2.5 Geology and Soils

The following section provides a Project-level geologic analysis for the proposed Project and describes the existing geologic and soil conditions, evaluates the potential geologic and soils-related impacts that may result from Project implementation, and identifies feasible mitigation measures. The primary source of the information contained in this section is the Geotechnical Investigation, Otay Ranch Resort Village Area A Tentative Map, **Appendix C-6** to this EIR; Geotechnical Investigation, Otay Ranch Resort Village Area B Tentative Map, **Appendix C-7** to this EIR; and the Geotechnical Investigation, Otay Lakes Road Widening and Realignment, **Appendix C-8** to this EIR.

In 1993, the Otay Ranch PEIR was adopted and provided a program-level analysis of the existing conditions, potential impacts, and mitigation measures related to geology and soils for the entire Otay Ranch area, including the Project site. The Plan addressed by the Otay Ranch PEIR included a Town Center land use designation adjacent to Otay Lakes Road that envisioned locating a resort hotel overlooking Lower Otay ~~Lake~~Reservoir, but at a much lower elevation than the Resort site proposed by the current Project. The PEIR concluded that the potential geologic and soils-related impacts could be mitigated to below a level of significance with incorporation of site-specific mitigation measures into the design and construction of the Project.

2.5.1 Existing Conditions

2.5.1.1 Geologic Setting

Regionally, the Project site lies in the western region of the Peninsular Range Geomorphic Province, which extends approximately from the Imperial Valley to the Pacific Ocean and from the Transverse Ranges to the north and into Baja California to the south~~.~~. More specifically, the Project site lies within the transition area between the foothills of the Peninsular Range, the coastal plain of San Diego County, and northwestern Baja California. The stratigraphy of the coastal plain of San Diego County and northwestern Baja California consists of a thick sequence of relatively undisturbed Upper Cretaceous, Eocene, Oligocene, Miocene, Pliocene, and Pleistocene sedimentary rocks underlain by Peninsular Range batholith and pre-batholith rocks.

The Project site is on the Santa Ana structural block, which extends southeast from the central Transverse Ranges to beyond the United States/Mexico border region. The Santa Monica–Raymond fault forms the approximate northern boundary of the Santa Ana block. In southern California, the Newport–Inglewood–Rose Canyon and Whittier-Elsinore fault systems form the southwest and northeast boundaries of the Santa Ana block.

Bedrock units underlying the Project site include metavolcanic rock (formerly known as the Santiago Peak Volcanics) and fanglomerate deposits (mapped as a lower facies of the Otay Formation), while surficial units underlying the Project site include alluvial deposits, colluvium, topsoil, and undocumented artificial fill. The metavolcanic rocks underlying the Project site display a strong northwest-trending structural grain across the Project site. The main structural grain is cross-cut by northwest- and northeast-trending joint systems. The geologic structure of the fanglomerate deposits at the site is characterized by a gentle southwest dip. The contact between the fanglomerate and underlying metavolcanic bedrock generally slopes down to the west and south.

Based on a review of published literature and geologic maps, the Project site is not located on any known active, potentially active, or inactive fault traces. In addition, the Project site lacks landslide features, and there is no evidence of previous landslides occurring on or adjacent to the Project site.

In June 2001, a field investigation was conducted and found surface water within one small, human-made reservoir within the southern-central portion of the Project site and within a drainage north of, and adjacent to, Otay Lakes Road in the southern-central portion of the Project site. Subsurface water was found only at the base of the canyon near Otay Lakes Road. No static groundwater table was encountered during exploratory excavations performed in 2008 and 2010 in connection with the Geocon geotechnical investigations; however, small diameter borings by Geocon in Otay Lakes Road encountered perched groundwater or seepage in areas near the drainages that pass beneath the road. The field investigation performed for the project site included geologic mapping and the excavation of 17 large-diameter borings, 48 excavator trenches, 71 trackhoe trenches, 22 air track borings, and 18 seismic refraction survey lines.

Due to the steep terrain and localized areas of large boulder outcrops in the northern and eastern portions of the property, the potential hazard for future rock fall is a consideration for development. The natural slopes were evaluated for their potential rock fall impact to proposed development by performing detailed field mapping of the rock slopes. The purpose of the mapping was to categorize the risk of rock fall by assigning a risk factor of low, medium, or high to the existing slopes. A low risk is defined as having no potential impact to proposed development and mitigation will not be required. A medium risk is defined as having some potential impact to proposed development and mitigation may be required. A high risk is an area that rock fall is eminent and significant mitigation will be required. The site has been classified as having both low and medium risk; however, no areas were observed that would be classified as having high risk.

A Rock Fall Hazard Map has been provided in **Figure 2.5-1**. The map indicates areas of development that encroach into the medium risk rock fall areas. The areas are located on the northwestern and eastern portions of the site. Mitigation measures will be required along portions of the edge of grading when cut slopes or daylight cuts encroach within the medium risk zone. Mitigation measures will not be required when fill slopes are constructed at the edge of grading that encroach into the medium risk zone as the fill slope provides a manufactured mitigation barrier to the adjacent development.

Both the surficial and global stability of the proposed slope configurations were evaluated based on the current geologic information. The portions of the site planned for development are generally underlain by Quaternary-age surficial soil, Tertiary-age Otay Formation and Fanglomerate Deposits, and Jurassic- to Cretaceous-age Metavolcanic Rock. The unit most likely to be subject to slope instability is the claystone portion of the Otay Formation, encountered at several locations throughout the site. The stability of graded slopes composed of Metavolcanic Rock is highly dependent on the degree of weathering and the geologic structure of the slope face. Slope stability analyses using the two-dimensional computer program *GeoStudio2007* created by Geo-Slope

International Ltd. are presented in **Appendices C-6** and **C-7**. The proposed slopes should be stable from shallow sloughing conditions provided the recommendations for grading and drainage are incorporated into the design and construction of the proposed slopes.

In general, permanent, graded fill slopes or cut slopes excavated within the sedimentary formational materials at the site with gradients of 2:1 (horizontal to vertical) or flatter would possess Factors of Safety of 1.5 or greater. However, stability fill construction may be required during grading operations if claystone beds are encountered on proposed cut slopes. The majority of rock cut slopes should be composed of *good quality* (Hoek and Bray 1981), moderately strong to very strong Metavolcanic Rock. Based on the results of slope stability analyses, slopes composed of moderately to slightly weathered rock should possess Factors of Safety of 1.5 or greater against large-scale, deep-seated slope failures at their present and proposed slope inclinations. Graded slopes in metavolcanic rock should possess Factors of Safety of 1.5 or greater at an inclination of 1.5:1 (horizontal to vertical) or flatter.

Kinematic analyses of the proposed 1.5:1 (horizontal to vertical) rock cut slopes were performed along a representative geologic cross-section using structural data obtained during field exploration, structural data presented by Neblett & Associates (2004), and structural orientations mapped by the California Geologic Survey (2002). The purpose of a kinematic analysis is to evaluate the critical discontinuities within a rock mass that may result in failures of the rock slope based on geologic structure and slope geometry. Rockpack III (2003) was used to create a stereonet of the dip vectors (dips and dip directions) of the discontinuities within the rock mass. Based on the results of the stereonet analysis, Markland's Tests for kinematically possible failures were performed on the data set. The resulting kinematic stereonet with the Markland's Test results are presented in **Appendices C-6** and **C-7**. An angle of internal friction of 20 degrees was used for the Markland's Tests based on parameters for gouge-filled shears (Afrouz 1992). The Markland's Test results indicate that localized minor hazards due to wedge and toppling failures may exist along portions of the proposed slopes where discontinuities intersect the slope face. The majority of cut slopes within moderately strong to very strong metavolcanic rock should not be subject to localized failures at the proposed slope inclinations. In areas where loose or potentially hazardous rock is encountered during grading, the loose material should be scaled off the slope face to mitigate the hazard.

Because of the potential presence of adverse geologic structures, the geologic structure of permanent cut slopes composed of Metavolcanic Rock should be analyzed in detail by an engineering geologist during the grading operations. Additional recommendations for slope stabilization may be necessary if adverse geologic structure is encountered. Grading of cut and fill slopes and intermediate terrace benching should be designed in accordance with the requirements of the local building codes or the 2013 CBC.

2.5.1.2 Regulatory Setting

Development of the proposed Project is subject to a number of regulatory requirements and industry standards related to potential geologic and soil hazards. These guidelines typically involve measures to evaluate risk and mitigate potential hazards through design and construction techniques. Specific guidelines encompassing geologic and soil criteria that may be applicable to the design and construction of the proposed Project include the Chapter 5, Safety Element, of the County General Plan; the County Watershed Protection, Storm Water Management and Discharge Control Ordinance (Storm Water Ordinance, Nos. 9424 and 9426) and associated Storm Water Standards Manual; Title 8, Division 7 (Excavation and Grading), and Title 5, Division 1 (Amendments to the State Building Standards Code) of the San Diego County Code of Regulatory Ordinances; the International Conference of Building Officials (ICBO) Uniform Building Code (UBC) and related CBC standards; the Greenbook Committee of Standard Specifications for Public Works Projects, 2003 (Greenbook); and the National Pollutant Discharge Elimination System (NPDES) General Construction Activity and General Groundwater Extraction permits (NPDES Nos. CAS000002 and CAG919002, respectively). Summary descriptions of these guidelines are provided below.

County Standards

The San Diego County General Plan Safety Element identifies and evaluates geological and seismic hazards in San Diego County and provides policy direction that supports laws and regulations related to safety hazards as well as policies that support the guiding principles of the General Plan. Specifically, Guiding Principle 5 of the County General Plan provides direction for the Safety Element to ensure that development accounts for physical constraints and the natural hazards of the land. The following Goals and Policies of the Safety Element are relevant to the Project:

GOAL S-7

Reduced Seismic Hazards. Minimize personal injury and property damage resulting from seismic hazards.

Policies

S-7.1 Development Location. Locate development in areas where the risk to people or resources is minimized. In accordance with the California Department of Conservation Special Publication 42, require development be located a minimum of 50 feet from active or potentially active faults, unless an alternative setback distance is approved based on geologic analysis and feasible engineering design measures adequate to demonstrate that the fault rupture hazard would be avoided.

S-7.2 Engineering Measures to Reduce Risk. Require all development to include engineering measures to reduce risk in accordance with the California Building Code, Uniform Building Code, and other seismic and geologic hazard safety standards, including design and construction standards that regulate land use in areas known to have or potentially have significant seismic and/or other geologic hazards.

GOAL S-8

Reduced Landslide, Mudslide, and Rock Fall Hazards. Minimize personal injury and property damage caused by mudslides, landslides, or rock falls.

Policies

S-8.1 Landslide Risks. Direct development away from areas with high landslide, mudslide, or rock fall potential when engineering solutions have been determined by the County to be infeasible.

S-8.2 Risk of Slope Instability. Prohibit development from causing or contributing to slope instability.

Among other requirements, the County Storm Water Ordinance/Storm Water Standards Manual requires construction-related BMPs to address issues such as erosion and sedimentation. The County may (at its discretion) require the submittal and approval of a Storm Water Pollution Prevention Plan (SWPPP) to address construction-related storm water issues prior to site development. The submittal and approval of a SWPPP under County guidelines would be in addition to similar SWPPP requirements under NPDES guidelines, as described below.

The County Excavation and Grading requirements are implemented through issuance of grading permits, which apply to most projects involving more than 200 cubic yards (cy) of material movement (e.g., grading and excavation). Specific requirements for "Major Grading" include, among other criteria, use of qualified engineering and geotechnical consultants to design and implement grading plans, implementation of appropriate measures related to issues such as manufactured slope design and construction, and conformance with erosion and storm water control requirements.

County Building Code standards related to geotechnical concerns include applicable portions of the UBC, with specific County amendments. Implemented through issuance of building permits, CBC requirements related to geotechnical concerns address preparation of soils reports and implementation of structural loading and drainage criteria.

<u>Uniform Building Code and Greenbook Standards</u>

The UBC and Greenbook standards are produced through joint efforts by industry groups, such as ICBO and the American Public Works Association, to provide standard specifications for engineering and construction activities, including measures to address geologic and soil issues. Specifically, these measures encompass issues such as seismic parameters (e.g., classifying seismic zones and faults), engineered fill specifications (e.g., compaction and moisture content), expansive soil characteristics, and pavement design. The referenced guidelines, while not being formal requirements, are widely accepted by regulatory authorities and are routinely included in standards such as municipal grading codes. The UBC and Greenbook guidelines are regularly updated to reflect current industry standards and practices. The previously noted CBC guidelines are derived from the UBC and encompass criteria specific to California, including geologic and seismic characteristics.

2.5.2 Analysis of Project Effects and Determination as to Significance

The following significance guidelines are based on the County of San Diego Guidelines for Determining Significance, Geologic Hazards approved by DPLU on July 30, 2007. A significant geology and soils impact would occur if the Project would do the following:

- Propose any building or structure to be used for human occupancy over or within 50 feet of the trace of an Alquist-Priolo fault or County Special Study Zone fault.
- Propose the following uses within an Alquist-Priolo Zone, which are prohibited by the County:
  - Uses containing structures with a capacity of 300 people or more. Any use having the capacity to serve, house, entertain, or otherwise accommodate 300 or more persons at any one time.
  - Uses with the potential to severely damage the environment or cause major loss of life. Any use having the potential to severely damage the environment or cause major loss of life if destroyed, such as dams, reservoirs, petroleum storage facilities, and electrical power plants powered by nuclear reactors.
  - Specific civic uses. Police and fire stations, schools, hospitals, rest homes, nursing homes, and emergency communication facilities.
- Be located within a County Near-Source Shaking Zone or within Seismic Zone 4 and the Project does not conform to the UBC.
- Has the potential to expose people or structures to substantial adverse effects because:
  - the Project site has potentially liquefiable soils; and
  - the potentially liquefiable soils are saturated or have the potential to become saturated; and
  - in-situ soil densities are not sufficiently high to preclude liquefaction.
- Expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving landslides.
- Be located on a geologic unit or soil that is unstable, or would become unstable as a result of the project, potentially resulting in an on- or off-site landslide.
- Be located directly below or on a known area subject to rock fall that could result in collapse of structures.
- Be located on expansive soil, as defined in **Table 18-1-B** of the UBC (1994), and does not conform with the UBC.

2.5.2.1 Fault Rupture

Guidelines for the Determination of Significance

A significant geology and soils impact would occur if the Project would do the following:

- Propose any building or structure to be used for human occupancy to be within 50 feet of the trace of an Alquist-Priolo fault or County Special Study Zone fault.
- Propose the following uses within an Alquist-Priolo Zone, which are prohibited by the County:
    - Uses containing structures with a capacity of 300 people or more. Any use having the capacity to serve, house, entertain, or otherwise accommodate 300 or more persons at any one time.
    - Uses with the potential to severely damage the environment or cause major loss of life. Any use having the potential to severely damage the environment or cause major loss of life if destroyed, such as dams, reservoirs, petroleum storage facilities, and electrical power plants powered by nuclear reactors.
    - Specific civic uses. Police and fire stations, schools, hospitals, rest homes, nursing homes, and emergency communication facilities.

Rationale for Selection of Guidelines

The significance thresholds for fault rupture are based on the County of San Diego Guidelines for Determining Significance, Geologic Hazards (County of San Diego 2007d). The Guidelines require evaluation of the Project's proximity to an Alquist-Priolo fault and/or County Special Study Zone fault, and is included to avoid human-occupied structures from being unsafely located in the above or in the immediate vicinity of a known fault. The Guidelines are also used to evaluate risk to human life and the environment by specifically considering uses that facilitate congregation of large groups of people or facilities that provide a vital service to the community.

Analysis

No known earthquake faults are located on the Project site as depicted on the most recent Alquist-Priolo Earthquake Fault Zoning Map. The Project site also does not contain any County Special Study Zone faults. A review of published literature and site mapping analysis conducted for the Project site did not reveal any known, active, or inactive faults directly underlying, or in proximity to, the Project site. The Rose Canyon and Newport-Inglewood fault zones, each located approximately 14 miles away, are the closest known active faults to the Project site. The next-closest known faults are the Coronado Bank and Palos Verde Connected fault zones, located approximately 22 miles away. Consequently, while the potential for on-site ground rupture cannot be completely discounted, the probability for these types of effects is considered ***less than significant*** and no mitigation is required.

As described above, the Project site is not located within an Alquist-Priolo Zone. For this reason, implementation of the Project would not place prohibited structures or uses within an Alquist-Priolo Zone. ***No significant impact*** would result and no mitigation is required.

2.5.2.2 Ground Shaking

Guideline for the Determination of Significance

A significant geology and soils impact would occur if the Project would do the following:

- Be located within a County Near-Source Shaking Zone or within Seismic Zone 4 and the Project does not conform to the UBC.

Rationale for Selection of Guidelines

The significance threshold for seismic ground shaking is based on the County of San Diego Guidelines for Determining Significance, Geologic Hazards (County of San Diego 2007d). This guideline is included to require evaluation of project safety and conformance with construction design standards in consideration of the strong seismic shaking that could occur throughout all areas of San Diego County.

Analysis

The Project site is not located within any areas identified as a County Near-Source Shaking Zone, which are predominately located along the Elsinore and San Jacinto fault zones in the eastern portions of the County, approximately 35 miles northeast of the Project site. The entire San Diego County geographic region, including the Project site, is within Seismic Zone 4 and is subject to ground shaking. A seismic evaluation of the Project site was conducted to assess the seismic hazard risks and to provide seismic design criteria, as required by Chapter 16 of the UBC (1997). This analysis produced peak ground acceleration and UBC seismic design coefficient values for the Project site. The seismic design coefficient values are presented in **Appendices C-6,** C-**7,** and **C-8**. Based on the information provided in these reports, the Project site is unlikely to be exposed to fault rupture. Construction in conformance to the UBC and compliance with any additional site-specific requirements described in the Project's Geotechnical Reports (**Appendices C-6,** C-**7,** and **C-8**), would result in ***less than significant impacts*** due to ground shaking.

2.5.2.3 Liquefaction

Guideline for the Determination of Significance

There would be a significant geology and soils impact if the Project would do following:

- Have the potential to expose people or structures to substantial adverse effects because:
  - the Project site has potentially liquefiable soils; and
  - the potentially liquefiable soils are saturated or have the potential to become saturated; and

- o in-situ soil densities are not sufficiently high to preclude liquefaction.

Rationale for Selection of Guidelines

The significance threshold for liquefaction is based on the County of San Diego Guidelines for Determining Significance, Geologic Hazards (County of San Diego 2007d). This guideline addresses liquefaction hazards that may exist on a project site and the potential safety risks that could result if structures were located on liquefiable soils.

Analysis

Liquefaction hazards are commonly associated with uncompacted, saturated or nearly saturated, noncohesive, sandy and silty soils. Subsurface exploration and field mapping revealed that the soil and alluvium at the Project site are generally shallow, unsaturated, fine- to coarse-grained clayey sand and silty sand, with abundant gravels, cobbles, and boulders. Much of the surficial materials located on the Project site are cohesive due to clay content and are generally considered to have a very low potential for liquefaction due to the lack of near-surface permanent groundwater within 50 feet of the proposed grade and the dense nature of the compacted fill and formational materials.

Subsurface water, within alluvial materials, was found only at the base of the canyon near Otay Lakes Road and no static groundwater table was encountered during exploratory excavations. Thus, the groundwater table most likely exists at lower elevations in the main drainages adjacent to Lower Otay ~~Lake~~Reservoir. The elevation of the groundwater table in the lower drainages is most likely correlative to the water level in Lower Otay ~~Lake~~ Reservoir during most of the year, and on-site soils are unlikely to become saturated.

Since the soil and alluvium will be removed and re-compacted as engineered fill within the proposed grading limits of the Project site, the potential for in-situ soil liquefaction within the proposed grading limits of the Project site is considered low. In addition, the Project site and vicinity are not within or adjacent to any County Liquefaction Hazard Zones (SanGIS 2006[13]). Therefore, impacts related to adverse effects due to liquefaction are considered ***less than significant*** and no mitigation is required.

2.5.2.4 Landslides

Guidelines for the Determination of Significance

A significant geology and soils impact would occur if the Project would do the following:

- Expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving landslides.
- Be located on a geologic unit or soil that is unstable, or would become unstable as a result of the project, potentially resulting in an on- or off-site landslide.

[13] See www.sangis.org, Interactive Mapping, Geologic Hazards.

- Be located directly below or on a known area subject to rock fall that could result in collapse of structures.

Rationale for Selection of Guidelines

The significance thresholds for landslides are based on the County of San Diego Guidelines for Determining Significance, Geologic Hazards (County of San Diego 2007d). Guideline "a" evaluates the hazard to humans or structures based on the potential for landslides in the project area. Guideline "b" addresses the potential for development of the project to create a landside hazard. Guideline "c" addresses the potential for adverse effects that may result if development is located below or on a known rock fall area.

Analysis

The Landslide Susceptibility map of the County General Plan Safety Element does not show the Project site to be within a "high" or "moderate" landslide susceptibility designation (County of San Diego 2011a). In addition, a review of published literature, site mapping, aerial photo analysis, and subsurface exploration revealed no evidence of previous landslides on or adjacent to the Project site. The lack of landslide features indicates that the Project site has been relatively stable in the recent geologic past, and has not been subject to earthquake-induced, large-scale landsliding. However, proposed grading could cause unstable slopes overlying the claystone units within the fanglomerate deposits, Otay Formation, and metavolcanic rocks. Therefore, while earthquake-induced large-scale landsliding is considered unlikely, the potential for landsliding due to unstable graded slopes, is considered a ***potentially significant Project impact*** (**Impact GE-1**).

Surficial boulders and rocky outcrops exist on the peripheral natural slopes above proposed development at the Project site and pose a potential rock fall hazard. These areas identified as "Medium Rock Fall Hazard" are shown in **Figure 2.5-1**. Additionally, on-site metavolcanic rocks have the potential for local rock fall in cut slope or steep natural areas because they are foliated, jointed, and fractured. This is considered a ***potentially significant Project impact*** (**Impact GE-2**).

2.5.2.5 Expansive Soils

Guidelines for the Determination of Significance

A significant geology and soils impact would occur if the Project would do the following:

- Be located on expansive soil, as defined in **Table 18-1-B** of the UBC (1994), and does not conform with the UBC.

Rationale for Selection of Guidelines

The significance threshold for expansive soil hazards is based on the County of San Diego Guidelines for Determining Significance, Geologic Hazards (County of San Diego 2007d). This guideline addresses conformance to the UBC's Expansive Soil Standards for construction on soils with high shrink/swell behavior, which are present throughout San Diego County.

<u>Analysis</u>

The geologic conditions present on the Project site have the potential for surficial instability due to expansive soils. The majority of the geologic units on the Project site likely possess a very low to medium expansion potential. However, some geologic units, including topsoil, colluvium, alluvium, and the claystone beds within the Otay Formation, fanglomerate deposits, and highly weathered metavolcanic rock may include highly expansive soils. Grading that may expose these expansive materials near the finish grade near building pads or public rights-of-way would be a potentially significant Project impact. However, the Project would conform to all UBC requirements to safely construct on expansive soils and would comply with the recommendations and requirements included in the Geotechnical Reports (**Appendices C-6, C-7,** and **C-8**). Recommendations to be followed include undercutting of lots, and street, curb and gutter, and sidewalk subgrade where highly expansive soil is exposed or located near grade. Therefore, with conformance with the UBC and requirements in the geotechnical reports, impacts from expansive soils are considered to be ***less than significant***.

Proposed grading may expose claystone layers (considered highly expansive) within cut slopes which could cause unstable slopes. This issue is considered a slope stability issue and is addressed in Section 2.5.2.4.

2.5.3 Cumulative Impact Analysis

The geographic scope for cumulative impacts related to geology and soils includes the unincorporated portions of San Diego County and the City of Chula Vista bounded by I-805 to the west, Main Street to the south, Campo Road to the east, and SR-54 to the north. Past, present, and reasonably anticipated future projects identified for the region are discussed in Section 1.7 of this EIR. Many of the projects described in Section 1.7 have, or would, convert undeveloped land to urban uses, resulting in population increases. The FEIR for the County General Plan Update (County of San Diego 2011) determined that direct and cumulative impacts to geology and soils would be less than significant based on existing requirements to comply with all relevant federal, state, and local regulations and building standards, including the California Building Code and County-required geotechnical reconnaissance reports and investigations.

The previously adopted Otay Ranch PEIR provided a comprehensive assessment of the cumulative impacts related to geology and soils for the entire Otay Ranch area. This cumulative impacts analysis, found in Section 6 of the Otay Ranch PEIR, is incorporated by reference in this EIR. The Otay Ranch PEIR determined that a significant cumulative effect would result from an increase in population and property that would be exposed to the effects of seismic ground shaking from local active faults, such as the Rose Canyon and Coronado Bank faults. The PEIR determined that construction in accordance with the UBC and site-specific geologic investigations to identify feasible mitigation measures would reduce the impact to a less than significant level.

The level of seismic activity within these areas and exposure of people or structures to risk of loss, injury, or death would be similar to that of the proposed Project. As cumulative projects are constructed, more people and structures will be exposed to seismic hazards due to earthquakes and other geotechnical constraints, such as expansive soils and landslides. All development within these areas will be required to be constructed to withstand probable seismic forces, including seismic-related fault rupture and ground shaking, ground failure/liquefaction, landslides, erosion, surficial instability, and expansive soils. Adherence to site-specific geotechnical recommendations, building codes, and applicable grading ordinances would reduce potential cumulative geotechnical impacts to a ***less than significant level***.

In addition, as noted below, all Project-specific geotechnical impacts would be avoided or reduced below identified significance thresholds through conformance with the mitigation measures proposed in Section 2.5.5 and through conformance with geotechnical recommendations in **Appendices C-6**, **C-7**, and **C-8** and established regulatory requirements. As stated above, the previously certified PEIR determined that feasible mitigation measures would reduce cumulative geology and soils impacts ***less than significant levels***.

In addition, issues such as seismic ground acceleration and liquefaction, and non-seismic expansive/reactive soils, drainage, and other conditions represent effects to the proposed development and are specific to on-site conditions. Accordingly, addressing these potential hazards for the proposed development involves using measures to conform with existing requirements, and/or site-specific design and construction efforts that have no relationship to, or impact on, off-site areas. Avoiding liquefaction impacts through excavation/replacement of susceptible surficial deposits would not affect similar deposits/hazards in off-site areas. Because of the site-specific nature of these potential hazards and the measures to address them, there is no connection to similar potential issues or cumulative effects to or from other properties. Therefore, cumulative impacts related to geology and soils are considered ***less than significant***.

2.5.4 Significance of Impacts Prior to Mitigation

The following significant impacts were identified in the analysis of the Project's effects related to geologic and soil hazards:

Impact Number	Description of Project's Effect	Significance of Impact
GE-1	Potential for unstable slopes.	Potentially significant direct impact.
GE-2	Potential for rock fall hazards on cut and natural slopes.	Potentially significant direct impact.

2.5.5 Mitigation

The following mitigation measures would be implemented in compliance with the Conclusions and Recommendations of the Project Geotechnical Reports (**Appendices C-6, C-7, and C-8**):

2.5.5.1 Unstable Slopes

M-GE-1a Otay Lakes Road, Widening & Realignment (**Appendix C-8**): Excavations of cut slopes shall be observed during grading by an engineering geologist to evaluate whether the soil and geologic conditions differ significantly from those expected. Cut slopes that expose shared claystone bedding may require slope stabilization consisting of stability fills. These stabilization measures shall be implemented if determined necessary by the engineering geologist.

M-GE-1b Area A and B, Tentative Map (**Appendices C-6** and **C-7**): Because of the potential presence of adverse geologic structures, the geologic structure of permanent cut slopes composed of Otay Formation, Fanglomerate materials, or metavolcanic rock shall be analyzed in detail by an engineering geologist during grading operations. Grading of cut and fill slopes and intermediate terrace benching shall be designed in accordance with the requirements of the local building codes and the 2010 California Building Code (CBC). Additional recommendations for slope stabilization may be necessary if adverse geologic structure is encountered. Mitigation of unstable cut slopes can be achieved by the use of drained stability fills. In addition, cut slopes exposing cohesionless surficial deposits or rock slopes with unfavorable geologic structure may require stability fills. In general, the Typical Stability Fill Detail presented in Figure 10 (**Appendices C-6** and **C-7**) should be used for design and construction of stability fills, where required. The backcut for stability fills should commence at least 10 feet from the top of the proposed finished-graded slope and should extend at least 3 feet into formational materials. For slopes that exceed 30 feet in height, the inclination of the backcut may be flattened as determined by the engineering geologist during grading operations.

M-GE-1c Area A and B Tentative Map (**Appendix C-6** and **C-7**): Because of the potential presence of adverse geologic structures, the geologic structure of permanent cut slopes composed of Metavolcanic Rock should be analyzed in detail by an engineering geologist during the grading operations. The use of drained stability fills and rock slope stabilization measures such as rock bolting, or rockfall protection systems shall be implemented if adverse geologic structure is encountered.

2.5.5.2 Rock Fall Hazards

M-GE-2a Otay Lakes Road, Widening & Realignment (**Appendix C-8**): Mitigation measures will be required along the eastern portion of the roadway due to the steepness of the natural slopes and boulder outcrops above the proposed cut slope. The areas of proposed rock fall mitigation are shown on **Figures 2.5-2A** and **2.5-2B.** The mitigation shall consist of the construction of a rock fall debris fence or other acceptable catchment device at the toe of the proposed cut slope. The hard rock slopes should be evaluated by an engineering geologist during site development and final locations of the debris fence or alternative method shall be provided at that time.

M-GE-2b Area A and Area B, Tentative Map (**Appendices C-6** and **C-7**): Mitigation shall consist of the construction of rock fall debris fences or other acceptable catchment device at the toe of proposed slopes or at the edge of daylight cut or fill areas. The area of proposed rock fall mitigation for Area A is shown on **Figure 2.5-2A** and Area B on **Figure 2.5-2B**. Area A consists of the northernmost section of proposed residential development, east of Upper Otay ~~Lake~~Reservoir, and the northern section of Lower Otay ~~Lake~~Reservoir. Area B encompasses the easternmost section of proposed residential development and resort. The hard rock slopes shall be evaluated by an engineering geologist during site development and final locations of the debris fences or alternative method shall be provided at that time.

M-GE-2c Area A and Area B, Tentative Map (**Appendices C-6** and **C-7**): Hard rock slopes shall be analyzed in detail by an engineering geologist during the grading operations. In areas where loose or potentially hazardous rock is encountered during grading, the loose material shall be scaled off the slope face to mitigate the hazard. If adverse geologic structures are encountered during grading, rock slope stabilization measures such as rock bolting, or rock fall protection systems may be necessary.

M-GE-2d ~~When all measures to mitigate rock fall hazards have been provided, a professional opinion from an engineering geologist shall be provided that indicates that the potential risk for rock fall hazards to impact the proposed development would be less than significant with the mitigation measures that were implemented.~~At the time of final design the geotechnical engineer shall certify that all mitigation measures provided to reduce the level of significance of rock fall hazards have been implemented. ~~It should also be stated that with mitigation measures incorporated, the proposed development is considered safe for human occupancy.~~

2.5.6 Conclusion

Potential geologic hazards related to fault rupture were found to be less than significant, as the Project would not place prohibited structures or uses within an Alquist-Priolo Zone or any other known fault. Potential ground shaking impacts and expansive soils impacts are considered less than significant because the Project would conform to the UBC and would also follow any additional site-specific requirements described in the Project’s geotechnical reports. Potential geologic hazards due to liquefaction were found to be less than significant per the significance guidelines, as the soil and alluvium would be removed and re-compacted as engineered fill within the proposed grading limits and the Project site is not within or adjacent to any County Liquefaction Hazard Zones.

Implementation of Mitigation Measure **M-GE-1** would require monitoring during grading operations at the project site by an engineering geologist, and implementation of any stabilization measures determined necessary at that time. This would avoid potential impacts from slope instability (**GE-1**) and would reduce the impact related to unstable slopes to a ***less than significant level***.

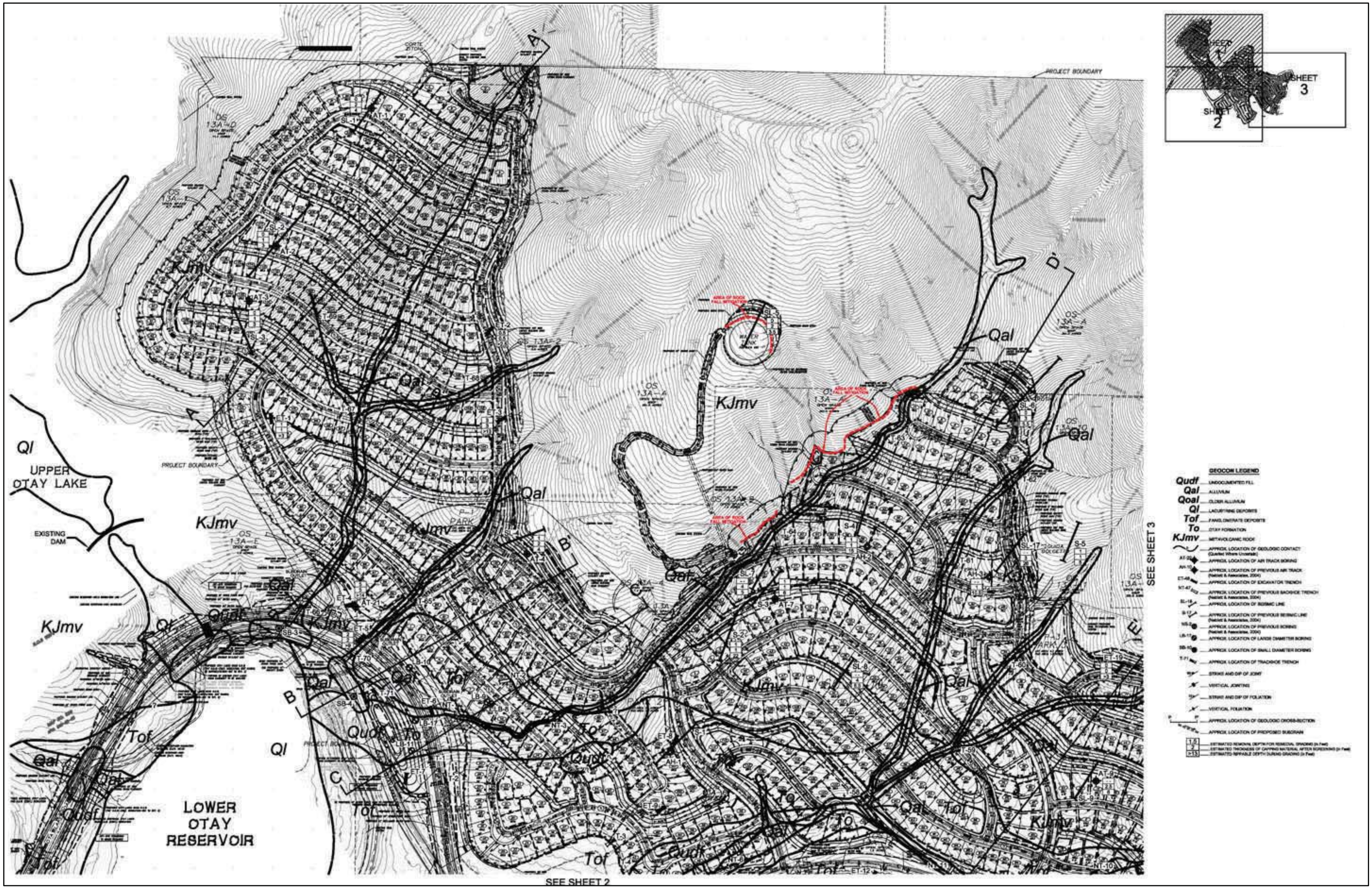
Implementation of Mitigation Measure **M-GE-2** would serve to provide protection from potential rock fall hazards on cut and natural slopes (**GE-2**) through placement of debris fences. Any boulders or loose rocks found during grading would be secured or removed. Providing protection from rock fall and securing and/or eliminating loose or unstable rocks or other geologic material that could present a hazard if it were to come loose and fall would reduce the impact related to rock fall to a ***less than significant level***.

The Project would conform to all recommendations and requirements included in the Geotechnical Reports (**Appendices C-6, C-7,** and **C-8**).

SOURCE: GEOCON Inc. 2011

Not to Scale

Figure 2.5-1
Rock Fall Hazard Map



SOURCE: GeoCon 2014

0 300 600 Feet

Figure 2.5-2A
Rock Fall Mitigation Map, Area A1

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Source: GeoCon 2014

0 300 600 Feet

Figure 2.5-2B
Rock Fall Mitigation Map, Area B4

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