3.6 - Geology and Soils

3.6.1 - Introduction

This section describes the existing geology and soils setting on the site and surrounding area and the potential impacts upon geology and soils associated with implementation of the Project. Section 15125 of the State CEQA Guidelines requires EIRs to include a description of the physical environmental conditions in the area of a project that exist at the time that the Notice of Preparation (NOP) is circulated. These environmental conditions normally constitute the baseline physical conditions relative to which the CEQA lead agency evaluates the change in conditions that would result from project implementation. The NOP for this Draft EIR was issued on February 27, 2009. Therefore, environmental conditions as of February 2009 represent the baseline for CEQA purposes. To evaluate the footprint impacts of the Proposed Action (e.g., effects on geology and soils), the conditions in 2009 are considered to be the baseline. Buildout of the Project is then added to existing conditions in order to determine whether Project implementation would substantially remove or impact the resources, thereby resulting in a significant impact on the environment. Data used to determine the baseline for geology and soils were derived from information contained in the Geotechnical Engineering Investigation Report prepared for this Project by Krazan and Associates, Inc. (KA), dated July 8, 2005, and is included in this Draft Environmental Impact Report (DEIR) as Appendix E. Therefore, data used to derive baseline conditions is based on existing conditions at the time of NOP issuance (February 27, 2009 through March 31, 2009) and are appropriate to use within the following analysis.

3.6.2 - Environmental Setting

The Project site is located in Southern California within the northern margin of the Peninsular Range Geomorphic Province, which is characterized by northwest trending elongated ranges and intervening valleys. More specifically, the Project site is located between two of the most active of these faults, the San Jacinto and the San Andreas Fault Zones. According to the Southern California Earthquake Center, the 30-year probability for M 7.3 earthquakes on the San Jacinto and San Andreas faults within the Project site is 37 and 28 percent, respectively. Maximum horizontal ground accelerations from these 30-year probable earthquakes are anticipated to substantially exceed 0.4g, which is the current maximum Uniform Building Code design value.

The topographic features of the Project site can be generally characterized as a relatively flat land that slopes approximately two percent from the south to the northeast towards the Santa Ana River. The Project site is located at an elevation of approximately 1,270 feet above mean sea level (amsl).

Soil Conditions

The Project site is located on the alluvial flood plain deposits of the Santa Ana River derived from erosion of the adjacent mountains surrounding the valley. Alluvial deposits underlying the Project sites are estimated to be several hundred feet thick. In general, the subsurface soils generally

consisted of six to twelve inches of loose disturbed soil and a thin layer of fill underlain by native alluvial silty sand and sand. According to the Engineering Investigation Report (KA 2005), fill materials are present in the majority of the Project site to a depth up to four feet. These soils are disturbed, have low strength characteristics, and are highly compressible when saturated. Additionally, a relatively denser silty sand and sand is located below the disturbed fill soils, these soils are moderately strong and slightly compressible (KA 2005).

In 1971, the U.S. Soil Conservation Service (SCS, now the Natural Resources Conservation Service) mapped soil units throughout San Bernardino County. The mapping indicates that on-site soils contain a majority (over 91 percent of the Project area) of Hanford Sandy Loam (HbA), while the rest is Tujunga Loamy Sand (TuB). The Project site is nearly level with slopes less than two percent. Exhibit 3.6-1, Local Soils, shows the location of the soils on-site.

Subsurface Conditions

Krazan & Associates Inc. drilled borings on the Project site to evaluate the subsurface profile. Subsurface soil conditions were explored by drilling sixty-five (65) borings using a truck-mounted drilling to depths ranging from approximately 10 to 50 feet below the Project site grade. Below is a summary of the findings.

The subsurface conditions encountered during the Engineering Investigation Report (KA 2005) consisted of six to twelve inches of loose disturbed soil and a thin layer of fill underlain by native alluvial silty sand and sand. Fill materials were also encountered in the majority of the borings to a depth up to four feet; however, thicker fill may be present at the site. The soils are disturbed, have low strength characteristics, and are highly compressible when saturated.

Below the disturbed and undocumented fill soils, relatively denser silty sand and sand were encountered. These soils are moderately strong and slightly compressible. Penetration resistance, measured by the number of blows required to drive a Modified California sampler or a Standard Penetration Test (SPT) sampler, ranged from three to over 50 blows per foot. Dry densities ranged from 102.3 to 119.1 pcf. Representative soil samples consolidated approximately 0.8 to 1.6 percent under a 2-ksf load when saturated. Representative soil samples had angles of internal friction of 33 to 37 degrees. A representative soil sample had a maximum dry density of 128 pcf.

One boring, Boring B-16 of the Engineering Investigation Report (KA 2005), was advanced to a depth of 50 feet to obtain additional information for use in evaluating the potential for liquefaction. The soil profile was found to consist of loose to dense silty sand and sand. This profile is consistent with the majority of the borings drilled during the Engineering Investigation Report (KA 2005).

Source: San Bernardino County NAIP (2009). USDA soils Data.

Michael Brandman Associates

NORTH

600 300 0 600 Feet

Exhibit 3.6-1
Local Soils

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Laboratory Testing

Krazan & Associates Inc. performed laboratory tests on selected soil samples to evaluate their physical characteristics and engineering properties. The laboratory-testing program was formulated with emphasis on the evaluation of natural in-situ moisture and density, gradation, shear strength, consolidation potential, R-value, maximum dry density, resistivity, pH value, sulfate and chloride contents of the materials encountered. Details of the laboratory-testing program are discussed in Appendix A of the Engineering Investigation Report (KA 2005). The results of the laboratory tests are presented on the borings logs or on the test reports, which are also included in Appendix A of the Engineering Investigation Report (KA 2005).

Groundwater

Test boring locations were checked for the presence of groundwater during and immediately following the drilling operations of the Engineering Investigation Report (KA 2005). Free groundwater was not encountered in any of the borings drilled as part of the Engineering Investigation Report's investigations.

Regional Seismicity

The term seismicity describes the effects of seismic waves that are radiated from an earthquake as it ruptures. While most of the energy released during an earthquake results in the permanent displacement of the ground, as much as 10 percent of the energy may dissipate immediately in the form of seismic waves. To understand the implications of seismic events, a discussion of faulting and seismic hazards is provided below.

Faulting

All of southern California is geologically and seismically active. The numerous faults include active, potentially active, and inactive faults. The criterion for these major groups is based on criteria developed by the California Division of Mines and Geology (CDMG) for the Alquist-Priolo Earthquake Fault Zoning Program.

Faults form in rocks when stresses overcome the internal strength of the rock, resulting in a fracture. Large faults develop in response to large regional stresses operating over a long time, such as those stresses caused by the relative displacement between tectonic plates. According to the elastic rebound theory, these stresses cause strain to build up in the earth's crust until enough strain has built up to exceed the strength along a fault and cause a brittle failure. The slip between the two stuck plates or coherent blocks generates an earthquake. Following an earthquake, strain will build once again until the occurrence of another earthquake. The magnitude of slip is related to the maximum allowable strain that can be built up along a particular fault segment. The greatest buildup in strain that is due to the largest relative motion between tectonic plates or fault blocks over the longest time will generally produce the largest earthquakes. The distribution of these earthquakes is a study of much interest for both hazard prediction and the study of active deformation of the earth's crust. Deformation is a

complex process, and strain caused by tectonic forces is not only accommodated through faulting but also by folding, uplift, and subsidence, which can be gradual or in direct response to earthquakes.

Faults are mapped to determine earthquake hazards, since they occur where earthquakes tend to recur. A historic plane of weakness is more likely to fail under stress than a previously unbroken block of crust. Faults are, therefore, a prime indicator of past seismic activity, and faults with recent activity are presumed to be the best candidates for future earthquakes. However, since slip is not always accommodated by faults that intersect the surface along traces, and since the orientation of stresses in the crust can shift, predicting the location of future earthquakes is complicated. Earthquakes sometimes occur in areas with previously undetected faults or along faults previously thought inactive.

Active faults are those that have demonstrated movement or surface displacement within Holocene time or 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 are those that are not known to have moved in the last 1.6 million years. These definitions are used to delineate Earthquake Fault Zones as mandated by the Alquist-Priolo Earthquake Zone Act, which requires fault investigation on sites located within Special Studies Zones (sometimes referred to as "A-P Zones") to preclude new construction of certain habitable structures across the trace of active faults.

Southern California contains a number of major active northwest-trending regional faults such as the right-lateral, strike-slip, San Andreas, San Jacinto, and Elsinore Fault zones. However, the dominant geologic feature in this region is the active San Andreas Fault Zone (SAFZ), including the San Jacinto Fault System and Elsinore-Temecula fault complexes due to their proximity and relative high seismic potential. This fault zone consists of several major northwest-southeast trending, right lateral strike slip faults that have experienced repeated disturbances (i.e., earthquakes and lateral movement) in the last 200-300 years.

According to the Engineering Investigation Report (KA 2005), the nearest significant active fault is the San Jacinto- San Jacinto Valley fault zone (Type B fault), located approximately 4.6 miles from the Project site. The nearest Type A fault is the San Andreas- Southern fault zone, located approximately 4.9 miles from the Project site (Exhibit 3.6-2, Regional Faults). The Project site is located within a Seismic Zone 4 (KA 2005).

Seismicity

Seismicity describes the effects of seismic waves that are radiated from an earthquake as it ruptures. While most of the energy released during an earthquake results in the permanent displacement of the ground, as much as 10 percent of the energy may dissipate immediately in the form of seismic waves. To understand the implications of seismic events, a discussion of faulting and seismic hazards is provided below.

Source: Census 2000 Data, The CaSIL, MBA GIS 2008.

Michael Brandman Associates

NORTH

5 2.5 0 5 Miles

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Exhibit 3.6-2
Regional Faults

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Seismic Hazards

Seismic hazards pose a substantial danger to property and human safety and are present because of the risk of naturally occurring geologic events and processes impacting human development. Therefore, the hazard is influenced by the conditions of human development as by the frequency and distribution of major geologic events. Seismic hazards present in California include ground rupture along faults, strong seismic shaking, liquefaction, ground failure, landsliding, and slope failure.

Fault Rupture

Fault rupture is a seismic hazard that affects structures sited above an active fault. The hazard from fault rupture is the movement of the ground surface along a fault during an earthquake. Typically, this movement takes place during the short time of an earthquake, but it also can occur slowly over many years in a process known as creep. Most structures and underground utilities cannot accommodate the surface displacements of several inches to several feet commonly associated with fault rupture or creep.

Ground Shaking

The severity of ground shaking depends on several variables such as earthquake magnitude, epicenter distance, local geology, thickness, and seismic wave-propagation properties of unconsolidated materials, groundwater conditions, and topographic setting. Ground shaking hazards are most pronounced in areas near faults or with unconsolidated alluvium.

The most common type of damage from ground shaking is structural damage to buildings, which can range from cosmetic stucco cracks to total collapse. The overall level of structural damage from a nearby large earthquake would likely be moderate to heavy, depending on the characteristics of the earthquake, the type of ground, and the condition of the building. Besides damage to buildings, strong ground shaking can cause severe damage from falling objects or broken utility lines. Fire and explosions are also hazards associated with strong ground shaking.

While Richter magnitude provides a useful measure of comparison between earthquakes, the moment magnitude is more widely used for scientific comparison since it accounts for the actual slip that generated the earthquake. Actual damage is due to the propagation of seismic or ground waves as a result of initial failure, and the intensity of shaking is as much related to earthquake magnitude as is the condition of underlying materials. Loose materials tend to amplify ground waves, while hard rock can quickly attenuate them, causing little damage to overlying structures. For this reason, the Modified Mercalli Intensity (MMI) Scale provides a useful qualitative assessment of ground shaking. The MMI Scale is 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. The MMI Scale is shown in Table 3.6-1, along with relative ground velocity and acceleration.

Table 3.6-1: Modified Mercalli Intensity Scale

Richter Magnitude	Modified Mercalli Intensity	Effects	Average Peak Ground Velocity (centimeters/seconds)	Average Peak Acceleration
0.1–0.9	I	Not felt. Marginal and long-period effects of large earthquakes	—	—
1.0–2.9	II	Felt by only a few persons at rest, especially on upper floors of building. Delicately suspended objects may swing.	—	—
3.0–3.9	III	Felt quite noticeable in doors, especially on upper floors of building, but many people do not recognize it as an earthquake. Standing cars may rock slightly. Vibration like passing a truck. Duration estimated.	—	0.0035–0.007 g
4.0–4.5	IV	During the day, felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensations like heavy truck striking building. Standing cars rocked noticeably.	1–3	0.015–0.035 g
4.6–4.9	V	Felt by nearly everyone, many awakened. Some dishes, windows, broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.	3–7	0.035–0.07 g
5.0–5.5	VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of falling plaster and damaged chimneys. Damage slight.	7–20	0.07–0.15 g
5.6–6.4	VII	Everyone runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well built, ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars.	20–60	0.15–0.35 g

Table 3.6-1 (cont.): Modified Mercalli Intensity Scale

Richter Magnitude	Modified Mercalli Intensity	Effects	Average Peak Ground Velocity (centimeters/seconds)	Average Peak Acceleration
6.5–6.9	VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monument walls, and heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving in cars disturbed.	60–200	0.35–0.7 g
7.0–7.4	IX	Damage considerable in specially designed structures; well-designed frame strictures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	200–500	0.7–1.2 g
7.5–7.9	X	Some well-built structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Railway lines bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks.	≥ 500	>1.2 g
8.0–8.4	XI	Few, if any masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.		
≥ 8.5	XII	Total damage. Waves seen on ground. Lines of sight and level distorted. Objects thrown into the air.		
Source: United States Geologic Survey.				

The Engineering Investigation Report indicated that the Project site will likely be subject to at least one moderate to severe earthquake and associated seismic shaking during the lifetime of the Project (KA 2005).

Ground Failure

Ground failure includes liquefaction and the liquefaction-induced phenomena of lateral spreading, and lurching.

Liquefaction is a process by which sediments below the water table temporarily lose strength during an earthquake and behave as a viscous liquid rather than a solid. Liquefaction is restricted to certain geologic and hydrologic environments, primarily recently deposited sand and silt in areas with high groundwater levels. The process of liquefaction involves seismic waves passing through saturated granular layers, distorting the granular structure, and causing the particles to collapse. This causes the granular layer to behave temporarily as a viscous liquid, resulting in liquefaction.

Liquefaction can cause the soil beneath a structure to lose strength, which may result in the loss of foundation-bearing capacity. This loss of strength commonly causes the structure to settle or tip. Loss of bearing strength can also cause light buildings with basements, buried tanks, and foundation piles to rise buoyantly through the liquefied soil.

Lateral spreading is lateral ground movement, with some vertical component, caused by liquefaction. In effect, the soil rides on top of the liquefied layer. Lateral spreading can occur on relatively flat sites with slopes less than two percent, under certain circumstances, and can cause ground cracking and settlement.

Lurching is the movement of the ground surface toward an open face when the soil liquefies. An open face could be a graded slope, stream bank, canal face, gully, or other similar feature.

Landslides and Slope Failure

Landslides and other forms of slope failure form in response to the long-term geologic cycle of uplift, mass wasting, and disturbance of slopes. Mass wasting refers to a variety of erosional processes from gradual downhill soil creep to mudslides, debris flows, landslides and rock fall—processes that are commonly triggered by intense precipitation, which varies according to climactic shifts. Often, various forms of mass wasting are grouped together as landslides, which are generally used to describe the downhill movement of rock and soil.

Geologists classify landslides into several different types that reflect differences in the type of material and type of movement. The four most common types of landslides are translational, rotational, earth flow, and rock fall. Debris flows are another common type of landslide similar to earth flows, except that the soil and rock particles are coarser. Mudslide is a term that appears in non-technical literature to describe a variety of shallow, rapidly moving earth flows.

3.6.3 - Regulatory Framework

State Alquist-Priolo Earthquake Fault Zoning Act

In response to the severe fault rupture damage of structures by the 1971 San Fernando earthquake, the State of California enacted the Alquist-Priolo Earthquake Fault Zoning Act in 1972. This act required

the State Geologist to delineate Earthquake Fault Zones (EFZs) along known active faults that have a relatively high potential for ground rupture. Faults that are zoned under the Alquist-Priolo Act must meet the strict definition of being "sufficiently active" and "well-defined" for inclusion as an EFZ. The EFZs are revised periodically, and they 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 in an EFZ is permitted only following the completion of a fault location report prepared by a California Professional Geologist.

California Building Code

The City of Redlands enforces a variety of codes to ensure the structural integrity of buildings constructed within the City. The City adopted revisions of the Uniform Building Code (UBC) that address the specific building conditions and structural requirements in California. California Code of Regulations (CCR), Title 24, Part 2, the California Building Code (CBC), provides minimum standards for building design in California. The City has adopted the 2001 CBC, as the City's building code which incorporates the most current seismic design standards and hazard reduction measures recommended by the Applied Technology Council (ATC) the Structural Engineers Association of California (SEAOC), the Earthquake Engineering Research Institute (EERI), the Seismic Safety Commission, and the Southern California Earthquake Center.

City of Redlands General Plan

Goals and policies in the City's General Plan that are relevant to geology and soils are presented below.

Guiding Policies: Seismicity, Geology and Soils

Policy 8.50a Investigating and mitigate geologic and seismic hazards, or locate development away from such hazards, in order to preserve life and protect property.

Analysis

Areas of unmitigable hazards should be preserved as open space.

Policy 8.50b Support *implementation* of San Bernardino County General Plan policies relating to geologic and seismic hazards, and consult with the San Bernardino County Geologist where conflicting information exists or where no published information is available.

Analysis

To some extent, sources vary or present incomplete coverage of the locations of faults and areas subject to liquefaction and landslides. The County Geologist, as well as USGS and the State Division of Mines and Geology, can provide a resolution to some of these issues, or references to the latest sources of information.

Implementing Policies: Seismicity, Geology and Soils

Policy 8.50c Continue to restrict development within Alquist-Priolo Earthquake Fault Zones and other active/potentially active faults, which have not yet received Alquist-Priolo classification.

Analysis

California's Alquist-Priolo Earthquake Fault Zoning Act went into effect in 1973, and has been amended several times. The purpose of this Act is to prohibit the location of most structures for human occupancy across the traces of active faults thereby to mitigate the hazard of fault rupture. Under the Act, the Division of Mines and Geology has delineated Earthquake Fault Zones along active faults in California and jurisdictions containing these zones must then regulate certain types of development within these zones. The San Andreas and San Jacinto faults, which bound the Planning Area, as well as the less-well-known Western Heights and Chicken Hill fault zones east of the Planning Area, have been classified as Earthquake Fault Zones under the Alquist-Priolo Earthquake Fault Zoning Act. These areas are identified on General Plan Figure 8.3.

Policy 8.50d Consult with the Division of Mines and Geology if there are issues or questions concerning fault alignment. Evaluate and, if necessary, perform site-specific investigation for development proposed on or near Alquist-Priolo Earthquake Fault Zones as well as within 500' of other active/potentially active faults as depicted on General Plan Figure 8.1.

Policy 8.50e Require areas identified as having significant liquefaction potential (including secondary seismic hazards such as differential compaction, lateral spreading, settlement, rockfall, and landslide) to undergo geotechnical study prior to development; mitigate the potential hazard to a level of insignificance; if mitigation is not possible, preserve these areas as open space or agriculture.

Analysis

The San Bernardino County Geologic Hazard Overlay Map shows the Santa Ana River Wash and portions of adjacent areas as having a high susceptibility to liquefaction, on a generalized basic. The liquefaction information on the County map is based on USGS data (1991).

Policy 8.50k For new construction and exterior building expansions including multi story additions or lateral expansions as deemed appropriate by the City Building Department, require the preparation of a geotechnical/soils/geologic report by a registered civil geotechnical/soils engineer and a certified engineering geologist.

This report shall address erodible, expansive and collapsible soils, existing or potential landslides, areas with unsuitable percolation characteristics, large-scale subsidence, non-rippable bedrock areas, ground motion parameters, active/potentially active faulting, liquefaction, and any other geotechnical concept as appropriate and make recommendations for mitigating any potential adverse impacts.

Policy 8.50l Require soil erosion mitigation during construction.

Analysis

See also Policy 8.20o – Design projects to minimize the possibility of wind or water erosion and, where necessary, require preparation and implementation of a soil erosion plan, including soil erosion mitigation during construction.

Policy 8.50m Adopt revisions of the UBC which incorporate the most current seismic design standards and hazard reduction measures recommended by the ATC the SEAOC, the EERI, the Seismic Safety Commission, and The Southern California Earthquake Center.

Policy 8.50n Ensure that the Emergency Management Plan addresses seismic hazards, including hazardous materials incidents, hazardous buildings, critical facilities (i.e., schools, hospitals), emergency response preparedness and recovery with consideration to evacuation routes, peak load water supply requirements and minimum road width/clearance around structures.

3.6.4 - Thresholds of Significance

According to the California Environmental Quality Act (CEQA) Guidelines' Appendix G Environmental Checklist, to determine whether project-related impacts to geology and soils may produce significant environmental effects, the following questions are analyzed and evaluated:

Would the Project:

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

   i. 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? Refer to Division of Mines and Geology Special Publication 42.

   ii. Strong seismic ground-shaking?

   iii. Seismic-related ground failure, including liquefaction?

iv. Landslides?

b) Result in substantial soil erosion or the loss of topsoil?

c) Be located on a geologic unit or soil that is unstable, or would become unstable because of the Project and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

d) Be located on expansive soil, as defined in Table 18-1-A of the California Building Code (2007) creating substantial risks to life or property?

e) Have 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?

3.6.5 - Project Impacts and Mitigation Measures

This section discusses potential impacts associated with the development of the Project and provides mitigation measures where appropriate.

Earthquakes

Impact GS-1	**Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:** **i) 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? Refer to Division of Mines and Geology Special Publication 42.** **ii) Strong seismic ground shaking?** **iii) Seismic-related ground failure, including liquefaction?** **iv) Landslides?** **[CEQA Geology and Soils Threshold 6(a)(i to iv)]**

Impact Analysis

The Project site is located in an area of regular seismic activity and is prone to periodic earthquakes, as is all of southern California. Specifically, the Project is located between two of the most active faults, the San Jacinto and the San Andreas Fault Zones. The potential seismic hazards include fault rupture, strong ground shaking, ground failure, and landsliding. The geotechnical investigation report evaluated the potential for these seismic hazards; the results are summarized below (KA 2005):

Fault Rupture

The site is not within any EFZ as created by the Alquist-Priolo Fault Zone Act. The nearest "zoned" active fault is the San Jacinto Valley Segment of the San Jacinto Fault Zone (Type B fault), located approximately 4.6 miles from the Project site (Exhibit 3.6-2, Regional Faults). Therefore, the potential for fault-induced ground rupture on the site is not considered a significant impact.

Seismic Ground Shaking

The surrounding area contains several regional faults, which have the potential to generate strong ground motions at the Project site. An earthquake occurring on the San Jacinto Valley Segment of

the San Jacinto Fault Zone would cause the most severe shaking. This fault has the potential of generating peak horizontal ground accelerations of 0.49 g (approximately 49 percent of the force of gravity applied in the horizontal direction). Given the moderate horizontal accelerations that could occur at this site (0.49 g), the impact of strong seismic ground motion could be a potentially significant impact. However, the Project site is located at a significant distance from the identified fault zone and the Project site shows no mapped faults on-site according to Geotechnical Hazards Map (GP Figure 8.3) in Section 8.0 Health and Safety of the General Plan of the City. In addition, the City of Redlands enforces a variety of codes to ensure the structural integrity of buildings constructed within the City. The City adopted revisions of the UBC that address the specific building conditions and structural requirements in California. CCR, Title 24, Part 2, the CBC, provides minimum standards for building design in California. The City has adopted the 2010 CBC, as the City's building code which incorporates the most current seismic design standards and hazard reduction measures recommended by the ATC the SEAOC, the EERI, the Seismic Safety Commission, and the Southern California Earthquake Center. Compliance with the State building code and building standards (i.e., Uniform Building Code/California Building Code for Zone 4), as well as the City's development review process, and the design guidelines outlined in the Project geotechnical studies should reduce ground shaking impacts to less than significant levels.

Seismic-Related Ground Failure

The liquefaction potential of the Project site was evaluated based upon soil type, groundwater depth, relative density, initial confining pressure and the intensity and duration of ground shaking. Based on the findings on the geotechnical investigation, the potential for seismic induced soil liquefaction within the Project site is low due to underlying soil characteristics and absence of shallow groundwater (KA 2005).

Landslides

A review of the "Slope Map," Figure 8.4 of City of Redlands General Plan, shows that the Project site is not located within an area prone to slope instability. The site reconnaissance does not show evidence of onsite landslides and the primary earth material at the site is resistant to landslides (KA 2005). In addition, the Project site area is a nearly leveled area and does not contain any unstable or steep slopes, which have a higher tendency for landslide activity. Therefore, based upon the existing topography and proposed design configurations, the occurrence of landslide due to seismic events is less than significant.

Level of Significance Before Mitigation

Less than significant.

Mitigation Measures

No mitigation required.

Level of Significance After Mitigation

Less than significant.

Soil Erosion or Topsoil Loss

Impact GS-2	**Result in substantial soil erosion or the loss of topsoil?** **[CEQA Geology and Soils Threshold 6(b)]**

Impact Analysis

According to the Geotechnical Report (2005) conducted for the Project, mass grading of the majority of the site is expected to entail minor cuts and fills (±5 feet) from existing grades to establish building pads and to provide for surface drainage of the site, thus resulting in a balance of cut and fill. The entire Project site is proposed to be massed graded in one phase. During construction activities, there would be the potential for surface water to carry sediment from on-site erosion into the stormwater system and local waterways. Soil erosion may occur along Project boundaries during construction in areas where temporary soil storage is required. In addition, the geotechnical report indicated that a majority of the areas planned for development on the Project site have soil types with moderate erosion potential. Therefore, a potentially significant risk of erosion associated with construction activities exists. However, consistency with mitigation measures MM HWQ 1a- and HWQ 1-b (See DEIR Section 3.8 Hydrology and Water Quality), as well as all other applicable water quality standards and requirements will reduce impacts from erosion associated with construction activities to a level of less than significant.

Level of Significance Before Mitigation

Less than significant

Mitigation Measures

Refer to the Mitigation Measures HWQ 1a- and HWQ 1-b (Section 3.8, Hydrology and Water Quality), and all other applicable water quality standards and requirements.

Level of Significance After Mitigation

Less than significant

Unstable Geologic Location

Impact GS-3	**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?** **[CEQA Geology and Soils Threshold 6(c)]**

Impact Analysis

The geotechnical report for the Project site indicates that the underlying bedrock is capable of supporting the proposed development (KA 2005). In addition, the potential for liquefaction is considered low based on the analysis of soil characteristics and depths to the groundwater (see Impact GS-1). However, the Preliminary Geotechnical Investigation by Krazan & Associates Inc. in 2005 concluded that the subsurface soils generally consisted of 6 to 12 inches of loose disturbed soil and a thin layer of fill underlain by native alluvial silty sand. These soils are disturbed, have low strength characteristics, and are highly compressible when saturated. The Geotechnical Engineering

Investigation Report (KA 2005) provided grading recommendations based on the underlying soil conditions, which should be implemented during grading activities. Unless these recommendations are implemented, the Project has the potential to produce potentially significant impacts concerning unstable geologic units.

Level of Significance Before Mitigation

Potentially significant.

Mitigation Measures

MM GS-3a The developer shall implement the grading recommendations identified in the Geotechnical Report (KA 2005). Prior to the commencement of building construction, the applicant shall retain a qualified engineer to design foundations adequate to support the Project's structures where necessary, based on the recommendations of the Geotechnical Report (KA 2005). Settlement analysis shall be performed once the structural design loads and foundation system geometry have been defined for each building. The total settlement due to foundation loads shall not exceed the 1-inch. The differential settlements shall be less than 1-inch between adjacent columns and perimeter walls to adjacent columns, and less than 1/2-inch in 40 feet along perimeter walls. Most of the settlement is expected to occur during construction as the loads are applied.

Level of Significance After Mitigation

Less than significant.

Expansive Soil

Impact GS-4	**Be located on expansive soil, as defined in Table 18-1-A of the California Building Code (2007), creating substantial risks to life or property?** **[CEQA Geology and Soils Threshold 6(d)]**

Impact Analysis

The laboratory tests indicate that on-site soils have very low expansion potential. The geotechnical report for the Project site indicate that on-site soils do not contain expansive clay materials and have low shrink-swell properties that may expose buildings to structural damage. In addition, subsidence within the building area is anticipated at less than 0.05 feet (KA 2005). Compliance with the recommendations set forth in the geotechnical report should render any risks associated with expansive soils to less than significant levels.

Level of Significance Before Mitigation

Less than significant.

Mitigation Measures

No mitigation required.

Level of Significance After Mitigation

Less than significant.

Wastewater Disposal Systems

Impact GS-5	**Have 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?** **[CEQA Geology and Soils Threshold 6(e)]**

Impact Analysis

The Project will connect to the City of Redlands sewer system. Accordingly, potential soil constraints for using septic or alternative wastewater disposal systems are not applicable and therefore, this is a less than significant impact.

Level of Significance Before Mitigation

Less than significant.

Mitigation Measures

No mitigation required.

Level of Significance After Mitigation

Less than significant.