This section of the Draft Environmental Impact Report (Draft EIR or DEIR) describes the geology and seismicity of the Planning Area, as well as the types of soils that have been identified and their properties as they relate to the proposed General Plan Update. Potential exposure of people and future improvements to soil-related hazards (e.g., unstable or expansive soils) and erosion are analyzed. In addition, potential geologic and seismic hazards, such as fault rupture, ground shaking, liquefaction, and landslides, are discussed. This section also addresses mineral resources within the Planning Area and discusses the proposed General Plan Update's potential to impact those resources.

4.8.1 EXISTING SETTING

REGIONAL GEOLOGIC SETTING

The Planning Area is located within the Great Valley Geomorphic Province (Great Valley), which includes the area known as the Great Central Valley of California. The Great Valley extends 400 miles north to south and 60 miles east to west and is encompassed by the Coast Ranges (metamorphic), the Klamath Ranges (metamorphic), the Cascade Range (volcanic), and the Sierra Nevada Range (granitic and metamorphic). The Great Valley consists of an elongated structural trough that has been filled with a sequence of sedimentary deposits ranging in age from Jurassic to recent. Geophysical evidence suggests that the Great Valley is underlain at depth with granitic rocks of the Sierra Nevada Province. The majority of rocks and deposits found within the Great Valley Geomorphic Province are sedimentary. The age of these rocks and deposits ranges from Upper Jurassic (between 154 and 135 million years ago) to recent.

LOCAL GEOLOGY AND TOPOGRAPHY

The topography of the Planning Area varies from relatively gentle sloped terrain in the western portion of the Planning Area to increasingly hilly terrain at the eastern edge of the city and into the surrounding unincorporated portions of the Planning Area. Average elevation throughout the city is approximately 230 feet above mean sea level.

Geologic Formations

The Planning Area is underlain by various geologic formations, including the Tuscan Formation, the Chico Formation, the Red Bluff Formation, and the Modesto Formation. Bedrock of the Tuscan Formation underlies eastern portions of the Planning Area (primarily Bidwell Park) along the base of the Cascade foothills. The Tuscan Formation consists of a series of layers deposited by streams and mudflows between two and four million years ago. The mudflows spread out over the area, burying older rock, filling low areas, and gradually building a flat subdued landscape. The Tuscan Formation is characterized by near horizontal layers within the formation and four-million-year-old volcanic ash horizon at the bottom of the formation. The Tuscan Formation is of Pliocene age and comprises volcanic mudflows, tuff, breccia, sandstone, and ash deposits. Groundwater in the Sacramento Valley Groundwater Basin is contained primarily within the pore spaces of the reworked sand and gravel layers of the Tuscan Formation, with much of the groundwater being confined under pressure by layers of impermeable clays, mudflows, or tuff breccia.

The Chico Formation of the Late Cretaceous age was named for its occurrence in both the Big Chico Creek and Little Chico Creek canyons. The Chico Formation also occurs along Butte Creek. The Chico Formation and its fossils were deposited by a warm shallow sea that covered the area 90 million years ago. The Chico Formation is characterized by its yellowish-brown color, fine-grained texture, and the presence of fossilized shells. This formation consists of sandstone, siltstone, thin layers of limestone, and conglomerate, all of which accumulated along the shore of the Pacific Ocean during the Cretaceous period of the Mesozoic Era (about 90 million years ago).

The Red Bluff Formation is the oldest (and generally highest) Pleistocene alluvial terrace deposit. This formation covers broad areas of the northern Sacramento Valley, including portions of the Planning Area. Because of its age between half a million and a million years old, this formation is highly weathered for considerable depth and exhibits a strong red-orange color. The Red Bluff Formation has been eroded away in most of the area in and around the City of Chico.

In much of the Sacramento Valley, especially east of the Sacramento River, the Modesto Formation overlies the Riverbank, Tehama, and Tuscan formations. The Modesto Formation consists of sand, silt, and clay seams deposited by rivers and ranges in depth from 10 to 200 feet. It was deposited during the Pleistocene Age, from 42,000 to 14,000 years ago. The formation consists of tan and light grey, gravelly sand, silt, and clay. The Modesto Formation is exposed in the central portion of Butte County and underlies significant portions of the Planning Area. The thickness of the Modesto Formation ranges from 200 to 10 feet, depending on location.

SOILS

The United States Department of Agriculture, Natural Resources Conservation Service's (NRCS) *Soil Survey of Butte Area, California*, characterizes the soils throughout Butte County and within the Planning Area. Acreages of specific soil types within the Planning Area are listed in **Table 4.8-1** and depicted in **Figure 4.8-1**. As shown, the most prominent soil types in the Planning Area are Bosquejo clay, Almendro loam, and Doemill-Jokerst complex.

Bosquejo clay consists of clayey alluvium over loamy alluvium that is derived from volcanic rocks. Bosquejo clays are somewhat poorly drained and have a high shrink-swell potential. Almendro loam consists of loamy alluvium that is derived from igneous, metamorphic, and sedimentary rocks. Almendro loam is well drained and has a moderate shrink-swell potential. The Doemill-Jokerst complex consists of loamy residuum weathered from volcanic breccia and is somewhat poorly drained and has a low shrink-swell potential (NRCS, 2006).

TABLE 4.8-1
PLANNING AREA SOIL TYPES BY ACREAGE

Soil Type	Acreage in the Planning Area
BOSQUEJO CLAY, 0 TO 1% SLOPES	8,624.60
ALMENDRA LOAM, 0 TO 1% SLOPES	7,857.50
DOEMILL-JOKERST COMPLEX, 3 TO 8% SLOPES	7,434.10
VINA FINE SANDY LOAM, 0 TO 1% SLOPES	5,982.50
XERORTHENTS, SHALLOW-TYPIC HAPLOXERALFS-ROCK OUTRCROP, CLIFFS COMPLEX, 15 TO 30% SLOPES	5,974.30
REDSLUFF GRAVELLY LOAM, 0 TO 2% SLOPES	5,462.80
CHICO LOAM, 0 TO 1% SLOPES	4,787.80
XERORTHENTS, SHALLOW-TYPIC HAPLOXERALFS-ROCK OUTCROP, CLIFFS COMPLEX, 30 TO 50% SLOPES	4,656.50

Soil Type	Acreage in the Planning Area
REDTOUGH-REDSWALE COMPLEX, 0 TO 2% SLOPES	4,502.30
CONEJO CLAY LOAM, 0 TO 1% SLOPES	3,991.50
JOKERST-DOEMILL-TYPIC HAPLOXERALFS COMPLEX, 8 TO 15% SLOPES	2,909.90
DOEMILL-JOKERST-ULTIC HAPLOXERALFS, THERMIC COMPLEX, 3 TO 8% SLOPES	2,305.00
BUSACCA CLAY LOAM, 0 TO 1% SLOPES	2,165.60
HAPLOXEROLLS CLAY LOAM, 0 TO 2% SLOPES	2,127.90
CHARGER FINE SANDY LOAM, 0 TO 1% SLOPES	1,889.30
DOEMILL-JOKERST-ULTIC HAPLOXERALFS, THERMIC COMPLEX, 8 TO 15% SLOPES	1,801.30
XERORTHENTS, SHALLOW-TYPIC HAPLOXERALFS COMPLEX, 2 TO 15% SLOPES	1,691.80
DOEMILL-JOKERST COMPLEX, 0 TO 3% SLOPES	1,639.00
ULTIC HAPLOXERALFS, MESIC - ROCKSTRIPE COMPLEX, 2 TO 15% SLOPES	1,593.40
PARROTT SILT LOAM, 0 TO 2% SLOPES, OCCASIONALLY FLOODED	1,489.50
ULTIC HAPLOXERALFS-ROCKSTRIPE-ROCKOUTCROP, CLIFFS COMPLEX,30 TO 50% SLOPES	1,403.90
CORIDGE-ROCK OUTCROP COMPLEX, 3 TO 8% SLOPES	1,141.40
XEROFLUVENTS, 0 TO 4% SLOPES FREQUENTLY FLOODED	1,125.50
XERORTHENTS, TAILINGS, 0 TO 50% SLOPES	1,091.30
ESQUON-NEERDOBE COMPLEX, 0 TO 1% SLOPES	986.8
JOKERST-DOEMILL-TYPIC HAPLOXERALFS COMPLEX, 15 TO 30% SLOPES	896.1
GIANELLA FINE SANDY LOAM, 0 TO 1% SLOPES, FREQUENTLY FLOODED	886.9
VINA LOAM, 0 TO 1% SLOPES	884.6
GALT CLAY, 0 TO 1% SLOPES	859.1
IGNORD FINE SANDY LOAM, 0 TO 2% SLOPES	847.6
WAFAP-HAMSLOUGH COMPLEX, 0 TO 2% SLOPES	838
ULTIC HAPLOXERALFS, MESIC - ROCKSTRIPE COMPLEX, 15 TO 30% SLOPES	728.6
KUSALSLOUGH SILTY CLAY LOAM, 0 TO 1% SLOPES, OCCASIONALLY FLOODED	685.1
GIANELLA FINE SANDY LOAM, 0 TO 1% SLOPES, OCCASIONALLY FLOODED	625.2
ROCKSTRIPE-ULTIC HAPLOXERALFS-ROCK OUTCROP, CLIFFS COMPLEX, 70 TO 100% SLOPES	564.7
CLEARHAYES-HAMSLOUGH COMPLEX, 0 TO 2% SLOPES	483
CHINACAMP GRAVELLY LOAM, 15 TO 30% SLOPES	482.3
FARWELL CLAY LOAM, 0 TO 1% SLOPES	455.2
ULTIC HAPLOXERALFS-ROCKSTRIPE-ROCK OUTCROP, CLIFFS COMPLEX, 50 TO 70% SLOPES	453.7
ROCK OUTCROP, CLIFFS-COALCANYON TAXADJUNCT COMPLEX, 15 TO 50% SLOPES	430
HAPLOXEROLLS LOAM, 0 TO 2% SLOPES	374.3
REDTOUGH LOAM, 8 TO 35% SLOPES	336.4
LUCKSEV-BUTTESIDE-CARHART COMPLEX, 2 TO 15% SLOPES	329.2

Soil Type	Acreage in the Planning Area
GALT CLAY LOAM, 0 TO 1% SLOPES, LEVELED	311.2
CARHART TAXADJUNCT, 0 TO 2% SLOPES	293.1
COALCANYON TAXADJUNCT VERY GRAVELLY LOAM, 15 TO 30% SLOPES	281
CHINACAMP GRAVELLY LOAM, 3 TO 15% SLOPES	242.1
EDJOBE SILTY CLAY, 0 TO 1% SLOPES	226
WATER	213.3
BOSQUEJO SILT LOAM, 0 TO 1% SLOPES, OVERWASH, OCCASIONALLY FLOODED	212.8
CORIDGE-ROCK OUTCROP COMPLEX, 8 TO 15% SLOPES	209.6
DURIXEROLLS-HAPLOXEROLLS CLAY LOAMS, 0 TO 2% SLOPES	195.7
HAPLOXERALFS, TERRACE, 0 TO 5% SLOPES	187.1
CONEJO FINE SANDY LOAM, 0 TO 1% SLOPES, OVERWASH	184.5
GIANELLA SILT LOAM, 0 TO 1% SLOPES, FREQUENTLY FLOODED	172.5
COALCANYON TAXADJUNCT VERY GRAVELLY LOAM, 30 TO 50% SLOPES	168.3
GIANELLA SANDY LOAM, 0 TO 1% SLOPES, FREQUENTLY FLOODED	160.3
BOSQUEJO CLAY LOAM, 0 TO 1% SLOPES	156.1
PARROTT-VERMET COMPLEX, 0 TO 2% SLOPES, FREQUENTLY FLOODED	148
ROCK OUTCROP-THERMALROCKS-CAMPBELLHILLS COMPLEX, 2 TO 15% SLOPES	140.4
RIVERWASH, 0 TO 2% SLOPES FREQUENTLY FLOODED	136
CHINACAMP GRAVELLY LOAM, 30 TO 50% SLOPES	115.2
ANITA-GALT COMPLEX, 0 TO 3% SLOPES	114.7
COLUMBIA TAXADJUNCT VERY FINE SANDY LOAM, 0 TO 1% SLOPES, FREQUENTLY FLOODED	112.5
ANITA, GRAVELLY DURIPAN-TUSCAN TAXADJUNCT COMPLEX, 0 TO 2% SLOPES	107.2
DUMPS, LANDFILL	94.1
TUSCAN-FALLAGER-ANITA, GRAVELLY DURIPAN, COMPLEX, 0 TO 3% SLOPES	83.5
COALCANYON TAXADJUNCT VERY GRAVELLY LOAM, 3 TO 15% SLOPES	72.7
DURIXEROLLS-HAPLOXEROLLS LOAMS, 0 TO 2% SLOPES	72.6
TYPIC XEROFLUVENTS COMPLEX, 0 TO 2% SLOPES	67
MUNJAR-TUSCAN TAXADJUNCT-GALT COMPLEX, 0 TO 2% SLOPES	66
PITS, GRAVEL	58.9
SLIDELAND GRAVELLY LOAM, 3 TO 15% SLOPES	30.2
CARHART-ANITA TAXADJUNCT COMPLEX, 0 TO 12% SLOPES	28.6
PARROTT SILT LOAM, 0 TO 2% SLOPES, FREQUENTLY FLOODED	26.3
MODA TAXADJUNCT-ARBUCKLE COMPLEX, 0 TO 2% SLOPES	15.2
COALCANYON TAXADJUNCT VERY GRAVELLY LOAM, 50 TO 70% SLOPES	14.5

Soil Type	Acreage in the Planning Area
DODGELAND SILTY CLAY LOAM, 0 TO 5% SLOPES, OCCASIONALLY FLOODED	12.1
CHEROKEESPRING GRAVELLY SILT LOAM, 2 TO 15% SLOPES	12
ULTIC HAPLOXERALFS, SANDSTONE, 50 TO 70% SLOPES	6.7
FARWELL SILT LOAM, 0 TO 1% SLOPES, OCCASIONALLY FLOODED	6.6
GIANELLA LOAM, 0 TO 1% SLOPES, OCCASIONALLY FLOODED	3.3
CHINACAMP GRAVELLY LOAM, 50 TO 70% SLOPES	0.9
Total	**100,554.5**

Source: NRCS, 2006

Landslides and Slope Instability

Landslides may be triggered by both natural and human-induced changes in the environment resulting in slope instability. The term *landslide* includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors including:

- Erosion by rivers, glaciers, or ocean waves creating over-steepened slopes;
- Rock and soil slopes being weakened through saturation by snowmelt or heavy rains;
- Earthquakes creating stresses that make weak slopes fail;
- Earthquakes of magnitude 4.0 and greater;
- Volcanic eruptions producing loose ash deposits, heavy rain, and debris flows; and
- Excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or from human-made structures stressing weak slopes to failure.

Slope material that becomes saturated with water may develop a debris flow or mud flow. The resulting slurry of rock and mud may pick up trees, houses, and cars, thus blocking bridges and tributaries and causing flooding along its path (USGS, 2009).

Although steep slopes are commonly present where landslides occur, it is not necessary for the slopes to be long. Landslides, rock falls, and debris flows occur continuously on all slopes; some processes act very slowly, while others occur very suddenly. Slope stability is dependent on many factors and their interrelationships, including rock type, slope steepness, and natural or human-made undercutting (Butte County, 2007).

Butte County has a history of landslides, most of which occur in areas that have experienced previous landslides. The areas of highest landslide potential are in the mountainous central area of the county where well-developed soils overlay impervious bedrock on steep slopes which at times undergo heavy rainfall. The slopes around flat uplands, such as Table Mountain, are also highly susceptible to landslides. Most of the rest of Butte County has moderate to low landslide potential. The majority of the Planning Area has no potential to low potential for landslides.

However, the eastern portion of the Planning Area in the foothills has a moderate to high potential for landslides (Butte County, 2007).

Erosion/Accelerated Erosion

The NRCS classifies soils based on the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. Erosion hazard is described as "slight," "moderate," "severe," or "very severe." A rating of slight indicates that erosion is unlikely under ordinary climatic conditions; moderate indicates that some erosion is likely under ordinary climatic conditions and that erosion-control measures may be needed; severe indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and very severe indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical. The erosion rating for many of the soil types found in the western and central portions of the Planning Area is slight. However, soils found in the eastern foothills are much more prone to erosion. Specifically, rock and cliff outcrop type soils generally have an erosion hazard rating of very severe to severe (NRCS, 2006).

Settlement

Surface settlement can occur due to immediate settlement of coarse-grained soils or consolidation of fine-grained soils under increased loading. Settlement can also result from shrinkage of expansive soil or liquefaction (both discussed below). Immediate settlement occurs when a load from a structure or placement of new fill material is applied, causing distortion in the underlying materials. This settlement occurs relatively quickly and is typically substantially complete within several hours or days after placement of the final load. Consolidation settlement occurs in saturated or near-saturated fine-grained (clay) soil due to volume change caused by load-induced squeezing out of water from the pore spaces. Consolidation occurs over a relatively long period of time (often years or even decades) and is followed by secondary compression, which is a continued change in void ratio under the continued application of the load from the pore water to the soil grains. Total settlements can vary over an area, referred to as differential settlement, due to variations in loading, soil characteristics, and thickness of compressible layers.

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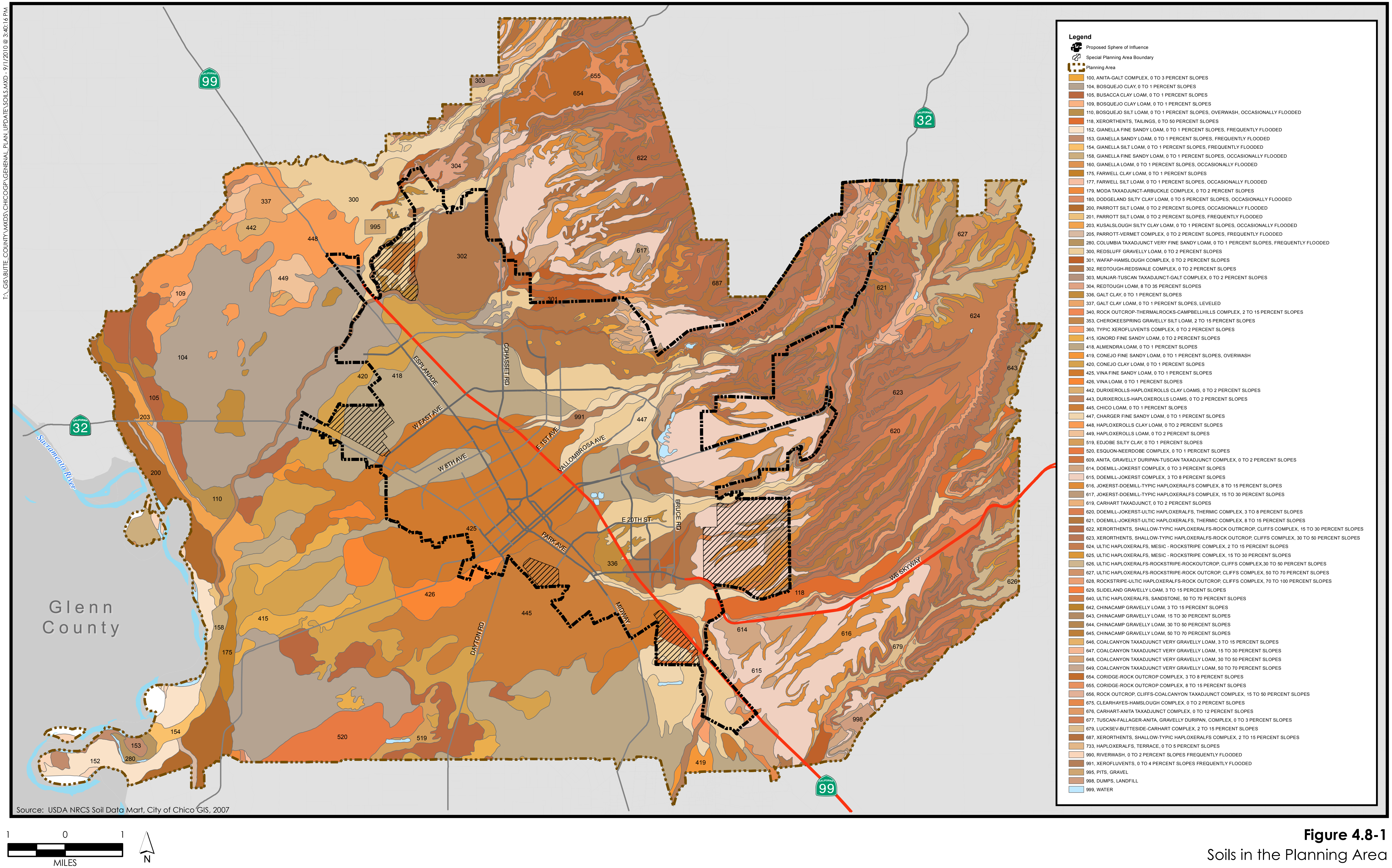

Figure 4.8-1

Soils in the Planning Area

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Expansive Soils

Expansive soils are soils that tend to shrink or swell depending on their moisture content. These swelling soils typically contain clay minerals, as many types of clay minerals are expansive. Expansive clay minerals include smectite, bentonite, montmorillonite, beidellite, vermiculite, attapulgite, nontronite, illite, and chlorite. When a soil contains a large amount of expansive minerals, it has the potential for significant expansion. As expansive soils get wet, the clay minerals absorb water molecules and expand; conversely, as they dry they shrink, leaving large voids in the soil. 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. Cracked foundations, floors, and basement walls are typical types of damage done by swelling soils. Damage to the upper floors of the building can occur when motion in the structure is significant.

The Planning Area is in a region where expansive soils are known to exist. The Central Valley region contains soils with slight to moderate shrink-swell potential (Geology.com, 2009). Within Butte County, soils with no or low expansion potential occur along stream and river valleys and on steep mountain slopes. Soils of high expansion potential generally occur in the level areas of the Sacramento Valley, including around the population centers of Chico, Oroville, Biggs, and Gridley (DC&E, 2007). Furthermore, many of the soils found within the Planning Area have a moderate to high shrink-swell potential. In fact, the most abundant soil in the Planning Area, Bosquejo clay, consists of clayey alluvium with high shrink-swell potential.

Septic Tank Soil Contamination

The discharge from individual septic systems has been cited by the Regional Water Quality Control Board (RWQCB) as a source of soil and groundwater nitrate contamination in the Planning Area. Methemoglobinemia (blue-baby syndrome), possible carcinogenic effects, and other health concerns are among the effects of excessive nitrate exposure, particularly in drinking water (water quality, including nitrate in groundwater, is discussed in Section 4.9, Hydrology and Water Quality, of this Draft EIR). Technical analysis conducted for the County's Nitrate Compliance Plan (discussed under Regulatory Framework below) found that average residential densities of approximately four or more dwelling units per acre in certain parts of the Planning Area exceed the capacity of the soil and receiving waters to assimilate nitrogen. Locations in the Planning Area that currently are the highest priority for sewering (nitrate elimination or nitrate reduction) per the Nitrate Action Plan are shown in **Figure 4.8-2**.

MINERAL RESOURCES

There are no active mines and no known areas with mineral resource deposits within the Planning Area, although historically several areas along Butte Creek were mined for gold, sand, and gravel. The majority of the closest mining operations are located to the southeast, outside of the Planning Area.

FAULTING AND SEISMICITY

An earthquake is the sudden, rapid shaking of the ground caused by the breaking and shifting of rock beneath the earth's surface. For hundreds of millions of years, the forces of plate tectonics have shaped the earth as the huge plates that form the earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual and at other times the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free and cause the ground to shake. Most earthquakes occur at the boundaries where the plates meet; however, some earthquakes occur in the middle of plates (Butte County, 2007).

Earthquakes can cause strong ground shaking that may damage property and infrastructure. The strength of an earthquake is generally expressed in two ways: magnitude and intensity. The magnitude is a measure that depends on the seismic energy radiated by the earthquake as recorded on seismographs. The intensity at a specific location is a measure that depends on the effects of the earthquake on people or buildings and is used to express the severity of ground shaking. Although there is only one magnitude for a specific earthquake, there may be many values of intensity (damage) for that earthquake at different sites.

The most commonly used magnitude scale today is the moment magnitude (Mw) scale. Moment magnitude is related to the physical size of fault rupture and the movement (displacement) across the fault, and it is therefore a more uniform measure of the strength of an earthquake. The seismic moment of an earthquake is determined by the resistance of rocks to faulting multiplied by the area of the fault that ruptures and by the average displacement that occurs across the fault during the earthquake. The seismic moment determines the energy that can be radiated by an earthquake and hence the seismogram recorded by a modern seismograph (CGS, 2002).

The most commonly used scale to measure earthquake intensities (ground shaking and damage) is the Modified Mercalli Intensity (MMI) Scale, which measures the intensity of an earthquake's effects in a given locality and is based on observations of earthquake effects at specific places. On the Modified Mercalli Intensity Scale, values range from I to XII (see **Table 4.8-2**). While an earthquake has only one magnitude, it can have various intensities, which decrease with distance from the epicenter (CGS, 2002).

Table 4.8-2 provides descriptions of the effects of ground shaking intensities along with a general range of moment magnitudes that are often associated with those intensities.

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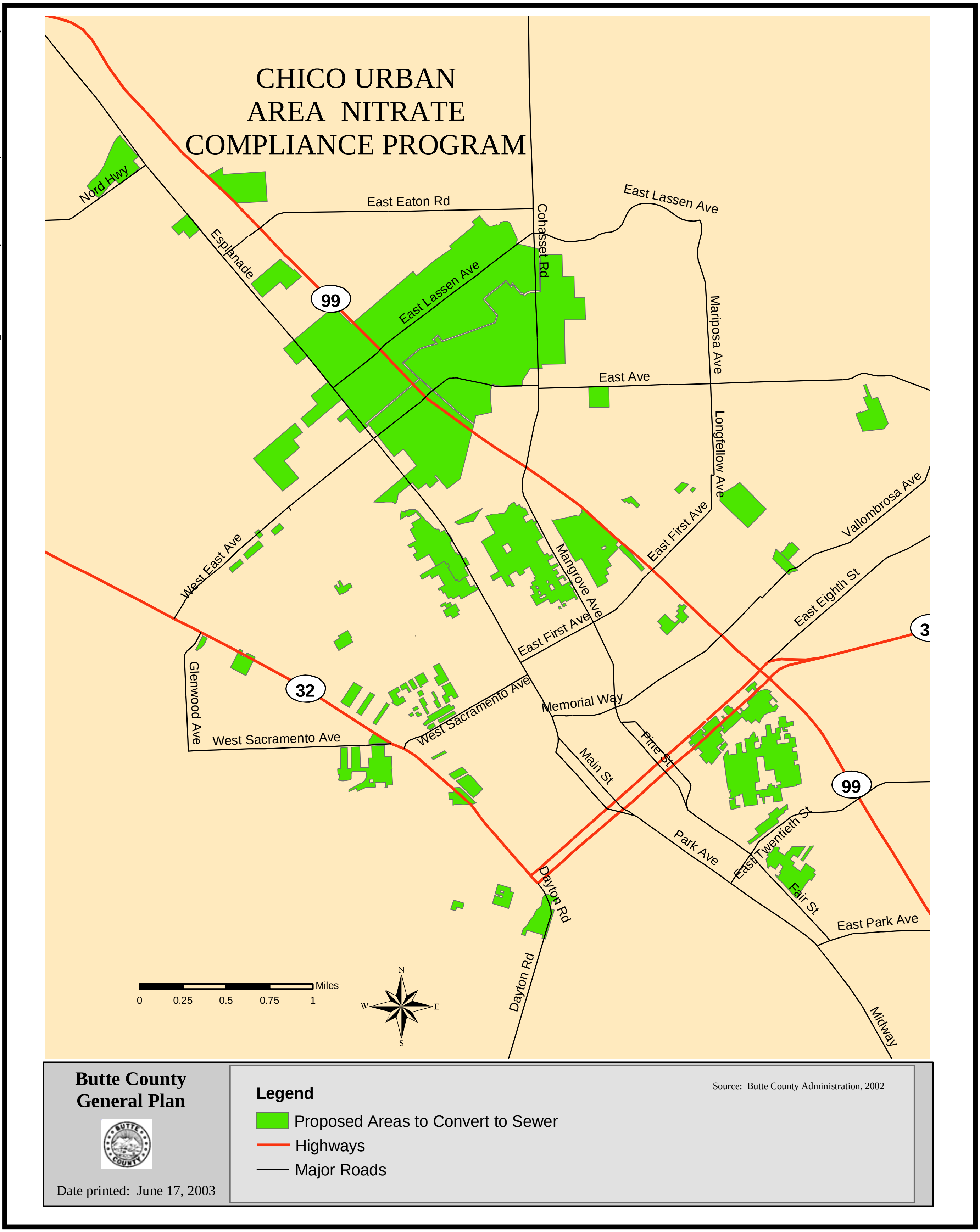

Figure 4.8-2

Chico Urban Area Nitrate Compliance Plan

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TABLE 4.8-2
EFFECTS OF RICHTER MAGNITUDE AND MODIFIED MERCALLI INTENSITY

Mw	Modified Mercalli Scale	Effects of Intensity
1.0 – 3.0	I	I. Not felt except by a very few under especially favorable conditions.
3.0 – 3.9	II – III	II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. 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.
4.0 – 4.9	IV – V	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, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
5.0 – 5.9	VI – VII	VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight. VII. Everybody runs outdoors. Damage negligible in building 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 motor cars.
6.0 – 6.9	VIII – IX	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, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed. IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
7.0 and higher	X or higher	X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. 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. XII. Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.

Source: CGS, 2002

The Seismic Hazards Zonation Program of the California Geological Survey (CGS) categorizes Butte County as a seismic hazard zone. Seismic risk in Butte County results from earthquake faults in the county as well as from faults outside the county whose seismic activity would cause potentially damaging ground shaking in Butte County, including in the Planning Area (Butte County, 2007). The following is a description of the active faults in or near Butte County and the potential effect they have on the county in terms of magnitude (Butte County, 2007). Faults in the vicinity of the Planning Area are also shown in **Figure 4.8-3.**

Cleveland Hills Fault. As discussed below, the only identified active fault located in Butte County is the Cleveland Hills fault. The Cleveland Hills fault is responsible for the 1975 Oroville earthquake of Richter magnitude 5.7, an event that produced surface displacement along about 2.2 miles of the fault. Ground motions were experienced at Gridley and Oroville, with significant structural damage occurring to unreinforced masonry buildings in Oroville. Geologic studies indicate that the total length of the Cleveland Hills fault is probably 11 to 15 miles (DC&E, 2007). The Cleveland Hills fault is located approximately 17 miles southeast of the Chico city limits. The maximum credible earthquake on this fault is approximately magnitude 6.5 to 6.7. An event of this magnitude would cause substantially more damage in the Planning Area than the 1975 event caused.

Foothills Shear Zone. The Foothills shear zone extends into southern Butte County and reaches a point approximately 26 miles southeast of Chico. A possible magnitude 7.0 earthquake in this zone would result in intensities as high as MMI IX in the Planning Area.

Chico Monocline Fault. The Chico Monocline fault, which extends northwesterly from Chico, was considered potentially active in an unpublished 1988 report by the CGS. Based on its length of approximately 42 miles, this fault could produce at least a magnitude 7.0 earthquake, which would cause major damage in the Planning Area.

Willows Fault. The 40-mile-long Willows fault is approximately 24 miles west of Chico and could produce a magnitude 7.0 earthquake and yield an MMI as high as VIII in the Planning Area (comparable to the intensity experienced during the 1975 Oroville earthquake).

Coast Ranges Thrust Zone. The Coast Ranges thrust zone is approximately 42 miles west of Chico. This fault zone could potentially produce a magnitude 8.0 earthquake, which could be experienced in the Planning Area as MMI IX or X. An event of this magnitude would cause major damage in the Planning Area.

San Andreas Fault System. The San Andreas fault, along with related faults such as the Hayward and Calaveras, is one of the most active faults in California. Total displacement along this fault has been at least 450 miles and could possibly be as much as 750 miles. This fault system was responsible for the magnitude 8.0 San Francisco earthquake of 1906 as well as numerous other damaging earthquakes, including the 1989 Loma Prieta earthquake. At its nearest point, the San Andreas fault is about 108 miles west of Chico. The 1906 earthquake was strongly felt in Butte County, at approximately MMI V and VI in western Butte County, but there was little damage. Earthquakes along this fault are not anticipated to result in major damage in the Planning Area.

Hayward-Calaveras Fault. The Hayward-Calaveras fault complex is considered to be a branch of the San Andreas fault. An 1868 earthquake is reported to have caused strong fluctuations in the water level in the Sacramento River near Sacramento and in a slough near Stockton. Earthquakes along this fault are not anticipated to result in major damage in the Planning Area.

Midland-Sweitzer Fault. The 80-mile-long Midland-Sweitzer fault lies approximately 62 miles southwest of Chico. Historically, earthquakes of Richter magnitudes between 6.0 and 6.9 have occurred on or near this fault, including two strong earthquakes in 1892. Based on the fault length and the historic activity, this fault is capable of producing a magnitude 7.0 earthquake, which would be experienced in Butte County with MMI as high as VIII or IX.

Eastern Sierra Faults/Russell Valley Fault. The Eastern Sierra contain a number of active faults including the Russell Valley fault, which produced the 1966 Truckee earthquake with a magnitude of approximately 6.0, and several faults in the Last Chance and Honey Lake fault zones, which have produced several magnitude 5.0 to 5.9 earthquakes. These fault zones are approximately 80 miles east of Chico. Earthquakes on these faults could be experienced in Butte County with MMI as high as VII or VIII.

Last Chance-Honey Lake Fault Zones. The Last Chance-Honey Lake fault zones are approximately 100 miles long and trend north-northwest along the California-Nevada border. These faults are active and have resulted in earthquakes ranging between magnitude 5.0 and 5.9. The Last Chance-Honey Lake fault zones are approximately 90 miles east of Chico, and earthquakes along this fault are not anticipated to result in major damage in the Planning Area.

Other Potentially Active Faults. Other potentially active faults in the vicinity of the Planning Area include the Sutter Buttes faults, Dunnigan fault, Camel's Peak fault, Melones-Dogwood Peak faults, and Hawkins Valley fault. All of these faults should be considered potentially active due to geologic, historic, or seismic data.

An "active" fault, as defined by the 1994 Alquist-Priolo Earthquake Fault Zoning Act, is one that shows displacement within the last 11,000 years and therefore is considered more likely to generate a future earthquake and surface rupture than a fault that shows no sign of recent rupture. The Alquist-Priolo Earthquake Fault Zoning Act requires the California State Geologist to establish regulatory zones (known as Earthquake Fault Zones) around the surface traces of active faults and to issue appropriate maps in order to mitigate the hazard of surface faulting to structures for human occupancy. No Alquist-Priolo Earthquake Fault Zones exist within the Planning Area (DOC, 2009). The only known active fault in Butte County is the Cleveland Hills fault south of Oroville, the site of the August 1975 Oroville earthquake. This earthquake was felt in Chico, but there was no recorded damage. The Cleveland Hills fault is within an Earthquake Fault Zone as mapped by the Alquist-Priolo Earthquake Fault Zoning Act.

Although there are no active faults in the Planning Area, the Sierra foothills contain hundreds of mapped faults, dozens of which are located in Butte County. Most of these faults are not considered active. Furthermore, most of these faults are very short and thus are probably not capable of producing severely damaging earthquakes.

Liquefaction

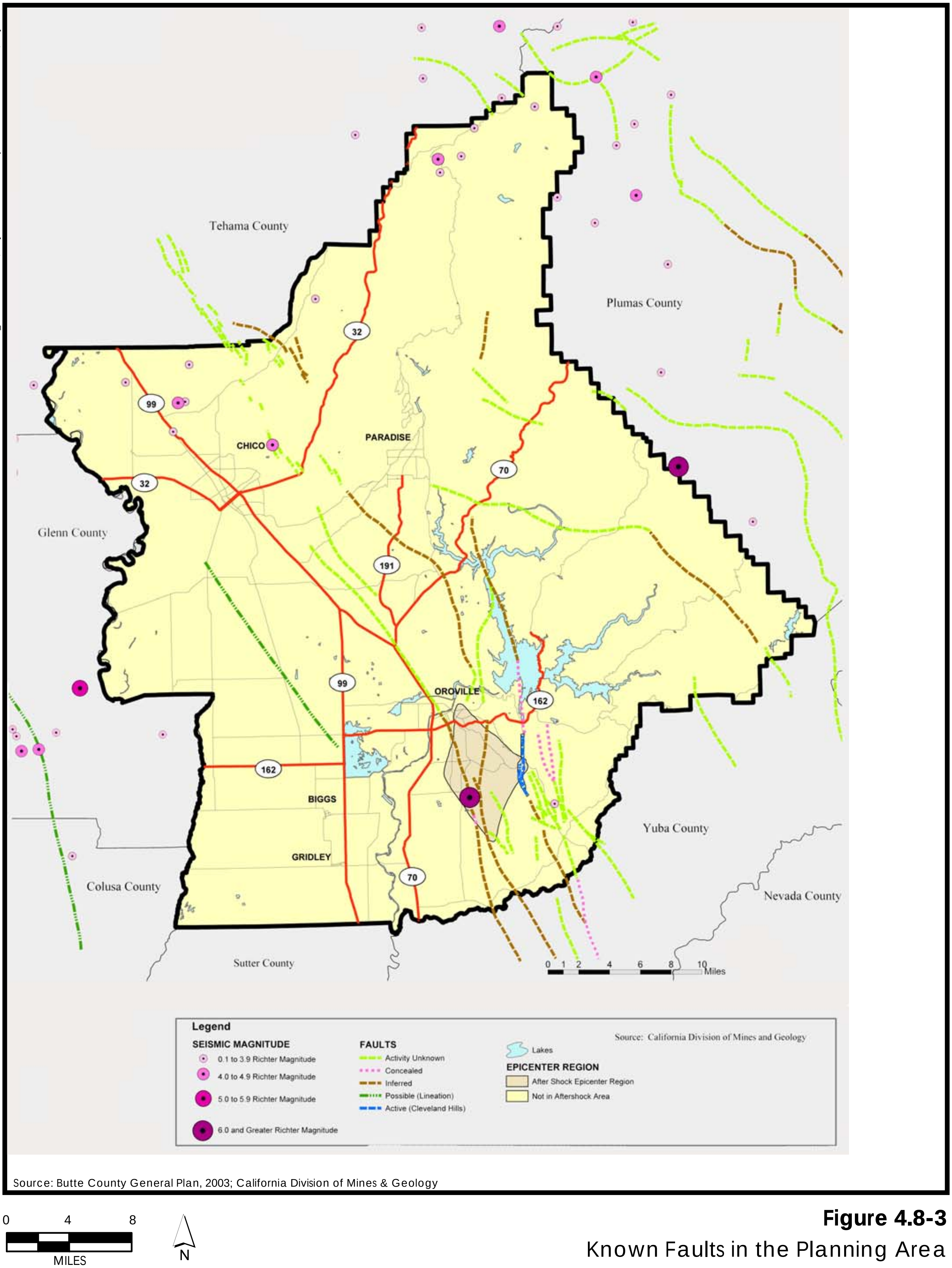
Liquefaction occurs when loose sand and silt that is saturated with water behaves like a liquid when shaken by an earthquake. Earthquake waves cause water pressures to increase in the sediment and the sand grains to lose contact with each other, leading the sediment to lose strength and behave like a liquid. The soil can loose its ability to support structures, flow down even very gentle slopes, and erupt to the ground surface to form sand boils. Many of these phenomena are accompanied by settlement of the ground surface, usually in uneven patterns that damage buildings, roads, and pipelines (USGS, 2009).

Three factors are required for liquefaction to occur: (1) loose, granular sediment (typically "made" land and beach and stream deposits that are young enough (late Holocene) to be loose); (2) saturation of the sediment by groundwater (water fills the spaces between sand and silt grains); and (3) strong shaking. Liquefaction causes three types of ground failure: lateral spreads, flow failures, and loss of bearing strength. In addition, liquefaction enhances ground settlement and sometimes generates sand boils (fountains of water and sediment emanating from the pressurized liquefied zone).

In Butte County, areas paralleling the Sacramento River that contain clean sand layers with low relative densities are estimated to have generally high liquefaction potential. Areas of bedrock, including most of eastern Butte County, have no liquefaction potential, although localized areas of valley fill alluvium can have moderate to high liquefaction potential (Butte County, 2007). The Planning Area, in general, has a low to moderate risk for liquefaction, with the low potential being in the eastern portion of the Planning Area and the moderate potential being within the Chico city limits and to the west (DC&E, 2007).

Subsidence

Land subsidence results in a slow-to-rapid downward movement of the ground surface as a result of the vertical displacement of the ground surface, usually resulting from groundwater withdrawal. Subsidence is common in the Sacramento Valley and in large areas of the San Joaquin Valley. Subsidence is a greater hazard in areas where the subsurface geology includes compressible layers of silt and clay. The amount of subsidence caused by groundwater withdrawal depends on several factors, including the extent of water level decline, the thickness of the water-bearing strata tapped, the thickness and compressibility of silt-clay layers within the vertical sections where groundwater withdrawal occurs, the duration of maintained groundwater level decline, the number and magnitude of water withdrawals in a given area, and the general geology and geologic structure of the groundwater basin. Subsidence can result in gradient changes in roads, streams, canals, drains, sewers, and dikes that may be significantly damaged by even small elevation changes. Other damaging effects of subsidence include damage to water wells resulting from sediment compaction and increased likelihood of flooding of low-lying areas. No land subsidence has been recorded in Butte County. However, land subsidence is considered to be a potential hazard for the portions of Butte County located within the Sacramento Valley, including areas of heavy groundwater withdrawal extending 2 miles north and south of Chico. Groundwater supplies and groundwater withdrawal are discussed further in Section 4.12, Public Services and Utilities, of this Draft EIR.



Source: Butte County General Plan, 2003; California Division of Mines & Geology

Figure 4.8-3

Known Faults in the Planning Area

PMC®

Lateral Spreading

Lateral spreading occurs when the ground slides down very gentle slopes or toward stream banks riding on a buried liquefied layer. In soils this movement is generally due to failure along a weak plane and is associated with liquefaction. Within the Planning Area, lateral spreading is possible along the banks of California Park Lake in southeast Chico as well as along the numerous creeks flowing through the city. These waterways include Big Chico, Little Chico, Sycamore, Comanche, and Butte creeks as well as the Lindo Channel.

Earthquake-Induced Settlement and Landslides

Past experience has shown that several types of landslides take place in conjunction with earthquakes. The most abundant types of earthquake-induced landslides are rock falls and slides of rock fragments that form on steep slopes. Shallow debris slides forming on steep slopes and soil, and rock slumps and block slides forming on moderate to steep slopes also take place, but they are less abundant. Reactivation of dormant slumps or block slides by earthquakes is rare (USGS, 2009).

Large earthquake-induced rock avalanches, soil avalanches, and underwater landslides can be very destructive. Rock avalanches originate on over-steepened slopes in weak rocks. Soil avalanches occur in some weakly cemented fine-grained materials, such as loess, that form steep stable slopes under non-seismic conditions. The size of the area affected by earthquake-induced landslides depends on the magnitude of the earthquake, its focal depth, the topography and geologic conditions near the causative fault, and the amplitude, frequency, composition, and duration of ground shaking. In past earthquakes, landslides have been abundant in some areas having intensities of ground shaking as low as VI on the Modified Mercalli Intensity Scale.

Within the Planning Area, the rocks that comprise the foothills along the eastern portion of the Planning Area have undergone extensive deformation and deep weathering and are susceptible to earthquake-induced landslides.

Seiches

Seismic seiches are periodic oscillations, or standing waves, on rivers, reservoirs, ponds, and lakes that occur when seismic waves from an earthquake pass through the area. The period of the oscillation varies depending on the size of the body of water and may be several minutes to several hours. Depending on the magnitude of the oscillations, seiches can cause considerable damage to dams, levees, and shoreline facilities. Seiches have not been recorded in any of the reservoirs in Butte County that are within the jurisdiction of the California Division of Dam Safety. However, the potential for seiches does exist in Butte County (DC&E, 2007). The Planning Area could also be at risk for seiches; however, this risk is considered very low since the only water bodies in the Planning Area that could be affected are California Park Lake, swimming pools, and water tanks.

4.8.2 REGULATORY FRAMEWORK

STATE

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. A direct result of the 1971 San Fernando earthquake and the extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures, the Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent the construction of buildings used for human occupancy on the surface of active faults. The act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Seismic Hazards Mapping Act (discussed below) addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.

The law 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 and controlling new or renewed construction. The law requires that before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults. An evaluation and written report of a specific site must be prepared by a licensed geologist. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault (generally 50 feet) (DOC, 2009).

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 (Public Resources Code, Chapter 7.8, Sections 2690–2699.6), passed by the legislature following the 1989 Loma Prieta earthquake, directs the Department of Conservation, California Geological Survey to identify and map areas prone to liquefaction, earthquake-induced landslides, and amplified ground shaking. The purpose of the act is to minimize loss of life and property through the identification, evaluation, and mitigation of seismic hazards.

Staff geologists in the Seismic Hazard Zonation Program gather existing geological, geophysical, and geotechnical data from numerous sources to produce the Seismic Hazard Zone Maps. They integrate and interpret these data regionally in order to evaluate the severity of the seismic hazards and designate as Zones of Required Investigation those areas prone to liquefaction and earthquake-induced landslides. Cities and counties are then required to use the Seismic Hazard Zone Maps in their land use planning and building permit processes. The Seismic Hazards Mapping Act requires that site-specific geotechnical investigations be conducted within the Zones of Required Investigation to identify and evaluate seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy (DOC, 2009).

California Building Code

The California Building Code (CBC) is another name for the body of regulations found in the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Code. The purpose of the CBC is to provide minimum standards to safeguard life or limb, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all building and structures within its jurisdiction. The provisions of the CBC apply to the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout the State of California (CBSC, 2008).

Published by the International Conference of Building Officials, the International Building Code is a widely adopted model building code in the United States. The CBC incorporates by reference the International Building Code with necessary California amendments. These amendments include significant building design criteria that have been tailored for California earthquake conditions. Design criteria for seismic loading and other geologic hazards are included in the design standards in the CBC. The CBC provides design criteria for geologically induced loading that govern sizing of structural members and provides calculation methods to assist in the design process. The City of Chico adopted the California Building Code in Chapter 16R.02 of the City of Chico Municipal Code.

LOCAL

City of Chico Municipal Code/Grading Ordinance

Chapter 16R.22 of the City of Chico Municipal Code contains the City's grading standards. The standards specify that the maximum permanent rate of sediment loss after completion of a project should not exceed the natural erosion rate which occurred prior to the grading project. In addition, if excessive erosion occurs from the project, erosion and sediment control measures are required to be immediately implemented to reduce erosion to allowable levels. The standards also require revegetation and slope stabilization to prevent erosion of slopes.

The City's Grading Ordinance can be found in Chapter 16 of the Municipal Code. The ordinance requires that when grading is performed as part of a project for which an environmental impact report, mitigated negative declaration, or other environmental document was prepared, the grading must comply with all applicable mitigation measures identified in that document and imposed on the project as conditions of approval. The Grading Ordinance requires a valid grading permit for any grading work within the city and provides for inspection and enforcement to ensure compliance with grading regulations.

Nitrate Compliance Plan

In the 1980s, the RWQCB recognized that on-site sewage disposal systems were contributing to elevated nitrate levels in groundwater in the Chico area and initially issued a Prohibition Order requiring all existing septic systems in the Chico Urban Area to convert to a community sewer system. In response, Butte County, the City of Chico, and the RWQCB developed strict standards limiting any new systems, the creation of a Joint Powers Authority, and a plan to finance the conversion of existing septic systems to the City sewer system. In 2001 the Butte County Board of Supervisors adopted the Nitrate Compliance Plan, which superseded the previous Nitrate Action Plan. The Nitrate Compliance Plan enacts strict standards for density requirements for new septic systems. The standards allow for conventional septic systems only in narrowly defined circumstances, call for the elimination of existing systems in most of the Chico Urban Area, and identify a financing mechanism to do this. The plan also provides for case-by-case evaluation of nonresidential septic systems and recognizes that sewer connection may not be practical or feasible in all cases (DC&E, 2007).

Butte County Environmental Health Division

In Butte County, septic systems are regulated by the Environmental Health Division. The County is currently preparing an environmental impact report (EIR) for the Butte County Individual On-Site Wastewater Ordinance. The ordinance would apply to unincorporated portions of Butte County not served by municipal wastewater treatment and disposal facilities. The ordinance would update and replace existing County regulations in order to be consistent with applicable requirements of the Central Valley RWQCB Basin Plan and to incorporate other changes based on the current state of knowledge and advances in practices and technologies for on-site wastewater treatment and disposal. Notably, the ordinance would (a) implement more standardized procedures for soil and site evaluations; (b) incorporate new requirements pertaining to the vertical separation between the bottom of dispersal systems and groundwater or restrictive layers; (c) provide a broader range of treatment and dispersal designs; and (d) institute a program to assure ongoing maintenance of certain types of systems (Butte County, 2009).

4.8.3 IMPACTS AND MITIGATION MEASURES

STANDARDS OF SIGNIFICANCE

This analysis evaluates the project's impacts on geology and soils and mineral resources based on the standards identified in the California Environmental Quality Act (CEQA) Guidelines Appendix G. The City has determined that a geology and soils impact is considered significant if implementation of the project would:

1) 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 or 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.

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

3) 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; be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property.

4) 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.

5) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state, or result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan.

As discussed under the Existing Setting subsection above, the Planning Area is not within an Alquist-Priolo Earthquake Fault Zone and therefore would not be subject to hazards associated with fault rupture. In addition, the Planning Area has a very low risk for seiche hazards, since the only water bodies in the Planning Area that could be affected are California Park Lake, swimming pools, and water tanks. Therefore, these seismic hazard issues are not discussed further in this Draft EIR.

As there are no active mines and no known areas with mineral resource deposits within the Planning Area, implementation of the proposed General Plan Update would not result in the loss of availability of a known mineral resource, and this issue is not discussed further in this Draft EIR.

METHODOLOGY

The geology and soils analysis is based on a review of published information, surveys, and reports regarding regional geology and soils. Information was obtained from private and governmental agencies and Internet websites, including the USDA Natural Resources Conservation Service, the California Geological Survey (formerly the California Department of Mines and Geology), and the United States Geological Survey. This material was then compared to the proposed General Plan Update's specific geology and soil-related impacts.

The analysis takes into account the density and type of existing and proposed land uses within the Planning Area, as well as proposed and anticipated development in the City of Chico and surrounding areas. The reader is referred to Section 4.0 of this DEIR for a discussion of assumed land uses and development conditions in the area.

The following proposed General Plan Update policies and actions address geology and soils:

Policy S-3.1 — *(Potential Structural Damage) – To the greatest extent feasible, prevent damage to new structures caused by seismic, geologic, or soil conditions.*

Action S-3.1.1 — *(California Building Code) – Require all new buildings in the City to be built under the seismic requirements of the California Building Code.*

Action S-3.1.2 — *(Potential Soil Hazards) – In areas with highly expansive soils, require appropriate studies and structural precautions as part of project review.*

Action OS-3.1.1 — *(Comply with State Standards) – Comply with the California Regional Water Quality Control Board's regulations and standards to maintain and protect water quality.*

Action OS-3.2.2 — *(Nitrate Compliance Plan) – Implement the Nitrate Compliance Plan and provide regular updates to the City Council.*

The impact analysis provided below utilizes these proposed policies and actions to determine whether implementation of the proposed General Plan Update would result in significant impacts. The analyses identify and describe how specific policies and actions as well as other City regulations and standards provide enforceable requirements and/or performance standards that address geologic conditions and avoid or minimize significant impacts.

PROJECT IMPACTS AND MITIGATION MEASURES

Seismic Hazards (Standard of Significance 1)

Impact 4.8.1 Subsequent land use activities associated with implementation of the proposed General Plan Update could result in the exposure of more people, structures, and infrastructure to seismic hazards. However, policy provisions in the proposed General Plan Update and continued implementation of the City's Municipal Code would ensure that people, structures, and infrastructure are not adversely impacted by seismic hazards. This is considered a **less than significant** impact.

As previously discussed, Butte County is located in a seismic hazard zone and could experience strong seismic ground shaking and seismic-related ground failure (i.e., liquefaction, settlement, and landslides) from earthquakes on faults both within and outside of the county. The increase in population and development under the proposed General Plan Update could expose more people, structures, and infrastructure to seismic hazards as a result of seismic activity.

However, the City of Chico adopted the California Building Code (CBC) in Chapter 16R.02 of the City of Chico Municipal Code. All new development and redevelopment would be required to comply with the CBC, which includes design criteria for seismic loading and other geologic hazards, including design criteria for geologically induced loading that govern sizing of structural members and provide calculation methods to assist in the design process. Thus, while shaking impacts would be potentially damaging, they would also tend to be reduced in their structural effects due to CBC criteria that recognize this potential. The CBC includes provisions for buildings to structurally survive an earthquake without collapsing and includes measures such as anchoring to the foundation and structural frame design. The proposed General Plan Update (Policy S-3.1 and Action S-3.1.1) specifically requires that all new buildings in the City be built under the seismic requirements of the CBC and that damage to new structures from seismic conditions be prevented to the maximum extent feasible.

In addition, the Seismic Hazards Mapping Act requires that cities use the Seismic Hazard Zone Maps in their land use planning and building permit processes and that site-specific geotechnical investigations be conducted within the Zones of Required Investigation in order to identify and evaluate seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy.

These requirements, along with continued implementation of the City's Municipal Code, would ensure this impact would be **less than significant** and no further mitigation is required.

Potential Increase of Erosion and Loss of Topsoil (Standard of Significance 2)

Impact 4.8.2 Implementation of the proposed General Plan Update could result in construction and grading activities that could expose topsoil and increase soil erosion. However, policy provisions in the proposed General Plan Update and continued implementation of the City's Municipal Code would ensure that there are no adverse impacts from erosion and loss of topsoil. This impact is considered to be **less than significant.**

Implementation of the proposed General Plan Update would result in the potential construction of new roadways and of substantial infrastructure (water and sanitary sewer facilities), improvements to existing roadways, and the potential for additional commercial, residential, and industrial development within the city, the Sphere of Influence (SOI), and the five Special Planning Areas (SPAs) included in the proposed General Plan Update. The grading and site preparation activities associated with such development would remove topsoil, disturbing and potentially exposing the underlying soils to erosion from a variety of sources, including wind and water. In addition, construction activities may involve the use of water, which may further erode the topsoil as the water moves across the ground.

Any development involving clearing, grading, or excavation that causes soil disturbance of 1 or more acres, or any project involving less than 1 acre that is part of a larger development plan and includes clearing, grading, or excavation, is subject to National Pollutant Discharge Elimination System (NPDES) State General Permit (Order No. 2009-0009-DWQ) provisions. Any development of this size within the Planning Area would be required to prepare and comply with an approved stormwater pollution prevention plan (SWPPP) that provides a schedule for the implementation and maintenance of erosion control measures and a description of the erosion control practices, including appropriate design details and a time schedule. The SWPPP would consider the full range of erosion control best management practices, including any additional site-specific and seasonal conditions. The State General Permit also requires that those implementing SWPPPs meet prerequisite qualifications that would demonstrate the skills, knowledge and experience necessary to implement SWPPPs. NPDES requirements would significantly reduce the potential for substantial erosion or topsoil loss to occur in association with new development.

In addition, the City's grading standards (Chapter 16R.22 of the City of Chico Municipal Code) specify that the maximum permanent rate of sediment loss after completion of the project should not exceed the natural erosion rate which occurred prior to the grading project. In addition, if excessive erosion occurs from the project, erosion and sediment control measures are required to be immediately implemented to reduce erosion to allowable levels. The standards also require revegetation and slope stabilization to prevent erosion of slopes. The City's Grading Ordinance requires a valid grading permit for any grading work in the city and provides for inspection and enforcement to ensure compliance with grading regulations. The City's grading regulations would further ensure that all public and private development projects would include the necessary control measures for erosion and sediment control as well as permanent features to minimize stormwater pollution from development projects. The City's current development review process also ensures that construction projects have the necessary permits and that on-site regional control measures are considered for new development projects.

In addition, subsequent development projects under the proposed General Plan Update would be required to use best management practices to control runoff from all new development and thus limit erosion (Action OS-3.1.1).

Since erosion impacts are often dependent on the type of development, intensity of development, and amount of lot coverage of a particular project site, impacts can vary. However, compliance with adopted City grading regulations and NPDES and SWPPP requirements, as well as implementation of the proposed General Plan Update action listed above, would ensure that soil erosion and related impacts would be **less than significant**, and no further mitigation is required.

Potential Development on Unstable Soils (Standard of Significance 3)

Impact 4.8.3 Implementation of the proposed General Plan Update could allow for development on a geologic unit or soil that is unstable, thus creating substantial risks to life and property. However, policy provisions in the proposed General Plan Update and continued implementation of the City's Municipal Code would ensure that potential development is not adversely impacted by unstable soils. This is considered a **less than significant** impact.

Many of the soils found within areas identified for development under the proposed General Plan Update, including opportunity sites within the city and SOI as well as the five SPAs, have a moderate to high shrink-swell potential, which could result in development constraints. Structures or improvements constructed on expansive soils can suffer damage as the expansive soils shrink and swell. A soil's potential to shrink and swell depends on the amount and types of clay in the soil, since certain clays expand when wet and disproportionately shrink when dry. Future structures and improvements associated with the proposed General Plan Update could experience stresses on various sections of foundations and connected utilities, as well as structural failure and damage to infrastructure if located on expansive or unstable soils.

The City of Chico Municipal Code, the CBC, and other related construction standards apply seismic requirements and address certain grading activities. The CBC includes common engineering practices requiring special design and construction methods that reduce or eliminate potential expansive soil-related impacts. Compliance with CBC regulations would ensure the adequate design and construction of building foundations to resist soil movement.

Proposed General Plan Update Action S-3.1.2 would require new development to conduct a geotechnical soils report in areas that have highly expansive soils. Such a report is a tool used by public agencies and developers to identify specific site conditions and to develop design and construction recommendations for infrastructure improvements and commercial and residential development projects. Geotechnical reports generally contain a summary of all subsurface exploration data including a subsurface soil profile, exploration logs, laboratory or on-site test results, and groundwater information. The reports also interpret and analyze the subsurface data, recommend specific engineering design elements, provide a discussion of conditions for the solution of anticipated problems, and recommend geotechnical special provisions. These provisions would address any site-specific expansive soil hazards for future development under the proposed General Plan Update.

The proposed General Plan Update policy and actions listed above, as well as adherence to the CBC, would reduce the effects resulting from developing on unstable soils to a minimum. This impact is therefore considered to be **less than significant**, and no further mitigation is required.

Soils Incapable of Supporting Septic Tanks (Standard of Significance 4)

Impact 4.8.4 Subsequent land use activities associated with implementation of the proposed General Plan Update may allow for development in areas where sewers are not available for the disposal of wastewater and where soils are incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems. However, policy provisions in the proposed General Plan Update would ensure no adverse impacts from soils incapable of supporting septic tanks. This is considered a **less than significant** impact.

The discharge from individual septic systems has been cited by the Central Valley RWQCB as a source of soil and groundwater nitrate contamination in the Planning Area. Technical analysis conducted for the County's Nitrate Compliance Plan found that average residential densities of approximately four or more dwelling units per acre in certain parts of the Planning Area would exceed the capacity of the soil and receiving waters to assimilate nitrogen. If development or redevelopment utilizing septic tanks were to occur in these or other areas where soils are incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems, the existing groundwater contamination could worsen.

The City's adoption of the County's Nitrate Compliance Plan seeks to remedy the existing water contamination and prevent further contamination as a result of new development by enacting strict standards for density requirements for new septic systems. The standards allow for conventional septic systems only in narrowly defined circumstances, call for the elimination of existing systems in most of the Chico Urban Area, and identify a financing mechanism to do this. The plan also provides for case-by-case evaluation of nonresidential septic systems and recognizes that sewer connection may not be practical or feasible in all cases.

Although the Central Valley RWQCB gives jurisdiction of individual wastewater treatment and disposal systems to local environmental health departments, the RWQCB has adopted the Disposal for Land Development Guidelines which contain criteria for the siting of septic tanks, sewer lines, leach fields, and seepage pits to protect water quality. The Butte County Environmental Health Division regulates septic tanks in the county and is currently in the process of preparing the Butte County Individual On-Site Wastewater Ordinance. The ordinance would apply to unincorporated portions of Butte County not served by municipal wastewater treatment and disposal facilities. The ordinance would update and replace existing County regulations in order to be consistent with applicable requirements of the Central Valley RWQCB Basin Plan and to incorporate other changes based on the current state of knowledge and advances in practices and technologies for on-site wastewater treatment and disposal.

Proposed General Plan Update Action OS-3.2.2 implements the Nitrate Compliance Plan, which enacts strict standards for density requirements for new septic systems. The standards allow for conventional septic systems only in narrowly defined circumstances and actually entitle for the elimination of most existing systems in the Planning Area. Compliance with the Butte County Environmental Health Services Division's septic tank requirements, as well as the Nitrate Compliance Plan, would ensure that impacts related to soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems would be mitigated to a **less than significant** level, and no further mitigation is required.

Mitigation Measure

None required.

4.8.4 CUMULATIVE SETTING, IMPACTS, AND MITIGATION MEASURES

CUMULATIVE SETTING

Site-specific topography, soil conditions, and surrounding development determine geological and soil-related impacts, which generally are not considered cumulative in nature. However, erosion and sediment deposition can be cumulative in nature, depending on the type and amount of development proposed in a given geographical area. The cumulative setting for soil erosion consists of existing, planned, proposed, and reasonably foreseeable land use conditions in the region (see Section 4.0 for a description of the cumulative setting). However, construction constraints are primarily based on specific sites within a proposed development and on the soil characteristics and topography of each site. As discussed throughout this section, all new development within the proposed General Plan Update Planning Area would be required to comply with the California Building Code.

CUMULATIVE IMPACTS AND MITIGATION MEASURES

Cumulative Geologic and Soil Hazards

Impact 4.8.5 Subsequent land use activities associated with implementation of the proposed General Plan Update, in combination with other existing, planned, proposed, and reasonably foreseeable development in the region, may result in cumulative geologic and soil hazards. However, policy provisions in the proposed General Plan Update and continued implementation of the City's Municipal Code would ensure that potential development is not adversely impacted by cumulative geologic and soil hazards. This is considered a **less than cumulatively considerable** impact.

All new development, including development in areas outside of the City of Chico, would have to comply with the CBC, which requires stringent earthquake-resistant design parameters and common engineering practices requiring special design and construction methods that reduce or eliminate potential expansive soil-related impacts. Furthermore, any development involving clearing, grading, or excavation that causes soil disturbance of 1 or more acres, or any project involving less than 1 acre that is part of a larger development plan and includes clearing, grading, or excavation, is subject to NPDES CGP provisions. NPDES CGP requirements would significantly reduce the potential for substantial erosion or topsoil loss to occur in association with new development by requiring an approved SWPPP that provides a schedule for the implementation and maintenance of erosion control measures and a description of erosion control practices, including appropriate design details and a time schedule. The proposed General Plan Update also requires that damage to new structures from seismic, geologic, or soil conditions be prevented to the maximum extent feasible.

Implementation of NPDES requirements and CBC standards as discussed under Impacts 4.8.1 through 4.8.3 above would reduce cumulative impacts associated with geology and soils throughout the region. Furthermore, site-specific review, including geotechnical reports, required by the City of Chico would reduce the proposed General Plan Update's contribution to cumulative impacts to **less than cumulatively considerable**, and no further mitigation is required.

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