4.4 GEOLOGY, SEISMICITY, SOILS, AND MINERAL RESOURCES

This section addresses geologic hazards in the Town of Mammoth Lakes. Topography, geology, faulting, seismicity, volcanoes, and soils are summarized as the basis for discussion of geotechnical constraints associated with implementation of the proposed General Plan Update.

4.4.1 EXISTING CONDITIONS

4.4.1.1 Regional Geology

The Sierra Nevada is the largest continuous mountain range in the contiguous United States. The range is bounded on the east by a system of normal faults, which locally produced the escarpment separating the Sierra Nevada fault block from the Owens Valley. The Owens Valley, formed on the downfaulted east side of the Sierra Nevada boundary fault system, exhibits many examples of ongoing geologic processes including lava fields, cinder cones, fault scarps, hot springs, abandoned lake shorelines, volcanic calderas, and glacial deposits.

The Town of Mammoth Lakes is located near the southwest edge of the Long Valley Caldera, which overprints the Sierra Nevada boundary fault system. Persistent earthquake and volcanic activity over the past four million years have formed the eastern Sierra landscape in the vicinity of Long Valley Caldera and the Mono Basin. The high mountains around Mammoth constitute the caldera walls with the Glass Mountains forming the west and southwest walls and the Benton Range forming the east wall. Near the center of the caldera and off to the west is a system of hills that marks the remnants of the resurgent dome (dome-shaped uplift of the caldera floor caused by volcanic or seismic activity). Mammoth Mountain is a smaller dome on the rim of the caldera formed by repeated eruptions from vents on the southwest rim of the caldera 220,000 to 50,000 years ago. The caldera and other geologic features such as Devil's Postpile, Mammoth Rock, and Crystal Crag are evidence that the region around the Town is geologically young with an active recent history.

Although much attention has been focused on the Long Valley caldera resurgent dome and on associated volcanic hazards at Mammoth Mountain, little is known about the details of the most recent (latest Pleistocene to Holocene) eruptions in the greater Long Valley caldera complex, specifically in the Mono and Inyo Craters chain. In general, activity within the resurgent dome has not been linked with the formation and later eruptions of the Mono and Inyo Craters; however, there may be evidence to connect the two.

The eruptions that created the Long Valley Caldera were fed by a large magma chamber in the shallow crust, which culminated in the cataclysmic eruption of 150 cubic miles of rhyolite 760,000 years ago. This massive eruption resulted in the 6,000 to 10,000 foot subsidence of the magma chamber roof to form the present 20-mile long and 9-mile wide oval depression of the Long Valley Caldera (USGS 1999). Despite recent activity in the resurgent dome east of Mammoth Mountain, the resurgent dome has experienced eruption only once every 100,000 to 200,000 years since the catastrophic caldera-forming event 760,000 years ago, and it last erupted roughly 50,000 years before present (B.P.). During the past 3,000 years the Mono-Inyo Craters have erupted at intervals of 700 to 250 years, the most recent eruptions being from Panum Crater and the Inyo Craters 500 to 600 years ago (Miller 1985; Bursik and Sieh 1986), and Paoha Island about 250 years ago (Stine 1990). Evidence from both seismic soundings of the crust and studies of the fabric and composition of the lava indicate that these eruptions probably originated from small, discrete magma bodies rather than from a single, large magma chamber of the sort that produced the caldera-forming eruption 760,000 years ago.

During the past 3,000 years, glaciers have formed and melted several times in the eastern Sierra. The tillites preserved in the Town represent younger Pleistocene glacial deposits including the Tahoe till, the Tioga till, and related outwash deposits of gravel and sand swept away from the glacial margins by meltwater streams.

In 1982, the United States Geological Survey (USGS) under the Volcano Hazards Program began an intensive effort to monitor and study geologic unrest in the Long Valley caldera. The goal of this effort was to provide residents and civil authorities in the area reliable information on the nature of the potential hazards posed by this unrest and timely warning of an impending volcanic eruption, should it develop. Most, perhaps all, volcanic eruptions are preceded and accompanied by geophysical and geochemical changes in the volcanic system. Common precursory indicators of volcanic activity include increased seismicity, ground deformation, and variations in the nature and rate of gas emissions.

4.4.1.2 Mineral Resources

Mineral resources in the Planning Area include industrial minerals (clay, aggregate, cinders, etc.) and precious metals associated with volcanic rocks and hot spring and geothermal activity. Figure 4.4-1 on page 4-95 depicts the distribution and extent of these resources within the Planning Area. As can be seen in Figure 4.4-1, a deposit of precious and base metals is located within the Municipal Boundary in the southern portion of the Town. A geothermal lease area is located in the northeastern portion of the Town and in the northern and central portion of the Planning Area. A deposit of aggregate and a deposit of precious metals are located in the eastern portion of the Planning Area to the north of the Mammoth-June Lakes Airport. There are no cinders within the Planning Area. Cinders used in the area are imported from Mono Basin.

Town of Mammoth Lakes

Explanation

- Planning Area
- Municipal Boundary

RESOURCE

- Aggregate
- Clay
- Geothermal Lease
- Precious Metals
- Precious and Base Metals

N

0 4,000 8,000 Meters

Base Map: Benton Range and Yosemite Valley 100k Quadrangles

Source: USFS Leases; Town of Mammoth Lakes Updated Plan, 2005

Figure 4.4-1 Mineral Resources Map

4.4.1.3 Soils

The Town is underlain by a variety of rock types, including Pliocene to Recent volcanic and pyroclastic deposits (12 million years old to less than 10,000 years old), Pleistocene glacial deposits (2.5 million to 10,000 years old), and Holocene alluvium (less than 10,000 years old). Soils are derived from these geologically recent deposits.

Soils in the Planning Area are characterized as Frigid and Cryic based on a four square mile survey, including the Town, by the USDA, Natural Resource Conservation Service (2002). The soils are typically gravelly loams with low water capacity generally developed on glacial outwash south of Mary Lake Road and on glacial moraines to the north. The soils in the survey area are sensitive to disturbances by development and have a moderate to high erosion potential, depending on the steepness of the slopes.

Soils derived from alluvial deposits are located in Sherwin Meadows, in the extreme eastern portion of the Planning Area, and north of the Mammoth Ranger Station. In general, the deepest soils are derived from water lain sediments deposited in relatively gentle terrain and are among the least erosion sensitive soils in the Planning Area.

Colluvial deposits located on the slopes of Mammoth Mountain and Mammoth Rock are generally loose unconsolidated material on slopes in excess of 30 percent. These deposits and the soils they support have moderate to high erosion and landslide potential.

4.4.1.4 Topography

The land surface of the Town rises irregularly, but gently, toward the southwest from approximately 7,910 feet amsl near the intersection of Joaquin Road and Main Street to approximately 8,070 feet amsl near Camp High off Lake Mary Road. Topographic expression ranges from level to rolling alluvial plains at about 7,200 feet amsl in Long Valley, to approximately 11,600 feet amsl at Mammoth Mountain Summit, west of Mammoth Lakes. Slope gradients in the Town range from relatively flat terrain in Sherwin Meadow and Long Valley to slopes of 50 percent or greater on Mammoth Mountain. Slopes exceeding 30 percent are found in portions of Old Mammoth (particularly the Bluffs area), Mammoth Slopes, Westridge and the Mammoth Knolls.

4.4.1.5 Volcanism

At least 30 volcanic events have occurred during the past 2,000 years in the Mono Lake Long Valley area, including at least ten eruptions in the Mono Inyo volcanic chain during the past 600 years. Actual volcanic eruptions in the vicinity of the Town have not occurred in

historic times. The most recent eruption in the region occurred in 1890 beneath the southern portion of Mono Lake, approximately 35 miles north of the Town. Another eruption occurred in approximately 1,400 A.D. within four miles of the Town at the southernmost Inyo Crater. Both eruptions were phreatic in type (i.e., they produced steam, water, mud, and other gasses and materials, as a result of ground water being heated by magma). The Mono and Inyo Craters comprise a young volcanic chain with a violent history, and there is strong evidence that another eruption in the region is very likely in the thousands of years.

Recently, the occurrence of Richter magnitude 6 earthquakes in May of 1980 initiated a new phase of magmatic activity and heightened potential for volcanic eruptions. Since the early 1980s, persistent, frequent low magnitude (Richter magnitude less than 3.0) seismic activity has indicated that magma is moving at depth. Detailed surveys indicate that the central portion of the Long Valley Caldera has risen more than 30 inches since the late 1970s, possibly in response to the filling of a shallow magma chamber. In 1990, it was recognized that magmatic gasses were killing trees in certain portions of the caldera. The trees were killed by high carbon dioxide content in the soil gasses surrounding their roots. The most well known location of high carbon dioxide soil gas is at the north end of Horseshoe Lake where scientists estimate that between 50 and 150 tons of carbon dioxide are emitted daily (USGS 2001).

4.4.1.6 Seismicity

The Mono Lake Long Valley region is part of one of the most active seismic regions in the U.S. Low and moderate magnitude earthquakes occurring within the Long Valley Caldera are felt occasionally by residents of Mono and Inyo Counties. The two main sources of earthquakes in the Mono Lakes area are tectonic and those generated by the movement of magma or the formation of cracks through which magma can move. Tectonic earthquakes occur from rapid displacement on faults as a result of regional geologic stresses. Earthquakes from magmatic activity rarely have Richter magnitudes greater than 5.0 (USGS 2000).

4.4.1.7 Geotechnical Hazards

Several types of potential geologic hazards may occur in the vicinity of the Town that could affect existing and future land uses within the Planning Area. These hazards are not all of equal severity and would not affect land uses in the Planning Area to the same extent. These potential hazards include slope instability, erosion, seismicity, and various volcanic events as discussed below.

Slope Stability Hazards

Regional Hazards: Landslides, earthslips, mudflows, and soil creeps are expressions of soil conditions related to the instabilities created by steep slopes. These conditions are also related to shallow soil development, the presence of excess water, or the lack of shear strength in the soil or at the soil/rock interface. Each of these conditions has been observed in Mono County; however, it is usually reported simply as a landslide. Earthquake activity induces some landslides, but most slides result from the weight of rain saturated soil and rock exceeding the shear strength of the underlying material. Erosion of supporting material at the foot of constructed slopes is another major cause of sliding.

Local Hazards: The moraines[16] south, west, and north of the Town are considered unstable, partly because they contain irregular deposits of clay that lack the strength to stand in steep slopes. Moraines in the center of the Town and to the east are considered generally stable, unless they are underlain by shallow groundwater because of the relatively low topography in this area. The southwest portion of the Lodestar project area has the potential for shallow groundwater; however, no groundwater was encountered in the 12 and 13 foot deep test pits dug in this area in 1976 (Lodestar Company 1991). Slope stability problems are primarily limited to steeper slopes, particularly those with significant talus accumulations. The stability of moraines in the Planning Area is variable.

Erosion Hazards

Erosion potential is variable throughout the Town. The highest erosion potential occurs in loose and/or shallow soils on steep slopes. As discussed in the Lodestar at Mammoth Final EIR, some areas consist of outwash and till including the Westridge, Mammoth Slopes, Main Street Commercial, Old Mammoth Commercial, Minaret, Meridian, Snowcreek, Sierra Valley and Gateway Planning Districts. The portions of the Town where loose, sandy soils occur are subject to erosion, when the surface area is disturbed or vegetation is removed. Under existing conditions in the Town, erosion potential of overland flow from snowmelt and rainfall runoff is reduced by ground cover, fallen leaves and needles, or the root systems of living trees.

Seismic Hazards

The Town could experience considerable seismic activity in the future due to a number of reasons that include the following: 1) a high degree of crustal faulting in the Mono Lake and Long Valley area, which may lead to the release of tectonic strain by frequent small or moderate

[16] *Moraines are the rocks and soil carried and deposited by a glacier. An "end moraine", either a ridge or low hill running perpendicular to the direction of ice movement, forms at the end of a glacier when the ice is melting.*

earthquakes; 2) the present frequent moderate earthquakes and earthquake swarms along the Sierra Front fault, which indicate the potential for a large earthquake; and 3) movement of magma beneath the caldera, which may be the cause of seismic events below the Long Valley Caldera.

The California Division of Mines and Geology has included the Town within seismic zone III in the Urban Geology Master Plan with an expected modified Mercali Rating of "IX" or "X" at maximum earthquake intensities. [The "IX" Mercali rating indicates that heavy damage to unreinforced structures would result and some structures would collapse. The "X" rating indicates that most masonry structures would be destroyed, some well built wooden structures would be destroyed, and public facilities would be damaged.]

Regional Seismic Activity: There are several active and potentially active fault zones within 60 miles of the Town. These zones include faults that are historically active (during the last 200 years), those that have been active in the Holocene (the last 10,000 years), and those that have been active at some time during the Quaternary Period (the last two million years). The Mono Lake, June Lake, and Hilton Creek faults form the northern extension of the Sierra Nevada Boundary fault system and are historically active. The southern extension of the Sierra Nevada Boundary fault system includes the main trace of the Sierra Nevada fault and the historically active Owens Valley fault. Holocene faults occur as branches within major active fault zones and as segments of other faults in Mono and Inyo Counties. The Bodie Hills, White Mountains, Death Valley Furnace Creek, and Saline Valley faults have been classified as Quaternary and display no recent offset.

Local Seismic Activity: Seismic activity in the vicinity of the Town is a result of continuing tectonic movement along the eastern front of the Sierra Nevada Mountain Range. Three historically active faults located in proximity to the Town have the greatest potential to create significant ground shaking in the Town. These faults include the Hilton Creek fault (1980 earthquake), the Owens valley fault (1972 earthquake) and the Chalfant Valley fractures (1986 earthquake). These three faults, as well as six other potentially active faults that have the potential for ground shaking within the Town, are described below. (See Figure 4.2.2; distances provided are measured from the Town.)

Hilton Creek Fault - The main shocks (Richter magnitude greater than 6.0) of the Mammoth Lakes earthquakes of May 1980 are attributed to movement on the Hilton Creek fault. At its nearest point, the Hilton Creek fault (including the northern splays) is located approximately 10 miles east of the Town. This fault has the greatest potential for ground shaking in portions of the Planning Area because of its close proximity to the Town and historic seismic activity.

In 1998 and 1999 three earthquakes with Richter magnitudes greater than 5.0 occurred on an unnamed north northeast trending fault zone west of the Hilton Creek fault. The sequence of earthquakes and their associated aftershocks appeared to propagate in a southerly direction away from the Town.

Owens Valley Fault - The Owens Valley fault is a major component of the Sierra Nevada boundary fault system. It extends from Coso Junction on the south to near Bishop on the north, a length of 56 miles. At its closest point, the Owens Valley fault is approximately 48 miles south of the Town.

Chalfant Valley Fractures - The Chalfant Valley fractures, at their closest point, are approximately 36 miles east of the Town.

Other Faults - Of the 37 active or potentially active faults within approximately 62 miles of the Town, the three historically active faults that have the greatest potential to cause seismic hazards in the Town are described above. However, six other potentially active faults that may have the potential for ground shaking in the Town include the following:

- Hartley Springs Fault (approximately four miles northwest);
- Laurel Convict Fault (approximately four miles southeast);
- Long Valley Caldera Faults (approximately two miles northwest);
- Mono Craters Caldera Faults (approximately 13 miles northwest);
- Silver Lake Fault (approximately ten miles northwest); and
- Wheeler Crest Fault (approximately 20 miles southeast).

The Long Valley Caldera lies along the Sierra Nevada Boundary fault system, overprinting the geographic and geologic boundary between the Sierra Nevada Mountain Range and the Owens Valley. Some of the faults along the western boundary of the caldera may now be considered part of the Sierra Nevada Boundary fault system and serve to link the Hilton Creek fault system to the south with the northern continuation of the Sierra Nevada Boundary fault system, the Silver Lake fault system to the north. These faults pass under Mammoth Mountain, within two miles of the Town (Figure 4.4-2 below).

Other geotechnical hazards: Other geotechnical hazards may result from seismic activity. These related hazards include surface rupture, ground shaking, landslides, liquefaction, and seiche inundation as described below.

Surface Rupture - Damage due to surface rupturing is limited to the actual location of the fault line break, unlike damage from ground shaking, which can occur at great distances from the fault. The potential for surface rupture in the Town is considered to be low.

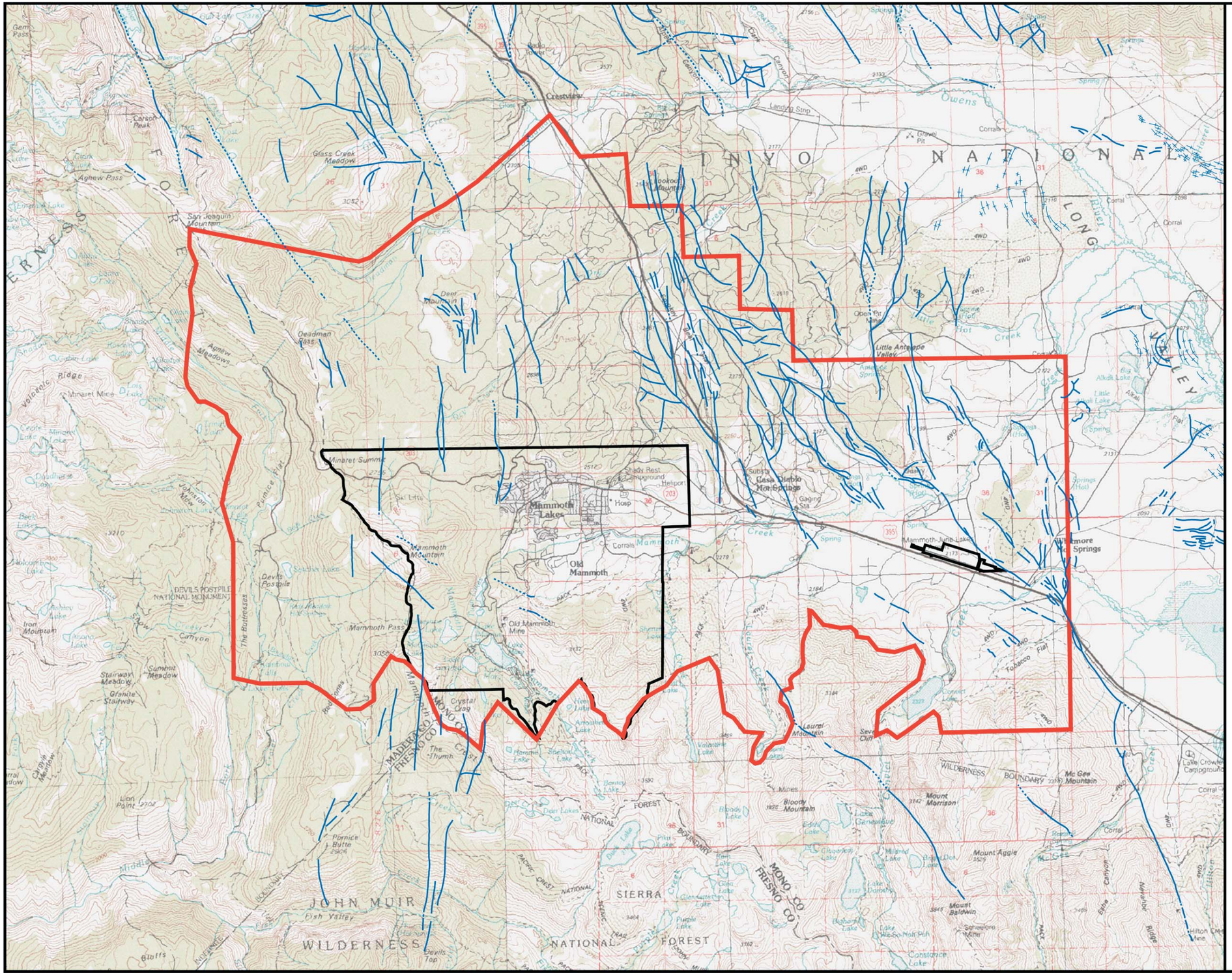

Figure 4.4-2 Regional Fault Map

Ground Shaking - As a general rule, the severity of ground shaking increases with proximity to the epicenter of the earthquake. Since the Town has primarily very low to moderate instability, the possibility of ground shaking is low.

Landslides - Landslides move under the force of gravity and are affected by the type of earth materials involved, the internal friction of the slide mass, and the slope over which the mass is moving. Triggering events for landslides include earthquakes, heavy precipitation, natural erosion, and earthwork/grading.

Liquefaction - Another response to severe ground shaking that can occur in loose soils is liquefaction. Liquefaction occurs in areas with shallow groundwater and where finer grained sands make up a significant part of the near surface (less than 30 feet amsl) soil section. Within Mammoth Lakes, areas of alluvium and moraine material with shallow groundwater have the potential for liquefaction.

According to the Lodestar EIR (1991), some areas within the Town are composed of glacial outwash and till including the Westridge, Mammoth Slopes, Main Street Commercial, Old Mammoth Commercial, Minaret, Meridian, Snowcreek, Sierra Valley and Gateway Planning Districts. Areas subject to liquefaction because of fine-grained alluvium are in the low areas including Sherwin Meadows, areas to the north and south of the Old Mammoth District, and to a lesser extent, an area of shallow groundwater near the Meridian Boulevard and Minaret Road. Based on the character of surface and subsurface soil and depth to groundwater, there appears to be little potential for liquefaction in the Town.

Seiche Inundation - A hazard associated with seismicity near large bodies of water in mountainous regions is the generation of seiches, commonly known as sloshing or surge waves, As no large bodies of water exist in or adjacent to the Town**,** seiche inundation is not a seismic concern in the area.

Volcanic Hazards

At least 30 volcanic events have occurred during the past 2,000 years in the Mono Lake-Long Valley area, including at least ten eruptions in the Mono-Inyo volcanic chain during the past 600 years. The Long Valley Caldera may be a center of volcanically-related seismic activity. Earthquake swarms and surface rupturing in the caldera are accompanied by uplift and deformation that have increased concerns about the possibility of renewed eruptive activity.

The possibility of such an occurrence in the Mono-Long Valley area has resulted in increased monitoring of seismic and non eruptive volcanic activity, and in increased efforts by local, state, and federal offices to prepare emergency response plans. The potential hazards from

future eruptions of volcanoes in the area are being studied by the USGS and they have estimated the chances of an eruption in the Planning Area in any given year a small possibility. The Safety Element of the Mono County General Plan (1993) indicates a one in a 1,000 annual likelihood of volcanic eruption in the vicinity of the Town.

Carbon Dioxide

Since 1980 scientists have monitored geologic unrest in the Long Valley Caldera. After a persistent swarm of earthquakes beneath Mammoth Mountain in 1989, geologists discovered large volumes of carbon dioxide gas likely derived from magma (molten rock). High concentrations of carbon dioxide in soil can kill the roots of trees. In addition, carbon dioxide gas is heavier than air and when it leaks from the soil it can collect in snow banks, depressions, and poorly ventilated enclosures, such as cabins and tents, posing a potential hazard to humans and animals.

4.4.2 REGULATORY FRAMEWORK

4.4.2.1 California's Alquist-Priolo Earthquake Fault Zoning Act

California's Alquist-Priolo Earthquake Fault Zoning Act (PRC Sec. 2621 et seq.), originally enacted in 1972 as the Alquist-Priolo Special Studies Zones Act and renamed in 1994, is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along known, active faults (earthquake fault zones). It also defines criteria for identifying active faults, giving legal weight to terms such as active, and establishes a process for reviewing building proposals in and adjacent to earthquake fault zones. Under the Alquist-Priolo Act, the California Geological Survey (previously known as the Division of Mines and Geology) maps the location of earthquake faults and establishes earthquake fault zones along faults that are "sufficiently active" and "well-defined." The resultant Alquist-Priolo maps are distributed to local governments who implement the provisions of the act to restrict construction along or across faults. A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the Act as referring to approximately the last 11,000 years). A fault is considered well-defined if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface, using standard professional techniques, criteria, and judgment (Hart and Bryant 1997).

4.4.2.2 Seismic Hazards Mapping Act of 1990

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC Sec. 2690-2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong groundshaking, liquefaction, and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act: the California Geological Survey is charged with identifying and mapping areas at risk of strong groundshaking, liquefaction, landslides, and other corollary hazards, and cities and counties are required to regulate development within mapped Seismic Hazard Zones.

Under the Seismic Hazards Mapping Act, permit review is the primary mechanism for local regulation of development. Specifically, cities and counties are prohibited from issuing development permits for sites within Seismic Hazard Zones until appropriate site-specific geologic or geotechnical investigations have been carried out and measures to reduce potential damage have been incorporated into the development plans.

4.4.2.3 Surface Mining and Reclamation Act

The Surface Mining and Reclamation Act (SMARA) was enacted for the dual purposes of identifying and mapping economically valuable mineral resources (including gold, sand, and gravel), and establishing a regulatory framework for the operation and eventual reclamation of surface mining operations. Pursuant to SMARA, and within budget constraints, the State Mining and Geology Board has mapped the location of mineral resources throughout much of the developed portions of the state. The value of these resources is identified through the particular mineral resource zone (MRZ) category applied to it by the State Geologist. The Town is the responsible agency for the implementation of the SMARA within its municipal boundaries.

Lands designated MRZ-l do not contain any significant mineral resources. MRZ-2 lands contain significant mineral resources. The MRZ-3 and MRZ-4 zones are used for lands where the mineral resource significance is unknown or undetermined. Projects affecting MRZ-2 lands are subject to the SMARA's policies that are intended to protect such resources by requiring consideration of the resources prior to development.

4.4.2.4 California Building Standards Code

The State of California's minimum standards for structural design and construction are given in the California Building Standards Code (CBSC) (CCRs, Title 24). The CBSC is based on the Uniform Building Code (UBC) (International Conference of Building Officials 1997), which is used widely throughout United States (generally adopted on a state-by state or district-

by-district basis), and has been modified for California conditions with numerous, more detailed and/or more stringent regulations.

The CBSC requires that "classification of the soil at each building site... be determined when required by the building official" and that "the classification... be based on observation and any necessary test of the materials disclosed by borings or excavations." In addition, the CBSC states that "the soil classification and design-bearing capacity shall be shown on the (building) plans, unless the foundation conforms to specified requirements." The CBSC provides standards for various aspects of construction, including but not limited to excavation, grading, and earthwork construction; fill placement and embankment construction; construction on expansive soils; foundation investigations and liquefaction potential; and soil strength loss. In accordance with California law, project design and construction would be required to comply with provisions of the CBSC.

4.4.2.5 Mammoth Lakes Municipal Code

The Town Municipal Code Section 12.08.076 requires that grading may be conducted under the following permits within the limits of each: 1) a letter of exemption, for minimal work; 2) a building permit, allowing grading within the footprint and as needed for the foundation excavations; and 3) a grading permit, for all other conditions. Municipal Code Section 12.08.080 requires engineered plans and a soils report to be submitted with an application for a grading permit.

The Town Municipal Code Section 17.16.050 (Grading and Clearing) enforces the preservation of trees and other vegetation. The code requires that in all residential zones, no lot may be graded or vegetation cleared until such action is shown on and consistent with an approved development plan or building permit. Development includes public improvements required by parcel and tract maps, use permits, grading permits and encroachment permits. Grading is limited to that area required for construction of the structure, utilities, driveways and access to one primary entrance of the structure which is provided for resident and guest access. Front, side and rear yards may not be graded or cleared except to provide for (1) the above construction and access requirements, (2) limited additional access to the front (streetside) of the structure, (3) snow storage, and (4) landscaping which is exempt from grading and clearing regulations identified in Title 12 of the Municipal Code, or (5) as approved under a design review process. The code requires that existing trees and vegetation be preserved to the maximum extent possible. No live trees over six inches in diameter can be removed without prior approval of the planning director. Approval to remove a tree is based on the health of the tree(s), the necessity to remove the tree(s) because of building or driveway construction or snow removal/storage, potential hazard or solar access. Creation of views, lawns or similar amenities is not considered sufficient cause to remove native trees. Replacement planting for tree removal can be required to mitigate the removal of a tree. Required replacement shall not exceed a total

trunk diameter equal to that removed and shall be limited to plantings in areas suitable for tree replacement.

The Town Municipal Code Section 8.26.030 requires that a reclamation plan be approved for the extraction, processing, or other mining operations within the town boundaries. A use permit for mining operations is required if the Town has jurisdiction over the land and a mining operations permit is required if the Town lacks full land use and zoning authority.

Chapter 15 of the Town Municipal Code requires that all structures within the boundaries of the town shall be designed to the requirements of Seismic Zone 4 as defined in the Uniform Building Code. One-third of the design snow load shall be added to the deadload for seismic design. In addition, a building permit is required for retaining walls exceeding four feet in height or retaining walls supporting any surcharge or special loads. Such walls are to be designed by a professional engineer licensed in the state.

4.4.2.6 Town Emergency Operations Plan

The Town maintains an Emergency Operations Plan (2001), which sets forth the responsibilities, functions, and operations of the Town government and its interrelationship with other agencies and jurisdictions which provide services during an emergency**.** The Emergency Operations Plan addresses earthquakes, volcanic activity, flooding, rapid snowmelt, fire, avalanches, landslides, transportation incidents, hazardous materials releases, medical emergencies, social unrest, terrorism, and war. The Plan meets the State's Standardized Emergency Management System (SEMS) and is updated regularly.

4.4.3 THRESHOLDS OF SIGNIFICANCE

Based primarily on Appendix G of the CEQA Guidelines, the Project would be considered to have a significant impact on geology and soils if the project would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  a. 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;
  b. Strong seismic ground shaking;
  c. Seismic-related ground failure, including liquefaction;
  d. Landslides;
  e. Volcanic activity; or
  f. Carbon dioxide.

- 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 UBC (1994), 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 waste water; or
- Result in the loss of availability of a known or locally important mineral resource.

4.4.4 IMPACTS AND MITIGATION

Issue 4.4-1: *Would development associated with implementation of the Updated Plan expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:*

a) 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;
b) Strong seismic ground shaking;
c) Seismic related ground failure, including liquefaction;
d) Landslides;
e) Volcanoes; or
f) Carbon dioxide?

Discussion: The community and surrounding area have been subject to volcanic activity for approximately 3.2 million years. Due to the Town's close proximity to the Hilton Creek Fault, Owens Valley Fault, and Chalfant Fractures, a major earthquake occurring in the Planning Area may be expected to produce moderate to extreme groundshaking and lurching.

Based on the character of surface and subsurface soil and depth to groundwater, there appears to be little potential for liquefaction in the Town. Within Mammoth Lakes, areas of alluvium and moraine material with shallow groundwater have the potential for liquefaction. Areas subject to liquefaction because of fine-grained alluvium are in the low areas including Sherwin Meadows, areas to the north and south of the Old Mammoth District, and to a lesser extent, an area of shallow groundwater near the Meridian Boulevard and Minaret Road.

Landslides are limited primarily to areas with a combination of poorly consolidated material and slopes that exceed 30 percent. While slopes with these gradients are found in

portions of Mammoth Knolls, Mammoth Slopes, and areas of Old Mammoth, there is no record of landslide activity in the Town.

Geotechnical hazards in the Planning Area related to volcanic activity are possible based on geologic history. Twenty eruptions at Mono Craters within the last 10,000 years have been dated through either radiocarbon or obsidian hydration analysis (Wood 1984). Two extensive pumice deposits, which blanket much of the eastern sierra region, have been dated at 640 and 1190 years B.P. (Wood 1977). The behavior of the Mono-Inyo Volcanic Chain during the last 10,000 years indicates that this local vent zone is likely a location of future eruption(s) since an eruption has broken out roughly every 250 to 750 years (Sieh 1984). Even if this seismic activity, related to volcanism, shifted several miles in any direction from its current location, the volcanic hazards analysis would not be significantly altered. In addition, since carbon dioxide derived from molten rock is heavier than air, when it leaks from the soil it can collect in snow banks, depressions, and poorly ventilated enclosures, such as cabins and tents. Potential impacts to the Town include inundation by ash deposition, lava, or lahars, or complete destruction from a catastrophic eruption.

A comprehensive daily monitoring program of activity along these known faults helps scientists to assess the volcanic hazards in the Long Valley area and to recognize the early signs of possible eruptions. The USGS, in cooperation with the California Office of Emergency Services and local jurisdictions in eastern California, has established procedures to promptly alert the public to a possible eruption.

Policies and Implementation Measures in the Updated Plan

The Plan Update proposes the adoption of several polices and implementation measures to reduce potential impacts associated with geologic hazards. These policies and measures are as follows:

II.3.A.b.l Implement the Uniform Building Code to comply with federal and State earthquake protection and slope stability standards for new development.

II.3.A.b.2 Require soils reports for new developments to identify the potential for liquefactions, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

II.3.A.b.3 Promote public education efforts to inform residents and businesses regarding earthquake preparedness and response.

II.3.A.b.4 The Town shall participate in any updating and implementation of hazards response planning, including an emergency evacuation facilities plan and training programs.

II.3.A.b.5 The Town shall render all available assistance and cooperation in emergency situations to minimize loss of life, injury to persons, and damage to property.

II.3.A.b.6 The Town shall maintain an Emergency Plan for Mammoth Lakes which sets forth the responsibilities, functions, and operations of the Town government and its interrelationship with other agencies and jurisdictions which provide services during an emergency.

II.3.A.b.7 The Town shall develop and maintain an emergency notification and information system to minimize loss of life during a time of emergency.

II.3.B.a The ~~town~~ Town shall limit the creation of new parcels on slopes over 30 percent.

II.3.B.a.1 The Town shall update its development standards as needed to include advances in construction techniques which minimize soil erosion and slope instability.

II.3.B.a.2 The Town shall require a soils report on all development permits within areas of known slope instability or where significant potential hazards have been identified.

II.4.A.d.1 The Town shall implement the Uniform Building Code to comply with Federal and State earthquake protection and slope stability standards for new development.

II.4.A.d.2 The Town shall require soils reports for new developments to identify the potential for liquefactions, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

II.4.A.f.4 The Town shall research the practicality of instituting a local ordinance that goes beyond the requirements of the State's Standardized Emergency Management System.

II.4.C.a.2 The Town shall establish appropriate evacuation routes, and incorporate them into the Emergency Preparedness and Response Plan.

II.4.D.a.l The Town shall assist USGS in continuing the efforts of the USGS Volcano Hazards Program to protect people's lives and property.

II.4.D.a Exposure and access to areas subject to high concentrations of carbon dioxide shall be minimized.

II.4.D.a.1 The Town shall assist USGS in continuing the efforts of the USGS Volcano Hazards Program to protect people's lives and property.

II.4.D.a.2 The Town shall work collaboratively with Inyo National Forest and USGS in developing public education efforts to inform residents and businesses regarding the hazards of CO2 and high hazard areas.

II.4.D.a.3 The Town shall promote the monitoring of CO2 through the use of carbon dioxide alarms in low-lying confined areas, such as basements and underground parking areas.

II.4.D.4 The Town shall work collaboratively with Inyo National Forest and USGS to ensure that all high-hazard areas are marked and/or closed to public access during high-risk periods.

Detailed recommendations regarding specific techniques and designs to reduce, eliminate or avoid geotechnical hazards would be provided by the reports of geotechnical investigations for specific projects within the Town. Development within the Town is required to comply with the California Building Code as well as Section 12.08.080 of the Town Municipal Code, which requires engineered plans and a soils report to be submitted with an application for a grading permit. Site development plans would be reviewed by the Town to determine conformance with specific recommended geotechnical procedures. Field inspection would be conducted by the Town during earthwork and construction operations. The observation of cuts, fills, backfills, foundation excavations, and the preparation of pavement subgrades shall take place during these phases of site development. Therefore, potential impacts associated with the exposure of people or structures to seismic hazards, including rupture of a known earthquake fault, strong seismic ground shaking, and seismic related ground failure, including liquefaction, would be reduced to the extent possible and would be less than significant.

With regard to landslides, while there is no record of landslide activity in the Town, the Updated General Plan includes a policy to limit the creation of new parcels on slopes over 30 percent. Section 17.16.040A6 of the Municipal Code does not permit building sites with slopes greater than 30 percent. With this requirement as well as the requirement for soils reports and the implementation of construction techniques identified in geotechnical reports, potential impacts associated with exposure of people or structures to landslides would be less than significant.

With regard to volcanic activity, the Town cooperates with USGS in the continuing efforts of monitoring volcanic activity, which provides for early warning of a potential eruption. In addition, the Town adopted an Emergency Operations Plan in 2001, which is updated regularly. With regard to exposure to carbon dioxide, the Updated Plan contains a policy and four implementation measures to address the risk of exposure to carbon dioxide. The areas in which carbon dioxide_–occur are outside the UGB and are within USFS jurisdiction. The occurrences are seasonal and USFS monitors the areas. Areas are closed off as needed by USFS. The Updated Plan includes measures to notify and educate people regarding the issue of carbon dioxide. In addition, the Town encourages the monitoring. With the policies and

implementation measures in the Updated Plan, the exposure of people or structures to volcanic activity and associated carbon dioxide would be reduced to a level of less than significant.

Mitigation Measures

The project would not result in the exposure of people or structures to potential effects due to seismic activity and associated ground failure, landslides, or volcanic activity. Therefore, no mitigation measures are necessary.

Level of Significance After Mitigation

Impacts from seismic and volcanic activity would be less than significant.

Issue 4.4-2: *Would the project result in substantial soil erosion or the loss of topsoil?*

Discussion: Implementation of the Updated Plan would result in construction on individual parcels in accordance with land use designations and densities. As noted in the baseline discussion, soils throughout the project area are sensitive to disturbance from development and exhibit moderate to high erosion potential depending on the grade of the slope. Construction of individual development sites would therefore, expose earth surfaces to wind and rain action. If slopes and exposed surfaces are not protected by vegetation or some other form of protection, uncemented soils could experience erosion during strong winds or heavy precipitation. In turn, erosion would generate potential impacts to nearby streams and watercourses or the storm drain system due to sedimentation. (See Section 4.6, Hydrology and Water Quality, for a discussion regarding water quality.)

Implementation Measures in the Updated Plan:

The Updated Plan proposes the adoption of the following three implementation measures to reduce potential impacts associated with soil erosion:

I.1.A.a.1 The Town shall require the use of Best Management Practices (BMPs) during and after construction and development as a means to prevent erosion, siltation, and flooding.

I.1.A.a.2. Projects requiring a grading permit shall implement Best Management Practices (BMPs) and shall be required to control erosion and sedimentation.

II.3.B.a.1 The Town shall update its development standards as needed to include advances in construction techniques which minimize soil erosion and slope instability.

All development must comply with Municipal Code Sections 12.08.090, Drainage and erosion design standards, 12.08, Land clearing, earthwork and drainage facilities, and 12.08.080,

Engineered grading permit requirements. These code sections serve to implement the implementation measures in the Updated Plan. The Town reviews the development standards in the Code to ensure that the Town's requirements include advances in construction techniques that serve to minimize soil erosion and slope instability. In addition, best management practices (BMPs), which would reduce and/or eliminate erosion potential, would be incorporated into development projects. Implementation of BMPs would ensure that development would not result in substantial soil erosion or the loss of topsoil. Therefore, erosion-related hazards would be less than significant.

Mitigation Measures

The implementation of the Updated Plan would not result in impacts with regard to soil erosion or the loss of topsoil. Therefore, no mitigation measures are required.

Level of Significance After Mitigation

Impacts with regard to soil erosion and the loss of top soil would be less than significant.

Issue 4.4-3: *Would the Project 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?*

Discussion: As noted above, soils in the Project Area are sensitive to disturbance from development and exhibit moderate to high erosion potential depending on the grade of the slope. Consequently, depending on the location of a development site, future development could occur on collapsible/loose sandy soils, which could potentially affect the structural integrity of a building. In general, slopes in the Mammoth Lakes Planning Area are comprised of stable materials; there are no mapped areas of unstable slopes and no known landslides have occurred.

Policies and/or Implementation Measures in the Updated Plan:

The Updated Plan proposes the adoption of the following policies and implementation measures to reduce potential impacts associated with soil stability:

II.3.A.b.l Implement the Uniform Building Code to comply with federal and State earthquake protection and slope stability standards for new development.

II.3.A.b.2 Require soils reports for new developments to identify the potential for liquefactions, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

II3.B.a The ~~town~~ Town shall limit the creation of new parcels on slopes over 30 percent.

II.3.B.a.1 The Town shall update its development standards as needed to include advances in construction techniques which minimize soil erosion and slope instability.

II.3.B.a.2 The Town shall require a soils report on all development permits within areas of known slope instability or where significant potential hazards have been identified.

II.4.A.d.1 The Town shall implement the Uniform Building Code to comply with Federal and State earthquake protection and slope stability standards for new development.

II.4.A.d.2 The Town shall require soils reports for new developments to identify the potential for liquefactions, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

Development within the Town is required to comply with the California Building Code as well as Section 12.08.080 of the Town Municipal Code, which requires engineered plans and a soils report to be submitted with an application for a grading permit. Site development plans would be reviewed by the Town to determine conformance with specific recommended geotechnical procedures. Field inspection would be conducted by the Town during earthwork and construction operations. The observation of cuts, fills, backfills, foundation excavations, and the preparation of pavement subgrades shall take place during these phases of site development. Therefore, impacts associated with unstable soils would be less than significant.

Mitigation Measures

Impacts related to unstable soils would be less than significant. Therefore, no mitigation measures would be required.

Level of Significance After Mitigation

Impacts related to unstable soils would be less than significant.

Issue 4.4-4: *Would the project be located on expansive soil, as defined in Table 18 1 B of the Uniform Building Code (UBC) (1994), creating substantial risks to life or property?*

Discussion: Soils in the survey area are sensitive to disturbances by development; however, no expansive soils have been mapped or encountered in the Project Area.[17]

[17] *Based on the Town of Mammoth Lakes Building Division.*

Implementation Measures in the Updated Plan:

The Updated Plan proposes the adoption of the following two implementation measures to reduce potential impacts associated with expansive soils:

II.3.A.b.2 Require soils reports for new developments to identify the potential for liquefactions, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

II.4.A.d.2 The Town shall require soils reports for new developments to identify the potential for liquefactions, expansive soils, ground settlement, and slope failure. Require reports to contain remedial measures that could be feasibly implemented to minimize potential impacts.

Mitigation Measures

No impacts would occur with regard to development on expansive soils. Therefore, no mitigation measures are required.

Level of Significance After Mitigation

Impacts with regard to expansive soils would be less than significant.

Issue 4.4-5: *Would the project 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 waste water?*

Discussion: In general, the soils in the Project Area would have the capacity to support the use of septic tanks or alternative waste water disposal systems. However, the Basin Plan for the Lahontan Region of the State Water Resources Control Board prohibits individual septic systems in the Mammoth Basin above an elevation of 7,650 feet and within the entire drainage area of the Town (LRWQCB, Basin Plan, online text from www.waterboards.ca.gov/lahontan/BPlan/Bplantxt.pdf). Therefore, septic tanks would not be used for wastewater disposal. No alternative wastewater disposal systems are proposed. The Town has existing infrastructure for the treatment of wastewater.

Mitigation Measures

No impact would occur with regard to wastewater treatment and the use of septic systems or alternative wastewater disposal systems.

Level of Significance After Mitigation

The project would not result in an impact with regard to wastewater treatment and the use of septic systems or alternative wastewater disposal systems.

Issue 4.4-6: *Would the project result in loss of a known mineral resource or a locally important mineral resource?*

Discussion: The project does not incorporate heavy industrial uses of any type within the UGB. However, mineral development including clay, aggregate, do occur in the Planning Area. These activities benefit Mammoth Lakes by providing a nearby source of materials used in construction, snow management and other purposes. The activities associated with mineral development have the potential to impact the environment through hauling activities, transport emissions, noise and other means. Any projects associated with mineral development would be required to undergo environmental review and permitting. In addition, any party proposing mineral extraction that is subject to SMARA would have to apply to the Town and pay the appropriate processing fees. Development associated with implementation of the Updated Plan within the UGB would not result in the loss of mineral resources.

In addition to the minerals identified above, the Mammoth Lakes region is characterized by significant geothermal resources including a geothermal lease that is located within the northeastern portion of the Municipal Boundary and extends to the northern boundary of the Planning Area (see Figure 4.4-1). Project implementation could potentially impede geothermal exploration in that area due to concerns for land use compatibility impacts. The presence of a significant resource also introduces the potential for future direct use of geothermal energy in the Town and a working group has been convened to explore this possibility. Project implementation would not adversely impact the potential for future direct use, and may support efforts to that end.

Policies and Implementation Measures in the Updated Plan

The Updated Plan proposes the adoption of the following policy and implementation measures to reduce potential impacts associated with mineral resources:

II.4.B.a. Mineral resource development projects shall meet or exceed applicable provision [sic] of the California Environmental Quality Act, the National Environmental Protection Act, and the Surface Mining and Reclamation Act shall [sic] acquire an Environmental Permit for mining from the Town.

II.4.B.a.1 If mineral extraction occurs within the Town of Mammoth Lakes, the Town is responsible for and shall prepare the Surface Mining and Reclamation Act. Surface

Mining and Reclamation Act requires local agencies to have Surface Mining Reclamation plans for surface mining activities.

Mitigation Measures

4.4-1 The Town shall continue to work with the MPLP to ensure that geothermal exploration in the Planning Area does not conflict with land uses in the Town and at the same time to ensure continued exploration and development of geothermal resources in the planning area in a manner that is compatible with Town land uses.

4.4-2 The Town shall continue to investigate the feasibility and opportunities for direct use of geothermal energy to meet Town heating requirements and other Project objectives.

Level of Significance After Mitigation

With incorporation of the mitigation measures, this impact is less than significant.