

# Section 5: Earthquake Hazards in the City of Rolling Hills

## Why Are Earthquakes a Threat to the City of Rolling Hills?

The most recent significant earthquake event affecting Southern California was the January 17<sup>th</sup> 1994 Northridge Earthquake. At 4:31 A.M. on Monday, January 17, a moderate but very damaging earthquake with a magnitude of 6.7 struck the San Fernando Valley. In the following days and weeks, thousands of aftershocks occurred, causing additional damage to affected structures.

57 people were killed and more than 1,500 people seriously injured. For days afterward, thousands of homes and businesses were without electricity; tens of thousands had no gas; and nearly 50,000 had little or no water. Approximately 15,000 structures were moderately to severely damaged, which left thousands of people temporarily homeless. 66,500 buildings were inspected. Nearly 4,000 were severely damaged and over 11,000 were moderately damaged. Several collapsed bridges and overpasses created commuter havoc on the freeway system. Extensive damage was caused by ground shaking, but earthquake triggered liquefaction and dozens of fires also caused additional severe damage. This extremely strong ground motion in large portions of Los Angeles County resulted in record economic losses.

However, the earthquake occurred early in the morning on a holiday. This circumstance considerably reduced the potential effects. Many collapsed buildings were unoccupied, and most businesses were not yet open. The direct and indirect economic losses ran into the 10's of billions of dollars.

Historical and geological records show that California has a long history of seismic events. Southern California is probably best known for the San Andreas Fault, a 400 mile long fault running from the Mexican border to a point offshore, west of San Francisco. "Geologic studies show that over the past 1,400 to 1,500 years large earthquakes have occurred at about 130 year intervals on the southern San Andreas Fault. As the last large earthquake on the Southern San Andreas occurred in 1857, that section of the fault is considered a likely location for an earthquake within the next few decades."<sup>1</sup>

But San Andreas is only one of dozens of known earthquake faults that crisscross Southern California. Some of the better known faults include the Newport-Inglewood, Whittier, Chatsworth, Elsinore, Hollywood, Los Alamitos, Puente Hills, and Palos Verdes Faults. Beyond the known faults, there are a potentially large number of "blind" faults that underlie the surface of Southern California. One such blind fault was involved in the October 1987 Whittier Narrows Earthquake.

Although the most famous of the faults, the San Andreas, is capable of producing an earthquake with a magnitude of 8+ on the Richter Scale, some of the "lesser" faults have the potential to inflict greater damage on the urban core of the Los Angeles Basin. Seismologists believe that a 6.0 earthquake on the Newport-Inglewood Fault would result in far more death and destruction than a "great" quake on the San Andreas Fault, because the San Andreas Fault is relatively remote from the urban centers of Southern California.

For decades, partnerships have flourished between the USGS, Cal Tech, the California Geological Survey and universities to share research and educational efforts with Californians. Tremendous earthquake mapping and mitigation efforts have been made in California in the past two decades, and public awareness has risen remarkably during this time. Major federal, state, and local government agencies and private organizations support earthquake risk reduction, and have made significant contributions in reducing the adverse impacts of earthquakes. Despite the progress, the majority of California communities remain unprepared because there is a general lack of understanding regarding earthquake hazards among Californians.

**Table 5-1: Earthquake Events in the Southern California Region**

Southern California Region Earthquakes with a Magnitude 5.0 or Greater			
1769	Los Angeles Basin	1916	Tejon Pass Region
1800	San Diego Region	1918	San Jacinto
1812	Wrightwood	1923	San Bernardino Region
1812	Santa Barbara Channel	1925	Santa Barbara
1827	Los Angeles Region	1933	Long Beach
1855	Los Angeles Region	1941	Carpenteria
1857	Great Fort Tejon Earthquake	1952	Kern County
1858	San Bernardino Region	1954	W. of Wheeler Ridge
1862	San Diego Region	1971	San Fernando
1892	San Jacinto or Elsinore Fault	1973	Point Mugu
1893	Pico Canyon	1986	North Palm Springs
1894	Lytle Creek Region	1987	Whittier Narrows
1894	E. of San Diego	1992	Landers
1899	Lytle Creek Region	1992	Big Bear
1899	San Jacinto and Hemet	1994	Northridge
1907	San Bernardino Region	1999	Hector Mine
1910	Glen Ivy Hot Springs		
Source: <a href="http://geology.about.com/gi/dynamic/offsite.htm?site=http%3A%2F%2Fpasadena.wr.usgs.gov%2Finfo%2Fcahist_eqs.html">http://geology.about.com/gi/dynamic/offsite.htm?site=http%3A%2F%2Fpasadena.wr.usgs.gov%2Finfo%2Fcahist_eqs.html</a>			

To better understand the earthquake hazard, the scientific community has looked at historical records and accelerated research on those faults that are the sources of the earthquakes occurring in the Southern California region. Historical earthquake records can generally be divided into records of the pre-instrumental period and the instrumental

period. In the absence of instrumentation, the detection of earthquakes is based on observations and felt reports, and is dependent upon population density and distribution. Since California was sparsely populated in the 1800s, the detection of pre-instrumental earthquakes is relatively difficult. However, two very large earthquakes, the 1857 Fort Tejon Earthquake (7.9) and the 1872 Owens Valley (7.6) are evidence of the tremendously damaging potential of earthquakes in Southern California. In more recent times two 7.3 earthquakes struck Southern California, in 1952 Kern County and 1992 Landers Earthquakes. The damage from these four large earthquakes was limited because they occurred in areas which were sparsely populated at the time they happened. The seismic risk is much more severe today than in the past because the population at risk is in the millions, rather than a few hundred or a few thousand persons.

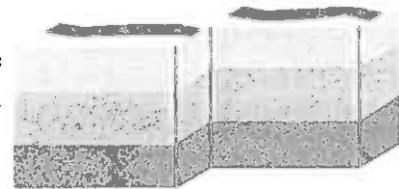
### History of Earthquake Events in Southern California

Since seismologists started recording and measuring earthquakes, there have been tens of thousands of recorded earthquakes in Southern California, most with a magnitude below three. No community in Southern California is beyond the reach of a damaging earthquake. Figure 5-1 describes the historical earthquake events that have affected Southern California.

**Figure 5-1: Causes and Characteristics of Earthquakes in Southern California**

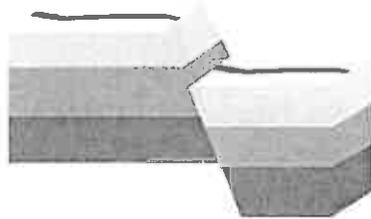
#### Earthquake Faults

A fault is a fracture along blocks of the earth's crust where either side moves relative to the other along a parallel plane to the fracture.



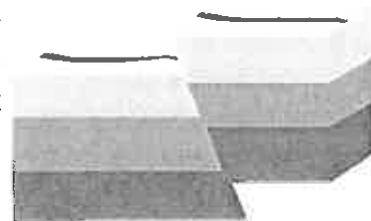
#### Strike-slip

Strike-slip faults are vertical or almost vertical rifts where the earth's plates move mostly horizontally. From the observer's perspective, if the opposite block looking across the fault moves to the right, the slip style is called a right lateral fault; if the block moves left, the shift is called a left lateral fault.



#### Dip-slip

Dip-slip faults are slanted fractures where the blocks mostly shift vertically. If the earth above an inclined fault moves down, the fault is called a normal fault, but when the rock above the fault moves up, the fault is called a reverse fault. Thrust faults have a reverse fault with a dip of 45 ° or less.



Dr. Kerry Sieh of Cal Tech has investigated the San Andreas Fault at Palmett Creek. "The record at Palmett Creek shows that rupture has recurred about every 130 years, on average,

over the past 1500 years. But actual intervals have varied greatly, from less than 50 years to more than 300. The physical cause of such irregular recurrence remains unknown.”<sup>2</sup> Damage from a great quake on the San Andreas Fault would be widespread throughout Southern California.

## **Earthquake Related Hazards**

Ground shaking, landslides, liquefaction, and amplification are the specific hazards associated with earthquakes. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake.

### **Ground Shaking**

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

### **Earthquake-Induced Landslides**

Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy the roads, buildings, utilities, and other critical facilities necessary to respond and recover from an earthquake. Many communities in Southern California have a high likelihood of encountering such risks, especially in areas with steep slopes.

### **Liquefaction**

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures. Many communities in Southern California are built on ancient river bottoms and have sandy soil. In some cases this ground may be subject to liquefaction, depending on the depth of the water table.

### **Amplification**

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk.<sup>3</sup> Amplification can also occur in areas with deep sediment filled basins and on ridge tops.

**Map 5-1: Seismic Zones in California**



**Darker Shaded Areas indicate Greater Potential Shaking**

**Source: USGS Website**

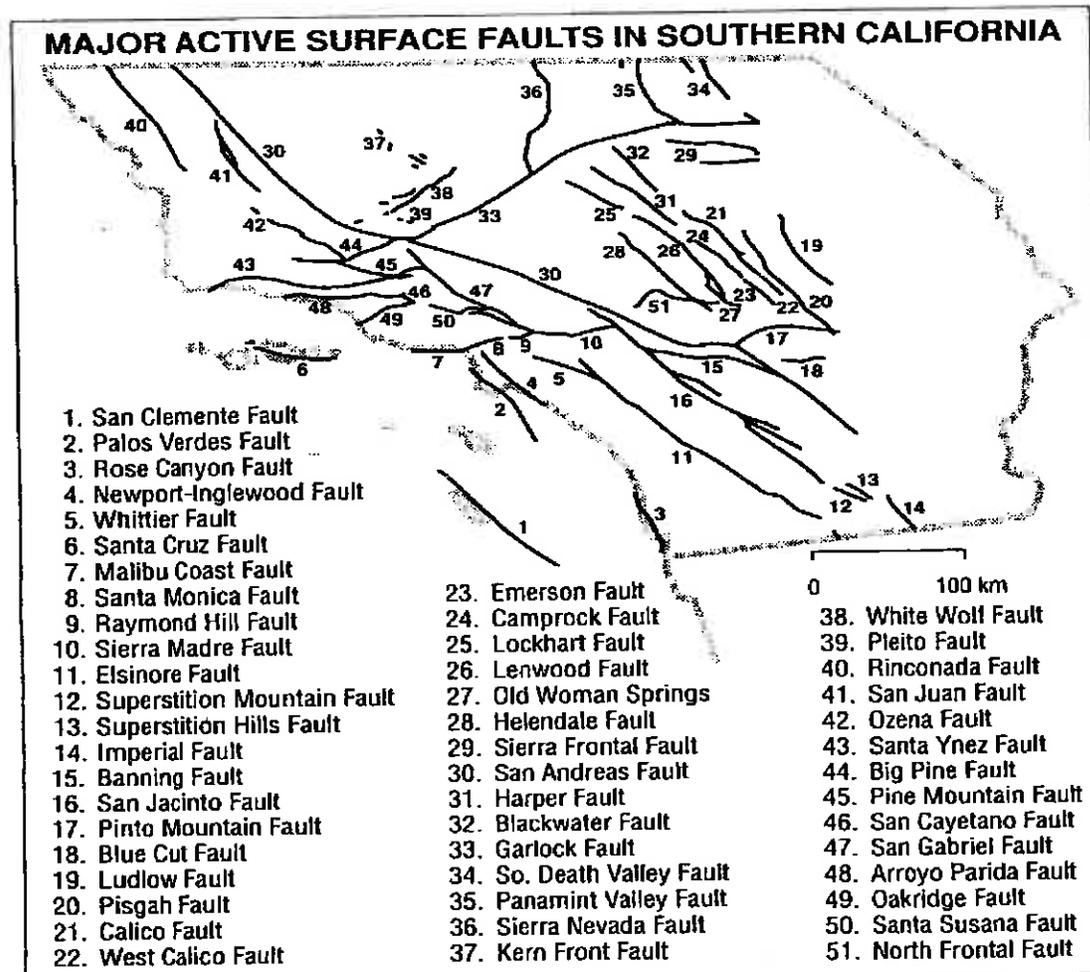
## Earthquake Hazard Assessment

### Hazard Identification

In California, many agencies are focused on seismic safety issues: the State's Seismic Safety Commission, the Applied Technology Council, Governor's Office of Emergency Services, United States Geological Survey, Cal Tech, the California Geological Survey as well as a number of universities and private foundations.

These organizations, in partnership with other state and federal agencies, have undertaken a rigorous program in California to identify seismic hazards and risks including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. Seismic hazard maps have been published and are available for many communities in California through the State Division of Mines and Geology. Map 5-2 illustrates the known earthquake faults in Southern California.

Map 5-2: Major Active Surface Faults in Southern California



Source: Adapted from the map of major active Southern California surface faults published in "Seismic Hazards in Southern California: Probable Earthquakes, 1994-2024." Southern California Earthquake Center.

In California, each earthquake is followed by revisions and improvements in the Building Codes. The 1933 Long Beach Earthquake resulted in the Field Act, affecting school construction. The 1971 Sylmar Earthquake brought another set of increased structural standards. Similar re-evaluations occurred after the 1989 Loma Prieta and 1994 Northridge Earthquakes. These code changes have resulted in stronger and more earthquake resistant structures.

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. Surface rupture is the most easily avoided seismic hazard.<sup>4</sup>

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.<sup>5</sup> The State Department of Conservation operates the Seismic Mapping Program for California.

Extensive information is available at their website:

<http://gmw.consrv.ca.gov/shmp/index.htm>

The following maps depict projected seismic intensities for earthquakes on both the Palos Verdes and Newport-Inglewood Faults (Source: California Department of Conservation). The Palos Verdes scenario is for a Magnitude 7.1 earthquake. The City of Rolling Hills is located on or very near the Palos Verdes Fault. As shown on the map, the “perceived shaking” in this projected event would be “Extreme”. There is no doubt whatsoever that such an event would be devastating to both the city and the nearby region that provides essential and critical services to the city.

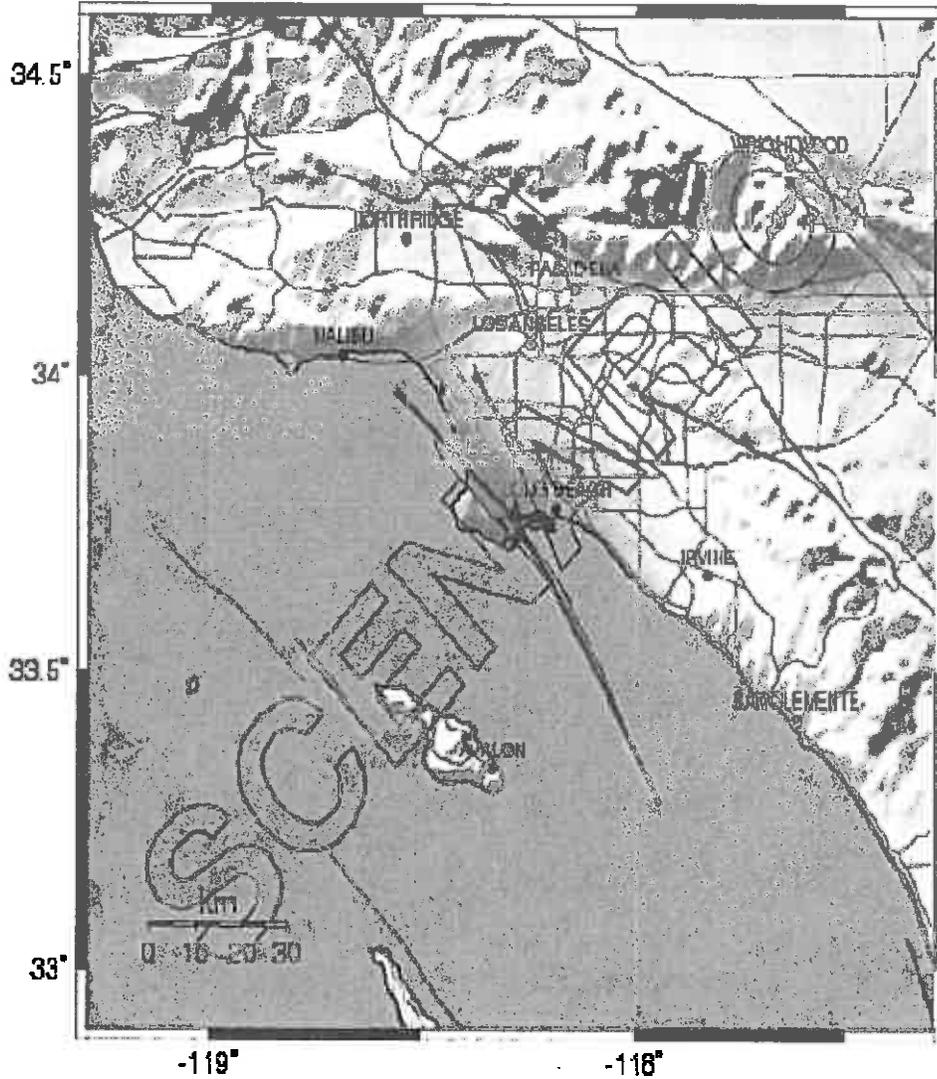
# SCENARIO: S-4

## Palos Verdes M7.1 Scenario

-- Earthquake Planning Scenario --

Rapid Instrumental Intensity Map for Palos Verdes M7.1 Scenario

Scenario Date: Fri Aug 3, 2001 05:00:00 AM PDT M 7.1 N33.75 W118.89 Depth: 10.0km



PLANNING SCENARIO ONLY -- PROCESSED: Tue Jul 30, 2002 02:06:42 PM PDT

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate Heavy	Heavy	Very Heavy
PEAK ACC. (mg)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VE. (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-115	>115
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X

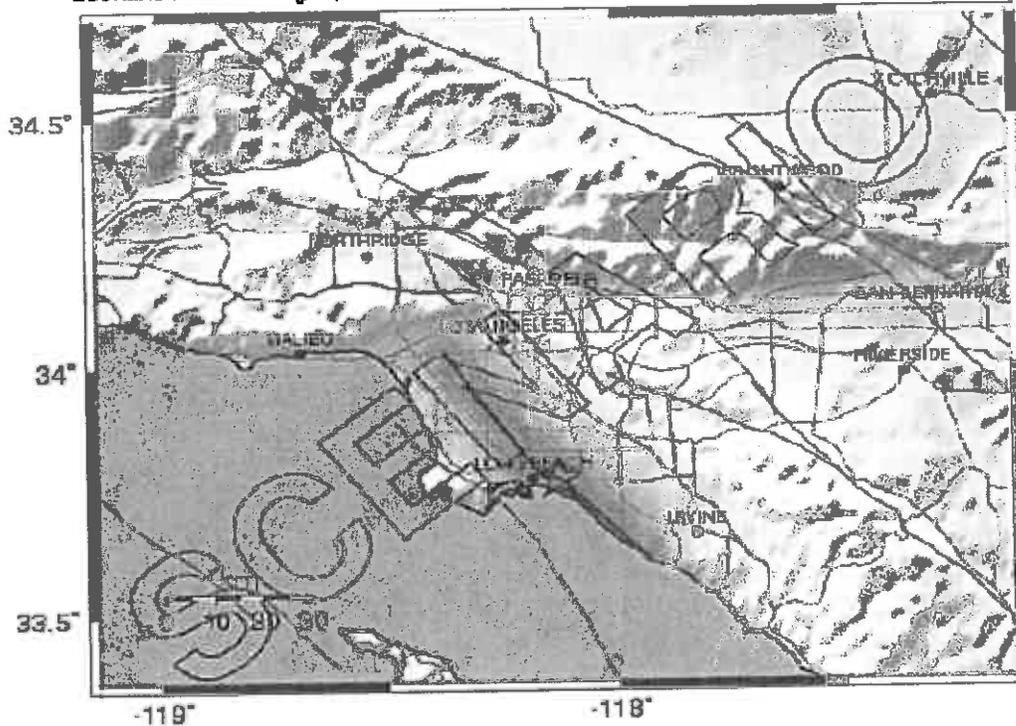
The Newport-Inglewood Fault is located a few miles east of the City of Rolling Hills. Although not as violent as the Palos Verdes Fault scenario, the “perceived shaking” in the Newport- Inglewood Magnitude 6.9 event would be “Very Strong”. Due to the proximity of this fault to the urbanized area of Los Angeles and Long Beach, the city’s essential and critical service providers could experience long term impacts.

**SCENARIO: S-3**  
**Newport-Inglewood M6.9 Scenario**

-- Earthquake Planning Scenario --

Rapid Instrumental Intensity Map for Newport-Inglewood M6.9 Scenario

Scenario Date: Fri Aug 3, 2001 05:00:00 AM PDT M 6.9 N33.78 W118.13 Depth: 8.0km



PLANNING SCENARIO ONLY -- PROCESSED: Tue Jul 30, 2002 02:01:27 PM PDT

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC (%g)	< 0.17	0.17-1.4	1.4-3.8	3.8-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL (cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-10	10-31	31-60	60-110	>110
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X

**Vulnerability Assessment**

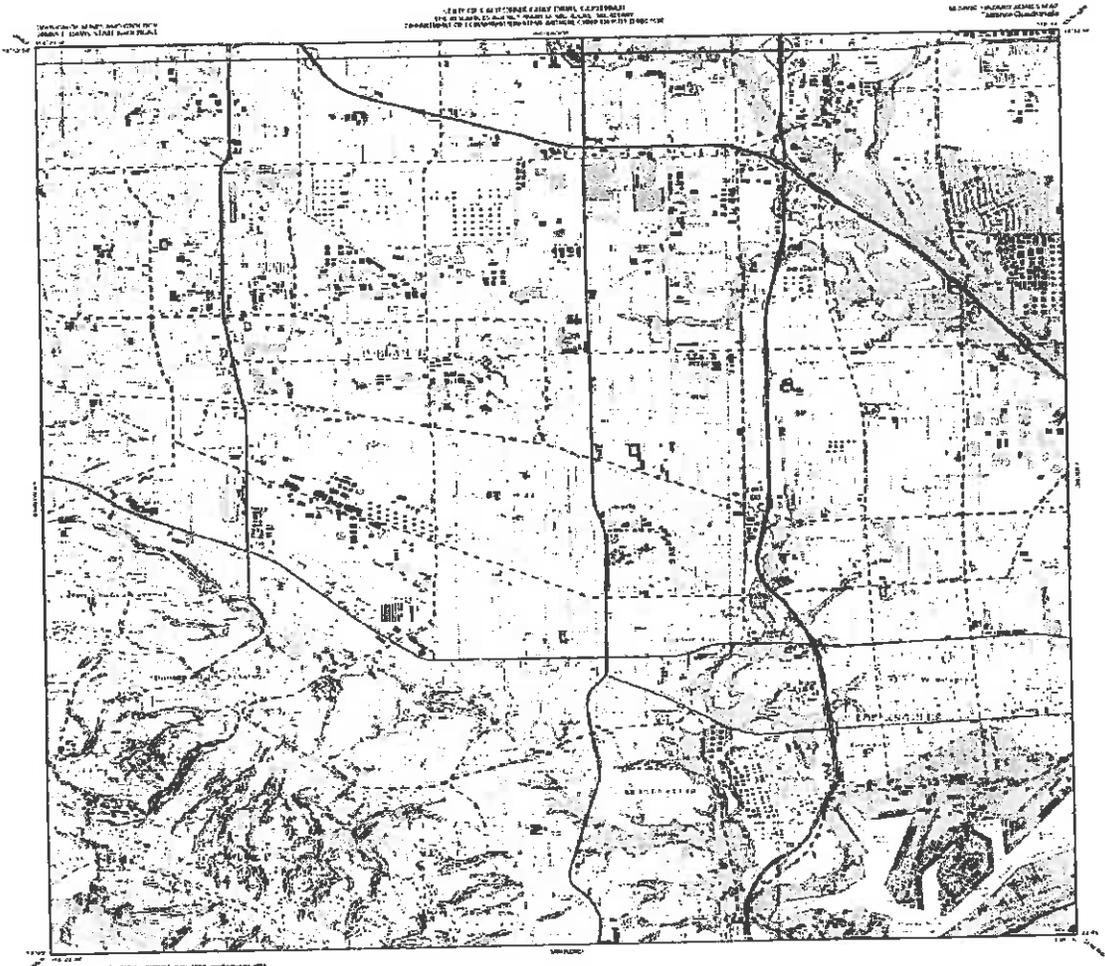
The effects of earthquakes span a large area, and large earthquakes occurring in many parts of the Southern California region would probably be felt throughout the region.

However, the degree to which the earthquakes are felt, and the damages associated with them may vary. At risk from earthquake damage are large stocks of old buildings and bridges; many high tech and hazardous materials facilities; extensive sewer, water, and natural gas pipelines; earth dams; petroleum pipelines; and other critical facilities and private property located in the county. The relative or secondary earthquake hazards, which are liquefaction, ground shaking, amplification, and earthquake-induced landslides, can be just as devastating as the earthquake.

The California Geological Survey has identified areas most vulnerable to liquefaction. Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures.

The City of Rolling Hills has liquefaction zones and areas subject to earthquake-induced landslides, as shown on Maps 5-3 and 5-4.

**Map 5-3: Liquefaction and EQ-Induced Landslide Zones in the City of Rolling Hills  
 - Torrance Quadrangle  
 (Source: California Seismic Hazard Zones)  
 (Key: Green indicates area prone to liquefaction following earthquakes; Blue indicates area prone to landslides following earthquakes)**



**FEDERAL ID MAP**  
 This map was prepared by the State of California, Department of Transportation, in cooperation with the Federal Bureau of Investigation, and is published under the authority of the Federal Bureau of Investigation, Department of Justice, and the Department of Transportation, Department of Justice.

**IMPORTANT - PLEASE NOTE**  
 This map is not a legal document. It is intended for informational purposes only. It is not to be used as a basis for any legal action. It is not to be used as a basis for any insurance policy. It is not to be used as a basis for any other financial or legal transaction.

**STATE OF CALIFORNIA  
 SEISMIC HAZARD ZONES  
 TORRANCE QUADRANGLE  
 OFFICIAL MAP  
 Released: March 25, 1999**

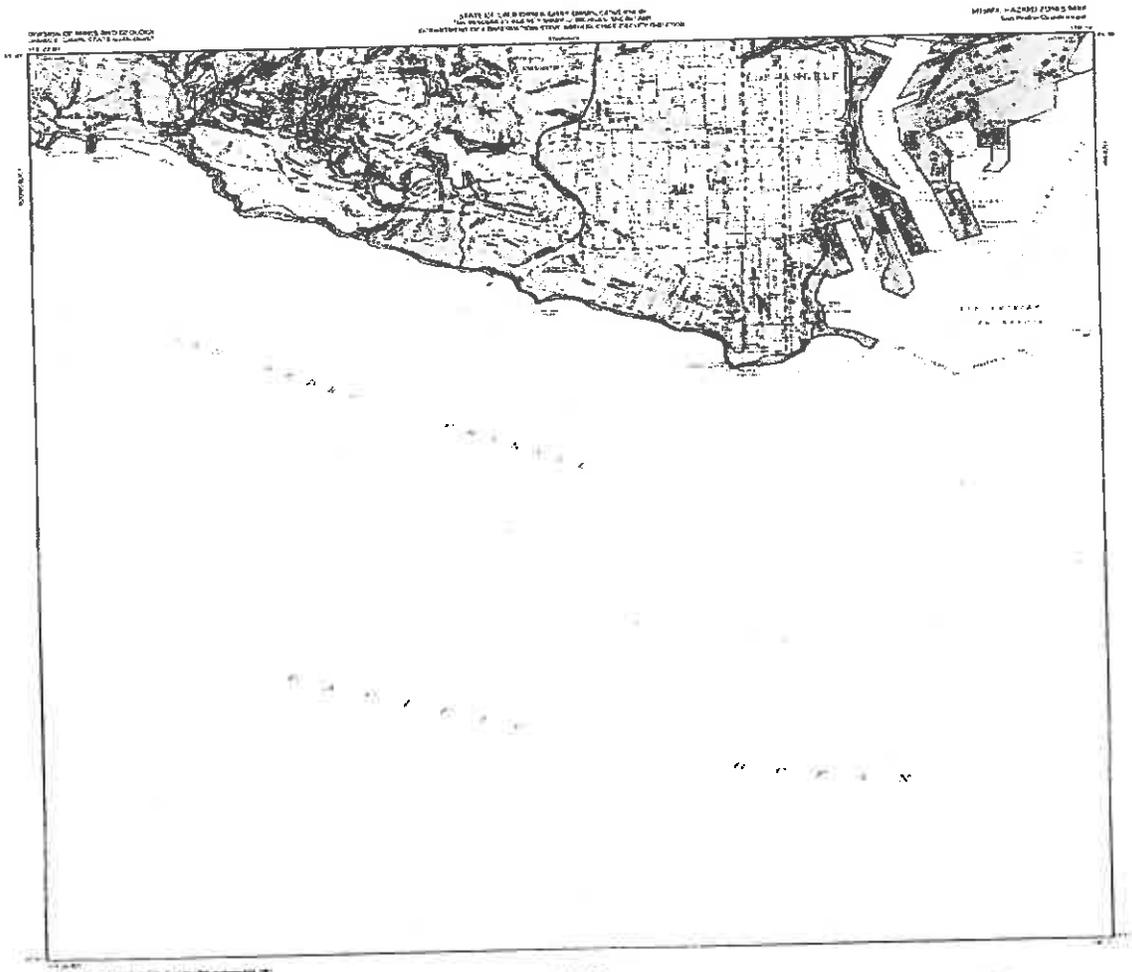
*John A. ...*  
 State Geologist

**MAP EXPLANATION**  
 Symbols of Required Investigation

**Legend**  
 Green shaded areas indicate areas prone to liquefaction following earthquakes. Blue shaded areas indicate areas prone to landslides following earthquakes.

**STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION**  
 DIVISION OF HIGHWAYS  
 1515 CALIFORNIA STREET, SACRAMENTO, CALIFORNIA 95833  
 (916) 227-1500

**Map 5-4: Liquefaction and EQ-Induced Landslide Zones in the City of Rolling Hills  
 – San Pedro Quadrangle  
 (Source: California Seismic Hazard Zones)  
 (Key: Green indicates area prone to liquefaction following earthquakes; Blue indicates area prone to landslides following earthquakes)**



**PURPOSE OF MAP**  
 This is a general purpose map of the San Pedro Quadrangle, California, showing the areas of the State of California that are prone to liquefaction and landslides following earthquakes. The map is intended for use by the public and the State of California. It is not intended to be used for any other purpose.

**COMMENTS - PLEASE NOTE**  
 1. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 2. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 3. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 4. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 5. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 6. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 7. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 8. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 9. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.  
 10. The map shows the areas of the State of California that are prone to liquefaction and landslides following earthquakes. It is not intended to be used for any other purpose.

STATE OF CALIFORNIA  
**SEISMIC HAZARD ZONES**  
 (Continued)  
**SAN PEDRO QUADRANGLE**  
 OFFICIAL MAP  
 Released: March 25, 1999

*John R. Davis*  
 STATE GEOLOGIST

**MAP EXPLANATION**  
 Symbols of Seismic Hazard Zones

**Legend**  
 Areas shaded in green indicate areas of the State of California that are prone to liquefaction following earthquakes. Areas shaded in blue indicate areas of the State of California that are prone to landslides following earthquakes.

**Scale**  
 1 inch = 1 mile

**Source**  
 Data from the California Geological Survey, Sacramento, California.

**Copyright**  
 © 1999 by the California Department of Conservation, Division of Mines and Geology.

Southern California has many active landslide areas, and a large earthquake could trigger accelerated movement in these slide areas, in addition to jarring loose other unknown areas of landslide risk.

### **Risk Analysis**

Risk analysis is the third phase of a hazard assessment. Risk analysis involves estimating the damage and costs likely to be experienced in a geographic area over a period of time.<sup>6</sup> Factors included in assessing earthquake risk include population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure, and disaster preparedness of the region. This type of analysis can generate estimates of the damages to the region due to an earthquake event in a specific location. FEMA's software program, HAZUS, uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data, and other information to estimate losses from a potential earthquake.<sup>7</sup> The HAZUS software is available from FEMA at no cost.

For greater Southern California there are multiple worst case scenarios, depending on which fault might rupture, and which communities are in proximity to the fault. But damage will not necessarily be limited to immediately adjoining communities. Depending on the hypocenter of the earthquake, seismic waves may be transmitted through the ground to unsuspecting communities. In the 1994 Northridge Earthquake, Santa Monica suffered extensive damage, even though there was a range of mountains between it and the origin of the earthquake.

Damages for a large earthquake almost anywhere in Southern California are likely to run into the billions of dollars. Although building codes are some of the most stringent in the world, ten's of thousands of older existing buildings were built under much less rigid codes. California has laws affecting unreinforced masonry buildings (URM's) and although many building owners have retrofitted their buildings, hundreds of pre-1933 buildings still have not been brought up to current standards. The City of Rolling Hills does not have any unreinforced masonry public buildings.

Non-structural bracing of equipment and contents is often the most cost-effective type of seismic mitigation. Inexpensive bracing and anchoring may be the most cost effective way to protect expensive equipment. Non-structural bracing of equipment and furnishings will also reduce the chance of injury for the occupants of a building.

### **Community Earthquake Issues**

#### **What is Susceptible to Earthquakes?**

Earthquake damage occurs because humans have built structures that cannot withstand severe shaking. Buildings, airports, schools, and lifelines (highways and utility lines) suffer damage in earthquakes and can cause death or injury to humans. The welfare of homes, major businesses, and public infrastructure is very important. Addressing the reliability of

buildings, critical facilities, and infrastructure, and understanding the potential costs to government, businesses, and individuals as a result of an earthquake, are challenges faced by the city.

### **Dams**

There are a total of 103 dams in Los Angeles County, owned by 23 agencies or organizations, ranging from the Federal government to Homeowner's Associations.<sup>8</sup> These dams hold billions of gallons of water in reservoirs. Releases of water from the major reservoirs are designed to protect Southern California from flood waters and to store domestic water. Seismic activity can compromise the dam structures, and the resultant flooding could cause catastrophic flooding. Following the 1971 Sylmar Earthquake the Lower Van Norman Dam showed signs of structural compromise, and tens of thousands of persons had to be evacuated until the dam could be drained. The dam has never been refilled.

The City of Rolling Hills is not subject to dam failure (Source: Threat Summary-1).

### **Buildings**

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people. Lives are at risk and the cost to clean up the damages is great. In most California communities, many buildings were built before 1993 when building codes were not as strict. In addition, retrofitting is not required except under certain conditions and can be expensive. Therefore, the number of buildings at risk remains high. The California Seismic Safety Commission makes annual reports on the progress of the retrofitting of unreinforced masonry buildings.

The Los Angeles County Building Code, Chapter 96, requires that all buildings built prior to March 20, 1933, except dwellings and lodging homes, and which have unreinforced masonry bearing walls, be retrofitted to reduce the risk of loss of life and injury. Los Angeles Building and Safety Department has no knowledge of any unreinforced masonry building in the City of Rolling Hills.

Almost all of the homes in Rolling Hills are engineered custom homes. The plan check staff reviews these designs for compliance with the current code seismic requirements.

### **Infrastructure and Communication**

Residents in the City of Rolling Hills commute frequently by automobiles and public transportation such as buses and light rail. An earthquake can greatly damage bridges and roads, hampering emergency response efforts and the normal movement of people and goods. Damaged infrastructure strongly affects the economy of the community because it disconnects people from work, school, food, and leisure, and separates businesses from their customers and suppliers.

### **Bridge Damage**

Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link - with even minor damages making some areas inaccessible. Because bridges vary in size, materials, location and design, any given earthquake will affect them differently. Bridges built before the mid-1970's have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made.

Much of the interstate highway system in Los Angeles County was built in the mid to late 1960's. Caltrans has retrofitted most bridges on the freeway systems; however there are still some county maintained bridges that are not retrofitted. The FHWA requires that bridges on the National Bridge Inventory be inspected every 2 years. Caltrans checks when the bridges are inspected because they administer the Federal funds for bridge projects.

### **Damage to Lifelines**

Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity, and communication networks. Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. Lifelines need to be usable after earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

### **Disruption of Critical Services**

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event. See Section 4, Risk Assessment for critical and essential facilities vulnerable to earthquakes.

### **Businesses**

Seismic activity can cause great loss to businesses, both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous, especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to large and small shop owners who may have difficulty recovering from their losses.

Forty percent of businesses do not reopen after a disaster and another twenty-five percent fail within one year according to the Federal Emergency Management Agency (FEMA). Similar statistics from the United States Small Business Administration indicate that over ninety percent of businesses fail within two years after being struck by a disaster.<sup>9</sup>

Although there are no businesses located within the boundaries of the City, the residents are dependent on the business services provided by the surrounding communities.

### **Individual Preparedness**

Because the potential for earthquake occurrences and earthquake related property damage is relatively high in the City of Rolling Hills, increasing individual preparedness is a significant need. Strapping down heavy furniture, water heaters, and expensive personal property, as well as being earthquake insured, and anchoring buildings to foundations are just a few steps individuals can take to prepare for an earthquake.

### **Death and Injury**

Death and injury can occur both inside and outside of buildings due to collapsed buildings falling equipment, furniture, debris, and structural materials. Downed power lines and broken water and gas lines can also endanger human life.

### **Fire**

Downed power lines or broken gas mains may trigger fires. When fire stations suffer building or lifeline damage, quick response to extinguish fires is less likely. Furthermore, major incidents will demand a larger share of resources, and initially smaller fires and problems will receive little or insufficient resources in the initial hours after a major earthquake event. Loss of electricity may cause a loss of water pressure in some communities, further hampering fire fighting ability.

### **Debris**

After damage to a variety of structures, much time is spent cleaning up bricks, glass, wood, steel or concrete building elements, office and home contents, and other materials. Developing a strong debris management strategy is essential in post-disaster recovery. Disasters do not exempt the City of Rolling Hills from compliance with AB-939 regulations.

### **Existing Mitigation Activities**

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations.

### **City of Rolling Hills Codes**

Implementation of earthquake mitigation policy most often takes place at the local government level. The City of Rolling Hills contracts with the County of Los Angeles for enforcement of building codes pertaining to earthquake hazards.

The following sections of the Los Angeles County UBC address the earthquake hazard:

- 1605.2.1 (Distribution of Horizontal Shear);
- 1605.2.2 (Stability against Overturning);
- 1626-1629 (Seismic);
- 1605.2.3 (Anchorage); and
- 1110.2 (Geotechnical Hazards)

The City of Rolling Hills Planning Department enforces the zoning and land use regulations relating to earthquake hazards.

Generally, these codes seek to discourage development in areas that could be prone to land movement, wildfire and / or seismic hazards; and where development is permitted, that the applicable construction standards are met. Developers in hazard-prone areas may be required to retain a qualified professional engineer to evaluate level of risk on the site and recommend appropriate mitigation measures.

### **Coordination Among Building Officials**

The City of Rolling Hills Building Code sets the minimum design and construction standards for new buildings. In 2002 the City of Rolling Hills adopted the most recent seismic standards in its building code, which requires that new buildings be built at a higher seismic standard.

The 2002 Los Angeles County Building Code also requires that site-specific seismic hazard investigations be performed for new essential facilities, major structures, hazardous facilities, and special occupancy structures such as schools, hospitals, and emergency response facilities.

### **Hospitals**

Although there are no hospitals in the City of Rolling Hills, earthquake damage to local hospitals would have a major effect on Rolling Hills residents. “The Alfred E. Alquist Hospital Seismic Safety Act (“Hospital Act”) was enacted in 1973 in response to the moderate magnitude-6.6 1971 Sylmar Earthquake when four major hospital campuses were severely damaged and evacuated. Two hospital buildings collapsed killing forty seven people. Three others were killed in another hospital that nearly collapsed.

In approving the Act, the Legislature noted that: “Hospitals, that house patients who have less than the capacity of normally healthy persons to protect themselves, and that must be reasonably capable of providing services to the public after a disaster, shall be designed and constructed to resist, insofar as practical, the forces generated by earthquakes, gravity and winds.” (Health and Safety Code Section 129680)

When the Hospital Act was passed in 1973, the State anticipated that, based on the regular and timely replacement of aging hospital facilities, the majority of hospital buildings would be in compliance with the Act’s standards within 25 years. However, hospital buildings were not, and are not, being replaced at that anticipated rate. In fact, the great majority of the State’s urgent care facilities are now more than 40 years old.

The moderate magnitude-6.7 1994 Northridge Earthquake caused \$3 billion in hospital-related damage and evacuations. Twelve hospital buildings constructed before the Act were cited (red tagged) as unsafe for occupancy after the earthquake. Those hospitals that had been built in accordance with the 1973 Hospital Act were very successful in resisting structural damage. However, nonstructural damage (for example, plumbing and ceiling systems) was still extensive in those post-1973 buildings.

Senate Bill 1953 (“SB 1953”), enacted in 1994 after the Northridge Earthquake, expanded the scope of the 1973 Hospital Act. Under SB 1953, all hospitals are required, as of January 1, 2008, to survive earthquakes without collapsing or posing the threat of significant loss of life. The 1994 Act further mandates that all existing hospitals be seismically evaluated, and retrofitted, if needed, by 2030, so that they are in substantial compliance with the Act (which requires that the hospital buildings be reasonably capable of providing services to the public after disasters). SB 1953 applies to all urgent care facilities (including those built prior to the 1973 Hospital Act) and affects approximately 2,500 buildings on 475 campuses.

SB 1953 directed the Office of Statewide Health Planning and Development (“OSHPD”), in consultation with the Hospital Building Safety Board, to develop emergency regulations including “...earthquake performance categories with sub gradations for risk to life, structural soundness, building contents, and nonstructural systems that are critical to providing basic services to hospital inpatients and the public after a disaster.” (Health and Safety Code Section 130005)

The Seismic Safety Commission Evaluation of the State’s Hospital Seismic Safety Policies

In 2001, recognizing the continuing need to assess the adequacy of policies, and the application of advances in technical knowledge and understanding, the California Seismic Safety Commission created an Ad Hoc Committee to re-examine the compliance with the Alquist Hospital Seismic Safety Act. The formation of the Committee was also prompted by the recent evaluations of hospital buildings reported to OSHPD that revealed that a large percentage (40%) of California’s operating hospitals are in the highest category of collapse risk.”<sup>10</sup>

**California Earthquake Mitigation Legislation**

California is painfully aware of the threats it faces from earthquakes. Dating back to the 19<sup>th</sup> Century, Californians have been killed, injured, and lost property as a result of earthquakes. As the State’s population continues to grow, and urban areas become even more densely developed, the risk will continue to increase. For decades the legislature has passed laws to strengthen the built environment and protect the citizens. Table 5-2 provides a sampling of some of the 200 plus laws in the State’s codes.

**Table 5-2: Partial List of the Over 200 California Laws on Earthquake Safety**

Government Code Section 8870-8870.95	Creates Seismic Safety Commission.
Government Code Section 8876.1-8876.10	Established the California Center for Earthquake Engineering Research.
Public Resources Code Section 2800-2804.6	Authorized a prototype earthquake prediction system along the Central San Andreas Fault near the City of Parkfield.
Public Resources Code Section 2810-2815	Continued the Southern California Earthquake Preparedness Project and the Bay Area Regional Earthquake Preparedness Project.
Health and Safety Code Section 16100-16110	The Seismic Safety Commission and State Architect, will develop a state policy on acceptable levels of earthquake risk for new and existing state-owned buildings.

Government Code Section 8871-8871.5	Established the California Earthquake Hazards Reduction Act of 1986.
Health and Safety Code Section 130000-130025	Defined earthquake performance standards for hospitals.
Public Resources Code Section 2805-2808	Established the California Earthquake Education Project.
Government Code Section 8899.10-8899.16	Established the Earthquake Research Evaluation Conference.
Public Resources Code Section 2621-2630 2621.	Established the Alquist-Priolo Earthquake Fault Zoning Act.
Government Code Section 8878.50-8878.52 8878.50.	Created the Earthquake Safety and Public Buildings Rehabilitation Bond Act of 1990.
Education Code Section 35295-35297 35295.	Established emergency procedure systems in kindergarten through grade 12 in all the public or private schools.
Health and Safety Code Section 19160-19169	Established standards for seismic retrofitting of unreinforced masonry buildings.
Health and Safety Code Section 1596.80- 1596.879	Required all child day care facilities to include an Earthquake Preparedness Checklist as an attachment to their disaster plan.
Source: <a href="http://www.leginfo.ca.gov/calaw.html">http://www.leginfo.ca.gov/calaw.html</a>	

### **Earthquake Education**

Earthquake research and education activities are conducted at several major universities in the Southern California region, including Cal Tech, USC, UCLA, UCSB, UCI, and UCSB. The local clearinghouse for earthquake information is the Southern California Earthquake Center located at the University of Southern California, Los Angeles, CA 90089, Telephone: (213) 740-5843, Fax: (213) 740-0011, Email: [SCEinfo@usc.edu](mailto:SCEinfo@usc.edu), Website: <http://www.scec.org>. The Southern California Earthquake Center (SCEC) is a community of scientists and specialists who actively coordinate research on earthquake hazards at nine core institutions, and communicate earthquake information to the public. SCEC is a National Science Foundation (NSF) Science and Technology Center and is co-funded by the United States Geological Survey (USGS).

In addition, Los Angeles County along with other Southern California counties, sponsors the Emergency Survival Program (ESP), an educational program for learning how to prepare for earthquakes and other disasters. Many school districts have very active emergency preparedness programs that include earthquake drills and periodic disaster response team exercises.

### **End Notes**

<sup>1</sup> <http://pubs.usgs.gov/gip/earthq3/when.html>

<sup>2</sup> <http://www.gps.caltech.edu/~sieh/home.html>

<sup>3</sup> Planning for Natural Hazards: The California Technical Resource Guide, Department of Land Conservation and Development (July 2000)

---

4 <http://www.consrv.ca.gov/CGS/rghm/ap/>

5 Ibid

6 Burby, R. (Ed.) Cooperating with Nature: Confronting Natural Hazards with Land Use Planning for Sustainable Communities (1998), Washington D.C., Joseph Henry Press.

7 FEMA HAZUS <http://www.fema.gov/hazus/hazus2.htm> (May 2001).

8 Source: Los Angeles County Public Works Department, March 2004

9 [http://www.chamber101.com/programs\\_committee/natural\\_disasters/DisasterPreparedness/Forty.htm](http://www.chamber101.com/programs_committee/natural_disasters/DisasterPreparedness/Forty.htm)

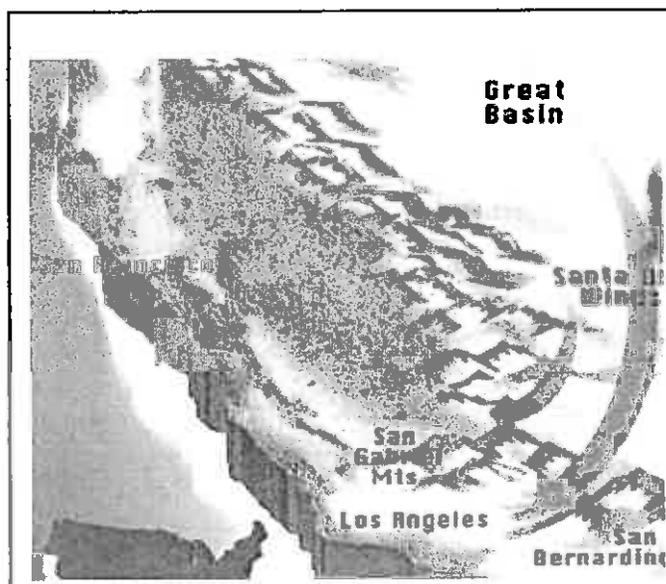
10 [http://www.seismic.ca.gov/pub/CSSC\\_2001-04\\_Hospital.pdf](http://www.seismic.ca.gov/pub/CSSC_2001-04_Hospital.pdf)

**Section 6:  
Windstorm Hazards  
in the  
City of Rolling Hills**

### **Why are Severe Windstorms a Threat to the City of Rolling Hills?**

Severe windstorms pose a significant risk to property and a risk to life in the region by creating conditions that disrupt essential systems such as public utilities, telecommunications, and transportation routes. High winds can and do occasionally cause tornado-like damage to local homes. Severe windstorms can present a very destabilizing effect on the dry brush that covers local hillsides and urban wildland interface areas. High winds can have destructive impacts, especially to trees, power lines, and utility services.

**Figure 6-1: Santa Ana Winds (Source: NASA's "Observatorium")**



### **Santa Ana Winds and Tornado-Like Wind Activity**

Based on local history, most incidents of high wind in the City of Rolling Hills are the result of the Santa Ana wind conditions. While high impact wind incidents are not frequent in the area, significant Santa Ana wind events and sporadic tornado activity have been known to negatively impact the local community.

### **What are Santa Ana Winds?**

“Santa Ana winds are generally defined as warm, dry winds that blow from the east or northeast (offshore). These winds occur below the passes and canyons of the coastal ranges of Southern California and in the Los Angeles basin. Santa Ana winds often blow with exceptional speed in the Santa Ana Canyon (the canyon from which it derives its name). Forecasters at the National Weather Service offices in Oxnard and San Diego usually place speed minimums on these winds and reserve the use of "Santa Ana" for winds greater than 25 knots.”<sup>1</sup> These winds accelerate to speeds of 35 knots as they move through canyons and passes, with gusts to 50 or even 60 knots.

“The complex topography of Southern California combined with various atmospheric conditions creates numerous scenarios that may cause widespread or isolated Santa Ana events. Commonly, Santa Ana winds develop when a region of high pressure builds over the Great Basin (the high plateau east of the Sierra Mountains and west of the Rocky Mountains including most of Nevada and Utah). Clockwise circulation around the center of this high pressure area forces air downslope from the high plateau. The air warms as it descends toward the California coast at the rate of 5 degrees F per 1000 feet due to compressional heating. Thus, compressional heating provides the primary source of warming. The air is dry since it originated in the desert, and it dries out even more as it is heated.”<sup>2</sup>

These regional winds typically occur from October to March, and, according to most accounts are named either for the Santa Ana River Valley where they originate or for the Santa Ana Canyon, southeast of Los Angeles, where they pick up speed.

### What are Tornadoes?

Tornadoes are spawned when there is warm, moist air near the ground, cool air aloft, and winds that speed up and change direction. An obstruction, such as a house, in the path of the wind causes it to change direction. This change increases pressure on parts of the house, and the combination of increased pressures and fluctuating wind speeds creates stresses that frequently cause structural failures.

In order to measure the intensity and wind strength of a tornado, Dr. T. Theodore Fujita developed the Fujita Tornado Damage Scale. This scale compares the estimated wind velocity with the corresponding amount of suspected damage. The scale measures six classifications of tornadoes with increasing magnitude from an “F0” tornado to a “F6+” tornado.

**Table 6-1: Fujita Tornado Damage Scale**

Scale	Wind Estimate (mph)	Typical Damage
F0	< 73	<b>Light damage.</b> Some damage to chimneys and TV antennas; breaks twigs off trees; pushes over shallow-rooted trees.
F1	73-112	<b>Moderate damage.</b> Peels surface off roofs; windows broken; light trailer houses pushed or overturned; some trees uprooted or snapped; moving automobiles pushed off the road. 74 mph is the beginning of hurricane wind speed.
F2	113-157	<b>Considerable damage.</b> Roofs torn off frame houses leaving strong upright walls; weak buildings in rural areas demolished; trailer houses destroyed; large trees snapped or uprooted; railroad boxcars pushed over; light object missiles generated; cars blown off highway.
F3	158-206	<b>Severe damage.</b> Roofs and some walls torn off frame houses; some rural buildings completely demolished; trains overturned; steel-framed hangar-warehouse-type structures torn; cars lifted off the ground; most trees in a forest uprooted snapped, or leveled.

F4	207-260	<b>Devastating damage.</b> Whole frame houses leveled, leaving piles of debris; steel structures badly damaged; trees debarked by small flying debris; cars and trains thrown some distances or rolled considerable distances; large missiles generated.
F5	261-318	<b>Incredible damage.</b> Whole frame houses tossed off foundations; steel-reinforced concrete structures badly damaged; automobile-sized missiles generated; trees debarked; incredible phenomena can occur.
F6-F12	319 to sonic	<b>Inconceivable damage.</b> Should a tornado with the maximum wind speed in excess of F5 occur, the extent and types of damage may not be conceived. A number of missiles such as iceboxes, water heaters, storage tanks, automobiles, etc. will create serious secondary damage on structures.
Source: <a href="http://weather.latimes.com/tornadoFAQ.asp">http://weather.latimes.com/tornadoFAQ.asp</a>		

### Microbursts

Unlike tornados, microbursts, are strong, damaging winds which strike the ground and often give the impression a tornado has struck. They frequently occur during intense thunderstorms. The origin of a microburst is downward moving air from a thunderstorm's core. But unlike a tornado, they affect only a rather small area.

University of Chicago storm researcher Dr Ted Fujita first coined the term “downburst” to describe strong, downdraft winds flowing out of a thunderstorm cell that he believed were responsible for the crash of Eastern Airlines Flight 66 in June of 1975.<sup>3</sup>

A downburst is a straight-direction surface wind in excess of 39 mph caused by a small-scale, strong downdraft from the base of convective thundershowers and thunderstorms. In later investigations into the phenomena he defined two sub-categories of downbursts: the larger macrobursts and small microbursts.<sup>4</sup>

Macrobursts are downbursts with winds up to 117 mph which spread across a path greater than 2.5 miles wide at the surface and which last from 5 to 30 minutes. The microburst, on the other hand is confined to an even smaller area, less than 2.5 miles in diameter from the initial point of downdraft impact. An intense microburst can result in damaging winds near 270 km/hr (170 mph) and often last for less than five minutes.<sup>5</sup>

“Downbursts of all sizes descend from the upper regions of severe thunderstorms when the air accelerates downward through either exceptionally strong evaporative cooling or by very heavy rain which drags dry air down with it. When the rapidly descending air strikes the ground, it spreads outward in all directions, like a fast-running faucet stream hitting the sink bottom.

When the microburst wind hits an object on the ground such as a house, garage or tree, it can flatten the buildings and strip limbs and branches from the tree. After striking the ground, the powerful outward running gust can wreak further havoc along its path. Damage associated with a

microburst is often mistaken for the work of a tornado, particularly directly under the microburst. However, damage patterns away from the impact area are characteristic of straight-line winds rather than the twisted pattern of tornado damage.”<sup>6</sup>

Tornados, like those that occur every year in the Midwest and Southeast parts of the United States, are a rare phenomenon in most of California, with most tornado-like activity coming from micro-bursts.

**Local History of Windstorm Events**

While the effects of Santa Ana Winds are often overlooked, it should be noted that in 2003, two deaths in Southern California were directly related to the fierce condition. A falling tree struck one woman in San Diego.<sup>7</sup> The second death occurred when a passenger in a vehicle was hit by a flying pickup truck cover launched by the Santa Ana Winds.<sup>8</sup>

**Table 6-2: Santa Ana Wind Events during 2003**

The following Santa Ana wind events were featured in news resources during 2003:	
January 6, 2003 OC Register	“One of the strongest Santa Ana windstorms in a decade toppled 26 power poles in Orange early today, blew over a mobile derrick in Placentia, crushing two vehicles, and delayed Metrolink rail service.” This windstorm also knocked out power to thousands of people in northeastern Orange County.
January 8, 2003 CBSNEWS.com	“Santa Ana's roared into Southern California late Sunday, blowing over trees, trucks and power poles. Thousands of people lost power.”
March 16, 2003 dailybulletin.com	Fire Officials Brace for Santa Ana Winds - - “The forest is now so dry and so many trees have died that fires, during relatively calm conditions, are running as fast and as far as they might during Santa Ana Winds. Now the Santa Ana season is here. Combine the literally tinder dry conditions with humidity in the single digits and 60-80 mph winds, and fire officials shudder.”

**Table 6-3: Major Windstorms in the Vicinity of Rolling Hills**

Date	Location and Damage
November 5-6, 1961	Santa Ana winds. Fire in Topanga Canyon
February 10-11, 1973	Strong storm winds: 57 mph at Riverside, 46 Newport Beach. Some 200 trees uprooted in Pacific Beach alone
October 26-27, 1993	Santa Ana winds. Fire in Laguna Hills

October 14, 1997	Santa Ana winds: gusts 87 mph in central Orange County. Large fire in Orange County
December 29, 1997	Gusts 60+ mph at Santa Ana
March 28-29, 1998	Strong storm winds in Orange County: sustained 30-40 mph. Gust 70 mph at Newport Beach, gust 60 Huntington Beach. Trees down, power out, and damage across Orange and San Diego Counties. 1 illegal immigrant dead in Jamul.
September 2, 1998	Strong winds from thunderstorms in Orange County with gusts to 40mph. Large fires in Orange County
December 6, 1998	Thunderstorm in Los Alamitos and Garden Grove: gust 50-60 mph called "almost a tornado"
December 21-22, 1999	Santa Ana winds: gust 68 mph at Campo, 53 Huntington Beach, 44 Orange. House and tree damage in Hemet.
March 5-6, 2000	Strong thunderstorm winds at the coast: gust 60 mph at Huntington Beach Property damage and trees downed along the coast
April 1, 2000	Santa Ana winds: gust 93 mph at Mission Viejo, 67 Anaheim Hills
December 25-26, 2000	Santa Ana winds: gust 87 mph at Fremont Canyon. Damage and injuries in Mira Loma, Orange and Riverside Counties
February 13, 2001	Thunderstorm gust to 89 mph in east Orange
Source: <a href="http://www.wrh.noaa.gov/sandiego/research/Guide/weatherhistory.pdf">http://www.wrh.noaa.gov/sandiego/research/Guide/weatherhistory.pdf</a>	

The following is a glimpse of major tornado-like events to hit in the vicinity of the City of Rolling Hills and surrounding areas:

**Table 6-4: Major Tornado-like Events in the Vicinity of Rolling Hills**

Major Tornado-like Events in the Orange County Area 1958-2001	
Date	Location and Damage
April 1, 1958	Tornado: Laguna Beach
February 19, 1962	Tornado: Irvine
April 8, 1965	Tornado: Costa Mesa
November 7, 1966	Newport Beach and Costa Mesa: Property Damage
March 16, 1977	Tornado skipped from Fullerton to Brea Damage to 80 homes and injured four people
February 9, 1978	Tornado: Irvine. Property damage and 6 injured
January 31, 1979	Tornado Santa Ana Numerous power outages
November 9, 1982	Tomadoes in Garden Grove and Mission Viejo. Property damage

January 13, 1984	Tornado: Huntington Beach. Property damage
March 16, 1986	Tornado: Anaheim. Property damage
February 22-24, 1987	Tomadoes and waterspouts: Huntington Beach
January 18, 1988	Tornadoes: Mission Viejo and San Clemente. Property damage
February 28, 1991	Tornado: Tustin
March 27, 1991	Tornado: Huntington Beach
December 7, 1992	Tornadoes: Anaheim and Westminster Property damage
January 18, 1993	Tornado: Orange County Property damage
February 8, 1993	Tomado: Brea. Property damage
February 7, 1994	Tornado from Newport Beach to Tustin. Roof and window damage. Trees were also knocked down
December 13, 1994	Two waterspouts about 0.5 mile off Newport Beach
December 13, 1995	Funnel cloud near Fullerton Airport
March 13, 1996	Funnel cloud in Irvine
November 10-11, 1997	Waterspout came ashore at Newport Pier on the 10 <sup>th</sup> and dissipated over western Costa Mesa. Tomadoes in Irvine on the 11 <sup>th</sup> and a funnel cloud developed. 10 <sup>th</sup> : Winds estimated at 60-70 mph. 11 <sup>th</sup> : Minor power outages occurred with little property damage. A fisherman was blown from one end of Newport Pier to the other. Property and vehicle damage in Irvine from flying debris. Ten cars were thrown a few feet.
December 21, 1997	Waterspout and tornado in Huntington Beach. Damage to boats, houses, and city property
February 24, 1998	Tornado in Huntington Beach. Property damage with a power outage, roof flew ¼ mile
March 13-14, 1998	Numerous waterspouts between Long Beach, Huntington Beach, and Catalina
March 31-April 1, 1998	Numerous funnel clouds reported off Orange County coastline, two of which became waterspouts off Orange County. One waterspout briefly hit the coast off the Huntington Beach pier.
June 6, 1998	Two funnel clouds off Dana Point
December 31, 1998	Funnel clouds in Santa Ana. Waterspout off Costa Mesa coast
February 21, 2000	Tornado: Anaheim Hills. Property damage
October 28, 2000	Funnel clouds around Newport Beach and Costa Mesa
January 10, 2001	Funnel cloud at Orange County airport and Newport Beach
February 24, 2001	Tornado in Orange. Damage to warehouse, 6 structures, fences, and telephone wires.

## **Windstorm Hazard Assessment**

### **Hazard Identification**

A windstorm event in the region can range from short term microburst activity lasting only minutes to a long duration Santa Ana wind condition that can last for several days as in the case of the January 2003 Santa Ana wind event. Windstorms in the City of Rolling Hills area can cause extensive damage including heavy tree debris, road and infrastructure, and critical utility facilities.

The map shows clearly the direction of the Santa Ana winds as they travel from the stable, high-pressure weather system called the Great Basin High through the canyons and towards the low-pressure system off the Pacific. Clearly the area of the City of Rolling Hills is in the direct path of the ocean-bound Santa Ana winds.

### **Vulnerability and Risk**

With an analysis of the high wind and tornado events depicted in the "Local History" section, we can deduce the common windstorm impact areas including impacts on life, property, utilities, infrastructure and transportation. Additionally, if a windstorm disrupts power to local residential communities, the American Red Cross and City resources might be called upon for care and shelter duties. Displacing residents and utilizing City resources for shelter staffing and disaster cleanup can cause an economic hardship on the community.

### **Community Windstorm Issues**

#### **What is Susceptible to Windstorms?**

##### **Life and Property**

Based on the history of the region, windstorm events can be expected, perhaps annually, across widespread areas of the region which can be adversely impacted during a windstorm event. This can result in the involvement of City of Rolling Hills emergency response personnel during a wide-ranging windstorm or microburst tornadic activity. Residential structures with weak reinforcement could be susceptible to damage. Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift suction forces that pull building components and surfaces outward. With extreme wind forces, the roof or entire building can fail causing considerable damage. Typically, wind damage in the Rolling Hills has been limited to downed trees and minor damage to residential structures.

Debris carried along by extreme winds can directly contribute to loss of life and

indirectly to the failure of protective building envelopes, siding, or walls. When severe windstorms strike a community, downed trees, power lines, and damaged property can be major hindrances to emergency response and disaster recovery.

The Beaufort Scale below, coined and developed by Sir Francis Beaufort in 1805, illustrates the effect that varying wind speed can have on sea swells and structures:

**Table 6-5: Beaufort Scale**

<b>BEAUFORT SCALE</b>		
<b>Beaufort Force</b>	<b>Speed (mph)</b>	<b>Wind Description - State of Sea - Effects on Land</b>
0	Less 1	Calm - Mirror-like - Smoke rises vertically
1	1-3	Light - Air Ripples look like scales; No crests of foam - Smoke drift shows direction of wind, but wind vanes do not
2	4-7	Light Breeze - Small but pronounced wavelets; Crests do not break - Wind vanes move; Leaves rustle; You can feel wind on the face
3	8-12	Gentle Breeze - Large Wavelets; Crests break; Glassy foam; A few whitecaps - Leaves and small twigs move constantly; Small, light flags are extended
4	13-18	Moderate Breeze - Longer waves; Whitecaps - Wind lifts dust and loose paper; Small branches move
5	19-24	Fresh Breeze - Moderate, long waves; Many whitecaps; Some spray - Small trees with leaves begin to move
6	25-31	Strong Breeze - Some large waves; Crests of white foam; Spray - Large branches move; Telegraph wires whistle; Hard to hold umbrellas
7	32-38	Near Gale - White foam from breaking waves blows in streaks with the wind - Whole trees move; Resistance felt walking into wind
8	39-46	Gale - Waves high and moderately long; Crests break into spin drift, blowing foam in well marked streaks - Twigs and small branches break off trees; Difficult to walk
9	47-54	Strong Gale - High waves with wave crests that tumble; Dense streaks of foam in wind; Poor visibility from spray - Slight structural damage
10	55-63	Storm - Very high waves with long, curling crests; Sea surface appears white from blowing foam; Heavy tumbling of sea; Poor visibility - Trees

		broken or uprooted; Considerable structural damage
11	64-73	Violent Storm - Waves high enough to hide small and medium sized ships; Sea covered with patches of white foam; Edges of wave crests blown into froth; Poor visibility - Seldom experienced inland; Considerable structural damage
12	>74	Hurricane - Sea white with spray. Foam and spray render visibility almost non-existent - Widespread damage. Very rarely experienced on land.
Source: <a href="http://www.compuweather.com/decoder-charts.html">http://www.compuweather.com/decoder-charts.html</a>		

### **Disruption of Critical Services**

Critical facilities include sheriff stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after natural hazard event.

### **Utilities**

Historically, falling trees have been the major cause of power outages in the region. Windstorms such as strong microbursts and Santa Ana Wind conditions can cause flying debris and downed utility lines. For example, tree limbs breaking in winds of only 45 mph can be thrown over 75 feet. As such, overhead power lines can be damaged even in relatively minor windstorm events. Falling trees can bring electric power lines down to the pavement, creating the possibility of lethal electric shock. Rising population growth and new infrastructure in the region creates a higher probability for damage to occur from windstorms as more life and property are exposed to risk.

### **Infrastructure**

Windstorms can damage buildings, power lines, and other property and infrastructure due to falling trees and branches. During wet winters, saturated soils cause trees to become less stable and more vulnerable to uprooting from high winds.

Windstorms can result in collapsed or damaged buildings or blocked roads. Roads blocked by fallen trees during a windstorm may have severe consequences to people who need access to emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. There are direct consequences to the local economy resulting from windstorms related to both physical damages and interrupted services.

### **Increased Fire Threat**

Perhaps the greatest danger from windstorm activity in Southern California comes from the combination of the Santa Ana winds with the major fires that occur every few years in the urban/wildland interface. With the Santa Ana winds driving the flames, the speed and reach of the flames is even greater than in times of calm wind conditions. The higher fire

hazard raised by a Santa Ana wind condition requires that even more care and attention be paid to proper brush clearances on property in the wildland/urban interface areas.

### **Transportation**

Windstorm activity can have an impact on local transportation in addition to the problems caused by downed trees and electrical wires blocking streets and roadways. During periods of extremely strong Santa Ana winds, roadways can be temporarily closed to vehicle traffic. However, typically these disruptions are not long lasting, nor do they carry a severe long term economic impact on the city.

### **End Notes:**

---

1 <http://nimbo.wrh.noaa.gov/Sandiego/snawind.html>

2 Ibid

3 Keith C. Heidorn at <http://www.suite101.com/article.cfm/13646/100918>, June 1, 2003

4 Ibid

5 Ibid

6 Ibid

7 [www.cbsnews.com](http://www.cbsnews.com), January 8, 2003

8 [www.cbsnews.com/stories/2003/01/06/national/](http://www.cbsnews.com/stories/2003/01/06/national/)

**Section 7:  
Wildland/Urban  
Interface Fire  
Hazards  
in the  
City of Rolling Hills**

### Why are Wildfires a Threat to Southern California?

For thousands of years, fires have been a natural part of the ecosystem in Southern California. However, wildfires present a substantial hazard to life and property in communities built within or adjacent to hillsides and mountainous areas. There is a huge potential for losses due to wildland/urban interface fires in Southern California. According to the California Division of Forestry (CDF), there were over seven thousand reportable fires in California in 2003, with over one million acres burned.<sup>1</sup> According to CDF statistics, in the October 2003 Firestorms, over 4,800 homes were destroyed and 22 lives were lost.<sup>2</sup>

### The 2003 Southern California Fires

The fall of 2003 marked the most destructive wildfire season in California history. In a ten day period, 12 separate fires raged across Southern California in Los Angeles, Riverside, San Bernardino, San Diego and Ventura counties. The massive "Cedar Fire" in San Diego County alone consumed of 2,800 homes and burned over a quarter of a million acres.

**Table 7-1: October 2003 Firestorm Statistics**

County	Fire Name	Date Began	Acres Burned	Homes Lost	Homes Damaged	Lives Lost
Riverside	Pass	10/21/03	2,397	3	7	0
Los Angeles	Padua	10/21/03	10,446	59	0	0
San Bernardino	Grand Prix	10/21/03	69,894	136	71	0
San Diego	Roblar 2	10/21/03	8,592	0	0	0
Ventura	Piru	10/23/03	63,991	8	0	0
Los Angeles	Verdale	10/24/03	8,650	1	0	0
Ventura	Simi	10/25/03	108,204	300	11	0
San Diego	Cedar	10/25/03	273,246	2,820	63	14
San Bernardino	Old	10/25/03	91,281	1,003	7	6
San Diego	Otay / Mine	10/26/03	46,000	6	11	0
Riverside	Mountain	10/26/03	10,000	61	0	0
San Diego	Paradise	10/26/03	56,700	415	15	2
<b>Total Losses</b>			<b>749,401</b>	<b>4,812</b>	<b>185</b>	<b>22</b>
Source: <a href="http://www.fire.ca.gov/php/fire_er_content/downloads/2003LargeFires.pdf">http://www.fire.ca.gov/php/fire_er_content/downloads/2003LargeFires.pdf</a>						

## Historic Fires in Southern California

Large fires have been part of the Southern California landscape for millennia. “Written documents reveal that during the 19th century human settlement of southern California altered the fire regime of coastal California by increasing the fire frequency. This was an era of very limited fire suppression, and yet like today, large crown fires covering tens of thousands of acres were not uncommon. One of the largest fires in Los Angeles County (60,000 acres) occurred in 1878, and the largest fire in Orange County’s history, in 1889, was over half a million acres.”<sup>3</sup>

**Table 7-2: Large Historic Fires in California 1961-2003**

<b>20 Largest California Wildland Fires (Structures Destroyed)</b>						
	<b>Fire Name</b>	<b>Date</b>	<b>County</b>	<b>Acres</b>	<b>Structures</b>	<b>Deaths</b>
1	Tunnel	October 1991	Alameda	1,600	2,900	25
2	Cedar	October 2003	San Diego	273,246	2,820	14
3	Old	October 2003	San Bernardino	91,281	1,003	6
4	Jones	October 1999	Shasta	26,200	954	1
5	Paint	June 1990	Santa Barbara	4,900	641	1
6	Fountain	August 1992	Shasta	63,960	636	0
7	City of Berkeley	September 1923	Alameda	130	584	0
8	Bel Air	November 1961	Los Angeles	6,090	484	0
9	Laguna Fire	October 1993	Orange	14,437	441	0
10	Paradise	October 2003	San Diego	56,700	415	2
11	Laguna	September 1970	San Diego	175,425	382	5
12	Panorama	November 1980	San Bernardino	23,600	325	4
13	Topanga	November 1993	Los Angeles	18,000	323	3
14	49er	September 1988	Nevada	33,700	312	0
15	Simi	October 2003	Ventura	108,204	300	0
16	Sycamore	July 1977	Santa Barbara	805	234	0
17	Canyon	September 1999	Shasta	2,580	230	0
18	Kannan	October 1978	Los Angeles	25,385	224	0

19	Kinneloa	October 1993	Los Angeles	5,485	196	1
20	Grand Prix	October 2003	San Bernardino	59,448	196	0
21	Old Gulch	August 1992	Calaveras	17,386	170	0
<a href="http://www.fire.ca.gov/FireEmergencyResponse/HistoricalStatistics/PDF/20LSTRUCTURES.pdf">http://www.fire.ca.gov/FireEmergencyResponse/HistoricalStatistics/PDF/20LSTRUCTURES.pdf</a>						
"Structures" is meant to include all loss - homes and outbuildings, etc.						

During the 2002 fire season, more than 6.9 million acres of public and private lands burned in the US, resulting in loss of property, damage to resources and disruption of community services.<sup>4</sup> Taxpayers spent more than \$1.6 billion<sup>5</sup> to combat more than 88,400 fires nationwide. Many of these fires burned in wildland/urban interface areas and exceeded the fire suppression capabilities of those areas. Table 7-3 illustrates fire suppression costs for state, private and federal lands.

**Table 7-3: National Fire Suppression Costs**

Year	Suppression Costs	Acres Burned	Structures Burned
2000	\$1.3 billion	8,422,237	861
2001	\$0.5 billion	3,570,911	731
2002	\$1.6 billion	6,937,584	815
<a href="http://research.yale.edu/gisf/assets/pdf/ppf/wildfire_report.pdf">http://research.yale.edu/gisf/assets/pdf/ppf/wildfire_report.pdf</a>			

### **Wildfire Characteristics**

There are three categories of interface fire:<sup>6</sup> The classic wildland/urban interface exists where well-defined urban and suburban development presses up against open expanses of wildland areas; the mixed wildland/urban interface is characterized by isolated homes, subdivisions and small communities situated predominantly in wildland settings; and the occluded wildland/urban interface exists where islands of wildland vegetation occur inside a largely urbanized area. Certain conditions must be present for significant interface fires to occur. The most common conditions include: hot, dry and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, several conditions influence its behavior, including fuel topography, weather, drought and development.

Southern California has two distinct areas of risk for wildland fire. The foothills and lower mountain areas are most often covered with scrub brush or chaparral. The higher elevations of mountains also have heavily forested terrain. The lower elevations covered with chaparral create one type of exposure.

“Past fire suppression is not to blame for causing large shrub land wildfires, nor has it proven effective in halting them.”” said Dr. Jon Keeley, a USGS fire researcher who studies both southern California shrub lands and Sierra Nevada forests. ““Under Santa Ana conditions, fires carry through all chaparral regardless of age class. Therefore, prescribed burning programs over large areas to remove old stands and maintain young growth as bands of firebreaks resistant to ignition are futile at stopping these wildfires.””<sup>7</sup>

The higher elevations of Southern California’s mountains are typically heavily forested. The magnitude of the 2003 fires is the result of three primary factors: (1) severe drought, accompanied by a series of storms that produce thousands of lightning strikes and windy conditions; (2) an infestation of bark beetles that has killed thousands of mature trees; and (3) the effects of wildfire suppression over the past century that has led to buildup of brush and small diameter trees in the forests.

“When Lewis and Clark explored the Northwest, the forests were relatively open, with 20 to 25 mature trees per acre. Periodically, lightning would start fires that would clear out underbrush and small trees, renewing the forests. Today's forests are completely different, with as many as 400 trees crowded onto each acre, along with thick undergrowth. This density of growth makes forests susceptible to disease, drought and severe wildfires. Instead of restoring forests, these wildfires destroy them and it can take decades to recover. This radical change in our forests is the result of nearly a century of well-intentioned but misguided management.”<sup>8</sup>

### **The Interface**

One challenge Southern California faces regarding the wildfire hazard is from the increasing number of houses being built on the urban/wildland interface. Every year the growing population has expanded further and further into the hills and mountains, including forest lands. The increased "interface" between urban/suburban areas and the open spaces created by this expansion has produced a significant increase in threats to life and property from fires and has pushed existing fire protection systems beyond original or current design and capability. Property owners in the interface are not aware of the problems and threats they face. Therefore, many owners have done very little to manage or offset fire hazards or risks on their own property. Furthermore, human activities increase the incidence of fire ignition and potential damage.

### **Fuel**

Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is classified by volume and by type. Volume is described in terms of "fuel loading", or the amount of available vegetative fuel.

The type of fuel also influences wildfire. Chaparral is a primary fuel of Southern California wildfires. Chaparral habitat ranges in elevation from near sea level to over 5,000' in Southern California. Chaparral communities experience long dry summers and

receive most of their annual precipitation from winter rains. Although chaparral is often considered as a single species, there are two distinct types; hard chaparral and soft chaparral. Within these two types are dozens of different plants, each with its own particular characteristics.

“Fire has been important in the life cycle of chaparral communities for over 2 million years; however, the true nature of the "fire cycle" has been subject to interpretation. In a period of 750 years, it generally thought that fire occurs once every 65 years in coastal drainages and once every 30 to 35 years inland.”<sup>9</sup>

“The vegetation of chaparral communities has evolved to a point it requires fire to spawn regeneration. Many species invite fire through the production of plant materials with large surface-to-volume ratios, volatile oils and through periodic die-back of vegetation. These species have further adapted to possess special reproductive mechanisms following fire. Several species produce vast quantities of seeds which lie dormant until fire triggers germination. The parent plant which produces these seeds defends itself from fire by a thick layer of bark which allows enough of the plant to survive so that the plant can crown sprout following the blaze. In general, chaparral community plants have adapted to fire through the following methods; a) fire induced flowering; b) bud production and sprouting subsequent to fire; c) in-soil seed storage and fire stimulated germination; and d) on plant seed storage and fire stimulated dispersal.”<sup>10</sup>

An important element in understanding the danger of wildfire is the availability of diverse fuels in the landscape, such as natural vegetation, manmade structures and combustible materials. A house surrounded by brushy growth rather than cleared space allows for greater continuity of fuel and increases the fire's ability to spread. After decades of fire suppression “dog-hair” thickets have accumulated, which enable high intensity fires to flare and spread rapidly.

### **Topography**

Topography influences the movement of air, thereby directing a fire course. For example, if the percentage of uphill slope doubles, the rate of spread in wildfire will likely double. Gulches and canyons can funnel air and act as chimneys, which intensify fire behavior and cause the fire to spread faster. Solar heating of dry, south-facing slopes produces up slope drafts that can complicate fire behavior. Unfortunately, hillsides with hazardous topographic characteristics are also desirable residential areas in many communities. This underscores the need for wildfire hazard mitigation and increased education and outreach to homeowners living in interface areas.

### **Weather**

Weather patterns combined with certain geographic locations can create a favorable climate for wildfire activity. Areas where annual precipitation is less than 30 inches per year are extremely fire susceptible.<sup>11</sup> High-risk areas in Southern California share a hot,

dry season in late summer and early fall when high temperatures and low humidity favor fire activity. The so-called “Santa Ana” winds, which are heated by compression as they flow down to Southern California from Utah, create a particularly high risk, as they can rapidly spread what might otherwise be a small fire.

**Drought**

Recent concerns about the effects of climate change, particularly drought, are contributing to concerns about wildfire vulnerability. The term drought is applied to a period in which an unusual scarcity of rain causes a serious hydrological imbalance. Unusually dry winters, or significantly less rainfall than normal, can lead to relatively drier conditions and leave reservoirs and water tables lower. Drought leads to problems with irrigation and may contribute to additional fires, or additional difficulties in fighting fires.

**Development**

Growth and development in scrubland and forested areas is increasing the number of human-made structures in Southern California interface areas. Wildfire has an effect on development, yet development can also influence wildfire. Owners often prefer homes that are private, have scenic views, are nestled in vegetation and use natural materials. A private setting may be far from public roads, or hidden behind a narrow, curving driveway. These conditions, however, make evacuation and fire fighting difficult. The scenic views found along mountain ridges can also mean areas of dangerous topography. Natural vegetation contributes to scenic beauty, but it may also provide a ready trail of fuel leading a fire directly to the combustible fuels of the home itself.

**Wildfire Hazard Assessment**

**Wildfire Hazard Identification**

Wildfire hazard areas are commonly identified in regions of the wildland/urban interface. Ranges of the wildfire hazard are further determined by the ease of fire ignition due to natural or human conditions and the difficulty of fire suppression. The wildfire hazard is also magnified by several factors related to fire suppression/control such as the surrounding fuel load, weather, topography and property characteristics. Generally, hazard identification rating systems are based on weighted factors of fuels, weather and topography.

Table 7-4 illustrates a rating system to identify wildfire hazard risk (with a score of 3 equaling the most danger and a score of 1 equaling the least danger.)

**Table 7-4: Sample Hazard Identification Rating System**

Category	Indicator	Rating
Roads and Signage	Steep; narrow; poorly signed	3
	One or two of the above	2

	Meets all requirements	1
Water Supply	None, except domestic	3
	Hydrant, tank, or pool over 500 feet away	2
	Hydrant, tank, or pool within 500 feet	1
Location of the Structure	Top of steep slope with brush/grass below	3
	Mid-slope with clearance	2
	Level with lawn, or watered groundcover	1
Exterior Construction	Combustible roofing, open eaves, Combustible siding	3
	One or two of the above	2
	Non-combustible roof, boxed eaves, non-combustible siding	1

In order to determine the "base hazard factor" of specific wildfire hazard sites and interface regions, several factors must be taken into account. Categories used to assess the base hazard factor include:

- Topographic location, characteristics and fuels
- Site/building construction and design
- Site/region fuel profile (landscaping)
- Defensible space
- Accessibility
- Fire protection response
- Water availability

The use of Geographic Information System (GIS) technology in recent years has been a great asset to fire hazard assessment, allowing further integration of fuels, weather and topography data for such ends as fire behavior prediction, watershed evaluation, mitigation strategies and hazard mapping.

In response to the disastrous 1991 Oakland Hills fire in the Bay Area, Assembly Bill 337 (the so-called "Bates bill"), as codified in Sections 51175-51189 of the California Government Code, required the Director of California Department of Forestry (CDF) to identify and designate Very High Fire Hazard Severity Zones (VHFHSZs) in certain specified counties (including Los Angeles County) by January 1, 1995, and in all remaining California counties by January 1, 1996. The entire Palos Verdes Peninsula area, of which Rolling Hills is a part, is designated as a VHFHSZ by the State, based upon information obtained from the California Department of Forestry and Fire Protection (CDF) website.

The designation of property as being located within a VHFHSZ imposes certain obligations for property maintenance upon property owners "in any mountainous area, forest-covered land, brush-covered land, grass-covered land, or any land that is covered

with flammable material." The City of Rolling Hills through its contract with the Los Angeles County Fire Department requires and enforces the following::

- Maintain around and adjacent to the dwelling or structure a firebreak made by removing and clearing away, for a distance of not less than 30 feet on each side thereof or to the property line, whichever is nearer, all flammable vegetation or other combustible growth. This paragraph does not apply to single specimens of trees, ornamental shrubbery, or similar plants that are used as ground cover, if they do not form a means of rapidly transmitting fire from the native growth to any dwelling or structure.
- Maintain around and adjacent to the occupied dwelling or occupied structure additional fire protection or firebreaks made by removing all brush, flammable vegetation, or combustible growth that is located from 30 feet to 100 feet from the occupied dwelling or occupied structure or to the property line, whichever is nearer, as may be required by the local agency if the local agency finds that, because of extra hazardous conditions, a firebreak of only 30 feet around the occupied dwelling or occupied structure is not sufficient to provide reasonable fire safety. Grass and other vegetation located more than 30 feet from the dwelling or structure and less than 18 inches in height above the ground may be maintained where necessary to stabilize the soil and prevent erosion.
- Remove that portion of any trees that extends within 10 feet of the outlet of any chimney or stovepipe.
- Maintain any tree adjacent to or overhanging any building free of dead or dying wood.
- Maintain the roof of any structure free of leaves, needles, or other dead vegetative growth.
- Provide and maintain at all times a screen over the outlet of every chimney or stovepipe that is attached to any fireplace, stove, or other device that burns any solid or liquid fuel. The screen shall be constructed and installed in accordance with the California Building Standards Code.

In addition, the City of Rolling Hills has one of the strictest rules for roof covering. The Rolling Hills Zoning Ordinance requires as follows "Roofing Material. Roof covering for all buildings shall be Class "A" (having satisfied the fifteen-year weathering test and certified as such by Underwriting Laboratories or an equivalent recognized test agency). Class "A" roof assembly utilizing wood or treated wood material and reflective type roofing shall not be permitted. Notwithstanding the foregoing, any new addition to, repair or re-roofing of a structure may match the existing roof covering, provided that the roof addition or the area to be re-roofed or repaired does not exceed two hundred square

feet in size. Any new roof addition, repair or re-roofing, which exceeds two hundred square feet shall comply with the requirements of this section”.

The City under its discretionary review process for reviewing development requires that to the maximum extent practicable all landscaping be drought and fire resistant, that any new trees introduced shall not be taller, at maturity than the roof ridge of the structures. This requirement may not prevent the fire to spread from the tree to the residence, but it would be very difficult for the fire to jump to another residence, as the City’s development consists of single-family residences on large lots with large distances between structures.

### **Vulnerability and Risk**

Southern California residents are served by a variety of local fire departments as well as county, state and federal fire resources. Data that includes the location of interface areas in the county can be used to assess the population and total value of property at risk from wildfire and direct these fire agencies in fire prevention and response.

Key factors included in assessing wildfire risk include ignition sources, building materials and design, community design, structural density, slope, vegetative fuel, fire occurrence and weather, as well as occurrences of drought.

The National Wildland/Urban Fire Protection Program has developed the Wildland/Urban Fire Hazard Assessment Methodology tool for communities to assess their risk to wildfire. For more information on wildfire hazard assessment refer to <http://www.Firewise.org>.

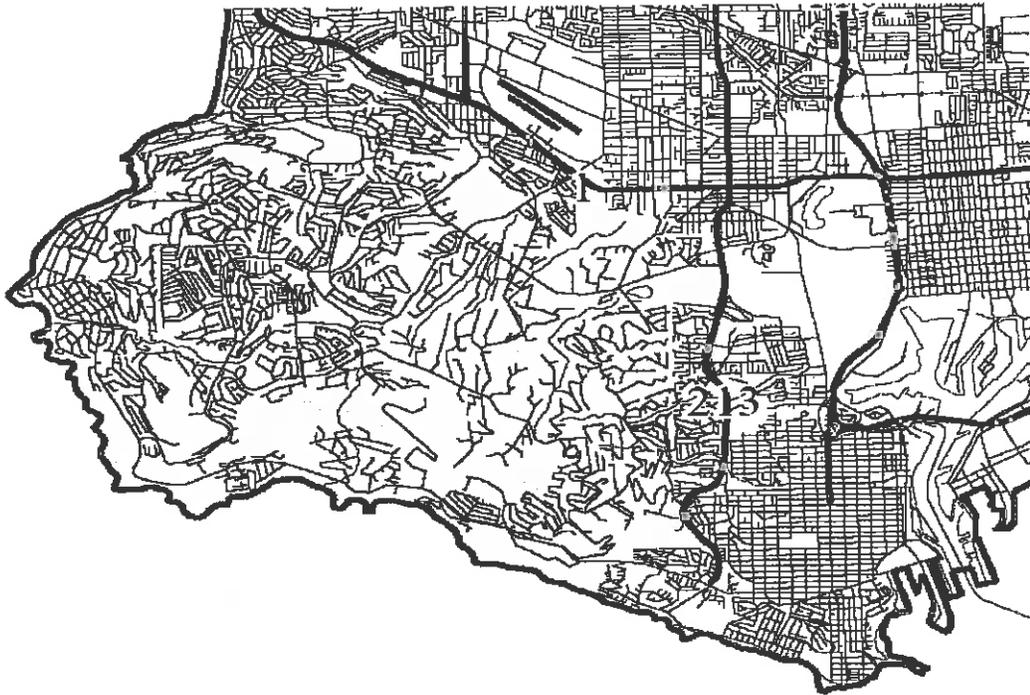
## Wildfire Threat to the City of Rolling Hills

**Table 7-5: Wildfire Vulnerability**

	Location (Where)	Extent (How Big)	Probability (How Often)*
<b>Hazard</b>			
Wildfire	Entire Project Area	California CDF-FRAP wildfire rating is "Very High Fire Hazard Severity Zone"	Moderate
* Probability is defined as: Low = 1:500 years, Moderate = 1:100 years, High = 1:10 years			

According to the County of Los Angeles Hazard Mitigation Plan, the California Division of Forestry wildland fire rating for the community of Rolling Hills is "Very High Fire Hazard Severity Zone". As can be seen in the following map from the County's Hazard Mitigation Plan, the entire Peninsula area is shown as "very high fire hazard severity zone".

**Map 7-1: Fire Hazard Map**



## Threat to Critical Facilities in the City of Rolling Hills

**Table 7-6: Wildfire Threat to Critical Facilities**

Wildfire	Facility	Address
	Los Angeles County Sheriff Substation	26123 Narborne Avenue, Lomita
X	Los Angeles County Fire Station #56	12 Crest Road W., Rolling Hills
X	City Hall	2 Portuguese Bend Road, Rolling Hills
X	Rolling Hills Community Association Office Building	1 Portuguese Bend Road, Rolling Hills
X	School (continuation HS, with less than 250 persons on campus)	38 Crest Road W., Rolling Hills
X	Water Company, Water Tanks, and Pumps	Various Locations in the City. Main Office: 2632 W. 237 <sup>th</sup> Street Torrance
X	Edison Company Utility Poles	Various Locations in the City. Main Office: 505 Maple Street, Torrance

### Community Wildfire Issues

#### What is Susceptible to Wildfire?

##### Growth and Development in the Interface

The hills and mountainous areas of Southern California are considered to be interface areas. The development of homes and other structures is encroaching onto the wildlands and is expanding the wildland/urban interface. The interface neighborhoods are characterized by a diverse mixture of varying housing structures, development patterns, ornamental and natural vegetation and natural fuels.

In the event of a wildfire, vegetation, structures and other flammables can merge into unwieldy and unpredictable events. Factors important to the fighting of such fires include access, firebreaks, proximity to water sources, distance from a fire station and available firefighting personnel and equipment. Reviewing past wildland/urban interface fires shows that many structures are destroyed or damaged for one or more of the following reasons:

- Combustible roofing material
- Wood construction

- Structures with no defensible space
- Fire department with poor access to structures
- Subdivisions located in heavy natural fuel types
- Structures located on steep slopes covered with flammable vegetation
- Limited water supply
- Winds over 30 miles per hour

As stated in Section 3, Community Profile, deep canyons and hilly terrain characterize the City of Rolling Hills. This combination makes the City vulnerable to the hazards associated with brush fires. The City is also vulnerable to brush fires from the adjacent communities, which also consist of steep canyons and open scrub-covered hillsides. Although there were no reports of fires that started within the Rolling Hills City limits, historically, there were several fires in the adjacent community of Rancho Palos Verdes, which threaten and/or spread to Rolling Hills.

As reported in the Peninsula News, a fire that started accidentally on Friday, June 22, 1973 by two youths playing with fireworks in Rancho Palos Verdes spread east and continued to move into the City of Rolling Hills, where it completely destroyed 9 homes. When the winds shifted to the west, the fire burned into the Portuguese Bend area of Rancho Palos Verdes and destroyed 3 more homes. In all, the 1973 fire consumed a total of 900 acres and raged for 28 hours before it was finally extinguished. Fortunately, no human lives were lost. However, in addition to the 12 homes that were destroyed, the conflagration also damaged 12 other structures. The disaster caused \$1.3 million in private property damage in Rolling Hills and an additional \$130,000 worth of damage in Rancho Palos Verdes.

As can be seen from the mitigation measures taken by the City described earlier in the section above and in the Mitigation Action Matrix, the City of Rolling Hills has implemented and is continually implementing measures to minimize the start of fire and the spread of fire. The development pattern of the City where the lots are large (more than one acre each) and where only single story, single family residences are permitted to be constructed, and where there are vast open areas between structures minimizes the spread of fires from property to property. The strict implementation of Fire Codes and strict roof requirements also minimize the threat of fires.

#### **Disruption of Critical Services**

Critical facilities include sheriff stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional during a wildfire event. See Section 4, Risk Assessment Table 4-2 for a listing of critical facilities and their vulnerability to wildfire.

#### **Road Access**

Road access is a major issue for all emergency service providers. As development encroaches into the rural areas of the county, the number of houses without adequate turn-around space is increasing. In many areas, there is not adequate space for emergency

vehicle turnarounds in single-family residential neighborhoods, causing emergency workers to have difficulty doing their jobs because they cannot access houses. As fire trucks are large, firefighters are challenged by narrow roads and limited access when there is inadequate turn around space, the fire fighters can only work to remove the occupants, but cannot safely remain to save the threatened structures.

### **Water Supply**

Fire fighters in remote and rural areas are faced by limited water supply and lack of hydrant taps. Rural areas are characteristically outfitted with small diameter pipe water systems, inadequate for providing sustained fire fighting flows.

### **Interface Fire Education Programs and Enforcement**

Fire protection in urban/wildland interface areas may rely heavily more on the landowner's personal initiative to take measures to protect his or her own property. Therefore, public education and awareness may play a greater role in interface areas. In those areas with strict fire codes, property owners who are resist maintaining the minimum brush clearances may be cited for failure to clear brush.

### **The Need for Mitigation Programs**

Continued development into the interface areas will have growing impacts on the wildland/urban interface. Periodically, the historical losses from wildfires in Southern California have been catastrophic, with deadly and expensive fires going back decades. The continued growth and development increases the public need for natural hazards mitigation planning in Southern California. Fire protection in the interface areas may rely more heavily on the landowner's personal initiative to take measures to protect his or her own property. Therefore, public education and awareness may play a greater role in interface areas. In those areas with strict fire codes, property owners who are resistant to maintaining the minimum brush clearances may be cited for failure to clear brush.

### **Wildfire End Notes**

- 1 [http://www.fire.ca.gov/php/2003fireseasonstats\\_v2.asp](http://www.fire.ca.gov/php/2003fireseasonstats_v2.asp)
- 2 [http://www.fire.ca.gov/php/fire\\_er\\_content/downloads/2003LargeFires.pdf](http://www.fire.ca.gov/php/fire_er_content/downloads/2003LargeFires.pdf)
- 3 [http://www.usgs.gov/public/press/public\\_affairs/press\\_releases/pr1805m.html](http://www.usgs.gov/public/press/public_affairs/press_releases/pr1805m.html)
- 4 <http://www.nifc.gov/stats/wildlandfirestats.html>
- 5 [http://research.yale.edu/gisf/assets/pdf/ppf/wildfire\\_report.pdf](http://research.yale.edu/gisf/assets/pdf/ppf/wildfire_report.pdf)
- 6 Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000)  
Department of Land Conservation and Development
- 7 [http://www.usgs.gov/public/press/public\\_affairs/press\\_releases/pr1805m.html](http://www.usgs.gov/public/press/public_affairs/press_releases/pr1805m.html)

- 
- <sup>8</sup> Overgrown Forests Require Preventive Measures, By Gale A. Norton (Secretary of the Interior), USA Today Editorial, August 21, 2002
- <sup>9</sup> <http://www.coastal.ca.gov/fire/ucsbfire.html>
- <sup>10</sup> Ibid
- <sup>11</sup> Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000), Department of Land Conservation and Development
- <sup>12</sup> <http://www.eqe.com/publications/revf93/firefoll.htm>
- <sup>13</sup> <http://www.fs.fed.us/land/wdfire7c.htm>
- <sup>14</sup> Source: National Interagency Fire Center, Boise ID and Karen Carroll, California Division of Forestry, Riverside Fire Lab.
- <sup>15</sup> [http://www.nifc.gov/fire\\_policy/docs/chp1.pdf](http://www.nifc.gov/fire_policy/docs/chp1.pdf)

**Section 8:  
Land Movement  
in the  
City of Rolling Hills**

### **Why is Land Movements a Threat to the City of Rolling Hills?**

Landslides are a serious geologic hazard in almost every state in America. Nationally, landslides cause 25 to 50 deaths each year.<sup>1</sup> The best estimate of direct and indirect costs of landslide damage in the United States range between \$1 and \$2 billion annually.<sup>2</sup> As a seismically active region, California has had significant number of locations impacted by landslide. Some landslides result in private property damage; other landslides impact transportation corridors, fuel and energy conduits, and communication facilities. They can also pose a serious threat to human life.

Landslides can be broken down into two categories: 1) rapidly moving (generally known as debris flows), and 2) slow moving. Rapidly moving landslide or debris flows present the greatest risk to human life, and people living in or traveling through areas prone to rapidly moving landslide are at increased risk of serious injury. Slow moving landslide can cause significant property damage, but are less likely to result in serious human injuries.

### **Historic Southern California Landslides**

#### **1928 St. Francis Dam failure**

Los Angeles County, California. The dam gave way on March 12, and its waters swept through the Santa Clara Valley toward the Pacific Ocean, about 54 miles away. Sixty five miles of valley was devastated, and over 500 people were killed. Damages were estimated at \$672.1 million (year 2000 dollars).<sup>3</sup>

#### **1956 Portuguese Bend, California**

Cost, \$14.6 million (2000 dollars) California Highway 14, Palos Verdes Hills. Land use on the Palos Verdes Peninsula consists mostly of single-family homes built on large lots, many of which have panoramic ocean views. All of the houses were constructed with individual septic systems, generally consisting of septic tanks and seepage pits. Landslides have been active here for thousands of years, but recent landslide activity has been attributed in part to human activity. The Portuguese Bend landslide began its modern movement in August 1956, when displacement was noticed at its northeast margin. Movement gradually extended downslope so that the entire eastern edge of the slide mass was moving within 6 weeks. By the summer of 1957, the entire slide mass was sliding towards the sea.<sup>4</sup> **This landslide was only a few miles southwest of the City of Rolling Hills.**

#### **1958-1971 Pacific Palisades, California**

Cost, \$29.1 million (2000 dollars) California Highway 1 and house damaged.<sup>5</sup>

#### **1961 Mulholland Cut, California**

Cost, \$41.5 million (2000 dollars) On Interstate 405, 11 miles north of Santa Monica, Los Angeles County.<sup>6</sup>

#### **1963 Baldwin Hills Dam Failure**

On December 14, the 650 foot long by 155 foot high earth fill dam gave way and sent

360 million gallons of water in a fifty foot high wall cascading onto the community below, killing five persons, and damaging 50 million (1963 dollars) of dollars in property.

**1969 Glendora, California**

Cost, \$26.9 million (2000 dollars) Los Angeles County, 175 houses damaged, mainly by debris flows.<sup>7</sup>

**1969 Seventh Ave., Los Angeles County, California**

Cost, \$14.6 million (2000 dollars) California Highway 60.<sup>8</sup>

**1970 Princess Park, California**

Cost, \$29.1 million (2000 dollars) California Highway 14, 10 miles north of Newhall, near Saugus, northern Los Angeles County.<sup>9</sup>

**1971 Upper and Lower Van Norman Dams, San Fernando, California**

Earthquake-induced landslide cost, \$302.4 million (2000 dollars). Damage due to the February 9, 1971, M7.5 San Fernando Earthquake. The earthquake of February 9 severely damaged the Upper and Lower Van Norman Dams.<sup>10</sup>

**1971 Juvenile Hall, San Fernando, California**

Landslide caused by the February 9, 1971, San Fernando, California, earthquake cost, \$266.6 million (2000 dollars). In addition to damaging the San Fernando Juvenile Hall, this 1.2 km-long slide damaged trunk lines of the Southern Pacific Railroad, San Fernando Boulevard, Interstate Highway 5, the Sylmar, California, electrical converter station, and several pipelines and canals.<sup>11</sup>

**1977-1980 Monterey Park, Repetto Hills, Los Angeles County, California**

Cost, \$14.6 million (2000 dollars) 100 houses damaged in 1980 due to debris flows.<sup>12</sup>

**1978 Bluebird Canyon Orange County**

California October 2, cost, \$52.7 million (2000 dollars), 60 houses destroyed or damaged. Unusually heavy rains in March of 1978 may have contributed to initiation of the landslide. Although the 1978 slide area was approximately 3.5 acres, it is suspected to be a portion of a larger, ancient landslide.<sup>13</sup>

**1979 Big Rock, California, Los Angeles County**

Cost, approximately \$1.08 billion (2000 dollars) California's Pacific Coast Highway 1 rockslide.<sup>14</sup>

**1980 Southern California Movements**

\$1.1 billion in damage (2000 dollars) Heavy winter rainfall in 1979-80 caused damage in six Southern California counties. In 1980, the rainstorm started on February 8. A sequence of 5 days of continuous rain and 7 inches of precipitation had occurred by February 14. Slope failures were beginning to develop by February 15 and then very high-intensity rainfall occurred on February 16. As much as 8 inches of rain fell in a 6

hour period in many locations. Records and personal observations in the field on February 16 and 17 showed that the mountains and slopes literally fell apart on those 2 days.<sup>15</sup>

#### **1983 San Clemente, California, Orange County**

Cost, \$65 million (2000 dollars), California Highway 1. Litigation at that time involved approximately \$43.7 million (2000 dollars).<sup>16</sup>

#### **1983 Big Rock Mesa, California**

Cost, \$706 million (2000 dollars) in legal claims condemnation of 13 houses, and 300 more threatened rockslide caused by rainfall<sup>17</sup>

#### **1978-1979, 1980 San Diego County, California**

Experienced major damage from storms in 1978, 1979, and 1979-80, as did neighboring areas of Los Angeles and Orange County, California. One hundred and twenty landslides were reported to have occurred in San Diego County during these 2 years. Rainfall for the rainy seasons of 78-79 and 79-80 was 14.82 and 15.61 inches (37.6 and 39.6 cm) respectively, compared to a 125-year average (1850-1975) of 9.71 inches (24.7 cm). Significant landslide occurred in the Friars Formation, a unit that was noted as slide-prone in the Seismic Safety Study for the City of San Diego. Of the nine landslides that caused damage in excess of \$1 million, seven occurred in the Friars Formation, and two in the Santiago Formation in the northern part of San Diego County.<sup>18</sup>

#### **1994 Northridge, California Earthquake Landslide**

As a result of the magnitude 6.7 Northridge, California, earthquake, more than 11,000 landslides occurred over an area of 10,000 km<sup>2</sup>. Most were in the Santa Susana Mountains and in mountains north of the Santa Clara River Valley. Landslide impacted dozens of homes, blocked roads, and damaged oil-field infrastructure. The spores released from the soil by the landslide activity<sup>19</sup> and blown toward the coastal populated areas caused deaths from Coecidioidomycosis (Valley Fever).

#### **March 1995 Los Angeles and Ventura Counties, Southern California**

Above normal rainfall triggered damaging debris flows, deep-seated landslide, and flooding. Several deep-seated landslides were triggered by the storms, the most notable was the La Conchita landslide, which in combination with a local debris flow, destroyed or badly damaged 11 to 12 homes in the small town of La Conchita, about 20 km west of Ventura. There also was widespread debris-flow and flood damage to homes, commercial buildings, and roads and highways in areas along the Malibu coast that had been devastated by wildfire 2 years before.<sup>20</sup>

### **Landslide Characteristics**

#### **What is a landslide?**

“A landslide is defined as, the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of “mass wasting” which denotes any down slope movement of soil and rock under the direct influence of gravity. The term “landslide” encompasses events

such as rock falls, topples, slides, spreads, and flows. Landslides can be initiated by rainfall, earthquakes, volcanic activity, changes in groundwater, disturbance and change of a slope by man-made construction activities, or any combination of these factors. Landslide can also occur underwater, causing tidal waves and damage to coastal areas. These landslides are called submarine landslide.”<sup>21</sup>

The size of a landslide usually depends on the geology and the initial cause. Landslides vary greatly in their volume of rock and soil, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names, depending on the type of failure and their composition and characteristics.

Slides move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface and translational slides where movement occurs along a flat surface. These slides are generally slow moving and can be deep. Slumps are small rotational slides that are generally shallow. Slow-moving landslide can occur on relatively gentle slopes and can cause significant property damage, but are far less likely to result in serious injuries than rapidly moving landslide.<sup>22</sup>

“Failure of a slope occurs when the force that is pulling the slope downward (gravity) exceeds the strength of the earth materials that compose the slope. They can move slowly, (millimeters per year) or can move quickly and disastrously, as is the case with debris-flows. Debris-flows can travel down a hillside of speeds up to 200 miles per hour (more commonly, 30 – 50 miles per hour), depending on the slope angle, water content, and type of earth and debris in the flow. These flows are initiated by heavy, usually sustained, periods of rainfall, but sometimes can happen as a result of short bursts of concentrated rainfall in susceptible areas. Burned areas charred by wildfires are particularly susceptible to debris flows, given certain soil characteristics and slope conditions.”<sup>23</sup>

### **What is a Debris Flow?**

A debris or mud flow is a river of rock, earth and other materials, including vegetation that is saturated with water. This high percentage of water gives the debris flow a very rapid rate of movement down a slope. Debris flows often with speeds greater than 20 mile per hour, and can often move much faster.<sup>24</sup> This high rate of speed makes debris flows extremely dangerous to people and property in its path.

### **Landslide Events and Impacts**

Landslides are a common hazard in California. Weathering and the decomposition of geologic materials produces conditions conducive to landslide and human activity further exacerbates many landslide problems. Many landslides are difficult to mitigate, particularly in areas of large historic movement with weak underlying geologic materials. As communities continue to modify the terrain and influence natural processes, it is important to be aware of the physical properties of the underlying soils as they, along with climate, create landslide hazards. Even with proper planning, landslide will

continue to threaten the safety of people, property, and infrastructure, but without proper planning, landslide hazards will be even more common and more destructive.

The increasing scarcity of buildable land, particularly in urban areas, increases the tendency to build on geologically marginal land. Additionally, hillside housing developments in Southern California are prized for the view lots that they provide.

Rock falls occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, can cause falls where the road has been cut through bedrock. They are fast moving with the materials free falling or bouncing down the slope. In falls, material is detached from a steep slope or cliff. The volume of material involved is generally small, but large boulders or blocks of rock can cause significant damage.

Earth flows are plastic or liquid movements in which land mass (e.g. soil and rock) breaks up and flows during movement. Earthquakes often trigger flows.<sup>25</sup> Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically rapidly moving and also tend to increase in volume as they scour out the channel.<sup>26</sup> Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances.

#### **Landslide Conditions**

Landslides are often triggered by periods of heavy rainfall. Earthquakes, subterranean water flow and excavations may also trigger landslide. Certain geologic formations are more susceptible to landslide than others. Human activities, including locating development near steep slopes, can increase susceptibility to landslide events. Landslides on steep slopes are more dangerous because movements can be rapid.

Although landslides are a natural geologic process, the incidence of landslide and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness. Grading and construction can decrease the stability of a hill slope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities effecting landslide include: excavation, drainage and groundwater alterations, and changes in vegetation.<sup>27</sup>

Wildland fires in hills covered with chaparral are often a precursor to debris flows in burned out canyons. The extreme heat of a wildfire can create a soil condition in which the earth becomes impervious to water by creating a waxy-like layer just below the ground surface. Since the water cannot be absorbed into the soil, it rapidly accumulates on slopes, often gathering loose particles of soil in to a sheet of mud and debris. Debris flows can often originate miles away from unsuspecting persons, and approach them at a high rate of speed with little warning.

### **Natural Conditions**

Natural processes can cause landslide or re-activate historical landslide sites. The removal or undercutting of shoreline-supporting material along bodies of water by currents and waves produces countless small slides each year. Seismic tremors can trigger landslide on slopes historically known to have landslide movement. Earthquakes can also cause additional failure (lateral spreading) that can occur on gentle slopes above steep streams and riverbanks.

### **Particularly Hazardous Landslide Areas**

Locations at risk from landslide or debris flows include areas with one or more of the following conditions:

1. On or close to steep hills;
2. Steep road-cuts or excavations;
3. Existing landslide or places of known historic landslide (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground);
4. Steep areas where surface runoff is channeled, such as below culverts, V-shaped valleys, canyon bottoms, and steep stream channels; and
5. Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons.
6. Canyon areas below hillside and mountains that have recently (within 1-6 years) been subjected to a wildland fire.

### **Impacts of Development**

Although landslides are a natural occurrence, human impacts can substantially affect the potential for landslide failures in the City of Rolling Hills. Proper planning and geotechnical engineering can be exercised to reduce the threat of safety of people, property, and infrastructure.

### **Excavation and Grading**

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslide, these steeper slopes can be at an increased risk for landslide. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

### **Drainage and Groundwater Alterations**

Water flowing through or above ground is often the trigger for landslide. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or septic systems can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation in landslide prone locations can result in damaging landslide. Ineffective storm water management and excess runoff can also cause erosion and

increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area; development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, ponding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslide.<sup>28</sup>

### **Changes in Vegetation**

Removing vegetation from very steep slopes can increase landslide hazards. Areas that experience wildfire and land clearing for development may have long periods of increased landslide hazard. Also, certain types of ground cover have a much greater need for constant watering to remain green. Changing away from native ground cover plants may increase the risk of landslide.

## **Landslide Hazard Assessment**

### **Hazard Identification**

Identifying hazardous locations is an essential step towards implementing more informed mitigation activities.

Landslides are the most serious geological hazard facing the residential community of Rolling Hills. Many residences in Rolling Hills have been built upon pre-existing, unrecognized, or recognized, but unstabilized landslide. Geologically, most of the landslides within the City occur in the Altamira Shale Member of the Monterey Formation. Landslide rupture surfaces are commonly along plastic clay beds or seams within clayey shale or siltstone units (Source: General Plan Safety Element-13). **Refer to the Earthquake-Induced Landslide Area Maps located in the Earthquake Section of this plan.**

Slope modification during grading can render slopes unstable. Slope instability occurs when bedding planes intersect the slope face of either natural slopes or designed cut slopes. Site specific investigations are necessary to determine potential slope instability problems at specific sites.

Landslide are considered “potentially active”, meaning they could be reactivated in the future, either by excessive rainfall, introduction of artificial water in the slope (landscaping irrigation/broken water or septic systems), or improper site design or grading practices. Grading activities must consider these geologic constraints as a condition of project approval. The County of Los Angeles Public Works Department acts as reviewer for the City of Rolling Hills to ensure all potential geologic problems are addressed.

The Flying Triangle landslide occupies an area of approximately 70 acres on the south side of the crest of Palos Verdes Hills overlooking Portuguese Bend. It was observed to

be moving since March 1980, but may have initiated movement as early as 1974. The current landslide represents reactivation of a relatively large complex compound ancient landslide of probable Pleistocene age unrelated to the infamous Portuguese Bend landslide, cause of movement is directly related to a period of unusual heavy precipitation during the last decade, ending in March 1983, in common with activation of many other ancient landslide along the coastline of Los Angeles County.

Most of the homes in the Flying Triangle landslide which experienced severe damage were damaged during the early stages of landslide movement. It is understood that the present rate of movement is slower than in the late 1970's or 1980's. Recent efforts to remove water from the area of the landslide have apparently been successful in slowing the rate of movement. Some portions of the landslide have appeared to have stopped moving entirely. Public and private roads are continually being damaged and repaired within the active landslide and many utility lines have been placed above the ground with flex-joints to allow for the continual landslide movement. The Flying Triangle landslide is an ancient landslide that is likely several tens of thousands of years old that has recently become reactivated. The landslide area within the Flying Triangle has rendered a large amount of land within the City's southwest area unsuitable for residential development, and is subject to ongoing changes in topography (Source: General Plan Land Use-9).

The City of Rolling Hills adopts the Los Angeles County Building Codes for any development within the City, with minor modifications, when necessary to meet local goals and constraints. Any development in the Flying Triangle is subject to the County's Building Code relative to Geotechnical Hazards Zones. Pursuant to the Los Angeles Building Code very limited development is permitted in the Geotechnical Hazards Zones.

The City enforces strict grading regulations for all areas in the City. Property owners are required to prove soils and geologic stability of the parcel upon which they are planning to construct, based on Los Angeles County's factor of stability.

No mapping of the hazard area has been performed in the City since 1980, when the Flying Triangle landslide area was identified. However, as parcels are being developed throughout the City, data is collected on soils and geology since each developed requires that solid and geologic conditions be established, to determine if construction can take place.

### **Vulnerability and Risk**

Vulnerability assessment for landslide will assist in predicting how different types of property and population groups will be affected by a hazard.<sup>29</sup> Data that includes specific landslide-prone and debris flow locations in the city can be used to assess the population and total value of property at risk from future landslide occurrences.

Rolling Hills, as a hillside coastal region community, may be described as having some of the most severe terrain of any jurisdiction in Los Angeles County. Slopes of 25 to 50 percent are present in virtually every remaining undeveloped parcel in the City (Source:

## General Plan Housing Element-34).

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not yet been conducted for the City of Rolling Hills landslide events, there are many qualitative factors that point to potential vulnerability. Landslide can impact major transportation arteries, blocking residents from essential services.

Past landslide events have caused major property damage and significantly impacted city residents, and mapping city landslide and debris flow areas would help in preventing future loss.

One area of the City, identified as geotechnically hazardous due to a landslide incident in the early 1980's is approximately 68 acres in size and contains 32 parcels. Each parcel is at least one acre in size. There are approximately 17 single family homes remaining in this area of the City. Although located in a landslide area, these homes have breathtaking views and when sold garner substantial amount of money. Since the City does not allow new construction in the Flying Triangle area, the vacant parcels have very little value. However, the potential for landslide exist on both, developed and undeveloped lots, and should there be a disaster the undeveloped lots could slip onto the developed lots causing great damage to property and lives. Although the exact value of the homes in the Flying Triangle are difficult to asses, the most recent sales ranged between \$350,000-\$800,000. It is important to note that any natural disaster would cause tremendous economic hardship to these property owners, as they would not be allowed to be re-built.

Factors included in assessing landslide risks include population and property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, soil characteristics, and precipitation intensity. This type of analysis could generate estimates of the damages to the city due to a specific landslide or debris flow event. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available.

## **Community Landslide Issues**

### **What is Susceptible to Landslide?**

Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damages and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, telecommunications, natural gas, and electric power are all essential to service community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as an inch or two.

### **Roads**

Losses incurred from landslide hazards in the City of Rolling Hills have been associated

with roads. The City contracts with the Los Angeles County Public Works Department for responding to slides that inhibit the flow of traffic or are damaging a road. The Rolling Hills Community Association provides road maintenance for addressing slow movement road damage. In the 1980 Landslide, the Rolling Hills Community Association incurred \$300,000 loss for street repairs in this area.

It is not cost effective to mitigate all slides because of limited funds and the fact that some historical slides are likely to become active again even with mitigation measures.

#### **Lifelines and Critical Facilities**

Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation arteries may be increased if the closed road is critical to access hospitals and other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas.

#### **Landslide Mitigation Activities**

Landslide mitigation activities include current mitigation programs and activities that are being implemented by Rolling Hills Community Association, Los Angeles County and the City.

#### **Landslide Building/Zoning Codes**

The City of Rolling Hills Building/Zoning Codes addresses development on steep slopes in subsection 15.04.130. No development can take place on slopes greater than 2:1 or which exceed a vertical height of 30 feet. In addition, no structure may be located on the sides or bottoms of canyons or natural drainage courses. As stated previously, prior to any development, the applicants must prove stability of the lot proposed for development. Soils, geology, and hydrology studies area required to be performed, reviewed, and approved by the appropriate divisions of the Los Angeles County Public Works Department.

The City of Rolling Hills implements strict development requirements. Only 40% of the net lot area may be disturbed. Disturbances is defined as any activity on the lot, which will result in grading of slopes and area for the building pads and includes any nongraded area where impervious surfaces will remain or are proposed to be added. Structural lot coverage, including all the structures on the property such as residence, garage, swimming pool, sports court and any other use may not cover more than 20% of the net lot area. The total structural coverage, which includes all the structures and impervious surfaces, may not cover more than 35% of the net lot area. These restrictions apply to construction throughout the City.

The Los Angeles Bounty Building Code requirements in the Geotechnical Hazard Areas stipulate that the building official may not issue building permits if he/she finds that the

property outside of the site proposed for development could be damaged by activation or acceleration of a geotechnical hazardous condition and such activation or acceleration could be attributed to the proposed work. Therefore, very limited development may occur in the Flying Triangle area of the City. Section 110 of the 2002 County of Los Angeles Building Code addresses prohibited uses of building sites on Geotechnical Hazards areas. Pursuant to the code repairs and minor alteration or reconstruction of existing structures in the Flying Triangle may be allowed. Certain types of new structures considered non-habitable, such as garage or a stable may also be permitted. Before a permit is issued, the owner must record a statement that the owner is aware that the subject property is subject to a physical hazard or a geotechnical nature and an agreement relieving the County and the City of any liability for any damages or loss which may result from issuance of such a permit.

### **Hazard Mapping**

No mapping of the hazard area has been performed in the City since 1980, when the Flying Triangle landslide area was identified. However, as parcels are being developed throughout the City, data is collected on soils and geology since each developed requires that solid and geologic conditions be established, to determine if construction can take place.

### **Community Issues Summary**

Landslides are a problem in City of Rolling Hills, and often impact the private infrastructure as well as private property. Risk Assessment Table 4-2 lists the critical and essential facilities serving the City that are vulnerable to land movement.

### **Landslide Mitigation Action Items**

The landslide mitigation action items provide direction on specific activities that the city, organizations, and residents in the City of Rolling Hills can undertake to reduce risk and prevent loss from landslide events. Each action item is followed by ideas for implementation, which can be used by the Planning Team and local decision makers in pursuing strategies for implementation.

### **Landslide End Notes**

---

1. Mileti, Dennis, *Disasters by Design: A Reassessment of Natural Hazards in the United States* (1999) Joseph Henry Press, Washington D.C.
2. Brabb, E.E., and B.L Harrod. (Eds) *Landslides: Extent and Economic Significance. Proceedings of the 28th International Geological Congress Symposium on Landslides.* (1989) Washington D.C., Rotterdam: Balkema.
3. Highland, L.M., and Schuster, R.L., *Significant Landslide Events in the United States.* (No Date) USGS, Washington D.C., [http://landslides.usgs.gov.html\\_files/pubs/report1/Landslides\\_pass\\_508.pdf](http://landslides.usgs.gov.html_files/pubs/report1/Landslides_pass_508.pdf)
4. Ibid.

---

5. Ibid.

6. Ibid.

7. Ibid.

8. Ibid.

9. Ibid.

10. Ibid.

11. Ibid.

12. Ibid.

13. Ibid.

14. Ibid.

15. Ibid.

16. Ibid.

17. Ibid.

18. Ibid.

19. Ibid.

20. Ibid.

21. Landslide Hazards, U.S. Geological Survey Fact Sheet 0071-00, Version 1.0, U.S. Department of the Interior - U.S. Geological Survey, <http://pubs.usgs.gov/fs/fs-0071-00/>

22. Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan (2000) Oregon Emergency Management*

23. Ibid.

24. Barrows, Alan and Smith, Ted, DMG Note 13, [http://www.consrv.ca.gov/cgs/information/publications/cgs\\_notes/note\\_33/](http://www.consrv.ca.gov/cgs/information/publications/cgs_notes/note_33/)

25. Robert Olson Associates, *Metro Regional Hazard Mitigation and Planning Guide (June 1999)* Metro

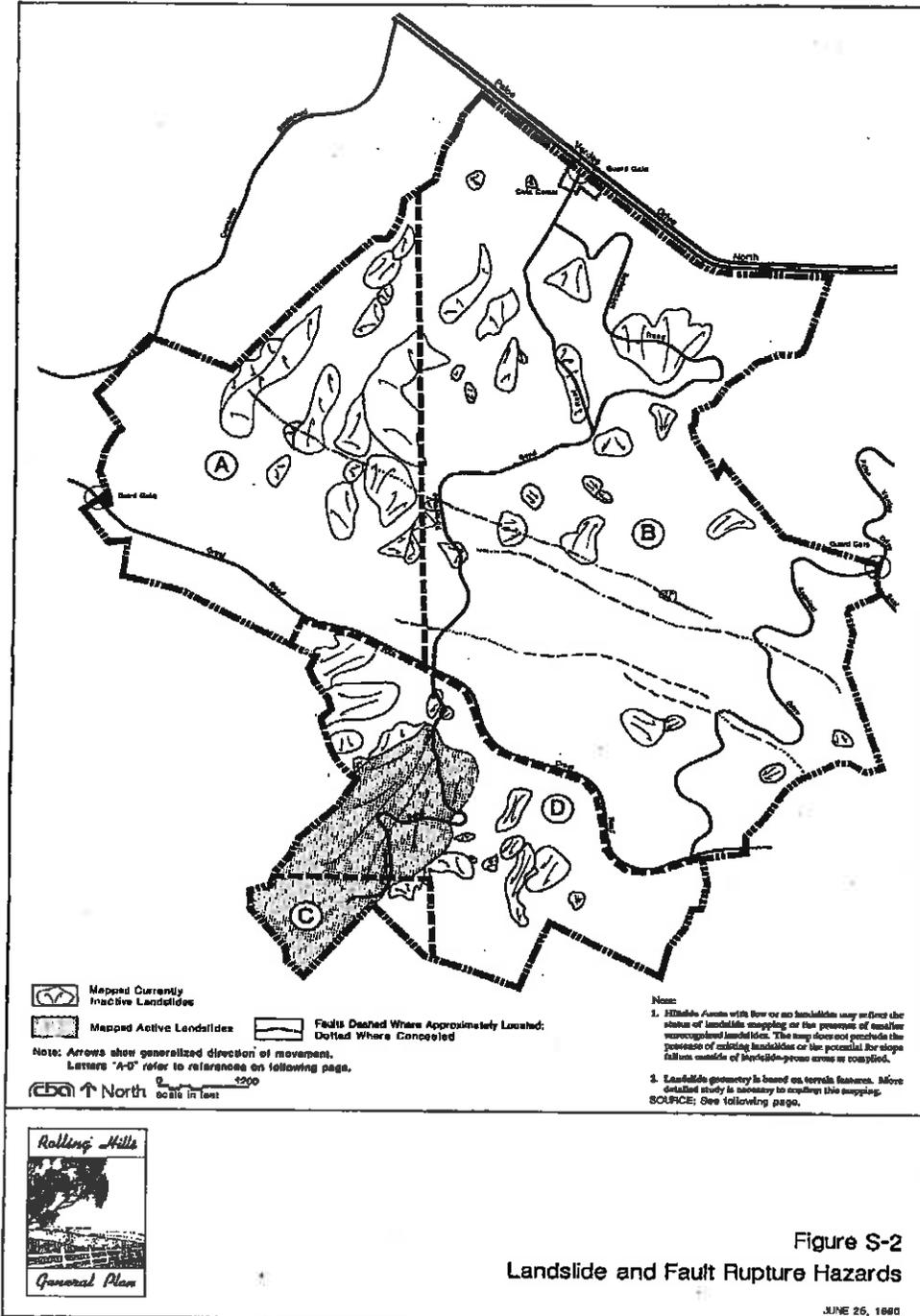
---

26. Ibid.

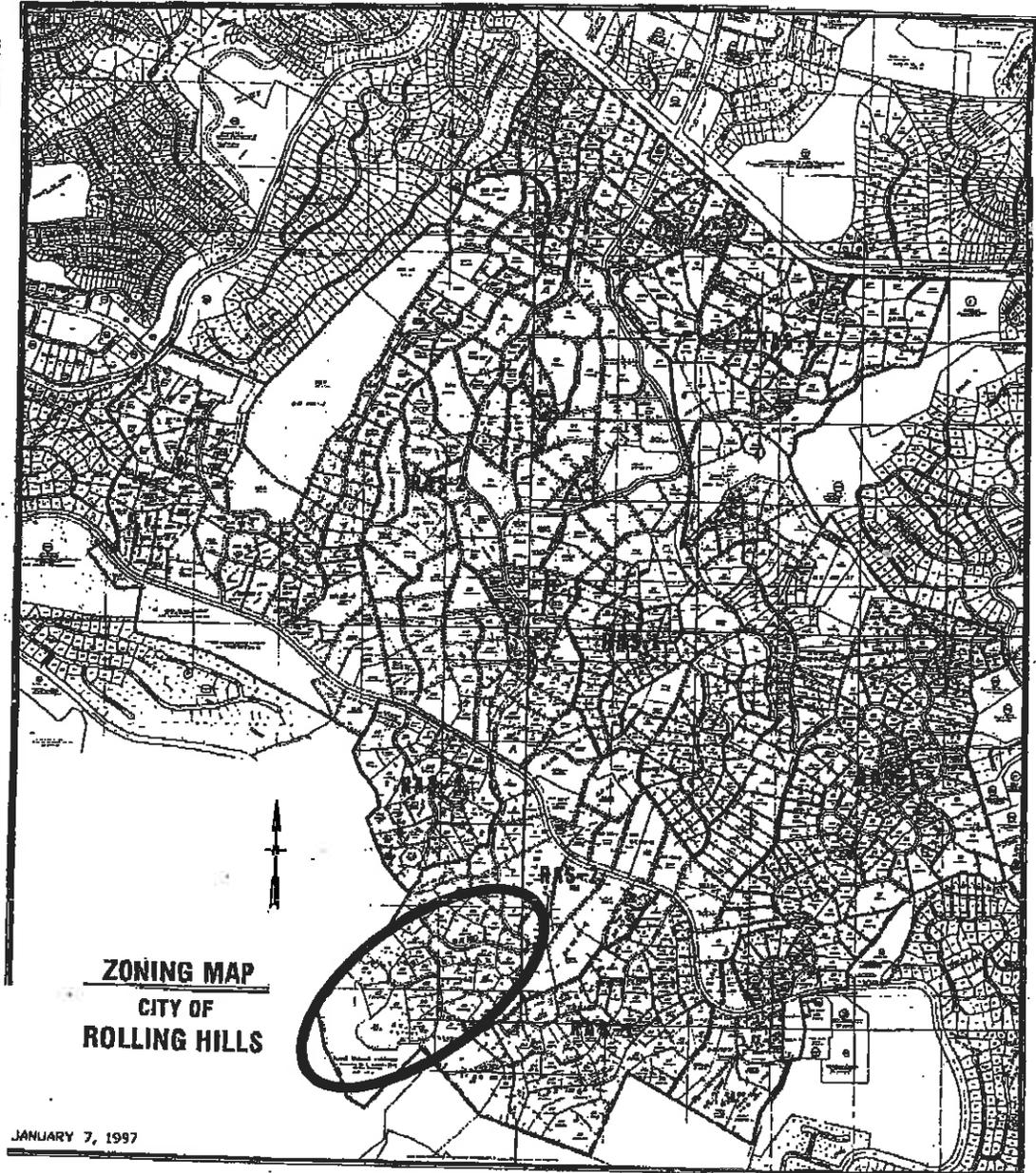
27. Planning For Natural Hazards: *The Oregon Technical Resource Guide*, Department of Land Conservation and Development (2000), Ch 5.

28. *Homeowners Guide for Landslide Control, Hillside Flooding, Debris Flows, Soil Erosion*, (March 1997)

29. Burby, R. (Ed.) *Cooperating With Nature* (1998) Washington, D.C.: Joseph Henry Press.



Map 8-1 City of Rolling Hills Probable Landslide Areas



TOTAL P.01

Map 8-2 Approximate Map of the Landslide Area