# ENGINEERING GEOLOGY INVESTIGATION
# LAS PILITAS ROCK QUARRY
# HIGHWAY 58, APN: 070-141-070 AND 071, SANTA MARGARITA AREA, SAN LUIS OBISPO COUNTY, CALIFORNIA

**PROJECT SL7059-1**

Prepared for

**Attn: Ken Johnston**
**Las Pilitas Resources, LLC.**
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Prepared by


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July 14, 2009

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July 14, 2009
Project No. SL07059-1

**Attn: Ken Johnston**
**Las Pilitas Resources, LLC.**
Post Office Box 875
Santa Margarita, California 93453

Dear Mr. Johnston,

This Engineering Geology Investigation has been prepared for the proposed Las Pilitas rock quarry to be located off State Highway 58, APN: 070-141-070 & 071, in the Santa Margarita area of San Luis Obispo County, California. This report includes a discussion of geological hazards and provides general recommendations.

Generally, Granitic Rock units are located throughout most of the site. Excavation is to occur within competent Granitic Rocks. Landslides were not observed or mapped at the site. Active faults are not mapped crossing the proposed development. Specific conclusions and recommendations are included within the report.

GeoSolutions, Inc. appreciates the opportunity to provide technical services to you. Should you have any questions regarding this report, please do not hesitate to call at (805) 543-8539.

Sincerely,
**GeoSolutions, Inc.**

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## TABLE OF CONTENTS


1.0 INTRODUCTION ..... 1

2.0 CONCLUSIONS ..... 2
- 2.1 Geologic Conditions ..... 2
- 2.2 Landslides and Liquefaction ..... 2
- 2.3 Seismic ..... 2
- 2.4 Seismically Induced Hazards ..... 2
- 2.5 Groundwater and Drainage ..... 3
- 2.6 Asbestos ..... 3

3.0 RECOMMENDATIONS ..... 3

4.0 SITE DESCRIPTION ..... 4

5.0 PURPOSE AND SCOPE ..... 4

6.0 ENGINEERING GEOLOGY INVESTIGATION ..... 5
- 6.1 Regional Geology ..... 5
- 6.2 Local Geology ..... 5
  - 6.2.1 Surficial Units ..... 5
  - 6.2.2 Formational Units ..... 5
- 6.3 Surface and Groundwater Conditions ..... 7
- 6.4 Erosion ..... 7

7.0 LANDSLIDES ..... 7
- 7.1 Numerical Slope Stability Analysis ..... 7
- 7.2 Modeling Conditions ..... 8
- 7.3 Discussion of Results of Numerical Analysis ..... 8
- 7.4 Nearby Slopes ..... 9

8.0 FLOODING AND SEVERE EROSION ..... 10

9.0 ON-SITE SEPTIC SYSTEMS AND WATER SUPPLY ..... 10

10.0 HYDROCOLLAPSE OF ALLUVIAL FAN SOILS ..... 10

11.0 REGIONAL FAULTING AND SEISMICITY ..... 10
- 11.1 Ridgetop Shattering ..... 11
- 11.2 Rinconada Fault ..... 11
- 11.3 Seismic Hazard Analysis ..... 12
- 11.4 Structural Building Design Parameters ..... 12
- 11.5 Design Response Spectra – 2007 CBC ..... 13
- 11.6 Active Faulting and Coseismic Deformation ..... 14
- 11.7 Seismically-Induced Water Waves and Flooding ..... 14
- 11.8 Seismically-Induced Settling and Slope Failure ..... 14

12.0 LIQUEFACTION ANALYSIS ..... 15

13.0 BLASTING ..... 15

14.0 GEOLOGIC HAZARDS ..... 15
14.1 Expansive Soils ..... 15
14.2 Corrosive Soils ..... 15
14.3 Naturally Occurring Asbestos ..... 15
14.4 Radon and Other Hazardous Gases ..... 15

15.0 SUBSIDENCE ..... 15

16.0 VOLCANIC ERUPTION ..... 16

17.0 ADDITIONAL SERVICES ..... 16

18.0 LIMITATIONS ..... 16

REFERENCES

PLATES

Plate 1 - Site Engineering Geologic Map
Plate 2 - Site Cross Section
Plate 3A, 3B - Regional Geologic Map, Hart, 1976 and Geologic Explanations
Plate 4A, 4B - Regional Geologic Map, Dibblee, 2004 and Geologic Explanations
Plate 5A, 5B, 5C - Regional Fault Map, Jennings, 1994 and Explanations
Plate 6A, 6B - Historical Seismicity Map and Historical Seismicity List
Plate 7 - Landslide Hazards Map, San Luis Obispo County Department of Building and Planning, 1999
Plate 8A, 8B - Flood Insurance Rate Map, FEMA, 1985 and Explanation
Plate 9A, 9B - Geologic Study Area Map and Explanations, San Luis Obispo County Department of Building and Planning, 1996

APPENDIX A

Trench Logs
Boring Logs
Boring Logs (Department of Water Resources, September, 2002)
Rock and Fracture Descriptors

APPENDIX B

Laboratory Test Results

APPENDIX C

Final Construction Geology Report, Coastal Branch Phase II, Reach 4 Pipeline, Calf Canyon Tunnel to Cuesta Tunnel and Calf Canyon Tunnel (Department of Water Resources, September, 2002, Appendix C) with Plate 3, As-Excavated Geology Plan and Profile

APPENDIX D

Probability of Exceedance Chart
Seismic Parameters

**ENGINEERING GEOLOGY INVESTIGATION**
**LAS PILITAS ROCK QUARRY**
**HIGHWAY 58, APN: 070-141-070 AND 071, SANTA MARGARITA AREA,**
**SAN LUIS OBISPO COUNTY, CALIFORNIA**

**PROJECT SL07059-1**

## 1.0 INTRODUCTION

As requested, representatives of GeoSolutions, Inc. completed an Engineering Geology Investigation for a proposed quarry located off Highway 58, APN: 070-141-070 and 071, in the Santa Margarita area of San Luis Obispo County, California. Figure 1 is an area location map. Figure 2 is a photograph of the site (Page 4). Plate 1, Site Engineering Geologic Map depicts local geologic conditions. Plate 2, Site Cross Section, presents an interpretive section of the property. Plates 3A and 4A, Regional Geologic Maps (Hart, 1976 and Dibblee, 2004), depict geologic conditions in the vicinity of the property. Plates 3B and 4B present Geologic Explanations. Plate 5A, Regional Fault Map (Jennings, 1994), depicts fault locations in the vicinity of the site. Plates 5B and 5C present the Fault explanations. Plate 6A, Historical Seismicity Map and Plate 6B, Historical Seismicity List depict significant historical earthquakes in the region. Plate 7, Landslide Hazards Map (San Luis Obispo County Department of Planning and Building, 1999) depicts the County of San Luis Obispo landslide hazard potential in the vicinity of the Site. Plate 8A and 8B are the Flood Insurance Rate Map (FEMA, 1985) and Explanations depicting the location of any 100-year flood zone in the vicinity of the Site. Plate 9A and 9B, Geologic Study Area Map (San Luis Obispo County Department of Planning and Building, 1996) depicts the geologic study area in the vicinity of the property. The signing Engineering Geologist of GeoSolutions, Inc. conducted geological reconnaissance mapping and subsurface investigation on June 22 and June 30, 2009. This report discusses geologic conditions observed at the Site and provides general engineering geologic

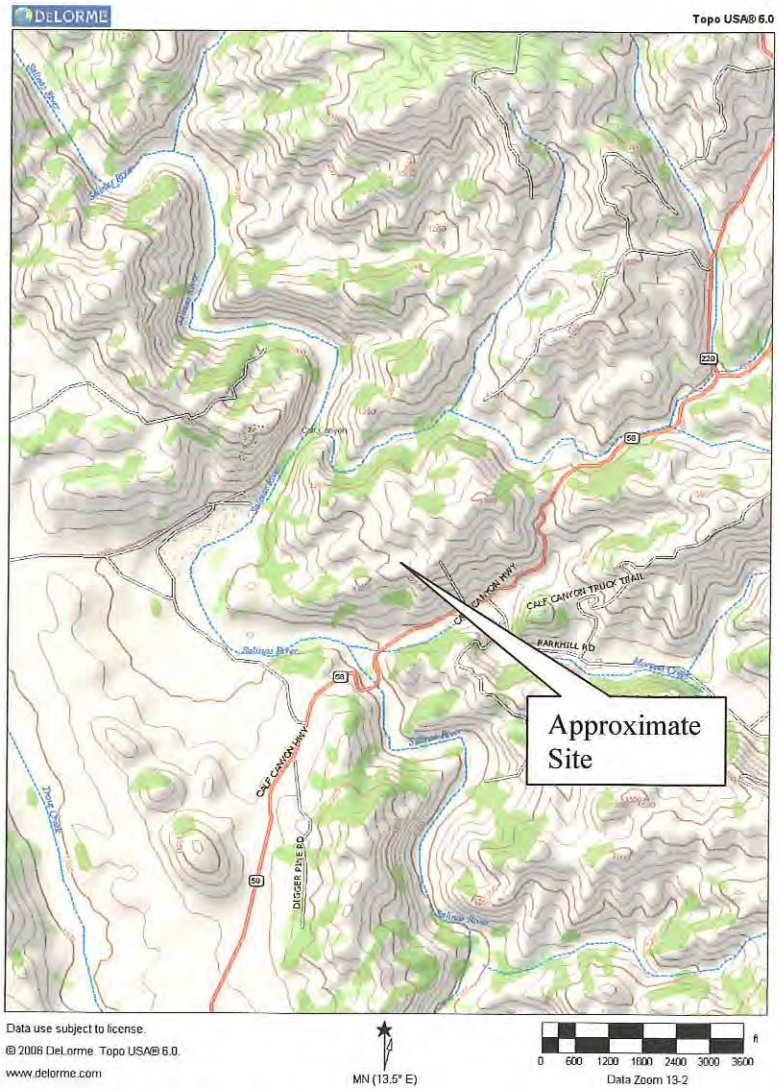


**Figure 1: Area Location Map**

recommendations regarding proposed development. This report was prepared in accordance with San Luis Obispo County Department of Planning and Building Land Use Ordinance Section 23.07.084, Guidelines for Engineering Geology Reports, December 2004, requirements of section 22.08.180 of the land use ordinance and the standards of the California Surface Mining and Reclamation Act of 1975.

## 2.0 CONCLUSIONS

A proposed rock quarry is assumed to occur in phases over a period of several years or decades. The proposed cut slopes for the rock quarry appear adequate provided the recommendations within this report are implemented. The following conclusions are made:

### 2.1 Geologic Conditions

Formational units of the Granitic Rocks (Kgr) on Plates 1 and 2 were encountered near the surface, along slopes, and outcropping in the vicinity of the proposed rock quarry. Colluvium (Qc) was encountered overlying these formational units. Colluvial surface materials generally consist of light gray silty SAND (SM) encountered in a dry condition. Based upon observations made during the field investigation, localized hard rock conditions will be encountered during excavation and blasting will be necessary depending upon production rates.

### 2.2 Landslides and Liquefaction

No immediate indications of landslides were observed at the Site. The potential for large slope instability to occur at the property is low based on near surface formational material. A numerical slope stability analysis was performed on the proposed quarry profile and is presented in Section 7.0. The liquefaction potential at the proposed development location is considered low due to the presence of near-surface, Granitic Rocks (Kgr).

### 2.3 Seismic

The potential for ground rupture and ground shaking is considered moderate since a splay of the Rinconada fault passes through the proposed quarry area. In addition, ground shaking from faults in the vicinity may cause failure of loose soil or loose rock on the face of slopes. The closest known Holocene age active fault and active portion is the Los Osos fault located approximately 12.5 miles southwest of the Site. The Site Class for the proposed structure is C. The Seismic Design Category for the proposed structure is D. There is an assumed moderate to high potential for ridgetop shattering at the property due to the location of portions of the quarry along ridges, however currently the only structure proposed are associated with the truck scale which is not located on a ridgetop therefore affects would be low to moderate. Potential adverse affects would mirror those conditions experienced at the nearby adjacent quarry where production was maintained after the recent San Simeon Earthquake.

### 2.4 Seismically Induced Hazards

The potential for a tsunami to affect the Site is low due to the distance to the Pacific Ocean and elevation above sea level. Flooding associated with a seismic event is considered low due to the absence of a body of water upgradient of the property. There is a low potential for seismically induced settlement at the Site based upon the depth to the resistant Granitic Rocks material.

### 2.5 Groundwater and Drainage

Surface drainage generally flows southwest along natural drainage courses toward the Salinas River. Groundwater was not observed in any trenches or borings excavated to a maximum depth of 84 feet below ground surface.

### 2.6 Asbestos

As the property is not within Franciscan Complex or similar type rock materials there is a low potential for naturally occurring asbestos at the Site.

## 3.0 RECOMMENDATIONS

The following are recommended for implementation at the Site.

1. A numerical slope stability analyses was conducted on soil or rock slopes excavated at 1.5-to-1 (horizontal to vertical) and locally 0.5:1 (horizontal to vertical) at approximately Station 26+60 on Profile A-A' (see Plate 2). Due to the presence of competent Granitic Rock units in the subsurface, un-retained rock cuts with slopes steeper than 1.5-to-1 (horizontal to vertical) may be considered under the supervision of the Engineering Geologist who verifies rock quality and performing a stability analysis at those particular locations. Locally steeper slopes may be allowed depending on further study and slope stability analysis.

2. Seepage is anticipated along the interface of the surface colluvial materials and the underlying formational units. Seepage within formational units should also be anticipated. Surface drainage facilities (graded swales, gutters, positive grades, etc) are recommended at the base of cut slopes that allow surfacing water to be transferred away from the base of the slope.

3. Surface drainage should be controlled to prevent concentrated water-flow on either natural or constructed slopes. Surface drainage gradients should be planned to prevent ponding and promote drainage of surface water away from natural or man-made slopes.

4. It's recommended that the benches be maintained periodically to remove collected debris. It is understood that this is a working reclamation and that heavy machinery is available at all times and safety precautions are a concern to those on-site.

5. It is our understanding that a structure is proposed associated with the truck scale which will utilize a sewage disposal system, therefore it is recommended that percolation testing be performed in this area.

6. It is recommended that the Engineering Geologist review the site grading plan prior to construction.

7. Excavation, fill, and construction activities should be in accordance with appropriate codes and ordinances of the County of San Luis Obispo. In addition, unusual subsurface conditions encountered during grading such as springs or fill material should be brought to the attention of the Engineering Geologist and Soils Engineer.

## 4.0 SITE DESCRIPTION

Based upon a review of the referenced Site Plan, it is our understanding that proposed quarry operations are to consist of excavations to depths of 250 feet below the existing ground surface. Final cut slopes are proposed to be 1.5:1 (horizontal: vertical) with a 25 foot wide terrace located every 50 feet in elevation and locally a 0.5:1 (horizontal:vertical) slope in the bottom of the proposed quarry is proposed to a maximum height of 50 feet. It is our understanding that the 0.5:1 slope will be backfilled with engineered fill to a shallower slope gradient during mine reclamation. The area of disturbance is approximately 55 acres with an access road at the southern portion providing access from State Highway 58. The quarry will be used as a source for construction materials, i.e. sand, gravel, coarse aggregate, rip-rap, and recycled concrete and asphalt. The property is currently vacant. The property consists of east-west trending gently rolling hills surrounding a canyon through the center of the proposed quarry area. The gradient ranges from 5:1 to 2:1 (horizontal to vertical). Existing unimproved agriculture dirt roads extends through the property and provides access to the site from Highway 58. Drainage is directed west toward the Salinas River through existing natural drainage courses towards the southwest. Plate 1 shows the location and extents of the proposed quarry.

**Figure 2: Site Photograph (red outline depicts the approximate quarry extents)**

The property will hereafter be referred to as the "Site." General Site coordinates are 35.415248 latitude and -120.564781 longitude. Elevation is approximately 1,000 to 1,475 feet above sea level.

## 5.0 PURPOSE AND SCOPE

The purpose of this study was to evaluate engineering geologic hazards at the Site and to develop conclusions and recommendations regarding site development. The scope of this investigation consisted of:

1. A review of available published and unpublished geologic data, geotechnical publications, maps, and reports pertinent to the project Site;

2. A review of regional faulting and seismicity hazards.

3. Review of borings and trenches at the site and in the vicinity of the site (Appendix A presents the trench and boring logs).

4. A general review of landslide potential, surface water and groundwater conditions, and liquefaction hazards.

5. Review of aerial images of the property.

6. Development of recommendations for site preparation.

7. Preparation of this report that summarizes our findings, conclusions, and recommendations regarding engineering geology aspects of the project.

## 6.0 ENGINEERING GEOLOGY INVESTIGATION

### 6.1 Regional Geology

The site is located in the vicinity of the San Luis Range of the Coast Range Geomorphic Province of California. The Coast Ranges lie between the Pacific Ocean and the Sacramento-San Joaquin Valley and trend northwesterly along the California Coast for approximately 600 miles between Santa Maria and the Oregon border.

### 6.2 Local Geology

Locally, the site is located within Granitic Basement Rock units. Plates 3A and 4A are Regional Geologic Maps of the general vicinity of the Site and Plates 3B and 4B provide descriptions of these Regional Geologic Maps (Hart, 1976 and Dibblee, 2004). Hart, 1976 mapped the specific site as within Upper Cretaceous age (99 to 65 million years before present {mybp}) Granitic Rocks (Kgr). Dibblee, 2004 mapped the specific site as within Cretaceous age (144 to 65 million year before present {mybp}) Granitic Basement Rocks (gr). Our subsurface trench exploration at the project encountered units of Granitic Basement Rocks. Information derived from the subsurface exploration was used to classify subsurface soil and formational units and to supplement geologic mapping. Plate 1 depicts the location of the trenches.

#### 6.2.1 Surficial Units

Light gray silty SAND (SM) was observed as surficial deposits in the vicinity of the proposed quarry area, which is termed colluvium (Qc). This material is thin to non-existent in areas of the proposed quarry due to the presence of granite outcrops. The trench logs encountered a maximum of 1 foot of surficial colluvium.

#### 6.2.2 Formational Units

Plate 1, Site Engineering Geology Map, depicts the property as within Granitic Rocks (Kgr) units. Plate 2 presents cross sections through the property.

Within Bulletin 199, Hart 1976 describes the Granitic Rocks (Kgr) as "unweathered granodiorite and adamellite are light to medium gray with pink and or green casts. They weather readily to yellowish-brown colors. Most rocks are coarse grained, porphyritic, hypidiomorphic, and seriate, although leucocratic varieties tend to be finer and more even grained." Dibblee, 2004 describes

the Granitic Basement Rocks (gr) as "Granitic rocks, granodiorite to quartz monzonite, medium-grained holocrystaline, massive, light gray, somewhat incohertant where weathered, composed of quartz, potassic feldspar and sodic plagioclase feldspar in nearly equal amounts and abundant biotite mica." The thickness of the unit at the site is unknown.

The Granitic Rock at the site is observed as bluish gray biotitic granodiorite, fresh to slightly weathered (W1-W3), hard (H3), and dry to moist encountered in the borings at a depth varying form 46 to 69 feet below ground surface. The upper unit of Granitic Rock at the site consisted of light brown "decomposed" biotitic granodiorite encountered in a moderately soft to moderately hard (H4-H5), moderately to intensely weathered (W5-W7), dry, slightly fractured, and massive. Rock and fracture descriptors are provided within Appendix A. Table 14 within the Soil Survey of San Luis Obispo County (USDA, 1983) identify the bedrock in the vicinity of the proposed quarry site as rippable, however hard rock conditions should be anticipated. The potential for blasting is further described in Section 13.0.

Eight trenches (T-1 though T-8) were excavated by Souza Engineering Contracting, Inc. and four borings (B-1 through B-4) were drilled by Alpha Explosives for this investigation to determine the depth to unweathered formational units, and preliminarily determine the quality of the formational material. Trench T-1 encountered Granitic Rocks (Kgr) to a termination depth of 16 feet below ground surface (bgs) with an increase of hardness to moderately hard (H4) at a depth of 4 feet bgs. Trench T-2 encountered Granitic Rocks (Kgr) to a termination depth of 12.5 feet bgs with an increase of hardness to moderately hard (H4) at a depth of 4 feet bgs. Trench T-3 encountered colluvium (Qc) to a depth of 0.5 foot bgs underlain by Granitic Rocks (Kgr) to a termination depth of 9 feet bgs with an increase of hardness to moderately hard (H4) at a depth of 4 feet bgs. Trench T-4 encountered Granitic Rocks (Kgr) to a termination depth of 12 feet bgs with an increase of hardness to moderately hard (H4) at a depth of 4 feet bgs. Trench T-5 encountered Granitic Rocks (Kgr) to a termination depth of 12.5 feet bgs with an increase of hardness to moderately hard (H4) at a depth of 4 feet bgs. Trench T-6 encountered colluvium (Qc) to a depth of 1 foot bgs underlain by Granitic Rocks (Kgr) to a termination depth of 11 feet bgs with an increase of hardness to moderately hard (H4) at a depth of 4 feet bgs. Trench T-7 encountered Granitic Rocks (Kgr) to a termination depth of 14 feet bgs with an increase of hardness to moderately hard (H4) at a depth of 2 feet bgs. Trench T-8 encountered colluvium (Qc) to a depth of 1 foot bgs underlain by Granitic Rocks (Kgr) to a termination depth of 12 feet bgs with an increase of hardness to moderately hard (H4) at a depth of 4 feet bgs. Boring B-1 encountered light brown moderately weathered "decomposed" granodiorite of the Granitic Rocks (Kgr) unit to a depth of 46 feet bgs underlain by fresh to slightly weathered "blue" granodiorite to a termination depth of 64 feet bgs. Boring B-2 encountered light brown moderately weathered "decomposed" granodiorite of the Granitic Rocks (Kgr) unit to a depth of 55 feet bgs underlain by fresh to slightly weathered "blue" granodiorite to a termination depth of 84 feet bgs. Boring B-3 encountered light brown moderately weathered "decomposed" granodiorite of the Granitic Rocks (Kgr) unit to a depth of 69 feet bgs underlain by fresh to slightly weathered "blue" granodiorite to a termination depth of 84 feet bgs. Boring B-4 encountered light brown moderately weathered "decomposed" granodiorite of the Granitic Rocks (Kgr) unit to a depth of 64 feet bgs underlain by fresh to slightly weathered "blue" granodiorite to a termination depth of 84 feet bgs. Trench and boring logs are presented in Appendix A. The locations of trenches and borings have been approximated on Plates 1.

Three borings (CCT-3 though CCT-5) were drilled in the vicinity of the proposed quarry during a previous investigation for the State Water Facilities California Aqueduct Coastal Branch-Phase II water pipeline (Department of Water Resources, September, 2002). Boring CCT-3

encountered Granitic Rocks (Kgr) to a termination depth of 50 feet bgs varying from "decomposed" to a depth of 25 feet bgs to slightly weathered from 30 feet bgs. Boring CCT-4 encountered Granitic Rocks (Kgr) to a termination depth of 121 feet bgs varying from "decomposed" to a depth of 36.3 feet bgs to moderately weathered from 80 feet bgs. Boring CCT-5 encountered residual soil to a depth of 15 feet bgs underlain by "decomposed" Granitic Rocks (Kgr) to a termination depth of 31 feet bgs. These boring logs are presented in Appendix A.

### 6.3 Surface and Groundwater Conditions

Surface drainage generally flows to the middle of the property toward natural drainage courses which flow southwest. General recommendations regarding drainage for the proposed development are provided. Groundwater was not observed in any of the borings or trenches to a maximum depth of 84 feet below ground surface. Depth to groundwater is assumed to approximate the Salinas River west of the site at an approximate elevation of 975 feet. The lowest proposed elevation is 1,083 feet within the detention basin adjacent to the proposed truck scale.

### 6.4 Erosion

The Soil Survey of San Luis Obispo County, California, Paso Robles Area (USDA, 1983) identified Cieneba coarse sandy loam and Cieneba-Andregg coarse sandy loams in the vicinity of the proposed quarry. Cieneba coarse sandy loam is described as "Surface runoff is very rapid, and the hazard of erosion is very high." and the Cieneba-Andregg coarse sandy loam is described as "Surface runoff is very rapid, and the hazard of erosion is very high." (USDA, 1983). Due to the high erosion potential, it is recommended that the benches be maintained periodically to remove collected debris. It is understood that this is a working reclamation and that heavy machinery is available at all times and safety precautions are a concern to those on-site.

## 7.0 LANDSLIDES

The San Luis Obispo County Safety Element maps the property within low to moderate potential for landslides (Plate 7). Hart, 1976 and Dibblee, 2004 did not map a landslide at the property or in the immediate vicinity of the property. The potential for large slope instability to affect the property is considered low due to the presence of near-surface Granitic Rocks units.

### 7.1 NUMERICAL SLOPE STABILITY ANALYSIS

The purpose of the numerical slope stability analysis was to determine the horizontal distance from the top of the bluff to the back of the potential slip surface for a factor of safety of 1.5 for static conditions and 1.1 for psuedo-static conditions. As the slope may be affected by seismic events, a dynamic loading condition was applied to the existing slope (pseudo-static conditions). As stated in *Guidelines for Evaluating and Mitigating Seismic Hazards in California* (CDMG, 1997), "In California, many state and local agencies, on the basis of local experience, require the use of a seismic coefficient of 0.15, and a minimum computed pseudo-static factor of safety of 1.0 to 1.2 for analysis of natural, cut, and fill slopes. Basic guidelines for making preliminary evaluations of embankments to ensure acceptable performance…were: using a pseudo-static coefficient of 0.10 for magnitude 6.5 earthquakes and 0.15 for magnitude 8.25 earthquakes, with an acceptable factor of safety of the order of 1.15." Calculations for pseudo-static numerical analysis utilized a seismic coefficient of 0.15g.

## 7.2 MODELING CONDITIONS

General modeling conditions included: 1) approximately 46 to 64 feet below existing ground surface of "decomposed" granite (Kgr) and 2) underlying "blue" granite (Kgr) unit. The stability analysis was performed utilizing the subsurface materials observed during the field investigation. The engineering properties of the materials utilized in the numerical analysis are presented in Table 1 and Appendix B. The Engineering Geologist determined the final profile by studying surface geologic conditions, geologic maps, and observations made during the field investigation.

**Table 1: Engineering Properties Utilized in Numerical Analysis**

The Numerical Analysis was Performed Utilizing Following Data:

Granitic Rocks (Kgr):
"Decomposed" Granite-
$\gamma_w$ = 133.3 - from laboratory test data
$\phi$ = 62.3 - from laboratory test data
c = 0 psf - from laboratory test data
"Blue" Granite-
$\gamma_w$ = 133.3 - from laboratory test data
$\phi$ = 62.3 - from laboratory test data
c = 13,120 psi - from laboratory test data

## 7.3 DISCUSSION OF RESULTS OF NUMBERICAL ANALYSIS

The global critical factor of safety values for both static and psuedo-static conditions along Profile A-A' were above 1.5 and 1.1, respectively. Figures 3 and 4 illustrate Profile A-A' with the potential critical slip surfaces for static and psuedo-static conditions.

**Table 2: Horizontal Distance from Top of Bluff to Potential Slip Surfaces**

| Profile | Static Factor of Safety | Psuedo-Static Factor of Safety |
|---|---|---|
| Profile A-A' | 9.12 | 6.58 |

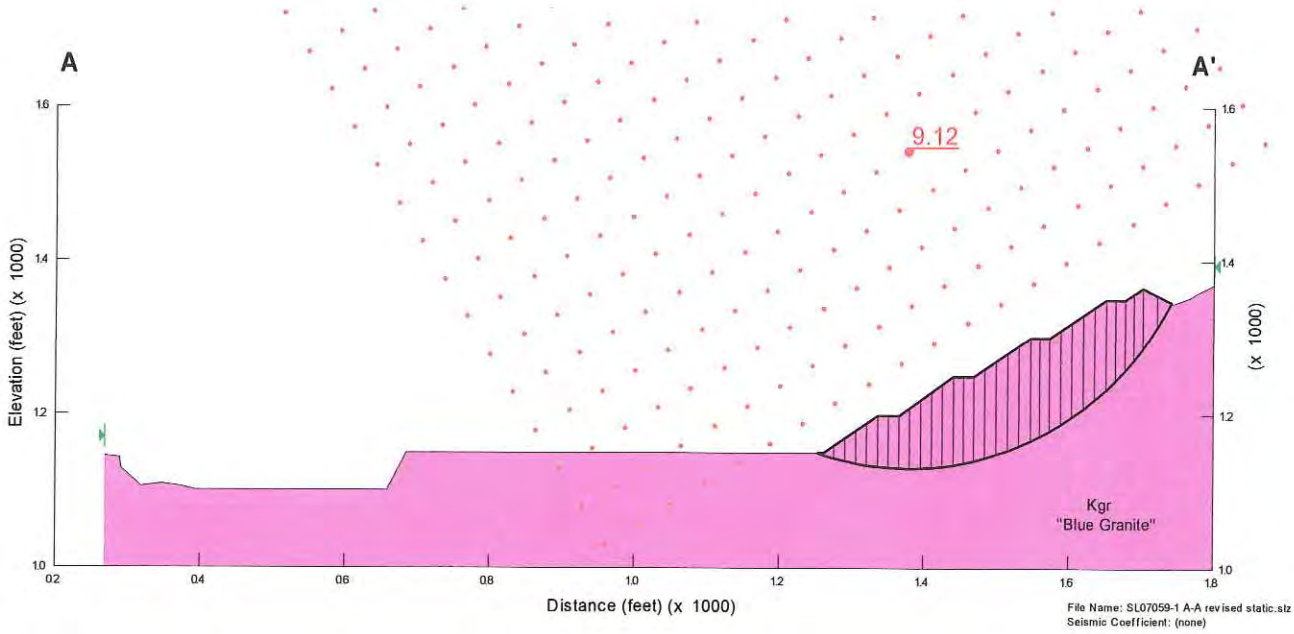


**Figure 3: Profile A-A' (Static Analysis)**

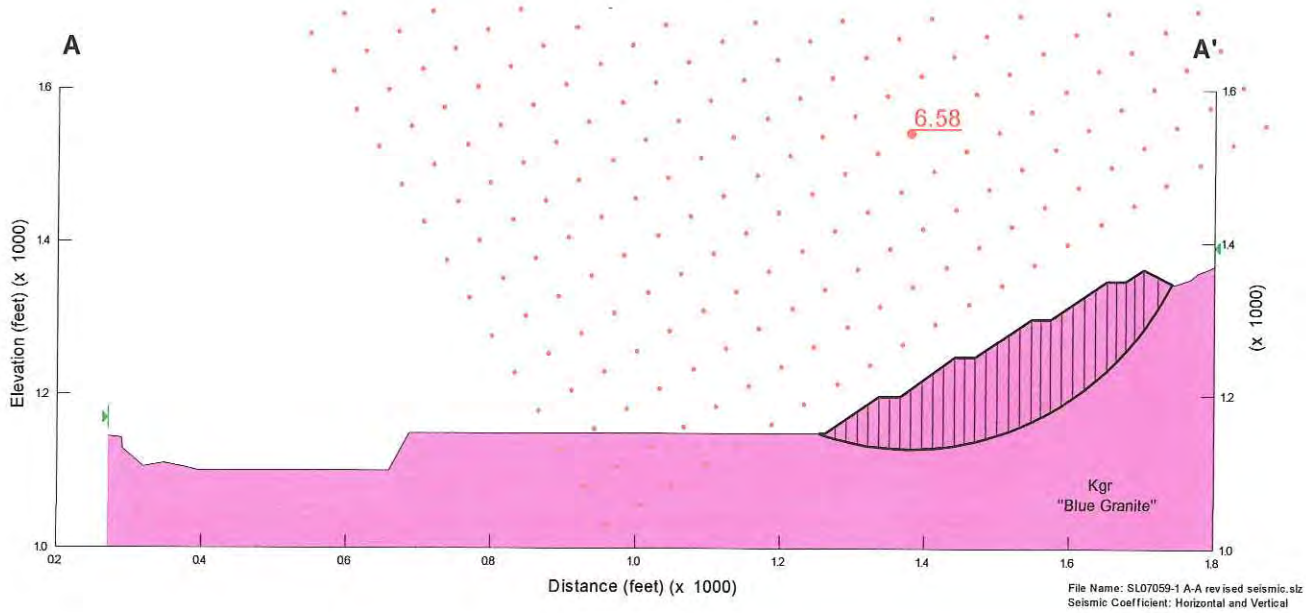


**Figure 4: Profile A-A' (Psuedo-Static Analysis)**

## 7.4 NEARBY SLOPES

The existing Hanson-Santa Margarita sand and gravel quarry is located approximately 0.5 mile to the west. The main quarry face is several hundred feet high, excavated near vertical and benched approximately every 50 feet vertically. These slopes have been constructed within the last 50 years. The

quarry face exposes approximately 100 feet of weathered "decomposed" granite overlying fresh "blue" granite. No gross failures have appeared in any of the slopes observed, however surficial failures are observed throughout. Maintenance would be anticipated for the proposed cut slopes. In addition, the Calf Canyon Tunnel was excavated for the existing water pipeline that extends through the southeast portion of the property. The referenced Geology Report presented in Appendix C (Department of Water Resources, September, 2002) describes the rock as "The entire tunnel was mined through Cretaceous granitic rock, petrographically identified as granodiorite, but referred to as "granite" in this report. About 90% of the granite encountered in the tunnel excavation was mostly fresh, hard, and strong to very strong. The remaining 10% of the tunnel excavation was in weathered granite, with variable hardness and strength." The referenced report also states "Steel support was installed over a distance of approximately 520 feet, or 16% of the tunnel length. The remainder (84%) of the tunnel was left unsupported. Support was installed at both north and south portals, at three major overbreak areas, and at numerous small, localized, jointed and/or sheared areas scattered throughout the length of the tunnel." It is anticipated that the shear areas extend through the proposed quarry and increased surficial instability may be encountered, however gross stability should be maintained. After excavation, the contractor should complete regular monitoring and any change in conditions, should be brought to the attention of the project Engineering Geologist.

## 8.0 FLOODING AND SEVERE EROSION

The site is not located within or near the 100-year or 500-year flood zone based on Federal Emergency Management Agency flood zone maps (Plate 8A).

## 9.0 ON-SITE SEPTIC SYSTEMS AND WATER SUPPLY

It is our understanding that a structure is proposed associated with the truck scale which will utilize a sewage disposal system, therefore it is recommended that percolation testing be performed in this area.

## 10.0 HYDROCOLLAPSE OF ALLUVIAL FAN SOILS

The potential for hydrocollapse of subsurface materials is low due to the presence of Granitic Rocks units.

## 11.0 REGIONAL FAULTING AND SEISMICITY

Similar to the general area, the Site can be affected by moderate to major earthquakes centered on one of the known large, Holocene active faults listed in Table No. 3. Moment magnitudes are expressed, although any event on these faults could result in moderate to severe ground shaking at the subject property.

**TABLE NO. 3 – Holocene Active Faults**

| Closest Active Faults to Site | Approximate Distance (miles) | Moment Magnitude |
|---|---|---|
| Los Osos | 12.5 | 7.0 |
| Hosgri | 23.5 | 7.5 |
| San Andreas | 26.5 | 8.0 |

The closest known Holocene age fault is the Holocene age active Los Osos fault that is located approximately 12.5 miles southwest of the Site. The San Andreas fault is the most likely active fault to produce ground shaking at the Site. Plate 6A, Historical Seismicity Map and Plate 6B, Historical Seismicity List depicts significant historical earthquakes in the region.

A December 22, 2003 earthquake of magnitude 6.5 is attributed to have occurred on the Oceanic-West Huasna fault. This fault is located approximately 6.5 miles southwest of the property. Until more specific information regarding this fault is available, GeoSolutions, Inc. considers this fault as an active fault.

### 11.1 Ridgetop Shattering

Obvious evidence of ridge-top spreading, shattered ground, sharply defined scarps, side hill benches, shallow depressions, fissures, sackung, or linear troughs were not apparent during the site investigation. There is an assumed moderate to high potential for ridgetop shattering at the property due to the location of portions of the quarry along ridges, however currently the only structure proposed are associated with the truck scale which is not located on a ridgetop therefore affects would be low to moderate.

The potential for ground rupture at the Site during ground shaking from a fault passing through the proposed development is considered moderate since a splay of the Rinconada fault passes through the proposed quarry area. Ground shaking from off-site faults may cause failure of loose soil or rocks on slopes.

### 11.2 Rinconada Fault

A splay of the Rinconada fault has been mapped as trending through or in the vicinity of the property by Hart, 1976 (Plate 3A). Dibblee, 1976 identifies the Rinconada Fault from the Rinconada mine to Paso Robles as the Rinconada segment and states "The Rinconada segment is nowhere well exposed and is poorly expressed topographically. As along the Nacimiento segment, the terrain is generally higher on the northeast. There are no deviated nor offset stream channels, and the Rinconada segment appears to be inactive. However, at a place 5 km (3 mi) east of Atascadero, there is a small trench like feature nearly a kilometer (half a mile) long in alluvium that may have been formed by recent movement on this segment."

The County of San Luis Obispo Safety Element describes the Rinconada Fault as "a linear, near-vertical zone of faults about 189 kilometers long that is located along the western margin of the La Panza Range…Large scale strike-slip movement along he fault zone is indicated by a predominance of right-lateral displaced drainages along various segments of this fault. The Rinconada fault clearly offsets the Paso Robles Formation indicating Pliocene to early Pleistocene activity. Late Pleistocene to Holocene activity is suggested by sag ponds, locally offset and clockwise-rotated drainages, faint aerial photographic lineaments in younger alluvium in the Rinconada drainage area, and possible crudely located, scattered seismic epicenters in the vicinity of the mapped trace of the fault zone" (San Luis Obispo County Department of Planning and Building, 1999).

Within Bulletin 199, Hart 1976 states, "The granitic mass is widely broken by faults, shears, and fractures that show a variety of orientations and types of movement (horizontal, oblique, and vertical). Most of these structures are minor and serve mainly to shatter the mass. The over-all patterns are not clear and probably represent variously oriented secondary stresses. Most of the fractures are presumed to be manifestations of a regional right-lateral shear imposed by the flanking Rinconada fault in the mapped area and the Huerhuero fault east of the area." Proposed quarry operations do not contain residential structures, therefore a setback zone has not been applied to the site. However, a weaker, softer, and highly fractured zone of gouge may be anticipated in the vicinity of the fault. The approximate location of the fault splay as mapped by Hart, 1976 is depicted on Plate 1.

## 11.3 Seismic Hazard Analysis

According to Section 11.4 of the *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2006), structures should be designed for seismic loadings caused by the Maximum Considered Earthquake (MCE). The MCE can be defined as an earthquake having a two percent chance of being exceeded in 50 years. A probabilistic seismic hazard analysis was performed in order to estimate the horizontal ground motion acceleration ($a_{max}$) produced at the Site during the MCE. The probabilistic seismic hazard evaluation for the Site was performed using the computer program FRISKSP (Blake, 2000).

The $a_{max}$ of the Site is dependent several factors, which include the distance of the Site from known active faults, the expected magnitude of the MCE, and the Site soil characteristics. The computer program FRISKSP produces a probability of exceedance chart using latitude and longitude coordinates of the Site, a database of known active faults, and a specified attenuation curve that is representative of the soil characteristics at the Site. The $a_{max}$ of the Site can be determined from this probability of exceedance chart.

In order to perform the seismic hazard analysis, an attenuation curve was chosen based on the site classification of the Site, which was determined from data gathered during the field investigation. As per section 1613.5.5 of the 2007 CBC (CBSC, 2007), the site classification is determined by the average properties in the upper 100 feet of the site profile. Based on the depth of Granitic Rocks observed during field investigations at the site, the Site was defined as Site Class C, Soft Rock profile per Table 1613.5.2 of the 2007 CBC (CBSC, 2007). Due to this site classification, the seismic hazard analysis was performed using the Horiz. - NEHRP C (520) attenuation relation by Boore et al., 1997. Using this attenuation relation, this analysis produced an $a_{max}$ of 0.4g for the Site. See Appendix D for the Probability of Exceedance Chart.

According to section 11.2 of ASCE7 (ASCE, 2006) and section 1613 of the 2007 CBC (CBSC, 2007), buildings and structures should be specifically proportioned to resist Design Earthquake Ground Motions (Design $a_{max}$). ASCE7 defines the Design $a_{max}$ as "the earthquake ground motions that are two-thirds of the corresponding MCE ground motions" (ASCE, 2006, p. 109). Therefore, the **Design $a_{max}$ for the Site is 0.27g**, which is equal to two-thirds of the $a_{max}$ for the Site.

Site coordinates of 35.415248 latitude and -120.564781 longitude and a search radius of 100 miles were used in the probabilistic seismic hazard analysis.

## 11.4 Structural Building Design Parameters

Structural building design parameters available within Chapter 16 of the 2007 CBC (CBSC, 2007) and Sections 11.4.3 and 11.4.4 of the *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2006) are dependent upon several factors, including site soil characteristics and the locations and characteristics of faults near the Site. Site classification was determined to be Site Class C. This site classification and the latitude and longitude coordinates for the Site were used to determine the structural building design parameters.

Spectral Response Accelerations and Site Coefficients were obtained from the Seismic Hazard Curves and Uniform Hazard Response Spectra, Earthquake Ground Motion Tool computer application (USGS, 2007); this program is available from the United States Geological Survey website (USGS, 2008). This computer program utilizes the methods developed in the 1997, 2000, and 2003 editions of the NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures and user-

inputted Site latitude and longitude coordinates to calculate seismic design parameters and response spectra (both for period and displacement), for Site Classifications A through E. This data is presented in tabular form in Table 4: 2007 California Building Code, Chapter 16, Structural Design Parameters. Analysis of the Design Spectral Response Acceleration Parameters for the Site and of the Occupancy Category for the proposed structure assign to this project a **Seismic Design Category of D** per Tables 1613.3.5.6(1) and 1613.3.5.6(2) of the 2007 CBC (CBSC, 2007).

**Table 4: 2007 California Building Code, Chapter 16, Structural Design Parameters**

| **Site Class- Soil Profile Type** | D – Soft Rock Profile |
|---|---|
| **Mapped Spectral Response Accelerations and Site Coefficients** | $S_S = 1.120$, $S_1 = 0.500$<br>$F_a = 1.0$, $F_v = 1.3$ |
| **Adjusted Maximum Considered Earthquake Spectral Response Accelerations** | $S_{MS} = S_S*F_a = 1.120*1.0 = 1.120$<br>$S_{M1} = S_1*F_V = 0.500*1.3 = 0.649$ |
| **Design Spectral Response Acceleration Parameters** | $S_{DS} = 2/3(S_{MS}) = 2/3(1.120) = 0.747$<br>$S_{D1} = 2/3(S_{M1}) = 2/3(0.649) = 0.433$ |
| **Occupancy Category (from Table 1604.5, 2007 CBC)** | II |
| **Seismic Design Category – Short Period Accel. (from Table 1613.5.6(1), 2007 CBC)** | D |
| **Seismic Design Category – Long Period Accel. (from Table 1613.5.6(2), 2007 CBC)** | D |

## 11.5 Design Response Spectra – 2007 CBC

According to Section 11.4.5 of the *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2006), a design response spectrum for a site may be required in order to design structures to resist lateral forces caused by ground motions at the Site. The design spectral response acceleration parameters, listed in Table 4: 2007 California Building Code, Chapter 16, Structural Design Parameters, is used to produce the design response spectrum. The Seismic Hazard Curves and Uniform Hazard Response Spectra computer program (USGS, 2007) was used to construct constructed a design response spectrum for the Site, which is shown in Figure 5.

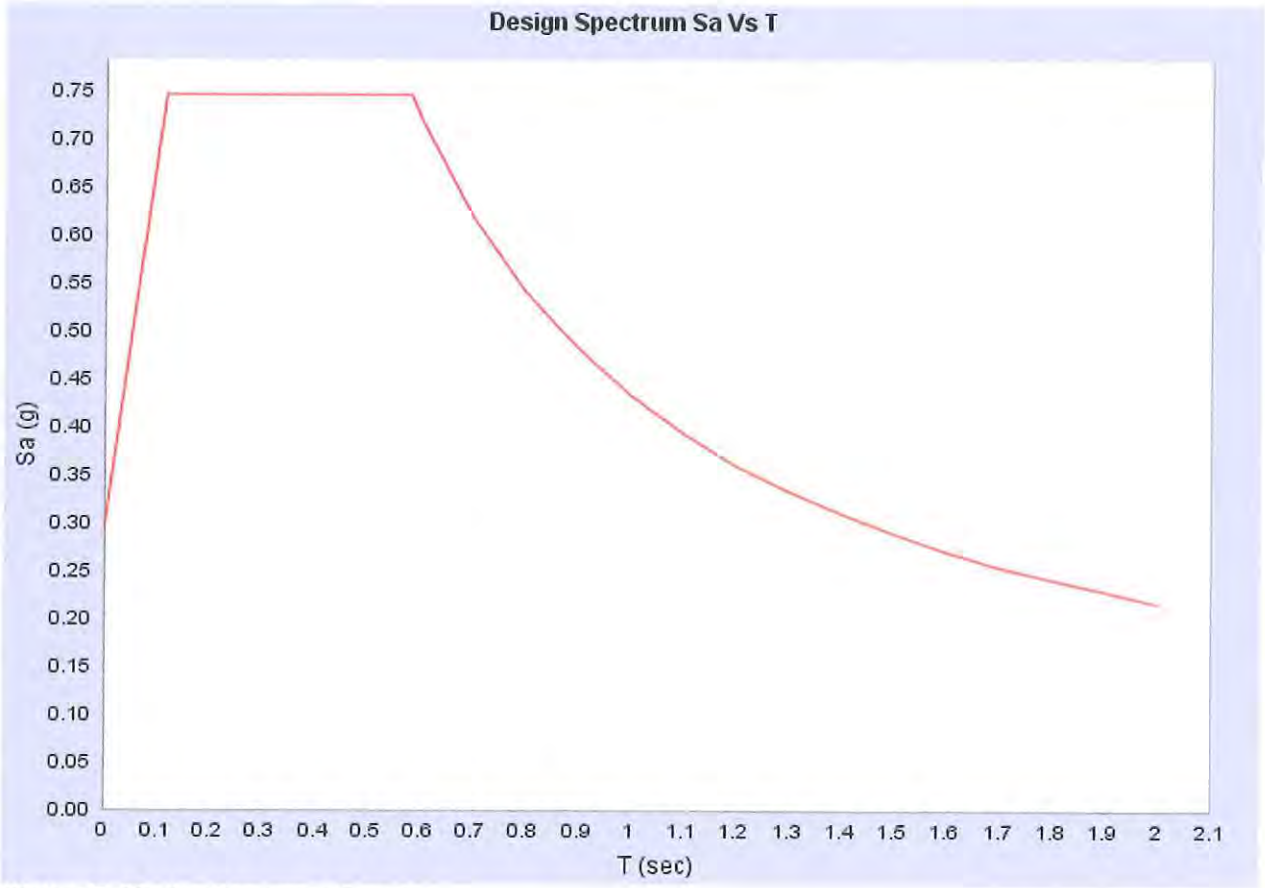


**Figure 5: Design Response Spectra**

## 11.6 Active Faulting and Coseismic Deformation

The Alquist-Priolo Earthquake Fault Zoning Act passed in 1972 requires that the State Geologist establish Earthquake Fault Zones around the surface traces of active faults and to issue appropriate maps. The closest Earthquake Fault Zone is the Los Osos fault located approximately 12.5 miles southwest of the Site. The subject site is not located within an Earthquake Fault Zone (Jennings, 1994).

## 11.7 Seismically-Induced Water Waves and Flooding

Tsunamis and seiches are two types of water waves that are generated by earthquake events. Tsunamis are broad-wavelength ocean waves and seiches are standing waves within confined bodies of water, typically reservoirs. The potential for a tsunami to affect the Site is low due to the distance to the Pacific Ocean and elevation above sea level. Elevation is approximately 1,000 to 1,475 feet above sea level. Flooding associated with a seismic event is considered low due to the absence of a body of water upslope of the property.

## 11.8 Seismically-Induced Settling and Slope Failure

There is a low potential for seismically induced settlement at the Site based upon the depth to Granitic Basement Rocks material.

## 12.0 LIQUEFACTION ANALYSIS

The liquefaction potential at the Site is considered low due to the presence of near-surface, Granitic Rocks. The San Luis Obispo County Safety Element maps the property within low potential liquefaction hazard zone (San Luis Obispo County Department of Planning and Building, 1999).

## 13.0 BLASTING

Blasting was performed in the granite for the state waterline excavation which extends through the southeast portion of the property. Department of Water Resources, September, 2002 states "Blasting was required in the trench excavation from about Station 2456+00 to 2460+66 (See Photo No. 1). In this area, the rock is mostly a hard to very hard, moderately fractured, slightly weathered granite. Shot holes were drilled to a depth of 10 feet on the sides of the excavation, and to a depth of 5 feet along centerline. Shot hole spacing was about 3 feet. Drilling was accomplished by a track driven, Ingersoll-Rand air rig (See Photo Nos. 2, 3, and 4)." It is our understanding that an expert in blasting technology will review and comment on the potential affects of blasting operations with respect to the water supply tunnel.

## 14.0 GEOLOGIC HAZARDS

### 14.1 Expansive Soils

Table 14 within the Soil Survey of San Luis Obispo County, California, Paso Robles Area (USDA, 1983) identified Cieneba coarse sandy loam and Cieneba-Andregg coarse sandy loams as having a low shrink-swell potential, therefore the potential for expansive soils is assumed to be low.

### 14.2 Corrosive Soils

Table 15 within the Soil Survey of San Luis Obispo County, California, Paso Robles Area (USDA, 1983) identified Cieneba coarse sandy loam and Cieneba-Andregg coarse sandy loams as having a low risk of corrosion for both concrete and uncoated steel, therefore the potential for corrosive soils is assumed to be low.

### 14.3 Naturally Occurring Asbestos

The potential for naturally occurring asbestos is low due to the absence of Franciscan Complex type ultramafic units at the site.

### 14.4 Radon and Other Hazardous Gases

The potential for radon or other hazardous gases is low due to the absence of Monterey Formation units and other radon producing formations known to exist in the central coast region.

## 15.0 SUBSIDENCE

Causes of significant land subsidence in California include compaction and decreased void space as a result of reduced pore pressure due to de-watering or withdrawal of oil and gas; hydro-compaction of dry, loose, clayey soils; and oxidation of organic material and subsequent compaction of remaining soil material. Due to the presence of near-surface resistant Granitic Rocks, there is a low potential for subsidence at the Site.

## 16.0 VOLCANIC ERUPTION

Volcanism in California is typically associated with the Cascade Ranges Geomorphic Province in northern California, and the Basin and Range Province on the eastern side of the Sierra Nevada Mountains. Prevailing westerly winds would most likely reduce the chance of ash fallout in the central California coastal area from volcanic activity on the eastern side of the Sierra Nevada. Other hazards generally related to volcanism are not pertinent to the subject site.

## 17.0 ADDITIONAL SERVICES

The recommendations contained in this report are based on excavated trenches, drilled borings, surface mapping, and on the continuity of the sub-surface conditions encountered. It is assumed that GeoSolutions, Inc. will be retained to perform the following services:

1. Consultation during plan development.

2. Plan review of final grading and drainage documents..

3. Additionally, construction observation by the Project Engineering Geologist may be necessary to verify sub-surface conditions during excavation activities.

## 18.0 LIMITATIONS

1. The recommendations contained in this report are based on Site reconnaissance; review of sub-surface data, and partly on certain plans, information, and data provided to us. Any changes in those plans, information and data will render our recommendations invalid unless we are commissioned to review the changes and to make any necessary modifications and/or additions to recommendations.

2. This report is issued with the understanding that it is the responsibility of the owner or his/her representative to ensure that the information in this report be incorporated into the project plans and recommendations contained herein be brought to the attention of the civil engineer. The owner or his/her representative is responsible to ensure that the necessary steps are taken to verify that the contractor and subcontractors comply with recommendations in the field.

3. Our recommendations have been made in accordance with the principles and practices generally employed by the engineering professions. This is in lieu of all other warranties, expressed or implied. Reference is made to our Agreement for Professional Services, which contains additional limitations concerning this project.

4. Any person concerned with this project who observes conditions or features of the Site or surrounding area that are different from those described in this report should report them immediately to this office for evaluation as part of an additional scope of work. Should additional evidence become available in the future that would indicate the need for additional study, this firm should be contacted.

5. As of the present date, the findings of this report are valid for the property studied. With the passage of time, changes in the conditions of a property can occur whether they are due to natural processes or to the works of man on this or adjacent properties. Therefore, this report should not be relied upon after a period of one (1) year without our review nor should it be used or is it applicable for any properties other than those studied. However many events such as

floods, earthquakes, grading of the adjacent properties and building and municipal code changes could render sections of this report invalid in less than 1 year.

END OF TEXT

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## REFERENCES


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## PLATES

Plate 1 - Site Engineering Geologic Map

Plate 2 - Site Cross Section

Plate 3A, 3B - Regional Geologic Map, Hart, 1976 and Geologic Explanations

Plate 4A, 4B - Regional Geologic Map, Dibblee, 2004 and Geologic Explanations

Plate 5A, 5B, 5C - Regional Fault Map, Jennings, 1994 and Explanations

Plate 6A, 6B - Historical Seismicity Map and Historical Seismicity List

Plate 7 - Landslide Hazards Map, San Luis Obispo County Department of Building and Planning, 1999

Plate 8A, 8B - Flood Insurance Rate Map, FEMA, 1985 and Explanation

Plate 9A, 9B - Geologic Study Area Map and Explanations, San Luis Obispo County Department of Building and Planning, 1996

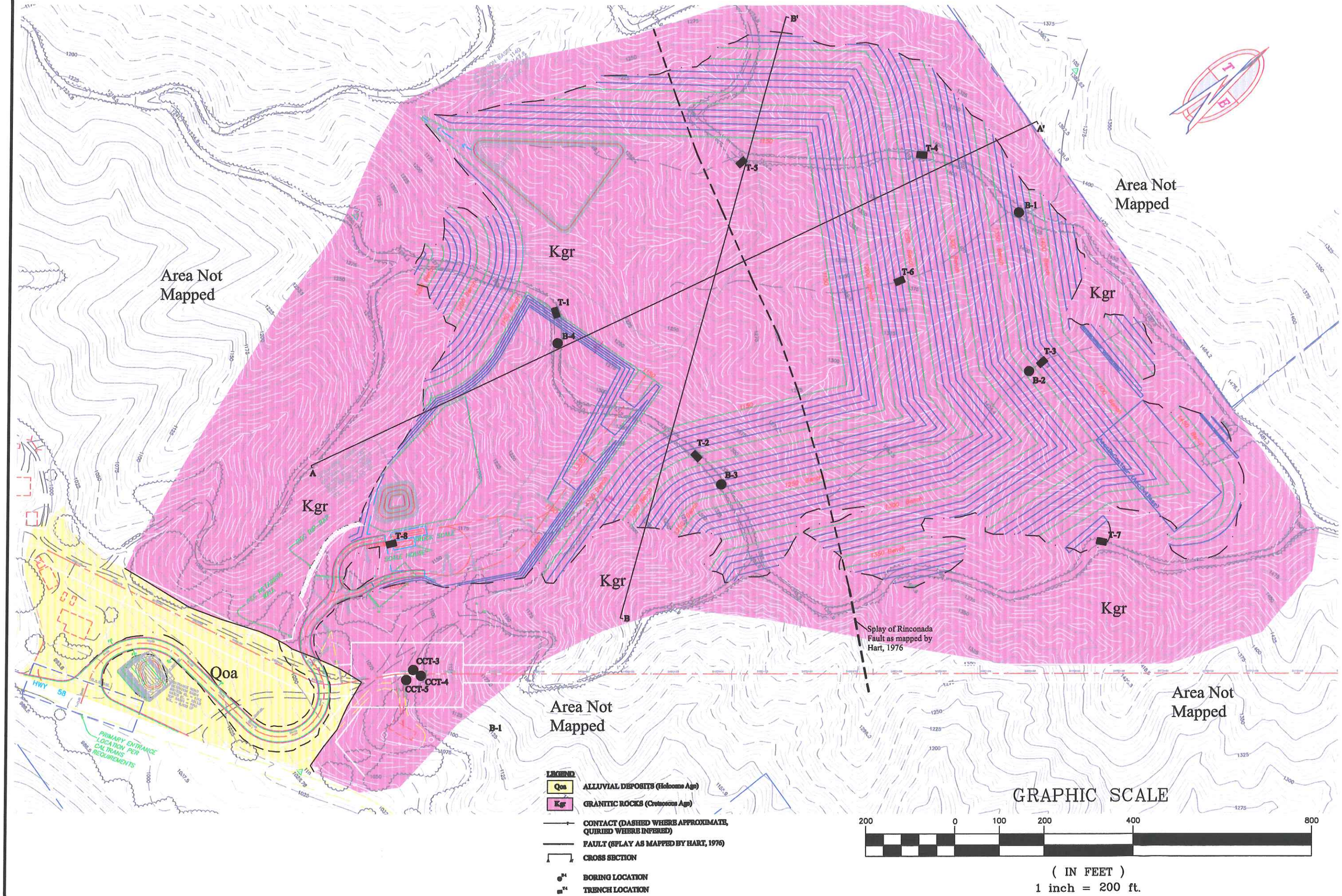


PLATE 1

PROJECT SL07059-1

# SITE ENGINEERING GEOLOGIC MAP

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA


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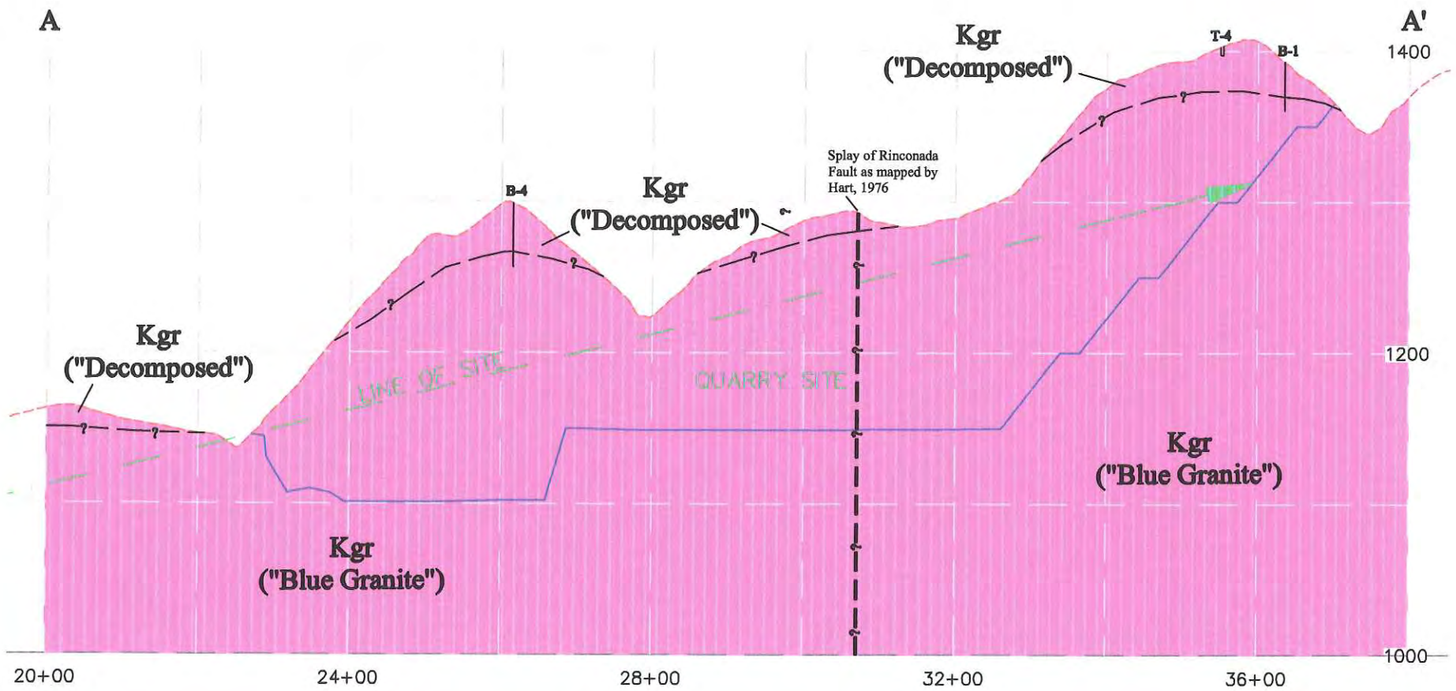


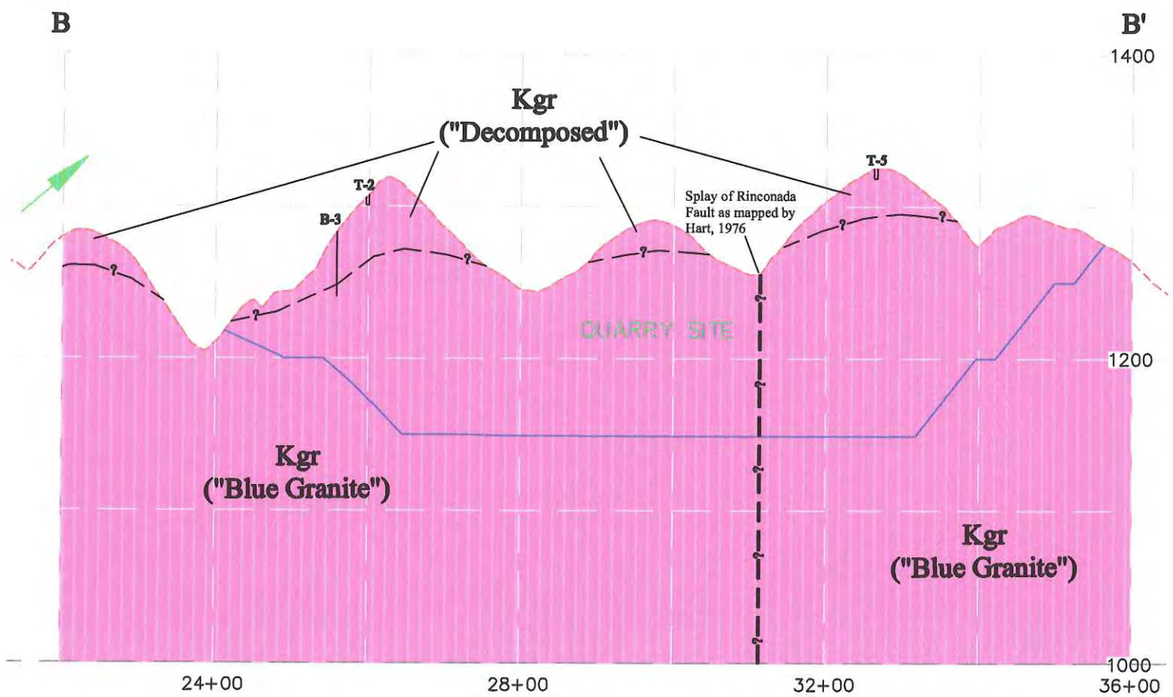


LEGEND

| | |
|---|---|
| Qoa | ALLUVIAL DEPOSITS (Holocene Age) |
| Kgr | GRANITIC ROCKS (Cretaceous Age) |
| | CONTACT (DASHED WHERE APPROXIMATE, QUIRED WHERE INFERRED) |
| | FAULT (SPLAY AS MAPPED BY HART, 1976) |
| | CROSS SECTION |
| | BORING LOCATION |
| | TRENCH LOCATION |

PLATE 2

PROJECT SL07059-1

# SITE CROSS SECTION

LAS PILITAS QUARRY, SANTA MARGARITA AREA
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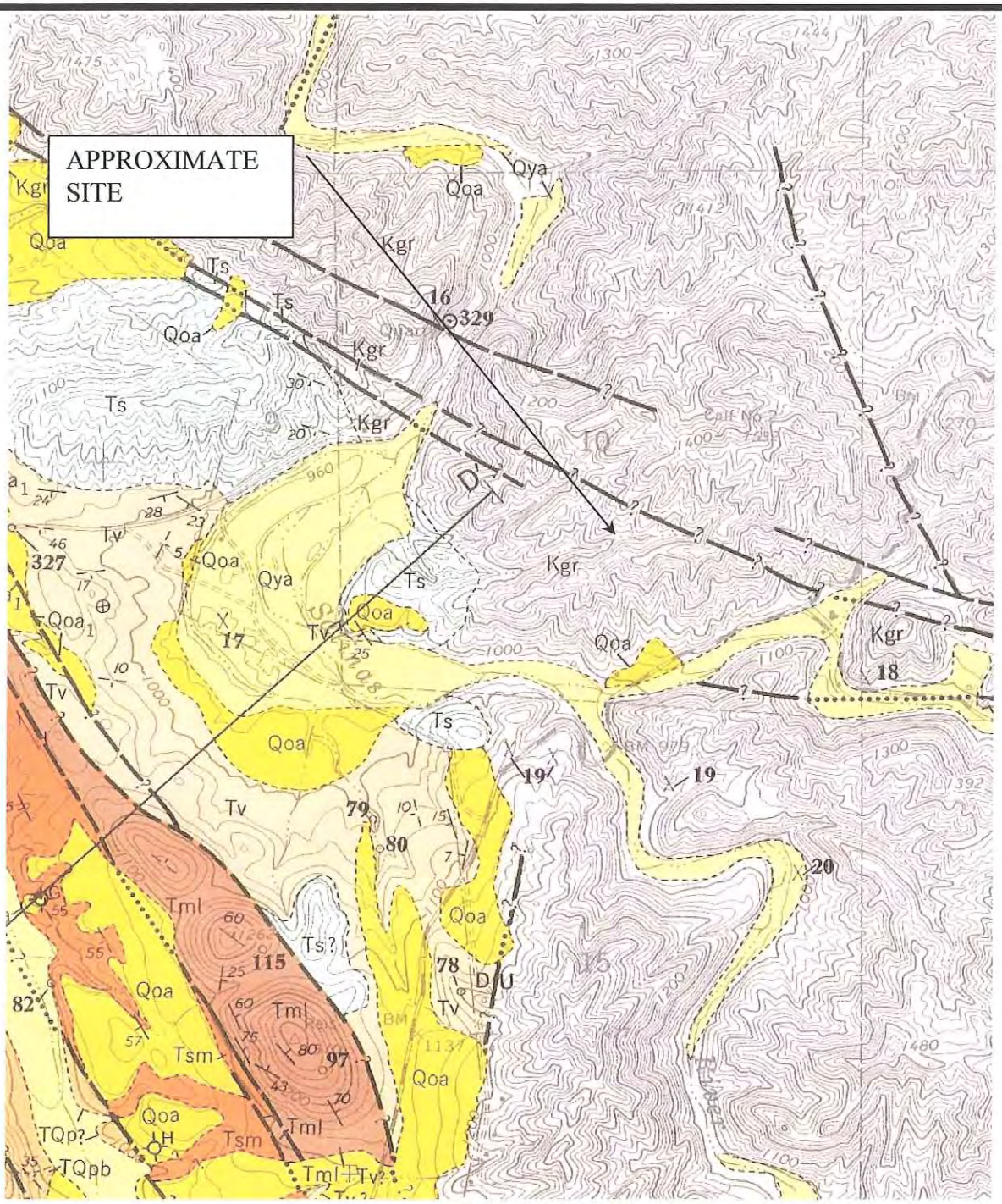


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STATE OF CALIFORNIA

# REGIONAL GEOLOGIC MAP

HART, 1976
LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
3A

PROJECT NO:
SL07059-1

## EXPLANATION

**QUATERNARY**

*Holocene*

af — Artificial fill

Qya — Younger alluvium

Qls — Landslide deposits

*Pleistocene*

Qoa — Older alluvium

$Qoa_2$ = Relatively younger locally
$Qoa_1$ = Relatively older locally

**TERTIARY**

*Pliocene*

West of Rinconada fault

TQp / TQpb — Paso Robles Formation

TQpb = Basal conglomerate member

East of Rinconada fault

TQp — Paso Robles Formation

*Miocene*

Tsm — Santa Margarita Formation

Tm, Tmu, Tmls, Tml, Tmlv — Monterey Formation

Tmu = Upper member
Tml = Lower member
Tmls = Sandstone unit
Tmlv = Volcanic unit

Tm, Tmu, Tml — Monterey Formation

Tmu = Upper member
Tml = Lower member

*Oligocene*

Tv — Vaqueros Formation

Tu — Unnamed conglomerate

Tv — Vaqueros Formation

Tvc = Basal conglomerate member

Ts — Simmler Formation(?)

Ku — Unnamed sandstone and conglomerate

**CRETACEOUS**

*Upper Cretaceous*

Ka, $Ka_4$, $Ka_3$, $Ka_2$, $Ka_1$, Kal — Atascadero Formation

$Ka_4$ = Upper sandstone with mudstone
$Ka_3$ = Sandstone with mudstone, conglomerate
$Ka_2$ = Graywacke and dark mudstone
$Ka_1$ = Lower dark mudstone with graywacke
Kal = Dark mudstone and sandstone, undifferentiated lower unit

} Local subdivisions near Paradise Valley

Kgr — Granitic rocks

*Lower Cretaceous*

JKt — Toro Formation

**JURASSIC**

*Upper Jurassic*

v — Mafic volcanic rocks

sp-db — Ultramafic-mafic complex

sp = Serpentinite
db = Intrusive diabase and related rocks

*Cretaceous-Upper Jurassic*

f — Franciscan melange

*pre-Upper Cretaceous*

m — Metamorphic rocks

Contact – *dashed where approximately located; queried where inferred*

Gradational contact – *crudely located*

Fault – *dashed where approximately located; dotted where concealed; queried where inferred; barbs are on upper plate of thrust and reverse faults; relative movement indicated by arrows and by U(up) and D (down) where known*

Shear zone – *poorly defined zones of deformation; somewhat diagrammatic*

Strike and dip of inclined beds
Strike and dip of vertical beds
} *Broken symbol indicates approximate attitude*

Horizontal beds

Strike and dip of overturned beds

Strike and dip of crumpled beds

General strike and dip of shear fabric in Franciscan melange

Sandstone
Conglomerate
Sandstone and conglomerate
Cherty shale
Shells
} *Trace of prominent beds*

5 — Open pits, quarries and prospect cuts
10 — Prospect shaft
2 — Mine adit
} *Mineral deposits and prospects; numbers refer to table in text*

Solid-waste disposal site

Accurate well location
Approximate well location
} *Exploratory wells drilled for oil; see tabulation of well data*

247 — Fossil localities
71 — Age-dated sample locality
} *Numbers are SLO localities referred to in text and in tables*

Syncline
Anticline
} *Folds – dotted where concealed*


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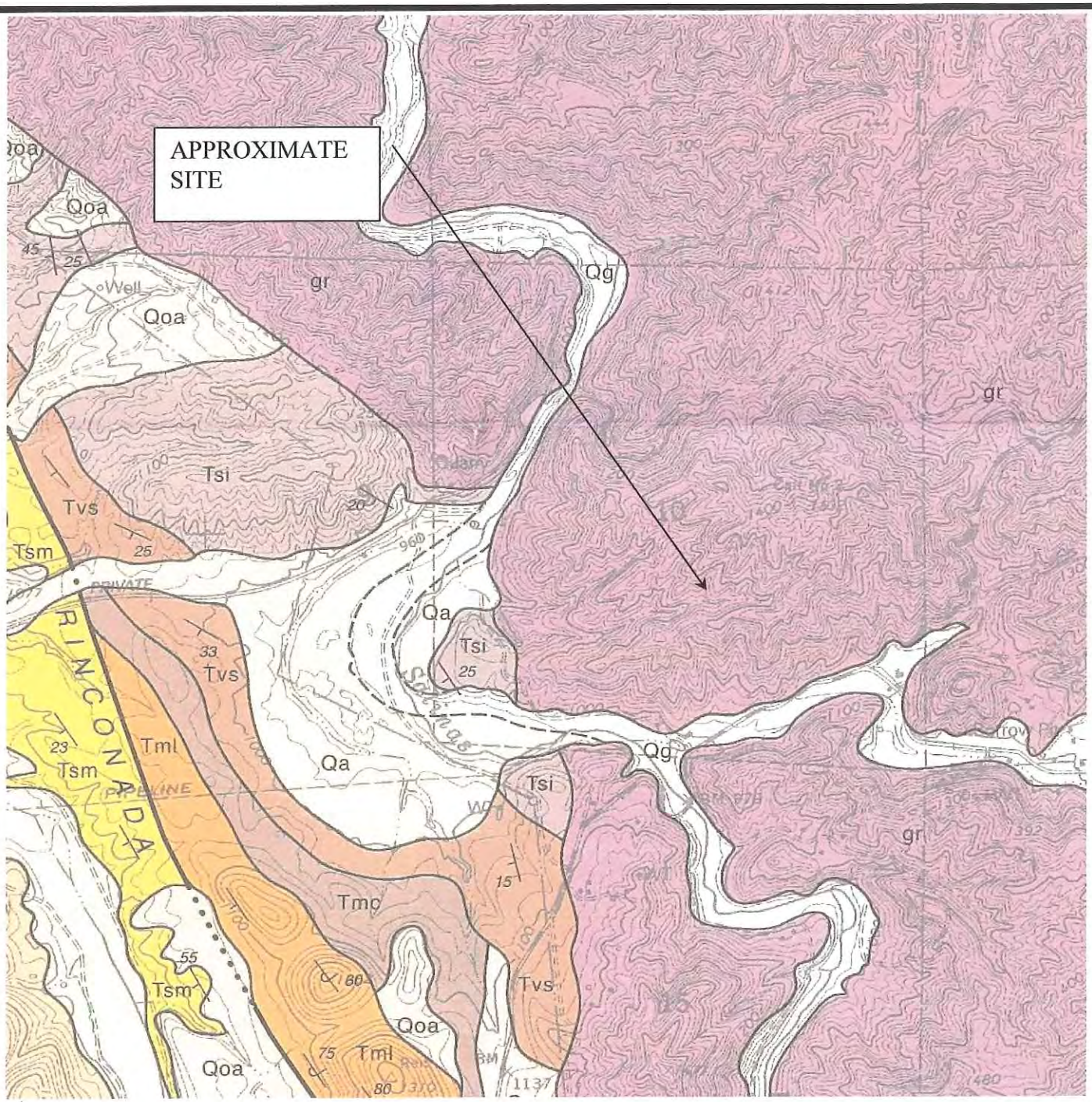
# GEOLOGIC EXPLANATIONS

HART, 1976
LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
3B

PROJECT NO:
SL07059-1




SCALE 1:24000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

NORTH

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# REGIONAL GEOLOGIC MAP

DIBBLEE, 1976
LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
4A

PROJECT NO:
SL07059-1

## SANTA MARGARITA MAP (DF-133)

### LEGEND

Qa / Og

SURFICIAL SEDIMENTS

**Og** *Stream channel gravel and sand*
**Qa** *Alluvium*

Qoa

OLDER ALLUVIUM

— *UNCONFORMITY* —

EAST OF RINCONADA FAULT

QTp

PASO ROBLES FORMATION
*Valley sediments weakly indurated; age, Pleistocene, possibly latest Pliocene*
**QTp** *Alluvial conglomerate of pebbles mostly of white siliceous shale from Monterey Formation in a matrix of sand and clay*

— *UNCONFORMITY* —

Tm / Tml / Tmc

MONTEREY SHALE
*Marine biogenic and clastic moderately lithified, age, late & middle Miocene (of Fairbanks, 1904)*
**Tm** *Upper part, siliceous shale, brown, weathers white, thin, platy, porcellaneous, locally cherty; Mohnian Stage, late Miocene*
**Tml** *Lower part (Sandholdt member of Durham, 1968) siliceous to semi-siliceous shale, brown, weathers cream-white, thin-bedded, includes soft fissile shale and thin, hard dolomite layers; contains locally abundant foraminifera; age, Luisian-Relizian Stages, middle Miocene*
**Tmc** *Rincon Formation (?) claystone, gray, soft, crumbly; locally includes thin fine grained sandstone layers; age, middle to early Miocene (Relizian-Saucesian Stages)*

Tvs

VAQUEROS FORMATION
*marine clastic, lithified*
**Tvs** *Sandstone, light brown, arkosic area; age, early Miocene (Saucesian? Stage)*

Tsi

SIMMLER (?) FORMATION
*(of Hart, 1989) terrestrial, clastic, lithified; age, early Miocene-Oligocene*
**Tsi** *Conglomerate breccia of unsorted granitic detritus, gray, rarely bedded*

— *UNCONFORMITY* —

gr

GRANITIC BASEMENT ROCKS
*Plutonic basement of Salinian Block; age, Cretaceous*
**gr** *Granitic rocks, granodiorite to quartz monzonite, medium-grained holocrystaline, massive, light gray, somewhat incoherent where weathered, composed of quartz, potassic feldspar and sodic plagioclase feldspar in nearly equal amounts and abundant biotite mica*

Holocene ? Pleistocene — QUATERNARY
Miocene ? Oligocene — TERTIARY
CRETACEOUS

WEST OF RINCONADA FAULT

QTp

PASO ROBLES FORMATION
*Valley sediments weakly indurated; age, Pleistocene, possibly latest Pliocene*
**QTp** *Alluvial conglomerate of pebbles mostly of white siliceous shale from Monterey Formation in a matrix of sand and clay*

— *UNCONFORMITY* —

Tsm

SANTA MARGARITA SANDSTONE
*Shallow marine biogenic and clastic, semi-lithified; age, late Miocene*
**Tsm** *Sandstone, white, massive, arkosic, semi-friable, locally calcareous, contains large marine molluscs (Ostrea titan, Lyropecley crassicardo)*

Tm

MONTEREY SHALE
*Marine biogenic and clastic moderately lithified, age, late & middle Miocene (of Fairbanks, 1904)*
**Tm** *Upper part, siliceous shale, brown, weathers white, thin bedded, platy, porcellaneous, locally cherty; upper Miocene (Mohnian Stage)*

— *UNCONFORMITY* —

Kas

ATASCADERO FORMATION
*(of Fairbanks, 1904), marine, clastic, lithified; age, late Cretaceous*
**Kas** *Hard, tan arkosic sandstone, minor micaceous clay shale*

Ktsh

TORO FORMATION
*(of Fairbanks, 1904), marine, clastic, lithified; age, early Cretaceous to latest Jurassic?*
**Ktsh** *Dark gray micaceous clay shale, minor thin layers of dark brown, fine-grained sandstone at west border only*

— *UNCONFORMITY OR FAULT CONTACT* —

Im

FRANCISCAN ASSEMBLAGE
*Pervasively sheared, slightly metamorphosed marine rocks*
**Im** *Melange of dark claystone, greywacke-sandstone and other Franciscan rocks, including varicolored chert & blueschist*

Pleistocene — QUATERNARY
Miocene — TERTIARY — CENOZOIC
CRETACEOUS
JURASSIC and CRETACEOUS — MESOZOIC

### GEOLOGIC SYMBOLS

*not all symbols shown on each map*

**FORMATION CONTACT** *dashed where inferred or indefinite, dotted where concealed*

**MEMBER CONTACT** *between units of a formation* — **Prominent bed**

**CONTACT BETWEEN SURFICIAL SEDIMENTS** *trained only approximately in places*

**FAULT:** *Dashed where indefinite or inferred, dotted where concealed, queried where evidence is doubtful. Parallel arrows indicate inferred relative lateral movement. Relative vertical movement is shown by U D (U=upthrown side, D=downthrown side). Short arrow indicates dip of fault plane. Sawteeth are on upper plate of low angle thrust fault.*

**FOLDS:** *overturned* — **ANTICLINE** — **SYNCLINE**

*arrow on axial trace of fold indicates direction of plunge, dotted where concealed by surficial sediments*

*Strike and dip of Sedimentary rocks* — *inclined* — *inclined (approximate)* — *overturned* — *horizontal* — *vertical*

*Strike and dip of metamorphic or igneous rock foliation or flow banding or compositional layers* — *inclined* — *inclined (approximate)* — *vertical* — *overturned*

**OTHER SYMBOLS:** *Direction of landslide movement* — *outline of water bodies shown on map* — *water well* — *oil well*


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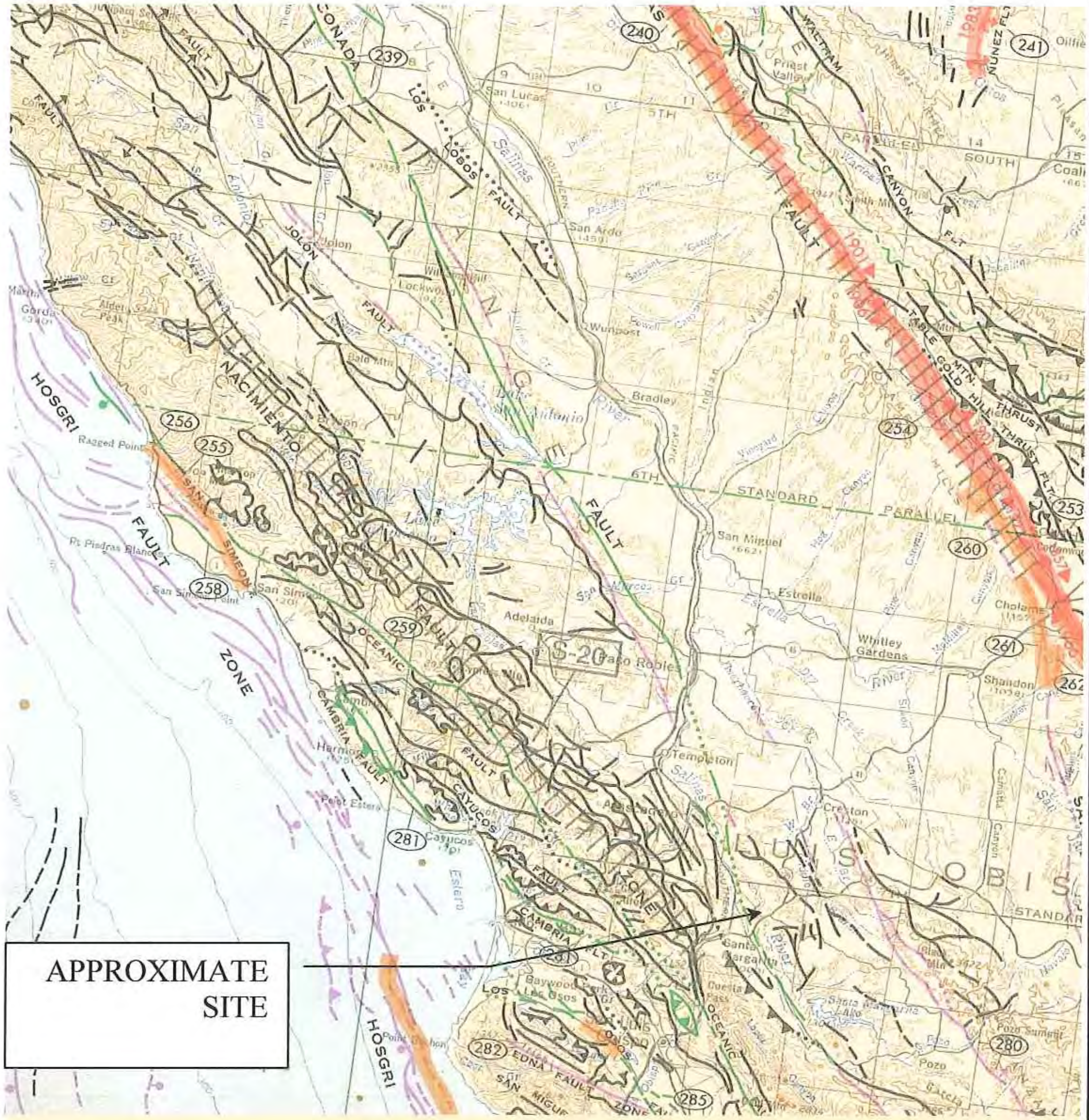
PROFESSIONAL GEOLOGIST — JEFFREY PFOST NO. 2493 CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

# GEOLOGIC EXPLANATIONS

DIBBLEE, 2006
LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
4B

PROJECT NO:
SL07059-1




SCALE 1:750,000

(1 INCH EQUALS APPROXIMATELY 12 MILES)

10 0 10 20 30 40 50 Miles

10 0 10 20 30 40 50 60 Kilometers

GRAPHICS BY ROSS MARTIN

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JENNINGS, 1994, SEE PLATE 5B AND 5C FOR EXPLANATIONS

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## REGIONAL FAULT MAP

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
5A

PROJECT NO:
SL07059-1

| Geologic Time Scale | | | Years Before Present (Approx.) | Fault Symbol | Recency of Movement | DESCRIPTION: ON LAND | DESCRIPTION: OFFSHORE |
|---|---|---|---|---|---|---|---|
| Quaternary | Late Quaternary | Historic | | | | Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep. | |
| | | | 200 | | | | |
| | | Holocene | | | ? ? ? ? | Displacement during Holocene time. | Fault offsets seafloor sediments or strata of Holocene age. |
| | | | 10,000 | | | | |
| | | Pleistocene | | | ? ? ? | Faults showing evidence of displacement during late Quaternary time. | Fault cuts strata of Pleistocene age. |
| | | | 700,000 | | | Undivided Quaternary faults – most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age. | |
| | Early Quaternary | | | | ? ? | Late Cenozoic faults within the Sierra Nevada, including parts of, but not restricted to, the Foothills fault system. These faults may have been active in Quaternary time. | Fault cuts strata of Quaternary age. |
| | | | 1,600,000 | | | | |
| Pre-Quaternary | | | | | | Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive. Pre-Quaternary faults not shown in Nevada and Oregon. | Fault cuts strata of Pliocene or older age. |
| | | | 4.5 billion (Age of earth) | | | | |

# EXPLANATION

Fault traces on land are indicated by solid lines where well located, by dashed lines where approximately located or inferred, and by dotted lines where concealed by younger rocks or by lakes or bays. Fault traces are queried where continuation or existence is uncertain. Concealed faults in the Great Valley are based on maps of selected subsurface horizons, so locations shown are approximate and may indicate structural trend only. All offshore faults based on seismic reflection profile records are shown as solid lines where well defined, dashed where inferred, queried where uncertain.

## FAULT CLASSIFICATION COLOR CODE
(Indicating Recency of Movement)

Fault along which historic (last 200 years) displacement has occurred and is associated with one or more of the following:

(a) a recorded earthquake with surface rupture. (Also included are some well-defined surface breaks caused by ground shaking during earthquakes, e.g. extensive ground breakage, not on the White Wolf fault, caused by the Arvin-Tehachapi earthquake of 1952). The date of the associated earthquake is indicated. Where repeated surface ruptures on the same fault have occurred, only the date of the latest movement may be indicated, especially if earlier reports are not well documented as to location of ground breaks.

(b) fault creep slippage – slow ground displacement usually without accompanying earthquakes.

(c) displaced survey lines.

Pink band added to emphasize location of historic fault displacement.

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**FAULT EXPLANATIONS**

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
5B

PROJECT NO:
SL07059-1

## SPECIAL NOTATIONS

A triangle to the right or left of the date indicates termination point of observed surface displacement.

1951 ▶ ◀ 1951

Date bracketed by triangles indicates local fault break.

No triangle by date indicates an intermediate point along fault break. 1906

Dot on fault indicates location where fault creep slippage has been observed and recorded.

Square on fault indicates where fault creep slippage has occurred that has been triggered by an earthquake on some other fault. Date of causative earthquake indicated. Squares to right and left of date indicate terminal points between which triggered creep slippage has occurred (creep either continuous or intermittent between these end points). 1968 1969 1968

Holocene fault displacement (during past 10,000 years) without historic record. Geomorphic evidence for Holocene faulting includes sag ponds, scarps showing little erosion, or the following features in Holocene age deposits: offset stream courses, linear scarps, shutter ridges, and triangular faceted spurs. Recency of faulting offshore is based on the interpreted age of the youngest strata displaced by faulting. Pale orange band added to emphasize location of Holocene fault displacement.

Late Quaternary fault displacement (during past 700,000 years). Geomorphic evidence similar to that described for Holocene faults except features are less distinct. Faulting may be younger, but lack of younger overlying deposits precludes more accurate age classification.

Quaternary fault (age undifferentiated). Most faults of this category show evidence of displacement sometime during the past 1.6 million years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age. Unnumbered Quaternary faults were based on Fault Map of California, 1975. See Bulletin 201, Appendix D for source data.

Late Cenozoic faults within the Sierra Nevada including, but not restricted to, the Foothills fault system. Faults show stratigraphic and/or geomorphic evidence for displacement of late Miocene and Pliocene deposits. By analogy, late Cenozoic faults in this system that have been investigated in detail may have been active in Quaternary time. (Data from PG&E, 1993).

Pre-Quaternary fault (older than 1.6 million years) or fault without recognized Quaternary displacement. Some faults are shown in this category because the source of mapping used was of reconnaissance nature, or was not done with the object of dating fault displacements. Faults in this category are not necessarily inactive.

S-25

Fault segment associated with a significant linear trend of accurately located earthquake epicenters (magnitude 0.2 or greater). Generally aligned along strike slip faults having Quaternary displacement, but not necessarily with historic surface rupture. Lack of seismic activity along any fault is no indication that the fault may not be active in the future (e.g. San Andreas fault north of San Francisco). Epicenter data are derived from closely spaced seismic stations and include either continuing microseismicity or aftershocks associated with relatively large earthquakes.

Aligned seismicity on fault segments are referenced in Appendices C and E .

## ADDITIONAL FAULT SYMBOLS

U
D

U = Upthrown side (relative or apparent)
D = Downthrown side (relative or apparent)

Bar and ball on downthrown side (used where space is limited).

Arrows along fault indicate relative or apparent direction of lateral movement.

Arrow on fault indicates direction of dip.

Low angle fault (barbs on upper plate). Fault surface generally dips less than 45° but locally may have been subsequently steepened. On offshore faults, barbs simply indicate a reverse fault regardless of steepness of dip.

## OTHER SYMBOLS

529

Numbers refer to annotations listed in the Appendices of the accompanying report. Annotations include fault name, age of fault movement, and pertinent references including Earthquake Fault Zone maps where a fault has been zoned by the Alquist-Priolo Earthquake Fault Zoning Act. This Act requires the State Geologist to delineate zones to encompass all potentially and recently active faults.

Cinder cone and other types of volcanoes. Most were active in Pleistocene time, some are Holocene, a few are historic.

21 8

Number in box or circle refers to Table 4 (Recent Volcanic Eruptions) in accompanying report. (Box refers to California, circle to Nevada.)

(1786 A.D.) = Date of historic volcanic eruption.

(9,500 B.P.) = Eruption occurrence in years before present (B.P.).

★ (0.5 m.y.) = Age of volcanic flow or eruption in million years (m.y.).

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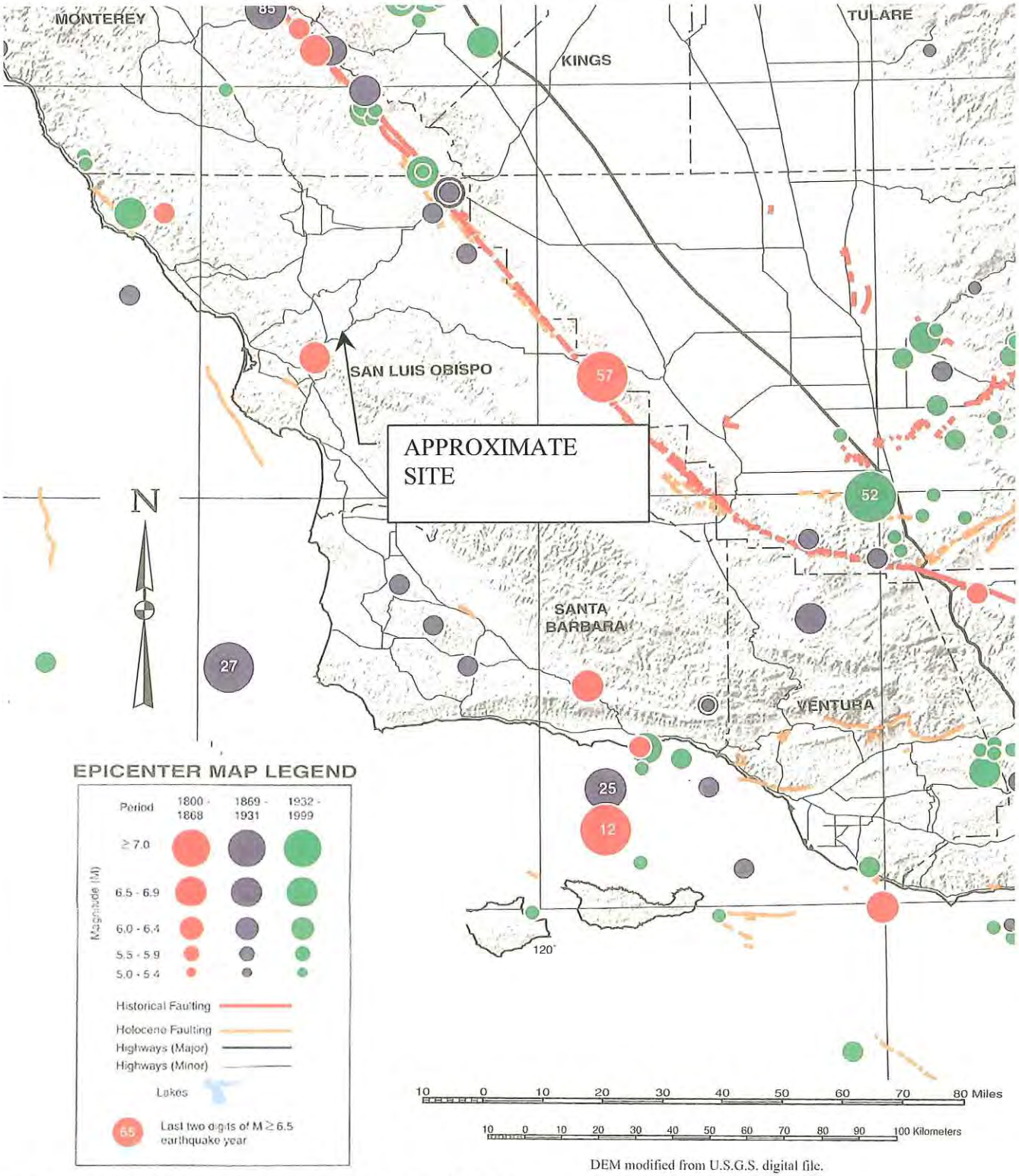
# FAULT EXPLANATIONS

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
5C

PROJECT NO:
SL07059-1




DEM modified from U.S.G.S. digital file.

T. TOPPOZADA, D BRANUM, M PETERSEN, C HALLSTROM, C. CRAMER, M. REICHLE, 2000

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## HISTORICAL SEISMICITY MAP

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
6A

PROJECT NO:
SL07059-1

## Significant Earthquakes That May Have Affected the Site in the Last 200 Years

| DATE | | | TIME (GMT) | LATITUDE | | LONGITUDE | | MAG | LOCATION |
|---|---|---|---|---|---|---|---|---|---|
| Year | mth | day | hr | (N) | | (W) | | | |
| 1812 | 12 | 21 | 19:00 | 34 | 12.00 | 119 | 54.00 | 7.0 | Santa Barbara Channel |
| 1830 | ? | ? | | 35 | 3 | 120 | 6 | 5.0 | San Luis Obispo area (?) |
| 1853 | 2 | 1 | | 35 | 6 | 121 | 1 | 5.0 | San Simeon area (?) |
| 1857 | 1 | 9 | 16:00 | 35 | 42.00 | 120 | 18.00 | 8.25 | Great Fort Tejon earthquake |
| 1866 | 7 | 15 | 06:30 | 37 | 30.00 | 121 | 18.00 | 6.0 | W. San Joaquin Valley |
| 1881 | 2 | 2 | 00:11 | 36 | 0. | 120 | 30.00 | 5.75 | Parkfield |
| 1881 | 4 | 10 | 10:00 | 37 | 24.00 | 121 | 24.00 | 6.0 | W. San Joaquin Valley |
| 1882 | 3 | 6 | 21:45 | 36 | 54 | 121 | 12. | 5.75 | Hollister |
| 1883 | 9 | 5 | 12:30 | 34 | 12.00 | 119 | 54.00 | 6.25 | Santa Barbara Channel |
| 1885 | 3 | 31 | | 36 | 7 | 121 | 3 | 5.5 | San Andreas Fault (?) |
| 1885 | 4 | 2 | | 36 | 8 | 121 | 4 | 5.4 | San Andreas Fault (?) |
| 1885 | 4 | 12 | | 36 | 4 | 121 | 0 | 6.2 | San Andreas Fault (?) |
| 1892 | 4 | 21 | 17:43 | 38 | 30.00 | 121 | 54.00 | 6.25 | Winters |
| 1892 | 11 | 13 | | 36 | 8 | 121 | 5 | 5.5 | San Andreas Fault (?) |
| 1892 | 11 | 13 | 12:45 | 36 | 48.00 | 121 | 30.00 | 5.75 | Hollister |
| 1897 | 6 | 20 | 20:14 | 37 | 0. | 121 | 30.00 | 6.25 | Gilroy |
| 1899 | 7 | 22 | | 34 | 2 | 117 | 4 | 5.5 | San Andreas Fault (?) |
| 1899 | 7 | 22 | | 34 | 3 | 117 | 5 | 6.5 | San Andreas Fault (?) |
| 1901 | 3 | 3 | 07:45 | 36 | 0. | 120 | 30.00 | 6.4 | Parkfield |
| 1901 | 3 | 3 | | 36 | 0 | 120 | 5 | 5.5 | Parkfield Area |
| 1902 | 7 | 28 | | 34 | 75 | 120 | 33 | 5.4 | Los Alamos area |
| 1902 | 12 | 12 | | 34 | 76 | 120 | 37 | 5.0 | Los Alamos area |
| 1906 | 4 | 18 | 13:12 | 37 | 42.00 | 122 | 30.00 | 8.25 | Great 1906 earthquake |
| 1907 | 9 | 20 | | 34 | 2 | 117 | 1 | 6.0 | San Andreas Fault (?) |
| 1910 | 3 | 11 | 06:52 | 36 | 54.00 | 121 | 48.00 | 5.8 | Watsonville |
| 1910 | 12 | 31 | | 36 | 8 | 121 | 4 | 5.0 | Hollister Area |
| 1913 | 10 | 20 | | 35 | 12 | 120 | 58 | 5.0 | Arroyo Grande area |
| 1915 | 1 | 20 | | 34 | 73 | 120 | 23 | 5.8 | Los Alamos area |
| 1916 | 8 | 6 | | 36 | 7 | 121 | 3 | 5.5 | Paicines area |
| 1916 | 10 | 23 | 02:44 | 34 | 54.00 | 118 | 54.00 | 5.3 | Tejon Pass region |
| 1916 | 10 | 23 | | 34 | 6 | 118 | 9 | 6.0 | Tejon Pass Area |
| 1916 | 10 | 23 | | 34 | 7 | 119 | 0 | 5.5 | Tejon Pass Area |
| 1916 | 12 | 1 | | 35 | 18 | 120 | 73 | 5.0 | Avila area |
| 1917 | 7 | 9 | | 35 | 25 | 120 | 48 | 5.0 | Lopez Canyon area |
| 1919 | 2 | 16 | | 35 | 0 | 119 | 0 | 5.0 | Tejon Pass Area |
| 1922 | 3 | 10 | 11:21 | 6 | 0. | 120 | 30.00 | 6.3 | Parkfield |
| 1922 | 3 | 10 | | 35 | 75 | 120 | 25 | 6.5 | Cholame Valley Area |
| 1922 | 8 | 18 | | 35 | 75 | 120 | 3 | 5.0 | Cholame Valley Area |
| 1925 | 6 | 29 | 14:42 | 34 | 18.00 | 119 | 48.00 | 6.3 | Santa Barbara |
| 1926 | 7 | 25 | | 36 | 6 | 120 | 8 | 5.0 | Idria area |
| 1926 | 12 | 27 | | 36 | 2 | 120 | 3 | 5.0 | Coalinga area |
| 1927 | 11 | 4 | 13:50 | 34 | 42.00 | 120 | 48.00 | 7.3 | SW of Lompoc |
| 1932 | 2 | 26 | | 36 | 0 | 121 | 0 | 5.0 | San Ardo area |
| 1934 | 6 | 8 | 04:47 | 36 | 0 | 120 | 30.00 | 6.0 | Parkfield |
| 1934 | 6 | 5 | | 35 | 80 | 120 | 33 | 5.0 | Parkfield Area |
| 1934 | 6 | 8 | | 35 | 80 | 120 | 33 | 6.0 | Parkfield Area |
| 1934 | 12 | 24 | | 35 | 93 | 120 | 48 | 5.0 | Parkfield Area |
| 1939 | 6 | 24 | | 36 | 80 | 121 | 45 | 5.5 | Hollister Area |
| 1939 | 9 | 21 | | 34 | 87 | 118 | 93 | 5.2 | Cuddy Valley Area |
| 1939 | 12 | 28 | | 35 | 80 | 120 | 33 | 5.0 | Parkfield Area |

| DATE | | | TIME (GMT) | LATITUDE | | LONGITUDE | | MAG | LOCATION |
|---|---|---|---|---|---|---|---|---|---|
| Year | mth | day | hr | (N) | | (W) | | | |
| 1941 | 7 | 1 | 07:50 | 34 | 22.00 | 119 | 35.00 | 5.9 | Carpenteria |
| 1951 | 7 | 29 | | 36 | 58 | 121 | 18 | 5.0 | Southeast of Mulberry |
| 1952 | 7 | 21 | 11:52 | 35 | 0. | 119 | 1.00 | 7.7 | Kern County earthquake |
| 1952 | 11 | 22 | 07:46 | 35 | 44.00 | 121 | 12.00 | 6.0 | Bryson |
| 1955 | 11 | 02 | | 35 | 96 | 120 | 92 | 5.1 | San Ardo area |
| 1956 | 11 | 16 | | 35 | 95 | 120 | 47 | 5.0 | Southwest of Coalinga |
| 1960 | 1 | 20 | | 36 | 78 | 121 | 43 | 5.0 | South of Hollister |
| 1966 | 6 | 28 | 04:26 | 36 | 0. | 120 | 30.00 | 6.0 | Parkfield |
| 1966 | 6 | 28 | | 120 | 50 | | | 5.1 | Parkfield Sequence |
| 1966 | 6 | 28 | | 35 | 95 | 120 | 50 | 5.5 | Parkfield Sequence |
| 1970 | 9 | 12 | | 34 | 27 | 117 | 54 | 5.4 | Lytle Creek Area |
| 1971 | 2 | 9 | 14:00 | 34 | 25.00 | 118 | 24.00 | 6.5 | San Fernando |
| 1972 | 2 | 24 | | 36 | 58 | 121 | 21 | 5.0 | Southeast of Hollister |
| 1980 | 5 | 29 | | 34 | 94 | 120 | 78 | 2.1 | Orcutt Frontal Fault |
| 1981 | 9 | 4 | 15:50 | 33 | 40.00 | 119 | 7.00 | 5.9 | N. of Santa Barbara Island |
| 1982 | 10 | 25 | | 36 | 32 | 120 | 52 | 5.4 | New Idria area |
| 1983 | 5 | 2 | 23:42 | 36 | 14.00 | 120 | 19.00 | 6.5 | Coalinga |
| 1983 | 7 | 22 | 00:23 | 36 | 14.00 | 120 | 25.00 | 5.7 | Coalinga |
| 1983 | 8 | 29 | | 35 | 84 | 121 | 34 | 5.4 | San Simeon area |
| 1984 | 1 | 23 | | 36 | 35 | 121 | 91 | 5.2 | Point Sur area |
| 1984 | 4 | 24 | 21:15 | 37 | 19.00 | 121 | 39.00 | 6.1 | Morgan Hill |
| 1985 | 8 | 4 | 12:10 | 36 | 8.00 | 120 | 10.00 | 5.9 | North Kettleman Hills |
| 1989 | 10 | 18 | 00:04 | 37 | 2.19 | 121 | 52.98 | 7.1 | Loma Prieta |
| 2003 | 12 | 22 | 19:16 | 35 | 41.98 | 121 | 5.84 | 6.5 | San Simeon |
| 2004 | 09 | 28 | 10:15 | 35 | 8.15 | 120 | 3.74 | 6.0 | Parkfield |

S:\Misc Drawings\Geology\locallargefaults.doc

San Luis Obispo County Department of Planning and Building, December 1999) Safety Element

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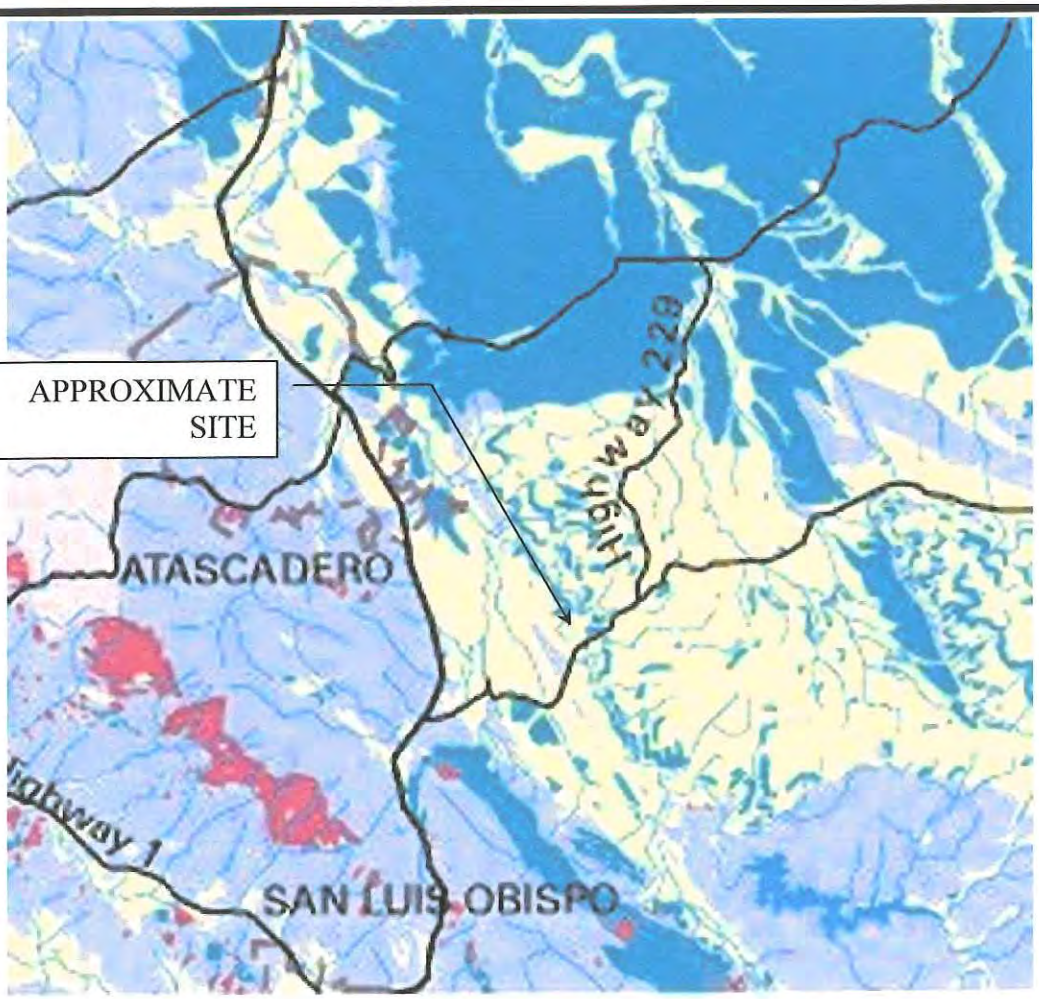
**HISTORICAL SEISMCITY LIST**

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
6B

PROJECT NO:
SL07059-1




N

SCALE: 1" = 50000'

0' 50000'

County Boundary
City Boundaries
Highways
Rivers, Lakes, and Streams

LANDSLIDE POTENTIAL

Very High
Existing Mapped Landslide (Qls, Qlsa)

High Potential
Franciscan and Other Potentially Unstable Rocks (KJfme, KJfmv, KJt, KJfg, Tm, s, Tr, KJs, K) and/or Slope Gradient > 50%

Moderate Potential
Formations Known to Have Localized Areas of Instability (QTp, Ka, K) and/or Slope Gradient > 20%

Low Potential
Slope Gradient < 20%

No Landslide Data

San Luis Obispo County Department of Building and Planning, 1999

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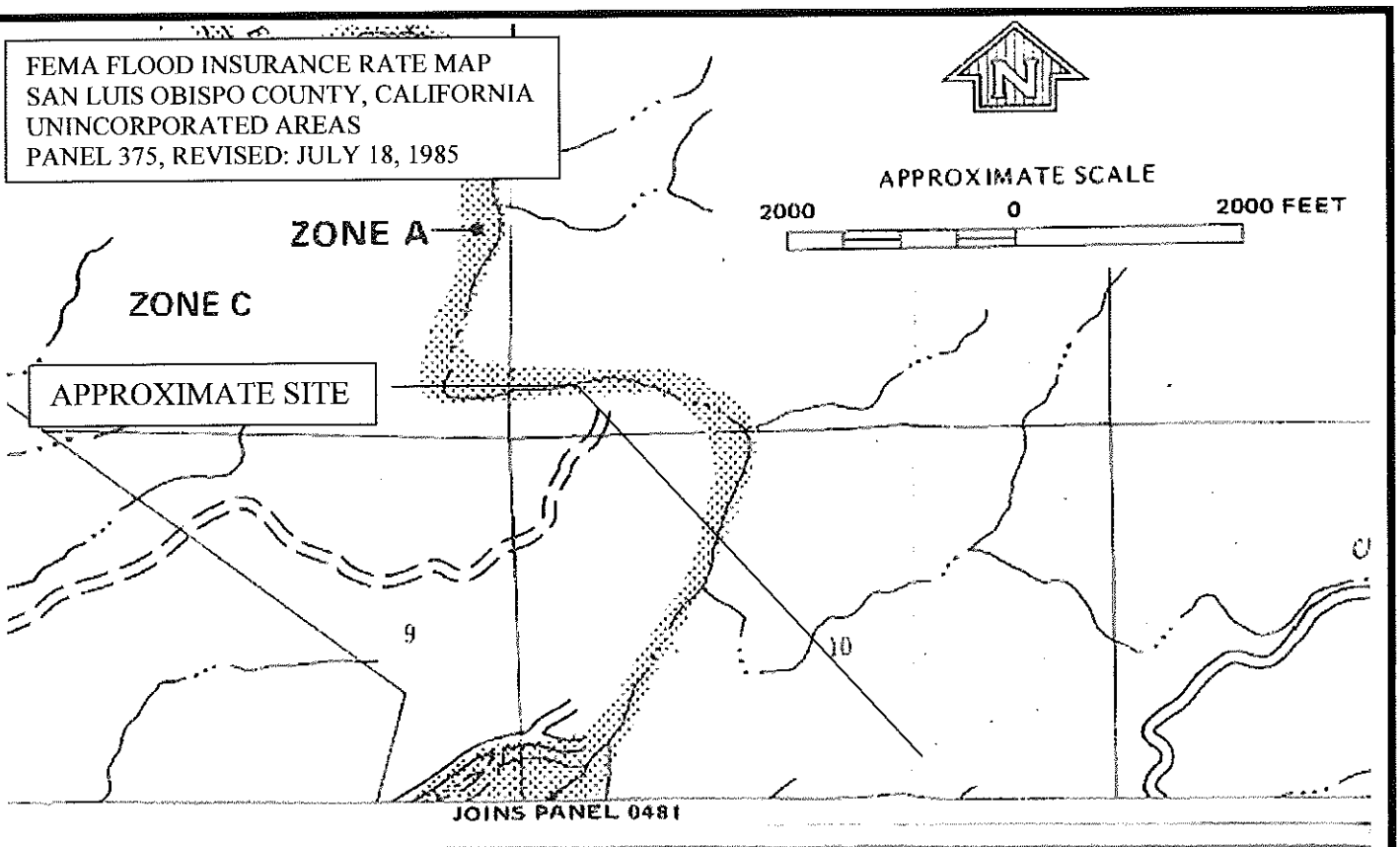
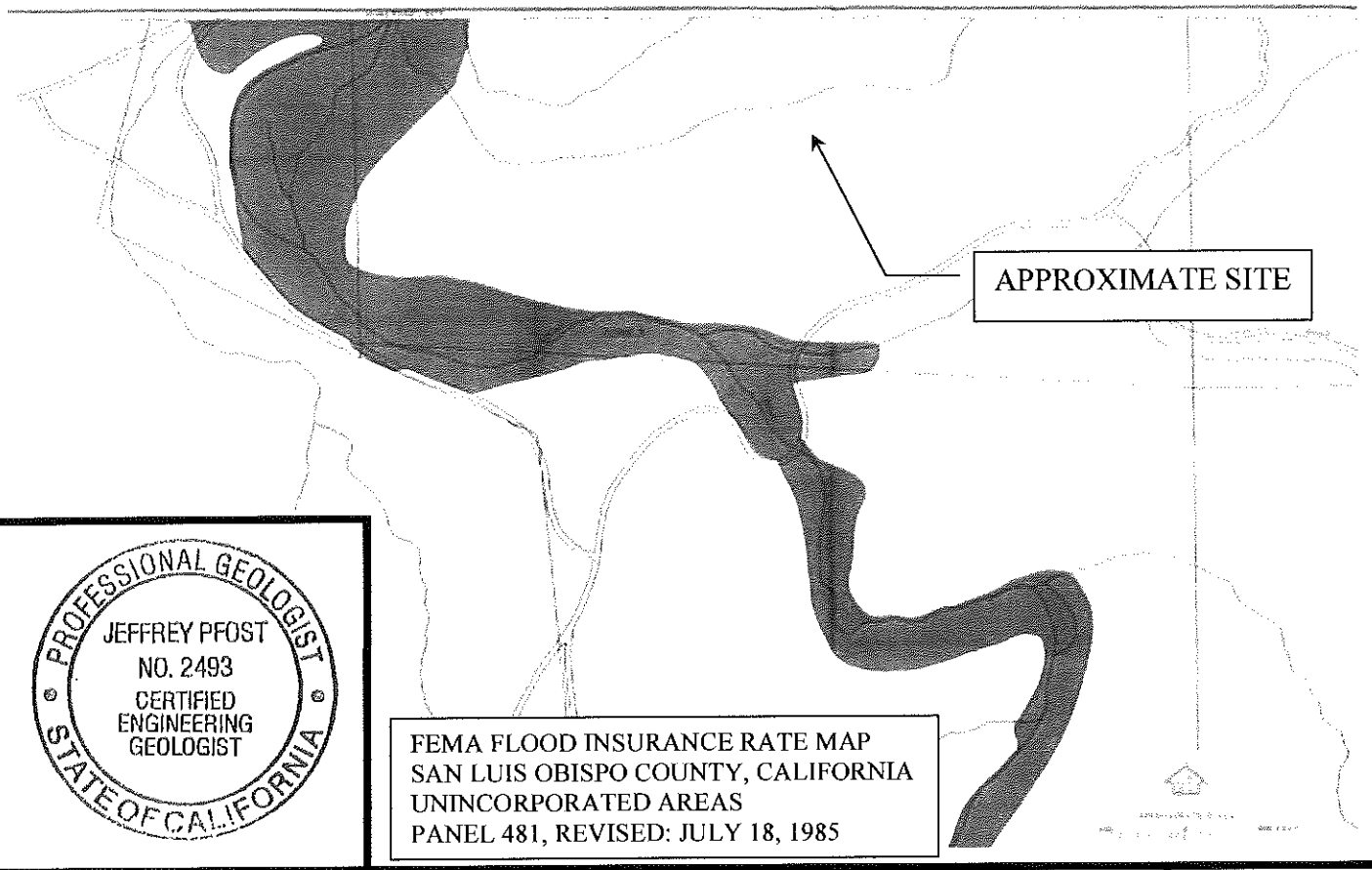
## LANDSLIDE HAZARDS MAP

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
7

PROJECT NO:
SL07059-1

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# FLOOD INSURANCE RATE MAP

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
8A

PROJECT NO:
SL07059-1

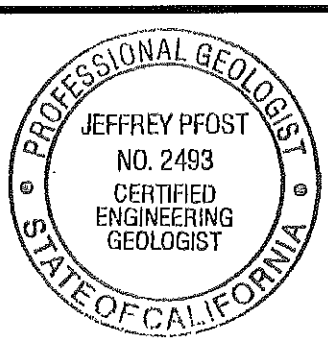
## KEY TO MAP

| | |
|---|---|
| SPECIAL FLOOD HAZARD AREA | ZONE A<br>ZONE B |
| Base Flood Elevation Line With Elevation In Feet** | 513 |
| Base Flood Elevation In Feet Where Uniform Within Zone** | (EL 987) |
| Elevation Reference Mark | RM7× |
| Zone D Boundary | |
| River Mile | •M1.5 |

**Referenced to the National Geodetic Vertical Datum of 1929

## *EXPLANATION OF ZONE DESIGNATIONS

| ZONE | EXPLANATION |
|---|---|
| A | Areas of 100-year flood; base flood elevations and flood hazard factors not determined. |
| A0 | Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; average depths of inundation are shown, but no flood hazard factors are determined. |
| AH | Areas of 100-year shallow flooding where depths are between one (1) and three (3) feet; base flood elevations are shown, but no flood hazard factors are determined. |
| A1-A30 | Areas of 100-year flood; base flood elevations and flood hazard factors determined. |
| A99 | Areas of 100-year flood to be protected by flood protection system under construction; base flood elevations and flood hazard factors not determined. |
| B | Areas between limits of the 100-year flood and 500-year flood; or certain areas subject to 100-year flooding with average depths less than one (1) foot or where the contributing drainage area is less than one square mile; or areas protected by levees from the base flood. (Medium shading) |
| C | Areas of minimal flooding. (No shading) |
| D | Areas of undetermined, but possible, flood hazards. |
| V | Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors not determined. |
| V1-V30 | Areas of 100-year coastal flood with velocity (wave action); base flood elevations and flood hazard factors determined. |

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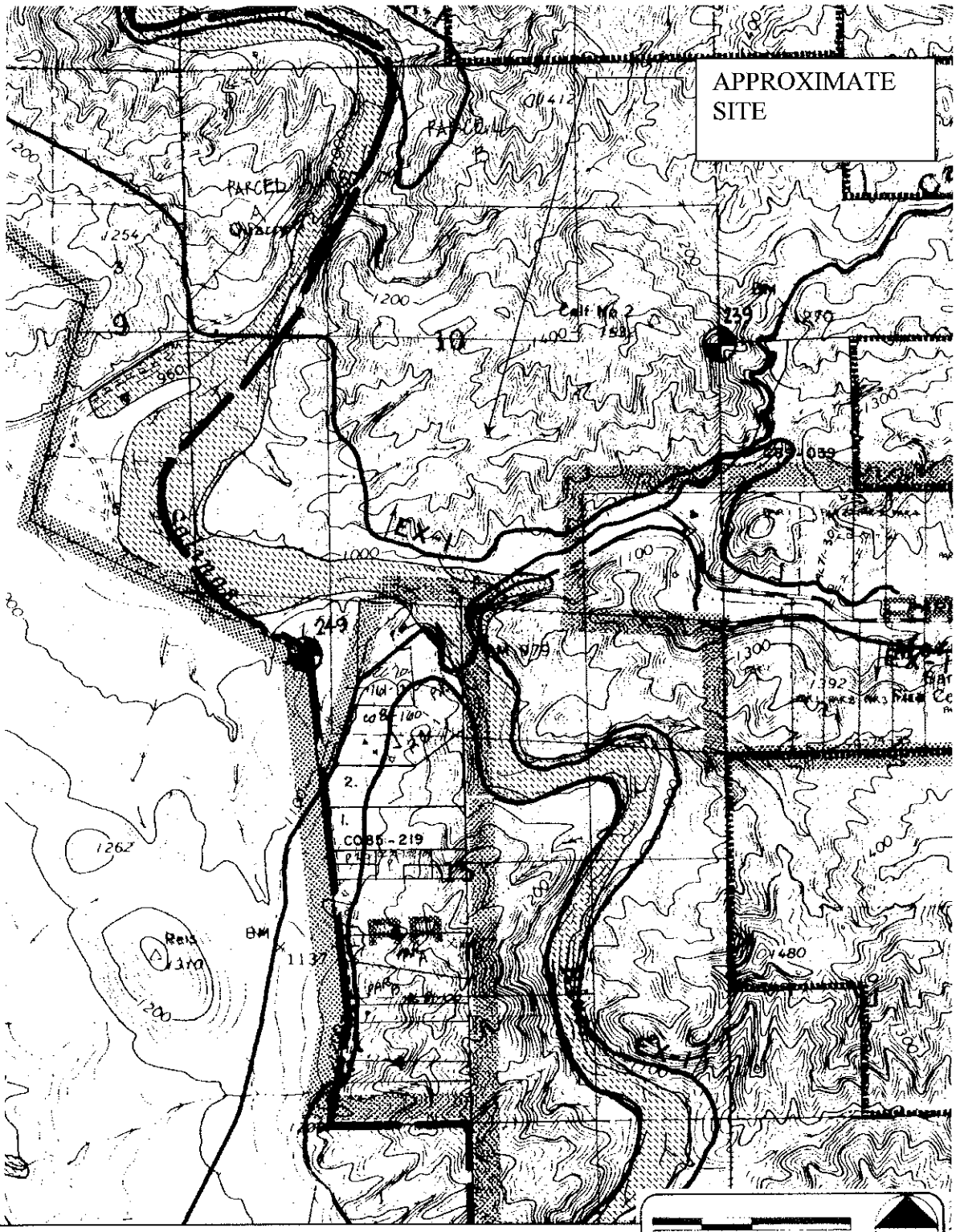
San Luis Obispo, California 93401
(805) 543-8539 fax: (805) 543-2171

# FLOOD MAP EXPLANATIONS

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
8B

PROJECT NO:
SL07059-1




San Luis Obispo County Department of Building and Planning, 1996

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PROFESSIONAL GEOLOGIST
JEFFREY PFOST
NO. 2493
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

# GEOLOGIC STUDY AREA MAP

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

**PLATE**
9A

PROJECT NO:
SL07059-1

# LEGEND

## LAND USE CATEGORIES

- AG AGRICULTURE
- RL RURAL LANDS
- REC RECREATION
- RR RESIDENTIAL RURAL
- RS RESIDENTIAL SUBURBAN
- RSF RESIDENTIAL SINGLE FAMILY
- RMF RESIDENTIAL MULTI-FAMILY
- OP OFFICE & PROFESSIONAL
- CR COMMERCIAL RETAIL
- CS COMMERCIAL SERVICE
- IND INDUSTRIAL
- PF PUBLIC FACILITIES
- OS OPEN SPACE

## BOUNDARIES

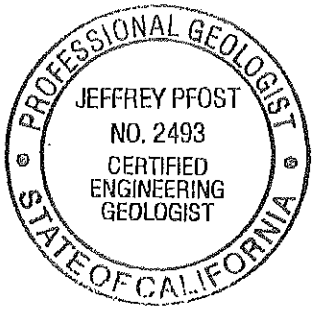
- LAND USE CATEGORY LINE
- URL - URBAN RESERVE LINE
- USL - URBAN SERVICE LINE
- VRL - VILLAGE RESERVE LINE
- CBD - CENTRAL BUSINESS DISTRICT
- COASTAL ZONE LINE
- PLANNING AREA

## COMBINING DESIGNATIONS

- AR AIRPORT REVIEW AREA
- GS GEOLOGIC STUDY AREA
- FH FLOOD HAZARD
- EX ENERGY & EXTRACTIVE AREA
- H HISTORIC
- V VISITOR SERVING AREA
- LCP LOCAL COASTAL PLAN
- ARCHAEOLOGICALLY SENSITIVE AREAS
- SRA SENSITIVE RESOURCE AREA
- SRA's THAT ARE ALSO ENVIRONMENTALLY SENSITIVE HABITATS
- TH TERRESTRIAL HABITAT
- COASTAL STREAMS AND RIPARIAN VEGETATION
- WETLANDS
- * MARINE HABITAT

## PROPOSED PUBLIC FACILITIES

- HS HIGH SCHOOL
- JHS JUNIOR HIGH SCHOOL
- E ELEMENTARY SCHOOL
- PARK
- POLICE OR PUBLIC SAFETY FACILITY STATION
- R PROPOSED RESERVOIR
- WT WATER TREATMENT FACILITIES
- ST SEWAGE TREATMENT FACILITIES
- SW SOLID WASTE FACILITIES
- GF GOVERNMENT FACILITY
- L LIBRARY

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## GEOLOGIC STUDY AREA EXPLANATIONS

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
9B

PROJECT NO:
SL07059-1

**APPENDIX A**

Trench Logs

Boring Logs

Boring Logs (Department of Water Resources, September, 2002)

Rock and Fracture Descriptors

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately soft, intensely weathered, "decomposed granite"

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately hard, moderately weathered, massive, "decomposed granite"




GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately soft, intensely weathered, some roots, "decomposed granite"

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately hard to hard, moderately weathered, slightly fractured, "decomposed granite"




COLLUVIUM (Qc) - Light Gray Silty SAND, dry

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately hard, moderately weathered, massive, "decomposed granite"




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GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately hard to hard, moderately weathered, slightly fractured, "decomposed granite," Fractures: very widely spaced (SP2), discontinuous to slightly continuous (C1-C2), E0-E1 ends, tight to slightly open (O0-O1), clean (T0), not healed (HL5), moderately to slightly rough (R3-R4), dry (M3)




COLLUVIUM (Qc) - Light Gray Silty SAND, dry

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately soft, intensely weathered, "decomposed granite"

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately hard to hard, moderately weathered, slightly fractured, "decomposed granite," Fractures: very widely spaced (SP2), discontinuous to slightly continuous (C1-C2), E0-E1 ends, tight to slightly open (O0-O1), clean (T0), not healed (HL5), moderately to slightly rough (R3-R4), dry (M3)




GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately soft, intensely weathered, some roots, "decomposed granite"

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately hard to hard, moderately weathered, moderately fractured, "decomposed granite," Fractures: very widely spaced (SP2), discontinuous to slightly continuous (C1-C2), E0-E1 ends, tight to slightly open (O0-O1), clean (T0), not healed (HL5), moderately to slightly rough (R3-R4), dry (M3)




COLLUVIUM (Qc) - Light Gray Silty SAND, dry

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately soft, intensely weathered, "decomposed granite"

GRANITIC ROCKS (Kgr) - Light Brown Granodiorite, dry, moderately hard to hard, moderately weathered, slightly fractured, "decomposed granite," Fractures: very widely spaced (SP2), discontinuous to slightly continuous (C1-C2), E0-E1 ends, tight to slightly open (O0-O1), clean (T0), not healed (HL5), moderately to slightly rough (R3-R4), dry (M3)

LOG 1

PROJECT SL07059-1

# TRENCH LOGS

LAS PILITAS QUARRY, SANTA MARGARITA AREA
SAN LUIS OBISPO COUNTY, CALIFORNIA




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**GeoSolutions, INC.**

220 High Street, San Luis Obispo, California 93401

# BORING LOG

Boring Number: **B-1**

Project Number: **SL07059-1**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| Project Name: | **Las Palitas Quarry** | Drill Rig: | **Furukawa HCR1500-ED** |
| Drilling Location: | **See Plate 1** | Hole Diameter: | **4 inches** |
| Date Drilled: | **6-30-09** | Sampling Method: | **-** |
| Logged By: | **JAP** | Hole Elevation: | **1425 feet** |

Depth of Groundwater: **NA** Boring Terminated At: **64 feet** 

| Depth (feet) | Soil Description | USCS | Lithology | Sample | Blows per 12 inches | $(N_1)_{60}$ | Friction Angle, (degrees) | Cohesion, C (psf) | Optimum Water Content (%) | Maximum Dry Density (pcf) | Expansion Index (EI) | Plasticity Index (PI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Granodiorite: Light brown, moderately weathered, dry, "Decomposed Granite", Granitic Rocks (Kgr) | | | | | | | | | | | |
| -5 | | | | | | | | | | | | |
| -10 | | | | | | | | | | | | |
| -15 | | | | | | | | | | | | |
| -20 | | | | | | | | | | | | |
| -25 | | | | | | | | | | | | |
| -30 | | | | | | | | | | | | |
| -35 | | | | | | | | | | | | |
| -40 | | | | | | | | | | | | |
| -45 | | | | | | | | | | | | |
| -50 | Granodiorite: Light gray to bluish gray, fresh to slightly weathered, dry, "Blue Granite", Granitic Rocks (Kgr) | | | | | | | | | | | |
| -55 | | | | | | | | | | | | |
| -60 | | | | | | | | | | | | |

Terminated at 64 feet due to crack in collar

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# BORING LOG

Boring Number: **B-2**

Project Number: **SL07059-1**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| Project Name: | **Las Palitas Quarry** | Drill Rig: | **Furukawa HCR1500-ED** |
| Drilling Location: | **See Plate 1** | Hole Diameter: | **4 inches** |
| Date Drilled: | **6-30-09** | Sampling Method: | - |
| Logged By: | **JAP** | Hole Elevation: | **1430 feet** |

Depth of Groundwater: **NA** Boring Terminated At: **84 feet** 

| Depth (feet) | Soil Description | USCS | Lithology | Sample | Blows per 12 inches | $(N_1)_{60}$ | Friction Angle, (degrees) | Cohesion, C (psf) | Optimum Water Content (%) | Maximum Dry Density (pcf) | Expansion Index (EI) | Plasticity Index (PI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Granodiorite: Light brown, moderately weathered, dry, "Decomposed Granite", Granitic Rocks (Kgr) | | | | | | | | | | | |
| -5 | | | | | | | | | | | | |
| -10 | | | | | | | | | | | | |
| -15 | | | | | | | | | | | | |
| -20 | | | | | | | | | | | | |
| -25 | | | | | | | | | | | | |
| -30 | | | | | | | | | | | | |
| -35 | | | | | | | | | | | | |
| -40 | | | | | | | | | | | | |
| -45 | | | | | | | | | | | | |
| -50 | | | | | | | | | | | | |
| -55 | Granodiorite: Light gray to bluish gray, fresh to slightly weathered, dry, "Blue Granite", Granitic Rocks (Kgr) | | | | | | | | | | | |
| -60 | | | | | | | | | | | | |
| -65 | | | | | | | | | | | | |
| -70 | | | | | | | | | | | | |
| -75 | | | | | | | | | | | | |
| -80 | | | | | | | | | | | | |

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# BORING LOG

Boring Number: **B-3**

Project Number: **SL07059-1**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| Project Name: | **Las Palitas Quarry** | Drill Rig: | **Furukawa HCR1500-ED** |
| Drilling Location: | **See Plate 1** | Hole Diameter: | **4 inches** |
| Date Drilled: | **6-30-09** | Sampling Method: | **-** |
| Logged By: | **JAP** | Hole Elevation: | **1335 feet** |

Depth of Groundwater: **NA** Boring Terminated At: **84 feet** 

| Depth (feet) | Soil Description | USCS | Lithology | Sample | Blows per 12 inches | $(N_1)_{60}$ | Friction Angle, (degrees) | Cohesion, C (psf) | Optimum Water Content (%) | Maximum Dry Density (pcf) | Expansion Index (EI) | Plasticity Index (PI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Granodiorite: Light brown, moderately weathered, dry, "Decomposed Granite", Granitic Rocks (Kgr) | | | | | | | | | | | |
| -5 | | | | | | | | | | | | |
| -10 | | | | | | | | | | | | |
| -15 | | | | | | | | | | | | |
| -20 | | | | | | | | | | | | |
| -25 | | | | | | | | | | | | |
| -30 | | | | | | | | | | | | |
| -35 | | | | | | | | | | | | |
| -40 | | | | | | | | | | | | |
| -45 | | | | | | | | | | | | |
| -50 | | | | | | | | | | | | |
| -55 | | | | | | | | | | | | |
| -60 | | | | | | | | | | | | |
| -65 | | | | | | | | | | | | |
| -70 | Granodiorite: Light gray to bluish gray, fresh to slightly weathered, dry, "Blue Granite", Granitic Rocks (Kgr), moist at 82 feet | | | | | | | | | | | |
| -75 | | | | | | | | | | | | |
| -80 | | | | | | | | | | | | |

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# BORING LOG

Boring Number: **B-4**

Project Number: **SL07059-1**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| Project Name: | **Las Palitas Quarry** | Drill Rig: | **Furukawa HCR1500-ED** |
| Drilling Location: | **See Plate 1** | Hole Diameter: | **4 inches** |
| Date Drilled: | **6-30-09** | Sampling Method: | - |
| Logged By: | **JAP** | Hole Elevation: | **1298 feet** |

Depth of Groundwater: **NA** Boring Terminated At: **84 feet**



| Depth (feet) | Soil Description | USCS | Lithology | Sample | Blows per 12 inches | $(N_1)_{60}$ | Friction Angle, (degrees) | Cohesion, C (psf) | Optimum Water Content (%) | Maximum Dry Density (pcf) | Expansion Index (EI) | Plasticity Index (PI) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Granodiorite: Light brown, moderately weathered, dry, "Decomposed Granite", Granitic Rocks (Kgr) | | | | | | | | | | | |
| -5 | | | | | | | | | | | | |
| -10 | | | | | | | | | | | | |
| -15 | | | | | | | | | | | | |
| -20 | | | | | | | | | | | | |
| -25 | | | | | | | | | | | | |
| -30 | | | | | | | | | | | | |
| -35 | | | | | | | | | | | | |
| -40 | | | | | | | | | | | | |
| -45 | | | | | | | | | | | | |
| -50 | | | | | | | | | | | | |
| -55 | | | | | | | | | | | | |
| -60 | | | | | | | | | | | | |
| -65 | Granodiorite: Light gray to bluish gray, fresh to slightly weathered, dry, "Blue Granite", Granitic Rocks (Kgr) | | | | | | | | | | | |
| -70 | | | | | | | | | | | | |
| -75 | | | | | | | | | | | | |
| -80 | | | | | | | | | | | | |

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

# DRILL HOLE LOG

SHEET 1 of 2
HOLE NO. CCT-3
ELEV. 1093 FEET
DEPTH 50.0 FEET

PROJECT COASTAL BRANCH - PHASE II
FEATURE Reach 4, Calf Canyon Tunnel, Outlet Portal
LOCATION N. 705,640, W. 1,236,000 Centerline Sta. 2493+39
CONTR. P.C. Exploration, Inc. DRILL RIG Mobile Puntel

DATE DRILLED 6/28-29/94
ATTITUDE Vertical
LOGGED BY Ted Bruce
DEPTH TO WATER 31.5'

R = Rotary

| DEPTH (ELEV.) | LOG | FIELD CLASSIFICATION AND DESCRIPTION | SAMPLE NO. | MODE | REMARKS |
|---|---|---|---|---|---|
| 0.0 (1093) | | CRETACEOUS GRANITE | | R | Drill pad has a 7 foot high cut of decomposed to intensely weathered granite that is closely fract. and friable. Joint Sets in Cut: 1) N32 - 46W, 55-62 SW 2) N36 - 52W, 60-73 NE Started drilling with HQ stratapac bit and wireline barrel with split tube. Circulating clear water. Installed 3' of 6" diam. surface casing. |
| (1090) | gr | 0.0 - 50.0' Granite: Light brown to whitish gray decomposed to intensely weathered from 0.0 to 25.0 intensely weathered to about 25.6', moderately weathered from 25.6 to 30.4', slightly weathered from 30.4 to 41.3'; friable to 15.0', low hardness and weak from 15.0 to 25.0', moderately hard and mod. strong from 25.0 to 30.4', and hard and strong from 30.4 to 50.0'; intensely fract. from 0.0 to 20.0', intensely to closely fract. from 20.0 to 30.4', closely fract. from 30.4 to 50.4'. Below 30.4' the slightly weathered rock appears to be more fractured than its natural state (possibly due to bad rods or bent quill rod). Blocking off is occurring from high angle fracts. lodging in shoe. Two prominent joints: (1) 47 to 60°, (2) 70 to 85°. In slightly weathered granite all joint fractures show oxidation with occasional slicks. | | 0.0 / 10.0 | |
| 10 | | | 10 | | Drilled from 0.0 to 10.0' in about 5 min. Only cuttings of decomposed granite. |
| (1080) | | | | 0.2 / 5.0 | |
| | gr | | 15 | | Drilled fast and smooth. 0.0 to 20.0', RQD = 0%. |
| | | | Box 1 | 1.5 / 5.0 | Drilled from 15.0-20.0' in 3 min. Advanced barrel mainly by rotation, no down pressure. |
| 20 | | 60° dipping joint plane with 3/8" of infilling and tree rootlet at 20.2'. | 20 | | |
| (1070) | | | | 3.0 / 5.0 | Drilled fast and smooth. RQD = 12%. |
| | | | 25 | | |
| | gr | | | 1.7 / 5.0 | About 80% water return. RQD = 0%. |
| 30 | | | 30 | | Drilled fast and smooth. 30.0 switched to diamond impregnated bit. Drilled slower with slight rod |

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# DRILL HOLE LOG

SHEET 2 OF 2

HOLE NO. CCT-3

PROJECT & FEATURE COASTAL BRANCH - PHASE II, Reach 4, Calf Canyon Tunnel, Outlet Portal

| DEPTH (ELEV.) | LOG | FIELD CLASSIFICATION AND DESCRIPTION | SAMPLE NO. | MODE | REMARKS |
|---|---|---|---|---|---|
| 32.0 (1060) | | | Box 1 | 3.5 / 3.5 | Blocked off. RQD = 0%. |
| | | | | 33.5 | |
| | | | | 3.5 / 3.5 | Blocked off. RQD = 0%. |
| | | | | 37.0 | |
| | | Below 37' the granite is mostly closely fract. (0.3-0.5') and high angle fracts. show less oxidation. 38.3', slickensided fract. dipping 70-75°, no gouge but fract. surface is coated with chlorite. | | 4.0 / 4.0 | Blocked off. RQD = 62%. |
| 40.0 | gr | | Box 2 | 41.0 | |
| (1050) | | 41.3' fresh rock, still closely fract. but two 0.7' core lengths. Fracts. are mostly dipping 65-80° with a secondary set dipping 35-50°. | | 4.5 / 4.3 | RQD = 82% |
| | | From 45.0 to 50.0' the rock is closely fract. but mostly 0.1-0.25'; fracturing is about 80% related to high angle (70-85°) jointing. | | 45.3 | |
| | | | | 4.7 / 4.7 | Drilled slow and smooth. RQD = 21%. |
| 50.0 (1043) | | | | 50 | |
| | | T.D. = 50.0' | | | Hole completion: backfill grouted hole with a bentonite/slurry. |

Hand Copied from Drawing

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# DRILL HOLE LOG

SHEET 1 of 4
HOLE NO. CCT-4
ELEV. 1095 FEET
DEPTH 121 FEET

PROJECT COASTAL BRANCH - PHASE II
DATE DRILLED 6/30-7/8/94
FEATURE Reach 4, Calf Canyon Tunnel, Outlet Portal
ATTITUDE -5°, Brng. N41E
LOCATION N. 705,642, E. 1,236,002 Centerline Sta. 2493+34
LOGGED BY T. Bruce
CONTR. P.C. Exploration, Inc. DRILL RIG Mobile Puntel
DEPTH TO WATER undetermined

RB = Rockbitted
R = Rotary

| DEPTH (ELEV.) | LOG | FIELD CLASSIFICATION AND DESCRIPTION | SAMPLE NO. | MODE | REMARKS |
|---|---|---|---|---|---|
| 0.0 (1095) | gr | CRETACEOUS GRANITE<br>0.0 - 121.0' Granite: Light brown to whitish gray; decomposed to intensely weathered from 0.0 to 36.3', intensely weathered to 39.0', intensely to moderately weathered to 41.0'; moderately weathered with 25% int. to about 80'; friable to 26.0', low hardness and weak from 26.0 to 36.3', moderately hard & mod. strong from 36.3 to 39.0', hard below 39.0' but still moderately strong; intensely fractured to 30.8', closely fract. from 30.8 to 99'. Prominent joint fractures inclined 5 to 20° to the core axis. | | RB | Started drilling with 5-1/4" rockbit to a depth of 6'. Pulled out and started drilling with impregnated diamond bit with wireline barrel and split innertube. Circulating clear water. started hole in drill pad cut. |
| 10 | | | | R<br>0.0/5.0 | No recovery. Washing away decomposed to intensely weathered granite. |
| | | | | 0.0/5.0 | No recovery. Same as above. |
| 20 | gr | Intensely weathered 0 to 39'. Very poor recovery, very friable. | | 0.6/5.0 | Drilled fast and smooth, but recovered only ground-up granite. |
| | | | Box 1 | 0.2/5.0 | Water return is still brown. |
| 30 | gr | | | 0.4/5.0 | @ 27' water return light brown to light gray, back to brown at 27.5'.<br>8 mins. to drill 26-31'.<br>RQD = 0% 6.0 to 31.0'. |

2

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# DRILL HOLE LOG

SHEET 2 OF 4

HOLE NO. CCT-4

PROJECT & FEATURE COASTAL BRANCH - PHASE II, Reach 4, Calf Canyon Tunnel

| DEPTH (ELEV.) | LOG | FIELD CLASSIFICATION AND DESCRIPTION | SAMPLE NO. | MODE | REMARKS |
|---|---|---|---|---|---|
| 32 | | | | 0.6 / 5.0 | Drilled moderately fast and smooth. RQD = 0%. |
| 36 | gr | | | | |
| | | 39'- Moderately weathered, yellow staining on fractures, low hardness, maximum size core about 5 inches. | | 3.2 / 5.0 | Drilled slow and smooth. RQD = 13%. |
| 40 | | | | | |
| 41 | | | | 4.0 / 5.0 | Drilled slow and smooth. RQD = 20%. |
| 46 | | | Box 1 | | |
| | | Drilling indicated intensely weathered zone from about 47.5 to 49.0'. | | 3.3 / 5.0 | Lost core from about 47.5' to about 48.5' where it drilled fast. RQD = 30%. |
| 50 | | | | | |
| 51 | | | | 2.3 / 5.0 | RQD = 26%. |
| | gr | About 55.5' prominent joint inclined 20°; not as heavily oxidized as fracts. above 55'. | | | |
| 56 | | | | 3.1 / 5.0 | RQD = 33%. |
| 60 | | | | | |
| 61 | | 61-76' Very poor recovery, drilled very fast, drill return water generally greenish color. | Box 2 | 0.7 / 5.0 | Begin 7/6/94 Rec. = 14% RQD = 0%. Drilled fast. Return water has a greenish color. |
| 66 | | | | | |
| | gr | | | 0.2 / 5.0 | 8 min. to drill 5'. Rec. = 5%, RQD = 0%. Abrupt color change in return water. Gray color at 70' then back to greenish at 71'. |
| 70 | | | | | |
| 71 | | | | | |

7

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# DRILL HOLE LOG

SHEET 3 OF 4

HOLE NO. CCT-4

PROJECT & FEATURE COASTAL BRANCH - PHASE II, Reach 4, Calf Canyon Tunnel

| DEPTH (ELEV.) | LOG | FIELD CLASSIFICATION AND DESCRIPTION | SAMPLE NO. | MODE | REMARKS |
|---|---|---|---|---|---|
| 72 | | | | | |
| | | Mostly intensely fractured with one 0.7' long piece, varies from friable to hard, breaks up when removed from core barrel, intensely weathered to fresh. | | 0.9 / 5.0 | Drilled very fast to 75.5'. Rec. 18% RQD = 10%. Drill time 8 min. |
| | | | | 76 | |
| | | | Box 2 | 3.5 / 5.0 | Drill time 30 min. Lost all drill water return at 78'. 60% drill water return at 78.5, milky gray color. Rec. = 70% RQD = 10%. |
| 80 | gr | | | | |
| | | Mostly in one to three inch pieces bounded by natural stained fractures, hard, fresh to moderately weathered fractures 30 to 60° and 10°. | | 81 | |
| | | | | 4.6 / 5.0 | Drill time 10 min. Rec. = 92% RQD = 20%. |
| | | | | 86 | |
| | | Mostly in two to five inch lengths, yellow staining on fractures. Rock is hard and strong but closely fractured, thin coating on some joints. | | 4.8 / 5.0 | Drill time 17 min. Rec. = 96% RQD = 35% |
| 90 | | | | 91 | |
| | | | Box 3 | 5.0 / 5.0 | Drill time 17 min. Rec. = 100% RQD = 30%. |
| | gr | | | 96 | Start 7/7/94 |
| | | | | 2.8 / 3.2 | Rec.=83% RQD = 50%. |
| | | Joints 15° and 70°. | | 99.8 | Changed bits. |
| 100 | | From 99' to 108' the rock is very hard and strong, fresh, moderately fractured, few joints with yellow staining. | | 4.0 / 4.0 | Rec. = 100% RQD = 35%. |
| | | | | 103.2 | |
| | | | Box 4 | 2.8 / 2.8 | Rec. = 100% RQD = 50%. |
| | | | | 106 | |
| | | | | 3.5 / 3.5 | Rec. = 100% RQD = 50%. |
| 110 | gr | | | 109.5 | |
| | | | | 4.5 / 4.5 | Rec. = 100% RQD = 60%. |

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES

# DRILL HOLE LOG

SHEET 4 OF 4

HOLE NO. CCT-4

PROJECT & FEATURE COASTAL BRANCH - PHASE II, Reach 4, Calf Canyon Tunnel

| DEPTH (ELEV.) | LOG | FIELD CLASSIFICATION AND DESCRIPTION | SAMPLE NO. | MODE | REMARKS |
|---|---|---|---|---|---|
| 112 | gr | 108-121' Hard, strong, fresh, slightly fractured. | Box 4 | 114 | Begin 7/8/94. |
| | | | | 3.0 / 3.0 | Rec. = 100% RQD = 80%. |
| | | | Box 5 | 117 | |
| 120 | | | | 4.0 / 4.0 | 35 min. to drill 3-1/2'. Rec. = 100% RQD = 90%. |
| | | T.D. = 121.0' | | | Hole completion: Backfill grouted hole with a bentonite/cement slurry. |

6

State of California
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# DRILL HOLE LOG

SHEET 1 of 1
HOLE NO. CCT-5
ELEV. 1082 FEET
DEPTH 32.0 FEET

PROJECT COASTAL BRANCH - PHASE II
DATE DRILLED 4/27/94
FEATURE Reach 4, Calf Canyon Tunnel, Outlet Portal
ATTITUDE Vertical
LOCATION N. 705,580, E. 1,235,980 Sta. 2493+75
LOGGED BY S. Killingsworth
CONTR. P.C. Exploration, Inc DRILL RIG Mobile B-53
DEPTH TO WATER Not encountered

A = Auger
B = Bag Sample
SPT = Standard Penetration Test

| DEPTH (ELEV.) | LOG | FIELD CLASSIFICATION AND DESCRIPTION | SAMPLE NO. | MODE | REMARKS |
|---|---|---|---|---|---|
| 0 (1082) | | RESIDUAL SOIL | | | Begin drilling with 3-1/4" hollow-stem auger. |
| (1080) | SW | 0.0 - 15.0' Well-Graded Sand: Brown, dry to damp, fine to coarse grained granitic sand with 5-10% nonplastic fines; medium dense. | Bulk 1 | A | |
| | | | B-1 | N=12 | SPT driven 5.0-6.5' 5/6/6 1.5/1.5' |
| | | | | A | |
| 10 (1070) | | | B-2 | N=14 | SPT driven 10.0-11.5' 6/7/7 1.5/1.5' |
| | | | | A | Easy drilling. |
| | gr | CRETACEOUS GRANITE 15.0 - 32.0' Granite: Light brown, dry, decomposed, friable. | B-3 | Refusal | SPT driven 15.0-15.4' 50 for 4" 0.4/0.4' |
| | | | | A | |
| 20 (1060) | | | B-4 | Refusal | SPT driven 20.0-20.4' 50 for 4" 0.4/0.4' |
| | | | | A | |
| | | | B-5 | Refusal | SPT driven 25.0-25.3' 50 for 3" 0.3/0.3' |
| | | | | A | |
| 30 (1050) | | 31.0' Hard, strong, fresh. Bottomed at 32.0' | | Refusal | SPT driven 30.0-30.2' 50 for 2" 0/0.2' 31' Grinding on hard material 32' Auger refusal Backfilled w/cuttings |

7

# ROCK DESCRIPTORS

## Weathering

| | | |
|---|---|---|
| W1 | Fresh | Body of rock is not oxidized or discolored; fracture surfaces are not oxidized or discolored*; no separation of grain boundaries; no change of texture and no solutioning. Hammer rings when crystalline rocks are struck |
| W2 | Slightly weathered to fresh** | |
| W3 | Slightly weathered | Discoloration or oxidation is limited to surface of, or short distance from fractures; some feldspar crystals are dull; fracture surfaces have minor to complete discoloration or oxidation; no visible separation of grain boundaries; texture preserved and minor leaching of soluble minerals may be present. Hammer rings when crystalline rocks are struck, body of rock is not weakened by weathering. |
| W4 | Moderately to slightly weathered** | |
| W5 | Moderately weathered | Discoloration or oxidation extends from fractures, usually throughout body of rock; ferromagnesian minerals are "rusty," feldspar crystals are "cloudy"; all fracture surfaces are discolored or oxidized; partial opening of grain boundaries visible; texture generally preserved but soluble minerals may be mostly leached. Hammer does not ring when rock is struck, body of rock is slightly weakened. |
| W6 | Intensely to moderately weathered** | |
| W7 | Intensely weathered | Body of rock is discolored or oxidized throughout; all feldspars and ferromagnesian minerals are altered to clay to some extent. All surfaces are discolored or oxidized, surfaces friable; partial separation of grain boundaries; rock is friable; in situ disaggregation of granitics common in semi-arid regions; texture altered and leaching of soluble minerals may be complete. Rock has dull sound when struck with hammer; rock is weakened, usually can be broken with moderate to heavy manual pressure, or by light hammer blow without reference to planes or weakness. |
| W8 | Very intensely weathered** | |
| W9 | Decomposed | Body of rock is discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and ferromagnesian minerals are completely altered to clay; complete separation of grain boundaries (disaggregated), partial or complete remnant rock structure may be preserved, but resembles a soil. |
| * | Characteristics of fracture surfaces do not include directional weathering along shears or faults and their associated fracture zones; for example a shear that carries weathering to great depths in a fresh rock mass would not require the whole rock mass to be classified as weathered. | |
| ** | Combination descriptors are used where equal distribution of both weathering characteristics are present over significant intervals or where characteristics noted are "in between" the diagnostic characteristics. | |

## Durability Index

| | |
|---|---|
| D10 | Rock specimen or exposure remains intact with no deleterious cracking after exposure longer than 1 year. |
| D11 | Rock specimen or exposure develops hairline cracking on surfaces within 1 month, but no disaggregation within 1 year of exposure. |
| D12 | Rock specimen or exposure develops hairline cracking on surfaces within 1 week, and/or disaggregation within 1 month of exposure. |
| D13 | Specimen or exposure may develop hairline cracks in 1 day and displays pronounced separation of bedding and/or disaggregation within 1 week of exposure |
| D14 | Specimen or exposure displays pronounced cracking and disaggregation within 1 day (24 hours) of exposure. Generally ravels and degrades to small fragments. |

## Bedding Foliation or Flow Texture

| | |
|---|---|
| Massive | Greater than 10 ft (>3m) |
| Very thickly (bedded, foliated, or banded) | 3 to 10 ft (1 to 3 m) |
| Thickly | 1 to 3 ft (300 mm to 1 m) |
| Moderately | 0.3 to 1 ft (100 to 300mm) |
| Thinly | 0.1 to 0.3 ft (30 to 100mm) |
| Very thinly | 0.03 [3/8 in] to 0.1 ft (10 to 30 mm) |
| Laminated (intensely foliated or banded) | Less than 0.03 ft [3/8 in] (<10 mm) |

## Bedrock Hardness / Strength

| | | |
|---|---|---|
| H1 | Extremely Hard | Core, fragment or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows |
| H2 | Very Hard | Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows. |
| H3 | Hard | Can be scratched with knife or pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen. |
| H4 | Moderately Hard | Can be scratched with knife or sharp pick with light or moderate pressure. Core or fragment breaks with moderate hammer blow. |
| H5 | Moderately Soft | Can be grooved 1/16 in (2 mm) deep by knife or sharp pick with (moderate or heavy) pressure. Core or fragment breaks with light hammer blow or heavy manual pressure. |
| H6 | Soft | Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure. |
| H7 | Very Soft | Can be readily indented, grooved, or gouged with fingernail, or carved with a knife. Breaks with light manual pressure. |
| Note: Bedrock Units softer than H7, Very Soft, are described using USCS (soils) consistency descriptions. | | |

## GRAIN-SIZE SCALE (MM)

| | | |
|---|---|---|
| GRAVEL | BOULDER | >256 |
| | COBBLE | 64-256 |
| | PEBBLE | 4-64 |
| | GRANULE | 2-4 |
| SAND | VERY COARSE SAND | 1-2 |
| | COARSE SAND | 1/4-1 |
| | MEDIUM SAND | 1/4 - 1/2 |
| | FINE SAND | 1/8 -1/4 |
| | VERY FINE SAND | 1/16 – 1/8 |
| MUD | COARSE SILT | 1/32 1/16 |
| | MEDIUM SILT | 1/64 – 1/32 |
| | FINE SILT | 1/128 – 1/64 |
| | VERY FINE SILT | 1/258 –1/128 |
| | CLAY | <1/256 |

Source: Wentworth, 1924

## Contact

-Sharp

-Gradual

-Slickensides

U.S. Department of the Interior, 1998, *Engineering Geology Field Manual,* Bureau of Reclamation.

## CONSISTENCY

| CLAYS AND PLASTIC SILTS | STRENTH TON/SQ FT | BLOWS FOOT + |
|---|---|---|
| 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

| SANDS, GRAVELS AND NON-PLASTIC SILTS | BLOWS FOOT+ |
|---|---|
| Very Loose | 0-4 |
| Loose | 4-10 |
| Medium Dense | 10-30 |
| Dense | 30-50 |
| Very Dense | Over 50 |

**Format for the Description of Fractures**

- Orientation
- Spacing
- Continuity
- Openness
- Fillings
  - Thickness
  - Composition
- Weathering/alteration
- Hardness
- Healing
- Surfaces
  - Roughness
  - Waviness
  - Weathering/alteration
  - Hardness
- Field index test results
- Moisture

**Table 5-2. – Fracture spacing descriptors**

| Alpha-numeric descriptor | Joint or fracture spacing descriptor | True Spacing |
|---|---|---|
| SP1 | Extremely widely spaced | Greater than 10 feet (ft) (<3m) |
| SP2 | Very widely spaced | 3 to 10 ft (1 to 3 m) |
| SP3 | Widely spaced | 1 to 3 ft (300 mm to 1 m) |
| SP4 | Moderately spaced | 0.3 to 1 ft (100 to 300 mm) |
| SP5 | Closely spaced | 0.1 to 0.3 ft (30 to 100 mm) |
| SP6 | Very closely spaced | Less than 0.1 ft (<30 mm) |

**Table 5-3. – Fracture continuity descriptors**

| Alpha-numeric descriptor | Descriptor | Lengths |
|---|---|---|
| C1 | Discontinuous | Less than 3 ft (>1 m) |
| C2 | Slightly continuous | 3 to 10 ft (1 to 3 m) |
| C3 | Moderately continuous | 10 to 30 ft (3 to 10 m) |
| C4 | Highly continuous | 30 to 100 ft (10 to 30 m) |
| C5 | Very Continuous | Greater than 110 ft (>30 m) |

**Table 5-4. – Descriptors for recording fracture ends in joint surveys**

| Alpha-numeric descriptor | Criteria |
|---|---|
| E0 | Zero ends leave the exposure (both ends of the fracture can be seen in the exposure). |
| E1 | One end can be seen (one end of the fracture terminates in the exposure). |
| E2 | Both ends cannot be observed (two fracture ends do not terminate in the exposure). |

**Table 5-5. – Fracture openness descriptors**

| Alpha-numeric descriptor | Descriptor | Openness |
|---|---|---|
| 00 | Tight | No visible separation |
| 01 | Slightly open | Less than 0.003 ft [1/32 inch (in)] (<1mm) |
| 02 | Moderately open | 0.003 to 0.01 ft [1/32 in to 1/8 in] (1 to 3 mm) |
| 03 | Open | 0.01 to 0.03 ft [1/8 to 3/8 in] (3 to 10 mm) |
| 04 | Moderately wide | 0.03 ft [3/8 in] to 0.1 ft (10 to 30 mm) |
| 05 | Wide | Greater than 0.1 ft (>30 mm) (record actual openness) |

**Table 5-6. – Fracture filling thickness descriptors**

| Alpha-numeric descriptor | Descriptor | Thickness |
|---|---|---|
| T0 | Clean | No film coating |
| T1 | Very thin | Less than 0.003 ft [1/32 inch (in)] (<1mm) |
| T2 | Moderately thin | 0.003 to 0.01 ft [1/32 in to 1/8 in] (1 to 3 mm) |
| T3 | Thin | 0.01 to 0.03 ft [1/8 to 3/8 in] (3 to 10 mm) |
| T4 | Moderately thick | 0.03 ft [3/8 in] to 0.1 ft (10 to 30 mm) |
| T5 | Thick | Greater than 0.1 ft (>30 mm) (record actual openness) |

**Table 5-7. – Fracture healing descriptors**

| Alpha-numeric descriptor | Descriptor | Criteria |
|---|---|---|
| HL0 | Totally healed | Fracture is completely healed or recemented to a degree at least as hard as surrounding rock. |
| HL2 | Moderately | Greater than 50 percent of fracture material, fracture surfaces, or healed filling is healed or recemented; and/or strength of healing agent is less hard than surrounding rock. |
| HL3 | Partly healed | Less than 50 percent of fractured material, filling, or fracture surface is healed or recemented. |
| HL5 | Not healed | Fracture surface, fracture zone, or filling is not healed or recemented; rock fragments or filling (if present) is held in place by its own angularity and/or cohesiveness. |

**Table 5-8. – Fracture roughness descriptors**

| Alpha-numeric descriptor | Descriptor | Criteria |
|---|---|---|
| R1 | Stepped | Near-normal steps and ridges occur on the fracture surface. |
| R2 | Rough | Large, angular asperities can be seen. |
| R3 | Moderately rough | Asperities are clearly visible and fracture surface feels abrasive. |
| R4 | Slightly rough | Small asperities on the fracture surface area are visible and can be felt. |
| R5 | Smooth | No asperities, smooth to the touch. |
| R6 | Polished | Extremely smooth and shiny. |

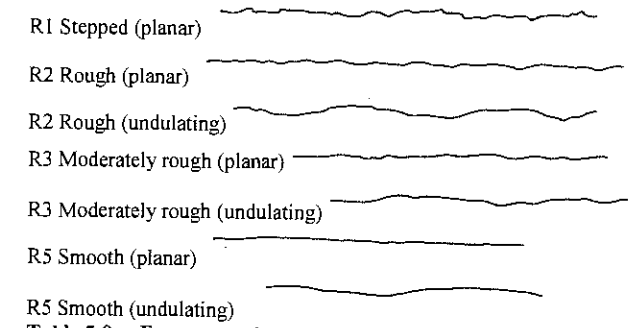



**Table 5-9. – Fracture moisture conditions descriptors**

| Alpha-numeric descriptor | Criteria |
|---|---|
| M1 | The fracture is dry, tight, or filling (where present) is of sufficient density or composition to impede water flow. Water flow along the fracture does not appear possible. |
| M2 | The fracture is dry with no evidence of previous water flow. Water flow appears possible. |
| M3 | The fracture is dry but shows evidence of water flow such as staining, leaching, and vegetation. |
| M4 | The fracture filling (where present) is damp, but no free water is present. |
| M5 | The fracture shows seepage and is wet with occasional drops of water. |
| M6 | The fracture emits a continuous flow (estimate flow rate) under low pressure. Filling materials (where present) may show signs of leaching or piping. |
| M7 | The fracture emits a continuous flow (estimate water flow) under moderate to high pressure. Water is squirting, and/or filling material (where present) may be substantially washed out. |

U.S. Department of the Interior, 1998, *Engineering Geology Field Manual*, Bureau of Reclamation.

# APPENDIX B

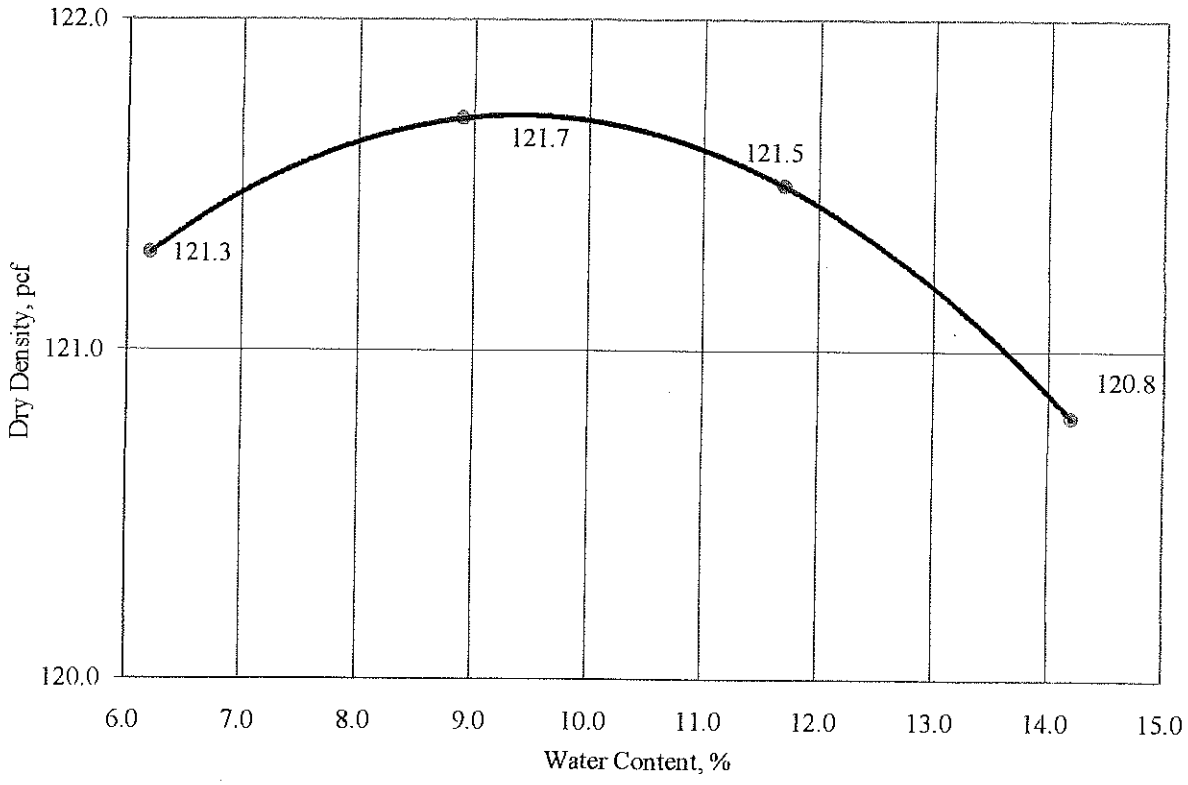
Laboratory Test Results

**GeoSolutions, Inc.**

# LABORATORY COMPACTION REPORT
## ASTM D1557-07

**(805) 543-8539**

| | | | |
|---|---|---|---|
| Project: | Las Pilitas Quarry | Date Tested: | June 23, 2009 |
| Client: | | Project #: | SL07059-1 |
| Sample #: | A  Depth: 2' | Lab #: | 14079 |
| Source: | T-2 | Sample Date: | June 22, 2009 |
| Material: | Dark Yellowish Brown Poorly Graded SAND | Sampled By: | JAP |




ASTM Test Designation: [ ] D 698 [x] D 1557 Method: [ ] A [x] B [ ] C

100 % Saturation Curve-Estimated Specific Gravity: 2.7

Laboratory Test Results

| Trial # | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Water Content,% | 6.2 | 8.9 | 11.7 | 14.2 |
| Dry Density, pcf | 121.3 | 121.7 | 121.5 | 120.8 |

| | | | |
|---|---|---|---|
| MAXIMUM DRY DENSITY, pcf: | 121.7 | OPTIMUM MOISTURE, %: | 9.5 |

Report By: Aaron Eichman

**GeoSolutions, Inc.**

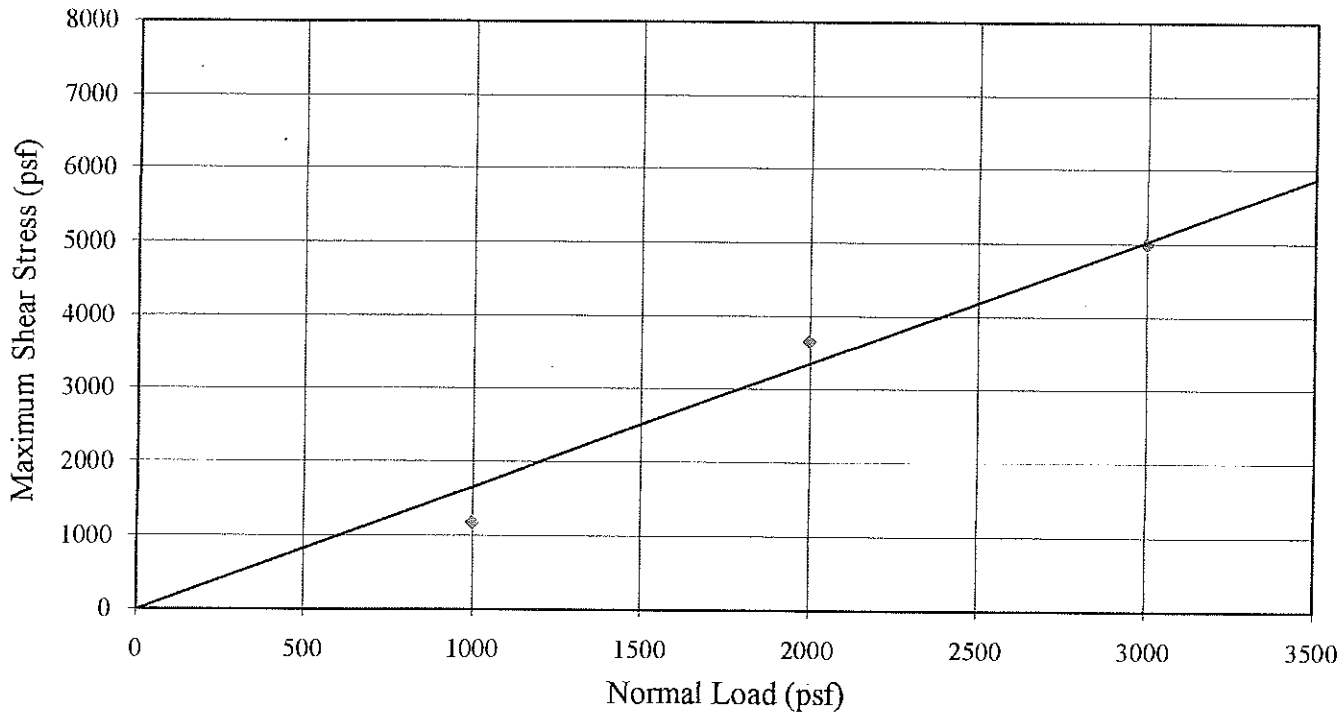
# DIRECT SHEAR TEST REPORT
## ASTM D3080-04

**(805) 543-8539**

| | | | | | |
|---|---|---|---|---|---|
| Project: | Las Pilitas Quarry | | | Date Tested: | June 25, 2009 |
| Client: | | | | Project #: | SL07059-1 |
| Sample #: | T-2 @ 2' | Depth: | 2.0 Feet | Lab #: | 14079 |
| Location: | T-2 | | | Sample Date: | June 22, 2009 |
| Material: | Dark Yellowish Brown Poorly Graded SAND | | | Sampled By: | JAP |

Test Data

| Specimen Number | Void Ratio | Saturation, % | Normal Load, psf | Max Shear Stress, psf | Water Content, % | Dry Density, pcf | Relative Density*,% |
|---|---|---|---|---|---|---|---|
| 1 | - | - | 1000 | 1190 | 16.7 | 101.6 | - |
| 2 | - | - | 2000 | 3657 | 14.5 | 109.7 | - |
| 3 | - | - | 3000 | 4999 | 12.8 | 119.8 | - |
| 4 | | | | | | | |
| 5 | | | | | | | |




The test specimens were in-situ samples.

| | |
|---|---|
| Angle of Internal Friction (In-Situ), Phi: | 62.3 ° |
| Cohesion (In-Situ), C: | 0 psf |

Report By: Aaron Eichman

# COMPRESSION TEST RESULTS

PROJECT: Las Pilitas Quarry
Santa Margarita, California

**LAS PILITAS RESOURCES**
Post Office Box 975
Santa Margarita, California 93453

PROJECT NO.: SL07059-1
DATE CAST:
DATE REC'D:
CONTRACTOR:

**GENERAL LOCATION OF PLACEMENT:** Quarry

**SPECIFIC LOCATION OF LOAD:**

| MIX DESIGN NO. | CLASS OF CONCRETE | MAX. SIZE OF AGGREGATE | LOAD NO. | TRUCK NO. | TICKET NO. | YARDS PER LOAD | TIME | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | BATCHED | DISCHARGE | |
| | | | | | | | | START | FINISH |
| - | - | - | - | - | - | - | - | - | - |

| TOTAL WATER ADDED, gal. | AIR CONTENT % | UNIT WEIGHT pcf | SLUMP ins. | TEMPERATURE (Degrees Fahrenheit) | | TYPE OF SAMPLE: CONCRETE - GROUT - MORTAR SHOTCRETE - OTHER |
|---|---|---|---|---|---|---|
| | | | | AIR | SAMPLE | |
| - | - | - | - | - | - | GRANITE |

WEATHER:
SAMPLE TIME:
SUPPLIER:

FIELD NOTES:
INSPECTOR:

**DESIGN STRENGTH: p.s.i. @ 28 days**

| FIELD SET NO. | SAMPLE AGE AT BREAK (DAYS) | LAB SAMPLE NO. | DATE OF BREAK | DIAMETER AND/OR DIMENSIONS | AREA sq.ins. | TOTAL LOAD lbs. | ULTIMATE STRENGTH psi. | TESTED BY |
|---|---|---|---|---|---|---|---|---|
| 1A | - | - | 6/30/09 | 2.8" x 5.75" | 6.2 | 80,820 | 13,120 | AE |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

NOTES: Testing for compressive strength in accordance with ASTM C39, C138, C143, C617, and C1064.

A-Unless otherwise indicated, the type of fracture of the test specimen is the usual cone fracture.

B-Cone & Split Fracture C-Cone & Shear Fracture D-Shear Fracture E-Columnar Fracture

SIGNED:
DATE: 6/30/09

C39con rev.8/1/97

**APPENDIX C**

Final Construction Geology Report, Coastal Branch Phase II, Reach 4 Pipeline, Calf Canyon Tunnel to Cuesta Tunnel and Calf Canyon Tunnel (Department of Water Resources, September, 2002, Appendix C) with Plate 3, As-Excavated Geology Plan and Profile

**Appendix C**
FINAL CONSTRUCTION GEOLOGY REPORT C-114
COASTAL BRANCH PHASE II

CALF CANYON TUNNEL

**TABLE OF CONTENTS**


| | PAGE |
|---|---|
| INTRODUCTION | 1 |
| GEOLOGIC INVESTIGATIONS AND REPORTS | 1 |
| GEOLOGIC INSPECTION DURING CONSTRUCTION | 3 |
| GEOLOGIC SETTING | 3 |
| Bedrock | 4 |
| Geologic Structure | 4 |
| ENGINEERING GEOLOGY | 7 |
| North Inlet Portal Excavation | 7 |
| South Outlet Portal Excavation | 7 |
| Tunnel Excavation | 8 |
| Rock Conditions | 9 |
| Tunnel Support | 10 |
| CLAIM ISSUES | 12 |
| CONCLUSIONS | 17 |


**APPENDIXES RELATED TO CALF CANYON TUNNEL**


Appendix D. Figure

Figure 1. Calf Canyon Tunnel Outlet Portal

Appendix E. Correspondence

Office Memo, August 18, 1995

Memorandum, November 14, 1997


**PLATES RELATED TO CALF CANYON TUNNEL**


Plate No.

4. As-excavated Calf Canyon Tunnel Geology, 34 sheets
5. Stereographic Plots of Joints and Shears, 1 sheet

# FINAL CONSTRUCTION GEOLOGY REPORT
# COASTAL BRANCH PHASE II
# CALF CANYON TUNNEL

## INTRODUCTION

The Calf Canyon Tunnel is a component of the Coastal Branch of the California Aqueduct. It is located in Reach 4 of the Coastal Branch, about three miles northeast of Santa Margarita, San Luis Obispo County, California (See Plates 1, 2, 3 (sheets 1 and 2), and Plate 4 (34 sheets)). The tunnel was constructed from May through October, 1995 at a cost of $4,358,100.

The 3,300-foot-long, 7.5-foot-diameter tunnel was driven through the area known as Granite Ridge. This alignment roughly parallels Highway 58 with the outlet (south) portal located just northeast of the Salinas River crossing for the Coastal Branch – Reach 4 pipeline.

A natural narrow corridor that contains Highway 58 and Unocal's oil and gas lines necessitated an alternative to a surface alignment. The surface alignment would have involved difficult construction conditions over ridges, across drainages, and two crossings of Highway 58. Construction of the Calf Canyon Tunnel alleviated these problems.

## GEOLOGIC INVESTIGATIONS AND REPORTS

Preconstruction geologic investigations for the tunnel alignment were conducted in two phases from January to July 1994. Phase 1 consisted of surface geologic

mapping and a series of seismic refraction lines. Phase 2, conducted in June and July 1994, consisted of drilling four core holes and one auger hole in the vicinity of the proposed portals. Due to the design time constraint, no core holes were drilled along the tunnel alignment.

Geologic surface mapping along the tunnel alignment and the roadcuts associated with Highway 58 showed that the granite surface outcrops were mostly intensely weathered and commonly decomposed. Moderately weathered and slightly weathered outcrops of granite were mapped in the drainages. An analysis of the limited geologic data correctly indicated that most of the tunnel excavation would probably be in fresh, hard granite. The surface mapping provided a good representation of the jointing that would be encountered in the tunnel excavation. Two primary joint sets were identified that correlated with the two most prevalent joint sets mapped in the tunnel excavation (See "Geologic Structure" section).

Six seismic refraction surveys were run in Phase 1 of the Calf Canyon Tunnel exploration. Rugged surface topography restricted the surveys to only the accessible ridge lines, and survey lines were restricted in length as well; therefore, the depth to which the seismic velocities would be useful became limited. In general, velocities increased at depth and from the portals towards the center of the tunnel. Details of the surveys can be found in the preconstruction Project Geology Report No. 55-02-12, dated November 17, 1994.

Exploration drill holes CCT-1 and CCT-2 at the north portal and drill holes CCT-3 and CCT-4 at the south portal were drilled to define rock weathering, strength, and the presence of discontinuities near the portal areas. Drill hole CCT-2 was drilled at an angle of 10 degrees below horizontal, parallel with the bearing of the tunnel, to a depth

of 240 feet. Drill hole CCT-4 was drilled at an angle of 5 degrees below horizontal, parallel with the tunnel axis to a depth of 121 feet. Holes CCT-1 and CCT-3 were drilled vertically to depths of 50 feet.

Detailed descriptions of conditions encountered in the drill holes are found in the preconstruction geologic exploration report. In general, the drill holes correctly indicated that rock conditions near the south portal were better than near the north portal, mainly due to close to intense fracturing associated with shears and shear zones near the north portal. Steel support associated with an extensive zone of shearing in the granitic rock was required in the tunnel near the north portal. Minimal steel was installed at the north portal (See Plate 4, Sheet 1, Calf Canyon Tunnel Logs).

## GEOLOGIC INSPECTION DURING CONSTRUCTION

During construction, visits to the site to inspect and record geologic data were made weekly by Associate Engineering Geologists Tim Todd and Steve Killingsworth. This work was supervised by Ted Bruce, Senior Engineering Geologist with the Project Geology Section, who also periodically visited the site.

## GEOLOGIC SETTING

The Calf Canyon Tunnel is located in a western extension of the La Panza Range, just east of the Rinconada fault in central San Luis Obispo County. This site is within the Coast Range Geomorphic Province.

The La Panza Range trends northwest to southeast and is comprised of Cretaceous granitic and Upper Cretaceous to Tertiary marine sedimentary rocks. The

granitic rocks are believed to have been an extension of the southern Sierra Nevada Range and are a resultant of right lateral displacement along the San Andreas system (including the Rinconada fault) forming the Salinian fault block. See Hart, E.W., 1976, California Division of Mines and Geology, Bulletin 199, page 39.

## Bedrock

The basement or bedrock in the tunnel area is Cretaceous granite, specifically identified by Hart as biotitic granodiorite and adamellite in nearly equal amounts. In surface outcrop the rock is mostly intensely weathered and commonly decomposed, but moderately and slightly weathered outcrops were noted in stream drainages along and near the alignment. The tunnel excavation is in mostly fresh and slightly weathered, hard granite. Very few inclusions are present; only a few small, tabular-shaped schlieren (modified inclusions) of mafic composition and a few small aplitic dikes were observed.

## Geologic Structure

The dominant geologic structure in the granite is pervasive jointing. This was initially indicated in preconstruction geologic surface and roadcut mapping (See Project Geology Report No. 55-02-12, November 17, 1994, "Geologic Structure") and became more evident in the tunnel mapping, in which hundreds of joints were mapped. Joints were mostly planar to undulating; most had a thin (less than 1/8 inch), whitish to light green, clayey coating on their surfaces, likely chlorite.

The joints mapped in the tunnel (See Calf Canyon Tunnel Geology logs, Plate 4, Sheets 1 through 34) are mostly steeply dipping to moderately dipping, and have been

grouped into four major sets, numbered 1 through 4, and two minor sets, 3a and 3b (See Plate 5). Plate 5 of this report is a stereonet overlay of the tunnel mapping onto the original joint information obtained from the surface and roadcut mapping. From Plate 5 it can be seen that joint sets 1 and 2, the most prominent sets mapped in the tunnel, generally correlate with the original sets 1 and 2 mapped during the preconstruction phase.

Joint sets 1 and 2 strike at acute angles across the tunnel alignment. Joint set 1 ranges in strike from north 20° west to north 10° east, with dips ranging mostly from 45° west to 80° east. Joint set 2 ranges in strike from north 60° to 80° east, with dips ranging mostly from 70° north to 80° south.

Joint set 3 strikes roughly parallel to the tunnel alignment, ranging from north 30° to 55° east and mostly dipping from 70° west to 70° east. Two minor joint sets, numbered 3a and 3b, are also found within this strike range. Joint set 3a dips mostly 40° to 50° west; joint set 3b dips mostly 40° to 50° east.

Joint set 4 strikes roughly normal to the tunnel alignment, ranging from north 40° to 60° west, with dips ranging mostly 70° north to 80° south.

Shearing is also pervasive in the tunnel area; numerous minor shears in various orientations were mapped. Most are steeply dipping, with dips averaging about 75° to 80°. Nearly all shears contain a light greenish-gray chloritic clay gouge. The thickness of this gouge ranged from 0.1 feet, to 2.5 feet (containing shears and gouge) in the major shears, averaging about 0.2 to 0.3 feet overall.

Within the tunnel there were three primary zones of highly sheared granite rock. These zones were characterized by abundant convoluted, multi-directional, internally slicked shear planes that dominate the fabric of the rock, causing it to be weak. Commonly these zones are where some overbreak occurred or the weak, sheared, rock conditions required permanent steel support. These shear zones in the tunnel occurred at the following locations:

(1) Stations 2463+04 to 2463+22 (See Plate 4, Sheet 4). This shear zone trends normal to the tunnel alignment, N50$^0$W, dipping 30 – 45$^0$ to the south and was encountered in exploration borehole CCT-2. This shear zone appears to be correlatable with a inactive fault zone mapped by Hart and exposed in the Highway 58 roadcut, (2) Stations 2464+54 to 2465+18. This shear zone is bounded by two steeply dipping shears trending about N75$^0$E (See Plate 4, Sheets 5 and 6); and
(3) Stations 2478+62 to 2479+01. This shear zone is bounded by steeply dipping shears trending between about N15$^0$W to N77$^0$W (See Plate 4, Sheets 19 and 20). This is the area where a cave-in occurred on July 25, 1995; (See Office Memo on Calf Canyon Tunnel Cave-in dated August 18, 1995).

No individual shears or shear zones, except shear zone #1, mapped in the tunnel can be definitively correlated with any geomorphic surface features, i.e., saddles or drainages, overlying the tunnel area. None of the shears or shear zones are related to known active faults.

# ENGINEERING GEOLOGY

## North Inlet Portal Excavation

At the north inlet portal the dominant feature is hard, strong, slightly weathered granite. The large, knob-like mass of hard, strong granite occurred below the moderately weathered rock that was excavated by common methods (See Photo Nos. 4, 5, and 6). This hard rock mass spanned almost the entire width of the portal excavation, measuring about 40 to 50 feet long, about 10 to 25 feet wide, and about 10 to 15 feet high, comprising approximately 340 cubic yards. This rock mass had to be blasted to develop the portal. The shot rock was excavated using a front-end loader and dump trucks to haul the rock to the designated spoil area.

Full steel sets, horseshoe-shaped false sets, and channel iron were installed to ensure the integrity of the rock around the tunnel portal. Finally, ten #11 steel crown bars, 40 feet long, were installed and grouted from crown to springline around the portal excavation.

## South Outlet Portal Excavation

The decomposed to intensely weathered granite in the south outlet portal excavation was accomplished by common methods. A well-graded sand derived from the granitic rock overlaid the decomposed granite at the surface. No blasting was required. Front-end loaders transported the excavated material about 200 feet downstation to a designated spoil area.

Tunnel mapping was performed from the outlet to the inlet portal and began in intensely weathered, moderately strong granite at Station 2493+43. Moderately weathered granite was encountered only 15 feet upstation at Station 2493+28, and slightly weathered, hard, and strong granite was encountered 18 feet further upstation, at Station 2493+10.

Full steel sets, horseshoe-shaped false sets, and channel iron were installed to ensure the integrity of the rock around the tunnel portal. Like the north portal, ten #11 steel bars, 40 feet long, were installed and grouted in place from crown to springline around the portal excavation (See Photo Nos. 11 and 12 and Plate 4, Sheet No. 34).

Tunnel Excavation

The tunnel was bored with a 240 HP Wirth 7.5 foot Tunnel Boring Machine (TBM) (See Photo Nos. 9, 10, 11, and 12). It measured 120 feet in length and bored the 7.5-foot-diameter tunnel by employing a rotating cutter head and six thrust rams. The TBM advanced by thrusting against the tunnel walls. Precise alignment of the tunnel and heading was achieved by utilizing a laser-surveying system. Waste rock was removed by a conveyor belt attached to the TBM and to three ore cars, which were pulled by a small diesel locomotive. The tunnel muck was hauled out to the south portal muck pile.

The 3,300-foot-long tunnel was driven beginning at the south portal on May 24, 1995, and completed at the north portal on October 14, 1995. It was driven in the upstation direction against a very gentle slope (less than 2 degrees) to assist in the gravitational flow of both groundwater encountered in the tunnel and operational water

associated with the TBM. Most of the tunnel was driven through fresh, hard, strong granite. The average thrust employed by the TBM was 548 foot-pounds. The average daily rate of tunnel advance was 31.9 feet, as determined from "Calf Canyon Tunnel Performance Data" compiled by Paul Martinez, Associate Engineer, Cuesta Tunnel Construction Office.

During the excavation of the tunnel, two events occurred (only one geologically related) that caused a delay in progress for several days. On July 25, 1995, a cave-in occurred between Stations 2478+70 and 2478+95. This area consisted of a zone with intensely to closely fractured, weak rock cut by several intersecting shears (See Appendix E, Office Memo dated 8/18/95 on Calf Canyon Tunnel Cave-in and tunnel log Sheet 16). No mining progress was made for eight days as the caved material was removed and the area supported with steel sets, wood cribbing and sacks of cement. The second event was when the TBM cutter head cracked on August 14, 1995, which caused five days of down time as the head was repaired by welding.

## Rock Conditions

The entire tunnel was mined through Cretaceous granitic rock, petrographically identified as granodiorite, but referred to as "granite" in this report. About 90% of the granite encountered in the tunnel excavation was mostly fresh, hard, and strong to very strong. The remaining 10% of the tunnel excavation was in weathered granite, with variable hardness and strength. See tunnel logs for details on weathering and associated hardness and strength.

Of the 3300 feet of tunnel excavation, approximately 80% of the granite was moderately to slightly fractured, about 17% was closely fractured, and about 3% was intensely to closely fractured.

Joints and shears are pervasive in the tunnel, as described previously in the "Geologic Structure" section. Most are steeply dipping; with the joints having a thin, whitish, clayey coating; most shears contain light greenish-gray, chloritic clay gouge from 0.1 to 0.3 feet thick, but up to 2.5 feet thick. Overbreaks generally occurred in areas where sheared rock associated with abundant multi-directional, convoluted, internally slicked, shears were present. Exact locations of the three rock zones of shears encountered in the tunnel excavation are discussed in the "Geologic Structure" section and are shown on Plate 2 and Plate 4, Sheets 3, 4, 5, 6, 19, and 20.

Water outflow from the tunnel excavation was minor, always below 5 gallons per minute (gpm), averaging 2 to 3 gpm. Groundwater inflows to the tunnel from the surrounding rock occurred along joints and shears. Most of the accumulated outflow probably consisted of wastewater utilized by the TBM to cool the cutters and dust control. This water was collected in a sump located a couple hundred feet south of the south portal.

Tunnel Support

Steel support was installed over a distance of approximately 520 feet, or 16% of the tunnel length. The remainder (84%) of the tunnel was left unsupported. Support was installed at both north and south portals, at three major overbreak areas, and at numerous small, localized, jointed and/or sheared areas scattered throughout the length of the tunnel (See Plate 4, Sheets 1-34 for details).

At the south portal, seven 270-degree steel sets and three horseshoe-shaped false sets, of W4 x 13 channel steel, were installed on four-foot centers. Eight-inch-wide channel steel was also installed, spanning the sets. Finally, ten #11 steel bars, 40 feet long, were installed from springline to crown along the outside of the tunnel bore, parallel with the tunnel alignment, and grouted in place (See Photo Nos. 11 and 12 and Plate 4, Sheet No. 34).

At the north portal, four 270-degree steel sets and two horseshoe-shaped false sets, of W4 x 13 channel steel, were installed on four-foot centers. Ten #11 steel bars, 40 feet long, were installed along the outside of the tunnel bore like at the south portal.

The first of three areas that required significant support occurred from Station 2462+82 to 2463+74, a length of 92 feet (See Plate 4, Sheets 3 and 4). This area consisted of a zone of sheared rock bordered by closely jointed rock. This area required ten full circular steel sets, and fifteen 270-degree steel sets of W4 x 13. Channel steel, mostly 8-inch-wide, were tack welded to connect the sets. Some 3-inch-wide channel steel was welded to the base of the 270-degree steel sets. Fifty, 3-foot-long split bolts secured the channel steel to the tunnel walls and the crown.

The second area that required significant support occurred from Station 2464+48 to 2465+25, a length of 77 feet (See Plate 4, Sheets 5 and 6). This interval of highly sheared rock required 24, 270-degree steel sets of W4 x 13, installed on approximately 3.5-foot centers. These sets were secured with 8-inch-wide channel steel in four- and eight- foot lengths that were tack welded at their base and attached to the tunnel wall with a total of 64, 3-foot-long split bolts.

The third significant overbreak area that required support was an area of intersecting shears between Stations 2478+70 and 2479+08 (See Plate 4, Sheets 19 and 20). This is the interval of the cave-in of July 25, 1995. In this 38-foot interval, seven 270-degree steel sets were installed on four-foot centers along with a significant amount of 8-inch-wide channel steel (about 450 feet). The channel steel was in four- and eight-foot lengths and mostly installed on the tunnel walls and in the crown. The channel steel was secured by 33, three-foot-long split bolts and five, one-half-inch-diameter by approximately one-foot-long rock bolts. Numerous, unopened sacks of cement and wooden cribbing was placed behind this steel framework (See Office Memo on Calf Canyon Tunnel Cave-in dated August 18, 1995 in Appendix A).

There were isolated locations within the tunnel where shears, joints, and/or fractured rock that required minor support of the tunnel walls and sometimes the crown. This support commonly consisted of ten- or twenty-foot lengths of 8-inch-wide channel steel. They were mostly installed in groups of two or three, with several short, stubby pieces of 4-inch-wide channel steel placed behind and normal to them for bracing against the weak rock; 3-foot-long split bolts secured the ends of the 8-inch steel pieces to the tunnel walls.

## CLAIM ISSUES

With the subsequent completion of the Calf Canyon Tunnel, the subcontractor (Elmore Pipe Jacking, Inc) submitted a claim that included alleged differing site conditions from those that were stated in the contract documents. Elmore's initial claim not including interest was for a total amount of $4,358,100. The negotiated settlement for all issues (including interest) came to $1,237,100 (about 40% dealt with differing site

conditions). The key issues associated with the differing site conditions claimed by Elmore with the geologic summary response from Project Geology are provided below. For additional details see appendixed November 14, 1997 memo.

1. Elmore stated that they encountered ground conditions which were significantly different than those indicated at the time of bid and that the actual conditions led to a much more difficult excavation of the tunnel.

   Project Geology's Reports (D-148 and 55-02-12) depicted conditions that were substantially agreeable with the as-excavated conditions mapped.

2. Elmore claimed that the bid documents did not indicate that extremely hard zones interspersed with shear zones filled with soft/broken seams of decomposed and altered rocks were present. Elmore also claimed that these unexpected zones of altered granite rock and associated softer material when interfaced with hard rock, caused a lower penetration rate of the TBM to reduce the potential of serious damage to the cutterhead of the TBM.

   Project Geology stated that drill hole CCT-2 clearly defines zones of hard granitic rock adjacent to friable and soft chloritically altered rock associated with shear zones. Rock conditions described in CCT-2 clearly depicted zones of altered granite that should have been expected.

3. Elmore claimed that from time to time it was necessary for the TBM to cut a tunnel face composed of hard rock in part of it, and soft materials in another part.

Project Geology stated that the as-excavated geologic tunnel logs illustrate that occasionally this did occur but was rare. This likely occurred where chlorite coated fractures associated with or adjacent to shear zones were present. Drill hole log CC-2 illustrated that this "time to time" possibility.

4. Elmore claimed that the unexpected range of conditions where sections of hard unaltered granite were interlaced with sections containing soft altered granite and altered by-products. These extreme ranges of conditions could not have been anticipated at the time of bid based on the available documents.

   Project Geology's response was that unexpected and extreme ranges of conditions could have been anticipated at the time of bid based on the conditions described in drill hole log CCT-2. Also, similar conditions were described in the text of report 55-02-12 which means that these conditions could have been anticipated at the time of bid.

5. Elmore claimed that the shear zones in CCT-2 were referenced zone that was the contract indication of the most difficult ground. The troublesome zones that were encountered in other locations along the tunnel were different and much more difficult to excavate than the worst ground indicated.

   Project Geology's response was that shear zones in CCT-2 were accurately described to represent what difficult ground conditions should be anticipated, not necessarily the most difficult ground conditions. The as-excavated geologic tunnel logs identified only two troublesome zones that slowed down or stopped the TBM advancement. These zones were associated with shear

zones. Geologic descriptions of these intervals are nearly identical, not different to the shear zones described in the geologic log for CCT-2.

6. Elmore claimed that the exploration employed by the Owner, included exploration drilling and surface mapping, allowing for the contractual indicated conditions to be grossly in error.

   Project Geology's data recorded on the as-excavated tunnel logs correlated extremely well with the preconstruction geology presented in the bid documents including the exploration drilling and the surface mapping. The tunnel excavation encountered the same rock conditions that exploration core holes CCT-1, -2, -3, and -4 all encountered. Report 55-02-12 showed a detailed "Summary of Drill Hole Data" including weathering, fracturing, hardness and strength, and rock quality designation. All of the rock conditions that were encountered in the tunnel excavation were accurately described in the prebid documents. The exploration drilling was not grossly in error.

7. Elmore claimed that the unexpected hard rock conditions slowed the progress of the TBM.

   Project Geology stated that the hard rock conditions encountered in the tunnel should not have been unexpected because the three reports referenced in this memorandum specifically address the hardness and strength of the granite in the text, in the drill hole logs, and the seismic velocities. DWR records showed that Elmore was provided with a fresh,

one-foot piece of drill core for testing. This piece of drill core showed that hard rock conditions were present.

8. Elmore claimed that the TBM encountered a laminated segment of hard rock adjacent and interlaced with the soft materials, the result would be that blocks would break off in large blocks at these contacts, creating significant areas of overbreak in unstable ground.

   Project Geology's response was that the geologic conditions described by Elmore that the resultant breakout blocks of rock were accurately described in report number 55-02-12. All of these overbreak areas were associated with shears or shear zones. The total length of overbreak was about 160 feet, or only 5% of the tunnel length. This should not be considered significant.

9. According to Elmore's claim, the TBM eliminates the overbreak and the TBM method commonly results in a more stable tunnel and fewer deviations in the tunnel walls and back.

   Project Geology stated that the minimal amount of overbreak that was present was not significant, nor was it outside of the shear zones. The overbreak areas that required support by the Contractor generally utilized mining straps held in place by split set bolts. These areas are all recorded on the geologic tunnel logs.

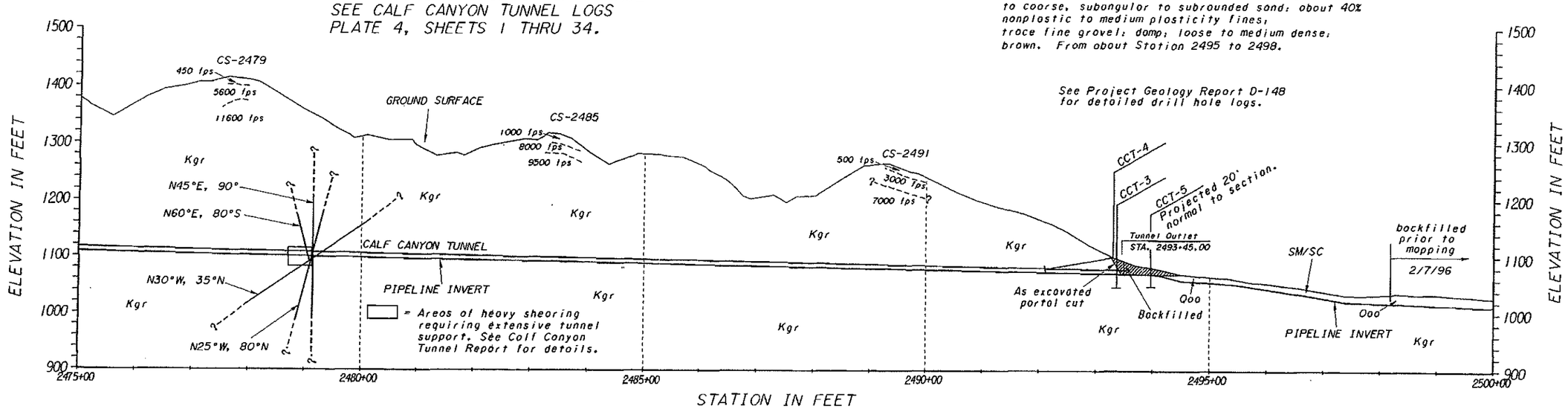
## CONCLUSIONS

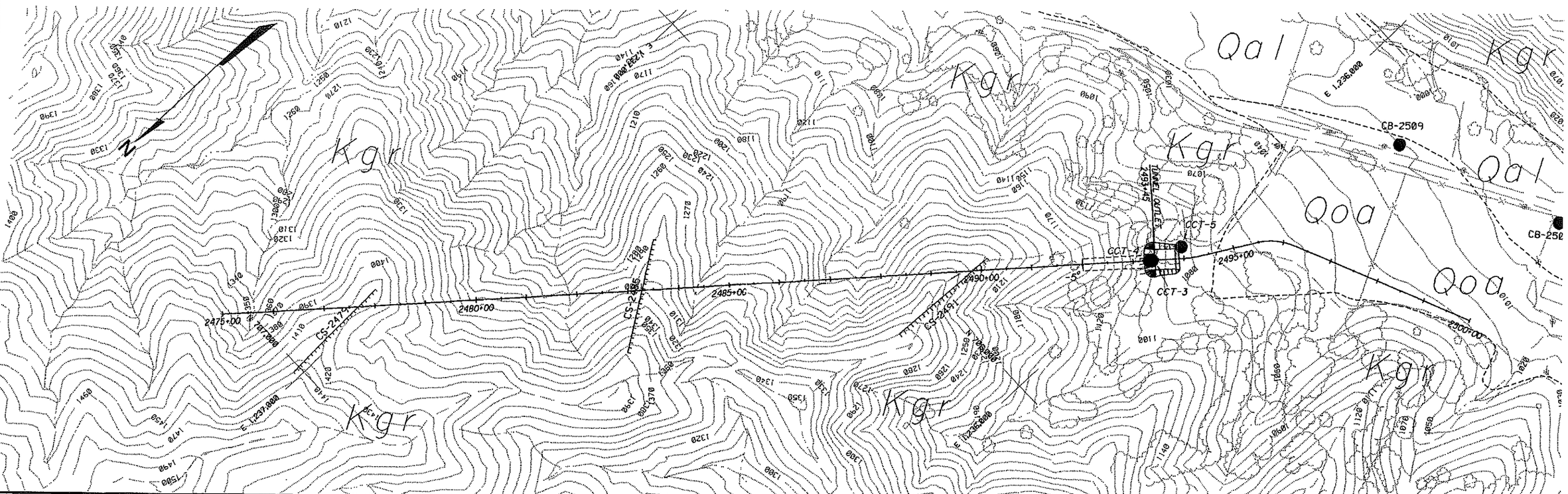
Project Geology concludes that the Calf Canyon Tunnel is a safe and stable addition to the State Water Project. It is our belief that the claim issues were grossly exaggerated by the Contractor. Construction of the tunnel essentially confirmed the geologic conditions described in the bidding documents.

FOR DETAILED GEOLOGY OF TUNNEL
SEE CALF CANYON TUNNEL LOGS
PLATE 4, SHEETS 1 THRU 34.

Silty Sand / Clayey Sand (SM/SC): About 60% fine to coarse, subangular to subrounded sand; about 40% nonplastic to medium plasticity fines; trace fine gravel; damp; loose to medium dense; brown. From about Station 2495 to 2498.

See Project Geology Report D-148 for detailed drill hole logs.




| REV. | DATE | DESCRIPTION |
|---|---|---|
| 1 | 10/11/94 | Alignment change. |

DRAWING SCALES

1" = 100' 100 0 100 200 300 400 SCALE OF FEET

| | |
|---|---|
| GEOLOGY REPORT No. | C-114 |
| CONSTRUCTION SPEC. No. | 94-29 |
| GEOLOGY DRAWING No. | PG-CBD-04 |

GEOLOGIC MAPPING AND/OR LOGGING BY:
1 TIM TODD
2 CHRIS BINGLEY

DRAWING PREPARED BY: A. LAGUARDIA, T. TODD DATE: 2-04-02

STATE OF CALIFORNIA
THE RESOURCES AGENCY
**DEPARTMENT OF WATER RESOURCES**
DIVISION OF DESIGN AND CONSTRUCTION
PROJECT GEOLOGY BRANCH
STATE WATER FACILITIES

CALIFORNIA AQUEDUCT
COASTAL BRANCH - PHASE II
REACH 4
# AS-EXCAVATED GEOLOGY PLAN AND PROFILE
STATION 2475+00 to 2500+00

RELEASE DATE: 10/22/0
SHEET No. 2 of 15
PLATE 3

A B C D E F G H

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22-OCT-2002

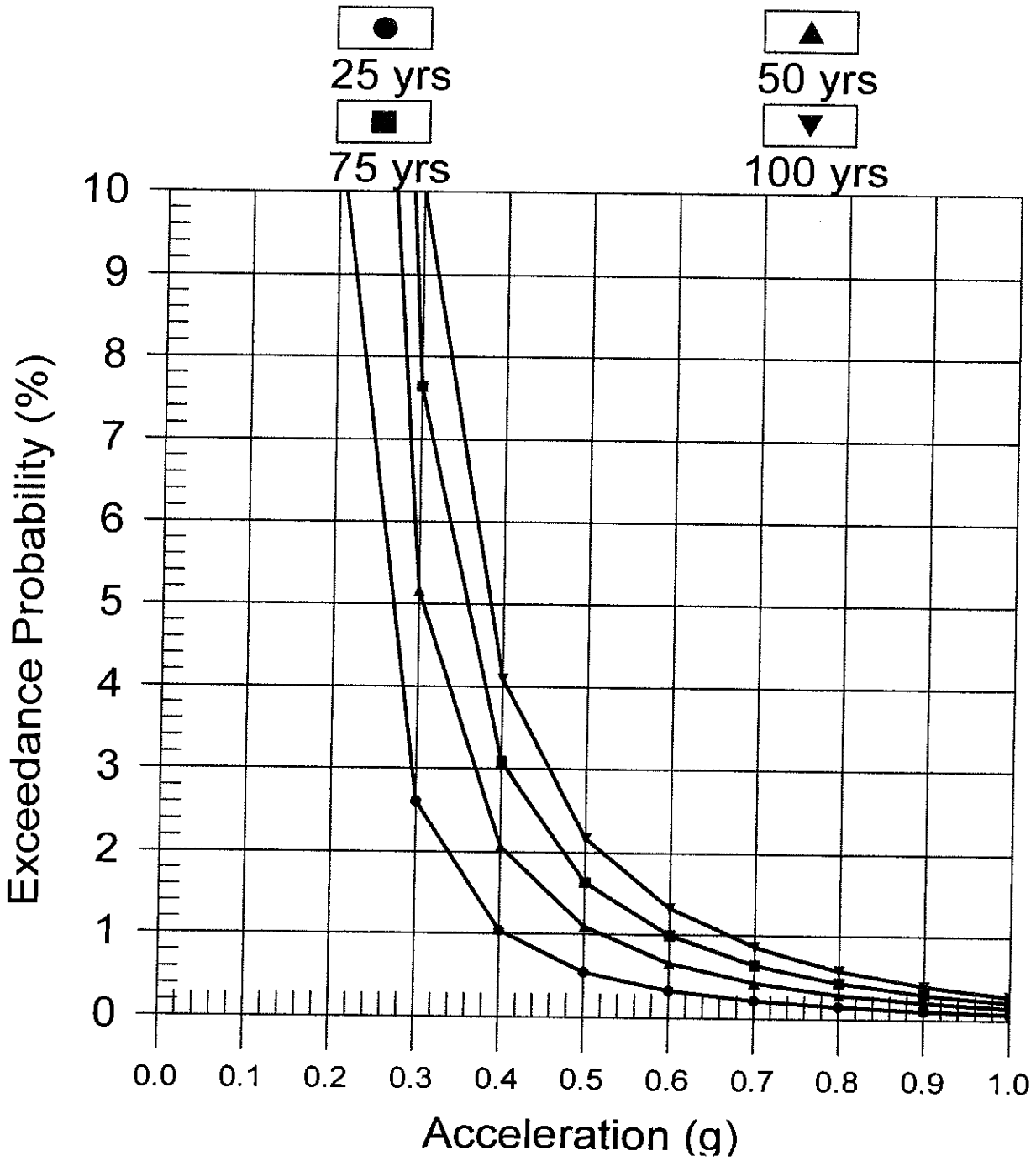
**APPENDIX D**

Probability of Exceedance Chart

Seismic Parameters

# PROBABILITY OF EXCEEDANCE

## BOORE ET AL(1997) NEHRP C (520)1



**Seismic Parameters**

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Latitude = 35.415248
Longitude = -120.564781
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Site Class B - Fa = 1.0 ,Fv = 1.0
Data are based on a 0.01 deg grid spacing

| Period (sec) | Sa (g) |
|---|---|
| 0.2 | 1.120 (Ss, Site Class B) |
| 1.0 | 0.500 (S1, Site Class B) |

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Latitude = 35.415248
Longitude = -120.564781
Spectral Response Accelerations SMs and SM1
SMs = Fa x Ss and SM1 = Fv x S1
Site Class C - Fa = 1.0 ,Fv = 1.3

| Period (sec) | Sa (g) |
|---|---|
| 0.2 | 1.120 (SMs, Site Class C) |
| 1.0 | 0.649 (SM1, Site Class C) |

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Latitude = 35.415248
Longitude = -120.564781
Design Spectral Response Accelerations SDs and SD1
SDs = 2/3 x SMs and SD1 = 2/3 x SM1
Site Class C - Fa = 1.0 ,Fv = 1.3

| Period (sec) | Sa (g) |
|---|---|
| 0.2 | 0.747 (SDs, Site Class C) |
| 1.0 | 0.433 (SD1, Site Class C) |