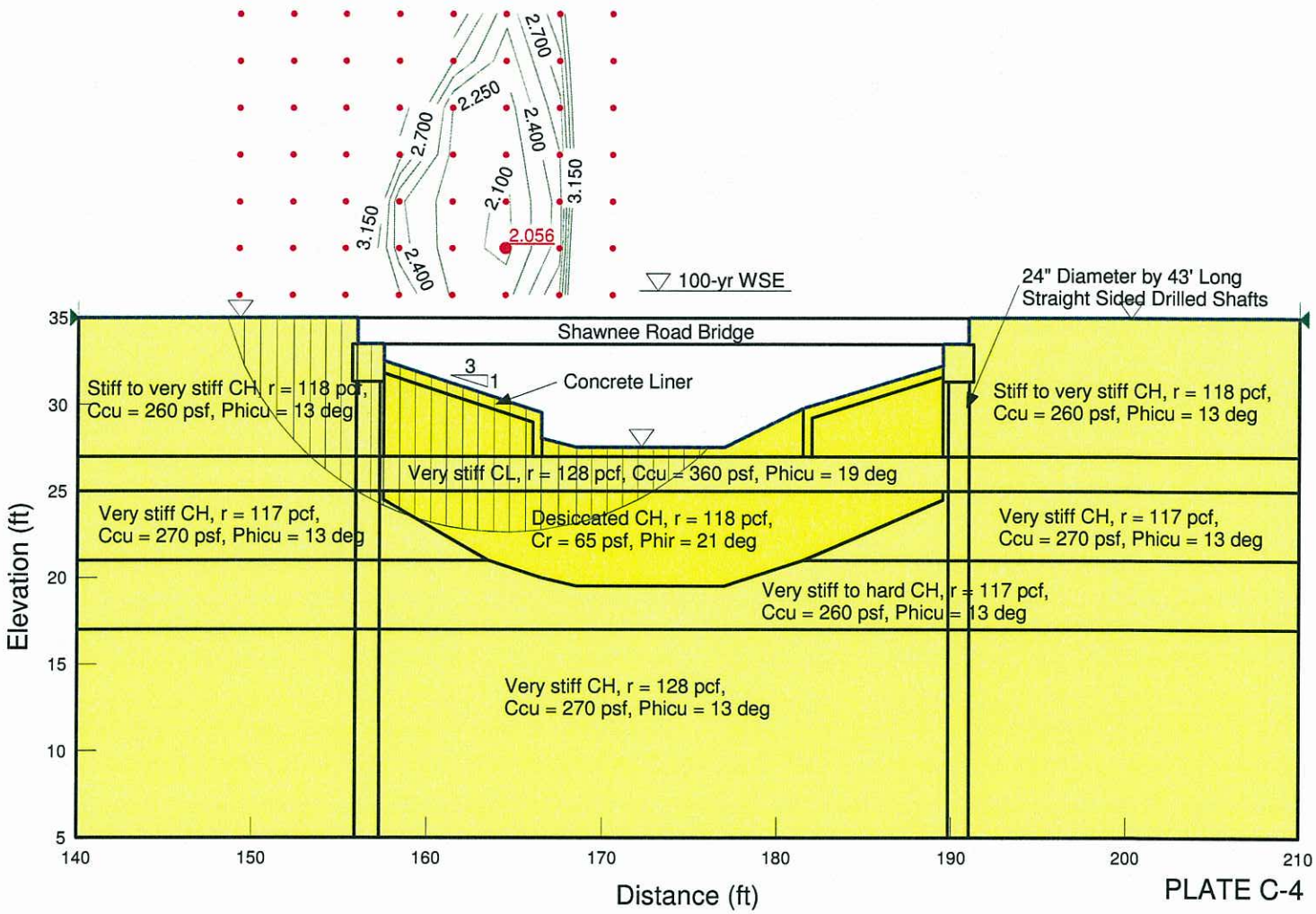


PLATE C-4

G164-11 SHAWNEE ROAD OVER DRAINAGE DITCH
SLOPE STABILITY ANALYSIS, BASED ON BORING B-1
RAPID DRAWDOWN CONDITION - LOCAL SLIDE

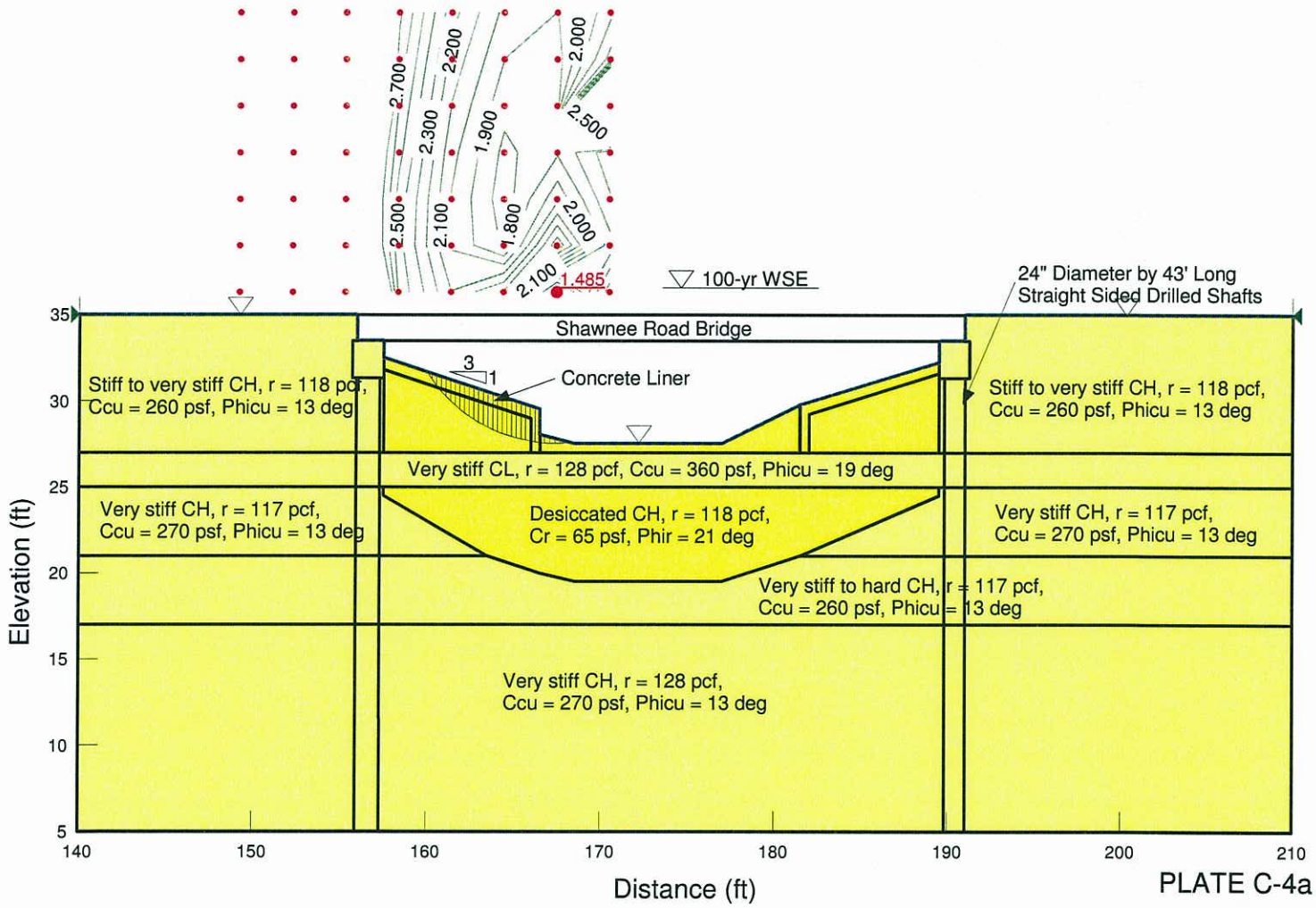


PLATE C-4a

AVLES
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APPENDIX D

Raw CU test data and Slope W inputs

PINHOLE TEST DATA
ASTM D-4647 METHOD A

Project No.: G164-11 **Project Description:**

Sample Location and Description: B-2 4-6

Type of Specimen: Undisturbed **Curing Time:** N/A **Eroding Fluid:** Water

Temperature: **Before Test:** 71F **After Test:** 71F

Tested By: W THOMAS **Date of Test:** 10/28/2011

Time (min)	Time (sec)	Head (Inch)	Flow Through Specimen		Flow Rate (ml/s)	Color of Effluent						hole size after test (mm)	Remarks
			ml	Sec		very dark	dark	moderately dark	slightly dark	barely visible	completely clear		
0	39	2"	10	39	0.26						*		
1	18		10	39	0.26						*		
2	0		10	42	0.24						*		
2	46		10	46	0.22						*		
3	29		10	43	0.23						*		
4	14		10	45	0.22						*		
5	2		10	48	0.21						*		
5	52		10	50	0.20						*		
6	47		10	55	0.18						*		
7	49		10	62	0.16						*		Flow Rate Too Slow
													Repunch Hole
0	42	2"	10	42	0.24						*		
1	25		10	43	0.23						*		
2	7		10	42	0.24						*		
2	51		10	44	0.23						*		
3	34		10	43	0.23						*		
4	20		10	46	0.22						*		
5	6		10	46	0.22						*		
5	53		10	47	0.21						*		
6	37		10	44	0.23						*		
7	22		10	45	0.22						*		
8	8		10	46	0.22						*		
8	56		10	48	0.21						*		
9	43		10	47	0.21						*		
10	32		10	49	0.20						*		
11	14	7"	20	42	0.48						*		
11	53		20	39	0.51						*		
12	33		20	40	0.50						*		
13	13		20	40	0.50						*		
13	50		20	37	0.54						*		
14	29		20	39	0.51						*		
15	8		20	39	0.51						*		
15	48		20	40	0.50						*		

PINHOLE TEST DATA
ASTM D-4647 METHOD A

Project No.: G164-11 **Project Description:** _____

Sample Location and Description: B-2 4-6

Type of Specimen: Undisturbed **Curing Time:** N/A **Eroding Fluid:** Water

Temperature: **Before Test:** 71F **After Test:** 71F

Tested By: W THOMAS **Date of Test:** 10/28/2011

Time (min)	Time (sec)	Head (Inch)	Flow Through Specimen		Flow Rate (ml/s)	Color of Effluent						hole size after test (mm)	Remarks
			ml	Sec		very dark	dark	moderately dark	slightly dark	barely visible	completely clear		
16	16	15"	20	66	0.30						*		
16	42		20	26	0.77						*		
17	9		20	27	0.74						*		
17	34		20	25	0.80						*		
18	0		20	26	0.77						*		
18	27		20	27	0.74						*		
18	52		20	25	0.80						*		
19	16		20	24	0.83						*		
19	41		20	25	0.80						*		
20	6		20	25	0.80						*		
20	30		20	24	0.83						*		
20	55		20	25	0.80						*	1.0	ND1

Plate D

TABLE __
RESULTS OF CRUMB TESTS

Project Name: _____

Project No.: G164-11

BORING NUMBER	DEPTH, FEET	Crumbling Characteristics				Crumb Test Classification	
		Soil Crumbles ? (Y/N)	If soil crumbles, rate of crumbling			@ 10 minutes	@ 30 minutes
			Minor	Moderate	Immediate		
B-2	4-6	Y	✓			1	1

Results interpretation:

1 No sign of cloudy water caused by colloidal suspension
2 Bare hint of colloidal cloud formation at surface or soil crumb
3 Easily recognized colloidal cloud covering at least 1/4 to ½ of the bottom of the glass container
4 Strong reaction with colloidal cloud covering most of the bottom of the glass container

Abe 8/30/11

Aviles Engineering Corp.

Advanced Testing Assignment Form

Project Number: 6164-11

Boring: B-1

Depth (ft): 4'-6'

Date Assigned: 8/18/11

Results Deadline:

Type(s) of Testing Required (check all that apply):

- [x] **CU Triaxial**
  Desired Confining Pressures: 5, 10, 20 psi
- [ ] **Consolidation**
- [ ] **Swell**

Any additional testing required for this sample:

- [x] P. I. assigned separately
- [x] -200 Sieve "
- [ ] Sieve Analysis
- [ ] Other: PP = 2.5

Assigned by:

Aviles Engineering Corporation
CU PRETEST DATA
ASTM D-4767

Project:	G164-11			Date:	8-31-11
Boring:	B-1	Depth (ft):	4-6	Cell #:	1
Soil Description:	GRAYISH-BROWN FAT CLAY				
Sample Mass (g):	1085.3	Scale ID:	615	Sigma3:	5, 10, 20
Sample Dimensions:	Height measurements taken 120 degrees apart, Diameter measurements taken at the quarter points of height.				
Caliper ID:	144				

Height Measurements (in):		**Diameter Measurements (in):**	
Height1:	5.575"	Diameter1:	2.805"
Height2:	5.575"	Diameter2:	2.745"
Height3:	5.580"	Diameter3:	2.818"
Average Height:	5.577"	Average Diameter:	2.789"
Sample Volume (cu. Ft.)	0.01972		

Initial Moisture Content:			
Tare ID:	MT-9	Scale ID:	670
Tare Wt (g):	58.04	Oven ID:	612
Wet Soil + Tare (g):	107.29	Thermometer ID:	614
Dry Soil + Tare (g):	96.52		
Moisture Content (%):	27.99		

Sample Density:		**Dial Gauge Data:**	
Wet Density:	121.3 PCF	Dial Gauge ID:	0632
Dry Density:	94.8 PCF	Initial Reading (in):	0.100
Test Prep. Technician:	W. THOMAS		
Technician Signature:			

CU Post-Test Datasheet

Project Name: G-164-11 Project Number: _____

Boring Number: B-1 Boring Depth (ft): 4-6 Cell#: 1

Date: 9/15/11

Moisture Content:

Tare ID:	MT-13
Tare Weight (g):	80.82
Wet Soil + Tare (g):	162.22
Dry Soil + Tare (g):	144.28
% Moisture:	28.3

Sample Sketch:

Failure Types: (circle all that apply)

(Bulge) Single Shear Multiple Shear Vertical Fracture SLS

Technician: W THOMAS

Aviles Engineering Corporation
CU BACKPRESSURE SATURATION
ASTM D-4767

Project: G164-11	Date: 8-31-11	Sigma3: 5, 10, 20
Boring: B-1	Depth (ft): 4-6	Cell #: 1

Date: 8-31-11	Time: 15:00	Cell Pressure (psi): 11.41
		Back Pressure (psi): 6.62
Pore Pressure Change (with backpressure valves closed, after 1 min):		-0.03 ✓
B-value: 0.67	Increase Pressures? Y	Saturation Complete? N
New Cell Pressure (psi): 15		New Back Pressure (psi): 10
Date: 9-6-11	Time: 14:14	Cell Pressure (psi): 15.33
		Back Pressure (psi): 10.11
Pore Pressure Change (with backpressure valves closed, after 1 min):		0.00 ✓
B-value: 0.85	Increase Pressures? Y	Saturation Complete? N
New Cell Pressure (psi): 20		New Back Pressure (psi): 15
Date: 9-6-11	Time: 15:12	Cell Pressure (psi): 20.01
		Back Pressure (psi): 14.99
Pore Pressure Change (with backpressure valves closed, after 1 min):		-0.02
B-value: 0.91	Increase Pressures? Y	Saturation Complete? N
New Cell Pressure (psi): 25		New Back Pressure (psi): 20
Date: 9-7-11	Time: 15:11	Cell Pressure (psi): 24.98
		Back Pressure (psi): 19.99
Pore Pressure Change (with backpressure valves closed, after 1 min):		-0.02 ✓
B-value: 0.97	Increase Pressures? N	Saturation Complete? Y
New Cell Pressure (psi): —		New Back Pressure (psi): —
Technician Signature: W Thomas		

H = 5.596

D = 2.799

Dry = 0.681

Triaxial Consolidation Datasheet

Stage: 2
Cell#: 1

σ3= 5 (10) 20

Job No.: G164-11
Boring No: B-1
Depth: 4-6

Cell Pressure: 30
Back Pressure: 20

Date	Time	Elapsed Time (min)	Pipette Reading (ml)	Dial Gauge Reading (in.)
9-9-11	15:48	0	23.00	0.167"/0.148
		0.1	22.80	
		0.25	22.79	
		0.5	22.72	
		1	22.70	
		~~2~~ 3	22.60	
		~~4~~ 6	22.50	
		~~8~~ 11	22.40	
		~~15~~ 52	21.80	
9-12-11	8:16	~~30~~	19.00	0.148
		60		
		120		

Final Height (in): 5.529"

Final Diameter (in): 2.806"

Triaxial Consolidation Datasheet

Stage: 3 **σ3=** 5, 10, 20
Cell#: 1

Job No.: G164-11 **Cell Pressure:** 40
Boring No: B-1 **Back Pressure:** 20
Depth: 4'-6'

Date	Time	Elapsed Time (min)	Pipette Reading (ml)	Dial Gauge Reading (in.)
9-13-11	9:33	0	23.00	0.283"/0.260"
		0.1	22.70	
		0.25	22.63	
		0.5	22.60	
		1	22.51	
		2.5	22.40	
		4	22.25	
		22 ~~30~~	21.60	
		60 ~~60~~	20.70	
		106 ~~90~~	19.90	
9-14-11	8:16	1363 ~~60~~	14.50	
	12:12	1599 ~~120~~	14.30	
	15:49	1816	14.20	0.262

Final Height (in): 5.415"

Final Diameter (in): 2.813

CALCULATION OF TRIAXIAL CU TESTING RESULTS

Job Name: Replacement Shawnee Bridge at Gulf Freeway Job No.: G164-11
Client: Entech 9/19/2011
Location: B-1, 4-6 File @: Z:\Engineering\Reports\2011\164-11

Three Staged Consolidated-Undrained Triaxial Tests
Brown Fat Clay (CH)
1) Initial Condition (before testing)

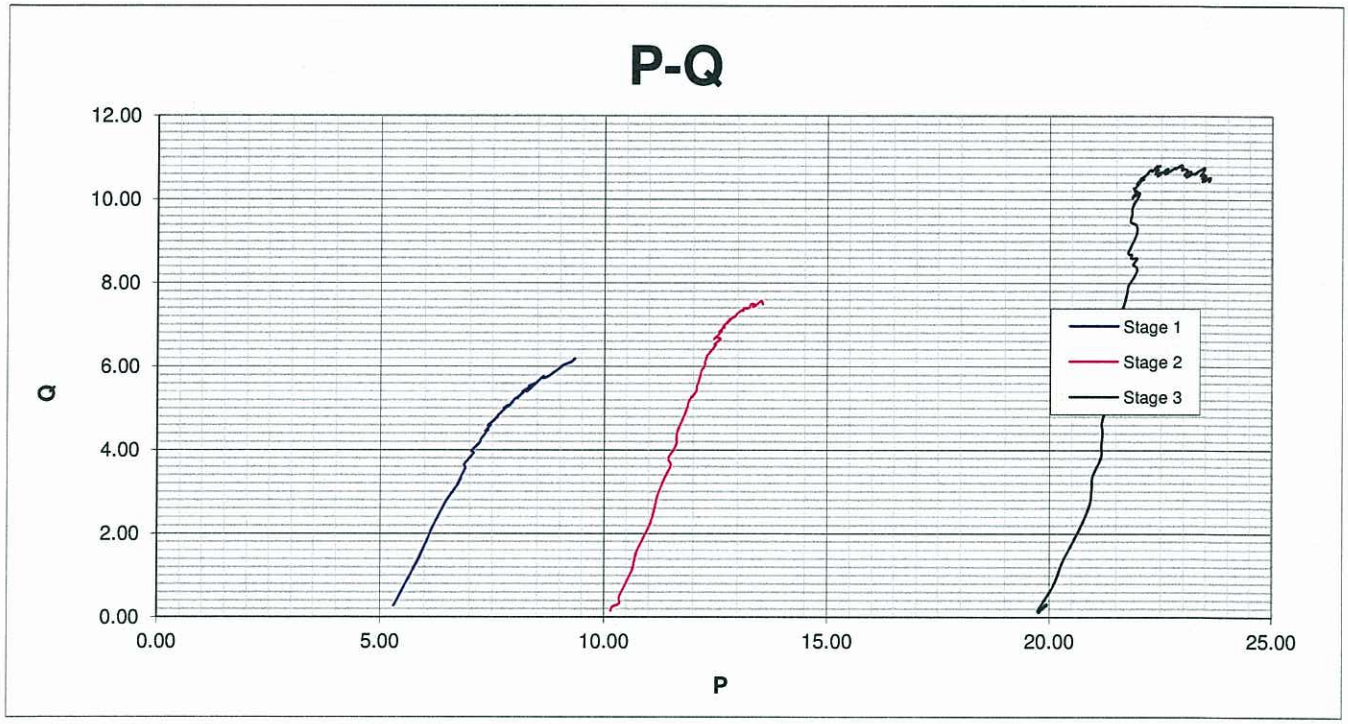
LL =	75	, PL =	24	, PI =	51 ,
Cu =		psf,			
w_0 =	27.99	%,	G =		2.75 ,
Wet γ =	121.3	pcf,	Dry γ_d =		94.8 pcf,
γ_w =	62.4	pcf,	$S = w_0/(\gamma_w/\gamma_d - 1/G)$ =		95.0 %
$e = w_0G/S$ =	0.811	.			

2) Final Condition (after testing)
w_f = 28.30 %,

Stage	Sigma_1' (psi)	Sigma_3' (psi)	u (psi)	Strain (%)	Sigma_1 (psi)	Sigma_3 (psi)
1	14.99	3.05	1.89	1.30	16.88	4.94
2	19.91	5.68	4.23	1.20	24.14	9.91
3	32.16	11.75	7.93	2.00	40.09	19.68
Residual					0.00	0.00

	Effective Stresses				Total Stresses	
Stage	Sigma_1' (ksf)	Sigma_3' (ksf)	u (ksf)	Strain (%)	Sigma_1 (ksf)	Sigma_3 (ksf)
1	2.16	0.44	0.27	1.30	2.43	0.71
2	2.87	0.82	0.61	1.20	3.48	1.43
3	4.63	1.69	1.14	2.00	5.77	2.83
Residual	0.00	0.00	0.00	0.00	0.00	0.00

G164-11 B-1-4-6 PQ



Proj. # G164-11 **Boring:** B-1 **Depth (ft):** 4-6

Initial Height Measurements (in.):

Height 1:	5.575		
Height 2:	5.575		
Height 3:	5.58	Average Height (in.):	5.576667

Initial Diameter Measurements (in.):

Diam 1:	2.805		
Diam 2:	2.745		
Diam 3:	2.818	Average Diameter (in):	2.789333

Initial Dial Gauge Reading (in): 0.1

End of Saturation Dial Gauge Reading (in.): 0.081

First Consolidation: *(if there is no first stage consolidation, enter '0' for initial and final pipette readings, copy DGs to DGc)*

Initial Pipette Reading (mL):	23
Final Pipette Reading (mL):	23
Final Dial Gauge Reading (in.):	0.081

Beginning of First Shear:

Height:	5.596
Diameter:	2.799

End of First Shear:

Dial Gauge Reading at end of shearing (in.):	0.167
Dial Gauge Reading after CV rebound (in):	0.148

Second Stage Consolidation:

Initial Pipette Reading (mL):	23
Final Pipette Reading (mL):	19
Final Dial Gauge Reading (in.):	0.148

Beginning of Second Shear:

Height:	5.529
Diameter:	2.806

End of Second Shear:

Dial Gauge Reading at end of shearing (in.):	0.283
Dial Gauge Reading after CV rebound (in):	0.26

Third Stage Consolidation:

Initial Pipette Reading (mL):	23
Final Pipette Reading (mL):	14.2
Final Dial Gauge Reading (in.):	0.262

Beginning of Third Shear:

Height:	5.415
Diameter:	2.813

G164-11 B-1-4-6 STAGE1

Elapsed Time (min.)	Vertical Load (lbs)	DCDT (inch)	Pore Pressure (psi)	Cell Pressure (psi)	Axial Strain (%)	Sigma 1 (psi)	Sigma 3 (psi)	Obliquity	q (psi)	p	Excess Pore Pr. (psi)
0.0	11.90	0.0000	19.64	24.68	0.00	5.56	5.04	1.10	0.26	5.30	0.00
1.5	18.18	0.0014	19.87	24.66	0.03	6.33	4.79	1.32	0.77	5.56	0.23
3.0	24.72	0.0028	20.10	24.61	0.05	7.12	4.51	1.58	1.30	5.82	0.46
4.5	30.63	0.0042	20.35	24.60	0.08	7.81	4.24	1.84	1.78	6.03	0.71
6.0	34.88	0.0056	20.55	24.59	0.10	8.29	4.03	2.05	2.13	6.16	0.91
7.5	38.58	0.0070	20.75	24.62	0.13	8.73	3.88	2.25	2.43	6.30	1.11
9.0	42.83	0.0084	20.92	24.63	0.15	9.24	3.70	2.50	2.77	6.47	1.28
10.5	46.97	0.0098	21.07	24.65	0.18	9.80	3.59	2.73	3.10	6.69	1.43
12.0	49.97	0.0112	21.19	24.65	0.20	10.15	3.46	2.93	3.35	6.81	1.55
13.5	52.59	0.0126	21.26	24.59	0.23	10.45	3.33	3.13	3.56	6.89	1.61
15.0	53.57	0.0140	21.37	24.61	0.25	10.51	3.23	3.25	3.64	6.87	1.73
16.5	56.96	0.0154	21.43	24.60	0.28	10.99	3.17	3.47	3.91	7.08	1.79
18.0	57.54	0.0168	21.23	24.31	0.30	10.99	3.08	3.57	3.96	7.03	1.59
19.5	60.09	0.0182	21.56	24.61	0.33	11.37	3.05	3.73	4.16	7.21	1.92
21.0	61.17	0.0196	21.61	24.61	0.35	11.50	3.00	3.84	4.25	7.25	1.97
22.5	63.88	0.0210	21.63	24.56	0.38	11.87	2.93	4.05	4.47	7.40	1.99
24.0	63.54	0.0224	21.69	24.60	0.40	11.78	2.90	4.06	4.44	7.34	2.05
25.5	65.44	0.0238	21.71	24.59	0.43	12.06	2.87	4.20	4.59	7.46	2.07
27.0	65.18	0.0252	21.74	24.57	0.45	11.97	2.83	4.23	4.57	7.40	2.10
28.5	66.61	0.0266	21.77	24.60	0.48	12.20	2.83	4.31	4.68	7.52	2.13
30.0	67.92	0.0280	21.77	24.60	0.50	12.41	2.83	4.39	4.79	7.62	2.13
31.5	68.43	0.0294	21.76	24.55	0.53	12.45	2.79	4.46	4.83	7.62	2.12
33.0	68.99	0.0308	21.79	24.60	0.55	12.56	2.81	4.47	4.87	7.68	2.15
34.5	71.24	0.0322	21.79	24.58	0.58	12.90	2.79	4.62	5.05	7.85	2.15
36.0	70.44	0.0336	21.79	24.55	0.60	12.74	2.76	4.61	4.99	7.75	2.15
37.5	71.35	0.0350	21.83	24.65	0.63	12.94	2.82	4.58	5.06	7.88	2.19
39.0	73.10	0.0364	21.77	24.56	0.65	13.19	2.79	4.73	5.20	7.99	2.13
40.5	73.38	0.0378	21.81	24.59	0.68	13.23	2.79	4.75	5.22	8.01	2.16
42.0	73.57	0.0392	21.81	24.65	0.70	13.31	2.84	4.69	5.23	8.07	2.17
43.5	73.88	0.0406	21.78	24.59	0.73	13.33	2.81	4.74	5.26	8.07	2.14
45.0	75.56	0.0420	21.80	24.63	0.75	13.61	2.82	4.82	5.39	8.21	2.16
46.5	75.06	0.0434	21.80	24.61	0.78	13.52	2.81	4.80	5.35	8.17	2.16
48.0	75.59	0.0448	21.76	24.54	0.80	13.56	2.78	4.88	5.39	8.17	2.12
49.5	77.28	0.0462	21.76	24.61	0.83	13.90	2.84	4.89	5.53	8.37	2.12
51.0	77.16	0.0476	21.72	24.50	0.85	13.82	2.79	4.96	5.52	8.30	2.08
52.5	77.75	0.0490	21.74	24.60	0.88	13.98	2.85	4.90	5.56	8.42	2.10
54.0	77.84	0.0504	21.71	24.58	0.90	14.00	2.87	4.88	5.57	8.44	2.07
55.6	77.75	0.0518	21.72	24.57	0.93	13.96	2.84	4.91	5.56	8.40	2.08
57.0	75.64	0.0532	21.73	24.61	0.95	13.66	2.88	4.74	5.39	8.27	2.09
58.6	79.97	0.0546	21.70	24.58	0.98	14.35	2.88	4.99	5.74	8.61	2.06
60.0	80.16	0.0561	21.67	24.55	1.00	14.38	2.88	4.99	5.75	8.63	2.03
66.0	79.70	0.0616	21.64	24.57	1.10	14.35	2.93	4.89	5.71	8.64	1.99
72.1	80.54	0.0673	21.60	24.59	1.20	14.53	3.00	4.85	5.77	8.76	1.96
78.1	83.13	0.0729	21.53	24.58	1.30	14.99	3.05	4.92	5.97	9.02	1.89
84.1	83.78	0.0785	21.47	24.52	1.40	15.09	3.05	4.94	6.02	9.07	1.83
90.1	84.93	0.0841	21.46	24.61	1.50	15.36	3.16	4.87	6.10	9.26	1.81
94.3	85.93	0.0880	21.39	24.55	1.57	15.51	3.15	4.92	6.18	9.33	1.75

G164-11 B-1-4-6 STAGE2

Elapsed Time (min.)	Vertical Load (lbs)	DCDT (inch)	Pore Pressure (psi)	Cell Pressure (psi)	Axial Strain (%)	Sigma 1 (psi)	Sigma 3 (psi)	Obliquity	q (psi)	p	Excess Pore Pr. (psi)
0.0	7.41	0.0000	19.70	29.70	0.00	10.30	10.00	1.03	0.15	10.15	0.00
1.5	8.50	0.0014	19.69	29.64	0.03	10.42	9.95	1.05	0.24	10.19	-0.01
3.0	9.55	0.0028	19.69	29.70	0.05	10.66	10.02	1.06	0.32	10.34	-0.01
4.5	11.58	0.0042	19.86	29.72	0.08	10.83	9.86	1.10	0.49	10.34	0.17
6.0	19.22	0.0055	20.19	29.71	0.10	11.72	9.51	1.23	1.10	10.62	0.50
7.5	25.04	0.0069	20.52	29.68	0.13	12.30	9.16	1.34	1.57	10.73	0.82
9.0	32.61	0.0083	20.81	29.64	0.15	13.20	8.83	1.49	2.18	11.01	1.11
10.5	37.54	0.0097	21.09	29.64	0.18	13.71	8.54	1.60	2.58	11.13	1.40
12.0	41.42	0.0111	21.38	29.68	0.20	14.08	8.30	1.70	2.89	11.19	1.68
13.5	46.53	0.0125	21.62	29.67	0.23	14.65	8.04	1.82	3.30	11.35	1.92
15.0	50.50	0.0138	21.84	29.71	0.25	15.12	7.87	1.92	3.62	11.49	2.14
16.5	52.59	0.0152	22.04	29.69	0.28	15.23	7.65	1.99	3.79	11.44	2.34
18.0	56.53	0.0166	22.22	29.71	0.30	15.71	7.50	2.10	4.11	11.61	2.52
19.5	59.30	0.0180	22.39	29.68	0.33	15.95	7.29	2.19	4.33	11.62	2.69
21.0	61.32	0.0194	22.52	29.69	0.35	16.15	7.17	2.25	4.49	11.66	2.82
22.5	65.44	0.0207	22.66	29.64	0.38	16.62	6.97	2.38	4.82	11.80	2.96
24.0	67.47	0.0221	22.77	29.64	0.40	16.84	6.87	2.45	4.99	11.85	3.08
25.5	70.00	0.0235	22.89	29.62	0.43	17.10	6.73	2.54	5.19	11.92	3.19
27.0	72.52	0.0249	23.00	29.67	0.45	17.44	6.67	2.62	5.39	12.05	3.30
28.5	74.24	0.0263	23.11	29.66	0.48	17.60	6.55	2.69	5.53	12.07	3.41
30.0	75.72	0.0277	23.22	29.69	0.50	17.76	6.47	2.74	5.64	12.12	3.52
31.5	77.60	0.0290	23.30	29.66	0.53	17.95	6.36	2.82	5.79	12.16	3.60
33.0	79.06	0.0304	23.36	29.63	0.55	18.09	6.28	2.88	5.91	12.18	3.66
34.5	80.46	0.0318	23.44	29.68	0.58	18.28	6.24	2.93	6.02	12.26	3.74
36.0	81.69	0.0332	23.52	29.67	0.60	18.38	6.15	2.99	6.12	12.26	3.82
37.5	83.47	0.0346	23.57	29.63	0.63	18.57	6.05	3.07	6.26	12.31	3.87

39.0	83.46	0.0360	23.59	29.65	0.65	18.57	6.06	3.06	6.26	12.32	3.90
40.5	85.49	0.0374	23.64	29.65	0.68	18.85	6.01	3.14	6.42	12.43	3.94
42.0	86.73	0.0387	23.71	29.70	0.70	19.01	5.98	3.18	6.52	12.50	4.02
43.5	86.88	0.0401	23.75	29.68	0.73	18.99	5.93	3.20	6.53	12.46	4.05
45.0	88.39	0.0415	23.80	29.75	0.75	19.24	5.95	3.23	6.65	12.60	4.10
46.5	88.91	0.0429	23.80	29.61	0.78	19.19	5.82	3.30	6.69	12.50	4.10
48.0	88.45	0.0443	23.79	29.60	0.80	19.10	5.81	3.29	6.65	12.46	4.09
49.5	89.45	0.0457	23.82	29.62	0.83	19.25	5.80	3.32	6.73	12.53	4.12
51.0	90.91	0.0470	23.89	29.68	0.85	19.47	5.79	3.36	6.84	12.63	4.19
52.5	90.67	0.0484	23.88	29.62	0.88	19.38	5.74	3.38	6.82	12.56	4.18
54.0	91.25	0.0498	23.88	29.62	0.90	19.48	5.75	3.39	6.87	12.61	4.18
55.5	92.19	0.0512	23.90	29.65	0.93	19.63	5.75	3.41	6.94	12.69	4.20
57.0	92.05	0.0526	23.93	29.70	0.95	19.62	5.77	3.40	6.93	12.69	4.23
58.5	92.48	0.0540	23.93	29.64	0.98	19.62	5.71	3.44	6.96	12.66	4.24
60.0	92.68	0.0553	23.93	29.64	1.00	19.66	5.71	3.44	6.97	12.68	4.23
66.0	94.97	0.0609	23.93	29.64	1.10	20.00	5.71	3.51	7.15	12.86	4.23
72.0	94.67	0.0664	23.93	29.61	1.20	19.91	5.68	3.51	7.12	12.80	4.23
78.0	95.84	0.0719	23.91	29.65	1.30	20.15	5.74	3.51	7.20	12.94	4.21
84.1	96.13	0.0775	23.93	29.65	1.40	20.16	5.72	3.52	7.22	12.94	4.23
90.1	97.02	0.0830	23.91	29.63	1.50	20.29	5.72	3.55	7.28	13.00	4.21
96.0	97.83	0.0885	23.87	29.61	1.60	20.42	5.74	3.56	7.34	13.08	4.17
102.0	97.81	0.0941	23.87	29.66	1.70	20.45	5.79	3.53	7.33	13.12	4.17
108.0	98.57	0.0996	23.83	29.57	1.80	20.51	5.74	3.57	7.38	13.13	4.13
114.0	98.79	0.1051	23.82	29.66	1.90	20.63	5.84	3.53	7.39	13.24	4.12
120.0	100.08	0.1107	23.79	29.59	2.00	20.77	5.80	3.58	7.49	13.28	4.09
126.1	100.09	0.1162	23.74	29.61	2.10	20.84	5.88	3.55	7.48	13.36	4.04
132.1	99.41	0.1217	23.75	29.66	2.20	20.75	5.91	3.51	7.42	13.33	4.05
138.1	100.37	0.1272	23.68	29.62	2.30	20.92	5.94	3.52	7.49	13.43	3.98
144.0	101.43	0.1328	23.64	29.59	2.40	21.08	5.95	3.54	7.56	13.51	3.94
147.9	100.48	0.1364	23.61	29.67	2.47	21.03	6.06	3.47	7.48	13.55	3.91

G164-11 B-1-4-6 STAGE3

Elapsed Time (min.)	Vertical Load (lbs)	DCDT (inch)	Pore Pressure (psi)	Cell Pressure (psi)	Axial Strain (%)	Sigma 1 (psi)	Sigma 3 (psi)	Obliquity	q (psi)	p	Excess Pore Pr. (psi)
0.0	10.56	0.0000	19.83	39.48	0.00	19.88	19.65	1.01	0.11	19.76	0.00
1.5	12.88	0.0014	19.82	39.46	0.03	20.24	19.63	1.03	0.30	19.94	-0.01
3.0	11.18	0.0027	19.82	39.46	0.05	19.96	19.64	1.02	0.16	19.80	-0.01
4.5	12.62	0.0041	19.82	39.48	0.08	20.22	19.66	1.03	0.28	19.94	-0.01
6.0	13.03	0.0054	19.82	39.44	0.10	20.25	19.62	1.03	0.31	19.94	-0.01
7.5	11.04	0.0068	19.86	39.45	0.13	19.90	19.59	1.02	0.15	19.74	0.03
9.0	18.76	0.0081	20.16	39.48	0.15	20.87	19.32	1.08	0.77	20.10	0.33
10.5	25.83	0.0095	20.52	39.48	0.18	21.64	18.97	1.14	1.34	20.30	0.69
12.0	34.56	0.0109	20.88	39.49	0.20	22.69	18.61	1.22	2.04	20.65	1.05
13.5	42.31	0.0122	21.23	39.47	0.23	23.56	18.24	1.29	2.66	20.90	1.40
15.0	47.13	0.0136	21.54	39.44	0.25	24.00	17.90	1.34	3.05	20.95	1.71
16.5	51.26	0.0149	21.87	39.47	0.28	24.35	17.60	1.38	3.38	20.98	2.04
18.0	56.83	0.0163	22.16	39.49	0.30	24.98	17.33	1.44	3.82	21.16	2.33
19.5	60.49	0.0176	22.43	39.48	0.33	25.29	17.05	1.48	4.12	21.17	2.60
21.0	64.19	0.0190	22.67	39.46	0.35	25.61	16.78	1.53	4.41	21.19	2.84
22.5	67.03	0.0203	22.93	39.46	0.38	25.81	16.53	1.56	4.64	21.17	3.10
24.0	70.41	0.0217	23.16	39.49	0.40	26.14	16.33	1.60	4.91	21.24	3.33
25.5	73.12	0.0230	23.36	39.47	0.43	26.36	16.11	1.64	5.12	21.24	3.53
27.0	78.13	0.0244	23.56	39.44	0.45	26.93	15.88	1.70	5.52	21.40	3.73
28.5	79.88	0.0258	23.78	39.48	0.48	27.03	15.70	1.72	5.66	21.36	3.95
30.0	83.11	0.0271	23.97	39.47	0.50	27.34	15.50	1.76	5.92	21.42	4.14
31.5	85.61	0.0285	24.13	39.44	0.53	27.55	15.31	1.80	6.12	21.43	4.30
33.0	88.30	0.0298	24.30	39.42	0.55	27.79	15.13	1.84	6.33	21.46	4.47
34.5	89.77	0.0312	24.50	39.50	0.58	27.89	14.99	1.86	6.45	21.44	4.67
36.0	92.23	0.0325	24.65	39.48	0.60	28.12	14.83	1.90	6.64	21.47	4.82
37.5	95.23	0.0339	24.78	39.45	0.63	28.43	14.67	1.94	6.88	21.55	4.95
39.0	96.85	0.0352	24.93	39.43	0.65	28.52	14.50	1.97	7.01	21.51	5.10
40.5	98.84	0.0366	25.12	39.47	0.68	28.68	14.35	2.00	7.17	21.51	5.29
42.0	101.75	0.0380	25.23	39.48	0.70	29.04	14.25	2.04	7.40	21.64	5.40
43.5	104.14	0.0393	25.35	39.46	0.73	29.28	14.11	2.08	7.59	21.69	5.52
45.0	105.89	0.0407	25.46	39.47	0.75	29.45	14.00	2.10	7.72	21.73	5.63
46.5	108.43	0.0420	25.57	39.41	0.78	29.69	13.84	2.15	7.93	21.76	5.74
48.0	110.06	0.0434	25.72	39.50	0.80	29.89	13.78	2.17	8.05	21.83	5.89
49.5	113.14	0.0448	25.79	39.46	0.83	30.26	13.66	2.21	8.30	21.96	5.96
51.0	114.39	0.0461	25.90	39.43	0.85	30.33	13.54	2.24	8.40	21.93	6.07
52.5	115.11	0.0475	26.06	39.48	0.88	30.32	13.42	2.26	8.45	21.87	6.23
54.0	116.90	0.0488	26.11	39.48	0.90	30.55	13.37	2.29	8.59	21.96	6.28
55.5	116.98	0.0502	26.18	39.41	0.93	30.42	13.23	2.30	8.59	21.83	6.35
57.0	118.11	0.0515	26.27	39.43	0.95	30.52	13.16	2.32	8.68	21.84	6.44
58.5	118.24	0.0529	26.37	39.46	0.98	30.47	13.08	2.33	8.69	21.77	6.54
60.0	119.04	0.0542	26.47	39.48	1.00	30.52	13.01	2.35	8.75	21.77	6.64
66.0	124.51	0.0597	26.72	39.49	1.10	31.13	12.77	2.44	9.18	21.95	6.89
72.0	127.26	0.0651	26.96	39.52	1.20	31.33	12.56	2.50	9.39	21.94	7.13
78.0	128.41	0.0705	27.14	39.49	1.30	31.29	12.34	2.53	9.47	21.82	7.31
84.0	130.73	0.0759	27.30	39.50	1.40	31.49	12.20	2.58	9.64	21.85	7.47
90.1	132.50	0.0814	27.39	39.46	1.50	31.62	12.07	2.62	9.78	21.85	7.56
96.0	134.25	0.0868	27.51	39.49	1.60	31.80	11.99	2.65	9.90	21.89	7.68
102.0	136.38	0.0922	27.57	39.49	1.70	32.04	11.92	2.69	10.06	21.98	7.74
108.0	137.84	0.0976	27.64	39.48	1.80	32.17	11.84	2.72	10.17	22.01	7.82
114.1	136.37	0.1030	27.71	39.52	1.90	31.89	11.81	2.70	10.04	21.85	7.88
120.1	138.56	0.1085	27.76	39.51	2.00	32.16	11.75	2.74	10.20	21.95	7.93
126.1	138.60	0.1139	27.79	39.50	2.10	32.10	11.71	2.74	10.20	21.91	7.96
132.1	139.19	0.1193	27.83	39.52	2.20	32.15	11.68	2.75	10.23	21.92	8.00
138.1	139.89	0.1247	27.86	39.47	2.30	32.16	11.61	2.77	10.28	21.88	8.03
144.1	139.77	0.1302	27.88	39.51	2.40	32.14	11.63	2.76	10.26	21.89	8.05
150.1	141.30	0.1356	27.89	39.51	2.50	32.35	11.62	2.78	10.37	21.99	8.06
156.1	142.69	0.1410	27.88	39.46	2.60	32.51	11.58	2.81	10.46	22.04	8.05
162.1	143.20	0.1464	27.88	39.50	2.70	32.60	11.62	2.81	10.49	22.11	8.05
168.1	142.64	0.1518	27.90	39.47	2.80	32.44	11.57	2.80	10.44	22.01	8.07
174.1	143.20	0.1573	27.95	39.52	2.90	32.52	11.57	2.81	10.47	22.05	8.12
180.1	142.16	0.1627	27.94	39.51	3.00	32.33	11.57	2.79	10.38	21.95	8.11
186.1	144.17	0.1681	27.93	39.48	3.10	32.60	11.54	2.82	10.53	22.07	8.10

192.1	144.87	0.1735	27.91	39.48	3.20	32.71	11.57	2.83	10.57	22.14	8.08
198.1	143.92	0.1789	27.90	39.46	3.30	32.53	11.56	2.81	10.48	22.04	8.07
204.1	144.41	0.1844	27.90	39.43	3.40	32.56	11.53	2.82	10.51	22.04	8.07
210.1	144.70	0.1898	27.89	39.45	3.50	32.60	11.55	2.82	10.52	22.08	8.06
216.1	145.61	0.1952	27.89	39.46	3.60	32.73	11.56	2.83	10.58	22.15	8.06
222.1	147.39	0.2006	27.88	39.43	3.70	32.96	11.54	2.86	10.71	22.25	8.05
228.1	147.51	0.2061	27.90	39.47	3.80	32.99	11.57	2.85	10.71	22.28	8.07
234.1	147.29	0.2115	27.92	39.53	3.90	32.97	11.61	2.84	10.68	22.29	8.09
240.1	149.08	0.2169	27.90	39.49	4.00	33.21	11.59	2.86	10.81	22.40	8.07
246.1	148.75	0.2223	27.87	39.51	4.10	33.17	11.63	2.85	10.77	22.40	8.04
252.1	149.45	0.2277	27.87	39.53	4.20	33.29	11.66	2.85	10.81	22.47	8.04
258.1	149.19	0.2332	27.84	39.48	4.30	33.20	11.64	2.85	10.78	22.42	8.01
264.1	148.88	0.2386	27.81	39.47	4.40	33.15	11.66	2.84	10.75	22.41	7.98
270.1	148.45	0.2440	27.81	39.47	4.50	33.07	11.66	2.84	10.70	22.37	7.98
276.1	149.48	0.2494	27.79	39.43	4.60	33.18	11.63	2.85	10.77	22.40	7.96
282.1	149.22	0.2548	27.79	39.47	4.70	33.16	11.68	2.84	10.74	22.42	7.96
288.1	149.44	0.2603	27.77	39.44	4.80	33.16	11.67	2.84	10.75	22.41	7.94
294.1	149.15	0.2657	27.77	39.49	4.90	33.15	11.72	2.83	10.71	22.43	7.94
300.1	149.14	0.2711	27.74	39.43	5.00	33.09	11.69	2.83	10.70	22.39	7.91
315.1	148.39	0.2847	27.75	39.50	5.25	32.98	11.75	2.81	10.61	22.36	7.92
330.1	148.87	0.2982	27.69	39.45	5.50	33.01	11.76	2.81	10.62	22.38	7.86
345.1	149.67	0.3118	27.68	39.53	5.75	33.16	11.85	2.80	10.66	22.50	7.85
360.1	148.85	0.3253	27.62	39.46	6.00	32.97	11.84	2.78	10.56	22.41	7.79
375.1	151.56	0.3389	27.55	39.45	6.25	33.38	11.90	2.81	10.74	22.64	7.72
390.1	151.32	0.3524	27.54	39.50	6.50	33.35	11.96	2.79	10.69	22.65	7.71
405.1	150.72	0.3660	27.51	39.46	6.75	33.20	11.95	2.78	10.62	22.58	7.68
420.1	151.21	0.3795	27.45	39.43	7.00	33.24	11.98	2.77	10.63	22.61	7.62
435.1	153.40	0.3931	27.43	39.47	7.25	33.57	12.04	2.79	10.76	22.81	7.60
450.1	153.45	0.4066	27.40	39.46	7.50	33.55	12.07	2.78	10.74	22.81	7.57
465.1	155.15	0.4202	27.33	39.45	7.75	33.79	12.12	2.79	10.84	22.95	7.50
480.1	154.83	0.4337	27.29	39.44	8.00	33.72	12.15	2.77	10.78	22.93	7.46
495.1	155.16	0.4473	27.28	39.49	8.25	33.76	12.20	2.77	10.78	22.98	7.46
510.1	155.07	0.4609	27.26	39.48	8.50	33.71	12.22	2.76	10.74	22.96	7.43
525.1	155.02	0.4744	27.19	39.44	8.75	33.66	12.25	2.75	10.71	22.95	7.36
540.1	155.78	0.4880	27.13	39.43	9.00	33.76	12.29	2.75	10.73	23.03	7.30
555.1	155.67	0.5015	27.11	39.50	9.25	33.78	12.39	2.73	10.70	23.08	7.29
570.1	154.64	0.5151	27.09	39.51	9.50	33.61	12.42	2.71	10.59	23.01	7.26
585.1	156.03	0.5286	27.02	39.46	9.75	33.76	12.44	2.72	10.66	23.10	7.19
600.1	156.43	0.5422	26.98	39.48	10.00	33.83	12.50	2.71	10.66	23.16	7.15
615.1	155.27	0.5557	26.96	39.46	10.25	33.61	12.51	2.69	10.55	23.06	7.13
630.1	155.79	0.5693	26.91	39.44	10.50	33.65	12.53	2.69	10.56	23.09	7.08
645.1	157.02	0.5828	26.89	39.46	10.75	33.80	12.56	2.69	10.62	23.18	7.06
660.1	157.44	0.5964	26.88	39.52	11.00	33.88	12.64	2.68	10.62	23.26	7.05
675.1	158.40	0.6099	26.83	39.47	11.25	33.95	12.64	2.69	10.66	23.30	7.00
690.1	158.24	0.6235	26.80	39.43	11.50	33.86	12.63	2.68	10.61	23.24	6.97
705.1	160.77	0.6370	26.74	39.44	11.75	34.23	12.70	2.70	10.76	23.46	6.91
720.1	159.98	0.6506	26.74	39.51	12.00	34.13	12.77	2.67	10.68	23.45	6.91
735.2	159.40	0.6641	26.71	39.50	12.25	34.00	12.79	2.66	10.61	23.39	6.88
750.1	159.35	0.6777	26.65	39.46	12.50	33.95	12.80	2.65	10.57	23.38	6.82
765.1	160.15	0.6912	26.61	39.46	12.75	34.04	12.84	2.65	10.60	23.44	6.78
780.2	160.41	0.7048	26.61	39.51	13.00	34.08	12.90	2.64	10.59	23.49	6.78
795.1	159.68	0.7184	26.58	39.48	13.25	33.91	12.90	2.63	10.51	23.40	6.75
810.1	161.03	0.7319	26.51	39.44	13.50	34.08	12.94	2.63	10.57	23.51	6.68
825.2	159.63	0.7455	26.51	39.48	13.75	33.86	12.98	2.61	10.44	23.42	6.68
840.1	160.09	0.7590	26.44	39.44	14.00	33.89	13.00	2.61	10.44	23.45	6.61
855.1	161.80	0.7726	26.41	39.47	14.25	34.12	13.06	2.61	10.53	23.59	6.58
870.2	161.63	0.7861	26.42	39.50	14.50	34.05	13.08	2.60	10.49	23.57	6.59
885.2	162.72	0.7997	26.38	39.45	14.75	34.14	13.07	2.61	10.53	23.61	6.55
900.2	161.89	0.8132	26.32	39.44	15.00	34.02	13.13	2.59	10.44	23.57	6.49
900.4	162.39	0.8135	26.33	39.45	15.01	34.08	13.12	2.60	10.48	23.60	6.50

Aviles Engineering Corp.

Advanced Testing Assignment Form

Project Number: 6164-11

Boring: B-2

Depth (ft): 8'-10'

Date Assigned: 8/18/11

Results Deadline:

Type(s) of Testing Required (check all that apply):

- [x] **CU Triaxial**
  Desired Confining Pressures: 6, 12, 24 psi
- [ ] **Consolidation**
- [ ] **Swell**

Any additional testing required for this sample:

- [x] P. I. Assigned separately DONE
- [x] -200 Sieve " NOT DONE
- [ ] Sieve Analysis
- [ ] Other:

Assigned by:

Minus 200 Mesh Sieve / Sieve Analysis Datasheet

Project #:	G164-11	Project Name:			
Boring #:	B-2	Depth (ft):	8-10	Date:	9-14-11
Visual Classification:					

Minus 200 Data:			
Tare ID:	FT	Wt. of Dry Soil + Tare, before sieving (g):	207.67
Tare Wt. (g):	81.65	Wt of Dry Soil + Tare, after sieving (g):	98.47
Percent Retained:	13.35	Percent Passing:	86.65

Sieve Analysis Data:		Sieve Analysis Done? (y/n):	
Sieve Size	Accumulated Wt. Retained (g)	Percent Passing	Percent Retained
3"			
2"			
1 1/2"			
1"			
3/4"			
3/8"			
#4			
#10			
#20			
#40			
#60			
#100			
#140			
#200			
PAN			

Test Technician: P. AYAZI

Calculated By: WT

Checked By: WT

S.A.?

Y N

Aviles Engineering Corporation
CU PRETEST DATA
ASTM D-4767

Project: G164-11		Date: 8-24-11	
Boring: B-2	Depth (ft): 8-10	Cell #: 4	
Soil Description: TANNISH BROWN & GRAY LEAN CLAY W/ CARC NODULES			
Sample Mass (g): 1164.3	Scale ID: 615	Sigma3: 6, 12, 24	

Sample Dimensions:	Height measurements taken 120 degrees apart, Diameter measurements taken at the quarter points of height.
Caliper ID: 144	

Height Measurements (in):		**Diameter Measurements (in):**	
Height1:	5.595"	Diameter1:	2.770"
Height2:	5.583"	Diameter2:	2.767"
Height3:	5.600"	Diameter3:	2.800"
Average Height:	5.593	Average Diameter:	2.779
Sample Volume (cu. Ft.)	0.01963		

Initial Moisture Content:			
Tare ID:	MT-3	*Scale ID:*	670
Tare Wt (g):	65.02	*Oven ID:*	614
Wet Soil + Tare (g):	104.20	*Thermometer ID:*	612
Dry Soil + Tare (g):	97.16		
Moisture Content (%):	22		

Sample Density:		**Dial Gauge Data:**	
Wet Density:	130.75 PCF	*Dial Gauge ID:*	144
Dry Density:	107.26 PCF	Initial Reading (in):	6.820"
Test Prep. Technician:	W. THOMAS		
Technician Signature:			

✓ DO +200 AFTER CU ✓

CU Post-Test Datasheet

Project Name: G164-11 Project Number: _____

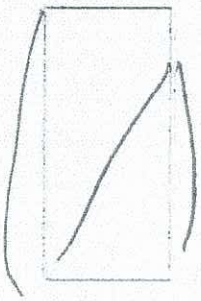
Boring Number: B-2 Boring Depth (ft): 8-10 Cell#: 4

Date: 9/13/11

Moisture Content:

Tare ID:	MT-13
Tare Weight (g):	80.81
Wet Soil + Tare (g):	189.75
Dry Soil + Tare (g):	171.54
% Moisture:	20.1

Sample Sketch:



Failure Types: (circle all that apply)

(Bulge) (Single Shear) Multiple Shear Vertical Fracture SLS

Technician: W. Thom

Aviles Engineering Corporation
CU BACKPRESSURE SATURATION
ASTM D-4767

Project: G164-11	Date: 8-24-11	Sigma3: 6, 12, 24
Boring: B-2	Depth (ft): 8-10	Cell #: 4

Date: 8-24-11	Time: 15:30	Cell Pressure *(psi)*:	10
		Back Pressure *(psi)*:	5
Pore Pressure Change *(with backpressure valves closed, after 1 min)*:			—
B-value: —	Increase Pressures? N	Saturation Complete?	N
New Cell Pressure *(psi)*: —		New Back Pressure *(psi)*:	—
Date: 8-25-11	Time: 11:46	Cell Pressure *(psi)*:	11.48
		Back Pressure *(psi)*:	6.16
Pore Pressure Change *(with backpressure valves closed, after 1 min)*:			0.00
B-value: 0.74	Increase Pressures? Y	Saturation Complete?	N
New Cell Pressure *(psi)*: 15		New Back Pressure *(psi)*:	10
Date: 8-29-11	Time: 12:17	Cell Pressure *(psi)*:	15.38
		Back Pressure *(psi)*:	10.48
Pore Pressure Change *(with backpressure valves closed, after 1 min)*:			0.00 ✓
B-value: 0.86	Increase Pressures? Y	Saturation Complete?	N
New Cell Pressure *(psi)*: 20		New Back Pressure *(psi)*:	15
Date: 8-29-11	Time: 15:30	Cell Pressure *(psi)*:	20.02
		Back Pressure *(psi)*:	15.00
Pore Pressure Change *(with backpressure valves closed, after 1 min)*:			−0.01 ✓
B-value: 0.89	Increase Pressures? Y	Saturation Complete?	N
New Cell Pressure *(psi)*: 25		New Back Pressure *(psi)*:	20

Technician Signature: W Thomas

Aviles Engineering Corporation
CU BACKPRESSURE SATURATION
ASTM D-4767

Project: G164-11	Date: 8-24-11	Sigma3: 6, 12, 24
Boring: B-2	Depth (ft): 8-10	Cell #: 4

Date: 8-31-11	Time: 13:45	Cell Pressure (psi):	25.17
		Back Pressure (psi):	20.06
Pore Pressure Change (with backpressure valves closed, after 1 min):			-0.08
B-value: 0.93	Increase Pressures? Y	Saturation Complete?	N
New Cell Pressure (psi): 30		New Back Pressure (psi):	25
Date: 9-1-11	Time: 10:52	Cell Pressure (psi):	30.02
		Back Pressure (psi):	25.01
Pore Pressure Change (with backpressure valves closed, after 1 min):			-0.02
B-value: 0.95	Increase Pressures? N	Saturation Complete?	Y
New Cell Pressure (psi): —		New Back Pressure (psi):	—
Date:	Time:	Cell Pressure (psi):	
		Back Pressure (psi):	
Pore Pressure Change (with backpressure valves closed, after 1 min):			
B-value:	Increase Pressures?	Saturation Complete?	
New Cell Pressure (psi):		New Back Pressure (psi):	
Date:	Time:	Cell Pressure (psi):	
		Back Pressure (psi):	
Pore Pressure Change (with backpressure valves closed, after 1 min):			
B-value:	Increase Pressures?	Saturation Complete?	
New Cell Pressure (psi):		New Back Pressure (psi):	
Technician Signature:			

H = 5.581"

D = 2.773"

DG = 6.808"

Triaxial Consolidation Datasheet

Stage: 2
Cell#: 4

σ3= 6, 12, 24

Job No.: G164-11
Boring No: B-2
Depth: 8-10

Cell Pressure: 37
Back Pressure: 25

Date	Time	Elapsed Time (min)	Pipette Reading (ml)	Dial Gauge Reading (in.)
9-2-11	12:19	0	23.00	6.658/6.695
		0.1	22.70	
		0.25	22.60	
		0.5	22.50	
		1	22.37	
		3 ~~2~~	21.90	
		4 ~~5~~	19.80	
		~~10~~ ~~8~~	18.72	
		170 ~~15~~	18.62	
9-6-11	8:25	5526 ~~30~~	18.10	
	10:42	5663 ~~60~~	18.05	
9-7-11	9:17	7018 ~~120~~	18.08	6.695

Final Height (in): 5.468"

Final Diameter (in): 2.789"

Triaxial Consolidation Datasheet

Stage: 3
Cell#: 4

σ3= 6, 12, 24

Job No.: G164-11
Boring No: B-2
Depth: 8-10

Cell Pressure: 49
Back Pressure: 25

Date	Time	Elapsed Time (min)	Pipette Reading (ml)	Dial Gauge Reading (in.)
9/7/11	13:38	0	23.00	6.580"/6.613"
		0.1	22.70	
		0.25	22.60	
		0.5	22.30	
		1	22.20	
		2	21.84	
		4	21.43	
		10	20.80	
		15	20.32	
		91 ~~30~~	18.03	
		121 ~~60~~	17.70	
		189 ~~120~~	17.30	
9/8/11	8:21		16.60	
	12:~~00~~		16.52	
9-9	8:40		16.42	
9-12	8:14		16.21	6.610"

Final Height (in): 5.383"

Final Diameter (in): 2.793"

CALCULATION OF TRIAXIAL CU TESTING RESULTS

Job Name: Replacement Shawnee Bridge at Gulf Freeway Job No.: G164-11
Client: Entech 9/13/2011
Location: B-2, 8-10 File @: Z:\Engineering\Reports\2011\164-11

Three Staged Consolidated-Undrained Triaxial Tests
Brown and gray Lean Clay with Sand (CL)
1) Initial Condition (before testing)

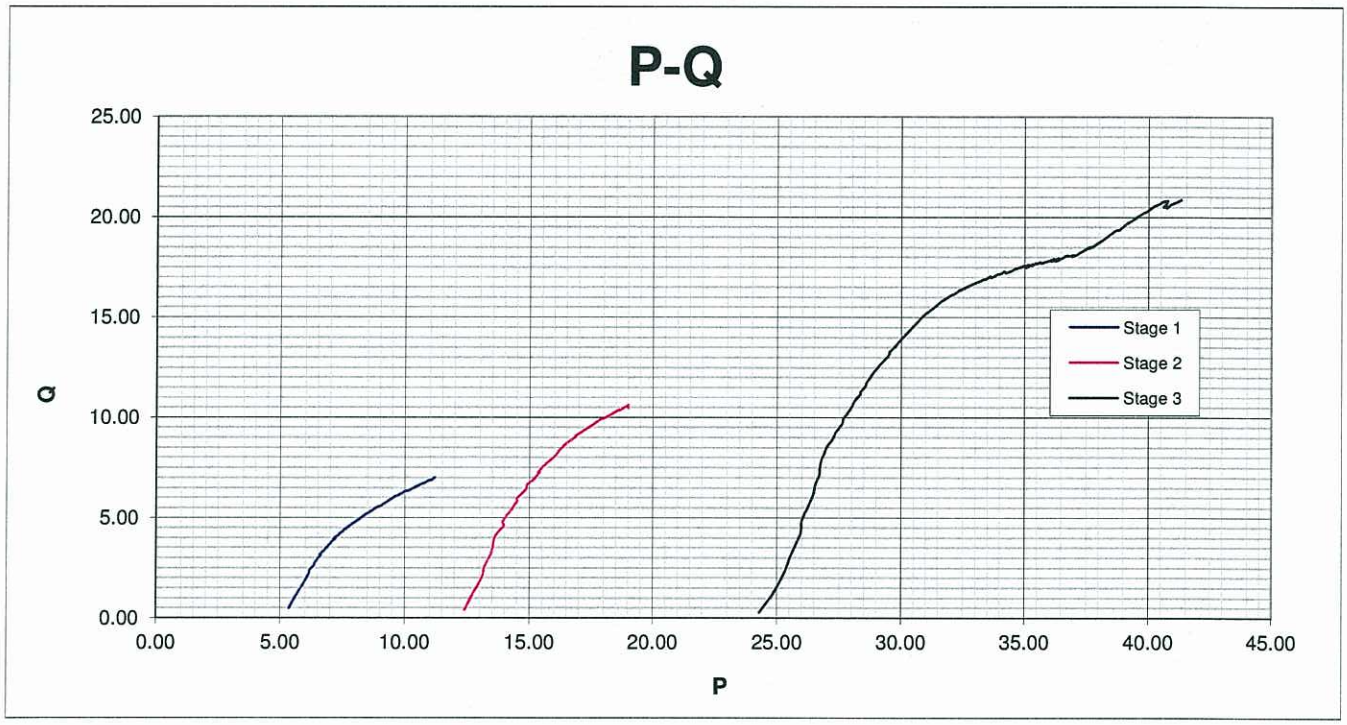
LL =	44 ,	PL =	19 ,	PI =	25 ,
Cu =		psf,			
w_0 =	22.00	%,	G =		2.7 ,
Wet γ =	130.8	pcf,	Dry γ_d =		107.2 pcf,
γ_w =	62.4	pcf,	$S = w_0/(\gamma_w/\gamma_d - 1/G)$ =		103.8 %
$e = w_0G/S$ =	0.572	.			

2) Final Condition (after testing)
w_f = 20.10 %,

Stage	Sigma_1'	Sigma_3'	u	Strain	Sigma_1	Sigma_3
	(psi)	(psi)	(psi)	(%)	(psi)	(psi)
1	17.80	4.12	0.79	2.60	18.59	4.91
2	28.11	8.11	3.86	1.60	31.97	11.97
3	48.12	15.91	8.07	1.70	56.19	23.98
Residual					0.00	0.00

	Effective Stresses				Total Stresses	
Stage	Sigma_1'	Sigma_3'	u	Strain	Sigma_1	Sigma_3
	(ksf)	(ksf)	(ksf)	(%)	(ksf)	(ksf)
1	2.56	0.59	0.11	2.60	2.68	0.71
2	4.05	1.17	0.56	1.60	4.60	1.72
3	6.93	2.29	1.16	1.70	8.09	3.45
Residual	0.00	0.00	0.00	0.00	0.00	0.00

G164-11 B-2-8-10 PQ



Proj. # G164-11 **Boring:** B-2 **Depth (ft):** 8-10

Initial Height Measurements (in.):

Height 1:	5.595		
Height 2:	5.583		
Height 3:	5.6	Average Height (in.):	5.592667

Initial Diameter Measurements (in.):

Diam 1:	2.77		
Diam 2:	2.767		
Diam 3:	2.8	Average Diameter (in):	2.779

Initial Dial Gauge Reading (in): -6.82

End of Saturation Dial Gauge Reading (in.): -6.808

First Consolidation: *(if there is no first stage consolidation, enter '0' for initial and final pipette readings, copy DGs to DGc)*

Initial Pipette Reading (mL):	23
Final Pipette Reading (mL):	23
Final Dial Gauge Reading (in.):	-6.808

Beginning of First Shear:

Height:	5.581
Diameter:	2.773

End of First Shear:

Dial Gauge Reading at end of shearing (in.):	-6.658
Dial Gauge Reading after CV rebound (in):	-6.695

Second Stage Consolidation:

Initial Pipette Reading (mL):	23
Final Pipette Reading (mL):	18.08
Final Dial Gauge Reading (in.):	-6.695

Beginning of Second Shear:

Height:	5.468
Diameter:	2.789

End of Second Shear:

Dial Gauge Reading at end of shearing (in.):	-6.58
Dial Gauge Reading after CV rebound (in):	-6.613

Third Stage Consolidation:

Initial Pipette Reading (mL):	23
Final Pipette Reading (mL):	16.21
Final Dial Gauge Reading (in.):	-6.61

Beginning of Third Shear:

Height:	5.383
Diameter:	2.793

G164-11 B-2-8-10 STAGE1

Elapsed Time (min.)	Vertical Load (lbs)	DCDT (inch)	Pore Pressure (psi)	Cell Pressure (psi)	Axial Strain (%)	Sigma 1 (psi)	Sigma 3 (psi)	Obliquity	q (psi)	p	Excess Pore Pr. (psi)
0.0	15.53	0.0000	24.56	29.43	0.00	5.80	4.87	1.19	0.47	5.34	0.00
1.5	21.80	0.0014	24.98	29.54	0.03	6.53	4.57	1.43	0.98	5.55	0.41
3.0	27.82	0.0028	25.21	29.53	0.05	7.28	4.32	1.69	1.48	5.80	0.65
4.5	32.58	0.0042	25.42	29.53	0.08	7.86	4.11	1.91	1.88	5.98	0.86
6.0	36.28	0.0056	25.56	29.50	0.10	8.30	3.94	2.11	2.18	6.12	1.00
7.5	38.47	0.0070	25.68	29.47	0.13	8.52	3.79	2.25	2.36	6.15	1.11
9.0	40.91	0.0084	25.80	29.55	0.15	8.87	3.75	2.37	2.56	6.31	1.24
10.5	42.59	0.0098	25.90	29.55	0.18	9.05	3.65	2.48	2.70	6.35	1.33
12.0	44.86	0.0112	25.97	29.53	0.20	9.33	3.56	2.62	2.89	6.44	1.41
13.5	47.53	0.0126	26.01	29.50	0.23	9.71	3.49	2.78	3.11	6.60	1.45
15.0	47.92	0.0140	26.08	29.49	0.25	9.69	3.41	2.84	3.14	6.55	1.52
16.6	50.43	0.0154	26.09	29.49	0.28	10.09	3.40	2.97	3.35	6.74	1.53
18.0	50.34	0.0168	26.15	29.54	0.30	10.06	3.39	2.97	3.34	6.72	1.59
19.6	52.95	0.0182	26.15	29.48	0.33	10.44	3.33	3.13	3.55	6.89	1.58
21.1	52.80	0.0196	26.19	29.52	0.35	10.40	3.33	3.13	3.54	6.87	1.63
22.6	53.88	0.0210	26.21	29.51	0.38	10.56	3.31	3.19	3.63	6.93	1.64
24.1	54.85	0.0224	26.25	29.55	0.40	10.72	3.31	3.24	3.71	7.01	1.68
25.6	55.26	0.0238	26.25	29.52	0.43	10.74	3.26	3.29	3.74	7.00	1.69
27.1	57.58	0.0252	26.27	29.53	0.45	11.12	3.26	3.41	3.93	7.19	1.71
28.6	57.21	0.0266	26.29	29.48	0.48	10.99	3.19	3.44	3.90	7.09	1.73
30.1	59.31	0.0280	26.28	29.47	0.50	11.33	3.20	3.55	4.07	7.26	1.71
31.6	59.71	0.0294	26.31	29.52	0.53	11.41	3.21	3.56	4.10	7.31	1.74
33.1	60.26	0.0308	26.29	29.49	0.55	11.49	3.20	3.59	4.15	7.34	1.73
34.6	60.46	0.0322	26.30	29.47	0.58	11.49	3.17	3.63	4.16	7.33	1.74
36.1	61.51	0.0336	26.30	29.47	0.60	11.66	3.17	3.68	4.25	7.41	1.74
37.6	61.00	0.0350	26.32	29.50	0.63	11.58	3.18	3.65	4.20	7.38	1.76
39.1	61.90	0.0364	26.33	29.53	0.65	11.75	3.20	3.68	4.28	7.47	1.77
40.6	62.82	0.0378	26.31	29.46	0.68	11.85	3.15	3.76	4.35	7.50	1.75
42.1	64.36	0.0392	26.32	29.50	0.70	12.13	3.18	3.82	4.48	7.66	1.76
43.6	63.57	0.0405	26.34	29.54	0.73	12.02	3.20	3.76	4.41	7.61	1.77
45.1	65.40	0.0419	26.30	29.50	0.75	12.31	3.19	3.86	4.56	7.75	1.74
46.6	65.12	0.0433	26.34	29.52	0.78	12.25	3.18	3.85	4.53	7.72	1.78
48.1	66.13	0.0447	26.30	29.49	0.80	12.42	3.19	3.89	4.62	7.81	1.74
49.6	66.68	0.0461	26.31	29.52	0.83	12.53	3.21	3.91	4.66	7.87	1.75
51.1	66.88	0.0475	26.31	29.50	0.85	12.55	3.19	3.93	4.68	7.87	1.74
52.6	67.46	0.0489	26.29	29.52	0.88	12.67	3.23	3.92	4.72	7.95	1.73
54.1	67.12	0.0503	26.29	29.52	0.90	12.61	3.22	3.91	4.69	7.92	1.73
55.6	69.00	0.0517	26.27	29.51	0.93	12.93	3.23	4.00	4.85	8.08	1.71
57.1	69.39	0.0531	26.29	29.53	0.95	12.99	3.23	4.02	4.88	8.11	1.73

58.6	70.01	0.0545	26.28	29.53	0.98	13.11	3.25	4.03	4.93	8.18	1.72
60.1	68.91	0.0559	26.28	29.50	1.00	12.89	3.22	4.00	4.84	8.06	1.72
66.1	71.99	0.0615	26.25	29.51	1.10	13.43	3.26	4.12	5.08	8.35	1.69
72.1	73.17	0.0671	26.18	29.46	1.20	13.63	3.28	4.15	5.17	8.45	1.62
78.1	75.75	0.0727	26.15	29.50	1.30	14.11	3.35	4.21	5.38	8.73	1.59
84.2	76.53	0.0782	26.12	29.46	1.40	14.22	3.34	4.25	5.44	8.78	1.56
90.2	78.41	0.0838	26.07	29.54	1.50	14.64	3.47	4.22	5.59	9.05	1.51
96.2	79.19	0.0894	26.02	29.49	1.60	14.76	3.47	4.25	5.64	9.12	1.45
102.2	83.21	0.0950	25.95	29.49	1.70	15.47	3.54	4.37	5.97	9.51	1.39
108.1	84.27	0.1006	25.87	29.44	1.80	15.65	3.56	4.39	6.05	9.61	1.31
114.1	85.68	0.1062	25.83	29.49	1.90	15.97	3.66	4.36	6.15	9.81	1.27
120.1	87.42	0.1117	25.75	29.46	2.00	16.29	3.71	4.39	6.29	10.00	1.19
126.2	87.59	0.1173	25.71	29.44	2.10	16.32	3.73	4.37	6.30	10.03	1.14
132.2	88.32	0.1229	25.65	29.48	2.20	16.53	3.83	4.32	6.35	10.18	1.09
138.2	89.97	0.1285	25.57	29.45	2.30	16.84	3.89	4.33	6.48	10.36	1.00
144.2	91.81	0.1341	25.48	29.44	2.40	17.20	3.97	4.34	6.62	10.58	0.91
150.2	93.04	0.1397	25.46	29.52	2.50	17.48	4.06	4.31	6.71	10.77	0.89
156.2	94.69	0.1452	25.36	29.48	2.60	17.80	4.12	4.32	6.84	10.96	0.79
162.2	94.90	0.1508	25.30	29.49	2.70	17.88	4.19	4.27	6.85	11.04	0.73
164.6	96.57	0.1531	25.25	29.45	2.74	18.15	4.20	4.32	6.98	11.18	0.69

G164-11 B-2-8-10 STAGE2

Elapsed Time (min.)	Vertical Load (lbs)	DCDT (inch)	Pore Pressure (psi)	Cell Pressure (psi)	Axial Strain (%)	Sigma 1 (psi)	Sigma 3 (psi)	Obliquity	q (psi)	p	Excess Pore Pr. (psi)
0.0	15.28	0.0000	24.62	36.61	0.00	12.78	12.00	1.07	0.39	12.39	0.00
1.5	24.67	0.0014	25.07	36.61	0.02	13.86	11.54	1.20	1.16	12.70	0.46
3.0	35.07	0.0027	25.52	36.59	0.05	15.09	11.07	1.36	2.01	13.08	0.91
4.5	41.49	0.0041	26.00	36.64	0.08	15.72	10.64	1.48	2.54	13.18	1.38
6.0	48.68	0.0055	26.38	36.68	0.10	16.55	10.30	1.61	3.12	13.42	1.77
7.5	53.33	0.0068	26.64	36.66	0.13	17.02	10.01	1.70	3.50	13.52	2.03
9.0	57.54	0.0082	26.94	36.65	0.15	17.40	9.71	1.79	3.85	13.55	2.32
10.5	61.75	0.0096	27.18	36.66	0.18	17.87	9.49	1.88	4.19	13.68	2.56
12.0	66.48	0.0110	27.30	36.68	0.20	18.54	9.39	1.97	4.58	13.96	2.68
13.5	68.63	0.0123	27.48	36.63	0.23	18.65	9.16	2.04	4.75	13.90	2.86
15.0	72.31	0.0137	27.64	36.64	0.25	19.10	9.00	2.12	5.05	14.05	3.02
16.5	76.34	0.0151	27.73	36.62	0.28	19.64	8.89	2.21	5.38	14.27	3.12
18.0	78.57	0.0164	27.81	36.61	0.30	19.92	8.80	2.26	5.56	14.36	3.20
19.5	81.64	0.0178	27.97	36.66	0.33	20.30	8.69	2.34	5.81	14.49	3.36
21.0	83.20	0.0192	28.03	36.58	0.35	20.41	8.55	2.39	5.93	14.48	3.41
22.5	85.49	0.0205	28.13	36.65	0.38	20.75	8.52	2.44	6.12	14.63	3.52
24.0	89.27	0.0219	28.18	36.62	0.40	21.29	8.44	2.52	6.42	14.86	3.56
25.6	90.67	0.0233	28.27	36.61	0.43	21.41	8.34	2.57	6.54	14.88	3.65
27.0	91.95	0.0247	28.38	36.65	0.45	21.55	8.27	2.61	6.64	14.91	3.77
28.5	95.27	0.0260	28.39	36.67	0.48	22.09	8.27	2.67	6.91	15.18	3.78
30.0	97.22	0.0274	28.42	36.63	0.50	22.34	8.21	2.72	7.07	15.28	3.80
31.5	99.83	0.0288	28.48	36.62	0.53	22.69	8.14	2.79	7.28	15.41	3.86
33.0	99.55	0.0301	28.56	36.65	0.55	22.59	8.09	2.79	7.25	15.34	3.94
34.6	102.08	0.0315	28.56	36.60	0.58	22.95	8.04	2.86	7.46	15.49	3.95
36.1	103.60	0.0329	28.61	36.63	0.60	23.17	8.01	2.89	7.58	15.59	4.00
37.6	105.90	0.0342	28.65	36.64	0.63	23.51	7.99	2.94	7.76	15.75	4.04
39.1	107.80	0.0356	28.63	36.61	0.65	23.80	7.98	2.98	7.91	15.89	4.01
40.6	109.49	0.0370	28.65	36.62	0.68	24.07	7.97	3.02	8.05	16.02	4.04
42.1	110.68	0.0384	28.72	36.66	0.70	24.23	7.94	3.05	8.14	16.08	4.11

43.6	112.16	0.0397	28.72	36.63	0.73	24.43	7.91	3.09	8.26	16.17	4.10
45.1	112.53	0.0411	28.71	36.59	0.75	24.46	7.87	3.11	8.29	16.16	4.10
46.6	114.18	0.0425	28.74	36.58	0.78	24.69	7.85	3.15	8.42	16.27	4.12
48.1	116.10	0.0438	28.75	36.57	0.80	24.97	7.82	3.19	8.58	16.39	4.14
49.6	116.76	0.0452	28.76	36.57	0.83	25.06	7.81	3.21	8.63	16.44	4.14
51.1	116.59	0.0466	28.79	36.56	0.85	24.99	7.77	3.22	8.61	16.38	4.17
52.6	119.88	0.0479	28.78	36.61	0.88	25.58	7.83	3.27	8.88	16.71	4.17
54.1	119.21	0.0493	28.78	36.57	0.90	25.43	7.79	3.26	8.82	16.61	4.17
55.6	119.92	0.0507	28.80	36.62	0.93	25.57	7.82	3.27	8.88	16.70	4.18
57.1	121.82	0.0520	28.81	36.65	0.95	25.89	7.84	3.30	9.03	16.87	4.20
58.6	122.47	0.0534	28.83	36.63	0.98	25.95	7.80	3.33	9.08	16.87	4.22
60.1	122.12	0.0548	28.80	36.59	1.00	25.88	7.79	3.32	9.05	16.83	4.18
66.1	125.96	0.0603	28.78	36.64	1.10	26.56	7.87	3.38	9.35	17.21	4.16
72.1	127.59	0.0657	28.73	36.63	1.20	26.85	7.91	3.40	9.47	17.38	4.11
78.1	129.82	0.0712	28.66	36.60	1.30	27.23	7.94	3.43	9.64	17.58	4.04
84.1	133.70	0.0767	28.59	36.58	1.40	27.88	7.99	3.49	9.94	17.94	3.98
90.1	133.50	0.0821	28.58	36.62	1.50	27.88	8.04	3.47	9.92	17.96	3.96
96.1	134.63	0.0876	28.48	36.59	1.60	28.11	8.11	3.47	10.00	18.11	3.86
102.1	137.28	0.0931	28.35	36.53	1.70	28.59	8.19	3.49	10.20	18.39	3.73
108.1	139.49	0.0986	28.30	36.56	1.80	29.00	8.26	3.51	10.37	18.63	3.68
114.1	139.15	0.1040	28.20	36.51	1.90	28.97	8.31	3.49	10.33	18.64	3.59
120.1	142.57	0.1095	28.10	36.51	2.00	29.60	8.41	3.52	10.60	19.00	3.49
126.1	141.52	0.1150	28.11	36.59	2.10	29.48	8.48	3.48	10.50	18.98	3.49
127.1	140.93	0.1159	28.09	36.64	2.12	29.46	8.56	3.44	10.45	19.01	3.47

G164-11 B-2-8-10 STAGE3

Elapsed Time (min.)	Vertical Load (lbs)	DCDT (inch)	Pore Pressure (psi)	Cell Pressure (psi)	Axial Strain (%)	Sigma 1 (psi)	Sigma 3 (psi)	Obliquity	q (psi)	p	Excess Pore Pr. (psi)
0.0	12.92	0.0000	24.53	48.55	0.00	24.55	24.02	1.02	0.27	24.28	0.00
1.5	23.85	0.0013	24.92	48.57	0.03	25.98	23.65	1.10	1.16	24.81	0.39
3.0	37.36	0.0027	25.51	48.55	0.05	27.56	23.03	1.20	2.26	25.30	0.98
4.5	48.99	0.0040	26.18	48.55	0.08	28.80	22.38	1.29	3.21	25.59	1.65
6.0	61.29	0.0054	26.79	48.52	0.10	30.16	21.73	1.39	4.21	25.94	2.26
7.5	69.17	0.0067	27.35	48.50	0.13	30.86	21.15	1.46	4.85	26.00	2.82
9.0	78.02	0.0081	27.86	48.55	0.15	31.83	20.69	1.54	5.57	26.26	3.33
10.5	85.64	0.0094	28.27	48.54	0.18	32.65	20.27	1.61	6.19	26.46	3.74
12.0	91.17	0.0108	28.66	48.55	0.20	33.17	19.89	1.67	6.64	26.53	4.13
13.5	97.52	0.0121	28.98	48.52	0.23	33.86	19.54	1.73	7.16	26.70	4.45
15.0	101.43	0.0135	29.28	48.52	0.25	34.19	19.24	1.78	7.47	26.72	4.75
16.5	106.11	0.0148	29.57	48.49	0.28	34.63	18.92	1.83	7.85	26.78	5.04
18.0	110.30	0.0162	29.82	48.52	0.30	35.08	18.70	1.88	8.19	26.89	5.29
19.5	114.53	0.0175	30.06	48.53	0.33	35.53	18.47	1.92	8.53	27.00	5.53
21.0	119.45	0.0188	30.25	48.55	0.35	36.16	18.30	1.98	8.93	27.23	5.72
22.5	123.68	0.0202	30.46	48.54	0.38	36.63	18.09	2.03	9.27	27.36	5.92
24.0	128.84	0.0215	30.63	48.55	0.40	37.30	17.92	2.08	9.69	27.61	6.10
25.5	131.59	0.0229	30.78	48.53	0.43	37.57	17.75	2.12	9.91	27.66	6.25
27.0	135.65	0.0242	30.95	48.55	0.45	38.08	17.60	2.16	10.24	27.84	6.41
28.5	139.69	0.0256	31.10	48.54	0.48	38.57	17.44	2.21	10.56	28.01	6.57
30.0	143.00	0.0269	31.22	48.51	0.50	38.95	17.29	2.25	10.83	28.12	6.69
31.5	146.99	0.0283	31.33	48.52	0.53	39.49	17.19	2.30	11.15	28.34	6.80
33.0	148.50	0.0296	31.47	48.55	0.55	39.62	17.08	2.32	11.27	28.35	6.94
34.5	152.32	0.0310	31.58	48.56	0.58	40.14	16.98	2.36	11.58	28.56	7.05
36.0	153.93	0.0323	31.69	48.57	0.60	40.29	16.88	2.39	11.71	28.59	7.16
37.5	157.15	0.0337	31.76	48.52	0.63	40.69	16.76	2.43	11.96	28.72	7.23
39.1	160.24	0.0350	31.85	48.49	0.65	41.06	16.64	2.47	12.21	28.85	7.32
40.5	162.12	0.0364	31.92	48.51	0.68	41.31	16.59	2.49	12.36	28.95	7.39
42.1	164.77	0.0377	32.01	48.53	0.70	41.67	16.52	2.52	12.57	29.10	7.48
43.5	168.31	0.0391	32.10	48.56	0.73	42.17	16.46	2.56	12.86	29.31	7.57
45.1	170.33	0.0404	32.16	48.58	0.75	42.45	16.42	2.59	13.02	29.44	7.63
46.5	172.50	0.0417	32.24	48.57	0.78	42.71	16.33	2.62	13.19	29.52	7.71
48.1	173.69	0.0431	32.29	48.53	0.80	42.81	16.25	2.64	13.28	29.53	7.76
49.5	175.58	0.0444	32.33	48.56	0.83	43.09	16.23	2.66	13.43	29.66	7.80
51.0	178.47	0.0458	32.38	48.55	0.85	43.49	16.17	2.69	13.66	29.83	7.85
52.5	178.75	0.0471	32.42	48.58	0.88	43.52	16.16	2.69	13.68	29.84	7.89
54.1	181.62	0.0485	32.47	48.56	0.90	43.91	16.09	2.73	13.91	30.00	7.94
55.6	182.64	0.0498	32.49	48.56	0.93	44.05	16.07	2.74	13.99	30.06	7.96
57.1	185.71	0.0512	32.54	48.55	0.95	44.48	16.02	2.78	14.23	30.25	8.01
58.6	187.67	0.0525	32.55	48.52	0.98	44.75	15.98	2.80	14.39	30.37	8.02
60.1	187.73	0.0539	32.56	48.54	1.00	44.76	15.98	2.80	14.39	30.37	8.03
66.1	192.52	0.0592	32.69	48.58	1.10	45.41	15.89	2.86	14.76	30.65	8.16
72.1	197.77	0.0646	32.69	48.50	1.20	46.15	15.81	2.92	15.17	30.98	8.16
78.1	200.89	0.0700	32.72	48.55	1.30	46.64	15.83	2.95	15.41	31.24	8.19
84.1	205.74	0.0754	32.72	48.54	1.40	47.39	15.82	2.99	15.78	31.61	8.19
90.1	206.07	0.0808	32.72	48.55	1.50	47.41	15.83	3.00	15.79	31.62	8.19
96.1	209.48	0.0862	32.64	48.53	1.60	47.99	15.89	3.02	16.05	31.94	8.11
102.1	210.37	0.0915	32.60	48.51	1.70	48.12	15.91	3.02	16.10	32.01	8.07
108.1	211.49	0.0969	32.59	48.56	1.80	48.32	15.97	3.03	16.18	32.14	8.06
114.1	214.28	0.1023	32.51	48.52	1.90	48.77	16.01	3.05	16.38	32.39	7.98
120.1	214.08	0.1077	32.47	48.50	2.00	48.73	16.03	3.04	16.35	32.38	7.94
126.1	217.29	0.1131	32.41	48.58	2.10	49.35	16.17	3.05	16.59	32.76	7.88
132.1	217.99	0.1184	32.32	48.52	2.20	49.45	16.19	3.05	16.63	32.82	7.79
138.1	219.51	0.1238	32.29	48.59	2.30	49.76	16.29	3.05	16.73	33.03	7.76
144.1	219.98	0.1292	32.20	48.51	2.40	49.82	16.31	3.05	16.75	33.06	7.67
150.1	220.87	0.1346	32.17	48.57	2.50	50.02	16.40	3.05	16.81	33.21	7.64
156.1	222.30	0.1400	32.09	48.53	2.60	50.24	16.43	3.06	16.90	33.34	7.56
162.1	222.25	0.1454	32.03	48.52	2.70	50.26	16.50	3.05	16.88	33.38	7.50
168.1	224.57	0.1507	31.94	48.50	2.80	50.66	16.56	3.06	17.05	33.61	7.41
174.1	223.91	0.1561	31.89	48.54	2.90	50.61	16.65	3.04	16.98	33.63	7.36
180.1	226.47	0.1615	31.81	48.57	3.00	51.08	16.75	3.05	17.17	33.92	7.28
186.1	226.70	0.1669	31.73	48.51	3.10	51.11	16.78	3.05	17.17	33.95	7.20
192.1	227.00	0.1723	31.69	48.53	3.20	51.19	16.84	3.04	17.17	34.02	7.16
198.1	228.72	0.1777	31.58	48.46	3.30	51.45	16.88	3.05	17.29	34.16	7.05
204.1	228.03	0.1830	31.56	48.57	3.40	51.44	17.01	3.02	17.22	34.22	7.03
210.1	228.54	0.1884	31.48	48.50	3.50	51.51	17.03	3.03	17.24	34.27	6.95
216.1	229.08	0.1938	31.45	48.54	3.60	51.61	17.09	3.02	17.26	34.35	6.92
222.1	231.69	0.1992	31.37	48.58	3.70	52.11	17.21	3.03	17.45	34.66	6.84
228.1	231.58	0.2046	31.31	48.55	3.80	52.09	17.24	3.02	17.43	34.66	6.78
234.1	233.03	0.2099	31.22	48.52	3.90	52.34	17.30	3.03	17.52	34.82	6.69
240.1	232.87	0.2153	31.19	48.52	4.00	52.31	17.33	3.02	17.49	34.82	6.66
246.1	234.50	0.2207	31.11	48.49	4.10	52.59	17.39	3.02	17.60	34.99	6.57
252.1	233.85	0.2261	31.08	48.53	4.20	52.51	17.45	3.01	17.53	34.98	6.55

258.1	235.36	0.2315	31.00	48.54	4.30	52.79	17.54	3.01	17.63	35.17	6.47
264.1	233.64	0.2368	30.99	48.55	4.40	52.52	17.56	2.99	17.48	35.04	6.46
270.1	236.17	0.2422	30.94	48.59	4.50	52.96	17.65	3.00	17.66	35.31	6.41
276.1	236.43	0.2476	30.83	48.49	4.60	52.98	17.66	3.00	17.66	35.32	6.30
282.2	235.71	0.2530	30.80	48.52	4.70	52.88	17.72	2.99	17.58	35.30	6.27
288.1	237.54	0.2584	30.74	48.48	4.80	53.16	17.74	3.00	17.71	35.45	6.21
294.1	237.44	0.2638	30.71	48.51	4.90	53.16	17.80	2.99	17.68	35.48	6.18
300.1	238.69	0.2691	30.64	48.52	5.00	53.40	17.88	2.99	17.76	35.64	6.11
315.1	238.59	0.2826	30.59	48.57	5.25	53.38	17.97	2.97	17.70	35.68	6.06
330.2	240.10	0.2960	30.47	48.55	5.50	53.62	18.07	2.97	17.77	35.85	5.94
345.1	240.92	0.3095	30.39	48.50	5.75	53.69	18.12	2.96	17.79	35.91	5.86
360.1	243.26	0.3229	30.33	48.59	6.00	54.11	18.26	2.96	17.92	36.18	5.80
375.2	242.29	0.3364	30.23	48.50	6.25	53.87	18.27	2.95	17.80	36.07	5.70
390.1	244.91	0.3498	30.16	48.59	6.50	54.33	18.43	2.95	17.95	36.38	5.63
405.1	243.70	0.3633	30.06	48.47	6.75	54.04	18.41	2.94	17.81	36.22	5.53
420.2	245.52	0.3768	30.00	48.54	7.00	54.34	18.54	2.93	17.90	36.44	5.47
435.1	248.36	0.3902	29.90	48.49	7.25	54.73	18.59	2.94	18.07	36.66	5.37
450.2	249.33	0.4037	29.83	48.50	7.50	54.85	18.67	2.94	18.09	36.76	5.30
465.2	249.47	0.4171	29.76	48.48	7.75	54.83	18.71	2.93	18.06	36.77	5.23
480.2	250.89	0.4306	29.70	48.56	8.00	55.09	18.87	2.92	18.11	36.98	5.17
495.2	250.64	0.4440	29.61	48.49	8.25	54.97	18.88	2.91	18.05	36.93	5.08
510.2	252.40	0.4575	29.57	48.55	8.50	55.23	18.98	2.91	18.13	37.10	5.04
525.2	254.28	0.4709	29.47	48.48	8.75	55.44	19.00	2.92	18.22	37.22	4.94
540.2	258.93	0.4844	29.44	48.55	9.00	56.13	19.11	2.94	18.51	37.62	4.91
555.2	258.64	0.4978	29.36	48.50	9.25	56.03	19.14	2.93	18.44	37.58	4.83
570.2	260.81	0.5113	29.30	48.52	9.50	56.32	19.22	2.93	18.55	37.77	4.77
585.2	263.34	0.5247	29.24	48.49	9.75	56.62	19.25	2.94	18.69	37.94	4.71
600.2	266.94	0.5382	29.21	48.51	10.00	57.09	19.30	2.96	18.90	38.20	4.68
615.2	273.49	0.5516	29.14	48.48	10.25	57.99	19.34	3.00	19.33	38.67	4.61
630.2	274.94	0.5651	29.15	48.60	10.50	58.21	19.45	2.99	19.38	38.83	4.62
645.2	279.77	0.5785	29.03	48.47	10.75	58.78	19.43	3.02	19.68	39.11	4.50
660.2	282.43	0.5920	28.99	48.48	11.00	59.12	19.49	3.03	19.81	39.30	4.46
675.2	288.50	0.6054	28.97	48.53	11.25	59.96	19.57	3.06	20.20	39.77	4.44
690.2	290.60	0.6189	28.89	48.53	11.50	60.23	19.64	3.07	20.29	39.93	4.36
705.2	294.61	0.6323	28.82	48.49	11.75	60.71	19.66	3.09	20.52	40.19	4.29
720.2	297.02	0.6458	28.79	48.54	12.00	61.03	19.75	3.09	20.64	40.39	4.26
735.2	300.21	0.6592	28.69	48.51	12.25	61.43	19.82	3.10	20.81	40.62	4.16
750.2	300.65	0.6727	28.66	48.49	12.50	61.40	19.84	3.10	20.78	40.62	4.13
765.2	302.14	0.6861	28.59	48.52	12.75	61.59	19.93	3.09	20.83	40.76	4.06
780.2	302.75	0.6996	28.52	48.47	13.00	61.57	19.95	3.09	20.81	40.76	3.99
795.2	301.74	0.7131	28.49	48.53	13.25	61.40	20.04	3.06	20.68	40.72	3.96
810.2	300.45	0.7265	28.41	48.48	13.50	61.13	20.07	3.05	20.53	40.60	3.88
825.2	300.84	0.7400	28.38	48.52	13.75	61.14	20.15	3.03	20.50	40.64	3.85
840.2	302.33	0.7534	28.32	48.54	14.00	61.30	20.22	3.03	20.54	40.76	3.79
855.2	302.07	0.7669	28.26	48.53	14.25	61.19	20.27	3.02	20.46	40.73	3.73
870.2	305.28	0.7803	28.19	48.45	14.50	61.52	20.26	3.04	20.63	40.89	3.66
885.2	306.83	0.7938	28.18	48.48	14.75	61.66	20.31	3.04	20.68	40.98	3.64
900.2	310.46	0.8072	28.13	48.57	15.00	62.18	20.45	3.04	20.87	41.31	3.60
900.4	310.62	0.8074	28.13	48.55	15.01	62.17	20.42	3.05	20.88	41.29	3.60

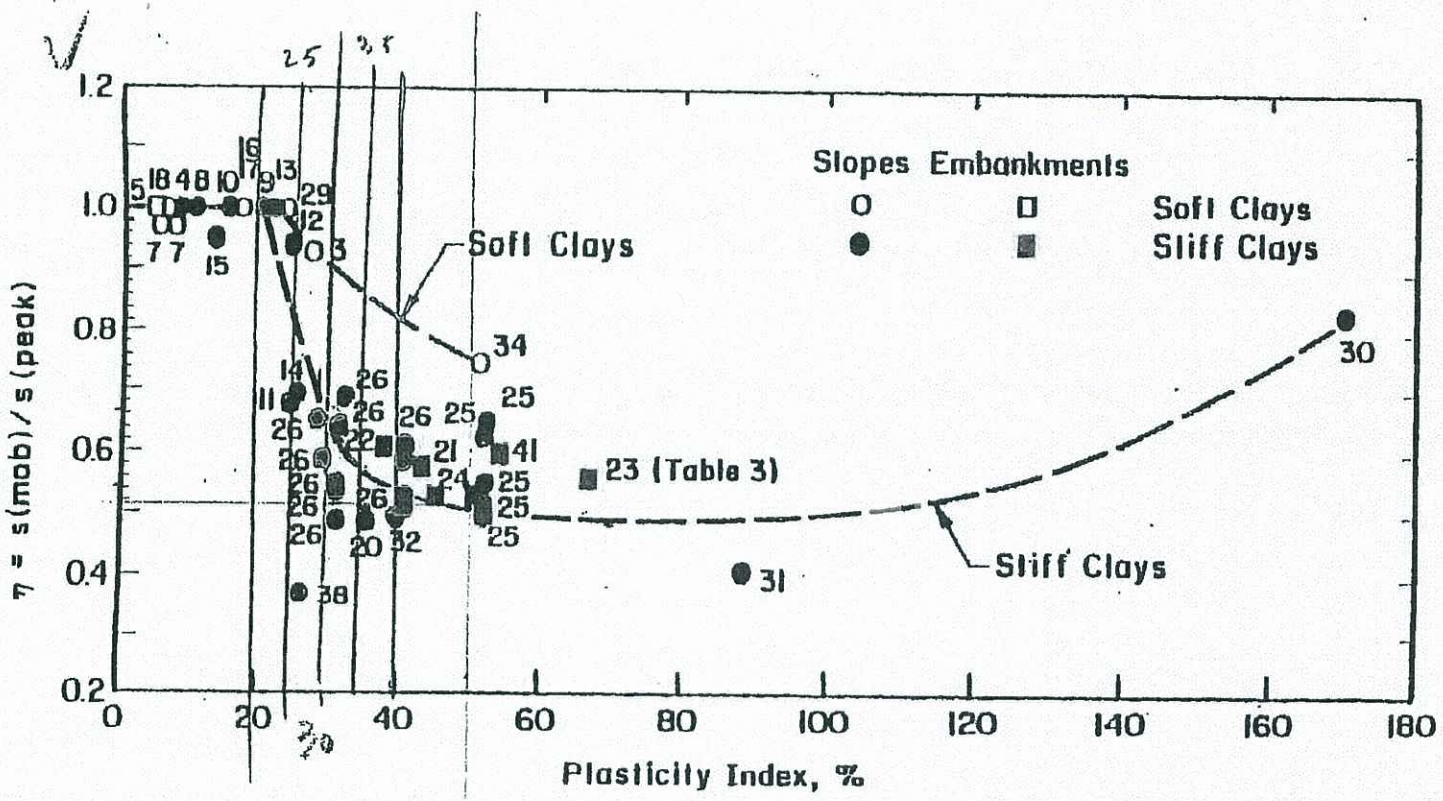


FIG. 13. Correction Factor for Peak Shear Strength Used in Effective Stress Stability Analysis

CU

B-1 4-6 CH PI = 51 $c' = 460$ psf $\phi' = 19.1°$

$C_{cu} = 520$ psf $\phi_{cu} = 12.9°$

B-2 8-10 CL PI = 25 $c' = 330$ psf $\phi' = 26.1$

$C_{cu} = 450$ psf $\phi'_{cu} = 19.1$

Design Soil Parameters, Borry B-1

0-8 CH PI = 51 to 54 $c' = 460 \times .5 = 230$ ϕ' rounded to 19°

$C_{cu} = 520 \times .5 = 260$ ϕ_{cu} rounded to 13

8-10 CL PI = 39 $c' = 330 \times .8 = 264 \downarrow 260$ psf ϕ' rounded to 26°

$C_{cu} = 450 \times .8 = 360$ psf ϕ_{cu} rounded to 19°

10-14 CH PI = 39 $c' = 460 \times .52 = 239 \Rightarrow 240$ psf ϕ' rounded to 19°

$C_{cu} = 520 \times .52 = 270$ psf ϕ_{cu} rounded to 13°

14-18 CH PI = 48 $c' = 460 \times .5 = 230$ ϕ' rounded to 19°

$C_{cu} = 520 \times .5 = 260$ ϕ_{cu} rounded to 13°

18-30 CH PI = 40-45 $c' = 460 \times .52 = 240$ psf $\phi' = 19$

$C_{cu} = 520 \times .52 = 270$ psf $\phi_{cu} = 13$

$C_r = 65$ $\phi_r = 21$

provided by HCFCD

G164-11 SHAWNEE ROAD OVER DRAINAGE DITCH
SLOPE STABILITY ANALYSIS, BASED ON BORING B-1
SHORT TERM CONDITION

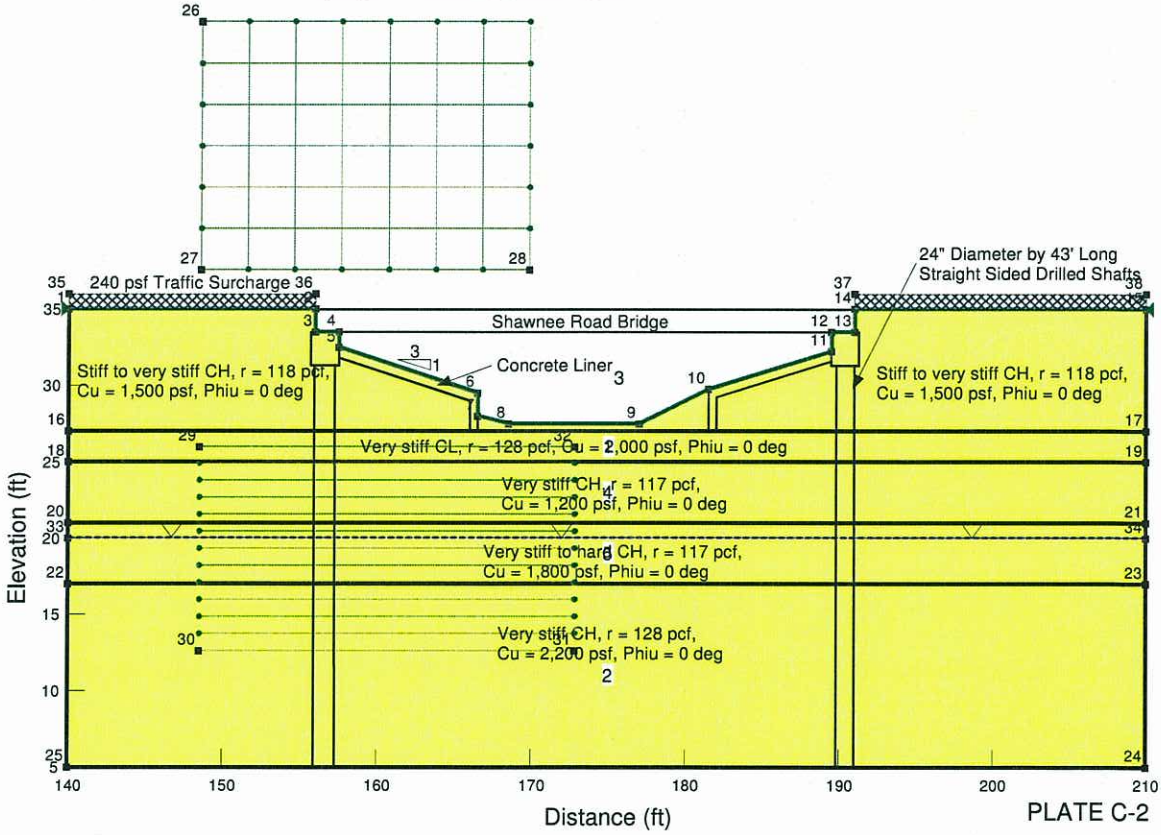


PLATE C-2

G164-11 SHAWNEE ROAD OVER DRAINAGE DITCH
SLOPE STABILITY ANALYSIS, BASED ON BORING B-1
LONG TERM CONDITION

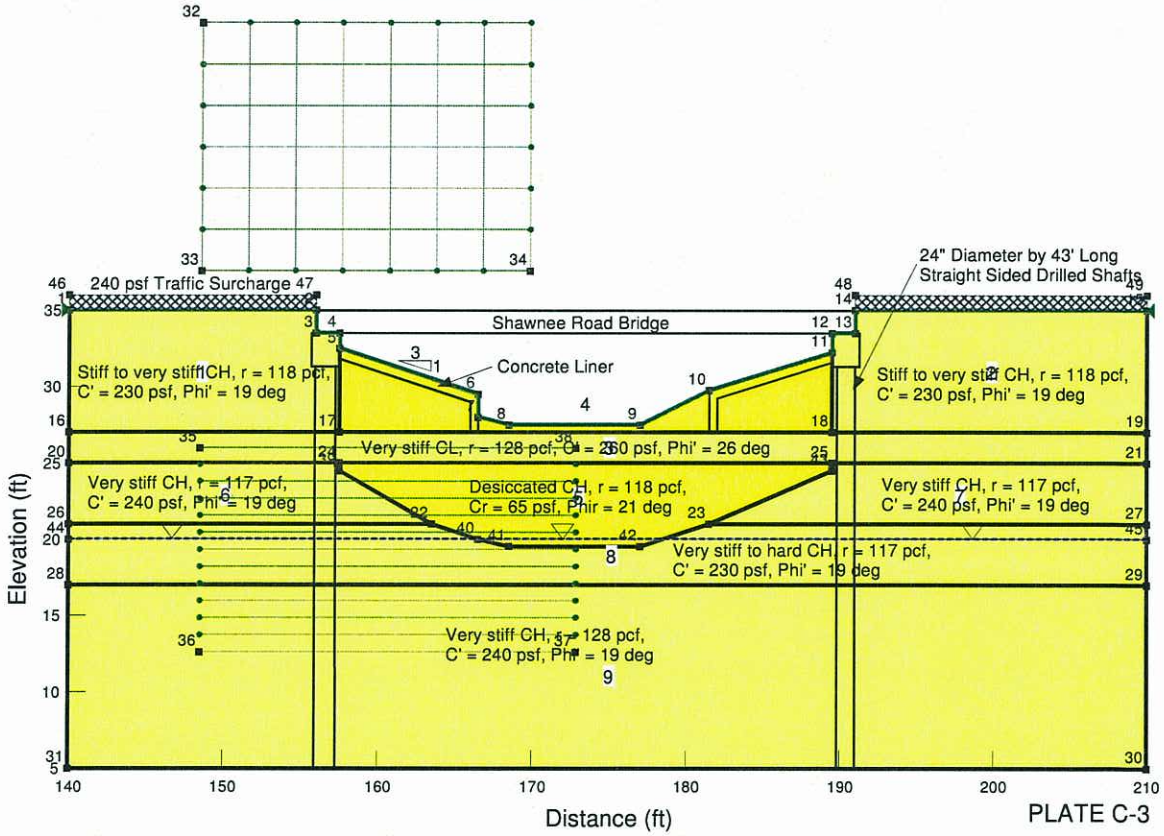


PLATE C-3

G164-11 SHAWNEE ROAD OVER DRAINAGE DITCH
SLOPE STABILITY ANALYSIS, BASED ON BORING B-1
RAPID DRAWDOWN CONDITION - GLOBAL SLIDE

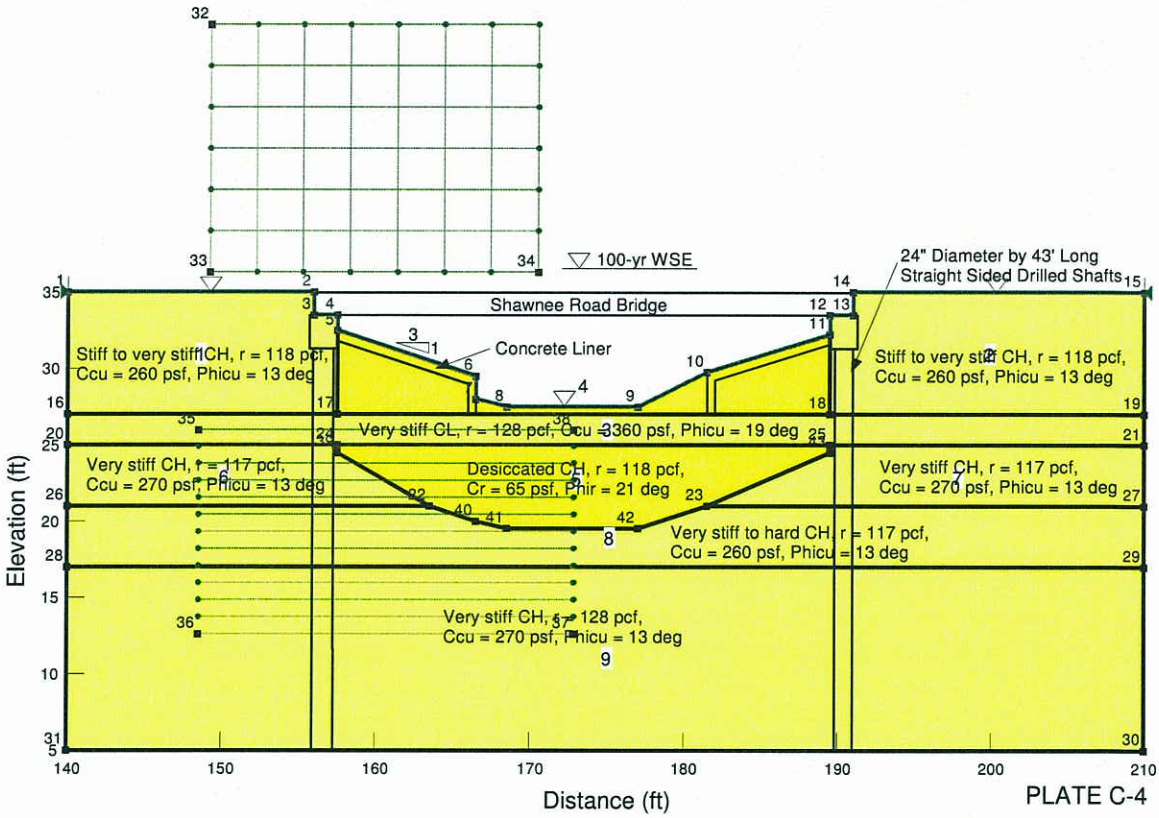


PLATE C-4

G164-11 SHAWNEE ROAD OVER DRAINAGE DITCH
SLOPE STABILITY ANALYSIS, BASED ON BORING B-1
RAPID DRAWDOWN CONDITION - LOCAL SLIDE

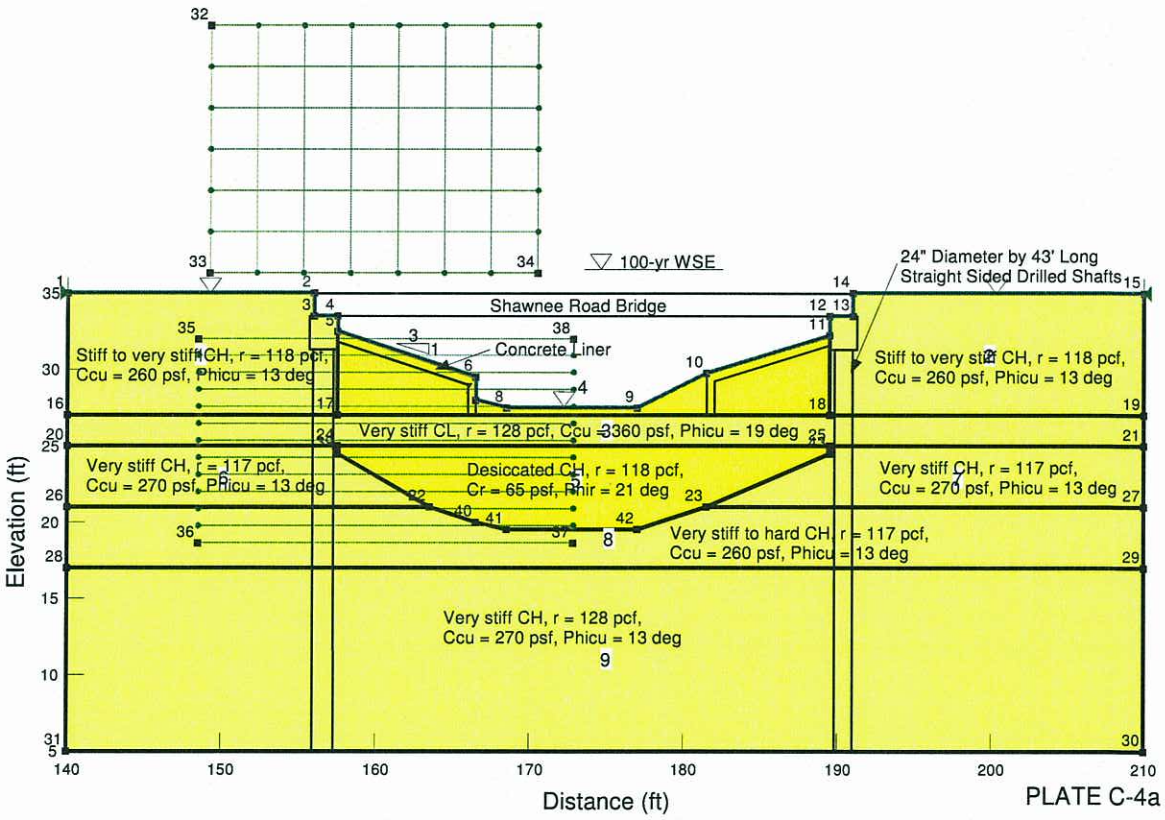


PLATE C-4a