COMMUNITY WILDFIRE PROTECTION PLAN
FOR THE
CALIFORNIA PORTION OF THE LAKE TAHOE BASIN

Prepared for:

Tahoe Basin Fire Safe Council
Fallen Leaf Fire Department
Lake Valley Fire Protection District
Meeks Bay Fire Protection District
North Tahoe Fire Protection District

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I. EXECUTIVE SUMMARY

The Lake Tahoe Basin is at risk of wildfire. Significant wildfire hazards exist in and around communities in the Tahoe Basin. This plan attempts to identify those hazards and proposes fuel reduction projects for their mitigation.

Four fire districts on the California side of the Lake Tahoe Basin are included in this plan. They are: Fallen Leaf Fire Department, Lake Valley Fire Protection District, Meeks Bay Fire Protection District, and North Tahoe Fire Protection District. Districts were divided into neighborhoods and communities for assessment and mitigation project development purposes.

In 2000, the Lake Tahoe Basin Watershed assessment quantified and assessed the wildfire threat to watersheds in the Tahoe Basin. Fuels analysis, ignition history, and fire behavior modeling was used to predict fire occurrence in the basin. Urban, erosion hazard, and old forest values were assessed by watershed to determine their risk to wildfire.

Field surveys were conducted to collect community and project specific information. Detailed fire behavior analysis, structural assessment, and community design assessments, were conducted to rate communities. Mitigation projects were developed around hazardous community areas. Mitigation projects were prioritized by reviewing field based hazard information, data from the Watershed Assessment, input from the public and input from the local fire chief.

Results of the field assessment indicated a majority of homes and structures in the Tahoe Basin lacked non-flammable building materials, fire safe construction techniques, and the state mandated 30 foot zone of defensible space. Fire behavior analysis conducted on sample points located within the communities found fire would reach the canopy of the forest 80% of the time. Wildfire hazards to the communities were significant from high fuel loadings within and around the communities.

Residents and landowners need to mitigate the hazards around homes by using non-flammable building materials and creating effective defensible space. California Prublic Resources Code requires homeowners to address wildfire hazards. The Living with Fire in the Lake Tahoe Basin education materials provide detailed instructions to homeowners on addressing the hazards identified in this study.

Around the communities, approximately 80 wildfire fuels mitigation projects were identified across the four fire districts. For each project, specific vegetation prescriptions were developed and treatment methods to achieve those vegetation prescriptions identified. Cost estimates were associated with each of the mitigation projects.

On the California side of the Tahoe Basin, a total of 18,356 acres is proposed for treatment across multiple land ownerships. The cost for treating these acres is estimated to be approximately $40 million.

Fire District	**Landowner**						**Total Acres**
	LTBMU by Fire District	**Future LTBMU**	**California State Parks**	**California Tahoe Conservancy**	**Local Agency**	**Private**	
Fallen Leaf	300	343	0	2	1	250	***896***
Lake Valley	1,601	4,750	104	632	56	2,107	***9,250***
Meeks Bay	89	700	179	41	13	685	***1,707***
North Tahoe	555	1,432	387	721	198	3,210	***6,503***
Total	***2,545***	***7,225***	***670***	***1,396***	***268***	***6,252***	**18,356**

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II. INTRODUCTION

At the Lake Tahoe Healthy Forest Restoration Act/Wildfire Prevention Summit on March 13, 2004, fire officials from the Fallen Leaf Fire Department, Lake Valley Fire Protection District, Meeks Bay Fire Protection District, and North Tahoe Fire Protection Districts (Districts) accepted the challenge to develop community wildfire protection plans. This report describes those community wildfire protection plans.

This document is intended to provide district wide planning level information for identification of wildfire hazards and proposed fuel mitigation projects to address those hazards. It is not intended to circumvent the public review process for vegetation management treatments or address the environmental compliance measures necessary for each project. NEPA and CEQA compliance for fuel mitigation projects will be addressed with detailed project planning to be completed prior to implementation of each project. This plan is advisory and will not result in changes in the human environment without appropriate environmental planning, therefore is not subject to NEPA or CEQA.

Wildfire hazards addressed in this plan are located in the Wildland Urban Interface (WUI). This zone is commonly described as the area where structures and human development are adjacent to or within undeveloped wildland vegetative fuels. Some federal and state definitions have included ¼ mile as the distance into the wildland from the community that is considered the WUI. The interface zone can be expanded in cases where fuels, weather, and topographic conditions pose threats to the community beyond the standard ¼ distance.

1. Project Location

The Districts are in the California portion of the Lake Tahoe Basin (Figure 1). The Lake Valley Fire Protection District is in the southern–most area of the Basin, covering seven communities. The Fallen Leaf Fire Department included three communities. Meeks Bay Fire Protection District is on the west shore of the Lake, covering seven communities from Emerald Bay to Tahoma. The North Tahoe Fire Protection District covers 7 communities from Homewood on the west shore to Brockway on the north shore.

2. Purpose

Community wildfire protection plans assist communities in defining priorities for the protection of assets in the wildland urban interface (Healthy Forest Restoration Act 2003). The community wildfire protection plans described here will:

- ensure that local efforts respond to and collaborate with federal, state, and regional direction and efforts;
- identify wildfire fuel treatments;
- prioritize treatments; and,
- contribute to the conservation of the Lake Tahoe Basin's human, natural, and economic assets.

Ultimately, these plans will be integrated with similar plans completed for communities on the Nevada side of the Lake Tahoe Basin to create a Basin-wide fuels treatment plan.

3. Need

Between 1875 and 1895, large-scale timber harvesting removed most of the large, widely spaced trees along the west side of the Basin (Murphy and Knopp 2000). Although the forest stands successfully regenerated, 55 years of effective fire suppression and a reduced emphasis in forest management on public lands have resulted in denser forest stands than occurred historically. Recent estimates indicate that in the Basin lower montane forests have four times the density of trees and upper montane forests have twice the density of trees when compared to forest conditions prior to 1870. Current forest stands exhibit a 70% higher disease incidence and a 5% greater mortality than remnant old growth stands in the Basin (Murphy and Knopp 2000).

Fuel hazards in the Basin have changed along with forest management practices. High rates of tree mortality, particularly white fir (*Abies concolor*), have increased the number of standing dead trees and downed logs. The lack of frequent low intensity fires has resulted in accumulations of dead fuels and increased understory shrubs. As a result, flame lengths and rates of fire spread lead to higher intensity fires. The mid-story trees in these stands create fuel ladders that allow fires to readily move into dense crowns that facilitate the movement of fire from one tree crown to another. This can result in a crown fire and a stand-destroying incident.

Recent estimates indicate that if a fire escaped initial control, at least 50% of the burned area would probably occur as a crown fire, with overstory tree mortality exceeding 50%. Locations that exhibit pronounced levels of drought-, insect-, and pathogen-related mortality would increase fire line construction times and reduce suppression effectiveness (Murphy and Knopp 2000). Few large fires have been recorded in the Tahoe Basin over the past 80 years. However, two recent fires – the Gondola and Showers fires – were sizable and occurred under less than extreme fire weather conditions. As such, these fires provide evidence that fuel hazards are pronounced and have increased substantially.

The unique qualities of Lake Tahoe have been described in fictional, non-fictional, and scientific publications. The lake's clarity and size are world-renowned. The wide range of recreational opportunities support a $1 billion local economy and over 40,000 residences (many valued at over $1 million) provide homes to a year-around population of over 57,000 people and substantially higher number of seasonal visitors (Murphy and Knopp 2000). As a result, even a small wildland fire may have significant impacts on the Basin's assets.

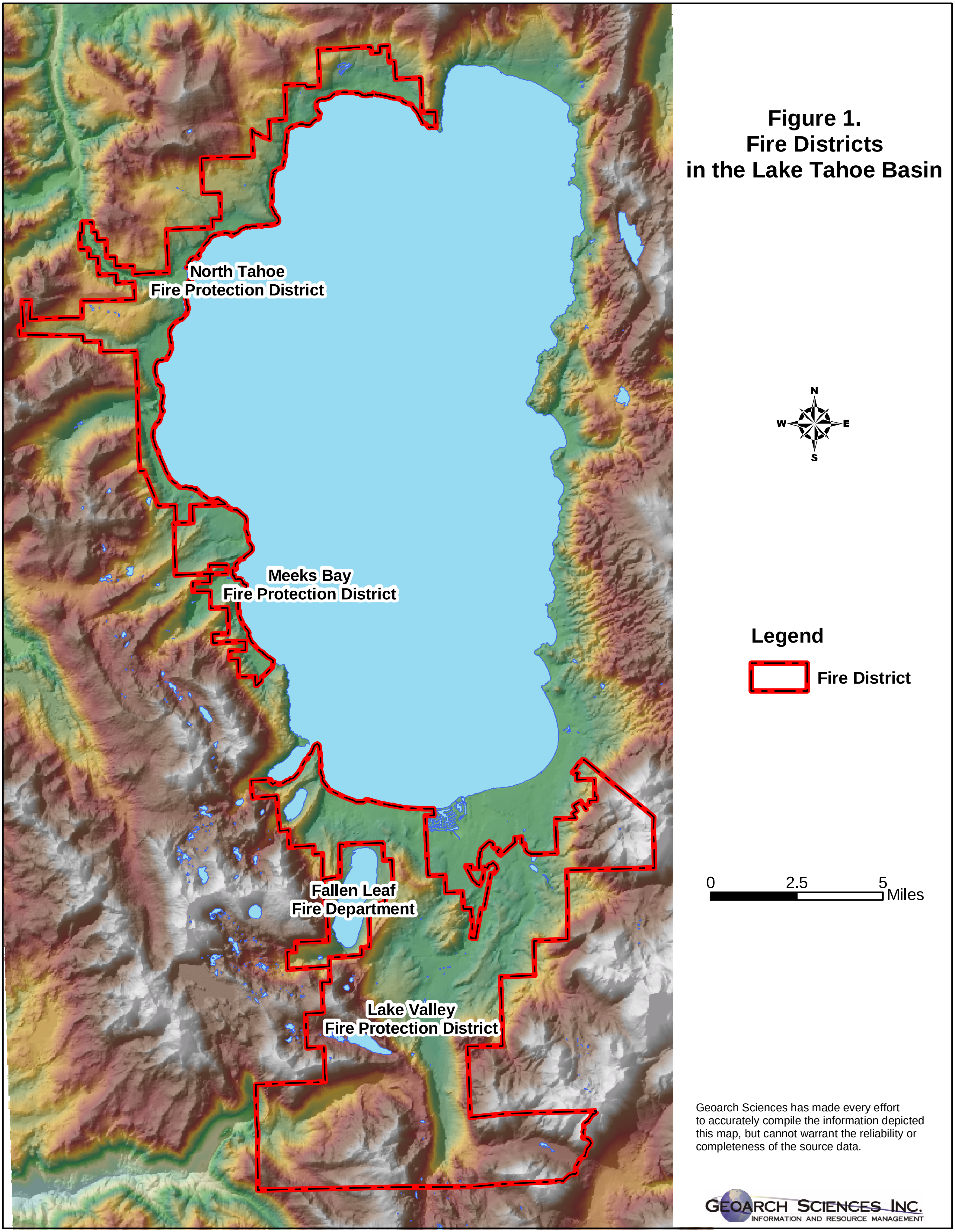

Figure 1.
Fire Districts
in the Lake Tahoe Basin

Geoarch Sciences has made every effort to accurately compile the information depicted this map, but cannot warrant the reliability or completeness of the source data.

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4. Recent Policy Changes

In response to the devastating fires in 2000, 2001, and 2003, national, state, and local policies have focused efforts on reducing the threat of wildfires, particularly in the wildland urban interface. The National Fire Plan provided direction, allowing for the identification of communities at risk. Eight communities in the California portion of the Basin have been designated as communities-at-risk: City of South Lake Tahoe, Homewood, Tahoe Pines, Sunnyside-Tahoe City, Dollar Point, Carnelian Bay, Tahoe Vista, and Kings Beach (Federal Register66[160]: 43384-43435).

In June of 2004, TRPA passed a resolution (number 2004-15) in support of the Community Wildfire Protection Planning effort. Specifically, TRPA agreed to support:

- Promotion of biomass utilization;
- Assist fire districts within the Lake Tahoe region to develop MOUs for defensible space advice and permitting;
- Assist the fire safe councils to develop community fire plans; and
- Assist in securing funding for those plans.

The Healthy Forest Restoration Act H.R. 1904 (December 2003):

- authorized fuel reduction projects on federal lands in the wildland urban interface;
- required federal agencies to consider recommendations made by at-risk- communities that have developed community wildfire protection plans; and,
- gave funding priority to communities that have adopted wildfire protection plans.

The USDA Forest Service amended the Sierra Nevada's Forest Plans, including the Lake Tahoe Basin Management Unit's (LTBMU), to emphasize the reduction of hazardous fuels in the wildland urban interface (January 2004). The plan adopted a regional goal, stating that 50% of all initial treatment should occur in the wildland urban interface. The amendment prohibited the removal of trees greater than 30 inches dbh and effectively conserved all trees greater than 25 inches dbh.

California Public Resources Code 4291 (PRC 4291) requires homeowners to address wildland fire hazards through creation of defensible space and other building construction mitigation measures. Specifically, the code requires homeowners to:

- Maintain adequate defensible space 30 feet around structures (this will increase to 100 feet January 1, 2005)
- Remove that portion of any tree which extends within 10 feet of the outlet of any chimney or stovepipe.
- Maintain any tree adjacent to or overhanging any building free of dead or dying wood.
- Maintain the roof of any structure free of leaves, needles, or other dead vegetative growth.
- Provide and maintain at all times a screen over the outlet of every chimney or stovepipe that is attached to any fireplace, stove, or other device that burns any solid

or liquid fuel. The screen shall be constructed of nonflammable material with openings of not more than one-half inch in size.

Though PRC 4291 has been available for many years, its enforcement has been limited to non-existent. Challenges to the enforcement include the amount of documentation necessary versus the amount of the fines. A number of notices are required before a fine can be levied, and the first fine cannot exceed $500. Typically the cost of completing appropriate fuels reduction work around the home is well in excess of the fine. Multiple violations of the law can increase the fines, but not necessarily address the hazardous situation by removing the fuels.

In response to these concerns, some counties and fire protection districts have adopted their own ordinances that increase the defensible space zone and provide for methods of enforcement. Enforcement methods include not only citing landowners but also creating the defensible space around the home. With either fire service staff or contracted labor, the hazard is abated and a bill is sent to the landowner. Nonpayment results in a lien on the property. Some counties in southern California have had limited success with such ordinances since the fires in 2003, but enforcement in counties near the Tahoe area has not been accomplished.

The California Public Resources Code was recently amended to increase the defensible space zone around structures from 30 feet to 100 feet. It is unlikely to have a significant effect since enforcement did not even occur with the 30 foot zone.

An additional challenge to mitigating hazards has been the California Forest Practice rules. These codes are designed to regulate commercial timber harvests, but definitions of commercial harvests within the codes typically included trees that needed to be removed for wildfire or other hazard reduction purposes. To address this issue, the California Department of Forestry and Fire Protection passed an emergency fuel hazard reduction rule (June 2004) to address private lands. Under those rules emergency conditions include:

- trees that are dead or dying from insects, disease, parasites, or animal damage;
- trees that have fallen or are damaged as a result of weather conditions, fires, floods, or earthquakes;
- trees that are dead as a result of pollution; or,
- where high, very high, or extreme fuel hazard conditions pose a threat to private timberlands.

With the changes to the rules, environmental compliance measures are more efficient to quickly mitigate hazards within communities. While this adjustment has been useful across the state, it has not been widely used in the Tahoe Basin due to regulations by other agencies that supercede the Forest Practice rules. Even though commercial harvest permits may not be necessary at the state level, the Regional Water Quality Control Board – Lahontan Region (Lahontan) and Tahoe Regional Planning Agency may require additional permits and waivers to remove trees on private lands.

5. Methodology

Reports, policies, and regulations governing forest, fire, and fuels management in the Lake Tahoe Basin were reviewed. Geographic information system (GIS) databases describing land ownership, land use, and resources were obtained from TRPA and LTBMU. These databases were used to plan and evaluate fire risks and hazards, projects completed or proposed by other agencies, and develop projects for the community wildfire protection plans.

Representatives from each fire district and land management and regulatory agency were interviewed to identify issues, and opportunities. Additionally, an agency workshop was held November 3, 2004 in Lake Valley. Four public workshops were held: Meeks Bay (September 27, for MBFPD and NTFPD), Lake Valley, Meyers (September 28, for Lake Valley FPD and Fallen Leaf Fire Department), Tahoe City (November 16, for MBFPD and NTFPD), and Lake Valley, Meyers (November 17, for Lake Valley FPD and Fallen Leaf Fire Department).

5.1 Field Surveys

Thirty-nine sampling points were installed in the four districts to estimate fire behavior. The sampling points were installed within proposed project areas and are representative of fuel hazards in those areas. The objective of the sampling points was to provide a site-specific evaluation of fuel hazards, evaluate those hazards based on information provided in the Lake Tahoe Watershed Assessment (Murphy and Knopp 2000), and document pre-treatment conditions for use during future monitoring. The sample sites are intended to represent unique fuel types within each district or community. Several photo series booklets developed by the US Forest Service created for use to assess fuel hazard loadings were used in conducting assessments of fire hazard across the range of the California Lake Tahoe Basin wildland fuel types.

At each sample point in the community, surface and canopy fuels data were collected. A photo with reference marker was taken of each plot site, and additional photos (to the north, east, south, and west of the plot) were taken to capture a complete characterization of the fuels within each plot.

For each sample site the following information was collected:

- The Forest Service Photo Series was used to determine the surface fuel loading.
- The surface fuel model was determined based on expected fire behavior from the 13 National Fire Behavior Prediction System (NFBS) models (Anderson, NFFL, 1982).
- A $1/40^{th}$ of an acre plot was established centered on the photo stake, and species, height, percent canopy, and DBH were recorded for all trees present. This data was entered into the CrownMass modeling program to characterize canopy fuel condition for each plot.
- The point was mapped with a 5-10m accuracy GPS so that it could be easily found again and revisited if necessary.
- An estimation of mortality was determined while at the site for comparison to the mortality estimated by the CrownMass program. We found these mortality estimates to be very similar to mortality estimates output from the computer model.

5.2 Fire Behavior Analysis

The data collected from each plot survey was then input to a series of fire behavior computer programs.

Fuels Management Analyst PLUS (FMAPlus) Modeling Software

The FMA Plus computer program was used to develop reports for each sample point surveyed. These reports, validated by experienced wildland fire fighters, provide a scientific basis for assessing fuel conditions in California Lake Tahoe Basin.

FMAPlus is a suite of fire behavior modeling tools that analyze field-collected fuel profile information to characterize predicted surface fire behavior and crown fire potential. FMAPlus was used to analyze data that collected during sample point analysis. These outputs are summarized as reports attached to the photos from each of our survey points in the photo series book – an example of the FMAPlus report can be found in Appendix A. Programs used in the FMAPlus suite included the 'Photo Series Explorer', 'Down Dead Woody (DDWoodyPC)' and 'Crown Mass' modules.

Photo Series Explorer

This program was used to develop fuel profiles for the sample points in the communities.

DDWoodyPC

We used this module to compare fuel loading estimates taken at our photo points to a database of other existing USFS fuel loading surveys undertaken in similar forest stands. The DDWoodyPC module calculates surface fuel loading using the Photo Series Explorer.

CrownMass

CrownMass uses inputs from field surveys, FMAPlus modules "Photo Series explorer and DDWoodyPC" along with historic USFS weather data to:

- Determine fuel loading for debris from crowns, boles, and tops.
- Determine crown mass and the stand's susceptibility to crown fires.
- Predict fire behavior in resultant fuel bed including crown fire potential.
- Predict fire effects including probability of tree mortality.
- Quickly generate sampling statistical graphs.
- Import tree information from plots taken with the photos.

Fire behavior attributes from several photos were used to portray a site. For example, the fuel loading statistics (1, 10, 100, and 1000 hr.) attached to each photo point applies only to surface (ground) fuels, and the resultant surface fire behavior. The "Crown Fuels Characterization", "Resultant Fire Spread and Type", and "Tree Effects" information is derived in part from a site's canopy fuel loads. To evaluate Crown Fire potential for a site, a different reference photo that better matches the canopy fuels at the site may be used.

Important fields for use in determining Crown Fire/Tree Mortality Potential include:

- Canopy Base Height(ft)- height of lowest branches/ladder fuels
- Flame Length(ft): Critical - length of flames needed to initiate crown fire
- Fire Flame Length(ft) - predicted height of flames from surface fuels
- If 'Fire Flame Length' exceeds the 'Critical Flame Length', torching or crown fire will occur.

5.3 Weather Data used in Fire Behavior Analysis

Weather data from the Meyers weather station on the south shore was the primary source of information for analyzing fire weather. For the fire behavior analysis, weather data during the fire season is typically summarized by percentiles; 75% moderate, 90%-96% high, and 97% to 100% extreme. The weather records for Meyers station covered the longest period of time and were the easiest to use in the modeling programs.

Table 1: Weather Station Data used in Analysis

Indices	Meyers
1 Hour Fuel Moisture	7%
10 Hour Fuel Moisture	7%
100 Hour Fuel Moisture	12%
Herbaceous Fuel Moisture	30%
Woody Fuel Moisture	109%
20' Wind Speed	12 MPH
1000 Hour Fuel moisture	10%

Ninetieth percentile (high severity weather) from the Lake Tahoe Basin weather station in Meyers was used in the fire behavior analysis. Weather information from Fallen Leaf Lake, Angora Lookout, North Lake Tahoe High School and the Martis lookout were used to support the weather data that was used in the analysis. Reviewing data from the other stations, the average wind from Meyers is slightly lower than that at other weather station locations.

According to the Lake Tahoe Basin Watershed Assessment, "Fires burning under the strongest winds (from the SW, W, SE) have the greatest opportunity to become larger in the area south and north of Lake Tahoe. In these areas, topography lines up better with wind direction, and these areas contain more area with continuous fuels." Our fire behavior analysis supports these findings. Wind will likely be the difference between a controllable fire and an uncontrolled fire in the Tahoe Basin. With the predominant wind from the southwest, the southwestern portions of these communities are most as risk from extreme fire behavior, many of the proposed mitigation projects address this side of the communities.

6. Structural Assessment

Fire protection district personnel conducted an assessment of building materials and defensible space within the communities. Using sampling sheets provided by our team, fire personnel reviewed (from the street) all or some of the lots in their communities, noting flammability of siding, roofing, and unenclosed features. They also assessed the presence of an effective 30 foot defensible space zone around the homes.

Community design was also considered. Estimates were made of the effectiveness of street signage, address numbering, and road network design. Water system infrastructure, fire department staffing, and ignition risk were considered in the overall structural assessment.

III. SECTION ONE

1. HAZARD, RISK, AND VALUE ASSESSMENT

This section describes the fuel hazards, risks, and assessment of value-at-risk in the California portion of the Lake Tahoe Basin. It provides a historical overview of factors (human use, changes in vegetation, and fire behavior) that have contributed to the current situation, describes current hazards and risks, and prioritizes property and natural resource values-at-risk. Most of the information summarizes data described in the Lake Tahoe Watershed Assessment (Murphy and Knopp 2000, Jones & Stokes et al. 1999).

Specific terms are used in this section to describe hazard, risk, and fire regimes. Fuel hazards refer to the amount of fuel available to burn. It includes surface fuels (litter, duff, and downed wood), ladder fuels (shrubs and small trees), and crown fuels (foliage in the overstory trees). Fire regimes include the return interval (period between fires) and fire intensity. Risk is the likelihood an ignition will occur. Sources of risks are either natural (lightning) or human (escaped campfires, matches, or sparks from equipment).

1.1 Fuel Hazards

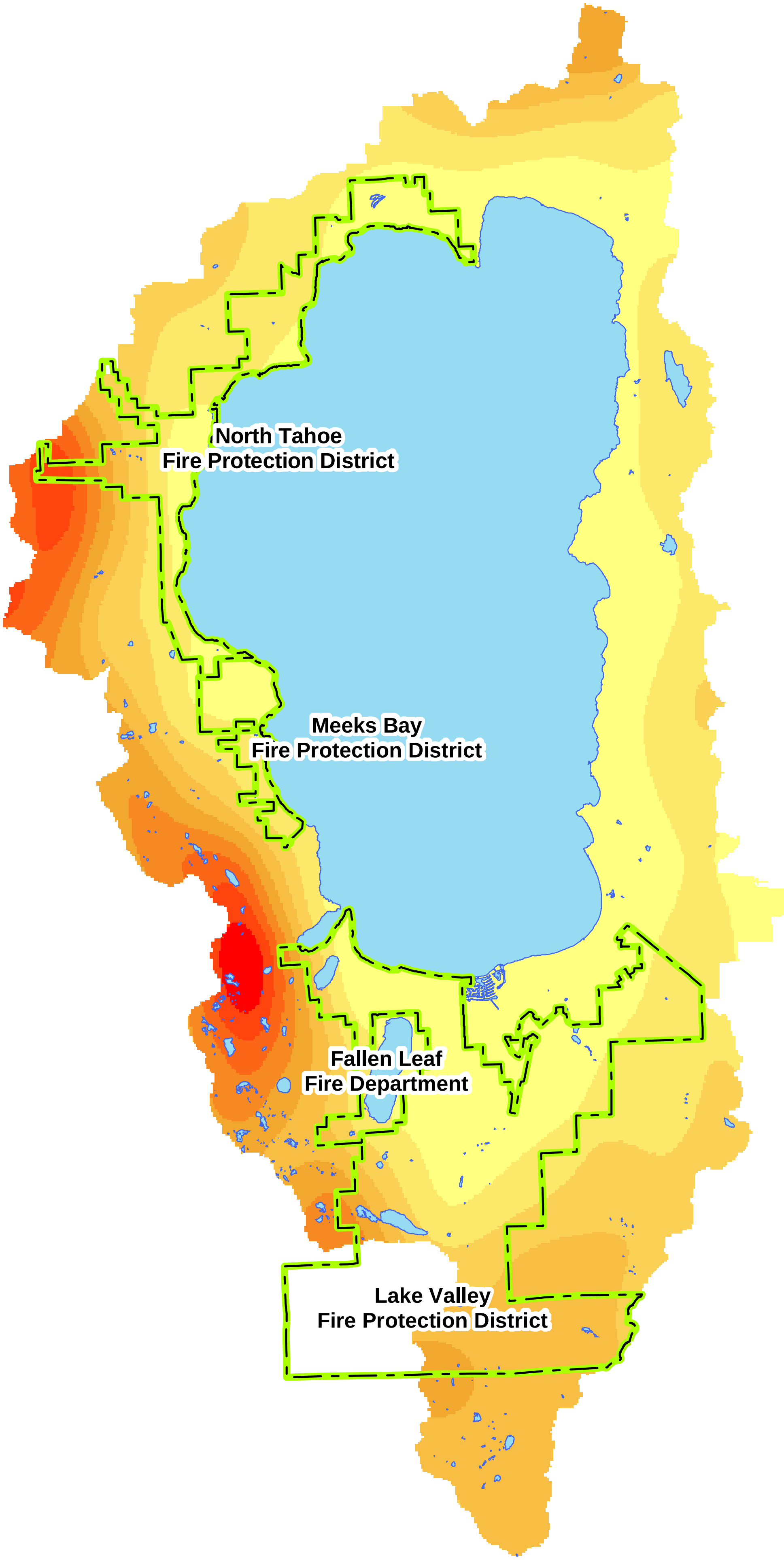
This discussion of fuel hazards includes a description of historical changes in the fire regime, fuel hazards, and the current fuel hazards and estimated fire behavior in the California portion of the Lake Tahoe Basin.

<u>*Historic Fire Regime and Fuel Hazards*</u>

Prior to European settlement, fires in the Basin were ignited by lightning or members of the Washoe tribe. Fire return intervals varied from 5-128 years throughout the Basin. However, at lower elevations where most of the Washoe camps and current communities occur, the fire return intervals were shortest. Fire return intervals averaged 5-18 years around the edge of the Lake and south to approximately Meyers. Immediately above this elevation, fire return intervals averaged 19-32 years (Figure 2). Based on fire return intervals, it is estimated 689-2,964 acres burned annually in the western portion of the Basin (Murphy and Knopp 2000).

Prior to European settlement, lower elevation montane forests were characterized by large, widely spaced trees with little understory. Because frequent fires reduced surface and ladder fuels, fire intensities were low and there was little mortality of mature trees. Fire return intervals in intermittent and ephemeral streams were probably similar to adjacent upland forest. Shrubs and small trees were widely scattered along these streams; however, dead and dying shrubs and mature lodgepole pines (*Pinus contorta*) were probably rare. Fire return intervals were longer along larger perennial streams. Fires that did occur along these streams resulted in a mosaic of age classes of riparian shrubs and trees. Mature lodgepole pines were rare or widely scattered along perennial streams. Frequent fires periodically destroyed shrubs and most lodgepole pines seedlings that regenerated in meadows. Shrubs and widely scattered mature lodgepole

Figure 2.
Historic Fire Return in the Lake Tahoe Basin
Source: Watershed Assessment 2000
(Murphy and Knopp 2000)



Legend

Fire District

Fire Return Interval (in years)

- 114-128
- 100-114
- 87-100
- 73-87
- 60-73
- 46-60
- 32-46
- 19-32
- 5-18

pines occurred in drier areas of meadows; however, the meadows were dominated by herbaceous vegetation.

As Europeans settled in the Basin the fire regime and fuel hazards changed. The frequent fires set by the Washoe were eliminated as the Native Americans were pushed out of the Basin. Between 1875 and 1895, large-scale timber harvesting clear-cut most of the old growth forests on the west shore. Large-scale harvesting continued after this; however, it was more localized. Large numbers of livestock removed herbaceous vegetation and fires set at the end of the summer grazing season probably killed tree seedlings that were regenerating in some of the clear-cuts. By 1900 the forests in the Basin were now comprised of individual stands of seedlings, saplings (1-6 inches dbh), poles (6-12 inches dbh), small trees (12-24 inches dbh) and old growth forests. The smaller size classes of these trees would have supported more intensive fires than the old growth stands. These high fuel hazards resulted in the largest fire recorded in the Basin in 1918 (1,013 acres) and the largest number of acres burned in the Basin during the decade between 1916 and 1925 (2,593 acres) (Table 2)(Murphy and Knopp 2000).

Livestock grazing was reduced significantly by 1930, allowing vegetation to regenerate. The drought from 1929-1934 probably limited some regeneration, increased tree mortality in some stands, and increased fuel hazards in the Basin. Fewer acres burned however, because the federal government had adopted a fire exclusion policy in 1924 and few people visited the Basin during the Great Depression and World War II. Although the number of visitors to the Basin increased after World War II, the number of acres burned by wildfires remained low. Federal and local fire agencies were able to effectively suppress fire; wetter than normal year's maintained higher moisture in small fuels during dry periods; and trees in forest stands were becoming larger and less likely to be ignited (Murphy and Knopp 2000).

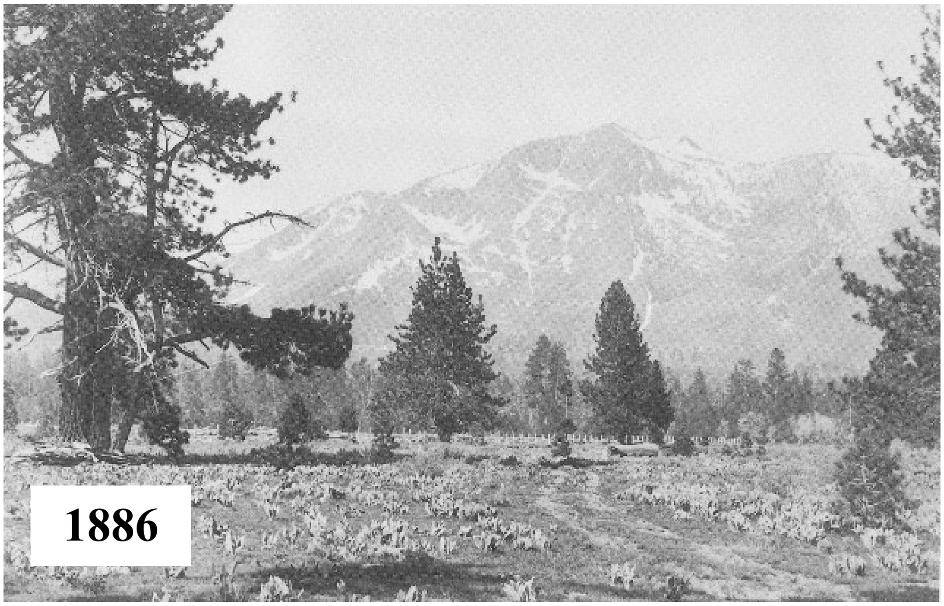
Current Fire Regime and Fuel Hazards

Several factors have combined to significantly change the fire regime and fuel hazards in the Basin. Since 1970s, public sentiment and management strategies increasingly emphasized the protection and preservation of natural resources. Without sources of disturbance such as fire or harvesting, forest vegetation continued to grow. As a result, there were a large number of all size classes of trees in forest stands that create a ladder of flammable vegetation from the ground to the overstory canopy. Conifer trees invaded meadows and other openings, increasing fuel loadings. Since 1975, three periods of drought increased mortality in forest and riparian vegetation. The limbs from dying trees and dead trees fell to the ground and increased surface fuels. Small trees of shade-tolerant species, such as white fir created ladder fuels in forest stands. As a result, fuel hazards may be the highest they have been in over 100 years. This is supported by the increasing number of acre burned each decade by wildfires since 1966-1975 (Table 2).

Table 2. Summary of factors affecting fire regimes in the California portion of the Lake Tahoe Basin.

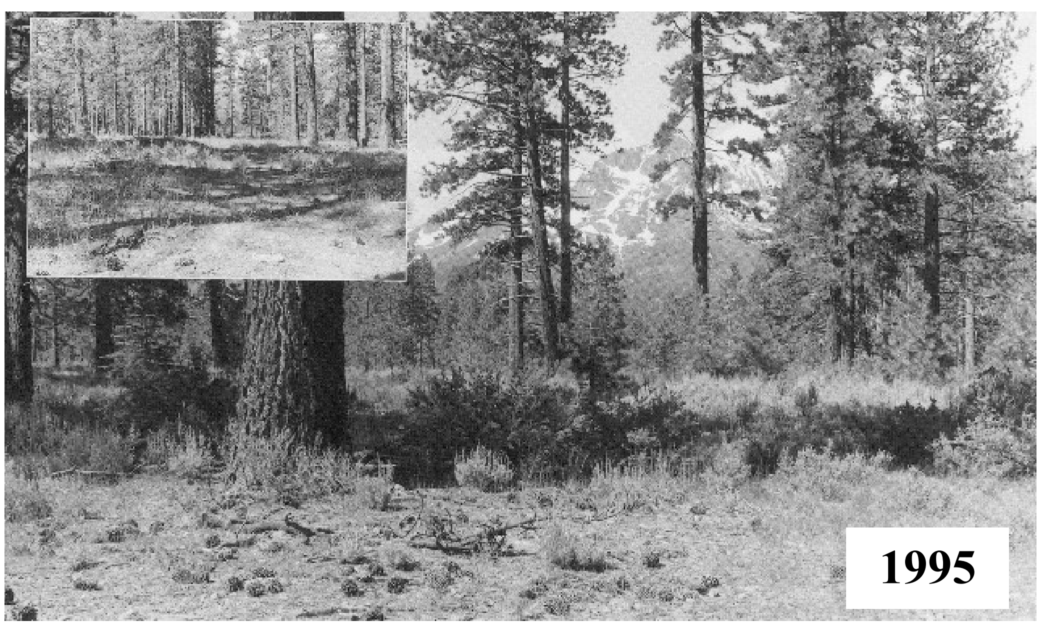
Droughts															
Management Emphasis	Seasonal Burning		Extensive Clear-Cutting		Localized Clear-Cutting and Even-Aged Management										
								Fire Exclusion Policy		Effective Fire Suppression					
Forest Characteristics															
Seedling < 1 in dbh															
Sapling 1-6 in dbh															
Pole 6-12 in dbh															
Small 12-24 in dbh															
Med-Large >24 in dbh															
Fire Regime															
Acres burned annually	689-2,964					345	2,593	780				12	44	179	318
Intensity	Low				Low-Moderate				High-Moderate		Low-Moderate				High
PERIOD	Pre-European contact	1850-1875	1876-1885	1886-1895	1896-1905	1906-1915	1916-1925	1926-1935	1936-1945	1946-1955	1956-1965	1966-1975	1976-1985	1986-1995	1996-2005

These photos from George Gruell's book "Fire in Sierra Nevada Forests: A Photographic Interpretation of Change Since 1849" (2001) illustrate this change in fuel loadings.



Note in this photo pair the change in tree density and understory fuels. Trees were so dense that the original photo location could not be recreated. The photographer had to stand in an alternate location to capture Mt. Tallac in the background.

Fire behavior in each of these scenes is significantly different. In the photo from the 1800's, a low intensity fire would burn through the understory, leaving the majority of trees unharmed. In the photo form the 1990's high surface fuel loadings and ladder fuels would easily carry fire up the large trees, causing damage and possibly mortality.



This set of photos illustrates the change in fuel bed continuity and loadings around Fallen Leaf Lake. In the photo from the 1800's, fuel loadings are much lower (notice the rock in the foreground) and tree density is sparse enough o preclude a crown fire. In the 1990's, only the tip of the rock is visible through the brush, with a continuous bed of fuels from the ground to the tops of the trees. The canopy is completely closed, allowing a fire to easily spread from the crown of one tree to another. In the older photo, a fire would leave the forest in much the same condition before and after the fire. In the newer photo, the forest would be completely destroyed, with no vegetation to hold the soil in place.

While it is certain that fuel loadings have increased in the last 100 years, determining the exact condition of the Basin 200 or 500 years ago is difficult. The Watershed Assessment provides the best explanation based on available tree core and historic stump records. In general, fuel loadings were much lower and crown spacing much greater. Natural variability in forest structure may have included clumps of trees, which could have produced small crown fires.

The description of the historic fire regime is intended to describe how the forest reacted to fire in the recent past, and why the management objectives described later in this document attempt to achieve fire behavior similar to that of the historic fire regime. This text should not be viewed as a comprehensive scientific assessment of fire regime in the Tahoe Basin. As a public document, it is intended to illustrate that the current forest stand conditions in the Tahoe differ from historic conditions.

This understanding is necessary for the public to play an active role in defining the future conditions of the public lands in the Tahoe Basin. Recommended prescriptions seek to attain forest stand conditions found previous the European man's entry into the ecosystem. The land management prescriptions contained in this document should not be viewed as the only land management solution. Any land management scheme which results in the desired fire behavior is appropriate. This may include forest stand structures that were not previously in the basin.

1.2 Estimated Fire Behavior

An initial estimate of fire behavior in montane forests for the community wildfire protection plans was developed using standard National Forest Fire Laboratory fuel models, weather data from the Meyers station, and BEHAVE (Table 3). Estimates of fire behavior are for high fire weather conditions. Photographs from Lake Tahoe describing fuel models are provided in Section Two.

Table 3: Estimated fire behavior in the Lake Tahoe Basin.

Fuel Model	Flame Length (ft)	Rate of Spread (ft/hour)
FM 2 - Grass in moderate pine/shrub	3.5-4.5	700-1050
FM 5 - Shrub (huckleberry oak and manzanita)	5-7	880-1180
FM 8 - Sparse forest with compact fuels	1-2	50-66
FM 9 - Closed forest overstory compact understory fuels	2-3	178-250
FM 10 - Forest with moderate understory fuels	4-6	300-400
FM 12 - Forest with heavy fuels	6-7	400-520

Currently, most of the project area is best categorized using fuel models 9, 10, and 12. Given the estimated flame lengths (especially in models 10 and 12) and the presence of mid-story fuel ladders, most forest stands are highly susceptible to crown fires. Projected rates of spread in models 10 and 12 are also considered high. Fire behavior estimated at 39 photo points in the planning area indicated 80% would result in a crown fire with extensive mortality.

The results of wildfires in montane forests under very high fire weather conditions were also simulated in selected watersheds (Table 4). The simulations were done with FARSITE using mapped fuel hazards and assumed the fires burned for two days without effective fire suppression (Jones & Stokes et al. 1999, Murphy and Knopp 2000). The simulated fires showed 2,243-3,653 acres were burned and the percent crown fire ranged from 13-24 percent. This represented the MINIMUM mortality that would occur. Substantially more mortality would actually occur because intensive surface fires would kill larger number of trees. This simulated fire behavior was observed recently in the Gondola Fire (673 acres) and Showers Fire (294 acres) under weather conditions well below high fire weather conditions.

Table 4: Results of simulated fire behavior in selected watersheds in the Lake Tahoe Basin.

Watershed	Acres Burned	Percent Crown Fire
Griff Creek	2,243	24
Ward Creek	2,991	13
Trout Creek	3,653	17

Fire behavior was also estimated in a stream environment zone just north of D. L. Bliss State Park. Data were obtained during field surveys for this plan and simulations were conducted with FUELS MANAGEMENT ANALYST. The fuel hazards would result in a passive crown fire and excessive mortality.

This type of fire behavior was observed in the November 2002 Pioneer Fire. A power line initiated a surface fire, which burned in a previously treated area. Driven by strong winds, the fire reached a stream environment zone where it quickly became a crown fire when it moved up through mature lodgepole pines growing in the riparian habitat.

Differences in fire behavior modeling results between analysis conducted for this assessment and previous analysis can be attributed to two major distinctions. First, fuel modeling information was collected differently. In the FARSITE analysis, the fuel modeling layer was generalized across the watershed and used standard forest stand parameters. This fuel model data was less specific within the communities. The fuel modeling developed for this document was site specific, with detailed forest sample plot measurements to adjust fuel model parameters. These plots were located within the high hazards areas in and adjacent to communities. Second, the information reported from each analysis is different (minimum flame lengths are reported from FARSITE, average flame lengths are reported from Fuels Management Analyst.).

The current fire regime in the Basin is now characterized by high intensity fires rather than the majority of low intensity fires that previously occurred there. This change in fire behavior is supported by the increase in number of acres burned annually by wildfires, despite highly effective suppression capabilities. Additionally, simulated fire behavior in montane forests and stream environment zones is supported by observed behavior of recent fires in the Basin. High intensity fires will result in high mortality in forest stands and dependent on the size of the fire, could result in extensive property loss and large amounts of erosion and sedimentation adversely affecting water quality.

1.3 Ignition Risk

The Lake Tahoe Basin has one of the highest fire ignition rates in the Sierra Nevada. Data from the LTBMU from 1973-1996 were used to describe ignition risks. In the planning area, the highest occurrence of ignitions (number of ignitions per 1,000 acres, Figure 3) occurs at Brockway, from Kings Beach to Tahoe Vista, Dollar Point, Camp

Richardson, and around the City of South Lake Tahoe. The lowest occurrence of ignitions occurred at Homewood, Meeks Bay, and D. L. Bliss State Park. Humans caused all but one fire during this period (Murphy and Knopp 2000).

1.4 Values at Risk

Given the diversity of people and resources in the Lake Tahoe Basin, there is a large number of real and perceived values at risk. Three values at risk are considered in this evaluation: communities, lake clarity, and old growth forests (Murphy and Knopp 2000). The economic value of individual communities varies around the lake; however, the personal value of every community is equally very important to each member of those communities. Therefore, community values were calculated as the percentage of each watershed covered by structures or developments. Soil erosion hazards in watersheds were used to characterize threats to water quality and lake clarity. Intense fires on highly erodible soils would have a greater impact on water quality and lake clarity than intense fires on less erodible soils. The percentage of old growth forests in each watershed were used as an umbrella indicator of upland biological resources.

Prioritizing Values at Risks

Values at risk were prioritized by integrating the community, lake clarity, and old growth forest indices with fire susceptibility and then ranking individual watersheds (Murphy and Knopp 2000). Wildland fire susceptibility includes simulated flame lengths, representing fire hazards, and ignition risks. Therefore, the prioritization process accounts for economic and natural resource values at risk and the susceptibility of that watershed to a fire. The communities in each fire district and the prioritization of values at risk are shown in Figure 4.

Based on this assessment of values at risk, the highest ranked communities are Brockway and portions of Kings Beach; Dollar Point, Cedar Flat, and the Highlands; portions of Tahoe City, the Truckee River corridor, and Talmont; portions of Gold Coast; and North Upper Truckee, Meyers, and Christmas Valley. This analysis is very similar to the communities at risk identified in the Federal Register.

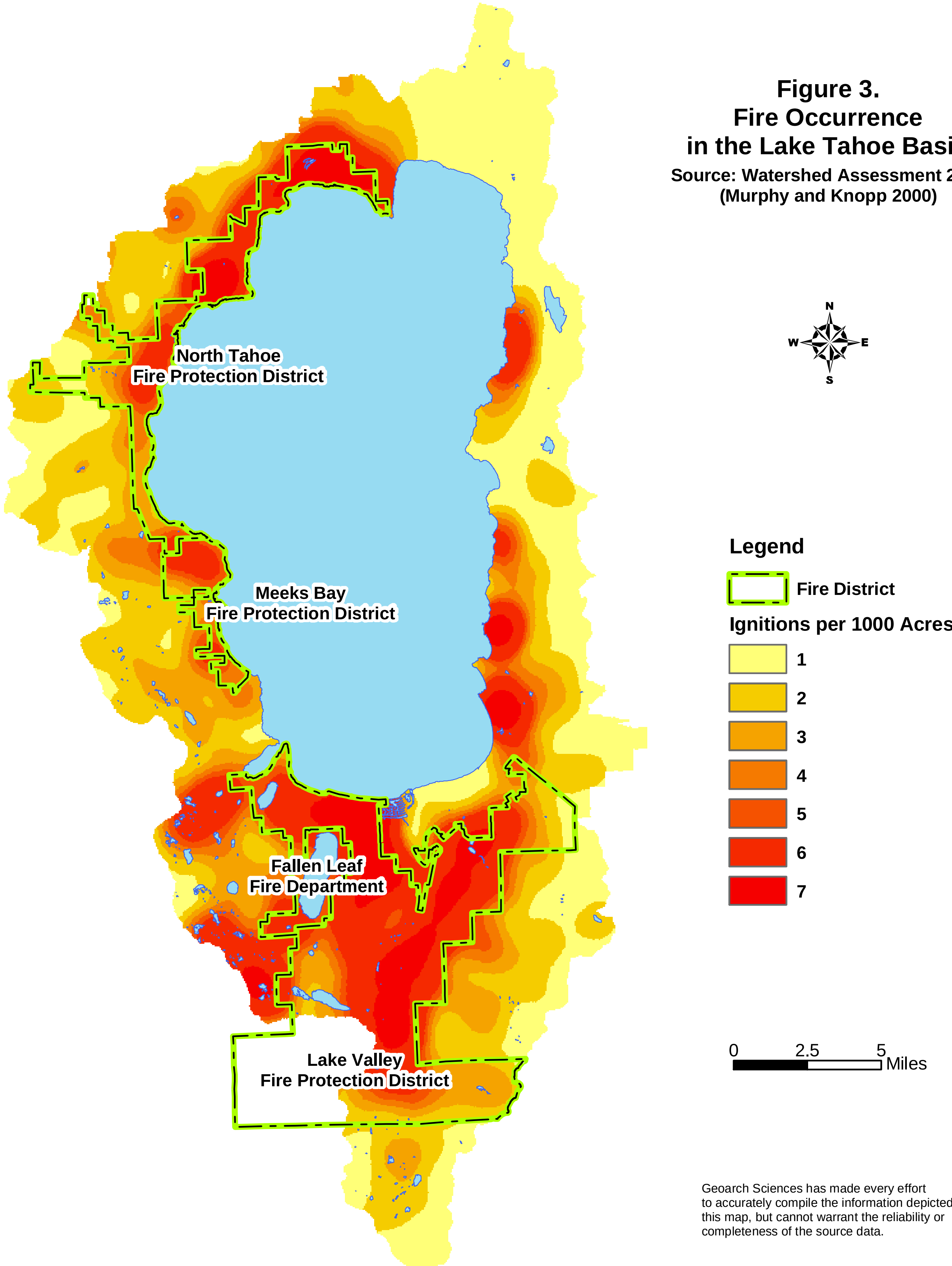


Figure 3.
Fire Occurrence
in the Lake Tahoe Basin

Source: Watershed Assessment 2000
(Murphy and Knopp 2000)

Geoarch Sciences has made every effort to accurately compile the information depicted this map, but cannot warrant the reliability or completeness of the source data.

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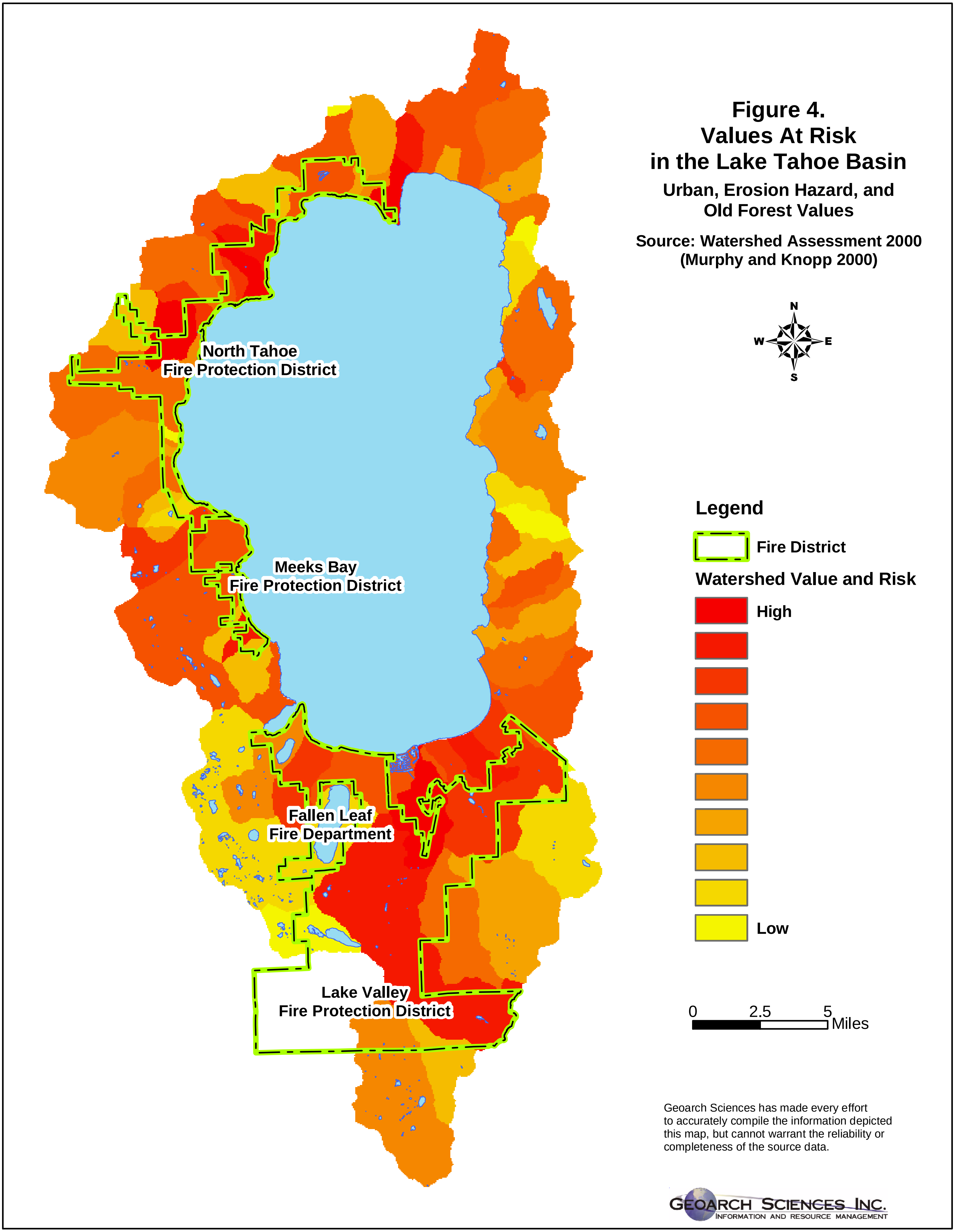

Figure 4.
Values At Risk
in the Lake Tahoe Basin
Urban, Erosion Hazard, and
Old Forest Values
Source: Watershed Assessment 2000
(Murphy and Knopp 2000)
N
W
E
S
North Tahoe
Fire Protection District
Meeks Bay
Fire Protection District
Fallen Leaf
Fire Department
Lake Valley
Fire Protection District
Legend
Fire District
Watershed Value and Risk
High
Low
0
2.5
5
Miles
Geoarch Sciences has made every effort
to accurately compile the information depicted
this map, but cannot warrant the reliability or
completeness of the source data.
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2. MITIGATION GOALS AND OBJECTIVES

The community wildfire protection plan is intended to assess wildfire hazards around communities and develop mitigation projects to address those hazards. Most mitigation projects involve some level of vegetation management, since wildland fuels are the common hazard around communities. This plan develops projects that address the wildfire hazard and, if possible, achieve land management goals and objectives.

This section describes the management goal and objectives for this set of community wildfire protection plans. Management goals are broad statements providing programmatic direction. Management objectives include numeric thresholds or desired conditions for specific components of the program.

Development of the management goal and objectives for these plans considered wildfire hazard reduction, the current characteristics of the Basin's ecosystem and direction in the Healthy Forest Restoration Act and the Water Quality Control Plan for the Lahontan Region (Basin Plan) to maintain water quality.

Many forest stands in the Tahoe Basin have high fuel loadings and are in poor health. The Basin's upland forests are characterized by high mortality, riparian areas have excessive mature, dead, or dying vegetation, and most meadows support encroaching lodgepole pines with varying levels of mortality. The forests are significantly different than they appeared prior to the Comstock era logging (Murphy and Knopp 2000). Prior to Comstock logging, forest stands were much less dense with larger trees and open understories. The current forest stand characteristics have also created excessive fuel hazards capable of supporting stand-destroying fires that threaten communities and ecosystem health.

The purpose of the Healthy Forest Restoration Act is to:

- Reduce wildfire risk to communities;
- Enhance efforts to protect watersheds and forest health; and
- Protect, restore, and enhance forest ecosystem components (H.R. 1904, section 2).

The goal of the community wildfire protection plans is to protect values at risk and restore ecosystem health by reducing fuel hazards using cost effective treatments.

Objectives are described by vegetation types in the planning area. Vegetation types were selected because they are easily identified; historic fire regimes and vegetation composition and structure differ among vegetation types; several vegetation types may be in a project area; and regulatory constraints differ among vegetation types.

Historic fire regimes refer to the frequent, low intensity fires that characterized the pre-Comstock era in the Lake Tahoe Basin. Restoring this fire regime is desired because it provides disturbance that creates mosaics of vegetation structure without completely destroying the forest stand. Vegetation descriptions were based on information in Murphy and Knopp (2000) and our own interpretation of the response of vegetation to disturbance.

Stream environment zones (SEZ) are one of the most protected and regulated resources in the Tahoe Basin. SEZs include perennial, intermittent, and ephemeral streams, beach soils areas, and meadows. They provide important functions for water quality, helping filter out impurities before they reach the Lake. SEZ's are also commonly associated with important wildlife habitat. The Basin Plan allows for the removal or disturbance of vegetation in SEZs to maintain the health and diversity of the vegetation or to maintain the character of the SEZ (section 5.13-3).

Healthy SEZ's are typically resistant to high intensity fire. Lush riparian vegetation with small groups of pine trees and less dead material limits the wildland fuels. Many SEZ's currently contain a significant amount of dead vegetation with lodgepole pines encroaching on the riparian vegetation. The result is the increased likelihood of a high intensity wildfire, which not only threatens neighboring communities but significantly impairs the SEZ.

2.1 Mitigation Project Objectives

The objectives for Forests Surrounding Communities are:

- Reduce the threat of wildfire destroying a community by restoring historic fire intensities by managing ground and mid-story fuels so fires burn as low intensity surface fires (flame lengths less than 2 feet).
- Restore the historic forest structure of widely spaced tree crowns to reduce the threat of a crown fire threatening a community. Restore the historic forest structure, with more and larger openings within the forest.
- Where possible, improve forest health by removing sufficient trees to achieve a basal area of approximately 90 to 150 ft^2/acre (with appropriate tree or clump spacing) to reduce tree mortality associated with insects and diseases.
- Where appropriate, maintain sufficient snags and downed logs to provide habitat components for dependent wildlife.

The objectives for Brush Fields Surrounding Communities are:

- Reduce the threat of wildfire to a community by establishing and maintaining a mosaic of shrub forms classes that support a low intensity surface fire (flame lengths less than 3 feet).

The objectives for Steam Environment Zones are:

- Achieve vegetation structure and species composition consistent with the historic, low intensity, fire regime.
- Reduce the amount of dead and down material that can carry wildfire within SEZ's.
- Reduce the density, and subsequent encroachment, of lodgepole pines in meadows.

3. ROLES AND RESPONSIBILITIES

This section describes the roles and responsibilities of agencies and organizations in the Lake Tahoe Basin to plan and implement proposed projects. The level of involvement of each agency or organization will vary by project; however, the success of implementing a project will be the shared responsibility of all agencies and organizations.

3.1 Residents and Landowners

According to the *Living with Fire in the Tahoe Basin* publication, defensible space and use of the appropriate building materials are the most important defenses against loss of structures during a wildfire event. As such, private homeowners and landowners constitute the most important group for limiting losses from a wildfire. Each homeowner has a responsibility, re-enforced by state and local codes, to create and maintain defensible space and use non-flammable building construction around their homes.

Public education and voluntary compliance with defensible space measures have been the preferred alternative to addressing the responsibilities of residents and landowners. However, California Public Resources Code mandates landowners and residents to mitigate wildfire hazards around homes with specific vegetation management recommendations. Though these codes have not typically been enforced, local and state agencies have the authority to cite and fine residents and land owners for non compliance with defensible space measures.

The relatively small parcel size of most private lands adds another level of complexity to creating defensible space. Should a homeowner create appropriate defensible space on the property they own, but adjacent property within 100 feet of the home do not have appropriate vegetation management, the adjacent landowner could be criminally liable. This is particularly true in jurisdictions outside the Tahoe Basin that have passed ordinances to address exactly this issue. Beyond the legal requirements, civil liabilities may also be an issue. If an action, or lack of action, by a landowner results in fire spreading from their land to a structure, the offending landowner may be civilly liable for damages. This is particularly true if the fire originated on the offending landowners land and there is legal precedent for this case.

The insurance industry is also addressing the exposure and risk of their insured properties to wildfire hazards. Already in the Tahoe Basin, some homeowners are finding it difficult, if not impossible, to obtain homeowners insurance without proper building materials and defensible space. Even in cases where building materials and defensible space is appropriate, some insurance carriers are denying coverage, opting instead to simply stop insuring structures in the wildland environment.

All of these issues underscore the important role residents and landowners play in mitigating wildfire hazards.

There are agencies available to assist the private landowner with wildfire hazard mitigation. The Tahoe Basin Fire Safe Council and the fire districts can provide technical support for identifying and address hazards. The Natural Resource Conservation Service (NRCS) has a long standing mission to assist private landowners with natural resource issues. In other areas of the state, the NRCS is actively engaged in hazardous fuels reduction projects. Though funding is limited, programs such as the Wildlife Habitat Improvement Program might offer some cost sharing benefits where landowners can mesh wildlife habitat improvement and fuels reduction goals.

In addition to their own backyard, homeowners should actively support fuels reduction projects in their neighborhoods. Fire protection districts, LTBMU, CTC, California State Parks, and other local agencies are implementing fuels reduction projects on public lands surrounding private ownership. Public projects with active support of local residents will likely be funded sooner and implemented more successfully. These agencies will need to conduct public project review and scoping, gathering input from the public on implementation concerns and specific hazards within the communities. Residents should be informed on the projects so that they may help refine project implementation to tie in with other fuels reduction efforts on private land.

3.2 Tahoe Basin Fire Safe Council

The Tahoe Basin Fire Safe Council (Council) is responsible for providing technical and tactical support to the fire districts, coordinating with land management and regulatory agencies, coordinating activities between homeowner groups, and developing education materials and reaching out to the public to assist with implementation of the community wildfire protection plans.

3.3 Fire Districts

The Fire Districts serve as the lead agencies for planning and implementation of the individual projects and serve as the decision-making body for approval of those projects. They will also be responsible for identifying project priorities, obtaining funding, and facilitating policy changes required to implement the proposed projects.

3.4 Land Management Agencies and Organizations

The role of the LTBMU, California State Parks, California Tahoe Conservancy, local agencies and special districts, and some homeowner associations is to manage the natural resources on lands they administer. These agencies and organizations are responsible for planning and implementing projects on their respective lands that restore ecosystem health by reducing fuel hazards. These groups are also responsible for ensuring their plans are consistent with federal, state, and local laws, regulations, and policies.

3.5 Regulatory Agencies

The regulatory agencies: California Department of Forestry and Fire Protection (CDF), Lahontan Regional Water Quality Control Board (Lahontan), and TRPA enforce regulations and policies designed to protect the environment. CDF enforces the Forest Practice Rules that regulate forest management on private land and some state lands. Removal of trees that are sold as a commercial product generally requires a timber harvest plan. Some activities are exempt from filing a timber harvest plan; these include projects that:

- remove trees within 150 feet of a residence or
- remove dead or dying trees from parcels smaller than 20 acres in the Lake Tahoe Basin.

Additionally, an emergency notice to remove trees (14 CCR 1052) may be filed to remove dead and dying trees or where high, very high, or extreme fuel conditions pose a significant threat on private timberlands.

CDF also enforces Public Resources Code 4291 which requires homeowners create and maintain defensible space around their homes. This code was recently amended to increase the defensible space zone from 30 feet to 100 feet.

Lahontan regulates water quality through the Water Quality Control Plan for the Lahontan Region (Basin Plan), specifically Chapter 5.13, which regulates timber harvest activities. Lahontan also issues waivers for waste discharge requirements for timber harvest activities. All individuals that cut and remove trees must apply for a waiver.

TRPA regulates timber harvest activities through its Code Ordinances, primarily Chapter 71 (Tree Removal) and Chapter 72 (Prescribed Burning). TRPA must approve the removal of all live trees greater than six inches dbh. Additionally, all forest management activities must be consistent with TRPA's Code of Ordinances.

4. PRESCRIPTIONS FOR MITIGATION PROJECT AREAS

Mitigation project prescriptions describe what the mitigation project area will look like when the mitigation project is completed. Prescriptions attempt to define the visual components of the mitigation project area as well as the desired fire behavior and forest health conditions. Four general prescriptions are described in this section. The prescriptions will be accomplished with one or more treatments based on stand structure, topography, and land use.

Vegetation management prescriptions require specifics for vegetation spacing and densities for practical implementation. Trying to apply the variability in nature to vegetation management activities is as much art as science. The prescriptions below are not intended to create a uniform landscape of evenly aged and evenly spaced trees, rather they are guidelines for modifying vegetation to achieve the fire behavior objectives. Groups of trees, with touching crowns, may be kept in a treatment area if the distance between the group of trees and other trees or structures is significant enough to limit the spread of fire should that group of trees “torch”, or burn into the crowns. In this scenario, the spacing around the group of trees should be greater than the individual tree spacing recommended below.

A mosaic pattern of forest stands across the landscape could achieve both fire behavior objectives and ecosystem health objectives desired by land management agencies. Accurately describing this mosaic pattern with a silvicultural prescription is difficult. Currently, no projects using such a prescription have been implemented in the Tahoe Basin. Likely, the use of group selection cuts (removing all of the trees in a small area) will be necessary to create this variability. Land management and regulatory agencies in the Tahoe basin must agree on a prescription for this variability such that contractors can implement such a prescription.

Clearly, additional and more detailed prescriptions will be necessary as projects are implemented and monitored. Agencies should assess completed fuels reduction projects for effectiveness in meeting fuel hazard reduction, ecosystem health, and aesthetic objectives. Lessons learned from complete projects should be used to adjust prescriptions for future projects to better meet the management objectives and, ultimately, the desired future condition of the Tahoe Basin.

4.1 Defense Zones

Defense zones generally surround communities; however, they may also be large blocks of open space within communities. These treatments are used to significantly alter fire behavior and restrict fire from entering (or leaving) a community. The overall objective is to reduce flame length to less than two feet. Flame lengths may vary slightly by vegetation type. When these treatments are around communities, they are 250-1,325 feet wide. Defense zones should meet wildfire hazard reduction, improved forest health and SEZ objectives.

Forest Stands
Forest stands are dominated by larger fire tolerant trees and surface and ladder fuels are reduced so crown fire ignitions are unlikely. Ground fuels should be reduced such that ground fire flame heights would be less than 2 feet. There would be at least 10 feet between the crowns or 20 feet between boles of trees with an average crown base height (distance from the ground to the base of the leaf [needle] crown) of at least 20 feet. On steep slopes within the defensible space zone for structures, tree spacing may be increased. The *Living with Fire in the Tahoe Basin* guidelines should be used in creating effective defensible space (Smith 2004). This tree spacing will make crown fires in the overstory unlikely and increasing the crown base height reduces ladder fuels. On drier sites, white fir should have a higher priority of removal than other species. Should clumps of trees be retained, spacing between clumps should be greater than spacing between individual trees.

Forest health would be improved by reducing tree stocking to approximately 90 to 150 $feet^2$ per acre. This will reduce competition among residual trees and mortality associated with insect and diseases. Maintain wildlife habitat components by retaining 0-3 snags per acre (minimum size is 15 inches dbh) and 0-3 large downed logs per acre (minimum size 14 inches dbh and 20 feet long), where possible.

Brush Fields
Brush fields within defense zones will not carry surface fires with flames lengths longer than 3 feet. Spacing between shrubs should be at least twice the height of the shrubs, with residual shrubs creating a mosaic pattern of shrubs and open space across the defense zone.

Stream Environment Zone
Dead and dying material and mature lodgepole will be reduced in all SEZ's. Riparian areas along perennial streams will be characterized by a mosaic of age classes and forms of deciduous vegetation. Mature lodgepole pines will widely scattered. Riparian areas along intermittent and ephemeral streams at lower elevations will be characterized by scattered shrubs. At higher elevations where adjacent uplands burned every 19-32 years, shrubs and trees less than 6 inches dbh should be common in riparian areas.

Defense zones are generally constructed using a combination of the techniques and prescriptions. Where feasible, mechanical methods should be used because they can achieve fuel hazard and forest health objectives in the most cost effective manner.

4.2 Meadow Restoration

Meadow restoration involves removing encroaching lodgepole pines. In many areas (Washoe Meadows State Park, Pope Beach, Baldwin Beach), high mortality of mature lodgepole pines has increased fuel hazards and impacted the meadow system. The purpose of this treatment would be restoring the historic fire intensity, where flame lengths are less than two feet and create a landscape-level area where fire behavior is significantly modified. Few if any mature lodgepole pines would exist in the meadows.

4.3 Roadside Protection

Roadside protection would occur within a corridor that extends up to 100 feet out from either side of the road. This treatment is designed to protect evacuation routes for community residents and provide safety for firefighters entering a community to provide protection in the event of a wildfire. Any road could be a candidate for a roadside protection project, but private roads and county roads providing access into neighborhoods are the most common locations for roadside protections projects. These roads are typically narrower and sometimes provide the only means of escape from a neighborhood.

Brush and shrubs would have a spacing of 3 times the height of the residual plants and be removed immediately adjacent to the road to keep flames from directly impinging the roadway. Spacing between trees would be at least 20 feet between crowns of residual trees, with an average crown base height (distance from the ground to the base of the leaf [needle] crown) of at least 20 feet. Trees immediately adjacent to the road would be few. Flame lengths would be less than 2 feet, with enough clearance to keep flames from traveling directly across the roadway.

Vegetation removal techniques may be accomplished by a combination of mechanical thinning, hand thinning, piling and burning, chipping, prescribed burn, and/or mastication. Mastication is the preferred method since it leaves the treated fuel material on-site. Leaving the treated material is particularly desirable on road shoulders to cover bare soil for erosion control.

4.4 Urban Lots

Fuels treatment on urban lots are generally conducted by hand thinning and designed to remove excessive fuels, thereby altering fire behavior and reducing the ability of a wildfire to move to neighboring lots. Trees spacing and ladder fuels will be the same as in the defense zone. On steep slopes within the defensible space zone for structures, tree spacing may be increased. The *Living with Fire in the Tahoe Basin* guidelines should be used in creating effective defensible space (Smith 2004). Urban lots will have about 40% canopy cover and will be between 100 and 150 sq ft basal area.

Urban lot prescriptions are accomplished through a specific combination of thinning with either pile burning or chipping as the disposal method. Implementation of the prescriptions is unique given the proximity to structures and the relatively easy access to the forest stand. Though hand thinning has been the favored treatment technique, mechanical thinning and mastication with small machines should be evaluated as an alternative cost-effective method of treating urban fuels.

Reduce the potential for crown fires by increasing the crown base height to at least 20 feet. Starting with the smallest diameter class and remove suppressed and intermediate trees to achieve the prescribed crown base height. Remove ground fuels greater than three inches diameter and treat shrub densities to achieve flame lengths of no more than two feet. Where possible, retain 0-3 large downed logs per acre (minimum size 14 inches dbh and 20 feet long).

5. TREATMENTS

5.1 Thinning

Thin stands from below by removing small trees up to 30 inches dbh. Where possible avoid removal of trees greater than 20 in dbh (TRPA Resolution 2004-15). Starting with the smallest diameter class, remove sufficient suppressed and intermediate trees to achieve the desired crown base height and tree spacing. Wherever possible, use mechanical thinning to achieve fuel hazard and forest health objectives. Treat slash by whole tree yarding or disposing of slash in stands by hand piling and burning or chipping and scattering. If it can be transported in whole or as chips, slash can also be disposed of through biomass utilization in cogeneration and wood composite products.

Thinning can be accomplished through either mechanical or hand techniques as described below.

Mechanical Thinning

Mechanical thinning utilizes heavy equipment with large hydraulically-driven saws to cut and remove trees (generally under 24 inches in diameter). The two major harvesting methods include "whole tree removal (WTR)" and "cut-to-length (CTL)". CTL machines use a "stroke delimber" to remove branches before automatically cutting a log to predetermined lengths (see photo). While whole tree removal is preferable from a fuels-reduction standpoint, CTL machines create a mat of slash on which they can operate, reducing impacts to the soil. The slash vs. soil disturbance tradeoff must be considered on a site-specific basis. It is possible to use an in-woods chipper to reduce surface fuels in concert with CTL. Mechanical thinning equipment is generally confined to slopes less than 30% and outside of SEZs except under certain conditions (over snow, or demonstrated non-soil disturbing equipment/conditions). WTR projects require large landings than can accommodate a skidder operation, a large chipper, and semi-trucks. CTL operations require fewer and smaller landings.

Disposal of material treated by mechanical thinning is typically part of the mechanical process. Trees, either whole or cut to length, are removed from the forest by the machine as part of the mechanical thinning process. Slash can be left behind and will need to be treated. Mechanical thinning is typically a process that includes every element of the vegetation management process, from felling of the trees, to removal of biomass.

Mechanical thinning has the ability to create a more precisely targeted stand structure than prescribed fire (Graham et. al, 2004). The net effect of removing ladder fuels is that surface fires burning through treated stands are less likely to ignite the overstory canopy fuels. By itself, mechanical thinning with machinery does little to beneficially affect surface fuel loading. The only exception is that some level of surface fuel compaction, crushing, or mastication may occur during the thinning process. Depending on how it is accomplished, mechanical thinning may add to surface fuel loadings, thereby increasing surface fire intensity. It may be necessary to remove or treat fine fuels that result from thinning the stand (Graham et. al., 1999).

Mechanical thinning techniques use equipment that has the potential to impact soil and sensitive resources. Proper planning and conscientious operation can reduce these impacts to acceptable levels. Mitigation measures may also be necessary to limit these impacts. Mitigation measures will be considered at a more detailed level of project planning.

Hand Thinning
Hand thinning is conducted with crews of approximately 10 individuals who cut trees with chainsaws. Hand thinning is generally used to cut smaller trees (less than 14 inches dbh), on steep slopes where machines cannot operate, or in environmentally sensitive areas where machines would have a significant environmental impact. Removal of smaller trees is generally limited to younger stands where the trees are smaller. Because hand thinning can only effectively remove smaller material, silvicultural and fuel management objectives may not be fully achieved compared to mechanical thinning. Additionally, hand thinning may require more frequent treatments to maintain acceptable fuel loads than mechanical thinning and hand thinning may not be cost effective in forest stands with excessive ground fuel loading where mechanical thinning would remove or compact those fuels.

Unlike mechanical thinning, hand thinning simply addresses how the vegetation will be cut, without addressing how the material is disposed. This is due to the varied uses for hand thinning (for example on steep slopes where equipment cannot operate, on environmental sensitive areas where equipment cannot operate, or on small lots where the use of equipment is not feasible). Depending upon the situation, hand thinning may be the most appropriate method for vegetation cutting, but some other mechanical means may be employed for removal of the cut material from the site. One or more of the following disposal treatments must be applied in concert with thinning to remove the fuels from the forest.

- Hand Piling and Burning- All cut material and dead and down material greater than 3 inches in diameter and up to 14 inches diameter shall be piled for burning. Piles shall be constructed compactly beginning with a core of fine fuels and minimizing air spaces to facilitate complete combustion. Piles will be constructed at least 1.5 times the diameter of the pile from residual trees and no taller than five feet to prevent damage when burning. If the area will not be broadcast burned, then each pile will be lined with a wet or hand fire line. At least one half of each pile will be covered with water resistant burnable paper to cover the fine material in the center of the piles. The LTBMU is pursuing research on the impact of pile burning in different SEZ types and conditions, however this practice is not authorized within SEZs at this time.

- Chipping- Chipping may be used as an alternative to burning. It redistributes forest vegetation that is cut by mechanical thinning or hand thinning. The chips may be removed from the site and converted to energy for other products, or they can be scattered throughout the project area. Chips scattered throughout the project area will not exceed four inches in depth.

- Forwarding- Forwarding is essentially the portion of mechanical thinning involving removal of material from the forest. A large machine with a stake side bed and grapple moves through the forest and picks up the material, logs, slash, or both and loads it onto the bed for transport back to a central landing area. All the same issues regarding soil disturbance, landing requirements, and slope limitation apply to forwarding as mechanical thinning.

- Yarding- Where steep slopes limit mechanical thinning and forwarding, removal of material is costly. An alternative method for tree and biomass removal is cable yarding. Cable yarding is accomplished through a system cable and pulleys laid out through the forest. Using towers and trees, the cable is suspended or partially suspended above the forest floor, allowing trees to be transported out of the forest without soil disturbance (yarding systems that completely suspend material would be given preference). Similar to helicopter logging (but less costly) cable yarding lifts the trees completely off the ground while moving them up or down to the landing.

  Yarding has not yet been used in the Tahoe Basin for fuels treatment and provides a unique solution to operational constraint issues for fuels mitigation projects. The systems take time to setup . Initial project costs with yarding systems may be higher than traditional methods, but as crews become more experienced, costs will decrease.

Thinning and Fire Behavior

Surface and canopy fuel treatments have variable effects on the factors affecting torching and crowning (Table 5). A thinning designed to reduce crown fire hazard will usually raise the effective crown base height (*CBH).* .Fuel reduction projects should concentrate on the removal of mainly smaller trees to increase *CHB* and other size classes to achieve forest health objectives. Similarly, while a broadcast burn will usually increase *CBH* by scorching lower branches, a broadcast burn under moderate burning conditions may be patchy and of insufficient intensity to raise effective *CBH* for the whole stand. (Graham et. al., 2004)

When evaluating the effect of fuel treatments on potential crown fire behavior, it is important to consider the effects of understory thinning on midflame windspeed and fuel moisture. Thinning opens the canopy and increases midflame and surface windspeeds. Increased surface windspeeds - coupled with increased sunlight on the forest floor - create drier fuel conditions in treated stands during summer. These two factors tend to increase surface fire behavior.

In many wildfire scenarios, heavy spotting into fuelbreaks has rendered them ineffective for fire suppression. Thinning stands increases the likelihood that firebrands from torching trees adjacent to the thinning will hit the ground - landing in a receptive, dry fuelbed instead of extinguishing in the overstory canopy.

For these reasons, it is useful to visualize Defense Zones as "anchors" in a landscape-scale strategy that treats large areas of forest adjacent to communities. Defense Zone thinning projects undertaken near communities provide a window of opportunity to implement larger-scale area treatment projects that utilize prescribed fire to treat large areas beyond the wildland urban interface.

Properly executed forest thinning treatments reduce the crown fire potential - improving the defensibility of communities. However, these projects often represent a tradeoff—the decrease in crown fire potential comes at the expense of increased surface fire spread rate, fire intensity, and spotting hazard. While a reduction in crown fire potential and decreased tree mortality following wildfire makes this tradeoff reasonable, proper maintenance of thinning projects is essential if these benefits are to last.

Table 5: Immediate-term effects of fuel treatments on factors that affect the Torching and Crowning Indices(from Graham et. al., 2004).

- *A blank cell in the table indicates no effect. I = increase, D = decrease, NE = no effect.*

Fuel Treatment	*Surface Fuels Load*	*Dead Fuels Moisture*	*Canopy Base Height*	*Wind Reduction factor*	*Canopy Bulk Density*
Overstory Thinning	I	D	I to NE	D	D
Understory Removal	I		I		D or NE
Pruning	I		I		
Pile burning	D				
Whole Tree Yarding	D				
Broadcast Burning	D		I or NE		

The most effective and appropriate sequence of fuel treatments depends on the amount of surface fuel present; the density of understory and mid-canopy trees; long-term potential effects of fuel treatments on vegetation, soils, and wildlife; and short-term potential effects on smoke production (Graham et. al., 1999). In forests that have not experienced fire for many decades, multiple fuel treatments are often required to achieve the desired fuel conditions. Thinning followed by prescribed burning reduces canopy, ladder, and surface fuels, thereby providing maximum protection from severe fires in the future (Graham et. al., 2004). Potential fire intensity and/or severity in thinned stands are significantly reduced only if thinning is accompanied by reducing the surface fuels (woody fuel stratum) created from the thinning operations (Graham et. al., 1999).

5.2 Mastication

Mastication requires machines to grind, rearrange, compact, or otherwise change fire hazard without reducing fuel loads. It provides a quick and cost effective method to modify the fuel bed structure to reduce flame length and therefore fire intensity. Mastication is a useful tool in plantations and brush fields, and has applications in thinning small trees for fuel break and roadside maintenance. Mastication is significantly more cost effective than hand crew brush treatments. Cutting and disposal of material occurs in a single action. Chips are left on the ground, providing soil erosion protection and a mat of material for the machine to travel across.

Like other mechanical methods, rocky sites, sites with heavy down logs, and sites dominated by large trees are difficult places in which to operate mastication equipment. Additionally, sparks from mastication heads have the potential to start fires and, when working on public land, these machines are subject to the same activity-level restrictions that apply to most other logging equipment (see photo).

Where mastication is recommended for projects proposed in this report, use rubber tired or low impact tracked vehicles to cut, chip, and scatter all shrubs and small trees up to 10” dbh on site. Brush cover should be reduced by creating a mosaic of treated and untreated shrubs. Brush that is treated should be cut to the maximum of six inches in height. No individual pieces of cut material shall be greater than 4 feet long. All masticated stumps shall be cut to within six inches of the ground. No debris shall average more than two inches over the entire project area. All cut vegetation will be kept within the unit boundaries.

Thin layers of wood chips spread on the forest floor tend to dry and rewet readily. Deep layers of both chips and chip piles may have insufficient air circulation, making poor conditions for decomposition. Moreover, when layers of small woody material are spread on the forest floor and decomposition does occur, the decomposing organisms utilize large amounts of nitrogen reducing its availability to plants. Therefore, the impact of any crushing, chipping, or mulching treatment on decomposition processes and their potential contribution to smoldering fires needs to be considered (Graham, 2004).

Mastication equipment has the potential to impact soil and sensitive resources. Proper planning and conscientious operation can reduce these impacts to acceptable levels. Mitigation measures may also be necessary to limit these impacts. Mitigation measures will be considered at a more detailed level of project planning.

5.3 Prescribed Burning

Prescribed burning reduces the loading of fine fuels, duff, large woody fuels, rotten material, shrubs, and other live surface fuels. These changes, together with increased fuel compactness and reduced fuel continuity change the fuel energy stored on the site, reducing potential fire spread rate and intensity (see photo). Burning reduces horizontal fuel continuity (shrub, low vegetation, woody fuel strata), which disrupts growth of surface fires, limits buildup of intensity, and reduces spot fire ignition probability (Graham, 2004). Given current accumulations of fuels in some stands, multiple prescribed fires—as the sole treatment or in combination with thinning—may be needed initially, followed by long-term maintenance burning or other fuel reduction (for example, mowing), to reduce crown fire hazard and the likelihood of severe ecosystem impacts from high severity fires.

Opportunities to use prescribed fire are limited because of smoke management concerns. Some studies indicate short-term effects of prescribed burning may affect water quality in the Basin. A prescribed burn in Pope Marsh (1995) increased nitrogen concentrations in water samples the first and second year after the burn. In another area, phosphorus concentration in runoff was the same in unburned and burned forest plots (Murphy and Knopp 2000). Neither study followed nutrient levels 3-6 years post-fire after vegetation became reestablished and that vegetation is characterized by high nutrient uptake to meet increased growth rates. Additionally, smoke particulates may also be associated with algal blooms (Murphy and Knopp 2000). Therefore, long-term effects of prescribed burning on Lake Tahoe may not be well understood.

Use of prescribed burning occurs in two different mitigation project settings:

Prescribed Burning in Forests.
Low intensity broadcast burning should be used to reduce all fuels < 3 inches diameter by 60-80%, the brush component by 50%, and 75% of trees less than three inches dbh. Use fire to prune ladder fuels by scorching the lower 1/3 of branches on 100% of trees less than eight inches dbh. Retain large down logs (14 inches in diameter or greater) to a maximum density of five per acre. Maintain 60 to 70% of ground cover on slopes 35% or less. Additionally, acceptable standards for prescribed fires should include:

- six foot maximum scorch height; and,
- less than 10% mortality in conifers > 12 inches dbh.

Do not ignite fires in stream environment zones (SEZs). However, allow backing fires to enter SEZs affecting a maximum of 45% of the area in a mosaic pattern. No more than 50% of the fuels <1 inch diameter should be consumed in SEZs.

Prescribed Burning in Meadows.
Broadcast burning will occur after all grasses have cured and soils are dried. The burns will be hand ignited and sufficiently hot enough to kill 90% of all standing lodgepole pine. It may be necessary to conduct additional burns in the future to remove unconsumed lodgepole pines and those that have regenerated. In some cases, mechanical or hand thinning may be necessary to remove trees from the edge of the meadow to create a control line for the prescribed burn.

5.4 Review of Cost Factors

Estimated treatment costs were based on those published by TRPA (2004) and by conferring with representatives from LTBMU, California Tahoe Conservancy, and North Lake Tahoe Fire Protection District. Cost factors vary widely because of fuel loadings, operational constraints, and crew capabilities. The costs are limited to the direct cost of project implementation. They do not include off-setting revenue that may be generated by providing commercial products or costs associated with project planning, preparation of environmental compliance reports and administrative overhead during implementation.

Table 6: Treatment specific cost estimates.

Fuel Reduction Treatment	Cost per acre
Mechanical thinning (urban interface)	\$2,000 - \$3,200
Hand thin	\$650 - \$1,350
Hand Pile Burn	\$300 - \$700
Chipping	\$200 - \$700
Mastication	\$700 - \$1,500
Prescribed burning	\$400 - \$900
Urban lots	\$1,850 - \$10,000

Examination of cost factors illustrates conflicting data. Based on the information provided, it appears that hand treatment is less expensive than mechanical treatment. This is not the case. Commercial forestry operations use mechanical methods whenever possible due to it cost effectiveness.

Cost data for completed projects in the Tahoe Basin cannot be compared across treatments. The treatments are not the same for mechanical thinning as they are for hand thinning. Though the prescription objectives might be the same, the projects where mechanical treatments have been employed have treated a significantly higher volume of material than the hand thinning treatments. Mitigation measures associated with environmental compliance for mechanical operation in the Tahoe Basin also adds significantly to the cost of mechanical treatments. Protection of sensitive resources is important, however a review of current regulatory constraints is recommended later in this document to clarify the environmental mitigation process for mechanical operations.

Further complicating existing cost data is the lack of variability of previous mitigation projects. The most common mitigation technique at this time in the Tahoe Basin is hand thinning and pile burning outside sensitive areas. Since pile burning and mechanical operations are not permitted within SEZs and many of the proposed projects are in sensitive areas, it is difficult to assign costs based on empirical data. Mechanical thinning costs are currently based on a cut-to-length harvest system, which is more expensive than other mechanical systems. Combinations of mechanical and hand treatment, such as hand falling and mechanical forwarding or in-woods chipping may prove most cost effective.

Cost estimates for the projects proposed in this document were based on a combination of costs for projects within the Tahoe Basin and a review of costs for projects outside the Tahoe Basin. Professional judgment was used to develop a cost matrix for proposed projects by prescription. The most appropriate treatment was selected to implement the prescription. Using the selected combination of techniques and the existing vegetation conditions in the projects areas as guides, the following cost estimates were used to developed costs estimates for projects.

Table 7: Summary of project cost estimates:

Fuel Reduction Project	Cost per acre
Defense Zone	
Brush, some trees	$1000
Moderately dense forest stand	$2500
Very dense forest stand	$4600
Meadow Restoration	$1200
Roadway Clearance	$800
Urban lots	$4075

Cost effectiveness is not the sole consideration in selecting a treatment method. Mechanized equipment's impact on the environment is also considered. The decision to use mechanical or hand techniques was made based on existing vegetation conditions, cost effectiveness, and existing transportation infrastructure.

6. ENVIRONMENTAL COMPLIANCE

Environmental regulations may protect the environment (e.g. Clean Water Act, Clean Air Act, and Endangered Species Act) or reduce impacts on the environment and allow the public to participate in agency decision-making processes that may affect the environment (e.g. National Environmental Policy Act and California Environmental Quality Act). The extent of environmental compliance is determined by the land ownership where the project is occurring, the funding agency, the complexity of the project, and the number of regulations that govern a project.

All individual projects designed to reduce fuel hazards that are proposed by public agencies, funded by public agencies, or that require federal, state, local, or local discretionary approval will be subject to federal, state, or regional environmental regulations. This plan is advisory and will not result in changes in the human environment without appropriate environmental planning, therefore is not subject to NEPA or CEQA.

6.1 National Environmental Policy Act

All fuel reduction projects funded by the federal government, that occur on federal land (e.g. LTBMU), or require a federal agency to issue a permit must comply with NEPA. Agencies comply with NEPA by preparing environmental impact statements or environmental assessments that evaluate impacts of the proposed project, propose mitigation measures to reduce those impacts, and consider alternative actions that may change impacts on the environment. Environmental assessments are simpler versions of environmental impact statements and they must conclude that the project will not result in a significant impact on the environment. The Healthy Forest Restoration Act only requires agencies to simplify the process by only evaluating two alternative projects in a NEPA document. In some cases, federal agencies have determined that some projects are categorically exempt from NEPA. The Forest Service has recently determined that several types of fuel reduction projects are categorically exempt (Federal Register 68:33814 and 68:44598). Projects that meet these requirements only need to demonstrate that there are no extraordinary circumstances affected by the project, these include threatened or endangered species, cultural resources, wetlands, wilderness, or roadless areas. Most of the projects in the Basin that require NEPA compliance will need an environmental assessment of categorical exclusion. Some projects may require more extensive environmental documentation.

6.2 California Environmental Quality Act

Fuel reduction projects on private lands and some state lands that require approval by a local or state agency must comply with CEQA or a functionally equivalent program (e.g. the California Forest Practice Rules). The documentary requirements for CEQA are very similar to those for NEPA. Most projects in the Basin will require an initial study/negative declaration to comply with CEQA. Some projects may require more extensive environmental documentation. If a timber harvest plan is prepared in lieu of a CEQA document, it must be signed by a California Register Professional Forester. Some small projects, such as defense zone clearing are generally exempt from CEQA or a functionally equivalent program.

6.3 TRPA

Tree removal on all lands must comply with the TRPA Code of Ordinances, Chapter 71 (2004). Removal of all live trees over six inches dbh requires approval by TRPA. A tree removal plan must be prepared for all projects involving substantial tree removal. Substantial tree removal projects are defined as cutting more than 100 trees over 10" dbh in an area greater than 20 acres or cutting more than 100 trees over 10" dbh on land capability classes 1a, 1b, 1c, 2 or 3. Tree removal plans will also be consistent with all other TRPA Code of Ordinances.

6.4 Regional Water Quality Control Board – Lahontan Region (Lahontan)

California State Water Code section 13269 authorizes Lahontan to waive the requirement to obtain a waste discharge permits and pay filing fees. To be eligible for the waiver all timber harvest activities, including fire hazard abatement, must apply for a waiver. Fire safe treatments, those within 150 feet of existing structures, are not required to apply for a waiver, unless they are within, or directly adjacent to an SEZ. Applications for waivers must be submitted to Lahontan for approval. The application process and required supporting documentation varies with the magnitude of potential impacts on soils and stream environment zones from different treatments (mechanical and hand thinning, mastication, prescribed burning). In the interest of streamlining implementation, Lahontan may approve specific fuels management areas under each fire plan under a single waiver through each of the fire protection districts.

6.5 Recommended Review of Environmental Compliance

Current regulatory policies are in need of review to ensure they appropriately protect sensitive resources from preventable threats. A review of the regulatory constraints is intended to further protect those resources from the threat of wildfire. This threat, until recently, has not been thoroughly considered in those regulations.

Regulatory agencies in the Tahoe Basin began addressing impacts to water quality over 30 years ago. The impacts perceived to be the greatest threats to water quality have evolved over the years as better scientific and empirical data becomes available. Additional natural resource disciplines have been incorporated and regulated as the impacts to water quality are better understood. Wildland fire, as a threat to water quality and watershed health, is no different. Regulatory agencies charged with protecting water quality must address the threat wildfire poses to water quality with the same vigor they address the threat road construction poses to water quality. The first step in addressing the wildfire threat to water quality is to review language in existing policies that is in conflict with activities designed to reduce the wildfire threat. This review is occurring within the existing Pathway 2007 planning process, however some issues may require immediate attention.

To successfully address the threat of wildfire, regulatory agencies must not only accept, but promote, vegetation management concepts that would not have been considered in the past. Since catastrophic wildfire has not visited the Tahoe Basin in the last 50 years it cannot be assumed that catastrophic wildfire will not occur in the next 50 years. In fact, the previous 50 years significantly increases the likelihood of a catastrophic wildfire in the next 50. Agencies charged with protecting sensitive resources should be at the forefront of efforts to mitigate the wildfire threat. Given their combined knowledge of water quality and watershed impacts, the regulatory agencies can best identify and inform on acceptable innovative technologies for vegetation management.

In many cases, the suggested review of ordinances and codes recommend not a removal of language, but a further clarification of interpretation. The codes and ordinances contain verbiage concerning what cannot be done in vegetation management activities. Language needs to be included defining acceptable limits for disturbance and mitigation measures that should be accomplished. It is recommended the following policies be evaluated:

- Basin Plan 5.13-3: "No vegetation shall be disturbed or removed from the Stream Environment Zones except to maintain the health and diversity of the vegetation or to maintain the character of the Stream Environment Zone."

Many SEZs are characterized by dead and dying vegetation, particularly lodgepole pines. These conditions are inconsistent with historic fire regimes that periodically disturbed or removed vegetation from these areas.

This policy should be expanded to provide a clear definition of a healthy SEZ, particularly regarding the amount of dead material in an SEZ. It is recommended the vegetation that resulted from the historic fire regime be used as a definition of a healthy SEZ.

- Basin Plan 5.13-2: "all vehicles shall be restricted to areas outside the SEZ or to existing roads within SEZ's, except for over snow removal. . ."

Simulated and observed fire behavior demonstrated high mortality in SEZs which would eliminate or reduce the vegetation that provides cover and reduced water temperature. Because of the number and size of these trees, hand labor is not a cost-effective means of tree removal. Over snow conditions offers an opportunity for mechanized vehicles to operate; however, those conditions are unpredictable and may not be widely available, particularly during dry years. Because these conditions are unpredictable, crews may be unavailable or mobilization costs increase significantly. Further, over snow operations will not allow treatments to address surface fuel hazards.

Project layout and timing can be used to limit the impacts of mechanical equipment. Careful placement of forwarding tracks and transport corridors can keep the impact to sensitive areas to a minimum. Working on dry portions of the sensitive areas at during dry seasons will also limit impacts. As stated above, the impacts of mechanical equipment usage can are offset by the long term benefit of treatment in the SEZ.

This policy should be reviewed to provide more predictability in allowing currently available mechanized vehicles to restore the health of SEZs.

- Basin Plan 5-13-3: "Forest management activities on high erosion hazard lands shall be solely by means of helicopter, balloon, over snow, or other techniques which will not result in any permanent soil disturbance."

A large number of projects requiring mechanical thinning are proposed on lands mapped as Bailey land classification category 1a (high erosion hazard). Field verification may determine these lands have not been mapped correctly. However, the inability to use mechanical equipment on those lands that have been mapped correctly would eliminate an opportunity to treat hazardous fuels in the wildland urban interface.

This policy should be reviewed to identify mechanical vehicles or operating techniques that would result in an acceptable level of soil disturbance but not permanent soil disturbance.

- TRPA Code of Ordinances 71.4.A(1)(2004): Objectives for tree removal include, "Restoration and expansion of stream environment zones and riparian vegetation."

The definition of restoration of stream environment zones and riparian vegetation should be developed in concert with Lahontan and adopted by both agencies.

- TRPA Code of Ordinances 71.4.C(1)(2004): "TRPA will review site-specific proposals for, and may permit, the use of 'innovative technology' vehicles and or 'innovative techniques' for the purpose of fire hazard reduction in SEZs provided no significant soil disturbance or significant vegetation damage will result from the use of equipment."

Innovative technology vehicles or techniques are not currently available. This is evident by the lack of projects in the Basin using unique technologies and the lack of regulation identifying acceptable technologies. Without significant funding, there is little incentive for companies to invest the capital and resources necessary to develop machinery specifically designed for the Tahoe Basin because of the limited use and available market.

This does not mean treatments should be limited to the current set of treatment techniques employed in the Basin. Instead, a review of existing vegetation management technologies outside the Basin should be completed. This policy should be reviewed in concert with Lahontan to clarify what level of soil disturbance would not be considered significant. Additionally, it should delete references to "innovative" and allow for currently available vehicles and technology that do not cause significant soil disturbance.

- TRPA Code of Ordinances 71.4.C(b)(vi)(2004): "Operations should incorporate measures to avoid impacts to wildlife during critical wildlife nesting and denning periods."

This policy allows no impacts on all wildlife. It establishes a more restrictive threshold than NEPA or CEQA which may avoid impacts on special-status species (candidate, threatened or endangered, sensitive species, fully protected species, or special-interest species) rather than all species of wildlife.

This policy should be reviewed to allow less than significant impacts on wildlife that are not classified as special-status species.

- Fuel management projects in the Tahoe Basin may involve multiple ownerships and regulatory reviews that will increase the cost of project planning and approval.

The land management regulatory agencies should review existing regulations and policies and develop a cost effective process to approve fuel reduction projects. This may include a checklist that can be used for projects that use standard treatments and techniques. The checklist would identify expected impacts and pre-approved mitigation measures that can be quickly reviewed and approved by the appropriate agencies.

IV. APPENDICES

A. REFERENCES

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Appendix B: Glossary

Active crown fire—A **crown fire** in which the entire **fuel complex** becomes involved, but the crowning phase remains dependent on heat released from the **surface fuels** for continued spread. Also called **running** and **continuous crown fire**.

Available canopy fuel—The mass of **canopy fuel** per unit area consumed in a crown fire. There is no post-frontal combustion in canopy fuels, so only fine canopy fuels are consumed. We assume that only the foliage and a small fraction of the branch wood is available.

Available fuel—The total mass of ground, surface and canopy fuel per unit area consumed by a fire, including fuels consumed in postfrontal combustion of duff, organic soils, and large woody fuels.

Canopy base height—The lowest height above the ground at which there is a sufficient amount of **canopy fuel** to propagate fire vertically into the canopy. Canopy base height is an effective value that incorporates ladder fuels such as shrubs and understory trees. See also **fuel strata gap** and **crown base height**.

Canopy bulk density—The mass of **available canopy fuel** per unit canopy volume. It is a bulk property of a stand, not an individual tree.

Canopy fuels—The live and dead foliage, live and dead branches, and lichen of trees and tall shrubs that lie above the **surface fuels**. See also **available canopy fuel**.

Conditional surface fire—A potential type of fire in which conditions for sustained active crown fire spread are met but conditions for crown fire initiation are not. If the fire begins as a surface fire then it is expected to remain so. If it begins as an **active crown fire** in an adjacent stand, then it may continue to spread as an active crown fire.

Continuous crown fire—See **active crown fire**.

Crown base height—The vertical distance from the ground to the bottom of the live crown of an individual tree. See also **canopy base height**.

Crown bulk density—The mass of available fuel per unit crown volume. In this paper it is a property of an individual tree, not a whole stand. See also **canopy bulk density**.

Crown fire—Any fire that burns in **canopy fuels**.

Crown fire cessation—The process by which a **crown fire** ceases, resulting in a **surface fire**.

Crown fire hazard—A physical situation (fuels, weather, and topography) with potential for causing harm or damage as a result of crown fire.

Crowning Index—The open (6.1-m) windspeed at which **active crown fire** is possible for the specified **fire environment**.

Environmental conditions—That part of the **fire environment** that undergoes short term changes: weather, which is most commonly manifest as windspeed and dead fuel moisture content.

Fire environment—The characteristics of a site that influence fire behavior. In fire modeling the fire environment is described by surface and canopy fuel characteristics, windspeed and direction, relative humidity, and slope steepness.

Fire hazard—A physical situation (fuels, weather, and topography) with potential for causing harm or damage as a result of wildland fire.

Fire intensity—See **frontal fire intensity**. Contrast with **fireline intensity**.

Fireline intensity—The rate of heat release in the **flaming front** per unit length of fire front (Byram 1959).

Flaming front—The zone at a fire's edge where solid flame is maintained.

Foliar moisture content—Moisture content (dry weight basis) of live foliage, expressed as a percent. Effective foliar moisture content incorporates the moisture content of other canopy fuels such as lichen, dead foliage, and live and dead branch wood.

Foliar moisture effect—A theoretical effect of **foliar moisture content** on active crown fire spread rate (Van Wagner 1974, 1979, 1983).

Frontal fire intensity—Similar to **fireline intensity**, it is the rate of heat release per unit length of fire front, including the additional heat released from postfrontal flaming and smoldering combustion (Forestry Canada Fire Danger Group 1992).

Fuel complex—The combination of ground, surface, and canopy fuel strata.

Fuel model—A set of surface fuel bed characteristics (load and surface-area-to volume-ratio by size class, heat content, and depth) organized for input to a fire model. Standard fuel models (Anderson 1982) have been stylized to represent specific fuel conditions.

Fuel strata gap—The vertical distance between the top of the **surface fuel** stratum and the bottom of the **canopy fuel** stratum.

Fuel stratum—A horizontal layer of fuels of similar general characteristics. We generally recognize three fuel strata: ground, surface, and canopy.

Full-range fire behavior simulation—The simulated behavior of a wildland fire whether it is a surface fire, passive crown fire, or active crown fire. Ground fire behavior is usually not included.

Ground fire—A slow-burning, smoldering fire in **ground fuels**. Contrast with **surface fire**.

Ground fuels—Fuels that lie beneath surface fuels, such as organic soils, duff, decomposing litter, buried logs, roots, and the below-surface portion of stumps. Compare with **surface fuels**.

Independent crown fire—A **crown fire** that spreads without the aid of a supporting **surface fire**.

Intermittent crown fire—A **crown fire** that alternates in space and time between active crowning and surface fire or passive crowning. See also **passive crown fire**.

Passive crown fire—A crown fire in which individual or small groups of trees torch out, but solid flaming in the canopy cannot be maintained except for short periods. Passive crown fire encompasses a wide range of crown fire behavior from the occasional torching of an isolated tree to a nearly active crown fire. Also called torching and candling. See also **intermittent crown fire**.

Plume-dominated fire-—A fire for which the power of the fire exceeds the power of the wind, leading to a tall convection column and atypical spread patterns. The models used in this paper do not address plume-dominated fire behavior. Contrast with **wind-driven fire**.

Running crown fire—See **active crown fire**.

Site characteristics—The characteristics of a location that do not change with time slope, aspect, elevation.

Surface fire—A fire spreading through **surface fuels**.

Surface fuels—Needles, leaves, grass, forbs, dead and down branches and boles, stumps, shrubs, and short trees.

Torching Index—The open (6.1-m) windspeed at which crown fire activity can initiate for the specified **fire environment**.

Total biomass—The mass per unit area of all living and dead vegetation at a site.

Total fuel load—The mass of fuel per unit area that could possibly be consumed in a hypothetical fire of the highest intensity in the driest fuels.

Wind-driven fire—A wildland fire in which the power of the wind exceeds the power of the fire, characterized by a bent-over smoke plume and a high length-to width ratio.

Wind reduction factor—The ratio of the midflame windspeed to the open (6.1-m) windspeed. For convenience of measurement eye-level winds are usually substituted for midflame winds.