

# FY 2014 Investigation Integrative Genomics Building (IGB) Previous Subsurface Data



September 30, 2014 Compilation

LEGEND:

-  9 BORINGS BY DAMES & MOORE 1948
-  9 BORINGS BY DAMES & MOORE 1956
-  9 BORINGS BY DAMES & MOORE 1960
-  9 BORINGS BY HA, 1965
-  9 BORINGS BY HLA, 1973
-  9 BORINGS BY HLA, 1976a
-  9 BORINGS BY HLA, 1976b
-  9 BORINGS BY HLA, 1976c
-  9 BORINGS BY HLA, 1983
-  B-2 BORINGS BY HLA, 1987
-  MM-4 BORINGS BY HLA, 1988
-  EB-1 BORINGS BY KALDVEER, 1992
-  EB-1 BORINGS BY HARZA, 1994
-  EB-1 BORINGS BY HARZA, 1996
-  9 ENVIRONMENTAL BORINGS BY LBNL (A3GEO/LCI 2011)
-  WT-9 BORINGS BY A3GEO/AKA, 2011
-  B-1 BORINGS BY A3GEO, 2011
-  B-1 ENVIRONMENTAL PUSH CORES BY LBNL (A3GEO/LCI 2011)
-  B-1 BORINGS BY A3GEO/AKA, 2012a
-  TT-9 BORINGS BY A3GEO/AKA, 2012b
-  B-1 BORINGS BY A3GEO/LCI, 2013
-  B-1 BORINGS BY A3GEO/LCI, 2014
-  7 BORINGS BY SCI, 1995
-  B-7 BORINGS BY GRC, 1993

1200+00N  
1100+00N  
1000+00N  
900+00N  
800+00N  
700+00N  
600+00N  
500+00N  
400+00N

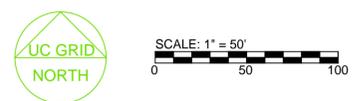
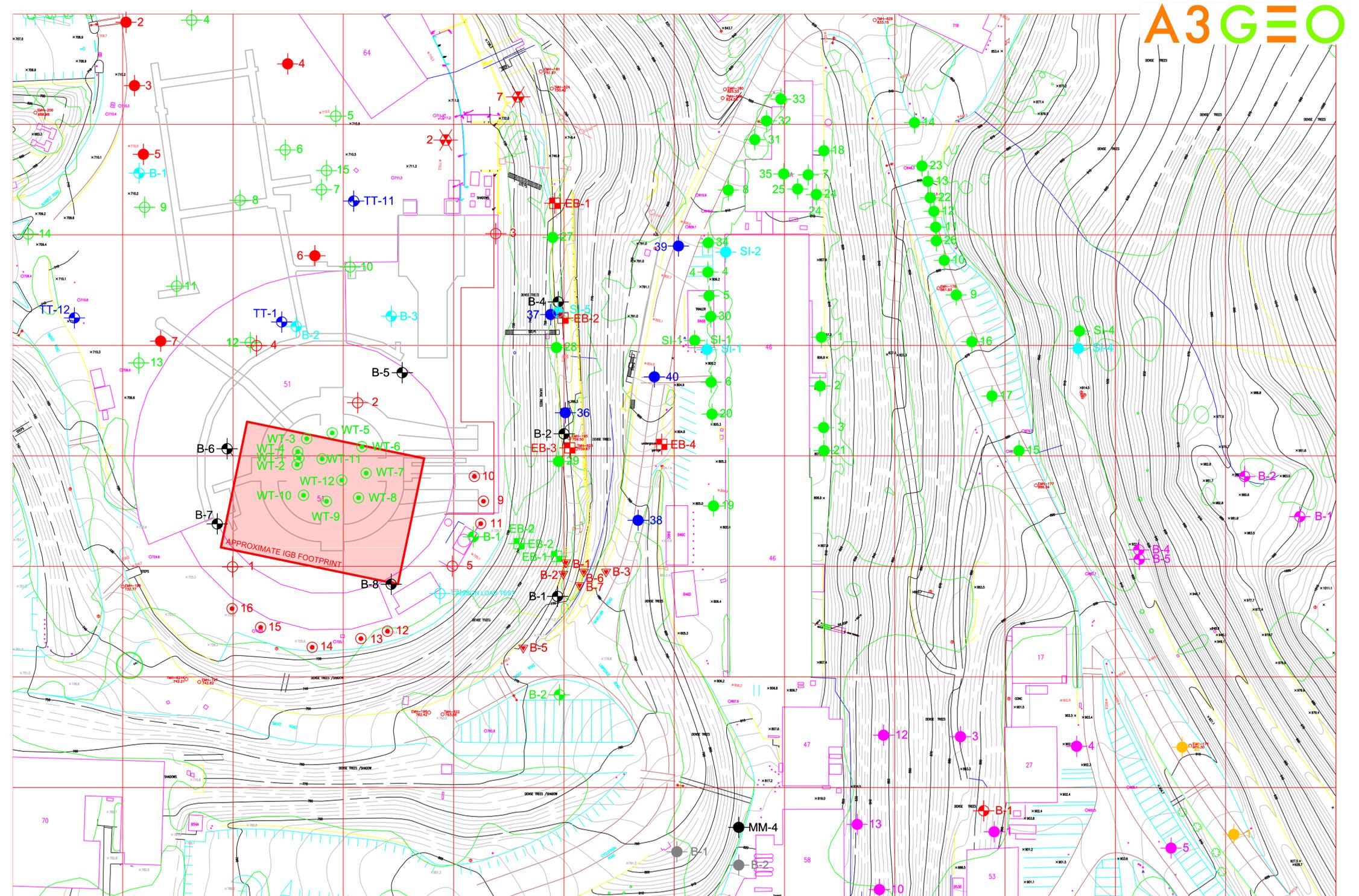
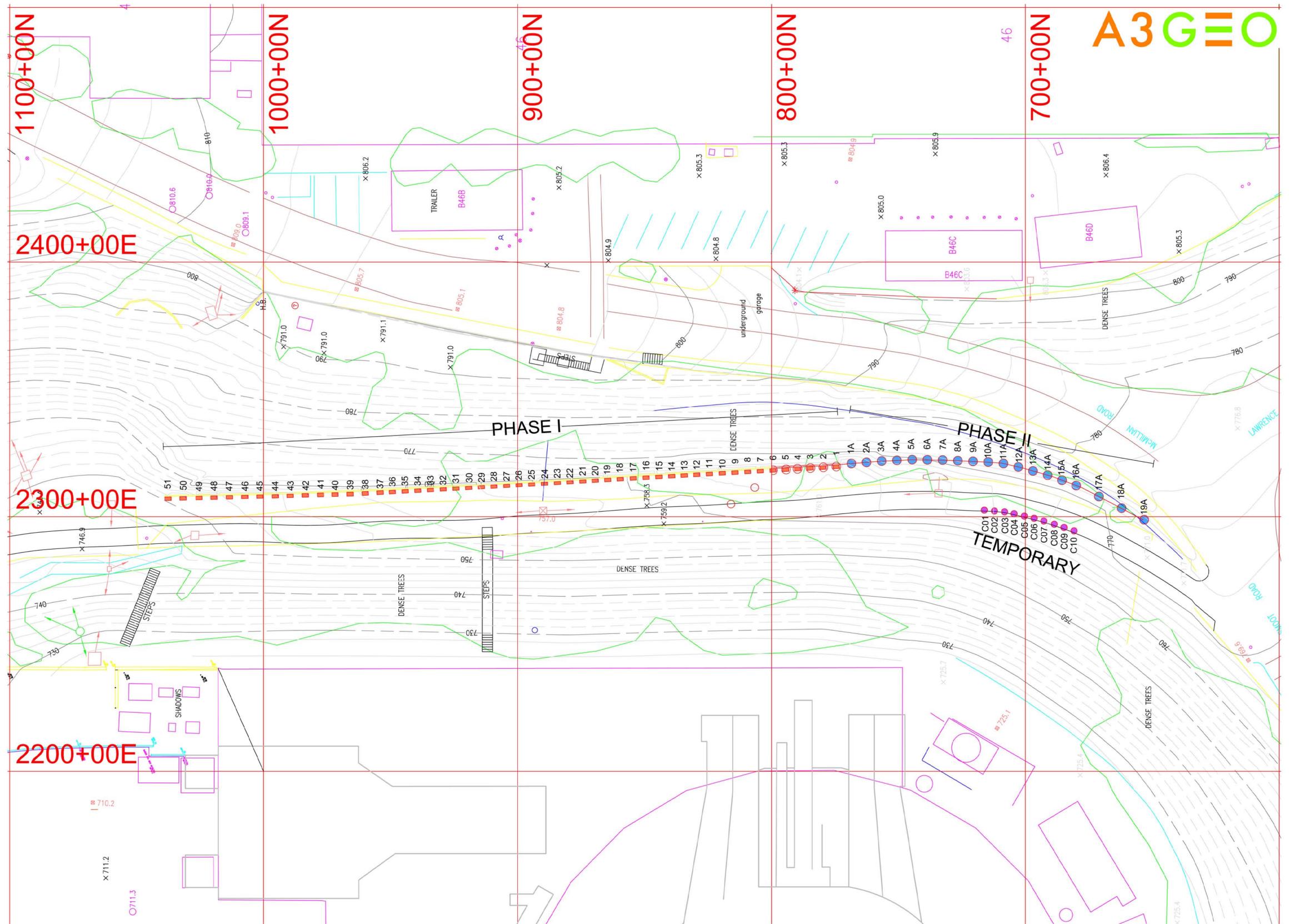


FIGURE 1  
SITE PLAN

- LEGEND**  
 CAISSON LOCATIONS  
 AND NUMBERS
- PHASE I
  - PHASE II
  - TEMPORARY



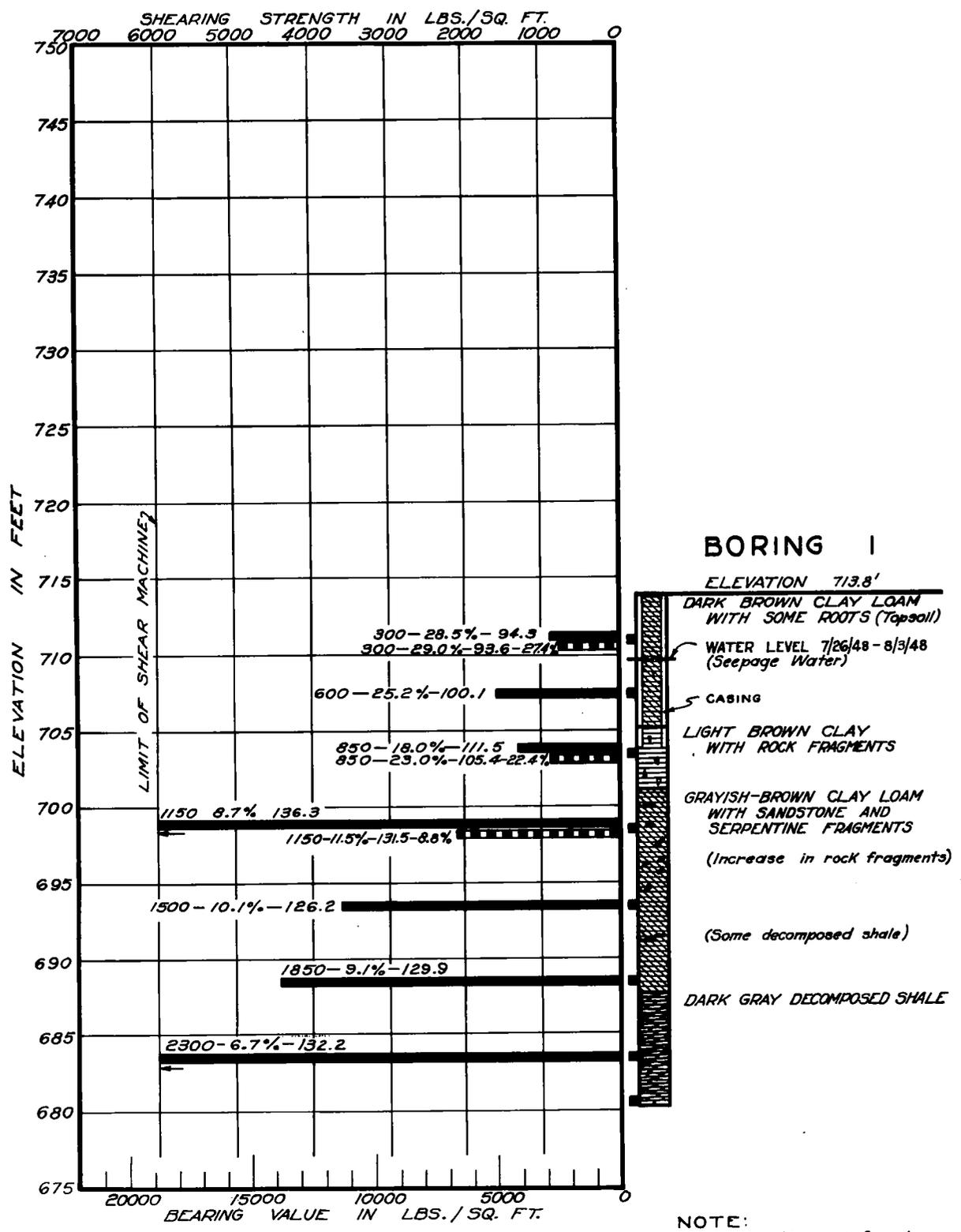
**FIGURE 1A**  
**CAISSON LOCATIONS**

**Dames & Moore (D&M), 1948**, “Foundation Investigation, Proposed Bevatron Building Radiation Laboratory, University of California, Berkeley, California,” consulting report dated November 17, 1948.

(LBNL #097)

**Logs of Borings 1 through 5**

PROJECT LOCATION: \_\_\_\_\_ DATE PRINTED: \_\_\_\_\_  
 DRAWING NO. \_\_\_\_\_ CLIENT: \_\_\_\_\_ DATE JOB STARTED: \_\_\_\_\_  
 SHEET NO. \_\_\_\_\_ DRAWING DATE: \_\_\_\_\_  
 CHECKED BY: \_\_\_\_\_  
 DRAFTING CHECK BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
 REPORT DICTATED BY: \_\_\_\_\_

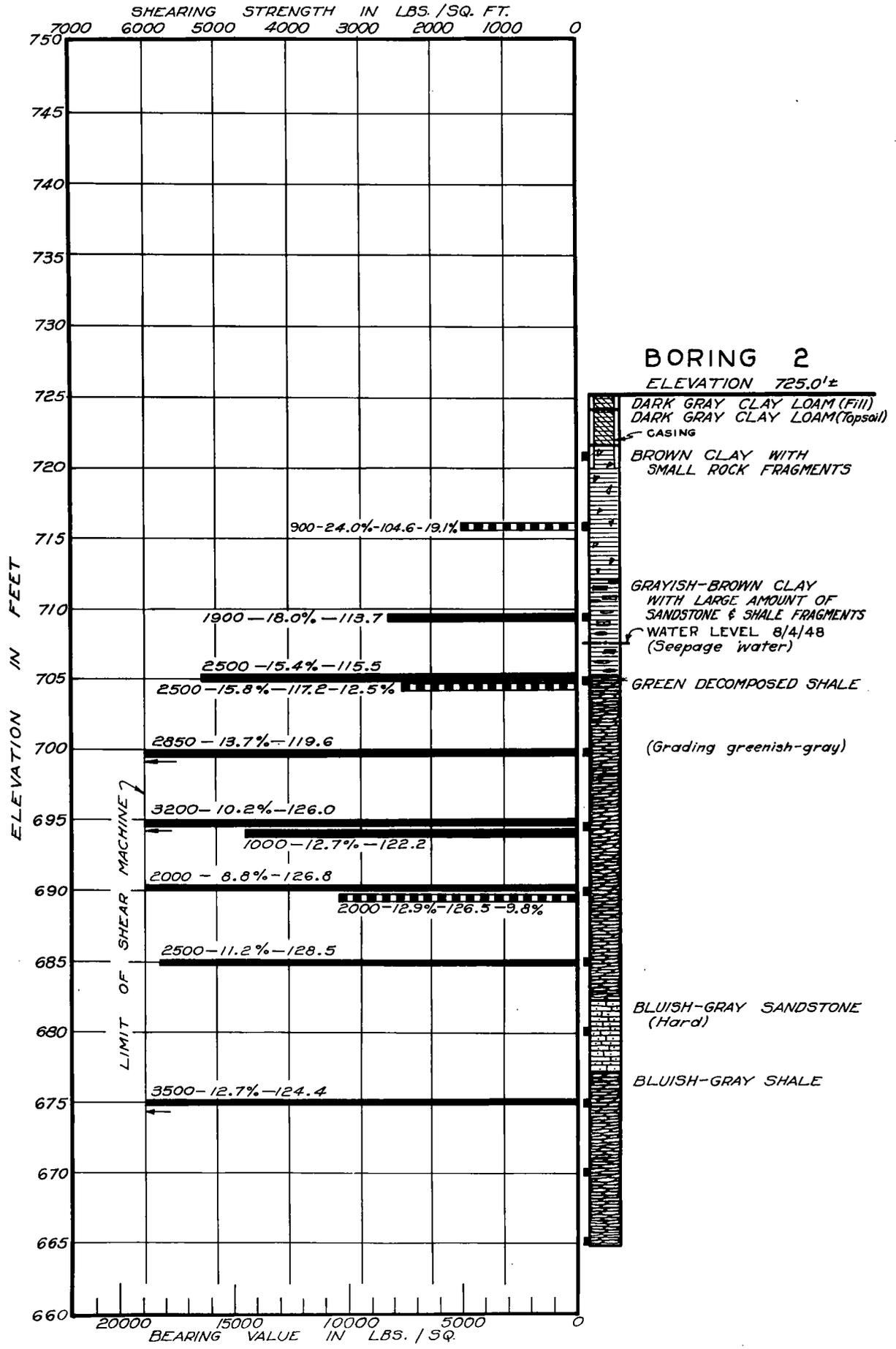


NOTE:  
All elevations refer to University of California Datum.

## LOG OF BORINGS

DAMES & MOORE  
FOUNDATION ENGINEERS

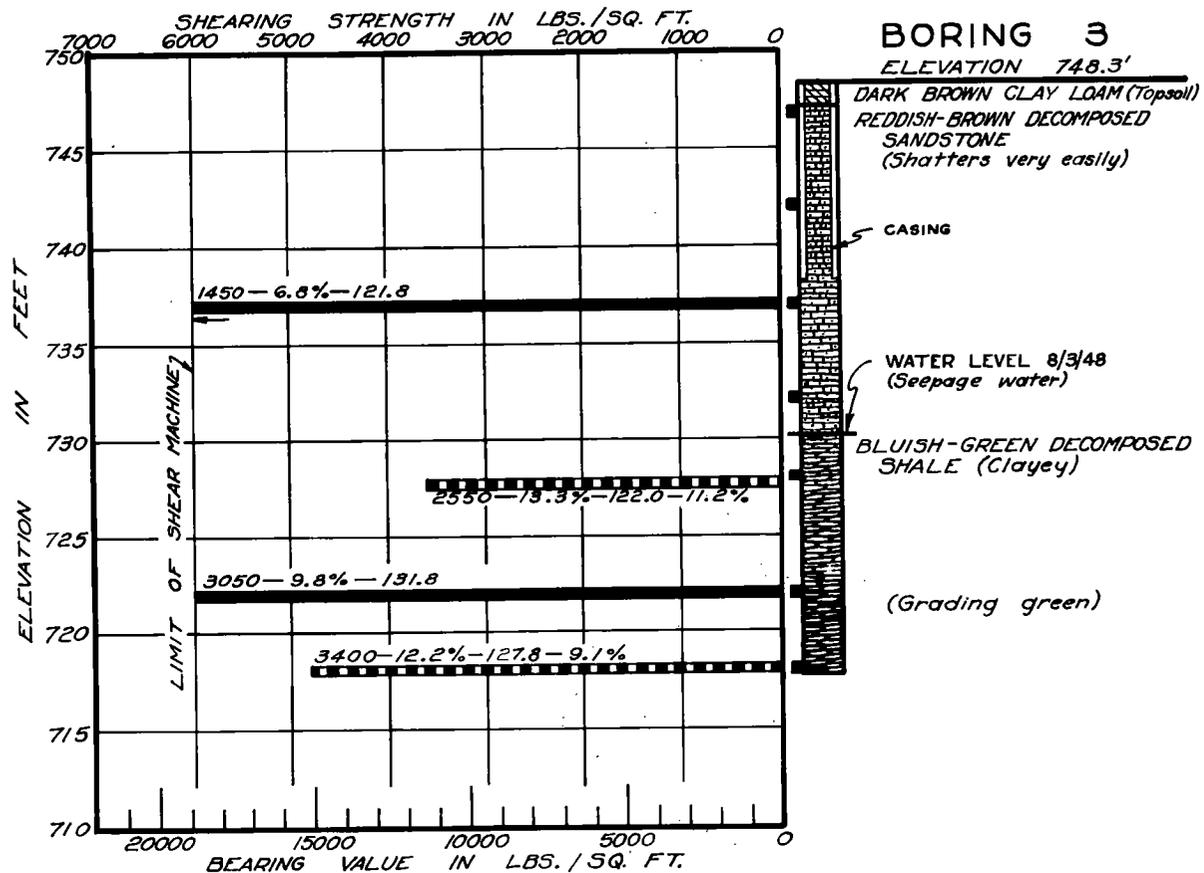
DRAWING NO. 104-1  
 SHEET NO. 1  
 DATE  
 BY  
 CHECKED  
 APPROVED  
 DRAWN BY



LOG OF BORINGS

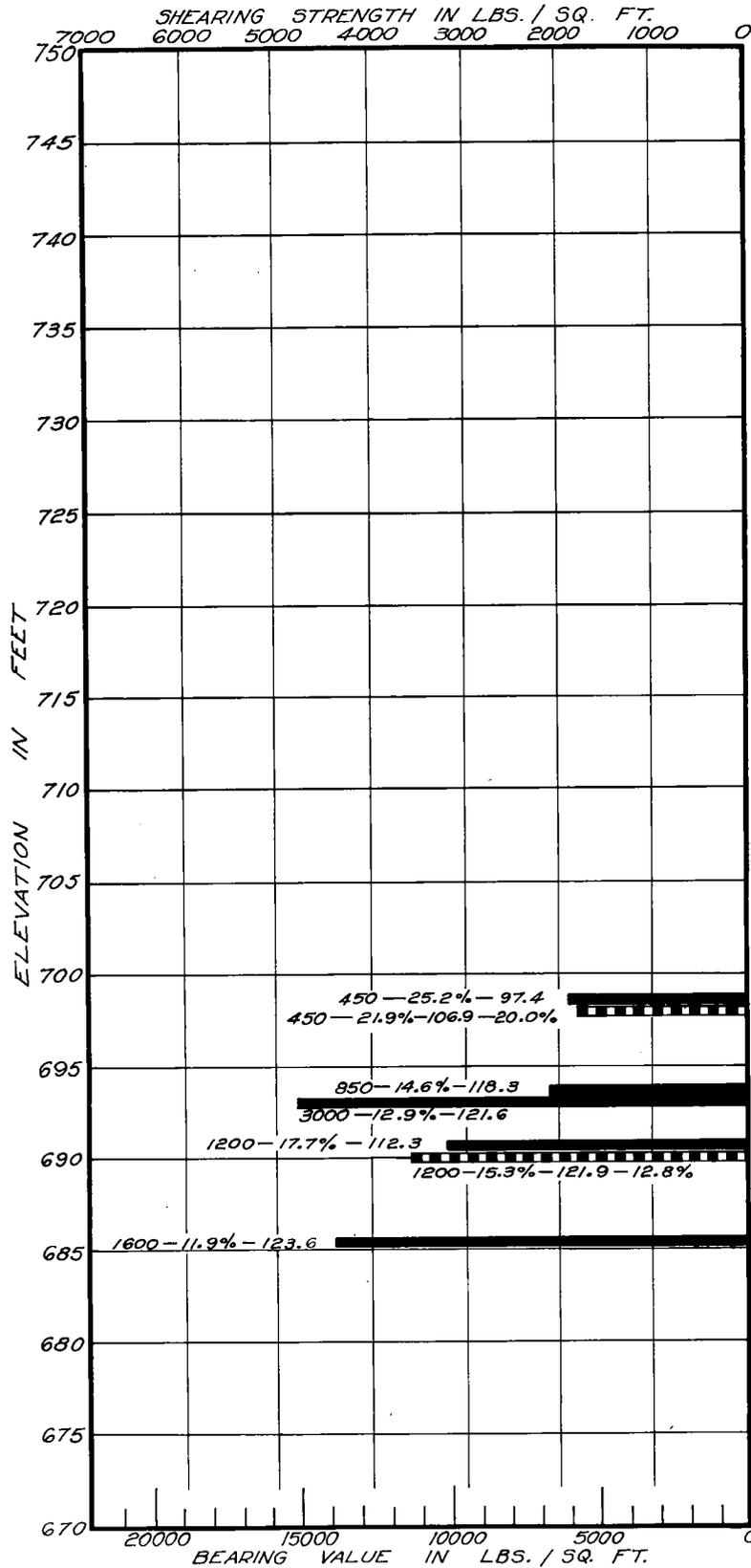
DAMES & MOORE  
FOUNDATION ENGINEERS

234-I  
 UNIVERSITY OF CALIF.  
 DATE OF TEST  
 DRAFTING CHECK BY  
 DATE  
 REPORT DATED BY  
 DATE  
 DATE OF STARTED  
 DATE PRINTED  
 DRAWN BY



## LOG OF BORINGS

DAMES & MOORE  
FOUNDATION ENGINEERS

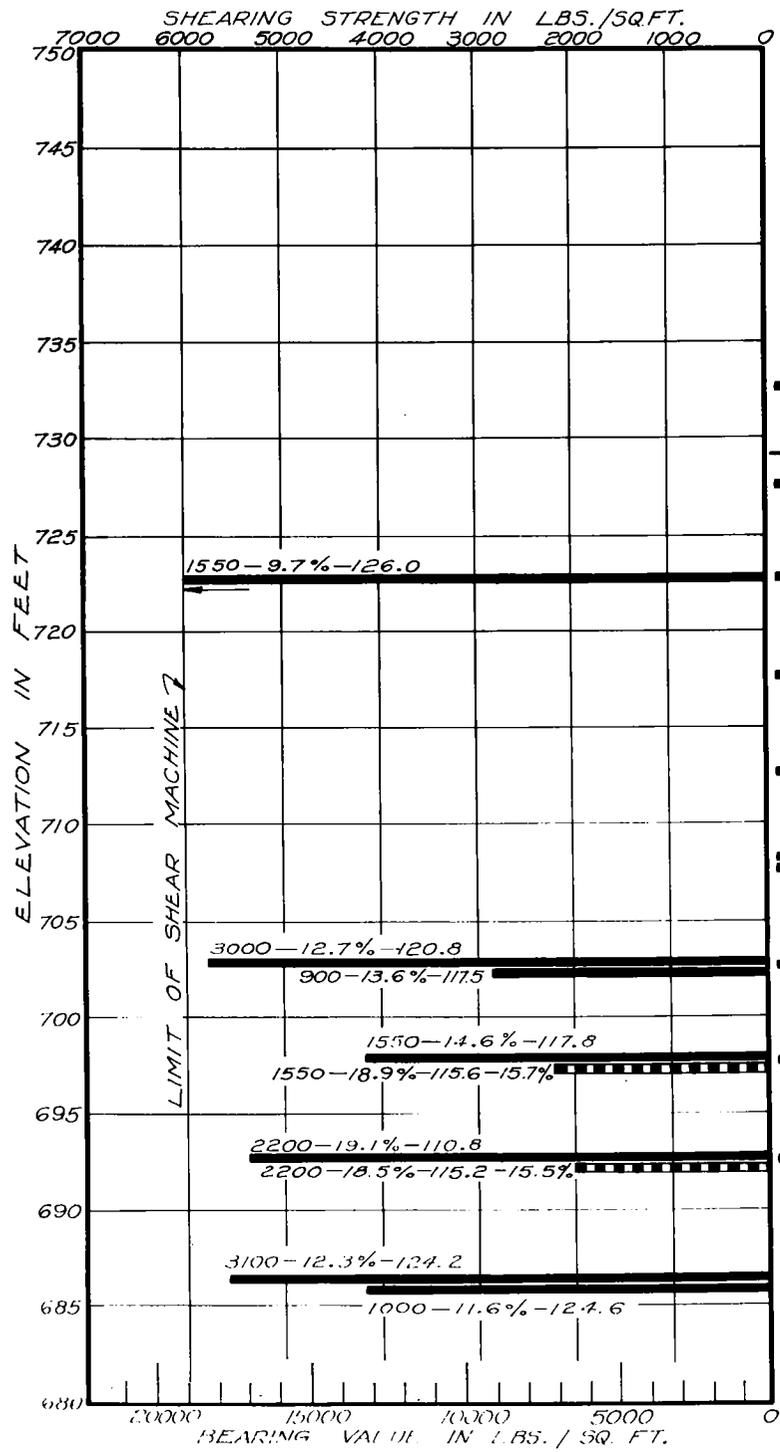


**BORING 4**  
ELEVATION 702.5'

DARK BROWN CLAY LOAM (Topsoil)  
 CASING  
 WATER LEVEL 8/3/48  
 (Seepage water)  
 GREENISH-GRAY CLAY (Hardpan)  
 BROWN SANDY LOAM  
 WITH STREAKS OF CLAY  
 BLUISH-GREEN DECOMPOSED SHALE

LOG OF BORINGS

DATE CHECK BY \_\_\_\_\_ DATE \_\_\_\_\_  
 DRAFTING CHECK BY \_\_\_\_\_ DATE \_\_\_\_\_  
 REPORT DICTATED BY \_\_\_\_\_ DATE \_\_\_\_\_  
 DATE JOB STARTED \_\_\_\_\_ DATE PRINTED \_\_\_\_\_  
 DRAWINGS \_\_\_\_\_  
 234-I  
 LOCATION: **UNION OF CALIF. AT BERKELEY**  
 SHEET NO. 5 ONE OF 4  
 SERIES 27



**BORING 5**  
ELEVATION 735.9'

DARK BROWN CLAY LOAM  
 (Topsail)  
 REDDISH-BROWN AND  
 GREENISH-GRAY CLAY  
 GREENISH-BROWN DECOMPOSED  
 SHALE (CLAYEY)  
 WATER LEVEL 8/3/48  
 (Seepage water)  
 (Grading green and firmer)  
 (Encountered spring  
 with low rate of flow.)

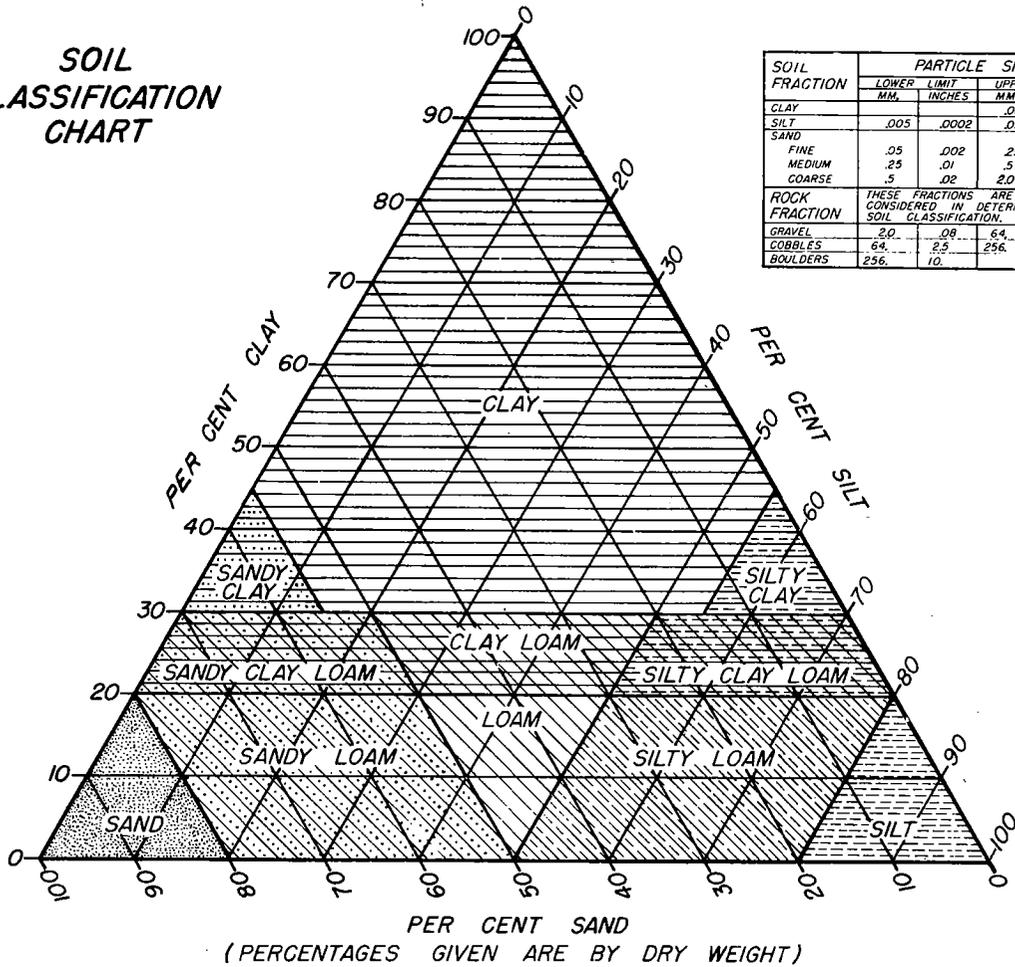
**LOG OF BORINGS**

DAMES & MOORE  
ENGINEERS

**APPENDIX**

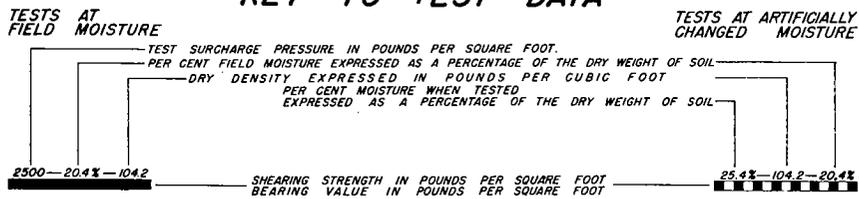
**SOIL CLASSIFICATION CHART AND KEY TO TEST DATA**

**SOIL CLASSIFICATION CHART**

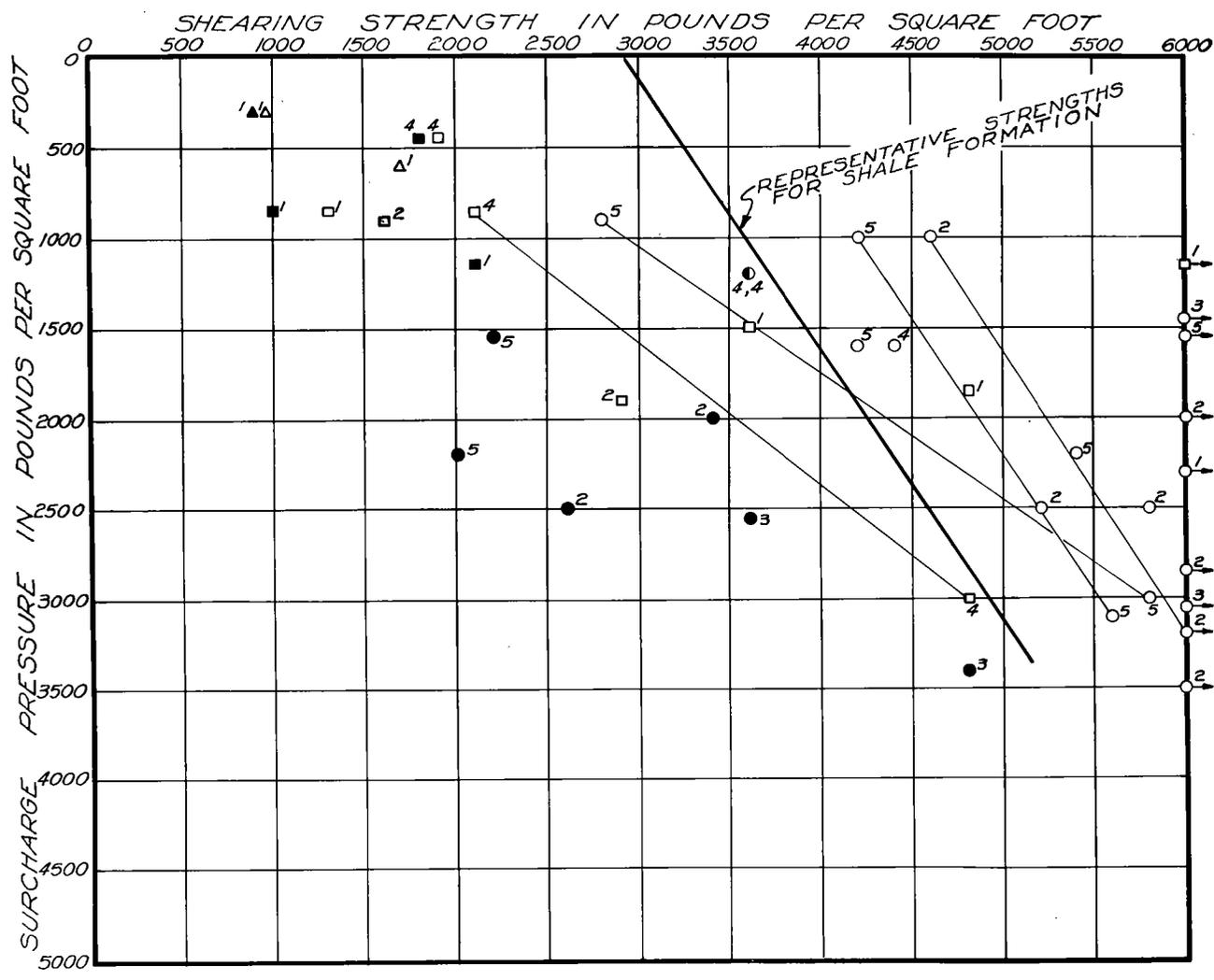


SOIL FRACTION	PARTICLE SIZE			
	LOWER LIMIT	UPPER LIMIT	LOWER LIMIT	UPPER LIMIT
	MM.	INCHES	MM.	INCHES
CLAY			.005	.002
SILT	.005	.002	.05	.002
SAND				
FINE	.05	.002	.25	.01
MEDIUM	.25	.01	.5	.02
COARSE	.5	.02	2.0	.08
ROCK FRACTION	THESE FRACTIONS ARE NOT CONSIDERED IN DETERMINING SOIL CLASSIFICATION.			
GRAVEL	2.0	.08	6.4	2.5
COBBLES	6.4	2.5	256	10
BOULDERS	256	10		

**KEY TO TEST DATA**



■ INDICATES DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED



**KEY:**

- ▲ Δ TOPSOIL
- □ RESIDUAL SOILS
- ○ SHALE FORMATION
- ↑ Test at field moisture content
- ↓ Test at artificially increased moisture content

## SUMMARY OF SHEAR TEST DATA

DAMES & MOORE  
FOUNDATION ENGINEERS

DATA CHECK BY \_\_\_\_\_ DATE \_\_\_\_\_  
 DRAFTING CHECK BY \_\_\_\_\_ DATE \_\_\_\_\_  
 REPORT DICTATED BY \_\_\_\_\_ DATE \_\_\_\_\_

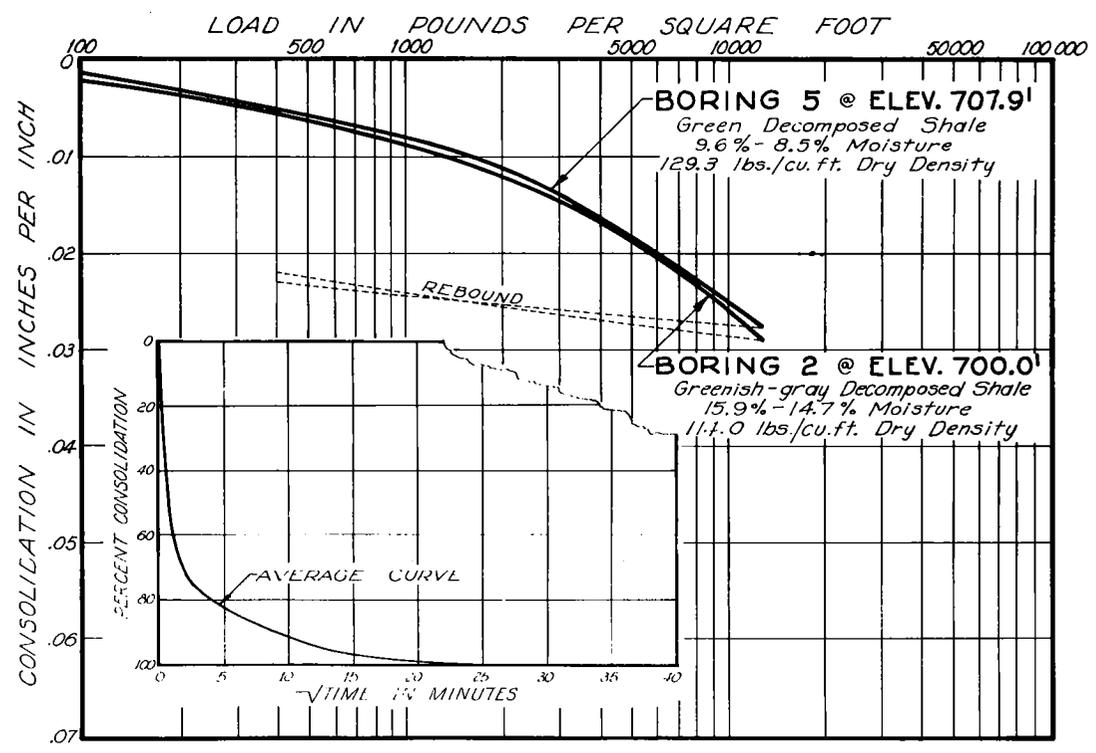
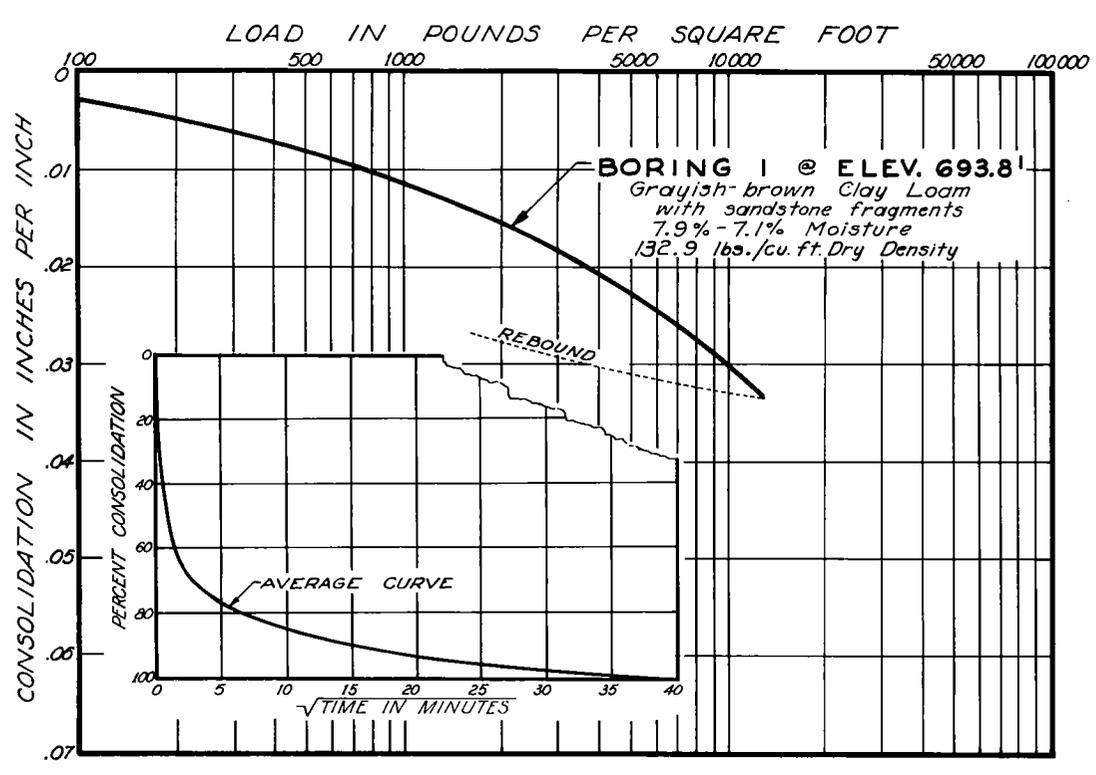
LOCATION \_\_\_\_\_ DATE PRINTED \_\_\_\_\_  
 CLIENT \_\_\_\_\_ DATE JOB STARTED \_\_\_\_\_  
 DRAWINGS \_\_\_\_\_

JOB NO. \_\_\_\_\_  
 THIS DRAWING IS ONE OF A \_\_\_\_\_  
 SERIES OF \_\_\_\_\_ DRAWINGS

DATE  
DRAWING CHECK BY  
REPORT DICTATED BY

DATE STARTED  
DATE PRINTED

DATE OF  
DRAWING



**CONSOLIDATION TEST DATA**

DAMES & MOORE  
 FOUNDATION ENGINEERS

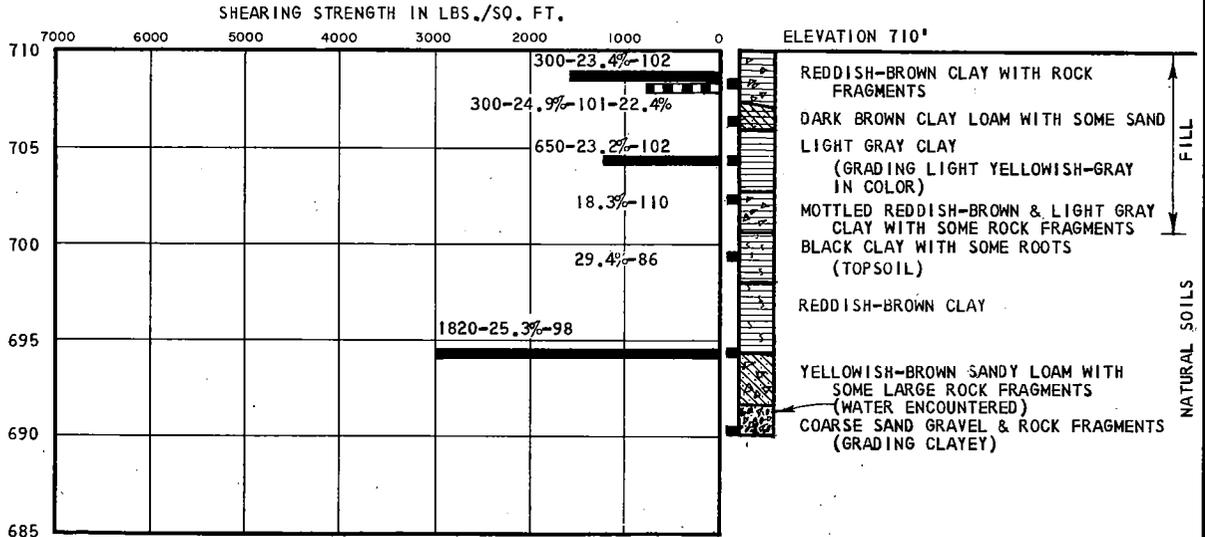
DATE

**Dames & Moore (D&M), 1956**, “Foundation Investigation, Proposed Development, Bevatron Area, Radiation Laboratory, Berkeley, California,” consulting report dated May 25, 1956.

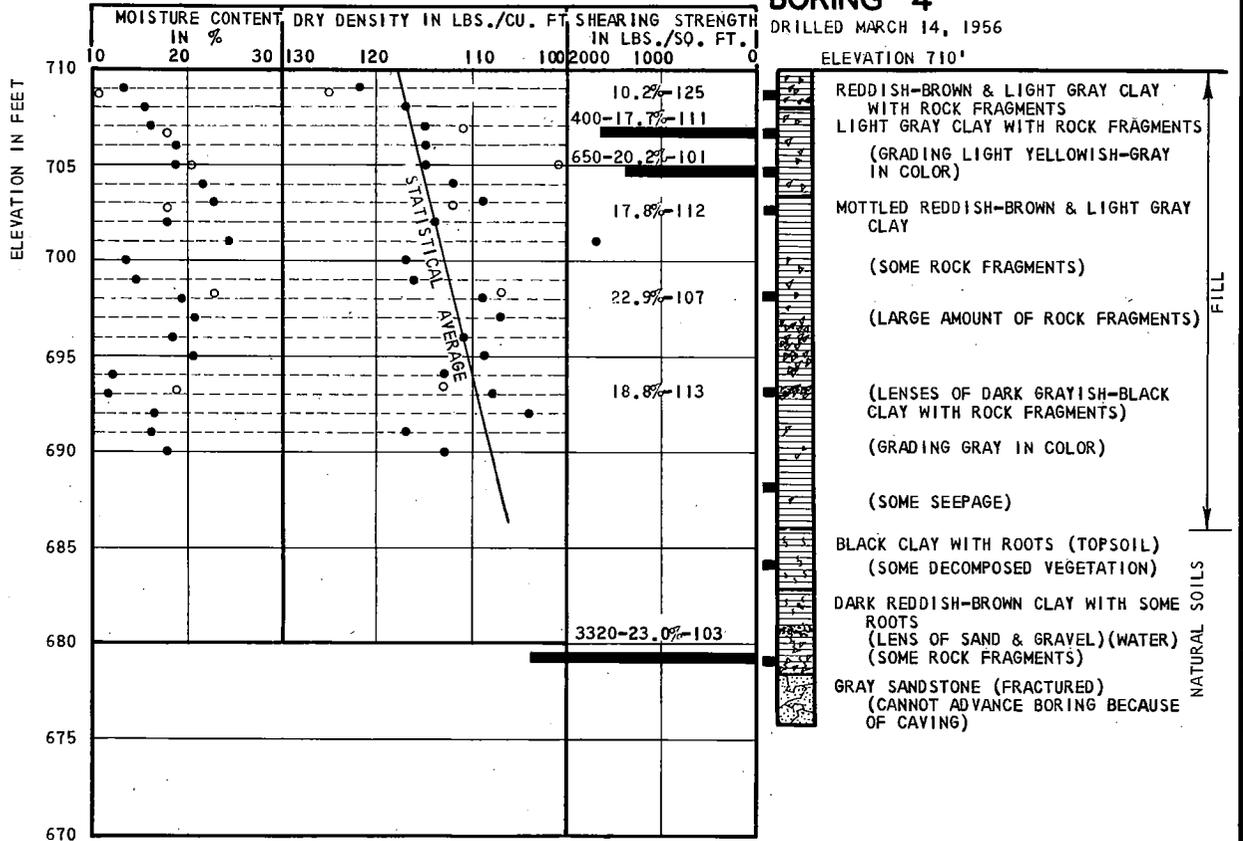
(LBNL #199)

**Logs of Borings 4 through 15**

**BORING 3**  
DRILLED MARCH 15, 1956



**BORING 4**  
DRILLED MARCH 14, 1956



**LOG OF BORINGS**

**DAMES & MOORE**  
SOIL MECHANICS ENGINEERS

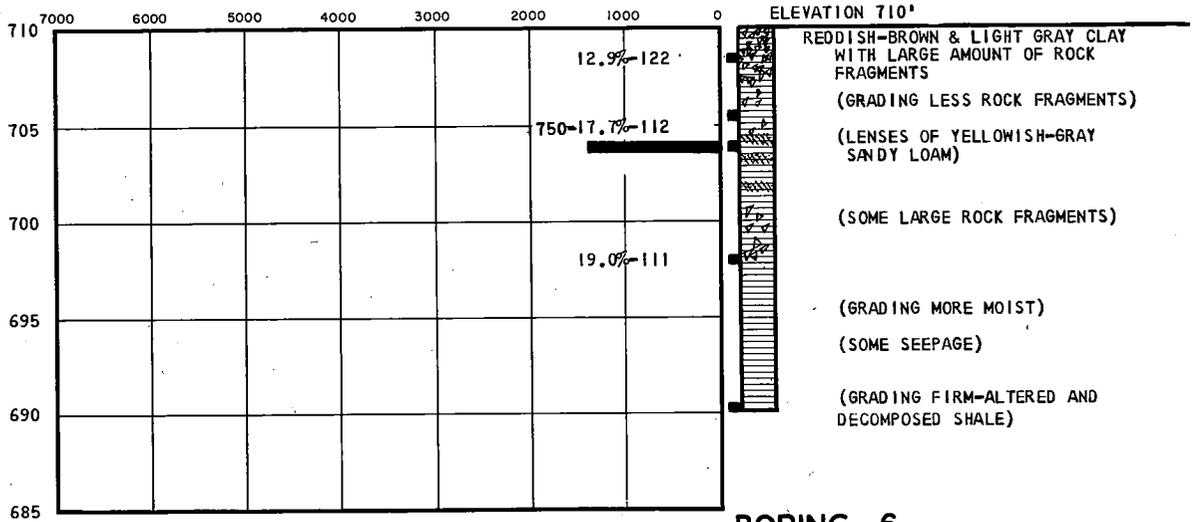
PLATE A1B

REVISIONS  
BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
PLATE \_\_\_\_\_ OF \_\_\_\_\_

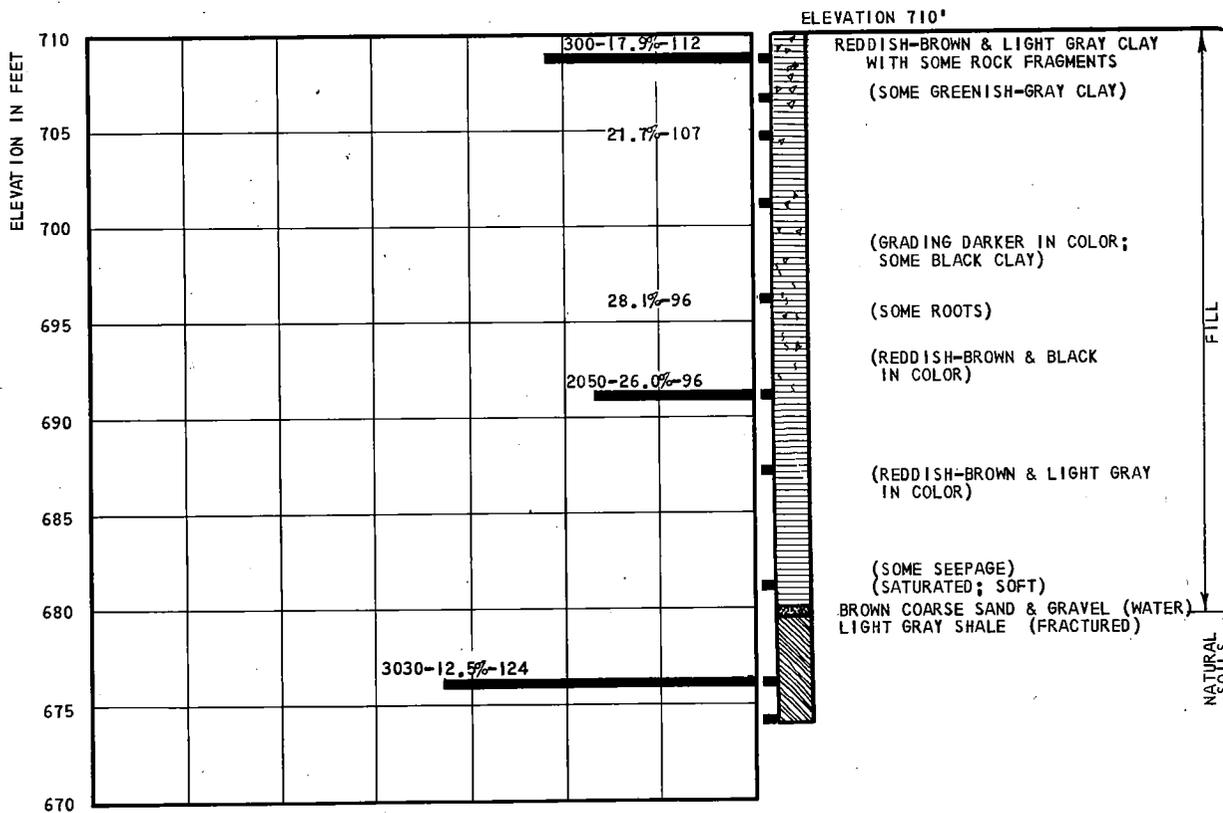
FILE 224-1  
UNIV. CAL., BERKELEY  
BY: C.L.S. DATE 3-22-56  
CHECKED BY: [Signature] DATE 5-23-56

**BORING 5**  
DRILLED MARCH 15, 1956

SHEARING STRENGTH IN LBS./SQ. FT.



**BORING 6**  
DRILLED MARCH 19, 1956



**LOG OF BORINGS**

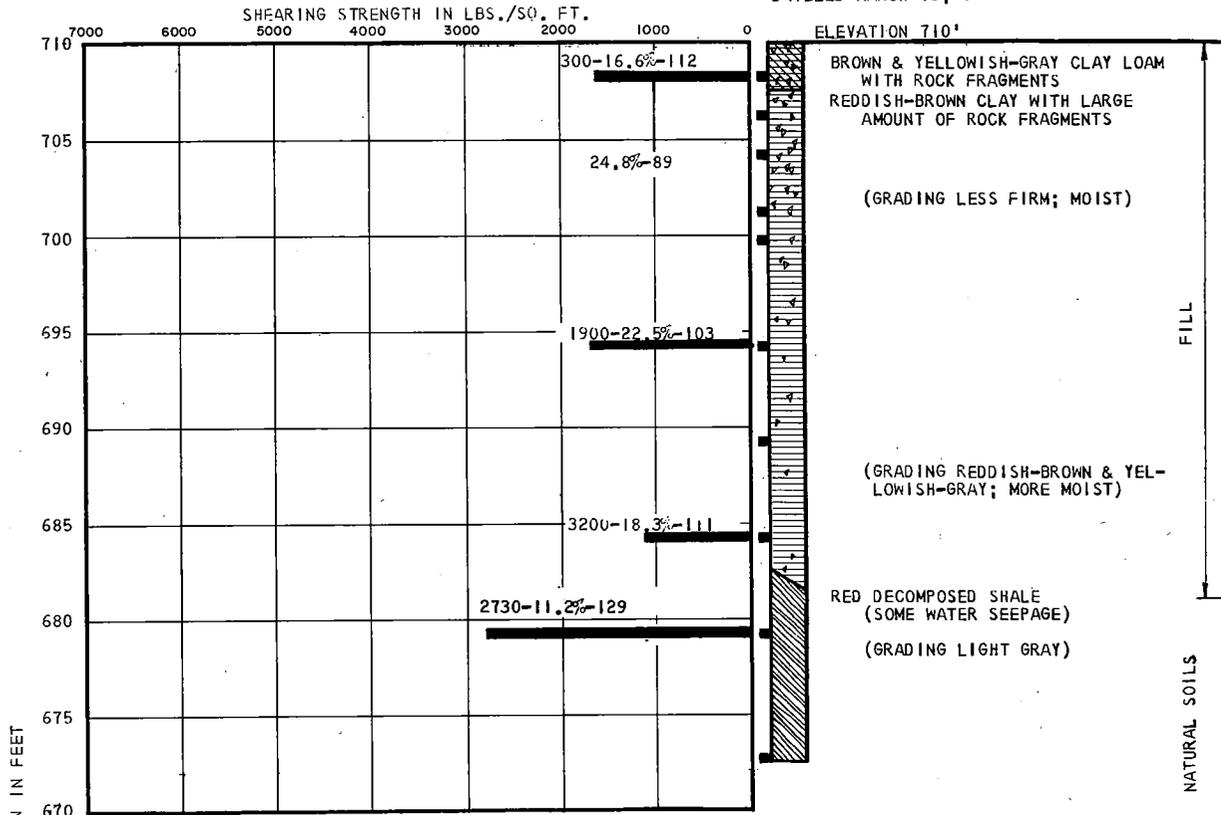
**DAMES & MOORE**  
SOIL MECHANICS ENGINEERS

PLATE AIC

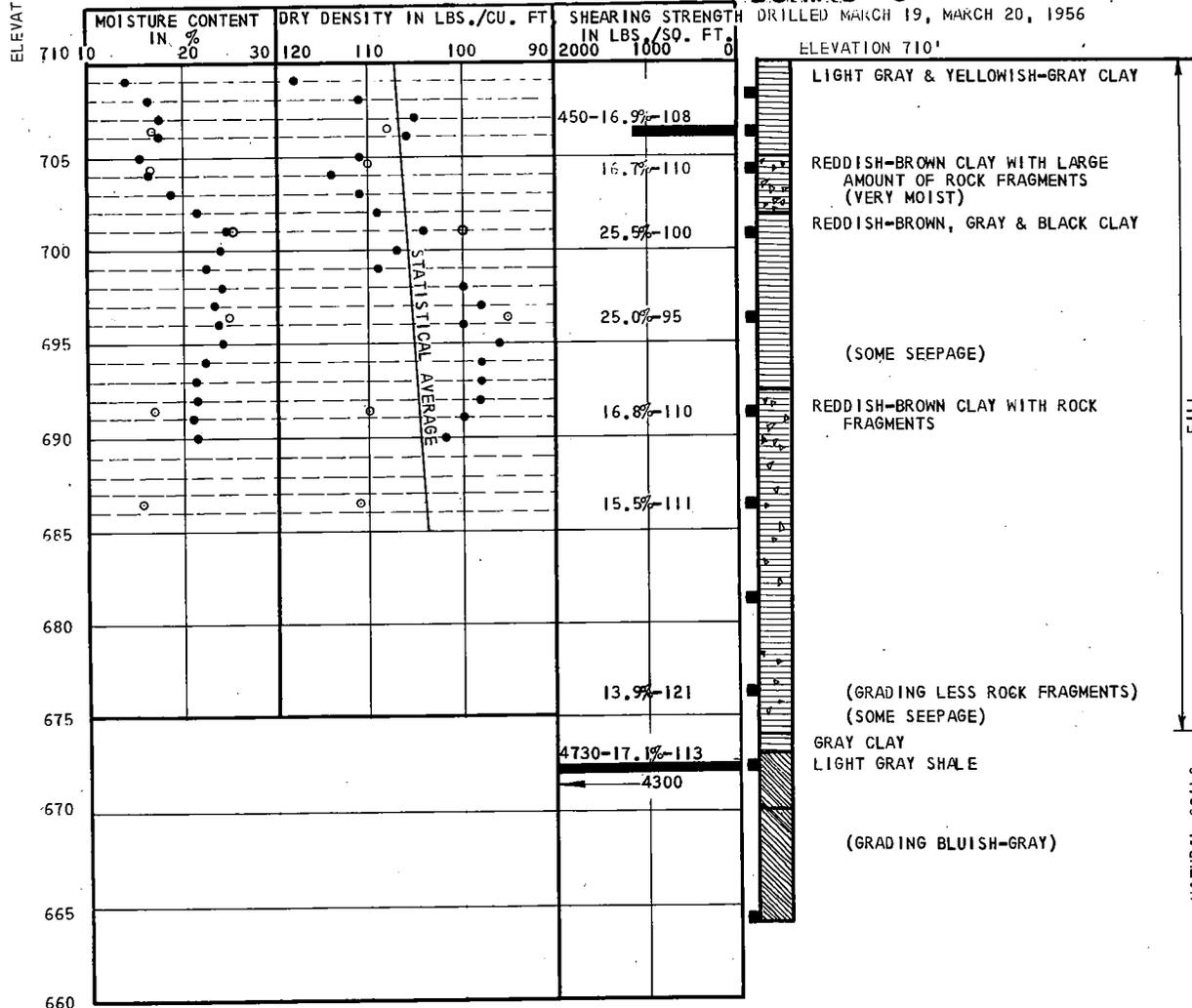
REVISIONS  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_

FILE 274-1  
UNIV CAL, BERKELEY  
BY GLS DATE 3-22-56  
CHECKED BY AA DATE 3-22-56

**BORING 7**  
DRILLED MARCH 15, 1956



**BORING 8**  
DRILLED MARCH 19, MARCH 20, 1956



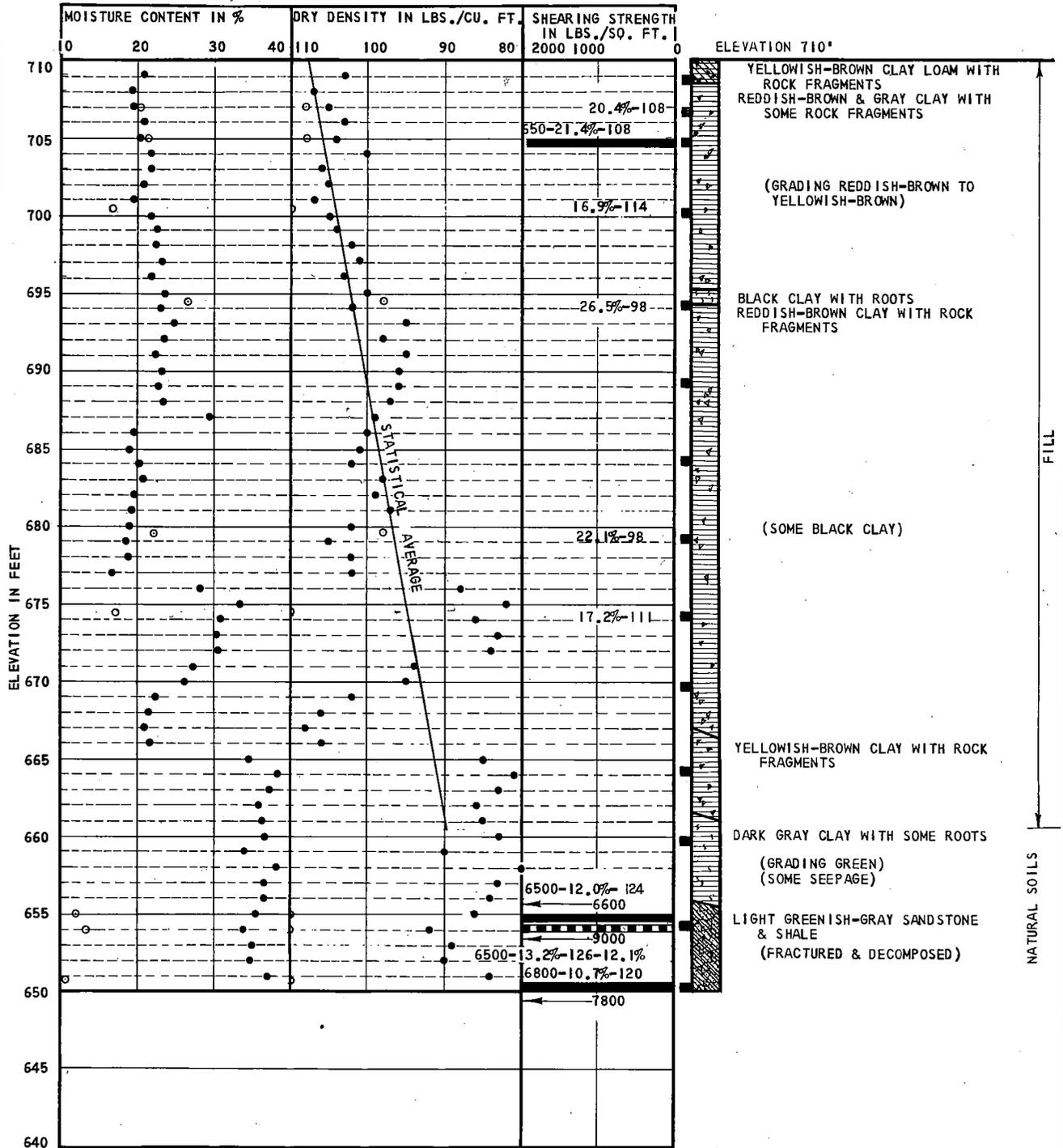
**LOG OF BORINGS**

**DAMES & MOORE**  
SOIL MECHANICS ENGINEERS

PLATE AID

BY: C.L.S. DATE: 7-23-56  
 CHECKED BY: P.H. DATE: 8-2-56

**BORING 9**  
DRILLED MARCH 20, 1956



REVISIONS  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_

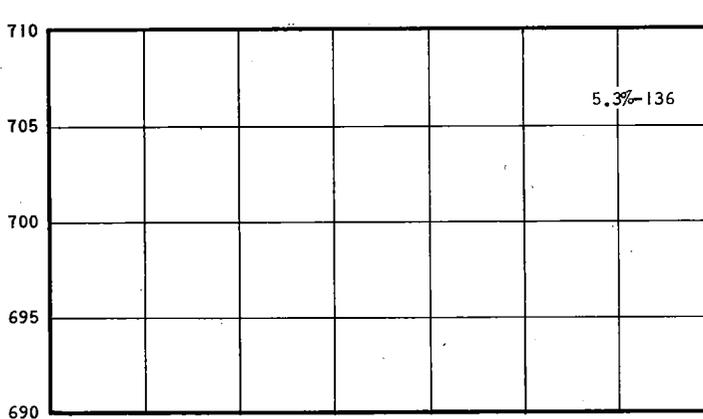
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UNIV. CAL. - BERKELEY  
BY C.L.S. DATE 3/23/56  
CHECKED BY J.E.L. DATE 5/2/55

**LOG OF BORING**

**DAMES & MOORE**  
SOIL MECHANICS ENGINEERS

**PLATE AIE**

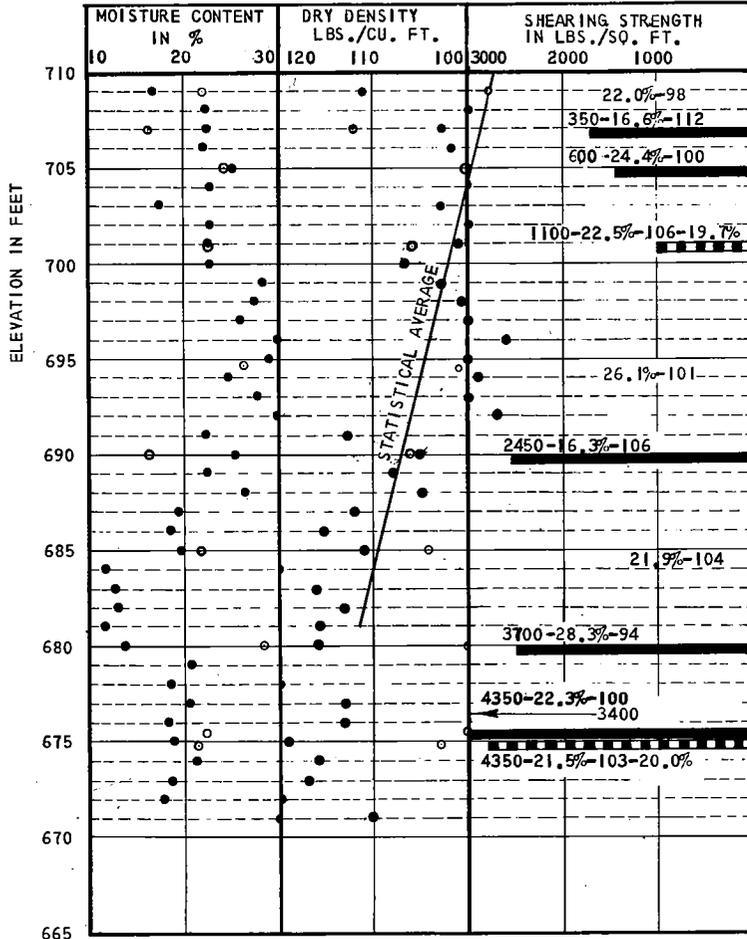
**BORING 10**  
DRILLED MARCH 16, 1956



ELEVATION 710'  
DARK BROWN SEVERELY FRACTURED & DECOMPOSED SANDSTONE

(GRADING REDDISH-BROWN)  
(SOME SEEPAGE)

**BORING 11**  
DRILLED MARCH 21, 1956



ELEVATION 710'  
YELLOWISH-GRAY CLAY

(SOME REDDISH-BROWN CLAY & ROCK FRAGMENTS)

(GRADING DARK GRAY)

(GRADING REDDISH-BROWN)

(LARGE ROCK FRAGMENTS)

(GRADING DARK GRAY)

BLACK CLAY WITH SOME SMALL ROOTS)  
(TOPSOIL)

LIGHT YELLOWISH-GRAY CLAY WITH  
LARGE AMOUNT OF ROCK FRAGMENTS  
(SOME REDDISH-BROWN CLAY &  
FINE SAND)

(WEATHERED SHALE)

FILL

NATURAL SOILS

REVISIONS  
BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
PLATE OF \_\_\_\_\_

FILE 294.Y  
UNIV. CAL. BERKELEY  
BY: C.S. DATE 2-23-56  
CHECKED BY: P.L. DATE 3-2-56

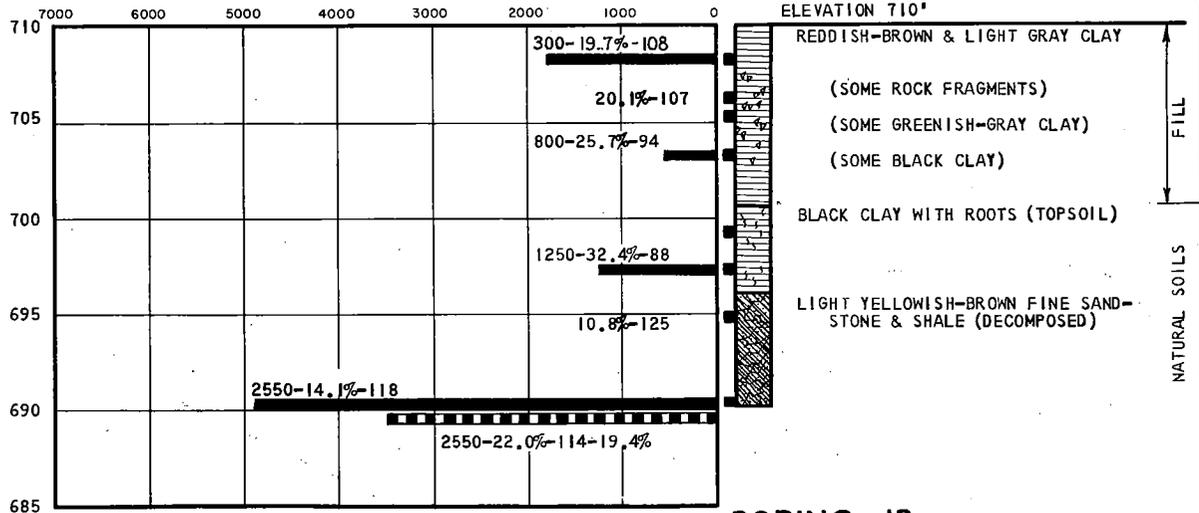
**LOG OF BORINGS**

**DAMES & MOORE**  
SOIL MECHANICS ENGINEERS

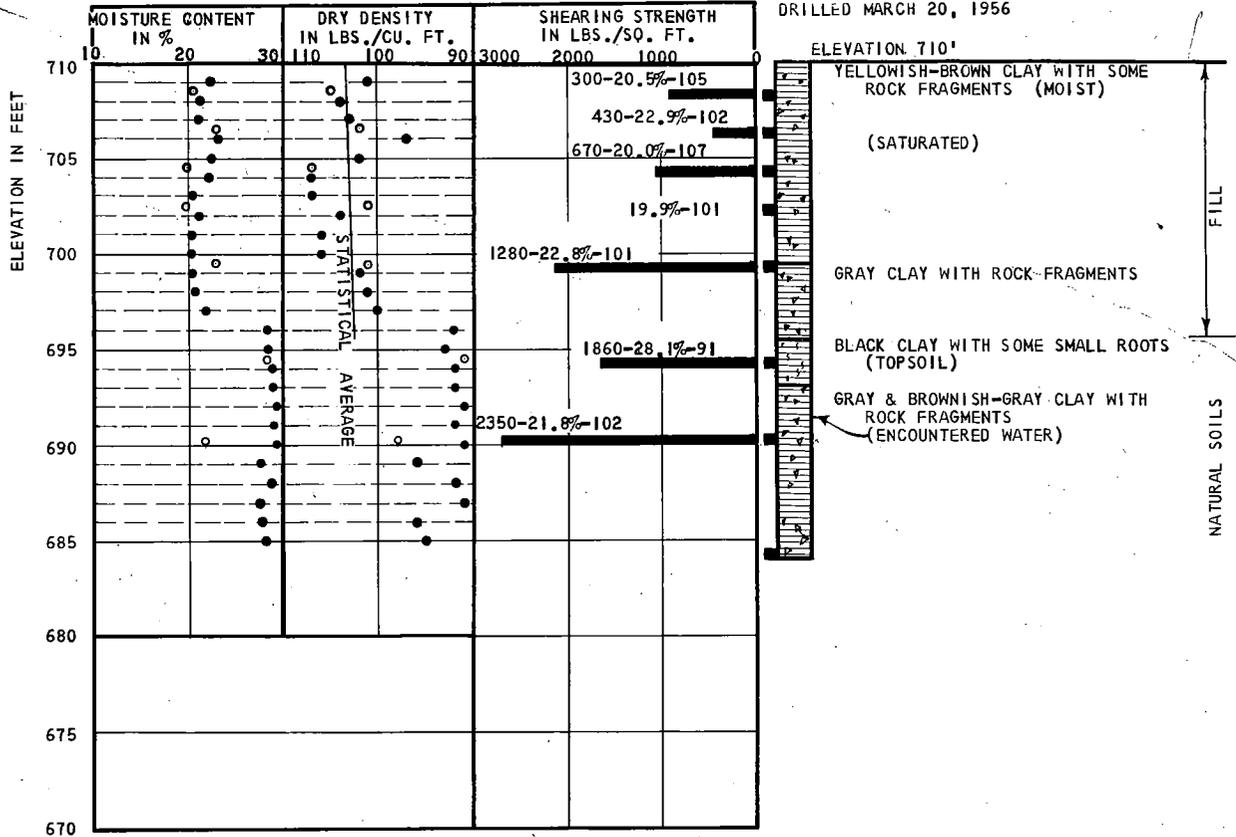
PLATE A1F

**BORING 12**  
DRILLED MARCH 19, 1956

SHEARING STRENGTH IN LBS./SQ. FT.



**BORING 13**  
DRILLED MARCH 20, 1956



**LOG OF BORINGS**

**DAMES & MOORE**  
SOIL MECHANICS ENGINEERS

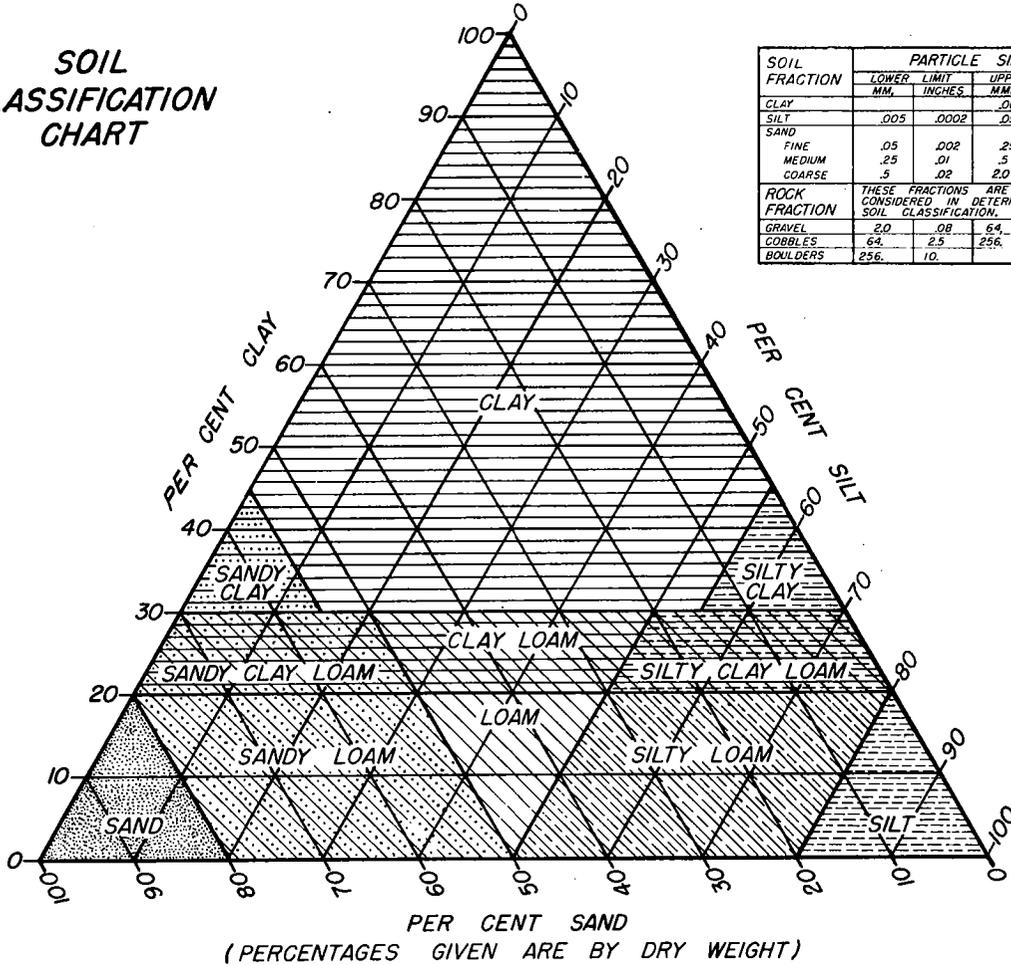
PLATE AIG

REVISIONS  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
BY \_\_\_\_\_ DATE \_\_\_\_\_  
PLATE \_\_\_\_\_ OF \_\_\_\_\_

FILE 224-Y  
UNIV. CAL. - BERKELEY  
BY C.L.S. DATE 3-23-56  
CHECKED BY RA DATE 5-23-56

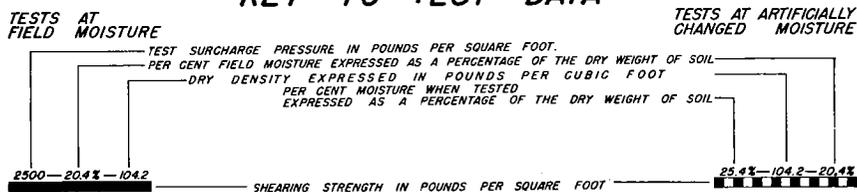
**SOIL CLASSIFICATION CHART AND KEY TO TEST DATA**

**SOIL CLASSIFICATION CHART**



SOIL FRACTION	PARTICLE SIZE				
	LOWER LIMIT	UPPER LIMIT	LOWER LIMIT	UPPER LIMIT	
	MM.	INCHES	MM.	INCHES	
CLAY			.005	.002	
SILT	.005	.002	.05	.002	
SAND					
	FINE	.05	.002	.25	.01
	MEDIUM	.25	.01	5	.02
COARSE	.5	.02	2.0	.08	
ROCK FRACTION	THESE FRACTIONS ARE NOT CONSIDERED IN DETERMINING SOIL CLASSIFICATION.				
GRAVEL	2.0	.08	6.4	2.5	
COBBLES	64	2.5	256	10	
BOULDERS	256	10			

**KEY TO TEST DATA**



■ INDICATES DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED

PLATE A2

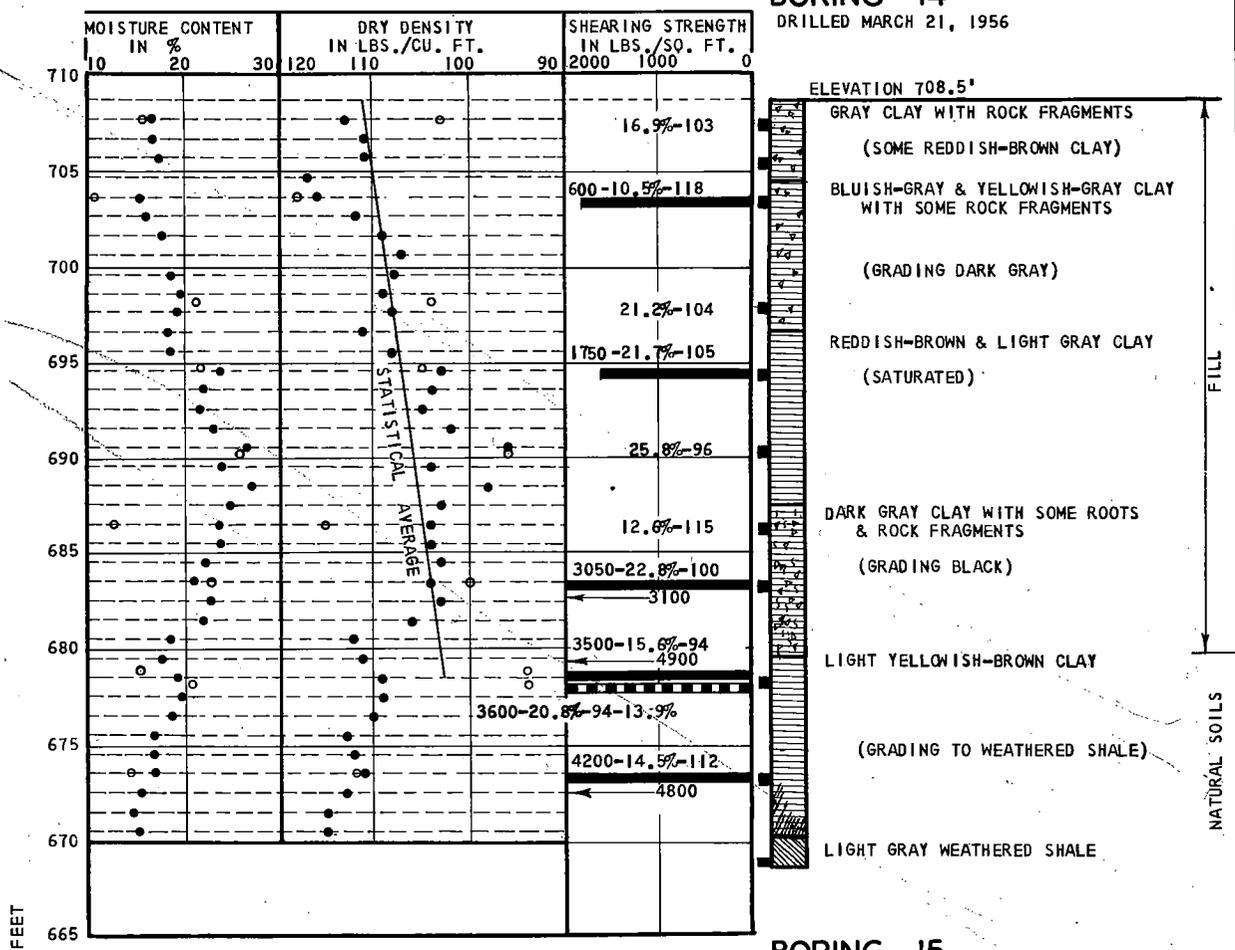
DAVIS & MOORE  
SOIL MECHANICS ENGINEERS

BY \_\_\_\_\_ DATE \_\_\_\_\_  
 BY \_\_\_\_\_ DATE \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

UNIV. CAL. BERKELEY  
 BY C.L.S. DATE 3-23-56  
 CHECKED BY J.M. DATE 3-26-56

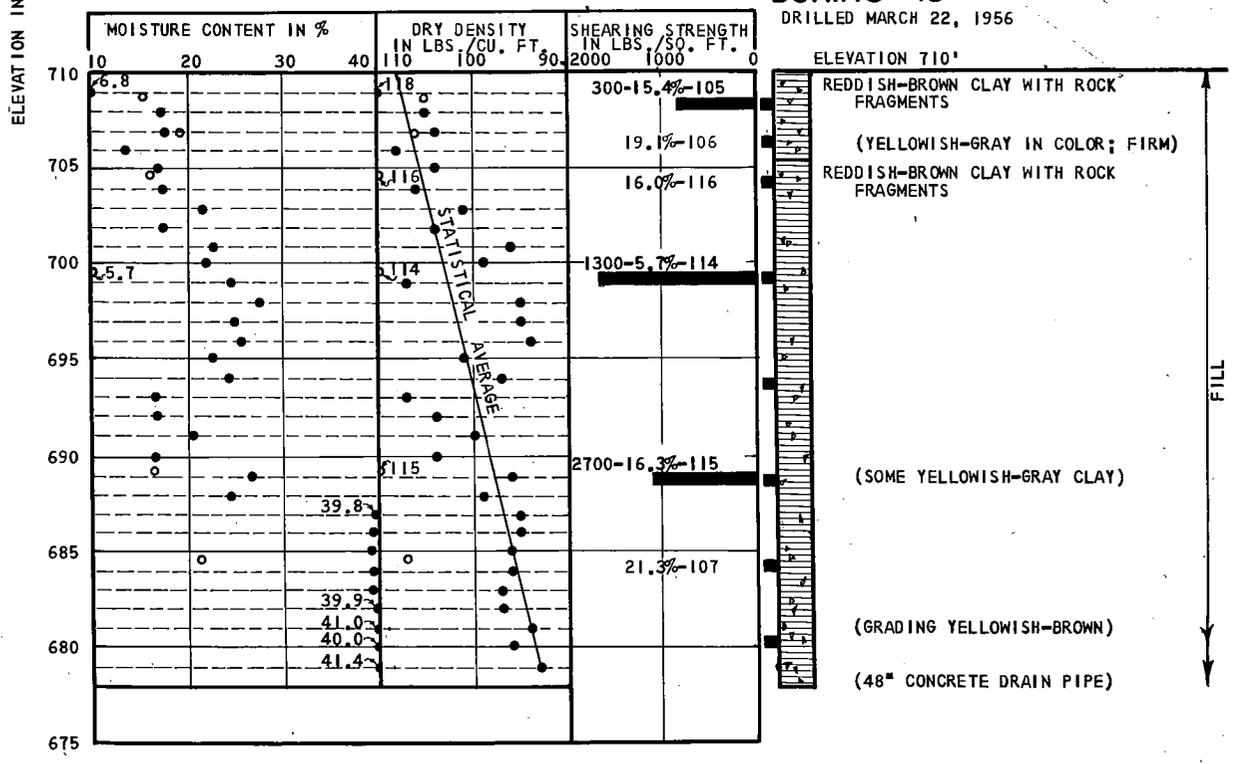
### BORING 14

DRILLED MARCH 21, 1956



### BORING 15

DRILLED MARCH 22, 1956



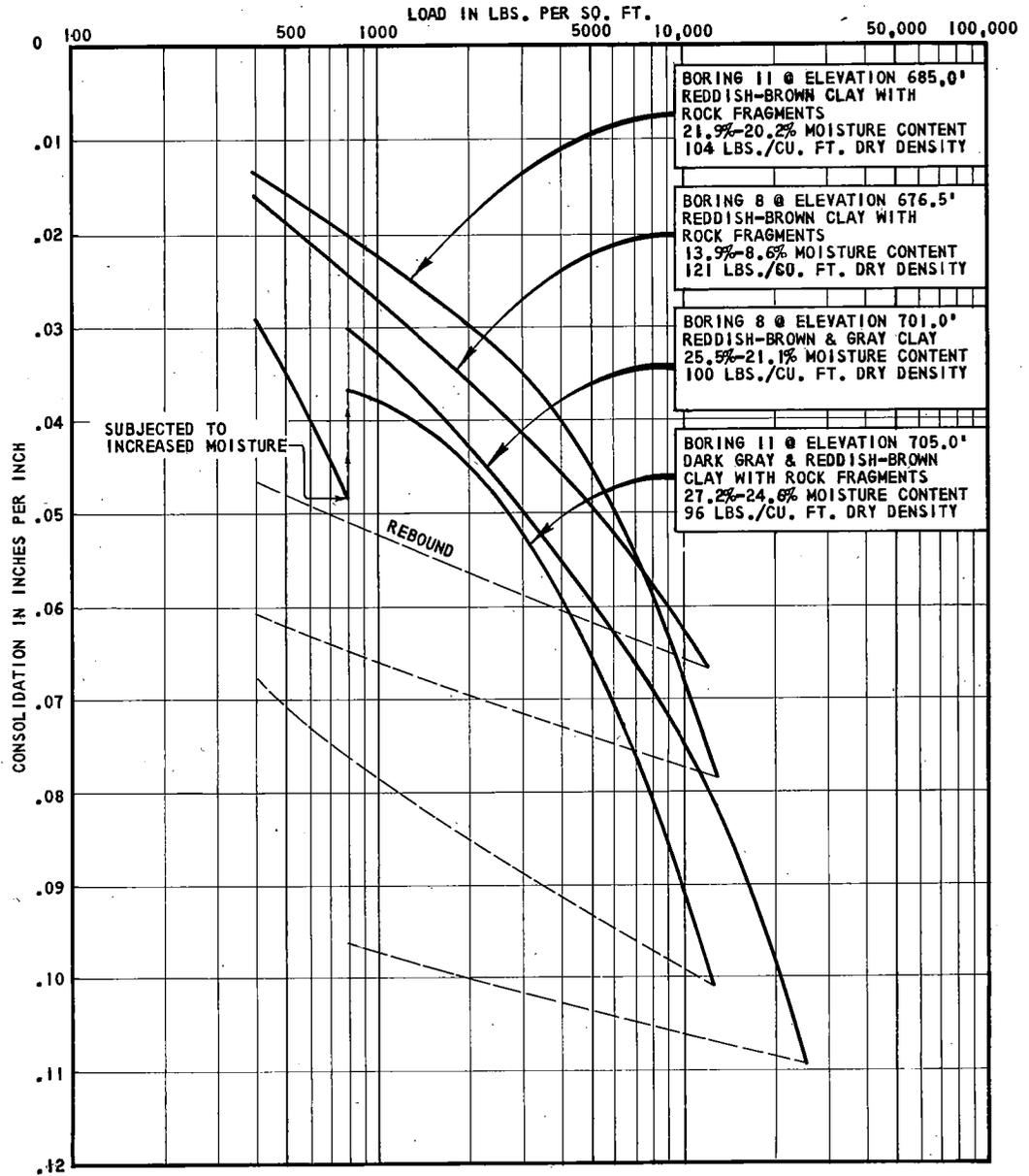
## LOG OF BORINGS

**DAMES & MOORE**  
 SOIL MECHANICS ENGINEERS

PLATE A1H

BY \_\_\_\_\_ DATE \_\_\_\_\_  
 BY \_\_\_\_\_ DATE \_\_\_\_\_  
 PLATE \_\_\_\_\_ OF \_\_\_\_\_

BY *G. VALE* DATE *1/11/56*  
 CHECKED BY *R. K.* DATE *5/18/56*



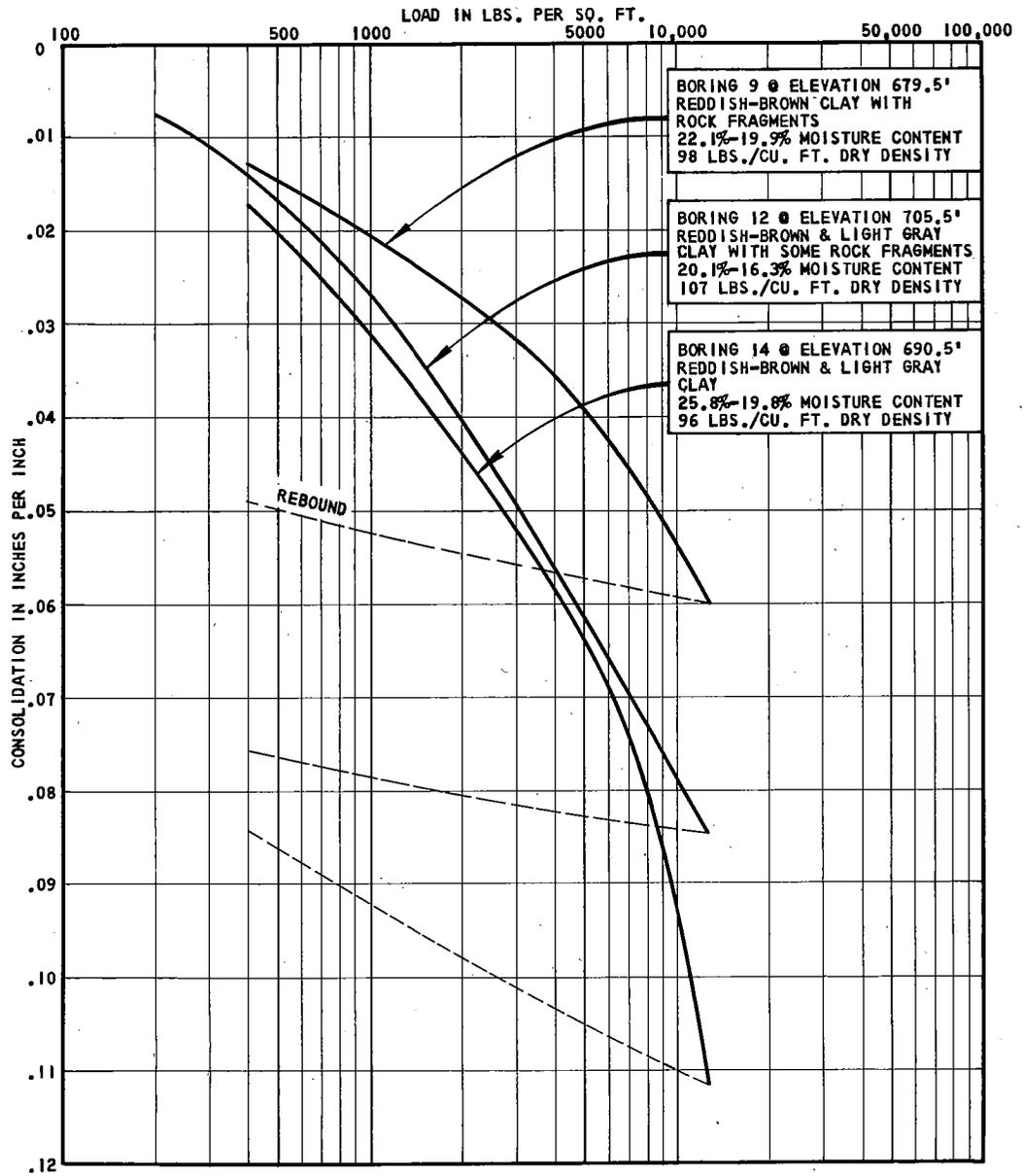
## CONSOLIDATION TEST DATA

**DAMES & MOORE**  
 SOIL MECHANICS ENGINEERS

PLATE A3A

BY \_\_\_\_\_ DATE \_\_\_\_\_  
 BY \_\_\_\_\_ DATE \_\_\_\_\_  
 CHECKED BY \_\_\_\_\_ PLATE \_\_\_\_\_

BY RB GAVIN DATE 4 MAY 56  
 CHECKED BY RA DATE 5/18/56



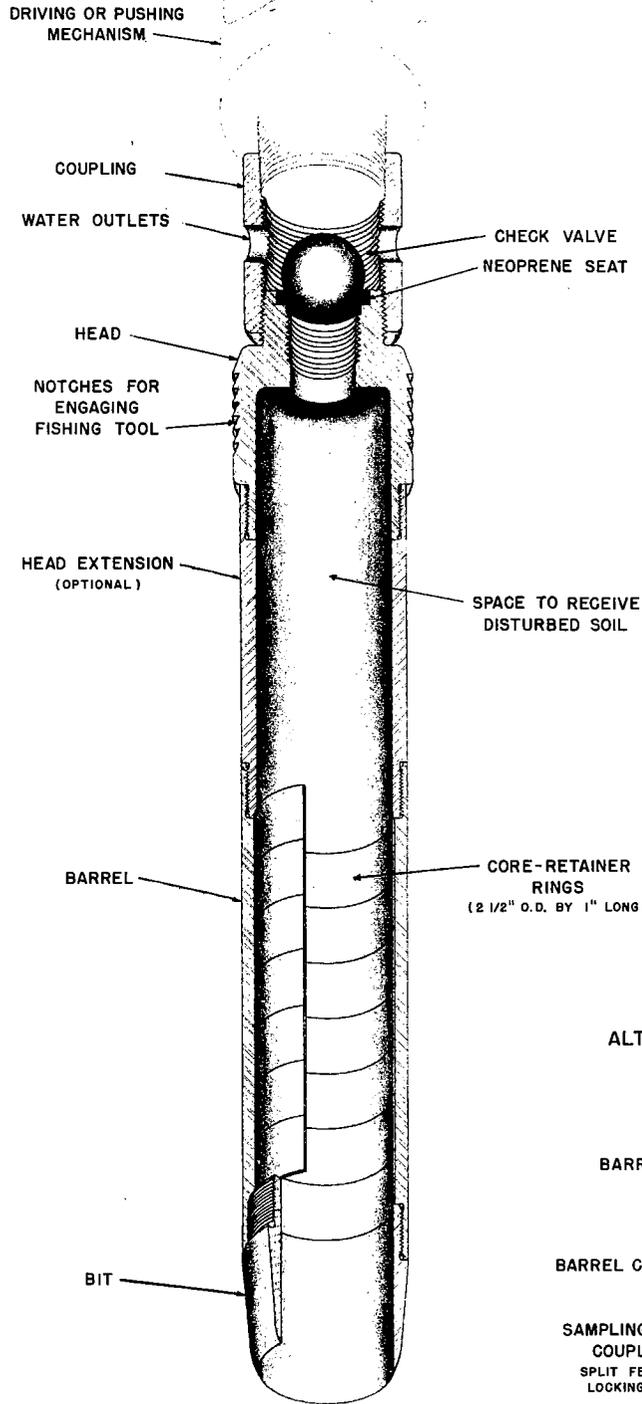
## CONSOLIDATION TEST DATA

**DAMES & MOORE**  
 SOIL MECHANICS ENGINEERS

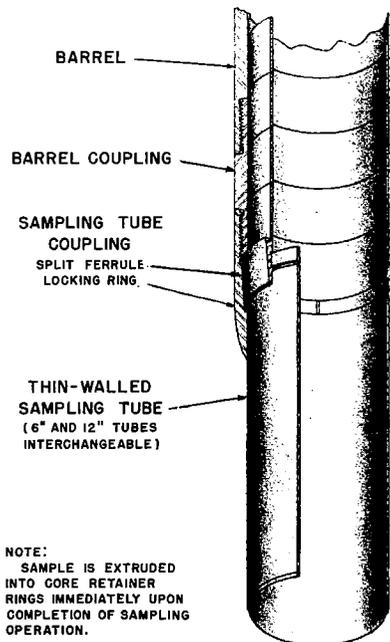
PLATE A3B

# SOIL SAMPLER TYPE D

FOR SOILS EASY TO RETAIN IN SAMPLER



## ALTERNATE ATTACHMENTS

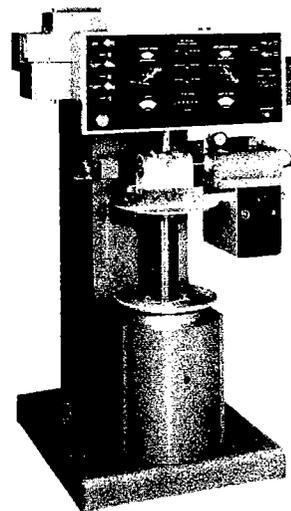


NOTE:  
SAMPLE IS EXTRUDED INTO CORE RETAINER RINGS IMMEDIATELY UPON COMPLETION OF SAMPLING OPERATION.

## METHOD OF PERFORMING DIRECT SHEAR AND FRICTION TESTS

Direct shear tests are performed to determine the shearing strengths of soils. Friction tests are performed to determine the frictional resistances between soils and various other materials such as wood, steel, or concrete. The tests are performed in the laboratory to simulate anticipated field conditions.

Each sample is tested within three brass rings, two and one-half inches in diameter and one inch in length. Undisturbed samples of in-place soils are tested in rings taken from the sampling tool in which the samples were obtained. Loose samples of soils to be used in constructing earth fills are compacted in rings to predetermined conditions and tested.



DIRECT SHEAR TESTING  
MACHINE

### Direct Shear Tests

A three-inch length of the sample is tested in direct double shear. A constant pressure, appropriate to the conditions of the problem for which the test is being performed, is applied normal to the ends of the sample through porous stones. A shearing failure of the sample is caused by moving the center ring in a direction perpendicular to the axis of the sample. Transverse movement of the outer rings is prevented.

The shearing failure may be accomplished by applying to the center ring either a constant rate of load, a constant rate of deflection, or increments of load or deflection. In each case, the shearing load and the deflections in both the axial and transverse directions are recorded and plotted. The shearing strength of the soil is determined from the resulting load-deflection curves.

### Friction Tests

In order to determine the frictional resistance between soil and the surfaces of various materials, the center ring of soil in the direct shear test is replaced by a disk of the material to be tested. The test is then performed in the same manner as the direct shear test by forcing the disk of material from between the soil surfaces.

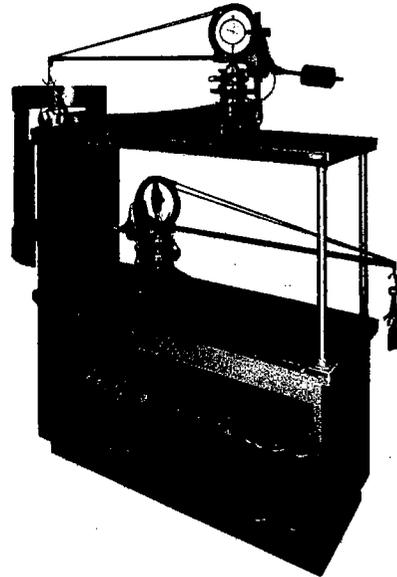
## METHOD OF PERFORMING CONSOLIDATION TESTS

Consolidation tests are performed to evaluate the volume changes of soils subjected to increased loads. Time-consolidation and pressure-consolidation curves may be plotted from the data obtained in the tests. Engineering analyses based on these curves permit estimates to be made of the probable magnitude and rate of settlement of the tested soils under applied loads.

Each sample is tested within a brass ring two and one-half inches in diameter and one inch in length. Undisturbed samples of in-place soils are tested in rings taken from the sampling tool in which the samples were obtained. Loose samples of soils to be used in constructing earth fills are compacted in rings to predetermined conditions and tested.

In testing, the sample is rigidly confined laterally by the brass ring. Axial loads are transmitted to the ends of the sample by porous disks. The disks allow drainage of the loaded sample. The axial compression or expansion of the sample is measured by a micrometer dial indicator at appropriate time intervals after each load increment is applied. Each load is ordinarily twice the preceding load. The increments are selected to obtain consolidation data representing the field loading conditions for which the test is being performed. Each load increment is allowed to act over an interval of time dependent on the type and extent of the soil in the field.

Soils saturated in the field are tested submerged in water. The effect of increased moisture content on partially saturated soils is determined by adding water to the sample during the test.



CONSOLIDATION MACHINES

PLATE A6

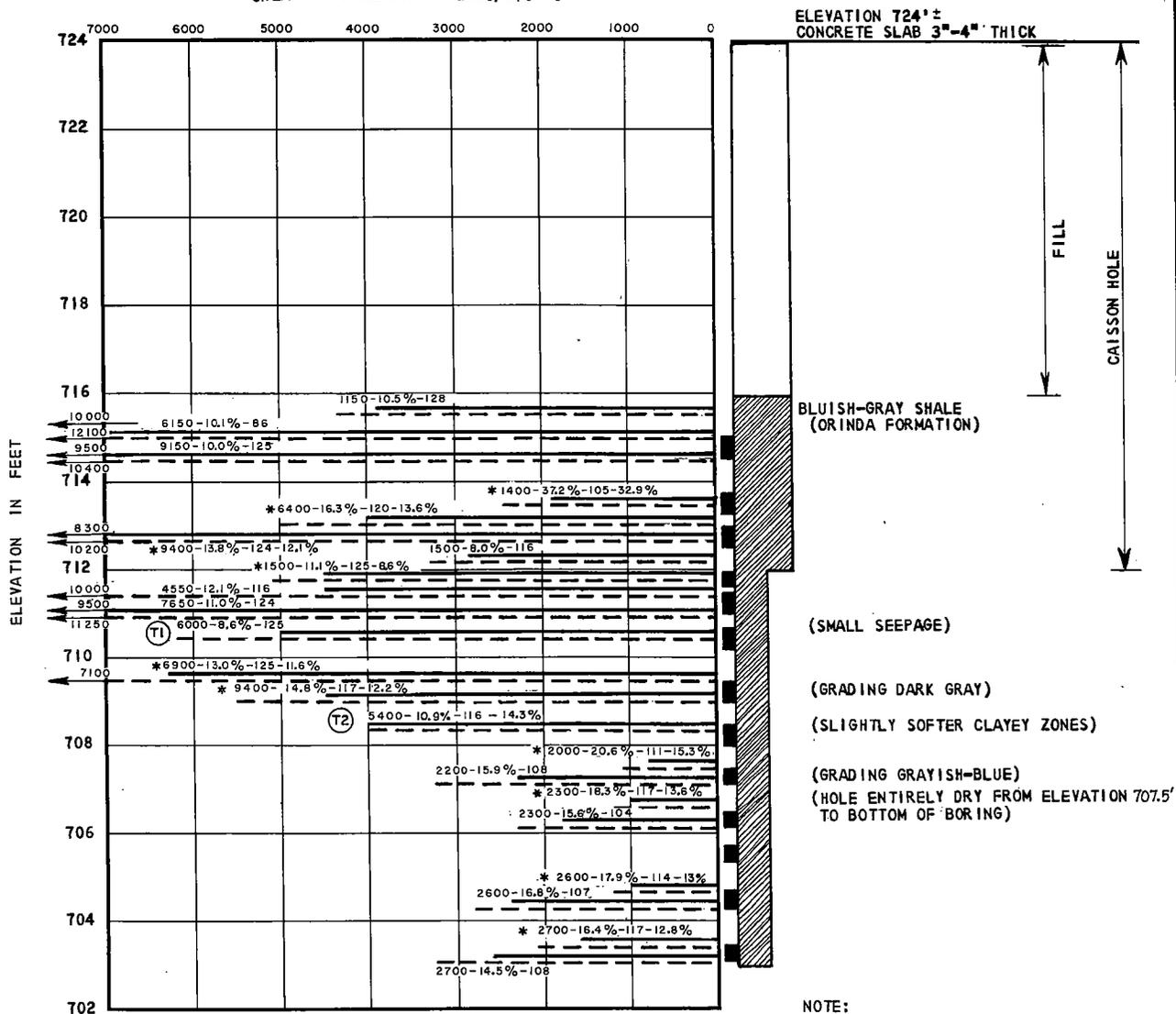
**DAMES & MOORE**  
SOIL MECHANICS ENGINEERS

**Dames & Moore (D&M), 1960**, "Consultation Re: Caisson Load Test, Bevatron Building, Lawrence Radiation Laboratory, Berkeley, California," consulting report dated February 29, 1960.

(LBNL #098)

**Log of Test Caisson**

Shearing Strength in lbs./sq.ft.



**LOG OF BORING**

REVISIONS BY DATE  
 BY DATE  
 BY DATE  
 CHECKED BY DATE

**TESTS AT FIELD MOISTURE**

**TESTS AT ARTIFICIALLY CHANGED MOISTURE**



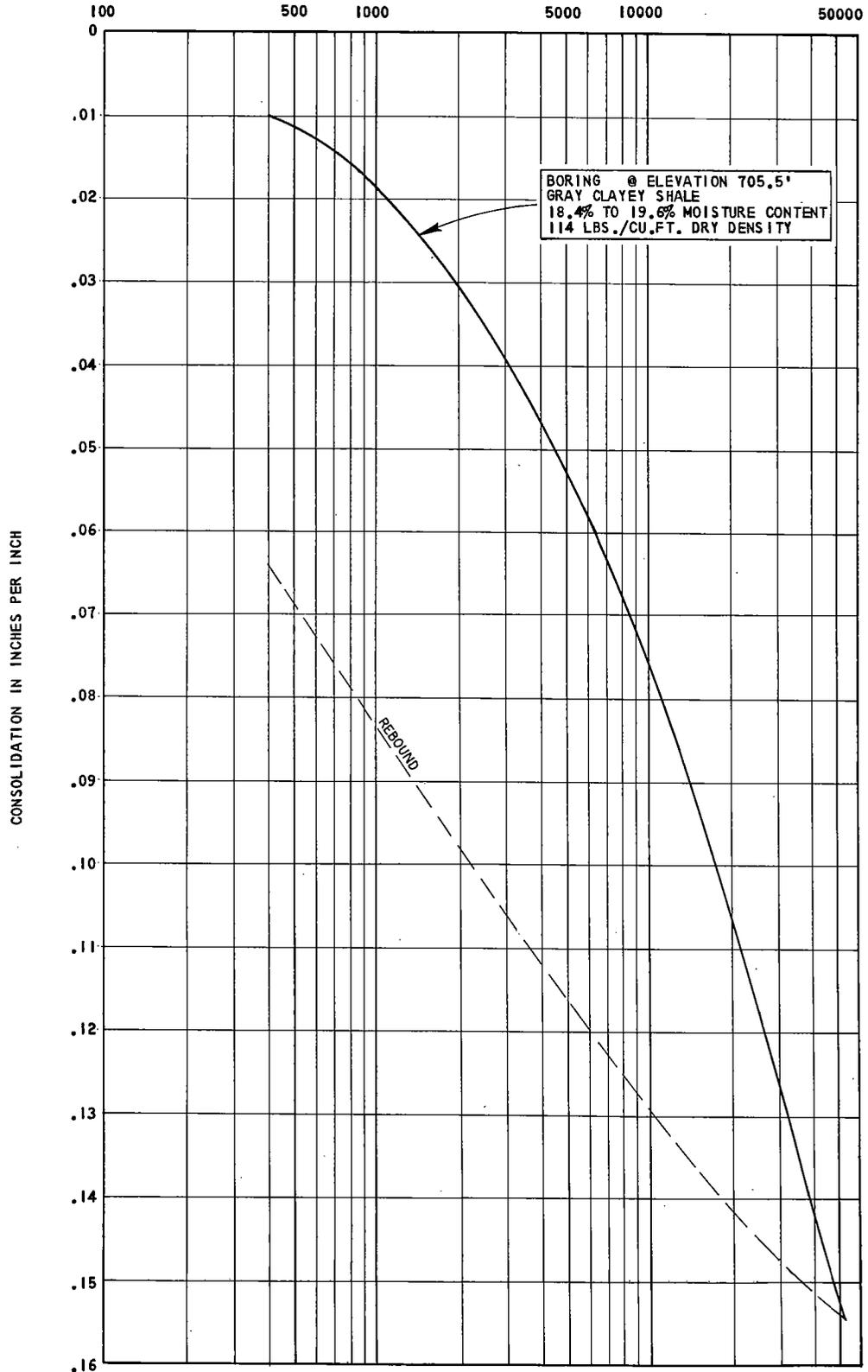
- \* DIRECT SHEAR-STRAIN CONTROL, TESTED AT ARTIFICIALLY INCREASED MOISTURE
- (T1) TRIAXIAL SHEAR TEST, UNCONSOLIDATED, UNDRAINED
- (T2) TRIAXIAL SHEAR TEST, CONSOLIDATED AT CONDITIONS OF SATURATION, UNDRAINED

■ INDICATES DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED

**KEY TO TEST DATA**

**DAMES & MOORE**  
 SOIL MECHANICS ENGINEERS

LOAD IN LBS. PER SQ. FT.



### CONSOLIDATION TEST DATA

**DAMES & MOORE**  
SOIL MECHANICS ENGINEERS

PLATE A2

098\_00018

REVISIONS  
BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
PLATE \_\_\_\_\_ OF \_\_\_\_\_

FILE 6-2-1-11-0  
BY: H.H. DATE: \_\_\_\_\_  
CHECKED BY: J.H. DATE: 2/13/60

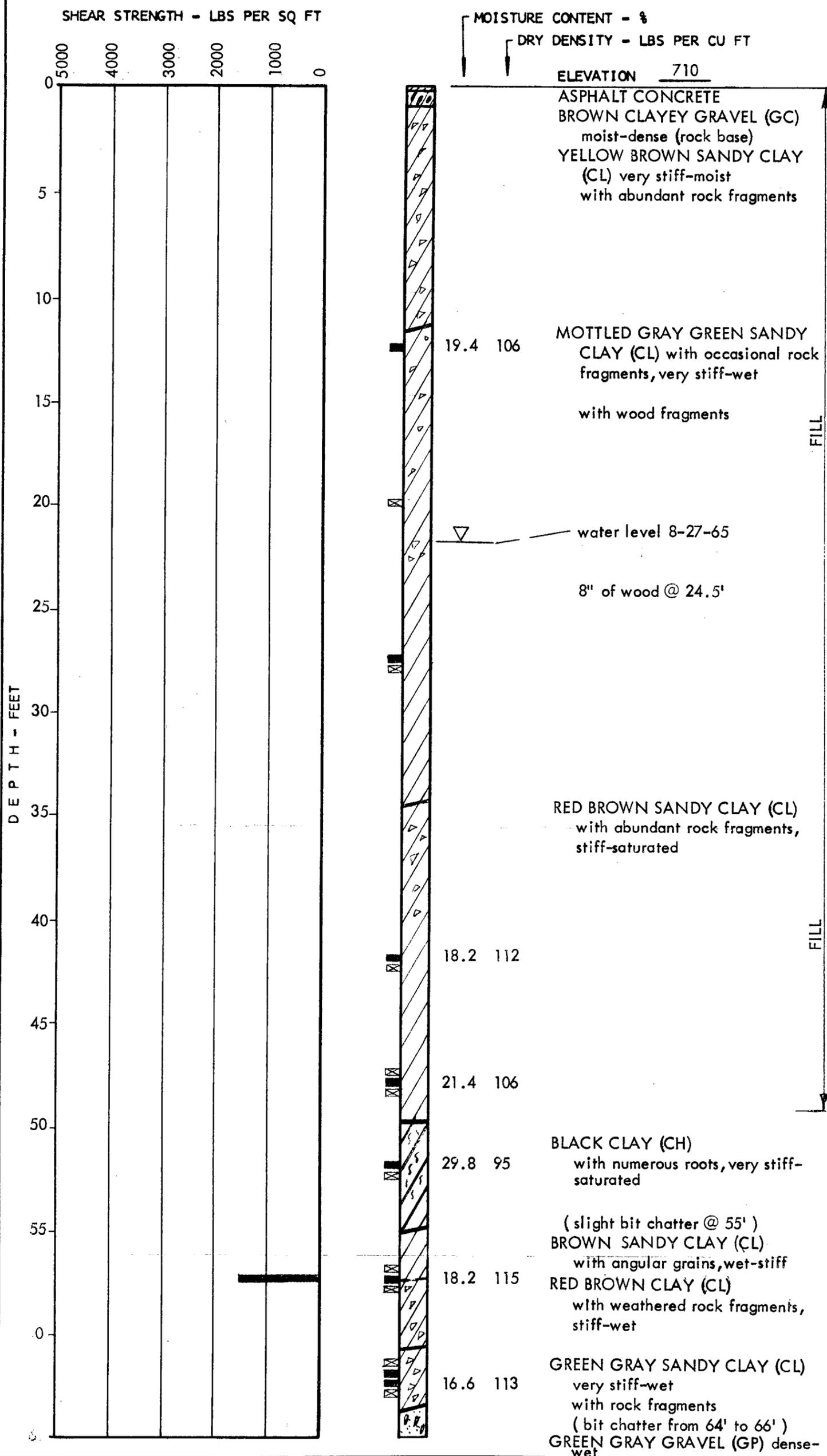
400510 (REV. 3)

**Harding Associates, Inc. (HA), 1965**, "Foundation Investigation, Proposed 30-Ton Overhead Crane, Lawrence Radiation Laboratory, Berkeley, California," consulting report dated October 21, 1965. HA Project No. 2000.32.

(LBNL # 100)

**Logs of Borings 2 through 7**

BORING 2 (Sheet 1 of 2)



HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 6" Flight Auger, Rotary Wash

DRILLED 8-23-65

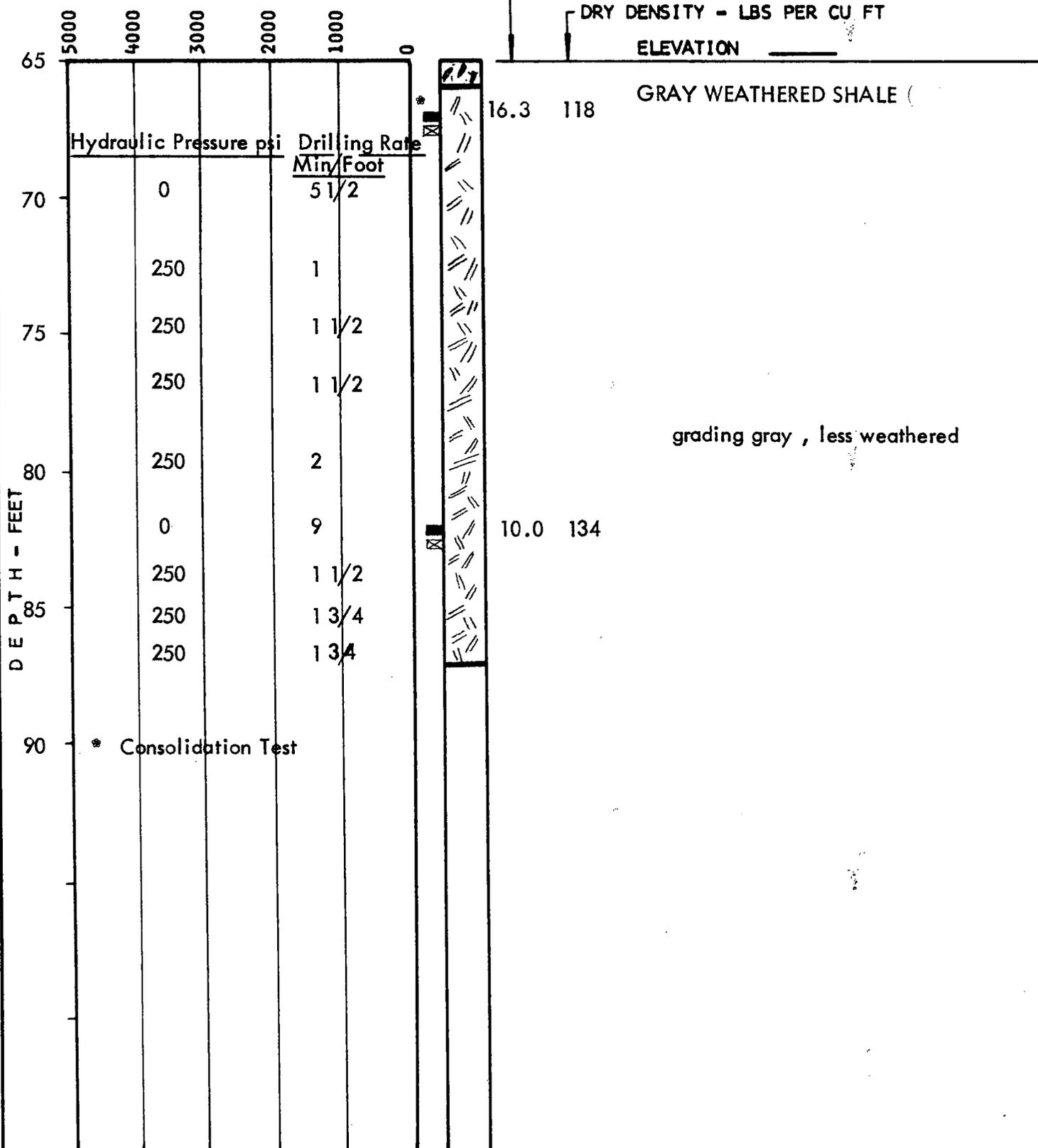
BORING 2 (Sheet 2 of 2)

SHEAR STRENGTH - LBS PER SQ FT

MOISTURE CONTENT - %

DRY DENSITY - LBS PER CU FT

ELEVATION

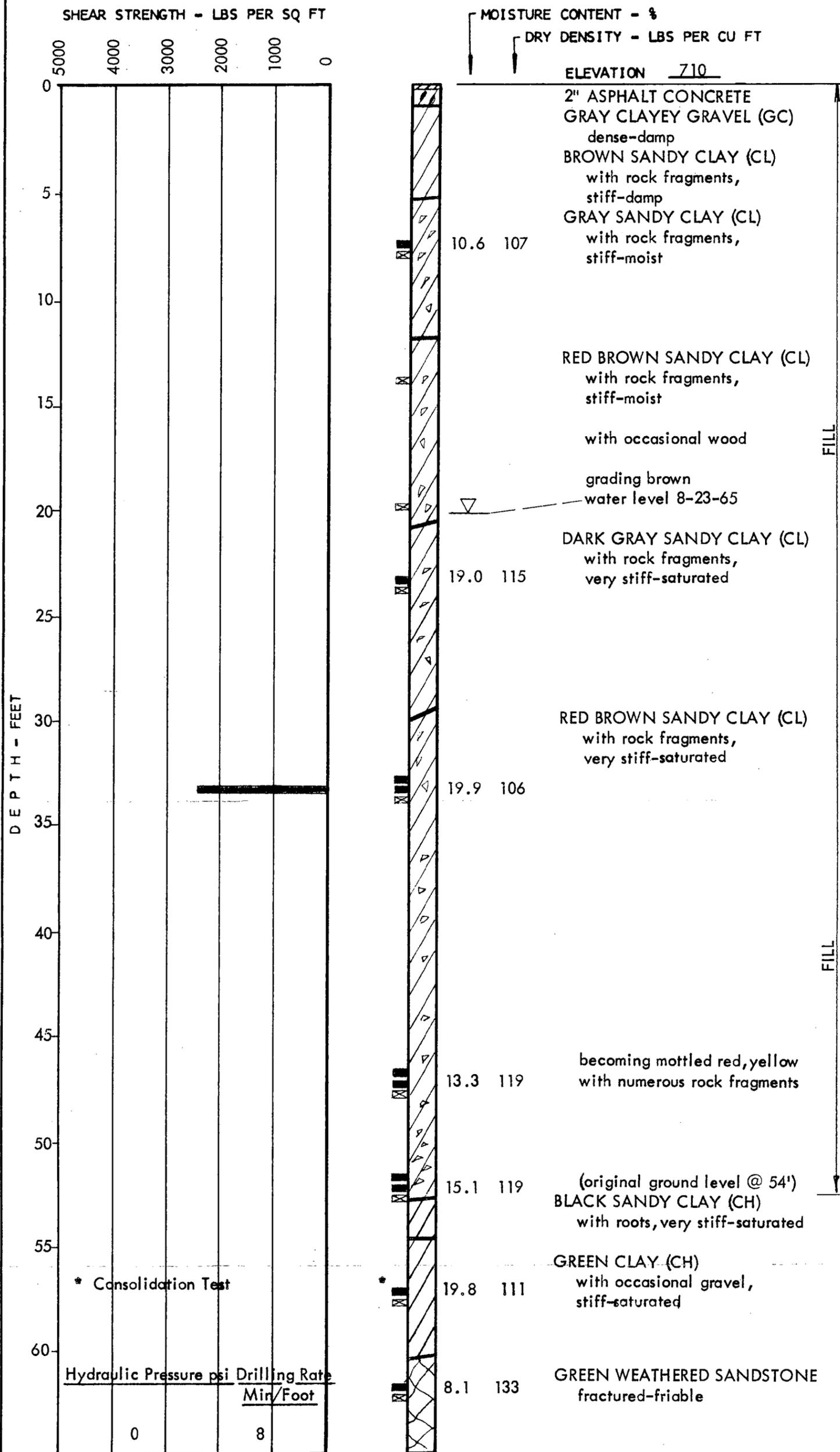


HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 6" Flight Auger & Rotary Wash DRILLED 8-23-65

BORING 3 (Sheet 1 of 2)



HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 6" Flight Auger & Rotary Wash DRILLED 8-19-65

BORING 3 (Sheet 2 of 2)

SHEAR STRENGTH - LBS PER SQ FT

MOISTURE CONTENT - %

DRY DENSITY - LBS PER CU FT

ELEVATION \_\_\_\_\_

(using hydraulic press)

DARK GREEN GRAY SHALE fractured

11.4 131

(harder drilling @80')

\* Consolidation Test

DEPTH - FEET	SHEAR STRENGTH - LBS PER SQ FT				Drilling Rate Min/Foot
	5000	4000	3000	2000	
65		250			1 1/2
70		250			1
75		0			4
		250			1
80		250			1 1/4
85					



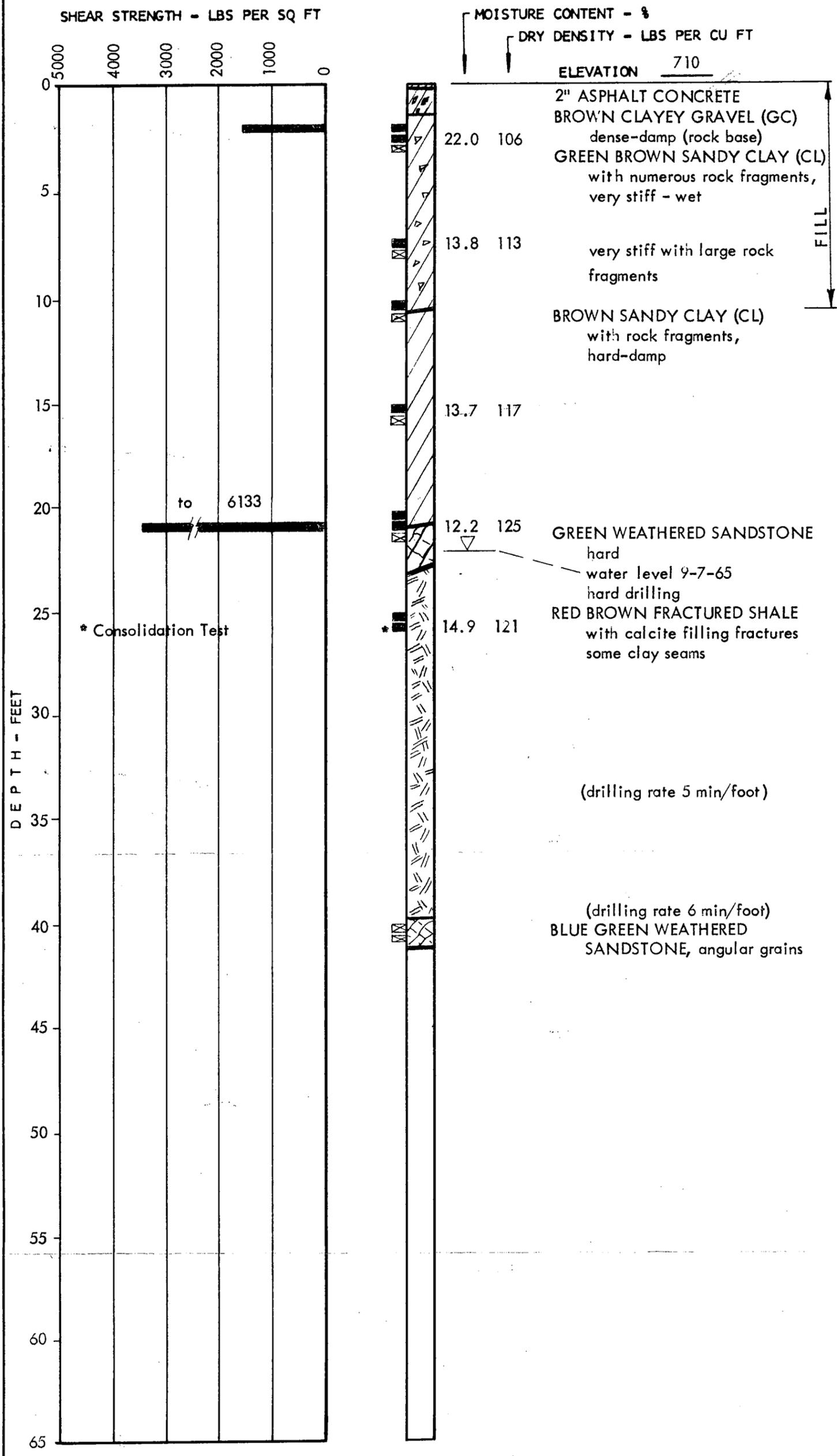
HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 6" Flight Auger

DRILLED 8-19-65

**BORING 4**



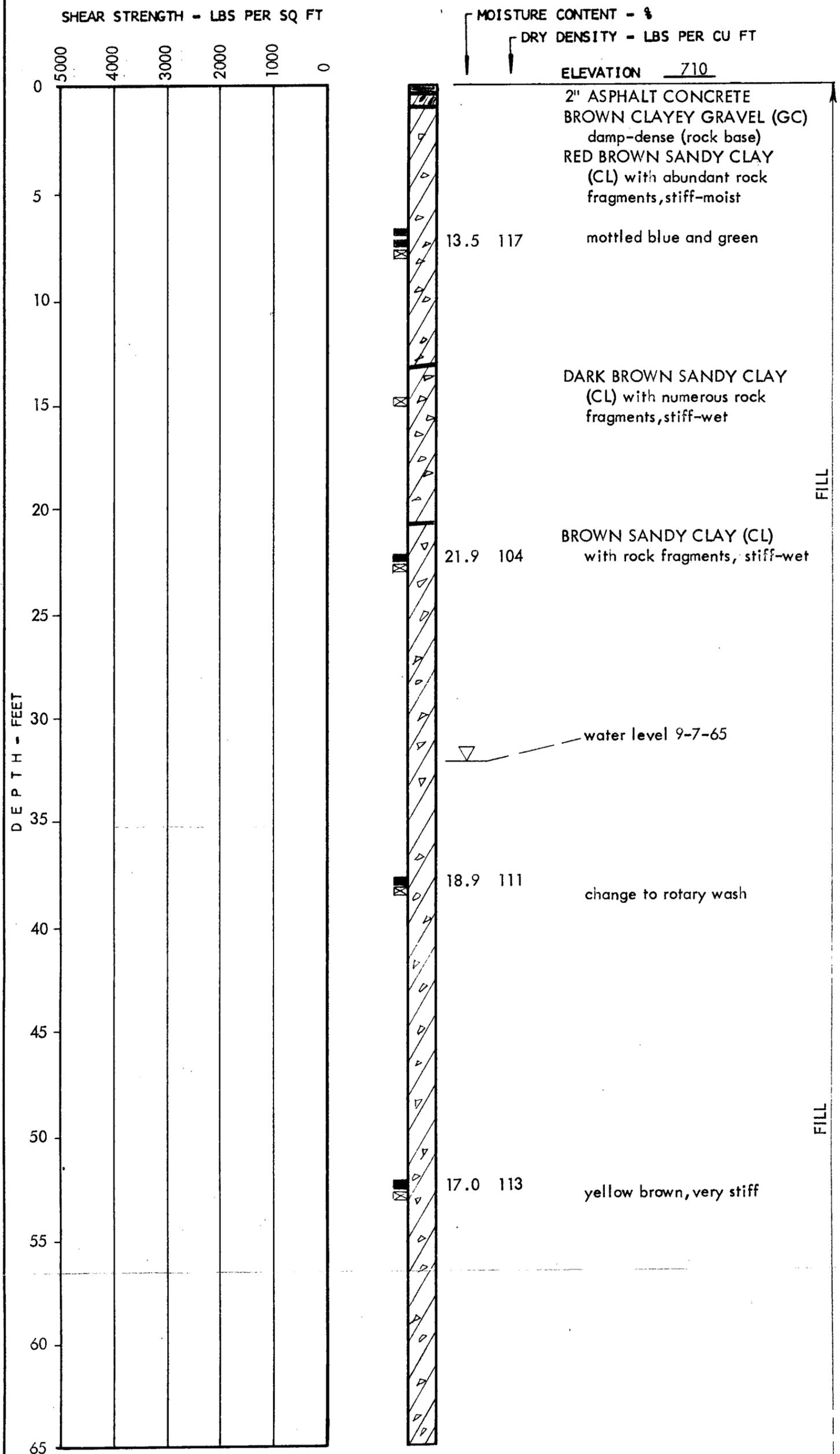
HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 6" Flight Auger

DRILLED 8-25-65

BORING 5 (Sheet 1 of 2)



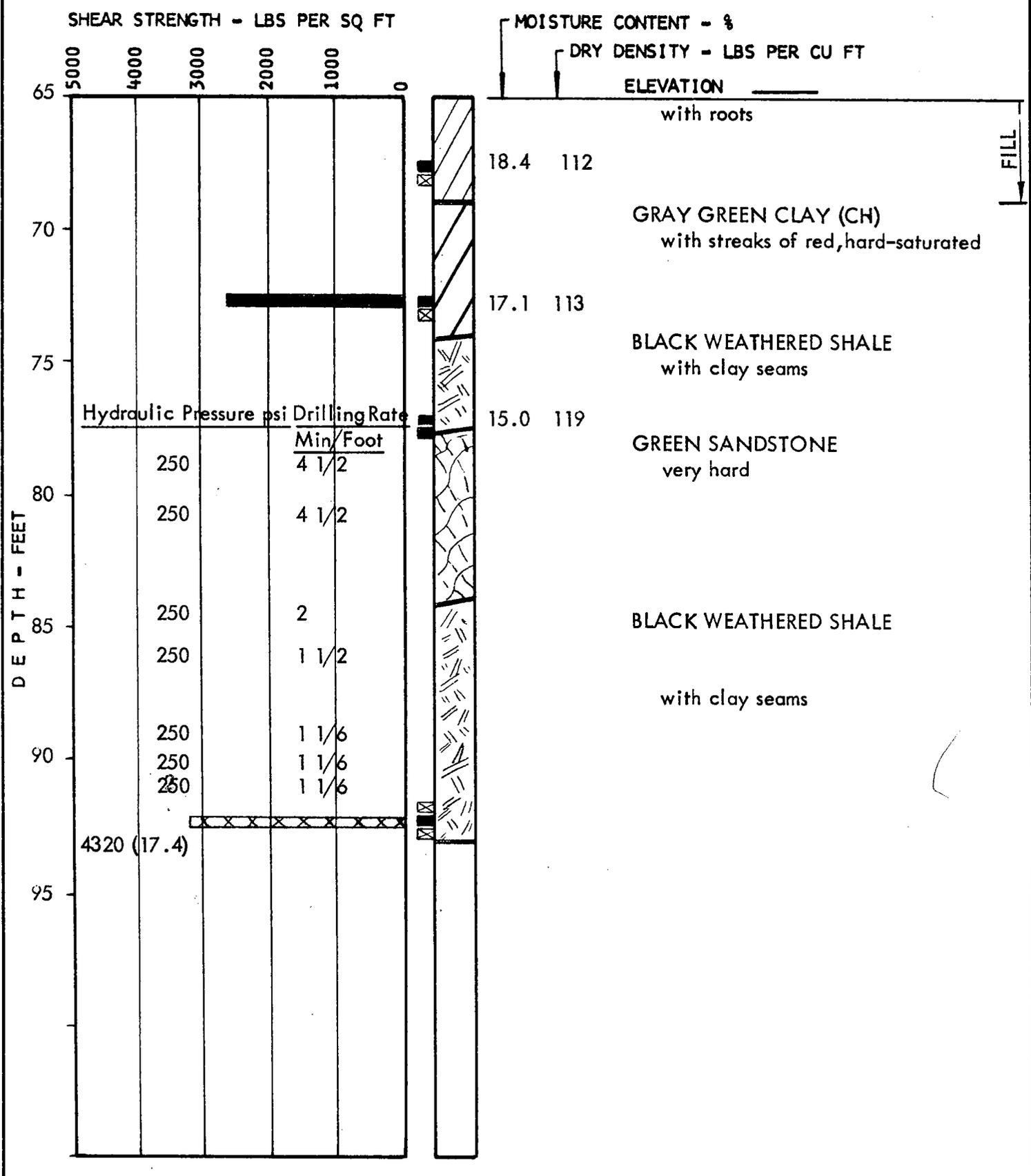
HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 6" Flight Auger, Rotary Wash

DRILLED 8-27-65

**B O R I N G 5** (Sheet 2 of 2)

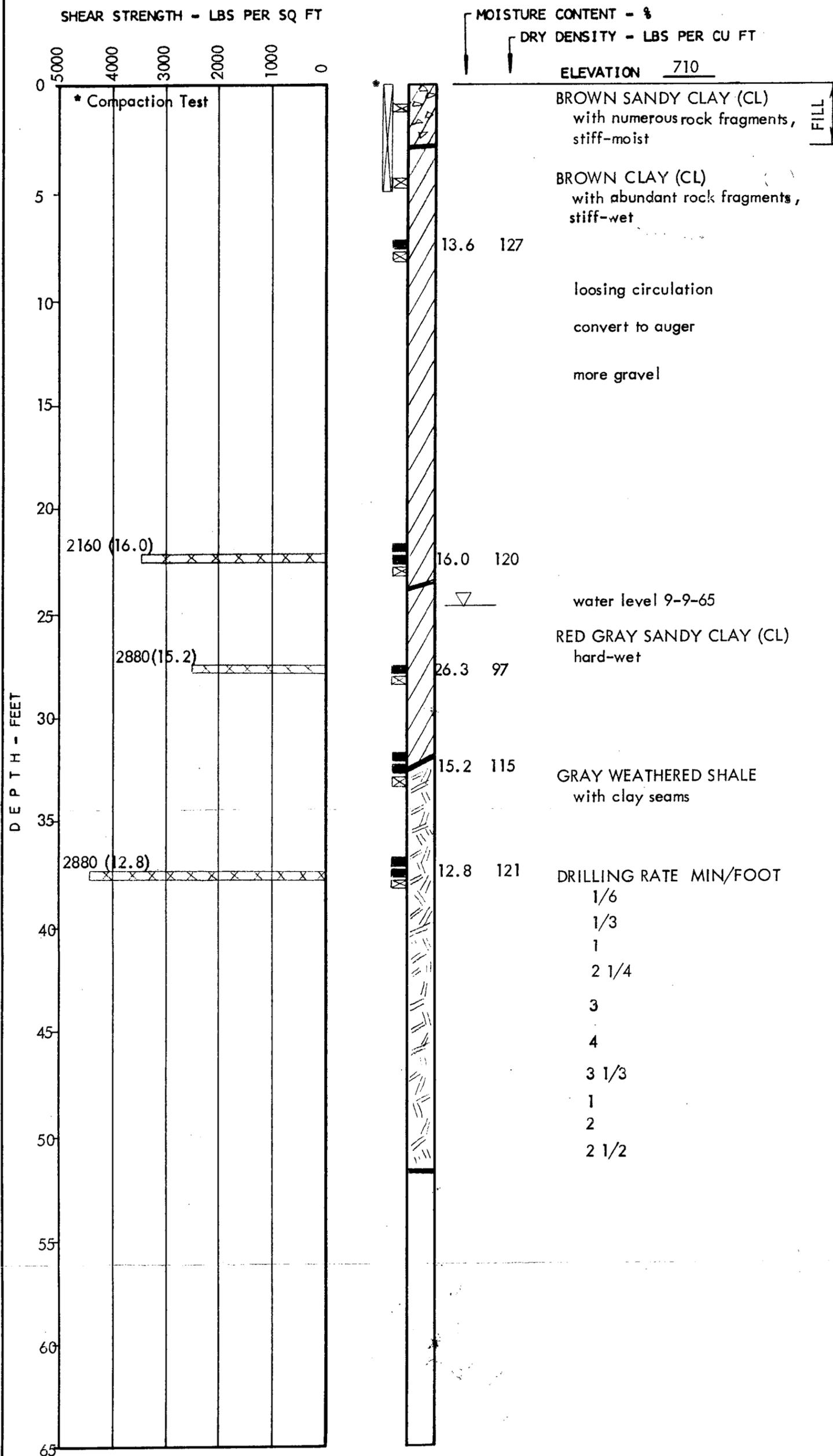


**HARDING ASSOCIATES**  
SOIL MECHANICS ENGINEERS

**LOG OF BORING**

EQUIPMENT **6" Flight Auger, Rotary Wash** DRILLED **8-27-65**

**BORING 6**



HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

**LOG OF BORING**

EQUIPMENT 6" Flight Auger, Rotary Wash DRILLED 9-9-65

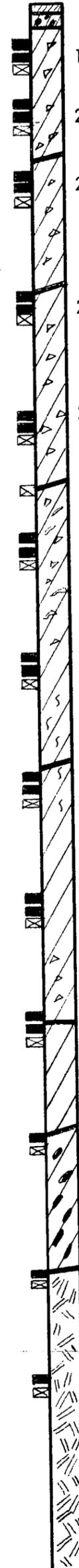
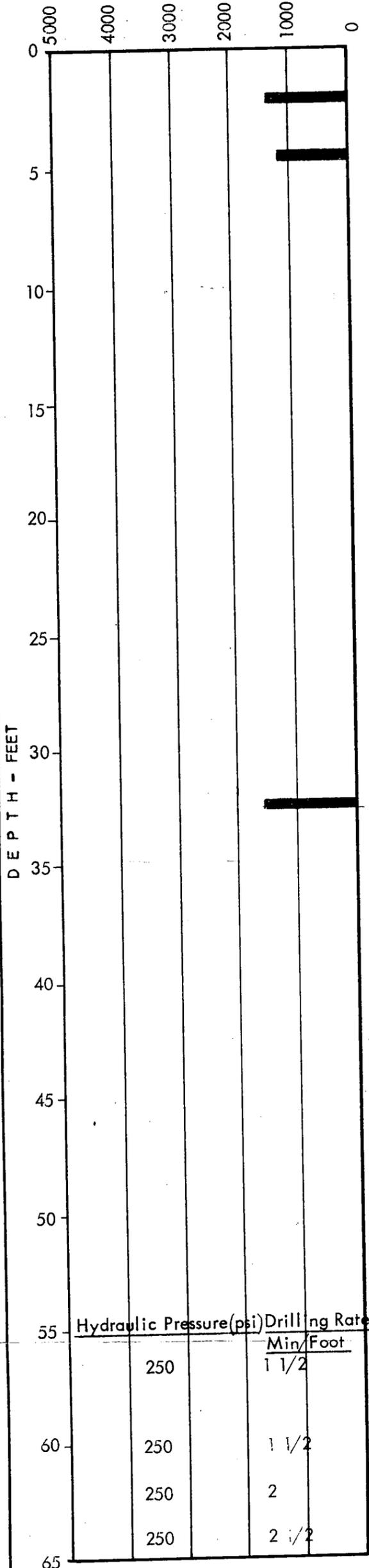
**BORING 7** (Sheet 1 of 2)

SHEAR STRENGTH - LBS PER SQ FT

MOISTURE CONTENT - %

DRY DENSITY - LBS PER CU FT

ELEVATION 710



0		8" CONCRETE
17.1	108	BROWN CLAYEY GRAVEL (GC) damp-dense (rock base)
20.2	102	GREEN BROWN SANDY CLAY (CL) with many rock fragments, very stiff-moist
23.9	102	YELLOW BROWN SANDY CLAY (CL) with many rock fragments, moderately stiff-moist
25.0	100	RED BROWN SANDY CLAY (CL) with small rock fragments stiff-wet
24.7	101	becoming yellow brown with topsoil
27.8	93	DARK GRAY CLAY (CL) with decayed wood & small rock fragments, moderately stiff-wet
28.2	95	with decayed vegetation
25.2	98	BROWN RED CLAY (CL) stiff-wet
27.7	96	with occasional rock fragments water level 9-7-65
24.0	103	GREEN CLAY (CH) stiff-saturated
23.3	104	BROWN CLAY (CL) with abundant rock fragments, stiff-saturated firm drilling
15.6	121	GRAY WEATHERED SHALE with clay seams hard drilling
13.5	123	with clay seams

Hydraulic Pressure (psi)	Drilling Rate Min/Foot
250	1 1/2
250	1 1/2
250	2
250	2 1/2

HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

LOG OF BORING

EQUIPMENT 6" Flight Auger. Rotary Wash

DRILLED 8-29-65  
9-7-65

PLATE 11

**BORING 7** (Sheet 2 of 2)

SHEAR STRENGTH - LBS PER SQ FT

MOISTURE CONTENT - %

DRY DENSITY - LBS PER CU FT

ELEVATION \_\_\_\_\_

5000  
4000  
3000  
2000  
1000  
0

DEPTH - FEET	Hydraulic Pressure (psi)		Drilling Rate	
	psi	psi	Min	Foot
65			12	
70	250		11	



LIGHT BROWN LIMESTONE  
very hard drilling

**HARDING ASSOCIATES**  
SOIL MECHANICS ENGINEERS

**LOG OF BORING**

EQUIPMENT 6" Flight Auger, Rotary Wash

8-29-65  
DRILLED 9-7-65

MAJOR DIVISIONS		TYPICAL NAMES		LABORATORY CLASSIFICATION CRITERIA		
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE**	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE*	CLEAN GRAVELS (little or no fines)	GW GP	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 4 $C_u = \frac{D_{200}}{D_{60}}$ BETWEEN 1 & 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR GW	
		GRAVEL WITH FINES (Appreciable amount of fines)	GM GC	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR PI LESS THAN 4 ATTERBERG LIMITS ABOVE "A" LINE WITH PI GREATER THAN 7	
		SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE*	CLEAN SANDS (Little or no fines)	SW SP	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 6 $C_u = \frac{D_{200}}{D_{60}}$ BETWEEN 1 & 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR SW
			SANDS WITH FINES (Appreciable amount of fines)	SM SC	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR PI LESS THAN 4 ATTERBERG LIMITS ABOVE "A" LINE WITH PI GREATER THAN 7
	FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE**	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY	<p>PLASTICITY CHART For laboratory classification of fine grained soils</p>	
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS		
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS	<p>Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% More than 12% 5% to 12% GW, GP, SW, SP GM, GC, SM, SC Borderline cases requiring use of dual symbols.</p>	
CH			INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS			
OH			ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS			
HIGHLY ORGANIC SOILS	Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS				

\*for visual classification, the 1/4 inch size may be used as equivalent to the no. 4 size.  
\*\*the no. 200 sieve size is about the smallest particle visible to the naked eye.

UNIFIED SOIL CLASSIFICATION SYSTEM

**SAMPLE DESIGNATION**

- Undisturbed Sample
- ▣ Disturbed or Bulk Sample
- Sample attempt with no recovery
- ∇ Vane Shear Test
- ▽ Observed Water Level

**STRENGTH TEST RESULTS**

- \* Vane Shear Test
- Unconfined Compression Test
- 1000 (30.0) Unconsolidated - Undrained Triaxial Compression Test
- 1000 (30.0) Consolidated - Undrained Triaxial Compression Test
- 1000 (30.0) Consolidated - Drained Triaxial Compression Test
- 1000 (30.0) "Quick" Direct Shear Test
- 1000 (30.0) Consolidated - Drained Direct Shear Test

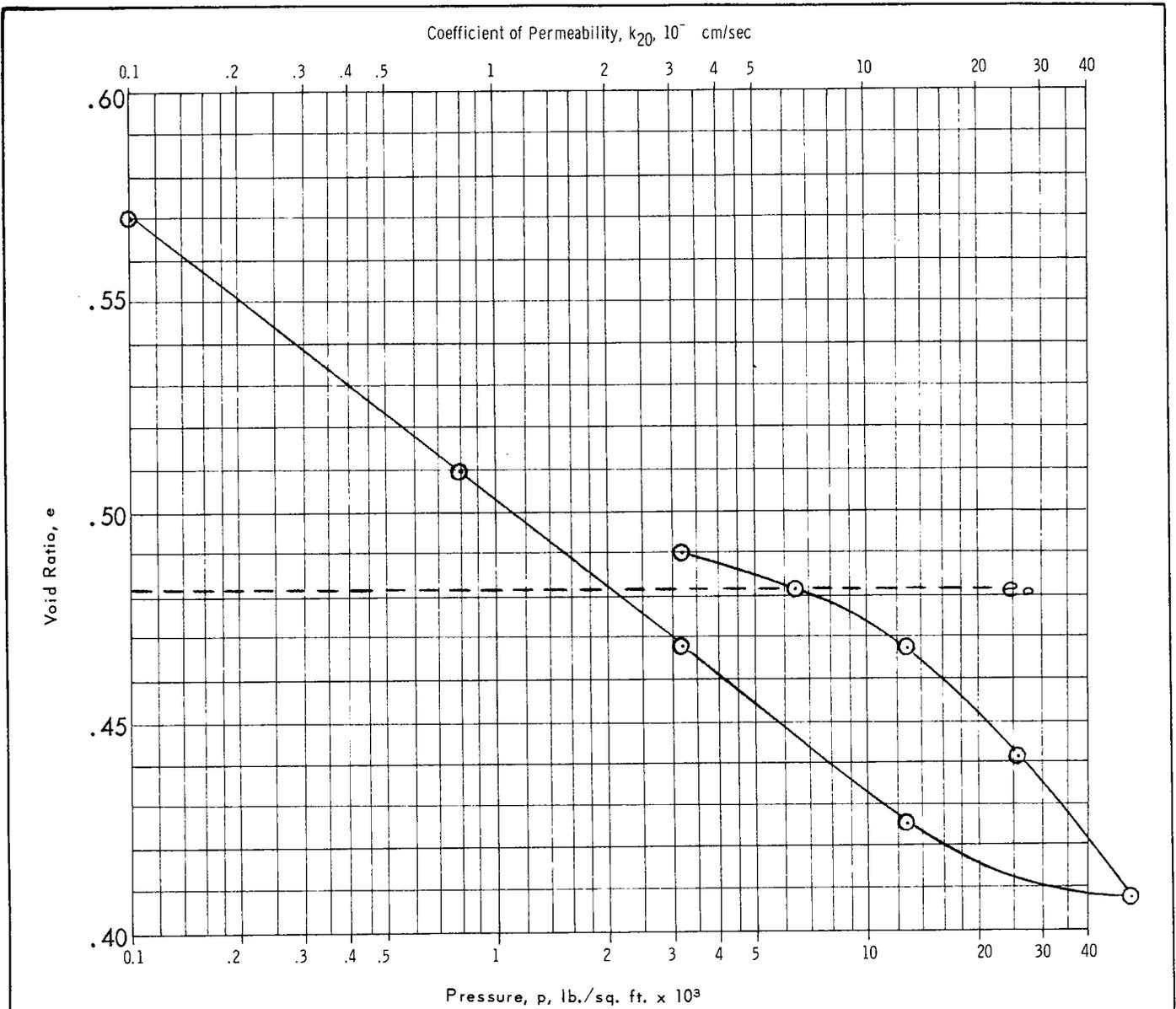
Bar Length Represents Shear Strength  
Moisture Content of Shear Zone after Test in Percent  
Stress Normal to Shear Plane in PSF

\* F denotes in-situ field test  
L denotes laboratory vane shear test  
(R) denotes remolded vane shear strength

HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

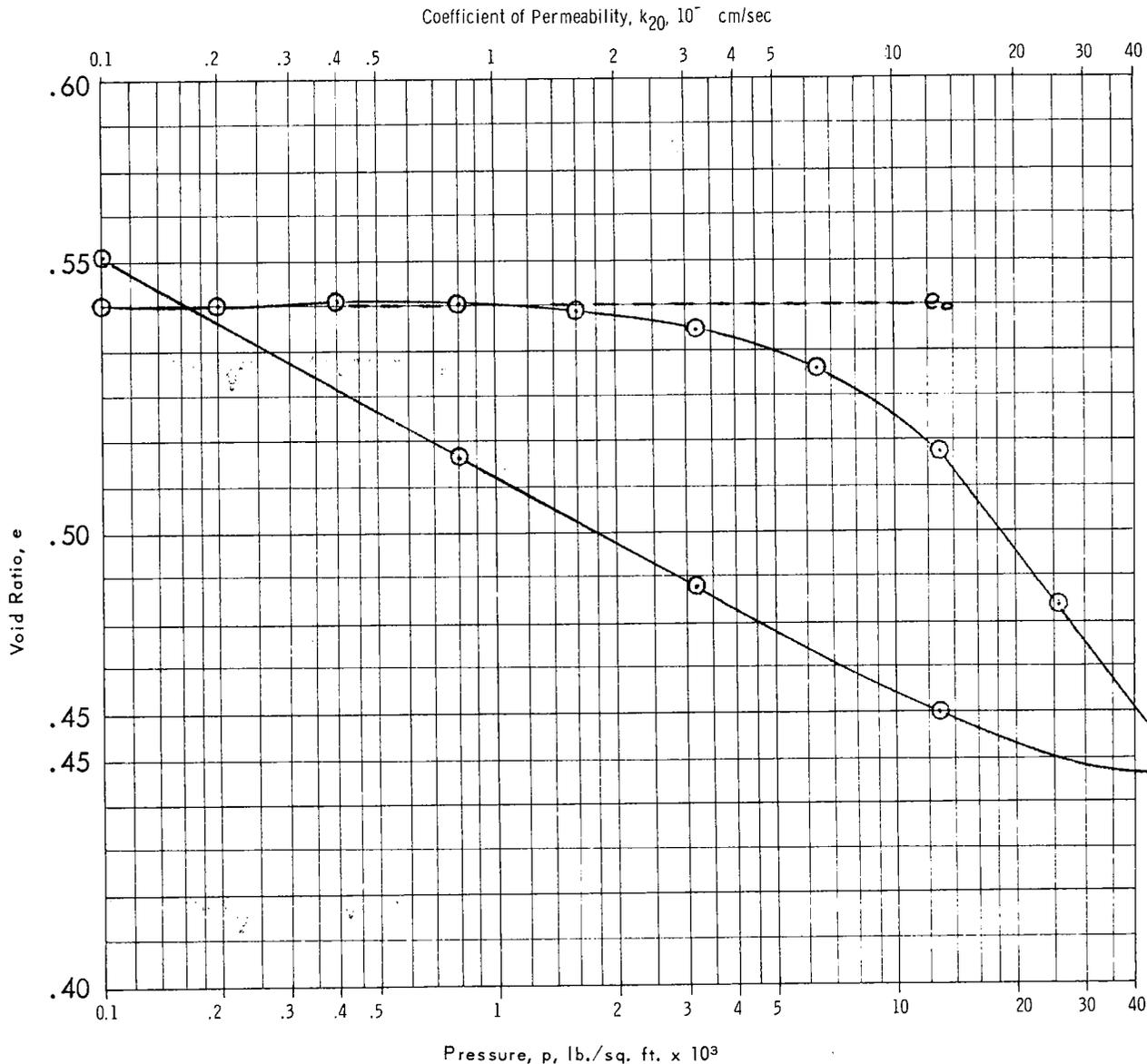
SOIL CLASSIFICATION CHART  
AND KEY TO TEST DATA

**HARDING ASSOCIATES**  
SOIL MECHANICS ENGINEERS



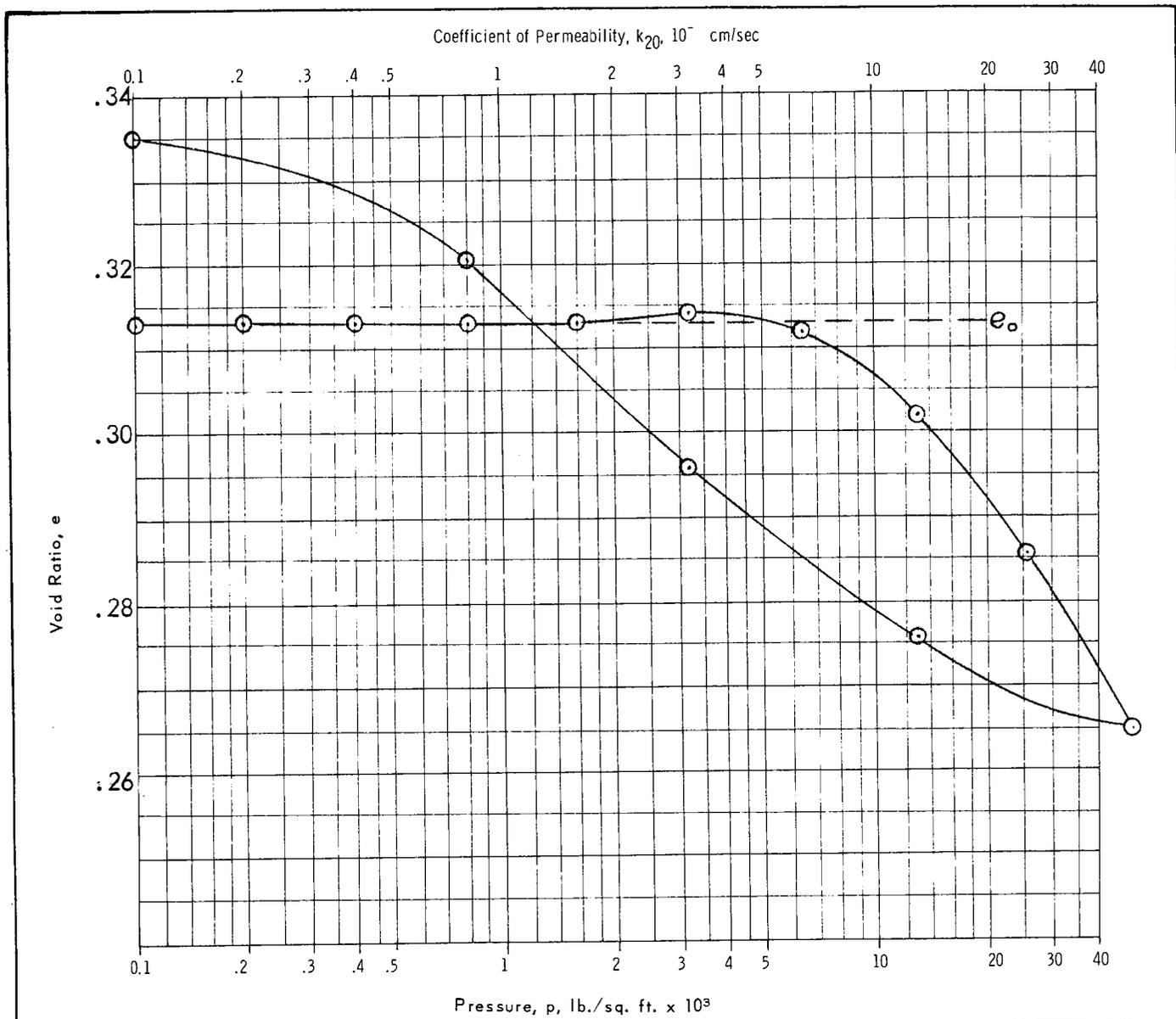
Type of Specimen <b>Undisturbed</b>		BEFORE TEST		AFTER TEST	
Diam. <b>2.43</b> in.	Ht. <b>1.00</b> in.	Water Content, $w_o$	<b>16.3</b> %	$w_f$	<b>21.2</b> %
Overburden Press, $P_o$	lb./sq. ft.	Void Ratio, $e_o$	<b>0.481</b>	$e_f$	<b>0.570</b>
Preconsol. Press, $P_c$	lb./sq. ft.	Saturation, $S_o$	<b>95</b> %	$S_f$	<b>100 +</b> %
Compression Index, $C_c$		Dry Density, $\gamma_d$	<b>118</b> lb/ft <sup>3</sup>		<b>111</b> lb/ft <sup>3</sup>
Classification <b>Gray Weathered Shale</b>		$k_{20}$ at $e_o$	$\times 10^{-7}$ cm/sec		
LL	$G_s$ <b>2.80 Assumed</b>	Project <b>U.C. Radiation Laboratory - 30 Ton Crane</b>			
PL	$D_{10}$	<b>Berkeley, California Job No. 2000.32</b>			
Remarks		Area			
		Hole No. <b>2</b>	Sample No.		
		Depth <b>67.0</b>	Date <b>9-20-65</b>		
<b>CONSOLIDATION TEST REPORT</b>					

**HARDING ASSOCIATES**  
SOIL MECHANICS ENGINEERS



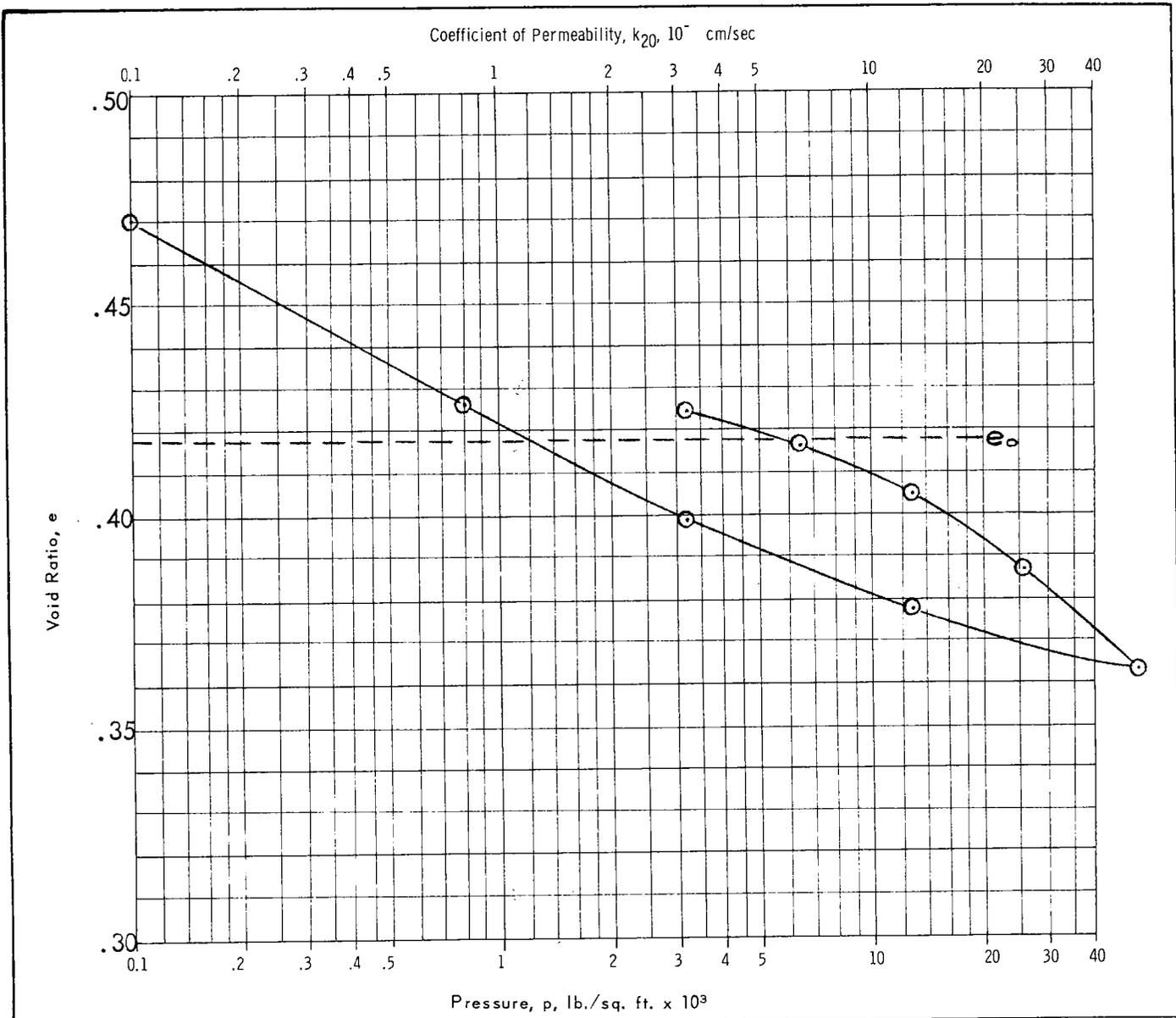
Type of Specimen <b>Undisturbed</b>		BEFORE TEST		AFTER TEST	
Diam. <b>2.43</b> in.	Ht. <b>1.00</b> in.	Water Content, $w_o$	<b>19.8</b> %	$w_f$	<b>21.0</b> %
Overburden Press, $P_o$	lb./sq. ft.	Void Ratio, $e_o$	<b>0.550</b>	$e_f$	<b>0.561</b>
Preconsol. Press, $P_c$	lb./sq. ft.	Saturation, $S_o$	<b>99</b> %	$S_f$	<b>100 +</b> %
Compression Index, $C_c$		Dry Density, $\gamma_d$	<b>111</b> lb/ft <sup>3</sup>		<b>110</b> lb/ft <sup>3</sup>
Classification <b>Green Clay (CH)</b>		$k_{20}$ at $e_o =$ <span style="float: right;"><math>\times 10^{-7}</math> cm/sec</span>			
LL	$G_s$ <b>2.74 Assumed</b>	Project <b>U.C. Radiation Laboratory-30 Ton Crane</b>			
PL	$D_{10}$	<b>Berkeley, California      Job No. 2000.32</b>			
Remarks		Area			
		Hole No. <b>3</b>		Sample No.	
		Depth <b>57.5</b>		Date <b>9-20-65</b>	
<b>CONSOLIDATION TEST REPORT</b>					

HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS



Type of Specimen		Undisturbed		BEFORE TEST		AFTER TEST	
Diam.	2.43 in.	Ht.	0.750 in.	Water Content, $w_o$	11.4 %	$w_f$	12.4 %
Overburden Press, $P_o$		lb./sq. ft.		Void Ratio, $e_o$	0.313	$e_f$	0.335
Preconsol. Press, $P_c$		lb./sq. ft.		Saturation, $S_o$	100 %	$S_f$	102 %
Compression Index, $C_c$				Dry Density, $\gamma_d$	131 lb/ft <sup>3</sup>		128 lb/ft <sup>3</sup>
Classification	Dark Green Shale		$k_{20}$ at $e_o$		$\times 10^{-7}$ cm/sec		
LL	$G_s$ 2.75 Assumed		Project U.C. Radiation Laboratory - 30 Ton Crane				
PL	D10		Berkeley, California Job No. 2000.32				
Remarks				Area			
				Hole No. 3		Sample No.	
				Depth 73.0		Date 9-20-65	
<b>CONSOLIDATION TEST REPORT</b>							

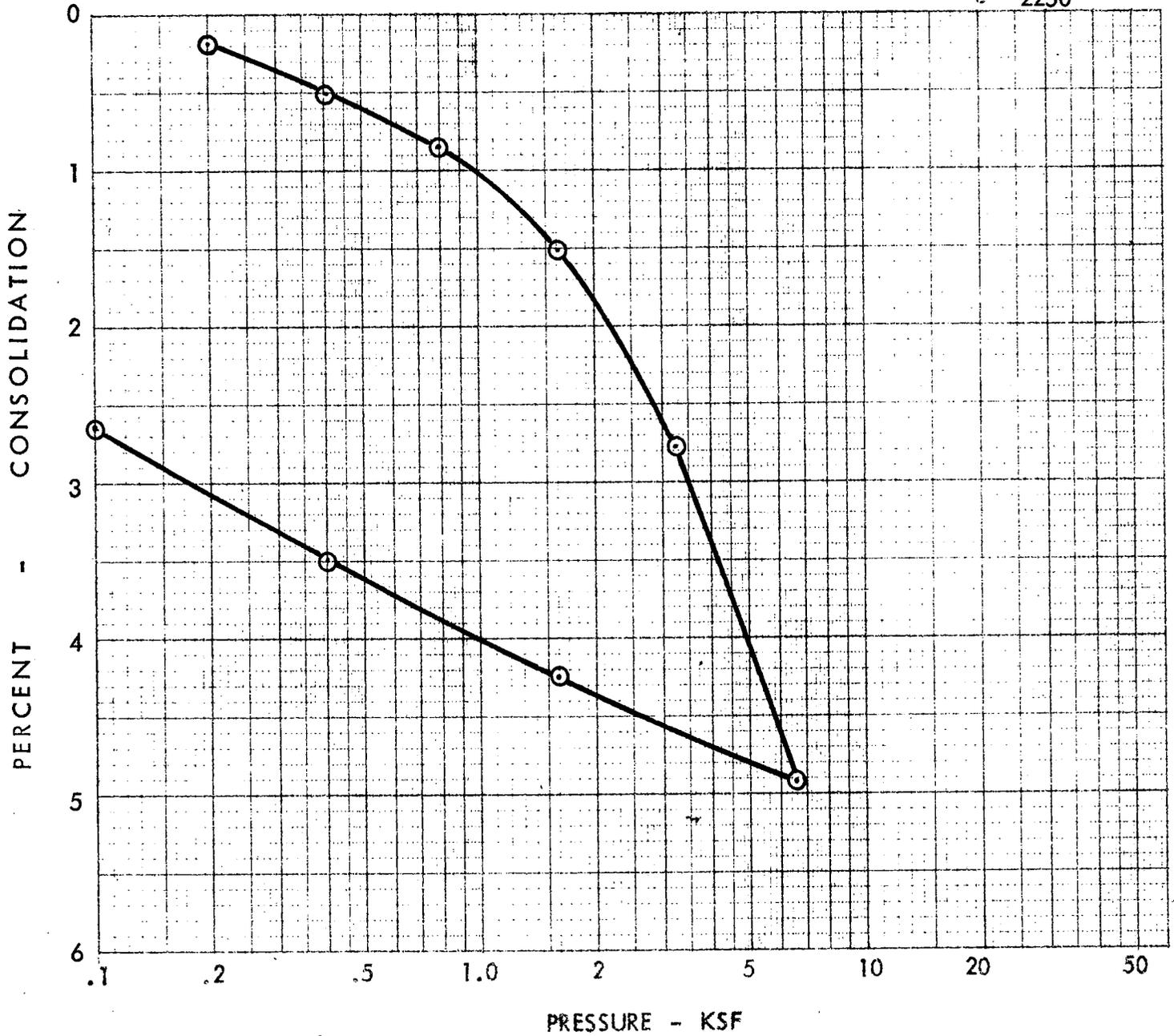
**HARDING ASSOCIATES**  
SOIL MECHANICS ENGINEERS



Type of Specimen <b>Undisturbed</b>		BEFORE TEST		AFTER TEST	
Diam. <b>2.43</b> in.	Ht. <b>1.00</b> in.	Water Content, $w_o$	<b>14.9</b> %	$w_f$	<b>17.3</b> %
Overburden Press, $P_o$	lb./sq. ft.	Void Ratio, $e_o$	<b>0.418</b>	$e_f$	<b>0.470</b>
Preconsol. Press, $P_c$	lb./sq. ft.	Saturation, $S_o$	<b>98</b> %	$S_f$	<b>100 +</b> %
Compression Index, $C_c$		Dry Density, $\gamma_d$	<b>121</b> lb/ft <sup>3</sup>		<b>117</b> lb/ft <sup>3</sup>
Classification <b>Red Brown Fractured Shale</b>		$k_{20}$ at $e_o$ <span style="float: right;"><math>\times 10^{-7}</math> cm/sec</span>			
LL	$G_s$ <b>2.76 Assumed</b>	Project <b>U.C. Radiation Laboratory - 30 Ton Crane</b>			
PL	$D_{10}$	Berkeley, California      Job No. <b>2000.32</b>			
Remarks		Area			
		Hole No. <b>4</b>		Sample No.	
		Depth <b>25.5</b>		Date <b>9-20-65</b>	
		<b>CONSOLIDATION TEST REPORT</b>			

C = 0.071

P<sub>c</sub> = 2250



CURVE	BORING	DEPTH	SOIL	MOISTURE CONTENT		DRY DENSITY LBS/CU FT
				INITIAL	FINAL	
	Trench	6.0	MOTTLED GRAY BROWN SANDY CLAY (CL)	18.4%	19.5%	106

HARDING ASSOCIATES  
SOIL MECHANICS ENGINEERS

CONSOLIDATION TEST DATA

**Harding Lawson Associates (HLA), 1973**, "Geologic Investigation, Building 46 Landslide, Lawrence Berkeley Laboratory, Berkeley, California," consulting report dated April 19, 1973. HLA Project No. 2000,063.01.

(LBNL # 083)

**Logs of Borings 1 through 35**  
**Logs of Slope Indicator Borings SI-1 through SI-4**

SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit	
1	807	2/9/73	18" Flight Auger	0 - 13.5	RED-BROWN GRAVELLY CLAY (CL) - medium stiff, wet, with abundant rock fragments	Qls (Tm) (2)	
				13.5 - 14.5	GRAY-BROWN SANDY CLAY (CL) - soft, wet (slip plane)		
				14.5 - 35.0	ALTERNATING BLUE-GREEN SILTSTONE, SANDSTONE & CLAYSTONE (free groundwater at 15 feet)	To	
2(1)	807	2/10/73	18" Flight Auger	±15 to 35	BLUE-GRAY CLAYSTONE	To	
3(1)	807	2/10/73	18" Flight Auger	±15 to 35	BLUE-GRAY CLAYSTONE	To	
4	807	2/12/73 and 2/20/73 and 2/21/73	18" Flight Auger	0 - 0.3	ASPHALTIC CONCRETE PAVING	Qls (Tm)	
				0.3 - 12.5	RED-BROWN CLAYEY GRAVEL (GC) - medium dense, moist, rock fragments to 8" composed of angular volcanics		
				12.5 - 31.8	RED-BROWN, BLUE-GRAY, & YELLOW-GREEN VOLCANICS (Basalt) - with some gravelly clay, moist to wet, hard		"
				31.8 - 39.0	GREEN-BROWN & RED-BROWN CLAYEY SANDY GRAVEL (GP) - moist, dense to medium dense, weak rock fragments to 3"		"
				39.0 - 42.2	RED-BROWN SANDY GRAVELLY CLAY (CL) - moist to wet, stiff, with rock fragments of basalt		"
				42.2 - 70.8	BLUE-GRAY, GREEN & RED-BROWN SILTSTONE - moist to wet, weak, slickensided in upper 2 feet		To
				70.8 - 82.0	RED-BROWN SILTSTONE - dry to moist, low hardness, medium strong, with rock fragments to 4" (slickensided siltstone @ 80.0 to 81.0 feet)		"

NOTES:

- (1) Not logged during drilling; description based on driller's comments.  
(2) Explanation of geologic symbols on Geologic Map, Plate 2.

SUMMARY OF TEST BORING LOGS  
 Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit
5	806	2/13/73	18" Flight Auger	0 - 0.25	ASPHALT PAVING	
				0.25 - 8.5	RED-BROWN SANDY CLAY (CL) - dense, moist, with rock fragments to 4" composed of angular volcanics	Qls (Tm)
				8.5 - 10.3 (Refusal)	GRAY VOLCANICS (Basalt) - hard, strong	"
6	804	2/13/73	18" Flight Auger	0 - 0.25	ASPHALT PAVING	
				0.25 - 35.0	RED-BROWN TO GRAY-BROWN GRAVELLY SANDY CLAY (CL) - stiff, moist to wet, with rock fragments of medium hard basalt	Qls (Tm)
7	816	2/13/73 and 2/14/73	18" Flight Auger	0 - 0.25	ASPHALT PAVING	
				0.25 - 4.0	RED-BROWN SANDY GRAVELLY CLAY (CL) - stiff, moist	
				4.0 - 13.0	BLUE-GRAY CLAY (CH) - soft, wet, with angular rock fragments	Fault Gauge?
				13.0 - 30.0	BLUE-GRAY & BLUE-GREEN SANDY GRAVELLY CLAY (CL) dry to moist, with rock fragments (saturated at 22 feet)	To
8	811	2/14/73	18" Flight Auger	0 - 0.25	ASPHALT PAVING	
				0.25 - 8.5	RED-BROWN SANDY CLAY (CL) - stiff, moist, wet at 2 feet	Qls (Qf)
				8.5 - 14.5	RED-BROWN CLAYEY SANDY GRAVEL (GP) - wet	Tm
				14.5 - 35.0	RED-BROWN TO YELLOW-GREEN SANDY CLAY (CL) stiff, wet to moist (weathered claystone & siltstone)	To
9	862	2/14/73	18" Flight Auger & 20" Bucket Auger	0 - 0.2	2" ASPHALT PAVING	
				0.2 - 19.0	RED-BROWN SANDY CLAY - soft, wet, with rock fragments, becoming drier at 7 feet	Qls
				19.0 - 20.8	GREEN, RED-BROWN SANDY CLAY - stiff, moist to wet	"
				20.8 - 41.8	GRAY, RED & BROWN SANDY CLAY - stiff, moist to wet, with rock fragments	Tm

SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit
9 (cont.)				41.8 - 53.5	GREEN TO BLUE-GRAY SILTSTONE - hard, moist (Hole offset at 20 feet, 2/28/73)	To
10	857	2/15/73	18" Flight Auger	0 - 21.0	RED-BROWN SANDY CLAY (CL) - soft, wet, with rock fragments	Qls
				22.0 - 25.5	GRAY-GREEN SANDY CLAY (CL) - stiff, moist	
				25.5 - 52.0	BLUE-GRAY SILTSTONE - stiff, moist to dry (Hole offset at 10 feet, 2/28/73)	To
11	855	2/15/73	18" Flight Auger	0 - 0.2	ASPHALT PAVING	
				0.2 - 10.0	RED-BROWN SANDY CLAY (CL) - soft, wet, with rock fragments to 4"	Tm
				10.0 - 14.0	GRAY-BLUE SILTSTONE - soft, moist, with rock fragments & sandy clay	To
				14.0 - 20.5	YELLOW-GREEN SILTSTONE - moderately hard, moist, with slickensides (fractured basalt lens from 18.0 to 19.0 feet)	"
				20.5 - 22.0	BLUE-GRAY SILTSTONE - very hard (free groundwater at 19.0 feet)	"
12	850	2/15/73	18" Flight Auger	0 - 0.2	ASPHALT PAVING	
				0.2 - 6.2	RED, BROWN & GRAY SANDY CLAY - soft, wet, with rock fragments to 4"	Tm
				6.2 - 17.2	GREEN SILTSTONE - hard, moist, with rock fragments	To
				17.2 - 19.5	BROWN-GREEN CONGLOMERATE - hard	"
13	847	2/15/73 and 2/16/73	18" Flight Auger	0 - 0.2	ASPHALT PAVING	
				0.2 - 18.2	GREEN SILTSTONE - hard, dry to moist, with basalt rock fragments	To

SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit
13 (cont.)				18.2 - 26.0	BLUE-GRAY & PURPLE CLAYSTONE - medium hard, moist to wet (free groundwater at 12.0 feet)	To
14	843	2/16/73	18" Flight Auger	0 - 2.0	ASPHALT, DRAINROCK & 6" CMP	
				2.0 - 13.8	GREEN SILTSTONE - moderately hard, moist, with rock fragments of basalt	To
				18.8 - 26.8	BLUE-GRAY SILTSTONE - moderately hard, moist	"
				26.8 - 28.0	GREEN-GRAY SILTSTONE - hard, moist	"
15	880	2/16/73	18" Flight Auger	0 - 4.8	RED-BROWN SANDY CLAY (CL) - moist to wet	Qc
				4.8 - 5.8	BLUE-RED SANDY CLAY (CL) - soft, wet	Tm
				5.8 - 8.8	RED-BROWN & GREEN SANDY CLAY - medium stiff, moist to wet	To
				8.8 - 30.0	GREEN-BROWN CLAYSTONE - soft, moist to wet (dry and hard below 13 feet)	"
16	867	2/16/73	18" Flight Auger	0 - 0.5	ASPHALT PAVING & BASEROCK	
				0.5 - 24.5	RED-BROWN SANDY CLAY (CL) - stiff, moist to wet, with rock fragments	Qls
				24.5 - 36.2	MOTTLED RED-BROWN, GREEN-BROWN & BROWN SANDY CLAY - stiff, moist, with rock fragments	Qls (Tm)
				36.2 - 45.5	LIME GREEN SILTSTONE - moist	To
				45.5 - 60.0	BLUE-GREEN SILTSTONE - dense, moist to wet	"
17	874	2/16/73	18" Flight Auger	0 - 17.0	RED-BROWN SANDY CLAY (CL) - soft, wet, with rock fragments	Qls
				17.0 - 34.0	GREEN SILTSTONE - moderately hard, moist to wet	To
				34.0 - 35.0	BLUE-GRAY SILTSTONE - moderately hard, dry to moist (Hole offset at 18 feet, 2/28/73)	"

SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit
18	818	2/16/73 and 2/17/73	18" Flight Auger & 20" Bucket Auger	0 - 0.2	ASPHALT PAVING	
				0.2 - 10.0	GREEN SILTSTONE - hard, dry	To
				10.0 - 17.0	RED, GREEN & BLUE-GRAY SILTSTONE - moderately hard, dry, (seepage at 12.0 to 13.5 feet)	"
				17.0 - 30.0	BLUE-GRAY SILTSTONE - moderately hard, dry to moist	"
19	804	2/17/73	18" Bucket Auger	0 - 0.8	ASPHALT PAVING & BASEROCK	
				0.8 - 18.0	RED-BROWN SANDY CLAY (CL) - medium stiff, wet, with rock fragments	Qls
				18.0 - 24.0	BROWN CLAYEY SANDY GRAVEL (GP) - soft to medium dense, wet, becoming weathered with depth	Qls (Tm)
				24.0 - 27.0	BLUE-GRAY SILTSTONE - soft to moderately hard, wet	To
				27.0 - 28.5	BROWN SILTSTONE - low hardness, weak, moist	"
				28.5 - 36.0	BLUE-GRAY SILTSTONE - moderately hard, moist	"
				36.0 - 39.0	BROWN SANDY SILT (ML) - dense, moist, with angular rock fragments	"
				39.0 - 51.2	RED-BROWN & BLUE-GRAY SILTSTONE - low hardness, slickensided, moist	"
				51.2 - 60.0	BLUE-GRAY SILTSTONE - low hardness, moist to dry	"
20	803	2/17/73	20" Bucket Auger	0 - 10.8	MOTTLED RED-GREEN & BROWN SANDY GRAVELLY SILT (ML) - dense, moist	Qls
				10.8 - 28.8	RED-BROWN SANDY GRAVELLY CLAY (CL) - medium stiff, moist to wet, with basalt rock fragments & cobbles	Qls (Tm)
				28.8 - 30.0	PURPLE-BROWN SANDY GRAVELLY CLAY (CL) soft, wet (slip plane)	

SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit
20 (cont.)				30.0 - 32.0	BLUE-GRAY SILTSTONE - low hardness, weak, moist to wet	To
				32.0 - 38.5	GRAY-GREEN SILTSTONE - moderately strong, wet	"
				38.5 - 61.0	BLUE-GRAY SILTSTONE - weak, wet, occasional shear zones, with slickensides	"
				61.0 - 82.0	ALTERNATING BEDS OF RED-BROWN & BLUE-GRAY SILTSTONE - low hardness, moist to dry, increasing in strength with depth (Hole offset at 31.5 feet, 2/28/73)	"
21	806	2/20/73	18" Flight Auger	0 - 15.0	RED-BROWN GRAVELLY CLAY (CL) - stiff, moist	Qls
				15.0 - 16.0	RED-GRAY CLAY (CH) - soft, saturated, with abundant siltstone fragments (sheared slip plane)	"
				16.0 - 18.0	GREEN SILTSTONE - low hardness, moderately strong	To
22	852	2/20/73	20" Bucket Auger	0 - 10.0	RED-BROWN GRAVELLY CLAY (CL) - stiff, moist	Qc/Tm
				10.0 - 23.0	GRAY-GREEN SILTSTONE	To
23	849	2/20/73	20" Bucket Auger	0 - ±13.0	RED-BROWN GRAVELLY CLAY (CL) - stiff, moist, seepage at 6 feet	Tm
				±13.0 - 27.0	GRAY-GREEN SILTSTONE - hard, some seepage at 20 feet	To
24	815	2/20/73	20" Bucket Auger	0 - 0.1	ASPHALT PAVING	
				0.1 - 3.0	RED-BROWN SANDY GRAVELLY CLAY (CL) - medium stiff, wet, with basalt rock fragments	Qc/Tm
				3.0 - 15.0	BLUE-GRAY SILTSTONE - weak, moist	To
				15.0 - 22.0	GREEN SILTSTONE - moderately hard, moderately strong, moist	"
				22.0 - 30.0	BLUE-GRAY SILTSTONE - moderately hard, moist	

SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit
25	815	2/20/73	18" Flight Auger	0 - 3.5	ASPHALT PAVING & BASEROCK MATERIAL	
				3.5 - 13.0	GRAY-GREEN SILTSTONE - moderately hard, moderately strong, moist to wet	To
				13.0 - 16.0	BLUE-GRAY SILTSTONE - moderately hard, moderately strong, moist	"
				16.0 - 28.5	GREEN SILTSTONE - moderately hard, moderately strong, moist, becoming wet & soft at 27 feet	"
				28.5 - 35.0	BLUE-GRAY SILTSTONE - soft, wet, with sand & gravel becoming dry to moist at 34.5 feet	"
26	756	2/20/73	20" Bucket Auger	0 - 30.0	(Not Logged - Little or No Water)	
27	750	2/21/73	20" Bucket Auger	0 - 12.2	RED-BROWN SILTSTONE MOTTLED WITH GRAY-BLUE SANDSTONE - low hardness, weak, soft to medium stiff, wet (Fill?)	Qf
				12.2 - 16.0	BLUE-GRAY SILTSTONE - low hardness, weak, wet	To
				16.0 - 19.0	RED-BROWN SILTSTONE - low hardness, wet, with slickensides	"
				19.0 - 30.0	BLUE-GRAY SILTSTONE - low hardness, moist to wet	"
28	755	2/21/73	20" Bucket Auger	0 - 19.8	MOTTLED RED-BROWN & BLUE-GRAY SILTSTONE - medium stiff, wet (Fill?)	Qf
				19.8 - 22.5	RED-BROWN SILTSTONE	To
				22.5 - 30.0	MOTTLED RED-BROWN & BLUE-GRAY SILTSTONE - moist to wet	"
29	760	2/21/73	20" Bucket Auger	0 - 11.0	MOTTLED RED-BROWN & BLUE-GRAY SANDY SILT (ML) - medium stiff, wet	Qf
				11.0 - 18.0	GREEN SILTSTONE - low hardness, moderately strong, moist	To

SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit
29 (cont.)				18.0 - 23.0	MOTTLED RED-BROWN & BLUE-GRAY SILTSTONE - moist to wet, slickensides at 19 feet	To
				23.0 - 25.0	MOTTLED RED-BROWN & GREEN CLAYSTONE - moderately hard, moderately strong, wet	"
				25.0 - 39.0	RED-BROWN & BLUE-GRAY SILTSTONE - moderately strong, moderately hard wet, badly sheared at 32.0 and 36.0 feet	"
				39.0 - 46.0	MOTTLED BLUE-GRAY & RED-BROWN SILTSTONE - highly fractured, moist to wet, sheared	"
30	805	2/27/73	20" Bucket Auger	0 - 8.8	RED-BROWN SANDY SILTY CLAY (CL) - soft, wet, with basalt fragments	Qls
				8.8 - 13.0 (Refusal)	RED-BROWN TO BLUE-GRAY BASALT - hard	Qls (Tm)
31	815	2/28/73	20" Bucket Auger	0 - 8.0	RED-BROWN SANDY CLAY (CL) - soft, wet, with basalt fragments (Fill)	Qf
				8.0 - 10.0	DARK BROWN SILTY CLAY (CL) - top soil, with organics	Qc
				10.0 - 21.0	GREEN SILTSTONE - moderately hard, weak, moist to wet	To
				21.0 - 30.0	GREEN SANDY SILTY GRAVEL (GP) - medium dense, wet	"
				30.0 - 38.0	GREEN SILTSTONE - low hardness, weak, moist	"
				38.0 - 60.0	BLUE-GRAY & RED-BROWN SILTSTONE - low hardness weak, dry to moist (free groundwater at 25.0 feet)	"
32	817	2/28/73	20" Bucket Auger	0 - 18.0	RED-BROWN SILTY CLAY (CL) - medium stiff, wet, with rock fragments (Fill?)	Qf/Qc
				18.0 - 39.0	GREEN SILTSTONE (free groundwater at 27.0 feet)	To

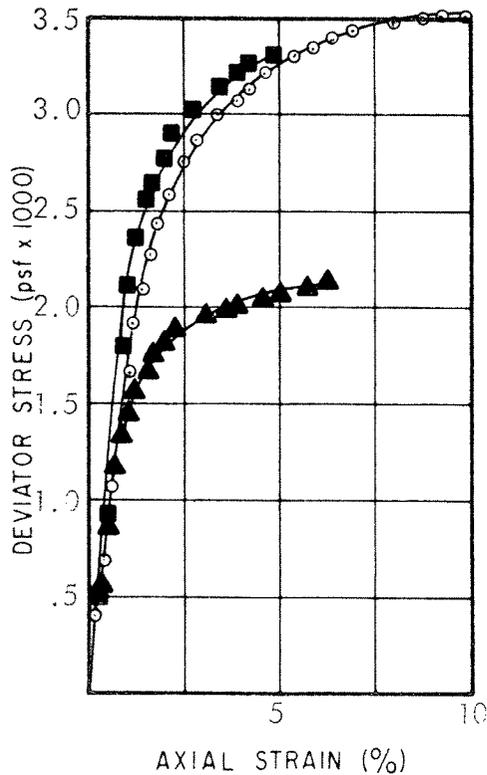
SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Unit
33	821	2/28/73 and 3/1/73	24" Bucket Auger	0 - 23.0	RED-BROWN SANDY SILTY CLAY (CL) - soft to medium stiff, moist to wet, with rock fragments to 6" (Fill?)	Qf
				23.0 - 25.2	DARK BROWN SANDY SILTY CLAY (CL) - soft to medium stiff, moist to wet, organics (Topsoil)	Qc
				25.2 - 37.0	MOTTLED RED-BROWN & GREEN SILTSTONE & CLAYSTONE low hardness, weak, moist to wet	To
				37.0 - 39.0	GRAY CONGLOMERATE	"
34	807	3/1/73	24" Bucket Auger	0 - 40.0	(Hole not logged) (wet zone found at 27.0 feet)	
35	815.5	2/20/73	18" Flight Auger	0 - 3.0	ASPHALT PAVING & SANDY CLAY BASE MATERIAL (FILL)	
				3.0 - 26.0	GREEN SILTSTONE - soft, wet at 23.5 feet	To
				26.0 - 30.0	BLUE-GRAY SILTSTONE - moderately hard, wet	"
SI-1	804.5	2/26/73 to 3/2/73	6" Rotary Wash	0 - 10.0	RED-BROWN TO GRAY CLAYEY GRAVEL (GC) hard, moist	Qls
				10.0 - 45.5	GRAY-BROWN BASALT - PURPLE ALTERED CLAY at 44 feet	Qls (Tm)
				45.5 - 65.5	ALTERNATING GREEN, RED, BROWN SILTSTONE & SANDSTONE (Slope Indicator Casing installed 3/20/73)	To
SI-2	±1045	3/2/73	6" Rotary Wash	0 - 20.0	RED-BROWN SANDY CLAY (CL) - moist, stiff	Qc
				20.0 - 90.0	ALTERNATING RED, BLUE, GRAY, GREEN SILTSTONES, CLAYSTONES, SANDSTONES - occasionally tuffaceous	To
				90.0 - 98.5	MOTTLED RED-GRAY SILTSTONE BRECCIA (Slope Indicator Casing installed 3/5/73)	To/Tm(?)
SI-3	843	3/6/73	6" Rotary Wash	0 - 43.5	MOTTLED RED, GRAY, BROWN SANDY GRAVELLY CLAY (CL) - stiff, moist to wet	Qf
				43.5 - 118.0	ALTERNATING RED-BROWN, GREEN SILTSTONES & SANDSTONES (Slope Indicator Casing installed 3/12/73)	To

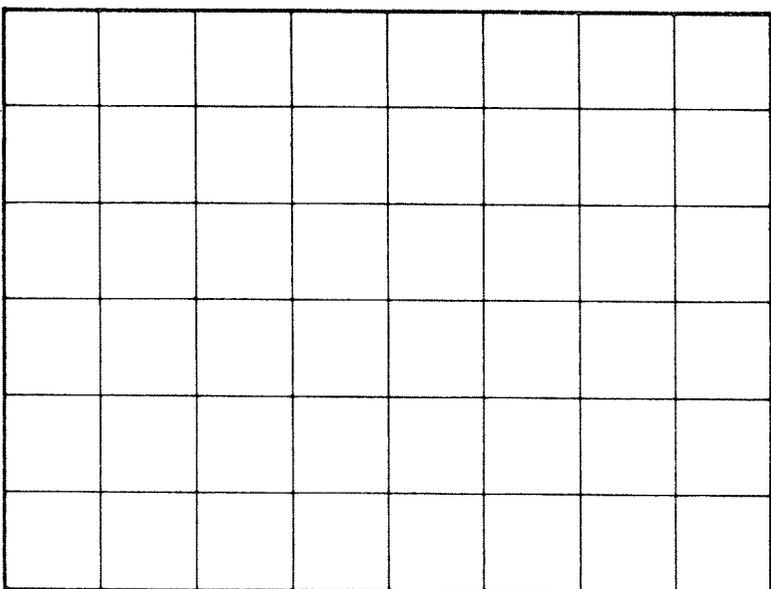
SUMMARY OF TEST BORING LOGS  
Building 46 Landslide Investigation

Boring No.	Elevation (Ft.)	Date	Equipment	Depth Interval (Ft.)	Description	Geologic Un
SI-4	±920	3/12/73	6" Rotary Wash	0 - 99.0	GRAY-BROWN VOLCANICS - BASALT, ANDESITE, BRECCIA, AGGLOMERATE	Tm
				99.0 - 106.0	MOTTLED BLUE-BROWN BASALT & SANDSTONE - deeply altered	Tm/To
				106.0 - 120.0	BLUE-GRAY SANDSTONE (Slope Indicator Casing installed 3/19/73)	To

RT



SHEAR STRESS (psf x 1000)

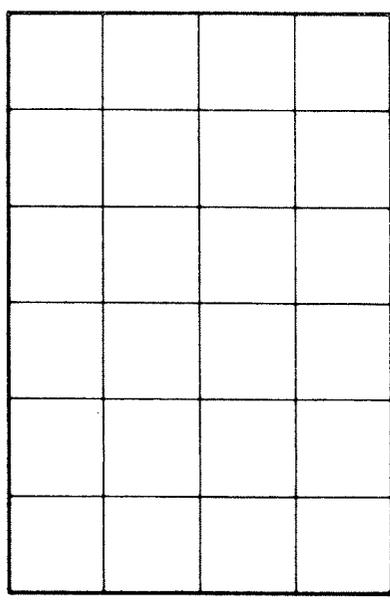


NORMAL STRESS (psf x 1000)

Test Type Undrained Controlled: Strain  
 Saturation Method -  $G_s$  2.75 (Assumed)

$\sigma_1 / \sigma_3$

PORE PRESSURE (psf)



AXIAL STRAIN (%)

$\phi =$   
 $c =$

Test No	A	B	C
Initial			
Diameter (in)	2.43	2.43	2.43
Height (in)	4.8	5.2	5.1
Moisture Content	22.9 %	20.2 %	37.5 %
Void Ratio			
Saturation	44 %	42 %	24 %
Dry Density (pcf)	97	102	80
Before Test			
Moisture Content	%	%	%
Void Ratio			
Saturation	%	%	%
Pressure (psf)			
Final			
Moisture Content	22.9 %	20.2 %	37.5 %
Void Ratio	.62	.65	1.11
$\sigma_1$ Major Prin. Stress (psf)	3500	3140	4320
$\sigma_3$ Minor Prin. Stress (psf)	1000	1000	1000
Time to Failure (min)			
Sample Source: A&B So. edge Bldg. 46; C No. of Bldg 46			
Classification: BROWN GRAVELLY SANDY SILT (ML)			

**HARDING - LAWSON ASSOCIATES**



Consulting Engineers and Geologists

TRIAXIAL COMPRESSION TEST REPORT

Building 46 Landslide  
 Lawrence Berkeley Laboratory  
 Berkeley, California

PLATE

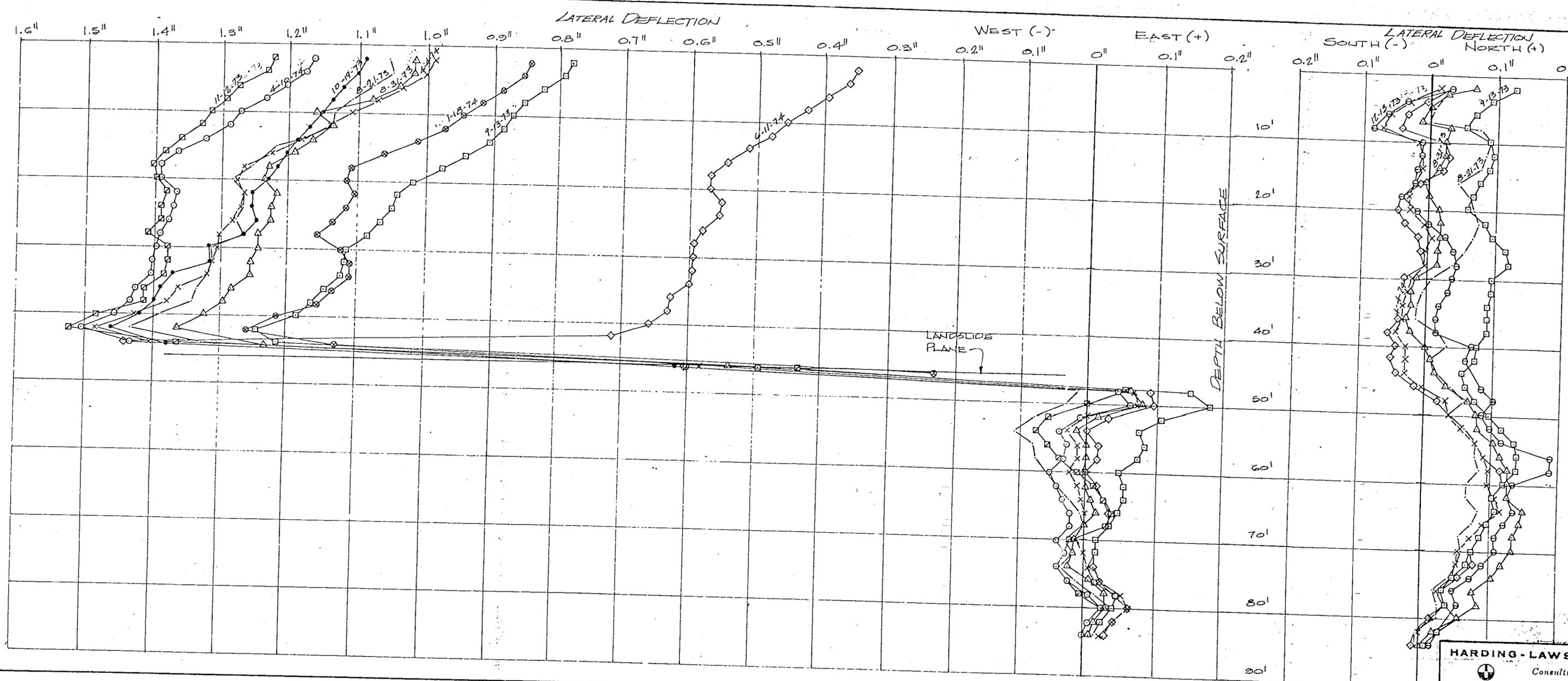
**5**

Job No. 2000,063.01 Appr: [Signature] Date 4/19/73

**Harding Lawson Associates (HLA), 1976a**, "Slope Monitoring Data, Building 46 Landslide, Lawrence Berkeley Laboratory, Berkeley, California," five slope indicator plots dated March 3, 1976, HLA Job No. 2000,085.01.

(LBNL # 282)

**Slope Indicator Plots SI-1 through SI-5**



Water Level Data

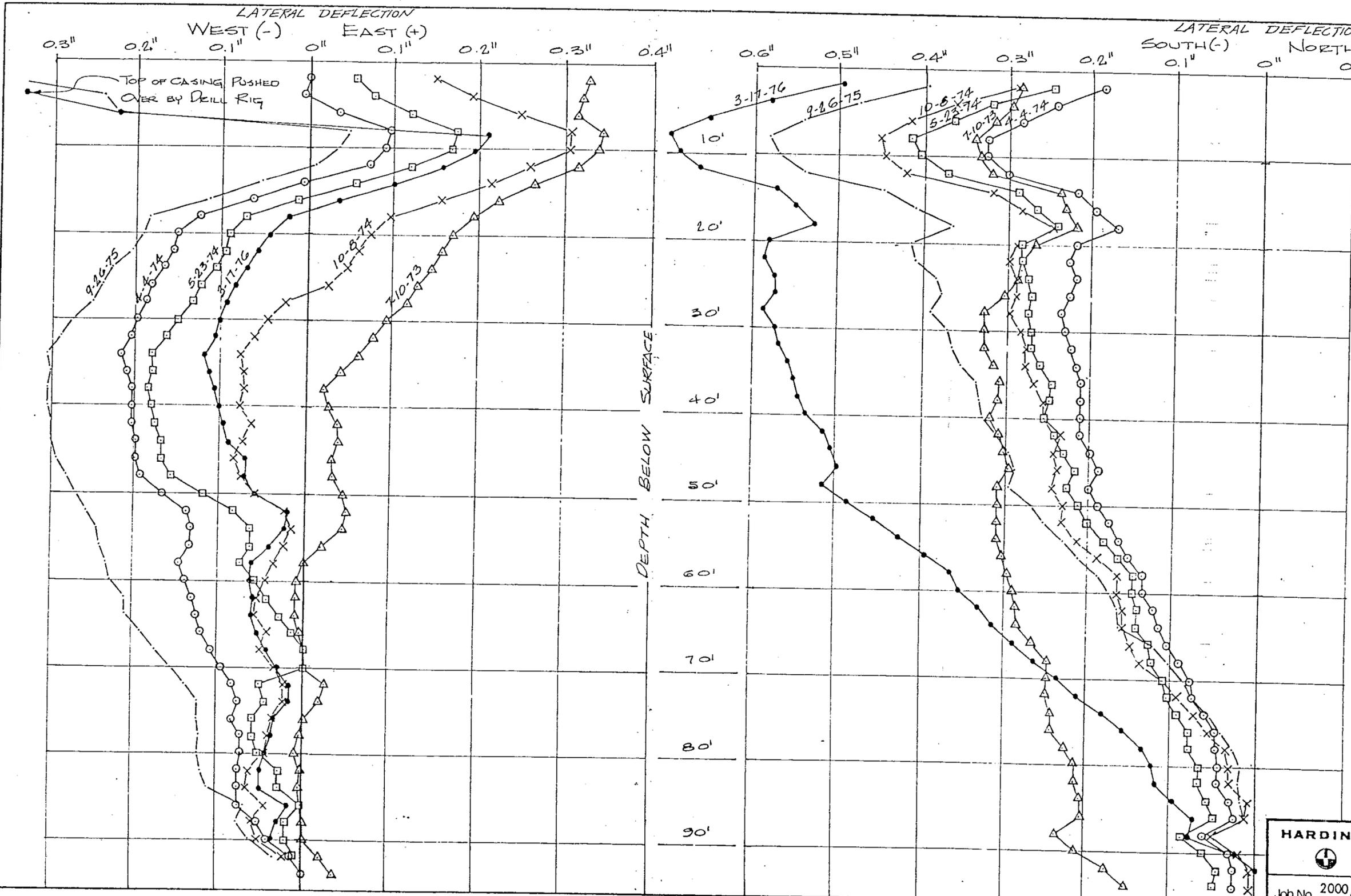
Date	Depth to Water (feet)
8/21/73	43.6
8/31/73	44.5
9/13/73	44.5
10/19/73	44.5
11/12/73	43.5
1/18/74	43.5
4/4/74	43.5
4/10/74	43.5
6/11/74	43.5

Each reading is represented by a curve with the date it was read adjacent to the curve. The readings are made by lowering a Slope Indicator instrument down a grooved aluminum casing. The grooves control the orientation of the instrument in a predetermined direction. The deflection in the casing became too great and readings were terminated 6/11/74. The former location and the orientation of the casing for SI-1 are indicated on plate 1.

**HARDING-LAWSON ASSOCIATES**  
 Consulting Engineers and Geologists  
 Job No. 2000,085.01      Appr. Date 3/8/76

SLOPE MONITORING DATA - SI-1  
 Building 46 Landslide  
 Lawrence Berkeley Laboratory  
 Berkeley, California

PLATE  
**23**

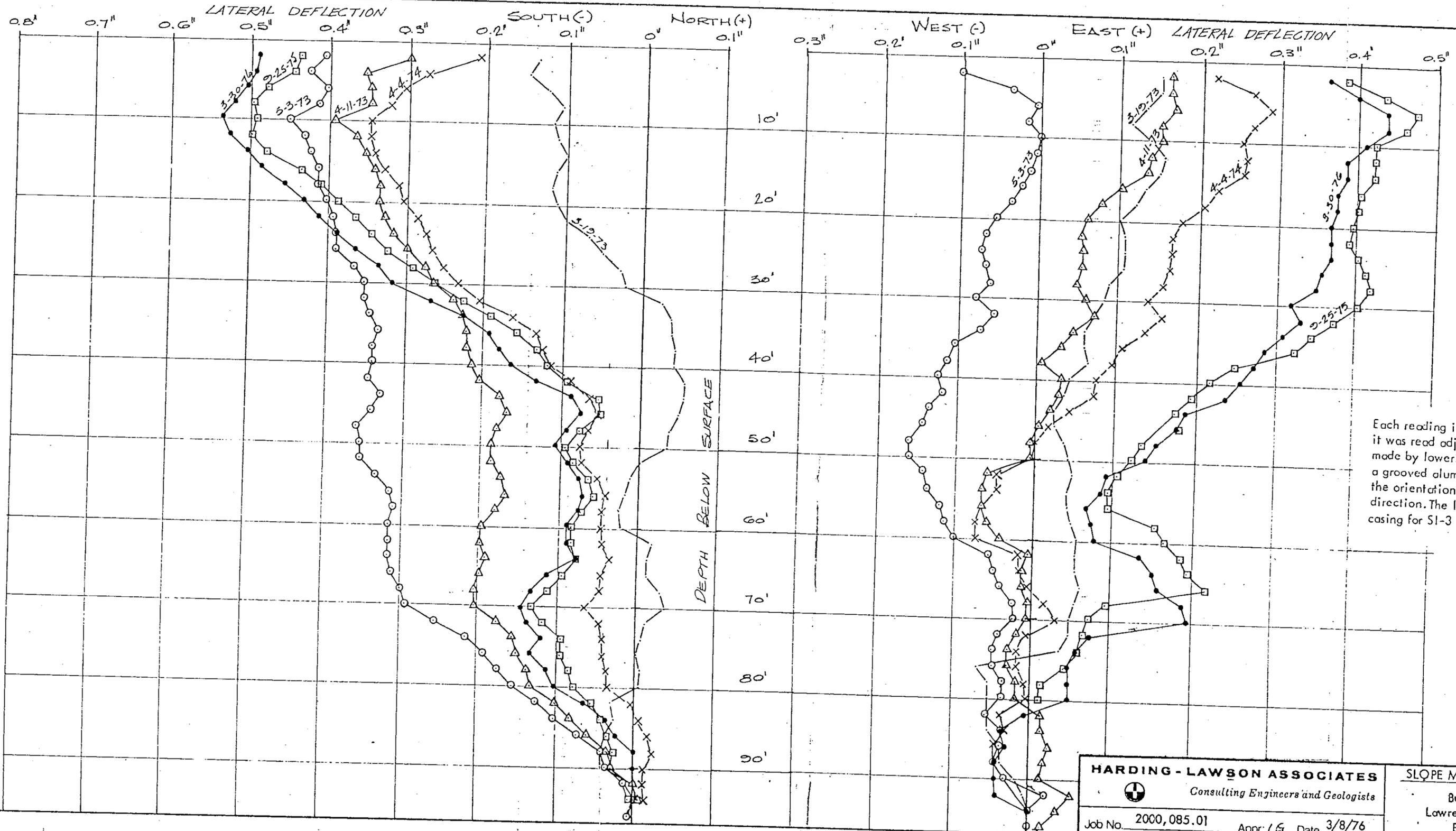


Water Level Data

Date	Depth to Water (feet)
7/10/73	34.0
4/ 4/74	31.0
5/23/74	34.5
10/8/74	35.5
9/25/75	37.5
3/17/76	39.5

Each reading is represented by a curve with the date it was read adjacent to the curve. The readings are made by lowering a Slope Indicator instrument down a grooved aluminum casing. The grooves control the orientation of the instrument in a predetermined direction. The location and the orientation of the casing for SI-2 are indicated on plate 1.

 <b>HARDING-LAWSON ASSOCIATES</b> Consulting Engineers and Geologists	SLOPE MONITORING DATA - SI-2		PLATE
	Building 46 Landslide Lawrence Berkeley Laboratory Berkeley, California		24
Job No. 2000,085.01      Appr. <u>LEL</u> Date <u>3/8/76</u>			



Water Level Data

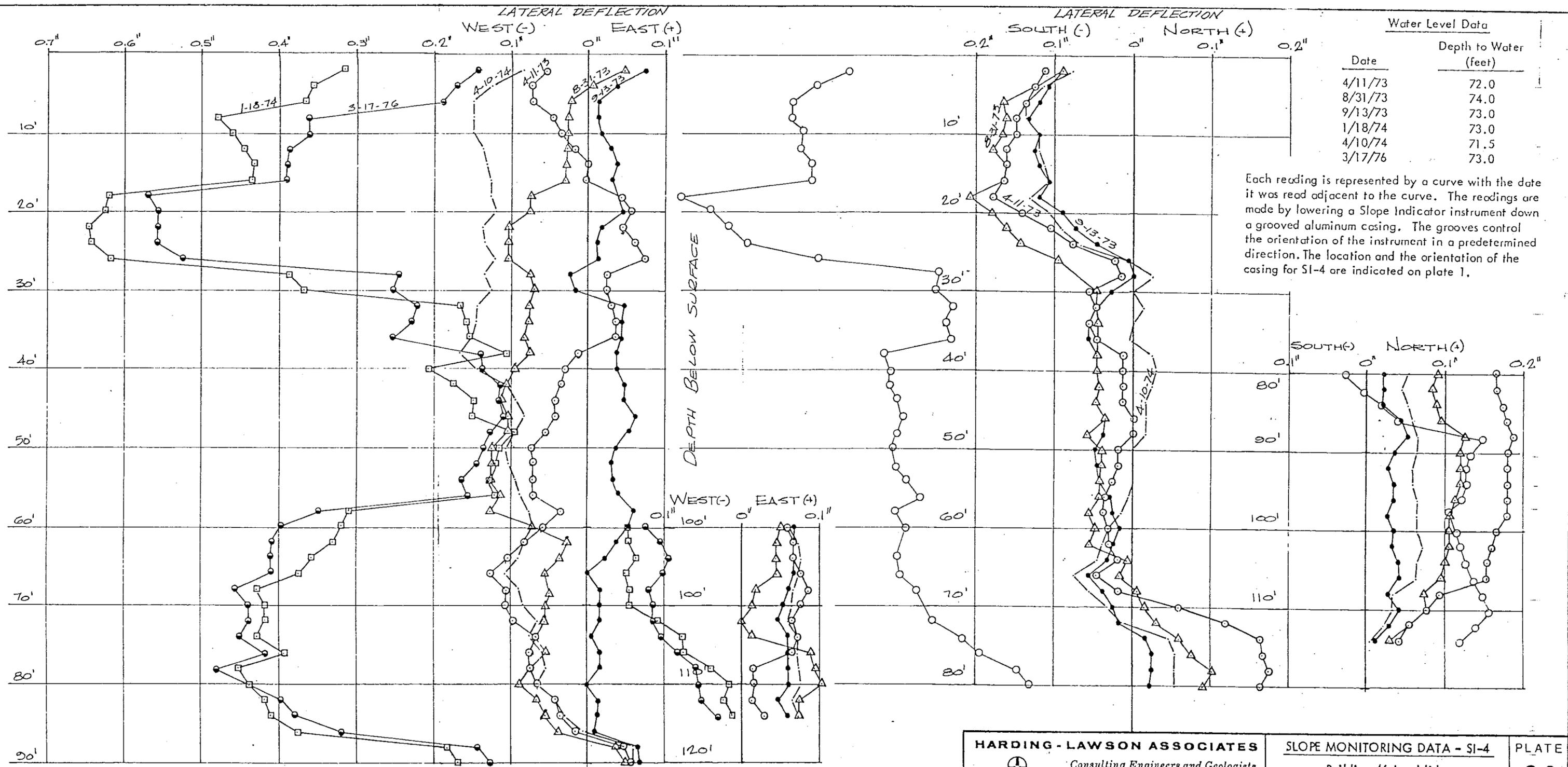
Date	Depth to Water (feet)
3/19/73	50.0
4/11/73	53.8
5/3/73	54.0
4/4/74	55.5
9/25/75	56.5
3/30/76	58.0

Each reading is represented by a curve with the date it was read adjacent to the curve. The readings are made by lowering a Slope Indicator instrument down a grooved aluminum casing. The grooves control the orientation of the instrument in a predetermined direction. The location and the orientation of the casing for SI-3 are indicated on plate 1.

**HARDING - LAWSON ASSOCIATES**  
 Consulting Engineers and Geologists  
 Job No. 2000,085.01    Appr. LEL Date 3/8/76

SLOPE MONITORING DATA - SI-3  
 Building 46 Landslide  
 Lawrence Berkeley Laboratory  
 Berkeley, California

RF2



Water Level Data

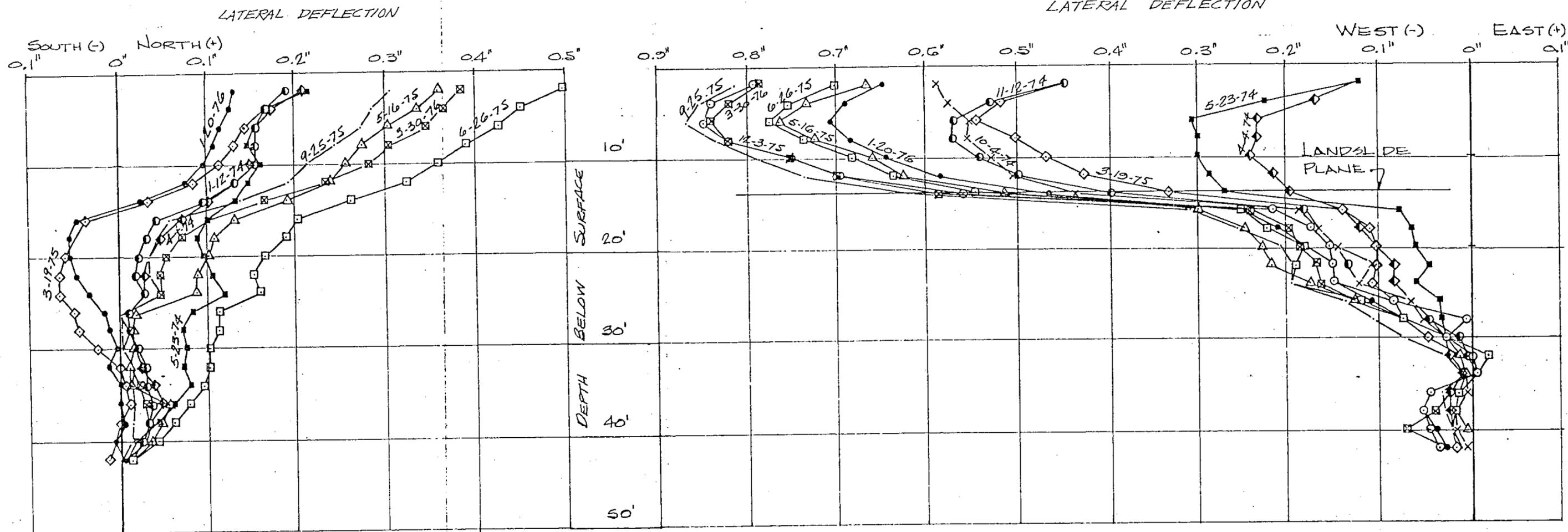
Date	Depth to Water (feet)
4/11/73	72.0
8/31/73	74.0
9/13/73	73.0
1/18/74	73.0
4/10/74	71.5
3/17/76	73.0

Each reading is represented by a curve with the date it was read adjacent to the curve. The readings are made by lowering a Slope Indicator instrument down a grooved aluminum casing. The grooves control the orientation of the instrument in a predetermined direction. The location and the orientation of the casing for SI-4 are indicated on plate 1.

**HARDING - LAWSON ASSOCIATES**  
 Consulting Engineers and Geologists  
 Job No. 2000,085.01      Appr. LEL Date 3/8/76

**SLOPE MONITORING DATA - SI-4**  
 Building 46 Landslide  
 Lawrence Berkeley Laboratory  
 Berkeley, California

PLATE  
**26**



Water Level Data  
Depth to Water

Date	Depth to Water (feet)
1/12/74	14.5
4/4/74	14.5
5/23/74	14.5
3/19/75	14.5
5/16/75	14.0
6/26/75	14.5
9/25/75	15.0
1/20/76	15.0
3/30/76	14.0

Each reading is represented by a curve with the date it was read adjacent to the curve. The readings are made by lowering a Slope Indicator instrument down a grooved aluminum casing. The grooves control the orientation of the instrument in a predetermined direction. The location and the orientation of the casing for SI-5 are indicated on plate 1.

<b>HARDING - LAWSON ASSOCIATES</b>  Consulting Engineers and Geologists	<b>SLOPE MONITORING DATA - SI-5</b>		<b>PLATE</b>
	Building 46 Landslide Lawrence Berkeley Laboratory Berkeley, California		<b>27</b>
Job No. 2000,085.01		Appr. LEL Date 3/8/76	

**Harding Lawson Associates (HLA), 1976b**, "Report, Soil Engineering and Geologic Services, Building 46 Landslide Stabilization, Lawrence Berkeley Laboratory, Berkeley, California," report dated April 21, 1976, HLA Job No. 2000,085.01.

(LBNL # 198)

**Logs of Borings 36 through 40**

**LOG OF BORING 36**

10,000  
8000  
6000  
4000  
2000  
0

Shear Strength (lbs/sq ft)

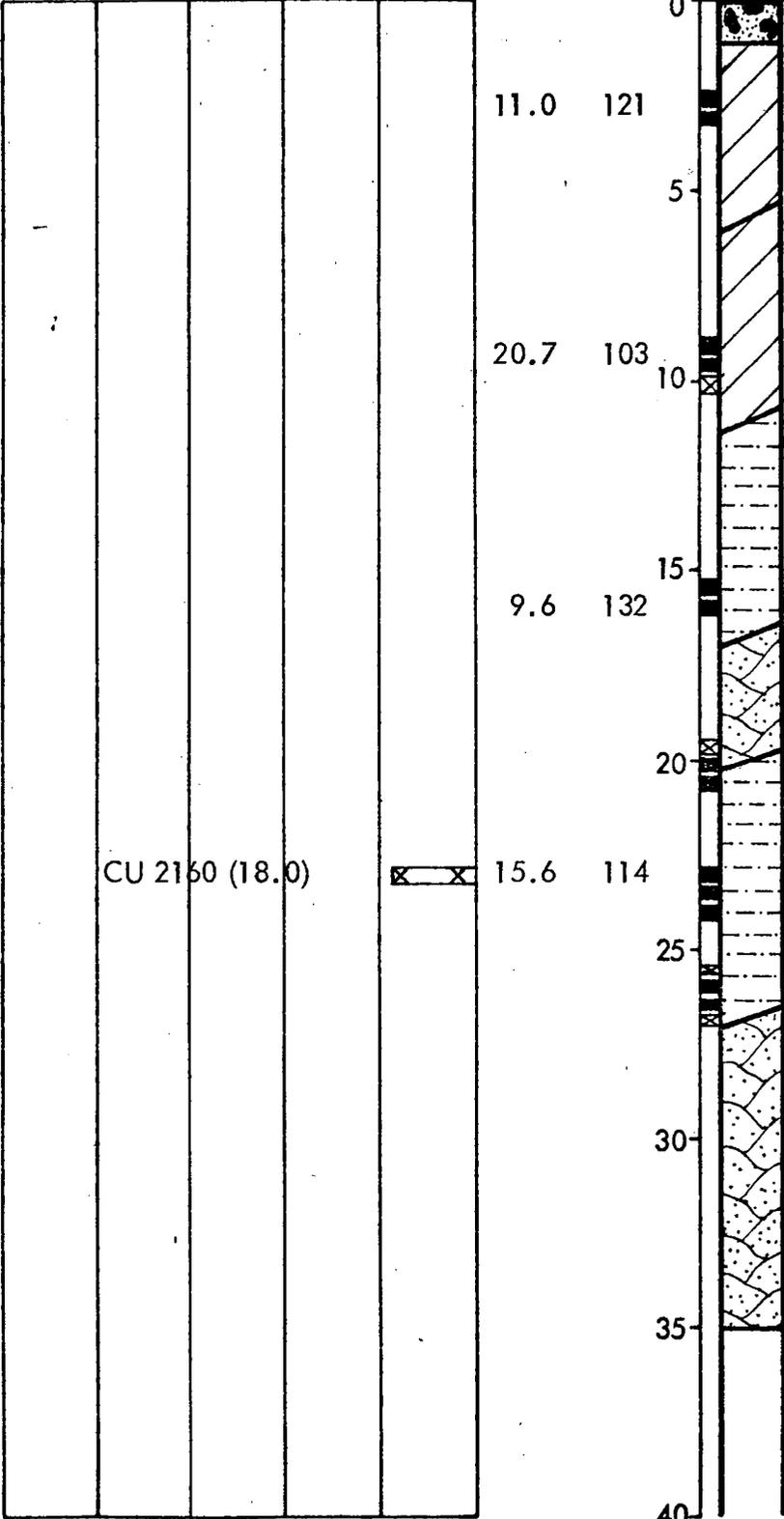
Moisture Content (%)

Dry Density (pcf)

Depth (ft)

Sample

Equipment 24" Bucket Auger  
Elevation 758 Date 11/26/73



CU 2160 (18.0)

15.6 114

GRAY-BROWN SANDY GRAVEL (GP) - medium dense, wet  
MOTTLED RED-BROWN SANDY CLAY (CL) - stiff, moist

BROWN SANDY CLAY (CL) medium stiff, wet, with occasional rock fragments

GRAY-GREEN SANDY SILTSTONE low hardness, weak, moderately weathered, with occasional thin lenses of red-brown claystone

GRAY-GREEN SANDSTONE moderately hard, weak, moderately weathered

RED-BROWN CLAYSTONE low hardness, weak, moderately weathered

change to friable, moderately sheared, wet @ 23'

GRAY-GREEN SANDSTONE moderately hard, weak, moderately weathered, with occasional thin lenses of red-brown claystone

small amount of free water @ 35'

**HARDING - LAWSON ASSOCIATES**  
Consulting Engineers and Geologists

**LOG OF BORING 36**  
Building 46 Landslide - Lower Slope  
Lawrence Berkeley Laboratory

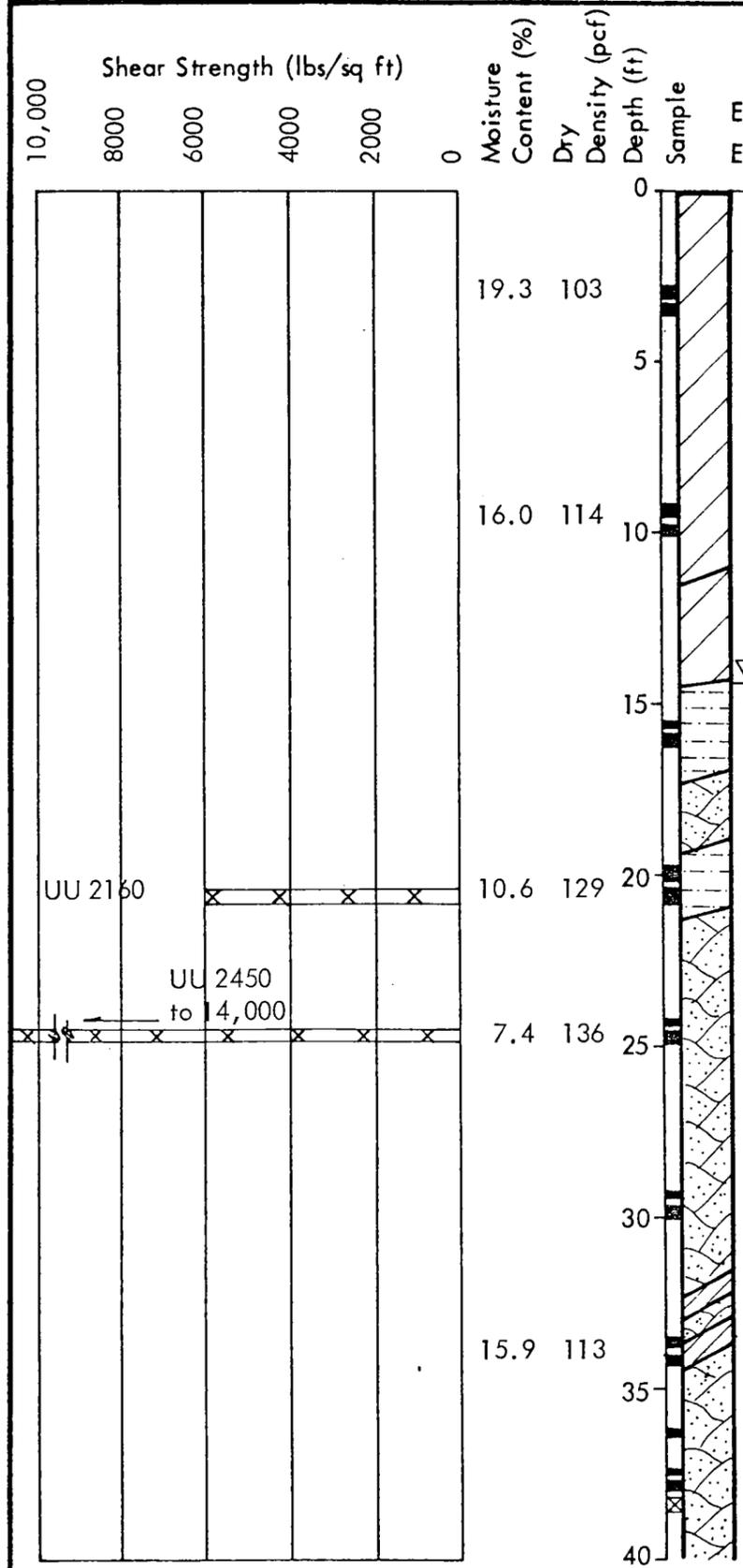
**PLATE 16**

Job No. 2000, 085.01 Appr. LEL Date 1/10/74

RF13

**LOG OF BORING 37**

Equipment 24" Bucket Auger  
 Elevation 753 Date 11/28/73



MOTTLED GRAY-BROWN SANDY CLAY (CL) - stiff, wet, with occasional rock fragments

Water Level 3-30-76

color change to red-brown @ 9'

MOTTLED RED-BROWN & GRAY SANDY CLAY (CL) - stiff, wet, with abundant rock fragments

6" drain rock blanket (subdrain) @ 14'

DARK RED-BROWN CLAYSTONE intensely fractured, low hardness, friable, moderately weathered, moderately sheared

seepage @ 16'

BLUE SANDSTONE low hardness, weak, with abundant thin lenses of red-brown claystone

3" soft clay zone @ 23.5'

with abundant small clay zones, some seepage

5" clay zone @ 32.8', soft, moist

6" clay zone @ 34', soft, saturated

visual inspection indicates clay strikes NW, dips 76 NE

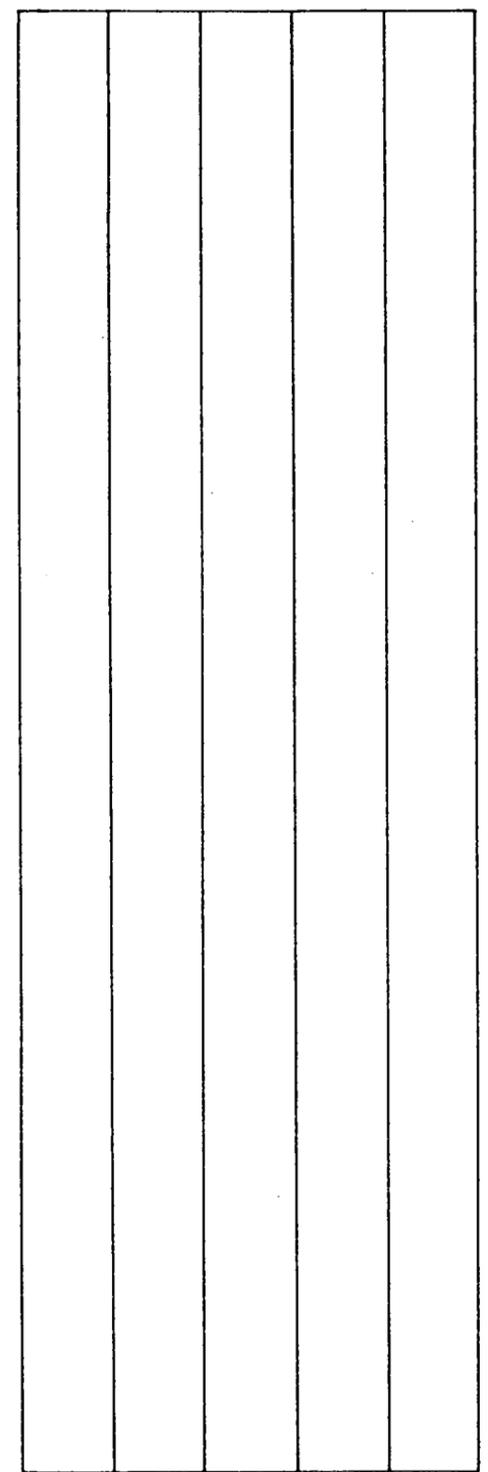
BLUE SANDSTONE & RED-BROWN CLAYSTONE - moderately fractured, low hardness, weak, moderately weathered, occasionally sheared

FILL

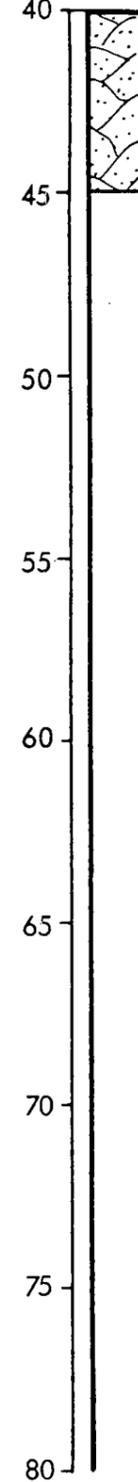
UU 2160

UU 2450 to 14,000

Shear Strength (lbs/sq ft)



Moisture Content (%)  
 Dry Density (pcf)  
 Depth (ft)  
 Sample



(Continuation of Log)

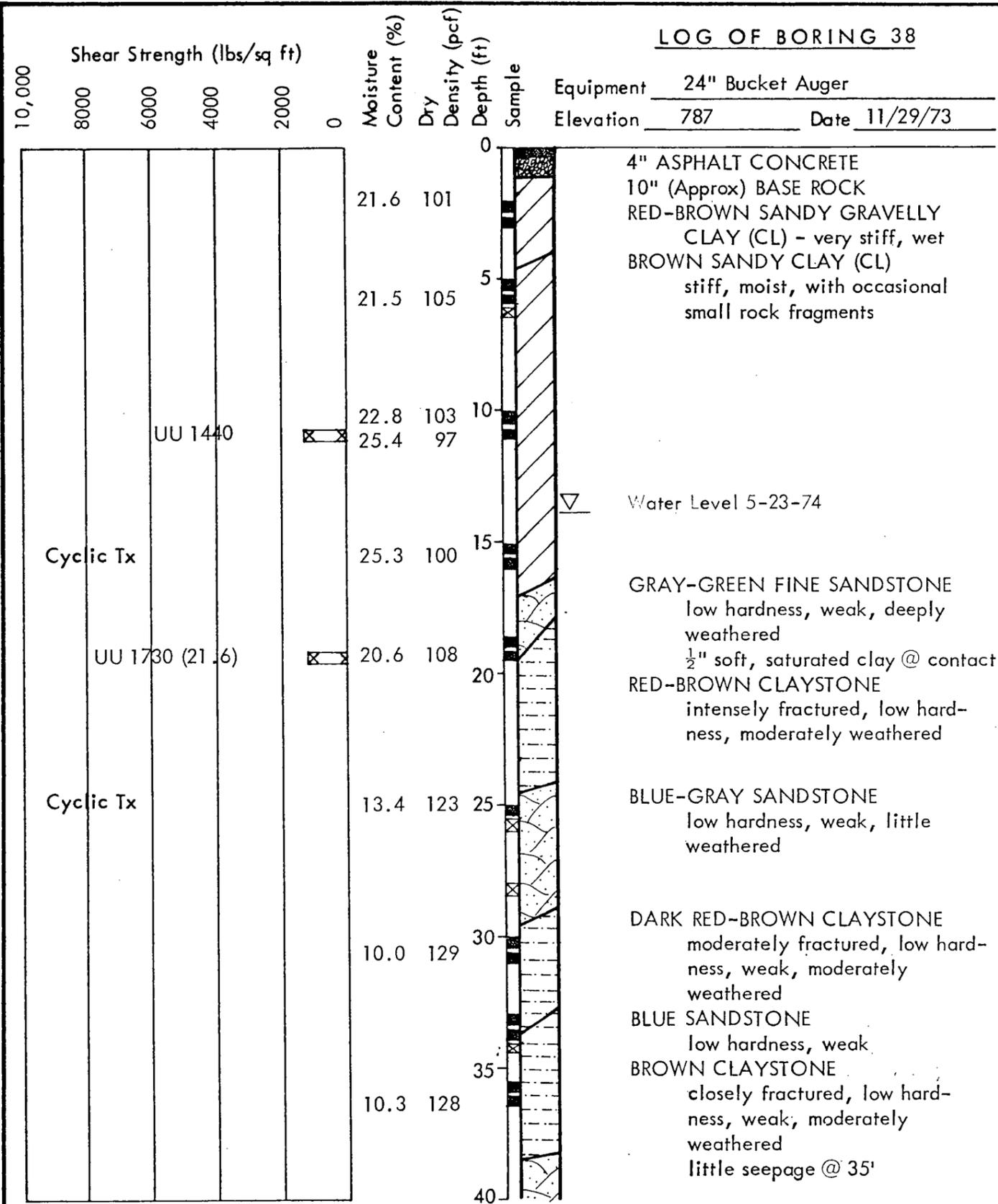
**HARDING - LAWSON ASSOCIATES**  
 Consulting Engineers and Geologists

Job No. 2000,085.01 Appr. LEL Date 1/10/74

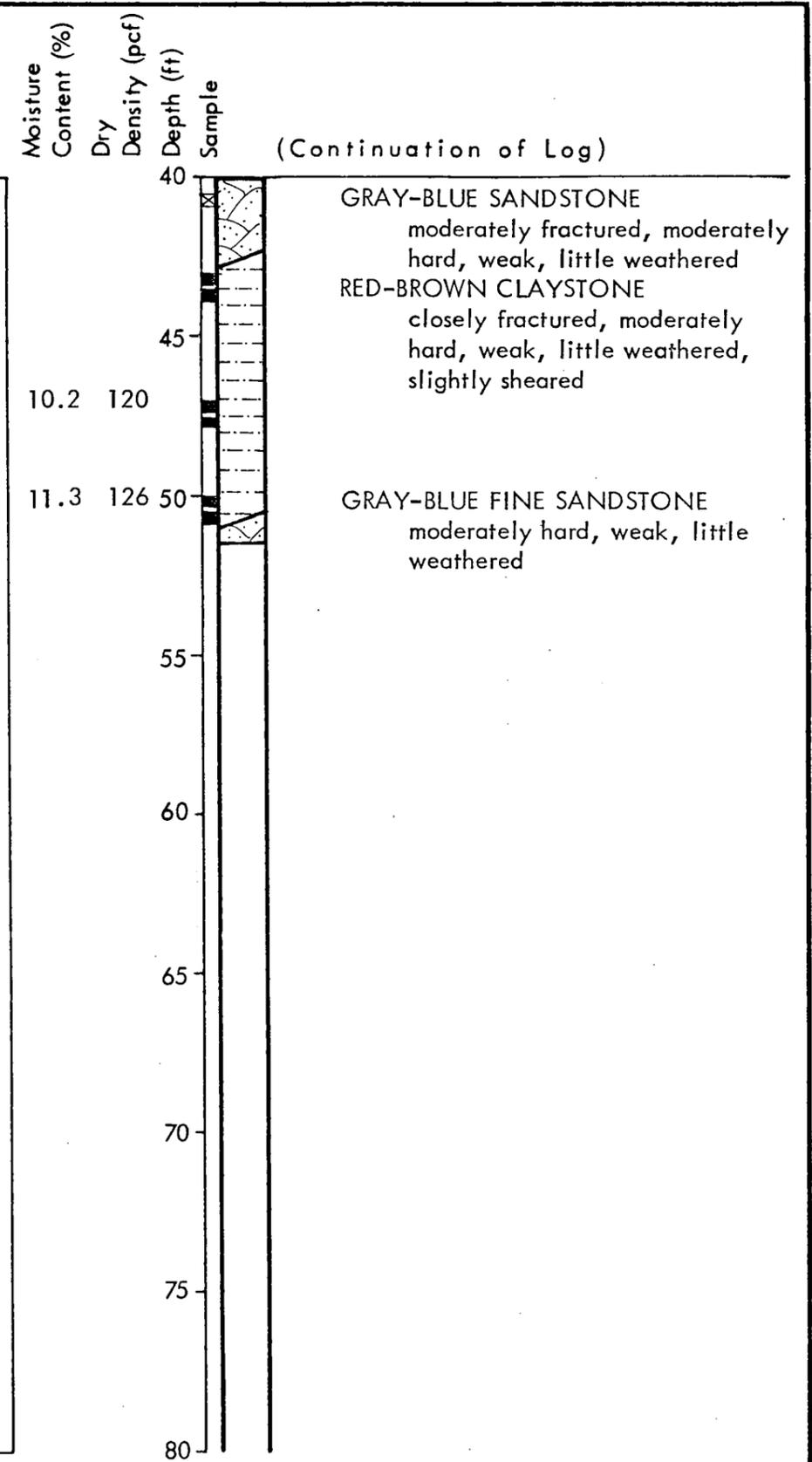
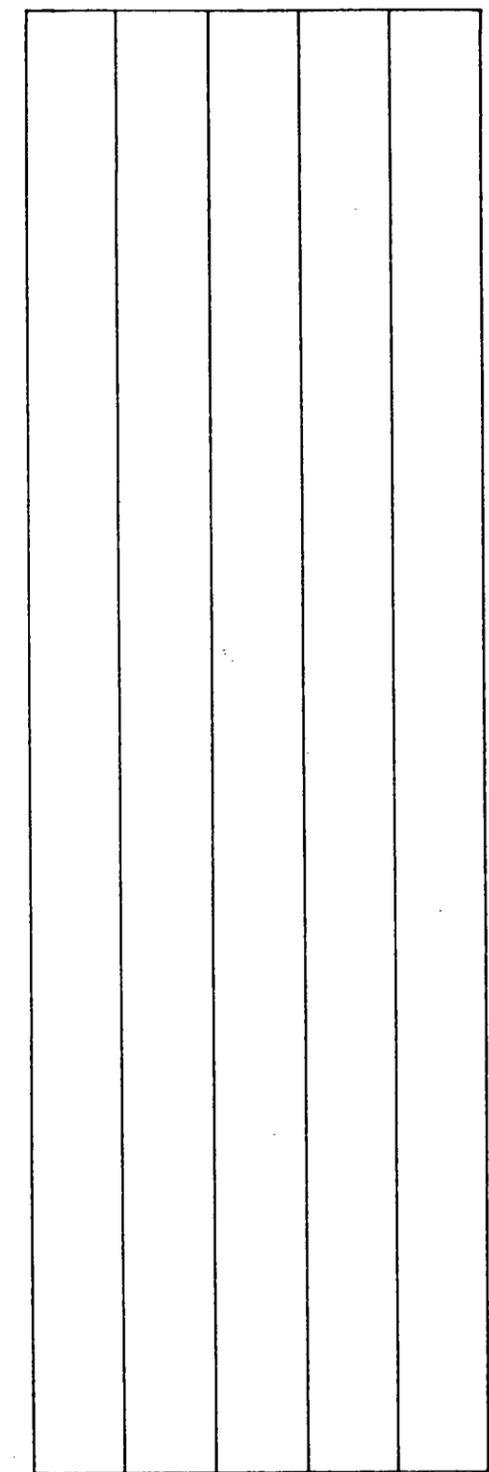
**LOG OF BORING 37**  
 Building 46 Landslide - Lower Slope  
 Lawrence Berkeley Laboratory

**PLATE 17**

**LOG OF BORING 38**



Shear Strength (lbs/sq ft)

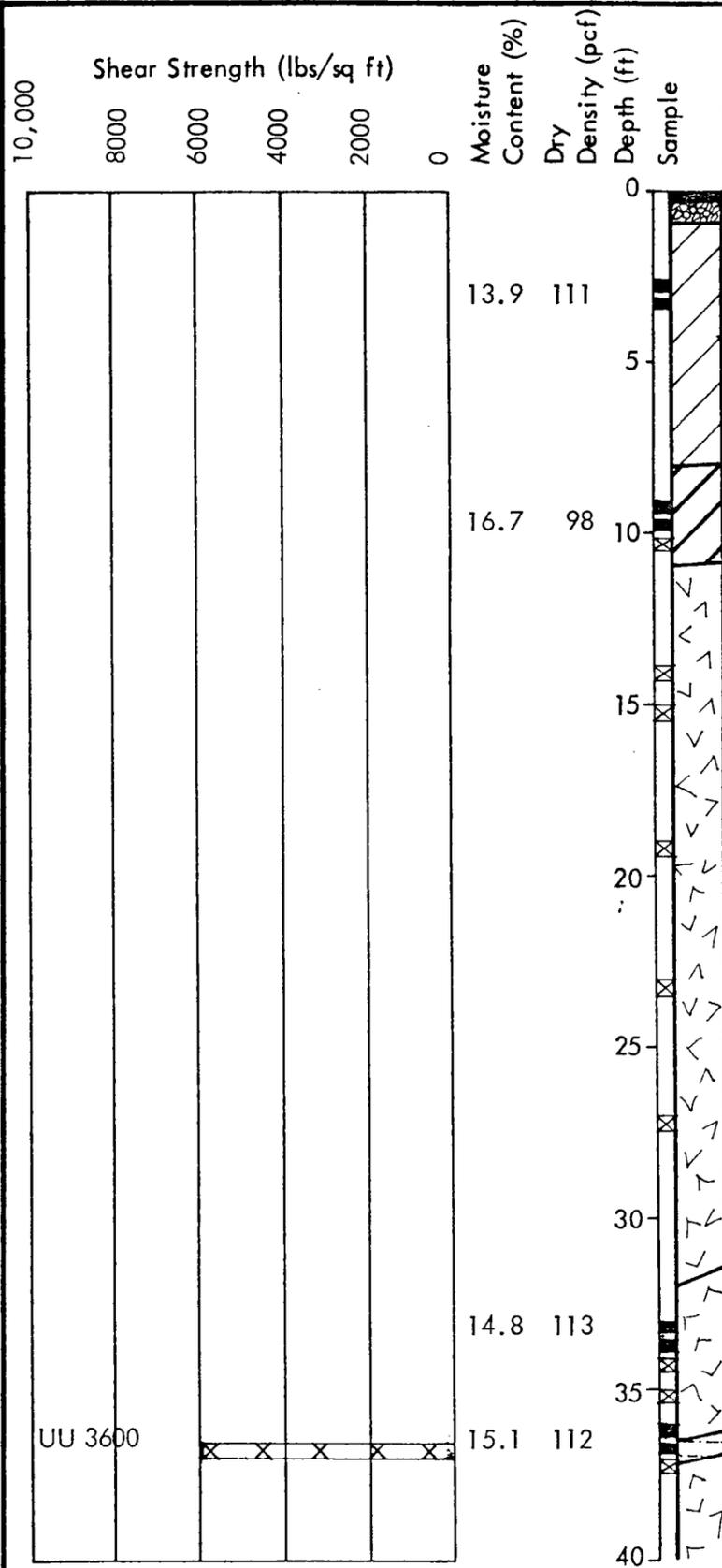


**HARDING - LAWSON ASSOCIATES**  
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 Job No. 2000,085.01      Appr: *LEL* Date 1/10/74

**LOG OF BORING 38**  
 Building 46 Landslide - Lower Slope  
 Lawrence Berkeley Laboratory

**LOG OF BORING 39**

Equipment 24" Bucket Auger  
 Elevation 808 Date 11/30/73



0 **1 1/2" ASPHALT CONCRETE & BASE ROCK**

5 **MOTTLED YELLOW-BROWN SANDY CLAY (CL) - very stiff, wet, with occasional small rock fragments**

10 **DARK BROWN SILTY CLAY (CH) stiff, moist, with occasional small roots**

10 **GRAY ANDESITE moderately fractured, hard, strong, little weathered**

15

20

25

30

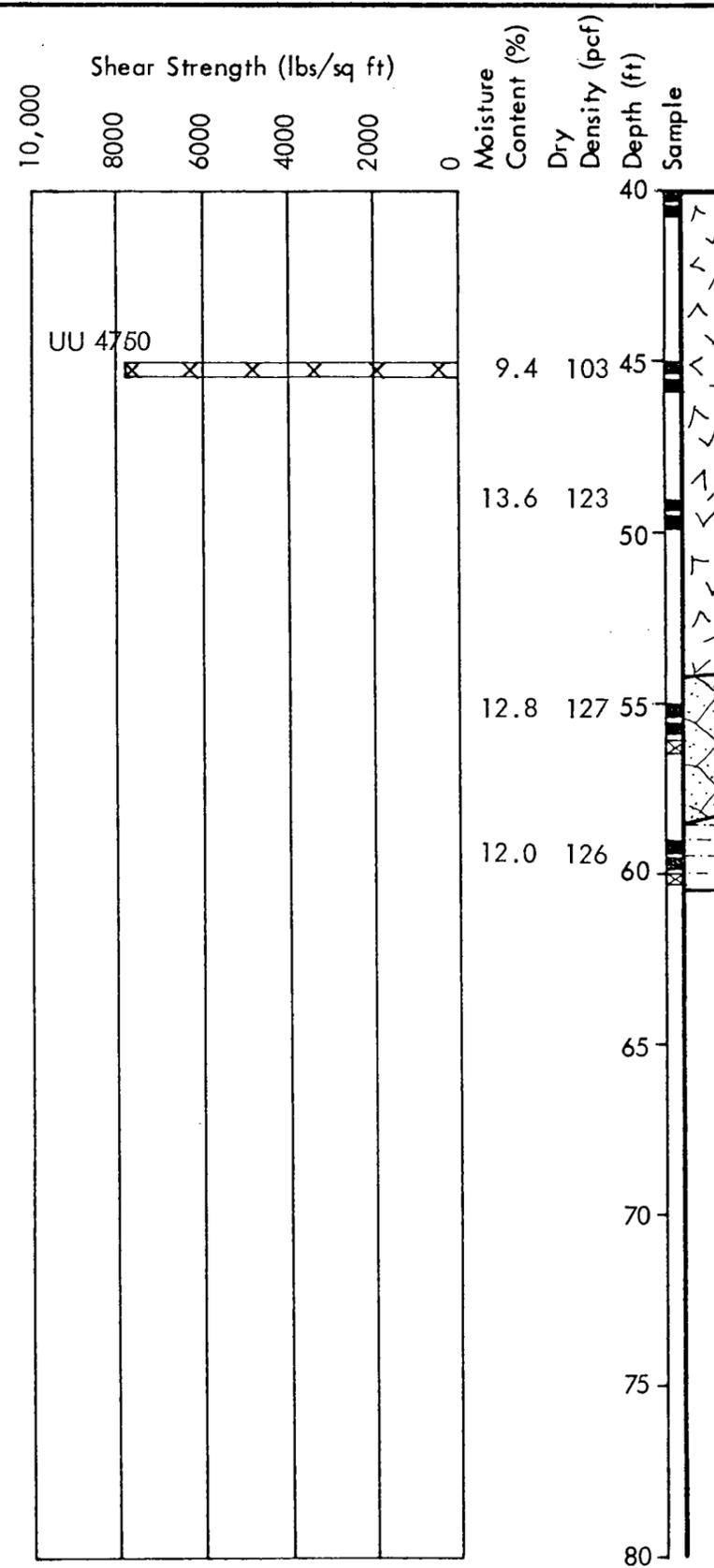
35 **DARK BROWN ANDESITE closely fractured, moderately hard, weak, deeply weathered, with abundant moist clay fracture fillings**

40 **GRAY-BROWN SILTSTONE intensely fractured, low hardness, weak, deeply weathered**

wet, with brown clay fracture fillings @ 26'

FILL

(Continuation of Log)



40 **DARK BROWN ANDESITE intensely fractured, moderately hard, moderately strong, deeply weathered, with abundant clay fracture fillings**

45 **seepage @ 45'**

50 **Water Level 4-10-74**

55 **BLUE-GRAY FINE SANDSTONE low hardness, weak, moderately weathered**

60 **MOTTLED RED-BROWN & BLUE CLAY-STONE - low hardness, weak, moderately weathered**

65

70

75

80

**HARDING - LAWSON ASSOCIATES**  
 Consulting Engineers and Geologists

Job No. 2000,085.01 Appr. LEC Date 1/11/74

**LOG OF BORING 39**  
 Building 46 Landslide - Lower Slope  
 Lawrence Berkeley Laboratory

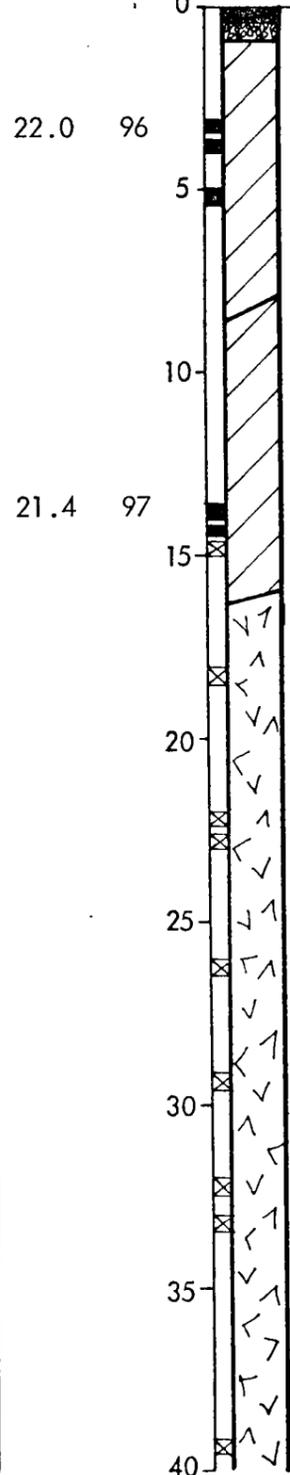
**PLATE 19**

**LOG OF BORING 40**

Shear Strength (lbs/sq ft)

Moisture Content (%)  
Dry Density (pcf)  
Depth (ft)  
Sample

Equipment 24" Bucket Auger  
Elevation 800 Date 12/3/73



3" ASPHALT CONCRETE  
10" (Approx.) BASE ROCK  
RED-BROWN SANDY GRAVELLY  
CLAY (CL) - stiff, wet

FILL

BROWN SANDY CLAY (CL)  
very stiff, wet, with  
abundant angular rock fragments

GRAY-BROWN ANDESITE  
moderately fractured, hard,  
strong, moderately weathered,  
with occasional clay fracture  
fillings

clay fracture fillings @ 28'

little seepage @ 32'  
change to deeply weathered  
@ 33'

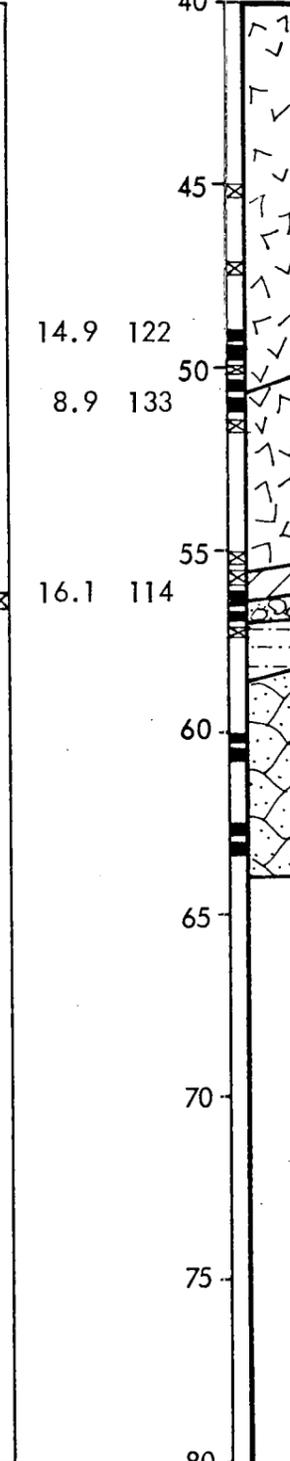
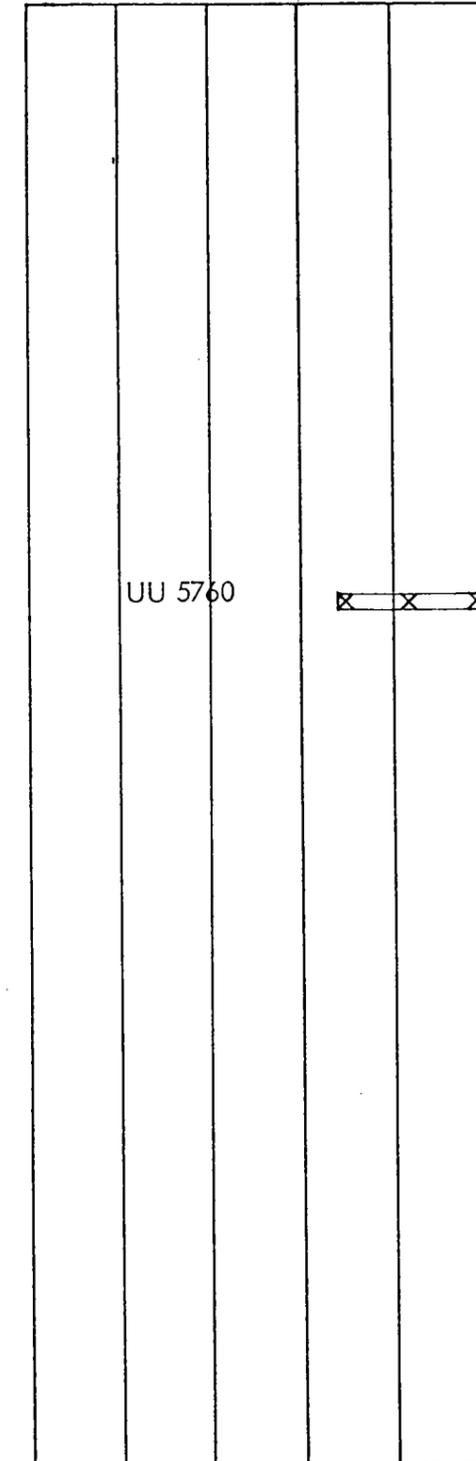
seepage @ 40'

Shear Strength (lbs/sq ft)

10,000  
8000  
6000  
4000  
2000  
0

Moisture Content (%)  
Dry Density (pcf)  
Depth (ft)  
Sample

(Continuation of Log)



Water Level 4-10-74

change to intensely fractured,  
moderately hard, moderately  
strong, with abundant wet clay  
@ 49'

yellow-brown clay zone @ 50'

BROWN ANDESITE  
moderately fractured, hard, strong,  
with occasional clay fracture  
fillings

change to crushed @ 55'

PURPLE SANDY CLAY (CL)  
soft, saturated

BLUE CONGLOMERATE  
hard, strong, moderately  
weathered

RED-BROWN CLAYSTONE  
closely fractured, low hardness,  
weak, moderately weathered

BLUE FINE SANDSTONE  
moderately hard, moderately  
strong, moderately weathered

**HARDING - LAWSON ASSOCIATES**



Consulting Engineers and Geologists

Job No. 2000,085.01 Appr. LSL Date 1/11/74

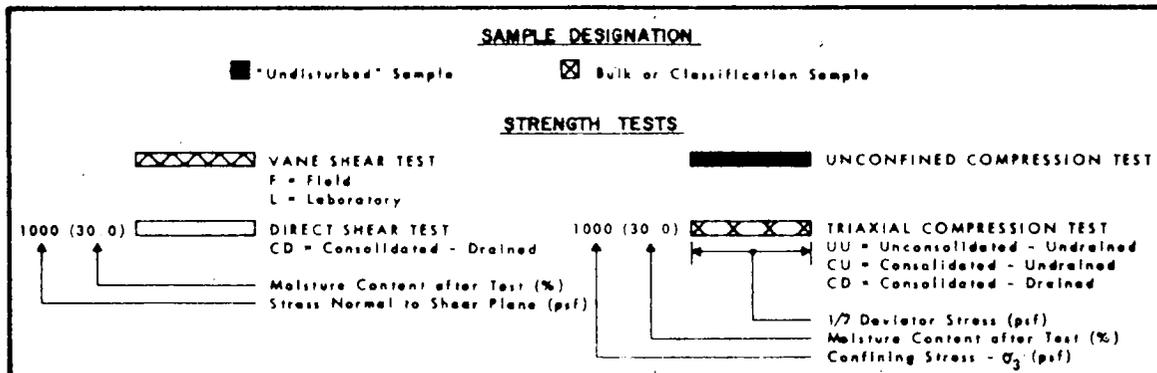
**LOG OF BORING 40**  
Building 46 Landslide - Lower Slope  
Lawrence Berkeley Laboratory

PLATE

**20**

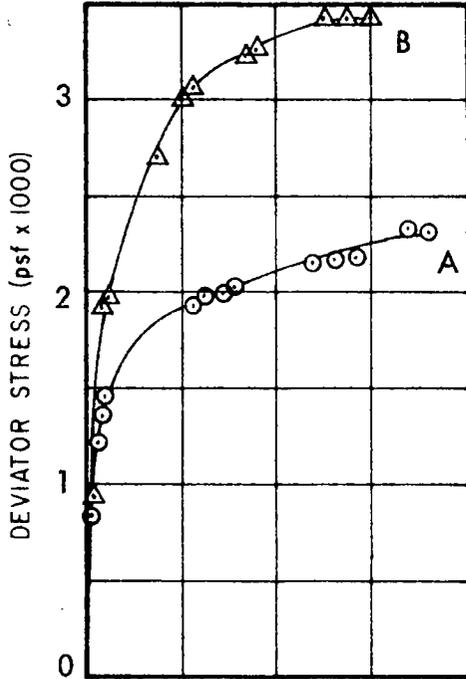
MAJOR DIVISIONS			TYPICAL NAMES	
COARSE GRAINED SOILS MORE THAN HALF IS LARGER THAN #200 SIEVE	GRAVELS  MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS  MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN HALF IS SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY	
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
		OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS	
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS	
		PI	PEAT AND OTHER HIGHLY ORGANIC SOILS	

**UNIFIED SOIL CLASSIFICATION SYSTEM**

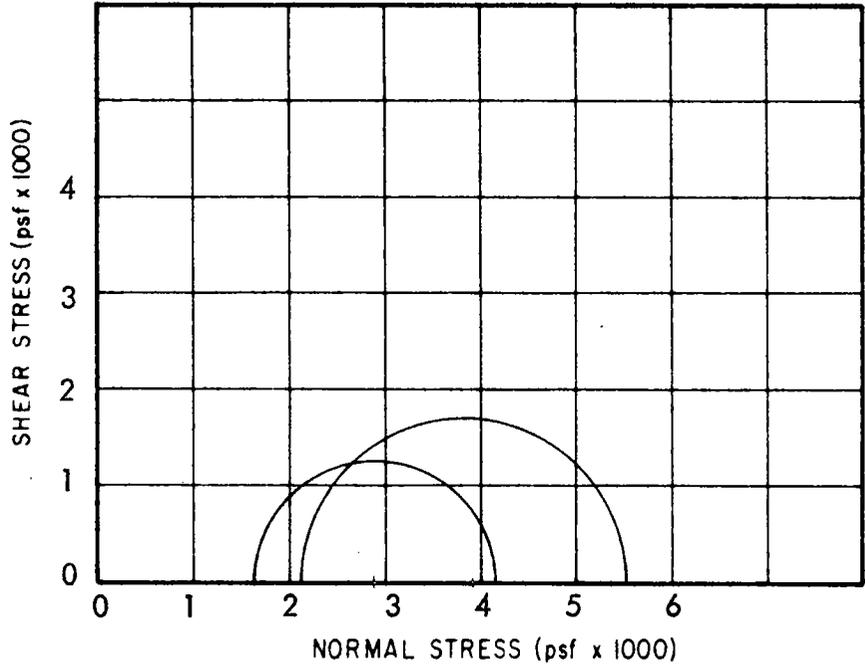


**KEY TO TEST DATA**

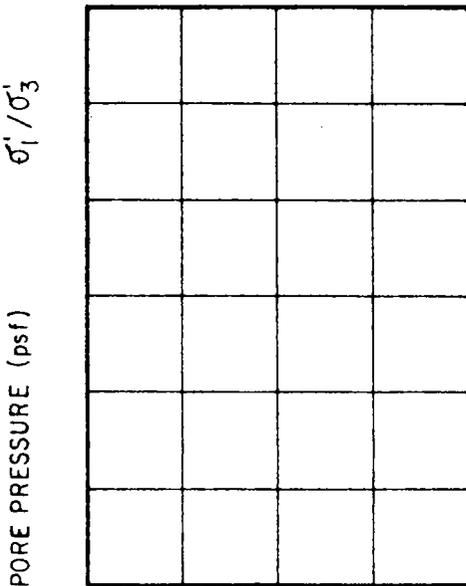
<b>HARDING - LAWSON ASSOCIATES</b>  Consulting Engineers and Geologists	<b>SOIL CLASSIFICATION CHART AND KEY TO TEST DATA</b>	<b>PLATE 21</b>
	Job No. <b>2000,085.01</b> Appr. <i>[Signature]</i> Date <b>2/9/76</b>	<b>Building 46 Landslide - Lower Slope</b>



AXIAL STRAIN (%)



Test Type Consolidated-Undrained Controlled: Strain  
 Saturation Method: Backpressure  $G_s$  2.84



AXIAL STRAIN (%)

$\phi =$  ---  
 $C =$  ---

Test No	A	B	C	
Initial	Diameter (in.)	2.43	2.43	
	Height (in.)	5.60	5.80	
	Moisture Content	20.6 %	15.6 %	%
	Void Ratio	.627	.549	
	Saturation	93 %	81 %	%
Before Test	Dry Density (pcf)	108	114	
	Moisture Content	21.6 %	18.0 %	%
	Void Ratio	.590	.517	
	Saturation	100+ %	100 %	%
Final	Pressure (psf)	1730	2160	
	Moisture Content	21.6 %	18.0 %	%
	Void Ratio	.590	.517	
	$\sigma_1$ Major Prin. Stress (psf)	4070	5590	
	$\sigma_3$ Minor Prin. Stress (psf)	1730	2160	
	Time to Failure (min)	4230	3600	
Sample Source: A-Bor. 38 at 19.0'; B-Bor. 36 at 22.8'				
Classification: A-Mottled Red-Brown Sandy Silt (ML) B-Red Fine Sandy Silt (ML)				

**HARDING - LAWSON ASSOCIATES**



Consulting Engineers and Geologists

TRIAXIAL COMPRESSION TEST REPORT

Building 46 Landslide - Lower Slope  
 Lawrence Berkeley Laboratory  
 Berkeley, California

PLATE

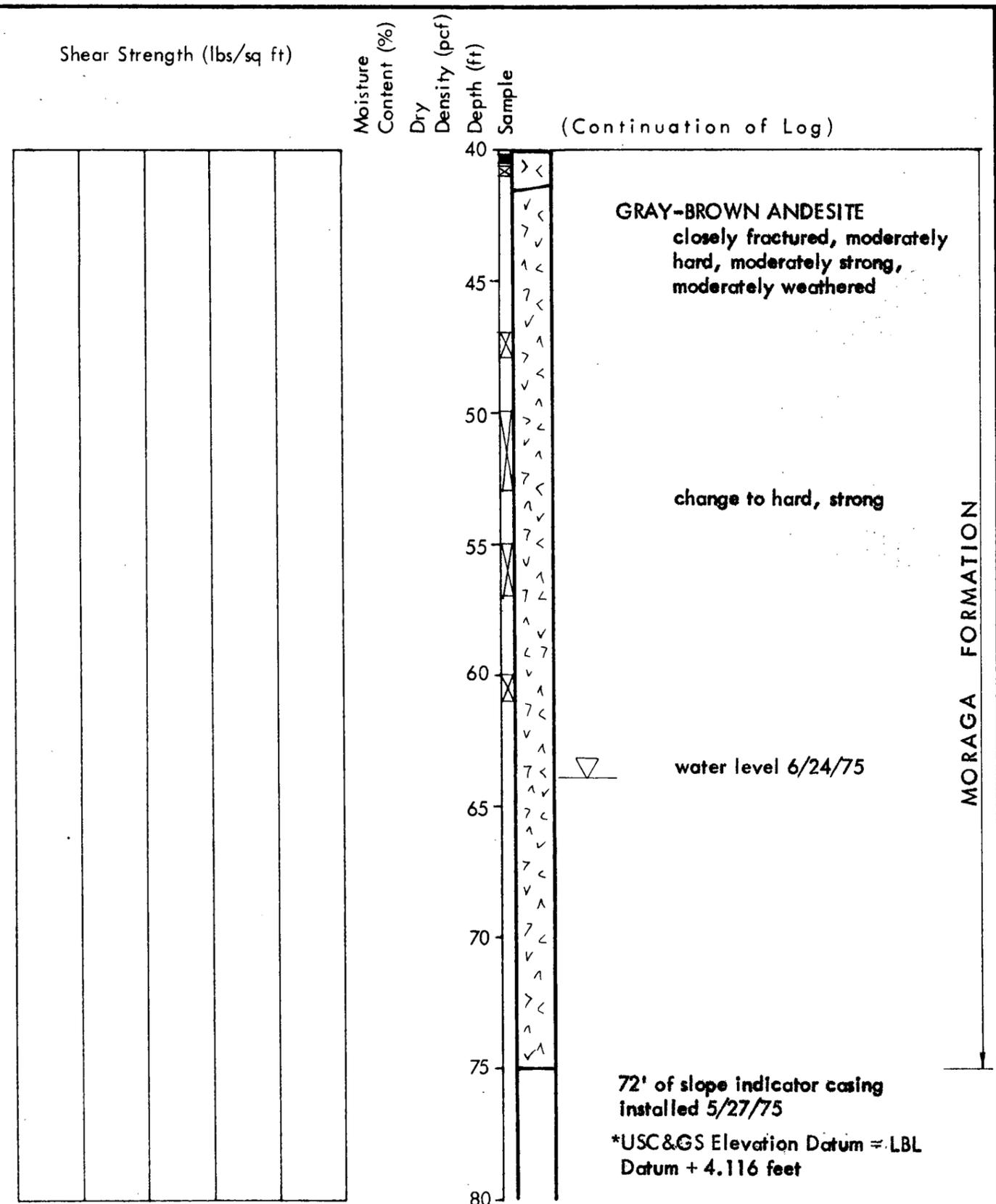
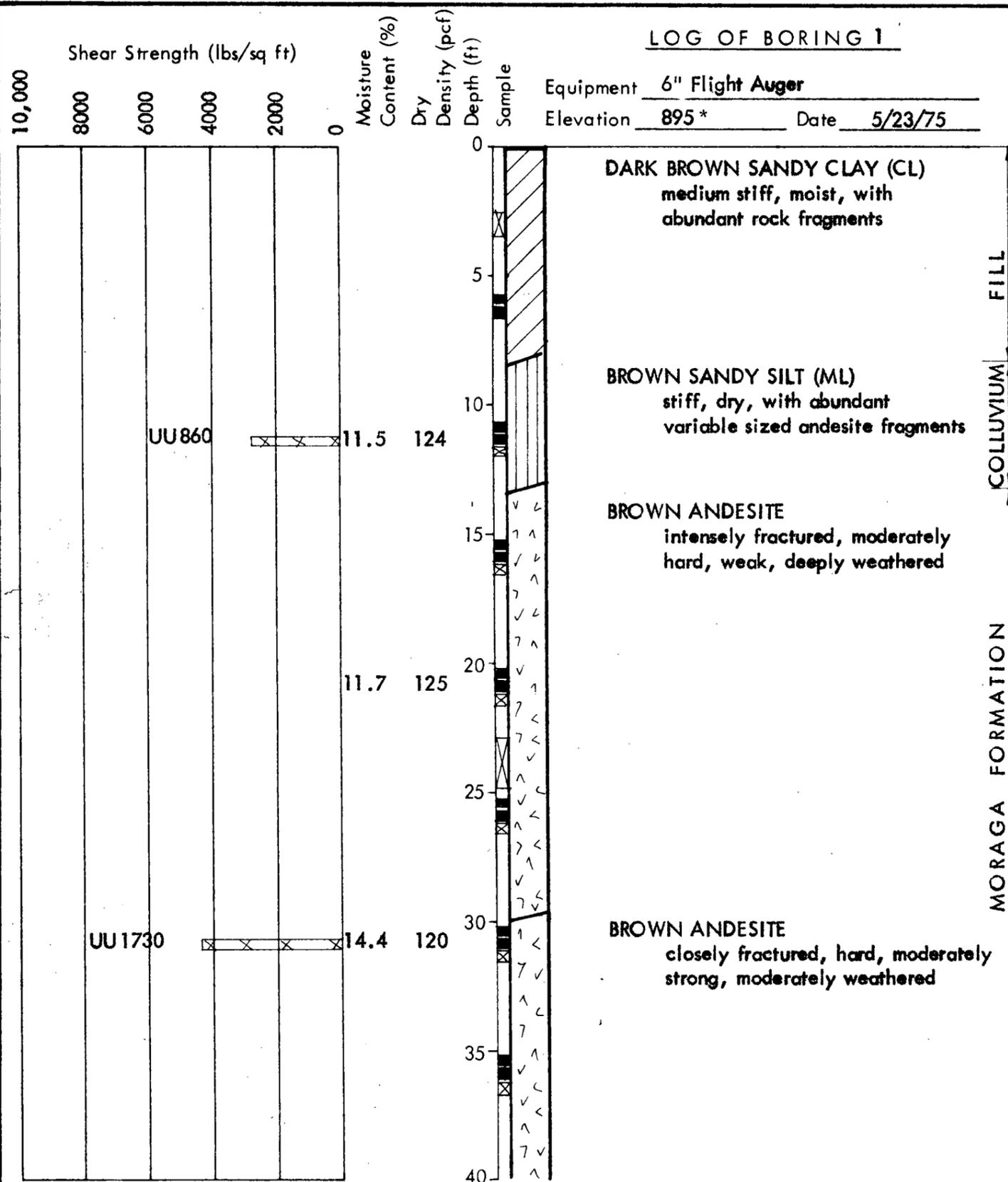
**22**

Job No. 2000,084.01 Appr: LEL Date 2/3/76

**Harding Lawson Associates (HLA), 1976c**, "Report, Supplemental Soil and Geologic Investigation, Proposed Energy Research Facility, Lawrence Berkeley Laboratory, Berkeley, California, report dated May 6, 1976, HLA Job No. 2000,102.01.

(LBNL # 106)

**Logs of Borings 1, 3, 4, 5, 10, 12 and 13**

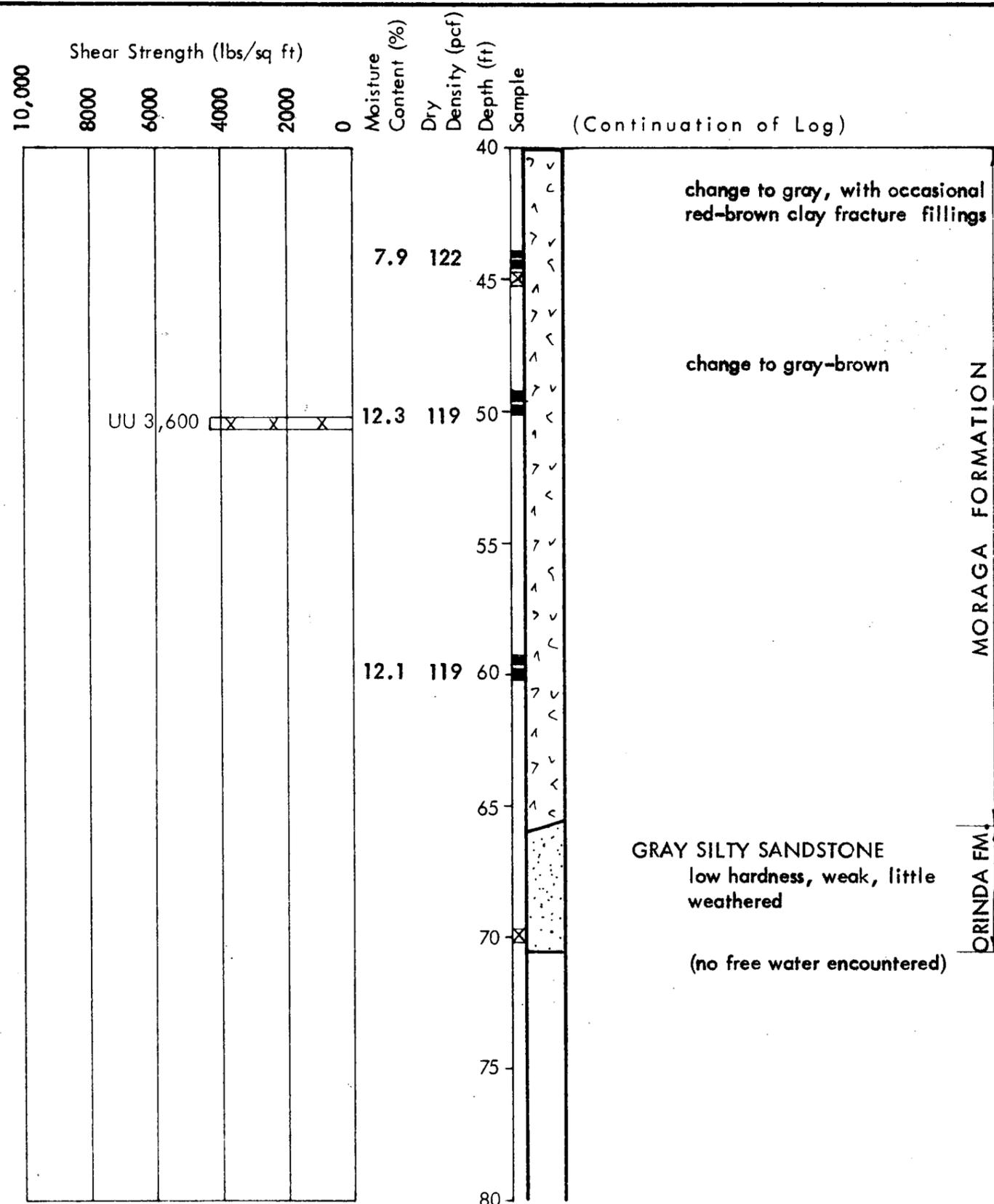
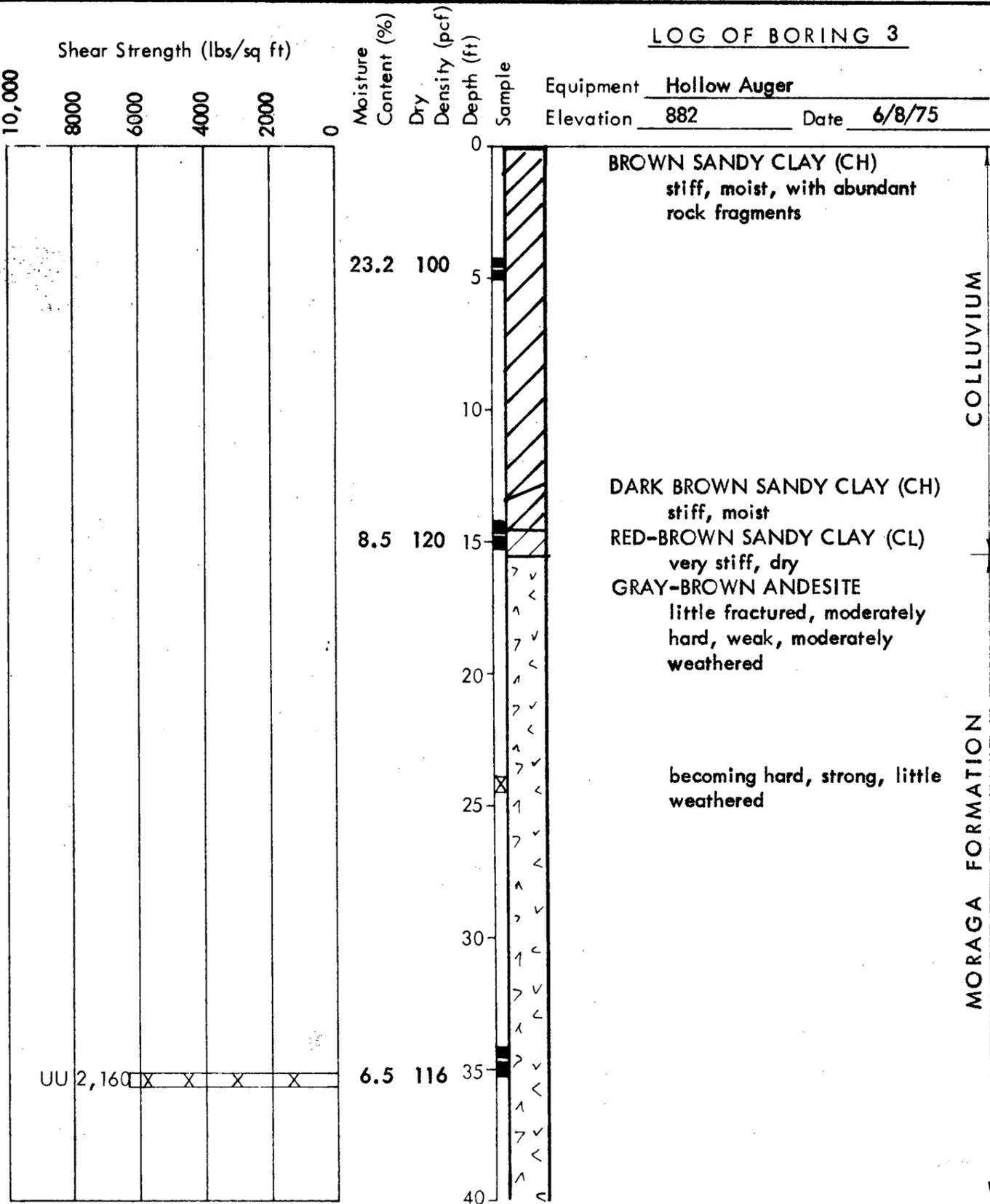


**HARDING - LAWSON ASSOCIATES**  
 Consulting Engineers and Geologists  
 Job No. 2000,102.01    Appr. LEL Date 5/28/75

**LOG OF BORING 1**  
 Energy Research Building  
 Lawrence Berkeley Laboratory

**PLATE 4**

LOG OF BORING 3



**HARDING - LAWSON ASSOCIATES**  
 Consulting Engineers and Geologists  
 Job No 2000,102.01 Appr: LEL Date 6/19/75

LOG OF BORING 3  
 Energy Research Building  
 Lawrence Berkeley Laboratory

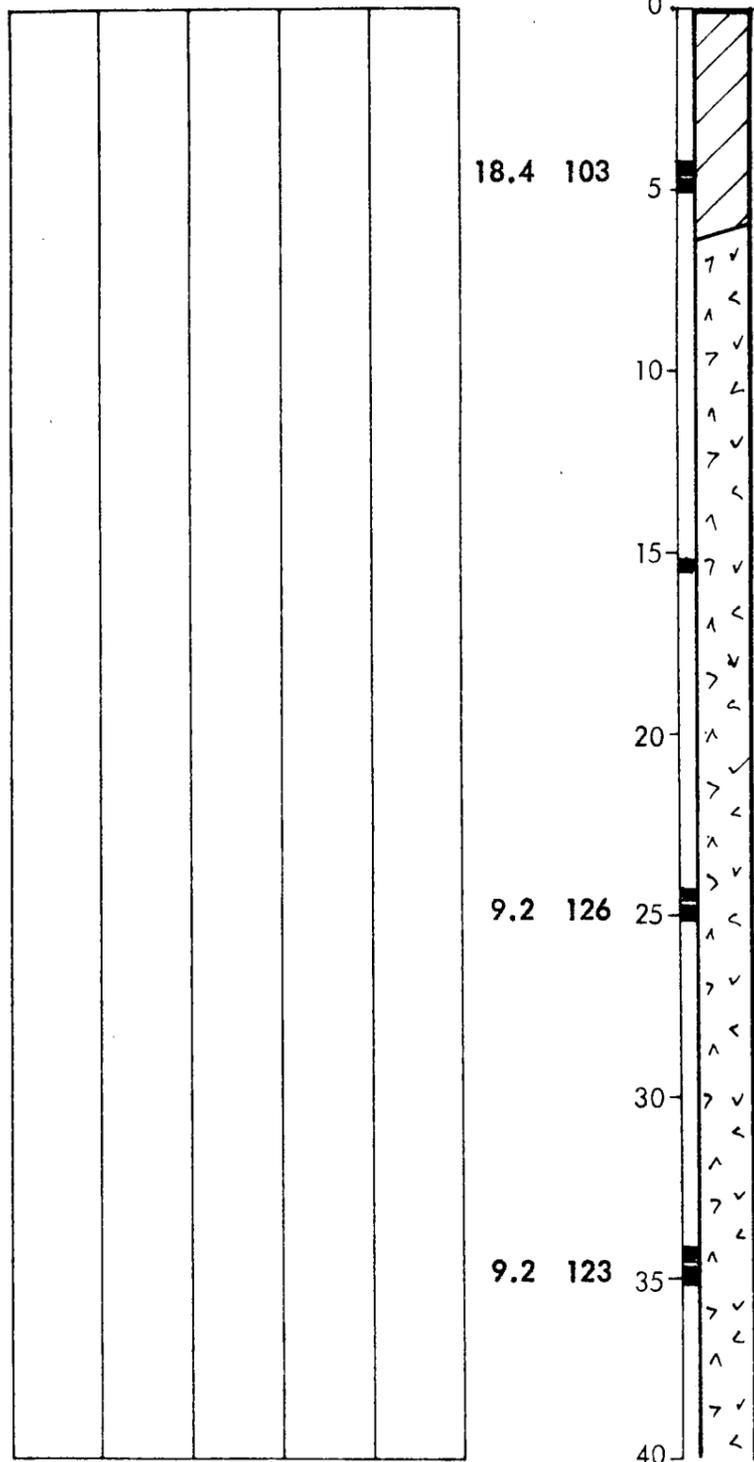
PLATE  
**6**

Shear Strength (lbs/sq ft)

Moisture Content (%)  
Dry Density (pcf)  
Depth (ft)  
Sample

LOG OF BORING 4

Equipment Hollow Auger  
Elevation 903 Date 6/7/75



BROWN SANDY CLAY (CL)  
stiff, wet, with abundant angular gravel

COLLUVIUM

GRAY-BROWN ANDESITE  
little fractured, hard, weak, moderately weathered

MORAGA FORMATION

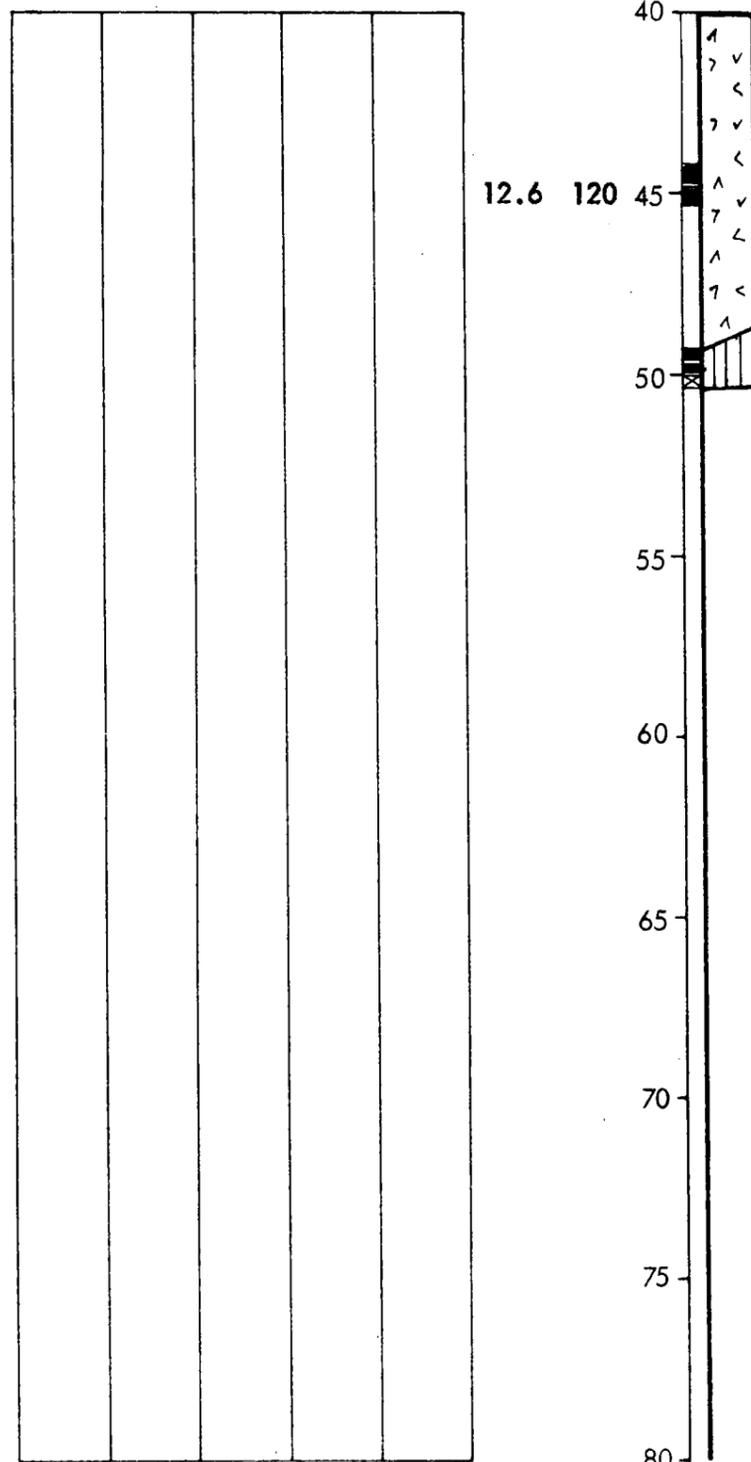
change to moderately hard, moderately strong, little weathered, with occasional clay fracture fillings

with abundant clay fracture fillings

Shear Strength (lbs/sq ft)

Moisture Content (%)  
Dry Density (pcf)  
Depth (ft)  
Sample

(Continuation of Log)



12.6 120

MOTTLED BROWN-GREEN SANDY CLAY (ML) - stiff, moist

ORINDA FORMATION

(no free water encountered)

HARDING - LAWSON ASSOCIATES



Consulting Engineers and Geologists

Job No. 2000,102.01

Appr: LEL Date 6/19/75

LOG OF BORING 4  
Energy Research Building  
Lawrence Berkeley Laboratory

PLATE

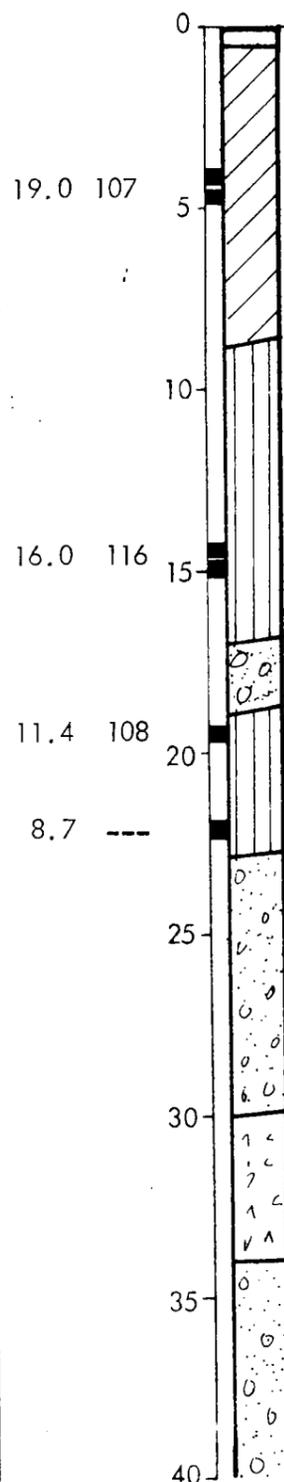
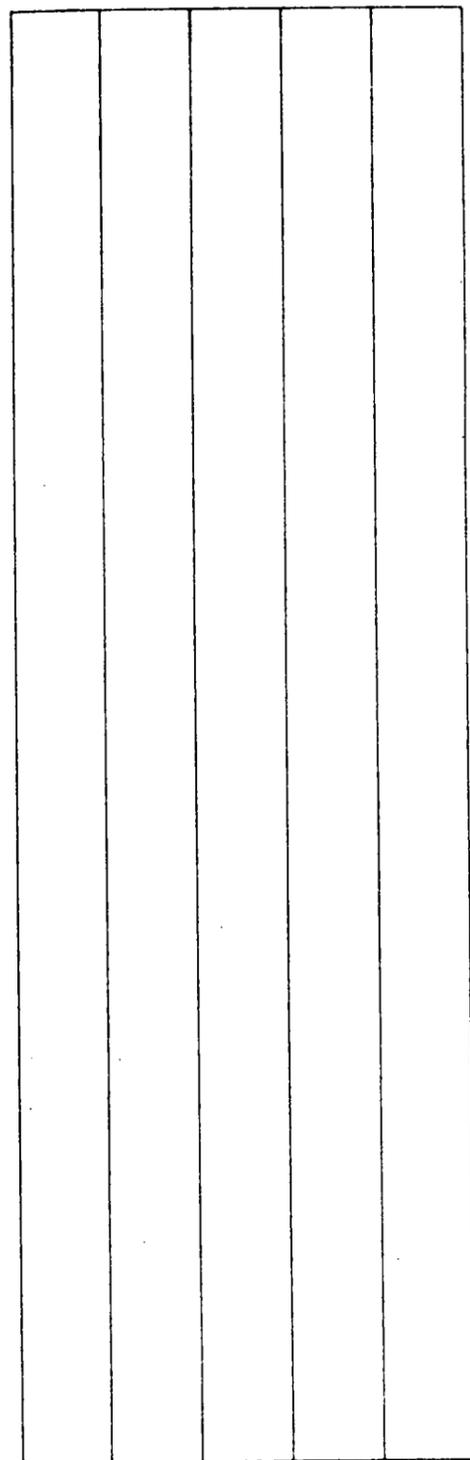
7

Shear Strength (lbs/sq ft)

Moisture Content (%)  
Dry Density (pcf)  
Depth (ft)  
Sample

**LOG OF BORING 5**

Equipment Bucket Auger  
Elevation 907 Date 10/27/75



ASPHALT CONCRETE & BASE ROCK  
BROWN SANDY CLAY (CL)  
medium stiff, moist, with abundant variable sized rock fragments  
change to stiff

BROWN SANDY SILT (ML)  
stiff, moist, with abundant rock fragments

RED VOLCANIC AGGLOMERATE  
moderately fractured, moderately hard, moderately strong, deeply weathered

BROWN GRAVELLY SILT (ML)  
stiff, moist

GRAY-BROWN AGGLOMERATE  
closely fractured, moderately hard, weak, moderately weathered, with abundant silt

GRAY BASALT  
intensely fractured, low hardness, strong, deeply weathered, with abundant silt

MOTTLED GREEN-BROWN ALTERED TUFFACEOUS AGGLOMERATE - crushed, low hardness, very friable, deeply weathered

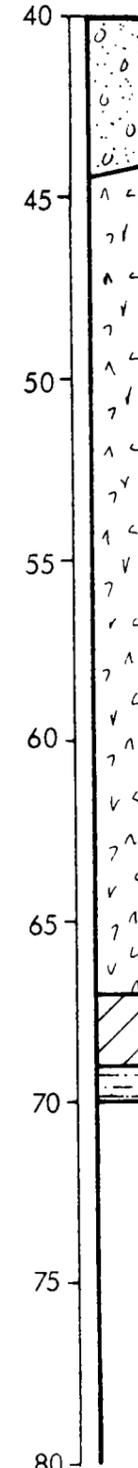
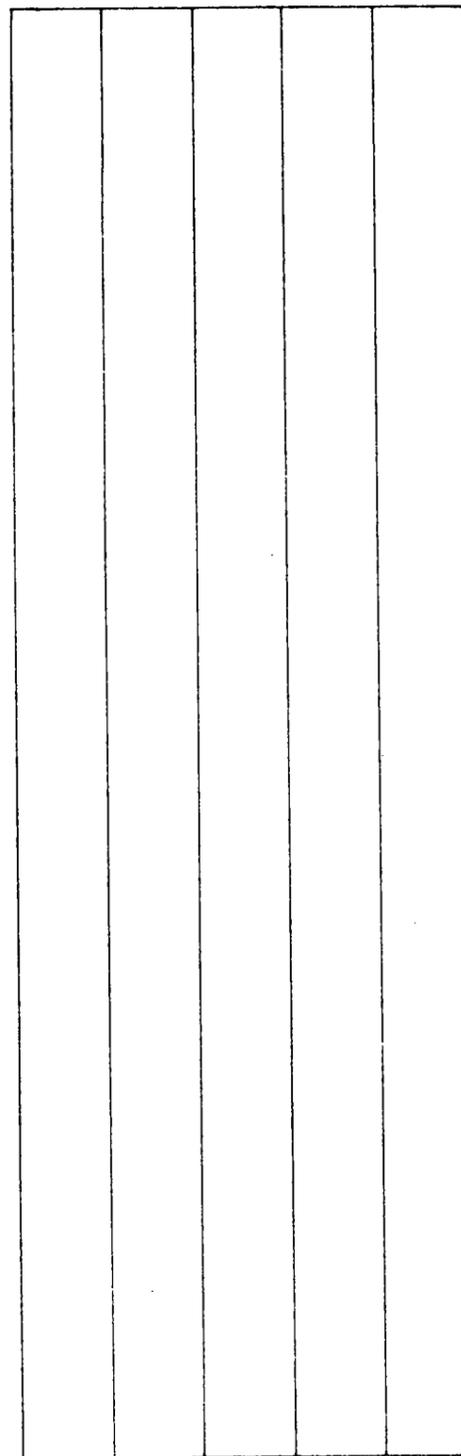
COLLUVIUM

MORAGA FORMATION

Shear Strength (lbs/sq ft)

Moisture Content (%)  
Dry Density (pcf)  
Depth (ft)  
Sample

(Continuation of Log)



GRAY-BROWN ANDESITE  
closely fractured, low hardness, weak, little weathered

water level 11/3/75  
MOTTLED PURPLE, GRAY, GREEN CLAY  
with volcanic and sedimentary rock fragments, sheared

GREEN SILTSTONE  
massive, low hardness, weak, little weathered

(3" perforated plastic pipe installed and hole gravel backfilled)

MORAGA FORMATION

ORINDA FORMATION

**HARDING - LAWSON ASSOCIATES**



Consulting Engineers and Geologists

Job No 2000,102.01

Appr. LEL Date 1/7/76

LOG OF BORING 5

Energy Research Facility  
Lawrence Berkeley Laboratory

PLATE

**8**

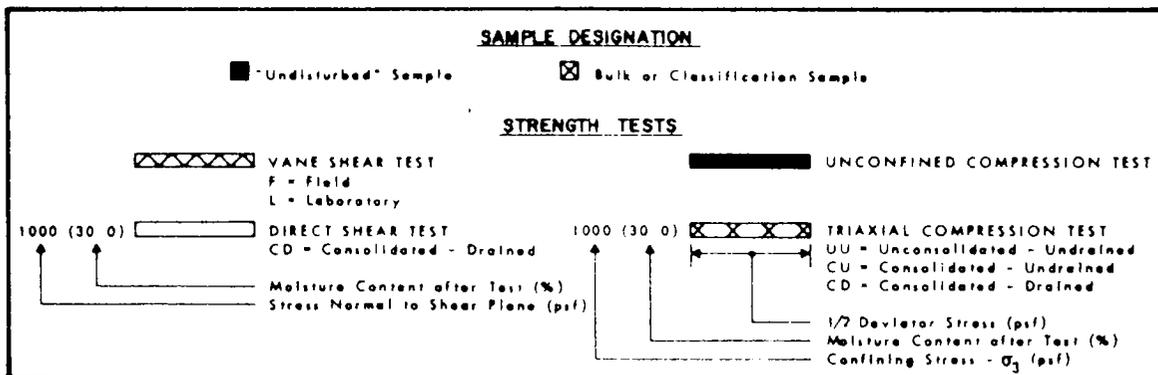






MAJOR DIVISIONS			TYPICAL NAMES				
COARSE GRAINED SOILS MORE THAN HALF IS LARGER THAN #200 SIEVE	GRAVELS  MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES			
			GP	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES			
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES			
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES			
	SANDS  MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS			
			SP	POORLY GRADED SANDS, GRAVELLY SANDS			
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES			
			SC	CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES			
			FINE GRAINED SOILS MORE THAN HALF IS SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
						CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY						
SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS			
		CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS			
		OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS			
HIGHLY ORGANIC SOILS		PI	PEAT AND OTHER HIGHLY ORGANIC SOILS				

### UNIFIED SOIL CLASSIFICATION SYSTEM



### KEY TO TEST DATA

**HARDING - LAWSON ASSOCIATES**



Consulting Engineers and Geologists

**SOIL CLASSIFICATION CHART**

**AND  
KEY TO TEST DATA**

Energy Research Facility

PLATE

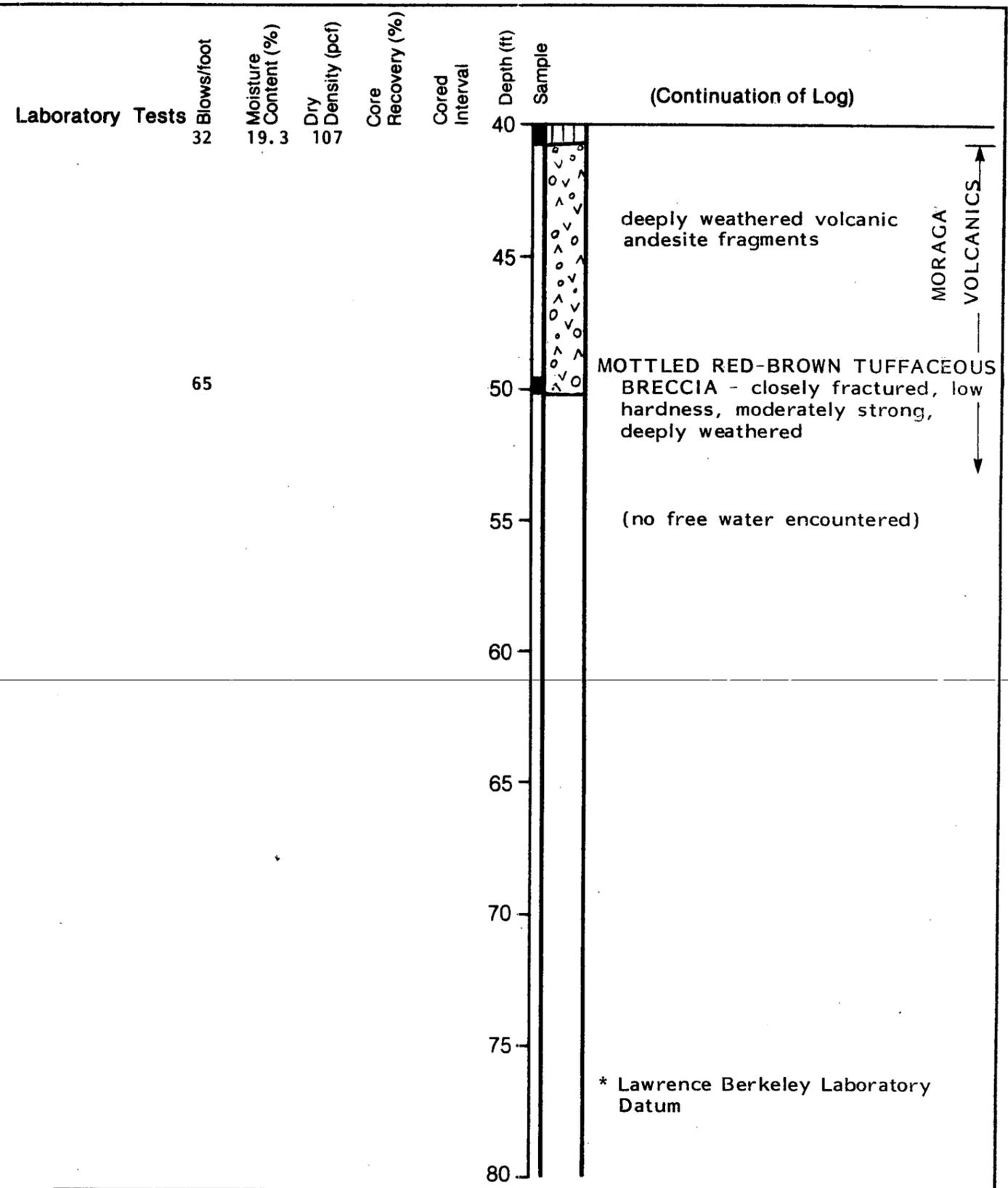
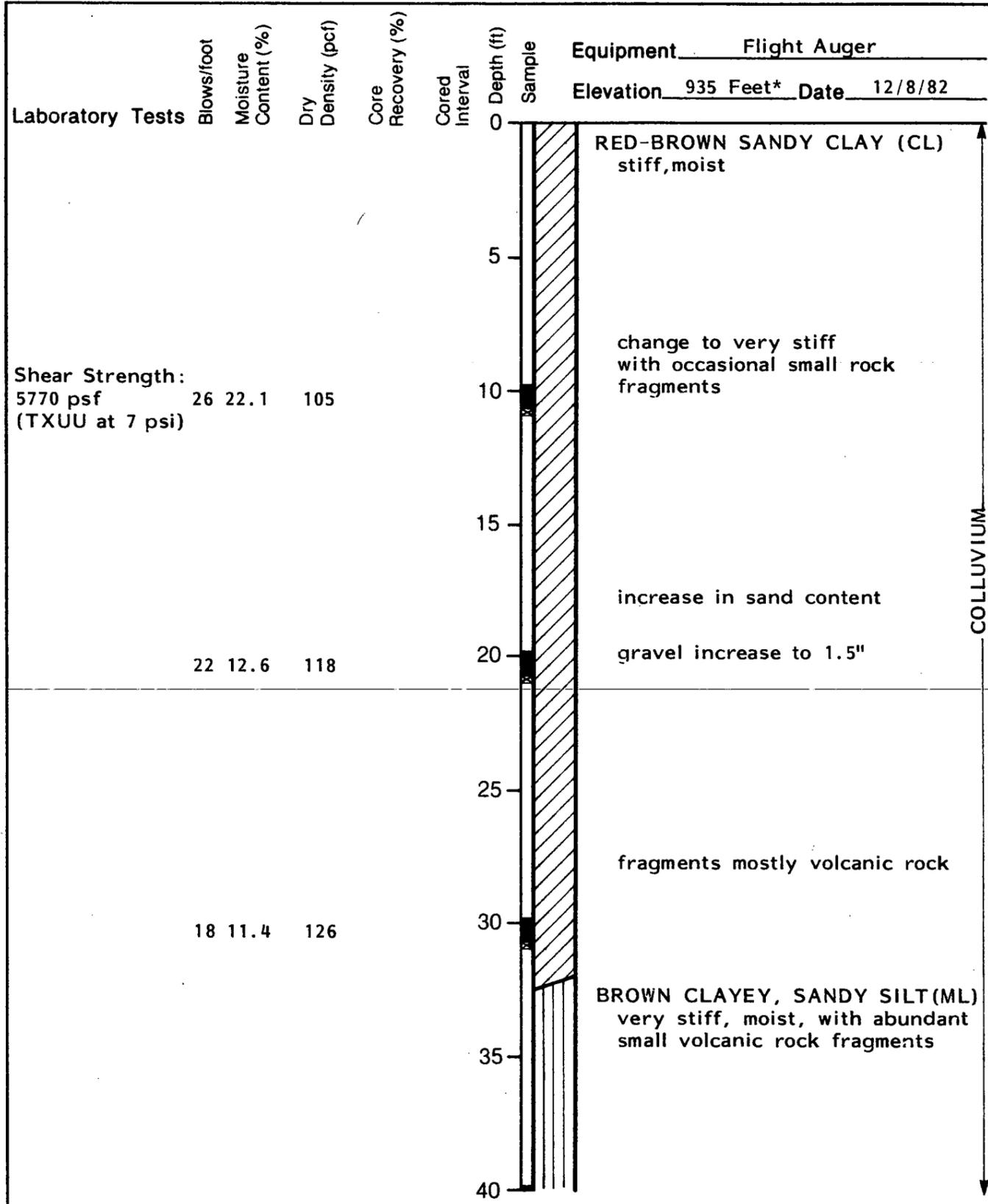
**20**

Job No. 2000,102.01      Appr. LEL Date 5/5/76

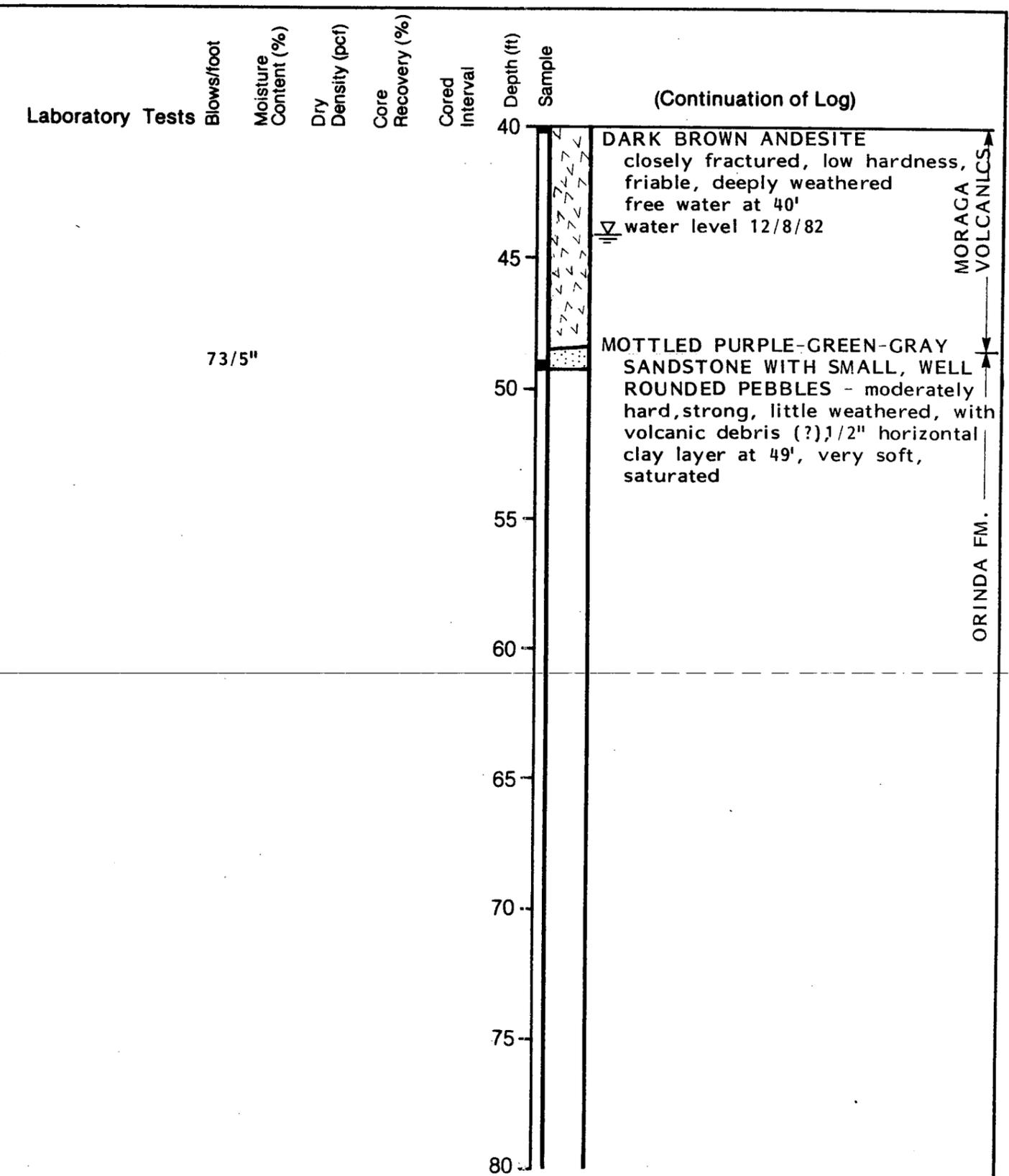
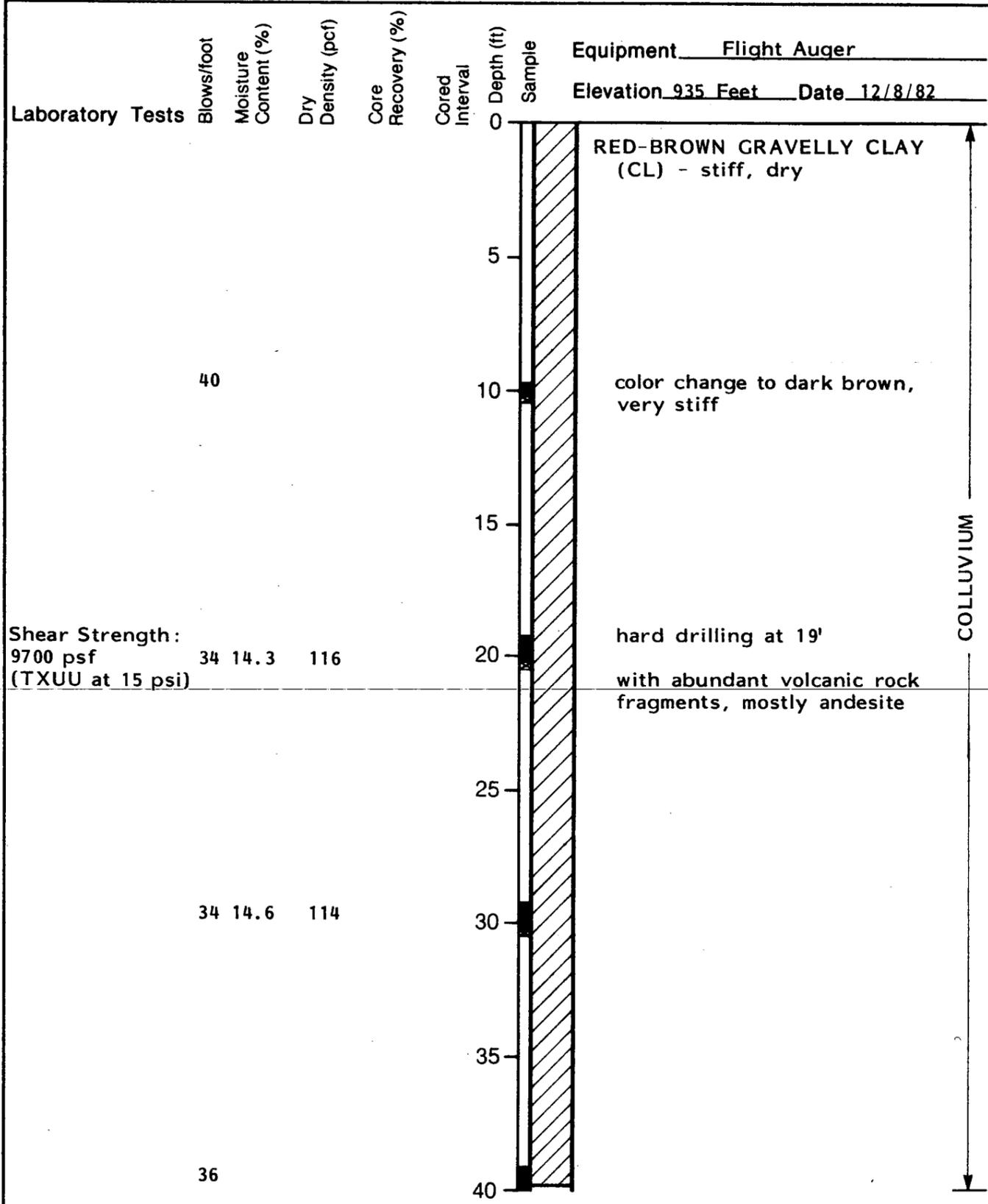
**Harding Lawson Associates (HLA), 1983**, "Geotechnical Investigation, Building 17 to 25A Road Realignment, Lawrence Berkeley Laboratory, Berkeley, California," dated March 4, 1983, Job 2000,169.01.

(LBNL #404)

**Logs of Borings 1 and 2**



 <b>Harding Lawson Associates</b> Engineers, Geologists & Geophysicists	<b>Log of Boring 1.169</b> Lawrence Berkeley Laboratory Berkeley, California		PLATE <b>3</b>
	DRAWN F. Hamilton	JOB NUMBER 2000,169.01	APPROVED 

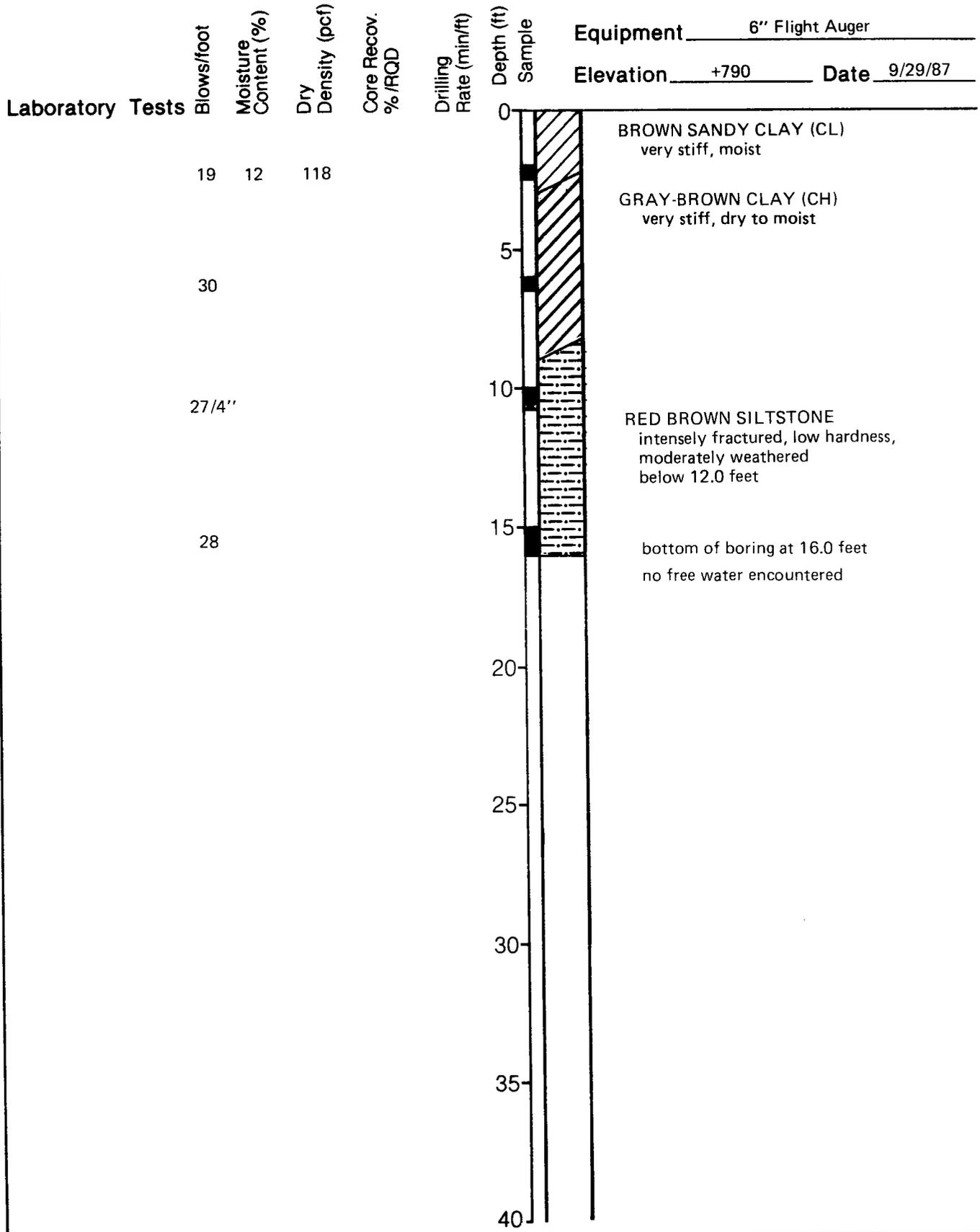


<b>HLA</b>	<b>Harding Lawson Associates</b>	<b>Log of Boring 2.169</b>	PLATE
	Engineers, Geologists & Geophysicists		
DRAWN F. Hamilton	JOB NUMBER 2000,169.01	APPROVED <i>SHK</i>	DATE 1/83
		REVISED	DATE

**Harding Lawson Associates (HLA), 1988,** “Final Report, Geotechnical Investigation, Building 58A Roadway, Lawrence Berkeley Laboratory, Berkeley, California,” dated May 20, 1988, Job 2000,210.01.

(LBNL #117)

**Logs of Borings B-1 and B-2 (1987)  
Log of Boring MM-4 (1988)**



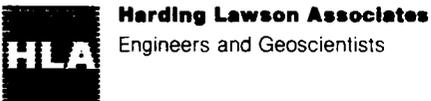
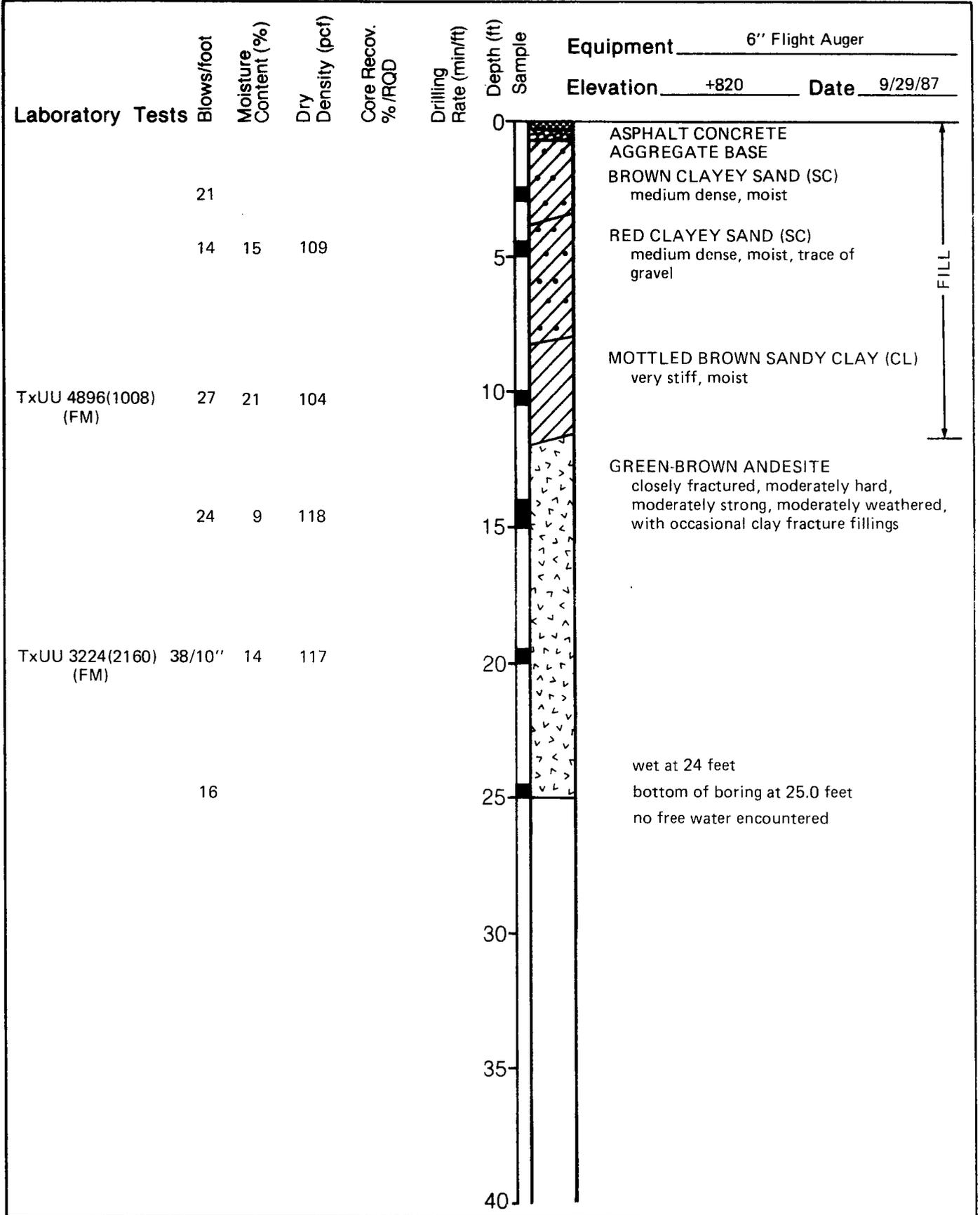
**Harding Lawson Associates**  
Engineers and Geoscientists

**Log of Boring B-1**  
Settlement Investigation - Building 58-A  
Lawrence Berkeley Laboratory  
Berkeley, California

PLATE

**2**

DRAWN CSN	JOB NUMBER 2000,210.01	APPROVED <i>LER</i>	DATE 10/87	REVISED	DATE
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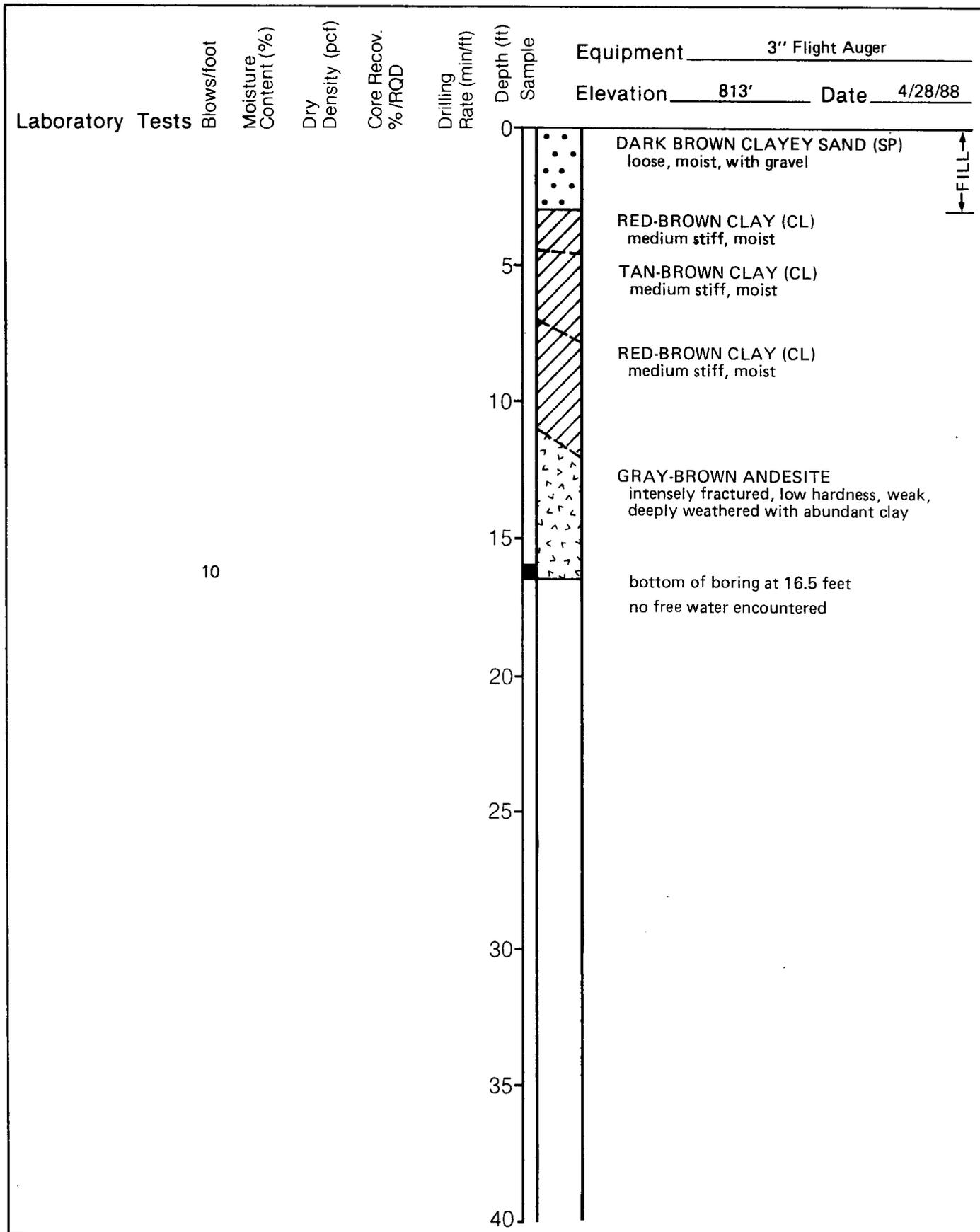


**Log of Boring B-2**  
Settlement Investigation - Building 58-A  
Lawrence Berkeley Laboratory  
Berkeley, California

PLATE

**3**

DRAWN CSN	JOB NUMBER 2000,210.01	APPROVED <i>[Signature]</i>	DATE 10/87	REVISED	DATE
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10



**Harding Lawson Associates**  
Engineers, Geologists  
& Geophysicists

**Log of Boring MM-4**  
Settlement Investigation - Building 58-A  
Lawrence Berkeley Laboratory  
Berkeley, California

PLATE

**8**

DRAWN CSN	JOB NUMBER 2000,210.01	APPROVED <i>d. LR</i>	DATE 5/88	REVISED	DATE
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***Kaldveer Associates, Inc. (KV), 1992***, “Geotechnical Investigation and Design Report, Seismic Slope Stabilization Bevatron-Building 51 and Mechanical Shops-Building 77, Lawrence Berkeley Laboratory, Berkeley, California,” consulting report dated February 28, 1992. KA Project No. K122-1-164.

(LBNL # 282)

**Logs of Borings 1 through 4**

DRILL RIG	<b>Hollow Stem Auger</b>		SURFACE ELEVATION	<b>747 feet</b>		LOGGED BY	<b>KF</b>		
DEPTH TO GROUNDWATER	<b>Not Enc.</b>		BORING DIAMETER	<b>8-inch</b>		DATE DRILLED	<b>7/5/90</b>		
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
<b>SAND (SM)</b> , tan-brown, fine- to coarse-grained, silty, trace clay <b>(FILL)</b>	medium dense								
<b>CLAY (CL)</b> , mottled brown-grey, trace sand (fine- to medium-grained), some silt, trace gravel (fine-grained) (grading sandy, trace silt, no gravel) (colluvial type soil) (sand lens, 6-1/2 inches thick) (possible slip plane @ 9'-10') (plastic clay matrix with thin sandy lenses) <b>(FILL) LANDSLIDE DEBRIS)</b>	stiff		5		19* 16* 21* 20* 17*				
			10		15*	19	94		
<b>SILTSTONE</b> , green mottled gray and olive, clayey, deeply weathered	soft-friable				31* 83*	9	132		Tx
<b>SANDSTONE</b> , green-blue-grey, fine- to coarse-grained, angular rock fragments, poorly cemented, deeply weathered	friable		15		78*				
<b>CLAYSTONE</b> , rust-brown, moderately weathered, closely to intensely fractured	friable		20		90*				
	moderate hardness		25		74*				
(lens of green-olive siltstone)									
<b>CLAYSTONE</b> , brown, moderately to deeply weathered, closely to intensely fractured, some slickenside surfaces	soft-friable		30		72*				
<b>SILTSTONE</b> , green-gray, moderately weathered, closely to intensely fractured	soft-friable		35		64*	16	116		Tx
(1/2 inch lens of soft plastic clay)									
<b>CLAYSTONE</b> , brown, deeply weathered, intensely fractured, lenses of green-gray siltstone, occasional water-filled joints, some slickenside surfaces	soft-friable								



**Kaldveer Associates**  
**Geoscience Consultants**  
 A California Corporation

**EXPLORATORY BORING LOG**

**LBL SLOPE STABILIZATION PROJECT-BLDG.51**  
**Berkeley, California**

PROJECT NO.

DATE

BORING NO

K1226-1-164

February 1992

**1**

DRILL RIG	<b>Hollow Stem Auger</b>	SURFACE ELEVATION	<b>747 feet</b>	LOGGED BY	<b>KF</b>
DEPTH TO GROUNDWATER	<b>Not Enc.</b>	BORING DIAMETER	<b>8-inch</b>	DATE DRILLED	<b>7/5/90</b>

DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
<b>CLAYSTONE, brown, deeply weathered, intensely fractured (ORINDA FORMATION)</b> Bottom of Boring = 41-1/2 Feet Notes: 1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual. 2. For an explanation of penetration resistance values marked with an asterisk (*), see first page Appendix A. 3. Ground water level was not encountered. 4. Tx = Triaxial Shear Test. Refer to Appendix B.	soft-friable			X	82*				

 <b>Kaldveer Associates</b> Geoscience Consultants A California Corporation	<b>EXPLORATORY BORING LOG</b>		
	<b>LBL SLOPE STABILIZATION PROJECT-BLDG.51</b> Berkeley, California		
	PROJECT NO.	DATE	BORING NO
	K1226-1-164	February 1992	<b>1</b>



DRILL RIG	Hollow Stem Auger	SURFACE ELEVATION	754 feet	LOGGED BY	KF
DEPTH TO GROUNDWATER	Not Enc.	BORING DIAMETER	8-inch	DATE DRILLED	7/5/90

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST							
<b>CLAYSTONE</b> , brown, deeply weathered, intensely fractured (ORINDA FORMATION) Bottom of Boring = 41 Feet Notes: 1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual. 2. For an explanation of penetration resistance values marked with an asterisk (*), see first page Appendix A. 3. Ground water level was not encountered. 4. Tx = Triaxial Shear Test. Refer to Appendix B.				150*/5*				



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**EXPLORATORY BORING LOG**

**LBL SLOPE STABILIZATION PROJECT-BLDG.51**  
 Berkeley, California

PROJECT NO.

DATE

BORING  
NO

K1226-1-164

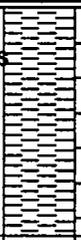
February 1992

**2**



DRILL RIG	<b>Hollow Stem Auger</b>	SURFACE ELEVATION	<b>758 feet</b>	LOGGED BY	<b>KF</b>
DEPTH TO GROUNDWATER	<b>Not Enc.</b>	BORING DIAMETER	<b>8-inch</b>	DATE DRILLED	<b>7/5/90</b>

DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						

<b>SILTSTONE</b> , gray-green, moderately weathered, intensely fractured  (grading gray-brown and laminated)  <b>(ORINDA FORMATION)</b>	low hardness		45	 refusal					
				 86*					

Bottom of Boring = 46-1/2 Feet Notes: 1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual. 2. For an explanation of penetration resistance values marked with an asterisk (*), see first page Appendix A. 3. Ground water level was not encountered.									
--	--	--	--	--	--	--	--	--	--

 <b>Kaldveer Associates</b> Geoscience Consultants A California Corporation	<b>EXPLORATORY BORING LOG</b>								
	<b>LBL SLOPE STABILIZATION PROJECT-BLDG.51</b> Berkeley, California								
	PROJECT NO.	DATE			BORING NO				
	<b>K1226-1-164</b>	<b>February 1992</b>			<b>3</b>				

DRILL RIG	<b>Hollow Stem Auger</b>		SURFACE ELEVATION	<b>795 feet</b>		LOGGED BY	<b>KF</b>			
DEPTH TO GROUNDWATER	<b>Not Enc.</b>		BORING DIAMETER	<b>8-inch</b>		DATE DRILLED	<b>7/6/90</b>			
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS	
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)							
<b>5" Asphaltic Concrete over 36" Baserock</b>										
<b>CLAY (CL), brown mottled rust, silty, with sand (fine- to coarse-grained), some gravel (fine- to coarse-grained)</b>  (grading sand pockets and blocks of rock)  <b>(FILL)</b>	hard		5	X	41*	14	98			
	very stiff		10	X	40*	9	111			
			15	X	95*	5				
<b>CLAY (CL), rust-brown, silty, some gravel (fine- to coarse-grained)</b>	hard		20	X	50*/6'					
<b>CLAYSTONE, rust-brown, silty, deeply weathered, intensely fractured</b>  (grading green-gray and sandy)  (grading rust-brown and trace sand)  (siltstone inclusions up to 1" diameter)  (very shaley at 32 feet)  (moderately hard siltstone pocket at 34 feet) (moderately hard clay shale at 34-1/2 to 35-1/2 feet) (siltstone block at 35-1/2 to 37 feet)	soft		25	X	refusa					
	friable		30	X	60*/6'					
			35	X	refusa					
	moderate hardness			X	refusa					
 <b>Kaldveer Associates</b> <b>Geoscience Consultants</b> A California Corporation			<b>EXPLORATORY BORING LOG</b>							
			<b>LBL SLOPE STABILIZATION PROJECT-BLDG.51</b> <b>Berkeley, California</b>							
			PROJECT NO.	DATE	BORING NO					
			K1226-1-164	February 1992	4					

DRILL RIG	<b>Hollow Stem Auger</b>	SURFACE ELEVATION	<b>795 feet</b>	LOGGED BY	<b>KF</b>
DEPTH TO GROUNDWATER	<b>Not Enc.</b>	BORING DIAMETER	<b>8-inch</b>	DATE DRILLED	<b>7/6/90</b>

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS		
DESCRIPTION AND REMARKS	CONSIST								SOIL TYPE	
<b>CLAYSTONE</b> , rust-brown, deeply weathered, intensely fractured, silty, trace sand (resistant pockets 39 to 46 feet)	soft-friable	45								
		low to moderate hardness							50	50* / 4'
		55								
low to moderate hardness	60	refusa								
<b>SILTSTONE</b> , green-gray, some sand (fine-grained), shaley fabric, moderately weathered, closely fractured  <b>(ORINDA FORMATION)</b>	low to moderate hardness	65								
Bottom of Boring = 69-3/4 Feet Notes: 1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual. 2. For an explanation of penetration resistance values marked with an asterisk (*), see first page Appendix A. 3. Ground water level was not encountered.										



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**EXPLORATORY BORING LOG**

**LBL SLOPE STABILIZATION PROJECT-BLDG.51**  
 Berkeley, California

PROJECT NO.

DATE

BORING  
NO

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**4**

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	Well graded gravels, gravel-sand mixtures little or no fines.
		GRAVEL WITH FINES	GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
			GM	Silty gravels gravel-sand-silt mixtures non-plastic fines
		GC	Clayey gravels gravel-sand-clay mixtures, plastic fines	
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS LIQUID LIMIT IS GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils

#### DEFINITION OF TERMS

		U.S. STANDARD SERIES SIEVE			CLEAR SQUARE SIEVE OPENINGS			
		200	40	10	4	3/4"	3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS	
	FINE	MEDIUM	COARSE	FINE	COARSE			

#### GRAIN SIZES

SANDS AND GRAVELS	BLOWS/FOOT <sup>†</sup>
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

SILTS AND CLAYS	STRENGTH <sup>‡</sup>	BLOWS/FOOT <sup>†</sup>
VERY SOFT	0 - 1/4	0 - 2
SOFT	1/4 - 1/2	2 - 4
FIRM	1/2 - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

#### RELATIVE DENSITY

<sup>†</sup> Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1-3/8 inch I.D.) split spoon (ASTM D-1586).

<sup>‡</sup> Unconfined compressive strength in tons/sq. ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

#### CONSISTENCY



**Kaldveer Associates**  
Geoscience Consultants  
A California Corporation

#### KEY TO EXPLORATORY BORING LOGS Unified Soil Classification System (ASTM D-2487)

LAWRENCE BERKELEY LABORATORY  
SEISMIC SLOPE STABILIZATION PROJECT  
Berkeley, California

PROJECT NO.	DATE	Figure A-1
K1226-1-164	February 1992	

ROCK CHARACTERISTICS CHART

Bedding of Sedimentary rocks

Stratification

Thickness of Beds

Massive  
 Very thick bedded  
 Thick bedded  
 Thin bedded  
 Very thin bedded  
 Laminated  
 Thinly laminated

No apparent bedding  
 Greater than 4 feet  
 2 feet to 4 feet  
 2 inches to 2 feet  
 1/2 inch to 2 inches  
 1/8 inch to 1/2 inch  
 Less than 1/8 inch

Fracturing

Intensity

Size of Pieces

Little  
 Occasional  
 Moderate  
 Close  
 Intense  
 Crushed

Greater than 4 feet  
 1 foot to 4 feet  
 6 inches to 1 foot  
 1 inch to 6 inches  
 1/2 inch to 1 inch  
 Less than 1/2 inch

Strength

Soft - Plastic or very low strength  
Friable - Crumbles easily by hand  
Low Hardness - Crumbles under light hammer blows  
Moderate Hardness - Crumbles under a few heavy hammer blows  
Hard - Breaks into large pieces under heavy, ringing hammer blows  
Very Hard - Resists heavy, ringing hammer blows and will yield with difficulty only dust and small flying fragments

Weathering

Deep - Moderate to complete mineral decomposition; extensive disintegration; deep and thorough discoloration; many extensively-coated fractures.

Moderate - Slight decomposition of minerals; little disintegration; moderate discoloration; moderately-coated fractures.

Little - No megascopic decomposition of minerals; slight to no effect on cementation; slight and intermittent, or localized discoloration; few stains on fracture surfaces.

Fresh - Unaffected by weathering agents; no disintegration or discoloration; fractures usually less numerous than joints.



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ROCK CHARACTERISTICS CHART

LAWRENCE BERKELEY LABORATORY  
 SEISMIC SLOPE STABILIZATION PROJECT  
 Berkeley, California

PROJECT NO.	DATE
K1226-1-164	February 1992

Figure A-2

**Geo/Resource Consultants, Inc. (GRC), 1993**, "Preliminary Geotechnical Investigation, Landslide at Fire Trail Access Gate East of Building 51, Lawrence Berkeley Laboratory, Berkeley, California" consulting report dated May 24, 1993. GRC Project 1746-005

(LBNL #297)

**Logs of Temporary Caissons 1 through 10  
Logs of Boring B-1 through B-3 and B-5 through B-7**

CAISSON INSTALLATION RECORD

Record No. \_\_\_\_\_  
 Caisson No. 1  
 Page 1 of 1  
 Date 3-22-93

Ground Elevation		Project	
Depth in feet	Graphic Log	USCS Symbol	
0.0			SUBSURFACE CONDITIONS
0.0 - 9.0			
9.0			9.0-10.0 Baserock # 6" clay pipe
10.0			10.0-13.10 SILTSTONE (s/y/g) orange FM, friable, weak hardness & strength, dry
13.10			13.10-14.5 CLAY, brown to red brown, some silt & gravel, soft, moist.
14.5			14.5-21.4 SILTSTONE - CLAYSTONE, brownish gray (syr 4/1), massive, moderate hardness, weak strength friable, dry.

CAISSON INFORMATION:

Caisson Location: \_\_\_\_\_

Type: Straight Shaft  Belled

Shaft Diameter: 30" Bell Diameter: N/A

Cutoff Elevation: \_\_\_\_\_

Caisson Tip: \_\_\_\_\_

Actual Depth 32.10 Design \_\_\_\_\_

Actual Elev. \_\_\_\_\_ Design \_\_\_\_\_

Total Caisson Length: 33.2'

Depth to Firm/End-bearing Soils: \_\_\_\_\_

Length of Penetration of Caisson into Firm Soils: \_\_\_\_\_

Actual Penetration \_\_\_\_\_ Design \_\_\_\_\_

DRILLING NOTES:

Time Start Drilling: 8:49 Finish: 10:37

Time Concrete Placed: 12:54

Depth of Casing: 7-8 uds

Any Caving? Yes Describe: 9.0-10.0' gravel-bdd clay pipe

Depth of Water: NE

REMARKS: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Field Engineer: BHL

ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached:

Ground Elevation \_\_\_\_\_  
 Project LBL Bldg 51

Job No. 1746-005

Depth in feet	Graphic Log	USCS Symbol	SUBSURFACE CONDITIONS
0			0.0-4.5 clayey, silty, silty GRAVEL (GC) dk yellow orange (10YR6/6), low plastic fines, fine to coarse sd gravel, asphalt chunks damp. FILL
5			4.5-11.0 silty silty CLAY (CL) dk yellowish brn. (10YR4/2) grysh brn (5YR3/2) trace gravel, low to med plastic fines, med stiff to stiff, Dry to damp FILL
10			9.5-10.5 GRAVEL & 6" clay drain pipe
15			11.0-14.0 CLAYSTONE DK grnsh gry (EGY4/1) friable, moderate hardness & strength, crushed. Dry.
20			14.0-33.6 mixed SILTST (med blsh gry (SB5/1) & CLAYST grysh red (SR4/2) - Red gray thin abnt highly polished surf. w/ weak hardness, & v. weak strength, crushed, abnt stuck to sides, & grass, soft
25			22.5-33.6 <u>doughy</u> beginning at
30			25.0 - gradg more med blsh gry, but still plenty of highly polished red gray CLAY
35			30.0 - gradg more grysh red, wk hardness & strength, intensely fractured. Dry.

CAISSON INFORMATION:

Caisson Location: See Plan  
 Type: Straight Shaft  Belled   
 Shaft Diameter: 30' Bell Diameter: \_\_\_\_\_  
 Cutoff Elevation: \_\_\_\_\_  
 Caisson Tip:  
 Actual Depth 33.6' Design \_\_\_\_\_  
 Actual Elev. 768.0 Design \_\_\_\_\_  
 Total Caisson Length: \_\_\_\_\_  
 Depth to Firm/End-bearing Soils: \_\_\_\_\_  
 Length of Penetration of Caisson into Firm Soils:  
 Actual Penetration \_\_\_\_\_ Design \_\_\_\_\_

DRILLING NOTES:

Time Start Drilling: 0752 Finish: 0840  
 Time Concrete Placed: \_\_\_\_\_  
 Depth of Casing: \_\_\_\_\_  
 Any Caving? Yes Describe: A little gravel  
 Depth of Water: \_\_\_\_\_

REMARKS:

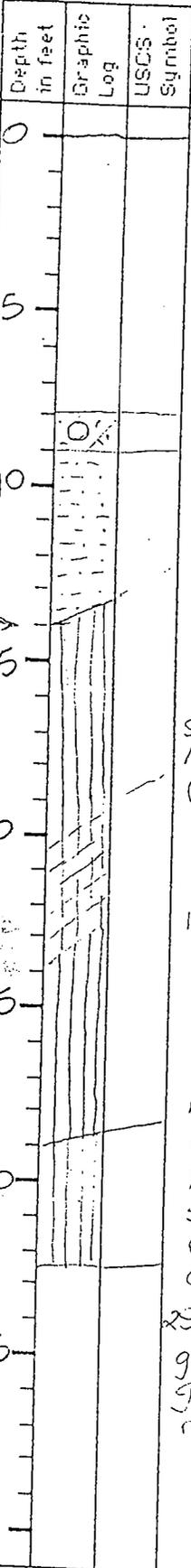
Blsh and clay is more consistent soil like in character; grysh red is planar, polished

Field Engineer: BLH

ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached:

Ground Elevation \_\_\_\_\_  
 Project LBL Bldg 51

Job No. 1746-005



**SUBSURFACE CONDITIONS**

0.0-4.5 clayey, silty, silty GRAVEL (Gc), dark yellowish brown (10YR 4/2), loose to medium stiff, moist-FILL

4.5-9.0 silty, silty CLAY (Cl) grayish brown (5YR 3/2) trace fine grnl., med plastic, med plastic, moist. - FILL  
 - grad'g gravelly at 5.5'  
 - cobbles at 8.0  
 - grad'g moderate brown (5YR 3/4) at 9.0 drill'g stiff to hard

9.0-10.0 gravel bdd clay pipe  
 10.0-14.0 SILTSTONE (Orinda Fm)  
 Lt olive gray (5Y 6/1) moderate hardness, weak strength, massive, moist

14.0-20.0 clayey silt (ML) dk yllsh brn (10YR 4/2) to brnsh gry (5YR 4/1), gravelly, med stiff to hard, dry

20.0-24.0 clay med lt gry (4Y 6) w/ grysh red (5P 4/3) clay seams w/ highly polished slicken sides, stiff to soft in the red clay; loose in gry clay. Concentrated at 22.0'

29.0-32.6 medium SILT (ML) graysh red (5R/4.2), trace grnl., med stiff to stiff, non plastic, dry.

**CAISSON INFORMATION:**

Caisson Location: \_\_\_\_\_  
 Type: Straight Shaft  Belled   
 Shaft Diameter: 30" Bell Diameter: \_\_\_\_\_  
 Cutoff Elevation: \_\_\_\_\_  
 Caisson Tip: \_\_\_\_\_  
 Actual Depth 32.6' Design \_\_\_\_\_  
 Actual Elev. : \_\_\_\_\_ Design \_\_\_\_\_  
 Total Caisson Length: 32 ft  
 Depth to Firm/End-bearing Soils: \_\_\_\_\_  
 Length of Penetration of Caisson into Firm Soils:  
 Actual Penetration 0.0 Design 0.0

**DRILLING NOTES:**

Time Start Drilling: 11:07 Finish: 12:00  
 Time Concrete Placed: 1:25 (7.5 yds)  
 Depth of Casing: \_\_\_\_\_  
 Any Caving? Yes Describe: \_\_\_\_\_  
A little from gravel at 9.0'  
 Depth of Water: NE

**REMARKS:**

14.0 - Probable slide plane depth  
29.0 - 32.6 - Similar color  
SILTST/CLAYST was present in cores of Orinda Fm at Bldg 90.

Field Engineer: BHR

ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached:

Record No.  
 Caisson No. C-4  
 Page 1 of 1  
 Date 3-24-93

Ground Elevation		Project
		<u>LBL Bldg 51</u>
		Job No. <u>1746-005</u>
Depth in feet	Graphic Log	USCS Symbol
SUBSURFACE CONDITIONS		
0		
0.0 - 4.5		clayey, silty, silty <u>GRAVEL (GC)</u> , low to med plastic fines, fine to coarse sd gravel, asphalt chunks, damp, FILL
5		
4.5 - 11.5		silty, silty, <u>CLAY (CL)</u> Mod brn. (SYR 3/4), low to med plastic fines, fine to coarse sd, some gravel. Mod stiff to stiff. Damp.
10		
11.5 - 16.5		<u>CLAYSTONE</u> brn to gry (SY 5/2) & pale brn (SYR 5/2), angular guls (fine to med.) friable, wk h & s; crushed; layering by color. Dry to moist.
15		
16.5 - 27.0		<u>SILTSTONE</u> Gmsh gry (SGY 6/1) Friable, massive, weak h & s, crushed, Dry. @ 22.6 mod strength, blocky
20		
24.0 - 33.0		<u>CLAYSTONE</u> Grayish red, Friable, wk h & s, crushed, silted to a series of highly polished slickenside planes
25		
30		
35		

CAISSON INFORMATION:

Caisson Location: See Plan

Type: Straight Shaft  Belled

Shaft Diameter: 30" Bell Diameter: \_\_\_\_\_

Cutoff Elevation: \_\_\_\_\_

Caisson Tip: \_\_\_\_\_

Actual Depth 33.0' Design \_\_\_\_\_

Actual Elev. 768.4 Design \_\_\_\_\_

Total Caisson Length: \_\_\_\_\_

Depth to Firm/End-bearing Soils: \_\_\_\_\_

Length of Penetration of Caisson into Firm Soils: \_\_\_\_\_

Actual Penetration \_\_\_\_\_ Design \_\_\_\_\_

DRILLING NOTES:

Time Start Drilling: 0853 Finish: 0931

Time Concrete Placed: \_\_\_\_\_

Depth of Casing: \_\_\_\_\_

Any Caving? No Describe: \_\_\_\_\_

Depth of Water: NE

REMARKS:

24.0 - grayish red clay highly polished

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\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Field Engineer: BLH

ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached:

Depth in feet	Graphic Log	USCS Symbol	SUBSURFACE CONDITIONS
0			0.0 - 4.0 clayey, silty, sdy GRAVEL (GC) dk yllsh brn. asphalt chunks, moist - FILL
5			4.0 - 9.0 silty CLAY (CL) graysh brn (5YR 3/2) some gravel, med stiff, med plastic moist. Shreds of plastic sheeting at 4.5'. On comp-wet (A little free water at 8' quickly gone). Asphalt chunks - FILL
10			9.0 - Driller reports layer of hard drill'g matrl.
15			9.0 - 16.0 silty CLAY (CL) dk yllsh brn (10YR 4/2), trace gravel, med stiff to stiff, non plastic fines, dry.
20			16.0 - 22.5 CLAYSTONE (Orinda) olive gry (5Y 4/1), friable, weak, some layering of clay. grades quickly to med dk gry (N4)
25			22.5 - 30.5 CLAY (CL) grayish red (5R 4/2); massive, non-plastic intense slickensides at 23.0 - 26.0'
30			27.5 - Admixed med dk gry & graysh red claus; hard, dry. Abnt. polished surface.
35			30.5 - 33.0 silty CLAY (CL) dk yllsh brn (10YR 4/2), trace fine gravel; non-plastic fines

CAISSON INFORMATION:

Caisson Location: \_\_\_\_\_

Type: Straight Shaft  Belled

Shaft Diameter: 30' Bell Diameter: \_\_\_\_\_

Cutoff Elevation: \_\_\_\_\_

Caisson Tip: \_\_\_\_\_

Actual Depth 33.0' Design \_\_\_\_\_

Actual Elev. \_\_\_\_\_ Design \_\_\_\_\_

Total Caisson Length: 33.0

Depth to Firm/End-bearing Soils: \_\_\_\_\_

Length of Penetration of Caisson into Firm Soils: \_\_\_\_\_

Actual Penetration \_\_\_\_\_ Design \_\_\_\_\_

DRILLING NOTES:

Time Start Drilling: 12:10 Finish: 12:51

Time Concrete Placed: 1:34

Depth of Casing: \_\_\_\_\_

Any Caving? NO Describe: \_\_\_\_\_

Depth of Water: NE

REMARKS:

8' - Trace of free water

22.5' - Earth red clay - Orinda:

remember PL-10, 9th cores.

Field Engineer: \_\_\_\_\_

ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached:



Ground Elevation		Project <u>LBL Bldg 51</u>		Job No. <u>1746-005</u>	
Depth in feet	Graphic Log	USCS Symbol	SUBSURFACE CONDITIONS		
0			0.0 - 12.6 clayey, silty, sdy GRAVEL (Gc) dk yllsh brn. (10 YR 4/2), non plastic to slightly plastic, moist to damp, loose to med dense. FILL Asphalt chunks		
5			3.5 - gradg grysh brn (5YR 2/2). 4.5 - shands of plastic sheeting; gradg damp 9.5 - nodules of drinda clayst.		
10			12.6 - 16.5 CLAYSTONE - SILTSTONE (Orinda Fm) Light olive gray (5Y 6/1) friable, weak strength & hardness, dry.		
15			16.5 - 19.0 SILTSTONE brnsh gry (5YR 4/1) as above		
20			19.0 - 27.0 SILTSTONE grysh red (5R 4/2), as above (26.7 - 27.0 zone of admixed med dk gry / grysh red crushed claystone)		
25			27.0 - 32.6 CLAYSTONE med dk gry (N4), friable weak strength & hardness, not polished surfaces, deforms under finger pressure		
30			31.0 - gradg to med. gry (N5)		
35					

CAISSON INFORMATION:

Caisson Location: \_\_\_\_\_

Type: Straight Shaft  Belled

Shaft Diameter: 30" Bell Diameter: NA.

Cutoff Elevation: \_\_\_\_\_

Caisson Tip: \_\_\_\_\_

Actual Depth 32.6" Design \_\_\_\_\_

Actual Elev. \_\_\_\_\_ Design \_\_\_\_\_

Total Caisson Length: \_\_\_\_\_

Depth to Firm/End-bearing Soils: \_\_\_\_\_

Length of Penetration of Caisson into Firm Soils: \_\_\_\_\_

Actual Penetration \_\_\_\_\_ Design \_\_\_\_\_

DRILLING NOTES:

Time Start Drilling: 1:13 Finish: 2:09

Time Concrete Placed: 3:42

Depth of Casing: \_\_\_\_\_

Any Caving? No Describe: \_\_\_\_\_

Depth of Water: NE

REMARKS:

stop drilling for ± 12 minutes to allow for concrete pump.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Field Engineer: BHL

ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached:

PROJECT NO. \_\_\_\_\_  
 CAISSON No. 8  
 Page 1 of 1  
 Date 3-24-93

Ground Elevation		Project	Job No.
Depth in feet	Graphic Log	USCS Symbol	SUBSURFACE CONDITIONS
0			0.0 - 4.5 clayey, silty, sdy, GRAVEL (GC), low plastic fines, fine to coarse silty gravel. Asphalt FILL
5			4.5 - 11.5 Gravelly, silty, sdy CLAY (CL) med plastic fines, fine to coarse silty gravel; med stiff to stiff. Damp. FILL
10			11.5 - 15.5 SILTSTONE Lt olive gray (5YS/2), Friable, weak h&s, crushed
20			15.5 - 23.5 CLAYSTONE gray red (5R4/2) w/ layers of med bluish gray (5B5/1), Friable weak to moderate strength; weak h&s, crushed, blocky, abnt highly polished clay surfaces
25			24.0 - 33.0 SILTST/SANDST med bluish gray (5B5/1) Friable, v. weak h&s; crushed, highly plastic, soft. Dmp. Abnt small highly polished surfaces gradg med dark gray (N4) @ 26.0 moderate h&s.
35			@ 28.0 SILTST/SANDST med lt gray (N6) mod. h&s, friable, massive, crushed blocky
CAISSON INFORMATION:			
Caisson Location: _____			
Type: Straight Shaft <input checked="" type="checkbox"/> Belled <input type="checkbox"/>			
Shaft Diameter: <u>30"</u> Bell Diameter: _____			
Cutoff Elevation: _____			
Caisson Tip:			
Actual Depth <u>33.0'</u> Design _____			
Actual Elev. <u>269.2</u> Design _____			
Total Caisson Length: _____			
Depth to Firm/End-bearing Soils: _____			
Length of Penetration of Caisson into Firm Soils:			
Actual Penetration _____ Design _____			
DRILLING NOTES:			
Time Start Drilling: <u>10:44</u> Finish: <u>11:14</u>			
Time Concrete Placed: _____			
Depth of Casing: _____			
Any Caving? _____ Describe: _____			
Depth of Water: <u>NE</u>			
REMARKS:			
<u>@ 22.0 - highly plastic deformable clay</u>			
Field Engineer: <u>BHR</u>			
ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached: <input checked="" type="checkbox"/>			

CAISSON INSTALLATION RECORD

RECORD NO.

Caisson No. 9

Page 1 of 1

Date 3-22-93

Ground Elevation		Project		Job No.
				<u>1746-005</u>
Depth in feet	Graphic Log	USCS Symbol	SUBSURFACE CONDITIONS	CAISSON INFORMATION:
				Caisson Location: _____ Type: Straight Shaft <input checked="" type="checkbox"/> Belled <input type="checkbox"/> Shaft Diameter: <u>30"</u> Bell Diameter: <u>NA</u> Cutoff Elevation: _____ Caisson Tip: _____ Actual Depth <u>33.0</u> Design _____ Actual Elev. _____ Design _____ Total Caisson Length: _____ Depth to Firm/End-bearing Soils: _____ Length of Penetration of Caisson into Firm Soils: _____ Actual Penetration _____ Design _____
0			0.0-9.0 clayey, silty sdg GRAVEL (GC) dk yllsh brn (10YR 4/2) slightly plastic fines, asphalt chunks, cobbles, moist to damp. FILL	DRILLING NOTES: Time Start Drilling: <u>2:20</u> Finish: <u>3:33</u> Time Concrete Placed: <u>3:45</u> Depth of Casing: _____ Any Caving? <u>No</u> Describe: _____ Depth of Water: <u>NE</u>
5			4.5 - grade ± brnsh gry (5YR 4/1)	
10			9.0-11.6 silty CLAY (CL) grnsh gry (5GY 6/1) & grysh brn (5YR 3/2) plastic fines, med stiff. FILL	REMARKS: <u>Stop at 2:33 for ± 8 min. to allow for concrete pumpg</u> <u>15.0-15.5 Hole blocked, deflects auger. large boulder of Orinda chertstone.</u> <u>20.0 - 2 pipes: [diagram] in the hole</u>
15			11.6-13.6 CLAY (CL) med. brn (5YR 3/4) & dusky brn (5YR 2/2) mottled, w/ gravel - damp. FILL	
20			13.6-21.5 SILTSTONE (Orinda) Grysh red (5R 4/2) friable, weak hardness & strength, crushed	
25			15.0-15.3 GRAVEL (GP) 15.3 - Hard fill, 20.0 - Two pipes	
30			21.5-22.0 zone of admixed grysh red & med dk gry clay. soft to med stiff.	
35			22.0 - SILTSTONE/CLAYST. Med dk gry (NA) friable, weak hardness & strength, crushed, med dk gry (NA) med light gry (N6).	
				Field Engineer: <u>BHR</u>
				ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached: <input checked="" type="checkbox"/>

# CAISSON INSTALLATION RECORD

Record No.
Caisson No. <u>10</u>
Page <u>1</u> of <u>1</u>
Date <u>3-24-93</u> <u>(Wed)</u>

Ground Elevation	Project <u>LBL Bldg 51</u>	Job No. <u>1746-005</u>	
Depth in feet	SUBSURFACE CONDITIONS	CAISSON INFORMATION:	
Graphic Log		Caisson Location: <u>See Plan</u>	
USCS Symbol		Type: Straight Shaft <input checked="" type="checkbox"/> Belled <input type="checkbox"/>	
		Shaft Diameter: <u>30"</u> Bell Diameter: _____	
		Cutoff Elevation: _____	
		Caisson Tip:	
		Actual Depth <u>33.0</u> Design _____	
		Actual Elev. <u>769.4±</u> Design _____	
		Total Caisson Length: _____	
		Depth to Firm/End-bearing Soils: _____	
		Length of Penetration of Caisson into Firm Soils:	
		Actual Penetration _____ Design _____	
		DRILLING NOTES:	
		Time Start Drilling: <u>11:12</u> Finish: <u>12:28</u>	
		Time Concrete Placed: _____	
		Depth of Casing: _____	
		Any Caving? <u>Yes</u> Describe: <u>Gravel around CAP</u>	
		Depth of Water: <u>NE</u>	
		REMARKS:	
		<u>@ 11.0' - @ 8" CAP, we break &amp; tear it out.</u>	
		<u>@ 29.5' - hard drilling</u>	
		<u>28.5' - moderately hard &amp; strong Orinda claystone.</u>	
		<u>Few polished surfaces.</u>	
		Field Engineer: <u>BHL</u>	
		ENGINEERS/GEOLOGISTS FIELD REPORT for the day's work attached: <input checked="" type="checkbox"/>	

\*) Hammer Wt. & Drop  
80 lbs; 30 inches

Equipment : Portable Hollow Stem Auger

Elevation ~766 Datum N.A.

Date 2/23/93 Borehole Size 6 Inches

Test Summary

Blows/ft.\*  
Push Pressure  
Moisture %  
Dry Density (pcf)

Depth (ft.)  
Sample Type

Test Summary	Blows/ft.* Push Pressure	Moisture %	Dry Density (pcf)	Depth (ft.)	Sample Type	Notes
				0		
				0 - 3	BROWN GRAVEL (GP) with silt and sand	Fill
qu/2=505 psf	19	14.0	108.0	3 - 9	BROWN CLAY (CL) wet, medium stiff, with sands and gravel	? - ?
qu/2=432 psf	13	19.1	104.9	9 - 12	grading soft between 9 and 12 feet becoming wet to saturated	
qu/2=1004 psf	21	21.4	101.4	12 - 20	GREEN GRAY CLAYSTONE weak, low hardness, deeply weathered, weak	
	55			20		Boring terminated @ 20.0 feet.
				25		
				30		



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Job No. 1746-005 Appr. KPP Date 3/3/93

**LOG OF BORING B-1**  
GEOTECHNICAL INVESTIGATION  
LANDSLIDE AT FIRETRAIL ACCESS  
GATE EAST OF BUILDING 51- LBL  
BERKELEY, CALIFORNIA

FIGURE

12

\*) Hammer Wt. & Drop  
80 lbs; 30 inches

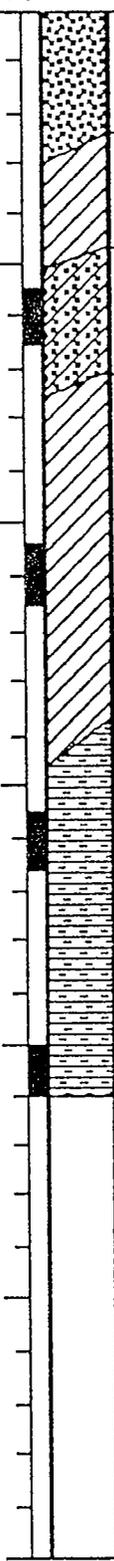
Equipment : Portable Hollow Stem Auger  
Elevation ~765 Datum N.A.  
Date 2/23/93 Borehole Size 6 inches

Test Summary

Blows/ft.\*  
Push Pressure  
Moisture %  
Dry Density (pcf)

Test Summary	Blows/ft.* Push Pressure	Moisture %	Dry Density (pcf)
qu/2=1472 psf	39	15.4	103.6
qu/2=927 psf	30	22.7	101.0
	75		
	44/6"		

Depth (ft.)  
0  
5  
10  
15  
20  
25  
30



BROWN GRAVEL (GP)  
with sand and silt, moist

BROWN GRAVELLY CLAY (CL)  
Fill

BROWN GREEN CLAYEY GRAVEL (GC)  
moist, medium dense

GREENISH BROWN CLAY (CL)  
wet, very stiff

GREEN GRAY CLAYSTONE  
low hardness, deeply weathered, weak

Boring terminated @ 20.0 feet.



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**LOG OF BORING B-2**  
**GEOTECHNICAL INVESTIGATION**  
**LANDSLIDE AT FIRETRAIL ACCESS**  
**GATE EAST OF BUILDING 51- LBL**  
**BERKELEY, CALIFORNIA**

FIGURE  
**13**

Job No. 1746-005 Appr. SPD Date 3/3/93

## LOG OF BORING B-3

Equipment Solid Flight Auger

Elevation 782 ft. Date 3/25/93

Laboratory Analyses

Blows/ft.

Moisture Content (%)

Dry density (pcf)

Depth (ft.)  
Sample pnts.

				0	0.0-3.1 ASPHALT
				5	3.1-8.8 SILTY CLAY (CL)(FILL) dusky yellowish brown (10YR 2/2) trace gravel, medium to highly plastic fines, medium stiff to stiff, moist
				10	ORINDA FORMATION 8.8-34.0 8.8-9.0 SILTSTONE light olive gray (5Y 6/1), loose, dry
				15	9.0-13.2 SILTSTONE grayish red (5R 4/2), friable hardness and weak strength, dry
				20	13.2-23.5 SILTSTONE light olive gray (5Y 6/1), friable hardness and weak strength, dry
				25	23.5-34.0 SANDSTONE/SILTSTONE pale blue (5B 6/2) friable hardness and weak strength, crushed, but holds together in small blocks, dry
				30	
				35	Boring terminated @ 34.0 feet. No groundwater encountered.
				40	



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Job No. 1746-005 Appr. [Signature] Date 4/1/93

### LOG OF BORING B-3

**GEOTECHNICAL INVESTIGATION  
LANDSLIDE AT FIRETRAIL ACCESS  
GATE EAST OF BUILDING 51- LBL  
BERKELEY, CALIFORNIA**

FIGURE

14

# LOG OF BORING B-5

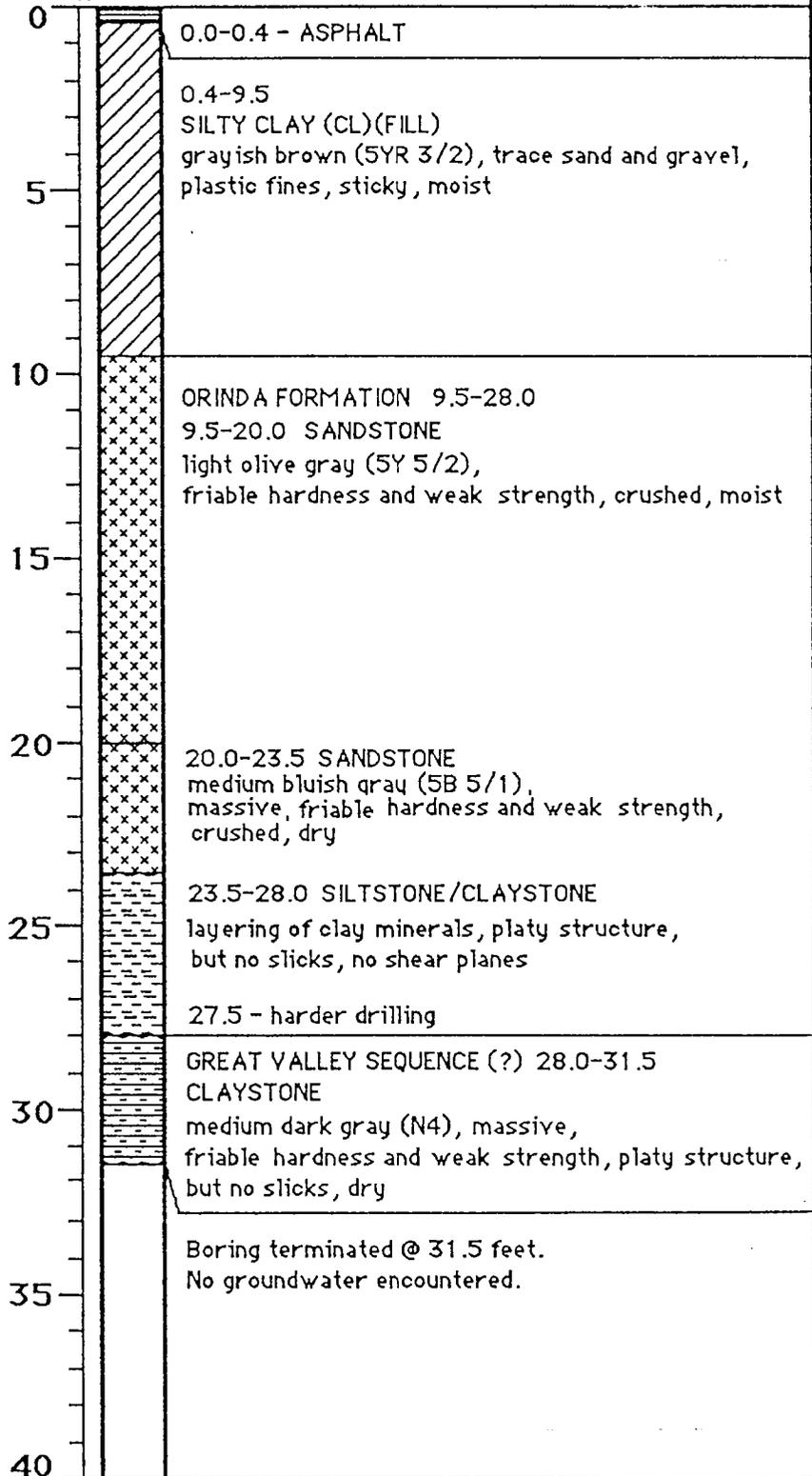
Equipment Solid Flight Auger

Elevation 770 ft. Date 3/25/93

Laboratory Analyses

Blows/ft.  
Moisture Content (%)  
Dry density (pcf)

Depth (ft.)  
Sample pnts.



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**LOG OF BORING B-5**  
**GEOTECHNICAL INVESTIGATION**  
**LANDSLIDE AT FIRETRAIL ACCESS**  
**GATE EAST OF BUILDING 51- LBL**  
**BERKELEY, CALIFORNIA**

FIGURE  
**16**

Job No. 1746-005 Appr. [Signature] Date 4/1/93

**LOG OF BORING B- 6**

Equipment Solid Flight Auger  
 Elevation 775 ft. Date 3/25/93

Laboratory Analyses

Blows /ft.  
 Moisture Content (%)  
 Dry density (pcf)

Depth (ft.)  
 Sample pnts.

0  
5  
10  
15  
20  
25  
30  
35  
40

0.0-0.5  
 GRAVEL & SILTY CLAY (FILL)  
 brown, loose

ORINDA FORMATION 0.5-33.6  
 0.5-17.0 SILTSTONE  
 light olive gray, very friable hardness and weak strength, deeply weathered, crushed, loose, dry

appears saturated from 10.5 to 15.0 ft.  
 perched aqifer?

17.0-24.0 SILTSTONE  
 dark greenish gray (5G 4/1), friable hardness and weak strength, crushed, moderately weathered, dry

24.0-31.0 SILTSTONE  
 medium bluish gray (5B 5/1), friable hardness and weak strength, crushed, dry

(24.0-24.5 contains CLAY (5Yr 2/2), highly plastic, soft, damp)  
 24.5-31.0  
 siltstone grades to a mottled medium bluish gray and brownish black weak to moderately hard, weak strength, crushed, moderately weathered, dry

31.0-33.6 SANDSTONE/SILTSTONE,  
 medium bluish gray (5B 5/1)  
 sandstone is fine-grained and sub-angular, quartz rich, friable hardness and weak strength, crushed, little to moderately weathered

Boring terminated @ 33.6 feet.  
 Groundwater encountered from 10.5-15.0 feet.



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**LOG OF BORING B- 6**  
 GEOTECHNICAL INVESTIGATION  
 LANDSLIDE AT FIRETRAIL ACCESS  
 GATE EAST OF BUILDING 51- LBL  
 BERKELEY, CALIFORNIA

FIGURE  
**17**

Job No. 1746-005 Appr: BHR Date 4/1/93

# LOG OF BORING B-7

Equipment Solid Flight Auger

Elevation 776 ft. Date 3/25/93

Laboratory Analyses

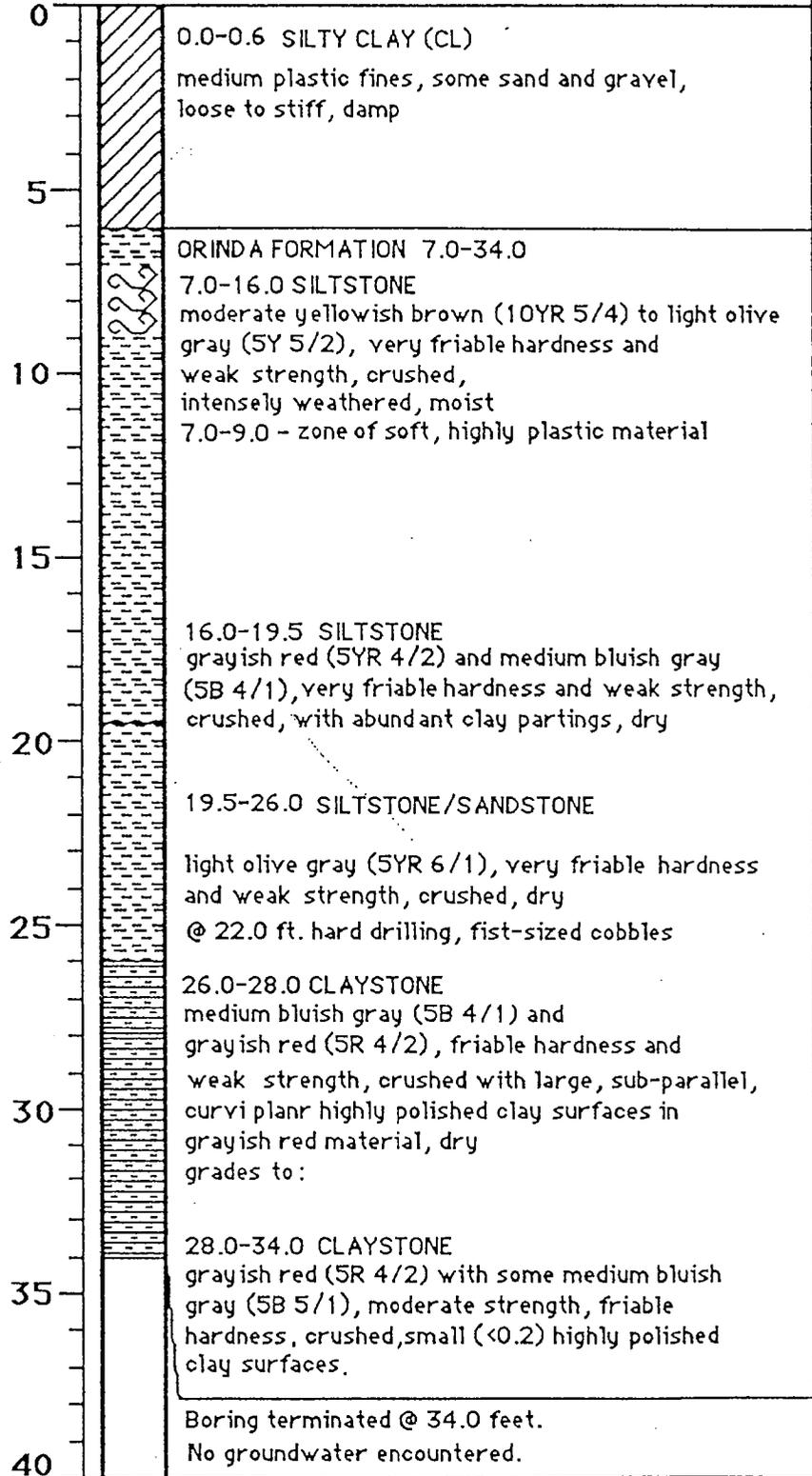
Blows/ft.

Moisture Content (%)

Dry density (pcf)

Depth (ft.)

Sample pnts.



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## LOG OF BORING B-7

**GEOTECHNICAL INVESTIGATION  
LANDSLIDE AT FIRETRAIL ACCESS  
GATE EAST OF BUILDING 51- LBL  
BERKELEY, CALIFORNIA**

FIGURE

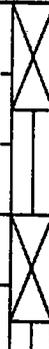
18

Job No. 1746-005 Appr. [Signature] Date 4/1/93

**Harza, 1994**, "Geotechnical Investigation and Design Report – Subcontract 5067, Slope and Seismic Stabilization Project, Surficial and Deep-Seated Landslides, Bevatron-Building 51 and Mechanical Shops-Building 77, Lawrence Berkeley Laboratory, Berkeley, California" , consulting report dated February 4, 1994, Harza-Kaldveer Project Number K1226-5-2034.

(LBNL # 337)

**Logs of Borings EB-1 and EB-2**

DRILL RIG	<b>Mobile Minuteman, CFA</b>		SURFACE ELEVATION	<b>762 Feet</b>	LOGGED BY	<b>CDT</b>			
DEPTH TO GROUND WATER	<b>Not Enc.</b>		BORING DIAMETER	<b>3-inch</b>	DATE DRILLED	<b>9/21/93</b>			
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOMS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
<b>LANDSLIDE DEBRIS: CLAY (CL)</b> , brown with gray mottling, silty, some sand (fine-to coarse-grained), and gravel (fine, angular), damp	Stiff				41	12	107		U-U Triaxial Test (Remolded)
					21				
<b>FILL: CLAY (CL)</b> , brown with gray mottling, silty, some sand (fine- to coarse-grained), and gravel (fine, angular), damp (asphalt fragments at 5 feet)	Very Stiff		5		70				LL = 39% PI = 21% Passing #200 Sieve = 58%  U-U Triaxial Test
					68	17	108		
					32				
			10		46				
Bottom of Boring = 10-1/2 Feet Notes: 1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual. 2. A 70-pound donut hammer was raised and dropped by hand to drive the samplers. For an explanation of penetration resistance values, see the first page of Appendix A. 3. Ground water was not encountered at the time of drilling. 4. The boring was backfilled with native soil cuttings immediately upon completion. 5. LL = Liquid Limit. PI = Plasticity Index.									
				<b>EXPLORATORY BORING LOG</b>					
				<b>SLOPE AND SEISMIC STABILIZATION - LBL</b> Berkeley, California					
				PROJECT NO.		DATE		BORING NO	
				K1226-5-2034		February 1994		EB-1	

DRILL RIG	Mobile Minuteman, CFA	SURFACE ELEVATION	738 Feet	LOGGED BY	CDT
DEPTH TO GROUND WATER	Not Enc.	BORING DIAMETER	3-inch	DATE DRILLED	9/21/93

DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
<p><b>LANDSLIDE DEBRIS: SILT (ML)</b>, bluish-gray, low to medium plasticity, with clay, some sand (fine-grained) and siltstone fragments, damp</p> <p><b>LANDSLIDE DEBRIS: CLAY (CL)</b>, bluish-gray, silty, some sand (fine- to coarse-grained), trace siltstone fragments and organics, damp</p>	Firm			X	18	13	97		U-U Triaxial Test
	Stiff					13			
	Very Stiff				X	64	16	105	
	Stiff		5			24			
						X	50/6"		
<p><b>FILL: CLAY (CL)</b>, bluish-gray, silty, some sand (fine- to coarse-grained), trace siltstone fragments and organics, damp</p>	Very Stiff				17				
			10		X	45			
<p><b>ORINDA FORMATION (SANDSTONE)</b>; bluish-gray, massive, crushed, deep to moderate weathering, dry</p> <p>Bottom of Boring = 12 Feet</p> <p>Notes:  1. The stratification lines represent the approximate boundaries between soil types and the transition may be gradual.  2. A 70-pound donut hammer was raised and dropped by hand to drive the samplers. For an explanation of penetration resistance values, see the first page of Appendix A.  3. Ground water was not encountered at the time of drilling.  4. The boring was backfilled with native soil cuttings immediately upon completion.</p>	Soft to Friable				72				

	<b>EXPLORATORY BORING LOG</b>		
	<b>SLOPE AND SEISMIC STABILIZATION - LBL</b> Berkeley, California		
	PROJECT NO.	DATE	BORING NO
	K1226-5-2034	February 1995	<b>EB-2</b>

## UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		grf	ltr	Description	Major Divisions		grf	ltr	Description		
Coarse Grained Soils	Gravel And Gravely Soils	●●●●	GW	Well-graded gravels or gravel sand mixtures, little or no fines	Fine Grained Soils	Sils And Clays LL < 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity		
			GP	Poorly-graded gravels or gravel sand mixture, little or no fines				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			GP	Silty gravels, gravel-sand-silt mixtures				OL	Organic silts and organic silt-clays of low plasticity		
			GC	Clayey gravels, gravel-sand-clay mixtures				MH	Inorganic silts, micaceous or diatomaceous fine or silty soils, elastic silts		
	Sand And Sandy Soils	●●●●	SW	Well-graded sands or gravelly sands, little or no fines		Sils And Clays LL > 50		CH	Inorganic clays of high plasticity, fat clays		
			SP	Poorly-graded sands or gravelly sands, little or no fines				OH	Organic clays of medium to high plasticity		
			SM	Silty sands, sand-silt mixtures				Highly Organic Soils		PT	Peat and other highly organic soils
			SC	Clayey sands, and-clay mixtures							

### GRAIN SIZES

U.S. STANDARD SERIES SIEVE							CLEAR SQUARE SIEVE OPENINGS				
200		40		10		4		3/4"		3"	12"
Sils and Clays	Sand						Gravel		Cobbles	Boulders	
	Fine		Medium		Coarse		Fine	Coarse			

### RELATIVE DENSITY

Sands and Gravels	Blows/Foot*
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

### CONSISTENCY

Sils and Clays	Blows/Foot*	Strength (tsf)**
Very Soft	0 - 2	0 - 1/4
Soft	2 - 4	1/4 - 1/2
Firm	4 - 8	1/2 - 1
Stiff	8 - 16	1 - 2
Very Stiff	16 - 32	2 - 4
Hard	Over 32	Over 4

\*Number of Blows for a 140-pound hammer falling 30 inches, driving a 2-inch O.D. (1-3/8" I.D.) split spoon sampler.

\*\*Unconfined compressive strength.

### SYMBOLS

	Standard Penetration sample		Ground Water level during drilling
	Modified California sample		Stabilized Ground Water level
	Shelby Tube sample		

### Increasing Visual Moisture Content



HARZA

Consulting Engineers and Scientists

### KEY TO EXPLORATORY BORING LOGS

SLOPE AND SEISMIC STABILIZATION - LBL  
Berkeley, California

PROJECT NO.

**K1226-5-2034**

DATE

**February 1994**

FIGURE NO.

**A-1**

## BEDDING OF SEDIMENTARY ROCKS

<u>Stratification</u>	<u>Thickness of Beds</u>
<p style="text-align: center;"> <b>Massive</b>  <b>Very thick bedding</b>  <b>Thick bedding</b>  <b>Thin bedding</b>  <b>Very thin bedding</b>  <b>Laminated</b>  <b>Thinly laminated</b> </p>	<p style="text-align: center;"> <b>No apparent bedding</b>  <b>Greater than 4 feet</b>  <b>2 feet to 4 feet</b>  <b>2 inches to 2 feet</b>  <b>1/2-inch to 2 inches</b>  <b>1/8-inch to 1/2-inch</b>  <b>less than 1/8-inch</b> </p>

## FRACTURING

<u>Intensity</u>	<u>Size of Pieces</u>
<p style="text-align: center;"> <b>Little</b>  <b>Occasional</b>  <b>Moderate</b>  <b>Close</b>  <b>Intense</b>  <b>Crushed</b> </p>	<p style="text-align: center;"> <b>Greater than 4 feet</b>  <b>1 foot to 4 feet</b>  <b>6 inches to 1 foot</b>  <b>1 inch to 6 inches</b>  <b>1/2-inch to 1 inch</b>  <b>Less than 1/2-inch</b> </p>

## STRENGTH

<b>Soft</b>	Plastic or very low strength
<b>Friable</b>	Crumbles easily by hand
<b>Low Hardness</b>	Crumbles under light hammer blows
<b>Moderate Hardness</b>	Crumbles under a few heavy hammer blows
<b>Hard</b>	Breaks into large pieces under heavy, ringing hammer blows
<b>Very Hard</b>	Resists heavy, ringing hammer blows and will yield only dust and small flying fragments, with difficulty

## WEATHERING

<b>Deep</b>	Moderate to complete decomposition; extensive disintegration; deep and thorough discoloration; many extensively-coated fractures
<b>Moderate</b>	Slight decomposition of minerals; little disintegration; moderate discoloration; moderately coated fractures
<b>Little</b>	No megascopic decomposition of minerals; slight to no effect on cementation; slight and intermittent, or localized discoloration; few stains on fracture surfaces
<b>Fresh</b>	Unaffected by weathering agents; no disintegration or discoloration; fractures usually less numerous than joints

<p style="font-size: 2em; font-weight: bold; margin: 0;">HARZA</p> <p style="font-weight: bold; margin: 0;">Consulting Engineers and Scientists</p>	KEY TO ROCK CHARACTERISTICS		
	SLOPE AND SEISMIC STABILIZATION - LBL Berkeley, California		
	PROJECT NO.	DATE	FIGURE NO.
	K1226-5-2034	February 1994	A-2

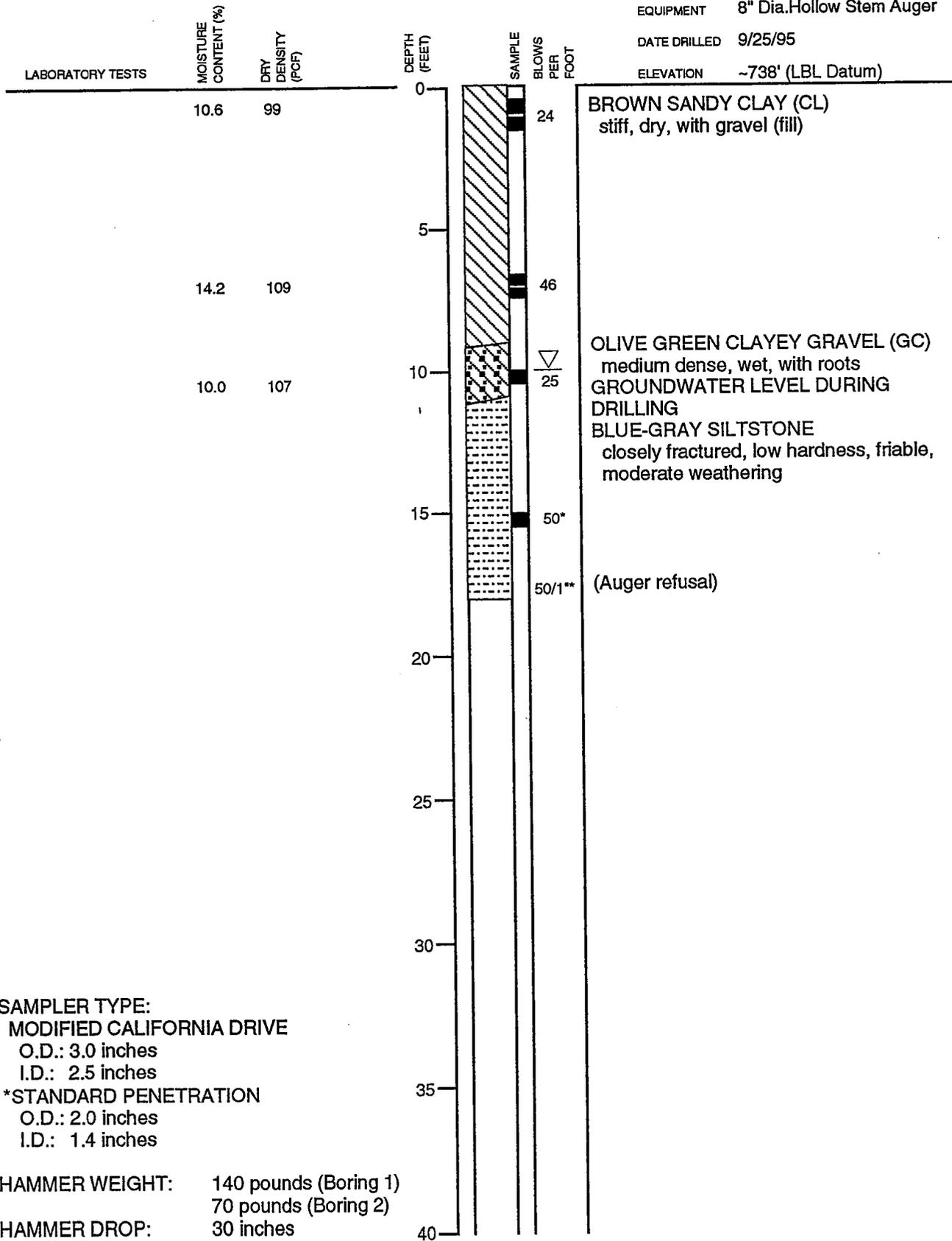
**Subsurface Consultants, Inc. (SCI), 1995**, "Geotechnical Investigation, Support Platform, Blackberry Canyon Substation, Lawrence Berkeley National Laboratory, Berkeley, California." report dated October 6, 1995, SCI Project Number 658.038.

(LBNL #335)

**Logs of Borings 1 and 2**

# LOG OF TEST BORING 1

EQUIPMENT 8" Dia. Hollow Stem Auger  
 DATE DRILLED 9/25/95  
 ELEVATION -738' (LBL Datum)



SAMPLER TYPE:  
 MODIFIED CALIFORNIA DRIVE  
 O.D.: 3.0 inches  
 I.D.: 2.5 inches  
 \*STANDARD PENETRATION  
 O.D.: 2.0 inches  
 I.D.: 1.4 inches

HAMMER WEIGHT: 140 pounds (Boring 1)  
 70 pounds (Boring 2)  
 HAMMER DROP: 30 inches

Subsurface Consultants	BLACKBERRY CANYON SUBSTATION SUPPORT PLATFORM - LBNL - BERKELEY, CA		PLATE
	JOB NUMBER 658.038	DATE 10/5/95	APPROVED  <b>2</b>

# LOG OF TEST BORING 2

EQUIPMENT 3 1/2" Solid Auger

DATE DRILLED 9/25/95

ELEVATION -710' (LBL Datum)

LABORATORY TESTS

MOISTURE  
CONTENT (%)

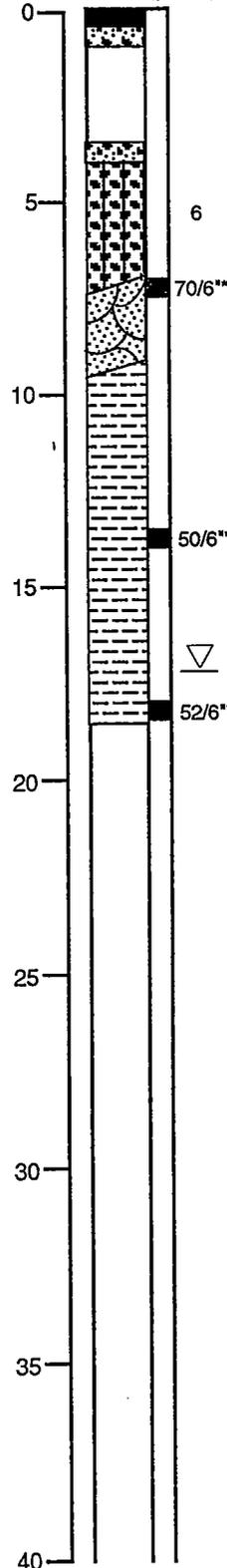
DRY  
DENSITY  
(PCF)

DEPTH  
(FEET)

SAMPLE

BLOWS  
PER  
FOOT

10.5 112



ASPHALTIC CONCRETE - 2 inches thick  
CONCRETE - 6 inches thick  
CONCRETE PIPE (Empty)

BROWN SILTY GRAVEL (GM)  
soft, moist (fill)

70/6\*\* OLIVE GREEN-GRAY SANDSTONE  
intensely fractured, low hardness, weak,  
moderate weathering  
10.6 RED-BROWN CLAYSTONE  
intensely fractured, low hardness, friable,  
deep weathering

50/6\*\*  
▽ GROUNDWATER LEVEL DURING  
DRILLING  
52/6\*\* (Borehole backfilled with neat cement grout)

Subsurface Consultants

BLACKBERRY CANYON SUBSTATION SUPPORT  
PLATFORM - LBNL - BERKELEY, CA

PLATE

JOB NUMBER

DATE

APPROVED

658.038

10/5/95

3

GENERAL SOIL CATEGORIES			SYMBOLS	TYPICAL SOIL TYPES
<b>COARSE GRAINED SOILS</b> More than half is larger than No. 200 sieve	<b>GRAVEL</b> More than half coarse fraction is larger than No. 4 sieve size	Clean Gravel with little or no fines	GW	Well Graded Gravel, Gravel-Sand Mixtures
			GP	Poorly Graded Gravel, Gravel-Sand Mixtures
		Gravel with more than 12% fines	GM	Silty Gravel, Poorly Graded Gravel-Sand-Silt Mixtures
			GC	Clayey Gravel, Poorly Graded Gravel-Sand-Clay Mixtures
	<b>SAND</b> More than half coarse fraction is smaller than No. 4 sieve size	Clean Sand with little or no fines	SW	Well Graded Sand, Gravelly Sand
			SP	Poorly Graded Sand, Gravelly Sand
		Sand with more than 12% fines	SM	Silty Sand, Poorly Graded Sand-Silt Mixtures
			SC	Clayey Sand, Poorly Graded Sand-Clay Mixtures
<b>FINE GRAINED SOILS</b> More than half is smaller than No. 200 sieve	<b>SILT AND CLAY</b> Liquid Limit Less than 50%	ML	Inorganic Silt and Very Fine Sand, Rock Flour, Silty or Clayey Fine Sand, or Clayey Silt with Slight Plasticity	
		CL	Inorganic Clay of Low to Medium Plasticity, Gravelly Clay, Sandy Clay, Silty Clay, Lean Clay	
		OL	Organic Clay and Organic Silty Clay of Low Plasticity	
	<b>SILT AND CLAY</b> Liquid Limit Greater than 50%	MH	Inorganic Silt, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic Silt	
		CH	Inorganic Clay of High Plasticity, Fat Clay	
		OH	Organic Clay of Medium to High Plasticity, Organic Silt	
<b>HIGHLY ORGANIC SOILS</b>			PT	Peat and Other Highly Organic Soils

## UNIFIED SOIL CLASSIFICATION SYSTEM

**Subsurface Consultants**

BLACKBERRY CANYON SUBSTATION SUPPORT  
PLATFORM - LBNL - BERKELEY, CA

JOB NUMBER  
658.038

DATE  
9/25/95

APPROVED  


PLATE

4

**BEDDING OF SEDIMENTARY ROCKS**

Very thick-bedded .....	Greater than 4.0	}	<b>Bed thickness in feet</b>
Thick-bedded .....	2.0 to 4.0		
Thin-bedded .....	0.2 to 2.0		
Very thin-bedded .....	0.05 to 0.2		
Laminated .....	0.01 to 0.05		
Thinly laminated .....	less than 0.01		

**FRACTURING**

Very little fractured .....	Greater than 4.0	}	<b>Size of pieces in feet</b>
Occasionally fractured .....	1.0 to 4.0		
Moderately fractured .....	0.5 to 1.0		
Closely fractured .....	0.1 to 0.5		
Intensely fractured .....	0.05 to 0.1		
Crushed .....	less than 0.05		

**HARDNESS**

Soft .....	reserved for plastic material alone.
Low hardness .....	can be gouged deeply or carved easily with a knife blade.
Moderately hard .....	can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and is readily visible after the powder has been blown away.
Hard .....	can be scratched with difficulty; scratch produces little powder and is often faintly visible.
Very hard .....	cannot be scratched with knife blade; leaves a metallic streak.

**STRENGTH**

Plastic .....	very low strength.
Friable .....	crumbles easily by rubbing with fingers.
Weak .....	an unfractured specimen of such material will crumble under light hammer blows.
Moderately strong .....	specimen will withstand a few heavy hammer blows before breaking.
Strong .....	specimen will withstand a few heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.
Very Strong .....	specimen will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

**WEATHERING**

Deep .....	moderate to complete mineral decomposition, extensive disintegration, deep and thorough discoloration, many fractures, all extensively coated or filled with oxides, carbonates and/or clay or silt.
Moderate .....	slight change or partial decomposition of minerals, little disintegration; cementation little to unaffected. Moderate to occasionally intense discoloration. Moderately coated fractures.
Little .....	no megascopic decomposition of minerals; little or no effect on normal cementation. Slight and intermittent, or localized discoloration. Few stains on fracture surfaces.
Fresh .....	unaffected by weathering agents. No disintegration or discoloration. Fractures usually less numerous than joints.

**ROCK CLASSIFICATION CRITERIA**

**Subsurface Consultants**

BLACKBERRY CANYON SUBSTATION SUPPORT PLATFORM - LBNL - BERKELEY, CA		PLATE
JOB NUMBER	DATE	APPROVED
658.038	9/25/95	

**5**

**Harza, 1996**, "Construction Observation Report, Slope and Seismic Stabilization Project, Phase II, Subcontract No. 711, Berkeley National Laboratory, Berkeley, California," consulting report dated February 5, 1996, Harza Project No. K1226-3-1773.

### **Logs of Caissons 1A to 19A**

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION 707		LOGGED BY Mark Caruso					
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch		DATE DRILLED 7-25-95					
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
FILL: CLAY (CL), MEDIUM BROWN, WITH GRAVEL (FINE AND COARSE), SOME SAND (FINE TO COARSE), SOME SILT, TRACE ROOTS, DRY	STIFF								STARTED DRILLING 10:34
FILL: GRAVEL (GC/GM), MOTTLED SHADES OF BROWN, FINE AND COARSE, WITH SAND (FINE TO COARSE), SOME CLAY AND SILT, DRY	LOOSE TO MEDIUM DENSE		5						COLLAR OF HOLE IS STABLE
CLAYSTONE, DARK RUST-BROWN, WITH SILTSTONE INTERBEDS, SHEARED AND SLICKENSIDED, WEAK (FRILABLE), VERY SOFT	VERY SOFT		10						
SILTSTONE, BLUE-GRAY AND DARK RUST-BROWN, WITH CLAYSTONE INTERBEDS THAT ARE SOFT, SHEARED AND LOCALLY SLICKENSIDED	SOFT		15						
(DARK RUST BROWN CLAY COATED DISCONTINUITY SURFACES FROM ABOUT 15 TO 19 FEET)			20						
(BECOMING MORE GRAY, LESS CLAYEY BY ABOUT 21 FEET)			25						
(GRAY, TRACE POCKETS OF GRAY CLAY BY 30 FEET)			30						
(SOME MODERATELY HARD BLOCKS AND MORE GRAY CLAYEY POCKETS FROM 34 FEET)									
<b>HARZA</b> Consulting Engineers and Scientists			<b>EXPLORATORY BORING LOG</b>						
			PROJECT NO.		DATE		BORING NO		
							EB-1A		

DRILL RIG <b>CASE PACIFIC 3000</b>	SURFACE ELEVATION <b>767</b>	LOGGED BY <b>Mark Caruso</b>
DEPTH TO GROUNDWATER <b>NOT ENC.</b>	BORING DIAMETER <b>42 -inch</b>	DATE DRILLED <b>7-25-95</b>

DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
SILTSTONE, GRAY, FRESH, SOME GRAY CLAY COATED DISCONTINUITY SURFACES, SOME MODERATELY HARD BLOCKS OF SILTSTONE  (MORE POCKETS OF GRAY CLAY AT 38 FEET)  (ABUNDANT GRAY CLAY, SOFT, FROM 40 TO 42 FEET)	SOFT		40						DRILLING HARDER FROM 34 TO ABOUT 40
SANDSTONE, MEDIUM BLUE-GRAY, FINE TO MEDIUM GRAINED  (FINE TO COARSE-GRAINED, TRACE FINE ROUNDED GRAVEL, DAMP TO MOIST AT 48 FEET)  (MEDIUM GREEN-GRAY, WITH FINE GRAINED-ROUND TO SUBROUND GRAVEL, SOME HARD BLOCKS, MOIST TO WET AT 51 FEET)  (FINE TO MEDIUM GRAINED AT 53 FEET)	SOFT TO LOW HARDNESS		45						
BOTTOM OF BORING = 58-1/2 FEET			55						STOPPED DRILLING 11:37  (1:03) TOTAL
			60						
			65						

<p><b>HARZA</b></p> <p>Consulting Engineers and Scientists</p>	<b>EXPLORATORY BORING LOG</b>		
	PROJECT NO.	DATE	BORING NO
			<b>EB-1A</b>

DRILL RIG CASE PACIFIC 3000	SURFACE ELEVATION 767	LOGGED BY Mark Caruso
DEPTH TO GROUNDWATER NOT ENC.	BORING DIAMETER 4 1/2 -inch	DATE DRILLED 7-26-95

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST							
FILL: CLAY (CL), MEDIUM BROWN, WITH GRAVEL (FINE AND COARSE) SOME SAND (FINE TO COARSE), SOME SILT, TRACE ROOTS, DR/	STIFF							STARTED DRILLING 09:56
FILL: GRAVEL (M/FIN), MOTTLED SHADES OF BROWN, FINE AND COARSE, WITH SAND (FINE TO COARSE), SOME CLAY AND SILT, DR/	LOOSE TO MEDIUM DENSE	5						COLLAR OF HOLE IS STABLE
CLAYSTONE, DARK RUST-BROWN WITH SILTSTONE INTERBEDS, SHEARED AND SLICKENSIDED, WEAK (FRIABLE) SOFT, MODERATELY WEATHERED	SOFT	10						
SILTSTONE, DARK RUST-BROWN AND GRAY, WITH CLAYSTONE INTERBEDS, SOME CONTAINING SILT WEATHERING / CHANGES THE APPEARANCE BY SLICKENSIDED WEAK (FRIABLE) SOFT, SLIGHTLY WEATHERED	SOFT	15						DOWN-TIME 10:09 TO 10:21
(INCREASE IN CLAY COATED SURFACES BY 16 FEET)								
(SHAPELY ZONE, SHEARED AND SLICKENSIDED FROM ABOUT 19 FEET)		25						
(BECOMING GRAYER, WITH CLAYEY POCKETS BY 22 FEET)								
(GRAY, NO SHEARING, SOME GRAY CLAYEY POCKETS BY 24 FEET)		30						
(SOME HARD BLOCKS WITH CLAYEY SURFACES BY 29 FEET)								

<h1>HARZA</h1> <p>Consulting Engineers and Scientists</p>	<b>EXPLORATORY BORING LOG</b>		
	PROJECT NO.	DATE	BORING NO
			<b>EB-2A</b>

DRILL RIG CASE PACIFIC 3000	SURFACE ELEVATION 767	LOGGED BY Mark Caruso
DEPTH TO GROUNDWATER NOT ENC.	BORING DIAMETER 42 -inch	DATE DRILLED 7-26-95

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST SOIL TYPE							
SILT TO CLAY, GRAY, FRESH, SOME CLAY COATED DISCONTINUITY SURFACES SOME MODERATELY HARD BLOCKS OF SILTSTONE  (SOME POCKETS OF GRAY CLAY FROM ABOUT 36 FEET)	SOFT	40						
SANDSTONE, MEDIUM BLUE-GRAY, FINE TO COARSE-GRAINED  (MORE SOFT CLAYEY ZONES, TRACE FINE GRAVEL BY 42 FEET) (SOME MODERATELY STRONG BLOCKS LESS CLAYEY POCKETS FROM ABOUT 43 FEET) (FINE TO MEDIUM GRAINED FROM ABOUT 49 FEET, SMALL TRACE OF CLAYEY POCKETS) (FINE TO COARSE GRAINED), MORE MODERATELY STRONG BLOCKS FROM ABOUT 58 FEET) (SAME AS ABOVE AT 57 FEET)	SOFT TO LOW HARDNESS	45 50 55 60						DRILLING MUCH HARDER FROM ABOUT 43 FEET  DOWN-TIME 10:33 TO 10:45  DOWN-TIME 10:47 TO 11:50  STOPPED DRILLING 12:20  (0:51) TOTAL
BOTTOM OF BORING = 58-1/2 FEET		65						

<b>HARZA</b> Consulting Engineers and Scientists	<b>EXPLORATORY BORING LOG</b>		
	PROJECT NO.	DATE	BORING NO
			<b>EB-2A</b>

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION 767		LOGGED BY Mark Caruso					
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch		DATE DRILLED 7-25-95					
DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOMS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
<p>FILL: CLAY (CL), MEDIUM BROWN, WITH GRAVEL (FINE TO COARSE, ANGULAR TO SUBANGULAR), SOME SAND (FINE TO COARSE), SOME SILT, DRY (DARK RUST-BROWN MOTTLED GRAY, GRAVELLY (FINE TO COARSE) BY 5 FEET)</p>			5						STARTED DRILLING 09:48
<p>SILTSTONE, MEDIUM GRAY AND DARK RUST-BROWN, SLIGHTLY WEATHERED, WEAK (FRIABLE), SOFT</p> <p>(WITH INTERBEDS OF DARK RUST-BROWN CLAYSTONE FROM ABOUT 11 FEET, SHEARED AND SLICKEN-SIDED, VERY WEAK, VERY SOFT)</p> <p>(LESS CLAYSTONE INTERBEDS, SILTSTONE HAS CLAYEY AND LOCALLY SLICKENSIDED DISCONTINUITY SURFACES BY 14 FEET)</p> <p>(MEDIUM GRAY, WITH FEW CLAYSTONE INTERBEDS BY 21 FEET)</p> <p>(NO CLAYSTONE INTERBEDS BY 24 FEET)</p> <p>(SOIL GRAY CLAYEY INTERBEDS, CRUSHED, VERY WEAK AND VERY SOFT BY 27 FEET)</p> <p>(ABUNDANT GRAY, CLAYEY INTERBEDS FROM 29 TO ABOUT 31)</p> <p>(LESS CLAYEY ZONES BUT CLAY COATED SURFACES REMAIN AT 35)</p>			10						COLLAR OF HOLE IS STABLE
			15						
			20						
			25						
			30						
<h1>HARZA</h1> <p>Consulting Engineers and Scientists</p>			<b>EXPLORATORY BORING LOG</b>						
			PROJECT NO.		DATE		BORING NO		
							EB-3A		

DRILL RIG <i>CASE PACIFIC 3000</i>		SURFACE ELEVATION <i>767</i>		LOGGED BY <i>Mark Caruso</i>					
DEPTH TO GROUNDWATER <i>NOT ENC.</i>		BORING DIAMETER <i>42 -inch</i>		DATE DRILLED <i>7-25-95</i>					
DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
<i>SILTSTONE, MEDIUM GRAY, SOME CLAY COATED DISCONTINUITY SUR- FACES (SANDY SILTSTONE BY 36 FEET)</i>	<i>SOFT</i>								
<i>SANDSTONE, MEDIUM BLUE-GRAY, FINE TO MEDIUM GRAINED, (FRIABLE), SOFT (TRACE POCKETS AND COATINGS OF WET, GRAY CLAY FROM ABOUT 38 TO 39 FEET)</i>	<i>SOFT</i>		<i>40</i>						<i>DRILLING HARDER AT 41 FEET</i>
<i>SILTSTONE, GREEN-GRAY, SANDY (FINE), GENERALLY (FRIABLE) AND SOFT, SOME MODERATELY HARD AND STRONG BLOCKS (LIGHT BLUE-GRAY, NO HARD BLOCKS BY 45 FEET) (INTERBED OF SANDSTONE, BLUE- GRAY, FINE TO MEDIUM GRAINED AT ABOUT 47 FEET) (TRACE GRAY CLAY COATINGS ON DISCONTINUITY SURFACES FROM ABOUT 51 FEET) (SAME AS ABOVE AT 53 FEET)</i>	<i>LOW TO MODERATE</i>		<i>50</i>						<i>VERY HARD DRILLING AT ABOUT 48 FEET</i>
<i>BOTTOM OF BORING = 59 FEET</i>			<i>65</i>						<i>STOPPED DRILLING 10:49 (1:01) TOTAL</i>
<p style="text-align: center;"><b>HARZA</b></p> <p style="text-align: center;"><i>Consulting Engineers and Scientists</i></p>			<b>EXPLORATORY BORING LOG</b>						
			PROJECT NO.		DATE		BORING NO		
							<b>EB-3A</b>		

DRILL RIG CASE PACIFIC 3000	SURFACE ELEVATION 767	LOGGED BY Mark Caruso
DEPTH TO GROUNDWATER NOT ENC.	BORING DIAMETER 42 -inch	DATE DRILLED 7-26-95

DESCRIPTION AND CLASSIFICATION	DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
FILL: CLAY (CL), MEDIUM BROWN, WITH GRAVEL (FINE AND COARSE, ANGULAR TO SUBANGULAR), SOME SAND (FINE TO COARSE), TRACE ROOTS, DRY (MOTTLED BROWN AND RUST, GRAVELLY (FINE AND COARSE) BY 4 FEET)	5						STARTED DRILLING 08:09
FILL: GRAVEL (GC/GM), RUST-BROWN, FINE AND COARSE, SOME SAND (FINE TO COARSE), SOME CLAY AND SILT, DRY	10						COLLAR OF HOLE IS STABLE
SILTSTONE, DARK RUST-BROWN AND MEDIUM GRAY, SLIGHTLY WEATHERED, WEAK (FRAGILE), SOFT (WITH INTERBEDS OF DARK RUST BROWN CLAYSTONE FROM ABOUT 16 FEET, SHEARED AND SLIGHTLY DEL.) (LESS CLAYSTONE, INTERBEDS ARE CLAYEY AND SOFTENED SURFACE FROM ABOUT 15 FEET) (MEDIUM GRAY WITH SAND CONTAINING INTERBEDS BY 17 FEET) (NO CLAYSTONE INTERBEDS BY 21 FEET) (CLAYEY DISCONTINUITY EVIDENT FROM ONLY COBBLES BY 24 FEET) (SOME GRAY, CLAYEY, VERY SOFT INTERBEDS FROM ABOUT 24 FEET TO 35 FEET)	15 20 25 30						DOWN-TIME TO REPAIR CABLE ON DRILL RIG 08:39

<b>HARZA</b> Consulting Engineers and Scientists	<b>EXPLORATORY BORING LOG</b>		
	PROJECT NO.	DATE	BORING NO
			<b>EB-4A</b>

DRILL RIG CASE PACIFIC 3000	SURFACE ELEVATION 767	LOGGED BY Mark Caruso
DEPTH TO GROUNDWATER NIST ENC.	BORING DIAMETER 4 1/2 -inch	DATE DRILLED 7-20-95

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST							
SILTSTONE (MEDIUM GRAY), SOME CLAY COATED SURFACES, (FRIABLE), SOFT								RESUMED DRILLING 04:08
(INTERBEDDED WITH SANDSTONE, MEDIUM TO FINE TO MEDIUM GRAINED FROM 30 TO ABOUT 40 FEET)		40						
(BLUE GREEN-GRAY, SANDY (FINE) SILTSTONE AT ABOUT 45 FEET, VERY FEW CLAY COATED SURFACES, NO HARD BLOCKS)		45						
(SOME SOFT, GRAY CLAYEY POCKETS, CLAY COATED SURFACES, AND MORE COMPETENT BLOCKS BY 48 FEET)		50						
(MEDIUM GRAY, NO CLAYEY POCKETS, NO HARD BLOCKS, LESS CLAY COATED SURFACES BY 52 FEET)		55						
(INTERBEDDED WITH DARK ROY-BROWN CLAYSTONE, LOCALLY CLAYEY, SHEARED AND SLICKENSIDED, WITH CLAY COATING ON BLOCKS DISPLAYING SLICKENSIDES FROM ABOUT 54 FEET)		60					STOPPED DRILLING 09:31 (0:53) TOTAL	
(FINE AS ABOVE TO 58 FEET)								
BOTTOM OF BORING = 58 - 1/2 FEET		65						

<h1>HARZA</h1> <p>Consulting Engineers and Scientists</p>		<b>EXPLORATORY BORING LOG</b>		
		PROJECT NO.	DATE	BORING NO
				<b>EB-4A</b>

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION 700		LOGGED BY Mark Caruso					
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch		DATE DRILLED 7/21/95					
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
FILL: CLAY (CL), MOTTLED SHADES OF BROWN, SOME GRAVEL (FINE AND COARSE), SOME SAND (FINE TO COARSE), SOME SILT, TRACE ROOTS, DRY	STIFF		5						STARTED DRILLING 11:18
FILL: GRAVEL (GC/GM), SHADES OF BROWN AND RUST, FINE AND COARSE, SUBANGULAR TO SUBROUND, WITH SAND (FINE TO COARSE). SOME CLAY AND SILT, DRY	LOOSE TO MEDIUM BENSE		10						COLLAR OF HOLE IS STABLE
SILTSTONE, MEDIUM GRAY AND DARK RUST BROWN, SLIGHTLY WEATHERED WITH CLAYSTONE INTERBEDS, WEAK (FRIABLE), SOFT	SOFT		15						
(FRESH, LESS CLAYSTONE INTERBEDS BY 13 FEET)									
(GRAY, TRACE CLAYSTONE INTERBEDS BY 17 FEET)			20						
(NO CLAYSTONE INTERBEDS, TRACE STANCHER BLOCKS OF SILTSTONE BY 19 FEET)									
(LIGHT TO MEDIUM BLUE - GRAY BY 22 FEET)			25						
(ROCK IS SANDY (FINE-GRAINED) BY 24 FEET)									
(LIGHT BLUE - GRAY ZONES OF CLAYEY, SHEARED SILTSTONE WITH WET SURFACES FROM 24 TO 36 FEET)			30						
<h1>HARZA</h1> Consulting Engineers and Scientists			<b>EXPLORATORY BORING LOG</b>						
			PROJECT NO.	DATE		BORING NO			
						EB-5A			

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION 7060		LOGGED BY Mark Caruso						
DEPTH TO GROUNDWATER NOT ENG.		BORING DIAMETER 42 -inch		DATE DRILLED 7-24-95						
DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS	
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE								
SILTSTONE, LIGHT TO MEDIUM BLUE-GRAY, WITH ZONES OF CLAYEY, SHEARED SILTSTONE WITH WET SURFACES, FRESH, (FRIABLE), SOFT (GREEN-GRAY, LOCALLY CLAYEY AT 37 FEET) (NO CLAYEY ZONES, SANDIER (FINE) BY 45 FEET) (LESS SAND, TRACE CLAYEY POCKETS AND SOME SLICKENSIDED SURFACES BY 47 FEET) (NO CLAYEY POCKETS OR SLICKENSIDED SURFACES BY 49 FEET) (SOME CLAY COATED AND SLICKENSIDED DISCONTINUITIES BY 51 FEET) (SOME DARK RUST-BROWN CLAY-STONE INTERBEDS, SOME SHEARING AND SLICKENSIDES AT 53 FEET) (GRAY AND DARK RUST BROWN, INTERBEDDED WITH SHALEY CLAY-STONE, WITH SHEARING AND SLICKENSIDES FROM ABOUT 54 FEET) ----- BOTTOM OF BORING = 58 - 1/2 FEET			SOFT							STOPPED DRILLING 12:05 (0:47) TOTAL
<b>HARZA</b> Consulting Engineers and Scientists				<b>EXPLORATORY BORING LOG</b>						
				PROJECT NO.		DATE		BORING NO		
								EB-5A		



DRILL RIG <b>CASE PACIFIC 3000</b>		SURFACE ELEVATION <b>760</b>		LOGGED BY <b>Mark Caruso</b>					
DEPTH TO GROUNDWATER <b>NOT ENC.</b>		BORING DIAMETER <b>42 -inch</b>		DATE DRILLED <b>7-25-95</b>					
DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
<p>SILTSTONE, MEDIUM GRAY, SILICEOUS AND SHALEY, WITH INTERBEDS OF FINE GRAINED SANDSTONE, AND POCKETS OF SOFT, CLAYEY AND SHEARED SILTSTONE WITH SOME RUST AND GRAY CLAY INTERBEDS; (FRIABLE), SOFT</p> <p>(POCKETS OF CRUSHED AND CLAYEY SILTSTONE AT 42 FEET, INCREASING BY 44 FEET)</p> <p>(LESS POCKETS OF CLAYEY SILTSTONE BY 48 FEET)</p> <p>(RUST-BROWN CLAY COATINGS ON DISCONTINUITY SURFACES WITH SOME SLICKENSIDES BY 50 FEET)</p> <p>(SAME AS ABOVE AT 57 FEET)</p> <p>-----  BOTTOM OF BORING = 58 1/2 FEET</p>			SOFT						
			40						
			45						
			50						
			55						STOPPED DRILLING 8:11 AM
			60						(1:07) TOTAL
			65						
<b>HARZA</b> Consulting Engineers and Scientists			<b>EXPLORATORY BORING LOG</b>						
			PROJECT NO.		DATE		BORING NO		
							<b>EB-6A</b>		

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION			LOGGED BY Mark Caruso				
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch			DATE DRILLED 7-18-95				
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
FILL: CLAY (CL), MOTTLED SHADES OF BROWN, SOME GRAVEL (FINE AND COARSE), SOME SAND (FINE TO COARSE), SOME SILT, DRY TO DAMP	STIFF								STARTED DRILLING 11:35
FILL: GRAVEL (GC), SHADES OF LIGHT GRAY AND YELLOW-BROWN, FINE AND COARSE, SUBANGULAR TO SUBROUND, SANDY (FINE TO COARSE), SOME CLAY AND SILT, DRY (BECOMING GRAY-BROWN AT 5 FEET)	MEDIUM DENSE		5						EASY DRILLING TO 5 FEET
SILTSTONE, GREEN-GRAY, SLIGHTLY WEATHERED, SOME DISCONTINUITY SURFACES SHOW IRON STAINING, LOW HARDNESS, (BECOMING BLUE-GRAY, LESS WEATHERED, HARD, STRONG BY 9 FEET, ROCK IS INTERBEDDED WITH CLAYSTONE WITH SLICKENSIDES ON DISCONTINUITY SURFACES, DRY)	LOW HARDNESS		15						DRILLING MUCH HARDER BY 9 FEET
(ROCK IS FRESH, VERY SOFT AND WEAK (FRILABLE) FROM ABOUT 13 FEET, NO CLAYSTONE INTERBEDS)	VERY SOFT		20						COLLAR OF HOLE IS STABLE
(MEDIUM GRAY, WEAK, SLICKENSIDES ON SOME DISCONTINUITY SURFACES, TRACE FINE SAND, DRY FROM 18 FEET)			25						LUNCH BEGAN 12:00
(BECOMING MEDIUM GRAY WITH MORE SAND (VERY FINE) NO SLICKENSIDES, MODERATELY STRONG ROCK FROM ABOUT 22 FEET)			30						RESUME WORK 12:40
(SAME AS ABOVE AT 28 FEET)									DRILLING SLOWER FROM 22 FEET IN MORE COMPETENT ROCK
									SOFT, EASY DRILLING FROM 33 TO 35 FEET
<b>HARZA</b> Consulting Engineers and Scientists				<b>EXPLORATORY BORING LOG</b>					
				PROJECT NO.		DATE		BORING NO (a) <b>EB-7A</b>	

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION			LOGGED BY Mark Caruso				
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch			DATE DRILLED 7-18-95				
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
<p>SILTSTONE (CONT.)</p> <p>(ZONE OF CLAY (CL/CH) DARK RUST AND GRAY, GOUGE - SHEAR PLANE, SHEARED AND SLICKENSIDED FROM ABOUT 33 TO 35 FEET, DAMP TO MOIST)</p> <p>(COMPETENT SILTSTONE MIXED WITH POCKETS OF CLAYEY AND SHEARED ROCK TO ABOUT 40 FEET)</p> <p>(LITTLE OR NO SAND IN SILTSTONE BELOW ABOUT 40 FEET, SOME DISCONTINUITIES ARE CLAYEY, VARIABLY STAINED AND SLICKENSIDED)</p> <p>(SHALEY INTERBEDS THAT ARE HARD AND SLICKENSIDED PRESENT FROM ABOUT 46 FEET)</p> <p>(BROWN SHALE INCREASING WITH DEPTH, SHALE APPEARING IN THE SILTSTONE GENERALLY AS RANDOMLY ORIENTED PARTINGS, AND NOT AS CLEAR INTERBEDS, GRADATIONAL TRANSITION)</p> <p>SHALE, MOTTLED BROWN AND GRAY, FRESH, SLICKENSIDED DISCONTINUITY SURFACES, SOME SILTSTONE, GRADATIONAL CONTACT ABOVE AND BELOW WITH SILTSTONE, WEAK</p> <p>SILTSTONE, (AS ABOVE)</p> <p>BOTTOM OF BORING = 59 FEET</p> <p>NOTES:</p> <p>1) <math>\nabla</math> GROUNDWATER WAS NOT ENCOUNTERED AT THE TIME OF DRILLING</p>	SOFT		40						SLIGHTLY HARDER DRILLING FROM ~35'
			45						STILL HAVE ROCKETS OF CLAYEY AND SHEARED ROCK TO 40 FEET
			50						DRILLING IS EASIER BELOW ABOUT 44 FEET
			55						DRILLING REMAINED EASY TO BOTTOM OF HOLE
	SOFT		60						DRILLING COMPLETED 13:15 (1:00) TOTAL
	SOFT		65						BEAM 57'6"
<p><b>HARZA</b></p> <p>Consulting Engineers and Scientists</p>				<b>EXPLORATORY BORING LOG</b>					
				PROJECT NO.		DATE		BORING NO (a) EB-7A	

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION 767		LOGGED BY Mark Caruso					
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch		DATE DRILLED 7-24-95					
DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
FILL: CLAY (CL), MOTTLED SHADES OF BROWN, SOME GRAVEL (FINE AND COARSE), SOME SAND (FINE TO COARSE), SOME SILT, TRACE ROOTS, DRY	STIFF	CL	5						STARTED DRILLING 08:48
FILL: GRAVEL (GC/GM), SHADES OF LIGHT GRAY AND YELLOW-BROWN, FINE AND COARSE, SUBANGULAR TO SUBROUND, SANDY (FINE TO COARSE), SOME CLAY AND SILT, DRY	MEDIUM DENSE	GM/GC	10						COLLAR OF HOLE IS STABLE
SILTSTONE, LIGHT BROWN AND GREEN GRAY, SLIGHTLY WEATHERED, SOME DISCONTINUITY SURFACES SHOW IRON STAINING, WEAK (FRIABLE), SOFT TO LOW HARDNESS  (INTERBEDDED WITH DARK RUST-BROWN CLAYSTONE BY 8 FEET WITH FEW SLICKENSIDES ON DISCONTINUITY SURFACES)  (OLIVE GRAY, LESS WEATHERED, NO CLAYSTONE BY 10 FEET)  (TRACE CLAYSTONE INTERBEDS THAT ARE SHEARED AND SLICKENSIDED FROM 13 TO 15 FEET)  (GRAY, FRESH BY 17, WITH OCCASIONAL FINE SANDY INTERBEDS BY 21 FEET)	SOFT		15						
SANDSTONE, MEDIUM GRAY, FINE GRAINED, FRESH, (FRIABLE), SOFT, WITH SILTSTONE INTERBEDS	SOFT		30						
SILTSTONE, MEDIUM GRAY, FRESH, (FRIABLE), SOFT  (SOME GRAY CLAYEY POCKETS, VERY SLT AND SHEARED AT 33 FEET)	SOFT								
<h1 style="text-align: center;">HARZA</h1> <p style="text-align: center;">Consulting Engineers and Scientists</p>			<b>EXPLORATORY BORING LOG</b>						
			PROJECT NO.		DATE		BORING NO. <b>EB-8A</b>		

DRILL RIG <i>CASE PACIFIC 3000</i>		SURFACE ELEVATION <i>767</i>		LOGGED BY <i>Mark Caruso</i>						
DEPTH TO GROUNDWATER <i>NOT ENC.</i>		BORING DIAMETER <i>1/2 -inch</i>		DATE DRILLED <i>7-24-95</i>						
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS	
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)							
<p><i>SILTSTONE, MEDIUM GRAY, FRESH, WITH INTERBEDS OF DARK RUST BROWN CLAYSTONE THAT IS LOCALLY SHEARED AND SLICKENSIDED, TRACE INTERBEDS OF FINE SANDSTONE</i></p> <p><i>( LIGHT BLUE GRAY, TRACE CLAYEY AND SHEARED SILTSTONE AT 38 FEET)</i></p> <p><i>( SOME SLICKENSIDES ON DISCONTINUITY SURFACES AT 39 TO 40 FEET)</i></p> <p><i>( NO SLICKENSIDES BY 42 FEET)</i></p> <p><i>( INTERBEDDED WITH DARK RUST-BROWN SHALEY CLAYSTONE, LOCALLY SHEARED AND SLICKENSIDED ON DISCONTINUITIES FROM ABOUT 48 FEET)</i></p> <p><i>( SAME AS ABOVE TO B.O.B.)</i></p> <p>-----  <i>BOTTOM OF BORING = 58 - 1/2 FEET</i></p>			<p>40</p> <p>45</p> <p>50</p> <p>55</p> <p>60</p> <p>65</p>							
				<p><i>STOPPED DRILLING (09:38)</i></p> <p><i>(0:50) TOTAL</i></p>						
<h1>HARZA</h1> <p><i>Consulting Engineers and Scientists</i></p>				<b>EXPLORATORY BORING LOG</b>						
				PROJECT NO.		DATE		BORING NO.		<b>EB-8A</b>

KCF

DRILL RIG <b>CASE 3000</b>	SURFACE ELEVATION <b>-767</b>	LOGGED BY <b>Mark Catuso</b>
DEPTH TO GROUNDWATER <b>N.E.</b>	BORING DIAMETER <b>42</b> -inch	DATE DRILLED <b>7-20-95</b>

DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
FILL: CLAY (CL), MOTTLED BROWN, SILTY, SOME SAND (F-C) AND GRAVEL (F-C), DAMP, OCCASIONAL ROOTS	STIFF	CL							STARTED DRILLING 0950
FULL GRAVEL (G-C), MOTTLED TAN- BROWN, F+C, SUBANG., SANDY (F-C), SOME SILT AND CLAY, OCCASIONAL ROOTS, DRY	LOOSE TO M. DENSE		5						STABLE HOLE, LITTLE OR NO OVERBREAK
SILTSTONE GREENISH-GRAY, SLIGHTLY WEATHERED, WEAK, SOFT TO LOW HARDESS, MINOR CLAY COATED SURFACES, DAMP TO DRY, OCCASIONAL SANDY SEAMS, BLOCKS FROM 1/2 in. TO 6 in., NO APPARENT SLICKS	SOFT TO LOW HARD,		10						
(BECOMING BLUE-GRAY)			15						
(OCCASIONAL RED CLAYEY SEAMS THAT ARE DAMP, VERY SOFT, PLASTIC, SLICKS, TO DEPTH OF ABOUT 38 FEET)			25						
			30						

<p><b>HARZA</b> Consulting Engineers and Scientists</p>	EXPLORATORY BORING LOG		
	PROJECT NO.	DATE	BORING NO
			<b>EB-9A</b>

KCF

DRILL RIG	CASE 3000	SURFACE ELEVATION	- 767	LOGGED BY	Mark Curuso
DEPTH TO GROUNDWATER	N.G.	BORING DIAMETER	42 -inch	DATE DRILLED	7-20-95

DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
SILTSTONE (CONT.)	SOFT TO LOW HARD,		40						
(BECOMING MODERATELY STRONG, LOW HARDNESS, BLOCKS 1" TO 12", OCCASIONAL CLAY COATED SURFACES, DRY TO DAMP)	LOW HARD.		45						
(ENCOUNTERING clayey, shaley seams BELOW 50 FEET, PLASTIC, SOFT, SOME SUCKS)	SOFT TO LOW HARD,		50						
			55						
BOB = 58 1/2 FEET			60						COMPLETED DRILLING 1040
1. NO $\frac{1}{2}$ IN SEEP DURING DRILLING			65						

<p><b>HARZA</b></p> <p>Consulting Engineers and Scientists</p>	<b>EXPLORATORY BORING LOG</b>		
	PROJECT NO.	DATE	BORING NO
			EB-9A

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION 708		LOGGED BY Mark Caruso					
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch		DATE DRILLED 7-24-95					
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
FILL: CLAY (CL), MOTTLED SHADES OF BROWN, SOME GRAVEL (FINE AND COARSE), SOME SAND (FINE TO COARSE) SOME SILT, TRACE ROOTS, DRY	STIFF								STARTED DRILLING 07:48
SILTSTONE, LIGHT GRAY-BROWN OR OLIVE BROWN, SLIGHTLY WEATHERED, SOME IRON STAINING ON DISCONTINUITY SURFACES, WEAK (FRIABLE), SOFT, DRY	SOFT		5						COLLAR OF HOLE IS STABLE
(LESS WEATHERED, TRACE IRON STAINING BY 10 FEET)			10						
(GRAY AND LIGHT BROWN, FRESHER, MORE COMPETENT BY 14 FEET)			15						
(GRAY, FRESH BY 16 FEET)									
(TRACE DARK RED-BROWN CLAYEY WEATHERED POCKETS BY 18 FEET)									
(OLIVE GRAY, NO CLAYEY POCKETS BY 20 FEET)			20						
(SLIGHTLY WEATHERED, SOME IRON STAINING ON DISCONTINUITY SURFACES BY 23 FEET)									
(GRAY, FRESH AT 25 FEET)			25						
SANDSTONE, MEDIUM BLUE-GRAY, FINE GRAINED, (FRIABLE), SOFT	SOFT		30						DRILLING MUCH HARDER AT 30 FEET
(BECOMING MORE COMPETENT WITH DEPTH)									
SILTSTONE, MEDIUM GRAY, FRESH (FRIABLE), SOFT	SOFT								
			<b>EXPLORATORY BORING LOG</b>						
<b>HARZA</b> Consulting Engineers and Scientists			PROJECT NO.		DATE		BORING NO		
							EB-10A		

DRILL RIG	CASE PACIFIC 3000	SURFACE ELEVATION	768	LOGGED BY	Mark Caruso
DEPTH TO GROUNDWATER	NOT ENC.	BORING DIAMETER	42 -inch	DATE DRILLED	7-24-95

DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
SILTSTONE, MEDIUM GRAY, FRESH, (FRIABLE), SOFT  (TRACE INTERBEDS OF DARK RUST BROWN CLAYSTONE FROM ABOUT 32 FEET)  (INTERBEDDED WITH CLAYSTONE, DARK RUST BROWN, WITH SHEARED ZONES AND SLICKENSIDES LOCALLY ON DISCONTINUITY SURFACES FROM ABOUT 36 FEET)  (LESS CLAYSTONE, INCREASE IN GRAY, SOFT AND SHEARED SILTSTONE FROM 40 FEET)  (FEW CLAYSTONE INTERBEDS BY 1/2 FEET)  (INTERBEDDED WITH CLAYSTONE, DARK RUST-BROWN, MANY SLICKEN- SIDED SURFACES AND SHEARED ROCK BY 45 FEET)	SOFT		40						
CLAYSTONE, DARK RUST-BROWN, SHEARED AND SLICKENSIDED WITH SILTSTONE INTERBEDS, (FRIABLE), SOFT	SOFT		55						
SILTSTONE, GRAY, FRESH, (FRIABLE), SOFT, WITH INTERBEDDED CLAYSTONE	SOFT		60						
CLAYSTONE, DARK RUST-BROWN, LOCALLY SHEARED AND SLICKEN- SIDED, WITH SILTSTONE INTERBEDS (FRIABLE), SOFT	SOFT		65						
BOTTOM OF BORING = 58-3/4 FEET									

STOPPED  
DRILLING  
09:40  
(01:50)  
TOTAL

<h1 style="text-align: center;">HARZA</h1> <p style="text-align: center;">Consulting Engineers and Scientists</p>				<b>EXPLORATORY BORING LOG</b>			
				PROJECT NO.	DATE	BORING NO.	<b>EB-10A</b>

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION			LOGGED BY Mark Caruso				
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch			DATE DRILLED 7-19-95				
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
FILL: CLAY (CL), MOTTLED SHADES OF BROWN, SOME GRAVEL (FINE AND COARSE), SOME SAND (FINE TO COARSE), SOME SILT, DRY	STIFF								STARTED DRILLING 10:48
SILTSTONE, LIGHT GRAY-BROWN OR OLIVE BROWN, SLIGHTLY WEATHERED, BLOCKY, SOME IRON STAINED AND SLICKENSIDED DISCONTINUITY SURFACES, WEAK (FRIABLE) AND SOFT, DRY  (LESS IRON STAINING, SOME SANDSTONE INTERBEDS BY 10 FEET)	SOFT		5						COLLAR OF HOLE IS STABLE  DRILLING IS EASY
SANDSTONE, LIGHT GRAY-BROWN, SLIGHTLY WEATHERED, FINE TO MEDIUM GRAINED, INTERBEDDED WITH SILTSTONE, SOME DISCONTINUITY SURFACES ARE IRON STAINED, WEAK (FRIABLE), SOFT	SOFT		15						STOPPED DRILLING 11:08  STARTED DRILLING 11:13
SILTSTONE, MEDIUM GRAY, SLIGHTLY WEATHERED, WEAK (FRIABLE), VERY SOFT  (ROCK FRESH BY 17 FEET)  (INTERBEDDED WITH FINE SANDSTONE, MEDIUM GRAY, WEAK (FRIABLE) AND SOFT FROM ABOUT 19 FEET)  (SAME AS ABOVE AT 23 FEET)  (ROCK STILL WEAK (FRIABLE) AND SOFT AT 26 FEET)	VERY SOFT		20						DRILLING ADVANCE SLOWER
SANDSTONE, MEDIUM GRAY, FINE, WEAK (FRIABLE), SOFT	SOFT		25						
SILTSTONE (NEXT PAGE)	HARD		30						
<h1 style="text-align: center;">HARZA</h1> <p style="text-align: center;">Consulting Engineers and Scientists</p>				<b>EXPLORATORY BORING LOG</b>					
				PROJECT NO.		DATE		BORING NO (E) <b>EB- 11A</b>	

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION			LOGGED BY Mark Caruso				
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 42 -inch			DATE DRILLED 7-19-95				
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
SILTSTONE, MEDIUM GRAY META-SILTSTONE, HARD, MODERATELY STRONG WITH POCKETS OF SHEARED CLAYSTONE AND SILTSTONE, SOME SHEARED SURFACES AND IRON STAINING (SHEARING AND IRON STAINING INCREASING WITH DEPTH BY 33 FEET) (LESS SHEARED AND CLAYEY POCKETS, MORE COMPETENT BY 36 FEET)	HARD		40						
CLAYSTONE, MEDIUM GRAY STAINED DARK RUST BROWN, WITH INTERBEDDED SILTSTONE, SHEARED, SLICKENSIDED, VERY WEAK, VERY SOFT (MORE SHEARED AND SLICKENSIDED FROM ABOUT 40 FEET) (MORE COMPETENT, LESS CLAYEY ZONE FROM ABOUT 42 OR 43 FEET) (INTERBED OF SILTSTONE WITH CLAY POCKETS AND SLICKENSIDES FROM ABOUT 45 TO 47 FEET) (VERY SHEARED AND SLICKENSIDED FROM ABOUT 48 FEET WITH SILTSTONE INTERBEDS)	VERY SOFT		45						
SILTSTONE, DARK GRAY WITH DARK RUST BROWN STAINING, SOME SLICKENSIDED DISCONTINUITY SURFACES, WEAK (FRIABLE), SOFT (SOME SHEARED CLAYEY POCKETS BY 55 FEET)	SOFT		60						
CLAYSTONE, MEDIUM GRAY STAINED DARK RUST BROWN, SHEARED AND SLICKENSIDED, VERY SOFT, VERY WEAK	VERY SOFT		65						
BOTTOM OF BORING = 58 FEET			<p style="text-align: right;">DRILLING ENDED 11:55 (0:56) TOTAL</p>						
<p style="text-align: center;"><b>HARZA</b> Consulting Engineers and Scientists</p>									
			PROJECT NO.	DATE	BORING NO (5) <b>EB-11A</b>				

DRILL RIG <b>CASE PACIFIC 3000</b>		SURFACE ELEVATION			LOGGED BY <b>Mark Caruso</b>				
DEPTH TO GROUNDWATER <b>NOT ENC.</b>		BORING DIAMETER <b>4 1/2 -inch</b>			DATE DRILLED <b>7-19-95</b>				
DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
SILTSTONE, LIGHT GRAY-BROWN OR OLIVE-BROWN, SLIGHTLY WEATHERED BLOCKY, SOME IRON STAINING AND SLICKENSIDES ON DISCONTINUITY SURFACES (MORE COMPETENT AND LESS IRON STAINING AND SLICKENSIDES BY 8 FEET)			5						STARTED DRILLING 09:10  COLLAR OF HOLE IS STABLE
SANDSTONE, LIGHT GRAY AND BROWN, FINE TO MEDIUM, SLIGHTLY WEATHERED WEAK (FRIABLE), SOFT			10						
SILTSTONE, LIGHT TO MEDIUM GRAY, SLIGHTLY WEATHERED, VERY SOFT (FRIABLE), WEAK, SOME DISCONTINUITIES DISPLAY IRON STAINING AND SLICKENSIDES (FRESH, MORE COMPETENT BY 15 FEET)			15						
SOFT (APPEARS SILICEOUS WITH NUMEROUS SLICKENSIDED SURFACES BY 17 FEET) (ZONES OF MEDIUM GRAY CLAY WITH IRON STAINING, SHEARED, WITH SLICKENSIDES BY 19 FEET) (LESS SHEARED CLAY AND SLICKENSIDED SURFACES BY 21 FEET)			20						AUGER TRYING TO DRIFT DOWNSLOPE
VERY SOFT CLAYSTONE, BLUE-GREEN-GRAY, SHEARED AND SLICKENSIDED			25						STOPPED DRILLING 9:51 REPAIR CENTER TOOTH
HARD SILTSTONE, SILICEOUS META-SILTSTONE HARD TO VERY HARD, WITH GREEN-GRAY SHEARED CLAYSTONE SEEN IN ZONES OR POCKETS			30						STARTED DRILLING 10:02
SOFT SANDSTONE, MEDIUM BLUE-GRAY, FRESH, FINE TO MEDIUM, WEAK, SOFT									
SOFT SILTSTONE (NEXT PAGE)									
<b>HARZA</b> Consulting Engineers and Scientists				<b>EXPLORATORY BORING LOG</b>					
				PROJECT NO.		DATE		BORING NO (4) <b>EB-13A</b>	

DRILL RIG <i>CASE PACIFIC 3000</i>		SURFACE ELEVATION			LOGGED BY <i>Mark Caruso</i>				
DEPTH TO GROUNDWATER <i>NOT ENC.</i>		BORING DIAMETER <i>4 1/2 -inch</i>			DATE DRILLED <i>7-19-95</i>				
DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
<i>SILTSTONE, MEDIUM GRAY, WITH SANDSTONE INTERBEDS, WEAK (FRIABLE), SOFT</i>	<i>SOFT</i>								
<i>CLAYSTONE, GREEN-GRAY AND DARK RUST BROWN, CLAYEY, SHEARED, SLICKENSIDED, VERY WEAK, VERY SOFT</i>	<i>VERY SOFT</i>		<i>40</i>						
<i>(DARK RUST BROWN, MORE SEVERELY SHEARED AND SLICKENSIDED BY 40 FEET)</i>			<i>45</i>						
<i>(SOME MORE COMPETENT BLOCKS BY 46 FEET)</i>									
<i>(VERY SHEARED AND SLICKENSIDED AT 48 FEET)</i>			<i>50</i>						
<i>(MORE COMPETENT, LESS CLAYEY AND SHEARED ROCK WITH SOME SANDSTONE INTERBEDS AT 50 FEET)</i>									<i>DRILLING SLIGHTLY HARDER IN SANDSTONE</i>
<i>(VERY SHEARED AND SLICKENSIDED AT 52 FEET)</i>			<i>55</i>						
<i>SANDSTONE, GREEN-GRAY, FINE TO COARSE, WEAK (FRIABLE), SOFT</i>	<i>SOFT</i>								<i>DRILLING ENDED 10:36</i>
<i>BOTTOM OF BORING = 58 FEET</i>			<i>60</i>						<i>(1:15) TOTAL</i>
			<i>65</i>						
<p style="text-align: center;"><b>HARZA</b></p> <p><i>Consulting Engineers and Scientists</i></p>				<b>EXPLORATORY BORING LOG</b>					
				PROJECT NO.		DATE		BORING NO (4) <b>EB-13A</b>	



DRILL RIG <b>CASE PACIFIC 3000</b>	SURFACE ELEVATION <b>771</b>	LOGGED BY <b>Mark Caruso</b>
DEPTH TO GROUNDWATER <b>NOT ENC.</b>	BORING DIAMETER <b>4 1/2 -inch</b>	DATE DRILLED <b>7-21-95</b>

DESCRIPTION AND CLASSIFICATION		DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST SOIL TYPE							
SILTSTONE, LIGHT BLUE-GRAY, WEAK (FRIABLE), SOFT (WITH POCKETS OF SHEARED CLAYSTONE BY 36 FEET)	SOFT							
CLAYSTONE, DARK RUST BROWN AND GRAY, WITH SILTSTONE INTERBEDS, LOCALLY SHEARED AND SLICKENSIDED, (MORE SILTSTONE INTERBEDS FROM ABOUT 40 FEET)	SOFT	40						
SILTSTONE, MEDIUM GRAY AND DARK RUST-BROWN, SOME CLAYSTONE INTERBEDS, (FRIABLE), SOFT	SOFT	45						
CLAYSTONE, DARK RUST BROWN, SOME SILTSTONE INTERBEDS, MANY SHEARED AND SLICKENSIDED SURFACES, (FRIABLE), SOFT (BECOMING MOTTLED GRAY, WITH SOME SILTSTONE INTERBEDS AT 53 FEET) (MORE COMPETENT SILTSTONE BLOCKS BY 55 FEET) (SOME INTERBEDDED LIGHT BLUE GRAY SANDSTONE AT 57 FEET)	SOFT	50						
BOTTOM OF BORING = 58 - 1/2 FEET		55						
		60						
		65						

STOPPED  
DRILLING  
09:34  
(0:49)  
TOTAL

<b>HARZA</b> Consulting Engineers and Scientists	<b>EXPLORATORY BORING LOG</b>		
	PROJECT NO.	DATE	BORING NO
			<b>EB-14A</b>

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION		LOGGED BY Mark Caruso					
DEPTH TO GROUNDWATER		BORING DIAMETER 4 1/2 -inch		DATE DRILLED 7-19-95					
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
FILL: CLAY (CL), MOTTLED SHADES OF LIGHT BROWN, SILTY, SOME SAND (FINE TO COARSE), TRACE GRAVEL (FINE AND COARSE), DRY	STIFF								STARTED DRILLING 08:11
SILTSTONE, LIGHT BROWN, SOME SAND (FINE), BLOCKY, SOFT, FRIABLE, WEAK, SLIGHTLY WEATHERED  (SHALE HC BELOW TO 10 FEET)	SOFT		5						
(MEDIUM GRAY, FRESH, SOFT, FRIABLE, WEAK FROM 16 FEET)  (BECOMING SHALEY SILTSTONE WITH SLICKENSIDED, RANDOMLY ORIENTED CLASTS FROM 14 FEET)			10						
(MEDIUM TO DARK GRAY, MORE COMPACT ROCK, LESS SHALE PALE SLICKENSIDED SURFACES BY 20 FEET)			15						
SANDSTONE, LIGHT BLUE-GRAY, FINE TO MEDIUM, FRESH, SOFT, FRIABLE, WEAK  (GRADING FINER GRAINED AND SILTY BY 20 FEET)	SOFT		25						
SILTSTONE, MEDIUM GRAY, WITH ZONES OF SHEARED, IRON STAINED, AND SLICKENSIDED CLAY  (BECOMING DARK RUST BROWN BY 33)	SOFT  VERY SOFT		30						
<h1>HARZA</h1> Consulting Engineers and Scientists			<b>EXPLORATORY BORING LOG</b>						
			BEVATRON BUILDING 51 - SLOPE STABILIZATION						
			PROJECT NO.	DATE	BORING NO (3) <b>EB-15A</b>				
				JULY 1995					

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION			LOGGED BY Mark Caruso						
DEPTH TO GROUNDWATER		BORING DIAMETER 4 1/2 -inch			DATE DRILLED 7-19-95						
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS		
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)								
SILTSTONE, DARK RUST BROWN, CLAYEY, SHEARED, ABUNDANT SLICKENSIDES (BECOMING LESS CLAYEY AND MORE COMPETENT FROM 36 TO 39 FEET) (NO SHEARED CLAY AT 42 FEET) (VERY SHEARED AND DECOMPOSED AT 43 FEET) (WITH GRAY AND RUST BROWN SHEARED CLAYSTONE AT 46 FEET) (BECOMING GRAYER BELOW 46 FEET)	VERY SOFT		40								
----- CLAYSTONE, GRAY AND DARK RUST BROWN, SHEARED, VERY SOFT (BECOMING MORE GRAY AND LESS SHEARED BELOW 49 FEET)	VERY SOFT		50								
----- SILTSTONE, MEDIUM GRAY, LOCALLY SHEARED, SOME DISCONTINUITY SURFACES SLICKENSIDED WEAK (FRIABLE) (MORE COMPETENT AND LESS SLICKENSIDES BELOW 54 FEET) (APPEARS MORE SILICIOUS AND MORE SHEARED WITH SLICKENSIDES BELOW 56 FEET)	SOFT		55								
----- BOTTOM OF BORING = 58 FEET			65								
<h2 style="text-align: center;">HARZA</h2> <p style="text-align: center;">Consulting Engineers and Scientists</p>				<b>EXPLORATORY BORING LOG</b>							
				PROJECT NO.		DATE		BORING NO (3)		<b>EB-15A</b>	
						JULY 1995					

STOPPED DRILLING  
08:55  
(0:44) TOTAL

DRILL RIG <i>CASE PACIFIC 3000</i>		SURFACE ELEVATION <i>773</i>		LOGGED BY <i>Mark Caruso</i>					
DEPTH TO GROUNDWATER <i>NOT ENC.</i>		BORING DIAMETER <i>42 -inch</i>		DATE DRILLED <i>7-21-95</i>					
DESCRIPTION AND CLASSIFICATION			DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)						
<i>SILTSTONE, DARK RUST-BROWN, CLAYEY, LOCALLY SHEARED, SOME SLICKENSIDED SURFACES</i>	<i>SOFT</i>								<i>STOPPED DRILLING 08:13</i>
<i>CLAYSTONE, DARK RUST BROWN, WITH GRAY SILTSTONE INTERBEDS, CLAYEY, LOCALLY SHEARED AND SLICKENSIDED, (FRIABLE), SOFT</i>	<i>SOFT</i>		<i>40</i>						<i>STARTED DRILLING 08:18</i>
<i>SILTSTONE, MEDIUM GRAY, WITH INTERBEDS OF DARK RUST-BROWN CLAYSTONE, LOCALLY SHEARED, SOME DISCONTINUITY SURFACES DISPLAY SLICKENSIDES (MORE COMPETENT, TRACE CLAYSTONE BY 44 FEET) (MEDIUM GRAY, COMPETENT BY 46, (FRIABLE), SOFT) (INTERBEDDED WITH DARK RUST-BROWN CLAYSTONE FROM ABOUT 50 TO 54 FEET)</i>	<i>SOFT</i>		<i>45</i>						<i>DRILLING BECOMING MORE DIFFICULT AT 45</i>
<i>SANDSTONE, LIGHT BLUE-GRAY, FINE, FRESH, (FRIABLE), SOFT</i>	<i>SOFT</i>		<i>50</i>						
<i>SILTSTONE, LIGHT BLUE GRAY, WITH INTERBEDDED SANDSTONE, LOCALLY CRUSHED AND CLAYEY</i>	<i>SOFT</i>		<i>55</i>						<i>STOPPED DRILLING 08:39 (0:52) TOTAL</i>
<i>BOTTOM OF BORING = 59 FEET</i>			<i>60</i>						
			<i>65</i>						

**EXPLORATORY BORING LOG**

**HARZA**

*Consulting Engineers and Scientists*

PROJECT NO.

DATE

BORING NO

**EB-16A**

KCF

DRILL RIG	CASE 3000	SURFACE ELEVATION	- 773	LOGGED BY	<del>Harza</del>
DEPTH TO GROUNDWATER	N.E.	BORING DIAMETER	42 -inch	DATE DRILLED	7-20-95

DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
FILL: CLAY (CL), mottled brown, silty, some sand (f-c) and gravel (f+g), damp	STIFF	CL							STARTED DRAWING 0900
CLAY (CL), mottled brown, silty, trace sand (f-c) and gravel (f+g), occasional rootlets, damp	STIFF	CL	5						
CLAY (CL), mottled light brown, silty, some sand (f-m), occasional rootlets, damp	STIFF	CL	10						
SILTSTONE, light brown-gray, some sand (f-g), very soft, weak, slightly weathered, damp	VERY SOFT		15						STABLE HOLE, LITTLE OR NO OVER-BREAK
(BECOMING <sup>SOFT,</sup> BLOCKY, ≥ 1", GRAY, VERY THIN BEDDING)	SOFT		20						
SHALE, rust-red, very soft, deeply weathered, weak, highly foliated, plastic, very thin bedding, slick surfaces, clayey surfaces, damp	SOFT		25						
(BECOMING BLOCKY, SOFT, WEAK) <sup>GRAY</sup> (CROSS-BEDDING WITH SILTSTONE) (THIN SEAM OF SANDSTONE)	SOFT		30						
SILTSTONE, blue-gray, soft, weak, occasional clay coated surfaces, occasional <sup>red</sup> clayey and shaley very soft seams, occasional slick surfaces	SOFT								

<h1>HARZA</h1> <p>Consulting Engineers and Scientists</p>	EXPLORATORY BORING LOG		
	PROJECT NO.	DATE	BORING NO
			EB-17A

DRILL RIG <b>CASE 3000</b>	SURFACE ELEVATION <b>- 773</b>	LOGGED BY <b>Mark Gattuso</b>
DEPTH TO GROUNDWATER <b>N.E.</b>	BORING DIAMETER <b>42 -inch</b>	DATE DRILLED <b>7-20-95</b>

DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
<b>SILTSTONE (CONT.)</b>	<b>SOFT</b>		40						
<b>(BECOMING BLOCKY, ≥ 2", MINOR CLAY COATED SURFACES, WEAK TO MODERATELY STRONG, GRAY, DAMP TO DRY)</b>			45						<b>SLOWER DRILLING</b>
<b>BOB = 50 FEET</b>			50						<b>COMPLETED DRILLING 0940</b>
<b>1. NO ± or SEEPAGE ENC. DURING DRILLING</b>			55						
			60						
			65						

<b>HARZA</b> Consulting Engineers and Scientists	<b>EXPLORATORY BORING LOG</b>		
	PROJECT NO.	DATE	BORING NO
			<b>EB-17A</b>

KCF

DRILL RIG <b>CASE 3000</b>	SURFACE ELEVATION <b>— 773</b>	LOGGED BY <b>Mark C. Russo</b>
DEPTH TO GROUNDWATER <b>N.E.</b>	BORING DIAMETER <b>42 inch</b>	DATE DRILLED <b>7-20-95</b>

DESCRIPTION AND CLASSIFICATION			DEPTH (FEET)	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE							
<b>SILTSTONE (cont.)</b> <b>(CLAY SEAM, BROWN, -36-37")</b>	<b>SOFT</b>								
<b>(BLOCKY, MODERATELY STRONG)</b> <b>(SOME CLAY COATED SURFACES)</b>	<b>LOW HARD.</b>		<b>40</b>						
<b>(THIN SHALE SEAM, BLUE-GRAY)</b>	<b>SOFT</b>								
<b>(WEAK, DRY)</b>			<b>45</b>						
<b>(DAMP, SHALEY SEAM, BROWN CLAY COATED SURFACES, VERY SOFT AND WEAK, HIGHLY FOLIATED)</b>			<b>50</b>						<b>COMPLETED DRILLING 0845</b>
<b>BOB - 50 FEET</b>									
<b>1. WATER OR SEEPAGE NOT ENC. DURING DRILLING.</b>			<b>55</b>						
			<b>60</b>						
			<b>65</b>						

<p><b>HARZA</b> Consulting Engineers and Scientists</p>	<b>EXPLORATORY BORING LOG</b>		
	PROJECT NO.	DATE	BORING NO
			<b>EB-184</b>

DRILL RIG CASE PACIFIC 3000		SURFACE ELEVATION			LOGGED BY <b>Mark Caruso</b>			
DEPTH TO GROUNDWATER NOT ENC.		BORING DIAMETER 4 1/2 -inch			DATE DRILLED 7-18-95			
DESCRIPTION AND CLASSIFICATION		DEPTH	SAMPLER	PENETRATION RESISTANCE (BLOWS/FT)	WATER CONTENT (%)	DRY DENSITY (PCF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	OTHER TESTS
DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	(FEET)					
SILTSTONE, LIGHT BLUE-GRAY, MANY DISCONTINUITIES DISPLAY SLICKEN-SIDES, SOME SHEARED, CLAYEY POCKETS, FRESH, DRY  (CUTTINGS BECOMING LESS BLOCKY, APPARENT VERY THIN BEDS, NUMEROUS SLICKENSIDED SURFACES, DRY)	SOFT		40					DRILLING ADVANCE RATE IS CONSISTENT  SLIDE PLANE BETWEEN 31 AND 37
SANDSTONE, BLUE-GRAY, FINE TO MEDIUM GRAINED, TRACE SAND COARSE GRAINED, TRACE GRAVEL (FINE, ROUND TO SUBROUND), FRESH, WEAK, SOFT  (ROCK BECOMING STRONG AND HARD FROM ABOUT 48 FEET)	HARD TO VERY HARD		45					DRILLING ADVANCE RATE IS SLOWER IN SANDSTONE  ADVANCE RATE MUCH SLOWER NEAR 50 FEET  CUTTINGS ARE PULVERIZED FROM ABOUT 48 FEET
BOTTOM OF BORING ≈ 50-1/2 FEET NOTES: 1) ▼ GROUNDWATER WAS NOT ENCOUNTERED AT THE TIME OF DRILLING. MINOR SEEPAGE WAS NOTED AT APPROXIMATELY 14 FEET BUT QUICKLY TERMINATED			50					DRILLING ENDED 10:25
			55					
			60					
			65					
<b>HARZA</b> Consulting Engineers and Scientists		<b>EXPLORATORY BORING LOG</b>						
		PROJECT NO.	DATE	BORING NO (I) <b>EB-1A</b>				

**A3GEO, Inc. (A3GEO), 2011**, Geotechnical Investigation Report, Meteorological Tower near Building 27, Lawrence Berkeley National Laboratory, Berkeley, California,” report dated July 28, 2011.

### **Log of Boring B-1**



A3GEO, Inc.  
1331 7th Street, Suite E  
Berkeley, CA 94710

# BORING NUMBER B-1

PAGE 1 OF 1

**CLIENT** Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA    **PROJECT NAME** Meteorological Tower  
**PROJECT NUMBER** 1100-8A    **PROJECT LOCATION** Near Building 27  
**DATE STARTED** 06/22/11    **COMPLETED** 06/22/11    **GROUND ELEVATION** 893 ft    **HOLE SIZE** 3.5"  
**DRILLING CONTRACTOR** Northstar Drilling, Inc.    **GROUND WATER LEVELS:**  
**DRILLING METHOD** Solid Stem Auger (Minute Man)    **AT TIME OF DRILLING** ---  
**LOGGED BY** DKM    **CHECKED BY** WM    **AT END OF DRILLING** ---  
**NOTES** No groundwater encountered    **AFTER DRILLING** ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
0		LEAN CLAY, (CL) Dark brown, firm, with silt and sand, moderately plastic, some organics, trace gravel, moist. - TOPSOIL							
5		MORAGA FORMATION - Reddish brown, low hardness, friable to weak, deeply weathered, crushed to intensely fractured, some clay, very sandy, 1/4" - 3/4" angular volcanic fragments, dry to moist - BEDROCK	MC	22					consistent drilling
10		slightly more clay	MC	23					
15		Reddish brown, moderately hard, moderately strong, moderately weathered, intensely fractured, little clay	MC	16/5"					
20		Reddish brown and gray, moderately hard, moderately strong, moderate to little weathering, intensely to closely fractured, sample completely disturbed, with increased clay and silt	SPT	27					
25			SPT	25/5"					slower drilling
Bottom of borehole at 28.0 feet.									

GEOTECH BH COLUMNS - GINT STD US.GDT - 06/29/11 15:31 - A:\A3GEO PROJECTS\1100 - LBNL\1100-8A B27 METEOROLOGICAL TOWER\BORING LOGS\BORING LOGS - METEOROLOGICAL TOWER.GPJ

UNIFIED SOIL CLASSIFICATION CHART				
MAJOR DIVISIONS			SYM	TYPICAL NAMES
<b>COARSE GRAINED SOILS:</b> more than 50% retained on No. 200 sieve	<b>GRAVELS:</b> 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES	GM	Silty gravels and gravel-sand-silt mixtures
			GC	Clayey gravels and gravel-sand-clay mixtures
	<b>SANDS:</b> more than 50% of coarse fraction passes through No. 4 sieve	CLEAN SANDS	SW	Well graded sands and gravelly sand, little or no fines
			SP	Poorly graded sands and gravelly sand, little or no fines
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-silt mixtures
<b>FINE-GRAINED SOILS:</b> 50% or more passes No. 200 sieve	<b>SILTS AND CLAYS:</b> Liquid Limit 50% or less	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		OL	Organic silts and organic silty clays of low plasticity	
	<b>SILTS AND CLAYS:</b> Liquid Limit greater than 50%	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic clays	
		CH	Inorganic clays of high plasticity, fat clays	
		OH	Organic clays of medium to high plasticity	
<b>HIGHLY ORGANIC SOILS</b>			PT	Peat, muck and other highly organic soils

BOUNDARY CLASSIFICATION AND GRAIN SIZES							
SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
U.S. STANDARD SIEVE SIZES	No. 200	No. 40	No. 10	No. 4	3/4"	3"	12"

KEY TO LOGS	
SAMPLE TYPE	DESCRIPTION
	<b>Modified California Sampler</b> (3" O.D.): blowcount is equivalent SPT N value (converted by multiplying field blowcounts by 0.63)
	<b>Standard Penetration Test</b> (2" O.D.)
	<b>Thin-walled tube using Pitcher Barrel</b>
	<b>Shelby Tube</b> , pushed or used Osterberg Sampler
	<b>Disturbed Sample</b>

\*NOTE: RECORDED BLOW COUNTS HAVE NOT BEEN ADJUSTED FOR HAMMER ENERGY

## BEDDING OF SEDIMENTARY ROCK

SPLITTING PROPERTY	THICKNESS	STRATIFICATION
Massive	Greater than 4.0 feet	Very Thick-Bedded
Blocky	2.0 to 4.0 feet	Thick-Bedded
Slabby	0.2 to 2.0 feet	Thin-Bedded
Flaggy	0.05 to 0.2 feet	Very Thin-Bedded
Shaly or Platy	0.01 to 0.05 feet	Laminated
Papery	Less than 0.01 feet	Thinly Laminated

## FRACTURING

INTENSITY	SIZE OF PIECES IN FEET
Very Little Fractured	Greater than 4.0 feet
Occasionally Fractured	1.0 to 4.0 feet
Moderately Fractured	0.5 to 1.0 feet
Closely Fractured	0.1 to 0.5 feet
Intensely Fractured	0.05 to 0.1 feet
Crushed	Less than 0.05 feet

## HARDNESS

<b>Soft</b>	Reserved for plastic material alone
<b>Low Hardness</b>	Can be gouged deeply or carved easily by a knife blade
<b>Moderately Hard</b>	Can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and is readily visible after the powder has been blown away
<b>Hard</b>	Can be scratched by a knife blade with difficulty; scratch produces little powder and is often faintly visible
<b>Very Hard</b>	Cannot be scratched by a knife blade; leaves a metallic streak



## STRENGTH

<b>Plastic</b>	Very low strength
<b>Friable</b>	Crumbles easily by rubbing with fingers
<b>Weak</b>	An unfractured specimen of such material will crumble under light hammer blows
<b>Moderately Strong</b>	Specimen will withstand a few heavy hammer blows before breaking
<b>Strong</b>	Specimen will withstand a few heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments
<b>Very Strong</b>	Specimen will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments

## WEATHERING:

<i>— the physical and chemical disintegration and decomposition of rocks and minerals by natural processes such as oxidation, reduction, hydration, solution, carbonation, and freezing and thawing</i>	
<b>Deep</b>	Moderate to complete mineral decomposition; extensive disintegration; deep and thorough discoloration; many fractures, all extensively coated or filled with oxides, carbonates and/or clay or silt.
<b>Moderate</b>	Slight change or partial decomposition of minerals; little disintegration; cementation little to unaffected. Moderate to occasionally intense discoloration. Moderately coated fractures.
<b>Little</b>	No megascopic decomposition of minerals; little or no effect on normal cementation. Slight and intermittent, or localized discoloration. Few stains on fracture surfaces.
<b>Fresh</b>	Unaffected by weathering agents. No discoloration or disintegration. Fractures usually less numerous than joints.

**A3GEO, Inc. and Lettis Consultants, International, Inc. (A3GEO/LCI), 2011**, “Bevatron Observations, Lawrence Berkeley National Laboratory”, consulting report dated September 30, 2011.

**Review of Environmental Boreholes SB51-11-9 to 16  
Review of Environmental Push Cores WT-1 to WT-12  
Sewer Trench Observations  
Review of Bevatron (Building 51) Excavations**

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# MEMORANDUM

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**Date:** September 30, 2011 **A3GEO Project #:** 1100-2D  
**Project:** Bevatron Observations  
LBNL, Berkeley, CA  
**To:** Joe Harkins, Project Director  
**From:** Dona Mann, G.E. (A3GEO), John Baldwin, C.E.G. (LCI)  
**R.E.:** Summary of Observations during Bevatron Demolition

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This memorandum documents our field observations made during the demolition of the Bevatron between April and September 2011. Observations were made by Dona Mann, G.E. of A3GEO, Inc. (A3GEO) and John Baldwin, C.E.G. of Lettis Consultants International, Inc. (LCI). Preston Jordan, LBNL geologist, was intermittently on site with Ms. Mann and/or Mr. Baldwin. The data collected from the excavations and environmental explorations conducted in 2011 should be compiled and interpreted for an overall geologic and geotechnical analysis of the Bevatron site; however, this was beyond the limits of this memorandum which transmits field observations only.

## Review of Environmental Boreholes SB51-11-9 to 11

Review of retrieved core samples occurred on April 29, 2011 after the drilling and installation of temporary groundwater sampling points by LBNL environmental staff. Samples were placed on plastic sheeting with relative depths noted at the base of each sample run. Boreholes SB51-11-09, 10 and 11 had been drilled prior to review of the core; thus significant drying had occurred from sun exposure and a moderate breeze. The sampling method (percussion hammer and direct push) and disturbed condition of the core generally allowed for only textural and color observations. No information on hammer resistance or elapsed time between samples was available. Inferences regarding rock mass properties are based on the size and condition of bedrock chips and blocks comprising the core samples. Colors were estimated, where time permitted using a Munsell color chart. The groundwater sampling points were being installed as part of the Environmental Health and Safety department's demolition of the Bevatron; information regarding the construction of the installed facilities is available through LBNL.

The following are field notes of the core review by John Baldwin. The information provided below should not be used for geotechnical planning purposes. Depths should be considered approximate and within +/- 6 inches, with possible larger uncertainties where sample(s) appeared missing. The elevations of SB51-11-9 and SB51-11-10 are roughly 710 ft (floor of Bevatron), whereas SB51-11-11 is about 725 ft. The approximate borehole locations are provided on the attached Site Plan, Figure 1.

### Borehole SB51-11-09

0-1 ft: light yellow brown (7.5 YR 5/4) silty clay with angular gravel; hard siltstone and sandstone clasts between 1" to 2" diameter (FILL).

1-2 ft: tannish gray (10YR 6/1) to grayish light brown, moderately weathered very fine-grained siltstone (Orinda Formation).

2-7 ft: light gray sandy siltstone with fine fractures; blocky to very blocky with an estimated moderate GSI; thin weak zone at 6 ft where it becomes pulverized (Orinda Formation).

7-8.5 ft: dark gray (7.5 YR 4/1) clayey siltstone with abundant random polished fracture faces and highly disintegrated to blocky/disturbed/seamy weak to moderately weak rock; very fine fractures; open to tight; chips break easily along partings (Orinda Formation).

8.5-9.5: (possibly missing core within this interval); gray sandy siltstone with zones of hard to weak calcium carbonate development (calcite crystals); becomes hard and blocky suggesting moderate to moderately high GSI; increase in sand content (20-30%); dry (Orinda Formation).

9.5 to 13 ft: dark gray siltstone; pulverized and disintegrated to blocky/disturbed/seamy with very fine fractures; clay lined and polished; interpreted as very weak with low to moderately low GSI; fractures open to tight; minor zones of calcite to calcium carbonate precipitation; dry (Orinda Formation).

13-15 ft: light gray to grayish brown siltstone; hard and competent; large  $\leq 2$ " diameter clasts suggest very blocky to blocky behavior; minor clay-lined seams; dry as above (Orinda Formation).

15-16 ft: clayey siltstone that is brecciated with small angular blocks of siltstone in clayey matrix; resembles a blocky/disturbed/seamy structure suggesting lower GSI values; possible moist zone based on appearance of core material (Orinda Formation).

16-18 ft: light gray, silty very fine-grained sandstone with abundant 1" diameter thin (2-5 mm) rock chips (as a result of sampling method); approximately 50% silty sandstone to very fine-grained sandy siltstone; assumed to be blocky to very blocky structure with moderate GSI (Orinda Formation).

18-19 ft: dark gray siltstone; transitions to siltstone with less sand; finer bedrock chips than above with occasional "brecciation" but no polished surfaces; medium competent siltstone and assumed moderate to low GSI (Orinda Formation).

19-21.8 ft: (possible moist zone based on appearance of core material); gray brecciated siltstone within clayey matrix; few slickensides or polished surfaces; possible coarse-grained clayey sand at 20.5 ft (or fill from above dropping in?); weak rock with low to moderately low GSI (Orinda Formation).

21.8 to 25 ft: dark gray siltstone with abundant tight fractures; assumed moderate to moderately low GSI with very blocky to blocky structure; fine fractures that are tight and some clay-lined; crumbles with moderate pressure; dry (Orinda Formation).

*Water apparently encountered in borehole based on conversations with drillers during logging of SB-51-11-11. This is consistent with inferred moist zones. Free flowing water noted emanating from the uppermost soil nail (3rd from corner on east wall) in the adjacent retaining wall.*

### **Borehole SB51-11-10**

0-7.5 ft: reddish brown clayey gravel to silty clay with fine angular gravel; wood fragments and plastic to 7.5 ft (FILL).

7.5-9.5 ft: brownish gray moderately weathered siltstone with strong reddish brown to purplish staining along pedogenic fractures (Orinda Formation).

9.5-11 ft: gray to light gray, brecciated siltstone with random slickensides and polished fracture surfaces; infer a low to moderately low GSI with very blocky to blocky/disturbed/seamy structure (Orinda Formation).

11-12.5 ft: gray (7.5 YR 6/1 to 5/1) silty, very fine-grained sandstone; assumed moderate GSI based on retrieved core and breakage; assumed to be blocky to massive and hard (Orinda Formation).

12.5-16 ft: light gray (7.5 YR 6/1) zone of highly fractured pulverized to crushed siltstone with manganese oxide staining and possible calcium carbonate precipitation (calcite); very tight clay lined fractures (Orinda Formation).

16-17 ft: gray siltstone; few to no fractures or breccia; competent rock with an inferred moderate GSI with possible very blocky to blocky structure (Orinda Formation).

17-19 ft: light to dark gray siltstone; highly fractured and pulverized/crushed with clayey matrix; zone of calcium carbonate or calcite crystallization at 18.5 ft; brecciated with clay-lined fractures and polished surfaces; inferred low to moderately low GSI and blocky/disturbed/seamy structure (Orinda Formation).

19-20 ft: gray siltstone; very fine-grained with thin bedrock chips with no brecciation or polished surfaces; inferred moderate GSI and very blocky structure (Orinda Formation).

*Drillers reported occasional moist zones within this borehole, but at time of logging no features suggestive of moisture content.*

### **Borehole SB51-11-11**

0-12.6 ft: Brown to dark brown with gray and orange brown mottling; silty clay with 15-20% angular clasts, massive with multiple fill horizons of which some are clayey sand; gravel clasts predominantly of Orinda Formation; basal fill is very stiff; moist (FILL).

12.6 to 16 ft: gleyed, very fine-grained sandy siltstone; gray to light bluish gray (2.5Y 5/1); 30-40% very fine-grained sand; becomes finer-grained with depth changing to a siltstone to clayey siltstone (Orinda Formation).

16-17 ft: dark gray (2.5Y 4/1 to 3/1); transitions to a siltstone with slickensides, polished fracture surfaces that are conchoidal; inferred to have low to moderately low GSI and blocky/disturbed/seamy structure to disintegrated; dry (Orinda Formation).

17-18.5 ft: disintegrated siltstone with pervasive fine fractures and slickensides; very weak with an inferred low GSI; fractures range from tight to open and clay-lined; dry (Orinda Formation).

20.5 ft: gray 2.5Y 6/1; transitions to a silty sandstone with trace to 15% very fine-grained sand and less pervasive shearing; inferred low to moderately low GSI with very blocky to blocky/disturbed/seamy structure; increase in very fine grained sand with depth to 20-40% sand; siltstone has very thin laminations (Orinda Formation).

22-25 ft: light gray to gray, pulverized/crushed sandy siltstone with possible very fine-grained sandstone at 25 ft; breaks down into fine chips  $\leq 1$  in. wide (Orinda Formation).

26.4 ft: black recrystallized magnetite within siltstone (10-20% very fine-grained sand) and polished slickensides; inferred low to moderately low GSI (Orinda Formation).

27-30 ft: gray to dark gray (2.5Y 3/1) very pulverized/crushed, weak and crumbly siltstone; abundant fine open hairline fractures with polished surfaces pervasive; faint calcium carbonate mineralization; fine chips of 0.5 " diameter; very weak, loose and disintegrated with an inferred low GSI (Orinda Formation).

*No water in borehole 1 hr after completion.*

### **Review of Environmental Push Cores WT-1 to WT-12**

The environmental push cores were installed as a part of LBNL's Environmental Health and Safety Department's demolition of the Bevatron. Push Cores WT-1 to WT-12 were drilled in May 2011 and reviewed in June 2011 by LCI. The elevation of the push cores is unknown but is assumed to be close to 703 feet (floor elevation of the center of the Bevatron). The depth of the reviewed cores ranges from 5 to 10 feet placing the base of the cores at or near a maximum depth of 603 feet. As shown on the Site Plan, Figure 1, the push cores generally delineate a circular shape that encompasses the center of Bevatron. Push core samples were retained in clear plastic tubes of variable lengths, labeled, and placed on site in a construction bin for temporary storage. The ends of the cores were available for inspection of sediment and core material. The clear plastic tubing permitted limited observation of sampled material in between the tube ends. LCI and A3GEO were on-site to observe and briefly summarize the core samples following drilling and sample collection. The discontinuous lengths of the cores suggest that not all samples were available for review. The drilling operation was performed by Gregg Drilling and Testing, Inc. using a Direct Push Rhino Drill Rig under the direction of LBNL Environmental officials. The Site Plan, Figure 1, shows the approximate locations of the push cores.

The classification of the cores retrieved from the boreholes is summarized below. The depth intervals for the different units should be considered approximate.

WT-1	0'-3.5' :	FILL
	3.5'-4' :	SILTSTONE - Yellow brown sandy silt, friable to weak; suggestive of siltstone (Orinda Formation)
	5'-7' :	SILTSTONE - Olive brown to grayish brown, very fine-grained sandy siltstone; faintly mottled, dry to moist, moderately hard with clay-lined fractures (Orinda Formation)
	7'-9' :	SILTSTONE - As above but more friable and weathered with 10-15% clay (Orinda Formation)
	9-10' :	SILTSTONE - Blue-gray to light gray hard blocky siltstone that is crushed to friable, weak with low hardness (Orinda Formation)
WT-2	0'-3.5' :	CLAY (CL) (Fill)
	3.5-4.5' :	SILTSTONE – Olive brown, friable to weak sandy siltstone with iron oxide mottling and clay-lined fractures (weathered Orinda Formation)
	5.5'-6' :	SILTSTONE - Light gray to bluish gray, very fine-grained siltstone, loose, friable and weak dry to moist (Orinda Formation)
WT-3	0-3' :	CLAY (CL) – yellowish brown with sandstone clasts (Fill)
	3'-4' :	SILT (ML) – Gray, loose to friable and grades to a yellow brown sandy silt at about 4'; contains silty sandstone fragments suggestive of weak/weathered bedrock or alternatively clasts within artificial fill (Orinda Formation?)
	4'-4.5' :	SILTY SANDSTONE (?) – Yellow brown and mottled greenish brown, weak.
	5'-6' :	SILTSTONE – Yellowish brown sandstone at about 5' that grades to a fine-grained sandy siltstone at about 6'; dry to moist, bluish gray to light gray; weak and friable (Orinda Formation)
WT-4	0'-1' :	FILL – Sandy with blocks of weathered siltstone
	1'-4' :	SILTSTONE – sandy fill grades to weathered bedrock that is interbedded siltstone and sandstone with yellow brown gravel lenses (Orinda Formation)
	6'-7.5' :	SILTSTONE - As Above – very hard and competent bedrock (Orinda Formation)
WT-5	4.5'-5' :	Blocks of weathered siltstone (bedrock or fill?)
WT-6	3.5'-4' :	SILTSTONE – Bluish gray, weathered, loose and friable (Orinda Formation)
	6'-7' :	SILTSTONE – Similar to above with slight increase in clay content (Orinda Formation)
	7'-8' :	CLAYSTONE – Dark gray to grayish brown, silty, wet to saturated (Orinda Formation/shear zone?)
	8'-10' :	SILTSTONE – Dark gray, clayey, very wet to saturated; possible all fill mixed with Orinda Formation blocks (Orinda Formation/shear zone?)
WT-7	3.5'-4' :	SILTSTONE – Bluish gray, fine-grained and weathered (Orinda Formation)
	9-10' :	SILTSTONE – Bluish gray, fine-grained as above but more competent and hard (Orinda Formation)
WT-8	0'-2' :	CLAY – Brown clay (CL) - FILL
	3'-4' :	SILTSTONE – Gray to white, calcium-carbonate stained siltstone, loose and friable (Orinda Formation)
	5'-6' :	SILTSTONE – Dark grayish brown, fine-grained sand component, hard, dry (Orinda Formation)
	6'-7' :	SILTSTONE – Gray and sandy, with calcium carbonate cement (Orinda Formation)
WT-9	0'-4' :	CLAY(CL) – with mixed Orinda Formation clasts - FILL
	4'-6' :	CLAY (CL) – Dark brown stiff clay (FILL or Qc?)
	6'-8' :	CLAY (CL) – Dark brown clay with pebble-sized clasts of siltstone; grades to weathered siltstone at depth with clay (Qc)
	8'-8.5' :	SILTSTONE – Weathered bedrock; dark gray clayey (Orinda Formation)
	8.5'-9' :	SILTSTONE – Calcium carbonate cemented siltstone (Orinda Formation)
	9'-9.5' :	SILTSTONE – as above; hard and pulverized from sampling technique (Orinda Formation)
	9.5'-10.5' :	SILTSTONE–Dark grayish brown with reddish weathered zones (Orinda Form.)

WT-10	3'-4' :	CLAY (CL) – Dark brown clay, very stiff with 10% very fine gravel, massive (FILL)
	5'-7' :	CLY (CL) – Dark brown to mottled yellow brown clay, very stiff with trace fine gravel, massive (FILL/Qc?)
	7'-10' :	CLAY (CL) – Brown clay with occasional yellowish brown, very fine-grained sandy siltstone clasts (FILL/Qc)
WT-11	0'-4' :	CLAY (CL) – Brown clay with gravel, moist to wet (FILL)
	7'-7.5' :	CLAY (CL) – Dark brown to reddish brown clayey silt to silty clay with bluish gray siltstone clasts (FILL/Qc?)
	7.5'-8' :	WEATHERED SILTSTONE – Dark grayish brown with clay, soft to weak, (Orinda Formation/shear zone?)
	8'-10' :	SILTSTONE – Dark gray to black siltstone; polished and slicken-sided surfaces, friable, soft and weak, with clay-lined fractures; possible fault zone material (Orinda Formation/shear zone)
WT-12	0'-4.5' :	CLAY (CL) – Brown clay with gravel, moist to wet (FILL)
	6'-7.5' :	CLAY (CL) – Reddish brown silty clay with zones of gray mottling with occasional clasts of siltstone (Qc?)
	7.5'-8' :	WEATHERED SILTSTONE – Gray to grayish brown fine-grained sandy siltstone, friable and weak (Orinda Formation)

### Review of Environmental Borings SB51-11-12 to SB51-11-16

Monitoring wells were installed as a part of LBNL's Environmental Health and Safety Department's demolition of the Bevatron. Boreholes SB51-11-12 through SB51-11-16 were drilled and installed on May 25, 2011 and May 26, 2011. Locations of these borings (designated as 12 through 16) are shown on the Site Plan, Figure 1. The borings were drilled east of Parking Lot I at an approximate elevation of 725 feet. A3GEO, Inc. was intermittently on-site to observe and classify the core samples while drilling and placement of monitoring wells was done by LBNL environmental staff. The drilling operation was performed by Gregg Drilling and Testing, Inc. using a CME 75 hollow stem auger rig. Cored samples were placed in core boxes with borehole numbers and sample depths noted on the box. LCI reviewed the core samples stored in the boxes at the Bevatron excavation site.

The classification of the cores retrieved from the boreholes is summarized below:

SB51-11-12	0'-2' :	CLAYEY GRAVEL (GC) – Yellowish brown (Fill)
	2'-5' :	SILTY CLAY (CL) – Yellowish brown to reddish brown with olive brown and dark brown mottles (Fill)
	5'-11' :	FAT CLAY (CH) – Dark brown to reddish brown soft clay with mixed reddish brown clay blebs, moist (Fill/Qc?)
	@10' :	Reddish brown, hard siltstone clast within clay(?) matrix (Fill/Qc?)
	11'-15' :	FAT CLAY (CH) - Reddish brown and gray, mottled, with sand and rock fragments, grades to weathered siltstone at 13-15 ft (Qc?/weathered Orinda Formation)
	15'-25' :	SILTSTONE - Light gray to dark gray - Orinda Formation
SB51-11-13	0'-5' :	SANDY CLAY (CL) - Light brown to gray, stiff, moderately plastic (Fill)
	5'-10' :	FAT CLAY (CH) - Dark gray clay, firm, possible buried soil horizon (Fill/Qc?)
	10'-14' :	SANDY CLAY (CH) – Reddish brown, firm, some plasticity (Fill mixed with Qc?)
	14' to 16' :	Weathered SILTSTONE – Reddish brown with thin gray laminations 2-5 mm thick (Orinda Formation)
	16'-18' :	SILTSTONE – Gray with banding and laminations, hard and competent – (Orinda Formation)
	18'-20' :	SILTSTONE - Reddish brown and gray streaked – (Orinda Formation)
	20'-25' :	SILTSTONE - light greenish gray, soft, friable, very fine-grained with faint to rare laminations, dry (lighter in color and siltier than B15 at same depth) – Orinda Formation)

SB51-11-14	1'-4' :	FAT CLAY (CH) - Reddish brown and gray, plastic – (Fill)
	4'-8' :	CLAY (CL) – Black organic-rich clay, soft (Qc?)
	8'-9.5' :	WEATHERED CLAYSTONE/SHALE-Gray (Orinda Formation or Great Valley Formation)
	9.5'-14' :	CLAYSTONE/SHALE- Light gray, hard, crushed, very angular, 1/8-3/4" rock fragments (Brecciated Orinda Formation or Great Valley Complex)
	14'-15' :	CLAYSTONE/SHALE - Dark gray, laminated with a shale-like fabric, platy-structure and partings; resembles a brecciated claystone/shale-(Brecciated Orinda Formation or Great Valley Complex)
	16'-25' :	CLAYSTONE/SHALE - Gray with some reddish brown seams, shale-like and platy partings with iron oxide staining and calcium carbonate cementation along fractures- (Brecciated Orinda Formation or Great Valley Complex)
SB51-11-15	0'-4' :	FILL
	4'-15' :	Alternating layers of possible buried soils within colluvia or mixed soil and fill (Quaternary colluvium/Fill)
	15'-25' :	CLAYSTONE/SHALE - Dark gray, moderately hard to hard, laminated to very thinly bedded (more competent than B16 claystone/shale @ 16'), weak zones noted at 16.5-17'; at 18-20' with multiple shears and clay-lined fractures; many shears and brecciated rock to 25' with highly crushed and seamy zones bounded by clay fractures (Brecciated Orinda Formation or Great Valley Complex)
SB51-11-16	0'-7' :	GRAVELLY FAT CLAY (CH) - Light brown, reddish brown and dark gray, variable, with gravel and rock fragments, plastic - FILL
	7'-16' :	FAT CLAY - Dark gray and reddish brown, with rock fragments and sand, variable, multiple possible buried soils within colluvium or mixed fill (Fill/Quaternary Colluvium)
	16'-19' :	Weathered CLAYSTONE/SHALE - Dark gray, hard, deeply weathered, intensely fractured and seamy, with platy fabric, 1/8 - 3/4" fragments with olive brown seams (same as B14 @ 9.5' to 14') - fractures (Brecciated Orinda Formation or Great Valley Complex)
	19'-26' :	CLAYSTONE/SHALE - Dark gray, shaly to seamy fabric (soft and clay-rich) between 23' and 25'; possible fault zone fabric (Brecciated Orinda Formation or Great Valley Complex)

### Sewer Trench Observations

Observations made by Dona Mann (A3GEO) on July 5, 2011. The sewer trench location is shown on the attached Site Plan, Figure 1. The trench excavation was approximately 2.5' wide and 2.5' to 4' deep. The trench was cut through the concrete slab of the Bevatron; the top of the trench was at elevation +710'. The following observations were made along the length of the trench (between 0' and 115'). The stationing of the trench is also shown on the Site Plan, Figure 1.

**0' to 64':** Gravelly fill over fat black clay (CH), clay appears native, no bedrock observed.

**78' to 79':** In-place bedrock observed, reddish brown and greenish gray sandy siltstone, low hardness, friable, no smooth fractures or laminations, crumbles with fingers, looks characteristic of Orinda Formation. Sample collected at 78'.

**89' to 99':** In-place bedrock; olive brown mudstone; oxidized fractures; closely fractured; fractures are planar, relatively smooth, and angular; weak to moderately strong, low hardness (can scratch with finger nail). Sample collected at 99'.

**@ 107':** Dark gray mudstone (?) with reddish brown fractures, large (up to 1') in-place blocks, hard, moderately strong to strong.

## Review of Bevatron (Building 51) Excavations

LCI provided limited observation and review of the Bevatron excavations between June and September 2011. The field reconnaissance was limited to periodic inspection of rock and fill cuts within the Bevatron footprint. The inspection intervals usually were between 15 and 45 minutes and held during the construction crew's lunch break. Observations were limited to views from above when the excavation was considered unsafe for entry, as well as direct observation, photography, and hand sample collection within the excavation upon approval by the LBNL safety officials.

The locations of observations were approximated using existing cultural features for sighting (e.g., former building columns and walls), and a hand-held GPS device. Bedding and fault orientations are considered approximate due to: (1) large quantities of iron from the Bevatron foundation and debris piles that occasionally impacted the operation of the magnetic compass; and (2) orientations were developed by "line of sight" with cultural features identified on drawings provided by LBNL officials with existing Building 51 framing and foundation components that remain unexcavated.

The field descriptions listed below and are meant to provide an approximate characterization of the bedrock and soil conditions observed. The observation points are identified on the Site Plan, Figure 1. Most of the observations listed below were made during the demolition of the underpinning tunnel inside the Bevatron. The bottom of the tunnel was at an approximate elevation of 690 feet; the top of the tunnel was at an approximate elevation of 697 feet.

The following descriptions refer to GPS waypoints defining the field observations and their approximate location.

WP-94	SILTSTONE	Observation made along outside excavation wall at about 690 ft. Sheared with a blocky/disturbed/seamy groundmass along a several foot wide shear zone separating very blocky siltstone on the south from brecciated siltstone on the north; trends subparallel to fault zone exposed near WP-095 (Orinda Formation)
WP-95	SANDSTONE	Observation made along outside excavation wall at about 690 ft. Silty sandstone, blocky to very blocky; projects across excavation to the inner excavation wall and a bedding parallel fault with blocky/disturbed/seamy siltstone on north and blocky sandy siltstone to sandstone on south (Orinda Formation). Relatively good bedding exposed along the outer wall: overall is northwest striking and dipping northeast 35 degrees.
WP-96	SILTSTONE	Observation collected on inside excavation wall at about 690 ft. Zone of sheared dark gray siltstone along (north side) juxtaposed against light gray sandstone (south side); shearing projects to northwest across excavation and defines a broad zone of weak and brecciated rock comprising WP097 and WP098 (Orinda Formation)
WP-97	SILTSTONE	Observation collected on outside wall of excavation at about 690 ft. Broad fault zone consisting of several 2- to 5-ft-wide zones of blocky/disturbed/seamy, dark gray to black siltstone bounded by more competent blocks of very blocky, moderately hard, gray silty sandstone. The entire zone of disturbance continues around the exposure toward WP094 with occasional very soft and friable zones of siltstone/claystone with seeps (Orinda Formation).
WP-98	SILTSTONE	Observation collected on inside wall of excavation at about 690 ft. Fault zone of blocky/disturbed/seamy, black to dark gray siltstone; abundant polished fractures and slickensides that are soft and friable; 5 to 10 ft west of WP096 (Orinda Formation)
WP-99	SILTSTONE	Observation collected on inside excavation wall at about 690 ft. Prominent shear zone directly to the west of WP097; likely represents a continuation of the zone of seamy and brecciated siltstone with blocks of competent sandy siltstone/silty sandstone trending northwest across the Bevatron foundation; multiple random shear orientations in brecciated siltstone (Orinda Formation).
WP-100	FAULT ZONE	As above and similar to WP099; waypoint was to provide an overall width and orientation of the shear zone (Orinda Formation)

WP-101	SANDSTONE	Observation made about 10 feet above WP100 or approximately 700 ft at base of outermost excavation (not within the magnet foundation excavation). Light brown to brown silty sandstone to fine-grained sandstone; weathered to yellow brown with oxidation stains; blocky to very blocky, low to moderate hardness, moderately spaced jointing, moderately strong; lies along projection of competent sandstone observed in fault zone near WP097; directly overlain by artificial fill (Orinda Formation-weathered).
WP-102	SILTSTONE	Observation made about 10 feet above WP100 or (about 700 ft) at base of outermost excavation wall and to west of WP-101. Light brown to yellow brown, weathered, very fine-grained sandy siltstone with oxidation staining along fractures; blocky to very blocky, low to moderate hardness, moderately spaced jointing, weak to moderately strong; a small fault juxtaposes siltstone on west against sandstone on east; orientation is northerly with an 82 degree easterly dip (Orinda Formation).
WP-103	SANDSTONE	Observation made at about 690 feet along outside excavation wall south of waypoint WP095; gray silty, fine-grained sandstone; on north side of observation is competent blocky to very blocky sandstone juxtaposed against a blocky/disturbed/seamy dark gray siltstone; the brecciated siltstone continues along the exposure toward WP104; the siltstone is overlain by artificial fill; bedding parallel fault strikes northwest and dips northeast 46 degrees (Orinda Formation).
WP-104	LIMESTONE	Observation made at about 690 feet along outside diameter of footing excavation southwest of waypoint WP103; light gray to white hard and competent blocks of limestone floating in a black blocky/disturbed/seamy groundmass of brecciated siltstone; polished slickensides give a weak and friable texture; steep south dipping limestone(?) on east and subhorizontal dipping limestone(?) on west define a 5-ft-wide shear zone trending southerly with a possible steep dip (Orinda Formation).
WP-138	FILL/COLLUVIUM	Observation made at about 690 feet along outside diameter of footing excavation and west of waypoint WP104; relatively thick sequence (10 ft exposed) of gravelly clay (artificial fill) overlying a brown to reddish brown, clay-rich colluvium; no bedrock exposed; fill and colluvium suggest buried paleochannel/swale (Fill over Quaternary colluvium).
WP-139	SANDSTONE	Observation made at about 690 feet along inside diameter of footing excavation; exposes gray silty fine-grained sandstone overlain by a brown to grayish brown blocky/disturbed/seamy siltstone to claystone; abundant slickensides and breccia within siltstone/claystone; fine-grained sandstone is competent, weak to moderately hard, very blocky; shear zone strikes southerly and dips NE 25 degrees (Orinda Formation).
WP-140	FILL/COLLUVIUM	Observation made at about 690 feet along outside diameter of footing excavation; gravelly clay (fill) overlying dark brown to reddish brown clay with rounded pebbles (colluvium derived from Orinda Formation); relatively thick sequence (about 5-8 ft exposed) of fill and colluvium filling an inferred paleochannel/swale; no bedrock exposed; deposit continues across excavation to waypoints WP141 and 142 (FILL over Quaternary colluvium).
WP-141	SHEAR ZONE	Observation made at about 690 ft along inside diameter of footing excavation; exposes dark brown to reddish brown clay with rounded pebbles (Quaternary colluvium) overlying black to dark gray siltstone/claystone; blocky/disturbed/seamy with pervasive slickensides and polished surfaces in both units; contact between colluvium and siltstone/claystone is sheared with clay gouge and moist; overlying fill and colluvium contact dips southwest defining margin of paleoswale(?) (Landslide debris overlying Orinda Formation).

WP-142	FILL/COLLUVIUM	Observation made at about 690 ft along outside diameter of footing excavation; gravelly clay FILL overlying dark brown to reddish brown colluvium with rounded pebbles; moist and soft, clay-rich colluvium that likely comprises landslide material observed at WP-141 (Fill over Quaternary colluvium).
WP-143	SHEAR ZONE	Observation made at about 690 ft along inside diameter of footing excavation; exposes dark brown to reddish brown clay (Quaternary colluvium) with pervasive shearing and slickensided surfaces with striae trending N63W and plunging 31SE; landslide debris/colluvium within paleosole (Landslide Deposits/Quaternary colluvium).
WP-144	SHEAR ZONE	Observation made at about 690 feet along inside diameter of footing excavation and northwest of WP-143; exposes dark brown to reddish brown clay (southwest) against black to dark gray slickensided siltstone ( northeast); orientation of shear zone is N85W, 45SW to N81W,65SW; entire zone of soft clay overlying brecciated siltstone projects toward WP139 possibly defining the northern limits of the landslide within the excavation (Landslide Deposits/Orinda Formation).

9/29/2011 lbnl site plan - observed bore holes.dwg

- LEGEND:
-  9 APPROXIMATE LOCATION OF ENVIRONMENTAL BORINGS BY LBNL (FULL DESIGNATION: SB 51-11-9)
  -  WT-9 APPROXIMATE LOCATION OF ENVIRONMENTAL PUSH CORES BY LBNL (FULL DESIGNATION: SB 51 WT-11-9)
  -  APPROXIMATE SEWER TRENCH LOCATION
  -  WP-104 APPROXIMATE LOCATION OF OBSERVATION POINT

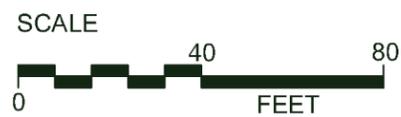
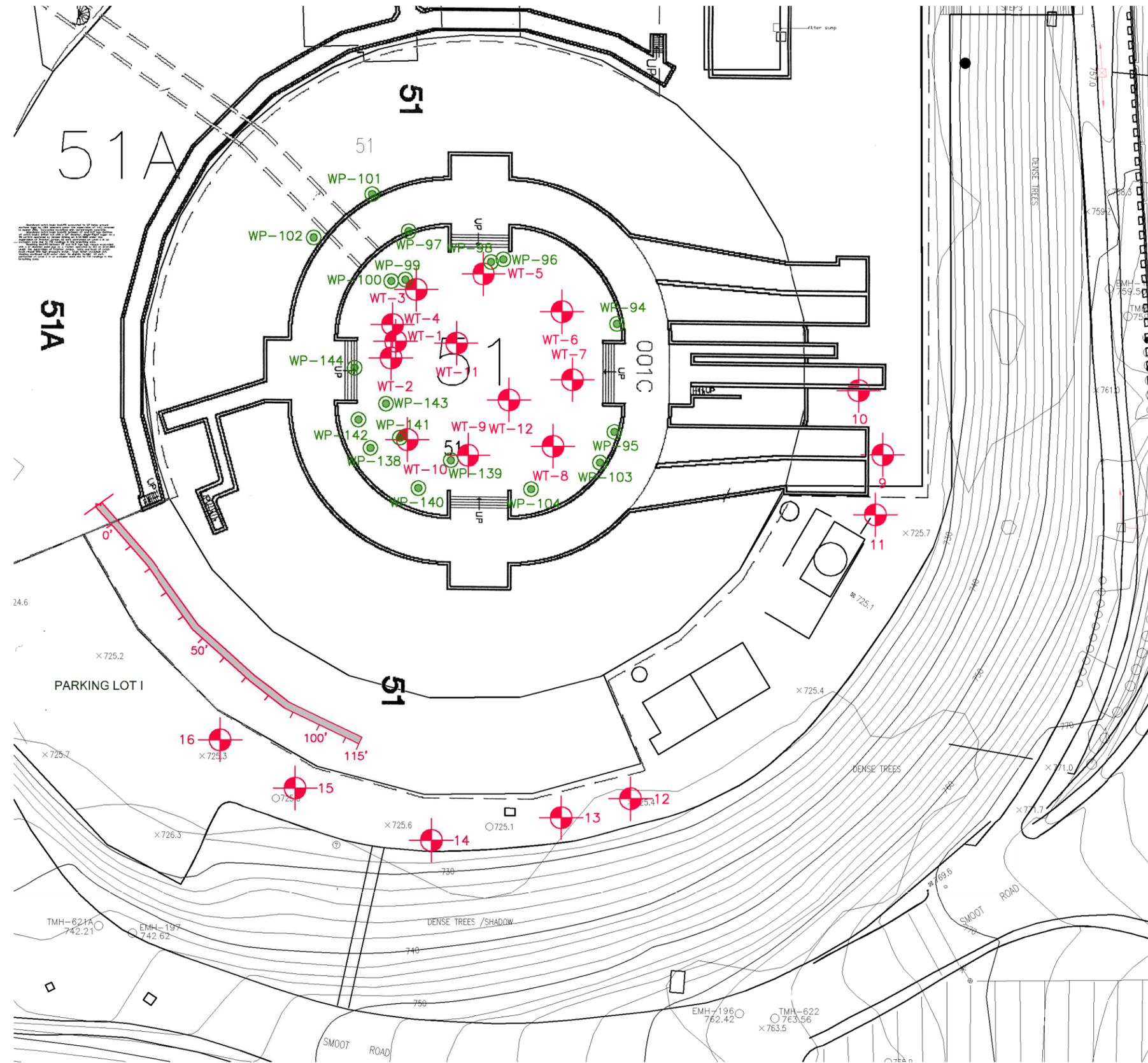


FIGURE 1  
 SITE PLAN

***Alan Kropp & Associates, Inc. and A3GEO, Inc. (AKA/A3GEO), 2011***, “Data Report, Preliminary Geotechnical and Geologic Studies, Lawrence Berkeley National Laboratory Future Scientific Facility, Berkeley Lab – Berkeley, California,” consulting report dated October 28, 2011.

### **Logs of Borings B-1 and B-2**



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Berkeley, CA 94710

**BORING NUMBER B-1**

PAGE 1 OF 5

**CLIENT** Lawrence Berkeley National Laboratory      **PROJECT NAME** LBL FSF Comparative Study  
**PROJECT NUMBER** 1100-2F      **PROJECT LOCATION** Berkeley, CA  
**DATE STARTED** 07/05/11      **COMPLETED** 07/05/11      **GROUND ELEVATION** 725.7 ft      **HOLE SIZE** 5"  
**DRILLING CONTRACTOR** Pitcher Drilling Co.      **GROUND WATER LEVELS:**  
**DRILLING METHOD** Mud Rotary      **AT TIME OF DRILLING** ---  
**LOGGED BY** DVT      **CHECKED BY** JB      **AT END OF DRILLING** ---  
**NOTES** \_\_\_\_\_      **AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US.GDT - 09/14/11 11:14 - A:\A3GEO PROJECTS\1100 - LBNL\1100-2F FSF COMPARATIVE STUDY\DATA REPORTS\LBNL - BEVATRON AREA\DATA\BORINGS\LBL BORINGS.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
0									
0 - 5		SILTY SAND, (SM) - Brown, wet, medium dense, fine to medium grained sand - FILL							
5 - 13		LEAN CLAY, (CL) - Brown to bluish gray, moist, firm, organics present (roots), weather bedrock clasts present (Orinda Formation) - FILL							
13 - 20		SILTSTONE, [Orinda Formation] - Greenish gray, moderately hard, moderately strong, moderate weathering - BEDROCK							

(Continued Next Page)



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# BORING NUMBER B-1

PAGE 2 OF 5

**CLIENT** Lawrence Berkeley National Laboratory  
**PROJECT NUMBER** 1100-2F  
**DATE STARTED** 07/05/11 **COMPLETED** 07/05/11  
**DRILLING CONTRACTOR** Pitcher Drilling Co.  
**DRILLING METHOD** Mud Rotary  
**LOGGED BY** DVT **CHECKED BY** JB  
**NOTES** \_\_\_\_\_

**PROJECT NAME** LBL FSF Comparative Study  
**PROJECT LOCATION** Berkeley, CA  
**GROUND ELEVATION** 725.7 ft **HOLE SIZE** 5"  
**GROUND WATER LEVELS:**  
**AT TIME OF DRILLING** ---  
**AT END OF DRILLING** ---  
**AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US.GDT - 09/14/11 11:14 - A:\A3GEO PROJECTS\1100 - LBNL\1100-2F FSF COMPARATIVE STUDY\DATA REPORTS\1B1 - BEVATRON AREA\DATA\BORINGS\1B1 BORINGS.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
20		SILTSTONE, [Orinda Formation] - Greenish gray, moderately hard, moderately strong, little weathering, occasional fracturing, fine grained sand - BEDROCK	ST					100	1000 psi for 25 min.
25		CLAYSTONE/SILTSTONE, [Orinda Formation] - Greenish gray, low hardness, weak, moderately weathered, moderately fractured, polished surfaces and slickensides - BEDROCK	ST					100	600 psi for 20 min.
30		CLAYSTONE/SILTSTONE, [Orinda Formation] - Bluish gray, low hardness, weak, little weathering, occasional fractures, little medium to coarse grained sand - BEDROCK	ST					100	1000 psi for 20 min
35									
40									

(Continued Next Page)



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**BORING NUMBER B-1**

PAGE 3 OF 5

<b>CLIENT</b> <u>Lawrence Berkeley National Laboratory</u>	<b>PROJECT NAME</b> <u>LBL FSF Comparative Study</u>
<b>PROJECT NUMBER</b> <u>1100-2F</u>	<b>PROJECT LOCATION</b> <u>Berkeley, CA</u>
<b>DATE STARTED</b> <u>07/05/11</u> <b>COMPLETED</b> <u>07/05/11</u>	<b>GROUND ELEVATION</b> <u>725.7 ft</u> <b>HOLE SIZE</b> <u>5"</u>
<b>DRILLING CONTRACTOR</b> <u>Pitcher Drilling Co.</u>	<b>GROUND WATER LEVELS:</b>
<b>DRILLING METHOD</b> <u>Mud Rotary</u>	<b>AT TIME OF DRILLING</b> <u>---</u>
<b>LOGGED BY</b> <u>DVT</u> <b>CHECKED BY</b> <u>JB</u>	<b>AT END OF DRILLING</b> <u>---</u>
<b>NOTES</b> _____	<b>AFTER DRILLING</b> <u>---</u>

GEOTECH BH COLUMNS - GINT STD US.GDT - 09/14/11 11:14 - A:\A3GEO PROJECTS\1100 - LBNL\1100-2F FSF COMPARATIVE STUDY\DATA REPORTS\1BNL - BEVATRON AREA\DATA\BORINGS\1B - BORINGS.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
40		CLAYSTONE/SILTSTONE, [Orinda Formation] - Reddish brown, low hardness, weak, little weathering, occasional fractures, 1/4 in. dia. gravels - BEDROCK	ST					100	1200 psi for 25 min.
45		- Color change to greenish gray							
50		CLAYSTONE/SILTSTONE, [Orinda Formation] - Reddish brown, moderately hard, moderately strong, little weathering, occasional fractures, massive - BEDROCK	ST					100	1200 psi for 20 min.
55									
60									

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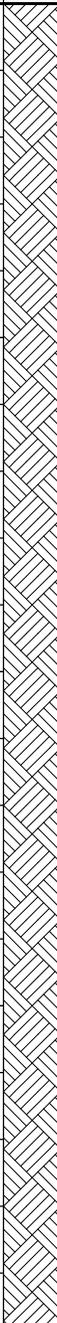


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**BORING NUMBER B-1**

**CLIENT** Lawrence Berkeley National Laboratory      **PROJECT NAME** LBL FSF Comparative Study  
**PROJECT NUMBER** 1100-2F      **PROJECT LOCATION** Berkeley, CA  
**DATE STARTED** 07/05/11      **COMPLETED** 07/05/11      **GROUND ELEVATION** 725.7 ft      **HOLE SIZE** 5"  
**DRILLING CONTRACTOR** Pitcher Drilling Co.      **GROUND WATER LEVELS:**  
**DRILLING METHOD** Mud Rotary      **AT TIME OF DRILLING** ---  
**LOGGED BY** DVT      **CHECKED BY** JB      **AT END OF DRILLING** ---  
**NOTES** \_\_\_\_\_      **AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US.GDT - 09/14/11 11:14 - A:\A3GEO PROJECTS\1100 - LBNL\1100-2F FSF COMPARATIVE STUDY\DATA REPORTS\LBNL - BEVATRON AREA\DATA\BORINGS\LBL BORINGS.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
60		SILTSTONE, [Orinda Formation] - Olive gray to dark reddish brown, moderately hard, moderately strong, little weathering, occasional fracturing - BEDROCK	ST					100	1000 psi for 20 min.
65									
70									
75									
80									

(Continued Next Page)



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# BORING NUMBER B-1

PAGE 5 OF 5

**CLIENT** Lawrence Berkeley National Laboratory      **PROJECT NAME** LBL FSF Comparative Study  
**PROJECT NUMBER** 1100-2F      **PROJECT LOCATION** Berkeley, CA  
**DATE STARTED** 07/05/11      **COMPLETED** 07/05/11      **GROUND ELEVATION** 725.7 ft      **HOLE SIZE** 5"  
**DRILLING CONTRACTOR** Pitcher Drilling Co.      **GROUND WATER LEVELS:**  
**DRILLING METHOD** Mud Rotary      **AT TIME OF DRILLING** ---  
**LOGGED BY** DVT      **CHECKED BY** JB      **AT END OF DRILLING** ---  
**NOTES** \_\_\_\_\_      **AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US.GDT - 09/14/11 11:14 - A:\A3GEO PROJECTS\1100 - LBNL\1100-2F FSF COMPARATIVE STUDY\DATA REPORTS\BNL - BEVATRON AREA\DATA\BORINGS\LBL BORINGS.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
80		SILTSTONE, [Orinda Formation] -Olive brown to dark reddish brown, hard, moderately strong, little weathering, occasional fracturing, fine grained sand - BEDROCK	ST					100	1200 psi for 20 min.

Bottom of borehole at 82.0 feet.









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**BORING NUMBER B-2**

PAGE 4 OF 6

**CLIENT** Lawrence Berkeley National Laboratory  
**PROJECT NUMBER** 1100-2F  
**DATE STARTED** 06/24/11 **COMPLETED** 06/27/11  
**DRILLING CONTRACTOR** Pitcher Drilling Co.  
**DRILLING METHOD** Mud Rotary  
**LOGGED BY** DVT/DKM **CHECKED BY** JB  
**NOTES** \_\_\_\_\_

**PROJECT NAME** LBL FSF Comparative Study  
**PROJECT LOCATION** Berkeley, CA  
**GROUND ELEVATION** 756.9 ft **HOLE SIZE** 5"  
**GROUND WATER LEVELS:**  
**AT TIME OF DRILLING** ---  
**AT END OF DRILLING** ---  
**AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US.GDT - 09/14/11 11:14 - A:\A3GEO PROJECTS\1100 - LBNL\1100-2F FSF COMPARATIVE STUDY\DATA REPORTS\BNC - BEVATRON AREA\DATA\BORINGS\LBL BORINGS.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
60		- Shear, 2.5 in. thick, moderately soft clay seam, 20 to 30 deg dip CLAYSTONE, [Orinda Formation] - Bluish gray, soft to low hardness, friable to weak, little weathering, occasionally fractured, massive - BEDROCK(continued) - Closed joint dipping at 35 degrees	RC					92 (77)	
65		- Possible bedding dipping at less than 40 degrees - Joint dipping 30 degrees  - Hard pebbles 1/4 in. to 1/2 in. diameter (approximately 30%)	RC					67 (0)	
70		- Brighter bluish green, higher silt content, angular clasts - Intensely fractured to crushed transition zone CLAYEY SILTSTONE, [Orinda Formation] - Reddish brown, soft, friable to weak moderate weathering, very intensely to intensely fractured, disintegrated and poor surfaces - BEDROCK  - Mottled bluish green and reddish brown, mostly reddish brown	RC					67 (17)	(GSI 15-25)
75		CLAYSTONE, [Orinda Formation] - Reddish brown, low hardness, weak, little weathering, occasionally fractured, little subrounded 1/2 in. to 1 in. diameter pebbles - BEDROCK - Possible bedding dipping at less than 10 degrees	RC					44 (29)	
80		CLAYSTONE, [Orinda Formation] - Reddish brown, low hardness, weak - BEDROCK	ST						

(Continued Next Page)



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**CLIENT** Lawrence Berkeley National Laboratory      **PROJECT NAME** LBL FSF Comparative Study  
**PROJECT NUMBER** 1100-2F      **PROJECT LOCATION** Berkeley, CA  
**DATE STARTED** 06/24/11      **COMPLETED** 06/27/11      **GROUND ELEVATION** 756.9 ft      **HOLE SIZE** 5"  
**DRILLING CONTRACTOR** Pitcher Drilling Co.      **GROUND WATER LEVELS:**  
**DRILLING METHOD** Mud Rotary      **AT TIME OF DRILLING** ---  
**LOGGED BY** DVT/DKM      **CHECKED BY** JB      **AT END OF DRILLING** ---  
**NOTES** \_\_\_\_\_      **AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US.GDT - 09/14/11 11:14 - A:\A3GEO PROJECTS\1100 - LBNL\1100-2F FSF COMPARATIVE STUDY\DATA REPORTS\BNL - BEVATRON AREA\DATA\BORINGS\LBL BORINGS.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
80		CLAYSTONE, [Orinda Formation] - Reddish brown, low hardness, weak - BEDROCK(continued)							
85		CLAYSTONE, [Orinda Formation] - Interbedded greenish gray to reddish brown, low hardness, weak - BEDROCK							
90		- Some polished surfaces present in cuttings							
95									
100									

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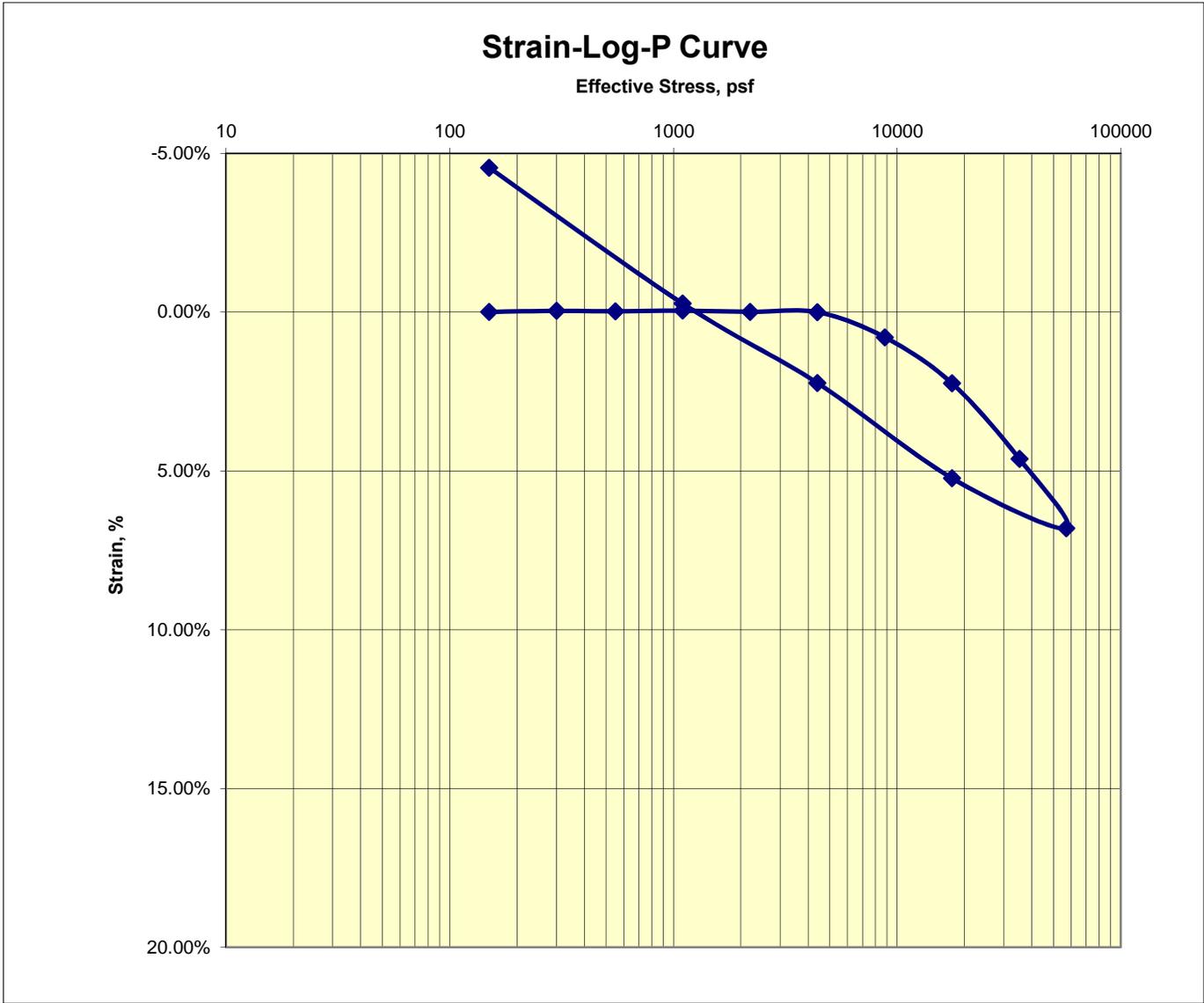




# Consolidation Test

## ASTM D2435

<b>Job No.:</b> 748-004	<b>Boring:</b> B1	<b>Run By:</b> MD
<b>Client:</b> A3GEO	<b>Sample:</b>	<b>Reduced:</b> PJ
<b>Project:</b> Lawrence Berkeley Labs	<b>Depth, ft.:</b> 30-32.5(Tip-3")	<b>Checked:</b> PJ/DC
<b>Soil Type:</b> Gray Lean CLAY w/ Sand (Weathered Claystone)		<b>Date:</b> 7/29/2011



<b>Ass. Gs =</b> 2.8	<b>Initial</b>	<b>Final</b>
<b>Moisture %:</b>	12.8	17.3
<b>Dry Density, pcf:</b>	124.7	117.8
<b>Void Ratio:</b>	0.402	0.483
<b>% Saturation:</b>	89.2	100

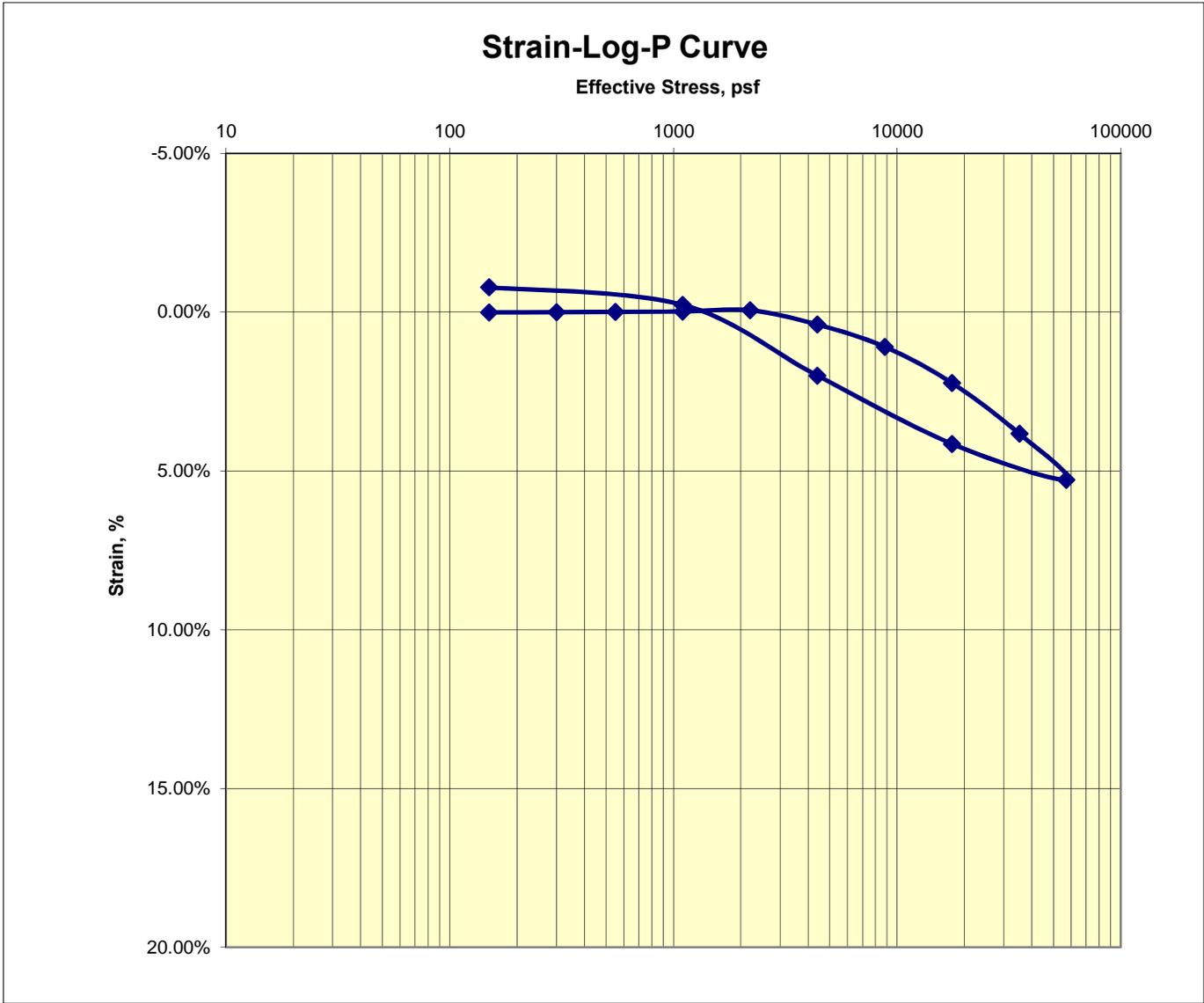
**Remarks:** Because the consolidation equipment is not designed to easily allow samples to swell, the final rebound point may indicate less swell than the sample was capable of.



# Consolidation Test

## ASTM D2435

<b>Job No.:</b> 748-004	<b>Boring:</b> B1	<b>Run By:</b> MD
<b>Client:</b> A3Geo	<b>Sample:</b>	<b>Reduced:</b> PJ
<b>Project:</b> Lawrence Berkeley Labs	<b>Depth, ft.:</b> 40-42.5(Tip-3")	<b>Checked:</b> PJ/DC
<b>Soil Type:</b> Grayish Red Sandy Lean CLAY, trace Gravel (Weathered Claystone)		<b>Date:</b> 7/21/2011



<b>Ass. Gs =</b> 2.8	<b>Initial</b>	<b>Final</b>
<b>Moisture %:</b>	12.6	15.1
<b>Dry Density, pcf:</b>	127.8	123.0
<b>Void Ratio:</b>	0.368	0.421
<b>% Saturation:</b>	96.1	100

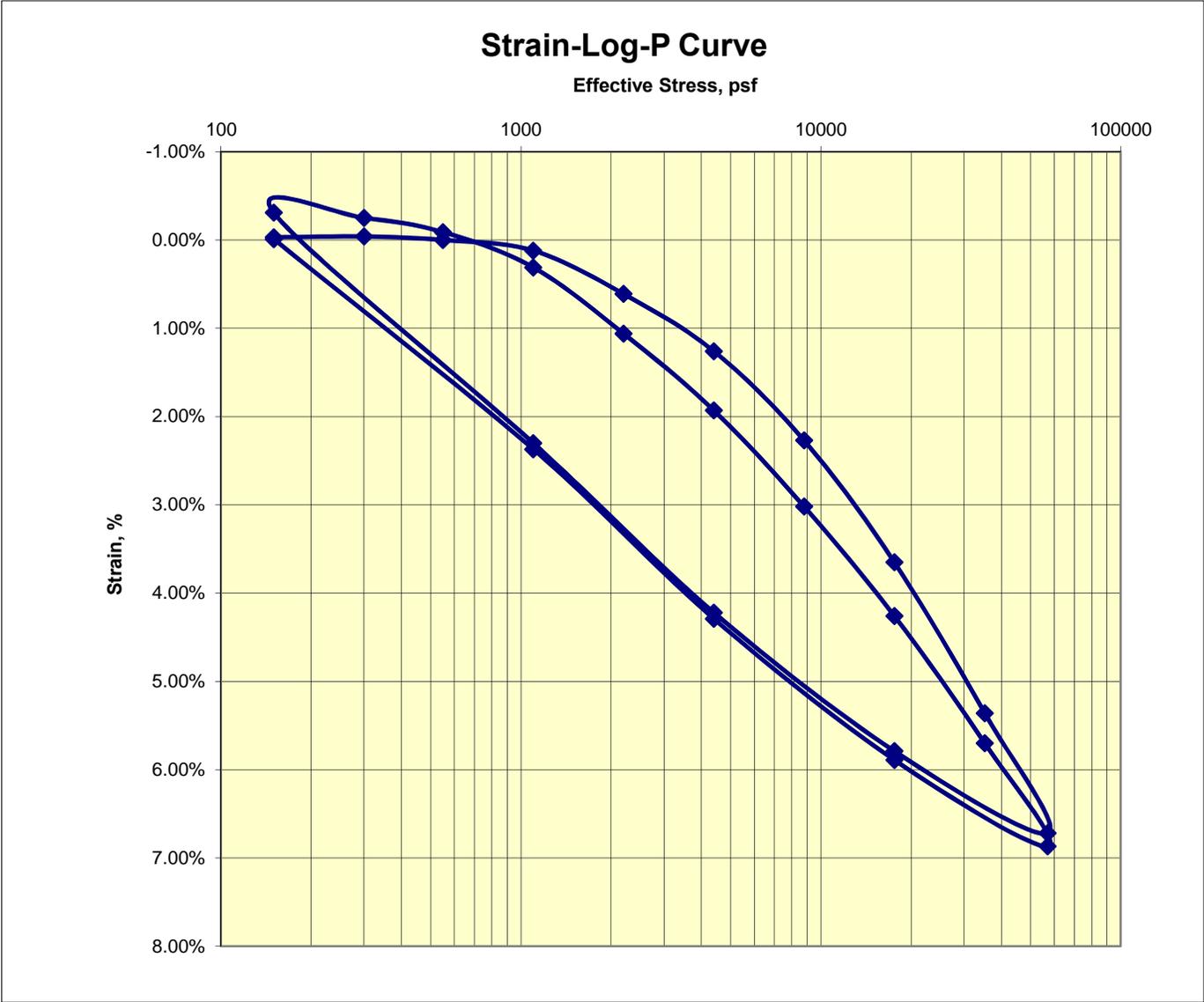
**Remarks:** Because the consolidation equipment is not designed to easily allow samples to swell, the final rebound point may indicate less swell than the sample was capable of.



# Consolidation Test

## ASTM D2435

<b>Job No.:</b> 748-004	<b>Boring:</b> B1	<b>Run By:</b> MD
<b>Client:</b> A3Geo	<b>Sample:</b>	<b>Reduced:</b> PJ
<b>Project:</b> Lawrence Berkeley Labs	<b>Depth, ft.:</b> 50-52(Tip-3")	<b>Checked:</b> PJ/DC
<b>Soil Type:</b> Grayish Red Sandy Lean CLAY, trace Gravel (Weathered Claystone)		<b>Date:</b> 8/5/2011



<b>Ass. Gs =</b> 2.8	<b>Initial</b>	<b>Final</b>
<b>Moisture %:</b>	10.7	13.8
<b>Dry Density, pcf:</b>	126.9	126.2
<b>Void Ratio:</b>	0.378	0.385
<b>% Saturation:</b>	79.0	100

**Remarks:** The initial loading increments above 8800 psf were loaded for 48 hours each.



## Hydraulic Conductivity ASTM D 5084

Method C: Falling Head Rising Tailwater

**Job No:** 748-004      **Boring:** B1      **Date:** 07/28/11  
**Client:** A3Geo      **Sample:**      **By:** MD/PJ  
**Project:** Lawrence Berkeley      **Depth, ft.:** 50-52(Tip-4.25")      **Remolded:**      **Visual Classification:** Grayish Red Sandy Lean CLAY , trace Gravel (Weathered Claystone)

Max Sample Pressures, psi:				B: = >0.95      ("B" is an indication of saturation)
Cell:	Bottom	Top	Avg. Sigma3	Max Hydraulic Gradient: = 26
43.5	39.5	37.5	5	
Date	Minutes	Head, (in)	K, cm/sec	
7/25/2011	0.00	79.38	Start of Test	
7/25/2011	546.00	79.18	4.6E-09	
7/26/2011	1434.00	78.73	5.8E-09	
7/26/2011	1840.00	78.63	5.1E-09	
7/26/2011	2049.00	78.50	5.4E-09	

**Average Hydraulic Conductivity: 5.E-09 cm/sec**

Sample Data:	Initial (As-Received)	Final (At-Test)
Height, in	2.99	3.03
Diameter, in	2.88	2.91
Area, in <sup>2</sup>	6.51	6.65
Volume in <sup>3</sup>	19.46	20.15
Total Volume, cc	319.0	330.2
Volume Solids, cc	253.8	253.8
Volume Voids, cc	65.1	76.4
Void Ratio	0.3	0.3
Total Porosity, %	20.4	23.1
Air-Filled Porosity (θ <sub>a</sub> ), %	0.8	0.2
Water-Filled Porosity (θ <sub>w</sub> ), %	19.6	23.0
Saturation, %	95.9	99.2
Specific Gravity	2.70      Assumed	2.70
Wet Weight, gm	747.8	761.2
Dry Weight, gm	685.4	685.4
Tare, gm	0.00	0.00
Moisture, %	9.1	11.1
Wet Bulk Density, pcf	146.3	143.8
Dry Bulk Density, pcf	134.1	129.5
Wet Bulk Dens.pb, (g/cm <sup>3</sup> )	2.34	2.30
Dry Bulk Dens.pb, (g/cm <sup>3</sup> )	2.15	2.07

Remarks:



## Hydraulic Conductivity

**ASTM D 5084**

Method C: Falling Head Rising Tailwater

**Job No:** 748-004      **Boring:** B1      **Date:** 07/27/11  
**Client:** A3Geo      **Sample:**      **By:** MD/PJ  
**Project:** Lawrence Berkeley      **Depth, ft.:** 40-42.5(Tip-4.5")      **Remolded:**        
**Visual Classification:** Grayish Red Sandy Lean CLAY, trace Gravel (Weathered Claystone)

Max Sample Pressures, psi:				B: = >0.95      ("B" is an indication of saturation)
Cell:	Bottom	Top	Avg. Sigma3	Max Hydraulic Gradient: = 32
43.5	39	38	5	
Date	Minutes	Head, (in)	K,cm/sec	
7/21/2011	0.00	97.33	Start of Test	
7/21/2011	658.00	96.93	7.9E-09	
7/22/2011	1606.00	96.53	6.6E-09	
7/22/2011	1935.00	96.33	6.9E-09	
7/23/2011	3010.00	95.83	6.7E-09	
7/24/2011	4577.00	95.03	6.7E-09	

**Average Hydraulic Conductivity: 7.E-09 cm/sec**

Sample Data:	Initial (As-Received)	Final (At-Test)
Height, in	3.00	3.04
Diameter, in	2.89	2.92
Area, in <sup>2</sup>	6.54	6.68
Volume in <sup>3</sup>	19.61	20.30
Total Volume, cc	321.4	332.7
Volume Solids, cc	235.4	235.4
Volume Voids, cc	85.9	97.3
Void Ratio	0.4	0.4
Total Porosity, %	26.7	29.2
Air-Filled Porosity (θ <sub>a</sub> ),%	1.7	0.6
Water-Filled Porosity (θ <sub>w</sub> ),%	25.0	28.6
Saturation, %	93.6	97.9
Specific Gravity	2.80	2.80
	Assumed	
Wet Weight, gm	739.7	754.5
Dry Weight, gm	659.2	659.2
Tare, gm	0.00	0.00
Moisture, %	12.2	14.4
Wet Bulk Density, pcf	143.6	141.5
Dry Bulk Density, pcf	128.0	123.6
Wet Bulk Dens.pb, (g/cm <sup>3</sup> )	2.30	2.27
Dry Bulk Dens.pb, (g/cm <sup>3</sup> )	2.05	1.98

Remarks:



## Hydraulic Conductivity ASTM D 5084

Method C: Falling Head Rising Tailwater

**Job No:** 748-004      **Boring:** B1      **Date:** 07/27/11  
**Client:** A3Geo      **Sample:**      **By:** MD/PJ  
**Project:** Lawrence Berkeley      **Depth, ft.:** 30-32.5(Tip-4")      **Remolded:**      **Visual Classification:** Gray Lean CLAY w/ Sand (Weathered Claystone)

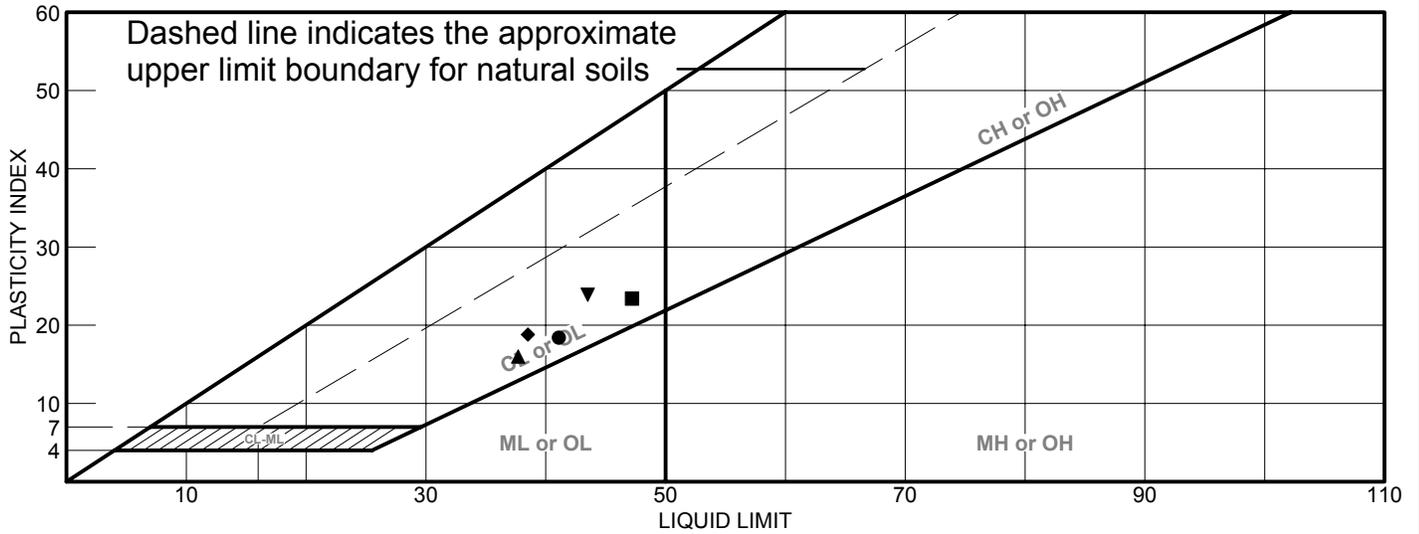
Max Sample Pressures, psi:				B: = >0.95      ("B" is an indication of saturation)
Cell:	Bottom	Top	Avg. Sigma3	Max Hydraulic Gradient: = 23
43.5	39.5	37.5	5	
Date	Minutes	Head, (in)	K, cm/sec	
7/21/2011	0.00	42.69	Start of Test	
7/22/2011	1847.00	41.19	1.9E-08	
7/24/2011	1589.00	41.49	1.8E-08	
7/25/2011	2735.00	40.69	1.8E-08	
7/25/2011	568.00	69.48	2.2E-08	
7/26/2011	1455.00	68.43	1.9E-08	

**Average Hydraulic Conductivity: 2.E-08 cm/sec**

Sample Data:	Initial (As-Received)	Final (At-Test)
Height, in	2.98	3.01
Diameter, in	2.88	2.91
Area, in <sup>2</sup>	6.51	6.65
Volume in <sup>3</sup>	19.39	19.99
Total Volume, cc	317.7	327.5
Volume Solids, cc	230.1	230.1
Volume Voids, cc	87.6	97.5
Void Ratio	0.4	0.4
Total Porosity, %	27.6	29.8
Air-Filled Porosity (θ <sub>a</sub> ), %	2.5	0.2
Water-Filled Porosity (θ <sub>w</sub> ), %	25.0	29.6
Saturation, %	90.8	99.5
Specific Gravity	2.80      Assumed	2.80
Wet Weight, gm	723.7	741.1
Dry Weight, gm	644.1	644.1
Tare, gm	0.00	0.00
Moisture, %	12.4	15.1
Wet Bulk Density, pcf	142.2	141.2
Dry Bulk Density, pcf	126.5	122.7
Wet Bulk Dens.pb, (g/cm <sup>3</sup> )	2.28	2.26
Dry Bulk Dens.pb, (g/cm <sup>3</sup> )	2.03	1.97

Remarks:

# LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Sandy Lean CLAY (Weathered Rock)	41.1	22.7	18.4			
■	Gray Lean CLAY w/ Sand (Weathered Claystone)	47.2	23.8	23.4			
▲	Grayish Red Sandy Lean CLAY, trace Gravel (Weathered Claystone)	37.7	21.7	16.0			
◆	Grayish Red Sandy Lean CLAY, trace Gravel (Weathered Claystone)	38.5	19.7	18.8			
▼	Gray Lean CLAY (Weathered Claystone)	43.5	19.6	23.9			

**Project No.** 748-004      **Client:** A3Geo  
**Project:** Lawrence Berkeley Labs  
  
**● Source:** B1      **Elev./Depth:** 25-27.5(Tip-3)  
**■ Source:** B1      **Elev./Depth:** 30-32.5(Tip-2)  
**▲ Source:** B1      **Elev./Depth:** 40-42.5(Tip-2)  
**◆ Source:** B1      **Elev./Depth:** 50-52(Tip-2)  
**▼ Source:** B3      **Elev./Depth:** 228'

**Remarks:**  
 ●  
 ■  
 ▲  
 ◆  
 ▼

***Alan Kropp & Associates, Inc. and A3GEO, Inc. (AKA/A3GEO), 2012a***, “Geotechnical/Geologic Data and Interpretations Report, FY 2012 Bevatron Pad Investigation, Future Scientific Facility (FSF) Settlement Study, Lawrence Berkeley National Laboratory,” consulting report dated June 29, 2012.

### **Logs of Borings B-1 through B-3**

<b>DRILL RIG:</b> Truck D30, Rotary Wash	<b>SURFACE ELEVATION:</b> 710 (see notes)	<b>LOGGED BY:</b> AL
<b>DEPTH TO GROUNDWATER:</b> N/A (see notes)	<b>BORING DIAMETER:</b> 5 inches	<b>DATE DRILLED:</b> 4/30/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<b>4" Concrete / 5.5" AC / Baserock</b>									
<b>CLAY, Lean</b> - with sand, trace fine to coarse-grained gravel, moist	Reddish Brown, Grayish Brown & Yellowish Brown		CL	1					
				2					
				3					
				4					
				5					
-some fine to coarse-grained sand	Brown & Grayish Brown			6					
				7					
				8					
-trace sand	Reddish Brown			9					
				10					
<b>CLAY, Lean, Gravelly</b> - fine-grained, angular, gravel	Brown to Reddish Brown		CL	11					
				12					
				13					
-medium to high plasticity, some fine-grained sand	Dark Gray to Reddish Brown		CL/CH	14					
				15					
				16					
				17					
				18					
				19					
-decrease gravel content, trace fine-grained sand	Dark Brown to Reddish Brown			20					
				21					
				22					
				23					
	Dark Brown to Grayish Brown			24					
				25					
				26					
				27					
				28					
				29					
	Bluish Gray			30					
				31					
				32					
	Reddish Brown to Gray			33					
				34					

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AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12



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**EXPLORATORY BORING LOG**  
FSF SETTLEMENT STUDY  
LBNL; Berkeley, California

PROJECT NO.	DATE	SHEET	BORING NO.
2335-16J	June 2012	1 of 4	<b>B1</b>

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<i>(Continued from Previous Page)</i>									
-with silt, some fine-grained, angular gravel, some coarse-grained sand	Reddish Brown			36 37 38 39 40 41					
<b>CLAY, Lean</b> - medium to high plasticity, trace fine-grained, angular gravel, trace sand, trace organics	Greenish Gray to Bluish Gray		CL/CH	42 43 44 45 46 47 48 49					
-with fine to coarse-grained gravel, some sand	Olive Gray & Gray			50 51 52 53 54					
	Mottled Bluish Gray, Gray & Reddish Brown			55 56 57					12:11 to 12:15
-some coarse-grained, angular gravel, composed of Orinda and Moraga Formation affinity	Mottled Olive Brown, Gray & Yellowish Brown			58 59 60					12:23 to 12:27
-increase in coarse blocks in clay matrix 61' to 64'	10YR 4/4-4/6			61 62 63 64					12:32 to 12:40
	Bluish Gray with Reddish Brown 5YR 3/4			65 66					12:45 to 12:54
<b>CLAYSTONE/SILTSTONE</b> - low hardness, friable, deep weathering, intensely fractured, moist; soft and weak when opened, slickensided and polished fractures	Bluish Gray		BR	67 68 69 70 71 72 73 74					1:37 to 2:07
-<0.5' thick sandstone lense, fine-grained, hard, moderately strong, moderate weathering, intensely fractured; cementation, trace oxidation stains	2.5Y 4/1								

↑  
**FILL**

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AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12



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**EXPLORATORY BORING LOG**  
FSF SETTLEMENT STUDY  
LBNL; Berkeley, California

PROJECT NO. <b>2335-16J</b>	DATE <b>June 2012</b>	SHEET <b>2 of 4</b>	BORING NO. <b>B1</b>
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AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<i>(Continued from Previous Page)</i>									
<b>SANDSTONE</b> - very fine-grained, low hardness, friable, moderate weathering; weak calcium carbonate cementation at 78'; bedding ~50° (Orinda Fm)	2.5Y 4/1		BR	76					2:12 to 12:27
				77					
				78					
				79					
<b>SILTSTONE</b> - low hardness, friable to weak, moderate weathering, moderately fractured, dry; highly fractured and pulverized when opened, polished surfaces (Orinda Fm)  <b>SILTSTONE</b> - low hardness, friable, moderate weathering, moderately fractured to pervasively fractured when opened, slickensides with clay  <b>SILTSTONE/SANDSTONE</b> - very fine-grained, moderately hard, weak, moderate weathering, moderately fractured; bedding ~40°	2.5Y 3/1 to 4/1  2.5Y 3/1  Bluish Gray to Gray 2.5Y 4/1		BR	80					swelled ~3 in
				81					
				82					
				83					
				84					
				85					
				86					
				87					
				88					
				89					
<b>CLAYSTONE</b> - low hardness, weak, moderate weathering, closely fractured with polished, clay-lined surfaces, blocky, disturbed, seamy, bedding diffuse and gradational (Orinda Fm)  -trace fine-grained CaCO3  <b>CLAYSTONE</b> - shale-like seamy fabric  -moderately fractured, trace limestone clasts, blocky, disturbed, seamy (102' and 102.5')  -moderately to highly fractured, closely spaced and shale-like fabric when opened; clay-lined seams  -weak to moderately strong, changes to reddish brown color.	2.5Y 2/1  Bluish Gray to Dark Gray 2.5Y 2/1  2.5Y 2/1  Bluish Gray 2.5Y 2/1  Gray to Bluish Gray & Reddish Brown 7.5YR 3/2		BR	90					swelled ~7 in
				91					
				92					
				93					
				94					
				95					
				96					
				97					
				98					
				99					
				100					
				101					
				102					
				103					
				104					9:43 to 10:12 swelled ~7 in
				105					
				106					
				107					
				108					
				109					
				110					
				111					
				112					
				113					
				114					

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**EXPLORATORY BORING LOG**  
FSF SETTLEMENT STUDY  
LBNL; Berkeley, California

PROJECT NO. <b>2335-16J</b>	DATE <b>June 2012</b>	SHEET <b>3 of 4</b>	BORING NO. <b>B1</b>
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<b>DRILL RIG:</b> Truck D30, Rotary Wash	<b>SURFACE ELEVATION:</b> 710 (see notes)	<b>LOGGED BY:</b> AL
<b>DEPTH TO GROUNDWATER:</b> N/A (see notes)	<b>BORING DIAMETER:</b> 5 inches	<b>DATE DRILLED:</b> 5/2/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<b>2" AC</b> <b>CLAY, Lean, Gravelly</b> - fine to coarse-grained, angular to sub-angular gravel, with sand, dry  -with coarse-grained sand, to fine-grained gravel  <div style="text-align: right;"><b>FILL</b> ↑</div>	Brown & Grayish Brown		CL	1					
				2					
				3					
				4					
				5					
				6					
				7					
				8					
<b>CLAYSTONE</b> - some coarse-grained sand (Orinda Fm)  -with silt, some sand, trace fine-grained, angular gravel (possibly weathered bedrock) <b>Gravelly</b> - fine-grained, angular  <b>Sandy</b> - fine to medium-grained sand, trace fine-grained, angular gravel	Light Brown to Olive Brown		BR	9					
				10					
				11	Yellowish Brown to Olive Brown				
				12					
				13	Dark Gray & Olive Gray				
				14					
				15	Olive Gray				
16									
17									
<b>CLAYSTONE</b> - medium to high plasticity, trace fine-grained sand (Orinda Fm)	Mottled Olive Brown & Reddish Brown		BR	18					
				19					
				20					
				21					
<b>CLAYSTONE</b> - soft, plastic, moderate weathering (Orinda Fm)	Bluish Gray 2.5Y 5/1 4/1		BR	22					
				23					
				24					
				25					
				26					
				27					
				28					
				29					
				30					
				31					
				32					
				33					
				34					

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AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12



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**EXPLORATORY BORING LOG**  
 FSF SETTLEMENT STUDY  
 LBNL; Berkeley, California

PROJECT NO.	DATE	SHEET	BORING NO.
2335-16J	June 2012	1 of 4	<b>B2</b>

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<i>(Continued from Previous Page)</i>									
<p><b>CLAYSTONE</b> - soft, plastic, moderate weathering (Orinda Fm)</p> <p>-soft, plastic to friable, deep weathering, trace limestone/marl lenses, strength increases with depth</p> <p>-very blocky to blocky, disturbed, seamy with polished slip surfaces; thinly bedded</p>	Bluish Gray  2.5Y 4/1		BR	36					12:17 to 12:52
				37					
				38					
				39					
				40					
				41					
				42					
				43					
				44					
				45					
<p><b>SANDSTONE</b> - fine to medium-grained, weak to moderately hard, moderately strong, little weathering, dry, massive, CaCO3 cementation (Orinda Fm)</p>	Bluish Gray 2.5Y 5/1 to 4/1		BR	46					swelled ~4 in
				47					
<p><b>CLAYSTONE</b> - low hardness, friable to weak, moderate weathering, oxidation stains, trace sandstone lenses, some clay in fractures; very blocky to blocky, disturbed, seamy, closely spaced fractures (Orinda Fm)</p> <p>-thin marl at 53' -bedding ~45°; diffuse</p>	Bluish Gray 2.5Y 4/1  Bluish Gray & Reddish Brown		BR	49					swelled ~4 in
				50					
				51					
				52					
				53					
				54					
				55					
				56					
<p><b>SANDSTONE/SILTSTONE</b> - interbedded with thin sandstone and siltstone lenses, fine-grained, low hardness, weak, moderate weathering, occasionally fractured, moist; very blocky (Orinda Fm)</p> <p>-bedding 40-45° CaCO3 cementation with sandstone</p>	Bluish Gray 2.5Y 4/1  Bluish Gray to Gray		BR	57					swelled ~4 in
				58					
				59					
				60					
				61					
				62					
				63					
				64					
<p><b>CLAYSTONE/SILTSTONE</b> - low to moderately hard, soft in places (62.5'), moderately strong, little weathering, moderately fractured [contains thin pyrite coatings (rare)] (Orinda Fm)</p> <p>-low hardness, weak, moderate weathering, pervasively fractured when opened, slickensided surfaces, blocky, seamy, shale-like fabric</p> <p>-hard, strong, little weathering, rock fragments -at 70' - 0.5' thick limestone/marl, CaCO3 and gypsum coatings along fractures in claystone. -brecciated fabric along basal contact</p>	Bluish Gray to Gray 2.5Y 3/1 to 2/1  Gray  Bluish Gray  Gray to Dark Gray Gray to Greenish Gray Dark Gray		BR	65					3:00 to 3:20 3:39 to 3:50  8:03 to 8:22  8:26 to 8:47 swelled ~10 in
				66					
				67					
				68					
				69					
				70					
				71					
				72					
				73					
				74					

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AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12



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**EXPLORATORY BORING LOG**  
FSF SETTLEMENT STUDY  
LBNL; Berkeley, California

PROJECT NO. <b>2335-16J</b>	DATE <b>June 2012</b>	SHEET <b>2 of 4</b>	BORING NO. <b>B2</b>
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AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<i>(Continued from Previous Page)</i>									
<p><b>CLAYSTONE</b> - low hardness, weak, moderate weathering, pervasively fractured when opened, polished and slickensided surfaces</p> <p>-moderately hard between 76.5' and 80' interbedded limestone/marl lenses 0.2' to 0.5' thick.</p> <p>-very blocky to blocky, disturbed, seamy</p> <p>-bedding ~45°; shearing along bedding</p>	Dark Gray 2.5Y 3/1 to 2/1		BR	76					swelled ~4 in
	77								
	78								
	79								
	80								
	81								
	82								
	83								
	84								
	85								
<p><b>SANDSTONE/SILTSTONE</b> - fine-grained, moderately hard, moderately strong, little weathering, dry; bounded by clay shear 0.4' to 0.5' thick; soft and moist (Orinda Fm)</p>			BR	86					9:49 to 10:05
87									
88									
<p><b>SILTSTONE/CLAYSTONE</b> - moderately hard, weak to moderately strong, little to moderate weathering, occasionally fractured, some fine-grained sandstone lenses, trace clay in fractures; pervasively fractured when opened, slickensided surfaces, blocky, disturbed, seamy, fine laminations dip 30° (Orinda Fm)</p>	Bluish Gray 2.5Y 3/1 to 4/1		BR	89					10:09 to 10:34 swelled ~7 in
90									
91									
92									
93									
94									
<p><b>CLAYSTONE</b> - moderately hard, moderately strong, moderate weathering, occasionally to closely fractured, thinly laminated siltstone and very-fine-grained sandstone; parts along lamination with some CaCO<sub>3</sub>-lined fractures (Orinda Fm)</p> <p>-bedding laminations 10° - 30° with CaCO<sub>3</sub>-lined fractures</p> <p>-occasional polished and slickensided surfaces, increases in shale-like fabric (polished slicks) between 104' to 130'</p> <p>-CaCO<sub>3</sub> nodules</p> <p>-clay shear at 112.7' at limestone contact</p> <p>-between 114' - 115' limestone / marl</p>	Gray to Light Gray  2.5Y 5/1 to 6/1 Gray to Bluish Gray  Gray to Bluish Gray, trace Light Brown  Gray to Dark Gray 2.5Y 3/1		BR	95					10:38 to 11:06 swelled ~4 in
96									
97									
98									
99									
100									
101									
102									
103									
104									
105									
106									
107									
108									
109									
110									
111									
112									
113									
114									

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**EXPLORATORY BORING LOG**  
FSF SETTLEMENT STUDY  
LBNL; Berkeley, California

PROJECT NO. <b>2335-16J</b>	DATE <b>June 2012</b>	SHEET <b>3 of 4</b>	BORING NO. <b>B2</b>
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<b>DRILL RIG:</b> Truck D30, Rotary Wash	<b>SURFACE ELEVATION:</b> 710 (see notes)	<b>LOGGED BY:</b> AL
<b>DEPTH TO GROUNDWATER:</b> N/A (see notes)	<b>BORING DIAMETER:</b> 5 inches	<b>DATE DRILLED:</b> 5/4/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<b>2" AC</b> <b>CLAY, Lean, Gravelly</b> - fine-grained, sub-rounded gravel, with sand, some silt, trace wood and concrete fragments	Brown to Grayish Brown	Firm to Stiff	CL	1 2 3					
<b>GRAVEL, Clayey</b> - fine-grained, angular  -decrease clay content (possibly broken up shale)	Reddish Brown		GC	4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22					
<b>FILL</b> ↑				23					
<b>CLAYSTONE/SILTSTONE</b> - soft, plastic, deep weathering, with fine-grained, angular gravel (Orinda Fm)	Gray to Greenish Gray  Reddish Brown  Bluish Gray & Reddish Brown		BR	24 25 26 27 28 29 30 31 32 33 34					

(Continued on Next Page)

AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12



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**EXPLORATORY BORING LOG**  
FSF SETTLEMENT STUDY  
LBNL; Berkeley, California

PROJECT NO. <b>2335-16J</b>	DATE <b>June 2012</b>	SHEET <b>1 of 4</b>	BORING NO. <b>B3</b>
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AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS	
<i>(Continued from Previous Page)</i>										
<b>CLAYSTONE/SILTSTONE</b> - soft, plastic, deep weathering, with fine-grained, angular gravel (Orinda Fm)	Gray to Greenish Gray		BR	36						
				37						
				38						
				39						
				40						
				41						
				42						
				43						
				44						
				45						
<b>CLAYSTONE/SILTSTONE</b> - low hardness, plastic to friable, deep weathering, intensely fractured, clay in fractures, some fine-grained sandstone lenses, trace quartz, very blocky to blocky, disturbed, seamy (Orinda Fm)	Bluish Gray			46						
					47					
					48					
					49					
					50					
					51					
					52					
					53					
					54					
					55					
<b>CLAYSTONE/SILTSTONE</b> - low hardness, plastic to friable, deep weathering, intensely fractured, clay in fractures, some fine-grained sandstone lenses, trace quartz, very blocky to blocky, disturbed, seamy (Orinda Fm)	Gray to Bluish Gray, trace Reddish Brown			60					11:18 to 11:32 swelled ~3 in	
	2.5Y 3/1 to 4/1			61						
<b>SILTSTONE</b> - very fine-grained sand, low hardness, friable, deep weathering, moderately fractured (Orinda Fm)	Bluish Gray			62					swelled ~3 in	
				63						
-bedding ~ 40° to 50°	2.5Y 4/1 to 3/1			64					12:10 to 12:30 swelled ~2 in	
<b>CLAYSTONE</b> - low hardness, weak, deep weathering, moderately fractured; pervasively fractured when opened, polished surfaces, blocky, disturbed, seamy fabric (Orinda Fm)	Dark Gray to Bluish Gray			65						
	2.5Y 4/1			66						
-weak, CaCO3 cementation				67					12:50 to 1:04	
				68						
				69					1:10 to 1:45 swelled ~9 in	
				70						
				71						
				72						
				73						
				74						

*(Continued on Next Page)*

 <p><b>ALAN KROPP &amp; ASSOCIATES</b> <i>Geotechnical Consultants</i></p>	<b>EXPLORATORY BORING LOG</b>			
	FSF SETTLEMENT STUDY LBNL; Berkeley, California			
	PROJECT NO.	DATE	SHEET	BORING NO.
2335-16J	June 2012	2 of 4	<b>B3</b>	

AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS	
<i>(Continued from Previous Page)</i>										
-moderately hard, weak, deep weathering, crushed to intensely fractured, with prominent slickensides, blocky, disturbed, seamy texture, in places disintegrated	Gray			76	[Hatched Pattern]					
-pervasively fractured	Bluish Gray to Dark Gray			77					2:09 to 2:20 swelled ~6 in	
	2.5Y 4/1			78						
				79						
-CaCO3 lined fractures				80						
				81						
				82						
				83					swelled ~7 in	
-pervasively sheared and fractured material between 74' and 88'				84						
				85						
				86					2:52 to 3:07	
				87						
-moderately hard, weak to moderately strong, moderate weathering, occasionally fractured, packets of crushed limestone/marl at ~90.5'	Gray to Bluish Gray, trace White			88						1:50 to 2:05
-interbedded limestone/marl 90.5' to 93.3'				89						
				90						
				91						
				92					2:12 to 2:33	
				93						
				94						
				95						
				96					swelled ~3 in	
<b>SANDSTONE</b> - very fine-grained, moderately hard, moderately strong, little weathered, moderately fractured; faintly laminated, CaCO3 lined fractures, silty, blocky to very blocky texture (Orinda Fm)	Bluish Gray to Light Gray 2.5Y 4/1		BR	97						
				98						
				99						
				100						
-some very hard, very strong, sandstone lenses				101					7:30 to 8:03 swelled ~2 in	
				102						
				103						
				104						
-thinly bedded - laminated sandstone and claystone/siltstone, moderately hard, moderately strong, moderate weathering, blocky to very blocky, bedding ~20° to ~30°	Gray & Bluish Gray 2.5Y 4/1			105					8:08 to 8:30	
				106						
				107						
				108						
				109					8:35 to 9:02	
<b>LIMESTONE</b> - hard, moderately strong, moderate weathering, intensely fractured, bedding ~35°, shearing along basal contact (Orinda Fm)	Grayish White		BR	110						
				111						
<b>CLAYSTONE</b> - low hardness, friable, moderate weathering, trace fine-grained, angular limestone fragments, trace sand;	Mottled Light Gray, Bluish Gray & Gray 2.5Y 5/1 to 4/1		BR	112					9:50 to 10:20	
				113						
				114					10:35 to 10:57	

*(Continued on Next Page)*



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**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY  
LBNL; Berkeley, California

PROJECT NO. <b>2335-16J</b>	DATE <b>June 2012</b>	SHEET <b>3 of 4</b>	BORING NO. <b>B3</b>
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DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS	
<i>(Continued from Previous Page)</i>										
<p>zone of brecciated and soft clay @ 112' dipping 15-25°</p> <p><b>CLAYSTONE</b> - low hardness to moderately hard, weak moderate weathering, occasionally fractured, blocky, disturbed, seamy fabric, with common polished surfaces (Orinda Fm)</p> <p><b>LIMESTONE</b> - hard, strong, deep weathering, intensely fractured to crushed, some clay, bedding ~30° to 40° (Orinda Fm)</p> <p><b>CLAYSTONE/SILTSTONE</b> - moderately hard, moderately strong, moderate weathering, polished slip surfaces and slickensided fractures when opened (Orinda Fm)</p> <p>-limestone fragments, oxidation stains</p> <p>-transitions to reddish brown at ~129'</p> <p>-occasionally fractured; some polished surfaces and slickensides when opened; very blocky</p> <p>-some CaCO<sub>3</sub> cementation along fractures</p> <p>-moderately fractured, very blocky</p> <p>-thin lense limestone/marl, very blocky</p>	Gray & Dark Gray 2.5Y 3/1 to 4/1		BR	116					swelled ~4 in	
	Bluish Gray, White & Light Gray		BR	117						11:03 to 11:22
	Bluish White, Gray to Grayish Brown		BR	118						11:26 to 11:40
	2.5Y 6/1 to 7/1			119						11:47 to 12:13 swelled ~11 in
	2.5Y 6/1 to 7/1			120						12:17 to 12:36 swelled ~7 in
				121						
				122						
				123						
				124						
				125						
				126						
				127						
				128						
				129						
			130							
			131							
			132							
			133							
			134							
			135							
			136							
			137							
			138							
			139							
			140							
			141							
			142							
			143							
			144							

Bottom of boring at 144.0 feet.

NOTES:

1. Groundwater levels were obscured due to rotary wash drilling method. (See report for discussion).
2. Stratification lines represent the approximate boundaries between material types and the transitions may be gradual.
3. Approximate ground surface elevation based on LBNL Topographic Survey Drawing, undated.

AKA BORING LOG BORING LOGS.GPJ AKA\_TEMPLATE.GDT 6/27/12



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**EXPLORATORY BORING LOG**  
FSF SETTLEMENT STUDY  
LBNL; Berkeley, California

PROJECT NO. <b>2335-16J</b>	DATE <b>June 2012</b>	SHEET <b>4 of 4</b>	BORING NO. <b>B3</b>
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***Alan Kropp & Associates, Inc. and A3GEO, Inc. (AKA/A3GEO), 2012b***, "Tell-Tale Installations Report, Evaluation of Future Settlement at Bevatron Pad, Future Scientific Facility (FSF) Initiative, Lawrence Berkeley National Laboratory," consulting report dated September 28, 2012.

### **Logs of Borings TT-1, TT-11 and TT-12**



DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS		
<i>(Continued from Previous Page)</i>											
<b>CLAYSTONE</b> - medium to high plasticity, soft, trace fine-grained sand (Orinda Fm)	Olive Gray to Gray		BR	21							
				22							
<b>CLAYSTONE</b> - soft, plastic, moderate weathering (Orinda Fm)	Bluish Gray		BR	23							
				24							
				25							
				26							
				27							
				28							
				29							
				30	Bluish Gray, trace Brown						
				31							
				32							
				33							
				34							
35											
36											
37											
38											
39											
40	Gray to Bluish Gray							11:59 to 12:08			
41	5BG 4/1 to 5B 4/1										
42								12:13 to 12:30			

-sandy layer

-low hardness, friable, moderate weathering, blocky, moist

-moderately close joint spacing  
JRC 6 - 8

-blocky to very blocky, friable to weak, closely fractured to crushed

*(Continued on Next Page)*

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



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**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
Berkeley, California

PROJECT NO. <b>2335-16L</b>	DATE <b>September 2012</b>	SHEET <b>2 of 5</b>	BORING <b>TT-1</b>
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DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS	
<i>(Continued from Previous Page)</i>										
<b>CLAYSTONE</b> - soft, friable, moderate weathering, closely fractured, very blocky	Bluish Gray		BR	43						
<b>SILTSTONE, Clayey</b> - trace fine-grained sand, low hardness, plastic to friable, moderate weathering, occasionally fractured, moist, massive (Orinda Fm)	Bluish Gray 5 DG 4/1 to 2.5 YR 4/N4		BR	45						
<b>SILTSTONE</b> - with fine-grained sand, moderately hard, weak to moderately strong, moderate weathering, moderately fractured, trace oxidized zones, dry, massive	Bluish Gray		BR	47						1:45 to 1:59
<b>SANDSTONE</b> - fine-grained, moderately hard, weak to moderately strong, moderate weathering, occasionally fractured, dry, blocky, massive -JRC 4 - 6	Bluish Gray 2.5 YR 4/N4 to 5 BG 4/1		BR	50						
<b>SILTSTONE, Clayey</b> - soft to low hardness, weak, moderate weathering, clay in fractures, very blocky bedding 30° - 40° -bedding contact marked by pervasive fracturing to crushed zone (3-6" thick) calcite crystallization on contact -Sandstone/Siltstone lenses at 53/4" with thin 1-3mm laminations bedding 30° -friable, soft in places, moist -intensely fractured, random, JRC 6 - 4, occasional polished slickensides, very blocky to seamy, tight fractures, smooth to slightly rough	Bluish Gray 2.5 YR 3/N3		BR	51						2:21 to 2:45
-moderately fractured, crushed lenses at 60'1" and at 60'11" JRC 6 - 3	Bluish Gray to Gray 2.5 YR 3/N3		BR	54						
-moderately hard, friable to weak, trace calcite lens and fractures	Bluish Gray to Gray 2.5 YR 3/N3		BR	55						
-hard, strong, little weathering, dry bedding limestone/claystone 30°	Light Gray		BR	65						3:37 to 4:00

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### EXPLORATORY BORING LOG

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
Berkeley, California

PROJECT NO. <b>2335-16L</b>	DATE <b>September 2012</b>	SHEET <b>3 of 5</b>	BORING <b>TT-1</b>
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DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<i>(Continued from Previous Page)</i>									
<b>CLAYSTONE/SILTSTONE</b> - low hardness, friable to weak, moderate weathering, clay in fractures, very blocky to seamy  -CaCO3 in fractures; pervasively sheared with random orientations  -zone of soft, weak claystone 6" thick at contact	Gray to Bluish Gray			66	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	7:25 to 7:57
	2.5 YR 4/N4 to 3/N3			67					
	Light Gray			68					
				69					
				70					
<b>LIMESTONE</b> - hard, strong, little weathering, closely fractured, dry, healed bedding 50-60°	Light Gray to Pinkish Gray		BR	71					
<b>CLAYSTONE</b> - low hardness, weak, moderate weathering, moderately fractured, trace oxidized zones, abundant random slickensides, moist bedding 50°	Bluish Gray		BR	72					
				73					
<b>LIMESTONE</b> - hard, strong, little weathering, occasionally fractured, dry bedding 50°  -zones of weak to friable, crushed, possible relict siltstone texture	Light Gray		BR	74					
				75					
				76					
<b>CLAYSTONE</b> - low hardness, weak, moderate weathering, moderately fractured, very blocky to seamy, closely spaced, random orientations, tight, moist, bedding 30°- 40° -hard, weak to moderately strong, little weathering, occasionally fractured, some weak interbedded zones, trace limestone fragments -very closely spaced, very blocky to seamy, polished slickensides JRC 7-4	Bluish Gray		BR	77					
	5 YR 3/1			78					
	Dark Gray to Bluish Gray			79					
				80					
				81					
				82					
<b>LIMESTONE</b> - hard, strong, little weathering, closely fractured, healed fractures, steeply dipping, bedding 20°- 30°	Light Gray		BR	83					
<b>CLAYSTONE</b> - low hardness, friable, with hard fragments, crushed, wet, trace limestone fragments	Bluish Gray		BR	84					
				85					
<b>SANDSTONE</b> - fine-grained, hard, moderately strong to strong, little weathering, CaCO3 lined fractures, blocky	Bluish Gray		BR	86					
	Bluish Gray		BR	87					
				88					
<i>(Continued on Next Page)</i>									

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



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### EXPLORATORY BORING LOG

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
 Berkeley, California

PROJECT NO.	DATE	SHEET	BORING
2335-16L	September 2012	4 of 5	TT-1

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS	
<i>(Continued from Previous Page)</i>										
<b>SANDSTONE, Silty</b> - fine to very fine-grained, moderately hard, moderately strong, little weathering, closely fractured, trace oxidized zones	5 YR 5/1 Bluish Gray		BR	89						
<b>CLAYSTONE</b> - low hardness to moderately hard, strong, little weathering, occasionally fractured	Bluish Gray 5 YR 3/1		BR	90						10:48 to 11:06
	Bluish Gray to Gray		BR	91						
<b>SILTSTONE, Sandy</b> - fine to medium-grained sand, moderately hard, moderately strong, moderately fractured, with crushed zones, very blocky to seamy, CaCO3 lined fractures				92						
<b>SILTSTONE</b> - with fine-grained sand, moderately hard, moderately strong, little to moderate weathering, trace sandstone lenses, closely fractured, healed, moderate steep dipping fractures	Bluish Gray to Dark Gray		BR	93						11:09 to 11:31
	5 YR 3/1			94						
-blocky to very blocky, occasional thin seamy zones				95						
				96						
				97						
-zone of brecciated siltstone and sandstone as it transitions to sandstone				98						
				99					11:35 to 11:57	
<b>SANDSTONE</b> - fine-grained, hard, strong, little weathering, moderately fractured, clay in fractures	Bluish Gray to Dark Gray		BR	100						
-shear zone, very blocky, claystone interbedded with sandstone, contains angular sandstone clasts in clay matrix, polished surfaces in fractures bedding 30° - 40°				101						
-transitions to silty, very fine-grained sandstone, massive				102						
				103						

Bottom of boring at 103.0 feet.

NOTES:

1. Groundwater levels were obscured due to rotary wash drilling method. (See report for discussion).
2. Stratification lines represent the approximate boundaries between material types and the transitions may be gradual.
3. Approximate ground surface elevation based on LBNL Topographic Survey Drawings, undated.

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



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**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
Berkeley, California

PROJECT NO.	DATE	SHEET	BORING
2335-16L	September 2012	5 of 5	TT-1

<b>DRILL RIG:</b> D30, Rotary Wash	<b>SURFACE ELEVATION:</b> 710 (see notes)	<b>LOGGED BY:</b> AL
<b>DEPTH TO GROUNDWATER:</b> (see notes)	<b>BORING DIAMETER:</b> 5 inches	<b>DATE DRILLED:</b> 9/11/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
-12" AC									
<b>CLAY, Lean, Sandy</b> - fine to coarse-grained sand, some fine to coarse-grained, angular gravel	Brown to Reddish Brown	Firm	CL	1					
				2					
				3					
				4					
				5					
				6					
				7					
				8					
				9					
				10					
				11					
				12					
				13					
				14					
<b>SAND, Clayey</b> - coarse-grained sand, with fine-grained gravel	Brown to Reddish Brown		SC	15					
-increase clay content				16					
				17					
				18					
				19					

(Continued on Next Page)

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



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<b>EXPLORATORY BORING LOG</b>			
FSF SETTLEMENT STUDY INSTALLATIONS (2012) Berkeley, California			
PROJECT NO.	DATE	SHEET	BORING
2335-16L	September 2012	1 of 5	<b>TT-11</b>



DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS				
<i>(Continued from Previous Page)</i>													
<p><b>CLAYSTONE</b> - soft, plastic, deep weathering, trace fine-grained sand -fine-grained silty sandstone lense at 43'1" to 43'3"</p> <p>-hard, strong, intensely fractured lense at 45'8"</p> <p>-3-5 inch thick shear zone; dips 40°, fractured and seamy claystone with slight plasticity, bright reddish brown clay</p> <p><b>CLAYSTONE/SILTSTONE</b> - low hardness, friable, moderate weathering, moderately fractured, clay in fractures, moist</p>	<p>Reddish Brown Light Gray</p>		BR	43					14:49 to 1:05				
	<p>Mottled Reddish Brown and Bluish Gray</p>			44									
	<p>Reddish Brown some Bluish Gray</p>			45									
	<p>Reddish Brown with Bluish Gray 5 YR 3/2</p>			46									
				47									
				48									1:10 to 1:27
				49									
				50									
				51									2:37 to 2:57
				52									
<p><b>SILTSTONE</b> - with very fine-grained sand, moderately hard, moderately strong, little weathering, closely fractured, blocky, closely spaced, tight to open fractures, dry, trace oxidation stains</p>	<p>Bluish Gray to Light Gray</p>			53									
	<p>5 BG 4/1</p>			54									
	<p>Mottled Dark Bluish Gray &amp; Reddish Brown</p>			55					3:10 to 3:27				
	<p>7.5 YR 4/N4.0 to N3.0</p>			56									
				57									
				58									
				59					3:41 to 3:58				
				60									
				61									
				62									
<p>-moderately hard, moderately strong, little weathering, moderately fractured</p> <p>-abundant polished slickensided surfaces that are continuous and less random, polished surfaces/pressure faces</p> <p>-hard, strong, little weathering, moderately fractured, some healed fractures</p>	<p>Mottled Dark Gray and Bluish Gray</p>			63					7:14 to 7:45				
				64									
				65									

*(Continued on Next Page)*

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



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**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
Berkeley, California

PROJECT NO. <b>2335-16L</b>	DATE <b>September 2012</b>	SHEET <b>3 of 5</b>	BORING <b>TT-11</b>
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DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<i>(Continued from Previous Page)</i>									
<b>SILTSTONE, Clayey</b> - low hardness, weak, moderate weathering, occasionally fractured, blocky; contains soft zones filling fractures and siltstone clasts -soft at places, with clay in fractures, trace hard fragments intensely fractured at 67' to 69'9", clay lined fractures, random slicks, basalt contact	Bluish Gray 5 BG 4/1 to 5B 4/1			66					7:49 to 8:16
	Mottled Reddish Brown & Bluish Gray			67					
				68					
				69					
<b>SILTSTONE</b> - fine-grained, moderately hard, moderately strong, little weathering, occasionally fractured, very clayey-seamy with fine sandstone -with very fine-grained sand, intensely fractured, calcite in fractures, trace oxidation stains with depth, blocky, weak, closely spaced healed fractures with CaCO3 lining, open faces polished with slickensides with random orientation, waxy fabric.	Bluish Gray 5 BG 4/1 to 5B 4/1			70					8:22 to 8:51
	5 YR 2.5/2			71					
				72					
				73					
<b>SANDSTONE</b> - fine to medium-grained, moderately hard, moderately strong, little weathering <b>CLAYSTONE</b> - moderately hard, moderately strong, moderate weathering, occasionally fractured, some oxidation stains, trace hard fragments  -blocky to very blocky and in places disturbed seams, closely spaced and healed 1-2 mm thick fractures, abundant polished slickensides.	Bluish Gray			74					8:58 to 9:23
	Mottled Reddish Brown & Bluish Gray			75					
				76					
				77					
<b>CLAYSTONE</b> - moderately hard, moderately strong, moderate weathering, occasionally fractured, some oxidation stains, trace hard fragments  -blocky to very blocky and in places disturbed seams, closely spaced and healed 1-2 mm thick fractures, abundant polished slickensides.	Mottled Reddish Brown & Bluish Gray			78					9:29 to 9:59
				79					
				80					
				81					
-becomes sandier with depth				82					10:02 to 10:32
				83					
				84					
				85					
	Bluish Gray to Gray			86					10:38 to 11:03
				87					
	N4 to N6 5BG 4/1			88					

*(Continued on Next Page)*

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



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**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
 Berkeley, California

PROJECT NO. <b>2335-16L</b>	DATE <b>September 2012</b>	SHEET <b>4 of 5</b>	BORING <b>TT-11</b>
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DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<i>(Continued from Previous Page)</i>									
<p><b>SILTSTONE</b> - to very fine grained sandstone, fine-grained sand (20-30%), moderately hard, moderately strong, little weathering, closely fractured, some calcite fragments, oxidation stains in fractures</p> <p><b>SANDSTONE</b> - fine to medium-grained, moderately hard, moderately strong, little weathering, occasionally fractured -contacted fractured, weak, with polished slicks and CaCO<sub>3</sub>; approximate bedding 40-50°</p> <p><b>SILTSTONE</b> - some very fine-grained sandstone, moderately hard, moderately strong, little weathering, highly fractured, dry, fractures closely spaced and contains anastomizing fabric with blocks, some CaCO<sub>3</sub> along fractures, blocky disturbed seamy</p> <p><b>CLAYSTONE/SILTSTONE</b> - moderately hard, moderately strong, little weathering, highly fractured, closely spaced, polished surface along fractures, abundant mechanical breaks -crushed at 97'5" and 98'11"</p> <p>-fine-grained sandstone lense at 100'3", trace calcite</p>	Bluish Gray to Gray			89	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
	Bluish Gray			90					
	Bluish Gray			91					
	N5 to 5B 4/1			92					
	N4-5B 4/1			93					
	N4-5B 4/1			94					
	N4-5B 4/1			95					
	N4-5B 4/1			96					
	N4-5B 4/1			97					
	N4-5B 4/1			98					
			99						
			100						
			101						
			102						
			103						

Bottom of boring at 103.0 feet.

NOTES:

1. Groundwater levels were obscured due to rotary wash drilling method. (See report for discussion).
2. Stratification lines represent the approximate boundaries between material types and the transitions may be gradual.
3. Approximate ground surface elevation based on LBNL Topographic Survey Drawings, undated.

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



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**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
 Berkeley, California

PROJECT NO.	DATE	SHEET	BORING
2335-16L	September 2012	5 of 5	TT-11

<b>DRILL RIG:</b> D30, Rotary Wash	<b>SURFACE ELEVATION:</b> 710 (see notes)	<b>LOGGED BY:</b> AL
<b>DEPTH TO GROUNDWATER:</b> (see notes)	<b>BORING DIAMETER:</b> 5 inches	<b>DATE DRILLED:</b> 9/14/12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
-12" AC									
<b>CLAY, Lean, Gravelly</b> - with fine to coarse-grained sand, angular gravel, wood fragments, moist	Mottled Brown, Gray & Olive Brown	Firm	CL	1 2 3 4 5					12:47 to 12:54
-fine to coarse-grained gravel				6 7 8					12:58 to 1:06
-trace cobbles				9 10 11					1:42 to 1:52
	Mottled Brown & Bluish Gray			12					
<b>GRAVEL, Poorly Graded</b> - sub-angular, granite, shale, sandstone clasts	Gray	Loose	GP	14 15					2:08 to 2:13
<b>SILTSTONE/SANDSTONE</b> - fine-grained, low hardness, plastic to friable, deep weathering, moist (Great Valley Formation)	Mottled Yellowish Brown & Gray		BR	16 17 18 19					3:19 to 3:35
-anastomosing clay shears <1" thick, 50° to vertical, thin sandy interbeds; clay seams may be pedogenic -thin gravel layer	10YR 4/1 to 7.5YR 5/6 to 5/8					[17]			

(Continued on Next Page)

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



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**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
Berkeley, California

PROJECT NO.	DATE	SHEET	BORING
2335-16L	September 2012	1 of 4	TT-12

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS	
<i>(Continued from Previous Page)</i>										
<p><b>GRAVEL, Poorly Graded</b> - sub-angular, very hard, siltstone clasts</p> <p><b>CLAYSTONE/SILTSTONE</b> - soft, friable, deep weathering, crushed, angular blocky weathering clasts, massive, no bedding</p> <p><b>SANDSTONE/SILTSTONE</b> - very fine-grained, hard, moderately strong, moderate weathering, closely fractured, mica on weathering surfaces, small mica grains throughout (Great Valley Formation)            -weak laminations &lt;5°            -healed fractures 90° to 70°</p> <p>-siltstone interbed, intensely fracturing but faint bedding remains, &lt; 10°, weathering surfaces include polished surfaces</p>	Gray	Loose	GP	21						
	Brown 7.5YR 4/6									BR
	<p><b>SANDSTONE/SILTSTONE</b> - low hardness, friable, moderate weathering, intensely fractured, clay in fractures, moist, mica grains, bedding about 30°, mottled zone 30'</p> <p>-low hardness, weak, moderate weathering, closely fractured, moist            -bedding 20-30°            -bedding &lt;10°            -fine-grained sandstone lense at 31'9", hard, strong, little weathering</p> <p>-siltstone with sandstone, subangular rounded chips of sandstone generally massive</p> <p>-Siltstone with interbedded sandstone, soft to low hardness, friable, moderate weathering, crushed, fine-grained sandstone fragments            -bedding &lt; 10°</p> <p>-Sandstone/Siltstone, highly weathered, subrounded sandstone clasts, bedding marked by sandstone and siltstone interbeds.            -bedding 30°</p> <p>-low hardness, intensely fractured with clay, trace calcite along fractures, generally</p>	Mottled Brown & Gray 10YR 4/2 to 4/3		BR	22					7:28 to 7:49
		10YR 6/1 to 4/1		BR	23					7:52 to 8:07
				BR	24					8:30 to 8:53
		Olive Brown & Gray 10YR 5/4 Bluish Gray to Dark Gray		BR	25					8:58 to 9:19
				BR	26					9:23 to 9:45
		10YR 4/1 to 3/1		BR	27					9:48 to 10:18
				BR	28					10:24 to 10:36
		10YR 2/1 to 5/1		BR	29					10:40 to 10:59
				BR	30					11:06 to 11:33
		10YR 2/1 to 5/1		BR	31					
BR	32									
10YR 2/1 to 5/1	BR	33								
	BR	34								
10YR 2/1 to 5/1	BR	35								
	BR	36								
10YR 2/1 to 5/1	BR	37								
	BR	38								
10YR 2/1 to 5/1	BR	39								
	BR	40								
10YR 2/1 to 5/1	BR	41								
	BR	42								

*(Continued on Next Page)*

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



**ALAN KROPP & ASSOCIATES**  
*Geotechnical Consultants*

**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
 Berkeley, California

PROJECT NO. <b>2335-16L</b>	DATE <b>September 2012</b>	SHEET <b>2 of 4</b>	BORING <b>TT-12</b>
--------------------------------	-------------------------------	------------------------	------------------------

DESCRIPTION AND REMARKS	COLOR	CONSISTENCY	SOIL TYPE	DEPTH (ft)	SAMPLER TYPE	SAMPLER BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	OTHER TESTS
<i>(Continued from Previous Page)</i>									
massive -bedding <10° <b>SHALE/SILTSTONE/SANDSTONE</b> - low hardness, weak, heavily weathered, closely fractured, massive, no bedding, generally fines upward, moist -sandstone interbed -45'- 46' hard sandstone, interbedded, intensely fractured, healed	Bluish Gray to Dark Gray  10YR 2/1			43					11:36 to 12:05
				44					
				45					
				46					
<b>SHALE/SANDSTONE</b> - fine-grained, hard, strong, little weathering, closely fractured, trace calcite in fractures -becomes intensely fractured, healed, anastomosing fractures; becomes sandy towards base -fractures vertical to 30°, closed, healed	Gray to Dark Gray  10YR 5/1 10YR 4/2		BR	47					12:09 to 12:35
				48					
				49					
<b>SHALE/SANDSTONE</b> - moderately hard, weak, moderate weathering, intensely fractured, more brecciated than above -crushed -stronger with depth, little weathering, closely fractured -becomes very fine-grained sandstone to shale, massive, no bedding	Brown to Grayish Brown  10YR 7/1 to 5/2  Gray			50					12:38 tp 1:08
				51					
				52					
				53					
-56' to 56.5' siltstone/shale with fine silty matrix, base marked by subrounded gravel clasts <b>SHALE/SANDSTONE</b> - fine-grained, moderately hard, moderately strong, little weathering, closely fractured, lots of healed fractures/joints -59'-60' rubbly zone, heavily fractured -60'-62' dipping fracture, anastomosing, separating, intensely weathered, siltstone from less weathered siltstone on other side, possibly old bedrock fault, clay filled fracture	10YR 5/1  Gray  10YR 5/1 to 4/2			54					1:12 to 1:35
				55					
				56					
				57					1:40 to 1:57
				58					
				59					
				60					
				61					
				62					
				63					

Bottom of boring at 63.5 feet.

NOTES:

*(Continued on Next Page)*

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



**ALAN KROPP  
& ASSOCIATES**  
*Geotechnical  
Consultants*

**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
Berkeley, California

PROJECT NO. <b>2335-16L</b>	DATE <b>September 2012</b>	SHEET <b>3 of 4</b>	BORING <b>TT-12</b>
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DESCRIPTION AND REMARKS

COLOR

CONSISTENCY

SOIL TYPE

DEPTH  
(ft)

SAMPLER TYPE

SAMPLER  
BLOW COUNTS

MOISTURE  
CONTENT (%)

DRY DENSITY  
(pcf)

OTHER TESTS

*(Continued from Previous Page)*

1. Groundwater levels were obscured due to rotary wash drilling method. (See report for discussion).
2. Stratification lines represent the approximate boundaries between material types and the transitions may be gradual.
3. Approximate ground surface elevation based on LBNL Topographic Survey Drawings, undated.

DRAFT

AKA BORING LOG BORINGS.GPJ AKA\_TEMPLATE.GDT 9/28/12



**ALAN KROPP  
& ASSOCIATES**  
*Geotechnical  
Consultants*

**EXPLORATORY BORING LOG**

FSF SETTLEMENT STUDY INSTALLATIONS (2012)  
Berkeley, California

PROJECT NO. <b>2335-16L</b>	DATE <b>September 2012</b>	SHEET <b>4 of 4</b>	BORING <b>TT-12</b>
--------------------------------	-------------------------------	------------------------	------------------------

**A3GEO, Inc. and Lettis Consultants, International, Inc. (A3GEO/LCI), 2012, "Bevatron Observations, LBNL, Berkeley, CA", memorandum dated April 6, 2012.**

**Geotechnical/Geologic Observations of Bevatron Excavations  
(Deep Tunnel, Western Branch Tunnel, Injector, MG Basement and Concrete Shielding Wall)**

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# MEMORANDUM

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**Date:** April 6, 2012 **A3GEO Project #:** 1100-2D  
**Project:** Bevatron Observations  
LBNL, Berkeley, CA  
**To:** Joe Harkins, Project Director  
**From:** Dona Mann, G.E. (A3GEO), John Baldwin, C.E.G. (LCI)  
**R.E.:** Summary of Observations during Bevatron Demolition

---

This memorandum documents our geologic field observations made during the demolition of the Bevatron between November and December 2011. Observations were made by Mr. John Baldwin, C.E.G. of Lettiss Consultants International, Inc. (LCI), in the following excavated areas: (1) the Deep Tunnel, (2) the Western Branch Tunnel, (3) the Injector, (4) the MG Basement, and (5) the Concrete Shielding Wall in the southeast corner of the site. These key observation locations are identified on the attached Site Plan (Figure 2) and are discussed in detail below. Photographs illustrating the key observations are attached and also identified on Figure 2.

The data collected from the excavations should be compiled and interpreted with all existing site information for a comprehensive geologic and geotechnical analysis of the former Bevatron site; however, this was beyond the limits of this memorandum which transmits field observations only. The observation locations indicated on the Site Plan (Figure 2) were determined by measuring from existing improvements and should be considered approximate.

## Deep Tunnel

The excavation of the Deep Tunnel was observed between November and December 2011 and included photo-documentation during various stages of excavation. Due to unstable and unshored excavation cuts, our observations were restricted to a zone above the southern end of the tunnel excavation. Based on conversations with the contractor and surveyor, the excavation approached depths of 20-25 feet, or elevations ranging between approximately 710 feet (at the surface) to 685 feet (at the base). Bedrock samples from the excavation were obtained from the contractor for close-up visual evaluation. As shown on the Site Plan (Figure 2), we provide two photographs of the excavation. Photograph 1 is an overall view of the Deep Tunnel excavation looking northwest; Photograph 2 is a view of the northern tunnel wall face showing the general geologic conditions exposed.

The southern and central part of the excavation exposed dark gray to greenish gray blocky/disturbed/seamy claystone overlain by a yellowish light brown, blocky to very blocky, fine-grained sandy siltstone (Photograph 2). These soft bedrock deposits are from the Orinda Formation. The claystone contained minor seeps, and abundant polished slickend-sided surfaces that were soft, friable and readily parted along discontinuities. The claystone is similar to the sheared claystone observed near previous waypoints WP-97, -99, and -100 in the central part of the Bevatron excavation (Figure 1, A3GEO, 2011). The sandy siltstone is correlative with the bedrock observed at previous waypoints WP-101 and -102 (Figure 1; A3GEO, 2011). The bedrock relations suggest the Orinda Formation dips northeast at a shallow to moderate angle. Northwest along the excavation, the bedrock defines a buried ridge capped by highly weathered and decomposed rock overlain by a colluvium with soil, and multiple packages of artificial fill (Photograph 2). Bedrock projects below the base of the excavation near the outer ring tunnel and abruptly transitions to dark brown clayey colluvium overlain by light brown to brown, sandy gravelly clay-rich fill. These deposits are tens of feet thick and project northwesterly into the filled portion of Blackberry Canyon. The colluvial deposits range from firm to stiff. No free flowing water was encountered in the excavation.

## Western Branch Tunnel

The Western Branch Tunnel excavation was observed in early to middle November 2011 (Figure 2). The excavation was relatively shallow (6 to 8 feet deep) and approached an elevation of about 702 feet. The exposures consisted of two packages of fill. The shallow fill typically was comprised of a dark brown to brown, soft, moist clay; the deeper fill was comprised of a brown, sandy gravelly clay that in places was loose and contained abundant Orinda Formation sandstone and siltstone clasts mixed with reddish brown clay. Bedrock was not observed in the excavation.

## Injector

The Injector excavation extended from the intersection of the MG Basement toward the southwest along three caissons supporting the former Injector (Figure 2). Photographs 3, 4 and 5 show the eastern wall of the excavation which generally consisted of bedded Orinda Formation bedrock overlain by artificial fill. The Orinda Formation consists of a lower package of reddish brown to grayish red claystone and siltstone with isolated thin blocks of hard limestone (Photograph 4). The claystone and siltstone is highly fractured and contains a distinct anastomosing fabric aligned with steeply east-dipping shear planes. The claystone and siltstone is overlain by a distinct 6-inch-thick, reddish brown clay shear zone (Photograph 5) that is soft, highly polished and contains occasional striae (groove marks). The base of the clay shear zone is at about elevation 704 feet. The base of the clay contact strikes N50-55°E and dips between 20-32°NW (i.e., out of slope), whereas the striae trend south-southwest. The clay shear zone is overlain by a discontinuous lens of olive to greenish brown silt (south end of excavation, Photograph 4) and a bedded conglomerate with basal channel-like deposits and thin laminations of reddish to greenish silt (central part of exposure). The northern extent of the clay shear zone is unclear, however, the conglomerate may truncate the clay shear zone, or alternatively, the clay shear thins and disappears as it approaches the conglomerate. Collectively, these weak to soft bedrock materials are overlain by gravelly, silty clay fill to the ground surface (about elevation 709-710 feet). We note that the clay shear zone has accommodated a significant amount of past displacement, and it is near the areas of slope instability previously documented during the original foundation excavation in 1949 (see historical photographs of landslides 1 to 3 in LBNL Report 015\_00077 dated November 18, 1949).

In addition, we made observations of an adjacent 10- to 15-foot high vertical cut located opposite (west) the Injector foundation. The base of the cut was at an approximate elevation of 695 feet and exposed reddish brown claystone mottled with grayish reduced zones overlain by a light brown colluvium. The clay shear zone exposed in the eastern wall (described above) was *not* observed in the vertical cut opposite the Injector foundation. The base of the excavation was dry with no visible seeps.

## MG Basement

The MG Basement observations were limited to the northeastern part of the basement. Due to restricted access and safety concerns, minimal exploration of the slope was permitted. Our observations were limited to several shallow soil pits high on the slope and limited probings made with a rock pick. A photomosaic (Photograph 6) of the eastern wall of the excavation shows that much of the material exposed consisted of artificial fill with large angular blocks of gravel (claystone, siltstone, sandstone affinity) randomly distributed in a clay-rich matrix. A small exposure of Orinda Formation bedrock was encountered in the southeastern end of the excavation near the intersection of an adjacent basement wing-wall and consisted of a reddish brown claystone to siltstone. No obvious signs of landslide material or seeps were noted; however, our exploration was significantly restricted to primarily distant observations. We note that this part of the former MG Basement is close to the previously mapped landslide at Building 46 as well as the slope failures encountered during the original foundation excavation in 1949 (see historical photographs of landslides 1 to 3 in LBNL Report 015\_00077 dated November 18, 1949).

## **Concrete Shielding Wall**

The Concrete Shielding Wall excavation in the southeastern corner of the Bevatron footprint provided an excellent exposure of Orinda Formation bedrock. The exposure was about 40 to 50 feet long and between 5 and 7 feet deep (approximate elevations of 705 to 703 feet). We were not permitted to enter the excavation so all notes were recorded from outside and above the excavation. A photomosaic of the eastern and central part of the excavation is provided in Photograph 7. In general, the photomosaic depicts the northwest-striking, shallow to moderately east dipping, black to gray, thinly bedded siltstone and claystone units with occasional discontinuous interbeds of limestone. The claystone typically is highly fractured tending toward a blocky/disturbed/seamy fabric. These observations are consistent with notes collected between previous waypoints WP-95 and -104 that encountered northwest striking and northeast dipping brecciated claystone with limestone interbeds (Figure 1; A3GEO, 2011). No groundwater or seeps were observed in the excavation.

## **REFERENCES**

A3GEO, 2011, Summary of Bevatron Observations Memorandum dated September 30, 2011 prepared by A3GEO and LCI.

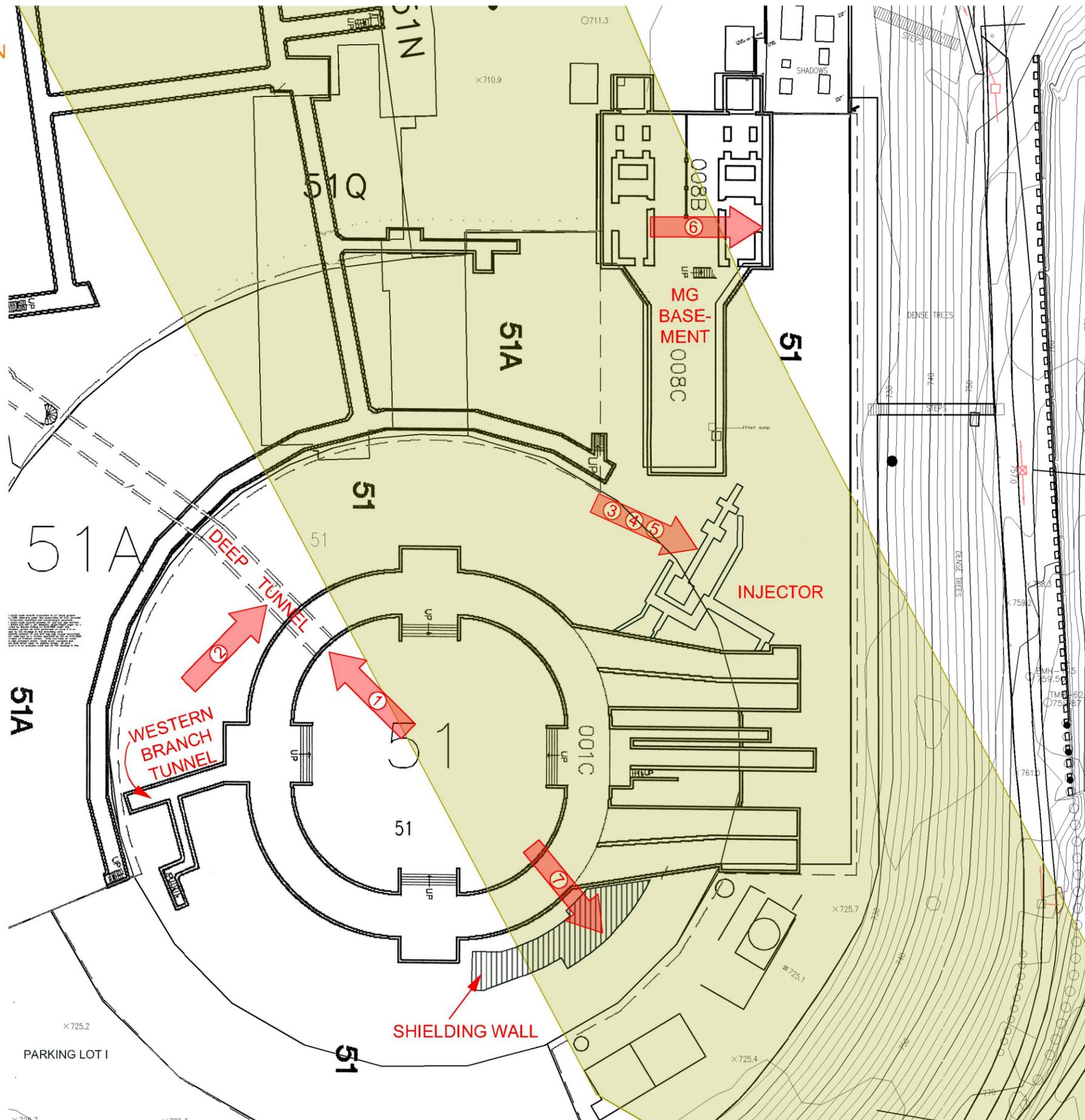
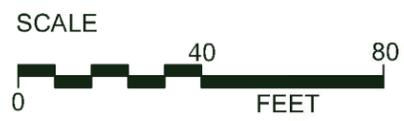
Lawrence Berkeley National Lab, 1949, correspondence to Mr. C.P. Moen, titled Landslides in Bevatron Area dated November 18, 1949; LBNL consultant report no. 015\_00077.

A3GEO, Inc.  
 PROJECT No. 1100-2D  
 BEVATRON DEMOLITION OBSERVATION  
 LAWRENCE BERKELEY NATIONAL LAB  
 BERKELEY, CALIFORNIA



**LEGEND:**

-  APPROXIMATE LOCATION OF PROPOSED NGLS TUNNEL
-  PHOTOGRAPH NUMBER AND DIRECTION

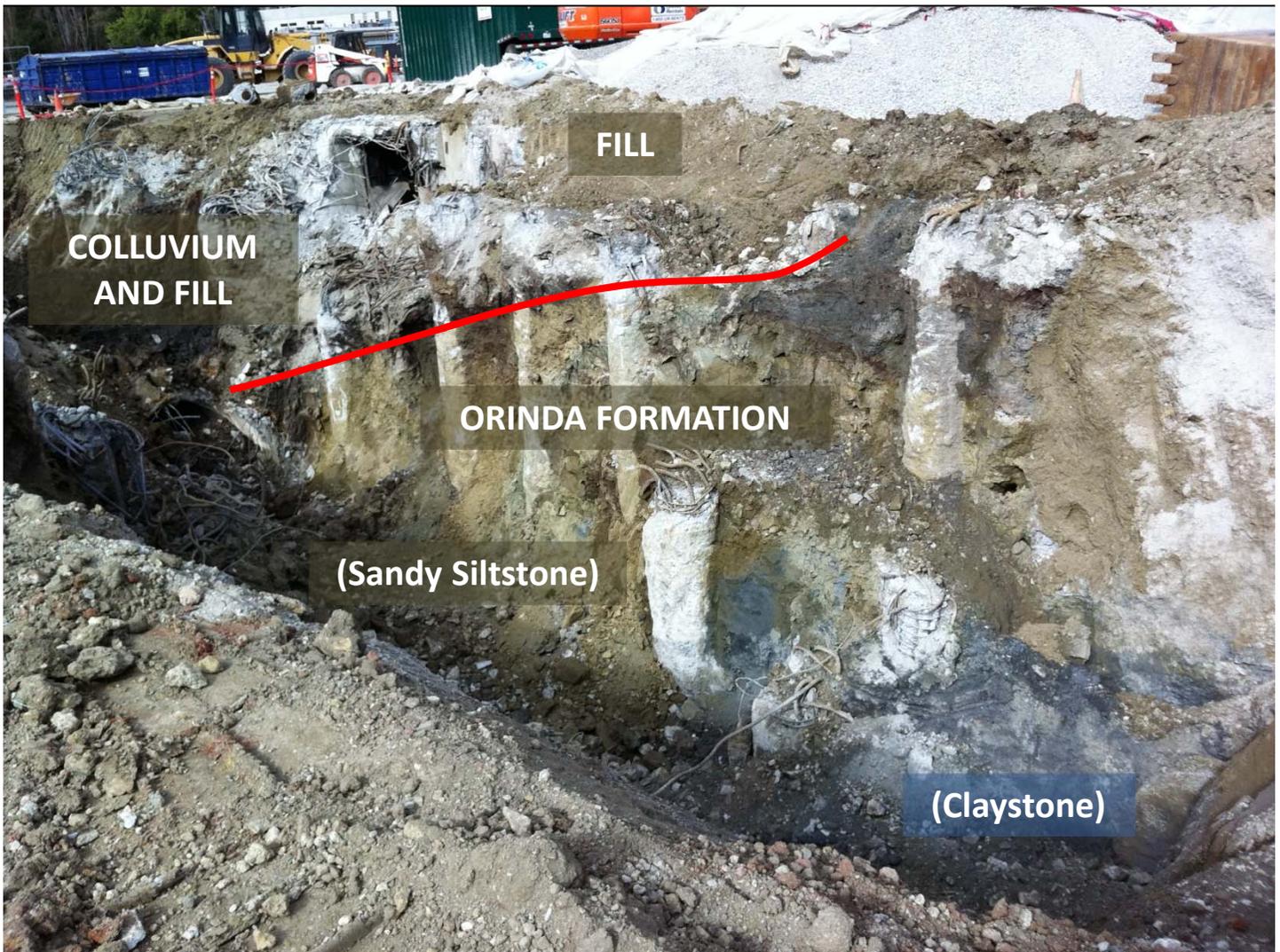


**FIGURE 2**  
**SITE PLAN**



BEVATRON DEMOLITION  
Berkeley, CA

Photograph 1  
Deep Tunnel Excavation



BEVATRON DEMOLITION  
Berkeley, CA

Photograph 2  
Deep Tunnel Excavation Northern Wall



BEVATRON DEMOLITION  
Berkeley, CA

Photograph 3  
Injector Excavation







BEVATRON DEMOLITION  
Berkeley, CA

Photograph 6  
MG Basement Excavation – Eastern Wall



BEVATRON DEMOLITION  
Berkeley, CA

**Photograph 7**  
**Concrete Shielding Wall Excavation**

**A3GEO, Inc., 2013**, "Geotechnical Investigation Report, Wilson Landslide, Lawrence Berkeley National Laboratory, Berkeley, California," consulting report dated March 11, 2013.

**Logs of Borings B-1, B-2, B-4 and B-5  
Slope Indicator Plots B-1 and B-2**



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 Fax: 1 (510) 373-1508

# BORING NUMBER B-1

PAGE 1 OF 2

**CLIENT** Lawrence Berkeley National Laboratory  
**PROJECT NUMBER** 1100-11B  
**DATE STARTED** 1/8/13 **COMPLETED** 1/10/13  
**DRILLING CONTRACTOR** Gregg Drilling and Testing, Inc.  
**DRILLING METHOD** Rotary Wash Drilling  
**LOGGED BY** DI **CHECKED BY** JNB  
**NOTES** Inclinometer installed; GW obscured by drilling method.

**PROJECT NAME** Wilson Slide Investigation  
**PROJECT LOCATION** Berkeley, California  
**GROUND ELEVATION** 988.5 ft **HOLE SIZE** 3.875"  
**GROUND WATER LEVELS:**  
**AT TIME OF DRILLING** ---  
**AT END OF DRILLING** ---  
**AFTER DRILLING** ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
0		FAT CLAY (CH) - Dark brown to gray, soft to firm, with trace coarse sand, trace silt, wet to saturated - Qc/Qls							
5			MC	7	1.5	91	32		LL: 68 PI: 47
10			MC	8	1.25	93	30		LL: 54 PI: 32
15		CLAYEY SAND/ SANDY LEAN CLAY (CL) - Dark brown to olive, stiff, little coarse sand, trace angular volcanic clasts, moist - Qc/Qls	MC	9	3	115	17		LL: 34 PI: 14
20		WEATHERED SILTSTONE - Olive brown and reddish brown, deeply weathered, friable, soft, crushed, with fine sand and clay in matrix, moist - Qc/Qls - at 21.5' - basal slide plane inferred.	MC	14					LL: 34 PI: 11
25		SILTSTONE - Greenish gray, deeply weathered, friable, soft with interbeds of silty very finegrained sandstone - ORINDA FORMATION	MC	29					
30		CLAYSTONE TO SILTSTONE - Greenish gray to reddish brown, soft to weak, discoloration at contact dipping 40-50", random slickensides, clay gouge.							
35		ANDESITIC VOLCANICS - Light gray to brown, moderately weathered, moderately strong, moderately hard, intensely fractured - MORAGA FORMATION							

(Continued Next Page)

GEOTECH BH COLUMNS - GINT STD US GDT - 3/1/13 14:36 - A:\A3GEO PROJECTS\1100 - LBNL\1100-11B WILSON SLIDE INVESTIGATION\BORING LOGS\BORING LOGS - WILSON SLIDE - 1100-11B.GPJ



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**BORING NUMBER B-1**

**CLIENT** Lawrence Berkeley National Laboratory  
**PROJECT NUMBER** 1100-11B  
**DATE STARTED** 1/8/13 **COMPLETED** 1/10/13  
**DRILLING CONTRACTOR** Gregg Drilling and Testing, Inc.  
**DRILLING METHOD** Rotary Wash Drilling  
**LOGGED BY** DI **CHECKED BY** JNB  
**NOTES** Inclinometer installed; GW obscured by drilling method.

**PROJECT NAME** Wilson Slide Investigation  
**PROJECT LOCATION** Berkeley, California  
**GROUND ELEVATION** 988.5 ft **HOLE SIZE** 3.875"  
**GROUND WATER LEVELS:**  
**AT TIME OF DRILLING** ---  
**AT END OF DRILLING** ---  
**AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US.GDT - 3/1/13 14:36 - A:\A3GEO PROJECTS\1100 - LBNL\1100-11B WILSON SLIDE INVESTIGATION\BORING LOGS\BORING LOGS - 1100-11B.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
35									
40		ANDESITIC VOLCANICS - Light gray to brown, moderately weathered, moderately strong, moderately hard, intensely fractured - MORAGA FORMATION(continued)							
45		- At 46' to 51': No Recovery							
50		BASALT - Brown, highly fracture, random fracture orientation.							
55									
60									

Bottom of borehole at 61.5 feet.



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**BORING NUMBER B-2**

**CLIENT** Lawrence Berkeley National Laboratory  
**PROJECT NUMBER** 1100-11B  
**DATE STARTED** 1/11/13 **COMPLETED** 1/14/13  
**DRILLING CONTRACTOR** Gregg Drilling and Testing, Inc.  
**DRILLING METHOD** Rotary Wash Drilling  
**LOGGED BY** DI **CHECKED BY** JNB  
**NOTES** Inclinometer installed; GW obscured by drilling method.

**PROJECT NAME** Wilson Slide Investigation  
**PROJECT LOCATION** Berkeley, California  
**GROUND ELEVATION** 979.8 ft **HOLE SIZE** 4.875"  
**GROUND WATER LEVELS:**  
**AT TIME OF DRILLING** ---  
**AT END OF DRILLING** ---  
**AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US GDT - 3/1/13 14:36 - A\A3GEO PROJECTS\1100 - LBNL\1100-11B WILSON SLIDE INVESTIGATION\BORING LOGS - WILSON SLIDE - 1100-11B.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
0									
0 - 5		FAT CLAY (CH) - Dark brown to brown, firm to stiff, trace silt, intermittent angular maraga clasts up to 3/4 inch in diamter, wet. Qc/Qls	MC	8	3				
5 - 10		CLAYEY GRAVEL (GC) - Brown to gray, moist to wet, Qc/Qls	MC	13	3.5				
10 - 15		FAT CLAY (CH) - Dark brown to stiff, trace silt and fine graind sand. Qc/Qls	MC	9	3.5				
15 - 20			MC	12					
20 - 25			MC	13	2.5				
20 - 23		OLD 1962 SLIDE PLANE - Yellowish brown to dark brown clay, very weathered, weak.	MC	6	1.75				
23 - 25			MC	10	2				
25 - 27			MC	10	2.25				
27 - 29			MC	9	2.5				
29 - 31			MC	9	2.5				
31 - 33			MC	9	2.5				
33 - 35			MC	52					
20 - 23		SILTSTONE - Gray to reddish brown, deeply weathered, moderately strong - ORINDA FORMATION							
23 - 25		CLAYSTONE - Reddish brown, deeply weathered - ORINDA FORMATION							
25 - 27		SILTSTONE - Reddish brown, deeply weathered, intensely fractured - ORINDA FORAMTION							
27 - 29		- at 23': Crushed and seamy zone, no distinct shear.							
29 - 31		SILTSTONE - Reddish brown, deeply weaterhed, moderately strong, intensely fractured to crushed, well cemented, highly sheared with some fine gravel and fine grained sand, no distinct clay gouge shears (random) - ORINDA FORMATION							
31 - 33		SILTSTONE - Gray to reddish brown, deeply weathered, moderately strong, some fine sand and gravel - ORINDA FORMATION							
33 - 35		- at 31': clayey gravelly sandstone lens							
35 - 37		SILTSTONE - Gray to reddish brown, deeply weathered, moderately strong, some fine sand and gravel, sheared, no distinct clay gouge polished random slicken sides - ORINDA FORMATION							

(Continued Next Page)



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**BORING NUMBER B-2**

**CLIENT** Lawrence Berkeley National Laboratory **PROJECT NAME** Wilson Slide Investigation  
**PROJECT NUMBER** 1100-11B **PROJECT LOCATION** Berkeley, California  
**DATE STARTED** 1/11/13 **COMPLETED** 1/14/13 **GROUND ELEVATION** 979.8 ft **HOLE SIZE** 4.875"  
**DRILLING CONTRACTOR** Gregg Drilling and Testing, Inc. **GROUND WATER LEVELS:**  
**DRILLING METHOD** Rotary Wash Drilling **AT TIME OF DRILLING** ---  
**LOGGED BY** DI **CHECKED BY** JNB **AT END OF DRILLING** ---  
**NOTES** Inclinometer installed; GW obscured by drilling method. **AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US.GDT - 3/1/13 14:36 - A:\A3GEO PROJECTS\1100 - LBNL\1100-11B WILSON SLIDE INVESTIGATION\BORING LOGS\BORING LOGS - 1100-11B.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
35									
		SILTSTONE - Gray to reddish brown, deeply weathered, moderately strong, some fine sand and gravel, sheared, no distinct clay gouge polished random slicken sides - ORINDA FORMATION(continued)							
40		- at 39': angular clasts of volcanics, with bedding dipping 45 degrees SILTSTONE - Greenish gray, deep to moderate weathering, friable to weak, low hardness - ORINDA FORMATION							
45		SILTSTONE - Reddish brown, clayey - ORINDA FORMATION							
50		TRANSITION ZONE - from ORINDA FORAMTION TO MORAGA FORMATION, sheared sandy clay, soft, varigated discoloration, laminae inclined subhorizontal to 70 degrees (Older shear zone?) BASALT - Greenish gray, little weathering, strong, closely fractured, very well cemented - MORAGA FORMATION							
55		- at 52': highly sheared clayey matrix, no change in rock-type.							

Bottom of borehole at 55.0 feet.



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**BORING NUMBER B-4**

**CLIENT** Lawrence Berkeley National Laboratory  
**PROJECT NUMBER** 1100-11B  
**DATE STARTED** 1/16/13 **COMPLETED** 1/17/13  
**DRILLING CONTRACTOR** Gregg Drilling and Testing, Inc.  
**DRILLING METHOD** Rotary Wash Drilling  
**LOGGED BY** BM **CHECKED BY** JNB  
**NOTES** Piezometer installed.

**PROJECT NAME** Wilson Slide Investigation  
**PROJECT LOCATION** Berkeley, California  
**GROUND ELEVATION** 920 ft **HOLE SIZE** 4.875"  
**GROUND WATER LEVELS:**  
**AT TIME OF DRILLING** ---  
**AT END OF DRILLING** ---  
**AFTER DRILLING** 19.80 ft / Elev 900.20 ft (1/23/2013)

GEOTECH BH COLUMNS - GINT STD US.GDT - 3/1/13 14:36 - A:\A3GEO PROJECTS\1100 - LBNL\1100-11B WILSON SLIDE INVESTIGATION\BORING LOGS\BORING LOGS - WILSON SLIDE - 1100-11B.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
0									
0 - 5		GRAVELLY LEAN CLAY (CL) - Olive brown, stiff to very stiff, angular clasts up to 1" in diameter, trace sand - FILL and weathered MORAGA FORMATION	MC	6	2.5				
5 - 10		BASALT AND ANDESITE - Reddish brown to olive brown, deeply weathered, strong, hard to very hard, intensely fractured to crushed, massive - MORAGA FORMATION	MC	8	3.5				
10 - 15			MC	14	3.5				
15 - 20		- at 16': Closely fractured, claylined, hard to very hard, strong.	MC	29					
20 - 25			MC	33					
25 - 30		TRANSITIONAL CONTACT - Reddish brown to gray, mottled, little weathering, friable to weak, soft to low hardness, intensely fractured to crushed andesite, blocky - Possible old shear zone - MORAGA FORMATION to ORINDA FORMATION	MC	54					
30 - 35		SANDY SILTSTONE - Mottled reddish brown to gray, deeply weathered, intensely fractured to crushed - ORINDA FORMATION							
35 - 35.5		- at 30': Poor recovery - inferred sandstone or conglomerate lense.							
35.5 - 35		SANDSTONE - Olive brown to blue gray with some mottled reddish brown, moderately weathered, friable, fine grained, trace small calcium carbonate inclusions, well cemented below 33.5' - ORINDA FORMATION							

(Continued Next Page)



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**BORING NUMBER B-4**

**CLIENT** Lawrence Berkeley National Laboratory **PROJECT NAME** Wilson Slide Investigation  
**PROJECT NUMBER** 1100-11B **PROJECT LOCATION** Berkeley, California  
**DATE STARTED** 1/16/13 **COMPLETED** 1/17/13 **GROUND ELEVATION** 920 ft **HOLE SIZE** 4.875"  
**DRILLING CONTRACTOR** Gregg Drilling and Testing, Inc. **GROUND WATER LEVELS:**  
**DRILLING METHOD** Rotary Wash Drilling **AT TIME OF DRILLING** ---  
**LOGGED BY** BM **CHECKED BY** JNB **AT END OF DRILLING** ---  
**NOTES** Piezometer installed. **▼ AFTER DRILLING** 19.80 ft / Elev 900.20 ft (1/23/2013)

GEOTECH BH COLUMNS - GINT STD US.GDT - 3/1/13 14:36 - A:\A3GEO PROJECTS\1100 - LBNL\1100-11B WILSON SLIDE INVESTIGATION\BORING LOGS\BORING LOGS - 1100-11B.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
35		CLAYSTONE - Blue gray, trace fine sand, gravel, well cemented in zones with calcium carbonate inclusions - ORINDA FORMATION( <i>continued</i> )  - at 37.5': Thin hard sandstone lense.							
40		- at 42': Introduction of reddish brown laminations							
45		SANDSTONE - Blueish gray to brown, well-cemented sandstone - ORINDA FORMATION.							
		CLAYSTONE TO SILTSTONE: Bluish gray to brown, trace fine grained sand - ORINDA FORMATION.							
50		SANDSTONE: Bluish gray with trace reddish brown mottling, very fine grained sand, trace clay - ORINDA FORMATION.							

Bottom of borehole at 51.5 feet.



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**BORING NUMBER B-5**

**CLIENT** Lawrence Berkeley National Laboratory **PROJECT NAME** Wilson Slide Investigation

**PROJECT NUMBER** 1100-11B **PROJECT LOCATION** Berkeley, California

**DATE STARTED** 1/18/13 **COMPLETED** 1/18/13 **GROUND ELEVATION** 920 ft **HOLE SIZE** 4.875"

**DRILLING CONTRACTOR** Gregg Drilling and Testing, Inc. **GROUND WATER LEVELS:**

**DRILLING METHOD** Rotary Wash Drilling **AT TIME OF DRILLING** ---

**LOGGED BY** BM **CHECKED BY** JNB **AT END OF DRILLING** ---

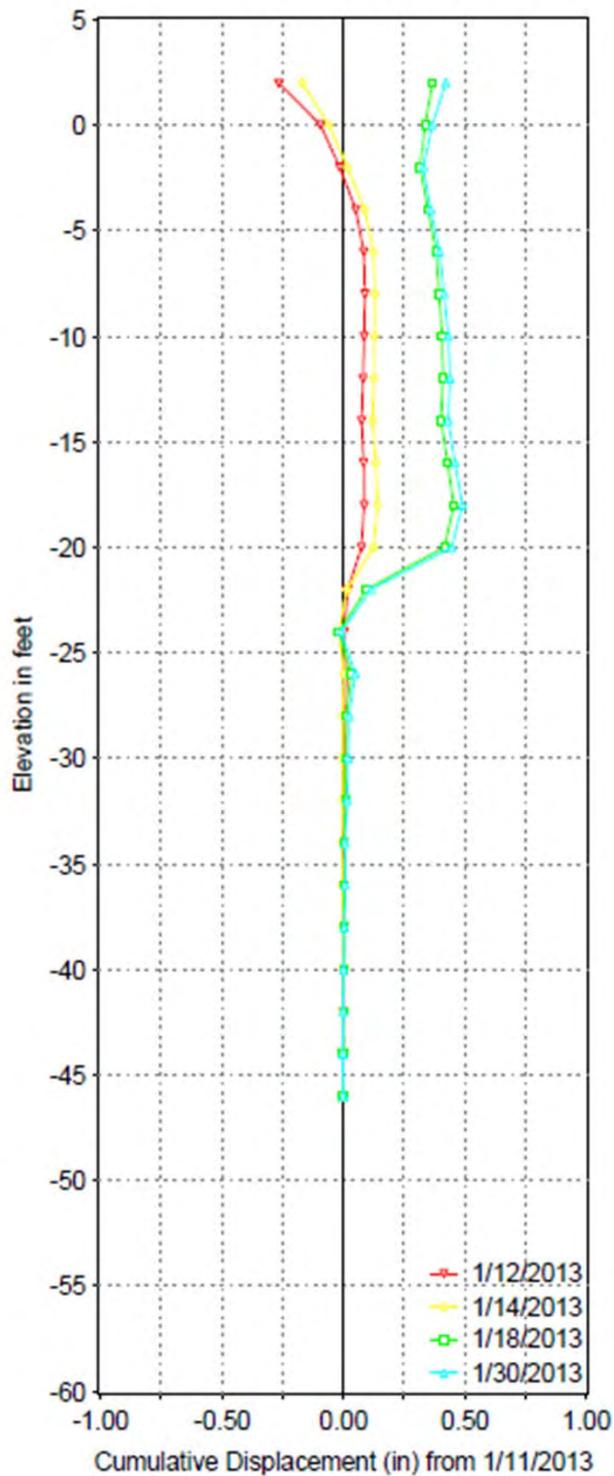
**NOTES** Borehole grouted upon completion. GW obscured by drilling method. **AFTER DRILLING** ---

GEOTECH BH COLUMNS - GINT STD US GDT - 3/1/13 14:36 - A:\A3GEO PROJECTS\1100 - LBNL\1100-11B WILSON SLIDE INVESTIGATION\BORING LOGS\BORING LOGS - WILSON SLIDE - 1100-11B.GPJ

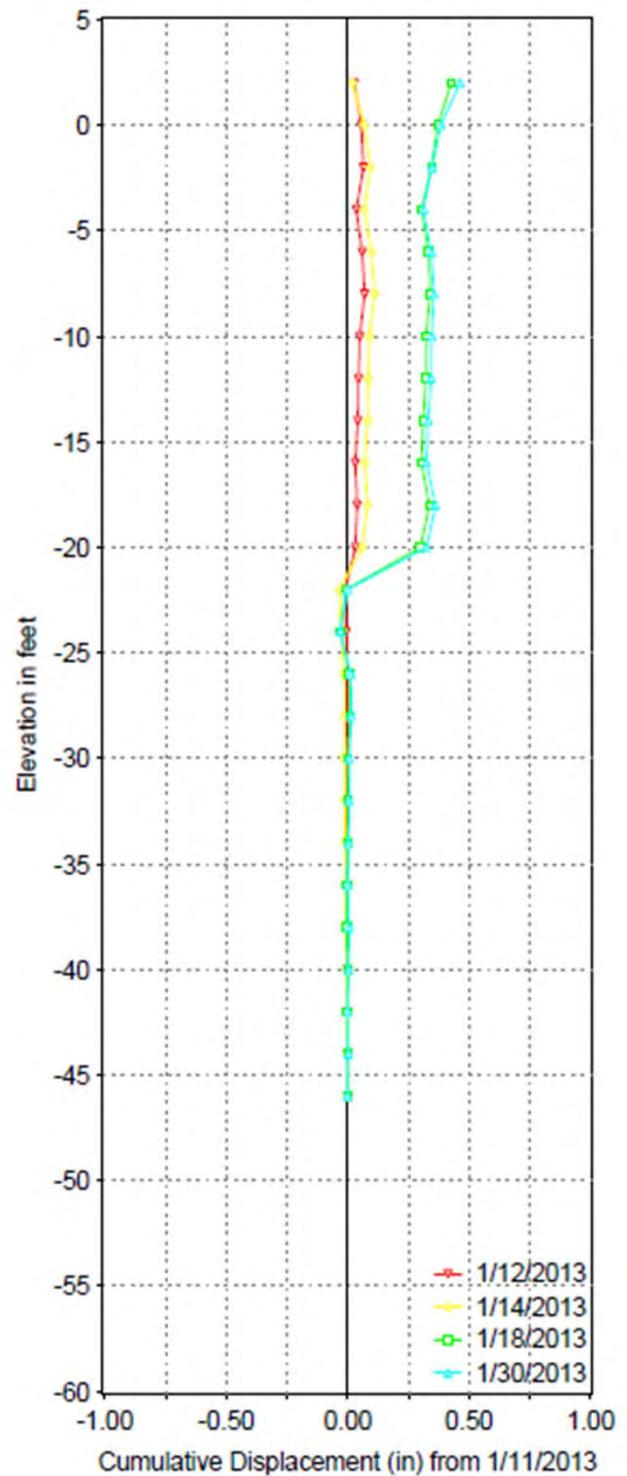
DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	ADJUSTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ROCK RECOVERY % (RQD)	OTHER LAB TESTS / NOTES
0		Not Logged See Log of Boring B-4							
5									
10									
15									
20									
25		BRECCIATED TUFF - Reddish brown to dark gray, hard, with some sand, angular clasts <3/4" in diameter, moist - MORAGA FORMATION	MC	32/5.0"	>4.5				
			MC	71					
			MC	42					
			MC	43					
30		CLAYEY SILTSTONE - Bluish gray to reddish brown, mottled, deeply weathered, friable, with fine gravel and conglomerate. - ORINDA FORMATION	MC	46					
			MC	30					
			MC	32					

Bottom of borehole at 32.5 feet.

Wilson B-1, A-Axis

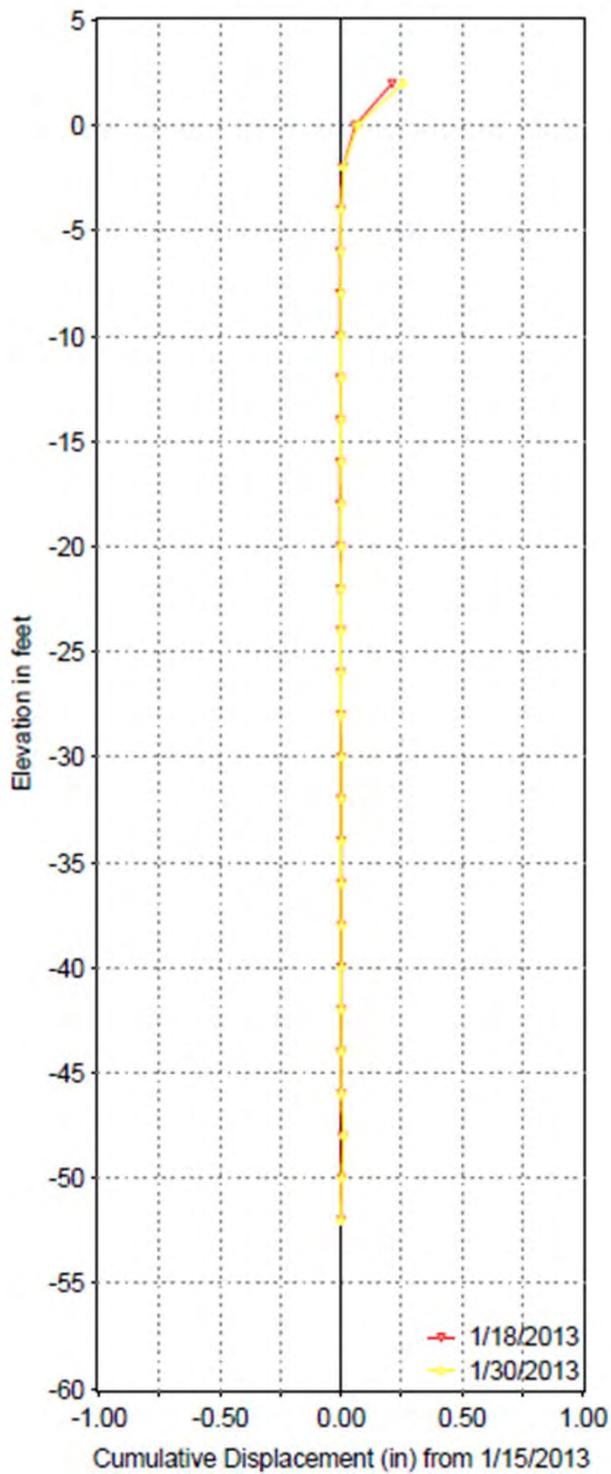


Wilson B-1, B-Axis

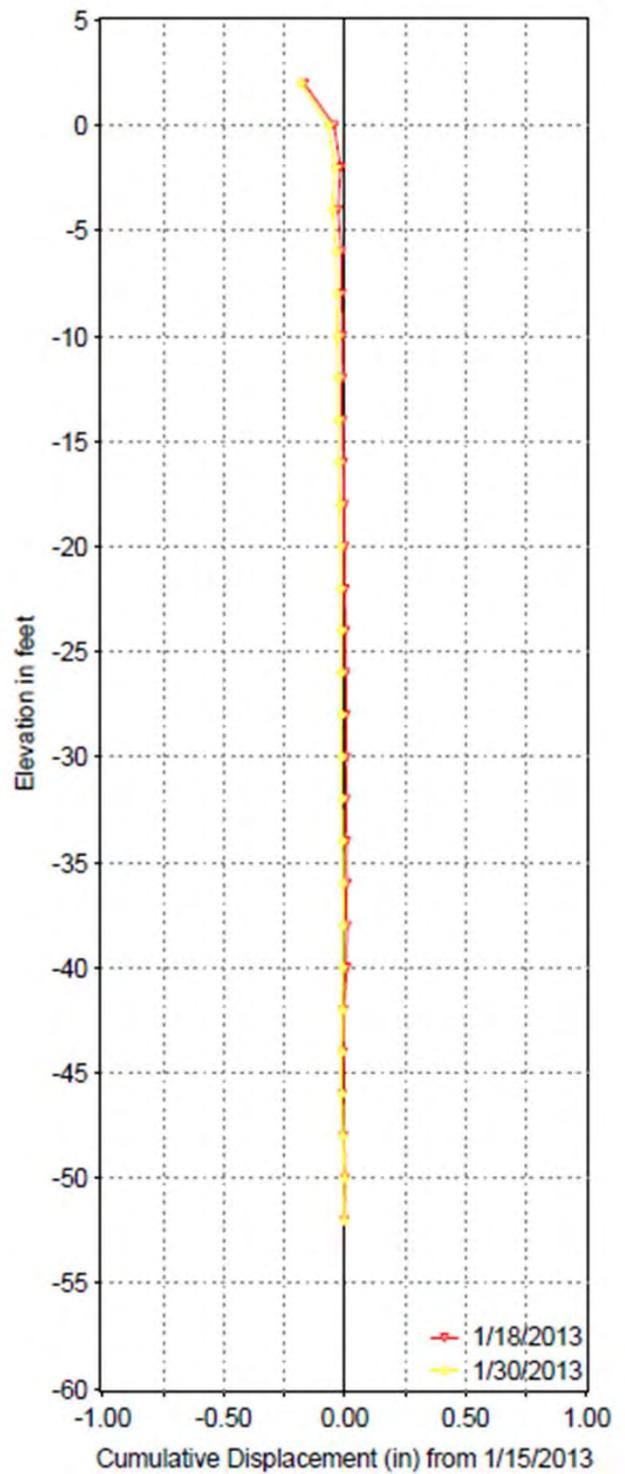


Wilson Slide  
 Inclinometer at B-1  
 A+ 205 degrees (Magnetic North)  
 A3GEO Project # 1100-11B

B-2, A-Axis



B-2, B-Axis



Wilson Slide  
 Inclinometer at B-2  
 A+ 235 degrees (Magnetic North)  
 A3GEO Project # 1100-11B