4.9 GEOLOGY AND SOILS

This section describes current conditions relative to geology and soils at the 1215 O Street Office Building project site. It includes a description of soils and mineral resources, analysis of environmental impacts, and recommendations for mitigation measures for any significant or potentially significant impacts. The primary source of information used for this analysis is the Draft Geotechnical Engineering Report prepared by Terracon Consultants, Inc. (Terracon 2016) (provided in Appendix G of this DEIR).

4.9.1 Regulatory Background

FEDERAL PLANS, POLICIES, REGULATIONS, AND LAWS

National Earthquake Hazards Reduction Act

In October 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act to reduce the risks to life and property from future earthquakes in the United States. To accomplish this, the act established the National Earthquake Hazards Reduction Program (NEHRP). The mission of NEHRP includes improved understanding, characterization, and prediction of hazards and vulnerabilities; improved building codes and land use practices; risk reduction through post-earthquake investigations and education; development and improvement of design and construction techniques; improved mitigation capacity; and accelerated application of research results. The NEHRP designates the Federal Emergency Management Agency (FEMA) as the lead agency of the program and assigns several planning, coordinating, and reporting responsibilities.

STATE PLANS, POLICIES, REGULATIONS, AND LAWS

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 (Public Resources Code [PRC] Section 2621-2630) intends to reduce the risk to life and property from surface fault rupture during earthquakes by regulating construction in active fault corridors, and by prohibiting the location of most types of structures intended for human occupancy across the traces of active faults. The act defines criteria for identifying active faults, giving legal support to terms such as active and inactive, and establishes a process for reviewing building proposals in Earthquake Fault Zones. Under the Alquist-Priolo Act, faults are zoned and construction along or across these zones is strictly regulated if they are “sufficiently active” and “well-defined.” A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the act as within the last 11,000 years). A fault is considered well defined if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface, using standard professional techniques, criteria, and judgment (Bryant and Hart 2007). Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults. The law addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards.

Seismic Hazards Mapping Act

The intention of the Seismic Hazards Mapping Act of 1990 (PRC Section 2690–2699.6) is to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including ground shaking, liquefaction, and seismically induced landslides. The act’s provisions are similar in concept to those of the Alquist-Priolo Act: The State is charged with identifying and mapping areas at risk of strong ground shaking, liquefaction, landslides, and other corollary hazards, and cities and counties are required to regulate development within mapped Seismic Hazard Zones. Under the Seismic Hazards Mapping Act, permit review is the primary mechanism for local regulation of development.

California Building Code

The California Building Code (CBC) (California Code of Regulations, Title 24) is based on the International Building Code. The CBC has been modified from the International Building Code for California conditions, with more detailed and/or more stringent regulations. Specific minimum seismic safety and structural design requirements are set forth in Chapter 16 of the CBC. The CBC identifies seismic factors that must be considered in structural design. Chapter 18 of the CBC regulates the excavation of foundations and retaining walls, while Chapter 18A regulates construction on unstable soils, such as expansive soils and areas subject to liquefaction. Appendix J of the CBC regulates grading activities, including drainage and erosion control. The CBC contains a provision that provides for a preliminary soil report to be prepared to identify "…the presence of critically expansive soils or other soil problems which, if not corrected, would lead to structural defects." (CBC Chapter 18 §1803.1.1.1).

LOCAL PLANS, POLICIES, REGULATIONS, AND LAWS

The 1215 O Street Office Building Project is located on State-owned property, has been authorized and funded by the State of California through the State Projects Infrastructure Fund, and would be implemented by the California Department of General Services (DGS). As explained in Section 4.2 "Land Use" of this EIR, under Section 4.2.1 "Local Plans, Policies, Regulations, and Laws," State agencies are not subject to local plans, policies, and zoning regulations. Nevertheless, in the exercise of its discretion, DGS does reference, describe, and address local plans, policies, and regulations that are applicable to the 1215 O Street Office Building Project. This evaluation is also intended to be used by local agencies for determining, as part of their permit process, the project's consistency with local plans, policies, and regulations.

City of Sacramento 2035 General Plan

The Environmental Constraints Element of the City of Sacramento 2035 General Plan outlines the City of Sacramento's (City's) goals and policies regarding seismic and geologic hazards. The following are those goals and policies most applicable to the 1215 O Street Office Building Project:

Goal EC 1.1 Hazards Risk Reduction. Protect lives and property from seismic and geologic hazards and adverse soil conditions.

- Policy EC 1.1.1 Review Standards. The City shall regularly review and enforce all seismic and geologic safety standards and require the use of best management practices (BMPs) in site design and building construction methods.

- Policy EC 1.1.2 Geotechnical Investigations. The City shall require geotechnical investigations to determine the potential for ground rupture, ground-shaking, and liquefaction due to seismic events, as well as expansive soils and subsidence problems on sites where these hazards are potentially present.

4.9.2 Existing Conditions

REGIONAL GEOLOGY

The site of the 1215 O Street Office Building Project is in the Sacramento Valley within the northern portion of the Great Valley geomorphic province. A "geomorphic province" is comprised of an area of similar geologic origin and erosional/depositional history. The Great Valley geomorphic province is an alluvial plain about 50 miles wide and 400 miles long in the central part of California, and is a trough in which sediments have been deposited almost continuously for tens of millions of years. Its northern area is the Sacramento Valley, drained by the Sacramento River, and its southern area is the San Joaquin Valley, drained by the San Joaquin River.

The Sacramento Valley is bounded by the foothills of the Sierra Nevada to the east, the Coast Ranges to the west, and the Cascade Range and Klamath Mountains to the north. The geology of the Great Valley geomorphic province incorporates thick sequences of alluvial sediments derived primarily from erosion of the Sierra Nevada to the east, and to a lesser extent from erosion of the Cascade and Klamath mountain ranges to the north. Sediments from these mountain ranges were transported downstream and laid down as river channel and floodplain deposits and alluvial fans. The thickness of the alluvial deposits in the project area is approximately 8,000 feet (Hackel 1966: Figure 1). The uppermost part of the alluvial plain is comprised of Holocene age (approximately 11,000 years ago to present time) Basin Deposits and Pleistocene age (2.5 million to 11,000 years before present) Riverbank Formation sediments.

LOCAL GEOLOGY

The project site and immediate vicinity is underlain by Holocene age terraced riverine alluvium deposits, consisting of cobble, gravel, sand, silt, and clay (California Geological Survey [CGS] 1999a). These deposits were laid down by the present-day stream and river systems that flow through the Sacramento area. Based on the findings of the preliminary geotechnical report (Terracon 2016), a total of nine strata were encountered beneath the 1215 O Street Office Building project site during site investigation activities. These strata consisted of interbedded layers of sand, silts, and gravels with shallow groundwater. Medium dense to very dense sands and gravels were encountered at depths between 40 and 90 feet below ground surface (bgs). Very dense to hard sands and silts were encountered below 90 feet bgs.

TOPOGRAPHY AND DRAINAGE

The project site is in a flat, urban area devoid of slopes. The site has been graded as part of urban development and is almost completed covered by impervious surfaces including an existing office building, a surface parking lot, street, alley, and sidewalk. There are no drainages or waterways on the project site. All stormwater enters the City of Sacramento Combined Sewer System which collects and conveys both stormwater and wastewater.

GROUNDWATER

The Sacramento area is underlain by geologic formations that include an upper, unconfined groundwater/aquifer system (able to receive water that infiltrates from the surface) and a lower semiconfined groundwater/aquifer system (infiltration of water can be partially blocked by impermeable layers). Depth to groundwater in the downtown area varies seasonally, is relatively shallow (can be less than 10 feet to the water table), with no predominant direction of groundwater flow (Sacramento Central Groundwater Authority 2012). Data collected in support of the preliminary geotechnical report (Terracon 2016) showed groundwater being encountered at a depth of approximately 17 feet bgs at the 1215 O Street Office Building project site.

SOILS

Borings were used to collect samples at the project site to identify subsurface soil characteristics. The following discussion summarizes the results of the soil investigations and is based on two exploratory test borings completed to date, to a depth of approximately 101.5 feet bgs (Terracon 2016).

Based on data provided in the November 29, 2016 Environmental Data Resources, Inc. Radius Map Report (provided in Appendix F of the Phase 1 Environmental Site Assessment included as Appendix H of this EIR), the soil at and surrounding the 1215 O Street Office Building project site is classified as Urban Land of variable surface texture and as non-hydric. Soils of this variety are characterized by heavy alteration from their natural character by urban land uses. Soil composition may have been altered during construction of structures and paved surfaces. Grading, excavation, and placement of fill are common construction practices and contribute to soil mixing and altered composition of soil.

Natural soil complexes that comprised the original, unaltered soil horizon have been truncated, mixed, or otherwise altered. Where native soils still exist, soil types are expected to be similar to those of nearby areas, consisting of those identified in Table 4.9-1 (USDA SCS 1985). In their unaltered state, most of these soils have low to moderate shrink-swell potential, but rarely can have high shrink-swell characteristics. Taken together, these soils are susceptible to a variety of soil risk factors such as shallow hardpan, shallow bedrock, caving, flooding, and low strength. Construction on these soils generally requires design features that reduce or eliminate structural damage or failure risks.

Table 4.9-1 Summary of Soil Characteristics

Soil Group	Texture	Shrink-Swell Potential	Risk and Restrictive Soil Features for Building-Site Development
Americanos	Silt loam, sandy loam	Low	Slight to moderate: low strength
Andregg	Coarse sandy loam, weathered bedrock	Low	Slight to moderate: depth to bedrock
Argonaut	Loam, clay loam, gravelly clay loam, gravelly loam, weathered bedrock	Low to high	Moderate to severe: depth to rock, too clayey, shrink-swell, low strength
Auburn	Loam, unweathered bedrock	Low	Severe: depth to rock
Columbia	Sandy loam, stratified sand to silt loam, clay loam, silty clay loam, clay	Low to high	Moderate to severe: cutbanks cave, flooding, shrink-swell, droughty
Cosumnes	Silt loam, stratified silty clay loam to clay, stratified clay loam to clay	Low to high	Slight to severe: too clayey, wetness, flooding, shrink-swell, low strength
Egbert	Clay, silty clay loam, clay, stratified clay loam to clay loam	Moderate to high	Moderate to severe: too clayey, wetness, flooding, shrink-swell, low strength
Fiddyment	Fine sandy loam, loam, sandy clay loam, coarse sandy loam	Low to moderate	Moderate to severe: depth to rock, cemented pan, shrink-swell, slope, low strength, droughty
Galt	Clay, silty clay, cemented	High	Severe: cemented pan, cutbanks cave, shrink-swell, low strength, too clayey
Hedge	Loam, fine sandy loam, clay loam, sandy clay loam, cemented, sandy loam	Low to moderate	Moderate to severe: wetness, flooding, cemented pan
Kaseberg	Loam, indurated, weathered bedrock	Low	Moderate to severe: depth to rock, cemented pan, slope
Kimball	Silt loam, clay, clay loam, sandy clay loam, sandy loam	Low to high	Slight to severe: too clayey, shrink- swell, low strength
Lang	Fine sandy loam, stratified sand to loamy fine sand	Low	Moderate to severe: cutbanks cave flooding, droughty
Laugenour	Loam, fine sandy loam, sandy loam, stratified very fine sandy loam to loam	Low	Slight to severe: wetness, flooding
Liveoak	Sandy clay loam, sandy loam, stratified gravelly loamy coarse sand to sandy loam	Low	Slight to severe: cutbanks cave, flooding
Natomas	Loam, clay loam, stratified gravelly coarse sandy loam to sandy loam	Low to moderate	Slight to moderate: shrink-swell, low strength
Orangevale	Coarse sandy loam, sandy clay loam	Low to moderate	Slight to moderate: shrink-swell, slope, droughty
Orthents	Not identified		
Red Bluff	Loam, clay loam, gravelly clay loam gravelly clay, very gravelly clay loam, very gravelly clay	Low to moderate	Slight to moderate: too clayey, shrink-swell, low strength
Rossmoor	Fine sandy loam, sandy loam	Low	Slight to severe: flooding
Sailboat	Silt loam, stratified sandy loam to silty clay loam, stratified sandy clay loam to silty clay loam, stratified loam to silt loam	Low to moderate	Slight to severe: wetness, flooding, low strength, shrink-swell

Table 4.9-1 Summary of Soil Characteristics

Soil Group	Texture	Shrink-Swell Potential	Risk and Restrictive Soil Features for Building-Site Development
San Joaquin	Silt loam, clay loam, clay, indurated, stratified sandy loam to loam	Low to high	Moderate to severe: cemented pan, shrink-swell, low strength, droughty
Tinnin	Loamy sand, loamy coarse sand, loamy sand, sand	Low	Slight to severe: cutbanks cave, slope, droughty
Valpac	Loam, stratified sandy loam to silty clay loam	Low to moderate	Slight to severe: wetness, flooding, shrink-swell
Xerarents	Not identified		

Source: USDA SCS 1985

SUBSIDENCE

Land subsidence is the gradual settling or sinking of an area with very little horizontal motion. Subsidence can be induced by both natural and human phenomena. Natural phenomena include shifting of tectonic plates and dissolution of limestone resulting in sinkholes. Subsidence related to human activity includes pumping water, oil, and gas from underground reservoirs; collapse of underground mines; drainage of wetlands; and soil compaction. The results of a geotechnical investigation (Terracon 2016) conducted beneath the project site identified potentially compressible soils at depths shallower than 30 feet. Although the project site and surrounding area is in an area of potential subsidence if there is sufficient groundwater withdrawal (City of Sacramento 2014), there is no reported evidence of subsidence in the immediate area of the project site.

EXPANSIVE SOILS

Expansive soils (also known as shrink-swell soils) are soils that contain expansive clay minerals that can absorb significant amounts of water. The presence of these clay minerals makes the soil prone to large changes in volume in response to changes in water content. When an expansive soil becomes wet, water is absorbed and it increases in volume, and as the soil dries it contracts and decreases in volume. This repeated change in volume over time can produce enough force and stress on buildings, underground utilities, and other structures to damage foundations, pipes, and walls.

The quantity and type of expansive clay minerals affects the potential for the soil to expand or contract. Where native soils still exist, soil types may be expected to be similar to those of the nearby areas. These soil types exhibit a range in shrink-swell potential from low to high (Table 4.9-1). However, potentially expansive soils were not identified in the geotechnical investigation conducted by Terracon (2016).

MASS WASTING AND LANDSLIDES

Mass wasting refers to the collective group of processes that characterize down slope movement of rock and unconsolidated sediment overlying bedrock. These processes include landslides, slumps, rockfalls, flows, and creeps. Many factors contribute to the potential for mass wasting, including geologic conditions as well as the drainage, slope, and vegetation of the site. A landslide susceptibility database developed by CGS (2011) indicates that the project site is located in an area where land sliding is not expected due to the site being located on a topographically flat area on the valley floor within the floodplain of the Sacramento River. With such minor topographic relief, the probability of a landslide is considered nonexistent.

SEISMICITY

Most earthquakes originate along fault lines. A fault is a fracture in the Earth’s crust along which rocks on one side are displaced relative to those on the other side due to shear and compressive crustal stresses. Most faults are the result of repeated displacement that may have taken place suddenly and/or by slow creep (Bryant and Hart 2007). The state of California has a classification system that designates faults as either active, potentially active, or inactive, depending on how recently displacement has occurred along them. Faults that show evidence of movement within the last 11,000 years (the Holocene geologic period) are considered active, and faults that have moved between 11,000 and 1.6 million years ago (comprising the later Pleistocene geologic period) are considered potentially active.

A review of available published geologic and seismic hazards maps indicates that there are no known active faults identified in or adjacent to the City of Sacramento. In addition, there has been no documented movement on faults mapped in Sacramento County during the past 150 years. However, the region has experienced numerous instances of groundshaking originating from faults in other areas. The closest known potentially active fault mapped by the California Geological Survey is the Dunnigan Hills fault located about 20 miles northwest of Sacramento, with the closest branches of the seismically active San Andreas Fault System (Historic activity, i.e., within the last 200 years) being the Green Valley and Concord faults, 43 and 50 miles to the southwest, respectively. The main trace of the San Andreas Fault System is approximately 80 miles to the southwest. Active nearby faults identified within 100 miles of the project area are listed on Table 4.9-2.

Table 4.9-2 Active Nearby Faults Within 100 Miles of the Project Area

Fault Name	Distance from Fault to Project Site (Miles)	Age of Movement	Characteristic Earthquake (moment magnitude)
Dunnigan Hills	20	Holocene (<11,000 years)	6.6[1]
Vaca	28	Quaternary	6.1[1]
Foothills, N central section	30	Quaternary (<130,000 years)	6.0[2, 3]
Foothills, S central section	36	Quaternary	6.0[2,3]
Greenville	43	Holocene	6.6
Green Valley	43	Recent (<150 years)	6.2
Cordelia	43	Holocene (<11,000 years)	NA
Concord	50	Recent	6.2
Healdsburg / Rogers Creek	56	Quaternary / Holocene	7.1
Hayward	61	Recent	6.9 – 7.1
Calaveras	61	Holocene	7.5
San Andreas	80	Recent	7.9

Notes: [1] Wesnousky, S.G., 1986
[2] General Plan, 2011
[3] Richter scale magnitudes
Source: Jennings and Bryant 2010

Seismic hazards resulting from earthquakes include surface fault rupture, ground shaking, and liquefaction. Each of these potential hazards is discussed below.

Surface Fault Rupture

Surface rupture is the surface expression of movement along a fault. Structures built over an active fault can be torn apart if the ground ruptures. The potential for surface rupture is based on the concepts of recency and recurrence. Surface rupture along faults is generally limited to a linear zone a few meters wide. The Alquist-Priolo Act (see the Regulatory Setting discussion above) was created to prohibit the location of structures designed for human occupancy across, or within 50 feet of, an active fault, thereby reducing the loss of life and property from an earthquake. The project site is not located within an Alquist-Priolo active fault zone (Bryant and Hart 2007), and there is no evidence of active faulting within or near the project site.

Ground Shaking

The intensity of seismic shaking, or strong ground motion, during an earthquake is dependent on the distance and direction from the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions of the surrounding area. Ground shaking could potentially result in the damage or collapse of buildings and other structures. The probable seismic ground shaking expected at the project site is anticipated to produce peak ground accelerations between 10 and 20 percent of the acceleration of gravity; 0.1g and 0.2g, respectively (California Department of Conservation 2002, Probabilistic Seismic Hazard Assessment Maps). Earthquake intensities generally associated with this amount of ground shaking are typically between VI and VII on the Modified Mercalli Intensity Scale (MMI) (Table 4.9-3). An expected characteristic earthquake on the entire San Andreas Fault System is a Moment Magnitude scale (Mw) of 7.9 and is probably the largest earthquake that would be felt in the project site. Given the distance between the San Andreas Fault and the project site, the felt intensity would be expected to be between MMI IV and V (light to moderate shaking). However, a felt intensity between MMI VII and VIII would be caused by a characteristic earthquake on the Dunnigan Hills fault of Mw 6.6 because it is much closer to the project area.

Overall, the project site is located in an area of low earthquake hazard and therefore experience low levels of ground shaking on an infrequent basis (CGS 2003). Based in data from the CGS (2008), the project site would be expected to have 2 percent chance in 50 years to experience a ground motion of 0.318 g.

Table 4.9-3 The Modified Mercalli Scale of Earthquake Intensities

If most of these effects are observed	Then the intensity is
Earthquake shaking not felt but people may observe marginal effects of large distance earthquakes without identifying these effects as earthquake-caused. Among them: trees, liquids, bodies of water sway slowly, or doors swing slowly.	I
Effect on people: Shaking felt by those at rest, especially if they are indoors, and by those on upper floors.	II
Effect on people: Felt by most people indoors. Some can estimate duration of shaking but many may not recognize shaking of building as caused by an earthquake; the shaking is like that caused by the passing of light trucks.	III
Other effects: Hanging objects swing. Structural effects: Windows or doors rattle. Wooden walls and frames creak.	IV
Effect on people: Felt by everyone indoors and by most people outdoors. Many now estimate not only the duration of shaking but also its direction and have no doubt as to its cause. Sleepers wakened. Other effects: Hanging objects swing. Standing autos rock. Crockery clashes, dishes rattle or glasses clink. Structural effects: Doors close, open or swing. Windows rattle.	V
Effect on people: Felt by everyone indoors and by most people outdoors. Many now estimate not only the duration of shaking but also its direction and have no doubt as to its cause. Sleepers wakened. Other effects: Hanging objects swing. Shutters or pictures move. Pendulum clocks stop, start, or change rate. Standing autos rock. Crockery clashes, dishes rattle or glasses clink. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Structural effects: Weak plaster and Masonry D* crack. Windows break. Doors close, open, or swing.	VI
Effect on people: Felt by everyone. Many are frightened and run outdoors. People walk unsteadily. Other effects: Small church or school bells ring. Pictures thrown off walls, knickknacks and books off shelves. Dishes or glasses broken. Furniture moved or overturned. Trees, bushes shaken visibly, or heard to rustle. Structural effects: Masonry D* damaged; some cracks in Masonry C*. Weak chimneys break at roof line. Plaster, loose bricks, stones, tiles, cornices, unbraced parapets, and architectural ornaments fall. Concrete irrigation ditches damaged.	VII
Effect on people: Difficult to stand. Shaking noticed by auto drivers. Other effects: Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Furniture broken. Hanging objects quiver. Structural effects: Masonry D* heavily damaged; Masonry C* damaged, partially collapses in some cases; some damage to Masonry B*; none to Masonry A*. Stucco and some masonry walls fall. Chimneys, factory stacks, monuments, towers, elevated tanks twist or fall. Frame houses move on foundation if not bolted down; loose panel walls thrown out. Decayed piling broken off.	VIII
Effect on people: General fright. People thrown to ground. Other effects: Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes. Steering of autos affected. Branches broken from trees.	IX

Table 4.9-3 The Modified Mercalli Scale of Earthquake Intensities

If most of these effects are observed	Then the intensity is
Structural effects: Masonry D* destroyed; Masonry C* heavily damaged, sometimes with complete collapse; Masonry B* is seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frames cracked. Reservoirs seriously damaged. Underground pipes broken.	
Effect on people: General panic. Other effects: Conspicuous cracks in ground. In areas of soft ground, sand is ejected through holes and piles up into a small crate, and, in muddy areas, water fountains are formed. Structural effects: Mast masonry and frame structures destroyed along with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, and embankments. Railroads bent slightly.	X
Effect on people: General panic. Other effects: Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Structural effects: General destruction of buildings. Underground pipelines completely out of service. Railroads bent greatly.	XI
Effect on people: General panic. Other effects: Same as for Intensity X. Structural effects: Damage nearly total, the ultimate catastrophe. Other effects: Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.	XII

* Masonry A: Good workmanship and mortar, reinforced, designed to resist lateral forces.
* Masonry B: Good workmanship and mortar, reinforced.
* Masonry C: Good workmanship and mortar, unreinforced.
* Masonry D: Poor workmanship and mortar and weak materials, like adobe.

Liquefaction and Lateral Spreading

Liquefaction is a phenomenon in which loose, saturated, granular soil deposits lose a significant portion of their shear strength because of excess pore water pressure buildup. An earthquake, typically causes the increase in pore water pressure and subsequent liquefaction. These soils are behaving like a liquid during seismic shaking and re-solidify when shaking stops. The potential for liquefaction is highest in areas with high groundwater and loose, fine, sandy soils at depths of less than 50 feet. Based on mapping conducted pursuant to the Alquist-Priolo Act, the project site and surrounding area are not identified as located within an area of potential liquefaction (Bryant and Hart 2007). However, a geotechnical investigation conducted (Terracon 2016) beneath the project site did identify groundwater at approximately 17 feet bgs and potentially liquefiable and compressible soils at depths shallower than 30 feet. Another geological and seismological study in 1972 in the downtown area indicated the potential for liquefaction (Sacramento County 2011). This study also concluded that potential liquefaction problems may exist throughout the downtown area where loose sands and silts are present below the ground water table. However, there have been no reported instances of liquefaction occurring in downtown Sacramento during major earthquake events, including the Loma Prieta earthquake in 1989, the Vacaville-Winters earthquake in 1982, or the San Francisco earthquake in 1906 (DGS 2005).

Liquefaction may also lead to lateral spreading. Lateral spreading (also known as expansion) is the horizontal movement or spreading of soil toward an “open face,” such as a streambank, the open side of fill embankments, or the sides of levees. It often occurs in response to liquefaction of soils in an adjacent area. The potential for failure from lateral spreading is highest in areas where there is a high groundwater table, where there are relatively soft and recent alluvial deposits, and where creek banks are relatively high. The Sacramento River is located approximately one mile to the west of the project site and could offer a potential opportunity for lateral spreading. However, because the project site and vicinity are on flat terrain and relatively distant from the Sacramento river, lateral spreading caused by liquefaction is not expected to be a concern.

MINERAL RESOURCES

The California Department of Conservation Division of Mines and Geology has developed guidelines for the classification and designation of mineral lands, known as Mineral Resource Zones (MRZs), and retains publications of the Surface Mining and Reclamation Act (SMARA) Mineral Land Classification Project dealing with mineral resources in California. The project site is located within a mapped MRZ and is designated MRZ-1, areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence (CGS 1999b).

4.9.3 Environmental Impacts and Mitigation Measures

ANALYSIS METHODOLOGY

The examination of geology, soils, and mineral resources is based on information obtained from reviews of:

- the project description;
- available literature, including documents published by the City, the County of Sacramento, State and federal agencies, and published information dealing with geotechnical conditions in the Sacramento area;
- applicable elements from the County of Sacramento General Plan and the City of Sacramento General Plan; and
- Draft Geotechnical Engineering Report prepared for the 1215 O St. Office Building Project (Appendix G).

THRESHOLDS OF SIGNIFICANCE

A geology and soils impact is considered significant if implementation of the 1215 O Street Office Building Project would do any of the following:

- expose people or structures to potential substantial adverse impacts, including risk of loss, injury, or death through the rupture of a known earthquake fault, strong seismic shaking, seismic-related ground failure, soil liquefaction, or landslides;
- locate project facilities on a geologic unit that is unstable, or that would become unstable as a result of the 1215 O Street Office Building Project, and potentially result in on-site or off-site lateral spreading, subsidence, liquefaction, or collapse;
- locate project facilities on expansive soil, creating substantial risks to property;
- result in substantial soil erosion or the loss of topsoil; or
- result in the loss of a known statewide, regional, or locally-important mineral resource.

ISSUES OR POTENTIAL IMPACTS NOT DISCUSSED FURTHER

The topography of the project site in downtown Sacramento is flat. Therefore, there is little to no potential for lateral spreading and landslides. Therefore, impacts associated with lateral spreading and landslides are not discussed further in this DEIR.

The project site is not located on soils susceptible to subsidence. No soft clay–type materials that would undergo long-term settlement were encountered in borings beneath the project site. Borehole data indicate medium stiff to hard silts and clays. On-site subsidence is not expected to occur and subsidence is not discussed further in this DEIR. The project site is an urban site developed with an office building, impervious surfaces, and landscaping. Because of the developed conditions of the sites and their generally flat topography, the proposed project would not generate the potential for substantial soil erosion or loss of topsoil. Grading, trenching, and excavation during construction can temporarily expose soil to erosive forces such as wind and stormwater. Such effects are addressed in Section 4.10, “Hydrology and Water Quality,” and are not addressed in this section.

The project site is located within a mapped MRZ and is designated MRZ-1, areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence (CGS 1999b). There is no evidence that there are important mineral resources underlying the project site and potential effects on mineral resources are not discussed further in this DEIR.

ENVIRONMENTAL IMPACTS

Impact 4.9-1: Seismic hazards

The project site is not located on any known faults or traces of active faults. Surface fault rupture, therefore, is extremely unlikely. Construction of the proposed facilities would conform to the current CBC, which contains specifications to minimize adverse effects on structures caused by ground shaking from earthquakes and to minimize secondary seismic hazards (i.e., ground lurching, liquefaction). Through conformance with the CBC and implementation of site-specific engineering measures developed in compliance with these codes, development of this project alternative would not result in exposure of people or structures to substantial adverse effects related to seismic hazards, nor would the project have the potential to exacerbate these hazards. This impact would be **less than significant.**

Although the Sacramento area is located between three seismically active fault regions, the project site would not be located on any known faults or traces of active faults. Surface fault rupture, therefore, is extremely unlikely.

In the event of a major earthquake, people and structures would be exposed to moderate to severe ground shaking. Potential secondary effects of ground shaking at the project site include seismic shaking and liquefaction.

The potential for seismic shaking and associated formation of cracks in the ground is considered greater at contacts between materials with substantially different properties, such as deep, soft soil and bedrock. These conditions were not found at the project site, and the probability of ground lurching and formation of cracks in the ground during a seismic event is considered low.

Construction of the project would conform to the current CBC, which contains specifications to minimize adverse effects on structures caused by ground shaking from earthquakes. Through conformance with the CBC and implementation of site-specific engineering measures developed in compliance with these codes, development of the project would not result in exposure of people or structures to substantial adverse effects related to seismic hazards. The impact would be **less than significant.**

Mitigation Measures

No mitigation is required.

Impact 4.9-2: Liquefaction

The project site is located in an area of potential liquefaction based on the findings of the geotechnical investigation performed by Terracon and from previous investigations in the area. Construction of the proposed facilities would conform to the current CBC, which contains specifications to minimize adverse effects on structures caused by liquefaction. Through conformance with the CBC and implementation of site-specific engineering measures developed in compliance with these codes, development of this project alternative would not result in exposure of people or structures to substantial adverse effects related to liquefaction. This impact would be less than significant.

The soils beneath the project site are susceptible to liquefaction, and potential liquefaction problems may exist throughout the downtown area where loose sands and silts are present below the ground water table. However, there have been no reported instances of liquefaction occurring in downtown Sacramento during past major earthquake events.

Lateral spreading occurs when soils liquefy and the overlying soils move horizontally or down a slope. Because the topography at the project site is relatively flat, the potential for lateral spreading is considered generally low.

Construction of the proposed facilities would conform to the current CBC, which contains specifications to minimize adverse effects on structures caused by liquefaction. Through conformance with the CBC and implementation of site-specific engineering measures developed in compliance with these codes, development of this project alternative would not result in exposure of people or structures to substantial adverse effects related to liquefaction. The impact would be less than significant.

Mitigation Measures

No mitigation is required.

Impact 4.9-3: Expansive soils

The project site is located in an area where native soils may still exist, and these soil types exhibit a range in shrink-swell potential from low to high. However, potentially expansive soils were not identified in a geotechnical investigation beneath the project site. Through conformance with the CBC and implementation of applicable measures (if needed) to address shrink-swell soils, development of the project would not result in exposure of people or structures to substantial adverse effects from these soil types. This impact would be less than significant.

The soils beneath the project site are not susceptible to expansion. It is not expected that shrink-swell soils would adversely affect underground facilities associated with the project. However, construction of project facilities would conform to the current CBC, which contains specifications to address shrink-swell soils where they might occur.

Through conformance with the CBC and implementation of applicable measures (if needed) to address shrink-swell soils, development of the project would not result in exposure of people or structures to substantial adverse effects from these soil types. This impact would be less than significant.

Mitigation Measures

No mitigation is required.

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