

4.5 GEOLOGY, SOILS AND SEISMICITY

This section summarizes information on geology, soils and seismic hazards, and mineral resources in the Truckee area, as well as potential area-wide geologic hazards and regional seismic characteristics that are relevant to development within this area. An evaluation of the impacts of adoption and implementation of the 2025 General Plan with regard to these potential hazards and resources follows.

A. Existing Setting

1. Regulatory Setting

The State of California has established a variety of regulations and requirements related to seismic safety and structural integrity, including the California Building Code, the Alquist-Priolo Earthquake Fault Zoning Act, and the Seismic Hazards Mapping Act.

a. California Building Code

The California Building Code (CBC) is included in Title 24 of the California Code of Regulations and is a portion of the California Building Standards Code. Under State law, all building standards must be centralized in Title 24 or they are not enforceable. The CBC incorporates the Uniform Building Code, a widely adopted model building code in the United States.

Through the CBC, the State provides a minimum standard for building design and construction. The CBC contains specific requirements for seismic safety, excavation, foundations, retaining walls, and site demolition. It also regulates grading activities, including drainage and erosion control.

Truckee enforces the CBC through its Municipal Code. The Town Building Code (Truckee Municipal Code, Title 15) incorporates the State Building Codes including recent changes.

b. Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Zones Act¹ was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The main purpose of the Act is to prevent the construction of buildings used for human occupancy on top of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards.²

The law requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones or Alquist-Priolo Zones)³ around the surface traces of active faults, and to issue appropriate maps. The maps are distributed to all affected cities, counties, and State agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones and there can generally be no construction within 50 feet of an active fault zone.⁴

As of May 1, 1999, the California Geologic Survey did not list the Town of Truckee on its list of cities affected by Alquist-Priolo Earthquake Fault Zones.⁵

c. Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically-induced landslides. Under the Act, seismic hazard zones are to be mapped by the State Geologist to assist local governments in land use planning. The Act

¹ Called the *Alquist-Priolo Special Studies Zones Act* until renamed in 1993.

² California Geological Survey, Alquist-Priolo Earthquake Fault Zones, <http://www.consrv.ca.gov/CGS/rghm/ap/>, accessed January 31, 2006.

³ Earthquake Fault Zones are regulatory zones around active faults. The zones vary in width, but average about one-quarter mile wide. <http://www.consrv.ca.gov/cgs/rghm/ap/index.htm>, accessed January 31, 2006.

⁴ California Geological Survey, Alquist-Priolo Earthquake Fault Zones, <http://www.consrv.ca.gov/CGS/rghm/ap/>, accessed January 31, 2006.

⁵ <http://www.consrv.ca.gov/CGS/rghm/ap/affected.htm>, accessed on January 31, 2006.

states that “it is necessary to identify and map seismic hazard zones in order for cities and counties to adequately prepare the safety element of their general plans and to encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety.” Section 2697(a) of the Act states that: “cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard.”⁶ Nevada County has not been mapped under the Seismic Hazards Mapping Act yet since the State has prioritized higher risk areas, such as the San Francisco Bay Area and the Los Angeles/Riverside areas.

2. Soils and Geology

a. Soils

Much of the soil underlying the Town of Truckee consists of glacial till, moraines and outwash. These soils, which can be described as silty/sandy gravels or gravelly/silty sands contain large quantities of sediments that were transported to the Truckee Basin from the crest of the Sierra Nevada by glacial activity. Past glacial activity has also resulted in the deposition of cobbles and boulders in the Basin. Soil depths typically range from 20 to 60 inches.⁷

An inventory of soils can be used to help identify potential geotechnical concerns, such as areas where soil types are especially susceptible to erosion and expansion. Identifying local soil types and understanding the associated characteristics helps cities and towns establish appropriate engineering and construction standards for new building and remodeling.

The potential for soil erosion in any location is largely determined by the soil type and its susceptibility to erosion, slope, and degree of exposure to

⁶ California Public Resources Code, Division 2, Chapter 7.8, Article 7.8, Section 2691(c), <http://www.consrv.ca.gov/cgs/codes/prc/chap-7-8.htm>, accessed on January 31, 2006.

⁷ Old Greenwood Planned Development, Draft EIR, Pacific Municipal Consultants, February 2002.

weather, especially wind and rain. Erosion of soils in Truckee that could result in a significant loss of topsoil and adversely affect development would largely depend on the location of that development, the properties of underlying soils, the extent of vegetative cover, and the prevailing weather patterns.

Expansive soils contain higher levels of clay and present hazards for development since they expand and shrink depending on water content and may damage structures that are appropriately engineered. Since all of the soils in the Truckee area are mainly comprised of sand, they pose a very low risk of expansion.

Each of the soil types found in Truckee has properties that may affect development of a particular site. Limitations to development due to soil type can range from slight (soil properties are favorable for the specified use; any limitation is minor and easily overcome) to severe (soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design or intensive maintenance is required). Truckee has no soil types that create severe development limitations that could not be addressed through appropriate engineering techniques. Despite this, an important part of the planning approval process is to ensure that appropriate soil studies and engineering are carried out prior to development to ensure that soil-type limitations are adequately addressed.

b. Geology

The Town of Truckee is located in the northern portion of the Sierra geologic province. The northern Sierra Nevada mountain range is subdivided into three main geologic complexes which are regions of distinct rock types, topography, and structure that were defined by the primary mountain building episodes of the Sierra Nevada Range. The Truckee Basin, in which the Town of Truckee is located, lies within the eastern most complex of the Sierra Nevada range. The basin is located between two north-trending mountain ranges, the 9,000-foot-high Sierra Nevada on the west and the 10,000-foot-high Carson Range on the east.

The bedrock of the Truckee Basin is primarily defined by Triassic (230 to 190 million years ago) and Jurassic (190 to 135 million years ago) metamorphic rock and includes granite intrusions associated with the Sierra Nevada range. These rocks are consolidated, very dense and hard, with small grain structure and little capacity for water storage. On top of the bedrock is a late Tertiary (from 63 million to two million years ago) sequence of volcanic flows, glacial deposits, and stream and lake deposits. The structure of the deposits is nearly horizontal beds of mostly unconsolidated volcanic material and sedimentary material.⁸ Sedimentary material is generally very porous and stores large amounts of ground water.

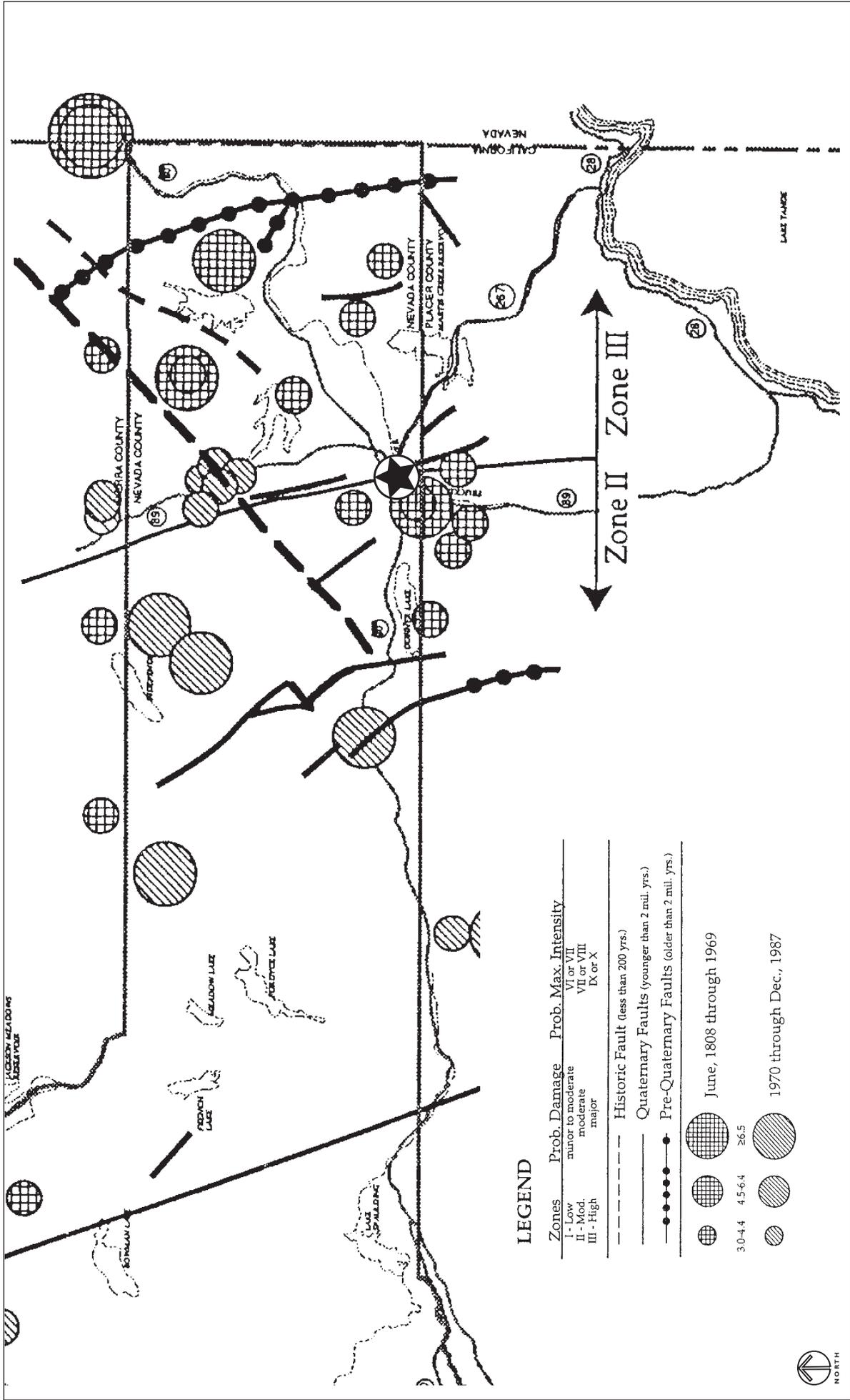
c. Seismic Setting

Faults located near Truckee include the Mohawk Valley Fault, the southern section of which lies approximately 20 miles northwest of Truckee in Sierra County, and the Dog Valley Fault, which extends in from Dog Valley (approximately 20 miles northeast of Truckee) southwest to near Donner Lake. Several small trace faults are also located within the Town limits. None of these faults are designated as Alquist-Priolo Special Study Zones, which identify fault areas considered to be of greatest risk in the state. A 1986 study by the California Bureau of Reclamation concluded that the Mohawk Valley and Dog Valley Faults could result in a maximum credible earthquake of 7.0 and 6.75 magnitude respectively.

There has been seismic activity in Truckee in recent years, including a magnitude 6+ earthquake in 1966, a magnitude 3.6 earthquake in 1998, and a magnitude 4.5 earthquake, centered six miles south of Truckee, in June, 2004.⁹ Figure 4-5.1 shows the location of known earthquake faults and epicenters in Nevada County.

⁸ Old Greenwood Planned Development, Draft EIR, Pacific Municipal Consultants, February 2002.

⁹California Integrated Seismic Network.



LEGEND

Zones	Prob. Damage	Prob. Max. Intensity
I - Low	minor to moderate	VI or VII
II - Mod.	moderate	VII or VIII
III - High	major	IX or X

--- (dashed line)	Historic Fault (less than 200 yrs.)
— (solid line)	Quaternary Faults (younger than 2 mil. yrs.)
—••••• (solid line with dots)	Pre-Quaternary Faults (older than 2 mil. yrs.)

⊗ (circle with cross-hatch)	June, 1808 through 1969
⊙ (circle with dots)	30-44 45-64 ≥65
⊘ (circle with horizontal lines)	1970 through Dec., 1987



FIGURE 4.5-1

EARTHQUAKE FAULTS AND SEISMIC ACTIVITY IN NEVADA COUNTY

Source: Nevada County General Plan Master Environmental Assessment



d. Seismic Hazards

While Truckee has a relatively low risk of seismic hazard when compared to the rest of California, the Town is surrounded by seismically active regions and will on occasion experience earthquakes. As illustrated in Figure 4.5-1, there are no faults within the Town's boundary, however there are faults in close proximity to the boundary. The Town of Truckee and its Sphere are subject to three principal earthquake-related seismic hazards: ground shaking, liquefaction, ground rupture. These seismic hazards can cause damage to structures and put the health and safety of citizens at risk.

i. *Ground Shaking*

The faults in the Truckee region are capable of generating earthquakes of significant magnitude on the Richter Scale, potentially producing ground shaking in the Town of Truckee. Earthquake ground shaking is the source of the most widespread earthquake damage. The intensity of ground shaking can be several times larger on sites underlain by thick deposits of saturated sediments than on bedrock. The amount of ground shaking at a particular site depends on:

- ◆ Characteristics of the earthquake source (magnitude, location, and area of causative fault surface).
- ◆ Distance from the fault.
- ◆ Amplification effects of local geologic deposit.

ii. *Liquefaction*

Liquefaction is a phenomenon primarily associated with saturated, cohesionless soil layers located close to the ground surface. During liquefaction, soils lose strength and ground failure may occur. The California Department of Conservation has not mapped the Town of Truckee to identify the potential for soil liquefaction. However, as granular soils must be saturated to be at risk of liquefaction, the areas in the Town most susceptible to liquefaction include areas along the Truckee River and where there are higher groundwater levels.

iii. Ground Rupture

As there are no faults in direct proximity to the Town, and Truckee is not within an Alquist-Priolo designated zone, the risk of seismically-induced ground rupture is low.

3. Slope Stability Hazards

This section describes the possible threats from slope stability hazards such as land subsidence, landslides and ground failure.

a. Land Subsidence

Land subsidence, or settlement, is a slow-to-rapid downward movement of the ground surface that can be caused by a variety of factors. Typically, significant subsidence occurs only in areas underlain by soft soils such as marsh deposits or in areas susceptible to liquefaction. Because the sedimentary soils underlying the Town of Truckee are not susceptible to liquefaction, the risk of land subsidence is considered to be low.

b. Landslides and Ground Failure

Some of the natural causes of landslides or ground failure are earthquakes, weak materials, stream and coastal erosion, and heavy rainfall. In addition, certain human activities tend to make earth materials less stable and increase the chance of ground failure. Activities contributing to instability include extensive irrigation, poor drainage or ground-water withdrawal, removal of stabilizing vegetation and over-steepening of slopes by undercutting them or overloading them with artificial fill. These causes of ground failure, which normally produce landslides and differential settlement, are augmented during earthquakes by strong ground motion.

Steep slopes of thirty percent or greater, limit development in several areas of Town, including some places along the Truckee River; the ridges and hillsides north and west of Downtown; the ridges north of Gateway and north and west of Donner Lake; and areas around Alder Hill. These steep slope areas, particularly where they occur in conjunction with weak soils, may present a

significant landslide or ground failure hazard, although no detailed study has been completed to assess the extent of landslide hazards in Truckee.

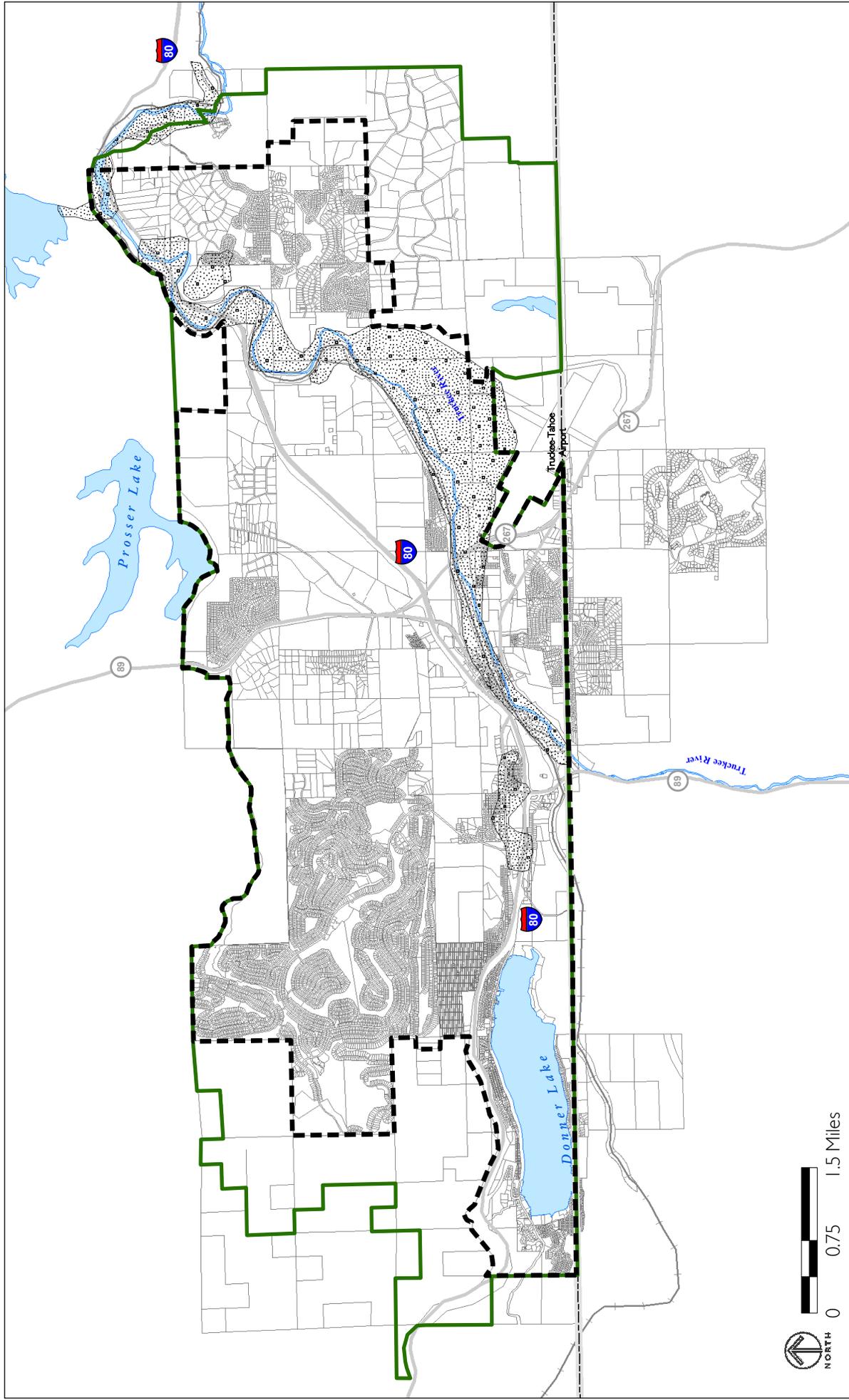
4. Mineral Resources

A number of important mineral resource areas (as defined by the State of California) exist in Truckee; their locations are mapped in Figure 4.5-2. As shown in the figure, these resources are generally associated with alluvial deposits along the length of the Truckee River Valley, although some mineral resources are associated with volcanic features, such as the Hirschdale cinder cone. Alluvial aggregates consist of gravel, sand and broken stone that are used in production of concrete and asphalt; cinders are also used for building and road construction materials. State law requires that the General Plan include policies for important mineral resource areas that address the conservation and development of identified mineral deposits, balance the value of these deposits against competing land uses, and minimize the impacts of mining activities.

B. Standards of Significance

The proposed project would have a significant impact if it 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.
 - Landslides, mudslides or other similar hazards.
- ◆ 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.
- ◆ Result in substantial soil erosion or the loss of topsoil.



Source: California Division of Mines and Geology, Mineral Classification Report for Nevada County, 1990

FIGURE 4.5-2

-  Important Mineral Resources
-  Truckee Town Limits
-  Proposed Sphere of Influence

- ◆ Be located on expansive soil, creating substantial risks to life or property.
- ◆ Have soils incapable of adequately supporting the use of septic tanks or alternative waste water 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 the residents of the state.
- ◆ Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan.

C. Impact Discussion

The following provides an analysis of the 2025 General Plan and its relationship to various seismic and geological hazards, as well as mineral resources.

1. Seismic Hazards

As discussed previously, the risk of ground rupture is less than significant since Truckee is not within a Alquist-Priolo Zone. However, recognizing that there is still a risk to the town from primary and secondary seismic hazards, the Safety Element in the 2025 General Plan includes several policies and actions intended to minimize this risk. For example, Policy P1.1 in the Safety Element calls for locating new residential development in such a way as to avoid areas of hazard including steep slopes and areas of unstable soils. Policy P1.2 encourages the retrofitting of structures, particularly older buildings, to withstand earthquake shaking and landslides, and adhering to design and engineering techniques that minimize the risk of damage from seismic events and land sliding. Furthermore, Policy P1.3 requires that soils reports be completed for new development in areas where geologic risks are known to exist and that these reports include recommendations for appropriate engineering and other measures to address identified seismic risks.

In addition to policies and actions regarding new or existing development, the 2025 General Plan also includes policies and actions to ensure the Town's ability to respond effectively to natural emergencies such as earthquakes. Safety Element Policy 7.2 calls for the support of the efforts of the Truckee Fire Protection District, Nevada County Office of Emergency Services, and other agencies to educate the public about emergency preparedness and response. In addition, Safety Element Action 7.1 requires the Town to coordinate with emergency response agencies to develop an Emergency Response Plan for Truckee that includes response measures for earthquakes and other events that could threaten public safety.

As a result of the policies and actions included in the 2025 General Plan, the potential impacts associated with seismic hazards would be reduced to a *less than significant* level.

2. Soil Conditions

As discussed previously, steep slopes of thirty percent or greater exist in several areas of town. These steep slope areas, should they be underlain by weak soils, may present a significant hazard in Truckee in terms of potential landslides. Liquefaction, expansion, and soil erosion are other possible risks associated with weak soils that could jeopardize the safety of the public. As discussed in Section 4.7 of this EIR, Hydrology and Water Quality, soils are especially susceptible to erosion when exposed as a result of construction activities such as clearing and grading.

There are policies contained in the 2025 General Plan Safety Element that would ensure that the hazards associated with soil conditions would be reduced to a *less than significant* level. As mentioned above, Policies P1.1 and P1.3 require consideration of the location of new residential development in relation to steep slopes and areas of unstable soils and that soils reports be completed for new development in areas where geologic risks are known to exist and that these reports include recommendations for appropriate engineering and other measures to address identified seismic risks.

As a result of these policies, the risks associated development occurring under the 2025 General Plan in regard to soils conditions would be *less than significant*.

3. Mineral Resources

The 2025 General Plan could result in a significant impact if it would result in the loss of availability of a mineral resource identified as being of local or statewide importance. This could occur if development were permitted that created land use incompatibilities with mining operations or otherwise precluded access to mineral resource areas. Active mining operations are currently limited to the aggregate mining area in the far southeast part of Truckee. The 2025 General Plan assigns the Public land use designation to these lands, which would generally not permit sensitive land uses such as residential development to occur in these areas.

The 2025 General Plan would also seek to reduce incompatibilities between sensitive land uses (e.g. residential developments) and the development of mineral resources, while fostering future development of such resources as an important component of the town's economy.

Goal COS-6 in the 2025 General Plan is to protect economically viable mineral resources and related industries in Truckee while avoiding land use conflicts and environmental impacts from mining activities. There are several policies and actions in support of this. For example, Policy 6.1 calls for the recognition, acceptance, and adoption by reference those State Classification Reports that provide information on the location of significant mineral deposits in and around Truckee. Policy P6.2 requires a restriction on uses permitted on lands mapped as important Mineral Resource Areas within the RC/OS land use designation to those compatible with mineral resource extraction activities. Similarly, Policy P6.3 requires a restriction on permitted uses on lands containing important mineral resources within the Public land use designation to those compatible with mineral extraction, except in cases where such uses offer public benefits that outweigh those of resource extraction. Policy 6.4 sets forth five guidelines related to new development or ex-

pansion of mining operations that are intended to minimize incompatibility between mining operations and existing land uses.

In addition, Action 6.1 requires that the Town amend the map of important mineral resources, as exhibited in Figure 4.5-2, when a new or revised Mineral Resource Classification Report is presented to the Town.

As a result of these policies and actions, potential impacts on the use and development of mineral resources would be *less than significant*.

D. Cumulative Impact Discussion

By their nature, geological and seismic impacts do not cumulate with other projects since they are site-specific. The increase in population that would result from implementation of the 2025 General Plan and other regional development would increase the number of people and structures that could be exposed to the region's known seismic hazards. Development outside of the town would be subject to similar requirements for conformance with the Uniform Building Code, which would generally reduce seismic risks to a less-than-significant level. Goals, policies, and action of the 2025 General Plan would reduce potential impacts on the development of mineral resources to a less than significant level. Cumulatively, therefore, impacts related to geology, soils and seismicity would be less than significant.

E. Impacts and Mitigation Measures

Since the implementation of 2025 General Plan would not result in *significant impacts* related to geology and soils, no mitigation measures are required.