4.7 GEOLOGY AND SOILS

This section contains an analysis of the impacts the 2030 General Plan geology, soils, mineral resources, and paleontological resources in the City of Live Oak. The section provides a description of existing soil, geologic and seismic conditions, as well as a brief analysis of regulations and plans pertinent to the implementation of the 2030 General Plan.

4.7.1 REGULATORY FRAMEWORK

FEDERAL PLANS, POLICIES, REGULATIONS, AND LAWS

The U. S. Department of Agriculture Natural Resources Conservation Service (NRCS) produces soil surveys that assist planners in determining which land uses are suitable for specific soil types and locations.

STATE PLANS, POLICIES, REGULATIONS, AND LAWS

The California Geological Survey (CGS) provides information pertaining to soils, geology, mineral resources, and geologic hazards.

Mineral Resource Protection Laws

CGS maintains and provides information about California's nonfuel mineral resources. CGS offers information about handling hazardous minerals and SMARA mineral land classifications.

Surface Mining and Reclamation Act of 1975

SMARA requires all jurisdictions to incorporate mapped mineral resources designations approved by the California Mining and Geology Board within their general plans. SMARA was enacted to limit new development in areas with significant mineral deposits. The California Department of Conservation's Office of Mine Reclamation and the California Mining and Geology Board are jointly charged with ensuring proper administration of the act's requirements. The California Mining and Geology Board promulgates regulations to clarify and interpret the act's provisions, and also serves as a policy and appeals board. The Office of Mine Reclamation (OMR) provides an ongoing technical assistance program for lead agencies and operators, maintains a database of mine locations and operational information statewide, and is responsible for compliance-related matters (OMR 2008).

Alquist-Priolo Earthquake Fault Zoning Act of 1972

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The purpose of the act was to prevent construction of buildings used for human occupancy on the surface trace of active faults. No Alquist-Priolo Earthquake Fault Zones are located in the Planning Area (CDMG 2007a).

California Seismic Hazards Mapping Act of 1990

The Seismic Hazards Mapping Act of 1990 directs CGS to identify and map areas prone to earthquake hazards of liquefaction, earthquake-induced landslides, and amplified ground shaking. The purpose of the act is to reduce threats to public safety and to minimize loss of life and property by identifying and mitigating these seismic hazards. The Seismic Hazards Mapping Act was passed by the California Legislature after the 1989 Loma Prieta earthquake. There are no Zones of Required Investigation in the Planning Area (CGS 2009).

California Building Standards Code, State Housing Law, and Fire Protection Codes

The State of California provides minimum standards for building design through the California Building Standards Code (California Code of Regulations [CCR] Title 24). Information on current code requirements can be found on the California Building Standard Commission's website (http://www.bsc.ca.gov/).

The applicability of California Building Standard Code (CBSC) is identified in the California Health and Safety Code (HSC). There are two portions of law addressing the application of the CBSC. First is the California Building Standards Law found in Division 13, Part 2.5, and second is the State Housing Law found in Division 13, Part 1.5. These portions of law establish that the CBSC is the applicable code for all occupancies throughout the state unless local amendments apply. The International Building Code Chapter 1 is incorporated into the 2007 CBSC parts based on model codes. It is adopted only in part by some state agencies. Local governments may adopt state codes by reference in their local adoption ordinance process.

The Department of Housing and Community Development has adopted regulations implementing the State Housing Law in the California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1 (CCR, T-25), for residential structures subject to the State Housing Law. These regulations, the CBSC, and the requirements of the State Housing Law, are applicable in all parts of the state.

Building standards in the CBSC are adopted by the State Fire Marshal to provide protection from fire and other public safety objectives. These provisions are adopted as state law administered in part by local fire protection districts organized under HSC (see Division 12, Part 2.7).

California Building Standards Commission

The California Building Standards Commission (BSC) is responsible for coordinating, managing, adopting, and approving building codes in California. In July 2007, the BSC adopted and published the 2006 International Building Code (IBC) as the 2007 California Building Code (CBC). This new code became effective on January 1, 2008 and updated all the subsequent codes under CCR Title 24. The 2007 CBC replaces the previous "seismic zones" (assigned as a number from 1 to 4, where 4 required the most earthquake-resistant design) with new Seismic Design Categories A through F (where F requires the most earthquake-resistant design) for structures designed for a project site. With the shift from seismic zones to seismic design, the CBC philosophy has shifted from "life safety design" to "collapse prevention," meaning that structures are designed for prevention of collapse for the maximum level of ground shaking that could reasonably be expected to occur at a site. Chapter 16 of the CBC specifies exactly how each seismic design category is to be determined on a site-specific basis through the site-specific soil characteristics and proximity to potential seismic hazards.

Local Amendments to State Building Codes, Housing Law, and Fire Protection Codes

Local governments may amend the building standards contained in the CBC. The provisions of law that permit these local government amendments contain subtle differences. Local governments must make specific findings about local amendments to state building, housing, and fire code requirements and file information on these amendments with the State to become effective.

For the building code, local governments must make express findings that amendments to the building standard contained in CCR, T-24 are necessary because of local climatic, geological or topographical conditions. The local government amendments must provide a more restrictive building standard than that contained in CCR, T-24.4.

The State Housing Law provides for amendment of building standards related to residential construction and for amendment of CCR, T-25. The governing body of the local government must make an express finding that amendments to either the building standards for residential construction contained in CCR, T-24, or the regulations of the Department of Housing and Community Development contained in CCR, T-25, are necessary because of local climatic, geological or topographical conditions. There is an exception in CCR, T-25, § 52 to the requirement for an express finding where alternate abatement procedures are determined by the local enforcement agency to be the equivalent of those contained in CCR, T-25. Unlike the California Building Standards Law, there is no specific requirement in the State Housing Law that local government amendments provide either more restrictive building standards than those contained in CCR, T-24, or more restrictive regulations than those contained in CCR, T-25.

Local government amendments to building standards in the CBSC adopted by the State Fire Marshal for fire and panic safety are permitted under this provision of state law for fire protection districts organized under HSC, Division 12, Part 2.7. The "governing body" shall be deemed to be the district board and the district shall be deemed to be the local agency. The district board must make an express finding that amendments to building standards for fire and panic safety that are contained in CCR, T-24 are necessary because of local climatic, geological or topographical conditions. The district is required to notify the city, county, or city and county where the amendments will apply of the proposed amendments, and receive their comments. Upon adoption, the amendments are required to be presented for ratification to the city, county, or city and county where it will apply. The amendment is not effective until copies of both the express findings and the amendments, with the amendments expressly marked and identified as to the applicable findings, have been filed with the Department of Housing and Community Development by the city, county, or city and county where it will apply, along with the adopting ordinance and any findings of the city, county, or city and county.

REGIONAL AND LOCAL PLANS, POLICIES, REGULATIONS, AND LAWS

The City of Live Oak is responsible for implementation of state and federally mandated laws and regulations related to geology and soils before permitting projects. In addition, several portions of the City Code relate to geology, soils, and other geologic hazards.

Live Oak Municipal Code

The Live Oak Municipal Code City Code provides regulations for buildings and construction, including adoption of the California Building Code.

4.7.2 ENVIRONMENTAL SETTING

This section presents the geologic and seismic hazards, as well as the soil and mineral resources in the City of Live Oak's Planning Area. The topics in this section overlap with Section 4.8, "Agricultural Resources," of this EIR.

TOPOGRAPHY AND REGIONAL GEOLOGY

The Planning Area is located in the Sacramento Valley, which forms the northern portion of the Great Valley geomorphic province of California. 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 mountain ranges as they formed 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 marine sediments from the receding ocean were followed more recently by river deposits (alluvial deposits) washing down from the Sierra Nevada and the Klamath, Cascade, and Coast Ranges.

The Great Valley covers more than 6,500 square miles and fills a northwest-trending structural depression bounded on the west by the Great Valley fault zone and the Coast Ranges and on the east by the Sierra Nevada and the Foothills fault zone. Relatively few faults in the Great Valley have been active during the last 10,000 years. Most of the surface of the Great Valley is covered with Holocene and Pleistocene-age alluvium, composed primarily of sediments from the Sierra Nevada and the Coast Ranges that were carried by water and deposited on the valley floor. Siltstone, claystone, and sandstone are the primary types of sedimentary deposits. Older Tertiary deposits underlie the Quaternary alluvium (Hackel 1966, Cherven and Graham 1983).

Holocene Alluvium (Holocene: Recent–10,000 years old)

These Late Holocene alluvial deposits overlie older Pleistocene alluvium and/or the upper Tertiary bedrock formations. This alluvium consists of sand, silt, and gravel deposited in natural levee, channel, and basin environments. This unit is typically in smooth, flat valley bottoms, in medium-sized drainages, and other areas where terrain allows a thin veneer of this alluvium to deposit, generally in shallowly sloping or flat environments (Graymer et al. 2002).

Modesto Formation (Pleistocene: 9,000–73,000 years old)

In the Sacramento Valley, the Modesto Formation represents the lowest alluvial deposits that occur topographically just above the Holocene deposits along streams and valleys. It is composed of unconsolidated gravel, sand, silt and clay.

In the Planning Area, the Modesto Formation consists of ancient alluvial fans of the Feather River and can be divided into upper and lower members. The Modesto Formation is Pleistocene in age; estimates place the age of this formation at approximately 12,000 to 42,000 years Before Present (BP) by Marchand and Allwardt (1981), and from 9,000 to 73,000 years BP by Atwater (1982).

Volcanic Activity

The Planning Area is within the Northern Coast Range region of the Pacific Mountain System. The Pacific Mountain System region is one of the most geologically young and tectonically active in North America (USGS 2006). The generally rugged, mountainous landscape of this province provides evidence of ongoing mountain building. The Pacific Mountain System straddles the boundaries between several of Earth’s moving plates—the source of the monumental forces required to build the sweeping arc of mountains that extends from Alaska to the southern reaches of South America. This province includes the active and sometimes deadly volcanoes of the Cascade Range and the young, steep mountains of the Pacific Border and the Sierra Nevada.

Nearby volcanoes and volcanic areas include Mount Lassen (potentially active, approximately 85 miles north-northeast of Live Oak), the Sutter Buttes (not active, approximately 3 miles west/southwest of the Live Oak Planning Area), and the Clear Lake volcanic field (potentially active, located approximately 50 miles west of Live Oak) (Jennings 1994, USGS 2003).

The Sutter Buttes, although formed by volcanic activity, are not considered active or potentially active. The most recent known eruptive activity at the Sutter Buttes took place approximately 1.4 million years ago (Jennings 1994). The most recent eruptive activity reported in the Clear Lake field occurred approximately 10,000 years ago (Wood and Kienle 1990). Volcanism in the Clear Lake volcanic field is considered to be largely nonexplosive. One major airfall tuff and no ash flows have occurred in this field. Eruptive activity at Mount Lassen has occurred more recently (as recently as 1917).

The Planning Area is not located within any of the identified volcanic fields, nor is the Planning Area located within an Area Subject to Potential Hazards from Future Eruptions (Miller 1989). There are no known risks associated with volcanic activity in the Planning Area.

Seismicity

Seismic activity may result in geologic and seismic hazards: seismically induced fault displacement and rupture, ground shaking, liquefaction, lateral spreading, landslides and avalanches, and structural hazards.

Earthquakes are measured based on either energy released (Richter Magnitude scale) or the intensity of ground shaking at a particular location (Modified Mercalli scale). The Richter Magnitude scale measures the magnitude of an earthquake based on the logarithm of the amplitude of waves recorded by seismographs, with adjustments made for the variation in the distance between the various seismographs and the epicenter of the earthquake. The Richter scale starts with 1.0 and has no maximum limit. The scale is logarithmic—an earthquake with a magnitude of 2.0 is 10 times the magnitude (30 times the energy) of an earthquake with a magnitude of 1.0. The Modified Mercalli scale is an arbitrary measure of earthquake intensity; it does not have a mathematical basis. This scale is composed of 12 increasing levels of intensity that range from imperceptible shaking (Scale I) to catastrophic destruction (Scale XII). Table 4.7-1 provides a description of the Modified Mercalli Intensity scale.

Table 4.7-1
Modified Mercalli Index

Intensity	Effect
I	Not felt. Marginal and long period effects of large earthquakes.
II	Felt by persons at rest, on upper floors, or favorably placed.
III	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
IV	Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frame creak.
V	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
VI	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle).
VII	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
VIII	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
IX	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
X	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
XI	Rails bent greatly. Underground pipelines completely out of service.
XII	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Notes:

Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

Source: ABAG 2003

Faults

The Planning Area is located within an area of California with relatively low seismic activity and is not located within a highly active fault zone. Seismic activity may result in geologic and seismic hazards, including seismically induced fault displacement and rupture, ground shaking, liquefaction, lateral spreading, landslides and avalanches, and structural hazards. Nearby fault systems and associated seismic hazards are described below.

No Alquist-Priolo Earthquake Fault Zones are located in the Planning Area (CDMG 2007a). Faults in the vicinity of the Planning Area include primarily inactive faults of the Foothills Fault System, running south-southeastward along the base of the Sierra Nevada, most of which show no evidence of displacement in the last 1.6 million years. Faults include the Prairie Creek Fault Zone, the Spenceville Fault, and the Swain Ravine Fault. Known fault traces in the vicinity of the City are shown on Exhibit 4.7-1.

According to the Probabilistic Seismic Hazard Assessment for the State of California (CDMG 1996, p. 22), the Planning Area is not believed to have experienced earthquake-induced ground shaking of MMI VII or greater (the range of damage to buildings) between 1800 and 1996.

Several faults that have experienced displacement within the past 10,000 years are located within approximately 60 miles of the City (Jennings 1994). Displacement has occurred on one fault during recorded time—the Cleveland Hill Fault near Oroville Dam in 1975. The 1975 Oroville earthquake occurred on the Prairie Creek/Swain Ravine lineament of the Cleveland Hill Fault. This earthquake was likely induced by stresses caused by the Oroville Reservoir, which was filled in 1968. The earthquake followed a large seasonal fluctuation in lake level (Toppozada and Morrison 1982). Other faults with evidence of movement during the Holocene (less than 10,000 years ago) include the Dunnigan Hills Fault between Dunnigan and Zamora, the Hunting Creek Fault (north of Lake Berryessa), faults on the south end of Clear Lake, and the Indian Valley Fault southeast of Lake Almanor.

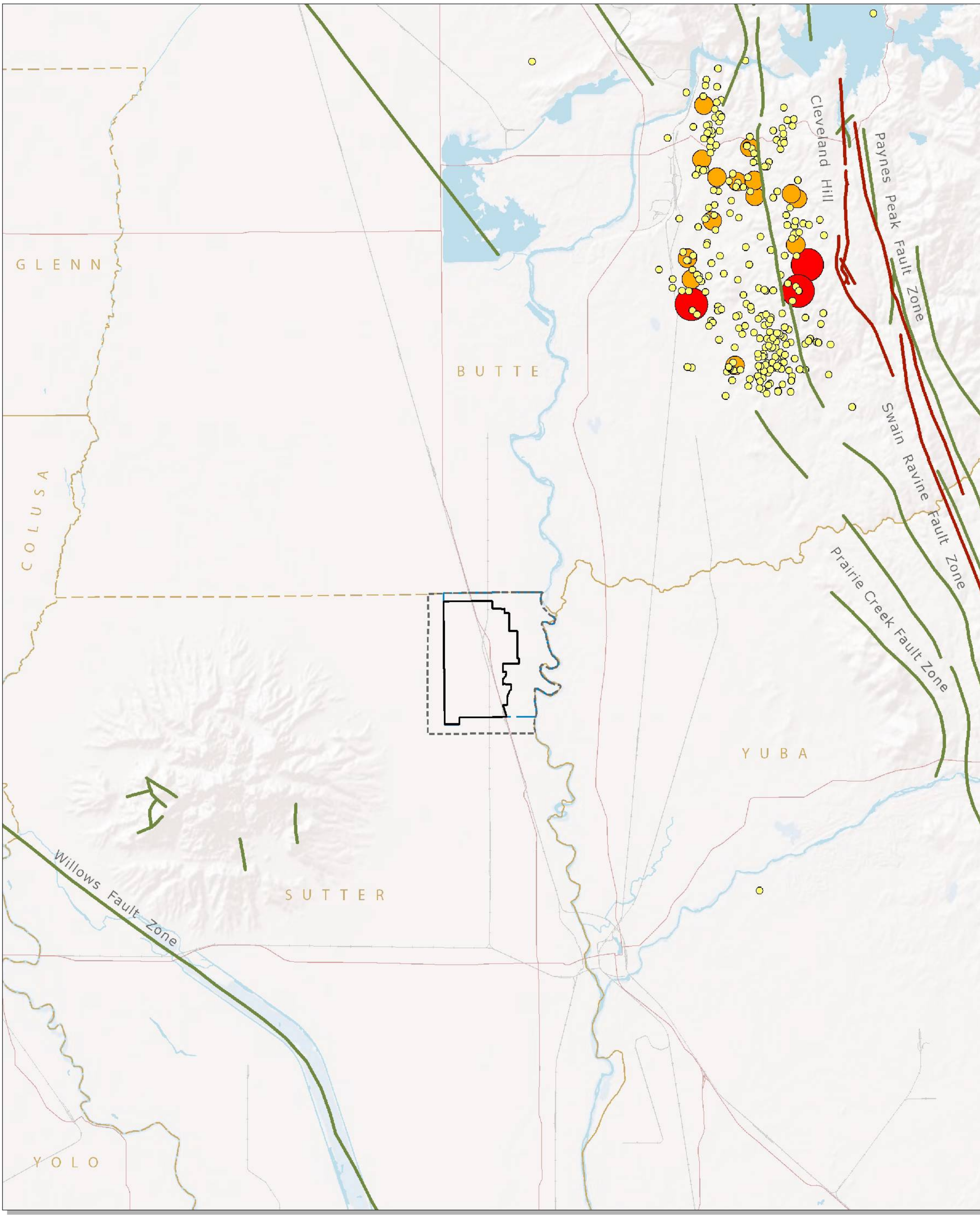
Ground Shaking

The Planning Area is not believed to have experienced ground shaking at a MMI level of VII or above, the level at which damage to unreinforced masonry buildings would be expected, during the period of 1800 through 1996 (CDMG 1996).

Liquefaction

Liquefaction, which may occur under strong ground shaking during earthquakes, is the transformation of granular sediment or fill material from a solid state to a temporarily liquid state. Liquefaction is a serious hazard because buildings on ground which undergoes liquefaction may sink or suffer major structural damage. Evidence of liquefaction may be observed in “sand boils,” which are expulsions of sand and water from below the surface due to increased pore-water pressure below the surface. Liquefaction during an earthquake requires strong shaking continuing for a long time period and loose, clean granular materials (particularly sands) that may settle and compact because of the shaking.

Areas paralleling the Feather River which contain clean sand layers with low relative densities coinciding with a relatively high water table are estimated to have generally high liquefaction potential. Granular layers underlying certain areas in the Sacramento Valley have higher relative densities and thus have moderate liquefaction potential. Clean layers of granular materials older than Holocene are of higher relative densities and are thus of low liquefaction potential.



LEGEND

- Planning Area
- Sphere of Influence
- Study Area
- County Boundaries
- Major Roads

Fault Traces

- Quaternary
- Prequaternary

Recorded Earthquake Epicenter* (magnitude)

- 3
- 4
- 5

* Data from USGS Northern California Seismic Network. Earthquakes shown occured after 1967.

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Source: USGS Northern California Seismic Network 2008, Sutter County Assessor's Office, Live Oak GIS, Adapted by EDAW 2008

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Exhibit 4.7-1
Faults and Epicenters

Tsunamis and Seiches

Tsunamis are long-period waves commonly caused by vertical faulting of the ocean floor. Such earthquake-associated waves (often erroneously called tidal waves) can cause considerable damage when they reach shallow coastal areas. A seiche is a stationary wave produced in reservoirs, lakes, and other closed or restricted bodies of water by ground shaking. The phenomenon is similar to the oscillations which result when a bowl of water is shaken. When they occur in large reservoirs, such waves can cause overtopping of dams, posing a serious threat to adjacent areas. The potential for seiches in the Planning Area is low as a predicted effect of an earthquake since ground shaking in the Planning Area is low to moderate and no reservoirs or lakes are located in or around the Planning Area. The Feather River, however, could be subject to seiches corresponding to the potential risk of ground shaking.

SLOPE STABILITY AND LANDSLIDING

Landslide susceptibility is a function of various combinations of factors including rainfall, rock and soil types, slope, aspect, vegetation, seismic conditions, and human construction. Generally, landslides are expected to occur most often on slopes steeper than 15%, in areas with a history of landslides, and in areas underlain by certain geologic units. Based on these criteria, the Planning Area is not generally at risk for landsliding. Locally steep slopes (such as along water courses) may be susceptible to slope failure.

SOILS

The NRCS of the U.S. Department of Agriculture (USDA) provides soils surveys and reports for Sutter County, including the City of Live Oak's Planning Area. Exhibit 4.7-2 shows the soil associations in the Planning Area.

Soil properties influence the development of building sites, including the site selection, structure design, construction, performance after construction, and site and structure maintenance. The NRCS soil database for Sutter County indicates the limitations of soils within the county with respect to dwellings, dwellings with basements, and small commercial buildings.

Soils limitations are rated numerically. The rating system indicates the extent to which the soils are limited by all of the soil features that affect building site development. The ratings are given by NRCS as decimal fractions ranging from 0.01 to 1.00, least limiting to most limiting. Areas defined as water or areas related to mining activities such as borrow pits, miscellaneous water features, quarries, salt ponds, and water were not rated within the NRCS soil database because construction of any dwelling or commercial buildings is considered inappropriate within such areas. Soils designated as having "No Limitations" possess features that are favorable for the specified use.

Two soils within the Planning Area have no limitations with respect to dwellings without basements and small commercial buildings: the Conejo loam, and the Live Oak sandy clay loam. All of the soil types in the Planning Area have limitations for dwellings with basements[1] (NRCS 2009).

Soil limitation ratings listed in the NRCS database for Sutter County are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (which is inferred from the

[1] As defined by NRCS, dwellings are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of about 7 feet.

Unified classification).[2] The properties that affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

The reported limitations are related to ponding, saturation, flooding, and shrink swell potential. These limitations can affect the load-supporting capacity of a soil. Shrink-swell potential is the relative change in volume to be expected with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes damage to building foundations, roads, and other structures. A high shrink/swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

SOIL HAZARDS

Shrink-Swell Potential

About 90% of the Planning Area's land is underlain by soil having a high shrink-swell potential. Expansive or shrink-swell soils contain substantial amounts of clay minerals that swell when wet and shrink when dry. These clays tend to swell despite the heavy loads imposed by large structures. Damage (such as cracking of foundations) results from differential movement and from the repetition of the shrink-swell cycle. In some cases, this problem may be avoided by removing the top soil layer before placing a foundation. Although these soils can be an expensive nuisance, awareness of their existence before construction often means that the problem can be eliminated through foundation design.

Erosion

Soils within the Planning Area have a generally low risk of erosion based on the low topographic relief. Highly erosive soils can damage roads, bridges, buildings, and other structures and result in damage to sensitive ecosystems such as riparian areas and waterbodies. NRCS soil erosivity is based on slope and on soil erodibility factors. Soil loss is caused by sheet or rill erosion in areas where 50–75% of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance (USDA 2004). Erosion hazards of disturbed soil are described as slight, moderate, severe, or very severe:

- Slight: Erosion is unlikely under ordinary climatic conditions.
- Moderate: Some erosion is likely and erosion control measures may be needed.
- Severe: Erosion is very likely and erosion control measures such as revegetation of bare areas may be needed.
- Very Severe: Significant erosion is expected, loss of soil productivity and off-site damage are likely and erosion control measures are costly and generally impractical.

One of the soil types mapped in the Planning Area has a severe risk of erosion; Gridley taxadjunct clay loam. This soil makes up about 1.6% of the Planning Area, primarily in the northwestern part of the Planning Area. Other soils in the Planning Area have a slight erosion risk.

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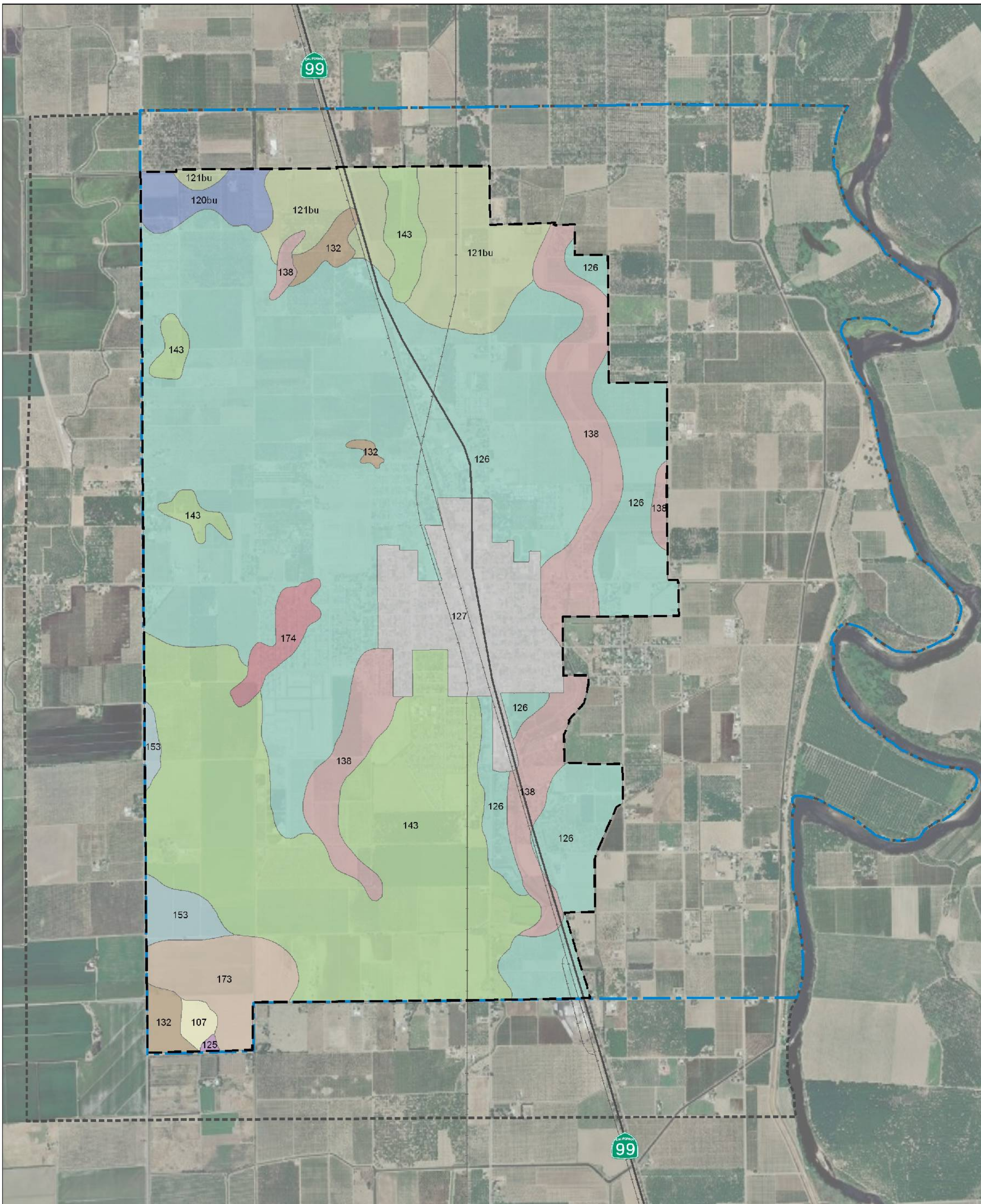
[2] The Unified Classification System is used to classify soils for engineering purposes. This specifically refers to the American Society for Testing and Materials (ASTM) Standard: D2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). All soil surveys related to soil engineering properties must be conducted in accordance with the ASTM Standard. NRCS references the Unified Classification System and ASTM Standards in all soil survey manuals and survey documents related to soils. Soil compressibility is defined as the resistance against volume decrease when soil is subjected to a mechanical load. Soil compression behavior can be influence by organic matter in soil, soil moisture content, and bulk density. The Unified Classification System provides a standardized means to determining the soil properties that contribute to compressibility.



LEGEND

Planning Area
Sphere of Influence
Study Area

Soil Type

121bu - Boga-Loemstone complex, 0 to 2 percent slopes
107 - Capay silty clay, siltstone substratum, 0 to 2 percent slopes
125 - Conejo loam, siltstone substratum, 0 to 2 percent slopes
126 - Conejo-Tisdale complex, 0 to 2 percent slopes
127 - Conejo-Urban land complex, 0 to 2 percent slopes
132 - Gridley clay loam, 0 to 1 percent slopes
120bu - Gridley taxadjunct clay loam, 0 to 2 percent slopes
138 - Liveoak sandy clay loam, 0 to 2 percent slopes
143 - Marcum-Gridley clay loams, 0 to 1 percent slopes
153 - Oswald clay, 0 to 2 percent slopes
173 - Subaco clay, 0 to 2 percent slopes
174 - Tisdale clay loam, 0 to 2 percent slopes

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LIVE OAK
General Plan

Exhibit 4.7-2
Soils in the Planning Area

Source: SSURGO 2006, Sutter County Assessor's Office, adapted by EDAW 2009

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MINERAL RESOURCES

No mineral resources are currently being mined or produced in the Planning Area. The Planning Area has not been evaluated for California Surface Mining and Reclamation Act (SMARA) Mineral Land Classification. SMARA classification projects assist the board in adopting and designating lands needed for their mineral content.

The classification system is intended to ensure consideration of statewide or regionally significant mineral deposits in planning and development administration. These mineral designations are intended to prevent incompatible land use development on areas determined to have significant mineral resource deposits. Permitted uses within a mineral resource zone include mining, uses that support mining such as smelting and storage of materials, or uses that will not hinder future mining such as grazing, agriculture, large-lot rural development, recreation, and open space.

The most important zone with respect to the presence of resources is MRZ-2, which is defined as "areas where adequate information indicates that significant mineral (aggregate) deposits are present or where it is judged that there is a high likelihood for their presence." This zone is applied to known mineral deposits or where well-developed lines of reasoning, based on economic geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high. MRZ-3 zones suggest the potential for aggregate deposits. This zone is less definitive than MRZ-2 and is defined as "areas containing mineral deposits the significance of which cannot be evaluated from available data."

Asbestos

Ultramafic rock complexes which would be expected to contain asbestos are not exposed in the Planning Area (Jennings 1994).

PALEONTOLOGICAL RESOURCES

A stratigraphic inventory and paleontological inventory was completed to develop a baseline paleontological resource inventory of the Planning Area and surrounding area by rock unit, and to assess the potential paleontological productivity of each rock unit.[3] The Planning Area includes geologic units (the Modesto and Riverbank formations) which have been found to contain fossils (including fossils of vertebrate animals ranging from rodents and lizards to mammoths) in other areas of the Central Valley.

Paleontological Resource Assessment Criteria

The potential paleontological importance of the project site can be assessed by identifying the paleontological importance of exposed rock units within the project site. Because the aerial distribution of a rock unit can be easily delineated on a topographic map, this method is conducive to delineating parts of the project site that are of higher and lower sensitivity for paleontological resources and to delineating parts of the project site that may require monitoring during construction.

A paleontologically important rock unit is one that: 1) has a high potential paleontological productivity rating, and 2) is known to have produced unique, scientifically important fossils. The potential paleontological productivity rating of a rock unit exposed at the project site refers to the abundance/densities of fossil specimens and/or

[3] Research methods included a review of published and unpublished literature and a search for recorded fossil sites at the University of California Berkeley Museum of Paleontology (UCMP). These tasks complied with Society of Vertebrate Paleontology (SVP) (1995) guidelines. This literature review was conducted to document the number and locations and previously recorded fossil sites from rock units exposed in and near the Planning Area and vicinity, as well as the types of fossil remains each rock unit has produced. The literature review was supplemented by an archival search of the University of California Berkeley Museum of Paleontology in Berkeley, California, reported on July 18, 2008. Geologic maps and reports covering the geology of the project site and surrounding study area were reviewed to determine the exposed rock units and to delineate their respective aerial distributions in the Planning Area.

previously recorded fossil sites in exposures of the unit in and near the project site. Exposures of a specific rock unit at the project site are most likely to yield fossil remains representing particular species in quantities or densities similar to those previously recorded from the unit in and near the project site.

An individual vertebrate fossil specimen may be considered unique or significant if it is identifiable and well preserved, and it meets one of the following criteria:

- a type specimen (i.e., the individual from which a species or subspecies has been described);
- a member of a rare species;
- a species that is part of a diverse assemblage (i.e., a site where more than one fossil has been discovered) wherein other species are also identifiable, and important information regarding life history of individuals can be drawn;
- a skeletal element different from, or a specimen more complete than, those now available for its species; or
- a complete specimen (i.e., all or substantially all of the entire skeleton is present).

For example, identifiable vertebrate marine and terrestrial fossils are generally considered scientifically important because they are relatively rare. The value or importance of different fossil groups varies, depending on the age and depositional environment of the rock unit that contains the fossils, their rarity, the extent to which they have already been identified and documented, and the ability to recover similar materials under more controlled conditions such as part of a research project. Marine invertebrates are generally common, well developed, and well documented. They would generally not be considered a unique paleontological resource.

The following tasks were completed to establish the paleontological importance of each rock unit exposed at or near the project site:

- The potential paleontological productivity of each rock unit was assessed, based on the density of fossil remains previously documented within the rock unit.
- The potential for a rock unit exposed at the project site to contain a unique paleontological resource was considered.

Paleontologic Resource Inventory Results

Stratigraphic Inventory

Regional and local surficial geologic mapping and correlation of the various geologic units in the vicinity of the Planning Area has been provided at a scale of 1:250,000 by Saucedo and Wagner (1992).

Paleontological Resource Inventory and Assessment by Rock Unit

Holocene Alluvium

By definition, to be considered a fossil, an object must be more than 11,000 years old. Therefore, Holocene alluvium at the project site would not contain paleontological resources.

Modesto Formation

Surveys of late Cenozoic land mammal fossils in northern California have been provided by Hay (1927), Lundelius et al. (1983), Jefferson (1991a, 1991b), Savage (1951), and Stirton (1939). On the basis of his survey of vertebrate fauna from the non-marine late Cenozoic deposits of the San Francisco Bay region, Savage (1951) concluded that two major divisions of Pleistocene-age fossils could be recognized: the Irvingtonian (older Pleistocene fauna) and the Rancholabrean (younger Pleistocene and Holocene fauna). These two divisions of Quaternary Cenozoic vertebrate fossils are widely recognized today in the field of paleontology. The age of the later Pleistocene, Rancholabrean fauna was based on the presence of bison and on the presence of many mammalian species that are inhabitants of the same area today. In addition to bison, larger land mammals identified as part of the Rancholabrean fauna include mammoths, mastodons, camels, horses, and ground sloths.

Remains of land mammals have been found in the project region at various localities in alluvial deposits referable to the Modesto Formation. Jefferson (1991a, 1991b) compiled a database of California late Pleistocene vertebrate fossils from published records, technical reports, unpublished manuscripts, information from colleagues, and inspection of museum paleontological collections at more than 40 public and private institutions. He listed two sites in Sutter County that have yielded Rancholabrean vertebrate fossils near Yuba City (approximately 10 miles south of the project site). These localities yielded a Pleistocene-age bison in sediments referable to the Modesto Formation and a Pleistocene-age horse in sediments referable to the Riverbank Formation.

A records search of the UCMP Paleontology Collections database yielded information regarding a number of vertebrate fossil localities referable to either the Modesto or Riverbank Formations. UCMP Localities V-91247, V-91204, and V-3402 west of Woodland yielded Rancholabrean-age horse and mammoth specimens from mixed sediments containing both the Modesto and Riverbank Formations. UCMP Localities V-5430, V-6911, and V-76199 west of Davis yielded Rancholabrean-age Harlan’s ground sloth and saber-toothed cat specimens also from mixed sediments containing both the Modesto and Riverbank Formations. UCMP Locality V-96015 north of Davis yielded 8 specimens of Rancholabrean-age rodents and reptiles from sediments of the Modesto Formation.

Fossil specimens from the Modesto Formation have been reported by Marchand and Allwardt (1981) near the type locality in the City of Modesto. Fossil specimens from sediments referable to the Modesto Formation have been reported at numerous other locations throughout the San Joaquin Valley (UCMP 2008), including Lathrop, Modesto, Stockton, Tracy (along the Delta-Mendota Canal), Manteca, and Merced. The Tranquility site in Fresno County (UCMP V-4401) has yielded more than 130 Rancholabrean-age fossils of fish, turtles, snakes, birds, moles, gophers, mice, wood rats, voles, jack rabbits, coyote, red fox, grey fox, badger, horse, camel, pronghorn antelope, elk, deer, and bison from sediments referable to the Modesto Formation.

Results of a paleontological records search at the UCMP indicated no fossil remains within the Planning Area. However, the occurrence of Pleistocene vertebrate fossil remains in sediments referable to the Modesto and Riverbank Formations from Yuba City, Davis, and Woodland, as well as their widespread occurrence throughout the Sacramento and San Joaquin Valleys, suggests there is a potential for uncovering additional similar fossil remains during construction-related earth-moving activities within the Planning Area.

4.7.3 ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

THRESHOLDS OF SIGNIFICANCE

Geology and Soils

Based on Appendix G of the State CEQA Guidelines, an impact on geologic resources is considered significant if the proposed project would:

- expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

- rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault;

- 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 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;

- 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;

- result in the loss of availability of a known mineral resource that would be of value to the region and residents of the state; or

- result in the loss of availability of a locally important mineral resource recovery site.

Although there are active faults within 30 miles of the Planning Area, there are no identified active or potentially faults within the Planning Area itself. Therefore, no impact due to exposure of people or structures to rupture of a known earthquake fault would result from implementation of the General Plan. This topic is not evaluated further in this EIR.

Based on the flat topography of the Planning Area, the California Division of Mines and Geology (now known as the California Geological Survey) estimated no risk of landslide in the Planning Area (CDM 1973). Therefore, no impact due to exposure of people or structures to landsliding would result from implementation of the General Plan. This topic is not evaluated further in this EIR.

No known mineral resources of value to the region and residents of the state have been identified in the Planning Area. Therefore, no impact from loss of such resource would result from implementation of the General Plan, and this topic is not evaluated further in this EIR.

No locally important mineral resources are identified in local land use plans. Therefore, no impact from loss of such a resource would result from implementation of the General Plan, and this topic is not evaluated further in this EIR.

The proposed project would not include construction of new buildings or land uses which would rely on septic systems for disposal of sewage. Therefore, suitability of soils for use with septic systems is not evaluated further in this EIR.

Paleontological Resources

For the purpose of the analysis of impacts to paleontological resources (Impact 4.7-5), the following applicable thresholds of significance have been used to determine whether implementing the General Plan would result in a significant impact. These thresholds of significance are based on the State CEQA Guidelines, which state that a paleontological resources impact is considered significant if implementation of the proposed project would directly or indirectly destroy a unique paleontological resource or site. For the purposes of this EIR, a unique resource or site is one that is considered significant under the following professional paleontological standards.

A paleontologically important rock unit is one that: 1) has a high potential paleontological productivity rating, and 2) is known to have produced unique, scientifically important fossils. The potential paleontological productivity rating of a rock unit exposed at a project site refers to the abundance/densities of fossil specimens and/or previously recorded fossil sites in exposures of the unit in and near the project site. Exposures of a specific rock unit at a project site are most likely to yield fossil remains representing particular species in quantities or densities similar to those previously recorded from the unit in and near a project site.

An individual vertebrate fossil specimen may be considered unique or significant if it is identifiable and well preserved, and it meets one of the following criteria:[4]

- a type specimen (i.e., the individual from which a species or subspecies has been described);
- a member of a rare species;
- a species that is part of a diverse assemblage (i.e., a site where more than one fossil has been discovered) wherein other species are also identifiable, and important information regarding life history of individuals can be drawn;
- a skeletal element different from, or a specimen more complete than, those now available for its species; or
- a complete specimen (i.e., all or substantially all of the entire skeleton is present).

IMPACT ANALYSIS

IMPACT 4.7-1	Potential for Exposure to Seismic Ground Shaking. *Buildout of the 2030 General Plan would not result in development of areas prone to strong seismic ground shaking. Implementation of policies and programs in the 2030 General Plan and existing regulations would implement best practices to reduce the potential for substantial adverse effects due to exposure to seismic ground shaking. This impact would be* ***less than significant.***

Different types of structures are subject to different levels of ground shaking damage from seismic activity. Conventional one- and two-story wood-frame residential structures generally have performed very well during strong seismic ground shaking. Collapse or total destruction of wood-frame homes is rare, even during strong earthquakes, except in cases where these structures are affected by ground rupturing or landsliding, or are affected by extremely high ground acceleration. Unreinforced masonry buildings and other buildings constructed before

[4] The value or importance of different fossil groups varies depending on the age and depositional environment of the rock unit that contains the fossils, their rarity, the extent to which they have already been identified and documented, and the ability to recover similar materials under more controlled conditions (such as for a research project). Marine invertebrates are generally common; the fossil record is well developed and well documented, and they would generally not be considered a unique paleontological resource. Identifiable vertebrate marine and terrestrial fossils are generally considered scientifically important because they are relatively rare. In its standard guidelines for assessment and mitigation of adverse impacts on paleontological resources, the SVP (1995) established three categories of sensitivity for paleontological resources: high, low, and undetermined. Areas where fossils have been previously found are considered to have a high sensitivity and a high potential to produce fossils. Areas that are not sedimentary in origin and that have not been known to produce fossils in the past typically are considered to have low sensitivity. Areas that have not had any previous paleontological resource surveys or fossil finds are considered to be of undetermined sensitivity until surveys and mapping are performed to determine their sensitivity. After reconnaissance surveys, observation of exposed cuts, and possibly subsurface testing, a qualified paleontologist can determine whether the area should be categorized as having high or low sensitivity. In keeping with the significance criteria of the SVP (1995), all vertebrate fossils are generally categorized as being of potentially significant scientific value.

1930 that have not been seismically retrofitted would be most likely to suffer structural failure or collapse as a result of seismic ground shaking.

The Planning Area is located in an area of low seismic activity that has not experienced an earthquake of MMI VII or greater (the intensity at which damage to buildings would be expected) between 1800 and 1996 (CDMG 1996, p. 22). The nearest active fault, the Cleveland Hills Fault, is located approximately 15 miles northeast of the Planning Area. The 1975 Oroville earthquake occurred on the Prairie Creek/Swain Ravine lineament of the Cleveland Hill Fault. This earthquake was likely induced by stresses caused by the Oroville Reservoir, which was filled in 1968. The earthquake followed a large seasonal fluctuation in lake level (Toppozada and Morrison, 1982).

Relevant Policies and Programs of the 2030 General Plan

The 2030 General Plan includes several policies and programs related to risk from seismic ground shaking:

- **Policy PS-1.1:** All new buildings in the City shall be built under the seismic requirements of the California Building Code.

- **Policy PS-1.2:** The City will encourage the retrofitting of older buildings to current safety standards, as specified in locally applicable fire and building codes.

Conclusion

Although potential damage to people or structures from seismic ground shaking could be a concern, the 2030 General Plan's proposed goals, policies, and programs, combined with compliance with the CBC regulations described in the regulatory setting of this chapter, would require seismic safety requirements to be established and incorporated into the design of all new residences and buildings on a site-specific basis. Roadways, utilities, and structures would be designed to withstand seismic forces based on CBC requirements for the appropriate site-specific Seismic Design Category. Therefore, potential damage to structures from seismic activity and related geologic hazards would be **less than significant**.

Mitigation Measure

No mitigation beyond compliance with existing regulations and 2030 General Plan policies and programs is required.

IMPACT 4.7-2	Potential for Seismic Ground Failure. *Buildout of the 2030 General Plan would result in development of areas with moderate potential for seismic-related ground failure, including liquefaction. Implementation of policies and programs in the 2030 General Plan and existing regulations would implement best practices to reduce the potential for substantial adverse effects due to exposure to seismic ground failure. This impact would be* ***less than significant****.*

Seismic ground failure refers to conditions such as soil liquefaction, associated lateral spreading, landslides, and collapse resulting from loss of strength during earthquake shaking. The liquefaction of soils can cause them to move laterally outward from under buildings, roads, pipelines, transmission towers, railroad tracks, and other structures such as bridges. Damage is usually greatest to large or heavy structures on shallow foundations and takes the form of cracking, tilting, and differential settlement. Where gentle slopes exist, such as on stream or slough banks, liquefaction may cause lateral-spreading landslides. Whole buildings can be moved downslope by this type of ground failure. Where the condition is known to exist, structural and foundation design can usually minimize or eliminate liquefaction hazard to new construction.

Liquefaction potential varies within the Planning Area. Areas paralleling the Feather River which contain clean sand layers with low relative densities coinciding with a relatively high water table are estimated to have generally high liquefaction potential. Granular layers underlying certain areas in the Sacramento Valley have higher relative densities and thus have moderate liquefaction potential. Clean layers of granular materials older than Holocene are of higher relative densities and are thus of low liquefaction potential.

Relevant Policies and Programs of the 2030 General Plan

The 2030 General Plan includes several policies and programs related to risk from seismic ground failure:

- **Policy PS-1.1:** All new buildings in the City shall be built under the seismic requirements of the California Building Code.
- **Policy PS-1.2:** The City will encourage the retrofitting of older buildings to current safety standards, as specified in locally applicable fire and building codes.

Conclusion

Implementation of policies and programs in the 2030 General Plan and existing regulations (including compliance with the CBC regulations described in the regulatory setting of this chapter) would reduce the potential for substantial adverse effects due to exposure to seismic-related ground failure. This impact would be **less than significant**.

Mitigation Measure

No mitigation beyond compliance with existing regulations and the 2030 General Plan policies and programs is required.

IMPACT 4.7-3	Soil Erosion or Loss of Topsoil. *Buildout of the 2030 General Plan would result in substantial soil erosion or the loss of topsoil. Implementation of policies and programs in the 2030 General Plan and existing regulations would result in use of best practices to prevent soil erosion and topsoil loss. This impact would be **less than significant**.*

Some soils within the Planning Area are considered to have high potential for erosion. Highly erosive soils can damage roads, bridges, buildings, and other structures and result in damage to sensitive biological habitats such as riparian areas and waterbodies (water quality impacts of soil erosion are discussed in Impact 4.5-2 in Section 4.5, “Hydrology and Water Quality.” Soil loss can be caused by sheet or rill erosion in areas where 50–75% of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.

Erosion is a large-scale impact caused by human activity and disturbance of surface soil, wind, and water. Erosion cannot be eliminated altogether, although existing regulations such as Chapter 15.01.114 of the City of Live Oak Municipal Code, the California Building Standards Code (which includes erosion control measures and best management practices) can reduce the potential impacts of erosion.

Conclusion

Implementation of existing regulations (including the California Building Standards Code regulations described in the regulatory setting of this chapter and Chapter 15.01.114 of the City of Live Oak Municipal Code), would reduce the potential for erosion caused by buildout of the land use diagram under the Preferred Plan through application of best management practices and engineering controls. This impact would be **less than significant**.

Mitigation Measure

No mitigation beyond compliance with existing regulations and the 2030 General Plan policies and programs is required.

IMPACT 4.7-4 **Potential for Unstable Soils.** *Buildout of the 2030 General Plan would result in construction of occupied structures in areas located on a geologic unit or soil that is unstable or that would become unstable, potentially resulting in on- or off-site lateral spreading, subsidence, liquefaction, or collapse. Implementation of policies and programs in the 2030 General Plan and existing regulations would prevent damage from unstable soils. This impact would be* ***less than significant****.*

Unstable soils include soils subject to landsliding, lateral spreading, liquefaction, or collapse. This kind of hazard can be caused by earthquake shaking (i.e., liquefaction, lateral spreading, landslides, collapse), caused by seasonal saturation of soils and rock materials (subsidence), or caused by grading and construction activities.

Soil liquefaction (and associated lateral spreading, landslides, and collapse) results from loss of strength during earthquake shaking. The liquefaction of soils can cause them to move laterally outward from under buildings, roads, pipelines, transmission towers, railroad tracks, and other structures such as bridges. Damage is usually greatest to large or heavy structures on shallow foundations, and takes the form of cracking, tilting, and differential settlement. Where gentle slopes exist such as on stream or slough banks, liquefaction may cause lateral-spreading landslides. Whole buildings can be moved downslope by this type of ground failure. Where the condition is known to exist, structural and foundation design can usually minimize or eliminate liquefaction hazard to new construction.

Subsidence and settlement are localized hazards, commonly caused by the withdrawal of fluids (such as groundwater) from subsurface reservoirs or from the collapse of surface soils over subterranean caves or mines. Settlement results when weak or porous soils (such as fill soils) are compressed as a result of construction activities.

Due to the flat topography of the project area, damage from lateral spreading, collapse, and landsliding is not expected. Liquefaction potential varies within the planning area. Areas paralleling the Feather River which contain clean sand layers with low relative densities coinciding with a relatively high water table are estimated to have generally high liquefaction potential. Granular layers underlying certain areas in the Sacramento Valley have higher relative densities and thus have moderate liquefaction potential. Clean layers of granular materials older than Holocene are of higher relative densities and are thus of low liquefaction potential.

Relevant Policies and Programs of the 2030 General Plan

The 2030 General Plan includes several policies and programs related to risk from unstable soils:

- **Policy PS-1.1:** All new buildings in the City shall be built under the seismic requirements of the California Building Code.

- **Policy PS-1.2:** The City will encourage the retrofitting of older buildings to current safety standards, as specified in locally applicable fire and building codes.

Conclusion

Implementation of existing regulations (including the CBC regulations described in the regulatory setting of this chapter), as well as the proposed policies and programs of the 2030 General Plan, would reduce the impacts of unstable soils on buildout of the 2030 General Plan through application of best management practices and engineering controls. This impact would be **less than significant**.

Mitigation Measure

No mitigation beyond existing regulations and the 2030 General Plan policies and programs is required.

IMPACT 4.7-5	**Construction in Areas with Expansive Soils.** *Buildout of the 2030 General Plan would result in construction of occupied structures in areas with expansive soils. This impact would be* ***less than significant.***

Expansive or shrink-swell soils contain significant amounts of clay minerals that swell when wet and shrink when dry. These clays tend to swell despite the heavy loads imposed by large structures. Damage (such as cracking of foundations) results from differential movement and from the repetition of the shrink-swell cycle. Soils having high shrink-swell potential in at least the top 12 inches are found throughout the Planning Area. Awareness of the presence of expansive soils before construction often means that the problem can be eliminated through foundation design.

Relevant Policies and Programs of the 2030 General Plan

The 2030 General Plan includes several policies and programs that would control development in areas of expansive soils:

- **Policy PS-1.1:** All new buildings in the City shall be built under the seismic requirements of the California Building Code.

- **Policy PS-1.2:** The City will encourage the retrofitting of older buildings to current safety standards, as specified in locally applicable fire and building codes.

Implementation of existing regulations (including the CBC regulations described in the regulatory setting of this chapter), as well as the proposed policies and programs of the 2030 General Plan, would reduce the impacts of expansive soils on buildout of the 2030 General Plan through application of best management practices and engineering controls. This impact would be less than significant.

Mitigation Measure

No mitigation beyond compliance with existing regulations and the 2030 General Plan policies and programs is required.

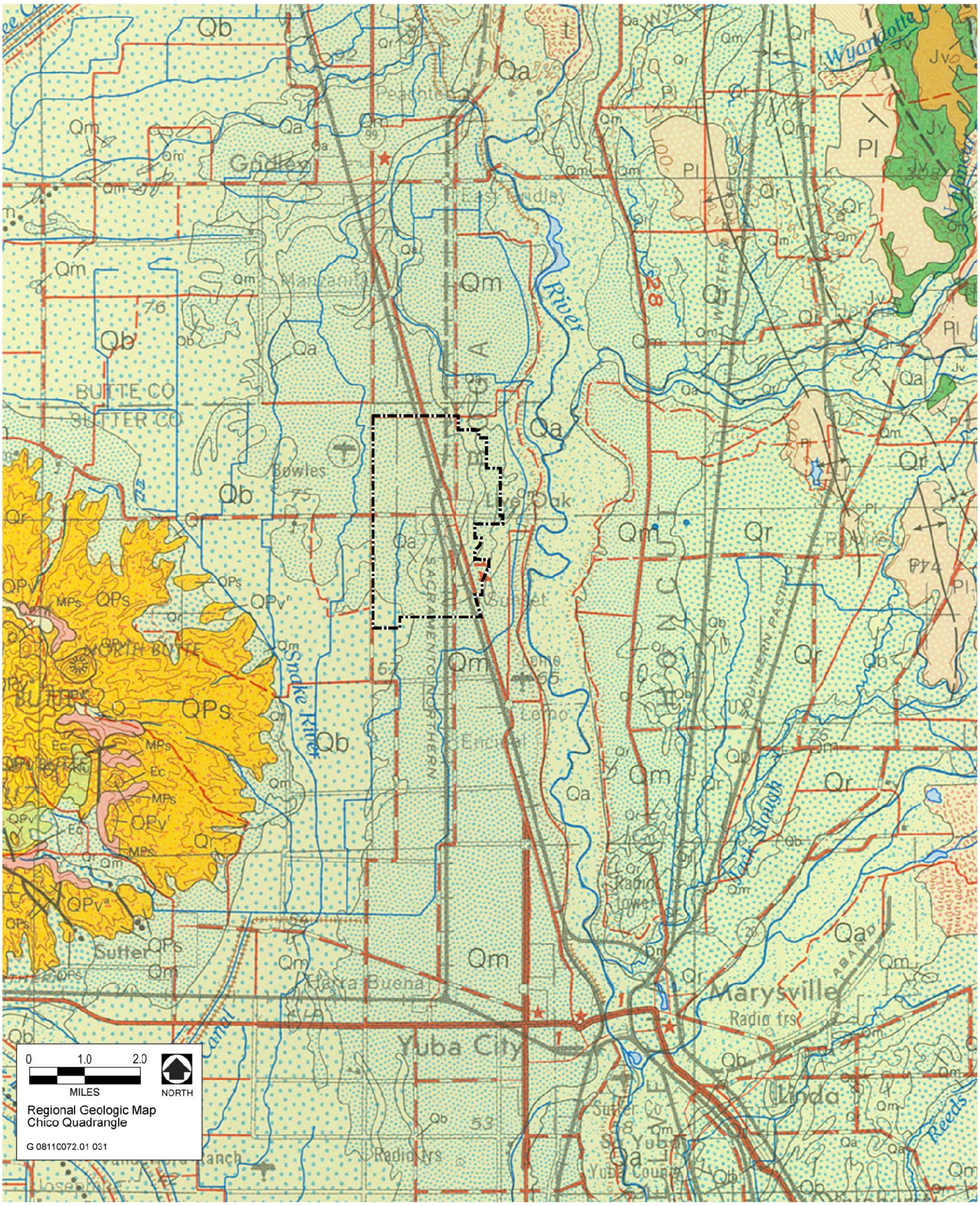
IMPACT 4.7-6	**Possible Damage to Unknown, Potentially Unique Paleontological Resources during Earthmoving Activities.** *Construction activities could disturb previously unknown paleontological resources at the project site and along the alignments of the off-site elements. This impact would be* ***less than significant.***

As shown in Exhibit 4.7-3, portions of the Planning Area are underlain by Holocene-age (less than 11,000 years old) basin deposits. By definition, in order to be considered a fossil, an object must be more than 11,000 years old. Therefore, construction activities that occur in the Holocene deposits would have no impact on paleontological resources. However, the remainder of the Planning Area (Exhibit 4.7-3) is underlain by Pleistocene-age sediments of the Modesto Formation, which is considered a paleontologically sensitive rock unit under SVP guidelines (1995).

The potential that unique paleontological resources could be discovered varies on a project-by-project basis, and increases with larger projects that disturb larger areas. Numerous of vertebrate fossil specimens have been recorded from the Modesto Formation in Yuba City, Woodland, and Davis. The fact that vertebrate fossils have been recovered near the project site and other recorded vertebrate fossil localities have been recorded throughout the Sacramento and San Joaquin Valleys, and that all have been in sediments referable to the Modesto Formations, suggests that there is a potential for uncovering additional similar fossil remains during construction-related earthmoving activities. This could include trenching for utilities throughout the Planning Area. The potential for damage to unique paleontological resources during earth-moving activities in the Planning Area, however, is reduced by an implementation program included in the Conservation and Open Space Element:

- **Implementation Program Cultural-4.** If potential paleontological resources are detected by construction workers or City staff during construction, work shall stop and consultation is required to avoid further impacts. Actions after work stoppage will be designed to avoid significant impacts to the greatest extent feasible. These measures could include construction worker personnel education, consultation with a qualified paleontologist, coordination with experts on resource recovery and curation of specimens, and/or other measures, as appropriate.

The City is not aware of any significant paleontological resources in the Planning Area. However, the City has recognized that resources could be uncovered during General Plan buildout. The City's implementation program would minimize potential adverse impacts on unique, scientifically important paleontological resources. With the implementation of this program, the impact is considered **less than significant**.



LEGEND

- Qa — Natural levee and channel deposits
- Qm — Modesto Formation *(alluvium)*
- ‑·‑·‑ Planning Area

Note:
Only those units present in the Live Oak Planning Area appear on the legend. Other units are defined on the Regional Geologic Map Series, Chico Quadrangle – Map No. 7A (Geology) Sheet 1 of 5

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General Plan

Exhibit 4.7-3
Geologic Map