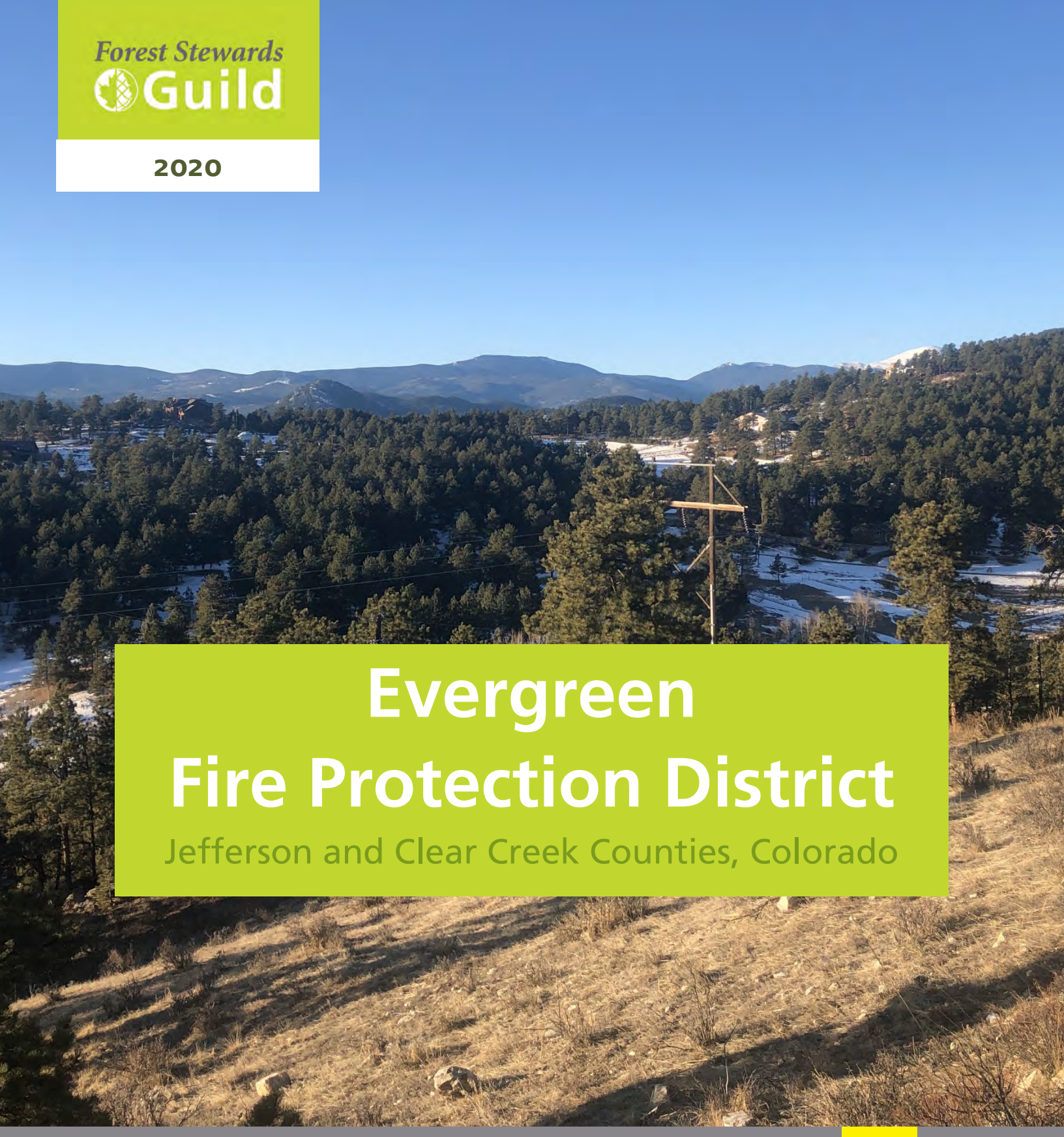
Forest Stewards Guild

2020



Evergreen Fire Protection District

Jefferson and Clear Creek Counties, Colorado

Community Wildfire Protection Plan

EVERGREEN FIRE PROTECTION DISTRICT

COMMUNITY WILDFIRE PROTECTION PLAN

2020 UPDATE

Prepared for Evergreen Fire/Rescue

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Prepared by Forest Stewards Guild

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CONTENTS

INTRODUCTION

This Community Wildfire Protection Plan (CWPP) will provide a wildfire risk analysis for the Evergreen Fire Protection District (EFPD). This plan will include a mitigation plan and implementation recommendations. The 2020 CWPP is a complete update of the 2007 Evergreen CWPP that addresses a changing landscape and fire science. This document is to be utilized as a tool by the community and local partners to begin prioritizing projects that make Evergreen a safer and more resilient community to wildfire.

Following the investigation of the Camp Fire in Paradise, California, the wildland fire community learned some difficult lessons about prioritization and preparedness in the event of catastrophic wildfire. Paradise, CA had undergone planning processes and had implemented projects designed for mitigating wildfire risk. Failed communication, poor evacuation routes, and unmitigated vegetation were all contributing factors in the 83 casualties that occurred in November 2018. The process used to develop the Evergreen CWPP was based on what was learned from this and other recent wildfires. This CWPP is a call to action, as Evergreen shares many risk factors with past catastrophic wildfire events.

This CWPP was developed in partnership with Evergreen Fire/Rescue (EFR) by The Forest Stewards Guild and Anchor Point Group. Anchor Point developed a proprietary wildfire hazard and risk assessment tool called No-HARM to help assess wildland fuels and topography. This will be available to Evergreen as a web-interface and will rank the risk to each community within the fire protection district.

The Forest Stewards Guild developed new products using metrics gathered from loss of life events throughout the country that will help focus Evergreen's emergency planning. The Forest Stewards Guild also gathered community and stakeholder input which was used to assess neighborhood level needs. Those analyses provided roadway survivability and evacuation congestion locations, predicted using fire intensity and projected traffic flow. These tools will provide Evergreen residents an introduction into wildfire risk/mitigation and will provide community leaders a clear path forward to ensure community safety.

Evergreen's Wildland Urban Interface (WUI)

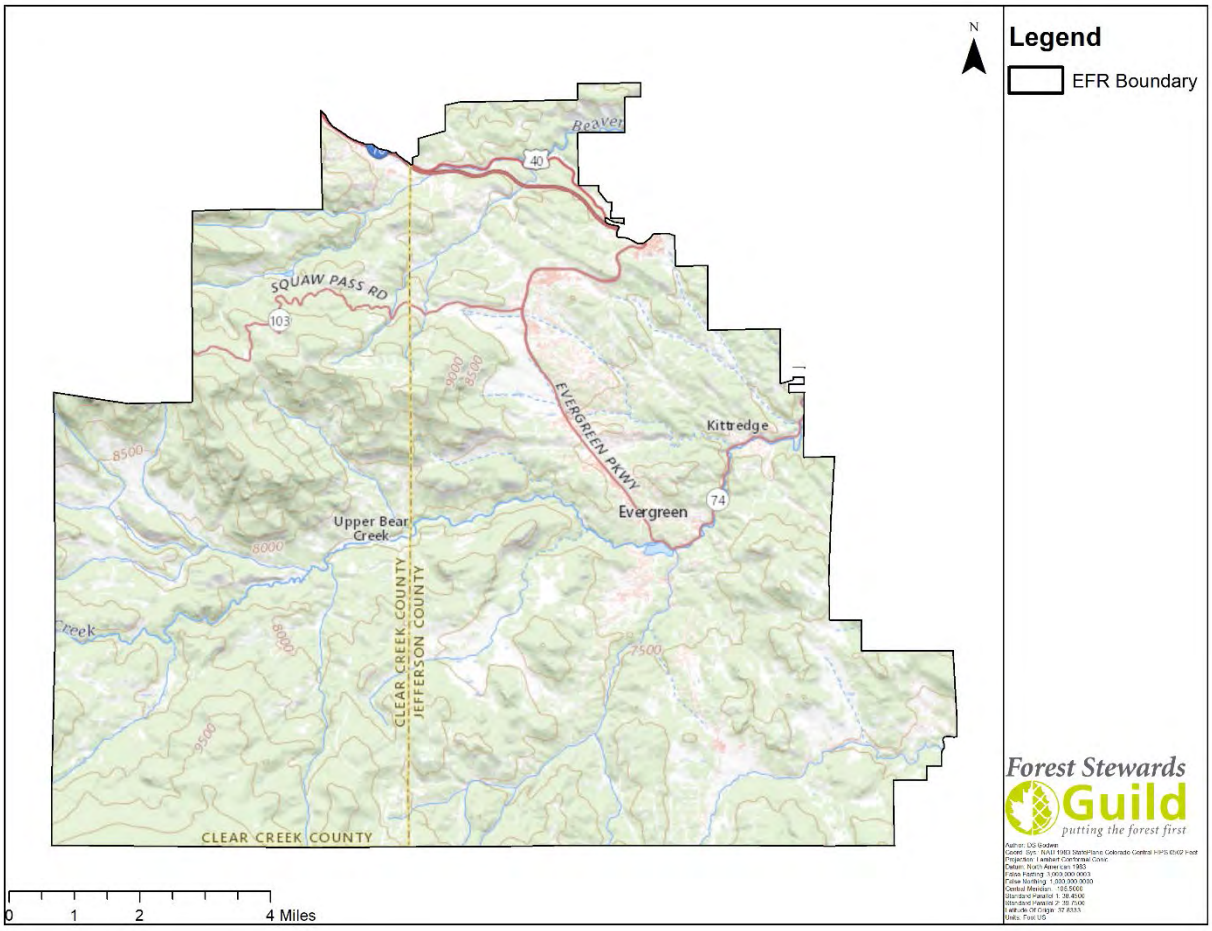


Figure 1. The extent of the Evergreen Fire Protection District

The Evergreen Fire Protection District is a Special District organized under Colorado Revised Statutes Title 32 to provide fire protection for the community of Evergreen. The District is in the foothills west of Denver, Colorado with a total area of 120 square miles (74,254 acres). All of the Evergreen Fire Protection District falls within the Bear Creek Basin with an altitude beginning (lower Bear Creek east of Kittredge) of 7,000 feet to over 11,000 feet in elevation on the southwestern boundary of EFPD.

This Fire Protection District is split between Clear Creek County and Jefferson County. The Evergreen Fire Protection District is bordered by Clear Creek Fire Authority, Elk Creek, Inter-Canyon, Indian Hills, Platte Canyon, Foothills, and Genesee Fire Protection Districts. On the Western edge of the district, they are bounded by the Arapaho-Roosevelt National Forest which extends into the district. The Mount Evans State Wildlife Area on the Southwestern portion of the district and Bergen Peak State Wildlife Area in the middle of the district are the major State Lands in Evergreen. Other major landowners in the Evergreen Fire Protection District are Jefferson County Open Space and Denver Mountain Parks with public recreation areas scattered throughout.

This land is the ancestral land of the Ute and Cheyenne First Nations. These indigenous groups utilized fire as a land management tool and lightning ignited fires were common before European settlement in the 1850's. As the initial farming and logging activities of settlers subsided in the region, trees grew back in a single age class, creating many single species stands of coniferous trees. Many residents in Evergreen see dense forest, the namesake of Evergreen, but it is not the historically wildfire-resilient landscape that existed before.

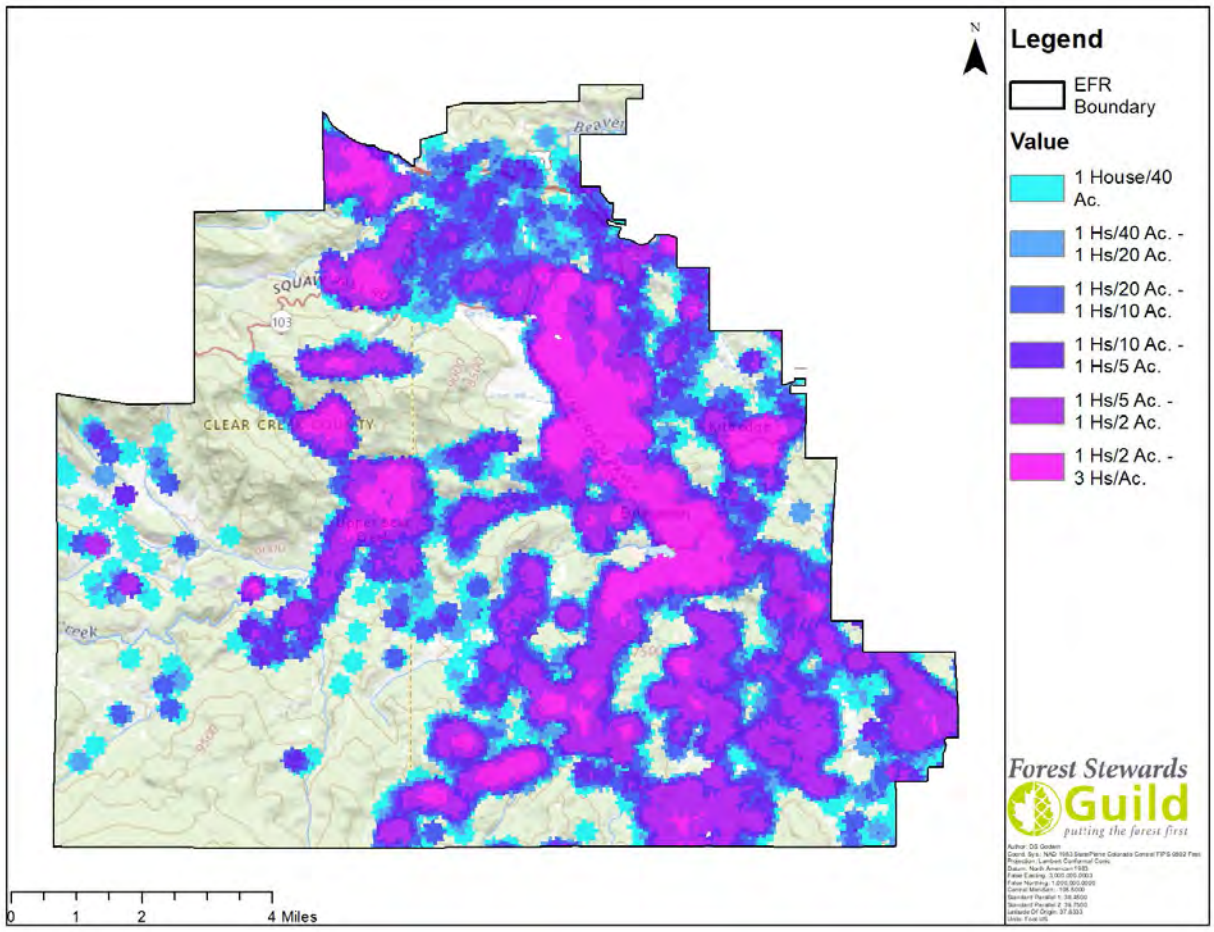


Figure 2. Wildland-Urban Interface in the Evergreen Fire Protection District. Displayed by housing (Hs) density per acre from the lowest density of 1 house per 40 acres to the highest density of 3 houses per acre.

Evergreen's Wildland Urban Interface is extensive. Over the past 50 years human migration to the mountains west of Denver has increased the number of occupied structures within the historically forested landscape. This population change has increased not only the density and size of the WUI but also the structural risk for wildfire damage. As of the 2010 US Census the population of the District was 26,334, and nearly 12,000 homes. The demographics are predominantly middle/upper class families.

Fire History

Colorado's Front Range was influenced heavily by fire before the era of fire exclusion. Frequent mixed-severity fire with occasional forest-stand-replacing fire created a patchwork of open structure forest with mixed-age forest stands. Government mandated fire suppression starting in the late 1800's increased tree density creating forest conditions that can develop high-severity fires that are more difficult to suppress and lead to large-scale fires with catastrophic loss, sometimes including lives (Hass 2014). Changing climate is likely to further increase risk by driving weather conditions that will produce catastrophic wildfires (Parks et al., 2016).

In addition to higher fuel loads in our Ponderosa and Mixed Conifer forest types, the Front Range's population has exploded in these areas at high wildfire risk. This increased risk to the Wildland-Urban Interface (WUI) has been demonstrated in recent wildfires like the Hayman, Waldo Canyon, and Black Forest Wildfires, to name a few (Figure 3). Damages may cost as much as $300 million dollars with losses of 100-500 homes. Many of these wildfires occurred on dry and windy days that caused rapid fire spread over short periods of time. On the Front Range, wind gusts can occur over 100 km/h (62 mph), making wildfire suppression nearly impossible during those weather events (Hass 2014).

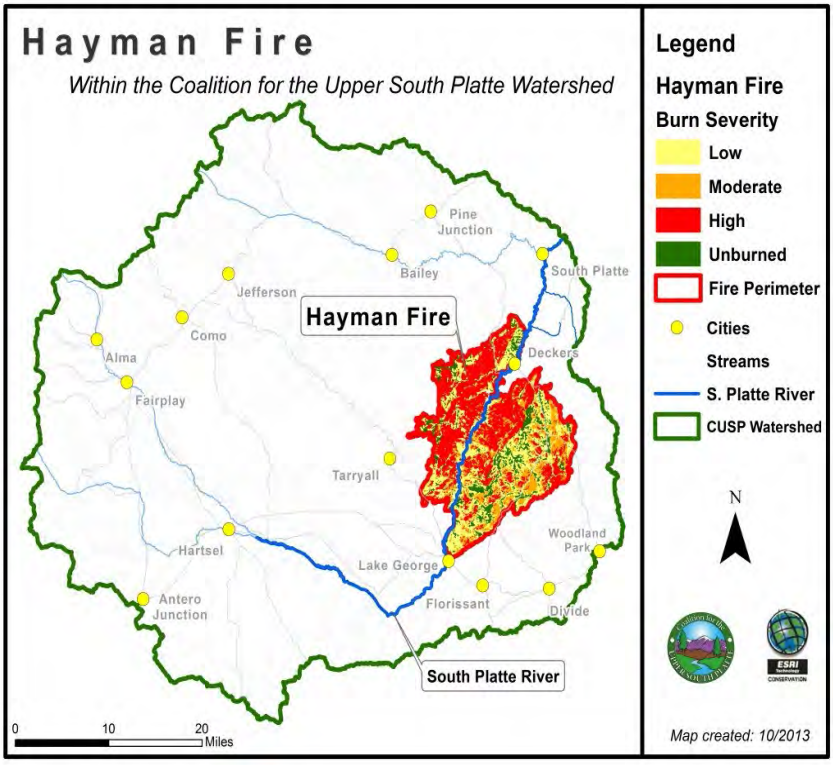


Figure 3. Extent of the Hayman Fire. Image courtesy of Coalition for the Upper South Platte Watershed. Note the relative size of this fire's extent compared to adjacent communities.

Catastrophic Wildfire – Common Factors

Extreme weather conditions with an unplanned ignition are what creates catastrophic wildfires. These wildfires have factors in common such as burn probability, indicating the underlying potential for fire to spread, and red flag days, indicating high winds and dry fuels. Red flag days are warnings issued by the National Weather Service with criteria found in Table 1. During 2018, 175 Red Flag Warnings were issued by the Denver/Boulder Forecast office as compared to 34 in 2017. Risk and probability of ignition are displayed in the Community Risk Assessment Section. During Red Flag Warnings, all residents need to be thinking about and preparing for evacuation, just as the fire department prepares for a wildfire response. Evergreen Fire/Rescue is planning to work with Jefferson and Clear Creek Counties to create additional criteria for burn bans that includes this information, but will consider other local factors.

National Weather Service – Denver/Boulder Forecast Office Red Flag Warning Criteria	
Option 1	**Option 2**
RH less than or equal to 15%	Widely Scattered Dry Thunderstorms
Wind gusts greater than or equal to 25 mph	Dry Fuels
Dry Fuels	

Table 1. National Weather Service Criteria for a Red Flag Warning

References:

Haas, J. R., Calkin, D. E., & Thompson, M. P. (2014). Wildfire Risk Transmission in the Colorado Front Range, USA. Risk Analysis, 00, 226–240. doi: 10.1111/risa.12270

Parks, S. A., Miller, C., Abatzoglou, J. T., Holsinger, L. M., Parisien, M.-A., & Dobrowski, S. Z. (2016). How will climate change affect wildland fire severity in the western US? *Environmental Research Letters*, *11*, 035002. https://doi.org/10.1088/1748-9326/11/3/035002

IGNITION PREVENTION

Wildfire planning must occur acknowledging that not all ignitions are avoidable in fire prone locations. Lessening the number of unplanned, human-caused ignitions, however, is an important factor to reducing the risk of wildfire to a community. Common human-caused ignition sources are "vehicles, cigarette butts, campfires, fireworks, debris burning, powerlines, arson" and other miscellaneous sources (Evans 2018). Likely sites of ignition include Maxwell Falls and the area around Cub Creek Park from unattended or negligent campfires. Transient populations are also a large risk in this area as they may not always be aware of burn bans and use camp/warming fires frequently.

Prevention campaigns can be a good investment when targeted locally to the risky ignition behavior, such as abandoned/negligent campfires (Evans 2018). Guidelines from the National Wildfire Coordinating Group (NWCG) from their Wildfire Prevention Guide should be utilized to outline intervention techniques. Each site of high ignition frequency should be treated with a custom intervention for that behavior.

Around Evergreen, sites of high ignition likelihood were provided by previous ignition data, experiences of Evergreen Fire/Rescue, and citizen input. The sites follow:

- Maxwell Falls Camping Area
- Recreational area along Brook Forest Road
- Harris Park shooting range
- Staunton State Park Camping Area
- Mount Evans State Wildlife Area camping sites
- Powerlines

For camping areas, burn bans and responsible fire recommendations are posted in parking lots, but enforcement does not always catch the behavior and provide consequences. Additional funding could be utilized for improved enforcement and monitoring of negligent campfires and escapes. Robust data of these ignitions including location and consequence would assist Evergreen Fire/Rescue to identify where resources are lacking. Homeless and transient populations are a concern to be educated about wildfire and burn bans. The best way to implement prevention work for these populations are to empower and educate support groups that address these individual's needs.

References:

Evans, A. (2018). Increasing Wildfire Awareness and Reducing Human-Caused Ignitions in Northern New Mexico. Retrieved from https://foreststewardsguild.org/wpcontent/uploads/2019/05/Wildfire_awareness_2018.pdf

EVERGREEN'S PREPAREDNESS FOR WILDFIRE

Community Accomplishments since first CWPP

During the initial round of CWPP development in Colorado, Clear Creek County officials wanted to package up the CWPP recommendations for citizen use. They created an action plan that engaged communities could work through to keep the recommendations in the CWPP alive. Some communities began utilizing grant funding with the backing of the state certified CWPP successfully and the program began to take off in Evergreen. At the time, Fire Chief Weege was supportive of the program and Community Wildfire Protection Implementation Plans (CWPIPs) were written, based on the 2007 Evergreen CWPP.

A CWPIP takes the recommendations of the broad CWPP and applies them to a smaller scale. These smaller areas are defined as Plan Units. For example, a recommendation may be to utilize a shaded-fuel break in residential areas of high to extreme risk. A CWPIP takes that recommendation and expands in greater detail by suggesting a shaded fuel break along Columbine Road to Forest Hill Road until its intersection with Bear Creek Road. It prioritizes individual home hardening practices which are key to community engagement and wildfire adaptation. CWPIP leaders are tasked to prompt neighborhood members for commitment letters so that if funding is available, they can quickly know what neighbors are willing to have work done on their property. They then move to the other recommendations of Roadways, Emergency Access, and thinning on adjacent acres which can be found in the Community Risk Assessment Section and Map Appendix A.

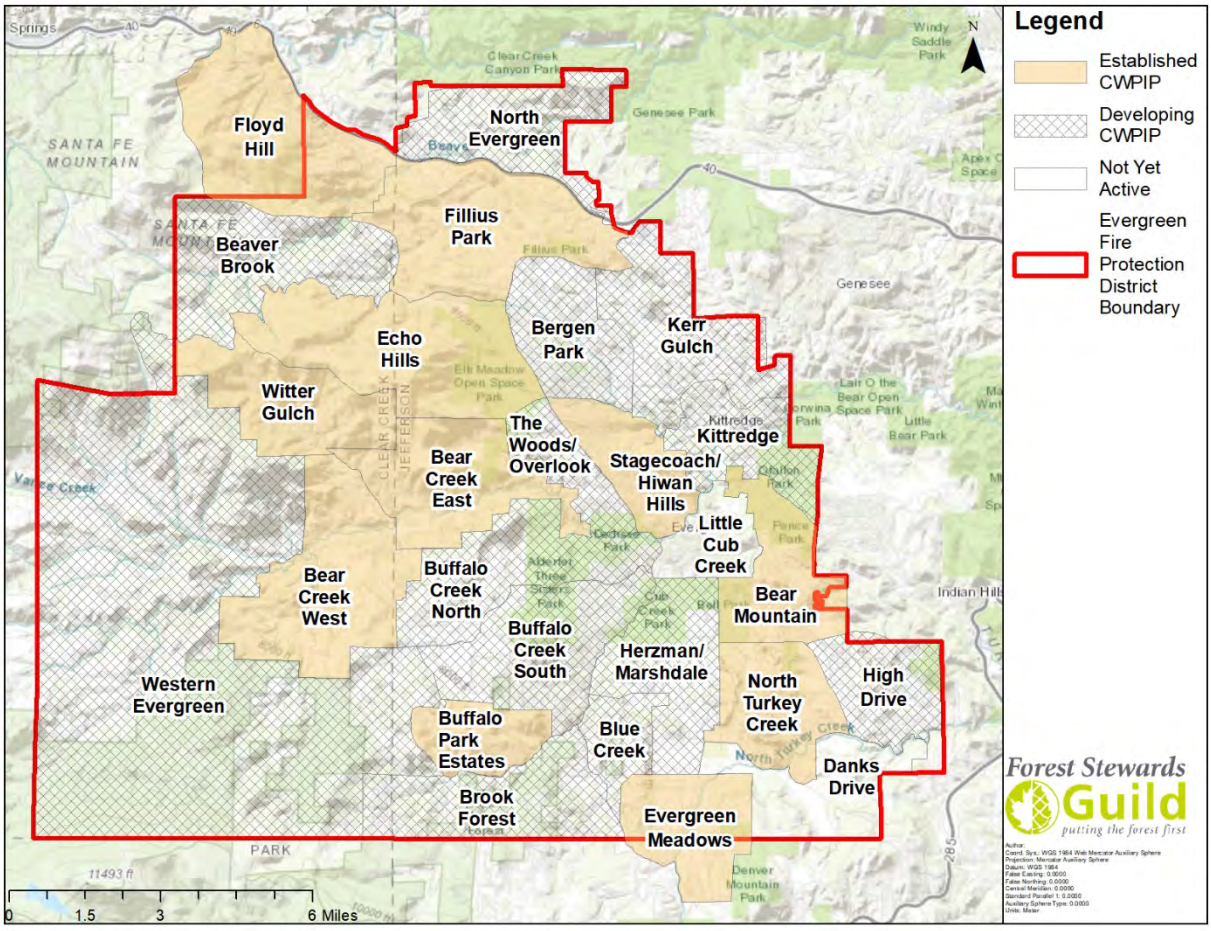


Figure 4. Plan Units in Evergreen Fire Protection District that have developed Implementation Plans.

11 of the 26 Plan Units have existing CWPIP documents. 13 Plan Units are at various stages in the planning process without an approved CWPIP, but are in the process of developing their implementation plan. Action taken so far on these CWPIPs by their respective community leaders has dramatically changed the potential wildfire outcome for Evergreen and this work needs to continue. Some communities, such as Buffalo Park Estate, have started neighborhood-funded chipping days. Others have changed HOA requirements to improve resident's ability to perform mitigation. It cannot be stressed enough how vital these grassroots efforts are. Some more recent mitigation actions may not be reflected by the fire behavior modeling for each Plan Unit, but are acknowledged in the description of each Plan Unit from the Forest Stewards Guild's Neighborhood Hazard Assessment. Any residents of Evergreen hoping to implement the mitigation projects outlined in this CWPP should contact Evergreen Fire/Rescue (EFR). To find out more information about this program please message info@evergreenfirerescue.com

Local groups have been a crucial part of the grassroots effort to help EFR become more wildfire resilient. The momentum in this community is an incredible resource to make the recommendations outlined in this CWPP a reality. Residents should look to the Rotary Clubs of Evergreen and Mountain Foothills and the Evergreen Chamber of Commerce to assist with community engagement after discussing with EFR.

As the program continues to grow, it is of utmost importance that additional communities get involved. Neighborhood action and community building centered around mitigation have been shown to boost wildfire outcomes across the mountain west. In Boulder County, neighbors that mitigate at a moderate to high level report 70-73% of surrounding neighbors mitigating, compared to 30% of surrounding neighbors for those that do little to no mitigation (Brenkert-Smith, et al. 2013). Neighborhood connections matter a great deal, as linked defensible spaces improve likelihood of home survival.

Fire Adapted Communities is a concept defined by the National Wildfire Coordinating Group as "a human community consisting of informed and prepared citizens collaboratively planning and taking action to safely coexist with wildland fire". This concept can guide residents, fire practitioners, and communities in becoming more resilient to fire through a holistic approach, as diagrammed below. There is an online community dedicated to supporting wildfire mitigation and education efforts called the Fire Adapted Community Learning Network. The CWPIP programs in Evergreen can utilize this framework and network when working through their local projects and obstacles.

Fire Adapted Colorado has developed a regional network to provide educational and networking opportunities for communities, group and individual stakeholders focused on reducing the negative impacts of wildfires in the state. This group can support and amplify local wildfire mitigation work by connecting practitioners, community members and organizations statewide. They offer a platform for members to connect and share resources and facilitate events that may help those interested in the Evergreen Fire Protection District.

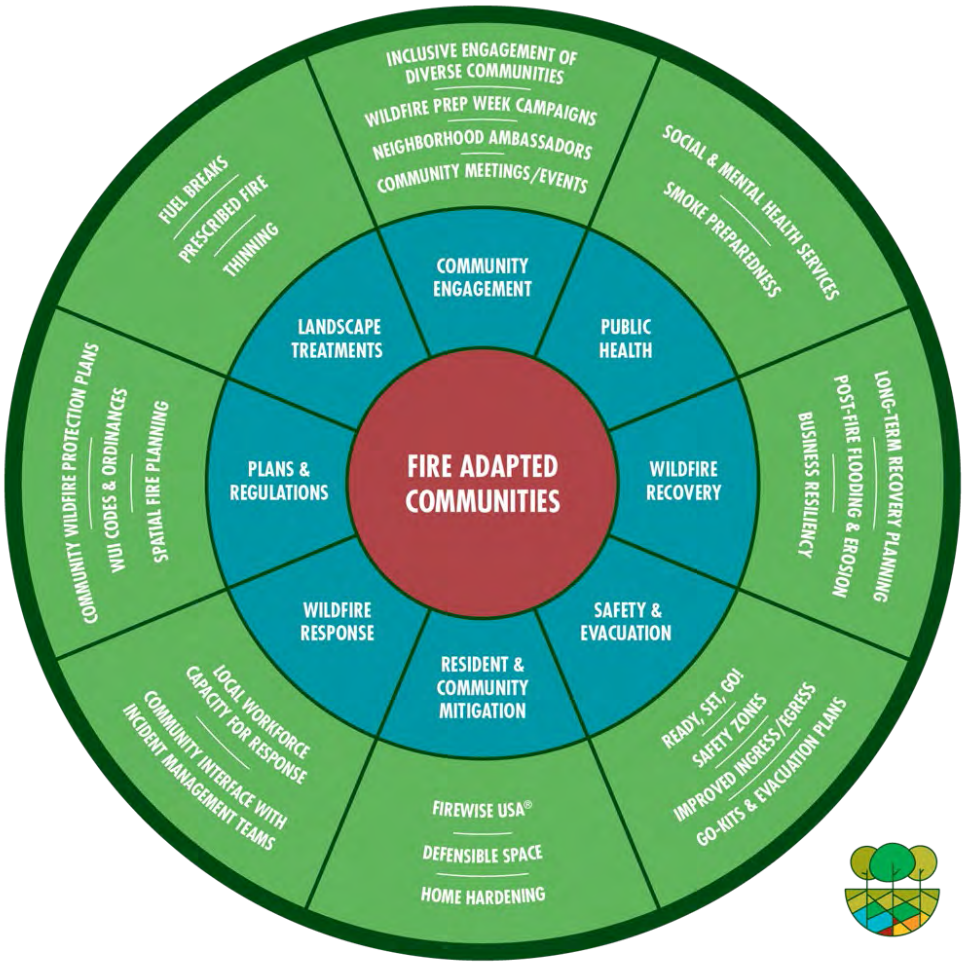


Figure 5. Fire Adapted Communities graphic to display the variety of work to become fire adapted.

Conversations and meetings with residents of the Evergreen Fire Protection District showed two main preparedness concerns that do not yet have a clear solution, communication during a wildfire incident and evacuation of vulnerable population. There is some use of a variety of technologies to improve communication around a wildfire, but we identified that this was a crucial part of the process that was not clear to residents. CodeRed is an alert system set up for the Evergreen Fire Protection District that should be utilized by all residents, including school children that may be home alone.

Sheriff's Departments in Clear Creek and Jefferson County will update the public via Public Information Officers (PIOs) at specific intervals during an incident, typically associated with morning briefings. Information gathered from community members revealed frustration regarding the limited flow of information during the incident. Education around wildfire event communication is crucial for residents who are concerned about their families and their property.

Evacuation planning is crucial for all residents in any wildland-urban interface, but vulnerable people will have less room to be flexible and adapt to a wildfire scenario. Vulnerable populations in Evergreen include school children, elderly and aging, and any person with mobility issues. School-aged children are a crucial source of concern in the district as many are home alone after school before commuting parents can get home, not to mention the time they are home alone during the summer. Many parents do not have a plan in place of how their child will evacuate when home alone and need to know that in certain evacuation situations they will not be allowed past certain areas, depending on the wildfire's location. Another major issue is elderly or limited-mobility persons who would need assistance evacuating or even getting the evacuation notice in a wildfire. Those that live alone or in some isolation will need to develop a plan for who will assist them. While this CWPP is designed to give the community a framework for planning, it is still imperative that each individual household create their own emergency plan.

References:

Brenkert-Smith, Hannah; Champ, Patricia A., Telligman, Amy L. 2013. Understanding change: Wildfire in Larimer County, Colorado. Res. Note RMRS-RN-58. Fort Collins, CO: U.S. Department of Agriculture, Forest Service. 46 p.

WUI Building Code for the Evergreen Fire Protection District

The Evergreen Fire Protection District covers part of Jefferson County and Clear Creek County. Jefferson County adopted Building Construction Regulations for 2020. Changes include requiring Class A roofs, non-combustible exterior walls and decks, and ember-resistant vent construction, among many other considerations. This is a great way to make more homes in a growing Wildland-Urban Interface hardened to wildfire. Homes currently existing without these features are not subject to this building code change until they replace a roof or siding on their home, but we recommend residents take the initiative to improve these materials to code anyways. Jefferson County should include Defensible Space requirements in the future to improve upon their WUI building code.

Clear Creek County has a similar building code that was adopted with their Wildfire Hazard Mitigation Plan. They also require Class A roofs but have less specific language on siding and decking. Their code focuses more on defensible space and access improvements for a breadth of tactical options. These are great pieces but should be strengthened with additional wildfire hardened construction requirements.

Any future changes or amendments should follow the best practices outlined with NFPA's 2013 Community Wildfire Safety Through Regulation guide, or any new, more strict guidelines they publish. WUI building code is one of the most important regulations for a jurisdiction as ember entry is the most likely cause of home loss, particularly through exposed eaves, vents, and windows (Syphard and Keeley 2019). Defensible space is also shown to reduce structure loss especially for homes on slopes where vegetation near the home is reduced by 40% (Syphard et al. 2014).

References:

Code Change. (2020). Retrieved from https://www.jeffco.us/3869/Code-Addendums-Effective-2020

Clear Creek County Building Department Requirements for a Single-Family Residence, Clear Creek County Building Department Requirements for a Single-Family Residence (2018). Retrieved from https://www.co.clear-creek.co.us/DocumentCenter/View/79/2015-IRC-New-SFR-Building-Packet-91118?bidId=

Syphard, A. D., Brennan, T. J., & Keeley, J. E. (2014). The role of defensible space for residential structure protection during wildfires. *International Journal of Wildland Fire*, *23*(8). doi: 10.1071/wf13158

Syphard, A. D., & Keeley, J. E. (2019). Factors Associated with Structure Loss in the 2013–2018 California Wildfires. *Fire*, *2*(49). doi: 10.3390/fire2030049

District Capacity

At Evergreen Fire/Rescue (EFR), the department is a combination department with volunteer firefighters supported by career administrative/maintenance staff, career EMS staff and career management of the volunteer fire department. As of December 1, 2019, there were 38 full and part time career staff along with 80 volunteers including 12 in the academy. There are 12 volunteers used in general administrative roles and 5 retiree volunteers used as tender drivers, instructors, and support. EFR has 8 stations, each referred to below for the consequence, or magnitude, of having an incident in that area and the probability, or likelihood, of an incident occurring.

Station 1 (Downtown) is considered high consequence and high probability for structure fires. The high probability is based on a history of commercial fires (1926 city block destroyed; 1997 Evergreen Hotel destroyed) and the high consequence is based on the economic impact and historical nature of the area. The areas surrounding downtown Evergreen were platted in the 1920's. Commercial structures were constructed prior to county building codes. Many roads are steep, narrow with multiple switchbacks. Many of these neighborhoods have water systems that are old and unreliable. Most of these areas will be difficult to access and evacuate. Station 1 is a seven-bay station with a small crew area. Apparatus: Pump truck (high volume pump on a truck body to use at water supply locations); Light Rescue, Type S-1 Water Tender; Type 4 engine 4X4; Type 7 engine.

Station 2 (Bergen Park) is considered a low consequence and a high probability as the commercial structures generally have sprinkler systems and the homes are newer. This is the location of the Administration Building, Apparatus Maintenance Building, Burn Building and the fire station. The area has many commercial buildings including, elderly housing, nursing care, big box stores, all intermixed with multi-residential and residential units. Most of the structures were constructed using building codes and the larger commercial building are sprinklered. Apparatus: 85' Tower; Heavy Rescue; Type 1 Engine 4X4; Medic Unit; Type 7 Engine.

Station 3 (Marshdale) is considered low consequence and low probability, as there are few commercial structures, some historic structures and the homes are generally newer. Apparatus: Type 4 Engine 4X4; Type T-2 Water Tender; (2) Type 6 Engines.

Station 4: (South Evergreen) is the EMS station for the southern part of the district. There are no operational resources in this station. Apparatus; Medic Units

Station 5 (Upper Bear Creek) is considered low consequence and low probability, as there are very few commercial structures, some historic structures and the residences are becoming newer and are sparse, spread over a large area. This area has multiple large spread out structures. The area has maintained its large acreage ownership and very large homes have been constructed. There are several historical homes and schools. Apparatus: Type 1 Engine 4X4; Type T-2 Water Tender.

Station 6 (Kittredge) is considered of moderate consequence and low probability. There is an economic and historical component, with both older homes and newer homes. Apparatus: Type 4 Engine 4X4; Type 6 Engine

Station 7 (Floyd Hill) is considered low consequence and low probability, as there are light commercial and newer homes. Apparatus: Type 1 Engine 4X4; Type T-2 Water Tender; Type 6 Engine.

Station 8 (Brook Forest) is considered low consequence and low probability. There are few commercial structures and a historic component. Apparatus: Type 1 Engine 4X4; Type T-2 Water Tender

STAKEHOLDER INPUT

Community Members

The Forest Stewards Guild worked closely with Evergreen Fire/Rescue to identify community members that work on wildfire mitigation efforts from fuel treatment to education. Evergreen has developed a robust CWPIP program with many community leaders at the helm. In the process of the Evergreen CWPP, many of those CWPIP leaders gave feedback about the challenges they face on wildfire mitigation and what resources should accompany the CWPP for them to achieve best results. Interviews were conducted June through August 2019.

A meeting to hear from all community members and share the CWPP process was held December 12th, 2019 at Evergreen Fire/Rescue. The Forest Stewards Guild described the work they and Anchorpoint Group would complete, asked audience members about their concerns, and got a sense of how knowledgeable this community was on wildfire mitigation topics. This meeting and other feedback provided in one-on-one conversations gave project managers a robust sense of the challenges facing Evergreen as well as a knowledge of what products to provide an advanced group of residents.

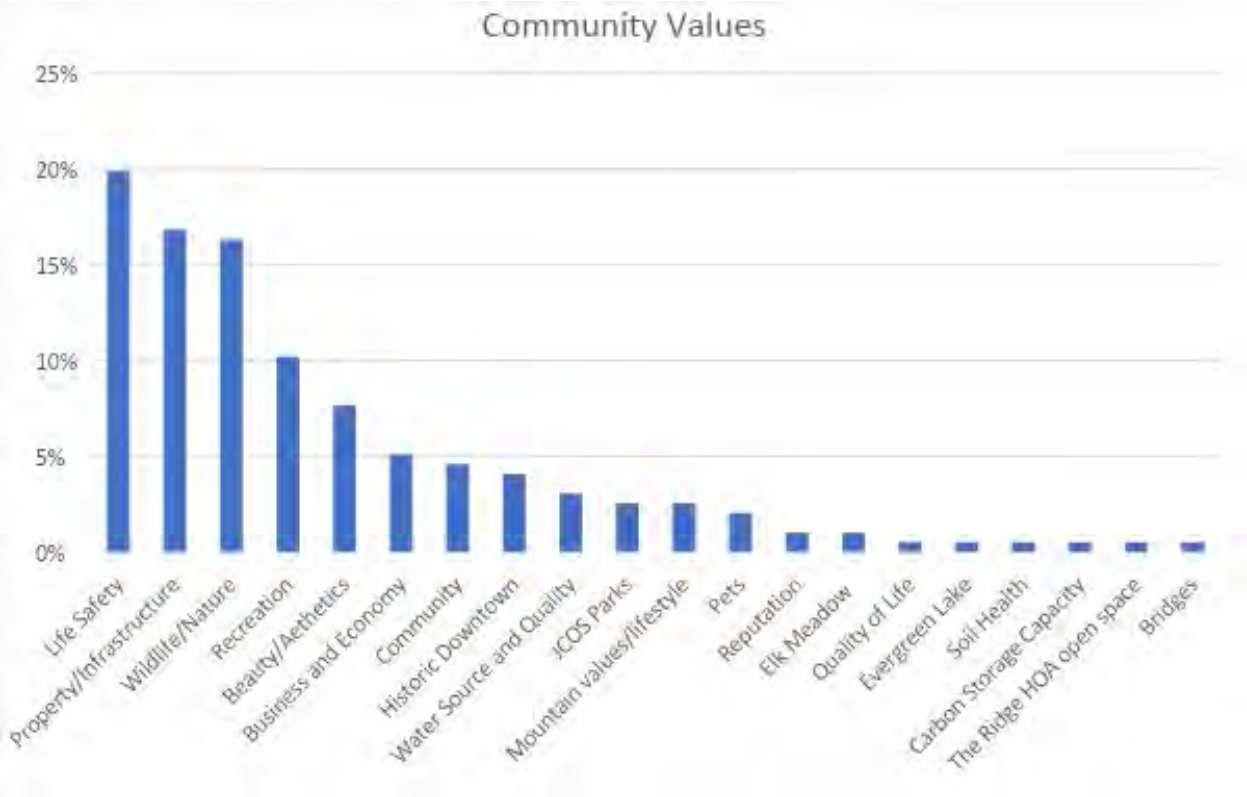


Figure 6. Percentage of Evergreen residents who responded to open ended questions about what they value in their community.

Beyond life safety and property concerns, residents of Evergreen deeply value the natural world around them. Some specific sites important to these values are the Jefferson County Open Space parks, particularly Elk Meadow, local HOA open spaces, and Evergreen Lake. See Values at Risk Treatment Recommendations for a list of the locations analyzed. These locations are based on local input and existing databases of these locations. If no meaningful action is taken to make Evergreen's forests more resilient, all these natural values will be compromised. The areas impacted by the Hayman or Hi Meadow Fires are examples of what happens to a natural landscape when no mitigation is completed. Vegetation and wildlife have not rebounded quickly in these areas because nothing was done to lessen the impacts of the fire. When fuels treatments are utilized, a wildfire can pass through and leave vegetated areas of refuge for wildlife and have minimal impact on water quality and soil health, other major concerns of Evergreen residents (Agee and Skinner, 2005).

Many residents are concerned about the impact a major wildfire would have on the local economy, individual businesses, and the fabric of the Evergreen community. After catastrophic wildfires, the need to rebuild and redesign communities can take a long time, preventing the tax base from rebounding quickly and impacting livelihoods. Taking steps to improve defensible space and harden structures to wildfire will change the economic risk to an area. Wildfire can be less destructive to property and economy when structures remain. This is an essential truth of community-level wildfire mitigation – no single act is effective alone. When neighborhoods work together to complete fuels treatments and community members plan together for their evacuation procedures, the entire district benefits. This CWPP should serve as a starting point to begin the conversation about wildfire with your neighbor, your coworkers, and your clients.

Analysis results were shared with the community by the release of this document July 1, 2020 and comments were made by July 26th. These helped inform the document and allowed the Forest Stewards Guild to clarify the explanation of this CWPP. Results were shared over live video August 10th, 2020. Changes made based on public input:

- Clarification of Evacuation models and the purpose of this information
- Reference to burn ban criteria in relation to red flag warnings in Catastrophic Wildfire – Common Factors
- Maps from Anchorpoint group of the fire modeling that was analyzed
- Clarification of Shelter-in-place as a treatment priority, rather than an active location to utilize during and evacuation
- Fillius Park name replaces Soda Creek as the name of Plan Unit 5
- Wildfire Prepared information added to Methods to Reduce Structural Ignitability as a new local tool available for home assessment

Agency Partners

The Forest Stewards Guild and Anchorpoint Group held an initial meeting with agency partners to share parameters of the project and the unique products being produced for this CWPP. They asked participants to share what these agencies are currently working on regarding wildfire mitigation, what flexibility they might have in the future, resources for mitigation both present and lacking, and learned about other stakeholders that should be considered in the process. This meeting assisted the CWPP process by showcasing the possibilities for implementation of fuels treatments, and where current work could be expanded.

After the wildfire risk assessment was completed, agency partners viewed results and discussed options and locations for implementation of fuels treatment projects. Due to the outbreak of COVID-19, these meetings took place over video conference with each land managing agency. Land managers were able to help verify the results of spatial analysis with on-the-ground knowledge of Evergreen's landscape and agree to high-priority fuel treatment locations. Partners discussed completed and planned treatments as well to help anchor recommended treatments to existing work.

Emergency Managers

Jefferson County Sheriff's Department engaged in the Evergreen CWPP by attending a public meeting in December 2019 to share their perspective on wildfire preparation and emergency response. They were able to answer questions from the public about evacuation communication and hear feedback from community members about overall wildfire communication. They then participated in evaluation and approval of the evacuation results modeled by the Forest Stewards Guild.

Jefferson County Schools Emergency Managers contributed to this project by sharing schools of concern to be analyzed and describing current wildfire preparation. Schools at risk and the prioritization of these values at risk was validated by the emergency managers and will be utilized to form a plan of action for mitigation going forward.

References

Agee, James K., and Carl N. Skinner. "Basic Principles of Forest Fuel Reduction Treatments." In *Forest Ecology and Management*, 211:83–96. Elsevier, 2005. https://doi.org/10.1016/j.foreco.2005.01.034.

Community Risk Assessment

Analysis of the Evergreen Fire Protection District will influence recommendations about treatment to values at risk, roadways, Plan Units, and the wildland landscape. This section will describe the analyses completed by the Forest Stewards Guild and Anchorpoint Group. Primary assessment was defined by the boundaries of the Fire Protection District, however, some landscape fuel treatment recommendations will go beyond these boundaries, as fire does not respect administrative lines. Assessment includes:

- Fire behavior modeling
- Fireshed analysis
- Neighborhood hazard analysis
- Radiant heat and short- & long-range spotting potential
- Roadway Survivability and Evacuation (Congestion points and estimated time to evacuate)
- Post-fire modeling

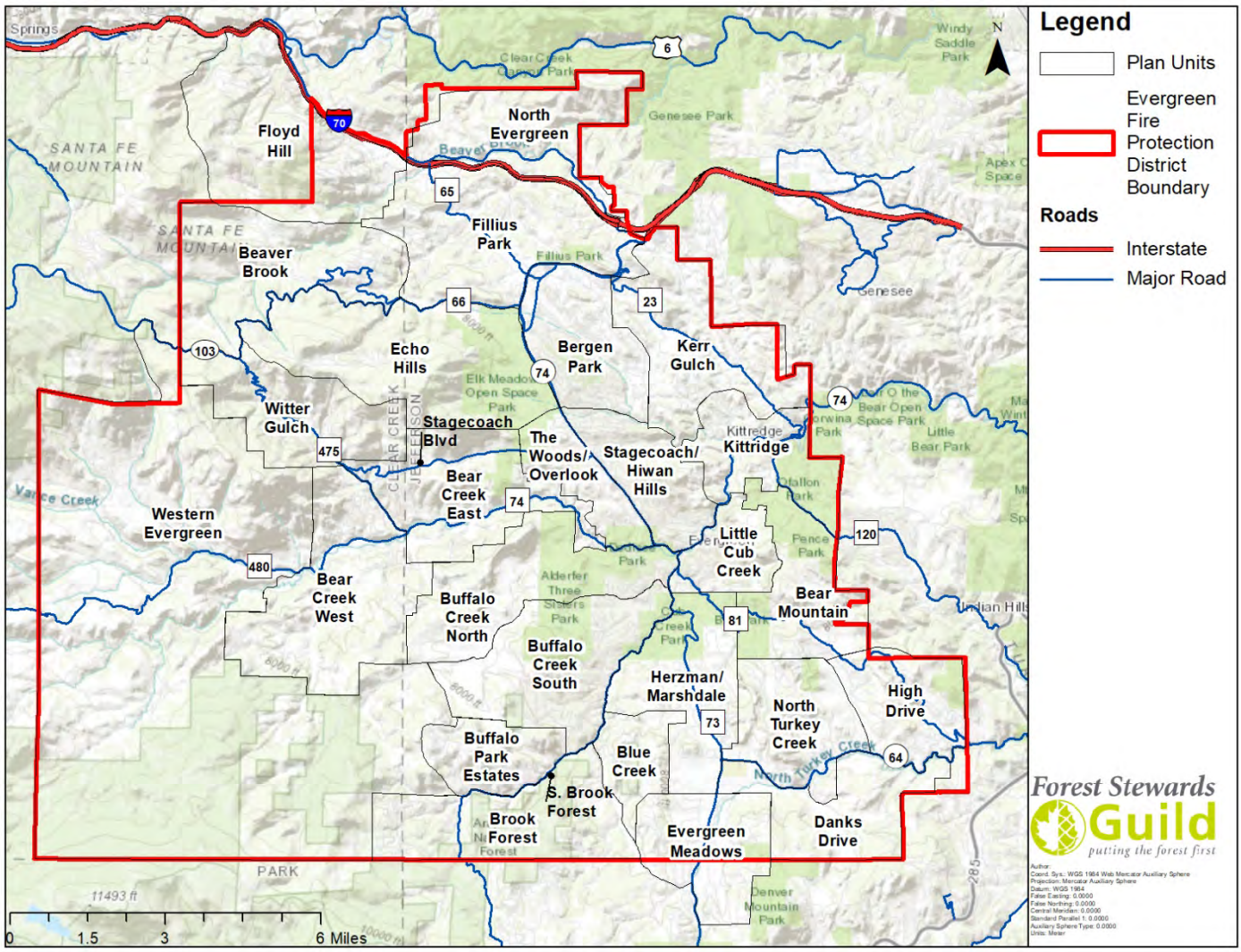
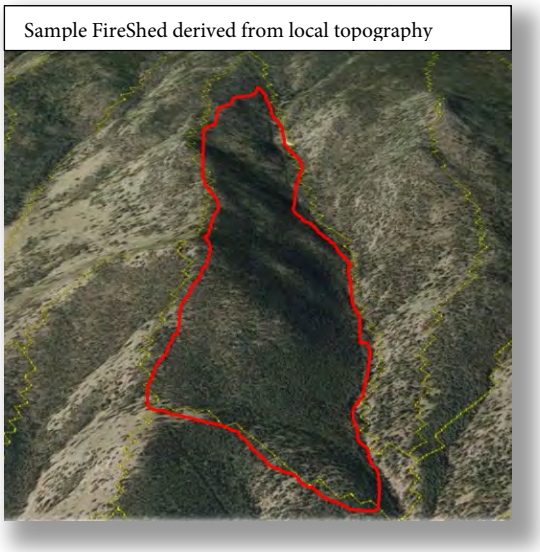


Figure 7. Plan Units in the Evergreen Fire Protection District with major roadways depicted.

Fire Behavior Analysis

Wildfire Risk Analysis was conducted by Anchor Point Group through their software No-HARM. The National Hazard and Risk Model (No-HARM) is a decision support tool for wildfire hazard and risk assessment. Incorporating the predicted severity (hazard) and the predicted frequency (risk) of wildfire in a given location, No-HARM gives a comprehensive view of the threat context a structure is exposed to.

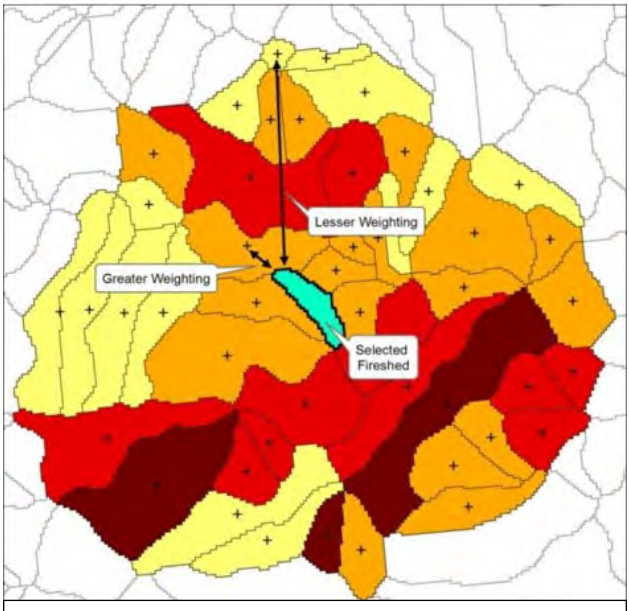


Sample FireShed derived from local topography

No-HARM divides the data up into "FireSheds" that are based on the topography (hills and valleys) of the landscape. These FireSheds tend to correlate to the vegetation and the directions that fires will burn in the absence of wind. This means that FireSheds divide the landscape up into like planning units. The wildland and intermix modules of No-HARM use FireSheds to aggregate the landscape.

No-HARM also accounts for the fact that FireSheds experience wildfire hazard and risk from outside their boundaries. A FireShed may contain mostly grass meadow but be surrounded by dense forest. If a house is built in the meadow, it is not only subject to the threat from the grass fuel in the meadow, it is also subject to the threat from the timber fuel in the surrounding FireSheds. Because of this, No-HARM incorporates the threat from surrounding FireSheds into the threat profile for every adjacent FireShed.

No-HARM uses the concept of dividing the landscape based on the relative amount of built environment (structures, roads, and other infrastructure) vs. wildland fuels. The rationale for this distinction is that wildland fires behave differently when burning in pure wildland fuels than when burning through fuel interrupted by structures and roads. Similarly, suppression of wildland fires is conducted differently, and with varying degrees of success, when in remote areas compared with densely populated areas. These differences are captured in No-HARM by categorizing the landscape into three separate threat types, each of which is modeled with its own individual set of inputs and associated methodology. The three threat types are divided into the following modules of the model: Wildland, Intermix, and Interface.



The impact of external FireSheds are taken into account in assigning the overall rating

The **Wildland** module operates in areas that are best represented by relatively continuous fuel with limited presence of structures, roads, and other human-caused disturbances. Relatively few people live in these areas which limits one type of ignition source (anthropogenic) but any structures that are in these areas are surrounded by fuel. Depending on weather and topography (both accounted for in No-HARM), this can make suppression difficult or impossible. Potential mitigation measures are typically focused on treatment of the vegetation immediately surrounding a structure and hardening of the structure itself. Fires occurring in the **Wildland** will typically burn uninterrupted until conditions are no longer favorable or until the fire moves into less volatile fuel.

The relative absence of the built environment in the **Wildland** module means that the factors included are mostly related to the fuel, topography, and typical weather patterns along with the history of wildfires experienced in a given area. The one nod to the influence of suppression capabilities in this module is the distance to the nearest fire station.

The **Intermix** module is characterized by a higher density of structures, roads and other infrastructure breaking up the continuity of natural fuel on the landscape. Threats to values-at-risk in this module focus not only on fuels, but also on the complexity of suppression in this environment. Higher road densities allow better access for suppression resources, but they also introduce an element of potential confusion for access and egress. Suppression strategies in **Intermix** areas must account for groups of houses as opposed to single structures as might be encountered in the **Wildland**. Along with suppression complexities, the presence of greater numbers of people in the **Intermix** also can mean a higher risk of ignitions due to barbecues, fireworks, matches, etc. The **Intermix** module accounts for this added complexity and added built environment by adding a greater number of appropriate input data sets. The inclusion of these added input data sets in conjunction with the wildland data sets (mentioned above) as a "baseline" threat profile, captures the threat to structures in areas represented by this fuel/structure mixture.

Interface: When structures and roads become the defining elements of a landscape, these areas are assigned to the interface module of No-HARM. Unlike wildland and intermix areas, structures in the interface are primarily threatened by flame impingement on one or two sides, ember cast and smoke from adjacent areas. Fuel does not surround structures and, therefore, the risk to houses is very different. (Note: Individual structures are not assessed directly for flammability.)

Additional data and methodology on No-HARM can be found in Appendix 1. Descriptions of variables considered for each module are contained in that description. No-HARM is the basis for the Web Map Interface located on Evergreen Fire/Rescue's website.

ANCHORPOINT
WILDLAND FIRE SOLUTIONS

Inputs to Fire Behavior

Underlying Fire Behavior by Anchor Point Group and the Forest Stewards Guild is based on these inputs. All data was taken at the 90th Percentile Fire Weather conditions. Percentile Fire Weather conditions are a standard used when calculating fire behavior. 90th percentile weather is defined as the severest 10% of the historical fire weather.

Inputs	90th Percentile Fire Weather Conditions
1 Hour Fuels Moisture	2.22
10 Hour Fuel Moisture	3.37
100 Hour Fuel Moisture	12.26
Woody Fuel Moisture	68.72
Herbaceous Fuel Moisture	30.00
Wind	17

Table 2. Inputs for fire behavior modeling so this work could be replicated, if desired.

Hour Fuel Moisture inputs are moisture contents for dead vegetation wildland fuels that have differing times to dry. For example, 10-hour fuels, size ¼ inch to 1-inch diameter, can take 10 hours to adjust to the current weather condition, either drying out or becoming wetter. These moisture inputs are used as an index to understand the fire potential for a given location and weather.

Wind inputs are measures of 20-foot wind speeds in mph. A 20-foot wind is a sustained wind over a 10-minute period and measured 20 feet over vegetation. This is a standard gathered from Remote Automated Weather Stations (RAWS) and input info the National Fire Danger Rating System (NFDRS). This is an industry standard for fire behavior modeling and based upon past, local Evergreen weather conditions. Weather inputs for the fire behavior models were based on the Corral Creek RAWS.

Vegetation data obtained for the Evergreen Fire Protection District from LANDFIRE 2014 and modified in places, as appropriate, by Anchorpoint Group. Below are the Evergreen existing fuel models of the Scott and Burgan 40 fire behavior fuel models. Descriptions of fuel models can be found here: https://www.fs.fed.us/rm/pubs/rmrs_gtr153.pdf

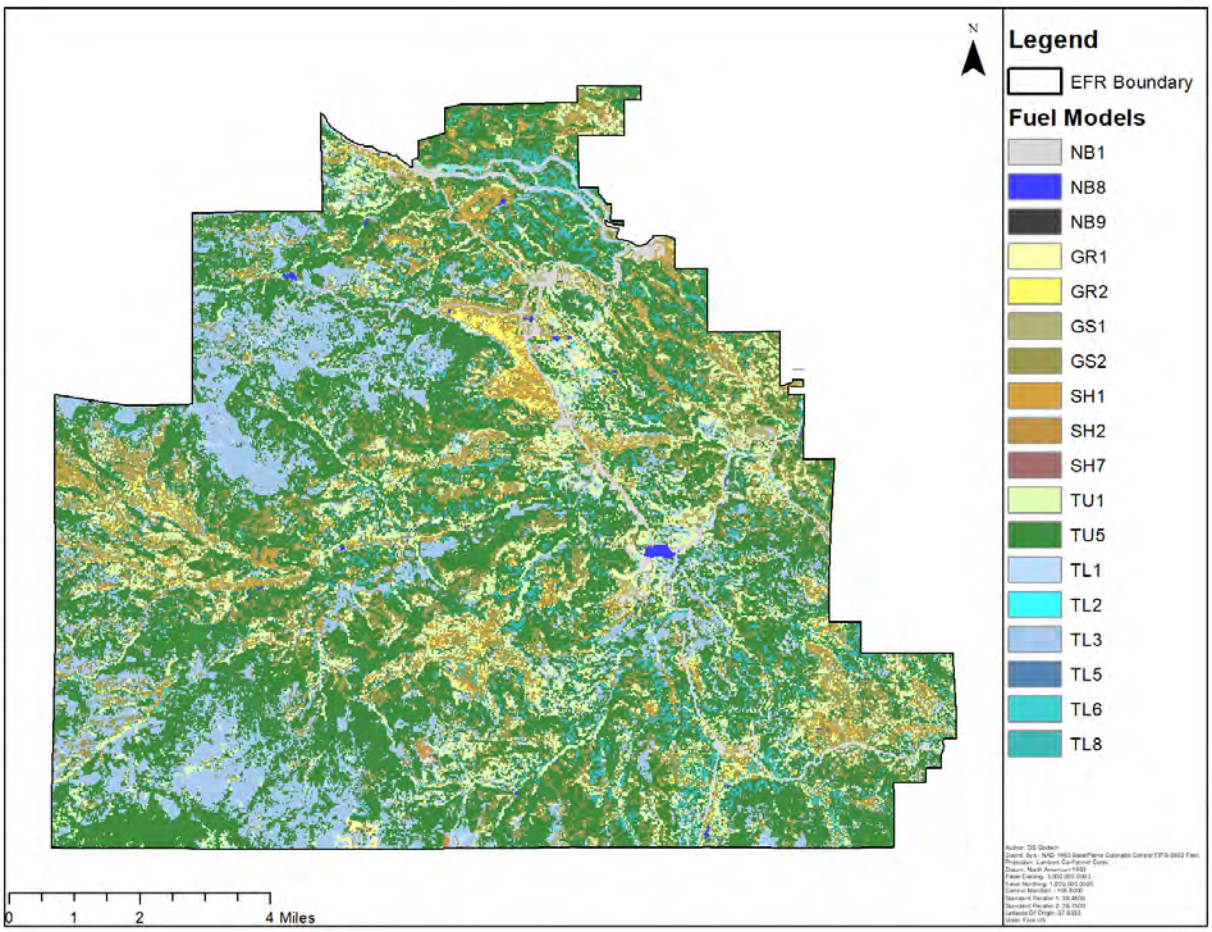


Figure 8. Vegetation Fuel models in the Evergreen Fire Protection District.

Dominant fuels models in Evergreen are TU, TL, and SH. SH is shrubs cover at least 50 percent of the site; grass sparse to nonexistent. TU is grass or shrubs mixed with litter from forest canopy. TL is Dead and down woody fuel (litter) beneath a forest canopy.

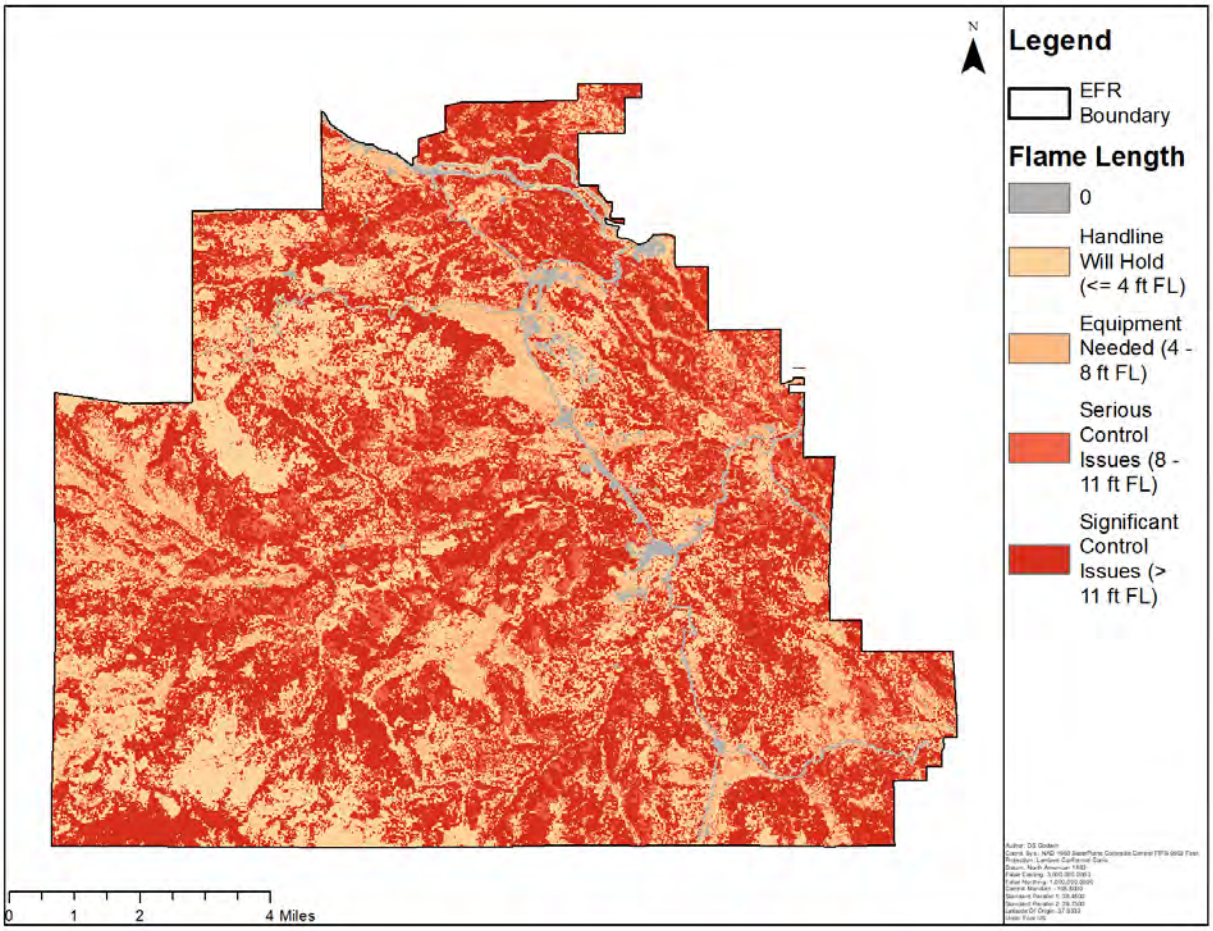


Figure 9. Flame Lengths in the Evergreen Fire Protection District categorized by the Haul Chart.

Flame Length is the distance measured from the average flame tip to the middle of the flaming zone at the base of the fire. It is measured on a slant when the flames are tilted due to effects of wind and slope. Flame length is an indicator of fireline intensity and is benchmarked into these categories by the Haul Chart.

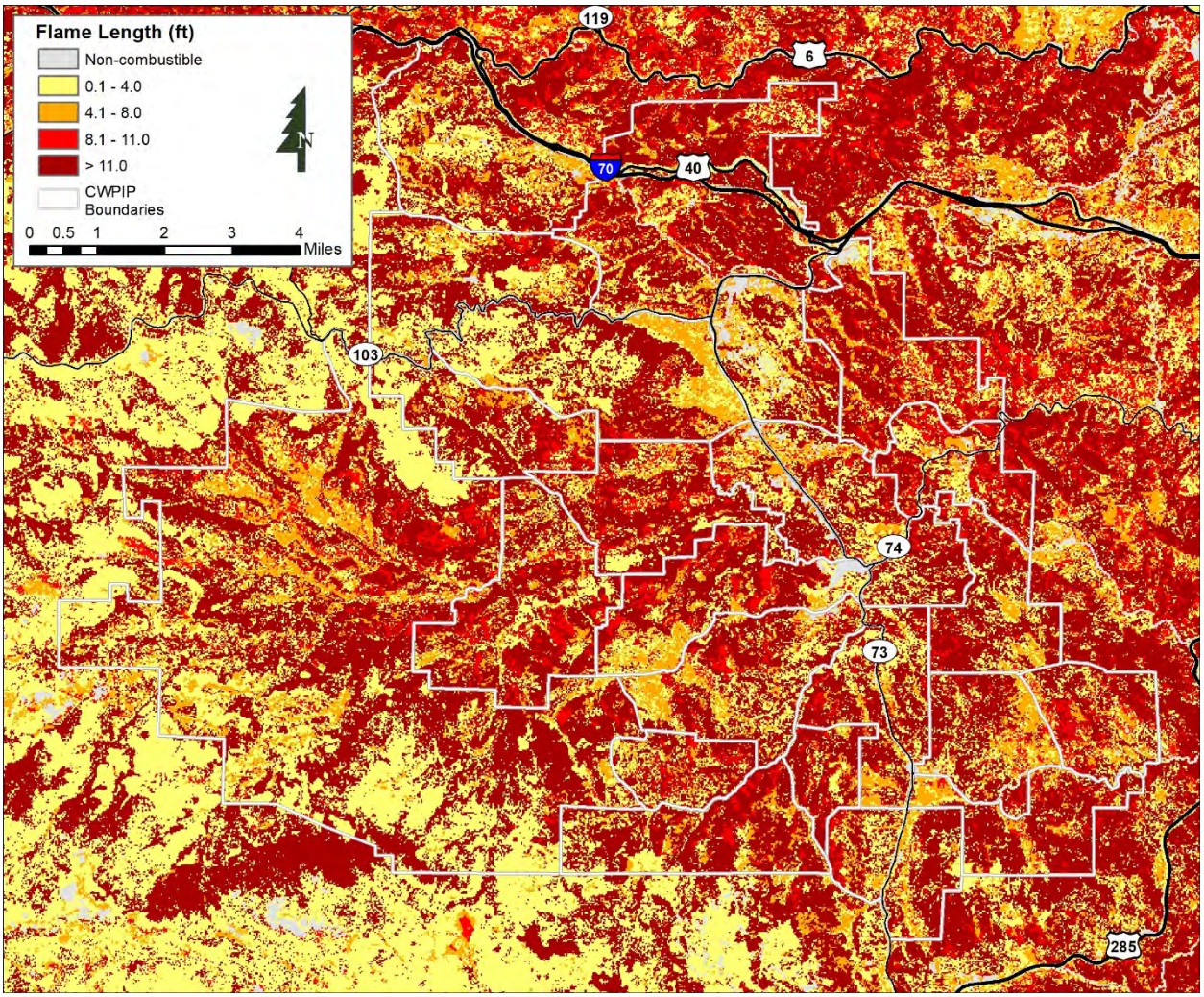


Figure 10. Flame Length in the Evergreen Fire Protection District and surrounding areas. Map created by Anchorpoint Group.

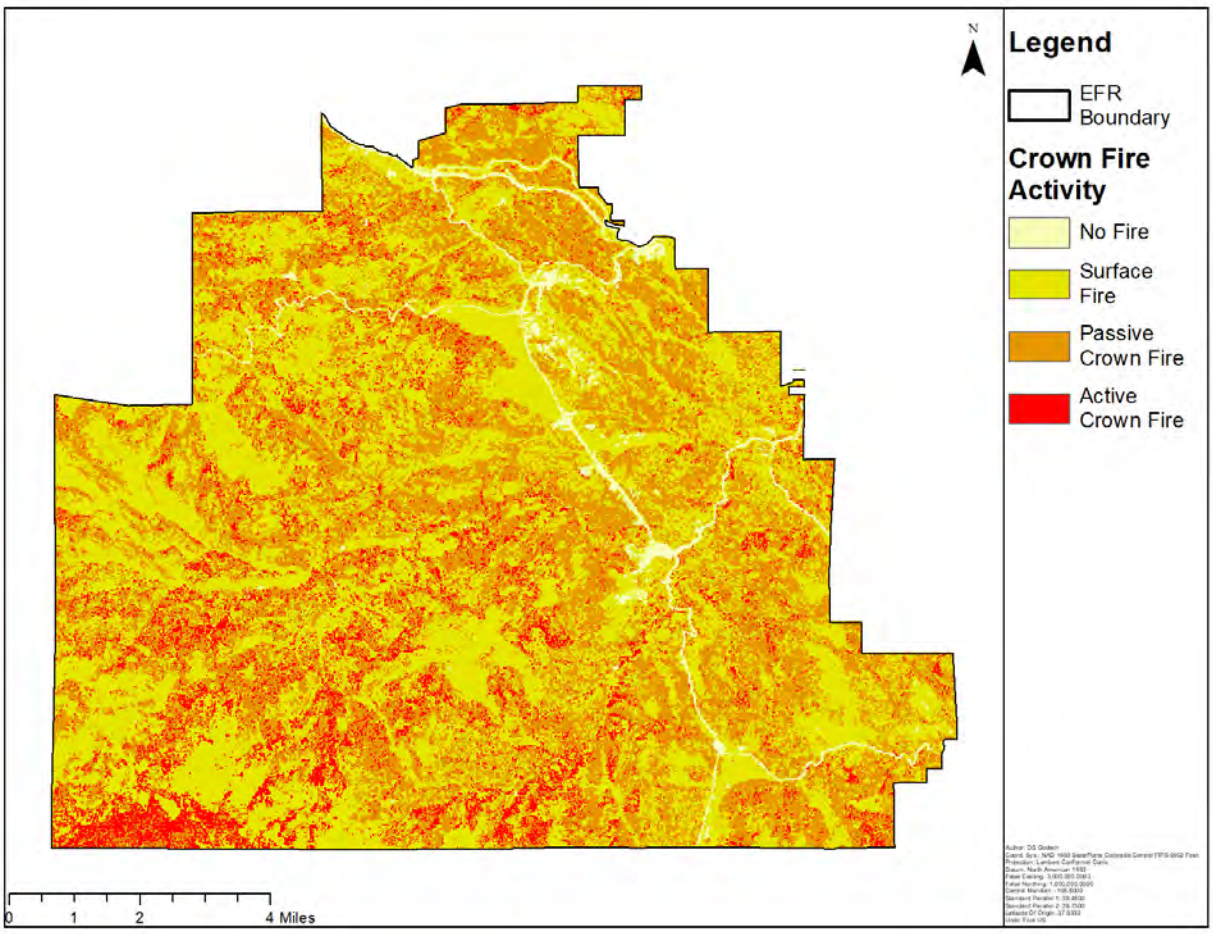


Figure 11. Crown Fire Activity in the Evergreen Fire Protection District.

Crown Fire Activity is calculated by points of fuel model, independent of any adjacent cells. This means active crown fire cannot "spread" from cell to cell and spotting is not modeled. Types of activity modeled:

- Non-burnable – Portions of the landscape fuels that will not support combustion. Generally associated with bodies of water or non-vegetated areas of the landscape
- Surface Fire – Fire that burns loose debris on the surface, which includes dead branches, leaves, and low vegetation.
- Passive Crown Fire - A fire in the crowns of trees in which trees or groups of trees torch, ignited by the passing front of the fire. The torching trees reinforce the spread rate, but these fires are not basically different from surface fires.
- Active Crown Fire - A fire in which a solid flame develops in the crowns of trees, but the surface and crown phases advance as a linked unit dependent on each other.

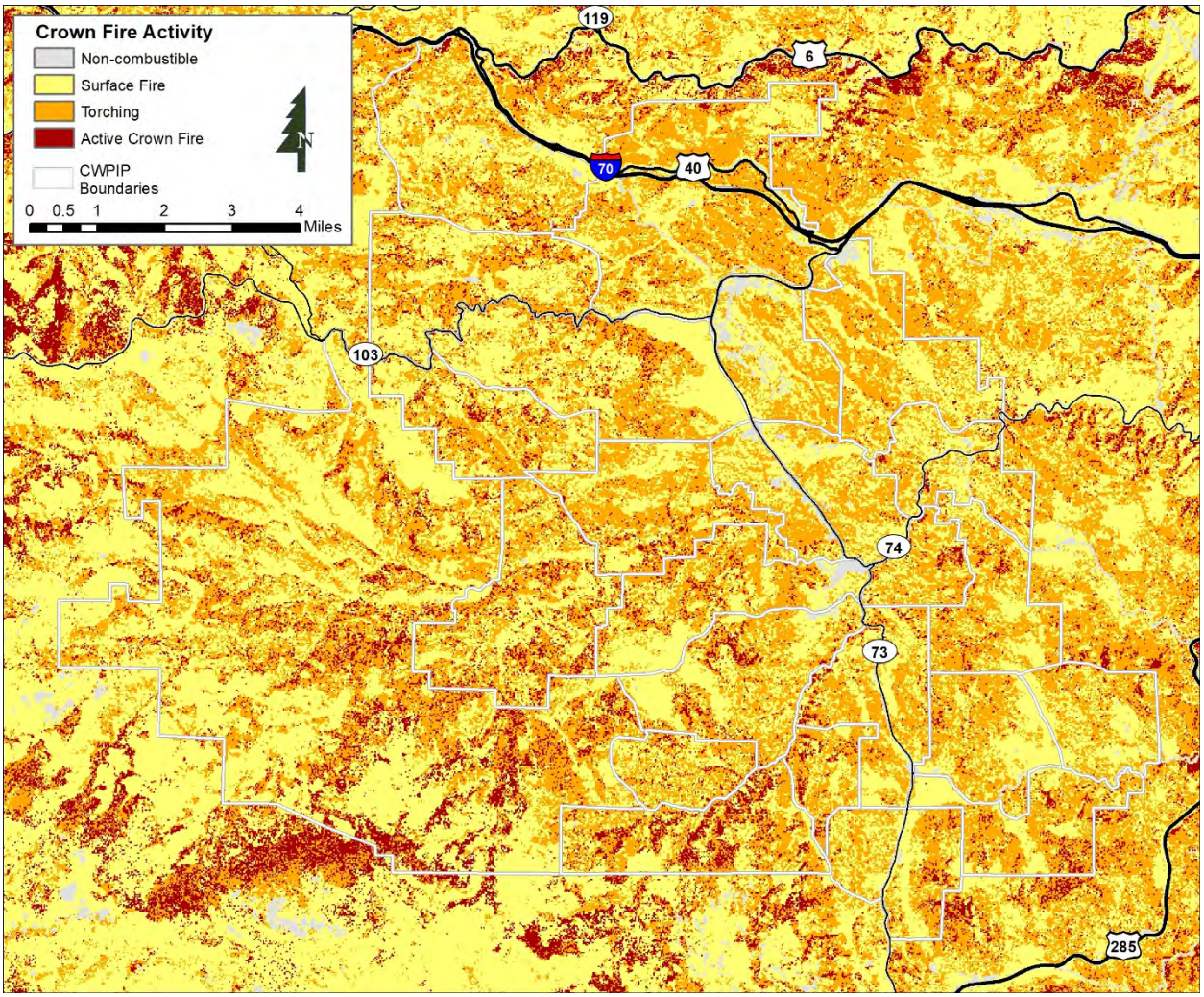


Figure 12. Crown Fire Activity in the Evergreen Fire Protection District and surrounding areas. Map created by Anchorpoint Group.

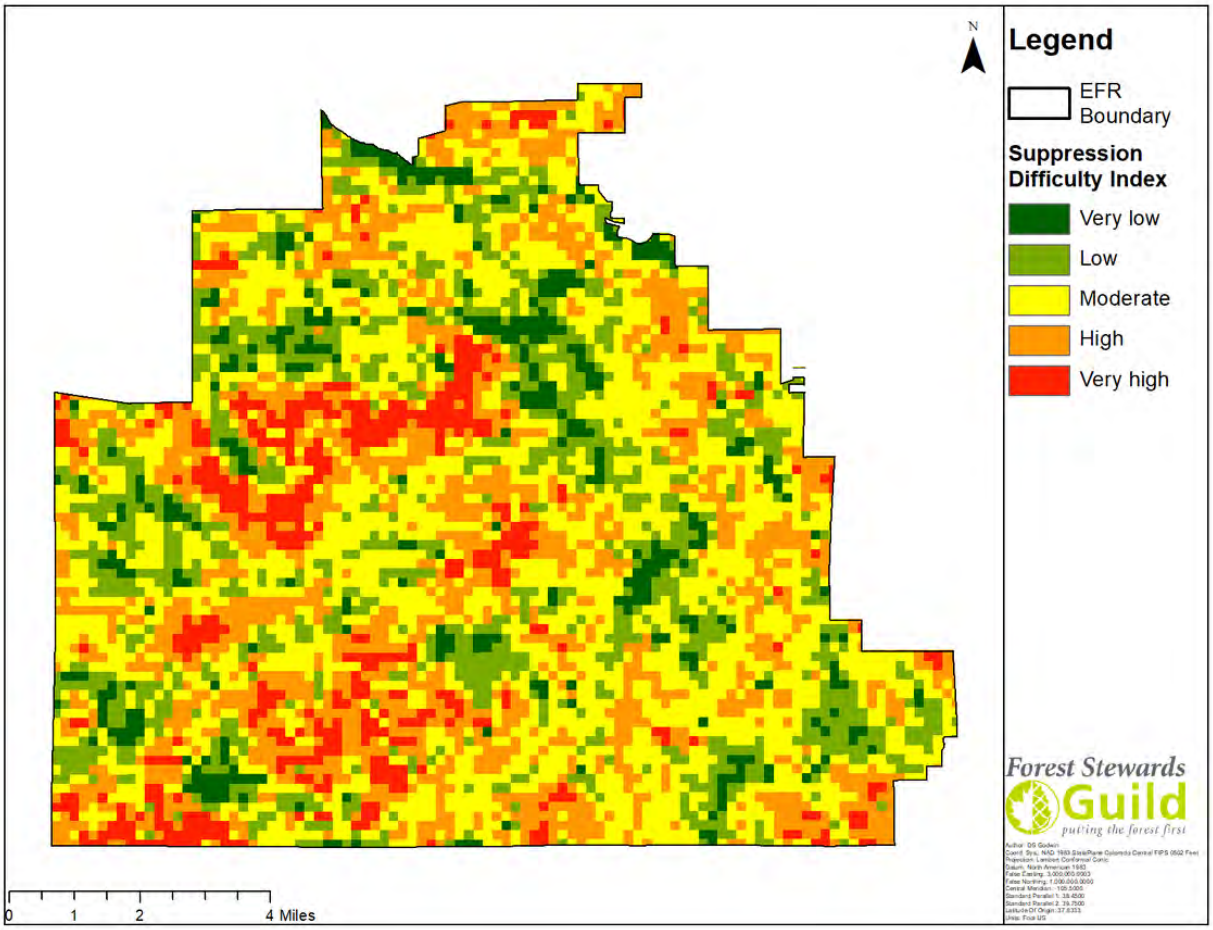


Figure 13. Suppression Difficulty Index modeled for the Evergreen Fire Protection District.

Suppression Difficulty Index identifies areas likely to exhibit extreme fire behavior that will be unsafe for firefighters and first responders. Knowing where suppression difficulty is "High" or greater, can help facilitate strategic and tactical fire management decisions. This Index is based upon vegetation data rather than structures. Dense housing stock will make a fire difficult to suppress, but no scientifically accepted model includes structural data to predict fire behavior.

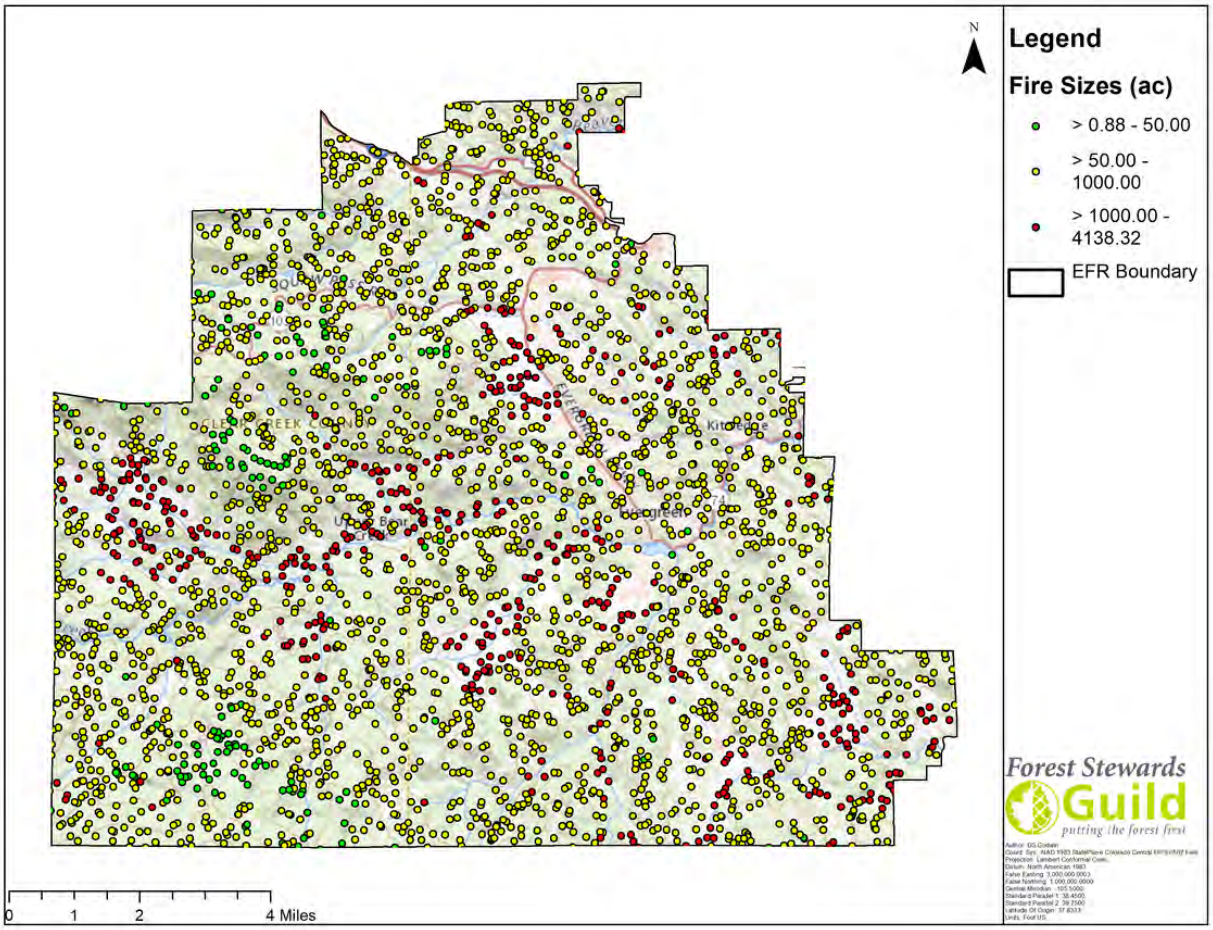


Figure 14. Fire Size probability in the Evergreen Fire Protection District.

Randomized ignitions were run in the Evergreen Fire Protection District. Simulated fires from these locations were set to continue burning for 8 hours. Each randomized ignition site is displayed on the map above and is categorized by the fire size modeled. Many of the locations with large fire sizes are open and grass dominated. This fuel type is much easier to manage during a wildfire but can contribute to high rates of fire spread. Figure 15 shows rates of spread withing the Evergreen Fire Protection District, and in surrounding areas.

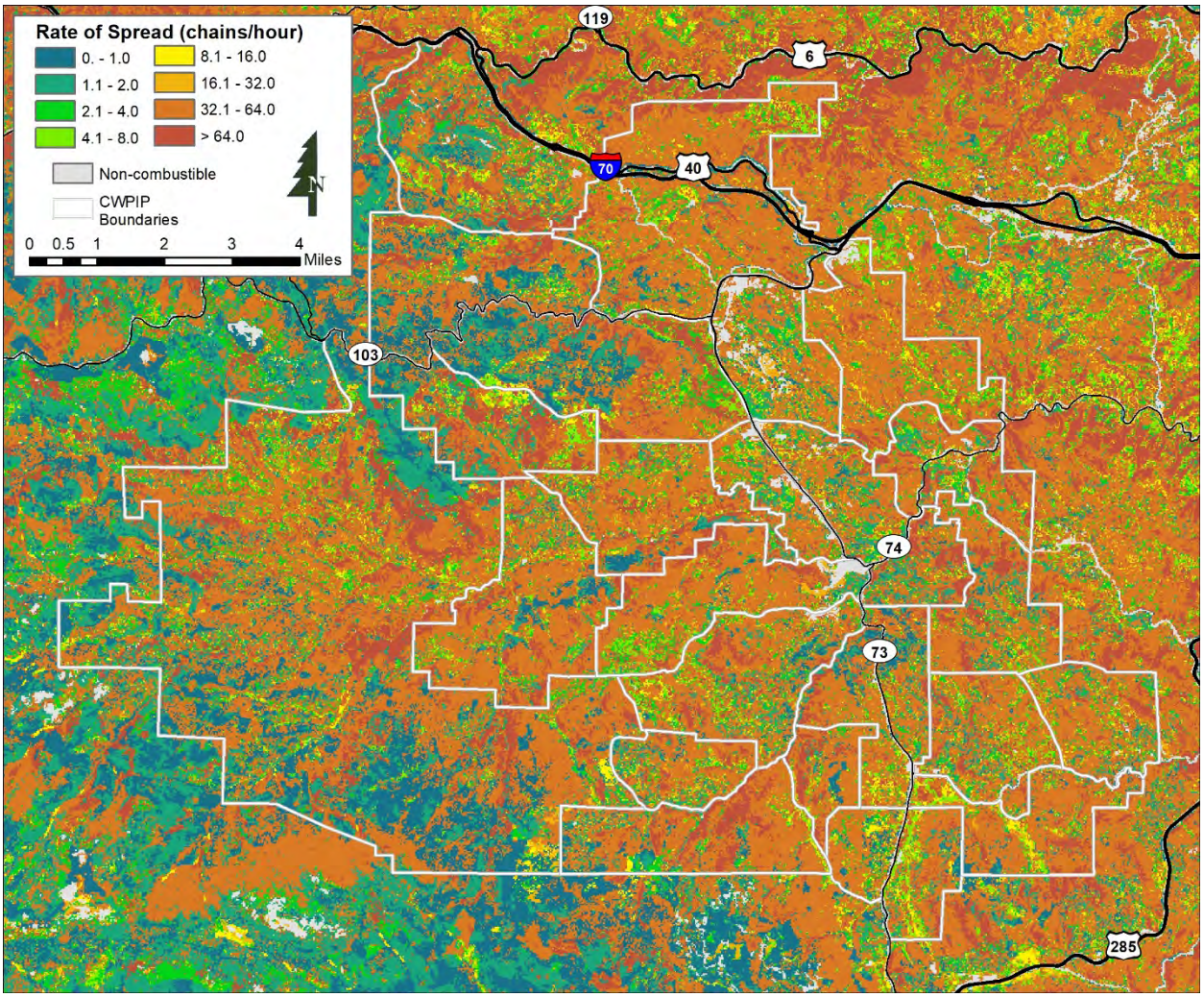


Figure 15. Rate of Spread in chains per hour in the Evergreen Fire Protection District and surrounding areas.

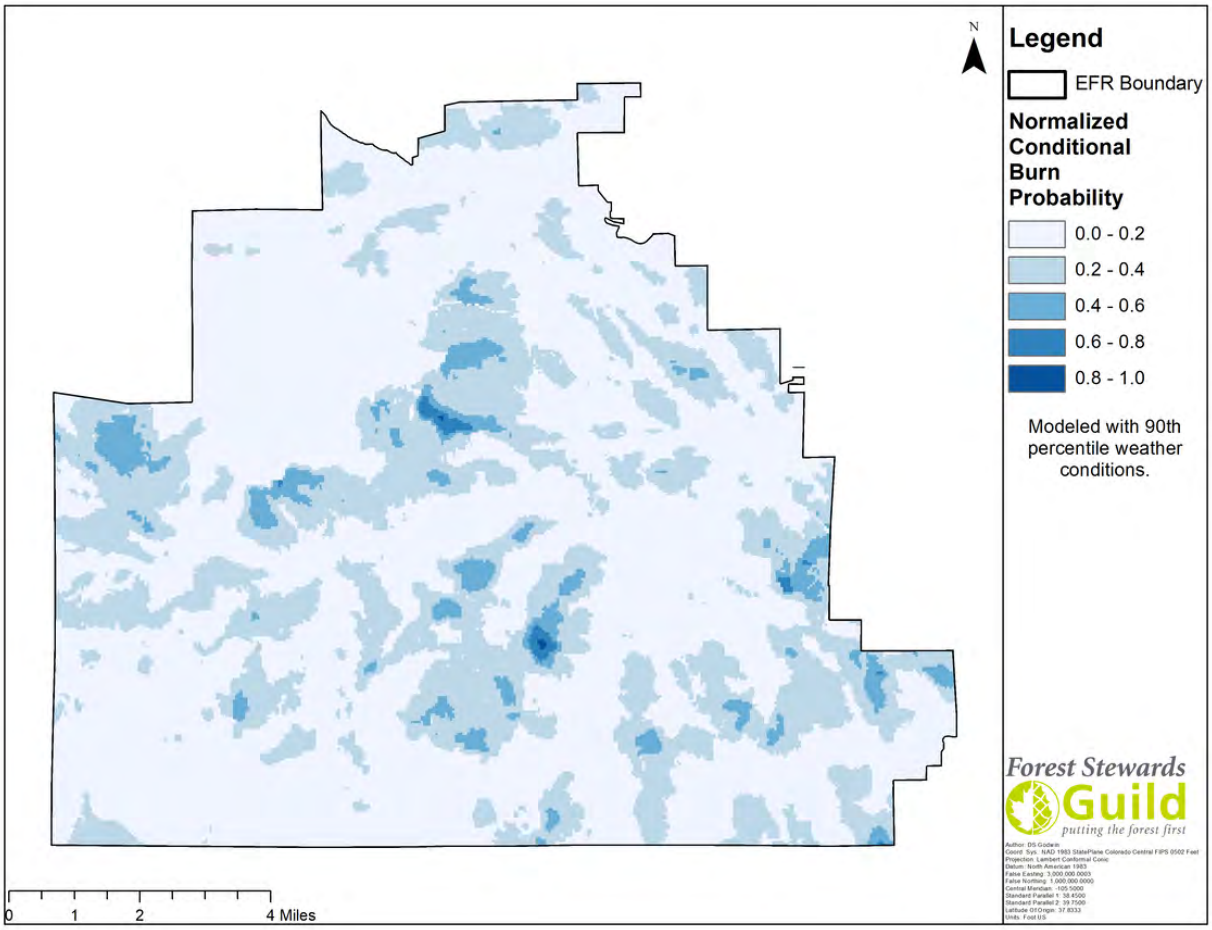


Figure 16. Normalized Conditional Burn Probability

Normalized Conditional Burn Probability shows how likely an area is to burn during a wildfire. It is run from the same randomized ignition locations used in **Figure 16**. Conditional burn probability is calculated as the percentage of fires that burn a 30m by 30m area during tens of thousands of simulated fires under 90th percentile weather conditions. The map that we use shows normalized conditional burn probability, meaning pixels with a value of "1" burned during the most simulated fires. It does not mean that they burned in 100% of fires.

The most a single pixel burned for our Evergreen analysis was 1.1%, meaning it burned in 143 of the 13,000 random fires we simulated. We gave that pixel a value of "1" in our map of normalized burn probability because it was the pixel that has the relative highest probability of burning.

Neighborhood Hazard Assessment

The Forest Stewards Guild surveyed the district from the ground to assess neighborhood hazards like subdivision design and housing construction materials at the Plan Unit scale. There is not a current method to assess structures' contribution to wildland fire behavior. This assessment utilizes criteria developed by the National Fire Protection Association to measure risks beyond wildland vegetation. Data was collected by the Forest Stewards Guild and utilized in Anchorpoint Groups rating of Plan Units. Neighborhood hazard assessment values fall into 3 categories: Construction and Infrastructure, Suppression Factors, and

Additional Rating Factors, such as homes on ridge tops, wood fencing, proximity to railroads, and other hazards. Narrative descriptions of what major hazards were in each Plan Unit, as well as photos of wildland fuel loading present can be found in Map Appendix A.

Community Risk Rating

Anchorpoint Groups analysis and maps can be found on their web map interface, but overall rankings of the plan units based on their methodology and analysis are located below in Table 3. This ranking is based off the risk to the intermix within Plan Unit areas and prioritizes treatment in the district.

Plan Unit Name	**Intermix Risk Rating**
Echo Hills	Extreme
Floyd Hill	Extreme
Beaver Brook	Extreme
Witter Gulch	Extreme
Danks Drive	Extreme
Little Cub Creek	Extreme
Brook Forest	Extreme
Buffalo Park Estates	Extreme
Kittredge	Very High
Bear Mountain	Very High
Herzman/Marshdale	Very High
Blue Creek	Very High
Buffalo Creek South	Very High
North Turkey Creek	High
Bear Creek West	High
Bear Creek East	High
Western Evergreen	High
North Evergreen	High
The Woods/Overlook	High
Stagecoach/Hiwan Hills	High
High Drive	High
Evergreen Meadows	Moderate
Fillius Park	Moderate
Kerr Gulch	Moderate
Buffalo Creek North	Moderate
Bergen Park	Low

Table 3. Risk Rating of Plan Units in the Evergreen Fire Protection District.

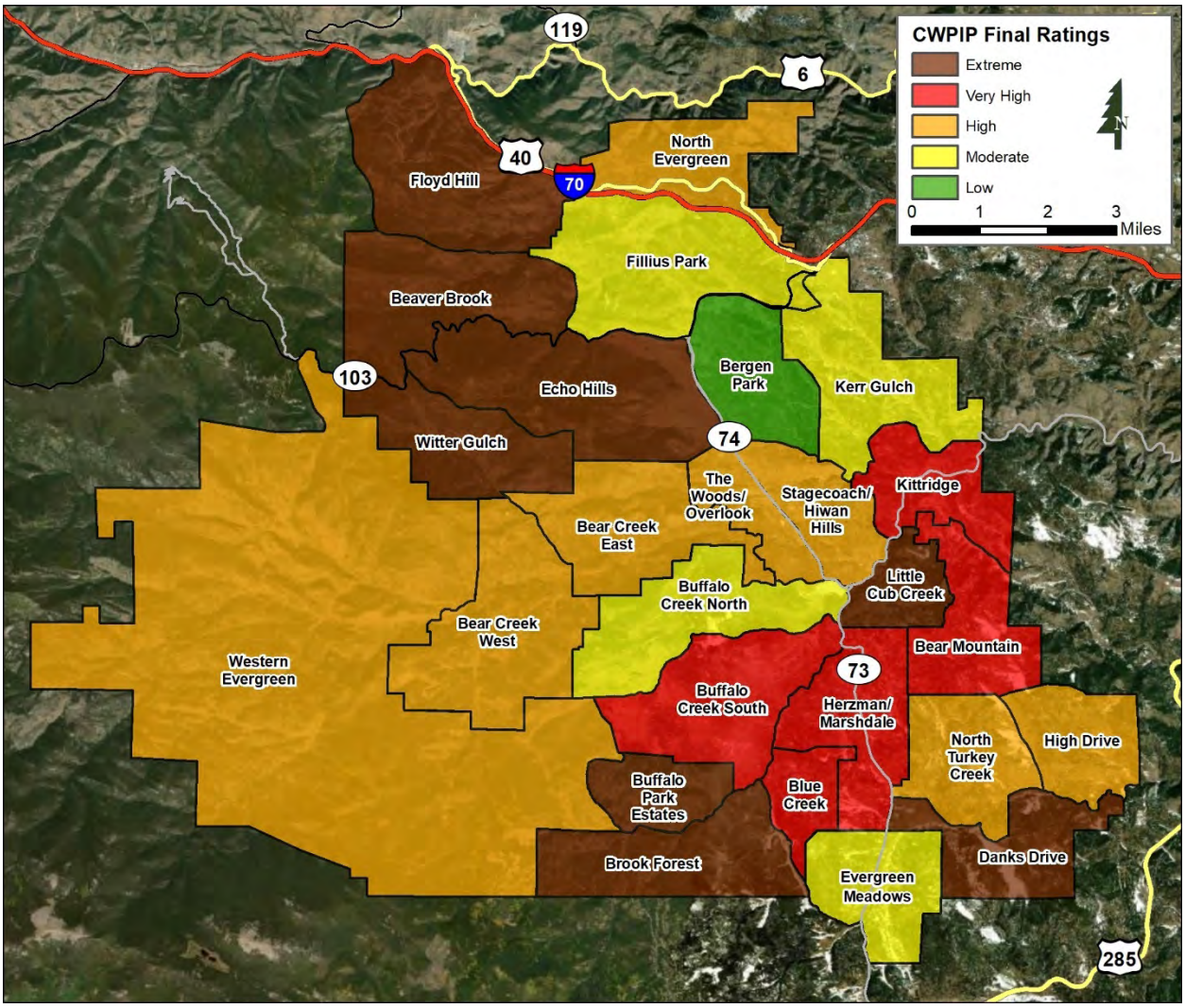


Figure 17. Risk Ratings for all Plan Units in the Evergreen Fire Protection District. Map created by Anchorpoint Group.

Radiant Heat and Spotting Potential

Radiant Heat exposure is designed to show neighborhoods where vegetation will create fire behavior extreme enough to ignite home materials. To avoid this and therefore home loss, employ mitigation practices that will ask you to remove vegetation and flammable material around your home, making ignition less likely and defense by firefighters possible. Short- and long- range spotting is when embers travel a distance from the fire and continue its spread away from the main fire –this can be a deluge of embers that is difficult to combat. As you will see in the analyses, Evergreen is exposed to both types of spotting and should use home hardening recommendations in the Methods to Reduce Structural Ignitability to decrease ember exposure.

Predicted potential structure exposure to radiant heat, short-range and long-range spotting calculations were based Jennifer Beverly's work, who validated this work in Alberta (Beverly et al., 2010). This is important information as homes are more likely to ignite from embers than direct flame contact. Areas with flame lengths greater than 8 were used and a moving window calculation identified adjacent areas exposed to radiant heat. Areas within 328 ft (100 m) of active crown fire were marked at risk from short-range spotting, and areas within 1640 ft (500 m) from active crown fire were marked at risk from long-range spotting. Only active crown fire was used as input; passive crown fire was so prevalent that nearly all the area was at risk from both short- and long-range spotting, therefore, under-predicting exposure.

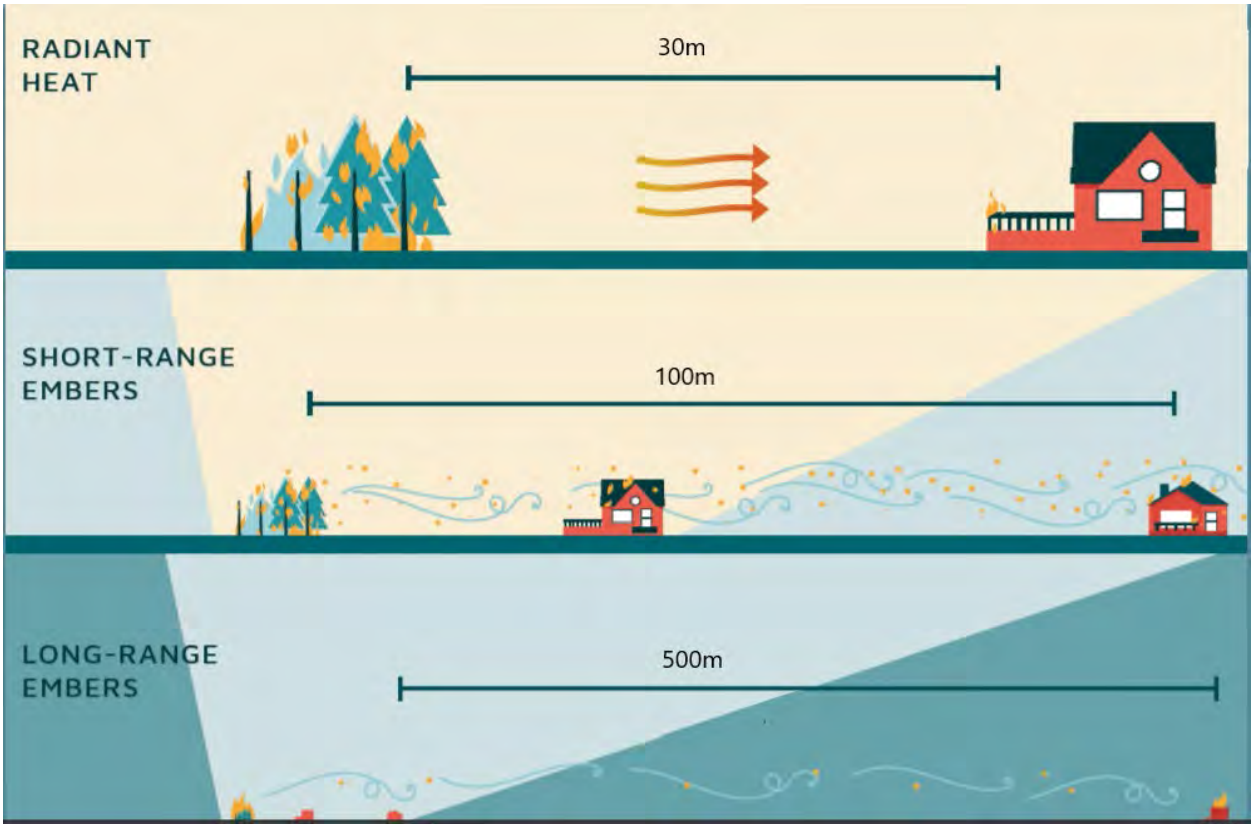


Figure 18. Depiction of Radiant Heat, Short Range Embercast, and Long Range Embercast that we have modeled in all neighborhoods in Evergreen.

Embercast modeling raster outputs (radiant heat, short range spotting, and long-range spotting) were overlaid with structure Home Ignition Zone (HIZ) polygons (100 ft). Structures in which greater than 50% of the home ignition zone was covered by radiant heat, short range spotting, or long-range spotting were defined as being at risk from that hazard. These hazard exposure values were then assigned to the structure associated within the HIZ. These values were then aggregated at the structure cluster level (following Syphard et al. 2012), which are dissolved 100 m buffers of structures.

Long Range spotting affects nearly all of Evergreen as embers can be carried through the air by a convection column up to 1.5 miles away from the main fire front. We did not break out the number of structures exposed to Long Range spotting in each neighborhood as Long Range in any maps.

Prioritization

Short- and long-range spotting and radiant heat are displayed for each Plan Unit in Map Appendix B. Home Ignition Zone Clusters impacted by short-range spotting and radiant heat are displayed for each Plan Unit in Map Appendix C. Lastly, this information is displayed and filtered by accessible treatment areas (by slope and distance to a roadway) for each Plan Unit, described below. These maps should assist CWPIP writing and plan development based on the models of radiant heat and short-range spotting that will impact many structures in Evergreen.

Treatment of these high-risk areas in each Plan Unit can be aided by these maps that depict locations of radiant heat and short-range embers that will impact the Home Ignition Zone. Treatment areas are filtered by accessibility for treatment, measured by distance to roadway and treatable slopes. Below is an example of what this will look like for each Plan Unit.

High to Extreme risk areas displayed in those maps are highest priority to protect from radiant heat and short-range spotting, however, this does not negate the need for defensible space treatment across the landscape. Any area in Evergreen could be impacted by a severe fire. All Plan Units were analyzed for these treatments and can be found in Map Appendix D, and an example of the Little Cub Creek Plan Unit is featured below in **Figure 19**.

References

Beverly, J. L., Bothwell, P., Conner, J. C. R., & Herd, E. P. K. (2010). Assessing the exposure of the built environment to potential ignition sources generated from vegetative fuel. *International Journal of Wildland Fire*, *19*(3), 299. https://doi.org/10.1071/WF09071

Syphard, A. D., Keeley, J. E., Massada, A. B., Brennan, T. J., & Radeloff, V. C. (2012). Housing arrangement and location determine the likelihood of housing loss due to wildfire. *PLoS ONE*, *7*(3). https://doi.org/10.1371/journal.pone.0033954

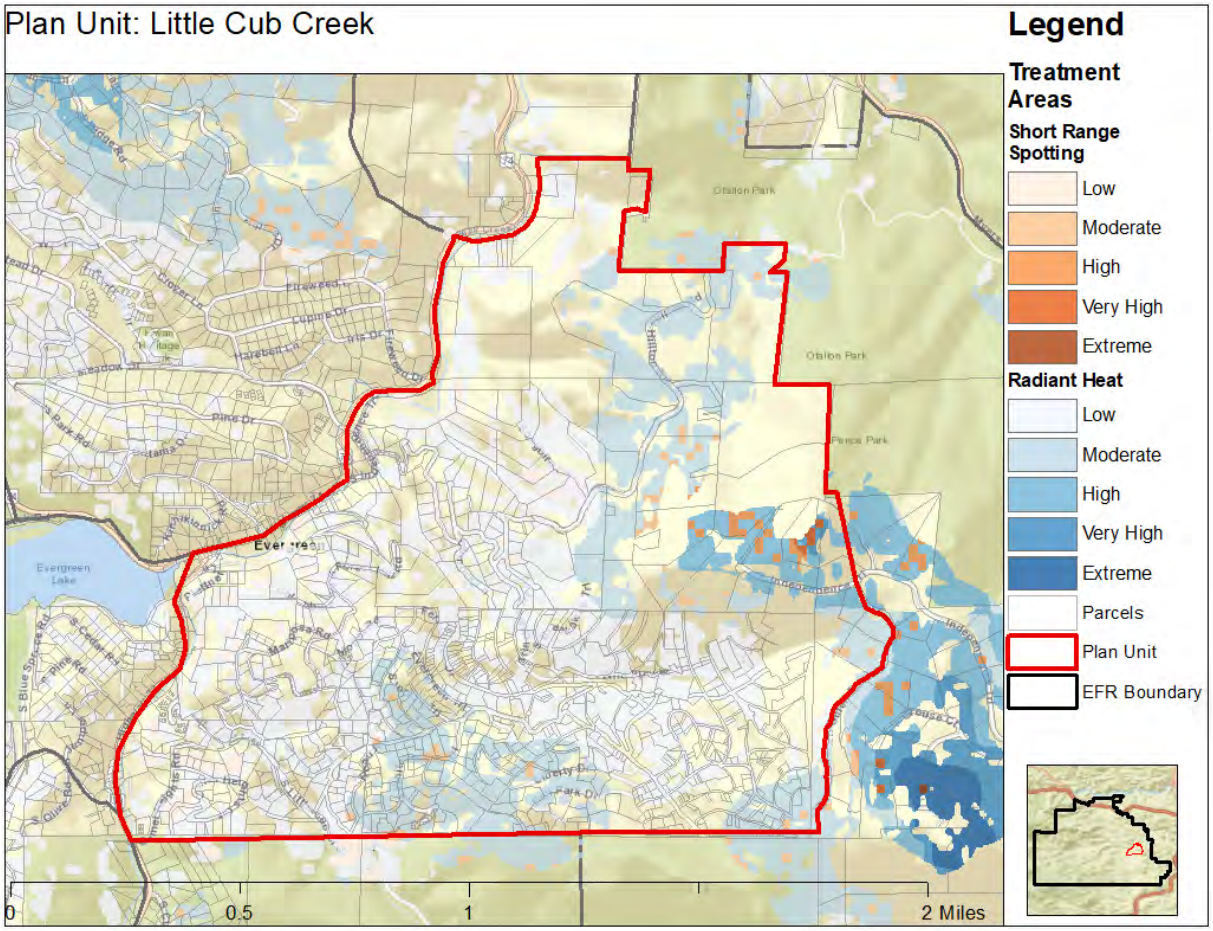


Figure 19. Treatment area map example, done for each Plan Unit in the Evergreen Fire Protection District, Map Appendix D contains all other Plan Unit maps.

ROADWAY SURVIVABILITY

Roadway Survivability identifies road segments that are not survivable and need mitigation. This model assumes that stopped drivers adjacent to flame lengths greater than 8 ft (per the haul chart, **Figure 20** below) are at risk of mortality. Roadways that overlap with predicted greater than 8 ft flame lengths under 90th percentile fire weather conditions are non-survivable. If residents are stranded on the roadways during a fire, mitigation action can create survivable conditions. Prioritization of this data is found in the Evacuation Section.

Fire Behavior Class	Rate of Spread (ch/hr)	Flame Length (ft)	Tactical Interpretation
Very Low	0-2	0-1	Direct, Hand crews
Low	2-5	1-4	Direct, Hand crews
Moderate	5-20	4-8	Direct, Equipment
High	20-50	8-12	Indirect
Very High	50-150	12-25	Indirect
Extreme	150+	25+	Indirect

Table 4. Description of fire behavior from the Haul Chart and how it is classified in this analysis.

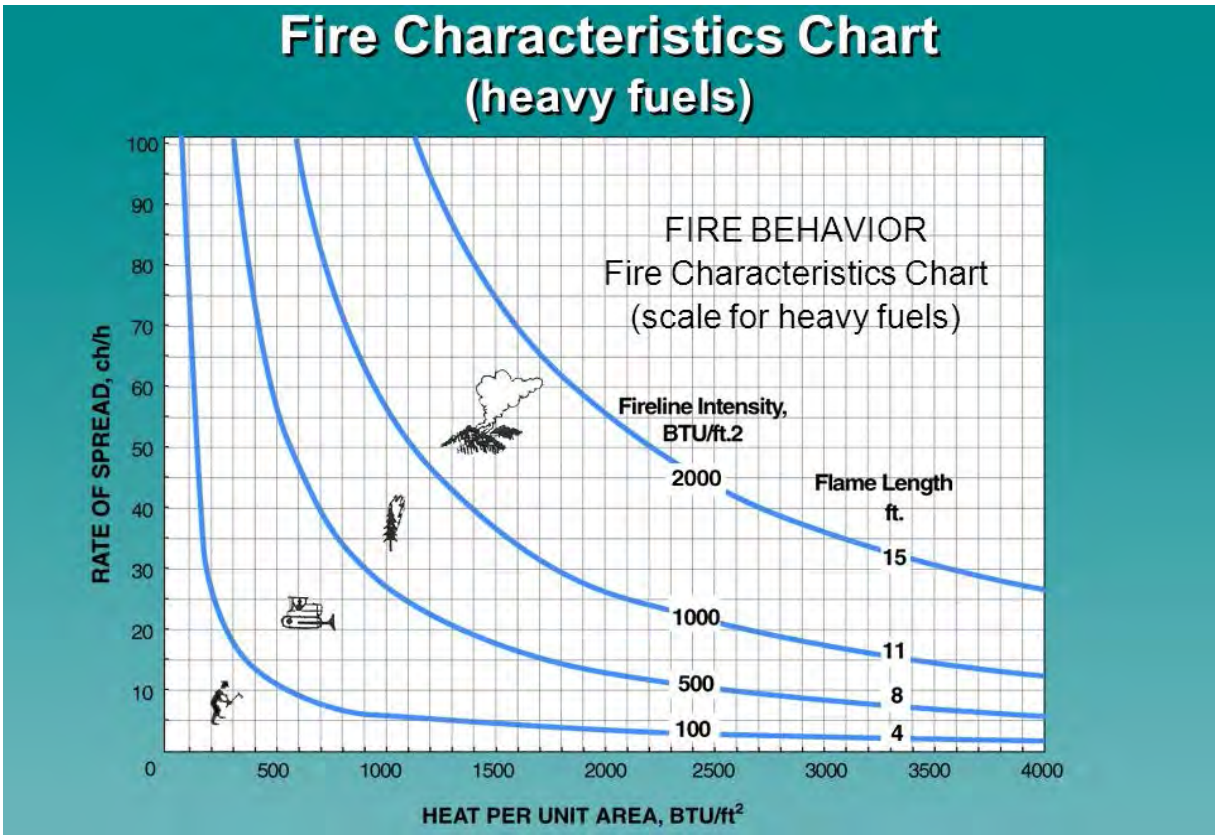


Figure 20. Haul Chart for fireline intensity, used to determine roadway survivability.

Fire Behavior Field Reference Guide, PMS 437 | NWCG.
https://www.nwcg.gov/publications/pms437/search-437?page=3.

EVACUATION

Evacuation information is intended to compliment the other fire behavior modeling and show relative risks to areas of the Evergreen Fire Protection District. All variables present during an evacuation cannot properly be addressed by this model, so it can be used as a guideline, rather than a depiction of what will occur in every possible evacuation event.

Evacuation Modeling was conducted using roadway capacity data. This model considers different variables that affect evacuation such as road speed and number of cars per structure. This model depicts what would happen on a high visibility day and does not account for unpredictable events, such as roadway blockage or reckless drivers. It assumes two vehicles are leaving each home, 10 are leaving each commercial building and does not account for RVs or trailers. It assumes simultaneous departure by car, with a quick exit from the home. This was conducted using the ArcCasper model (Shahabi & Wilson, 2014) and maps the evacuation of each address point to a chosen check point.
Roadway speed limits followed these settings for Evergreen:

Road Type	MPH
Driveway	15
Motorway	30
Primary	30
Residential	15
Secondary	25
Service	15
Tertiary	15
Track	20
Trunk	30
Unclassified	20

Table 5. Roadway speeds utilized in evacuation modeling for the Evergreen Fire Protection District.

Parks that attract a lot of visitors in the Evergreen area were included manually. Each parking lot was modeled to have additional visitors, per the direction of Evergreen Fire/Rescue:

Park	Assigned Visitors
Elk Meadow	100
Alderfer/ Three Sisters	100
Maxwell Falls (Upper and Lower)	150
Corwina Park (East and Panorama)	100
Evergreen Lake	150
O'Fallon Park	65

Table 6. Parks and Open Spaces in Evergreen Fire/Rescue with added vehicles for evacuation modeling.

The model allows for prediction of congestion from normal traffic flow, not considering all the additional visitors to the district, or emergency vehicles trying to travel the opposite direction of evacuation. As traffic during the weekends along I 70 and US 74 can be extremely congested, the evacuation time could be longer than predicted.

Congestion

Modeled traffic flow shows high congestion areas during an evacuation event. Points of high congestion are important to note for law enforcement personnel. All roadways in Evergreen were modeled, however all routes exiting the district could not be modeled. Law enforcement personnel will direct traffic during a wildfire event, so this depiction is not meant to suggest alternate routes to individual residents.

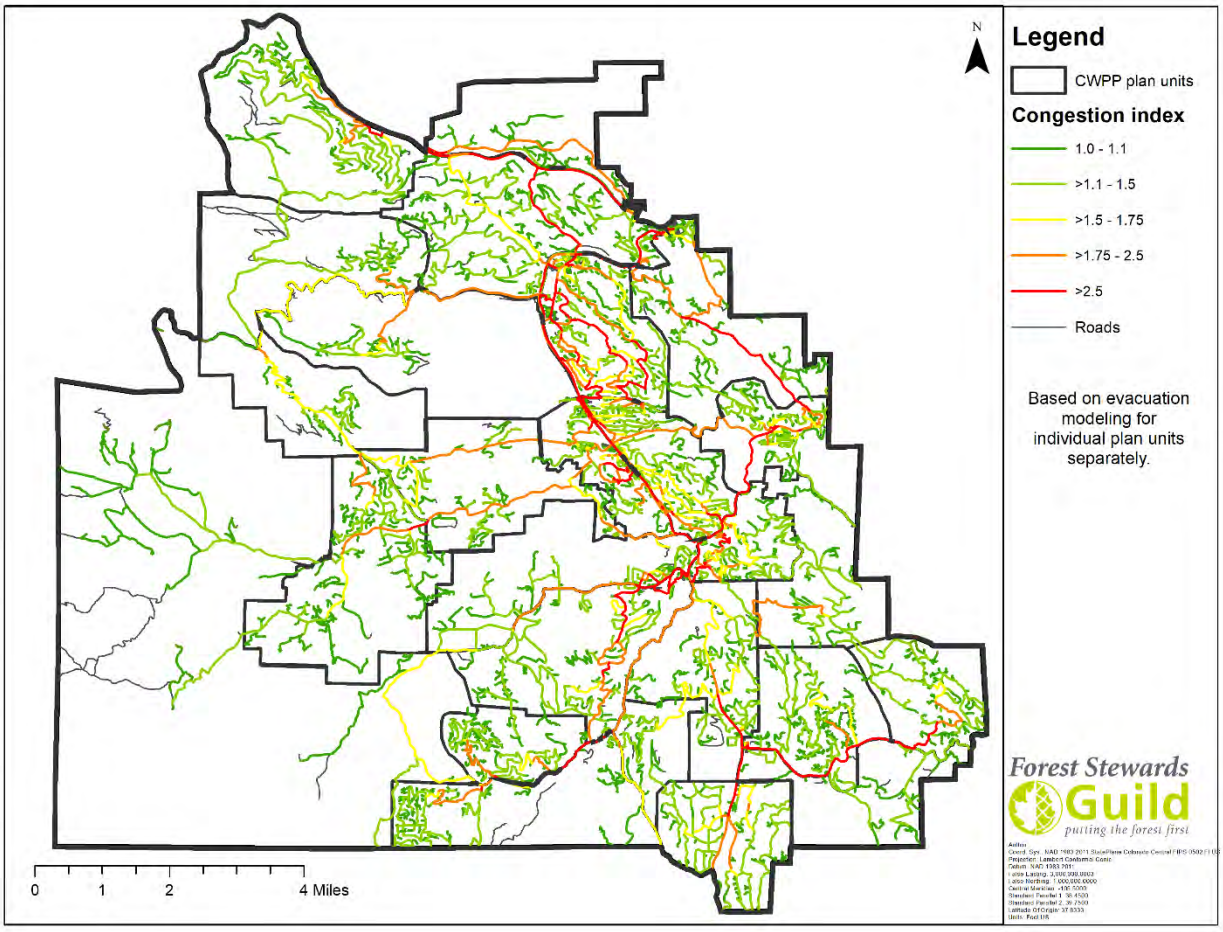


Figure 21. Evacuation Congestion Index based upon evacuation of individual Plan Units.

Roadways with an Evacuation Congestion Index over 2.5 that appear on this map are:

County Highway 74	County Highway 64 (North Turkey Creek Road)
County Highway 73	Interstate 70
Kerr Gulch Road	Buffalo Park Road to S. Cliff Road
County Highway 63 (Soda Creek Road)	Bergen Parkway through S. Interlocken Drive
County Highway 78 (S. Brook Forest Drive)	S. Pebble Beach Drive to Keystone Drive

If high congestion and non-survivable roadway are in the same place, there is a high risk to life safety. These sites are referred to as Evacuation Pinch Points in this CWPP. This is the basis for roadway fuel treatment recommendations. These locations that appear in each Plan Unit should become a guide for CWPIP leaders. Below, in **Figure 22**, is an example of non-survivable roadways and evacuation pinch points in the Blue Creek Plan Unit. Maps of the rest of the Plan Units can be found in Map Appendix E.

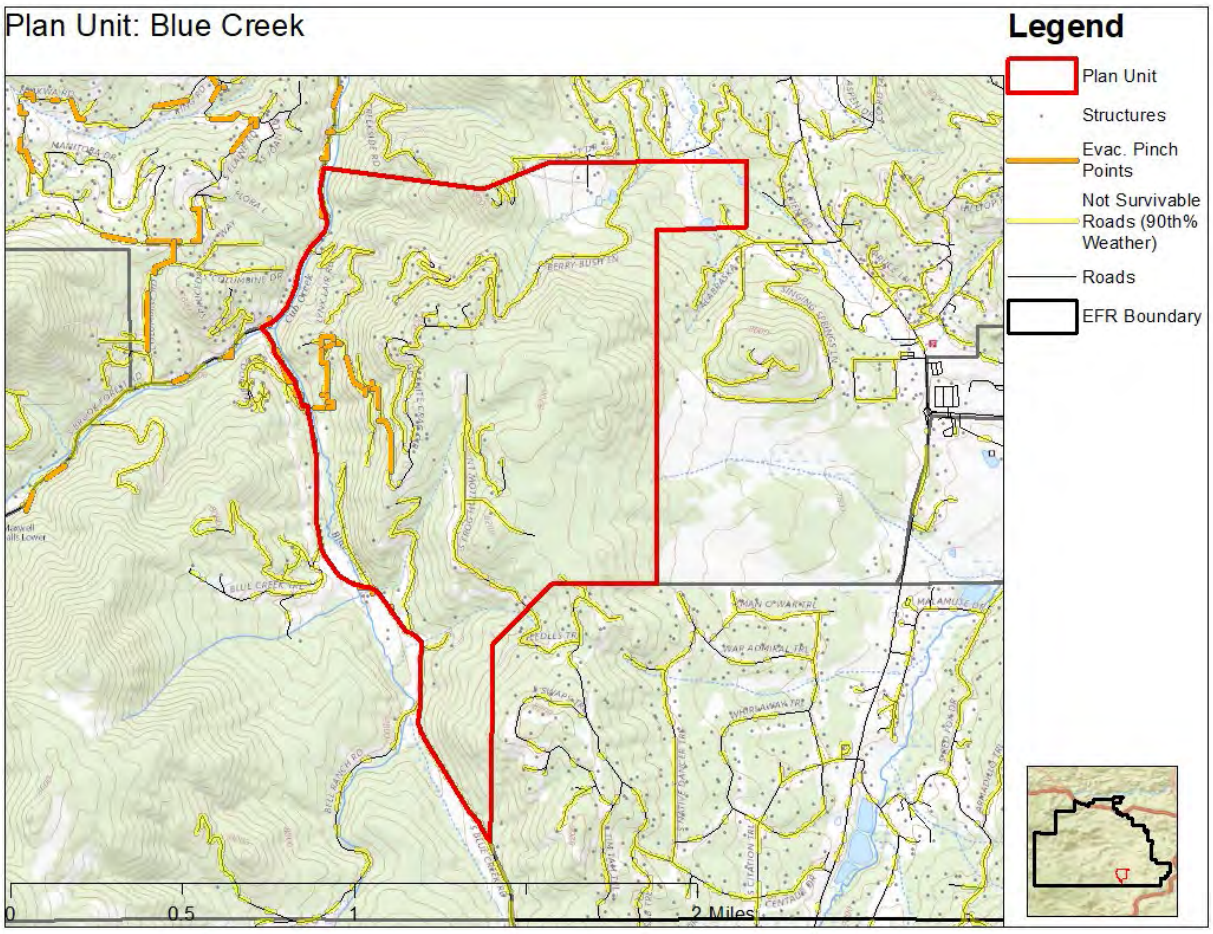


Figure 22. Example of Evacuation Pinch Points and Roadway Survivability displayed in a Plan Unit. An Evacuation Pinch Point is where high congestion and non-survivable roadways are in the same place.

Time to Evacuate

Evacuation Time was modeled for each Plan Unit. Each Plan Unit is evacuated on its own, to serve as a benchmark for evacuation timing, rather than indicate how first responders might stagger evacuation requests. On the graph below, **each address** in the Plan Unit is modeled for its time to evacuate and plotted along a measure of time. If there is a peak, that means many addresses will evacuate at that time, according to the model. On the other hand, like in Buffalo Creek South, evacuation may be more spread out with some residents evacuating in a minimum of 40 minutes, while others evacuate in a minimum of 120 minutes.

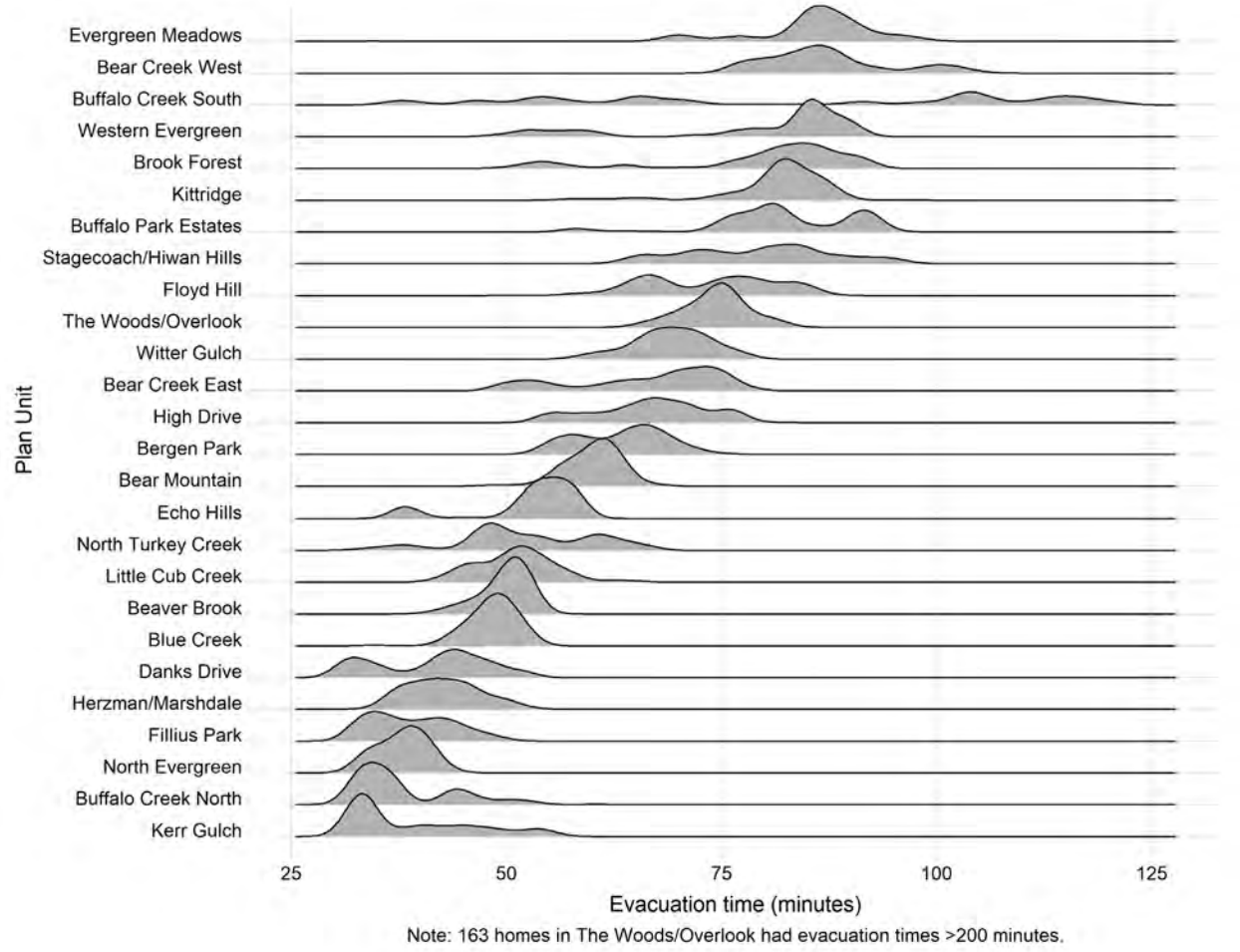


Figure 23. Each Plan Unit's evacuation times for each mapped address point, graphed for time to evacuate to show distribution of vehicles.

Plan Unit	Number Of Structures	Number Of Cars	Median	1st quantile	3rd quantile	Evacuations > 200 minutes	% > 200 minutes	Average	Minimum	Maximum
Bear Creek East	443	1006	69	61	73	0	0	66	49	79
Bear Creek West	431	894	86	82	90	0	0	87	76	105
Bear Mountain	247	534	60	58	62	0	0	60	47	69
Beaver Brook	179	358	51	49	52	0	0	50	41	54
Bergen Park	1577	4266	64	59	67	0	0	63	31	76
Blue Creek	142	308	49	47	50	0	0	48	35	53
Brook Forest	408	925	83	77	86	0	0	79	45	93
Buffalo Creek North	434	1154	36	34	44	0	0	38	31	61
Buffalo Creek South	899	2150	85	57	106	0	0	82	33	123
Buffalo Park Estates	450	1076	81	78	90	0	0	82	56	95
Danks Drive	82	212	43	35	46	0	0	41	31	53
Echo Hills	196	452	54	52	57	0	0	53	37	59
Evergreen Meadows	583	1350	87	84	89	0	0	86	34	100

Plan Unit	Number Of Structures	Number Of Cars	Median	1st quantile	3rd quantile	Evacuations > 200 minutes	% > 200 minutes	Average	Minimum	Maximum
Fillius Park	492	1184	39	35	43	0	0	39	32	50
Floyd Hill	521	1154	75	67	79	0	0	74	51	88
Herzman / Marshdale	573	1482	42	39	46	0	0	43	33	53
High Drive	300	664	67	63	71	0	0	67	53	82
Kerr Gulch	309	1154	34	33	45	0	0	39	31	56
Kittredge	699	1725	82	81	85	0	0	81	56	97
Little Cub Creek	622	1540	51	48	54	0	0	51	42	65
North Evergreen	60	120	38	36	40	0	0	38	32	44
North Turkey Creek	425	970	51	48	60	0	0	52	31	67
Stagecoach/ Hiwan Hills	1625	4538	80	73	85	0	0	79	62	97
The Woods / Overlook	734	3908	76	73	81	163	22	309	65	2533
Western Evergreen	53	114	85	77	86	0	0	79	49	91
Witter Gulch	182	364	69	66	72	0	0	69	58	78

Table 7. Summary of evacuation time data for each Plan Unit in the Evergreen Fire Protection District.

Another way to visualize this data is to see each individual address point in the Evergreen Fire Protection District color coded to represent time to evacuate. What becomes clear is addresses further from main evacuation roadways will take a dramatically longer time to evacuate than residents living at addresses along major points of ingress and egress.

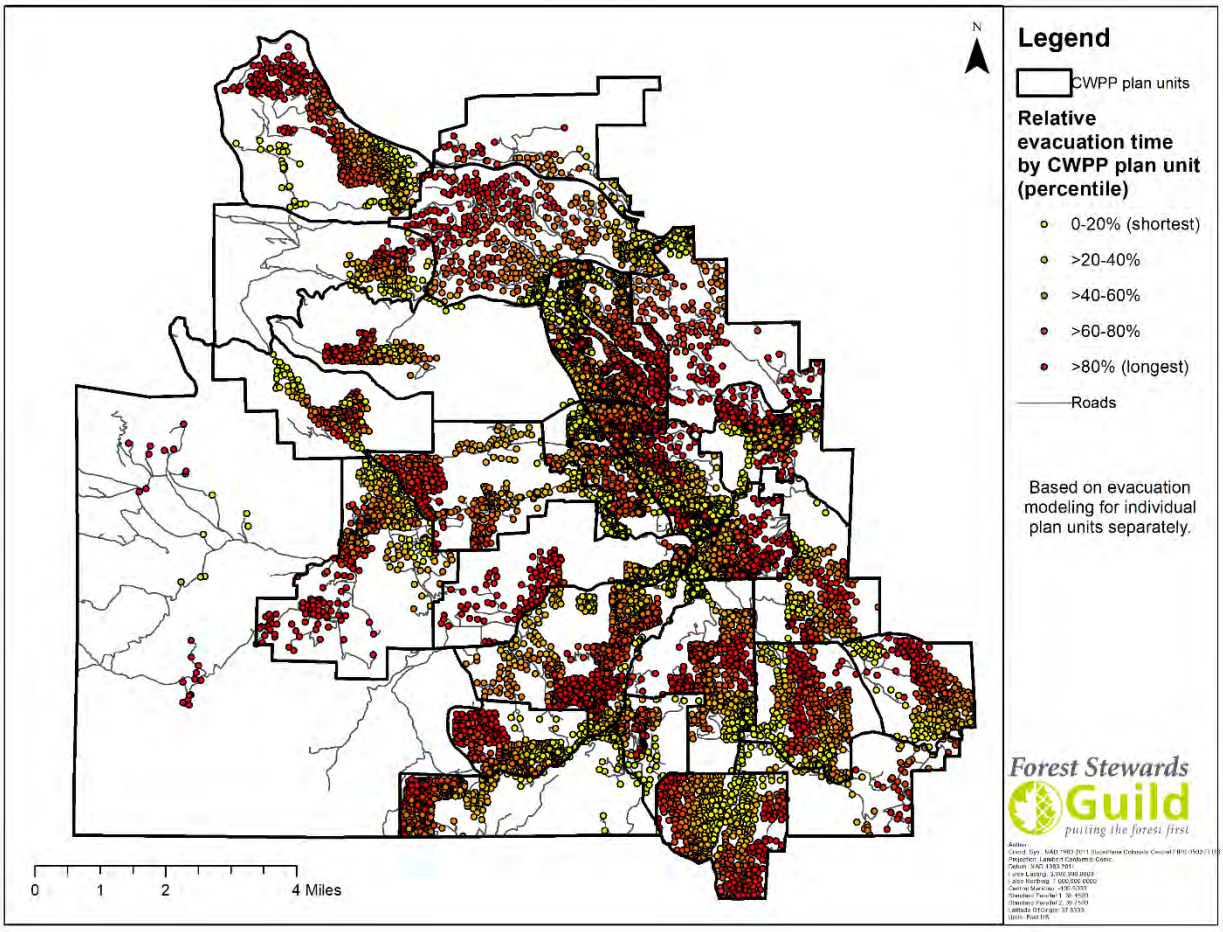


Figure 24. Evacuation Time at each address point in Evergreen Fire/Rescue, with modeled evacuation based on individual Plan Units.

In addition to evacuation modeled for each Plan Unit, we modeled larger groups to show where evacuation congestion and timing will be most extreme due to population density and roadway considerations. This is not meant to dictate groups that will evacuate together, but this example of modeled evacuation time can show Evergreen Fire/Rescue and the residents of the district the approximate timing and congestion during a extremely large-scale evacuation scenario. Each group is modeled to evacuate all at once, which is not how first responders will handle an evacuation event. In a wildfire evacuation, first responders will stagger evacuations to avoid dramatic congestion. The intent of running the evacuation model by these large groups is to find areas of major congestion during a large-scale evacuation, rather than to depict a realistic evacuation scenario. Below are the Plan Units that were evacuated together.

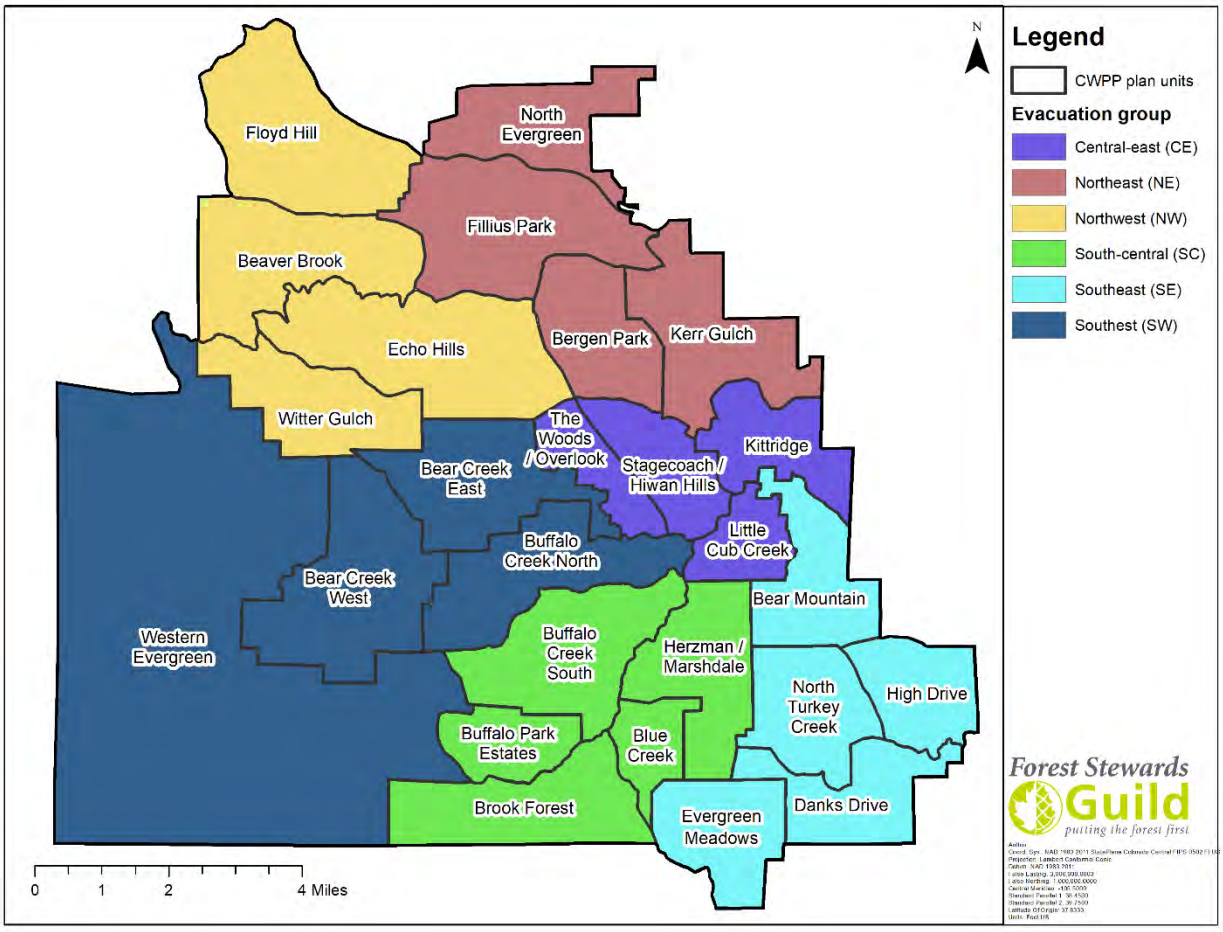


Figure 25. Plan Units analyzed in groups to estimate larger scale evacuations.

The Central-east group contains a high population and though they are closer to some major evacuation roadways, they face extreme evacuation times and many congestion points. This modeling, however, does not consider all potential directions of travel and decisions made by law enforcement professionals to evacuate the population safely and quickly. The intent of this information is to show the complicated nature of evacuating this area and that Highway 74 is going to become backed up quite quickly, even during a modeled scenario where no accidents or blockages occur.

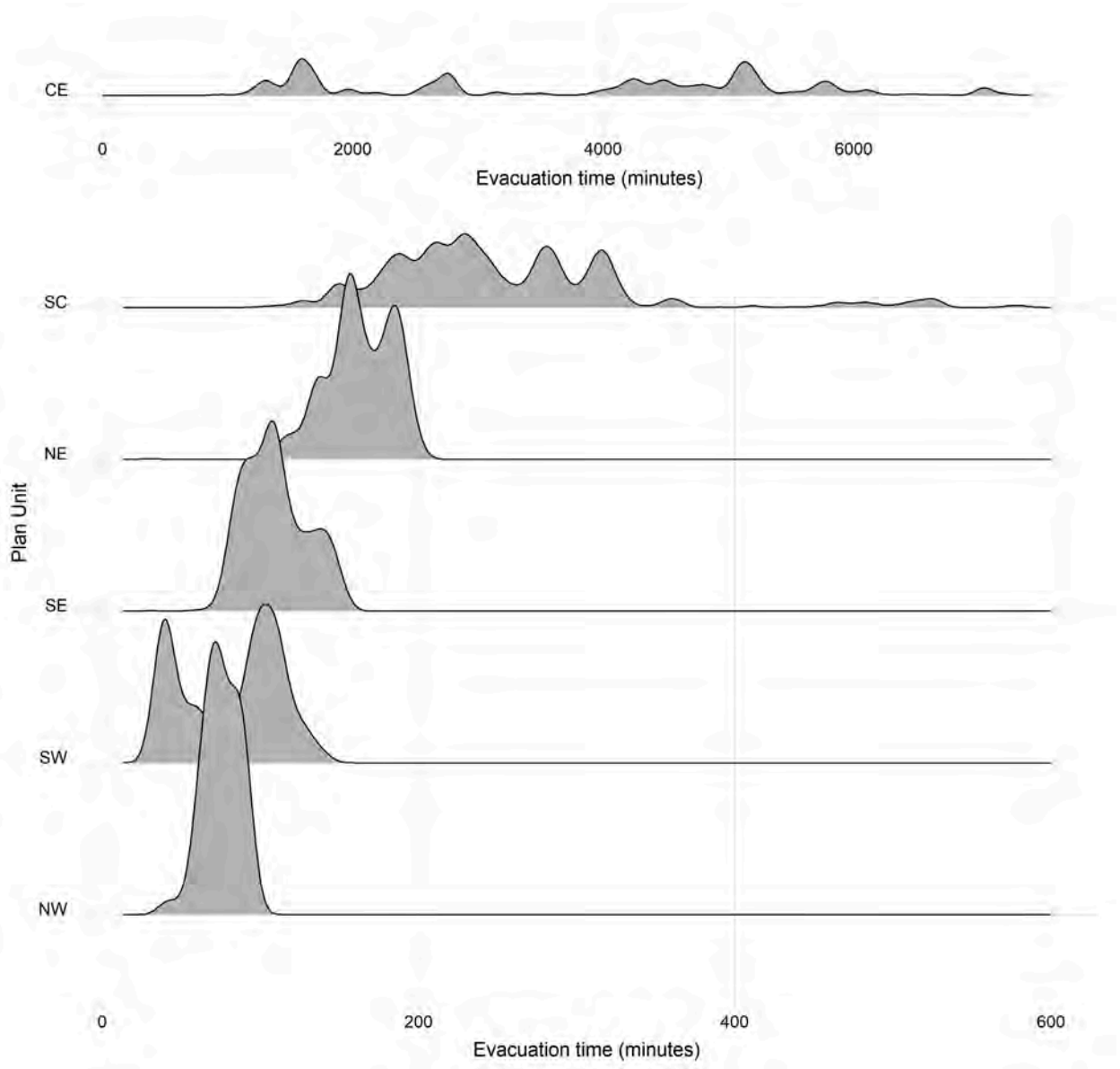


Figure 26. Each Evacuation Group times graphed for each address point's time to evacuate to show distribution of vehicles.

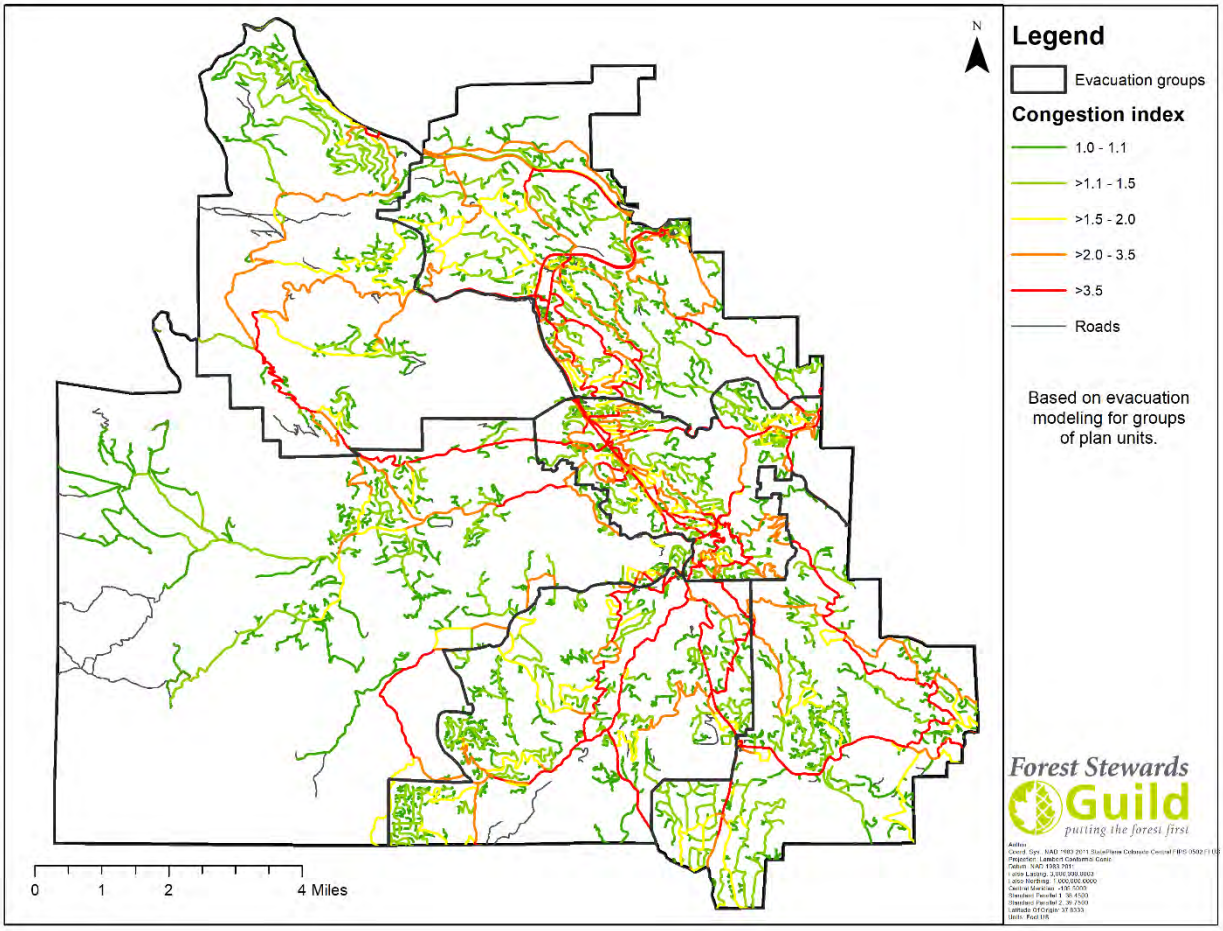


Figure 27. Evacuation Congestion Index based upon evacuation of evacuation groups.

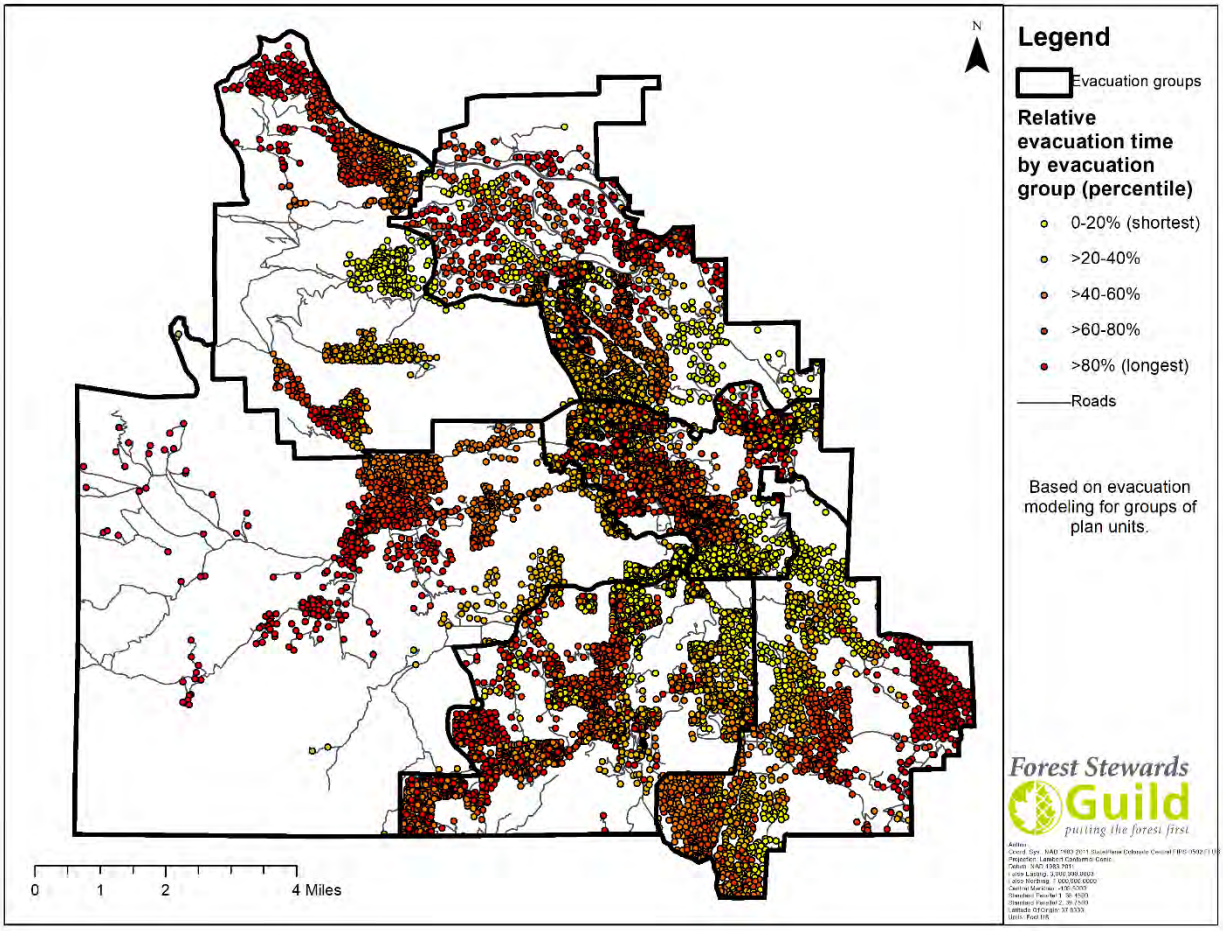


Figure 28. Evacuation Time at each address point in the Evergreen Fire Protection District, with modeled evacuation based on Evacuation Groups.

Prioritization

Evacuation concerns and roadway survivability should direct the Evergreen Fire Protection District to mitigate high priority roadway locations. These locations should be prioritized by the presence of Evacuation Pinch Points, where high evacuation congestion and non-roadway survivability overlap. A thinning treatment, following the guidelines of Appendix 3, defines what type of wildland vegetation reduction will improve these extreme risk areas. Map Appendix A contains maps of all these locations in each Plan Unit and describes roadway priorities for each unit. Each Plan Unit should prioritize locations described in Map Appendix A within the boundaries, and the Fire Protection District should use estimated evacuation timing to prioritize among district priorities for roadway mitigation. Evergreen Meadows, Bear Creek West, Buffalo Creek South, Western Evergreen, Brook Forest, Kittredge, Buffalo Park Estates are the highest priority Plan Units, and Evacuation Pinch Points must be mitigated to improve evacuation survival.

POST FIRE EFFECTS MODELING

Impacts of wildfires do not end once the flames extinguish. Intense rainfall events following a wildfire can result in massive erosion and sediment delivery. Erosion rates are highest one to three years after wildfire and return to pre-fire conditions as vegetation regrows (Neary and others 2005). Post-fire erosion can damage infrastructure and reshape streams, kill, or displace fish, and damage riparian vegetation.

Two months after the 1996 Buffalo Creek Fire south of the Evergreen Fire Protection District (EFPD), flooding and erosion following a severe thunderstorm led to the death of two residents, washed out Jefferson County Highway 126, damaged the City of Buffalo Creek's potable water supply and telephone facilities, and inundated Stronita Springs Reservoir with sediment (Agnew and others 1997; **Figure 29**).

Definitions

Erosion: Detachment and transport of soil and rock due to gravity, water, or wind.

Sediment delivery: Movement of soil into streams. Rates of sediment delivery are less than rates of erosion. Variation in topography and other barriers can stop the downhill movement of soil before it enters a stream.

Watershed: Area of land where all precipitation falling in that area drains to the same location (see figure A.1 in appendix 2).

Hillslope: Portion of a watershed on the same side of a stream that drains to the same location (see figure A.1 in appendix 2).

All citations and methods can be found in Appendix 2.

Changes to soils and vegetation after wildfires can increase the likelihood of erosion. Wildfires can kill vegetation that once anchored soil in place with their roots and consume litter from trees and plants, exposing bare soil and decreasing surface roughness. Extreme heat from wildfires breaks apart clumps of soil, known as aggregates, thereby reducing infiltration rates and soil stability. Soil on steep slopes that experienced high-severity wildfires are very prone to erosion. Soils classified as very fine sandy loam, silty, or silt loam are most prone to erosion, particularly if the amount of freshly decayed plant matter is low.

Wildfires occasionally result in soil that repels water, known as hydrophobic soil, resulting in substantial erosion. Soil with high sand content that experienced prolonged and extreme heating are most prone to hydrophobic conditions, as was the case with portions of the 2002 Hayman Fire. Organic compounds that cause hydrophobic soil disappear a couple years after wildfire (Huffman and others 2001).

Erosion from undisturbed hillslopes is usually 0 to 2.5 tons / acre / year in the western U.S. (Neary et al. 2005). Erosion after a wildfire can stay within this range if vegetation and litter cover remain intact, slopes are shallow, soils are stable, and storm intensity is low. Under different conditions, erosion rates can reach 140 tons / acre / year the first years following wildfires (Binkley and Fisher 2013). Rain intensities greater than 0.4 inches / hour can result in exponentially greater sediment yields (Moody and Martin 2001).

Emergency response, mitigation measures, and sediment removal after major flood events carry a hefty cost. Emergency cleanup of erosion caused by a 100-year storm following the 1996 Buffalo Creek Fire totaled nearly $1 million, and dredging Strontia Springs Reservoir cost $15-20 million over 10 years (EPA 2015). Bear Creek in the Evergreen FPD experienced flooding in September 2013 following prolonged rainfall and dredging of sediment delivered to Evergreen Lake cost over $1 million in 2016 (Brobst 2016).

Figure 29. A 100-year storm two months after the 1996 Buffalo Creek Fire resulted in massive erosion and flooding (photo credit: R.H. Meade, U.S. Geological Survey. Public domain.)

Potential post-fire erosion in Evergreen Fire Protection District

Assessing the potential for post-fire erosion and sediment delivery can help residents and managers in the EFPD to identify areas most likely to experience damage and to plan for actions to mitigate impacts. We modeled potential post-fire erosion and sediment delivery using the Water Erosion Prediction Project (WEPP) under current unburned conditions and potential post-fire conditions (see Appendix 2 for methods). The post-fire scenario assumed that fires burn every portion of the landscape under 90th percentile fire weather conditions.

We focused on sediment delivery instead of erosion because movement of soil into streams and reservoirs can cause the greatest post-fire damage. We modeled annual sediment delivery under average precipitation and 30-year precipitation (i.e., conditions likely to occur once in thirty years) based on records from the National Weather Service cooperative weather station in Evergreen, CO (Table 8).

Table 8. Average precipitation and 30-year precipitation (i.e., conditions likely to occur once in thirty years) based on records from 1961 to 2012 from the National Weather Service cooperative weather station in Evergreen, CO (station ID 052790).

	Average conditions	30-year conditions
Precipitation (inch / year)	19.1	26.4
Number of storms / year	85	106

Predicted post-fire erosion

Sediment delivery could increase dramatically after wildfires in the Evergreen FPD. Across all simulated rainfall conditions, the likelihood of sediment delivery into streams is less than 20% in almost all watersheds under current, unburned conditions, but the likelihood is greater than 60% for all watersheds after wildfires (**Figure 30**).

The average predicted rates of post-fire sediment delivery from watersheds is about 9 times greater than unburned conditions across the EFPD. Potential post-fire sediment delivery under average rainfall conditions varies from to 0 to 19 tons / acre / year, with 15% of watersheds falling in the "extreme" category for sediment delivery (**Figure 31**). Sediment delivery rates are higher for watersheds expected to experience high-severity wildfires (**Figure 32**) and those with higher average percent slopes (**Figure 33**).

Predicted sediment delivery rates are within the range of observed post-fire sediment delivery rates after wildfires along the Front Range of Colorado (Pietraszek 2006). Under average precipitation conditions in the EFPD, predicted sediment delivery rates in 12% of watersheds exceed maximum sediment delivery rates measured the first two years after the Hayman Fire (11.5 tons / acre) (Pietraszek 2006). Under average precipitation conditions, predicted sediment delivery rates in only one watershed exceed observed rates after the 1996 Buffalo Creek Fire (18-30 tons / acre) (Moody and Martin 2001).

Sediment delivery would be significantly greater across the EFPD were once-in-thirty-year rainfall conditions to occur the first year following wildfire. Predicted sediment delivery varies from 5 to 89 tons / acre / year under these conditions (average of 43 tons / acre / year). Once-in-thirty-year precipitation could produce sediment delivery rates comparable to those observed after the 1996 Buffalo Creek Fire in over 90% of watersheds in the FPD.

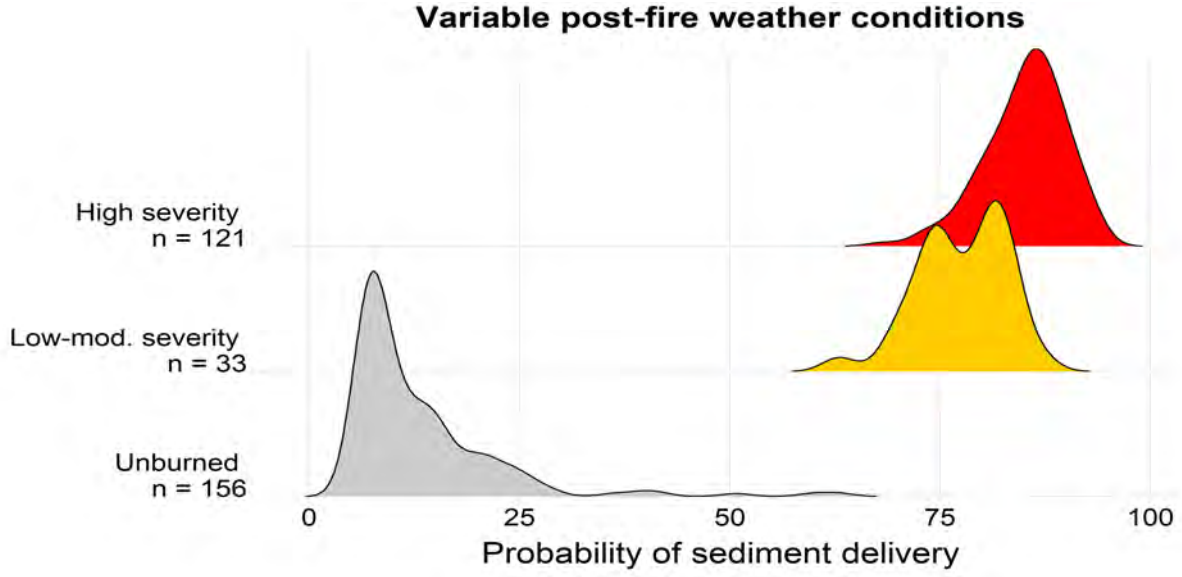


Figure 30. Predicted probability of sediment delivery from watersheds within the Evergreen Fire Protection District under current, unburned conditions and under burned conditions. Results are presented for watersheds predicted low to moderate severity wildfire (flame lengths ≤8.2 feet) and high severity wildfire (flame lengths >8.2 feet).

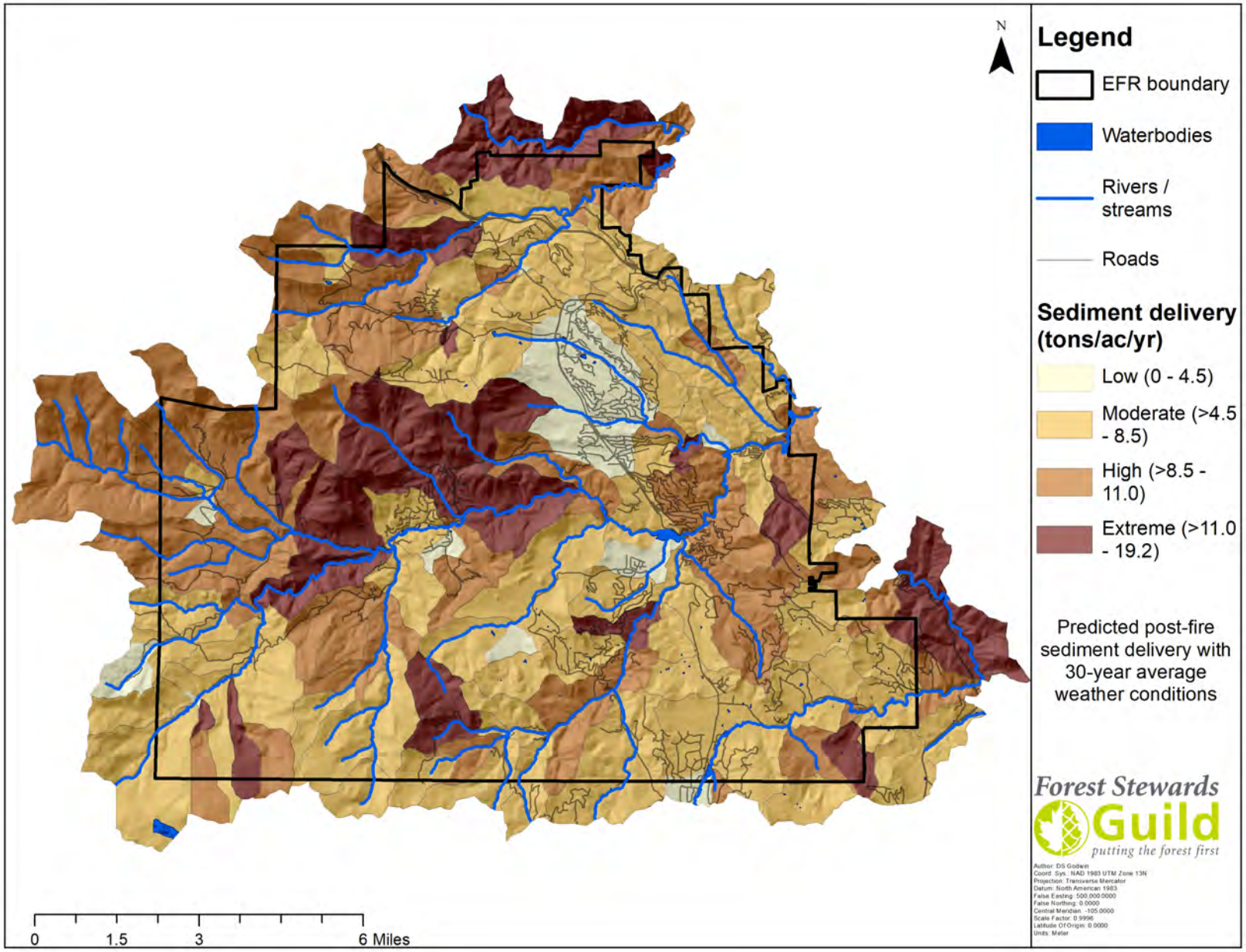


Figure 31. Predicted post-fire sediment delivery for watersheds within the Evergreen Fire Protection District under average rainfall conditions the first year following wildfire (see Appendix 2 for a description of cutoffs for sediment delivery categories).

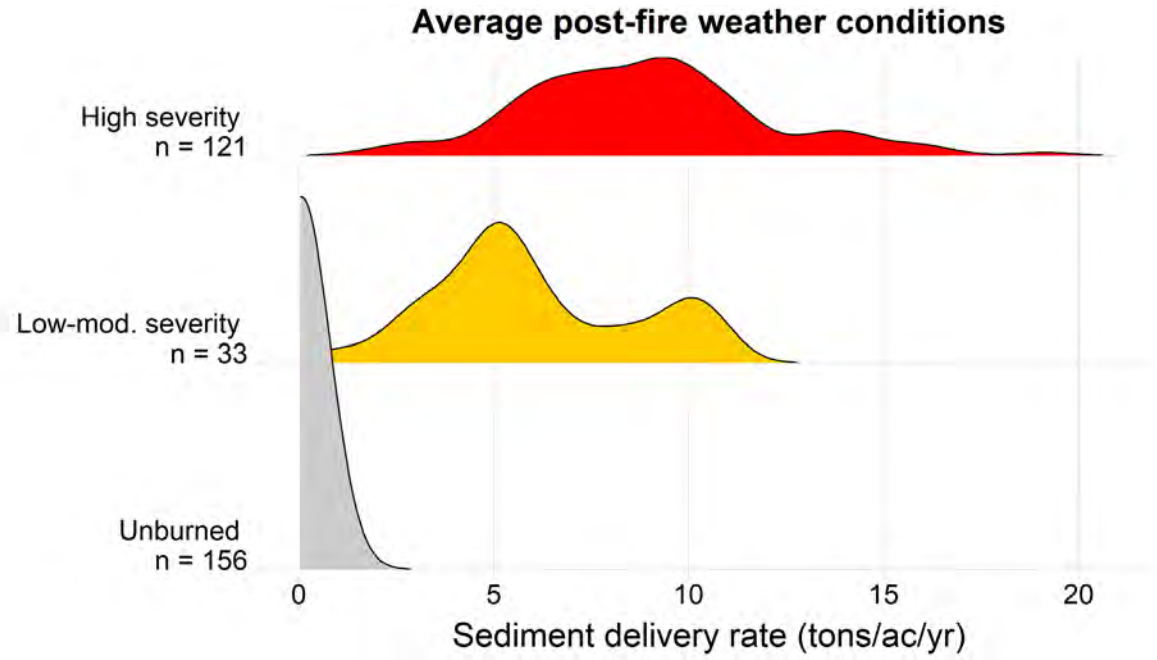


Figure 32. Distribution of predicted sediment delivery rates under current, unburned conditions and under burned conditions for watersheds within the Evergreen Fire Protection District. Predictions are for average weather conditions occurring the first year following wildfire.

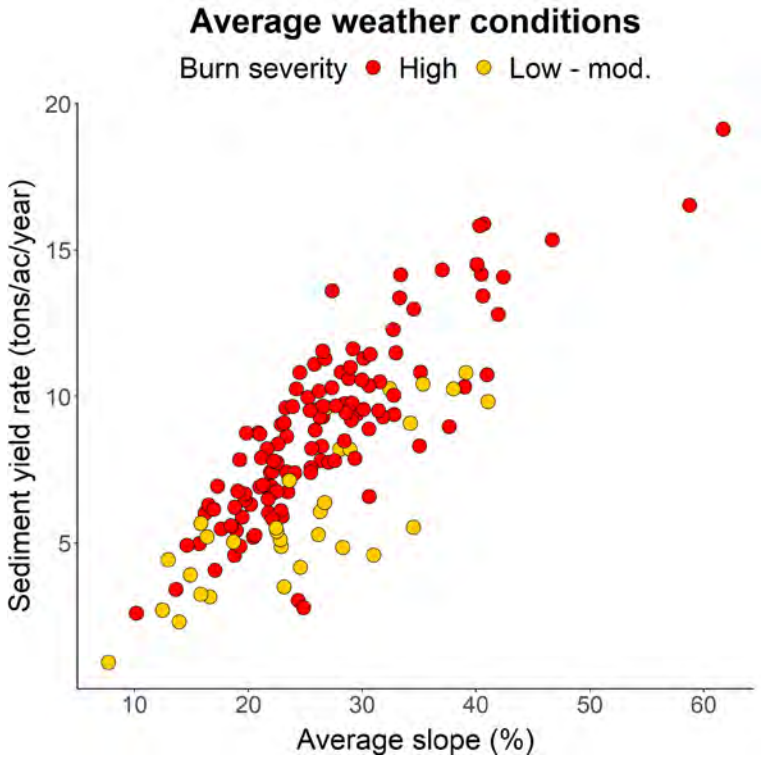


Figure 33. Predicted post-fire sediment delivery rates increase with the average percent slope within watersheds. Predictions are for average precipitation occurring the first year following wildfire.

WATERSHED MANAGEMENT RECOMMENDATIONS

Prioritization

Rivers and watersheds within EFPD are rated as healthy to very healthy based on an analysis by The Nature Conservancy (White et al. 2017). Many watersheds in the Evergreen Fire Protection District are rated as highly important for drinking water based on the 2017 Colorado wildfire risk assessment (CSFS 2017). Severe rainstorms occurring the first year following wildfires could change these conditions, and some infrastructure and ecological values in the Evergreen FPD might experience significant damage.

Based on the location of watersheds where predicted post-fire sediment delivery is "high" to "extreme", values at risk from post-fire erosion in the Evergreen FPD include:

- Lengths of I-70, CO-74, US-40, and several county roads throughout the FPD and powerlines running parallel to these roads, including the 230 kV transmission line alongside I-70 (**Figure 34**).
- Clear Creek Middle / High School and King-Murphy Elementary School, and several childcare centers (Bearly Tawl, Evergreen Academy, Episcopal Day School of Evergreen, and Mount Evans Outdoor Laboratory) (**Figure 35**).
- Homes, business, and roads in downtown Evergreen.
- Neighborhoods and scattered homes and businesses across EFPD, particularly in the western half of the district (**Figure 35**).
- Communication sites including cellular, FM radio, microwave, and private land-mobile transmission towers throughout the FPD, including those on Bear Mountain (**Figure 35**).
- Parks and open spaces owned by Denver Mountain Parks (Bell Park, Bergen Park, Birch Hill, Corwina Park, Cub Creek Park Dedisse Park, Elephant Butte, Hicks Mountain, Hobbs Peak, Mount Judge, Mount Pence, North Turkey Creek, O'Fallon Park, Pence Park, Snyder Mountain, and Stanley Park), Jefferson County Open Space (Elk Meadow Park and Alderfer / Three Sisters Park), and the Colorado Division of Wildlife (Mount Evans State Wildlife Area) (**Figure 35**).
- Lengths of numerous rivers and streams, including Bear Creek, which flows into Evergreen Lake—a popular spot for recreational fishing and water source for the Evergreen Metropolitan District Water Treatment Plant (**Figure 34**).
- The Upper and Lower Beaver Brook Dams and Reservoirs owned by the Lookout Mountain Water District, which supply water to over 500 homes, businesses, and service providers, including the Clear Creek Middle / High School, Evergreen Fire, and Foothills Fire (**Figure 34**).
- Priority habitat for the Colorado Greenback Cutthroat Trout (*Oncorhynchus clarkia stomias*) in the Bear Creek Watershed and the Orangespotted Sunfish (*Lepomis humilus*) in the Clear Creek Watershed, both of which are Colorado Tier 1 species of greatest conservation need (Colorado Parks & Wildlife 2016). The Colorado Greenback Cutthroat Trout is listed as threatened under the Endangered Species Act, and the species is vulnerable to significant loss or local extinction from extreme sedimentation (Young 2009).
- Freshwater ecosystems with high conservation value in the Troublesome Creek-Bear Creek and Headwaters Bear Creek Watersheds (White and others 2017).

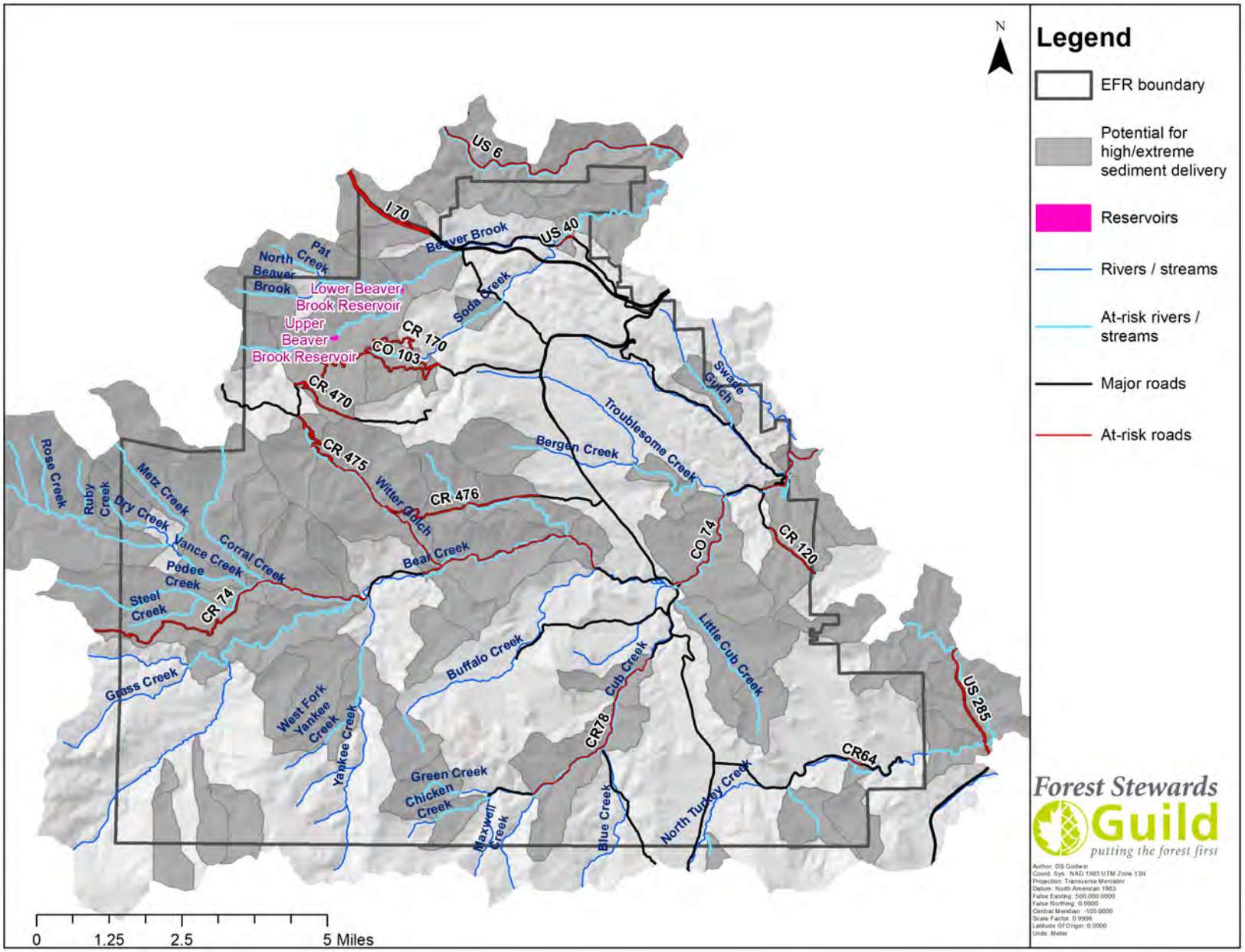


Figure 34. Roads and streams located in watersheds that could experience high to extreme rates of sediment delivery under average rainfall conditions the first year following wildfire.

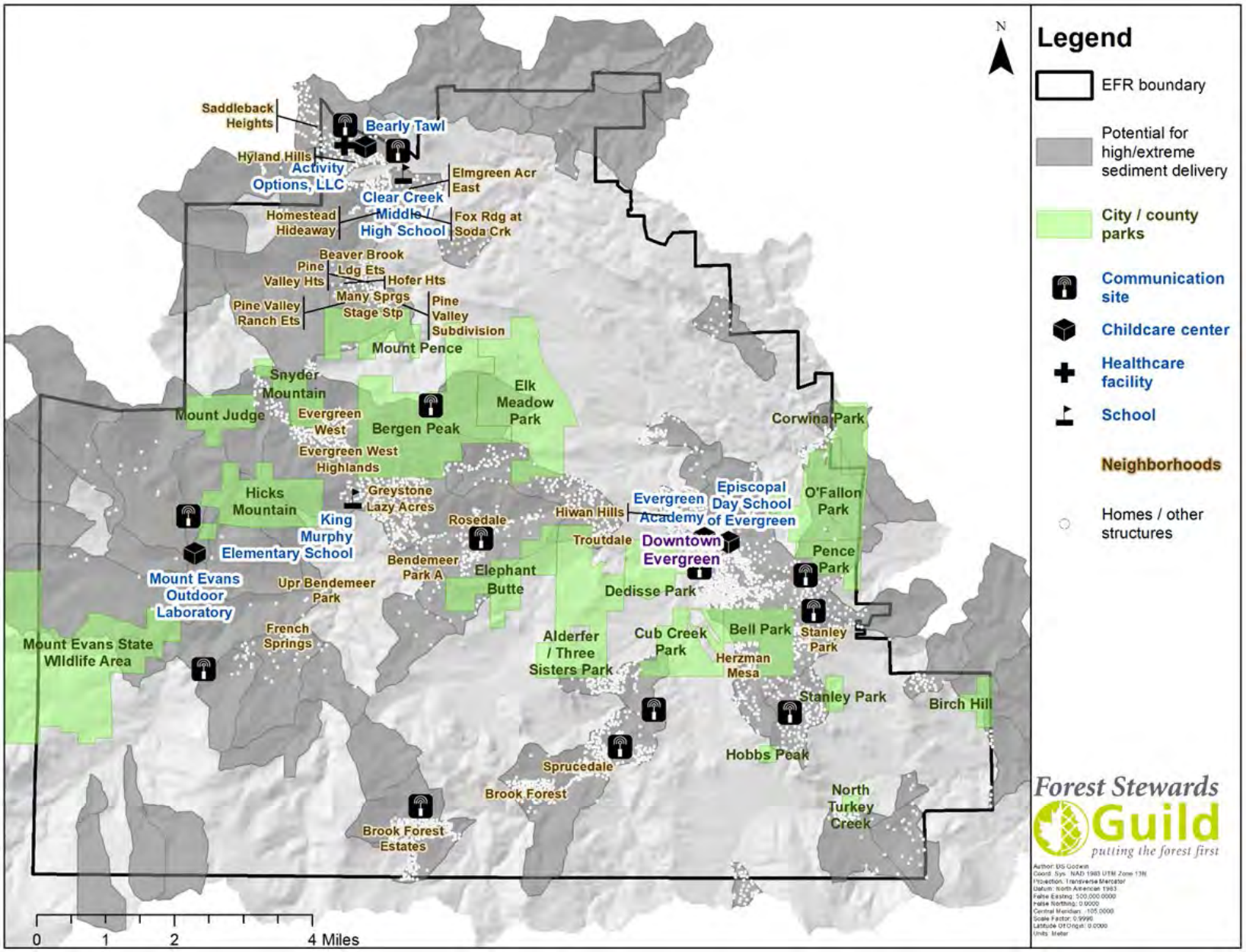


Figure 35. Schools, healthcare facilities, childcare centers, communication sites, parks, neighborhoods, and homes in watersheds that could experience high to extreme rates of sediment delivery under average rainfall conditions the first year following wildfire.

Mitigation Actions

The potential for post-fire sediment delivery to watersheds and values at risk can be mitigated through strategic fuel treatments to reduce fire hazards, as well as pre-planning for post-fire erosion mitigation. Research shows that fuels treatments can reduce post-fire sediment delivery along the Front Range of Colorado (Gannon and others 2019; Jones and others 2017).

After a wildfire, a variety of mitigation options can stabilize hillslopes and reduce post-fire erosion. Common stabilization treatments include the application of straw mulch or a seed mix (usually annual grasses) to burned hillsides. Water barriers, such as contour-felled logs or straw wattles, can also slow the movement of water and sediment downslope. Particularly effective measures are straw or wood mulches and log or rock check dams. Contour-felling can reduce sediment delivery under low-intensity rainfall but are less effective under high-intensity rainfall conditions. See Robichaud and Ashmun (2013) for a review of different mitigation measures, their relative effectiveness, and other considerations, such as the risk of introducing noxious weeds. Robichaud and others (2000) provide cost estimates for different post-fire mitigation measures.

When determining the best plan of action for post-fire, this CWPP does not provide guidance on the full suite of options and considerations that must be made. A separate plan of this length would adequately address all of the challenges associated with planning, communications, logistics, operations, and financial needs after a catastrophic wildfire event. Without such a guide developed, the Colorado Post Fire Recovery Playbook is essential for every district and municipality to be aware of and begin to work through. This guide can be found in Appendix 8, which will be useful to the Evergreen Fire Protection District, local land managing agencies, and local residents.

Landscape Fuel Treatment Locations

This section identifies priority areas on the landscape where fuel treatment will have a great impact on the rest of the Evergreen Fire Protection District. This analysis was based upon the fire behavior modeling done for the Evergreen Fire Protection District and was filtered for accessible areas with <35% slope and being within 1000m of a road or trail. Other areas with slope up to 50% and 2000m from a road may be possible to treat but are more expensive and labor intensive. This report focuses on the "best" treatment areas for recommendations but does not discourage wildland mitigation in other areas.

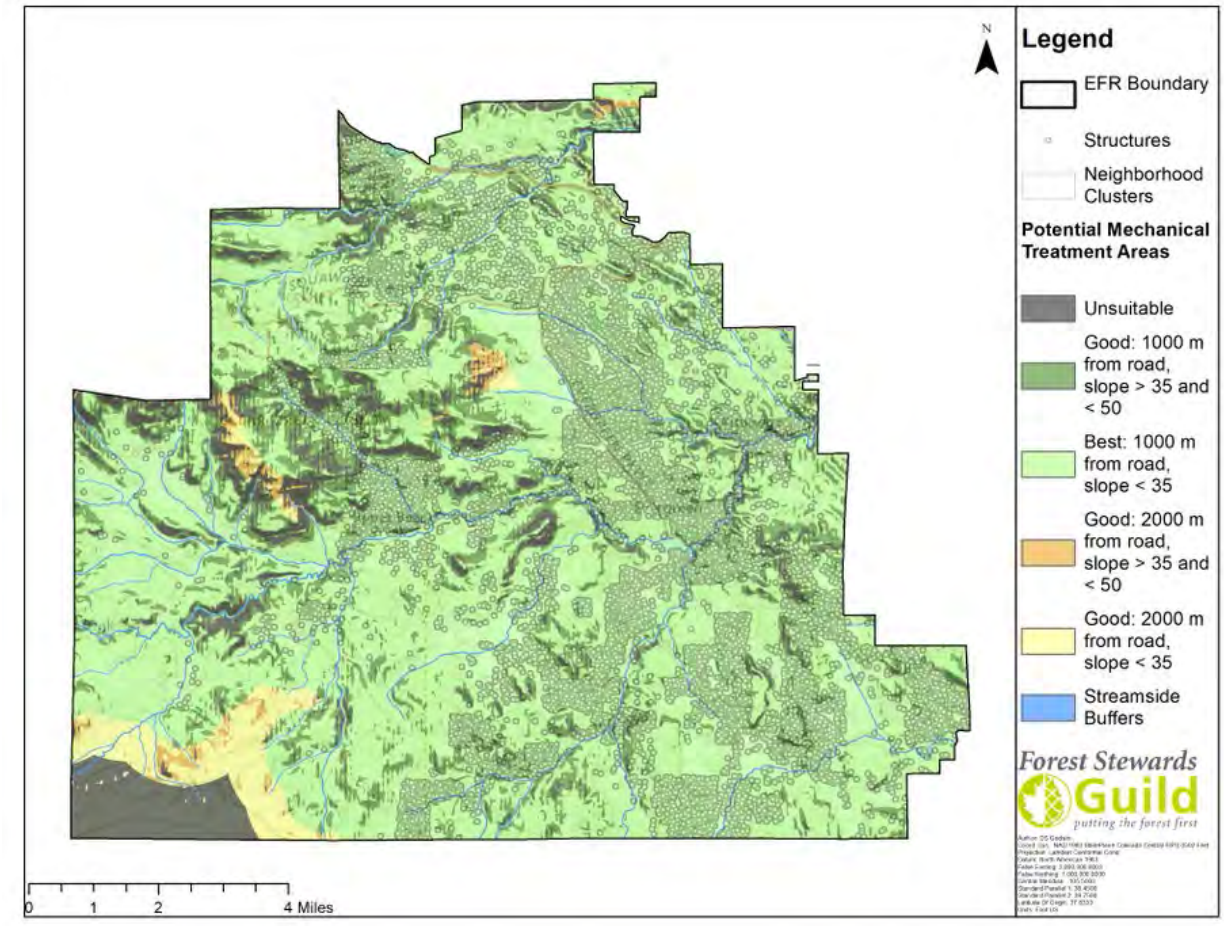


Figure 36. Wildland fuel treatment accessibility in the Evergreen Fire Protection District.

Prioritization

After modeling accessibility for fuel treatment in Evergreen, an analysis was completed to designate areas of high risk and therefore high treatment priority. The factors are each displayed spatially and a value of 1 per factor was used to visually combine these datasets. Factors utilized are as follows:

- Suppression Difficulty Index
- Normalized Fire Size Probability
- Normalized Conditional Burn Probability
- Radiant Heat Proximity to Structure Clusters
- Short Range Spotting Proximity to Structure Clusters

Where these risk factors occur, over the 50th percentile for each separate analysis, it is added to the others where spatially overlapping. This produces the following map of locations, with 4 of the previous 5 factors occurring in the same pixel. All areas highlighted by this map should be treated to reduce wildland fuel loading and improve tactical decision-making options during a wildfire. The following recommendations serve to prioritize areas within Evergreen based on this analysis, but do not discourage other highlighted areas from being treated.

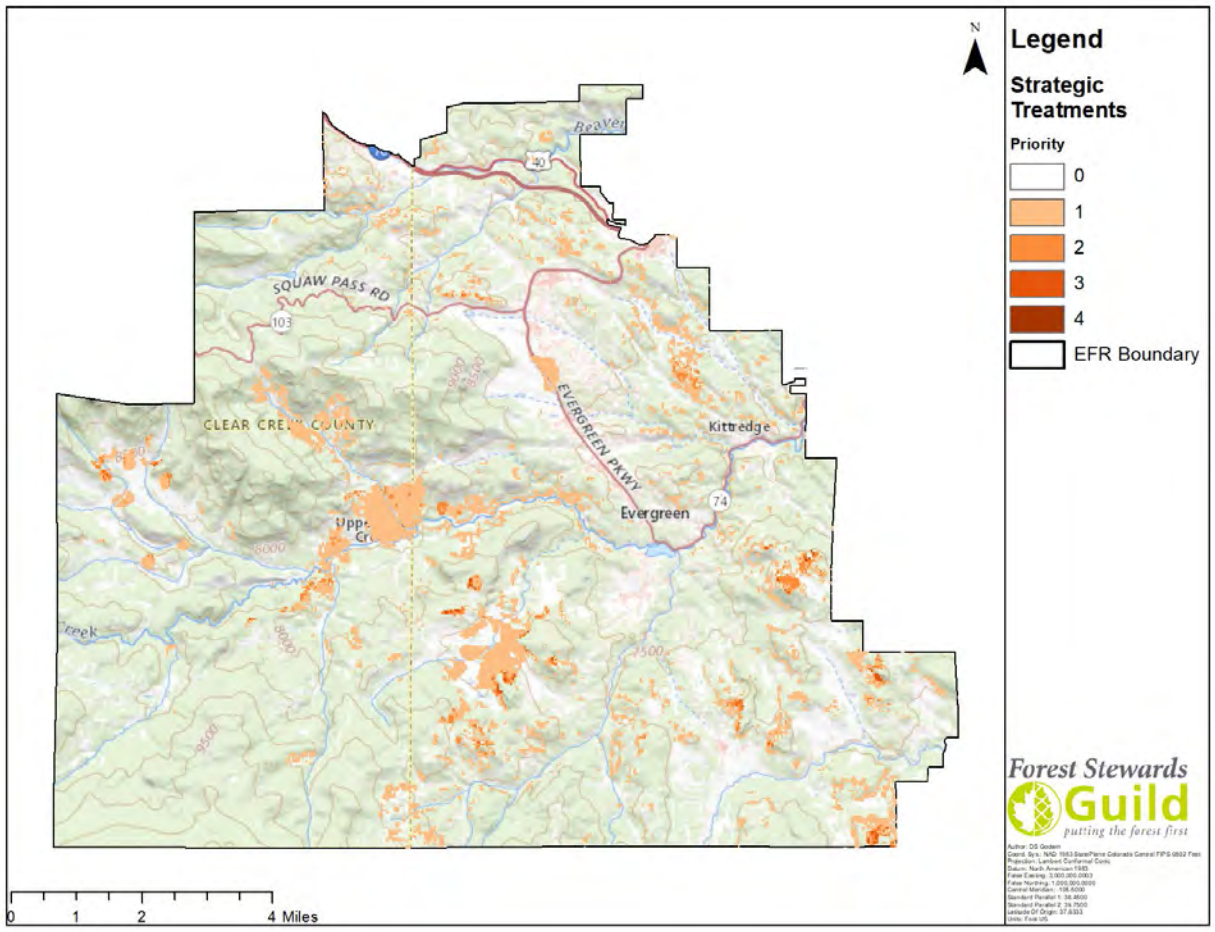


Figure 37. Strategic treatments of high priority that are accessible in the Evergreen Fire Protection District. Priority ranked for value of wildfire risk factors (4 being highest), but all represent the highest priority areas overall of this district.

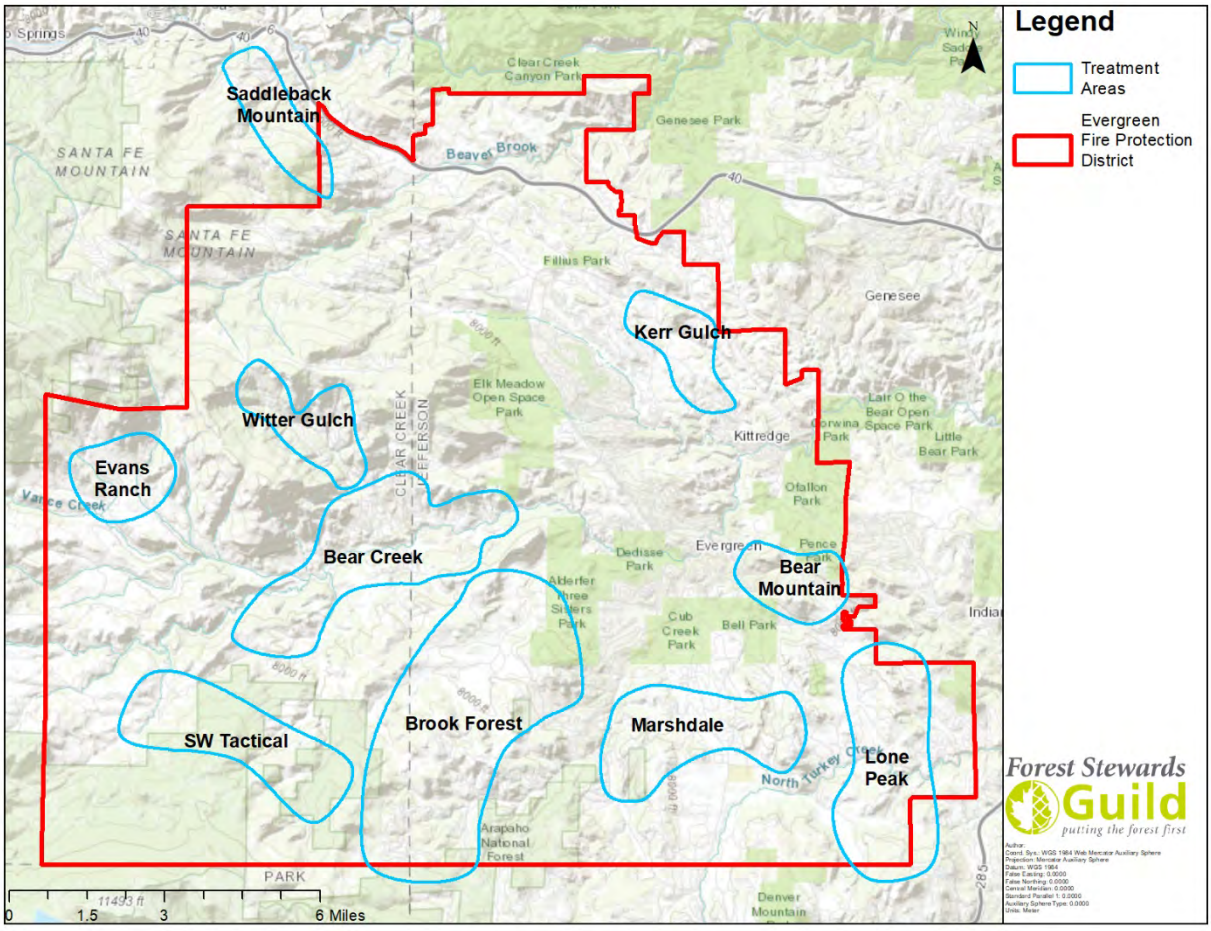


Figure 38. Landscape priorities for wildland vegetation mitigation in EFPD.

Each treatment is listed in the following pages with a map of the extent and streets visible for better orientation. Keep in mind the following when looking at the zoomed in maps.

Important to note:

- Figure 38 treatment polygons include the area prioritized by accessibility and risk from **Figure 37** and include surrounding areas as context of treatment is important.
- See Prescriptions for Treatment section for guidance. All fuel treatments should consult forestry and/or fire professionals to define exact treatment prescriptions.
- Public land managers can only achieve so much alone – please support local open spaces, land managers and other forestry professionals by allowing access for mitigation action and creating defensible space on your own property. Treatments on public lands are carried out by appropriate agencies and may be subject to federal, state, and county policies and procedures such as adherence to the Health Forest Restoration Act (HFRA) and National Environmental Policy Act (NEPA).
- These treatments are not prioritized relative to each other – all are extremely important.
- Most recommended treatment areas are anchored to existing wildfire mitigation treatments. It is imperative to improve and expand on the great work already accomplished in Evergreen.

Bear Creek

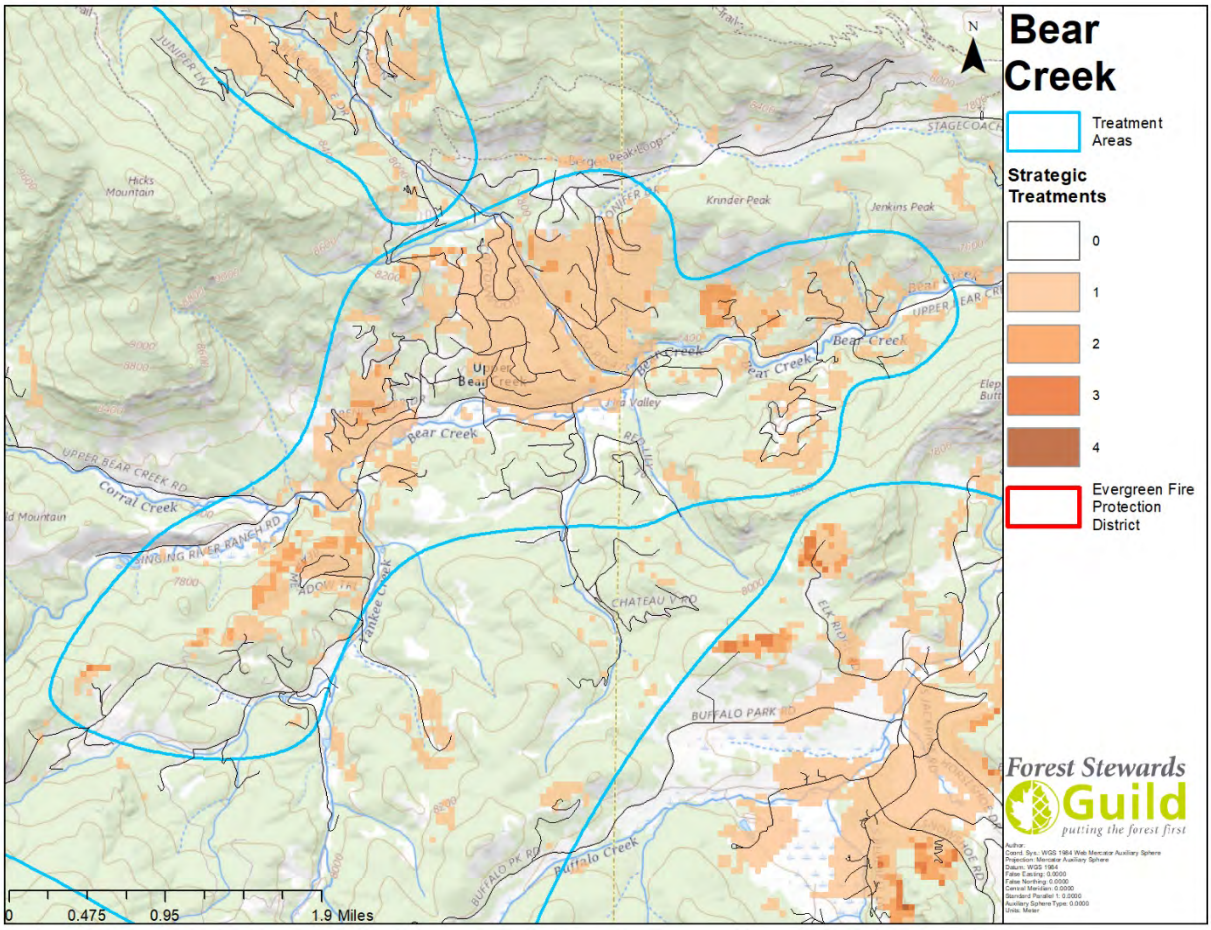


Figure 39. Bear Creek priority treatment area.

This area in Evergreen consistently shows up with high risk to the residents that live in the area and high likelihood to quickly channel wildfire into areas of high suppression difficulty. On the southern end of this recommended treatment area, by Yankee Creek Rd. and up towards Brookvale, high conditional burn probability and fast rates of spread will contribute to rapid movement of a wildfire towards the Northeast. This recommendation shows a stop just South of Jenkins Peak. For the sake of prioritization, this treatment location ends here, though any work on that corridor is encouraged for improved tactical options south of Evergreen and improved ingress/egress to the area.

The highest priority section of this treatment is the southwestern area, between Bear Mountain Trail and Yankee Creek Road. Not only does this area have very high risks and high burn probability but treating here will provide better suppression options during a wildfire. Dense vegetation on north-facing slopes will contribute to extreme fire behavior unless mitigated.

Mountain Area Land Trust should work closely in this area to mitigate properties that fall within this treatment boundary. This location is adjacent to Hicks Mountain and Elephant Butte, both managed by Denver Mountain Parks. All work should be tied to previously completed wildfire mitigation by Jefferson Conservation District along Upper Bear Creek Road, Colorado State Forest Service along the southern border, and ongoing roadway mitigation.

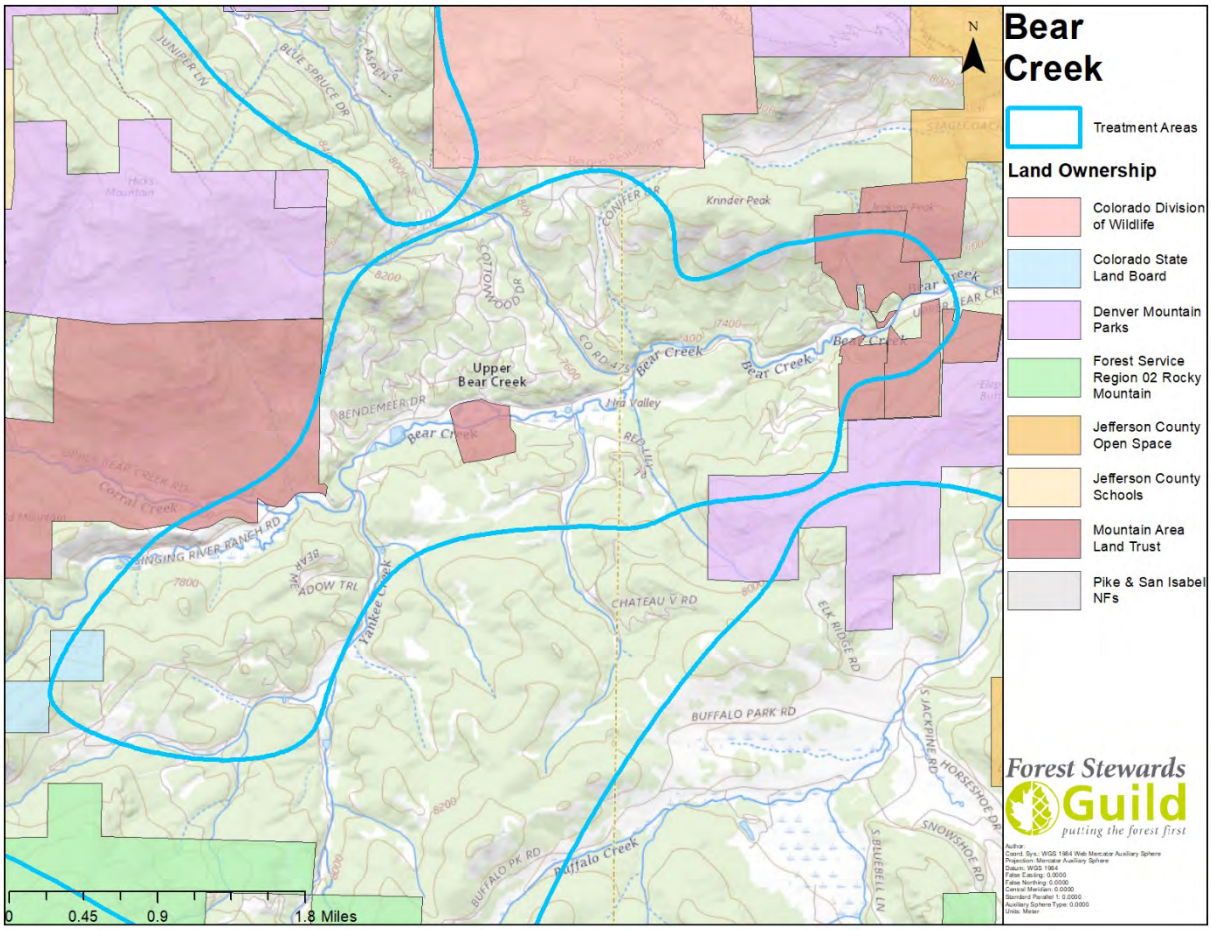


Figure 40. Bear Creek priority treatment area and ownership.

Brook Forest

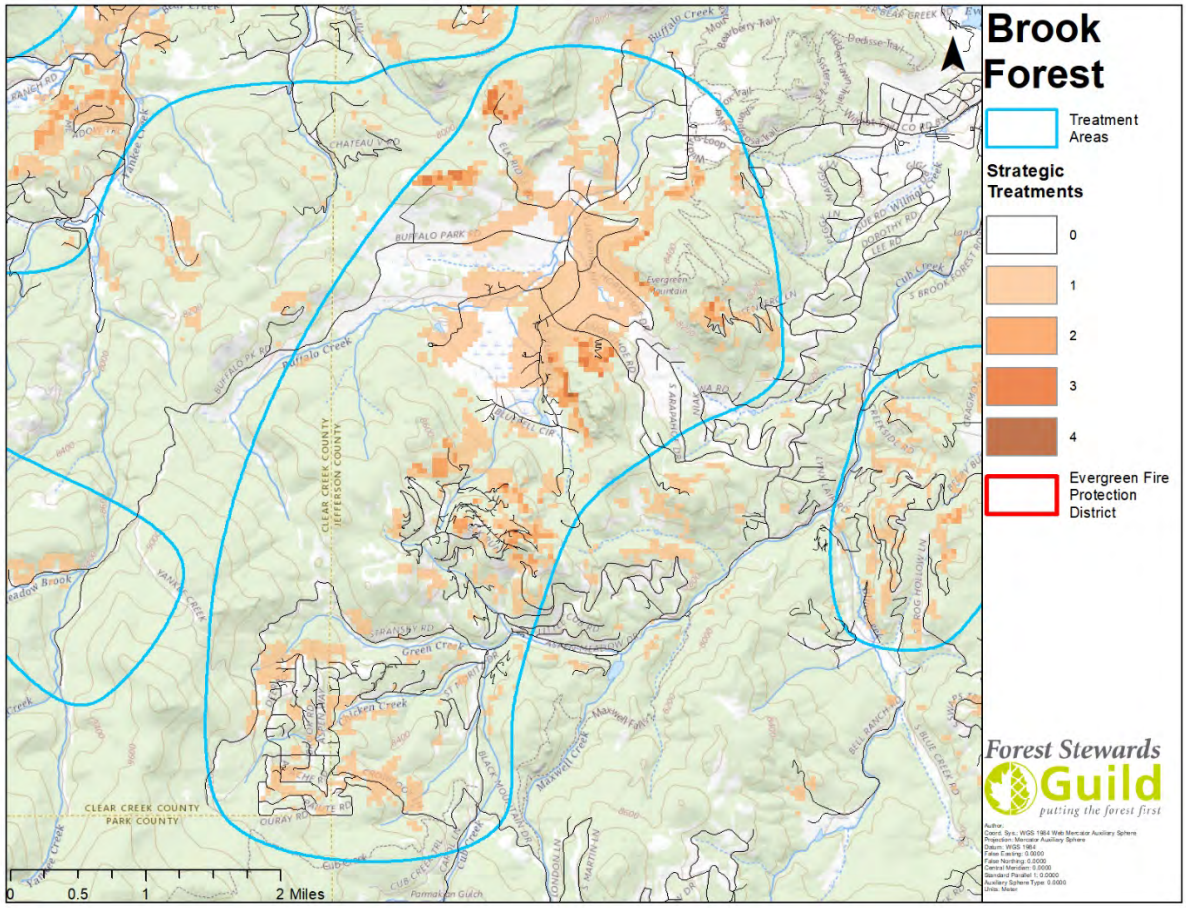


Figure 41. Brook Forest priority treatment area.

This treatment area is important to improve tactical options for fire suppression and protect residential areas from intense wildfire behavior. The southern end of this treatment recommendation is fully residential, surrounding Brook Forest Estates. Hazardous fuels remain in these residential areas that need to be reduced. In the more central area of this treatment recommendation, wildland fuels between Bluebell Circle and Snowshoe Road remain high and will contribute to intense fire behavior in the area with high spotting potential. On the northern extent of the treatment, areas near S. Elk Ridge road show extreme fire behavior and must be treated where accessible.

The highest priority section of this treatment is central, between S Brook Forest Drive and Snowshoe Drive. This area has very high risk and high burn probability with a great deal of population living here. Dense vegetation must be treated aggressively where accessible to provide protection for residents, structures, and first responders.

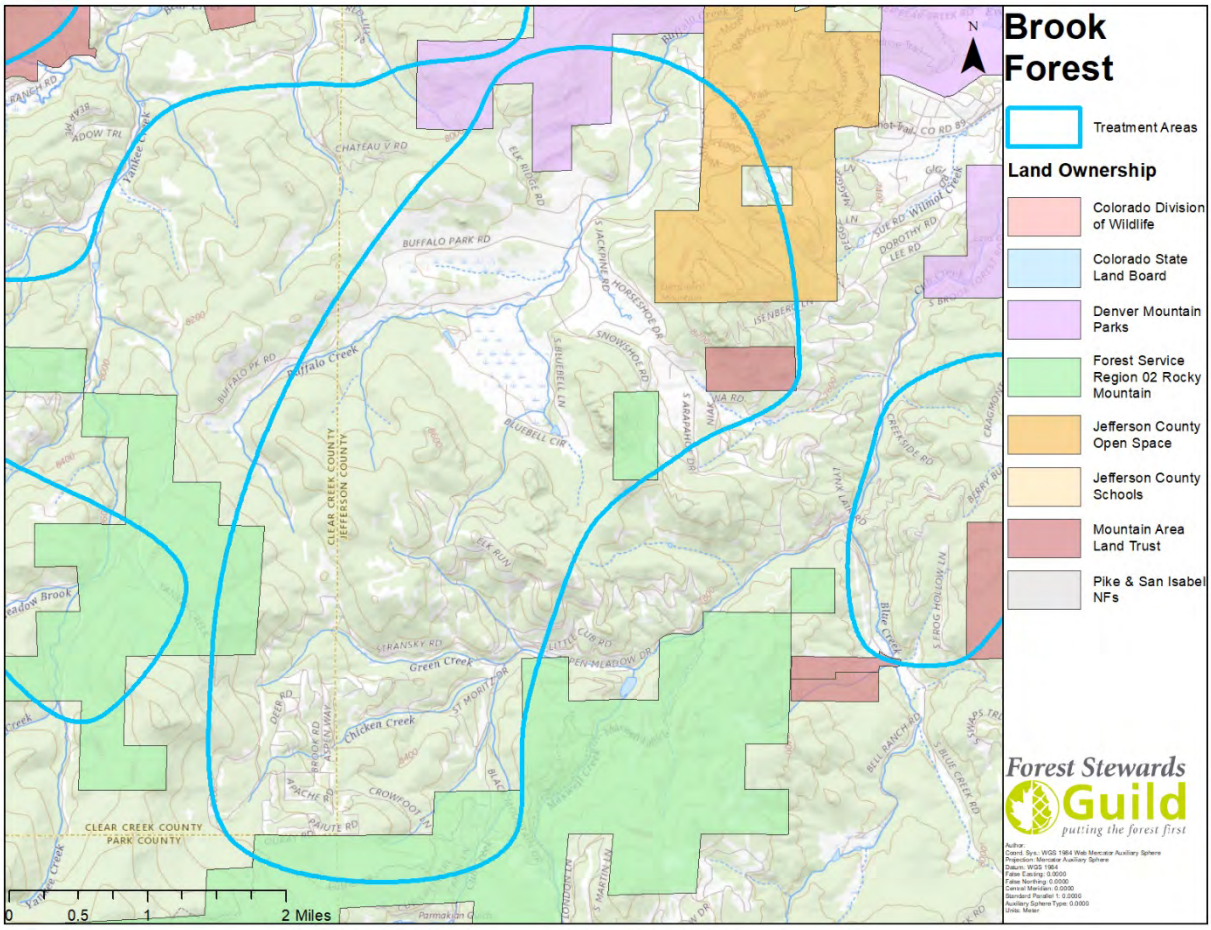


Figure 42. Brook Forest priority treatment area and ownership.

The U.S Forest Service borders much of this recommended area in the south. Their wildland fuel reduction has made a positive contribution and must continue to improve. Jefferson Conservation District has also worked with private landowners in the south, which is a place to tie in future wildland fuels modification. The northeast boundary of this treatment area occurs on Alderfer/Three Sisters, managed by Jefferson County Open Space. Mitigation has already occurred in the park, east of the treatment boundary – the models indicate this area has been sufficiently thinned for wildfire risk. Increased implementation on the southwest portion of the park would contribute to this location, though portions of this area in Alderfer do not show up on **Figure 41** due to steep slopes and would be difficult to treat. This treatment ends to the northwest by Elephant Butte. Much of Alderfer/Three Sisters is not accessible for mitigation, but work done in the area by Denver Mountain Parks and Colorado State Forest Service provides a great anchor for work along S. Elk Ridge Road.

Lone Peak

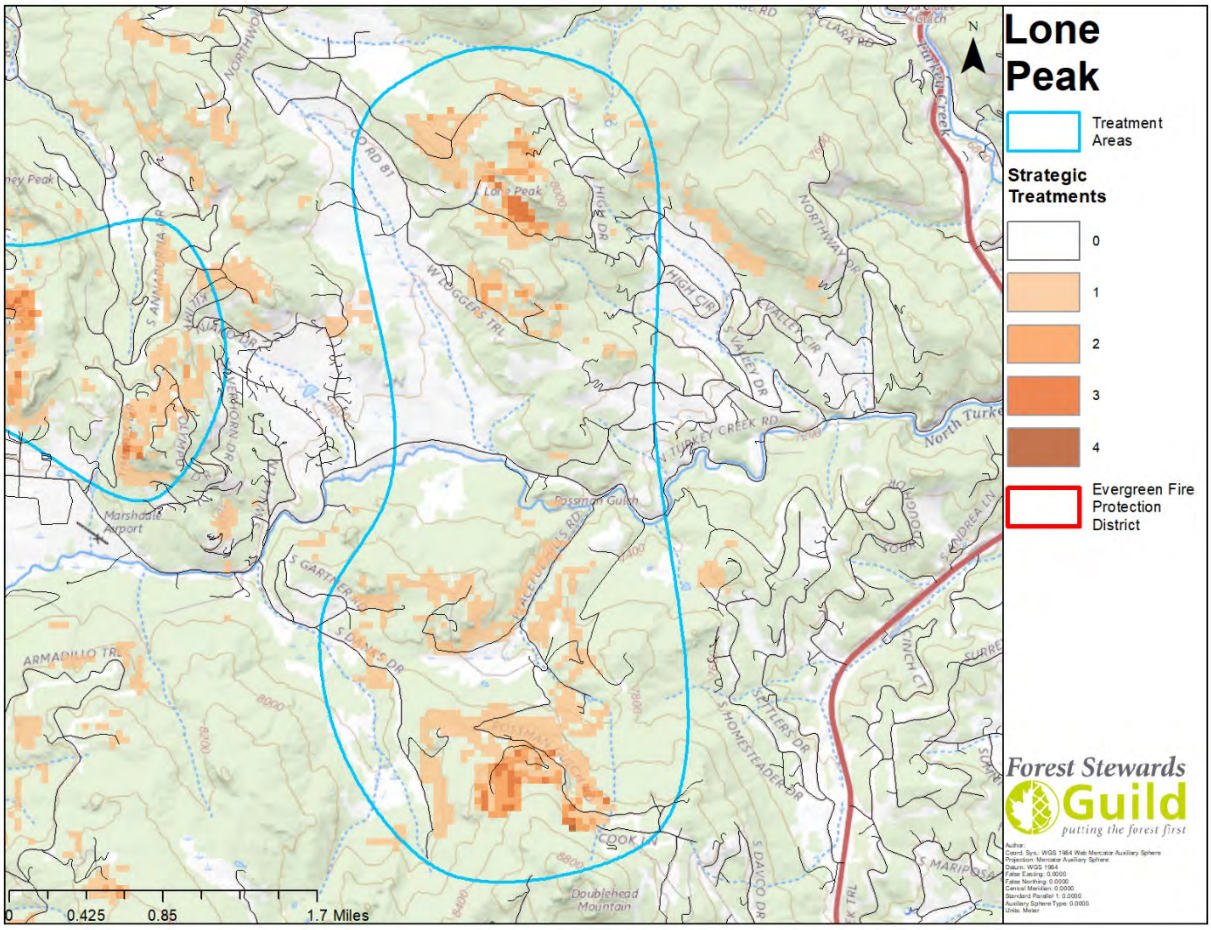


Figure 43. Lone Peak priority treatment area.

This treatment starts on the northern side of Doublehead Mountain where slope and road access would allow mitigation. Intense fire behavior exists in the area surrounding Rossman Gulch Rd. to be mitigated for protection of residents and provide tactical options before wildfire moves out of the district towards U.S. 285. Treatment should extend north towards Lone Peak to protect the residential areas surrounding Lone Pine Estates and anchor to open areas along N Turkey Creek Road. On the northern end of the treatment, the accessible areas around Lone Peak are a priority treatment area to prevent intense fire behavior and spotting, allowing for first responders to have successful suppression in the area.

The highest priority section of this treatment is the accessible areas of and around Lone Peak. This is one of the highest burn probability areas in the Evergreen Fire Protection District. With the higher population in this area, it is going to be the first place in this treatment area to improve with local landowners.

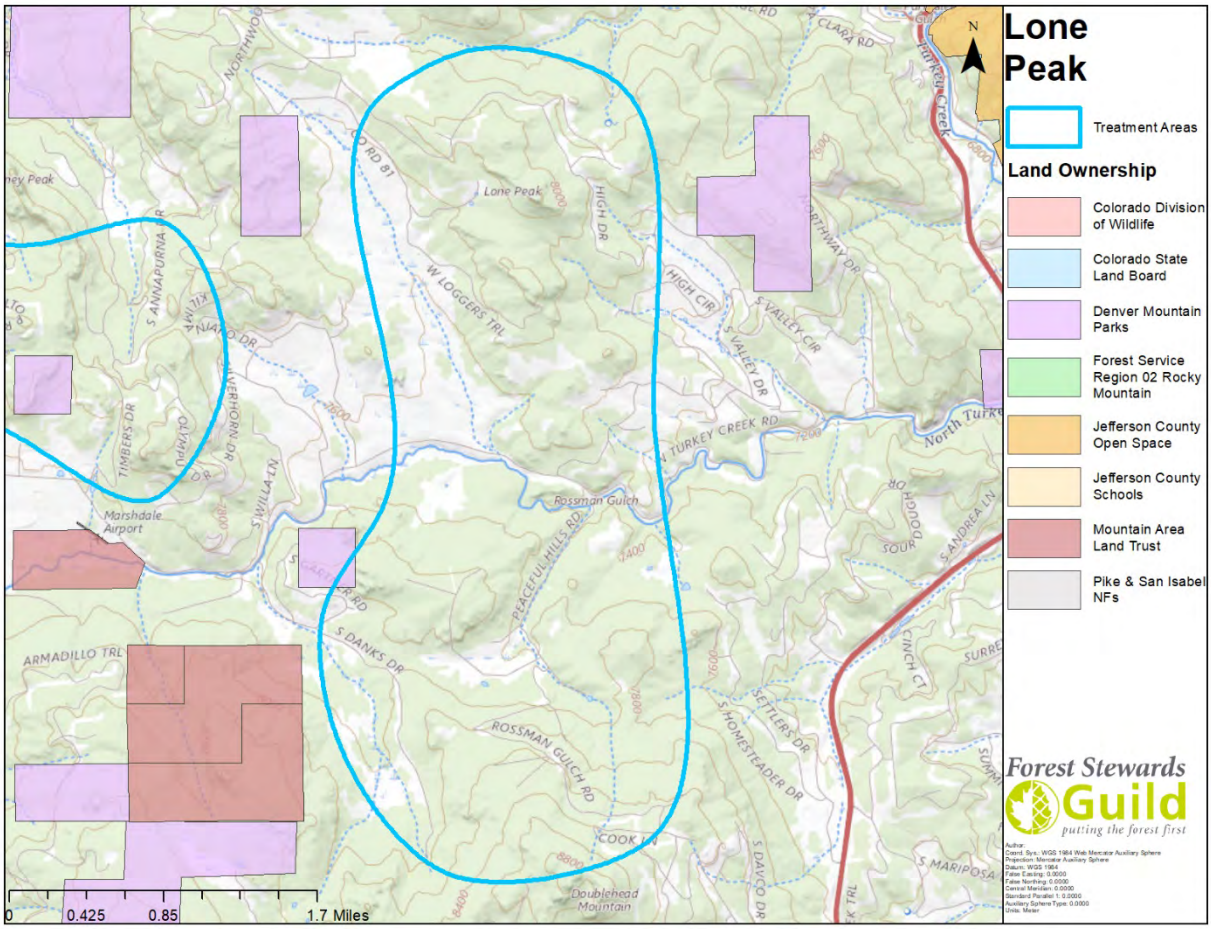


Figure 44. Lone Peak priority treatment area and ownership.

Just to the southwest of this treatment area, the Colorado State Forest Service and the Jefferson Conservation District have completed helpful work in coordination with the Mountain Area Land Trust that should be utilized to anchor and improve this location. This recommended treatment area flanks a few areas of Denver Mountain Parks ownership, but their properties here are in good shape overall. Much of this area is held privately and all residents should work to improve defensible space and work with local technical assistance to implement large scale treatments.

Bear Mountain

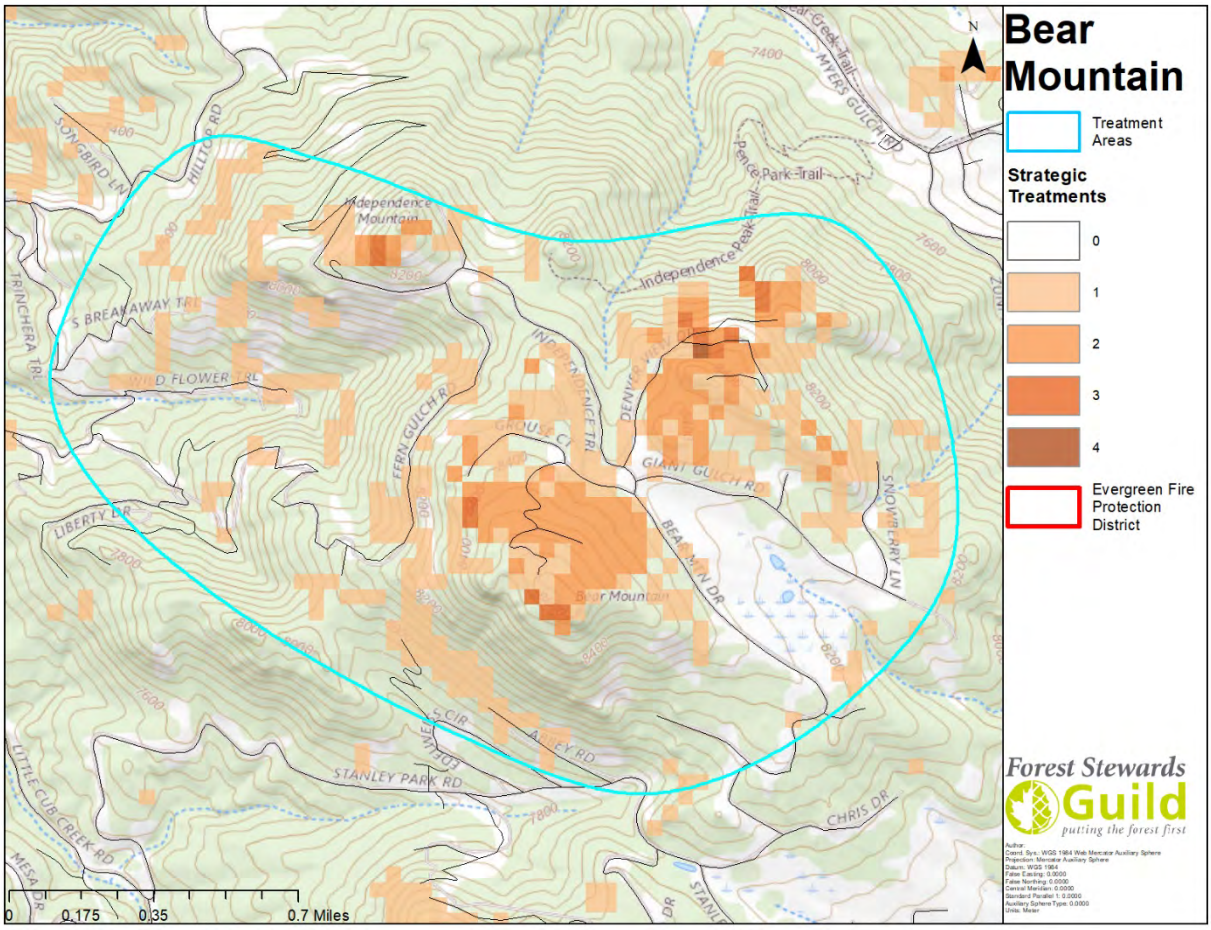


Figure 45. Bear Mountain priority treatment area.

This treatment area has steep slopes and dense wildland fuels. Any accessible area here should be mitigated promptly to allow improved tactical options and prevention of escape towards Parmalee Gulch. Residents in this area must work with local technical assistance to create defensible space that will contribute to this landscape-scale treatment. Areas surrounding Bear Mountain's peak and around S. Denver View Dr. are of highest priority, though this entire treatment is of high importance.

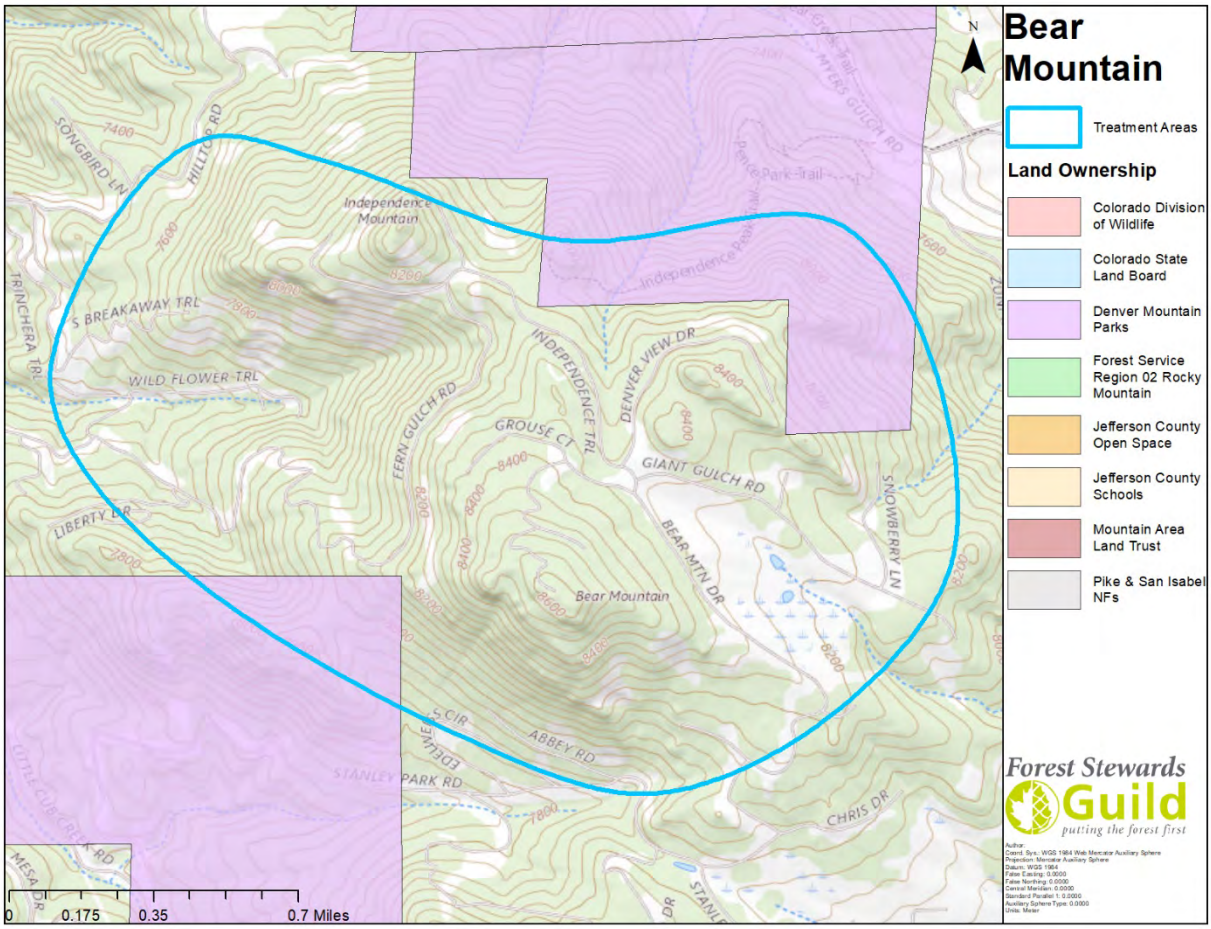


Figure 46. Bear Mountain priority treatment area and ownership.

Denver Mountain Parks has two adjacent areas, Pence Park and Bell Park, that should develop wildfire mitigation in coordination with this high-risk area. Much of the parks have lower fire risk than some of the residential areas, but coordination between residents and the parks will improve communication and access. Proximity to downtown Evergreen and many values at risk in this area are additional considerations to be made when planning treatments for Bear Mountain.

Marshdale

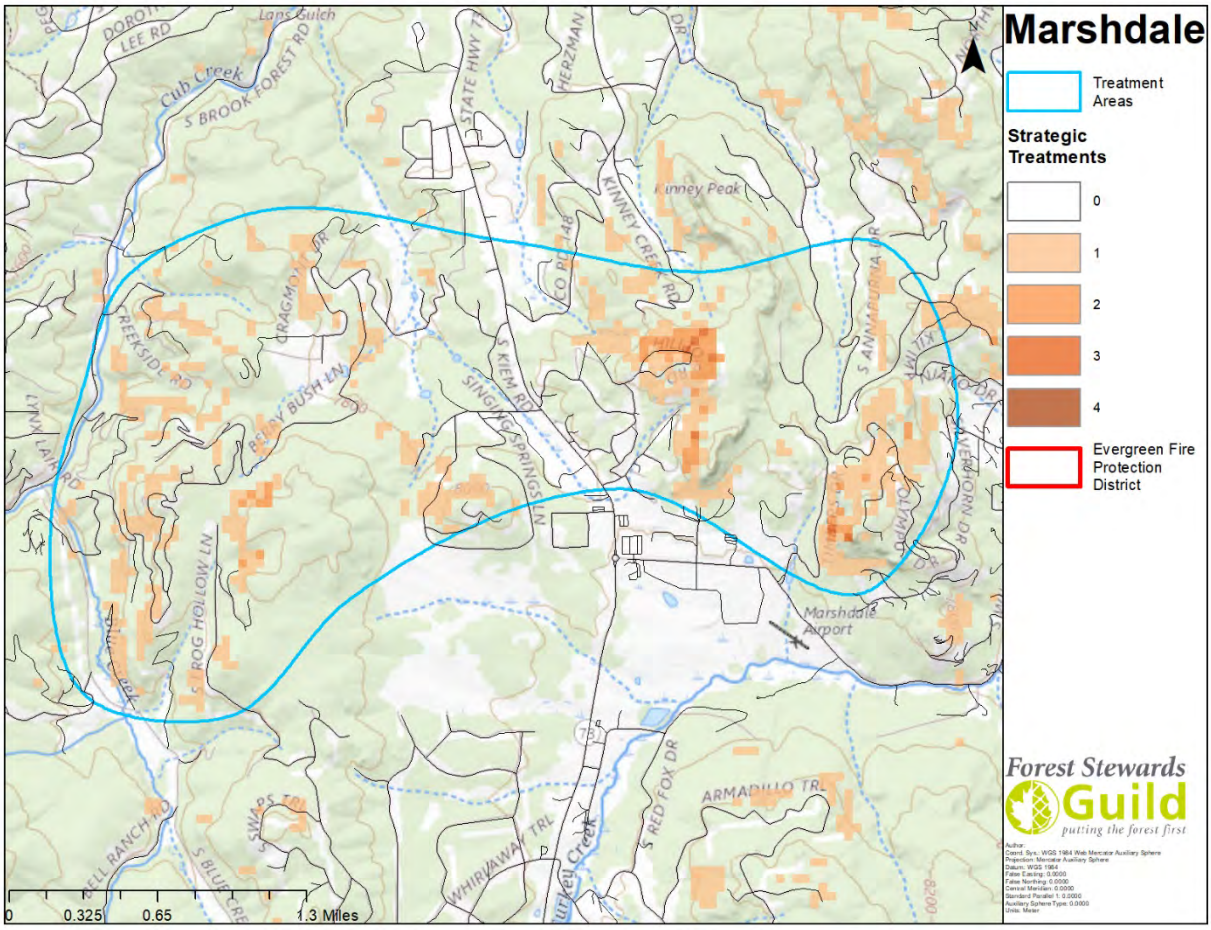


Figure 47. Marshdale priority treatment area.

This treatment area starts, to the west, along S. Blue Creek Rd. and S. Brook Forest Rd. with high fuel loading in residential areas. Moving east and across Highway 73, a high-risk area occurs around Hilltop Rd. and extending into Hobbs Peak, a Denver Mountain Park. Then to the eastern extent of this treatment, fuels along Timbers Dr. are dense and will contribute to extreme fire behavior affecting many residents in the area.

The highest priority section of this treatment is central, around Hilltop Road. This area has very high burn probability. A treatment here could provide a great opportunity to stop a wildfire moving through this populated area.

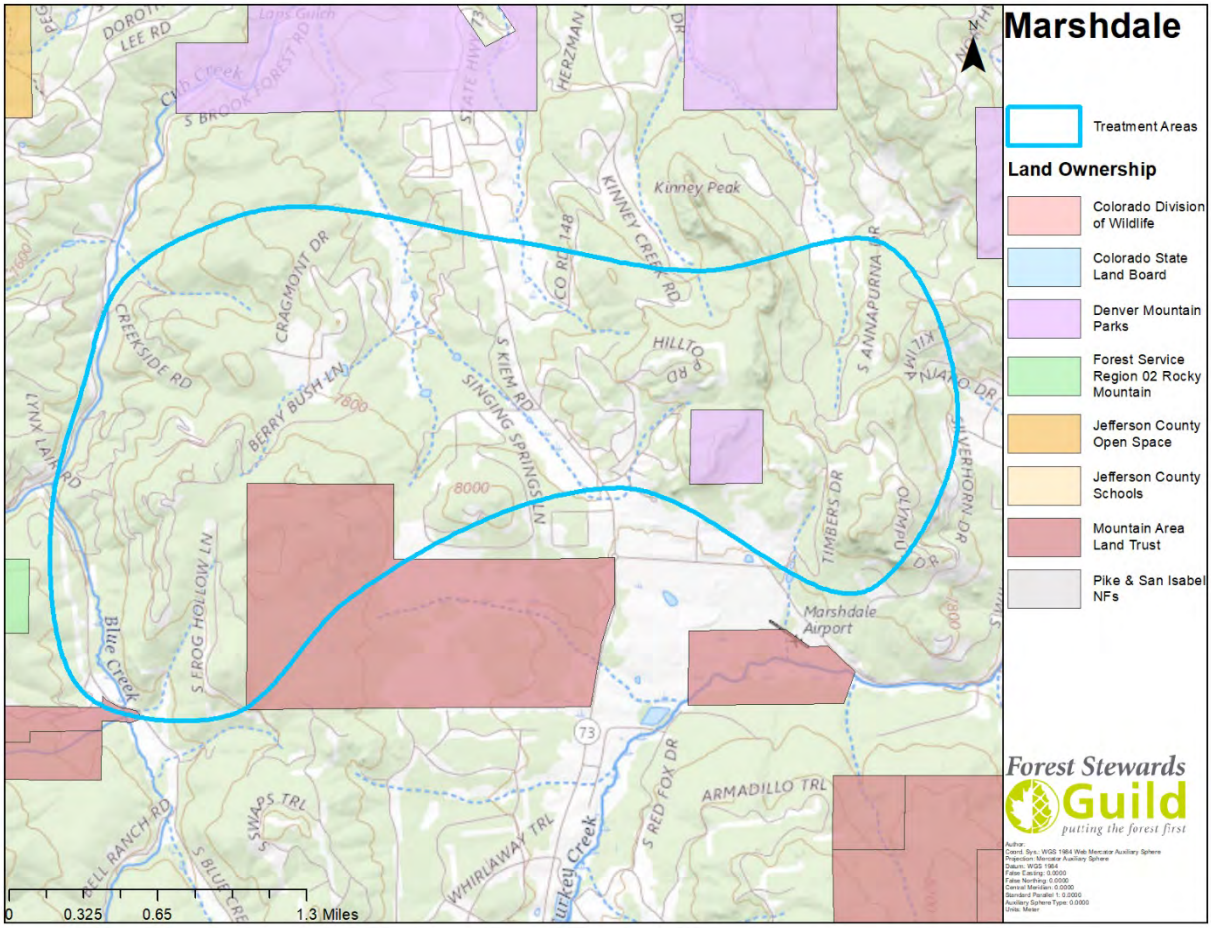


Figure 48. Marshdale priority treatment area and ownership.

Colorado State Forest Service has contributed to many projects in this area, including vegetation reduction along Creekside Rd. and in the North Turkey Creek community. Mountain Area Land Trust has land in this area that should work to lessen wildland fuel loading, particularly in the area around S Frog Hollow Lane. Denver Mountain Parks should also work in this area to mitigate their small property in the Marshdale area. Much of the surrounding area to this treatment is well mitigated with low fuel loading. Work in this treatment area will have a major impact and create a sustainable living situation for these residents.

Kerr Gulch

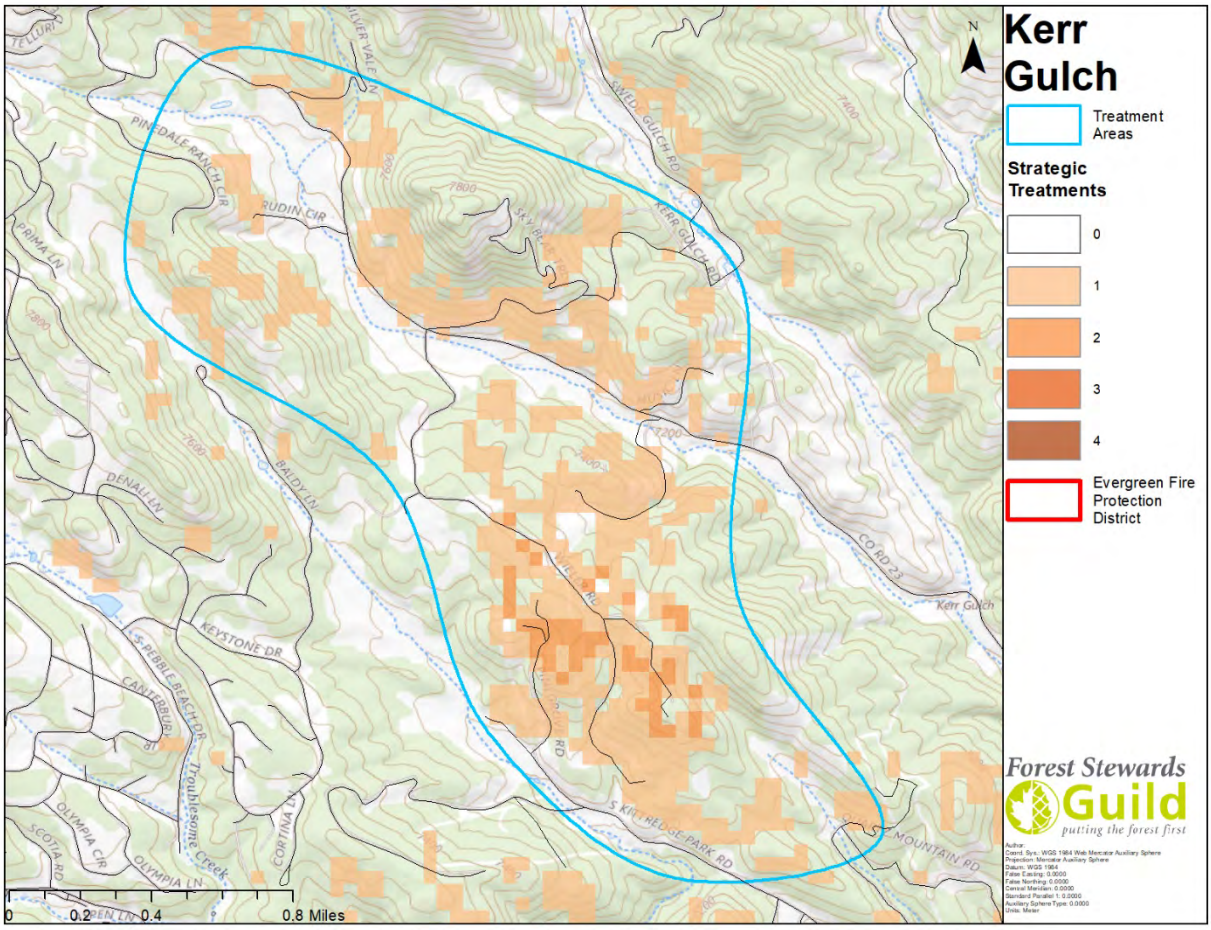


Figure 49. Kerr Gulch priority treatment area.

This treatment starts to the south along Kittredge Park Rd. with heavy fuel loading on accessible slopes. The area surrounding Wieler Rd. and Freehouse Hill Rd. is of highest priority as many homes are at risk and the fire intensity in this area will create a difficult tactical environment for communities nearby. Towards the north end of this recommended treatment area, following Kerr Gulch Rd. burn probability is high and threatens to bring fire east and out of the Evergreen Fire Protection District.

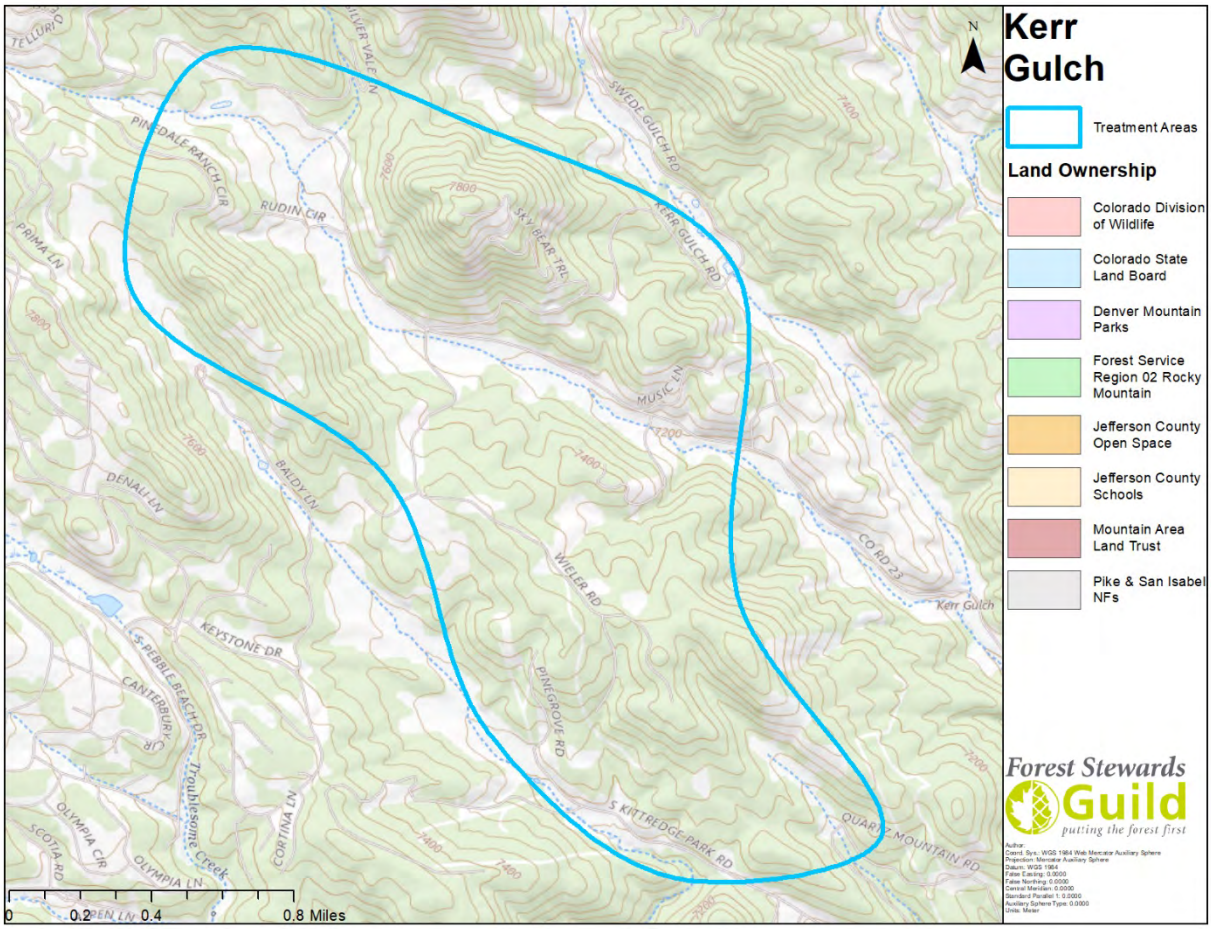


Figure 50. Kerr Gulch priority treatment area and ownership.

This treatment area should anchor to the Colorado State Forest Service thinning to the north which shows considerably lower intensity fire behavior. This treatment area is all private lands and will require resident participation in wildfire mitigation. These projects will allow residents safer egress during a wildfire and increased likelihood that firefighter personnel will be able to defend this area. This treatment will provide crucial tactical options that must be prioritized by local property owners.

Saddleback Mountain

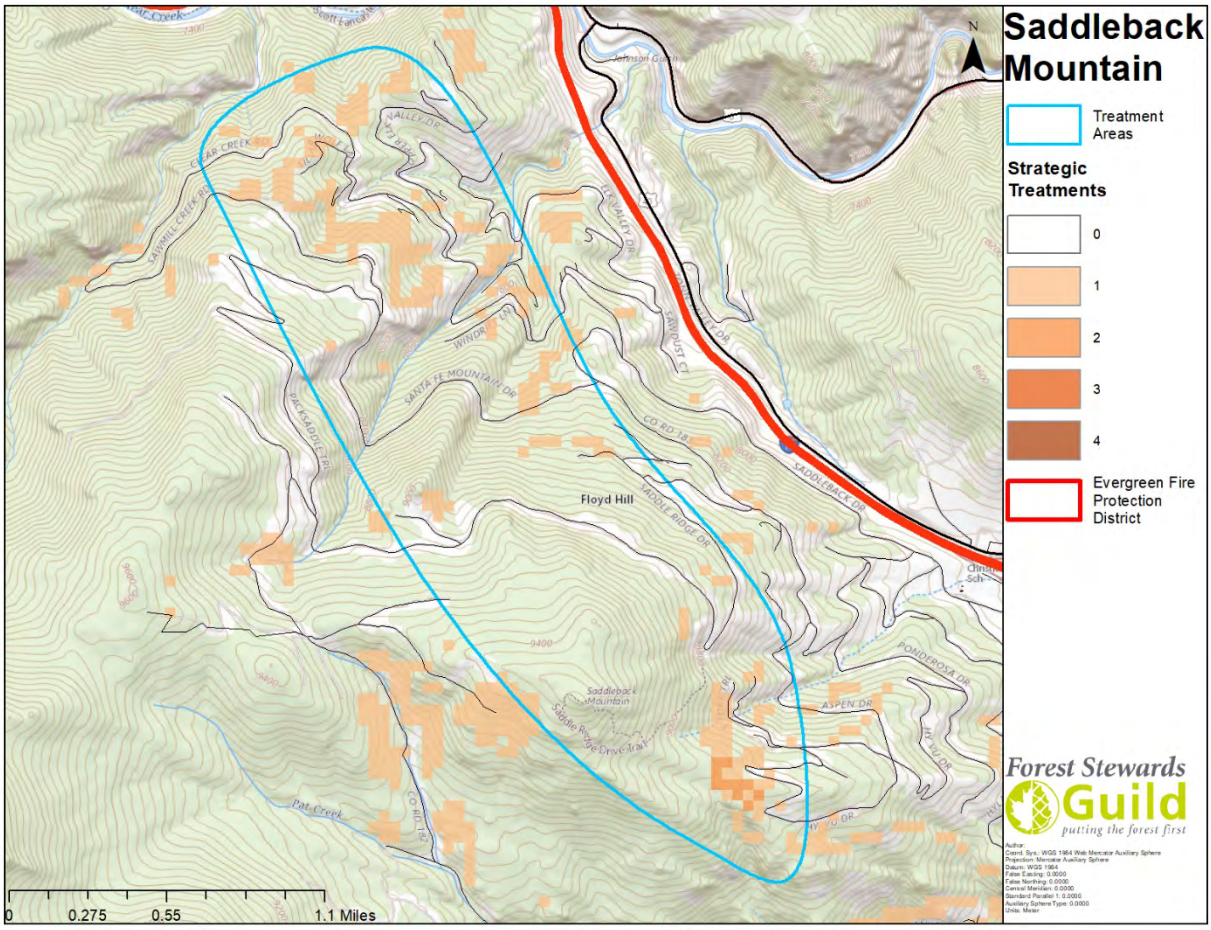


Figure 51. Saddleback Mountain priority treatment area.

This treatment mostly follows the western edge of the Floyd Hill Plan Unit. On the northern extent of the treatment area, Sawmill Gulch should be treated, moving into the residential areas and towards Johnson Gulch. Much of the Saddleback Mountain area, moving south, is not easily accessible, but full of dense vegetation and steep slopes. Fuels treatments will make this area more defensible during a wildland fire and increase protection options of the residential area.

The highest priority area is at the southern end of this treatment boundary, along Aspen Dr. and Hy-Vu Dr., pockets of extreme fuel loading threaten to bring wildfire from the west into the residential areas. A fuel treatment will provide tactical options and lessen the ember wash into the neighborhood.

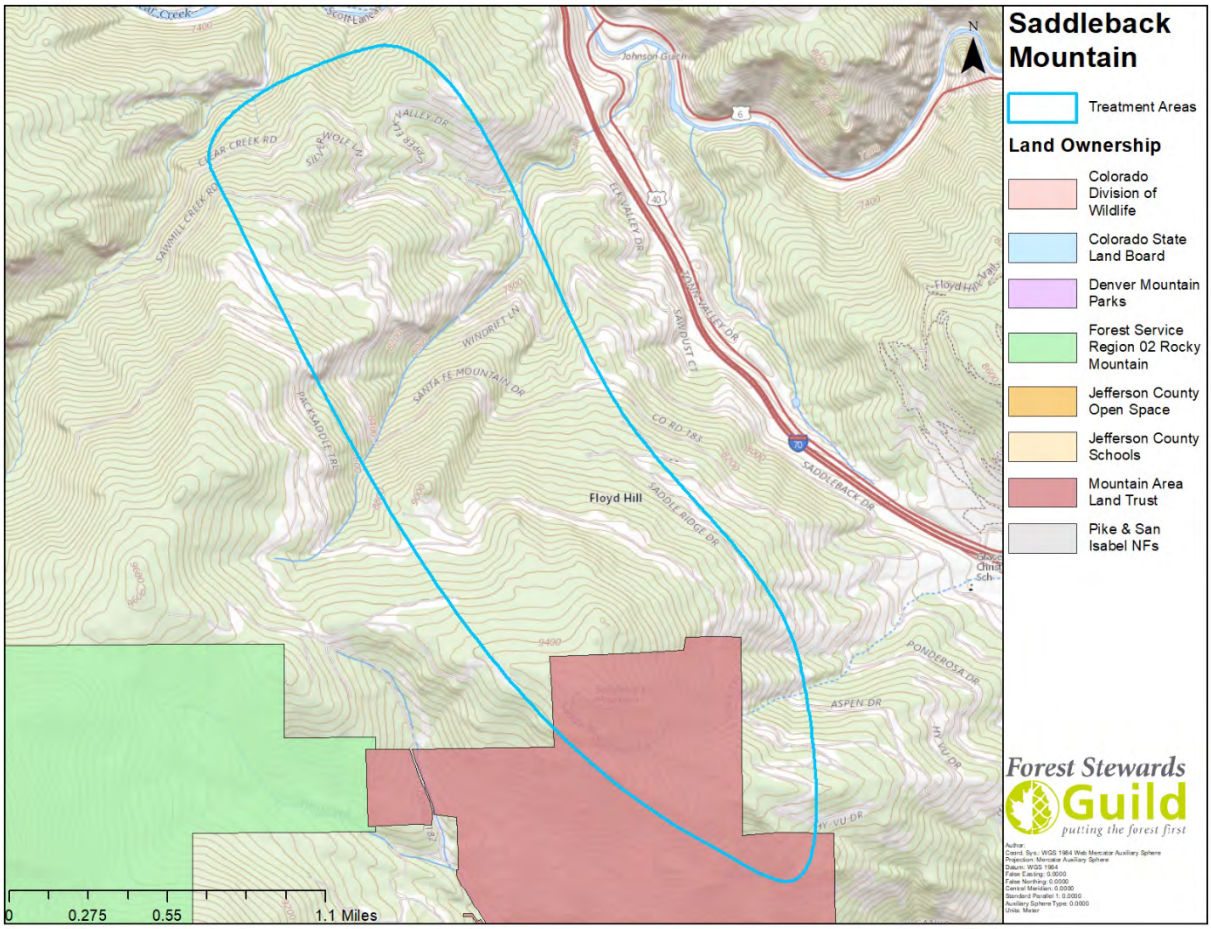


Figure 52. Saddleback Mountain priority treatment area and ownership.

Treatment along Beaver Brook Canyon Road is helpful for tactical options west of many residences and can be expanded to the north or east to improve connectivity with this treatment area. Much of the land in the southern extent is owned by Mountain Area Land Trust and the U.S. Forest Service. Wildfire mitigation on this land should collaborate with residential areas working to expand defensible space and complete larger scale fuel treatments.

Southwest Tactical

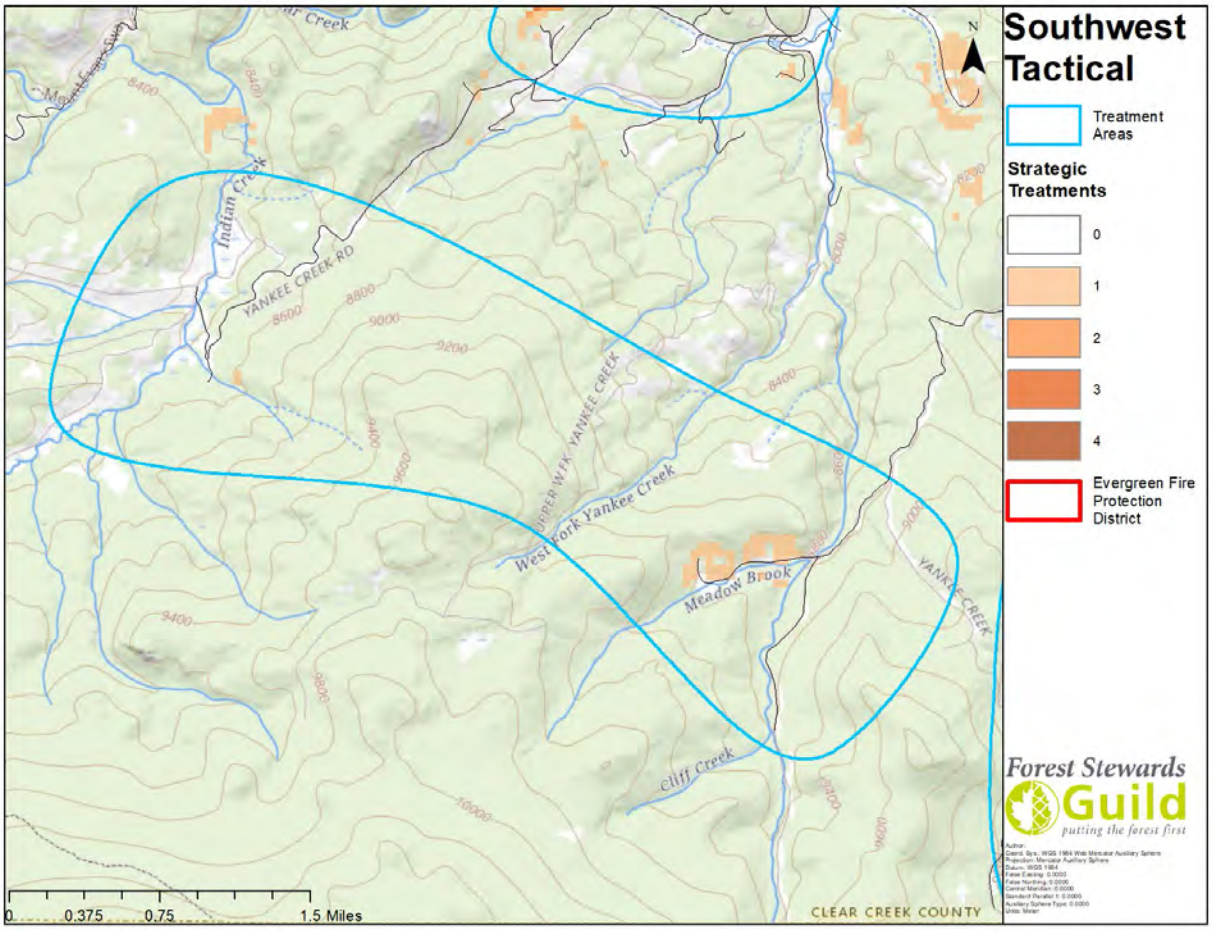


Figure 53. Southwest Tactical priority treatment area.

A slightly different treatment than the others, this recommendation is intended to suggest a fuel treatment boundary that will serve all the Evergreen Fire Protection District. Wildland fuels in this southwest corridor make all of Evergreen vulnerable to a northeast-travelling wildfire. The proposed treatment boundary spans the distance between Indian Creek Park Cabin Sites and slightly beyond Buffalo Park Rd. On the east and west sides of this proposed treatment area are existing wildland fuels treatments. This connection between those treatments will be vital to Evergreen Fire/Rescue and the U.S. Forest Service by providing a large-scale tactical option for wildfire moving into the district. Much of this area does not show up on **Figure 37** because it is less accessible for treatment. This area is recommended nevertheless due to its high tactical importance.

The highest priority area of this treatment is on steep slopes, but at the beginning of the West Fork of Yankee Creek, extreme burn probability exists and will produce challenging fire behavior during a wildfire. Using existing riparian and road corridors to begin this treatment should be considered a starting place for this treatment area.

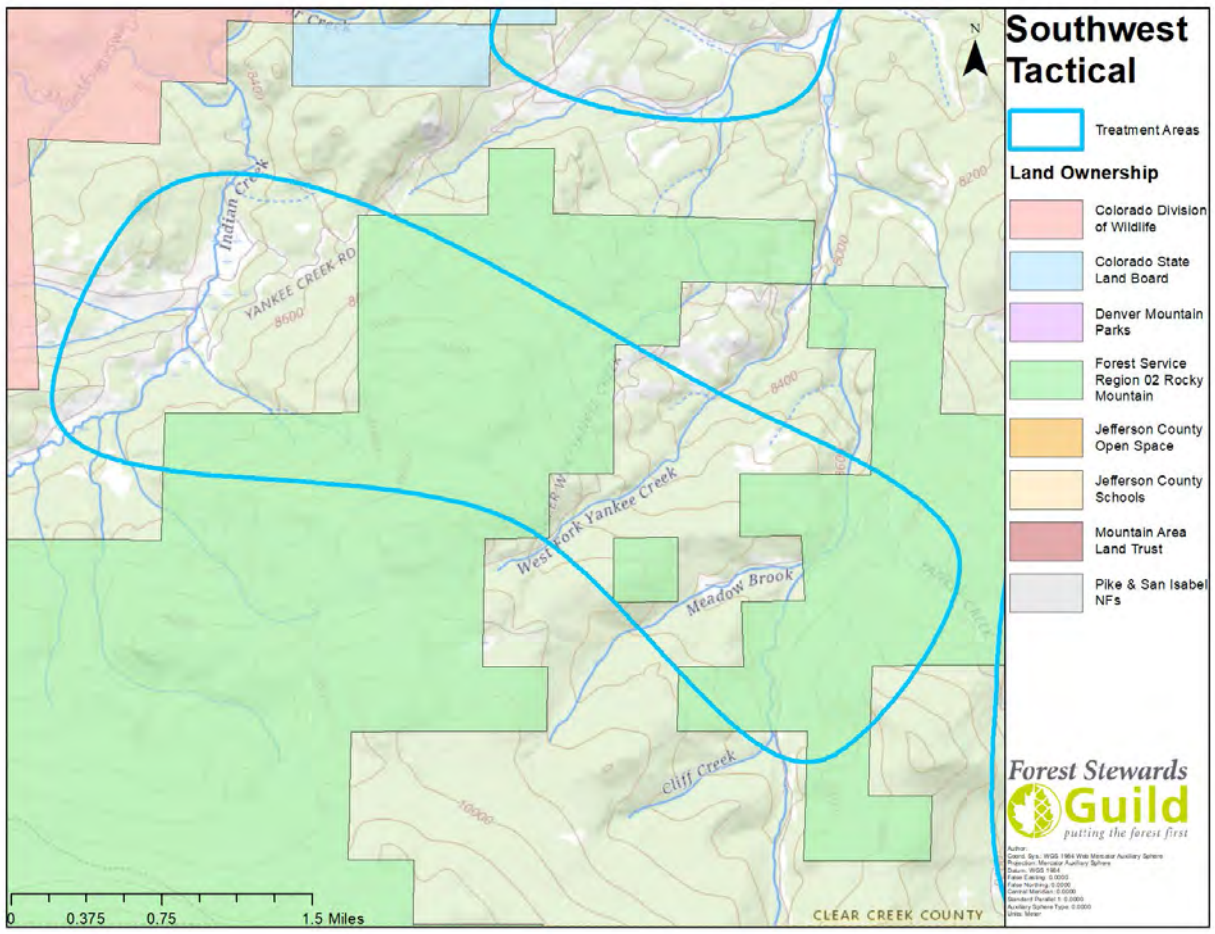


Figure 54. Southwest Tactical priority treatment area and ownership.

A large majority of this treatment area is on U.S. Forest Service land. Connecting mitigated areas on either side from the Colorado State Forest Service and Jefferson Conservation District will be vital to the success of this treatment as a tactical option. Few structures exist in this treatment boundary, but structures in adjacent Brook Forest and Bear Creek West Plan Units will benefit greatly from this treatment, as well as many vital watersheds in this portion of Western Evergreen.

Evans Ranch

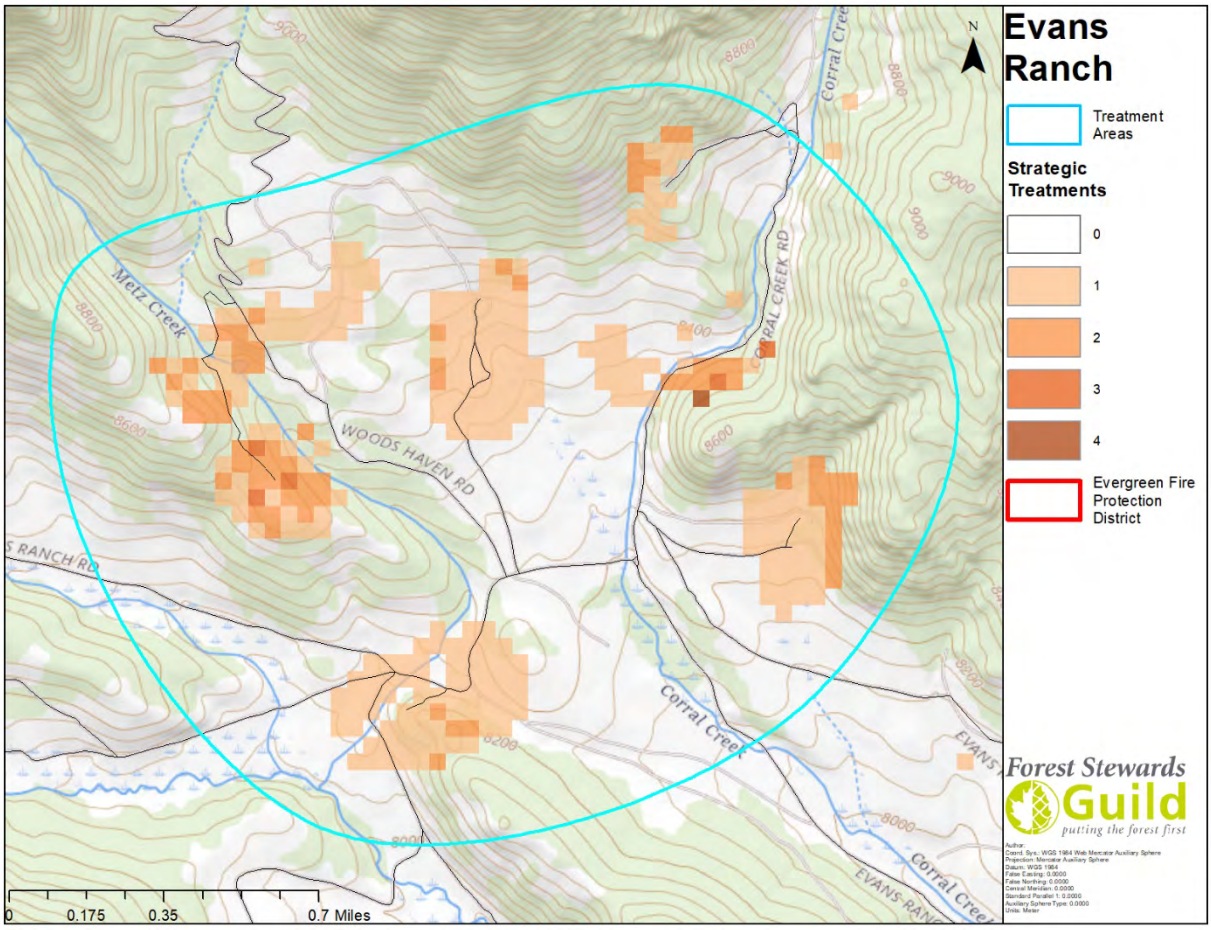


Figure 55. Evans Ranch priority treatment area.

In the Western Evergreen Plan Unit, many high peaks with intense fuel loading remain, but this is an area with high risk and accessibility for fuel treatment. Between Haystack Canyon, Metz Creek, and Mount Susan, wildland fuel treatments can serve to protect adjacent communities and values at risk. Heavily timbered areas here can anchor to more open areas within this treatment area. Having this location to anchor tactical treatments to in the Corral Creek corridor will provide great benefit to first responders, and to the very vulnerable, Witter Gulch Plan Unit to the northeast.

The highest priority area of this smaller treatment area is along Corral Creek, working to create a buffer for Jefferson County School property. In this riparian corridor, fire size is expected to grow very quickly. Treatment prescriptions should consider this fact and be designed not to increase rates of spread.

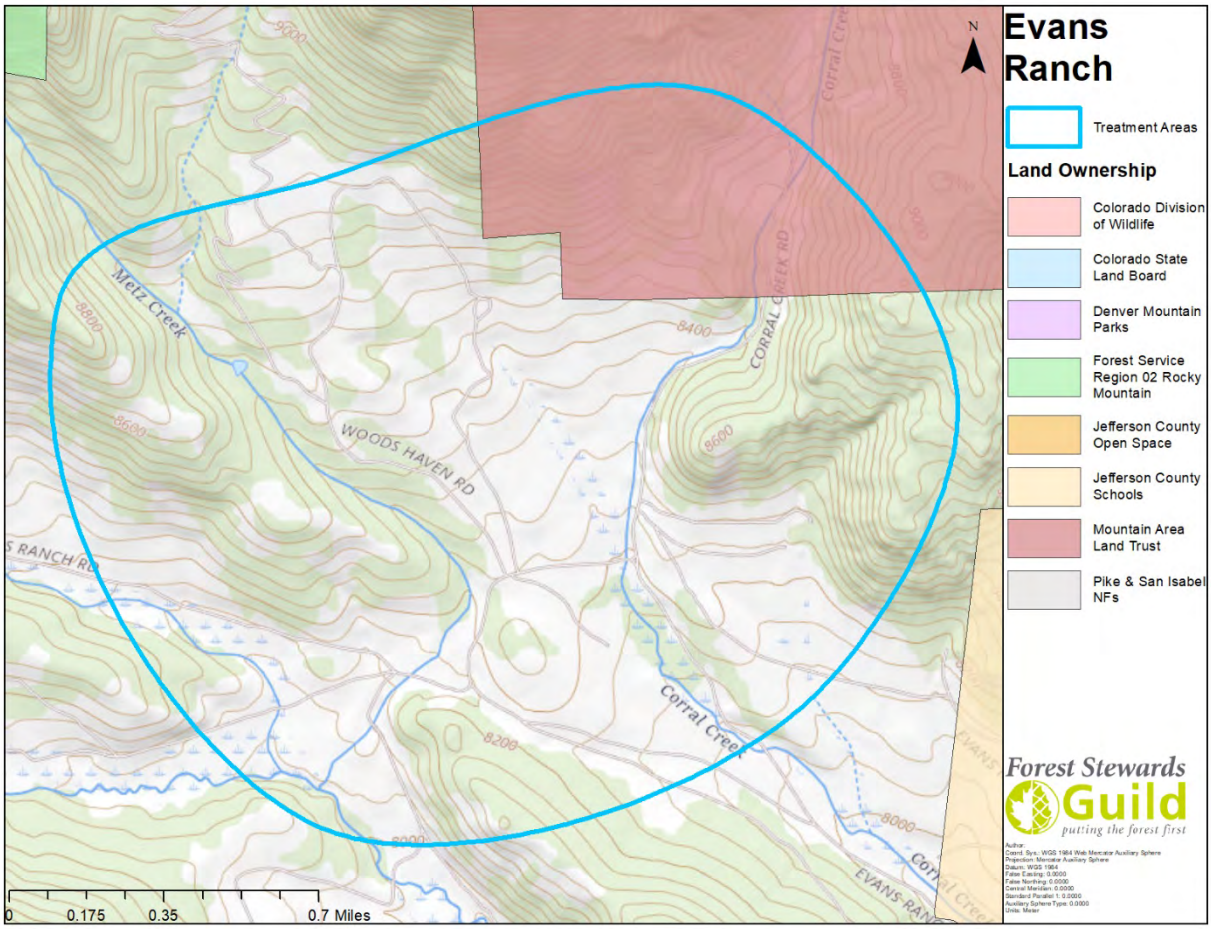


Figure 56. Evans Ranch priority treatment area and ownership.

Adjacent land ownership in this area is U.S. Forest Service, Mountain Area Land Trust, and Jefferson County Schools. With the Mt. Evans Outdoor Lab in this area, the Evans Ranch treatment area is vital for life safety. Much of the other areas surrounding these values at risk will be less accessible for mitigation work, so treating this area will improve tactical options and egress outcomes during a wildfire. Adjacent areas managed by Denver Mountain Parks should mitigate in relation to this treatment where accessible for continued landscape scale treatment.

Witter Gulch

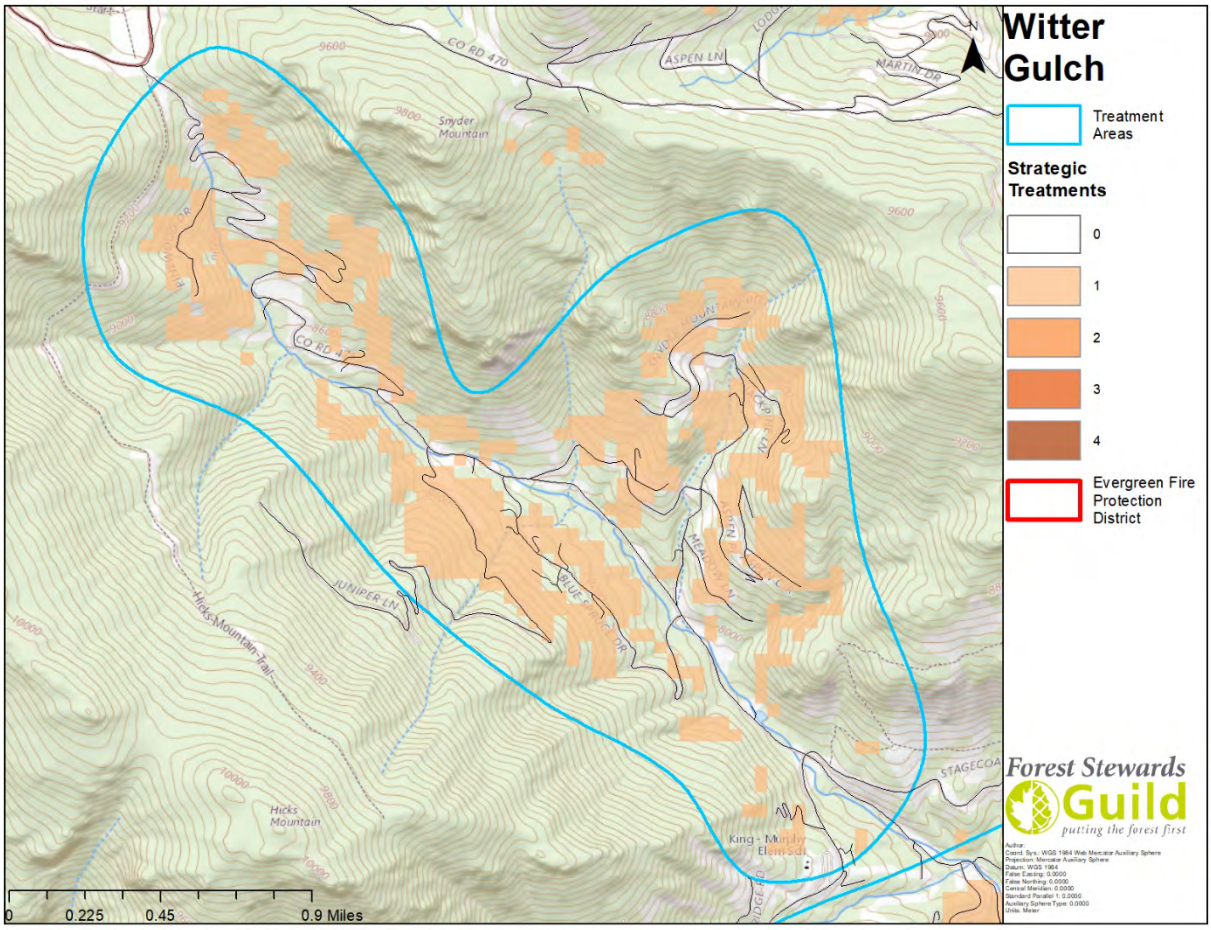


Figure 57. Witter Gulch priority treatment area.

This is a highly residential area, which may seem unusual for large scale treatment, but the fire risk in this area is so high, that it will negatively impact many other communities and values at risk if left as it is now. The north face of Hicks Mountain has some of the most intense fuel loading in the Evergreen Fire Protection District and must be reduced where possible. All accessible areas must be mitigated in this fuel treatment area, as the surrounding area has extreme wildland fuel loading. This treatment starts at the base of the gulch, near Circle K Ranch Rd and King Murphy Elementary and Preschool. This school and the surrounding community needs substantial wildland fuel reduction to be defensible. On the northwest end of the treatment, this proposed area ends where slope becomes too high along Witter Gulch Rd.

The highest priority area for treatment is Snyder Mountain Drive. Fire behavior will funnel quickly up this south-facing gulch, and vegetation must be mitigated to lessen wildfire intensity and reduce rates of spread. North-facing slopes in this treatment area need treatment as well, but practitioners must consider, when writing a prescription for them, ways not to increase rates of spread in vulnerable areas like this one.

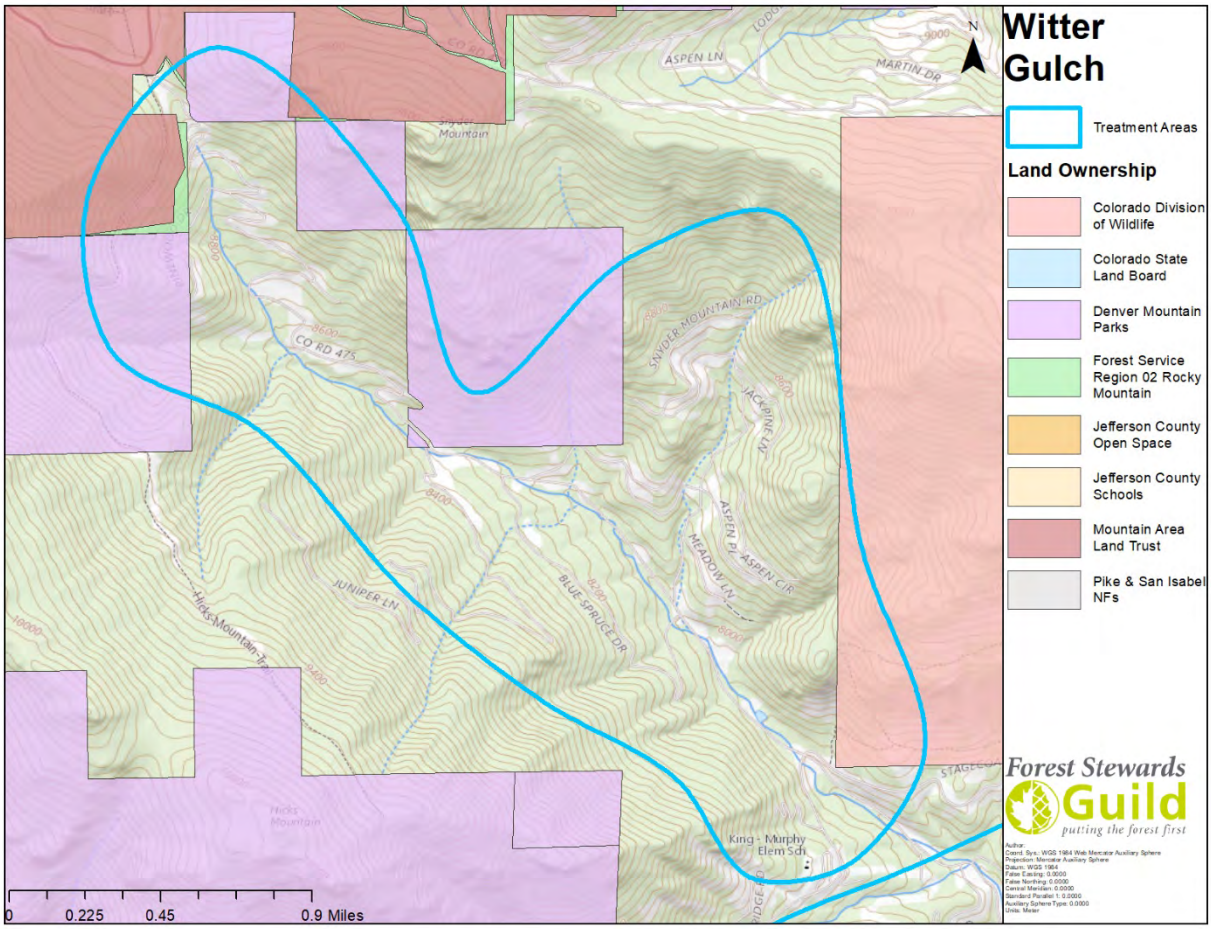


Figure 58. Witter Gulch priority treatment area and ownership.

Land ownership in this area includes Denver Mountain Parks, Mountain Area Land Trust, Colorado Division of Wildlife, and U.S. Forest Service. Where accessible, wildland fuel mitigation must be completed near to residential areas, and residents must both provide access for this work and improve defensible space of their own property. A major barrier for Denver Mountain Parks to mitigate some of their properties is access denial from adjacent residents, which serves no residents well.

Existing Priority Landscape

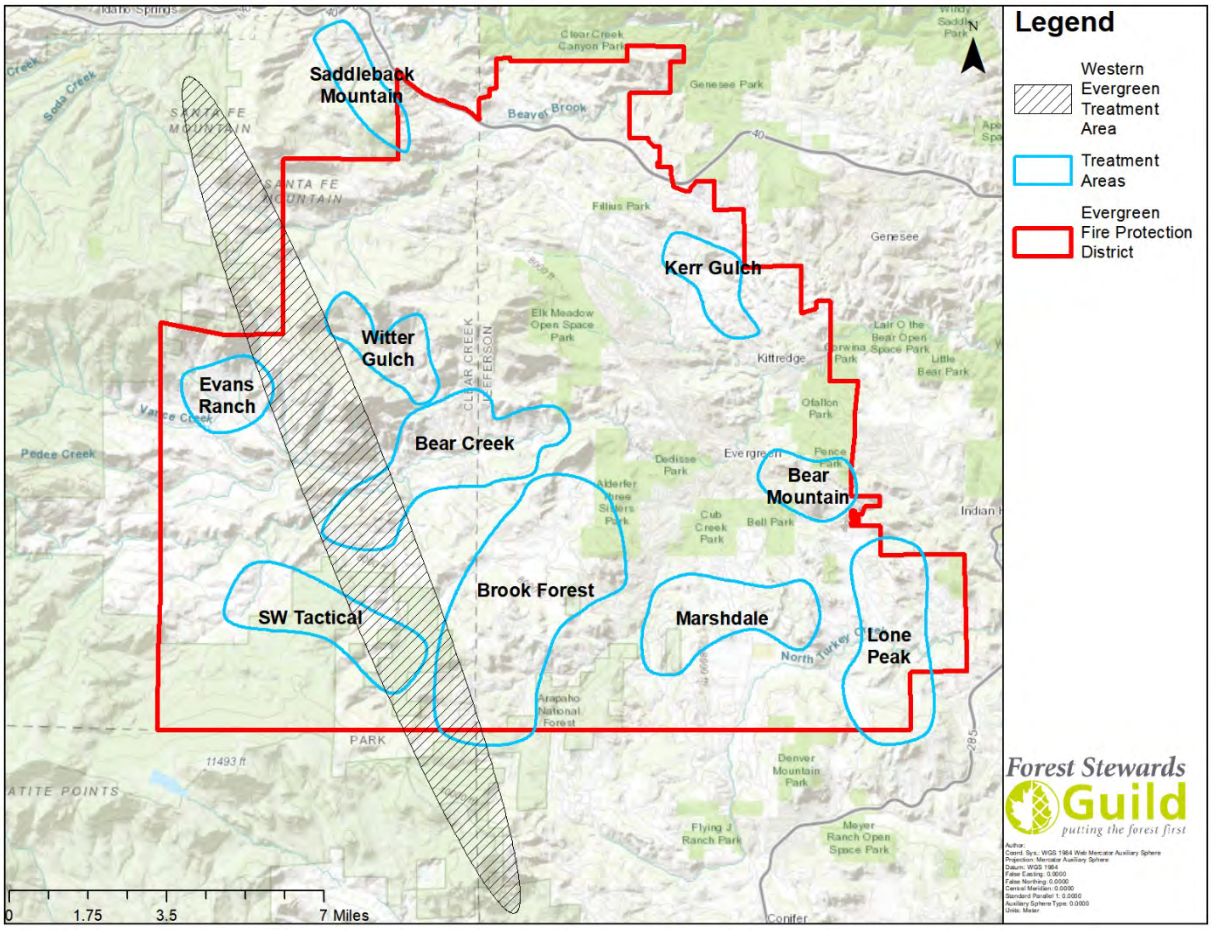


Figure 59. Western Evergreen Treatment Area

Western Evergreen has low population density and fewer property owners. A lot of time and effort has occurred before the genesis of this CWPP to implement forest management and wildfire risk reduction in this area. The prioritization plan in this document fully supports continued engagement in the treatment area depicted in **Figure 59**, which is a preliminary position that may be adjusted by further planning with involved landowners. This treatment area overlaps with other priority areas as shown and work in those new priority landscapes should serve to strengthen this priority area that existed before the CWPP was generated. With a large expanse of land to the west of the Evergreen Fire Protection District covered by the Arapaho Roosevelt National Forest, treating the western boundary of the district provides an essential operational option for fire response. This treatment location is prioritized by the existing work done, the accessibility, and the tactical option it creates. As with any fuel treatment, no one treatment will stop or prevent a wildfire, but a mosaic of treatments and tactical options for firefighters will reduce overall wildfire risk.

Values at Risk Treatment Recommendations

This CWPP analysed schools, historical sites, healthcare facilities, communication infrastructure and major power lines. Wildfire behavior near these sites that creates high risk of loss is modeled. Risk is ranked in Table 9 below where the most concerning locations are exposed and linked with an associated recommendation. Home Ignition Zone improvement recommendations to reduce structural ignitability can be found in Methods to Reduce Structural Ignitability, with special attention to historical structures.

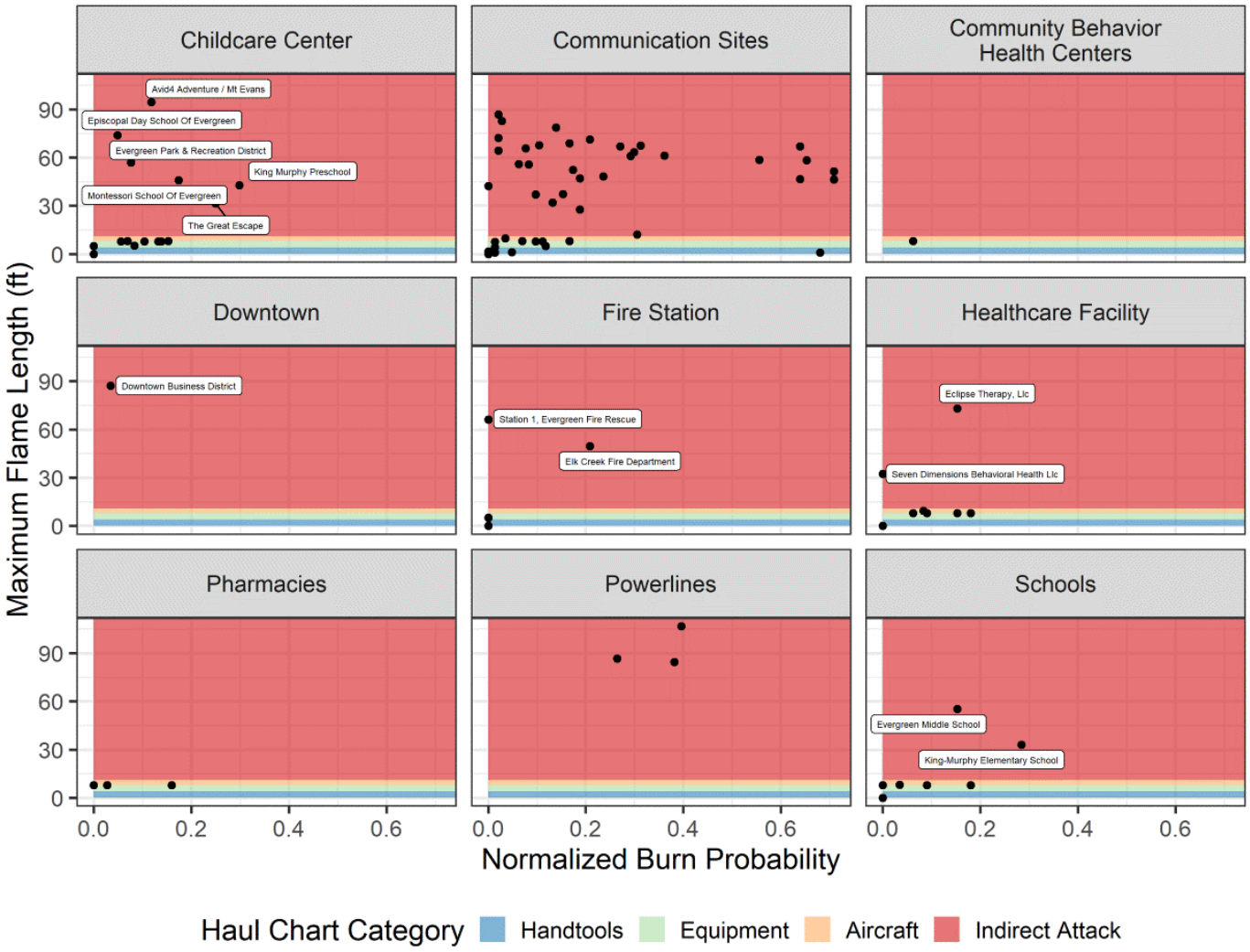


Table 9. Normalized burn probability and maximum flame lengths at each analyzed value at risk.

The flame length values are based on the Haul Chart, indicating what type of suppression activity is likely to contain a wildfire during that scenario. Many Evergreen values at risk are in areas that expect over 11 feet of predicted flame length during 90th percentile fire weather conditions, meaning methods of direct attack such as using engines or aircraft will likely be ineffective. These locations, particularly schools and childcare facilities will require immediate, high priority fuels treatment and structure hardening to protect them from the extreme wildfire situations they face.

Highest Priority Locations

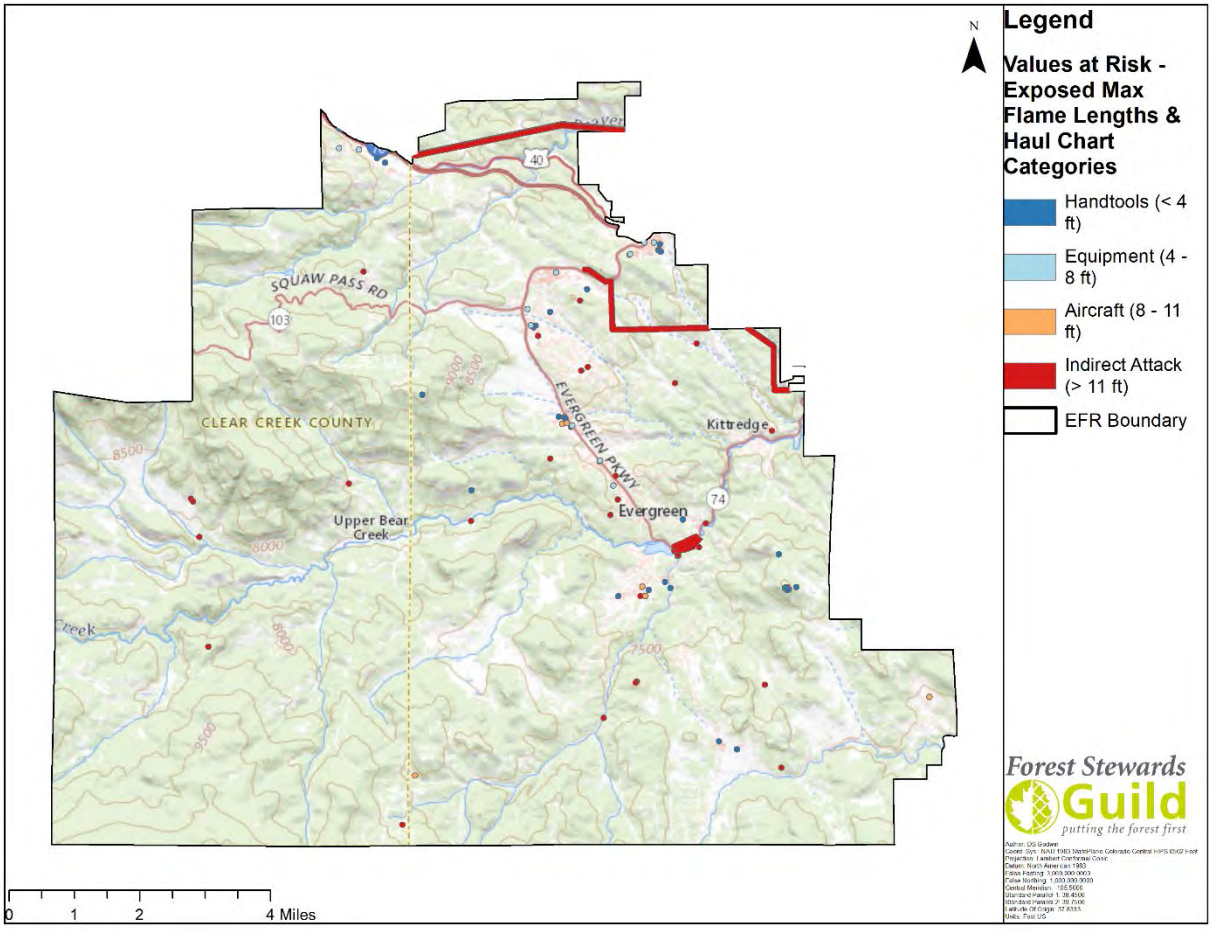


Figure 60. Values at Risk mapped for risk across the Evergreen Fire Protection District.

All locations of community values at risk that have predicted flame length over 11 feet and would require indirect attack are highest priority for fuel treatment and structure hardening, as applicable. Some of these locations are found within the Landscape Fuel Treatment Locations, however all values at risk are of high importance and should absolutely be mitigated first, if the large treatments are not completed yet. The highest priority locations that have identifiable names are as follows:

Evergreen Downtown Historic Business District	Montessori School of Evergreen (Troutdale & Hwy 73 Locations)
King Murphy Elementary and Preschool	Wulf Recreation Center
Evergreen Middle School	Episcopal Day School of Evergreen
Mount Evans Outdoor Lab	Eclipse Therapy LLC
Seven Dimensions Behavioral Health LLC	

Important communication sites and powerlines are also at risk in Evergreen, which will fall to other agencies to mitigate. An additional area that did not model as 11 feet flame length is added to the highest priority list based upon community interviews and Evergreen Fire/Rescue knowledge of the wildland fire risk to that location. The structures west of Wah Keeney Park along Royale Elk Way that contain assisted living and childcare facilities are of high priority and at risk to wildfire that does not show up on the model as clearly. This includes Augustana Elk Run Assisted Living, Jefferson Center for Mental Health, and Adventures in Childcare.

Locations vary in forest structure and treatment prescription; however, a thinning treatment surrounding each of these locations is recommended. Following guidelines in Prescriptions for Treatment and the Colorado State Forest Service fuel break guidelines in Appendix 3 will greatly reduce expected flame length at these locations. Managers of these properties must consult with Evergreen Fire/Rescue to better collaborate on the wildfire mitigation effort and connect with other efforts for grant funding.

SHELTER-IN-PLACE RECOMMENDATIONS

For the purposes of this CWPP, a shelter-in-place location is an area within a neighborhood that residents could drive to and survive the flame front of a wildfire. Shelter-in-place locations are a worst-case scenario option where all other evacuation and rescue efforts have failed. If these locations are needed, ONLY first responders will direct vehicles in the right direction and determine how many vehicles will be safe during that wildfire event. This section should be utilized by EFR and local land managers and is not intended to independently guide residents.

Please locate the area identified for your neighborhood and assist Evergreen Fire/Rescue in improving these locations for your community's safety, but DO NOT plan to utilize these locations unless directed. For this CWPP's analysis, these locations were not limited by capacity for cars or residents. These locations can also provide valuable staging locations for firefighters and other first responders as they work to protect your home and neighborhood.

The Evergreen Fire Protection District was modeled for slope and vegetation throughout Evergreen and 20 mph winds using the Butler equation, described in detail in the Shelter-in-Place fuel treatment prescription section. Much of the district is not suitable for sufficiently large shelter-in-place locations, due to steep slopes and heavy fuels. Mapping locations that are sufficient shows us where there are currently moderate options which will require fuels reduction to be considered safe. Locations for shelter-in-place are described in the table below, and maps of these locations can be found in Map Appendix A. These locations have been listed by the Plan Unit that the area is located within, not by the Plan Units or communities that might utilize them in the future.

Many of these locations have wildland fuels causing unsafe conditions for shelter. These locations are included in the CWPP for prioritization as fuel treatments, not to indicate to residents where to go. Locations will be prioritized based on population size and modeled time to evacuate. Then locations will need to mitigate fuels that disrupt the shelter space. Within the proposed shelter locations, hazardous fuel must still be mitigated per recommendations in the Prescriptions for Treatment Section.

Shelter-in-Place Locations – Ready	
Plan Unit	**Description**
Echo Hills	Elk Meadow creates a great location for shelter in place here, though access from 74 will prove challenging. Most of this location falls in Jefferson County Open Space - Elk Meadow and needs very little mitigation to be a successful shelter-in-place location. Coordination with JCOS will be crucial to effectively utilize this property. There is no currently possible shelter-in-place location where the residential population lives. At this time, evacuation completely out of this Plan Unit is recommended, as it is not easy for residents to access the proposed shelter-in-place location that falls within the boundaries.
Bergan Park	Hiwan Golf Club area will be possible for shelter in place, though access will need to be coordinated. Bergen Park itself on the north side of the plan unit, though a commercial area, will be a good place to shelter in place as well.

Shelter-in Place Locations – Needs Improvement	
Bear Creek East	On a south facing slope around Bergen Mountain Road, a shelter-in-place location would be possible. This location is on private land, meeting up with Bergen Peak SWA, Denver Mountain Park - Bergen Peak, and Jefferson County Open Space - Elk Meadow. Those public lands do not have much space that meets the criteria of this model, and it is recommended those organizations work to improve and expand this Shelter-in-Place location. There are portions of this proposed location that are not currently suitable for shelter-in-place, but if wildland vegetation were cut, this would make this location more viable. Parts of the roadway in this location are not survivable and the surrounding fuels for those roadways are the primary areas of concern for mitigation.
Bear Mountain	Between S Bear Mountain Drive and Giant Gulch Road, agricultural fields are good for shelter-in-place, but adjacent fuels need to be mitigated to expand this area. Similarly, agricultural fields at the end of Stanley Park Road could be great locations with some clearing to the east where wildland vegetation is too dense.
Danks Drive	The Marshdale area is well maintained with great access. Adjacent wildland fuels need to be mitigated before this area will be safe to send residents, as well as patched of fuel internal to the unit.
Buffalo Creek North /South	The Evergreen Golf Course and surrounding Denver Mountain Park - Dedisse Park should be expanded upon to create a great shelter-in-place, centrally located in Evergreen. Evergreen High School south of Buffalo Park Road is also a great location to shelter in place. The Jefferson County School District and Denver Mountain Parks should assist, as possible, in maintaining and expanding this area. To the east of S. Lemasters Road, a small area to shelter is located on Jefferson County Open Space - Alderfer/Three Sisters Property. The surrounding area should be mitigated and expanded to make this a great shelter-in-place location. Lastly, the area surrounding Buffalo Park Road and Broce Ranch Trail has some great agricultural properties to be used for shelter-in-place, but first, a great deal of thinning and clearing must be done to make this area feasible and safe.
Floyd Hill	A potential shelter-in-place location starting at Clear Creek High School and up towards Saddle Ridge Road needs mitigation and access improvements but could be a great location for Floyd Hill residents. North-facing slope wildland fuels adjacent to this treatment need to be thinned.
High Drive	Location described for North Turkey Creek
Kerr Gulch	A section of private land in the center of Kerr Gulch along Kerr Gulch Rad and Music Lane could be a shelter-in-place location, although it is quite small and steep. This would need mitigation and clear direction for residents to be utilized properly. Residents could also shelter near Home Depot and Walmart and in the adjacent meadow along Swede Gulch Road. This area could house a great number of residents with very little flammable material. Some wildland fuels should be mitigated on the adjacent north-facing slope.
North Turkey Creek	A long agricultural meadow on the border of North Turkey Creek and High Drive Plan Units, or slightly west of County Road 81, will make an incredible shelter-in-place location. Some

	thinning around the margins of this treatment would improve the condition and safety. Private landowners in this area should assist Evergreen Fire/Rescue to mitigate where patches of fuel decrease the safety of this shelter location. The two treatment locations in this area are separated to acknowledge that they are both large projects to undertake with many trees to cut for mitigation.
Fillius Park	Between Alta Vista Drive and Meadow Vista Drive, this location, though primarily residential, could become a shelter-in-place location for Fillius Park residents. Mitigation in the center of this area is crucial to make this a possible location for shelter. North-facing slopes in this area are the primary concerns influencing the safety of this location.
Stagecoach/Hiwan Hills	Along Stagecoach Boulevard, and around Buckboard Drive, shelter-in-place could be possible with some expansion North and South into the dense wildland vegetation. In this area, it is all private land, so Evergreen Fire/Rescue will need the support of local residents to create a shelter-in-place location in this neighborhood.
Western Evergreen	Along Evans Ranch Road, a riparian and agricultural corridor could become a shelter-in-place if the surrounding vegetation were thinned and removed. This location is partially Jefferson County Schools property and should be a great place to create a shelter location for the Mount Evans Outdoor Lab School, an important value at risk. North facing slopes south of this location are highest priority for improving this location and reducing the surrounding flame lengths.

Table 10. Shelter-in-Place descriptions for the Evergreen Fire Protection District.

Prioritization

All Plan Units with a minimum evacuation time of 100 minutes, or more must be the first priority for shelter-in-place location improvements. Other Plan Units should work to improve these shelter-in-place options as well, as evacuation could become blocked by unforeseen circumstances in other locations with shorter predicted evacuation times. These highest priority Plan Units are as follows:

- The Woods/Overlook
- Buffalo Creek South
- Bear Creek West
- Brook Forest
- Buffalo Park Estates
- Evergreen Meadows
- Kittredge
- Stagecoach/Hiwan Hills
- Western Evergreen

All Plan Unit maps for shelter-in-place show possible areas for refuge. The overwhelming majority of these locations are on private land. Residents should allow access for these treatments and support Evergreen Fire/Rescue's effort to improve these locations. For the locations that would be best suited for public land, all land managing organizations must work to develop these locations where possible. Elk Meadow is a good example. The eastern edge of this property is already in good shape and could be utilized as a shelter location, but this process must be worked out and formalized between Evergreen Fire Recue and Jefferson County Open Space.

Beyond the original treatment to make these locations suitable, maintenance is key. Mowing and cutting of regrowth is essential. Without a way to know when a wildfire will occur, these locations should be kept ready all year round. Refer to descriptions of maintenance work in Prescriptions for Treatment.

WILDLAND FUEL TREATMENTS

The Evergreen Fire Protection District, community members, and the local agency partners that manage land within its boundaries work to mitigate extreme wildland fuels and have ongoing projects to improve wildfire outcomes for the residents of Evergreen. More work, however, must be done to mitigate the risks still present. Those risks are analyzed in the Community Risk Assessment Section. This section depicts the impact of wildland fuels treatments and suggests methods and prescriptions to help Evergreen Fire/Rescue and other land managers achieve their objectives.

A fuel treatment is a land management project utilized to reduce wildfire hazard by reducing vegetative materials or "fuels". The reduction in fuels reduces the intensity of fire behavior and increases tactical firefighting options. The treatments include vegetation thinning, pile and broadcast prescribed burning, pruning or mechanical harvest. Treatments are designed to disturb the existing horizontal and vertical arrangement of fuels. This increases the spacing between trees and increases the distance from the ground to the tree canopy. Other factors affecting fire behavior, like topography and weather, are harder to change but must be considered when designing a project.

All fuel treatments are not created equal, and local knowledge and professional experience needs to be employed when designing parcel-level fuel treatments. When mitigating wildland fuels these recommendations should provide clarity on what will make a difference for residents and first responders. Home Ignition Zone recommendations from Methods to Reduce Structural Ignitability in coordination with these wildland fuels treatments will make a difference when done together. This fire protection district is well positioned to navigate the complex public and private partnerships to complete treatment, but all residents must do their part.

Guidelines

The commonly used term "fuel break" does not prevent fire spread as the conventional wisdom might suggest. In steep and complex terrain and forest conditions that cause long-range spotting conditions – two characteristics that are present throughout the Evergreen Fire Protection District – fuels breaks have reduced efficacy. Nowhere in Evergreen is there a current, or recommended, fuel treatment that could prevent long range spotting. What fuels treatments do change, however, is the impact of long-range spotting. Fuel treatments can change fire behavior, reducing flame lengths and fire intensity under certain weather conditions. Fuel treatments create tactical options for suppression in advance of the flame front.

Specific fuel treatment recommendations are dependent on forest type, terrain, and land use. Most of Evergreen's population lives in Ponderosa Pine dominant or Mixed Conifer forest types, depending on elevation and aspect as seen in Figure 61. Moving up in elevation the forest type changes to Lodgepole Pine and Spruce Fir Forest. Rocky Mountain Research Station General Technical Report 373 describes the ecology of the Front Range at great depth and it is essential that all land managers in the Evergreen area read this document thoroughly when writing a forest treatment prescription.

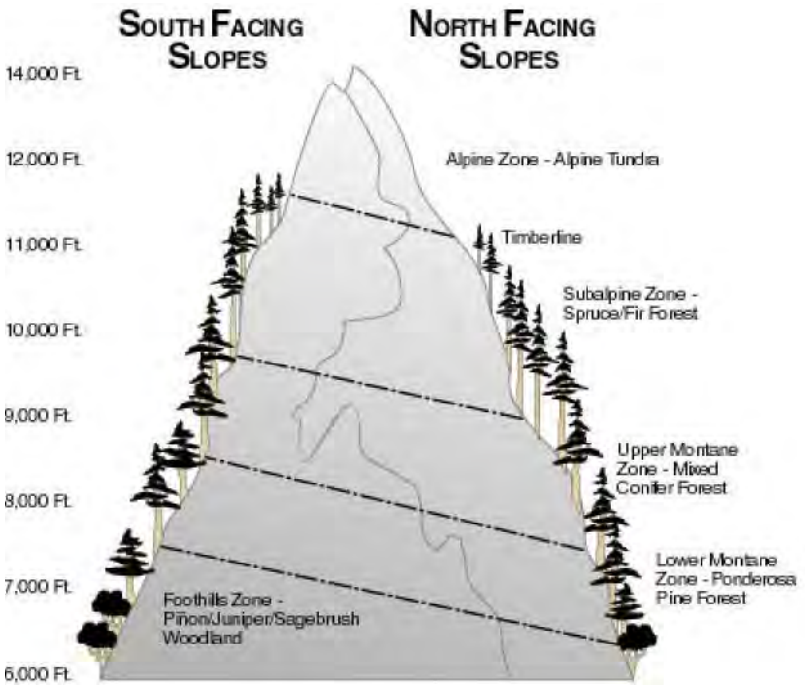


Figure 61. Typical forest type at elevation on North and South facing slopes on the Front Range.

Tree densities in a Ponderosa Pine ecosystem were historically much lower than what we see today. Ponderosa forests should be very open, often with a grass and shrub understory. Growth patterns are a mosaic across the landscape. They include open meadows, individual trees standing alone, clumps of trees growing close together but spaced well away from other trees, and large openings within the forest canopy. These healthy, "fire-adapted" ecosystems are very resilient to fire. This stand structure was created by a more frequent fire regime before there was a European presence in these areas and fires were suppressed. This ecological system is very resilient to fire and would produce easier-to-control wildfire scenarios for communities. Ponderosa stands should be of low to moderate density and dispersed according to site conditions and tactical necessity, though clumped dispersion is best ecologically. In Ponderosa Pine systems, we recommend two types of treatment: Thinning and Shelter-In-Place.

Mixed-Conifer refers to Ponderosa Pine & Douglas-Fir dominant stands, with lodgepole, blue spruce, white fir mixed in. Ponderosa Forests follow a gradient into Mixed-Conifer stands with increasing soil moisture, often associated with increasing elevation and North facing slopes. Vegetation growth is often higher in Mixed-Conifer stands, with denser canopy cover. This increased growth contributes to increased ladder fuels and an increased likelihood for fire to move into the canopy, particularly from Douglas Fir. Openings in Mixed-Conifer stands, like Ponderosa, were much more prevalent before fire suppression. Restoring these natural openings will help to provide fuels treatments to mitigate wildfire risk while improving the ecosystem. We recommend the same treatment to Mixed-Conifer as Ponderosa, Thinning and Shelter-In-Place.

PRESCRIPTIONS FOR TREATMENT

Thinning/Timber Harvest

Cutting vegetation can be manual or mechanical, providing for slope considerations. Minimum prescription recommended by this CWPP is 15-foot crown spacing between trees in Ponderosa Pine and mixed conifer stands, keeping in mind the importance of a mosaic of tree densities for ecological benefit. Higher elevation forests may not benefit from this treatment. Refer to Appendix 3 for thinning treatment guidelines by the Colorado State Forest Service. Cutting with a chainsaw or other tools should be done by experienced persons providing first for safety. Mechanical tree harvest will work on shallower slopes and should be contracted with a prescription written by the Colorado State Forest Service, Jefferson Conservation District, or other forestry professional with experience in wildfire mitigation.

Figure 62. Thinning treatment in progress to increase canopy spacing and increase canopy base height. Photo Credit: FSG

Prescription will vary based on slope, surface fuel, and forest type, but should always work to decrease canopy density and increase canopy base height. Colorado State Forest Service shaded fuelbreak guidelines, mentioned above, describes the minimum distance from roadways for effective treatment. This guideline can be utilized for thinning around homes and other values at risk, in addition to the home ignition zone improvements outlined in Methods to Reduce Structural Ignitability. These guidelines should also be used to add tactical options near a neighborhood or on a landscape scale.

Fuelbreak Width/Slope

Percent Slope (%)	Minimum Uphill Distance (ft)	Minimum Downhill Distance (ft)	Total Width of Modified fuels (ft)*
0	150	150	300
10	140	165	303
20	130	180	310
30	120	195	315
40	110	210	320
50	100	225	325
60	100	240	340

*As slope increases, total distance for cut-and-fill for road construction rapidly increases, improving fuelbreak effective width.

CSFS

Figure 63. Fuelbreak Width/Slope recommended, per Appendix 3.

Thinning treatments impact wildfire behavior "by changing both the amount and distribution of fuel available to burn" (Hunter et al., 2007). Decreasing the density and proximity of tree crowns lowers the risk of running crown fire, a type of wildfire that is difficult to suppress. Increasing canopy base height must accompany this work and can be accomplished by selecting trees of large diameter and limbing or pruning branches 6-8 feet and under.

Recommended treatment projects will focus on accessible areas with ≤35% slope and being within 1000 m of a road or trail. According to a report produced by CSU, CFRI, and TNC that studied fuel treatments in the Strontia Springs Reservoir area, treatments to 40% of accessible areas that reduced canopy cover 5% decreased the fire extent from 87% to 60% (Jones et al. 2016). Treatments to 100% of accessible areas that reduced canopy cover 14% decreased the fire extent from 87% to 16%. This indicates that fuels treatment in accessible areas can reduce high severity fire extent and that treating beyond 40% of that accessible area provides meaningful reduction in fire size and severity.

Brush Thinning

All brush that grows in the Front Range of Colorado is flammable and will contribute to fire spread. Brush beneath trees and timber stands should be removed, along with young trees, so they cannot bring ground fire into the tree canopy. Brush should be spaced like tree canopies, at least 15 feet apart to minimize their contribution to wildland fire intensity. Brush in and around the home ignition zone should follow Firewise standards for defensible space and be removed where hazardous.

Cutting/limbing

Pruning and limbing trees can help wildfire from burning through the tree canopy by increasing the height of the canopy from the ground, often referred to as Canopy Base Height. This treatment alone is not effective as a thinning treatment and needs to accompany a thinning treatment to have tree canopies at least 15 feet apart. It is, however, a treatment that many residents can do without much professional assistance. Hand tools like pole saws are all that are needed to trim bushes and branches 6-8 feet and under.

Patch Clear Cut

This treatment will be most effective for Lodgepole Pine and high elevation plant communities that burn intensely, but infrequently. The goal is to break up crown density to allow first responders a chance to suppress a fire within the WUI. Fires in this fuel type that do not impact the WUI should be left to burn in a wildfire, as this is the natural ecological process this vegetation has adapted to. Patch cuts can serve both suppression and ecological purposes. This treatment can be utilized to combat dwarf mistletoe or pine beetle episodes. Utilize the guide in Appendix 5 for distances and treatments in Lodgepole Pine.

Shelter-in-Place

For this CWPP, a shelter-in-place location is a location within a neighborhood that residents could drive to and survive the flame front of a wildfire. Sheltering in your neighborhood during a wildland fire event is the worst-case scenario. The goal of first responders will always be safe and thorough evacuation. Evergreen is discussing these locations with acknowledgement that in other catastrophic wildfires in the United States, evacuations did not go as planned, and lives were lost as people were overcome by fire in unsafe areas during evacuation proceedings. These are not ideal places to evacuate to.

These treatments will vary by slope and anticipated wind and fire behavior. For example, assume an average slope, moderate fire behavior, and 20 mph winds. For this example, if an area that is intended for a shelter in place is on a 15% slope and surrounded by 20-ft trees, a 600-foot radius clearing of trees or 200 yards would be needed. Appendix 4 contains a description of this calculation so it can be tailored to individual project locations throughout the district. The basic formula is 8 x Δ x Height of vegetation. Δ is a combination of wind, slope, and fire behavior factors as you can determine from Table 11.

Table 11. Table to help calculate space needed for Shelter-In-Place. Source: Butler, 2019

Δ	Slope %					
		0	15	30	>40	Burning Conditions
Wind (mph)	0	0.8	1	1	2	Low
		1	1	1.5	2	Moderate
		1	1.5	1.5	3	Extreme
	10	1.5	2	3	4	Low
		2	2	4	6	Moderate
		2	2.5	5	6	Extreme
	>20	2.5	3	4	6	Low
		3	3	5	7	Moderate
		3	4	5	10	Extreme

Biomass Management and Maintenance:

The fire hazard has not been decreased, it has only been redistributed, when biomass is left in place after a fuel treatment. The Forest Stewards Guild recommends prescribed fire as the absolute best method to remove remaining fuel post-treatment because it consumes all material and is a cost-effective maintenance method.

One approach is to construct burn piles. It is crucially important to burn these piles as soon as a burn prescription allows, as they can become a hazard in a wildfire situation. This is especially true if the loose horizontal logs catch fire and roll down slope. After a pile burn, a broadcast burn should be the next step to remove any remaining surface fuels. Then a treatment area can be maintained with periodic prescribed fire. If prescribed fire is not an option, the Forest Stewards Guild recommends removing all debris from a thinning treatment area.

A quote from the Colorado State Forest Service guide sums up the reality of maintenance well: "If fuel break maintenance is not planned and completed as scheduled, consider carefully whether the fuel break should be constructed. An un-maintained fuel break may lead to a false sense of security among residents and fire suppression personnel". This sentiment echoes an earlier paragraph that describes a fuel treatment that does not include proper canopy spacing. It is unwise to complete fuels treatments that are not high quality with sufficient biomass removal and maintenance as part of the plan because ineffective actions may provide people with an illusion of safety. Below are some detailed recommendations of how to remove biomass post-fire or maintain a wildland fuel treatment.

Pile Burning

Pile construction and burning should be completed by the standards outlined in the 2015 Colorado Pile Construction Guide produced by the Colorado Department of Public Safety, the Division of Fire Prevention and Control, and the Colorado State Forest Service, located in Appendix 6. Before starting a project, check with local law enforcement and/or fire authorities, as smoke and burn permits are required and plans must be approved. These entities can help identify issues before pile construction begins. Evergreen Fire/Rescue has a wildland fire module that should be consulted before pile construction to aid in proper set up. Piles should be compact and no larger than 8 ft wide x 8 ft long x 8 feet high and can be constructed by hand or machine.

Figure 64. Example of Pile Burning in Colorado. Photo Credit: FSG

Mastication

This CWPP does not recommend mastication treatments unless the other mentioned options are completely unavailable. Biomass removal in this part of Colorado is quite difficult and mastication is a commonly proposed alternative, but it does not remove material from a forest, it just re-structures the way it is arranged. If done, no more than 2-3 inches of wood chips must be left on the ground. Pile burning or any method to get woody debris off site is preferable to mastication.

Slash or Chipping Programs

Jefferson County has a slash collection program that accepts slash, and by-products like needles and cones June 1st through October 27th each year. Each load dropped off costs $20 at collection locations across Jefferson County. More information can be found: https://www.jeffco.us/2493/Slash-Collection

Clear Creek County also accepts slash from April 15th to September 30th. They accept branches ≤ 4 inches in diameter and ≤ 8 feet in length, also at $20 a load. Information and locations can be found: https://www.co.clear-creek.co.us/142/Waste-Recycling

Many CWPIP groups bring in chippers or coordinate slash pick up days for their neighborhoods. Contact the local area CWPIP leader for more information.

Figure 65. Example of chipping to reduce biomass left behind from vegetation thinning. Photo Credit: FSG

Broadcast Burning

With proper planning and implementation broadcast burning is an extremely effective tool at reducing fuel loads as an initial treatment and in maintaining existing treatments. Otherwise, the treatment may occur after other fuels treatments have concluded to reduce fuel load. Colorado Department of Public Safety and the Division of Fire Prevention and Control's 2019 Colorado Prescribed Fire Planning and Implementation Policy Guide should be used as a resource to inform any broadcast burns in the state (Appendix 7). Any planning and treatment design should consult the fire protection district and local law enforcement.

Figure 66. Example of prescribed fire in Colorado. Photo Credit: FSG

Mowing

Mowing must be at least annual and perhaps several times during the growing season to keep grass height under 10 inches. More frequent mowing is discouraged as it will disrupt grass and local flora growth and contribute to erosion. Any mower that can handle a natural grass density and length can be utilized to complete this fuel reduction treatment. This is an alternative to broadcast burning, which is a preferred option, where possible, as it is part of the natural ecology in this region.

Cost of Treatment

Fuel treatment cost varies by slope, accessibility, time to initiate contract, and type of treatment. For Colorado's Front Range, wildland mitigation generally costs $1,500 to $3,000 per acre, with little biomass or timber industry to provide financial return (Jones et al. 2017). Suppression costs in California can reach $2,672 per acre with rehabilitation costs up to $4,277 per acre (Buckley et al. 2014). Though suppression costs are not all tied to cost to put a fire down per acre, this is an easy way to reference cost. The Hayman Fire cost $1,668 per acre for suppression and rehabilitation costs, the Fourmile Canyon Fire cost $1,650 per acre for suppression alone. The Buffalo Creek Fire just south of Evergreen cost $2,000 per acre for suppression and rehabilitation (Mackes 2015).

Fuel treatments can reduce suppression costs due to the increased efficiency of firefighter action. They also dramatically reduce rehabilitation costs to property and water sources. It is also important to maintain existing treatments as maintenance is less costly than the initial entry and maintains the original investment. It is a moral imperative to conduct fuels treatments to save lives and ecosystems, but even a strict economic analysis quickly reveals the numerous benefits of robust wildland mitigation treatments.

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METHODS TO REDUCE STRUCTURAL IGNITABILITY

During catastrophic wildfires, property loss happens mostly due to *Home Ignition Zone* conditions, defined by the National Fire Protection Association (NFPA) as "the condition of the home and everything around it." Treatments to your home and the area within a close distance to it will make a difference in the outcome for your home, property, and the firefighters that will work on your property during a wildfire. Firefighters prioritize the homes that have the most defensible space since it makes it possible for them to succeed and poses less risk to their lives.

Defensible Space is an area around a building in which vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of fire to and from the building. The name reflects protecting firefighters from injury – the area around a structure where firefighters can safely work. When defensible space around homes is linked, it makes entire neighborhoods defensible. Collective action will change the risk and allow for tactical decision making, as well as change the likelihood that homes will ignite due to ember cast. Vegetation treatments near your neighborhood will not prevent ember cast from igniting fuels within your neighborhood that could ignite your home. Reducing structural ignitability through home hardening and defensible space work is necessary in tandem with wildland fuels treatments – doing one or the other is not worth the investment on its own.

Wildfire Prepared Home Assessment Program

To assist residents with the implementation of the practices described in the following sections, Evergreen fire Protection District and Elk Creek Fire Protection District are teaming up to provide home assessments. This program is called Wildfire Prepared and promotes wildfire awareness, education and action for homeowners. Local residents can request a professional evaluation of the external conditions of their home and the surrounding property to determine their susceptibility to wildfire and what actions residents can take to make their home more defensible. This program is starting in the fall of 2020, and more information can be found at www.wildfireprepared.com.

Home Hardening – Recommended Practices

Home Hardening is a method to reduce the likelihood of structural ignition by including ignition resistant features and materials. Main parts of the home to focus on are the roof, vents, windows, exterior siding, decks, and gutters. Two resources we recommend for home hardening practices are CalFire and the Insurance Institute for Business & Home Safety. Extended information can be found in Appendices 9-11. Generally, it is important to have a Class A roof and keep it and your gutters free of debris that would easily ignite from an ember (**Figure 67**). Noncombustible siding, decking, and fencing materials will also prevent home ignition, particularly when combined with a border around the base of your home made of rock or other noncombustible material, rather than mulch or landscaping. Some of these practices are of low cost and can be implemented by the homeowner, making this an easy first step in wildfire preparedness.

Figure 67. Examples of Home Hardening Practices from the Insurance Institute for Business & Home Safety.

Defensible Space – Recommended Practices

Defensible space requires reducing the vegetation and flammable materials within the first 100 feet of your home. Removing the flammable materials decreases the radiant heat exposure to your home and gives firefighters an opportunity to defend it. It creates a buffer between a structure and the grass, trees, and shrubs that will ignite during a wildland fire. It can slow or stop direct flame contact and reduce the available fuel bed for embers to ignite away from the main wildfire front.

Different organizations will specify slightly different Zones of Defensible Space, but the basic idea remains the same. We will use CSFS recommendations for defensible space that advises 15-30 feet in Zone 1 of extreme fuel hazard reduction, and reducing hazards up to 100 feet from the home (**Figure 68**). They recommend removing all dead vegetation and wood away from the home, reducing live vegetation near the home, and ensuring no trees overhang your roof, creating an area of low fire intensity. Learn more about the details of Defensible Space and how to achieve it in Appendix 9.

Figure 68. Colorado State Forest Service (CSFS) Defensible Space in the Home Ignition Zone.

Multiple homes in a row that follow these recommendations make everyone collectively safer. Home to home ignitions are common during wildfires so the safer your neighbor's home, the safer your home. We recommend residents of Evergreen utilize the materials in Appendices 9-11 to educate neighbors and make a checklist of actions to take in each calendar year. We want to make sure residents are aware that trees and natural landscapes are possible near the home and mimic the original ecology of Evergreen. It is not safe to have dense forest or dead vegetation right up to the side of the home – this is not defensible by firefighters.

Historic Structures

Historic Structures made of wood and other flammable materials in Evergreen are at high risk during a wildfire. Due to their construction materials they are inherently hard to protect from embers, but there are some techniques that can be utilized to improve the chances of structure survival. The National Institute of Building Sciences recommends including fire-retardant roof assemblies to protect the part of a building most vulnerable to wildfire embers, but "some historic roof coverings like slate, tile, and metal are non-combustible by nature and should be retained where possible". In addition, fire detection and suppression systems can save a structure, depending on the ability to install this type of system in a historic building. As with any structure, defensible space will help prevent ignition, but further distance from a historical structure to wildland vegetation will improve chances. The last option, which can be resource intensive, is using Fire Wrap which is basically aluminum foil to shield a structure from embers.

References

Hardening Your Home – Ready for Wildfire. https://www.readyforwildfire.org/prepare-for-wildfire/get-ready/hardening-your-home/.

Historic Preservation | WBDG - Whole Building Design Guide. https://www.wbdg.org/design-objectives/historic-preservation.

NFPA - Preparing Homes for Wildfire. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Preparing-homes-for-wildfire.

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