5.1 SEISMIC AND GEOLOGIC HAZARDS

5.1.1 Introduction

Section 65302(g) of the California Government Code requires that General Plans include an element containing identification and appraisal of seismic and geologic hazards. Seismic hazards addressed by this element include surface faulting, ground shaking, and ground failure. Non-seismic hazards addressed include volcanoes, erosion, and expansive soils.

5.1.2 Findings

Seismic Hazards

Although not as active as some areas of the State, Shasta County is a seismically active region. The seismicity of a region is described as the distribution, recurrence, and intensity of earthquakes over a period of time. Earthquake activity has not been a serious hazard in Shasta County's history, nor is it probable that it will become a serious hazard in the future.

Surface Faulting

During an earthquake, ground rupture with horizontal and/or vertical displacement may occur. Usually, the width of surface faulting is narrow in rock and much wider in saturated soils. Ground rupture also tends to occur along lines of previous faulting. With detailed investigation, surface faulting usually can be recognized and avoided. However, not all fault traces have been mapped, and some active faults have no surface expression. Where a known active fault or potentially active fault is approximately located, a geological investigation should be conducted prior to development to determine the precise location of fault traces.

The Fault Map of California (1975, Jennings, C.W., et al.) places Quaternary faults in the eastern and southern portion of Shasta County. Quaternary faults are those with the latest movement within the last two to three million years. The State of California (California Division of Mines and Geology) considers Quaternary faults to be potentially active. In the western portion of the County are older, inactive faults from which future movement is considerably unlikely. Figure SG-1 shows the approximate location of both active and inactive faulting in Shasta County.

In 1972, the California State Legislature enacted the Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code Section 2622), which requires the State Geologist to delineate Earthquake Fault Zones around all known traces of potentially and recently active faults in California. For the purposes of the Alquist-Priolo Act, active faults are faults which have caused surface rupture within the Holocene Period, which is defined as the last 11,000 years.

The Alquist-Priolo Act requires withholding of construction permit approval until geologic investigation has determined that the building site is not threatened by surface fault displacement. The Earthquake Fault Zones are usually one-quarter mile or less in width. The California Division of Mines and Geology (CDMG) has prepared maps which identify Alquist-Priolo Earthquake Fault Zones in Shasta County. These maps were adopted in November 1991 by the CDMG and affect some rural areas in northeastern Shasta County which include generally the following areas (see Figure SG-2):

- Portion of upper Butte Creek area north of Lassen Park. (southern McArthur Fault)
- Generally the Hat Creek Rim area including portions of Cassel. (Hat Creek Fault)
- Portions of the Day Bench area. (Pittville Fault)
- Eastern portions of Fall River Valley including eastern McArthur. (McArthur Fault)
- Portions of Long Valley north of Burney. (Rocky Ledge Fault)
- East of Johnson Park. (Rocky Ledge Fault)

This northeastern area of the County is part of a slightly larger area between Lassen Peak and Medicine Lake volcano (in Siskiyou County) which is cut by a series of active normal faults. These faults form high, steep scarps called "rims" where they offset Pliocene and early Pleistocene volcanic rocks. The largest of these, the Hat Creek Rim, is more than 25 miles long and 1,600 feet high. [1]

The CDMG is also conducting research on the extent and significance of a series of "thrust" faults recently discovered in the extreme southwest portion of the County in areas of sedimentary shelf rocks located at the eastern base of the Coast Range in the Sacramento Valley.

Development proposals for critical or high density structures within a half mile of any fault which is identified as needing a special geologic hazard study by the CDMG Earthquake Fault Zone Maps should include this information with the proposal's application. Critical or high density structures may include hospitals, schools, power plants, dams, administrative/office buildings, or high density apartment buildings. Such a study should be performed by a registered geologist according to the general guidelines of the California Division of Mines and Geology. As more detailed geologic investigations are completed, the data should be reviewed and incorporated into the General Plan.

Ground Shaking and Failure

Ground shaking is the most hazardous effect of earthquakes because it is the most widespread and accompanies all earthquakes. The largest losses of life and property during an earthquake are due to structure failure caused by violent ground shaking and resulting ground failures. Ground shaking can be described as ranging from high to low intensity. Higher magnitude earthquakes generally produce higher shaking intensities over wider areas which may result in greater damage. This is reflected in the Modified Mercalli intensity ratings.

Shasta County has a low level of historic seismic activity. In the past 120 years there has been no significant property damage or loss of life due to earthquakes occurring within or near the County. Maximum recorded intensities have reached Modified Mercalli VII, with possibly one instance of Modified Mercalli VIII. Most of the stronger intensity seismic activity in Shasta County has occurred in the eastern half of the County around Lassen Peak.

The maximum intensity event expected to occur in eastern Shasta County is Modified Mercalli VIII. In the less seismically active western half of Shasta County, the maximum intensity is expected to be Modified Mercalli VII (see Figure SG-1). Shasta County is entirely within Seismic Zone 3 of the Uniform Building Code. Redding is referred to as an area of “moderate seismicity” and the Hat Creek and McArthur areas are referred to as areas of “moderate-to-high seismicity.”

Various processes are grouped within the general phenomenon called ground failure. These include seismically induced landslides, liquefaction, lateral spreading and slumping, settlement, and lurch cracking. All of these involve a displacement of the ground surface due to loss of strength or failure of the underlying materials during earthquake shaking.

Landslides occur throughout Shasta County, although they have not been considered a major problem. Landslides are more prevalent in the eastern and northern portions of the County and are commonly related to the sedimentary and volcanic rocks in these vicinities. In the Whitmore Quadrangle mapped by G.A. MacDonald and P.A. Lydon, 1972, slumping and landsliding were widespread and attributed to poorly consolidated sedimentary rocks overlain by massive volcanic rocks. This type of instability has occurred in the Montgomery Creek Formation, in mudflow deposits of the Tuscan Formation, and in the sedimentary rocks of the Chico and Red Bluff Formations. Landslides in the western portion of the County are not as widespread, but occur in areas of sedimentary and volcanic rocks. Seismically-induced landsliding is not considered a significant hazard in Shasta County.

Liquefaction is the temporary transformation of a loose, saturated, granular soil from a solid into a semi-liquefied state, usually as a result of earth shaking. Liquefied soil behaves like a fluid. This phenomenon is most likely to occur in alluvial (geologically recent, unconsolidated sediments) and stream channel deposits, especially when the groundwater table is high. Areas of potential liquefaction are located in the north central valley area referred to in this report as the South Central Region (SCR). Further information regarding liquefaction can be obtained by referring to the California Mines and Geology Special Publication 117, "Guidelines for Evaluating and Mitigating Seismic hazards in California", (1997).

The Seismic Hazards Assessment for the City of Redding, completed in 1995, includes maps of the potential liquefaction areas within the City's sphere of influence, which includes unincorporated areas of the County. The Assessment recommends that where areas of liquefaction potential are anticipated, site specific investigations regarding liquefaction potential should be made.[2]

Damage in Shasta County resulting from earthquakes would most likely be from ground shaking and related ground failure. The effects of ground shaking and ground failure are best mitigated by adequate geotechnical investigations of specific sites, and by adequate design for the maximum credible earthquake for Shasta County.

Shasta County has adopted the Uniform Building Code, which establishes building requirements for all new structures based on predicted earthquake intensities. The risk of loss of life and property damage due to seismic activity is minimal if the Uniform Building Code is enforced.

The Seismic Hazards Assessment for the City of Redding states "... the UBC (Uniform Building Code) generally provides conservative ground motion criteria for the design of new buildings and structures. ... the probability is small that the UBC [design standard] will be exceeded." However, the Assessment also states that some structures on alluvial deposits and soft rock could experience peak horizontal accelerations greater than those anticipated in the UBC and, therefore, recommends that site specific seismic hazard evaluations be performed for critical facilities.

The Seismic Hazards Mapping Act (California Public Resources Code Section 2690 et seq.) became effective April 1, 1991. Under this act, the State Geologist will eventually map seismic hazards in certain areas of the County, including liquefaction hazard zones and earthquake-induced landslide hazard zones. Shasta County is required to comply with the requirements of the act when the Seismic Hazards Maps for the County are completed and become available.

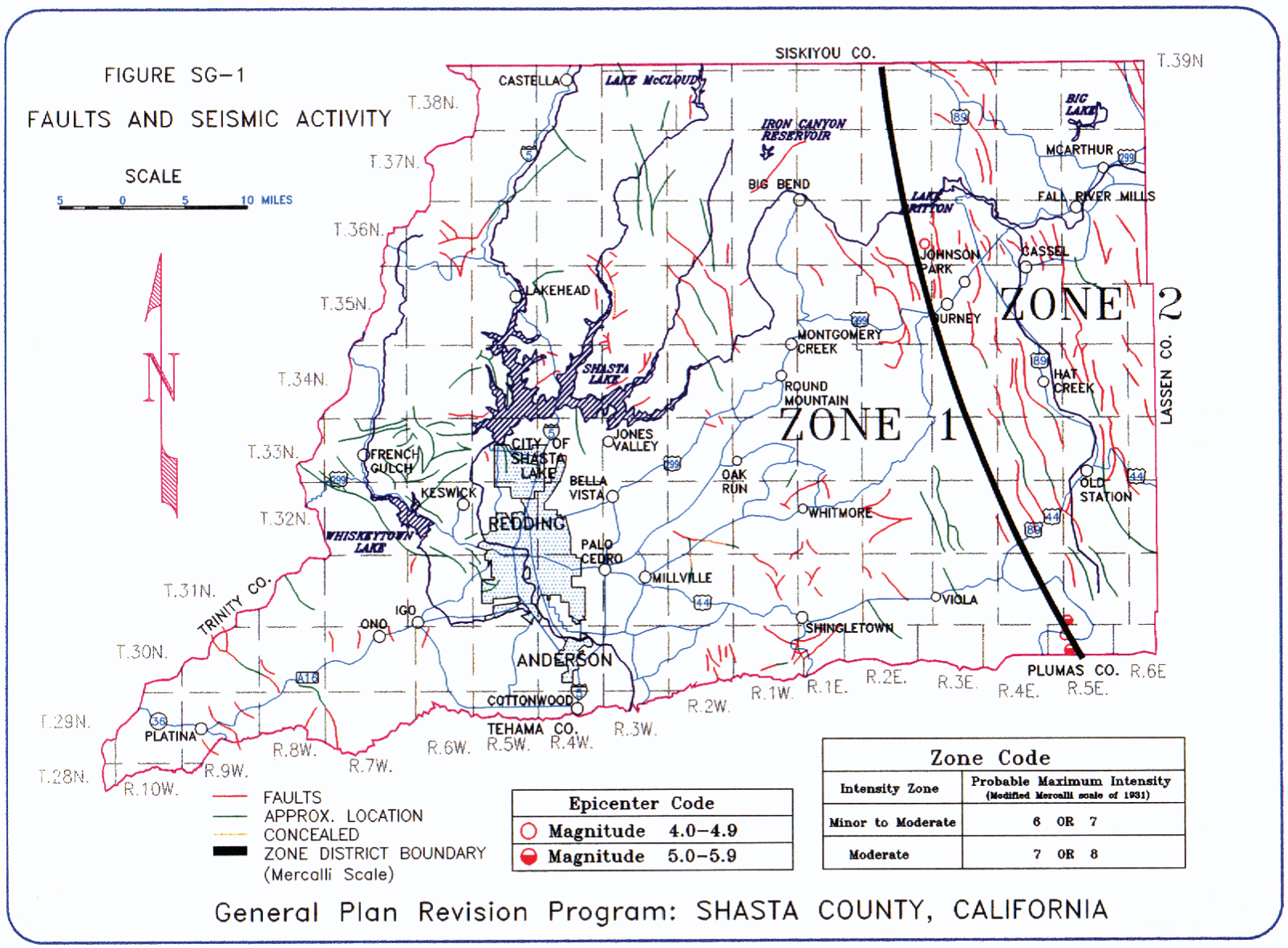
FIGURE SG-1
FAULTS AND SEISMIC ACTIVITY
SCALE
5 0 5 10 MILES
N
SISKIYOU CO.
T.39N
T.38N.
T.37N.
T.36N.
T.35N.
T.34N.
T.33N.
T.32N.
T.31N.
T.30N.
T.29N.
T.28N.
R.10W.
R.9W.
R.8W.
R.7W.
R.6W.
R.5W.
R.4W.
R.3W.
R.2W.
R.1W.
R.1E.
R.2E.
R.3E.
R.4E.
R.5E.
R.6E
CASTELLA
LAKE McCLOUD
IRON CANYON RESERVOIR
BIG BEND
BIG LAKE
MCARTHUR
FALL RIVER MILLS
LAKE BRITTON
JOHNSON PARK
CASSEL
BURNEY
ZONE 2
LASSEN CO.
LAKEHEAD
SHASTA LAKE
MONTGOMERY CREEK
ROUND MOUNTAIN
HAT CREEK
ZONE 1
JONES VALLEY
CITY OF SHASTA LAKE
FRENCH GULCH
KESWICK
BELLA VISTA
OAK RUN
OLD STATION
WHITMORE
REDDING
WHISKEYTOWN LAKE
PALO CEDRO
MILLVILLE
VIOLA
TRINITY CO.
IGO
ONO
SHINGLETOWN
ANDERSON
PLUMAS CO.
COTTONWOOD
TEHAMA CO.
PLATINA
FAULTS
APPROX. LOCATION
CONCEALED
ZONE DISTRICT BOUNDARY
(Mercalli Scale)
Epicenter Code
Magnitude 4.0-4.9
Magnitude 5.0-5.9
Zone Code
Intensity Zone
Probable Maximum Intensity
(Modified Mercalli scale of 1931)
Minor to Moderate
6 OR 7
Moderate
7 OR 8
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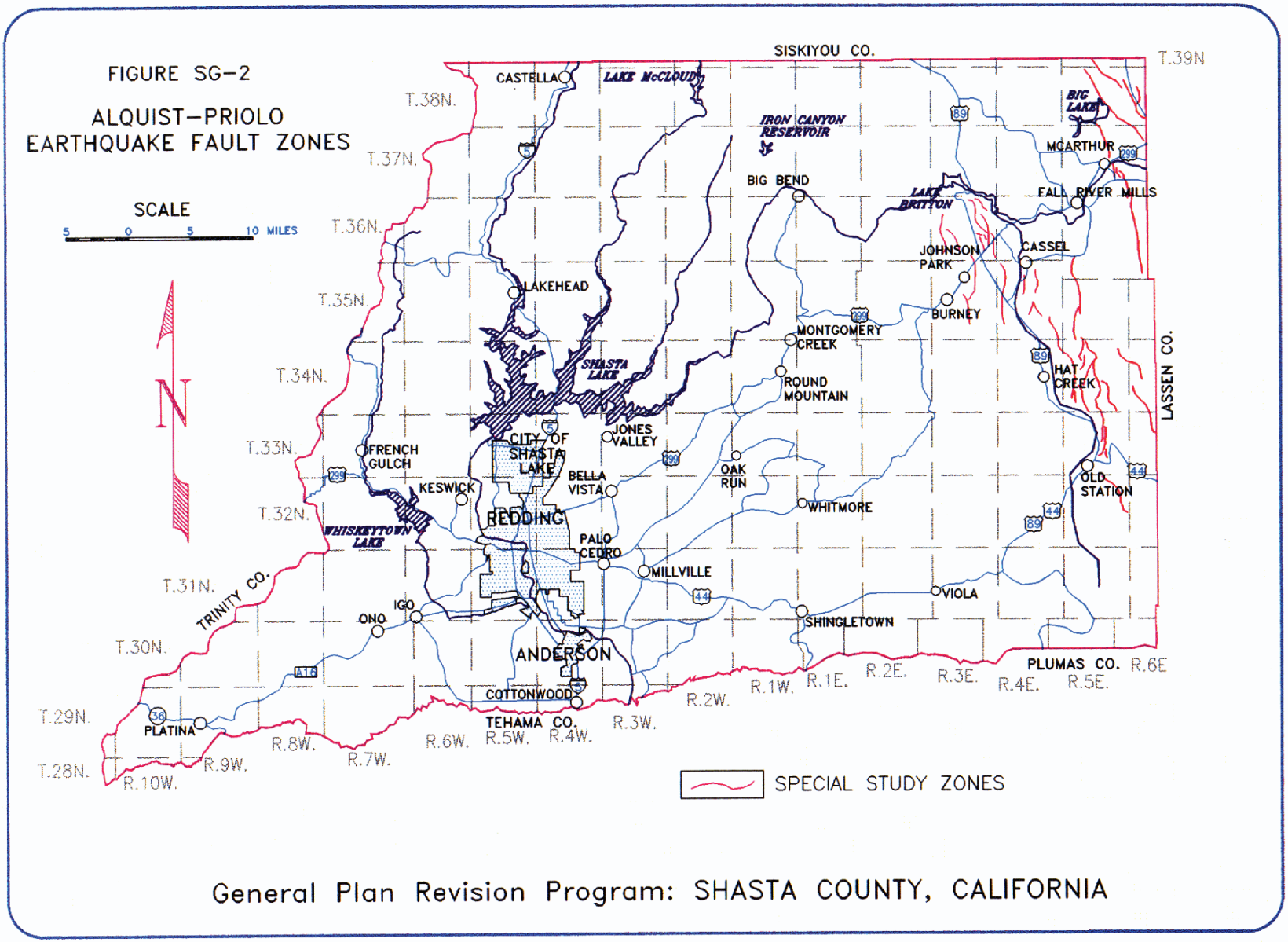

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Non-Seismic Hazards

Volcanoes

Shasta County is at the southern end of the Cascade Range, an active volcanic chain that extends northward into British Columbia. As the recent history of Mt. St. Helens indicates, the Cascades are still young and active. The most recent volcanic activity in Shasta County was in 1914-1917, when eruptions of Lassen Peak produced lava flows on the flank of the crater, numerous ash falls, and a large mudflow. The mudflow, a result from melting snow and ash, moved down Lost Creek and Hat Creek. Several days after the mudflow, a nuee ardente, or "hot cloud", which is a mass of incandescent ash and gas, flowed down the same creeks and covered a wider area. The only indications remaining of previous volcanic activity are hot springs and fumaroles (gas vents) and occasional small magnitude earthquake swarms below the mountain.

Hot springs and fumaroles are present on Mt. Shasta, though there is no evidence of recent historic volcanic activity. As with Lassen Peak, the danger from volcanic activity on Mt. Shasta may not necessarily be from an eruption but from mudflows. Historic mudflow maps indicate that some mudflows have traveled more than 18 miles down the flanks of Shasta. While the potential is there, it is doubtful that even a large mudflow from Mt. Shasta would endanger Shasta County, except in the case where a significant event occurred when Shasta Lake was completely full and spilling water for flood control.

Most of the eastern half of Shasta County is downwind from relatively active and explosive volcanoes and about 75 to 80 percent of ash from these volcanoes would be expected to fall within these areas.

About 300 years ago within Lassen National Park, a rockfall avalanche occurred in Chaos Crags, an area of dacite lava domes. A recent study by the U.S. Geological Survey found that the potential for rockfall avalanches still exists, and they could happen with little or no warning.

The U.S. Geological Survey and the State of California monitor Lassen Peak and Mt. Shasta using seismometers and tiltmeters. With this system established, there would be sufficient warning of renewed volcanic activity to evacuate the immediate vicinity of the mountain.

Erosion

Erosion generally involves the removal of earth materials from one area with deposition in another, and is a normal and inevitable geologic process. Erosion can be concentrated, as when land surfaces are gullied and stream banks are undercut, or it can be spread widely by sheetwash and slope denudation. Excessive erosion will cause sedimentation and can damage or destroy waterway and riparian habitat, clog drainage structures, lakes and reservoirs, and floodplains. Activities by people, such as grading, frequently accelerate erosion and sedimentation.

Extra special erosion concerns are found whenever development activities are proposed in soils containing parent materials of decomposed granite. Once disturbed, decomposed granite soils are very difficult to restabilize and offer very poor nutritional support for reestablishment of vegetative cover. A significant band of decomposed granite soils is located west of the Redding area from west of Shasta Dam south to Clear Creek, as shown in Figure SG-3. Special development and erosion control practices are needed whenever soil disturbing activities are proposed in these areas.

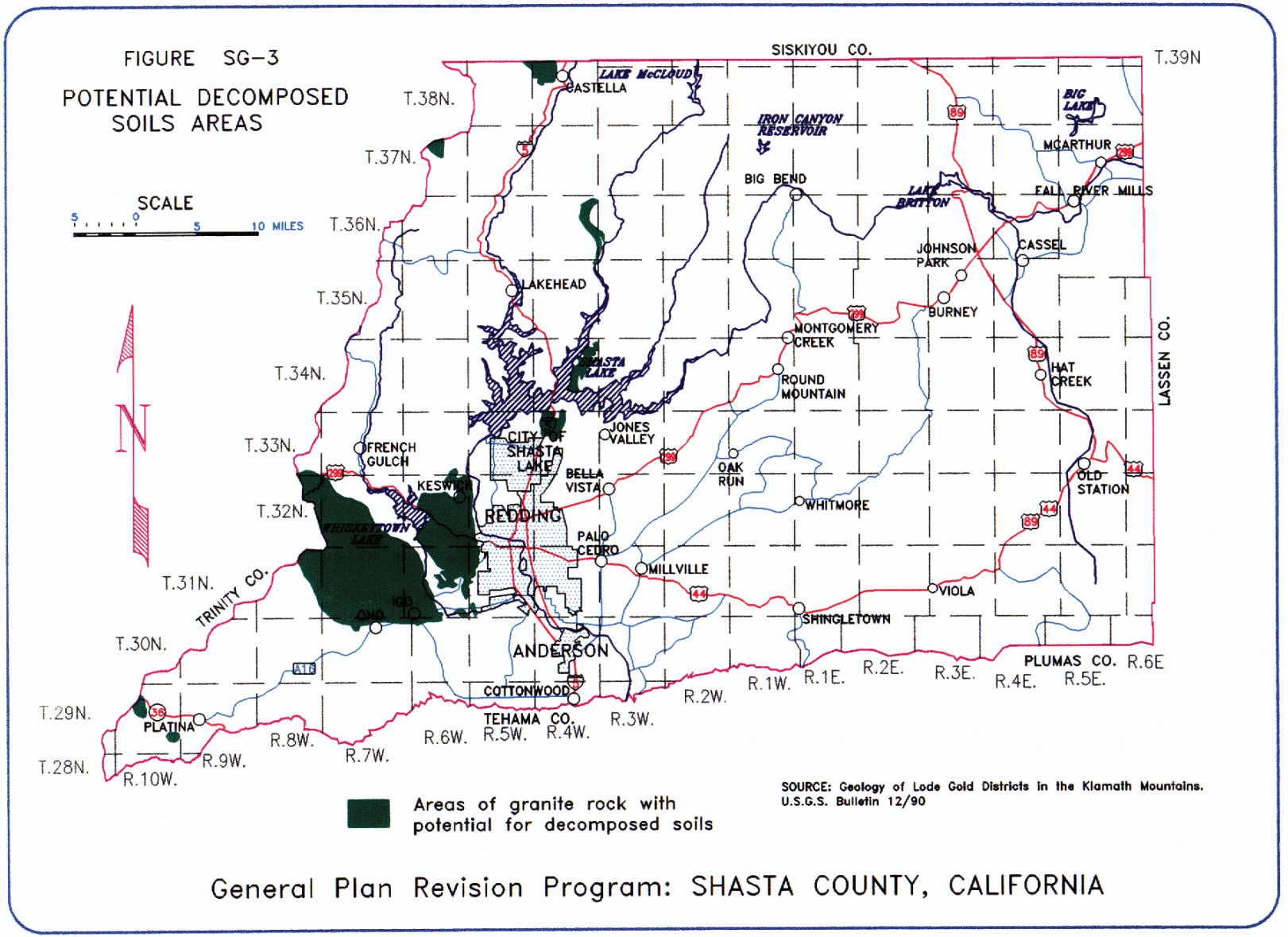
Readers interested in more detailed erosion control techniques and methods should review the Shasta County Erosion Control Study (CH2M Hill, 1980) and Erosion and Sediment Control Handbook (Goldman, 1986).

The Shasta County Erosion Control Study presents a set of guidelines for the preparation of an erosion and sedimentation control plan for a particular project. Also included are detailed appendices describing the use of these guidelines and specific control methods. These erosion and sediment control reference materials should be utilized by the County while developing a set of guidelines to assist the public in implementing the County Grading Ordinance.

Since adoption of the General Plan in 1984, considerable rural residential development has occurred in some of the County's steeper and highly erodible hillsides, particularly west of Redding. As a result, several area creeks, and most notably Middle Creek, have been subject to serious degradation as a result of large volumes of sediment eroding from disturbed hillsides in the watershed. In response, the County should implement special development standards for hillside areas where highly erodible soils may have significant sediment impact off-site. These standards should be comprehensive and address other resource and public safety concerns that are often faced in the County's hillside areas.

Expansive Soils

Some soils have a potential to swell when they absorb water and shrink when they dry out. These expansive soils generally contain clays that expand when moisture is absorbed into the crystal structure. Most of Shasta County is characterized by moderately expansive soils with areas of low expansiveness in the South Central Region and southeastern corner of the County. Small scattered areas of highly expansive soils occur in the mountains of the Western Upland, French Gulch, and North East Shasta County Planning Areas. This hazard is identifiable through standard soil tests. Its effects on structures can be mitigated through the requirement of proper engineering design and standard corrective measures.



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5.1.3 Objectives

SG-1 Protection of all development from seismic hazards by developing standards for the location of development relative to these hazards; and protection of essential or critical structures, such as schools, public meeting facilities, emergency services, high-rise and high-density structures, by developing standards appropriate for such protection.

SG-2 Protection of development on unstable slopes by developing standards for the location of development relative to these hazards.

SG-3 Protection of development from other geologic hazards, such as volcanoes, erosion, and expansive soils.

SG-4 Protection of waterways from adverse water quality impacts caused by development on highly erodible soils.

5.1.4 Policies

SG-a Development proposals for critical or high density structures, as defined in the Uniform Building Code, located within a half mile of any fault identified as an Earthquake Fault Zone by the California Division of Mines and Geology shall include a geologic study of potential fault rupture. Geologic studies which are undertaken shall be performed by a registered geologist according to general guidelines of the California Division of Mines and Geology. Proposals for critical structures, as defined in the Uniform Building Code, within the study area shall include a site-specific seismic hazards evaluation, including ground motion criteria for the design of new buildings and structures.

SG-b In order to minimize development that would be endangered by landslides, geological investigations by a registered geologist or a geological engineer will be required on all subdivision and/or developments where the preliminary staff report indicates the possibility of landslides on or adjacent to the development. A landslide map shall be developed and maintained as these reports are accumulated for reference by the development sponsors.

SG-c Shasta County shall coordinate with State and Federal agencies monitoring volcanic activity and shall periodically review and update the Shasta County Emergency Plan with respect to volcanic hazards.

SG-d Shasta County shall develop and maintain standards for erosion and sediment control plans for new land use development. Special attention shall be given to erosion prone hillside areas, including those with extremely erodible soils types such as those evolved from decomposed granite.

SG-e When soil tests reveal the presence of expansive soils, engineering design measures designed to eliminate or mitigate their impacts shall be employed.

SG-f Shasta County shall pursue preparation of development standards based on topography and soil erosion potential in revising its land capability standards pursuant to Policy CO-h.

SG-g Shasta County should comply with the requirements of the Seismic Hazards Mapping Act, when the Seismic Hazards Maps for the County are completed and made available by the State Geologist. The Maps will include liquefaction hazard zones and earthquake-induced landslide hazard zones.

Footnotes:

1. Further information on active faults in Northeastern Shasta County is found in the article entitled "Active Faults North of Lassen Volcanic National Park, Norther California", California Geology, California Department of Conservation-Division of Mines and Geology, March, 1991.

2. Seismic Hazards Assessment for the City of Redding, California, prepared for Development Services Department, City of Redding, July 6, 1995, by Woodward-Clyde Federal Services, Oakland, California.