4.8 GEOLOGY AND SOILS

This section describes the existing geology and soils conditions in the project area, potential environmental impacts, recommended mitigation measures to help reduce or avoid impacts and the level of significance of project impacts after mitigation. The information and analysis in this section was summarized from the *Preliminary Geotechnical Investigation Report* (PGIR) (Leighton and Associates, Inc., 2007). The complete PGIR is included in Appendix H of this EIR.

4.8.1 EXISTING CONDITIONS

4.8.1.1 Regional Setting

The East Area 1 Specific Plan (Specific Plan) project site is located within the Transverse Ranges physiographic province of California. This geomorphic province is characterized by an east-west trending geologic grain, meaning that its primary faults, folds, mountains and valleys are all aligned in an east-west direction. The Transverse Ranges are a tectonically active region, with high rates of uplift, folding and sedimentation. This deformation is driven by north-south compression associated with interaction of the North American Plate and the Pacific Plate. This convergence has caused folding and faulting in the rock units and overlying sediments in the region.

4.8.1.2 Local Setting

The project site is on the north side of the Santa Clara River Valley, which is a deep synclinal[1] trough with a very thick sequence of Plio-Pleistocene sediments that were deposited contemporaneously with regional folding. The project site is also on the northern limb of the Santa Clara Syncline. The Santa Clara Syncline is truncated by the Oak Ridge Fault to the south and the San Cayetano Fault to the north.

4.8.1.3 Site Conditions

The project site is generally bounded by the Santa Clara River on the south (approximately 3,000 feet), Haun Creek on the east, Santa Paula Creek on the west, and the foothills of the Topatopa Mountains on the north. The topography of the site ranges from relatively flat or gentle sloping in the south to rugged in the northern portion of the project site. The on-site elevations range from 300 feet above mean sea level (amsl) in the south to 800 feet amsl in the north or an elevation difference of approximately 500 feet.

4.8.1.4 Subsurface Conditions

The subsurface of the project site consists of surficial deposits underlain by the bedrock of the Saugus Formation. The bedrock of the Saugus Formation generally strikes to the east-northeast consistently and dips toward the southeast at angles ranging from 27 to 65 degrees. Dip angles on-site become shallower towards the south. North of the project site, progressively older strata of the Las Posas Sand, Pico, Sisquoc Shale, and Monterey Formations are progressively tilted, folded, and overturned until the stratigraphic section is cut off by the San Cayetano fault (Dibblee, 1990).

The Saugus Formation is overlain by surficial deposits including colluvium, shallow debris flow and landslide deposits, alluvium, and older alluvium. The older alluvium generally appears to dip at shallow angles toward the southeast, south of the hills located in the northern part of the project site. Thicknesses of older alluvium of approximately 50 feet were encountered in orchard areas in the south eastern part of

[1] Note: *Syncline*- Basin- or trough-shaped fold in rock in which rock layers are downwardly convex. The youngest rock layers form the core of the fold and outward from the core progressively older rocks occur.

the project site during the geotechnical site exploration. These deposits scour and onlap onto the Saugus Formation unconformably.

Alluvium derived from the Santa Paula Creek, Haun Creek, and smaller canyons in between is deposited on top of both older alluvium and the Saugus Formation. Approximately 20 feet of alluvium deposited on top of Saugus Formation bedrock was encountered in the western part of the project site. In areas close to Hahn Creek, the thicknesses of alluvium and older alluvium exceed 50 feet.

Other surficial units mapped on-site include uncertified fill, colluvium, landslide, and debris flow deposits (see Appendix H, Plate 1 of this EIR for the location of all soil units mapped on-site).

4.8.1.5 Groundwater

Modified maps from California Geological Survey (CGS, 2002) show estimated historically shallowest groundwater depths (i.e., historical high groundwater levels) in the Santa Paula vicinity. These data suggest historically shallowest groundwater depths of greater than forty feet below the ground surface (bgs) for the project site. California Department of Water Resources (2007) well data notes three wells on the project site. The water table in the subject property is at a depth of approximately 20 to 40 feet. The main sources of water for irrigation are three on-site water wells. Well No. 4 was drilled in 1968 as is located near the existing barn on-site (3N/21W-2R2) and well No. 6, drilled in 1988 located north of the farm structures (3N/21W-1N2). These wells supply water for both domestic consumption and agriculture irrigation uses. At the time each of these wells was drilled, they were capable of 1,200 gallons per minute (gpm) and 2,500 gpm, respectively. A third well is located on the Newsom Ranch property (3N/21W-11AO1); the drilling of the well was completed on February 18, 1969, and it is an agricultural irrigation well. There is no well history or production data available for this well. The well at the center of the project site near the intersection of Padre Lane and Loop Road has a historic depth to ground water high of 45.1 feet bgs. The two other wells on-site are closer to Santa Paula Creek and are located within orchards. These wells have historic high ground water levels of 65.7 and 75.2 feet bgs. However, investigative geologic sampling conducted as part of the PGIR indicated that groundwater was encountered as high as 21 feet bgs near the central part of the project site. Also, groundwater was discovered between 28 and 39 feet in the vicinity of Hahn Creek. If subsurface conditions include shallow fine-grained layers, then perched groundwater may be encountered at even shallower depths.

4.8.1.6 Faulting and Seismicity

<u>Faults</u>[2]

Fault rupture hazards occur when regional earth movements change the surface configuration of the earth. The movement may be in response to an earthquake (seismically induced) or without any earthshaking (aseismic). These vertical or horizontal changes in the earth can damage structures, utilities, and transportation corridors. Fault rupture/displacement may also alter natural drainage and ground water flow direction. The Alquist-Priolo Earthquake Fault Zoning Act[3] was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy.

[2] Note: *Fault* - A fracture or a zone of fractures along which there has been displacement of the sides relative to one another parallel to the fracture.

[3] The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.

The project site is not located within a defined Alquist-Priolo Earthquake Zone[4] (CGS, 1998). Alquist-Priolo Earthquake Zones are defined as zones which delineate areas of known active faults,[5] as defined by the State of California. However, several zoned active faults are delineated near the project site. Approximately three-quarters of a mile south of the project site is the Oak Ridge fault, which is a south-dipping reverse fault[6]. Other known active faults located north of the project site include (from south to north) the Orcutt, Timber Canyon, Sissar, and San Cayetano faults (Dibblee, 1990 and 1992). Several smaller unnamed secondary faults have been mapped between the larger fault systems. These smaller faults accommodate a fraction of the regional strain relative to the primary faults.

The San Cayetano and Oak Ridge faults to the north and south of the project site, respectively, are the most important controlling faults in the project region. The Oak Ridge fault is an active, mostly south-dipping reverse fault that trends to the northeast along the south side of the Santa Clara River Valley (CGS, 2002a). The San Cayetano fault is an active north-dipping reverse fault that trends east to west. Several secondary active normal and reverse faults associated with folding of the Santa Clara syncline are to the south of the San Cayetano fault (CGS, 2003a). These features have been mapped as short strands approximately two to ten miles in length. These faults are relatively short compared to the Oak Ridge and San Cayetano faults which are mapped as laterally continuous strands that extend for tens of miles (CGS, 2003a; Dibblee, 1990, 1992). Eight unnamed secondary faults cut Holocene alluvial fan deposits located in Orcutt and Timber Canyons to the northeast of the project site.

The Ventura County Geographic Information System website identifies a fault east of the site that trends along the southernmost foothills of Santa Paula Ridge toward the site, but ends east of Haun Creek. The source documents for the Ventura County Geographic Information System website (Gay, 1975) depicts the same feature (an inferred fault) to trend across the site (VCGIS, 2004; Gay, 1975). Subsurface investigation of the fault was included in the PGIR (see Appendix H of this EIR) of this previously mapped fault did not confirm the existence of the purported feature onsite (Leighton and Associates, Inc., 2007).

Seismicity

Ground shaking (i.e., cyclic earth movements) results from the sudden motions in the earth (earthquake) caused by the abrupt release of slowly accumulated strain energy. Earthquakes occur primarily along faults or folds in areas undergoing active deformation. The motion of each earthquake is characterized by a unique set of body, longitudinal, and transverse waves. These waves can cause damage to structures, utilities and transportation corridors; cause landslides, rockfalls and embankment failures and induce liquefaction failure in certain cohesionless soils.

As noted above, there are several active faults located within close proximity of the project site and which could affect the proposed project. These active faults are shown in Table 4.8-1.

[4] Note: Earthquake Fault Zones are regulatory zones around active faults. The zones are defined by turning points connected by straight lines. Most of the turning points are identified by roads, drainages, and other features on the ground. Earthquake Fault Zones are plotted on topographic maps at a scale of 1 inch equals 2,000 feet. The zones vary in width, but average about one-quarter mile wide.
[5] Note: *Active Fault* - A fault which has had demonstrated ground surface displacement within Holocene time (the past 11,000 years) and which is considered capable of experiencing movement in response to future earthquakes.
[6] Note: *Reverse Fault*- A type of fault formed when the hanging wall fault block moves up along a fault surface relative to the footwall. Such movement can occur in areas where the Earth's crust is compressed. A thrust fault, sometimes called an overthrust if the displacement is particularly great, is a reverse fault in which the fault plane has a shallow dip, typically much less than 45°.

TABLE 4.8-1
FAULTS

FAULT	MAXIMUM MOMENT MAGNITUDE	APPROXIMATE DISTANCE FROM THE PROJECT SITE (IN KILOMETERS)
Oak Ridge	7.0	1.1
Simi-Santa Rosa	7.0	5.0
San Cayetano	7.0	7.0
Ventura – Pitas Point	6.9	9.1
Mission Ridge-Arroyo Parida-Santa Ana	7.2	16.2
Santa Ynez, East	7.1	17.3
Channel Islands Thrust	7.5	22.1
Anacapa-Dume	7.5	22.9
Orcutt*	**	1.5
Timber Canyon	**	3.2
Sissar	6.8	5.5

Sources:

Blake, T. F., 2000, FRISPKSP, A Computer Program for the Probabilistic Estimation of Peak Acceleration and Uniform Hazard Spectra Using 3-D Faults as Earthquake Sources, Version 4.00.

Dibblee, Jr., T.W., 1992a, Geologic Map of the Santa Paula Quadrangle, Ventura County, California, Dibblee Foundation Map #DF-41, Scale of 1 inch to 2,000 feet.

Dibblee, Jr., T.W., 1992b, Geologic Map of the Santa Paula Peak Quadrangle, Ventura County, California, Dibblee Foundation Map #DF-26, Scale of 1 inch to 2,000 feet.

California Division of Mines and Geology (CDMG), 2000, Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Southern region: DMG CD 2000-003.

*An unnamed strand the Ocutt-Timer Canyon fault is located within approximately 1.3 kilometers of the site according to CDMG, 2000.

**Orcutt and Timber Canyon faults are not considered to be significant seismogenic faults.

4.8.1.7 Geohazards

Liquefaction

Liquefaction is the phenomena whereby strong, cyclic ground motions during an earthquake transform a soil mass from a solid to a liquid state. The process involves densification and pore pressure increases in a saturated soil mass. The occurrence of liquefaction is dependent upon the strength and duration of ground shaking, the depth to saturated soil, and local soil properties. It most readily occurs in loose, Holocene-age soil with a near-surface groundwater table. Five types of ground failure are commonly associated with liquefaction: 1) loss of bearing, 2) flow failure, 3) lateral spreading, 4) ground oscillation, and 5) sand boils.

According to the CGS's Seismic Hazards Reports Seismic Hazard Maps for the Santa Paula and Santa Paula Peak (CGS, 2002a, 2002b, 2003a, and 2003b) quadrangles, the project site is not within a State of California zone for potential liquefaction hazard. However, the subsurface explorations in the eastern part of the project site found relatively low N-values[7] (from Standard Penetration Test (SPT) in the

[7] N-value is related to SPT and is equivalent to the number of blows required to penetrate a vertical foot at 60% energy.

hollow-stem-auger borings) and low tip resistances (from the cone penetrometer test (CPT) soundings). These are indicative of potential liquefaction in loose sands. It should be noted, though, that the soil layers within which these low values occur appear to be sufficiently clayey to not be susceptible to liquefaction. Therefore, the potential for liquefaction affecting the project site is considered to be low based on the subsurface exploration data and test results provided in the PGIR for the project site.

Subsidence

Subsidence is a general term for the slow, long-term regional lowering of the ground surface with respect to sea level. It can be caused by natural forces such as the consolidation of recently deposited sediments or by man-induced changes such as the withdrawal of oil field fluids or the dewatering of an aquifer. Subsidence occurs as a gradual change over a considerable distance (miles) or, less commonly, it can occur in discrete zones.

There are three active water wells contained on-site which are used for irrigation and potable water. There are no active oil wells contained on-site. As noted above, withdrawal of oil fluids or dewatering of an aquifer can result in subsidence. The analysis contained within the geotechnical report indicates that the project site is not experiencing and/or contributing to local or county-wide subsidence.

Expansive Soils

Expansive soils are primarily clay-rich soils subject to changes in volume with changes in moisture content. The resultant shrinking and swelling of soils can influence all fixed structures, utilities and roadways. Included within the definition of expansive soils are certain bedrock formations with expansive rock strata and weathered horizons.

All of the soils tested fall into the low to very low range for expansion potential, as shown in Table 4.8-2. The samples tested had an Expansion Index of between 4 and 36. Accordingly, the potential for expansive soils detrimentally impacting the site is considered to be low.

TABLE 4.8-2
EXPANSION INDEX AND EXPANSION POTENTIAL

EXPANSION INDEX	EXPANSION POTENTIAL
0 – 20	Very Low
21 – 50	Low
51 – 90	Medium
90 – 130	High
Above 130	Very High

Seismically Induced Settlement

Seismically induced settlement is expected to occur at the project site due to the presence of some loose granular soils encountered onsite. In the western part of the project site, soil tests indicate that the seismically induced settlement is expected to be negligible. However, in the eastern part of the project site, up to several inches of seismically induced settlement may occur in the event of strong ground shaking at the project site.

Slope Instability and Erosion

Landslide and mudflow are terms used to designate certain forms of natural or man-induced slope instability that may adversely influence life or property. Included are a number of different processes that range from very slow (a few inches in a hundred years) to extremely rapid (70 or more miles per hour). Included within the definition of this hazard are all gravity-induced downslope movements including the separate phenomena of rockfall, soil creep, soil failures, dry raveling, rotational and transitional slides, flows, slumps and complex combinations of the above phenomena. The hazard applies to both natural and constructed slopes. Contributing factors include erosion, earthquake ground shaking, brush fires, and groundwater.

The north and northwestern parts of the project site border hillsides that are identified by the CGS as requiring investigation to address the potential for seismically-induced landslides (CGS, 2002b; 2003b). Preliminary slope stability analyses indicate that slopes within the northwest portion of the project site do not meet the required minimum factor of safety of 1.5[8] for habitable structures planned within their zone of influence. Portions of slopes in these areas are considered to be grossly and surficially unstable. Landslides and surficial failures observed on-site substantiate the potential for slope instability in these areas.

Erosion is the wearing away or deposition of land surface by wind or water. Erosion occurs naturally from weather or runoff, but can be intensified by land clearing practices. The northern portion of the site exhibits evidence of erosion. These conditions are most readily apparent within the minor canyons and hillsides contained within the northern portion of the site. In addition, some topsoil loss occurs on-site due to sheet flow from precipitation events. However, this amount is minor since the existing agricultural operations and on-site plant communities assist in soil retention.

4.8.2 THRESHOLDS OF SIGNIFICANCE

Based upon the thresholds contained in Appendix G of the CEQA Guidelines, the proposed project would have a significant impact on the environment if it would:

- Exposes people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning map issued by the State Geologist from the area or based on other substantial evidence of a known fault.
  - Strong seismic ground shaking.
  - Seismic related ground failure, including liquefaction.
  - Landslides.
- Results in substantial soil erosion or the loss of topsoil.
- Is located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in an off-site landslide, lateral spreading, subsidence liquefaction or collapse.
- Is located on expansive soil as defined in Table 18-1-B of the Uniform Building Code (1994) creating substantial risk to life or property.

[8] The ratio of available resistance to demand load (driving force).

4.8.3 METHODOLOGY RELATED TO GEOLOGY AND SOILS

A field reconnaissance was performed to observe the current project site conditions and layout exploration locations.

Field exploration was performed to evaluate and analyze subsurface conditions on-site. The approximate exploration locations are shown in the PGIR (see Plate 1) contained in Appendix H of this EIR. The field explorations were performed between January 18, 2006 and January 4, 2007. Explorations included the following:

- Excavation of twelve hollow-stem auger borings.
- Three mud-rotary borings.
- Eight backhoe trenches.
- Four bucket-auger borings.
- Six Cone Penetration Test (CPT) soundings.
- One excavator trench.
- All borings were backfilled with materials generated during their excavation and tamped per standard practice.
- Trenches were backfilled with materials generated during their excavation.
- Boring samples were obtained by driving a Modified California Split-Spoon Sampler, with a 3.0-inch outside diameter, into the bottom of the boring as it was being incrementally advanced. The barrel of the sampler was lined with six 1-inch-high by 2.41-inch-inside-diameter sampling rings. The rings containing undisturbed samples were placed in plastic cans and labeled.
- Bulk samples were placed in plastic bags.
- Standard Penetration Tests (SPT) were performed in each of the hollow stem auger borings. The SPTs were preformed in accordance with the American Society for Testing and Materials (ASTM) D1586 Test Method. Samples from the SPT sampler were placed in plastic bags.
- All samples were transported to a laboratory for analysis.

Materials encountered during excavations were visually logged under the supervision of a Certified Engineering Geologist.

Details regarding field exploration methods and logs of the drill holes and CPTs are included in the PGIR (see Appendix H of this EIR).

Laboratory testing was performed to classify earth material types and assess engineering properties. The laboratory performed a visual classification of soils, in-situ dry density and moisture content, particle size analysis, one-dimensional swell or settlement, consolidation, direct shear, maximum dry density and optimum moisture content, expansion index, and soil corrosivity tests. These test methods and the test results are provided in the PGIR (see Appendix H of this EIR).

4.8.4 POTENTIAL IMPACTS

4.8.4.1 Faulting and Seismicity

Faults

The analysis contained within the PGIR determined that the project site is not located within an Alquist-Priolo Earthquake Fault Zone and therefore, the potential for fault rupture was considered negligible. In addition, the PGIR also concluded that none of the faults contained within Table 4.8-1 cross the project site or would not generate earthquakes of a sufficient magnitude to cause ground rupture on the project site. Therefore, no significant impacts to the proposed project related to earthquake fault rupture would occur.

Seismicity

The project site is located within southern California, a seismically active region capable of generating earthquakes (including groundshaking) of considerable magnitude. As noted in Table 4.8-1, there are active faults located within close proximity of the project site and which are capable of generating a maximum moment magnitude earthquake of 6.8 or greater. Movement along these faults could generate an earthquake capable of causing damage to buildings and infrastructure located on-site, although similar risks would exist for adjacent areas. The California Building Code requires that structures built in the State be constructed to address the seismic nature of the region. In addition, there are other safety considerations (Alquist-Priolo Earthquake Fault Zone) required to be evaluated before a structure can be built. As such, the implementation of the proposed project would not expose residents to unknown safety issues associated with seismicity (including groundshaking). Therefore, impacts to the proposed project from seismicity (including groundshaking) are less than significant.

4.8.4.2 Geohazards

Liquefaction

The PGIR determined that groundwater depths of 21 to 39 feet bgs exist on-site. However, the PGIR did also note that perched groundwater could be encountered on-site at even shallower levels if subsurface conditions included shallow fine-grained layers. Although the analysis indicated that the SPTs and CPT sounding in the eastern part of the site yielded results indicative of liquefaction in clean sands due to low N values, these soils are sufficiently clayey and as such, would not be susceptible to liquefaction. Therefore, implementation of the proposed project would result in less than significant impacts related to hazards associated with liquefaction.

Subsidence

The proposed project would entail the construction of five water wells (including reserve) for use in providing potable water and fire suppression to the project site. A total of 1,174.4 to 1,359.2 acre feet per year (AFY)[9] of water would be withdrawn from these wells for potable and non-potable uses. The proposed project would also include the construction of a recycled water system designed to irrigate landscape and park areas contained on-site. At present, the City does not have a recycled water system in place. However, during the interim, potable water will be used until recycled water is available. A total of 197.6 AFY of potable water would be dispersed via the on-site distribution system until recycled water is available. The PGIR determined that use of the on-site water wells would not (due to the quantity of withdrawal) affect the Santa Paula or Fillmore Groundwater Basins resulting in regional and/or localized subsidence. Therefore, the implementation of the proposed project would not result in significant impacts related to subsidence.

Expansive Soils

The PGIR determined that highly expansive soils are not anticipated to be encountered within the project site. However, soils derived from the siltstone and claystone units of the Saugus Formation bedrock (which are isolated) may be sufficiently expansive (medium to very high) to be of concern. This could

[9] Note: Information derived from the Water Supply and Verification for the East Area 1 Specific Plan, November 2007.

include topsoil, debris flow deposits, landslide, or fill from that source. It should be noted though that the only location onsite that these soils could be encountered is along the steep slopes or bluffs facing Santa Paula Creek adjacent to and outside of the proposed project in the hills to the north. In addition, as discussed in the PGIR (see Plate 1) a Preliminary Setback zone has been established for this portion of the project site and as such, no habitable structures would be constructed. Therefore, implementation of the proposed project would not result in the construction of structures within soils that are known to be highly or even medium expansive and as such, no significant impacts would result.

Seismically Induced Settlement

The analysis contained within the PGIR concluded that seismically induced settlement is expected to occur within portions of the project site. In the western parts of the project site, the seismically induced settlement is expected to be negligible. However, the eastern parts of the project site may experience up to several inches of seismically induced settlement in the event of strong ground motion. Therefore, implementation of the proposed project would result in an adverse and significant impact related to seismically induced settlement.

Slope Instability and Erosion

The PGIR noted that the north and northwestern parts of the project site border hillsides that have the potential to result in seismically-induced landslides. Moreover, the preliminary slope stability analyses performed as part of the PGIR indicates that slopes near the northwest part of the project site may result in seismically induced landslides due to their existing slope safety factor (i.e., 1.5). However, to address these safety issues the PGIR identified a Preliminary Setback zone along the western and northern portions of the project site (see Appendix H, Plate 1 of this EIR) which precludes the construction of habitable structures within this area of the project site. It should be noted though that the western and northern portions of the project site, respectively are designated by the Specific Plan as Open Space and Agricultural Preserve. These areas would be accessible to area residents for walking and hiking. The proximity of people to an area known to potentially be susceptible to seismically induced landslides could expose these persons to substantial risks. Therefore, implementation of the proposed project could result in significant adverse impacts related to exposure of people to seismically induced landslides.

As noted previously, the northern portion of the site exhibits both weather and runoff erosion. Implementation of the proposed project would not affect these areas since no modifications are planned. These areas would remain as Open Space and Agricultural Preserve (as currently designated by the Specific Plan).

Development of the remainder of the project site would include construction of urban land uses and associated stormwater conveyance facilities, thereby reducing the potential for erosion occurring on-site. As such, implementation of the proposed project would result in less than significant impacts related to substantial soil erosion.

The loss of topsoil within the northern portion of the project site would continue occur under normal conditions during precipitation events since this area is not proposed for development. The remainder of the project site would be converted from agriculture to urban uses and may require topsoil removal as part of geotechnical remediation. In addition, the conversion of this area to urban land uses would permanently remove the existing topsoil from use, since it would be covered by roadways and other non-agricultural uses. Since the amount of topsoil available within adjacent areas and regionally is considerable, the loss of the existing topsoil on-site would not result in an adverse significant impact.

4.8.5 MITIGATION MEASURES

The following mitigation measures were developed to avoid or minimize the potential impacts on the proposed project related to geology and soils**.**

G-1 Additional explorations must be performed at the tentative tract map and grading plan review stages of the development planning. The purpose of the explorations would be to establish required removal depths and delineate the transition from the finer-grained soils in the eastern portion of the project site deemed susceptible to seismically-induced settlement to the rocky soils of the western part where the soils are not deemed vulnerable to seismically-induced settlement.

G-2 Additional explorations (deep bucket auger borings or continuous core drilling) of the slope and ridgelines above the planned Santa Paula Creek neighborhood (Unit A) should be performed at the tentative tract map stage in order to verify their susceptibility to landslides, mudflows, and seismically-induced instability.

G-3 To the greatest extent possible, equipment that can penetrate very boulder-rich strata should be used for the exploratory drilling.

G-4 To aid in planning and to provide data for use in analyses, water level monitoring wells should be installed at the project site. At least four monitoring wells, one well in each quadrant of the project site, should be installed. The wells should extend to at least 60 feet bgs and should be protected with vaults. The wells should be installed as soon as possible and monitored at least monthly until the basic water level patterns have been determined and at least quarterly thereafter for assessment of yearly trends.

G-5 Within the northwest corner of the project site, below the slope that faces west toward Santa Paula Creek, habitable or essential service structures should not be planned within the "Preliminary Setback" zone depicted on Plate 1 of the Preliminary Geotechnical Investigation Report or the adjacent slopes. The setback line is based on the location of the toe of an imaginary slope composed of same materials as the existing slope and having a static factor of safety of at least 1.5 and a pseudo-static factor of safety of at least 1.1.

G-6 Water should not be allowed to pond or accumulate anywhere on the project site except in designated detention or debris basins. Pad drainage should be designed to collect and direct surface water away from structures to approved drainage facilities.

G-7 Detention basins or debris basins should be incorporated into the project design below canyon areas.

G-8 Grading at the project site should consist of removal and replacement of the upper on-site soils and placement of compacted fill. Over excavation of the upper soils should be performed to provide support for foundations, floor slabs, and paving. Backfills will be required for utilities, walls, and foundations.

G-9 Field investigations indicate that a significant amount of oversized material (boulders) would be encountered during grading. Oversize materials (generally greater than 8 inches; refer to "Material for Fill" below) can cause problems with utility trenching and foundations for structures. The presence of the oversize materials may make it prudent to over excavate areas where utilities and other subsurface construction will occur. The need for processing and special handling of oversized materials (i.e., screening, crushing, or disposal of) should be considered.

G-10 Project site preparation should include the following:

- Removal of existing vegetation and debris from the project site.
- Over excavation of the upper soils to remove soils disturbed by past site uses and demolition activities.
- Additional over excavation to allow placement of compacted fill beneath the proposed building foundations. For preliminary planning purposes, the over excavation should be expected to extend at least 5 feet below the existing grade or as required to allow placement of at least 3 feet of compacted fill beneath the proposed building foundations. The over excavation should extend beyond the building footings in plan view at least a distance equal to the thickness of the fill underlying the footings, but no less than 5 feet. Deeper removals should be made where obviously unsuitable materials are encountered.
- Generally, to provide suitable soils for support of the proposed paving, at least the upper 2 feet of the soils in those areas should be excavated. The over excavation should extend at least 2 feet beyond the paved areas in plan. However, for roads under the jurisdiction of the California Department of Transportation (Caltrans), the over excavation should comply with the Caltrans requirements. Deeper removals should be made where obviously unsuitable materials are encountered.
- To facilitate installation of utilities, including storm drains, the on-site materials should be over excavated to at least one-half of the diameter/width of the utility or I-foot, whichever is deeper, below the proposed invert of the utilities. The excavated materials should be replaced with soils containing materials less than 3 inches in size with no more than 25 percent larger than 1½ inches in size. The over excavation should extend in plan view 1 foot beyond the utility or one-half the depth of the over excavation, whichever is greater.

G-11 Required fill soils should be placed in accordance with the following recommendations:

- The fill soils should be placed in loose layers that do not exceed 8 inches in thickness per layer. Each layer should be spread evenly and thoroughly mixed during spreading to promote uniformity of the materials and moisture content.
- The moisture content of the fill soils at the time of compaction should be brought to approximately 110 percent to 120 percent of optimum moisture content. The moisture content should be uniform throughout the soils.
- Fill soils should be mechanically compacted to at least 90 percent of their maximum dry density as determined by the ASTM Designation D1557 Method of Soil Compaction.
- Flooding should not be permitted. For Caltrans roads, the upper 2~ feet of the sub grade soils should be compacted to at least 95 percent.
- The placement and compaction of fill materials should be under the continuous observation of the Geotechnical Consultant.

G-12 The on-site soils, less debris or organic matter, may be used in required fills and backfills. Soils with an expansion index of 30 or higher should not be used within 5 feet of the sub grade beneath floor slabs. The expansion index of the upper fill soils should be checked prior to and at the completion of grading. Some of the on-site clay soils are expansive and their placement in fills beneath buildings, flatwork, pools, and other structures should be avoided.

G-13 Generally, rocks larger than 8 inches in greatest dimension should not be placed in fills. However, in deeper (approximately 15- foot deep) fills, rocks up to 12 inches in size may be placed in the deeper portions of the fills in accordance with specific recommendations. Rocks larger than 4 inches in greatest dimension should not be placed in utility backfills. Gravel and cobbles incorporated into fills should be thoroughly mixed into the soil, and should not be clumped or segregated in heaps. Observations of the materials at the project site indicate a significant amount of oversize material should be expected to require processing for use in compacted fills.

G-14 Approximately 15 percent to 20 percent shrinkage of the upper, approximately 5 feet, soils should be expected when they are over excavated and replaced as compacted fill. Crushing of oversize materials will cause apparent bulking that is not considered in the quoted shrinkage value. Shrinkage value should be revised to accommodate the crushing of oversize material.

G-15 Manufactured permanent slopes should be inclined at 2: 1 or flatter.

G-16 The reworking of the upper soils and the compaction of all required fill and backfill should be observed and tested during placement by the Geotechnical Consultant of Record.

G-17 The governmental agencies having jurisdiction over the project should be notified before commencement of grading so that the necessary grading permits can be obtained and arrangements made for the required inspection or inspections.

G-18 Provided that the soils loosened by clearing of the project site, together with over excavation and recompacted of the upper soils, it is expected that low- to relatively light mid-rise buildings in the western portion of the project site may be supported on conventional shallow footings underlain by compacted fill. In the eastern portion of the project site, the low-rise buildings may be supported on post-tensioned slabs or mat-type foundations. More detailed recommendations should be developed at the completion of additional explorations and testing.

G-19 It is expected that taller or relatively heavy buildings or structures in the western portion of the project site can be supported on conventional shallow footings. In the eastern portion of the project site, building specific investigations should be performed and project specific recommendations developed.

G-20 As with foundations, provided that the soils loosened by clearing of the project site, together with over excavation and recompacted of the upper soils, it is expected that floor slabs in the western portions of the project site may be supported on-grade. If desired, post-tensioned floor slabs may be used for these structures. Floor slabs beneath indoor living spaces, as opposed to garages or patios, in all areas of the project site should be underlain by a vapor retarder or barrier.

G-21 Under the Earthquake Design regulations of Chapter 16, Divisions IV and V of the 2001 edition of the California Building Code (CBC), the following coefficients and factors apply to lateral-force design for structures at the project site:

SEISMIC COEFFICIENTS

Seismic Zone, Z	0.4
Soil Profile Type	S_C
Near-Source Factor N_a	1.3
Near-Source Factor N_v	1.6
Seismic Coefficient C_a	0.57
Seismic Coefficient C_v	1.02
Period T_o*	0.14
Period T_s*	0.72

Source: Leighton & Associates, 2007.
*Use with Figure 16-3 of the CBC.

Fault Type	Nearest Fault	Distance (km)	Magnitude
A	San Andreas (1857 Rupture)	52	7.8
B	Oak Ridge	1.5	7.0

Source: Leighton & Associates, 2007.

4.8.6 LEVEL OF SIGNIFICANCE AFTER MITIGATION

With implementation of the mitigation measures provided above, the potential for impacts to the proposed project related to geology and soils would be less than significant.