3.5 GEOLOGY/SOILS

3.5.1 INTRODUCTION

This section describes the project's impacts related to geology and soils, including such factors as seismology, soils, topography, and erosion. It also includes an examination of potential hazards associated with potential damage to proposed structures and infrastructure from ground shaking, potential liquefaction hazards and soils and soils stability. Applicable laws, regulations and relevant local planning policies that pertain to geology are also discussed.

Much of the information contained in this subsection was based upon the following geotechnical reports submitted by consultants under contract to the Chandler’s Palos Verdes Sand and Gravel Company and the peer review of those technical studies by Arroyo/Willdan Geotechnical:


All these reports are included in full in Appendix E of this EIR.
3.5.2 ENVIRONMENTAL SETTING

REGIONAL SEISMIC ACTIVITY

The City of Rolling Hills Estate is located on the Palos Verdes Hills. This area is bounded by two active faults in southern California: the Palos Verdes fault on the northeast and the Cabrillo fault to the west. The Palos Verdes fault zone runs along the northeastern section of the Palos Verdes Hills and crosses the northeastern tip of the City of Rolling Hills. The Cabrillo fault traverses the eastern portion of the City. The Newport-Inglewood fault and the Torrance-Wilmington Fault are located near the City as well. Other nearby faults include the Redondo Canyon and San Pedro Basin faults.

According to the City of Rolling Hills Estates General Plan, the project site lies adjacent to the Palos Verdes Fault Zone (PVFZ). The fault traces of the Palos Verdes fault are uncertain; and thus, its fault zone is not an Alquist-Priolo Earthquake Fault Zone identified by the Division of Mines and Geology. However, the Palos Verdes fault is a Holocene active fault, and Exhibit 8-4 of the City of Rolling Hills Estates General Plan (Seismic Hazards in Rolling Hills Estates) identifies a 400-feet wide Palos Verdes Fault Zone.

The onshore portion of the PVFZ exhibits the most westerly strike of the fault and represents a restraining bend in the right-lateral, strike-slip fault zone. Uplift of the peninsula has preserved a prominent set of marine terraces that encircle the Palos Verdes Hills. Several past slip rate estimates of the Palos Verdes fault have focused on the vertical component of slip. These studies yielded uplift rates of 0.35 millimeters per year (mm/yr) for the Palos Verdes Hills and 0.3 mm/yr from vertically separated stratigraphy imaged in offshore seismic profiles across the San Pedro shelf. These rates only account for the vertical component of slip and, therefore, underestimate the total slip rate.

More recent studies support a slip rate for the Palos Verdes fault that is an order of magnitude greater than the long-term uplift rate of the Palos Verdes Hills. Computer simulations of various fault geometries and slip rates were used to explain the observed uplift and deformation of the flight of emergent marine terraces ringing the Palos Verdes Hills. This study found that the Peninsula portion of the fault slips obliquely at a rate of about 3 mm/yr with a dominant strike-slip component. Another study estimates a 2.5-3.0 mm/yr slip rate for the Palos Verdes Fault Zone based on an apparent 300 meter offset of an old channel of the Los Angeles River.

Another recent study quantified the net slip of the fault using an offset Holocene paleochannel in the Los Angeles Harbor. Using a Holocene slip rate of 2.7-3.0 mm/yr and segmentation models for the fault, this study estimates that the Palos Verdes fault is capable of producing a magnitude 7 to 7.2 earthquake about every 400 to 900 years.

PROJECT VICINITY SEISMIC ACTIVITY

Thirteen known earthquake faults with Maximum Credible Richter Magnitudes (MCR) of 6.4 or greater (see Table 3.1, below and Figure 3.5.1) could affect the City of Rolling Hills Estates. Of these faults, two of the most active faults in southern California are located in the project vicinity – the Palos Verdes fault and the Newport-Inglewood fault. The Palos Verdes fault zone runs along the
northeastern section of the Palos Verdes Hills and crosses the northeast portion of Rolling Hills Estates. The Newport-Inglewood fault is located six miles north of Rolling Hills Estates.

Table 3.5.1 identifies the relative likelihood and impact of selected major earthquake faults on Rolling Hills Estates.

<table>
<thead>
<tr>
<th>Fault Name</th>
<th>Occurrence</th>
<th>MCR</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Andreas (Mojave Segment)</td>
<td>High</td>
<td>7.5</td>
<td>VII</td>
</tr>
<tr>
<td>San Andreas (San Bernardino Mountain Segment)</td>
<td>High</td>
<td>7.5</td>
<td>VII</td>
</tr>
<tr>
<td>San Fernando</td>
<td>Moderate</td>
<td>6.5</td>
<td>V-VI</td>
</tr>
<tr>
<td>San Andreas (Carrizo Segment)</td>
<td>Moderate</td>
<td>8.0</td>
<td>VII-VIII</td>
</tr>
<tr>
<td>Elsinore</td>
<td>Moderate</td>
<td>7.1</td>
<td>VI-VII</td>
</tr>
<tr>
<td>Whittier</td>
<td>Moderate</td>
<td>7.3</td>
<td>VII-VIII</td>
</tr>
<tr>
<td>Newport-Inglewood</td>
<td>Low</td>
<td>6.9</td>
<td>VII-VIII</td>
</tr>
<tr>
<td>Offshore Newport-Inglewood</td>
<td>Low</td>
<td>6.9</td>
<td>VII-VIII</td>
</tr>
<tr>
<td>Palos Verdes</td>
<td>Low</td>
<td>7.0</td>
<td>IX-X</td>
</tr>
<tr>
<td>Malibu Coast</td>
<td>Low</td>
<td>6.9</td>
<td>VI-VII</td>
</tr>
<tr>
<td>Cabrillo</td>
<td>Low</td>
<td>6.6</td>
<td>VII-VIII</td>
</tr>
<tr>
<td>Santa Monica</td>
<td>Low</td>
<td>6.7</td>
<td>VI-VII</td>
</tr>
<tr>
<td>Redondo Canyon</td>
<td>Low</td>
<td>6.4</td>
<td>VI-VII</td>
</tr>
</tbody>
</table>

*a Maximum Credible Earthquake each fault is predicted capable of generating, and the likelihood of such an earthquake occurring within the next 100 years. The probabilities were ranked as high, moderate and low as follows: high- greater than 50%, moderate- 10 to 50%, low- less than 10%.

*b Intensity is based on the Modified Mercalli Intensity described below:

I. Tremor not felt.
II. Tremor felt by persons at real or in upper floors of a building.
III. Tremor felt indoors. Vibrations feel like a light truck passing by; may not be recognized as an earthquake. Hanging objects swing.
IV. Hanging objects swing. Vibrations feel like a heavy truck passing by, and the jolt feels like a heavy ball striking the walls. Standing cars rock. Windows, dishes and doors rattle. Glasses clink and crockery clashes. Wooden walls and frames crack in the upper range of scale IV.
V. Earth felt outdoors, and its direction can be estimated. Liquids are disturbed, some spilled. Small unstable objects are displaced or upset. Doors swing, closing and opening. Shutters and pictures move. Pendulum clocks stop, start, or change rate.
VI. Earthquake felt by everyone. Windows, dishes, and glassware are broken. Knick-knacks and books fall off shelves; pictures fall off walls. Furniture moves or is overturned. Weak plaster and masonry cracks. Cracks in the walls.
VII. Steering of motor cars is affected. Partial collapse of masonry C structures. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting and falling of chimneys, factory stacks, monuments, towers, and elevated tanks. Frame structures, if not bolted to foundation, shift. Loose panel walls are thrown out; decayed pilings brake off.
VIII. Damage slight in specially designed structures though considerable in unreinforced buildings.
IX. Masonry D structures destroyed, masonry C heavily damaged, sometimes completely collapsed. General damage to foundations. Frame structures, if not bolted, shift off their foundations. Underground pipes are broken. Conspicuous cracks in the ground.
X. Most masonry and frame structures are destroyed. Most foundations destroyed. Some well-built wooden structures and bridges are destroyed. Serious damage to dams, dikes, and embankments. Underground pipelines
are seriously damaged. Large landslides.

XI Underground pipelines completely out of service. Many and widespread disturbances of the ground, including broad fissures, earth slumps and land slips in soft, wet ground. Sea-waves (tidal waves or tsunami) of significant magnitude. Severe damage to wood-frame structures, especially if near to the shock center.

XII Damage is nearly total. Lines of sight and level are distorted. Objects are thrown into the air. Great and varied disturbance of the ground, including numerous shearing cracks, landslides, large rockfalls, and numerous and widespread slumping of river banks.

Source: Rolling Hills Estates General Plan, Table 8-1.

The presence of faults indicates that major destructive earthquakes may occur. Such earthquakes can entail significant ground shaking with the potential for significant ground failure, including liquefaction and subsidence. The properties of geologic materials beneath a site can significantly influence and even amplify earthquake ground motions. Shear-wave velocities of shallow subsurface materials are commonly used to characterize site conditions and account for site response. Classification schemes of shear-wave velocities have been developed and are used in building codes. In general, seismic impacts can be minimized by appropriate design and construction procedures maintained through strict enforcement of seismic safety standards for new construction contained in the Uniform Building Code. Also of concern are potential cuts and fills associated with pad grading for the proposed residential home sites and for the locations of proposed retaining walls, including Verdura walls. Cuts and fills, which are required to implement the project, can create significant adverse impacts when unstable slopes are disturbed or over-irrigated. Overly steep cut and fill slopes can cause the same problems. Both of these conditions should be avoided. Any planned cuts and the placement of engineered fill must be done according to accepted standards and guidelines to avoid this impact.
Figure 3.5.1 Earthquake Fault Zones
(Source: Earth Consultants International)
3.5 Geology/Soils

TOPOGRAPHY AND SOILS

The proposed project improvements are located on the gently rolling northeastern slope of the foothills of the Palos Verdes Peninsula, at the southwestern corner of the Los Angeles basin. This area is underlain by Quaternary marine and non-marine terrace deposits approximately 30 feet thick. These deposits are overlain by fine to medium grained Pleistocene sands of the San Pedro formation. The San Pedro marine sand consists of generally fine to coarse-grained, light gray and medium dense to dense soils. The site’s elevation ranges from 178 feet above mean sea level (AMSL) in the north end to 238 feet AMSL in the south end. The site’s topography slopes downwards to the north.

Geographically, the project site lies in the extreme northern portion of the Palos Verdes Peninsula and on the north-facing flanks of the Palos Verdes Hills overlooking the Los Angeles Basin. The northern flank of the Palos Verdes Hills is composed of older alluvium (Qoa) and marine San Pedro Sands (Qsp). The northern flank of the hills form the north limb of the Gaffey Anticline in which the Qoa and underlying Qsp strike easterly and dip moderately to shallowly to the north. The Qoa extends northward to the base of the slope, where it is either depositionally overlapped by, or in fault contact with, the younger alluvium of the Torrance plain.

Based on regional mapping conducted in 1999, local mapping, previous borings, and the logging of a 83-meter (273-foot) -long trench exposure, the earth materials in the area of the proposed improvements and immediate surroundings consist of Qoa overlying marine San Pedro Sands Qsp. Undocumented artificial fill soils (Afu) are locally distributed on the north sloping flank of the hills and extensive fills have been placed in the Chandler quarry. These units are described as follows:

- **Undocumented Fill Soils (Afu):** Undocumented fill soils were encountered in and around the margins of the quarry. A thin veneer of fill may also be present locally within and adjacent to the reservoir site.

- **Older Alluvium (Qoa):** These deposits have been described as the “nonmarine terrace cover”, which consists of “sandy loam and loamy clay, includes sand and pebble gravel...” (Dibblee, 1999)\(^1\). The basal section (depth 10-20 feet) of this Pleistocene alluvium is actually a marine terrace deposit that directly overlies an abrasion platform that was cut across the San Pedro Sands. The basal marine terrace deposit is referred to as the Palos Verdes Sand. The abrasion platform and overlying marine sands and non-marine terrace cover were observed in the quarry exposures west of the reservoir site. These deposits were also encountered in the Converse (1989) borings drilled on the reservoir site.

- **San Pedro Sands (Qsp):** This deposit has been described as massive to locally cross-bedded, light gray to reddish-tan sands and pebble gravel (Dibblee, 1999)\(^2\). Pebbles within this deposit are derived mostly from Miocene hard siliceous shale and limestone detritus. Most of the northern walls of the quarry expose the Pleistocene San Pedro Sands, which overlie the Timms Point Silt and Lomita Marl.

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2 Ibid.
Based on amino-acid stereochemistry at the Upper Bent Spring type locality (located in the northwestern corner of the Chandler quarry), the marine terrace overlying the Qsp represents the approximately 330,000-year-old, oxygen isotope Stage 9 high sea level stand. Because the underlying Qsp and overlying strata within the non-marine terrace cover of Qoa also exhibit similar northward dips between 20 and 30, it is inferred that these units are not significantly different in age from the 330,000-year-old platform. Therefore, the Qoa deposits are of considerable and sufficient age to evaluate the presence or absence of any Holocene faulting at the site.

In trench exposure, soils were observed to develop into the non-marine terrace deposits described above. The term soil, as used herein, refers to the weathering profile at the ground surface and is expressed as a function of climate, parent material, topography, and time. In portions of the trench, where deposits lacked primary stratigraphy, soil horizons provided continuous contacts to evaluate the presence or absence of faulting.

The soil horizon boundaries observed in the trench exposure are parallel to slope and discordant with bedding attitudes. This indicates that these soils formed on this slope do not represent paleosoils within the non-marine trench deposits. Near the top of the slope or southern portion of the trench, the soils appear to have been stripped leaving the Qsp exposed at the ground surface with no observable weathering profile (or soils) developed. Because of apparent mass wasting processes on the slope and possible grading near the top of the slope, a complete soil profile, with an intact horizon, was not observed in the trench exposure.

The soil profile observed for the area appears similar in development, and therefore age, to Rockwell’s geomorphic surfaces Qt5a (15,000 to 20,000 years) and Qt5b (25,000 to 30,000 years). Soils in the area have advanced clay film development similar to surface Qt5a, and have diagnostic subsurface horizon colors similar to those on surface Qt5b. Therefore it can be estimated that the soils exposed in the trench represent approximately 15,000 to 30,000 years of development. Thus, the soil horizons in the trench are Pleistocene in age and provide useful marker horizons for evaluating the surface rupture hazard.

**LIQUEFACTION AND LANDSLIDES**

The project site is not within the zone of required investigation for liquefaction on the Division of Mines and Geology, Seismic Hazards Zone Map, Torrance Quadrangle, 1999 (Reference A). However, the City’s General Plan mentions “quarry operations have resulted in various types and quantities of fill material within and adjacent to the Chandler property [the project site]. Hydraulic fills and desilting basins of various sizes and depths occur both on and off site. Hydraulic fills in the area are extremely susceptible to earthquake-induced ground failure.”
3.5.3 NOTABLE GEOTECH RELATED PROJECT IMPROVEMENTS

GRADING

The proposed project involves 3.2 million cubic yards (yds\(^3\)) of earthwork\(^3\), which would balance onsite. The majority of the proposed cut would be excavated from the western and southern rims of the existing quarry pit and on the existing golf course adjacent to the southern rim of the quarry pit. The majority of the fill would be placed within the quarry pit and in the existing valleys in the southwestern portion of the site. Additional grading would occur at various locations throughout the project site to establish building pads and shape the proposed golf course.

In general terms, the topography of the proposed residential development would consist of tiers of homes, descending from south to north and from west to east. The development’s two main east-west roads, “A” and “G” Streets, would have residential pads ranging from 253-275 ft amsl and 280-300 ft amsl, respectively, which would create two east-west oriented tiers of homes. An additional tier would be created in the southwest portion of the proposed development, comprising the three motor courts on “D” and “E” Streets. This tier would have pad elevations ranging from 310-318 ft amsl. In the northwester corner of the site, the “B”, “A”, and “C” Street cul-de-sacs would create three additional tiers, descending in that order from west to east. The residential pads in this area would range from 303-308 ft amsl along “B” Street, 274-280 ft amsl along “A” Street, and 239-249 ft amsl along “C” Street.

The most notable topographical change on the golf course would occur north of Club View Lane between PV Drive East and Peacock Lane. The golf course in this area would be substantially lowered by removing a knoll. Cuts in this area would reach as deep as 90 feet. In comparison, the reshaping of the remainder of the golf course would be subtle, with cuts reaching as deep as 10 feet and fills extending up to 25 feet.

The greatest proposed fills (outside of the quarry pit) would occur in the existing valleys that are located in the southwestern portion of the site. Fills in this area would reach 53 feet where these valleys converge near the existing Chandler’s storage buildings. As proposed, this area would comprise the residential pads along the western portions of “A” and “G” Streets and the “D” and “E” Street motor courts.

RETAINING WALLS

Based on a preliminary review of the Tentative Tract Map filed for the proposed project, retaining walls are planned at the following locations:

MID-SLOPE VERDURA WALLS

Two 10-foot high Verdura walls are proposed in the northwest portion of the site at approximately mid-height of two east-facing 30+ foot high slopes above "C" Street and "A" Street (see Figure 3.5.2). The most easterly lower slope above "C" Street would have a 10-foot high Verdura wall extending approximately 800 lineal feet within certified engineered fill as shown in

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\(^3\) Ongoing Chandler’s inert landfill operations would import additional fill material prior to project initiation. Such import would occur with or without the project as part of Chandler’s existing permitted landfill operations.
Cross-section A-A' in Figure 3.5.2. The westerly slope above "A" Street would have a 10-foot high Verdura wall extending for approximately 750 lineal feet within the San Pedro Formation as shown in Cross-section A-A'.

**CLUBHOUSE VERDURA WALL**

Two parallel Verdura walls with maximum heights of 16 feet are planned south of the proposed Clubhouse at the toe of the slope, ascending to Lots 1 through 6 (Figure 3.5.2). This wall extends from approximately 700 lineal feet within bedrock of the Fernando Formation's Repetto member as shown on Cross-section B-B'.

**ADDITIONAL WALLS**

Smaller walls are located at the toe of slopes in other locations as shown on the Tentative Tract Map. A 10-foot high retaining wall is located at the toe of slope, west of Fairway 9. A 2- to 5-foot high retaining wall is located at the toe of slope below Lots 60 through 68, west of the proposed clubhouse facility. Two walls, 5 feet high and 6 feet high, are located on each side of the cart path, at the toe of slope north of Lot 48 near Alta Loma Park.

**3.5.4 GENERAL PLAN PUBLIC SAFETY ELEMENT**

The City of Rolling Hills Estates General Plan Public Safety Element includes goals, policies, and implementation measures to ensure public safety and to protect life and property. Potential hazards due to the area's geology, seismic hazards, urban and wild fire potential, dam inundation and flooding potential, hazardous materials contamination, and crime are addressed in the Public Safety Element. Policies and implementation measures included in the Element that are relevant to the proposed project fall into two major issues areas: Critical Facilities and Future Development. Policies and implementation measures for each area are described below.

**ISSUE: CRITICAL FACILITIES**

**Policy 1.5:** Support earthquake strengthening and provision of alternative or backup services, such as water, sewer, electricity, and natural gas pipelines and connections, especially in areas of high seismic or geologic high hazard or where weak segments are identified by existing or future studies.

1.5.1 **Implementation Measure:** The City will identify those active and potentially active fault traces as for special study. Future development within the areas will have to provide geotechnical studies indicating the location of the fault trace to proposed improvements and identify appropriate mitigation. The City will evaluate the seismic risk to existing infrastructure in these areas and where appropriate, examine the feasibility of mitigating the risk over time.

**Policy 1.6:** Enforce seismic design provisions for Seismic Zone 4 of the Uniform Building Code to ensure adequate review and inspection to ensure that stairways and elevators are adequately strengthened and nonstructural components such as emergency generators, water heaters, computers, and cabinets are securely anchored in critical facilities.
1.6.1 **Implementation Measure:** The City will work with Los Angeles County Building and Safety Department and other agencies in ensuring that all proposed structures in the City meet current seismic safety code requirements.

**Policy 1.7:** Require fault investigations along traces of the Palos Verdes and Cabrillo faults to comply with guidelines implemented by the Alquist-Priolo special Studies Zone Act. Buildings for human occupancy should be setback a minimum of 50 feet from those faults that are shown to be active or from fault traces where the risk cannot be determined.

1.7.1 **Implementation Measure:** The City will continue to use the Uniform Building Code and update as necessary to ensure seismic safety.

**Policy 1.8:** Require review by a structural engineer when a critical building or facility undergoes substantial improvements.

1.8.1 **Implementation Measure:** City staff will review existing ordinances to ensure that the appropriate review requirements are included within them. In addition, the Seismic Safety Ordinance will require a structural engineer to review development proposals within designated Special Studies Zones.

**Policy 1.9:** Require site specific geotechnical analysis in areas of potential liquefaction, especially in and adjacent to the Chandler landfill.

1.9.1 **Implementation Measure:** Future development within areas designated as having a liquefaction risk will be required to evaluate and mitigate the risk prior to development via the environmental review process.

**ISSUE: FUTURE DEVELOPMENT**

**Policy 2.1:** Discourage development which is adjacent to earthquake faults and other geological hazards.

2.1.1 **Implementation Measure:** All development will comply with the Seismic Hazards Overlay Zone.

**Policy 2.2:** Prohibit residential development on non-engineered fill of any kind.

2.2.1 **Implementation Measure:** The City will continue to enforce the existing Uniform Building Code and the requirement to install methane barriers for new construction within the vicinity of the landfill.
Figure 3.5.2 Wall Exhibit
3.5.5 THRESHOLDS OF SIGNIFICANCE

Without mitigation, the proposed project would result in a significant impact if it would:

1. Involve modifications on slopes that are greater than 2:1.

2. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
   - 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;
   - Strong seismic ground shaking;
   - Seismic-related ground failure, including liquefaction; or
   - Landslides;

3. Result in substantial soil erosion or the loss of topsoil;

4. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse;

5. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risk to life or property; or

6. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

3.5.6 IMPACT DISCUSSION

TOPICS FOR WHICH THE PROJECT WOULD HAVE NO IMPACT

EXPANSIVE SOILS (THRESHOLD 5)

The project site is underlain by alluvial sand and gravel from the San Pedro formation as discussed above. These soils onsite are not expansive, and the proposed project would have no associated impacts.

SOILS INCAPABLE OF SUPPORTING SEPTIC TANKS (THRESHOLD 6)

The project proposes to construct new sewer facilities and would connect to the City’s existing sewer system. No septic systems are proposed or required. As such, soil suitability for alternative wastewater systems is not applicable in this case, and the project would cause no related impacts.
TOPICS FOR WHICH THE PROJECT WOULD HAVE POTENTIAL IMPACTS

SLOPE STABILITY, LIQUEFACTION, LANDSLIDES (THRESHOLDS 1, 2, 4)

Impact GEO-1: Topography onsite consists of gradual to steep natural slopes on the existing golf course and a manmade quarry pit with very steep sloping sides. The stability of both the natural and manmade slopes onsite is a concern for the project as well as potential liquefaction and landslide hazards. Furthermore, the project involves reusing Chandler's inert landfill, which is continually being filled with imported earth materials. The stability of this inert landfill is also a concern for the project. This is a significant but mitigable impact.

Slope Stability

The project involves modifications to slopes greater than 2:1. In order to stabilize these slopes a series of retaining walls, including Verdura walls, are proposed within the project boundaries at specified locations (see Figure 3.5.2). An analysis of these retaining walls from a “global stability standpoint” was conducted. This analysis concluded that the proposed retaining walls, including the proposed Verdura walls, were feasible and effective from a global stability standpoint. However, certain features of the proposed Verdura walls, depending on location, were recommended for further engineering modifications to make them structurally sound. These recommendations are discussed in Mitigation Measures MM GEO-1 and MM GEO-2.

Liquefaction

The project site is not within the zone of required investigation for liquefaction on the Division of Mines and Geology, Seismic Hazards Zone Map, Torrance Quadrangle, 1999. However, the City’s General Plan mentions “quarry operations have resulted in various types and quantities of fill material within and adjacent to the Chandler property [the project site]. Hydraulic fills and desilting basins of various sizes and depths occur both on and off site. Hydraulic fills in the area are extremely susceptible to earthquake-induced ground failure.” However, the conditions required for liquefaction are not present onsite since groundwater at the project site is expected to occur at depths greater than 70 feet below ground surface (bgs). Furthermore, the proposed project is designed such that no habitable structures would be placed atop Chandler’s landfill. Rather, the landfill area would be developed with portions of the golf course. Therefore, the proposed project would not have significant impacts from seismic related liquefaction.

Landslides

According to the Division of Mines and Geology, Seismic Hazards Zone Map, Torrance Quadrangle, 1999, landslide hazards in the vicinity of the project area are confined to the sides of

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5 Ibid.
the quarry. These hazards are concentrated in three regions on the site, all of which can be mitigated if required depending on the nature of future developments. These include: the north-facing and east-west trending cut-slope along the southern portion of the quarry; the north-facing escarpment located in the northern portion of the quarry property; and a number of near vertical cliffs developed in the San Pedro Sands, which constitute the inward facing walls within the quarry pit. Mitigation Measure MM GEO-3 is recommended to address potential landslide hazards.

**SOIL EROSION (THRESHOLD 3)**

**Impact GEO-2:** Construction of the proposed project could temporarily increase the erosion potential of the project site. However, compliance with Best Management Practices, as required by the National Pollutant Discharge Elimination System, will prevent any significant erosion impacts.

The completed project, including the residential homes, golf course and clubhouse improvements, will not cause any additional soil erosion in and of themselves. During construction, however, soil could be exposed to erosion from runoff. Runoff erosion during construction of the proposed project is typical of any construction site, and the National Pollutant Discharge Elimination System (NPDES) was established to control construction sediment and erosion impacts. In accordance with NPDES permit requirements, construction of the proposed project would be required to follow the Best Management Practices (BMP). This required compliance would ensure the project’s potential impacts from soil erosion would not be significant. See Section 3.7 for additional detail regarding NPDES and BMPs.

**SEISMIC SAFETY (THRESHOLD 2)**

**Impact GEO-3:** According to the City of Rolling Hills Estates’ General Plan, the project site lies adjacent to the Palos Verdes Fault. The fault traces of the Palos Verdes fault are uncertain and, thus, its fault zone is not an Alquist-Priolo Earthquake Fault Zone as identified by the Division of Mines and Geology. However, the Palos Verdes fault is a Holocene active fault, and Exhibit 8-4 (Seismic Hazards in Rolling Hills Estates) of the City of Rolling Hills Estates General Plan clearly identifies a 400-feet wide Palos Verdes fault zone.

The City of Rolling Hills Estates is located on the Palos Verdes Hills. This area is bounded by two faults in southern California: the Palos Verdes fault on the northeast and the Cabrillo fault to the west. The Palos Verdes fault zone runs along the northeastern section of the Palos Verdes Hills and crosses the northeastern tip of the City of Rolling Hills and is considered an active fault by the State of California. The Cabrillo fault traverses the eastern portion of the City and is not considered an active fault by the State of California.

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An analysis of the potential for fault rupture to occur on the project site was undertaken by the project applicant’s geotechnical consultant, Earth Consultants International. This included conducting a geologic constraints investigation of the Chandler Inert Land Fill and adjacent properties with an emphasis on the hazard of surface rupture posed by faults within the Palos Verdes Fault Zone. The consultant examined eight exploratory trenches across previously identified lineaments, conducted detailed geologic mapping of the site, and interpreted a series of stereo aerial photographs that date back to 1928. The geologic mapping resulted in useful information regarding the magnitude and timing of local folding, areas of concern regarding slope stability, composition and stratigraphy of the rock units, identification of small-scale faults, and relative timing of deformational events. The results of the study determined the following in regards to potential fault rupture hazards:

- **Lineament C (Main Palos Verdes Fault):** No evidence of surface rupture associated with the main Palos Verdes Fault located near the northern boundary of the property was found. It was determined possible, however, that if these faults do rupture the surface, they would rupture north of the project site, and/or along the lineament in the northeastern portion of the subject site.

- **Lineament B:** No surface faulting was observed associated with lineament B, which was investigated utilizing trench T-7. The consultant determined that no fault is associated with this lineament on the project site.

- **Lineament A, the “western” end:** In the western end of Lineament A, some small-scale faults were observed, which are late Pleistocene in age. However, the cumulative exposure of the exploratory trenches indicates that no fault transects this region which would account for the 400 to 500 feet of suggested right "deflection" in Bent Springs Creek. The consultant determined, based on an evaluation of the available data, that no active faults associated with the western end of lineament A occur on the site.

- **Lineament A, the “eastern” end:** No faults were observed in the late Pleistocene age sediments exposed in T-4, which investigated the eastern end of lineament A in the site. This is a moderately strong lineament, and if it results from faults, may indicate that the fault pre-dates the deposition of the late Pleistocene stream channel sands, or that it may reside west of the western end of trench T-4.

- **Lineament D and possible Concrete Batch Plant Fault:** This zone represents a group of previously mostly unrecognized structures and lineaments located in the region of the entrance/exit of the quarry and northern concrete batch plant property. A local Pleistocene (450,000 years old) angular unconformity, laterally short aerial-photograph lineaments, local folding, and disrupted seismic profile lines suggest that local deformation has occurred in this region. These structures could result from just folding or combinations of folding and small scale faulting. The age of the angular unconformity suggests that the faults are late Pleistocene in age.

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In summary, it was concluded by Earth Consultants International that the potential for surface rupture on the project site is low for the areas tested. However, three zones of relatively small aerial extent exist on the property in which the existence of faulting was not ruled out by Earth Consultants International, but were rather recommended for further study. These include the eastern end of Lineament A and Lineament C, and the region of the newly identified Lineament D.

In follow-up to the Earth Consultants International study, further investigation of these lineaments was conducted by a different geotechnical consultant, Neblett & Associates, Inc., April 29, 2005. The Neblett & Associates, Inc. investigation resulted in a finding that these lineaments do not constitute “active” faults and would not affect future development of the project site. This determination was made based on further investigations by Neblett & Associates including fault trench logs, field mapping, soils stratigraphic analyses, and a geophysical investigation.

**Impact GEO-4:** Since the project site is within the range of known active faults, the proposed project could experience strong ground shaking. However, the risk of earthquake damage is minimized because new structures must be built according to the Uniform Building Code. Structures for human habitation must be designed to meet or exceed California Uniform Building Code standards for Seismic Zone 4. Conforming to these required standards will ensure the proposed project would not result in significant impacts due to strong seismic ground shaking, thus resulting in a less-than-significant impact.

Ground shaking in the northern portion of the property resulting from an earthquake on the main Palos Verdes Fault will likely result in local accelerations in the range of 1.5 to 2 g (1 g = the "force" of gravity). Due to the oblique nature of the main Palos Verdes Fault, strong vertical and horizontal shaking is expected to occur in the event of a local earthquake. However, as indicated, structures for human habitation must be designed to meet or exceed California Uniform Building Code standards for Seismic Zone 4. In addition, the City’s Seismic Safety Ordinance requires a structural engineer to review development proposals within designated Special Studies Zones, including the Seismic Hazards Overlay Zone, to ensure the proposed project would not result in significant impacts due to strong seismic ground shaking.

### 3.5.7 CUMULATIVE IMPACTS

The proposed project would not contribute to any cumulative impacts related to geology or soils. The project’s impacts related to geology and soils are limited to the project site and immediate vicinity.

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3.5.8 MITIGATION MEASURES

MM GEO-1: To the satisfaction of the City’s Geotechnical Engineer, the internal stability of geogrid reinforced Verdura walls shall be addressed by the Verdura wall engineer during the design phase of the project. In particular, the Verdura wall engineer shall specify the details of the Clubhouse Verdura wall geogrid behind the wall in order to provide adequate global stability. The geogrid reinforcement may need to extend a minimum 20 feet behind the wall and it may also be necessary to place reinforcement layers below the toe of wall to enhance the global stability. Actual reinforcement type, spacing and length shall be based on the shear strength characteristics of the backfill materials.

MM GEO-2: To the satisfaction of the City’s Geotechnical Engineer, detailed evaluation of the proposed retaining walls shall be performed at the design phase of this project.

MM GEO-3: All development shall comply with the Seismic Hazards Overlay Zone requirements, including measures to reduce potential landslide hazards.

3.5.9 LEVEL OF SIGNIFICANCE AFTER MITIGATION

With the implementation of mitigation measures, the proposed project would not result in significant impacts related to geology/soils. The following table presents a summary of the thresholds of significance, mitigation measures, and the project’s corresponding level of impact.

<table>
<thead>
<tr>
<th>Threshold of Significance</th>
<th>Applicable Mitigation Measures</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involve modifications on slopes that are great than 2:1</td>
<td>MM GEO-1 and MM GEO-2, as shown above in Section 3.5.8</td>
<td>Less than significant after mitigation</td>
</tr>
<tr>
<td>Exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving 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.</td>
<td>None required</td>
<td>Less than significant</td>
</tr>
<tr>
<td>Exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking.</td>
<td>None required</td>
<td>Less than significant</td>
</tr>
</tbody>
</table>
### Table 3.5.2
Summary of Thresholds of Significance, Mitigation Measures, and Level of Significance for Geology/Soils Impacts

<table>
<thead>
<tr>
<th>Threshold of Significance</th>
<th>Applicable Mitigation Measures</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction.</td>
<td>None required</td>
<td>Less than significant</td>
</tr>
<tr>
<td>Exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides.</td>
<td>MM GEO-3, as shown above in Section 3.5.8</td>
<td>Less than significant after mitigation</td>
</tr>
<tr>
<td>Result in substantial soil erosion or the loss of topsoil.</td>
<td>None required</td>
<td>Less than significant</td>
</tr>
<tr>
<td>Location on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.</td>
<td>None required</td>
<td>Less than significant</td>
</tr>
<tr>
<td>Location on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risk to life or property.</td>
<td>None required</td>
<td>No Impact</td>
</tr>
<tr>
<td>Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.</td>
<td>None required</td>
<td>No Impact</td>
</tr>
</tbody>
</table>