6.9 GEOLOGY AND SOILS

6.9.1 INTRODUCTION

This section describes the existing geologic and soil conditions at the project site and provides an analysis of the potential geologic hazards associated with development of the proposed project. Water quality effects during construction are addressed in Section 6.10, "Hydrology, Drainage, and Water Quality."

Impacts related to landslides and the incapability of project site soils to support the use of septic tanks or alternative wastewater disposal are not analyzed in this section as detailed in Section 1.7, "Effects Found to be Less Than Significant."

6.9.2 ENVIRONMENTAL SETTING

REGIONAL AND LOCAL GEOLOGY

The project site is located in the Sacramento Valley, in unincorporated Sacramento County immediately to the north and west of the City of Sacramento. This area is located within the central portion of the Great Valley geomorphic province of California, which includes most of Sacramento County. The Great Valley is an alluvial plain approximately 50 miles wide and 400 miles long that lies between the mountains and foothills of the Sierra Nevada to the east and the Coast Ranges to the west. It was once an arm of the ocean that became isolated by new mountains and eventually rose above sea level. As a result, the valley is underlain by an asymmetrical depression (formed by intersecting, downward sloping folds of bedrock) in which various sedimentary deposits have accumulated in a sequence of units (known as the Great Valley Sequence) for more than 100 million years.

Formation of the Great Valley Sequence began with marine sediments from the receding ocean and was followed more recently by river deposits (alluvial deposits) washing down from the Sierra Nevada, Klamath, Cascade, and Coast Ranges. The U.S. Geological Survey (USGS) *Geologic Map of the Late Cenozoic Deposits of the Sacramento Valley and Northern Sierran Foothills, California* shows the project area to be underlain by undivided Holocene basin deposits and the lower member of the Riverbank Formation (Helley and Harwood 1985, cited in Wallace Kuhl & Associates 2004). The Holocene basin deposits (occurring within the last 10,000 years) consist of fine-grained silt and clay derived from the nearby mountain ranges and deposited by the Sacramento and American Rivers. The lower member of the Riverbank Formation consists of red semiconsolidated gravel, sand, silt, and clay derived from the nearby mountain ranges and deposited by the Sacramento and American Rivers.

The project site is a flat, low-lying alluvial plain. Based on review of the USGS *Topographical Map of the Taylor Monument Quadrangle, California*, Wallace Kuhl & Associates (2002) found topography to vary from approximately 15 to 20 feet above mean sea level. However, more recently Wood Rodgers (2005), in its drainage study for the proposed project, found topography to vary from 5 to 25 feet. The site was historically part of a larger area of marshland until the Sacramento River levee system was completed around 1915. Eventually the site was drained by a network of canals and pumping stations and converted to farmland (in the 1930s).

SITE SOILS

Review of the April 1993 U.S. Department of Agriculture, Soil Conservation Service (SCS) *Soil Survey of Sacramento County, California* (SCS 1993) indicates that near-surface soils on the property are as follows:

- Clear Lake clay, hardpan substratum, drained, 0 to 1% slopes;
- Cosumnes silt loam, partially drained, 0 to 2% slopes;
- Durixeralfs, 0 to 1% slopes;
- Jacktone clay, drained, 0 to 2% slopes;

- San Joaquin-Durixeralfs complex, 0 to 1% slopes;
- San Joaquin silt loam, leveled, 0 to 1% slopes; and
- San Joaquin-Xerarents complex, leveled, 0 to 1% slopes.

Exhibit 6.9-1 shows the location of the soils at the project site. As shown in Exhibit 6.9-1, Clear Lake clay, and to a lesser extent Jacktone clay and San Joaquin-Durixeralfs complex, comprise the majority of the soils on the property. All of these soil units formed as alluvium derived from mixed-rock sources and are reportedly used for rangeland and dry-farmed crops. These soil types can be described as follows (Wallace Kuhl & Associates 2002):

- The Clear Lake clay soil profile typically consists of 15-inch-thick dark gray clay over a 19-inch-thick dark gray and yellowish brown clay with segregated lime concentrations over silica cemented hardpan that extends to 64 inches below the surface.

- The Cosumnes silt loam soil profile typically consists of a surface layer of pale brown silt loam about 8 inches thick. The next layer is a pale brown silty clay loam and clay about 13 inches thick. Below this to a depth of 43 inches is a buried surface layer of gray clay. The next layer, to a depth of 60 inches, is gray and pale brown clay loam.

- The Durixeralfs soil profile typically consists of a 20-inch layer of brown clay over strongly silica cemented hardpan to a depth of 55 inches over an indurated (i.e., firm) hardpan.

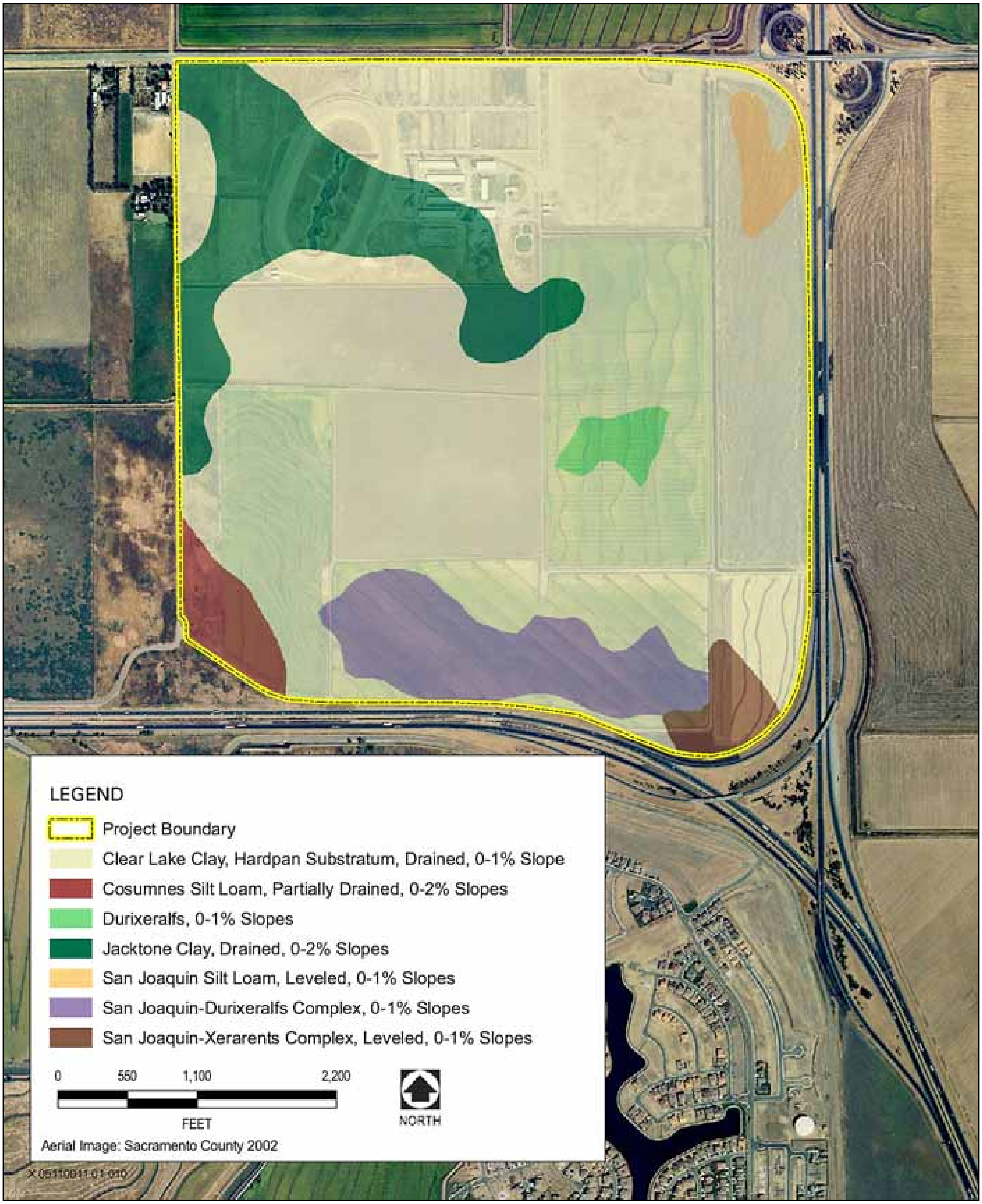
  The Jacktone clay soil profile typically consists of a surface layer of very dark gray clay about 11 inches thick. The underlying material is a very dark clay about 23 inches thick. The next layer is a light brownish gray and light gray weakly silica cemented hardpan about 18 inches thick. The underlying material, to a depth of 60 inches, is light yellowish brown sandy loam.

- The San Joaquin Series soil profile typically consists of a 23-inch-thick brown silt loam over a 5-inch-thick yellowish-red clay loam, underlain by a 5- to 11-inch-thick indurated hardpan over strongly silica cemented hardpan.

The characteristics of these soils are summarized in Table 6.9-1. These soils are generally characterized by their high shrink-swell potential, low strength, generally slow permeability and runoff, and in some cases, their tendency to drain (flooding potential). These factors can limit the urban uses suitable for these soils, such as building foundation types. The project site is generally flat, so the tendency of soils to pond water would be greater than on a sloped site with the same soils. The seasonal high-water table can reach a height of 48–60 inches in Clear Lake clays, and water is perched above the claypan in San Joaquin soils for short periods after heavy winter and early spring rainfall (SCS 1993). The Sacramento County groundwater map (published March 2002) indicated that groundwater was located 10–15 feet below the surface in spring 2000, but Wallace Kuhl & Associates (2002), in its preliminary geotechnical investigation for the site in August 2002, noted groundwater at approximately 5–7 feet below the surface. In its subsequent Phase 1 Environmental Site Assessment (ESA) for the site, conducted in January 2004, Wallace Kuhl & Associates (2004) noted that groundwater is estimated to have historically varied from approximately 6.3 to 19.6 feet below the ground surface.

SUBSIDENCE

Subsidence is a gradual settling or sinking of the earth's surface with little or no horizontal motion. This lowering of the ground surface can be caused by the compaction or loss of unconsidated soils by earthquake shaking; compaction by heavy structures; the erosion or oxidation of peat (organic) soils; or the extraction of groundwater, gas, oil, or geothermal energy resources. Subsidence (and its opposite, uplift) can also be triggered by seismic activities. The pumping of water from subsurface water tables causes the greatest amount of subsidence in



Source: SSURGO, NRCS 2004

Soils on the Project Site **Exhibit 6.9-1**

Table 6.9-1
Summary of Project Site Soil Characteristics

Soil Profile	Soil Type	Texture	Shrink-Swell Potential	Wind/Water Erosion Potential	Flooding Tendency
Clear Lake clay	Clear Lake clay, hardpan substratum, drained, 0 to 1% slopes	Clay underlain by clay loam	High	- Slow permeability - Very slow runoff - Negligible to slight erosion hazard	Rare
Cosumnes silt loam	Cosumnes silt loam, partially drained, 0 to 2% slopes	Silt loam underlain by silty clay loam and clay	High	- Slow permeability - Slow runoff - Slight erosion hazard	Occasional during prolonged, high-intensity storms
Durixeralfs	Durixeralfs, 0 to 1% slopes	Clay; sometimes underlain by sandy clay loam or clay loam	N/A	- Slow to very slow permeability - Very slow runoff - Negligible to slight erosion hazard	N/A
	San Joaquin-Durixeralfs complex, 0 to 1% slopes	Silt loam underlain by clay loam and loam	High	- Slow to very slow permeability - Very slow runoff - Negligible to slight erosion hazard	N/A
Jacktone clay	Jacktone clay, drained, 0 to 2% slopes	Clay underlain by sandy loam or clay loam	High	- Slow permeability - Very slow runoff - Negligible to slight erosion hazard	Rare
San Joaquin Series	San Joaquin silt loam, leveled, 0 to 1% slopes	Silt loam underlain by clay loam and loam	High	- Very slow permeability - Very slow runoff - Negligible to slight erosion hazard	Perching of water for short periods after heavy rainfall in winter and early spring and when soil is over irrigated
	San Joaquin-Xerarents complex, leveled, 0 to 1% slopes	Silt loam underlain by clay loam and loam (San Joaquin); sandy loam and sandy clay loam underlain by loamy sand, sandy loam, and loam (Xerarents)	High (San Joaquin); low to high (Xerarents)	*San Joaquin:* - Very slow permeability - Very slow runoff - Negligible to slight erosion hazard *Xerarents:* - Moderate to very slow permeability - Very slow runoff - Negligible to slight erosion hazard	Rare

Source: U.S. Department of Agriculture, Soil Conservation Service 1993

Sacramento County (County of Sacramento 1993). Although the project site is not located in a known subsidence area as denoted by the *County of Sacramento General Plan* (County General Plan), it is located on soils that exhibit the potential to subside because of their high shrink-swell potential and low strength.

EXPANSIVE SOILS

Expansive soils are composed largely of clays, which greatly increase in volume when saturated with water and shrink when dried. Because of this effect, building foundations may rise during the rainy season and fall during the dry season. If this expansive movement varies underneath different parts of a single building, foundations may crack, structural portions of the building may be distorted, and doors and windows may become warped so that they no longer function properly (County of Sacramento 1993). While the California Geological Survey (formerly the California Division of Mines and Geology) indicates a low rating of expansive soils for the overall Sacramento area, expansive soils are found to exist in approximately 75% of the Natomas area (City of Sacramento 1988). In addition, Wallace Kuhl & Associates (2002) conducted tests on the surface and near-surface clays on sites adjacent to the Greenbriar project site, and found them to be medium to highly plastic (that is, capable of being molded or deformed continuously and permanently by relatively moderate pressure into various shapes). Wallace Kuhl & Associates concluded that the clay soils are expected to experience volume changes with increasing or decreasing soil moisture content, and that they are capable of exerting significant expansion pressures on building foundations and concrete slabs-on-grade (Wallace Kuhl & Associates 2002).

SEISMICITY

Seismically induced hazards include damage resulting from ground shaking, surface rupture, and liquefaction. These potential hazards are described in more detail below.

Ground Shaking

Ground shaking, motion that occurs as a result of energy released during faulting, could potentially result in the damage or collapse of buildings and other structures, depending on the magnitude of the earthquake, the location of the epicenter, and the character and duration of the ground motion. Other important factors to be considered are the characteristics of the underlying soil and rock, the building materials used, and the workmanship of the structure.

Although the entire state of California is subject to ground shaking from numerous active fault systems that cross the state, earthquake occurrence in the Sacramento area over the last 150 years is considered minor, based on records kept over this time period. No major active faults transect Sacramento County. The nearest known faults are located generally west to southwest of Sacramento. However, similar to most of the Sacramento area, the project site is located on alluvium, which increases the amplitude of the earthquake wave. Structures located on alluvium typically suffer greater damage than those located on solid rock (County of Sacramento 1993).

The nearest potentially active faults (defined as faults that have been active in historic time, suggesting that future displacement may be expected) are shown in Table 6.9-2, which also displays the maximum credible earthquake, in Richter scale magnitude, that these faults could produce. The Richter scale is a logarithmic scale that expresses the magnitude of an earthquake in terms of the amount of energy generated, with 1.5 indicating the smallest earthquake that can be felt, 4.5 an earthquake causing slight damage, and 8.5 a very damaging earthquake.

The San Andreas, Green Valley, Concord, and Hayward Faults are considered to be active as defined by the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act), meaning they have experienced activity within the last 11,000 years. In addition to the faults listed above, which are considered active, inactive faults lie beneath the surface. For example, the Midland Fault, which is buried under alluvium and has been only approximately located from natural gas exploration work, is believed to extend north of Bethel Island in the Sacramento–San

Joaquin Delta. This fault is considered inactive but possibly capable of generating an earthquake measuring near 7.0 on the Richter Scale (County of Sacramento 1993, City of Sacramento 2005).

Table 6.9-2
Faults Affecting the Project Area

Fault	Approximate Distance (miles) from Sacramento	Maximum Credible Earthquake (Richter Scale Magnitude) [1]
San Andreas Fault	100	8.3
Hayward Fault	80	7.0
Calaveras Fault	70	7.0
Rodgers Creek Fault	70	7.0
Greenville Fault	48	6.9
Concord-Green Valley Fault	38	6.9
Hunting Creek–Berryessa Fault	38	6.9
Great Valley Fault (segment 4)	27	6.8
West Napa Fault	48	6.5
Foothills Fault System	25	6.5
Great Valley Fault (segment 3)	26	6.5
Dunnigan Hills Fault	30	6.25 [2]

Note:

[1] The term "maximum credible earthquake" is defined as the largest earthquake that is likely to be generated along an active fault zone (Slemmons and Chung 1982). The magnitude of the maximum credible earthquake is estimated from the geologic character and earthquake history of the fault. Most workers, when calculating the maximum credible earthquake for the strike-slip faults of the Coast Ranges, estimate the potential length of surface rupture, then use empirical relations that equate rupture length with earthquake magnitude. As a minimum, the maximum credible earthquake must equal the largest historic earthquake on a fault.

[2] Source: Wesnouski 1986.

Sources: *Probabilistic Seismic Hazard Assessment for the State of California* (Petersen et al. 1996), cited in City of Sacramento 2005; County of Sacramento 1993; information compiled by EDAW 2005

The Modified Mercalli Scale, presented in Table 6.9-3, is a scale used to illustrate the effects of earthquake intensity. Table 6.9-4 shows the approximate relationships between earthquake magnitude (Richter scale) and intensity (Modified Mercalli Scale).

Although Sacramento has experienced relatively little seismic activity, as shown in Table 6.9-2 ground motion originating from neighboring regions such as the San Francisco Bay Area and the Sierra Nevada region could affect the Sacramento area. Records indicate that occasional ground shaking and slight structural damage caused by earthquakes has occurred on several occasions. A series of earthquakes occurring in April 1892, which were thought to have originated in Yolo County between Winters and Vacaville, measured VI and VII on the Modified Mercalli Intensity Scale and caused some structural damage to buildings in Sacramento (statuary falling from building tops, cracks in chimneys). These earthquakes and the May 1983 Coalinga earthquake are both noteworthy, however, in that they occurred on previously unmapped faults (City of Sacramento 2005). The 1906 San Francisco earthquake caused minimal impacts in Sacramento, as did the 1989 Loma Prieta earthquake (7.1 Richter magnitude at its epicenter in the Santa Cruz Mountains). Other earthquakes felt in the Sacramento area occurring in 1869, 1954, and 1966 were centered in Western Nevada.

Table 6.9-3 Modified Mercalli Scale of Earthquake Intensity	
Scale	Effects
I.	Not felt except by a very few under especially favorable conditions.
II.	Felt only by a few persons at rest, especially on upper floors of buildings.
III.	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV.	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V.	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI.	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII.	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII.	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X.	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI.	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII.	Damage total. Lines of sight and level are distorted. Objects thrown into the air.
Source: U.S. Geological Survey 2005	

Table 6.9-4 Approximate Relationships between Earthquake Magnitude and Intensity		
Richter Scale Magnitude	Maximum Expected Intensity (Modified Mercalli Intensity Scale)	Distance Felt (Approx. Miles)
3.0 – 3.9	I – III	15
4.0 – 4.9	IV – V	30
5.0 – 5.9	VI – VIII	70
6.0 – 6.9	VII – VIII	125
7.0 – 7.9	IX – X	250
Source: OES 2005		

The California Geological Survey identifies low, medium, and high severity zones within California. Although Sacramento lies in a low severity zone, the probable maximum intensity of an earthquake could be as high as VII on the Modified Mercalli scale; some structural damage could occur at that intensity (City of Sacramento 1988).

The California Geological Survey has found that the western portion of Sacramento County is in a relatively moderate ground shaking zone (City of Sacramento 1988). For purposes of this EIR, the California Geological Survey's Probabilistic Seismic Hazards Mapping Ground Motion Page (California Geological Survey 2005a) was consulted to estimate site-specific probabilistic ground acceleration for the project site. Based on the latitude and longitude for Sacramento International Airport (approximately 1 mile west of the project site), peak horizontal ground acceleration (the level of ground shaking) with 10% probability of being exceeded in 50 years was calculated for firm rock, soft rock, and alluvium in percentage of gravity (g) (or percentage of the earth's normal gravitational strength). These calculations found that there is a 1-in-10 probability that an earthquake will occur within 50 years that will result in a peak horizontal ground acceleration on alluvium (on which the project site is located) exceeding 0.209g (California Geological Survey 2005a). By comparison, the California Geological Survey peak ground acceleration map for the state (California Geological Survey 2005b) shows corresponding peak horizontal ground acceleration in areas in the immediate vicinity of the San Andreas Fault to be approximately 0.8g, nearly four times greater.

Surface Rupture

Surface rupture is an actual cracking or breaking of the ground along a fault during an earthquake. Structures built over an active fault can be torn apart if the ground ruptures. The project site is not located within an earthquake fault zone as designated by the Alquist-Priolo Earthquake Fault Zone Act (California Geological Survey 2005c) (see Section 6.9.3, "Regulatory Setting," below) and would not likely be subject to surface ruptures. However, as described above, several active earthquake faults are located within 100 miles of Sacramento.

Liquefaction

Liquefaction is a type of ground deformation associated with unconsolidated soils. Water in such soils is subjected to pressure, usually produced by ground motion, which causes the soil to behave like quicksand and to literally flow out from underneath buildings. Earthquake shaking is the major cause of such ground motion. A combination of factors contributes to the potential for liquefaction including the intensity of ground shaking, the soil type and density, and the depth to groundwater.

Liquefaction poses a hazard to engineered structures. The loss of soil strength can result in insufficient bearing capacity to support foundation loads, increased lateral pressure on retaining or basement walls, and slope instability. The possibility that liquefaction will occur is greatest in very loose, clean sands with the groundwater level near the ground surface. The Sacramento area is located on a broad alluvial plain with areas of low lying, poorly consolidated to unconsolidated sediments that are often water-saturated. It is these areas that are potentially subject to liquefaction as a result of seismic activity. The potential for damage from liquefaction exists in Sacramento, and North Natomas is listed as an area that especially exhibits this potential (City of Sacramento 1988).

In addition, as mentioned previously, the groundwater table at the Greenbriar site is shallow; Wallace Kuhl & Associates (2002) noted groundwater at approximately 5–7 feet below the surface. The upper foot or so was relatively loose from agricultural use, and in hand augered holes the soils were found to be moist just a few feet below the surface.

6.9.3 REGULATORY SETTING

FEDERAL

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). This program was significantly amended in November 1990 by the National Earthquake Hazards Reduction Program Act (NEHRPA) by refining the description of agency responsibilities, program goals, and objectives.

The mission of NEHRP includes improved understanding, characterization, and prediction of hazards and vulnerabilities; improved building codes and land use practices; risk reduction through postearthquake 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 several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, National Science Foundation, and USGS.

STATE

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The main purpose of the law is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The law addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Alquist-Priolo Act requires the State Geologist to establish regulatory zones known as “Earthquake Fault Zones” around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning efforts. Local agencies must regulate most development projects within the zones, including all land divisions and most structures for human occupancy.

The project site is not located within an earthquake fault zone as designated by the Alquist-Priolo Act (California Geological Survey 2005c).

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act, passed by the California legislature in 1990, addresses earthquake hazards from nonsurface fault rupture, including liquefaction and seismically induced landslides. The act established a mapping program for areas that have the potential for liquefaction, landslide, strong ground shaking, or other earthquake and geologic hazards.

National Pollutant Discharge Elimination System Permit

In California, the State Water Resources Control Board (SWRCB) administers regulations promulgated by the U.S. Environmental Protection Agency (55 Code of Federal Regulations [CFR] 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 nine regional water quality control boards. Under these federal regulations, an operator must obtain a General Permit through the NPDES Stormwater Program for all construction activities with ground disturbance of 1 acre or more. The General Permit requires the implementation of best management practices (BMPs) to reduce sedimentation into surface waters and control erosion. One element of compliance with the NPDES permit is preparation of a Storm Water Pollution Protection Plan (SWPPP) that addresses control of water pollution, including sediment, in runoff during construction. (See Section 6.10, “Hydrology, Drainage, and Water Quality,” for more information about the NPDES and SWPPPs.)

California Uniform Building Code

The State of California provides minimum standards for building design through the California Building Standards Code (California Code of Regulations, Title 24). Where no other building codes apply, Chapter 29 regulates excavation, foundations, and retaining walls. The California Uniform Building Code (UBC) also applies to building design and construction in the state and is based on the national UBC used widely throughout the country (generally adopted on a state-by-state or district-by-district basis). To reflect California conditions, the California UBC has numerous regulations that are more detailed or more stringent than those in the national UBC.

The state earthquake protection law (California Health and Safety Code Section 19100 et seq.) requires that structures be designed to resist stresses produced by lateral forces caused by wind and earthquakes. Specific minimum seismic safety and structural design requirements are set forth in Chapter 16 of the California UBC. The California UBC identifies seismic factors that must be considered in structural design.

Chapter 18 of the California UBC regulates the excavation of foundations and retaining walls, and Appendix Chapter A33 regulates grading activities, including drainage and erosion control, and construction on unstable soils, such as expansive soils and areas subject to liquefaction.

LOCAL

City of Sacramento General Plan

The following goal and policies from the Health and Safety Element of the *City of Sacramento General Plan* (City General Plan) are applicable to the proposed project:

- **Goal A:** Protect lives and property from unacceptable risk of hazards due to seismic and geologic activity to the maximum extent feasible.
  - **Policy 1:** Prohibit construction of structures for permanent occupancy across faults, should any be designated.
  - **Policy 2:** Continue to require soils reports and geological investigations for determining liquefaction, expansive soils, and subsidence problems on sites for new subdivision and/or multiple-story buildings in the City of Sacramento.
  - **Policy 3:** Continue to implement the Uniform Building Code requirements that recognize State and federal earthquake protection standards in the construction or repair of buildings.
  - **Policy 7:** Cooperate with and encourage the federal, State, and other local jurisdictions to investigate seismic and other hazards and to develop mitigation measures.

Current construction standards in Sacramento require that all new structures be sufficiently built to withstand seismic activity designated for Zone 3 of the UBC's Seismic Zone Map of the United States. Zone 3 is defined as a major damage area corresponding to an intensity of VIII or and higher on the Modified Mercalli scale (City of Sacramento 1988). Analysis of the project's consistency with these City of Sacramento General Plan goals and policies is provided in Chapter 5.0 "Project Consistency with Plans and Policies" of this DEIR.

City of Sacramento Grading, Erosion, and Sediment Control Ordinance

The City Grading, Erosion, and Sediment Control Ordinance (Chapter 15.88 of the City Code) requires applicants to prepare plans to control erosion and sediment both during and after construction, prepare preliminary and final grading plans, and prepare plans to control urban runoff from the project site during construction. The ordinance requires that a soils report be completed before issuance of a building permit in areas where the potential for expansive soils is present.

LAFCo

The LAFCo Policies, Procedures, and Guidelines document does not contain any policies related to geology or soils.

6.9.4 IMPACTS AND MITIGATION

METHOD OF ANALYSIS

This analysis is based on review of the preliminary geotechnical engineering report and Phase 1 ESA prepared by Wallace Kuhl & Associates in 2002 and 2004, respectively. This analysis also relies on review of the April 1993 U.S. Department of Agriculture, Soil Conservation Service *Soil Survey of Sacramento County, California* (SCS 1993); review of the County and City General Plans and the *City of Sacramento General Plan: Technical Background Report* (City of Sacramento 2005); and a site visit conducted by EDAW staff on June 21, 2005.

THRESHOLDS OF SIGNIFICANCE

An impact is considered significant, as defined by the State CEQA Guidelines (Appendix G), if the proposed project or alternatives would:

- expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - the 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 active fault;
  - strong seismic ground shaking;
  - seismic-related ground failure, including liquefaction; or
  - landslides;
- result in substantial soil erosion or the loss of topsoil;
- be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on or off-site landsliding, lateral spreading, subsidence, liquefaction, or collapse; or
- be located on expansive soil, as defined in Table 18-1-B of the UBC, creating substantial risks to life or property; or
- 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.

IMPACTS AND MITIGATION MEASURES

IMPACT 6.9-1	Risks to People and Structures Caused by Seismic Hazards, Including Strong Ground Shaking and Liquefaction. *The project site is not located within an earthquake fault zone. Surface rupture from faulting is therefore not expected to occur on the project site. However, the project site is located in an area considered by the California Geological Survey to be a relatively moderate ground shaking zone. Ground shaking, as a result of seismic activity from nearby or distant earthquake faults, could cause seismic-related ground failure. The water-saturated alluvial soils occurring on the project site are considered to possess low strength and could potentially liquefy during a seismic event. Thus, development of the project site with homes and other structures has the potential to expose people to substantial adverse effects from seismic hazards, including ground shaking and liquefaction. This impact would be* ***potentially significant****.*

The project site is not located within an earthquake fault zone as designated by the Alquist-Priolo Earthquake Fault Zone Act (California Geological Survey 2005c). The nearest active fault is the Dunnigan Hills fault, approximately 30 miles west/southwest of the project site; this fault is estimated to have a maximum credible earthquake of 6.25 on the Richter scale. Because no known faults are located on the project site, the potential for surface rupture (cracking or breaking of the ground during an earthquake) would be less than significant.

The project site is classified as being within Seismic Zone 3 in the 1997 edition of the UBC; as such, the level of anticipated ground shaking is lower than in many areas within the state of California. The project would comply with City of Sacramento policies related to Health and Safety, as identified in the City's General Plan. In addition, the project would not construct any structures across faults and would implement all requirements of the UBC in design and construction of buildings.

Strong ground shaking may still occur at the site, however, as a result of large, distant earthquakes. The California Geological Survey indicates that the project area is located in a region of moderate maximum earthquake intensity, corresponding with a zone of VII to VIII on the Modified Mercalli scale (City of Sacramento 1988). Earthquakes in this region would cause general alarm and moderate damage. As required by current City of Sacramento construction standards as well as standard engineering practices, project facilities would be designed in accordance with seismic standards of the UBC for structures located within Seismic Zone 3. These construction standards would minimize the effects of seismic ground shaking on developed structures. However, the alluvial soils occurring on the project site are considered to possess low strength and could potentially liquefy during a seismic event. A preliminary geotechnical report for the proposed project has been prepared (Wallace Kuhl & Associates 2002) that provides an overview of geotechnical engineering aspects of and considerations for development at the project site. Preliminary conclusions and recommendations were made regarding soil-related aspects of development at the property with residential and commercial uses. However, specific design recommendations were beyond the scope of this report. Thus, development of the project site with homes and other structures has the potential to expose people to substantial adverse effects from seismic hazards, including ground shaking and liquefaction. This impact would be ***potentially significant***.

Mitigation Measure 6.9-1. (City of Sacramento)

a. Before issuance of a grading permit, a geotechnical report shall be prepared by a qualified geotechnical engineer. This report shall be completed to assess the extent to which the recommendations are appropriate and sufficient for construction of the buildings described in the final project design plans. The geotechnical engineer shall prepare a comprehensive site-specific geotechnical report with specific design recommendations sufficient to ensure the safety of soil conditions (e.g., percent subsidence/expansive soils impacts), project structures, and site occupants.

b. All water supply and wastewater pipelines shall be designed per City standards to minimize the potential for damage in the event of strong ground shaking and potential liquefaction.

c. During project design and construction, all measures outlined in the preliminary geotechnical report for the project (Wallace Kuhl & Associates 2002) as well as specific design measures included in the geotechnical report shall be implemented, at the direction of the City engineer, to prevent significant impacts associated with seismic activity. A geotechnical engineer shall be present on-site during earthmoving activities to ensure that requirements outlined in the geotechnical reports are adhered to for proper fill and compaction of soils.

d. Should the construction schedule require continued work during the wet weather months (e.g., October through April), the project applicant shall consult with a qualified civil engineer and implement any additional recommendations provided, as conditions warrant. These recommendations would include but not be limited to (1) allowing a prolonged drying period before attempting grading operations at any time after the onset of winter rains; and (2) implementing aeration or lime treatment, to allow any low-permeability surface clay soils intended for use as engineered fill to reach a moisture content that would permit the specified degree of compaction to be achieved (Wallace Kuhl & Associates 2002; Perry, pers. comm., 2005).

Significance After Mitigation

Review of construction plans and onsite supervision by a geotechnical engineer and consultation with a civil engineer, if needed, would reduce significant impacts under the proposed project associated with seismic hazards to a ***less-than-significant*** level.

IMPACT 6.9-2

Construction-Related Erosion Hazards. *Excavation and grading of soil could result in localized erosion during project construction. Further, dewatering may be required during some excavation activities as a result of high groundwater levels, which could increase the potential for construction-related erosion. This would be a* potentially significant *impact.*

Project construction activities would involve excavation and grading of soil and would remove all vegetative cover on-site exposing on-site soils to wind and water erosion. In addition, high groundwater levels could result in the need for dewatering during excavation activities deeper than 5 feet (Wallace Kuhl & Associates 2002), increasing the potential for erosion.

Although excavation activities, grading, and construction would be conducted according to standard construction practices and building codes, construction activities associated with project site development have the potential to create substantial localized erosion during wind and rain events. Therefore, this impact would be a ***potentially significant*** impact.

Mitigation Measure 6.9-2: (City of Sacramento)

a. A grading and erosion control plan shall be prepared by a California Registered Civil Engineer and submitted to the City of Sacramento Department of Public Works for approval prior to issuance of the first building permits. The plan shall be consistent with the California Building Standards Code grading requirements and shall identify the site-specific grading to be used for new development. All grading shall be balanced on-site, where feasible.

b. To ensure soils do not directly or indirectly discharge sediments into surface waters as a result of construction activities, the project applicant shall develop a Stormwater Pollution Prevention Plan (SWPPP) as discussed in Section 6.10, “Hydrology, Drainage, and Water Quality.” The SWPPP shall identify Best Management Practices that would be used to protect stormwater runoff and minimize erosion during construction. The project applicant shall prepare plans to control erosion and sediment, shall prepare preliminary and final grading plans, and shall prepare plans to control urban runoff from the project site during construction, in compliance with the City of Sacramento Grading, Erosion, and Sediment Control Ordinance.

Significance After Mitigation

Preparation and approval of a grading and erosion control plan that would require measures to prevent on- and off-site erosion and SWPPP would reduce significant impacts related to construction erosion hazards to a ***less-than-significant*** level.

IMPACT 6.9-3

Potential for Subsidence or Compression of Unstable Soils. *Although the project site is not located in a known subsidence area as denoted by the County General Plan, it is located on soils that exhibit the potential to subside because of their high shrink-swell potential and low strength. This impact would be* ***potentially significant****.*

Subsidence, the sinking of land, is caused by compaction of unconsolidated soil units during a seismic event, compaction by heavy structures, erosion of peat soils, or groundwater depletion. Subsidence usually occurs over a broad area and is therefore not detectable at the ground surface. This normally occurs in areas underlain by alluvium soils. Because the project site is underlain by these soils, there is potential for subsidence or soil compression and consolidation. Further, the pumping of water from subsurface water tables causes the greatest amount of subsidence in the local area, and dewatering may be required during some excavation activities as a result of high groundwater levels, which could also increase the potential for subsidence. This would be a ***potentially significant*** impact.

Mitigation Measure 6.9-3: (City of Sacramento)

The project applicant shall implement Mitigation Measure 6.9-1, described above, to reduce the risks to people and structures from subsidence or compression of unstable soils at the project site.

Significance After Mitigation

Review of construction plans and onsite supervision by a geotechnical engineer would reduce significant impacts under the proposed project associated with subsidence or compression of unstable soils to a ***less-than-significant*** level.

IMPACT 6.9-4

Potential for Damage Associated with Expansive Soils. *Soils on portions of the project site are moderately susceptible to expansive soil behavior. Expansive soils may cause differential and cyclical foundation movements that can cause damage and/or distress to overlying structures. In addition, the groundwater table is shallow, which enhances the potential for shrink and swell. This impact would be* ***potentially significant****.*

Approximately 75% of the Natomas area contains soils that are considered to be expansive (City of Sacramento 1988). Expansive soils comprise mainly clays that increase in volume when water is absorbed and shrink when dry. All of the soil types occurring on the project site contain various levels of clay in their compositions. Most of the soils (including Clear Lake and Jacktone clay soils, which comprise the majority of the site soils) exhibit a high shrink-swell potential (SCS 1993). In addition, Wallace Kuhl & Associates (2002) conducted tests on the surface and near-surface clays on sites adjacent to the project site, and found them to be medium to highly plastic (that is, capable of being molded or deformed continuously and permanently by relatively moderate pressure into various shapes). Wallace Kuhl & Associates concluded that the clay soils are expected to experience volume changes with increasing or decreasing soil moisture content, and that they are capable of exerting significant expansion pressures on building foundations and concrete slabs-on-grade (Wallace Kuhl & Associates 2002). Development at the project site has the potential to expose people and structures to adverse effects associated with soils that expand during the rainy season and shrink during the dry season. Structural damage, warping, and cracking of roads and sidewalks, and rupture of utility lines may occur if the potential expansive soils are not considered during design and construction. This impact would be ***potentially significant***.

Mitigation Measure 6.9-4: (City of Sacramento)

The project applicant shall implement Mitigation Measure 6.9-1, described above, to reduce the potential for damage associated with expansive soils.

Significance After Mitigation

Implementation of this mitigation measure would properly design on-site features and would reduce significant impacts under the proposed project associated with expansive soils to a ***less-than-significant*** level.