3.6 GEOLOGY, SOILS, AND MINERAL RESOURCES

3.6.1 Introduction

This section evaluates the potential for implementation of the Proposed Project to have impacts on geological resources, such as mineral extraction, as well as the potential for local and regional geological, seismic, and soil conditions to affect development in the Project Area. The potential for impacts is associated with hazards that could be caused by seismic activity (groundshaking, landsliding, and liquefaction), development on unstable geologic units or expansive soils, limitation of access to mineral deposits, and potential erosion from project construction and operation. Data used to prepare this section were taken from the Orange County's existing General Plan, the City of Lake Forest General Plan, Lake Forest Municipal Code, numerous state and federal studies of geologic and seismic hazards in the vicinity of the City, site-specific investigations in the Project Area, and field observations. Full bibliographic references are noted in Section 3.6.8 (References). No comments with respect to geologic and soil resources or seismic conditions were received during the NOP comment period.

This section also describes mineral resources within the City and Project Area. Mineral resource information was obtained from the City's existing General Plan, the 1994 General Plan Final Master EIR, and the Orange County General Plan. In general, the information summarized within these documents is based on the State of California's Mineral Land Classification/Designation Program.

3.6.2 Environmental Setting

Geology

Regional Characteristics

The City of Lake Forest is near the coastal margin of the Los Angeles Basin, which includes Orange County, and is underlain by more than 15,000 feet of stratified sedimentary rocks of marine origin. The regional geologic framework of the Los Angeles Basin area can be understood through the theory of plate tectonics. Earth's mantle is composed of several large plates that move relative to each other and are bounded by major fault zones. The San Andreas Fault zone, about 40 miles northeast of the Project Area, is the boundary between the Pacific Plate, on the west side of the zone, and the North American Plate on the east side. One of the results of the movement of these plates is the regional rock deformation that is expressed in the general northwest trend of valleys and ridges in the Los Angeles Basin. All of the geologic formations in the Los Angeles Basin are on the Pacific Plate (Oakeshott 1978).

The Santa Monica and San Gabriel Mountains, about 50 miles north of the Project Area, form the northern boundary of the Los Angeles Basin, and are part of the Transverse Ranges Geomorphic Province, which is characterized by east-west trending faults, folds, and mountain ranges. The Santa Ana Mountains and adjacent hills are located in the northeastern portion of the City and form the eastern boundary of the Los Angeles Basin. The Santa Ana Mountains are part of the Peninsular Ranges

Geomorphic Province, which is characterized by northwest-southeast trending faults, folds, and mountain ranges. Both of these provinces, as well as the Los Angeles Basin, are considered to be highly active seismically.

Local Characteristics

The City of Lake Forest comprises about 17 square miles in a transition zone between an elevated coastal terrace and the Santa Ana Mountains (see Figure 2-1, Regional Location). The western portion of the City, on the coastal terrace, is about 200 feet above mean sea level (+200 feet msl). The land becomes progressively higher and steeper to the east, eventually reaching elevations above +1,500 feet msl along the ridgeline of the Santa Ana Mountains. Traces of fault segments associated with the Newport-Inglewood Fault Zones parallel the ocean edge of the coastal terrace. Traces of the Elsinore Fault Zone follow the ridge of the Santa Ana Mountains (Yerkes 1965).

The geology of the region is complex and has undergone several alternating periods of subsidence and uplift, mass wasting (erosion), and sediment deposition. In the Santa Ana Mountains igneous, metavolcanic, and metasedimentary rocks of Jurassic age (208 million to 144 million years ago) and younger form the core of the range. The exposed rocks in the mountainous areas are slightly metamorphosed volcanics, which have been intruded by granitic rocks of Cretaceous age (144 million to 66.4 million years ago), principally granites, gabbros, and tonalites (see Section 3.6.9, Glossary). Overlying these rocks are about 15,000 feet of younger sandstones, siltstones, and conglomerates of upper Cretaceous age, composed largely of material eroded from the older igneous and metavolcanic rocks now underlying the Santa Ana Mountains (Stadum n.d.).

The valleys of creeks and washes cross the City, providing additional topographic relief in the foothills and on the coastal terrace (see Section 3.4.2 [Biological Resources] for watershed and climate information). In the City, Aliso Creek, Serrano Creek, and Borrego Canyon Wash are major waterways whose ancestral channels cut deeply into the marine sediments of the terrace during the lower sea levels of the last Ice Age in late Pleistocene time. Over the last 17,000 years, the rivers have filled their channels to their present levels with unconsolidated sand, silt, and gravel (alluvium).

Physiographic features of the Project Area range from moderately steep to rugged terrain in the foothills of the Santa Ana Mountains, to nearly flat level surfaces in graded portions of the City on the elevated coastal terrace.

■ Soils

Regional Characteristics

There are about three dozen soil types in the Opportunities Study Area, related to the substrate on which they have developed. Soil types are based on a variety of distinguishing characteristics, such as texture, slope, and agricultural capability. The terrace lowlands in the Project Area contain pockets of deep, level, relatively poorly drained, fine-grained soils (clay and clayey loam), with some moderately well-drained, fine to medium grained soils (clayey loam and sandy loam) developed on edges of alluvial channels. The foothills contain moderately well-drained, medium-grained soils (sandy loam and loamy sand) overlying coarser-grained subsoils (cobbly sandy loam) developed on older alluvial fans and terraces (USDA 1978).

Local Characteristics

Twenty-three soil types are represented on the seven parcels. The distribution is shown in Table 3.6-1 (Soil Characteristics) along with some of the soils specific characteristics. From the table it may be seen that most of the soils at Site 1 have low to moderate erosion potential, moderately rapid permeability, low to moderate expansion potential, moderate to moderately high compatibility rations, low corrosivity to concrete, and variable corrosivity to steel. The exceptions are the Myford sandy loams, which have moderate to high erosion potential (USDA 1978).

Similarly, most of the soils at Site 2 have low to moderate erosion potential (with the exception of the Myford sandy loam, which has moderate to high erosion potential), variable permeability, low to moderate expansion potential, moderate to moderately high compatibility rations, low corrosivity to concrete, and variable corrosivity to steel.

Most of the soils at Site 3 have very low to moderate erosion potential (with the exception of the Myford sandy loam, which has moderate to high erosion potential), moderately rapid to very rapid permeability, low to moderate expansion potential, moderate to moderately high compatibility rations, low corrosivity to concrete, and variable corrosivity to steel.

Most of the soils at Site 4 have low to moderate erosion potential (with the exception of the Myford sandy loams, which have moderate to high erosion potential), moderately rapid permeability, low expansion potential, moderately high compatibility rations, low corrosivity to concrete, and low corrosivity to steel.

The soils at Site 5 have low to moderate erosion potential, moderately rapid permeability, low expansion potential, moderately high compatibility rations, low corrosivity to concrete, and low corrosivity to steel.

About half the soils at Site 6 have low erosion potential and half have moderate to high erosion potential (Myford sandy loams), moderately rapid permeability, low to moderate expansion potential, moderate compatibility rations, low corrosivity to concrete, and high corrosivity to steel.

About half the soils at Site 7 have very low to moderate erosion potential (with the exception of the Myford sandy loam, which has moderate to high erosion potential), very slow to very rapid permeability, low expansion potential (with the exception of the Cropley clay, which has high expansion potential), moderate to moderately high compatibility rations, low corrosivity to concrete, and low to high corrosivity to steel.

Soils with low erosion potential in their natural condition can become erosion-prone when disrupted, unless specific measures are taken to control erosion. Because the major adverse effect of potential erosion is sedimentation in drainage ways, this issue is discussed in Section 3.8 (Hydrology and Water Quality) of this EIR.

Table 3.6-1 Soil Characteristics

Map Unit No.	Map Unit Name	Erosion Potential	Permeability	Shrink-Swell Potential	Percent Compaction	Corrosivity to Concrete	Corrosivity to Steel	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
3	Balcom Clay Loam, 30 to 50 Percent Slopes	Low	Moderately Slow	Moderate	85	Low	Moderate	X						
4	Balcom Clay Loam, 15 to 30 Percent Slopes								X					
6	Bosanko Clay, 15 to 30 Percent Slopes	Very Low to Low	Very Slow to Slow	High	80	Low	High		X					
7	Bosanko Clay, 30 to 50 Percent Slopes								X					
8	Bosanko Clay, 9 to 15 Percent Slopes								X					
10	Botella Loam, 2 to 9 Percent Slopes	Low to Moderate	Moderately Rapid	Moderate	85	Moderate	Moderate		X					
11	Calleguas Clay Loam, 50 to 75 Percent Slopes, Eroded	Low	Moderately Rapid	Moderate	75	Low	High	X	X	X			X	
12	Capistrano Sandy Loam, 2 to 9 Percent Slopes	Low	Moderately Rapid	Low	80	Low	Low	X			X			X
13	Capistrano Sandy Loam, 9 to 15 Percent Slopes							X		X	X	X	X	X
14	Chino Silty Clay Loam	Low to Moderate	Moderately Slow	Moderate	85	Low	High		X					
15	Cieneba Sandy Loam, 15 to 30 Percent Slopes	Low to Moderate	Moderately Rapid	Low	85	Low	Low		X			X		
16	Cieneba Sandy Loam, 30 to 75 Percent Slopes, Eroded							X	X	X	X	X	X	X
20	Cropley Clay, 2 to 9 Percent Slopes	Very Low to Low	Very Slow to Slow	High	70	Low	High							X
23	Myford Sandy Loam, 15 to 30 Percent Slopes	Moderate to High	Moderately Rapid	Low	—	—	—	X	X					
24	Myford Sandy Loam, 2 to 9 Percent Slopes							X			X		X	X
25	Myford Sandy Loam, 9 to 15 Percent Slopes							X		X	X			

Table 3.6-1 Soil Characteristics														
Map Unit No.	*Map Unit Name*	*Erosion Potential*	*Permeability*	*Shrink-Swell Potential*	*Percent Compaction*	*Corrosivity to Concrete*	*Corrosivity to Steel*	*Site 1*	*Site 2*	*Site 3*	*Site 4*	*Site 5*	*Site 6*	*Site 7*
26	Myford Sandy Loam, 9 to 30 Percent Slopes, Eroded							X					X	
28	Riverwash	Very Low to Low	Very Rapid	Low	—	—	—			X				X
29	San Andreas Sandy Loam, 15 to 30 Percent Slopes	Low	Moderately Rapid	Low	—	—	—							X
30	San Emigdio Fine Sandy Loam, 2 to 9 Percent Slopes	Low to Moderate	Moderately Rapid	Low	—	—	—	X						
31	Soper Gravelly Loam, 30 to 50 Percent Slopes	Low to Moderate	Moderate	Low	—	—	—		X					
34	Sorrento Loam, 2 to 9 Percent Slopes	Low	Moderate	Low	—	—	—							X
36	Water	—	—	—	—	—	—		X					

Potentially liquefiable soils exist along the creeks and washes that cross the Project Area. Additionally, damaging liquefaction can occur at depth if the water table is less than about 50 feet below the ground surface in pockets of fine-grained, uniformly sized sand, such as can exist in the alluvial deposits.

Seismicity

Faulting and Seismicity

The faulting and seismicity of Southern California are dominated by the San Andreas Fault zone. The San Andreas Fault Zone separates two of the major tectonic plates that comprise the earth's crust. West of the San Andreas Fault zone lies the Pacific Plate. This plate is moving northwest relative to the North American Plate, which is east of the San Andreas Fault zone. This relative movement between the two plates is the driving force of fault ruptures in the western portion of Southern California. The San Andreas Fault generally trends northwest-southeast. North of the Transverse Ranges Province, the fault trends more in an east-west direction, causing a north-south compression between the two plates. The rate of north-south compression in Southern California has been estimated at between 5 and 20 millimeters per year (SC/EC 2005). This compression has produced rapid uplift of many of the mountain ranges in Southern California, including those surrounding the Los Angeles Basin.

There are numerous faults in the Los Angeles Basin that are categorized as active, potentially active, and inactive. A fault is classified as active if it has either moved during the Holocene epoch (the last 10,000 to 11,500 years) or is included in an Alquist-Priolo Earthquake Fault zone (as established by the California Geological Survey [CGS], formerly the Division of Mines and Geology). A fault is classified as potentially active if it has experienced movement during the Quaternary period (the last 1.8 million years), but shows little or no evidence of movement during the Holocene. Faults that have not moved in the last 1.8 million years generally are considered inactive. Surface displacement can be recognized by the existence of cliffs in alluvium, terraces, offset stream courses, fault troughs and saddles, the alignment of depressions, sag ponds, and the existence of steep mountain fronts.

Relationship between Faulting and Seismicity

Generally defined, an earthquake is an abrupt release of accumulated energy in the form of seismic waves created when movement occurs along a fault plane. The specific faulting characteristics of the Los Angeles Basin are governed by regional north-south compression, a product of the continued motion between the Pacific and North American Plates (Yerkes 1985). More than half the energy produced by this motion is stored by the San Andreas Fault, the main boundary between the Pacific and North American Plates. The remaining energy is distributed through movement on two principal fault systems: the northwest/southeast-trending faults sub-parallel to the San Andreas system and the east/west-trending faults of the Transverse Ranges.

Reporting Earthquake Measurements

The severity of an earthquake generally is expressed in two ways—magnitude and intensity. The energy released, measured on the Moment Magnitude (M_W) scale, represents the magnitude of an earthquake (see Glossary). The use of the Richter Magnitude (M) scale (see Glossary) is being replaced in most modern building codes by the M_W scale because it provides more useful information to design engineers. The intensity of an earthquake is measured by the Modified Mercalli Intensity (MMI) scale (see Glossary), which emphasizes the current seismic environment at the subject site and measures groundshaking severity according to damage done to structures, changes in the earth surface, and personal accounts (see Table 3.6-2).

Table 3.6-2 Modified Mercalli Intensity Scale

Modified Mercalli Intensity	*Description*
I	Detected by only sensitive instruments
II	Felt by a few people at rest
III	Felt noticeably indoors, but not always recognized as a quake; vibration like a passing truck
IV	Felt indoors by many and outdoors by few
V	Felt by most people. Some breakage of windows, dishes, and plaster
VI	Felt by all; falling plaster and chimneys; damage small
VII	Damage to buildings varies; depends on quality of construction
VIII	Walls, monuments, chimneys fall; panel walls thrown out of frames
IX	Buildings shift off foundations; foundations crack; ground cracks; underground pipes break
X	Most masonry and frame structures destroyed; ground cracks; landslides
XI	Ground fissures; pipes break; landslides; rails bent; new structures remain standing
XII	Damage total; waves seen on ground surface; objects thrown into the air

SOURCE: *Nuclear Reactors and Earthquakes*, Atomic Energy Commission, TID7024

Ground motions also are reported in terms of a percentage of the acceleration of gravity (percent g), where g = 32 feet per second. One hundred percent of gravity (1 g) is the acceleration a skydiver would experience during free-fall. An acceleration of 0.4 g is equivalent to accelerating from 0 to 60 miles per hour in about seven seconds.

The terms Maximum Credible Earthquake (MCE) and Maximum Probable Earthquake (MPE) have been used for many years to describe the largest earthquake that would be likely to occur along a particular fault and within a given timeframe, respectively (see Glossary). Recent revisions incorporated by the State of California into the California Building Code (CBC), based on recommendations identified by the Seismology Committee of the Structural Engineers Association of California, have eliminated the use of these terms. The 2001 CBC revisions require that the M_W of the "characteristic earthquake" be used in geotechnical calculations for design purposes. The new criterion for describing the energy release (i.e., the "size" of an earthquake along a particular fault segment) was determined by the Seismology Committee to represent a more reliable descriptor of future fault activity than the MCE or the MPE. Although the M_W value may differ slightly from the MCE or MPE values reported in some of the older documents cited in this EIR, this current method for describing future fault activity does not alter the assumptions or conclusions of this EIR.

Local Geologic Hazards

The most significant active fault traces in the vicinity of the City of Lake Forest are along the Newport-Inglewood and Elsinore fault zones, which are considered active. The Newport-Inglewood Fault zone was responsible for both the 1933 Long Beach Earthquake (magnitude M6.3) and the 1920 Inglewood Earthquake (estimated magnitude M4.9). This zone is visible on the surface as a series of northwest trending elongated hills extending from Newport Beach to Beverly Hills, including Signal Hill and Dominguez Hills. The fault zone exhibits as much as 6,000 feet of right lateral displacement that has occurred since mid-Pliocene time, about 3.4 million years ago, with a maximum displacement of 10,000 feet since late Miocene time, at least 5.3 million years ago (Woodward-Clyde Consultants 1979). An estimated characteristic earthquake of M_W 7.1 is assigned to the zone based on its estimated rupture length and slip rate. Active or potentially active fault segments of the Newport-Inglewood Fault zone closest to Lake Forest include the north and south branches of the Newport-Inglewood Fault. The Project Area is 10 to 14 miles northeast of these fault segments, which places it just outside the CBC Near-Source Area for known active faults (see Regulatory Framework, below).

Other known active segments of faults at greater distances from the City that could pose seismic groundshaking hazards for the Project Area include those of the Palos Verdes Fault zone about 26 miles southwest of the City, the San Jacinto Fault zone about 35 miles northeast of the City, the San Andreas Fault Zone about 43 miles northeast of the City, the Sierra Madre Fault zone about 32 miles north of the City, and the Santa Monica–Raymond Fault zone about 42 miles northwest of the City.

There are no known active or potentially active faults in the Project Area itself, nor is the Project Area located in an Earthquake Fault Zone as defined by the *Alquist-Priolo Earthquake Fault Zoning Act of 1994* (formerly known as the *Alquist-Priolo Special Studies Zone Act of 1972*). According to the 2001 CBC, the Project Area is in Seismic Zone 4, which includes lands that have been subjected to major historic earthquakes (i.e., M_W 7.0 or greater during the last 200 years) and recent high levels of seismicity. Earthquake-related damage corresponding to intensities of VIII or higher on the Modified Mercalli Intensity Scale would be expected in this Seismic Zone. As such, the Project Area is in a seismically active area.

The Palos Verdes Fault zone trends southeast offshore through San Pedro Bay about 26 miles southwest of Lake Forest. The fault is thought to contain active segments (CBC Seismic Source Type B) that could produce severe seismic shaking in the City. One of several major faults of similar trend in Southern California, the Palos Verdes Fault is nearly parallel in orientation to the Newport-Inglewood Fault zone. The characteristic earthquake for the Palos Verdes Fault is M_W 7.1, based on comparisons with the Newport-Inglewood zone (GeoSoils 2004).

The Newport-Inglewood Fault zone trends southeast onshore and offshore through San Pedro Bay about 12 miles southwest of Lake Forest. The fault contains active segments (CBC Seismic Source Type A) that would cause severe seismic shaking in the City. The characteristic earthquake for the Newport-Inglewood fault is M_W 6.9 (GeoSoils 2004). The surface trace of the fault is discontinuous in the Los Angeles Basin, but is marked by a chain of low hills extending from Culver City to Signal Hill.

South of Signal Hill, the fault roughly parallels the coastline to just south of Newport Bay, where it extends offshore (SC/EC 2005).

The Elsinore Fault Zone trends southeast about 14 miles northeast of Lake Forest. The fault contains active segments (CBC Seismic Source Type A) that would cause severe seismic shaking in the City. The characteristic earthquake for the Elsinore fault is M_W 6.8 (GeoSoils 2004). At 112 miles in length, the Elsinore Fault Zone is one of the largest in Southern California, and in historic times, has been one of the least active. At its northern end, the Elsinore fault splays into two segments, the Chino fault and the Whittier fault (SC/EC 2005).

The San Jacinto Fault Zone trends southeast about 35 miles northeast of Lake Forest. The fault contains active segments (CBC Seismic Source Type A) that would cause severe seismic shaking in the City. The characteristic earthquake for the San Jacinto fault is M_W 6.7 (GeoSoils 2004). As with other large fault zones, many of the individual fault traces in the San Jacinto Fault Zone are identified by individual names, including the Coyote Creek, Hot Springs, and Buck Ridge faults. At its northern end, where the San Jacinto meets the San Andreas fault about 44 miles north of Lake Forest, the fault zone is made up of several parallel fault traces, including the Glen Helen and Lytle Creek faults (SC/EC 2005).

The San Andreas Fault zone trends east-southeast about 43 miles northeast of Lake Forest. The fault contains active segments (CBC Seismic Source Type A) that would cause severe seismic shaking in the City. The characteristic earthquake for the San Andreas Fault is M_W 7.4 (GeoSoils 2004). The geology along the fault in this area is fairly complex: the San Andreas fault interacts other faults and becomes somewhat fractured over the 70 miles between San Bernardino and Indio, indicated by inactive strands of the San Andreas fault more than one million years old. Other faults in the area have been reactivated recently after being dormant for hundreds of thousands of years. There is evidence to suggest that there is no active, continuous main trace of the San Andreas Fault going all the way along this zone, implying that the San Andreas Fault may be in the process of creating a new fault path through the area (SC/EC 2005).

The Sierra Madre Fault Zone Segment E (Cucamonga Fault Zone) trends east about 32 miles north of Lake Forest. The fault is thought to contain active segments (CBC Seismic Source Type B) that could produce severe seismic shaking in the City. The characteristic earthquake for the Cucamonga fault is M_W 7.0 (GeoSoils 2004). Segment E represents the easternmost part of the Sierra Madre Fault Zone, and at its eastern end, it meets several other faults including several; traces of the San Jacinto Fault. The general trend of the fault zone continues east along the base of the San Gabriel Mountains (SC/EC 2005).

The Santa Monica–Raymond Fault Zone trends east about 42 miles northwest of Lake Forest. The fault is thought to contain active segments (CBC Seismic Source Type B) that could produce severe seismic shaking in the City. The characteristic earthquake for the Santa Monica and Raymond faults is M_W 6.6 (GeoSoils 2004). There is evidence that at least eight surface-rupturing events have occurred along the fault in this area during the last 36,000 years, but none in historic times (SC/EC 2005).

Potential Geo-Seismic Hazards in the Project Area

Groundshaking

The major cause of structural damage from earthquakes is groundshaking. The intensity of ground motion expected at a particular site depends upon the magnitude of the earthquake, the distance to the epicenter, and the geology of the area between the epicenter and the property. Greater movement can be expected at sites located on poorly consolidated material, such as alluvium, within close proximity to the causative fault, or in response to an event of great magnitude. Table 3.6-2 (Modified Mercalli Intensity Scale) above describes the local effects of groundshaking. The Project Area is in close proximity to the Newport-Inglewood and Elsinore Faults, and would experience substantial groundshaking if a characteristic seismic event occurred on either fault. The San Jacinto and San Andreas Faults also are capable of generating significant earthquakes that could affect the Project Area.

For the CBC Seismic Source Type A and B faults described above, Table 3.6-3 lists the expected groundshaking parameters for the respective characteristic earthquakes (GeoSoils 2004).

Table 3.6-3 Expected Groundshaking Parameters

Fault	*CBC Seismic Source Type*	*Characteristic Earthquake (MW)*	*Distance from Project Area (miles)*	*Peak Ground Acceleration (g)*	*Modified Mercalli Intensity*
Palos Verdes	B	7.1	26 SW	0.23	IX
Newport-Inglewood	A	6.9	12 SW	0.36	IX
Elsinore	A	6.8	14 NE	0.32	IX
San Jacinto	A	6.7	35 NE	0.15	VIII
San Andreas	A	7.4	43 NE	0.18	VIII
Sierra Madre (Cucamonga)	B	7.0	32 N	0.22	IX
Santa Monica–Raymond	B	6.6	42 NW	0.13	VIII

Liquefaction

Another substantial local geologic hazard is liquefaction potential. Liquefaction is a seismic-related phenomenon during which loose, saturated, fine-grained granular soils lose internal shear strength and behave similarly to fluid when subjected to high-intensity groundshaking. Liquefaction occurs when three general conditions exist: (1) shallow groundwater; (2) low-density, fine, clean, sandy soils; and (3) high-intensity ground motion. The valleys of the creeks and washes in the Project Area have relatively shallow groundwater tables and contain fine grained soils, which are not necessarily subject to liquefaction, but in which pockets of liquefiable materials commonly occur. Because of uncertainty regarding the exact locations of these pockets, CGS has identified the valleys as being in state-designated Seismic Hazard Zones for Liquefaction, in which site-specific investigations of liquefaction potential are required (CGS 2001). If liquefaction were to occur, potential differential settlement of the overlying soils could be minor because of the high silt and clay content, but that has yet to be demonstrated for the Project Area sites that include the liquefaction hazard zones. If major differential settlement occurred, foundations supported on the liquefied material could be warped or cracked, possibly beyond repair.

The associated hazards of seismically induced lateral spreading or subsidence can be caused by liquefaction of materials at depth below the ground surface. Lateral spreading is a horizontal ground movement, which can occur as a response to severe groundshaking if liquefiable materials are adjacent to a "free face," i.e., a steep cliff, river bank, pit wall, etc. Because the face is not supported on its free side, i.e., the side exposed to the air, liquefiable materials tend to move toward the face, pushing other soil materials ahead of them and/or spilling out of the free face themselves. Stable or marginally stable soils above the liquefied of laterally spread materials may remain more or less intact, but sink (subside) to fill the void left by the movement of the unstable subsurface materials. Because conditions such as depth to water table, uniformity of grain size and mix of grain size can vary dramatically within alluvial deposits, liquefaction potential and its attendant hazards are required to be addressed during project design at each construction site in the areas where liquefaction is suspected.

Landslides

A few parts of the uplands in the Project Area, particularly in Site 2, are in state-designated Seismic Hazard Zones for Landslides, in which site-specific investigations of landslide potential are required (CGS 2001). Landslide potential is required to be addressed during project design at each construction site in the areas where landslides are suspected because soil and slope conditions apparent at the scale of the stare mapping are not sufficiently precise to provide site-specific foundation and structural parameters for development.

Seismic Settlement

Strong groundshaking can cause soil settlement by vibrating sediment particles into more tightly compacted configurations, thereby reducing pore space. Unconsolidated, loosely packed alluvial deposits are especially susceptible to this phenomenon. Poorly compacted artificial fills also may experience seismically induced settlement. In general, areas that contain potentially liquefiable soils have some susceptibility to seismic settlement. Settlement of the underlying soils of a site could create surface depressions that can damage foundations in ways similar to liquefaction. The required site-specific liquefaction investigations also would reveal any potential settlement issues in the subsoil.

Subsidence

Land subsidence is a condition wherein the elevation of a land surface drops because of the withdrawal of fluids such as groundwater or oil. Such extraction sufficient to create subsidence is not occurring or anticipated in the Project Area.

Subsidence also can be the result of the seismic-related ground failure liquefaction. Settlement of the ground surface can be accelerated and accentuated by earthquakes. During a seismic event, subsidence could occur as a result of the relatively rapid compaction and settling of subsurface materials due to the rearrangement of soil particles during prolonged ground shaking; especially loose, non-compacted and variable sandy sediments. Given the nature of soils within the Project Area, subsidence due seismic-related ground failure liquefaction is not anticipated.

Expansive Soils

Expansive soils are naturally occurring materials often found in low-lying regions and valley flood plains. Expansive soils, such as clay, tend to swell as they absorb water and shrink as water is drawn away. Some expansive materials occur in the substrate of the clays and clayey loams in the Project Area. Specific treatments to eliminate expansion of soils include, but are not limited to, grouting (cementing the soil particles together), recompaction (watering and compressing the soils), and replacement with a non-expansive material (excavation of unsuitable soil followed by filling with suitable material), all of which are commonly used in the City.

Soil Erosion

Erosion refers to the removal of soil from exposed ground surfaces by water or wind. The effects of erosion are intensified with an increase in slope (as water moves faster, it gains momentum to carry more debris), the narrowing of runoff channels (which increases the velocity of water), and by the removal of groundcover (which leaves the soil exposed to erosive forces). Surface improvements, such as paved roads and buildings, decrease the potential for erosion onsite, but can increase the rate and volume of runoff, potentially causing off-site erosion. The sites in the Project Area are, for the most part, undeveloped with structures or large paved areas. In the areas of sand and gravel mining (Site 4), the vegetation has been removed and the subsoils are exposed. In other areas the vegetation has been disturbed or replaced with plant nursery uses.

Mineral Resources

Regional Characteristics

Mining activities in California are regulated by the Surface Mining and Reclamation Act (SMARA) of 1975. This Act provides for the reclamation of mined lands and directs the state Geologist to classify (identify and map) the non-fuel mineral resources of the state to show where economically significant mineral deposits occur and where they are likely to occur based upon the best available scientific data. Based on guidelines adopted by the CGS, areas known as Mineral Resource Zones (MRZs) are classified according to the presence or absence of significant deposits, as defined below. These classifications indicate the potential for a specific area to contain significant mineral resources.

- **MRZ-1:** Areas where available geologic information indicates there is little or no likelihood for presence of significant mineral resources.
- **MRZ-2:** Areas where adequate information indicates that significant mineral resources are present or where it is judged that it is a high likelihood for their presence exists. The zone shall be applied to known mineral deposits or where well developed lines of reasoning, based upon economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.
- **MRZ-3:** Areas containing known mineral occurrences of undetermined mineral resource significance.
- **MRZ-4:** Areas of no known mineral occurrences where geologic information does not rule out the presence or absence of significant mineral resources.

According to the County's General Plan, Orange County has a significant amount of mineral resources. As identified in CGS's Special Report 143, Parts III and IV, for the Orange County Region, the areas classified and designated as deposits containing significant sand and gravel resources are located in portions of the Santa Ana River, Santiago Creek, San Juan Creek, Arroyo Trabuco, as well as other scattered areas.

In addition to the County, the City of Lake Forest contains many important natural resources and features, including mineral resource areas and other open lands. Extractions of mineral resources in the Project Area include sand and gravel. According to the City's existing General Plan, approximately 62 acres of land in the eastern portion of the City is designated as MRZ-2, which is described further below.

Project Area Characteristics

The MRZ-2 resource area in the eastern portion of the City is currently excavated for sand and gravel materials. Specifically, the area is classified as an important MRZ for Portland cement concrete (PCC) grade aggregate by the state Department of Conservation (DOC). PCC-grade aggregate is valuable in Southern California where it is used for a variety of construction purposes. Figure 3.6-1 shows the location of the MRZ-2 area, known as the El Toro Materials Sand and Gravel Operation.

As illustrated in Figure 3.6-1, the MRZ-2 area encompasses one parcel in Project Area: Site 4 (Baker Ranch), which consists of 50 acres.

3.6.3 Planning and Regulatory Framework

■ State

California Building Code

The state regulations protecting the public from geo-seismic hazards, other than surface faulting, are contained in California Code of Regulations, Title 24, Part 2 (the *California Building Code* [CBC]) and California *Public Resources Code*, Division 2, Chapter 7.8 (the *Seismic Hazards Mapping Act*). Both of these regulations apply to public buildings (and a large percentage of private buildings) intended for human occupancy. The CBC provides minimum standards for building design that are based on the current *Uniform Building Code*, but modified by Additions, Amendments, and Repeals that are specific to building conditions and structural requirements in the State of California.

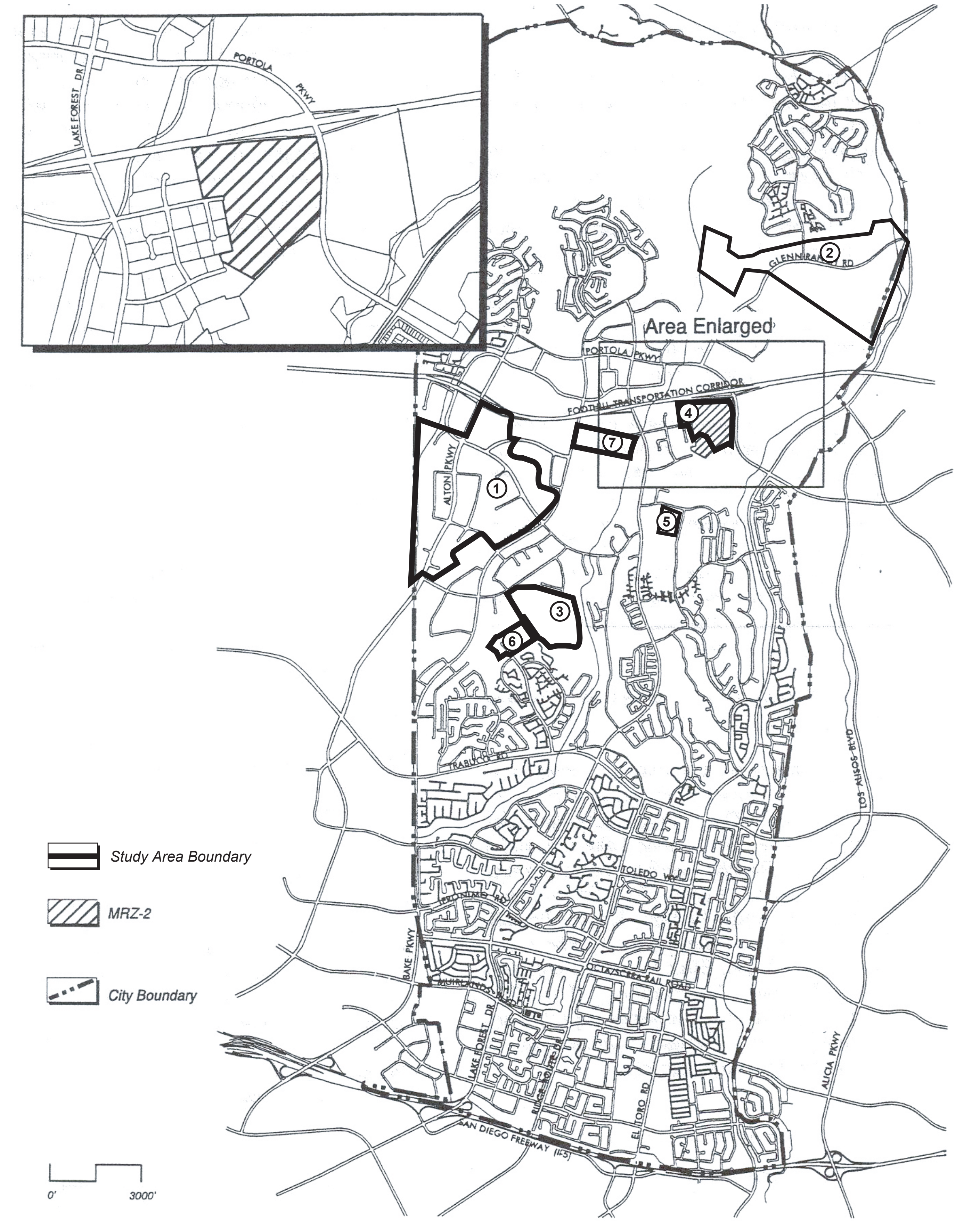

FIGURE **3.6-1**

MRZ-2 Mineral Resource Area

10953-00

***Sources*: Lake Forest General Plan; State of California Department of Mines and Geology** City of Lake Forest

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County and city building codes are permitted to be more stringent than Title 24, but are required to be no less stringent. Chapter 16 of the CBC deals with General Design Requirements, including (but not limited to) regulations governing seismically resistant construction (Chapter 16, Division IV) and construction to protect people and property from hazards associated with excavation cave-ins and falling debris or construction materials. Chapters 18 and A33 deal with site demolition, excavations, foundations, retaining walls, and grading, including (but not limited to) requirements for seismically resistant design, foundation investigations, stable cut and fill slopes, and drainage and erosion control (International Conference of Building Officials 1994). Construction activities are subject to occupational safety standards for excavation, shoring, and trenching as specified in Cal OSHA regulations (Title 8 of the California Code of Regulations) and in Section A33 of the CBC.

Among other things, the CBC defines different building regions in the state and ranks them according to their seismic hazard potential. There are four types of these regions: Seismic Zones 1 through 4, with Zone 1 having the least seismic potential and Zone 4 having the highest seismic potential. The City of Lake Forest is in Seismic Zone 4, as is about 45 percent of California. Accordingly, any future development would be required to comply with all design standards applicable to Seismic Zone 4, the most stringent in the state.

The Project Area is very close to, but not actually in, the CBC Seismic Zone 4 Near-Source Area, i.e., it is just over 15 kilometers (9.3 miles) from the ground surface projection of a known active fault plane. Inside this area, Near-Source Factors are required to be applied to the seismic-resistant design of structures for human occupancy. CBC Section 1629.4.2 and Tables 16 S and 16 T define the areas in which Seismic Zone 4 Near-Source Factors apply, identifying them by their distance from the fault and the type of seismic source represented by the fault. Being about 12 miles from the Newport-Inglewood fault, the Project Area is outside the CBC Near-Source Area.

Seismic Hazards Mapping Act

The *Seismic Hazards Mapping Act* became effective in 1991 to identify and map seismic hazard zones for the purpose of assisting cities and counties in preparing the safety elements of their general plans and to encourage land use management policies and regulations that reduce seismic hazards. The recognized hazards include strong groundshaking, liquefaction, landslides, and other ground failure. These effects account for approximately 95 percent of economic losses caused by earthquakes. The Act has resulted in the preparation of maps delineating Earthquake-Induced Liquefaction and Landslide Zones of Required Investigation. The map for El Toro Quadrangle, which encompasses the Project Area, was issued by the CGS in 2001. The map shows that the creeks and washes bounding and bisecting the Project Area contain Liquefaction Hazard Zones and that there are scattered Landslide Hazard Zones, mostly in the eastern third of the Project Area.

The CGS provides guidance with regard to Seismic Hazard Zones. Under CGS's Seismic Hazards Mapping Program, seismic hazard zones are identified and mapped to assist local governments in land use planning. The intent of this Act is to protect the public from the effects of strong groundshaking and other hazards caused by earthquakes. In addition, CGS's Special Publication 117, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, provides guidance for the evaluation and mitigation of earthquake-related hazards for projects in the designated zones of required investigations. Because the Project Area contains state-designated hazard areas for liquefaction and landsliding, the City would require site-specific investigations to address the actual soils conditions at each development site and to provide appropriate treatment of those conditions as part of the construction design.

Surface Mining and Reclamation Act

The state legislation regulating aggregate mineral resource zones is the *Surface Mining and Reclamation Act of 1975*. The purpose of this Act is to create and maintain effective and comprehensive surface mining and reclamation policies with regulation of surface mining operations to assure that (1) adverse environmental effects are prevented or minimized and that mined lands are reclaimed to a usable condition, which is readily adaptable for alternative land uses; (2) the production and conservation of minerals are encouraged, while giving consideration to values relating to recreation, wildlife, range and forage, and aesthetic enjoyment; and (3) residual hazards to the public health and safety are eliminated. These goals are achieved through land use planning by allowing a jurisdiction to balance the economic benefits of resource reclamation with the need to provide other land uses.

This Act classifies aggregate resources (sand, gravel and stone) in California and transmits the information to local governments, which regulate land use in each region of the state. Local governments are responsible for designating lands that contain regionally significant mineral resources in the local general plans to assure resource conservation in areas of intensive competing land uses. The law has resulted in the preparation of Mineral Land Classification Maps delineating Mineral Resource Zones (MRZ) 1 through 4 for aggregate resources. As discussed above, Site 4 in the Project Area is designated as MRZ-2.

Regional

Southern California Association of Governments

The Southern California Association of Governments (SCAG) *Regional Comprehensive Plan and Guide* is a tool for coordinating regional planning and development strategies in Southern California. SCAG policies related to seismic and other hazards and applicable to the Proposed Project include the following.

Policy 3.22 Discourage development, or encourage the use of special design requirements, in areas with steep slopes, high fire, flood, and seismic hazards.

Policy 3.23 Encourage mitigation measures that reduce noise in certain locations, measures aimed at preservation of biological and ecological resources, measures that would reduce exposure to seismic hazards, minimize earthquake damage, and to develop emergency response and recovery plans.

Local

City of Lake Forest General Plan

Safety and Noise Element

The Safety and Noise Element of the Lake Forest General Plan is concerned with providing a comprehensive analysis of seismic factors, among other issues, to reduce loss of life, injuries, damage to property, and social and economic impacts resulting from future earthquakes. The Element focuses on current developmental policies, as well as the allocation of future land uses, and its purpose is to serve as a guide for future development such that development will be responsive to seismic safety considerations. To provide a general direction for development in the City, goals, policies, and implementation programs regarding seismic safety are presented in the Element. The goal and policy applicable to the Proposed Project are:

Goal 1.0 Reduction in the risk to the community from hazards associated with geologic conditions, seismic activity, and flooding.

Policy 1.1 Reduce the risk of impacts from geologic and seismic hazards.

Recreation and Resources Element

The Recreation and Resources Element of the Lake Forest General Plan deals with community goals to protect environmental resources and open space while providing opportunities for economic development and growth. Resource issues addressed in the Element include parks and other open space, natural resources and features, historic and archaeological resources, and paleontological resources. The Element addresses continued development and enhancement of public involvement in civic activities with relation to these resource issues. To provide a general direction for such development, goals, policies, and implementation programs regarding resource issues are presented in the Element. The mineral resources goal and policies applicable to the Proposed Project are:

Goal 3.0 Extraction of mineral resources and reclamation of mined land, while preserving the City's plans for future use as described in the Land Use Element.

Policy 3.1 Provide for the conservation and development of significant identified mineral resource sites within Lake Forest.

Policy 3.2 Provide for the reclamation of mineral resource sites in concert with future use as described in the Land Use Element and required environmental mitigation.

Policy 3.3 Regulate mineral extraction activities to minimize hazards and conflicts with other land uses by the issuance of sand and gravel site permits.

Policy 3.4 Address and mitigate the significant environmental effects of surface mining operations.

Policy 3.5 Promote land use decisions that ensure, to the greatest extent possible, compatibility between mineral resource extraction and adjacent land uses.

City Municipal Code

Site development in the City of Lake Forest is required to comply with the CBC and all state and City requirements pertaining to construction and occupation hazards. As such, the 2001 CBC has been adopted as the base document of the Lake Forest Building Code. The CBC, discussed above under state regulations, is adopted by the City in Title 8, Buildings and Construction, of the Municipal Code. The Building Code, as adopted, includes amendments and modifications to the CBC as set forth in Chapter 8.02, *California Building Code*, of Title 8. Among these amendments and modifications are those related to definitions and references, roofing tile applications, strength design, structural systems, construction requirements, design methods, etc. Chapter 8.30, Lake Forest Grading and Excavation Code, of Title 8 contains specific regulations to safeguard life, limb, property, and the public welfare by regulating grading on private property in the City.

The provisions of the City's Building Code are legal requirements: the investigation and treatment of geologic, soils, and seismic conditions through the use of site-specific suitability analyses conducted to establish design criteria for appropriate foundation type and support, are standard. The important information for the City as lead agency is not the specific location and exact extent of unsuitable conditions at each potential construction location, but the knowledge that such conditions have been identified in the Project Area, that standard techniques are available for avoiding or correcting them, and that oversight responsibility for them is vested in the lead agency.

3.6.4 Methodology

The City's General Plan Safety and Noise Element and widely available industry sources were examined to document regional and local geology. Information about soil characteristics was derived from the Natural Resources Conservation Service's Soil survey of Orange County. Information regarding regional geology and seismically induced hazards was taken from various sources at the CGS, the United States Geological Survey (USGS), and the Department of the Interior. Information related to groundshaking resulting from potential seismic activity on various active faults in the area was obtained from the CGS and the Serrano Highlands limited preliminary geotechnical investigation (GeoSoils 2004). In addition, information related to other seismic hazards, such as liquefaction, seismic settlement, soil erosion, subsidence, and expansive soils was taken from the City's General Plan Safety and Noise Element, the CGS, the NRCS, and the California Building Code. The analysis focuses on the potential geological hazards identified in the Project Area and the extent of possible effects from or to the Proposed Project. Comparison of existing geologic, soils, and seismic conditions with those expected to occur as a result of implementation of the Proposed Project, based on the CEQA thresholds of significance, was used to determine the extent of potential effects.

Information regarding the presence of mineral resources in the City was obtained from consultation with the CSG, from the City's General Plan Recreation and Resources Element, and from the official website for the City of Lake Forest. The analysis focuses on the existence of mineral resources in the Project Area and whether implementation of the Proposed Project would result in the loss of access to identified mineral resources.

3.6.5 Thresholds of Significance

As the City's 2001 CEQA Significance Thresholds do not cover geology, soils, seismicity, or mineral resource issues, the following thresholds of significance are based on Appendix G of the 2005 CEQA Guidelines. For the purposes of this section of the EIR, implementation of the Proposed Project would create a potentially significant impact if any of the following conditions would occur as a result of such implementation.

Geology, Soils, and Seismicity

- Exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving
  - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area of based on other substantial evidence of a known fault
  - Strong seismic groundshaking
  - Seismic-related ground failure, including liquefaction
  - Landslides
- Result in substantial soil erosion or the loss of topsoil
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse
- Be located on expansive soil, as defined in Table 18-1-A of the California Building Code (2001), creating substantial risks to life or property
- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of wastewater

Mineral Resources

- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state
- Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan

Adverse impacts in any of the above categories would be considered unavoidable significant effects of the project, if they could not be (a) reduced to an acceptable level of risk by using techniques, generally recognized to be applicable and feasible, or (b) eliminated.

3.6.6 Impacts

Geology and Soils

CEQA requires that the Proposed Project's potential environmental impacts be compared to on-the-ground conditions in the Project Area at the time the Notice of Preparation is issued or at the time the analysis of such impacts is commenced. Such on-the-ground conditions are considered, and often referred to as, the environmental or CEQA "baseline." Thus, the following section analyzes the Proposed Project's potential environmental impacts on baseline conditions. However, it should be noted that the land under consideration for the Proposed Project, while currently undeveloped, would not necessarily remain undeveloped. Most sites within the Project Area are subject to existing development agreements or entitlements and, in the absence of the Proposed Project, would in the future likely be developed with approximately 9.8 million square feet of industrial and commercial space under the existing General Plan. Given this, the analysis of alternatives to the Proposed Project in Chapter 4 of this EIR, under the "No Project/Reasonably Foreseeable Development" alternative, analyzes the potential environmental impacts associated with buildout of the existing General Plan. That analysis includes a comparison of the impacts of buildout of the existing General Plan with the potential environmental impacts of the Proposed Project.

Impact 3.6-1 **Implementation of the Proposed Project would not expose people or structures to potential substantial adverse effects involving rupture of a known earthquake fault as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.**

Significance Level: No impact

As discussed in Section 3.6.2 (Environmental Setting), no part of the Project Area is in a known Earthquake Fault Zone as defined by the *Alquist-Priolo Earthquake Fault Zoning Act of 1994*. Because there are no known active faults traces in the Project Area, fault rupture is not anticipated, and there would be no impact.

Impact 3.6-2 **Implementation of the Proposed Project could expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving strong seismic groundshaking.**

Significance Level: Less than significant with compliance with statutory requirements

The Project Area is approximately mid-way between the Newport-Inglewood and the Elsinore Fault zones, as delineated on the State of California Earthquake Fault Zones Official Maps. In addition, as with all of Southern California, the Project Area will continue to be exposed to groundshaking during seismic events, irrespective of the type and timing of development. Consequently, if implementation of the Proposed Project did *not* adhere to existing City regulations, it would expose on-site structures and people to substantial seismic hazards if a major earthquake occurred on the Newport-Inglewood fault or the Elsinore fault. Because other active and potentially active faults in Southern California are capable of producing seismic shaking in the Project Area, it is anticipated that the building sites would experience ground acceleration caused by small and moderate magnitude earthquakes on active distant faults.

To reduce the risks associated with seismically induced groundshaking, the Building Code requires the developer to take the location and type of subsurface materials into consideration when designing or retrofitting foundations and structures for a particular site. Because the Proposed Project is in Seismic Zone 4, structures are required to be designed in accordance with parameters of Chapter 16 of the current CBC. In addition, as stipulated in the Lake Forest Municipal Code, specific engineering design and construction measures as required by CBC Chapter 33 for the construction of new buildings and/or structures would be implemented to anticipate and avoid the potential for adverse impacts to human life and property caused by seismically induced groundshaking. Furthermore, construction and occupation of the proposed residential and public facilities would be required to follow standard engineering techniques described in the City's Building Code.

Adherence to the Building Code, as required by City and state law, would ensure the maximum practicable protection available for structures and their associated trenches, slopes and foundations. The Proposed Project design is required to include the application of CBC Seismic Zone 4 Standards as the minimum seismic-resistant design for all proposed facilities; additional seismic-resistant earthwork and construction design criteria, based on the site-specific recommendations of a California Certified Engineering Geologist in cooperation with the project's California-registered geotechnical and structural engineers; engineering analyses that demonstrate satisfactory performance of any unsupported cut or fill slopes, and of colluvium and/or fill where they form part or all of the support for structures, foundations and underground utilities; and an analysis of soil expansion potential and appropriate remediation (compaction, removal-and-replacement, etc.) prior to using any expansive soils for foundation support.

In view of these regulatory requirements, the potential impacts of seismically induced groundshaking in the Project Area would be reduced to a less-than-significant level.

Impact 3.6-3 **Implementation of the Proposed Project could expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving seismic-related ground failure, including liquefaction and associated lateral spreading or subsidence.**

Significance Level: **Less than significant with compliance with statutory requirements**

Parts of the Project Area, including portions of Sites 1 and 7, are underlain by alluvium that, in its natural state, could respond poorly to loading during seismic ground motion. State-designated Liquefaction Hazards Zones are mapped across these two sites because pockets of potentially liquefiable soil materials may exist in the alluvial deposits. Consequently, the potential for liquefaction is present in the Project Area and the proposed residential and public facilities could experience liquefaction-related damages in the event of a moderate or large earthquake. Because the public facilities would draw visitors as well as local residents, the location of the Proposed Project has the potential to expose a large concentration of people to risks associated with liquefaction, if implementation of the Proposed Project did *not* adhere to existing City regulations.

To reduce the risks associated with seismically induced liquefaction and the associated hazards of seismically induced lateral spreading or subsidence, the same considerations of location and type of subsurface materials are required when designing or retrofitting foundations and structures for a particular site (see Impact 3.6-2). Potentially unstable soils discovered during excavation are required by provisions of the Building Code to be removed and replaced, or otherwise treated to provide appropriate foundation support and to protect them from failures such as liquefaction (see Impact 3.6-6, below). Adherence to the Seismic Zone 4 soil and foundation support parameters in Chapters 16 and 18 of the Building Code and the grading requirements in Chapters 18 and A33 of the Building Code, as required by City and state law, ensures the maximum practicable protection available from soil failures under static or dynamic conditions for structures and their associated trenches, slopes and foundations. By monitoring and enforcing the requirements of the Building Code, as described previously, the City would ensure the structural integrity of the completed project. In view of these regulatory requirements, seismically induced ground failures would be reduced to a less-than-significant level.

Impact 3.6-4 **Implementation of the Proposed Project could expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving seismically induced landslides.**

Significance Level: Less than significant with compliance with statutory requirements

Parts of the Project Area, including portions of Sites 2, 3, and 4 are underlain by hillside deposits (colluvium) that contain active and dormant landslide features, and alluvium that, in its natural state, could respond poorly to loading during seismic ground motion. State-designated Landslide Hazards Zones occur on these three sites. Consequently, the potential for landsliding is present in the Project Area, and the proposed residential and public facilities could sustain damage in the event of an earthquake-induced landslide. Because the public facilities would draw visitors as well as local residents, the location of the Proposed Project has the potential to expose a large concentration of people to risks associated with liquefaction, if implementation of the Proposed Project did *not* adhere to existing City regulations.

Adherence to the Seismic Zone 4 soil and foundation support parameters of the Building Code, as required by County and state law, as described in Impact 3.6-2, ensures the maximum practicable protection available from slope failures under static or dynamic conditions for structures and their associated trenches, slopes and foundations. In view of these circumstances, seismically induced landslides would be reduced to a less-than-significant level.

Impact 3.6-5 **Implementation of the Proposed Project could expose the drainage systems downslope from the construction areas to substantial soil erosion or the loss of topsoil.**

Significance Level: Less than significant with compliance with statutory requirements

The proposed sites in the Project Area are, for the most part, undeveloped with structures or large paved areas. In the areas of sand and gravel mining, the vegetation has been removed and the subsoils are exposed to the forces of erosion. In other areas the vegetation has been disturbed or replaced with plant nursery uses, which also expose the sites to erosion. Proposed development would include the moving and recompaction of soils at each site and grading, followed by construction of buildings and the associated parking areas. Trenching, grading, and compacting associated with construction of structures, modification/relocation of underground utility lines, and landscape/hardscape installation could expose areas of soil to erosion by wind or water during these construction processes. The addition of paved and landscaped areas would, over the long term, decrease the potential for erosion because fewer exposed soils would exist at the sites.

Because one of the major effects of loss of topsoil is sedimentation in receiving waters, erosion control standards are set by the Regional Water Quality Control Board (RWQCB) through administration of the National Pollutant Discharge Elimination System (NPDES) permit process for storm drainage discharge. As described in Section 3.8 (Hydrology and Water Quality) of this EIR, the NPDES permit requires implementation of nonpoint source control of stormwater runoff through the application of a number of Best Management Practices (BMPs). These BMPs are meant to reduce the amount of constituents, including eroded sediment, that enter streams and other water bodies. A Storm Water Pollution Prevention Plan (SWPPP), as required by the RWQCB, must describe the stormwater BMPs (structural and operational measures) that would control the quality (and quantity) of stormwater runoff. Erosion and sedimentation issues are addressed more fully in Chapter 3.8 (Hydrology and Water Quality) of this EIR, because they are they are, primarily, related to turbidity and other depositional effects in local and regional water bodies.

Because each site, with the exceptions of Sites 5 and 7, contain steep slopes, the potential exists for erosion by water through surface drainage during construction. Earth-disturbing activities associated with demolition and construction would be temporary and would be regulated by the NPDES permitting process. They would result in relatively long-term alteration of the existing disrupted topographic features that would tend to decrease erosion at each site. Specific erosion impacts would depend largely on the effectiveness of the required erosion control programs for the sites and the length of time soils would be subject to conditions that would be affected by erosion processes.

Each proposed site is greater than one acre in size, and, therefore, is subject to the provisions of the General Construction Activity Stormwater Permit adopted by the State Water Resources Control Board (SWRCB). The developer for the Proposed Project must submit a Notice of Intent (NOI) to the SWRCB for coverage under the Statewide General Construction Activity Stormwater Permit and must comply with all applicable requirements, including the preparation of a SWPPP, applicable NDPES Regulations, and BMPs. The SWPPP must describe the site, the facility, construction period erosion and sediment controls, runoff water quality monitoring, means of waste disposal, implementation of approved local plans, control of post-construction sediment and erosion, maintenance responsibilities, and non-stormwater management controls. Inspection of construction sites before and after storms is required to identify stormwater discharge from the construction activity and to identify and implement controls where necessary.

In addition, all construction activities would be required to comply with Chapter 33 of the CBC, which regulates excavation activities and the construction of foundations and retaining walls, and Appendix Chapter 33 of the CBC, which regulates grading activities, including drainage and erosion control. Compliance with the NPDES permit process and the CBC requirements would minimize effects from erosion. The City's monitoring and enforcing the requirements of the NPDES permit and the Building Code, as described previously, would ensure the control of potential erosion.

Because the NPDES permit requirements of the RWQCB and the City's Building Code must be satisfied prior to project construction, the potential hazards posed by substantial soil erosion or the loss of topsoil would be regulated and reduced to a less-than-significant level.

Impact 3.6-6 **Implementation of the Proposed Project could locate structures on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.**

Significance Level: **Less than significant with compliance with statutory requirements**

The existence of slightly to moderately compressible, corrosive, and expansive soils at the proposed sites makes it necessary to ensure the soils used for foundation support are sound. Using unsuitable soils would have the potential to create future liquefaction, subsidence, or collapse problems leading to building settlement and/or utility line disruption. When weak soils are re-engineered specifically for stability prior to use these potential effects can be reduced or eliminated. An acceptable degree of soil stability would be achieved for expansive, liquefaction-prone, and compressible soils by the required incorporation of soil treatment programs (replacement, grouting, compaction, drainage control, etc.) in the excavation and construction plans to address site-specific soil conditions. A site-specific evaluation of soil conditions is required and must contain recommendations for ground preparation and earthwork specific to the site, that become an integral part the construction design.

As part of the construction permitting process, the City requires completed reports of soil conditions at the specific construction sites to identify potentially unsuitable soil conditions including liquefaction, subsidence, and collapse. The evaluations must be conducted by registered soil professionals, and measures to eliminate inappropriate soil conditions must be applied, depending on the soil conditions. The design of foundation support must conform to the analysis and implementation criteria described in the City's Building Code, Chapters 16, 18, and A33. Adherence to the City's codes and policies would ensure the maximum practicable protection available for users of buildings and infrastructure and their associated trenches, slopes, and foundations.

The City's monitoring and enforcing the requirements of the Building Code, as described previously, would ensure that unstable soils or geologic units were stabilized or removed and replaced prior to their being used for foundation support. Because the requirements of the City's Building Code must be satisfied prior to project construction, the potential hazards posed by unstable soils or geologic units would be regulated and reduced to a less-than-significant level.

Impact 3.6-7 **Implementation of the Proposed Project could locate structures on expansive soil, as defined in Table 18-1-A of the California Building Code (2001), creating substantial risks to life or property.**

Significance Level: **Less than significant with compliance with statutory requirements**

The existence of slightly to moderately expansive soils at the Project Area raises concerns about foundation stability for public facilities, dwellings, roads, and utilities. Using expansive soils would have the potential to create future settlement or collapse problems leading to building damage and/or utility line disruption. As discussed in Impact 3.6-6, such weak soils are required to be re-engineered specifically for stability prior to use for foundation support. An acceptable degree of soil stability would be achieved for expansive soils by the required incorporation of soil treatment programs in the excavation and construction plans to address site-specific soil conditions. A site-specific evaluation of expansive soils is required and must contain recommendations for ground preparation and earthwork specific to the site, that become an integral part the construction design.

As discussed in Impact 3.6-6, the City requires, as part of the construction permitting process, completed reports of soil conditions at the specific construction sites to identify potentially unsuitable soil conditions including expansive soils. The evaluations must be conducted by registered soil professionals, and measures to eliminate the effects of expansive soils must be applied. The design of foundation support must conform to the analysis and implementation criteria described in the City's Building Code, Chapters 16, 18, and A33. Adherence to the City's codes and policies would ensure the maximum practicable protection available for users of buildings and infrastructure and their associated trenches, slopes, and foundations.

The City's monitoring and enforcing the requirements of the Building Code, as described previously, would ensure that expansive soils were stabilized or removed and replaced prior to their being used for foundation support. Because the requirements of the City's Building Code must be satisfied prior to project construction, the potential hazards posed by expansive soils would be regulated and reduced to a less-than-significant level.

Impact 3.6-8 **Implementation of the Proposed Project would not locate structures on soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.**

Significance Level: No impact

As discussed in Section 3.15 (Utilities and Service Systems) of this EIR, development in the Project Area would be served by existing wastewater treatment facilities. Because no known septic systems or alternative wastewater disposal systems would be installed there would be no impact.

Mineral Resources

Impact 3.6-9 **Implementation of the Proposed Project would not result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state.**

Significance Level: No impact

As discussed in Chapter 3.7, Land Use, of this EIR, mineral resource recovery operations occur on Site 4 (gravel mining). This site is classified by the City and the state as MRZ-2 for PCC-grade aggregate, but is not in any Aggregate Resource Sector. The site is being mined in advance of urbanization and will be excavated to the final grade for development (Miller 1995). Mineral resources on the site will be depleted and mining will cease in 2006; all mining operations and reclamation of the site will be completed prior to any development occurring under the Proposed Project. Although information about the volume of aggregate resources on this specific site is proprietary, CGS projects that Orange County has sufficient PCC-grade aggregate to continue producing about 30 percent of the local demand (the historic level of production) through 2012. The projection factors in known Aggregate Resource Sectors and permitted sites (such as Site 4), including plans for reuse of those sites following the cessation of aggregate production. Consequently, implementation of the Proposed Project would not alter the projected aggregate production or consumption of the county and is not considered an impact.

Impact 3.6-10 **Implementation of the Proposed Project would not result in the loss of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan.**

Significance Level: No impact

The discussion in Impact 3.6-9 of the lack of impacts to known mineral resources that would be of value to the region and the residents of the state applies equally to locally important mineral resource recovery sites. Consequently, implementation of the Proposed Project would not alter the projected aggregate production or consumption of the county and is not considered an impact.

3.6.7 Summary of Impacts

Table 3.6-4 summarizes the potential long-term adverse impacts of the Proposed Project related to geology, soils, seismicity, and mineral resources in the Project Area, and identifies the significance of those impacts after any applicable mitigation measures. Table 3.6-4 reflects that the Proposed Project will not have any significant impacts on geology, soils, seismicity, or mineral resources in the Project Area. Given this, no mitigation measures are required for these resource areas.

Table 3.6-4 Summary of Impacts

Impact	*Threshold*	*Significance*
3.6-1	Implementation of the Proposed Project would not expose people or structures to potential substantial adverse effects involving rupture of a known earthquake fault as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault.	No impact.
3,6-2	Implementation of the Proposed Project could expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving strong seismic groundshaking.	Less than significant with compliance with statutory requirements.
3.6-3	Implementation of the Proposed Project could expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving seismic-related ground failure, including liquefaction and associated lateral spreading or subsidence.	Less than significant with compliance with statutory requirements.
3.6-4	Implementation of the Proposed Project could expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving seismically induced landslides.	Less than significant with compliance with statutory requirements.
3.6-5	Implementation of the Proposed Project could expose the drainage systems downslope from the construction areas to substantial soil erosion or the loss of topsoil.	Less than significant with compliance with statutory requirements.

Table 3.6-4 Summary of Impacts

Impact	Threshold	Significance
3.6-6	Implementation of the Proposed Project could locate structures on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.	Less than significant with compliance with statutory requirements.
3.6-7	Implementation of the Proposed Project would locate structures on expansive soil, as defined in Table 18-1-A of the California Building Code (2001), creating substantial risks to life or property.	Less than significant with compliance with statutory requirements.
3.6-8	Implementation of the Proposed Project would not locate structures on soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.	No impact.
3.6-9	Implementation of the Proposed Project would not result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state.	No impact.
3.6-10	Implementation of the Proposed Project would not result in the loss of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan.	No impact.

3.6.8 References

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3.6.9 Glossary

Alquist-Priolo Earthquake Fault Zone: In 1972, California began delineating special studies zones (called Earthquake Fault Zones since January 1994) around active and potentially active faults in the state. The zones are revised periodically, and extend 200 to 500 feet on either side of identified fault traces. No structures for human occupancy may be built across an identified active fault trace. An area of 50 feet on either side of an active fault trace is assumed to be underlain by the fault, unless proven otherwise. Proposed construction within the Earthquake Fault Zone is permitted only following the completion of a fault location report prepared by a California Registered Geologist.

Characteristic Earthquake: Characteristic earthquakes are repeat earthquakes that have the same faulting mechanism, magnitude, rupture length, location, and, in some cases, the same epicenter and direction of rupture propagation as earlier shocks. As used in this report, the moment magnitude (M_W) of the "characteristic earthquake" indicates the scale of the seismic event considered representative of a particular fault segment, based on seismologic observations and statistical analysis of the probability that a larger earthquake would not be generated during a given time frame (often 50 or 100 years). In the Bay Area, the characteristic earthquake for the Peninsula segment of the San Andreas Fault has a moment magnitude (M_W) of 7.3; the Northern and Southern segments of the Hayward Fault, a MW of 6.9; and the Calaveras Fault, M_W 6.2. The term "characteristic earthquake" replaces the term "maximum credible earthquake" as a more reliable descriptor of future fault activity (Working Group on California Earthquake Probabilities, 2003).

Granite: A medium- to coarse-grained, usually light-colored, igneous rock consisting of 20 to 60 percent free quartz, several other types of silicon-based minerals, and dark iron silicates, such a biotite (mica).

Gabbro: A medium- to coarse-grained, usually dark-colored igneous rock consisting of 0 to 5 percent free quartz and greater than 90 percent low-acid, silicon-based minerals.

Horizontal Ground Acceleration: The speed at which soil or rock materials are displaced by seismic waves. It is measured as a percentage of the acceleration of gravity (0.5 g = 50 percent of 32 feet per second squared, expressed as a horizontal force). Peak horizontal ground acceleration is the maximum acceleration expected from the characteristic earthquake predicted to affect a given area. Repeatable acceleration refers to the acceleration resulting from multiple seismic shocks. Sustained acceleration refers to the acceleration produced by continuous seismic shaking from a single, long-duration event.

Igneous: Rock formed by under ground crystallization from a molten or partially molten material (magma).

Maximum Credible Earthquake (MCE): The largest Richter magnitude (M) seismic event that appears to be reasonably capable of occurring under the conditions of the presently known geological framework. This term has been replaced by "characteristic earthquake," which is considered a better indicator of probable seismic activity on a given fault segment within a specific time frame.

Maximum Probable Earthquake (MPE): The largest Richter magnitude (M) seismic event that appears to be reasonably expectable within a 100-year period.

Metasedimentary: A rock formed by a combination of deposition (sedimentation) and the subsequent application of heat and/or pressure (metamorphism).

Metavolcanic: A specific type of metasedimentary rock formed from lava, pyroclastic flows, ash falls, etc.

Modified Mercalli Intensity (MMI) Scale: A 12-point scale of earthquake intensity based on local effects experienced by people, structures, and earth materials. Each succeeding step on the scale describes a progressively greater amount of damage at a given point of observation. Effects range from those, which are detectable only by seismicity recording instruments (I) to total destruction (XII). Most people will feel Intensity IV ground motion indoors and Intensity V outside. Intensity VII frightens most people, and Intensity IX causes alarm approaching panic. The scale was developed in 1902 by Giuseppi Mercalli for European conditions, adapted in 1931 by American seismologists Harry Wood and Frank Neumann for conditions in North America, and modified in 1958 by Dr. Charles F. Richter to accommodate modern structural design features.

Moment Magnitude (M_W): A logarithmic scale introduced by Hiroo Kanamori in 1977 that is used by modern seismologists to measure the total amount of energy released by an earthquake. For the purposes of describing this energy release (i.e., the "size" of an earthquake on a particular fault segment for which seismic-resistant construction must be designed) the moment magnitude (M_W) of the characteristic earthquake for that segment has replaced the concept of a maximum credible earthquake of a particular Richter magnitude. This has become necessary because the Richter scale "saturates" at the higher magnitudes; that is, the Richter scale has difficulty differentiating among the sizes of earthquakes above M 7.5. To correct for this effect, the formula used for the M_W scale incorporates parameters associated with the rock types at the seismic source and the area of the fault surface involved in the earthquake. Thus, the moment magnitude is related to the length and width of the fault rupture. It reflects the amount of "work" (in the sense of classical physics) done by the earthquake. The relationship between Richter and moment magnitudes is not linear (i.e., moment magnitude is not a set percentage of Richter magnitude): the two values are derived using different formulae. The four well-studied earthquakes listed below exemplify this relationship.

Location	*Date*	*Richter Magnitude*	*Moment Magnitude*
New Madrid MO	1812	8.7	8.1
San Francisco CA	1906	8.3	7.7
Anchorage AK	1964	8.4	9.2
Northridge CA	1994	6.4	6.7

Although some of the values shown on the M_W scale appear lower than those of the traditional Richter magnitudes, they convey more precise (and more useable) information to geologic and structural engineers.

Near-Source Factors: California Building Code Section 1629.4.2 and Tables 16-S and 16-T define the areas in which Seismic Zone 4 Near-Source Factors apply. The zones extend as far as 15 kilometers (9.3 miles) from the ground surface projection of a known active fault plane. The Near-Source Factors and, therefore, the standards for seismic-resistant design, increase as the distance from a construction site to the fault trace decreases. Seismic Source Type A is described by CBC Table 16-U as "Faults that are capable of producing large magnitude events and that have a high rate of seismic activity," and defined by a maximum moment magnitude of M_W / 7.0.

Richter Magnitude Scale: The Richter Magnitude Scale is a logarithmic scale developed during 1935 and 1936 by Dr. Charles F. Richter and Dr. Beno Gutenberg to measure earthquake magnitude (M) by the amount of energy released, as opposed to earthquake intensity as determined by local effects on people, structures, and earth materials (as in the Modified Mercalli Intensity Scale). Each whole number on the Richter scale represents a 10-fold increase in amplitude of the waves recorded on a seismogram and about a 32-fold increase in the amount of energy released by the earthquake. Because the Richter scale tends to saturate above approximately M 7.5, it is being replaced in modern seismologic investigations by the moment magnitude (M_W) scale.

Tonalite: A medium- to coarse-grained, usually light-colored, igneous rock consisting of 10 to 50 percent free quartz and several other types of silicon-based minerals.