City of South Lake Tahoe
NATURAL HAZARD MITIGATION PLAN

SECTION I – INTRODUCTION

Carved out of the beautiful Sierra Nevada, the City of South Lake Tahoe was incorporated in 1965 to serve the citizens whom live and visit the southern end of the largest alpine lake in North America. Those who have come to live and visit in this the most scenic of California cities have had to address the various natural hazards inherent to this mountainous landscape.

Today, the population of the City of South Lake Tahoe remains steady, with 23,850 Residents. The city experiences a large seasonal influx of visitors as well as a transient population on weekends and holidays. The tremendous levels of population growth, has taxed the infrastructure as most of the city remains an essentially unchanged hamlet. Increasing growth often equates into escalating potential impacts resultant from natural hazards. The threat of natural hazards typical to this mountain region is real to the City's residents and the absence of growth does not minimize the potential impact of natural hazards to the population, the business community, or the natural environment of the City.
The City of South Lake Tahoe is subject to flooding, wildfires, earthquakes, landslides, avalanches, severe weather, and droughts. It is essentially impossible to predict exactly when any of these disasters might occur. It is also impossible to gauge the extent of damage, the extended cost of that damage, or the degree to which the City of South Lake Tahoe will be affected. What is certain is that these natural hazards will happen. Natural disasters highlight the City's past and they will continue to occur in the City's future. Nonetheless, with prudent and thorough planning, cooperation among County, state, and federal agencies, partnership with private-sector organizations, and an informed citizenry, losses from natural disasters can be minimized.

The City of South Lake Tahoe nearly experienced extensive damage resulting from a natural hazard. In July of 2002, the Gondola fire which started in the city and burned in the national forest, caused the loss of 360 acres of natural resources and threatened numerous homes. In total, damage caused by the wild fire reached nearly 2 million dollars and the cost to suppress the fire reached 3 million dollars. Could damages have been less extensive if a natural hazards mitigation plan was present?

Could government more effectively respond to natural hazards when they occur in the future with a natural hazards mitigation plan in place and functioning? Yes. This is the purpose of the following Natural Hazards Mitigation Plan for the City of South Lake Tahoe

What is natural hazards mitigation?

Natural hazards mitigation is the development and implementation of actions intended to diminish or eliminate losses sustained as a result of a natural hazard.

Why develop a natural hazards mitigation strategy?

The importance of having a strategy for responding to emergency incidents was realized almost immediately by the original European settlers of the region. Mountains can be dangerous places in any season. In order for settlers to exist and thrive in the area now known as the City of South Lake Tahoe, the ability to respond to and recover from natural disasters was a prerequisite. That prerequisite continues to be a necessity. Today though, there is much more to be lost in the event of a natural disaster.

The amount of resources potentially threatened by natural disaster grows annually as citizens make improvements to the land. Naturally, as a result of this growth, the costs associated with recovering from a natural disaster continue to climb.

In 2004, El Dorado County released its El Dorado County Disaster Plan. Within it are guidelines for appropriate response to emergencies and the effective utilization of County resources in emergency situations with the hope of effectively managing emergency and/or disaster events. In 2005, the City of South Lake Tahoe developed an annex to that plan. This annex (NHMP) is developed as a tool for realizing three intertwined goals:

1.) Identifying natural hazards that potentially threaten the City
2.) Minimizing or eliminating the effects of these identified natural hazards
3.) Reducing the prospective costs of reparations before any natural disaster takes place.

What are the benefits of hazard mitigation?

There are many benefits to be realized in the creation and implementation of a natural hazards mitigation plan.

Save lives and protect property – The city can save lives and reduce the amount of property damage by mitigating the effects of natural hazards. For example, the city can identify areas with high threat potentials to natural hazards, use zoning ordinances to guide the development of these properties, and subsequently facilitate a safer city for its citizens and their possessions.

Reduce impact of future disaster events – By identifying natural hazards before they happen, the city can effectively plan for natural hazards and mitigate the damaging influences of natural hazards. Natural disasters are going to occur. This plan's goal is to reduce their effects. In essence, this plan is the modern day equivalent to the old saying that, "An ounce of prevention is worth a pound of cure." Applicable words for the original settlers of the area, words that are still applicable today.

Enable post-disaster funding – In the past, federal legislation has provided funding for disaster relief, recovery, and some hazard mitigation planning. With the federal Disaster Mitigation Act of 2000, the importance of natural hazards mitigation is reinforced as a primary tool in local and state natural disaster response preparedness. As such, this Act requires that an approved mitigation plan be in place prior to receiving any post disaster Hazard Mitigation Grant Program funds. the City of South Lake Tahoe, NHMP will fulfill this requirement.

Hasten recovery from disasters – In the development of a hazard mitigation strategy, the City of South Lake Tahoe, will be better prepared to react, respond, and recover from a future natural disaster by knowing in advance particular mitigation measures appropriate in post-disaster response scenarios.

Demonstrate a dedication to improving the cities safety and wellbeing – By having a natural hazards mitigation plan in place, the citizens of the city can rest assured that the city is committed to safeguarding the people and their possessions from unforeseen future natural disasters.

Who does the natural hazards mitigation plan benefit?

The City of South Lake Tahoe NHMP was conceived, developed, written, and adopted as an annex to the El Dorado County NHMP document. The primary recipients of the benefits of this plan are the citizens and visitors of the City of South Lake Tahoe, itself. It is anticipated that various special purpose districts located within the County that receive services from the City of South Lake

Tahoe will also benefit from this plan, the knowledge it provides, and the future natural hazard mitigation funding the plan enables.

The information within this plan is generally applicable to the entire City. This information provides a framework for natural hazard mitigation within the City of South Lake Tahoe, and is the primary natural hazard mitigation document for the City, plan participants, and plan stakeholders.

The **City of South Lake Tahoe Natural Hazard Mitigation Plan** satisfies the federal legislation, The Disaster Mitigation Act of 2000, and the requirement for local governments to formulate and enact a pre-disaster mitigation program in order "to identify the natural hazards that impact them, to identify actions and activities to reduce any losses from those hazards, and to establish a coordinated process to take advantage of the plan, taking advantage of a wide range of resources" (44 CFR, sec. 201.1).

Additionally, the NHMP is a "commitment to reduce risks from natural hazards and serves as a guide for decision makers as they commit resources to reducing the effects of natural hazard, [acting as a] basis for the State to provide technical assistance and prioritize project funding" (44 CFR, sec. 201.6).

Documentation of the Planning Process

On October 30, 2000, the President of the United States signed into law the Disaster Mitigation Act of 2000 (DMA 2000). The DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act by adding a new section, 322 – Mitigation Planning. Section 322 placed a new emphasis on the importance of local hazard mitigation planning, and required local government to develop and submit hazard mitigation plans by November 1, 2004.

On May 20th 2005, in response to this requirement, City of South Lake Tahoe designated the City of South Lake Tahoe Fire Department as the lead agency for preparation of the Cities NHMP. Fire Marshal Ray Zachau was assigned as the lead for preparing the plan document.

Local Capability Assessment

The City of South Lake Tahoe is a rural moderately populated City of 34,000 citizens located at the south edge of Lake Tahoe. The City though, is not without a talented human resources pool of dedicated private citizens, public and private employees, business owners, and organizations. Combined, the people of the City of South Lake Tahoe provide a formidable and wide-ranging knowledge base from which a meaningful planning process was developed.

From human resources inside the City came technical expertise appropriately applicable to the interdisciplinary nature of hazard mitigation planning. An immense amount of data was provided by City departments, plan participants, and plan stakeholders throughout the process of developing this plan. Essential and significant technical assistance was provided by many agencies and organizations outside the City. Of tremendous assistance were the California Office of Emergency Services, the Department of Water Resources, the Department of Forestry, and the Office of Planning and Research. FEMA technical support was also indispensable in completing the plan.

Although the City of South Lake Tahoe's small size and limited funding base is a handicap to aggressive implementation of natural hazard mitigation measures, funding sources are still available to assist the City in accomplishing its natural hazard mitigation goals. Wherever plausible and possible, the City will pursue funding sources in an effort to complete the actions of this plan. The end result being a City made safer from the dangerous consequences related to natural hazard events.

The City of South Lake Tahoe already has a meaningful foundation of codes and ordinances in place to use as guidance within implementation of a natural hazard mitigation strategy. Of primary importance is the City General Plan. Adopted in 1999, the General Plan is the principal guiding document of the City. The plan acts as the template for the future long-term development of the City of South Lake Tahoe, The information in the General Plan is the basis for any land use decisions, and closely interacts with the Tahoe Regional Planning Agency providing the framework to successfully convert community values and visions into actual realities. The California Environmental Quality Act (CEQA) ensures those actual realities are in harmony with the environment of the County. CEQA legislation acts as the environmental guide to appropriate development, development designed to be in harmony with the natural beauty of the area.

Within the Building Department, all construction within the City must meet or exceed the 2001 edition of the California Building Standards Code, known as the California Code of Regulations, Title 24. Incorporated within this code are the following:

Uniform Building Code, 2000 Edition
Uniform Mechanical Code, 2000 Edition
National Electrical Code, 2000 Edition
Uniform Plumbing Code, 2000 Edition
Uniform Fire Code, 2000 Edition
Uniform Housing Code, 1997 Edition
Uniform Abatement of Dangerous Buildings Code, 1997 Edition

Also adopted by the County are the 1999 National Electrical Code and references to the 2002 National Fire Code. Combined, these ordinances guide construction of safe natural-hazard-resistant structures within the City. The City General Plan, CEQA, and State Building Standards, as well as many other local, county, state, and federal ordinances, all act as the platform from which effective natural hazard mitigation planning is orchestrated. This natural hazard mitigation plan will function in conjunction and agreement with these preexisting ordinances.

How to Use This Plan

This plan is divided into three separate sections.

Section I – Introduction and Overview
Section II –Multi-Jurisdictional Risk Assessment
Section III –Multi-Jurisdictional Natural Hazards

Mitigation Strategy

The first section is an introduction to and overview of The City of South Lake Tahoe's natural hazards that affect the City. This section acts as a primer to natural hazards mitigation, providing definition of what natural hazard mitigation is, justification for the creation of a natural hazard mitigation plan, and a set of goals that might be realized as a result of enacting the City of South Lake Tahoe NHMP. Section I also documents the planning process and includes a local capabilities assessment.

Section II is a natural hazards identification and risk assessment for the City of South Lake Tahoe and the participating jurisdictions within this multi-jurisdictional planning document. Potential losses are analyzed and future development trends examined as part of this section.

Section III is the natural hazard mitigation strategy portion of the plan. This section includes a prioritization process in which natural hazards are rated. From the rating, mitigation measures for the City of South Lake Tahoe and all participating jurisdictions within the City are ranked. Implementation of mitigation strategies is discussed, as is the plan maintenance process.

Section II – MULTI-JURISDICTIONAL RISK ASSESSMENT

The City of South Lake Tahoe has identified several natural hazards that are examined and addressed within this Natural Hazards Mitigation Plan. These hazards were identified via several avenues of research.

The first method utilized input from community members involved in the plan process. These members included individuals from participating jurisdictions, interested stakeholders, concerned citizens, community groups, and service organizations. Second, a thorough review of applicable literature pertaining to the city historic record of natural hazards was undertaken, incorporating data from numerous local, county, state, and federal organizations. Third, governmental support from the California Governor's Office of Emergency Services (OES) and the Federal Emergency Management Agency (FEMA) was utilized. Invaluable aide was provided by OES, including information, guidance, and supervision. Written plan guides, on-line support, and personal assistance all helped smooth the plan-writing process. FEMA guides and website support also provided important resources.

In addition, the City of South Lake Tahoe is developing a GIS database that will map the City's infrastructure, critical facilities, and land uses. Initial data from this study was used to determine those hazards that present the greatest risk to the City.

The following is the natural hazards risk assessment for The City of South Lake Tahoe.

AVALANCHE

The City of South Lake Tahoe is located in a basin surrounded by the mountain peaks of the Sierra Nevada. The city's elevation ranges from a low of about 6200 feet to high elevations in excess of 7440 feet. With these elevation characteristics, all areas of the city are susceptible to snow storms, even the lowest lying areas around the lake.

Moreover, the city's topography is high-relief. The Sierra Nevada mountain range, a tilted fault block geologic formation, forms steep mountain slopes. The city's drainage patterns are typically fast-flowing streams and rivers which enunciate the high-relief terrain. The combination of snowfall potential and high relief creates a potential danger for snow avalanches throughout the winter months in the City of South Lake Tahoe. An avalanche shall refer to any fall, release, or slide of snow in an amount sufficient enough to cause damage to or threaten the safety of people.

Avalanches are possible when weak layers of snow within the cumulative seasonal snow pack fail to support the weight of the snow above and collapse. The result causes the overlying snow to break free and flow down hill. There are two destructive elements at work within an avalanche. Primarily, the actual impact from the displaced snow and ice is a concern. Embedded within the snow, debris such as broken-off trees and branches are just as dangerous as the

snow itself. Secondly, the avalanche wind, caused by air pushed ahead of the moving mass of snow, can cause damage as well.

Areas most susceptible to snow avalanche are typically in sheltered regions of the mountain topography where snow is most prone to accumulate. In general, the most sheltered aspects in the Sierra Nevada, where snow can most greatly accumulate, are upon north and northeast facing slopes. These slope faces must also be situated above 7000 feet where snow is more likely to accumulate over the course of the winter snowfall season.

Hazard Assessment

The effects of an avalanche are for all intents and purposes confined to the areas within and around the avalanche path. In the City of South Lake Tahoe historical past, areas of considerable avalanche danger were an unknown. Today, the areas of substantial avalanche danger are clearly known and usually avoided. Avalanche areas in the city's downhill ski resort and along the city's state highways are administered to drastically reduce the chance for avalanche causing conditions to develop. Thus, few unplanned or damage-causing avalanches occur in places where people or property might be threatened. Still, avalanches can and do happen in The City of South Lake Tahoe and although personal injury or property damage is unlikely, these misfortunes are a possibility. The avalanche season extends from the first major snowfalls of late fall to whenever the last remnants of snow have melted away. In some of the highest elevation areas around the city, it may be possible during some years for snow to remain the entire year.

The greatest impact that avalanches have on The City of South Lake Tahoe are to transportation infrastructure. Two state highways pass through the city, Highway 50 over Echo pass summit and Highway 89. Highway 89 over Luther Pass is closed intermittently during the winter months, in part because of avalanche danger. Their closure limits the travel options of city residents and places increased importance on Nevada State Route 207 over 7,334-foot Daggett Pass, which is maintained as a year-round highway. Highway 50 thus is the city's only east to west travel corridor during the winter months and its importance to transportation cannot be underestimated. Avalanches do impact this and other year-round thoroughfares.

During winter storms, periodic avalanche control must be performed on the highway in order to promote motorist safety over the pass. Without these avalanche control measures being performed by the California Department of Transportation, travel over the county's main highway corridors would be a very treacherous proposition during the winter season. With avalanche control, public safety is improved and avalanche danger is minimized.

The major ski resort in the city, Heavenly Valley employs avalanche control techniques to mitigate avalanche danger. Ski patrollers perform avalanche control every morning that it is required in order to promote safety throughout the mountain for all skiers and riders.

Much of the dangers associated with avalanches are known and efforts are made to lessen the potential for avalanche events in areas frequented by people. Problems can arise in backcountry areas where avalanche control measures are not in place. Here, out-of-bounds downhill skiers, cross country skiers, and snowmobile riders can trigger avalanches. Thus, avalanches are natural hazards that still pose a threat to life and property. Away from areas that have developed and maintain avalanche control methods, the City of South Lake Tahoe is still very vulnerable to avalanche danger. As long as individuals travel into backcountry regions during the winter, injuries will still be a possibility. Other problems associated with avalanches are loss of electricity due to power lines being disabled by avalanche and localized damage to the environment within the avalanche path.

Probability and Risk

Avalanches are isolated occurrence predominantly located in the backcountry areas of the county. Any avalanche would most likely affect individuals in the backcountry during the winter. There is also a lesser degree of avalanche danger within the established ski resorts of the county as well as on the highways that traverse the high-elevation passes in the county. Still, the greatest danger is to the very few who venture into winter backcountry settings. This considered, there is **low probability** and **very low risk** associated with avalanche hazard in the City of South Lake Tahoe.

Conclusion

Avalanche hazards in the City of South Lake Tahoe are most prevalent during the winter in the backcountry regions outside the city. Individuals who venture into the backcountry during the winter need to be aware of the dangers posed by avalanches and take the necessary precautions when the potential for an avalanche is present. Individuals who frequently snowmobile, ski, cross-country ski, or snowshoe in the backcountry in the winter should educate themselves in avalanche awareness and safety. Many certificate programs are available. The California Department of Transportation, the United States Forest Service, and the National Weather Service all have avalanche danger forecasting capabilities which they utilize to inform the public of any avalanche hazards. Regardless, no absolutely successful method has been found to keep individuals out of avalanche danger zones, even when it is extremely unwise to be present.

DAM FAILURE

Dam failure is a potential “man-made” natural disaster that has the possibility to impact the City of South Lake Tahoe. It is man-made in that the dam itself was constructed through human effort. Without man’s effort, no dam would exist and, as such, no dam failure could be contemplated. It is a natural disaster from two perspectives. First, the inundation from released waters resulting from dam failure is related to naturally occurring floodwaters. Second, dam failure would most probably happen in consequence of another natural disaster. An earthquake, severe storm, or flood could trigger dam failure within that larger disaster event.

Very few of the water bodies located in The City of South Lake Tahoe are man-created reservoirs. One reservoir only slightly raises the level of the water body behind it. As a general rule, reservoirs formed via dam construction hold back large volumes of water.

With only one dam as a direct threat to the population of the city, the remote location of other dams in the area shields residents from the potential hazards associated with dam failure and the resulting inundation. The exception to this pattern is Heavenly Creek Dam. Located above the community of South Lake Tahoe and the dam that holds back its waters do form a natural hazard to the community below and within the path of inundation that would occur if a failure occurred.

Thankfully, no dam failure events within the Tahoe Basin South shore region are found within the historic record of El Dorado County.

Hazard Assessment

Dams in the areas around the City of South Lake Tahoe are closely monitored to ensure dam stability and integrity. The California Department of Water Resources is entrusted with supervision over non-federal dams in the State. Dams under jurisdiction are artificial barriers, together with appurtenant works, which are 25 feet or more in height or have an impounding capacity of 50 acre-feet or more. Any artificial barrier not in excess of 6 feet in height, regardless of storage capacity, or that has a storage capacity not in excess of 15 acre-feet, regardless of height, is not considered. Smaller dams that are not within California Department of Water Resources jurisdiction exist within the county and are inspected and maintained by their owners.

There has never been a recorded dam failure in El Dorado County. Retention devices designed to hold back water are described in the historical record as having failed, but these were designed as temporary construction and not to be construed as being true permanent dam structures. Just because the county has never experienced a dam failure does not exclude the county from ever suffering a dam failure. Although a dam could be considered a very small possibility of failing due to poor construction or lack of appropriate maintenance, the possibility for a dam failure increases during other natural hazard events. Dam failure could occur in an earthquake. Dependent upon the seismic epicenter, and the measured magnitude of the quake, it becomes increasingly possible for dam integrity to be compromised and dam failure to occur. Severe storms and floods also heighten the threat to dams within the county. If large amounts of precipitation fall in a very short period of time, dams can be crested, their structure weakened, and supports eroded. Added awareness of dam conditions is critical during these other natural disaster events.

The one dam that is located in close proximity to human population is the aforementioned Heavenly Creek dam which holds back Heavenly creek . Both the creek and dam are located in the County outside of the city. The city however would be inundated in a dam failure. The dam was built in 1985 under the direction of the California Department of Water Resources. At high water, the lake encompasses nearly fourteen (2) acres, with a total water capacity of 15 acre-feet of water. If dam failure occurred at Heavenly creek dam, families would be impacted. These families would reside in either single-family residences or condominiums within the path of inundation. Additionally, facilities below the dam would be affected. Electricity service would be interrupted as a result of the inundation. Propane gas services would also be impacted as gas lines might be ruptured or even swept away by floodwaters. Loss of power and gas services would inconvenience and discomfort both citizens inside and outside the path of inundation.

Infrastructure associated with communication and transportation would also be affected in a dam failure. Telephone lines could be washed away, cellular towers might be lost, and cabling related to computer technologies might be damaged, further taxing information exchange options. Roads and other transportation amenities might be made impassible by mud and debris from the dam failure. Emergency personnel response times can be lengthened as a result of dangerous travel conditions. Other impacts of dam failure would be related to and determined by any natural disaster that could be considered responsible for the dam failure, such as an earthquake or severe storm.

Probability and Risk

Dam failure is an ever-present threat to the residents of the City of South Lake Tahoe who live near or around a dam. Especially impacted are those residents who live below a dam and within the potential path of inundation from water released by a dam failure. Still very few residents face those circumstances. Most dam sites are located in the predominantly remote regions of the county. Failure of this remote dam would cause damage to the landscape in the path of floodwaters, but threat to life and property would be very minimal. Moreover, there has never been a dam failure in the City of South Lake Tahoe, further reducing the any present tangible danger of a dam failure materializing. Thus, there is a **very low probability** of a dam failure in the city of South Lake Tahoe, and a **very low risk** associated with this natural hazard.

Conclusion

The possibility of a dam failure is an ever-present possibility in the City of South Lake Tahoe just as one cannot accurately predict the occurrence of an earthquake, such is the case with dam failures as well. Individuals do have an opportunity to plan for a dam failure though, in order to lessen the potential impact of the hazard event and the resulting threat to life and property.

In the areas of the City of South Lake Tahoe that are near a dam site or within a dam's potential path of inundation, damage to property and threat to the health of county residents is decreased with their ability to be prepared for dam failure. To be able to most effectively address the threat dam failure poses, citizens, families, and businesses should:

1.) Have an escape plan, including a path out of the inundation area.
2.) Store extra supplies of food and water.
3.) Store other related supplies such as flashlights, batteries, and firewood.
4.) Have a battery operated radio within their home or business.
5.) Know the locations for turning off all electrical and gas utilities.

DROUGHT

Droughts are a natural disaster that can impact the City of South Lake Tahoe. Extended periods of substantially reduced or no precipitation can severely injure recreational industries of the county. Reduction of ground and surface water resources resulting from periods of drought can also threaten residential and commercial water supplies, making drought a very serious matter among residents throughout the city. There is no specific timeframe concerning droughts; a drought can occur at any time and last for wide-ranging periods of time. An exact threshold that indicates precipitation is at drought levels is

lacking, subsequently drought measurement levels usually vary from one locale to another. There is no warning as to when a drought will begin either, making the phenomenon of drought a very enigmatic concern. For the City of South Lake Tahoe, drought occurs when winter precipitation fails to materialize.

During the winter months, the City of South Lake Tahoe experiences the majority of its annual precipitation. Four climatic factors together work to develop this annual season of precipitation: high altitude, orographic (mountain) barriers, prevailing storm tracks, and air masses.

- The city's location in a basin along the crest of the Sierra Nevada naturally gives the cities a high average elevation. Elevation ranges from about 6240 feet to over 7400 feet, with the majority of the city being in excess of 6300 feet.

- The City of South Lake Tahoe is located in a basin along the crest of the Sierra Nevada mountain range. The mountain range acts as a barrier to approaching air masses which approach the mountains from the west. The mountains act as a lifting mechanism as air masses migrate over them, increasing the chance for precipitation.

- The winter storm track for the City of South Lake Tahoe funnels storm systems from a semi permanent low pressure system in the Gulf of Alaska southward to the California coast following the Westerlies, a global atmospheric wind pattern that provides a relatively consistent westerly flow of air throughout most of City for most of the year.

- Air masses typical of the area are classified as marine polar. The city's proximity to the Pacific Ocean, in conjunction with the aforementioned storm track, brings cold and moist marine polar air masses over the city throughout much of the year, especially during the winter months.

These climatic variables are the driving factors in analyzing and categorizing the climate of the city of South Lake Tahoe, identified as a Csb climate type within the Köppen Geiger climate classification system. The Csb classification signifies that climate within the city can be considered generally temperate, with a warm temperature range, and dry summers. Important here is the indication that precipitation predominantly occurs in the winter months. Thus, drought events happen when conditions develop that redirect or hinder the path of the storm track or alter the characteristics of air masses that migrate through the city, or both conditions transpire to concurrently alter or stop the arrival of winter storms in the city. When the winter storms fail to arrive or fail to provide substantial amounts of moisture, then the potential for the development of drought is present.

The City of South Lake Tahoe is presently in a period of moderate drought based on the recent series of below-average precipitation winters. Subsequent seasonal precipitation totals have done little to mitigate overall drought conditions.

Hazard Assessment

Drought can have extensive, far-reaching effects within the city of South Lake Tahoe. Below average precipitation can have increasingly dire effects as each year of substandard precipitation builds on the years before. As seasons of drought pass, more and more hazards and threats become real dangers to the population.

The greatest effects from drought are economic in nature. Impacts on recreation operations can be devastating in an extended drought condition. Water is a necessity, the forest products industry also suffers during drought. Trees become weakened without a source of water. Trees can eventually die as a result of an extended period of no water or succumb to insect infestation in consequence of being in a drought-weakened state, water is an important ingredient. Lack of water equates to economic hardship.

Drought also impacts recreational concerns and ventures within the county. During the winter, lack of snowfall can keep Heavenly Sky Resort and Sierra At Tahoe ski resorts closed, causing a tremendous fiscal hardship on those resort operators. Other winter resort accommodations suffer in kind, as much of their business is derived from the two aforementioned major winter resorts. Day trips into the City of South Lake Tahoe for skiing, cross-county skiing, snowshoeing, and winter play are diminished. In the summer, camping can be substantially restricted during drought conditions. Dry forest conditions can cause campgrounds to close or to have campfire restrictions. Low stream and reservoir levels reduce or eliminate the potential for water sport activities. Beaches may be closed, recreational quality may be minimized, or the variety of water-related activities may be lessened.

Visitors to the City of South Lake Tahoe in the summer can expect numerous aquatic activities, including swimming, beach bathing, boating, sailing, canoeing, and fishing. All of these endeavors can be eliminated or decreased during drought.

The lack of water usually means fewer visitors to the City of South Lake Tahoe. Lowered visitation equates to lowered city sales tax revenues. During the winter, lack of snow means a lack of snow enthusiasts. During the summer, lack of water means less campers and fishermen. The effects on city economic infrastructure can be substantial, especially if the drought lasts an extended

period of time.

Not to be minimized is the threat to domestic and commercial water supplies that drought introduces. Most of the city's water supplies are drawn from groundwater supplies. In drought conditions, depth to water table increases and well production can decrease. As drought conditions worsen, well production can continue to decrease. In the worst drought conditions, well production can be severely reduced or eliminated. This danger is a real concern of citizens who, for the most part, rely upon well water for their primary water supply. City residents who rely upon reservoir water supplies are no less at risk of reduced water supplies during extended periods of drought. If drought conditions persist long enough, reservoir levels drop and surface water supplies become compromised, surface water supplies can entirely dry up when drought conditions persist.

Drought also initiates concern for other natural hazards. Wildfire potential grows exponentially as drought conditions lengthen in time. A reduction in fuel moisture can exacerbate wildland fire conditions .Additionally, to a much lesser extent, drought can be responsible for more landslide events. Lowered moisture content weakens soil structure characteristics and increases landslide potential.

Probability and Risk

Droughts are naturally occurring climatic phenomena that can and do develop in the City of South Lake Tahoe. Long periods of drought-free years can allay concerns for drought and the level of preparation for addressing periods of drought. Inevitably though, drought conditions happen and residents learn to live with periods of less than normal precipitation. Thus, there is a **high probability** of a drought developing in the City of South Lake Tahoe, but a **low risk** associated with this natural hazard.

Conclusion

The possibility of drought in the City of South Lake Tahoe is a constant concern. As with most climatic trends, one cannot accurately predict when or with what severity a drought might materialize. Despite the inability to predict drought, the certainty that a drought will eventually develop and impact residents is inarguable. Conservation of water resources should not be a response to drought conditions, but instead it should be a conscious practice at all times. Citizens should always be prepared for the onset of drought conditions.

Drought can be a devastating natural disaster. It can have far reaching economic impacts to the county and its residents. It can cripple agricultural and recreational business concerns, and leave residential and commercial properties

without water supplies. It also heightens fear and threat for wildfire events. Learning to conserve water resources is perhaps the most effective way to mitigate drought. The more residents of the county that work to protect the quantity and quality of ground and surface water resources, the more effectively and efficiently the city will be able to address drought situations.

EARTHQUAKE

Earthquakes can occur at any time in the City of South Lake Tahoe. There are no precursory events to signal an increased potential for an earthquake, no advanced alarm to warn of impended seismic activity, and no earthquake season per se. Earthquakes are simply a part of living in the City of South Lake Tahoe.

It should come as no surprise that such is the case. The City of South Lake Tahoe is located along the border of California and Nevada, two of the most geologically active, earthquake prone states in the United States. Here, two of the Earth's tectonic plates collide. The North American plate slowly moves westward, colliding with the Pacific plate. Simultaneously, the Pacific plate migrates north and westward. As it does so, the Pacific plate pulls at the North American plate to follow suit. This tensional force stretches the Earth's crust, causing a system of north-and south fault structural systems all along the boundary between the two tectonic plates. Also as a result of this tensional stress, ranges of tilted fault block mountain ranges are formed in response to this faulted crustal structure.

The City of South Lake Tahoe earthquake prone geology is resultant from this tectonic stretching. The city's is considered to be part of the Basin and Range province of the western United States. Here the Earth's crust has been stretched up to 100% of its original width. The entire region has been subjected to extension that thinned and cracked the crust as it was pulled apart, creating large faults. Earthquakes occur as part of these huge faulted mountain ranges. Moreover, virtually the entirety of the city lies within the Sierra Nevada range of mountains. This mountain range formed less than five million years ago. Through a combination of uplift of the Sierran block and down dropping of the area to the east, the Sierra rose upward, rising far more steeply to the east than the west. The entire Sierra Nevada can be thought of as an enormous tilted fault block with a long, gentle slope westward to California's Central Valley and a steep eastern slope. the City of South Lake Tahoe sits atop the crest of this gigantic tilted block of granite.

With mountain ranges formed through the stretching and faulting of the Earth's surface, earthquakes occur constantly within and around the county. Thankfully, most are of a magnitude that causes no damage and may not even be felt by the population. Earthquake magnitude is commonly measured using the Richter

scale. The Richter magnitude scale was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value. Thus, a 4.0 earthquake is roughly 31 times stronger than a 3.0 earthquake. Earthquakes with magnitude of about 2.0 or less are usually called micro earthquakes; they are not commonly felt by people and are generally recorded only on local seismographs. Events with magnitudes of around 4.5 or greater are strong enough to cause damage to property. As the magnitude increases beyond 5.0, the potential for damage to life and property increases dramatically.

Hazard Assessment

Earthquakes that occur within the City of South Lake Tahoe are unpredictable, and can occur at any time. Their anticipated magnitude is also an unknown, but an earthquake of high magnitude, 7.0 or greater, has occurred in the past and is a probability in the future. The Genoa Fault, which extends along the eastern front of the Carson Range south of Carson City, Nevada into the southern reaches of El Dorado , has been identified as responsible for two large earthquakes measuring in the magnitude seven (7) range during the past 1,000 years. Earthquakes can also initiate other natural hazard events to include Seiche”s. An earthquake can be the direct cause of landslides, avalanches, and dam failure due to seismic shaking of the ground and fracturing that might accompany any shaking. The damages wrought within an earthquake event can be the indirect cause of other natural hazard events too. Damages resulting from an earthquake might be responsible for igniting wildland fires if fallen power lines ignite or gas lines are ruptured.

The primary concern in assessing earthquake hazard is structural damage from the earthquake event. High magnitude earthquakes would most probably cause widespread structural damage within the city, especially near the epicenter of the seismic activity. It could be surmised that the closer a locale is to the origination of an earthquake the greater the extent of damage would be. Also, areas more susceptible to ground shaking are at a greater risk of damage from

earthquakes. The City of South Lake Tahoe does include land with higher probabilities for amplified shaking during an earthquake. Thus, the distance from the epicenter and the potential for ground shaking are the two major indicators of potential damage from an earthquake. In that earthquakes cannot be predicted, all of the structures in South Lake Tahoe are at risk of damage to one degree or another.

In conjunction with structural damage, earthquakes also can cause damage to utilities. Electrical lines can be compromised and power lost during an earthquake. Gas and propane lines can be ruptured. Loss of power can complicate recovery efforts. Loss of gas for heating and cooking can additionally exacerbate conditions and further discomfort citizens.

Transportation and communication infrastructure can be damaged in an earthquake. Roads can be closed by landslides or debris. Roads can suffer structural damage from fissuring, subsidence, or upheaval of the paved surface. Bridges can also be structurally compromised. When roads are compromised by earthquake events, safety is threatened, travel time is extended, and emergency personnel response times are lengthened. Telephone and internet communications can be interrupted in an earthquake as well. Telephone poles can be knocked over and telephone service lost. Likewise, internet and computer capabilities can be interrupted causing difficulties in exchange of information potentially critical in post-disaster response.

In an extreme earthquake, dam failure can become a concern. The City of South Lake Tahoe has one small dam that creates a small to medium-size lake used to create snow for recreation. Although this reservoir is in the county, a failure would directly impact the city. If the reservoir were to be compromised as a result of an earthquake, there would be many resulting ramifications to residents in the resulting path of inundation. Unfortunately, the City of South Lake Tahoe has many residents and threat to life is significant. Tremendous property damage could be anticipated in the event of any dam failure resulting from an earthquake.

City residents cannot be expected to be ever vigilant in the anticipation of an earthquake. They can though, know that a future earthquake is a likely if not guaranteed event.

Probability and Risk

Earthquakes are naturally occurring events that will eventually and inevitably occur in this region of the world. The combination of plate tectonics and associated mountain building geology, essentially guarantees earthquake as a result of the

periodic release of tectonic stresses. The City of South Lake Tahoe mountainous terrain lies in the center of the North American and Pacific tectonic plate activity. There have been earthquakes as a result of this activity in the historic past, and there will continue to be earthquakes in the future of the city. Thus, there is a **moderate to high probability** of an earthquake in the City of South Lake Tahoe, but a **moderate to low risk** associated with this natural hazard.

Conclusion

The possibility of an earthquake is an ever-present phenomenon in the City of South Lake Tahoe. Although one cannot accurately predict the occurrence of seismic activity, they can be assured that the eventuality of an earthquake is a certainty. Therefore, individuals have an opportunity to plan for an earthquake in order to lessen the potential hazards that result either directly or indirectly from an earthquake event.

With this said, damage to property and threat to the health of city residents is decreased with their ability to be prepared for earthquakes. To be able to most effectively address the threat of earthquakes, and the landslides, avalanches, and other dangers associated with them, citizens, families, and businesses should:

1.) Have a plan, including alternative travel routes.
2.) Store extra supplies of food and water.
3.) Store other related supplies such as flashlights, batteries, and firewood.
4.) Have a battery operated radio within their home or business.
5.) Know the locations for turning off electrical and gas utilities.
6.) Develop a home escape plan and practice implementing the plan.

FLOOD

The City of South Lake Tahoe is located entirely within the mountainous Sierra Nevada. The Drainages that course from the Sierra Nevada traverse through high-relief, deeply-cut river canyons with only occasional level areas that might be termed floodplains, finding Lake Tahoe at their end. Regardless, tremendous amounts of water can be gravitationally fed through these river canyons with 63 tributaries empting in Lake Tahoe and only one river the Truckee empting out, The City of South Lake Tahoe subsequently has a long history of flood events.

There are miles of drainage within the City of South Lake Tahoe There are over 276 square miles of slope drainages from El Dorado county and a small northern section of Alpine County which drain into Lake Tahoe.

Three types of flood events are typical to the City of South Lake Tahoe. Each type of flood event causes associated water, erosion, and sediment damage within the watersheds where the flood event transpires. The three types of flooding are:

- Wet-mantle
- Rain-on-snow
- Dry-mantle

Wet-mantle and rain-on-snow are typically late winter or early spring occurrences and are generally widespread in nature. Characteristically, wetmantle and rain-on-snow flooding develops when warm rains fall on already saturated ground. Particularly devastating are flood events where heavy snows precede warmer rain events, causing the mantle of snow to melt and run off in conjunction with the rain. Dry-mantle flood events are a result of violent summer thunderstorms and are much more localized in nature.

The City of South Lake Tahoe has a well-chronicled history of flooding dating to the 1850s and the settlement of the areas in and around the city. The earliest flood of record following permanent habitation of the region occurred in December 1852 and was a precursor to the type of flooding characteristic to the Carson River watershed. As described in one historical journal, the storms began "with a heavy wet snow, which lasted for two days and left a three-foot snow depth across Carson Valley. Beginning with the storm's third day, the snow typically turned to a relatively warm rain, which lasted another four days, until December 30. By that time, the snow accumulation had completely melted and run off, along with great quantities of rainwater." Most of the substantial flood events on the historical record occurred in this fashion.

Dry-mantle flooding is characteristic of localized summer thunderstorm activity. Dry-mantle flooding is not widespread, as in the case of wet-mantle and rain-on snow events. This thunderstorm related flooding can be a major concern though, as severe local rain and hail can create conditions for flash-flooding and considerable threat to life and property. No historical record is available for dry-mantle flood events.

Hazard Assessment

Because of the predominantly high relief of the City of South Lake Tahoe, the effects of flooding are generally confined to areas near the waterways of the city. As waterways grow in size, from local drainages up to the primary rivers of the city, so grows the threat of flood and the dimensions of that threat. The presence of floodplain topography severely multiplies the flood hazards and the scope of flood impact.

The majority of flood related hazards in the City of South Lake Tahoe are transportation related floods waters do not normally cause road closure due to inundation because of the aforementioned lack of floodplains. Rather, roads are closed due to varying degrees of erosion-related washout. At the most minimal levels, road shoulders are compromised due to high levels of runoff from precipitation. Roads may be reduced to passage in only one direction at a time. At the most severe levels, whole road structures are eroded away from high river discharges for distances in excess of one-hundred yards. In these instances, bridge facilities can be threatened or lost because of debris impacting the bridge structures. In either case, road damage and road closure affects the transportation infrastructure of the city, interrupting the movement of people, supplies, and services while reducing productivity because of increased commute time. The city's public safety response is affected as well, slowing the arrival of police officers and fire suppression personnel as well as other emergency response personnel.

Flood related erosion can cause damage to homes, businesses, and government structures, including damage to ancillary structures, utilities, and parking facilities. Structural foundation undercutting is the most prevalent form of damage to structures. Structures can also be damaged from trees falling as a result of water-logged soils.

Electrical power outages happen and the interruption of power causes many problems. The effects of lost electricity are elaborated upon in the severe storm section of this document. Lost power is usually a precursor to the closure of government offices, or the offices may be subject to reduced schedules. Public schools may also be closed or on a delayed start schedule as well.

Dry-mantle flooding, although not as impressive in extent, possesses many hazards as well. Dramatic, localized flash flooding can occur as a result of extreme thunderstorm activity and associated heavy rainfall. Flood damages can be just as substantial in a flash flood/thunderstorm event. The production of lightning and hail stones introduces additional natural hazard. Property damage can include erosion of structural foundations, hail damage to structures and vehicles, and the potential of electrical outages and wildland fires due to lightning strikes.

Probability and Risk

Floods have been a part of the City of South Lake Tahoe historical past and will continue to be so in the city's future. The presence of floodplain within the vast majority of the city control the extent and magnitude of damages directly attributed to any flood event. The geography of the city, namely it's, large wetland and meadows funnels floodwater out of the city and deposits it on

floodplains before reaching the lake. Winter wet-mantle and rain on-snow flood events are more widespread and more severe than summer dry-mantle flood events. In the spring, the type of precipitation and the timing of that precipitation are critical in determining the threat of flood, and these characteristics further dictate the potential for widespread damages.

Consequently, the spring flood is of most concern to assorted governmental services, including the public works department, fire departments, emergency medical services, search and rescue units, and the City's police. department. Depending upon the severity of flooding, emergency shelters might occasionally be required.

Based on the history of flooding in the City of South Lake Tahoe, there is **High Probability** of a flood event occurring in the City of South Lake Tahoe. Although the probability of flooding is high, there is **Low to Moderate Risk** to life and property within the city due to the geography of this mountainous region and the rivers that flow from it.

Conclusion

Aside from severe storms, flooding is the most frequent natural hazard event in the City of South Lake Tahoe. Floods can cause a tremendous amount of damage within the city, but the overwhelming majority of that damage is generally limited to transportation infrastructure. The presence of floodplains within the city restricts damages to within the wet land and meadows of the city and consequently limits the amount of damages inflicted upon residents and real and personal property to a relatively small area of the city. In contrast though, flash flooding resultant from summer thunderstorms could happen anywhere within the city, but not nearly at the level of a spring flood event.

Although a flood is not going to occur with the frequency of a severe storm, individual citizens, families, and businesses of the city should to be prepared to address floods when they occur. As in the case of earthquake, fire, and other natural disasters, citizens should prepare themselves before such an event takes place. To be able to effectively address flood problems, citizens, families, and businesses should:

1. Have a plan, including a set of alternate travel routes.
2. Store extra supplies of food and water.
3. Store other related supplies such as flashlights, batteries, firewood, etc.
4. Have a battery-operated radio within their home or business.
5. Stay aware of weather trends, especially after considerable periods of snowfall or rain.

LANDSLIDE

The City of South Lake Tahoe's terrain and climate combine to create conditions conducive to landslide. Where avalanches are a threat isolated primarily to the winter months, the threat of landslides is generally distributed throughout the year. Most landslide events are associated with and resultant from other natural hazards such as seismic activity or floods.

Landslide is a generic term which is defined as the downward sliding of a relatively dry mass of earth and rock. An even more simplistic definition is "slope failure." The primary factor involved in landslides is gravity, but three other factors have varying degrees of influence. They are:

- slope angle
- slope material, and
- amount of water.

Gravity is the constant in any equation trying to quantify the stability or instability of a slope face. Slope angle, slope material, and the amount of water are the variable factors that, combined with gravity, determine slope stability. Other factors that help identify the stability of a slope to a lesser degree are vegetation and climate.

Landslides are categorized into groups using two variables; the type of movement and the type of material that is involved. Type of movement is categorized into three groups:

- falls
- slides, and
- flows.

The amount of water usually is the defining ingredient when classifying the movement. In falls, very little water is present, whereas in flows there is a substantial amount of water involved. The type of material involved is broken into three groups: soil (earth), rock, and debris. Thus, one can identify rockfalls, earthflows, or debris slides. Again, each of these events is determined by the composition of materials and the speed of movement. A rockfall is dry and fast while a debris flow is wet and fast. Regardless of the speed of the slide, the materials within the slide, or the amount of water present in the movement, landslides are a serious natural hazard.

Landslides and mudslides cause up to two billion dollars in damage annually in the United States. They are attributed to between 25 and 50 deaths annually.

In the City of South Lake Tahoe, with the city's high-relief landscape, landslides are a natural hazard concern. Although no lives have been taken as a result of landslides, the threat to life and property is real. In recent history, landslides occurred as a result of the weather associated with the January 1997 storm.

Landslides are a natural process and are unavoidable in the long term, being due to the patient nature of gravity and the gradual weathering of the Earth's surface. Although natural disturbances like earthquakes and storms can trigger landslide events, humans can also have a direct effect on and even accelerate landslide occurrence. Any time a slope is graded or cut into, a formerly stable slope can become unstable, eventually seeking a new equilibrium in the form of a landslide.

Hazard Assessment

Landslides that occur within the City of South Lake Tahoe are most often experienced as part of a larger, more widespread natural hazard event. Landslides can take place as a result of severe storms, floods, and earthquakes. They can also happen as an aftermath to wildland fires.

In that landslides are ancillary events within larger natural hazard events, the dangers resulting from these parent hazard events are concurrent to landslides. If electrical lines are compromised within the slide, electrical power can be lost. The length of time power is interrupted is a direct result of the size of the slide and its impact upon the power lines and electrical infrastructure. Water lines and other buried facilities can be put in danger or lost to a landslide as well. Roads and highways are often victimized by landslide events. Excavations into slopes to create roadbeds cause a disruption to the natural slope while simultaneously steepening the slope face. These two consequences together weaken slope structure and introduce the potential for landslides. This potential is often realized when severe storms produce increased moisture, the result being slope failure and landslides. When roads are compromised by landslides, motorist safety is threatened and travel time is lengthened. Emergency personnel response time is also affected.

Landslides can threaten the stability and safety of homes in two ways. If the slope fails above a home, the foundation and the structure itself can be threatened. The weight of the slide, the water, earth, and vegetation that has become mobile, can slam into a house, knock the structure from its foundation and perhaps even destroy the house. If the home sits on a bench cut into a hillside, the potential for a landslide is again introduced. Construction of a home on a graded or altered slope can have devastating effects. Changing of the slope face, the additional weight of the home and associated materials, plus the added water of sprinkler systems and septic tanks, make a formerly stable slope

unstable. Add a severe storm with substantial rainfall and the home and the artificial slope it sits upon can be victimized by landslides.

Since degree of slope directly affects the gravitational force exerted upon land and its potential to slide, much of the City of South Lake Tahoe is potentially impacted by landslides. This potential threat is increased when other natural hazards that trigger landslides occur. In this fact, city residents should be more alert to the potential for landslides whenever natural hazards that generate landslides, such as severe storms or floods, are happening.

Probability and Risk

Landslides are naturally occurring events that will inevitably happen as long as gravity itself is a controlling factor upon the landscape. Since the City of South Lake Tahoe mountainous terrain challenges gravity as it rises to over 7,400 feet, much of the high-relief topography in the county can be identified as land with the potential for landslides. Much of that land though is in remote and undeveloped locales, which reduces the risk of this natural hazard. Thus, there is a **moderate to high probability** of landslide in the City of South Lake Tahoe, but a **moderate to low risk** associated with this natural hazard.

Conclusion

Landslide hazard in the City of South Lake Tahoe can be considered a year-round phenomenon. The city's high-relief and high-altitude landscape promote the wearing away of the landscape via both physical and chemical weathering mechanisms. In the winter, added moisture in the soil strata can generate landslides, and the varying temperature ranges during the summer months can have a similar effect. In general, higher slopes equate to higher landslide potential. Therefore, individuals should be alert in high-relief areas to the threat to landslides at all times of the year. In flatter, level areas of the city, the threat from landslide is greatly diminished.

Landslides are more prevalent as a result of earthquakes, floods, and severe storms. They are also to be expected after wildland fires. This tendency can act as an early warning to the presence of landslide danger, allowing the public to be appropriately prepared for the possible occurrence of a landslide. With this said, damage to property and threat to the health of county residents is decreased with their ability to be prepared for landslide events during or as part of larger natural hazard events.

To be able to most effectively address the threat of landslides, citizens, families, and businesses should:

1.) Have a plan, including alternative travel routes.
2.) Store extra supplies of food and water.
3.) Store other related supplies such as flashlights, batteries, and firewood.
4.) Have a battery operated radio within their home or business.
5.) Stay aware of soil conditions, especially during periods of considerable rainfall.

SEVERE STORMS

The climate of the City of South Lake Tahoe is inherently conducive to severe storm weather events and severe weather events can happen at any time of the year. These severe weather events can be broken down into three categories:

1.) severe winter storm
2.) severe windstorm
3.) severe thunderstorm

Severe Winter Storm

During the winter months, the City of South Lake Tahoe can experience strong winter storms. Four climatic factors together work to create a higher than average potential for severe winter storms: high altitude, orographic (mountain) barriers, prevailing storm tracks, and air masses.

o The city's location in a basin along the crest of the Sierra Nevada naturally gives the county a high average elevation. Elevation ranges from about 6,240 feet to over 7,440 feet, with the majority of the county being in excess of 6,300 feet.

o The City of South Lake Tahoe is located along the crest of the Sierra Nevada mountain range. The mountain range acts as a barrier to approaching air masses which approach the mountains from the west. The mountains act as a lifting mechanism as air masses migrate over them, increasing the chance for precipitation.

o The winter storm track for the City of South Lake Tahoe funnels storm systems from a semi permanent low pressure system in the Gulf of Alaska southward to the California coast following the Westerlies, a global atmospheric wind pattern that provides a relatively consistent westerly flow of air throughout most of the year.

o Air masses typical of the City of South Lake Tahoe are classified as marine polar. The city's proximity to the Pacific Ocean, in conjunction with the aforementioned storm track, brings cold and moist marine polar air masses over the city throughout much of the year, especially during the winter months.

Putting all four of these climatic variables together equals a higher than average potential for severe winter weather events. Cold moisture-laden air masses are carried from the Gulf of Alaska southward with the Westerlies. Following the storm track, this moist air encounters the Sierra Nevada, becomes unstable as it is forced over this natural barrier, and provides large amounts of precipitation before migrating eastward. In the winter months, heavy snows might be the result, with extremely strong winds accompanying the precipitation.

An example of a severe winter weather event in the City of South Lake Tahoe is the winter storm of December, 2004. In a three day span, two to as much as three feet of snow fell in the area of the City of South Lake Tahoe accompanied by "ferocious" winds. At higher elevations in the city, as much as ten feet of snow was reported to have fallen. The combination of heavy snows and strong winds knocked out power to the city, while residents of the county went without power for several days. County offices and local schools were shut down. Roofs in the Y area of the city were damaged. In summary, every resident of the city was in some way adversely affected by this severe weather event.

Severe Windstorm

In any season, the mountainous landscape promotes the formation of wind, often winds at very high speed. Windstorms can affect all areas of the city during any month of the year. During the December, 2004 storm, wind speeds in excess of 80 miles per hour were recorded at Heavenly Ski Resort and over the western rim of the Tahoe basin.

Severe Thunderstorm

During the summer months, climatic factors combine to promote the development of thunderstorms. As heated air from lower elevations rises and rapidly cools, intense thunderstorm cells can develop in South Lake Tahoe's high elevation landscape. These thunderstorms often have hail as large as golf balls.

Hazard Assessment

The effects of severe weather events such as snowstorms, thunderstorms, and windstorms are likely to exhibit certain similarities. Downed trees and fallen power lines might occur. Transportation around the city can be affected too, with road closures interrupting movement. Damages to homes, businesses, and government buildings are a possibility. Fatalities as a result of severe weather events are uncommon, but can occur on occasion. Electrical power outages happen with most extreme weather event. The interruption of power causes many problems. Loss of electricity affects heating of homes, heating of water, pumping of water, refrigeration, lighting, computing, and loss of communication systems like television and the internet. Additionally, businesses lose the use of cash registers, gasoline pumps, restaurant kitchen appliances, and the like.

Severe winter storms produce snow and ice. The majority of problems associated with severe winter storms are transportation related. Roads are closed or are open only to vehicles that are properly equipped. Productivity is lost due to the increased time it takes to go from one point in the county to another. When roads are closed for avalanche prevention or snow removal, drivers who must wait by the roadside are put at an increased risk because being stranded in route. Electrical power might be lost. Government offices may be closed or subject to reduced schedules. Public schools also may be closed or on a delayed start schedule. Structures are put at an increased risk due to increased snow loads on roofs, and the increased threat of falling trees or power lines.
Severe windstorms pose potential hazards. Power and phone lines may be knocked over and electrical power might be lost. Downed power lines pose a fire and/or electrocution threat. Uprooted trees and fallen limbs pose possible hazards to roadways, structures, vehicles, and people. Extremely violent windstorms might also damage large tracts of commercial forest causing economic losses to the forest products industry and to recreation.

Severe thunderstorms introduce natural hazards of lightning, hail stones, and flash flood. Electricity can be interrupted by lightning strikes, property damage can occur if hail stones reach a large diameter, and flooding can occur with particularly intense or prolonged rain events associated with the thunderhead. Recreational activities can also be interrupted. Playing field and pools and beaches may be temporarily evacuated, and hot springs facilities may close for safety reasons.

Probability and Risk

Severe storm events happen in all parts of South Lake Tahoe at all times of the year. The degree of regularity is greater during various seasons for the different

storm types, but the overall threat of a severe storm event is a relative constant over the calendar year.

Some storms are more severe than others. When this is the case, assorted governmental services might be activated. These might include the public works department, Police and fire departments, emergency medical services, search and rescue units, and the county sheriffs department Basin sub station. The length of time electrical power is interrupted is often the leading indicator of a storm's severity, and also dictates the level of response from the indicated agencies. If a storm causes an extended period of power interruption, emergency shelter might be required, especially during the cold winter months.

Based on the history of severe storms in South Lake Tahoe, there is a **High Probability** of a severe storm event occurring in South Lake Tahoe Although the probability of a severe storm is high, there is a **Low to Moderate Risk** to life and property within the city, due to the overall preparedness of this mountainous region in addressing, managing, and acclimating to severe weather events.

Conclusion

Of all natural hazards, the severe storm event has the greatest probability of occurrence in South Lake Tahoe. Severe storms of any type can cause a great amount of damage and can affect the lives of the City of South Lake Tahoe citizens in a meaningful way. All of the City of South Lake Tahoe is subject to severe storm events, and these events can occur during any time of the year. The City of South Lake Tahoe experiences all types of severe weather during all seasons of the year. Severe weather events can take the form of wind storms, rain storms, snow storms, hail and thunderstorms. When severe storm events do occur, they have the potential to significantly impact South Lake Tahoe, presenting a genuine threat to the lives of South Lake Tahoe's residents and the personal and real property of citizens, triggering the prospect for considerable economic loss. Due to the possible frequency of severe storm events, individual citizens, families, and businesses of the city need to be prepared to address severe storms when they occur. As in the case of earthquake, fire, and other natural disasters, citizens should prepare themselves before such events take place. To be able to effectively "weather the storm," citizens, families, and businesses should:

1. Have a plan.
2. Store extra supplies of food and water.
3. Store other related supplies such as flashlights, batteries, firewood, etc.
4. Have a battery-operated radio within their home or business.

5. Trim all tree limbs away from buildings.
6. Secure all potentially wind-blown possessions when not in use.

WILDLAND FIRE

Wildland fire is perhaps the most dangerous natural disaster threat in the City of South Lake Tahoe. Annually, as winter precipitation diminishes and the seasonal snow pack melts, the possibility of fire concurrently increases. Generally, the wetter the winter, the lower the wildfire threat during the following dry summer months. Other climatic variables can, and often do, skew that simplified statement though. When the precipitation fell, whether the precipitation was snow or rain, when the moisture melted, how fast the melt-off occurred, and wind characteristics; all of these considerations as well as others are seasonal indicators as to the potential severity of wildland fires during the dry summer season.

Regardless of the seasonal environmental variables that act as indicators of wildland fire potential, most wildland fire events are caused by human actions. Whether the ignition source is a discarded cigarette, an unattended campfire, or an act of arson, it is people who have the greatest impact on and control over the number of wildland fires in a fire season. Mother Nature can also be responsible for igniting wildland fires. Lightning is an especially dangerous element during the dry summer season.

Wildland fires also tend to originate in lesser developed areas. These natural lands pose a difficult problem for fire suppression personnel. First, natural lands tend to contain a denser variety of vegetation, providing more fuels to ignite and spread a fire. Fires can grow rapidly in these denser fuel environments. Second, fire fighting personnel are usually located farther from these lesser developed areas. The extended time it takes for fire suppression personnel to reach and react to a wildland fire further complicates the effort to contain and extinguish a newly ignited wildland fire.

There have been relatively few major wildland fires in the City of South Lake Tahoe in the last twenty (20) years. In July 2002, the Gondola Fire burned approximately 670 acres in the county and cost 3 million dollars to suppress. As with most fires it started in the dry summer months and the fire was caused by human activity.

Hazard Assessment

Wildland fire danger is a seasonal hazard and provides some measure of awareness and predictability to the hazard. The threat of wildland fire increases

as winter snowpack melts, summer temperatures rise, and forest fuels become dry and susceptible to fire. The summer months of June, July, August, and September are traditionally the wildland fire season in the City of South Lake Tahoe. Fire season can extend later into the year until appreciable precipitation arrives in the fall.

The California Department of Forestry (CDF) is responsible for providing wildland fire protection on all State and private timberlands, watersheds, and rangelands in El Dorado County . For much of El Dorado County, the CDF contracts out this responsibility to the United States Forest Service (USFS). While, in general, the USFS is adequately prepared to protect developed areas in the instance of wildland fire, Forest Service fire fighters are not equipped, trained, or legally permitted to fight structural fires. The City is served by a paid fire department with three stations strategically located in the population centers of the city for structural fire protection. With only approximately 23,850 year-round residents, and a large tourist population, structural fire protection has been adequate.

Despite having a sound Urban wildland interface planning document in place, which includes fuel reduction strategies and working closely with the Tahoe basin Management unit, wildland fire remains a threat. According to the National Fire Danger Rating System wildland fire severity classifications for El Dorado County, many areas of the county that presently contain or are planned to contain residential development have moderate or high wildland fire hazard ratings. The CDF also has a fire rating system called the Fire Hazard Severity Classification System which considers quantity of flammable vegetation within a critical fire area, weather, and slope. This system rates the entire El Dorado County as "high hazard."

The Insurance Services Office of California has given communities low fire insurance ratings that indicate a high potential for fire occurrence. The ratings are on a scale of one (1) to ten (10) with ten being the worst fire potential rating possible. The City of South Lake Tahoe area is rated 5, The Lukens Water area is rated at 9 for areas within 100 feet of a fire hydrant. These ratings only substantiate the high potential for wildland fire throughout The City of South Lake Tahoe.

Of greatest concern in assessing wildland fire hazard is the threat to human life that wildland fire poses. The City of South Lake Tahoe geography promotes swift movement of fire once one has been ignited. Combined with possibly high fuel loading due to large urban wildland interface areas, and dry summer conditions, the City's high-relief landscape and strong localized wind patterns only enhance the rapid spread of fire. Population clusters in the city are predominantly located in areas less vulnerable to wildland fire, but the hazard is obviously still a very prevalent one as indicated in the previous

rating scales. Three variables dictate the level of hazard a wildland fire potentially presents:

- The location of the fire's origin.
- The weather at the time of the fire.
- The time of year the fire ignited.

The further the fire's point of ignition is to the primary responder to the fire, the greater the opportunity for the fire to grow and establish itself. The longer it takes a fire fighting team to arrive on scene, the greater the potential for a wildland fire to spread. The weather at the time the fire starts weighs tremendously into how the fire might spread. If the fire starts during a period of high humidity or cooler temperatures, again the potential for rapid spread is lessened. If the fire starts during low humidity and high temperatures, the potential growth of the fire is substantially increased. The time of year when the fire starts is critical as well. If a fire ignites early in the summer when fuels are still relatively wet, the growth of the fire is hampered. But if the fire is ignited late in the summer when fuels are tinder-dry, then the potential for a large wildland fire grows exponentially. The three previous variables together act as indicators of the potential size of a wildland fire. The presence of wind equates to additional growth of the fire.

Wildland fires can have devastating effects that are essentially measured in terms of how much area is burned in the fire. The more area that burns, the greater the impact to the following:

- Loss of forest can have a serious impact on wildlife and wildlife habitat. Restoration of wildlife habitat could take decades to evolve back into prefire habitat conditions.

- Loss of timber in a wildland fire event could impact the economic health of the city for decades.

- Recreational opportunities could be deteriorated or reduced as a result of fire. Campgrounds and other recreational features could be destroyed or damaged.

Just as important are the environmental hazards created in the aftermath of wildland fire. Burnt slopes could become unstable without vegetation. Steep slopes could suffer landslides and mudslides when winter precipitation arrives. Mud and debris could choke streams and rivers, diminishing water quality and endangering fish habitat. Recreational access roads could be damaged or washed away, reducing or eliminating recreational opportunities in the city. In turn, the economic health of the county could be jeopardized by a large-scale wildland fire event. Loss of revenue from the tourism and recreation industry

might impact city revenues and consequently lower the level of City services. The recreational industry might see a reduction in camping, fishing, hiking, biking, sight-seeing, and other recreational activities, lowering sales and transient occupancy tax revenues to the city. The service industry and the Real Estate industry could be impacted as well.

Depending on the size and location of the fire, transportation and communication infrastructure could be seriously affected. Electrical power poles and transmission lines could be lost to flames. Underground utilities could be damaged, including transmission cables, gas pipelines, and water delivery systems. Roads could be closed for an extend length of time, or open on a reduced access schedule.

Loss of power also complicates daily routines. Lack of electricity and/or natural gas can make cooking, cleaning, and heating impossible for many. More catastrophic is the potential loss of homes, structures, and lives if a wildland fire enters a home site. This becomes more and more a possibility as homes are built in the City of South Lake Tahoe

Probability and Risk

Wildland fires are naturally occurring hazard events that have and will happen in the City of South Lake Tahoe. The probability and risk of a wildland fire is seasonal in nature, with the greatest potential for a wildland fire being during the dry months of summer and early fall. Many variables combine to dictate the severity of risk for wildland fire occurrence. These considered, there is a **moderate to high probability** of a wildland fire in the city of South Lake Tahoe, and a **moderate to high risk** associated with this natural hazard.

Conclusion

Wildland fires have happened in the City of South Lake Tahoe in the past and will inevitably happen in the future. The city's dry summer climate enables an annual seasonal threat to wildland fire, a threat that is periodically realized in potentially devastating fashion. Citizens have an opportunity to minimize the threat of wildland fire by creating defensible space around structures, which includes appropriate landscaping. Use of fire resistant roofing assists in protecting structures from wildland fire. Because of residents ability to be prepared for the possibility of wildland fire, damage to property and the threat to human life is decreased. To be able to most effectively address the threat of wildland fires, citizens, families, and businesses should:

1.) Have an escape plan, including alternative travel routes.
2.) Store extra water for use against wildland fire.

3.) Have a battery operated radio within their home or business.
4.) Know the locations for turning off electrical and gas utilities.
5.) Develop defensible spaces around all structures on their property.
6.) Consult with fire officials for specific advice and guidelines to protect both their lives and their property.

Seiches

Seiches are oscillations in enclosed bodies of water caused by or causing seismic waves. They can occur very far from the source of an earthquake. A seiche occurred in Lake Union and Lake Washington in 1964 following the large Alaskan earthquake. The long, large waves beat boats against docks, damaging many of them.

Long period movement of water can also be produced in lakes and reservoirs by large, usually distant, earthquakes, and sometimes by strong winds. In the late nineteenth century a Swiss professor, F.A. Forel made a systematic study of this type of a water wave, which he called a seiche. Seiches are described as "a standing wave in a closed body of water such as a lake or bay". A seiche can be characterized as the sloshing of water in the enclosing basin. The permanent tilting of lake basins caused by nearby fault motions has produced very energetic seiches. Seiches caused by earthquakes are termed as seismic seiches, a term coined by Anders Kvale in 1955 to describe oscillations of lake levels in Norway and England caused by the **M**8.6 1950 Chayu earthquake. More recently the **M**7.9 Denali earthquake in 2002, caused seiches as far as Louisiana and many other states in the continental United States.

Lakes in seismically active areas, such as Lake Tahoe in California/Nevada, are significantly at risk from seiches. Geological evidence indicates that the shores of Lake Tahoe may have been hit by seiches and tsunamis as much as 10 m (33 feet) high in prehistoric times, and local researchers have called for the risk to be factored into emergency plans for the region

Hazard Assessment

Several factors could influence the size, shape, volume, and potential destructiveness of a seiche's generated by local faults. First, since Lake Tahoe is deep, there is large volumes of water to displace. Therefore, a resulting seiche would be faster and have greater volume than those generated in the shallow water. Second, Lake Tahoe steeply sloping bed tends to increase the chance that a seiche will break on the shore, thus potentially enhancing a seiche's destructiveness. All major roads that provide ingress and egress to the Tahoe Basin circumnavigate the lake and would be affected if not rendered impassable. Finally, the shape of Lake Tahoe could increase damage by

funneling waves together, increasing wave height. The net result is unclear, as the depth versus shape relationship of Lake Tahoe is relatively unknown.

Estimated recurrence rate of an earthquake in the Lake Tahoe area faults of the size necessary to generate a seiche is estimated at once every 1,100 years. With regards to seiche threats, Lake Tahoe could experience a seiche as it did in prehistoric times. In those years, there was no development near the waterfront as there is now. As a result, since the seiche threat was not recognized until recently, most of the structures located near the water were probably not engineered to withstand them.

Additional impacts from a seiche include floating debris with the potential to batter and damage inland structures. The sheer impact of the waves could cause breakwaters and piers to collapse. Boats moored in harbors would also be at risk, as they could be swamped, sunk or left battered and stranded high on the shore.

A seiche's rapid onset could also hamper the ability of motorists to exit the city before it began. Additionally, the “sloshing” effect of a seiche could cause damage to moored boats, piers and facilities close to the water. Secondary problems, including landslides and floods, are related to accelerated water movements and elevated water levels. Many landslide prone bluff areas are in residential settings, so risk could be quite high in the event of a secondary seiche threat.

Probability and Risk

Seiche’s are naturally occurring hazard events that have occurred in the City of South Lake Tahoe. The probability and risk of a seiche is directly related to land movement. That considered, there is a **moderate to high probability** of a land movement in this seismically active area, and, a **moderate to high risk** associated with this natural hazard.

Conclusion

The possibility of a seiche is an ever-present phenomenon in the City of South Lake Tahoe. Although one cannot accurately predict the occurrence of seismic activity, they can be assured that the eventuality of an seiche is a certainty. Therefore, individuals have an opportunity to plan for an seiche in order to lessen the potential hazards that result either directly or indirectly from an seiche event.

With this said, damage to property and threat to the health of city residents is decreased with their ability to be prepared for seiche. To be able to most effectively address the threat of seiche, and the landslides,

floods, and other dangers associated with them, citizens, families, and businesses should:

1.) Have a plan, including alternative travel routes.
2.) Store extra supplies of food and water.
3.) Store other related supplies such as flashlights, batteries, and firewood.
4.) Have a battery operated radio within their home or business.
5.) Know the locations for turning off electrical and gas utilities.
6.) Develop a home escape plan and practice implementing the plan.

IDENTIFIED ASSETS AND POTENTIAL LOSSES

The City of South Lake Tahoe Natural Hazard Mitigation Plan identifies critical facilities located in the City and the hazards to which these facilities are susceptible. A critical facility is defined as a facility in either the public or private sector that provides essential products and services to the general public, is otherwise necessary to preserve the welfare and quality of life in the City of South Lake Tahoe, or fulfills important public safety, emergency response, and/or disaster recovery functions. The table on the following pages identifies critical facilities in the City, specific natural hazards that might affect each individual facility, and the potential losses that might occur. This data was compiled from numerous sources. These sources include insurance industry records. Additionally, historical records were researched, citizens interviewed, and the County GIS was employed as an analysis tool to define hazards and gauge levels of vulnerability. The City of South Lake Tahoe is a predominantly rural, mountainous area of the Sierra Nevada in central eastern California. The majority of the land in the city, roughly 80 percent, is privately held. The remaining lands are in the federal trust, and held by the California Tahoe Conservancy.

As of 2003, the City's population was 34,000 residents, with an anticipated growth rate of less than five (1) percent projected. Nonetheless, the city of South Lake Tahoe is surrounded by areas that are experiencing high levels of development. In Douglas County, Nevada to the east, there has been record growth in the past decade. To the north in Placer, County California, a similar although not quite as dramatic development trend has occurred. The City of South Lake Tahoe General Plan will function to guide that development. The remaining areas of the city should not anticipate any significant changes in present land uses. Improvements to community road and utility infrastructure might certainly be initiated within or apart from any development proposal.

Section III –South Lake Tahoe Natural Hazards Mitigation

Strategy

Mitigation Goals

The City of South Lake Tahoe Natural Hazard Mitigation Plan has identified the natural hazards that could impact the residents and property in the city and assessed the risks inherent to each hazard.

Mitigating the effects of these natural hazards has long been a goal of city residents. Throughout the history of the city, residents have looked for and implemented measures designed to lessen the effects of natural hazards. As an example, the Tahoe Fire Safe Council recently completed a hazardous fuels reduction program in the Pioneer Trail area . Here, a grant program was utilized to facilitate community-based wildland fire prevention activities, including a fuel break around the neighborhood and fuel reduction treatments on individual lots.

The goals identified in the City of South Lake Tahoe Natural Hazard Mitigation Plan are multi-jurisdictional in their scope and intent. As indicated in the introduction of this document, the goals of creating and implementing the Natural Hazard Mitigation Plan are to:

- Save lives and protect property.
- Reduce impact of future disaster events.
- Enable post-disaster funding.
- Hasten recovery from disasters.
- Demonstrate a dedication to improving the city's safety and well-being.

These goals are applicable to all natural hazards identified in this plan. Although the plan goals might appear overly broad in scope, their intent, namely to reduce the threat of natural hazards through mitigation approaches, is still quite clear in definition and vision. From these goals come the objectives of the City of South Lake Tahoe Natural Hazard Mitigation Plan. The objectives are arranged in a manner that addresses each natural hazard individually. From the goals, objectives are derived, and from the objectives, actions are formulated.

A final set of objectives addresses mitigation measures that are applicable to all natural hazards identified within the plan.

Prioritizing Mitigation Measures

In order to identify which natural hazards pose the greatest threat to the city, a multi-faceted and multi-tiered approach was utilized. First, the probability and risk assessments from Section II of this plan were scaled and quantified in order to provide an overall City-wide assessment of where the greatest threats from

natural hazards lie. From this probability and risk matrix, an initial measure of the identified natural hazards was calculated. Although basic in nature, the Natural Hazard Probability/Risk Assessment Scoring Matrix provides a fundamentally sound, broad-based foundation from which to build more refined comprehension of natural hazard threats in the City.

Natural Hazard Probability/Risk Assessment Scoring Matrix

SCALING NATURAL HAZARD PROB. RISK TOTAL

1 Dam Failure, Very Low 1 1 2
2 Seiche, Low 2 1 3
3 Avalanche, Low 2 1 3
4 Drought, Moderate/Low 6 2 8
5 Earthquake, Moderate, 5 3 8
6 Landslide, Moderate/High, 5 3 8
7 Flood, High 6 3 9
8 Severe Storm, Very High 6 3 9
9 Wildland, Very High, Fire 5 5 10

Mitigation Objectives

The following is a list of objectives developed in conjunction with the overall goals of this plan. These objectives are multi-jurisdictional in their intent and scope. Within each objective, one or more actions designed to facilitate the realization of the objective are identified. The objectives are sorted by specific natural hazards and are arranged in the order of priority identified in the Natural Hazard Rating Table. The highest priority objectives and actions are listed first, with the lowest priority objectives and actions listed last.

WILDLAND FIRE

Objective #1: Minimize the threat to lives and property posed by the possibility of wildland fire within the county.

Action 1.1: Review and update City ordinance to ensure the construction of fire-resistant homes in the future.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: Fire, Public Works, Building, and Planning Department.

Action 1.2: Enforce City ordinance relating to road construction to facilitate emergency vehicle ingress and egress.
Timeframe: Ongoing
Funding: No additional funding required.
Staff: Fire, Public Works, Building, and Planning Department.

Action 1.3: utilize the existing Urban wildland planning document to Identify wildland interface buffer areas surrounding established communities in the city.
Timeframe: On-going.
Funding: No additional funding required.
Staff: Fire, USFS, TRPA, Nevada Fire Safe Council.

Action 1.4: Reduce fuel loading within identified wildland interface buffer areas.
Timeframe: On-going.
Funding: Unknown funding source.
Staff: Individual property owners, Nevada Fire Safe Council, the California Conservation Corp, TRPA and affected government agencies.

Action 1.5: Promote improved forest health within the National Forests of the City to reduce fuel loading in the forests of the City.
Timeframe: 5 year plan.
Funding: No additional funding required.
Staff: TRPA United States Forest Service Basin Management unit.

Action 1.6: Endorse “firewood sales” by the Forest Service as a method of fuel load reduction in the National Forests of the City.
Timeframe: On-going.
Funding: No additional funding required.
Staff: Forest Service personnel.

Action 1.7: Sponsor a community “refuse pile” to promote the removal of vegetive refuse material from private parcels.
Timeframe: On-going.
Funding: No additional funding required.
Staff: Public Works Department Local Chipper Programs.

Action 1.8: Develop a homeowner guide for reducing the threat of wildland fire to private homes.
Timeframe: On-going.
Funding: No additional funding required.
Staff: Nevada Fire Safe Council.

Action 1.9: Develop partnerships with concerned citizen groups to identify and implement neighborhood-specific fire safety programs.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: Citizens and the Nevada Fire Safe Council.

EARTHQUAKE
Objective #2: Minimize the threat to lives and property as a result of a possible earthquake within the Tahoe basin region.

Action 2.1: Review and update the City Building Code to ensure the construction of seismically safe buildings in the City of South Lake Tahoe.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: Building Department.

Action 2.2: Develop a homeowner's guide to earthquake preparedness techniques to educate homeowners on earthquake preparedness.
Timeframe: 1 year.
Funding: Unknown funding source.
Staff: Fire Department, Building Department.

Action 2.3: Inspect all City buildings and, where applicable, upgrade structures to withstand earthquake events.
Timeframe: Ongoing.
Funding: Unsecured grant funding.
Staff: Building Division.

SEVERE STORM
Objective #3: Lessen storm related damages for all types of severe storms that impact the City.

Action 3.1: Review and update City ordinance to facilitate adequate snow storage and drainage easements.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: TRPA, Public Works, Building, and Planning Department.

Action 3.2: Dedicate snow storage and drainage easements within all new development.
Timeframe: Ongoing.
Funding: No additional funding required.
Staff: TRPA, Public Works, Building, and Planning Department.

FLOOD
Objective #4: Minimize the threat to lives and property posed by the

possibility of flood within the City.

Action 4.1: Within new permit applications applicable to existing parcels, promote appropriate uses on parcels located within recognized flood-prone areas.
Timeframe: Ongoing.
Funding: No additional funding required.
Staff: TRPA, Planning Department.

Action 4.2: Review and update City ordinance to ensure only appropriate construction takes place in recognized flood-prone areas in the future.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: TRPA, Planning Department.

Action 4.3: Ensure that all bridges within the city are structurally safe from failure during peak flow scenarios by inspecting the bridges in the city.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: Public Works Department, California Department of Transportation.

Action 4.4: Stockpile sandbags in order to ensure an adequate supply to combat erosion during flood events.
Timeframe: Ongoing.
Funding: Unknown funding source.
Staff: Public Works Department.

LANDSLIDE
Objective #5: Reduce landslide events and overall soil erosion in the City.

Action 5.1: As part of road maintenance, inspect road cuts and fills for signs of slope failure. Stabilize slopes as necessary.
Timeframe: On-going.
Funding: No additional funding required.
Staff: Public Works Department and the California Department of Transportation.

Action 5.2: Review and adapt the City grading ordinance.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: TRPA, Planning Department, Public Works Department.

Action 5.3: Within the City grading ordinance, ensure cut and fill techniques provide for finished slopes at the angle of repose.
Timeframe: 1 year.

Funding: No additional funding required.
Staff: TRPA, Planning Department, Public Works Department.

Action 5.4: Within the city grading ordinance, ensure that all disturbed slopes are revegetated after grading to reduce erosion potential while promoting slope stabilization.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: TRPA, Planning Department, Public Works Department.

Action 5.5: Within city zoning ordinance, review and adapt measures that limit construction on steep slopes where extensive cut and fill would be necessary.
Timeframe: 1 year.
Funding: No additional funding required.
Staff: TRPA, Planning Department.

DROUGHT
Objective #6: Minimize the threat to property posed by the possibility of drought within the City.

Action 6.1: Develop a homeowner's guide to water conservation techniques.
Timeframe: On-going.
Funding: Unknown funding source.
Staff: South Tahoe Public Utility District.

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AVALANCHE
Objective #7: Improve techniques of informing the public on the level of avalanche danger in the City's in order to diminish the threat to lives and property posed by the potential for avalanche.

Action 7.1: Initiate an avalanche warning information system to inform and warn users of the current level of avalanche danger.
Timeframe: 1 year.
Funding: Unknown funding source.
Staff: Ski Resorts Public Works.

Action 7.2: Work with the ski resorts of the city on educating skiers on avalanche hazards.
Timeframe: On-going.
Funding: No additional funding required.
Staff: Ski resort personnel.

Action 7.3: Develop and expand a patrol to enforce and fine

out-of-bounds violations to reduce avalanche potential.
Timeframe: On-going.
Funding: Additional United States Forest Service funding required.
Staff: United States Forest Service.

DAM FAILURE

Objective #8: Improve dam inspection policy and procedure in order to minimize the threat to lives and property posed by the possibility of dam failure within the County.

Action 8.1: Improve communication with the California Department of Water Resources to ensure that the dams in the County have been and continue to be inspected per law.
Timeframe: On-going.
Funding: No additional funding required.
Staff: County staff.

Action 8.2: Develop a "Living with Dams" pamphlet to inform potentially affected citizens about dam safety and being prepared in the event of a dam emergency.
Timeframe: 1 year.
Funding: Unknown funding source.
Staff: County staff.

JURISDICTION-SPECIFIC

Lake Tahoe Community College District

Objective #1: Reduce the threat from wildfire to Lake Tahoe Community College District campuses.

Action 1.1: Develop a fuels reduction program around school campuses to include removal of dead and dying trees and vegetation.
Timeframe: 1 year.
Funding: Unknown funding source.
Staff: School District Buildings and Grounds staff.

Objective #2: Reduce the threat from earthquakes to Lake Tahoe Unified School District campuses.

Action 2.1: Have all school buildings in the district surveyed by a structural engineer to make certain that all structures meet state earthquake standards.
Timeframe: 6 months.
Funding: District general funds.
Staff: Structural engineer.

Objective #3: Reduce the threat from flooding to Lake Tahoe Unified

School District campuses.
Action 3.1: Increase the capacity of the drainage systems servicing district campuses.
Timeframe: Ongoing.
Funding: District general funds.
Staff: School District Buildings and Grounds staff.

South Tahoe Public Utility District
Objective #1: Reduce the threat of wildland fire to the residents and property in and around South Tahoe Public Utility District installations.
Action 1.1: Control vegetation growth within and around STPUD facilities.
Timeframe: Ongoing.
Funding: Land Application Operations and Maintenance budget
Staff: STPUD Maintenance staff.

Action 1.2: Provide reclaimed water for use in fire fighting.
Timeframe: As soon as possible.
Funding: Unknown funding source.
Staff: STPUD Engineering.

Objective #2: Ensure that no effluent is released during flooding events.

Action 2.1: Construct a facility to provide emergency effluent storage.
Timeframe: As soon as possible.
Funding: Unknown funding source.
Staff: STPUD Engineering.

Action 2.2: Convert/replace network of ditches with pipeline.
Timeframe: 10 years
Funding: Unknown funding source.
Staff: STPUD Engineering.

NOTE: Conversion to pipeline would also mitigate the effects of earthquakes, landslides, and severe storms.

Many mitigation measures are pre-existing functional strategies. These actions are included as a means of reinforcing those current hazard mitigation efforts. Many are linked to city and jurisdictionally specific codes and ordinances or to existing plans such the city's General Plan. In all cases, the City of South Lake Tahoe's Natural Hazard Mitigation Plan seeks to function in harmony with, and as an enhancement to pre-existing plans, ordinances, rules and regulations.
Other mitigation actions are new and not a part of any preexisting governmental or organizational decree. In this case, the implementation of these action strategies will be contingent upon the necessary approvals from the appropriate governmental bodies and the securing of necessary funding from yet to be determined sources. Generally speaking, the City has little or no funding earmarked for natural hazard mitigation. Thus, the City and plan participants will look to secure federal and state natural hazard mitigation grant funding in an effort toward implementing mitigation strategies. A comprehensive list of federal mitigation programs, activities, and initiatives is available online through the Federal Emergency Management Agency's website. This information can be accessed at http://www.fema.gov/doc/fima/fmpai.

A primary emphasis will be placed upon implementing actions that provide the highest cost-to-benefit ratio. Knowing that funding is an ever-present issue, all effort will be given to identify actions most beneficial to the citizens and property within the city. The greatest natural hazard threat to lives and property is wildland fire. Wildland fire is the highest-scoring natural hazard threat in the Natural Hazard Probability / Risk Assessment Scoring Matrix and also is identified as the greatest natural hazard threat in the Natural Hazard Rating Table. Therefore, it is clearly indicated that mitigation actions focused toward reducing the threat of wildland fire in the City have the greatest cost-to-benefits ratios and will provide the greatest mitigative relief for the residents of the City.

Plan Maintenance

The City of South Lake Tahoe's plan will be evaluated every year to ascertain the effectiveness of the plan. As part of this evaluation, the overall effectiveness of the plan will be considered in context to; the number of natural hazard mitigation projects effectively completed the number of mitigation projects in progress, and the success of related programs and activities associated with the plan. Additionally within these annual evaluations, natural hazard mitigation strategies will be examined for a continued level of appropriateness in relationship to any changes in land uses or the level of intensity associated with prevailing land uses. Participants of the plan will be asked to provide an annual evaluation report of the status of natural hazard mitigation efforts within their respective jurisdictions.

Whenever the annual evaluation indicates a necessity to update the plan, an

update of the plan will be initiated. Regardless of the plan's status, a mandatory update to the City of South Lake Tahoe's NHMP will occur every five years in conjunction with the annual plan evaluation process.

The City of South Lake Tahoe Fire Department will be the responsible organizing agency for both the annual evaluative efforts as well as any plan update initiated by the city. The Fire Department will take responsibility for agendizing and noticing all action related to any plan review or update. The Fire Department will also act as the intermediary between plan participants and the City's administration. The Fire Department will be responsible for exercises to insure the plan remains valid. The City of South Lake Tahoe Fire Department will be the determining body when assessing the need for any plan update in excess of the fixed five-year update period. The South Lake Tahoe Fire Department will act as the preliminary administrator for any plan update. The City of South Lake Tahoe City Manager will make recommendations to the City Council, who will have final authority for adoption of any updates or revisions to the City of South Lake Tahoe's Hazards Mitigation Plan. At all times, opportunities for the incorporation of the City of South Lake Tahoe's NHMP into other appropriate city plans will be developed and utilized.

The City of South Lake Tahoe is committed to public involvement within this hazard mitigation plan. For both the plan evaluation and update, a public hearing will be held at a regularly scheduled City Council meeting. The hearing will be publicized and the public will be asked for comment concerning the plan.
With constant and concerned review, The City of South Lake Tahoe Natural Hazard Mitigation Plan will continue to develop as an outstanding planning tool, helping the citizens of The City of South Lake Tahoe to create a safer place to live, work, and play.