

4.5 GEOLOGY AND SOILS

This section describes the existing geology and soils on and near the project site, potential environmental impacts, recommended mitigation measures to reduce or avoid impacts to the identified geology and soils, and the level of significance after mitigation. The discussion of geology and soils in this section was summarized from the *Draft Geotechnical Exploration for the Proposed City Place Sky Lofts, Jeanette Lane, City of Santa Ana, California* (Leighton and Associates, Inc. 2007) (*Geotechnical Report*), included as Appendix E of this DEIR. This is the preliminary geotechnical report for the proposed project.

4.5.1 EXISTING SETTING RELATED TO GEOLOGY AND SOILS

4.5.1.1 Geologic Setting

The project site is located in the Downey Plain within the southeastern margin of the Los Angeles Basin, a large structural depression within the Peninsular Ranges geomorphic province of California. In general, the Downey Plain is bordered by hills and mountains on the north and east, the Pacific Ocean to the southwest and continues in Los Angeles County to the northwest. Several mesas or highlands along the coast represent uplifted areas along the Newport-Inglewood structural zone. These mesas are separated by erosional gaps which were created by historic routes of the Santa Ana River. The project site lies near the lower reaches of the Santa Ana River. The surface distribution of Holocene sediments, as recorded in early editions of regional soil survey maps, suggests that the Santa Ana River has recently wandered back and forth across the Orange County coastal plain from Alamitos Bay to Newport Bay. Historical accounts and documents further support the process of widespread sheet flooding being the dominant depositional process associated with the Santa Ana River prior to the construction of Prado Dam in 1941.

4.5.1.2 Subsurface Earth Materials

As described in the *Geotechnical Report*, in Borings B-1 through B-3, which were taken within the proposed tower location, undocumented fill materials and Quaternary-age alluvium were encountered. The thickness of undocumented fill ranged from two to three feet below the existing grade and consisted primarily of gravelly, silty sand with varying contents of clay. The soils encountered below the fill to the depth of 30 feet were predominately comprised of loose to medium dense silty sand and sand with interbedded layers of soft to firm silty clay and clayey silt. At depths ranging from 30 to 45 feet, very dense gravelly sand layers were encountered. The soils below 45 feet to 110 feet were comprised of predominately soft to very stiff silty clay to clayey silt material with interbedded layers of loose to medium dense silty sand and sand. From depths 110 feet to 131.5 feet, the maximum depths of the borings, dense to very dense gravelly sand layers were encountered.

As described in the *Geotechnical Report*, in Borings B-4 and B-5, which were taken within the location of the proposed town homes, undocumented fill materials and Quaternary-age alluvium were encountered. The thickness of undocumented fill ranged from approximately zero to three feet below the existing grade and consisted primarily of clayey sand to sandy clay with varying contents of silt. The soils encountered below the fill to the depth of 30 feet were predominately composed of loose to medium dense silty sand and sand with interbedded layers of soft to firm silty clay and clayey silt. The soils below 40 feet to 81.5 feet, the maximum depth of borings within the town homes, were predominately composed of soft to very stiff silty clay to clayey silt material with interbedded layers of loose to medium dense silty sand and sand. At depths ranging from 30 to 45 feet, very dense gravelly sand layers were encountered.

4.5.1.3 Seismic Hazards

Results of specific evaluation for potential liquefaction, landsliding, and lateral spreading hazards affecting the project site are presented below.

Liquefaction

Liquefaction is a seismic phenomenon in which loose, saturated, fine grained granular soils behave similarly to a fluid when subjected to high-intensity ground-shaking. Liquefaction occurs when three general conditions exist: (1) shallow groundwater; (2) low density, fine, clean sandy soils; and (3) high-intensity ground motion. Studies indicate that saturated, loose and medium dense, near-surface cohesionless soils exhibit the highest liquefaction potential, while dry, dense, cohesionless soils and cohesive soils exhibit low to negligible liquefaction potential. Effects of liquefaction on level ground include sand boils, settlement, and bearing capacity failures below structures. Review of the State of California Seismic Hazard Zones Map for Orange Quadrangle indicates the project site is not within an area potentially susceptible to liquefaction.

Landslides

Seismically-induced landslides and other slope failures are common occurrences during or soon after earthquakes. There are no significant ground slopes within the project site.

Lateral Spreading

Seismically-induced lateral spreading involves primarily lateral movement of earth materials due to ground-shaking. It differs from slope failure in that complete ground failure involving large movement does not occur due to the relatively smaller gradient of the initial ground surface. Lateral spreading results in near-vertical cracks with predominately horizontal movement of the soil mass involved.

Ground Motion

No active faults are known or mapped as crossing the subject site. The closest active faults with surface rupture to the project site are the Newport-Inglewood Fault Zone (NIFZ) to the southwest, the Whittier Fault to the northeast, and the Elsinore (Glen Ivy) fault to the southeast. These faults are approximately 16.4 kilometers (km), 16.4 km, and 21.6 km from the project site, respectively. The San Andreas Fault System, which is the largest active fault in California, is approximately 66 km northeast of the project site.

4.5.1.4 Soils

Seismic Densification of Dry Soils

Seismic densification of dry soils is a phenomenon in which loose, dry soils, primarily sands and silty sands, densify and settle when subjected to earthquake shaking. In Southern California, evidence of seismically-induced densification and resultant settlement of dry soils have been observed in the 1971 San Fernando and 1994 Northridge Earthquakes. The project site has relative density of the granular soils below the anticipated foundation of the lowest subterranean level.

Expansive Soil Characteristics

An Expansion Index (EI) test was performed on representative soil samples that were obtained. Based on the laboratory test results, the soils at 20 to 30 feet depth have a low expansion potential (EI values between 20 and 50), as defined in Table 18-I-B of the 2001 California Building Code (CBC).

Soil Corrosivity

Tests were performed on bulk samples to determine the soluble sulfate content, pH, minimum resistivity, and chloride content of the on-site soils. In general, soil environments that are detrimental to concrete have high concentrations of soluble sulfates and/or pH values of less than 5.5. Laboratory test results on representative samples indicated sulfate contents between 52 and 143 ppm and pH values ranging between 7.3 and 8.1. Based on the laboratory test results and in accordance with Table 19-A-4 of the 2001 CBC, concrete in contact with the on-site soils is expected to have negligible exposure to sulfate attack.

4.5.1.5 Groundwater Conditions

As described in the Geotechnical Report, groundwater was encountered in four of the borings, namely B-1, B-2, B-3, and B-5, ranging from 76 feet to 84 feet below existing grade. However, groundwater in Boring B-4 drilled to 61.5 feet below the existing grade, was not encountered. The historical high groundwater level for the project site is deeper than 40 feet below the existing ground surface. Fluctuations of the groundwater level, localized zones of perched water, and an increase in soil moisture should be anticipated during and following the rainy seasons or periods of locally intense rainfall or storm water runoff.

4.5.2 THRESHOLDS OF SIGNIFICANCE RELATED TO GEOLOGY AND SOILS

Based on the Appendix G of the CEQA Guidelines, implementation of the proposed project would result in a significant adverse impact on the environment related to geology and soils if it would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:
 - Strong seismic ground shaking.
 - Seismic-related ground failure, including liquefaction.
- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the proposed project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.

4.5.3 METHODOLOGY RELATED TO GEOLOGY AND SOILS

To evaluate the geotechnical conditions and characteristics at the project site and to provide recommendations for the design and construction of the proposed development, the following tasks were conducted:

- Reviewed readily available geotechnical reports.

- Field exploration consisting of drilling, logging, and sampling a total of five 8-inch-diameter, hollow-stem auger borings ranging from approximately 61.5 to 131.5 feet in depth. Relatively undisturbed and bulk soil samples were obtained from the borings.
- Laboratory testing of representative samples of the on-site soils to determine their physical and engineering characteristics. Laboratory tests were performed on representative samples to verify the field classification of the recovered samples and to evaluate the geotechnical properties of the subsurface materials. The laboratory tests performed included:
 - In situ moisture content and dry density (ASTM [American Society for Testing and Materials] D2216 and ASTM D2937).
 - Sieve analysis (ASTM D422).
 - Percent passing No. 200 sieve (ASTM D1140).
 - Atterberg limits (ASTM D4318).
 - Consolidation (ASTM D2435).
 - Direct Shear (ASTM D3080).
 - Expansion index (ASTM D4829).
 - R-value (ASTM D2844).
 - Corrosivity suite – pH, sulfate content, chloride content and resistivity (California Test Methods 532/643, 417, and 422).
 - Geotechnical analyses of the collected data.

To evaluate the ground motion and a peak level of ground acceleration that the proposed project is likely to experience, a probabilistic analysis approach was utilized. The probabilistic approach to forecasting future ground motion at the site estimates the expected peak ground acceleration level that has a 10 percent probability of exceedance over the approximate lifetime of the proposed project (commonly 50 years). This approach takes into account the historical seismicity of the region, the nature of nearby active faults, their distance to the site, records of previous historical earthquakes, and the site-specific response characteristics. The computer program FRISKSP was used for the analysis and three attenuation relationships were used in the analysis.

4.5.4 IMPACTS RELATED TO GEOLOGY AND SOILS

4.5.4.1 Surface Earth Materials

The primary geotechnical aspect of the project site that would affect the design and construction of the proposed project is the presence of clays at depths of approximately 45 to 80 feet below grade that are susceptible to compression under the magnitude of stress imposed by the proposed project and, in particular, the proposed high-rise tower. The results of the settlement analyses indicated that the potential exists for significant differential settlement between the tower and town home portions of the proposed project. Therefore, the proposed project has the potential to be exposed to differential settlement which would be considered a significant adverse impact.

4.5.4.2 Seismic Hazards

Liquefaction

Review of the State of California Seismic Hazard Zones Map for Orange Quadrangle indicates the project site is not within an area potentially susceptible to liquefaction. Therefore, due to the absence of shallow groundwater, dense nature of subsurface conditions and fine grained soils, potential for liquefaction is considered to be low. No significant adverse impact related to liquefaction would occur.

Landslides

There are no significant ground slopes within the project site; therefore, the potential for seismically-induced landslides that would affect the proposed site is considered low. No significant adverse impact related to landslides would occur.

Lateral Spreading

Based on the materials encountered in the borings, the potential for lateral spreading is considered low. Therefore, no significant adverse impact related to lateral spreading would occur.

Ground Motion

The project site is likely to be subjected to strong ground-shaking during the life of the proposed project. The analysis from the computer program FRISKSP indicated an average value for peak horizontal ground acceleration (PHGA) with a 10 percent probability of exceedance in 50 years of 0.33 g. Therefore, the proposed project has the potential to be exposed to strong seismic ground-shaking which would be considered to be a significant adverse impact.

4.5.4.3 Soils

Soil Erosion and Loss of Soils

As described later in Section 4.7 (Hydrology and Water Quality), implementation of the proposed project would require grading, excavation and other construction-related activities that could cause soil erosion from exposed soil at an accelerated rate during storm events, if not properly controlled. The amount and rate of erosion would vary depending on a number of factors, including the time of year of construction, the amount and intensity of rainfall, and the amount of natural and/or artificial fill. Therefore, implementation of the proposed project could result in significant adverse impacts related to erosion and loss of soils.

The State's General Construction Activity Storm Water National Pollutant Discharge Elimination System (NPDES) Permit requires the preparation of a Storm Water Pollution Prevention Plan (SWPPP) to control discharges from the site, including soils, to protect waterways. A SWPPP describes the measures or practices to control discharges during both the construction and post-construction phases of the proposed project. A SWPPP typically identifies project design features and a list of target structural and non-structural Best Management Practices (BMPs) that would be used to control, prevent, remove or reduce pollution from the site, including sediment from erosion. Construction BMPs may include the placement of gravel bag dikes, installation of silt fencing, and general good housekeeping practices intended to ensure that sediment and other construction-related materials are not discharged in storm water runoff. Compliance with the SWPPP may be monitored by site inspections from the Regional Water Quality Control Board (RWQCB). In addition to the requirements of the NPDES program, provisions of the Uniform Building Code and the City's Grading Code also require reduction of erosion impacts.

Seismic Densification of Dry Soils

The potential for seismic densification is considered low based upon the relative density of the granular soils below the anticipated foundation of the lowest subterranean level. Therefore, no significant adverse impact related to seismic densification of dry soils would occur.

Expansive Soils

Based on the laboratory test results, the soils at 20 to 30 feet depth have a low expansion potential (EI values between 20 and 50), as defined in Table 18-I-B of the 2001 CBC. Therefore, no significant adverse impact related to expansive soils would occur.

Soil Corrosivity

Based on the chloride content, the on-site soils are not considered corrosive to rebar used for reinforced concrete. The resistivity test indicated minimum resistivity values of 1,660 and 2,356 ohmcentimeters for polyvinyl chloride (PVC) and ferrous metal, respectively. Based on the resistivity tests results, the on-site soil is not considered to be corrosive to PVC or plastic pipes. However, the on-site soil is considered to be moderately to highly corrosive to ferrous metals in direct contact with the soils.

4.5.4.4 Groundwater Conditions

As described in the *Geotechnical Report*, groundwater was encountered in four of the borings, namely B-1, B-2, B-3, and B-5, ranging from 76 feet to 84 feet below existing grade. However, groundwater in Boring B-4 drilled to 61.5 feet below the existing grade was not encountered. The historical high groundwater level for this site is deeper than 40 feet below the existing ground surface. Fluctuations of the groundwater level, localized zones of perched water, and an increase in soil moisture should be anticipated during and following the rainy seasons or periods of locally intense rainfall or storm water runoff. Therefore, the proposed project has the potential to be exposed to significant adverse impacts due to groundwater conditions.

4.5.4.5 Conclusions of the Geotechnical Report

Based on the exploration and analysis provided in the *Geotechnical Report*, Fuscoe Engineering concludes that the proposed project is feasible from a geotechnical standpoint, provided the recommendations presented in the report are implemented in the design and construction of the project. No significant geotechnical constraints were identified on site that cannot be mitigated to below a level of significance by proper planning, design, and sound construction practices.

The recommendations to ensure the stability of the structure given the geologic conditions of the site are provided in the *Geotechnical Report* in Appendix E of this DEIR. Recommendations are specific for a mat foundation which is anticipated to be the foundation-type used for the proposed project. However, these recommendations are preliminary and may change as the details of the project design are not yet finalized. As stated, impacts of the proposed project related to stability of the structure would be significant unless the project is designed and constructed in accordance with engineering measures that address the specific site conditions.

4.5.5 MITIGATION RELATED TO GEOLOGY AND SOILS

- G-1 Prior to issuance of a grading permit, a final geotechnical report that addresses site-specific geotechnical considerations will be submitted to the City Engineer for approval.
- G-2 Recommendations for grading/earthwork, surface, and subsurface drainage, temporary and/or permanent dewatering, foundations, pavement structural sections, seismic design, and other pertinent, geotechnical design considerations will be formulated and will be included in the grading and building plans for the proposed project.

4.5.6 LEVEL OF SIGNIFICANCE AFTER MITIGATION RELATED TO GEOLOGY AND SOILS

Mitigation measure W-3 provided in Section 4.7 (Hydrology and Water Quality) that requires the preparation and implementation of a SWPPP would reduce impacts related to erosion and loss of soils to a level that is less than significant.

With implementation of mitigation measures W-3, G-1 and G-2, the potential for significant adverse impacts related to geology and soils would be less than significant.