4.9 GEOLOGY AND SOILS

4.9.1 Introduction and Methodology

The discussion within this section summarizes applicable information within the following four reports:

- Geotechnical Investigation Proposed Inns at Bridgecreek, prepared by Geotechnical Professionals Inc., 2014 (Appendix M)
- Feasibility Level Geotechnical Evaluation, prepared by Geotechnical Professionals Inc., 2010 (Appendix N)
- Geotechnical Engineering Investigation, prepared by Krazan and Associates Inc., 2004 (Appendix O)
- Geotechnical Engineering Recommendation North County Plaza – Phase II, prepared by Robert Prater Associates, 1992 (Appendix P).

4.9.2 Existing Conditions

Site History

The 12.5-acre project site originally consisted of a relatively low-lying tidal mud flat area directly east of Buena Vista Lagoon, at an elevation of approximately 6 feet above mean sea level (amsl). Vegetation at the project site was reportedly cleared in 1972, and fill was placed to increase the elevation between 16 to 19 feet amsl. In 1982, some minor grading of the site was performed to shape the ground surface to drain uniformly to the south and install storm drain lines (Appendix P). Subsequently, in 1983 additional fill materials, consisting of 3 to 4 feet of clayey lagoon deposits (from Buena Vista Lagoon), were placed at the site without compaction.

Regional Geologic Setting

The project site is located within the Peninsular Range Geomorphic Province. The Peninsular Range Province is characterized by northwest-trending mountain ranges separated by subparallel fault zones. The mountain ranges are underlain by basement rocks consisting of Jurassic meta-volcanic and meta-sedimentary rocks and Cretaceous igneous rocks of the Southern California batholith. Surface and near-surface deposits of the Peninsular Range Province are composed of late Cretaceous, Tertiary, and Quaternary sediments that flank the mountain ranges to the northeast and southwest. The site is located at the eastern end of Buena Vista Lagoon. The local geologic area is underlain by the Santiago Formation and Quaternary alluvium consisting of unconsolidated clay, silt, sand, and gravel.

Site Geology

The proposed project site consists of approximately 12.5 acres of undeveloped vacant land with sparse grass vegetation and exposed soils. A small portion of the site is covered with dense vegetation and small trees surrounding the creek along the southern perimeter. The project site is relatively flat, with minimal sloping toward the north and south. The existing elevation of the site ranges from approximately 23 feet amsl near the center of the site and decreases as it nears Buena Vista Creek to approximately 8 to 10 feet amsl along the creek bed. This relatively flat site has been previously filled with approximately 85,000 cubic yards of dredge spoils from Buena Vista Lagoon, which raised the project site by approximately 3 feet. The project site has also been previously cleared and graded. The area for the proposed bridge abutment south of the creek is relatively flat, at approximately 23 feet amsl, and Buena Vista Creek slopes downward to approximately 7 to 10 feet amsl.

Soil and Geologic Conditions

The project site is underlain by three surficial soil types and one geologic formation. The surficial soil consists of previously placed fill consisting of clayey lagoon deposits, undocumented fill, and Quaternary alluvial deposits. The geologic units consist of the Pleistocene-age alluvium and Eocene-age sedimentary rocks of the Santiago Formation (SDNHM 2010). The surficial soil and geologic units are further described below.

<u>Soil Types</u>

<u>*Clayey Lagoon Deposits*</u>

Fill soils were encountered within the upper 10 to 15 feet of the soil profile. The fill soils consisted of interbedded layers of clay, silty clay, sandy clay, clayey silt, sandy silt, and silty sand. The silts and clays range from soft to stiff, and the silty sands ranged from loose to medium density. These fill soils are anticipated to be very moist.

<u>*Undocumented Fill Material*</u>

Directly below the fill materials, the soils consisted of a layer of normally consolidated fat clay (a clay which has a high value of liquid limit and plasticity index) and elastic silt ranging in thickness from 15 to 35 feet. This clay/silt layer is soft, exhibiting very low strength and very high compressibility, and contains thin lenses of silty sand and sandy silt. This layer appeared to be thicker in the southern portion of the site near the creek, and thinner in the northeast portion of the site near State Route 78. The thickest layers of clay/silt without intermittent lenses of sandy silts and silty sands are approximately 10 to 15 feet (Appendix M).

<u>*Quaternary Alluvial Deposits*</u>

Underneath the soft fat clay and elastic silt layers, the soil contains layers of medium-dense to dense sands and silty sands interbedded with layers of firm to stiff layers of clayey silt, silty clay, and clay. The dense sand layers are approximately 2 to 5 feet thick. The interbedded layers of clay and silt are over-consolidated with moderate compressibility characteristics and extend to a depth ranging from approximately 55 to 80 feet below existing site grade. Below these deposits, at depths past 80 feet below the existing grade, are very dense sands and hard clays that consist of soft bedrock material (Appendix M).

<u>Geologic Unit</u>

The Santiago Formation is considered to be middle Eocene in age and it is correlated with the Torrey sandstone of the La Jolla group and the Delmar Formation. The Santiago Formation is classified as light-colored, poorly bedded, poorly indurated, fine- to medium-grained sandstone, interbedded with siltstone and claystone (Bowman 1973). The Santiago Formation was encountered below the Quaternary alluvial deposits.

Geologic Hazards

Faulting and Seismicity

Based on the commonly accepted definition provided by the California Mining and Geology Board, an active fault is a fault that has had surface displacement within Holocene time (approximately the last 11,000 years). The state geologist has defined a potentially active fault as any fault considered to have been active during Quaternary time (the last 1.6 million years). These definitions are used in delineating earthquake fault zones as mandated by the Alquist-Priolo Earthquake Fault Zone Act. The intent of this act is to ensure that any urban development planned on or near traces of active faults is planned in accordance with seismic safety considerations, thereby reducing potential damage due to fault surface rupture.

The project site is located in a seismically active area of Southern California. The most significant fault in the proximity of the site is the Newport–Inglewood, an offshore fault approximately 5.6 miles west of the site. In addition, the Rose Canyon fault is located approximately 6 miles west of the project site. The project site may be subject to a peak ground acceleration of 0.44g (acceleration due to earth's gravity). This was computed through the mapped ground acceleration from ASCE 7-10 and a site coefficient based on the site class (Appendix M).

No mapped faults, including those classified as Alquist-Priolo, exist on the project site according to maps prepared by the California Geological Survey (CGS 1999) and the Geotechnical Investigation provided in Appendix M. In addition, no evidence of surface faulting was documented as occurring on the property. Therefore, ground rupture due to faulting is considered unlikely at the project site (Appendix M).

Liquefaction

Soil liquefaction is a phenomenon in which saturated, cohesionless soils undergo a temporary loss of strength during severe ground shaking and acquire a degree of mobility sufficient to permit ground deformation. In extreme cases, the soil particles can become suspended in groundwater, resulting in the soil deposit becoming fluid-like (Appendix M). Liquefaction occurs primarily in loose to medium-dense deposits of saturated soils such as sand and clay under vibratory conditions such as those induced by seismic events.

The project site is not located within a Seismic Hazard Zone for liquefaction, as defined by the Seismic Hazards Mapping Act, State of California. However, due to shallow groundwater on site and relatively thin layers of silt and sand occurring at depths of up to 50 feet, there is a potential for liquefaction on site. The estimated magnitude of induced settlement in these layers due to liquefaction would be approximately 1.75 to 1.5 inches. Differential settlement due to liquefaction across 40 feet may reach 0.5 to 1.0 inch (Appendix M).

An additional concern associated with soil liquefaction is lateral spreading, which is the differential movement of the ground surface due to open face excavations. Buena Vista Creek, which runs along the southern perimeter of the project site, is an open face excavation approximately 10 to 15 feet deep. Although layers of clay and silt subject to liquefaction are noted on site, for lateral spreading to occur these layers must be continuous across the site. Since these clay and sand layers are embedded and intermittent, lateral spreading is not considered likely to occur during a seismic event (Appendix M).

Expansive Soils

Soil expansion occurs when soils absorb water and increase in volume, which can cause structural damage. According to the Geotechnical Investigation, subsurface soil conditions were explored by drilling 3 boring and 14 cone penetration tests. In addition, in 2010, a feasibility evaluation included one additional boring and seven cone penetration tests. The exploratory boring was drilled to a depth of approximately 70 to 80 feet below existing site grades, and the cone penetrating tests accorded at depths between 47 to 121 feet below existing grades (Appendix M).

The clayey soils in the upper 5 feet of the existing grade were tested to assess the expansion potential of on-site soils. The results of the test indicated that clay soil samples had an expansion index of 108. According to the Uniform Building Code of 1994 (Table 18-B), an expansion index of 91 to 130 is considered to have a high expansion potential. Potential impacts resulting from expansive soils are discussed below.

Tsunamis and Seiches

A tsunami is a high ocean wave generated by an underwater earthquake or volcanic eruption. The Pacific Ocean could cause inundation of the beaches, lagoons, and harbor areas with waves ranging from 10 to 15 feet high (City of Oceanside 2002). The project site is located approximately 1.5 miles east of the Pacific Ocean. According to the California Geological Survey's Tsunami Inundation Map for Emergency Planning (CGS 2009), the project site is not located within a tsunami inundation area.

A seiche is an oscillating wave in an enclosed or restricted body of water generated by ground motion during an earthquake. A seiche could cause a lake, reservoir, or lagoon to overflow. The project site is located approximately 0.06 mile east of Buena Vista Lagoon. According to the City of Oceanside's General Plan Public Safety Element (City of Oceanside 1975), there is a minimal potential for a seiche to occur in the lagoons within the City's planning area.

Landslides

Landslides include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Landslide hazard areas are generally considered to exist when substantial slopes are located on or immediately adjacent to a subject property. While gravity is the main factor in causing a landslide to occur, the original slope stability is also a contributing factor. While minor slope movement is occurring throughout the City of Oceanside, the City's General Plan Public Safety Element (City of Oceanside 1975) documented that there are no published reports or any evidence in reconnaissance or aerial photographs of landslides occurring within the City. The minor slope movement has been identified as occurring as soil creep, slumping, and sloughing along road cuts and where soils have accumulated on steep slopes. According to figure PS-3 of the Public Safety Element, the project site is located in an area that is designated as least susceptible to landslides.

Groundwater

Groundwater is water found below the land surface in aquifers, pore spaces, and unconsolidated sediments, and as soil moisture. Groundwater flows to the surface naturally at springs and seeps and can pool in depressions on the land surface. It may also be tapped artificially by digging wells for beneficial uses such as drinking water and irrigation. Sandy soils are expected to cave below groundwater.

Groundwater was encountered at a depth of 15 feet below the existing ground surface. This level is representative of the level of the adjacent Buena Vista Creek and the tidal fluctuations of Buena Vista Lagoon directly to the west. The depth to groundwater is anticipated to fluctuate between 12 to 20 feet across the current grades at the site. The specific depth to groundwater is anticipated to fluctuate across the site and seasonally (Appendix M).

4.9.3 Thresholds of Significance

Based on the significance criteria established by Appendix G of the California Environmental Quality Act (CEQA) Guidelines (14 CCR 15000 et seq.) and the City of Oceanside, a significant impact from geology and soils would generally occur as a result of project implementation if the project would:

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:
    a. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist, or based on other substantial evidence of a known fault (refer to Division of Mines and Geology Special Publication 42);
    b. Strong seismic ground shaking;
    c. Seismic-related ground failure, including liquefaction; or
    d. Landslides.
2. Result in substantial soil erosion or the loss of topsoil.
3. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
4. 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.
5. Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

4.9.4 Environmental Impacts

1. Would the proposed project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving (i) rupture of a known earthquake fault; (ii) strong seismic ground shaking; (iii) seismic-related ground failure, including liquefaction; or (iv) landslides?

No active earthquakes have been identified as occurring on or directly adjacent to the project site and the project site is not located within an Alquist-Priolo Earthquake Fault Zone. Ground surface rupture, or cracking of the ground surface due to an active fault, is considered unlikely in the project area. Based on the proximity of several dominant active faults capable of generating earthquakes, as well as the historical seismic record, the area of the proposed project site is considered subject to relatively high seismicity. The nearest active faults are the Newport–Inglewood Fault and the Rose Canyon Fault, located approximately 5.6 miles and 6 miles west of the project site, respectively. Because the site is located in an area of high seismicity, the geotechnical investigation computed the peak ground acceleration at 0.44g. With incorporation of the geotechnical recommendations (PDF-GEO-1 – PDF-GEO-3) provided in the project's Geotechnical Investigation (Appendix M; refer to Table 3-2, Summary of Project Design Features and Construction Measures, in Section 3.2 of this Environmental Impact Report (EIR) and adherence to the California Building Code requiring specific performance standards to address geologic hazards, impacts relating to faulting and seismicity would remain below a level of significance.

According to the City's General Plan (Figure PS-3 of the Public Safety Element; City of Oceanside 1975), the project site is located in an area that is designated as least susceptible to landslides. There are no steep slopes on the project site. Overall, the potential for substantial adverse effects to people or property from landslides would be less than significant.

Liquefaction typically occurs when a site is subjected to strong seismic shaking, on-site soils are cohesionless, groundwater is encountered within 50 feet of the surface, and soil relative densities are less than approximately 70%. Per the Geotechnical Investigation (Appendix M), the project site consists of deep alluvium and shallow groundwater at a depth of 15 to 20 feet below the ground surface, which presents the potential for liquefaction to occur below existing grades. The main impact of liquefaction would be settlement of the ground surface. A liquefaction analysis was performed based on these site conditions and concluded that liquefaction settlement on the order of 0.75 to 1.5 inches may occur during a seismic event, and differential settlements may occur on the order of 0.5 to 1.0 inch (Appendix M). The depth and thickness of liquefiable soil layers make foundation-bearing failure under lightly loaded structures (retaining walls, site walls, trash enclosures) unlikely in the event of liquefaction. However, these magnitudes of total settlement are typically not tolerable for structures supported on shallow foundations (Appendix M). With incorporation of the geotechnical recommendations provided in the project's Geotechnical Investigation (Appendix M; refer to Table 3-2, Summary of Project Design Features and Construction Measures, in Section 3.2 of this EIR) requiring specific structural design, impacts associated with liquefaction due to static and seismic conditions would remain below a level of significance.

2. Would the project result in substantial soil erosion or the loss of topsoil?

The relatively flat site has been previously graded and cleared and consists of an existing empty lot with sparse vegetation. The potential for erosion would increase during construction as a result of vehicles and heavy equipment accelerating the erosion process. Wind erosion could occur on bare soils or where vehicles and equipment cause dust. Construction activities would require approximately 64,500 cubic yards of cut and approximately 70,960 of fill material, requiring approximately 6,460 cubic yards of soil to be imported to the site. Mass grading activities are anticipated to last approximately 4 months and may result in erosion. However, potential erosion impacts would be avoided by adherence to the erosion control standards established by the City's Grading Ordinance and through implementation of best management practices required by the stormwater pollution prevention plan (refer to Section 4.10, Hydrology and Water Quality, and Table 3-2, Summary of Project Design Features and Construction Measures, in Section 3.2 for more information). Construction impacts related to erosion would be less than significant.

During the operational phase of the project, the project would convert the vacant land with the development of three hotel structures and associated pavilion and parking structure. The construction of the proposed buildings would preclude erosion from occurring in those areas. In addition, the project would provide landscape and hardscape features throughout the project site, and revegetation of native plant species within the proposed biological buffer area that would further stabilize soils and reduce the potential for erosion to occur on the project site. As such, during the operational phase of the project, impacts related to erosion would be less than significant.

3. Would the project 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?

Refer to the discussion provided under Threshold 1. The fill material previously placed on the project site resulted in long-term settlement of the underlying normally consolidated clays and silts. Settlement from the increased site elevation is anticipated to occur over a 5- to 30-year time frame. Since the grade was increased in 1972 and 1983, additional settlement from these past actions could still occur at the project site; however, it is anticipated that less than 1 inch of residual settlement remains to occur at the project site. The project would place up to 10 feet of fill material in some areas of the site. For every 1 foot of fill placed above the current grade, settlement of 0.75 to 1.25 inches is anticipated to occur over a period of 5 to 30 years. The settlement would be greater along the south portions of the site adjacent to the creek, as the compressible layers are thicker in this area. Therefore, the proposed raising of the site may result in settlements estimated to range from 1.5 to 10 inches over 5 to 30 years. Increases to the site's current grade would induce long-term settlement of the underlying consolidated clays and silts, having an adverse impact on the proposed structures.

The potential for lateral spreading on site was analyzed further in the project-specific Geotechnical Investigation (Appendix M). For lateral spreading to occur, the layers subject to liquefaction must be continuous across the site, and have an overburden-normalized standard penetration test blowcount of less than 15. According to the project-specific Geotechnical Investigation, only intermittent and thin layers of soils on site exhibit an equivalent normalized standard penetration test blowcount of less than 15, and these soil layers are not continuous across the site. Therefore, lateral spreading is not anticipated to occur on site. If isolated areas of minor lateral spreading were to occur on site, implementation of pile foundations as outlined in Table 3-2, Summary of Project Design Features and Construction Measures; adherence with the recommendations provided in the project's Geotechnical Investigation (Appendix M); and adherence to the California Building Code requiring specific performance standards would ensure that geologic hazard impacts relating to on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse would be less than significant.

Soils at the site consist of severely corrosive to ferrous metals. Chlorides in excess of 300 milligrams per kilogram (mg/kg) are typically a concern for concrete reinforcement. Testing of the on-site soils found chloride concentrations of 6,424 mg/kg indicating that they would contribute to the corrosion of the steel reinforcement bar within the concrete. Implementation of project design features, as summarized in Table 3-2, Summary of Project Design Features and Construction Measures, would be implemented to ensure that potential impacts of the on-site soils to the proposed concrete, metals, and concrete reinforcements remain less than significant.

4. Would the project 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?

According to the Geotechnical Investigation, the clay soils within the project site have an expansion index of 108. Table 18-B of the Uniform Building Code states that an expansive index of 91 to 130 is considered to hold a high expansion potential. However, through the implementation of project design features outlined in Table 3-2, Summary of Project Design Features and Construction Measures; the geotechnical recommendations provided in the project's Geotechnical Investigation; and adherence to the California Building Code requiring specific performance standards to address geologic hazards, impacts relating to expansive soils would remain below a level of significance.

5. Would the project have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

The project would connect to the existing Vista–Carlsbad Inceptor for treatment services. The Vista–Carlsbad Interceptor is located along Buena Vista Creek just south of the project site. Sewage along the interceptor is pumped southwest via the Buena Vista Sewer Lift Station, located on the west side of the project boundaries. Therefore, no septic tanks would be necessary and no impacts would occur.

4.9.5 Mitigation Measures

No mitigation measures would be required.

4.9.6 Level of Significance After Mitigation

Through implementation of project design features outlined in Table 3-2, Summary of Project Design Features and Construction Measures, potential impacts associated with seismicity and soil stability would remain below a level of significance.