CULVER CITY SEISMIC SAFETY

THE SEISMIC SAFETY ELEMENT OF THE REVISED GENERAL PLAN

MAY 1974

Planning Division
Culver City, California

1/14/77-100

RESOLUTION NO. CS-7008

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF CULVER CITY, CALIFORNIA, ADOPTING THE SEISMIC SAFETY ELEMENT OF THE REVISED GENERAL PLAN OF THE CITY OF CULVER CITY, 1973.

WHEREAS, the Planning Commission of the City of Culver City has conducted duly noticed public hearings as required by law on the proposed Seismic Safety Element of the Revised General Plan and the Negative Environmental Impact Declaration relating thereto; and

WHEREAS, the Planning Commission by its Resolution No. 1198 has recommended to the City Council the adoption of the Seismic Safety Element of the Revised General Plan; and

WHEREAS, the City Council of the City of Culver City on April 22, 1974, conducted a public hearing as required by law on the Seismic Safety Element of the Revised General Plan and the Negative Environmental Impact Declaration relating thereto,

NOW, THEREFORE, the City Council of the City of Culver City, California, DOES HEREBY RESOLVE as follows:

1. That the Seismic Safety Element of the Revised General Plan of the City of Culver City, 1973, as recommended by Planning Commission Resolution No. 1198 is hereby adopted by reference as though set forth herein in its entirety,

2. That a copy of the Seismic Safety Element of the Revised General Plan of the City of Culver City, 1973, is on file in the offices of the City Clerk and the Planning Division and may be inspected in either of said offices.

APPROVED and ADOPTED this 13th day of May, 1974.

[signature]
DR. JAMES D. BOULGARIDES
MAYOR
City of Culver City, California

ATTEST:

AGNES V. CHRISTENSEN
City Clerk
By: [signature] Deputy City Clerk

APPROVED AS TO FORM:

[signature]
EUGENE L. DAVIS
Acting City Attorney

dfs
4/25/74

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John Carl Brogdon, Mayor Pro Tem
James Astle, Jr., Councilman
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DIVISION OF PLANNING AND COMMUNITY DEVELOPMENT

PLANNING DIVISION

William Phelps, Director
Susan Berg, City Planner
Jay Cunningham, Associate Planner

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BEACH LEIGHTON STUDY

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INTRODUCTION

Section 65302(f) of the Government Code of the State of California requires a General Plan to include, "A Seismic Safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to the effects of seismically induced waves such as tsunamis and seiche. The seismic safety element shall also include an appraisal of mudslides, landslides, and slope stability as necessary geologic hazards that must be considered simultaneously with other hazards such as possible surface ruptures from faulting, ground shaking, ground failure and seismically induced waves."

The technical and very specialized scientific nature of the information necessary to comprise a seismic safety element is such that the services of a geologic professional were necessary in order that this element be accurate and meaningful in terms of complying with the intent of above mentioned state requirements. Consequently, in the fall of 1971, the City contracted with F. Beach Leighton & Associates, Inc., an engineering and geology firm, for the preparation of a Seismic Study and Report of the Culver City Planning Area (see map, page 3).

The study and report were conducted and prepared under the general supervision of the Planning Director as required under Sections 37-124, 125, and 126 of the Culver City Municipal Code. This was achieved through numerous telephone conversations and discussions at meetings between representatives of Beach Leighton and the Culver City Planning Division. These conversations and discussions normally involved directional and supervisory input from staff and explanations of scientific matters in layman's terms on the part of the geologists. As a result, the completed report, presented to the City in the spring of 1972, was prepared in such a manner so as to be virtually ready for adoption as the Seismic Safety Element of the General Plan in terms of its contents either meeting or exceeding applicable State government Code requirements.

Prior to submission of the final report, Dr. Leighton gave a progress report to the Planning Commission on the seismic study (March, 1972). However, this introductory report did not involve Planning Commission consideration of the matter in terms of arriving at a recommendation to Council regarding its adoption as a Revised General Plan Element. Such consideration, and subsequent recommendation, can only be reached through the public hearing process. Even though there will have lapsed almost two years between submission of the report to the City and its consideration during the public hearing process, a review of the geologic and seismic material contained therein reveals that it is as accurate and up to date now as it was when compiled in 1972.

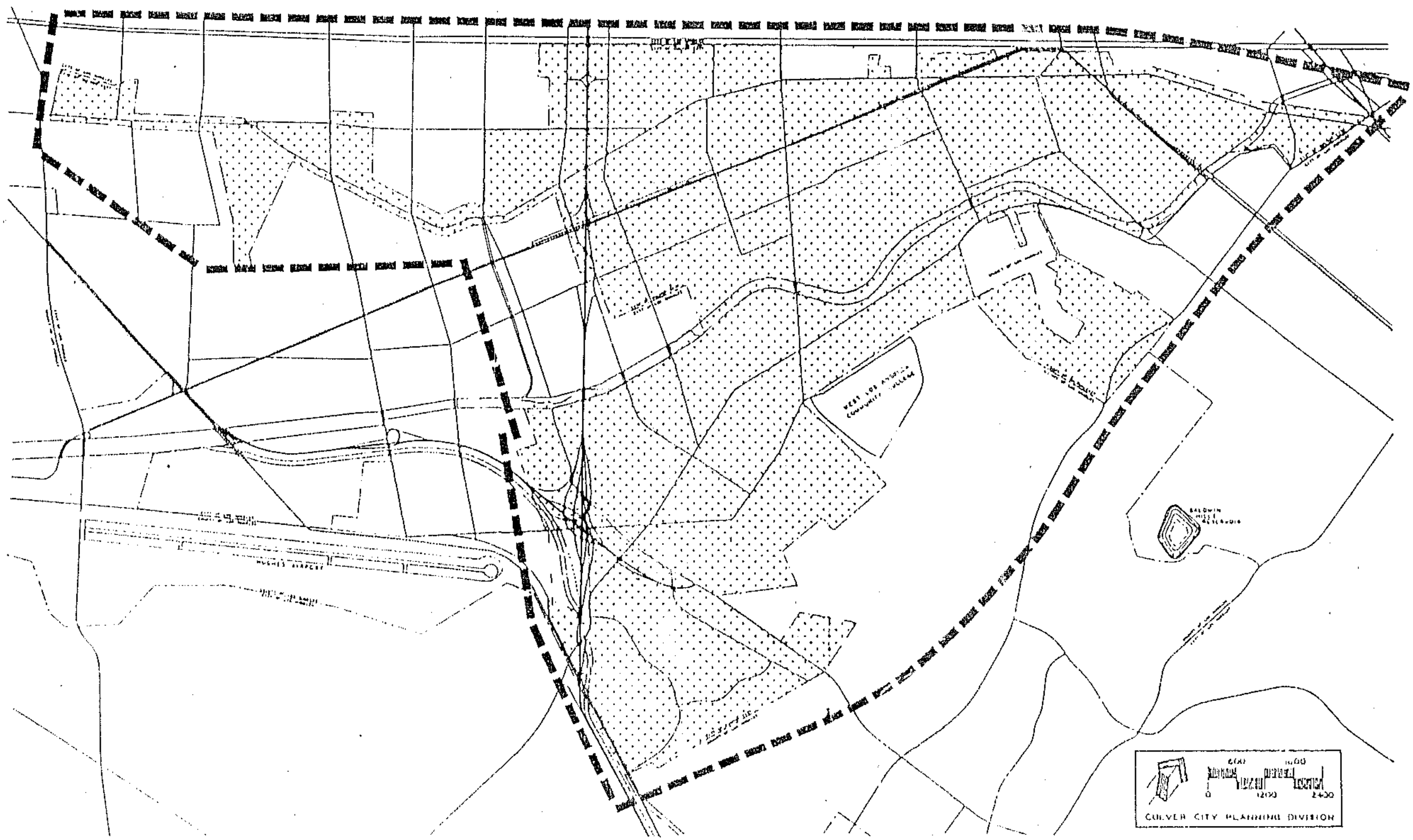
Staff review of this Geologic-Seismic Report, which report constitutes the scientific data portion of the Seismic Safety Element, resulted in a determination that its adoption and implementation would have no significant adverse environmental impact. Consequently, a Negative Declaration for this project was prepared and filed with the Los Angeles County Recorder in accordance with the requirements of the CEQA of 1970. A copy of the recorded document has been attached following this section, and thereby becomes a part of this document.

It should also be mentioned here that emergency preparedness, response, and recovery plans, which some sources feel should constitute a part of a community's Seismic Safety Element, have not been specifically included herein because it is believed they can more appropriately be dealt with in Culver City's future Public Safety Element of the Revised General Plan.

In March, 1973, the City adopted its Revised General Plan, consisting of Land Use, Circulation, Housing and Conservation Elements. Three months later the City adopted its Open Space Element, and three months thereafter the City adopted its revised Recreation Element. The Seismic Safety Element contained herein is correlated to the adopted General Elements of the City, and in turn will, following adoption, become part of the basic material to which the remaining general plan elements will be coordinated.

Finally, as a general statement of policy, it should be made clear that the primary intent and purpose of adopting a Seismic Safety Element into Culver City's General Plan, aside from complying with State Laws relative thereto, is to reduce as much as possible, given the present state of technology, the harmful effects to life and property which can result from geologic, seismic, and/or tectonic occurrences within the Culver City Planning Area. To achieve this end, active implementation of the policies and guidelines set forth in the Seismic Safety Element is imperative.

Culver City Planning Area



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CITY OF CULVER CITY

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DOCUMENT FILED
LOS ANGELES COUNTY
JAN 23 1974
OFFICE OF COUNTY CLERK
CORPORATION DIV

te: January 9, 1974

unty Clerk
rporations Division -- Room 106
st Office Box 151
s Angeles, California 90053

RE: NEGATIVE DECLARATION
For: Seismic Safety Element of the Revised General (project) Plan, File No. 006.PL-902.

ntlemen:

accordance with the requirements of Section 65302(f) of the Government le of the State of California, the City of Culver City has prepared a smic Safety Element for adoption as an additional element to its Revised eral Plan.

project is briefly described as:

ocument, to be adopted by resolution of the City Council, which is rised of scientifically meaningful yet readily understandable geologic eismic information on the Culver City Planning area, which information to be utilized primarily through application to future public and private elopments within said area in terms of the land use decision-making cess, and through future adoption of new, and/or amendments to existing, tinent provisions in the Municipal Code.

accordance with the authority and criteria contained in the California ironmental Quality Act, State Guidelines, and Culver City Guidelines the Implementation of the California Environmental Quality Act, the sion of Planning and Community Development of the City of Culver City lyzed the project and determined that the project will not have a signi- ant impact on the environment. Based on this finding the Division pre- ed and hereby files this NEGATIVE DECLARATION.

eriod of ten (10) working days from the date of filing of this NEGATIVE ARATION will be provided to enable public review of the project speci- tions and this document prior to action on the project by the City of er City. A copy of the project specifications is on file in the Offices he Division of Planning and Community Development, City Hall, Culver City.

document is being filed in duplicate. Please acknowledge filing date return the acknowledged copy in the enclosed stamped self-addressed en- p.

red and filed by:
Division of Planning and Community Development

Jay B. Cunningham, Associate Planner

PURPOSE AND SCOPE OF INVESTIGATION

This report presents an analysis of seismic and terrain parameters as related directly to future land planning in the City of Culver City. Guidelines have been developed for each of the following contract items: (1) building and grading codes, (2) municipal projects, such as new road alignments, water storage tank sites and recreation areas, (3) type and scope of geologic-soils reports to be required of private consultants for City review, (4) review of construction and grading plans received by the City for potentially problematic areas, (5) review of land use variances where geologic-soils hazards might be involved, (6) preparation of storm damage and other reports related to geologic hazards, and (7) legal matters involving the City and geology-soils.

The following steps have been taken in this investigation:

1. Review of all available geologic-soils data.
2. Stereoscopic examination of aerial photos covering each decade from 1928 in order to decipher man-made changes in terrain conditions.
3. Field reconnaissance surveys of pertinent and problematic areas.
4. Preparation of maps and tables showing the known seismic, geologic and soils conditions pertinent to future land use planning.
5. Analysis of geologic-soils parameters in light of existing codes and regulations.
6. Development of guidelines for future geologic-soils work in the City.

This study has resulted in certain findings, conclusions, and recommendations as enumerated hereinbelow.

Three major geologic-seismic risks exist within the study area of Culver City: (1) potential future fault movements, (2) the probability of continued significant subsidence in the Baldwin Hills, and (3) instability resulting from development of hillside areas, particularly those coincident with the Inglewood Oil Field.

The potential is high for future earthquakes along the Newport-Inglewood Zone. Within the next 50 years it is likely that an earthquake with a Richter Magnitude of 6.0 to 7.0 will occur along this zone. Fault rupture within five miles of Culver City is expected to produce ground accelerations of up to 0.4g.

The other most likely earthquake source would be the San Andreas Fault Zone, 45 miles away at its closest point. Ground accelerations of 0.2g. to 0.35g. should be expected from this source with the duration of shaking of about one minute.

Recent studies based on Los Angeles County and City survey data show that subsidence movements are concentrated in an elliptically shaped subsidence bowl which generally coincides with the outline of the Inglewood Oil Field. Areas containing subsidence rates within the critical area range of .05 to .20 feet per year are shown on two newly-prepared subsidence maps.

Subsidence has been attributed to (1) oil production (withdrawal of fluids and consequent decrease in pressure), and/or (2) water injection (with consequent increase in pressure). This subsidence is anticipated to continue in the near future at about the same rate as it has over the last 10 years, producing possible surface cracks and shallow displacement on known faults within the planning area. However, continued water injection in the Inglewood Oil Field may slow the rate in the future, as has been demonstrated by injection in the Wilmington Oil Field.

Hillside areas are divided into two major geologic zones based on the number and types of constraints to future development. Major restraints in these areas are (1) steep natural and man-made slopes, (2) active subsidence, (3) proximity to the Inglewood Fault, (4) oil field operations, and (5) potentially expansive soil.

Six different geologic zones within the planning area have been designated on the geologic-seismic summary map. The map is accompanied by a table listing these six zones with recommended type of geologic-soils investigations needed, including the problems requiring special emphasis.

TERRAIN CONDITIONS

Topographic Setting

The City consists of an old floodplain and a portion of the Baldwin Hills. The central lowland portion occupies the floodplain of an ancestral westward flowing Los Angeles River, now known as Ballona Creek. This plain slopes gently upward to the north and northeast and is bounded on the south by stream cut bluffs. The narrowest section of the floodplain lies between the Baldwin Hills and Beverly Hills and is referred to as Ballona Gap. At Ballona Gap the floodplain is underlain by up to 80 feet of recent alluvial deposits. This thickness decreases downstream to the southwest, being approximately 50 feet thick near the coast.

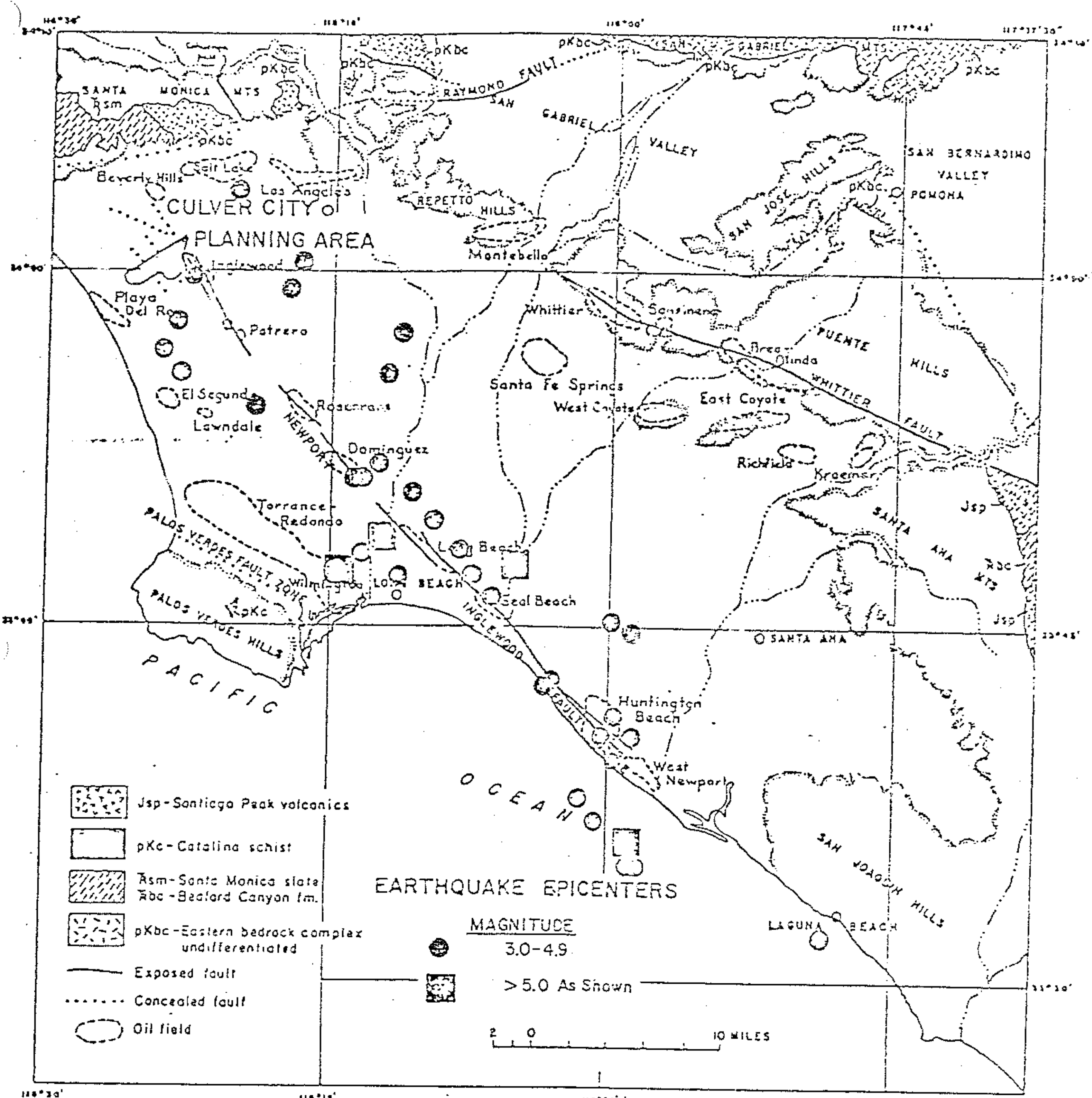
The Baldwin Hills include the southeastern portion of the planning area. As a zone of discontinuous low hills, its continuation extends from the Santa Monica Mountains southeastward to just north of Newport Beach. The hills are the result of geologically recent deformation along the Newport-Inglewood zone, a geologic structural feature composed of faults and folds that control associated oil fields (see Index Map, Fig. 1).

The most rugged and steep portion, designated Zone "C" on the Geologic-Seismic Summary Map, includes a major portion of the Inglewood Oil Field. This area has been highly modified over the years by construction of well and tank pads, access roads, treatment plants and oil, water and waste sumps. Coincident with the general limits of oil production is an area experiencing ground subsidence at a continuing rate of from .05 to .20 feet per year (see section entitled "Subsidence"). The combination of the steep slopes, cut, fill and sump operations of the oil field and land subsidence make this area highly problematic with relation to future development irrespective of other underlying geologic conditions.

The southwestern portion of the hills that lies within the planning area, designated Zone "D", exhibits much gentler slopes and is predominantly outside of the oil field and major area of ground subsidence. From a terrain point of view, this area is much better suited to development than Zone "C".

Surface Runoff - Flood Control

The planning area is drained by the main Ballona Creek flood control channel and its two major contributories, Centinela Creek Channel and Sawtelle-Westwood Storm Drain Channel. All three are improved concrete channels and appear to afford the City adequate major flood facilities. Future development in the hills lying southeast of Ballona Creek and east of Centinela Creek will not add appreciably to the runoff in this area, but continued surveillance of new flood facilities by the City will be necessary in this area.



Index map of the Los Angeles basin showing approximate location of earthquake epicenters along the Newport-Inglewood Zone, 1933-1970 (Base Map after Woodford, et al - 1954) Data from Table II

GENERAL GEOLOGY

The Newport-Inglewood zone of deformation is responsible for the formation of the Baldwin Hills in geologically recent times and remains a zone of potentially active geologic and seismic processes. The youthfulness of this structure is exemplified by (1) the young age of sedimentary rocks involved in the deformation, (2) observed regional and local changes in surface elevation along and across the zone, and (3) the abundance of earthquake epicenters over the last 40± years that appear to be closely associated with this zone at depth (see section on "Seismicity").

The geology of the Baldwin Hills has been mapped in detail by R. O. Castle for the U.S.G.S. (1959). A copy of the open file map has been furnished by Culver City and has been reproduced for this report at the scale of 1"= 800' (see Appendix VII). Within the Baldwin Hills several major faults and numerous smaller faults have been mapped by Castle. The Inglewood Fault represents the major fault within the planning area. It is well exposed in the hills and trends northward across the Ballona Gap area. Two other faults which may be associated with the Newport-Inglewood Zone are buried under the recent floodplain alluvium and have been mapped by discontinuities in the ground-water regime (Poland, et al, 1959). These faults are shown on the Geologic-Seismic Summary Map (Appendix VIII) and are discussed in more detail in the following section under "Faulting".

The hills and related upland plain to the southwest are underlain at depths ranging up to 30 feet by a surface of marine erosion developed in late Pleistocene time. This surface is covered by a thin layer of beach and near-shore sands and represents the latest position of the sea prior to its final withdrawal. Locally, surface material consisting of stream deposits and wind-blown sand covers the marine units.

The older geologic units which make up the bulk of the hills are composed of interbedded marine sandstone and siltstone of upper Pliocene and lower Pleistocene age. These units have been locally faulted and deformed during formation of the hills in late Pleistocene to recent times.

Surficial units cover the entire lowlands north and northwest of the hills. These surficial units can be divided into (1) the most recent stream deposits that underlie the floodplain surrounding Ballona Creek, and (2) the older alluvium lying at slightly higher elevations which was deposited by ancestral streams and by side drainages to Ballona Creek.

Faulting

The Inglewood Fault and associated faults of the Newport-Inglewood Zone represent the most likely faults to experience surface displacement during the next 50 years. Small surface displacement of these faults within the main subsidence area of the Baldwin Hills appears very probable if the current ate of subsidence continues. These displacements, however, would be as a irect result of continued subsidence and would not be due to deepseated ovement on the Newport-Inglewood Zone. Significant surface displacement long the Inglewood Fault due to tectonic movement associated with a possible arthquake is a possibility although no surface displacements resulting from arthquakes have been observed since significant settlement of the greater os Angeles area during at least the last 100 years.

The northern extension of the Inglewood Fault can be projected beneath he recent stream deposits in the Ballona Gap area based on (1) its established rend through the Baldwin Hills, (2) the existence of a hydraulic barrier in he water-bearing deposits of Pleistocene age underlying the recent gravels, nd (3) evidence from well logs that these sediments have been down-faulted n the east side of the fault (Poland, et al, 1959).

There is no evidence which would suggest that the recent stream gravels ave been faulted in the area of Ballona Gap; however, Mendenhall (1905) shows hat prior to development of the area and channeling of Ballona Creek, a substantial artesian area existed east of the projected trace of the Inglewood ault north of Baldwin Hills. This area also shows evidence of ponded, organcally rich, fine-grained sediments which locally approach peat bog conditions. t is possible that contemporaneous faulting or warping and sedimentation along e projected fault trace could have caused these ponding conditions.

Two other faults have been mapped across the planning area through the terpretation of well log and ground-water data (Poland, et al, 1959). These aults - the Overland and Charnock - are also buried beneath the recent alluvial ravels but appear to offset the underlying lower Pleistocene marine sediments. ey have not been mapped in the youngest marine sediments (presumably of late eistocene) in the hills and stream cut bluff south of the alluvial and floodain sediments. The lack of mappable observations of the faults may be due either: (1) poor natural exposures of the poorly consolidated sediments in e low hills and bluff, or (2) the absence of faulting in these young sediments. ditional information from man-made cuts in these areas is required to resolve is problem. The only evidence of their existence comes from water well data d not from direct observation. At the present time, there is no evidence at either of these faults cuts beds younger than the lower Pleistocene and, us, their exact location is unknown.

The trend of the Overland and Charnock faults parallels that of the glewood Fault. Thus, they may be related to this zone, but this relationip requires substantiation. Because these faults could be more recent than wer Pleistocene, reactivation cannot be precluded at this time.

SEISMICITY

Past History of Earthquakes

Several significant earthquakes and numerous smaller shocks have occurred in proximity to the Newport-Inglewood Zone and may have originated on the deeper faults within the zone. Earthquake epicenters recorded since 1933 fall along the Newport-Inglewood Zone or close to it; these have been plotted on Figure 1 and are also tabulated in Table II.

Table I lists six significant earthquakes which occurred in the same general area prior to 1933 and which could have originated on the Newport-Inglewood Zone.

The two most significant earthquakes to occur in the area were the Inglewood earthquake of 1920 (see description in Table I) and the Long Beach earthquake of 1933 (see description in Table III). Since 1933, four quakes have been recorded with magnitudes of 5 or greater on the Richter Scale with the Long Beach earthquake recording 6.3.

Although the history of recorded earthquakes occurring along the Newport-Inglewood trend is very short, it serves to indicate that an earthquake of Magnitude 5 or greater has occurred on the average of once per decade with numerous smaller quakes occurring every year or two. The close proximity of many of the recorded epicenters to the Newport-Inglewood Zone strongly suggests their origin within the zone. On the basis of this evidence, the Newport-Inglewood Zone must be considered a potentially active zone at least at depth and, therefore, capable of producing future earthquakes at the approximate regularity and of the same magnitude as those previously recorded.

No surface displacements have been recorded on the known faults along the zone which could be directly related to seismic activity. Surface movements recorded along faults in the Baldwin Hills have been attributed to subsidence associated with oil field production and to repressuring operations (see section entitled "Subsidence"). The only faulting which appears to be directly related to seismic activity along the zone occurred at shallow depth in the West Dominguez oil field during the earthquake of October 21, 1941. The faulting was inferred from damage to tubing in several wells.

Future Seismic Activity

In order to establish criteria for future seismic design, it is necessary to estimate the maximum likely seismicity that will be recorded in the Culver City area and its source. For Culver City, the two most probable major earthquake sources are the San Andreas Fault Zone approximately 45-50 miles distant and the Newport-Inglewood Zone close by.

TABLE I

SIGNIFICANT EARTHQUAKES POSSIBLY ORIGINATING ON THE NEWPORT-INGLEWOOD ZONE PRIOR TO 1933 (SOURCE: WOOD, ET AL - 1966)

Date		Locality	Intensity (Modified Mercalli)	Estimated Epicenter N. Lat.	W. Long.
.769	7/28	L. A. Region		34°	118°
.827	9/23	L. A.		34°	118°
855	7/10	L. A. County	VIII	34°	118.5°
878	Late Summer	Inglewood		34°	118.5°
918	11/19	Santa Monica Bay	VI	34°	118.5°
920	6/21	Inglewood	VIII	34°	118.5°

DESCRIPTION

769. July 28. Los Angeles region. Four violent shocks were felt in camp near the present site of Olive on the Santa Ana River; many more shocks were experienced during the next several days as the Portola Expedition marched northwestward. The incomplete record strongly suggests a major earthquake with numerous strong aftershocks, possibly continuing into 1770.

827. September 23.(?) Los Angeles. People ran outdoors in panic.

855. July 10 or 11. Los Angeles County. Four shocks felt in about 12 seconds. Bells in San Gabriel Mission Church thrown down. Twenty-six buildings damaged in Los Angeles (almost every structure, according to Harris Newmark); the walls of the Star Hotel were cracked, and the west wall of the church was cracked in several places. Submarine origin suggested by sea waves.

78. Late Summer At the present site of Inglewood, kiln under construction was knocked down.

18. November 19. Santa Monica Bay. Two shocks, total duration 30 seconds. At Venice, plaster brought down. At Santa Monica, pedestrians thrown off balance and chimneys cracked.

20. June 21. Inglewood. This shock was highly localized in and just west of Inglewood. Typical damage was the wrecking of a two-story school building which had to be rebuilt. Walls of a hotel and of an electric substation fell, cemetery monuments were upset, and telephone service was interrupted. In a sparsely settled region, this shock might have passed unnoticed. It was highly selective in its effects, damaging only poorly built structures.

SIGNIFICANT LOCAL EARTHQUAKES POSSIBLY ORIGINATING ON THE NEWPORT-INGLEWOOD ZONE, MARCH 1933 THROUGH 1970

Date		Locality	Intensity (Modified Mercalli)	Magnitude	Epicenter N. Lat.	Epicenter W. Long
1933	3/11	Long Beach-Newport Beach (off shore)	IX	6.3	33° 36'	118°
1933	10/02	Signal Hill (Long Beach, Los Angeles, Compton, Bell)	VI	5.4	33° 48'	118° 06'
1934	4/17	Newport Beach (off shore)		4.0	33° 34'	117° 59'
1934	11/16	Midway City		4.0	33° 45'	118° 0'
1935	12/25	Newport Beach (off shore)		4.5	33° 36'	118° 01'
1937	7/07	Newport Beach (off shore)		4.0	33° 34'	117° 59'
1938	5/21	Huntington Beach (off shore)		4.0	33° 37'	118° 02'
1938	8/31	Dominguez Hills		4.5	33° 48'	118° 14'
1938	12/07	Culver City-Venice		4.0	34° 00'	118° 25'
1939	12/27	Long Beach (Huntington Park, and Long Beach damaged)	VI	4.5	33° 47'	118° 12'
1940	1/13	Seal Beach		4.0	33° 47'	118° 08'
1940	2/08	Sunset Beach (off shore)		4.0	33° 42'	118° 04'
1940	2/11	Inglewood-Huntington Park		4.0	33° 59'	118° 18'
1940	7/18	Sunset Beach (off shore)		4.0	33° 42'	118' 04'
1941	10/21	Gardena (damage in West Dominguez oil field)	VII	4.9	33° 49'	118° 13'

1941	10/22			3.8	33° 52'	118° 13'
1941	11/14	Torrance		5.5	33° 47'	118° 15'
1944	6/18	Dominguez Hills 16:03:33 PST	VI	4.5	33° 52'	118° 13'
1944	6/18	Dominguez Hills 19:06:07 PST		4.4	33° 52'	118° 13'
1961	10/20	Orange County (4 larger shocks out of 8 tremors)		3.9	33.7°	117.9°
1961	10/20	"		4.6	33.6°	118.0°
1961	10/20	"		4.2	33.7°	118.0°
1961	10/20	"		4.2	33.7°	118.0°
1961	11/20	Orange County (with 3 aftershocks)		4.0	33.7°	117.9°
1963	2/18	Torrance		3.4	33° 55.4'	118° 22.5'
1963	8/09	Downey		3.2	33° 51.1'	118° 10.8'
1963	11/28	Downey		3.0	33° 49.7'	118° 9.5'
1964	2/20	Downey		3.2	33° 48.1'	118° 8'
1964	3/21	Torrance		3.0	33° 56.2'	118° 24'
1965	11/12	Santa Monica-Inglewood (felt over 800 Sq. Mi. of SW L.A. County - most sharply in Santa Monica-Inglewood).		3.0	33° 58.8'	118° 23.5'

TABLE II
(continued)

1966	6/13	Midway City		3.5	33° 44.8'	117° 59.5'
1966	10/02	Los Angeles (felt over SW L.A. County; felt sharply in Los Angeles)		3.8	34°	118°.18°
1967	5/12	South Gate- Lynwood; felt in Pasadena		2.9	33° 55.8'	118° 13.2'
1969	10/27	Laguna Beach (off shore)		4.3	33° 32.7'	117° 48.4'
1970	9/14	West Los Angeles area		3.0	34° 3.7'	118° 21.0'
1970	9/22	West Los Angeles area		4.2	34° 00'	118° 17'
1970	9/23	Inglewood-Torrance area		3.3	33° 54'	118° 20'
1970	9/23	Inglewood-Torrance area		3.2	33° 54'	118° 20'

Sources:

1. Calif. Dept. Water Resources, Bull. No. 116-2, 1964
2. Seismological Notes, Bull. Seismol. Soc. America.
3. Richter, Nord[illegible]ist, Taylor (1967).
4. Allen, Brune, Nordquist, Richter, Taylor (1968)

TABLE III

DESCRIPTION OF SOME SIGNIFICANT EARTHQUAKES POSSIBLY ORIGINATING ON THE NEWPORT-INGLEWOOD ZONE, 1933 TO 1963. (SOURCE: WOOD, ET AL, 1966)

1933. March 10. Long Beach. This shock was not of major magnitude from the seismological point of view, but because of its location near a thickly settled district with many poorly constructed buildings, it ranks as the second most destructive shock of the United States history. About 115 lives were lost and hundreds were injured. Damage of about $40,000,000 resulted. The fire loss was small while the main damage was due to the earthquake, an opposite condition to that which prevailed in 1906.

The epicenter was located just offshore near Newport Beach. The major destruction, however, was in the more thickly settled district from Long Beach to the industrial section, south of Los Angeles, where watersoaked alluvium and other unfavorable geological conditions combined with the presence of much poor structural work to increase the damage. The strongly shaken area was bounded by a line from southern Los Angeles southwest to Manhattan Beach and by another from southern Los Angeles to Anaheim and thence to Laguna Beach. At Compton there was wholesale destruction of buildings over a limited area on very bad ground. At Long Beach, buildings collapsed, tanks fell through roofs, houses were displaced from foundations, and there was serious structural damage to buildings left standing. In factories, in addition to other damage, delicate machinery was thrown out of alignment.

There was little evidence of ground movement, and no fault displacement visible. Slight slumps and distortion of made and unconsolidated ground took place in the region from Compton to Long Beach. Places where damage was exceptionally severe included Compton, Long Beach, and Huntington Park. Many structures including water tanks, suffered. School buildings were among those most generally and severely damaged due largely to unsuitable design to resist shaking, and had the shock taken place during school hours great loss of life would have occurred. Magnitude 6.3. It is difficult to give an adequate condensed description. Reference is made to United States Earthquakes, 1933, which in turn gives other references. There were numerous aftershocks, but no important ones.

933. October 2. Signal Hill. Moderately strong earthquake near Long Beach, possibly not a true aftershock of the March 10 shock. Considerable minor damage at Long Beach, Los Angeles, Compton, Bell, and other towns, chiefly to structures weakened in previous shocks. Felt as far as San Diego and Santa Barbara. Magnitude 5.4.

939. December 27. Long Beach. Walls cracked and street lights damaged at Huntington Park and Long Beach. Magnitude 4.5.

941. October 21. Gardena Area. Greatest damage was in the West Dominguez oil field east of Gardena where well tubing was damaged and almost all wells went off production temporarily. In surrounding towns many walls and plaster cracked, many windows broke, and some chimneys twisted. Store stocks suffered considerable damage. Damage in Gardena was about $10,000. In Moneta, a fire wall was thrown down. Magnitude 4.9.

1941. November 14. Torrance-Gardena Area. Damage was approximately $1 million. At least 50 buildings were severely damaged. Suburban areas were darkened for 30 seconds to 5 minutes as power lines fell, and in some places telephone service was disrupted. Two oil tanks were demolished, two buckled severely, a 6-inch pipeline broke in four places, and a natural gas pipeline burst.

In Torrance, about 50 percent of all brick chimneys and fireplaces were either twisted, broken loose, or thrown down. One of two schools suffering structural damage was condemned. Several houses moved off their foundations. In Gardena, the elementary school building was condemned and the Bank of America building was severely damaged. Some fire walls and many chimneys were thrown down or damaged. A collapsing wall of a two-story building broke through the roof of a low adjoining building practically destroying its contents. Magnitude 5.4.

1944. June 18. Near Dominguez Junction. Two shocks caused minor property damage and jangled nerves in the Los Angeles area. At Long Beach, the shock was the heaviest since 1933. Dishes crashed to the floor, burglar alarms clattered, and many persons fled to the streets. A 4-foot marble slab toppled 12 feet from the front of a shop at Redondo Beach. Minor damage in the Compton-Torrance area. Magnitudes 4.5 and 4.4, respectively.

1961. October 20. Near Huntington Beach. A series of nine sharp shocks were felt over an area of about 1,200 square miles of southern California, principally in Orange County. Slight damage, consisting mainly of cracked plaster, broken windows, and fallen merchandise in stores, was reported from a number of towns. Magnitude 4.3.

The intensity of ground shaking at any one place is measured on the Modified Mercalli Intensity Scale and is a function of (1) the magnitude of the earthquake (amount of energy released), (2) the distance from the epicenter of the earthquake, and (3) the nature of earth material underlying the site. This intensity scale measures the amount of shaking damage on a scale of I to XII and is determined by observation of the damage done.

A comparison of earthquake magnitude as measured on the Richter Scale and earthquake intensity as measured on the Modified Mercalli Intensity Scale is shown in Figure 2. This comparison assumes the intensity is calculated on a bedrock site near the earthquake epicenter. For the same magnitude shock, the intensity will decrease with distance from the epicenter and will vary with the nature of the underlying earth units.

At the present time, there is insufficient history of recorded major earthquakes in Southern California to ascertain with any degree of certainty the most probable maximum earthquake that could occur along the Newport-Inglewood Zone and what acceleration forces and intensities of damage would affect the Culver City area. However, based on available data given in Tables I and II, and recent experiences on other Southern California fault movements, such as the San Fernando Earthquake of February 9, 1971 and historic movements on the San Andreas Fault Zone throughout California, the probable ranges of maximum quakes which might occur during the next 50-year period are given in Table IV, below.

TABLE IV

Causitive Fault and Distance (Miles)	Expected Magnitude (Richter)	Expected Intensity Range (Mercalli)	Expected Ground Acceleration (Gravity)	Probability of Occurrence
Newport-Inglewood 0 - 5	6.0-7.0	VIII - X	.15 - .40	Likely
Newport-Inglewood 0 - 5	7.0-7.5	X - XI	.40 - .60	Low
San Andreas 45 - 50	7.0-7.5	VII - VIII	.10 - .20	Likely
San Andreas 45 - 50	8.0-8.5	VIII - IX	.15 - .35	Intermediate

NOTE: Recorded data on major earthquakes is not sufficient to statistically define precise probabilities of occurrence; therefore, the generalized ranges included above are estimated to have the following probabilities: Low - less than 10%; intermediate - 10-50%; likely - greater than 50%.

EARTHQUAKE SCALES

MAGNITUDE ON RICHTER SCALE	INTENSITY ON MERCALLI SCALE	
1	I	DETECTED ONLY BY INSTRUMENTS
2	II	BARELY FELT NEAR EPICENTER
4.5	VII	DAMAGE SLIGHT
6-7	VIII-X	MODERATELY DESTRUCTIVE (1933,1971)
7-7.7	X-XII	MAJOR EARTHQUAKE (1952)
7.7-8.9+	XI-XII	GREAT EARTHQUAKE (1906,1964)

Figure 2

Earthquake intensities of VIII - X accompanied by ground accelerations of 0.2g. to 0.4g. are considered likely to occur sometime during the next 50 years. The more severe events with accelerations in excess of 0.5g. cannot be completely discounted but they are considered to have a "low" probability of occurrence over this length period.

The actual accelerations and duration of shaking experienced at any site will depend not only on the magnitude and location of the event causing the shaking but, also, on the particular properties of the earth units underlying the site and, also, on their degree of saturation, i. e., the ground-water level. Given sufficient geologic and soils data for a specific site, it is possible to estimate the approximate ground response spectra at that site for each separate seismic event. These response spectra would obviously vary from site to site as the soils and geologic conditions vary. Response spectra calculated for a specific site can be used to establish suitable seismic design factors for any new structure at that site.

Ground failure such as differential settlement or liquefaction may occur during periods of severe ground shaking due to the presence of semiconsolidated earth materials and/or shallow ground-water conditions. These conditions can be established through geologic-soils site investigations prior to construction.

EARTH MOVEMENTS - SUBSIDENCE

Earth Movements

Growing emphasis has been placed on continuing earth movements in certain areas of the Baldwin Hills following the failure ~~of the~~ Baldwin Hills reservoir in 1963. Leveling surveys begun as early as 1910 have shown continuing earth movements and subsidence and these movements had been detected prior to construction and failure of the reservoir.

Evidence of continuing deformation includes surface displacement along known fault lines, regional and local elevation changes and recorded seismic events; the latter are discussed in the section on "Seismicity". Leveling in and around the Baldwin Hills by Los Angeles County and City of Los Angeles surveyors has shown that the lowland stations within the planning area north and west of the hills have been subsiding consistently at a slow rate of .02 - .03 feet per year, while a prominent elliptical-shaped subsidence "bowl" located in the northwest portion of the hills has been subsiding at a maximum rate of approximately 0.20 feet per year, as ~~measured near~~ the center of the bowl.

Earth cracks and surficial fault displacements have been recognized in the hills since 1957. These earth cracks are almost completely confined to the eastern and southeastern portion of the above mentioned subsidence bowl and appear to be associated with preexisting faults. The major movements have occurred in the area of the Baldwin Hills reservoir and near the intersection of Stocker Street and La Brea Avenue. They are believed to be in direct response to the continuing subsidence and are not thought to represent tectonic movement (Castle and Yerkes, 1969). However, several known faults including the Inglewood Fault traverse the subsidence bowl in the ~~eastern~~ portion of the planning area and continued subsidence could possibly cause surface displacements along these fault traces (see fault lines on Subsidence Maps 1 and 2, Appendixes IX and X).

Subsidence

The subsidence rate of .02 to .03 feet per year in the lowland portion of the planning area appears to be rather consistent and is not considered significant for planning or design purposes as long as it continues at or below the previously recorded rate. However, the main subsidence bowl within the Baldwin Hills is significant. Maximum measurements made near the center of subsidence indicate a total elevation change of 5.67 feet during the period 1911 to 1963.

The accompanying Subsidence Map (Subsidence Map 1, Appendix IX) was prepared by the Los Angeles County Survey Division. It shows the configuration of the subsidence area and the average annual rate of subsidence through 1961. The subsidence area is an elliptical-shaped bowl that trends northwest-southeast and overlies the Inglewood Oil Field. In fact, the subsidence in this area has been attributed to (1) oil production from the field, and (2) water injection operations associated with the fields operation (Castle and Yerkes, 1969 and Hamilton and Meehan, 1971).

Recent survey data obtained from Los Angeles County and City surveyors and Subsidence Map 2 (Appendix X) show the average annual subsidence rate from 1960 to 1970. The rate of subsidence does not appear to have changed much over the last decade; however, continued water injection into the oil reservoirs may slow the subsidence rate with time as has been accomplished in the Wilmington Oil Field.

Some lateral movements are associated with the main area of subsidence. Survey markers have generally shown a small shift towards the center of the subsidence.

Surficial cracks and fault displacements are also associated with the subsidence and are discussed in the previous section on "Earth Movements".

Future movements, at least for the next decade, are expected to continue at approximately the same rate as during the last decade (see Subsidence Map 2).

The rate may slow slightly and, in fact, may already be slowing. Comparison of surveys made by Los Angeles County Survey Division show that in some areas the rate has dropped by about 20 percent between the periods 1960-65 and 1965-70. However, additional survey data will be necessary over the next five to 10 years to confirm these rate changes.

Landslides and Slope Stability

Natural slope failures are rare in the Baldwin Hills primarily due to the generally low slope angles, seldom exceeding 2:1 (horizontal to vertical), and the predominance of nearly horizontal bedding within the sedimentary units making up the hills. The areas most prone to failure are those where the underlying strata has been tilted and folded due to faulting and related tectonic activity.

For the purpose of this report and future planning, the hills within the study area have been divided into two major geologic zones designated "C" and "D" on the Geologic-Seismic Summary Map (Appendix VIII).

Zone "C" covers that portion of the hills where the slopes are steepest and the bedrock is tilted, folded and faulted and represents that area of aximum potential instability. Within this zone, one possible landslide has een mapped (see Summary Map). The existence of this slide has not been con-firmed by subsurface investigation but the slide is highly suspect due to its opographic configuration as revealed by photogeologic and field investigations.

This zone also includes the Inglewood Oil Field and its associated problem-tic conditions, such as: (1) old oil, mud and waste water sumps, (2) uncontrolled ill placed for access road and well and tank sites, (3) oversteepened cut-slopes, nd (4) old dump sites. This area also includes the area of maximum ground sub-idence.

Zone "D" covers the western portion of the hills where slopes are flatter and the underlying sedimentary units have shallow dips. Natural slope stability is high and problematic conditions should generally be restricted to the steeper portions of the natural drainages and to oversteepened man-made slopes.

In both zones, slope stability is dependent upon (1) nature of bedrock underlying the site, (2) proximity to faulting and degree of folding and fracturing, (3) structural dip of the sedimentary bedding planes in relation to direction of natural or man-made slopes, (4) slope angle, (5) presence or absence of ancestral slope failures, and (6) presence or absence of shallow or problematic ground-water conditions.

Evaluation of slope stability for natural, man-made or proposed slopes must include geologic-soils evaluation of these factors which, in turn, must be based on detailed field and laboratory observations by the geologist and soils engineer.

GROUND WATER

It is essential that seismic parameters for a site include water table and saturation data as well as the nature of underlying materials. For example, where silts or sands are loosely consolidated and are saturated at or close to the surface, seismic shaking can produce "liquefaction". This is a condition where the grain-to-grain support provided by the sediment grains is temporarily destroyed and the water between the grains suddenly assumes the weight of the overlying materials. Because the grain-to-grain friction is eliminated, the sediment assumes the frictionless properties of a liquid that fails to support overlying structures.

In Culver City, problematic shallow ground-water conditions are generally confined to the floodplain and adjacent areas surrounding Ballona Creek. Two major water-bearing zones exist in this area: (1) a deep zone that consists of Lower Pleistocene sediments of sandstone and siltstone ranging in thickness from 50 to 400 feet within the planning area, and (2) a shallow zone composed of recent stream deposits of loose, unconsolidated sand, silt and gravel which ranges in thickness from approximately 80 feet in the Ballona Gap area north of Baldwin Hills to approximately 50 feet to the west near the coast.

Water levels in the deep zone are controlled by domestic water production and by the location of ground-water barriers such as the Inglewood, Overland and Charnock faults. The depth of this zone, as a result of pumping operations, is generally below 50 to 80 feet. The great depth of the water level minimizes its potential for liquefaction from seismic shaking.

Table V, below, summarizes the most recent water levels in the shallow zone for the six wells monitored in the planning area. Well locations are shown on the Geologic-Seismic Summary Map. The data are gathered from Los Angeles County Flood Control records. These records indicate that little, if any, domestic water is being pumped from shallow sand and gravel beds within the planning area.

TABLE V

WATER LEVELS IN SHALLOW ZONE

Well Number	Date Measured	Depth to Water Table	Elevation of Water Table
2626DD	6-4-71	36 feet	56 feet
2609H	4-7-71	71 feet	-17 feet
2609J	4-7-71	78 feet	-21 feet
2598	6 - 71	68 feet	17 feet
1281C	4-6-71	18 feet	0 (Sea Level)
1271T	4-5-71	7 feet	3 feet

Water levels vary within the upper water-bearing zone but a general drop occurs to the south and west. Owing to the westward slope of the ground surface, the shallowest water occurs in the western portion of the planning area.

Areas of shallow ground water (less than 50 feet in depth) should be considered potentially problematic in terms of liquefaction and, therefore, should be evaluated in terms of seismic design. There is no evidence that the Inglewood, Overland and Charnock faults cut this shallow zone or affect the water table as they do the lower zone.

SOIL CONDITIONS

Little data based on soils sampling and laboratory testing are available in the Culver City area. However, for the purpose of this report, the soils conditions which are relevant to seismic analysis and city planning can be divided into two major areas of concern: (1) those in the hillside areas, and (2) those in lowland alluvial areas.

Lowland Alluvial Areas

In lowland alluvial areas there are several areas within the City that show distress in the form of sunken, cracked and buckled curbs, cracked and sunken sidewalks, disparities in road pavement, driveway and curb elevations and general random cracking of pavement. These areas of distress are indicative of unstable surficial soil conditions, i. e., expansive clayey soil or organic-rich "boggy" soil conditions.

The area shown by stippling on the Geologic-Seismic Summary Map in the Ballona Gap area east of the Inglewood Fault is reportedly underlain by organically-rich soils associated with a former marsh or boggy area. This is one of the areas experiencing severe distress at this time.

Two other areas experiencing distress are also shown by stippling. These areas lie north of the floodplain sediments and are underlain by older alluvium. Again, the settlement and associated problems appear to be the result of expansive and possibly organically-rich clays and silts. Present soils technology can resolve these problematic conditions through the collected and laboratory analysis of subsurface samples. Due to the highly variable nature of these alluvial soils, this is generally best accomplished on a site-by-site basis.

Hillside Areas

The soils conditions in the Baldwin Hills area are directly related to the underlying geologic units. The soil profile is generated by inplace weathering of the native units and by slow downhill creep of surficial materials on the steeper slopes, resulting in local thick buildups of thick soil (colluvium) in swales and at the heads of shallow reentrants. In the hills, these soils are predominantly sandy loam but locally become clayey where underlain by clayey silt. Where clayey, these soils are potentially expansive, necessitating detailed soils analysis for foundation design.

Land Fills

Over the years, numerous land fills have been placed adjacent to Ballona Creek either to reclaim lowlands along the old creek bed, or in connection with flood control improvements. These fills have been delineated by aerial photo analysis from photos flown in 1928, 1937, 1951 and 1952. By 1952, the Ballona Creek Channel had been completed and all significant fill operations were also completed. Fills placed during these periods are shown on the

Summary Map. During the time that these fills were placed, few controls were generally placed on the compaction of the materials and no records are available covering these fill areas. Therefore, the suitability or stability of the fill areas cannot be attested to.

No dump sites other than those possibly associated with uncontrolled fills along Ballona Creek, and shown on the map, are known to exist other than in the area now being used as "little league" ball diamonds in the hills south of Jefferson Boulevard. Prior to construction of the ball diamonds this area was a dump site and prior to that it was a sand quarry.

A minimum of 85 oil, mud and waste water sumps have been identified by aerial photo inspection in the Inglewood Oil Field within the planning area. Numerous uncontrolled fills have also been placed in connection with grading operations within the field. Many of the major fills are shown on the geologic map by R. O. Castle (Appendix VII).

CONCLUSIONS

Seismicity

Culver City, as well as other cities in Southern California, will be subjected to future seismic shaking from movements along the active fault zones in Southern California. For Culver City, the two most probable major earthquake sources are the San Andreas Fault Zone and the Newport-Inglewood Zone and future seismic planning should include the following specific considerations.

1. One of the two most likely earthquake events to severely affect Culver City during the next 50 years could occur at depth on the Newport-Inglewood Zone. Should the fault rupture occur within five miles of Culver City, ground accelerations of up to 0.4g. should be expected.

2. The other most likely earthquake could occur on the San Andreas Fault Zone, 45 miles away at its closest point. Ground accelerations of 0.2 to 0.35 should be expected and the duration of shaking could last as long as one minute.

3. The ranges for ground accelerations given above are taken from Table IV and are for bedrock areas. Accelerations in alluvial areas would probably be higher.

4. Movements on the Newport-Inglewood Fault could be accompanied by ground rupture along its mapped surface trace. There is no evidence of recent ground displacements due to recorded earthquakes possibly originating along the Newport-Inglewood Zone and, therefore, the amount of surface displacement that could occur is unknown.

5. Movement on the Overland and Charnock faults is not anticipated because evidence suggests that these faults are no longer active. However, more geologic data are needed on these faults before their state of activity can be definitely established.

Earth Movements and Subsidence

Leveling surveys begun as early as 1910 have shown continuing earth movements and subsidence in the Baldwin Hills area. Recent studies, based on Los Angeles County and City survey data, give the following results:

1. Earth cracks and surficial fault displacements have been mapped since 1957 and are confined to the east side of the subsidence area which is outside of the Culver City planning area.

2. Maximum subsidence is occurring in an elliptical-shaped area overlying the Inglewood Oil Field. Subsidence Map I shows subsidence rates to 1961. Subsidence Map II shows subsidence rates during the period 1960 to 1970.

3. Subsidence has been attributed to the oil production and water injection in the Inglewood Oil Field.

4. Subsidence is anticipated to continue in the near future at about the same rate as it did over the last ten years. However, continued water injection may slow the rate in the future as has been demonstrated by injections in the Wilmington Oil Field.

5. Continued subsidence within the main subsidence bowl could possibly cause surface cracks and/or shallow displacement on known faults within the planning area similar to those now experiencing displacement on the eastern side of the subsidence bowl.

Hillside Areas

For the purpose of this report and future planning, the hills within the study area have been divided into two major geologic zones and the constraints to development within each zone are as follows:

1. Zone "C" includes the higher and more rugged portions of the Baldwin Hills west of La Cienega Boulevard. Constraints to development in this zone are (1) steep natural and man-made slopes, (2) existence of active subsidence including area of maximum subsidence, (3) proximity to Inglewood Fault, (4) oil field operations including presence of oil, drilling mud and waste water sumps and uncontrolled cuts and fills, and (5) potentially expansive soil conditions in areas of thick soil or clayey bedrock.

2. Zone "D" includes the lower portions of the hills west of Zone "C" and contains fewer restraints to development than Zone "C". The major problems are: (1) significant subsidence, though on the edge of the main subsidence bowl, (2) easily erodible earth units, and (3) potentially expansive soil conditions in areas of thick soil and clayey bedrock.

Lowland Alluvial Areas

The lowland area of Culver City is located on a floodplain of an ancestral westward flowing Los Angeles River now represented by Ballona Creek. The area is underlain by recent alluvium along the creek and older alluvium on the higher ground both to the north and south. In these areas the major problems associated with development are:

1. The presence of locally severe expansive and boggy soil conditions.

2. The presence of the buried and little-known Overland and Charnock faults whose state of activity has not been definitely established.

Ground Water

In the planning area potentially problematic ground-water conditions are generally confined to the floodplain and adjacent areas surrounding Ballona Creek. Even here, domestic water production, though generally from the deeper measure, has lowered the water level in the upper alluvial zone to 50 - 80 feet below the surface. This depth of the water level greatly reduces the potential for liquefaction of the soils from seismic shaking. However, should the water level rise to near the surface, through either reduced withdrawals or increased recharge, the hazard of liquefaction would arise.

ROLE OF THE CITY

Future land use planning by Culver City and land development or redevelopment whether by municipal or private sources can benefit from geologic-soils study and interpretation. Small cities like Culver City generally cannot justify having experienced engineering geologists and soils engineers on their permanent payrolls. However, these professionals are needed to review and evaluate soils and geologic studies within the City. In order to fulfill these important needs, a certified engineering geologist and a qualified soils engineer should be retained by the City of Culver City to assist them in developing, interpreting and enforcing the code and in reviewing the work of the private consultants.

As an alternative to the City retaining consultants, these services also can be contracted through the Los Angeles County Engineer. Although many small cities do contract with the County and do receive satisfactory service from the County, they do not have the local control that can be obtained by retaining experienced consultants to add to their own engineering and planning capabilities.

In regard to the City requirements for geologic-soils investigations, the following procedures are recommended:

1. Geologic investigations should be required in the hillside areas and along the Inglewood, Overland and Charnock faults. These areas designated A, B, C and D are shown on the Geologic-Seismic Summary Map. A table which lists the recommended geologic and soils reports for each area or zone is also shown on the Summary Map and is included as Appendix VI. Major considerations in the hillside areas will be cut-slope stabilities, subsidence, possible surface cracking and faulting related to subsidence, oil field operations and related waste sumps, uncontrolled fills and over-steepened cut-slopes. The principal considerations along the fault zones will be their exact location and state of activity.

2. Soils investigations should be required for all developments within the City. Problems of expansive and boggy soil conditions will be particularly important considerations by the soils engineer. Potentially high ground-water conditions could result in the future and should receive the attention of the soils engineer.

3. The above investigations should be required prior to City approval of the following three stages of development: (1) tentative tract design, (2) the final grading plan, and (3) following rough grading but prior to issuing building permits. Guidelines for geologic-soils investigation and report requirements for strengthening geologic-soils building and grading codes are given in Appendixes I and II.

4. Guidelines for municipal projects, geologic services and legal matters and for preparation of storm damage and other geologic hazards reports are given in Appendixes III, IV and V, respectively.

5. Specific studies that the City should consider making at this time are: (1) the monitoring of continued rate of subsidence based on continued survey data available from City and County engineering and survey divisions, and (2) investigation of the Inglewood, Overland and Charnock faults in the subsurface.

The fault investigation can be considered a City-wide problem since the critical relationships necessary to establish the state of activity of a fault normally occur only at scattered localities that are not necessarily within the bounds of a tract or development. This study should include a continuing program of geologically inspecting any roadcuts or excavations being made along any of the fault alignments, and the monitoring of ground-water levels in the lowland areas to establish current levels and trends.

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APPENDIX I

GUIDELINES FOR GEOLOGIC AND SOIL INVESTIGATION AND REPORT REQUIREMENTS BY THE CITY

Definition of Purview of Engineering Geologist and Soils Engineer

A registered geologist certified by the State of California as an engineering geologist and a qualified soils engineer experienced in hillside subdivision must be retained by the developer and be responsible for geologic-soils aspects relevant to the project. The consultants will be concerned with such terrain problems as landslides and erosion, delineating widths and state of activity of faults, ground-water circulation problems, expansive earth materials, loose foundation materials, and subsidence.

Preliminary Geologic-Soils Reports

The pre-grading investigation by the engineering geologist and soils engineer must be sufficient to outline geologic-soils problems and provide solutions to these problems. This pre-grading work should include: (1) subsurface exploration, (2) sampling, (3) construction of suitable map(s) and cross section(s), and (4) comprehensive geologic-soils reports. The professional's opinion should be sought in the form of a letter-report wherever it appears that no potential hazards are present, rather than waiving a professional report statement.

Geologic-Soils Inspections

Geologic-soils inspections shall be conducted during all significant hillside grading operations and sufficient remapping, data collection and analysis shall be done to assess the as-graded plan. This inspection work shall be sufficient to document and certify that (2) all geologic-soils recommendations have been followed during rough grading operations, (b) that all adverse geologic-soils conditions have been corrected or taken into account, and (c) that all lots or sites are suitable and safe for construction from the viewpoints of geology and soils engineering.

As-Graded Engineering Geologic Map

An as-graded geologic map should be required for sites having problematic geologic conditions. This map should summarize relevant geologic information obtained prior to, during, and at the termination of rough grading. It shall define the limits and geometry of geologic problems and their treatment, including the position of earth buttresses and other retaining devices for geologic purposes, impermeable blankets, subdrains, graded slope angles in cuts, conditional use areas and measurements in areas now buried by fill or subsiding. Geologic cross sections through the chief problem areas should be included.

APPENDIX III

GUIDELINE FOR MUNICIPAL PROJECTS

Site Selection

The selection of a site for a particular land use benefits from geologic study and interpretation, particularly in hillside areas. For example, the location of a municipal water tank requires (1) a hillside site to provide the necessary hydraulic head to service the project area, and (2) a hillside site with geologic stability. Additional considerations include the economics of the construction, aesthetics of the site and ready access to the site. All of these factors relate to a greater or lesser extent to the geology of the site: economics depends on the amount of material to be removed which, in turn, depends on the rippability or degree of hardness of the material and the extent of blasting that will be necessary. By minimizing the height of excavation and the total yardage excavated, an unsightly location can be prevented as well as artificial instability. On the other hand, in some locations a deeper excavation might serve the multiple purpose of hiding a tank site, removing an unstable surficial deposit, and acquiring valuable borrow material for a road or other engineering project.

The concept of multiple purpose planning and multiple use planning in land use deserves extension to many other projects. For example, borrow areas might be planned as future parking areas for parks or picnic spots, or as observation points. Other knolls reduced to a level for borrow purposes might serve as recreational centers or nature centers.

Geologic conditions and features should be considered early in the planning process. The earlier terrain factors are applied, the more design will benefit from the geology by both avoiding geologic pitfalls and capitalizing on numerous savings related to the use of resource materials and more imaginative and creative designs.

Site Development

Because of the wide variation in the character of earth materials and the geometric arrangement of these materials, and because very subtle geologic features can significantly influence the overall performance of a slope, individual site analysis is necessary. Intensive engineering geologic studies must be made of individual properties prior to their development. On an individual site, subsurface exploration in the form of backhoe trenches, dozer pits or drill holes may be necessary to define such features and conditions as the width of a fault zone, the orientation of a thin clay seam of montmorillonite that can render a slope potentially unstable, the depth of the overburden or the configuration of a landslide that may be too thick to economically stabilize. The degree of subsurface exploration will be dependent upon the complexity of the geology, the abundance and magnitude of natural terrain problems and the relationship of the geology to design.

GUIDELINES FOR GEOLOGIC SERVICE ON LEGAL MATTERS FOR CULVER CITY

Claims against the City involving soils and geology can be reduced in several ways: (1) reduce the area of City liability, (2) avoid geologic-soils pitfalls that can lead to claims, (3) enforce present and future building and grading codes and ordinances.

Legal research has shown that there is no real duty on the part of the City to carry out extensive and detailed investigations on lands that are suspect of having geologic and soils problems except as required in connection with general planning for the City. The duty is that of the landowners. It is the duty of the landowner to employ competent geologists, soils engineers, and other private consultants in order to supply the necessary technical information related to stability of the land and its future safety for building purposes. Therefore, in order to reduce the area of liability, it is important to extend responsibility wherever possible to private consultants and the private sector. This commonly can be done by requiring consulting reports and signed building and grading plans that include acceptance of responsibility for each phase of construction, as well as completed construction.

There is growing emphasis on contract specifications, but in geology and soils this source of lawsuit is not nearly as important as claims arising from instability and the following subject categories.

<u>Surface Runoff</u> - Promoting changes in drainage patterns that will concentrate drainage in certain areas where damage can be done and failure to provide for the collection and control of surface runoff and deposition of sediment and failure to provide for repair and maintenance of existing flood control facilities.

<u>Ground Water</u> - Ground water barriers can result in surface seepages during wet seasons, as can lithologic changes in the sediments at depth. Perched or shallow ground water can add to natural or cut-slope instabilities.

<u>Public Health - Safety</u> - Pollution of ground water or surface waters; vibrations from blasting; protection of workers in trenches and other excavations; provisions for tunneling; etc.

<u>Natural Slopes and Cut-Slopes</u> - Failure to recognize potential slide conditions which generally can be deciphered in advance of development.

Most pitfalls can be avoided by requiring that facts are obtained in advance of construction and insisting on completion of "state-of-the-art" professional geologic and soils reports. Subsurface interpretations are important and, as a result, subsurface exploration and an in-depth study should be required wherever this information does not already exist. Pre-grading meetings should be held, during which the City serves as a coordinator for various consultatnts on the project and assures itself that one of them will serve as the chief coordinator from that time on.

The real key to reducing the claims is enforcement of present and future building and grading codes and ordinances. It is deemed advantageous to the City of Culver City to rely upon the services of a certified engineering geologist for third-party reviews of engineering geological reports inasmuch as engineering geologists employed full time by the City are not feasible at this time.

A review of a consultant's report by the City of Culver City is probably one of the most critical steps in analysis of a proposed development. These reviews are needed in order to see (1) that provisions of the ordinance are enforced, (2) that the private consultant's findings have been fully expounded and considered and that his recommendations are taken into account by the designers and developers, and (3) that the investigators advance safe solutions to all geologic-soils problems.

Ideally, the consulting engineering geologist for the City should be well acquainted with the actual and potential geologic-soils problems in the area, and yet, should be removed from conflicts of interest by practice in the area. This relationship will help to achieve an atmosphere of mutual respect and cooperation, essential for effective implementation of this recommendation. The use of a third-party reviewer will help to assure that a detailed and full geologic investigation is made and will help to avoid City liability.

Creation of a Geologic-Soils Advisory Review Board

This board would serve in an advisory capacity to the City of Culver City in evaluating controversial matters appealed by landowners and developers. The board would review these matters and make recommendations to the City Planning Commission. It should be in a position to determine from data submitted and from on-site observation whether a proposed development meets the requirements of the "state-of-the-art" and state and local ordinances.

Membership should include a certified engineering geologist, an architect, a landscape architect, a seismologist and a civil engineer who practices in soil mechanics and is familiar with the methods of stability analysis.

Members should be rotated on a 2-3 year basis. The flexibility of its composition should permit that two engineering geologists be present when the problem is largely geologic and two soils engineers when the problem is chiefly soils engineering in nature.

APPENDIX V

GUIDELINES FOR PREPARATION OF STORM DAMAGE AND OTHER GEOLOGIC HAZARD REPORTS

1. The City should maintain a file of all published information on storm damage and geologic-soils hazard damage. This should include meteorologic data, descriptions of site damage, photographs of damage, and drainage area parameters.

2. The City should maintain an inspection file of photographs (Polaroid, etc.) that show unsatisfactory completion of construction elements, code violations, and damaged areas both before and after the storm seasons.

3. The City should maintain maps that show locations of significant storm damage and other terrain problems.

4. All stability control and erosional control devices should be shown on the City map in relationship to the problem areas defined in this study.

5. The City should require, at the first signs of a potential hazard to public safety involving geologic hazards, an engineering geologic report.

RECOMMENDED DISTRIBUTION SOILS AND GEOLOGIC INVESTIGATIONS

Zone Symbol	Type of Investigations and Problems of Special Emphasis					
	Soils		Geology			
	General	High Groundwater & Liquefaction	General	Cut-Slope Stability	Seismic	Subsidence where rate > 0.05 ft/yr
A	X	X	X		X	X
B	X	X	X		X	
C	X		X	X	X	X
D	X		X	X	X	X
E	X	X				
F	X	X				X