This section discusses the geology of the project site and general vicinity and analyzes issues related to geology and soils such as potential exposure of people and property to geologic hazards, landform alteration, and erosion. Water quality issues are addressed in Section 4.8, Hydrology and Water Quality.

4.4.1. EXISTING SETTING

LOCAL GEOLOGY AND TOPOGRAPHY

Regional Setting

The majority of Sacramento County, including the entire City of Elk Grove and the project site, lies in the Great Valley geomorphic province. A "geomorphic province" is defined as an area with similar geologic origin and erosional/depositional history. The Great Valley geomorphic province is an alluvial plain approximately 50 miles wide and 400 miles long located in central California (CA Geological Survey, 2002a). The Great Valley province is bounded on the north by the Klamath and Cascade mountain ranges, on the east by the Sierra Nevada Mountains, and on the west by the California Coast Mountain Range. The Great Valley is a trough in which sediments consisting of Cenozoic non-marine (continental) sedimentary rocks and alluvial deposits have been deposited almost continuously since the Jurassic period approximately 160 million years ago. Elk Grove is in the northern portion of the Great Valley geomorphic province, the Sacramento Valley, and is drained by the Sacramento River (CA Geological Survey, 2002a; CA Geological Survey, 2002b).

Surface elevations within the Great Valley generally range from several feet below mean sea level (msl) to more than 1,000 feet above msl. The ground surface elevation in the vicinity of Elk Grove ranges from approximately 10 to 150 feet above msl (City of Elk Grove, 2003a).

Project Site

The project site and the surrounding area are underlain with quaternary alluvium terraces. Based on the U.S. Geologic Survey (USGS) 7.5' quadrangle map of Elk Grove, the site is approximately 12 meters (40 feet) above mean sea level with topography that is generally level throughout the site (City of Elk Grove, 2004). State Route (SR) 99, located to the west of the project site, is approximately 7.6 meters (25 feet) below the Sheldon Road overpass.

There are no distinctive geological features, such as rock outcroppings, on the proposed project site.

FAULTS AND SEISMICITY

Sacramento County is less affected by seismic events and geologic hazards than other portions of the state. Nevertheless, some property damage has occurred as a result of seismic events in the past. The damage experienced was largely the result of major seismic events occurring in adjacent areas, especially the San Francisco Bay Area and, to a lesser extent, the foothills of the Sierra Nevada Mountain Range. The areas of Sacramento County most vulnerable to seismic and geologic hazards are typically those areas subject to liquefaction, expansive soils, shaking, and subsidence. Sacramento County, like most of California, is considered a seismically active region (City of Elk Grove, 2004).

Earthquakes can cause strong ground shaking that may damage property and infrastructure. The severity of ground shaking at any particular point is referred to as intensity and is a subjective measure of the effects of ground shaking on people, structures, and earth materials. The intensity of shaking generally decreases with distance away from the source of an earthquake. The level of intensity is commonly defined by comparison to the Modified Mercalli Scale that subjectively categorizes the intensity on the basis of observed effects of seismic shaking on people and objects. Quantitative measurements of the level of ground motion during an earthquake are made by strong-motion seismographs that measure the acceleration of objects at the ground surface caused by seismic shaking. These measurements are made relative to, and are expressed as a fraction of, the acceleration of gravity.

The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and finally total destruction. Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli (MM) Intensity Scale. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments which have a common calibration. The magnitude or strength of earth movement associated with seismic activity is typically quantified using the Richter scale. This scale is a measure of the strength of an earthquake or strain energy released by it, as determined by seismographic observations.

Table 4.4-1 compares the effects of Mercalli intensity to Richter magnitude for earthquakes.

TABLE 4.4-1
COMPARISON OF RICHTER MAGNITUDE AND MODIFIED MERCALLI INTENSITY

Richter Magnitude Scale	Modified Mercalli Scale	Effects of Intensity
2	I – II	Usually detected only by instruments.
3	III	Felt indoors.
4	IV – V	Felt by most people; slight damage.
5	VI – VII	Felt by all; many frightened and run outdoors; damage minor to moderate.
6	VII - VIII	Everybody runs outdoors; damage moderate to major.
7	IX - X	Major damage.
8+	X – XI	Total and major damage.

Source: California Geological Survey. Revised April, 2002. How Earthquakes and Their Effects Are Measured. http://www.conservation.ca.gov/cgs/information/publications/cgs_notes/note_32/Documents/note_32.pdf.

Local Seismic Activity

Table 4.4-2 identifies known faults in the vicinity of Elk Grove and their maximum magnitudes. There are no known active faults in the City of Elk Grove and no active or potentially active faults underlie the City. The City is not located in an Alquist-Priolo Earthquake Fault Zone (City of Elk Grove, 2003b).

TABLE 4.4-2
FAULTS IN THE VICINITY OF ELK GROVE

Fault Name	Approximate Distance from Elk Grove (in miles)	Maximum Magnitude (MW)
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
Hunting Creek-Barryessa Fault	45	6.9
West Napa Fault	49	6.5
Calaveras Fault	50	6.8
Rodgers Creek Fault	56	7.0
Hayward Fault	59	7.1
Bartlett Springs Fault	72	7.1
Maacama Fault (south)	73	6.9
Coliayomi 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

* *Nine segments of the Great Valley Fault are located approximately 27 to 91 miles west of the city and have maximum magnitudes of 6.4 to 6.8.*

Source: City of Elk Grove General Plan Background Report, 2003.

Surface Rupture

In major earthquakes, fault displacement can cause rupture along the surface trace of the fault, leading to severe damage to any structures, roads, and utilities located on the fault trace. Surface rupture generally occurs along an active fault trace, but occasionally displacement along presumably inactive faults also occurs. No known faults traverse the project site. Therefore, the risk of surface rupture at the project site is considered low.

Groundshaking

Groundshaking is motion that occurs as a result of energy released during faulting. The damage or collapse of buildings and other structures caused by groundshaking is among the most serious seismic hazards. The intensity of shaking and its potential impact on buildings is determined by the physical characteristics of the underlying soil and rock, the building materials and workmanship, the earthquake magnitude and location of the epicenter, and the character and duration of ground motion. Much of Sacramento County is located on alluvium, which increases the amplitude of an earthquake wave. Ground motion lasts longer and waves are amplified on loose, water-saturated materials as compared to solid rock. As a result, structures located on alluvium typically suffer greater damage than those located on solid rock.

The California Geological Survey's "Seismic Shaking Hazards in California" map shows the vast majority of Sacramento County, including the project site, as being located in a relatively low intensity groundshaking zone. While Sacramento County has experienced relatively little seismic activity, faulting in neighboring regions, especially the San Francisco Bay and Sierra Nevada areas, suggests that the county could be affected by future ground motion originating elsewhere.

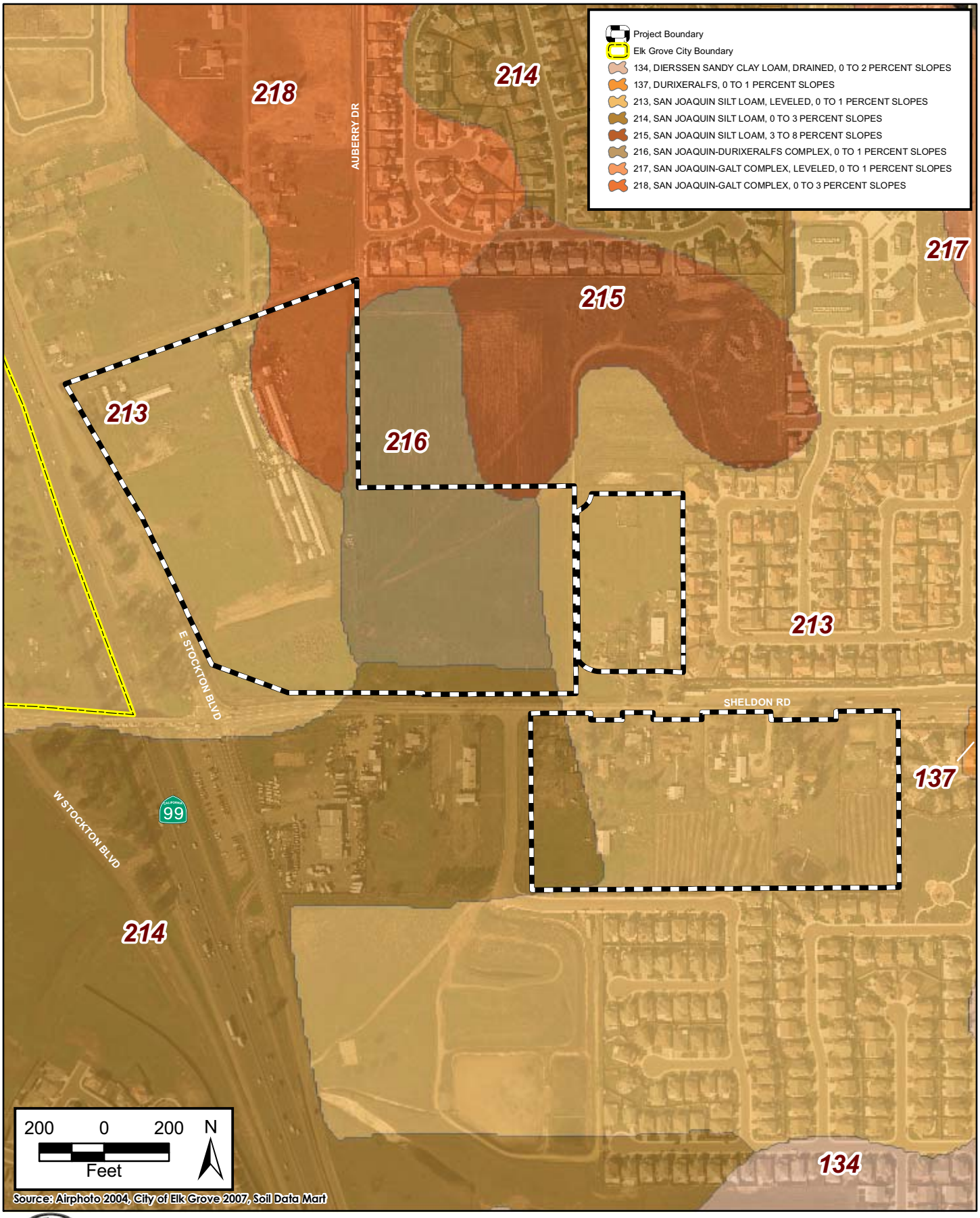
Liquefaction

Liquefaction is the loss of soil strength due to seismic forces generating various types of ground failure. The evaluation of potential for liquefaction is complex, and factors that must be considered include soil type, soil density, groundwater tower, and the duration and intensity of shaking. Liquefaction is most likely to occur in deposits of water-saturated alluvium or similar deposits of artificial fill. Within Sacramento County, the Delta and downtown Sacramento are the two areas most susceptible to liquefaction in the event of an earthquake.

Given the relatively dense/stiff nature of the soils underlying the proposed project site, combined with the lack of groundwater in the upper 15 meters (50 feet) of soil, the potential for liquefaction on the proposed project site is considered to be low (City of Elk Grove, 2004). The potential for ground lurching, differential settlement, or lateral spreading to occur during or after seismic events in the project area is also considered to be low.

SOILS

According to the Sacramento County Soil Survey prepared by the United States Department of Agriculture (USDA), the project site soils are classified in the San Joaquin soils group (USDA-NRCS, 2007b). "Official soil series description" is a term applied to a description approved by the Natural Resources Conservation Service (NRCS) that defines a specific soil series in the United States. The descriptions contain soil properties that define the soil series, distinguish it from other soil series, serve as the basis for the placement of that soil series in the soil family, and provide a record of soil properties needed to prepare soil interpretations (USDA-NRCS, 2007a). The official soil series description classifies the San Joaquin soils group as moderately deep to a duripan, well and moderately well drained soils that formed in alluvium derived from mixed but dominantly granitic rock sources. The soils series description also indicates that San Joaquin soils are on undulating low terraces with slopes of 0 to 9 percent and have medium to very high runoff with very slow permeability (USDA-NRCS, 2007b). The following San Joaquin soils were mapped on the project site (**Figure 4.4-1**):



City of Elk Grove
Development Services

Figure 4.4-1
Soils Map

- 134 – Dierssen Sandy Clay Loam, drained, 0 to 2 percent slopes;
- 137 – Durixeralfs, 0 to 1 percent slopes;
- 213 - San Joaquin Silt Loam, Leveled, 0 to 1 percent slopes;
- 214 - San Joaquin Silt Loam, 0 to 3 percent slopes;
- 215 - San Joaquin Silt Loam, 3 to 8 percent slopes;
- 216 - San Joaquin Durixeralfs Complex, 0 to 1 percent slopes;
- 217 - San Joaquin Galt Complex, Leveled, 0 to 1 percent slopes;
- 218 - San Joaquin Galt Complex, 0 to 3 percent slopes.

Table 4.4-3 identifies the development limitations for the types of soils found on the project site. The ratings are from the U. S. Department of Agriculture Natural Resources Conservation Service and are both verbal and numerical. Verbal rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the uses identified. "No limitations" indicates that the soil has features that are very favorable for the specified use, and good performance and very low maintenance can be expected. "Limitations" indicates that the soil has some features that are favorable for the specified use and some that are unfavorable. This interpretation identifies only the most significant limitations for any given soil. The limitations listed can be overcome or minimized by special planning, design, or installation. Fair to poor performance and moderate to high maintenance costs can be expected, depending on the number of limitations and the severity of each limit. Numerical ratings indicate the severity of individual limitations and are shown as decimal fractions ranging from 0.01 to 1.00 which indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which a soil feature is not a limitation (0.00) (USDA-NRCS, 2007b).

TABLE 4.4-3
SOIL BUILDING SITE LIMITATIONS

	San Joaquin Silt Loam 213	San Joaquin Durixeralfs Complex 216	San Joaquin Silt Loam 214	San Joaquin Galt Complex 218	San Joaquin Silt Loam 215
Dwellings with Basements	Limitations 0.65	Limitations 0.65 to 1.00	Limitations 0.65	Limitations 0.65 to 1.00	Limitations 0.65
Dwellings without Basements	No Limitations	No Limitations	No Limitations	No Limitations	No Limitations
Shallow Excavations	Limitations 0.3 to 0.65	Limitations 0.3 to 0.65	Limitations 0.3 to 0.65	Limitations 0.3 to 1.00	Limitations 0.3 to 0.65
Small Commercial Buildings	No Limitations	No Limitations	No Limitations	No Limitations	Limitations 0.50
Local Road and Street Construction	No Limitations	No Limitations	No Limitations	No Limitations	No Limitations

Source: USDA, NCRS, Web Soil Survey. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Expansive Soils

Expansive soils are soils that shrink or swell depending on the level of moisture they absorb. These swelling soils typically contain clay minerals. As they get wet, the clay minerals absorb water molecules and expand; conversely, as they dry they shrink, leaving large voids in the soil. Settlement caused by soils with a high shrink-swell potential can occur at structures, and

structures could be damaged by differential settlement due to soil expansion and contraction. When structures are located on expansive soils, foundations have the tendency to rise during the wet season and shrink during the dry season. This movement can create new stresses on various sections of the foundation and connected utilities and can lead to structural failure and damage to infrastructure. The City of Elk Grove Background Report identifies a high shrink-swell potential in the main soil type found in Elk Grove and at the project site, the San Joaquin soil series. San Joaquin soils generally contain approximately 5 inches of claypan in the subsoil and a surface layer of brown silt loam, a soil that has a high percentage of claypan (City of Elk Grove, 2003b).

4.4.2 REGULATORY FRAMEWORK

STATE

California Building Code

The City of Elk Grove has adopted the State codes as set forth by the State of California Building Standards Commission. Building codes provide the first line of defense against future earthquake damage and help to ensure public safety. Records of building response to earthquakes, especially those from structures that failed or were damaged, have led to many revisions and improvements in building codes. The California Building Code (CBC) specifies the levels of earthquake forces that structures must be designed to withstand. These specifications are based on current information from strong-motion instruments. As ground motions of greater intensity have been recorded, the minimum earthquake requirements have been raised. In addition, provisions for different soil conditions have been added to the CBC as scientists have documented the significant influence of soil type on shaking intensity. In recent earthquakes, buildings built to modern codes have generally sustained relatively little damage (http://quake.usgs.gov/prepare/factsheets/SaferStructures/, 2008).

LOCAL

Grading Provisions

The City's Buildings and Construction Ordinance (Title 16 Chapter 16.44 of the City Code) establishes administrative procedures, minimum standards of review, and implementation and enforcement procedures for controlling erosion, sedimentation and other pollutant runoff, including construction debris and hazardous substances used on construction sites, and disruption of existing drainage and related environmental damage caused by land clearing, grubbing, grading, filling, and land excavation activities. The ordinance applies to projects that would disturb 350 cubic yards or more of soil. The intent of the ordinance is to minimize damage to surrounding properties and public rights-of-way, minimize degradation of water quality in water courses, minimize disruption of natural or City authorized drainage flows caused by construction activities, and make projects comply with the provisions of the City's National Pollutant Discharge Elimination System (NPDES) Permit Number CA0082597, issued by the California Regional Water Quality Control Board (RWQCB). The City of Elk Grove is co-permittee on an NPDES permit along with Sacramento County and the cities of Sacramento, Folsom, Galt, and Citrus Heights.

City of Elk Grove General Plan

The City of Elk Grove General Plan contains goals, objectives, and policies relating to geology, soils, and seismicity, which are contained in the safety and conservation/air quality elements. **Table 4.4-4** identifies the applicable General Plan policies and summarizes the project's consistency with the General Plan. While this EIR analyzes the project's consistency with the General Plan pursuant to CEQA Section 15125(d), the Elk Grove City Council and Planning Commission determine the project's consistency with the General Plan.

TABLE 4.4-4
PROJECT CONSISTENCY WITH GENERAL PLAN GEOLOGY, SOILS, AND SEISMICITY OBJECTIVES AND POLICIES

General Plan Policies	Consistency with General Plan	Analysis
Policy CAQ-5: Roads and structures shall be designed, built, and landscaped so as to minimize erosion during and after construction.	Yes	The City's Building and Construction Ordinance (Title 16 Chapter 16.44 of the City Code) establishes administrative procedures, minimum standards of review, and implementation and enforcement procedures for controlling erosion. Any development associated with the proposed project would be subject to the ordinance standards. In addition, any construction projects clearing or grubbing one acre or more of land must have an Erosion and Sediment Control Plan. Compliance with the City's Building and Construction Ordinance and the Erosion and Sediment Control Plan would ensure consistency with this policy.
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.	Yes	Consistent with Policy SA-25-Action 1, the City of Elk Grove has adopted the California Building Code (CBC). All subsequent development resulting from the proposed project would be subject to the CBC, which includes special design requirements for building and foundation stress capabilities, masonry and concrete reinforcement, and building spacing to accommodate moderate earthquake shaking. Compliance with the CBC would ensure consistency with this policy.
Policy SA-26: The City shall seek to ensure that new structures are protected from damage caused by geologic and/or soil conditions.	Yes	Consistent with Policy SA-26-Action 1, subsequent development projects on the project site would be required to prepare geotechnical engineering reports for the project sites that would analyze the shrink-swell potential and stability of the soil for construction projects and identify measures necessary to ensure stable soil conditions.

4.4.3 IMPACTS AND MITIGATION MEASURES

STANDARDS OF SIGNIFICANCE

The impact analysis provided below is based on the following State CEQA Guidelines Appendix G thresholds of significance:

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.

   ii. Strong seismic groundshaking.

   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 waste water disposal systems where sewers are not available for the disposal of waste water.

The Notice of Preparation (NOP) for this project found that the implementation of the project would result in less than significant impacts regarding seismic hazards, less than significant impacts related to substantial soil erosion or the loss of topsoil, and no impacts related to wastewater disposal. Section 1.0, Introduction, contains a discussion regarding environmental impacts associated with the proposed project that were found to be less than significant and are not addressed further in this DEIR.

METHODOLOGY

Evaluation of potential geologic and soil impacts of the proposed project was based on review of USDA Soil Survey maps and data, the Elk Grove City Code, the City of Elk Grove General Plan, the City of Elk Grove General Plan Draft EIR, the City of Elk Grove Background Report, and field review of the project site and surrounding area. A detailed list of resources used to evaluate potential geologic and soil impacts is located under the References section at the end of this section.

PROJECT IMPACTS AND MITIGATION MEASURES

Expansive and Unstable Soils

Impact 4.4.1 Future development resulting from the proposed project, including buildings, pavement, and utilities, could incur damage as a result of underlying expansive or unstable soil properties. All development is required to comply with applicable building codes and commonly accepted engineering practices which address these conditions. Therefore impacts associated with expansive or unstable soils are considered **less than significant**.

The City of Elk Grove Background Report identifies a high shrink-swell potential in the San Joaquin soil series, which is the primary soil type found at the project site (City of Elk Grove, 2003b). When structures are located on expansive soils, foundations have the tendency to rise during the wet season and shrink during the dry season. Movements can occur under the structures, creating new stresses on various sections of the foundations and connected utilities. These variations in ground settlement can lead to structural failure and damage to infrastructure.

Furthermore, the gradual sinking or settling of the earth's surface with little or no horizontal motion, known as subsidence, could occur at the proposed project site (City of Elk Grove, 2003b). Land subsidence is most often caused by human activities, mainly from the removal of subsurface water (http://ca.water.usgs.gov/, 2007). The City of Elk Grove Background Report identifies the pumping of water for residential, commercial, and agricultural uses as the greatest cause of subsidence in the city. In addition, subsidence can be caused by compaction by heavy structures, erosion of peat soils, peat oxidation, and compaction of unconsolidated soils by earthquake shaking. Subsidence causes a loss of soil stability and can result in structural and infrastructure damage.

The Sheldon/99 GPA and Rezone project would increase the intensity of uses on the project site by allowing Commercial and High Density Residential development on land that is currently developed with rural residential uses, thereby resulting in an increased risk associated with expansive and unstable soils. However, all residential and commercial development constructed on the project site subsequent to approval of the proposed Sheldon/99 GPA and Rezone project would be required to submit a geotechnical report that would include recommendations, design criteria, and specifications to reduce impacts related to expansive and unstable soils. In addition, all development proposed on the site would be required to comply with all applicable building codes and commonly accepted engineering practices. The City of Elk Grove Building Code and commonly accepted engineering practices require special design and construction methods for dealing with expansive and unstable soil behavior

Compliance with recommendations included in the geotechnical reports and applicable building codes would ensure that soils at future development sites would be capable of supporting the structures resulting from approval of the Sheldon/99 GPA and Rezone project and would therefore reduce impacts resulting from expansive and unstable soils to a **less than significant** level.

Mitigation Measure

None required.

4.4.4 CUMULATIVE SETTING, IMPACTS, AND MITIGATION MEASURES

CUMULATIVE SETTING

The geology and soils cumulative setting includes the Great Valley geomorphic province of California, which is bounded on the north by the Klamath and Cascade mountain ranges, on the east by the Sierra Nevada Mountains, and on the west by the California Coast Mountain Range. Impacts associated with geology and soils are generally site-specific rather than cumulative in nature as geologic properties can vary by site. Individual development projects would be subject to, at a minimum, uniform site development and construction standards relative to seismic and other geologic conditions that are prevalent in the region. The reader is referred to Section 4.8, Hydrology and Water Quality, regarding cumulative water quality impacts from soil erosion.

CUMULATIVE IMPACTS AND MITIGATION MEASURES

Cumulative Geologic and Soil Impacts

Impact 4.4.2 Implementation of the proposed project in combination with other reasonably foreseeable development would not contribute to cumulative geologic and soil impacts, as the impacts would be site-specific. This would be a **less than cumulatively considerable** impact.

Impacts associated with geology and soils, including expansive and unstable soils, are based on existing site-specific conditions within the subsurface materials that underlie the project area. These inherent conditions are an end result of natural historical events that have played out through vast periods of geologic time. Geology and soil-related impacts are generally site-specific and are determined by a particular site's soil characteristics, topography, and proposed land uses. Development projects are analyzed on an individual basis and must comply with established requirements of the City of Elk Grove, as well as the CBC standards as they pertain to protection against known geologic hazards and potential geologic and soil-related impacts. All development would be required to submit a site-specific geotechnical report as well. Therefore, the proposed project's contribution to cumulative geology and soil-related impacts would be considered **less than cumulatively considerable**.

Mitigation Measure

None required.

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