
# appendix e: geologic and seismic hazards

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The following definitions provide a more comprehensive discussion of the hazards that are described in the main body of the text of Chapter 7: Health and Safety Element.

## FAULT RUPTURE

Surface fault rupture is the breaking of the ground along a fault trace usually during a large magnitude earthquake. Although the risk of damage associated with surface fault rupture is high, it can be avoided by not placing structures across active fault traces. Thus, an important element in community planning involves knowing the locations of active fault traces. The State of California has produced maps depicting the general locations of known active fault traces. These maps, referred to in the past as the Alquist-Priolo Special Studies Zones Maps and more recently as Earthquake Fault Maps, provide a location information about the most widely known active faults. Such as the San Andreas fault. However, the scale and resolution of these maps are not sufficient to accurately identify the location of faults with respect to individual properties and building sites. In addition, other significant local faults, such as the Monta Vista-Shannon and Sargent-Berrocal faults, are not covered by the State maps. The City has updated its Geology Map and Geologic Hazards Map to reflect the most recent data concerning local fault trace alignments. Within the City Fault Rupture "Zone F", as illustrated on **Figure HS-5**: Geologic and Seismic Hazards, property owners must retain professional geologic consultants to determine whether or not specific fault traces impact proposed building sites for habitable or critical structures.

## GROUND SHAKING

Buildings and other structures located in seismically active regions such as the San Francisco Bay area are exposed to the hazard of severe ground shaking during earthquakes. Ground shaking is the vibration caused by rupture of a fault segment during an earthquake, and it can be felt over a wide area when the magnitude of the earthquake is very strong. The shaking intensity also is stronger in the area close to the earthquake epicenter and weaker in areas further away from the earthquake. In addition, the level of ground shaking is influenced by underlying rock formations, soil conditions and the depth to groundwater. A widely used shaking intensity scale is the Modified Mercalli Intensity Scale (**Table E-1**), which describes the amount of damage occurring at any geographical location in response to seismic shaking.

The intensity of an earthquake ground shaking is related to the size or magnitude of the earthquake. Each magnitude represents 10 times the amount of ground motion and approximately 31 times the amount of energy as the next lower numeral. Thus, an earthquake of magnitude 8 releases about 1,000 times more energy (31 x 31) than a magnitude 6 earthquake. A large-magnitude earthquake on nearby faults could cause considerable local damage, depending on the distance from the epicenter and characteristics of the ground. In general, structures on less well-consolidated bedrock and soil will experience greater shaking intensities than structures situated on hard rock.

The 1997 Uniform Building Code (UBC) incorporates new seismic design parameters that take into account various types of faults, soil profile types and near-source acceleration factors. The majority of the City located west of Highway 85 is located within 2 kilometers of known seismic sources (per California Division of Mines and Geology Near-Source Zones Map E-19). Proposed new development located within two kilometers of a known seismic source receives the most stringent near-source design factor, which is required for use with 1997 UBC structural design calculations. **Figure E-1** generally depicts the location of the various faults and hazard zones within the Cupertino planning area.

## Table E-1 General Comparison Between Earthquake Magnitude and the Earthquake Effects Due to Ground Shaking

| Earthquake Category | Richter Magnitude | Modified Mercalli Intensity Scale (After Huser, 1970) | Damage to Structure |
|---|---|---|---|
| Minor | 2.00 | I Detected only by sensitive instruments | No Damage |
| | | II Felt by few persons at rest, esp. on upper floors; delicate suspended | |
| | 3.00 | III Felt noticeably indoors, but not always recognized as an earthquake; standing cars rock slightly, vibration like passing trucks | |
| | | IV Felt indoors by many, outdoors by a few; at night some awaken; dishes, windows, doors disturbed; | |
| | 4.00 | V Felt by most people; some breakage of dishes, windows and plaster; disturbance to tall objects | Architectural Damage |
| | | VI Felt by all; many are frightened and run outdoors; Falling plaster and chimneys; damage small | |
| | 5.00 | | |
| | 5.3 | VII Everybody runs outdoors. Damage to buildings varies depending on quality of construction; noticed by driver of cars | |
| Moderate | 6.00 | VIII Chimneys fall; sand and mud ejected; drivers of cars disturbed | Structural Damage |
| | 6.9 | IX Building shifted off foundations, cracked, thrown out plumb; ground cracked, underground pipes broken; serious damage to reservoirs/embankments | |
| Major | 7.00 | X Most masonry and frame structures destroyed; ground cracked; rails bent slightly; landslides | |
| | 7.7 | XI Few structures remain standing; bridges destroyed; fissures in ground; pipes broken; land slides; rails bent | |
| Great | 8.00 | XII Damage total; waves seen on ground surface; lines of sight and level distorted; objects thrown into the air; large rock masses displaced | Total Destruction |

## SEISMIC GROUND DEFORMATION

Ground located in relatively close proximity to active fault traces may experience some level of ground deformation beyond the primary surface fault rupture zones. The distribution of this anticipated deformation is illustrated by the updated City Geologic Hazard Map – "Zone D". Ground deformation away from the primary rupture zones may include broad bowing or warping of the surface, ground cracking and secondary ground fissuring. The general magnitudes of such deformation could be up to several inches, whereas ground impacted by primary surface fault rupture could experience offsets of several feet.

Adjacent to local thrust faults (Berrocal and Monta Vista faults), relatively broad zones of ground deformation should be anticipated immediately west of the mapped fault trace alignments. These zones of deformation are anticipated to result from seismic displacement at depth along inclined fault planes descending to the west. The potential for such ground deformation should be considered during design of new structures near active fault traces.

## LIQUEFACTION

Soil liquefaction is the phenomenon in which certain water-saturated soils lose their strength and flow as a fluid when subjected to intense shaking. With loss of soil strength, lateral spreading or sliding of soil toward a stream embankment can occur. Liquefaction can also result in the formation of sand boils, which represent conduits of pressure release from within the liquefied layer (at depth) to the ground surface. Liquefaction can also lead to local settlement of the ground surface and a reduction of bearing support for building foundations. The potential exists for tilting or collapse of structures due to liquefaction of underlying earth materials.

Currently identified lands subject to a moderate or higher level of risk for liquefaction are essentially coincident with areas of potential flood inundation adjacent to local creek channels. Relatively deep, unconsolidated granular soil materials potentially prone to liquefaction may occur in these areas. The combined liquefaction and flood inundation hazard is depicted by Hazard "Zone I" on the City Geotechnical Hazards Map.

## SEISMICALLY INDUCED LANDSLIDING

Reactivation of existing landslides or generation of new slope failures (as discussed in the following section on landslides) may be initiated under intense seismic ground shaking conditions. As a result of the 1989 Loma Prieta earthquake, many large pre-existing landslides demonstrated lurching or other signs of movement and partial reactivation within the local Santa Cruz Mountains to the southwest of the City. Intense seismic ground shaking from a nearby earthquake could trigger new slope failures or movement of pre-existing landslides. Steep to precipitous banks adjacent to the flood plane of Stevens Creek may be particularly susceptible to seismically induced land sliding.

These areas, and other mapped landslides within the City, are included within "Zone L" on the City Geotechnical Hazard Map.

## LANDSLIDE HAZARDS

Landslides present the greatest geologic hazards to the foothills and low mountains in the planning area. The sliding of a slope is the normal geologic process that widens valleys and flattens slopes. The rate ranges from rapid rock fails to very slow soil and bedrock creep. Landslides are caused by inter-related natural factors, such as weak soil and rock over hillsides made steeper by rapid stream erosion, adverse geologic structure, groundwater levels and high rainfall rates. Landslides can be caused by improper grading, excessive irrigation, removal of natural vegetation and altering surface and subsurface drainage.

**Figure E-1** on page 5 shows mapped landslide deposits within Cupertino. Geologic mapping in the hillsides shows that landslide deposits cover as much as 20 to 30 percent of the hillsides in the planning area. Landslides range from small, shallow deposits made up of soil and weak bedrock materials to large, deep landslides involving a large amount of bedrock.

Extensive geologic characterization and engineering analyses are necessary to determine the long-term stability of a landslide deposit. Old deposits are the most difficult to judge. Experience shows that old landslide deposits are far more likely to move again than areas that have not had landslides before.

Areas in these old landslides that are next to steep, new stream channels are more likely to have new landslides than areas further from the new channels. This would be especially true with severe shaking during a major earthquake on any of the three faults in Cupertino. The historic account of the 1906 earthquake shows many landslides occurred throughout the Santa Cruz Mountains. Some of these were catastrophic, causing loss of life, personal injury and severe damage to buildings.

Landslides are expected along the high, steep embankments that bound the Stevens Creek flood plane, confined to local sites along the stream channel alignment extending from the front the hillsides across the valley floor. This hazard can be reduced significantly by restrictive building at the base and top of the embankments.

FIGURE E-1
**CUPERTINO GEOLOGY**