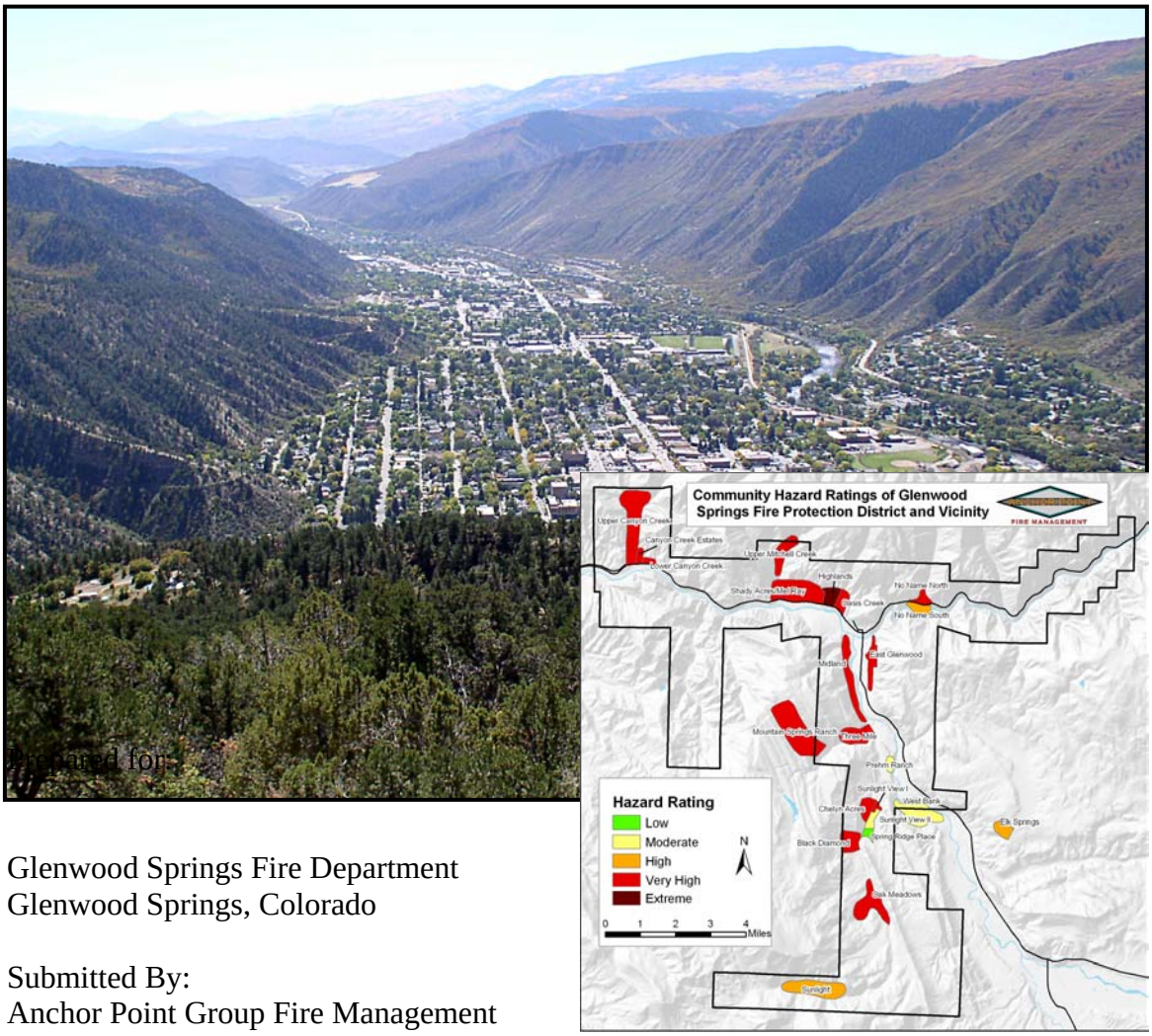
Glenwood Springs Fire Protection District

Wildland Urban Interface
Community Wildfire Protection Plan



Prepared for:

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SUMMARY OF THIS DOCUMENT

This document incorporates new and existing information relating to wildfire for citizens, policy makers, and public agencies in the City of Glenwood Springs, Colorado, and the Glenwood Springs Fire Protection District (GSFPD). Wildfire hazard data is derived from the community wildfire hazard rating system (WHR) and the analysis of fire behavior potential. Because this data is extensive and/or technical in nature, detailed findings and methodologies are included in appendices rather than in the main report text. This approach is designed to make the actual plan more readable, while establishing a reference source for those interested in the technical elements of the GSFPD Wildfire Hazard and Risk Assessment.

The GSFPD Community Wildfire Protection Plan (CWPP) is the result of a community-wide fire-protection planning effort that included extensive field data gathering, compilation of existing fire suppression documents, and a scientific analysis of fire behavior potential in the study area. This CWPP is the result of collaboration with various participants, including homeowners, the Glenwood Springs Fire Department (GSFD), and the Bureau of Land Management (BLM). The plan was compiled in 2006 in response to a contract from GSFD to convert their existing "Wildland Fire Hazard and Risk Assessment" (HRA) to a conforming CWPP.

This project meets the requirements of the federal Healthy Forests Restoration Act (HFRA) of 2003 for community fire planning by:

1. Identifying and prioritizing fuels reduction opportunities across the landscape. (See section Fuels Modification Projects beginning on page 40 of this document.)
2. Addressing structural ignitability. (See pages 36-39 and Appendix B.)
3. Collaborating with stakeholders. (See Appendix E.)

THE NATIONAL FIRE PLAN

In the year 2000, more than eight million acres burned across the United States, marking one of the most devastating wildfire seasons in American history. One high-profile incident, the Cerro Grande fire at Los Alamos, NM, destroyed more than 235 structures and threatened the Department of Energy's nuclear research facility.

Two reports addressing federal wildland fire management were initiated after the 2000 fire season. The first report, prepared by a federal interagency group, was titled "Review and Update of the 1995 Federal Wildland Fire Management Policy" (2001).This report concluded, among other points, that the condition of America's forests had continued to deteriorate.

The second report, titled "Managing the Impacts of Wildfire on Communities and the Environment: A Report to the President in Response to the Wildfires of 2000", was issued by the Bureau of Land Management (BLM) and the United States Department of Agriculture Forest Service (USFS). It became known as the National Fire Plan (NFP). This report, and the ensuing congressional appropriations, ultimately required actions to:

1. Respond to severe fires.
2. Reduce the impacts of fire on rural communities and the environment.
3. Ensure sufficient firefighting resources.

Congress increased specific appropriations to accomplish these goals. In 2002 we witnessed another severe season: more than 1,200 homes were destroyed and over seven million acres burned. In response to public pressure, congress and the Bush administration continued to designate funds specifically for actionable items such as preparedness and suppression. That same year, the Bush administration announced the HFRA initiative, which enhanced measures to restore forest and rangeland health and reduce the risk of catastrophic wildfires. In 2003, the act was signed into law.

Through these watershed pieces of legislation, Congress continues to appropriate specific funding to address five categories: preparedness, suppression, reduction of hazardous fuels, burned-area rehabilitation, and state and local assistance to firefighters. The spirit of the NFP is reflected in the Glenwood Springs CWPP.

PURPOSE

The purpose of the fire behavior analysis, WHR, and the resulting CWPP is to provide a comprehensive, scientifically based assessment of the wildfire hazards and risks within the GSFPD.

The assessment estimates the risks and hazards associated with the occurrence of wildland fires in proximity to communities. This information, in conjunction with values-at-risk, defines "areas of concern" for the community and allows for prioritization of mitigation efforts. From this analysis, solutions and mitigation recommendations are offered that will aid homeowners, land managers, and other interested parties in developing short-term and long-term fuels and fire management plans.

For the purpose of this report the following definitions apply:

Risk is the likelihood of an ignition occurrence. This is primarily determined by the fire history of the area.

Hazard is the combination of the WHR ratings of the WUI communities and the analysis of fire behavior potential, as modeled from the fuels, weather, and topography of the study area. Hazard attempts to quantify the severity of undesirable fire outcomes to the values at risk.

Values at Risk are the intrinsic values that the inhabitants of the study area have identified as being important to their way of life. These are values such as life safety, property conservation, access to recreation, and wildlife habitat. (See page 11 for a comprehensive overview.)

GOALS AND OBJECTIVES

Objectives

The primary objective of this analysis is to provide a comprehensive, scientifically based assessment of wildfire hazards and risks within the Glenwood Springs Fire Protection District. The assessment will aid stakeholders in developing short-term and long-term fuel and fire management plans. This initial level of pre-planning will assist land managers in making valid, timely decisions for planned and unplanned ignitions. The assessment estimates the hazards associated with wildland fire in proximity to communities. The hazard information, in conjunction with values-at-risk information, defines "areas of concern" for the community and allows prioritization of mitigation efforts. In addition to the primary objective, several task-specific goals are addressed within this study.

Goals for this project include the following:

1. Enhance Life Safety for Residents and Responders.
2. Mitigate Undesirable Fire Outcomes to Property and Infrastructure.
3. Mitigate Undesirable Fire Outcomes to the Environment and Quality of Life.

In order to accomplish these goals the following objectives have been identified:

1. Establish an approximate level of risk (the likelihood of a significant wildfire event for the study area).
2. Provide a scientific analysis of the fire behavior potential of the study area.
3. Group values-at-risk into "communities" that represent relatively similar hazard factors.
4. Identify and quantify factors that limit (mitigate) undesirable fire effects to the values-at-risk (hazard levels).
5. Recommend specific actions that will reduce hazards to the values-at-risk.

OTHER DESIRED OUTCOMES

1. Promote community awareness:

   A report that quantifies the community's level of hazard and risk from wildfire will facilitate public awareness and assist in creating public action to mitigate the defined hazards.

2. Improve wildfire prevention through education:

   Awareness and education will help reduce the risk of unplanned human ignitions. It will also create an opportunity for GSFD to partnership with the community in reducing risks from wildfire through education and prevention.

3. Facilitate and prioritize appropriate hazardous fuel reduction:

   Organizing and prioritizing hazard mitigation actions into Fire Management Units (FMU) can assist stakeholders in focusing future efforts from both social and fire management perspectives.

4. Promote improved levels of response:

   Identifying areas of concern will improve the accuracy of pre-planning efforts and will facilitate the implementation of cross-boundary, multi-jurisdictional projects.

COLLABORATION: COMMUNITY/AGENCIES/FIRE SAFE COUNCILS

Representatives involved in the development of the GSFPD CWPP are included in the following table. Their names, organizations, and various roles and responsibilities are indicated in **Table 1**. For more information on the collaborative process that led to the development of this CWPP see **Appendix E** GSFPD CWPP Collaborative Effort.

Table 1. CWPP Development Team

Name	Organization	Roles / Responsibilities
Michael Piper, Chief Ron Biggers, Deputy Fire Marshal	Glenwood Springs Fire Department	Local information and expertise, including community risk and value assessment, development of community protection priorities, and establishment of fuels treatment project areas and methods.
Dan Sokol	Bureau of Land Management, Glenwood Springs Office	Provides input and expertise on planning and hazard mitigation. Provides information on existing and planned projects on adjacent BLM lands.
Kelly Rogers, District Forester	Colorado State Forest Service	Facilitation of planning process and approval of CWPP minimum standards. Provides input and expertise on forestry, fire and fuels, and FireWise concepts.
Chris White, CEO Marc McDonald, Project Manager Mark McLean, GIS Project Manager Rod Moraga, Fire Behavior Analyst	Anchor Point Group LLC Consultants	Development of CWPP, decision-making, community risk and value assessment, development of community protection priorities, establishment of fuels treatment project areas and methods.

STUDY AREA OVERVIEW

The Glenwood Springs Fire Protection District (GSFPD) is located in Garfield County, 165 miles west of Denver, Colorado. The district includes the city of Glenwood Springs, the northernmost portion of the Highway 82 corridor, a portion of the I-70 corridor extending from east of No Name to west of the Canyon Creek exit and surrounding areas. GSFPD covers an area of 76 square miles, including the City of Glenwood Springs, and has approximately 13,000 residents. The primary access to the district is via Interstate Highway 70 and Colorado Highway 82.

Figure 1: Typical Area

For the purpose of this report, communities have been assessed for the hazards and risks that occur inside the district boundaries. Some of these communities continue into other fire districts. Rankings and descriptions of communities as well as hazard and risk recommendations only pertain to the portions of those areas that lie within the boundaries of GSFPD unless otherwise noted.

The study area is considered to be in the Foothills and Montane zones (5,500'- 9,500') of the western slope of the Northern Colorado Front Range.[1] A portion of GSFPD can be considered to be in the Sub-Alpine zone (areas above 9,500'); however this represents such a small and uninhabited portion of the district that it has no noticeable impact on fire in the Wildland/Urban Interface (see Figure 3). At the lower elevations the predominant vegetation is composed of Gambel's oak (*Quercus gambelii)*, piñon pine (*Pinus edulis*), Rocky Mountain juniper (*Juniperus scopulorum*) and various subspecies of big sagebrush (Genus *Artemesia*), see Figure 1. At higher elevations aspen (*Populus tremuloides*) and dense stands of mixed conifers are common primarily on north facing slopes.

For this project the most populated areas were divided into 23 communities. Each community represents certain dominant hazards from a wildfire perspective. Fuels, topography, structural flammability, availability of water for fire suppression, egress and navigational difficulties as

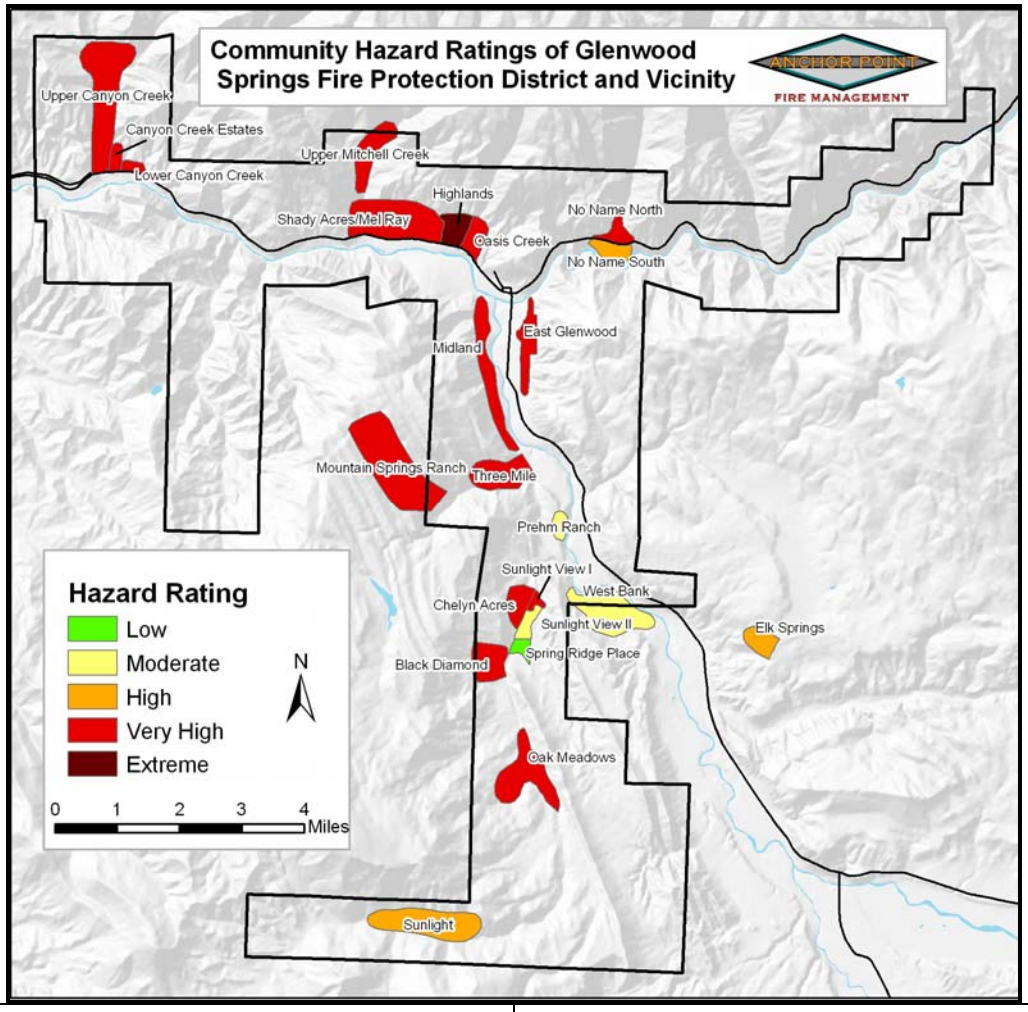
[1] Elevation limits for life zones were based on life zone ranges from: Jack Carter, "Trees and Shrubs of Colorado" (Boulder, CO: Johnson Books, 1988).

well as other hazards both natural and manmade are considered in the overall hazard ranking of these communities. The methodology for this assessment uses the WHR community hazard rating system that was developed specifically to evaluate communities within the WUI for their relative wildfire hazard.[2] The WHR model combines physical infrastructure such as structure density and roads as well as fire behavior components like fuels and topography, with the field experience and knowledge of wildland fire experts. **Figure 2** shows the communities that define the WUI study area. For more information on the WHR methodology please see **Appendix B**.

As a reference for the rest of this document, please see **Figure 3** and **Figure 4,** which show the general topography of the area. These graphic representations of the landforms within the study area (elevation and slope) will be helpful in interpreting other map products in this report.

[2] C. White, "Community Wildfire Hazard Rating Form" *Wildfire Hazard Mitigation and Response Plan*, Colorado State Forest Service, Ft. Collins, CO, 1986.

Figure 2: Hazard Ranking of Communities in the Study Area



1. Highlands	**13. East Glenwood**
2. North No Name	**14. Three Mile**
3. Midland	**15. Oak Meadows**
4. Canyon Creek Estates	**16. Lower Canyon Creek**
5. Mel Ray/Shady Acres	**17. Sunlight**
6. Chelyn Acres	**18. South No Name**
7. Upper Canyon Creek	**19. Elk Springs**
8. Upper Mitchell Creek	**20. Sunlight View II**
9. Oasis Creek	**21. Prem Ranch**
10. Sunlight View I	**22. West Bank**
11. Black Diamond	**23. Spring Ridge Place**
12. Mountain Springs Ranch	

Extreme Very High High Moderate Low

Figure 3: Slope

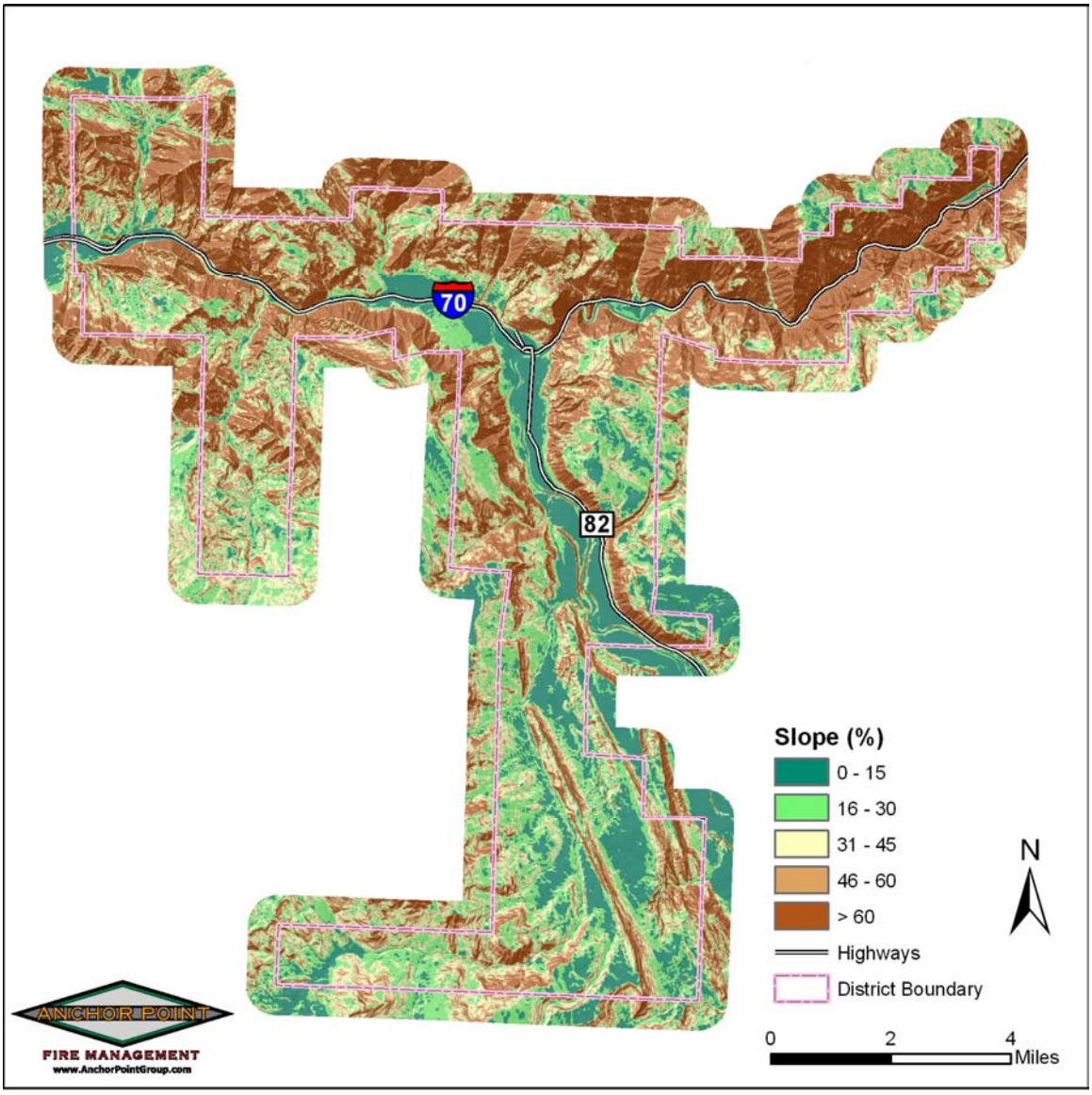
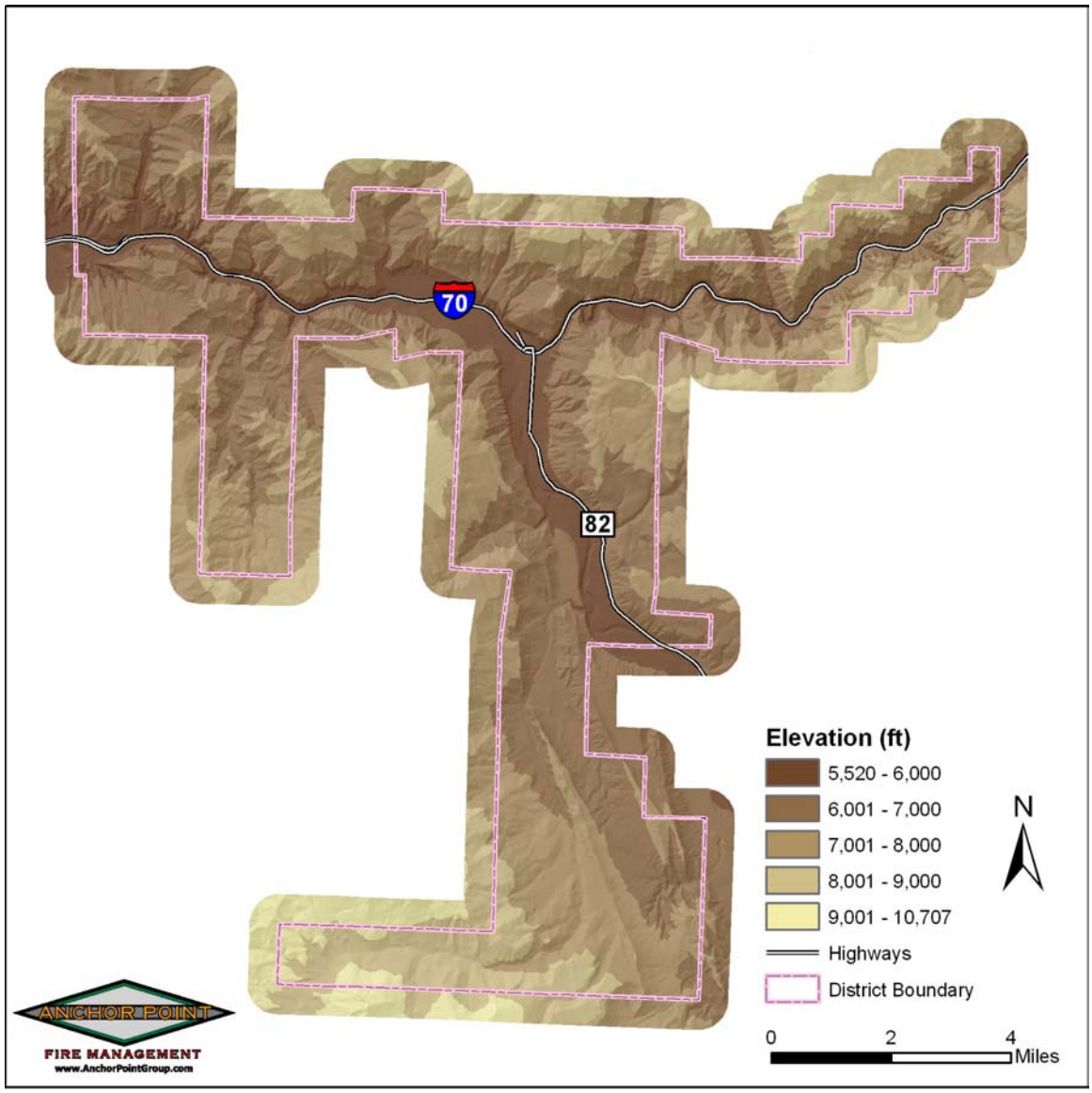


Figure 4: Elevation



VALUES

LIFE SAFETY AND HOMES

GSFD services approximately 8,000 residents in the City of Glenwood Springs and an approximate total of 13,000 in the GSFPD.[3] The most populated areas in the GSFD response area WUI, the study area for this document, were divided into 23 communities. The areas within each community represent certain dominant hazards from a wildfire perspective. Fuels, topography, structural flammability, availability of water for fire suppression, egress and access difficulties, as well as other hazards both natural and manmade, are considered in the overall hazard ranking of these communities. The hazard assessment identified 16 of the 23 communities in the study area to be extreme or very high hazard areas. Under extreme burning conditions, there is a likelihood of rapid increases in fire intensity and spread in this area due to steep topography, fast burning or flashy fuel components and other topographic features that contribute to channeling winds and promotion of extreme fire behavior. These areas may also represent a high threat to life safety due to poor egress, the likelihood of heavy smoke, heat, and /or long response times.

With tens of thousands of people moving to Colorado each year, building in the once inaccessible mountain areas has become a growing concern. Of the 63 counties in Colorado, Garfield County is the eighth fastest growing with a population increase of 8.7% between 2000 and 2003.[4] 202 new building permits for single family homes were issued from January thru September of 2006 in Garfield County.[5]

Most of Garfield County is vulnerable to some form of natural disturbance. Recent national disaster events have focused increased attention at both local and state government levels on the need to mitigate such events where possible and to prepare to cope with them when unavoidable.

COMMERCE AND INFRASTRUCTURE

In 2004 Garfield County had a per capita personal income (PCPI) of $29,064. The 2004 PCPI reflected an increase of 6.3% from 2003. The 2003-2004 state change was 4.6% and the national change was 5.0%. The 1994-2004 average annual growth rate of PCPI was 3.9%. The average annual growth rate for the state was 4.6% and for the nation was 4.1%.

In 2004 Garfield County had a total personal income (TPI) of $1,408,643. The 2004 TPI reflected an increase of 7.8% from 2003. The 2003-2004 state change was 5.8% and the national change was 6.0%. The 1994-2004 average annual growth rate of TPI was 7.4%. The average annual growth rate for the state was 6.9% and for the nation was 5.2%.[6]

[3] http://www.glenwoodfire.com/
[4] http://www.epodunk.com/top10/countyPop/coPop6.html
[5] http://socds.huduser.org/permits/index.html?
[6] http://www.bea.gov/bea/regional/bearfacts/action.cfm

The earnings for people employed in Garfield County increased from $992,087 in 2003 to $1,089,131 in 2004, an increase of 9.8%. The 2003-2004 state change was 6.2% and the national change was 6.3%. The average annual growth rate from the 1994 estimate of $465,298 to the 2004 estimate was 8.9%. The average annual growth rate for the state was 7.1% and for the nation was 5.5%.[7]

Glenwood Springs is known worldwide as the home to the Glenwood Springs Hot Springs Pool and Lodge, the largest naturally heated outdoor swimming pool in the world. Also, 60% of the lands in Garfield County are publicly-owned state and national forestlands, making tourism one of the main industries in Glenwood Springs.[8] Gas & coal mining, sheep & cattle ranching, fruit and vegetable growing are the other main industries in the region.[9] Another significant component of the local economy is the quality of life that attracts professionals to establish residences. The 2002 NAICS Economic Census for Garfield County reported 235 business offering professional, scientific and/or technical services.[10] Wildfire, therefore, has the potential to cause significant damage to the local economy.

Recreation and Life Style

Glenwood Springs is known for its natural hot springs, large year round hot springs pool, skiing, and snowboarding. Recreational opportunities abound, attracting hunters, fishermen, mountain bikers, hikers, river rafters, skiers and snowmobilers. The Fairy Caves (now called the Glenwood Adventure Park) were the first real tourist attraction in Glenwood Springs, opening to the public in 1886. The Hot Springs Pool was completed in 1888. Soon after, the elegant Hotel Colorado opened its doors in 1893. The hotel staff was imported from the East Coast and Europe to add to the aura of wealth and privilege. The Hot Springs Pool, the vapor caves and the Fairy Caves, still are among the major attractions of Glenwood Springs today.[11]

Residents who live in the study area have a keen appreciation for their natural environment. They like to be in the mountains, it's the context of their quality of life. Recreation and the natural beauty of the area are frequently quoted as reasons local residents have chosen to live in the study area.

Environmental Resources

Residents are clear that the preservation of wildlife is important to the quality of life of the area. The White River National Forest provides critical habitat to several species of concern including Canada Lynx, Colorado River Cutthroat Trout, Boreal Toad, Leopard Frog, Townsend's Big-Eared Bat and others. Habitat effectiveness is defined as the degree to which habitat is free of human disturbance and available for wildlife to use. Effective habitat is mostly undisturbed land

[7] http://www.bea.gov/bea/regional/bearfacts/action.cfm
[8] http://72.14.253.104/search?q=cache:_eFQgVyb_FMJ:www.glenwoodspringscolorado.com/Business-Directory.html+Tourism+economy+Glenwood+Springs+Colorado&hl=en&gl=us&ct=clnk&cd=3
[9] Ibid
[10] http://www.census.gov/econ/census02/data/co/CO045.HTM
[11] http://www.glenwoodchamber.com/pages/history.htm

area, which is buffered (at least 300 feet in essentially all situations) from regular motorized and non-motorized use of roads and trails (11 or more people or vehicle trips per week). [12] The USFS has made improving habitat effectiveness and ensuring the viability of these species one of their forest-wide objectives.[13] Wildfire, specifically severe wildfire, can have significant adverse effects on habitat effectiveness and species viability.

The Glenwood Springs CWPP process is in concert with the guiding principles of environmental stewardship. Through public involvement, local support and a regional perspective, the fuels reduction elements described in this document can and should enhance and protect the values of the study area.

[12] Peak to Peak Community Indicators Project 2003 Presented by Peak to Peak Healthy Communities Project ©Copyright 2003 Peak to Peak Healthy Communities Project

[13] White River National Forest Land and Management Resource Plan-2002 Revision, Chapter 1, page 1-4, Objective 1c.

CURRENT RISK SITUATION

For the purpose of this report the following definitions apply:

Risk is considered to be the likelihood of an ignition occurrence. This is primarily determined by the fire history of the area.

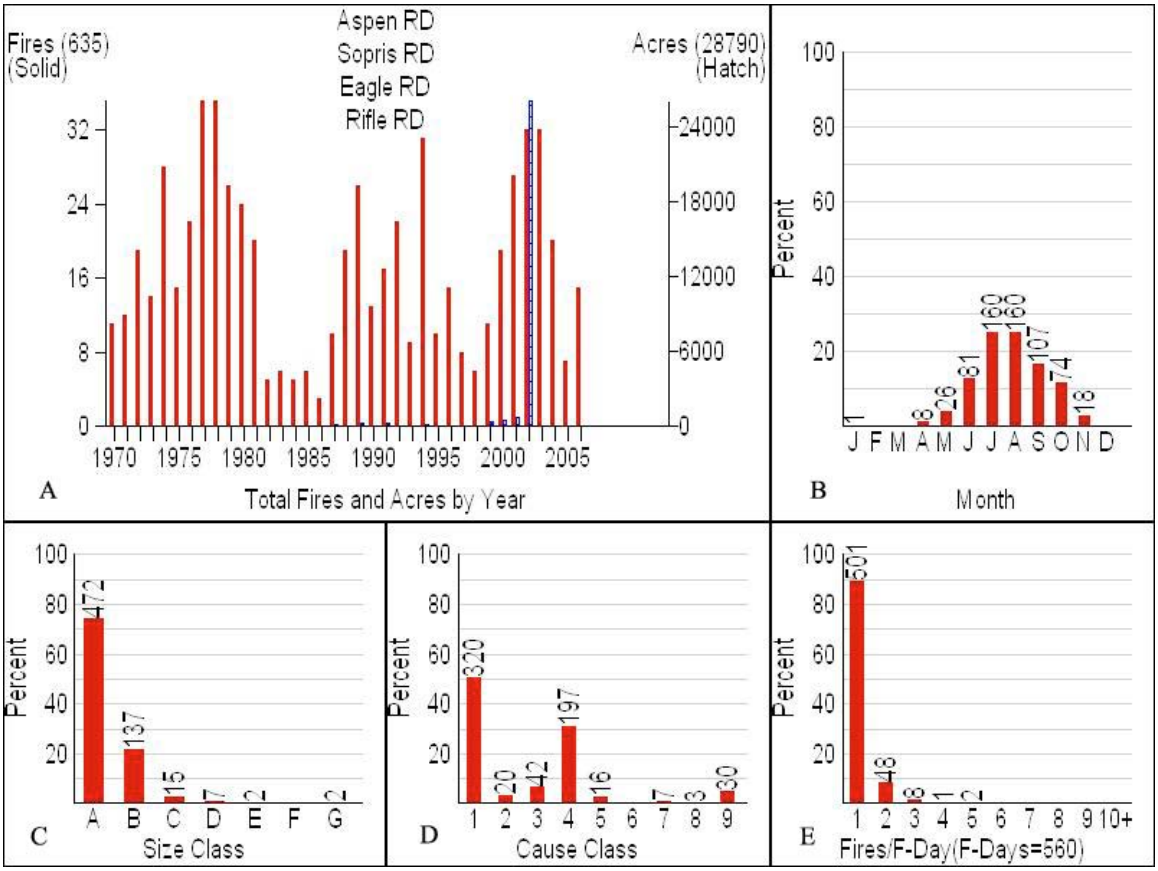
Hazard is the combination of the wildfire hazard ratings of the Wildland Urban Interface (WUI) communities and fire behavior potential, as modeled from the fuels, weather and topography of the study area.

The majority of the district is at a very high risk for WUI fires. This assessment is based on the analysis of the following factors:

- The city of Glenwood Springs is listed in the Federal Register as a community at high risk from wildfire (http://www.fireplan.gov/reports/351-358-en.pdf).
- The study area is shown in the Colorado State Forest Service WUI Hazard Assessment map to be an area of high Hazard Value (an aggregate of Hazard, Risk and Values Layers).
- The study area has a recent major-fire history (fires larger than 100 acres). The last major fire to occur in the district occurred in 2002 (the Coal Seam Fire 12,209 acres), The South Canyon Fire (7/2/1994, 2,115 acres) resulted in the largest loss of life to wildland firefighters of any fire in the western United States in the last century.
- The Glenwood Springs Fire Department responded to 87 WUI ignitions between 2000 and 2003, the most recent year run data was available for (32 starts in 2000, 10 in 2001, 26 in 2002 and 19 in 2003).
- The USDA Forest Service fire regime and condition class evaluation of forest stands in the study area shows that historic fire regimes have been moderately to substantially altered. Please see the “Fire Regime and Condition Class” section of this report for details.

The surrounding federal lands report an active fire history. Fire occurrences for the Aspen, Eagle, Rifle and Sophris Ranger Districts of the White River National Forest were calculated from the USDA Forest Service Personal Computer Historical Archive for the thirty six-year period from 1970-2006. These areas represent federal lands in and adjacent to the study area, but do not include any data from state, county or private lands (See **Figure 6** on **Page 18**). The data have been processed and graphed using the Fire Family Plus software program and are summarized below.

Figure 5: White River National Forest Fire History 1970-2006



Size Class (in acres)	A < ¼	B ¼ - 9	C 10 – 99	D 100-299	E 300-999	F 1000 - 4999	G 5000 +		
Causes	1 Lightning	2 Equip-ment	3 Smoking	4 Campfire	5 Debis Burning	6 Railroad	7 Arson	8 Kids	9 Misc.

Figure 5a shows the number of fires (red bars) and the total acres burned (blue hatched bars) in the four ranger districts each year. While the number of annual fires ranges from four to over 30, there is little year-to-year pattern to the variation. Acres burned spiked dramatically in 2002 due primarily to the Coal Seam (12,209 acres) and Spring Creek (13,493 acres) fires. Smaller spikes in acreage burned occurred in the late 1970s, 1989 to 1991 and 1999 to 2001. It is interesting to note that the South Canyon Fire is not reflected in this data since this major fire did not occur within the boundaries of these ranger districts.

Figure 5b shows the percentage and number of fires between 1970 and 2006 occurring in each month of the year. July and August had the greatest number of fires followed by, September and

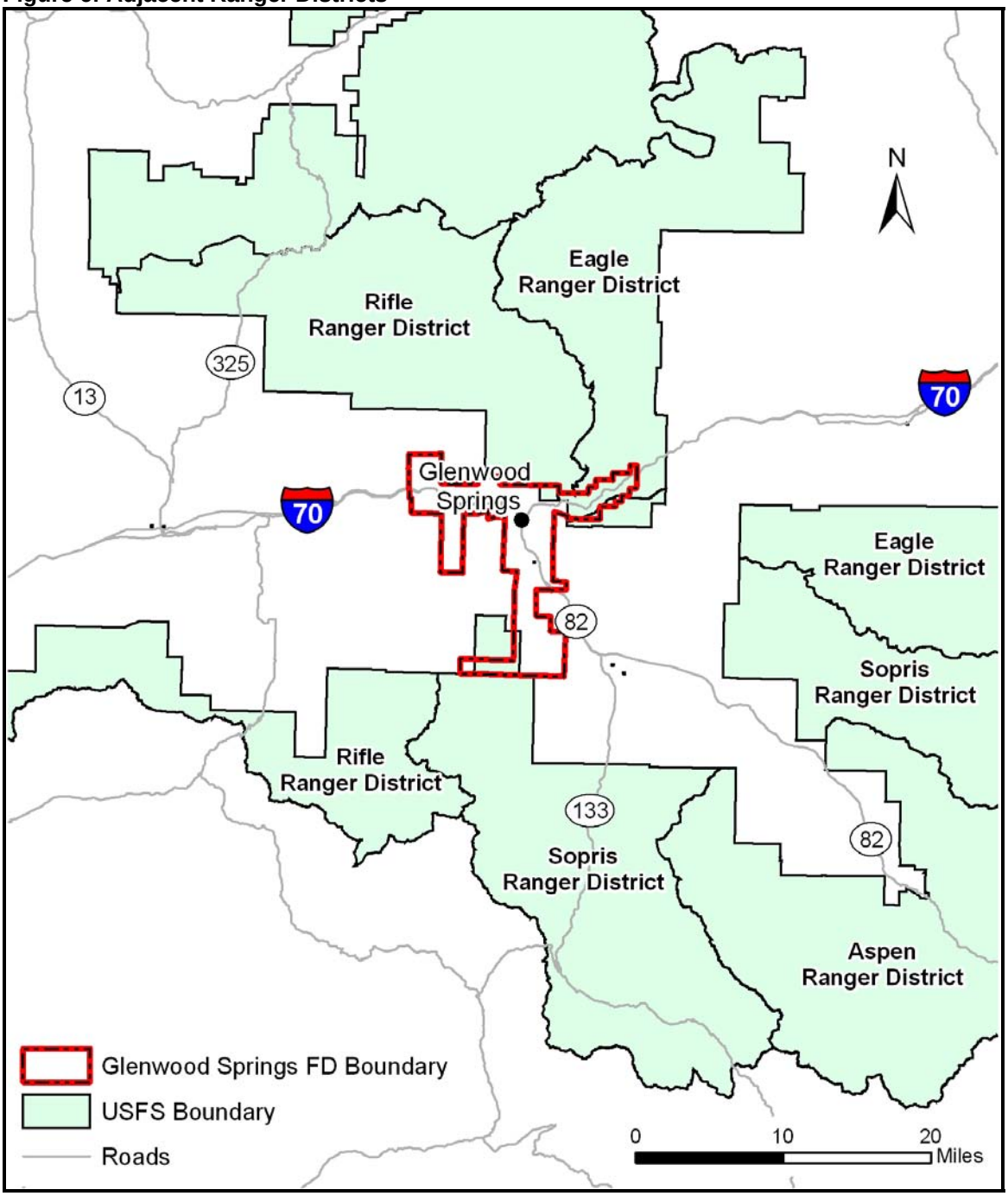
June. The fewest fires occurred between the months of December and April, which reflects the climate conditions for the area. It is interesting to note that fall fires are relatively common in the study area and the fire season extends later in the year than some other parts of the Colorado Rockies.

Figure 5c shows the size class distribution of fires. Approximately 74% of the reported fires (609 of 635) were less than 10 acres in size. These statistics reflect the widely held opinion that throughout the western US the vast majority of fires are controlled during initial attack.

Figure 5d shows the number of fires caused by each factor. As shown in this graph, the most common cause for ignitions is lightning (50%); the next most common cause is campfire (31%). If we remove the miscellaneous cause category, natural causes represent a slim majority of ignitions (50% natural causes and 45% human caused), however it should be noted that these numbers are for national forest areas which lack the concentrated development and other human-related risk factors present in the portions of the study area where private land is dominant.

Figure 5e shows the number of fire starts for each day that a fire start was recorded. Most fires (501) occurred on days that only had one fire start. Approximately 9% of fire days had two fire starts recorded and days with three or more fire starts represent less than 2% of all fire days. The statistics suggest that multiple start days are a rare occurrence compared to fire days with a single ignition.

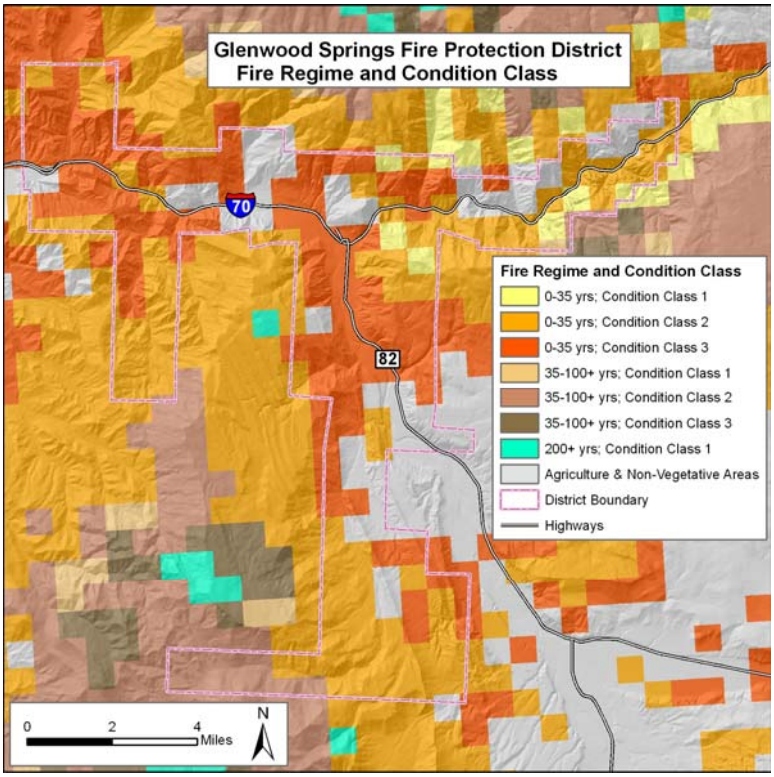
Figure 6: Adjacent Ranger Districts



FIRE REGIME CONDITION CLASS

The Fire Regime Condition Class (FRCC) is a landscape evaluation of expected fire behavior as it relates to the departure from historic norms. The data used for this study is from a national level map. The minimum mapping unit for this data is 1 square kilometer. FRCC is not to be confused with BEHAVE and FlamMap fire behavior models, detailed in the fire behavior section, which provide the fire behavior potential analysis for expected flame length, rate of spread and crown fire development.

Figure 7: Condition Class Map



The FRCC is an expression of the departure of the current condition from the historical fire regime. It is used as a proxy for the probability of severe fire effects (e.g., the loss of key ecosystem components - soil, vegetation structure, species, or alteration of key ecosystem processes - nutrient cycles, hydrologic regimes). Consequently, FRCC is an index of hazards to the status of many components (e.g., water quality, fish status, wildlife habitats, etc.). Figure 7 displays graphically the return interval and condition class of the study area.

Deriving fire-regime condition class entails comparing current conditions to some estimate of the historical range that existed prior to substantial settlement by Euro-Americans. The departure of the current condition from the historical baseline serves as a proxy to likely ecosystem effects. In applying the condition class concept, it is assumed that historical fire regimes represent the conditions under which the ecosystem components within fire-adapted ecosystems evolved and have been maintained over time. Thus, if it is projected that fire intervals and/or fire severity has

changed from the historical conditions, then it would be expected that fire size, intensity, and burn patterns would also be subsequently altered if a fire occurred. Furthermore, it is assumed that if these basic fire characteristics have changed, then it is likely that there would be subsequent effects to those ecosystem components that had adapted to the historical fire regimes. As used here, the potential of ecosystem effects reflect the probability that key ecosystem components may be lost should a fire occur within the study area. Furthermore, a key ecosystem component can represent virtually any attribute of an ecosystem (for example, soil productivity, water quality, floral and faunal species, large-diameter trees, snags, etc.).[14]

The following categories of condition class are used to qualitatively rank the potential of effects to key ecosystem components:

Table 2. Condition Class Descriptions15

Condition Class	Condition Class Description
1	Fire regimes are within their historical range and the risk of losing key ecosystem components as a result of wildfire is low. Vegetation attributes (species composition and structure) are intact and functioning within an historical range. Fire effects would be similar to those expected under historic fire regimes.
2	Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystem components as a result of wildfire is moderate. Fire frequencies have changed by one or more fire-return intervals (either increased or decreased). Vegetation attributes have been moderately altered from their historical range. Consequently, wildfires would likely be larger, more intense, more severe, and have altered burn patterns than that expected under historic fire regimes.
3	Fire regimes have changed substantially from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have changed by two or more fire-return intervals. Vegetation attributes have been significantly altered from their historical range. Consequently, wildfires would likely be larger, more intense, and have altered burn patterns from those expected under historic fire regimes.

[14] Fire Regime Condition Class, website, http://www.frcc.gov/, July 2005.
[15] Ibid

The study area is dominantly classified under Condition Class 2 and 3. By definition, historic fire regimes have been moderately to substantially changed. Consequently, **Wildfires are likely to be larger, more severe and have altered burn patterns from those expected under historic fire regimes**.

FIRE BEHAVIOR POTENTIAL

From the fire behavior potential analysis carried out as a part of this study (see Appendix A), the fire behavior potential of the study area was mapped. These maps can be combined with the WHR and values-at-risk information to generate current and future "areas of concern," which are useful for prioritizing mitigation actions.

Figures 8-10 show fire behavior potential maps for average conditions. They graphically display potential crown fire activity, flame length, and rate of spread generated. These maps were generated with FlamMap 2.0 fire behavior modeling software (see **Glossary**). Weather observations from the nearby Rifle Remote Automated Weather Station (RAWS) site were averaged for a nineteen-year period (1987-2006) to derive relevant wind and fuel moisture variables for inclusion in FlamMap. The average conditions class (16^{th} to 89^{th} percentile) was calculated for each variable (1 hour, 10 hour, and 100 hour fuel moisture, woody fuel moisture, herbaceous fuel moisture, and wind speed) using the Fire Family Plus (see **Glossary**) computer software package. This weather condition class most closely represents an average fire season day.

The extreme conditions maps, **Figures 11-13**, were calculated using ninety-seventh percentile weather data. This means that the weather conditions of the four most severe fire weather days (sorted by Spread Component) in each season for the nineteen-year period were averaged together. It is reasonable to assume that similar conditions may exist for at least four days of the fire season during an average year. In fact, during extreme years such conditions may exist for significantly longer periods. Even these calculations may be conservative compared to observed fire behavior.

Weather conditions are extremely variable and not all combinations are accounted for. These outputs are best used for pre-planning and not as a stand-alone product for tactical planning. When this information is used for tactical planning, it is recommended that fire behavior calculations be done with actual weather observations during the fire event. For greatest accuracy, the most current Energy Release Component (ERC) values should be calculated and distributed during the fire season, for use as a guideline for fire behavior potential. For a more complete discussion of the fire behavior potential methodology, please see **Appendix A**.

Figure 8: Flame Length Predictions (Average Weather Conditions)

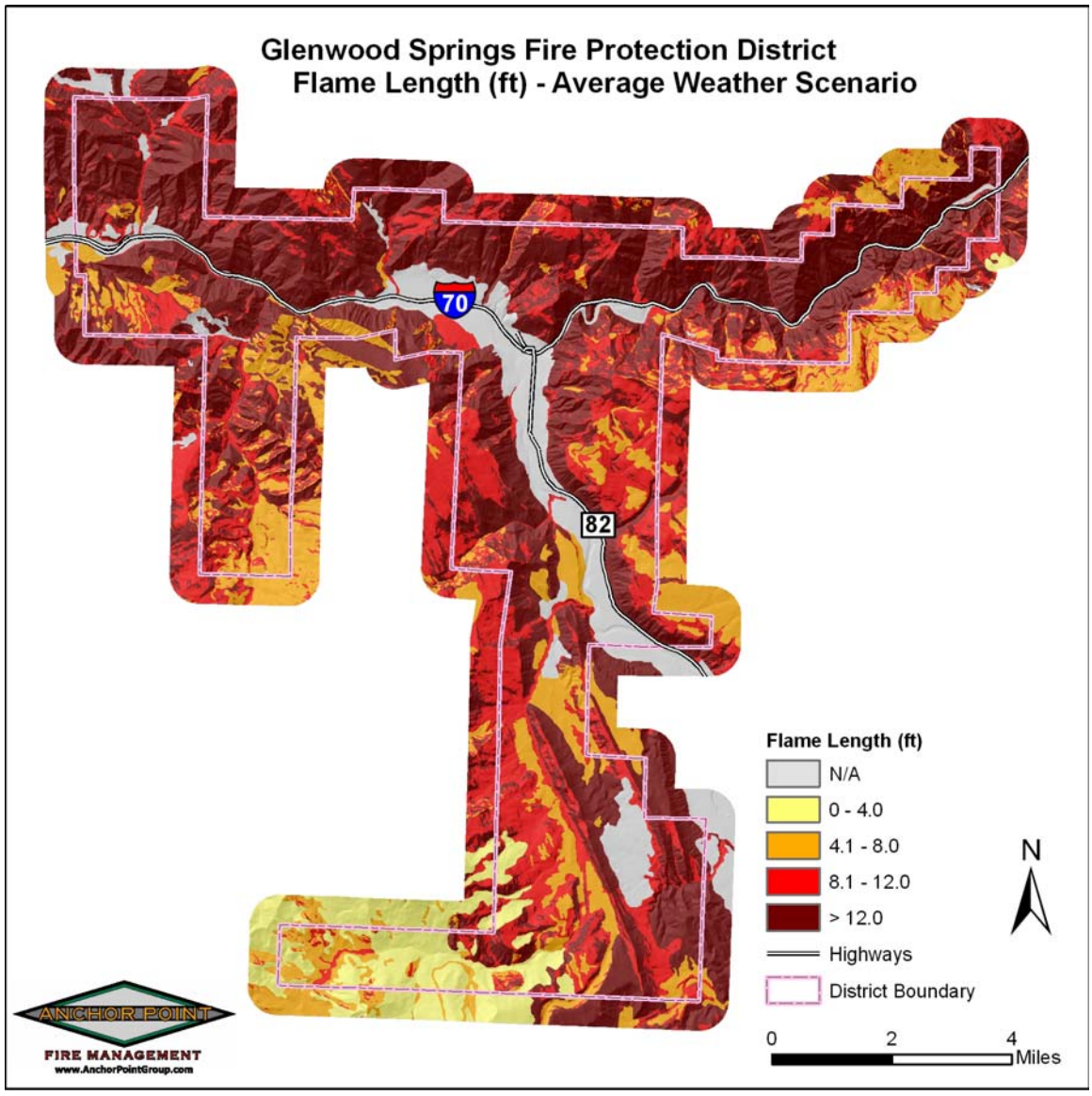


Figure 9: Flame Length Predictions (Extreme Weather Conditions)

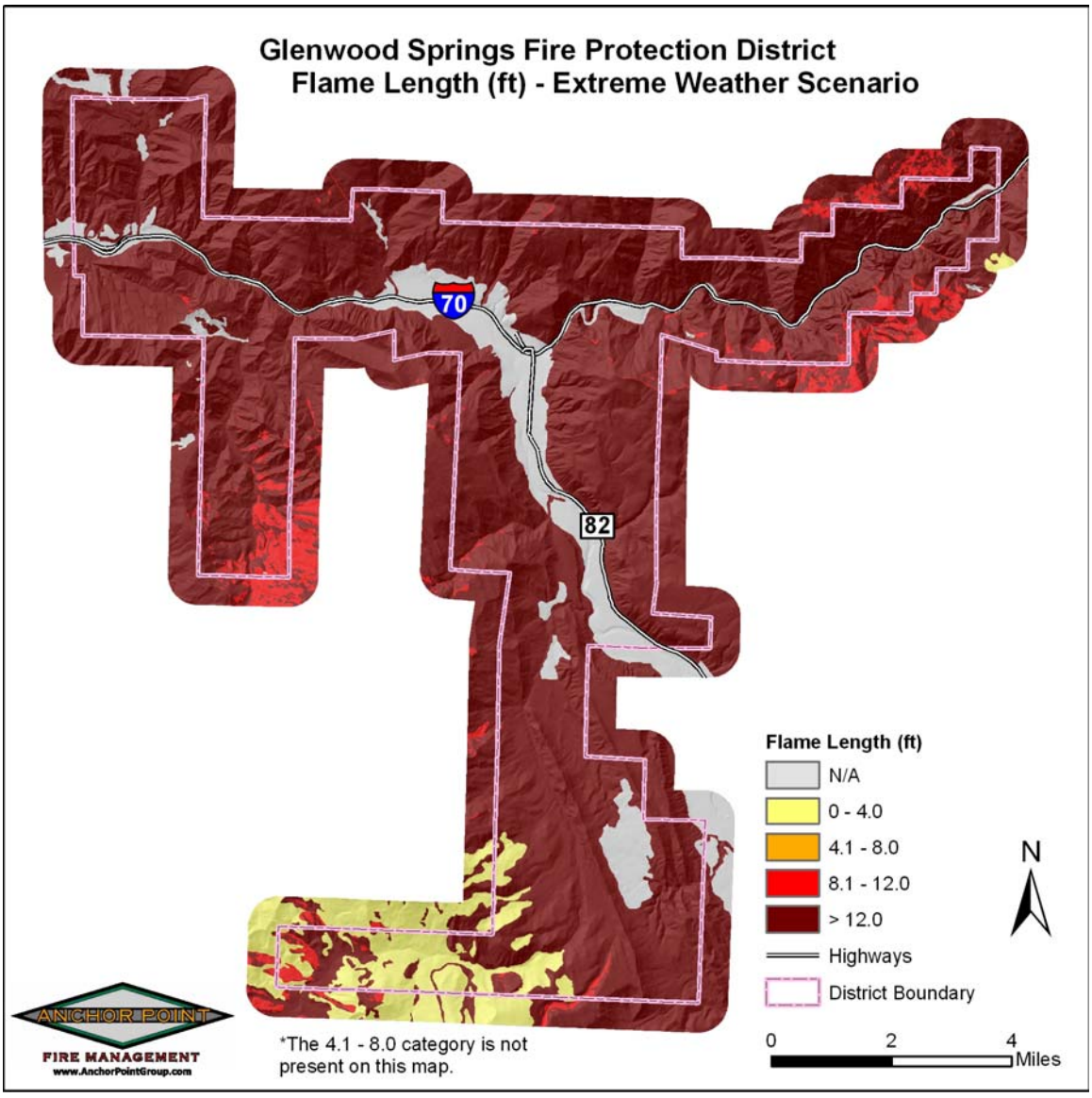


Figure 10: Rate of Spread Predictions (Average Weather Conditions)

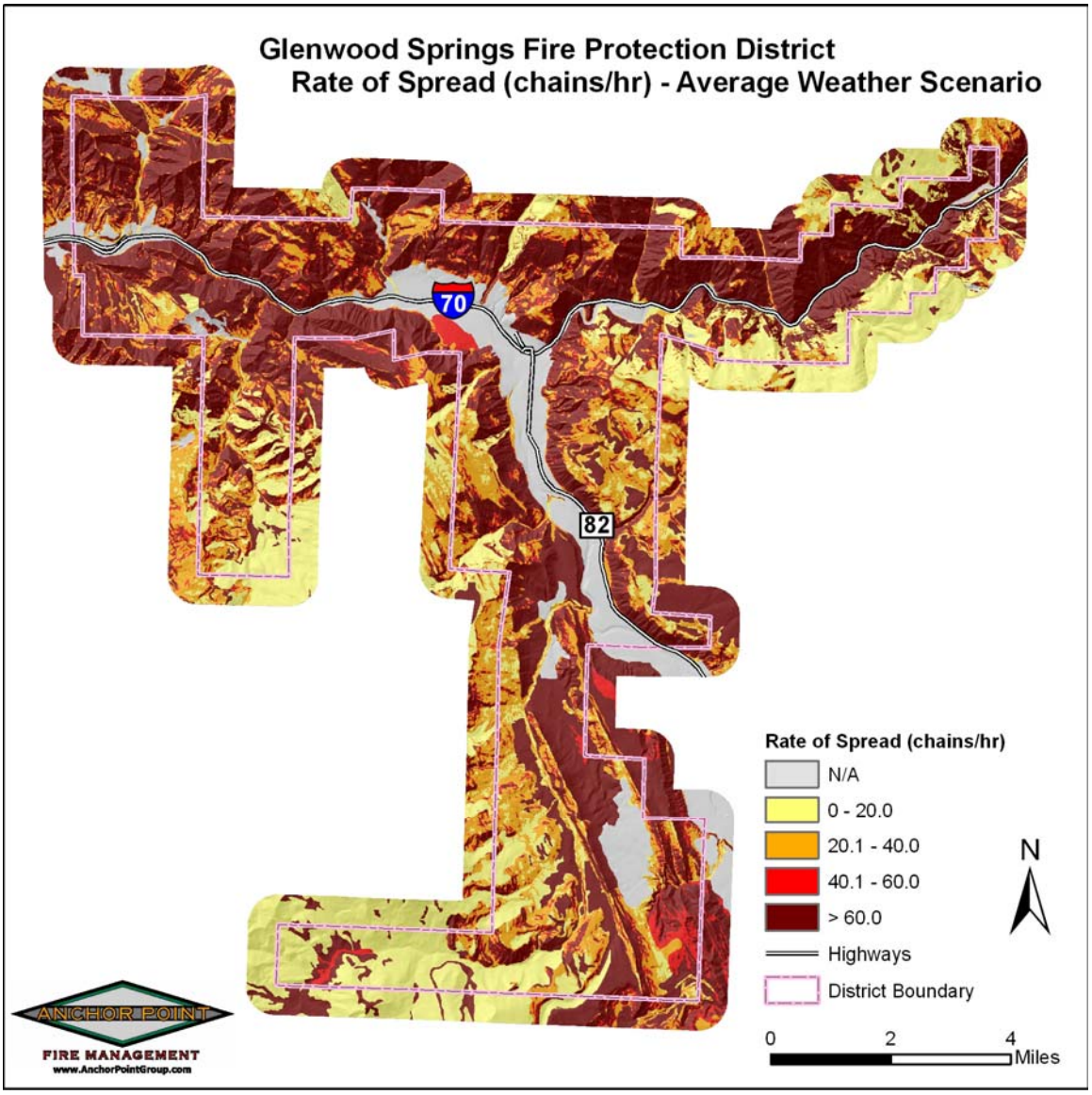


Figure 11: Rate of Spread Predictions (Extreme Weather Conditions)

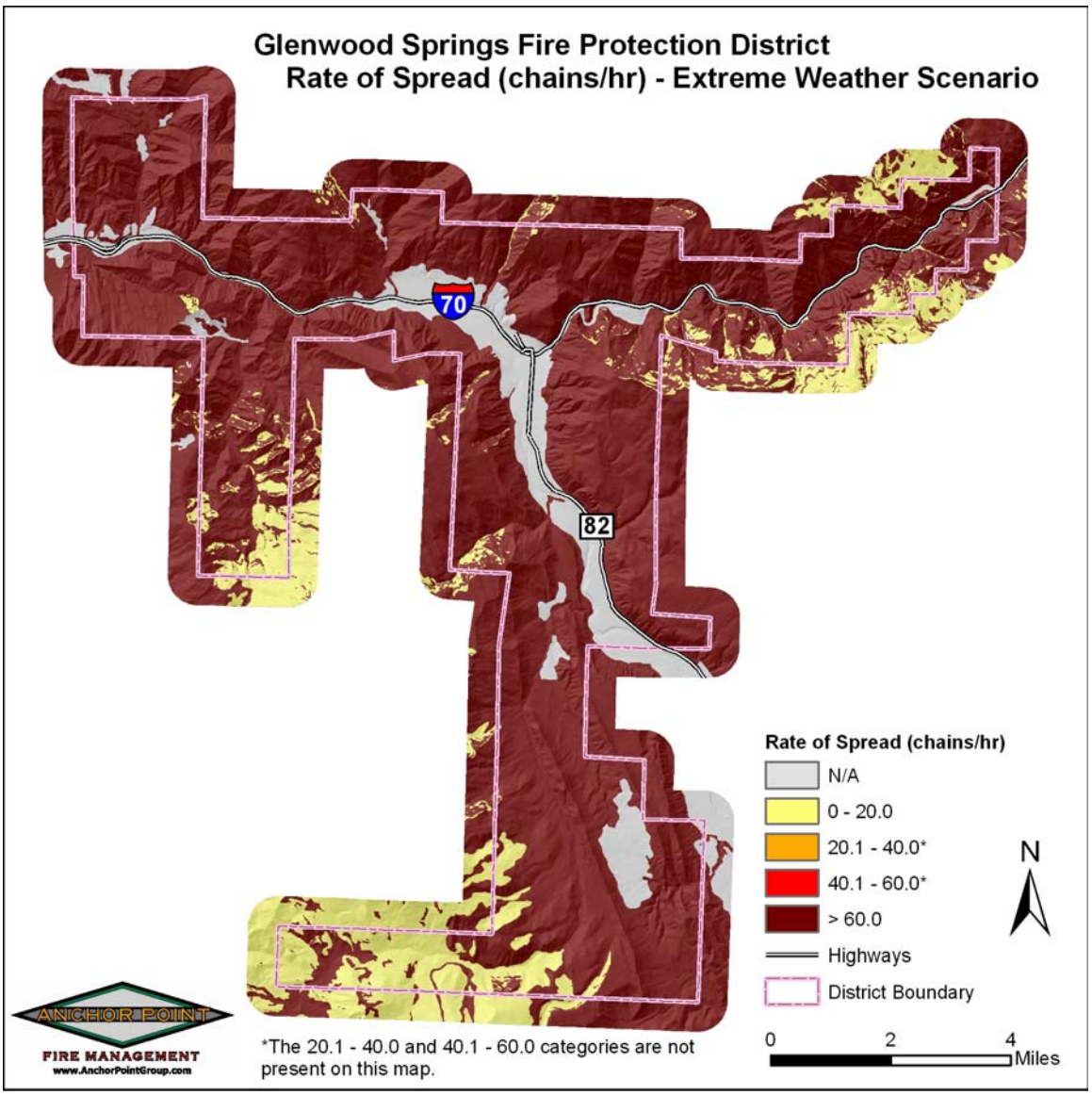


Figure 12: Crown Fire Activity Predictions (Average Weather Conditions)

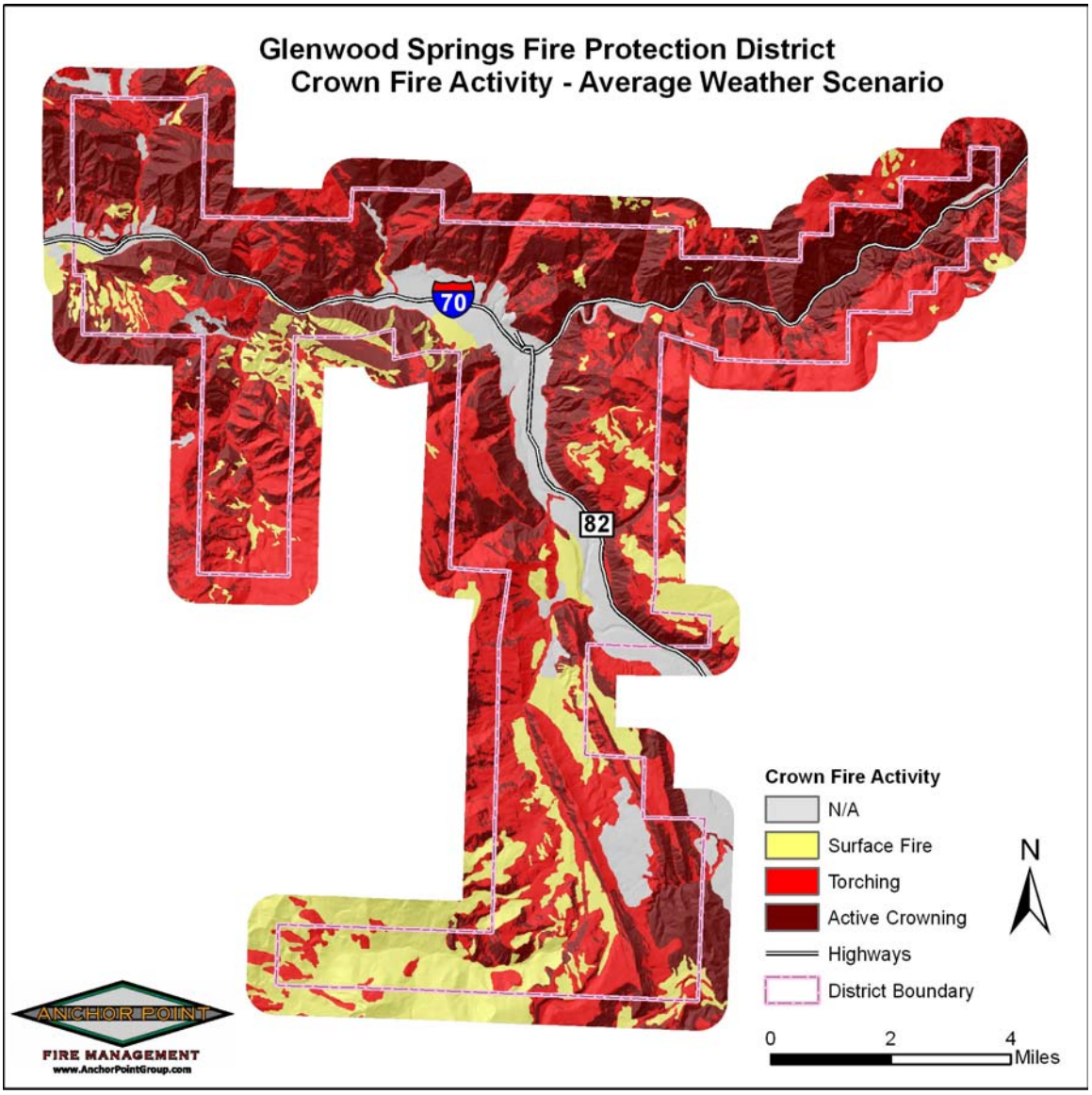
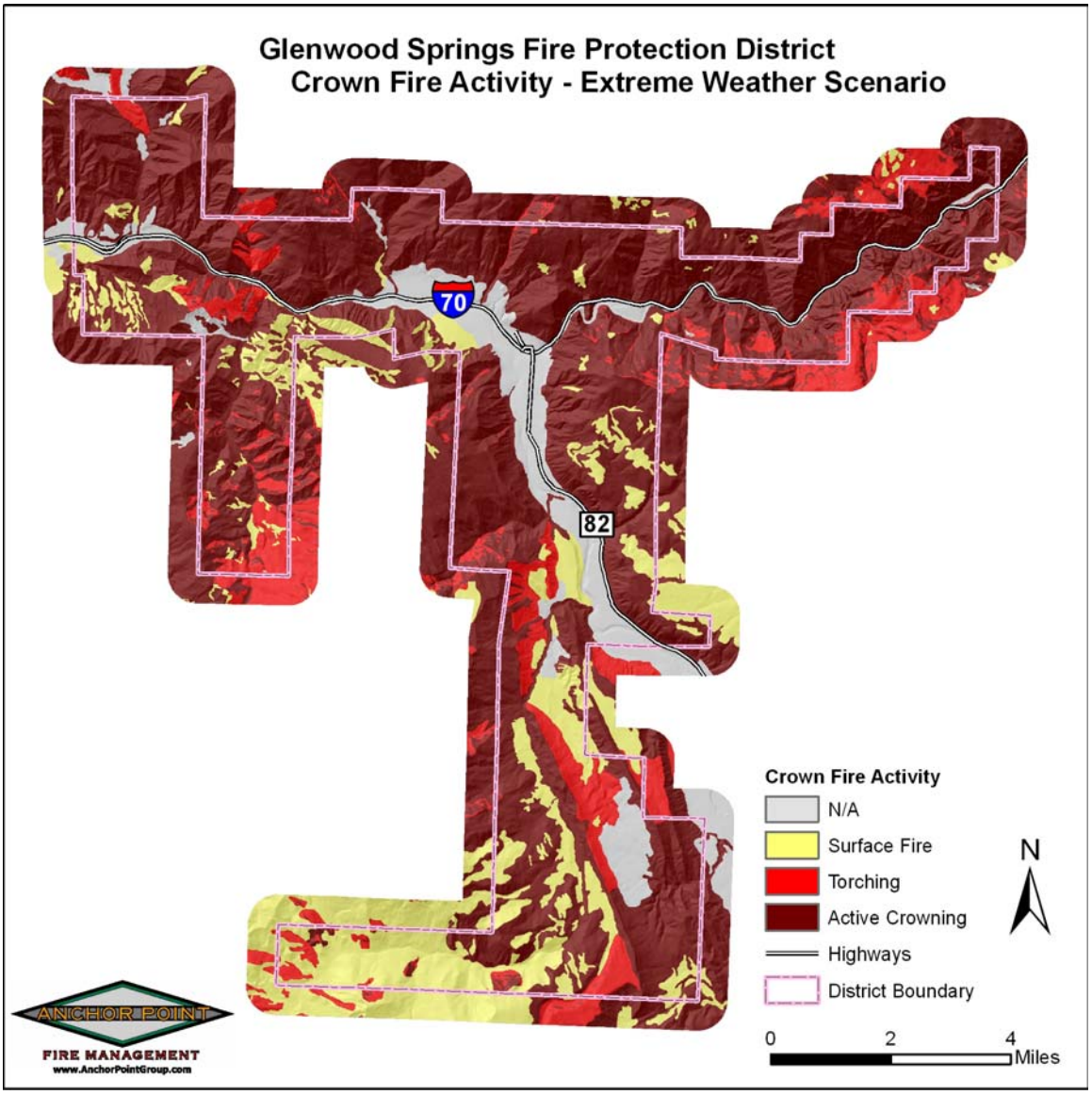


Figure 13: Crown Fire Activity Predictions (Extreme Weather Conditions)



SOLUTIONS AND MITIGATION

ESTABLISHING AND PRIORITIZING FIRE MANAGEMENT UNITS (FMUS)

An efficient method of prioritizing work efforts is to create Fire Management Units (FMUs). FMUs should be created prior to planning or initiating fuels management projects and other mitigation. There are unique vegetation and/or mitigation management activities recommended for each unit. Units may be functional or geographic. The local land management and fire management agencies (ideally with the input of the citizen's advisory council) must determine priority actions. The following FMUs have been identified for the study area; recommendations are provided for each. FMUs are NOT ranked by priority, however priority recommendations have been provided for specific tactical mitigation actions, where appropriate, within FMUs.

- Addressing, Evacuation and Shelter-In-Place FMU
- Public Education FMU
- Local Preparedness and Firefighting Capabilities FMU
- Home Mitigation FMU
- Fuels Modification Projects FMU
- Water Supply FMU

ADDRESSING, EVACUATION AND SHELTERING-IN-PLACE FMU

Addressing

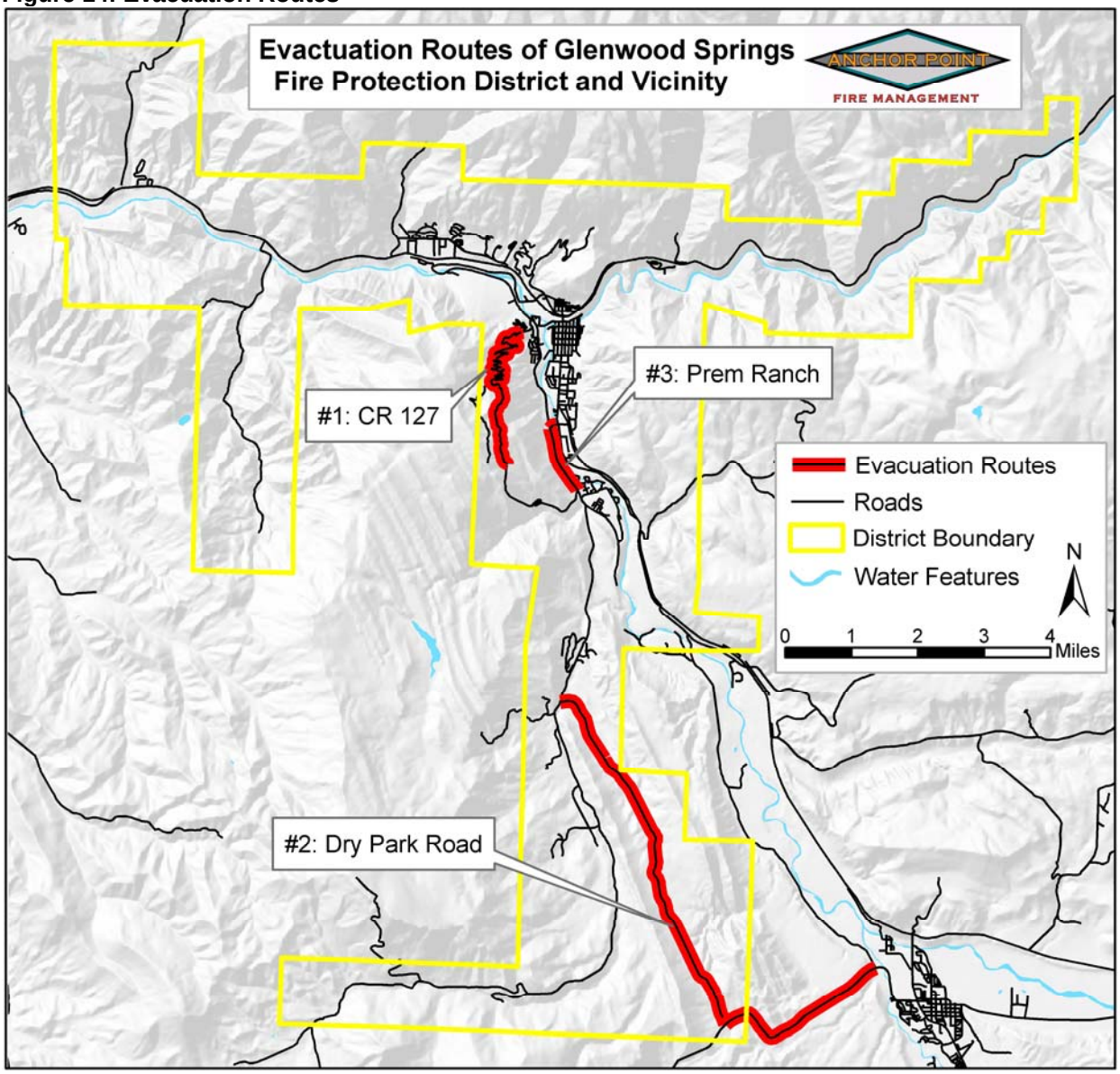
There are many areas within GSFPD that have missing or inadequate street signage and addressing. This problem was especially notable in the Highlands, North No Name, Upper Canyon Creek, Upper Mitchell Creek, Black Diamond, Mountain Springs Ranch, Three Mile, Oak Meadows and Sunlight communities. While residents may consider non-reflective wooden address signage to be decorative, it is an impediment to quick and effective response. We consider proper reflective signage to be a critical operational need. The time saved, especially at night and in difficult conditions, is not to be underestimated. Knowing at a glance the difference between a road and a driveway (and which houses are on the driveway) cuts down on errors and time wasted interpreting maps. This is especially true for volunteer operators who do not have the opportunity to train on access issues as often as career firefighters. Recommendations for address markers can be found in **Appendix D**.

Evacuation Routes

Three roads that could serve as alternative evacuation routes to the primary access have been identified. Of these, only one is potentially important and its usefulness may be compromised by rough terrain and poor surface condition. These routes are highlighted in the overview of the district shown in **Figure 14**.

1. **CR127**: Priority level-High. According to our information CR127 has been improved enough to provide a viable escape route from the Mountain Spring Ranch and upper Three Mile communities. This route escapes these areas to the north by connecting with West 9th Street. This is a potentially important route as ignitions occurring in the Three Mile Road drainage and on the slopes below the Mountain Springs Ranch area could easily cut off the primary access to these areas (Three Mile Road). This road currently has a gate and requires 4WD especially in wet conditions. It may also be possible to escape Mountain Springs Ranch via two 4WD roads that connect to South Canyon; however a BLM easement and much surface improvement would be needed for this to be effective.
2. **Dry Park Road (CR125)**: Priority level-Low. If the access along Four Mile Road were to be cut off it would be possible to escape from the Spring Ridge Place, Chelyn Acres, Black Diamond and Sunlight View I and II communities to the south by using Dry Park Road to connect to County Road 108 and then to Carbondale via Hwy133. This is assuming that evacuees could get out of the neighborhoods, which may not be possible especially in Chelyn Acres and Black Diamond. It is unlikely that fire conditions would close Four Mile Road. If they did, it is likely that the fire would have already burned through some or all of the neighborhoods on the west side of Four Mile Road. It is unlikely that this is an important escape route from wildfire.
3. **Prem Ranch**: Priority level-Low. If for some reason the bridge that is the primary access from Hwy 82 into the West Bank neighborhood were to be compromised, it is possible to evacuate the portion of West Bank that is within GSFPD through Prem Ranch. This access is gated and, due to position and fuels, is much more likely to be threatened by wildfire than the primary access. This access is likely to be more useful for fire fighting resources than evacuating citizens.

Figure 14: Evacuation Routes



ACCESS ROUTE RECOMMENDATIONS

- See *Access Route Fuels Modification Recommendations* in the *Fuels Modification Projects FMU* section of this report.
- In order to reduce potential conflicts between evacuating citizens and incoming responders, it is desirable to have nearby evacuation centers for citizens and staging areas for fire resources. Evacuation centers should include heated buildings with facilities large enough to handle the population. Schools and churches are usually ideal for this purpose. Fire staging areas should contain large safety zones, a good view in the direction of the fire, easy access and turnarounds for large apparatus, a significant fuel break between the fire and the escape route, topography conducive to radio communications, and access to water. Golf courses and large irrigated greenbelts may make good safety zones for firefighting forces. Local responders are encouraged to preplan the use of potential staging areas with property owners. Priority level-High.
- Identify and pre-plan primary escape routes for all WUI communities. Emergency management personnel should be included in the development of preplans for citizen evacuation. Priority level-High.
- Educate citizens on the proper escape routes, and evacuation centers to use in the event of an evacuation. Priority level-High.
- Utilize a reverse 911 system or call lists to warn residents when an evacuation may be necessary. Notification should also be carried out by local television and radio stations. Any existing disaster notification systems, such as tornado warnings, should be expanded to include wildfire notifications. Priority level-High.
- Perform response drills to determine the timing and effectiveness of escape routes and fire resource staging areas. Priority level-Moderate.

Shelter-In-Place

The communities of Highlands, Oasis Creek, Upper Canyon Creek, Upper Mitchell Creek, Canyon Creek Estates, Three Mile, Black Diamond, Oak Meadows and North No Name could be easily cut off by ignitions in drainages below homes. In addition to improved access/egress, consideration should be given to developing “shelter-in-place” areas that are designed as alternatives to evacuation through hazardous areas.

There are several ways of protecting the public from an advancing wildfire. One of these methods is evacuation and involves relocation of the threatened population to a safer area. Another is to instruct people to remain inside their homes or public buildings until the danger passes. This concept is new to wildfire in the United States, but not to hazardous materials incident response where time, hazards, and sheer logistics often make evacuation impossible. This concept is the dominant modality for public protection from wildfires in Australia where fast moving, non-persistent fires in light fuels make evacuation impractical. The success of this tactic depends on a detailed preplan that takes into account the construction type and materials of the building used, topography, depth and type of the fuel profile, as well as current and expected weather and fire behavior.

Shelter–in-place should only be considered when the structure is determined to be “stand alone” in structural triage terms. In order to be "stand alone", homes need to be of ignition resistant construction and have defensible space. Depending on the fuel type and fuel bed depth, it may be

necessary to continue treatment beyond the minimum recommended defensible space boundaries in order to make the home stand alone. For a list of defensible space recommendations please see the "General Recommendations" section of **Appendix B**.

Ignition resistant construction is also necessary for shelter-in-place tactics. Wooden roofs and old structures with untreated wooden sidings are particularly hazardous and should not be considered. It is preferable to have metal or asphalt roofs and ignition resistant materials such as stucco or concrete, especially close to the ground. Heavy timber constructions, such as log homes, are also resistant to surface fires. When combined with an ignition resistant roof type, heavy timber may be acceptable. Eves should be enclosed. Any holes in the foundation, siding, or eves should be covered to prevent embers from entering.

Threats to residents remaining in structures include heat, smoke, and ignition of the structure itself. Several steps can be taken by residents to mitigate the effects of heat exposure. The following list highlights some of the more important concepts:

- Close all doors and windows and shut down all ventilation systems such as air conditioning, heating, and attic fans.
- If there is adequate time and water, consider plugging downspouts and filling any gutters with water. The sand bags that mountain residents commonly have are good for this purpose.
- Fill all of the tubs and sinks, and any buckets that are easily handled, with water.
- Remove any lightweight or highly flammable window coverings. Heavy drapes or blinds should be closed in case the windows break.
- Move furniture away from windows, and be sure to remove flammables, such as gasoline and propane, to a safe distance away from the structure. Propane, and other volatile compressed gas, tanks may rocket as high as ½ mile, so they are best removed to an area cleared of fuels, such as a concrete driveway or pad.
- Wear clothes of fire resistant natural fibers such as wool or cotton. Be sure to cover as much exposed skin as possible, and keep water with you for personal protection. Do not wear polyester or other synthetics that may melt to your skin when exposed to high temperatures.
- When the fire arrives retreat to the room in the house farthest away from the flaming front.
- Take drinking water with you and drink often to avoid dehydration.
- Even if it becomes uncomfortably hot and smoky do not run outside while the fire is passing.

Fires consume oxygen and produce toxic gasses and smoke. Much work has been done in the hazardous materials field on the infiltration of toxic gasses into structures. Average homes under average weather conditions may experience indoor concentrations of smoke and contaminants of 45% to 65% of the outdoor concentrations in 30 minutes. In two hours the concentrations may

reach 60% to 65% of the outdoor levels.[16] These numbers are for homes with all doors and windows closed and ventilation systems turned off. Buildings with open windows, doors, or operating ventilation systems will experience contamination levels close to the outdoor levels in minutes. Residents can further slow contamination by blocking gaps around doors and windows with wet towels.

After the fire has passed, the main danger to residents is the home igniting from embers and sparks that entered during the flame front passage. Systematically patrol inside and outside looking for embers and spot fires. Be sure to include attics and other roof spaces. Houses may catch fire several hours after the fire has passed if embers are not found and extinguished. For more information on structural triage and preparation please see **Appendix C**.

PUBLIC EDUCATION FMU

The area around Glenwood Springs is experiencing continual development. Increasing property values have resulted in recently constructed high value residences mixed in with older residences, seasonal cabins, ranch properties and historic buildings in various states of decay. There is likely to be a varied understanding among property owners of the intrinsic hazards associated with building in these areas. An approach to wildfire education that emphasizes safety and hazard mitigation on an individual property level should be undertaken, in addition to community and emergency services efforts at risk reduction. Combining community values such as quality of life, property values, ecosystem protection and wildlife habitat preservation with the hazard reduction message will increase the receptiveness of the public.

RECOMMENDATIONS

- Use these web sites for a list of public education materials, and for general homeowner education:
    - http://www.nwcg.gov/pms/pubs/pubs.htm
    - http://www.firewise.org
    - http://www.colostate.edu/Depts/CSFS/fire/interface.html

- Encourage homeowners associations and mortgage lenders to eliminate covenants and deed restrictions requiring the retention of dangerous vegetation. Request that these groups promote the development of defensible space and firewise plantings.

- Provide citizens with the findings of this study including:
    - Levels of risk and hazard.
    - Values of fuels reduction programs.
    - Consequences and results of inaction for planned and unplanned ignitions within the community.

- Create a Wildland Urban Interface (WUI) citizen advisory council to provide peer level communications for the community. Too often government agency advice can be construed

[16]"Handbook of Chemical Hazard Analysis Procedures" (Washington, D.C.: FEMA, 1990).

as self-serving. Consequently, there is poor internalization of information by the citizens. The council should be used to:

- Bring the concerns of the residents to the prioritization of mitigation actions.
- Select demonstration sites.
- Assist with grant applications and awards.

LOCAL PREPAREDNESS AND FIRE FIGHTING CAPABILITIES FMU

Glenwood Springs Fire Department (GSFD) provides suppression services for the study area. The department has three fire stations. Station One is located in West Glenwood on Mel Ray Drive, Station Two is located in downtown Glenwood Springs on 8th Street and Cooper Avenue and Station Three is located on Four Mile Road (County Road 117) south of the intersection with Midland Ave. The previous Dry Park Station, at the intersection of Four Mile Road and Dry Park Road, has been replaced by Station 3. Mutual aid is available from the Basalt, Carbondale, Burning Mountains, Rifle and Aspen Fire Departments. GSFD maintains three type I pumpers, one 100' aerial apparatus, one type III interface engine, two 1,800 gallon water tenders, both with foam capability, one type VI engine, three command vehicles, three ambulances, and a hazardous materials response trailer.

GSFD employs 21 full time career firefighters, 22 part-time reserves, and nine volunteers. Two of GSFD's firefighters have NWCG (National Wildfire Coordinating Group) S-130/190 training (basic wildland fire fighter training and fire behavior). One firefighter is qualified as a Single Resource (Crew Boss/Engine Boss level or higher).

Although there are five fire departments in Garfield County (GSFD, Carbondale, Rifle, Burning Mountains and Grand Valley) only 33% of the county is within a fire jurisdiction. There are already areas of increasing growth near Glenwood Springs, such as Spring Valley and most of Mountain Springs Ranch, which are not within a fire department service area. There are also areas like West Bank and Elk Springs that are in two different fire jurisdictions. Both of these situations result in reduced service to residents and complications for responding agencies. The need for more firefighters is clear. The ability to add and adequately train additional firefighters will be critical to the successful defense of this rapidly growing and increasingly complex Wildland Urban Interface.

RECOMMENDATIONS

- Priority level-High. Provide continuing education for all firefighters including:
  - NWCG S-130/190 for all department members.
  - Annual wildland fire refresher and “pack testing” (physical standards test).
  - S-215 Fire Operations in the Urban Interface.
  - S-290 Intermediate Fire Behavior.
  - I-200 and I-300 – Basic and Intermediate ICS.

- Equipment:
    - Priority level-High. Continue to ensure all firefighters have wildland Personal Protective Equipment (PPE).
        - (See NFPA Standard 1977 for requirements).
    - Priority level-High. Provide gear bags for both wildland and bunker gear to be placed on engines responding to fire calls. This will help ensure that firefighters have both bunker gear and wildland PPE available when the fire situation changes.
    - Priority level-Moderate. Consider the purchase of an additional type VI (4WD) engine.
    - Priority level-Moderate. Provide and maintain a ten-person wildland fire cache in addition to the tools on the apparatus. The contents of the cache should be sufficient to outfit two squads for handline construction and direct fire attack. Recommended equipment would include:
        - Four cutting tools such as pulaskis or super pulaskis
        - Six scraping tools such as shovels or combis
        - Four smothering tools such as flappers
        - Four backpack pumps with spare parts
        - Two complete sawyer's kits including chainsaw, gas, oil, sigs, chaps, sawyer's hard hat, ear protection, files, file guides, spare chains and a spare parts kit
        - MREs and water cubies sufficient for 48 hours
- Communications:
    - Surveys of GSFD officers revealed radio communications are poor or nonexistent in the following areas:
        - No Name and other areas in Glenwood Canyon
        - South Canyon

All Garfield County emergency services agencies will switch to 800 MHz radios in the spring of 2007. Additional repeaters currently being installed may solve some of the existing communications problems, however due to the nature of 800 MHz (more direct line of site is required than for the lower frequency VHF radios currently in use, but 800 MHz is also less susceptible to multipath and reflected signal cancellation) new problem spots may arise. It is our recommendation that communications be reevaluated throughout the district once the new system is fully operational.

Federal land managers (USFS, BLM) will continue to operate on the existing VHF band. In order to have universal communication on wildland fires, responders will be required to maintain VHF radio equipment which will still have the current problem areas. The suggestions that follow will need to be evaluated for cost/benefit effectiveness by the fire department before implementation. Due to the restrictions of terrain, it is unlikely more powerful base stations or portable radios will make any impact on VHF communication problems. Some areas may see slight improvements in base station reception by increasing the height above average terrain of the base station antenna. However, the best solution is to increase the number of VHF repeaters in the problem areas. If landowners are a barrier to fixed repeater sites, another solution is to construct one or more mobile repeaters in engines or command vehicles. Mobile repeaters allow

the vehicle to be positioned for optimum communication for each incident. Repeaters are expensive, but considering the fact that cell phone communications are only reliable in the I-70 and Hwy. 82 corridors, grants and other sources of funding could be pursued in order to solve this operational problem. If it is not possible to obtain a repeater frequency, which is likely, and the new 800 MHz system does not improve communications in these areas, then satellite phones may be a reasonable additional tool for incident communication (Priority level-Low to Moderate depending on cost effectiveness).

- Jurisdictional Boundaries:
    - Priority level-High. As mentioned earlier in this section there is a need to include nearby populations within a fire protection district and to resolve the balkanization of some existing neighborhoods. If it is not possible to pursue jurisdictional changes we strongly recommend some other course of action be pursued. If nothing is done to alleviate this situation, the problem will only become increasingly more difficult to deal with.

HOME MITIGATION FMU

Community responsibility for self-protection from wildfire is essential. Educating homeowners is the first step in promoting a shared responsibility. Part of the educational process is defining the hazard and risks both at the community-level and parcel level.

The community-level assessment has identified 16 of the 23 communities in the study area to be at extreme or very high risk. Construction type, condition, age, the fuel loading of the structure/contents and position are contributing factors in making homes more susceptible to ignition under even moderate burning conditions. There is also a likelihood of rapid fire growth and spread in these areas due to steep topography, fast burning or flashy fuel components and other topographic features that contribute to channeling winds and promotion of extreme fire behavior.

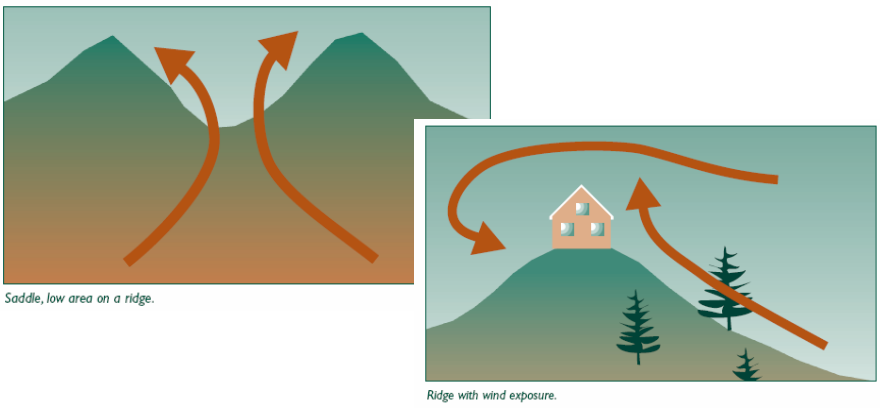
Table 3 illustrates the relative hazard rankings for communities in the study area.

- A rating of 5 or less indicates an area of extreme hazard.
- A rating of 6 to 15 indicates a very high hazard.
- A rating of 16 to 25 indicates high hazard.
- A rating of 26 to 35 indicates moderate hazard.
- A rating of 36 or greater indicates a low hazard.

The communities with extreme and very high hazard ratings should be considered an FMU where a parcel level analysis should be implemented as soon as possible. Please see **Appendix B** for more detailed information.

The most important element for the improvement of life safety and property preservation is for every home in the study area to have compliant, effective defensible space. This is especially important for homes with wood roofs and homes located on steep slopes, in chimneys, saddles, or near any other topographic feature that contributes to fire intensity.

Figure 15: Saddle & Ridge Top Development[17]



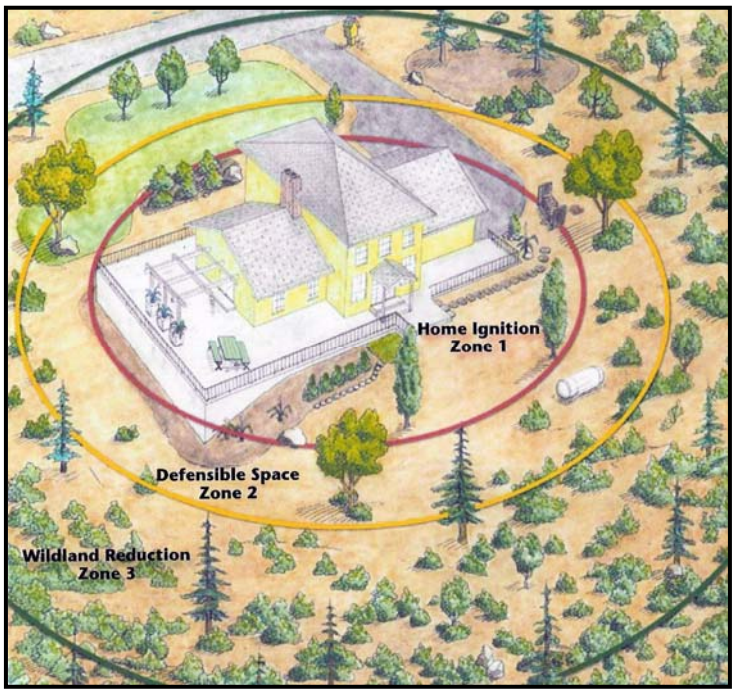
An aggressive program of evaluating and implementing defensible space for homes will do more to limit fire-related property damage than any other single recommendation in this report.

There is no question that any type of dense/flammable vegetation should be removed from around a home in order to reduce the risk of structural ignition during a wildfire. The question is how much should be removed. The basic rule is to eliminate all flammable materials (fire-prone vegetation, wood stacks, wood decking, patio furniture, umbrellas, etc.) from within 30 feet of the home. Then for structures near wildland open space, an additional 70 feet should be modified in such a way as to remove all dead wood from shrubbery, thin and trim trees and shrubs into "umbrella" like forms (lower limbs removed), and prevent the growth of weedy grasses (see **Figure 16**). Steep slopes and/or the presence of dangerous topographic features as described above may require the defensible space distances to be increased.

The term “clearance” leads some people to believe all vegetation must be removed down to bare soil. This is not the case. Removing all vegetation unnecessarily compromises large amounts of forested terrain, increases erosion, and will encourage the growth of weeds in the now disturbed soil. These weeds are considered “flashy fuels,” which actually increase fire risk because they ignite so easily. Defensible space must be ecologically sound, aesthetically pleasing and relatively easy to maintain. Only then will the non-prescriptive use of fuels reduction around homes become commonplace.

[17] *FireWise Construction*, Peter Slack, Boulder Colorado

Figure 16: Defensible Space Zones[18]



RECOMMENDATIONS

- Priority level-High. Conduct a parcel level wildfire hazard analysis for the homes in the study area. Completing this process will facilitate the following important fire management practices:

    - Establish a baseline hazard assessment for homes in these communities
    - Education of the community through the presentation of the parcel level Hazard-Risk Analysis at neighborhood public meetings
    - Identification of defensible space needs and other effective mitigation techniques
    - Identification and facilitation of "cross-boundary" projects
    - Community achievement of national FIREWISE status
    - Development of a Pre-Attack/Operational Plan for the FMU and eventually the entire study area. A pre-attack plan assists fire agencies in developing strategies and tactics that will mitigate incidents that occur

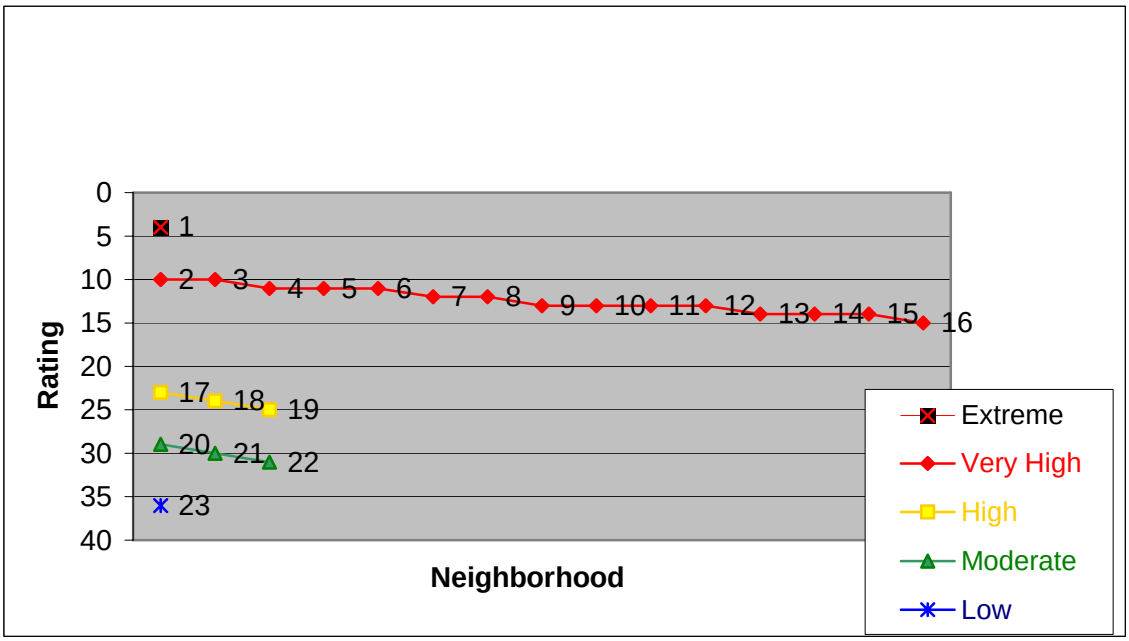
- Priority level-High. Add reflective address signs at each driveway entrance to all homes (See Appendix D for recommendations).

- Priority level-High. Use the structure triage methodology provided in **Appendix C** to identify homes not likely to be defendable.

[18] *A Homeowner's Guide to Fire Safe Landscaping*(2005) www.FireSafeCouncil.org

- Priority level-Moderate. Improve access roads and turnarounds to create safe access for firefighting resources. See "Glenwood Springs Hazard Assessment Emergency Access and Water Supply" (**Appendix D**).

Table 3. Hazard Ratings by Community



1. Highlands	**13. East Glenwood**
2. North No Name	**14. Three Mile**
3. Midland	**15. Oak Meadows**
4. Canyon Creek Estates	**16. Lower Canyon Creek**
5. Mel Ray/Shady Acres	**17. Sunlight**
6. Chelyn Acres	**18. South No Name**
7. Upper Canyon Creek	**19. Elk Springs**
8. Upper Mitchell Creek	**20. Sunlight View II**
9. Oasis Creek	**21. Prem Ranch**
10. Sunlight View I	**22. West Bank**
11. Black Diamond	**23. Spring Ridge Place**
12. Mountain Springs Ranch	

LANDSCAPE SCALE FUELS MODIFICATIONS FMU

One of the most effective forms of landscape scale fuels modification is the fuelbreak (sometimes referred to as "shaded fuelbreak"). A fuelbreak is an easily accessible strip of land of varying width, depending on fuel and terrain, in which fuel density is reduced, thus improving fire control opportunities. Vegetation is thinned removing diseased, fire-weakened and most standing dead trees. Thinning should select for the more fire resistant species. Ladder fuels, such as low limbs and heavy regeneration are removed from the remaining stand. Brush, dead and down materials, logging slash and other heavy ground fuels, are removed and disposed of to create an open park-like appearance. The use of fuelbreaks under normal burning conditions can limit uncontrolled spread of fires and aid firefighters in slowing the spread rate. Under extreme burning conditions where spotting occurs for miles ahead of the main fire and probability of ignition is high, even the best fuelbreaks are not effective. That being said, however, fuelbreaks have proven to be effective in limiting the spread of crown fires in Colorado.[19] Factors to be considered when determining the need for fuelbreaks in mountain subdivisions include:

- The presence and density of hazardous fuels
- Slope
- Other hazardous topographic features
- Crowning potential
- Ignition sources

With the exception of Aspen, all of Colorado's major timber types represent a significant risk of wildfire. Increasing slope causes fires to move from the surface fuels to crowns more easily due to preheating. A slope of 30% causes the fire spread rate to double compared with the same fuels and conditions on flat ground. Chimneys, saddles and deep ravines are all known to accelerate fire spread and influence intensity. Communities with homes located on or above such features as well as homes located on summits and ridge tops would be good candidates for fuel breaks. Crown fire activity values for the study area were generated by the FlamMap model and classified into three standard ranges (surface fire only, passive crown fire and active crown fire). In areas where active crown fire activity is likely to exist, fuelbreaks should be considered. If there are known likely ignition sources (such as railroads and recreation areas that allow campfires) that are present in areas where there is a threat of fire being channeled into communities, fuelbreaks should be considered.

Fuelbreaks should always be connected to a good anchor point like a rock outcropping, river, lake, or road. The classic location for fuelbreaks is along the tops of ridges to stop fires from backing down the other side or spotting into the next drainage. This is sometimes not practical from a WUI standpoint as the structures firefighters are trying to protect are usually located at the tops of ridges or mid-slope. Mid-slope positioning is considered the least desirable for fuelbreaks; however it may be easiest to achieve as an extension of defensible space work or an extension of existing roads and escape routes. One tactic would be to create fuelbreaks on slopes below homes located mid-slope and on ridge tops so that the area of continuous fuels between

[19] Frank C. Dennis, "Fuelbreak Guidelines for Forested Subdivisions" (Colorado State Forest Service, Colorado State University, 1983), p. 3.

the defensible space of homes and the fuelbreak is less than ten acres. Another tactic that is commonly used is to position fuelbreaks along the bottom of slopes. In most of the study area this would require the cooperation of many individual landowners. In some areas, like Midland, the only way to separate residences from fuels is to locate the fuelbreak mid-slope above homes. This would provide some protection from backing fires and rolling materials. It would make sense to locate fuelbreaks mid-slope below homes, where this is possible, to break the continuity of fuels into the smaller units mentioned above. Even though this position is considered the least desirable from a fire suppression point of view, it would be the most effective approach in some portions of the study area.

Fuelbreaks are often easiest to locate along existing roadbeds (see the "**Access Route Fuels Modification Recommendations**"). The minimum recommended fuelbreak width is usually 200 feet. As spread rate and intensity increases with slope angle, the size of the fuel break should also be increased with an emphasis on the downhill side of the roadbed or centerline employed. The formulas for slope angles of 30% and greater are as follows: below road distance = 100' + (1.5 x slope %), above road distance = 100' – slope % (see **Table 4**). Fuelbreaks that pass through hazardous topographic features should have these distances increased by 50%.[20] Since fuelbreaks can have an undesirable effect on the esthetics of the area, crown separation should be emphasized over stand density levels. That is to say that isolating groupings rather than cutting for precise stem spacing will help to mitigate the visual impact of the fuelbreak. Irregular cutting patterns that reduce canopy and leave behind islands with wide openings are effective in shrub models.

Another issue in mechanical thinning is the removal of cut materials. It is important to note that in Colorado's dry climate slash decomposes very slowly. One consequence of failing to remove slash is to add to the surface fuel loading, perhaps making the area more hazardous than before treatment. It is imperative that all materials be disposed of by piling and burning, chipping, physical removal from the area, or lopping and scattering. Of all of these methods lopping and scattering is the cheapest, but also the least effective since it adds to the surface fuel load.

It is also important to note that fuelbreaks must be maintained to be effective. Thinning usually accelerates the process of regenerative growth. The effectiveness of the fuelbreak may be lost in as little as three to four years if ladder fuels and regeneration are not controlled. Fuelbreaks should not be constructed without a maintenance plan.

One of the most difficult issues in establishing and maintaining fuelbreaks is securing cooperation and participation of landowners. Ownership maps of the area indicate that implementation of fuels reduction projects recommended here and in the "Access, Evacuation, and Sheltering-In-Place FMU" section, would require the approval of several public land management agencies as well as private landowners. These entities include the City of Glenwood Springs, the United States Forest Service, the Bureau of Land Management and possibly others.

[20] Frank C. Dennis, "Fuelbreak Guidelines for Forested Subdivisions" (Colorado State Forest Service, Colorado State University, 1983), p. 11.

Table 4. Recommended Treatment Distances For Mid-Slope Roads

% Slope	Distance Above Road	Distance Below Road
30	70 feet	145 feet
35	65 feet	153 feet
40	60 feet	160 feet
45	55 feet	168 feet
50	50 feet	175 feet

Special Considerations for Fuel Treatments in Oak Brush

In the majority of the Extreme, Very High, and High hazard communities in the study area, the dominant fuel is Gambel's Oak (fuel models 4 and 6). When burned, Gambel's Oak produces significantly more energy than other common Southwestern trees: 52% more than Aspen, 42% more than Ponderosa pine, 36% more than Lodgepole pine and 24% more than Rocky Mountain juniper.[21]

Gambel's Oak is extremely fire tolerant and is seldom actually killed by fire. The USFS Fire Effects Information website reports that following a fire that had consumed all above-ground vegetation, herbaceous plants and litter, Gambel's Oak quickly reestablished in densities greater than those present before the burn. In a Colorado study Gambel's Oak increased 100% to 150% in density and 10% to 40% in frequency following a single burn. Fuels reduction by prescribed fire seems to be most effective in Gambel's Oak when performed during the summer growth period when the plant's carbohydrate reserves are at their lowest. This, of course, is the time when prescribed burning would be least desirable from a control standpoint. Even if it were possible to burn during this period, evidence suggests that it would still require repeated, high-severity fires to reduce Gambel's Oak.[22]

The preferred method of control is mechanical thinning combined with herbicide application to prevent sprouting and new growth. Thinning with heavy machinery is not likely to be a popular tactic in interface areas. Hand thinning with chainsaws is likely to be the most acceptable method to residents. Ideally herbicide should be applied within the first hour after cutting to prevent sprouting or alternatively, to emerging sprouts three to six weeks after cutting. USFS information indicates that treatment is most effective if done during the period of low carbohydrate reserves just prior to the full leaf stage. Evidence indicates that herbicides that are applied during periods when carbohydrate reserves are high may actually stimulate root sprouting in Gambel's Oak therefore, the timing of fuels reduction efforts becomes more important in Oak brush than other fuels.[23] Coordinated efforts between private landowners and public land managers are critical to prevent fuels reduction efforts that actually result in an increased fuel load.

[21] USDA Forest Service Fire Effects Information website (http://www.fs.fed.us/database/feis/index.html), 2000.
[22] Ibid
[23] Ibid

BLM/USFS Current and Planned Projects

The Upper Colorado River Interagency Fire Management Group is composed of the BLM Glenwood Springs and Grand Junction Field Offices and the USFS White River and Grand Mesa National Forests. The Fire Management Group supports city and county WUI hazard reduction efforts through fuels reduction on adjacent federal lands and by funding WUI planning efforts. Major funding for the "Glenwood Springs Fire Protection District Wildland Fire Hazard and Risk Assessment" (2003) was provided by a BLM grant. The following is a list of planned and proposed fuels reduction projects under consideration for fiscal years (October 1-September 30) 2004-2009 that could impact GSFPD. For the purpose of BLM/USFS project descriptions; "planning" involves project design and coordination with adjacent property owners, fire districts and other stakeholders. Other activities included in the planning stage would be any resource work and inventories necessary for compliance with the National Environmental Policy Act (NEPA).

- **Lookout Mountain Communication Site**: (Completed in 2004) Twelve acres surrounding the tower and structures on the Lookout Mountain Communication site were targeted for defensible space construction and fuels reduction. This project reduces hazards in the WUI by reducing the risk of losing emergency response communications. We believe this is an important project as it protects a critical communication infrastructure resource.
- **Four Mile Project**: The proposed fuels reduction project in the Four Mile Road area involves three adjacent communities, Chelyn Road, Black Diamond Road, and Oak Meadows. The reduction of fuels on the BLM and USFS lands indicated by the proposed project map could have a noticeable impact on the intensity of fires in these populated areas, especially when combined with mitigation efforts on private land. Please see specific recommendations for Chelyn Acres, Black Diamond, and Oak Meadows in the recommendations section below.
- **Mountain Springs/Three Mile:** Fuels reduction work on federal lands in this area could reduce the intensity of fires in the residential areas as well as improve access safety for firefighting forces. This project may also involve the granting of an easement for and the development of, alternate escape routes from the Mountain Springs Ranch community into South Canyon.
- **Glenwood Gondola Project**: From the borders indicated on the BLM proposed project map (draft 5/12/03) this project, could significantly impact the Oasis Creek community.
- **Midland Project**: (This potential project is scheduled for planning in fiscal year 2007, with possible implementation in fiscal year 2008.) A small but important portion of the Midland community is being considered for hazardous fuels reduction on the BLM land to the west of residences. This project would provide a fuelbreak between the homes and steep slopes with heavy loads of shrub fuels, primarily Oak Brush.

In accordance with the National Fire Plan, federal land managers in this area have demonstrated a willingness to preplan treatments with local fire departments and landowners to create cross-boundary hazard reduction efforts. It is important for GSFD, the city of Glenwood and private landowners to coordinate all fuels reduction projects so they complement these BLM/USFS efforts.

ACCESS ROUTE FUELS MODIFICATION RECOMMENDATIONS

The primary transportation corridors through the district are I-70, Colorado Highway 82 and Four Mile Road. In general, these roads have adequate openings. However, many of the communities in the study area would benefit from fuels reduction along their principal access routes.

Thinning along primary access roads into communities should include an area of at least 100' on either side of the centerline of the access routes where practical. This distance should be modified to account for increased slope and other topographic features that increase fire intensity (see **Table 4**). This is especially important in communities with steep narrow roads and few turnouts. In these areas, safer access for firefighters would make an impact in the number of structures that could be defended in a wildfire. Existing and natural barriers to fire should be incorporated into the project dimensions.

The communities that should be considered highest priority for fuels reduction along access corridors include:

- Highlands
- North No Name
- Chelyn Acres
- Upper Canyon Creek
- Mitchell Creek (especially above the fish hatchery)
- Oasis Creek
- Black Diamond
- Mountain Springs Ranch
- Three Mile
- Oak Meadows
- Elk Springs

In addition to the escape routes suggested previously, other possibilities should be defined and similar fuels reduction projects employed. For example, aerial photographs show that it may be possible to construct an escape route from the northern portion of the Highlands community to the golf course by using natural clearings and old trails. If field checking shows this is possible, the additional access would improve the safety of residents and firefighters. In areas where multiple routes exist, consider separating access routes for responders and escape routes for citizens in pre-attack plans.

The cooperation of adjacent, contiguous landowners should be secured. If this is not possible, more intensive thinning may need to occur within the road easement. Landowner participation allows the project to be more flexible in selecting trees and shrubs for removal. It allows greater consideration for the elements of visual screening and aesthetics. Enlarging the project dimensions, allows more options for vegetative selection while still protecting the access/egress corridor.

- Elements of the fuels modification space for access and egress routes should include:
    - Tree crown separation of at least 10' with groups of trees and shrubs interspersed as desired

- Crown separation greater than 10' may be required to isolate adjacent groups or clumps of trees
- Limb all remaining trees to a height of 8' or 1/3 of the tree height (whichever is lower)
- Clean up ground fuel within the project area
- Post placards clearly marking "fire escape route" (This will provide functional assistance during an evacuation and communicate a constant reminder of wildfire to the community. Be sure to mount signage on non-combustible poles.)

OTHER FUELS MODIFICATION RECOMMENDATIONS

The following recommendations are in addition to, not in place of, the fuels reductions mentioned in the "Access Route Fuels Modification Recommendations" and the BLM/USFS projects listed above.

Of the communities assessed in this study, the following are recommended for fuel breaks:

- **Highlands** – Priority level-High. In addition to the thinning along the access road that was discussed in the "Access, Evacuation and Sheltering-In-Place FMU", fuels reduction should be undertaken in the ravine between Highlands and Oasis Creek. Homes that are located above heavy loads of Oak brush, especially those above ravines, need extended defensible spaces. If enough homeowners are interested, it may be possible to tie these individual treatments into a landscape scale fuel break that would slow fire spread and reduce the intensity of fires occurring on the slopes below the homes.
- **Oasis Creek** – Priority Level-High. As mentioned before, there is a critical need to thin fuels in the ravine between Oasis Creek and Highlands. The ravine to the east of Oasis Creek is also a critical fuels reduction need to protect access into the community as well as the Transfer Trail. If this work was done, a fuel break could be used to connect the two ravines and isolate Oasis Creek from the steep slopes to the north. Thinning on the slopes to the south of homes is also recommended and could be tied into a similar project in the Highlands community.
- **Oak Meadows** – Priority Level-High. Decadent Aspen stands mentioned in Appendix B could be cleaned up to provide a good natural barrier to north/south fire spread. Thinning along the old railroad grade would also help prevent ignitions occurring along the road and in the eastern part of the community from spreading rapidly into the upper slopes and ravines. Any work done here should be coordinated with the BLM project that is under consideration.
- **Mel Ray/Shady Acres** – Priority Level-High. It would be advisable to tie a fuelbreak in from the golf course to the thinning along Mitchell Creek Road mentioned in the "Access Route Fuels Modification Recommendations" section. This would help isolate this community from the steep slopes to the north. Even though the western parts of this area burned during the Coal Seam fire, there is still a significant fuel load present. Fuel loading combined with the close together

wooden structures that dominate this community makes fuels reduction especially important.

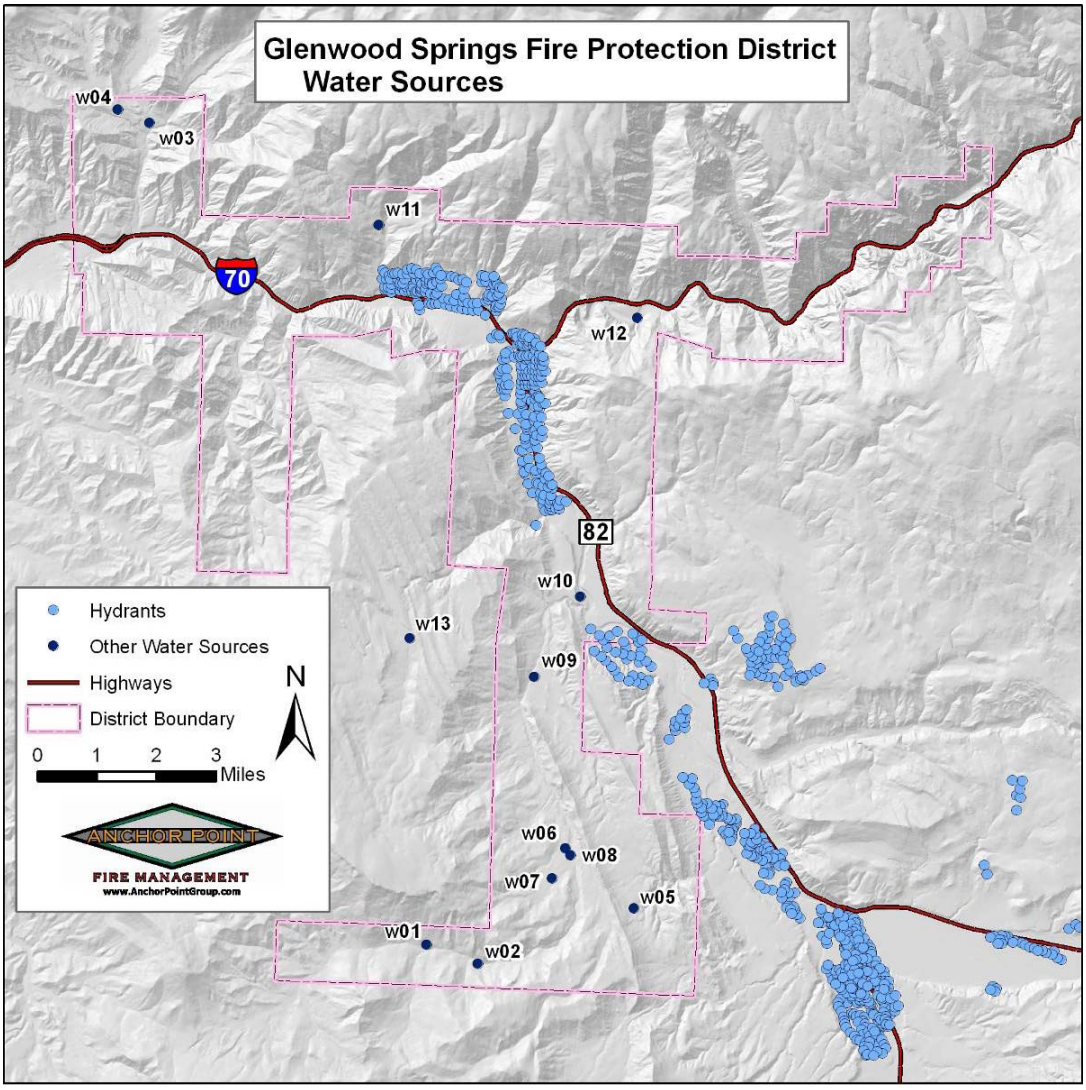
- **Midland** – Priority Level-Moderate. Combine private landowner efforts with the BLM project mentioned above to create a fuel break between the homes and the steeper slopes of heavy fuels to the west. It would also be desirable to thin vegetation between Midland Avenue and residences to the west.
- **Chelyn Acres** – Priority Level-Moderate. A fuel break could be extended from the power line cut to the south and tied into Fourmile Creek. Thinning between residences and Fourmile Creek should also be considered to protect access and reduce the spread of ignitions occurring from the road. This work should be coordinated with the BLM fuels reduction project in this area.
- **Black Diamond** – Priority Level-Moderate. Thinning and improvements along the access road to the Black Diamond Mine may help slow the spread of fire from the west into this community. This area lacks good anchor points for a fuelbreak. Any work done here should be coordinated with the proposed BLM project.
- **Canyon Creek -** Priority Level-Moderate. A fuels reduction project on the BLM lands on both sides of the access into the Upper Canyon Creek area would reduce the intensity of fires in that community. These treatments would be most effective if combined with defensible spaces and fuels reduction in the private lands surrounding the road.
- **Elk Springs** – Priority Level-Moderate. Elk Springs needs a fuelbreak to separate this community from the steep slopes of continuous piñon/juniper to the west. The fuelbreak could be anchored into Spring Valley Road to the south and jeep trails to the north. None of this area is within a fire protection district.

There are some communities in the study area that have a notable amount of standing dead and diseased trees. Tree mortality due to Ips beetle infestation is becoming an increasing problem in Highlands and other communities. Cooperation between public and private landowners in removing dead and diseased trees and treating for beetles is recommended.

WATER SUPPLY FMU

Like most of the mountainous areas of Colorado, water in the study area is a critical fire suppression issue. The City of Glenwood Springs has an excellent network of hydrants. In most of the interface communities, however city hydrants are not available. In the spring of 2006 GSFD contracted for an on-the-ground evaluation of alternative water sources in these areas. Twelve additional water sources were identified and pre-planned for these areas. Approximate locations of hydrants and these supplemental water sources within the study area are shown in Figure 17.

Figure 17: Water Supply Locations in the Study Area



Field verification showed that the hydrants listed on this map, which was provided by the Glenwood Springs Planning Department, did indeed exist in the areas depicted. Several communities were found, however, where hydrants were present, and appeared to be in good condition, but are not shown in **Figure 17**. These communities are listed below:

- North and South No Name
- Canyon Creek Estates
- Sunlight View I and II
- Oak Meadows
- Spring Ridge Place

Even with the additional water sources identified in the 2006 project, homes exist in several communities which are located more than 1,000 feet from the nearest water source or hydrant. These communities include:

- Chelyn Acres
- Black Diamond
- Upper Canyon Creek
- Upper Mitchell Creek
- Mountain Springs Ranch
- Three Mile (above the trailer park)
- Lower Canyon Creek
- Sunlight

Some of these areas (Chelyn Acres, Lower Canyon Creek and Three Mile), are adjacent to areas where hydrants are present, however there are some homes located in all the communities listed above which are a considerable distance from reliable water sources for fire suppression. Improvement of the water supply in these communities constitutes an important FMU.

GSFD is equipped with a good supply of water tenders and portable tanks (See the "Local Preparedness and Firefighting Capabilities FMU" section); however, firefighting efforts can be enhanced by improving water supplies in the FMU.

RECOMMENDATIONS

- Priority Level-High. In Upper Canyon Creek, Upper Mitchell Creek and along Four Mile Road, there are private ranches and landowners with water supplies suitable for fire suppression. For example, the Storm King Ranch in Upper Mitchell Creek has its own water source for fire suppression. During the Coal Seam fire, the ranch effectively suppressed the fire on its property. Wherever such private water sources exist, agreements should be sought with the property owners for the use of the water during emergency suppression operations. When such agreements are reached, the water source should be included in fire department pre-plans with information including maps, access information such as gate codes or key locations, the size and type of the water source, whether or not it is accessible to aircraft and equipment and connections needed for use. This information will be important for the successful use of the water supply by outside resources unfamiliar with the area.
- Priority Level-High. Consider the installation of a large, 10,000 to 20,000 gallon, community cistern in the western portion of Chelyn Acres. The nearest water supply for this community is the hydrant system in Sunlight View 1.
- Priority Level-High. In Upper Canyon Creek private water sources should be identified and preplanned. Homes above mile 2.5 should have on-site cisterns or draftable all-season ponds because they are a long way from other water sources.
- Priority Level-High. The Mountain Springs Ranch area is desperately in need of additional water supply. At the current level of development, the area could be covered by three or four large, 10,000 to 20,000 gallon, cisterns or by individual, 1,800 to 2,500

gallon, on-site cisterns for homes located more than 1,000 from draftable ponds. If development continues a comprehensive pre-plan including water sources should be considered for this community.

- Priority Level-High. Homes in the Three Mile Community west of the Three Mile Trailer Park need cisterns. Three Mile Creek is not a reliable draft source due to low flows and difficult access. Individual cisterns are probably the best solution for isolated homes, however a community cistern could be considered for the grouping of homes on the south facing slopes north of the road and approximately 3/4 of a mile west of the trailer park.
- Priority Level-Moderate. In Upper Mitchell Creek homes above the fish hatchery should have on-site cisterns, or draftable all-season ponds.
- Priority Level-Moderate. One or two large, 10,000 to 20,000 gallon cisterns should be added in the Lower Canyon Creek area to prevent the need to shuttle water from Canyon Creek Estates.
- Priority Level-Moderate. Standardize connection size, sex, and thread type for dry hydrants and cisterns. A standard for new construction and refitting of existing water supplies, where possible, is recommended. Standardization would result in a smoother, faster and more reliable connection. In most areas the water district supplying service to the area specifies fitting sizes and types. A standard should be adopted by a cooperative effort between the water district, GSFD and mutual aid agencies. Our recommendation would be to use the construction standards proposed in the Summit County Dry Hydrant Manual. This manual was developed specifically for rural fire protection in the mountains of Colorado. A copy of the manual has been included with this report.

GLOSSARY

The following definitions apply to terms used in the Glenwood Springs Fire Protection District Community Wildfire Protection Plan.

1 hour Timelag fuels: Grasses, litter and duff; <1/4 inch in diameter

10 hour Timelag fuels: Twigs and small stems; ¼ inch to 1 inch in diameter

100 hour Timelag fuels: Branches; 1 to 3 inches in diameter

1000 hour Timelag fuels: Large stems and branches; >3 inches in diameter

Active Crown Fire: This is a crown fire in which the entire fuel complex – all fuel strata – become involved, but the crowning phase remains dependent on heat released from the surface fuel strata for continued spread (also called a Running Crown Fire or Continuous Crown Fire).

ArcGIS 9.x: This is Geographic Information System (GIS) software that is designed to handle mapping data in a way that can be analyzed, queried, and displayed. ArcGIS is in its ninth major revision and is published by the Environmental Systems Research Institute (ESRI).

Crown Fire (Crowning): The movement of fire through the crowns of trees or shrubs, which may or may not be independent of the surface fire.

Defensible Space: An area around a structure where fuels and vegetation are modified cleared or reduced to slow the spread of wildfire toward or from the structure. The design and distance of the defensible space is based on fuels, topography, and the design/materials used in the construction of the structure.

Energy Release Component: An index of how hot a fire could burn. ERC is directly related to the 24-hour, potential worst case, total available energy within the flaming front at the head of a fire.

Extended Defensible Space (also known as Zone 3): This is a defensible space area where treatment is continued beyond the minimum boundary. This zone focuses on forest management with fuels reduction being a secondary consideration.

Fine Fuels: Fuels that are less than ¼ inch in diameter such as grass, leaves, draped pine needles, fern, tree moss, and some kinds of slash which, when dry, ignite readily and are consumed rapidly.

Fire Behavior Potential: The expected severity of a wildland fire expressed as the rate of spread, the level of crown fire activity, and flame length. This is derived from fire behavior modeling programs using the following inputs: fuels, canopy cover, historical weather averages, elevation, slope, and aspect.

Fire Danger: In this document we do not use this as a technical term due to various and nebulous meanings that have been historically applied.

Fire Hazard: Given an ignition, the likelihood and severity of Fire Outcomes (Fire Effects) that result in damage to people, property, and/or the environment. The hazard rating is derived from the Community Assessment and the Fire Behavior Potential.

Fire Mitigation: Any action designed to decrease the likelihood of an ignition, reduce Fire Behavior Potential, or to protect property from the impact of undesirable Fire Outcomes.

Fire Outcomes (aka Fire Effects): This is a description of the expected effects of a wildfire on people, property and/or the environment based on the Fire Behavior Potential and physical presence of Values-at-Risk. Outcomes can be desirable as well as undesirable.

Fire Risk: The probability that an ignition will occur in an area with potential for damaging effects to people, property, and/or the environment. Risk is based primarily on historical ignitions data.

Flagged Addressing: A term describing the placement of multiple addresses on a single sign, servicing multiple structures located on a common access.

FlamMap: A software package created by the Joint Fire Sciences Program, Rocky Mountain Research Station. The software uses mapped environmental data such as Elevation, Aspect, Slope, and Fuel Model, along with fuel moisture and wind information, to generate predicted fire behavior characteristics such as Flame Length, Crown Fire Activity, and Spread Rate.

Flame Length: The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface)—an indicator of fire intensity.

FMU (Fire Management Unit): A method of categorizing and prioritizing fire mitigation work efforts. Units can be defined by function (e.g., public education efforts) or geography (e.g., fuel reduction projects in a given area).

Fuelbreak: A natural or constructed discontinuity in a fuel profile used to isolate, stop, or reduce the spread of fire. Fuelbreaks may also make retardant lines more effective and serve as control lines for fire suppression actions. Fuelbreaks in the WUI are designed to limit the spread and intensity of crown fire activity.

ICP (Incident Command Post): The base camp and command center from which fire suppression operations are directed.

ISO (Insurance Standards Office): A leading source of risk (as defined by the insurance industry) information to insurance companies. ISO provides fire risk information in the form of ratings used by insurance companies to price fire insurance products to property owners.

Jackpot Fuels: a large concentration of fuels in a given area such as a slash pile.

Passive Crown Fire: a crown fire in which individual or small groups of trees torch out (candle), but solid flaming in the canopy fuels cannot be maintained except for short periods.

Shelter-in-Place Areas: A method of protecting the public from an advancing wildfire involving instructing people to remain inside their homes or public buildings until the danger passes. This concept is new to wildfire in the United States, but not to hazardous materials incident response where time, hazards, and sheer logistics often make evacuation impossible. This concept is the dominant modality for public protection from wildfires in Australia where fast-moving, short-duration fires in light fuels make evacuation impractical. The success of this tactic depends on a detailed preplan that takes into account the construction type and materials of the building used, topography, depth and type of the fuel profile, as well as current and expected weather and fire behavior. For a more complete discussion of the application

and limitations of Shelter-in-place concepts see the “Addressing, Evacuation, and Shelter-In-Place FMU” section in the main report.

Slash: Debris left after logging, pruning, thinning, or brush cutting; includes logs, chips, bark, branches, stumps, and broken understory trees or brush.

Spotting: Refers to the behavior of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire.

Structural Triage: The process of identifying, sorting, and committing resources to a specific structure.

Surface Fire: This is a fire that burns in the surface litter, debris, and small vegetation on the ground.

Timelag: Time needed under specified conditions for a fuel particle to lose about 63% of the difference between its initial moisture content and its equilibrium moisture content.

Values-at-Risk: People, property, ecological elements, and other human and intrinsic values within the project area. Values-at-Risk are identified by inhabitants as important to the way of life of the study area and are susceptible specifically to damage from undesirable fire outcomes.

WHR (Community Wildfire Hazard Rating. AKA Community Assessment): A sixty-point scale analysis designed to identify factors that increase the potential for and/or severity of undesirable fire outcomes in WUI communities.

WUI (Wildland Urban Interface): The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. This is sometimes referred to as Urban Wildland Interface, or UWI.

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