SSCL-SR-1197
SGR-11

Raba-Kistner Consultants, Inc.

Engineers, Geologists, Chemists, Water Planners
Hygienists and Environmental Scientists

GEOTECHNICAL REPORT

FOR

BLOW DOWN POND
SUPERCONDUCTING SUPER COLLIDER

Engineers, Geologists, Chemists, Water Planners, Hygienists and Environmental Scientists

Raba-Kistner Consultants, Inc.

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Project No. ASA91-020-00
October 25, 1991

Mr. Charles Daugherty
The PB/MK Team
Redbird Business Center, Building 5
5610 Redbird Center Drive, Suite 400
Dallas, Texas 75237

Re.: Geotechnical Report
Blow Down Pond
Superconducting Super Collider

Dear Mr. Daugherty:

Submitted here is a report of subsurface conditions within the designated area of the Blow Down Pond on the E1 Site of the Superconducting Super Collider in Ellis County, Texas. At the request of The PB/MK Team, our study was limited to field drilling activities and laboratory analyses of soil specimens gathered from the test borings. Engineering analyses and recommendations concerning design and construction of the Blow Down Pond were not included within the scope of work for this study and, therefore, are not addressed in this report. This report was submitted in draft form on July 12, 1991, for comments. No comments were received and the report is being reissued without changes. This work was conducted under PB/MK Subcontract No. SC-A43-1013, dated February 4, 1991.

FIELD EXPLORATION AND LABORATORY TESTS

Borings Subsurface conditions at the sites were evaluated by five borings drilled at the locations shown on the Plan of Borings, Plate 1. The number of borings included in this study, their field locations, and their termination depths were selected by The PB/MK Team. Grid coordinates and surface elevations for the boring locations were provided by PB/MK, and are shown on the individual boring logs. The borings were drilled in accordance with ASTM D 420 procedures to depths ranging from 5.5 to 15.5 ft below existing grades using a rotary drilling rig.

A field log was prepared for each boring by a staff geologist. Each log contains information concerning the boring method, drill crew, time of drilling, samples attempted and recovered, indications of the presence of various materials such as silt, clay, gravel, sand or rock, and observations of ground water.

study. A new moisture-density relationship was required to establish density and moisture parameters for purposes of remolding the brownish-tan clay test specimen. The moisture-density relationships for both materials are provided on attached Plates 8 and 9.

The permeability tests were performed using laboratory triaxial compression equipment. The test specimens were subjected to a cell pressure of 30 psi, with a 10 psi gradient across the samples (20 psi head pressure and 10 psi tail pressure). Results of the permeability testing, together with pertinent data regarding the test specimens, are tabulated below:

Material	Unit Dry Weight pcf	Moisture Content Initial %	Moisture Content Final %	Degree Saturation Initial %	Permeability cm/sec
CLAY, Dark Gray	93.9	22.0	35.0	75.7	2.6×10^{-8}
CLAY, Dark Gray	93.8	22.4	35.1	75.8	4.1×10^{-8}
CLAY, Brownish Tan	98.9	20.4	24.8	80.4	3.8×10^{-8}

Consolidated, drained direct shear testing was conducted on a specimen of the dark brown subgrade clays remolded to 94.7 percent of the laboratory determined maximum dry density at 22.4 percent moisture content. The test method consisted of a "multi-stage" procedure specified by The PB/MK Team. The procedure involved consolidating the specimen overnight at the selected normal stress, shearing the specimen the following day to sufficient displacement to attempt to measure the peak and residual stress of the compacted soil, returning the test apparatus and specimen to the original horizontal position, and repeating the consolidation/shear procedure described previously. The test was continued in this manner for the three normal pressures selected for the test (10, 20 and 30 psi). The test specimens were sheared at a displacement rate of 6.4 x 10-4 in./min.

The results of the "multi-stage" direct shear testing are provided on Plates 10 through 14. Plates 10 through 12 show shear stresses and horizontal displacements for each normal stress. Shear stresses measured for each normal stress are presented with respect to cumulative displacement on Plate 13. Finally, "apparent" peak shear stress vs. normal stress has been graphically presented in Plate 14. The peak shear stresses for the 20 and 30 psi normal stresses are described as "apparent" because the maximum displacement of the Wykeham Farrance direct shear test apparatus was achieved prior to certain determination of the peak stress.

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GENERAL SITE AND SUBSURFACE CONDITIONS

Existing Conditions The project site generally consists of an open, native grass-covered tract of land most recently used for livestock grazing. The topography in this region is generally described as gently rolling, with the ground surface at the Blow Down Pond site sloping downward in an east-southeasterly direction. Based on the existing topography, site drainage is considered to be fair to poor.

Stratigraphy The soils/rock underlying the proposed Blow Down Pond site within the depths explored can be divided into three generalized strata that possess similar physical and engineering characteristics, as described below.

Stratum I consists of light brown to dark brown and black clays and extends to depths ranging from 0.5 to 10.5 ft below existing grades in the test borings. Limestone gravels and rubble were encountered in Boring BDP-2, suggesting possible fill dumping from construction activities currently underway at the E1 Site. These clays are indicated to be plastic to highly plastic, with measured liquid limits of 68 and 69 percent and corresponding plasticity indices of 45 and 46. Designated as CH soils under the Unified Soil Classification System (USCS), clays of this plasticity are generally recognized to possess moderate to high shrink/swell potential. Based on the results of hand penetrometer tests performed on undisturbed specimens, these clays exhibit firm to hard consistencies.

Stratum II consists of tan and white, calcareous, silty clays with calcareous deposits and extends to depths of 1.9 to 5.5 ft below existing grades in the test borings. These silty clays are visually assessed to be moderately plastic to plastic, with measured liquid limits of 35 to 57 percent and corresponding plasticity indices of 12 to 35. Penetration resistance values recorded in these soils indicate hard clay consistencies.

Stratum III consists of tan, weathered, soft to moderately hard limestone of the Austin Chalk Formation and extents to at least the termination depths of the borings. Argillaceous seams and close horizontal partings/joints are common within this formation. Recovery ratios and rock quality designations (RQD) measured for core runs performed in this stratum substantiate the weathered, intermittently jointed nature of the limestone, with RQD values varying from 25 to 98 percent. The low RQD values measured in Boring BDP-5 are believed to be primarily the result of the weathered, closely jointed nature of the limestone within the depth explored, which in turn may have resulted in partial core blockage during drilling.

Ground Water Ground water was not encountered in the test borings prior to the introduction of drilling water for rock coring activities. However, ground water seepage may exist on a transient basis within the weathered upper reaches of the Stratum III limestone, particularly following periods of heavy precipitation.

* * * * *

The following illustrations are attached and complete this report:

Plate 1	Plan of Borings
Plates 2 through 6	Logs of Borings
Plate 7	Key to Terms and Symbols
Plate 8 and 9	Moisture-Density Relationships
Plates 10 through 14	Direct Shear Test Results

We appreciate the opportunity to be of service to you on this project. Please call should you have questions concerning the contents of this report, or other aspects of the project.

Very truly yours,

RABA-KISTNER CONSULTANTS, INC.

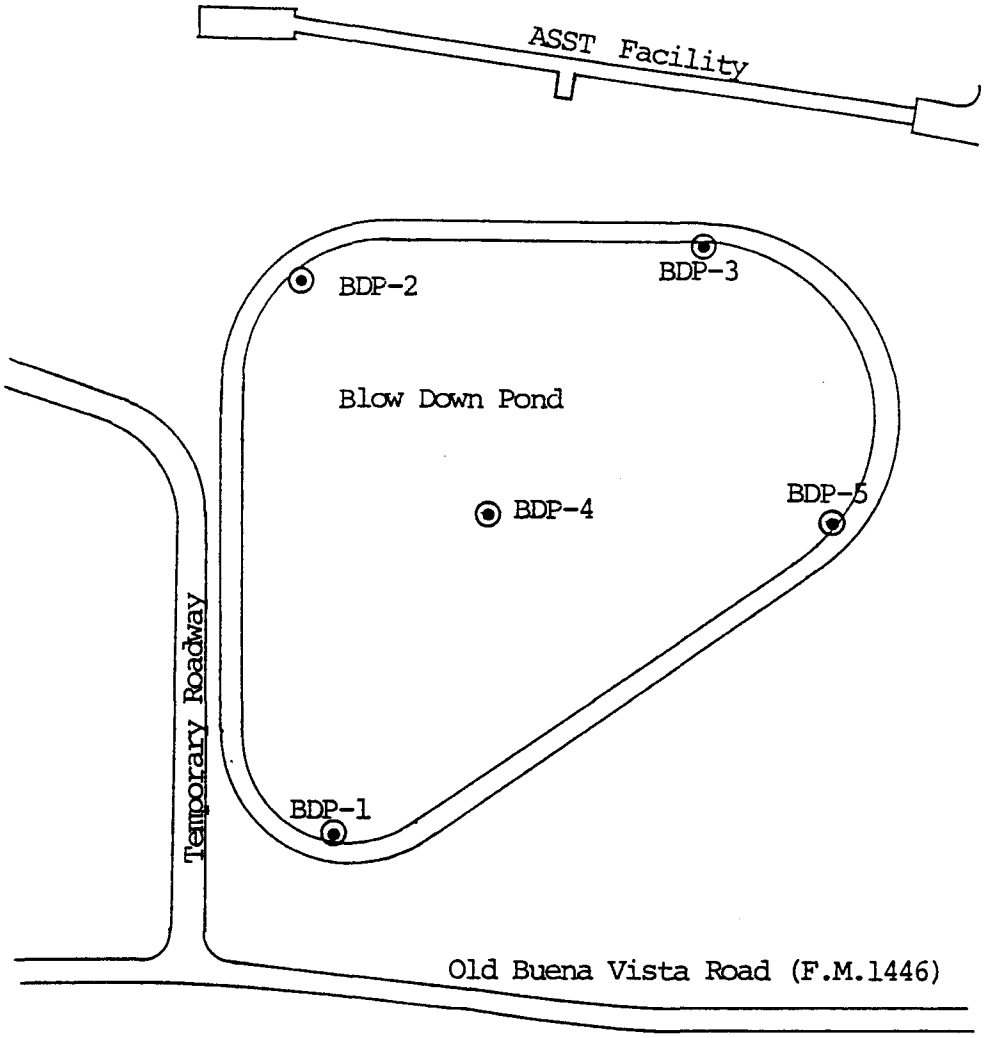
STATE OF TEXAS
JAMES M. BREWER
64004
REGISTERED
PROFESSIONAL ENGINEER

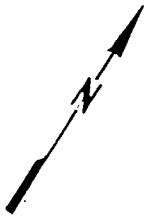
10-25-91

for A. Scot Harrell, P.E.
Project Manager

ASH/cad
Copies submitted: Above (5)

ILLUSTRATIONS





PLAN OF BORINGS

Raba-Kistner Consultants, Inc.

Proj.No.ASA91-020-00
Plate 1

LOG OF BORING NO. BDP-1
E1 BLOW DOWN POND - SSC PROJECT
WAXAHACHIE, TEXAS

Raba-Kistner Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger / NX Core Barrel

LOCATION: N6817850.00 / E2448908.00

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	⊗ UNCONF. COMPRESSION, tsf (10 20 30 40 50 60 70)	PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	%-200
	SURFACE ELEVATION: 747.90'					
	CLAY, Hard, Plastic, Slightly Moist, Dark Brown with abundant calcareous fragments 0.5'	*				
5	CLAY, Silty, Calcareous, Hard, Moderately Plastic, Slightly Moist, Light Tan (extremely weathered limestone) 2.5'					
10	LIMESTONE, Weathered, Soft to Moderately Hard, Light Tan - argillaceous below 4.8'					
15	START: 9:00 AM END: 9:30 AM					
20	GEOLOGIST: MICHAEL A. GILES					
25	DRILL CREW: LARRY TAYLOR JAMES STUBBS JOHN SALMON					
30	Blows per 6 in.: * = 18/26/14/2"					
35						
40						
45						
50						

Core Run #	Core Depth (ft)	% Rec.	% RQD
1	2.5-5.5	90	90

DEPTH DRILLED: 5.5'	**DEPTH TO WATER:**	**PROJ. No.** ASA91-020-00
DATE DRILLED: 6-14-91	**DATE MEASURED:**	**PLATE** 2

LOG OF BORING NO. BDP-2

E1 BLOW DOWN POND - SSC PROJECT
WAXAHACHIE, TEXAS

Raba-Kistner Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger / NX Core Barrel

LOCATION: N6818310.00 / E2448550.00

DEPTH, FT	DESCRIPTION OF MATERIAL	#BLOWS PER FT	UNIT DRY WEIGHT, pcf	UNCONF. COMPRESSION, tsf (10 20 30 40 50 60 70)	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	%-200
	SURFACE ELEVATION: 756.60'					
	CLAY, Firm, Dry, Black with gravels and limestone rubble (possible fill?) 2.5'	*		⊗4.25		
5	CLAY, Silty, Calcareous, Very Stiff to Hard, Moderately Plastic, Slightly Moist, Light Yellowish-Tan (extremely weathered limestone) 5.5'	**	119	⊗2.5	●	79
10	LIMESTONE, Weathered, Soft to Moderately Hard, Light Tan - missing 2.7' of core (probably result of core blocking and/or washout of extremely weathered, argillaceous rock in upper reaches of formation) - close horizontal partings in upper 2.4' of core recovered - intermittent slightly argillaceous seams in core recovered - 45 degree joints within lower 2' of core recovered					141 ⊗
15						
20						
25	START: 3:10 PM END: 4:30 PM					
30	GEOLOGIST: MICHAEL A. GILES					
35	DRILL CREW: LARRY TAYLOR JAMES STUBBS JOHN SALMON					
40	Blows per 6 in.: * = 3/3/3 ** = 50/2"					
45						
50						

Core Run #	Core Depth (ft)	% Rec.	% RQD
1	5.5-15.5	74	39

DEPTH DRILLED: 15.5'	**DEPTH TO WATER:**	**PROJ. No.** ASA91-020-00
DATE DRILLED: 6-13-91	**DATE MEASURED:**	**PLATE** 3

LOG OF BORING NO. BDP-3
E1 BLOW DOWN POND - SSC PROJECT
WAXAHACHIE, TEXAS

Raba-Kistner Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger / NX Core Barrel

LOCATION: N6818584.00 / E2449002.00

DEPTH, FT	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 750.80'	*BLOWS PER FT	UNIT DRY WEIGHT, pcf	⊗ UNCONF. COMPRESSION, tsf (10 20 30 40 50 60 70) / PLASTIC LIMIT + WATER CONTENT ● LIQUID LIMIT + (10 20 30 40 50 60 70)	%-200
	CLAY, Silty, Calcareous, Very Stiff, Moderately Plastic, Slightly Moist, Light Tan (extremely weathered limestone) 1.9'				
5	LIMESTONE, Weathered, Soft to Moderately Hard, Light Tan 4.3'		126	● ⊗	
10	LIMESTONE, Unweathered, Soft to Moderately Hard, Gray to Dark Gray - slightly argillaceous from 4.6' to 5.0' and 7.3' to 7.8' - argillaceous from 9.8' to 9.9'				
15	START: 5:05 PM END: 6:10 PM				
20	GEOLOGIST: MICHAEL A. GILES				
25	DRILL CREW: LARRY TAYLOR JAMES STUBBS JOHN SALMON				
30	Blows per 6 in.: * = 7/8/19				
35					
40					
45					
50					

Core Run #	Core Depth (ft)	% Rec.	% RQD
1	2-5	97	97
2	5-10	98	98

DEPTH DRILLED: 10.0'	DEPTH TO WATER:	PROJ. No. ASA91-020-00
DATE DRILLED: 6-13-91	DATE MEASURED:	PLATE 4

LOG OF BORING NO. BDP-4
E1 BLOW DOWN POND - SSC PROJECT
WAXAHACHIE, TEXAS

Raba-Kistner Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger

LOCATION: N6818210.00 / E2448848.00

DEPTH, FT	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 752.00'	BLOWS PER FT	UNIT DRY WEIGHT, pcf	⊗ UNCONF. COMPRESSION, tsf (10 20 30 40 50 60 70)	PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	%-200
	CLAY, Very Stiff, Highly Plastic, Moist, Dark Brown			2.0		95
	- brown below 3'			2.75		
5				3.0		
	- moderately plastic, brownish-tan with abundant calcareous nodules below 7.5'			1.75		68
10	10.5	*		2.75		
	LIMESTONE, Extremely Weathered, Argillaceous, Soft, Light Tan					
15	START: 6:55 END: 7:45					
20	GEOLOGIST: MICHAEL A. GILES					
25	DRILL CREW: LARRY TAYLOR JAMES STUBBS JOHN SALMON					
30	Blows per 6 in.: * = 50/6"					
35						
40						
45						
50						

DEPTH DRILLED: 11.0'	**DEPTH TO WATER:**	**PROJ. No.** ASA91-020-00
DATE DRILLED: 6-14-91	**DATE MEASURED:** 6-14-91	**PLATE** 5

LOG OF BORING NO. BDP-5
E1 BLOW DOWN POND - SSC PROJECT
WAXAHACHIE, TEXAS

Raba-Kistner Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger / NX Core Barrel

LOCATION: N6818380.00 / E2449162.00

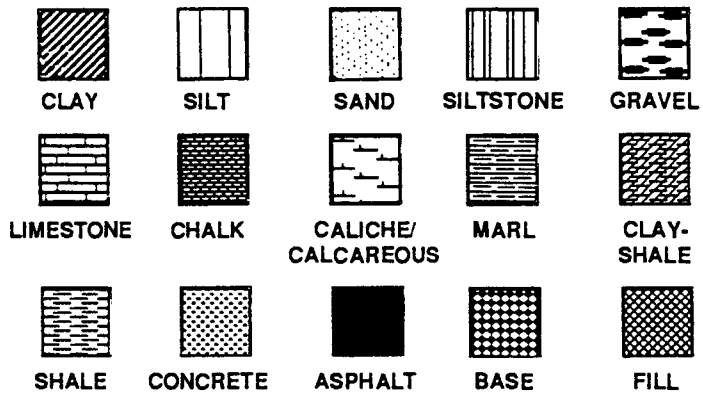
DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	⊗ UNCONF. COMPRESSION, tsf (10 20 30 40 50 60 70) / PLASTIC LIMIT + WATER CONTENT ● LIQUID LIMIT + (10 20 30 40 50 60 70)	%-200
	SURFACE ELEVATION: 749.70'				
	CLAY, Hard, Highly Plastic, Slightly Moist, Black with calcareous fragments 0.5'		110	● ⊗	
5	LIMESTONE, Weathered, Soft to Moderately Hard, Light Tan - close horizontal partings from 0.5' to 3'				
	- 80 degree joint at 1.1'				
10	- slightly argillaceous from 1.5' to 2.3'				
	- very argillaceous from 2.3' to 2.7'				
	- slightly fossiliferous from 2.7' to 5'				
15	- slightly argillaceous from 5' to 5.2'				
	- 30 degree joint at 6'				
20	- argillaceous with close horizontal partings from 6' to 7'				
	START: 8:15 AM				
	END: 8:50 AM				
25	GEOLOGIST: MICHAEL A. GILES				
	DRILL CREW: LARRY TAYLOR, JAMES STUBBS, JOHN SALMON				
30					
35					
40					
45					
50					

Core Run #	Core Depth (ft)	% Rec.	% RQD
1	0.5-5.5	94	46
2	5.5-7.5	100	25

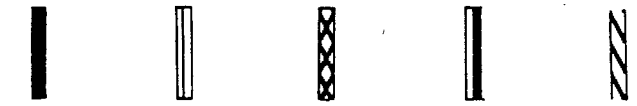
DEPTH DRILLED: 7.5'	**DEPTH TO WATER:**	**PROJ. No.** ASA91-020-00
DATE DRILLED: 6-14-91	**DATE MEASURED:**	**PLATE** 6

TERMS AND SYMBOLS USED ON BORING LOGS

SOIL OR ROCK TYPES
(shown in symbols column)



SAMPLER TYPES
(shown in sample column)



STRENGTH TEST RESULTS

- ⊗ Pocket Penetrometer
- ◇ Torvane
- ⊗ Unconfined Compression

TRIAXIAL COMPRESSION

- △ Unconsolidated-undrained
- □ Consolidated-undrained

- C Cohesion (Total)
- Φ Angle of Internal Friction (Total)

- C′ Cohesion (Effective)
- Φ′ Angle of Internal Friction (Effective)

NOTE: Values symbolized on boring logs represent shear strengths unless otherwise noted.

TERMS DESCRIBING CONSISTENCY, CONDITION OR TEXTURE

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOIL MECHANICS IN ENGINEERING PRACTICE. Terzaghi and Peck, John Wiley & Sons, Inc. 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No. 3-357, Waterways Experiment Station, March 1953.

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	having inclined planes of weakness that are slick and glossy in appearance
Fissured	containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical
Laminated	composed of thin layers of varying colors and texture
Interbedded	composed of alternate layers of different soil types
Calcareous	containing appreciable quantities of calcium carbonate
Well graded	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Poorly graded	predominantly of one grain size, or having a range of sizes with some intermediate size missing

TERMS DESCRIBING CONSISTENCY OR CONDITION

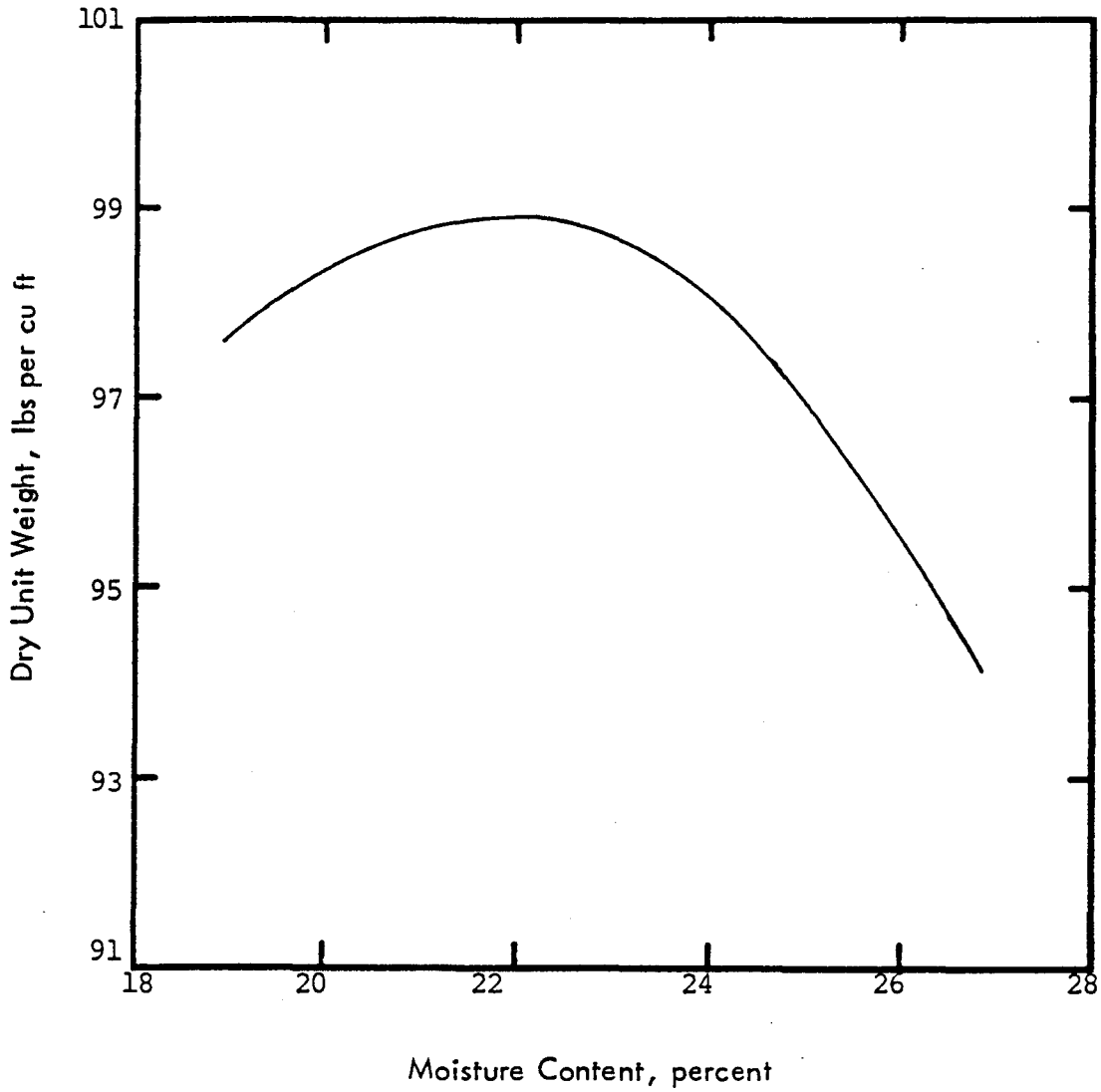
RELATIVE DENSITY		COHESIVE STRENGTH			PLASTICITY	
Penetration Resistance blows per ft.	Relative Density	Penetration Resistance, blows per ft.	Consistency	Cohesion TSF	Plasticity Index	Degree of Plasticity
0-4	Very loose	0-2	Very Soft	0-0.125	0-5	Non-Plastic
4-10	Loose	2-4	Soft	0.125-0.25	5-10	Low
10-30	Medium Dense	4-8	Firm	0.25-0.5	10-20	Moderate
30-50	Dense	8-15	Stiff	0.5-1.0	20-40	Plastic
>50	Very Dense	15-30	Very Stiff	1.0-2.0	>40	Highly Plastic
		>30	Hard	>2.0		

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

Project Name: Hoyt Road, SSC
Project Number: ASA91-020-00
Liquid Limit: 58
Plasticity Index: 34
Material Description: CLAY, Plastic, Dark Brown, (CH)

Date Sampled: 5/18/91
Sampled By: Mike Giles
Date Completed: 5/31/91

ATTERBERG LIMITS AND COMPACTION TEST RESULTS



THD TEX-113-E (6.63 ft lbs/cu.in.)

Maximum Dry Density at Optimum Moisture	98.9 lbs./cu. ft.
Optimum Moisture	22.0 %
CBR (Remolded to 96.9% Maximum Dry Density at 22.3% moisture content and soaked for 96 hours)	1.6 %
Percent Swell	3.0%

Lab No: 4-105484

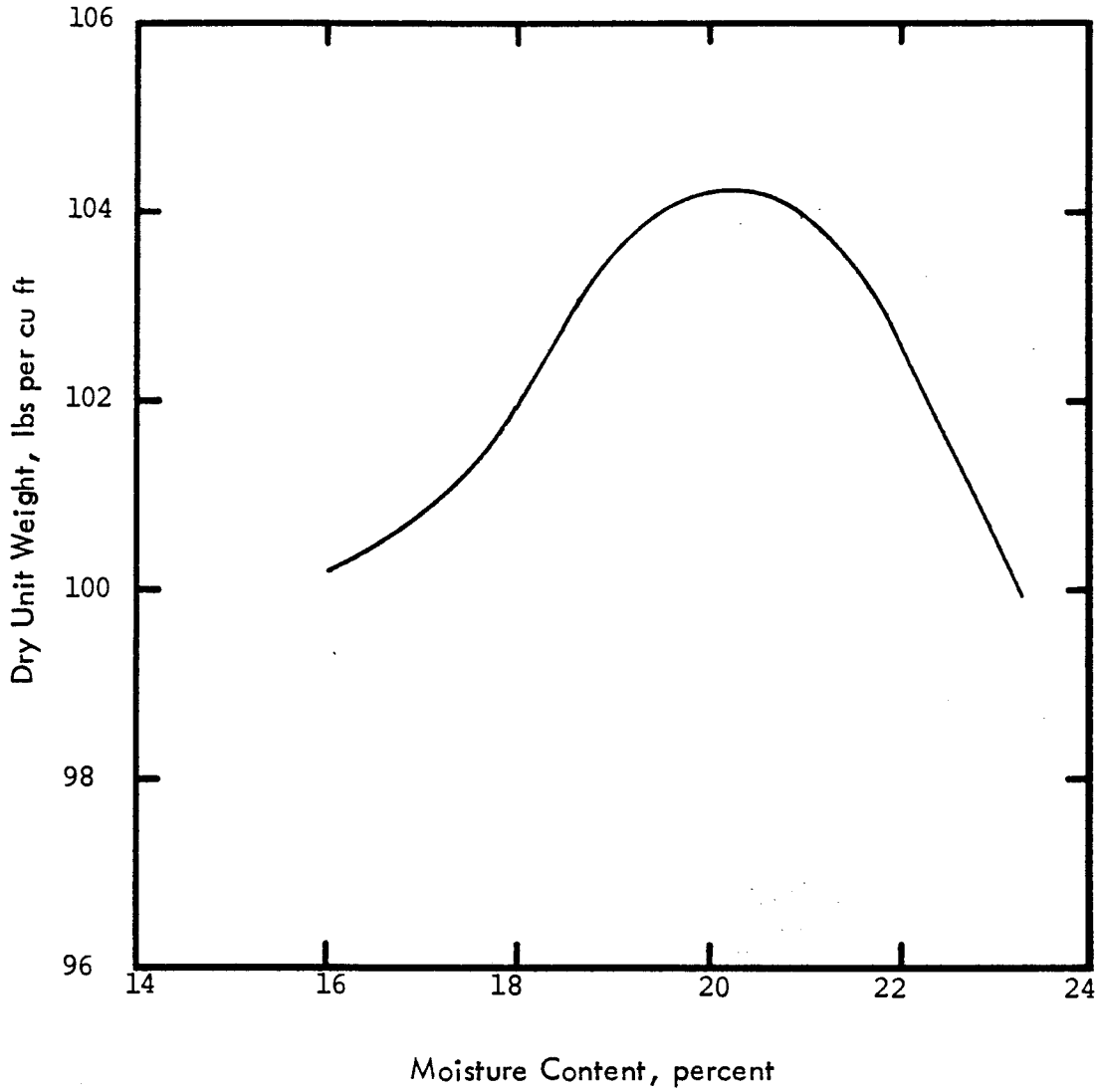
Raba-Kistner Consultants, Inc

Proj.No.ASA91-020-00
Plate 8

Project Name: Blow Down Pond-SSC Project
Project Number: ASA91-020-00
Liquid Limit: 47
Plasticity Index: 30
Material Description: CLAY, Plastic, Brownish-Tan

Date Sampled: 6/14/91
Sampled By: Michael A. Giles
Date Completed: 7/2/91
Source: Boring BDP-4 (7.5'-10' depth)

ATTERBERG LIMITS AND COMPACTION TEST RESULTS

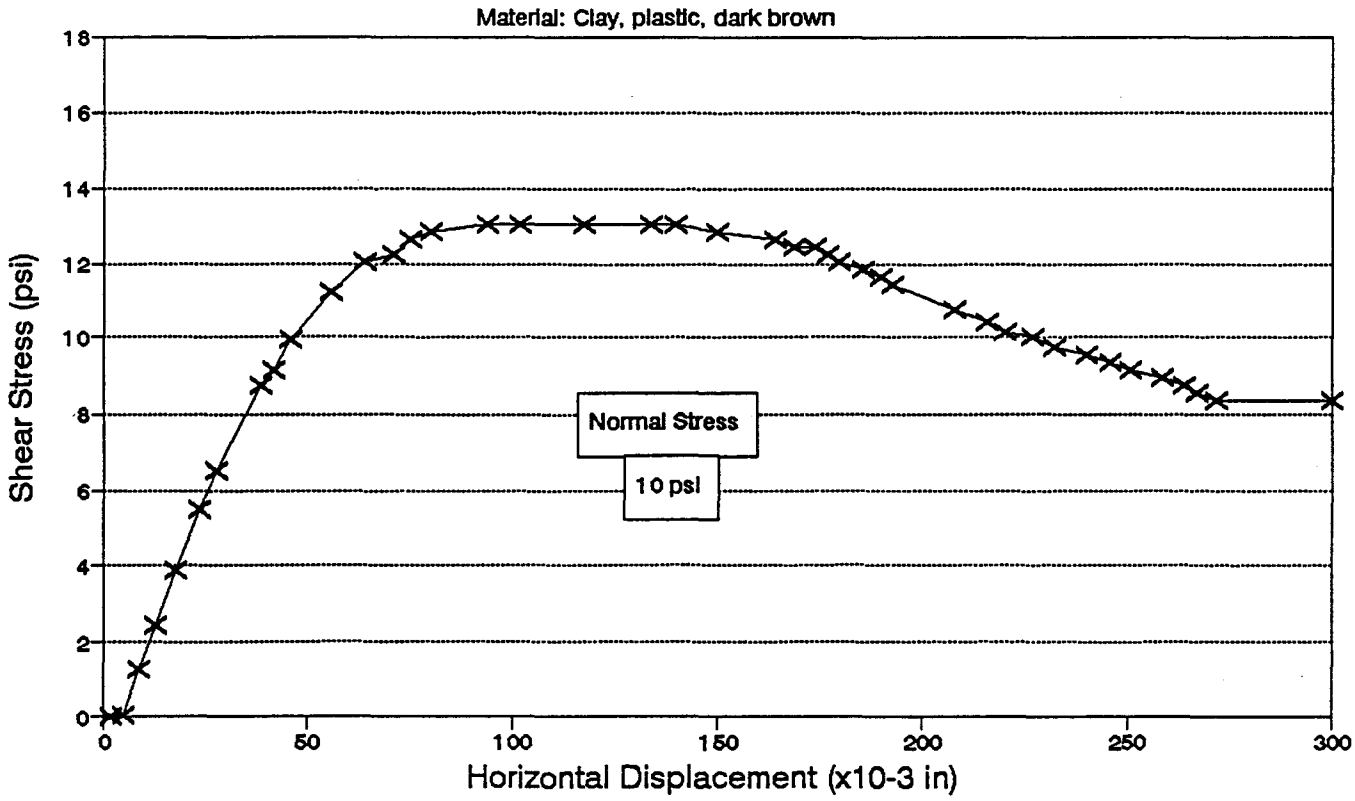


THD TEX-113-E

Maximum Dry Density at Optimum Moisture	104.2	lbs./cu. ft.
Optimum Moisture	20.3	%

Multi-Stage CD Direct Shear Test

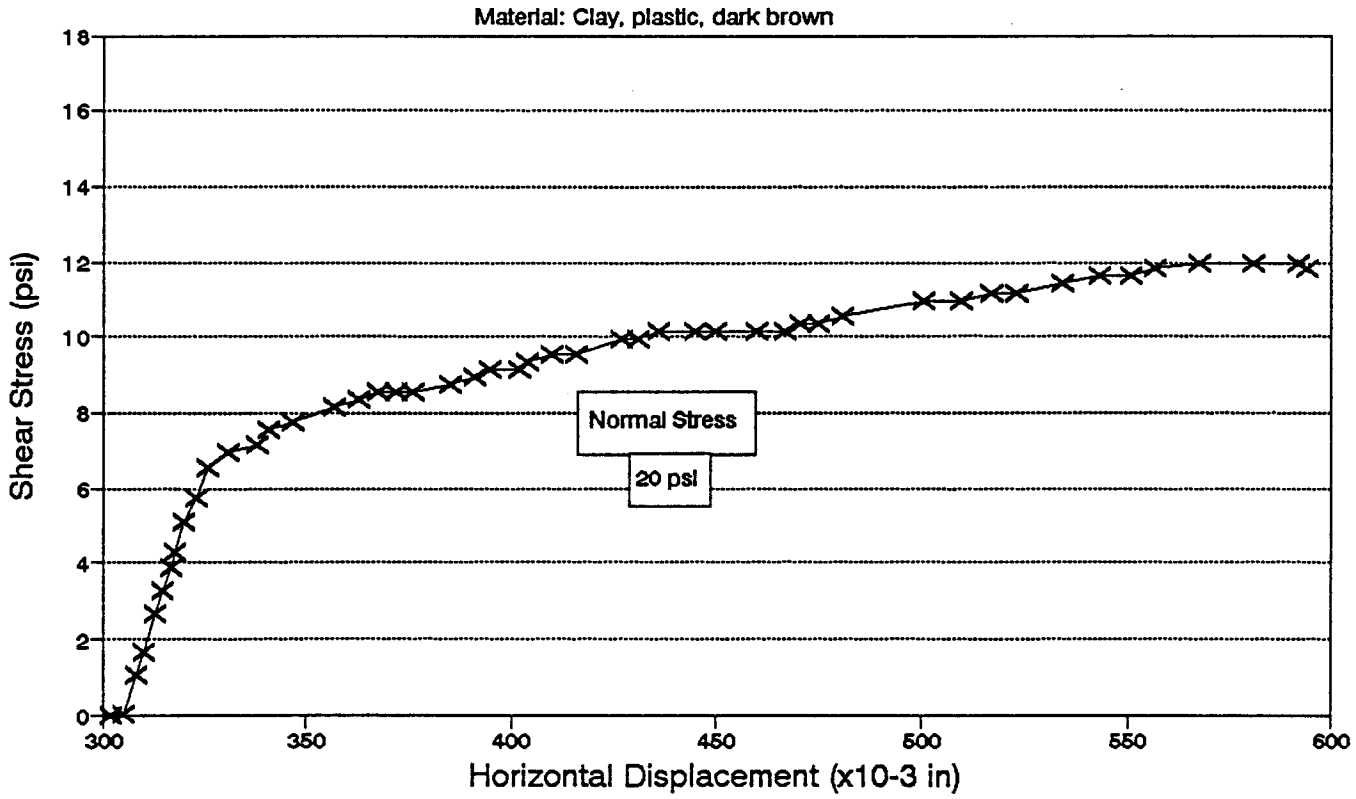
Blow Down Pond - SSC Project



Proj.No.ASA91-020-00
Plate 10

Multi-Stage CD Direct Shear Test

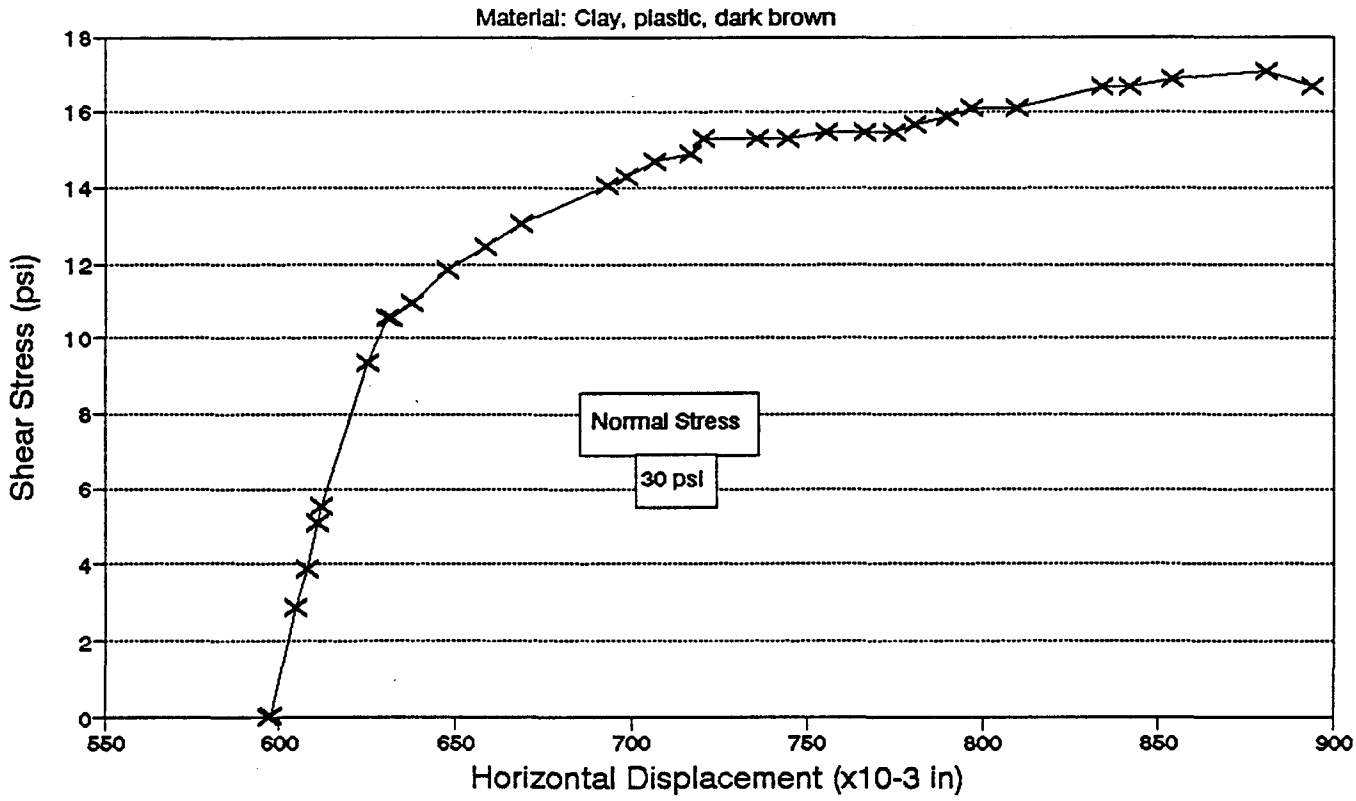
Blow Down Pond - SSC Project



Proj.No.ASA91-020-00
Plate 11

Multi-Stage CD Direct Shear Test

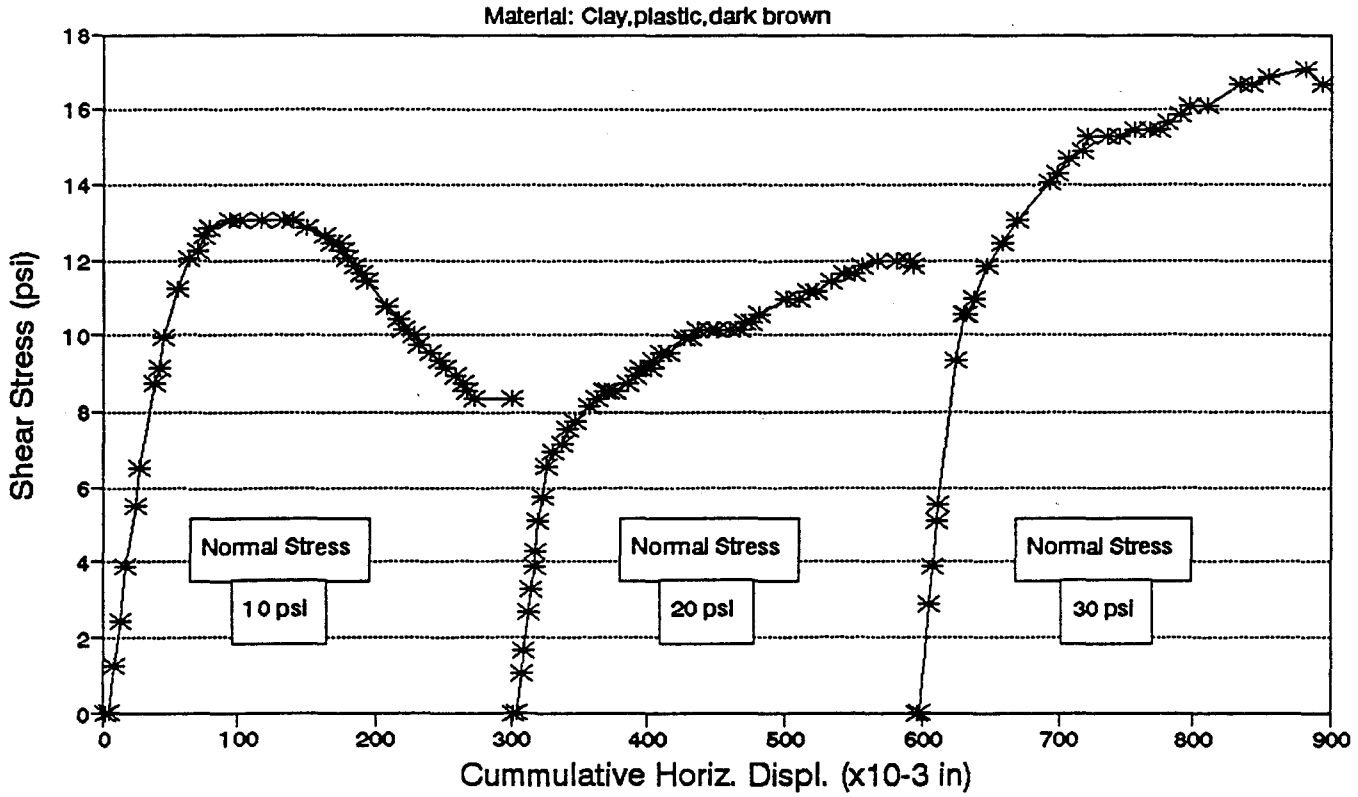
Blow Down Pond - SSC Project



Proj.No.ASA91-020-00
Plate 12

Multi-Stage CD Direct Shear Test

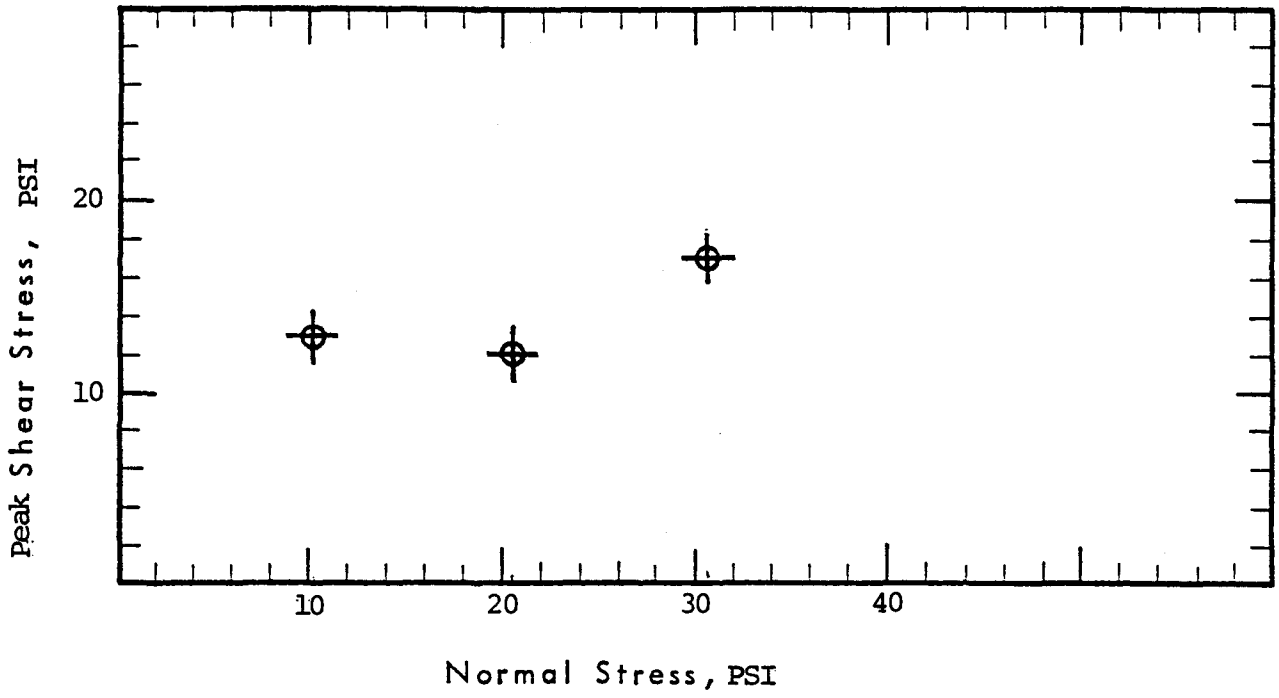
Blow Down Pond - SSC Project



Proj.No.ASA91-020-00
Plate 13

Boring: BDP-1 Through BDP-5
Sample: Subgrade
Depth: Surficial
Material: CLAY, Plastic, Dark Gray with trace fine Gravel (remolded)

Unit Dry Weight: 93.65 lbs/ cu ft
Water Content: 22.4
Liquid Limit 69
Plastic Limit: 22



Type of Test: Consolidated-Drained

Rate of Strain: 6.4×10^{-4} in/min.

MULTI-STAGE DIRECT SHEAR TEST SUMMARY