LAW/CRANDALL, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES

REPORT OF GEOTECHNICAL EVALUATION FOR ENVIRONMENTAL IMPACT REPORT ALAMEDA DISTRICT PLAN MASTER PLAN PROGRAM EIR

Los Angeles, California

March 31, 1995

Project 2663.50161.0001

LAW/CRANDALL, INC.
ENGINEERING AND ENVIRONMENTAL SERVICES

March 31, 1995

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Subject: **Report of Geotechnical Evaluation for Environmental Impact Report**
Alameda District Plan Master Plan Program EIR
Los Angeles, California
Law/Crandall Project 2663.50161.0001

Ladies/Gentlemen:

We are pleased to submit our "Report of Geotechnical Evaluation for Environmental Impact Report, Alameda District Plan Master Plan Program EIR, Los Angeles, California".

It has been a pleasure to be of service to you on this project. Please call if you have any questions or need additional information.

Respectfully submitted,

LAW/CRANDALL, INC.

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1.0 SCOPE

This report presents the results of our geotechnical evaluation for the Alameda District Plan. It is our understanding that the report will be used to provide the necessary geotechnical information for the preparation of an Environmental Impact Report (EIR) for the Alameda District Plan Master Plan Program EIR. As requested, this report addresses Sections B.1, B.2, D.2, and K of the Planning Company Associates' request for proposal dated December 11, 1992. Our studies included a geologic reconnaissance of the site and an office analysis of published and unpublished literature pertinent to the study area. The City of Los Angeles Seismic Safety Plan (1975) and the County of Los Angeles Seismic Safety Element (1974, draft revision 1990) were reviewed as part of our literature analysis.

We are familiar with the soil conditions beneath the site, having performed numerous geotechnical investigations for several previously proposed developments at the site. As part of these previous investigations we have drilled 35 borings on-site to depths ranging from 10 to 125 feet. In addition, we have drilled over 120 borings within 1,500 feet of the site for various projects such as the Central Jail, the Piper Center, and the RTD Plaza. Additionally, we performed detailed seismic evaluations for nearby structures such as the Federal Building/Courthouse, the Veterans Administration-Outpatient Clinic, the Southern California Rapid Transit District's Central Maintenance Facility, and Gateway Center. These seismic studies bracket the subject property.

The information in this report represents professional opinions that have been developed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report.

2.0 GEOLOGIC AND SEISMIC CONDITIONS

2.1 GENERAL

The Alameda District Plan site is located in the northern part of the Los Angeles Basin near the boundary of the Peninsular Ranges geomorphic province and the Transverse Ranges geomorphic province. The Peninsular Ranges geomorphic province is characterized by elongated northwest-trending mountain ridges separated by straight-sided, sediment-floored valleys (Yerkes et al., 1965). The northwest trend is further reflected in the direction of the dominant geologic structural features of the province, which are northwest to west-northwest trending faults and fault zones including the active Newport-Inglewood fault zone located approximately 8.4 miles to the west-southwest of the site. Generally, the physiographic and structural trends in the Transverse Ranges geomorphic province are east-west as reflected by the active Raymond fault located approximately 4.7 miles to the northeast and the potentially active Santa Monica-Hollywood fault zone approximately 4.3 miles to the northwest of the site. The Raymond fault and the Santa Monica-Hollywood fault zone are considered the boundary between the two geomorphic provinces.

The site is located approximately 0.3 mile west of the Los Angeles River on a gently sloping alluvial surface. Topography in the vicinity of the site slopes gently to the southeast at a gradient less than 20:1 (horizontal to vertical). Site elevations range from approximately 279 to 293 feet above sea level (U.S. Geological Survey datum). Geologic units in the vicinity of the site include artificial fill, Holocene and Pleistocene age alluvial deposits, and Miocene age sedimentary rock units of the Puente Formation.

The geology and topography at the site and in the general vicinity are shown on Figure 1, Local Geology. The relationship of the site to regional geologic features is shown on Figure 2, Regional Geology. Figure 3, Regional Seismicity, shows major faults and earthquake epicenters in Southern California.

2.2 GEOLOGIC MATERIALS

The site is mantled by artificial fill material consisting primarily of silty sand, silt, sand, and clay, with various amounts of construction debris (concrete, brick, etc.). A review of exploratory borings drilled at the site (by Law/Crandall and by others) indicates that up to 30 feet of uncertified fill materials are present at the site. Underlying the artificial fill is Holocene age alluvium consisting of sand, silty sand, and silt with varying amounts of gravel and cobbles. These sediments range from approximately 45 to 63 feet thick and are underlain by Pleistocene age alluvium. The Pleistocene age alluvium consists of sand and silt with varying amounts of gravel and extends to depths of approximately 63 to 108 feet beneath the site. The Holocene and Pleistocene age alluvium were deposited by the ancestral Los Angeles River. These sediments are unconformably underlain by sedimentary rock units of the Miocene age Puente Formation consisting of interbedded sandstone and siltstone. The Puente Formation sedimentary rock units are underlain by undifferentiated Tertiary age sedimentary bedrock units that are underlain by crystalline basement rocks at a depth of about 10,000 feet beneath the site.

2.3 GROUNDWATER

The site is located southeast of the Elysian Park Hills, near downtown Los Angeles. This area is in the Lower Los Angeles River Forebay area of the Central Hydrologic Subarea of the Los Angeles-San Gabriel Hydrologic Unit (California Department of Water Resources, 1961). The area is south of the convergence of the Arroyo Seco Channel and the Los Angeles River. The site lies on floodplain alluvium of the Los Angeles River. The site elevation ranges from about 279 to 293 feet above mean sea level.

In the vicinity of the site, groundwater primarily occurs in the river alluvium which overlies bedrock of the Miocene age Puente Formation. The alluvium consists primarily of sand, silty sand, silt, silty clay, gravelly sand, and gravelly sand with cobbles. The thickness of the alluvial materials may range from about 63 to 108 feet below ground surface (Levine/Fricke, 1989a; Law/Crandall, 1991, 1992, and 1993).

We reviewed several reports describing past groundwater quality problems in the immediate site area. These reports describe subsurface hydrogeologic conditions through time, and provide background data for groundwater levels and chemical quality. These include reports by: Law/Crandall, Inc. (1991), LeRoy Crandall and Associates, (1981, 1983, 1984a, 1984b, 1992, and 1993), Converse Consultants West (Converse, 1992), and Levine/Fricke (1989a, 1989b, 1990, 1991a, and 1991b), listed in Section 5.0, Bibliography.

Groundwater elevations have not varied significantly since records began. Water level records from Well No. 1S/13W-27G01, located about 1,000 feet east of the site, indicate the groundwater depth in the well ranged from about 26 to 33 feet below ground surface (bgs) between 1934 and 1964. This corresponds to elevations of about 257 to 250 feet above sea level. The highest groundwater level in Well 1S/13W-27G01 was recorded on January 1, 1935, when groundwater was 25.7 feet bgs. This corresponds to a water surface elevation of 256.8 feet above sea level.

Water level data from November 7, 1990 (Levine/Fricke, 1991a) show the depth to water at the site has ranged from about 28 to 68 feet bgs. These water levels correspond to elevations of 215 to 255 feet above mean sea level. The shallowest known groundwater occurs at the west end of the site, near the corner of Macy and Alameda Streets. Groundwater levels may have risen after the rains of 1992/1993 and after Metro Rail construction dewatering stopped. Limited recent data indicate that groundwater levels have risen to a depth of 19 feet bgs at Vignes Street, 650 feet northwest of Bauchet Street. This depth to groundwater corresponds to 256 feet above mean sea level (Law/Crandall, 1993).

Groundwater recharge for the Los Angeles Forebay occurs mainly through subsurface inflow through the Los Angeles River Narrows. The Los Angeles River itself is lined below gage F-57, 1 mile north of the site. Under natural conditions, groundwater gradients are toward the southeast (Levine-Fricke, 1989b). Dewatering operations for the Metro Rail tunnel construction deflected local groundwater flow in the eastern portion of the site toward the south (Levine/Fricke, 1991a). Dewatering operations have been completed and it is likely that the flow direction has returned to its previous condition.

2.4 MINERAL RESOURCES

The site is located approximately 1,000 feet north of the Union Station Oil Field and approximately 2,000 feet south-southeast of the Los Angeles City Oil Field. According to California Division of Oil and Gas (CDOG) Map No. 119, no documented wells exist at the site. According to the CDOG map, the closest known well is the Chevron Miller corehole located approximately 900 feet northeast of the site.

The alluvial deposits underlying the site are a potential source of aggregate. However, no evidence of previous or active mining of these deposits was observed during our site reconnaissance. Additionally, a review of published aggregate resources indicates the site is not within an area of historic aggregate production (Evans et al., 1979).

Since the site is not in an area of current or historical aggregate mining and is outside the limits of the Los Angeles City and the Union Station Oil Fields, development of the site would not result in the loss of potential aggregate or petroleum resources; the loss of potential mineral resources is considered negligible.

2.5 GEOLOGIC HAZARDS

2.5.1 Faults

The numerous faults in Southern California include active, potentially active, and inactive faults. The criteria for these major groups are based on criteria developed by the California Division of Mines and Geology (CDMG) for the Alquist-Priolo Earthquake Fault Zoning Program (Hart, 1994). By definition, an active fault is one that has had surface displacement within Holocene time (about the last 11,000 years). A potentially active fault is a fault that has demonstrated surface displacement during Quaternary time (approximately the last 2 million years), but has had no known Holocene movement. Faults that have not moved in the last two million years are considered inactive.

Under the Alquist-Priolo Earthquake Fault Zoning Act of 1972, the State Geologist is required to delineate 'Earthquake Fault Zones' along known active faults. Affected cities or counties must regulate development within the state-designated zones by withholding building permits until geologic investigations demonstrate that there is not a potential for surface displacement from future faulting within the site boundaries.

The site is not within an Alquist-Priolo Earthquake Fault Zone for surface fault rupture. The nearest Alquist-Priolo Earthquake Fault Zone, established along the active Raymond fault, is located approximately 4.7 miles northeast of the site. No active or potentially active faults are known to pass directly beneath the site. Therefore, the potential for surface rupture due to faulting occurring beneath the site during the design life of the development is considered low.

Active Faults: The closest active fault to the site is the Raymond fault, located about 4.7 miles to the northeast. The fault is a high-angle reverse fault thrusting basement rocks north of the fault, over alluvial sediments south of the fault. It has long been recognized as a groundwater barrier in the Pasadena/San Marino area, and numerous geomorphic features along its entire length (such as fault scarps, sag ponds, springs, and pressure ridges) attest to the fault's activity during the

Holocene epoch (last 11,000 years). Within the last 36,000 years, eight separate earthquake events have been recognized along the Raymond fault (Crook et al., 1987). The most recent fault movement, based on radiocarbon ages from materials collected in an excavation exposing the fault, occurred sometime between 2,160 +/- 105 and 1,630 +/- 100 years before present (LeRoy Crandall and Associates, 1978; Crook et al., 1987). The Raymond fault is considered capable of generating a maximum credible earthquake of magnitude 6.9 (Slemmons, 1979).

Other nearby active faults include the Newport-Inglewood, Whittier, San Fernando, and San Gabriel faults located 8.4 miles west-southwest, 11.5 miles east-southeast, 15 miles north-northwest, and 15 miles north of the site, respectively. The active San Andreas fault is located 34 miles north-northeast of the site.

Elysian Park Fold and Thrust Belt: The 1987 Whittier Narrows earthquake (magnitude 5.9) has been attributed to subsurface thrust faults that are reflected at the earth's surface by a west-northwest trending anticline known as the Elysian Park Anticline (Lamar, 1970), or the Elysian Park Fold and Thrust Belt (Hauksson, 1990). The axial trace of the anticline extends approximately 12 miles through the Elysian Park-Repetto Hills from about Silver Lake on the west to the Whittier Narrows on the east. The site lies within the boundaries of the Elysian Park Fold and Thrust Belt as defined by Hauksson (1990). The subsurface faults that create the structure are not exposed at the surface and do not present a potential surface rupture hazard; however, as demonstrated by the 1987 earthquake and two smaller earthquakes on June 12, 1989, the faults are a source for future seismic activity. As such, the fold and thrust belt should be considered an active feature capable of generating future earthquakes. Based on the approximate length of the axial trace of 12 miles, we have assigned a maximum credible earthquake of magnitude 6.75, using Mark's fault length versus magnitude relationship (1977).

Potentially Active Faults: The closest potentially active fault to the site is the Coyote Pass fault, located about 2.2 miles east-southeast of the site. This fault trends east-west across the southerly flank of the Repetto Hills for a distance of about 3 miles (California Department of Water Resources, 1961). Based on available information, the fault is a northerly dipping reverse fault with rocks of the Pliocene age Fernando Formation, north of the fault, thrust over younger Pleistocene sediments, south of the fault.

Other nearby potentially active faults are the Santa Monica-Hollywood, Verdugo, Overland, and Charnock faults, located 4.3 miles northwest, 6.7 miles north, 10.2 miles west-southwest, and 11.1 miles west-southwest of the site, respectively.

2.5.2 Seismicity

The seismicity of the region surrounding the site was determined from research of a computer catalog of seismic data. This catalog includes earthquake data compiled by the California Institute of Technology for 1932 to 1992 and data for 1812 to 1931 compiled by Richter and the U.S. National Oceanic Atmospheric Administration (NOAA). The database printout is presented at the end of this report as Table 1. The search for earthquakes that occurred within 100 kilometers (62 miles) of the site indicates that 325 earthquakes of Richter magnitude 4.0 and greater occurred between 1932 and 1992, 2 earthquakes of magnitude 6.0 or greater occurred between 1906 and 1931, and 1 earthquake of magnitude 7.0 or greater occurred between 1812 and 1905. An earthquake recurrence curve, based on the data presented in Table 1, is included as Figure 4, Recurrence Curve.

The information listed for each earthquake listed in Table 1 includes the date and time in Greenwich Civil Time (GCT), location of the epicenter in latitude and longitude, quality of epicentral determination (Q), depth in kilometers, and magnitude. Where a depth of 0.0 is given, the solution was based on an assumed 16-kilometer (9.9 mile) focal depth. The letter code for the quality factor is presented on the first page of the table. The approximate locations of moderate to great earthquakes (Richter magnitude 6 to 7.75) in the Southern California area are shown on Figure 3.

Several earthquakes of moderately large magnitude have occurred in the Southern California area within the last 60 years. The earliest of these earthquakes was the March 11, 1933 (Greenwich Civil Time) Long Beach earthquake. The epicenter of this earthquake was located about 34 miles south-southeast of the site.

The epicenter of the February 9, 1971 San Fernando earthquake, magnitude 6.4, was about 26 miles northwest of the site. Surface rupture occurred on various strands of the San Fernando fault zone as a result of this earthquake, including the Tujunga and Sylmar faults.

The magnitude 5.9 Whittier Narrows earthquake occurred on October 1, 1987, on a previously unrecognized fault. The earthquake epicenter was located about 9 miles east of the site.

The Sierra Madre earthquake occurred on June 28, 1991 along the Sierra Madre fault zone. The epicenter of the magnitude 5.4 earthquake was located in the San Gabriel mountains about 20 miles northeast of the site.

On June 28, 1992, two major earthquakes occurred east of Los Angeles. At 4:58 a.m., a magnitude 7.5 earthquake occurred in the High Desert region and is known as the Landers earthquake. The epicenter was located about 102 miles east-northeast of the site. The second event occurred at 8:04 a.m. near Big Bear Lake and had a magnitude of 6.6; the epicenter was about 81 miles east-northeast of the site.

Most recently, on January 17, 1994, at 4:31 a.m., a magnitude 6.8 earthquake occurred in the San Fernando Valley. This event is known as the Northridge earthquake. The epicenter was located about 14 miles northwest of the site.

The site is not exposed to a greater than normal seismic risk than other areas in Southern California. However, based on the active and potentially active faults in the region, the site could be subjected to significant ground shaking, in the event of an earthquake. This hazard is common to Southern California and can be mitigated if the buildings are designed and constructed in conformance with current building codes and engineering practices.

2.5.3 Ground Shaking

Significant ground shaking could occur at the site as a result of earthquakes on any of the nearby active or potentially active faults including, but not limited to, the Elysian Park Fold and Thrust Belt, the Verdugo fault zone, the Santa Monica-Hollywood fault zone, the Newport-Inglewood fault zone, and the San Andreas fault zone.

Several postulated design earthquakes were selected for study based on the proximity and estimated magnitude for nearby faults. These earthquakes, their associated faults, estimated Richter magnitudes, distance from the site, estimated ground acceleration levels, and estimated duration of strong shaking at the site are indicated in the following table. The duration of strong shaking is defined as that time period during which the acceleration is greater than 0.05g.

Ground Shaking Effects						
Design Earthquake	Fault	Estimated Magnitude	Distance From Fault to Site (miles)	Ground Acceleration		Estimated Duration (seconds)
				Peak	Sustained	
Maximum Credible:						
Distant	San Andreas	8.25	34	0.22	0.22	28
Local	Elysian Park Fold and Thrust Belt	6.75	0	0.62	0.47	24
Local	Santa Monica-Hollywood	6.9	4.3	0.47	0.35	25
Local	Verdugo	7.4	6.7	0.43	0.32	30
Local	Newport-Inglewood	7.0	8.4	0.36	0.27	26
Maximum Probable:						
Local	Elysian Park Fold and Thrust Belt	6.5	0	0.61	0.39	20

2.5.4 Landslides and Slope Stability

The site is on relatively flat ground with no slope stability problems and no potential for lurching (movement at right angles to a steep slope during strong ground shaking). The site is not located within a Slope Stability Study Area as designated by the City of Los Angeles (1975). Additionally, the site is not in the path of any existing or potential landslides. Therefore, the potential impact of landslides at the site is considered low.

Proposed construction excavations at the site will expose artificial fill and alluvial materials. These materials are massive or horizontally stratified and lack any well-defined planar features or discontinuities (such as bedding or jointing) that could act as planes of weakness. This condition is considered favorable for gross stability from a geologic standpoint.

2.5.5 Liquefaction

The significant factors that affect liquefaction include soil type, particle size and gradation, water level, relative density, confining pressure, intensity of shaking, and duration of shaking. Liquefaction potential has been found to be the greatest where the water level is shallow and loose, fine sands occur within a depth of about 50 feet or less. Liquefaction potential decreases with increasing grain size and clay and gravel content, but increases as the ground acceleration and duration of shaking increase. According to the Los Angeles County Seismic Safety Element (1974, draft revision 1990), the site has not been identified as a potential liquefaction area.

The alluvial deposits beneath the site consist primarily of silty sand and sand with varying amounts of gravel and cobbles, underlain by consolidated sandstone and siltstone at depths ranging from about 63 to 108 feet. Standard Penetration Tests conducted during previous investigations at the site indicate that the sandy deposits are firm and dense below the water level (19 feet to about 68 feet beneath the existing ground surface). Additionally, the underlying bedrock units of the Puente Formation are not prone to liquefaction.

2.5.6 Flooding, Erosion and Sedimentation

The site is located within an area of minimal flooding (Zone C) as designated by the Federal Insurance Administration. Accordingly, the potential for flooding at the site is considered low.

No unprotected drainage ways were observed on the site. We anticipate the proposed development will result in an increase in impervious surfaces (such as parking lots, streets, walkways) at the site. On-site grading should be performed in such a manner that alteration of runoff or erosion of graded areas will not occur. All areas of construction should be fine-graded to direct water away from foundation areas and direct runoff to the street or to the nearest available storm drain. Runoff at the site should not be allowed to flow in an uncontrolled fashion, especially over any permanent or temporary slopes.

2.5.7 Subsidence

The site is not in an area of known ground subsidence due to the extraction of fluids (petroleum or groundwater) or peat oxidation. No known subsidence has been associated with the nearby Union Station Oil Field or the Los Angeles City Oil Field.

2.5.8 Seismic Settlement and Differential Compaction

Seismic settlement often occurs when loose to medium-dense granular soils densify during ground shaking. If such settlement were uniform beneath a given structure, damage would be minimal. Because of variations in distribution, density, and confining conditions of the soils, however, such settlement is generally non-uniform and can cause serious structural damage. Dry and partially saturated soils as well as saturated granular soils are subject to seismically-induced settlement. Generally, differential settlements induced by ground failures such as liquefaction, flow slides, and surface ruptures would be much more severe than those caused by densification alone.

The natural sandy soils encountered in our previous exploratory borings at the site are not in the loose to medium-dense category, and are not prone to seismic settlement or differential compaction. Therefore, the potential for seismic settlement and differential compaction of the natural soils beneath the site will have little impact on the proposed development. However, the presence of deep fills at the site could result in significant seismic settlement and associated damage to the proposed structures.

2.5.9 Tsunamis, Inundation and Seiches

The site is located approximately 15 miles east of the Pacific Ocean at elevations of 279 to 293 feet above mean sea level. Therefore, tsunamis (earthquake-induced sea waves) will not have a potential impact on the site development.

According to the County of Los Angeles Seismic Safety Element (1974, draft revision 1990), the site is located within a potential inundation area for an earthquake-induced dam failure or seiches (oscillating waves that form in an enclosed or semi-enclosed body of water) from Hansen Dam and Sepulveda Dam. These dams, as well as others in California, are continually monitored by various governmental agencies (such as the State of California Division of Safety of Dams and the U.S. Army Corps of Engineers) to guard against the threat of dam failure. The possibility of dam failures during an earthquake has been addressed by the California Division of Mines and Geology in the earthquake planning scenarios for a magnitude 8.3 earthquake on the San Andreas fault zone (Davis et. al., 1982) and a magnitude 7.0 earthquake on the Newport-Inglewood fault zone (Toppozada et al., 1988). As stated in both reports, catastrophic failure of a major dam as a result of a scenario earthquake is regarded as unlikely. Current design and construction practices and ongoing programs of review, modification, or total reconstruction of existing dams are intended to ensure that all dams are capable of withstanding the maximum credible earthquake (MCE) for the site. Accordingly, the potential impacts of seiches and inundation at the site are considered low.

2.5.10 Volcanic Hazards

The site is not subject to any known volcanic hazards. The nearest Quaternary age volcanic fields are located about 120 miles to the north near Little Lake and the Coso Mountains. Another area of recent volcanic activity is located about 100 miles to the northeast at Amboy and Piogah Craters.

3.0 GEOTECHNICAL ENGINEERING

3.1 GENERAL SOIL CONDITIONS

Based on previous explorations, the site is mantled by up to about 30 feet of uncertified fill. Twenty-nine (29) borings were reviewed that were drilled within or directly adjacent to the site. Artificial fill was encountered in all the borings, and the average fill depth encountered was about 7 to 15 feet. Fill of variable thickness is apparently distributed across most of the site. As required by the City of Los Angeles, Department of Building and Safety, Grading Division, any fill which has not been observed and certified during placement is considered uncertified fill. The fill consists of silty sand, silt, sand, and clay. Various types of debris are present in the fill. The fill is underlain by alluvial deposits of sand, silty sand, and silt to depths of about 63 to 108 feet below the existing grade. The natural soils are generally dense to very dense and contain varying amounts of gravel and cobbles.

The fill and natural alluvial soils at the site are underlain by sedimentary rock units consisting of siltstone and sandstone of Puente Formation. The bedrock units are firm to very firm.

3.2 GRADING AND CONSTRUCTION CONSIDERATIONS

3.2.1 Excavation

At this time, proposed grading plans for the site are not available and the depth of excavations is not known. We anticipate that conventional earth-moving equipment may be used in excavating the existing fill soils and alluvial deposits at the site.

3.2.2 Grading

Our previous work at the site indicates the natural soils should be suitable for use as compacted fill. Existing fill, less any organic debris or oversize materials, would also be suitable for use as compacted fill.

It is not known at this time whether or not the finished grades at the site will result in a balanced cut and fill grading operation (i.e., whether export or import soil will be required). However, if it becomes necessary to dispose of excess excavated materials, we expect that most of the soils would be suitable for use in other construction projects. However, oversized cobbles may require special handling during grading. If contaminated soils are encountered during grading, these soils will require special testing to determine the nature of contamination and requirements for proper disposal.

We anticipate graded slopes at gradients of 2:1 (horizontal to vertical) will be grossly stable. However, stability of proposed graded slopes should be addressed when grading plans are completed for the proposed development.

3.2.3 Foundations

Existing uncertified fill materials at the site will not be suitable to support buildings on conventional spread foundations. However, it should be possible to support buildings on conventional spread foundations placed in natural soils or in properly compacted fill. If any fill is to be placed during grading, it should be placed in accordance with the regulations of the appropriate governmental agencies. Conventional spread foundations may be established in the resulting fill. If expansive soils are exposed near final grades, floor slabs and adjacent hardscape should be underlain by a layer of predominantly granular non-expansive soil.

Depending, on the depth of the proposed excavations, the building subterranean levels may extend into the groundwater. If shoring is to be used, special installation techniques will be required due to caving of sandy soils below the water table. Building foundations, basement walls, and floor slabs could be affected, and special remedial measures would have to be incorporated in design.

The existing Metro Rail tunnel traverses the site. The invert elevation of the tunnel is about 45 feet below the existing grade. There is a 30-inch-thick slurry wall along the alignment of the tunnel. Tie-back anchors associated with wall construction extend beneath the site. Special foundation systems (such as drilled piles) may be required for construction of heavier and larger structures directly on or adjacent to the tunnel.

4.0 CONCLUSIONS AND RECOMMENDATIONS

It is our opinion that the site is suitable for the planned development. No known active or potentially active faults traverse the site and the site is not within an Alquist-Priolo Earthquake Fault Zone for surface rupture hazard. However, the site could be subject to strong ground shaking as the result of an earthquake on a nearby fault. Deep fills present at the site could be subject to seismic settlement and differential compaction. Based on previous nearby investigations, liquefaction is not a problem in the general area. However, the liquefaction potential at the site should be evaluated during the comprehensive geotechnical investigation. Other geologic hazards such as slope stability, subsidence, flooding, inundation, tsunamis, and seiches should not affect the site. Additionally, volcanic hazards should not affect the site. The loss of potential mineral resources at the site is considered negligible.

Groundwater beneath the site is relatively shallow and would be encountered in excavations deeper than 25 feet. Dewatering and special shoring techniques during construction will be required. Proposed basements and other subterranean structures will require special design in areas where water is anticipated.

The natural soils should be suitable for use as compacted fill. Existing fill, less any organic debris or oversize materials, would also be suitable for use as compacted fill. Existing uncertified fill materials at the site will not be suitable to support buildings on conventional spread foundations. However, it should be possible to support buildings on conventional spread foundations placed in natural soils or in properly compacted fill. Special foundation systems (such as drilled piles) may be required for construction of heavier and larger structures directly on or adjacent to the Metro Rail tunnel.

The following measures are recommended for site development:

- Design and construction of proposed structures should be in conformance with current building codes and engineering practices.

- A comprehensive geotechnical investigation should be performed at the site to evaluate the liquefaction, seismic settlement, and differential compaction of the artificial fill and natural soils underlying the specific building locations.

- Environmental and engineering investigations should be reviewed and/or conducted by qualified professionals to assess present soil and groundwater conditions and characteristics. Contaminant location and migration patterns should be analyzed. Work plans and health and safety plans for safe handling of removed soil and groundwater should be prepared. These recommendations should include measures to protect the public, site occupants, and structures from exposure to hazardous substances.

- Treatment and disposal of on-site groundwater may require appropriate permits from CAL-EPA and the Regional Water Quality Control Board. Conditions and requirements for treatment and discharge in the site area are primarily set by the California Regional Water Quality Control Board, Los Angeles Region.

- A detailed geotechnical investigation should be performed at the site to delineate specific areas containing deep fill soils.

- If the depth of fill material within the building area is too excessive to make its removal and recompaction economical, the proposed structures may be supported on pile foundations. The piles should penetrate the existing fill soils to develop adequate capacity. The building floor slabs must be structurally supported.

- Where the planned depth of excavation does not extend below the existing fill soils, the existing fill soils should be removed and recompacted in accordance with the requirements of the appropriate governmental agencies.

- Specifications for cut and fill shall be subject to approval by the City Engineer or other responsible agency.

- A registered geotechnical engineer or his representative should be present on site to observe grading operations.

- The soils at the site are quite granular in nature, and non-contaminated soils may be exported to other project sites to be used as fill materials.

- During construction, exposed earth surfaces should be sprayed with water by the contractor to minimize dust generation.

- Prior to issuing a grading permit, the applicant should obtain a haul route approval for the export materials from the City and should comply with applicable restrictions.

- Where there is sufficient space for sloped excavations, temporary cut slopes less than 30 feet in height may be made at a 1½:1 or 2:1 (horizontal to vertical) gradient. However, the stability of the graded slopes should be addressed when grading plans are completed for the proposed development. Vertical cuts deeper than 4 feet in height should be avoided.

- Where sufficient space for sloped excavations is not available, shoring should be used. The shoring system may consist of soldier piles and lagging. Recommendations for the proper design of the shoring system should be provided by a licensed geotechnical engineer.

- A detailed geotechnical investigation should be performed to determine the depth to groundwater table. Excavations extending below the water table will require temporary dewatering during construction and may require permanent dewatering. The permanent dewatering system may consist of waterproofing of basement walls and a subdrain system beneath the subterranean floor slab.

- In lieu of installing a permanent subdrain system, the portion of building walls and floor slabs extending below the groundwater table may be waterproofed and designed to resist the hydrostatic pressures in addition to resisting the pressures imposed by the retained earth.

- The site should be properly graded to provide for adequate drainage to storm drains. The capacities of the existing drains should be considered when planning the drainage patterns across the site. If the existing storm drains are not adequate for disposal of site surface runoff, additional storm drains should be installed.

- An NPDES permit should be obtained from the Regional Water Quality Control Board prior to discharging water into city storm drains.

- Construction of structures that are more than one or two levels and extending over 10,000 square feet should be avoided over the tunnel.

- Large structures located directly located above the tunnel may be supported on drilled piles extending below the tunnel. The building floor slabs should also be structurally supported.

- If the excavation for the proposed development subterranean levels extend below the invert elevation of the tunnel, the stability of the tunnel must be properly addressed.

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EXPLANATION:

- **Qal** HOLOCENE ALLUVIUM
- **Qt** TERRACE DEPOSITS
- **Qoa** OLDER ALLUVIUM
- **Tf** FERNANDO FORMATION
- **Tps** PUENTE FORMATION, SILTSTONE
- 24 STRIKE AND DIP OF BEDDING
- GEOLOGIC CONTACT
- ? FAULT, DASHED WHERE APPROXIMATE, QUERIED WHERE UNCERTAIN
- OIL FIELD BOUNDARY

N

REFERENCES:

BASE MAP FROM U.S.G.S. 7.5' LOS ANGELES QUADRANGLE, PHOTO REVISED 1981 AND HOLLYWOOD QUADRANGLE, PHOTO REVISED 1972.

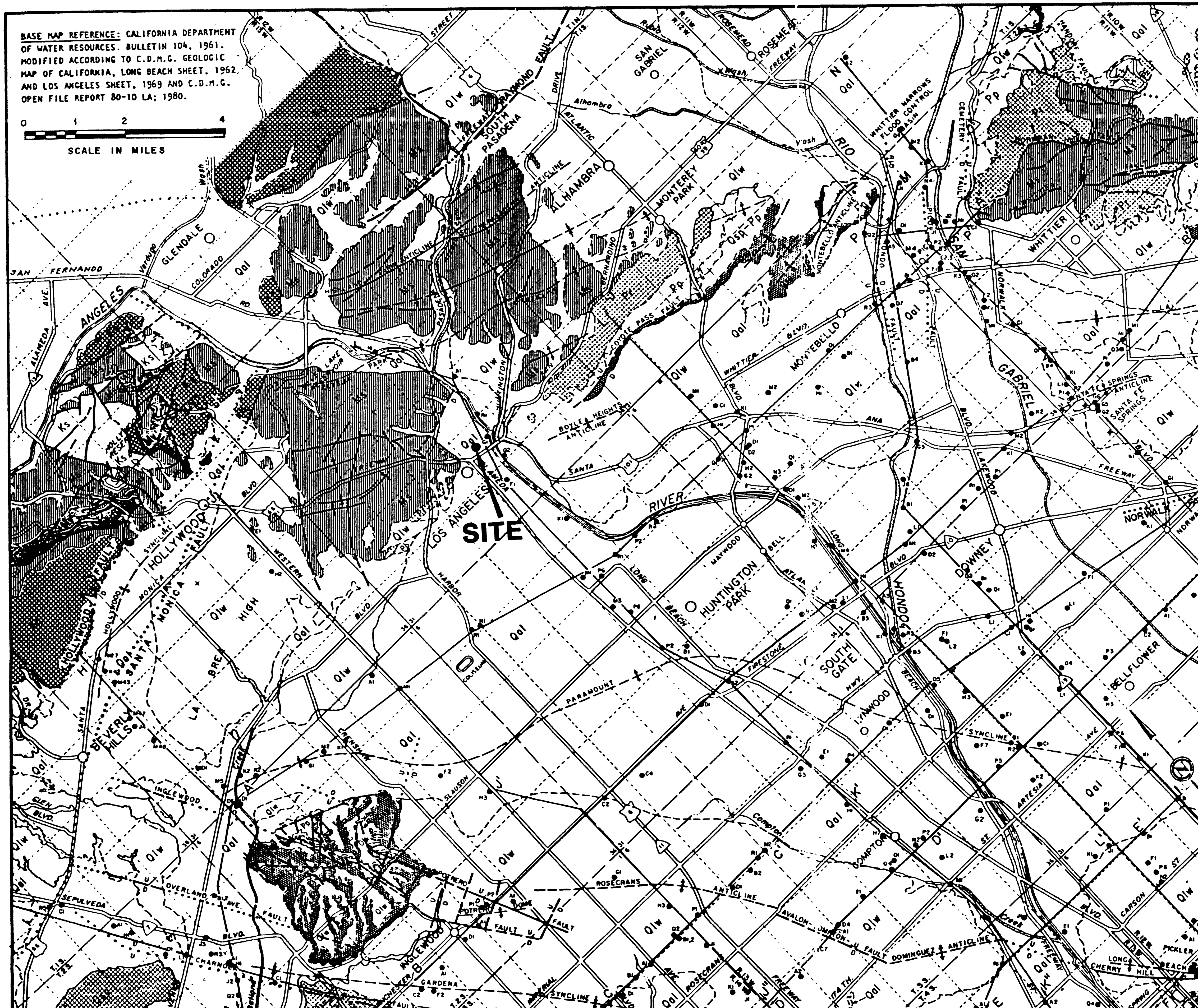
GEOLOGY ADAPTED FROM LAMAR (1970).

LOCAL GEOLOGY

SCALE 1"= 2000'

LAW/CRANDALL, INC.

PLATE 1



LEGEND

SEDIMENTARY ROCKS

QUATERNARY

RECENT

- Qal — ALLUVIUM: GRAVEL, SAND, SILT, AND CLAY
- Qsr — ACTIVE DUNE SAND: WHITE OR GREYISH, WELL SORTED SAND

PLEISTOCENE

- UPPER — OLDER DUNE SAND: FINE TO MEDIUM SAND WITH SILT, AND GRAVEL LENSES
- UPPER — Qlw — LAKEWOOD FORMATION (INCLUDES "TERRACE DEPOSITS," "PALOS VERDES SAND," AND "UNNAMED UPPER PLEISTOCENE DEPOSITS"): MARINE AND CONTINENTAL GRAVEL, SAND, SANDY SILT, SILT, AND CLAY WITH SHALE PEBBLES
- LOWER — SAN PEDRO FORMATION (INCLUDES "LA HABRA CONGLOMERATE" AND PART OF "SAUGUS FORMATION"): MARINE AND CONTINENTAL GRAVEL, SAND, SANDY SILT, SILT, AND CLAY
- Qsp-Pp — UNDIFFERENTIATED SAN PEDRO FORMATION AND/OR PICO FORMATION: MARINE, PARTIALLY CONSOLIDATED GRAVEL, SAND, SILT, AND CLAY

TERTIARY

PLIOCENE

- Pp — PICO FORMATION: MARINE SAND, SILT, AND CLAY INTERBEDDED WITH GRAVEL
- REPETTO FORMATION: MARINE SILTSTONE WITH LAYERS OF SANDSTONE AND CONGLOMERATE

MIOCENE

- (SANTA MONICA MOUNTAINS) MODELO FORMATION: MARINE CONGLOMERATIC SANDSTONE, SANDSTONE, AND SHALE
- TOPANGA FORMATION: MARINE CONGLOMERATE, SANDSTONE, AND SHALE
- (PALOS VERDES HILLS) MONTEREY FORMATION: MUDSTONE, DIATOMITE, AND SHALE
- (ELYSIAN HILLS, REPETTO HILLS, AND PUENTE HILLS) PUENTE FORMATION: MARINE SILTSTONE, SANDSTONE, SHALE, CONGLOMERATE, LIMESTONE, AND TUFF

OLIGOCENE(?)

- VAQUEROS AND SESPE FORMATIONS: CONTINENTAL RED CONGLOMERATE AND SANDSTONE

EOCENE

- MARTINEZ FORMATION: MARINE CONGLOMERATE, SANDSTONE, SANDY SHALE, AND SHALE

PALEOCENE(?)

- E-K — UNDIVIDED MARTINEZ AND CHICO FORMATIONS

CRETACEOUS — UPPER

- Ks — CHICO FORMATION: UPPER MARINE MEMBER-HARD CONGLOMERATE, SANDSTONE, AND SHALE; LOWER CONTINENTAL MEMBER-RED CONGLOMERATE AND SANDSTONE

IGNEOUS AND METAMORPHIC ROCKS

TERTIARY — MIOCENE

- MIDDLE MIOCENE VOLCANIC ROCKS: VOLCANIC FLOWS, BRECCIAS, TUFFS, AND INTRUSIVES CHIEFLY BASALTIC AND ANDESITIC WITH OCCASIONAL ACID ROCKS GENERALLY ASSOCIATED WITH TOPANGA, MODELO, OR PUENTE FORMATIONS

CRETACEOUS — UPPER

- (SANTA MONICA MOUNTAINS): INTRUSIVES OF GRANITE AND GRANODIORITE

JURASSIC

- J — (PALOS VERDES HILLS): CATALINA SCHIST COMPARED WITH FRANCISCAN FORMATION OF THE COAST RANGES VARIED TYPES OF SCHISTOSE ROCKS

TRIASSIC

- ħ — SANTA MONICA SLATE: GREY TO BLACK SLATE, SPOTTED SLATE, MICA SCHIST WITH QUARTZ VEINS

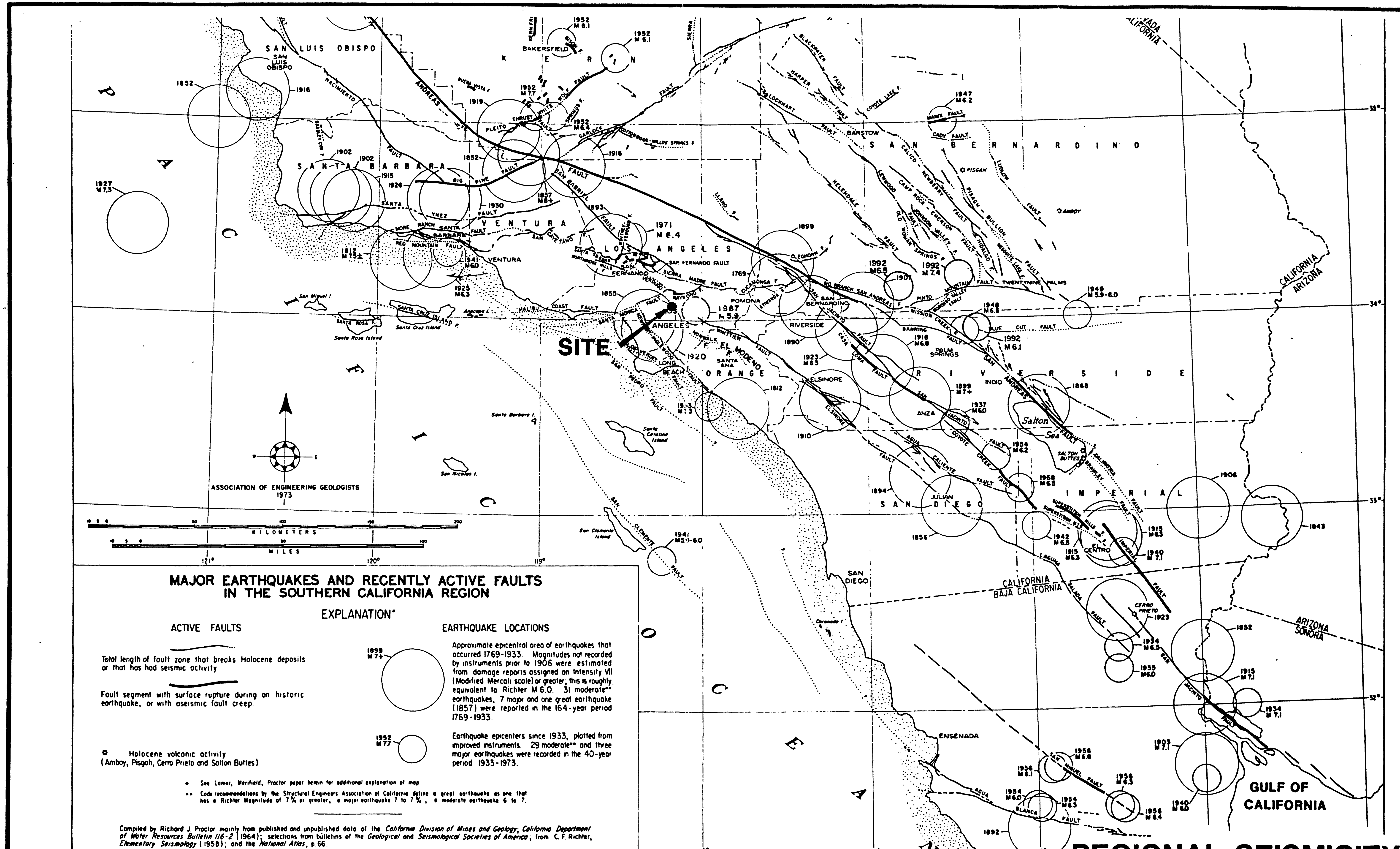
Symbols

- FAULT (DASHED WHERE APPROXIMATLY LOCATED, U-UPTHROWN SIDE; D-DOWNTHROWN SIDE)
- CONCEALED FAULT
- ANTICLINE (DASHED WHERE APPROXIMATLY LOCATED.
- SYNCLINE (DASHED WHERE APPROXIMATLY LOCATED.
- CONTACT (DASHED WHERE APPROXIMATLY LOCATED.
- • A5 — WELLS USED IN PREPARATION OF GEOLOGIC SECTIONS.
- A———A' — LINE LOCATION OF GEOLOGIC SECTIONS SHOWN ON PLATES 6A THROUGH 6G.

REGIONAL GEOLOGY

LAW/CRANDALL, INC.

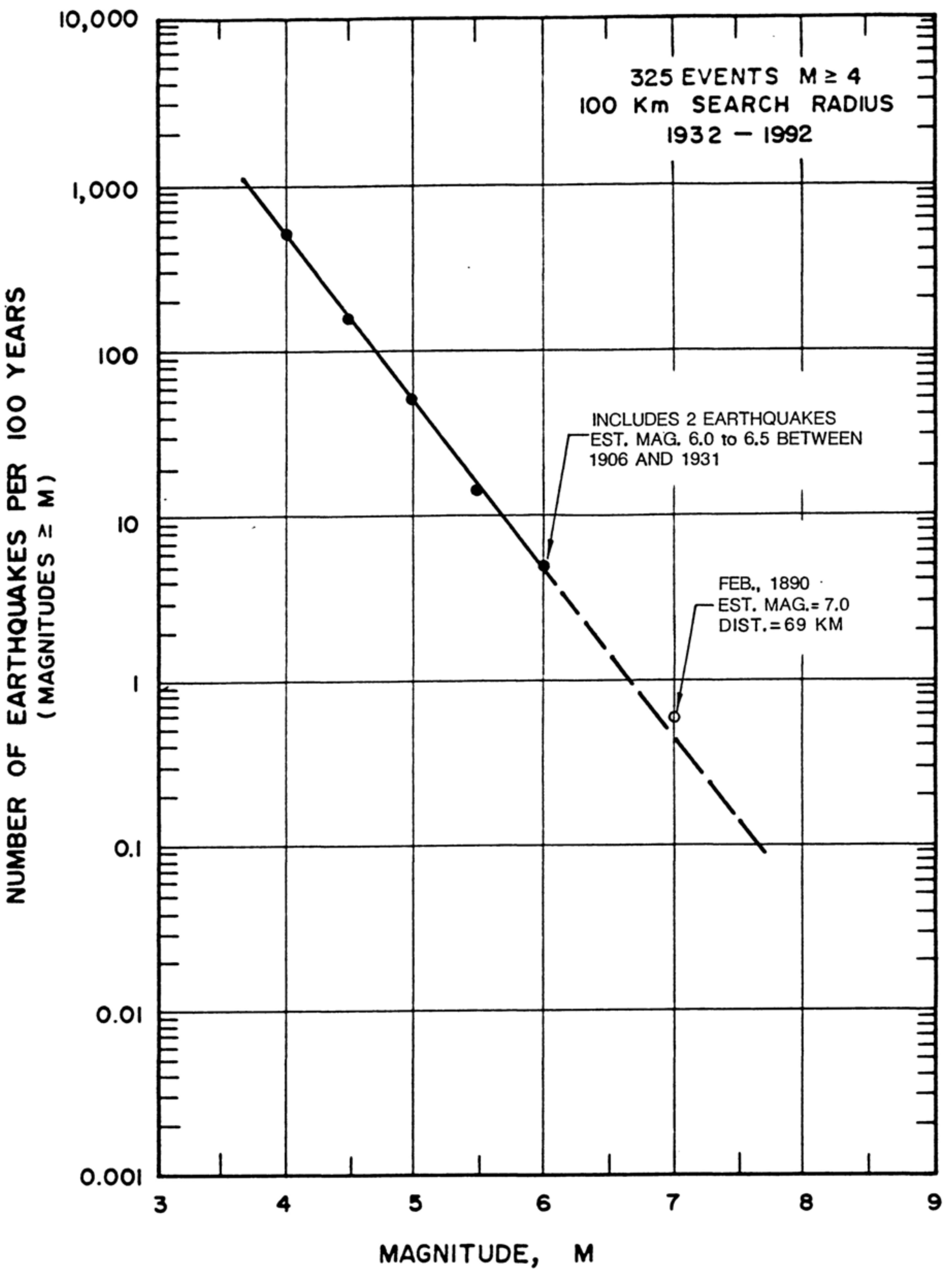
PLATE 2



REGIONAL SEISMICITY

LAW/CRANDALL, INC.

PLATE 3



RECURRENCE CURVE

O REPRESENTS SINGLE EVENT, AND THEREFORE HAS BEEN DISCOUNTED IN PREDICTION.

LAW/CRANDALL, INC.

PLATE 4

TABLE 1

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 4.0 OR
GREATER WITHIN 100 KM OF THE SITE
(CAL TECH DATA 1932-1992)

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
11-01-1932	04:45:00	34.00 N	117.25 W	E	92	.0	4.0
03-11-1933	01:54:08	33.62 N	117.97 W	A	55	.0	6.3
03-11-1933	02:04:00	33.75 N	118.08 W	C	37	.0	4.9
03-11-1933	02:05:00	33.75 N	118.08 W	C	37	.0	4.3
03-11-1933	02:09:00	33.75 N	118.08 W	C	37	.0	5.0
03-11-1933	02:10:00	33.75 N	118.08 W	C	37	.0	4.6
03-11-1933	02:11:00	33.75 N	118.08 W	C	37	.0	4.4
03-11-1933	02:16:00	33.75 N	118.08 W	C	37	.0	4.8
03-11-1933	02:17:00	33.60 N	118.00 W	E	56	.0	4.5
03-11-1933	02:22:00	33.75 N	118.08 W	C	37	.0	4.0
03-11-1933	02:27:00	33.75 N	118.08 W	C	37	.0	4.6
03-11-1933	02:30:00	33.75 N	118.08 W	C	37	.0	5.1
03-11-1933	02:31:00	33.60 N	118.00 W	E	56	.0	4.4
03-11-1933	02:52:00	33.75 N	118.08 W	C	37	.0	4.0
03-11-1933	02:57:00	33.75 N	118.08 W.	C	37	.0	4.2
03-11-1933	02:58:00	33.75 N	118.08 W	C	37	.0	4.0
03-11-1933	02:59:00	33.75 N	118.08 W	C	37	.0	4.6
03-11-1933	03:05:00	33.75 N	118.08 W	C	37	.0	4.2
03-11-1933	03:09:00	33.75 N	118.08 W	C	37	.0	4.4
03-11-1933	03:11:00	33.75 N	118.08 W	C	37	.0	4.2
03-11-1933	03:23:00	33.75 N	118.08 W	C	37	.0	5.0
03-11-1933	03:36:00	33.75 N	118.08 W	C	37	.0	4.0
03-11-1933	03:39:00	33.75 N	118.08 W	C	37	.0	4.0
03-11-1933	03:47:00	33.75 N	118.08 W	C	37	.0	4.1
03-11-1933	04:36:00	33.75 N	118.08 W	C	37	.0	4.6
03-11-1933	04:39:00	33.75 N	118.08 W	C	37	.0	4.9
03-11-1933	04:40:00	33.75 N	118.08 W	C	37	.0	4.7
03-11-1933	05:10:22	33.70 N	118.07 W	C	43	.0	5.1
03-11-1933	05:13:00	33.75 N	118.08 W	C	37	.0	4.7
03-11-1933	05:15:00	33.75 N	118.08 W	C	37	.0	4.0
03-11-1933	05:18:04	33.57 N	117.98 W	C	59	.0	5.2
03-11-1933	05:21:00	33.75 N	118.08 W	C	37	.0	4.4
03-11-1933	05:24:00	33.75 N	118.08 W	C	37	.0	4.2
03-11-1933	05:53:00	33.75 N	118.08 W	C	37	.0	4.0
03-11-1933	05:55:00	33.75 N	118.08 W	C	37	.0	4.0

NOTE: Q IS A FACTOR RELATING THE QUALITY OF EPICENTRAL DETERMINATION

A = SPECIALLY INVESTIGATED
B = EPICENTER PROBABLY WITHIN 5 KM, ORIGIN TIME TO NEAREST SECOND
C = EPICENTER PROBABLY WITHIN 15 KM, ORIGIN TIME TO A FEW SECONDS
D = EPICENTER NOT KNOWN WITHIN 15 KM, ROUGH LOCATION
E = EPICENTER ROUGHLY LOCATED, ACCURACY LESS THAN "D"
P = PRELIMINARY

DATE	TIME	LATITUDE	LONGITUDE		Q	DIST	DEPTH	MAGNITUDE
03-11-1933	06:11:00	33.75 N	118.08	W	C	37	.0	4.4
03-11-1933	06:18:00	33.75 N	118.08	W	C	37	.0	4.2
03-11-1933	06:29:00	33.85 N	118.27	W	C	23	.0	4.4
03-11-1933	06:35:00	33.75 N	118.08	W	C	37	.0	4.2
03-11-1933	06:58:03	33.68 N	118.05	W	C	46	.0	5.5
03-11-1933	07:51:00	33.75 N	118.08	W	C	37	.0	4.2
03-11-1933	07:59:00	33.75 N	118.08	W	C	37	.0	4.1
03-11-1933	08:08:00	33.75 N	118.08	W	C	37	.0	4.5
03-11-1933	08:32:00	33.75 N	118.08	W	C	37	.0	4.2
03-11-1933	08:37:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	08:54:57	33.70 N	118.07	W	C	43	.0	5.1
03-11-1933	09:10:00	33.75 N	118.08	W	C	37	.0	5.1
03-11-1933	09:11:00	33.75 N	118.08	W	C	37	.0	4.4
03-11-1933	09:26:00	33.75 N	118.08	W	C	37	.0	4.1
03-11-1933	10:25:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	10:45:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	11:00:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	11:04:00	33.75 N	118.13	W	C	36	.0	4.6
03-11-1933	11:29:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	11:38:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	11:41:00	33.75 N	118.08	W	C	37	.0	4.2
03-11-1933	11:47:00	33.75 N	118.08	W	C	37	.0	4.4
03-11-1933	12:50:00	33.68 N	118.05	W	C	46	.0	4.4
03-11-1933	13:50:00	33.73 N	118.10	W	C	39	.0	4.4
03-11-1933	13:57:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	14:25:00	33.85 N	118.27	W	C	23	.0	5.0
03-11-1933	14:47:00	33.73 N	118.10	W	C	39	.0	4.4
03-11-1933	14:57:00	33.88 N	118.32	W	C	21	.0	4.9
03-11-1933	15:09:00	33.73 N	118.10	W	C	39	.0	4.4
03-11-1933	15:47:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	16:53:00	33.75 N	118.08	W	C	37	.0	4.8
03-11-1933	19:44:00	33.75 N	118.08	W	C	37	.0	4.0
03-11-1933	19:56:00	33.75 N	118.08	W	C	37	.0	4.2
03-11-1933	22:00:00	33.75 N	118.08	W	C	37	.0	4.4
03-11-1933	22:31:00	33.75 N	118.08	W	C	37	.0	4.4
03-11-1933	22:32:00	33.75 N	118.08	W	C	37	.0	4.1
03-11-1933	22:40:00	33.75 N	118.08	W	C	37	.0	4.4
03-11-1933	23:05:00	33.75 N	118.08	W	C	37	.0	4.2
03-12-1933	00:27:00	33.75 N	118.08	W	C	37	.0	4.4
03-12-1933	00:34:00	33.75 N	118.08	W	C	37	.0	4.0
03-12-1933	04:48:00	33.75 N	118.08	W	C	37	.0	4.0
03-12-1933	05:46:00	33.75 N	118.08	W	C	37	.0	4.4
03-12-1933	06:01:00	33.75 N	118.08	W	C	37	.0	4.2
03-12-1933	06:16:00	33.75 N	118.08	W	C	37	.0	4.6
03-12-1933	07:40:00	33.75 N	118.08	W	C	37	.0	4.2

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
03-12-1933	08:35:00	33.75 N	118.08 W	C	37	.0	4.2
03-12-1933	15:02:00	33.75 N	118.08 W	C	37	.0	4.2
03-12-1933	16:51:00	33.75 N	118.08 W	C	37	.0	4.0
03-12-1933	17:38:00	33.75 N	118.08 W	C	37	.0	4.5
03-12-1933	18:25:00	33.75 N	118.08 W	C	37	.0	4.1
03-12-1933	21:28:00	33.75 N	118.08 W	C	37	.0	4.1
03-12-1933	23:54:00	33.75 N	118.08 W	C	37	.0	4.5
03-13-1933	03:43:00	33.75 N	118.08 W	C	37	.0	4.1
03-13-1933	04:32:00	33.75 N	118.08 W	C	37	.0	4.7
03-13-1933	06:17:00	33.75 N	118.08 W	C	37	.0	4.0
03-13-1933	13:18:28	33.75 N	118.08 W	C	37	.0	5.3
03-13-1933	15:32:00	33.75 N	118.08 W	C	37	.0	4.1
03-13-1933	19:29:00	33.75 N	118.08 W	C	37	.0	4.2
03-14-1933	00:36:00	33.75 N	118.08 W	C	37	.0	4.2
03-14-1933	12:19:00	33.75 N	118.08 W	C	37	.0	4.5
03-14-1933	19:01:50	33.62 N	118.02 W	C	53	.0	5.1
03-14-1933	22:42:00	33.75 N	118.08 W	C	37	.0	4.1
03-15-1933	02:08:00	33.75 N	118.08 W	C	37	.0	4.1
03-15-1933	04:32:00	33.75 N	118.08 W	C	37	.0	4.1
03-15-1933	05:40:00	33.75 N	118.08 W	C	37	.0	4.2
03-15-1933	11:13:32	33.62 N	118.02 W	C	53	.0	4.9
03-16-1933	14:56:00	33.75 N	118.08 W	C	37	.0	4.0
03-16-1933	15:29:00	33.75 N	118.08 W	C	37	.0	4.2
03-16-1933	15:30:00	33.75 N	118.08 W	C	37	.0	4.1
03-17-1933	16:51:00	33.75 N	118.08 W	C	37	.0	4.1
03-18-1933	20:52:00	33.75 N	118.08 W	C	37	.0	4.2
03-19-1933	21:23:00	33.75 N	118.08 W	C	37	.0	4.2
03-20-1933	13:58:00	33.75 N	118.08 W	C	37	.0	4.1
03-21-1933	03:26:00	33.75 N	118.08 W	C	37	.0	4.1
03-23-1933	08:40:00	33.75 N	118.08 W	C	37	.0	4.1
03-23-1933	18:31:00	33.75 N	118.08 W	C	37	.0	4.1
03-25-1933	13:46:00	33.75 N	118.08 W	C	37	.0	4.1
03-30-1933	12:25:00	33.75 N	118.08 W	C	37	.0	4.4
03-31-1933	10:49:00	33.75 N	118.08 W	C	37	.0	4.1
04-01-1933	06:42:00	33.75 N	118.08 W	C	37	.0	4.2
04-02-1933	08:00:00	33.75 N	118.08 W	C	37	.0	4.0
04-02-1933	15:36:00	33.75 N	118.08 W	C	37	.0	4.0
05-16-1933	20:58:55	33.75 N	118.17 W	C	35	.0	4.0
08-04-1933	04:17:48	33.75 N	118.18 W	C	35	.0	4.0
10-02-1933	09:10:18	33.78 N	118.13 W	A	33	.0	5.4
10-02-1933	13:26:01	33.62 N	118.02 W	C	53	.0	4.0
10-25-1933	07:00:46	33.95 N	118.13 W	C	16	.0	4.3
11-13-1933	21:28:00	33.87 N	118.20 W	C	21	.0	4.0
11-20-1933	10:32:00	33.78 N	118.13 W	B	33	.0	4.0
01-09-1934	14:10:00	34.10 N	117.68 W	A	52	.0	4.5

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
01-18-1934	02:14:00	34.10 N	117.68 W	A	52	.0	4.0
01-20-1934	21:17:00	33.62 N	118.12 W	B	50	.0	4.5
04-17-1934	18:33:00	33.57 N	117.98 W	C	59	.0	4.0
10-17-1934	09:38:00	33.63 N	118.40 W	B	50	.0	4.0
11-16-1934	21:26:00	33.75 N	118.00 W	B	41	.0	4.0
06-11-1935	18:10:00	34.72 N	118.97 W	B	100	.0	4.0
06-19-1935	11:17:00	33.72 N	117.52 W	B	76	.0	4.0
07-13-1935	10:54:17	34.20 N	117.90 W	A	35	.0	4.7
09-03-1935	06:47:00	34.03 N	117.32 W	B	85	.0	4.5
12-25-1935	17:15:00	33.60 N	118.02 W	B	55	.0	4.5
02-23-1936	22:20:43	34.13 N	117.34 W	A	83	.0	4.5
02-26-1936	09:33:28	34.14 N	117.34 W	A	84	.0	4.0
08-22-1936	05:21:00	33.77 N	117.82 W	B	50	.0	4.0
10-29-1936	22:35:36	34.38 N	118.62 W	C	50	.0	4.0
01-15-1937	18:35:47	33.56 N	118.06 W	B	58	.0	4.0
03-19-1937	01:23:38	34.11 N	117.43 W	A	75	.0	4.0
07-07-1937	11:12:00	33.57 N	117.98 W	B	59	.0	4.0
09-01-1937	13:48:08	34.21 N	117.53 W	A	68	.0	4.5
09-01-1937	16:35:34	34.18 N	117.55 W	A	65	.0	4.5
05-21-1938	09:44:00	33.62 N	118.03 W	B	53	.0	4.0
05-31-1938	08:34:55	33.70 N	117.51 W	B	78	.0	5.5
07-05-1938	18:06:56	33.68 N	117.55 W	A	76	.0	4.5
08-06-1938	22:00:56	33.72 N	117.51 W	B	77	.0	4.0
08-31-1938	03:18:14	33.76 N	118.25 W	A	33	.0	4.5
11-29-1938	19:21:16	33.90 N	118.43 W	A	25	.0	4.0
12-07-1938	03:38:00	34.00 N	118.42 W	B	18	.0	4.0
12-27-1938	10:09:29	34.13 N	117.52 W	B	67	.0	4.0
04-03-1939	02:50:45	34.04 N	117.23 W	A	93	.0	4.0
11-04-1939	21:41:00	33.77 N	118.12 W	B	34	.0	4.0
11-07-1939	18:52:08	34.00 N	117.28 W	A	89	.0	4.7
12-27-1939	19:28:49	33.78 N	118.20 W	A	31	.0	4.7
01-13-1940	07:49:07	33.78 N	118.13 W	B	33	.0	4.0
02-08-1940	16:56:17	33.70 N	118.07 W	B	43	.0	4.0
02-11-1940	19:24:10	33.98 N	118.30 W	B	10	.0	4.0
04-18-1940	18:43:44	34.03 N	117.35 W	A	82	.0	4.4
05-18-1940	09:15:12	34.60 N	118.90 W	C	85	.0	4.0
06-05-1940	08:27:27	33.83 N	117.40 W	B	82	.0	4.0
07-20-1940	04:01:13	33.70 N	118.07 W	B	43	.0	4.0
10-11-1940	05:57:12	33.77 N	118.45 W	A	38	.0	4.7
10-12-1940	00:24:00	33.78 N	118.42 W	B	35	.0	4.0
10-14-1940	20:51:11	33.78 N	118.42 W	B	35	.0	4.0
11-01-1940	07:25:03	33.78 N	118.42 W	B	35	.0	4.0
11-01-1940	20:00:46	33.63 N	118.20 W	B	48	.0	4.0
11-02-1940	02:58:26	33.78 N	118.42 W	B	35	.0	4.0
01-30-1941	01:34:47	33.97 N	118.05 W	A	20	.0	4.1

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
03-22-1941	08:22:40	33.52 N	118.10 W	B	61	.0	4.0
03-25-1941	23:43:41	34.22 N	117.47 W	B	73	.0	4.0
04-11-1941	01:20:24	33.95 N	117.58 W	B	62	.0	4.0
10-22-1941	06:57:19	33.82 N	118.22 W	A	27	.0	4.9
11-14-1941	08:41:36	33.78 N	118.25 W	A	31	.0	5.4
04-16-1942	07:28:33	33.37 N	118.15 W	C	77	.0	4.0
09-03-1942	14:06:01	34.48 N	118.98 W	C	83	.0	4.5
09-04-1942	06:34:33	34.48 N	118.98 W	C	83	.0	4.5
04-06-1943	22:36:24	34.68 N	119.00 W	C	98	.0	4.0
10-24-1943	00:29:21	33.93 N	117.37 W	C	82	.0	4.0
06-19-1944	00:03:33	33.87 N	118.22 W	B	21	.0	4.5
06-19-1944	03:06:07	33.87 N	118.22 W	C	21	.0	4.4
02-24-1946	06:07:52	34.40 N	117.80 W	C	55	.0	4.1
06-01-1946	11:06:31	34.42 N	118.83 W	C	68	.0	4.1
03-01-1948	08:12:13	34.17 N	117.53 W	B	67	.0	4.7
04-16-1948	22:26:24	34.02 N	118.97 W	B	68	.0	4.7
10-03-1948	02:46:28	34.18 N	117.58 W	A	62	.0	4.0
01-11-1950	21:41:35	33.94 N	118.20 W	A	14	.0	4.1
01-24-1950	21:56:59	34.67 N	118.83 W	C	87	.0	4.0
02-26-1950	00:06:22	34.62 N	119.08 W	C	99	.0	4.7
09-22-1951	08:22:39	34.12 N	117.34 W	A	83	.0	4.3
02-17-1952	12:36:58	34.00 N	117.27 W	A	90	.0	4.5
08-23-1952	10:09:07	34.52 N	118.20 W	A	51	.0	5.0
10-26-1954	16:22:26	33.73 N	117.47 W	B	80	.0	4.1
11-17-1954	23:03:51	34.50 N	119.12 W	B	95	.0	4.4
05-15-1955	17:03:26	34.12 N	117.48 W	A	70	.0	4.0
05-29-1955	16:43:35	33.99 N	119.06 W	B	76	.0	4.1
01-03-1956	00:25:49	33.72 N	117.50 W	B	78	.0	4.7
02-07-1956	02:16:57	34.53 N	118.64 W	B	64	.0	4.2
02-07-1956	03:16:39	34.59 N	118.61 W	A	68	.0	4.6
03-25-1956	03:32:02	33.60 N	119.10 W	A	94	.0	4.2
03-18-1957	18:56:28	34.12 N	119.22 W	B	91	.0	4.7
06-28-1960	20:00:48	34.12 N	117.47 W	A	71	.0	4.1
10-04-1961	02:21:32	33.85 N	117.75 W	B	51	.0	4.1
10-20-1961	19:49:51	33.65 N	117.99 W	B	51	.0	4.3
10-20-1961	20:07:14	33.66 N	117.98 W	B	50	.0	4.0
10-20-1961	21:42:41	33.67 N	117.98 W	B	49	.0	4.0
10-20-1961	22:35:34	33.67 N	118.01 W	B	48	.0	4.1
11-20-1961	08:53:35	33.68 N	117.99 W	B	48	.0	4.0
09-14-1963	03:51:16	33.54 N	118.34 W	B	58	.0	4.2
08-30-1964	22:57:37	34.27 N	118.44 W	B	30	.0	4.0
01-01-1965	08:04:18	34.14 N	117.52 W	B	67	.0	4.4
04-15-1965	20:08:33	34.13 N	117.43 W	B	75	.0	4.5
07-16-1965	07:46:22	34.48 N	118.52 W	B	53	.0	4.0
01-08-1967	07:37:30	33.63 N	118.47 W	B	52	.0	4.0

DATE	TIME	LATITUDE	LONGITUDE		Q	DIST	DEPTH	MAGNITUDE
01-08-1967	07:38:05	33.66 N	118.41	W	C	47	.0	4.0
06-15-1967	04:58:06	34.00 N	117.97	W	B	26	.0	4.1
02-28-1969	04:56:12	34.57 N	118.11	W	A	58	.0	4.3
05-05-1969	16:02:10	34.30 N	117.57	W	B	67	.0	4.4
10-27-1969	13:16:02	33.55 N	117.81	W	B	69	.0	4.5
09-12-1970	14:10:11	34.27 N	117.52	W	A	70	.0	4.1
09-12-1970	14:30:53	34.27 N	117.54	W	A	69	.0	5.4
09-13-1970	04:47:49	34.28 N	117.55	W	A	68	.0	4.4
02-09-1971	14:00:42	34.41 N	118.40	W	B	42	.0	6.4
02-09-1971	14:01:08	34.41 N	118.40	W	D	42	.0	5.8
02-09-1971	14:01:33	34.41 N	118.40	W	D	42	.0	4.2
02-09-1971	14:01:40	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:01:50	34.41 N	118.40	W	D	42	.0	4.5
02-09-1971	14:01:54	34.41 N	118.40	W	D	42	.0	4.2
02-09-1971	14:01:59	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:02:03	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:02:30	34.41 N	118.40	W	D	42	.0	4.3
02-09-1971	14:02:31	34.41 N	118.40	W	D	42	.0	4.7
02-09-1971	14:02:44	34.41 N	118.40	W	D	42	.0	5.8
02-09-1971	14:03:25	34.41 N	118.40	W	D	42	.0	4.4
02-09-1971	14:03:46	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:04:07	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:04:34	34.41 N	118.40	W	C	42	.0	4.2
02-09-1971	14:04:39	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:04:44	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:04:46	34.41 N	118.40	W	D	42	.0	4.2
02-09-1971	14:05:41	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:05:50	34.41 N	118.40	W	D	42	.0	4.1
02-09-1971	14:07:10	34.41 N	118.40	W	D	42	.0	4.0
02-09-1971	14:07:30	34.41 N	118.40	W	D	42	.0	4.0
02-09-1971	14:07:45	34.41 N	118.40	W	D	42	.0	4.5
02-09-1971	14:08:04	34.41 N	118.40	W	D	42	.0	4.0
02-09-1971	14:08:07	34.41 N	118.40	W	D	42	.0	4.2
02-09-1971	14:08:38	34.41 N	118.40	W	D	42	.0	4.5
02-09-1971	14:08:53	34.41 N	118.40	W	D	42	.0	4.6
02-09-1971	14:10:21	34.36 N	118.31	W	B	34	.0	4.7
02-09-1971	14:10:28	34.41 N	118.40	W	D	42	.0	5.3
02-09-1971	14:16:13	34.34 N	118.33	W	C	32	.0	4.1
02-09-1971	14:19:50	34.36 N	118.41	W	B	37	.0	4.0
02-09-1971	14:34:36	34.34 N	118.64	W	C	48	.0	4.9
02-09-1971	14:39:18	34.39 N	118.36	W	C	38	.0	4.0
02-09-1971	14:40:17	34.43 N	118.40	W	C	44	.0	4.1
02-09-1971	14:43:47	34.31 N	118.45	W	B	34	.0	5.2
02-09-1971	15:58:21	34.33 N	118.33	W	B	31	.0	4.8
02-09-1971	16:19:26	34.46 N	118.43	W	B	48	.0	4.2

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
02-10-1971	03:12:12	34.37 N	118.30 W	B	35	.0	4.0
02-10-1971	05:06:36	34.41 N	118.33 W	A	40	.0	4.3
02-10-1971	05:18:07	34.43 N	118.41 W	A	44	.0	4.5
02-10-1971	11:31:35	34.38 N	118.45 W	A	40	.0	4.2
02-10-1971	13:49:54	34.40 N	118.42 W	A	41	.0	4.3
02-10-1971	14:35:27	34.36 N	118.49 W	A	40	.0	4.2
02-10-1971	17:38:55	34.40 N	118.37 W	A	40	.0	4.2
02-10-1971	18:54:42	34.45 N	118.44 W	A	47	.0	4.2
02-21-1971	05:50:53	34.40 N	118.44 W	A	42	.0	4.7
02-21-1971	07:15:12	34.39 N	118.43 W	A	41	.0	4.5
03-07-1971	01:33:41	34.35 N	118.46 W	A	38	.0	4.5
03-25-1971	22:54:10	34.36 N	118.47 W	A	39	.0	4.2
03-30-1971	08:54:43	34.30 N	118.46 W	A	33	.0	4.1
03-31-1971	14:52:23	34.29 N	118.51 W	A	36	.0	4.6
04-01-1971	15:03:04	34.43 N	118.41 W	A	44	.0	4.1
04-02-1971	05:40:25	34.28 N	118.53 W	A	36	.0	4.0
04-15-1971	11:14:32	34.26 N	118.58 W	B	38	.0	4.2
04-25-1971	14:48:07	34.37 N	118.31 W	B	35	.0	4.0
06-21-1971	16:01:08	34.27 N	118.53 W	B	35	.0	4.0
06-22-1971	10:41:19	33.75 N	117.48 W	B	78	.0	4.2
02-21-1973	14:45:57	34.06 N	119.03 W	B	73	.0	5.9
03-09-1974	00:54:32	34.40 N	118.47 W	C	43	.0	4.7
08-14-1974	14:45:55	34.43 N	118.37 W	A	43	.0	4.2
01-01-1976	17:20:13	33.96 N	117.89 W	A	34	.0	4.2
04-08-1976	15:21:38	34.35 N	118.66 W	A	50	.0	4.6
08-12-1977	02:19:26	34.38 N	118.46 W	B	41	.0	4.5
09-24-1977	21:28:24	34.46 N	118.41 W	C	47	.0	4.2
05-23-1978	09:16:51	33.91 N	119.17 W	C	87	.0	4.0
01-01-1979	23:14:39	33.94 N	118.68 W	B	43	.0	5.0
10-17-1979	20:52:37	33.93 N	118.67 W	C	42	.0	4.2
10-19-1979	12:22:38	34.21 N	117.53 W	B	68	.0	4.1
09-04-1981	15:50:50	33.66 N	119.10 W	C	91	6.0	5.3
10-23-1981	17:28:17	33.64 N	119.01 W	C	85	6.0	4.6
10-23-1981	19:15:52	33.62 N	119.02 W	A	87	14.8	4.6
04-13-1982	11:02:12	34.05 N	118.96 W	A	66	16.6	4.0
05-25-1982	13:44:30	33.54 N	118.21 W	A	58	13.7	4.1
01-08-1983	07:19:30	34.14 N	117.45 W	A	73	4.6	4.1
06-12-1984	00:27:52	34.54 N	118.99 W	A	87	11.7	4.1
10-26-1984	17:20:44	34.02 N	118.99 W	A	69	13.3	4.6
10-02-1985	23:44:12	34.02 N	117.25 W	A	92	15.2	4.8
10-01-1987	14:42:20	34.06 N	118.08 W	A	15	9.5	5.9
10-01-1987	14:45:41	34.05 N	118.10 W	A	13	13.6	4.7
10-01-1987	14:48:03	34.08 N	118.09 W	A	14	11.7	4.1
10-01-1987	14:49:06	34.06 N	118.10 W	A	13	11.7	4.7
10-01-1987	15:12:32	34.05 N	118.09 W	A	14	10.8	4.7

DATE	TIME	LATITUDE	LONGITUDE		Q	DIST	DEPTH	MAGNITUDE
10-04-1987	10:59:38	34.07 N	118.10	W	A	13	8.3	5.3
10-24-1987	23:58:33	33.68 N	119.06	W	A	87	12.2	4.1
02-11-1988	15:25:56	34.08 N	118.05	W	A	18	12.5	4.7
06-26-1988	15:04:58	34.14 N	117.71	W	A	50	7.9	4.7
11-20-1988	05:39:29	33.51 N	118.07	W	C	63	6.0	4.9
12-03-1988	11:38:26	34.15 N	118.13	W	A	14	13.3	4.9
01-19-1989	06:53:29	33.92 N	118.63	W	A	39	11.9	5.0
02-18-1989	07:17:05	34.01 N	117.74	W	A	46	3.3	4.1
04-07-1989	20:07:30	33.62 N	117.90	W	A	58	12.9	4.7
06-12-1989	16:57:18	34.03 N	118.18	W	A	6	15.6	4.6
06-12-1989	17:22:26	34.02 N	118.18	W	A	7	15.5	4.4
12-28-1989	09:41:08	34.19 N	117.39	W	A	80	14.6	4.3
02-28-1990	23:43:37	34.14 N	117.70	W	A	51	5.3	5.2
03-01-1990	00:34:57	34.13 N	117.70	W	A	50	4.4	4.0
03-01-1990	03:23:03	34.15 N	117.72	W	A	49	11.4	4.7
03-02-1990	17:26:25	34.15 N	117.69	W	A	52	5.6	4.7
04-17-1990	22:32:27	34.11 N	117.72	W	A	48	3.6	4.8
06-28-1991	14:43:55	34.26 N	118.00	W	A	31	10.5	5.4
06-28-1991	17:00:56	34.25 N	117.99	W	A	31	9.5	4.3
07-05-1991	17:41:57	34.50 N	118.56	W	A	57	10.9	4.1

S E A R C H   O F   E A R T H Q U A K E   D A T A   F I L E   1

SITE: Alameda District Corridor, 2663.50161.0001

COORDINATES OF SITE	34.06 N 118.24 W
DISTANCE PER DEGREE	110.9 KM-N 92.3 KM-W
MAGNITUDE LIMITS	4.0 - 8.5
TEMPORAL LIMITS	1932 - 1992
SEARCH RADIUS (KM)	100
NUMBER OF YEARS OF DATA	61
NUMBER OF EARTHQUAKES IN FILE	3084
NUMBER OF EARTHQUAKES IN AREA	325

L A W / C R A N D A L L , I N C .

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 6.0 OR
GREATER WITHIN 100 KM OF THE SITE
(RICHTER DATA 1906-1931)

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
05-15-1910	15:47:00	33.70 N	117.40 W	D	87	.0	6.0
07-23-1923	07:30:26	34.00 N	117.25 W	D	92	.0	6.3

S E A R C H   O F   E A R T H Q U A K E   D A T A   F I L E 2

SITE: Alameda District Corridor, 2663.50161.0001

COORDINATES OF SITE .... 34.06 N 118.24 W

DISTANCE PER DEGREE ..... 110.9 KM-N 92.3 KM-W

MAGNITUDE LIMITS .... 6.0 - 8.5

TEMPORAL LIMITS .... 1906 - 1931

SEARCH RADIUS (KM) 100

NUMBER OF YEARS OF DATA 26

NUMBER OF EARTHQUAKES IN FILE 35

NUMBER OF EARTHQUAKES IN AREA 2

L A W / C R A N D A L L , I N C .

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 7.0 OR
GREATER WITHIN 100 KM OF THE SITE
(NOAA/CDMG DATA 1812-1905)

DATE	TIME	LATITUDE	LONGITUDE	Q	DIST	DEPTH	MAGNITUDE
02-09-1890	04:06:00	34.00 N	117.50 W	D	69	.0	7.0

S E A R C H   O F   E A R T H Q U A K E   D A T A   F I L E 3

SITE: Alameda District Corridor, 2663.50161.0001

COORDINATES OF SITE	34.06 N 118.24 W
DISTANCE PER DEGREE	110.9 KM-N 92.3 KM-W
MAGNITUDE LIMITS	7.0 - 8.5
TEMPORAL LIMITS	1812 - 1905
SEARCH RADIUS (KM)	100
NUMBER OF YEARS OF DATA	94
NUMBER OF EARTHQUAKES IN FILE	9
NUMBER OF EARTHQUAKES IN AREA	1

L A W / C R A N D A L L , I N C .

S U M M A R Y   O F   E A R T H Q U A K E   S E A R C H

* * *

NUMBER OF HISTORIC EARTHQUAKES WITHIN 100 KM RADIUS OF SITE

MAGNITUDE RANGE	NUMBER
4.0 - 4.5	217
4.5 - 5.0	78
5.0 - 5.5	22
5.5 - 6.0	6
6.0 - 6.5	4
6.5 - 7.0	0
7.0 - 7.5	1
7.5 - 8.0	0
8.0 - 8.5	0

* * *

L A W / C R A N D A L L , I N C .

C O M P U T A T I O N   O F   R E C U R R E N C E   C U R V E

L O G   N = A - B M

* * *

BIN	MAGNITUDE	RANGE	NO/YR (N)
1	4.00	4.00 - 8.50	5.35
2	4.50	4.50 - 8.50	1.79
3	5.00	5.00 - 8.50	.511
4	5.50	5.50 - 8.50	.150
5	6.00	6.00 - 8.50	.515E-01
6	6.50	6.50 - 8.50	.552E-02 NU
7	7.00	7.00 - 8.50	.552E-02 NU
8	7.50	7.50 - 8.50	.000
9	8.00	8.00 - 8.50	.000

A = 1.125   B = .5632   (NORMALIZED)
A = 4.825   B = 1.0219   SIGMA = .258E-01

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L A W / C R A N D A L L , I N C .

C O M P U T A T I O N   O F   D E S I G N   M A G N I T U D E

C O N S T A N T   A R E A

* * *

TABLE OF DESIGN MAGNITUDES

RISK		RETURN PERIOD (YEARS)					DESIGN MAGNITUDE			
		DESIGN LIFE (YEARS)								
		25	50	75	100		25	50	75	100
.01	..	2487	4974	7462	9949	..	7.92	8.12	8.21	8.27
.05	..	487	974	1462	1949	..	7.32	7.59	7.74	7.84
.10	..	237	474	711	949	..	7.03	7.31	7.47	7.58
.20	..	112	224	336	448	..	6.72	7.01	7.17	7.29
.30	..	70	140	210	280	..	6.52	6.81	6.98	7.10
.50	..	36	72	108	144	..	6.24	6.54	6.71	6.83
.70	..	20	41	62	83	..	6.01	6.30	6.47	6.59
.90	..	10	21	32	43	..	5.73	6.03	6.20	6.32

MMIN = 4.00 MMAX = 8.50
MU = 5.46 BETA = 2.353

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L A W / C R A N D A L L , I N C .