D. GEOLOGY

This Section includes data and findings from the Geotechnical Engineering Investigation prepared for the site by Jerry Kovacs and Associates, Inc., included in **Appendix D** of this EIR.

Existing Conditions

Geologic Units and Structure

The Project site is located in Westwood Village, which is situated on the southern side of the Santa Monica Mountains near the intersection of two geologic provinces: the Transverse Ranges and the Peninsular Ranges. The Santa Monica Mountains and associated east-west trending "frontal fault system" (including the Malibu, Santa Monica, Hollywood, and Elysian Park faults) form the southern boundary of the Transverse Ranges geologic province. The Transverse Ranges are named for this east-west trend, which is 'transverse' to the dominant northwest-southeast trending mountain ranges in the region.

The site is located within the northernmost portion of the geologic area known as the Los Angeles Basin (Basin). A thick sequence (several thousand feet) of Tertiary age sedimentary rocks underlies this portion of the Basin.[1] From oldest to youngest, these rocks are represented by the Topanga Formation, Monterey Formation (also known as the lower Modelo Formation), Modelo Formation, and Fernando Formation (Dibblee, 1991; Lamar, 1970). Each formation is comprised of rock layers alternating between sandstone, conglomerate and siltstone.

Figure V.D-1 (from Dibblee, 1991) shows surficial alluvial deposits at the site and various bedrock units in the Santa Monica Mountains. These bedrock units are folded into a series of buried geologic structures, anticlines and synclines. Upward arching anticlines form traps where oil and gas accumulate. Three old oil fields are near the Project area. Sawtelle, Beverly Hills and Cheviot Hills Oil Fields are located approximately 1,500 feet southwest, 2,500 feet east and 3,000 feet southeast, respectively, of the Project site.

Erosion of Tertiary rocks resulted in formation of relatively flat areas in the Basin. Deposition during Quaternary (Recent and Pleistocene) time covered these geologic structures with alluvial deposits from local mountains.[2] As shown in Figure V.D-1, the Project site is underlain by Older Alluvium (Dibblee 1991). Beneath the surface these older alluvial deposits (Qoa) merge with the Upper Pleistocene Lakewood Formation, and reach a thickness of approximately 40 feet or more in the Project area (DWR, 1961). DWR (1961) designates surface exposures at the site as Lakewood Formation. Younger surficial alluvial deposits (Qa of Dibblee, 1991) are found about immediately west of the site. These younger deposits range in thickness from 5 to 35 feet (DWR, 1961). Primarily unconsolidated and uncemented gravels, sands, silts, and clays comprise these younger alluvial deposits.

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[1] Geologic time since the formation of the Earth is divided into several period s each of which is characterized by the formation of a distinctive rock system. The Tertiary Period began approximately 65 million years before present and ended approximately 1.6 million years before present.

[2] The Quaternary Period began approximately 1.6 million years before present and extends to the present day. Geologic periods are divided into epochs, each of which is characterized by the formation of a distinctive rock system. The Pleistocene Epoch formed the earlier part of the Quaternary Period and extended from approximately 1.6 million years to 11,000 years before present. The Recent Epoch, also known as the Holocene Epoch, formed the latter part of the Quaternary Period, began at the end of the last Ice Age, and has extended from approximately 11,000 years before present to the present day.

Figure VD-1 Local Geology

Upper Pleistocene Older Alluvium forms the upper portion of the Lakewood Formation, which is an aquifer at depth.[3] The Lakewood Formation consists of primarily unconsolidated discontinuous gravel and sand layers, interbedded with silt or clay layers. The Exposition Aquifer, present in upper (shallow subsurface) part of the Lakewood Formation, is comprised of sand and gravel beds separated by silt and clay deposits.

Soils at the Project site have been modified and disturbed by grading and earthmoving associated with previous land uses. It is unlikely that undisturbed native soils are present at the site. Descriptions of geologic units presented in various geotechnical reports (see below) are consistent with DWR's (1961) description of the Lakewood Formation.

Stratigraphy

In February 2000, Kovacs and Associates (Kovacs)[4] conducted a geotechnical engineering investigation for the proposed development at the Project site. As part of this investigation, data from previous geotechnical investigations Crandall and Associates (Crandall) in 1990, and Kovacs in 1996 were reviewed. Kovacs incorporated results of laboratory testing from their 1996 study into the 2000 report. Borehole data previously collected by Crandall were included in the 1990 Crandall study reviewed by Kovacs.

Sixteen exploratory borings were drilled during these geotechnical investigations. Kovacs (2000) drilled two borings, to depths 100 feet below ground surface, for their recent investigation. In addition, Kovacs (1996) drilled 4 borings and Crandall (1990) drilled 10 borings at the site.

The 1990 Crandall investigation drilled seven holes to depths from 71 to 112 feet below surface (approximately 223 to 261 feet above sea level). Data from three previously drilled holes at the site were incorporated into their study. Primarily brown to reddish-brown (with a minor amount of gray) old alluvium, alternating between silty sand, clayey silt, sandy silt and sand, were encountered in each hole. Some cobbles or gravel were noted in various zones. Well-graded gravel lenses were penetrated in boreholes #4, 5 and 6. Sedimentary layers or zones ranged in thickness from a few feet to more than 15 feet. Most layers were between 3 and 5 feet thick. Approximately two feet of artificial fill was identified in boreholes #2, 3 and 10.

In two studies, Kovacs drilled a total of six boreholes at the site (depth 80 to 110 feet, approximately 228 to 250 feet above sea level). Kovacs incorporated data from their 1999 study into their recent (2000) study. Similar to the Crandall study, boreholes drilled by Kovacs encountered primarily brown to reddish-brown (with minor black, gray and grayish-brown) beds of old alluvium, comprised of clayey sand, sandy clay, clayey gravel, sandy gravel, silty sand, and clayey sand. Some sand and gravelly sand layers were also noted. Sedimentary beds ranged in thickness from a few feet to more than 15 feet. Most beds were between 3 and 8 feet thick. Kovacs (2000) described native soils as mostly combinations of sand, silt and clay, generally dense to very dense and stiff.

Groundwater

The Santa Monica Mountains represent the northern boundary of the Los Angeles County Coastal Plain. Along the base of the Santa Monica Mountains, Quaternary sedimentary layers are faulted

[3] California Department of Water Resources (DWR), 1961. Planned Utilization of the Ground Water Basins of the Coastal Plain of Los Angeles County, Appendix A, Ground Water Geology. Bulletin No. 104.

[4] Kovacs and Associates is the former name of Geotechnologies, Inc. (Geotechnologies).

and folded. East of the Project area, sedimentary layers are folded downward into a geologic structure known as the Hollywood syncline. East of the Newport-Inglewood fault zone, this syncline forms the Hollywood Basin, a groundwater basin parallel to the Santa Monica Mountain front. The Santa Monica Basin extends from the Pacific Ocean east to the Newport-Inglewood fault zone and from the Santa Monica Mountains south to the Ballona Escarpment (DWR, 1961). The Project site overlies the Santa Monica Basin.

The Santa Monica Basin was originally considered part of the larger West Coast Basin to the south. Along its southern boundary, the Santa Monica Basin is separated from the West Coast Basin by a subsurface structure and surface divide known as the Ballona Escarpment. The Santa Monica Basin is subdivided into five physiographic features: Santa Monica Plain, Sawtelle Plain, Ocean Park Plain, Beverly Hills, and Ballona Gap.

The Project site is near the boundary between the Santa Monica and Sawtelle Plains. Water levels in wells producing from Recent alluvium in the Sawtelle Plain are much higher than water levels in wells that penetrate older sediments. This suggests that a perched or semi-perched aquifer is present in this area (DWR, 1961).

In northern and eastern portions of the basin, groundwater is present in unconfined aquifers (such as the Exposition Aquifer). In other areas of the basin, as well as in deeper aquifers, groundwater is confined. Flowing wells from deeper Miocene[5] sediments were once known to exist in the eastern part of the Hollywood Basin (DWR, 1961).

Depth to groundwater beneath the site is estimated at greater than 30 feet (County of Los Angeles, 1990). In January 2000, Kovacs measured depth to groundwater in two boreholes (# 5 and 6) at 64 and 62 feet (elevation approximately 273 feet above sea level). No water levels were measured in their previous 1996 study (boreholes #1 through 4).

Monitoring wells were constructed in both Kovacs boreholes #5 and 6. Water depth measurements in each well were made twice, February 8 and 24, 2000. During February, depth to water measured in boreholes #5 and 6 were approximately 43 and 45 feet (elevation 293 and 290 feet), respectively. Measurements were approximate (within one-foot) because the elevation of these wells was not surveyed. These groundwater levels are about 20 feet higher than those measured in January, and may reflect water level fluctuation resulting from winter precipitation. Kovacs (2000) refers to the February 1996 de-watering study by Hydroquip wherein depths were measured at 57 feet and 69.75 feet (elevations 278 and 267 feet).

During their 1989 and 1988 studies, Crandall measured depth to groundwater in bore holes #1 through 7 and #9 through 10 (no water encountered in #8), respectively. In September 1989, water was measured at depths from 35 to 69.5 feet (elevation 299 to 252.5 feet). During December 1988 and January 1989, ground water was measured at depths of 59 and 53 feet (elevation 270 and 274 feet).

Groundwater elevations measured by Crandall in winter 1988-1989 are similar to those measured by Kovacs in January 2000. Groundwater levels measured by Crandall in September 1989 were about 10 to 20 feet higher, similar to those in Kovacs wells measured in February 2000. All measurements were made during "dry" years, following several years of predominantly below average rainfall. Since water levels fluctuated by 10 to 20 feet during "dry" periods, greater fluctuations (higher

[5] The Miocene Epoch formed part of the upper Tertiary Period and extended from approximately 24 to 5 million years before present.

groundwater levels) would be anticipated during wet or above average rainfall periods. In addition, the presence of perched groundwater in shallow sandy and gravelly zones (less than 30 feet deep) is also likely during wet periods.

Groundwater in the Santa Monica Basin is recharged from percolating precipitation, and from streams originating in the Santa Monica Mountains flowing into the Quaternary alluvial sands and gravels. The interbedded nature of clayey zones in the area would inhibit percolation and vertical migration of surface water, thus allowing groundwater accumulation in shallow perched zones. Urban development now covers much of the land surface with structures and pavement, thus limiting recharge from precipitation.

The Newport-Inglewood fault appears to inhibit recharge from the Central Basin. The Overland fault also appears to form a groundwater barrier, while the groundwater movement is only slightly affected by the Charnock fault. It is possible that groundwater moves between the Santa Monica and Hollywood Basins (DWR, 1961).

Faulting and Seismicity

Faults are fractures or lines of weakness in the earth's crust, along which rocks on one side of the fault are offset relative to the same rocks on the other side of the fault. Sudden movement along a fault results in an earthquake. Faults that allow plates or landmasses to move horizontally past each other are called strike-slip fault zones (e.g. San Andreas, San Jacinto, Elsinore, and Newport-Inglewood). In contrast, mainly vertical movement occurs along normal, reverse and thrust fault zones. Buried low angle thrust faults that do not rupture the surface are known as blind thrusts (Elysian Park and Compton Blind Thrusts). Faults exhibiting both vertical and horizontal movement are oblique faults (e.g. Santa Monica-Hollywood, Cucamonga, Palos Verdes, and Raymond).

Plate tectonics, and the forces that cause these plates to move within the earth's crust, affect geology and seismicity throughout southern California. The San Andreas Fault system forms the boundary between two of these major plates, the North American and Pacific plates. These two plates are in constant motion, with the Pacific Plate moving northwest relative to the North American Plate.

The tectonic regime of southern California is marked by the interaction between two distinct systems of geologically young fault systems, the northwest trending San Andreas Fault System and the west trending faults of the Transverse Ranges. A major bend in the San Andreas fault occurs northwest of Los Angeles. As a result, a major zone of north-south compression exists in the southern California region, creating the mountains within the transverse ranges. The most obvious local features are the Santa Monica and San Gabriel Mountains.

During the past 230 years (1769 to 1999), about 20 notable earthquakes (M6.0 or greater) were recorded in southern California. Six of these events equaled or exceeded M7.0. The two largest earthquakes in the Los Angeles Basin during recent time are the January 1994 M6.7 Northridge and February 1971 M6.6 San Fernando earthquakes.

During Pliocene[6] and Quaternary times, tectonic stresses in the Los Angeles Basin caused compression, resulting in extensive folding and thrust faulting. Destructive compressional

[6] The Pliocene Epoch was the most recent epoch of the Tertiary Period and extended from approximately five to two million years before present.

earthquakes, such as the 1971 San Fernando, 1989 Whittier, and 1994 Northridge earthquakes, along with numerous smaller compressional events, are reminders that active reverse and thrust faulting activity continues. The Elysian Park and other buried blind thrust faults, along with the frontal fault system and other oblique reverse fault zones have a substantial potential to generate large earthquakes in the Los Angeles Basin.

Historic occurrences of strike-slip style earthquakes in the basin are less common, with the 1933 Newport-Inglewood (Long Beach) earthquake being the largest local event. The Whittier-Elsinore, San Andreas, and San Jacinto Fault Zones are strike-slip faults with the potential to generate major earthquakes affecting the region. Strike-slip fault zones caused several major earthquakes felt in southern California during the 1800s.

Several major fault zones and numerous smaller faults are located throughout the Los Angeles region (**Figure V.D-2**). Active or potentially active faults located within 50 miles of the Project site include the San Andreas, Newport-Inglewood, Palos Verdes, Whittier-Elsinore, and San Gabriel Fault Zones, and the Santa Monica-Hollywood-Raymond-Cucamonga, Santa Susana-San Fernando-Sierra Madre, and Elysian Park and Torrance-Wilmington (Compton) Fault Systems.[7] These faults are capable of generating moderate to large damaging earthquakes and associated surface rupture. A major earthquake (Magnitude [M] 7.0 to 7.9) on one of these faults could generate strong to intense ground shaking at the Project site. Historical records indicate that activity on these faults includes surface rupture during historic, Recent (past 11,000 years), and late Quaternary (past 750,000 years) time.

The San Andreas, Newport-Inglewood, San Fernando, Whittier-Elsinore, Cucamonga, Raymond, and part of the San Gabriel fault zones are considered "active", and are designated as fault-rupture hazard zones under the Alquist-Priolo Special Studies Zones Act of 1972.[8] With the exception of the San Gabriel, Whittier-Elsinore, Cucamonga, and Raymond faults, these faults have documented historic surface displacement. The Project site does not lie within an Alquist-Priolo Earthquake Zone. No known fault trace was identified on the site (Kovacs, 2000).

<u>San Andreas Fault Zone</u>

The San Andreas fault zone is located approximately 39 miles northeast of the Project site. Numerous historic earthquakes have occurred along this fault zone. Twelve major earthquakes have been recorded in the Los Angeles region on this fault zone over the last 2,000 years, at intervals ranging from 100 to 200 years and averaging one large event approximately every 132 years (Sieh et al., 1989).

There is a combined 44 percent probability of a M7.5 event occurring along either the Mojave or San Bernardino segments of the San Andreas Fault Zone in southern California during the 30-year period between 1990 and 2020 (Ward and Page, 1990). A M7.5 event would generate strong to very

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7 An active fault is one that has demonstrated offset of Holocene materials (less than 11,000 years ago) or significant seismic activity. Potentially active faults have demonstrated movement within Pleistocene time (approximately 1.6 million years before present). According to the California Department of Conservation, Division of Mines and Geology, active and potentially active faults must be considered as potential sources of fault rupture.

8 Under the Alquist-Priolo Earthquake Fault Zoning Act, the State Geologist is required to delineate earthquake zones along known active faults. Cities or counties affected by the zones must regulate development within the designated zones. Building permits for sites within State-designated zones must be withheld until geologic investigation demonstrates that a proposed development is not threatened by surface displacement from future seismic activity.

Figure V.D-2 Fault Map

strong ground motion in the Los Angeles region. A major or great (M8.0 or larger) earthquake on the San Andreas Fault Zone would produce extended periods of strong ground motion throughout the Los Angeles region.

Newport-Inglewood Structural Zone

The Newport-Inglewood structural zone, located four miles southwest of the Project site, manifests itself as a line of positive topographic features or hills. It is projected to within 2.3 miles of the site (LA County, 1990). Analysts speculate that a deep-seated "master" fault underlies the zone (Toppozada et al., 1988). Continuous seismic activity exists along this zone, and Woodford et al. (1954) suggested as much as 5,000 feet of right lateral offset.

Due to its location in the metropolitan area, the Newport-Inglewood Structural Zone poses one of the greatest seismic hazards to Los Angeles. The impact of a large or major earthquake along this zone has been studied extensively (Evernden and Thomson, 1985; Toppozada et al., 1988, 1989). A major event along this zone will produce strong or intense ground motion at the Project site. Computer modeling of hypothetical M6.5 (Evernden and Thomson, 1985; Ziony et al., 1985) and M7.0 (Toppozada et al., 1989) earthquakes along the northern portion of the zone indicate Modified Mercalli intensities of VIII+ at the site, causing widespread damage to man-made structures.[9]

The Charnock and Overland faults, both considered potentially active, are also in relatively close proximity to the site. These faults parallel the Newport-Inglewood Structural Zone, one to two miles to the west. The closest traces of the Charnock and Overland faults are about 1.4 miles south and 0.9 mile southeast of the site, respectively (LA County, 1990).

Santa Monica-Hollywood-Raymond-Cucamonga Fault System

The Santa Monica-Hollywood-Raymond-Cucamonga fault system is comprised of several individual segments, together known as the frontal fault system. The frontal fault system forms the southern boundary of the Transverse Ranges. Faults within this system have been active within Quaternary and Holocene time (Crook et al., 1987; Hill et al., 1979; Webber, 1980). The most notable recent earthquake along this system near the site is the M5.9 Point Mugu earthquake of February 21, 1973.

Faults within this system are considered capable of producing strong to intense ground motion at the Project site. Analyses by Kovacs (2000) indicate a M6.6 earthquake on the Santa Monica fault could generate peak ground accelerations of 0.768g, causing a Modified Mercalli intensity of XI at the site.

As shown in Figure V.D-2, the Hollywood fault passes within about one mile north of the Project site, while the Santa Monica fault is approximately 0.8 miles south-southeast of the site (LA County, 1990). A more detailed map shows one branch of the Hollywood fault approximately 0.8 mile north of the Project site (Dibblee, 1991).

Hill et al. (1979) conclude that movement occurred along the Santa Monica fault during at least part of the Pleistocene, and that movement during Holocene time cannot be excluded on the basis of present knowledge. Recent micro-seismic activity presents strong evidence that subsurface fault traces within the Santa Monica Fault Zone in the area are actively accumulating and releasing

9 The Modified Mercalli Scale (Roman numerals I-XII) is used to measure the intensity of an earthquake in a particular area. It differs fromthe Richter Scale, which measures the energy released by an earthquake.

tectonic strain (Hill et al., 1979). Based on available data, this fault is classified as potentially active. If a surface scarp identified by Webber et al. (1980) were a surface expression of the Santa Monica fault disrupting Holocene deposits, this fault would be classified as active.

The most active research on faulting in the area is being conducted in association with the Southern California Earthquake Center (SCEC) at the University of Southern California. The SCEC did not have specific information on faults in the immediate vicinity of the Project site, but indicated that studies on the Hollywood fault indicate active faulting is a substantial distance south of the main Hollywood fault (S. Lindvall, personal communication, 1999; T. Rockwell, personal communication, 1999). This suggests that specific fault traces within the Santa Monica-Hollywood fault system should be considered active.

Elysian Park Fold and Thrust Belt

The Elysian Park Fold and Thrust Belt (hereinafter the Elysian Park fault) is deeply buried low angle reverse or thrust fault that underlies the Los Angeles Basin. Its existence onshore, along with other related blind thrust faults, is inferred from the clustering of data from deep earthquakes, from oil well log data, and from geophysical data. Offshore geophysical data also provides evidence for these low angle reverse faults. Biddle (1991) presents a geologic model, showing these low angle reverse faults.[10]

It is inferred that the Elysian Park fault passes beneath the Project site. The Elysian Park fault's possible surface expression is located north and northeast of the site. It follows a line of hills extending from Whittier through Montebello, Elysian Park, the Cahuenga and Sepulveda Passes to Malibu and Point Dume (Reich, 1989). Both the M5.9 Whittier Narrows earthquake of October 1, 1987 and the M4.5 Montebello earthquake of June 12, 1989 resulted from movement on this fault.

It has been postulated that the Elysian Park fault and other related thrust faults are capable of generating earthquakes of M6.5 to M7.5, but the probability of this occurring is unknown. An earthquake of these magnitudes will generate very strong or intense ground motion at the site similar to those experienced during the 1994 M6.7 Northridge earthquake.

Liquefaction and Lateral Spreading Potential

Strong ground motion can cause various types of ground failures, including liquefaction. Liquefaction occurs during extended periods of ground shaking, when pore water pressures increase and water-saturated sediments are temporarily altered from a solid to a liquid state. Liquefaction is most likely to occur in unconsolidated, granular sediments that are water saturated less than 30 feet below the ground surface (Tinsley et al., 1985).

The Project site is located in an area where the depth to groundwater is more than 30 feet (County of Los Angeles, 1990; Tinsley et al., 1985). The City of Los Angeles (1988) and the County of Los Angeles (1990) classify the vicinity of the Project site area as very low liquefaction potential. Based on the relatively dense nature of interbedded sediments underlying the site, moderate depth to groundwater, and findings presented in other studies (Toppozada, et al, 1988; Tinsley et al., 1985), it is concluded that a low potential for liquefaction exists at the Project site. The State Seismic Hazard Map (1999) for the Beverly Hills Quadrangle indicates that the immediate Project vicinity is not susceptible to liquefaction.

10 Biddle, K. T., 1991. "The Los Angeles Basin - An Overview," Active Margin Basins. AAPG Memoir 52.

Lateral spreading is the horizontal displacement of surficial sediments as a result of liquefaction in a subsurface layer. It is most likely to occur where loose, water saturated sandy sedimentary deposits are situated near a free face; such as storm drain channels, sloughs and waterfront areas (Tinsley and Youd, 1985). Lateral spreading can occur in areas with relatively gentle slopes. Since no free face areas are present in the Project vicinity and liquefaction potential is considered low, potential for lateral spreading at the site is very low.

If liquefaction occurs at depth, and slopes are too gentle to permit lateral displacement, ground oscillation is likely to occur. Overlying sediments may oscillate on liquefied sediments underneath, causing damage to structures and sub-grade facilities. The Project site is expected to experience strong to intense ground motion. Due to the nature of sedimentary layer underlying the site, the potential for ground oscillation is considered low.

Landslide and Seismically Induced Slope Failure Potential

The Project site is not immediately adjacent any mountains or steep slopes. It is approximately one mile south of the Santa Monica Mountains. While some geologic formations in some areas of the Santa Monica Mountains exhibit unstable slope conditions, these areas are not near the Project vicinity. Since the mountains are about one mile from the site, it is highly unlikely that a landslide in the Santa Monica Mountains would affect the site. Furthermore, the Project site is virtually flat, sloping less than 2.5 degrees toward the southwest. Slopes of less than ten degrees are usually not subject to landslides. Therefore, the probability of landslides, including seismically induced landslides, is considered very unlikely at the Project site.

Other Geologic Hazards

Flooding

The western half of the Project site is located within a potential flood-inundation hazard area (County of Los Angeles, 1990). It is approximately three miles downstream (south) of Stone Canyon Reservoir. Stone Canyon reservoir is located in the southern part of the Santa Monica Mountains, almost directly north of the Project site, in the hills above Sunset Boulevard. Based on the topographic map of the area (USGS Beverly Hills, CA Quadrangle, 1995), the Stone Canyon Reservoir has a spillway elevation of 847 feet, 507 feet higher than the approximate Project site elevation of 340 feet.

If a dam failure occurred along the reservoir's south side, floodwaters would flow south through Stone Canyon and spread laterally after passing onto the alluvial plain below. Most of the water would flow directly south down the canyon toward the UCLA campus. Examining the topography shown in Figure V.D-2, one can see that floodwaters would spread laterally over the flatter topography in the Village, inundating adjacent areas and possibly including part of the Project site. The flood hazard zone was delineated using a "worst-case" scenario. This assumes an immediate catastrophic release of all stored water while the reservoir is at full capacity. The probability of this scenario is remote. Also, the site is located on the edge of the mapped potential flood inundation area, so only the greatest estimated reservoir failure scenario would affect the site. Given the remote-ness of this possibility, no significant impact is anticipated.

Tsunami, Seiches and Seismically Induced Reservoir Failure

Site elevation, at over 300 feet above mean sea level, and distance from the ocean (over five miles) preclude the potential for tsunami effects. Earthquake shaking can cause standing waves in enclosed water bodies. The sloshing effect can induce reservoir overtopping with possible failure of the reservoir wall. Seismically induced dam failure at the Stone Canyon Reservoir could also result from strong ground shaking alone. In either case, the likelihood and consequences of dam failure would be as described in the flooding section above.

Threshold of Significance

As stated in the LA CEQA Thresholds Guide, a project would normally have a significant Geologic Hazard impact if it would cause or accelerate geologic hazards that would result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Additional threshold considerations, incorporating relevant issues from the current CEQA Appendix G as they pertain to the Proposed Project, are:

- 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;
- Seismic-related ground failure, including liquefaction;
- On- or off-site landslide, lateral spreading, subsidence, expansive or collapsible soil;
- Soil erosion or the loss of topsoil;
- Strong seismic ground motion;
- Flooding due to failure of dams or other water-impounding structures up stream from the site;
- Shallow groundwater; and
- Excavation/cut slope stability.

Project Impacts

Liquefaction, Settlement and Other Surface and Subsurface Soil Conditions

Kovacs (2000) prepared a detailed site-specific geotechnical studies to determine potential adverse subsurface conditions such as liquefaction potential, insufficient load-bearing strength of underlying materials, or presence of expansive soils. Unconsolidated porous materials, such as alluvial deposits, may consolidate and settle when subjected to either static (weight of structures) or dynamic (earthquake shaking) loads. Severe earthquake induced ground shaking can cause liquefaction in loose saturated materials, resulting in substantial surface settlement in areas overlain by heavy structures. Lateral spreading on shallow slopes is also possible when liquefaction prone materials are present. Differential surface movement caused by settling, liquefaction or lateral spreading could damage buildings and other engineered structures. Liquefaction, lateral spreading, settlement, soil collapse, landslides, flooding, soil erosion, and the loss of topsoil are not considered sources of significant impact for the Proposed Project due to (a) the lack of low density sandy liquefaction susceptible soils based on site-specific analysis, (b) the presence of generally compact and clayey soils, (c) negligible slope angle and no evidence of landslides at the Project site; and (d) local drainage conditions and the past disturbance of topsoil that may have existed prior to development in the area. Therefore, it was determined that these factors did not represent a potentially significant impact.

Excavation and Grading

Construction of subterranean parking structures requires excavation and removal of extensive quantities of earth materials. Extensive shoring will be required to stabilize the surrounding properties, utilities, and roadways. This part of the construction process could create potentially adverse conditions with regard to worker safety and stability of surrounding structures. Without proper planning and precautions, excavation and grading could result in a significant impact.

Stability of temporary and permanent cut slopes is determined by performing standard stability calculations based on site-specific geotechnical data. Building codes, grading codes, and engineering investigation report requirements are in place as safeguards for construction workers to prevent unsafe design and construction practices related to surface stability, grading, and unsatisfactory geotechnical and foundation conditions. Kovacs (2000) conducted a geotechnical field exploration and analysis study to define actual geotechnical conditions and shoring design parameters. This study provides several shoring recommendations to limit the impact of excavation and grading for the Proposed Project. A final review of proposed excavation parameters is to be conducted by a qualified geotechnical/shoring specialist to ensure that potential impacts of the Project are mitigated and the stability of surrounding properties, utilities and roadways are adequately maintained.

Seismically Induced Flooding

Failure of the Stone Canyon Reservoir is highly unlikely. However, if it were to fail, part of the Project site and its facilities could be flooded. Depending on the extent of flooding, the subterranean parking levels of the structures and possibly the commercial street level of the structures could be adversely impacted. These levels of the structure would not contain permanent populations, and the residential levels are higher up. An entrance to subterranean parking structure (a residential entrance) is located on the northeastern quarter of the Project site. This would reduce the amount of water flowing directly into the structures in the unlikely event of a reservoir failure. Since the probability of reservoir failure is remote, and the Project site is located on the flood inundation boundary, potential impacts are not considered significant.

Ground Rupture

As discussed in Existing Conditions, above, potentially active branches of the Santa Monica and Hollywood faults are about 0.8 mile from the Project site. Based on current data, Holocene displacement cannot be precluded along these fault zones. Kovacs (2000) concluded in their site study that no known fault traces pass beneath the site. Therefore, based on the Kovacs study ground rupture at the site is unlikely, and no adverse impacts should be anticipated.

The most active research on faulting in the area is being conducted in association with the Southern California Earthquake Center (SCEC) at the University of Southern California. The SCEC website did not have specific information on faults at the Project site, but SCEC investigators have indicated that studies on the Hollywood fault indicate active faulting is a substantial distance south of the main Hollywood fault (S. Lindvall, personal communication, 1999; T. Rockwell, personal communication, 1999). This suggests that specific fault traces within the Santa Monica-Hollywood fault system should be considered active.

Because the site lies between two fault zones that very likely have earthquake and ground rupture potential, there is often a concern that previously unmapped faults may exist that are hidden by existing development and modifications to pre-development topography. Past researchers (e.g., Crook and Proctor, 1992) cite aerial photo data as leading to identification of previously unknown Santa Monica fault traces at University High School and the Veteran's Administration Hospital west-southwest of the site. In addition, other reports (if any exist) for recent major projects in close proximity east and west of the site may provide information regarding the presence or absence of young faulting. However, without specific data and evidence it would be speculation to conclude that faulting may be an issue at the site.

Earthquake Ground Motion

A moderate (M6.0 to 6.9) or major (M7.0 to 7.9) earthquake on a fault in the Project vicinity would generate very strong to intense ground motion at the site. High ground accelerations (1.0g or greater), similar to those measured during the Northridge earthquake, could result from large earthquakes on blind thrust faults passing beneath the Project site. A major or great (M8.0 or larger) earthquake on the San Andreas fault will cause an extended period of strong ground shaking. Either high ground accelerations or extended periods of strong ground shaking can cause extensive damage to engineered structures. Kovacs (2000) analysis indicates an M6.6 earthquake on the Santa Monica fault could generate peak ground accelerations of 0.768g at the Project site, with a Modified Mercalli intensity of XI. The potential for severe damage resulting from strong to intense ground motion would be considered a significant adverse impact.

Shallow Groundwater

Limited long-term site-specific information is available for groundwater underlying the Project site. Based on available data, it is assumed that depth to groundwater in the general area is normally greater than 30 feet. If present, groundwater close to the surface can create many problems. It is possible that groundwater could reach less than 30 feet from the surface during extreme "wet" periods. Above average rainfall can occur every two to five years. Wet periods (multiple years) of above-average rainfall occur about every ten to fifteen years. Therefore, the site should expect groundwater elevations higher than those measured by Kovacs (2000) multiple times during the Project life. The magnitude of high groundwater cannot be precisely determined based on current data.

Groundwater levels could affect construction of the Project. Construction of the subterranean parking structure would require excavation down to 55 feet below the surface. Since water levels were measured at depths ranging from 35 to 45 feet below the surface, de-watering may be required during construction. De-watering would temporarily lower groundwater levels and without proper mitigation, may cause local subsidence/settlement. Final geotechnical design refinements will need to meet all City requirements in this regard.

The subterranean parking structures would not result in a significant impact on groundwater levels locally or regionally. These structures are not likely to encounter groundwater on an annual basis, and if so, will not displace large volumes of groundwater or cause water levels to rise. The groundwater volumes found during site testing indicated that very little draw-down area would be generating by dewatering. Depending upon the actual groundwater depth during "wet" periods, the lower level(s) of the subterranean parking structure could reach groundwater and water could enter the parking structure if proper mitigation measures are not employed. A significant impact would result if no mitigation measures were provided to deal with the potential "wet" periods when groundwater might rise to a level such that it would enter the parking structure.

Excavation, Grading, and Cut-Slope Stability

Construction of subterranean parking structures requires excavation and removal of 330,000 cubic yards of earth materials. This part of the construction process could create potentially adverse conditions with regard to worker safety and stability of surrounding structures, if proper precautions are not taken. Proper design and code compliance is required to assure that excavation and grading will not result in significant impacts. Such design and mitigation must include proper shoring to stabilize the proposed structure, and surrounding properties, utilities, and roadways.

Settlement and Other Subsurface Conditions

Kovacs (2000) prepared a detailed site-specific geotechnical studies to determine potential adverse subsurface conditions such as insufficient load-bearing strength of underlying materials, liquefaction potential, or presence of expansive soils. Unconsolidated porous materials, such as alluvial deposits, may consolidate and settle when subjected to either static (weight of structures) or dynamic (earthquake shaking) loads. Severe earthquake induced ground shaking can cause liquefaction, resulting in substantial surface settlement in areas overlain by heavy structures. Lateral spreading on shallow slopes is also possible when liquefaction prone materials are present. Differential surface movement caused by settling, liquefaction or lateral spreading could damage buildings and other engineered structures. The potential for damage resulting from these factors was addressed by Kovacs (2000), and it was determined that these factors did not represent a potentially significant impact.

Mitigation Measures

Applicant Proposed Project-Specific Mitigations and City Regulations

A Project-specific geotechnical and engineering geology study was conducted at the site (Kovacs, 2000). Such studies are necessary to comply with the City of Los Angeles Municipal Code, including building and grading regulations. Properly conducted studies provide the necessary data, analysis, and recommendations for design and construction of the Project. For purposes of mitigating potentially adverse geology and soil impacts, earthquake design for high ground motions is a very important aspect of this Project, due to its high occupancy. Kovacs (2000) conducted an engineering geologic and geotechnical evaluation of the site to determine applicable ground motion parameters. Because the estimated future ground motions are very strong to severe, for what would be a rare event, particular attention should be paid to aspects of the design dependent upon this parameter. Long-term site-specific information on groundwater depth beneath the site is limited. The Project would have potentially significant impacts with regard to excavation, seismicity and shallow groundwater prior to mitigation; the following mitigation measures/regulations shall apply to the Project to reduce impacts to less than significant.

1. The Project shall comply with all the requirements of the City of Los Angeles Building Code and recommendations of the site-specific soils and geology studies for excavation activities, including appropriate seismic requirements, dewatering requirements, and shoring requirements, as reviewed and approved by the City of Los Angeles Bureau of Engineering or Department of Building and Safety. Dewatering analysis must consider mitigation of settlement to neighboring structures.
2. Remaining on-site water level monitoring wells should be measured to confirm expected groundwater depths for purposes of confirming planned excavations, shoring, dewatering, and permanent drainage/pumping requirements. The Project Applicant shall coordinate with the City of Los Angeles Bureau of Engineering and Building and Safety on design to assure that substantial building inundation would not occur in the event of high groundwater during "wet" periods.
3. The Project shall comply with the National Pollutants Discharge Elimination System Permit regulations for the short and long-term discharge of groundwater from the site.
4. Excavation and grading activities shall be scheduled during dry weather periods. If grading occurs during the rainy season (October 15 through April 1), construct diversion dikes to channel runoff around the site. Line channels with grass or roughened pavement to reduce runoff velocity.

5. Incorporate appropriate erosion control and drainage devices to the satisfaction of the Building and Safety Department shall be incorporated, such as interceptor terraces, berms, "vee-channels", and inlet and outlet structures, as specified by Section 91.7013 of the Building Code, including planting fast-growing annual and perennial grasses in areas where construction is not immediately planned. These will shield and bind the soil.
6. Stockpiles and excavated soil shall be covered with secured tarps or plastic sheeting.

Significant Project Impacts After Mitigation

Based on City standard of acceptable risk reflected in the City of Los Angeles Building Code and the performance review procedures of the Bureau of Engineering and Building and Safety, no significant Project impacts would remain after implementation of the Project mitigation measures.

Cumulative Impacts

The Project is not located adjacent or close enough to any of the related projects to compound any of the potential engineering geology or geotechnical impacts from development. Further, all related projects would require municipal government approvals of grading plans, design, and the imposition of mitigation measures where needed. Significant cumulative grading and geotechnical impacts resulting from the potentially concurrent construction of the related projects are not anticipated.

The proposed and related projects would be subject to potentially severe ground motion during a severe earthquake. Assuming adherence to the building codes and other locally imposed plans, cumulative seismic impacts would be reduced, but not eliminated. Related projects would not be exposed to a greater than normal seismic risk than other areas in Southern California. To the degree that these projects bring together a greater concentration of people, the immediate post-earthquake evacuation and assistance will be more difficult. However, related projects should not significantly compound the specific effects that could occur on the Project site. Therefore, cumulative geology, soils, and seismic impacts should not be considered significant.