3.6 - Geology, Soils, and Seismicity

3.6.1 - Introduction

This section describes the existing geology, soils, and seismicity setting and potential direct and indirect effects from project implementation on the site and its surrounding area. Descriptions and analysis in this section are based on information provided by the City of Elk Grove General Plan, City of Elk Grove Zoning Ordinance, 2011 County of Sacramento General Plan, 2009 Sacramento County General Plan Update Draft Environmental Impact Report, and applicable state laws.

3.6.2 - Environmental Setting

Regional Geology

The Elk Grove Sphere of Influence Amendment (SOIA) Area is located within the San Joaquin Valley, in the northern section of the Great Valley geomorphic province. The Great Valley geomorphic province is described as a relatively flat alluvial plain consisting of sedimentary deposits dated from the Jurassic age through the Holocene age. The province is approximately 50 miles wide and 400 miles long, bounded by the Klamath and Cascade mountain ranges to the north, the Sierra Nevada to the east, and the California Coast Mountains to the west. The major topographical feature in the Sacramento Valley is the Sutter Buttes, which is a volcanic remnant that rises approximately 1,980 feet above the valley floor.

The Great Valley province is divided into four smaller geomorphic subunits: the Delta, the River Floodplain, the Alluvial Plain, and the Low Foothills.

The Delta

The Delta includes the low-lying lands located in the southwestern portion of the County. Historically, the Delta contained tidal marshes and meandering sloughs, which have been altered over time. The area now contains present era, Holocene deposits.

River Floodplain

The River Floodplain contains unconsolidated, inorganic soils, which were formed by the deposition of sediment when floodwaters overtopped the natural levees of the County’s rivers and major streams.

Alluvial Plain

The Alluvial Plain subunit is located to the east of the River Floodplain. This subunit contains older Quaternary deposits and is underlain by layers of dense, impervious clay hardpan.

Low Foothills

The Low Foothills subunit is located to the east of the alluvial plain. This subunit contains moderately consolidated silts, sands, and clays of continental origin.

Regional Seismicity

Seismicity is defined as the geographic and historical distribution of earthquakes, or more simply, earthquake activity. Seismic activity may result in geologic and seismic hazards, including seismically induced fault displacement and rupture, ground shaking, liquefaction, lateral spreading, landslides and avalanches, and structural hazards.

To understand the implications of seismic events, discussions of faulting and seismic hazards are provided below.

Faulting

Earthquake activity is intrinsically related to the distribution of fault systems (i.e., faults or fault zones) in a particular area. A fault is defined as a fracture or zone of closely associated fractures along which rocks on one side have been displaced with respect to those on the other side. Depending on activity patterns, faults and fault-related geologic features may be classified as active, potentially active, or inactive.

Faults form in rocks when stresses overcome the internal strength of the rock, resulting in a fracture. Large faults develop in response to large, regional stresses operating over a long time, such as those stresses caused by the relative displacement between tectonic plates. According to the elastic rebound theory, these stresses cause strain to build up in the earth's crust until enough strain has built up to exceed the strength along a fault and cause a brittle failure. The slip between the two stuck plates or coherent blocks generates an earthquake. Following an earthquake, strain will build once again until the occurrence of another earthquake. The magnitude of slip is related to the maximum allowable strain that can be built up along a particular fault segment. The greatest buildup in strain that is due to the largest relative motion between tectonic plates or fault blocks over the longest period of time will generally produce the largest earthquakes. The distribution of these earthquakes is a study of much interest for both hazard prediction and the study of active deformation of the earth's crust. Deformation is a complex process, and strain caused by tectonic forces is not only accommodated through faulting but also by folding, uplift, and subsidence, which can be gradual or in direct response to earthquakes.

Faults are mapped to determine earthquake hazards, since they occur where earthquakes tend to recur. A historic plane of weakness is more likely to fail under stress and strain than a previously unbroken block of crust. Faults are therefore a prime indicator of past seismic activity, and faults with recent activity are presumed to be the best candidates for future earthquakes. However, since slip is not always accommodated by faults that intersect the surface along traces, and since the orientation of stresses and strain in the crust can shift, predicting the location of future earthquakes is complicated. Earthquakes sometimes occur in areas with previously undetected faults or along faults previously thought inactive.

No active faults or Alquist-Priolo earthquake hazard zone have been identified in the Elk Grove SOIA Area (Sacramento County 2009). Several inactive subsurface faults have been identified in the Delta region, ranging in distance from 21 to 94 miles from the SOIA Area. The faults nearest to the Elk Grove SOIA Area are summarized in Table 3.6-1.

Table 3.6-1: Fault Summary

Fault	Approximate Distance from SOIA Area (miles)	Maximum Credible Earthquake Magnitude (MCE)[1]
Foothills Fault System	21	6.5
Great Valley Fault (segment 5)	27	6.5
Great Valley Fault (segment 4)	29	6.6
Greenville Fault	41	6.9
Concord-Green Valley Fault	42	6.9
Huntington Creek-Berryessa Fault	45	6.9
West Napa Fault	49	6.5
Calaveras Fault	50	6.8
Rodgers Creek	56	7.0
Hayward Fault	59	7.1
Bartlett Springs Fault	72	7.1
Maacama Fault (south)	73	6.9
Collayomi Fault	76	6.5
Ortigalita Fault	76	6.9
San Andreas Fault (1906)	76	7.9
San Gregorio Fault	78	7.3
Monte Vista-Shannon Fault	80	6.8
Mohawk Valley-Honey Lake Fault Zone	82	7.3
Point Reyes Fault	82	6.8
Genoa	87	6.9
Sargent	91	6.8
Zayante-Vergeles	94	6.8

Note:
[1] According to the California Department of Transportation, the Maximum Credible Earthquake Magnitude (MCE) is defined as the maximum intensity earthquake that is assumed to occur closest to the site. This earthquake is also described as the maximum magnitude earthquake, or maximum earthquake.
Source: City of Elk Grove, 2003

Seismic Hazards

Seismicity describes the effects of seismic waves that are radiated from an earthquake as it ruptures. While most of the energy released during an earthquake results in the permanent displacement of the ground, as much as 10 percent of the energy may dissipate immediately in the form of seismic waves. Seismic hazards pose a substantial danger to property and human safety and are present because of the risk of naturally occurring geologic events and processes impacting human development. Therefore, the hazard is influenced as much by the conditions of human development as by the frequency and distribution of major geologic events. Seismic hazards present in California include ground rupture along faults, strong seismic shaking, liquefaction, ground failure, landsliding, and slope failure.

Fault Rupture

Fault rupture is a seismic hazard that affects structures sited above an active fault. The hazard from fault rupture is the movement of the ground surface along a fault during an earthquake. Typically, this movement takes place during the short time of an earthquake, but it also can occur slowly over many years in a process known as creep. Most structures and underground utilities cannot accommodate the surface displacements of several inches to several feet commonly associated with fault rupture or creep.

Ground Shaking

The severity of ground shaking depends on several variables such as earthquake magnitude, epicenter distance, local geology, thickness, seismic wave-propagation properties of unconsolidated materials, groundwater conditions, and topographic setting. Ground shaking hazards are most pronounced in areas near faults or with unconsolidated alluvium.

Earthquakes are measured either on energy released (Richter Magnitude scale) or the intensity of ground shaking at a particular location (Modified Mercalli scale). The Richter Magnitude scale measures the magnitude of an earthquake based on the logarithm of the amplitude of waves recorded by seismographs, with adjustments made for the variation in the distance between the various seismographs and the epicenter of the earthquake. This scale starts with 1.0 and has no maximum limit. The scale is logarithmic—an earthquake with a magnitude of 2.0 is 10 times the magnitude (30 times the energy) of an earthquake with a magnitude of 1.0. The Modified Mercalli scale is an arbitrary measure of earthquake intensity; it does not have a mathematical basis. This scale is composed of 12 increasing levels of intensity that range from imperceptible shaking (Scale I) to catastrophic destruction (Scale XII). The Modified Mercalli Intensity Scale is summarized in Table 3.6-2.

Based on observations of damage from recent earthquakes in California (e.g., San Fernando 1971, Whittier-Narrows 1987, Landers 1992, Northridge 1994), ground shaking is responsible for 70 to 100 percent of all earthquake damage. The most common type of damage from ground shaking is structural damage to buildings, which can range from cosmetic stucco cracks to total collapse. The overall level of structural damage from a nearby large earthquake would likely be moderate to heavy, depending on the characteristics of the earthquake, the type of ground, and the condition of the building. Besides damage to buildings, strong ground shaking can cause severe damage from falling objects or broken utility lines. Fire and explosions are also hazards associated with strong ground shaking.

While Richter magnitude provides a useful measure of comparison between earthquakes, the moment magnitude is more widely used for scientific comparison since it accounts for the actual slip that generated the earthquake. Actual physical damage is due to the propagation of seismic or ground waves as a result of initial failure, and the intensity of shaking is as much related to earthquake magnitude as is the condition of underlying materials. Loose materials tend to amplify ground waves, while hard rock can quickly attenuate them, causing little damage to overlying structures.

Table 3.6-2: Modified Mercalli Intensity Scale

Richter Magnitude	Modified Mercalli Intensity	Effects	Average Peak Ground Velocity (centimeters/seconds	Average Peak Acceleration
0.1–0.9	I	Not felt. Marginal and long-period effects of large earthquakes.	—	—
1.0–2.9	II	Felt by only a few persons at rest, especially on upper floors of building. Delicately suspended objects may swing.	—	—
3.0–3.9	III	Felt quite noticeable in doors, especially on upper floors of building, but many people do not recognize it as an earthquake. Standing cars may rock slightly. Vibration like passing a truck. Duration estimated.	—	0.0035–0.007 g
4.0–4.5	IV	During the day, felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensations like heavy truck striking building. Standing cars rocked noticeably.	1–3	0.015–0.035 g
4.6–4.9	V	Felt by nearly everyone, many awakened. Some dishes, windows, broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.	3–7	0.035–0.07 g

Table 3.6-2 (cont.): Modified Mercalli Intensity Scale

Richter Magnitude	Modified Mercalli Intensity	Effects	Average Peak Ground Velocity (centimeters/seconds	Average Peak Acceleration
5.0–5.5	VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of falling plaster and damaged chimneys. Damage slight.	7–20	0.07–0.15 g
5.6–6.4	VII	Everyone runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well built, ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars.	20–60	0.15–0.35 g
6.5–6.9	VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monument walls, and heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving in cars disturbed.	60–200	0.35–0.7 g
7.0–7.4	IX	Damage considerable in specially designed structures; well-designed frame strictures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	200–500	0.7–1.2 g
7.5–7.9	X	Some well-built structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Railway lines bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks.	≥ 500	>1.2 g
8.0–8.4	XI	Few, if any masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	—	—
≥ 8.5	XII	Total damage. Waves seen on ground. Lines of sight and level distorted. Objects thrown into the air.	—	—
Source: United States Geologic Survey, 2010.				

Ground Failure

Ground failure includes liquefaction and the liquefaction-induced phenomena of lateral spreading, as well as lurching.

Liquefaction is a process by which sediments below the water table temporarily lose strength during an earthquake and behave as a viscous liquid rather than a solid. Liquefaction is restricted to certain geologic and hydrologic environments, primarily recently deposited sand and silt in areas with high groundwater levels. The process of liquefaction involves seismic waves passing through saturated granular layers, distorting the granular structure, and causing the particles to collapse. This causes the granular layer to behave temporarily as a viscous liquid, resulting in liquefaction.

Liquefaction can cause the soil beneath a structure to lose strength, which may result in the loss of foundation-bearing capacity. This loss of strength commonly causes the structure to settle or tip. Loss of bearing strength can also cause light buildings with basements, buried tanks, and foundation piles to rise buoyantly through the liquefied soil.

Lateral spreading is lateral ground movement, with some vertical component, caused by liquefaction. In effect, the soil rides on top of the liquefied layer. Lateral spreading can occur on relatively flat sites with slopes less than 2 percent, under certain circumstances, and can cause ground cracking and settlement.

Lurching is the movement of the ground surface toward an open face when the soil liquefies. An open face could be a graded slope, stream bank, canal face, gully, or other similar feature.

Landslides and Slope Failure

Landslides and other forms of slope failure form in response to the long-term geologic cycle of uplift, mass wasting, and disturbance of slopes. Mass wasting refers to a variety of erosional processes from gradual downhill soil creep to mudslides, debris flows, landslides and rock fall—processes that are commonly triggered by intense precipitation, which varies according to climactic shifts. Often, various forms of mass wasting are grouped together as landslides, which are generally used to describe the downhill movement of rock and soil.

Geologists classify landslides into several different types that reflect differences in the type of material and type of movement. The four most common types of landslides are translational, rotational, earth flow, and rock fall. Debris flows are another common type of landslide similar to earth flows, except that the soil and rock particles are coarser. Mudslide is a term that appears in non-technical literature to describe a variety of shallow, rapidly moving earth flows.

Soils

The predominant soil series in the developable portion of the SOIA Area is the San Joaquin soil type, which is classified as moderately well drained, moderately deep over a cemented hardpan, and contains a relatively high percentage of clay minerals. Because these soils are not susceptible to structural failures and are located at shallow depths, they are conducive to urban development. However, shrink/swell potential in the planning area is high, due to the high percentage of claypan present in this soil type (City of Elk Grove 2003).The soil properties are summarized in Table 3.6-3:

Table 3.6-3: Soils Properties Summary

Soil Name	Surface Texture	Source Material	Depth to Restrictive Feature	Drainage Class	Constraints
Dierssen	Sandy clay loam, 0-2% slopes	Alluvium derived from granite	31 to 60 inches to duripan	Somewhat poorly drained	Severe
San Joaquin-Galt	Complex leveled, 0-1% slopes	Alluvium derived from granite	20 to 46 inches to duripan	Moderately well drained	Moderate/ Severe
San Joaquin-Urban	Land complex, 0-2% slopes	Alluvium derived from granite	28 to 54 inches to duripan	Moderately well drained	Moderate/ Severe
Bruella	Sandy loam, 0-2% slope	Alluvium derived from granite	More than 80 inches	Well drained	Slight/ Moderate
Clear Lake Clay	Partially drained, 0-2% (frequently flooded)	Alluvium	More than 80 inches	Somewhat poorly drained	Severe
Clear Lake Clay	Hardpan substratum, drained, 0-1% slopes	Alluvium	48 to 64 inches to duripan	Poorly drained	Severe
Columbia	Sandy loam, drained, 0-2% slopes	Alluvium	48 to 64 inches to duripan	Somewhat poorly drained	Moderate/ Severe
Columbia	Sandy loam, clayey substratum, drained, 0-2% slopes	Alluvium	More than 80 inches	Somewhat poorly drained	Moderate/ Severe
Columbia	Sandy loam, clayey substratum, drained, 0-2% slopes (occasionally flooded)	Alluvium	More than 80 inches	Somewhat poorly drained	Moderate/ Severe
Durixeralfs	0-1% slopes	Alluvium derived from granite	20 to 60 inches to duripan	Well drained	Moderate/ Severe
Galt	Clay, leveled, 0-1% slopes	Alluvium derived from granite	32 to 60 inches to duripan	Moderately well drained	Severe
Galt	Clay, 0-2% slopes	Alluvium derived from granite	32 to 60 inches to duripan	Moderately well drained	Severe

Table 3.6-3 (cont.): Soils Properties Summary

Soil Name	Surface Texture	Source Material	Depth to Restrictive Feature	Drainage Class	Constraints
Madera	Loam, 0-2% slopes	Alluvium derived from granite	29 to 60 inches to duripan	Moderately well drained	Moderate/ Severe
San Joaquin	Silt, loam, leveled, 0-1% slopes	Alluvium derived from granite	28 to 54 inches to duripan	Moderately well drained	Moderate/ Severe
San Joaquin	Silt, loam, leveled, 0-3% slopes	Alluvium derived from granite	28 to 54 inches to duripan	Moderately well drained	Moderate/ Severe
San Joaquin	Silt, loam, leveled, 3-8% slopes	Alluvium derived from granite	28 to 54 inches to duripan	Moderately well drained	Moderate/ Severe
San Joaquin-Durixeralfs	Complex, 0-1% slopes	Alluvium derived from granite	28 to 54 inches to duripan	Moderately well drained	Moderate/ Severe
San Joaquin-Galt	Complex, 0-3% slopes	Alluvium derived from granite	28 to 54 inches to duripan	Moderately well drained	Moderate/ Severe
Xerarents-San Joaquin	Complex, 0-1% slopes	Alluvium derived from granite	More than 80 inches	Well drained	Moderate/ Severe
Columbia	Sandy loam, drained, 0-2% slopes, occasionally flooded	Alluvium	More than 80 inches	Somewhat poorly drained	Moderate/ Severe
Kimball	Silt loam, 0-2% slopes	Alluvium derived from granite	More than 80 inches	Well drained	Slight/ Moderate
Kimball	Silt loam, 2-8% slopes	Alluvium derived from granite	More than 80 inches	Well drained	Slight/ Moderate
Sailboat	Silt loam, drained, 0-2% slopes, occasionally flooded	Alluvium	More than 80 inches	Somewhat poorly drained	Moderate/ Severe
San Joaquin-Xerarents	Complex, leveled, 0-1% slopes	Alluvium derived from granite	28 to 54 inches to duripan	Moderately well drained	Moderate/ Severe
Source: United States Department of Agriculture Natural Resources Conservation Service, 2010.					

3.6.3 - Regulatory Framework

Federal

Federal Earthquake Hazards Reduction Act

In 1977, the US Congress passed the Earthquake Hazards Reduction Act to reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program. The act established the National Earthquake Hazards Reduction Program (NEHRP). The National Earthquake Hazards Reduction Program Act (NEHRPA) significantly amended this program in 1990 by refining the description of the agency responsibilities, program goals, and objectives.

The NEHRP's mission 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 NEHRPA designates the Federal Emergency Management Agency (FEMA) as the lead agency of the program and assigns it several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, the National Science Foundation, and the US Geological Survey (USGS).

US Uniform Building Code

The US Uniform Building Code (UBC) provides site development and construction standards. The UBC is widely used throughout the United States and is generally adopted on a district-by-district or state-by-state basis. The UBC has been modified for California conditions with more detailed and more stringent regulations.

State

California Building Code

The California Building Code establishes building requirements for construction and renovation. The most recent version of the California Building Code was adopted in 2010 by the California Building Standards Commission and took effect January 1, 2011, and it is based on the International Code Council's Building and Fire Codes. Included in the California Building Code are the Electrical Code, Mechanical Code, Plumbing Code, Energy Code, and Fire Code.

The State of California provides minimum standards for building design through the California Building Code (California Code of Regulations, Title 24). Where no other building codes apply, Chapter 29 regulates excavation, foundations, and retaining walls. Finally, the 2010 California Building Code regulates grading activities, including drainage and erosion control and construction on unstable soils, such as expansive soils and areas subject to liquefaction.

California Seismic Hazards Mapping Act

The California Seismic Hazards Mapping Act of 1990 (California Public Resources Code Section 1690-2699.6) addresses seismic hazards other than surface rupture, such as liquefaction and induced landslides. The Seismic Hazards Mapping Act specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

Alquist-Priolo Earthquake Fault Zoning Act

In response to the severe fault rupture damage of structures by the 1971 San Fernando earthquake, the State of California enacted the Alquist-Priolo Earthquake Fault Zoning Act in 1972. This act required the State Geologist to delineate Earthquake Fault Zones along known active faults that have a relatively high potential for ground rupture. Faults that are zoned under the Alquist-Priolo Act must meet the strict definition of being "sufficiently active" and "well-defined" for inclusion as an Earthquake Fault Zones. The Earthquake Fault Zones are revised periodically, and they extend 200 to 500 feet on either side of identified fault traces. No structures for human occupancy may be built across an identified active fault trace. An area of 50 feet on either side of an active fault trace is assumed to be underlain by the fault, unless proven otherwise. Proposed construction in an Earthquake Fault Zone is permitted only following the completion of a fault location report prepared by a California Registered Geologist.

National Pollutant Discharge Elimination System Permit

In California, the State Water Resources Control Board (SWRCB) administers the US Environmental Protection Agency's promulgated regulations (55 Code of Federal Regulations 47990) requiring the permitting of stormwater-generated pollution under the National Pollutant Discharge Elimination System (NPDES). In turn, the SWRCB's jurisdiction is administered through Regional Water Quality Control Boards. Pursuant to these federal regulations, an operator must obtain a General Permit under the NPDES Stormwater Program for all construction activities with ground disturbance of 1 acre or greater. The General Permit requires the implementation of best management practices (BMPs) to reduce pollutant loads into the waters of the State and measures to reduce sediment and erosion control. In addition, a Stormwater Pollution Protection Plan (SWPPP) must be prepared. The SWPPP addresses water pollution control during construction. SWPPPs require that all stormwater discharges associated with construction activity, where clearing, grading, and excavating results in soil disturbances, must by law be free of site pollutants. Water Quality Order 99-08-DWQ requires permittees to implement specific sampling and analytical procedures to determine whether BMPs implemented on a construction site are (1) preventing further impairment by sediment in stormwaters discharged directly into waters listed as impaired for sediment or silt, and (2) preventing other pollutants, that are known or should be known by permittees to occur on construction sites and that are not visually detectable in stormwater discharges, from causing or contributing to exceedances of water quality objectives. Further, the order contains information regarding the type of construction covered and not covered by the general permit, notification requirements, and a description of general permit conditions.

Local

City of Elk Grove

The City of Elk Grove General Plan establishes goals and policies to guide both present and future development within the City's jurisdiction. The City of Elk Grove's General Plan policies related to geology, soils, or seismicity that may apply to potential future development in the SOIA Area are provided below.

- **Policy SA-25:** The City supports efforts by Federal, State, and other local jurisdictions to investigate local seismic and geological hazards and support those programs that effectively mitigate these hazards.
- **SA-25-Action 1:** Implement the Uniform Building Code to ensure that structures meet all applicable seismic standards.
- **Policy SA-26:** The City shall seek to ensure that new structures are protected from damage caused by geologic and/or soil conditions.
- **SA-26 Action 1:** Require that a geotechnical report or other appropriate analysis be conducted to determine the shrink/swell potential and stability of the soil for public and private construction projects and identifies measures necessary to ensure stable soil conditions.

3.6.4 - Methodology

Michael Brandman Associates (MBA) evaluated potential project impacts on geology and soils through site reconnaissance and review of applicable plans and policies. The City of Elk Grove General Plan and the City of Elk Grove Zoning Code were reviewed to determine applicable policies for the proposed project.

The impacts related to geology from implementation of the 2003 Elk Grove General Plan were evaluated in the General Plan Environmental Impact Report (EIR). All mitigation measures identified for impacts in the Elk Grove General Plan EIR and adopted by the City continue to remain the responsibility of the City as part of implementation of the General Plan. Consequently, upon approval of any future annexation request for the SOIA Area, those General Plan policies and EIR mitigation measures are assumed to apply to development within the SOIA Area.

3.6.5 - Thresholds of Significance

According to Appendix G, Environmental Checklist, of the CEQA Guidelines, geology, soils, and seismicity impacts resulting from the implementation of the proposed project would be considered significant if the project would:

a) 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, 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. Refer to Division of Mines and Geology Special Publication 42.

    ii. Strong seismic ground shaking.

iii. Seismic-related ground failure, including liquefaction.

iv. Landslides.

b) Result in substantial soil erosion or the loss of topsoil.

c) 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.

d) 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.

e) 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. (Refer to Section 7, Effects Found Not to Be Significant.)

3.6.6 - Project Impacts and Mitigation Measures

This section discusses potential impacts associated with the development of the project and provides mitigation measures where appropriate.

Seismic Hazards

Impact GEO-1:	**Development of the proposed project may expose persons or structures to seismic hazards.**

Impact Analysis

This impact evaluates potential exposure of the proposed project to seismic hazards, including fault rupture, strong ground shaking, ground failure and liquefaction, and landslides.

Fault Rupture

There are no Alquist-Priolo Earthquake Fault Zones within the SOIA Area as determined from the County General Plan Safety Element Background Report, Figure II-4. Several inactive subsurface faults have been identified in the Delta region, ranging in distance from 21 to 94 miles from the SOIA Area. Future development within the SOIA Area may result in the construction and occupation of structures, critical facilities, and pipelines adjacent to known and/or as yet undetected earthquake fault zones. Such development would increase the number of persons and the amount of developed property exposed to fault rupture hazards. To lessen the potential for property loss, injury, or death that could result from rupture(s) of faults during earthquake events, a mitigation measure has been identified below. Implementation of Mitigation Measure GEO-1 would reduce potential impacts associated with fault rupture hazards to a less than significant level. Therefore, indirect impacts would be less than significant.

Strong Ground Shaking

According to the USGS's Probabilistic Hazard Map, ground shaking in Sacramento County is predicted to have a 10 percent probability that a seismic event would produce horizontal ground shaking of 10 to 25 percent within a 50-year period. Using a 10 percent probability of exceedance within 50 years, the maximum horizontal ground acceleration was calculated for the site at 0.20 g. This calculation considered all active earthquake fault zones within a 100-kilometer radius of the site and a return period of 475 years.

However, no physical development is being proposed in conjunction with the SOIA application. Approval of an SOIA by LAFCo indicates that the Commission has designated the revised SOIA Area for future urbanization. Increases in population, and the development of residential and nonresidential development that may occur after implementation of the proposed project, may increase the exposure of persons and property to ground shaking hazards. State and local building and grading codes regulate structural design. The California Building Code includes seismic design methodology and requirements. To lessen potentially significant indirect impacts associated with ground shaking, Mitigation Measure GEO-1 is identified below. Implementation of Mitigation Measure GEO-1 would reduce potential ground shaking impacts to a level of less than significant.

Ground Failure and Liquefaction

Liquefaction occurs when saturated soil loses shear strength and deforms as a result of increased pore water pressure induced by strong ground shaking during an earthquake. As the excess pore pressure dissipates, volume changes are produced within the liquefied soil layer that can manifest at the ground surface as settlement of structures, floating of buried structures, and failure of retaining walls. Soil types most susceptible to liquefaction are saturated, loose, sandy soils. As noted on page 10 of the County General Plan Safety Element Background Report, Sacramento County has two areas that have been suggested as posing potential liquefaction problems: the downtown area of Sacramento and the Delta (Sacramento County General Plan, Amended 2011). The soils identified within the SOIA Area do not pose a risk for liquefaction. Because the known liquefaction areas are not located in the vicinity of the growth areas of the SOIA Area, and the soils identified within the SOIA Area do not pose a risk for liquefaction, direct and indirect project impacts related to liquefaction are expected to be less than significant.

Landslides

There are no substantial slopes on or near the project site. This condition precludes the possibility of landslides inundating the project site. Additionally, the soils identified within the SOIA Area do not pose significant urban development constraints related to landslides. No impacts would occur.

Conclusively, because of the known soil, groundwater, and ground shaking conditions within the SOIA Area, the potential for liquefaction, lateral spreading, and ground lurching is considered to be low. Implementation of mitigation measure GEO-1 would require conformance with the applicable sections of the Uniform Building Code, reducing potential seismic hazard impacts to a less than significant level.

Level of Significance Before Mitigation

Potentially significant impact.

Mitigation Measures

MM GEO-1 At the time of submittal of any application to annex territory within the SOIA Area, the City shall demonstrate that it will require a geotechnical report or other appropriate analysis be conducted at time of development application submittal to determine the shrink/swell potential and the stability of the soil for public and private construction projects and to identify measures necessary to ensure stable soil conditions.

Level of Significance After Mitigation

This mitigation will ensure geologic hazards are identified and addressed.

Less than significant impact.

Erosion

Impact GEO-2:	**Construction activities associated with the proposed project would not have the potential to create erosion and sedimentation.**

Impact Analysis

This impact evaluates the proposed project's potential to create erosion and sedimentation.

The proposed project would result in an amendment and expansion to the existing City of Elk Grove SOI. The project would indirectly accommodate land uses and population increases by allowing future development of residential and nonresidential structures and facilities. This development would result in the alteration of existing topography and/or the removal of existing vegetation/topsoil. The project's indirect potential for soil erosion, by either wind or water, is substantially increased upon the exposure of underlying soils during grading activities or other landform modifications. Future development within the SOIA Area has the potential to increase the risk of erosion and sedimentation and/or siltation of surface water. This may occur due to short-term disturbance of large quantities of earth during construction and/or possible increases in erosion in areas of new construction. All future activities would be subject to preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) under the National Pollutant Discharge Elimination System (NPDES) Permit for construction activities that would disturb an area of 1 acre or more. The SWPPP must identify potential sources of erosion or sedimentation that may be reasonably expected to affect the quality of stormwater discharges as well as identify and implement best management practices (BMPs) that ensure the reduction of these pollutants during stormwater discharges. Typical BMPs intended to control erosion include sand bags, detention basins, silt fencing, storm drain inlet protection, street sweeping, and monitoring of water bodies. Water Quality Order 99-08-DWQ requires permittees to implement specific sampling and analytical procedures to determine whether BMPs implemented on a construction site are (1) preventing further impairment by sediment in stormwaters discharged directly into waters listed as impaired for sediment or silt, and (2) preventing other pollutants, that are known or should be known by permittees to occur on construction sites and that are not visually detectable in stormwater discharges, from causing or contributing to exceedances of water quality objectives. Further, the order contains information regarding the type of construction covered and not covered by the general permit, notification requirements, and a description of general permit conditions. Future annexation and development activities would result in less than significant impacts, because they would be required to comply with Water Quality Order 99-08-DWQ, which would avoid erosion and sedimentation through implementation of the BMPs and monitoring procedures outlined above.

Level of Significance Before Mitigation

Less than significant impact.

Mitigation Measures

No mitigation is required.

Level of Significance After Mitigation

Less than significant impact.

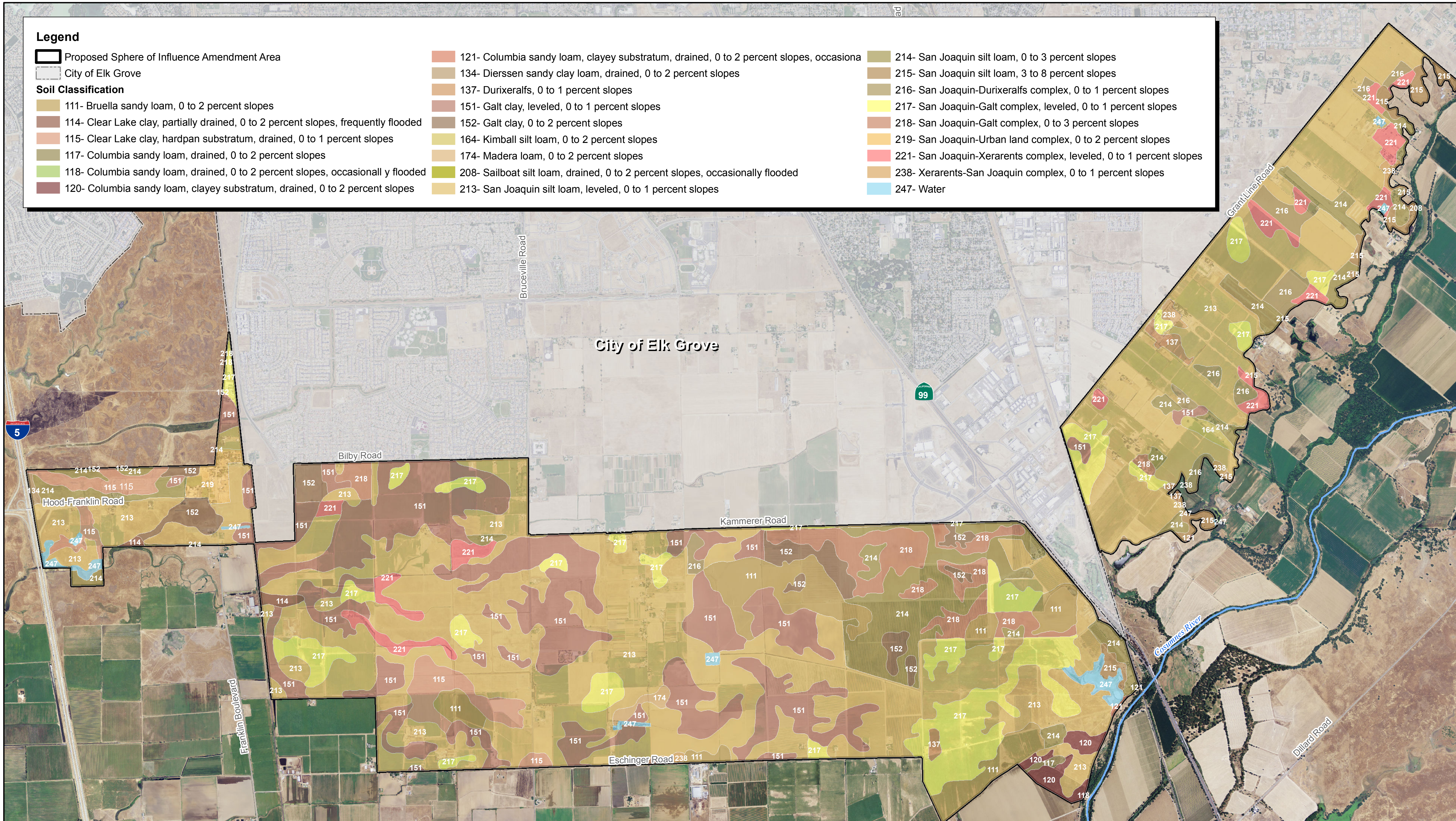
Unstable Geologic Units or Soils

Impact GEO-3:	**The proposed project would not expose persons or structures to hazards associated with unstable geologic units or soils.**

Impact Analysis

This impact evaluates the proposed project's potential to expose persons or structures to hazards associated with unstable geologic units or soils.

The proposed project would result in an amendment and expansion to the existing City of Elk Grove SOI. As described previously, the primary soil and geologic hazards identified with the SOIA Area are related to the potential for strong ground shaking and several subsurface faults. The soil and geologic hazards previously described could cause isolated structural damage to future pavement, bridges, foundations, and/or structures; however, these conditions do not pose a significant geologic constraint to the future urban development of the SOI Area. This is because standard engineering requirements and practices that are embodied in the 2010 California Building Code (Title24), which were adopted the City of Elk Grove, will ensure that future development is properly designed to take on-site soil conditions into account. Specific requirements will be developed by an engineering geologist, and will be reviewed and approved by the City, prior to issuance of any grading or building permits. As shown on Exhibit 3.6-1, with the exception of the Dierssen, Clear Lake Clay, and Galt soil series, which include overall severe urban development constraints, the majority of the SOIA Area does not contain specific areas of soil-related constraints.



Source: Sacramento County NAIP, 2009. USDA Soils Data.

Michael Brandman Associates

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Exhibit 3.6-1
Soils Map

Therefore, development of the SOIA Area would not result in significant geologic or soils impacts based upon compliance with the comprehensive requirements of the Uniform Building Code and 2010 California Building Code, as adopted and enforced by the City of Elk Grove. Impacts would be less than significant.

Level of Significance Before Mitigation
Less than significant impact.

Mitigation Measures
No mitigation is required.

Level of Significance After Mitigation
Less than significant impact.

Expansive Soils

Impact GEO-4:	**Development of the proposed project would not expose persons or structures to hazards associated with expansive soils.**

Impact Analysis
This impact evaluates the proposed project's potential to expose persons or structures to hazards associated with expansive soils.

The proposed project would result in an amendment and expansion to the existing City of Elk Grove Sphere of Influence. Expansive soils are those soils with a significant amount of clay particles that have the ability to give up water (shrink) or take on water (swell). When these soils swell, the change in volume exerts significant pressures on loads (such as buildings) that are placed on them. Expansive soils represent approximately one-third of all soil types in Sacramento County (Figure II-8) (Sacramento County General Plan Safety Element Background Report 2011). Generally, the Dierssen, Clear Lake Clay, and Galt soil series feature greater expansive characteristics than other soil types within the SOIA Area. Implementation of the proposed project may indirectly result in the construction and occupation of structures within areas underlain by expansive soils. As noted above, development of the SOIA Area would not result in significant geologic or soils impacts due to mandatory compliance with the comprehensive requirements of the 2010 California Building Code, as adopted and enforced by the City of Elk Grove. Accordingly, impacts would be less than significant.

Level of Significance Before Mitigation
Less than significant impact.

Mitigation Measures
No mitigation is required.

Level of Significance After Mitigation
Less than significant impact.