8.3 GEOLOGIC AND SEISMIC HAZARDS

Environmental Setting

This section describes the existing geologic hazards that may impact the Planning Area. A critical review of existing city policies, regarding evaluation and mitigation of geologic hazards relative to new development, is also included.

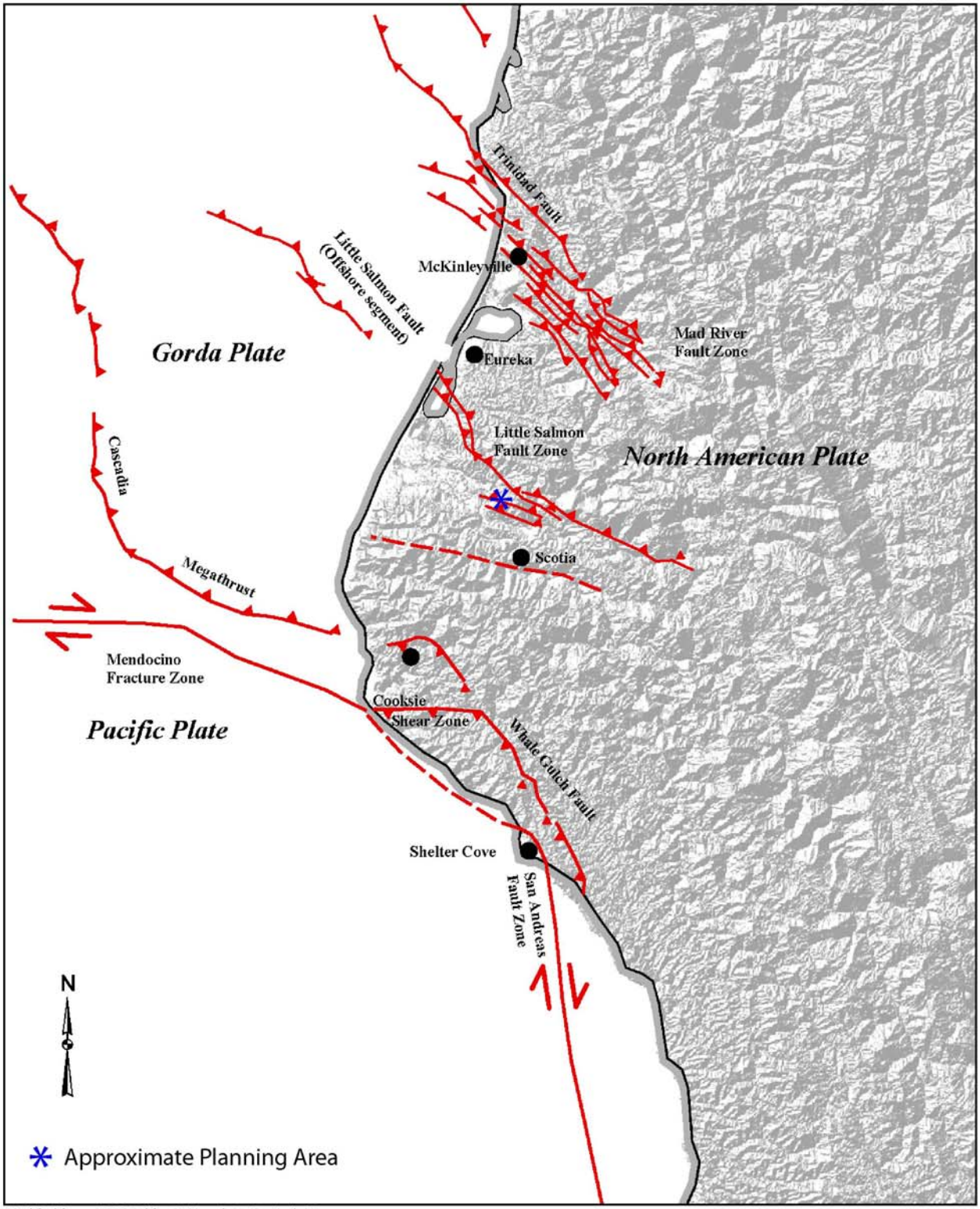
The entire Planning Area is subject to a variety of geologic hazards, especially in the outlying sections that will be subject to most of the future growth. Planning for this growth must incorporate an understanding of these hazards to prevent substantial loss of life and property

The City of Fortuna is located within a complex geologic environment, characterized by very high rates of active tectonic deformation and seismicity. This area lies just north of the Mendocino Triple Junction: the intersection of three crustal plates (the North American, Pacific, and Gorda plates; Figure 8-2). North of Cape Mendocino, the Gorda plate is being actively subducted beneath North America, forming what is commonly referred to as the Cascadia subduction zone. In much of coastal Humboldt County, secondary deformation related to the subduction zone is manifested on-land, as a series of northwest-trending thrust faults and intervening folds (fold and thrust belt). The geomorphic landscape of the region is largely a result of the active tectonic processes and the setting in this dynamic coastal environment.

Basement rock, beneath the lower Eel River Valley area, is the Paleocene-Eocene Yager terrane, a part of the Coastal belt of the Franciscan Complex (Blake et al., 1985; Clarke, 1992). The Franciscan Complex is a regional bedrock unit that consists of a series of "terranes," that are discrete blocks of highly deformed oceanic crust welded to the western margin of the North American plate over the past 140 million years. The Yager terrane consists of 9,800 feet of well-indurated marine mudstone and thin-bedded siltstone. Yager terrane bedrock is at least 8,000 feet below the ground surface in the vicinity of Fortuna, based on geologic cross-sections presented in Ogle (1953).

Basement rock in the region is overlain by a late Miocene, to middle Pleistocene, age sequence of marine and terrestrial deposits, referred to as the Wildcat Group (Ogle, 1953). The marine portion of the Wildcat Group includes some 6,000 to 8,000 feet of mudstone and lesser amounts of sandstone that were deposited in a deep coastal basin (the Eel River basin). Gradationally overlying the marine portion of the Wildcat Group are 2,500 to 3,250 feet of nonmarine sandstone and conglomerate, which represent the uppermost part of the Wildcat depositional sequence. The Wildcat Group is truncated at its top by an unconformity of middle Pleistocene age, and is overlain by coastal plain and fluvial deposits of middle, to late, Pleistocene age. In the Eureka and Eel River valley areas, these middle and late Pleistocene age deposits are referred to as the Hookton Formation (Ogle, 1953). Hookton Formation sediments are described as gravel, sand, silt, and clay, which have a characteristically yellow-orange color (Ogle, 1953).

Fortuna General Plan 2030
Figure 8-3a, Regional Faults



Modified from: USGS California-Nevada Active Fault Map from http://quake.wr.usgs.gov/info/faultmaps; San Andreas Fault Location taken from Prentice et al., 1999.

Schematic - NO SCALE

PLANWEST PARTNERS, INC.

Local Geologic Setting

The local geologic setting of the Fortuna Planning Area is characterized by its proximity to two of the most significant geomorphic influences in Humboldt County–the Little Salmon fault and the Eel River (see Figures 8-2 and -3). The City lies directly east of the Eel River, and is built on alluvium derived from the Eel and Van Duzen rivers and from streams draining the hills east of town (Rohner, Strongs, and Jameson Creeks). The Little Salmon fault is perhaps the most active on-land fault in the region. The main stem of the fault traverses the slopes directly east of the City limits with portions in the Planning Area, while two traces of the fault occur parallel to State Route 36 east of Wolverton Gulch with portions in the Planning Area. The fault is associated with a large amount of cumulative displacement, and therefore defines a distinct geologic boundary between earth materials on either side of the fault.

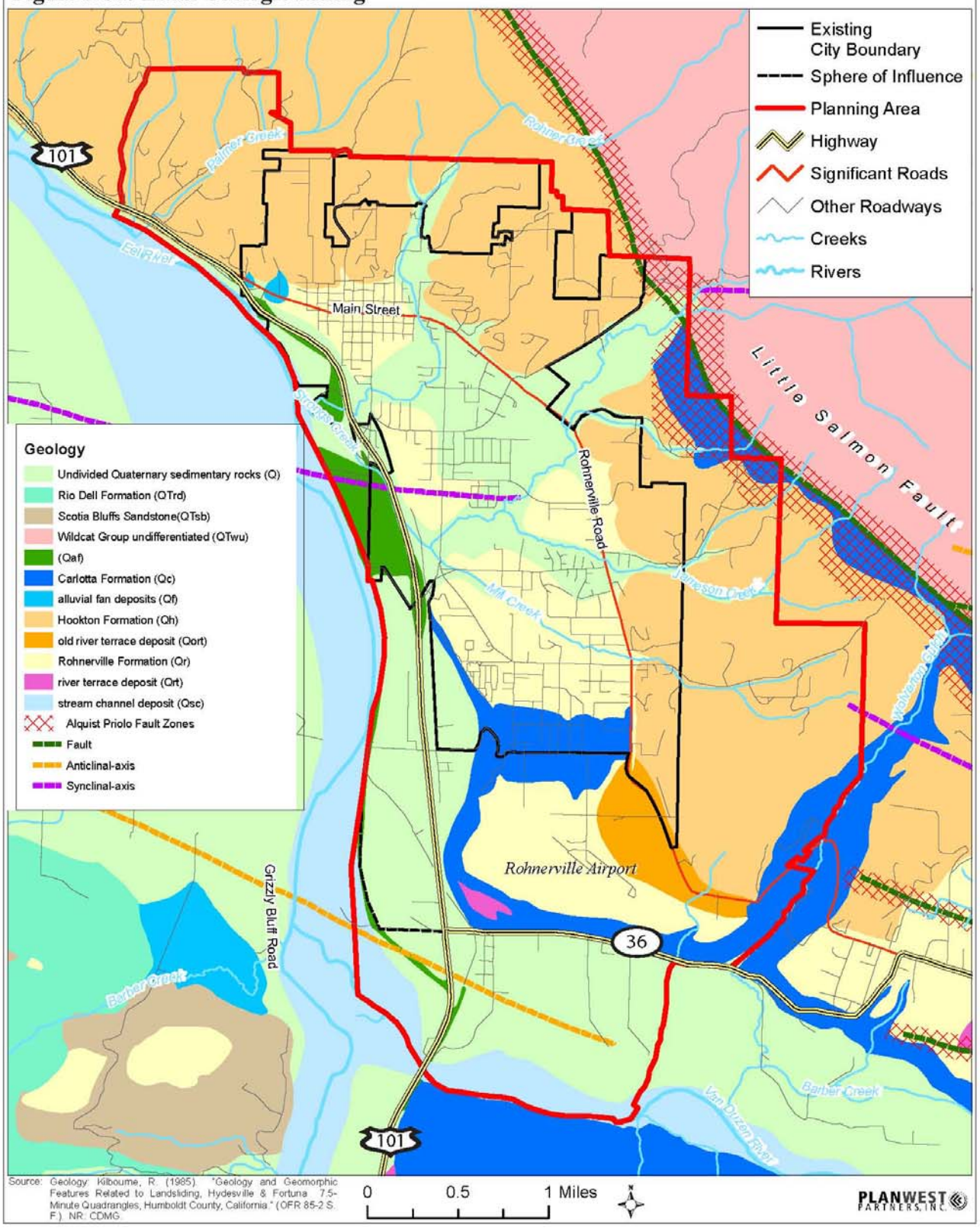
The area around the confluence of the Van Duzen and Eel rivers is underlain by a series of alluvial terraces that date back to the late Pleistocene. Uplift and folding associated with the Eel River syncline (a roughly east-west trending, active crustal fold) have resulted in broad deformation of these low-relief surfaces, such that they are no longer level. The most prominent alluvial surface in the area is the broad Rohnerville terrace (often referred to as the Rohnerville "Formation"). Elevation of the terrace beneath the airport is approximately 400 feet; it descends steadily to as low as 60 feet in the northern part of downtown Fortuna. The terrace sediments are defined by Kilbourne (1985) as "unconsolidated and gently folded, older Eel River flood plain deposits consisting predominantly of gravel with smaller amounts of sand, silt, and clay."

As the Rohnerville surface descends beneath Fortuna, it is mapped by Kilbourne (1985) as being buried by younger alluvial deposits derived from the series of streams that drain the hills east of Fortuna (Rohner, Strongs, and Jameson Creeks). This alluvium is mapped as Holocene in age by Kilbourne, and is defined as "unconsolidated sand, silt, gravel, and clay deposited by streams in canyon bottoms." These younger alluvial deposits extend up the stream canyons bordering Fortuna as recent stream channel deposits.

The hills directly east of Fortuna are underlain by middle to late Pleistocene age sediments of the Hookton Formation. These sediments are described by Kilbourne (1985) as "well-to-poorly sorted, gently folded, unindurated marine, grading to non-marine sand, gravel, and silt." Hookton Formation sediments extend east to the Little Salmon fault, where they are juxtaposed against undifferentiated Wildcat Group sediments. Undifferentiated Wildcat Group sediments on the northeast side of the Little Salmon Fault are described as "moderately-to-poorly indurated, massive-to-poorly bedded, folded, compact, blue-gray, clayey siltstones with smaller amounts of sandstone, pebbly sandstone, and conglomerate."

Seismic Setting. Fortuna is located in a region of high seismicity. More than 60 earthquakes have produced discernible damage in the region since the mid-1800s (Dengler et al., 1992). Historic seismicity and paleoseismic studies in the area suggest there are six distinct sources of damaging earthquakes in the region (see Figure 8-2): (1) the Gorda Plate, (2) the Mendocino fault, (3) the Mendocino Triple Junction, (4) the northern end of the San Andreas fault, (5) faults within the North American Plate (including the Mad River fault zone), and (6) the Cascadia Subduction Zone (Dengler et al., 1992).

Fortuna General Plan 2030
Figure 8-3b: Local Geologic Setting



Earthquakes originating within the Gorda Plate account form the majority of historic seismicity. These earthquakes occur primarily offshore, along left-lateral faults, and are generated by the internal deformation within the plate as it moves toward the subduction zone. Significant, historic Gorda Plate earthquakes have ranged from magnitude 5 to 7.5. The November 8, 1980, earthquake (magnitude 7.2) was generated 30 miles (48 kilometers [km]) off the coast of Trinidad on a left-lateral fault within the Gorda Plate.

The Mendocino Fault is the second most frequent source of earthquakes in the region. The fault represents the plate boundary between the Gorda and Pacific plates, and typically generates right lateral strike-slip displacement. Significant, historic Mendocino fault earthquakes have ranged from magnitude 5 to magnitude 7.5. The September 1, 1994, magnitude 7.2 event originating west of Petrolia was generated along the Mendocino fault. The Mendocino triple junction was identified as a separate seismic source, only after the magnitude 6.0 August 17, 1991, earthquake. Significant seismic events associated with the triple junction are shallow onshore earthquakes that appear to range from magnitude 5 to 6. Raised Holocene age marine terraces near Cape Mendocino suggest larger events are possible in this region.

Earthquakes originating on the northern San Andreas Fault are extremely rare, but can be very large. The northern San Andreas Fault is a right lateral strike-slip fault that represents the plate boundary between the Pacific and North American plates. The fault extends through the Point Delgada region and terminates at the Mendocino triple junction. The 1906 San Francisco earthquake (magnitude 8.3) caused the most significant damage in the north coast region, with the possible exception of the April 1992, Petrolia earthquake (Dengler et. al., 1992).

Earthquakes originating within the North American plate can be anticipated from a number of intraplate sources, including the Mad River Fault zone and Little Salmon Fault. There have not been large magnitude earthquakes associated with faults within the North American plate; however, the December 21, 1954, magnitude 6.5 event may have occurred in the Mad River Fault zone. Damaging North American plate earthquakes are expected to range from magnitude 6.5 to 8. The Little Salmon Fault appears to be the most active fault in the region, and is capable of generating very large earthquakes.

Little Salmon Fault. The Little Salmon Fault -- the closest fault to Fortuna that is known to be active -- traverses the easterly portions of the Planning Area (Figure 8-5; Ogle, 1953; Kilbourne, 1985; Wills, 1990). The Little Salmon Fault is a northwest-trending, northeast-dipping thrust fault (the northeast side of the fault slides up and over the southwest side of the fault along a northeast-dipping fault plane). Offset relations within the upper Wildcat Group suggest that vertical separation exceeds 5,900 feet (1,800 meters), representing about 4.4 miles (7 km) of dip-slip motion on the Little Salmon Fault since the Quaternary (in the past 700,000 to 1 million years). Estimates of the amount of fault slip for individual earthquakes along the fault range from 15 to 23 feet (4.5 to 7 meters). Radiocarbon dating suggests that earthquakes occurred on the Little Salmon fault about 300, 800, and 1,600 years ago. Average slip rate for the Little Salmon fault for the past 6,000 years is between 6 and 10 millimeters per year. Based on currently (2005) available fault parameters, the maximum magnitude earthquake for the Little Salmon fault is thought to be between 7.0 (CDMG/USGS, 1996) and 7.3 (Geomatrix Consultants, 1994).

Cascadia Subduction Zone. The Cascadia Subduction Zone (hereafter referred to as CSZ) represents the most significant potential earthquake source in the north coast region. The CSZ is the location where the oceanic crust of the Gorda and Juan de Fuca plates are being subducted beneath the continental crust of the North American Plate. A great subduction event may rupture along 200 km or more of the coast, from Cape Mendocino to British Columbia, resulting in tsunami inundation in low-lying coastal areas. The April 25, 1992, Petrolia earthquake (magnitude 7.1) appears to be the only historic earthquake involving slip along the subduction zone, but this event was confined to the southernmost portion of the fault. It is estimated that there have been 6 significant subduction zone events along the CSZ in the last 3,000 years (Darienzo and Peterson, 1995). Paleoseismic studies along the subduction zone suggest that great earthquakes are generated along the zone every 300 to 500 years. Historic records from Japan, describing a tsunami thought to have originated along the CSZ, suggest the most recent great subduction event occurred on January 27, 1700. A great subduction earthquake would generate long duration, very strong ground shaking throughout the north coast.

The CSZ is located offshore, west of the north coast region. Available mapping indicates that the surface expression of the subduction zone is located some 30 to 35 miles west of the project site (Clarke, 1992; McLaughlin et al., 2000). Seismic profiles suggest that the subduction interface dips landward at an angle of about 11 degrees (McPherson, 1992), which would place it at a depth of about 6 miles beneath the project area (using right angle projection).

Geologic Hazards

Strong Seismic Shaking. Fortuna is located within an active seismic region with multiple, nearby, seismic sources. The region is likely to experience strong seismic shaking within the term of the proposed City of Fortuna General Plan 2030 (e.g., proposed General Plan or proposed plan). The amount and strength of ground shaking depends on the magnitude of the earthquake, the distance to the hypocenter, and the type of earth materials at the site and between the site and hypocenter. Due to the proximity of the Fortuna Planning Area to the Little Salmon fault, Mendocino triple junction, and the Cascadia subduction zone, the potential exists for long, sustained periods of intense ground shaking. The region could potentially be subject to strong earthquakes as stated above.

Local site conditions can profoundly influence the nature of seismically-induced strong ground motions. The geometry and strength properties of subsurface materials, and site topography, can influence the amplitude, frequency, and duration of ground shaking. Portions of the Planning Area underlain by youthful geologic materials (for example, late Pleistocene or Holocene age alluvium) may be subject to amplification of seismic energy.

Surface Fault Rupture. Surface fault rupture hazards in the State of California are evaluated under the guidelines of the Alquist-Priolo Earthquake Fault Zone Act. The intent of the Act is to mitigate the hazard of surface fault rupture. It mandates specific, detailed geologic studies to demonstrate the presence, or absence, of active faults for certain projects in the vicinity of faults identified by the California Geological Survey. Where active fault traces are identified during subsurface investigations, a structural exclusion zone, known as an “Alquist-Priolo Special Studies Zone” or “Alquist-Priolo Fault Zone”, is defined to preclude construction over the fault.

The portion of the Little Salmon Fault within the Fortuna Planning Area has been determined to be active, and an Alquist-Priolo Fault Zone has been established around the fault (Figure 8-5).

Landslides. Landslides are gravity-driven downslope movements of earth materials, typically triggered by earthquakes, or elevated pore pressures, resulting from peak rainfall events. Factors that influence the susceptibility of an area to landslides, or mudflows, include slope gradient (see Figure 8-4), the nature of earth materials, vegetative cover, and groundwater levels. Because of the presence of moderate and steep slopes, weak earth materials, seismic shaking, and high rainfall amounts within the Planning Area, landsliding is a significant hazard in Fortuna. This hazard is greatest in the upland areas bordering the Planning Area, where most future development is likely to occur. Areas susceptible to landsliding are shown on the California Geological Survey's "Geologic and Geomorphic Features Related to Landsliding" map of the Fortuna 7.5' quadrangle, although this map is based primarily on aerial photograph interpretation, with only minor field checking. That map shows extensive areas of "debris slide slopes," along upland slopes adjacent to watercourses (see Figure 8-5).

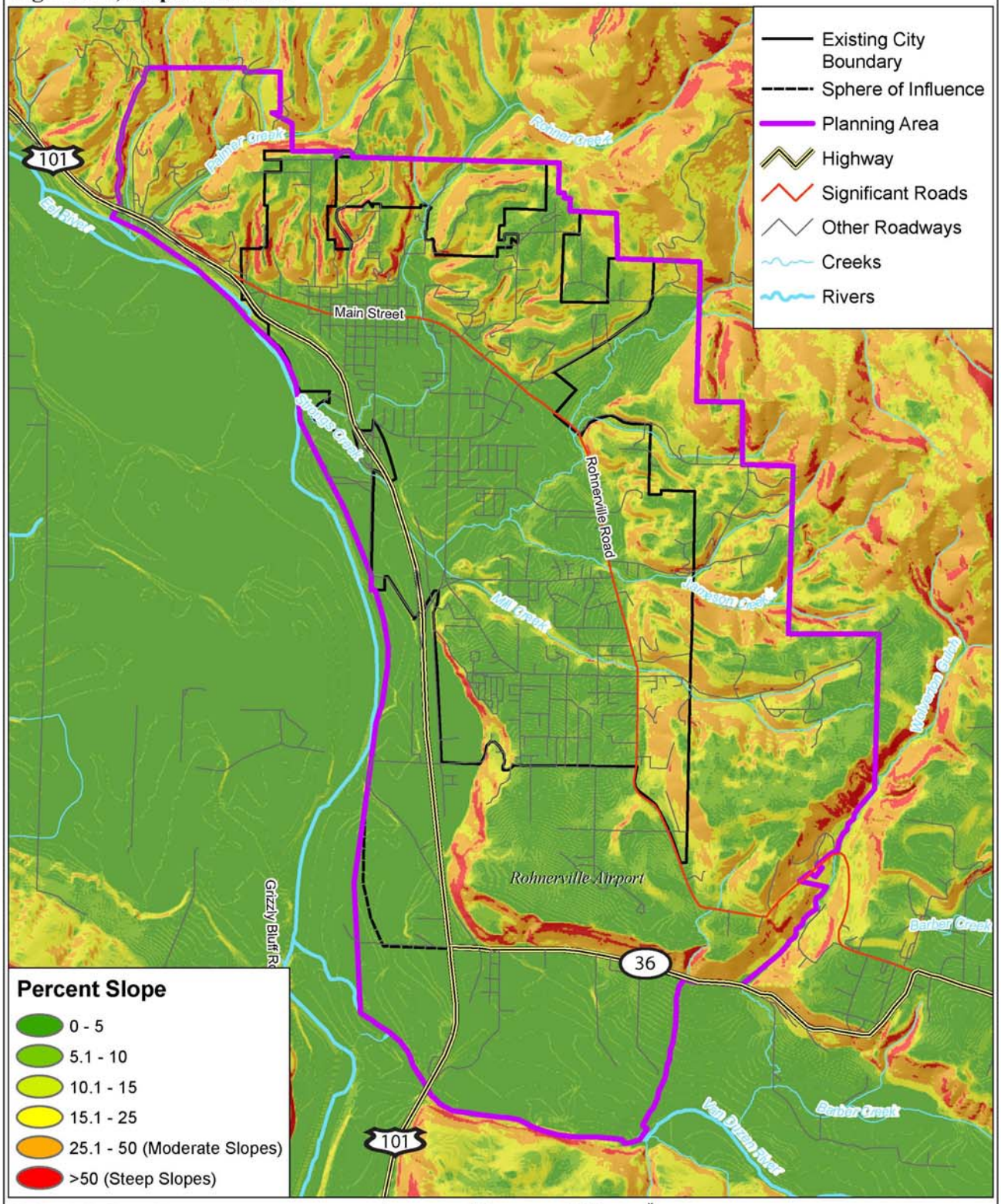
Liquefaction. Liquefaction is defined as the sudden loss of soil shear strength due to a rapid increase of soil pore water pressures, caused by cyclic loading from a seismic event. In simple terms, it means that a liquefied soil acts more like a fluid than a solid when shaken during an earthquake. In order for liquefaction to occur, the following are needed:

- Granular soils lacking significant clay content (sand, silty sand, sandy silt, and some gravels);
- A high groundwater table; and
- A low density of the granular soils (usually associated with young geologic age).

The adverse effects of liquefaction include local and regional ground settlement, ground cracking and expulsion of water and sand, the partial or complete loss of bearing and confining forces used to support loads, amplification of seismic shaking, and lateral spreading. Lateral spreading is defined as lateral earth movement of liquefied soils, or competent strata riding on a liquefied soil layer, downslope toward an unsupported slope face (such as, a creek bank or an inclined slope face). In general, lateral spreading has been observed on low to moderate gradient slopes, but has been noted on slopes with an inclination as flat as one degree.

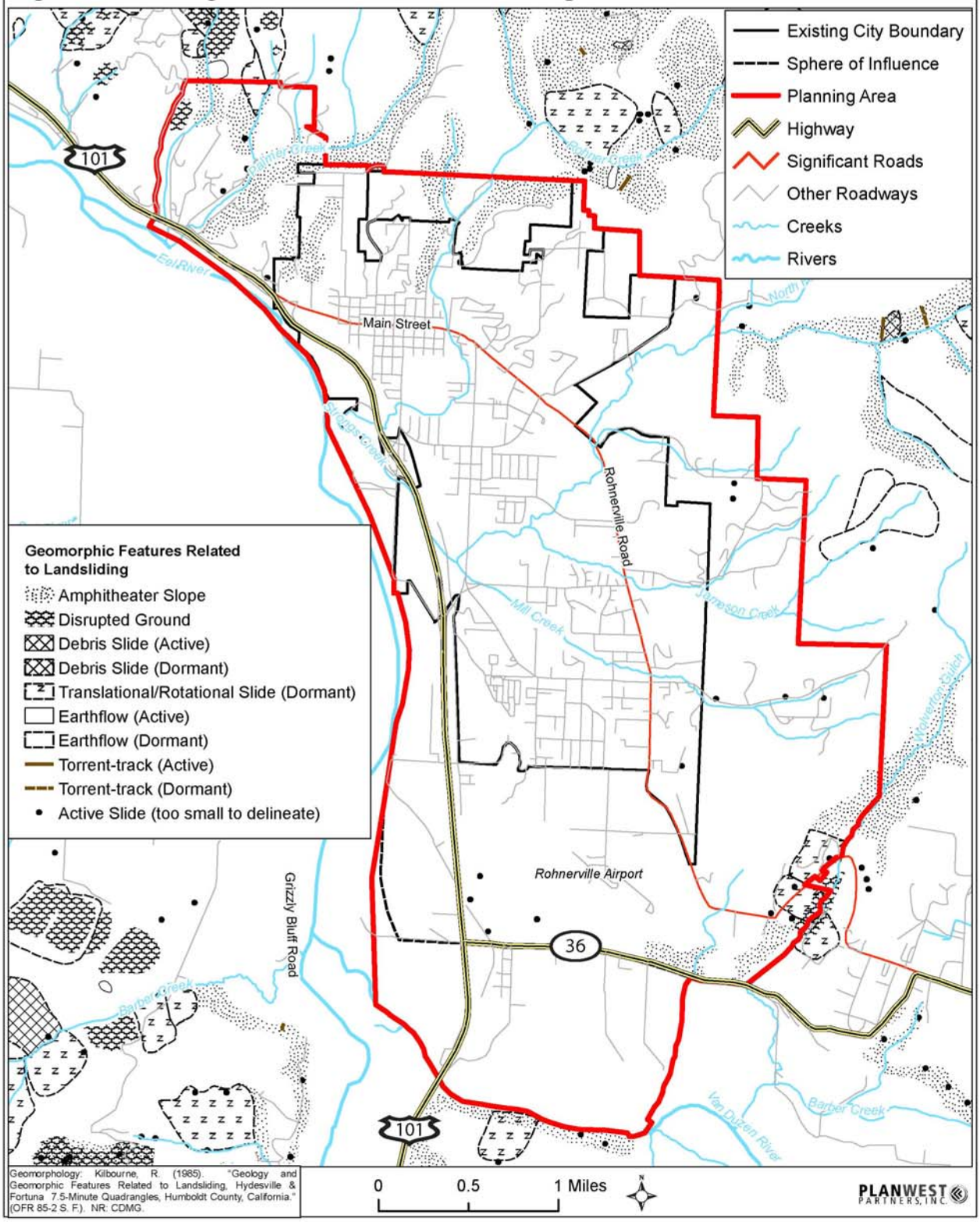
The liquefaction potential of youthful alluvial deposits in the Planning Area is not known. There are ample historic accounts of extensive liquefaction in Eel River floodplain sediments, but none within the Planning Area. There appear to be areas within the Planning Area that may meet the criteria listed above: young, loose, and saturated granular sediments. Hence, a potential for liquefaction may occur in portions of the Planning Area near the Eel River.

Fortuna General Plan 2030
Figure 8-4, Slope Gradients



Map Compiled by Planwest Partners
July 31, 2007 Percent Slope derived from USGS 10 meter DEM

Fortuna General Plan 2030
Figure 8-5, Geomorphic Features Related to Landsliding



Geomorphology: Kilbourne, R. (1985). "Geology and Geomorphic Features Related to Landsliding, Hydesville & Fortuna 7.5-Minute Quadrangles, Humboldt County, California." (OFR 85-2 S. F.). NR: CDMG.

Applicable Plans, Policies, Codes, and Regulations

State

Alquist-Priolo Earthquake Fault Zone (A-P) Act. The Alquist-Priolo Act of 1972 (California Public Resources Code, Chapter 7.5, Division 2) is intended to mitigate the hazard of surface fault rupture. It mandates specific, detailed geologic studies for certain projects proposed in the vicinity of faults mapped by the California Geological Survey to determine whether the faults are active. "Active" faults are defined by the State as those with activity within the Holocene Epoch (the past 11,000 years). For faults determined to be active, the Act mandates the establishment of "Alquist Priolo Fault Zones" around the faults within which development setbacks from the fault apply.

Seismic Hazards Mapping Act. The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong seismic ground shaking, liquefaction, seismically-induced landslides or other ground failure, and amplification of seismic energy due to soft ground conditions. This Act requires the State Geologist to delineate various seismic hazard zones and issue a series of maps. It also requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones.

The hazards maps depict areas susceptible to these secondary seismic hazards and are accompanied by a report describing the basis for the maps. Location of a site within a seismic hazard zone identified by the State will require special study by a licensed geologist, or geotechnical engineer, to characterize and mitigate the hazard.

The California Geological Survey (formerly the California Division of Mines and Geology) has not completed preparation of a preliminary seismic hazards map for Humboldt County, as the State is developing the seismic hazards maps in areas with the highest population and growth potential first. The estimated date for completing the maps is not known.

Local

Fortuna General Plan 1993. The goal of regulatory policy related to seismic and geologic hazards set forth under the Fortuna General Plan is to "minimize loss of life, injury, and property damage due to seismic and geologic hazards." This goal is achieved through the adoption and implementation of new policies described within this General Plan:

Methodology

Policy Background

The following policy background is used to assess the geologic and seismic impacts of the proposed plan:

- The City of Fortuna is located in a seismically active region, and there are numerous seismic sources in the area that may produce strong ground shaking. The Planning Area is very likely to experience significant seismic ground shaking during the time period for which the proposed plan applies.
- Because most of the lower elevation areas of the City are built on alluvium, a liquefaction hazard likely exists in Fortuna. The degree of this hazard is poorly understood. Historically, there has been a notable lack of subsurface data and analysis for developments in Fortuna. Quantitative liquefaction, ground motion, or slope stability analyses have not typically been requested, or performed, despite the presence of liquefaction, earthquake strong motion, and landslide hazards within the Fortuna Planning Area.
- Slope stability hazards exist in sloping areas on the outskirts of the Planning Area.
- Because most of the favorable, stable ground has been built on, future development in Fortuna will increasingly encroach into slope areas with lower stability conditions.
- More than 60 earthquakes have produced discernible damage in this region since the mid-1800s.
- Historic seismicity and paleoseismic studies in the area suggest there are six distinct sources of damaging earthquakes in the region.
- The 1906 San Francisco earthquake (magnitude 8.3), generated on the San Andreas Fault, caused the most significant damage in the North Coast Region.
- The Little Salmon Fault, traversing the hills east of the City, is the closest fault to Fortuna that is known to be active. It also appears to be the most active fault in the region, and is capable of generating very large earthquakes. Based on currently available fault parameters, the maximum magnitude earthquake for the Little Salmon Fault is thought to be between 7.0 and 7.3.
- The CSZ represents the most significant, potential earthquake source in the north coast region. A great subduction event along the CSZ may rupture along up to 1,000 km of the coast from Cape Mendocino to British Columbia, may be up to magnitude 9.5.

Thresholds of Significance

General Plan implementation will have a significant environmental impact if it:

- Exposes people, or structures, to potential substantial adverse effects -- including the risk of loss, injury, or death involving:
    - i. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map, issued by the State Geologist for the area or based on other substantial evidence of a known fault;
    - ii. Strong seismic ground shaking;
    - iii. Seismic-related ground failure, including liquefaction;
    - iv. Landslides, mudslides, or other hazards.
- Results in substantial soil erosion or the loss of topsoil;

- Permits development 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;
- Permits development on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1997), creating substantial risks to life or property; and
- Permits rural development over 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.

Implications of the Land-Use Diagram

Land uses and development patterns consistent with those shown on the proposed Land Use Diagram (Figure 3-7 in Chapter 2 of this PEIR) may expose people, or property, to substantial risk associated with geologic hazards, unless properly mitigated. As development spreads outward from the relatively low relief alluvial surface in the city center, geologic hazards will become an increasingly important factor to consider.

The primary concern is the potential for resulting from a large earthquake on a nearby fault. The most significant effects would appear to be related to a great earthquake on the CSZ (Cascadia Subduction Zone), as the CSZ has the potential for generating very large earthquakes (up to Magnitude 9.5) that would significantly impact the City and surrounding areas.

In addition, a fault rupture on the Little Salmon Fault (the fault closest to the City of Fortuna that is known to be active) has the potential for a maximum magnitude earthquake of between 7.0 (CDMG/USGS, 1996) and 7.3 (Geomatrix Consultants, 1994). An earthquake generated on this fault would likely result in surface fault rupture within the eastern portion of the Planning Area and cause very strong ground shaking.

A substantial earthquake on either of these faults will generate significant secondary effects including liquefaction and landslides. Many of these will occur in areas designated for future development as identified on the proposed Land Use Diagram. In addition, land sliding (even under static conditions) is a potentially significant hazard on sloping ground around the margins of the Planning Area, portions of which are designated for development.

General Plan Policy Response

The proposed General Plan includes the following policies and programs relevant to geologic and seismic hazards.

Policy HS-5.1 Mapping Geologic Hazard Areas. The City shall prepare a Hazards Map that identifies areas at “high risk” from fault rupture, strong seismic ground shaking, seismic-related ground failure, liquefaction, landslides, soil instability, expansive soils, high soil erosion, the Little Salmon Fault and the associated Alquist Priolo Fault Zone around the fault.

Policy HS-5.2 Regulating Land Uses in Geologic Hazard Areas. The City shall regulate land uses in mapped hazard areas by: (1) prohibiting new critical facilities (hospitals, police stations, fire stations, and water and wastewater treatment plants) in "high risk" areas; and (2) requiring proposed non-critical development in "high risk" areas to have a geotechnical report that identifies hazards and recommends design standards and mitigation measures to reduce hazards.

Policy HS-5.3 Regulating Land Uses on Steep Slopes. The City shall prohibit new development on slopes greater than 25 percent (see Figure HS-1), and require new development proposed on slopes of between 15 and 25 percent to have a geotechnical report that identifies any site-specific landslide hazards and recommends design standards and mitigation measures to reduce hazards.

Policy HS-5.4 Regulating Land Uses in Alquist Priolo Fault Zones. The City shall not permit any new development within the development setbacks established by the Alquist Priolo Fault Zones around the Little Salmon Fault and the two associated un-named fault traces.

Policy HS-5.5 Code Enforcement. The City shall continue to enforce the Uniform Building Code to minimize future structural problems in buildings from geologic hazards.

Policy HS-5.6 Structure Design. The City shall require new structures intended for human occupancy to be designed and constructed to minimize risk to the safety of occupants due to ground shaking.

Policy HS-5.7 Preliminary Soils Reports. The City shall require submission of a preliminary soils report, prepared by a registered civil (geotechnical) engineer and based upon adequate test borings, for all proposed subdivisions.

Policy HS-5.8 Grading Guidelines. The City shall require a Grading Permit for all clearing and earthwork not exempt by Uniform Building Code Chapter 33, to minimize natural terrain and land feature disturbances, avoid the rainy season where possible, retain trees and native vegetation to stabilize hillsides and reduce erosion, be balance on-site where possible, and not impact off-site areas. Graded areas shall be developed or landscaped or watered developed.

Program HS-11. The City shall review and regularly update its geologic hazard mapping based on new information, including soils and geologic reports for specific sites and updated maps from the State Geologist.

Program HS-12. The City shall amend the Zoning Ordinance to provide development standards and site design criteria for development on areas containing slopes of between 15 and 25 percent.

Program HS-13. The City shall adopt standards, guidelines, and procedures for evaluating and mitigating geologic hazards (e.g., surface faulting, liquefaction, landslides, and ground shaking) in the review and approval of both public and private projects.

Impacts and Mitigation

Impact 8.3-1: Fault Rupture

Proposed General Plan implementation will not expose more people to fault rupture hazards because state law requires building setbacks around active faults. Within the context of Alquist-Priolo Fault Zones setbacks already been established around the only known active fault within the Planning Area (the Little Salmon Fault and associated fault traces), and proposed policies enforce state setback requirements.

Discussion

The eastern portion of the Planning Area is bisected by the Little Salmon Fault and two associated fault traces. Each of these has an established Alquist Priolo Fault Zone around them (Figure 8-5). Because state law requires building setbacks around faults and fault traces for which Alquist Priolo Fault Zones have been established, and because the City must comply with the required setbacks, there is no potential for the construction of new buildings directly over the fault or associated traces under the proposed plan. In addition, the following policies and programs included in the proposed General Plan are intended to mitigate potential impacts associated with fault rupture:

- Policy HS-5.1 requires the City to map high risk geologic hazard areas including faults and Alquist-Priolo Fault Zones;
- Policy HS-5.2 requires the City to prohibit and/or regulate new development in high risk areas;
- Policy HS-5.4 requires the City to prohibit new development within the development setbacks established by the Alquist Priolo Fault Zones; and
- Program HS-13 requires the City to adopt standards, guidelines, and procedures for evaluating and mitigating geologic hazards including fault rupture.

  By complying with the state setback requirements and by implementing the proposed policies and programs, the fault rupture hazard will be less than significant.

Determination of Level of Significance

Less-Than-Significant

Mitigation

No mitigation necessary

Impact 8.3-2: Strong Seismic Ground Shaking

Proposed General Plan implementation could expose more people to strong seismic ground shaking, because the Planning Area is located in a seismically active area.

Discussion

The Planning Area is located within a region of high seismicity. Within recorded history, the region has experienced more than 60 earthquakes that have produced damage. Multiple fault systems in the region have generated strong seismic ground shaking and there are several active local faults capable of producing earthquakes, including the Little Salmon Fault within the eastern portion of the Planning Area. The Planning Area is likely to experience strong ground shaking during the time horizon of the proposed plan. However, the following policies and programs are included in the proposed General Plan to mitigate impacts associated with strong seismic ground shaking:

- Policy HS-5.1 requires the City to map high risk geologic hazard areas including areas of strong seismic ground shaking;
- Policy HS-5.2 requires the City to prohibit new critical facilities in mapped geologic hazard areas and requires new non-critical development in these areas to include a geotechnical report that characterizes the ground shake hazard and recommends design standards and mitigations to reduce the hazard to acceptable levels; and
- Program HS-13 requires the City to adopt standards, guidelines, and procedures for evaluating and mitigating geologic hazards including strong ground shaking.

Incorporation and enforcement of these policies and programs will reduce significant impacts associated with strong seismic ground shaking so that the ground shake hazard will be no greater than is the average for California.

Enforcing Policies HS-5.5 and HS-5.6 within the framework of the proposed General Plan will ensure that development occurs according to current codes and regulations so that structures are designed and constructed to minimize the risk from seismic ground shaking. These policies will serve to significantly reduce seismic ground shaking hazards by using the current California Building Standards Code (CBC) requirements for site investigations, design, and construction.

Generally, implementing the policies included in the proposed General Plan, and complying with State and local regulations, adequately addresses the potential impacts from most sources of seismic and geological concern within the Planning Area. These policies will be supplemented with compliance with California Building Code, along with required geotechnical studies for future development that specify required site-specific seismic safety design features.

The most significant mitigation efforts available to minimize the impacts of the hazards discussed above include the development of a comprehensive Geologic Hazards Map for the Planning Area in conjunction with increased subsurface investigation as required by proposed

Policy HS-5.1, and limiting development in high risk areas as required by proposed Policy HS-5.2. Incorporating these policies and programs will reduce these impacts to less than significant.

Determination of Level of Significance

Less-Than-Significant

Mitigation

No mitigation necessary

Impact 8.3-3: Landslides

Proposed General Plan implementation could expose people, or structures, to landslides caused by earthquake shaking, seasonal saturation of the soils and rock materials, erosion, or grading activities.

Discussion

Development and land use in the Planning Area will likely expose people and property to landslides when it occurs at the periphery of the Planning Area on steep, less stable, slopes. However, the following policies and programs are included in the Proposed General Plan to reduce the potential risk from landslides to acceptable levels:

- Policy HS-5.1 requires the City to map high risk geologic hazard areas including landslide areas;
- Policy HS-5.2 requires the City to prohibit new critical facilities in mapped landslide hazard areas and requires new non-critical development in such areas to include a geotechnical report that characterizes the landslide hazard and recommends design standards and mitigations to reduce the hazard to acceptable levels;
- Policy HS-5.3 prohibits new development on slopes greater than 25 percent and requires geotechnical reports for new development proposed on slopes between 15 and 25 percent;
- Policy HS-5.5 requires the City to enforce CBC design requirements that minimize geologic hazards such as landslides;
- Program HS-13 requires the City to adopt standards, guidelines, and procedures for evaluating and mitigating geologic hazards including landslides; and
- Program HS-13 requires the City to adopt standards, guidelines, and procedures for evaluating and mitigating geologic hazards including landslides.

Complying with UBC requirements and implementing these programs and policies will reduce the potential risk for damage associated with landslides to less than significant.

Determination of Level of Significance

Less-Than-Significant

Mitigation

No mitigation necessary

Impact 8.3-4: Liquefaction, Lateral Spreading, Subsidence and Expansive Soils

Proposed General Plan implementation could expose people and structures to liquefaction, lateral spreading, subsidence and expansive soils.

Discussion

The Eel River Valley is underlain by the Hookton Formation that includes coastal plain and fluvial deposits. The western two-thirds of the Planning Area overlays this formation. Given the unconsolidated nature of this formation and its proximity to the Eel and Van Duzen rivers this portion of the Planning Area is subject to varying levels of liquefaction, lateral spreading, subsidence, and expansive soils. However, the following policies and programs are included in the proposed General Plan to reduce the potential risk from these hazards to acceptable levels:

- Policy HS-5.1 requires the City to map high risk geologic hazard areas including areas of liquefaction, lateral spreading, subsidence and expansive soils;
- Policy HS-5.2 requires the City to prohibit new critical facilities in mapped geologic hazard areas and requires new non-critical development in such areas to include a geotechnical report that characterizes the hazard and recommends design standards and mitigations to reduce the hazard to acceptable levels;
- Policy HS-5.5 requires the City to enforce CBC design requirements that minimize geologic hazards such as these;
- Policy HS-5.7 requires preliminary soils reports for all proposed subdivisions; and
- Program HS-13 requires the City to adopt standards, guidelines and procedures for evaluating and mitigating these geologic hazards.

Complying with CBC requirements and implementing these programs and policies will reduce the potential risks from hazards associated with liquefaction, lateral spreading, subsidence and expansive soils to less than significant.

Determination of Level of Significance

Less-Than-Significant

Mitigation

No mitigation necessary

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