3E. Geology and Soils

INTRODUCTION

The purpose of this chapter is to evaluate the proposed project's impacts on local geological features and whether it would expose people or structures to adverse geological impacts. Potential geologic hazards include seismically induced groundshaking, fault rupture, liquefaction, landsliding, and weak or unstable soil conditions.

SETTING

The proposed commercial complex site is located on 22.83 acres at the southeast corner of Gladstone Street and Lone Hill Avenue in the City of San Dimas. The San Jose Hills are located one mile south and the South Hills are ½ mile north-northeast of the proposed project site. The San Gabriel Mountains are located two miles to the north.

The proposed project site is regionally located near the eastern portion of the San Gabriel Mountains in Los Angeles County, along the border of the Peninsular Ranges and Transverse Ranges geomorphic province. The Peninsular Ranges province extends from the Santa Monica and San Gabriel Mountains to the north to 775 miles beyond the Mexican border to the south. The Peninsular Ranges are bounded on the east by the Colorado Desert, and include Orange County and the San Jacinto Mountains in the western portion of Riverside County. The Transverse Ranges extend from Point Arguello and the Channel Islands on the west, to the Joshua Tree National Monument area on the east.

The Peninsular Ranges are comprised of a series of northwest-southeast trending mountains with gradual western slopes and steep eastern faces. Geologic history of the Peninsular Ranges began with deposition of marine sedimentary rocks in the Paleozoic followed by volcanism in the Jurassic. Placements of granitic rocks characterize the mid-Cretaceous with the older rocks being folded and deformed. Uplift, warping, and faulting continued into the late Tertiary and Quaternary, forming the mountains we see today. The Peninsular Ranges contain Jurassic-aged rocks and extensive Cretaceous-aged igneous rocks associated with the mountain building event responsible for the first of the Sierra-Nevada Mountains. Sedimentary rocks from the cretaceous are abundant and younger rocks consist of volcanic, marine, and non-marine sediments. Faults dominate the structure of the range.

The Transverse Ranges are characterized by east-west mountain ranges with intervening alleviated, broadly synclinal valleys and narrow stream canyons. Major features include the Santa Ynez Mountains, the Central Ventura County Mountains, Santa Clara and Simi Valleys, the Santa Ana Mountains, the San Gabriel Mountains, the Los Angeles Basin, and the San Bernardino Mountains. The province ranges from 10 to 50 miles wide and contains rock units from nearly all major geologic eras and periods beginning with the Precambrian.

The proposed project site is located on several hundred feet of Holocene-age alluvial fan deposits comprised of loose to moderately dense sand and gravel- to boulder-sized rocks, which originated from the San Gabriel Mountains and San Jose Hills.

Seismology and Faults

The proposed project site is within the seismically active Los Angeles Basin. The numerous faults in the area include active, potentially active, and inactive faults. These major groups are based on criteria developed by the California Geological Survey (CGS), formerly known as the California Division of Mines and Geology, for the Alquist-Priolo Earthquake Fault Zoning Program.[1] By definition, an active fault is one that has had surface displacement within Holocene time (about the last 11,000 years). A potentially active fault is a fault that has demonstrated surface displacement of Quaternary age deposits (last 1.6 million years). Inactive faults have not moved in the last 1.6 million years.

The site is not located within an Alquist-Priolo Earthquake Fault Zone and no active faults are known to underlie the site.[2] Therefore, surface rupture is not expected to affect the site. However, several faults exist within close proximity of the proposed project area, which could produce strong ground shaking at the site if an earthquake were to occur on one of these faults. Table 3E-1 summarizes the faults in the area and their distance to proposed project site.

TABLE 3E-1: MAJOR SEISMIC FAULTS IN THE PROPOSED PROJECT VICINITY

Fault	Distance From Site (miles)	Classification
Sierra Madre	3.6	Active
San Jose	3.6	Active
Cucamonga	7.2	Active
Chino-Central Avenue	8.4	Active
Whittier	15.6	Active
San Andreas	24.0	Active
San Jacinto	30.0	Active
Walnut Creek Fault	*	Potentially Active
Indian Hill Fault	*	Potentially Active

* Not available

Source: EEI, Preliminary Geotechnical Investigation, Costco Wholesale, San Dimas, California, May 14, 2003.

[1] State of California, Division of Mines and Geology, Alquist-Priolo Earthquake Fault Zoning Program, Hart, 1997.
[2] EEI, Preliminary Geotechnical Investigation, Costco Wholesale, San Dimas, California, May 14, 2003.

Liquefaction

Liquefaction occurs when water-saturated sandy soil materials lose strength and become susceptible to failure during strong ground-shaking in an earthquake. Liquefaction potential is greatest where the groundwater level is shallow (less than 50 feet) and soils are unconsolidated. The CGS identifies Seismic Hazard Zones, which indicate areas prone to liquefaction and earthquake-induced landslides. According to CGS, the proposed project site lies in an area of potential liquefaction hazard.[3] Historical high groundwater levels at the proposed project site are reported at approximately 30 feet.[4] Depth to water measured at nearby locations were 88 feet below ground surface (bgs) in a well approximately ¼-mile north of the proposed project site and 216 feet bgs near the intersection of West Arrow Highway and West Bonita Avenue, approximately ½-mile southeast of the proposed project site.[5] Local groundwater levels and flow may be affected by faults and clay layers, which act as barriers and can cause "perched" water to be found at relatively shallow depths. Changes in groundwater conditions may also occur from seasonal precipitation.

Slope Stability

Soil type, climate, topography, slope geometry, and excavations can initiate slope failures and landslides. Shaking during an earthquake may lead to seismically induced landslides, especially in areas that have previously experienced landslides or slumps, in areas of steep slopes, or in saturated hillsides. Seismically induced lateral spreading involves lateral movement of earth materials due to ground shaking. It differs from slope failure in that complete ground failure involving large movement does not occur due to the relatively smaller gradient of the initial ground surface. Lateral spreading occurs as near-vertical cracks with predominantly horizontal movement of the soil mass involved. There are no portions of the site classified by CGS as an earthquake-induced landslide hazard area. Due to the relatively level terrain and in immediately surrounding areas, earthquake induced landslide potential is considered low.[6]

Subsidence and Settlement

Ground subsidence is a localized mass movement that occurs where underlying geologic materials (typically loosely consolidated surficial silt, sand, and gravel) undergo a change from looser to tighter compaction. Subsidence can result from the extraction of mineral resources, subsurface oil, groundwater, or other subsurface liquids, such as natural gas.

Rapid settlement may be induced by seismic activity. Seismically-induced settlement is often caused by loose to medium-dense granular soils densified during ground shaking. Uniform shaking beneath a given structure would cause minimal damage. However, seismically-induced settlement is generally non-uniform and can cause serious damage to structures placed on the fill material.

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[3] California Geological Survey website, ftp://ftp.consrv.ca.gov/pub/dmg/shezp/zonemap/pdf/ozn_sdim.pdf, accessed June 11, 2002.

[4] EEI, Preliminary Geotechnical Investigation, Costco Wholesale, San Dimas, California, May 14, 2003.

[5] Advanced GeoEnvironmental, Inc., Phase I Environmental Assessment, February 1999, and EEI, Preliminary Geotechnical Investigation, Costco Wholesale, San Dimas, California, May 14, 2003.

[6] EEI, Preliminary Geotechnical Investigation, Costco Wholesale, San Dimas, California, May 14, 2003.

Expansive Soils

Expansive soils are generally clay-rich shales that swell when wetted. The saturation of soil from rainfall or irrigation can cause damage to structural foundations and cement walkways.

APPLICABLE REGULATIONS

California Environmental Quality Act (CEQA)

CEQA defines a significant effect on the environment as a substantial, or potentially substantial, adverse change in the physical conditions within the area affected by the project. *CEQA Guidelines* lists several geology-related impacts that would normally be considered significant. These include exposing people or structures to major geologic (expansive soils, landslides) and seismic hazards (fault rupture, groundshaking, liquefaction); erosion or siltation; substantial changes in topography; adversely affecting unique geologic or topographic features; or, inundation due to dam failure, sieche or tsunami. For a project under CEQA review, potential adverse effects of a particular identifiable geologic or seismic hazard is analyzed to determine the overall impact to the environment. The conclusions drawn from the impact analysis provides the framework for identification and evaluation of feasible mitigation measures to reduce the intensity of the impact.

Alquist-Priolo Earthquake Fault Zones

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 requires that special geologic studies be conducted to locate and assess any active fault traces in and around known active fault areas prior to development of structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures.

The Alquist-Priolo Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. This Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. The law requires the State Geologist to establish regulatory zones (Earthquake Fault Zones) around the surface traces of active faults and to issue appropriate maps. These maps (Alquist Priolo Maps) are distributed to all affected cities, counties and state agencies for their use in planning and controlling new or renewed construction. Local cities and counties must regulate certain development projects within the zones, which include withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement. Projects include all land divisions and most structures for human occupancy.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides. The purpose of the Act is to protect public safety from the effects of strong ground shaking, liquefaction, landslides, or other

ground failure, and other hazards caused by earthquakes. This Act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects with these zones. Before a development permit is granted for a site within a seismic hazard zone, a geotechnical investigation of the site has to be conducted and appropriate mitigation measures incorporated into the project design. Seismic Hazard maps have been completed for much of the Southern California region.

California Building Code

The *California Building Code* (CBC) is codified in the California Code of Regulations (CCR), Title 24, Part 2, which incorporates the California Building Standards Code. Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under state law, all building standards must be centralized in Title 24 or they are not enforceable.[7] Published by the International Conference of Building Officials, the Uniform Building Code (UBC) is a widely adopted model building code in the United States. The California Building Code incorporates (by reference) the Uniform Building Code with necessary California amendments. About one-third of the text within the California Building Code has been tailored for California earthquake conditions.

City of San Dimas General Plan and Seismic Safety Element

As part of the General Plan, cities and county governments typically develop safety and seismic elements that identify goals, objectives, and implementing actions to minimize the loss of life, property damage, and disruption of goods and services from man-made and natural disasters including floods, fires, non-seismic geologic hazards and earthquakes. General Plans can provide policies and develop ordinances to ensure acceptable protection of people and structures from risks associated with these hazards. Ordinances can include those addressing unreinforced masonry construction, erosion, or grading.

The Safety Element of the City of San Dimas General Plan lists the following objectives and policies that apply to the proposed project:

Objective 1.1: Manage development of San Dimas to protect areas subject to geologic hazards.

Policies: 1.1.3 – Require that adequate soils, geologic and structural evaluation reports be prepared by registered soils engineers, engineering geologists, and/or structural engineers, as appropriate, for all new development.

1.1.4 – Require that geological reports, building plans and the appropriate sections of environmental impact reports be reviewed by registered engineering geologists and/or structural engineers.

[7] Bolt, B., *Earthquakes*, W. H. Freeman and Company, New York, New York, 1988.

IMPACTS AND MITIGATION

Methodology

Alquist Priolo maps, published geo-hazard maps, phase one investigations, and geotechnical reports previously prepared for the project site were used to assess geological impacts of the project.

Criteria for Determining Significance

The proposed project may result in a significant impact if it would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

  i) Rupture of 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. Refer to California Division of Mines and Geology (CDMG) Special Publication 42.

  ii) Strong seismic ground shaking.

  iii) Seismic-related ground failure, including liquefaction.

  iv) Landslides.

- Result in substantial soil erosion or the loss of topsoil;

- Be located on strata 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; or,

- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property.

Project Impacts

Impact 3E1: The proposed project could expose people or structures to strong ground shaking in the event of an earthquake.

Ground-shaking is a common hazard in Southern California. The proposed structures would be constructed on alluvial materials that would be subject to strong ground-shaking intensities in the event of an earthquake on one of the faults in the area. Any new structures would be required to meet the most recent CBC and City of San Dimas building standards specific for the underlying

geologic materials in order to ensure the safety of the occupants. A preliminary geotechnical investigation prepared for the site has found the site to be suitable for the proposed project from a geologic and geotechnical engineering viewpoint.[8] Applying the following mitigation measure would reduce the effects of ground-shaking to less than significant levels.

Mitigation Measures

M-3E.1 *The applicant shall implement recommendations of site-specific geotechnical studies and secure a qualified engineer to design all buildings, facilities, and landscaping to withstand ground-shaking potential, as stipulated in the California Building Code and applicable City of San Dimas building and safety standards.*

Residual Impacts

Impacts would be less than significant.

Impact 3E2: The proposed project could expose people or structures to ground failure, including liquefaction, due to seismic activity.

According to the CGS, the proposed project site is located in a Liquefaction Seismic Hazard Zone.[9] The preliminary geotechnical investigation prepared for the project site evaluated liquefaction potential to be low due solely to the poorly sorted, coarse-grain of the underlying native alluvium.[10] However, access to portions of the site was limited due to existing private property improvements. Consequently, the report recommends further investigation of groundwater and deeper alluvial soils prior to final design.

Further assessment and design by a certified engineer prior to construction of the proposed project would ensure that liquefaction impacts are less than significant.

Mitigation Measures

M-3E.2 *The applicant shall complete a geotechnical investigation of the remaining portions of the proposed project site that were inaccessible during the preliminary investigation. A certified engineer shall design all buildings, facilities, and landscaping to adequately minimizes geologic hazards including liquefaction, settlement, subsidence, and expansive soils as stipulated in the California Building Code and applicable City of San Dimas building and safety standards.*

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[8] EEI, Preliminary Geotechnical Investigation, Costco Wholesale, San Dimas, California, May 14, 2003.
[9] California Geological Survey website, ftp://ftp.consrv.ca.gov/pub/dmg/shezp/zonemap/pdf/ozn_sdim.pdf, accessed June 11, 2002
[10] EEI, Preliminary Geotechnical Investigation, Costco Wholesale, San Dimas, California, May 14, 2003.

Residual Impacts

Impacts would be less than significant.

Impact 3E3: The proposed project could cause wind or water induced soil erosion during construction of the proposed project.

Water and wind erosion may occur during construction of the proposed project when vegetation is removed. The 22.83-acre project site would be cleared and graded prior to construction. During this time and throughout the construction period, exposed soils would be subject to wind- and water-induced erosion. Upon proposed project completion, the majority of the site will be covered with impervious surfaces and the remaining areas with soil cover would be vegetated. Therefore, post-construction erosion would be considered less than significant.

Soil erosion from the proposed project site during construction would impact the quality of storm water runoff from the site and surrounding areas, which could impair the quality of receiving waters. This impact is further discussed in Section 3G. Hydrology and Water Quality. In order to comply with regulations to preserve water quality, the project proponent would be required to develop and implement measures to reduce pollutant loads, including sediment, in storm water runoff from the site. Compliance with these regulations would reduce project impacts and no further mitigation measures would be necessary.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

Impact 3E4: The proposed project could be located on soil prone to subsidence, settlement, or expansion/shrinkage.

The proposed project site is not located within an area of known subsidence.[11] Therefore, the potential for future subsidence is considered low. Seismically induced settlement could occur at the site due to the presence of loose to moderately dense alluvium underlying the site. Shrinkage at the site was estimated as part of the preliminary geotechnical investigation. Based on earth materials encountered at the site, shrinkage was estimated at 3 to 7 percent. However, Costco's construction guidelines require that rock fragments in fills placed on-site be no more than 2 inches in diameter.[12] Under this requirement, shrinkage was estimated at approximately 20

[11] Southern California Association of Governments, *2001 Regional Transportation Plan Update Community Link 21, Program Environmental Impact Report*, Areas Subject to Subsidence in the SCAG Region, Map Book (Volume 2 of 4), February 1, 2001.

[12] EEI, Preliminary Geotechnical Investigation, Costco Wholesale, San Dimas, California, May 14, 2003.

percent. As stated in mitigation measure **M-3E.2**, based on further geotechnical investigations, a certified engineer will design structures to withstand the groundmotion predicted for the site location and ground materials in accordance with applicable building and safety standards. No further mitigation is necessary.

Mitigation Measures

Refer to mitigation measure **M-3E.2**.

Residual Impacts

Impacts would be less than significant.

Impact 3E5: Together with other area projects, the proposed project would not have cumulative impacts on geology and soils in the project area.

Impacts on geology and soils are generally localized or site-specific and do not result in regionally cumulative impacts. None of the project's impacts would be cumulatively considerable.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would not be cumulatively considerable.