4.8 GEOLOGY

EXISTING CONDITIONS

Geological characteristics and conditions often pose significant opportunities and constraints to land use development and the location of major public facilities and infrastructure.

Seismic events present the most widespread threat of devastation to life and property. With an earthquake, there is no containment of potential damage. Since 1800 there have been approximately 60 damaging seismic events, or earthquakes, in the Los Angeles region. The most recent of these was the 6.7 magnitude Northridge earthquake which occurred at 4.31 a.m. on January 17, 1994, and was centered in the northwest part of the City, in the general vicinity of the 1971 San Fernando (a.k.a. Sylmar) quake.

The Northridge earthquake was listed by seismologists as a moderate quake. Nevertheless, it was the most costly seismic event in the United States since the 1906 San Francisco earthquake, resulting in the loss of life, physical injury, psychological trauma, and property damage estimated in the billions of dollars.

The Northridge earthquake was one of the most measured earthquakes in history due to extensive seismic instrumentation in buildings and on the ground throughout the region. The quake provided valuable data for evaluating existing standards and techniques and improving hazard mitigation. Two weeks after the Northridge quake, a seismic retrofit tilt-up (concrete walls poured and tilted-up on the site) ordinance was adopted and made retroactive by the City of Los Angeles. Subsequently, the City adopted a series of ordinances which required retrofitting of certain existing structures (e.g., foundation anchoring of hillside dwellings) and for new construction, as well as an ordinance which required evaluation of structures by a structural engineer during the construction process.

A more detailed discussion of the Northridge earthquake and its impacts is provided in the Safety Element of the City of Los Angeles General Plan.

The Westchester-Playa del Rey Community Plan Area (CPA) lies within the Los Angeles Basin. The basin is bounded on the north by the Santa Monica Mountains and Puente Hills, on the east by the Santa Ana Mountains and San Joaquin Hills, and on the west and south by the Palos Verdes Hills and the Pacific Ocean. The basin is made up of a great thickness of sediments that were deposited on an ancient sea floor. Three major groups of rocks are represented: older igneous and metamorphic bedrock (100 to 75 million years old), older sedimentary rocks (about 65 to 15 million years old) and younger sedimentary rocks (15 to 1 million years old). The sedimentary rock layers contain shale, siltstone, sandstone, and conglomerates, as well as some interbedded volcanic rocks. The Westchester-Playa del Rey Community Plan Area overlies thick layers of alluvium.

Geologic Structure. The Los Angeles Basin is divided structurally into fairly well defined blocks, mostly by major faults or fault zones. The basin is bounded on two sides by major faults: the Palos Verdes fault to the south, and the San Gabriel-Foothill fault to the north. To the east the Los Angeles Basin is bounded by the Puente Hills, Santa Ana Mountains and the San Joaquin Hills. Many other folds and faults exist in the basin and most follow the dominant northwesterly structural grain of Southern California.

Topography. The City of Los Angeles contains many landforms that reflect recent geologic folding and faulting. Four major landform types are represented in the Los Angeles area: high mountains (the San Gabriel Mountains and smaller ranges), broad valleys (San Fernando and San Gabriel Valleys which are separated from the coastal plain by low hills), low hills, and the coastal plain. The Westchester-Playa del Rey CPA is within the lowlands area of the City. There are no major hills or land forms within the CPA.

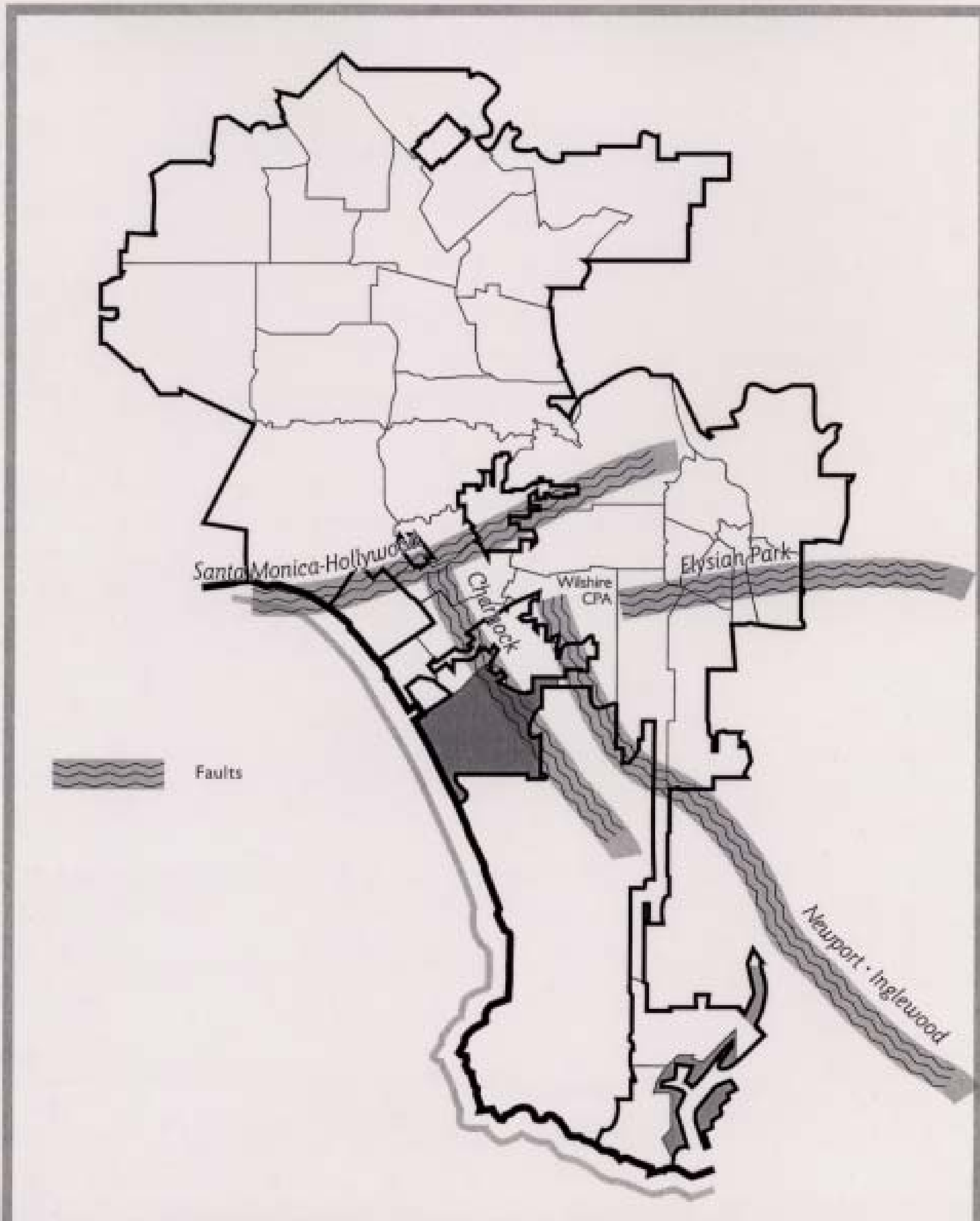
Faults. A fault is a fracture or line of weakness in the earth's crust, along which rocks on one side of the fault are offset relative to the same rocks on the other side of the fault. Sudden movement along a fault results in an earthquake. The entire Los Angeles basin is seismically active and is traversed by many known active and potentially active faults. **Figure 4.8-1** shows the faults in the vicinity of the Westchester-Playa del Rey CPA . **Figure 4.8-2** shows the faults throughout the Los Angeles basin.

Active Faults. Active faults are defined as those which have had surface displacement within Holocene time (about the last 11,000 years). The most significantly known active faults in the vicinity of the CPA include the Malibu Coast, Newport-Inglewood, and Raymond Hills.

Potentially Active Faults. Potentially active faults are those which show evidence of Pleistocene displacement (during the past two million years) without evidence of Holocene displacement (during the past 11,000 years). Potentially active faults in the vicinity of the CPA include the Charnock and Santa Monica-Hollywood.

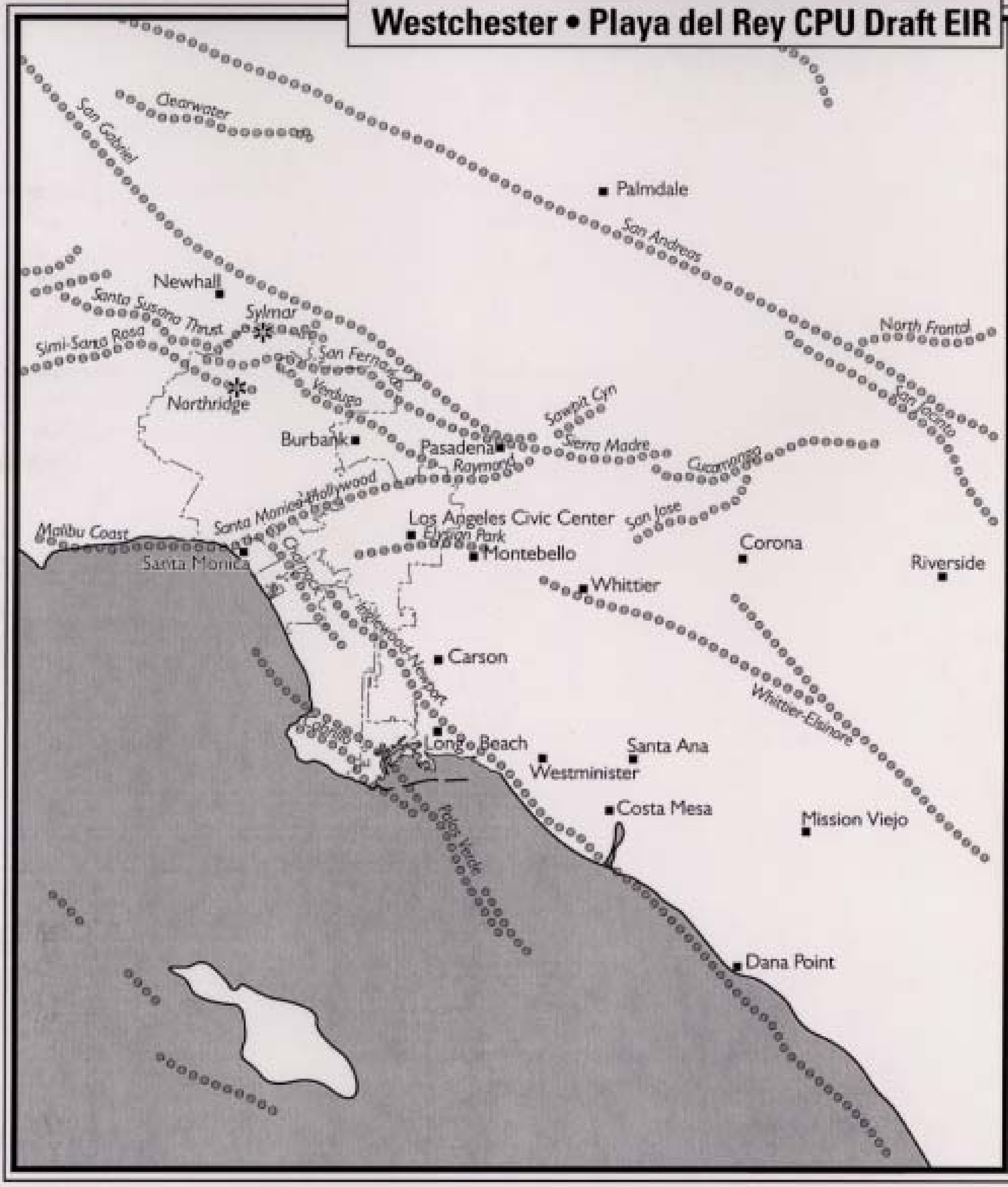
A recently discovered fault that is not potentially active is the Elysian Park fault.

While many active earthquake faults zones have been mapped in the Los Angeles area, typically they have been visible, above ground faults, such as the San Andreas fault. However, quakes along the unmapped faults, such as the blind thrust fault associated with the Northridge earthquake, are increasingly becoming the focus of study and concern. The concept of blind thrust faults has been recognized only recently by seismologists. The effect of such faults may dominate the geology of the Los Angeles basin in a way not previously known.



Generalized Location of Faults Adjacent to the Westchester * Palaya del Rey CPA

Source: "Los Angeles Citywide General Plan Framework EIR," City of Los Angeles, 1995



Generalized Location of Faults in the Los Angeles Region

Source: "Los Angeles Citywide General Plan Framework EIR," City of Los Angeles, 1995

Earthquakes are classified, based on the amount of energy released, using a logarithmic scale known as the Richter scale. Each whole number of Richter magnitude (M) represents a tenfold increase in the wave amplitude (earthquake size) generated by an earthquake, as well as a 3.16 fold increase in energy released. Thus, a M 6.3 earthquake is 10 times larger than a M 5.3 earthquake and releases 31.6 times more energy. In contrasts, a M 7.3 event is 100 times larger than 5.3, and releases almost 1,000 times more energy. Earthquakes of M 6.0 to 6.9 are classified as "moderate", M 7.0 to 7.9 as "major", and M 8.0 and larger as "great".

Earthquake frequency is expressed as recurrence interval, i.e., the average time between events of a specific magnitude. At this time, estimates are only available for the San Andreas fault which has an average recurrence interval of 140 years for the maximum credible earthquake (MCE). The frequency of earthquakes anticipated for other active faults in Los Angeles has not been determined.

Only the San Andreas and the San Jacinto faults have probability estimates available. The U.S. Geological Survey estimates that there is a 60 to 70 percent chance that a Richter magnitude 7.5 to 8 earthquake will occur on the southern San Andreas fault in the next 30 years. There is a 50 percent chance that a Richter magnitude 6.5 to 7 earthquake will occur on the San Jacinto fault in the same period.

Table 4.8-1 below lists active and potentially active faults in the CPA and the associated MCE using Richter scale magnitude.

Table 4.8-1 Active and Potentially Active Faults in the Area

	Fault Name	MCE
Active Faults	Malibu Coast Newport-Inglewood Raymond Hills	7.0 7.0 6.6
Potentially Active Faults	Charnock Santa Monica-Hollywood	6.6 6.8
Recently Discovered	Elysian Park	N/A

Source: Terry A. Hayes Associates, Draft Master Environmental Assessment South Los Angeles Subregion, 1992

Geologic Hazards. Primary hazards associated with seismicity include surface rupturing and groundshaking. The major secondary effects of groundshaking is liquefaction, landsliding and land subsidence.

Surface Rupturing and Groundshaking. Surface rupturing along the trace of a fault affects all types of material; however, it does not always show clearly in loose soils. Damage due to surface rupturing is limited to the actual location of the fault-line break; unlike damage from ground shaking, which can occur at great distances from the fault. Even a moderate earthquake can be accompanied by enough rupturing to damage foundations and bury utility lines that have not been adequately protected where they cross fault traces.

The Earthquake Planning Scenario for the Newport-Inglewood Fault Zone prepared by the California Department of Conservation, Division of Mines and Geology, indicates ground shaking estimates on the Modified Mercalli scale (see **Table 4.8-2)**.

In areas estimated to have ground shaking of 8 magnitude, the damage is estimated to be slight in structures (brick) built especially to withstand earthquakes. Considerable damage is expected in ordinary substantial buildings with partial collapse, racked, tumbled down, wooden houses in some case, and falling of walls, chimneys, columns, monuments, factory stacks, and towers. Those areas expected to experience ground shaking of 9 magnitude would result in considerable damage in masonry and wood built structures especially designed to withstand earthquakes, great damage in substantial masonry buildings, some collapse in large part or wholly shifted frame buildings off foundations, racked frames, and sometimes broken underground pipelines.

The Pre-Earthquake Planning to Post-earthquake Rebuilding (PEPPER) report has considered potential damage from theoretical earthquakes. Of particular concern were poor masonry buildings, where there is greatest probable potential for damage. The least damage would occur to single story wood frame buildings.

Alquist-Priolo Special Study Zones. Under the Alquist-Priolo Earthquake Fault Zoning Act of 1972 (originally known as the Alquist-Priolo Special Studies Zone Act), the State Geologist is require to delineate “Special Studies Zones” along known active faults in California. The purpose of the Act is to regulate development near active faults in order to mitigate the hazard of surface fault-rupture. Cities and countries affected by the zones must regulate certain development projects within these zones. They must withhold development permits for sites within zones until geologic investigations demonstrate that the sites are not threatened by surface displacement. Special studies zone boundaries range from 200 to 500 feet from the fault/presumed fault location. For purposes of Alquist-Priolo, an active fault is defined as one which has had surface displacement within Holocene time (about the last 11,000 years).

Alquist-Priolo Special Zones have been identified for several faults in the City of Los Angeles. All zone locations are recorded on US Geological Survey Quadrangle Maps (1 inch = 24,000 inches or 1 inch = 2000 feet or 610 meters). Alquist-Priolo faults include the Inglewood branch of the Newport-Inglewood system and the Raymond Hills fault. There are no special studies zones in the Westchester-Playa del Rey community plan area.

Table 4.8-2: Modified Mercalli Intensity Scale

Scale Rating	Description
I	Not Felt
II	Felt by persons at rest, on upper floors, or favorably placed.
III	Felt indoors; hanging objects swing; vibration like passing of light trucks; duration estimated; may not be recognized as an earthquake.
IV	Hanging objects swing; vibration like passing of heavy trucks or sensation of a jolt like a heavy ball striking the walls; standing automobiles rock; windows, dishes, doors rattle; wooden walls and frame may creak.
V	Felt outdoors; direction estimated; sleepers wakened; liquids disturbed, some spilled; small unstable objects displaced or upset; doors swing; shutters, pictures move; pendulum clocks stop, start, change rate.
VI	Felt by all; many frightened and run outdoors; persons walk unsteadily; windows, dishes, glassware broken; knickknacks, books, etc., off shelves; pictures off walls; furniture moved or overturned; weak plaster and masonry D/a/ cracked.
VII	Difficult to stand; noticed by drivers of automobiles; hanging objects quiver; furniture broken; weak chimneys broken at roof line; damage to masonry D, including cracks, fall of plaster, loose bricks, stones, tiles, and unbraced parapets; small slides and caving in along sand or gravel banks; large bells ring.
VIII	Steering of automobiles affected; damage to Masonry C, partial collapse; some damage to masonry B; none to Masonry A; fall of stucco and some masonry walls; twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks; frame houses moved on foundations if not bolted down; loose panel walls thrown out; decayed piling broken off. Branches broken from trees; changes in flow or temperature of springs and wells; cracks in wet ground and on steep slopes.
IX	General panic; Masonry D destroyed; Masonry C heavily damaged, sometimes with complete collapse; Masonry B seriously damaged; general damage to foundations; frame structures, if not bolted, shifted off foundations; frames racked; serious damage to reservoirs; underground pipes broken; conspicuous cracks in ground and liquefaction.

Scale Rating	Description
X	Most masonry and fame structures destroyed with their foundations; some well built wooden structures and bridges destroyed; serious damage to dams, dikes, embankments; large landslides; water thrown on banks of canals, rivers, lakes, etc.; sand and mud shifted horizontally on beaches and flat land; rails bent slightly.
XI	Rails bent greatly; underground pipelines completely out of service.
XII	Damage nearly total; large rock masses displaced; lines of sight and level distorted; objects thrown in the air.

/a/ Masonry A Good workmanship and mortar, reinforced designed to resist lateral force.
Masonry B Good workmanship and mortar, reinforced.
Masonry C Good Workmanship and mortar, unreinforced.
Masonry D Poor workmanship and mortar and weak materials, like adobe.
Source: Spangle, William E. "Pre-Earthquake Planning for Post-Earthquake Rebuilding", 1987, Figure 4.

Liquefaction. **Figure 4.8-3** shows areas where liquefaction is very likely and where the potential for liquefaction exists. Liquefaction is the condition in relatively loose, saturated sandy sediments where internal shear strength is lost due to the repeated vibrations from earthquake shaking. Such sediment is often described as taking on the properties of a liquid or quicksand. The more severe the shaking and the longer the duration of shaking, the more likely liquefaction will occur. Liquefaction can lead to a loss of bearing capacity for structures overlying or adjacent to a liquefied layer thereby causing severe settlement, lateral dislocation and possible overturning of buildings. Dynamic settlement can occur under these same conditions where sediments are only partially saturated due to the densification and consolidation of these loose sandy materials. Both types of sediment "failure" can vary over a given area causing differential movements and displacements of structures. These failures have been observed in the 1971 San Fernando and the 1994 Northridge earthquakes.

In the presence of a large earthquake, the liquefaction potential of an area is controlled both by the depth to the water table (saturation) and the relative density of the sediments (soils). The City has

used the mapping prepared by the County of Los Angeles (1990) based on occurrences of shallow water and recent alluvial deposits to define liquefiable areas (water less than 30 feet deep). For this study these areas are deemed to have a high (H) and moderate (M) hazard level, respectively. Where such alluvial areas have a surface slope of 0.5 to 5 percent, or more, flow failures and lateral spreading (a shallow landslide) can occur as was seen in Sylmar in 1971 at the Juvenile Hall facility. Methods exist for safely designing and constructing facilities in liquefaction-prone areas, however they are costly. While avoidance is a better option, the areas lie within already developed regions making identification of the condition important. The state of soils engineering practice is improving the ability to protect both larger discrete structures and linear lifeline-type structures from the effects of liquefaction. Therefore, early planning recognition will allow more intelligent siting of critical facilities which must remain functional following a large local earthquake.

Land Subsidence. Subsidence is the downward settling of the earth's surface with little or no horizontal motion. Land subsidence would occur from one or more of several causes, including withdrawal of fluids (oil, gas or water) and application of water to moisture-deficient unconsolidated deposits. Subsidence is relatively slow process that may continue for several decades; however, it may produce conditions that trigger some instantaneous events such as failure of dams and bridges.

Landsliding. A landslide is a mass downslope movement of earth materials under the influence of gravity, and includes a variety of forms: rockfalls, debris slides, mudflows, block slides, soil slides, slumps and creep. These mass movements are triggered or accelerated by earthquake-induced ground motion, increased water content, excessive surface loading, or alteration of existing slopes by man or nature. Earthquake-induced landslides, usually associated with steep canyons and hillsides, can originate on or move down slopes as gentle as one degree in areas underlain by saturated, sandy materials. Landsliding is perhaps the leading cause of property damage and personal danger related to earthquakes.

IMPACT ASSESSMENT

Threshold of Significance. Significance is difficult to define precisely with respect to certain geologic hazards because of the many variables involved. For example, the significant effects of a major earthquake may vary widely with the physical characteristics of the event, such as location, magnitude, intensity, and duration. In contrast, the probable occurrence of other geologic hazards can be determined with a much higher degree of accuracy. Such is the case with projects slated for development in areas prone to landslides and slope failure. The impact potential of these hazards can be readily identified since the manner in which unstable slopes can affect and/or be affected by the implementation of a given project is well understood. For the purpose of this analysis, significant impacts associated with geologic hazards are those that adversely affect life, property, and/or major public facilities.

If any geologic hazard is identified that will potentially impact a proposed project (especially structures for human habitation or use), the geohazard shall be considered significant.

The following significance criteria is relevant to the proposed plan (project):

Impacts of the proposed project on the geologic environment would be considered significant if:

- Unique geologic features (such as paleontologic resources) or geologic features of unusual scientific value for study or interpretation would be destroyed, disturbed, covered or other wide adversely affected.

- Substantial alteration of topography beyond that resulting from natural erosion and deposition processes would occur.

- Disruption, displacement, excavation, or compaction of large amounts of soil would occur.

Impacts of the following geologic hazards on the proposed project would be considered significant if:

- Ground rupture due to an earthquake occurs at the site, resulting in attendant damage to structures.

- Earthquake-induced ground shaking capable of causing liquefaction, settlement and surface cracks at the site occurs, and attendant damage to structures results.

- General soil characteristics (such as shear strength, expansiveness, etc.) require extensive foundation/engineering or slope stabilization measures; especially artificial fill materials.

- Anticipated ground accelerations exceed design parameters outlined in local building codes.

Assessment. Development resulting from the implementation of the proposed plan will not be subject to a greater seismic risk than other locations within the region. Nevertheless, as with all areas of Los Angeles, during an earthquake, significant ground shaking could result at various project sites and in the surrounding area. Implementation of the proposed plan will increase the density of development and human occupancy at various locations/sites, thereby increasing the potential for damage or injury during a major earthquake.

Development resulting from the implementation of the proposed plan may cause or be subject to the following environmental impacts:

- Earthquake related hazards, including ground shaking and high ground accelerations.
- Liquefaction, subsidence and/or settlement of sediments on project site.

- Ground rupture from active or potentially active fault traces located on site.

- Improperly cut slopes resulting in slope instability.

MITIGATION POLICIES

The City should do the following:

1. Continue to require that all new developments comply with existing, newly revised, building codes.

2. Require that all new developments implement the mitigation measures proposed in the geotechnical reports which assess potential consequences of liquefaction and soil strength loss as required by the Uniform Building Code, as amended in 1994, and the L. A. City Grading Code.

3. Where there is a potential for liquefaction, require that developers properly compact unconsolidated surficial sediments and fill.

4. Continue to require that all new developments comply with the Safety Element of the Los Angeles City General Plan.

UNAVOIDABLE SIGNIFICANT ADVERSE IMPACTS

Earthquake related hazards such as ground rupture, high ground accelerations, and ground shaking cannot be avoided in the Los Angeles Region. The complex Los Angeles fault system interacts with the alluvial soils and other geologic conditions in the hills and basins, and poses a potential seismic threat to every part of the City.

As discovered during damage assessment following the 1994 Northridge earthquake, existing building codes were inadequate to protect engineered structures from hazards associated with an earthquake. Although building codes have been revised and updated, new data and information on seismic risk associated with a major earthquake requires constant re-evaluation of existing statutes. Consequently, designing new facilities based on existing building codes may not prevent significant damage to these structures resulting from a major or great earthquakes on a nearby fault. Structural intensity of the shaking, distance from the epicenter, composition of the soil and type of construction, all determine the extent of damage which may occur. Therefore, seismic hazards related to future major or great earthquakes are unavoidable.