#241

GEOTECHNICAL INVESTIGATION
PROPOSED CHEMISTRY BUILDING ADDITION
PHYSICAL SCIENCES
MAIN CAMPUS
UNIVERSITY OF CALIFORNIA
SANTA BARBARA

HOOVER & ASSOCIATES, INC. Geologists - Hydrologists - Soil Engineers
800 GARDEN STREET, SUITE L • SANTA BARBARA, CALIFORNIA 93101 • (805) 965-3045

June 16, 1987

Rec'd 18 June 87 JJ.

Facilities Management
Office of Planning and Construction
University of California, Santa Barbara
Santa Barbara, California 93106

Attention: Mr. J.B. Julian, Senior Engineer

Subjeft: Geotechnical Investigation
Proposed Chemistry Building Addition
Main Campus
University of California, Santa Barbara

Gentlemen:

Transmitted herewith is our geotechnical investigation for the proposed addition to the Chemistry Building.

At this time the specific design and location of the addition are unknown, however, several alternatives (schemes 1-5) have been developed by your architects and were presented to us by Mr. J. B. Julian. We have evaluated the maximum area that would be utilized by all alternatives.

Our investigation focused primarily on the relationship of the proposed buildings to the Campus fault. The location of the Campus fault is based on borings and trenching studies performed for Engineering Unit #2 in 1973.

We have concluded that the Campus fault is located at least 70 feet from the proposed structure "footprint". No other active or potentially active faults appear to cross the site, thus we do not recommend any building design modifications to accommodate faulting.

Other geologic and soil hazards that were evaluated include seismic shaking, expansive soils, high water table, and liquefaction. With respect to seismic shaking, we believe that the structures should be designed to withstand shaking from an earthquake generated by an active offshore fault, rather than one generated from the nearby Campus or More Ranch faults. Trenching and boring excavation performed in the 1970's by others (Dames & Moore, 1973) and by this office in 1985 (Hoover & Associates, 1985 a,b) fail to demonstrate that either the Campus or More Ranch faults are active. Both faults are, however, "potentially active" (Quaternary fault activity), an intermediate category established by the State between active and inactive.

Preliminary Soil Engineering data were gathered at various boring locations that were required for the fault investigation. Those data indicate that the moderately firm silty sands and sands present beneath the Chemistry building and other nearby structures are present at this site to depths of 14 to 16 feet, where shale is encountered. Therefore, it is likely that a foundation design consisting of conventional spread footings for one-story structures and caissons or piles drilled or driven into the shale for three and four-story structures can be utilized for this addition. The presence of ground water will require special design considerations for structures more than 6 or 8 feet below existing grade. More detailed soil engineering investigation can be performed when your building plans are more specific.

In summary, it is our opinion that the proposed Chemistry Building Addition is feasible from a geotechnical standpoint at any one of the proposed locations if the recommendations in this report are followed.

Sincerely,
Hoover & Associates, Inc.

Michael F. Hoover
Principal Geologist

MFH/ag

GEOTECHNICAL INVESTIGATION
PROPOSED CHEMISTRY BUILDING ADDITION
MAIN CAMPUS
UNIVERSITY OF CALIFORNIA, SANTA BARBARA

INTRODUCTION

Purpose

This report summarizes the results of our geotechnical investigation of the area proposed for the construction of an addition to the chemistry building (Plate 1). The area of study encompasses a maximum building "footprint" of 110,000 square feet, which includes all five schemes under consideration.

The purpose of the study was to evaluate the suitability of the site from a geotechnical standpoint, and to provide geotechnical information for use in planning the proposed project. More specifically, we evaluated the site for fault(s), seismic shaking, groundwater levels, liquefaction, differential soil compaction, soil expansion, and other appropriate geologic and soils parameters.

This investigation is intended to meet the requirements for geologic reports outlined by the California Division of Mines and Geology, the State Board of Registration, and to conform to our proposal dated July 18, 1986. The soil engineering portion of our Proposal was not authorized except that some soil samples obtained from geologic borings were evaluated in a general way. Specific soil engineering work will proceed when the exact nature of the development is known.

Proposed Development

The proposed development is in the planning stage, thus the exact location of the building(s) is unknown. We are assuming, pursuant to conversations with Mr. J. B. Julian that some structures will be single story while others may be three to four story. Construction will be steel and concrete similar to other major structures on campus.

SITE CONDITIONS

The site presently consits of lawns, walkways, and temporary office structures. The topography at the site is relatively flat, ranging in elevation from 47 to 50 feet above sea level. Total relief is 3 feet. Drainage is by sheet flow to interior drains.

PREVIOUS WORK

Several investigations have discussed the geologic and soil conditions in the vicinity of the site including Dames & Moore (1972a,b), and Crandall (1964).

The Campus fault was first mapped by Upson (1951). The 1972 Dames & Moore studies performed for the Engineering Unit #2 provided a detailed fault location with borings and trenches. The activity of the fault was also determined in these studies.

Other reports of interest include OSI (1974), Evenson (1962), Dibblee (1966), Coudray and Richards (1966), the Santa Barbara County Seismic Safety Element (1974), and Hoffman (1986).

Most of these reports map the Campus fault as a branch of the More Ranch fault. All investigators map the fault near, but not beneath the proposed addition. The More Ranch fault is considered by some investigators to be active (Santa Barbara County Seismic Safety Element, 1974 and Hoffman (IBI), 1986.

GEOLOGY

Regional Setting

The Santa Barbara/Goleta area consists of a south-dipping homocline (foothills) and adjacent coastal plain cut by numerous faults and disturbed by several folds.

Of regional significance are active offshore faults, principally by Red Mountain Thrust and the Pitas Point faults, located 7 to 10 miles south of the project. One of these faults probably generated the 1925 Santa Barbara earthquake and the 1978 Santa Barbara/Goleta earthquake. Both of these faults are capable of causing earthquakes during the design life of the project.

Local Geology: Lithology

Geologic formations of interest include artificial fill, Pleistocene age marine terrace deposits, and the Pliocene age Sisquoc Formation.

Artificial Fill (AF)

Limited portions of the site have been filled with artificial materials up to at least 2 feet thick (see Boring Logs, Appendix A). The fill is in the western part of the site. The fill consists principally of brown to yellow fine sand to clayey sand, with minor brown silty clay.

Marine Terrace Deposits (Ot)

The site is underlain by Pleistocene age terrace deposits which are principally a tan silty sand approximately 15 feet thick. The terrace deposits have been divided into 3 members: an upper silty sand, a middle sandy member, and a basal fossiliferous sand member.

Sisquoc Formation

Underlying the marine terrace is a dense green to olive colored thinly laminated shale. The shale extends several hundred feet in depth.

Local Geology: Faults

The Campus fault is a southwest trending near vertical dip-slip fault with relative upthrown displacement on the northwest side.

The More Ranch fault is an east-west trending near vertical, dip-slip fault with relative upthrown displacement on the south. As is the case with most faults in the Santa Barbara/Goleta coastal area, the More Ranch fault is poorly exposed because it is overlain by Recent alluvium.

Past movement on the More Ranch fault (since deposition of the Pleistocene-age terrace deposits) has resulted in the uplift on the south side of the fault of the More Mesa and Hope Ranch areas. Oil well logs in the vicinity of the project site indicate vertical displacement at depth of as much as 2000 feet on the fault. Past movement of the Campus fault is much less, probably on the order of 5 feet in the last 60,000 years.

The More Ranch-Campus fault is considered by recent investigators (Dames & Moore, 1973; Crandall, 1979) to be a potentially active fault rather than an active fault (that is, movement in the last 2 million years but not in the last 11,000 years). Previous investigators' opinions that the More Ranch fault may be active (Santa Barbara County Seismic Safety Element, 1974) have not been substantiated by recent studies by this office (Hoover & Associates, 1985 a,b).

FIELD INVESTIGATION

General

In order to more accurately locate the faults identified by previous investigators and to evaluate subsurface soil and geologic conditions, an investigation was undertaken consisting of analysis of boring log data and drilling and evaluation of new borings.

Data Analysis

Several Dames & Moore reports and numerous foundation studies were analyzed during this investigation. Our analysis focused on boring log data. These data indicate an offset in the contact (between the Pleistocene terrace and the Sisquoc Shale) which defines the Campus fault (Plate 2). A fault that does not offset this contact would likely be inactive.

Borings

Hollow stem auger borings were dug at the locations shown on Plate 3 for geologic unit identification and for soil properties evaluation. The boring logs (see Appendix) do not indicate an offset of critical layers beneath the proposed Chemistry Addition. There is an apparent offset in the fossiliferous layer at various locations to the northwest (Plate 4). This offset is approximately 4 to 5 feet, indicating the presence of a fault that is at least potentially active (no movement in the last 11,000 years, but movement in the last 2.5 million). The boring data suggest an en echelon fault. The fault does not appear to extend beneath any of the five schemes under consideration (Plate 3). Further, on the basis of the size of the fault and analysis of trench logs (D&M, 1973) it is our opinion that the zone of soil disturbance resulting from fault movement would not extend beneath any of the scenarios, thus a building setback zone extending beyond the Campus fault would not effect the proposed construction.

GEOLOGIC HAZARDS

Faults

The Campus fault is within 70 feet of the northwest corner of the project (scheme 5). Our borings indicate that no active or potentially active faults cross the building footprint of schemes 1-5. The Campus fault appears to be potentially active rather than active since the youngest Pleistocene materials are not offset. (Dames & More, 1973, Plate 3). Pleistocene age marine terrace deposits Pleistocene are, however, offset, implying fault movement within the last 60,000 to 100,000 years but not within the last 11,000 years.

Seismic History

The Santa Barbara area has experienced several significant earthquakes in historical times, including a magnitude (M) 6.3 in 1925, a M6 in 1941, and M5.1 in 1978. These events and their aftershocks were all apparently generated by offshore faults. Although the causative fault has not been positively recognized, it is thought that either the Pitas Point Fault or Red Mountain Fault was responsible.

Much larger events (although more distant geographically) occurred in 1912 (M7+) and 1857 (M8+). The 1812 event probably originated in the central Santa Barbara Channel, but due to its offshore location and the lack of population and structures the epicenter cannot be precisely established. The 1857 event was the Fort Tejon earthquake on the San Andreas Fault.

Future Seismic Events

An evaluation of the active and potentially active faults in the Santa Barbara region provides a basis for assessing future seismic events. The largest earthquake that could be expected on an active or potentially active fault may be determined empirically by using total fault length (Greensfedler, 1973). Based on the work of Albee and Smith (1966) and Bonilla and Buchanan (1971), the maximum credible earthquake is defined as the event that would occur if 50% of the fault length would rupture. The magnitude of possible seismic events on faults in the Santa Barbara area is given in Table 1.

Because of their proximity to the project, the most critical faults are the active offshore Pitas Point/North Channel and Red Mountain faults, and the potentially active Campus/More Ranch/Mesa/Carpinteria and Santa Ynez faults. Earthquakes generated by larger more distant faults would attenuate (lose energy) before reaching the site, and therefore be less significant.

Ground Shaking

Significant damage to structures may occur when the energy produced by an earthquake generates wave motion in the surface soils and rock. The intensity of ground shaking is measured as acceleration. The acceleration at any particular site is a function of the size of the earthquake, the distance from the source, and the type of the wave generating medium, or rock type.

Considering the uncertainty of the causative fault in the area, we have calculated the expected ground accelerations for design earthquakes generated by several different faults on Table 1.

Table 1 shows that the More Ranch/Mesa/Carpinteria fault system is potentially capable of generating an earthquake of M6.3, resulting in peak ground acceleration at the project site of approximately .68. It is more likely that, during the lifetime of the project, an earthquake will occur on the active Pitas Point/North Channel or Red Mountain faults than on the More Ranch/Mesa/Carpinteria fault system. A M6.6 earthquake generated by the Pitas Point/North Channel fault would result in a site acceleration of about .63.

Since a M6.6 earthquake on the Pitas Point/North Channel is much more likely to occur than a M6.3 on the More Ranch/Mesa/Carpinteria fault system, it is our recommendations that design criteria be planned for an event on the Pitas Point/North Channel fault.

It should be kept in mind that the values shown on Table 1 are peak accelerations. Repeated acceleration values would be somewhat lower.

Landslides/Slope Stability

The site is flat and not susceptible to landslides or slope instability.

Soil Stability

Soil Liquefaction, settlement, and differential compaction can be evaluated more thoroughly when the soil engineering studies are authorized. However, soil borings, blow counts during sampling, and laboratory data developed during this investigation indicate that liquefaction, settlement and compaction problems can be mitigated with a foundation design similar to the existing Chemistry building.

Flooding

Flooding is not expected to occur at this site. Normal site drainage control will be required.

Groundwater

Groundwater was encountered at depth of 9 to 13 feet.

Other Geologic Hazards

Other geologic hazards such as tsunamis, volcanism, and seiches were evaluated and found unlikely to occur at this site.

RECOMMENDATIONS

1. No special considerations are necessary due to hazards associated with the nearby Campus fault since ground rupture, should it occur in the future, will not likely extend beneath the proposed structure.

2. Habitable structures should be designed to withstand, without collapse, peak ground acceleration of .63g associated with a design earthquake of M6.6 on the Pitas Point/North Channel fault located 4.5 miles south of the project.

3. Excavations extending more than 10 to 13 feet below grade will likely require dewatering or shoring due to high groundwater levels.

4. Structures extending more than 6 to 8 feet below existing grade should have a groundwater drainage system.

5. Preliminary soil engineering information suggests that the marine terrace deposits are generally moderately firm to firm and suitable for the support of relatively light one-story structures on conventional continuous/spread footings. Existing artificial fill and near surface, dry, loose terrace deposits (upper 2 to 5 feet) will likely require removal and replacement as compacted fill. To assure adequate support for heavy three to four-story structures, it appears that foundations should be extended into the underlying shale. Either drilled cast-in-place concrete piles or drilled-and-belled caissons may be considered; however, due to water seepage and the caving nature of the soils above the shale, the use of drilled piling would minimize construction difficulties and should result in overall economies. If desired, one-story structures may also be supported on drilled piles. Additional soil engineering investigation should be performed when building plans are more specific to provide detailed foundation and grading recommendations.

Sincerely,
Hoover & Associates, Inc.

Michael F. Hoover
Certified Engineering
Geologist #977
Registered Geologist #3373

MFH/ag

REFERENCES

Coudray, R. M. and Richards R. Jr., 1968, Geologic Map of the Goleta Basin: Santa Barbara County Department of Public Works.

Crandall, LeRoy & Associates, 1964. Report of Foundation Investigation, Proposed Chemistry Building, University of California, Santa Barbara A&E #121.

Crandall, LeRoy & Associates, 1966, Report of Soil Investigation, Storke Property, Goleta, California: for the University of California, (Job No. A-66268). Report #150.

Crandall, LeRoy & Associates, 1979. Investigation of Fault Hazard, Proposed Residential Apartment Complex Site 2, University of California Santa Barbara A&E #219.

Curran, John F., 1966, Geologic Investigation, Storke Property, University of California at Santa Barbara. (Written in Conjunction with LC & A Report A-66268)

Dames & Moore, 1972a. Geology and Seismology Studies, Engineering Unit 2 A&E #177.

Dames & Moore, 1972b. Additional Studies. Engineering Unit 2. A&E #178.

Dames & Moore, 1973. Supplemental Report #1, Engineering Unit 2. A&E #178.

Dibblee, T. W., Jr., 1966, Geology of the Central Santa Ynez Mountains, Santa Barbara County, California: Calif. Div. of Mines and Geology, Bull. 196, 99 p.

Donovan, N. and Bornstein, A., 1975, Probabilistic Approach to Seismic Risk: Paper presented at Soil Dynamics Conf. Aachen, Germany.

Evenson, R. E., Wilson, H. D., and Muir, K. S., 1962, Yield of the Carpinteria and Goleta Ground Water Basin, Santa Barbara County, California, 1941-1958: U.S.G.S. Open File Report, 112 p.

Hoffman, Rick & Associates, 1986. Preliminary Geologig Analysis, UCSB Expansion for IBI dated May 27, 1986.

*— Hoover & Associates, 1985a. Geotechnical Investigation Residential Apartment Complex, Step III. Storke Campus, University of California, Santa Barbara, dated August 13, 1985.

Hoover & Associates, 1985b. Geologic Investigation, Proposed Student Housing Project, Storke Property, Goleta, California for Theimer Associates and the Storke Estate dated September 25, 1985.

Santa Barbara County, Seismic Safety Element, July, 1974.

Santa Barbara County Planning Department, Santa Barbara County Comprehensive Plan, Seismic Safety and Safety Element, Revised April 7, 1978.

Upson, J. E., 1951, Geology and Grond-Water Resources of the South-Coast Basins of Santa Barbara County, California: U.S. Geol. Survey Water Supply Paper 1108.

TABLE 1

Estimated Magnitude of Future Earthquakes on Significant Faults in the Vicinity of the Project

Fault Name	Length (1)	Activity (2)	Distance (1) From Project (miles)	Magnitude of (3) Maximum Cred. Earthquake	Magnitude of (4) Design Earthquake	Peak(5)(6) Bedrock Accel. (g)	Peak(7) Ground Accel. (g)
More Ranch/Mesa/Campus Carpinteria Faults	40	PA	<1	6.8	6.3	.80	.68*
Pitas Point/North Channel	65	A	4.5	7.2	6.6	.75	.63**
Red Mountain Fault	40+	A	16	7.0	6.5	.25	.24
Santa Ynez Fault	95+	PA	9	7.25	6.8	.50	.45
Big Pine Fault	53+	A	19	7.0	6.5	.20	.20
San Andreas Fault	620	A	52	8.2+	--	.18	.18
Mid-Channel Fault	62	PA(?)	12	7.1	6.5	.32	.30

(1) Data from Yerkes, et al (1981)

(2) A - Active Fault
Fault with surface displacement during the last 11,000 years or earthquake related to it.

PA - Potentially Active Fault
Quarternary fault with demonstrable movement within the last 2 million years, but not within the Holocene (last 11,000 years).

IA - Inactive Fault
Fault with no demonstrable movement within the past 2 million years.

(3) Assumes 50% fault rupture (Greensfedler, 1974, Albee and Smith, 1966).

(4) Assumes 25% fault rupture.

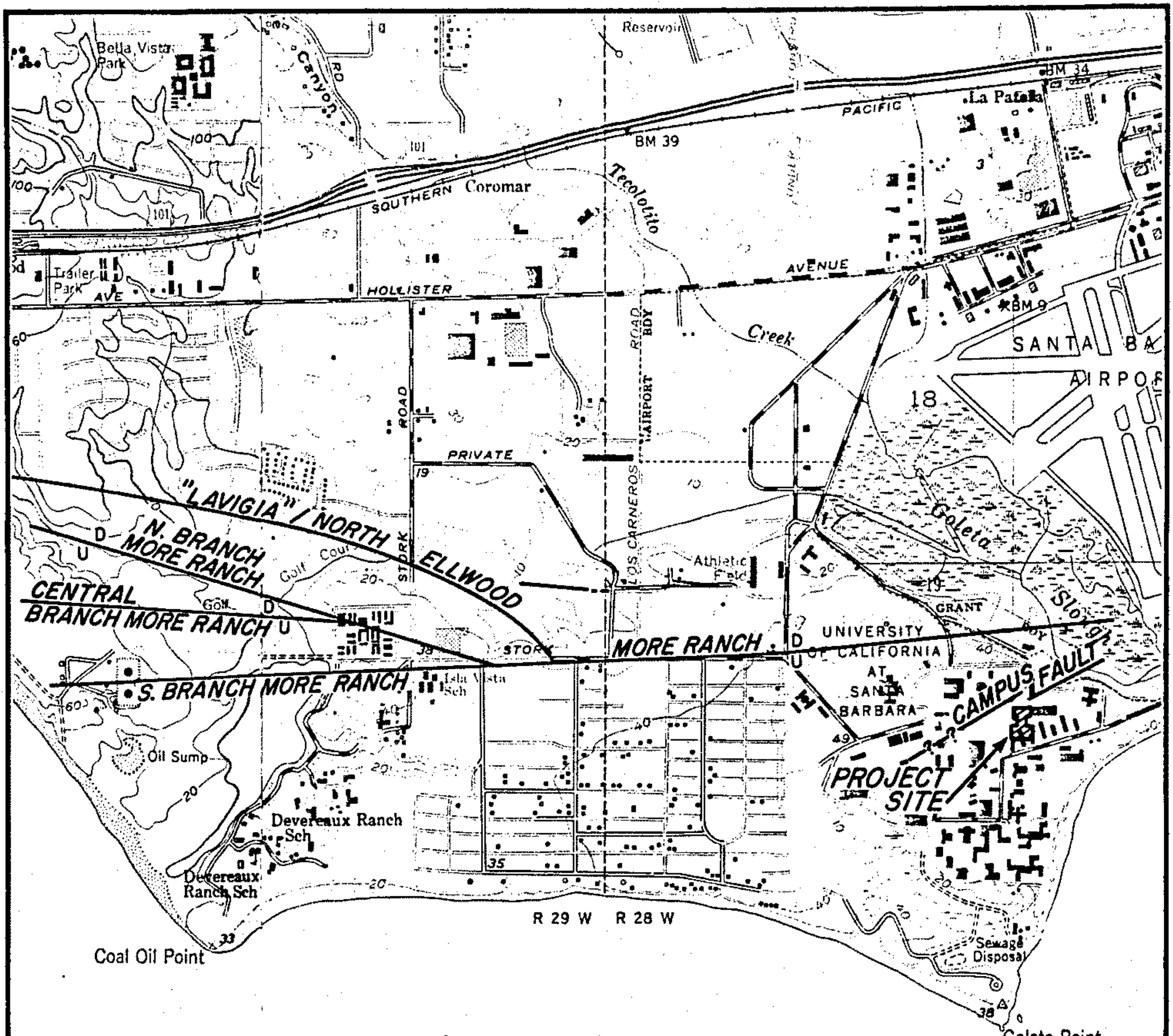
(5) 84% probability that the prediction will exceed the real value.

(6) Joyner and Boare (1981).

(7) Seed et al (1976).

* Not recommended for design since probability of larger near field event (within 3 miles) on a fault that is not active is extremely low.

** Recommended for design.

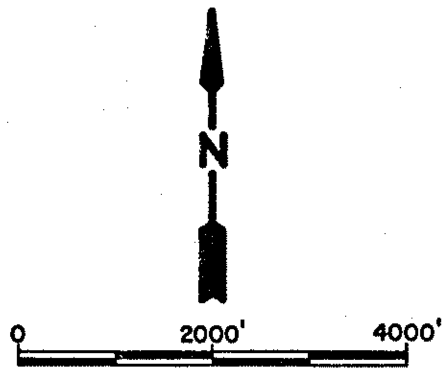


Portions of the Dos Pueblos and the Goleta 7 1/2' quadrangles

PROJECT LOCATION MAP
and
FAULT MAP

PROPOSED CHEMISTRY BUILDING ADDITION

UNIVERSITY OF CALIFORNIA, SANTA BARBARA



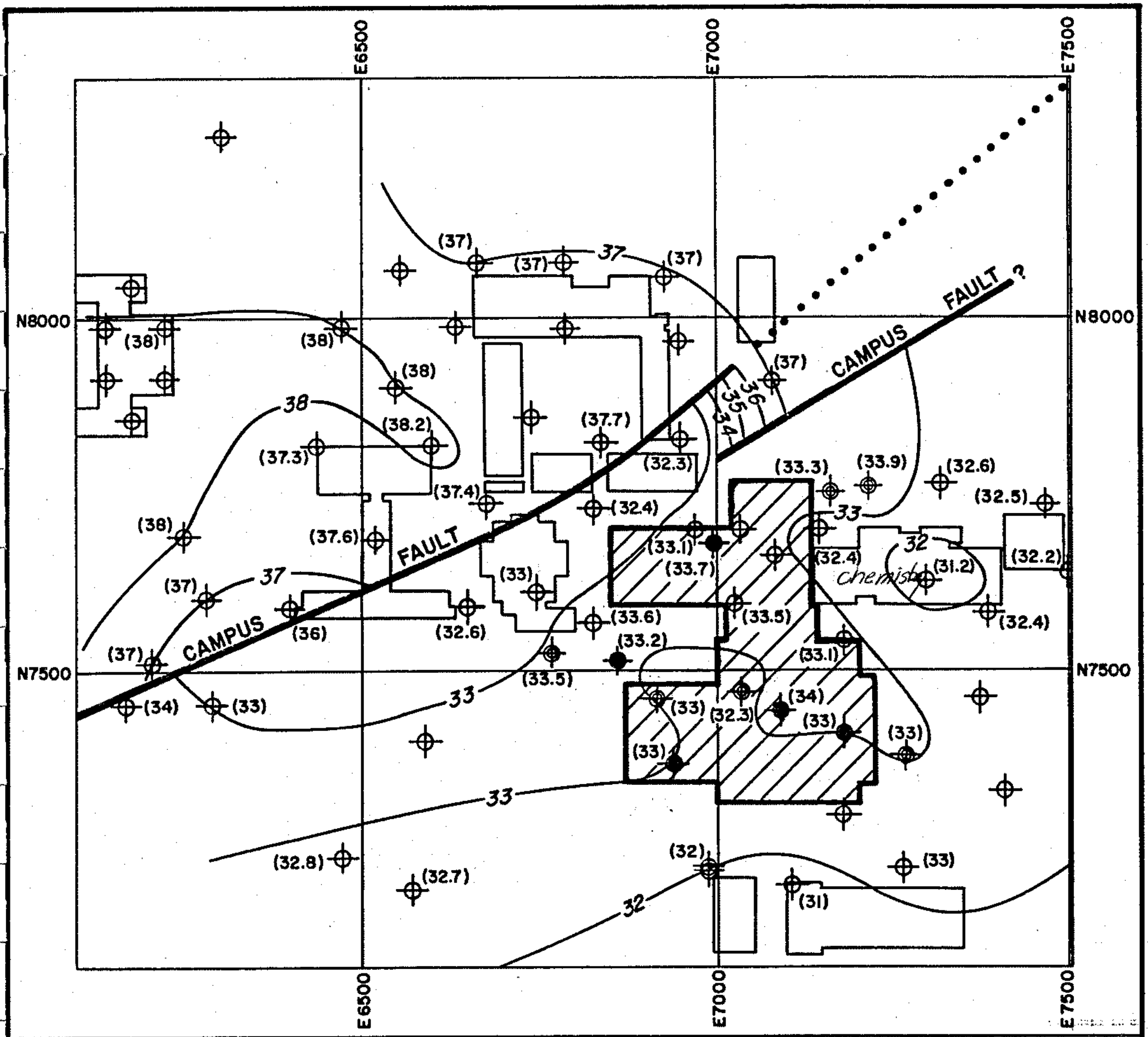
Modified from Crandall (UCSB No.74031) and
Hoover & Associates (UCSB No. 216-009)

HOOVER & ASSOCIATES, INC.
Geologists - Hydrologists - Soil Engineers

Plate I

File ______

By DAS Date 6/87



STRUCTURAL CONTOUR MAP
PROPOSED CHEMISTRY BUILDING ADDITION

0 200' 400'
SCALE

LEGEND

—37— Elevation of Surface of Sisquoc Shale

Maximum Building Footprint - Proposed Chemistry Addition Schemes 1-5

Campus Fault; solid where Quaternary Age Marine Terrace is offset (potentially active), dotted where Marine Terrace is not offset (inactive fault)

Boring Location; number in parenthesis indicates elevation of Sisquoc Shale above sealevel

(33) This Investigation

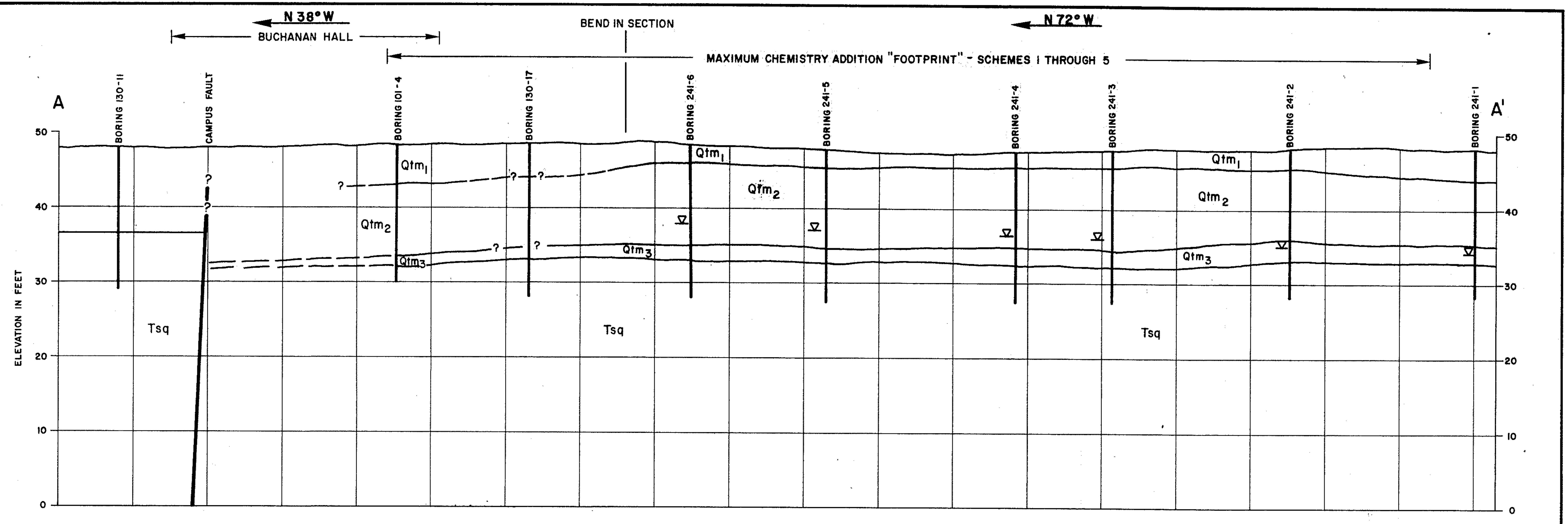
(32) This Investigation; sampled for soil engineering

(33) Previous Investigation

N

HOOVER & ASSOCIATES, INC.
Geologists - Hydrologists - Soil Engineers

Plate 2



LEGEND

Quaternary	Pleistocene	Qtm1	Terrace Marine Formation – Upper Member
		Qtm2	Terrace Marine Formation – Middle Member
		Qtm3	Terrace Marine Formation – Lower Member
Tertiary	Pliocene	Tsq	Sisquoc Formation
		▽	Water Table

See Plate 3 for location of cross-section

GEOLOGIC CROSS-SECTION A—A'

PROPOSED CHEMISTRY ADDITION

SCALE

HORIZONTAL

0 40' 80'

0 10' 20'

VERTICAL

VERTICAL EXAGGERATION = 4X

HOOVER & ASSOCIATES

APPENDIX

Boring Logs

KEY TO LOGS OF TEST BORINGS

3.0-Inch O. D. Modified California Sampler

Standard Penetration Test

Bulk Sample

Pocket Penetrometer, tsf

Water Level, First Encountered

Water Level After Drilling

NS	No Sample Recovered
Qtm_1	Brown silt
Qtm_2	Blue/Gray silty sand
Qtm_3	Gray/Black fossiliferous sand
Tsq	Sisquoc Formation (Shale)

Note: SOIL CLASSIFICATION SHOWN ON THE LOGS ARE FIELD CLASSIFICATIONS BASED ON UNIFIED SOIL CLASSIFICATION SYSTEM.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

BORING LOG

BORING NO. B-1

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location: SE building footprint N7382 E7266
Elevation: 48.0'

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION		IN-PLACE DRY DENSITY p.c.f.	IN-PLACE MOISTURE CONTENT % dry wt.
0	1-1B	☒		lt. brn./gray silt (ML) moist to dry; loose	Qtm_1		
5				mottled yellow/gray silty sand (SM); moist, somewhat cohesive (slightly firm)	Qtm_2		
				lt. brn. silty sand (SM); moist			
10		▨	44	small rounded black organics; yellow/brn. silty sand (SM); v. moist	▽ Qtm_2		
				black sand (SP); v. moist loose	Qtm_3		
15		▨	37	blue gray mudstone; dry to moist; firm to stiff	Tsq		
				blue gray silstone; dry to moist; firm to stiff			
20		▨	45	EOB - 20' Groundwater as noted Date of drilling 5/6/87			

BORING LOG

BORING NO. B-2

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location: NW on line from B-1 98'
Elevation: 47.4 N 7416 E7174

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION		IN-PLACE DRY DENSITY pcf	IN-PLACE MOISTURE CONTENT % dry wt.
0	2-1B			lt. brn. silt (ML);dry;loose			
	2-1		37		Qtm1		
	2-2		78	mottled yellow/brn.silty sand (SM); dry to moist; loose to firm	Qtm2		
5	2-3		46	some black organics (small round pebble shapes)			
				silty sand (SM); v. moist to saturated; loose			
10	2-4	NS	47		Qtm2		
				black sand (SP); v.moist; loose	▽ Qtm3		
15	2-5		104	blue mudstone; dry to moist; firm to stiff	Tsq		
20	2-6		73				
				EOB - 20' Groundwater as noted Date of drilling - 5/6/87			

BORING LOG

BORING NO. B-3

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location: NW from B-2 100;
Elevation: 47.5' N7446 E7081

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION		IN-PLACE DRY DENSITY p.c.f.	IN-PLACE MOISTURE CONTENT % dry wt.
0	3-1 3-1B		22	lt. brn. silt (ML); dry to moist; loose	Qtm1		
	3-2		52	mottled yellow/brn. silty sand (SM); moist; loose to firm	Qtm2		
5	3-3		33	small black organic spots			
10			39	gray/blue silty sand (SM); v.moist to saturated; loose to firm	▽ Qtm2		
				black sand (SP); saturated loose to firm; shell fragments	Qtm3		
15	3-5		50	blue mudstone; dry to moist; firm to stiff	Tsq		
				green silstone; dry to moist; stiff to hard			
20	3-6		80				
				EOB - 20' Groundwater as noted Date of drilling - 5/6/87			

BORING LOG

BORING NO. B-4

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION Job: UCSB Boring Location: 50' NW from B-3 Elevation: 47.3' N7464 E7034	IN-PLACE DRY DENSITY pcf.	IN-PLACE MOISTURE CONTENT % dry wt.
0				lt. brn. silt (ML); dry; loose — Qtm_1		
				Qtm_2 mottled yellow/gray silty sand (SM); moist; firm to loose		
5				gray blue silty sand (SM); moist to v. moist; firm, some dark organic spots		
10				(5/7/87) ▽ ▽		
				Qtm_2		
				black sand (SP); v. moist to saturated — Qtm_3		
15		⧄	39	?		
				blue mudstone; dry to moist; hard — Tsq		
20				EOB - 18.5' Groundwater as noted Date of drilling - 5/5/87		

BORING LOG

BORING NO. B-5

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location: 100' NW from B-4
Elevation: 47.6 N7472 E6862

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION		IN-PLACE DRY DENSITY p.c.f.	IN-PLACE MOISTURE CONTENT % dry wt.
0				lt.brn. silt (ML); dry to moist; loose	Qtm_1		
				gray silty sand (SM); moist; loose	Qtm_2		
5				mottled gray blue silty sand (SM); moist; loose to firm; some pebbles and recemented sand	Qtm_2		
10				▽ ▽ (groundwater)	Qtm_2		
				dark gray/black sand (SP); sub-rounded and angular shale fragments; saturated			
15				dark gray/black sand (SP), numerous shells	Qtm_3		
				blue/green mudstone, dry to moist; stiff to hard	Tsq		
20		▨	73	bedding/lamination orientation 090/30N			

EOB-20'
Groundwater as noted
Date of drilling - 5/7/87 9:30 A.M.

Note - hole caved to 11'9" 3:00 P.M.
no water

BORING LOG

BORING NO. B-6

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location: Eucalyptus row
Elevation: 48.2' N7505 E6862

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION		IN-PLACE DRY DENSITY p.c.f.	IN-PLACE MOISTURE CONTENT % dry wt.
0	6-1B			lt. brn. silty sand (SM) and silt (ML); dry; hard	Qtm_1		
				lt. brn./gray silty sand (SM); moist; loose to firm	Qtm_2		
	6-2		20				
				mottled brn., orange silty sand (SM); moist; loose to firm			
5	6-3		78				
				blue/gray silty sand (SM); v. moist to saturated; loose to firm			
10	NS		50				
	6-4		43		Qtm_2		
				dark gray/black sand (SP) with shells; saturated soft	Qtm_3		
	6-5						
15			68	blue/green mudstone; dry to moist; hard	Tsq		
20							
				EOB - 20' Groundwater as noted Date of drilling 5/7/87			

BORING LOG

BORING NO. B-7

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location S. of Buchanan Hall
Elevation: 49.5' N7517 E6760

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION		IN-PLACE DRY DENSITY p.c.f.	IN-PLACE MOISTURE CONTENT % dry wt.
0				brn. sandy silt (SM); moist; loose; some stone fragments (fill?)	Qaf		
2				lt. brn. sandy silt (SM); moist; loose	Qtm_2		
6				yellow/gray sandy silt (SM); moist to v. moist; loose and silty sand			
11		/	39	blue/gray silty sand (SM); v. moist to saturated; loose	▽		
13.5					▽		
15		/	11		Qtm_2		
16				blue/green mudstone; dry to moist; hard	Tsq		
20				EOB - 20' Groundwater as noted Date of drilling 5/7/87 - 1:00 P.M.			

BORING LOG

BORING NO. 8-8

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location: North side of Chemistry Bldg.
Elevation: 47.7' N7692 E6998

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION		IN-PLACE DRY DENSITY p.c.f.	IN-PLACE MOISTURE CONTENT % dry wt.
0							
	8-1B			lt. brn. silt (ML); dry to moist, loose	Qtm_1		
	8-1		8				
	8-2		67	mottled yellow gray and brn. silty sand (SM); moist to v. moist; firm to stiff	Qtm_2		
5	8-3		37	some re-cemented pebbles/ sand			
10	8-4		45	gray silty sand (SM); v.moist to saturated; firm ▽	Qtm_2		
				black sand (SP), shells; saturated	Qtm_3		
15	8-5		53	blue/green mudstone; dry to moist; stiff	Tsq		
20			60				

EOB - 20'
Groundwater as noted
Date of drilling - 5/7/87

BORING LOG

BORING NO. B-9

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location: N side Chemistry Building
Elevation: 48.3'   N7752   E7152

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE DRY DENSITY p.c.f.	IN-PLACE MOISTURE CONTENT % dry wt.
0				yellow/brn. sandy silt (SM); gravels; dry; loose — Qtm1		
				lt. brn. silt (ML); dry; loose to firm — Qtm(?)		
5				yellow mottled silty sand (SM); dry to moist; loose to firm — Qtm2		
10			43	mottled yellow/gray silty sand (SM); moist to v. moist, firm — Qtm2		
				black silty sand (SM); v.moist; firm; no shells — Qtm3		
15			14	blue/green mudstone; dry to moist; stiff to hard — Tsq		
20				EOB - 20' Groundwater as noted Date of drilling - 5/8/87		

BORING LOG

BORING NO. B-10

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

Job: UCSB
Boring Location: N. side of Chemical Building
Elevation: 48.9 N7763 E7205

Depth in Feet	Sample No.	Log & Location of Sample	Penetration Resistance Blows/ft	Description		In-Place Dry Density p.c.f.	In-Place Moisture Content % dry wt.
0				lt. brn. silt (ML); gravels; organics; dry to moist; loose	Qtm_1		
5				mottled yellow/gray silty sand (SM); moist; firm	Qtm_2		
10							
		sample	41	▽ (groundwater)			
				yellow silty sand, v. moist to saturated; firm	Qtm_2		
15			46	black sand (SP), saturated; firm	Qtm_3		
		sample		green/blue mudstone; dry to moist; stiff	Tsq		
20				EOB - 20' Groundwater as noted Date of drilling - 5/8/87			

BORING LOG

BORING NO. B-11

HOOVER & ASSOCIATES
Geologists • Hydrologists • Soil Engineers

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION Job: UCSB Boring Location: SW Bldg. footprint Elevation: 47.4' N7363 E6942		IN-PLACE DRY DENSITY pcf	IN-PLACE MOISTURE CONTENT % dry wt.
0	11-1B			lt. brn./gray silt (ML); moist; loose			
	11-2		62	lt. brn./gray silty sand (SM); moist to v. moist; loose	Qtm_1		
5	11-3		43	mottled yellow silty sand (SM); moist; firm			
10	11-4		39	gray silty sand (SM); v. moist to saturated;firm (groundwater ▽)	Qtm_2		
				black sand (SP); saturated; firm	Qtm_3		
15	11-5		50	blue/green mudstone; dry;stiff	Tsq		
20				EOB - 20' Groundwater as noted Date of drilling - 5/8/87			