Appendix H: Safety Element Resources

I. Active Faults

Cabrillo Fault

The Cabrillo Fault consists of several en echelon strands striking 20 to 25 degrees west of north and dipping 50 to 75 degrees (Ziony and Yerkes, 1985). The onshore portion of the fault lies on the Palos Verdes Peninsula and extends offshore into the San Pedro Bay.

Compton Fault

The Compton thrust fault (blind) extends below the western Los Angeles Basin, lying entirely within Mesozoic metamorphic basement (Catalina Schist) (Shaw and Suppe, 1996). Most of the thrust fault is a ramp that rises to the southwest from depths as great as 10 km up to 5 km. The ramp connects the Central Basin Decollement, a thrust flat below the Los Angeles Basin, with shallower parts of the thrust fault near its tip below the Palos Verdes Peninsula. Leon and others (2009) identified 6 events in the past 14 ka, established event dates, and estimated a thrust fault slip rate of 1.2+0.5, -0.3 mm/yr.

Cucamonga Fault

The Cucamonga Fault Zone consists of one to three subparallel anastomosing strands of up to one kilometer in width and measuring between 20 and 25 kilometers in length (Morton and Matti, 1987; Wesnousky, 1987; Ziony and Yerkes, 1985). This segment is sometimes referred to as Sierra Madre Fault Segment E. The frontal fault zone in this area strikes about 70 degrees east of north and has moderate to steep northerly dips. Some workers confine this fault zone segment to the frontal southern margin of the San Gabriel and San Bernardino Mountains, from San Antonio Canyon to the west and Lytle Creek to the east (Morton and Matti, 1987; Smith, 1977; Lamar, et al., 1973). Morton and Matti (1987) suggest, however, that because of the complex structural relations at the west end, the Fault could be interpreted to extend farther west and merge with the Sierra Madre Fault System as a through-going, segmented, frontal fault system.

Garlock Fault

Major Holocene active, east to northeast-striking sinistral strike-slip fault that forms the boundary between the Tehachapi Mountains, Sierra Nevada, and Basin and Range province on the north and the Mojave Desert province to the south. This fault has 3 sections. Garlock fault zone is divided based on McGill (1992 #6053). The western Garlock fault section extends from the complex intersection with the San Andreas fault near Frazier Park east-northeast to a 3-km-wide left-releasing step-over in the vicinity of Koehn Lake. The central Garlock section extends from the left-releasing step-over near Koehn Lake eastward to the Quail Mountains where the Owl Lake fault intersects the Garlock fault zone. The eastern Garlock fault section extends from the Owl Lake fault eastward to the complex intersection with the southern extent of the Southern Death Valley fault zone.

Hollywood Fault

The Hollywood Fault is mapped as a narrow strand that trends along the southern front of the Santa Monica Mountains (Ziony and Yerkes, 1985; Weber, et al., 1980). Ziony and Yerkes (1985) list the fault as having reverse or reverse-oblique motion. The eastern segment of the Hollywood Fault Zone trends through the Repetto Hills as a complex series of faults and folds within the Puente Formation. In this area, the fault and several splays are in close proximity to the Raymond Fault (which is an Alquist Priolo-Earthquake Fault Zone, or APEFZ). Physiographic features such as scarps and inclined spurs are interpreted as evidence of Holocene movement along the eastern 17 kilometers of the

Hollywood Fault (Ziony and Yerkes, 1985; Weber, et al., 1980). The age of movement along the western portion of the Hollywood Fault is not reported, suggesting the Fault has been inactive for the last 750,000 years.

Holser Fault

The Holser Fault is a south dipping reverse fault consisting of several closely spaced strands that strike from 80 degrees east of north to 70 degrees west of north (Ziony and Yerkes, 1985; Winterer and Durham, 1962). The Fault Zone is as much as 1.5 kilometers wide along its western portion. The portion of the Fault transecting the County is approximately 13 kilometers long.

Ziony and Yerkes (1985) list offset stratigraphy and physiography as clear evidence of Late Quaternary movement. The Fault is shown as active for the following reasons: 1) the Fault is associated with known active faults, accommodating the north-south shortening between the San Cayetano and Santa Susana faults in a complex zone of south-dipping reverse faults (Yeats, 1987; Yeats et al., 1985; Ziony and Jones, 1989; Smith, 1977); 2) the Fault intersects an APSSZ fault; and 3) geomorphic evidence (i.e.,drainage control of several streams including Piru Creek) supports a Holocene, or at least Late Quaternary age for the Holser Fault (Yeats et al, 1985).

Although no Holocene deposits are known, to date, to be displaced by the Fault (Allan Seward, 1990 personal communication), no published trenching program has conclusively shown the Fault Zone to be inactive. Trenching across the APSSZ segment of the San Gabriel Fault may have indirectly proven that the Fault is active, since the San Gabriel Fault may be a reactivated tear fault in the Holser Thrust System (Tom Rockwell, 1990 personal communication).

Llano Fault

The Llano Fault is located west of Victorville in the Mojave Desert. The Fault strikes 65 degrees west of north along a single-strand with a presumed dip to the southwest (Ziony and Yerkes, 1985). The reverse fault shows evidence of Holocene monoclinal folding and is shown as active by Ziony and Jones (1989).

Lower Elysian Park Fault

Lower Elysian Park thrust and associated fold structures form a segment of the southern boundary of the Transverse Ranges (Oskin and others, 2000). The Los Angeles basin is located at the northwestern margin of the Peninsular Ranges and is overridden on the north and northeast by a series of contractional structures (Wright, 1991; Schneider and others, 1996; Shaw and Suppe, 1996). Oskin and others (2000) consider the Elysian Park anticline as a transitional structure forming a kinematic link between the sinistral-oblique uplift of the Santa Monica Mountains of the Transverse Ranges and the dextral-oblique uplift of the Puente Hills.

Malibu Coast Fault

The onshore Malibu Coast Fault consists of several subparallel strands trending east-west along the southern margin of the western Santa Monica Mountains. The onshore Fault Zone is comprised of reverse faults with dips averaging between 45and 80 degrees to the north, with zones of deformation as wide 0.5 kilometers (Ziony and Yerkes, 1985). There is an offshore portion of the Fault merging with the northern strand of the Santa Monica Fault, as interpreted by Weber (1980) and Crook and Ward (1983).

As early as 1965, Wentworth and Yerkes (1965) reported that the fault cut terrace deposits older than 25,000 years. The State fault evaluation conducted in 1977 concluded that the Fault was well-defined, but because no Holocene displacement had been documented, the Fault was not zoned within the APSSZ Act. Such evidence has recently been reported for a portion of the Fault located at the intersection of Kanan Dume Road and Pacific Coast Highway. Converse Consultants, working with Dr. Roy Schlemon, have found evidence of Holocene displacement within colluvial soils determined to be 5,000 to 6,000 years old at this location (oral communication, Greg Rzonak, 1988).

Mission Hills Fault

The Mission Hills Fault trends east-northeast to east-west for 10 kilometers along the south side of Mission Hills. The Fault is expressed by young fault morphology in some instances. The width has been described as a single-strand occurring within a zone as narrow as 150 feet (Ziony and Yerkes, 1985). Smith (1978) has interpreted the age of the Fault as late Pleistocene; however, Slosson (1977) and Kowalewsky (1978) documented Holocene rupture based on evidence of bedrock thrust over Holocene-aged soil. Ziony and Jones (1989) concur with a possible Holocene Age.

Newport-Inglewood Fault Zone

The trace of the Newport-Inglewood Fault Zone is marked by a series of low-lying hills including the Cheviot Hills, Baldwin Hills, Rosecrans Hills, Dominquez Hills, Signal Hill, and Reservoir Hill. These hills are sites of oil fields in which faulted anticlines form structural traps. The Fault Zone consists of a set of left stepping, discontinuous faults, which indicates a through-going right-lateral strike-slip fault at depth. Harding (1973) indicates that the Fault Zone is a nearly-vertical, right-lateral strike-slip fault at depth. The Fault Zone is covered under the APSSZ Act. Five separate en echelon faults comprise the Fault Zone in the County. These faults are as follows (Ziony and Yerkes, 1985):

- **Inglewood:** Northwest-trending fault with stratigraphic evidence of late Quaternary movement and recent physiographic features. Normal to normal-right-oblique sense of movement. Possible source of 1920 earthquake.
- **Potrero:** Northwest trending fault with normal to normal-right-oblique sense of movement with Late Quaternary physiographic features and groundwater impediments along trace in late Quaternary alluvial deposits (Poland and others, 1959). Numerous small earthquakes nearby.
- **Avalon-Compton:** Northwest-trending, vertical fault, which experienced movement in 1941 and 1944. Has reverse-right-oblique sense of movement and Late Quaternary physiographic features and groundwater impediments (Poland and others, 1959).
- **Cherry-Hill:** Northwest-trending near vertical fault with reverse-right-oblique sense of movement. Late Quaternary activity evidenced by offset stratigraphy, physiographic features, and groundwater impediments. Numerous small earthquakes east of trace.
- **Reservoir Hill-Seal Beach:** Northwest-trending, near vertical fault with normal-right-oblique or right-lateral strike-slip sense of movement. Late Quaternary activity is evidenced by offset stratigraphy, physiographic features, and groundwater impediments. Numerous small earthquakes east of trace.

North Hollywood Fault

The North Hollywood Fault, listed as a “possible fault in North Hollywood" by Ziony and Yerkes (1985), dips vertically along a single-strand approximately 2 kilometers in length. This Fault is but one of many groundwater impediments (faults) within the San Fernando Valley; however, Weber, et al., (1980) noted that the Fault formed an ENE-trending, linear break in topography on older quadrangle maps published in 1901 and 1926. Weber (1980) noted that because the south-facing physiographic lineament apparently offset youthful deposits of the Tujunga Wash, the fault may be Holocene in age.

Northridge Hills Fault

The Northridge Hills Fault consists of nine en echelon strands each with zones approximately 0.7 kilometers wide (Ziony and Yerkes, 1985). The Fault Zone strikes 70 to 80degrees west of north through the central San Fernando Valley. The style of slip is probably reverse, with a dip of 35 degrees north near the surface and 80 degrees north at depth (Ziony and Yerkes, 1985). Several aftershocks of the 1971 San Fernando Earthquake occurred coincident with the subsurface extension of the fault (Ziony and Yerkes, 1985). The Fault has been described as Late Quaternary Age by many workers (Ziony, et al., 1974; Barnhardt and Slosson, 1973; Wentworth and Yerkes, 1971); however, Ziony and Yerkes (1985) have reinterpreted groundwater offset data and fault physiography to suggest possible Holocene Age activity. Additional evidence of activity is the folding and warping of Holocene and Pleistocene Age sediments exposed during trench excavations by George Larson (Jerry Treiman, 1989; personal communication). Ziony and Jones (1989) show the Fault as possibly Holocene.

Palos Verdes Fault Zone

The portion of the Palos Verdes Fault Zone in the County can be discussed in terms of three separate segments: 1) the San Pedro Bay segment, 2) the onshore segment, and 3) the Santa Monica Bay segment (Ziony and Yerkes, 1985*).*

All segments are believed to possess reverse right oblique or reverse motion (Ziony and Yerkes, 1987). The San Pedro Bay segment is characterized as a complex zone of en echelon faults with evidence of offset Holocene stratigraphy (Fischer, et al., 1987). Fischer and others (1987) state that the eastern faults of the zone displace seismic reflectors or horizons that represent Holocene surficial sediments.

The onshore segment of the Palos Verdes Fault Zone is depicted by Ziony and Jones (1989) as Late Quaternary; however, Woodward and Clyde (1983) point to several factors that suggest Holocene displacements have occurred along the Palos Verdes Peninsula. These factors include the extensive deformation of the 120,000 year old terrace and apparent Holocene folding of the Gaffy anticline, a probable drag feature related to movement on the Palos Verdes Fault. This portion of the Fault is considered active despite the lack of unequivocal evidence for Holocene displacement.

The Santa Monica Bay segment is inferred to be a Late Quaternary feature by Ziony and Yerkes, (1985); however, increased seismicity in this offshore area, especially in association with the longest, single coherent strand in Santa Monica Bay, suggests that this segment is active.

Raymond Fault Zone

The Raymond Fault Zone consists of one to three strands, which diverge from the Sierra Madre Fault Zone in the area of Monrovia and trend to South Pasadena. Ziony and Yerkes (1985) indicate that the sense of movement on the Fault is reverse-left-oblique. Crook, et al., (1987) have presented a detailed description of numerous physiographic features that attest to the Fault's recent activity. The most impressive feature is the nearly continuous fault scarp between Monrovia Canyon and Arroyo Seco. The Fault displaces recent alluvium and forms a significant groundwater barrier, which has been the subject of several previous studies.

Numerous trench studies and radiometric dating of exposed sediments has allowed definition of five major seismic events in the last 36,000 to 155,000 years B.P., and an additional three events, which cannot be dated precisely in the last 29,000 years (Crook, et al., 1987). Crook, et al., (1987) infer an average recurrence interval of 3,000 years, with an average vertical displacement of 0.4 meters per event. A maximum credible earthquake of ML6-3/4 can reasonably be assumed if the entire 22 kilometer length of the Fault were to break. Crook, et al., (1987) have also recognized a scarp feature in alluvium on the south side of the Raymond Fault in the South Pasadena area. This Fault, named the York Boulevard Fault, lies outside of the APSSZ, but due to its close proximity, is identified as active.

Redondo Canyon Fault

The Redondo Canyon Fault is presumed to be a single strand, which strikes 80 to 85 degrees east of north as it trends offshore from a point just north of the Palos Verdes Peninsula down Redondo Canyon. The fault length is approximately 13 kilometers and the dip is unknown. Scattered small earthquakes have occurred near the fault trace.

San Andreas Fault Zone

The San Andreas Fault Zone extends from northwest to southeast across the County. Numerous fault related geomorphic features, such as linear troughs are present over much of its length. The sense of displacement on the Fault is right-lateral strike-slip and most faults within the zone are vertical (ZionyandYerkes, 1985). The California Geological Survey (formerly known as the California Division of Mines and Geology) has completed a multi-year study of the San Andreas Fault through which detailed maps of the Fault Zone and the geologic units they affect have been compiled (Barrows, 1979; Beeby, 1979; Kahle, 1980; Barrows, et al., 1985).

Activity along the San Andreas Fault Zone has been recorded during historic events, including the Magnitude 7.1, 1989 Lorna Prieta Earthquake, the 1906 Magnitude 8 earthquake in San Francisco, and the 1857 Magnitude 7.9 Fort Tejon event. The segment in the County is one of eight discrete fault segments, with each segment exhibiting a unique character and return period for damaging earthquakes along strike of the more than 1,000 kilometer long fault. The 1857 event is believed to have ruptured the section in County.

Offset stratigraphy of Holocene deposits provides evidence that rupture occurs on the San Andreas Fault at Pallet Creek on the average of every 145 to 200 years (Seih, 1984). This work has given rise to an assessment that the Mojave Segment stands a 30 percent chance of being the origin of a 7.5 Magnitude earthquake by the year 2018 (Davis, et al., 1988).

San Antonio Fault

The San Antonio Fault is not well studied. It is a left-lateral strike slip fault interposed and oblique to the San Andreas and Sierra Madre/Cucamonga Fault Zones. On the basis of seismicity data, Hauksson (in press) has suggested that it maybe a northern segment of the San Jose Fault, which has been associated with significant seismicity. However, it is its suspect relationship (tear fault) with the Cucamonga and the Sierra Madre faults, and reports of fault trench evidence showing left-lateral displacement of the Cucamonga Fault by the San Antonio Fault, that suggest the fault should be considered active; at least until detailed investigation proves otherwise.

San Fernando Fault Zone

The San Fernando Fault was not known until February 9, 1971, at which time it ruptured and caused extensive damage in the northern and eastern San Fernando Valley. The San Fernando Fault is comprised of five major reverse-left-oblique en echelon strands that vary in strike from 75 degrees east of north to 70 degrees west of north. The Fault dips 50 degrees north near the surface and shallows to 35 degrees north at depth. The total length is at least 17 kilometers (Ziony and Yerkes, 1985).

The five segments consist of:

- **Reservoir Segment:** Extends from the lower Van Norman reservoir embankment eastward along the east flank of a series of low hills where it meets the Mission Wells segment.
- **Mission Wells Segment:** Located 1.5 kilometers east of Lower Van Norman Lake. Small south facing scarps define the trends of the fault segment. Surface cracks from the 1971 earthquake displayed left lateral offsets (USGS, 1971).
- **Sylmar Segment:** Well-defined zone of fractures that extends from the southern corner of Hubbard Street and Glenoaks Boulevard to south of Lopez Dam. The zone generally ranges from 75 to more than 200 meters in width (USGS, 1971).
- **Tujunga Thrust:** Extends along the base of the hills on the north side of Tujunga Valley eastward into Little Tujunga Canyon.
- **Lake View Segment:** Continuation of Tujunga segment, trends eastward along the low hills from Little Tujunga Wash to Big Tujunga Wash.

These faults were zoned within the APSSZ Act in 1976. It is generally recognized that the eastern fault segments are structurally related to the Sierra Madre Fault System; however, the structural relationship of the western segment is less well-defined. The western San Fernando segment may have structural ties to the Mission Hills Fault.

San Gabriel Fault

The San Gabriel Fault is reported by Ziony and Yerkes (1985) to consist of a zone of en echelon strands striking 45 to 65 degrees west of north with dips between 50 to 80 degrees toward the north. The Fault displays a complex sense of movement that appears to change from one section of the fault to another (Stitt, 1986). The San Gabriel Fault has been divided by various workers into a number of different segmentation schemes (Ehlig, 1973; Weber, 1979; Ziony andYerkes, 1985; Stitt, 1986; Wesnousky, 1987).

Recent exploratory subsurface work near Castaic indicates that a portion of the segment cuts Holocene alluvium dated by radiocarbon methods as 8140 ± B.P., 777 ± 60 years B.P., and 3500 ± 250 years B.P. (Cotton, 1986). The State has designated a 10 kilometer portion of the San Gabriel Fault that includes this site as an APSSZ fault. Stitt (1986) has stated that the segment of the San Gabriel Fault to the northwest is apparently not Late Quaternary because the fault is buried by the Plio-Pleistocene Hungry Valley Formation. However, Roquemore, 1989 (personal communication) has submitted evidence for Holocene movement in the Violin Canyon area to the APSSZ fault evaluation program in apparent contradiction to Stitt's (1986) interpretation. In light of this evidence, the active segment of the San Gabriel Fault is extended to Violin Canyon. Ziony and Jones (1989) concur with this interpretation. Segment SG-B is arbitrarily extended to the southeast until the San Gabriel splits into the Dillon and Demille Fault. Weber (1979) notes that the evidence for the recency of faulting becomes less clear-cut at this point. The geomorphic and stratigraphic evidence documented by

Weber (1979) still suggests Late Quaternary movement.

Santa Cruz-Catalina Ridge Fault Zone

The Santa Cruz-Catalina Ridge fault zone is a right-lateral strike-slip fault that strikes northwest from the offshore area south of Santa Catalina Island and terminates at the faults that make up the province boundary that separates the western Transverse Ranges from the California continental borderland (Vedder, 1987; Legg, 1992). This fault connects to the southeast with the San Diego Trough fault [292] through a left restraining bend at Santa Catalina Island (Legg and Borrero, 2001; Legg and others, 2003).

The Santa Cruz-Santa Catalina fault zone extends through the Catalina terrane, which underlies the area west of the coast of the California mainland where Miocene extension unroofed a metamorphic core complex (Catalina Schist) (*e.g.*, Bohannon and Geist, 1998; Wilson and others, 2005). Following the Miocene extension, the region underwent transpression, and strike-slip faults formed. The metamorphic basement exposed during the Miocene is buried beneath middle Miocene and younger sedimentary deposits. Regional strike-slip faults, like Santa Cruz-Santa Catalina fault zone, probably developed along pre-existing structural features, such as extensional faults. Chaytor and others (2008) proposed that as much as 50 km of dextral strike-slip offset has occurred along the Santa Cruz-Catalina Ridge fault zone.

Santa Monica Fault

North-dipping, generally high-angle surface fault (shallower at depth) is part of east-west frontal fault system (also including Anacapa-Dume [100], Malibu Coast [99], Hollywood [102] and Raymond [103] faults) that has accommodated 80° of clockwise rotation of the western Transverse Ranges and perhaps as much as 60 km left slip displacement since early Miocene (Hornafius and others, 1986); modern activity is combination of continued strike-slip movement and compression (Dolan and others, 1995; Dolan and others, 2000).

Santa Susana Fault

The Santa Susana Fault dips north along the southern flank of the Santa Monica Mountains, extending eastward until it merges with the Sierra Madre Fault System (Yeats, 1987). Wenousky (1986) and Ziony and Yerkes (1985) assign a length of 38 kilometers and 28 kilometers, respectively. The Fault dips 0 to 30 degrees in the near surface, which results in a fault zone width between 0.25 and 1.5 kilometers (Ziony and Yerkes, 1985).

The eastern portion of the Fault experienced reverse-left-oblique sympathetic rupture during the 1971 San Fernando Earthquake (Saul and Weber, 1975). This portion of the Fault has been designated an APSSZ fault. To the west of the APSSZ, in the Porter Ranch area, subsurface trench investigations have revealed minor faults within terrace deposits. No faulting was observed within an overlying fanglomerate that was carbon-dated as 10,010± 580 years y.b.p. (Lung and Weick, 1987). However, massive landsliding and bedding plane faulting have been prevented an unequivocal determinations of the age of faulting for this portion of the fault. Based on this uncertainty, the western portion of the fault is considered active.

Sierra Madre Fault System

The Sierra Madre Fault System lies at the southern base of the San Gabriel Mountains. Ziony and

Yerkes (1985) indicate that the Fault System consists of one to five anastomosing strands in a zone as wide as one kilometer. The Fault System has a reverse sense of slip and forms a complex zone with two identified sections. Each section consists of a mechanically coherent salient (Crook, et al., 1987). These sections extend: 1) from Mount Wilson to Big Tujunga Canyon (14 kilometers); and 2) from Big Tujunga Canyon to Arroyo Seco (17 kilometers). Crook, et al., (1987) estimate a maximum credible earthquake of magnitude (ML) 7 for these segments, and an average recurrence interval between major shocks longer than 5,000 years.

The fault segments in numerous places have juxtaposed basement bedrock over alluvium and dip northerly below the steep topographic front of the San Gabriel Mountains. Barriers to groundwater flow have been cited as evidence of alluvial-buried faults of the Sierra Madre Fault System (Proctor and Kalin, 1965; Shelton, 1955). Offset Holocene deposits are reported along the two segments and have been designated as APSSZ faults. The mechanically distinct segments are designated active. Note that the APSSZ segment is correctly identified as a segment of the Sierra Madre Fault and not as the Mount Lukens Thrust, as described by Smith, 1978.

Verdugo Fault

The Verdugo Fault trends northward along the west flank of the Verdugo Mountains and separates a Precambrian Age basement complex on the east from alluvial and sedimentary Tertiary strata on the west. The Fault consists of multiple strands in a zone 0.5 to 1.0 kilometers in width as evidenced by southwest facing scarps in alluvium in the Burbank area (Ziony and Yerkes, 1985; Weber, et al., 1980). The fault apparently dips 45 to 60 degrees to the northeast and forms groundwater cascades in the alluvium north of the terminus of the Verdugo Mountains. On the north, the Fault may curve westward and join the Mission Hills Fault. To the southeast of the Verdugo Mountains, the Fault becomes less well-defined and shallows in dip as it trends through Verdugo Wash where it apparently connects with the Eagle Rock Fault. Groundwater cascades and surface scarps are evidence of recent activity along the Fault (Weber, et al., 1980).

Whittier Fault Zone

The Whittier Fault Zone consists of one to three subparallel strands in a zone as wide as 1.2 kilometers. The length of the Whittier Fault to the point where it merges with the Elsinore Fault Zone is approximately 45 kilometers; however, Wesnousky (1986) has defined a longer Whittier segment (74 kilometers). The 14 kilometer length within the County strikes 65 to 85 degrees to the northwest and dips 65 to 80 degrees to the north. The sense of movement on the Whittier Fault is believed to be reverse right oblique (Ziony and Yerkes, 1985), or nearly pure right slip (Gath and Rockwell, in press). Evidence of offset Holocene stratigraphy northwest of Brea Canyon in Orange County is recognized by Ziony and Jones (1989); however, these workers interpret the northwesternmost portion of the Whittier Fault in the County as late Quaternary. Gath, et al., (1988) and Leighton, et al., (1987) have uncovered evidence of offset Holocene stratigraphy four kilometers east of the City of Whittier in Arroyo San Miguel near Colima Boulevard. Based on these trench studies, the Fault is considered active along its entire length in the County.

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II. Zones of Required Investigation

The Seismic Hazards Mapping Act (SHMA) of 1990 (Public Resources Code, Chapter 7.8, Section 2690-2699.6) directs the Department of Conservation, California Geological Survey to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides and amplified ground shaking. The purpose of the SHMA is to reduce the threat to public safety and to minimize the loss of life and property by identifying and mitigating these seismic hazards. The SHMA was passed by the legislature following the 1989 Loma Prieta earthquake.

A Seismic Hazard Zone is a regulatory zone that encompasses areas prone to liquefaction (failure of water-saturated soil) and earthquake-induced landslides.

Liquefaction occurs when loose, water-saturated sediments lose strength and fail during strong ground shaking. Liquefaction is defined as the transformation of granular material from a solid state into a liquefied state as a consequence of increased pore-water pressure. The process of zoning for liquefaction combines Quaternary geologic mapping, historical ground-water information and subsurface geotechnical data. Required Investigation boundaries are based on the presence of shallow historic groundwater (< 40 feet depth) in uncompacted sands and silts deposited during the last 15,000 years and sufficiently strong levels of earthquake shaking expected during the next 50 years.

Landslides tend to occur in weak soil and rock on sloping terrain. The landslide hazard Zone of Required Investigation boundaries generally indicate steep hillslopes composed of weak materials that may fail when shaken by an earthquake. The process for zoning earthquake-induced landslides incorporates expected future earthquake shaking, existing landslide features, slope gradient, and strength of hillslope materials.

The SHMA requires the State Geologist to establish regulatory zones (Zones of Required Investigation) and to issue appropriate maps (Seismic Hazard Zone maps). These maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling construction and development. Single family frame dwellings up to two stories not part of a development of four or more units are exempt from the state requirements.

~~II~~ III. Awareness Floodplain Mapping

The intent of the Awareness Floodplain Mapping project by the California Department of Water Resources (DWR) is to identify all pertinent flood hazard areas by 2015 for areas that are not mapped under the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP). The Awareness project will also provide the community and residents with an additional tool in understanding potential flood hazards currently not mapped as a regulated floodplain. The awareness maps identify the 100-year flood hazard areas using approximate assessment procedures. These floodplains will be shown as flood prone areas without specific depths and other flood hazard data. ~~Awareness floodplain maps will be added as they become available.Figure H.1 identifies the currently mapped Awareness Floodplains for the unincorporated areas mapped in the following USGS quadrangles: Neenach School, Rosamond Lake, Redman, Burnt Peak, Lake Hughes, Del Sur, Lancaster West, Lancaster East, Alpine Butte, Hi Vista, Adobe Mountain, Warm Springs Mountain, Green Valley, Sleepy Valley, Ritter Ridge, Littlerock, Lovejoy Buttes, El Mirage, Newhall, Mint Canyon, Agua Dulce, Acton, Pacifico Mountain, Juniper Hills, Valyermo, Mescal Creek, Oat Mountain, San Fernando, Sunland, Condor Peak, Crystal Lake, Mount San Antonio, Burbank, Mt. Wilson, and Glendora.~~

For more information and to view the Awareness Floodplain Mapping layer, please visit DWR's Best Available Maps web mapping portal~~site~~ at:
~~http://www.water.ca.gov/floodmgmt/lrafmo/fmb/fes/awareness_floodplain_maps/los_angeles~~
http://gis.bam.water.ca.gov/bam/.

~~**Figure H.1: Awareness Floodplain Map**~~

III IV. Development in Flood Hazard Zones

Figures H.21 through H.43 represent existing and planned developments, and streets, which are located within the County's flood hazard zones.

Figure H.21: Existing Development in Flood Hazard Zones

Figure H.32: Planned Development in Flood Hazard Zones

Figure H.43: Streets in Flood Hazard Zones

IV V. Flood Repetitive Loss Sites

As of ~~January 3, 2011~~ September 2018, ~~FEMA~~County of Los Angeles Public Works (PW) identified ~~55~~54 repetitive loss properties located within unincorporated Los Angeles County. ~~The County has since reduced this number to 43 repetitive loss properties by clarifying property locations or incorporating flood hazard mitigation measures.~~ The County adopted a Comprehensive Floodplain Management Plan on ~~May 11, 2010~~ June 15, 2021 to mitigate the flooding of 35 repetitive loss properties. Four of the repetitive loss properties have been approved by FEMA as mitigated. The remaining 50 unmitigated repetitive loss properties were mapped into 24 repetitive loss areas. PW conducted a Repetitive Loss Area Analysis included mapping of the areas and recommended action items to address the problem.

For more information on the County's repetitive loss sites, please refer to Appendix I in the County's Comprehensive Floodplain Management Plan~~All-Hazard Mitigation Plan~~, which is available on ~~the CEO~~PW's web site at ~~http://lacoa.org/hazmit.htm.~~https://dpw.lacounty.gov/wmd/nfip/fmp/Plan.aspx.

V VI. Regulatory Agencies for Flood Management, Protection, and Financial Assistance

Table H.5: Federal, State, and Local Agencies Responsible for Flood Management, Protection, and Financial Assistance

Agency	Type
U.S. Army Corps of Engineers	Federal
Federal Emergency Management Agency	Federal
U.S. Bureau of Reclamation	Federal
Natural Resources Conservation Service	Federal
U.S. Fish and Wildlife Service	Federal
National Marine Fisheries Service	Federal
U.S. Environmental Protection Agency	Federal

U.S. Geological Survey	Federal
U.S. Small Business Administration	Federal
U.S. Department of Housing and Urban Development	Federal
California Department of Water Resources	State
California Water Commission	State
State Water Resources Control Board	State
California Department of Fish and Wildlife	State
State Lands Commission	State
California Emergency Management Agency	State
California Department of Housing and Community Development	State
California Department of Real Estate	State
Los Angeles County Department of Public Works	Local
Los Angeles County Flood Control District	Local
Los Angeles Office of Emergency Management	Local

~~VI~~ VII. Historic Wildfires in Los Angeles County

Table H.6: Los Angeles County Wildfire Incident Statistics, 2007-~~2011~~ 2020**

Fire Name	Year	Acres Burned	Structures	
			Damaged	*Destroyed*
Buckweed/ Agua Dulce	2007	38,356	30	43
Canyon	2007	4,500	14	8
Magic	2007	2,824	0	0
Ranch	2007	58,401	2	10

Meadow Ridge	2007	20	0	0
October	2007	100	0	0
Sayre	2008	11,262	0	634
Sesnon	2008	14,703	11	78
Marek	2008	4,824	10	42
Osito	2009	304	0	0
Morris	2009	2,168	0	0
Station	2009	160,577	57	209
Crown	2010	14,000	6	10
Briggs	2010	530	0	0
Oasis	2011	355	0	0
Wagon Wheel	2011	500	0	0
Mint	2011	634	0	0
Sage	2016	1,100	2	0
Old	2016	465	1	9
Fish	2016	4,253	0	0
Reservoir	2016	1,146	0	0
Sand	2016	41,383	20	116
Lake	2017	850	2	0
Creek	2017	15,619	81	123
Rye	2017	6,049	3	6
La Tuna	2017	7,194	0	5
Skirball	2017	422	13	9
Stone	2018	1,352	0	0

Charlie	2018	3,380	0	0
Woolsey***	2018	96,949	364	1,643
Saddle Ridge	2019	8,799	91	24
Tick	2019	3,950	46	29
Getty	2019	745	19	13
Totals		**~~314,058~~ 507,714**	**~~130~~ 772**	**~~1,034~~ 3,011**

Source: Cal Fire ~~Fire Incident Reports~~ Wildfire Activity Statistics

*Data on structures damaged and destroyed was not available for all wildfires, just for the ones listed above.

** Year 2020 statistics pending availability of 2020 Wildfire Activity Statistics from Cal Fire

*** Categorized under Ventura County by Cal Fire

Table H.7: Acres Burned in Los Angeles County, 2004-~~2013~~ 2020

Year	Unincorporated Areas	Other Jurisdictions	All Jurisdictions
2004	34,354	362	34,715
2005	5,221	23,835	29,056
2006	7,355	164	7,519
2007	116,894	2,231	119,125
2008	30,714	402	31,116
2009	162,266	871	163,136
2010	1,514	45	1,559
2011	1,813	64	1,883
2012	5,077	885	5,962
2013	31,464	282	31,746
2014	320	1,755	2,075
2015	943	343	1287
2016	42,762	5,796	48,559
2017	19,276	4,833	24,109
2018	49,728	13,377	63,106
2019	8,897	4,861	13,759
2020	149,987	4,516	154,503
Totals	**~~396,672~~ 668,586**	**~~29,141~~ 64,623**	**~~425,817~~ 733,214**

Source: Los Angeles County Fire Department, Information Management Section, ~~2013~~ 2021.

~~VII~~ VIII. Fire Department Functions

The following provides an overview of applicable functions of the County of Los Angeles Fire Department:

1. **Fire Prevention Division:** This Division is responsible for conducting plan checks for building, processes and fire extinguishing systems. The Division coordinates with building and safety officials, federal, state, city and County officials to implement the Title 26 Building (Wildland-Urban Interface and Chapter 7A) and the County Fire Code, Title 32.

   The Fire Prevention Division also focuses on educating the community about the benefits of proper safety practices and identifying and eliminating all types of hazardous conditions, which pose a threat to life, the environment and property. Commercial, industrial, and residential development and operations are processed and inspected.

2. **Forestry Division:** The Forestry Division enforces and observes all orders and ordinances of the Board of Supervisors pertaining to forest, brush, and other fires, and all statutes relating to prevention or extinguishment of forest, brush or grass fires. The Division cooperates with the State Forester and the Federal Forest Supervisors in the prevention and suppression of forest fires in the County of Los Angeles. The Forestry Division coordinates inspections with Emergency Operations personnel on private lands for the purpose of determining if a fire hazard exists. Where it is found that a fire hazard exists, the County Forester orders the owner or person responsible to abate or diminish such hazard. County Foresters educate the public about fire prevention and the conservation of natural resources, and disseminate such information by means of lectures, motion pictures, slides or other projection of pictures, displays and exhibits, or by any other appropriate means. The Forestry Division program areas are:

   Conservation Education

   Urban and Wildland Forestry Programs

   Fire Hazard Reduction Programs

   Oak Tree Ordinance

   Fire Weather/Fire Danger

   Emergency Incident Services

   Wildland Urban Interface/Fire Safety Organizations

   - **Environmental Review Unit:** This unit works with the Department of Regional Planning (DRP) to implement existing environmental ordinances. ~~The u~~Unit personnel review all County Oak Tree Permit applications submitted to DRP, and develop recommendations for implementation. Additionally, ~~the~~ unit personnel produce environmental documentation and recommendations, such as non-significant impact documents, negative declarations and mitigation measures consistent with California Environmental Quality Act (CEQA) mandates for construction projects and developments. The County Forester and Fire Warden are also represented on the

Subdivision Committee, which advises the Regional Planning Commission and Hearing Examiner (Title 21, Subdivisions, Section 21.12.010).

- **Fuel Modification Unit:** This unit provides guidelines and reviews ~~the~~ landscape and irrigation plans submitted by the property owner for approval before construction or remodeling of a structure. As described in the Strategic Fire Plan, the objective of the Fuel Modification Unit is to create the defensible space necessary for effective fire protection in newly constructed and/or remodeled homes within the Department's Fire Hazard Severity Zones (FHSZ). Fuel modification reduces the radiant and convective heat, and provides valuable defensible space for firefighters to make an effective stand against an approaching fire front. Fuel modification zones are strategically placed as a buffer to open space or areas of natural vegetation and generally would occur surrounding the perimeter of a subdivision, commercial development, or isolated development of a single-family dwelling.

- **Brush Clearance Unit:** The Brush Clearance Program is a joint effort between the Fire Department and the County of Los Angeles Department of Agricultural Commissioner/Weights and Measures, Weed Hazard and Pest Abatement Bureau (Weed Abatement Division). This unified enforcement legally declares both improved and unimproved properties a public nuisance, and where necessary, requires the clearance of hazardous vegetation. The Department's Brush Clearance Unit enforces the Fire Code as it relates to brush clearance on improved parcels, coordinates inspections and compliance efforts with fire station personnel, and provides annual brush clearance training to fire station personnel.

- **Fire Plan Unit/Fire Safe Councils:** The Fire Plan Unit coordinates countywide projects and provides direction in the planning of pre-fire projects.

  Fire Safe Councils are grassroots community-based organizations that share the objective of making California's communities less vulnerable to catastrophic wildfire. Fire Safe Councils accomplish this objective through education programs and fire hazard reduction projects such as shaded fuel breaks or home structure hardening to protect area residents against an oncoming wildfire and to provide fire fighters with a place to fight the oncoming fire.

  The Fire Plan Unit supports ~~the~~ fire prevention efforts of ~~the~~ local Fire Safe Councils, assisting with project planning and implementation. Projects include hazardous tree and plant removal and trimming as well as fuel break treatment. A list of geographically-specific fire risk reduction projects (operational and proposed) is published annually in the Strategic Fire Plan.

~~[Text Box]~~

VIII. Post-Fire Safety, Recovery and Maintenance

The Fire Department's Forestry Division implements post-fire reforestation projects to create resilient landscapes and restore functioning ecosystems. For example, the Forestry Division operates nurseries to supply native plants for revegetation of burned areas.

The Fire Department uses Cal MAPPER (CAL FIRE's Management Activity Project Planning Event Reporter) as the Department's designated GIS database for collecting activity and fiscal data on forest and fuels reduction projects executed through the County. CAL MAPPER assists with project planning and maintenance, risk assessment, performance measures and emergency response.

The following are additional programs at the County for Post-Fire Safety, Recovery, and Maintenance:

- **Coordinated Agency Recovery Effort (C.A.R.E):** During storm season there is an elevated risk of flooding, as well as an increased threat of mud and debris flows, particularly in foothill communities and in communities below recent wildfire burn areas. After the 2009 Station Fire, the Los Angeles County Public Works Department developed the Coordinated Agency Recovery Effort (C.A.R.E.), a multi-agency media and community outreach campaign. C.A.R.E. partners include County Public Works, Sheriff's and Fire Departments, the County Office of Emergency Management, the U.S. Forest Service, U.S. Geological Survey, the National Incident Management Organization, the National Weather Service, the California Department of Transportation (Caltrans), the American Red Cross, and the City of Los Angeles. C.A.R.E. program elements and community resources include a speakers' bureau for community meetings; educational/storm preparation materials; and information on road closures and evacuations, weather forecasts and updates, and links to other emergency response and recovery agencies. In addition, C.A.R.E.'s eNotfiy System allows at-risk residents to register to receive storm-related updates and alerts. More information on C.A.R.E. is available at http://dpw.lacounty.gov/care/.

- **Burned Area Emergency Response (BAER) and State Emergency Assessment Teams (SEATs):** While many wildfires cause little damage to the land and pose few threats to fish, wildlife and people downstream, some fires create situations that require special efforts to prevent further catastrophic damage after the fire. Loss of vegetation exposes soil to erosion; runoff may increase and cause flash flooding; sediments may move downstream and damage houses or fill reservoirs; and put endangered species and community water supplies may be at risk. The Burned Area Emergency Response (BAER) federal program and State Emergency Assessment Teams (SEAT) program address these situations with the goal of protecting life, property, water quality, and deteriorated ecosystems from further damage after the fire is out. Concern for possible post-fire effects on fish, wildlife, archeological sites and endangered species is often a primary consideration in the development of BAER and SEAT plans.

- **Wildland-Urban Interface Fire Safety Organizations:** The Fire Department is represented in many local collaborative fire safety and prevention efforts. These include the following:

California Fire Safe Council (CFSC)

California Fire Safe Council's mission is to "mobilize Californians to protect their homes, communities and environment from wildfires." California Fire Safe Council was formed as a committee of the California Department of Forestry and Fire Protection (CDF) (now called CAL FIRE) in 1993 and its intent was to bring together governmental agencies and corporations to provide education to the residents of California on the dangers of wildfires and how they could be prevented. For more information, please visit www.cafiresafecouncil.org.

Santa Monica Mountains Fire Safe Alliance (SMMFSA)

The mission of the Santa Monica Mountains Fire Safe Alliance, a collaboration of related public agencies, departments, and communities, is to find solutions and resources for property owners and land managers to improve stewardship in the wildland-urban interface. Integration of best management practices will create defensible space while protecting wildland. The Alliance will help create safer communities and protect natural areas by involving and educating stakeholders, sharing information, and locating and providing beneficial resources.

~~**Southern California Regional Area Safety Task Force (SoCal RAST)**~~

~~The SoCal RAST is an organization formed to speak with a unified, forward-thinking voice to facilitate regional collaborative fire shed management, planning, and local implementation activities that foster safe and sustainable communities. Members include invited entities from federal, state, and county or multi-county levels. In addition, other participants include Fire Safe Councils and business that deal with related issues. For more information, please visit www.socalrast.org.~~

Sustainable and Fire ~~Safe~~Resistant Landscapes (~~S.A.F.E.~~SAFER Landscapes)

Fire safety in the wildland-urban interface starts in the home, with the use of fire-resistant building materials and architectural features, practices to avoid starting fires in and around the home, and a household fire response plan. University of California Cooperative Extension provides information on maintaining sustainable and fire-safe landscapes in the home and beyond. For more information, please visit http://ucanr.edu/sites/SAFELandscapes/.

Los Angeles County Weed Management Area (LAWMA)

The WMA brings together local landowners, managers, and stewards to coordinate efforts and expertise against invasive plant species. For more information, please visit http://lacountywma.org.

Center for Invasive Species Research (CISR)

Inadvertent introductions of exotic insect pests, plant diseases, weeds, and other noxious organisms (e.g., exotic crabs and mussels) pose a major and continuing threat to California's agricultural, urban, and natural environments as well as the state's precious supplies of fresh water. The Center for Invasive Species Research, based at the University of California, Riverside, provides a forward-looking approach to managing invasions by exotic pests and diseases. The Fire Department's Forestry Division alerts CISR when invasive species are discovered. For more information, please visit http://cisr.ucr.edu/.

VIIII. Possible Evacuation Routes

Methodology for Identifying Possible Evacuation Routes

Evacuation routes are determined by emergency responders at the time of the emergency the routes that should be used for evacuation after assessing the conditions and location of the emergency to avoid endangering the lives of others, personal injury, or death. Roads that were (1) public, (2) paved, and (3) through-ways were identified as possible evacuation routes.

To identify these roads, two datasets were combined: (1) the Master Plan of Highways (updated May 30, 2019), and (2) the Countywide Address Management System (CAMS). The Master Plan of Highways designates roadways in Los Angeles County by their planned capacity. All roads from this dataset were coded possible evacuation routes because all roads were public and paved. From the CAMS dataset, all primary and secondary roads were coded as possible evacuation routes because they met all three criteria. Other categories in the CAMS dataset, such as trails, dirt roads, onramps, offramps, some driveways, some private roads, and pedestrian walkways were excluded. Gates or road obstacles were not identified due to lack of data. Information on the capacity of these roads is available by clicking on the following links: (1) Master Plan of Highways - Overview (arcgis.com), and (2) CAMS Data (arcgis.com).

The County also classifies some roads as disaster routes (last updated September 9, 2015 by PW). Disaster routes are freeway, highway or arterial routes pre-identified for use during times of crisis. These routes are utilized to bring in emergency personnel, equipment, and supplies to impacted areas in order to save lives, protect property, and minimize impact to the environment. During a disaster, these routes have priority for clearing, repairing, and restoration over all other roads. Disaster routes are not evacuation routes. Although an emergency may warrant a road to be used as both a disaster and evacuation route, an evacuation route is used to move affected populations out of an impacted area.

Methodology for Identifying Communities with Residential Developments with Limited Egress

A list of unincorporated communities was compiled using a combination of Countywide Statistical Areas (CSA) and the County of Los Angeles Chief Executive Office's List of Unincorporated Communities. As some CSAs are quite large, such as the Santa Monica Mountains and the Antelope Valley, combining CSAs and community names as the unit for analysis enabled a refined identification of residential developments with access to fewer than two possible evacuation routes. The list of unincorporated communities from the Chief Executive Office is here: https://ceo.lacounty.gov/wp-content/uploads/2018/08/Unincorp-Alpha-Web.pdf

A multi-step process was undertaken to determine communities with residential developments with access to fewer than two possible evacuation routes. Residential developments, based upon zones that allow for residential development, located on non-through streets were identified. The possible evacuation routes were overlaid to determine if these residential developments were able to access two possible evacuation routes. The CSA was used as the unit basis for determining whether or not a community contained a residential development with access to fewer than two possible evacuation routes. If a minimum of one residential development within the CSA had access to fewer than two possible evacuation routes, the CSA would be identified as having limited egress. The community names found on the County Chief Executive Office's List of Unincorporated Communities was then used to augment the CSA community names to refine the referenced community. Unincorporated communities that had only one possible evacuation route were flagged and included in Table 12.2. These communities are visible on the Residential Developments with Limited Egress mapping application (http://bit.ly/SE-SB99).