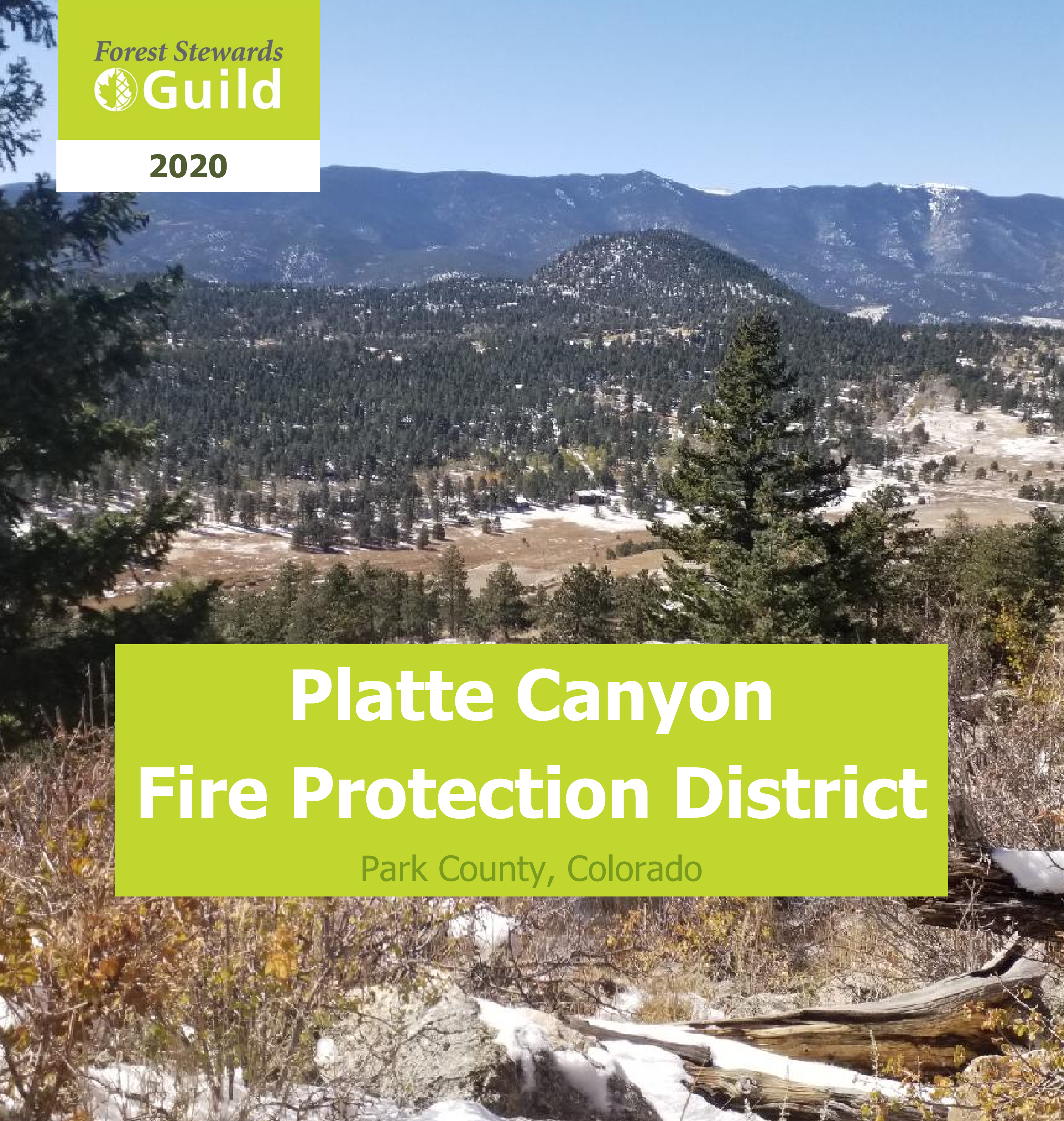
Forest Stewards Guild

2020



Platte Canyon Fire Protection District

Park County, Colorado

Community Wildfire Protection Plan

Platte Canyon Community Wildfire Protection Plan

2020 Update

Prepared for

Platte Canyon Fire Protection District

153 Delwood Drive

Bailey, CO 80421

Prepared by

Forest Stewards Guild

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PLATTE CANYON COMMUNITY WILDFIRE PROTECTION PLAN 2020 UPDATE

We, the undersigned, approve the Platte Canyon Community Wildfire Protection Plan: 2020 Update

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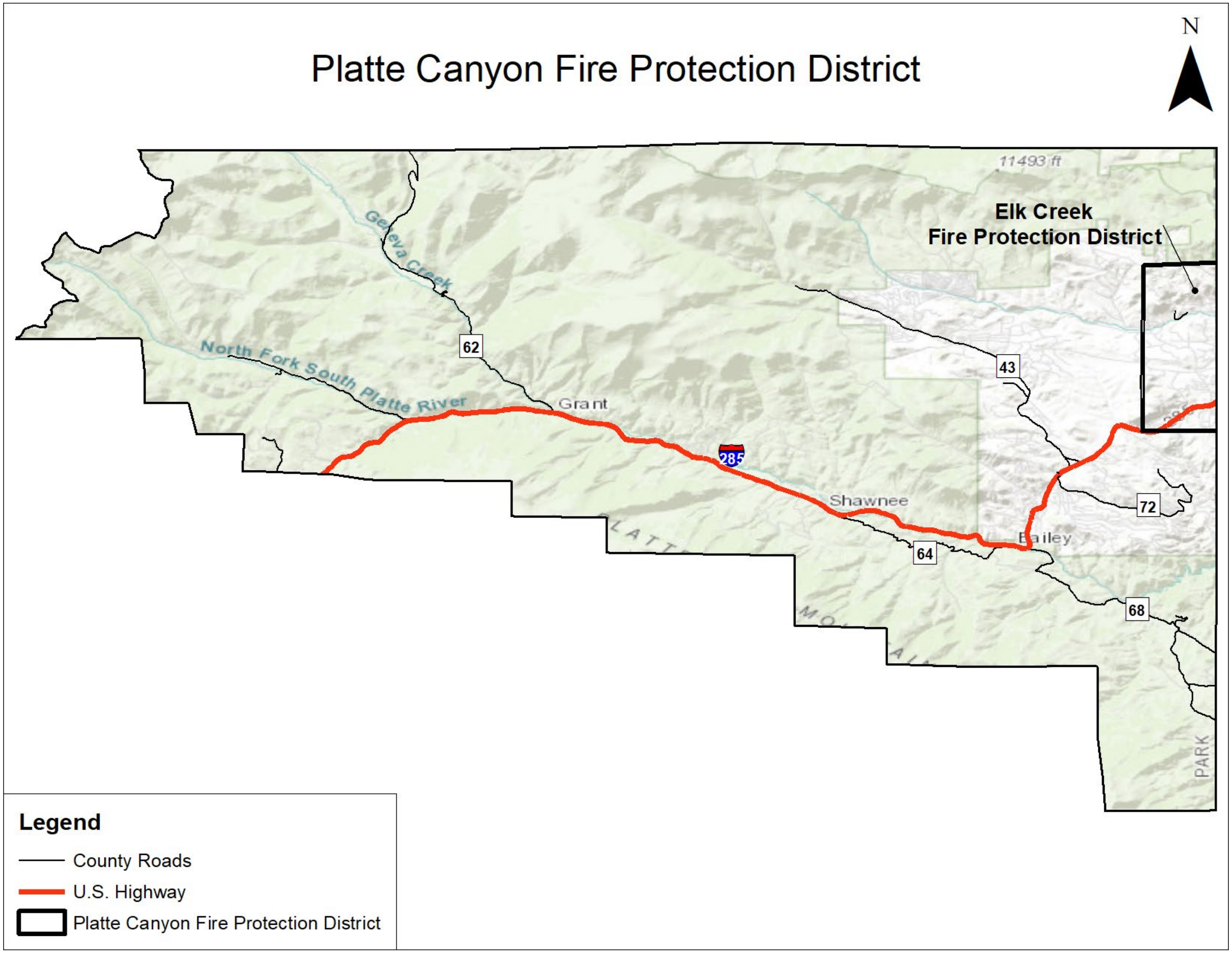
EXECUTIVE SUMMARY

This Community Wildfire Protection Plan (CWPP) was created by the Platte Canyon Fire Protection District and the Forest Stewards Guild for the district, local stakeholders, and the residents.

The 2020 Platte Canyon Fire Protection District Community Wildfire Protection Plan was designed to analyze risk, discuss implementation options, and prioritize lifesaving actions. Platte Canyon Fire and residents living under their protection can utilize this document to mitigate risk to their homes, neighborhoods, and evacuation routes. The analyses in this document summarizes risks to population centers by utilizing neighborhood and evacuation unit boundaries. This allowed for the Fire Protection District to be broken down into manageable pieces to prioritize areas of highest risk.

This document should be used to identify wildfire risk mitigation practices. Residents can look at what factors, such as roadway survivability or short-range ember cast, affect their neighborhood and look to the mitigation recommendations to determine which actions will make a meaningful difference. We recommend residents read through the **Description of Analyses** to learn about the types of wildfire risk information we've provided, then look to **Community Project Prioritization** to see what factors in their neighborhood have a high or extreme risk rating. Tailored neighborhood information is provided in Appendix 1 for residents to act on, where possible.

Agency-level fuels treatment recommendations are designed for Platte Canyon Fire Protection District and local partners to prioritize treatment that will change the wildfire outcome for neighborhoods with few other options to mitigate their risk. The entire community must work hard to change the outcome for Platte Canyon Fire Protection District during the next catastrophic wildfire and this document will serve as the guidelines.



This map displays the area covered by this Community Wildfire Protection plan, including an area of Elk Creek Fire Protection District. This image of the district will be displayed throughout the document and can be used to orient readers to locations mentioned in the plan.

CONTENTS

INTRODUCTION

This Community Wildfire Protection Plan (CWPP) will provide a wildfire risk analysis for Platte Canyon Fire Protection along with a mitigation plan and recommendations on how to implement the plan. The 2019 CWPP is a complete update of the 2004 Platte Canyon CWPP ensuring inclusion of a changing landscape and fire science. This document is to be utilized as a tool by the community to begin prioritizing projects that make Platte Canyon a safer and more resilient community.

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 took place in November 2018. The construction of the Platte Canyon CWPP was based on learning from this and other recent wildfires. A sense of urgency and call to action will be the tone of this CWPP as Platte Canyon shares many risk factors with other catastrophic wildfire events.

The Forest Stewards Guild (www.foreststewardsguild.org) developed new products using metrics gathered from loss of life events throughout the country that will help focus Platte Canyon's evacuation planning. Platte Canyon's location near the Arapaho Roosevelt and Pike San Isabel National Forests poses a problem for mitigating the entire fire protection district at landscape scale. In the meantime, roadways need to be cleared to facilitate safe egress and evacuation congestion points need to be identified for mitigation. Our analysis provided roadway survivability and evacuation congestion locations, predicted using fire intensity and projected traffic flow. Survivability data was used to predict the location of mitigation projects along roadways. Fire behavior was utilized as a base to determine potential for embers to reach homes and radiant heat capable of structure ignition. These tools will be informative and will show residents of Platte Canyon a path forward, as mitigating for wildfire risk can be overwhelming and expensive.

WILDLAND-URBAN INTERFACE

The Platte Canyon Fire Protection district serves the Bailey, Colorado area. This district is designated to cover 271 square miles around Bailey, located in Park County. 40 miles Southwest of Denver along highway 285, this district is home to just over 9,663 people with elevation ranging from 7,155ft to 13,575 ft. This area is populated by Ponderosa Pine and Lodgepole Pine ecological communities with other fire adapted shrub and grassland flora. The landmark feature in this area is Platte Canyon itself, a steep and narrow gorge carved by the South Platte River.

The wildland-urban interface, or WUI, is any area where man-made improvements are built close to, or within, natural terrain and flammable vegetation. All homes in Platte Canyon Fire Protection District are within the Wildland-Urban Interface. There are 5,571 mapped structures in the district, including a small segment of Elk Creek Fire Protection District. For many residents, this rural land is part of the appeal that brought them to this landscape. Figure 1 depicts the density of structures in the district.

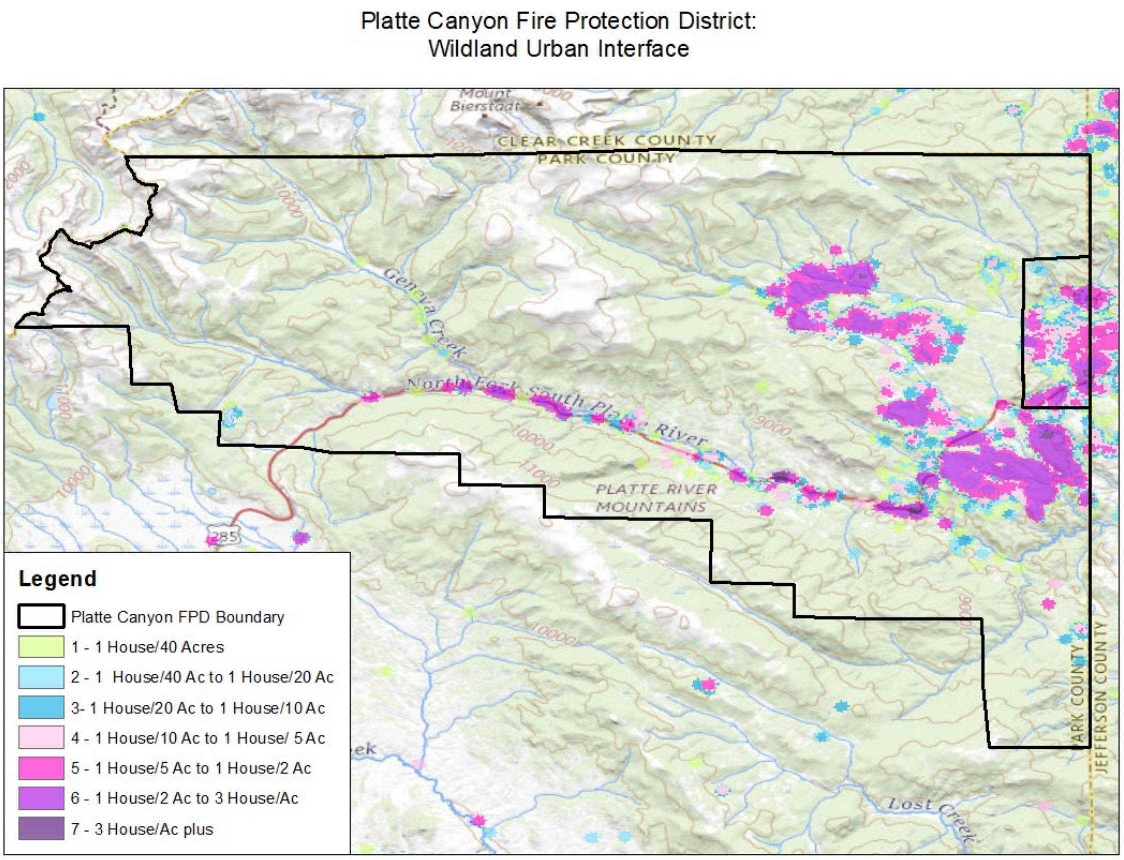


Figure 1. Wildland-Urban Interface: Housing density in Platte Canyon Fire Protection District.

Colorado has been growing rapidly along the Front Range and many people are looking to areas like Platte Canyon to build homes and businesses. This growth, when occurring in the WUI, is important to manage. These areas have potential for extreme fire behavior compounded by new homes or communities being built. As you can see in Figure 1, the WUI in Platte Canyon follows the US 285 corridor to Grant and is dense in the Burland area, Woodside Park, as well as going north along County Road 43 or Deer Creek Road. These densities of houses are particularly problematic when analyzing fire behavior due to high fuel load and potential home ignition.

Fuels include live vegetation such as timber, shrubs, and grasses, and the highly flammable dried vegetation. When we discuss fuel for wildland fire, this is what we are referring to – notably, we are not referring to structures or other man-made objects in the Wildland-Urban Interface. There is not a scientifically proven method of predicting fire behavior for homes and other structures, though they are very flammable and burn at higher temperatures than most vegetation.

Most of the land-area within the Platte Canyon Fire Protection District is U.S. Forest Service Land including two National Forests: the Arapaho-Roosevelt and the Pike San Isabel, with all the WUI occurring within the Pike San Isabel National Forest. Figure 2 shows where in the district this divide between these National Forests is located, generally, not accounting for private inholdings.

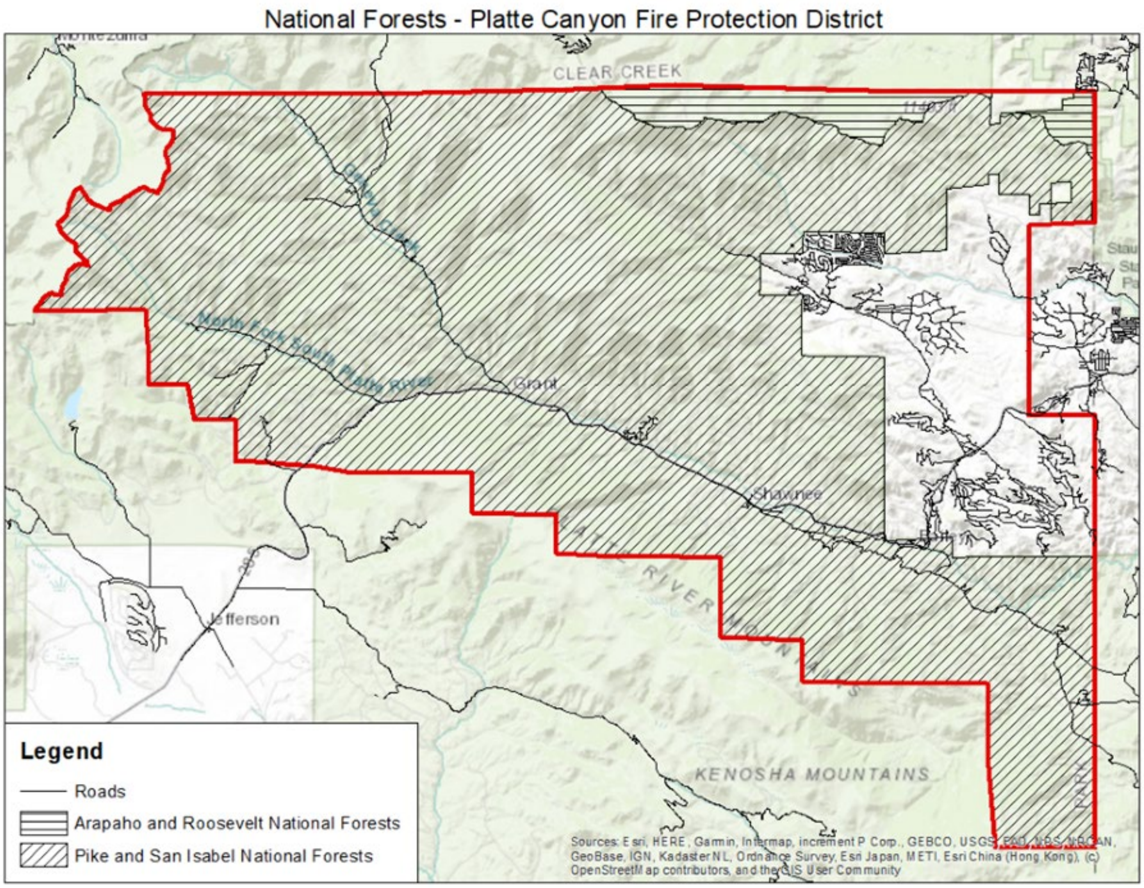


Figure 2. United States National Forest in Platte Canyon Fire Protection District.

Neighboring Fire Protection Districts are the Red, White & Blue Fire Protection District surrounding Breckenridge, the Jefferson-Como Fire Protection District, the North Fork Fire Protection District, Elk Creek Fire Protection District, and the Evergreen Fire Protection District. Platte Canyon Fire Protection District is bounded by the Arapaho-Roosevelt, Pike San Isabel and the White River National Forest, thought the White River is across the continental divide to the West.

It is important to note that a section of the Elk Creek Fire Protection District goes across the Park County line. Though Elk Creek is responsible for this area, we included it in our analysis as there is a neighborhood in Platte Canyon's district, Hidden Valley Estates, that requires travel through Elk Creek Fire Protection District to access. It is the hope of the Forest Stewards Guild that the adjoining districts work together to mitigate fire risk, as wildfires don't stop at district lines.

COMMUNITY AND STAKEHOLDER PROCESS

Overview

The core planning team starts with the Platte Canyon Fire Protection District, under direction of Chief Joe Burgett. The Forest Stewards Guild managed the project, ran the spatial analysis, made management recommendations and helped to host community and local stakeholder meetings. They brought the experience of Dave Lasky, Director of Fire Management, Daniel Godwin Ph.D., Assistant Director of Fire Management, Meg Matonis Ph.D., Intermountain West Regional Manager, and Corrina Marshall, Intermountain West Regional Coordinator.

Agency stakeholders on this project were the United States Forest Service, Colorado State Forest Service, Denver Water, Park County Public Works, and Fire Adapted Bailey. These organizations shared information on completed and planned fuels treatments in Platte Canyon. Stakeholders discussed community protection and tactical options on the landscape scale. They each committed to following the recommendations in this CWPP and working in the identified high-risk areas.

Platte Canyon community members were the leading voice throughout the construction of this CWPP. Due to the influence of Fire Adapted Bailey, there is a great and knowledgeable base of Firewise Leaders and active community participants who were able to provide crucial information to the project.

Meetings Held

We first hosted a kick off meeting to introduce the project to the community and the stakeholders, attended by Chief Joe Burgett, Joe Sean Kennedy, District Fire Management Officer, Division 11 of the USFS, John Van Doren of Fire Adapted Bailey, Mike Caggiano from Colorado Forest Restoration Institute and many community members previously involved in wildfire mitigation work.

We held a community leader meeting on to get final say on Platte Canyon values at risk, state of preparedness of their community, and sites they identify as likely sources of ignition. We had collected much of this information before through the informational interviews, but this meeting allowed everyone to collectively focus on the questions and give us finalized community information. We were also able to share some preliminary information with these community leaders from our risk analysis and discuss how best to share that information with the community at-large.

A meeting was held with all major agency stakeholders to discuss the findings of our analyses and facilitate a discussion of how the USFS, CSFS, Park County, Denver Water, and Platte Canyon Fire Protection District can work on mitigation collectively, rather than acting separately. See discussion of the results of this meeting in the Proposed Fuels Treatments Projects. The analysis results were shared with non-agency stakeholders as well. Many of the attendees had a background on wildland fire and mitigation. Community stakeholders were presented the findings to provide feedback on the preliminary CWPP to ensure they have room to ask questions and become more familiar with our findings before sharing with the general public as these leaders will be helping to move recommendations forward.

We also met with adjacent fire protection districts Evergreen, Elk Creek, and North Fork on to discuss our findings at a technical and tactical level. Wildfires don't obey arbitrary boundaries and it will be a regional effort to decrease the risk to residents that live there. These other protection district partners are a valuable asset for discussing the regional possibilities and opportunities for funding.

To share findings of the CWPP with the entirety of Platte Canyon, we hosted two meetings to make sure anyone who wanted to attend was able to. We discussed the findings of the CWPP and shared additional resources that residents could use to take action. If that meeting was missed, all resources are either within this document or attached as an appendix.

Community Values At Risk

In speaking with community leaders about the values at risk in Platte Canyon, it was clear that Platte Canyon residents are committed to their district's success. Residents discussed what they value about their community (Table 1) and their willingness to problem-solve for their safety.

Table 1. Values at Risk identified by community members. Percent response refers to the individual times that value was identified, rounded to the neared 5%. Responses were not voted on.

Value	Community Member Response
Safety	80%
Wildlife/Nature	70%
Water and Air Quality	65%
Property	75%
Rural Value and Aesthetics	70%
Historical Structures	65%
Health	60%
Community	50%
Infrastructure and Technology	35%

Safety was identified as the primary value at risk for residents regarding their lives and homes, their ability to evacuate, and for local first responders. This is a large focus of the Community Wildfire Protection Plan and is the number one priority for Chief Joe Burgett. All analyses are designed to improve safety for residents when evacuating a wildfire and to give firefighters tactical options to fight wildfire and stage resources safely and efficiently.

Other highly rated values include water resources, abundant wildlife, and the landscape aesthetics of Platte Canyon. If no meaningful action is taken to make Platte Canyon forests more resilient, all these natural values will be compromised. The areas impacted the Snaking, Buffalo Creek or Hi Meadow Fires are examples of what happens to a natural landscape when no mitigation is completed. Vegetation and wildlife have not rebound 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.

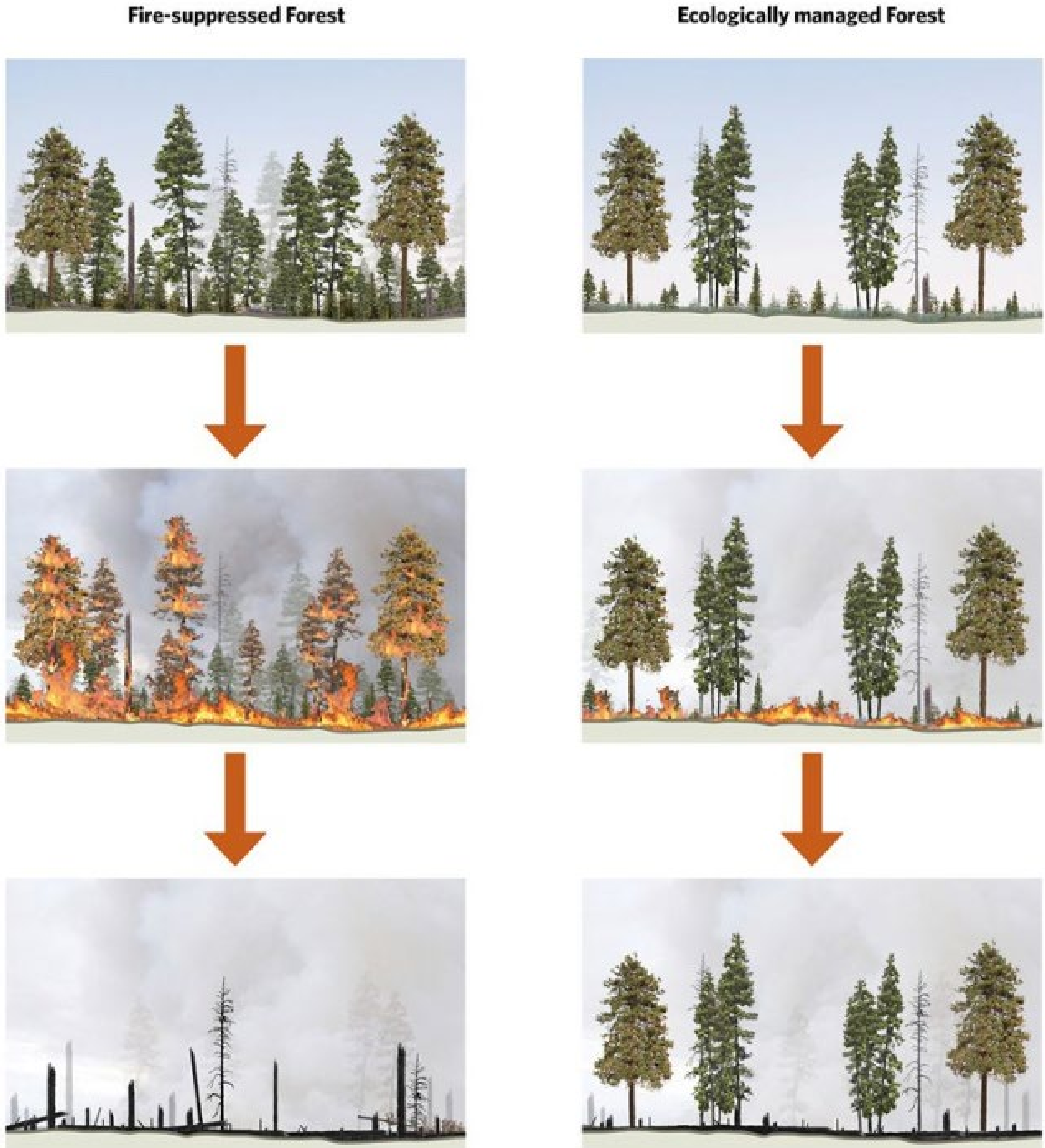
Platte Canyon residents value property, infrastructure, and historical buildings. We will discuss ways to make structures more fire resistant and how fuels mitigation should be implemented for structure survival later in this document. Historical structures pose a significant challenge because they are often constructed out of very flammable materials. In the Methods to Reduce Structural Ignitability Section, we discuss the measures needed to protect these structures, which may not always be adequate in areas of high wildfire risk like Platte Canyon.

Finally, Community Strength and Health are important to Platte Canyon residents. All our recommendations will serve these values, but we want to be sure that we address 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. Please use this CWPP as an excuse to talk with your neighbor, your coworkers, or your clients. Platte Canyon can only be Mountain Strong Together.

FIRE HISTORY

Wildfires along the entirety of the Front Range have been increasing in size and frequency over the last few decades. A report to the Pike and San Isabel National Forests done by long term fire analyst Rick Stratton details the effect of front range wildfires and lessons learned from past fires here. In his report titled, The Waldo Canyon Fire: Fires on the Colorado Front Range and Home Destruction, Stratton says "these fires are not only large and often destructive and deadly, but they exhibit rapid growth and can occur any time of year, typically with high winds and low humidity" (Appendix 12). Nearby fires that have occurred in similar elevation zones and vegetation types are the Buffalo Creek Fire in the Pike National Forest, the Hi Meadow Fire in Pine, CO which caused $15 million in damages, and the Hayman Fire. Hayman was the largest wildfire in Colorado history, claiming 6 lives, 600 structures, and $42 million in damages. Each of those fires were started by human activity and were exacerbated by high fuel loads and a lack of proper vegetation management. Wildfire activity and acreage per wildfire is expected to increase in the future due to drought and other extreme weather brought on by climate change. Before European settlement in this region, low to moderate wildfire events were more frequent, eliminating buildup of fuels on the ground and up into the canopy. This reduced the number of catastrophic stand-replacing fires and maintained a healthy and diverse forest ecosystem. The image below depicts what these forests look like without fire suppression and should be treated to look like.


Flume, 2000



ECOLOGICALLY MANAGED FORESTS By thinning the forest understory, we can safely reintroduce fire as a restorative process. Fire suppressed forest on left. Ecologically thinned forest on right. © TNC

Due to years of fire suppression during the 1800s and 1900s, and changes to ecosystem structure due to logging, grazing, and development, we are seeing more acres burned, homes lost, and higher disaster mitigation costs. Success stories on avoiding catastrophic wildfire loss have come from adequate fuel reduction treatments, improvements to housing materials, and planned evacuation routes. Stratton's research has found that changing the flammability of the Home Ignition Zone (HIZ) can really make a difference in the effects of a wildfire, yet Stratton says "unfortunately we tend to focus on the wildlands and less on the home" (Appendix 12). Fuel treatments like the one shown in the image below are a piece of the puzzle, but home hardening and defensible space are critical mitigation steps for changing outcomes of property loss and wilderness destruction. See definitions of Home Ignition Zone, home hardening, and defensible space in the Methods to Reduce Structural Ignitability Section and recommendations of how to protect your home.

Historical ignitions have been spread throughout the Platte Canyon Fire Protection District and can help predict where likely sites of ignition in the future could be. This information helps us prioritize prevention but cannot say for certain where a major wildfire will ignite in the future. Figure 3 shows the distribution of human and natural ignitions across the district while the Figure 4 shows a breakdown of ignitions per neighborhood.

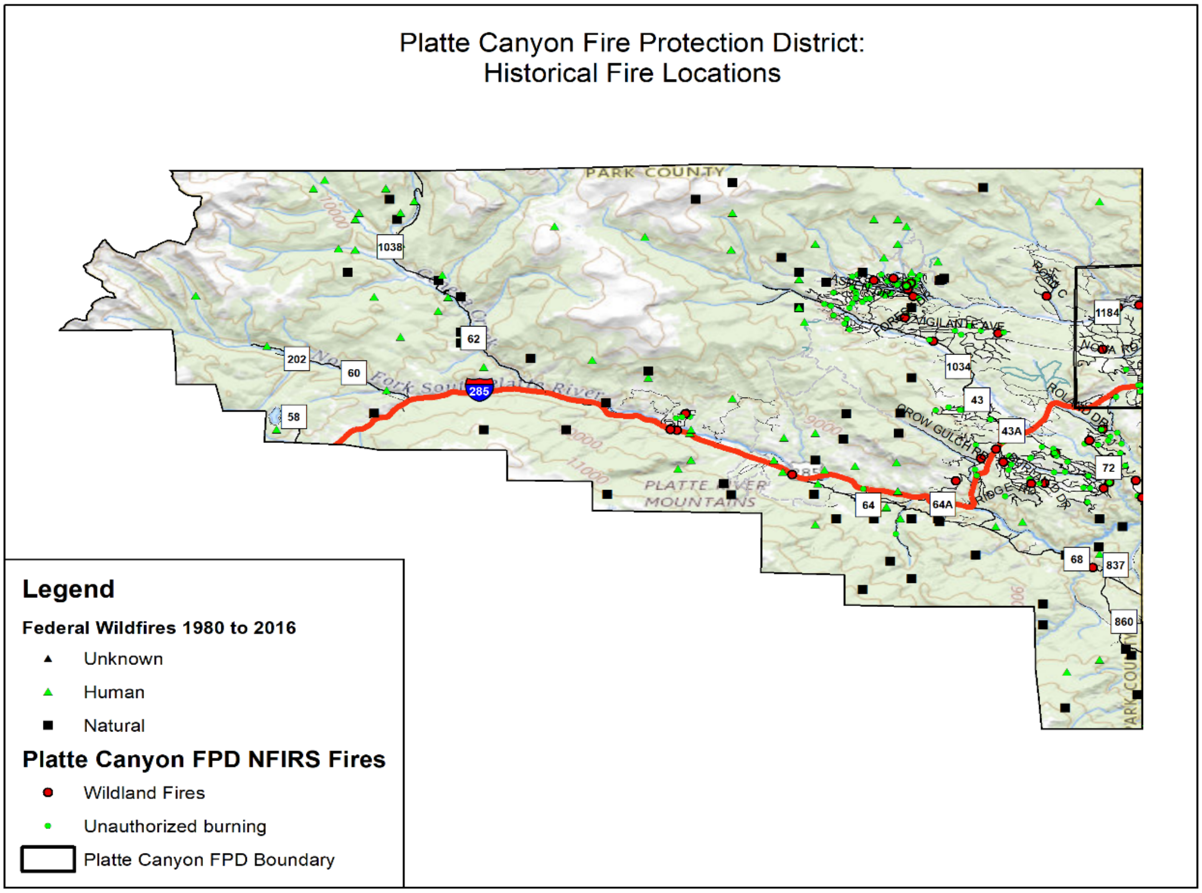


Figure 3. Platte Canyon Fire Protection District Historical Fire Ignitions.

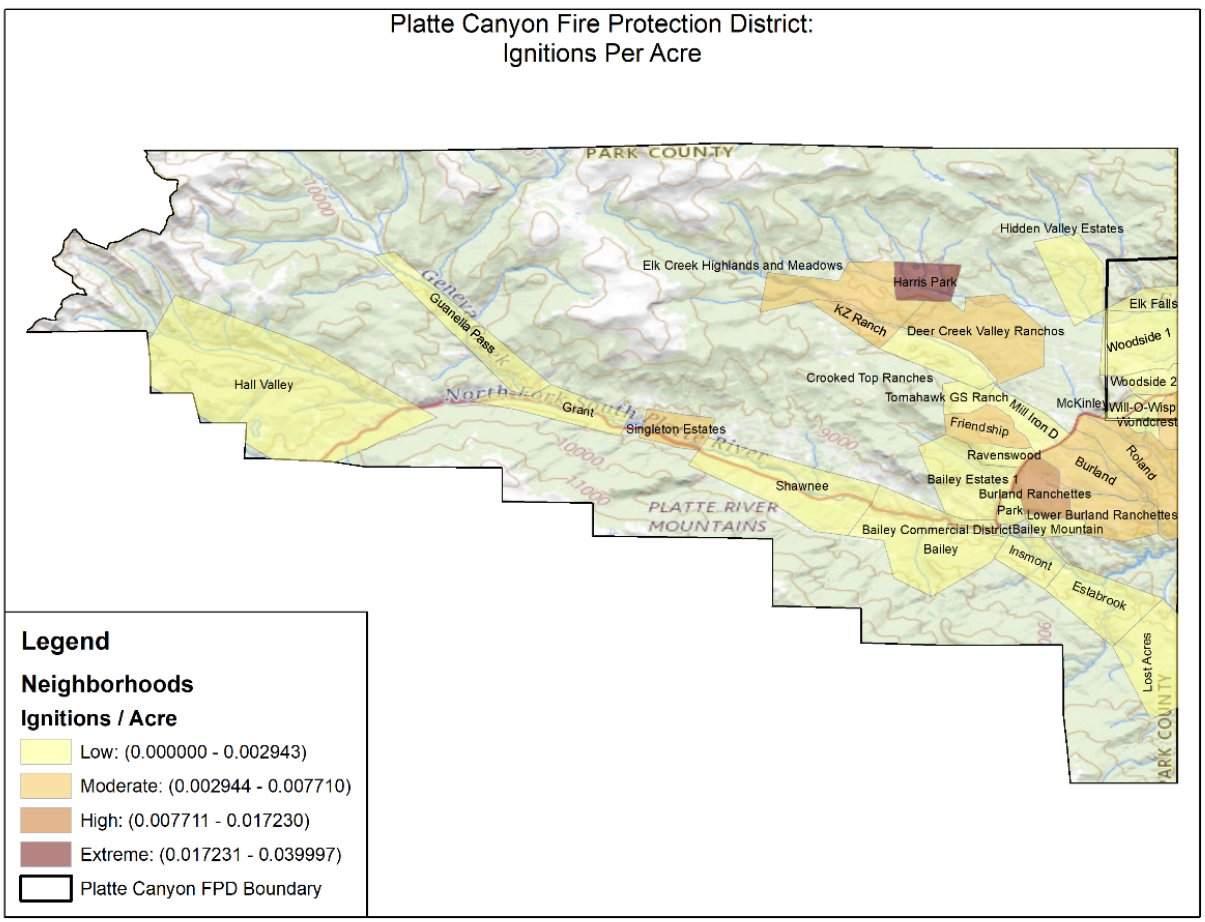


Figure 4. Platte Canyon Fire Protection District Neighborhoods Ranked for number of ignitions per acre, historically.

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Fire Protection District Capacity

Platte Canyon Fire Protection District (PCFPD) covers 271 square miles along US 285 and serves a population of 9,663 with a 25% occupancy swell in the summer months. The district was formed as a volunteer organization in 1947, and in 1980 it became a formal protection district.

There are 4 stations in the Platte Canyon Fire Protection District. Station 1 is in Downtown Bailey equipped with one Type 1 Engine, one Type 6 Engine, one 2,500-gallon tactical tender, and serves as the wildland station. This houses the Platte Canyon Wildland Fire Module, staffed Monday-Friday with 4 full time firefighters, growing to 10 during the fire season with volunteers. Station 2 on Delwood Dr. houses all the administrative offices and is equipped with two Type 1 Engines, two 2,500-gallon tactical tenders, one Type 6 Engine, one Type 3 engine, three Type 1 Ambulances. This station is staffed 24/7 with four fire medics and Monday-Friday with one Chief Officer. Station 3 is right in Grant along 285, equipped with one Type 1 Engine, staffed by volunteers. Lastly, Station 4 is in Harris Park with one Type 1 Engine, one 2,500-gallon Tender, and one pump truck at 1250 gpm.

PCFPD is a full-service agency with 13 career firefighter/medical staff and 22 volunteer firefighters. Ten firefighters comprise their wildland fire crew, with four permanent staff and six seasonal employees. Approximately 80% of calls in the district are medical, but Platte Canyon responds to structural and wildland fires, traffic accidents, swift water and ice rescues, HazMat, and more. All staff are ICT 5 qualified, and each shift is staffed with at least one lieutenant and three firefighters.

The Platte Canyon Wildland Fire Module is a ten-person crew that provides technical and ecological assistance to the district. They help the district to use prescribed fire as a management tool, and complete fuels treatments for the districts long term mitigation plan. The crew is qualified to assist in wildfire suppression activities, which strengthens the knowledge they bring to prescribed fire.

PCFPD has a FireLine ISO (Insurance Service Office) of 4 within 5 road miles of a station, or a 10 beyond that. There are three factors that affect the risk of wildfire, based on the property address.

- Fuel—Grass, trees, or dense brush can feed a wildfire, a model calculates a weighted average of fuel amounts in a 3 radial distance bands within a mile of the dwelling.
- Slope—Steeper slopes can increase the speed and intensity of wildfire and affect reconstruction costs.
- Access—Identifies whether a risk is located on a Dead-end road that firefighting equipment may have trouble negotiating. FireLine shows you the risk from each of the three factors, as well as providing overall hazard ratings for specific properties.

Also, FireLine identifies properties located in Special Hazard Interface Areas—risks outside fuel areas but exposed to wind-borne embers and high heat from nearby fuels.

Community Preparedness

Residents, non-profits, local agencies, and the fire protection district are working hard to become better prepared for a wildland fire. Many initiatives are aimed at education and outreach and wildland fuels mitigation. Emergency communication strategies, evacuation planning, and non-year-round residents or short-term rentals have been identified by residents as topics they feel unprepared for. These topics fall outside of the scope of this CWPP, but residents are encouraged to develop plans with the local agencies and resources mentioned in this section.

Platte Canyon Wildland Fire Module

Platte Canyon Fire Protection District has been working hard to mitigate their wildfire risk through a combination of fuels treatments, roadway improvements, and home ignition zone work. PCFPD has the capacity to work on a wide variety of projects with its wildland fire module. This module can provide technical and ecological-based expertise in the areas of prescribed fire and wildfire response. This includes long-term planning, ignitions holding, suppression, hazard fuels reduction and fire effects monitoring. While implementing these techniques, the crew helps ensure fire fulfills its natural role to meet resource and management objectives.

Fire Adapted Bailey

Fire Adapted Bailey is a non-profit organization affiliated with Fire Adapted Colorado. They assist in all facets of wildfire education and mitigation, including crowdfunding mitigation projects, assisting neighborhood Firewise groups, home risk evaluations, grant writing, and planning, among other projects.

Firewise Groups

Six Firewise groups are active in Platte Canyon: Burland Ranchettes, Deer Creek Valley Ranchos, Elk Creek Highlands and Meadows, KZ Ranch, Woodside Park, and newly started Harris Park. These organizations are scheduling workdays, helping receptive neighbors to make their homes safer, and educating their neighborhoods.

State and Federal Forest Services

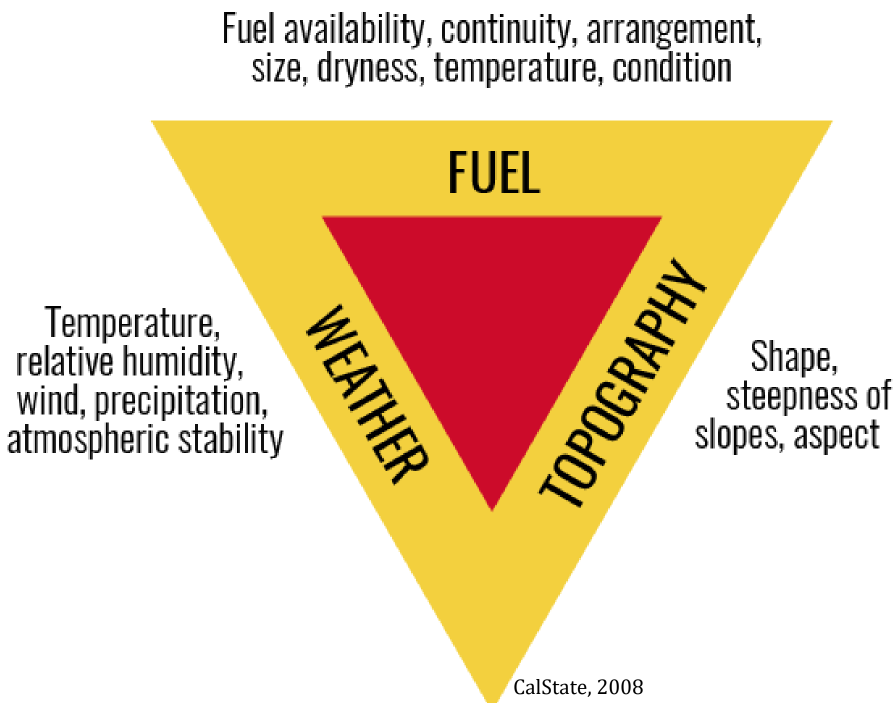
The United States Forest Service and the Colorado State Forest Service have been working on federal and private lands in Platte Canyon to improve the forest structure for wildfire protection. Some of these treatments are described in the Recent Fuels Treatments Section.

Evacuation Planning

Since 2015, Platte Canyon Fire Protection District has led the implementation of an annual multi-agency wildfire evacuation drill throughout its populated territories. The drill is a civilian-focused community risk reduction training, and its primary intent is to educate civilians on evacuation procedures by giving them a chance to practice receiving Code Red evacuation notifications, drive evacuation routes, and arrive at a temporary area of refuge. The secondary benefit of these drills has been a multi-agency practice of large wildfire management in order to identify operational weak-links and future areas of improvement. To-date Subdivision's evacuated in the drill include The Deer Creek Valley Ranchos, Elk Creek Highlands, Burland Ranchettes, and Will-O-the-Wisp. This great practice must continue so that these residents and emergency response agencies can avoid the obstacles that negatively affected communities like Paradise, CA.

WILDFIRE BASICS

This section will help the community understand common terms and processes in wildland fire. Every wildland firefighter must take wildland fire basics courses S130/190 from the National Wildfire Coordinating Group, Introduction to Wildland Fire Behavior before serving on a crew. These basics help firefighters make quick assessments of an area's fire risk and we would recommend taking the course to anyone who wants to be deeply involved in the fire community. The following is a summary of the topics from this course that are important introductory concepts. Informational materials found in Appendix 3.



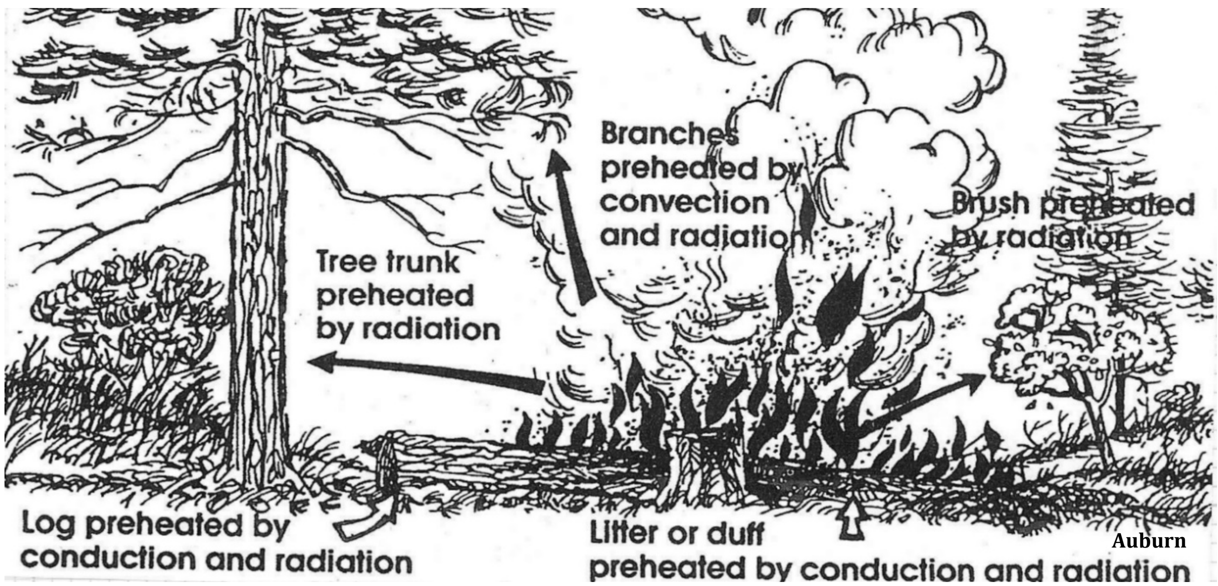
Fuel and Ignition

Fuels are live vegetation from timber, shrubs, and grasses, and dead vegetation that is highly flammable. When we discuss fuel for wildland fire, this is what we are referring to – notably, we are not referring to structures or other man-made objects in the Wildland-Urban Interface. The reason for this is because there are no current, scientifically-sound models to predict how these materials will behave during a wildland fire. We will refer to homes and structures for their likelihood to ignite due to embers or adjacent burning fuel.

Each vegetation type has different behavior when on fire. Grasses burn the hottest and fastest of all fuel types. They can be more predictable and easier for firefighters, but with high rates of spread (ROS) they contribute to fast of changes in fire size. Shrubs can increase fire intensity, burn longer than grasses, and bring fire from the ground up into the tree canopy. Shrubs and small trees that bring the fire up from the ground can be referred to as "ladder fuels". Timber consists of trees, both evergreen and deciduous, and it is very difficult to control a fire when it is spreading from canopy to canopy. When we refer to heavy fuels or high fuel loading, we may be referring to a combination of shrub and timber or dense timber with other ladder fuels underneath – anything that will behave intensely during a wildland fire and be hard to control. All vegetation treatments are designed to reduce fuel loading and give firefighters additional tactical options.

One style of ignition during a fire is particularly troublesome – a spot fire. "Spot fires are small fires burning beyond the main fire boundary. As gases rise from a fire into the convection column, sparks, embers, and burning twigs are carried aloft. Spot fires result as these hot and burning items fall back to the ground or are blown across the fire line into unburned fuels beyond the main fire. If spot fires burn unchecked, they may form a new head or another major fire. If this happens, firefighters could be trapped between two fires, or the fire may move in an unanticipated direction."

Types of heat in a wildland fire describe how heat energy moves between objects on fire and can be used to identify the risk from vegetation adjacent to your home. The three types are Conduction, Convection, and Radiation. For example, homes with downslope fuel and homes situated in canyons are at increased risk due to convection and radiation.



Conduction: When two objects of different temperatures contact each other directly or through a medium, heat conducts from the warmer object to the cooler one until their temperatures equalize. This affects structure ignition as metals conduct heat rapidly. Fibrous materials such as wood are poor conductors of heat, therefore, conduction has a limited effect on the spread of wildfires.

Convection: Gases heated in a fire expand, become lighter, and rise. In a wildland fire, fire gases rise in a convection column, and cooler air flows in to replace the rising gases. In some cases, this inflow is sufficiently strong to affect local winds. As these gases rise into the column, sparks, embers, and burning twigs are carried aloft. These burning materials fall back to earth up to several miles downwind and can start spot fires. Hot convected gases moving up a slope can dry out fuels, lowering their ignition temperature. These fuels also become preheated by the convected heat, thus increasing their susceptibility to ignition and rapid fire-spread.

Radiation: Heat transfer by radiation is one of the major sources of spread in wildland fires. It's comprised of heat waves that radiate in all directions from the source, travelling through the air until they are totally or partially absorbed which then gains heat and in turn radiates heat from its surface. This is how a home may ignite due to intense heat, without direct flame contact. One of the most common examples of radiant heat in a wildland context is fire burning in a narrow canyon. Radiating heat preheats and dries fuels adjacent to the fire and initiates combustion.

Figure 10—Spotting Across Narrow Canyon

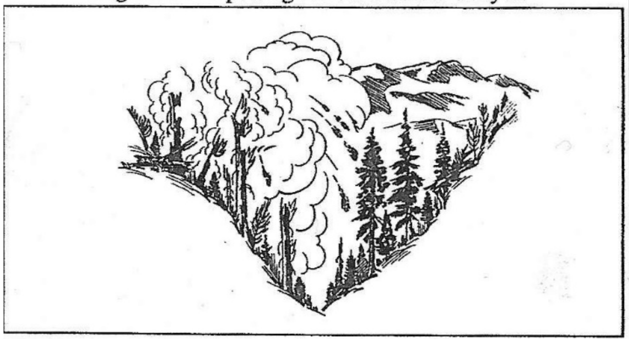
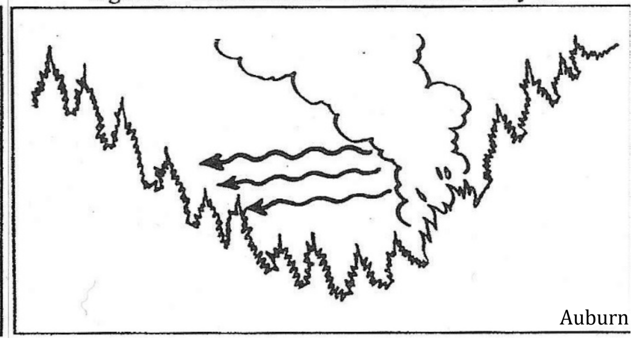


Figure 9—Radiant Heat Across Narrow Canyon

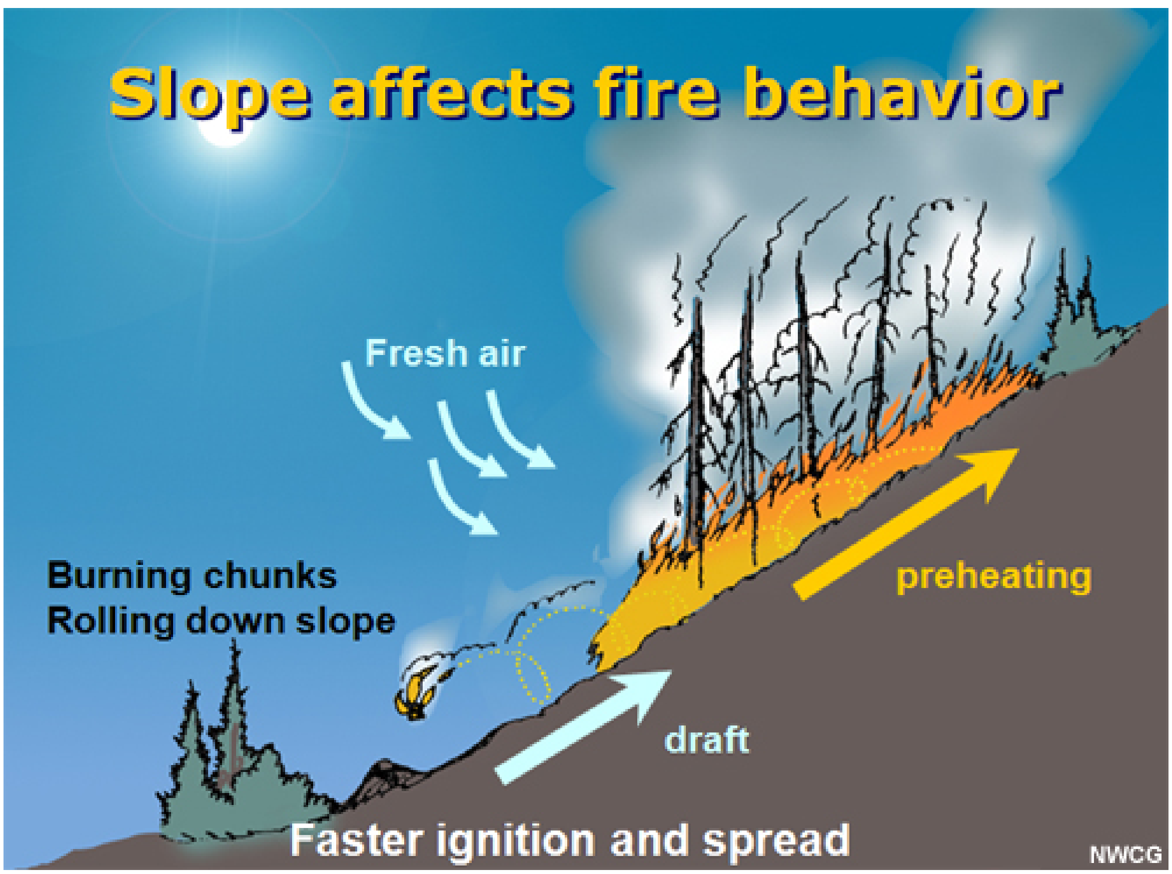


Auburn

Aspect and Topography

Local topography affects a fires intensity, spread, and speed. First, it is important to note aspect which is the compass direction that a slope faces. North facing slopes tend to experience less sun exposure during the day, resulting in heavier vegetation density and higher fuel moisture. South Facing slopes receive the most direct sun rays and dry out much quicker. Typically, they have rapid loss of fuel and soil moisture, growing fewer trees and more dry, flashy fuels like grass. These slopes are much more susceptible to fire and will experience quick rates of fire spread.

Fire moves quickly upslope due to convective heat and quickly ignites vegetation across narrow canyons. Wildland Urban Interface areas like Platte Canyon that exist in areas of complex topography are at high risk for catastrophic and quick moving fires. Topography makes a fire harder to control for firefighters and can change wind behavior, making a fire's spread unpredictable.



Wind and Weather

On the Front Range, wind and weather can be unpredictable and change rapidly. The Platte Canyon area is in an area of high wind, active storms, and dry conditions. This is why Red Flag days are frequently experienced – these days indicate a combination of hot temperatures, very low humidity, and strong winds. **Table 2** shows the two options of criteria needed.

Table 2. Description of conditions needed to trigger a Red Flag Warning

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	

Weather is a result of the interaction of temperature, wind, relative humidity (RH) and precipitation. All these factors are important to how a fire will behave. During a wildland fire, there are dedicated firefighters to taking weather measurements and helping everyone on the incident to understand what is happening and how it will impact fire behavior. When you are paying attention to these risky weather events, it will help you identify days to be on high alert for evacuation notice.

From our Fire Triangle, heat is one side. "Direct sunlight and hot temperature can preheat fuels and bring them closer to their ignition point, cooler temperatures have the opposite effect". Relative humidity is important in the context of air temperature too, as hotter air can hold more moisture. "Moisture in the air is known as relative humidity (RH) – the percentage of moisture in a volume of air relative to the total amount of moisture that the volume of air can hold at the given temperature and atmospheric pressure". All of this is incredibly important when thinking about how quick fuels will ignite during a wildfire. With hot air and low RH, the air absorbs moisture from fuels, making them more susceptible to ignition – hot and dry conditions are conducive to fire.

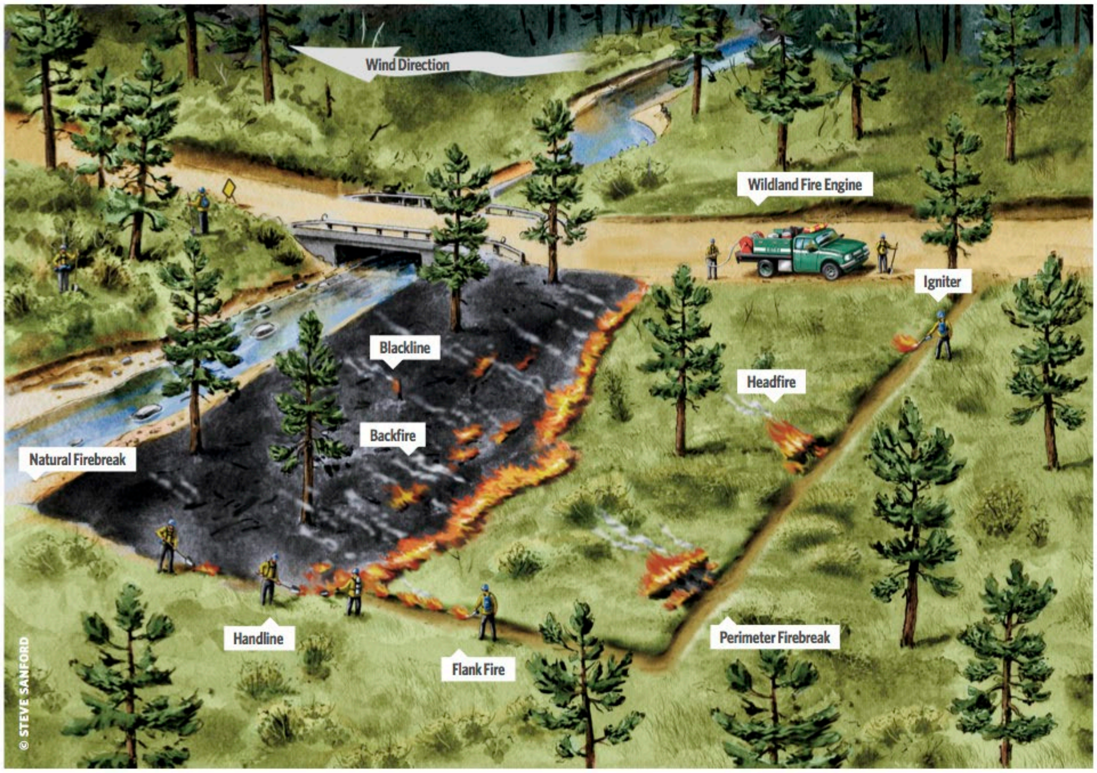
Wind quickly aids in drying out fuels and absorbing moisture, increases the amount of oxygen to a fire, preheats vegetation by directing flames towards unburnt fuels, and can carry embers more than a mile ahead of an active fire. Wind moving towards unburnt fuels describes Flame Length, the distance 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.

Winds are quickly funneled by topography in unpredictable directions and can even be created by an active fire itself. Wind channeling is a direct result of natural features like chutes and saddles. Convected air and heated fire gasses take the path of least resistance. Chutes and saddles as well as narrow canyons suddenly act like chimneys. You should especially look for deep canyons. They can burn rapidly because the radiant heat and embers generated by a fire tend to ignite the other side.

Prescribed Fire

All these factors mentioned above, and more, are considered carefully during a prescribed fire and a lot of work is done before anything is ignited to ensure the fire can be controlled safely. Breaks in fuel may be created down to bare mineral soil to allow ignitors to choose how fire enters an area and where it may be controlled from. Weather past, present, and future is carefully studied to make sure fuel has the right moisture content, winds will be predictable, and temperatures don't make fire behavior too intense for safe ignition. What is quite incredible about prescribed fire is firefighters understand how fire spreads in a vegetation type and can make calculated decisions about how much fire intensity to create and where a prescribed fire will be most useful in reducing fuel loading.

Fire is a natural process on the Front Range and our forests types are adapted to it. Dense timber stands are not a natural feature on this landscape and have only developed in the absence of fire. This has created non-resilient forests and when fire happens, it can be catastrophic and with entire forests being burned down. We cannot erase hundreds of years of fire suppression with tree cutting alone. Prescribed fire mimics natural processes by truly removing fuel at all levels, grass, shrubs, and trees, and helps the ecosystem select for trees that will be resilient to fire, standing alone in a savanna-like arrangement. See the **Recommended** Fuels Treatments Section for a more in-depth description of ecologically informed recommendations.



THE ABCs OF A CONTROLLED BURN

A burn boss's first priority is to conduct a safe burn, which requires long hours of preparation. **Wind speed and direction**, humidity and a host of other factors must meet safety requirements before a burn can begin. After establishing a perimeter of natural and hand-cleared **firebreaks** devoid of fuel, the crew will light a downwind **backfire**, which burns slowly as it moves into the wind. As the backfire burns away fuels, it creates a **blackline.** The crew patrols the firebreak perpendicular to the backfire, establishing a **handline,** where an **igniter** will use a drip torch to set a **flank fire** to clear fuels along the handline. When the flank fire has burned away enough fuel, an igniter will set the **headfire** along the windward firebreak. Fueled by the wind, the headfire typically burns quickly, but extinguishes itself by burning straight into the backfire.

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FIRE BEHAVIOR

Spatial analysis using ArcGIS (geographic information systems) was conducted for vegetation data to model fire behavior. Basic fire behavior outputs were calculated using the Interagency Fuel Treatment Decision Support System (IFTDSS). Landfire 2014 data were used as spatial inputs, and the Scott and Burgan 40 fire behavior fuel models were chosen to add a greater degree of specificity to outputs (LANDFIRE 2014). Weather inputs for the fire behavior models were based on the Bailey RAWS (052001) for a period of record 2008 – 2018, May 15 – September 15 (Table 3).

Table 3. Fuel moistures used as inputs for fire behavior simulations.

	Percentile Fire Weather Conditions	
Inputs	60th	90th
1-Hour Fuel Moisture (%)	4.19	2.22
10-Hour Fuel Moisture (%)	5.36	3.37
100-Hour Fuel Moisture (%)	9.82	12.26
Live Woody Fuel Moisture (%)	90.56	68.72
Herbaceous Fuel Moisture (%)	50.01	30.00
Wind	14 mph	17 mph

All data was taken at both 60th and 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, 60th percentile weather is defined as the severest 40% of the historical fire weather). 90th shows the possibilities of extreme fire behavior, and 60th shows conditions that are frequent in Platte Canyon. Wind is a measurement of sustained winds, at 20 feet above ground level. This CWPP combined data from these sets and then utilized this basic data to perform risk analysis for Platte Canyon. Figure 5-8 are examples of these underlying fire behavior datasets in Platte Canyon.

Flame length and crown fire activity were calculated at 30 m^2 resolution using the Interagency Fuels Treatment Decision Support System. These were downsampled to 10 m^2 and used as inputs for two models: roadway survivability and embercast.

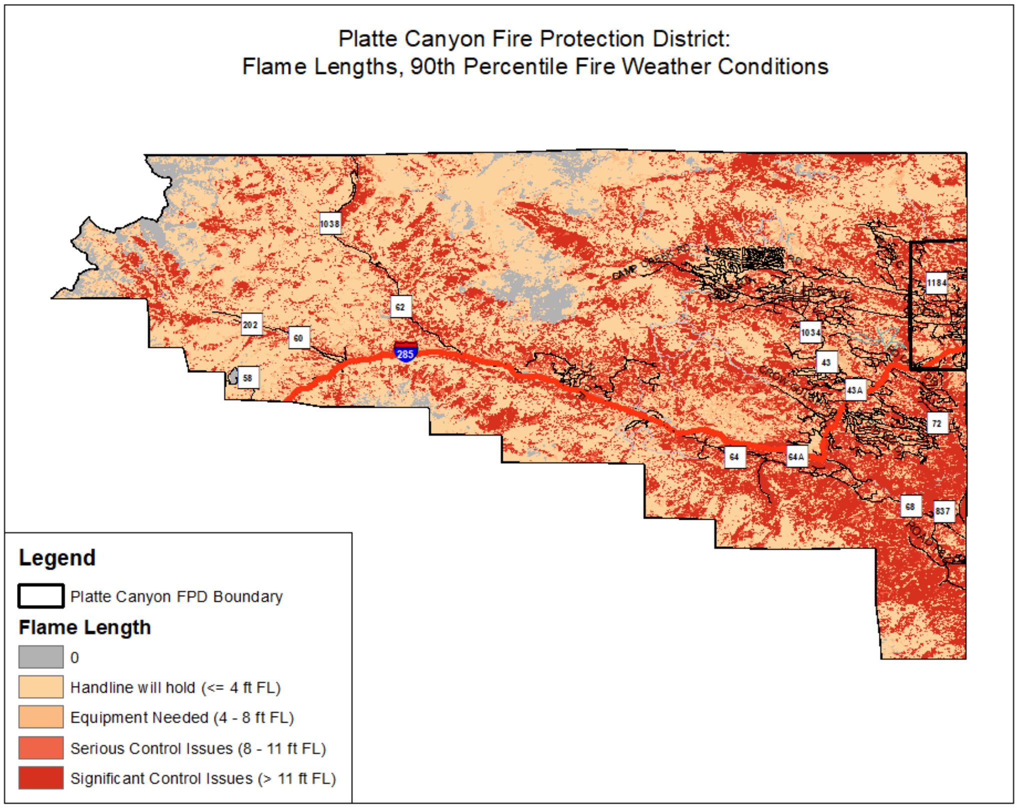

Figure 5. Flame Length under 90th Percentile Fire Weather Conditions across Platte Canyon Fire Protection District. Flame Length is the distance measured from the average flame tip to the middle of the flaming zone at the base of the fire. It is measured on a slant when the flames are tilted due to effects of wind and slope.

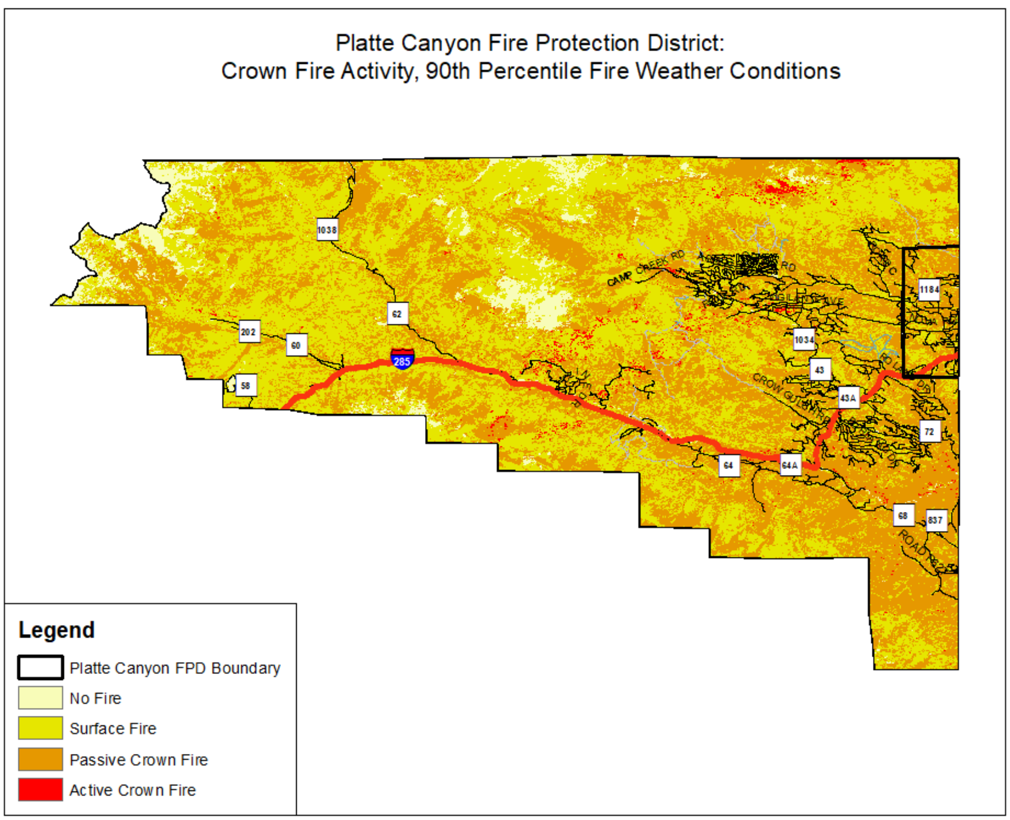

Figure 6. Crown Fire Activity in 90th Percentile Fire Weather Conditions across Platte Canyon. Crown Fire is when fire is spreading from treetop (crown) to treetop.

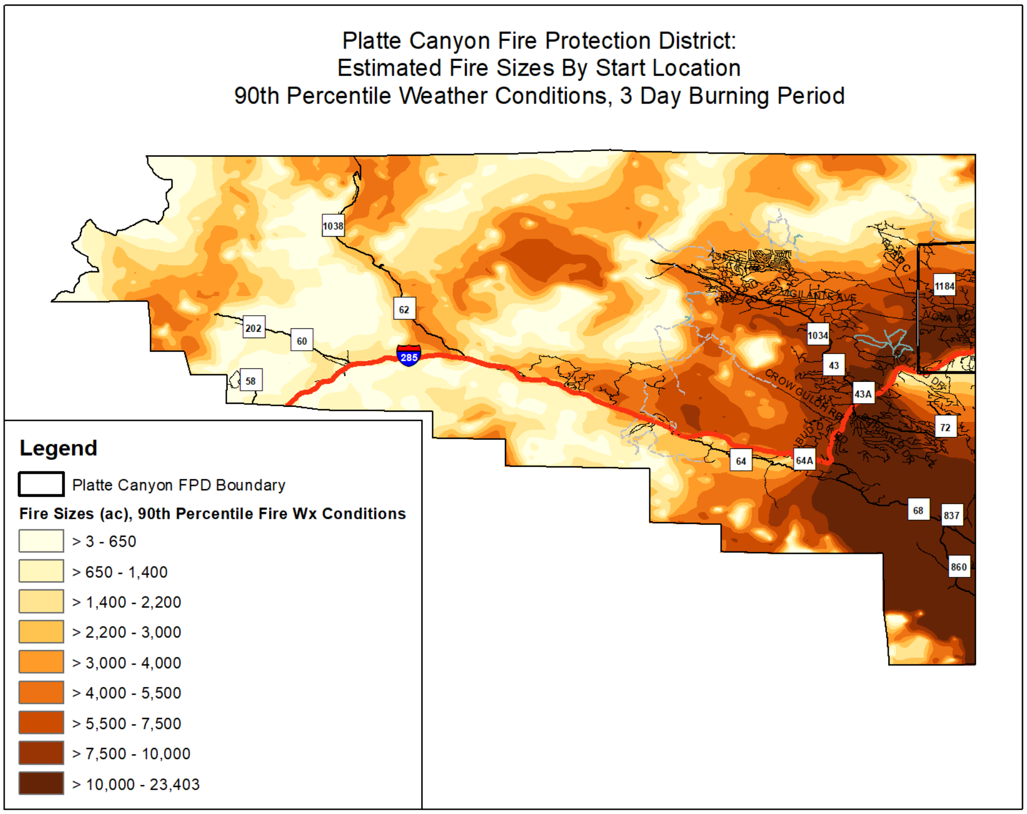

Figure 7. Platte Canyon Estimated Fire Sizes with simulated Start Location. This model predicts how large a fire could become with extreme weather, making it hard to control.

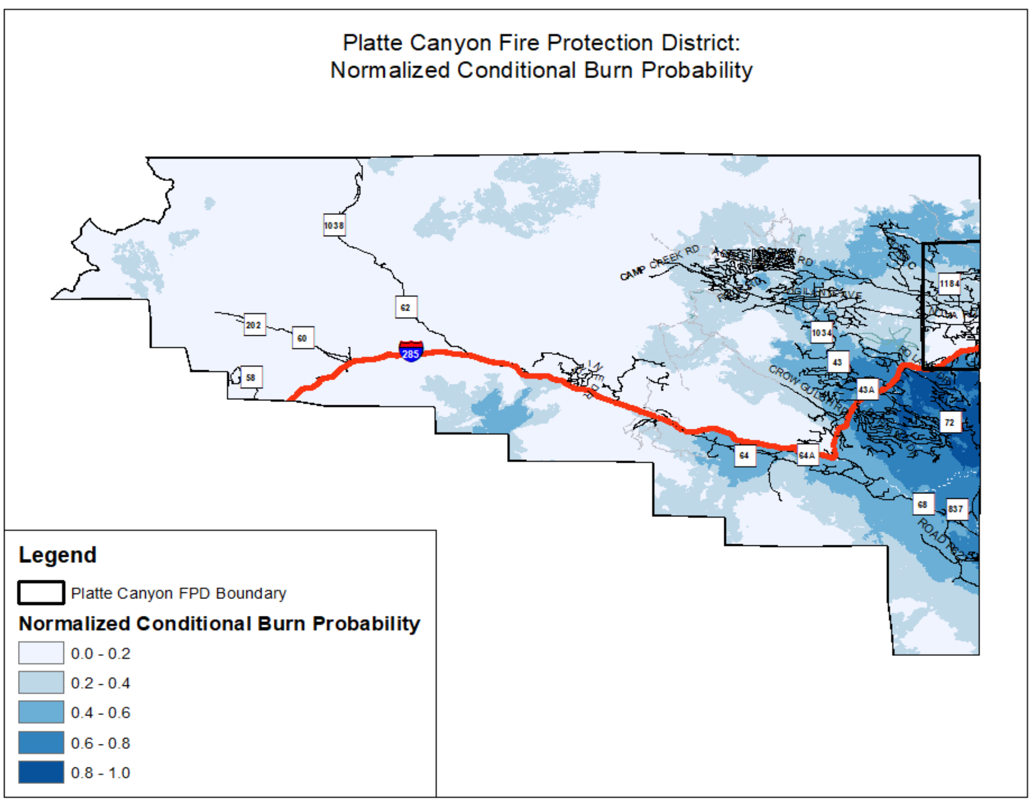

Figure 8. Burn probability is the likelihood that a wildfire will burn a given point or area over a specified period of time. Burn probability given a specific set of defining criteria. The specific criteria can be a weather scenario and a fixed, usually short period of active fire spread.

Risk Analyses

To best understand Platte Canyon Fire Protection District's risk of wildfire, this CWPP evaluated beyond fire behavior to determine where priority mitigation should take place. Primary assessment was defined by the boundaries of the Fire Protection District then communities were identified within for a secondary analysis. This CWPP will consider roadway survivability, evacuation, embercast exposure, radiant heat exposure, temporary areas of refuge, community hazard assessments, and Suppression Difficulty Index for risk analysis.

Recommendations are focused on population centers in PCFPD. Areas of the WUI were broken down into Neighborhoods and Evacuation Units. In most cases, these are the same locations, but in a few instances, Evacuation Zones further divided neighborhoods in order to assist the district in staggered evacuation planning. Most areas described will be familiar to residents, but some designations are due to topography, fuel load, and roadway capacity, rather than political or subdivision boundaries. Figure 9 shows the neighborhoods, while Figure 10 shows evacuation units that will be used to organize analyses and ranks in the Community Project Prioritization Section. Each neighborhood is displayed in Appendix 1 and shows roadways within the neighborhood.

The difference between the Neighborhoods and the Evacuation Units is to divide Belford Estates and Singleton Estates into separate areas, divide Elk Creek Highland and Meadows and Upper 43 into separate areas, merge Bailey and the Bailey Commercial District, and divide Deer Creek Valley Ranchos into Elkhorn Acres, and Evac A & B of Deer Creek Valley Ranchos.

Neighborhoods In Platte Canyon Fire Protection District

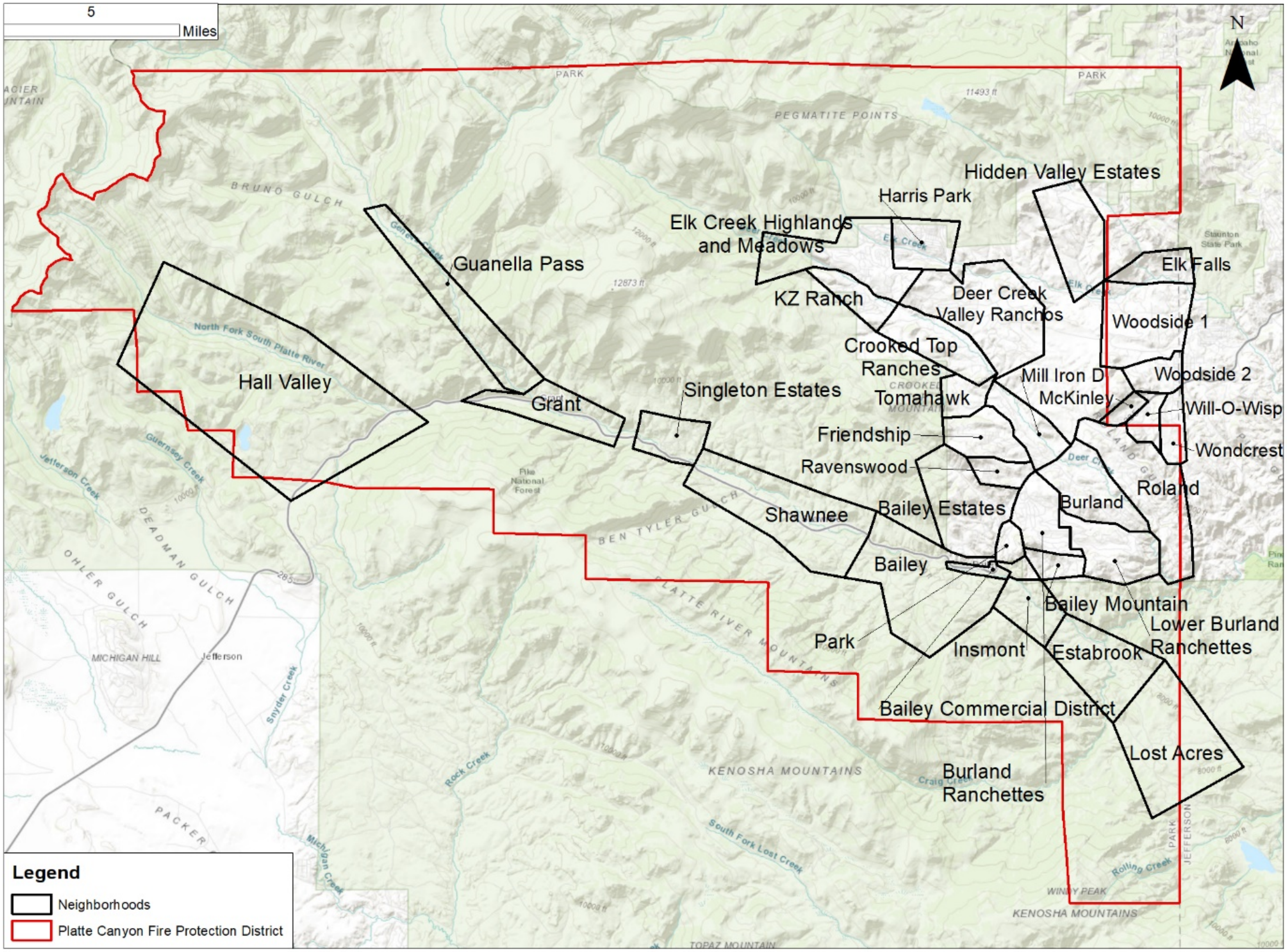

Figure 9. Outlines of Neighborhoods used in this CWPP Analysis.

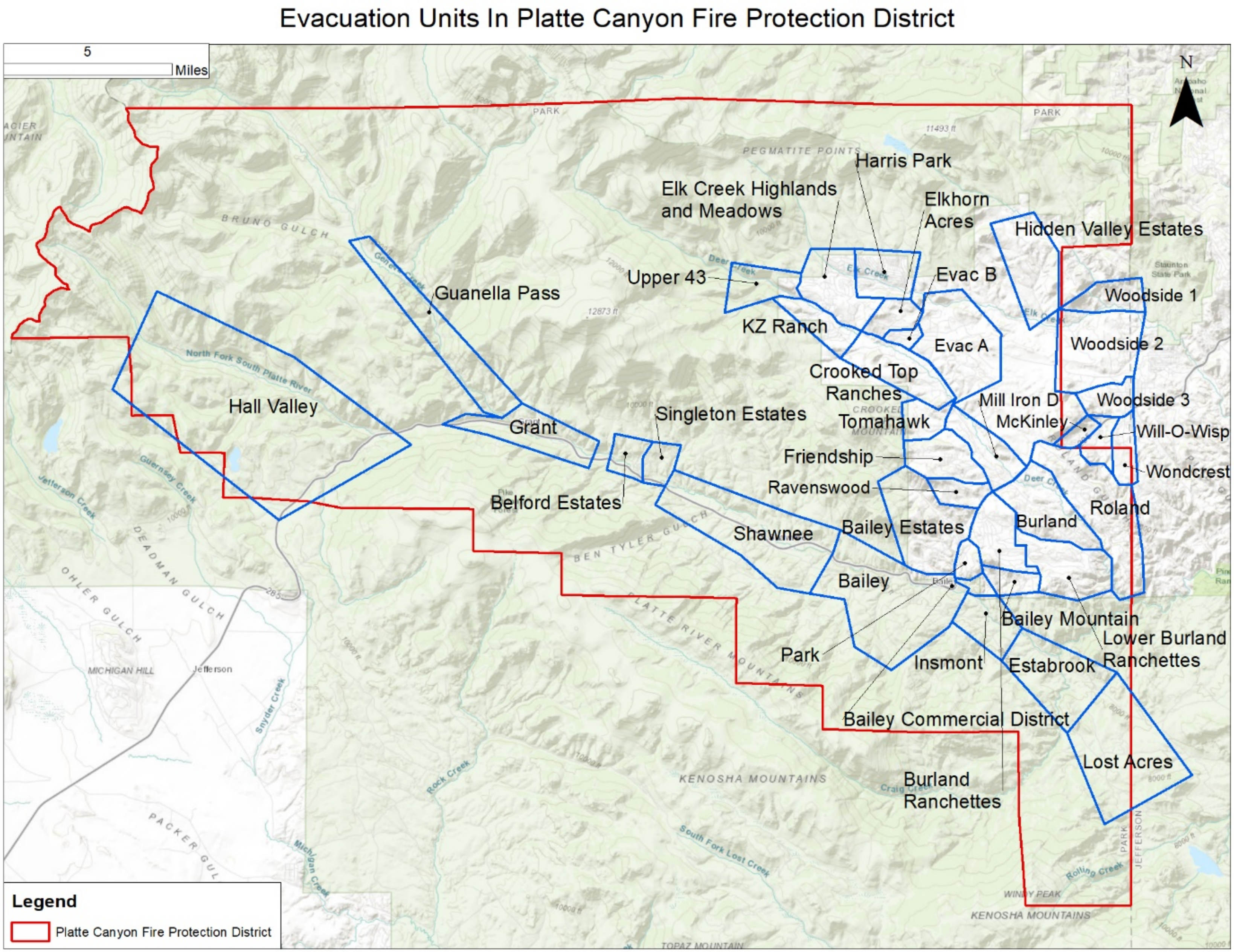

Figure 10. Outlines of Evacuation Zones used in this CWPP Analysis.

Roadway Survivability and Evacuation

Roadway Survivability uses spatial data to identify 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) are at risk of mortality. Roadways that overlap with predicted greater than 8 ft flame lengths under 60th and 90th percentile fire weather conditions are non-survivable. If residents are stuck on the roadways, mitigation action can create survivable conditions. In Figure 11, an example of Roadway Survivability is displayed.

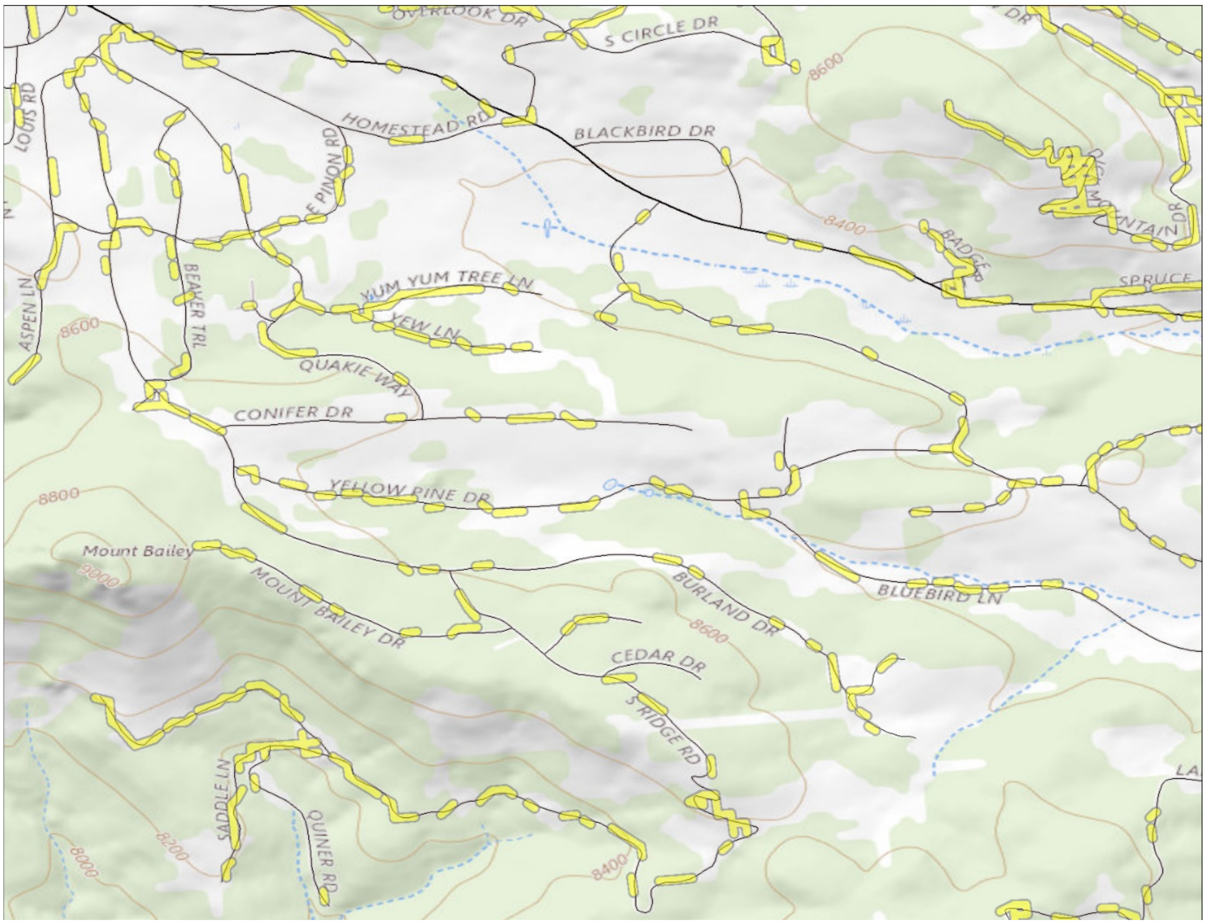

Figure 11. Example of Non-Survivable roadway displayed in yellow

Please see the **Recommended** Fuels Treatments Section for a description of thinning treatment guidelines that can be used for roadways. The images in Figure 12 give an example of what survivable and non-survivable roadways look like. Roadway treatments when coupled with home hardening will dramatically improve the survivability of a neighborhood and provide increased tactical options. Life safety should be prioritized for residents evacuating during a wildfire, and ingress of first responders or firefighters.

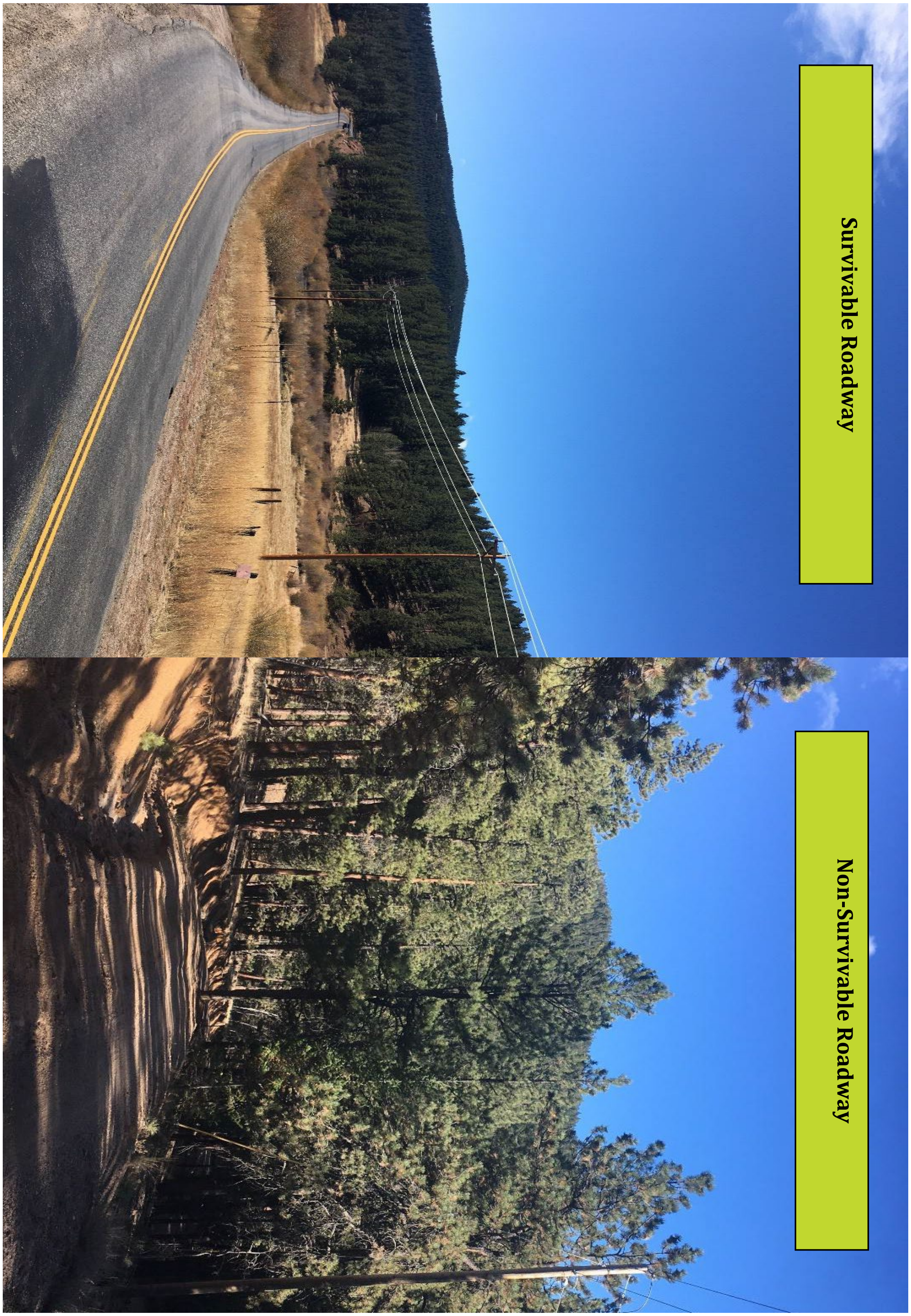

Figure 12. Examples of Survivable and Non-Survivable Roadway.

Evacuation Time and Congestion

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 structure and doesn't account for RVs or trailers. It assumes simultaneous departure by car, with a quick exit from the home. The model allows for prediction of congestion from normal traffic flow, not considering additional visitors to the district, or emergency vehicles trying to travel the opposite direction of evacuation. As traffic during the weekends along US 285 can be extremely congested, the likely evacuation time will be much longer than predicted.

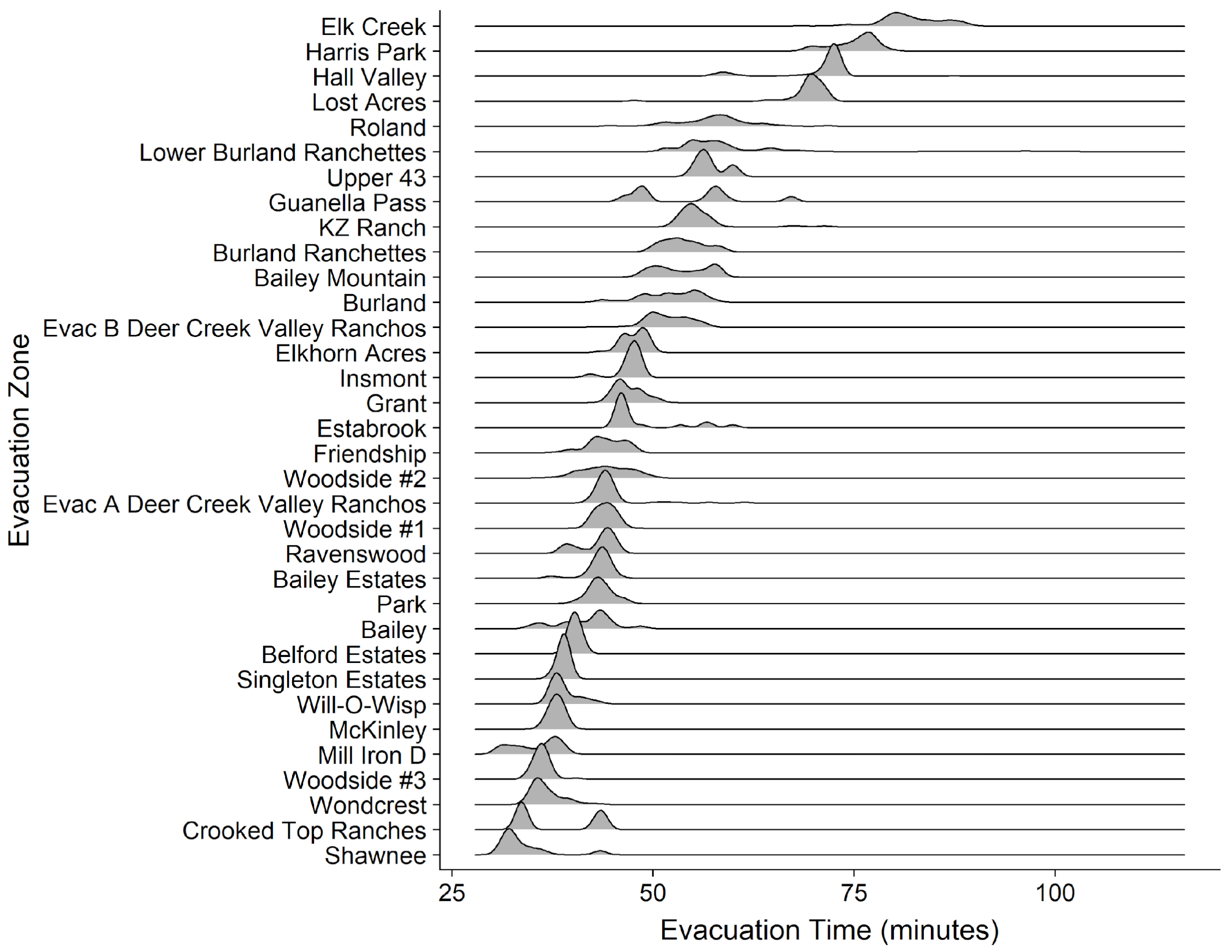

Figure 13. Evacuation Time by Evacuation Zone. SeeFigure 10 for a map of Evacuation Zones.

This was conducted using the ArcCasper model (Shahabi & Wilson, 2014) and maps the evacuation of each address point to a chosen check point. The graph in Figure 13 depicts the distribution of time to evacuate for all address points in that Evacuation Zone. For example, in Shawnee, most address points will be able to evacuate in 30 minutes, but some will take closer to 45 minutes.

Modeled traffic flow shows high congestion areas, referred to as pinch points. If high congestion and non-survivable roadway are in the same place, it high risk. These sites are referred to as Evacuation Pinch Points in the analyses. An example is below in Figure 14 of these non-survivable, Evacuation Pinch Points mapped in an evacuation zone.

Evacuation Zone: Will-O-Wisp - Rating: High

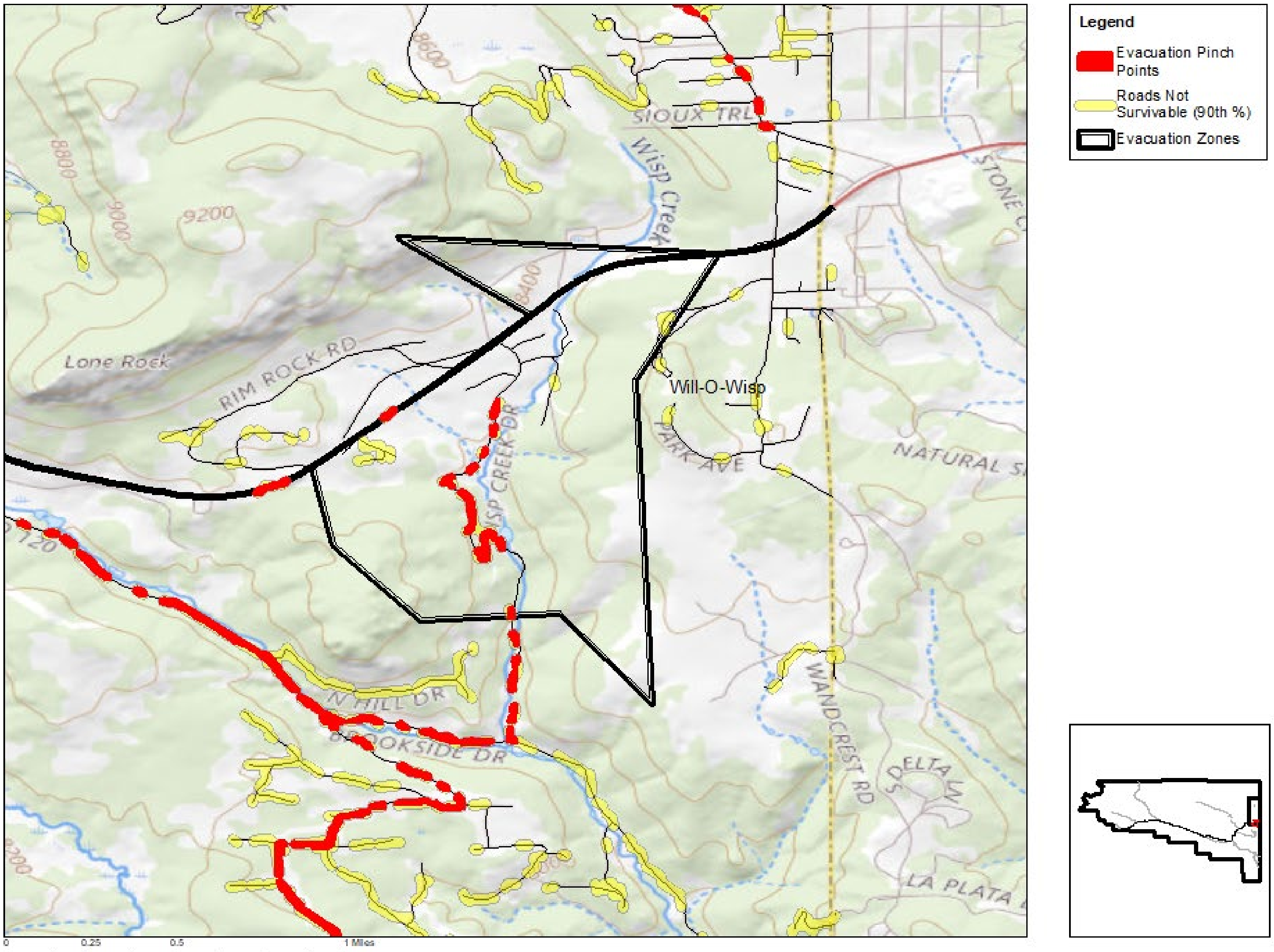

Figure 14. **Example** of Evacuation Pinch Points and Non-Survivable Roadway in the Will-O-Wisp Evacuation Zone.

Embercast and Radiant Heat Exposure

These models were used to predict potential structure exposure to radiant heat, short range spotting, and long-range spotting. This is vitally important information as homes are more likely to ignite from embers than direct flame contact. There are two types of spotting: short range and long range (Figure 15). Calculations were based on the work of Jennifer Beverly, who validated this work in Alberta (Beverly et al., 2010). Areas on the landscape with flame lengths greater than 8 were identified and a moving window calculation identified adjacent areas exposed to radiant heat from those areas. Areas within 328 ft (0.1 - 100 m) of calculated active crown fire were marked as being at risk from short range spotting, and areas within a 1640 ft (100 – 500 m) from active crown fire were marked as being at risk from long range spotting. **Notably, only active crown fire was used as input for these models; passive crown fire (group torching) was so prevalent that nearly all of the area of interest was at risk from both short range and long-range spotting. Therefore, these models under-predict exposure.**

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 with the HIZ.

Long Range spotting affects nearly all of Platte Canyon 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 Spotting equally affects all neighborhoods in the district. Figure 16 depicts Long Range Spotting across Platte Canyon to demonstrate how it impacts every location in the district.

Short Range Spotting is when embers travel a short distance from the fire and continue its spread closer to the main fire – in many cases this can be a deluge of embers that is difficult to combat. As you will see in our analyses, Platte Canyon neighborhoods are exposed to both types of spotting and should use home hardening recommendations in the **Methods to Reduce Structural Ignitability** Section to decrease exposure to embers.

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.

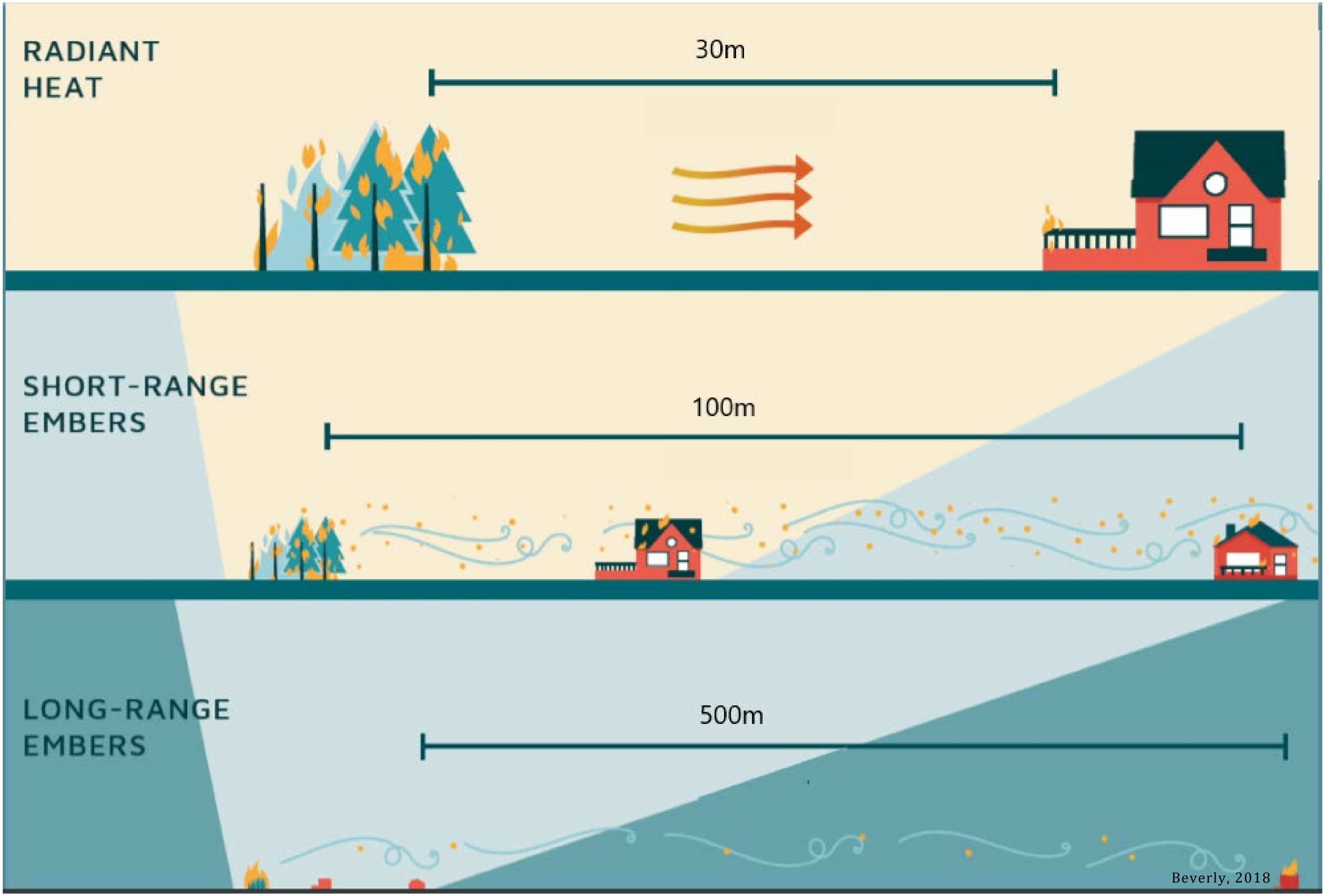

Figure 15. Depiction of Radiant Heat, Short Range Embercast, and Long Range Embercast that we have modeled in all neighborhoods in Platte Canyon.

Platte Canyon Fire Protection District:
Long Range Spotting
Active and Passive Crown Fire, 90th Percentile Fire Weather

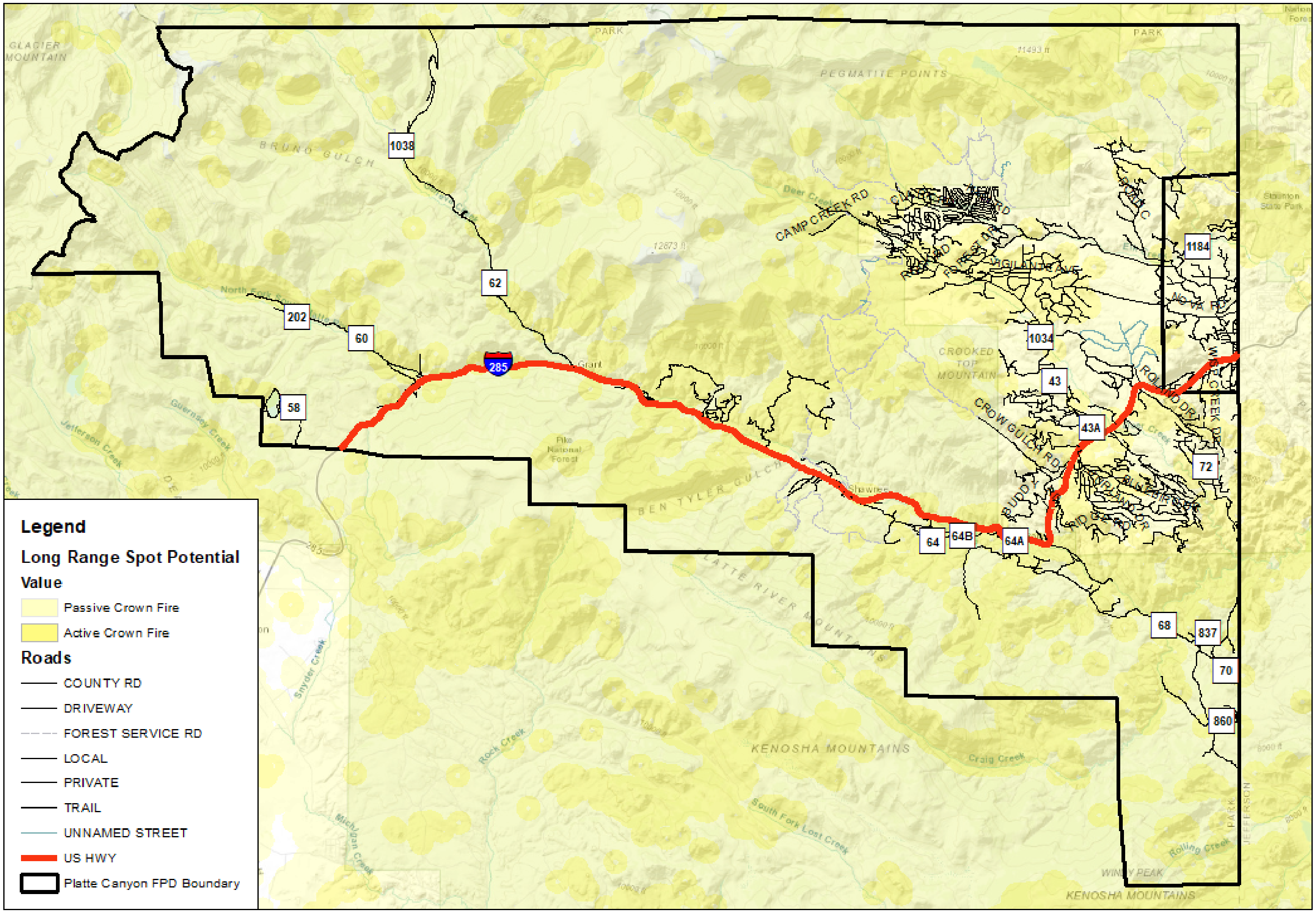

Figure 16. Long Range Spotting in Platte Canyon Fire Protection District.

Temporary Areas of Refuge locations

Seeking refuge in your neighborhood during a wildland fire event is a worst-case scenario. The goal of first responders will always be safe and thorough evacuation. We are discussing these locations with acknowledgment that in other catastrophic wildfires in the United States, evacuations did not go as planned, and lives were lost as people were overcome in unsafe areas. We will describe and suggest areas where people could go during a quickly approaching wildfire where they may have a greater chance for survival if complete evacuation is not possible. These are not ideal places to evacuate to.

These locations came from both spatial analyses of wildland fire behavior and driving tours through Platte Canyon neighborhoods to help identify areas that are not yet in the right condition but could be modified to increase survivability. Please locate the area identified for your neighborhood or see the current lack of option in Appendix 1 and assist the Fire Department to improve these locations for your community's safety. 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. See Appendix 1 for a description of how these areas need to be modified and maintained for the best chance of survival in a disaster scenario.

Hazard Assessment

The Forest Stewards Guild drove the district to "ground truth" the data and identify hazards that will affect fire behavior. Hazards assessed are neighborhood design, home construction materials, available fire protection, and additional rating factors like housing density. Criteria are based on National Fire Protection Association Wildfire Hazard Checklist, seen in Appendix 2. This information is not available through spatial data but is necessary to make smaller-scale recommendations. We call this analysis Neighborhood Hazard Ratings, please see Appendix 1 to learn more about your neighborhood.

Suppression Difficulty Index

Suppression Difficulty 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.

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), 299-313.

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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. 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 won't 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.

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 4,5 & 6. 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 17). Noncombustible siding, decking, and fencing materials will also prevent home ignition, particularly when combined with a border around the base of your home make of rock or other noncombustible material, rather than mulch or landscaping.

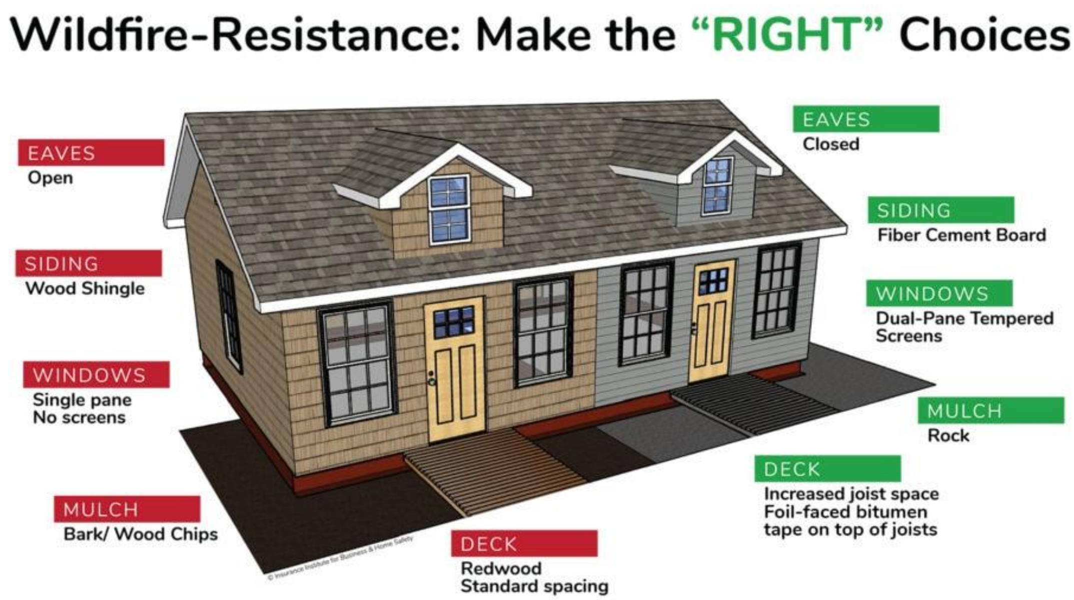

Figure 17. Examples of Home Hardening Practices from the Insurance Institute for Business & Home Safety.

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 specify slightly different Zones of Defensible Space, but the basic idea is the same. We will use NFPA recommendations for defensible space that advises 18-foot canopy spacing in the first 30 feet of your home (Figure 18). Treatments must at least meet Colorado State Forest Service standards for grant applications (Appendix 4). They recommend removing all dead vegetation and wood away from the home, reducing live vegetation or landscaping near the home, and ensuring no trees overhang your roof, creating an area of low fire intensity.

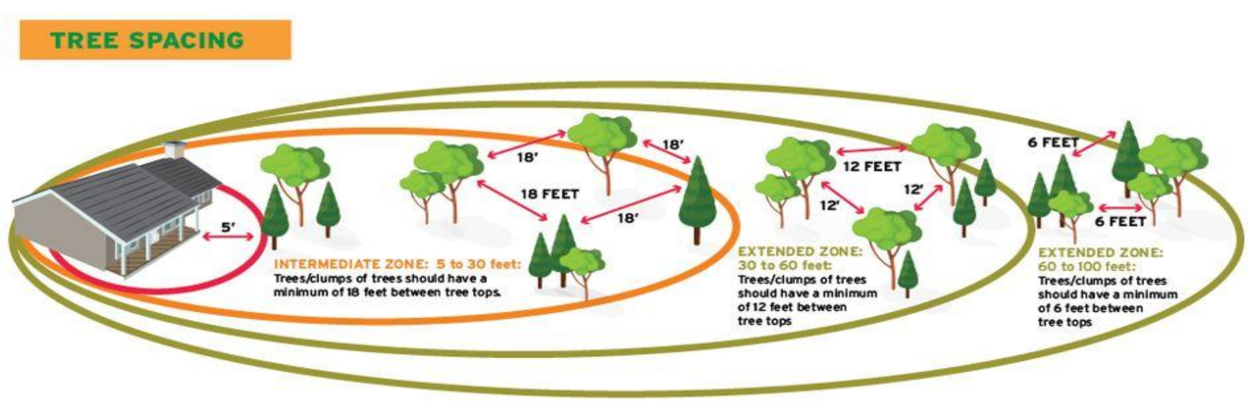

Figure 18. National Fire Protection Association Defensible Space in the Home Ignition Zone.

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 Platte Canyon utilize the materials in Appendices 4-6 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 Platte Canyon. What is not safe, is to have very dense forest or dead vegetation right up to the side of the home – this is not possible to defend by firefighters.

Historic Structures

Historic Structures made of wood and other flammable materials in Platte Canyon 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.

Recommended Fuels Treatments

A fuels treatment is a land management project utilized to reduce wildfire hazard by reducing vegetative materials or "fuels". The reduction in fuels, in turn reduces the intensity of fire behavior, and increases tactical firefighting options. The treatments include 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 fuels to the tree canopy. This work, and then introducing prescribed fire to consume the surface fuels is the major way to influence fire behavior. The other factors affecting fire behavior, topography and weather, are much harder to change.

The Forest Stewards Guild's approach to Fuels Treatment will be formatted to inform the goals of residents and agency stakeholders in Platte Canyon. We demonstrate that there are no one-size-fits-all projects that will meet all the variety of existing goals for the district. Our analyses provide a robust assessment of Platte Canyon's fuels, particularly along roadways and evacuation routes. In this Fire Protection District there is extremely high fuel loading which will take a long time to mitigate. Roadway thinning, a combination of improved defensible space and home hardening, and the creation or improvement of temporary ares of refuge will be the most important short-term projects for improved life safety and structure preservation. Longer term landscape scale fuel treatments are also recommended but will require complex public/private partnership to complete.

Guidelines for General Fuels Treatment:

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 in all of Platte Canyon – fuels breaks have reduced efficacy. Nowhere in Platte Canyon is there a current, or recommended, fuel treatment that could prevent long range spotting. What fuels treatments can change however is the result of long-range spotting. Fuel breaks can change fire behavior and bring it out of the forest canopy, reducing flame lengths and fire intensity. They can also create tactical options for suppression activities in advance of the flame front. When the forest beyond the fuel break has higher than historic fuel loading, a fuel break won't affect the long-term impact of the flame front. A fuel break is not a forcefield.

Specific fuel treatment recommendations are dependent on forest type, terrain, and land use. Most of Platte Canyon's population lives in Ponderosa Pine dominant or Mixed Conifer forest types, depending on elevation and aspect as seen in Figure 19. Moving up in elevation, particularly towards the Western end of the district, the forest type gets into 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 we recommend all land managers in Platte Canyon read this document thoroughly when writing a forest treatment prescription.

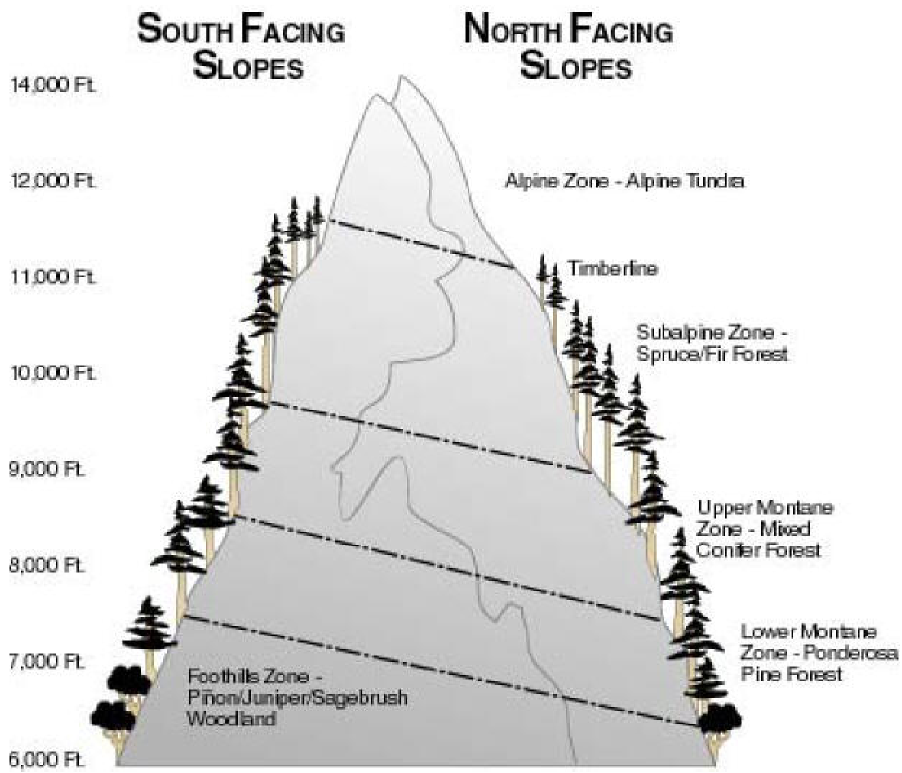

Figure 19.Typical Forest type at elevation on North and South Facing slopes in the Front Range.

Ponderosa and Mixed Conifer Recommendations

The tree densities of the 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. Uniformly thinned stands will also have a positive impact on fire intensity and increase tactical decision-making options for firefighters, even though they may not be as ecologically robust. Figure 20 depicts the range of options with tree density and dispersion.

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 Temporary Areas of Refuge.

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 Temporary Areas of Refuge.

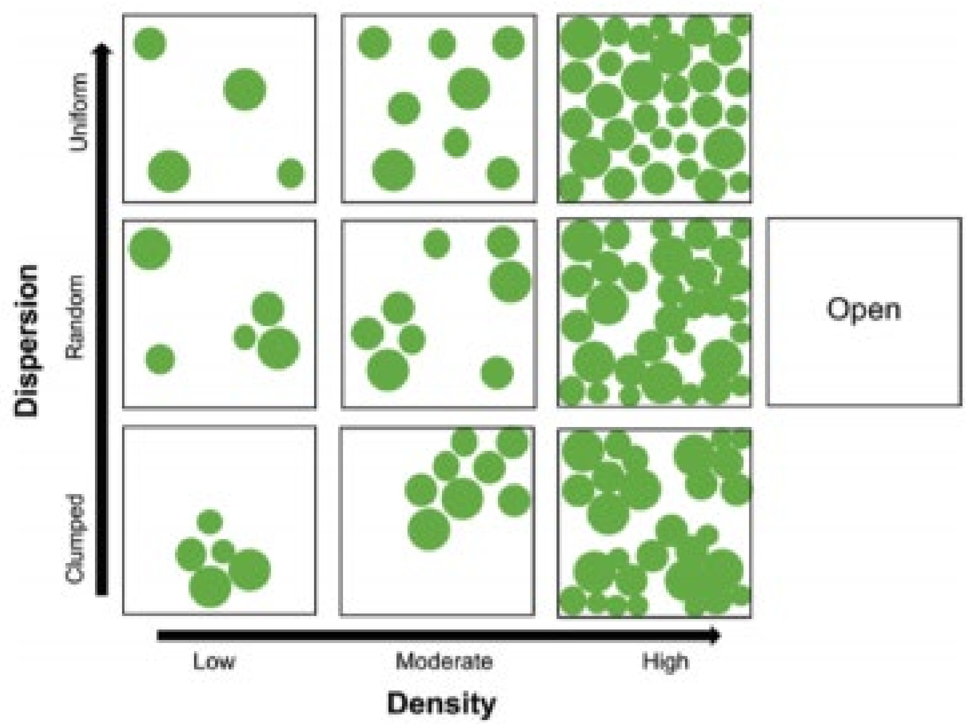

Figure 20. Depiction of Density and Dispersion of trees possible to show recommended Low Density, Clumped Dispersion.

Thinning Treatment:

The Colorado State Forest Service Fuel Break Guidelines for Forested Subdivisions & Communities (Appendix 7) describe considerations that will help inform how to design this treatment based upon local conditions. A fuel break should be a timber harvest or thinning, leaving the largest and healthiest trees, with spacing that accounts for slope and topography. The Forest Stewards Guild does not recommend crown spacing less than 15 feet or a base canopy height lower than 6 feet on flat terrain. Douglas Fir has emerged in lower elevations due to fire suppression. Conditions such as site index, aspect, and elevation should influence management decisions. Brush like Mountain Mahogany and Choke Cherry should be cleared away from trees to prevent fire spread into the canopy. Our recommendation is to implement these treatments throughout neighborhoods, in coordination with defensible space work around homes and structures. It is also important to recognize that fuels treatments should not be carried out unless there is a post-treatment plan for biomass and debris removal. Please see Appendix 7 or more information on fuel breaks.

Temporary Areas of Refuge Treatment:

These treatments are intended for areas where human lives will be at risk and the presence of any vegetative material will jeopardize survivability. These treatments will vary by slope and anticipated wind and fire behavior. For a general rule, though, we will assume an average slope, moderate fire behavior, and 20 mph winds. Under 15% slope surrounded by 20 ft trees, we'd be looking for a 600-foot radius clearing of trees or 200 yards. Appendix 8 contains a description of how this calculation is made so it can be tailored to individual project locations. 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 4.

Table 4. Table to help calculate space needed for Temporary Areas of Refuge. Source: RMRS

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

In these treatments, all fuels need to be removed and it must be maintained either through mowing or prescribed fire to keep grasses and vegetation low. Please see the next section for a description of the maintenance required on both the Temporary Areas of Refuge and Thinning Treatments.

Post-Treatment 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 fuels 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.

Prescribed fire is a great maintenance tool for keeping grass and woody vegetation down in fuel breaks. Mowing is also an option utilized by many communities, particularly on roadways. If mowing is utilized, it must be at least annual and perhaps several times during the growing season to keep grass height under 10 inches. The logic behind this grass height is to balance the ecological impact and to target the desired fire behavior of reduced flame lengths.

<u>Lodgepole Pine Recommendations</u>

Fire events were historically much less frequent in Lodgepole than Ponderosa Pine systems with a natural fire return interval of up to 120 years. However, when fires did occur in lodgepole pines, they were generally large, high-intensity, "stand-replacing" fires that are extremely resistant to control. This has been exacerbated in modern times with fire suppression coupled with factors such as the Mountain Pine Beetle epidemic in Colorado. This epidemic has killed Lodgepole Pines at an unprecedented rate and contributes to extreme fire behavior development.

Lodgepole forest fires are more likely to occur in forests with mountain pine beetle kill as timber accumulates and dries. Due to the intensity of the fire when it does happen, defensible space around structures needs to be intensively managed and distances from structures should be guided by the Colorado State Forest Service Lodgepole Pine Management Guidelines for Land Managers in the WUI, Appendix 9. Buffers between Lodgepole stands and all structures is crucial.

We recommend patch clear cuts near structures, as this is an ecologically sound practice in this ecosystem and dramatically reduces fire intensity. With the intensity of heat produced by these stands, there is no thinning practice that would adequately prevent direct flame contact with a home. A buffer of at least ¼ mile distance is required to protect a well hardened home and increasing distance for homes with any flammable materials, increasing with slope and other risk factors. See Table 1 in Appendix 9 to determine treatment characteristics needed.

References

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Rob Blair, The Western San Juan Mountains. Their Geology, Ecology, and Human History. (1996) University of Colorado Press

Treatment Methods

Thinning or Timber Harvest

Cutting for the thinning or temporary areas of refuge treatments can be manual or mechanical, providing for slope considerations. Refer to Appendix 7 for guidelines on this thinning treatment. For Temporary Areas of Refuge treatments, the prescription will make similar considerations, but will cut more trees. Hand cutting with a chainsaw or other individual tools should be done by experienced persons providing first for safety. Mechanical tree harvest will work on flatter ground and should be contracted with a prescription written by Colorado State Forest Service, Jefferson Conservation District, or other forestry professional with experience in wildfire mitigation.

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 10. 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. In Platte Canyon, the Wildland Fire Module will be the best implementation resource. 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 by machine.

Broadcast Burning

Initial broadcast burning in Colorado and in the Wildland-Urban Interface often must occur after other fuels treatments to reduce fuel load. Colorado Department of Public Safety and the Division of Fire Prevention and Control's 2014 Colorado Prescribed Fire Planning and Implementation Policy Guide should be used as a resource to learn about what it would take to put on a broadcast burn in Platte Canyon (Appendix 11). Platte Canyon's Wildland Fire Module is the best implementation resource for prescribed fire in the area. Any planning and treatment design should consult the module, fire protection district, and local law enforcement.

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.

Increasing Canopy Base Height

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 fuel treatment and needs to accompany a thinning treatment to have tree canopy's at least 15 feet apart. It is, however, a treatment that many residents can do without much professional assistance. Hand tools like pole saws and loppers or motorized pruners and pole saws are all the tools needed to trim bushes and branches 6-8 feet and under.

Mastication

We do 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. Pile burning or any method to get woody debris off site is preferable to mastication.

References

Colorado Department of Public Safety, Division of Fire Prevention and Control. (2014). *Colorado Prescribed Fire Planning and Implementation Policy Guide*.

Colorado Department of Public Safety, Division of Fire Prevention and Control, Colorado State Forest Service. (2015). *Colorado Pile Construction Guide*.

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Recent Fuels Treatments

Figure 21 shows both planned and completed treatments in Platte Canyon Fire Protection District. The United States Forest Service has mainly completed fuels thinning projects south of Bailey and surrounding Harris Park. These treatments have increased canopy spacing, reduced ladder fuels, and piled cut timber to be burned. This treatment would allow broadcast prescribed fire after piles have burned, making these treatments ideal to anchor other fuels treatment to.

Other treatments visible on Figure 21 are administered by Platte Canyon Wildland Fire Module, Colorado States Forest Service, or other local agency partners, and occur on private land. The planned treatments SW of County Road 43 are an excellent start to protecting a major population center and crowded evacuation route. Treatment prescriptions vary by landowner, but all will reduce fuel loading, thin canopy spacing, and improve tactical decision-making options for firefighters defending nearby neighborhoods.

Long-term maintenance plans are not in place for many of the treatments shown in Figure 21. We strongly recommend maintenance be part of the wildfire fuel treatment work plan every 10 years. It is cheaper and more efficient to maintain treatments, than to expand treatment to new areas.

Priorities for fuel treatments recommended in the **Proposed Fuels Treatments Projects** Section will take these treatments into account and aim to strategically expand them as points of control and safety for the population-dense areas of PCFPD.

Platte Canyon Fuels Treatment and Wildfire Scar Boundaires

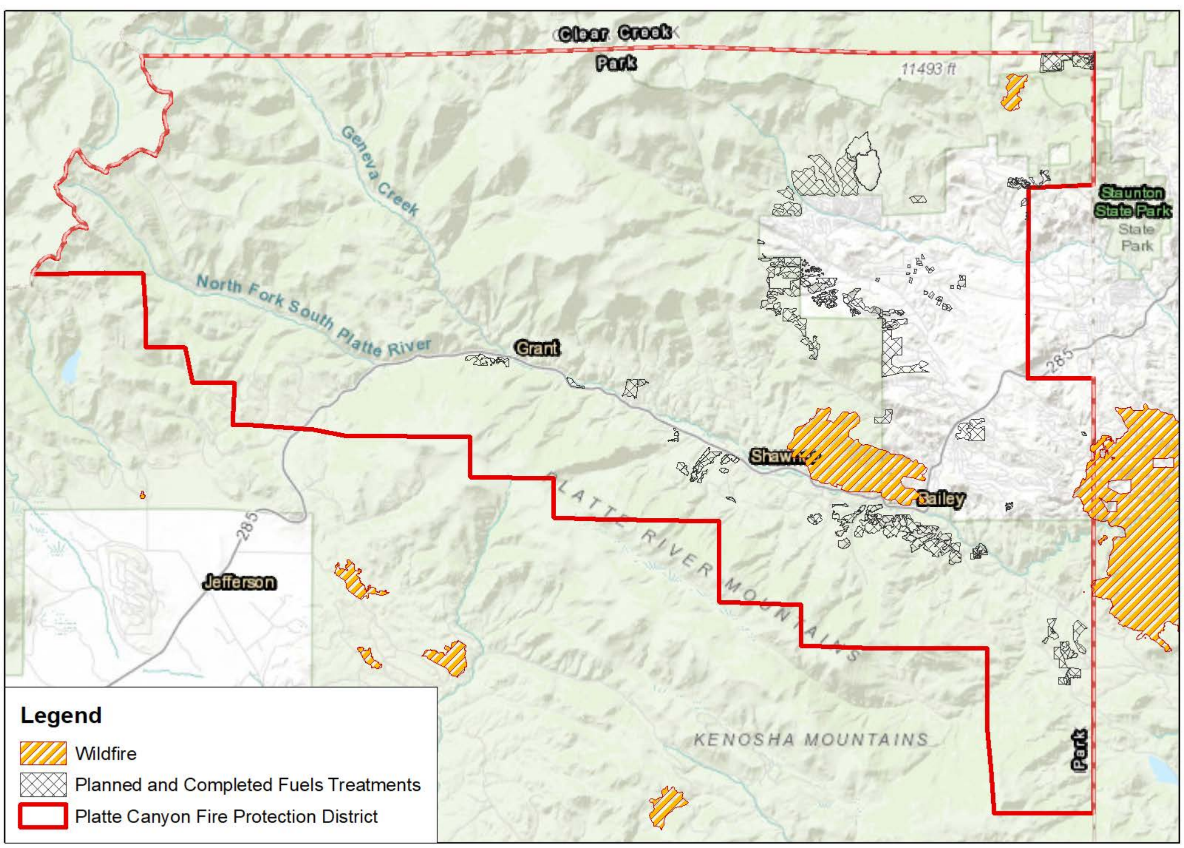

Figure 21. Completed and Planned Treatments in and around Platte Canyon.

PROPOSED FUELS TREATMENTS PROJECTS

The Forest Stewards Guild and the Platte Canyon Fire Protection District held a meeting on November 19th with agency stakeholders in the area to discuss the findings of our spatial analyses and think about a landscape scale plan. Representatives from the U.S. Forest Service (USFS), the Colorado State Forest Service (CSFS), Park County Road and Bridge, and Denver Water were in attendance. The goal was to identify existing and proposed treatments to expand from and create larger areas of modified forest structure to improve tactical decision-making options. The group identified these major focus areas (Figure 22).

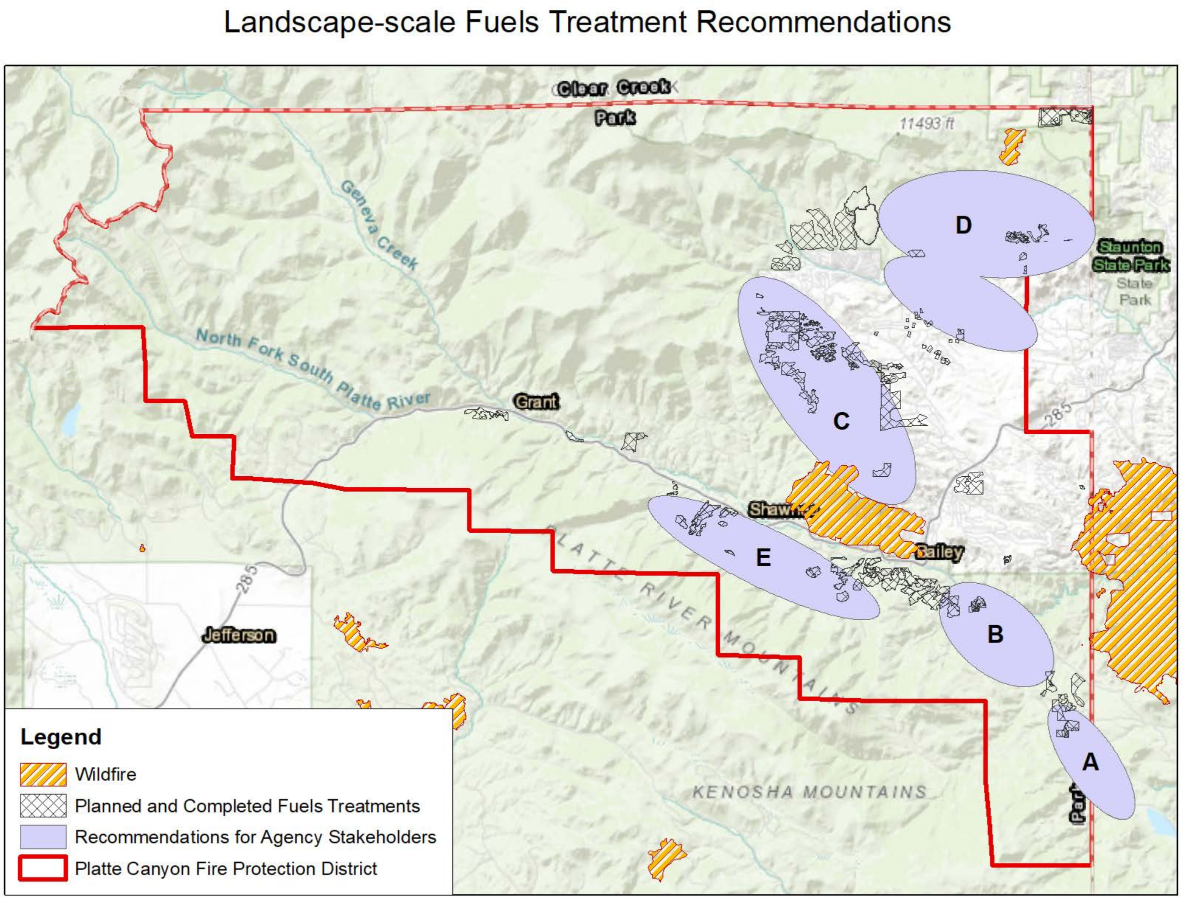

Figure 22. Treatment areas discussed by stakeholders to be completed for greater community protection in Platte Canyon.

Project Area A and B

One landscape-scale treatment area connects work done near Lost Acres and the Windy Peak Outdoor Lab with recent USFS treatments south of Bailey. There has been a good deal of work in this area, but a connection between A and B is recommended. The most likely wildfire spread is from SW to NE, and this band of fuels treatments would provide a better tactical option when working on an incident moving this direction. This could provide good protection to part of Denver Water – Bailey Zone of Concern and expanded west to better protect this resource. The gap identified on the map is a combination of different land types and will take work from CSFS and JCD working with private landowners to the USFS working up to those boundaries to support this effort.

Project Area C

The next landscape-scale treatment is on the Western boundary of communities along County Road 43. Fuels treatments can be anchored into the Snaking Fire scar and should connect all the way up to the USFS treatments north of Harris Park. The neighborhoods on the West of CR 43 are extremely vulnerable to wildfire as there is a great deal of untreated National Forest surrounding these neighborhoods. Fuels Treatments will not be enough to save neighborhoods from a wash of long-range spotting, but can provide firefighters more tactical options when working to put down the direct flame fronts that will approach these communities, likely moving SW to NE.

Project Area D

The area to the east of Harris Park, connecting to Hidden Valley Ranch and Staunton State Park, should be mitigated to provide community protection. This will also protect the Elk Creek Zone of Concern for Denver Water. Most ownership is private, so we recommend all stakeholders working with and supporting local landowners to find a collaborative solution. This treatment could be beneficial as an evacuation support area and provide incident managers a chance to catch wildfires heading into Elk Creek and Evergreen Fire Protection Districts.

Project Area E

From Ben Tyler Gulch to Payne Gulch, parallel to US 285, additional and expanded treatments are recommended. This area is vitally important for protection of Bailey Zone of Concern for Denver Water. Bailey Commercial District needs additional tactical options and these treatments could be anchored into areas with low fuel loading. Protection should include focus on Glen Isle Resorts and Macarthur Gulch, in addition to residential areas. With recent wildfires in this area, agency partners agree that fuel reduction treatments will assist with potential future ignitions.

The specific treatments needed to accomplish these goals will have to be determined by private landowners and the agencies supporting them but will help reduce fire intensity and increase tactical decision-making options. Thinning as described earlier in the document is recommended in each of these areas with a fuel treatment approximately ½ mile wide in order to really offer a tactical attack option. Biomass should be completely removed from the premises or made into piles as described in Treatment Methods**.**

Proposed Tactical Planning

This CWPP utilized a new product developed by Colorado State University's Colorado Forest Restoration Institute called the Potential Operational Delineations (PODs). The PODs as a planning tool for wildfire response. Utilizing a combination of advanced spatial analysis and local engagement, they have worked to identify effective control lines for a wildfire incident that account for the type of land a fire might burn through. Using control lines like roads, fuel treatments, and old wildfire scars, they develop polygons to identify where fires are likely contained. Then, each polygon is assigned a strategic response code to assist responders in identifying what type of response is necessary. The overall goal is to integrate wildfire response with land management priorities so incident commanders can have local context and build it into decisions made during a wildfire.

The Platte Canyon Fire Protection District PODs utilize existing roads and natural features for control (Figure 23). We discussed tactical lines of engagement with Platte Canyon Fire Protection District and cross referenced them to our own spatial analysis of fire behavior. All treatments identified for improved tactical opportunities are in areas identified by our agency stakeholder meeting which indicates the importance and prioritization of these projects for community safety and firefighter tactical options.

PODs and Proposed Tactical Lines

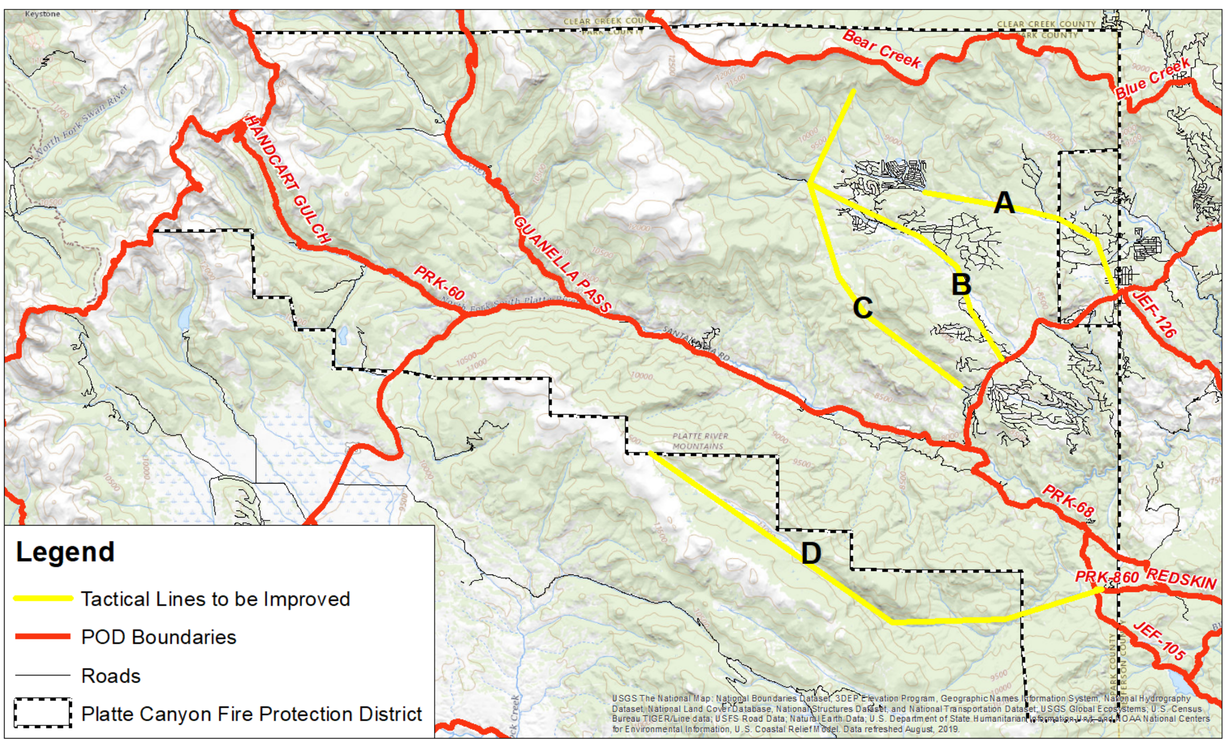

Figure 23. PODs boundaries created by CFRI and proposed tactical lines for Platte Canyon.

Areas of engagement that need additional work to become full control lines are in Craig Creek and the surrounding wetland, just south of the Platte Canyon border and below the ridgeline. This will help protect the town of Bailey and the important Evacuation Corridor on Highway 285. County Road 43 is a line of direct engagement following Deer Creek Valley and providing many tactical options. Following the Deer Creek Valley all the way to Highway 285 to the South, is already well defensible. Going north, there may be some engagement concerns towards Royal Mountain along the roadway. We recommend mitigation action to connect this road to the POD control line "Bear Creek" so that this may be a stronger line to engage a fire and hold safely. Mount Evans Boulevard, turning into County Road 74, and leading into the Hidden Valley Estates will be another great point of engagement from any fire moving in from the West, connecting to Harris Park.

An important area of concern is along Forestry Road 101 or Crow Gulch connecting to Slaughterhouse Gulch or Derringer Peak. There is high need for a better line of control west of the communities up Deer Creek going up towards Royal Mountain and Bandit Peak. Along the Eastern edge of the Pike San Isabel National Forest in this area, we recommend the USFS work to develop a robust fire break, utilizing existing topographic features.

COMMUNITY PROJECT PRIORITIZATION

Our analyses identified all areas of concern for neighborhoods, roadways, and hotspots of dangerous fire behavior. To prioritize these findings, we developed a rating system based on numerical values found in all analyses. This system will allow residents and the Fire Protection District to identify areas of high risk and prioritize fuels treatment projects there, without being limited by projects that fall apart or are not feasible for unforeseen circumstances.

Two types of risks were developed for numerical rating to prioritize risk to neighborhoods and homes, called a Neighborhood Risk Rating, and a rating to prioritize lives and safe evacuation, called an Evacuation Risk Rating. Table 5 describes what goes into each rating.

The Evacuation Risk Rating was used to develop Figure 24 and suggests roadside treatment and temporary areas of refuge locations be prioritized first in Extreme risk evacuation zones.

The Neighborhood Risk Rating suggests investment in home hardening and defensible space work be prioritized in the Extreme risk neighborhoods (Figure 25). All neighborhoods are at risk of home ignition, because every home in Platte Canyon is exposed to Long Range Spotting, according to our model described in the **Risk Analyses** Section. This means every home is at risk of ignition.

Prioritization of thee Extreme neighborhoods should first priority. Neighborhoods with Moderate to High risk should be looking at their ratings in the Evacuation and Neighborhood Matrices found in Table 6 and Table 7 to identify what factors give them the greatest risk and acting on those, first.

Table 5. Description of variables in Evacuation and Neighborhood Risk Ratings.

Evacuation Risk Rating	**Neighborhood Risk Rating**
Time to Evacuate	Hazard Assessment
Evacuation Pinch Point	Radiant Heat
Temporary Area of Refuge	Short Range Embercast
Roadway Survivability	Suppression Difficulty
Suppression Difficulty	Structure Density

Recommendations

Priority One

Thinning treatments should be utilized on roadways with Evacuation Pinch Points in every neighborhood that has them. This is the most important due to the impact on life safety.

Priority Two

Temporary Areas of Refuge should be improved in neighborhoods that currently have them and put into place where no current proposed location is. These locations give residents an emergency option and improves life safety, if executed to Temporary Area of Refuge Treatment standards.

Priority Three

Evacuation Zones with High and Extreme Risk Ratings need Fire Protection District approved evacuation plans. Most of these zones have long evacuation times and fewer options for egress. Developing a Primary, Alternative, Contingency, and Emergency (PACE) plan in coordination with roadway mitigation is critical for residents of these neighborhoods.

Priority Four

Neighborhood-scale fuels mitigation must occur in neighborhoods with High and Extreme risk ratings. Changing the ignitability of the Home Ignition Zone, linking defensible space with adjoining properties, and making suppression easier will change the risk to these areas.

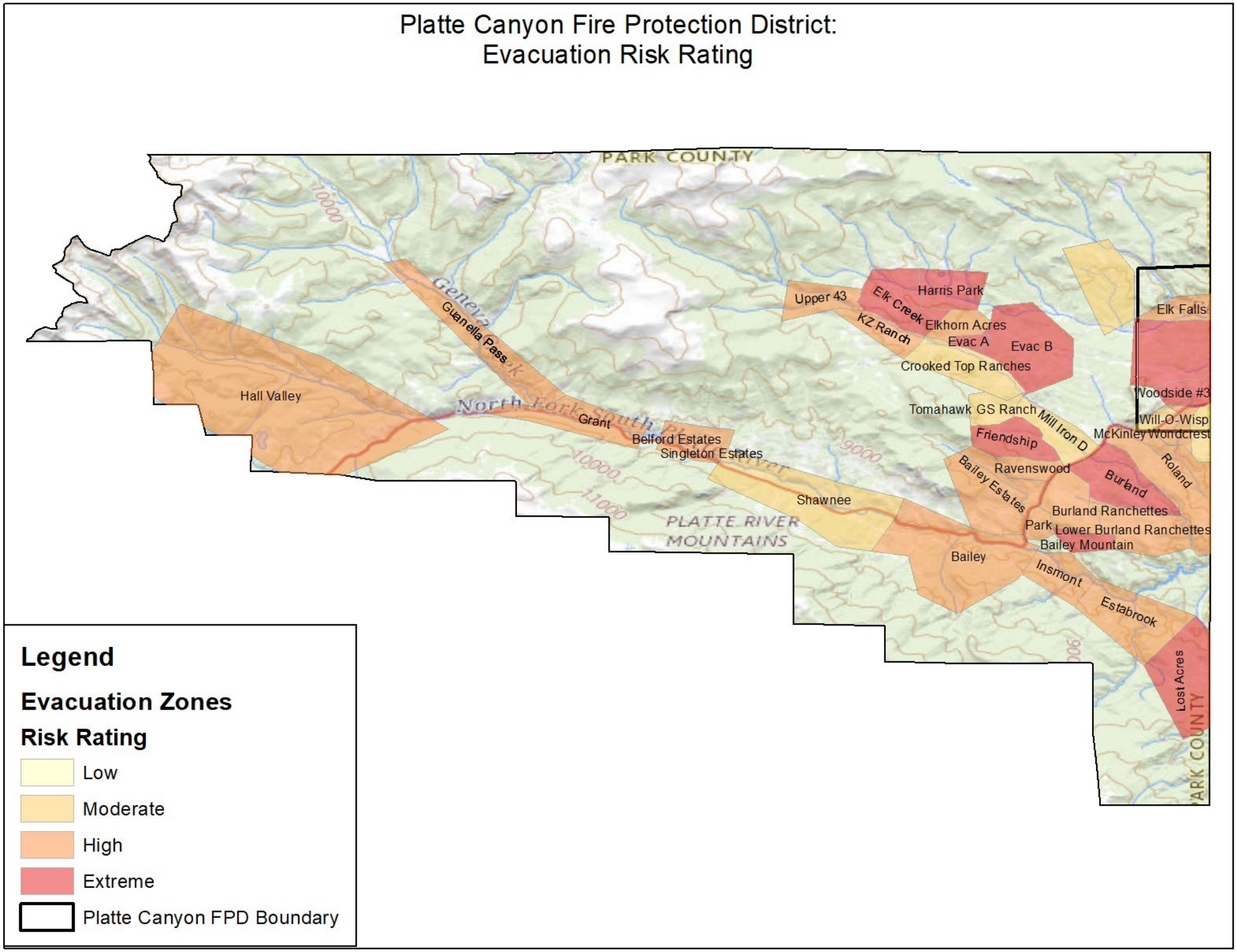

Figure 24. Evacuation Risk Rating for each Evacuation Zone in Platte Canyon.

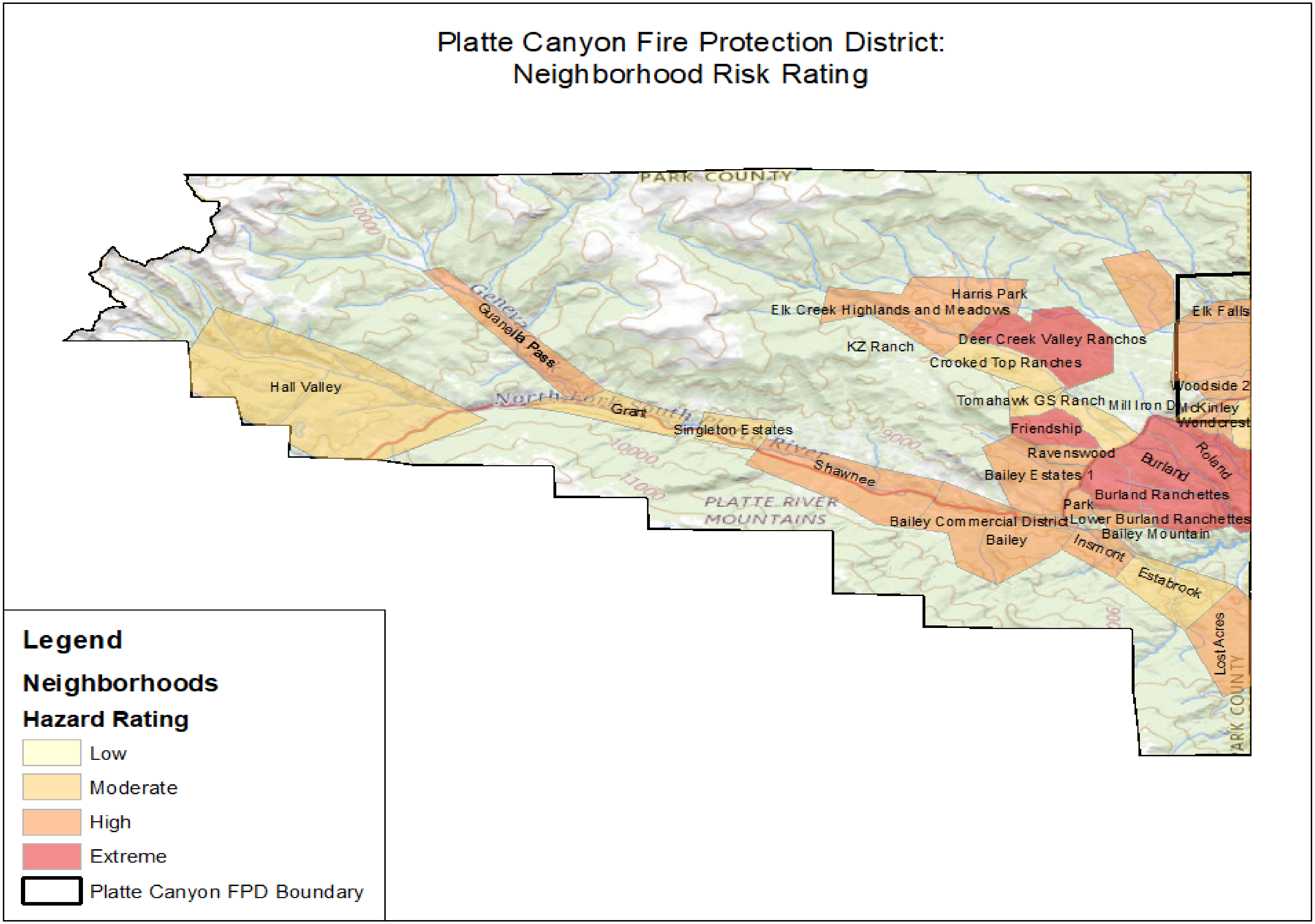

Figure 25. Neighborhood Risk Rating for each Neighborhood in Platte Canyon.

Table 6. Evacuation risk rating matrix.

	Time to Evacuate	Evacuation Pinch Point	Temp. Refuge	Roadway Survivability	Suppression Difficulty	Total	
Shawnee	1	1	1	2	3	8	Moderate
McKinley	1	1	4	1	2	9	Moderate
Wondcrest	1	1	4	1	2	9	Moderate
Mill Iron D	1	4	1	2	2	10	Moderate
Crooked Top Ranches	1	1	1	4	3	10	Moderate
Hidden Valley Estates	3	1	1	2	3	10	Moderate
KZ Ranch	3	1	1	4	2	11	High
Grant	2	1	4	1	3	11	High
Singleton Estates	1	1	4	3	2	11	High
Upper 43	3	1	4	2	2	12	High
Ravenswood	2	1	4	2	3	12	High
Woodside #1	2	1	4	3	2	12	High
Park	2	1	4	2	3	12	High
Belford Estates	2	1	4	3	2	12	High
Elkhorn Acres	2	1	4	4	2	13	High
Bailey Estates	2	1	4	3	3	13	High
Hall Valley	4	1	4	2	3	14	High
Roland	3	4	1	3	3	14	High
Bailey	2	1	4	4	3	14	High
Lower Burland Ranchettes	3	1	4	3	3	14	High
Guanella Pass	3	1	4	3	3	14	High
Burland Ranchettes	3	4	1	3	3	14	High
Insmont	2	1	4	4	3	14	High
Estabrook	2	1	4	3	4	14	High
Will-O-Wisp	1	4	4	2	3	14	High
Harris Park	4	4	4	1	2	15	Extreme
Bailey Mountain	3	1	4	4	3	15	Extreme
Burland	3	4	1	4	3	15	Extreme
Friendship	2	4	4	2	3	15	Extreme
Woodside #2	2	4	4	2	3	15	Extreme
Elk Creek	4	4	4	2	2	16	Extreme
Lost Acres	4	1	4	4	3	16	Extreme
Evac A Deek Creek Valley Ranchos	2	4	4	4	2	16	Extreme
Woodside #3	1	4	4	4	3	16	Extreme
Evac B Deer Creek Valley Ranchos	3	4	4	4	2	17	Extreme

Table 7. Neighborhood risk ratings matrix.

	Hazard Assessment	Radiant Heat	Short Range Embercast	Suppression Difficulty	Structure Density	Total	
Tomahawk GS Ranch	2	1	2	2	2	9	Moderate
Singleton Estates	2	1	3	1	2	9	Moderate
Wondcrest	1	1	3	1	3	9	Moderate
Crooked Top Ranches	3	1	2	3	1	10	Moderate
Mill Iron D	1	2	3	1	3	10	Moderate
Grant	2	1	3	2	2	10	Moderate
Hall Valley	3	1	3	2	1	10	Moderate
Estabrook	2	1	2	4	1	10	Moderate
McKinley	1	1	3	1	4	10	Moderate
Shawnee	1	2	4	3	1	11	High
Guanella Pass	3	1	2	4	1	11	High
Insmont	3	1	2	4	1	11	High
Park	3	1	2	3	2	11	High
KZ Ranch	1	2	4	2	3	12	High
Bailey Commercial District	3	1	3	1	4	12	High
Lost Acres	4	1	2	4	1	12	High
Woodside 2	3	1	3	2	3	12	High
Ravenswood	2	2	3	2	3	12	High
Hidden Valley Estates	4	1	3	3	1	12	High
Bailey	3	2	3	4	1	13	High
Bailey Mountain	4	1	2	4	2	13	High
Elk Creek Highlands and Meadows	4	2	4	1	3	14	High
Harris Park	4	1	4	1	4	14	High
Bailey Estates 1	4	2	3	3	2	14	High
Will-O-Wisp	3	1	3	3	4	14	High
Woodside 1	3	3	4	1	3	14	High
Elk Falls	3	2	3	4	2	14	High
Deer Creek Valley Ranchos	3	4	4	1	3	15	Extreme
Friendship	3	1	4	3	4	15	Extreme
Burland Ranchettes	3	3	4	2	4	16	Extreme
Burland	3	3	4	2	4	16	Extreme
Lower Burland Ranchettes	4	3	4	3	4	18	Extreme
Roland	4	4	4	4	3	19	Extreme

Evacuation Risk Rating

Time to Evacuate

Neighborhoods got a 1-4 rating corresponding to Low to Extreme rating provided by Figure 26.

Evacuation Pinch Point

Neighborhoods were either given a 1 for no evacuation choke points or given a 4 for their presence.

Temporary Areas of Refuge

Neighborhoods were either given a 1 for the presence of a temporary area of refuge and a 4 for the absence of a location.

Roadway Survivability

Neighborhoods received a 1-4 rating corresponding to Low to Extreme ratings for 90th percentile roadway survivability, show on Figure 27.

Suppression Difficulty

Neighborhoods were assigned a value from 1-4 corresponding to Low to Very High as shown by Figure 28.

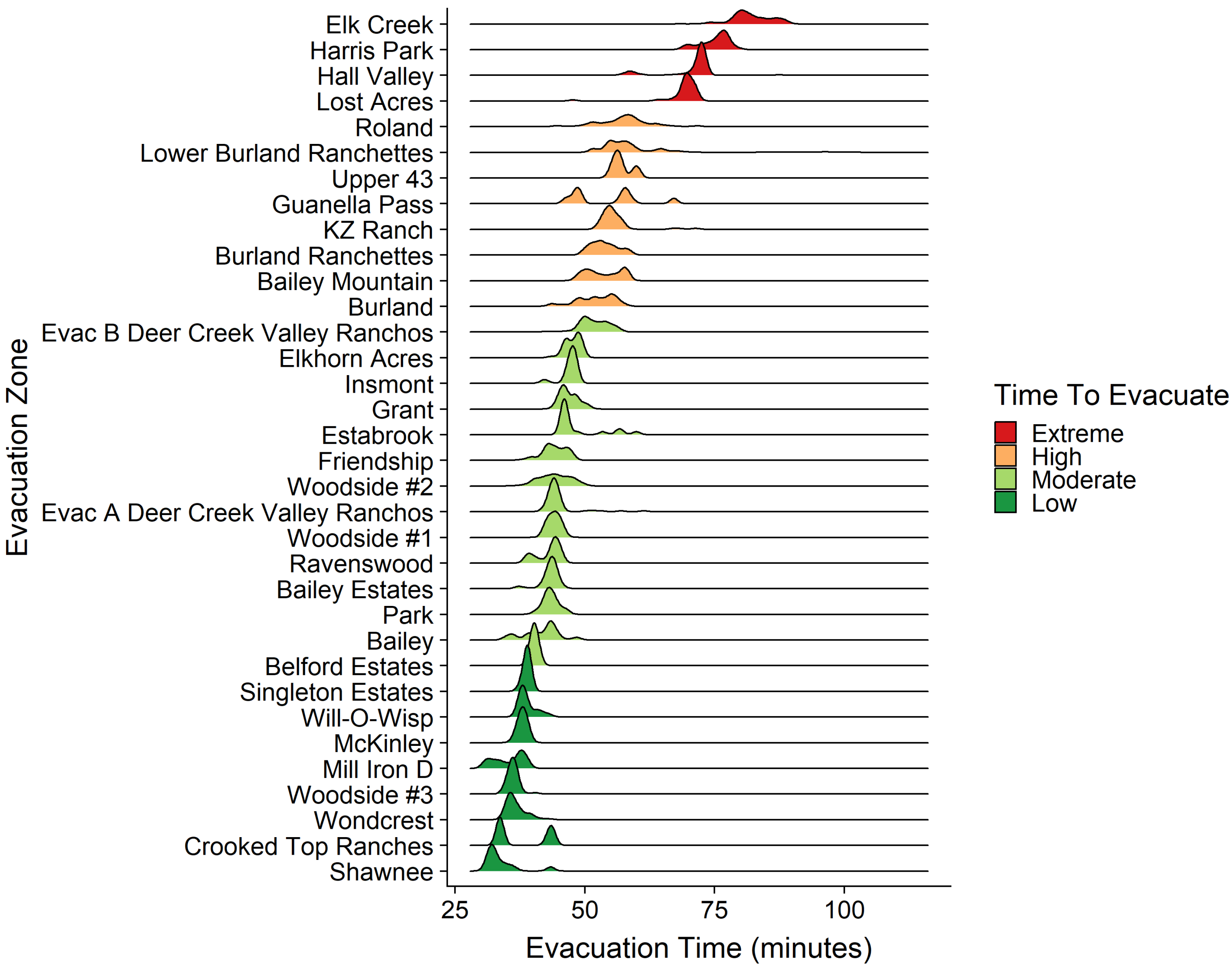

Figure 26. Time to Evacuate per Evacuation Zone. For each evacuation zone, address points are graphed by time to evacuate.

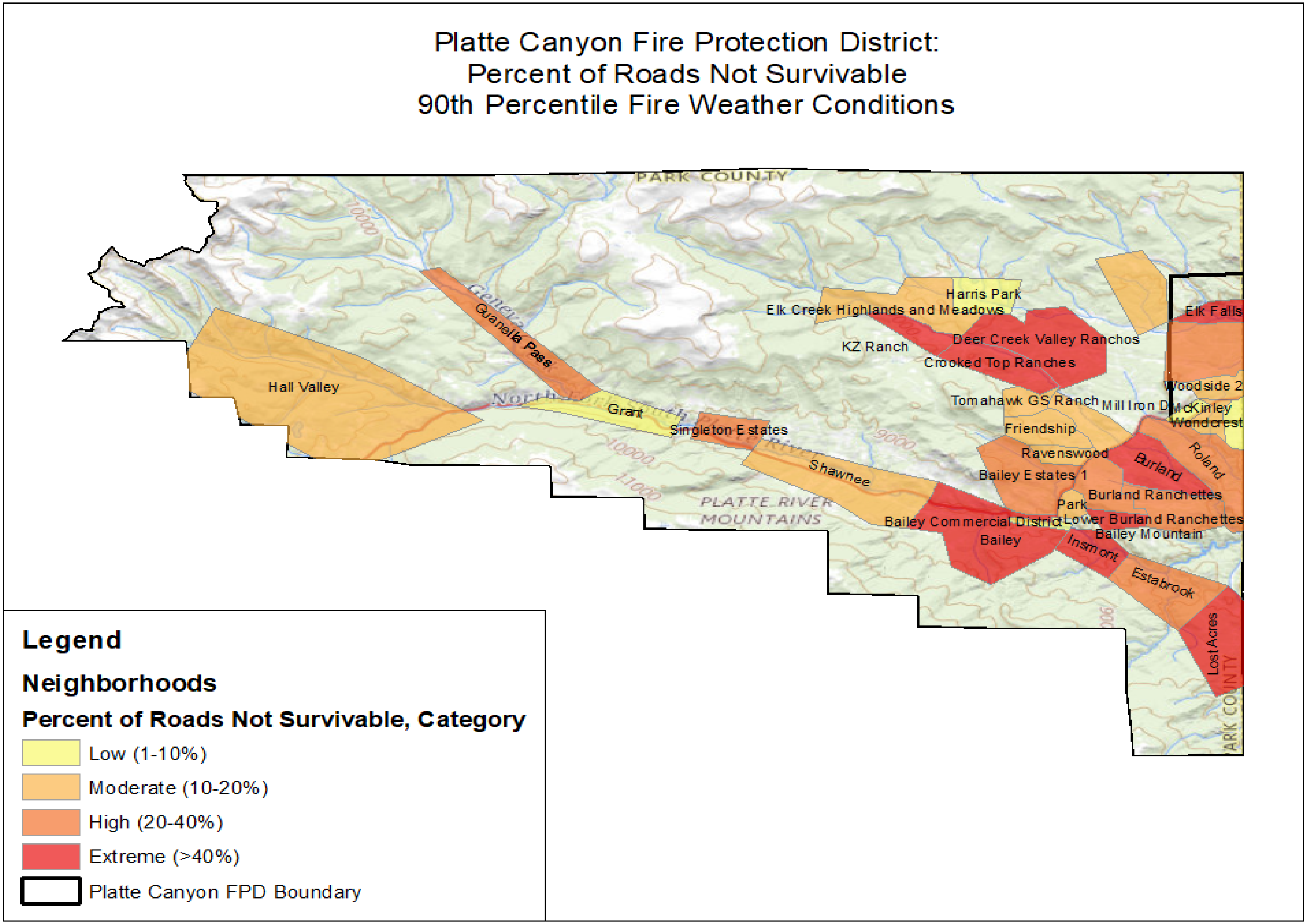

Figure 27. Percent of Road Not Survivable under 90th percentile fire weather conditions per neighborhood in Platte Canyon.

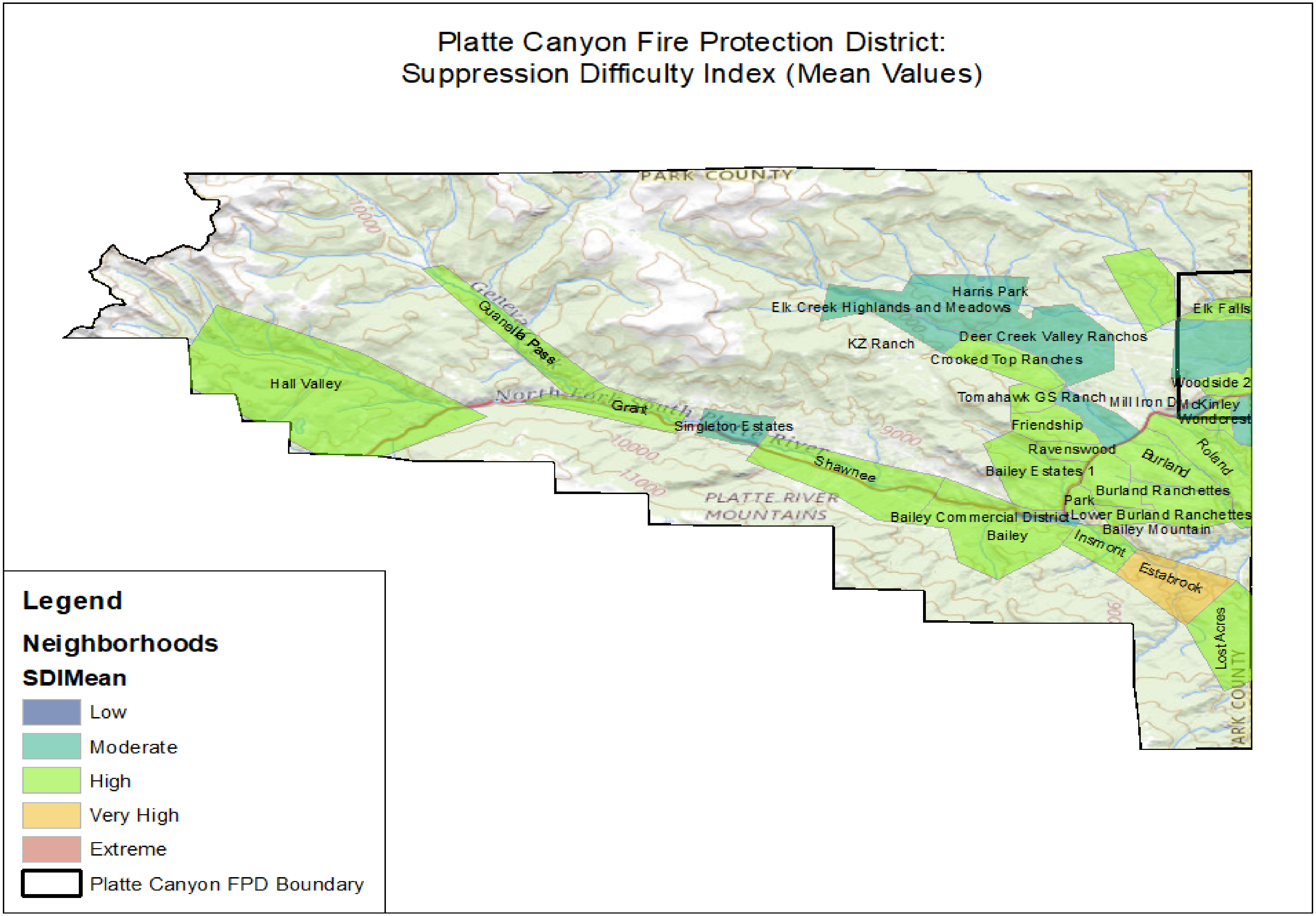

Figure 28. Mean Values of Suppression Difficulty Index under 90th percentile fire weather conditions per neighborhood in Platte Canyon.

Neighborhood Risk Rating

Hazard Assessment

From field surveys each neighborhood was given an Extreme to Low Rating based upon field observations. See Appendix 1 for these descriptions.

Radiant Heat Exposure

Neighborhoods were given a 1-4 rating based upon the Low-Extreme ratings in Figure 29.

Short Range Embercast

Neighborhoods were given a 1-4 rating based upon the Low-Extreme ratings in Figure 30.

Suppression Difficulty

Neighborhoods were assigned a value from 1-4 corresponding to Low to Very High as shown by Figure 28.

Structure Density

Neighborhoods were assigned a 1-4 ratings corresponding to Low to Extreme densities on Figure 31.

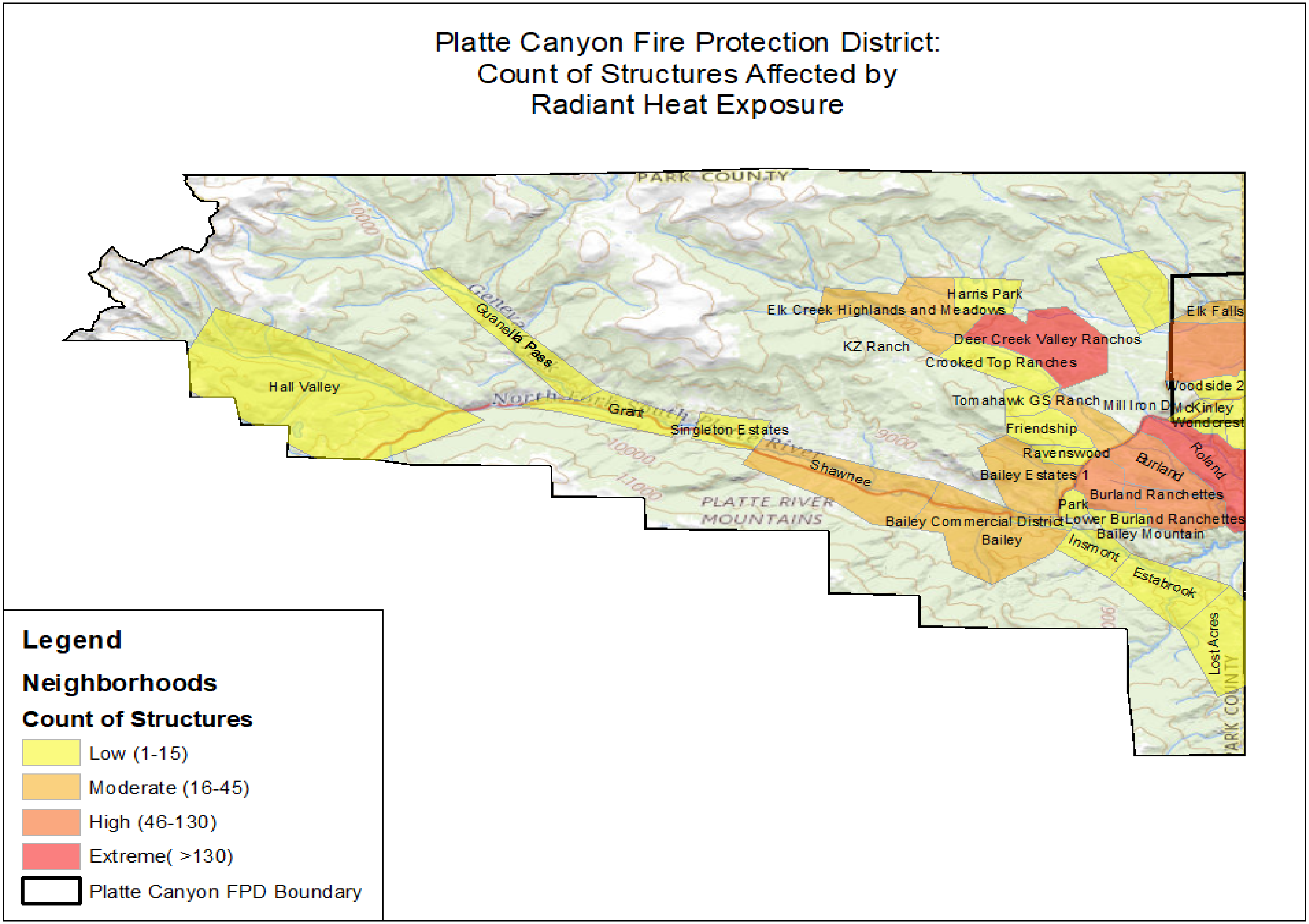

Figure 29. Count of Structures exposed to Radiant Heat in Platte Canyon.

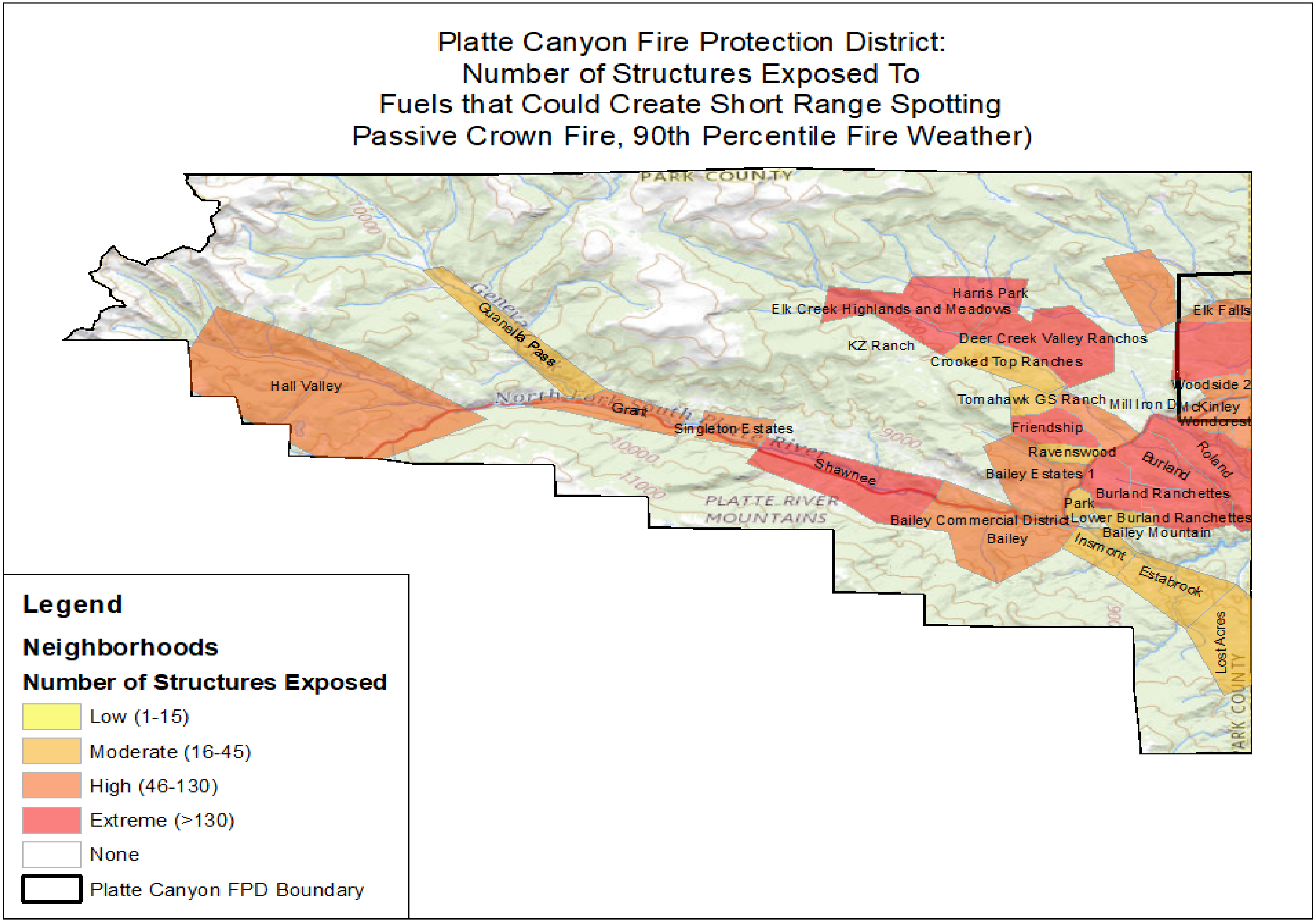

Figure 30. Count of Structures exposed to Short Range Embercast in Platte Canyon.

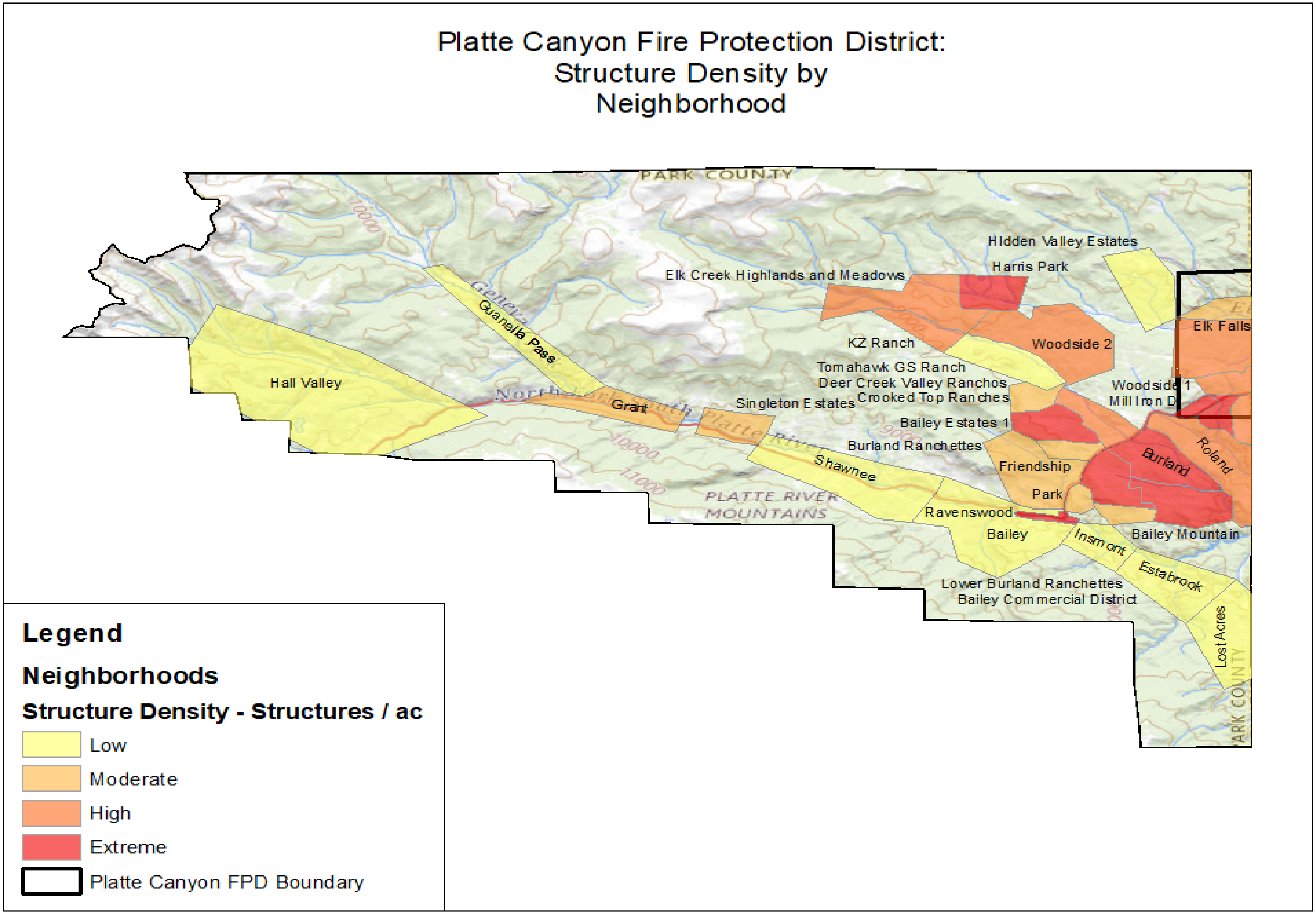

Figure 31. Structure Density per neighborhood in Platte Canyon.

MODELED POST FIRE EFFECTS

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 typically highest one to three years after a wildfire and return to pre-fire conditions as vegetation regrows (Neary et al. 2005).

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.

Hillslope: Portion of a watershed on the same side of a stream that drains to the same location.

Two months after the 1996 Buffalo Creek Fire near the Platte Canyon Fire Protection District, a severe thunderstorm resulted in erosion and flooding resulted in 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 et al. 1997; Figure 32). Post-fire erosion can also reshape streams, kill or displace fish, and damager riparian vegetation.

Wildfires impacts to soil properties and vegetation can increase soil erodibility. Wildfires consume litter from trees and plants, exposing bare soil and decreasing surface roughness, and wildfires can kill vegetation that once anchored soil in place with their roots. 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 particularly 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, which contribute massive movement of water over the soil surface. 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 water repelling conditions breakdown within months to a couple years after a wildfire (Huffman et al. 2001).

Erosion from undisturbed hillslopes is usually 0 to 2.5 tons / acre / year in the western United States (Neary et al. 2005). Erosion after a wildfire can remain within this range if vegetation and litter cover remain intact, slopes are shallow, soils are less erodible, and storm intensity is low. Under different conditions, erosion rates can reach 140 tons / acre 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). The 100-year storm after the 1996 Buffalo Creek Fire had a maximum rainfall rate of 3.1 inches / hour and resulted in sediment yields of 18-30 tons / acre (Moody and Martin 2001).

Figure 32.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

Assessing the potential for post-fire erosion and sediment delivery can help residents and managers in the Platte Canyon Fire Protection District identify areas most likely to experience damaging erosion and 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 A for methods). The post-fire scenario assumes that fires burn every portion of the landscape under 90th percentile fire weather conditions.

We focus on sediment delivery instead of erosion because movement of soil into streams and reservoirs can cause the greatest post-fire damage. We present results for 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 remote automatic weather station in Bailey, 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 the remote automatic weather station in Bailey, CO.

	Average conditions	30-year conditions
Precipitation (inch / year)	15.7	23.3
Number of storms / year	81	104

Predicted Post-Fire Erosion

Sediment delivery could increase dramatically after wildfires in Platte Canyon Fire Protection District. Across all simulated rainfall conditions, the likelihood of sediment delivery into streams is less than 40% for all but four watersheds under current, unburned conditions, but the likelihood is greater than 40% for all watersheds after wildfires. The likelihood is very high for almost 65% of watersheds that could experience high-severity wildfire (Figure 33). Post-fire results are presented for watersheds predicted to experience low to moderate severity wildfire (flame lengths up to 4 feet and between 4 and 8.2 feet, respectively) and high severity wildfire (flame lengths over 8.2 feet). Only four watersheds were predicted to experience moderate-severity wildfires.

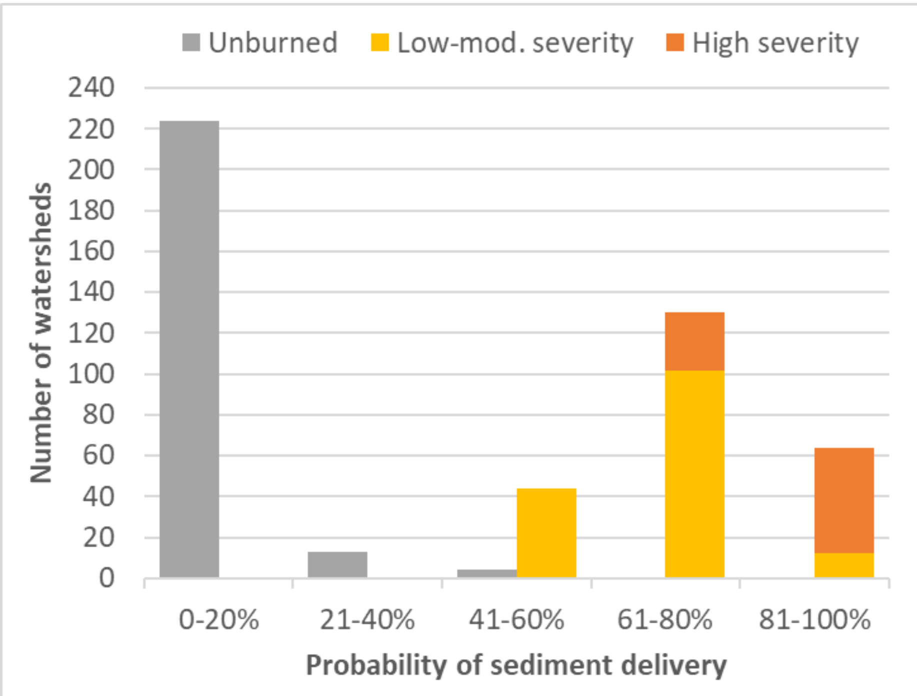

Figure 33. Probability of sediment delivery from watersheds within the Platte Canyon Fire Protection District under current, unburned conditions versus the first year following wildfire.

Predicted rates of post-fire sediment delivery from watersheds is 85 times greater than unburned conditions on average (range of 1 to 252 times greater). Potential post-fire sediment delivery under average rainfall conditions varies across the Fire Protection District from to 0.3 to 14.4 tons / acre / year, with 42 of 241 watersheds falling in the “extreme” category for post-fire sediment delivery (Figure 34). Sediment delivery rates are higher for watersheds expected to experience high-severity wildfires (Figure 35) and those with higher average percent slopes.

Sediment delivery would be significantly worse across the entire Fire Protection District were once-in-thirty-year rainfall conditions to occur the first year following wildfire. Predicted sediment delivery varies from to 3.0 to 60.0 tons / acre under these conditions, with 235 of 241 watersheds falling in the “extreme” category for post-fire sediment delivery (Figure 37).

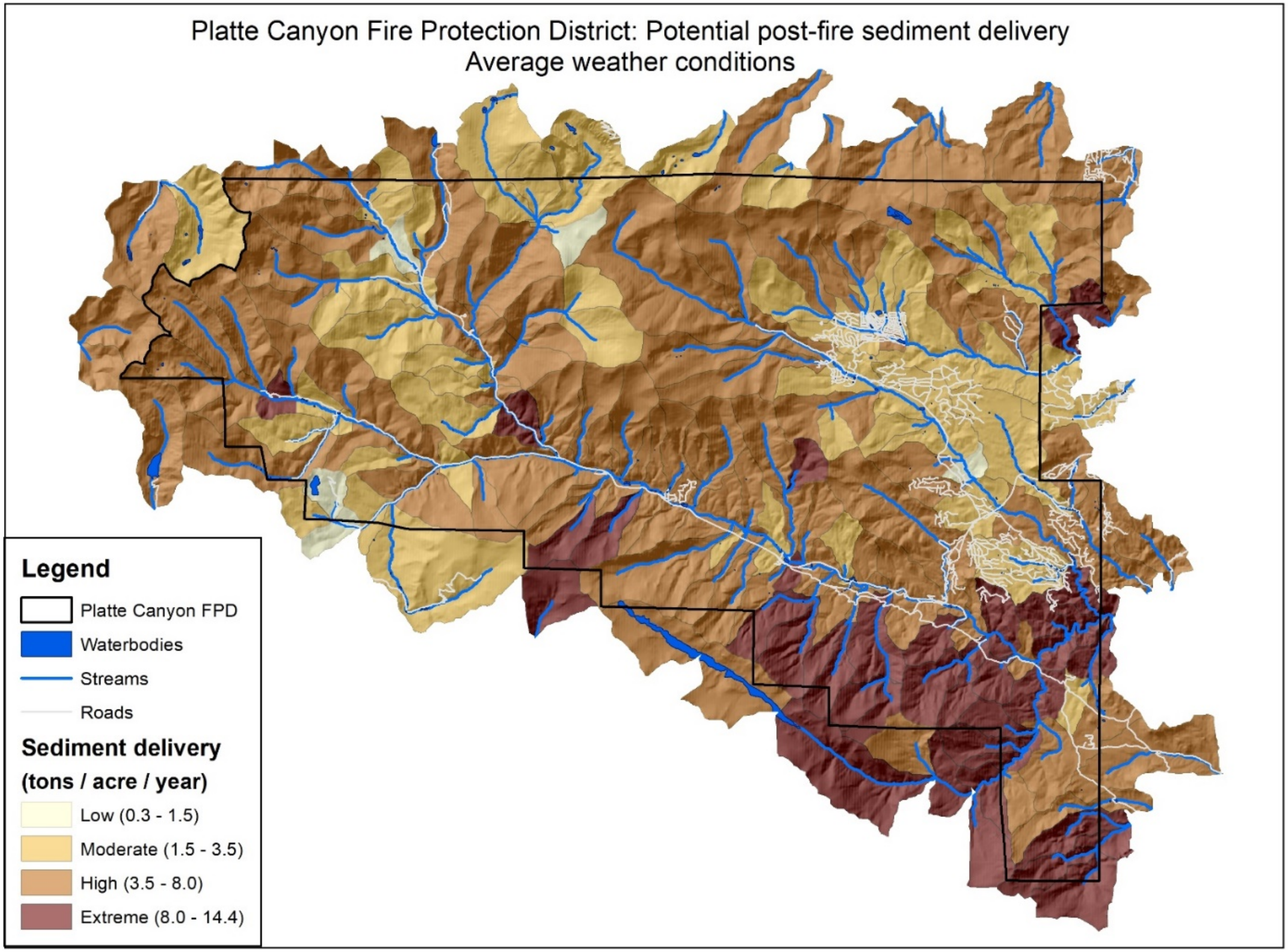

Figure 34. Predicted post-fire sediment delivery for watersheds within the Platte Canyon Fire Protection District under average rainfall conditions the first year following fire (see Appendix A for a description of cutoffs for sediment delivery categories).

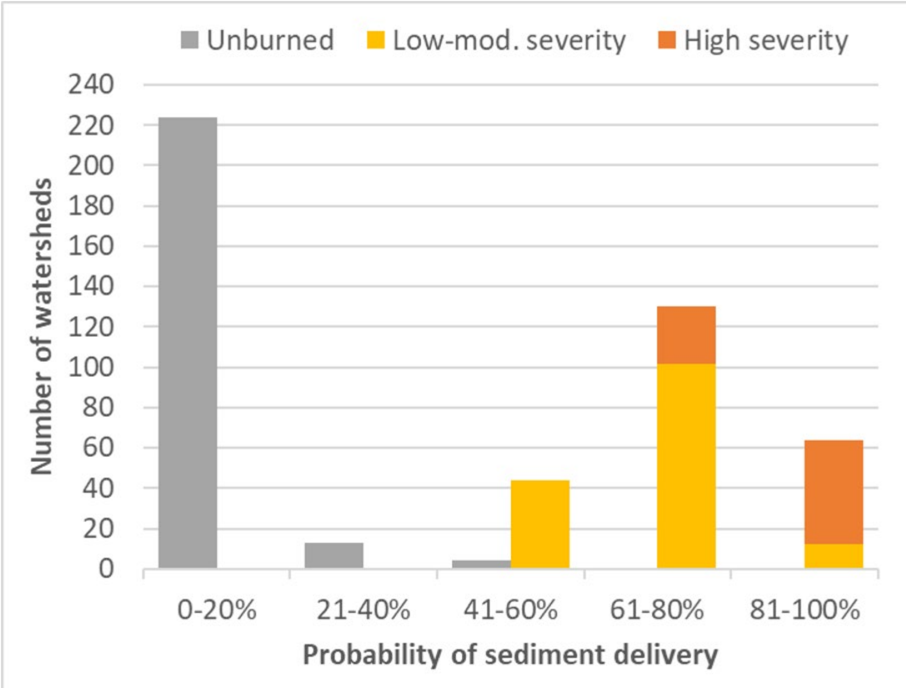

Figure 35. Distribution of sediment delivery rates under current, unburned conditions and under burned conditions for watersheds within the Platte Canyon Fire Protection District. Predictions are for average precipitation occurring the first year following fire.

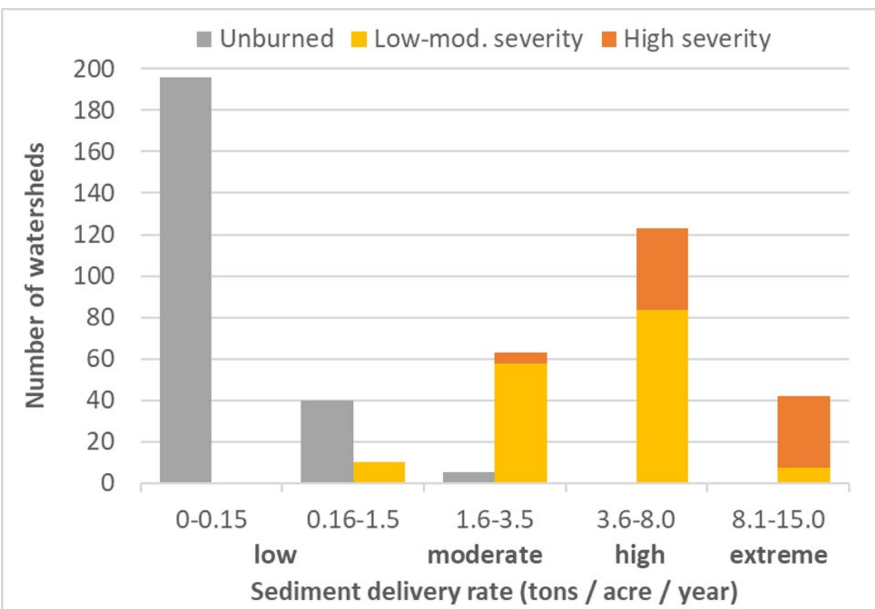

Figure 36. Post-fire sediment delivery rates increase with the average percent slope within watersheds. Predictions are for average precipitation occurring the first year following fire.

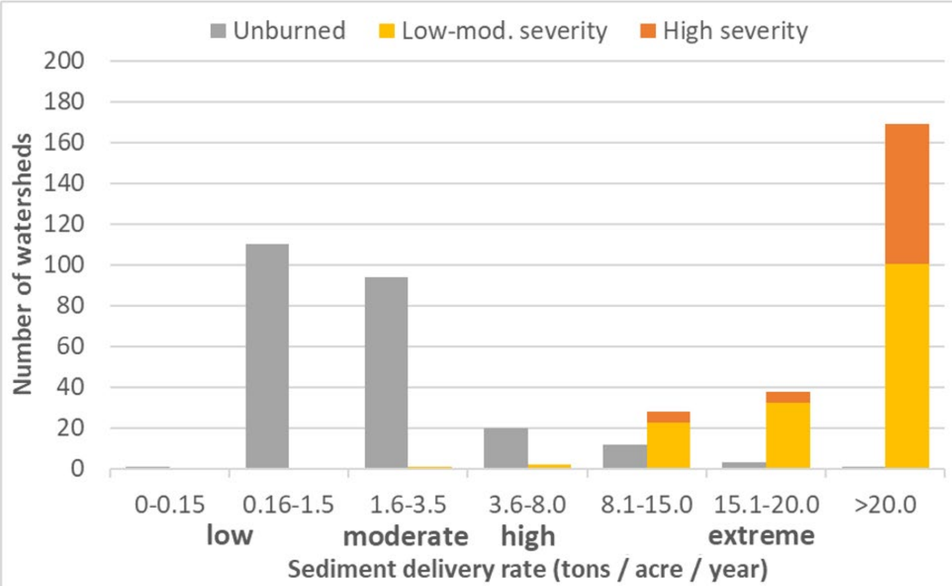

Figure 37. Distribution of sediment delivery rates under current, unburned conditions and under burned conditions for watersheds within the Platte Canyon Fire Protection District. Predictions are for once-in-thirty-year precipitation occurring year after fire.

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, predicted sediment delivery rates for 8 of 241 watersheds in Platte Canyon exceed maximum sediment delivery rates measured the first two years after the Hayman Fire (11.5 tons / acre) (Pietraszek 2006). Under average precipitation conditions, sediment delivery rates for Platte Canyon do not exceed observed rates after the Buffalo Creek Fire in 1996 (18-30 tons / acre) (Moody and Martin 2001). However, once-in-thirty-year precipitation could produce sediment delivery that exceed 20 tons / acre in 85% of watersheds.

Implications and Management Recommendations

Values at Risk

Under current conditions, rivers and watersheds within the Platte Canyon Fire Protection District are rated as healthy to very healthy based on an analysis by The Nature Conservancy (White et al. 2017). Many watersheds in the Fire Protection District are also rated as "most valuable" based on the Colorado Wildfire Risk Assessment and U.S. Forest Service Forest to Faucet Program. Severe rainstorms occurring the first year following wildfires could change these conditions due to erosion and sediment delivery. Fortunately, many neighborhoods and schools in Platte Canyon occur on areas with shallower slopes and have lower risk for post-fire sedimentation.

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 Fire Protection District include:

- Portions of U.S. Highway 285 and County Road 68, and utilities paralleling these roads.
- Shutetown Creek, and portions of the North Fork of the South Platte River, Rock Creek, Craig Creek, and Rolling Creek.
- Outflow of the Harold D Roberts Tunnel.
- Homes and roads in the Insmont, Estabrook, and Lower Burland Ranchettes neighborhoods.
- Small waterbodies in the Grant and Singleton Estates neighborhoods.

- Freshwater ecosystems with high biodiversity in the northern portion of the Fire Protection District (White et al. 2017).

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 et al. 2019; Jones et al. 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 relatively effectiveness, and other considerations, such as the risk of introducing noxious weeds. Robichaud et al. (2000) provide cost estimates for different post-fire mitigation measures.

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