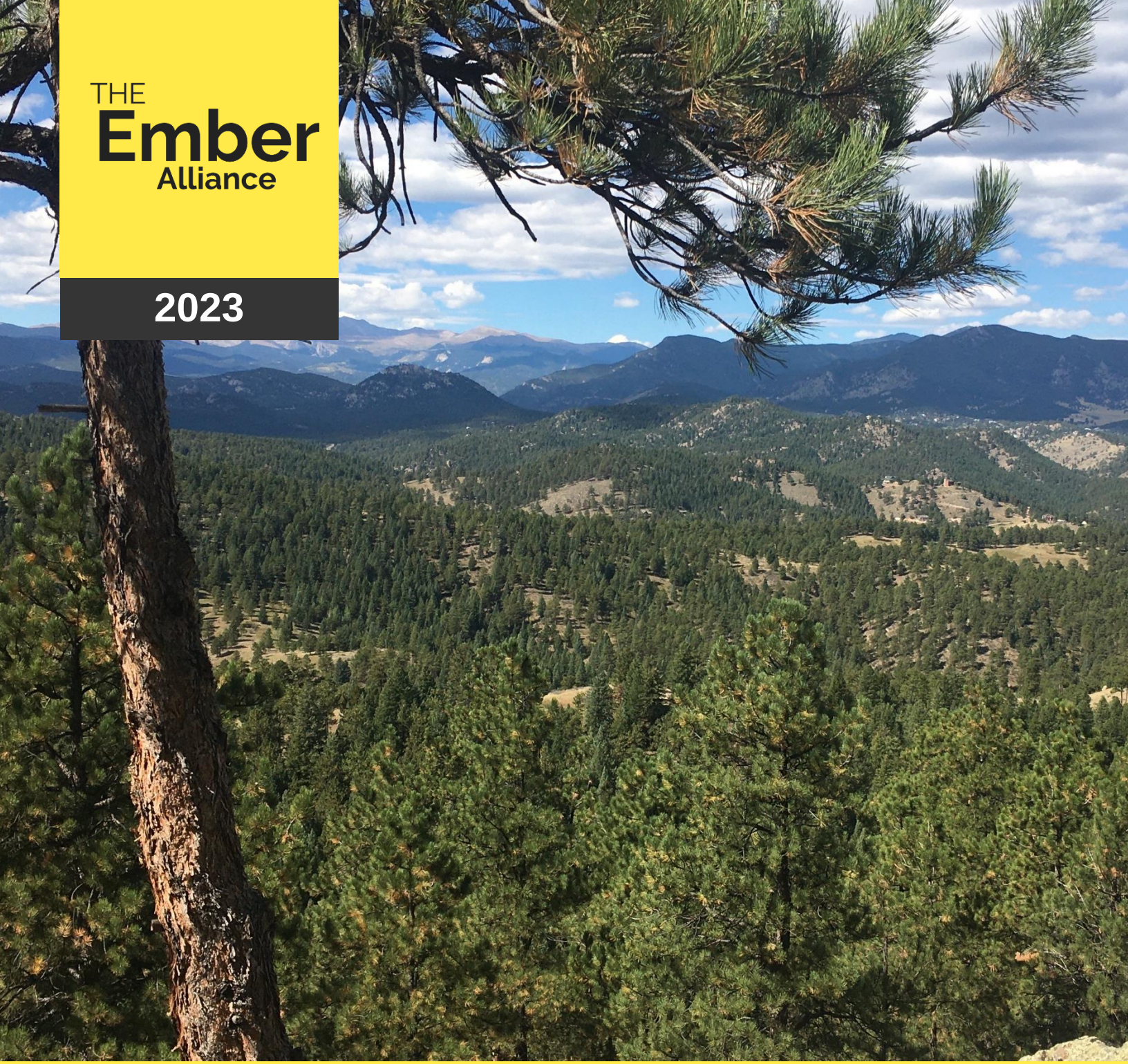
THE Ember Alliance

2023



Indian Hills
FIRE PROTECTION DISTRICT

Jefferson COUNTY, COLORADO

Community Wildfire Protection Plan

Indian Hills
Fire Protection District
Community Wildfire Protection Plan
2023 Update

Prepared for Indian Hills Fire Protection District

4476 Parmalee Gulch Road, Indian Hills, CO 80454

Prepared by The Ember Alliance

1631 E Lincoln Ave, Fort Collins, CO 80524

Table of Contents

How to use this CWPP Document

This document is designed for everyone that lives, works, and manages land within and around the IHFPD. Use this guide to direct you to portions of the CWPP that might be most relevant to you.

I want to learn the basics about wildfires, local wildfire risk, and CWPPs.	• Section 1.a to learn about CWPPs •Section 2 to learn about wildfire threats in IHFPD •Section 3.a for next steps to protect your home and family •Appendix A for an introduction to fire behavior
I'm a resident / homeowner and want to learn about protecting my family, home, and property from wildfires.	• Section 3.a to learn about the actions you can take, including detailed recommendations and research-backed guidance for protecting your home and family •Section 3.b to find detailed hazard ratings and recommendations for your neighborhood
I want to learn about community-led wildfire mitigation actions.	• Sections 3.c, 3.d, and 3.e to learn about the actions communities can take together to better protect everyone, including funding opportunities •Section 3.b to find detailed hazard ratings and recommendations for your neighborhood •Section 5 for prioritiy actions to help the CWPP result in meaningful change for the community
I'm with a government agency or cross-boundary organization and want to learn about landscape-scale wildfire mitigation.	• Section 2.e, 2.f, and 2.g to learn about fire history, fire risk, and treatment history in the area •Section 4.b to learn about priority fuel treatment projects for this community •Sections 4.c and 4.d for general recommendations for stand-level and roadside fuel treatments •Section 4.d to learn about pros and cons of different slash management options
I want to learn about the science behind these recommendations and how priorities were made.	•Appendix B to learn about modelling methodology for fire behavior and evacuation modelin, on-the-ground hazard assessments, and treatment prioritization •Appendix C for survey metholodogy and results

Acronyms

CSFS	Colorado State Forest Service
CWDG	Community Wildfire Defense Grant
CWPP	Community Wildfire Protection Plan
DFPC	Division of Fire Prevention and Control
DMP	Denver Mountain Parks
FAC	Fire Adapted Community
FEMA	Federal Emergency Management Agency
HIZ	Home Ignition Zone
IHFPD	Indian Hills Fire Protection District
IHFR	Indian Hills Fire Rescue
IHIA	Indian Hills Improvement Association
IHWD	Indian Hills Water District
IIBHS	Insurance Institute for Business & Home Safety
IRPG	Incident Response Pocket Guide
ISO	Insurance Services Office
JCD	Jefferson Conservation District
JCOS	Jefferson County Open Space
JCSO	Jefferson County Sherriff's Office
NFPA	National Fire Protection Association
NWCG	National Wildfire Coordinating Group
RAWS	Remote Automatic Weather Stations
TEA	The Ember Alliance
USFS	U.S. Forest Service
WUI	Wildland-Urban Interface

Refer to the **Glossary** on page 142142 for definitions of the words and phrases used throughout this document.

1. Introduction

1.a. Purpose and Need for a Community Wildfire Protection Plan

Community Wildfire Protection Plans (CWPPs) help communities assess local hazards and identify strategic actions to mitigate risk and promote preparedness (**Figure 1.a.1**). Assessments and discussions during the planning process can assist fire protection districts with fire operations in the event of a wildfire and help residents prioritize mitigation actions. These plans also assist with funding gaps for fuel mitigation projects since many grants require an approved CWPP.

> ***Community Wildfire Protection Plans (CWPPs) represent the best opportunity we have to address the challenges of the wildland-urban interface (WUI) in a way that brings about comprehensive and locally supported solutions. – Colorado State Forest Service***

Indian Hills Fire Rescue (IHFR) is the volunteer fire department that serves the Indian Hills Fire Protection District (IHFPD). The district covers 11.4 square miles in Jefferson County and is in the foothills of Colorado's Front Range approximately 23 miles southwest of Denver (**Figure 1.a.2**). This area was the ancestral lands of the Cheyenne and Ute First Nations.

Figure 1.a.1. Elements of a holistic and actionable CWPP.

The 2023 CWPP for IHFPD is a robust update to the 2007 CWPP that takes advantage of recent advances in fire science and addresses changes to fire risk, home construction, and other characteristics of the community that have occurred since the original CWPP was prepared. The CWPP includes a wildfire risk analysis, prioritization of mitigation activities, and implementation recommendations. This document is a tool for the fire district, land managers, residents, neighborhoods, and community organizations to begin prioritizing projects that will make IHFPD a safer and more resilient community to wildfire. The objectives of this project are to:

- Produce an actionable CWPP based on robust analyses of fuel hazards, burn probability, evacuation routes, and community values across the fire district.
- Provide recommendations, including prioritization, for reducing fire hazards, hardening homes, and increasing evacuation safety.
- Engage community members during the CWPP process to address local needs and concerns.
- Set the stage for planning and implementation by residents, IHFPD, and agency partners to mitigate hazards and promote community preparedness.
- Create strategic and tactical maps and evacuation pre-plans to increase community preparedness and safety of firefighters and residents.

Complex interactions among wildland fuels, weather, and topography determine how wildfires behave and spread. Many aspects of wildfires are predictable based on known scientific research on the physical processes driving fire. Much of the work in this CWPP is based on scientific research and computer models of wildfire behavior. A basic understanding of fire behavior aids in interpreting the findings and recommendations reported herein. See **Appendix A. Introduction to Wildfire Behavior and Terminology** and the **Glossary** on page 142142 for the definition of key terms. Several maps presented throughout this document are provided in an interactive online format so you can zoom in and explore output from this CWPP. Visit the IHFPD CWPP Map Experience for more information.

Why is the CWPP relevant to me?

Becoming a fire adapted community that can safely coexist with wildland fire takes a concerted, ongoing effort by everyone who lives, owns property, protects, or manages land in and around this community. Conditions in the IHFPD share some risk factors common to past catastrophic wildfires across the country. This CWPP provides recommendations for how to prepare your family to safely evacuate during a wildfire, how to mitigate your home ignition zone to give your house a fighting chance at surviving wildfires and protect the lives of firefighters engaged in protecting your community.

Even if you do not have a permanent home on your property, you can take steps to protect your camper and other assets, including the value of your property; areas that are heavily burned have less aesthetic and monetary value. More importantly, work you do to reduce fire risk on your property can amplify the work that your neighbors do on theirs, resulting in greater protection for everyone. Removing trees from along roadways can increase the visibility of your property to firefighters, increase the accessibility of your property for fire engines, and reduce the chance that non-survivable conditions can develop and entrap residents and first responders during wildfires.

This CWPP is a call to action to do your part to continue making IHFPD a beautiful and safe community. Land management partners and IHFPD are here to support your individual efforts, and they are committed to taking action to reduce wildfire risk and increase emergency preparedness for the benefit of this amazing community.

Indian Hills Fire Protection District is a beautiful mountain community. Everyone has a role to play in becoming a fire adapted community to protect this extraordinary area, the natural resources, and the people. Photo credit: The Ember Alliance.

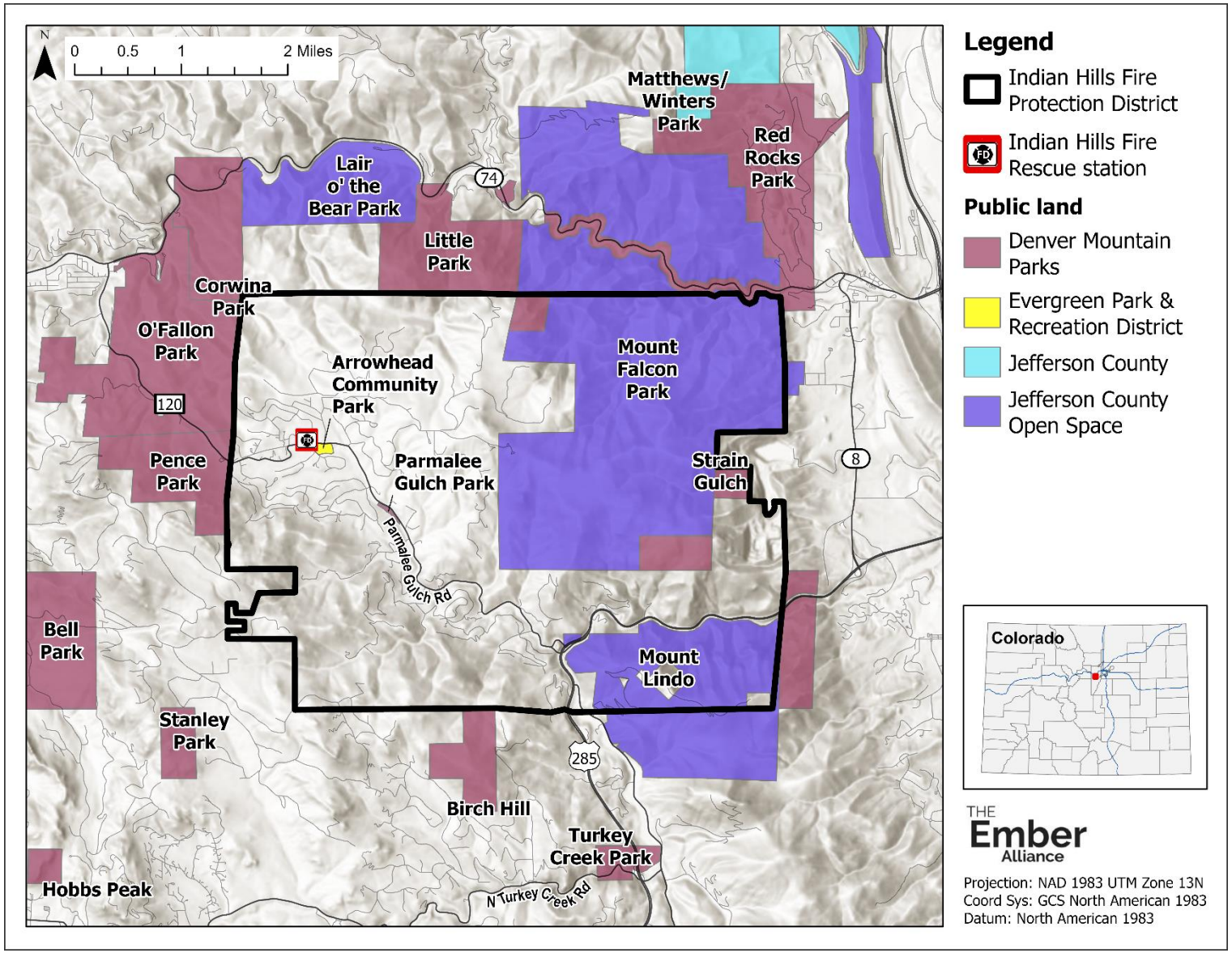


Figure 1.a.2. *Boundary of IHFPD in Jefferson County, Colorado, and public land in and around the IHFPD. Source: Colorado Department of Local Affairs, and U.S. Geological Survey, Protected Areas Database of the United States.*

1.b. Community and Partners Engagement

Collaboration is an essential part of CWPPs. Community engagement, partner commitment, and follow-through are what make a CWPP successful. The Ember Alliance (TEA)—a Colorado nonprofit dedicated to fire management and community engagement—worked with the Indian Hills Fire Rescue (IHFR) to write the CWPP. The Ember Alliance and representatives from the IHFR engaged partners from across the district and neighboring districts to develop the recommendations set forth in this CWPP. We would like to thank the following partners for their time and effort in developing, providing data, providing feedback, and planning implementation projects for this CWPP:

- Colorado State Forest Service (CSFS)
- Indian Hills Improvement Association (IHIA)
- Indian Hills Water District (IHWD)
- Jefferson County Open Space (JCOS)
- Jefferson Conservation District (JCD)
- Denver Mountain Parks (DMP)
- Tall Timber Ranch
- Geneva Glen Camp
- Jefferson County School District
- Xcel Energy
- Olinger Mount Lindo Cemetery

Members of TEA organized an in-person meeting with IHFPD residents on June 22, 2022, to introduce the CWPP process. In attendance were 29 people representing themselves as residents or as members of IHFR, the Indian Hills Fire Protection District board, Geneva Glen Camp, Indian Hills Improvement Association, Parmalee Elementary School, and Tall Timber Ranch. TEA gave an overview of the CWPP process and wildfire risk in the IHFPD. Most of the meeting was spent breaking residents into small groups to discuss their primary concerns about wildfire and emergency preparedness and brainstorm solutions to these challenges.

We also passed out a resident survey at the meeting and made the survey available online for all residents. The survey gauged resident knowledge and concerns about wildfire, barriers and needs for conducting mitigation on their property, and preferred means of communication. Questions developed by the Wildfire Research group (WiRē) were instrumental in designing the survey. Feedback from the community surveys informed the development of recommendations and priorities for the 2023 CWPP. We received a total of 46 survey responses. See **Appendix C** for a summary of survey methodology and all findings.

In fall 2022 and early 2023, we held virtual and in-person meetings with agencies and organizations that have a shared interest in mitigation of wildfire hazards across the IHFPD. We discussed priority treatment locations and developed an implementation plan to help connect the CWPP to on-the-ground action. Participants included CSFS, Geneva Glen Camp, JCOS, JCD, Denver Mountain Parks, Tall Timber Ranch, Geneva Glen Camp, Jefferson County School District, Xcel Energy, and Mount Lindo Park. We had additional conversations with IHWD to discuss their recent accomplishments, role in wildfire response, and plans for continued improvement.

A community-wide meeting was held on February 27, 2023, to share the results of the CWPP and give community members an opportunity to ask questions and share resources. About 34 community members were in attendance in person, as well as IHFR. The CWPP document was then open for public review for a two-week period from February 27 – March 10, 2023. Community feedback was incorporated into the final version of the document.

Community members sharing their wildfire concerns, needs, and potential solutions at a public meeting for the CWPP on June 22, 2022. Photo credit: The Ember Alliance.

1.c. Accomplishments Since the Previous CWPP

Indian Hills Fire Rescue

IHFR is the volunteer fire department that provides emergency medical services, structural fire response, wildfire response, and outreach and training to residents in IHFPD.

- IHFR began work with Tall Timbers Ranch and Geneva Glen Camp to encourage wildfire mitigation work.
- IHFR now has 3 engine bosses and 14 red-carded volunteer firefighters. These refer to certifications by the National Wildfire Coordinating Group (NWCG), which sets standard for wildland firefighting personnel. They have updated their fire equipment to now include two Type 6 and one Type 3 wildland fire engine, and one Type 1 Tactical Tender. This has allowed the department to go on assignments outside the district. See more information on the IHFR website.

Indian Hills Water District

IHWD is a special district that supplies water to the residents of Indian Hills for domestic, commercial, and fire-protection uses. See **Appendix D** for pressure and fire flow rates from a system check in 2021 as well as planned improvements for the IHWD water system.

- Completed an updated Master Plan in 2020 to replace the 1972 plan, provide an assessment of current conditions, and outline plans for capital improvements (see **Appendix D**).
- IHWD regularly pressure tests hydrants and performs annual maintenance to verify they are in working order in case of an emergency (see **Appendix D**).
- Added 2 new hydrants to the system for a total of 34 across the community.
- Installed equipment for instant monitoring of tank water availability.

- Repaired storage tank lining, upgraded air vacuum vents, and replaced valves between pressure zones for better control of water distribution.
- Assessed pipelines to help prioritize pipeline projects in accordance with their Master Plan.
- Began scoping a project to upsize storage tanks in the coming years.
- Cross-posted information from IHFR about how to mitigate wildfire risk to homes.

Indian Hills Improvement Association

IHIA is a voluntary nonprofit association of residents whose purpose is to promote the general welfare of residents in Indian Hills.

- Indian Hills Improvement Association (IHIA) and IHFR, and private donors helped kickstart the Indian Hills Chipping Program, a grassroots effort started by the Indian Hills Fire Mitigation & Prevention committee in 2021 to help residents remove slash from their properties. See more information on the IHIA website.

Geneva Glen Camp

Geneva Glen Camp is a co-educational, non-profit, residential summer camp located in Indian Hills, and they own a substantial amount of land in the southwestern part of IHFPD. Their mission is to provide a safe, loving atmosphere full of rich traditions where children and young adults develop a love of nature, create life-long friendships, and enrich their character, values, and leadership, inspired by dedicated and caring leaders who model exemplary conduct.

- Replaced flammable siding and roofing on many of the camp's cabins.
- Removed trees to create defensible space around many of the camp's cabins.
- Conducted fuel treatments on over 100 acres of ponderosa pine and mixed-conifer forests in coordination with Jefferson Conservation District.
- Updated camp's evacuation plan based on lessons learned from other camps during wildfires.

Community members creating a slash pile in Indian Hills, for pickup by the IHIA Curbside Chipping Program. Photo Credit: IHIA.

2. Indian Hills Fire Protection District: Background

2.a. General Description

IHFPD is home to approximately 1474 residents, and the community is celebrating its centennial in 2023. Compared to the general population of the United States, IHFPD residents are slightly older (38.5 vs 49.4 years old, respectively) and wealthier than average (annual income of $65,000 vs $126,583 respectively). Two-thirds of the residents are employed and many of them commute from the Indian Hills area to west Denver for work (U.S. Census Bureau, 2020).

IHFPD is located in Jefferson County and surrounded by the Foothills, West Metro, Inter-Canyon, and Evergreen Fire Protection Districts. IHFR often coordinates with these districts to provide mutual aid and respond to calls near the borders of the district.

Highly valued community assets within IHFPD include Parmalee Elementary School and two summer camps, Geneva Glen and St. Anne's in the Hills. Wildfire risk is elevated on the Geneva Glen property, and the camp has invested in replacing flammable roofs and siding with noncombustible materials and reducing the amount of forest vegetation in strategic locations to moderate potential wildfire behavior. Olinger Mount Lindo Cemetery is located on private property within Mount Falcon Park in the southeastern corner of the IHFPD. The Indian Hills post office, located inside the historic building of the Indian Hills Trading Post, and the Indian Hills Community Center are in the southern part of the IHFPD off Parmalee Gulch Road. Important communication infrastructure are located in Mount Lindo and Mount Falcon Parks (**Figure 2.a.1**).

Approximately 4.1 mi^2 of land (36%) of the IHFPD is publicly managed. DMP administers Stain Gulch, Parmalee Gulch Park, a portion of Little Park, and a portion of Mount Falcon Park within the IHFPD. DMP administers Corwina Park, O'Fallon Park, Pence Park, Red Rocks Park, Birch Hill, and a portion of Mount Lindo immediately adjacent to the IHFPD. JCOS administers Mount Falcon and Mount Lindo Parks within the IHFPD and Matthew/Winters and Lair o' the Bear Parks north of the IHFPD. Evergreen Park & Recreation District administer Arrowhead Community Park, located south of the IHFR station (**Figure 1.a.2**).

Elevations in the IHFPD range from 5,845 to 8,225 feet above sea level. About half of the IHFPD is covered in dense mixed-conifer stands with a mixture of ponderosa pine, Douglas-fir, Engelmann spruce, and aspen. About 30% of the IHFPD is ponderosa pine forests with moderate to high tree densities. Shrublands are scattered across 10% of the IHFPD on drier south- and southeast-facing slopes. Riparian vegetation with cottonwoods and aspen occur alongside the intermittent stream that parallels Parmalee Gulch Road and along several other intermittent streams in the IHFPD (**Figure 2.a.2**). Black bear, elk, deer, turkey, and Abert's squirrels are some of the wildlife found in the IHFPD.

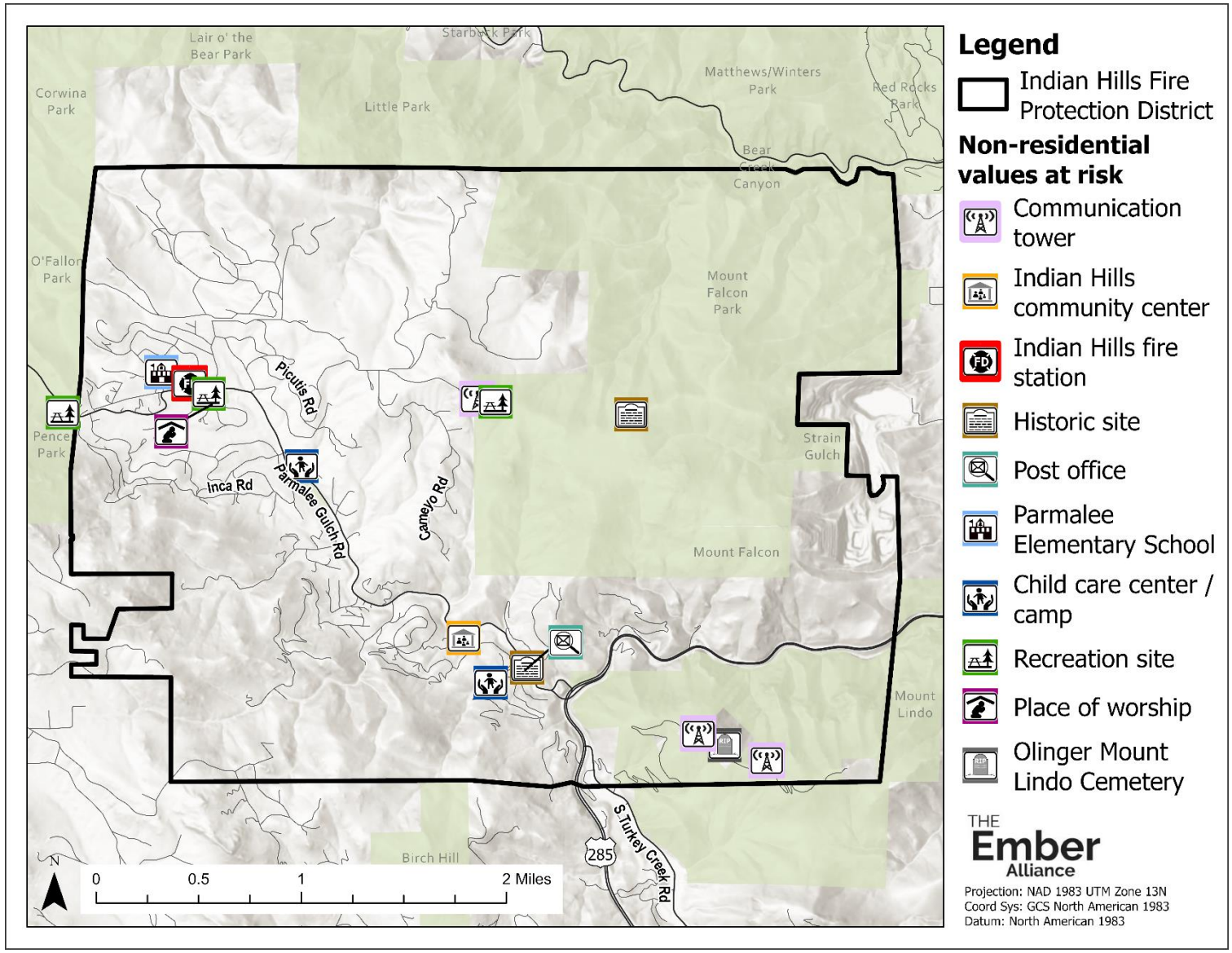


Figure 2.a.1. *Non-residential values within and around the IHFPD. Sources: Homeland Infrastructure Foundation-Level Data and U.S. Geological Survey.*

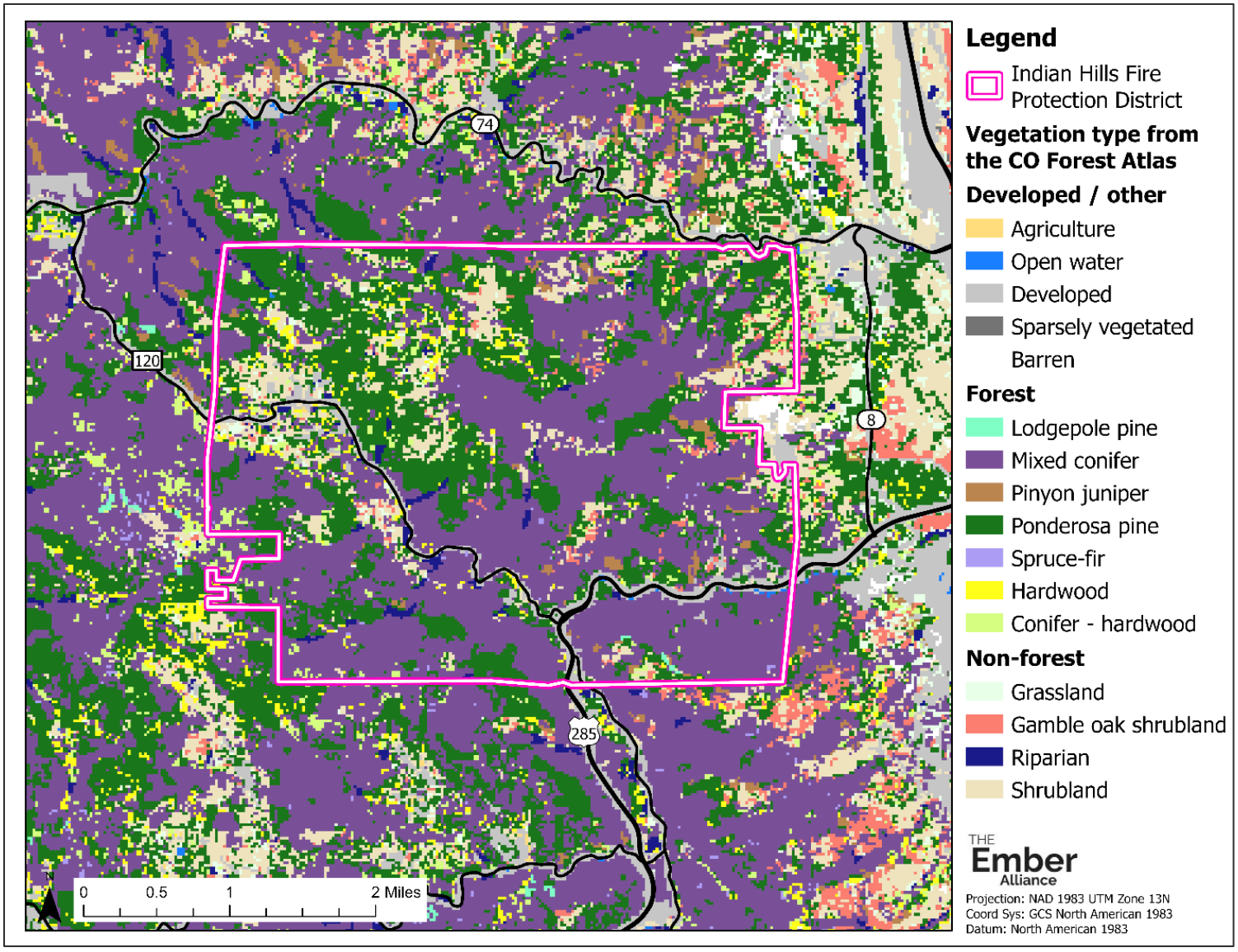


Figure 2.a.2. *Map of vegetation across the IHFPD. Most of the land is mixed conifer stands and ponderosa pine woodland, interspersed with montane shrublands and hardwood. Source: Colorado State Forest Service, Colorado Forest Atlas.*

2.b. District Capacity

Indian Hills Fire Rescue

IHFR is a small but highly effective volunteer department with about 20 volunteers and a full-time, paid Fire Chief who is responsible for directing all activities of the fire department and volunteer firefighters. IHFR members help provide a safe, secure environment for the community by minimizing the impact of fires, natural and/or human-caused disasters, hazardous conditions, and personal emergencies. The department is dedicated to the protection of life, property, and the environment through a commitment to excellence in emergency response, training, public education, fire prevention, and the efficient utilization of resources.

IHFR respond to about 150-175 calls each year, including both medical incidents and wildland fires. Despite their small size, IHFR has some of the fastest response times out of surrounding fire protection districts in the area.

All volunteers take introduction to wildland fire behavior (S130/190), and about 90% of volunteers maintain red cards so they can go on out-of-district fire assignments. A refresher training (RT-130) and pack test are offered every year for volunteers. Some volunteers go on extended dispatches to wildland fires outside of the IHFPD. In addition to providing funding for IHFPD, these assignments are a valuable source of training and experience for IHFR personnel.

Three of the IHFR volunteers have engine boss qualifications. IHFR has two type 6 and one type 3 wildland fire engines in addition to their structural engine, all of which are housed at the IHFR station at 4476 Parmalee Gulch Road.

Visit the IHFR website if you are interested in becoming a volunteer and to read important safety information for your community.

Indian Hills Water District

IHWD is a special district that supplies water to the residents of Indian Hills for domestic, commercial, and fire-protection uses. According to the IHWD 2020 Master Plan, the district has a total of 34 hydrants, 13 wells, 5 drinking water sources, 6 water storage tanks, 4 booster pump stations, 3 distribution pumps, 2 pressure control valve stations, and 2 water treatment facilities. The IHWD system can currently store around 440,000 gallons, and future improvements should increase this to 800,000 gallons. IHWD maintains water storage at the highest possible level throughout the year so they can provide adequate water during a wildland fire. They coordinate with IHFR so firefighters can open valves between pipes and pumps during incidents.

IHWD faces three significant challenges with providing adequate water flow for firefighting: inconsistent pressure and storage capacity across the community, drought years that diminish the water table, and old infrastructure that is costly to update. The IHWD 2020 Master Plan outlines future capital improvements to enhance their ability to provide adequate water for firefighters during structure or wildland fires. This includes plans to:

- Install new hydrants so they are placed every 1,000 feet throughout the distribution system.
- Redrill two of the six offline wells to increase capacity.
- Expand the capacity of water tanks on Picutis Road.
- Improve their ability to detect and repair leaks.
- Install monitoring systems on wells to provide real-time estimates of water availability.
- Alter pipes to achieve minimum fire flow of 1,000 gallons/minute across IHFPD.

Headquarters for IHFR, the volunteer fire department that serves the IHFPD. Photo credit: The Ember Alliance.

IHWD maintains 34 hydrants across IHFPD and is making continual improvements to ensure adequate water quantity and flow during wildland fires. Photo credit: Google Maps.

2.c. Wildland-Urban Interface

Every year, wildfires result in billions of dollars in fire suppression costs and destroy thousands of homes across the United States. Some of the most destructive, deadly, and expensive wildfires have occurred in the past several years, partly due to construction of additional homes in the wildland-urban interface (WUI). Wildfire risk in the WUI is further exacerbated by severe fire weather perpetuated by climate change (Caton et al., 2016). Some examples include the 1996 Buffalo Creek Fire that destroyed 10 homes, the 2000 Hi Meadow Fire that destroyed 51 homes, the 2002 Hayman Fire that destroyed 133 homes, and the 2021 Marshall Fire that destroyed over 1,000 structures. See **Appendix A** for a discussion about how wildfires can threaten and destroy homes.

The WUI is any area where the built environment meets wildfire-prone areas—places where wildland fire can move between natural vegetation and the built environment and result in negative impacts on the community (Forge, 2018). People that live and work in the WUI must be aware of the effect that ecosystem processes and disturbances, such as wildland fire, have on their lives. WUI exists along a continuum of wildland to urban densities (**Figure 2.c.1**). Wildland-urban intermix refers to areas where housing and wildland vegetation intermingle, while wildland-urban interface refers to areas where housing is in the vicinity of a large area of dense wildland vegetation (Martinuzzi et al., 2015).

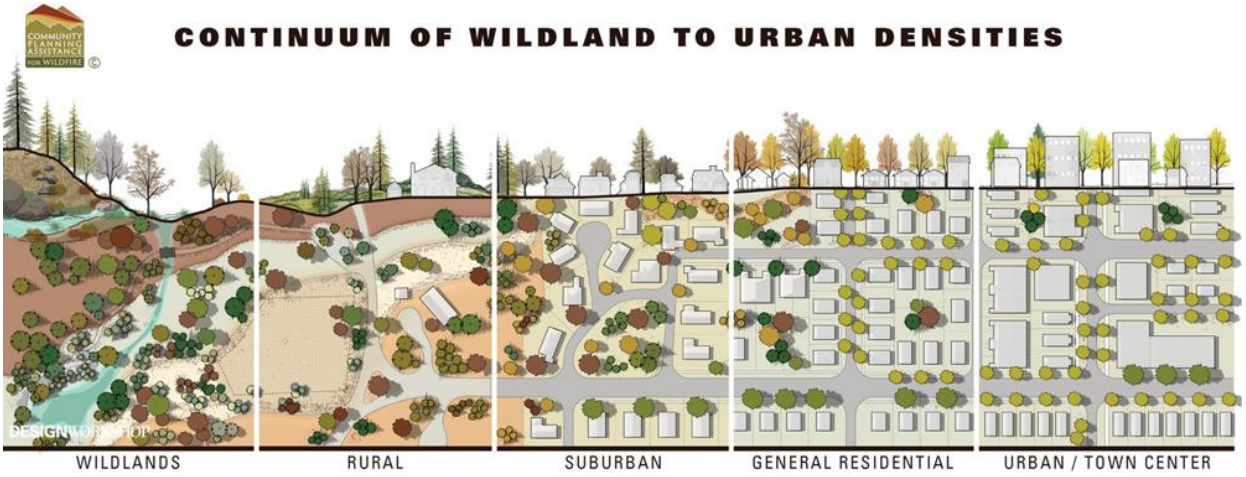


Figure 2.c.1*. The wildland-urban interface exists along a continuum of wildland to urban densities. Source: Community Planning Assistance for Wildfire.*

All residents of the IHFPD live in the WUI (**Figure 2.c.2**). According to the 2020 Wildfire Risk to Communities analysis by the U.S. Forest Service, homes in the IHFPD and the surrounding areas have a higher risk of fire than 99% of the communities in the state of Colorado (USFS, 2021a). Over the past 50 years, immigration to the mountains along the Colorado Front Range has increased the number of occupied structures within this historically forested landscape. This population change has increased not only the density and size of the WUI, but also increased the risk of structure loss from wildfire and the likelihood of fire starts.

For the purpose of this CWPP, the WUI boundary includes all of the IHFPD, the surrounding landscape that could transmit wildland fire into the IHFPD, and the area along important evacuation routes (**Figure 2.c.2**; see methodology in **Appendix B**). Strategic wildfire mitigation across the WUI can increase the safety of residents and wildland firefighters and reduce the chances of home loss.

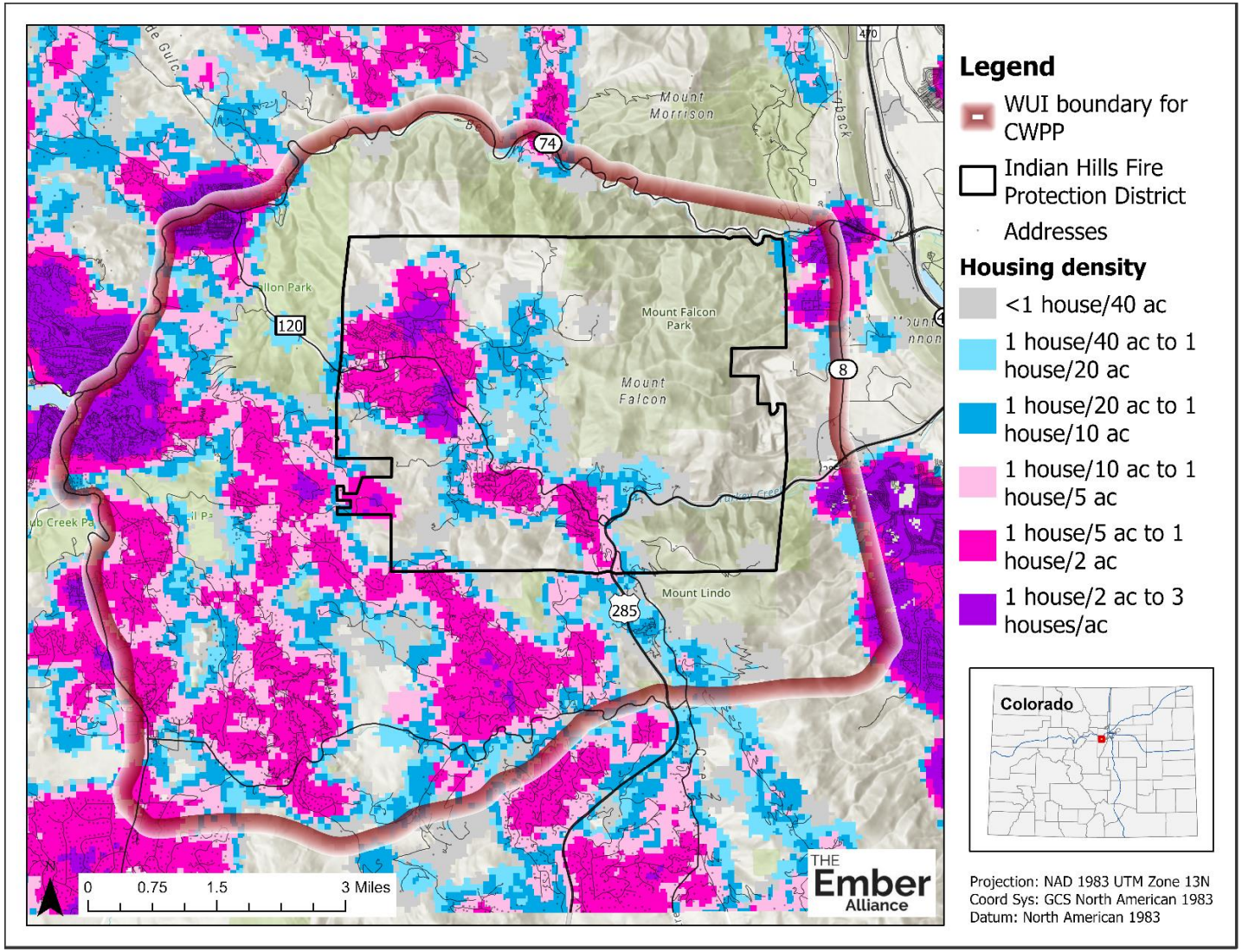


Figure 2.c.2. *All residents of the IHFPD live in the WUI and/or Intermix and are exposed to elevated wildfire risk. For this CWPP, the WUI boundary includes all of the IHFPD, the surrounding landscape that could transmit wildland fire into the IHFPD, and the area along important evacuation routes (see methodology in* ***Appendix B****). Housing density comes from the Colorado State Forest Service, Colorado Forest Atlas. Visit the IHFPD CWPP Map Experience for an interactive version of this map.*

2.d. Firefighting in the WUI

One of the standard firefighter orders is to "fight fires aggressively, having provided for safety first" (NWCG, 2018a). Firefighters are committed to protecting lives and property, but firefighting is particularly perilous in the WUI. The firefighter community is increasingly committed to safety of wildland firefighters, which can require the difficult decision to cease structure protection when conditions become exceedingly dangerous, particularly around homes with inadequate defensible space, safety zones, and egress routes.

High-intensity, fast-moving wildfires in the WUI can quickly overwhelm firefighting resources when homes begin igniting each other (Caton and others 2016). Firefighters are often forced to perform structure triage to effectively allocate limited resources during an incident, and more importantly, to protect the lives of firefighters. The Incident Response Pocket Guide (IRPG), which is carried by all firefighters certified under the National Wildfire Coordinating Group, explicitly states, "**Do not** commit to stay and protect a structure unless a safety zone for firefighters and equipment has been identified at the structure during sizeup and triage" (NWCG, 2018a). The IRPG outlines four categories of structure triage: (1) defensible – prep and hold, (2) defensible – stand alone, (3) non-defensible – prep and leave, and (4) non-defensible – rescue drive-by.

Do not count on firefighters staying to defend your home—your home should be able to survive a wildfire on its own. There are never enough firefighters to stay and defend every single home during large incidents. Section 3.a. of this CWPP provides recommendations for how residents can increase the chance of their homes surviving wildfires and enhance the safety of wildland firefighters.

2.e. Fire History Along the Colorado Front Range

Colorado's Front Range was influenced heavily by fire before the era of fire suppression. This land is the ancestral land of the Cheyenne and Ute First Nations. Many Indigenous peoples utilized fire as a land management tool. Lightning ignited fires were common in ponderosa pine and dry mixed-conifer forests before European settlement in the 1850's.

Ponderosa pine ecosystems with mixtures of Douglas-fir, Gamble oak, Rocky Mountain juniper, and aspen were fire-adapted ecosystems and very resilient to wildfires. Low- to mixed-severity fires occurred every 7 to 50 years and resulted in a mosaic of widely spaced trees and small tree clumps interwoven with grasslands and shrublands, particularly on drier south-facing slopes. North-facing slopes often supported denser forest stands (**Figure 2.e.1**) (Addington et al., 2018). Frequent fires would kill many tree seedlings and saplings, thereby preventing the accumulation of ladder fuels and reducing the potential for surface fires to transition into crown fires. Fire spread was more rapid through understory grasses but released far less heat, which allowed many larger trees to survive unscathed. Occasionally, dense clumps of trees would experience mortality from passive crown fire or active crown fires over several hundred acres, further increasing the diversity of habitat in these ecosystems. Ponderosa pine ecosystems with fewer trees support more abundant and species-diverse understories of grasses, forbs, and shrubs and provide habitat for a variety of wildlife that prefer more open forest structure (Kalies et al., 2012; Matonis and Binkley, 2018; Pilliod et al., 2006).

Mixed-conifer forests dominated by Douglas-fir and with variable mixture of ponderosa pine, lodgepole pine, Englemann spruce, Colorado blue spruce, subalpine fir, and aspen experienced wildfires every 20 to >100 years (**Figure 2.e.1**). These forests burned less frequently due to cooler, moister conditions at higher elevations, particularly on north-facing slopes, and they had higher tree densities than ponderosa pine ecosystems (Addington et al., 2018). High-severity wildfire could kill patches of trees and create a mosaic landscape with recently burned forests and dense unburned

forests. Spruce and fir trees in Douglas-fir forests are not resistant to fire and will burn easily. The death of overstory trees increases the availability of sunlight to regenerating trees, including sun-loving aspen.

As the initial ranching and logging activities of Euro-American settlers subsided in the region and government-mandated fire suppression began in the late 1800's, forests began to fill in with trees (**Figure 2.e.2**) (Addington et al., 2018). Although many residents consider dense forest as "natural," these conditions are vastly different from the fire-resilient ecosystems that existed before. Tree densities in lower-elevation forests along the Colorado Front Range average 4.5 times higher today than they were in the mid-1800s, and tree densities in mid-elevation forests average 2.3 times higher today (Battaglia et al., 2018). Landscapes of continuous, dense forests are more prone to high-severity fires that are difficult to suppress and can result in catastrophic losses to lives and property (Haas et al., 2015), and climate change is making high-severity wildfires more frequent, intense, and larger in extent (Parks et al., 2016).

Gambel oak is part of many fire-adapted vegetative communities, including ponderosa pine forests, mixed conifer forests, and montane shrublands. Gambel oak have low resistance and high resilience to fire, and much like quaking aspen, they demonstrate vigorous growth after disturbance because they can sprout new trunks from their extensive root system and do not rely on acorns for reproduction (Abella and Fulé, 2008; Jester et al., 2012). Under moderate or severe burning conditions, Gambel oak can be a heavy and continuous fuel source that is difficult to suppress and has contributed to fast-moving and destructive runs on fires such as the 1994 South Canyon Fire and the 2012 Waldo Canyon Fire (Kaufmann et al., 2016).

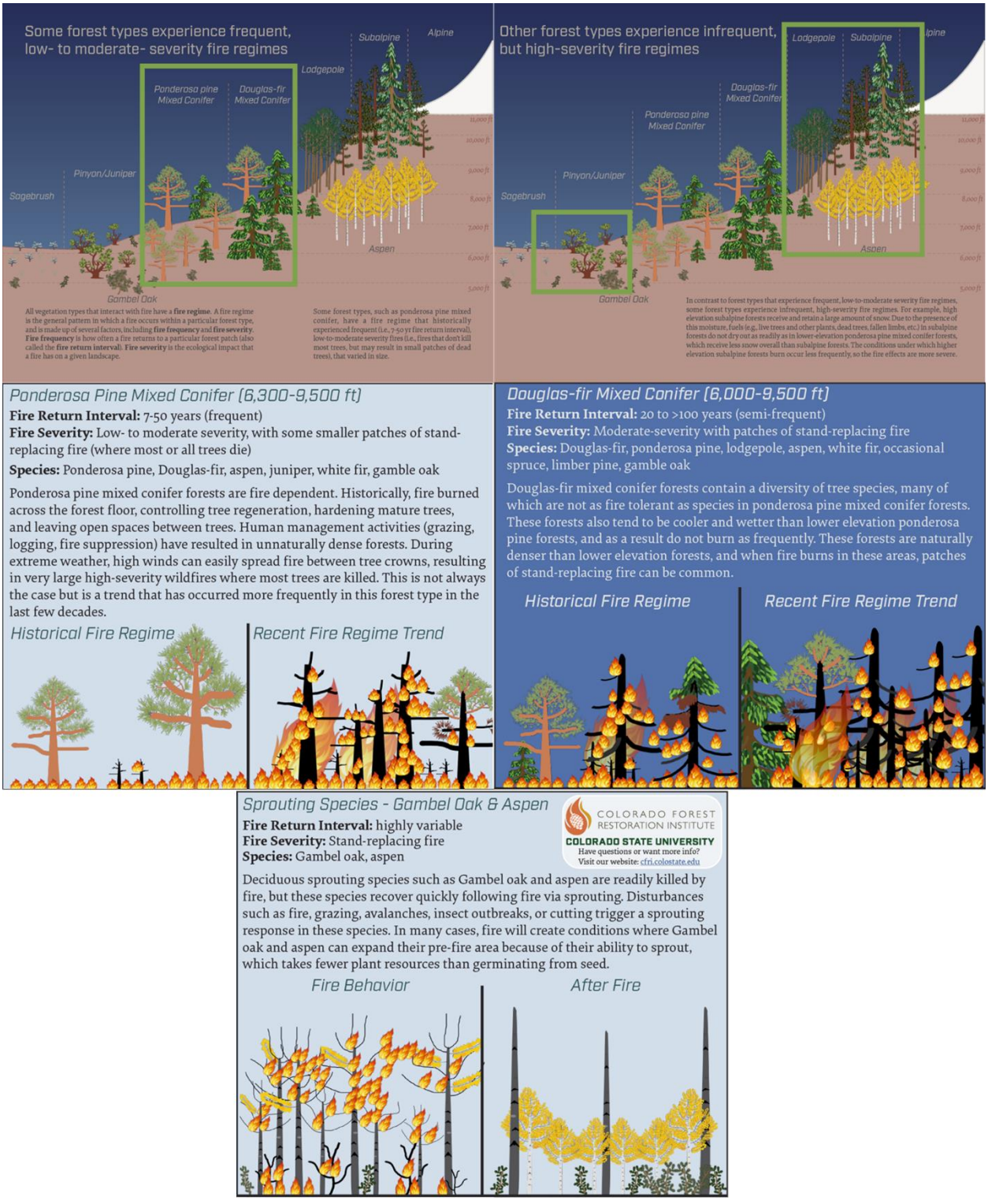


Figure 2.e.1. *Ponderosa pine forests along the Colorado Front Range historically experienced frequent fires every 7-50 years and mixed-conifer forests experienced semi-frequent fires every 20 to >100 years, resulting in less dense forest conditions than we see today. Gambel oak experienced variable fire regimes, but likely more frequent that what they see today, resulting in more frequent regrowth. Source: Colorado Forest Restoration Institute.*

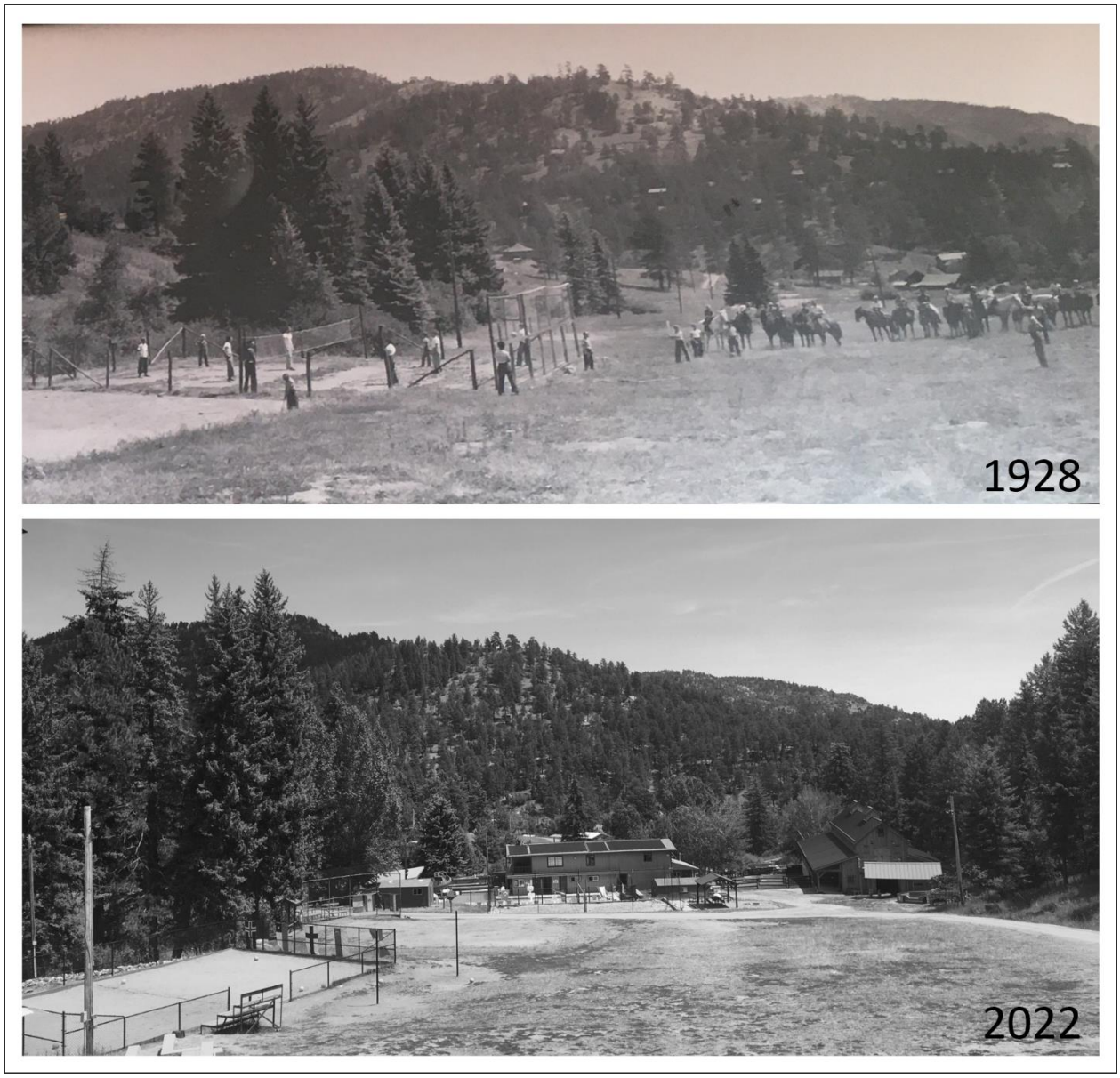


Figure 2.e.2. *Tree densities in many ponderosa pine and mixed-conifer forests are higher today than they were historically, as demonstrated by these paired photographs of forested hills east of Geneva Glen Camp in IHFPD. Tree densities were likely even lower in the mid-1800s prior to Euro-American settlement and the era of fire suppression. More open ponderosa pine and dry-mixed conifer forests are less likely to experience severe wildfires that spread from treetop to treetop. Photo credit: Geneva Glen Camp and The Ember Alliance.*

Along the Front Range of Colorado, a combination of extreme fire weather conditions (extreme heat and high winds), unplanned ignitions, and dry, unmitigated wildland vegetation can create catastrophic wildfire scenarios in the WUI. Climate change is further increasing wildfire risk and lengthening fire seasons (Parks et al., 2016). Many catastrophic wildfires in Colorado's history have occurred on dry and windy days, resulting in rapid fire spread over short periods of time. On the Front Range, wind can gust over 60 miles/hour, which makes wildfire suppression nearly impossible (Haas et al., 2015).

Days with red flag warnings indicate severe fire weather and require extra vigilance by fire departments and residents (see **Table 2.e.1** for red flag warning criteria). The occurrence of red flag warnings is highly variable from year to year due to regional weather patterns and weather anomalies such as El Niño and La Niña. The IHFPD experienced between 0 and 33 red flag warnings per year from 2006 to 2020, with 6 red flag warnings in 2019 and 22 red flag warnings in 2020 (**Figure 2.e.3**). Red flag conditions are most common in March, April, June, and October in the IHFPD. Climate change is expected to cause 7 to 10 more red flag warning days each year in the coming fifty years, making fire adaptation even more important to the community. See **Appendix B** for additional information on climate change and wildfire risk.

Several large wildfires have occurred within the vicinity of the IHFPD over the past 20 years, including the 2002 Hayman Fire, which was the largest fire in Colorado's history until even larger fires broke the record three times in 2020. Other notable fires in the area include the 1996 Buffalo Creek Fire, 2000 High Meadows Fire, and 2012 Lower North Fork Fire (**Figure 2.e.4**). Recent fires closer to or within the IHFPD have been smaller, such as the 1989 Mount Falcon Fire which burned about 100-acres on Mount Falcon Park, the 2020 Elephant Butte Fire near Evergreen that burned about 54 acres and prompted evacuations for about 1,000 homes, and a 1-acre wildfire on the eastern face of Mount Lindo in June 2021. Almost every year, volunteers with IHFR respond to at least one fire start within the district. The potential exists for these fires to grow out of control and escape the capacity of firefighters under high, dry, and windy conditions.

During red flag warnings, all residents need to be prepared for evacuations in the case of a wildfire, just as the fire department will be preparing for wildfire response.

***Table 2.e.1**. Red flag days are warnings issued by the National Weather Service using criteria specific to a region. IHFPD falls within the Denver/Boulder Forecast Office.*

National Weather Service – Denver/Boulder Forecast Office Red Flag Warning Criteria	
Option 1	**Option 2**
Relative humidity less than or equal to 15%	Widely scattered dry thunderstorms
Wind gusts greater than or equal to 25 mph	Dry fuels
Dry fuels	

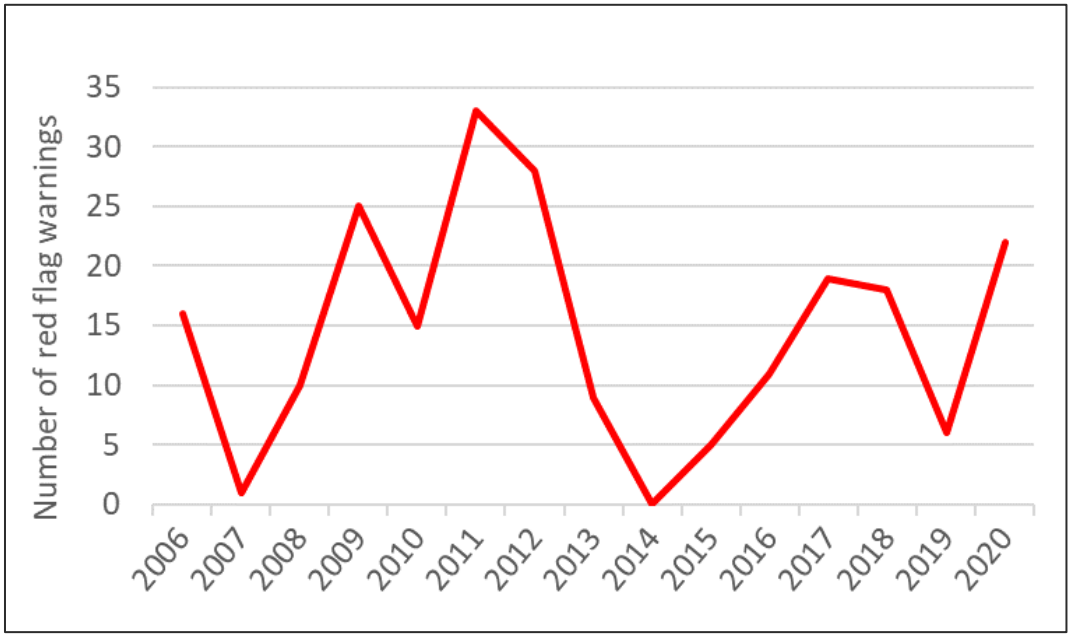


***Figure 2.e.3.** Total number of red flag days by year from 2006 to 2020 in IHFPD. March, April, June, and October are the most common months for experiencing red flag weather. Source: Iowa State University, Iowa Environmental Mesonet.*

Top: Strong, gusty wind contributed to rapid growth of the 2002 Hayman Fire in Colorado. Photo credit: CBS Colorado. Bottom: Smoke rises from a small, 1-acre wildfire on the eastern face of Mount Lindo in June 2021 IHFR supported West Metro Fire Protect District in responding to the wildfire to prevent it from spreading. Photo credit: Sue Ryplewski.

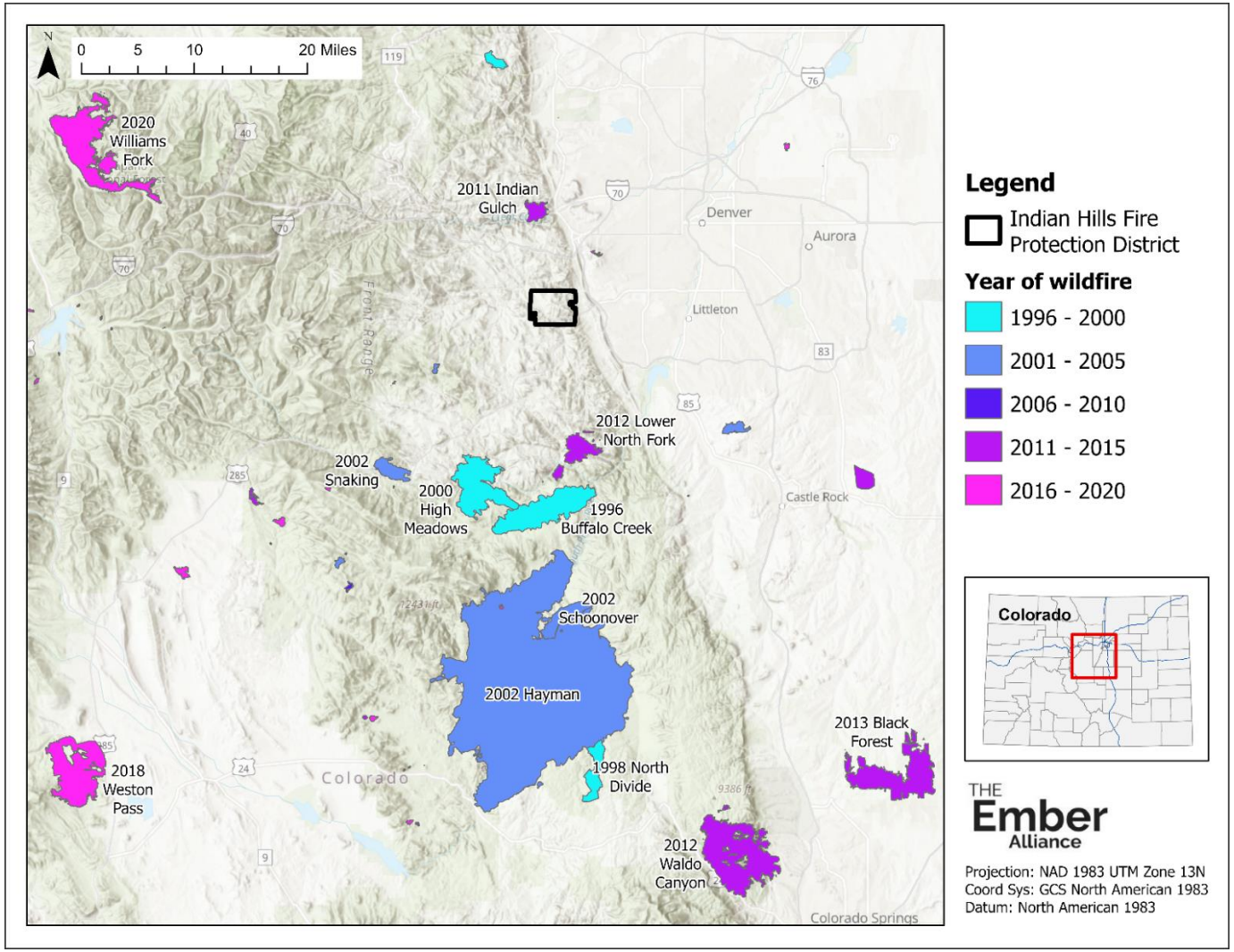


Figure 2.e.4. *Several large wildfires occurred along the Colorado Front Range between 1996-2020, several of which burned an area equivalent to or larger than the IHFPD. Firefighters with IHFR usually respond to several wildfires within the district each year and contain them to less than a few acres. However, were a wildfire to escape initial control during hot, dry, and windy conditions, it could easily overwhelm IHFR's capacity to respond and burn across large portion of the IHFPD. Source: National Interagency Fire Center. Visit the IHFPD CWPP Map Experience for an interactive version of this map.*

2.f. Extreme Danger in Indian Hills Fire Protection District

Many neighborhoods in the IHFPD could experience extreme fire behavior that could put the lives of residents, visitors, and firefighters at risk. Steep slopes, dense forests, limited road access in and out of neighborhoods, and flammable building material contribute to this dangerous situation. **There is an immediate need for this community to undertake proactive measures to mitigate wildfire risk to protect lives and property.**

Topography and fuel conditions are highly variable across the IHFPD (**Figure 2.f.1**), and patterns in these factors, plus alignment between wind patterns and topography, help explain the patterns in potential fire behavior across the IHFPD and surrounding landscape. Very high to extreme fire behavior is more likely in wet mixed-conifer forests on north-facing slopes with high tree density and abundant ladder fuels. Some south-facing slopes in IHFPD have moderately dense ponderosa pine forests that can experience wildfires that transition from burning grasses, forbs, and shrubs into treetops. Riparian vegetation with deciduous trees along Parmalee Gulch Road and grasslands and irrigated fields north of Parmalee Gulch Road and Mount Falcon Road are likely to experience surface fires with lower flame lengths and moderate to fast rates of spread.

Under moderate fire weather conditions—conditions typical of a summer day in IHFPD—about 40% percent of the IHFPD could experience very high to extreme fire behavior. This percentage increases to 55% under less common but more extreme, hot, dry, and windy conditions (**Figure 2.f.2**).

Important Considerations about Fire Behavior Predictions

Fire behavior models can provide reasonable estimates of relative wildfire behavior across a landscape. However, wildfire behavior is complex, and models are a simplification of reality. It is recommended to use fire behavior analyses to assess relative risk across the entire IHFPD. Models cannot produce specific and precise predictions of what will occur in the vicinity of an individual home during a wildfire incident.

Exceptional hot, dry, and windy conditions are increasingly common due to climate change and could result in even more extreme fire behavior across the IHFPD than predicted by this analysis.

See **Appendix A** for details on fire behavior modeling used for this CWPP.

Very high to extreme fire behavior includes ember production that ignites additional fires away from the main fire and the movement of high-intensity fire from treetop to treetop. Such fires are extremely challenging if not impossible to control until winds die down and fuel moistures increase. Fire growth could be extensive across the IHFPD if wildland firefighters cannot engage due to dangerous conditions from extreme fire behavior (**Figure 2.f.3**).

High to extreme fire behavior can also create non-survivable conditions along roadways, which is of particular concern in a community like IHFPD where there are few points of egress for an evacuation. Under moderate fire weather conditions, 23% of the roads in the IHFPD could experience non-survivable conditions, but this percentage rises to 40% under extreme fire weather conditions (**Figure 2.f.4**).

On days with extreme fire weather conditions, about 70% of homes within the IHFPD could be exposed to embers from burning vegetation, regardless of vegetation in the immediate vicinity of the home (**Figure 2.f.5**). Homes serve as an additional source of fuel that could produce high-intensity flames, emit embers, and initiate home-to-home ignitions. Potential exposure to radiant heating and embers is widespread across the IHFPD, and this awareness should encourage residents and business owners to complete home hardening practices to reduce the risk of ignition. Evacuation

preparedness is of the utmost importance for residents in neighborhoods with hazardous conditions (see **Section 3.a. Evacuation Preparedness**).

Residents in the IHFPD are highly concerned about wildfire risk. Top concerns to residents are receiving timely and accurate information, evacuating safely and promptly, loss of life, post-fire erosion and flooding, loss of insurance coverage, and damage to property (**Figure 2.f.6)**. Fortunately, these concerns can be addressed through concerted effort across the community to mitigate wildfire risk and increase emergency preparedness. **Implementing recommendations in this CWPP will go a long way towards helping the IHFPD become a fire adapted community.**

Some neighborhoods in IHFPD are at extreme danger of destructive wildfires because they are located on steep slopes with dense mixed-conifer forests surrounding the roadways and homes. Wildfires can burn quickly up steep hills, spreading from treetop to treetop in active crown fires that are difficult, if not impossible to suppress. Steep, narrow roads make it challenging and dangerous for firefighters to access the area and protect homes and lives. Photo credit: The Ember Alliance.

Take Away Message

The IHFPD is at high risk for large, high-severity wildfires due to dense forest conditions, dry and hot weather, and strong, gusty winds. Increasing drought and warming temperatures exacerbate wildfire risk in the area. **The IHFPD and residents in the IHFPD must prepare for large wildfire events. Proactive work is imperative to protect lives and property.**

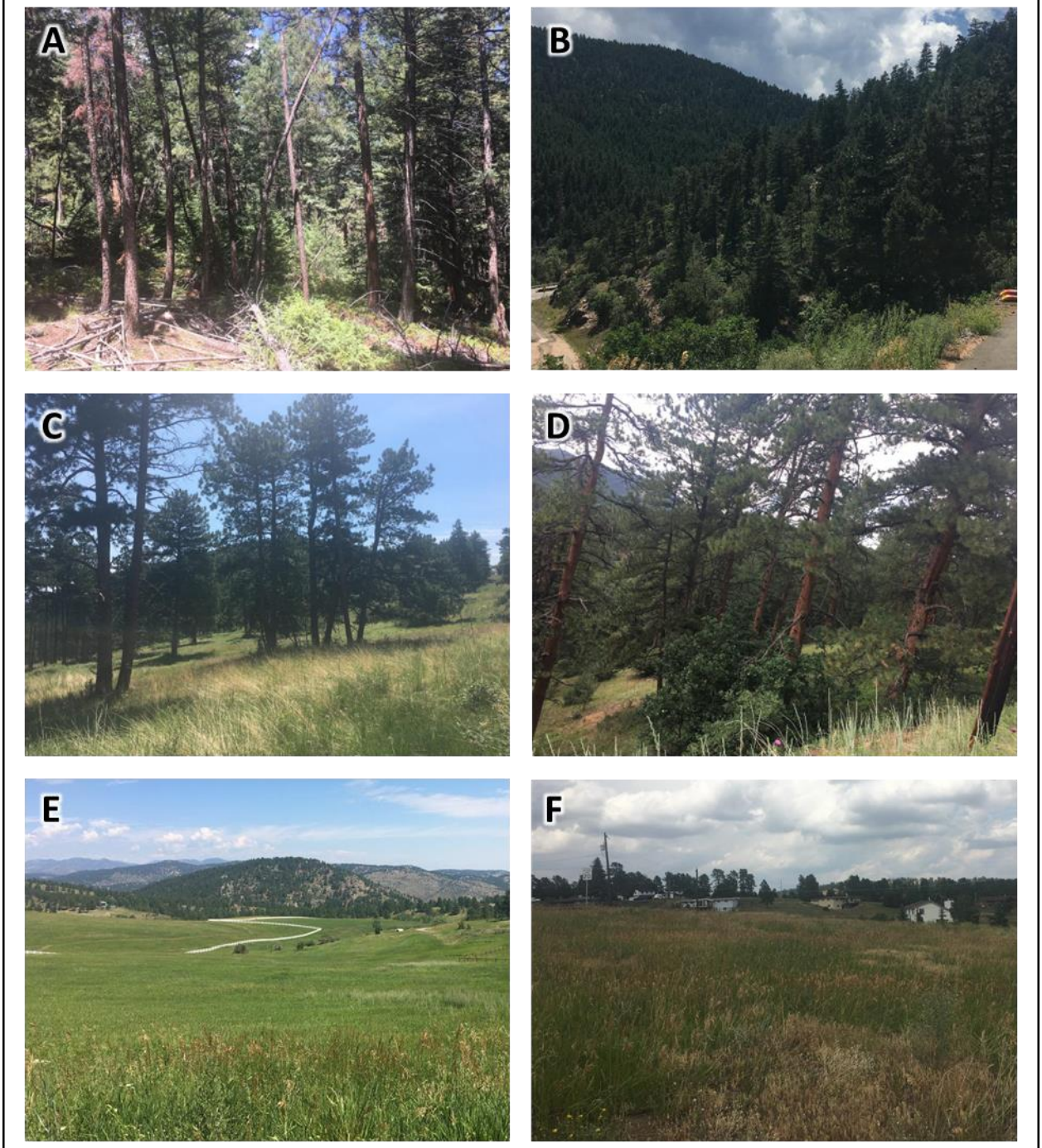


Figure 2.f.1. *Fuel loads are variable across the IHFPD and can result in different types of fire behavior. Wildfires burning in dense wet mixed-conifer forests with abundant ladder fuels (A and B) can spread from treetop to treetop and are difficult if not impossible to suppress. Wildfires burning in open ponderosa pine forests with widely spaced trees and few ladder fuels (C) are less likely to transition into treetops but can experience rapid rates of spread where grasses are continuous and dry. The presence of shrubs and low branches in ponderosa pine (D) increases the chance of fire transitioning into treetops. Wildfires can spread rapidly in grasslands (E and F), particularly when tall grasses are dry from prolonged drought. Photo credit: The Ember Alliance.*

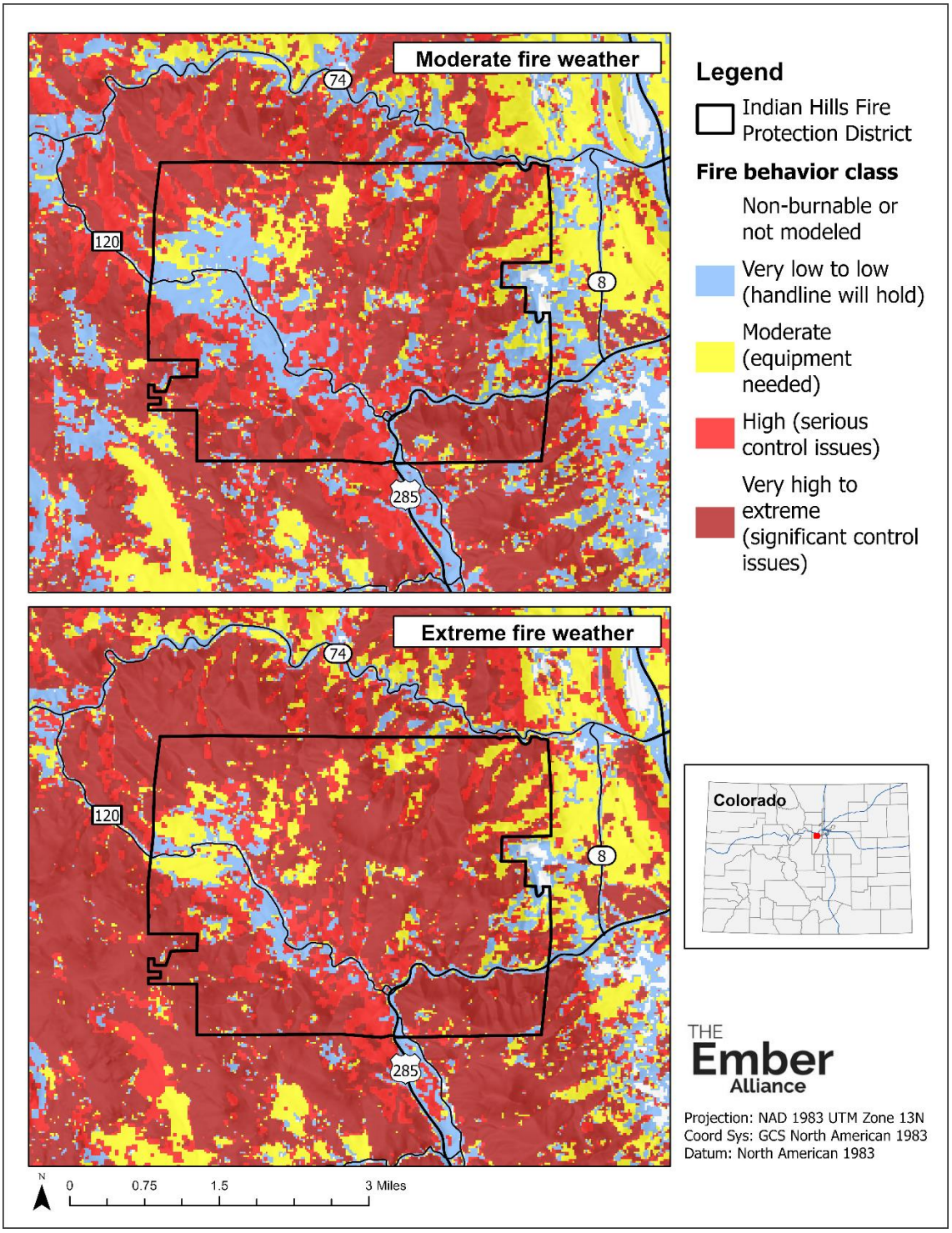


Figure 2.f.2. *Under moderate fire weather conditions—conditions typical of a summer day in IHFPD—40% percent of the IHFPD could experience very high to extreme fire behavior, and this percentage increases to 55% under less common but more extreme, hot, dry, and windy conditions. High to extreme fire behavior includes ember production that ignites additional fires away from the main fire and the movement of high-intensity fire from treetop to treetop. Such fires are extremely challenging if not impossible to control until winds die down and fuel moistures increase. Visit the IHFPD CWPP Map Experience for an interactive version of this map.*

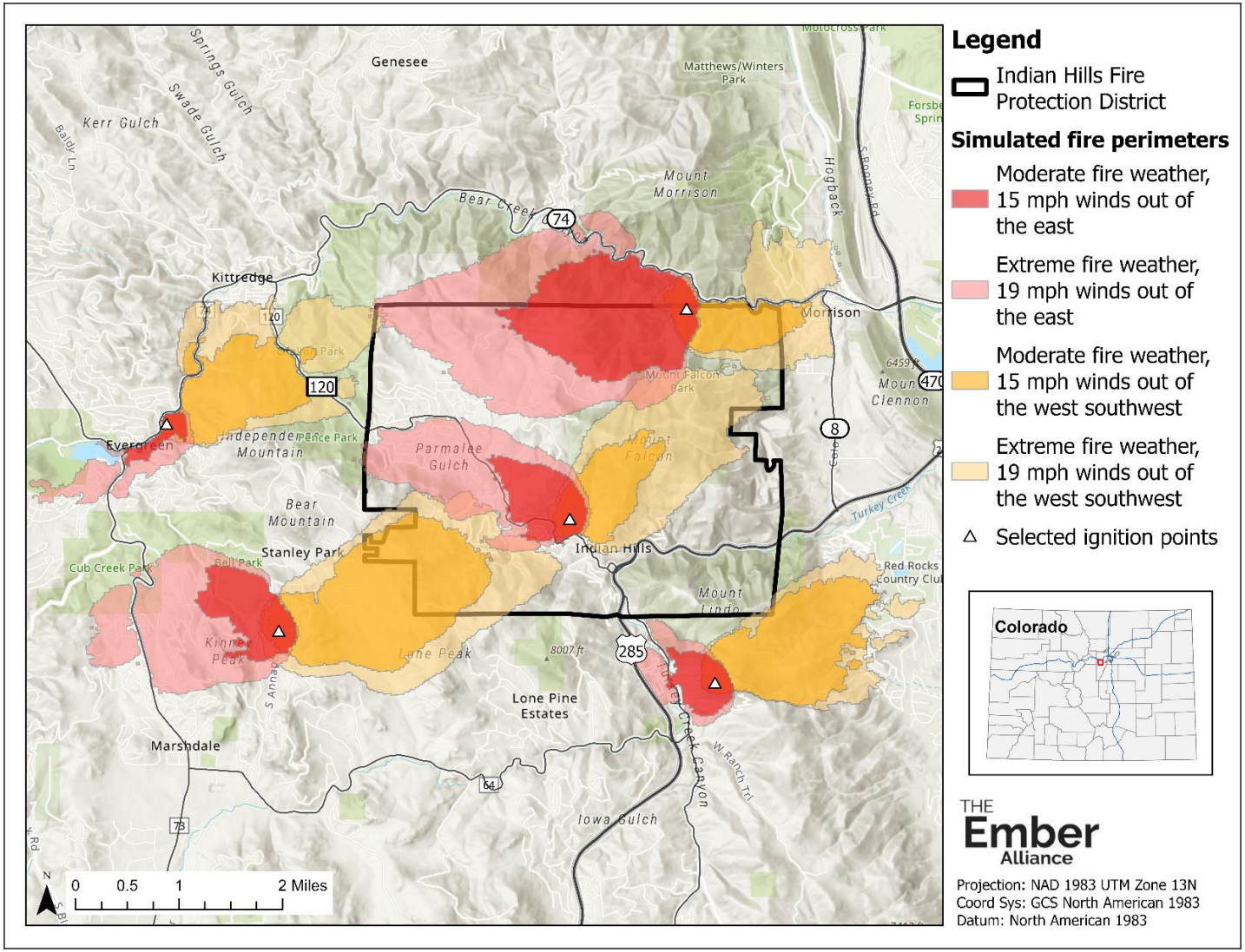


Figure 2.f.3. *Fire growth could be extensive across the IHFPD under extreme fire weather conditions if wildland firefighters cannot engage due to dangerous conditions from extreme fire behavior. Simulated fire perimeters were based on fire behavior predictions after 4-hours of fire growth without suppression activities from hypothetical ignition locations. Multiple fire perimeters are shown to demonstrate the variety of fire sizes, shapes, and travel paths that could happen in and around the IHFPD under different fire weather conditions and wind directions.*

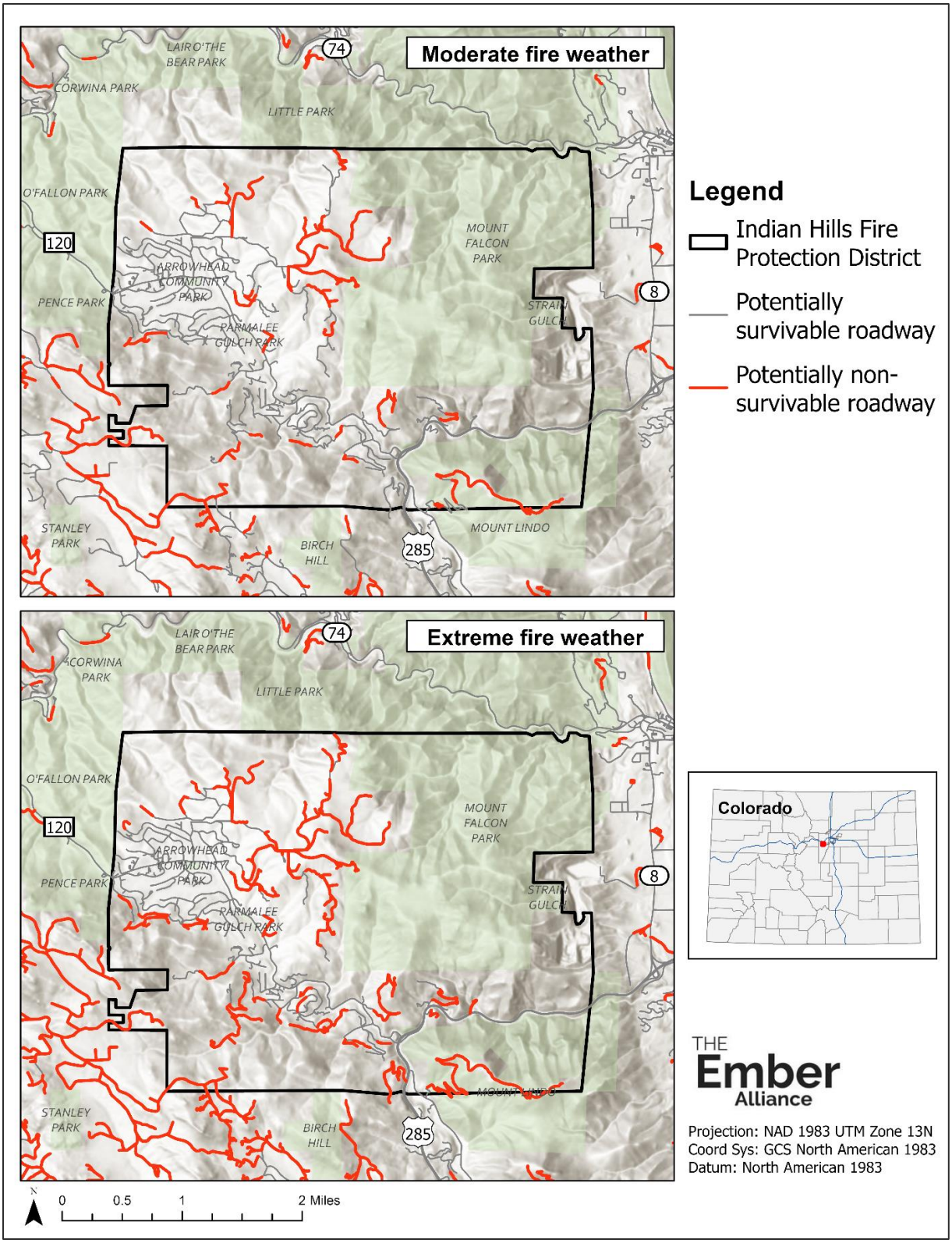


Figure 2.f.4. *Under moderate fire weather conditions, 23% of roads and driveways in the IHFPD could potentially experience non-survivable conditions during wildfires (i.e., flame lengths over 8 feet). This percentage rises to 40% under extreme fire weather conditions.*

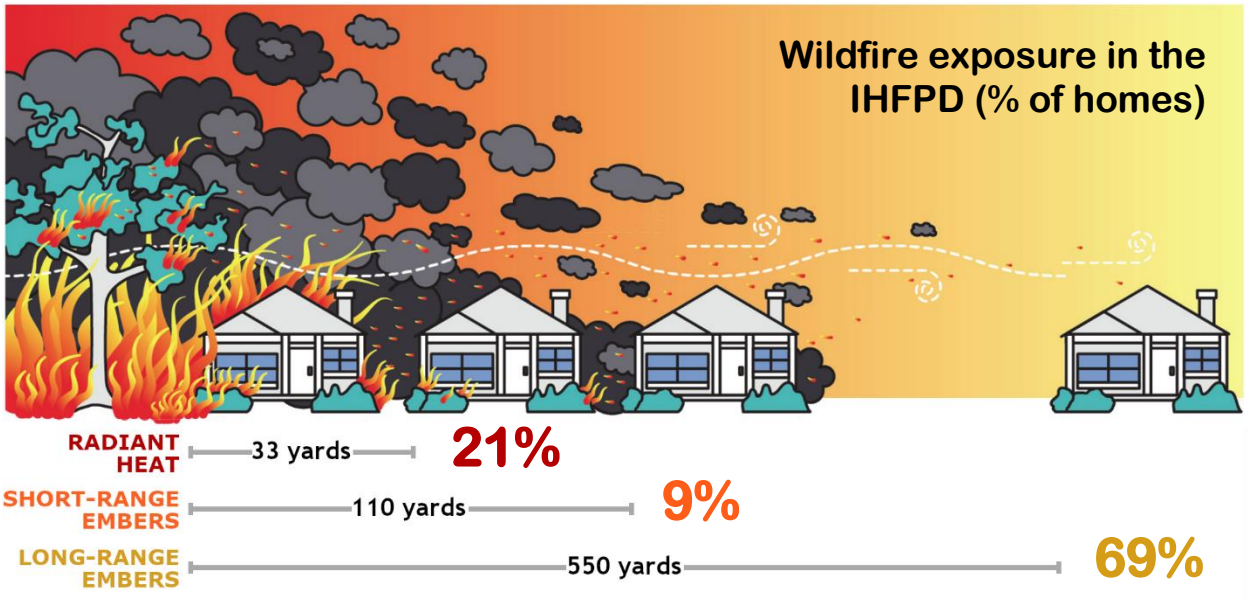


Figure 2.f.5. *Percentage of homes the IHFPD with different types of exposure to wildfire under extreme fire weather conditions. Radiant heat from burning vegetation can ignite nearby homes, and embers emitted from burning vegetation or other homes can travel long distances and ignite vegetation and homes away from the main fire. Analysis based on research by Beverly et al., (2010) (see* ***Appendix B*** *for details). Image modified from Reducing Brushfires Risks by the Victorian Auditor-General's Office.*

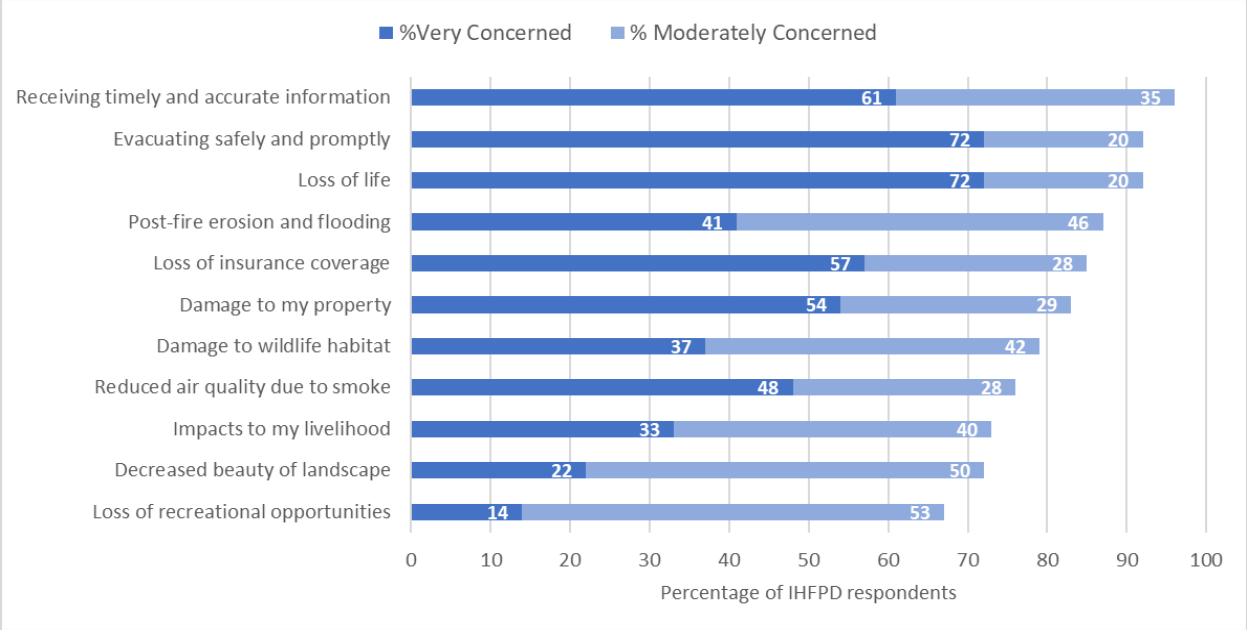


Figure 2.f.6. *Percentage of IHFPD residents who responded to the CWPP survey as being moderately concerned or very concerned about different impacts of wildfire in the community. See* ***Appendix C*** *for a full summary of survey findings.*

2.g. Fuel Treatment History in and Around the IHFPD

Fuel treatments reduce the amount of fuel in strategic locations, reducing fire risk to nearby communities and creating tactical opportunities for wildland firefighters to engage with wildland fires. Fuel treatments can create healthy, restored forest conditions with abundant understory plants, improved wildlife habitat, and lower risk of high-severity wildfires (**Figure 2.g.1**).

Public land managers and private residents in and around IHFPD are conducting fuel treatments to reduce wildfire risk and restore ecosystem health (**Figure 2.g.2**). In 2008, Jefferson County Open Space (JCOS) removed trees along Mount Falcon Road to create safer conditions for residents and visitors, and they conducted a 43-acre broadcast prescribed burn to restore grasslands and meadows on Mount Falcon Park. Denver Mountain Parks completed mechanical fuel treatments on 40 acres in Birch Hill south of the IHFPD in 2014 and on 310 acres in O'Fallon Park northwest of the IHFPD in 2015.

The Colorado State Forest Service and Jefferson Conservation District are working with several private landowners to write forest management plans and implement fuel treatments in the southwestern part of IHFPD. The Jefferson Conservation District and Geneva Glen Camp treated over 100 acres with mechanical thinning from 2018-2022, and they have plans to continue this work in the coming years. Tall Timbers Ranch has an active forest management program to reduce wildfire risk across the northwestern part of the IHFPD.

An important component of this CWPP was identifying locations for additional fuel treatments to protect the community. **Section 4** outlines these priority locations and the land management agency that will lead these efforts in the coming years.

Before treatment

1 Year Post-Treatment

2 Years Post-Treatment

3 Years Post-Treatment

Figure 2.g.1. *In 2018, Jefferson Conservation District and Geneva Glen Camp removed small trees and low limbs that can serve as ladder fuels and removed large trees to create greater distances between treetops in strategic locations across the Camp. The area now supports a healthy, restored ecosystem with abundant understory plants and a lower chance of high-severity wildfires. Photo credit: Jefferson Conservation District.*

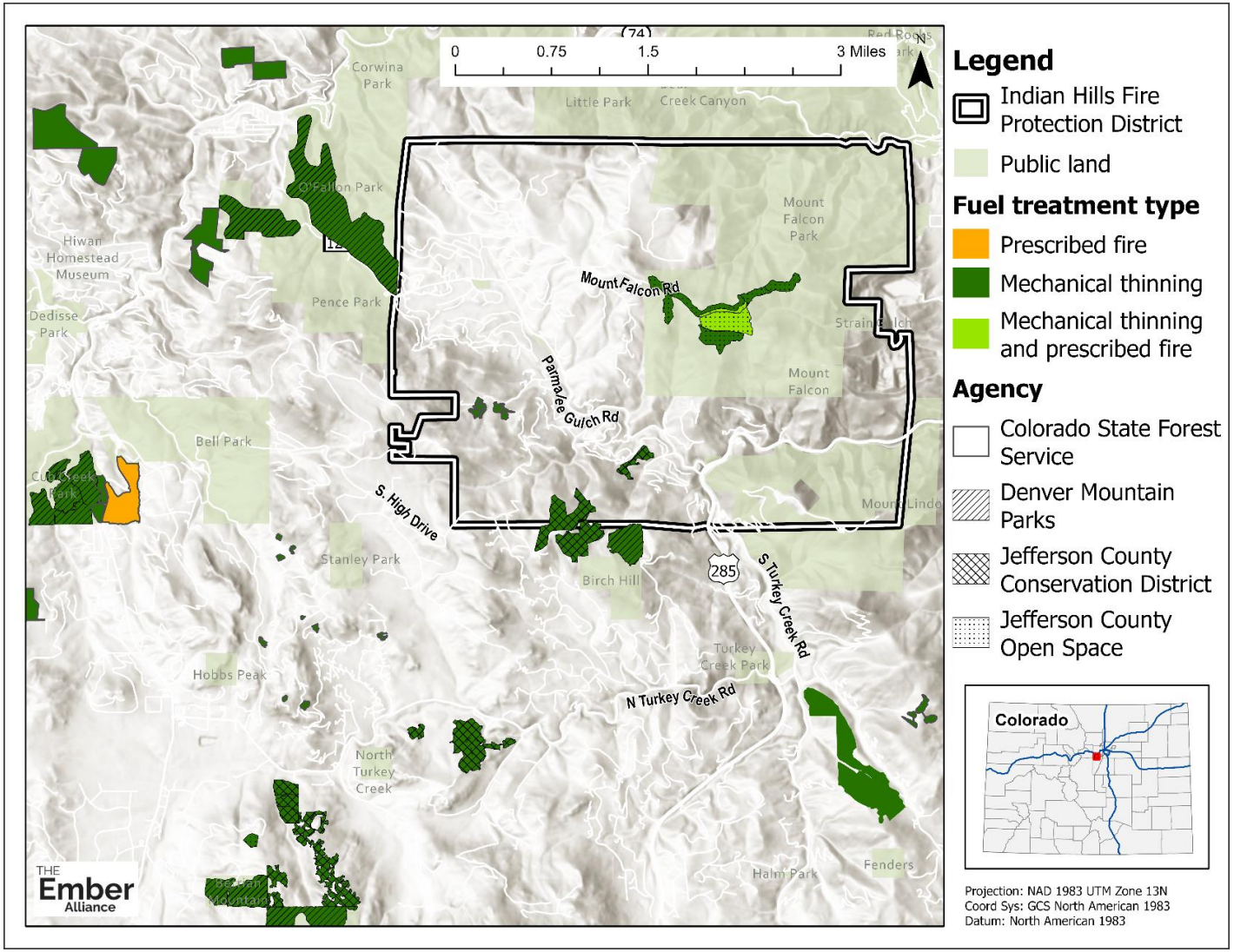


Figure 2.g.2. *Locations of forest management treatments and wildfires in and around the IHFPD from 1995 - 2020 conducted by Colorado Parks and Wildlife, Colorado State Forest Service, Jefferson County Open Space, Denver Mountain Parks, and Jefferson Conservation District. Source: Colorado Forest Restoration Institute through 2020; Geneva Glen Camp through 2022. Visit the IHFPD CWPP Map Experience for an interactive version of this map.*

3. Becoming a Fire Adapted Community

It is recommended that the IHFPD, residents, and community organizations embrace the concept of Fire Adapted Communities (FAC), which is defined by the National Wildfire Coordinating Group as "a human community consisting of informed and prepared citizens collaboratively planning and taking action to safely coexist with wildland fire". This concept can guide residents, fire practitioners, and communities through a holistic approach to become more resilient to fire (**Figure 3.1**).

Your community's CWPP sets the stage for fire adaptation, and the next step is on-the-ground action and an ongoing commitment to risk mitigation at all levels of the community, from individual homeowners to neighborhoods to the IHFPD to land managers and other partners. This section of the CWPP includes recommendations and resources for mitigating wildfire risk and enhancing emergency preparedness. The IHFPD and public land managers have an important role to play in implementing the recommendations in this CWPP, and they have made commitments to take on-the-ground action as outlined in **Section 4.**

Individual homeowners, neighborhoods, and community groups also have a vital role to play in addressing shared wildfire risk. Action and community-building centered around mitigation have reduced wildfire risk and increased community resilience across the mountain west. Mitigation work by residents can spur mitigation by their neighbors (Brenkert-Smith et al., 2013). The cumulative impact of linked defensible space across private properties can improve the likelihood of home survival and protect firefighters during wildfire events (Jolley, 2018; Knapp et al., 2021).

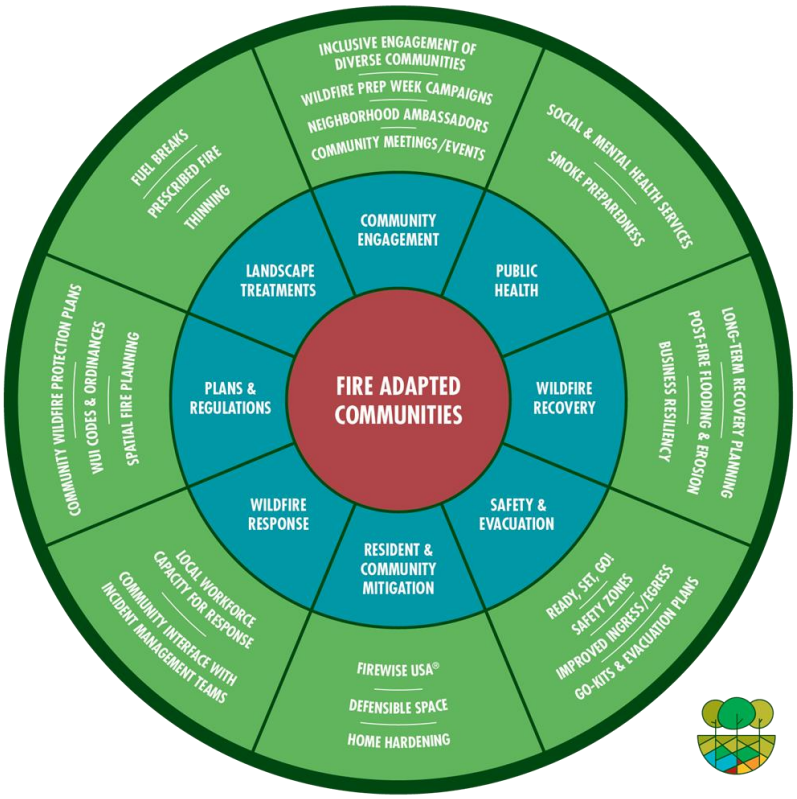


Figure 3.1. *The Fire Adapted Communities graphic provides specific programs and activities that communities can take to reduce their wildfire risk and increase their resilience Source: [Fire Adapted Community Learning Network](#).*

3.a. Individual Recommendations

Mitigate the Home Ignition Zone

During catastrophic wildfires, property loss happens mostly due to conditions in the **home ignition zone** (HIZ). The home ignition zone includes your home and other structures (e.g., sheds and garages) and area within 100 feet of each structure. Firefighter intervention, adequate defensible space, and home hardening measures were common factors for homes that survive major wildfires (IIBHS, 2019; Maranghides et al., 2022). Research following the 2018 Camp Fire showed that homes were more likely to burn down when they were close to other structures that had also burned, and when they had combustible materials (firewood or propane tanks) near the home (Knapp et al., 2021).

You can increase the likelihood that your home will survive a wildfire and help protect the safety of firefighters by creating defensible space, replacing, or altering building materials to make your home less susceptible to ignition, and taking steps to increase firefighter access along your driveway.

It is important for residents to work together as a community to mitigate shared wildfire risk in the HIZ. Structure-to-structure ignition is a major concern in WUI communities and can cause substantial property loss. Neighbors can increase their homes' chances of survival during a wildfire if they work together to reduce hazards in their overlapping defensible space.

Defensible space is the area around a building where vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of fire and reduce exposure to radiant heat and direct flame. It is encouraged that residents develop defensible space so that during a wildfire their home can stand alone without relying upon limited firefighter resources due to the great reduction in hazards they have undertaken.

Home hardening is the practice of making a home less likely to ignite from the heat or direct contact with flames or embers. It is important to remember that embers can ignite homes even when the flaming front of a wildfire is far away. Home hardening involves reducing this risk by changing building materials, installation techniques, and structural characteristics of a home. Home hardening measures are particularly important for WUI homes; 50 to 90% of homes ignite due to embers rather than radiant heat during wildfires (Babrauskas, 2018; Gropp, 2019).

Defensible space allowed firefighters to protect this home during the 2016 Cold Springs Fire near Nederland, CO. Photo credit: Wildfire Partners.

Fortunately, many residents in the IHFPD have already started taking actions to mitigate their home ignition zone (**Figure 3.a.1**). Over 90% of residents who responded to the CWPP survey have removed trees or low limbs on their property and 84% of residents annually remove debris from around their homes. Only 47% have replaced their roofs with less flammable materials, but most newer homes in the IHFPD already have ignition-resistant roofs. Residents should follow the defensible space and home hardening recommendations outlined below to continue increasing their home's chances of surviving a wildfire.

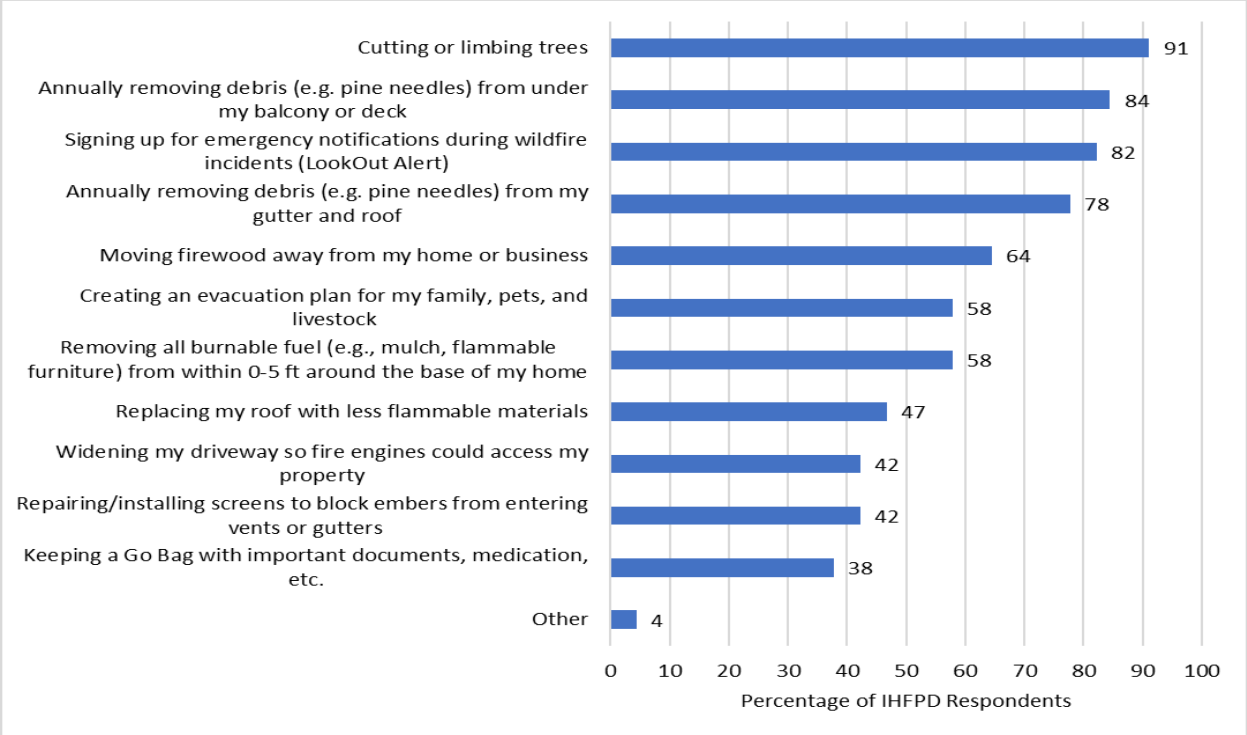


Figure 3.a.1. *Percentage of IHFPD residents who responded to the CWPP survey and have completed different actions to mitigate risk in their home ignition zone. See* ***Appendix C*** *for a full summary of survey findings.*

Some homes in the IHFPD have exemplary defensible space with mowed grass near structures, trees limbed and not overhanging roofs, and non-flammable barriers within home ignition zone 1. Photo credit: The Ember Alliance.

Defensible Space

Defensible space creates a buffer between your home and grass, trees, and shrubs that could ignite during a wildland fire. Defensible space can slow the spread of wildfire, prevent direct flame contact, and reduce the chance that embers will ignite material on or near your home (Hakes et al., 2017). Substantially reducing vegetation within the HIZ and removing vegetation that overhangs decks and roofs can reduce structure loss, especially for homes on slopes (Syphard et al., 2014).

Do not count on firefighters staying to defend your home—your home should be able to survive a wildfire on its own. There are never enough firefighters to stay and defend every single home during large incidents. Properties that are not defensible will not often receive firefighter resources due to unsafe conditions and the higher likelihood of home loss.

Defensible space is divided into multiple zones around a home, and recommended practices vary among zones. The Colorado State Forest Service (CSFS) defines zone one as 0 to 5 feet from the home, zone two as 5 to 30 feet from the home, and zone three as 30 to about 100 feet from the home (**Figure 3.a.2**). Some organizations call zone one the "noncombustible zone" (0 to 5 feet from the home) and zone two the "lean, clean, and green zone" (5 to 30 feet from the home).

Property owners should establish defensible space around each building on their property, including campers / RVs, detached garages, storage buildings, barns, and other structures. RVs are highly flammable and can emit embers that might ignite nearby homes and vegetation. Removing all vegetation under and around campers in HIZ 1 is crucial. Campers / RVs, boats, detached garages, storage buildings, barns, and other large structures should be placed at least 50 feet away from primary structures to prevent structure-to-structure fire spread (Maranghides et al., 2022).

A 2021 study from the University of Colorado-Boulder showed that homeowners living in the WUI in Bailey, CO typically underestimated the level of risk their home is at due to wildfire, and tended to overestimate the amount of work they have done to protect their property (Simpkins, 2021). Make sure you are informed about best practices for protecting your home. See **Table 3.a.1** and the CSFS publication The Home Ignition Zone for recommendations. **Section 4.c.** includes specific recommendations for home ignition zone 3 by forest type.

Some homeowners in the WUI are concerned that removing trees will destroy the forest and reduce the aesthetic and monetary value of their property. In fact, many dense ponderosa pine forests are unhealthy and greatly diverged from historical conditions that were maintained by frequent wildfires (**Figure 2.e.1**). The reality is that nothing will decrease the aesthetic and monetary value of your home as much as a high-severity wildfire burning all the vegetation in the community, even if your home survives the fire. Forest management can look messy and destructive in the first years following treatment; however, grasses, shrubs, and wildflowers will respond to increased light availability after tree removal and create beautiful ecosystems with lower fire risk (**Figure 3.a.4**). It might even be said that the more trees you cut, the more trees you save from wildfire.

Many property owners enjoy their land even more after conducting effective fuel treatments. Removing trees can open incredible views of mountains, rivers, and rock formations, and wildlife are often attracted to forests with lower tree densities and a greater abundance of understory plants. Reducing fuel loads and increasing the spacing between trees increases the chance that your home and your neighbors' homes will survive a wildfire, and most importantly, it increases the safety of wildland firefighters working to protect your community.

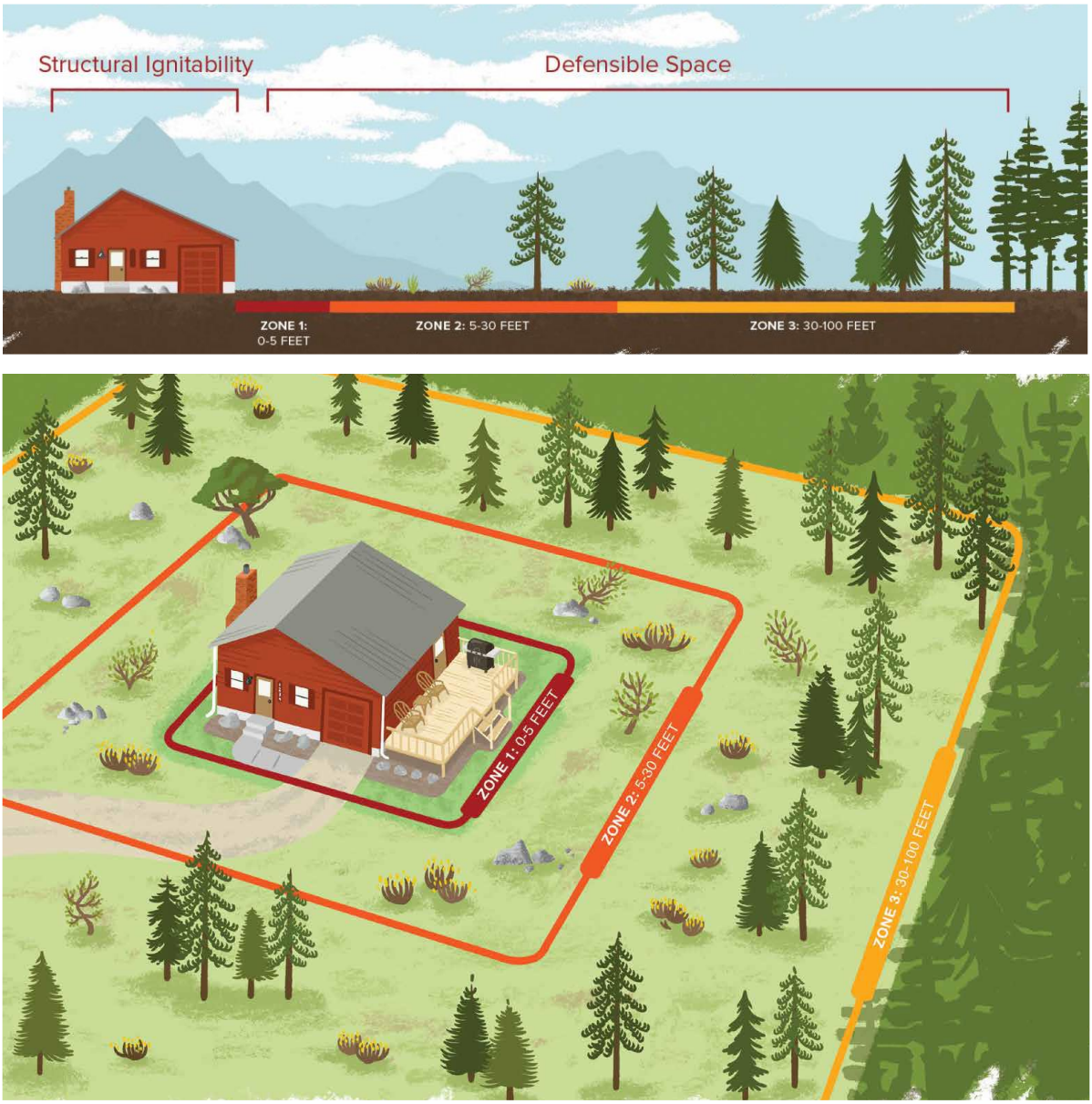


Figure 3.a.2. *Home ignition zones recommended by the Colorado State Forest Service. Using ignition-resistant building materials and removing burnable fuel around primary structures, outbuilding such as sheds, and campers / RVs is crucial for increasing your home's chance of surviving a wildfire and creating safe conditions for wildland firefighters. Source: Colorado State Forest Service, The Home Ignition Zone.*

Table 3.a.1. *Home ignition zone recommendations based on the CSFS publication The Home Ignition Zone. This is not an all-inclusive list of activities. Specific measures will depend on the placement and condition of your property.* ***Section 4.c.*** *includes specific recommendations for zone 3 by forest type.*

Zone 1: 0 to 5 feet from your home – the noncombustible zone.
Goal: Prevent flames from having direct contact with your home.
• Create a noncombustible border 5 feet around your home. Remove all vegetation and replace flammable wood chips or mulch with alternatives like dirt, stone, flagstone, concrete, or gravel. Research shows that the worst material to use in zone 1 are shredded rubber, pine needles, and shredded western red cedar due to their high flammability (Quarles and Smith, 2011). • Remove branches that hang over your roof and drop needles onto your roof and remove all fuels within 10 feet of the chimney. • Remove combustible materials (dry vegetation, wooden picnic tables, juniper shrubs, etc.) from underneath, on top of, or within 5 feet of decks, overhangs, windows, and doors. • Annually remove dead or dry leaves, pine needles, and dead plants within 5 feet of your home and off your deck, roof, and gutters. Farther than 5 feet from structures, raking material will not significantly reduce the likelihood of ignition and can negatively affect other trees. • Move firewood or other combustible materials to Zone 3. • Do not use space under decks for storage.

Zone 2: 5 to 30 feet from your home – the lean, clean, and green zone.
Goal: Slow the movement of flames approaching your home and lower the fire intensity.
• Irrigate and mow grasses to 4 inches tall or less. If you are unable to irrigate, replace dry grasses with Firewise Plant Materials that are more drought tolerant and less flammable. • Remove any accumulated surface fuels such as logs, branches, slash, and mulch. • Remove all common junipers because they are highly flammable and tend to hold a layer of flammable material beneath them. Landscape with plants that have more fire-resistant attributes, like short-statures, deciduous leaves, and higher moisture content. See Firewise Plant Materials from Colorado State University Cooperative Extension for suggestions. • Remove enough trees to create at least 10 feet* of space between crowns. Measure from the outermost branch of one tree to the nearest branch on the next tree. Create even more space between trees if your home is on a slope (**Table 3.a.2**). See **Figure 3.a.3** for how to measure crown spacing. • Favor the retention of aspen trees because this species naturally has high fuel moisture, no low branches, and smooth bark, making them less likely to ignite than conifer trees. • Remove ladder fuels under remaining trees. This is any vegetation that can bring fire from the ground up into taller fuels. • Remove limbs so branches do not hang below 6 feet above the ground, ideally not below 10 feet above the ground. See **Figure 3.a.3** for a depiction of how to measure limb height. • Keep spacing between shrubs at least 2-3 times their height. • Relocate wood piles and propane tanks to Zone 3. • Remove stressed, diseased, dead, or dying trees and shrubs. This reduces the amount of vegetation available to burn and improves forest health. • Keep shrubs at least 10 feet* away from the edge of tree branches.

Zone 3: 30 to 100 feet from your home
If you live on a slope, this zone should be larger due to potential extreme fire behavior.

Goal: Slow movement of flames, move fire to the ground, reduce ember production.

- Store firewood and propane tanks at least 30 feet away and uphill from your home and away from flammable vegetation. Store even farther away if your home is on a slope.
- Move campers / RVs, boats, detached garages, storage buildings, barns, and other large structures at least 50 feet away from your home.
- Mow or trim grasses to maximum height of 6 inches. Grasses can be taller in zone 3 than zone 2 because of the greater distance from your home, but shorter grass is always better for reducing potential flame lengths and therefore radiant heat exposure.
- Remove enough trees to create at least 6- to 10-foot spacing* between the outermost branches of remaining trees. Create even more space between trees if your home is on a slope (**Table** 3.a.2). See **Figure 3.a.3** for a depiction of how to measure crown spacing.
- Favor the retention of aspen trees because this species naturally has high fuel moisture, no low branches, and smooth bark, making them less likely to ignite than conifer trees.
- Remove limbs so branches do not hang below 6 feet above the ground, ideally not below 10 feet above the ground. See **Figure 3.a.3** for a depiction of how to measure limb height.
- Remove shrubs and saplings that can serve as ladder fuels.
- Remove heavy accumulations of dead trees and branches and piles of fallen leaves, needles, twigs, pinecones, and small branches. Thin trees to increase spacing and remove ladder fuels to reduce the likelihood of torching, crown fires, and ember production.
- Consult with a qualified forester to develop a plan to manage your property to achieve fuel reduction and other goals, such as creating wildlife habitat. Follow principles of ecological restoration as outlined in **Section 4.c.**

*Spacing recommendations are a general guideline and should be increased for properties on steeper slopes. Reach out to the CSFS, Jefferson Conservation District, or other forestry professionals to develop a plan for mitigating wildfire risk on your property.

Aspen trees naturally have high fuel moisture, no low branches, and smooth bark, making them less likely to ignite than conifer trees. Retaining small groups of aspen trees is acceptable in HIZ 2—just remember to rake up dry leaves that fall onto your roof or on the ground within 5 feet of your home. Photo credit: Fire Adapted Colorado.

Table 3.a.2. *Minimum recommended spacing between tree crowns and shrubs is greater for properties on steeper slopes due to the exacerbating impact of slope on fire behavior (Dennis, 2003).*

Percent slope	Minimum spacing between tree crowns	Minimum spacing between shrubs / small clumps of shrubs
0 to 10 %	10 feet	2.5 x shrub height
11 to 20%	15 feet	3 x shrub height
21 to 40%	20 feet	4 x shrub height
>40%	30 feet	6 x shrub height

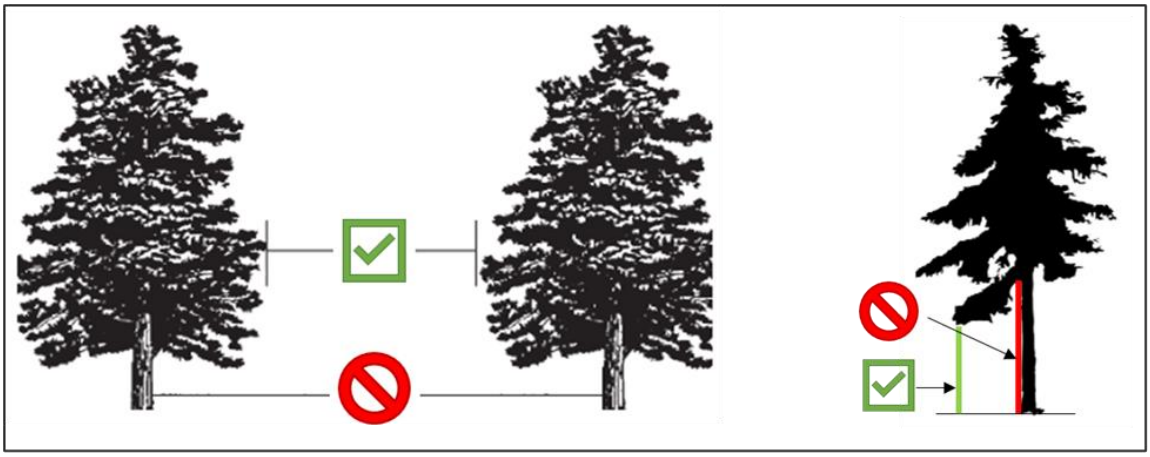


Figure 3.a.3. *Spacing between tree crowns is measured from the edge of tree crown to tree crown, NOT from tree stem to tree stem (left). Height of limbs above the ground is measured from the ground to the lowest point of the limb, NOT from where the limb attaches to the tree (right).*

Some homeowners in the WUI are concerned that removing trees will destroy the forest and reduce the aesthetic and monetary value of their property. In fact, many dense mixed-conifer forests are unhealthy and greatly diverged from historical conditions that were maintained by frequent wildfires (**Figure 2.e.1**). The reality is that nothing will decrease the aesthetic and monetary value of your home as much as a high-severity wildfire burning all the vegetation in the community, even if your home survives the fire. Forest management can look messy and destructive in the first years following treatment; however, grasses, shrubs, and wildflowers will respond to increased light availability after tree removal and create beautiful ecosystems with lower fire risk (**Figure 3.a.4**).

According to the Director for the Jefferson Conservation District, many residents enjoy their land even more after conducting effective fuel treatments. Removing trees can open incredible views of mountains, rivers, and rock formations, and wildlife are often attracted to forests with lower tree densities and a greater abundance of understory plants. Many residents feel safer in a forest that is less dark and more open, and they rest easier knowing firefighters would have a greater chance of safely defending their home. It might even be said that the more trees you cut, the more trees you save from wildfire. Reducing fuel loads and increasing the spacing between trees also increases the chance that your home and your neighbors' homes will survive a wildfire**.** See **Section 4.c.** for more information on treatments that achieve ecological and fuel reduction objectives.

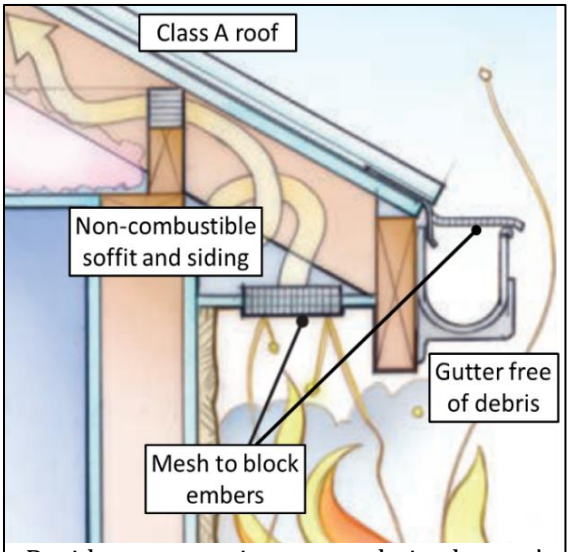
Figure 3.a.4. *Grasses, shrubs, and wildflowers quickly respond to increased light availability after tree removal, resulting in beautiful ecosystems with lower fire risk. The green star in each photo indicates the same tree. Image sizes vary due to the use of different cameras over the years. Photo credit: Jefferson Conservation District.*

Home Hardening

Home hardening involves modifying your home to reduce the likelihood of structural ignition. Almost 70% of homes in the IHFPD are at risk of long-range embers, and over 20% are at risk of radiant heat from burning vegetation under severe fire weather conditions (**Figure 2.f.5**). Risk to ignition from radiant heating is likely higher than estimated by this analysis due to the abundance of vegetation in many HIZs around the community. Homes in denser neighborhoods are also at risk of short-range embers from nearby homes, which could lead to structure-to-structure ignitions.

Buildings cannot be made fireproof, but the chance of your home surviving wildfires increases when you reduce structural ignitability through home hardening in tandem with the creation and maintenance of defensible space. Research from the Insurance Institute for Business & Home Safety (IIBHS) clearly illustrates the benefits of home hardening for reducing the chance of home ignition from embers (watch a video of the research here). **Figure 3.a.5** depicts important home hardening measures.

Roofs, vents, windows, exterior siding, decks, and gutters are particularly vulnerable to wildfires. Research on home survival during wildfires demonstrates that enclosed eaves and vent screens can reduce the penetration of wind-born embers into structures (Hakes et al., 2017; Syphard and Keeley, 2019). According to the CWPP survey, **very few residents in the IHFPD have installed screens to reduce ember penetration into their home (*Figure 3.a.1*), and this is a low-cost action that all residents should consider.**



Residents can increase their homes' chance of survival by making it harder for embers to enter and ignite their homes (image from *Healthy Building Science*).

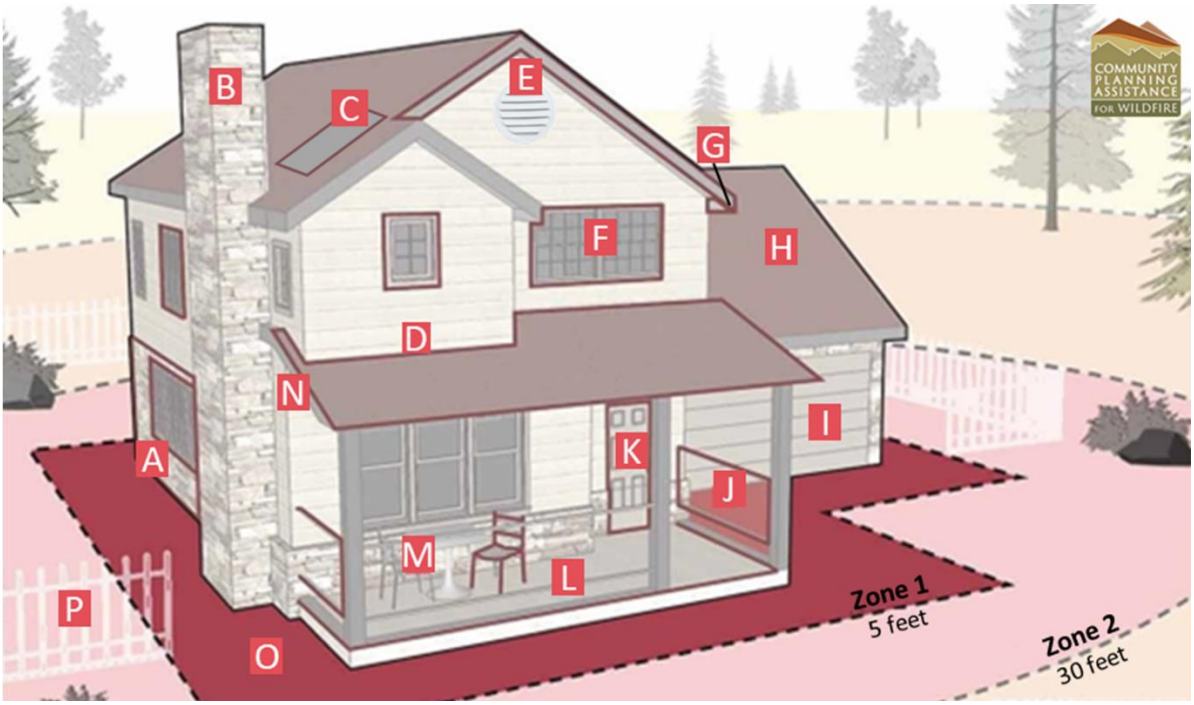
Multi-pane windows have greater resistance to radiant heat. Windows often fail before a home ignites, providing a direct path for flames and airborne embers to enter a home (CSFS, 2021).

It is important to replace wood or shingle roofs with noncombustible materials[1] such as composite, metal, or tile. Ignition-resistant or noncombustible siding and decking further reduce the risk of home ignition, particularly when homes also have a 5-foot noncombustible border of dirt, stone, or gravel. Non-wood siding and decking are often more durable and require less routine maintenance.

Residents should also consider replacing wooden fences with noncombustible materials and keeping fences at least 8 feet away from the home. Keep double combustible fences at least 20 feet away from the home. Fences can serve as pathways for wildfire to travel between vegetation and structures and from structure to structure (Maranghides et al., 2022).

There are many low-cost actions you can start with to harden your home (see **Table 3.a.3**). Keep home-hardening practices in mind and use ignition-resistant materials if you replace a hail-damaged roof or remodel your home. In January 2020, Jefferson County approved new building construction regulations for homes above 6,400 feet in elevation, and the Jefferson County Department of Development and Transportation provides a list of approved building materials to help address the high potential for home loss in the WUI. New construction and replacement construction that require a building permit must comply with the new building standards.

[1] See the **Glossary** on page 142142 for the definition of terms used the describe the performance of building materials when exposed to fire (e.g., wildfire-resistant, ignition-resistant, and noncombustible).



Low-cost actions:

- **B.** Cover chimneys and stovepipe outlets with 3/8th to ½ inch corrosion-resistant metal mesh.
- **C.** Minimize debris accumulation under and next to solar panels.
- **E.** Cover vent openings with 1/16th to 1/8th inch corrosion-resistant metal mesh. Install dryer vents with metal flappers and keep closed unless in use.
- **G.** Clear debris from roof and gutters regularly.
- **I.** Install metal flashing around and under garage doors that goes up at least 6 inches inside and outside the door.
- **J.** Use noncombustible lattice, trellis, or other decorative features.
- **K.** Install weather stripping around and under doors.
- **L.** Remove combustible materials from underneath, on top of, or within 5 feet of deck.
- **M.** Use noncombustible patio future.
- **N.** Cover all eaves with screened vents.
- **O.** Establish and maintain a 5-foot noncombustible buffer around the home.

Actions to plan and save for:

- **A.** Use noncombustible or ignition resistant siding and trim (e.g., stucco, fiber cement, fire-retardant treated wood) at least 2 feet up around the base of your home.
- **C.** Use multipaned glass for skylights, not materials that can melt (e.g., plexiglass), and use metal flashing.
- **D.** Install a 6-inch vertical noncombustible surface on all gables above roofs.
- **F.** Install multi-pane windows with at least one tempered-glass pane and metal mesh screens. Use noncombustible materials for window frames.
- **G.** Install noncombustible gutters, gutter covers, and downspouts.
- **H.** Install ignition-resistant or noncombustible roofs (composite, metal, or tile).
- **I.** Install 1-hour fire rated garage doors.
- **K.** Install a 1-hour fire rated doors.
- **L.** Use ignition-resistant or noncombustible decking. Enclose crawl spaces.
- **N.** Use noncombustible eaves.
- **P.** Replace wooden fences with noncombustible materials and keep at least 8 feet away from the home. Keep double combustible fences at least 20 feet away from the home.

Figure 3.a.5. *A home can never be made fireproof, but home hardening practices decrease the chance that flames, radiant heat, and embers will ignite your home. Infographic by Community Planning Assistance for Wildfire with modifications to include information from CALFIRE 2019 and Maranghides et al. 2022.*

Annual Safety Measures and Home Maintenance in the WUI

Reviewing safety protocols, creating defensible space, and hardening your home are not one-time actions, but part of *annual* home maintenance when living in the WUI. During a wildland fire, homes that have clear defensible space are identified as sites for wildland firefighters to engage in structure protection, and homes that are not safely defensible will not usually receive firefighter resources.

The **Colorado State Forest Service** provides the following recommendations for annual activities to mitigate risks and increase your wildfire preparedness:

- ✓ Check fire extinguishers to ensure they have not expired and are in good working condition.
- ✓ Review your family's evacuation plan and practice family fire and evacuation drills.
- ✓ Verify that your home telephone number, cell phone, and/or email are properly registered for emergency notifications. Visit the Jefferson County Sherrif's website on emergency notifications for more information.
- ✓ Review the contents of your "go-bag" and make sure it is packed and ready to go. Visit the Rotary Wildfire Ready website to learn about preparing go-bags. Your go-bag should include supplies to last at least three days, including cash, water, clothing, food, first aid, and prescription medicines for your family and pets. Keep important documents and possessions in a known and easily accessible location so you can quickly grab them during an evacuation.
- ✓ Pay attention to red flag-day warnings from the National Weather Service and stay vigilant. Ensure your family is ready to go in case of an emergency.
- ✓ Walk your property to identify new hazards and ways to maintain and improve current defensible space. Take pictures of your defensible space to help you monitor regrowth and determine when additional vegetation treatments are necessary.
- ✓ Clear roofs, decks, and gutters of pine needles and other debris. Remove all pine needles and flammable debris from around the foundation of your home and deck. Remove trash and debris accumulations within 30 feet of your home. Repeat throughout the year as necessary.
- ✓ Properly thin and prune trees and shrubs that have regrown in home ignition zones 1 and 2 (0-5 feet and 5-30 feet from your home). Remove branches that overhang the roof and chimney. Prune trees and shrubs that are encroaching on the horizontal and vertical clearance of your driveway.
- ✓ Mow grass to a height of 4 inches or less within 30 feet of your home, camper / RV, sheds, and barns. If possible, keep your lawn irrigated, particularly within 30 feet of your home. Consider replacing dry grasses with Firewise Plant Materials that are more drought tolerant and less flammable.
- ✓ Check the visibility of your address and remove vegetation that obscures it.
- ✓ Dispose of leaves, needles, and branches during slash drop-off dates organized by Jefferson County. See the County Slash Collection website for more information.
- ✓ Check screens over chimneys, eaves, and vents to make sure they are in place and in good condition.
- ✓ Ensure that an outdoor water supply is available for responding firefighters. Put a hose and nozzle in a visible location. The hose should be long enough to reach all parts of your home.

Mitigation Barriers and Opportunities

Homeowners and residents in the WUI share concerns about mitigating risk and maintaining safe conditions in their home ignition zone. **Table 3.a.3** proposes several opportunities to address these challenges.

Table 3.a.3. *Common concerns from residents in the WUI, and potential solutions to encourage mitigation measures in the home ignition zone.*

Concern	Potential solutions
I don't know where to start with creating defensible space.	Review **Figure 3.a.2**, **Table 3.a.1**, and read the CSFS publication *Protecting your home from wildfire: Creating wildfire-defensible zones* for mitigation recommendations. Visit Rotary Wildfire Ready and the Colorado State Forest Service for useful information and tips about defensible space creation. Talk to neighbors who have taken steps to mitigate fire risk on their property to learn what they did to protect their home. Reach out to Indian Hills Fire Rescue, Colorado State Forest Service, or Jefferson Conservation District to learn about defensible space and home hardening tactics from their qualified specialists.
I don't have the resources to invest in defensible space.	Creating adequate defensible space can take years and a significant financial investment. Fortunately, there are **effective, low-cost measures** that residents can start with: ✓ Annually remove leaves, needles, and other vegetation from roofs, gutters, decks, and around the base of homes. ✓ Use hand tools like a pole saw to remove tree branches that hang less than 10 feet above the ground. ✓ Remove combustible materials (dry vegetation, wooden picnic tables, juniper shrubs, etc.) from underneath, on top of, or within 5 feet of decks. ✓ Remove vegetation and combustible materials within 5 feet of windows and doors. ✓ Replace wood mulch within 5 feet of all structures with dirt, stone, or gravel. ✓ Remove downed logs and branches within 30 feet of all structures. ✓ Participate in community slash pickup dates organized by Jefferson County. See https://www.jeffco.us/2493/Slash-Collection for more information. ✓ Apply for cost-sharing grants with your neighbors to subsidize the creation of defensible space (see **Section 3.e. .** for potential funding sources). ✓ Research tax credits that will offset the costs or the work you want to do from the Colorado Department of Revenue.
I don't have the resources to invest in home hardening.	Retrofitting an existing home to be ignition-resistant can be expensive, particularly actions like replacing flammable roofs and siding. Some of these costs can be divided and prioritized into

	smaller projects. If you are building a new home, the cost of using ignition-resistant materials is roughly the same as using traditional building materials (Quarles and Pohl, 2018). Ignition-resistant features often come with additional benefits, such as greater durability and reduced maintenance. Many home hardening practices are required in Jefferson County per building construction regulations approved in January 2020 for homes above 6,400 feet in elevation. New construction and replacement construction that requires a building permit must comply with the new building standards. Fortunately, there are **effective, low-cost measures** that residents can start with to harden their homes: ✓ Install noncombustible metal gutter covers. ✓ Cover vent openings with 1/16th- to 1/8th-inch corrosion-resistant metal mesh. ✓ Cover chimney and stovepipe outlets with 3/8th- to ½-inch corrosion-resistant metal mesh to prevent embers from escaping and igniting a fire. ✓ Caulk and plug gaps greater than 1/16th-inch in siding or around exposed rafters. ✓ Install weather stripping around and under garage doors to reduce gaps to less than 1/16th-inch. ✓ Remove combustible materials from underneath, on top of, and within 5 feet of a deck. ✓ Replace wood mulch within 5 feet of all structures with noncombustible products like dirt, stone, or gravel. ✓ Store all combustible and flammable liquids away from potential ignition sources. ✓ Keep a fire extinguisher and tools such as a shovel, rake, bucket, and hose available in your garage for fire emergencies. Suggestions from CAL FIRE's 2020 Low Cost Retrofit List.
I am afraid that removing trees will destroy the forest and reduce the aesthetic and monetary value of my property.	The reality is that nothing will decrease the value of your home as much as a high-severity wildfire burning all the vegetation in the community, even if your home survives the fire. Drive around the community and look for homes that have followed the guidelines in **Figure 3.a.2** and **Table 3.a.1**. Some properties in the IHFPD have exemplary defensible space and beautiful landscaping at the same time. Read Firewise Plant Materials from Colorado State University Cooperative Extension and Firescaping from FIRESafe MARIN for suggestions on beautiful, fire-resistant landscaping. As an added benefit, fire-resistant landscaping is often more drought tolerant. Learn about the ecology of frequent-fire forests along the Colorado Front Range by reading *Back to the future: Building resilience in Colorado Front Range forests using research findings and a new guide*

	for restoration of ponderosa and dry-mixed conifer landscapes (Miller, 2018). Restored ecosystems can be aesthetically pleasing, benefit wildlife and light-loving wildflowers and grasses, and protect your home from high-severity wildfires.
My neighbors haven't mitigated risk on their property.	Some residents in the IHFPD are rightfully concerned about high hazards on their neighbors' properties. Your home ignition zone might overlap with your neighbor's property. Given the high fire risk in the area, it is important that residents across the IHFPD create defensible space and harden their homes. Ideas to inspire action by your neighbors include: • Inviting your neighbors over for a friendly conversation about the risk assessment in this CWPP. Review resources about defensible space together, discuss each other's concerns and values, and develop joint solutions to address shared risk. • Organizing walking tours to visit the property of residents with exemplary defensible space. Witnessing the type of work that can be done, and seeing that a mitigated property can still be aesthetically pleasing, can encourage others to follow suit.

Fire-resistant landscaping in zone 1 can be aesthetically pleasing and more drought tolerant, requiring less watering during the summer. Limbed and thinned trees in zone 2 (as seen in the background of this photo) can create beautiful, open conditions that allow understory vegetation to flourish under higher light conditions and provide habitat for wildlife. Photo credit: Washington State University Master Gardener Program.

Evacuation Preparedness

The best way to get out quickly and safely during an evacuation is to be prepared. Prepare a go-bag and have a family emergency plan **before** the threat of wildfire is in your area. Talk to children and elderly family members about what they would be expected to do. Visit the Rotary Wildfire Ready website to learn about go-bags and evacuation planning. Signing up for local emergency notifications can also help you leave quickly. Residents should register their cell phones and email addresses through Lookout Alert—the official emergency notification system for Jefferson County[1]. See the Jefferson County Sherrif's Office website on emergency notifications for more information.

Evacuation preparedness is the responsibility of each resident in the IHFPD. Unfortunately, only 58% of respondents to the CWPP survey have evacuation plans for their family and only 38% have go-bags at the ready. These are simple and crucial actions that can save lives.

Understand the types of emergency communications you might receive during an incident. The following definitions are provided by the Jefferson County Sherriff's Office:

> **Advisory messages** provide information but do not require any action on your part.
>
> **Instruction messages** provide information AND require you to take some action to be safe. There are three types of standard instructions:
>
> - **Shelter in place:** There is a hazard in your area and you should remain or go indoors, not go outdoors, and not evacuate the area. This may be the safest strategy for hazardous materials, law enforcement, or other incidents wherein an evacuation could actually increase the danger to you.
> - **Pre-evacuation:** There is a hazard in your area that may require you to evacuate in the near future. Everyone should be prepared to leave at a moment's notice. If you feel you are in danger and want to leave, do so. If you need additional time to evacuate, you should consider leaving now. If you need to arrange for transportation assistance, you should do so immediately. If you have livestock or other large animals, you should consider removing them from the hazard area now.
> - **Evacuation:** There is a hazard in your area, and you have been ordered to evacuate immediately. If you need assistance evacuating yourself or need help evacuating animals, call 911. You will be provided the safest escape routes known, so make sure you follow the instructions as other routes may be closed or unpassable. You will also be told where an evacuation point has been established to provide information and safe place if you have nowhere else to go. **Do not delay – evacuation means you need to leave immediately!**

Some residents have family members or neighbors with physical limitations who might struggle to evacuate in a timely manner. Family members or individuals living alone also need to address the unique needs and vulnerabilities that arise from mobility or hearing impairments during an evacuation. Other residents are concerned about school-aged children who might be home alone during an evacuation. Parents should work with their neighbors to develop a plan for how their children would evacuate if they were home alone. Families with these concerns should put extra time into having go bags ready and using the earliest evacuation warnings to leave in the event of a wildfire, rather than waiting for mandatory evacuation orders. Having a plan in place ahead of time can ensure prompt evacuations and save lives during wildfires.

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[1] Lookout Alert is the official emergency notification system for Jefferson County as of January 2023.

Residents with livestock trailers or large camper vehicles should plan to leave during voluntary evacuation notices to allow time for their preparations and create more space on the roads for other residents during a mandatory evacuation. It is important to have a plan for where to take livestock to reduce some of the chaos and uncertainty created by wildfire evacuations. An available resource is the Jefferson County Horse Evacuation Assistance Team (HEAT), which is a large animal rescue team in Jefferson County, Colorado. HEAT provides the highest quality large animal evacuation assistance response for wildland fires and natural disasters; vehicle accidents; entrapments; impounds; cruelty cases; and other animal emergencies and rescues.

Follow evacuation etiquette *to increase the chance of everyone exiting the IHFPD in a safe and timely manner during a wildfire incident:*

- Register for emergency notifications through Lookout Alert for timely information about evacuations. See the Jefferson County Sheriff's Office website for details.
- Leave as quickly as possible after receiving an evacuation notice.
- Have a go-bag packed and ready during the wildfire season, especially on days with red flag warnings.
- Leave with as few vehicles as necessary to reduce congestion and evacuation times across the community.
- Drive safely and with headlights on. Maintain a safe and steady pace. Do not stop to take pictures.
- Yield to emergency vehicles.
- Follow directions of law enforcement officers and emergency responders.

Lookout Alert
EMERGENCY NOTIFICATIONS

Accessibility and Navigability for Firefighters

Address signs

Installing reflective address numbers can save lives by making it easier for firefighters to navigate to your home at night and under smokey conditions. Reflective signs are available from the IHFR ($20 for one-sided signs and $25 for two-sided signs; see IHFR website), making is an easy and inexpensive action you can accomplish to protect firefighters and your family. Mount reflective address signs on noncombustible posts, not on stumps, trees, wooden posts, or chains across driveways. Chains across driveways might be removed during wildfire suppression to facility access to your property. Make sure the numbers are clearly visible from both directions on the roadway.

Driveways

It is important to ensure emergency responders can locate and access your home. Narrow driveways without turnarounds, tree limbs hanging over the road, and lots of dead and down trees by the road may make firefighters choose to not defend your home during a wildfire event (Brown, 1994).

Some roads in the IHFPD have accessibility and navigability issues, such as narrow widths, inadequate vertical clearance for engines, and heavy fuel loading on the sides of the road. These unsafe road and driveway conditions could turn firefighters away from attempting to defend homes. According to the National Fire Protection Association, driveways and roads should have a minimum of 20 feet of horizontal clearance and 13.5 feet of vertical clearance to allow engines to safely access the roads (O'Connor, 2021). Residents should remove trees and low-hanging limbs along driveways to facilitate firefighter access, as well as removing all dead trees that could fall across the driveway and block access.

Where possible, residents should improve roadway access, and where this is not feasible, it is vital that homeowners take measures to harden their home and create defensible space. Some actions to increase access to your home are simple, such as installing reflective address numbers, and others take time and investment, such as widening driveways to accommodate fire engines.

Many driveways within the IHFPD do not meet current access requirements and pose safety issues that are difficult to mitigate. Long, narrow, steep driveways lacking turnarounds, and dense vegetation on the sides of the road can create challenges for emergency response vehicles during wildfires. Home hardening and fuel mitigation are particularly important to reduce wildfire risk around homes with accessibility issues. Photo credit: The Ember Alliance.

Private Water Resources

Water resources to fight fires in the foothills can be scarce, especially during the fire season in late summer and fall. Firefighters are skilled at determining the most beneficial ways to use water to protect structures from an approaching fire. Providing clear access to suitable water resources (e.g., cisterns, water tanks, and ponds) around your home or neighborhood can help them defend your home.

Do not turn sprinklers on around your home as you evacuate. This is counterproductive to protecting your home because continuous use of water far in advance of the fire can drain local wells and cisterns long before the fire reaches your neighborhood. This can leave firefighters with less resources to defend your home, putting their lives and your property at higher risk. Leaving sprinklers out but **turned off** allows the firefighters to determine whether they will be useful or not.

IHFR and IHWD request that residents NOT turn on sprinklers around their homes during wildfires. This significantly drains local water storage capacity and can decrease pressure to fire hydrants. Firefighters will make informed decisions about where to use hydrants, active resident sprinkler systems, and install portable sprinkler systems during incidents.

Prepare personal water resources by making them easily accessible and clearly labelling how to access them. Unlock pump house doors and remove vegetation or other obstructions. If you have a generator, leave it in an accessible location in case power is turned off. Leaving a note on the front door explaining access and providing a cell phone number for questions regarding a homeowner's pump/cistern and generator is helpful to firefighters. Notify the fire department of community cisterns or tanks and ensure they are compatible with their firefighting equipment.

Most importantly, create defensible space around your home and buildings so that water resources can be used effectively. Water is not a reliable resource in the Colorado foothills and mountains. Maintaining a property that requires less water and resources to defend is more likely to survive a fire. See **Table 3.a.1** and **Figure 3.a.5** for guides on defensible space and home hardening recommendations.

Steps to enhance firefighter safety and access to your home:

- ✓ Install reflective address numbers on the street to make it easier for firefighters to navigate to your home under smokey conditions and at night. Make sure the numbers are clearly visible from both directions on the roadway. Use noncombustible materials for your address sign and sign supports. **Installing reflective address numbers can save lives and is inexpensive and easy to accomplish.**
- ✓ Address roadway accessibility for fire engines. Long, narrow, steep, and curving private drives and driveways without turnarounds significantly decrease firefighter access to your property, depending on fire behavior.
- ✓ Fill potholes and eroded surfaces on private drives and driveways.
- ✓ Increase fire engine access to your home by removing trees along narrow private drives and driveways so the horizontal clearance is 20 feet wide, and prune low-hanging branches of remaining trees so the unobstructed vertical clearance is at least 13.5 feet per the National Fire Protection Association (O'Connor, 2021).
- ✓ Park cars in your driveway or garage, not along narrow roads, to make it easier for fire engines to access your home and your neighbors' homes.
- ✓ Clearly mark septic systems with signs or fences. Heavy fire equipment can damage septic systems.
- ✓ Clearly mark wells and water systems. Leave hoses accessible for firefighters to use when defending your home, but **DO NOT** leave the water running. This can reduce water pressure to hydrants across the community and reduce the ability of firefighters to defend your home. Read this post by FIRESafe Marin about why it is dangerous to leave water running when you evacuate during a wildfire.
- ✓ Post the load limit at any private bridges or culverts on your property.
- ✓ Leave gates unlocked during mandatory evacuations to facilitate firefighter entrance to your property.
- ✓ Leave exterior lights on to increase visibility.
- ✓ If time allows, leave a note on your front door confirming that all parties have evacuated and providing your contact name and phone number.

3.b. Neighborhood Recommendations

The CWPP is a useful planning document, but it will only affect real change if residents, neighbors, IHFPD, and agency partners come together to address shared risk and implement strategic projects. This section of the CWPP discusses the concept of linked defensible space and mosaic landscapes and provides relative hazard ratings and specific recommendations for CWPP plan units in the IHFPD. CWPP plan units are groups of neighborhoods with shared fire risk. We encourage residents within CWPP plan units to organize and support each other to effectively reduce wildfire risk and enhance emergency preparedness.

Linked Defensible Space

The home ignition zone of individual residents can overlap that of their neighbors, so wildfire hazards on one property can threaten adjacent properties. Structures that are on fire can emit significant radiant heat and embers and endanger homes and structures near them**.** A vast majority of homes in the IHFPD (85%) could be exposed to short-range ember cast from at least one neighboring home (**see Appendix B Figure B.9**).

Neighbors can increase their homes' chances of survival during a wildfire if they work together to create linked defensible space. Linked defensible space also creates safer conditions and better tactical opportunities for wildland firefighters. According to James White, the Prescribed Fire and Fuels Specialist for the Arapaho/Roosevelt National Forests, "Broadcast burning, mechanical thinning, and other treatments are proven to mitigate wildfire risk, but they are even more effective when we work together to integrate treatments across the landscape, across borders and ownerships" (Avitt, 2021). Defensible space projects that span ownership boundaries are better candidates for grant funding due to their strategic value.

How can you help inspire action by your neighbors? Start by creating defensible space and hardening your own home. Then try the ideas below:

- Invite your neighbors over for a friendly conversation about the risk assessment in this CWPP. Review resources about defensible space together, discuss each other's concerns and values, and develop joint solutions to address shared risk.
- Volunteer with community groups or Indian Hills Fire Rescue to help educate your community about the benefits of defensible space and home hardening.
- Help organize walking tours in your neighborhood to visit the property of residents with exemplary defensible space. Witnessing the type of work that can be done, and seeing that a mitigated property can still be aesthetically pleasing, can encourage others to follow suit.

Mosaic Landscapes

Varied fuel types are known to slow the spread of fire, and heterogeneous landscapes (landscapes with multiple fuel types and trees of different sizes and ages) are more typical of historical forest conditions (Duncan et al., 2015). Creating a mosaic landscape in neighborhoods can help slow fire spread by changing the fuel types as it moves across a hill or valley. A mosaic landscape can be created many ways. For example, a neighborhood could have a few acres of old growth conifer trees next to a couple acres of aspen stands, and a few acres of young regenerating conifer trees by a large grassy meadow. This can be arranged in many ways for aesthetic and tactical purposes, and will resemble a patchwork quilt or mosaic art (**Figure 3.b.1**).

The homes in these patches still need to have adequate defensible space, but this would create a more diverse landscape where fire may move slower as it transitions between forest types and unforested locations like shrublands or meadows. Slower fire movement means firefighters have time to defend more homes in the neighborhood. It also creates a diversity of biomes that both residents and wildlife enjoy.

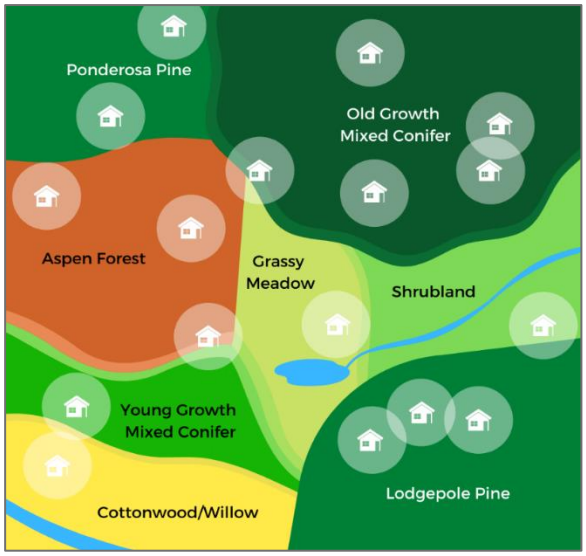


Figure 3.b.1. *Example of a mosaic landscape in a neighborhood. Each home has defensible space around it, and the landscape is varied throughout, providing tactical opportunities for firefighters working to defend homes.*

Relative Risk Ratings by CWPP Plan Unit

CWPP plan units are areas with shared fire risk where residents can organize and support each other to effectively reduce wildfire risk and enhance emergency preparedness. We delineated seven plan units in the IHFPD by considering clusters of addresses, connectivity of roads, topographic features, land parcels, and the type of vegetation available to burn in a wildfire (**Figure 3.b.2**). Amendments were made to boundaries based on local knowledge from the IHFPD.

Colorado CWPPs must include relative risk ratings within fire protection district to help prioritize action. TEA combined on-the-ground observations and summary output from our fire behavior and evacuation analyses to assess hazards in four categories across CWPP plan units: fire risk, fire suppression challenges, evacuation hazards, and home ignition zone hazards (**Figure 3.b.3**). See **Appendix B** for a description of hazard rating methodology. Plan unit hazard ratings are specific to the IHFPD and not suitable for comparing this fire protection district to other communities in Colorado or the United States.

The potential for wildfires to pose a threat to lives and property is high across the IHFPD, but risk is relatively higher in some parts of the district than others. Plan units with higher relative risk are strong candidates for immediate action to mitigate hazardous conditions. However, plan units with moderate relative risk still possess conditions that are concerning for the protection of life and property in the case of a wildfire.

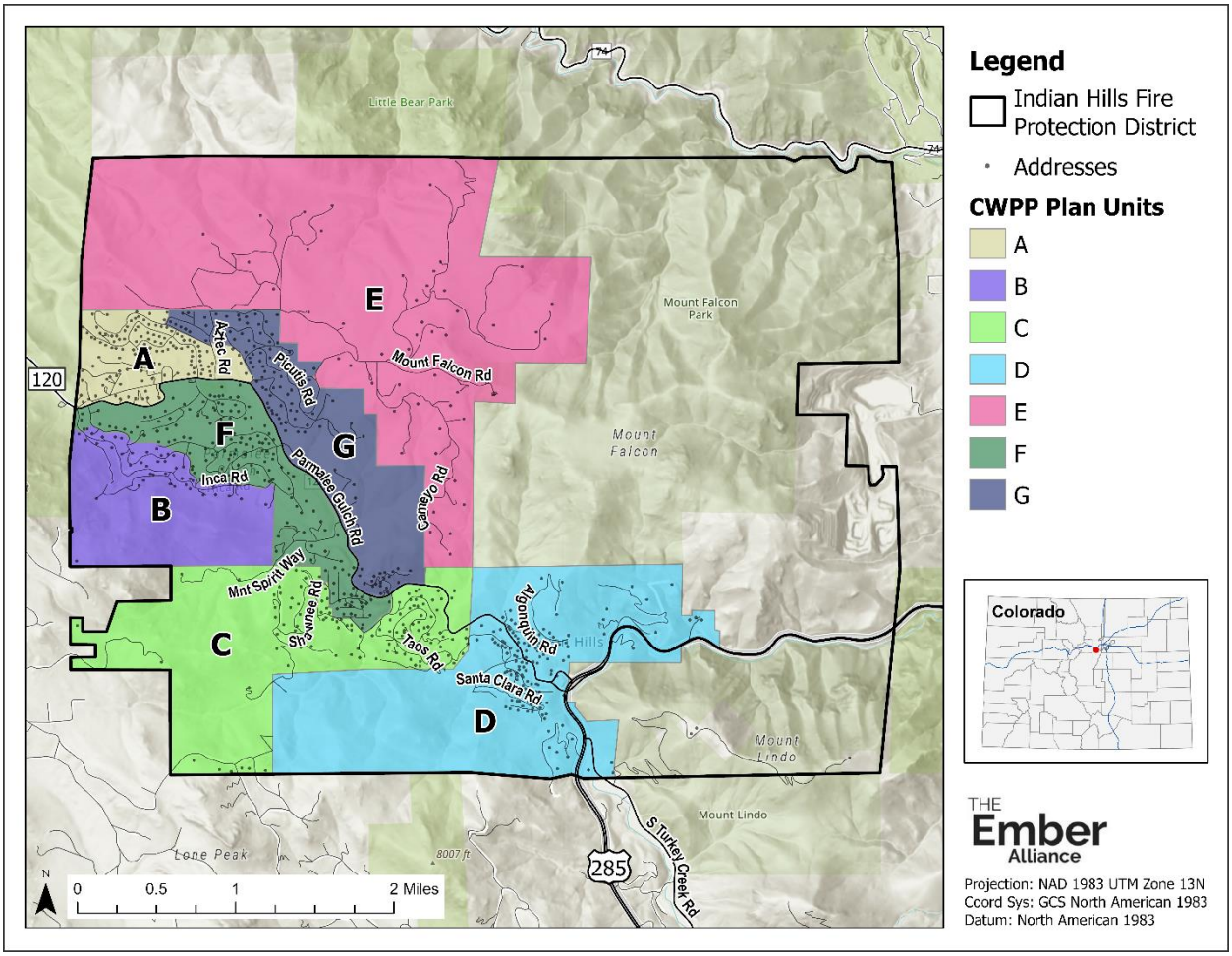


Figure 3.b.2. *CWPP plan units in the IHFPD are areas with shared fire risk where residents can organize and support each other to effectively reduce wildfire risk and enhance emergency preparedness.*

The southwestern portion of IHFPD (plan units B, C, and D) has extreme relative hazard ratings due to the potential for extreme fire behavior in dense forests on steep slopes and an abundance of narrow one-lane roads that could potentially experience non-survivable conditions during wildfires (**Figure 3.b.3**). There are notable hazards in home ignition zones in plan units B, C, and D, including flammable building materials and heavy fuel loads near homes. Suppression challenges are extreme in plan units B, C, D, and E due to limited water sources and the presence of roads and driveways that are inaccessible to Type 3 engines due to low vertical and horizontal clearance, high grades, sharp switchbacks, and an absence of turnarounds or pullouts.

The northwestern portion of IHFPD (plan unit E) also has elevated potential for extreme fire behavior due to dense forest conditions and steep slopes, particularly on adjacent public land. These conditions contribute to extreme evacuation hazards due to an abundance of roadways with potentially non-survivable conditions. However, the overall relative risk in plan unit E is moderate due to the presence of hydrants and other water sources for fire suppression, an abundance of wide roads and driveways that are accessible to Type 3 engines, and a greater proportion of homes with mitigated hazards in the home ignition zones.

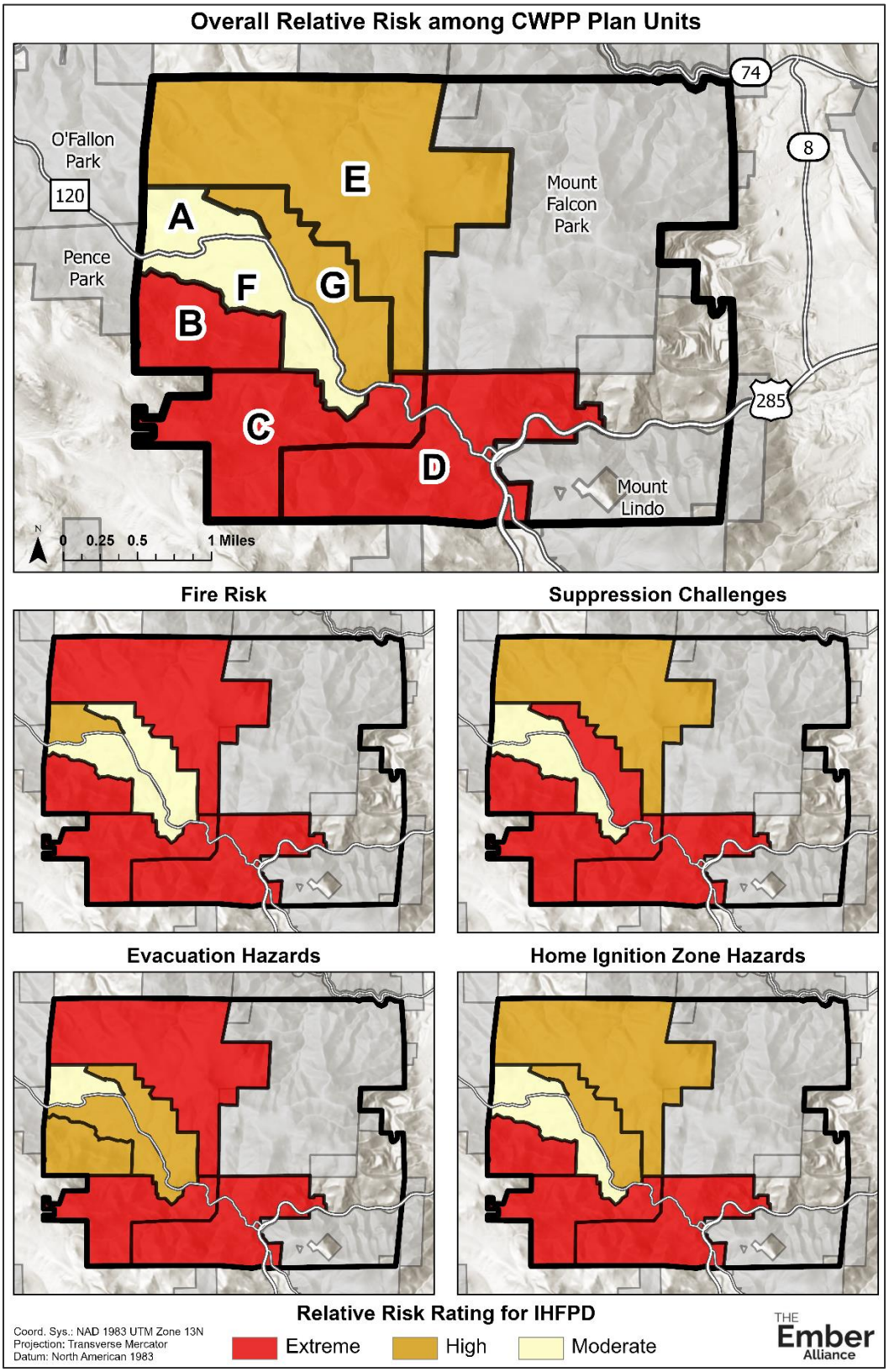


Figure 3.b.3*. Relative risk rating for plan units across the IHFPD. "Moderate" risk is a relative term – all residents within the IHFPD are exposed to elevated fire danger due to topography and fuels in this part of Colorado and should take recommended actions in this CWPP seriously. Visit the IHFPD CWPP Map Experience for an interactive version of this map.*

Priority Action for CWPP Plan Units

Here we describe conditions in each CWPP plan unit from our on-the-ground relative risk rating assessment and include a summary of predicted fire behavior, roadway survivability, and home exposure to radiant heat and short- and long-range embers from burning vegetation (see **Appendix B** for methodology). We also provide priority recommendations for collective action by homeowners to address shared risk and magnify the impact of individual mitigation actions. Guidelines for priority action could be spearheaded by neighborhood ambassadors in each plan unit with support from fellow residents (see **Section 3.d.** for a description of a neighborhood ambassador program recommended for IHFPD). Photos of representative vegetation in each plan unit were taken by TEA during the IHFPD community assessment.

Plan Unit A – Moderate relative risk rating

Predicted wildfire exposure under extreme fire weather in Plan Unit A:

2% of roadways with potentially non-survivable conditions	2% of homes exposed to short-range embers from burning vegetation
2% of homes exposed to radiant heat from burning vegetation	57% of homes exposed to long-range embers from burning vegetation

Vegetation in plan unit A is primarily grassy meadows with widely spaced ponderosa pine trees. Dense ponderosa pine and mixed-conifer forests occur along Pima Road and Tongue Road. Slopes are flat to shallow, except for moderate slopes on the hills traversed by Matterhorn Drive, San Isabel Road, Pima Road, and Tongue Road. Low to moderate fire behavior is predicted for most of the plan unit. However, un-mowed grass can support fast rates of spread. There is a high potential for extreme fire behavior in dense forests on steep slopes to the west of the unit in O'Fallon Park.

Home construction materials are highly mixed across the plan unit. Some homes have ignition-resistant siding (stone, adobe, composite, and treated wood siding), but several homes have flammable siding (untreated wood, plywood, and slab). Most homes have ignition-resistant roofs made from metal, concrete tile, or new asphalt, but they have wooden decks and fences. Wooden fences can serve as a pathway for fire to spread between vegetation, outbuildings, and homes. About

half of the homes in this plan unit have abundant hazards in HIZ 1 and 2, including tree branches overhanging roofs, pine needles accumulating in gutters, and tall, un-mowed grass, shrubs, and trees abutting homes. Many homes have old wooden sheds and other outbuildings within 30 ft of the home; these secondary structures could emit embers and radiant heat that threaten primary structures.

Conditions along almost all roads in this plan unit are predicted to be survivable during wildfires. All roads and most driveways are accessible for Type 3 engines. All roads can accommodate two-way traffic, except for San Isabel Road. Several homes have wooden address signs that could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in plan unit A:

- Remove vegetation along the end of San Isabel Road to reduce the risk of non-survivable conditions during wildfires and increase access for firefighters (see **Figure 3.c.3**).
- Support ecological restoration and fuel mitigation projects by Denver Mountain Parks (DMP) to reduce the potential for extreme fire behavior in O'Fallen Park to the west of plan unit A. Encourage coordination between DMP and private landowners to facilitate access to the priority project area on O'Fallen Park (see project area in **Section 4.b.**).
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved.
- Every homeowner in plan unit A should review and consider actions outlined in **Section 3.a.** Many homes in this plan unit have the potential for ignition from long-range ember cast during wildfires.
- Encourage all residents to develop evacuation plans for their family, sign up for emergency notifications from Jefferson County, and coordinate with neighbors who might need additional support during evacuations.
- Encourage residents to purchase metal, reflective address signs from IHFR (available through the IHFR website) to make it easier for firefighters to locate homes through heavy smoke and at night.

Plan Unit B – Extreme relative risk rating

Predicted wildfire exposure under extreme fire weather in Plan Unit B:

41% of roadways with potentially non-survivable conditions	2% of homes exposed to short-range embers from burning vegetation
24% of homes exposed to radiant heat from burning vegetation	41% of homes exposed to long-range embers from burning vegetation

Much of plan unit B occurs on moderately steep to steep north-facing slopes with dense ponderosa pine and mixed-conifer forests. Douglas-fir saplings are abundant in the understory. Dense forests cover steep slopes in Pence Park to the west of plan unit B. There is a high potential for extreme fire behavior in dense forests with abundant ladder fuels on steep slopes, particularly on hot, dry, and windy days. Grassy meadows with scattered ponderosa pine trees are present at lower elevations in plan unit B along Navajo Road.

Several homes are located mid-slope, which increases their potential exposure to extreme fire behavior. Home construction materials are highly mixed across the plan unit. Some homes have ignition-resistant siding (stone, adobe, composite, and treated wood siding), but over half of homes have flammable siding (untreated wood, plywood, and slab). Most homes have ignition-resistant roofs made from metal, concrete tile, or new asphalt, but they have wooden decks and fences. Wooden fences can serve as a pathway for fire to spread between vegetation, outbuildings, and homes. A vast majority of homes in this plan unit have abundant hazards in HIZ 1 and 2, including tree branches overhanging roofs, pine needles accumulating in gutters, and tall, un-mowed grass, shrubs, and trees abutting homes. Many homes have old wooden sheds and other outbuildings within 30 ft of the home; these secondary structures could emit embers and radiant heat that threaten primary structures.

About 40% of roads in plan unit B could potentially experience non-survivable conditions during wildfires due to the presence of dense vegetation and ladder fuels. Over half of roads and driveways can only accommodate one-way traffic and are inaccessible for Type 3 engines due to low vertical and horizontal clearance and an absence of pullovers and turnarounds. Some roads are poorly

marked, which could make it hard for firefighters to navigate the neighborhood. About half of residents have flammable address signs that could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in plan unit B:

- Remove vegetation along Inca Road, Zuni Road, and driveways to reduce the risk of non-survivable conditions during wildfires and increase access for firefighters (see **Figure 3.c.3**).
- Support ecological restoration and fuel mitigation projects by Denver Mountain Parks (DMP) to reduce the potential for extreme fire behavior in Pence Park to the west of plan unit B. Encourage coordination between DMP and private landowners to facilitate access to the priority project area on O'Fallen Park (see project area in **Section 4.b.**).
- Several homeowners in plan unit B have worked with contractors to create defensible space, and the effectiveness of this work could be magnified if neighbors work together to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved.
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in plan unit B should review and consider actions outlined in **Section 3.a.** Many homes in this plan unit have the potential for ignition from radiant heat and long-range ember cast during wildfires. Old plywood and slab siding and wood shake, wooden shingle, or old asphalt roofs are particularly concerning from a flammability perspective.
- Encourage all residents to develop evacuation plans for their family, sign up for emergency notifications from Jefferson County, and coordinate with neighbors who might need additional support during evacuations.
- Install reflective road signs at all junctions and ensure vegetation is pruned so it does not hide road names.
- Encourage residents to purchase metal, reflective address signs from IHFR (available through the IHFR website) to make it easier for firefighters to locate homes through heavy smoke and at night.

Plan Unit C – Extreme relative risk rating

Predicted wildfire exposure under extreme fire weather in Plan Unit C:

59% of roadways with potentially non-survivable conditions	8% of homes exposed to short-range embers from burning vegetation
34% of homes exposed to radiant heat from burning vegetation	99% of homes exposed to long-range embers from burning vegetation

Much of plan unit C occurs on steep north-facing slopes with dense ponderosa pine and mixed-conifer forests with abundant Englemann spruce and Douglas-fir saplings in the understory. Steep east- and south-facing slopes in the plan unit are covered in ponderosa pine forests with Gambel oak, juniper, and Douglas-fir. Aspen, Englemann and blue spruce, and riparian vegetation occur within a drainage along Mountain Spirit Way. There is a high potential for extreme fire behavior in dense forests with abundant ladder fuels on steep slopes, particularly on hot, dry, and windy days. Grass-shrub understories in lower-density forests could support fast rates of spread, and passive crown fires could occur in areas with ladder fuels.

Numerous homes are located mid-slope and several on ridgetops, which increases their potential exposure to extreme fire behavior. In general, homes in plan unit C are older and have flammable siding (untreated wood, plywood, and slab). Many homes have ignition-resistant roofs made from metal, concrete tile, or new asphalt, but about a quarter of homes have wood shake, wooden shingle, or old asphalt roofs. Many homes have wooden decks and fences. Wooden fences can serve as a pathway for fire to spread between vegetation, outbuildings, and homes. A vast majority of homes in this plan unit have abundant hazards in HIZ 1 and 2, including tree branches overhanging roofs, pine needles accumulating in gutters, and tall, un-mowed grass, shrubs, and trees abutting homes. Many homes have old wooden sheds and other outbuildings within 30 ft of the home; these secondary structures could emit embers and radiant heat that threaten primary structures.

About 60% of roads in plan unit C could potentially experience non-survivable conditions during wildfires due to the presence of dense vegetation and ladder fuels. Over half of roads and driveways can only accommodate one-way traffic and are inaccessible for Type 3 engines due to low vertical

and horizontal clearance, steep grades, tight switchbacks, and an absence of pullovers and turnarounds. About half of residents have flammable address signs that could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in plan unit C:

- Remove vegetation along Shawnee Road, Salugi Road, Adahi Road, Cherokee Road, Taos Road, and driveways to reduce the risk of non-survivable conditions during wildfires and increase access for firefighters (see **Figure 3.c.3**). Treatments along Shawnee Road are called out as priority project areas for this CWPP (see **Section 4.b.**).
- Explore options to widen narrow roads, or at the minimum to create pullouts and turnarounds to assist with evacuation and emergency traffic. Homeowners can remove trees and prune low-hanging branches from their property along roadways. Widening roads maintained by the county requires coordination between IHFR and Jefferson County Road and Bridge. Vegetation removal in powerline right-of-ways adjacent to streets can be coordinated between IHFR and Xcel Energy. Residents can work together to fund the construction of pullouts and turnarounds on private drives and driveways, and IHFR can use the permitting process for new construction to require increased accessibility for emergency vehicles.
- A couple homeowners in plan unit C have worked with contractors to create defensible space, and the effectiveness of this work could be magnified if neighbors work together to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved.
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in plan unit C should review and consider actions outlined in **Section 3.a.** Many homes in this plan unit have the potential for ignition from radiant heat and long-range ember cast during wildfires. Old plywood and slab siding and wood shake, wooden shingle, or old asphalt roofs are particularly concerning from a flammability perspective.
- Encourage all residents to develop evacuation plans for their family, sign up for emergency notifications from Jefferson County, and coordinate with neighbors who might need additional support during evacuations.
- Encourage residents to purchase metal, reflective address signs from IHFR (available through the IHFR website) to make it easier for firefighters to locate homes through heavy smoke and at night.

Plan Unit D – Extreme relative risk rating

Predicted wildfire exposure under extreme fire weather in Plan Unit D:

33% of roadways with potentially non-survivable conditions	16% of homes exposed to short-range embers from burning vegetation
29% of homes exposed to radiant heat from burning vegetation	95% of homes exposed to long-range embers from burning vegetation

Topography and vegetation are highly varied in plan unit D. Over half of the unit occurs on steep north- and west-facing slopes with dense ponderosa pine and mixed-conifer forests with abundant Englemann spruce and Douglas-fir saplings in the understory. Parts of the unit occur on steep east- and south-facing slopes covered in ponderosa pine forests with Gambel oak, juniper, and Douglas-fir. There is a high potential for extreme fire behavior in dense forests with abundant ladder fuels on steep slopes, particularly on hot, dry, and windy days. Narrow ravines with dense fuel have an even higher risk of extreme fire behavior. Grass-shrub understories in lower-density forests could support fast rates of spread, and passive crown fires could occur in areas with ladder fuels.

Numerous homes are located mid-slope and several on ridgetops, which increases their potential exposure to extreme fire behavior. In general, homes in plan unit D are older and have flammable siding (untreated wood, plywood, and slab). Many homes have ignition-resistant roofs made from metal, concrete tile, or new asphalt, but about a quarter of homes have wood shake, wooden shingle, or old asphalt roofs. Newer homes with ignition-resistant construction materials are more common on Brookmont Road. Many homes across the plan unit have wooden decks and fences. Wooden fences can serve as a pathway for fire to spread between vegetation, outbuildings, and homes. A vast majority of homes in this plan unit have abundant hazards in HIZ 1 and 2, including tree branches overhanging roofs, pine needles accumulating in gutters, and tall, un-mowed grass, shrubs, and trees abutting homes. Many homes have old wooden sheds and other outbuildings within 30 ft of the home; these secondary structures could emit embers and radiant heat that threaten primary structures.

Geneva Glen has taken steps to harden structures and mitigate fuel on their property. The camp has replaced flammable siding and roofing with ignition-resistant materials and removed trees to create

defensible space around many cabins. The camp has conducted fuel treatments on over 100 acres of ponderosa pine and mixed-conifer forests in coordination with Jefferson Conservation District to help protect the camp and adjacent community from wildfires (see **Figure 2.g.2** for a location of treatment areas).

A third of roads in plan unit D could potentially experience non-survivable conditions during wildfires due to the presence of dense vegetation and ladder fuels. Over half of roads and driveways can only accommodate one-way traffic and are inaccessible for Type 3 engines due to low vertical and horizontal clearance, steep grades, tight switchbacks, and an absence of pullovers and turnarounds. Some residents have flammable address signs that could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in plan unit D:

- Remove vegetation along Hiawatha Trail, Santa Clara Road, Brookmont Road, Seminole Road, Algonquin Road, Raven Gulch Road, and driveways to reduce the risk of non-survivable conditions during wildfires and increase access for firefighters (see **Figure 3.c.3**). Treatments along Santa Clara Road, Seminole Road, and Algonquin Road are called out as priority project areas for this CWPP (see **Section 4.b.**).
- Explore options to widen narrow roads, or at the minimum to create pullouts and turnarounds to assist with evacuation and emergency traffic. Homeowners can remove trees and prune low-hanging branches from their property along roadways. Widening roads maintained by the county requires coordination between IHFR and Jefferson County Road and Bridge. Vegetation removal in powerline right-of-ways adjacent to streets can be coordinated between IHFR and Xcel Energy. Residents can work together to fund the construction of pullouts and turnarounds on private drives and driveways, and IHFR can use the permitting process for new construction to require increased accessibility for emergency vehicles.
- Geneva Glen and a couple homeowners in plan unit D have worked with Jefferson Conservation District or private contractors to create defensible space. The effectiveness of this work could be magnified if neighbors work together to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved.
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in plan unit D should review and consider actions outlined in **Section 3.a.** Many homes in this plan unit have the potential for ignition from radiant heat and short- and long-range ember cast during wildfires. Old plywood and slab siding and wood shake, wooden shingle, or old asphalt roofs are particularly concerning from a flammability perspective.
- Encourage all residents to develop evacuation plans for their family, sign up for emergency notifications from Jefferson County, and coordinate with neighbors who might need additional support during evacuations.
- Encourage residents to purchase metal, reflective address signs from IHFR (available through the IHFR website) to make it easier for firefighters to locate homes through heavy smoke and at night.

Plan Unit E – High relative risk rating

Predicted wildfire exposure under extreme fire weather in Plan Unit E:

77% of roadways with potentially non-survivable conditions	58% of homes exposed to short-range embers from burning vegetation
83% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Topography and vegetation are highly varied in plan unit E. Some south-facing slopes are covered in low- to moderate-density ponderosa pine forest with ponderosa pine saplings, Gamble oak, and juniper understories. Grass-shrub understories in lower-density forests could support fast rates of spread, and passive crown fires could occur in areas with ladder fuels. Other areas have shallow slopes with aspen and open meadows, including large, irrigated pastures. Un-mowed grass can support fast rates of spread under dry conditions. Dense ponderosa pine and mixed-conifer forests cover steep slopes in Mount Falcon Park to the east of plan unit E. There is a high potential for extreme fire behavior in dense forests with abundant ladder fuels on steep slopes, particularly on hot, dry, and windy days.

In general, homes in plan unit E are newer and have ignition-resistant siding (stone, adobe, composite, and treated wood siding). Almost all homes have ignition-resistant roofs made from metal, concrete tile, or new asphalt. Several homes have wooden decks and fences, but others have ignition-resistant decks and vinyl or metal fences. Wooden fences can serve as a pathway for fire to spread between vegetation, outbuildings, and homes. The quality of defensible space is mixed across the unit. Some homes have non-burnable barriers in HIZ1, but others have tall, un-mowed grass, shrubs, and trees abutting homes. Some residents have removed trees and limbs in HIZ2, but others have dense vegetation within 30 feet of their homes, including trees with branches overhanging their roofs.

About 77% of roads in plan unit E could potentially experience non-survivable conditions during wildfires due to the presence of dense vegetation and ladder fuels. Ongoing work to remove vegetation along Camayo Road and pave the road is a positive step to increase safety in this plan unit.

Over half of roads and driveways can only accommodate one-way traffic and are inaccessible for Type 3 engines due to low vertical and horizontal clearance and an absence of pullovers and turnarounds. Most residents have metal, reflective address signs.

Recommendations for collective action in plan unit E:

- Remove vegetation along Lakota Road, Nambe Road, Clara Road, Brookmont Road, Seminole Road, Algonquin Road, Raven Gulch Road, Mount Falcon Road, Cameyo Road, Falcon Wing Road, Talon Trail, and driveways to reduce the risk of non-survivable conditions during wildfires and increase access for firefighters (see **Figure 3.c.3**). Treatments Mount Falcon Road and Cameyo Road are called out as priority project areas for this CWPP (see **Section 4.b.**).
- Explore options to widen narrow roads, or at the minimum to create pullouts and turnarounds to assist with evacuation and emergency traffic, particularly on Cameyo Road. Homeowners can remove trees and prune low-hanging branches from their property along roadways. Widening roads maintained by the county requires coordination between IHFR and Jefferson County Road and Bridge. Vegetation removal in powerline right-of-ways adjacent to streets can be coordinated between IHFR and Xcel Energy. Residents can work together to fund the construction of pullouts and turnarounds on private drives and driveways, and IHFR can use the permitting process for new construction to require increased accessibility for emergency vehicles.
- Support ecological restoration and fuel mitigation projects by Jefferson County Open Space (JCOS) to reduce the potential for extreme fire behavior in Mountain Falcon Park to the east of plan unit E (see project area in **Section 4.b.**).
- Tall Timbers has created defensible space and reduced fuel loads across the Leprino property in the northwest part of plan unit E. Several other homeowners have worked with private contractors to create defensible space. The effectiveness of this work could be magnified if neighbors work together to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved.
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in plan unit E should review and consider actions outlined in **Section 3.a.** Many homes in this plan unit have the potential for ignition from radiant heat and short- and long-range ember cast during wildfires.
- Encourage all residents to develop evacuation plans for their family, sign up for emergency notifications from Jefferson County, and coordinate with neighbors who might need additional support during evacuations.
- Encourage residents to purchase metal, reflective address signs from IHFR (available through the IHFR website) to make it easier for firefighters to locate homes through heavy smoke and at night.

Plan Unit F – Moderate relative risk rating

Predicted wildfire exposure under extreme fire weather in Plan Unit F:	
3% of roadways with potentially non-survivable conditions	0% of homes exposed to short-range embers from burning vegetation
1% of homes exposed to radiant heat from burning vegetation	19% of homes exposed to long-range embers from burning vegetation

The majority of plan unit F is flat and covered in open, grassy meadows or valley bottoms with riparian vegetation of willows, cottonwoods, blue spruce, and aspen. Some moderately dense ponderosa pine forests are present along Hopi and Inca Road, but ladder fuels are sparse. The risk of extreme fire behavior is low in this plan unit.

Home construction materials are highly mixed across the plan unit. Some homes have ignition-resistant siding (stone, adobe, composite, and treated wood siding), but several homes have flammable siding (untreated wood, plywood, and slab). Most homes have ignition-resistant roofs made from metal, concrete tile, or new asphalt, but they have wooden decks and fences. Wooden fences can serve as a pathway for fire to spread between vegetation, outbuildings, and homes. The quality of defensible space is mixed across the unit. Some homes have non-burnable barriers in HIZ1, but others have tall, un-mowed grass, shrubs, and trees abutting homes. Some residents have removed trees and limbs in HIZ2, but others have dense vegetation within 30 feet of their homes, including trees with branches overhanging their roofs. Many homes have old wooden sheds and other outbuildings within 30 ft of the home; these secondary structures could emit embers and radiant heat that threaten primary structures.

Conditions along almost all roads in this plan unit are predicted to be survivable during wildfires. Over half of roads and driveways can only accommodate one-way traffic, but practically all roads are accessible for Type 3 engines. Some residents have flammable address signs that could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in plan unit F:

- Explore options to widen narrow roads, or at the minimum to create pullouts and turnarounds to assist with evacuation and emergency traffic. Homeowners can remove trees and prune low-hanging branches from their property along roadways. Widening roads maintained by the county requires coordination between IHFR and Jefferson County Road and Bridge. Vegetation removal in powerline right-of-ways adjacent to streets can be coordinated between IHFR and Xcel Energy. Residents can work together to fund the construction of pullouts and turnarounds on private drives and driveways, and IHFR can use the permitting process for new construction to require increased accessibility for emergency vehicles.
- Several other homeowners have worked with private contractors to create defensible space. The effectiveness of this work could be magnified if neighbors work together to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved.
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in plan unit F should review and consider actions outlined in **Section 3.a.** Some homes in this plan unit have the potential for ignition from long-range ember cast during wildfires.
- Encourage all residents to develop evacuation plans for their family, sign up for emergency notifications from Jefferson County, and coordinate with neighbors who might need additional support during evacuations.
- Encourage residents to purchase metal, reflective address signs from IHFR (available through the IHFR website) to make it easier for firefighters to locate homes through heavy smoke and at night.

Plan Unit G – High relative risk rating

Predicted wildfire exposure under extreme fire weather in Plan Unit G:	
26% of roadways with potentially non-survivable conditions	1% of homes exposed to short-range embers from burning vegetation
15% of homes exposed to radiant heat from burning vegetation	84% of homes exposed to long-range embers from burning vegetation

Much of plan unit G occurs on moderate to steep southwest-facing slopes covered in ponderosa pine forests with ponderosa pine saplings, Gambel oak, juniper, and grass-shrub understories. There is a high potential for extreme fire behavior in dense forests with abundant ladder fuels on steep slopes, particularly on hot, dry, and windy days. Narrow ravines with dense fuel have an even higher risk of extreme fire behavior. Tall grasses in lower-density forests could support fast rates of spread, and passive crown fires could occur in areas with ladder fuels.

Several homes are located mid-slope, which increases their potential exposure to extreme fire behavior. Many homes in plan unit G are older and have flammable siding (untreated wood, plywood, and slab) and wood shake, wooden shingle, or old asphalt roofs. Many homes across the plan unit have wooden decks and fences. Wooden fences can serve as a pathway for fire to spread between vegetation, outbuildings, and homes. A vast majority of homes in this plan unit have abundant hazards in HIZ 1 and 2, including tree branches overhang roofs, pine needles accumulating in gutters, and tall, un-mowed grass, shrubs, and trees abutting homes. Many homes have old wooden sheds and other outbuildings within 30 ft of the home; these secondary structures could emit embers and radiant heat that threaten primary structures. There were more woodpiles and propane tanks within 30 feet of homes in this plan unit than any other part of IHFPD.

About a quarter of roads in plan unit G could potentially experience non-survivable conditions during wildfires due to the presence of dense vegetation and ladder fuels. Over half of roads and driveways can only accommodate one-way traffic and are inaccessible for Type 3 engines due to low vertical and horizontal clearance, steep grades, tight switchbacks, and an absence of pullovers and

turnarounds. Some residents have flammable address signs that could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in plan unit G:

- Remove vegetation along Nambe Road, Picutis Road, and driveways to reduce the risk of non-survivable conditions during wildfires and increase access for firefighters (see **Figure 3.c.3**). Treatments along Nambe Road and Picutis Road are called out as priority project areas for this CWPP (see **Section 4.b.**).
- Explore options to widen narrow roads, or at the minimum to create pullouts and turnarounds to assist with evacuation and emergency traffic. Homeowners can remove trees and prune low-hanging branches from their property along roadways. Widening roads maintained by the county requires coordination between IHFR and Jefferson County Road and Bridge. Vegetation removal in powerline right-of-ways adjacent to streets can be coordinated between IHFR and Xcel Energy. Residents can work together to fund the construction of pullouts and turnarounds on private drives and driveways, and IHFR can use the permitting process for new construction to require increased accessibility for emergency vehicles.
- There is a great need to create defensible space around homes in plan unit G. The effectiveness of mitigation work by individual residents could be magnified if neighbors work together to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved.
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in plan unit G should review and consider actions outlined in **Section 3.a.** Many homes in this plan unit have the potential for ignition from radiant heat and short- and long-range ember cast during wildfires. Old plywood and slab siding and wood shake, wooden shingle, or old asphalt roofs are particularly concerning from a flammability perspective.
- Encourage all residents to develop evacuation plans for their family, sign up for emergency notifications from Jefferson County, and coordinate with neighbors who might need additional support during evacuations.
- Encourage residents to purchase metal, reflective address signs from IHFR (available through the IHFR website) to make it easier for firefighters to locate homes through heavy smoke and at night.

3.c. Community-Wide Recommendations

Slash Management Recommendations

Residents in IHFPD have experienced difficulties with slash management, like many other communities in Colorado. During the community engagement process for this CWPP, residents shared that access to inexpensive means of slash disposal would help enable them to do more work to reduce wildfire risk on their property (**Figure 3.c.1**).

The Indian Hills Improvement Association (IHIA) currently operates a community chipping program, that is open to all Indian Hills residents, with chipping sessions in May and September. There is a fee to participate that is paid the week before chipping. The program contracts local tree service companies who do all the work and give a group discounted rate to the community. People can put out two cords of slash by the curb and the contractors chip the material but don't haul it away. Jefferson County also has an ongoing slash collection program open to all Jefferson County residents. The slash collection sites accept tree debris, pine needles, pinecones, and limbs with a maximum length of eight feet and a maximum diameter of six inches. See the County Slash Collection website for more information.

IHFR is exploring the idea of a "tools cache" with pole pruners, shears, and other small equipment for residents to checkout and use for mitigation projects on their property. Neighbors can organize workdays to help each other accomplish the work, thereby making everyone's property safer.

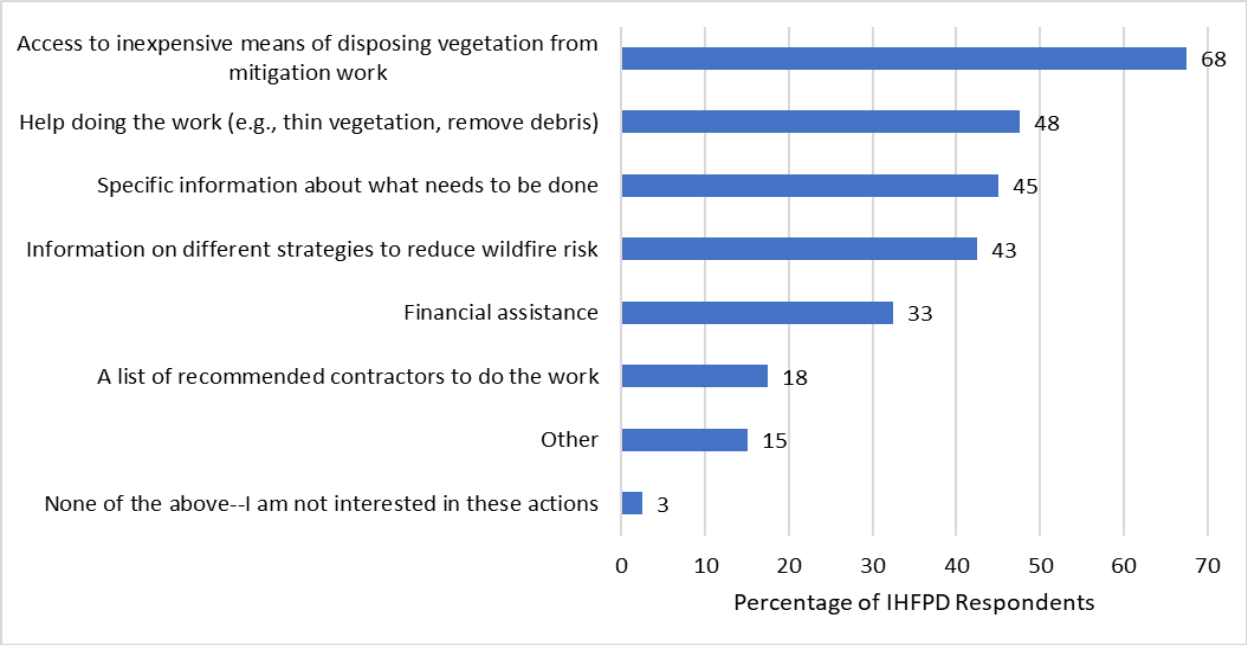


***Figure 3.c.1**. Resident responses to the survey question "Which of the following would encourage and enable you to reduce the wildfire risk on your property?" 68% of respondents requested free and easy slash disposal.*

Pile burning is the most feasible and effective method to eliminate slash in some instances (see **Section 4.e.**). Pile burning is permitted in Jefferson County within certain parameters (see the Open Burn Permit website via Jefferson County). Jefferson County Sheriff's Office does NOT allow open burning during fire restrictions and fire bans. Pursuant to Colorado House Bill 22-1132 (Darcy's Last Call Act), individuals must contact their local fire department before burning. Contact the IHFR for specific requirements to burn piles in IHFPD.

It is understandable for IHFR leadership and residents to have some reservations about allowing residents to pile burn; however, 75% of residents who responded to the CWPP survey support or highly support pile burning to mitigate wildfire risk (see survey results in **Appendix C**). Residents expressed concerns about prescribed burning conducted near homes and on windy days, so community-wide conversations are necessary to determine when, how, and if pile burning should be allowed on private land.

Pile burning can be safely conducted under certain weather conditions and with adequate training. The Colorado Division of Fire Prevention and Control (DFPC) offers a certified burner program to ensure that individuals are knowledgeable and capable of safely planning and conducting pile burns. According to DFPC, "By training and certifying private entities to plan and implement prescribed fire in a more systematic and educated manner, like that required by policy for natural resource and fire management agencies at all levels of government, the end result would be to promote the relatively safe and efficient use of fire as a management tool regardless of land ownership. The program is also designed to provide some level of civil liability protection for those trained and certified entities." The Ember Alliance also hosts pile burn workshops to provide further hands-on experience and training to Colorado residents.

WUI Building Regulations

In January 2020, Jefferson County approved new building construction regulations for homes above 6,400 feet in elevation, and the Jefferson County Department of Development and Transportation provides a list of approved building materials to help address the high potential for home loss in the WUI. New construction and replacement construction that require a building permit must comply with the new building standards:

- Home and structure setbacks should be structure-centric, not parcel-centric. Cross-boundary structure separation should always be a consideration.
- Existing high-density housing areas should prioritize home hardening as opposed to defensible space.
- New high-density developments should have complete defensible space and buildings that are extremely resistant to ignition. They should have forms of financial and regulatory collaboration, such as HOAs, to maintain community wildfire protection.
- Replace wooden fences with noncombustible materials and keep at least 8 feet away from the home. Keep double combustible fences at least 20 feet away from the home. Fences can serve as pathways for wildfire to travel between vegetation and structures and from structure to structure.

Evacuation Planning and Capacity

There is a high likelihood of evacuation congestion and long evacuation times during a wildfire. Evacuation times for individual residents could approach 3 hours in some parts of the IHFPD due to the high density of homes and limited number of egress routes. See **Appendix B** for more information on potential evacuation congestion and timing for IHFPD. Another concern is high visitor traffic from recreators at Mount Falcon Park. This highly visited recreational area can have upwards of 300

vehicles in the parking lot on weekends. IHFPD residents have expressed concern that visitors at Mount Flacon Park might not receive timely evacuation updates.

Many roads throughout the community are narrow and lined with dense vegetation that could create non-survivable conditions during wildfires (**Figure 3.c.2**). Under extreme fire weather conditions, 40% of roadways in the IHFPD could experience non-survivable conditions (**Figure 2.f.4**). **Mitigation actions along sections of road with high risk for non-survivable conditions during a wildfire can increase the chances of survival for residents stranded in their vehicles and decrease the chance that roadways become impassable due to flames.**

Reliable technology to provide warnings and information about evacuations can help residents feel confident in their ability to evacuate during a wildfire. Jefferson County Communications Center Authority (JeffCom) uses Lookout Alert, also known as reverse 911, to communicate evacuation orders to residents. Residents should actively extend awareness about Lookout Alert to neighbors that are unaware of the program.

Lookout Alert is the official emergency alert system (aka, reverse 911) used by JeffCom to contact residents during emergencies, including during wildfire evacuations. Residential landlines are automatically registered unless their phone uses VoIP (voice-over internet protocol). Residents should register their cell phones and email addresses with Lookout Alert. Learn more about Lookout Alert and emergency notifications on the Jefferson County Sheriff's Office website.

Lookout Alert
EMERGENCY NOTIFICATIONS

We recommend the following steps for residents, community groups, IHFPD, and the Jefferson County Sherriff's Office to address evacuation concerns in the IHFPD:

- Conduct tree removal, cut low limbs, and mow grass along roadways to increase the likelihood of survivable conditions during a wildfire. Prioritize the roads with the most traffic and congestion and work out to the less congested roads (**Figure 3.c.3**). See **Section 4.d.** for recommended approaches to reduce wildfire risk along roadways.
- Coordinate with the Jefferson County Sherriff's Office to conduct evacuation drills to practice safe and effective evacuation for the entire IHFPD.
- Coordinate with JeffCom to increase participation in Lookout Alert across the IHFPD. Fortunately, 82% of respondents to the CWPP survey indicated that they have signed up for Lookout Alert, but this number should ideally be 100%.
- Regularly test the Lookout Alert system to ensure timely and accurate communication could occur during an evacuation.
- Educate residents about warning systems, protocols for evacuation orders, and evacuation etiquette prior to the need to evacuate the community. Communicate the importance of following evacuation orders; **failing to leave the community in a timely manner during a wildfire emergency can put first responders at risk.**
- Encourage residents to leave with only one vehicle per household to reduce congestion for everyone.
- Encourage all households to develop family evacuation plans and to pack go-bags that are at the ready. Unfortunately, only 58% of respondents to the CWPP survey have evacuation plans for their family and only 38% have go-bags at the ready.
- Encourage residents to work with their neighbors to develop a plan for helping each other with evacuation if a resident is not at home, school-aged children or pets might be home alone, or residents have mobility impairments and need special assistance.

- Encourage residents to evacuate whenever they feel unsafe, even before receiving mandatory evacuation orders. All residents should leave promptly when they receive a mandatory evacuation order. This means having a family emergency plan already in place and having go-bags prepacked.
- Evaluate the efficacy of alternate methods of warnings and alerts, such as warning sirens. Research suggests that individuals trust and are more likely to respond to sirens than other warning systems like social media (National Academies of Sciences, Engineering, and Medicine, 2018).
- Make sure warnings and alerts can be understood by all residents, including those with English as a second language and with hearing impairments.
- Partner with Jefferson County Open Space to help educate visitors at Mount Falcon about Lookout Alert and evacuation protocols. Putting QR codes on signage across the park to direct people to the Lookout Alert website could be a great place to start.

• Potentially Survivable Roadways	Potentially Non-Survivable Roadways
	
	

Figure 3.c.2*. Some roads in the IHFPD have been well mitigated by removing tall trees and saplings, removing limbs on the remaining trees, and keeping grass mowed (left images). Other roads could experience potentially non-survivable conditions because they are lined by thick forests that have an abundance of ladder fuels (right images). Photo credit: The Ember Alliance.*

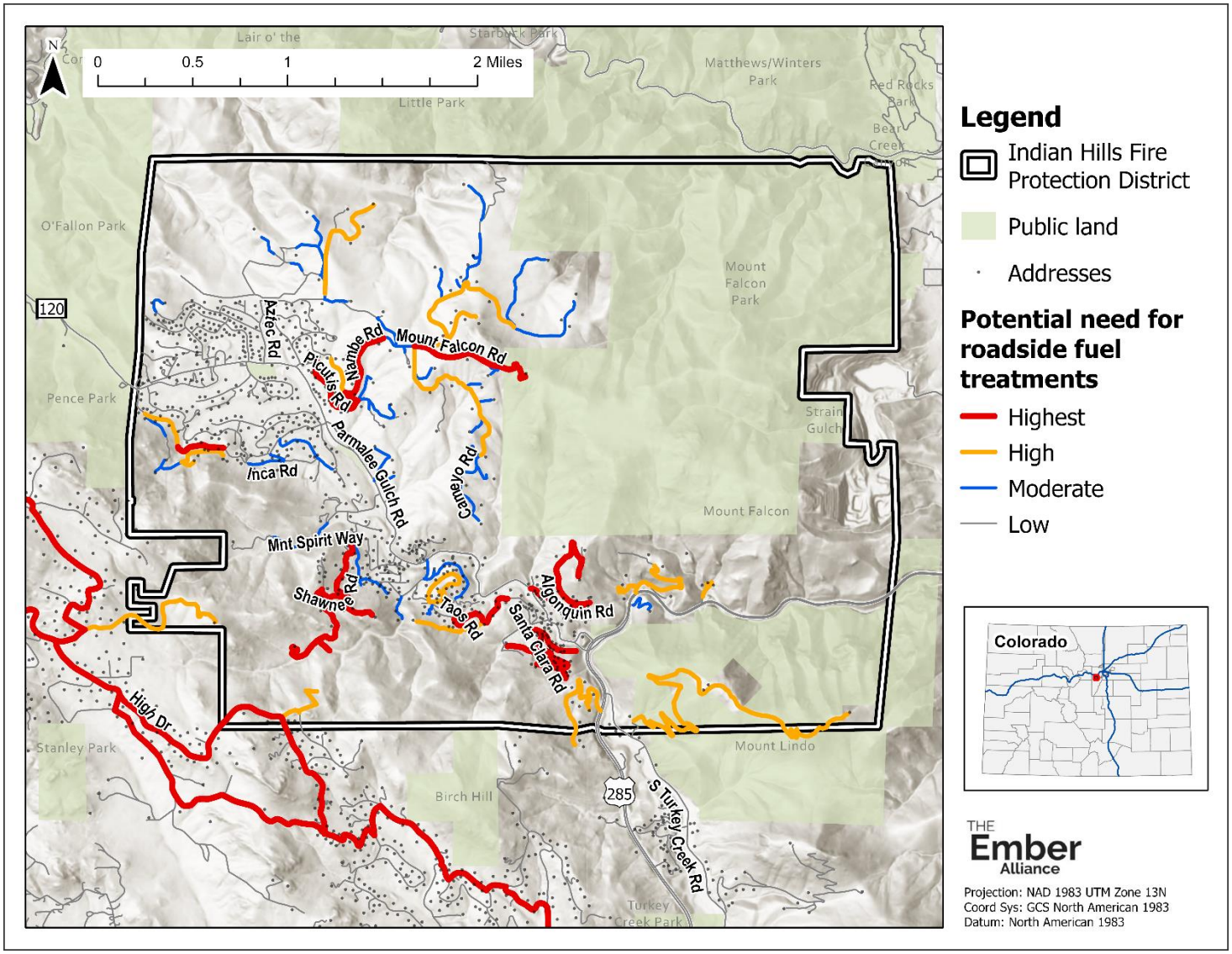


Figure 3.c.3. *Potential need for roadside fuel treatments based on the potential for wildfire to create non-survivable conditions along roadways and the potential for congestion during evacuations (methodology provided in* ***Appendix B****). See* ***Section 4.d.*** *for recommended approaches to reduce wildfire risk along roadways. Visit the IHFPD CWPP Map Experience for an interactive version of this map.*

Water Supply for Firefighting

Hydrants in parts of IHFPD have excellent flow rates for firefighting, particularly at the top end of the valley where there is greater storage and pump capacity (see **Appendix D**). Flow rates are lower in areas with smaller diameter pipes. In addition, water storage can be diminished later in the summer once Turkey Creek stops flowing. IHWD outlined capital improvements in their 2020 Master Plan to enhance their ability to provide adequate water for firefighters (see list of projects in **Section 2.b.**) . The community should demonstrate support for these goals and projects to enhance safety for everyone. Through conversations with IHWD and IHFR, we developed a wish-list of additional projects to include in this CWPP. Inclusion in the CWPP will open new funding sources and provide a vision for future improvements:

- Update hydrants across the community to mountain hydrants—an action that is cost-prohibitive action under current budgets for IHWD.
- Install a 30,000-gallon cistern on Shawnee Road.
- Make improvements to the cistern off Falcon Wing Road and the cistern on Cameyo Road. The Falcon Wing Road cistern is below the road and difficult to draft from and the cistern on Cameyo Road has plastic piping which could be easily broken making connections when in use.

Water conservation by residents is another important step to ensure adequate water supply is available during a wildland fire. Firewise landscaping and xeriscaping not only reduce the flammability of vegetation around your home, but many of these plants require less water usage. Follow water restrictions posted by IHWD on the sign outside the Indian Hills Community Center.

As part of this CWPP, IHFR also coordinated with large private landowners to assess their private water storage systems and develop plans to use these resources to protect the entire community during wildfires. Contact IHFR if you have private water supplies, such as large water tanks and cisterns, that you would like them to be aware of as a resource for fire suppression.

Accessibility and Navigability for Firefighters

Shared Driveways and Community Roads

Residents, IHFPD, and Jefferson County can work together to ensure emergency responders can locate and access everyone's home. Narrow roads without turnarounds, tree limbs hanging over the road, and lots of dead and down trees by the road may make firefighters choose to not defend your home during a wildfire event (Brown, 1994). According to the National Fire Protection Association, driveways and roads should have a minimum of 20 feet of horizontal clearance and 13.5 feet of vertical clearance to allow engines to safely access the roads (O'Connor, 2021). Five of seven plan units in the IHFPD have some roads that are inaccessible to fire engines. Many roads can only accommodate one-way traffic, which could cause substantial congestion and dangerous conditions during emergency evacuations.

To improve access, homeowners can remove trees and prune low-hanging branches from their property along roadways. Not all roads with names and signs are maintained by the county—private drives longer than 150 feet that access two or more homes must have a name and sign. Check with IHFR to determine the responsibility of road maintenance in your neighborhood. Widening roads maintained by the county requires coordination between IHFR and Jefferson County Road and Bridge. Vegetation removal in powerline right-of-ways adjacent to streets can be coordinated between IHFR and Xcel Energy. Residents can work together to fund the construction of pullouts and turnarounds on private drives and driveways, and IHFR can use the permitting process for new construction to require increased accessibility for emergency vehicles. IHFR and IHIA can apply for grants to remove trees from along roads to make conditions safer during wildfires.

3.d. Outreach and Education

The IHFPD should continue to engage with community members using a variety of methods, including the Indian Hills Fire Rescue/Fire Boots Fourth of July celebration and presentations given by the IHFR. Other methods include social media, education materials for visitors of short-term rentals, and adopting a community ambassador program if desired. The following priority recommendations may fall to different entities or partners within and around the IHFPD.

As your community makes progress on the top-priority actions outlined below, refer to the fire adapted communities' "wheel" (**Figure 3.1**) and seek additional ideas and resources from the Fire Adapted Community Learning Network and Fire Adapted Colorado (FACO). Visit their websites for more information on their programs and upcoming events.

Firewise Community

IHFPD should consider becoming a designated Firewise community. Firewise USA® is a national recognition program that provides instructional resources to inform people how to adapt to living with wildfire and encourages neighbors to work together and take action to reduce their wildfire risk. Becoming a Firewise community creates a framework for action, builds community around wildfire risk, and can increase access to funding and assistance for grant money allocated to wildfire safety and fuels mitigation. For more information on becoming a Firewise Community, visit: Becoming a Firewise-USA community.

Neighborhood Ambassador Program

This CWPP can only result in on-the-ground change if property owners and community groups work with forestry professionals such as the Colorado State Forest Service and Jefferson Conservation District to address shared risk. Creating and supporting a **Neighborhood Ambassador Program** could help property owners better understand wildfire risks and spark coordinated action that effects positive change in the IHFPD. The neighborhood ambassador approach requires engaged volunteer ambassadors and a dedicated lead coordinator, potentially one leader for each CWPP plan unit. The ambassadors could be part of a group called "Mission: Firewise Coalition" organized under IHIA.

See **Table 3.d.1** from the guide *Fire adapted communities neighborhood ambassador approach: Increasing preparedness through volunteers* for effective activities that neighborhood ambassadors can undertake (Wildfire Adapted Partnership, 2018). A neighborhood ambassador program has been highly successful in fire protection districts adjacent to IHFPD.

***Table 3.d.1**. Potential activities for the neighborhood ambassador program. Table adapted from (Wildfire Adapated Partnership, 2018).*

Example activity	Ambassador responsibility	Coordinator responsibility
Educational programs about defensible space and home hardening	Gauge interest of neighbors and select topics. Find meeting location. Encourage neighbors to attend.	Arrange for specialists to make presentations (IHFR/Jefferson Conservation District/CSFS). Coordinate to advertise sign up for home assessments via IHFR. Angel Program that has volunteers to spread information about assistance for home mitigation. Advertise program through community newsletters, social media, etc.
Emergency planning	Organize an event for people to ask firefighters and law enforcement personnel about emergency planning and evacuation. Encourage residents to work with their neighbors to develop a plan for evacuation if a resident is not at home, school-aged children or pets might be home alone, or residents have mobility impairments and need special assistance. Neighborhood buddy system to help elderly or disabled residents. Get "go-bag" instructions to everyone. Get everybody signed up for Lookout Alert.	Provide information to residents about emergency planning and go-bags. Arrange for specialists to make presentations. Advertise program through community newsletters, social media, etc.
IHIA Community Chipping Program	Secure more community buy-in, continuing fundraising, and request more financial support. Find ways to collaborate with IHFR. Encourage neighbors to sign up.	Secure grants or other financial support. Increase communication and advertise program through community newsletters, social media, etc.

Example activity	Ambassador responsibility	Coordinator responsibility
Defensible-space walking tour	Identify homeowners with exemplary defensible space. Select a date and organize event logistics. Encourage neighbors to attend.	Arrange for fuel treatment specialists to attend and make presentations. Provide handouts and other educational material about defensible space. Advertise program through community newsletters, social media, etc.
Defensible space projects	Work with neighbors to identify high-priority project locations using insights from this CWPP. Secure community buy-in and request financial support. Select contractors and solicit bids. Oversee project completion.	Work with a certified forester for insights about effective treatment location and prescriptions, following guidelines in this CWPP. Find volunteer grant writers. Identify potential contractors. Write scope of work for contract. Inspect project upon completion. Celebrate success through social media posts and newspaper articles.
Roadside fuel treatment projects	Work with neighbors to identify roads and driveways with potentially non-survivable conditions using insights from the CWPP. Secure community buy-in and request financial support. Select contractors and solicit bids. Oversee project completion.	Work with a certified forester for insights about effective treatment location and prescriptions, following guidelines in this CWPP. Identify potential contractors. Write scope of work for contract. Inspect project upon completion. Celebrate success through social media posts and newspaper articles.
Become a designated Firewise community	Plan volunteer mitigation events. Account for money, time, and resources spent on mitigation in their neighborhood.	Support annual community-wide education program.

Social Media

Social media is a powerful tool when used properly to connect with audiences. FEMA has a Wildfire and Outdoor Fire Safety Social Media Toolkit that is a great starting place for fire protection districts to begin gaining an audience with their constituents and sharing important fire safety information. Put Fire to Work highlights programs and organizations that successfully engage audiences around wildland fire and prescribed burning. CalFire's Ready for Wildfire campaign is active and collaboratively created to engage and encourage people to act on wildfire preparedness. If possible, IHFR could find a volunteer to be focused on the website and social media outreach. Many residents prefer Facebook as a means of communication from IHFR about wildfire information (see **Appendix C** for survey results). We also recommend that IHFR create an account on NextDoor to connect with the community about wildfire information.

Considerations for Vulnerable Populations

Social factors influence how impacted an individual or a community may be in the event of wildfire. This so-called social vulnerability is due to a lack of access to resources. The resources that are lacking can include infrastructure, social support, health, and financial means (Cutter et al., 2003). While IHFPD at large may be well prepared for wildfire after engaging in this CWPP planning process, there is potential for some to fall through the cracks or struggle to engage in necessary mitigation and preparation work which makes them more at risk in the event of a fire.

Poverty, racial and ethnic discrimination, age, and physical ability are frequently factors that are associated with social stratification and result in resource inequity (Crowley, 2020; Cutter et al., 2003; Davies et al., 2018; Emrich et al., 2020; Hewitt, 2013; Ojerio et al., 2008). Thus, it is important to consider how to ensure that all community members can participate in the wildfire preparedness actions outlined in this CWPP.

Pre-fire

Before a fire, it is important to ensure that preparation and potential evacuation communication materials are available in other languages spoken in IHFPD. Sole use of English in materials makes it difficult for people with lower proficiency in English to understand. This includes children, people with low literacy, and people who primarily speak other languages. Materials that use images and diagrams rather than words can make sure the broadest audience can understand any materials that IHFR and IHIA distribute about wildfire.

Another major barrier is the ability to do the work recommended in this plan. Populations that may be impacted by this include those in lower income brackets who don't have the resources to harden their homes (i.e., by replacing their roofs, siding, and decks with non-combustible construction materials) and those with physical disabilities or impairments that keep them from doing the physical labor often involved in preparation and mitigation actions themselves. A CWPP is a great way to begin addressing economic disparity because it can provide a basis for IHFPD to apply for grant funding to support mitigation work on behalf of the community.

To truly reduce the economic barrier at a community level, community leaders must design programs that are accessible for all income brackets. For example, providing mitigation services such as a community chipping program that is free for residents who fall within lower income brackets can encourage those residents to mitigate their properties when they may have otherwise found it inaccessible. Similarly, volunteer days can help those who are not physically able to engage in pre-fire protection of their home by connecting physically able community members with them to help do home hardening work.

Post-fire

Following a fire, households are often solely responsible for their own recovery. While challenging for everyone, this is a particular issue for those without equal access to the social aid that is available like FEMA recovery funds, information on the internet, and claims for insurance (Laska and Morrow, 2006; Méndez et al., 2020). Groups impacted by this can include older adults, undocumented folks, and those who speak English as a second language or not at all.

While planning for post-fire is less of a focus of this CWPP, it is worth mentioning that community ties are as important after a fire as they are in trying to reduce the impact of potential fire. Communities that consider who will need the most assistance after a fire ahead of time are better able to get those folks the help they need quickly.

Short-Term Rentals

Short-term rentals are home or apartment rentals that are leased for 30 days or less at a time. These are frequently called vacation rentals, Airbnb's, or VRBOs. Local governments have struggled to regulate short-term rentals, and a study published in 2018 found that 20% of short-term rentals in the U.S. did not have smoke detectors and 58% didn't have fire extinguishers. Many of these short-term rentals offer escapes from city life to rural, mountainous areas of the IHFPD with dense trees and unmaintained road networks. Visitors are often unaware of the risks that come with their vacation location. Short term rentals without defensible space, clearly defined escape routes, or basic fire safety measures put visitors and neighbors at high risk in the event of a wildfire. We encourage owners of short-term rentals to ensure safe conditions for their visitors and provide information on evacuation notifications and evacuation routes (**Table 3.d.2**).

***Table 3.d.2**. Recommended mitigation actions for owners of short-term rentals in the IHFPD. Goals are adapted from Firewise USA.*

Mitigation Measure	Goals
Home Ignition Zones	Create defensible space around homes and outbuildings according to the CSFS Guidelines. See **Figure 3.a.2** and **Table 3.a.1** for specific recommendations.
Landscaping	Maintain Zone 1 (0-5 feet from the home) to clean, unburnable conditions with litter and duff removed regularly.
Roofing and Vents	Install and maintain a Class-A roof with mesh covers on vents.
Decks and Porches	Keep decks free of flammable materials such as propane tanks or firewood piles. Use non-combustible deck materials when possible.
Siding and Windows	Clean and maintain windows and siding. Use ignition-resistant siding and tempered multi-paned windows when building or remodeling.
Emergency Responder Access	Maintain a 20-foot-wide driveway with 13.5 feet of overhead clearance for emergency vehicles. Ensure that street and house numbers are clearly marked from the road, and there is enough turnaround space for fire trucks in front of your house.
Informed Renters	Provide evacuation maps to renters with multiple ways out of the neighborhood. Require renters to sign up for emergency alerts while they are visiting. Share current fire ban information with renters before they visit, and close off outdoor fire pits when they are not allowed to be used.

Collaboration

Collaboration with landowners, community members, local governments, business owners, and other partners is the best way to ensure recommendations from this plan from paper to on-the-ground action. Where some organizations may be able to offer incentives to homeowners, others may be able to provide structure and requirements that must be met to keep life safety for residents and firefighters a priority. This multi-faceted approach is only possible through compromise, mutual respect, and collaboration on shared goals.

Numerous partners were engaged in the development of this CWPP and offered input on the recommendations and priorities for IHFPD. It is recommended that the IHFR continue meetings with land management and emergency response partners to provide accountability on projects, support cross-boundary efforts, and create consistent messaging around fire adaptation. An important collaborative group that IHFR is a part of is the Mountain Metro Wildfire Mitigation Council (MMWMC). Fire protection districts can work together to apply for Community Wildfire Defense Grants and increase their capacity to support fire adaptation across their communities (see description of funding opportunities below). IHFR should engage with Jefferson County as they update their county-wide CWPP to ensure that concerns, values, and needs of residents in the IHFPD are represented and addressed.

3.e. Funding Opportunities for Wildfire Hazard Mitigation and Emergency Preparedness

There are many funding opportunities from federal, state, and local agencies as well as non-profits to assist in forest health and wildfire mitigation projects. These funds can increase capacity but cannot cover all the costs of fire mitigation needed within the valley. Residents and partners must put forth funds and time to complete this work.

Opportunities from Local and State Agencies in Colorado

- The Colorado State Forest Service (CSFS) **Forest Restoration and Wildfire Risk Mitigation (FRWRM)** is a competitive grant program designed to assist with funding community-level actions across the entire state to: reduce the risk to people, property and infrastructure from wildfire in the wildland-urban interface; promote forest health and the utilization of woody material including for traditional forest products and biomass energy; and encourage forest restoration projects. Eligible applicants include local community groups, local government entities such as fire protection districts, public and private utilities, state agencies, and non-profit groups.
- CSFS administers programs for landowner and community assistance, including the **Colorado Forest Ag Program** and **Colorado Tree Farm Program**.
- CSFS regularly updates their **Natural Resources Grants & Assistance Database** to help residents, agencies, and other partners find funding for natural resource projects.
- The Colorado Department of Revenue provides a **Wildfire Mitigation Measures Subtraction** whereby individuals, estates, and trusts may claim a subtraction on their Colorado income tax return for certain costs incurred in performing wildfire mitigation measures on property in the WUI.
- The **Jefferson Conservation District** helps landowners navigate forestry projects to promote forest health and complete wildfire mitigation projects.

Funding from Federal Agencies

- **Building Resilient Infrastructure and Communities (BRIC) grant program** supports states, local communities, Tribes, and territories as they undertake large-sale projects to reduce or eliminate risk and damage from future natural hazards. Homeowners, business operators, and non-profit organizations cannot apply directly to FEMA, but they can be included in sub-applications submitted by an eligible sub-applicant (local governments, Tribal governments, and state agencies).
- **Hazard Mitigation Assistance Grants Program (HMGP)** provides funding to state, local, Tribal, and territorial governments so they can rebuild in a way that reduces, or mitigates, future disaster losses in their communities. This grant funding is available after a presidentially declared disaster.
- **Assistance to Firefighters Grants (AFG)** help firefighters and other first responders obtain critical resources necessary for protecting the public and emergency personnel from fire and related hazards.
- **Fire Prevention & Safety (FP&S) Grants** support projects that enhance the safety of the public and firefighters from fire and related hazards.
- **Staffing for Adequate Fire and Emergency Response (SAFER)** grants directly fund fire departments and volunteer firefighter organizations to help increase their capacity.
- **Community Wildfire Defense Grants** (CWDG) are funded annually through the National Forest Service and help communities take action on implementation projects outlined in recent CWPPs.

Opportunities from Non-Governmental Organizations

- Coalitions and Collaboratives, Inc. manages the **Action, Implementation, and Mitigation Program (AIM)** to increase local capacity and support wildfire risk reduction activities in high-risk communities. AIM provides direct support to place-based wildfire mitigation organization with pass-through grant funding, on-site engagement, technical expertise, mentoring, and training on mitigation practices to help high-risk communities achieve their wildfire adaptation goals.
- Fire Adapted Colorado (FACO) manages the **FACO Opportunity Fund**, which is a matching mini-grant program to support projects, build capacity, and address local needs with funding from the National Fire Adapted Communities Learning Network.

Supporting the Fire Protection District

The IHFR strives to be supportive of forestry projects that improve forest health and wildfire safety. Creating, managing, and implementing fuels mitigation projects takes time and effort that is often unfunded to the district. Education and outreach are incredibly important to the district – connecting with their constituents is a vital part of building relationships and providing the highest quality services. This work requires time and resources that the FPDs do not always have to spare.

- The **Staffing for Adequate Fire and Emergency Response (SAFER)** grants can help fund staff capacity for fire departments.
- The **Assistance to Firefighters Grants (AFG)** can provide critical response resources for firefighters and emergency responders.
- Community support is also vital to the success of the fire stations:
    - IHFR is supported by volunteer responders who respond to fires, medical emergencies, and rescues every day of the year. Learn more about how you can volunteer by contacting your local fire department at join@ihfr.org or calling (303) 697-4568.
    - Financial support in the form of monetary donations or support of local ballot measures that provide tax revenue for the FPD is vital to their success in responding to residents in their time of need.
    - Attend events hosted by the IHFR. Seeking out information to protect your home from fire danger can also help protect your local firefighters. Sharing this information within your community can build community resilience and can help lower implementation costs for individual homeowners for many projects.

4. Implementation Recommendations for Fuel Treatments and Ecological Restoration

4.a. Objectives and Benefits of Fuel Treatments and Ecological Restoration

Fuel Treatments

Fuel treatments are a land management tool for reducing wildfire hazard by decreasing the amount and altering the distribution of wildland fuels. Common goals of stand-scale fuel treatments are to reduce the risk of active or passive crown fires and to reduce fire intensity. This is achieved by removing trees, increasing the distance between tree crowns, removing small trees, shrubs, and low branches to increase the distance between surface fuels and tree crowns, and removing downed trees and other dead vegetation (Agee and Skinner, 2005). Fuel treatment methods include tree thinning, pruning, pile burning, broadcast prescribed burning, and fuel mastication.

> "Given the right conditions, wildlands will inevitably burn. It is a misconception to think that treating fuels can 'fire-proof' important areas... Fuel treatments in wildlands should focus on creating conditions in which fire can occur without devastating consequences, rather than on creating conditions conducive to fire suppression" (Reinhardt et al. 2008).

Fuel treatments can alter the spread and behavior of wildfire. According to an analysis of the 2002 Hayman Fire, which burned over 138,000 acres and to within 20 miles south of IHFPD, "Landscape effects of treatment units and previous wildfires were important in changing the progress of the fire. These include the Polhemus prescribed burn (2001), which stopped the forward progress of the eastern head burning as a crown fire under extreme weather conditions" (Martinson et al., 2003). Strategically located, high-quality fuel treatments can also create tactical options for fire suppression (Jolley, 2018; Plucinski, 2019; Reinhardt et al., 2008). Fuel treatments along trails, ridgelines, and other features can allow firefighters opportunities to use direct or indirect suppression techniques to contain fire spread.

Strategic fuel treatments, in tandem with work by individual residents to mitigate hazards in their home ignition zone (see **Section 3.a.)**, can help protect life and property. Based on responses to the CWPP survey, almost all residents understand the risk of fire in the IHFPD. 97% of residents support or highly support fuel treatments on private and/or public land, and 91% of residents have already cut trees or removed low limbs within their home ignition zone (see **Appendix C**). Many residents and local agencies that manage land within and around the IHFPD are actively reducing wildland fuels. Additional strategic work is required to mitigate wildfire risks across the IHFPD.

Ecological Restoration

Ecological restoration is the process of assisting the recovery of an ecosystem that has been damaged, degraded, or destroyed (SER, 2004). Many forests in the western United States have been damaged, degraded, or destroyed because of changes to their historical fire regimes following Euro-American colonization.

Ecological restoration in ponderosa pine and mixed-conifer forests seeks to transform dense forests into ecosystems that are more resilient to wildfire. Tree densities in ponderosa pine forests along the Colorado Front Range average 4.5 times higher today than they were in the mid-1800s, and tree

densities average 2.3 times higher today in dry mixed-conifer forests (Battaglia et al., 2018). Landscapes of continuous, dense forests are more prone to high-severity fires that are difficult to suppress and can result in catastrophic losses to lives and property (Haas et al., 2015). Restoration treatments in dry mixed-conifer and ponderosa pine forests seek to reduce tree density and create patterns with single trees, clumps of trees, and meadows—conditions that are more like historical ecosystems along the Front Range of Colorado. Such restoration treatments can reduce crown-fire hazard, increase the abundance and diversity of grasses, shrubs, and wildflowers, and improve habitat for many wildlife species, including deer and elk (Addington et al., 2018).

In some cases, fuel treatments can achieve both ecological objectives and wildfire risk reduction. Restoration treatments in dry-mixed conifer and ponderosa pine forests tend to achieve both fuel treatment and ecological restoration objectives. In contrast, a treatment that creates a forest with widely, evenly spaced trees could serve as an effective fuel treatment but would not achieve ecological objectives in most forest types.

Methods Used to Conduct Fuel Treatments and Restore Ecosystems

Mechanical Treatments

Trees can be removed manually or mechanically, providing for considerations of safety, slope, road access, cost, and potential damage to soil. Use of mechanical equipment is often infeasible on slopes greater than 35% (Hunter et al., 2007). Handcrews with chainsaws can operate on steeper slopes, but handcrews usually cover less ground each day than mechanical thinning. Sometimes the only option for tree removal on steep, inaccessible slopes is expensive helicopter logging.

Thinning operations often increase surface fuel loads and can fail to achieve fire mitigation objectives if fuels created by the harvest activities (also known as slash) are not addressed (Agee and Skinner, 2005). See below for options to mitigate surface fuel loads created by fuel management.

Broadcast Prescribed Burning

Broadcast prescribed burning is the most effective method to mitigate wildfire risk and create healthy forest conditions in a variety of grassland, shrubland, and forest ecosystems (Paysen et al., 2000; Stephens et al., 2009). This method has unique impacts on vegetation, soils, and wildlife habitat that cannot be replicated by mechanical treatments alone (McIver et al., 2013). Prescribed burning mimics naturally occurring wildfire, can treat hundreds of acres at a time, removes surface fuel, and is relatively cost-effective (Hartsough et al., 2008; Hunter et al., 2007). Prescribed burns can reduce property damage during wildfires because they are so effective at altering forest fuel loads (Loomis et al., 2019).

Prescribed burning can remove surface fuels and ladder fuels and return ecological processes to frequent-fire ecosystems. Firefighters who plan and implement burns must hold rigorous certifications as set by the National Wildfire Coordinating Group Photo credit: The Ember Alliance.

Broadcast prescribed burning can be used following mechanical treatments to magnify treatment impacts. Thinning and

burning treatments tend to achieve fuel reduction objectives and modify fire behavior to a greater extent than thinning alone (Fulé et al., 2012; Prichard et al., 2020).

Broadcast prescribed burning is challenging in the WUI due to diverse fuel types, proximity to homes, risk of visibility impairments on roads from smoke, health impacts of smoke, and political and social concerns. However, with proper planning and implementation, qualified firefighters can safely conduct prescribed burns, even in the WUI (Hunter et al., 2007). Life safety is always a top consideration when developing and conducting prescribed burns.

Broadcast burning is carefully regulated in Colorado by the Division of Fire Prevention and Control (DFPC), the Colorado Department of Public Health and Environment, local sheriff's offices, and fire departments as outlined in the *Colorado Prescribed Burning Act of 2013* and *2019 Colorado Prescribed Fire Planning and Implementation Policy Guide*. Firefighters who plan and conduct prescribed burns are highly qualified under national standards set forth by the National Wildfire Coordinating Group.

It is extremely uncommon for prescribed burns to escape containment lines (Weir et al., 2019) and when they do, the wildland fire community soberly reviews those escapes to produce lessons learned and make improvements (Dether, 2005). Unfortunately, one example is the Lower North Fork Fire which happened within this CWPP planning area. This experience has understandably created fear among some members of the public. The prescribed burn community has taken lessons away from the Lower North Fork Fire to reduce the likelihood of future escapes.

Mowing / Grazing

Mowing involves using equipment or grazing animals to trim the height of grasses and forbs. Some equipment can mow down shrubs and small saplings. Mowing is primarily used to reduce flashy fuels in home ignition zones 1 and 2 and along roadways.

Mowing and grazing can decrease flame length by reducing the height and volume of fine flashy fuels (Harper, 2011). In some cases, it can stimulate the regeneration and growth of native plants.

Treatment Types Covered in the CWPP

This CWPP covers fuel treatments in the home ignition zone 3, stand-level fuel treatments, and roadside fuel treatments, each with their own objectives and benefits:

Fuel Treatment Category	Primary Objectives and Benefits
Defensible space in home ignition zone 3 (30-100 feet away from the home)	Reduce surface fuels, reduce tree density, and increase the distance between surface and canopy fuels. Moderate fire behavior near structures and increase their chance of surviving a wildfire. Increase safety and access for wildland firefighters. Increase the visibility of structures from roadways to assist wildland firefighters with locating and accessing your home. Coordinate with partners when home ignition zone 3 overlaps neighboring properties to address shared wildfire risk. Linked defensible space creates safer conditions and better tactical opportunities for wildland firefighters. Defensible space projects that span ownership boundaries are better candidates for grant funding due to their strategic value.
Stand-level ecological restoration / fuel treatments	Reduce surface fuels, reduce tree density, and increase the distance between surface and canopy fuels. Restore ecological conditions to create more fire-resilient ecosystems. Reduce the likelihood of high-severity wildfires near communities. Create tactical opportunities for fire suppression.
Roadside fuel treatments	Dramatically reduce or eliminate surface and canopy fuels. Reduce the likelihood of non-survivable conditions along roadways during wildfires. Create tactical opportunities for fire suppression. Increase the visibility of structures from roadways to assist wildland firefighters.

4.b. Priorities for Ecological Restoration and Roadside Fuel Treatments in the IHFPD

Altering potential wildfire behavior and restoring ecological conditions requires a landscape-scale approach to treatments across ownership boundaries. We located and prioritized project areas for roadside fuel treatments, ecological restoration, and/or stand-level fuel treatments within and around the IHFPD to be implemented in the next 5-10 years (**Figure 4.b.1**). These project areas cross ownership boundaries and require community-wide commitment, coordination, and collaboration among private landowners, public land managers, and forestry professionals.

Project areas were identified by assessing potential need for treatment based on fire behavior, the exposure of values at risk and roads to wildfire, and potential evacuation congestion (see **Appendix B** for methodology), the location of previous fuel treatments and planned future work, potential funding sources, and other feasibility considerations such as access and slope. Unfortunately, much of the forested area in IHFPD is too steep, inaccessible, and dense for treatments.

In fall 2022 and early 2023, TEA, IHFR, and representatives from land management agencies and other partner groups met to refine project areas and assign project leads. Partners included representatives from the CSFS, JCOS, JCD, DMP, Geneva Glen Camp, Olinger Mount Lindo Cemetery, and Xcel Energy. Specific project boundaries will be refined after conversations with adjacent private landowners and while developing treatment prescriptions.

The section below describes the current conditions in each CWPP project area, treatment objectives and benefits, potential treatment types, project leads, and relative importance. The relative importance and feasibility of treatments is reflected in their timeline—partners aim to conduct treatments for immediate action in the next 1-2 years, short-term priorities are targeted for the next 3-4 years, and mid-term priorities for the for the next 5-10 years. Mid-term projects will require more coordination, funding, and other enabling conditions before implementation can begin.

The CWPP implementation plan for stand-level and roadside treatments focuses on high-priority locations, but this does not discourage ecological restoration and fuel mitigation in other areas. If multiple neighbors work together to mitigate fire risk across ownership boundaries, it could attract funding and increase the priority and effectiveness of treating those areas. IHFPD, residents, and land managers should reevaluate fire risks and reprioritize treatment units as conditions change.

Meeting at Geneva Glen on September 20, 2022, to discuss fuel treatment priorities for the IHFPD CWPP. Photo credit: The Ember Alliance.

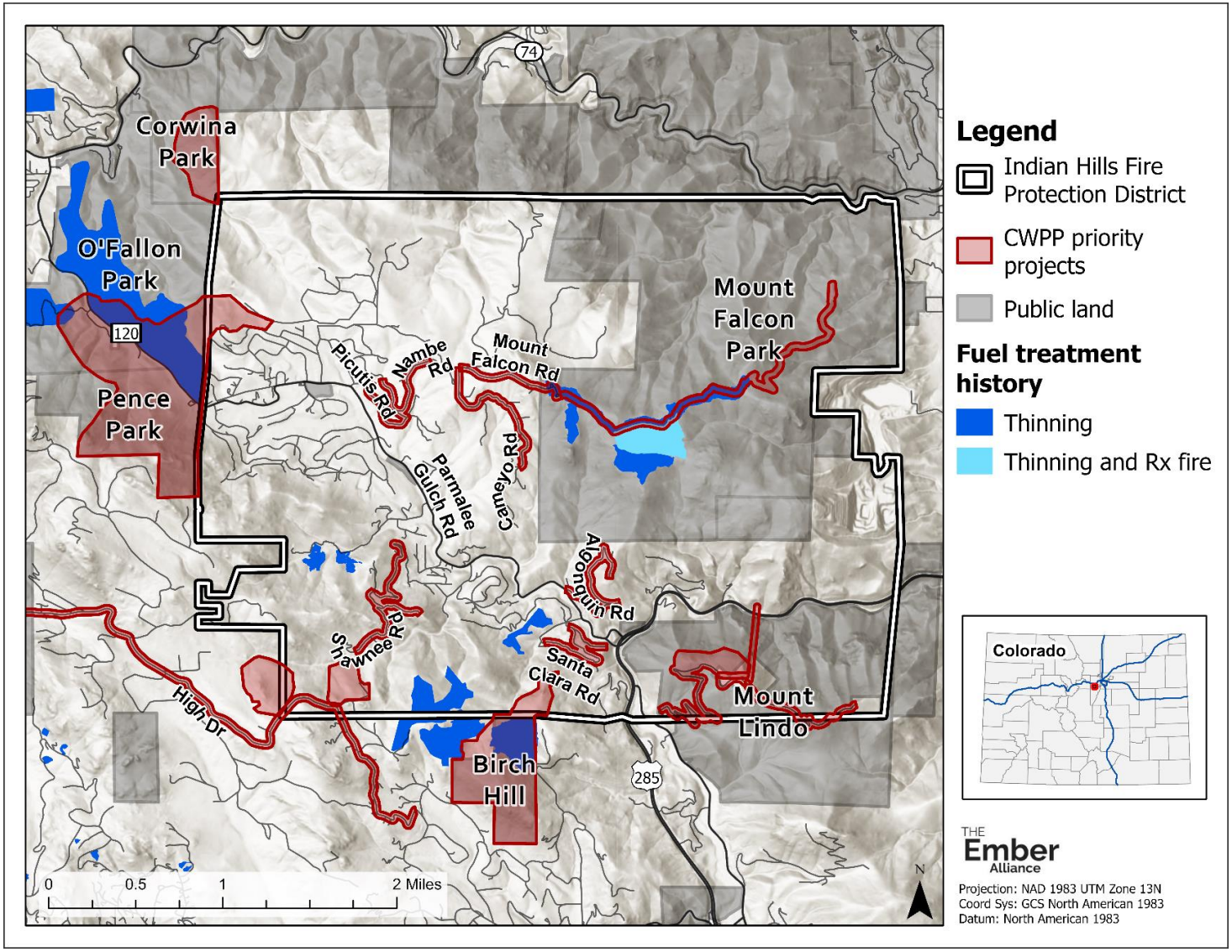


Figure 4.b.1. *Priority project areas for implementation in the next 5 years to reduce the impact of wildfire in the IHFPD, create strategic opportunities for wildland firefighters, create safe condi-q0tions for evacuations, and restore ecological conditions. Visit the IHFPD CWPP Map Experience for an interactive version of this map.*

Roadside Fuel Treatments: Shawnee Road and Salugi Road

Roadside fuel treatments and road improvements along Shawnee Road and Salugi road would increase the safety of residents and first responders (**Figure 4.b.2**). The road occurs on a steep northeast-facing slope and is lined with dense mixed-conifer forests with abundant ladder fuels. Tight switchbacks, steep grades, and low clearance have caused problems with access for fire engines in the past. Two-way traffic is impossible in some sections of this road. Dense vegetation along roadways could result in non-survivable conditions for residents from about 25 addresses for whom this is the only egress during wildfire emergencies.

Based on fire behavior modeling and preliminary assessments, about 1.3 miles of the road could potentially benefit from fuel treatments. The specific location of treatments would require a thorough assessment on-the-ground and coordination with private landowners.

Roadside Fuel Treatments Along Shawnee Road and Salugi Road	
Treatment objectives:	Increase the safety of evacuation routes for residents. Improve access for fire responders.
Treatment type:	Mechanical thinning and slash removal to create a shaded fuelbreak and reduce fuel loads. Roadway improvements to create pullovers and turnarounds. See **Section 4.d.** for details on roadside fuel treatments and **Section 4.e.** for information on slash management.
Priority:	Immediate action—start work within 1-2 years.
Lead and support organizations:	IHFR will coordinate with private landowners, County Road & Bridge, and Xcel Energy where powerline rights-of-way coincide with the road.

Dense forest conditions in mixed-conifer forests along Shawnee Road limit firefighter access and could result in non-survivable conditions during wildfires. This road is the only point of egress for about 25 addresses. Photo credit: The Ember Alliance.

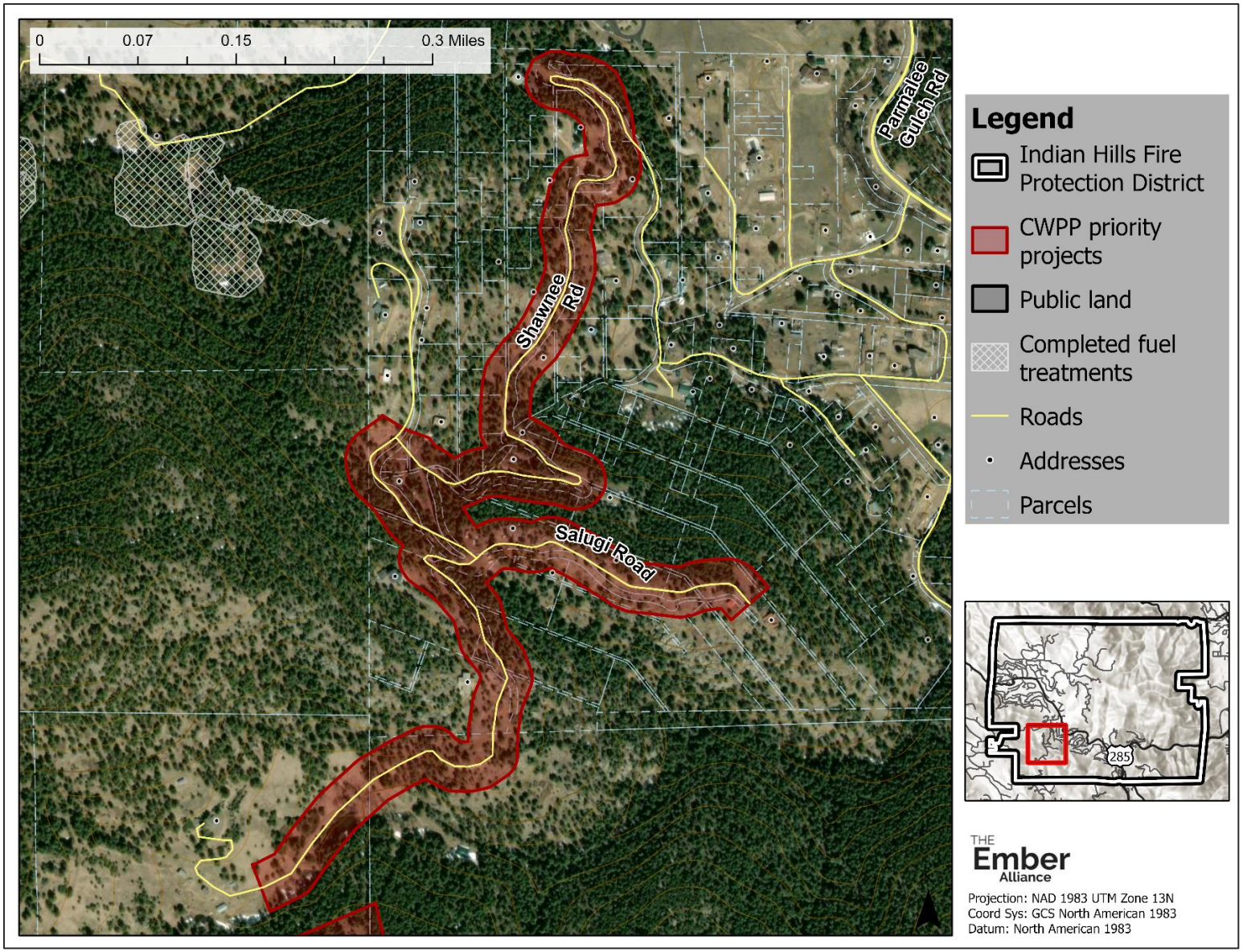


Figure 4.b.2. *General areas in need of roadside fuel treatments along Shawnee Road and Salugi Roads.*

Roadside Fuel Treatments: Santa Clara Road and Hiawatha Trail

Roadside fuel treatments and road improvements along Santa Clara Road and Hiawatha Trail would increase the safety of residents, children and counselors at Geneva Glen Camp, and first responders (**Figure 4.b.3**). The road occurs on a steep north- to northeast-facing slope and is lined with dense ponderosa pine and mixed-conifer forests with abundant ladder fuels. Tight switchbacks, steep grades, and low clearance could limit access for large fire engines along the main road and driveways. Two-way traffic is impossible in some sections of this road. Dense vegetation along roadways could result in non-survivable conditions for residents from over 40 addresses for whom this is the only egress during wildfire emergencies.

Based on fire behavior modeling and preliminary assessments, almost 1 mile of the roads could potentially benefit from fuel treatments. The specific location of treatments would require a thorough assessment on-the-ground and coordination with private landowners. Small lot sizes will pose challenges for establishing sufficient roadside treatment areas, but there is still plenty of work that can be done to increase safety along this roadway.

Roadside Fuel Treatments Along Santa Clara Road and Hiawatha Trail	
Treatment objectives:	Increase the safety of evacuation routes for residents. Improve access for fire responders.
Treatment type:	Mechanical thinning and slash removal to create a shaded fuelbreak and reduce fuel loads. Roadway improvements to create pullovers. See **Section 4.d.** for details on roadside fuel treatments and **Section 4.e.** for information on slash management.
Priority:	Immediate action—start work within 1-2 years.
Lead and support organizations:	IHFR will coordinate with private landowners, County Road & Bridge, Geneva Glen Camp, and Xcel Energy where powerline rights-of-way coincide with the road.

Dense forest conditions in ponderosa pine and mixed-conifer forests along Santa Clara Road and Hiawatha Trail limit firefighter access and could result in non-survivable conditions during wildfires. Photo credit: The Ember Alliance.

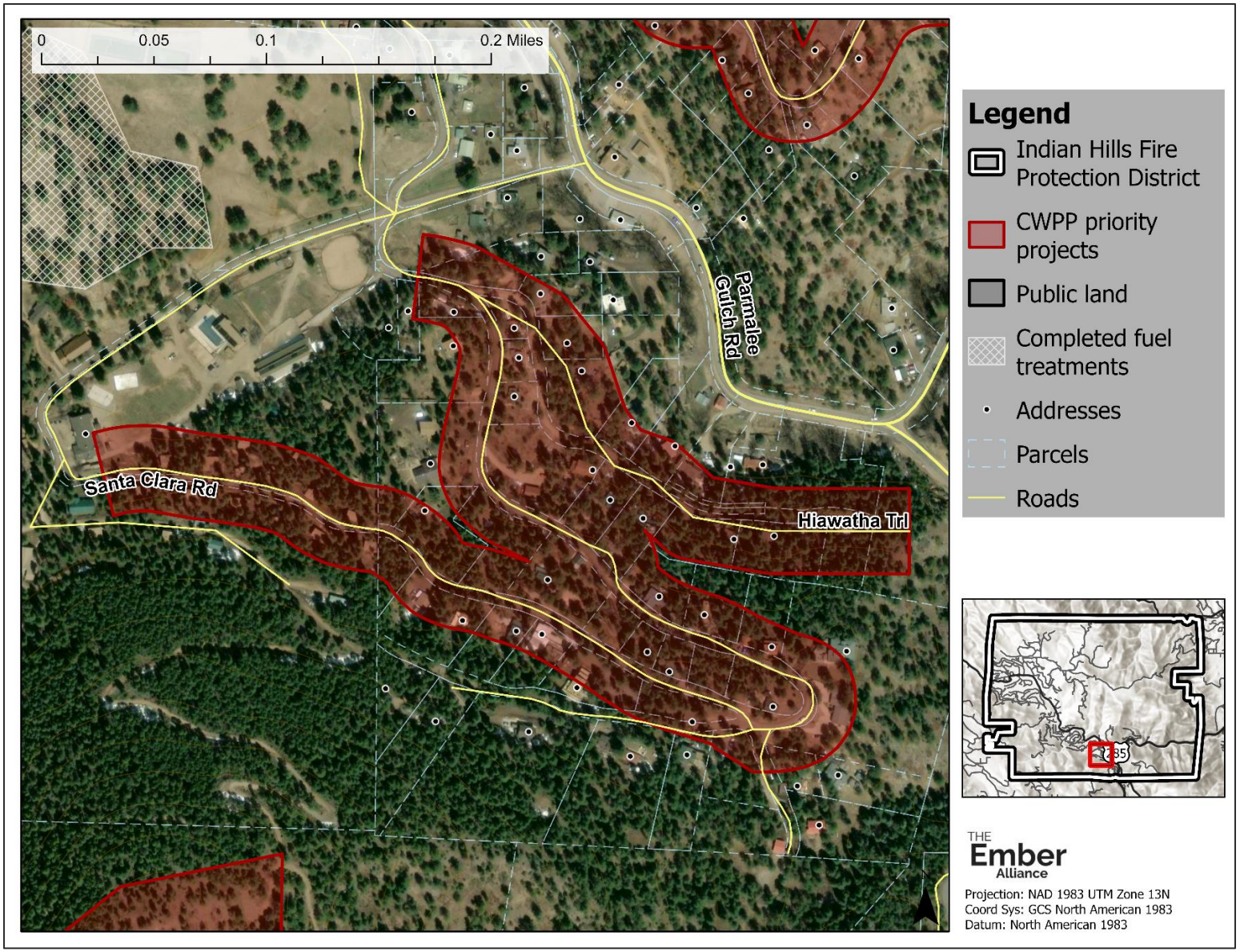


Figure 4.b.3. *General areas in need of roadside fuel treatments along Santa Clara Road and Hiawatha Trail.*

Roadside Fuel Treatments: Algonquin Road and Seminole Road

Roadside fuel treatments and road improvements along Algonquin Road and Seminole Road would increase the safety of residents and first responders (**Figure 4.b.4**). The road occurs on a steep south- to southwest-facing slope and is lined with dense ponderosa pine and mixed-conifer forests with abundant ladder fuels. Tight switchbacks, steep grades, and low clearance could limit access for large fire engines along the main road and driveways. Two-way traffic is impossible in some sections of this road. Dense vegetation along roadways could result in non-survivable conditions for residents from about 35 addresses for whom this is the only egress during wildfire emergencies.

Based on fire behavior modeling and preliminary assessments, almost 1 mile of the roads could potentially benefit from fuel treatments. The specific location of treatments would require a thorough assessment on-the-ground and coordination with private landowners. Small lot sizes will pose challenges for establishing sufficient roadside treatment areas, but there is still plenty of work that can be done to increase safety along this roadway.

Roadside Fuel Treatments Along Algonquin Road and Seminole Road	
Treatment objectives:	Increase the safety of evacuation routes for residents. Improve access for fire responders.
Treatment type:	Mechanical thinning and slash removal to create a shaded fuelbreak and reduce fuel loads. Roadway improvements to create pullovers and turnarounds. See **Section 4.d.** for details on roadside fuel treatments and **Section 4.e.** for information on slash management.
Priority:	Immediate action—start work within 1-2 years.
Lead and support organizations:	IHFR will coordinate with private landowners, County Road & Bridge, and Xcel Energy where powerline rights-of-way coincide with the road.

Dense forest conditions in ponderosa pine and mixed-conifer forests along Algonquin Road and Seminole Road limit firefighter access and could result in non-survivable conditions during wildfires. This road is the only point of egress for about 35 addresses. Photo credits: IHFR.

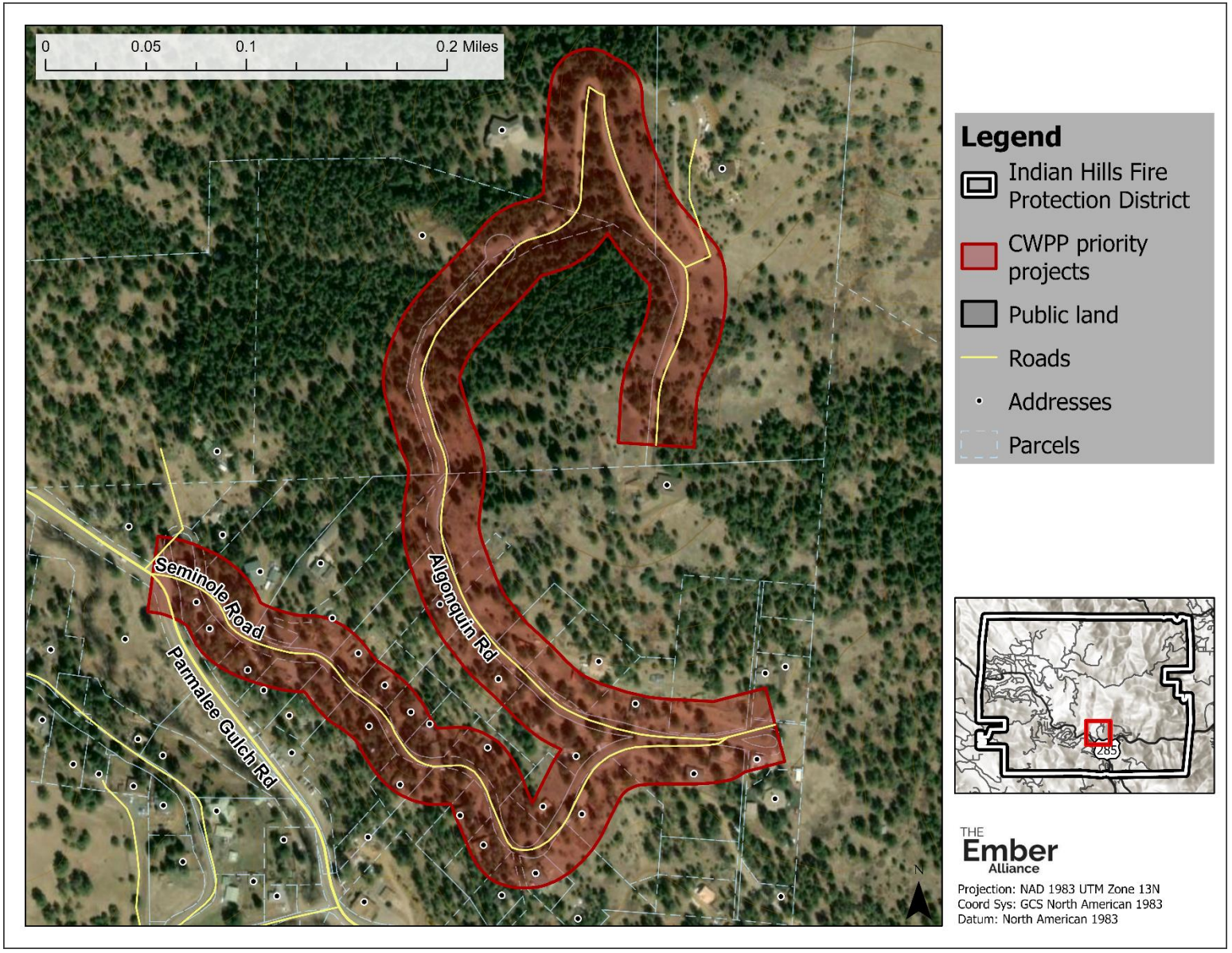


Figure 4.b.4. *General areas in need of roadside fuel treatments along Algonquin Road and Seminole Road.*

Roadside Fuel Treatments: Picutis Road and Nambe Road

Roadside fuel treatments and road improvements along Picutis Road and Nambe Road would increase the safety of residents and first responders (**Figure 4.b.5**). The road occurs on a southwest-facing slope and is lined with dense ponderosa pine forests with abundant ladder fuels. Two-way traffic is impossible in some sections of this road. Dense vegetation along roadways could result in non-survivable conditions for residents from over 30 addresses for whom this is the primary egress during wildfire emergencies.

Based on fire behavior modeling and preliminary assessments, about 1.2 miles of the roads could potentially benefit from fuel treatments. The specific location of treatments would require a thorough assessment on-the-ground and coordination with private landowners.

Roadside Fuel Treatments Along Picutis Road and Nambe Road	
Treatment objectives:	Increase the safety of evacuation routes for residents. Improve access for fire responders.
Treatment type:	Mechanical thinning and slash removal to create a shaded fuelbreak and reduce fuel loads. Roadway improvements to create pullovers. See **Section 4.d.** for details on roadside fuel treatments and **Section 4.e.** for information on slash management.
Priority:	Short-term priority—start work within 3-4 years.
Lead and support organizations:	IHFR will coordinate with private landowners, County Road & Bridge, and Xcel Energy where powerline rights-of-way coincide with the road.

Dense forest conditions in ponderosa pine forests along Picutis Road and Nambe Road limit firefighter access and could result in non-survivable conditions during wildfires, underscoring the need for roadside fuel mitigation. Photo credit: Google Maps.

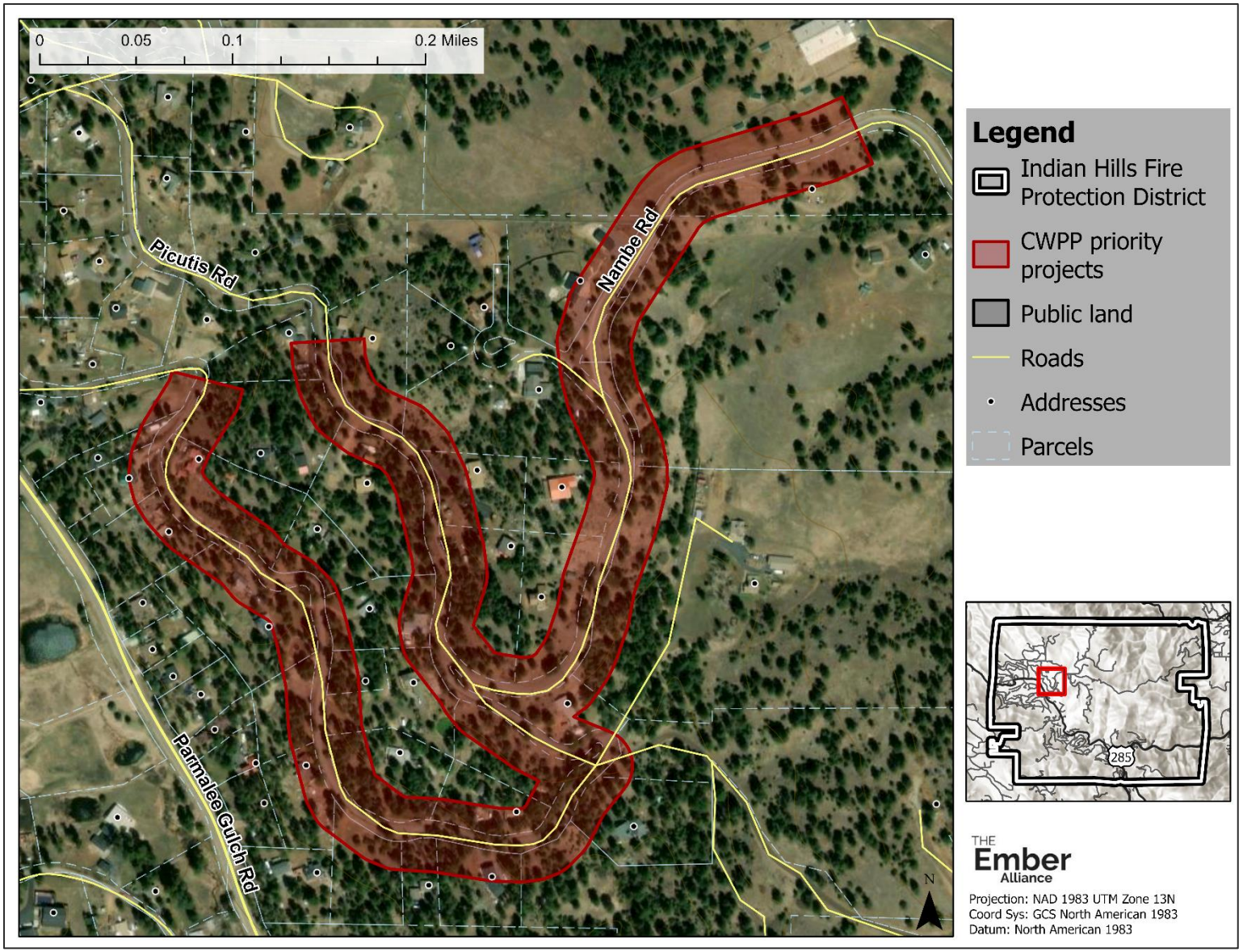


Figure 4.b.5. *General areas in need of roadside fuel treatments along Picutis Road and Nambe Road.*

Roadside Fuel Treatments: Mount Falcon Road and Cameyo Road

Roadside fuel treatments and road improvements along Mount Falcon Road would increase the safety of residents, visitors at Mount Falcon Park, and first responders (**Figure 4.b.6**). Hundreds of visitors and vehicles can be in the west parking lot for Mount Falcon Park on the weekends, which could create severe evacuation congestion. Dense vegetation along roadways could result in non-survivable conditions during wildfires. The road has relatively shallow grades as it follows a wide ridgeline up to the parking lot, past which it becomes a narrow two-track (Castle Trail). The path has steep grades and tight switchbacks in the eastern half of Mount Falcon Park. The two-track could serve as a control feature for wildfire suppression, but it is not an evacuation route.

JCOS conducted fuels treatments along 1.2 miles of Mount Falcon Road and Castle Trail and a prescribed burn in grassy fuels in 2008. The area could benefit from follow-up treatments to further mitigate fire risk. JCOS identified this area as a moderate to high priority for wildfire risk mitigation in their 2022 Forest Health Plan. Based on fire behavior modeling and preliminary assessments, about 2.2 miles of the road and two-track could potentially benefit from improvements. The specific location of treatments would require a thorough assessment on-the-ground and coordination with private landowners.

Cameyo Road could also benefit from treatments to increase safety of residents and first responders. Residents in the area have already begun mitigating fuels along Cameyo Road, and continued effort could make this road even safer for the 16 address that rely on this road as their only egress route. Cameyo Road lacks pullovers and turnarounds and is difficult to maneuver with large fire engines, so it is important to address access along this road as well.

Roadside Fuel Treatments Along Mount Falcon Road and Cameyo Road	
Treatment objectives:	Increase the safety of evacuation routes for residents, visitors at Mount Falcon Park, and fire responders. Improve the potential for Mount Falcon Road and Castle Trail to serve as a control feature during wildfire suppression.
Treatment type:	Mechanical thinning and slash removal to create a shaded fuelbreak and reduce fuel loads. Roadway improvements to create pullovers and turnarounds. See **Section 4.d.** for details on roadside fuel treatments and **Section 4.e.** for information on slash management.
Priority:	Short-term priority—start work within 3-4 years (potentially within 5-10 years on Mount Falcon Park depending on the schedule of other high-priority projects for Jefferson County Open Space).
Lead and support organizations:	JCOS will lead efforts on Mount Falcon Park, and IHFR will coordinate with private landowners, County Road & Bridge, and Xcel Energy where powerline rights-of-way coincide with the road.

Ladder fuels in ponderosa pine forests along Mount Falcon Road could result in non-survivable conditions during wildfires. Photo credit: Google Maps.

Residents have started mitigating fuels along Cameyo Road by removing ladder fuels, but additional tree removal to increase the space between tree crowns would further mitigate wildfire hazards in dense ponderosa pine forests. Photo credit: The Ember Alliance.

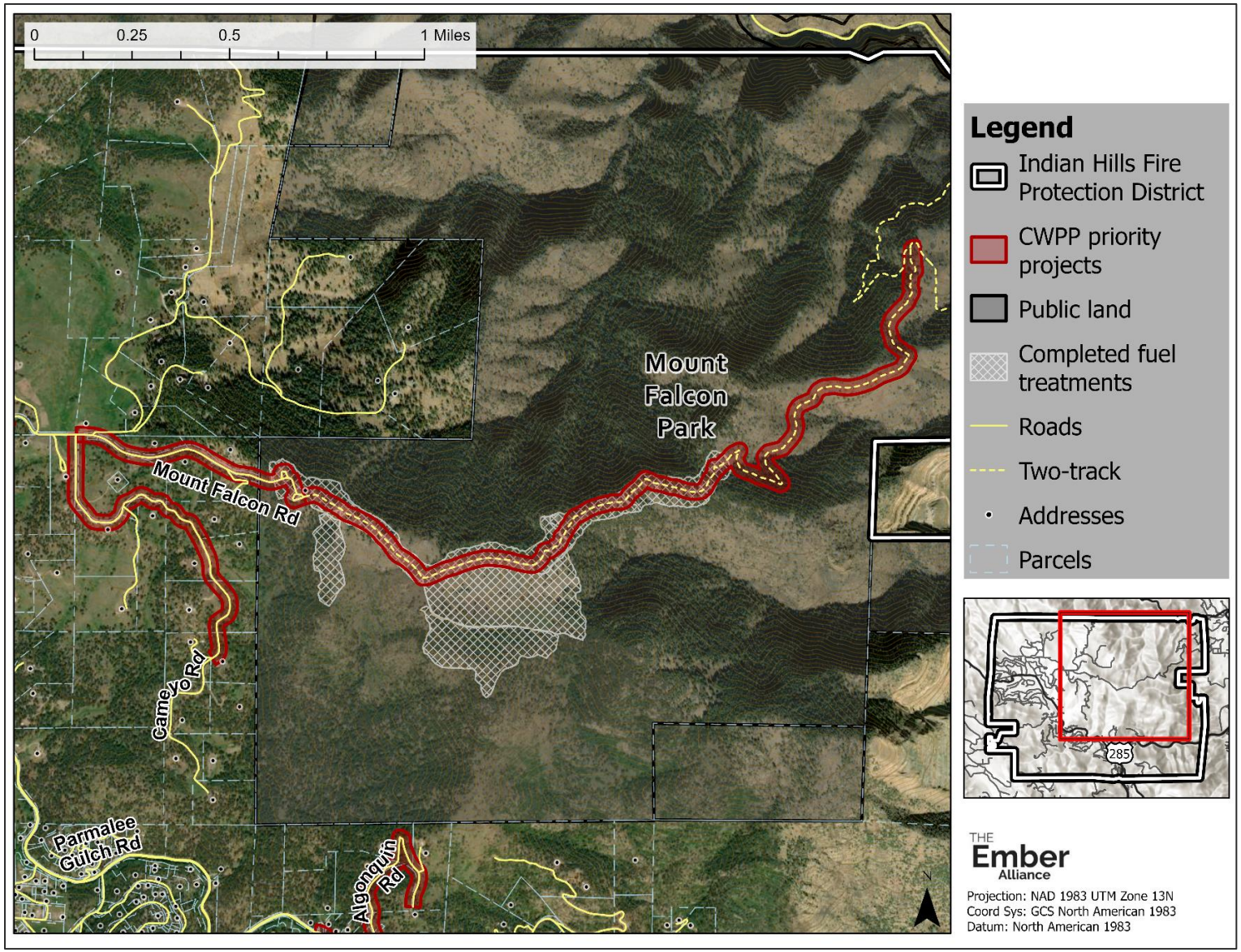


Figure 4.b.6. *General areas in need of roadside fuel treatments along Mount Falcon Road, Castle Trail, and Cameyo Road.*

Roadside Fuel Treatments: High Drive

Roadside fuel treatments and road improvements along High Drive would increase the safety of residents and first responders (

Figure 4.b.7). The road could potentially serve as a control feature during wildfire suppression. The road curves across rolling hills and is lined with dense ponderosa pine and mixed-conifer forests with abundant ladder fuels in many places. Dense vegetation along roadways could result in non-survivable conditions for residents from over 125 addresses for whom this segment of road is the primary egress during wildfire emergencies. Six addresses along this road are within the boundary of the IHFPD and the rest are in the Evergreen Fire Protection District.

Based on fire behavior modeling and preliminary assessments, about 2.0 miles of the road could potentially benefit from fuel treatments. The specific location of treatments would require a thorough assessment on-the-ground and coordination with private landowners. This area falls within the Lone Peak priority project area from the 2020 CWPP for Evergreen Fire Protection District.

Roadside Fuel Treatments Along High Drive	
Treatment objectives:	Increase the safety of evacuation routes for residents and fire responders. Improve the potential for High Drive to serve as a control feature during wildfire suppression.
Treatment type:	Mechanical thinning and slash removal to create a shaded fuelbreak and reduce fuel loads. See **Section 4.d.** for details on roadside fuel treatments and **Section 4.e.** for information on slash management.
Priority:	Mid-term priority—start work within 5-10 years.
Lead and support organizations:	IHFR will coordinate with Evergreen Fire Protection District, private landowners, County Road & Bridge, and IREA where powerline rights-of-way coincide with the road.

Dense forest conditions in ponderosa pine and mixed-conifer forests along High Drive could result in non-survivable conditions during wildfires. Photo credit: Google Maps.

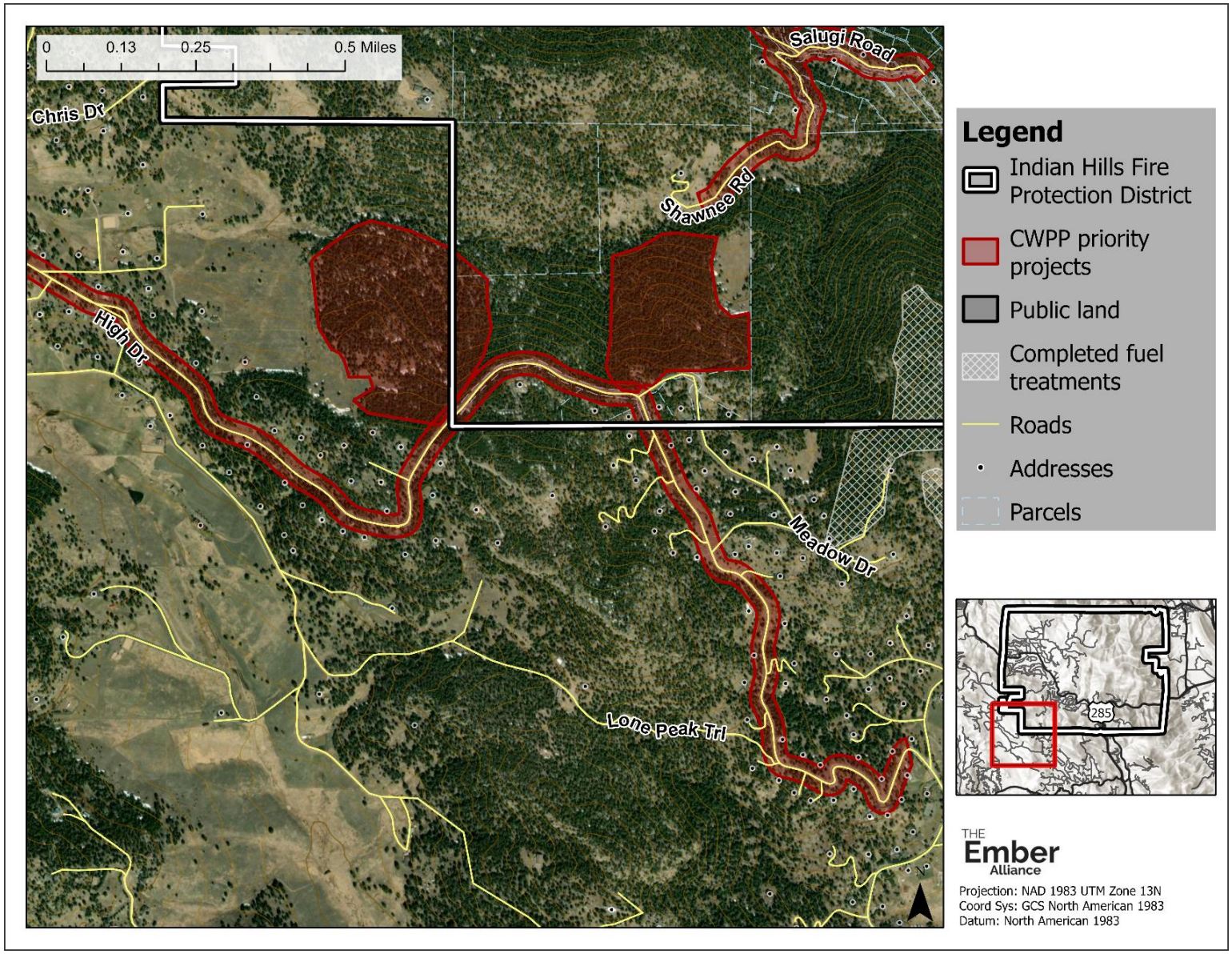


Figure 4.b.7. *General areas in need of roadside fuel treatments along High Drive.*

Roadside and Stand-Scale Treatments: Mount Olinger Cemetery / Mount Lindo Park

Roadside fuel treatments, treatments along powerline corridors, and stand-scale treatments around Mount Olinger Cemetery in Mount Lindo Park could protect the cemetery, visitors, employees, fire responders, and the IHFR radio repeater, which is important for emergency communications (**Figure 4.b.8**). The road could potentially serve as a control feature during wildfire suppression. The road to Mount Olinger Cemetery is lined with dense ponderosa pine and mixed-conifer forests with abundant ladder fuels, which could result in non-survivable conditions during wildfires.

Xcel Energy has mitigated fuels along the overhead distribution line that serves the cemetery and radio repeater, but additional work can help ensure that power is maintained to these important community assets. JCOS identified this area as a moderate to higher priority for wildfire risk mitigation in their 2022 Forest Health Plan.

Based on fire behavior modeling and preliminary assessments, about 2.6 miles of the road could potentially benefit from fuel treatments, 0.1 miles of the powerline corridor, and about 25-acres of the forest to the north of the cemetery. The specific location of treatments would require a thorough assessment on-the-ground. Unfortunately, much of Mount Lindo is extremely steep and inaccessible for fuel mitigation work, despite the high potential for extreme fire risk.

Roadside and Stand-Scale Treatments around Mount Olinger Cemetery and Mount Lindo Park	
Treatment objectives:	Increase the safety of evacuation routes for visitors and employees of the cemetery. Improve access for fire responders. Improve the potential for the road to Mount Olinger Cemetery to serve as a control feature during wildfire suppression. Reduce risk of interrupted service to overhead powerlines that serve the IHFR radio repeater.
Treatment type:	Mechanical thinning and slash removal to create a shaded fuelbreak and reduce fuel loads. Stand-scale treatments to restore ecological conditions in ponderosa pine and mixed-conifer forests. See **Section 4.c.** for details on stand-scale treatments, **Section 4.d.** for details on roadside fuel treatments, and **Section 4.e.** for information on slash management.
Priority:	Short-term priority—start work within 3-4 years.
Lead and support organizations:	Mount Olinger Cemetery and JCOS will work together to conduct fuel treatments and coordinate with Xcel Energy to mitigate along overhead powerlines.

Dense forest conditions in ponderosa pine and mixed-conifer forests on a steep, north-facing slope below Mount Olinger Cemetery and Mount Falcon Park could support extreme fire behavior. Fuel treatments are exceptionally challenging on such steep slopes, but treatments along the access road to the cemetery, flatter ground around the cemetery, and along powerline corridors could increase safety of visitors, employees, and first responders and protect important assets in this area. Photo credit: The Ember Alliance.

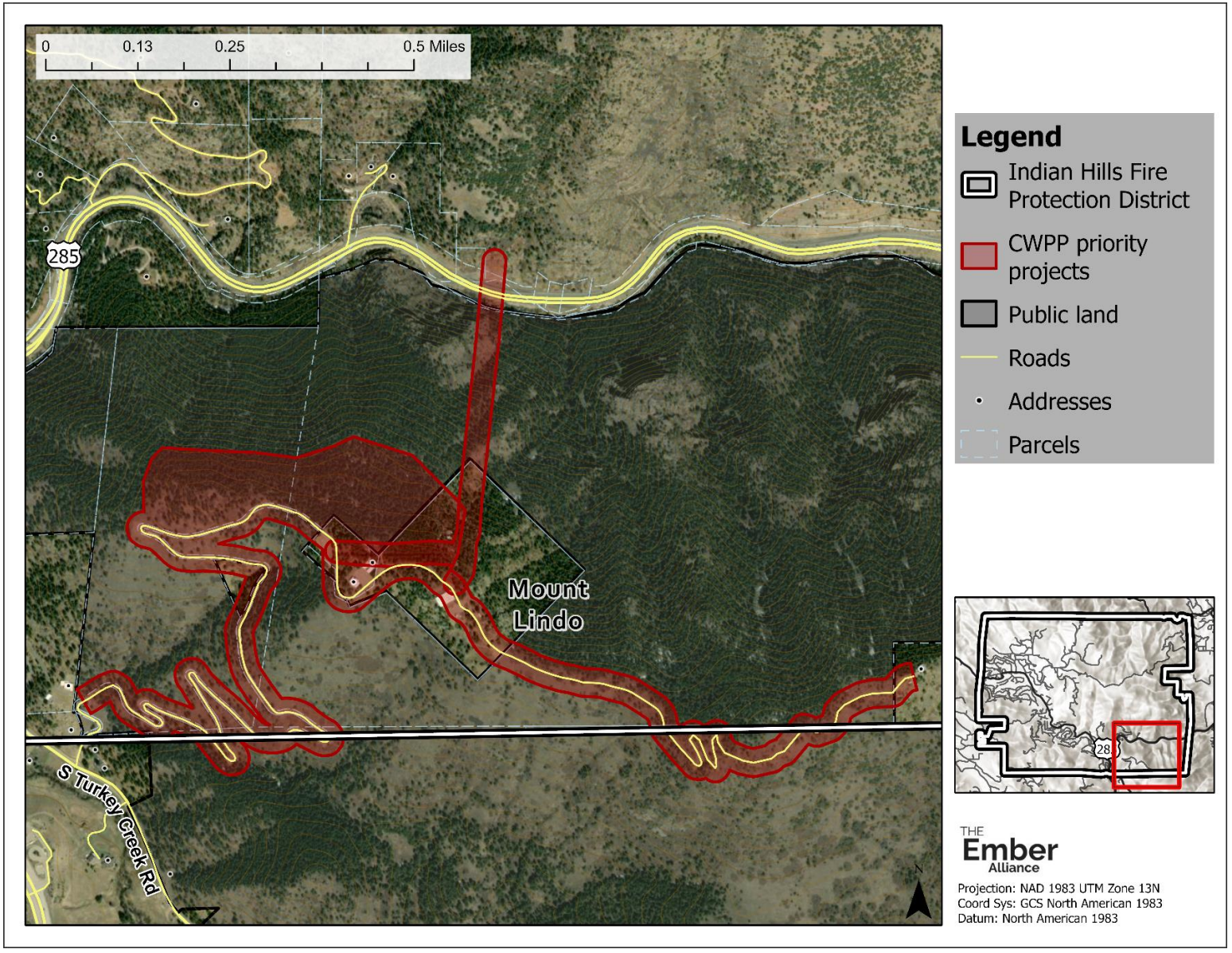


Figure 4.b.8. *General areas in need of roadside and stand-scale treatments around Mount Olinger Cemetery and Mount Lindo Park.*

Stand-Scale Treatments: Geneva Glen Camp and Birch Hill Park

Stand-scale treatments in ponderosa pine and mixed-conifer forests in Birch Hill Park, administered by DMP, and Geneva Glen Camp would restore ecological conditions and mitigate fire risk along the southern edge of the IHFPD (**Figure 4.b.9**). Much of the area is covered in dense mixed-conifer forests with abundant ladder fuels on moderately steep north-facing slopes. The southern part of Birch Hill Park has lower density forest on a moderately steep south- and southwest-facing slope. There is a high potential for extreme fire behavior due to topography and forest conditions in this area.

Geneva Glen Camp worked with JCD to restore ecological conditions across 90-acres of ponderosa pine and mixed-conifer forests in 2018 and 2022 to the west of Birch Hill. Geneva Glen Camp and JCD are planning to treat additional acres north of Birch Hill in the next several years. DMP treated 40-acres of Birch Hill in 2014, but slash piles from that treatment have yet to be burned and DMP forest managers would like to retreat the area to achieve ecological restoration and fuel mitigation objectives. Cross-boundary collaboration among Genva Glen, JCD, and DMP is exactly the type of landscape-scale approach needed to protect at-risk communities in this part of Colorado.

Stand-scale treatments on Geneva Glen Camp and Birch Hill Park	
Treatment objectives:	Create healthy forest conditions that are more resistant and resilient to fire. Magnify benefits of treatments by working across boundaries.
Treatment type:	Mechanical treatments to restore ecological conditions in ponderosa pine and mixed-conifer forests. Pile burning or other slash management approaches to eliminate fuels. See **Section 4.c.** for details on stand-scale treatments and **Section 4.e.** for information on slash management.
Priority:	Short-term priority—start work within 3-4 years.
Lead and support organizations:	Geneva Glen Camp, JCD, and DMP will work together to coordinate access to each other's properties and to design and implement effective treatments.

Dense forest conditions in a ponderosa pine and mixed-conifer forest on a steep, south-west facing slope on Birch Hill Park. Photo credit: Google Maps.

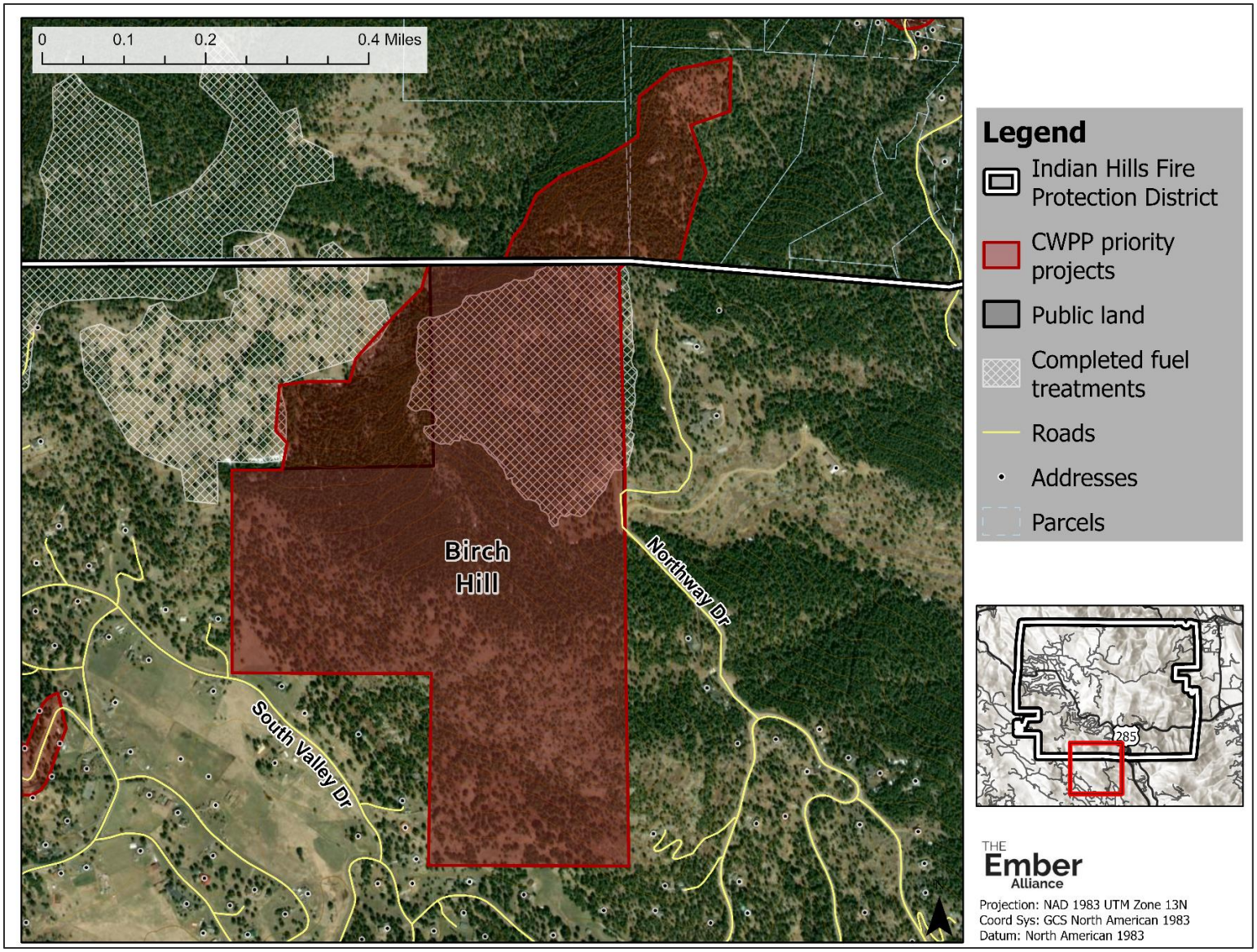


Figure 4.b.9. *General area of proposed stand-scale treatments on Geneva Glen Camp and Birch Hill Park.*

Stand-Scale Treatments: Giant Gulch Project

JCD is working with a private landowner to conduct 65-72 acres of stand-scale treatments in a mixed-conifer forest on the southwestern edge of the IHFPD (**Figure 4.b.10**). The Giant Gulch Project seeks to restore ecological conditions and mitigate wildfire risk in dense forests on moderately steep north-facing slopes. There is a high potential for extreme fire behavior in this area due to topography and forest conditions in this area. High Drive is located above the project area and could experience non-survivable conditions if a fire were to burn upslope through the dense mixed-conifer forests and towards the road.

This project will magnify the impact of work already completed and underway by JCD and Geneva Glen Camp to the east. The property falls within the Lone Peak priority project area from the 2020 CWPP for Evergreen Fire Protection District.

Stand-scale treatments in the Giant Gulch project area	
Treatment objectives:	Create healthy forest conditions that are more resistant and resilient to fire. Mitigate fire risk on a steep slope below High Drive. Magnify benefits of treatments conducted on Geneva Glen Camp to the east.
Treatment type:	Mechanical treatments to restore ecological conditions in mixed-conifer forests. Robust slash management to eliminate fuels. See **Section 4.c.** for details on stand-scale treatments and **Section 4.e.** for information on slash management.
Priority:	Immediate action—start work within 1-2 years.
Lead and support organizations:	JCD and a private property owner a working together to design and implement effective treatments. JCD will coordinate with Xcel Energy to increase access and remove fuels along overhead powerlines in the project area.

The Giant Gulch project will restore ecological conditions in a dense mixed-conifer forest in the southwest part of the IHFPD. Photo credit: The Ember Alliance.

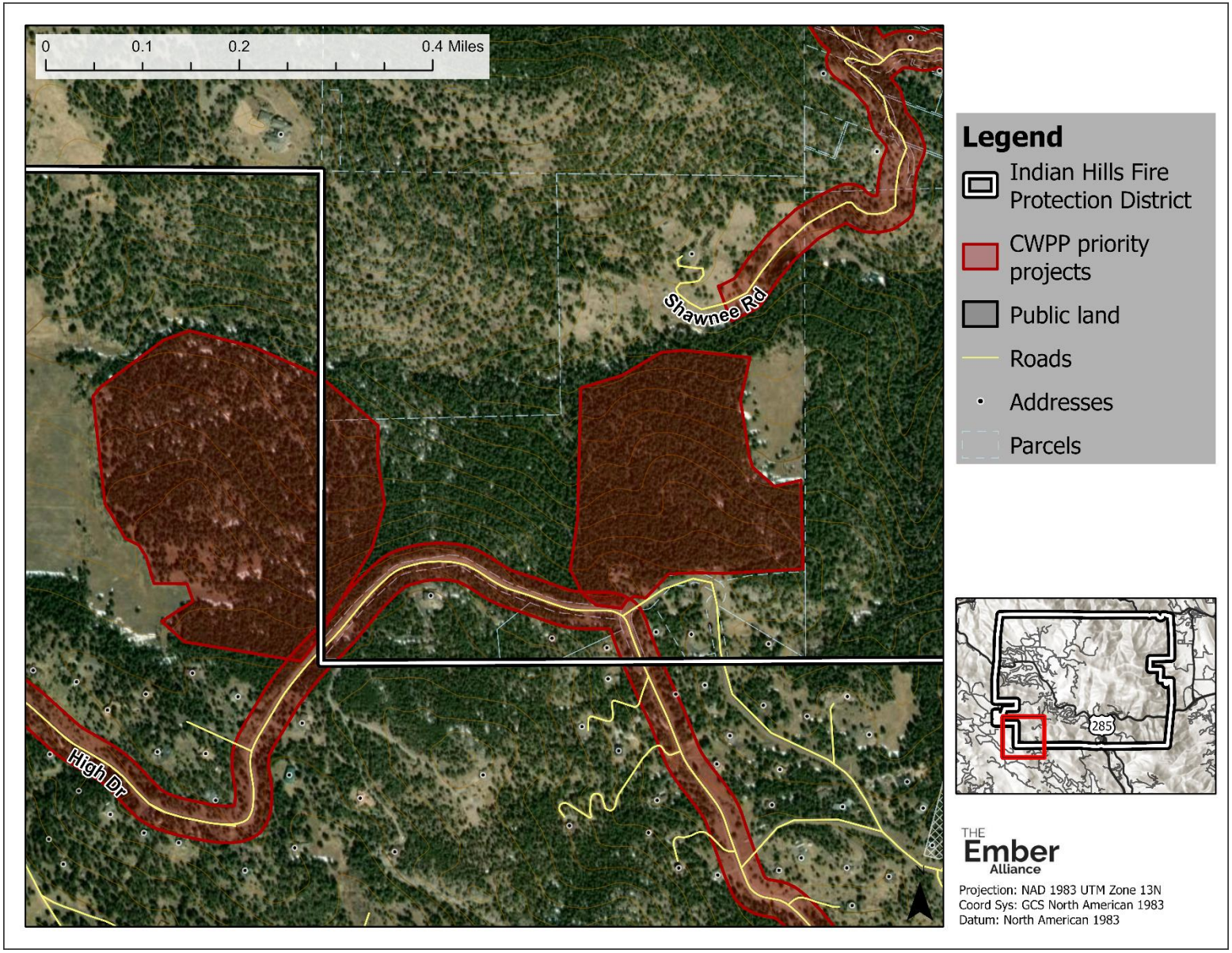


Figure 4.b.10. *General area of proposed stand-scale treatments for the Giant Gulch project.*

Stand-Scale Treatments: Pence Park and O'Fallon Park

Stand-scale treatments in ponderosa pine and mixed-conifer forests in Pence Park and O'Fallon Park, administered by DMP, would restore ecological conditions and mitigate fire risk along the northwestern edge of the IHFPD (**Figure 4.b.11**). These parks are characterized by complex topography and a variety of open meadows, low- to moderate-density ponderosa pine forests, and dense mixed-conifer forests with abundant ladder fuels. Forests on steep slopes could support high to extreme fire behavior in this area, and were fires to grow out of control, they could spread into neighborhoods on the western edge of IHFPD.

DMP conducted stand-scale treatments across 310 acres in O'Fallon in 2015, and additional treatments in the area, including cross-boundary work with adjacent private landowners, could help protect the community from high-severity wildfires. The southern portion of Pence Park falls within the Bear Mountain priority project area from the 2020 CWPP for Evergreen Fire Protection District.

Stand-scale treatments on Pence Park and O'Fallon Park	
Treatment objectives:	Create healthy forest conditions that are more resistant and resilient to fire. Mitigate fire risk on steep slopes to the west of IHFPD. Magnify benefits of previous treatments conducted in the area.
Treatment type:	Mechanical treatments to restore ecological conditions in ponderosa pine and mixed-conifer forests. Pile burning or other slash management approaches to eliminate fuels. See **Section 4.c.** for details on stand-scale treatments and **Section 4.e.** for information on slash management.
Priority:	Short-term priority—start work within 3-4 years.
Lead and support organizations:	DMP will design and implement effective treatments on public land. IHFR will coordinate with adjacent private landowners and Xcel Energy to facilitate access and remove fuels along overhead.

Dense forests and complex topography can support high-severity wildfires on Pence Park and O'Fallon Park to the west of IHFPD. Picture credit: The Ember Alliance.

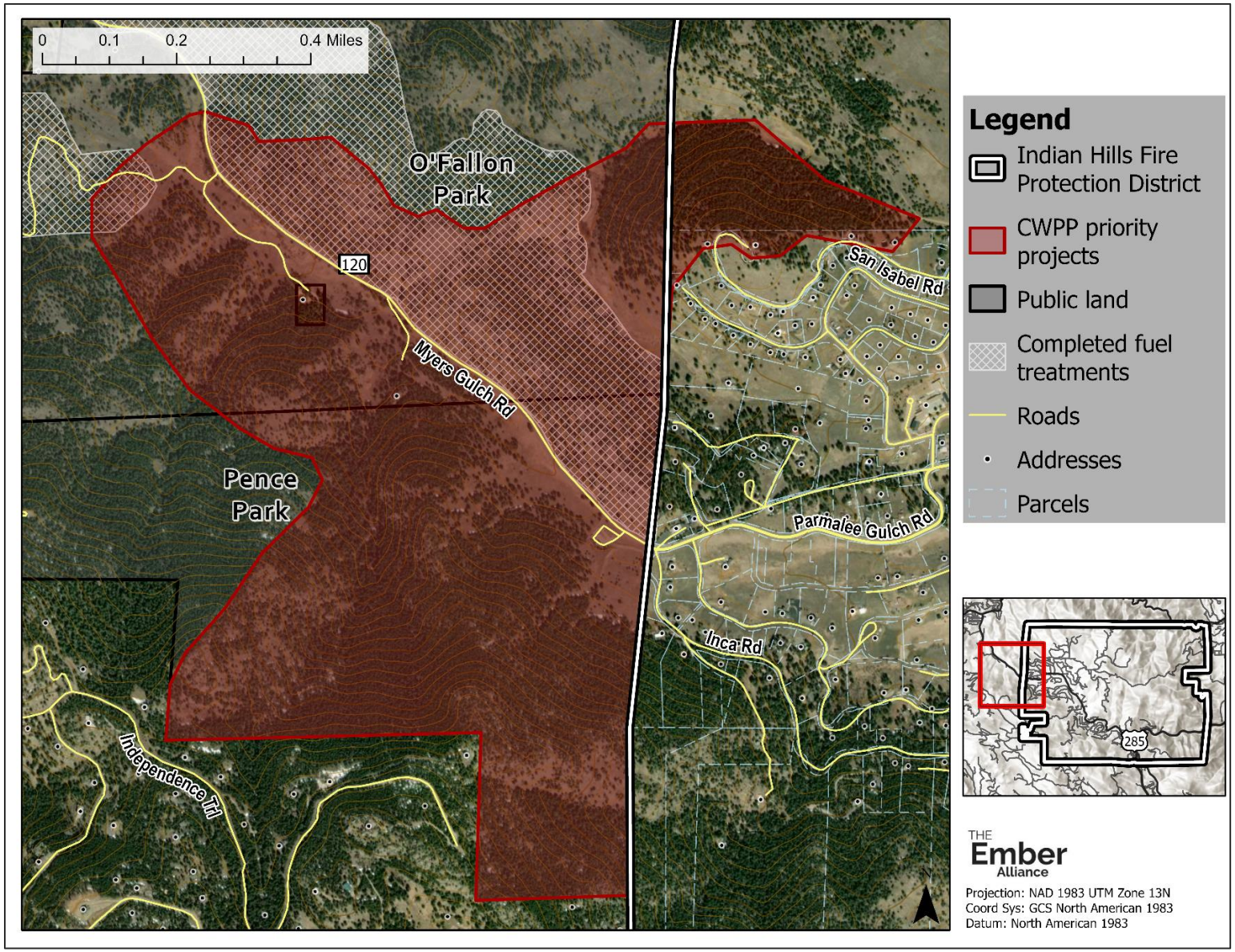


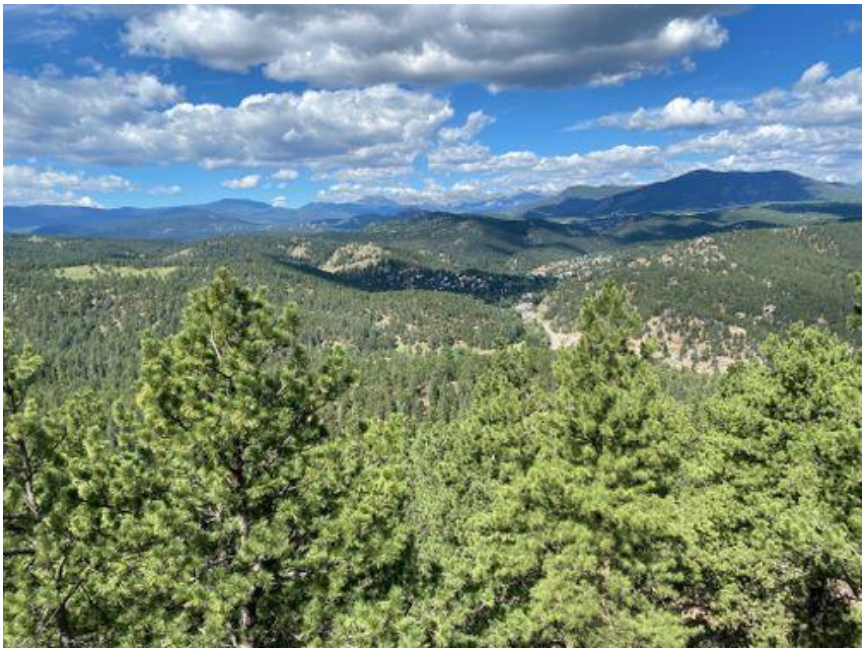
Figure 4.b.11. *General area of proposed stand-scale treatments on Pence Park and O'Fallon Park.*

Stand-Scale Treatments: Corwina Park

Stand-scale treatments in ponderosa pine and mixed-conifer forests in Corwina Park, administered by DMP, would restore ecological conditions and mitigate fire risk along the northwestern edge of the IHFPD (**Figure 4.b.11**). Corwina Park is characterized by dense ponderosa pine and mixed-conifer forests with abundant ladder fuels on steep to extremely steep north and west-facing slopes to the south of Highway 74 and low-density ponderosa pine forest on moderate south-facing slopes to the north of High 74. Forests on steep slopes could support high to extreme fire behavior in this area, and were fires to grow out of control, they could spread into neighborhoods on the western edge of IHFPD.

DMP has not conducted any recent stand-scale treatments in Corwina Park due to steep slopes and poor accessibility. Coordination with adjacent private landowners in IHFPD could create opportunities for accessing and treating portions of this high-risk area. The southern portion of Pence Park falls within the Bear Mountain priority project area from the 2020 CWPP for Evergreen Fire Protection District.

Stand-scale treatments on Corwina Park	
Treatment objectives:	Create healthy forest conditions that are more resistant and resilient to fire. Mitigate fire risk on steep slopes to the west of IHFPD.
Treatment type:	Mechanical treatments to restore ecological conditions in ponderosa pine and mixed-conifer forests. Pile burning or other slash management approaches to eliminate fuels. See **Section 4.c.** for details on stand-scale treatments and **Section 4.e.** for information on slash management.
Priority:	Mid-term priority—start work within 5-10 years.
Lead and support organizations:	DMP will design and implement effective treatments on public land. IHFR will coordinate with adjacent private landowners to facilitate access to the property.



Dense forests and complex topography can support high-severity wildfires on Corwina Park to the west of IHFPD. Picture credit: AllTrails.com.

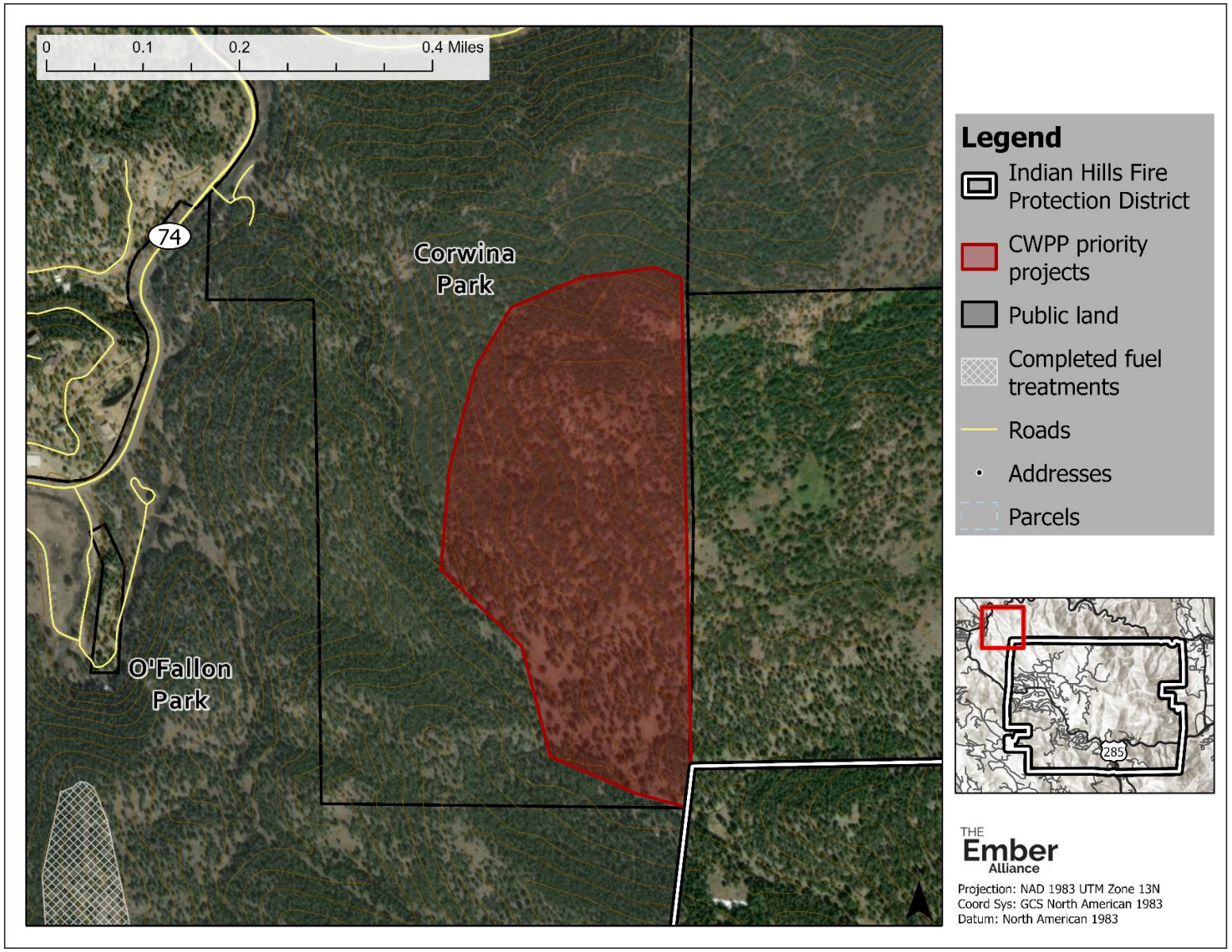


Figure 4.b.12. *General area of proposed stand-scale treatments on Corwina Park.*

4.c. General Recommendations for Home Ignition Zone 3 and Stand-scale Treatments

Local knowledge and professional expertise are needed to design effective, site-specific fuel treatments based on the best available science. Specific fuel treatment recommendations are dependent on forest type, tree density, fuel loads, terrain, land use, and management objectives. The location and purpose of treatments also matter. Treatments in large, forested areas can include the retention of individual trees and groups of trees. Evenly and widely spacing trees might be reasonable in the home ignition zone 3, but this tree arrangement would not be appropriate for restoration-style fuel treatments.

Treatments in home ignition zone 3 (30-100 feet away from the home) can restore historical forest structure, but it is most important to focus on reducing wildfire risk to the home, creating safe conditions for firefighters, and increasing the visibility of your home from the road for firefighters. Homeowners often enjoy the more open forest around their home because it lets in more light which encourages understory grasses and shrubs to grow and, in turn, can increase wildlife sightings near their home. Home ignition zone 3 often overlaps neighboring properties and requires residents to work together to address shared wildfire risk.

For all fuel treatments, it is important to address surface fuels. Forest management operations often increase surface fuel loads and can fail to achieve fire mitigation objectives if fuels created by the harvest activities (also known as slash) are not addressed (Agee and Skinner, 2005). Slash can include small trees, limbs, bark, and treetops. See **Section 4.e. f**or pros and cons of different slash management options.

Mitigating the impacts of tree removal on soil compaction and erosion is also important when treatments occur near streams and riparian ecosystems. The Colorado State Forest Service recommends streamside management zones of at least 50 feet (CSFS, 2010). Treatments should be monitored for colonization of invasive, weedy plants that might require control through integrated weed management. It's always a good idea to take pictures of treatments before and after to help evaluate effectiveness and monitor changes over time (for an example, see **Figure 2.g.1**).

Here we provide general recommendations for treatments in home ignition zone 3 and stand-scale fuel treatments and ecological restoration by vegetation types. Guidance for treatments in the home ignition zone are summarized from the CSFS publication The Home Ignition Zone. It is important to work with a forester that has experience creating defensible space so they can help you design an effective treatment specific to vegetation type, slope, and other conditions around your home.

Ponderosa Pine Forests

Ponderosa pine forests occur across about a third of the IHFPD (**Figure 2.a.2**). These forests are dominated by ponderosa pine with mixtures of Douglas-fir, Gamble oak, Rocky Mountain juniper, and aspen. Some ponderosa pine forests on drier south-facing slopes have low to moderate tree densities and understories with abundant grasses, forbs, and shrubs. Forests on moister north-facing slopes in IHFPD tend to have higher tree densities and abundant ladder fuels from regenerating trees.

Gamble oak and Rocky Mountain juniper are highly flammable components of ponderosa pine ecosystems. Gambel oak demonstrate vigorous growth after disturbance because they can sprout new trunks from their extensive root system. Rocky Mountain juniper does not resprout after the aboveground vegetation is burned by wildfire. These species add diversity to the landscape and provide food and shelter to wildlife species, but they can be dangerous sources of fuel in the home ignition zone.

Ponderosa pine forests were fire-adapted ecosystems and very resilient to wildfires. Prior to the implementation of modern fire control practices, low- to mixed-severity fires occurred every 7 to 50 years and resulted in a mosaic of widely spaced trees and small tree clumps interwoven with grasslands and shrublands, particularly on drier south-facing slopes (**Figure 2.e.1**) (Addington et al., 2018). Frequent fires would kill many tree seedlings and saplings, thereby preventing the accumulation of ladder fuels and reducing the potential for surface fires to transition into crown fires.

Ponderosa pine forests in the IHFPD range from open woodlands with grasses, forbs, and shrubs in the understories to high-density forests. Regenerating trees and shrubs, including Rocky Mountain juniper and Gamble oak, can serve as ladder fuels that transition surface fires into treetops. Photo credits: The Ember Alliance.

Recommendations for home igntion zone 3:

- Remove large trees so that the crown spacing of remaining trees is 6 to 10 feet. If desired, retain scattered, small clumps of trees (about 6-10 trees) with interlocking crowns. Ensure these clumps are at least 10 feet away from single trees and other tree clumps. See **Figure 3.a.3** for a depiction of how to measure crown spacing.
- Favor leaving large, older trees that have naturally lost their lower branches and have thick bark that confers resistance to wildfires.
- Favor leaving aspen on site to create beautiful post-treatment conditions with greater resistance to wildfire.

- Remove limbs of all remaining trees so branches do not hang below 6 feet above the ground**,** ideally not below 10 feet above the ground, to reduce the risk of wildfire transitioning from the surface into treetops. See **Figure 3.a.3** for a depiction of how to measure limb height.
- Remove shrubs and small trees that can serve as ladder fuels or abut sheds and other outbuildings, particularly Gamble oak and Rocky Mountain juniper.
- Thin Gamble oak if they occur in continuous, dense stands. Favor leaving large, old, Gamble oaks to maintain diversity in the ecosystem. Use mastication, mowing, and herbicide to remove Gambel oak and control the regrowth every three to five years, or more frequently depending on growing conditions. Triclopyr is recommended as the most effective herbicide when applied to the stump directly after cutting the stem (Jester et al., 2012).
- Remove slash from the site. Avoid lop-and-scatter and mulching treatments that only rearrange fuels without removing them.

Recommendations for stand-scale fuel treatments and ecological restoration:

Follow the principles of ecological restoration as outlined in Addington et al., 2018 to help achieve fuel reduction and ecosystem restoration objectives. In frequent-fire forests, such as ponderosa pine forests along the Colorado Front Range, restoration treatments involve converting dense forests into a mosaic of single trees, clumps of trees, and meadows. These conditions are similar to historical forests that were maintained by wildfires and very resilient to them.

Thinning combined with broadcast burning is the most effective treatment for ponderosa pine forests (Addington et al., 2018; Fulé et al., 2012; Prichard et al., 2020). Older trees can withstand the fire while small trees, shrubs, downed logs, and fine fuels are consumed. It is important to go through the proper permitting process and coordinate with IHFR before burning vegetation on your property. See more details on broadcast and pile burning in the section below on slash management.

Gambel oak should not always be eradicated from ponderosa pine forests because it is an important species for wildlife. Favor leaving large, old, Gamble oaks to maintain diversity in the ecosystem. If Gamble oak occurs in dense thickets under ponderosa pine trees near human habitation, mastication and prescribed burning can be effective at managing this species. Prescribed burning during the growing season – particularly later growing season, when the stored sugar levels in the roots are lowest – can reduce the volume of resprouting (Harrington, 1989).

Example of a high-quality HIZ 3 treatment in a ponderosa pine forest adjacent to a home in IHFPD. All limbs less than 10 feet above the ground have been removed, and individual trees and small groups of trees are separated by at least 10 feet spacing.

Mixed-Conifer Forests

Mixed-conifer forests dominated by Douglas-fir and with variable mixtures of ponderosa pine, lodgepole pine, Englemann spruce, Colorado blue spruce, subalpine fir, and aspen cover about 50% of the IHFPD (**Figure 2.a.2**). These forests are dense and have abundant ladder fuels from regenerating trees and shrubs, particularly on north-facing slopes and in drainages with cooler temperatures and higher soil moisture.

Wildfires burned mixed-conifer forests dominated by Douglas-fir every 20 to >100 years prior to Euro-American settlement (**Figure 2.e.1**). These forests tended to burn less frequently than ponderosa pine forests due to cooler, moister conditions at higher elevations, particularly on north-facing slopes (Addington et al., 2018). Higher tree densities and fuel loads could support high-severity wildfires that killed patches of trees and create a mosaic landscape with recently burned forests and dense unburned forests. The death of overstory trees increases the availability of sunlight to regenerating trees, including sun-loving aspen.

Dense, mixed-conifer forests with abundant ladder fuels and a high risk of active crown fires are prevalent in IHFPD. These forests are dominated by Douglas-fir and with variable mixtures of ponderosa pine, lodgepole pine, Englemann spruce, Colorado blue spruce, subalpine fir, and aspen. Photo credits: The Ember Alliance.

Recommendations for home ignition zone 3:

There are two main options for tree removal in home ignition zone 3 in mixed-conifer forests. Consult a forestry professional to determine the best approach for forests on your property:

- Remove large trees so that the crown spacing of remaining trees is 6 to 10 feet. If desired, retain scattered, small clumps of trees (about 6-10 trees) with interlocking crowns. Ensure these clumps are at least 10 feet away from single trees and other tree clumps. See **Figure 3.a.3** for a depiction of how to measure crown spacing.
- Create a mosaic of open areas and groups of trees through patch cutting. Groups can include 30-50 trees and must be separated from other groups by at least 30-50 feet.

Regardless of the approach taken above, the following guidelines are recommended for all treatments in mixed-conifer forests:

- Remove small trees and shrubs that serve as ladder fuels.
- Remove limbs of all remaining trees so branches do not hang below 6 feet above the ground**,** ideally not below 10 feet above the ground, to reduce the risk of wildfire transitioning from the surface into treetops. See **Figure 3.a.3** for a depiction of how to measure limb height.
- Favor leaving aspen on site to create beautiful post-treatment conditions with greater resistance to wildfire.
- Remove slash from the site. Avoid lop-and-scatter and mulching treatments that only rearrange fuels without removing them.

Removing trees to increase the distance between treetops is important for reducing the potential for active crown fire in home ignition zone 3. Photo credit: Colorado State Forest Service.

Recommendations for stand-scale fuel treatments and ecological restoration:

Follow the principles of ecological restoration as outlined in Addington et al., 2018 and fuel treatment recommendations in (Evans et al., 2011) to help achieve fuel reduction and ecosystem restoration objectives. Depending on site conditions and species composition, ecological restoration in mixed-conifer forests can be similar to treatments in ponderosa pine forests—thinning and/or broadcast burning to convert dense forests into a mosaic of single trees, clumps of trees, and meadows. It is important to go through the proper permitting process and coordinate with IHFR before burning vegetation on your property. See more details on broadcast and pile burning in the section below on slash management.

On north-facing slopes or ravines with higher tree densities and soil moistures, patch cutting can be an appropriate approach to reduce fuel loads and create heterogeneous landscapes with a variety of stand ages and tree densities. Mechanical thinning is often used in dense mixed-conifer forests on moderate to steep slopes because of the high potential for active crown fire that is not easily managed in prescribed burning scenarios.

Treatment conducted by Geneva Glen and Jefferson Conservation District to dramatically reduce the density of Douglas-fir and favor the retention of clumps of ponderosa pine tree. Photo credit: The Ember Alliance.

Aspen and Cottonwood

Aspen is found scattered throughout forests and riparian areas in IHFPD. Aspen trees provide important habitat for wildlife and contribute to biodiversity in ponderosa pine and mixed-conifer forests. They tend to have higher moisture contents and can slow the spread of wildfire. Fires often kill mature aspen but initiate rapid resprouting, and the death of conifer trees from wildfire can increase light availability for aspen.

Cottonwood trees occur along large drainages in IHFPD, such as Parmalee Gulch. Cottonwood trees are excellent at stabilizing riverbanks and wetland habitat. They grow quickly and provide habitat and forage for many species.

Recommendations for home ignition zone 3:

- There is no need to remove aspen, cottonwood, or willows in home ignition zone 3 unless they are within 5 feet of sheds or other outbuildings.
- Remove shrubs and small conifer trees that can serve as ladder fuels below hardwood trees.
- Mitigate the impacts of tree removal on soil compaction and erosion by maintaining streamside management zones of at least 50 feet (CSFS, 2010).
- More information can be found in the Cottonwood Management publication from the Colorado State Forest Service.
- Remove slash from the site. Avoid lop-and-scatter and mulching treatments that only rearrange fuels without removing them.

4.d. General Recommendations for Roadside Fuel Treatments

*Treatments along roadways require a dramatic reduction of fuels to create safe and survivable conditions. This includes removing most trees adjacent to the roadway, limbing remaining trees, and regularly mowing grass and shrubs (**Figure 4.d.1**). Treatments along roadways are often described as shaded fuelbreaks (Dennis, 2005). See*

Table 4.d.2 for sample recommendations for roadside fuel treatments in IHFPD.

The width of an effective roadside fuel treatments (distance to the left and right of a road) is dependent on slope. CSFS recommends that treatments extend 150 to 240 feet off the downhill side of the road and 100 to 150 feet off the uphill side. Wider treatments are necessary on the downhill side on steeper slopes due to the exacerbating effect of slope on fire intensity when fires travel uphill (**Table 4.d.1**) (Dennis, 2005). Important aspects of all roadside fuel treatments include:

- Removing limbs overhanging the road to create ***at least*** 13.5-feet of vertical clearance. See **Figure 3.a.3** for a depiction of how to measure limb height.
- Removing trees alongside the road to create ***at least*** 20-feet of horizontal clearance.
- Removing trees to create ***at least*** 10-feet crown spacing between remaining trees within the roadside treatment zone specified in
-
- **Table 4.d.1**. See **Figure 3.a.3** for a depiction of how to measure crown spacing.
- Removing all dead trees that could fall across the road and block traffic.
- Removing shrubs and regeneration that can serve as ladder fuels.
- Mowing grasses adjacent to the road.
- Remove slash following fuel treatments. See **Section 4.e.** Approaches to Slash Management for pros and cons of different slash management options.

Along important evacuation routes that could experience extreme congestion, roadside treatments should be more aggressive and consist of near removal of all trees within at least 30 feet of roadways. Clearcutting along roads when surrounding forests remain dense can cause problems with snow drifting, so shaded fuelbreaks might be more appropriate in areas where drifting is more likely, or snow fences might need to be installed.

Some residents find roadside fuel treatments aesthetically displeasing because of the removal of so many trees, but these treatments are vital for increasing the safety of residents and firefighters in this community. Roadside treatments must dramatically reduce fuel loads to effectively reduce the risk of non-survivable conditions developing during wildfires.

Figure 4.d.1. *Effective roadside fuel treatments remove enough trees to result in widely space crowns, remove ladder fuels (seedlings, saplings, shrubs, and low limbs), and reduce surface fuels. More dramatic tree removal along roadways can create even safer roadside conditions where appropriate. Photo credits: Genesee Foundation.*

Table 4.d.1. *Minimum fuel treatment width uphill and downhill from roads depends on the slope along the roadway[1]. Recommendations from the Colorado State Forest Service (Dennis, 2005).*

Percent slope (%)	Downhill distance (feet)	Uphill distance (feet)	Total fuel treatment width (feet)
0	150	150	300
10	165	140	305
20	180	130	310
30	195	120	315
40	210	110	320
50	225	100	325
60	240	100	340

[1]Measurements are from the toe of the fill for downhill distances and above the road cut for uphill distances. Distances are measured parallel to flat ground, not along the slope.

***Table 4.d.2**. Examples of conditions along roadways in the IHFPD and suggestions for improvement.*

Roadway example	Suggestions for improvement
	• Remove limbs overhanging the road and trees adjacent to the road to create at least 20-feet of horizontal clearance and 13.5-feet of vertical clearance. • Thin remaining trees to create at least 10-feet crown spacing within 180-feet on the downhill side and 130-feet on the uphill side (assuming a slope of 20% on the downhill side). • Remove regeneration that could serve as ladder fuels. • Widen the road and create pullovers to facilitate fire engine access and two-way traffic.
	• Remove trees that might interfere with overhead powerlines. • Remove additional trees to increase crown spacing to at least 10-feet within 165-feet on the downhill side and 140-feet on the uphill side (assuming a slope of 10% on the downhill side). • Mow grasses on an annual basis. • Create pullovers to facilitate fire engine access.
	• Remove limbs overhanging the road and trees adjacent to the road to create at least 20-feet of horizontal clearance and 13.5-feet of vertical clearance. • Remove additional trees to increase crown spacing to at least 10-feet within 165-feet on the downhill side and 140-feet on the uphill side (assuming a slope of 10% on the downhill side). • Remove Gamble oak and regeneration that can serve as ladder fuels. • Create turnarounds at the end of driveways for fire engines. • Post reflective address signs at the base of long driveways.

Roadway example	Suggestions for improvement
	• Remove limbs overhanging the road to create at least 20-feet of horizontal clearance and 13.5-feet of vertical clearance. • Remove trees that might interfere with overhead powerlines. • Create a pullout at the switchback to facilitate two-way traffic and access by fire engines.
	• Remove limbs overhanging the road to create at least 20-feet of horizontal clearance and 13.5-feet of vertical clearance. • Remove additional trees to increase crown spacing to at least 10-feet within 150 feet of each side of the road. • Favor the retention of aspen trees. • Remove low limbs, shrubs, and regeneration that can serve as ladder fuels. • Annually mow grass. • Create turnarounds at the end of driveways for fire engines. • Post reflective address signs at the base of long driveways.

4.e. Approaches to Slash Management

Forest management operations often increase surface fuel loads and can fail to achieve fire mitigation objectives if fuels created by the harvest activities (also known as slash) are not addressed (Agee and Skinner, 2005). Slash can include small trees, limbs, bark, and treetops. Slash management is a critical step in the forest management process. It is unwise, ineffective, and even dangerous to conduct poor-quality fuels treatments that fail to reduce canopy fuels, result in increased surface fuel loads, and do not receive maintenance treatments. Such treatments can lead to a false sense of security among residents and fire suppression personnel (Dennis, 2005), and they divert limited funds away from more effective, strategic projects.

Leaving untreated slash within roadside fuel treatments is particularly counterproductive. The risk of active crown fire might be lower after a thinning operation, but untreated slash in fuel treatments can burn at high intensities and endanger the lives of residents stuck on roadways during a wildfire. Slash is easier and cheaper to manage along roadways due to access, and roads can serve as highly effective holding features for controlled burning of grass in the spring and fall and pile burning in the winter.

Methods for managing slash come with different benefits and challenges (**Table 4.e.1**). For example, lop-and-scatter and mastication do not remove surface fuels from the site, they only rearrange them. It can take a decade or more for slash to decompose to a point where it no longer poses a significant fire hazard. Broadcast prescribed burning and pile burning are more effective at removing surface fuels, but they require extensive planning and expertise to conduct properly.

IHFPD, residents, and land management agencies should work together to develop a slash management strategy for the area. This can and should include a combination of the following slash management techniques.

Broadcast Prescribed Burning

Broadcast prescribed burning is generally the most effective method to reducing surface, ladder, and canopy fuel loads. Prescribed burning mimics naturally occurring wildfire, can treat hundreds of acres at a time, consumes surface fuel, and is relatively cost-effective (Addington et al., 2018; Fulé et al., 2012; McIver et al., 2013; Prichard et al., 2020). Strategically-located prescribed burns can reduce property damage during wildfires by effectively reducing fuel loads (Loomis et al., 2019).

Broadcast burning can be safely and successfully conducted with proper planning and implementation by qualified firefighters. Broadcast burning requires careful planning and tactical decisions to prevent smoke from impacting sensitive populations and roadways. Broadcast burning is regulated in Colorado by the Division of Fire Prevention and Control, Department of Public Health and Environment, local sheriff's offices, and fire departments as outlined in the *2019 Colorado Prescribed Fire Planning and Implementation Policy Guide.*

Challenges with broadcast burning can include public concerns about risk from flames, embers, and smoke. There are often limited opportunities to conduct burns under appropriate fire weather conditions, and firefighters are often on wildfire assignments and unavailable to conduct burns.

Pile Burning

Pile burning can be a safe and effective method to consume slash created by thinning operations
Photo credit: The Ember Alliance.

Pile burning can be the best and sometimes only option for slash removal in steep, inaccessible areas. Pile burning is different from broadcast burning; the overall complexity of pile burn operations is lower because fire activity is limited to discrete piles, and piles can be burned when snow covers the ground. Burning piles can produce embers, but the risk of these embers igniting spot fires or structures is low. Piles are typically burned on days with snowpack, high fuel moistures, and low to moderate wind speeds. Embers from burn piles travel shorter distances than embers from passive and active crown fires because the burning material is closer to the ground (Evans and Wright, 2017). In the rare occurrence that a wildfire encounters unburned piles, unintended ignition of the pile can exacerbate fire behavior, as was observed during the 2010 Fourmile Canyon Fire in Colorado (Evans and Wright, 2017).

Challenges with pile burning can include public concerns about risk from flames, embers, and smoke. There are often limited opportunities to conduct pile burns because of requirements for snowpack and atmospheric ventilation. Intense heat from pile burning can sterilize soils and result in slow recovery of plants. Mitigation measures, such as raking the burnt soil and seeding with native plants, are sometimes warranted after pile burning if the soil was completely sterilized by extreme heat or if invasive species are prevalent in the area (Miller, 2015).

It is critical to properly construct piles either by hand or with machines and to burn them as soon as conditions allow (see the 2015 *Colorado pile construction guide* from the DFPC and CSFS for guidance). Unburnt slash piles can become a hazard during wildfires, especially if loose logs catch fire and roll down slopes. Burning older piles is less effective and does not consume as much material because piles become compact and lose fine fuels over time (Wright et al., 2019).

Individuals must apply open burn permits from the Jefferson County Department of Public Health to burn fewer than 50 piles. Burning more than 50 piles requires a smoke management permit from the Colorado Department of Public Health and Environment. Jefferson County Sheriff's Office does NOT allow open burning during fire restrictions and fire bans. Pursuant to Colorado House Bill 22-1132 (Darcy's Last Call Act), individuals must contact their local fire department before burning. Contact the IHFR for specific requirements to burn piles in IHFPD.

DFPC administers a certified burner program that provides civil liability protection to individuals planning and leading burns if smoke or flames cause damage. The burn must have been properly planned, approved, and executed to receive liability protection. The rigorous certification program requires individuals to complete 32-hours of training, pass an exam, lead at least three pile burns, complete a task book, and comply with all legal requirements for pile burning in Colorado.

Air Curtain Burners

Air curtain burners are machines that burn woody material cleanly in contained space. They typically consist of a box or trench into which slash is loaded and ignited. A strong fan blows a curtain of air down and over the burning material in a way that keeps oxygen flowing through the fire and keeps smoke from escaping out the top. Carbon from the smoke is filtered out of the air and kept inside the box.

Air curtain burners can be used under a much wider range of conditions and locations than pile burning or broadcast burning. Air curtain burners can burn more kinds of slash than pile burning, including green wood, lumber, and general yard waste. Burning material is contained and can be extinguished with relative ease.

Air curtain burners can be an acceptable form of slash removal where there is not social license for pile or broadcast burning. They produce significantly less smoke than open burns and can be placed in accessible locations in the WUI.

Challenges with air curtain burners include their substantial upfront cost and the need for professional operators. They also come with effort to haul slash from treatment areas to the site of the air curtain burner. Nutrients are permanently removed from the treatment site, but they can be returned to the ground in the location of the burner if ash is removed and spread out.

Community Slash Piles

Community slash piles allow residents to immediately reduce fuel loads on their property, and it eliminates the need for residents to burn or chip their own material. However, it can be challenging for residents to haul material from their properties to the slash pile.

The success of community slash piles is dependent on consistent management of the pile. If large slash piles are left in the community, they can pose a fire risk. Community slash piles also come with a cost for management and maintenance, but the cost is spread across all residents and therefore lower than if individual residents were to create and burn their own slash piles.

68% of survey respondents reported that access to inexpensive/easy means of slash disposal would encourage and enable them to reduce the risk of wildfire on their property. That was the most supported action that the community could take to enable residents to do more work, so IHFPD should consider having a slash disposal site free to residents and nearby neighbors. Providing a program that will pick up the slash material and bring it to a slash disposal site will also reduce barriers for residents to complete mitigation work thoroughly. This program could be either hosted by the IHIA or by neighbor-to-neighbor mutual aid.

Lop-and-Scatter

Lopping involves cutting limbs, branches, treetops, smaller-diameter trees, or other woody plant residue into shorter lengths. Scattering involves spreading lopped slash so it lies evenly and close to the ground. The lop-and-scatter approach reduces the height of slash relative to untreated slash, therefore increasing the distance between surface and canopy fuels (but not as effectively as broadcast prescribed burning or pile burning).

Lop-and-scatter can contribute to more intense fire behavior by not addressing increased surface fuel loads created by thinning (Agee and Skinner, 2005; Hunter et al., 2007). **Lop-and-scatter should not be utilized in HIZ 1, 2, or 3 or along roadways** because this method does not remove surface fuels from the site, it just rearranges them. Lop-and-scatter is better suited to areas with low slash accumulations and for stand-scale fuel treatment areas far away from homes.

Mastication or Chipping

Mastication involves using specialized machines like a tow-behind chipper or a hydro-ax to grind up standing saplings and shrubs and cut slash into medium-sized chips. Chipping involves processing slash through a mechanical chipper to break material into small chips or shreds. Mastication and chipping can reduce fire intensity and rates of spread by increasing the distance between surface and canopy fuels and suppressing the regrowth of grasses (Kreye et al., 2014).

However, unless material is hauled away after treatment, fuels are just rearranged, not reduced. Smoldering fires in masticated and chipped fuels can be difficult to suppress, produce abundant smoke, kill tree roots, and lead to spot fires if high winds reignite masticated fuels and blow them across containment lines (Kreye et al., 2014). Additionally, fuels left behind in mastication and chipping treatments are deeper and more compact than natural fuels (Kreye et al., 2014). Chip depths over 4 inches can impede plant regeneration (Jain et al., 2018).

Neighborhood chipping programs are cost-effective ways for communities to gain access to chippers without individuals paying for the unit and service each time they need it. Many communities create chipping programs where a chipper can be brought to anyone's property and chip the material there for them to spread across their land again.

IHIA manages a community chipping program, that is open to all Indian Hills residents, with chipping sessions in May and September. There is a fee to participate that is paid the week before chipping. The program contracts local tree service companies who do all the work and give a group discounted rate to the community. People can put out two cords of slash by the curb and the contractors chip the material but don't haul it away. Jefferson County also has an ongoing slash collection program open to all Jefferson County residents. The slash collection sites accept tree debris, pine needles, pinecones, and limbs with a maximum length of eight feet and a maximum diameter of six inches. See the County Slash Collection website for more information.

Hauling Material Offsite

Cut trees can be loaded on trucks and removed completely from the site, thereby immediately reducing fuel loads on the site. The destinations of removed trees are mills to be turned into boards, yard waste disposal sites to be composted and turned into garden soil or mulch, or the landfill.

Hauling material offsite can be expensive and labor intensive. There is a limited biomass and timber industry in Colorado, so material often costs more to transport than it is worth. Needles, bark, and small branches are often left behind, which means surface fuel loads can be greater after treatment than before. Hauling material outside the community can also spread insects like mountain pine beetles and emerald ash borer.

Utilizing Material for Firewood

Wood leftover from thinning operations can be used as firewood. Firewood needs to be "seasoned" before use, which involves splitting the wood into usable logs and drying it for 6-18 months. Homeowners can often manage preparing firewood themselves, so it can be an inexpensive way to manage slash. Utilizing material for firewood can relocate surface fuels from one site to another, but it increases fuel loads near a home until burned. **Firewood must be stored at least 30 feet and uphill of structures; otherwise, it can create hazardous conditions during a wildfire.**

If firewood is used locally, it reduces the chances of introducing non-native insects and diseases to the ecosystem that cause outbreaks and damage forest health. Transporting firewood outside the community is not recommended if there are insects like mountain pine beetles and emerald ash borer in the area.

Table 4.e.1. Many methods are available to remove slash created by forest thinning, each with their own benefits and challenges.

Method	Removes surface fuel from site	Restores ecosystem functions	Retains nutrients on the site	Expertise required to conduct	Effort to conduct	Relative cost / acre	Total time to plan and conduct
Broadcast prescribed burning	✓	✓	✓	Very high	Very high	$$$	Months to years
Pile burning on site	✓		✓	Moderate	Moderate to high	$$	Weeks to months
Air curtain burner	✓			High	Moderate	$$$$ (upfront)	Weeks to months
Community slash pile	✓			Low to moderate	Moderate	$$	Ongoing
Lop-and-scatter			✓	Low to moderate	Moderate	$ - $$	Weeks to months
Mastication or chipping	(✓)		✓	High	Moderate to high	$$$	Weeks to months
Hauling material away	✓			Low to moderate	High	$$ - $$$	Weeks to months
Utilizing material for firewood	(✓)			Low	Low to moderate	$	Days to weeks

Note: Mastication and chipping only remove surface fuel from the site if material is hauled away after treatment. Utilizing material for firewood can relocate surface fuels from one site to another but increase fuel loads near a home until burned.

4.f. Logistics of Treatment Implementation

Roles and Responsibilities

Landowners are responsible for fuel mitigation on their own lands, including along their private driveways. Residents must initiate and follow through on this work, but that does not mean they must do it alone. For assistance in planning and implementing fuel treatments, contact the Jefferson Conservation District, CSFS, or other wildfire mitigation specialists. Tree cutting with a chainsaw and other forestry equipment should be done by experienced and certified individuals. The CSFS provides guidance for how to select a contractor for forest management. Contact the CSFS Golden field office (CSFS_Golden@mail.colostate.edu) for a list of local contractors.

Land managers with Denver Mountain Parks and Jefferson Conservation District helped develop fuel treatment priorities for this CWPP. Both agencies are committed to restoring forest health and reducing fire risk on public lands in and around IHFPD.

Widening roads maintained by the county requires coordination between IHFR and Jefferson County Road and Bridge. Vegetation removal in powerline right-of-ways adjacent to streets can be coordinated between IHFR and Xcel Energy. Residents can work together to fund the construction of pullouts and turnarounds on private drives and driveways, and IHFR can use the permitting process for new construction to require increased accessibility for emergency vehicles. IHFR and IHIA can apply for grants to remove trees from along roads to reduce the chance of non-survivable conditions occurring during wildfires.

The responsibility for conducting roadside fuel treatments depends on the location of the road. Not all roads with names and signs are maintained by the county—private drives longer than 150 feet that access two or more homes must have a name and sign. Check with IHFR to determine the responsibility of road maintenance in your neighborhood—it might be your or your neighborhood's responsibility. Widening roads maintained by the county requires coordination between IHFR and Jefferson County Road and Bridge. Vegetation removal in powerline right-of-ways adjacent to streets can be coordinated between IHFR and Xcel Energy. Residents can work together to fund the construction of pullouts and turnarounds on private drives and driveways, and IHFR can use the permitting process for new construction to require increased accessibility for emergency vehicles. **Cooperation from private property owners is necessary for effective roadside fuel treatments; roadside easements are rarely wide enough to satisfy the minimum of 150 feet treatment depth on each side of roads.**

Treatment Costs

The cost of fuel treatment depends on management objectives, treatment specifications, slope, accessibility, and treatment method (e.g., mechanical thinning, hand thinning, or prescribed burning). Costs of $2,500 to $10,000 per acre are not uncommon along the Colorado Front Range where there is little biomass or timber industry to provide financial return (Gannon et al., 2019). The Jefferson Conservation District cites costs ranging from $1,500 to $3,500 per acre depending on access, terrain, tree species and sizes, and equipment used. Follow-up treatments are generally less expensive than the initial entry and help maintain the efficacy of the original treatment investment.

Since fuel treatments are expensive, it is important to conduct strategic, well-designed, landscape-scale treatments to increase the likelihood that fuel treatments modify fire behavior, save lives, and restore ecosystems. Fuel treatments can reduce property damages by making wildfires less damaging and easier to control; this is especially true for prescribed burning which is often cheaper and more effective at altering forest fuel loads than mechanical thinning alone (Fulé et al., 2012; Loomis et al., 2019; Prichard et al., 2020). Proactive management of forests can also reduce the cost

of rehabilitating water sources when wildfires are followed by large storms and result in massive erosion (Jones et al., 2017). Fuel treatments can also reduce suppression costs due to the increased efficiency of firefighting (Loomis et al., 2019).

Longevity of Fuel Treatment Benefits

Benefits of fuel treatments are not permanent and decrease overtime, with treatment "lifespan" depending on forest type, topography, rates of seedling regeneration (which is often influenced by precipitation), and the number of trees removed during treatments. Many forests require more than one treatment to reduce fuels and restore ecosystem structure. Some areas might require mechanical tree removal followed by prescribed burning, and then a maintenance treatment with tree removal and/or prescribed burning 10 to 20 years later. With a single pulse of tree regeneration, the risk of torching returns to near pre-treatment levels within 10 to 35 years in ponderosa pine forests in Colorado (Tinkham et al., 2016). Gamble oak shrublands can require retreatment every 3-5 years due to vigorous sprouting after treatment (CSFS, 2021).

5. The Future of the CWPP and Implementation Plan

Below are strategic actions for residents, IHFR, IHIA, other community groups, public land managers, county, state, and federal agencies, and non-profit conservation groups to accomplish in the short-, mid-, and long-term (see definitions below). Some activities have low financial cost but require a fundamental shift in attitudes and behavior to prioritize wildfire risk mitigation. Other actions are more substantial and require commitment and collaboration across the community to pool resources, apply for grants, and make incremental steps towards meaningful change.

5.a. Implementation Phases

Short-term actions	Mid-term actions	Long-term actions
• Can be implemented within the remainder of 2023. • Can be accomplished within the current funding capacity for the IHFR, IHIA, and residents. • Can occur within the context of the current IHFR and IHIA volunteer base, with modest expansion. • Can capitalize on current relationships with emergency response partners and land managers.	• Can be implemented within 18-24 months, generally in 2024 and 2025. • Will require expansion of the current IHFR and IHIA volunteer base. • Requires new cooperative relationships with emergency response partners, land managers, and non-profit organizations. • Actions that are already in the planning stages and have some portion of funding already identified.	• Requires planning to start within 18-24 months so implementation can occur after 2025. • Requires multi-year planning and funding. • Requires extensive grant funding. • May require local staffing beyond volunteers.

5.b. Implementation Activities and Responsibilities

Recommendation	Responsibility	Timeline
Category: Fire Adapted Communities		
Adopt the Fire Adapted Communities as the overarching vision and strategy for CWPP implementation.	IHFR, IHIA, residents	Short-term
Become designated as a Firewise-USA community. Learn more at: Becoming a Firewise-USA community and Program Benefits.	IHFR, IHIA	Mid-term

Recommendation	Responsibility	Timeline
Hold an IHFR Firewise Education Day during the summer to encourage residents to implement home hardening and defensible space. This could be done at a BBQ or dessert potluck with IHIA.	IHFR, IHIA	Mid-term
Category: District Capacity		
Continue supporting the involvement of volunteer firefighters in out-of-county incidents where they gain invaluable experience.	IHFR	Ongoing
Support ongoing efforts by IHWD to enhance fire water supply as outlined in their 2020 Master Plan.	IHWD, IHFR, residents	Short-term
Apply for grants to make further enhancements to the community's water infrastructure (see items listed in **Section 3.c.**).	IHWD, IHFR	Mid-term
Category: Community Outreach and Engagement		
Form a volunteer group called "Mission: Firewise Coalition" within or outside the IHIA, or other mutually agreeable name to continue momentum developed by the CWPP. Have a liaison to create more fluid communication between IHIA and IHFR.	IHFR, IHIA	Short-term
Become a volunteer with the IHFR to inspire fellow residents to engage in wildfire mitigation and emergency preparedness.	Residents	Short-term
Improve the IHFR website, social media, and other outreach materials to increase resident awareness of wildfire risk and resources available for mitigation. Create an account on NextDoor and post regularly on Facebook.	IHFR	Short-term
Category: Home Ignition Zone		
Engage in annual maintenance of your home ignition zone.	Residents	Short-term
Use the CSFS The Home Ignition Zone guide as the foundation for defensible space and home hardening.	Residents	Short-term

Recommendation	Responsibility	Timeline
Establish defensible space around homes, detached garages, storage buildings, barns, and other structures so that the home can stand alone without relying on limited firefighting resources.	Residents	Short- to mid-term
Conduct home assessments to provide specific recommendations to individual homeowners.	IHFR	Mid-term
Explore a "tools cache" with pole pruners, shears, and other small equipment for residents to checkout and use for mitigation projects.	IHFR	Short-term
Category: Linked Defensible Space and Fuel Treatments		
Prioritize mitigating fire risk in CWPP plan units with extreme fire risk (plan units B, C, and D).	IHFR, residents, and other partners	Mid-term
Organize neighborhood workdays to help each other with mitigation work and maintenance of the home ignition zone.	Residents	Short-to mid-term
Discuss shared risk and encourage neighborhood-wide implementation of defensible space, for example through walking tours of well-mitigated properties.	Residents	Short-to mid-term
Build off the CWPP to identify projects that improve linked defensible space and create mosaic landscapes. Two priority projects have resulted from the IH CWPP.	IHFR and residents	Short-to mid-term
Work together to pool financial and other resources and pursue grants.	IHFR and residents	Mid- to long-term
Continue collaborating with large landowners and public lands to conduct priority fuel treatments.	IHFR and other partners	Mid- to long-term
Category: Slash Management		
Continue promoting the IHIA Curbside Chipping Program to residents, expanding participation.	IHIA	Short-term
Continue promoting the Jefferson County Slash Management Program to residents.	IHFR	Short-term
Develop a slash management strategy, including judiciously relaxing slash burning prohibitions.	IHFR	Long-term

Recommendation	Responsibility	Timeline
Increase resident awareness of the county and state burn permitting systems.	IHFR	Long-term
Participate in the Colorado Certified Burner Program to learn proper burning methods.	Residents	Long-term
Increase resident training on proper burning methods.	IHFR	Long-term
Category: Evacuation Preparedness		
Develop a family evacuation plan and go-bags. Plans should include considerations of pets and livestock if applicable.	Residents	Short-term
Cooperate with neighbors to develop plans for evacuating children who may be home alone or residents with mobility impairments or other special needs.	Residents	Short-term
Increase resident awareness of evacuation planning, processes, and Lookout Alert. Provide information on evacuations with visitors at short-term rentals.	IHFR	Short-term
Sign up for emergency notification through the Lookout Alert.	Residents	Short-term
Provide access to water supplies on properties for firefighters when evacuating. Residents must not turn on sprinklers during evacuation.	Residents	Short-term
Cooperate with emergency response partners to conduct district-wide evacuation drills.	IHFR and emergency response partners	Mid-term
Work with Jefferson County Open Space to inform visitors at Mount Falcon Park about evacuation protocol and alert systems. Putting QR codes on signage across the park to direct people to the Lookout Alert website could be a great place to start.	IHFR and Jefferson County Open Space	Mid-term
Explore the potential for warning sirens across IHFPD.	IHFR	Long-term

Recommendation	Responsibility	Timeline
Category: Firefighter Access and Evacuation Safety		
Improve access for firefighters on private drives and driveways.	Residents	Mid-term
Coordinate efforts to mitigate hazardous conditions along roadways.	IHFR, Jefferson County Road and Bridge, and local land managers	Mid- to long-term

5.c. CWPP as a Living Document

The CSFS requires CWPPs to be updated on a regular basis. It is recommended to update them every 5 years, at a minimum. CWPPs greater than 10 years old are outdated and can exclude communities from successfully applying for competitive funding opportunities.

The update to this plan can either be a preface to this document or a new document that integrates with this one. The update to this plan must include:

- A description of progress made since the CWPP was created.
- A description of demographic changes in the community and other important infrastructure changes.
- Identification of new risks in the community.
- Updated risk analysis if major changes have happened between revisions.
- Updated and prioritized projects for the community with maps and descriptions

The suggested review process by CSFS involves:

- Reviewing the existing CWPP.
- Engaging partners that have a vested interest in the plan.
- Hosting collaborative meetings.
- Documenting completed projects and demographic and landscape changes.
- Developing updated wildfire risk reduction priorities.
- Updating maps.
- Distributing updated drafts to key partners for review and input prior to final approval.
- Finalizing with core team signatures and submit to CSFS State Office.

The Indian Hills CWPP is a **call to action!** Becoming a fire adapted community and decreasing wildfire risk takes concerted effort, time, and coordination. Use the risk analyses and implementation recommendations from the CWPP to spark action on your property and across your neighborhood and entire community. The need to protect lives, safety, and property from wildfire is too great to wait.

6. Glossary

20-foot wind speed: The rate of sustained wind over a 10-minute period at 20 feet above the dominant vegetation. The wind adjustment factor to convert surface winds to 20-foot wind speeds depends on the type and density of surface fuels slowing down windspeeds closer to the ground (NWCG, 2021).

Active crown fire: Fire in which a solid flame develops in the crowns of trees and advances from tree crown to tree crown independently of surface fire spread (NWCG, 2018b).

ArcCASPER: An intelligent capacity-aware evacuation routing algorithm used in the geospatial information system mapping program ArcMap to model evacuation times and congestion based on roadway capacity, road speed, number of cars evacuating per address, and the relationship between roadways congestion and reduction in travel speed (Shahabi and Wilson, 2014).

Basal area: Cross sectional area of a tree measured at breast height (4.5 feet above the ground). Used as a method of measuring the density of a forest stand in units such as ft^2/acre (USFS, 2021b).

Broadcast prescribed burning (aka, prescribed burn, controlled burn): A wildland fire originating from a planned ignition in accordance with applicable laws, policies, and regulations to meet specific objectives (NWCG, 2018b).

Canopy fuels: The stratum of fuels containing the crowns of the tallest vegetation (living or dead), usually above 20 feet (NWCG, 2018b).

Canopy: The more or less continuous cover of branches and foliage formed collectively by adjacent tree crowns (USFS, 2021b).

Canyon: A long, deep, very steep-sided topographic feature primarily cut into bedrock and often with a perennial stream at the bottom (NRCS, 2017).

Chain: Chains are commonly used in forestry and fire management as a measure of distance. 1 chain is equivalent to 66 feet. Chains were used for measurements in the initial public land survey of the U.S. in the mid-1800s.

Chute: A steep V-shaped drainage that is not as deep as a canyon but is steeper than a draw. Normal upslope air flow is funneled through a chute and increases in speed, causing upslope preheating from convective heat, thereby exacerbating fire behavior (NWCG, 2008).

Community Wildfire Protection Plan (CWPP): A plan developed in the collaborative framework established by the Wildland Fire Leadership Council and agreed to by state, Tribal, and local governments, local fire departments, other partners, and federal land management agencies in the vicinity of the planning area. CWPPs identify and prioritize areas for hazardous fuel reduction treatments, recommend the types and methods of treatment on Federal and non-Federal land that will protect one or more at-risk communities and essential infrastructure, and recommend measures to reduce structural ignitability throughout the at-risk community. A CWPP may address issues such as wildfire response, hazard mitigation, community preparedness, and structure protection (NWCG, 2018b).

Convection: A type of heat transfer that occurs when a fluid, such as air or a liquid, is heated and travels away from the source, carrying heat along with it. Air around and above a wildfire expands as it is heated, causing it to become less dense and rise into a hot convection column. Cooler air flows in to replace the rising gases, and in some cases, this inflow of air creates local winds that further fan the flames. Hot convective gases move up slope and dry out fuels ahead of the flaming front, lowering their ignition temperature and increasing their susceptibility to ignition and fire spread. Homes

located at the top of a slope can become preheated by convective heat transfer. Convection columns from wildfires carry sparks and embers aloft.

Crown (aka, tree crown): Upper part of a tree, including the branches and foliage (USFS, 2021b).

Defensible space: The area around a building where vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of fire and reduce exposure to radiant heat and direct flame. It is encouraged that residents develop defensible space so that during a wildfire their home can stand alone without relying upon limited firefighter resources due to the great reduction in hazards they have undertaken. The Colorado State Forest Service defines three zones of defensible space: zone 1 (HIZ 1) as 0 to 5 feet from the home, zone 2 (HIZ 2) as 5 to 30 feet from the home, and zone 3 (HIZ 3) as 30 to about 100 feet from the home (CSFS, 2021).

Direct attack: Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel (NWCG, 2018b).

Draws: Topographic features created by a small, natural watercourse cutting into unconsolidated materials. Draws generally have a broader floor and more gently sloping sides than a ravine or gulch (NRCS, 2017).

Ecological restoration: The process of assisting the recovery of an ecosystem that has been damaged, degraded, or destroyed (SER, 2004). In ponderosa pine and dry mixed-conifer forests of the Colorado Front Range, ecological restoration involves transforming dense forests into a mosaic of single trees, clumps of trees, and meadows similar to historic forests that were maintained by wildfires and very resilient to them (Addington et al., 2018).

Ember: Small, hot, and carbonaceous particles. The term "firebrand" is also used to connote a small, hot, and carbonaceous particle that is airborne and carried for some distance in an airstream (Babrauskas, 2018).

Ember cast: The process of embers/firebrands/flaming sparks being transported downwind beyond the main fire and starting new spot fires and/or igniting structures. Short-range ember cast is when embers are carried by surface winds and long-range ember cast is when embers are carried high into the convection column and fall out downwind beyond the main fire. The number of embers reaching an area decreases exponentially with distance traveled, and the likelihood of structure ignition increases with the number of embers landing on receptive fuels (Caton et al., 2016). The distance used to differentiate short-range and long-range ember cast varies among sources. NWCG (2018b) classifies short-range ember cast as embers that travel less than 0.25 miles and long-range ember cast as embers that travel more than 0.25 miles, whereas Beverly et al., (2010) use a threshold of 0.06 miles. We use the Beverly et al., (2010) definition in this CWPP.

Fire adapted community (FAC): A human community consisting of informed and prepared citizens collaboratively planning and taking action to safely coexist with wildland fire (NWCG, 2018b). There is not a checklist or one silver bullet to become a FAC; there are many strategic actions and tools that should be used together to reduce shared risk. Risk mitigation is the responsibility of everyone who lives and works in the community—residents, community groups, fire protection districts, agency partners, non-governmental organizations, etc. Fire adaptation is an ongoing process of collaborative action to identify risk, mitigate it, and maintain the work overtime.

Fire behavior: The manner in which a fire reacts to the influences of fuel, weather, and topography. Characteristics of fire behavior include rate of spread, fire intensity, fire severity, and fire behavior category (NWCG, 2018b).

Fire history: A general term referring to the historic fire occurrence in a specific geographic area (NWCG, 2018b).

Fire intensity (aka, fireline intensity): (1) The product of the available heat of combustion per unit of ground and the rate of spread of the fire, interpreted as the heat released per unit of time for each unit length of fire edge, or (2) the rate of heat release per unit time per unit length of fire front (NWCG, 2018b).

Fire regime: Description of the patterns of fire occurrences, frequency, size, and severity in a specific geographic area or ecosystem. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval (NWCG, 2018b).

Fire severity. Degree to which a site has been altered or disrupted by fire; loosely, a product of fire intensity and residence time (NWCG, 2018b). Fire severity is determined by visually inspecting or measuring the effects that wildfire has on soil, plants, fuel, and watersheds. Fire severity is often classified as low-severity (less than 20% of overstory trees killed) and high severity (more than 70% of overstory trees kills). Moderate-severity or intermediate fire severity falls between these two extremes (Agee, 1996). Specific cutoffs for fire severity classifications differ among researchers. For example, Sherriff et al. (2014) define high-severity fires as those killing more than 80% of overstory trees.

Fire weather conditions: Weather conditions that influence fire ignition, behavior, and suppression, for example, wind speed, wind direction, temperature, relative humidity, and fuel moisture (NWCG, 2018b).

Firebreak: A natural or constructed barrier where all vegetation and organic matter have been removed down to bare mineral soil. Firebreaks are used to stop or slow wildfires or to provide a control line from which to work (Bennett et al., 2010; NWCG, 2018b).

FireFamilyPlus: A software application that provides summaries of fire weather, fire danger, and climatology for one or more weather stations extracted from the National Interagency Fire Management Integrated Database (NWCG, 2018b).

Fireline: (1) The part of a containment or control line that is scraped or dug to mineral soil, or (2) the area within or adjacent to the perimeter of an uncontrolled wildfire of any size in which action is being taken to control fire (NWCG, 2018b).

Flame length: The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface). Flame length is measured on an angle when the flames are tilted due to effects of wind and slope. Flame length is an indicator of fire intensity (NWCG, 2018b).

FlamMap: A fire analysis desktop application that can simulate potential fire behavior and spread under constant environmental conditions (weather and fuel moisture) (Finney, 2006). FlamMap is one of the most common models used by land managers to assist with fuel treatment prioritization, and it is often used by fire behavior analysts during wildfire incidents.

Fuel model: A stylized set of fuel bed characteristics used as input for a variety of wildfire modeling applications to predict fire behavior (Scott and Burgan, 2005).

Fuel reduction: Manipulation, combustion, or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage from wildfires and resistance to control (NWCG, 2018b).

Fuelbreak: A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled. Fuelbreaks differ from firebreaks due to the

continued presence of vegetation and organic soil. Trees in shaded fuelbreaks are thinned and pruned to reduce the fire potential but enough trees are retained to make a less favorable microclimate for surface fires (NWCG, 2018b).

Fuels mitigation / management: The act or practice of controlling flammability and reducing resistance to control of wildland fuels through mechanical, chemical, biological, or manual means, or by fire, in support of land management objectives (NWCG, 2018b).

Fuels: Any combustible material, most notably vegetation in the context of wildfires, but also including petroleum-based products, homes, and other man-made materials that might combust during a wildfire in the wildland-urban interface. Wildland fuels are described as 1-, 10-, 100-, and 1000-hour fuels. One-hour fuels are dead vegetation less than 0.25 inch in diameter (e.g., dead grass), ten-hour fuels are dead vegetation 0.25 inch to 1 inch in diameter (e.g., leaf litter and pine needles), one hundred-hour fuels are dead vegetation 1 inch to 3 inches in diameter (e.g., fine branches), and one thousand-hour fuels are dead vegetation 3 inches to 8 inches in diameter (e.g., large branches). Fuels with larger diameters have a smaller surface area to volume ratio and take more time to dry out or become wetter as relative humidity in the air changes (NWCG, 2018b).

Handcrews: A number of individuals that have been organized and trained and are supervised principally for operational assignments on an incident (NWCG, 2018b).

Handline: Fireline constructed with hand tools (NWCG, 2018b).

Hazards: Any real or potential condition that can cause injury, illness, or death of personnel, or damage to, or loss of equipment or property (NWCG, 2018b).

Home hardening: Steps taken to improve the chance of a home and other structures withstanding ignition by radiant and convective heat and direct contact with flames or embers. Home hardening involves reducing structure ignitability by changing building materials, installation techniques, and structural characteristics of a home (California Fire Safe Council, 2020). A home can never be made fireproof, but home hardening practices in conjunction with creating defensible space increases the chance that a home will survive a wildfire.

Home ignition zone (HIZ): The characteristics of a home and its immediate surroundings within 100 feet of structures. Conditions in the HIZ principally determine home ignition potential from radiant heat, convective heat, and ember cast (NWCG, 2018b).

Ignition-resistant building materials: Materials that resist ignition or sustained flaming combustion. Materials designated ignition-resistant have passed a standard test that evaluates flame spread on the material (Quarles, 2019; Quarles and Pohl, 2018).

Incident Response Pocket Guide (IRPG): Document that establishes standards for wildland fire incident response. The guide provides critical information on operational engagement, risk management, all hazard response, and aviation management. It provides a collection of best practices that have evolved over time within the wildland fire service (NWCG, 2018a).

Indirect attack A method of suppression in which the control line is located some considerable distance away from the fire's active edge. Generally done in the case of a fast-spreading or high-intensity fire and to utilize natural or constructed firebreaks or fuelbreaks and favorable breaks in the topography. The intervening fuel is usually backfired; but occasionally the main fire is allowed to burn to the line, depending on conditions (NWCG, 2018b).

Insurance Services Office (ISO) rating: ISO ratings are provided to fire departments and insurance companies to reflect how prepared a community is for fires in terms of local fire department capacity, water supply, and other factors (see more information online at https://www.isomitigation.com/ppc/fsrs/).

Ladder fuels: Fuels that provide vertical continuity between strata, thereby allowing fire to carry from surface fuels into the crowns of trees with relative ease. Ladder fuels help initiate torching and crowning and assure the continuation of crowning. Ladder fuels can include small trees, brush, and lower limbs of large trees (NWCG, 2018b).

LANDFIRE: A national program spearheaded by the U.S. Department of the Interior and the U.S. Department of Agriculture to provide spatial products characterizing vegetation, fuels, fire regimes, and disturbances across the entire United States. LANDFIRE products serve as standardized inputs for fire behavior modeling. More information about the program is available online at https://www.landfire.gov/.

Lop-and-scatter: Cutting (lopping) branches, tops, and unwanted boles into shorter lengths and spreading that debris evenly over the ground such that resultant logging debris will lie close to the ground (NWCG, 2018b).

Mastication: A slash management technique that involves using a machine to grind, chop, or shred vegetation into small pieces that then become surface fuel (Jain et al., 2018).

Mitigation actions: Actions that are implemented to reduce or eliminate (mitigate) risks to persons, property, or natural resources. These actions can be undertaken before and during a wildfire. Actions before a fire include fuel treatments, vegetation modification in the home ignition zone, and structural changes to increase the chance a structure will survive a wildfire (aka, home hardening). Mitigation actions during a wildfire include mechanical and physical tasks, specific fire applications, and limited suppression actions, such as constructing firelines and creating "black lines" through the use of controlled burnouts to limit fire spread and behavior (NWCG, 2018b).

Mosaic landscape: A heterogeneous area composed of different communities or a cluster of different ecosystems that are similar in function and origin in the landscape. It consists of 'patches' arranged in a 'matrix', where the patches are the different ecosystems and the matrix is how they are arranged over the land (Hansson et al., 1995).

National Wildfire Coordinating Group (NWCG): An operational group established in 1976 through a Memorandum of Understanding between the U.S. Department of Agriculture and Department of the Interior to coordinate programs of the participating agencies to avoid wasteful duplication and to provide a means of constructively working together. NWCG provides a formalized system and agreed upon standards of training, equipment, aircraft, suppression priorities, and other operational areas. More information about NWCG is available online at https://www.nwcg.gov/.

Noncombustible building materials: Material of which no part will ignite or burn when subjected to fire or heat, even after exposure to moisture or the effects of age. Materials designated noncombustible have passed a standard test (Quarles, 2019; Quarles and Pohl, 2018).

Non-survivable road: Portions of roads adjacent to areas with predicted flame lengths greater than 8 feet under severe fire weather conditions. Potentially non-survivable flame lengths start at 8 feet according to the Haul Chart, which is a standard tool used by firefighters to relate flame lengths to tactical decisions (NWCG, 2019). Drivers stopped or trapped on these roadways would have a low chance of surviving radiant heat from fires of this intensity. Non-survivable conditions are more common along roads that are lined with thick forests, particularly with trees that have limbs all the way to the ground and/or abundant saplings and seedlings.

Overstory: Layer of foliage in a forest canopy, particularly tall mature trees that rise above the shorter immature understory trees (USFS, 2021b).

Passive crown fire: Fire that arises when surface fire ignites the crowns of trees or groups of trees (aka, torching). Torching trees reinforce the rate of spread, but passive crown fires travel along with surface fires (NWCG, 2018b).

Pile burning: Piling slash resulting from logging or fuel management activities into manageable piles that are subsequently burned during safe and approved burning conditions (NWCG, 2018b).

Radiation: A method of heat transfer by short-wavelength energy through air (aka, infrared radiation). Surfaces that absorb radiant heat warm up and radiate additional short-wavelength energy themselves. Radiant heat is what you feel when sitting in front of a fireplace. Radiant heat preheats and dries fuels adjacent to the fire, which initiates combustion by lowering the fuel's ignition temperature. The amount of radiant heat received by fuels increases as the fire front approaches. Radiant heat is a major concern for the safety of wildland firefighters and can ignite homes without direct flame contact.

Rate of spread: The relative activity of a fire in extending its horizontal dimensions. It is expressed as rate of increase of the total perimeter of the fire, as rate of forward spread of the fire front, or as rate of increase in area, depending on the intended use of the information. Rate of spread is usually expressed in chains or acres per hour for a specific period in the fire's history (NWCG, 2018b).

Ravine: Topographic features created by streams cutting into unconsolidated materials and that are narrow, steep-sided, and commonly V-shaped. Ravines are steeper than draws (NRCS, 2017).

Remote Automatic Weather Stations (RAWS): A weather station that transmits weather observations via satellite to the Wildland Fire Management Information system (NWCG, 2018b).

Risk: (1) The chance of fires starting as determined by the presence and activity of causative agents (e.g., lightning), (2) a chance of suffering harm or loss, or (3) a causative agent (NWCG, 2018b).

Roadside fuel treatment: A natural or manmade change in fuel characteristics along a roadway which affects fire behavior so that fires burning into them can be more readily controlled, survivable conditions with shorter flame lengths are more likely during a wildfire, and firefighter access is enhanced (NWCG, 2018b).

Saddle: A low point on a ridge or interfluve, generally a divide or pass between the heads of streams flowing in opposite directions. The presence of a saddle funnels airflow and increases windspeed, thereby exacerbating fire behavior (NRCS, 2017).

Safety zones: An area cleared of flammable materials used by firefighters for escape in the event the line is outflanked or spot fires outside the control line render the line unsafe. In firing operations, crews progress so as to maintain a safety zone close at hand, allowing the fuels inside the control line to be consumed before going ahead. Safety zones may also be constructed as integral parts of fuelbreaks; they are greatly enlarged areas which can be used with relative safety by firefighters without the use of a fire shelter (NWCG, 2018b).

Shaded fuelbreak: Fuel treatments in timbered areas where the trees on the break are thinned and pruned to reduce fire potential yet enough trees are retained to make a less favorable microclimate for surface fires (NWCG, 2018b).

Slash: Debris resulting from natural events such as wind, fire, or snow breakage or from human activities such as road construction, logging, pruning, thinning, or brush cutting. Slash includes logs, bark, branches, stumps, treetops, and broken understory trees or brush (NWCG, 2018b).

Smoldering combustion: The combined processes of dehydration, pyrolysis, solid oxidation, and scattered flaming combustion and glowing combustion, which occur after the flaming combustion

phase of a fire; often characterized by large amounts of smoke consisting mainly of tars (NWCG, 2018b).

Spot fire: Fire ignited outside the perimeter of the main fire by an ember (NWCG, 2018b). Spot fires are particularly concerning because they can form a new flaming front, move in unanticipated directions, trap firefighters between two fires, and require additional firefighting resources to control.

Spotting: Behavior of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire (NWCG, 2018b).

Stand: An area of forest that possesses sufficient uniformity in species composition, age, size, structural configuration, and spatial arrangement to be distinguishable from adjacent areas (USFS, 2021b).

Structure protection: The protection of homes or other structures from an active wildland fire (NWCG, 2018b).

Structure triage: The process of inspecting and classifying structures according to their defensibility or non-defensibility, based on fire behavior, location, construction, and adjacent fuels. Structure triage involves a rapid assessment of a dwelling and its immediate surroundings to determine its potential to escape damage by an approaching wildland fire. Triage factors include the fuels and vegetation in the yard and adjacent to the structure, roof environment, decking and siding materials, prevailing winds, topography, etc. (NWCG, 2018b). There are four categories used during structure triage: (1) defensible – prep and hold, (2) defensible – stand alone, (3) non-defensible – prep and leave, and (4) non-defensible – rescue drive-by. The most important feature differentiating defensible and non-defensible structures is the presence of an adequate safety zone for firefighters (NWCG 2018a). Firefighters conduct structure triage and identify defensible homes during wildfire incidents. Categorization of homes are not pre-determined; triage decisions depend on fire behavior and wind speed due to their influence on the size of safety zones needed to keep firefighters safe.

Suppression: The work and activity used to extinguish or limit wildland fire spread (NWCG, 2018b).

Surface fire: Fire that burns fuels on the ground, which include dead branches, leaves, and low vegetation (NWCG, 2018b).

Surface fuels: Fuels lying on or near the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants (NWCG, 2018b).

Task book: A document listing the performance requirements (competencies and behaviors) for a position in a format that allows for the evaluation of individual (trainee) performance to determine if an individual is qualified in the position. Successful performance of tasks, as observed and recorded by a qualified evaluator, will result in a recommendation to the trainee's home unit that the individual be certified in the position (NWCG, 2018b).

Torching: The burning of the foliage of a single tree or a small group of trees from the bottom up. Torching is the type of fire behavior that occurs during passive crown fires and can initiate active crown fires if tree canopies are close to each other (NWCG, 2018b).

Values at risk: Aspects of a community or natural area considered valuable by an individual or community that could be negatively impacted by a wildfire or wildfire operations. These values can vary by community and include diverse characteristics such as homes, specific structures, water supply, power grids, natural and cultural resources, community infrastructure, and other economic, environmental, and social values (NWCG, 2018b).

Watershed (aka, drainage basin or catchment): An area of land where all precipitation falling in that area drains to the same location in a creek, stream, or river. Smaller watersheds come together to create basins that drain into bays and oceans (NOAA, 2021).

Wildfire-resistant building materials: A general term used to describe a material and design feature that can reduce the vulnerability of a building to ignition from wind-blown embers or other wildfire exposures (Quarles, 2019; Quarles and Pohl, 2018).

Wildland-urban interface (WUI): Any area where the built environment meets wildfire-prone areas—places where wildland fire can move between natural vegetation and the built environment and result in negative impacts on the community (Forge, 2018). For the purpose of this CWPP, the WUI boundary includes all of the IHFPD and the surrounding landscape that could transmit wildland fire into the IHFPD and the area along important evacuation routes (**Figure 2.c.2**). Strategic wildfire mitigation across the WUI can increase the safety or residents and wildland firefighters and reduce the chances of home loss.

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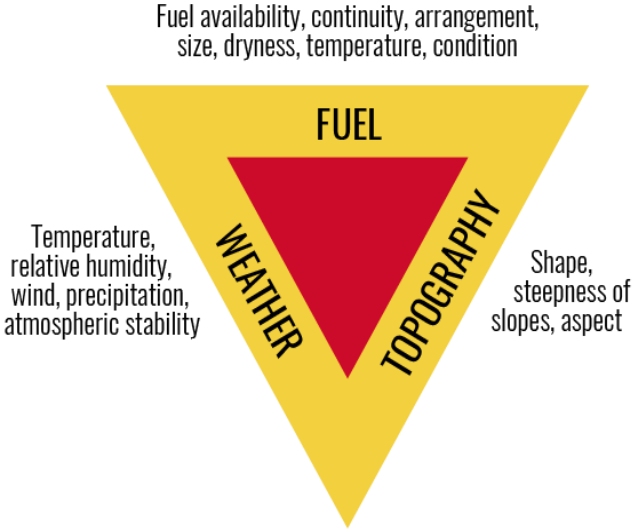
Appendix A. Introduction to Wildfire Behavior and Terminology

Fire Behavior Triangle

Complex interactions among wildland fuels, weather, and topography determine how wildfires behave and spread. These three factors make up the sides of the fire behavior triangle, and they are the variables that wildland firefighters pay attention to when assessing potential wildfire behavior during an incident (NWCG, 2019).



Interactions between fuels, weather, and topography dictate fire behavior. Source: California State University.

Fuels

Fuels include live vegetation such as trees, shrubs, and grasses, dead vegetation like pine needles and cured grass, and materials like houses, sheds, fences, trash piles, and combustible chemicals.

Grasses and pine needles are known as "flashy" fuels because they easily combust and burn the fastest of all fuel types. If you think of a campfire, flashy fuels are the kindling that you use to start the fire. Flashy fuels dry out faster than other fuel types when relative humidity drops or when exposed to radiant and convective heat[2]. Fires in grassy fuel types can spread quickly across large areas, and fire behavior can change rapidly with changes in weather conditions.

Dead branches on the surface dry out slower than flashy fuels, release more radiant heat when they burn, and take longer to completely combust. The rate of spread is fast to moderate through shrublands depending on their moisture content, and long flame lengths can preclude direct attack by firefighters. Shrubs and small trees can also act as ladder fuels that carry fire from the ground up into the tree canopy.

Dead trees (aka, snags) and large downed logs are called "heavy fuels", and they take the longest to dry out when relative humidity drops and when exposed to radiant and convective heat. Heavy fuels release tremendous radiant heat when they burn, and they take longer to completely combust, just

[2] Radiant heat transfer occurs by short-wavelength energy traveling through air. Radiant heat is what you feel when sitting in front of a fire. Radiant heat preheats and dries fuels adjacent to a wildfire, which initiates combustion by lowering the fuel's ignition temperature. Convective heat transfer occurs when air is heated, travels away from the source, and carries heat along with it. Convective heat is what you would feel if you put your hand in the air above an open flame. Air around and above a wildfire expands as it is heated, causing it to become less dense and rise into a hot convection column. Cooler air flows in to replace the rising gases, and in some cases, this inflow of air creates local winds that further fan the flames. Hot convective gases move up slope and dry out fuels ahead of the flaming front, lowering their ignition temperature and increasing their susceptibility to ignition and fire spread.

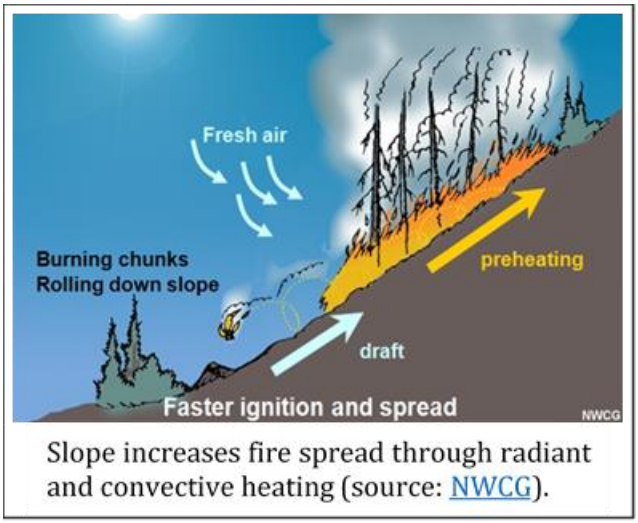
like a log on a campfire. Fire spread through a forest is slower than in a grassland or shrubland, but forest fires release more heat and can be extremely difficult and unsafe for firefighters to suppress. An abundance of dead trees killed by drought, insects, or disease can exacerbate fire behavior, particularly when dead trees still have dry, red needles (Moriarty et al., 2019; Parsons et al., 2014).

Topography

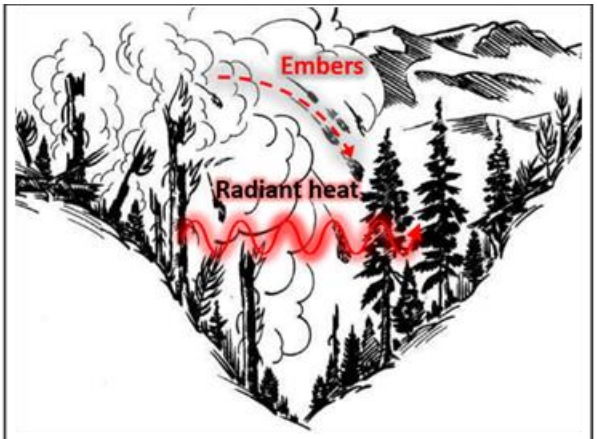
Topography (slope and aspect) influences fire intensity, speed, and spread. In the northern hemisphere, north-facing slopes experience less sun exposure during the day, resulting in higher fuel moistures. Tree density is often higher on north-facing slopes due to higher soil moisture. South-facing slopes experience more sun exposure and higher temperatures and are often covered in grasses and shrubs. The hotter and drier conditions on south-facing slopes mean fuels are drier and more susceptible to combustion, and the prevalence of flashy fuels results in fast rates of fire spread.

Fires burn more quickly up steep slopes due to radiant and convective heating. Fuels are brought into closer proximity with the progressing fire, causing them to dry out, preheat, and become more receptive to ignition, thereby increasing rates of spread. Steep slopes also increase the risk of burning material rolling and igniting unburnt fuels below.

Narrow canyons can experience increased combustion because radiant heat from fire burning on one side of the canyon can heat fuel on the other side of the canyon. Embers can easily travel from one side of a canyon to the other. Topography also influences wind behavior and can make fire spread unpredictable. Wildfires burning through steep and rugged topography are harder to control due to reduced access for firefighters and more unpredictable and extreme fire behavior.



Slope increases fire spread through radiant and convective heating (source: NWCG).



Fires can easily cross narrow canyons (source: U.S. Forest Service).

Steep slopes and topographic features such as narrow canyons exacerbate fire behavior.

Weather

Weather conditions that impact fire behavior include temperature, relative humidity, precipitation, and wind speed and direction. The National Weather Service uses a system called a red flag warning to indicate local weather conditions that can combine to produce increased risk of fire danger and behavior. Red flag warning days indicate increased risk of extreme fire behavior due to a combination of hot temperatures, very low humidity, dry fuels, strong winds, and the presence of thunderstorms (**Table A.1**).

Direct sunlight and hot temperatures impact how ready fuels are to ignite. Warm air preheats fuels and brings them closer to their ignition point. When relative humidity is low, the dry air can absorb moisture from fuels, especially flashy fuels, making them more susceptible to ignition. Long periods of dry weather can dehydrate heavier fuels, including downed logs, increasing the risk of wildfires in areas with heavy fuel loads.

Wind influences fire behavior by drying out fuels (think how quickly your lips dry out in windy weather), increasing the amount of oxygen feeding the fuel, preheating vegetation through convective heat, and carrying embers more than a mile ahead of an active fire. Complex topography, such as chutes, saddles, and draws, can funnel winds in unpredictable directions, increasing wind speeds and resulting in erratic fire behavior.

Table A.1*. Red flag days are warnings issued by the National Weather Service using criteria specific to a region. IHFPD is in the area overseen by the Denver/Boulder Forecast Office.*

National Weather Service – Denver/Boulder Forecast Office Red Flag Warning Criteria	
Option 1	**Option 2**
Relative humidity less than or equal to 15%	Widely scattered dry thunderstorms
Wind gusts greater than or equal to 25 mph	Dry fuels
Dry fuels	

Categories of Fire Behavior

Weather, topography, and fuels influence fire behavior, and fire behavior in turn influences the tactical options available for wildland firefighters and the risks posed to lives and property. There are three general categories of fire behavior described throughout this CWPP: surface fire, passive crown fire, and active crown fire.

- **Surface fire –** Fire that burns fuels on the ground, which include dead branches, leaves, and low vegetation. Surface fires can be addressed with direct attack using handcrews when flame lengths are less than four feet and with equipment when flame lengths are less than eight feet. Surface fires can emit significant radiant heat, which can ignite nearby vegetation and homes.
- **Passive crown fire –** Fire that arises when surface fire ignites the crowns of trees or groups of trees (aka, torching). Torching trees reinforce the rate of spread, but passive crown fires travel along with surface fires. Firefighters can sometimes address passive crown fires with indirect attack, such as dropping water or retardant out of aircraft or digging fireline at a safe distance from the flaming front. The likelihood of passive crown fire increases when trees have low limbs and when smaller trees and shrubs grow below tall trees and act as ladder fuels. Radiant heat and ember production from passive crown fires can threaten homes during wildfires.
- **Active crown fire –** Fire in which a solid flame develops in the crowns of trees and advances from tree crown to tree crown independently of surface fire spread. Crown fires are very difficult to contain, even with the use of aircraft dropping fire retardant, due to long flame lengths and tremendous release of radiant energy. The likelihood of active crown fires increases when trees have interlocking canopies. Radiant heat and ember production from active crown fires can threaten homes during wildfires.

Passive and active crown fires can result in short- and long-range ember production that can create spot fires and ignite homes. Spot fires are particularly concerning because they can form a new flaming front, move in unanticipated directions, trap firefighters between two fires, and require additional firefighting resources to control. Crown fires are generally undesirable in the wildland-urban interface (WUI) because of the risk to lives and property; however, passive and active crown fires are part of the natural fire regime for some forest types and result in habitat for plant and animal species that require recently disturbed conditions (Keane et al., 2008; Pausas and Parr, 2018). Passive and active crown fires historically occurred in some lodgepole pine forests and higher-elevation ponderosa pine and mixed-conifer forests on north-facing slopes (Addington et al., 2018; Romme, 1982).

Wildfire Threats to Homes

Wildfires can ignite homes through several pathways: radiant heat, convective heat, and direct contact with flames or embers. The ability for radiant heat to ignite a home is based on the properties of the structure (i.e., wood, metal, or brick siding), the temperature of the flame, the ambient air temperature, and distance from the flame (Caton et al., 2016). Ignition from convective heat is more likely for homes built along steep slopes and in ravines and draws. For flames to ignite a structure, they must directly contact the building long enough to cause ignition. Flames from a stack of firewood near a home could cause ignition to the home, but flames that quickly burn through grassy fuels are less likely to ignite the home (although the potential still exists). Fires can also travel between structures along fuel pathways such as a fence or row of shrubs connecting a shed and a home (Maranghides et al., 2022). Some housing materials can burn hotter than the surrounding vegetation, thereby exacerbating wildfire intensity and initiating home-to-home ignition (Mell et al., 2010).

Homes built mid-slope and at the top of steep slopes and within ravines and draws are at greater risk of convective heat from wildfires. A wildfire could rapidly spread up this steep slope and threaten the home above. Photo credit: The Ember Alliance

Homes can be destroyed during wildfires even if surrounding vegetation has not burned. During many wildland fires, 50 to 90% of homes ignite due to embers rather than radiant heat or direct flame (Babrauskas, 2018; Gropp, 2019). Embers can ignite structures when they land on roofs, enter homes through exposed eaves, or get under wooden decks. Embers can also ignite nearby vegetation and other combustible fuels, which can subsequently ignite a home via radiant heating or direct flame contact. Burning homes can release embers that land on and ignite nearby structures, causing destructive home-to-home ignitions, as evidenced by the destructive 2021 Marshall Fire in Boulder County. Structural characteristics of a home can increase its exposure to embers and risk of combustion, such as wood shingle roofs and unenclosed eaves and vents (Hakes et al., 2017; Syphard and Keeley, 2019). Embers can also penetrate homes if windows are destroyed by radiant or convective heat. See your community's CWPP for specific recommendations to harden your home against wildfires.

Resources for More Information on Fire Behavior

- Introduction to Fire Behavior from the National Wildfire Coordinating Group (9:57 minute video)
- The Fire Triangle from the National Wildfire Coordinating Group (7:26 minute video)
- Understanding Fire Behavior in the Wildland/Urban Interface from the National Fire Protection Association (20:51 minute video)
- Understanding Fire from California State University (website)
- S-190 Introduction to Wildland Fire Behavior Course Materials from the NWCG (PowerPoints, handouts, and videos)

Appendix B. Community Risk Assessment and Modeling Methodology

WUI Delineation

Delineating the wildland-urban interface is a critical component of CWPPs in compliance with the Healthy Forest Restoration Act (HFRA) of 2003. Communities can extend the WUI boundary into adjacent areas that pose a wildfire threat to their community, can serve as a strategic location for wildland firefighting, and are adjacent to evacuation routes for the community (HFRA 4 U.S.C. §101.16). Strategic wildfire mitigation across the WUI can increase the safety or residents and wildland firefighters and reduce the chances of home loss.

We delineated the WUI for the IHFPD to include any area that could transmit wildland fire into the community during a 4-hour period in the absence of firefighter suppression and control measures under extreme fire weather conditions with 19 mph winds out of the west southwest based on our wildfire modeling with FlamMap (see below). The northern and western boundaries of the WUI area capture Bear Creek Road (CO Highway 74) and County Road 73; these roads could serve as important evacuation routes for the community.

Fire Behavior Analysis

Interpretations and Limitations

Fire behavior models have been rigorously developed and tested based on over 40 years of experimental and observational research (Sullivan, 2009). Fire behavior models allow us to identify areas that could experience high-severity wildfires and pose a risk to lives, property, and other values at risk.

We used the fire behavior model FlamMap, which is a fire analysis desktop application that simulates potential fire behavior and spread under constant weather and fuel moisture (Finney, 2006). FlamMap is one of the most common models used by land managers to assist with fuel treatment prioritization, and it is often used by fire behavior analysts during wildfire incidents.

Fire behavior analyses are useful for assessing relative risk across the entire IHFPD and are not intended to assess specific fire behavior in the vicinity of individual homes. It is not feasible to predict every combination of fire weather conditions, ignition locations, and suppression activities that might occur during a wildfire. Uncertainty will always remain about where and how a wildfire might behave until a fire is actually occurring, and even then, fire behavior can be erratic and unpredictable.

> Fire behavior models can provide reasonable estimates of relative wildfire behavior across a landscape. However, wildfire behavior is complex, and models are a simplification of reality. It is recommended to use fire behavior analyses to assess relative risk across the entire IHFPD. Models cannot produce specific and precise predictions of what will occur in the vicinity of an individual home during a wildfire incident.

Fire behavior models like FlamMap do not include structures as a fuel type. Structures like homes, sheds, fences, and other buildings are absolutely a source of fuel during wildland fires and can produce massive amounts of embers that contribute to home-to-home ignitions (Maranghides et al., 2022). However, FlamMap cannot account for fine-scale variation in surface fuel loads, defensible

space created by individual homeowners, and the ignitability of building materials, nor are these data available at the scale of individual homes across an entire fire protection district. In the absence of this information and a deeper quantitative understanding of interactions between structures and wildland vegetation during a wildfire, fire behavior cannot be modeled for areas dominated by homes in the same fashion as areas dominated by grassland, shrubland, or forest vegetation. For this reason, we conducted a separate analysis to predict potential exposure of homes to radiant heat and ember cast (see section below).

Model Specifications and Inputs

We used FlamMap to model flame length, crown fire activity, potential fire sizes, and conditional burn probability. FlamMap requires information on topography and fuel loads across the area of interest (**Figure B.1**). See **Table B.1** and **Table B.2** for details on model inputs and specifications.

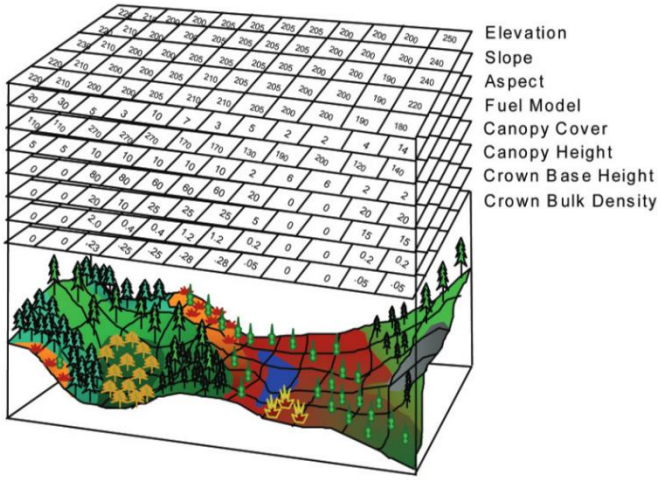


Figure B.1. *FlamMap requires a variety of information about topography and fuels. Image from Finney (2006).*

We used LANDFIRE data modified by the Colorado Forest Restoration Institute in 2021 as the basis for our modeling. LANDFIRE is a national program spearheaded by the U.S. Department of the Interior and the U.S. Department of Agriculture to provide spatial products characterizing vegetation, fuels, fire regimes, and disturbances across the entire United States. LANDFIRE products serve as standardized inputs for fire behavior modeling. We thoroughly quality controlled fuel data and worked with IHFPD to assess the reasonableness of model predictions.

Figure B.2 depicts the fire behavior fuel models present across the IHFPD. Fuel models are a stylized set of fuel bed characteristics used as input for a variety of wildfire modeling applications to predict fire behavior (Scott and Burgan, 2005). Fuel models in IHFPD include grass, grass-shrub, shrub, and timber understory types. The most abundant fuel model is very high load, dry climate timber and shrub (TU5), followed by moderate load, dry climate grass-shrub (GS2), low load dry climate timber, grass, and shrub (TU1), and low load, dry climate grass (GR2). Our maps of fire behavior predictions include areas indicated as "unburnable / not modeled"—parking lots, roadways, bodies of water, and barren areas are considered unburnable; areas dominated by homes and buildings were classified as "not modeled" because fire behavior models do not include structures as a fuel type (Scott and Burgan, 2005).

Fire behavior models require estimates of fire weather conditions, and a common practice is to model fire behavior under hot, dry, and windy conditions for an area—not the average conditions, but extreme conditions. Wildfires that grow to large sizes, exhibit high-severity behavior, and overwhelm suppression capabilities tend to occur under extreme fire weather conditions (Williams, 2013).

We modeled potential wildfire behavior under moderate (60th percentile) and extreme (90th percentile) fire weather conditions (**Table B.2**). Weather parameters for this analysis came from data collected at the Bailey RAWS and fuel moisture conditions from FireFamilyPlus. 60th percentile conditions are like a normal summer day, whereas 90th percentile conditions are extremely hot, dry

days—days that would qualify for red flag warnings and result in large-fire growth, such as conditions in early June 2002 during the Hayman Fire. These two benchmarks allow us to analyze where an average fire in the district may burn so the IHFPD can prioritize outreach and treatment under regular circumstances, as well as what can be expected under more extreme circumstances, as was seen in 2020.

Winds across the Front Range of Colorado are unpredictable and can be extremely gusty in mountainous areas. We modeled 20-foot windspeeds of 15 mph for moderate fire weather conditions and 19 mph for extreme fire weather conditions. We modeled potential fire spread under winds blowing out of the east (90°) and blowing out of the west-southwest (245°) based on observations from the Bailey RAWS and observations of local firefighters. We modeled flame length and crown fire activity based on west-southwest winds, and we modeled burn probability based on both these prevailing winds.

Fire spread was modeled with FlamMap's "minimum travel time" algorithm to predict fire growth between cells and account for fire spread through spotting. We modeled fire growth under 1,500 random ignitions across the landscape, and we allowed fires to grow for 4 hours in the absence of firefighter suppression and control measures. We modeled fire behavior in an area eight times larger than the IHFPD and centered on the IHFPD to capture the landscape-scale movement of fire.

FlamMap offers two methods for calculating crown fire initiation and spread: the Scott and Reinhardt method and the Finney method. We used the Scott and Reinhardt method as this method resulted in predictions of crown fire occurrence more consistent with expectations and has been found more reliable than the Finney method (Scott, 2006). Conditional burn probability is calculated as the percentage of simulated fires that burn each 30-meter by 30-meter (0.2 acre) area under specified fire weather conditions, wind directions, and wind speeds.

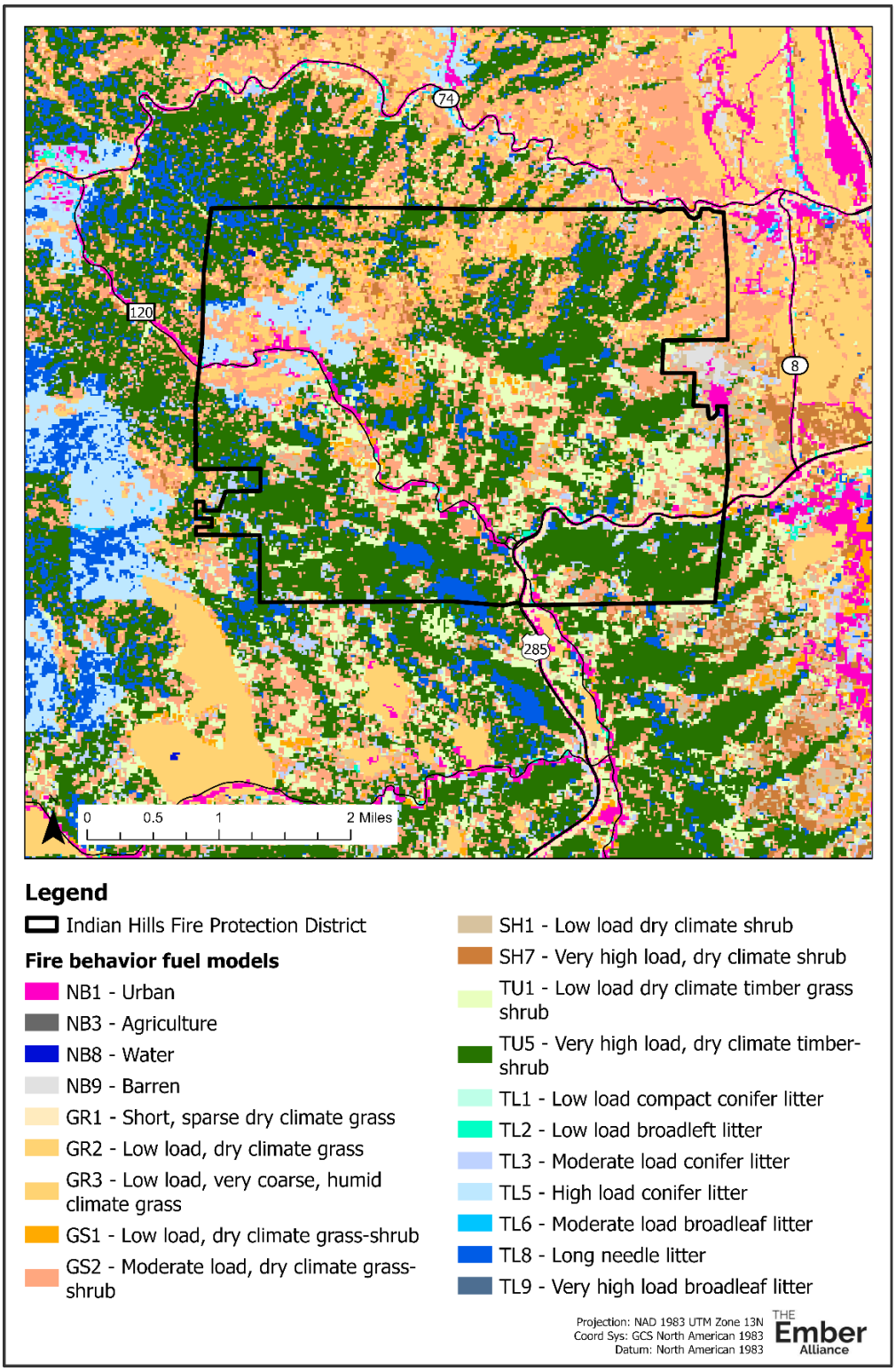


Figure B.2. *About 40% of the IHFPD is characterized by very high load dry climate timber-shrub (TU5). Other prevalent fuel models are moderate load, dry climate grass-shrub (GS2), low load dry climate timber, grass, and shrub (TU1), and low load, dry climate grass (GR2). Fire behavior fuel models are an important input for making fire behavior predictions. See Scott and Burgan (2005) for a description of each fuel model. Source: 2015 LANDFIRE data.*

Table B.1. *Model specifications used for fire behavior analyses with FlamMap for the 2023 IHFPD CWPP.*

Model specification	Value
Crown fire calculation method	Scott/Reinhardt (2001)
Wind options	Gridded winds
Wind grid resolution	60 meters
Number of random ignitions	1,500*
Resolution of calculations	30 meters
Maximum simulation time	240 minutes
Minimum travel paths	500 meters
Spot probability	0.7
Spotting delay	15 minutes
Lateral search depth	6 meters
Vertical search depth	4 meters

*We used the same random ignition locations for fire spread analysis under 60th and 90th fire weather conditions. Ignitions were randomly located across an area eight times the size of IHFPD.

Table B.2. *Fire weather conditions utilized for fire behavior modeling are based on weather observations from the Bailey Remote Automatic Weather Station between 2002 and 2020, fuel moisture predictions from FireFamilyPlus, and wind speeds and directions from the Bailey RAWS. Average weather conditions on June 9, 2002, during the Hayman Fire are presented for comparison.*

Variable	Moderate fire weather (60th percentile)	Extreme fire weather (90th percentile)	Hayman Fire (for comparison)
Temperature	77° Fahrenheit	84° Fahrenheit	83° Fahrenheit
Relative humidity	21%	11%	8%
Wind Direction	East (90°) and west-southwest (245°)	East (90°) and west-southwest (245°)	South-southwest (194°)
20-foot wind speed[1]	15 mph	19 mph	14 mph, gusting up to 44
Fuel moisture[2]			
1-hour	4%	2%	2%
10-hour	5%	3%	3%
100-hour	9%	6%	7%
1000-hour[3]	11%	9%	11%
Live woody	80%	73%	84%
Live herbaceous	30%	30%	48%
Crown foliage	100%	80%	---

[1]20-foot wind speeds are approximately 5 times faster than winds at ground level in fully sheltered fuels; vegetation and friction slow down windspeeds closer to ground level (NWCG, 2021).

[2]One-hour fuels are dead vegetation less than 0.25 inch in diameter (e.g., dead grass), ten-hour fuels are dead vegetation 0.25 inch to 1 inch in diameter (e.g., leaf litter and pine needles), one hundred-hour fuels are dead vegetation 1 inch to 3 inches in diameter (e.g., fine branches), and one thousand-hour fuels are dead vegetation 3 inches to 8 inches in diameter (e.g., large branches). Fuels with larger diameters have a smaller surface area to volume ratio and take more time to dry out or to become wetter as relative humidity in the air changes.

[3]1000-hour fuel is moisture not used by FlamMap for predicting fire behavior but is included here to provide additional context.

Predicted Fire Behavior

Wildland firefighters keep abreast of current and expected fire behavior when making tactical decisions. Fire behavior classes are based on flame length, rate of spread, and crown fire activity and are utilized by firefighters to guide tactical decisions following the Haul Chart (**Table B.3**).

Flame length is the distance measured from the average flame tip to the middle of the flaming zone at the base of the fire. Flame length is measured on an angle when the flames are tilted due to effects of wind and slope (see image at right). Flame length is an indicator of fireline intensity—the amount of energy released by a fire. **Figure B.3** depicts predicted flame lengths across the IHFPD.

The occurrence of torching (aka, passive crown fire), spotting, and active crown fire are notable fire behaviors that must inform tactical decisions on the fireline. Both passive and active crown fires pose a significant risk to the safety of firefighters and residents and can destroy homes through radiant and convective heating and ember production. See **Appendix A** for a description of different types of fire behavior. **Figure B.4** depicts crown fire occurrence across the IHFPD.

Fire behavior class was determined for the IHFPD by combining predictions of flame length and crown fire activity following the Haul Chart. Under moderate fire weather conditions—conditions typical of a summer day in IHFPD—40% percent of the IHFPD could experience very high to extreme fire behavior, and this percentage increases to 55% under less common but more extreme, hot, dry, and windy conditions (**Figure B.5**).

Even under moderate fire weather conditions, extreme and erratic fire behavior is possible on dense north-facing slopes around Mount Lindo the southern part of the IHFPD. This are is extremely steep and covered in dense mixed-conifer forests with abundant ladder fuels. Under extreme fire weather conditions, ponderosa pine and mixed-conifer forests on steep slopes across IHFPD could produce extreme and erratic fire behavior. Very high to extreme fire behavior includes ember production that ignites additional fires away from the main fire and the movement of high-intensity fire from treetop to treetop. Such fires are extremely challenging if not impossible to control until winds die down and fuel moistures increase.

Firefighters would struggle to suppress fires across the IHFPD under hot, dry, and windy conditions due to extreme flame lengths and radiant heat emissions. Extreme fire weather conditions are increasingly common due to climate change and could result in even more extreme fire behavior across the IHFPD than predicted by this analysis.

Table B.3. *Description of fire behavior and tactical interpretations for firefighters from the Haul Chart (NWCG, 2019).*

Fire behavior class	Flame length (feet)	Rate of spread (chains/hr)*	Tactical interpretation
Very low, smoldering	<1	0-2	Fire is not spreading and has limited flaming. Fire can be attacked at the head or flanks by persons using handtools. Handline will hold the fire.
Low, creeping, spreading	1-4	2-5	Fire can be attacked at the head or flanks by persons using handtools. Handline should hold the fire.
Moderate, running	4-8	5-20	Fires are too intense for direct attack on the head of the fire by persons using handtools. Handline cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft may be effective.
High, torching and spotting	8-11	20-50	Fires present serious control problems with torching, crowning, and spotting. Control efforts at the head of the fire are probably ineffective.
Very high, active crown fire	11-25	50-150	Crowning, spotting, and major fire runs are expected. Control efforts at the head of the fire are ineffective.
Extreme and erratic	>25	>150	Extreme intensity, turbulent fire, and chaotic spread. Escape to safety should be considered.

*__Note:__ 1 chain = 66 feet. Chains are commonly used in forestry and fire management as a measure of distance. 1 chain / hour = 1.1 feet / minute.

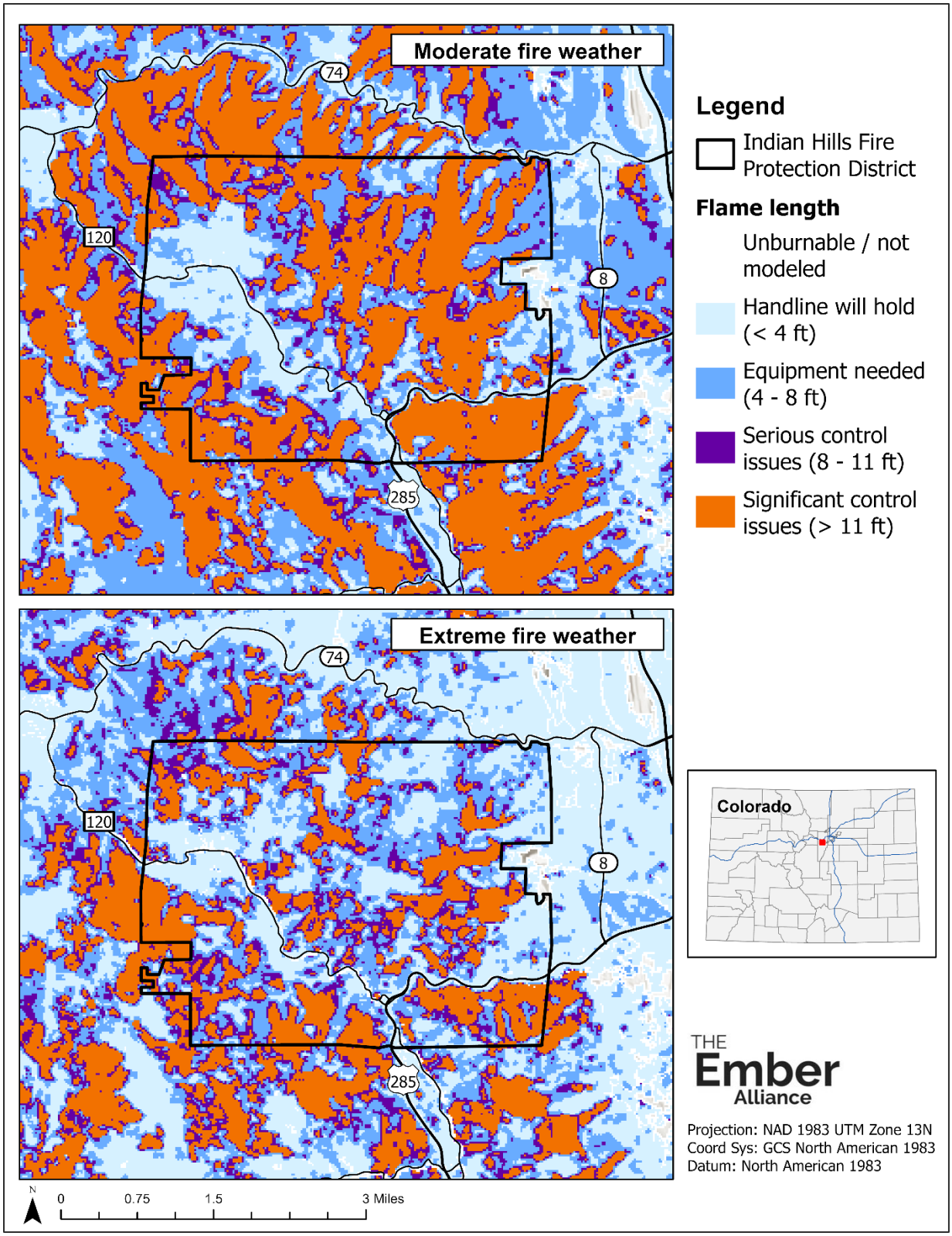


Figure B.3. *Flame lengths in the IHFPD under moderate and extreme fire weather conditions, categorized by the Haul Chart (**Table B.3**).*

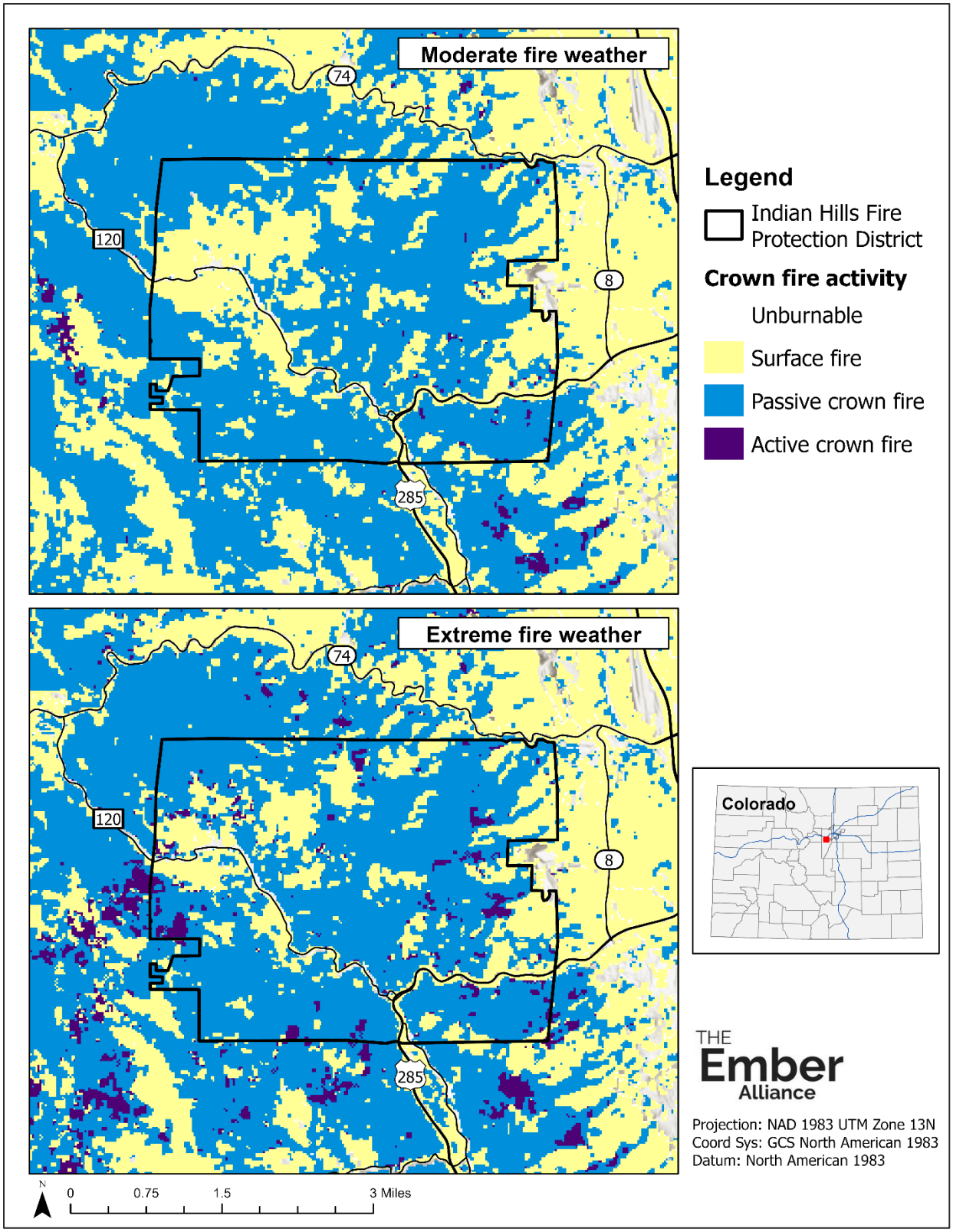


Figure B.4. *Crown fire activity in the IHFPD under moderate and extreme fire weather conditions.*

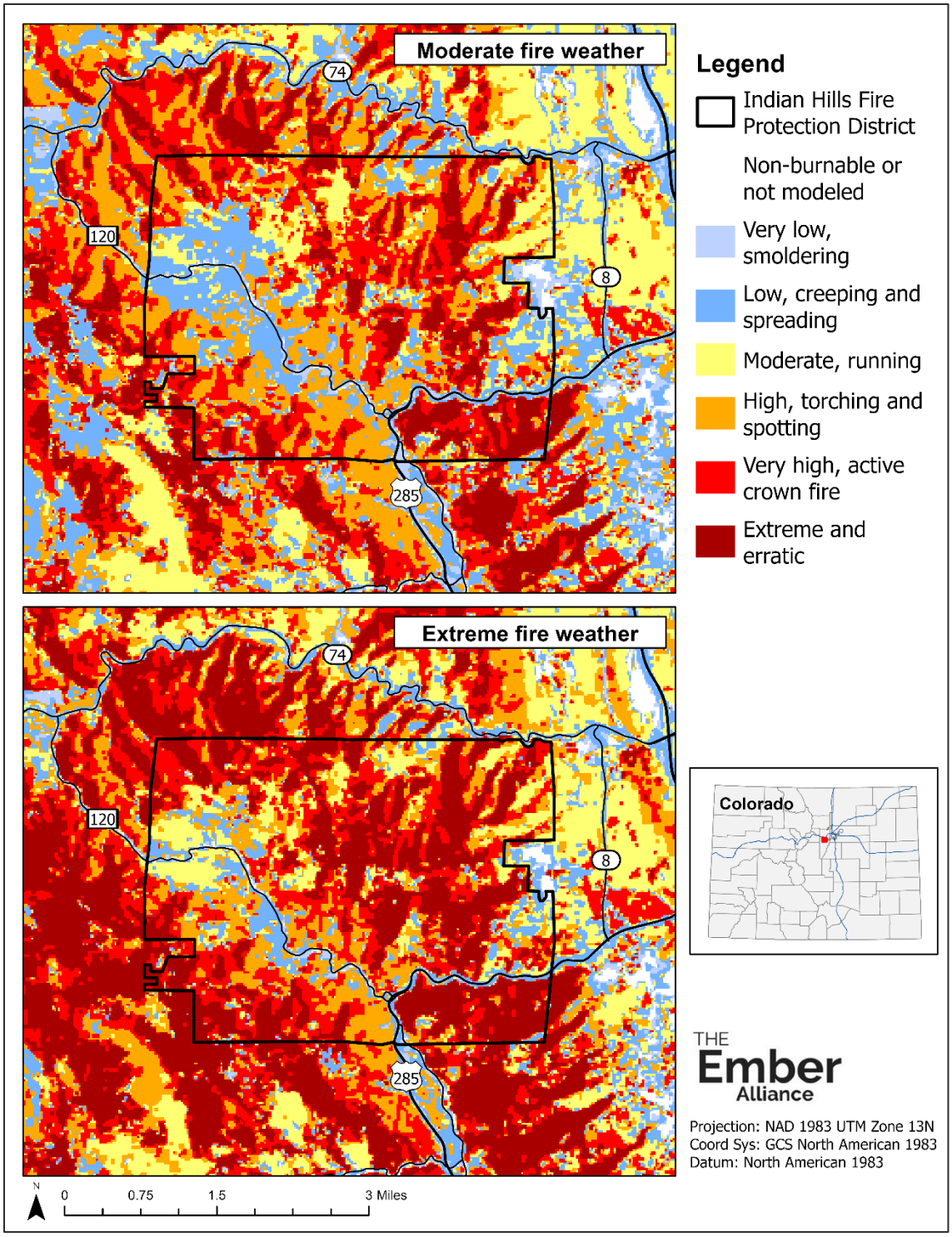


Figure B.5. *Under moderate fire weather conditions—conditions typical of a summer day in IHFPD—40% percent of the IHFPD could experience very high to extreme fire behavior, and this percentage increases to 55% under less common but more extreme, hot, dry, and windy conditions. High to extreme fire behavior includes ember production that ignites additional fires away from the main fire and the movement of high-intensity fire from treetop to treetop. Such fires are extremely challenging if not impossible to control until winds die down and fuel moistures increase.*

Predicted Conditional Burn Probability

Conditional burn probability indicates how likely an area is to burn during a wildfire. Wind direction strongly affects burn probability, carrying fires quickly up slopes facing toward the incoming winds. Topography, non-burnable barriers such as wide rivers, interstates, and highways, and fuel loads also influence conditional burn probability by dictating how fire spreads across the landscape.

Short-range transport of embers can cause spot fires to ignite even across unburnable barriers such as Parmalee Gulch Road. Rapid fire growth and spotting across roadways is more likely under higher windspeeds and with drier fuel conditions. **Unpredictable wind conditions along the Colorado Front Range make it difficult to predict potential fire spread, making it imperative for residents across the IHFPD to take measures to mitigate their home ignition zone.**

Conditional burn probability is relatively higher in the southwestern and northeastern parts of IHFPD under winds blowing out of the west southwest. Large areas of uninterrupted, dense forests could support the growth of large fires in these areas. Conditional burn probability is higher in the central and northwestern parts of IHFPD under winds blowing out of the east, particularly in densely forested areas across ravines aligned southwest to northeast (**Figure B.6**).

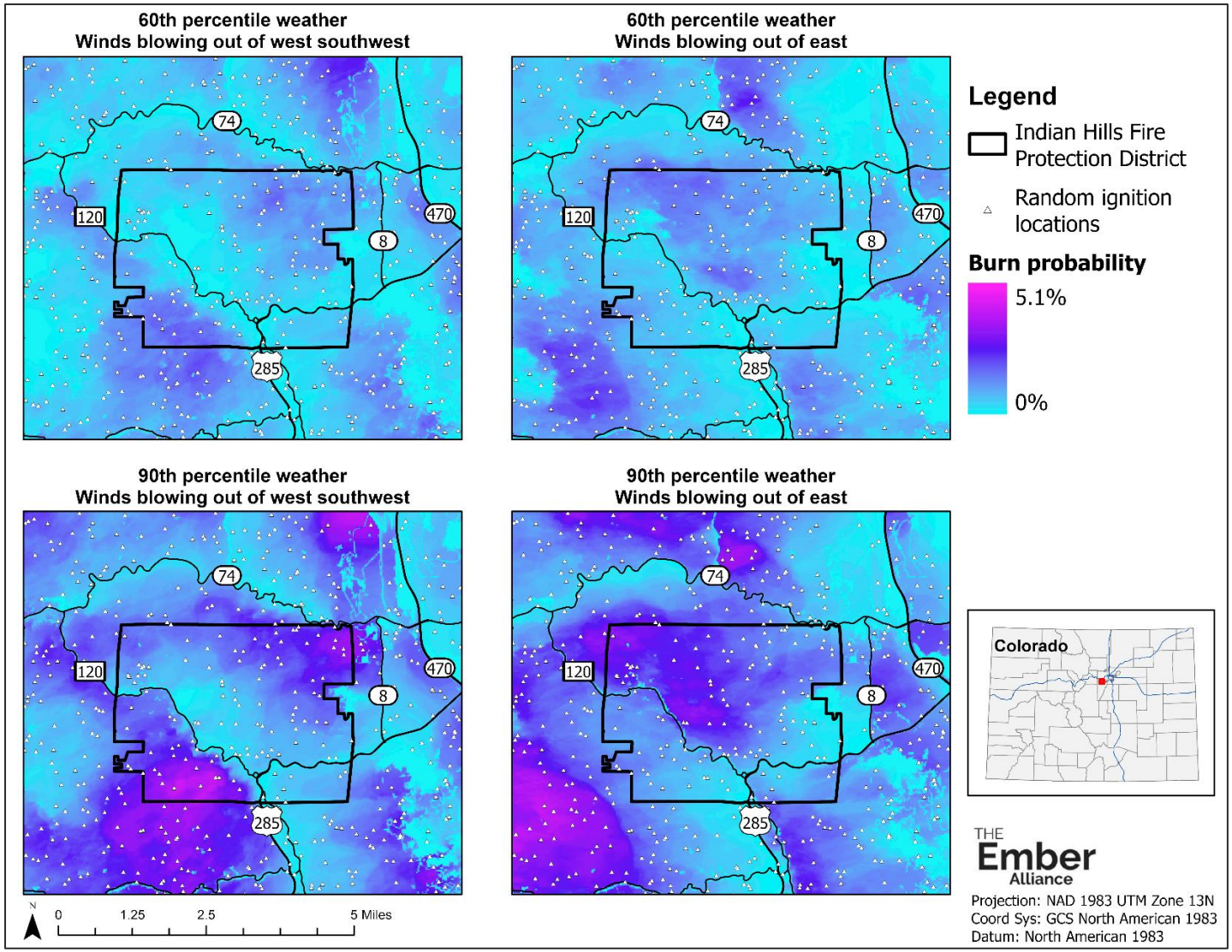


Figure B.6. *Conditional burn probability under moderate and extreme fire weather conditions with winds blowing out of the west southwest and east. Wildfire spread was simulated for 4-hours without suppression activities from 1,500 random ignition locations across an area eight times larger than and centered on the IHFPD.*

Predicted Radiant Heat and Ember Cast Exposure

We assessed the risk that radiant heat and short-range and long-range ember cast pose to structures[3]. See **Appendix A.** for a description of how wildfires can ignite homes. Ember production and transport and their ability to ignite recipient fuels are guided by complex processes, so we utilized the simplified approach of Beverly et al., (2010) to assess home exposure to radiant heating and short- and long-range ember cast. Exposure is based on distance from long flame lengths and potential active crown fire assuming:

- Radiant heat can ignite homes when extreme fire behavior (flame lengths > 16 feet) occurs within 33 yards (30 meters) of structures.
- Short-range embers can reach homes within about 110 yards (100 meters) of active crown fires.
- Long-range embers can reach homes within about 550 yards (500 meters) of active crown fires.

Embers can ignite homes even when the flaming front of a wildfire is far away. See **Section 3.a.** for tangible and relatively simple steps you can take to harden your home against embers. Mitigation practices, such as removing pine needles from gutters and installing covers over vents, can make ignition less likely and make it easier for firefighters to defend your property.

Distance thresholds used by Beverly et al., (2010) are based on observations from actual wildfires, but their estimates are lower than those from some researchers. Studies on wildfires burning eucalyptus forests in Australia and wildfires burning chaparral in California demonstrated that embers can travel 12 to 15 miles from the flaming front and ignite spot fires (Caton et al., 2016), but these fuel types are very different from conifer forests in Colorado. Embers from ponderosa pine trees tend to ignite fuels at a much lower rate than embers from other tree species (Hudson et al., 2020). In addition, the number of embers reaching an area decreases exponentially with distance traveled, and the likelihood of structure ignition increases with the number of embers landing on the structure (Caton et al., 2016). Therefore, using conservative estimates of distance allows us to identify areas with the greatest risk of ignition from short- and long-range embers.

Potential exposure to long-range ember cast is widespread across the IHFPD. Under extreme fire weather conditions, about 20% of homes could be damaged or destroyed from radiant heat, almost 10% from short-range ember cast, and almost 70% from long-range ember cast (**Figure B.8**), Homes in flat valleys along Parmalee Gulch Road have lower exposure to embers or radiant heat, but even homes in flat, unwooded areas could be exposed to long-range embers under extreme fire weather conditions. Homes with the greatest exposure to radiant heat and ember cast are located along Cameyo, Algonquin, and Lakota Roads under extreme fire weather condition (**Figure B.7**).

Most homes (85%) in IHFPD could be exposed to short-range ember cast from at least one other home, putting all those homes at risk of home-to-home ignition, especially if they are not mitigated or hardened (Syphard et al., 2012). On average, homes could be exposed to short-range ember cast from 4.5 other homes, with some homes exposed to as many as 15 other homes (**Figure B.9**). Fuel treatments within HIZs and surrounding undeveloped areas could help reduce the exposure of homes to radiant heat and short-range ember cast.

[3] It is recommended to use this analysis to assess relative risk across the entire Fire Protection District and not to evaluate absolute risk to individual homes. FlamMap and the approach of Beverly et al. (2010) cannot account for defensible space, the fire resistance of materials used in home construction, and other fine-scale variation in fuel loads that contribute to the ignition potential of individual homes.

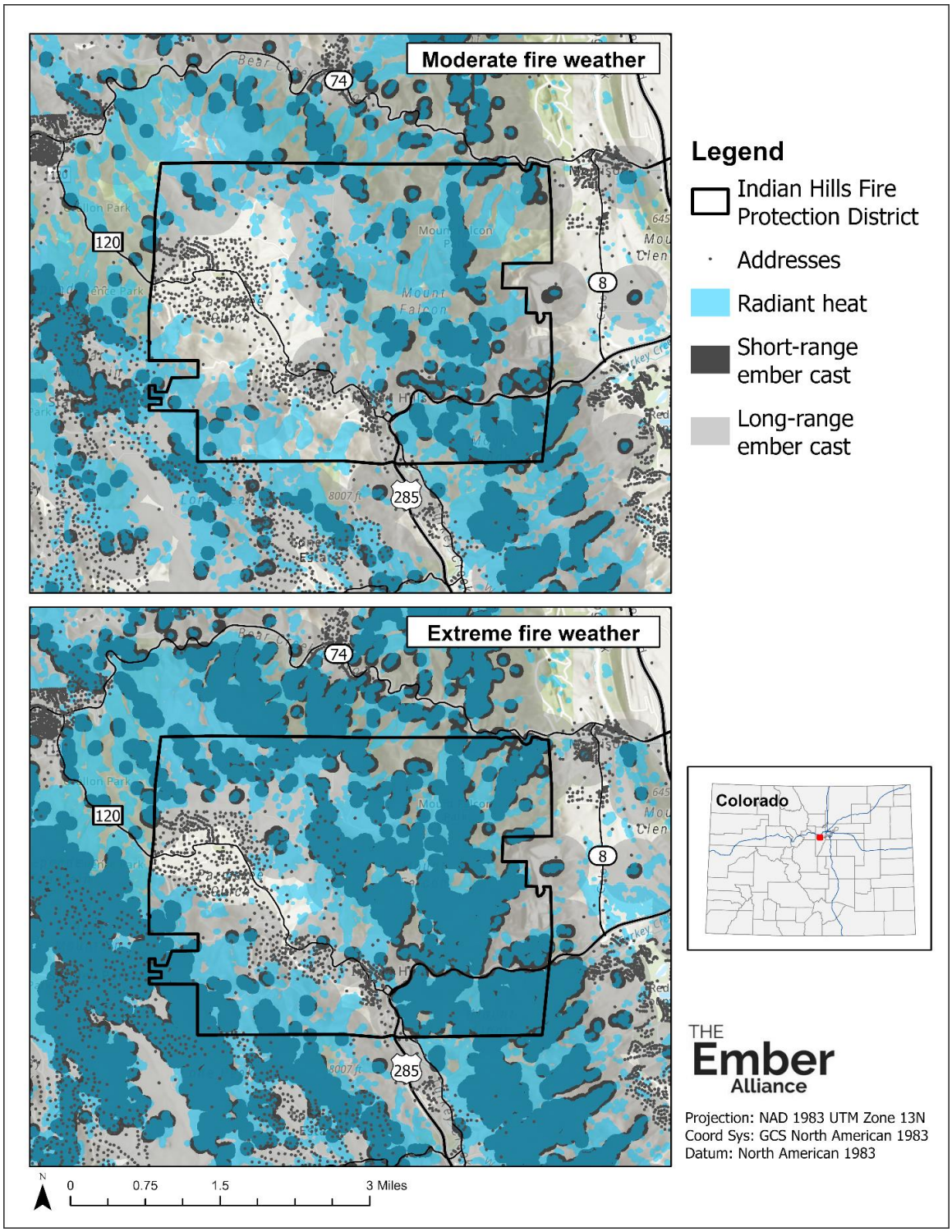


Figure B.7. *Predicted exposure to short-and long-range ember cast and radiant heat under moderate and extreme fire weather conditions in the IHFPD.*

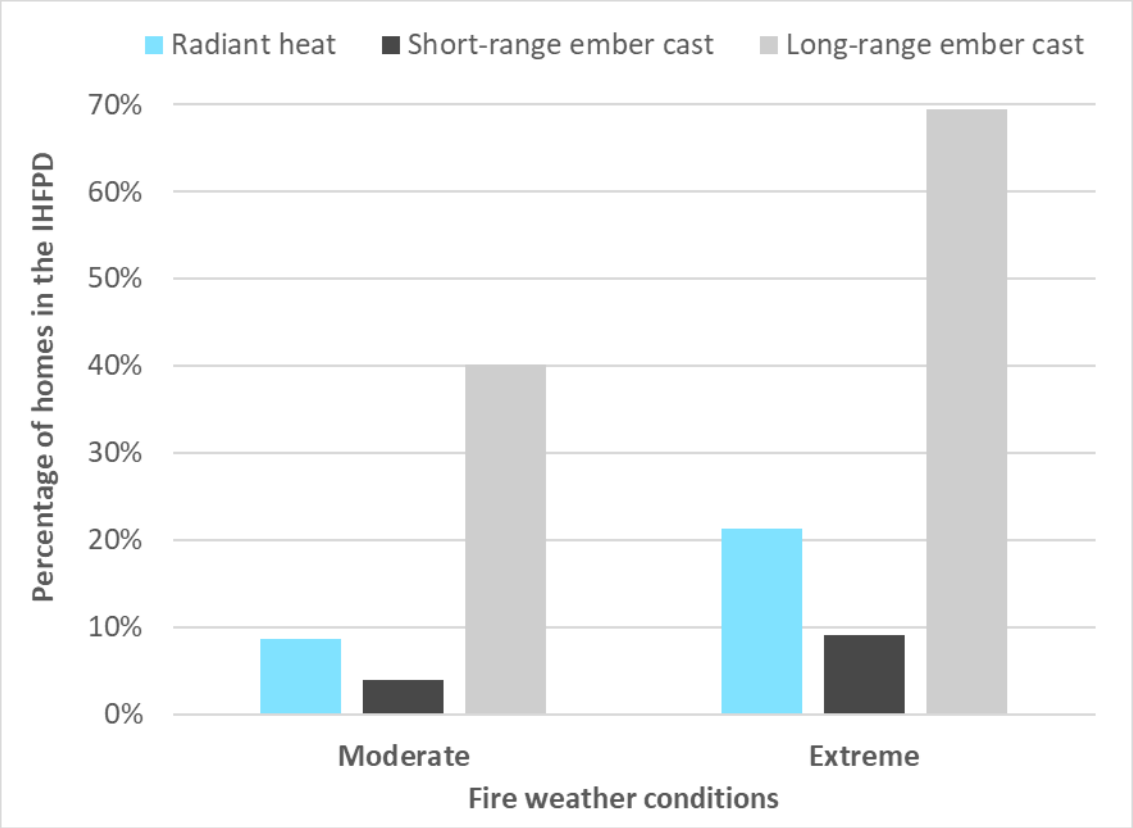


Figure B.8. *Percentage of homes in the IHFPD with different types of exposure to wildfire under moderate and extreme fire weather conditions. Radiant heat from burning vegetation can ignite nearby homes, and embers emitted from burning vegetation or other homes can travel long distances and ignite vegetation and homes away from the main fire.*

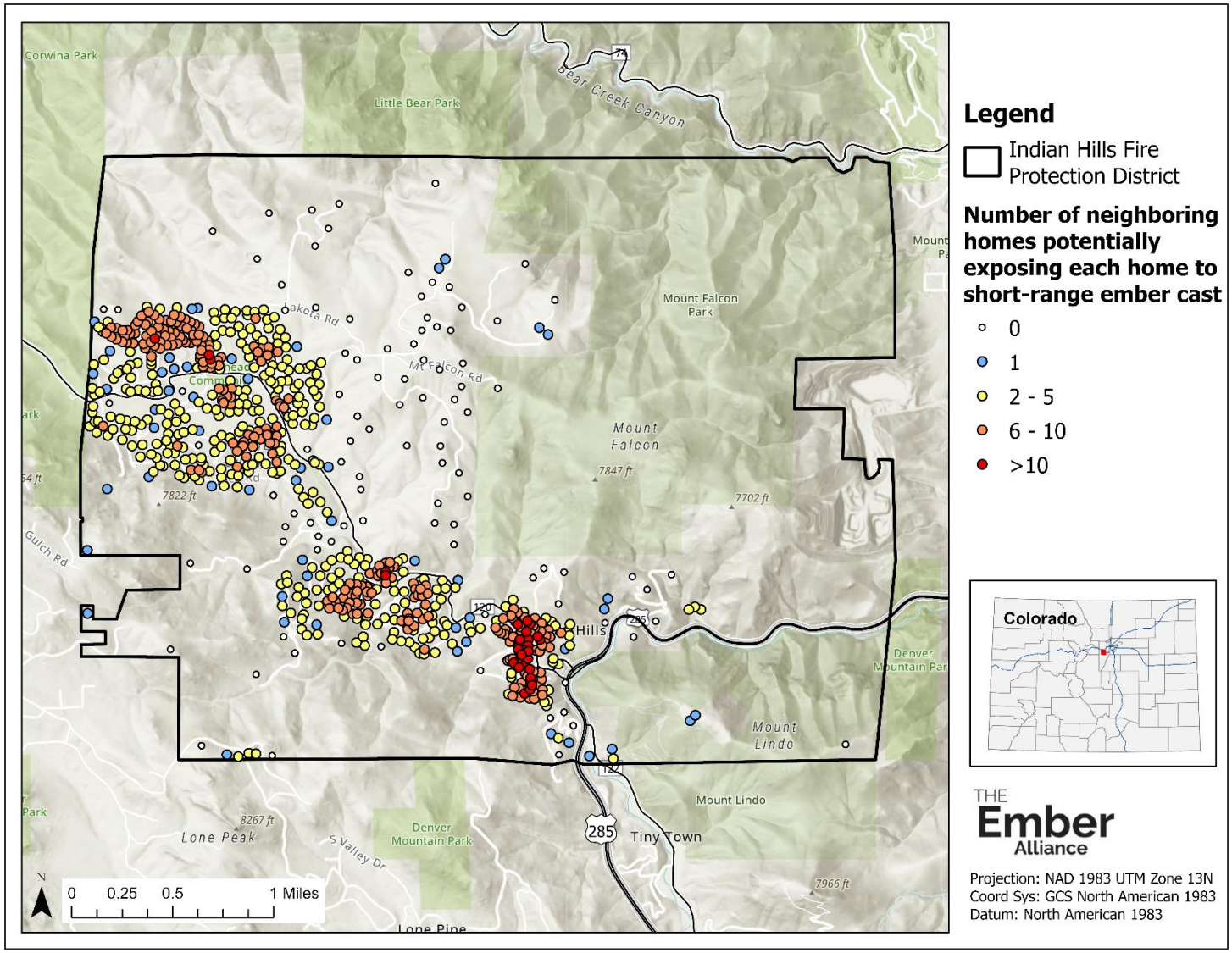


Figure B.9. *About 85% of homes could be exposed to short-range ember cast from at least one neighboring home, with the average home in IHFPD potentially exposed to short-range ember cast from 4.5 other homes. Homes within 100-meters of other homes are at greater risk of home-to-home ignitions from short-range ember cast (Syphard et al., 2012).*

Evacuation Analysis

Evacuation concerns can weigh heavily on the minds of many residents in the IHFPD. The death of 86 people in Paradise, California during the 2018 Camp Fire, many of whom were stranded on roadways during evacuation, underscores the importance of evacuation preparedness and fuel mitigation along evacuation routes.

Evacuation Modeling and Scenarios

We modeled evacuation time and roadway congestion using ArcCASPER (Shahabi and Wilson, 2014). The ArcCASPER model considers roadway capacity, road speed, number of cars evacuating per address, and the relationship between roadway congestion and reduction in travel speed. The model assumes simultaneous departure of vehicles, but it starts by determining evacuation routes for vehicles with the longest distance to travel. The purpose of the model is to minimize evacuation time for the entire district, not to minimize the evacuation time for each individual resident.

Keep in mind: Simulation models cannot account for all variables present during an evacuation, so these results are useful as a guide for strategic planning rather than a depiction of what will occur in any specific evacuation event.

The model's algorithm starts with the evacuee farthest from predefined evacuation destinations and finds that evacuee's shortest path to a predefined safe evacuation location. It iteratively continues this process until there are no more evacuees left. During the analysis, ArcCASPER dynamically updates how long it takes to traverse each road segment based on the number of evacuees using that route and the relationship between traffic and travel speeds. The model adjusts evacuation routes until it minimizes the global evacuation time (i.e., the time it takes for all evacuees to reach a safe evacuation location).

For our analysis, we used an exponential traffic model with a critical density of 10 and saturation density of 100. The critical density is the maximum number of cars that can be on a road with two lanes (one lane in each direction) without a reduction in travel speed, and saturation density is the number of cars on the road at which the traversal speed reduces to half the original speed.

ArcCASPER does not account for unpredictable events, such as roadway blockage from accidents or reduced visibility from smoke. It also does not consider emergency vehicles traveling the opposite direction of evacuation traffic.

Based on research by Beloglazov et al., (2016), we assumed that it takes 30 minutes for individuals to mobilize and depart their homes after receiving a mandatory evacuation order. We modeled two different scenarios—one where residents were directed east out of the IHFPD to northbound US285 and another scenario where residents were directed north out of the IHFPD along CR120 (Parmalee Gulch Road) to west or east-bound CO74. We used roadway data from OpenStreetMap and the Colorado Department of Transportation, with modifications to the road network based on local expertise.

For the evacuation scenario with eastward routing, we evacuated all 743 addresses in the IHFPD and 245 addresses east of the IHFPD, 78 addresses in the Tiny Town area, and 600 addresses along High Drive and Stanely Park Road. For the scenario with northwestern routing, we evacuated all 743 addresses in the IHFPD and 78 addresses in the Tiny Town area, 600 addresses along High Drive and Stanely Park Road, 524 addresses from Evergreen, and 659 addresses from Kittredge (see evacuee locations in **Figure B.10**). These additional addresses outside the IHFPD would likely evacuate at the same as addresses within the IHFPD during a wildfire. We modeled two vehicles departing from each standalone residential address, 10 vehicles departing from each apartment and non-residential

address (e.g., businesses and government buildings), 150 from the western parking lot for Mount Falcon Park, 45 from Parmalee Elementary School, and 30 from Geneva Glen Summer Camp based on feedback from the IHFPD.

Estimates of evacuation times assume that all addresses are occupied, and a mandatory evacuation time is issued for everyone simultaneously. This scenario could occur were a wildfire to ignite near IHFPD during the summer when there are many residents and visitors in the area. The intent of running the evacuation model for all of the IHFPD at once was to assess an extreme scenario when the most cars would be on the road at the same time. This allowed us to identify areas of major congestion during a large-scale evacuation and therefore plan for worst-case scenarios.

Estimates from ArcCASPER are useful for determining relative evacuation capacity and congestion across the IHFPD and are not intended to predict household-specific evacuation times. Law enforcement personnel will direct traffic during a wildfire event, so our evacuation modeling is not meant to suggest alternate routes for individual residents. **Residents need to follow guidance from law enforcement personnel during evacuation events, practice safe driving, and practice good evacuation etiquette (e.g., allowing cars to merge and not texting or stopping to take photographs).**

Evacuation Congestion

It is important for law enforcement personnel to plan for areas of high congestion when making decisions about how to conduct actual evacuations in the IHFPD. Roads were categorized by how much congestion may occur, and how much longer it may take to evacuate compared to everyday scenarios without evacuation traffic. Under the scenario with evacuation routing towards US 285, portions of Parmalee Gulch Road, US 285, North Turkey Creek Road, South Turkey Creek Road, South Valley Drive, High Drive, and Stanely Park Road could experience high to extreme congestion (**Figure B.10**). Under the scenario with evacuation routing towards US CO 74, Parmalee Gulch Road, Inca Road, CO 74, High Drive, Stanely Park Road, Little Cub Creek Road, and Independence Trail could experience high to extreme congestion.

It is important to reiterate that congestion modeling does not account for unexpected barriers such as cars breaking down, car accidents, road closures, etc. It also does not take into consideration additional traffic aside from individual evacuation groups; if an evacuation were ordered over a weekend, these congestion indices would increase dramatically. However, this analysis does show areas that are prone to traffic build up even under the best-case scenario.

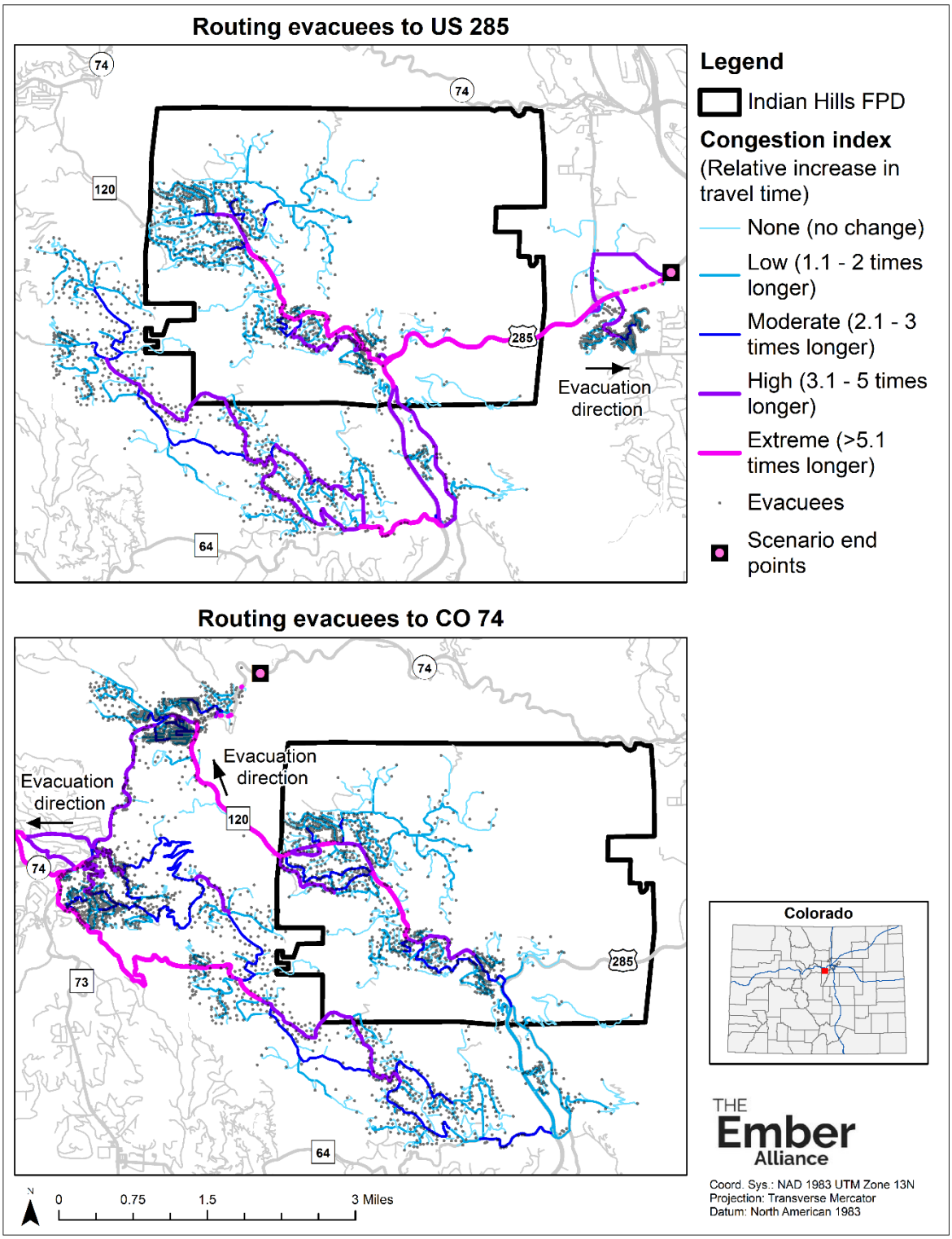


Figure B.10. *Predicted congestion across the IHFPD under a simultaneous district-wide evacuation order for a scenario with evacuation routing to the east of the IHFPD to US285 and another scenario with evacuation routing to the northwest of the IHFPD to CO74. Congestion categories (none, low, moderate, high, extreme) are based on the ratio between the time required to traverse a segment of road with congestion vs. without congestion.*

Evacuation Time

Evacuation time indicates how long it might take for a vehicle to receive an evacuation order, depart from an address, and reach the scenario endpoints (see locations in **Appendix B Figure B.10**). Estimates of evacuation time can serve as a benchmark for emergency pre-planning and strategic decision making. Remember, these scenarios assume an emergency, mandatory evacuation with simultaneous departures and assuming residents are safely and efficiently evacuating (i.e., there are no accidents blocking the roads, there is no smoke hindering visibility, etc.).

The actual time it would take to evacuate during a specific incident is influenced by a variety of factors not considered in this modeling effort, such as the staggering of evacuation orders, the nature of evacuation orders (i.e., voluntary versus mandatory), traffic accidents, delays from people stopping to take photographs, reduced visibility from smoke, etc.

Residents in the IHFPD could experience long evacuation times due to a high density of homes in and around the district and a limited number of egress routes (**Figure B.11**). Evacuation times could take between 1.5 to 2.5 hours for residents in the northwestern part of the IHFPD were residents to be routed to northbound US285 due to a wildfire moving from the southwest into the district. Residents that depart onto High Drive could have evacuation times as long as 3 hours under these conditions.

Were a wildfire to be moving into the IHFPD out of the east and residents asked to evacuate along Parmalee Gulch Road towards CO74, evacuation times could take 1 hour 20 minutes to 3 hours for residents in the IHFPD. Long evacuation times could occur due to funneling of most traffic from the district onto one road (Parmalee Gulch Road) and substantial congestion that could accumulate along CO74 with simultaneous evacuations of western Evergreen and Kittredge.

Due to the potential for substantial evacuation traffic, all residents in the IHFPD need to be prepared for evacuation warnings so they can leave promptly in the case of an evacuation. Understanding and practicing evacuation etiquette during an evacuation is also critical so everyone can evacuate safely and efficiently.

How realistic are estimated evacuation times from ArcCASPER?

The estimates we present make assumptions about the number of vehicles leaving each residency and the time it takes for residents to mobilize and depart after receiving an evacuation order. We could not account for unpredictable events in this modeling effort, such as roadway blockage from accidents or reduced visibility from smoke. It is impossible to know what actual evacuation times might be during a wildfire incident. There has never been an actual district-wide evacuation, and law enforcement personnel make evacuation decisions based on specific fire behavior during an incident.

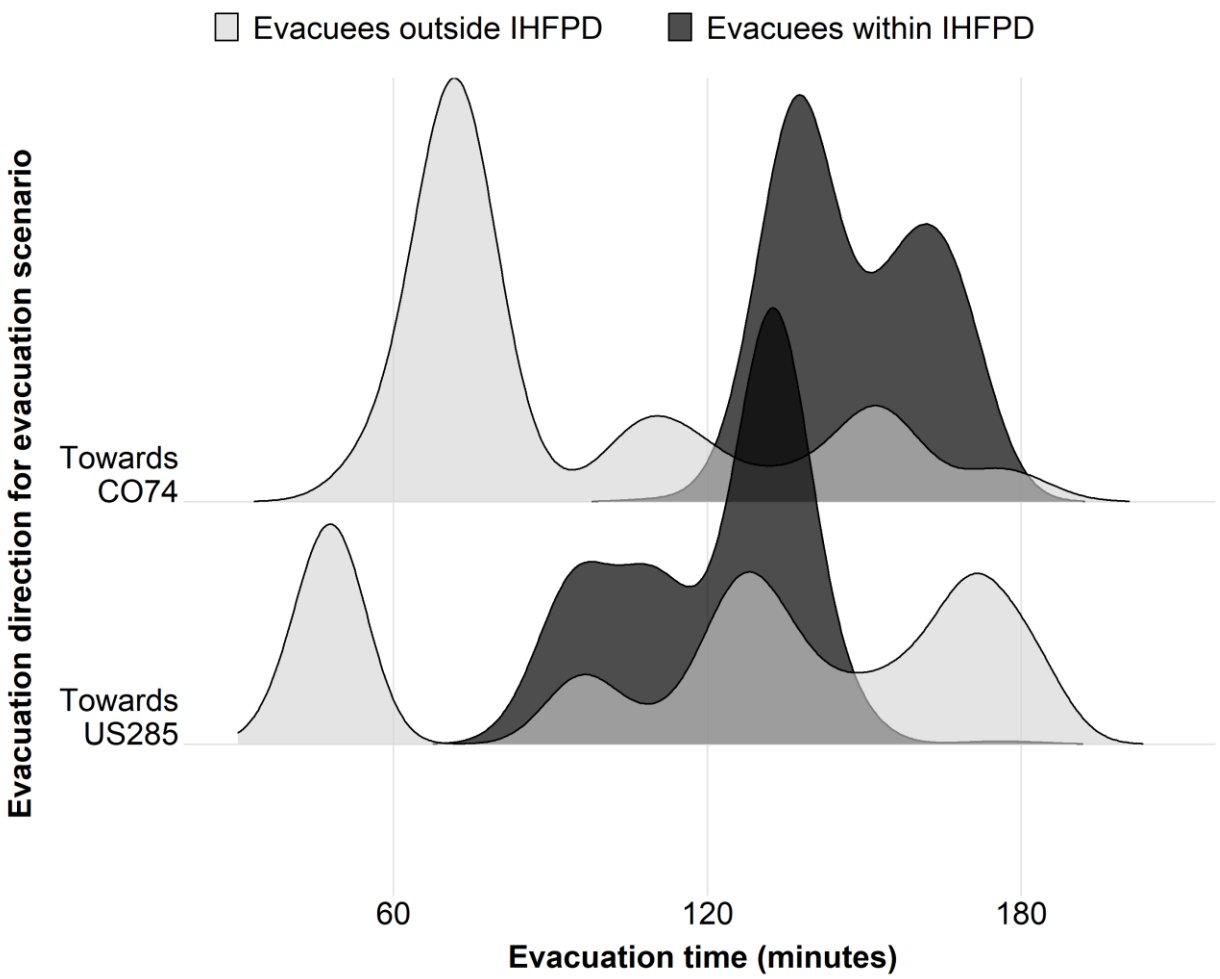


Figure B.11. *Predicted evacuation times under a simultaneous district-wide evacuation order for a scenario with evacuation routing to the east of the IHFPD to US285 and another scenario with evacuation routing to the northwest of the IHFPD to CO74. We assumed that it takes 30 minutes for individuals to mobilize and depart after receiving an evacuation order. Locations of evacuees are shown in* ***Figure B.10****. Peaks in the distribution indicate a larger number of evacuees with that predicted evacuation time. Evacuation times include a 30-minute estimate for people to gather their belongings and depart after receiving an evacuation order.*

Roadway Survivability

Tragedies have occurred when flames from fast-moving wildfires burn over roads while residents are evacuating. Residents can perish in their vehicles trapped on the road, and egress routes can become blocked from flames. **Mitigation actions along sections of road with high risk for non-survivable conditions during a wildfire can increase the chances of survival for residents stranded in their vehicles during a wildfire and decrease the chance that roadways become impassable due to flames.**

We utilized fire behavior predictions to identify road segments that could experience non-survivable conditions during a wildfire. We used roadway data from OpenStreetMap and the Colorado Department of Transportation, with modifications to the road network based on local expertise. We identified "non-survivable roadways" as portions of roads adjacent to areas with predicted flame lengths greater than 8 feet. Drivers stopped or trapped on these roadways could have a low chance of survival due to radiant heat emitted from fires of this intensity. This assumption is based on the Haul Chart, which is a standard tool used by firefighters to relate flame lengths to tactical decisions (**Table B.3**) (NWCG, 2019). Direct attack of a flaming front is no longer feasible once flame lengths exceed about 8 feet due to the intensity of heat output. Flames greater than 8 feet could also make roads impassable and cut residents off from egress routes. Non-survivable conditions are more common along roads lined by thick forests with abundant ladder fuels, such as trees with low limbs and saplings and tall shrubs beneath overstory trees.

Under moderate fire weather conditions, 23% of the roads in the IHFPD could experience non-survivable conditions, and this percentage rises to 40% under extreme fire weather conditions (**Figure B.12**). Some non-survivable roadways are lined with numerous homes and the primary egress for those residents during emergency evacuations. Of particular concern are conditions along Algonquin Road, Shawnee Road, and Santa Clara Road. Conditions are also potentially dangerous along High Drive, which is the primary evacuation route for several residents in the southwestern corner of IHFPD. We incorporated predictions of roadway survivability and potentially evacuation congestion into recommendations for roadside fuel treatments across the IHFPD.

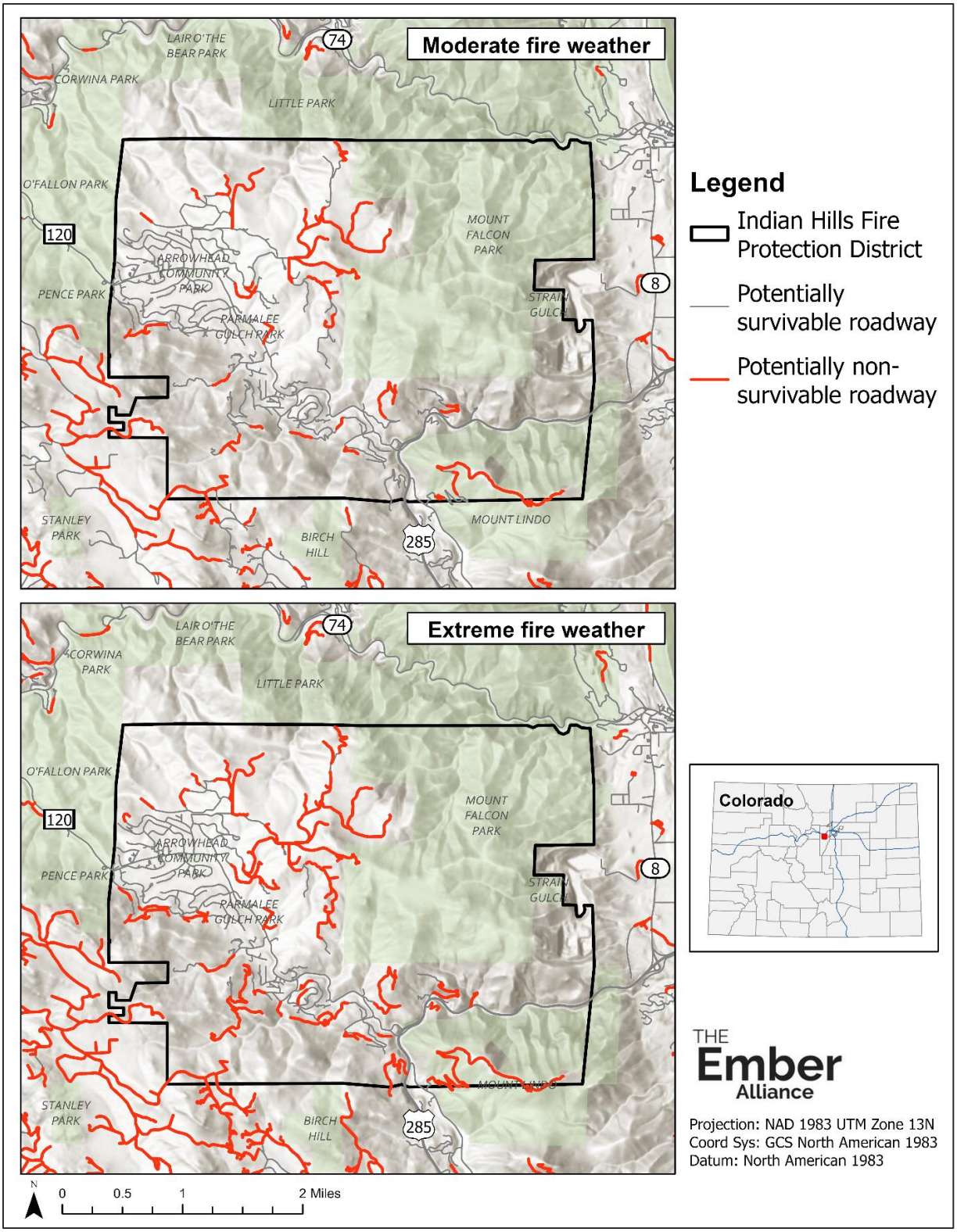


Figure B.12. *Under moderate percentile fire weather conditions, 23% of roads and driveways in the IHFPD could potentially experience non-survivable conditions during wildfires (i.e., flame lengths over 8 feet). This percentage rises to 40% under extreme percentile fire weather conditions.*

Climate Change Assessment

Climate change has a measurable impact on fire intensity and frequency, and this is likely to continue given current trajectories. Fire behavior modeling for this CWPP utilizes weather data from 2002-2020 and does not include future weather predictions. Therefore, we used the Climate Toolbox's Future Climate Scatter to explore the potential for exacerbated fire weather conditions in the future for this area. This tool models climate scenarios for the next fifty years using the Representative Concentration Pathways 4.5 and 8.5. These two models forecast future climate scenarios based on different levels of global greenhouse gas emissions. We analyzed four variables: expected summer maximum temperature, the number of days expected to be "high fire danger" days, summer 100-hour fuel moisture levels, and the number of days with a heat index over 90° Fahrenheit.

The models predict that under moderate or intense greenhouse gas concentrations, IHFPD will experience hotter summer temperatures and an increased number of days considered to be high fire danger. In the next 50 years, it would be reasonable to expect maximum summer temperatures to increase by 2-3° Fahrenheit, and **the number of days with high fire danger is likely to increase by 7 to 10 more days per year (Figure B.13)**. The number of days with a heat index over 90° Fahrenheit could increase from less than 1 to over 4 days **(Figure B.14)**.

Fire behavior has the potential to be extreme based on the weather from the past twenty years, and it may be even more extreme and frequent under the future conditions presented here. This behavior could include longer flame lengths, faster rates of spread, higher fire severity, and more crown fire activity. More extreme fire behavior increases danger to the life safety of residents, as well as to their homes, businesses, and community resiliency.

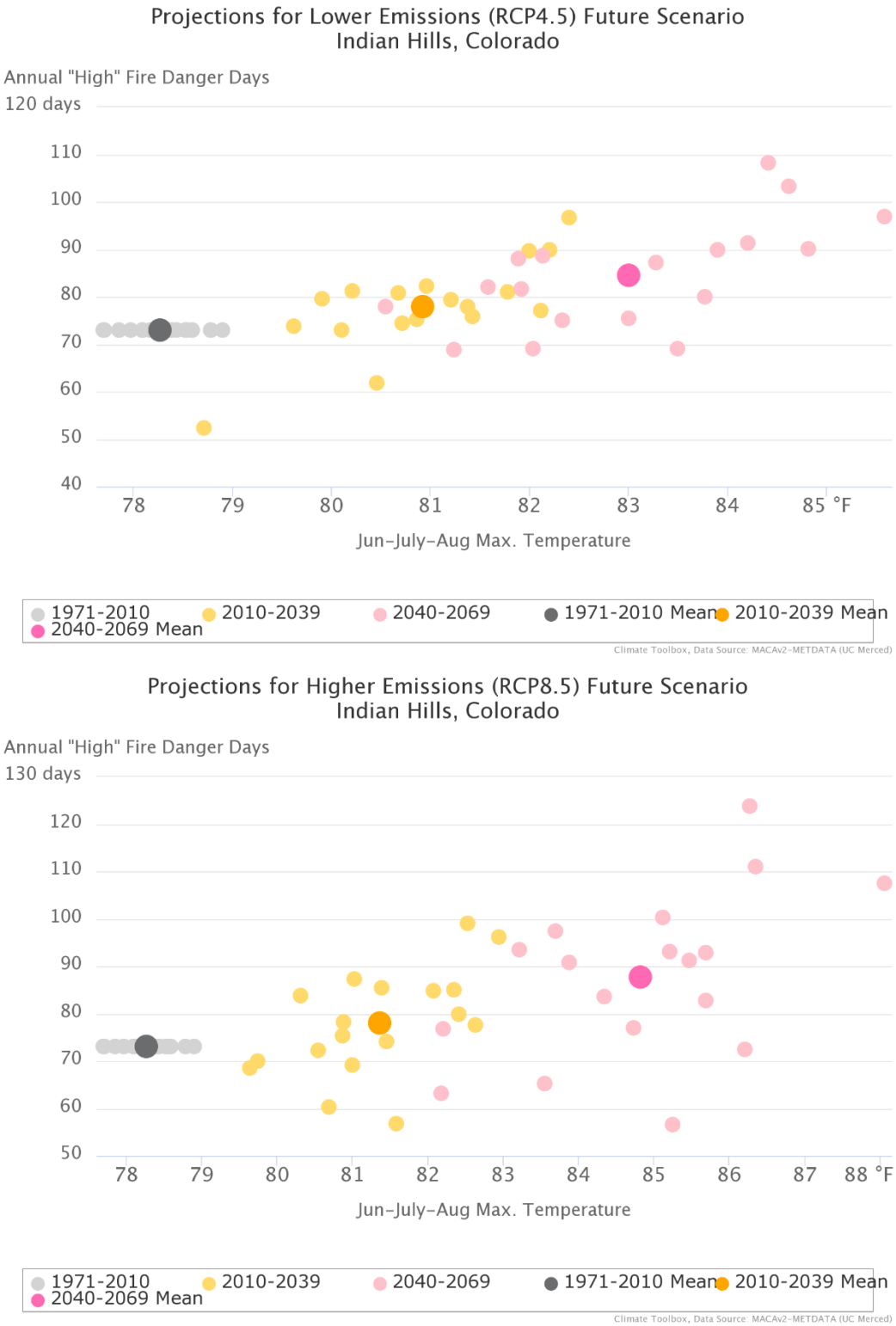


Figure B.13. *Potential maximum summer temperatures and number of days per year with high fire danger in the IHFPD modelled with the Climate Toolbox Future Climate Scatter (Hegewisch et al., 2021). The top graph is modelled under the RCP 4.5 scenario, where greenhouse gas emissions stabilize before the year 2100, peaking around 2040. The bottom graph is modelled under the RCP 8.5 scenario, where greenhouse gas emissions are not curtailed by 2100.*

Figure B.14. *Potential future conditions that impact fire behavior and suppression activities in the IHFPD modelled with the Climate Toolbox Future Climate Scatter (Hegewisch et al., 2021). The top graph is modelled under the RCP 4.5 scenario, where greenhouse gas emissions stabilize before the year 2100, peaking around 2040. The bottom graph is modelled under the RCP 8.5 scenario, where greenhouse gas emissions are not curtailed by 2100.*

Plan Unit Relative Risk Assessment

CWPP Plan Units

We compared the ***relative*** risk that wildfires pose to life and property in 7 plan units across the IHFPD (**Figure B.15**). Plan units are areas with shared fire risk where residents can organize and support each other to effectively mitigate hazardous fuels across the plan unit. To delineated plan units in the IHFPD, we considered clusters of addresses, connectivity of roads, topographic features, vegetation types, and potential fire behavior. No plan unit splits a land parcel, ensuring that fuel treatment recommendations within each plan unit can be realistically implemented by landowners. Amendments were made to boundaries based on local knowledge from the IHFPD.

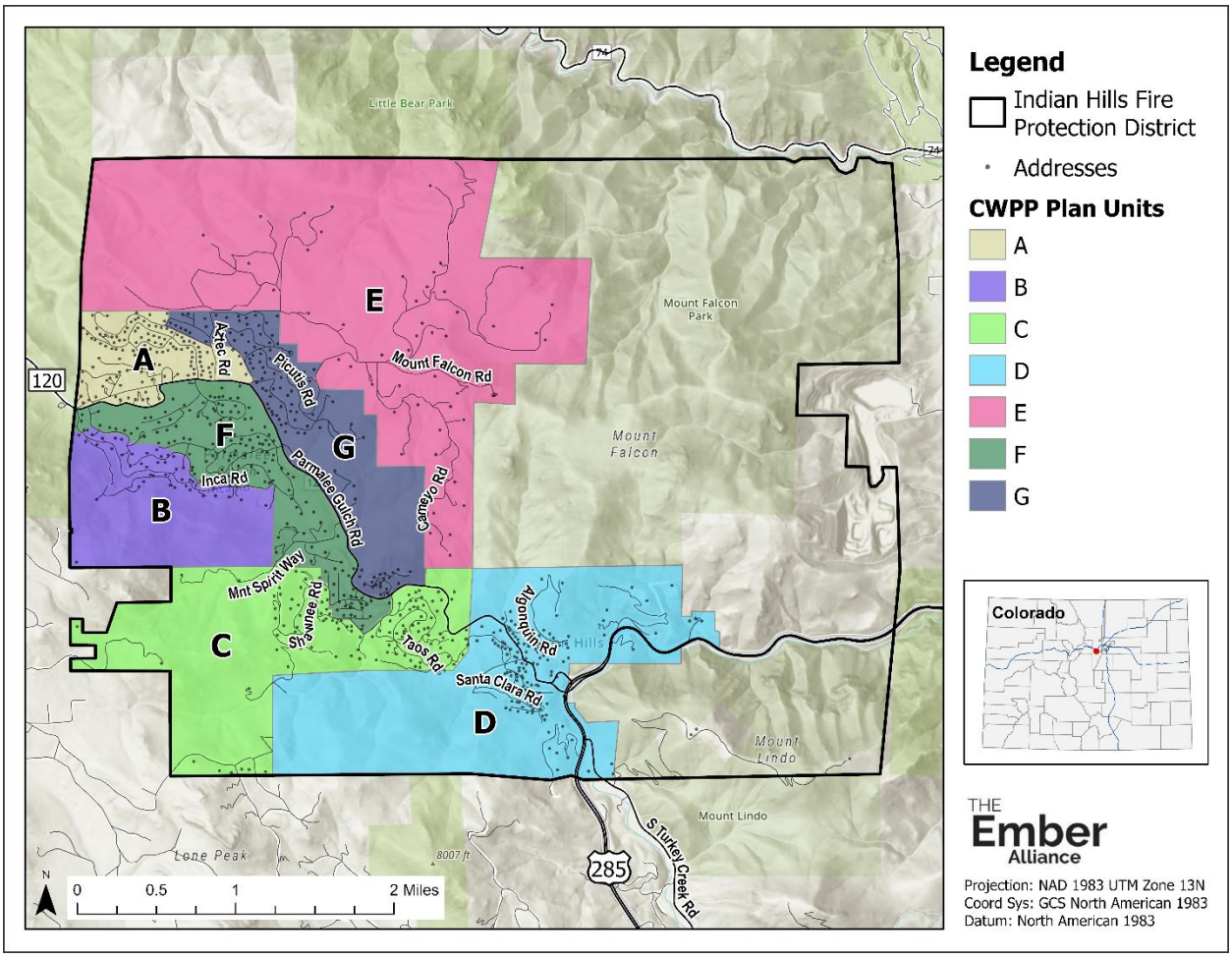


Figure B.15. *CWPP plan units in the IHFPD.*

Risk Rating Approach

Homes across the IHFPD have high risk from wildfire damage, but to help prioritize hazard mitigation, we developed a rating of relative risk. A plan unit receiving a relative rating of "moderate risk" has risk factors that are lower than risk factors in other plan units, but it is still an area with wildfire hazards. We assessed hazards in four categories: fire risk, fire suppression challenges (e.g., limited hydrant availability and engine access), evacuation hazards, and home ignition zone hazards. We developed the ratings of relative risk specifically for the IHFPD, so the assessment is not suitable for comparing this fire protection district to other communities in Colorado or the United States.

Our assessment was based on predictions of fire behavior, radiant heat and ember cast exposure, roadway survivability, and evacuation time, as well as an on-the-ground assessment of each plan unit. In summer 2022, TEA employees drove around the IHFPD and used a modified version of the NFPA Wildfire Hazard Severity Form Checklist (NFPA 299 / 1144) to rate home ignition zone hazards within each plan unit.

A rating scale was developed specifically for the IHFPD based on the range of values observed across the community (**Table B.4**). The purpose of the assessment is to compare relative hazards within the community and is not suitable for comparing the IHFPD to other communities.

Table B.4. *Relative risk rating values for the IHFPD.*

	Points		**Relative hazard rating**		
Hazard category	Max. possible	Range of values observed in IHFPD plan units	Moderate	High	Extreme
A. Fire risk	59	9 – 54	<15	15 – 30	>30
B. Fire suppression challenges	40	8 – 37	<10	10 – 25	>25
C. Evacuation hazards	44	0 – 40	<15	15 – 25	>25
D. Home ignition zone hazards	58	12 – 53	<20	20 – 40	>40
Overall risk	201	56 – 166	<100	100 – 139	>139

Relative Risk Rating Form

A. Fire Risk	Points
1. Average flame length[1]	
<12 feet	0
12-<14 feet	6
≥14 feet	12
2. Percent area predicted for active crown fire[2]	
<6%	0
6-<10%	6
≥10%	12
3. Percent of homes exposed to extreme radiant heat[2]	
<15%	0
15-<33%	6
≥33%	12
4. Average conditional burn probability[2]	
<1.5%	0
1.5-<1.65%	3
≥1.65%	6
4. Additional risk factors	
Mid-slope homes	2
Homes on ridge tops	2
Saddles / ravines / chimneys	4
Utilities (gas / electric) placement	
All underground	0
Infrequent overhead powerlines	3
Frequent overhead powerlines	5
A. Total points possible	**59**

[1]Predictions from FlamMap under 60th percentile fire weather conditions for plan unit and adjacent watersheds.
[2]Predictions from FlamMap under 90th percentile fire weather conditions for plan unit and adjacent watersheds.
*Different percentile fire weather conditions were used for flame length than other metrics of fire behavior to capture a greater variation in potential fire behavior among plan units.

B. Fire Suppression Challenges	Points
1. Average response time[3]	
<3 minutes	0
3-<6 minutes	2
≥6 minutes	4
2. Percentage of homes near hydrants	
>75%	0
25-75%	5
<25%	10
3. Presence of dip / draft sites	
At least one dip / draft site OR not necessary due to hydrants	0
No dip / draft site	5
4. Road/driveway accessibility for Type 3 engines (percent of roads/driveways)	
>90%	0
75-90%	5
50-75%	10
<50%	15
5. Presence of legible and reflective signs (percent of roads and homes)	
>90%	0
75-90%	3
<75%	5
6. Presence / absence of HazMat	
Absent	0
Present	5
B. Total points possible	**44**

[3]Response time estimated using Service Area analysis in ArcMap.

C. Evacuation Hazards	Points
1. Number of lanes in each direction	
At least 1 lane on >75% of roads	0
At least 1 lane on >50-75% of roads	5
Less than 1 lane on >50% of roads	10
2. Mean household evacuation time[4]	
<140 minutes	0
140-<158 minutes	5
≥158 minutes	10
3. Percentage of road with non-survivable conditions under 90th percentile fire weather	
<25%	0
25-<50%	10
≥50%	20
C. Total points possible	**40**

[4]Estimates from ArcCASPER (see evacuation modeling methodology above).

D. Home Ignition Zone Hazards	Points
1. Roof construction material	
Class B or C on <10% of homes	0
Class B or C on 10-15% of homes	5
Class B or C on >25% of homes	10
Class C on >50% of homes	15
2. Percent of homes with combustible or non-ignition resistant siding	
<10%	0
10-50%	3
>50%	5
3. Percent of homes with combustible or non-ignition resistant decking	
<10%	0
10-25%	3
>25%	5
4. Percent of homes with wooden fences	
<10%	0
10-25%	1
>25%	2
5. Percent of homes with adequate mitigation in home ignition zone 1	
>90%	0
75-90%	3
50-75%	6
<50%	10
6. Percent of homes with adequate mitigation in home ignition zone 2	
>90%	0
75-90%	3
50-75%	6
<50%	10
7. Percent of homes with additional hazards in zones 1 and 2 (e.g., wood piles, propane tanks, wooden sheds)	
<10%	0
10-25%	1
25-50%	3
>50%	5
8. Average number of homes potentially exposed to short-range ember cast from other homes	
0 homes	0
1-3 homes	3
≥4 homes	6
D. Total points possible	**58**

Fuel Treatment Prioritization

Roadside Fuel Treatments

We assessed the potential need for roadside fuel treatments based on non-survivable conditions (predicted flame lengths >8 feet) under moderate (60th percentile) and extreme (90th percentile) fire weather conditions and potential congestion under a district-wide evacuation order. Areas with non-survivable conditions under moderate fire weather are at greater risk than those with conditions that only become non-survivable under extreme percentile weather. **Table B.5** describes the criteria used for rating the potential need for roadside fuel treatments. Keep in mind that our fire behavior analyses occurred at the scale of 0.2 acres (30 x 30 meters), so locations of potential treatment areas are approximate.

Roads in need of fuel treatments are abundant and scattered across the IHFPD (**Figure B.16**; **Table B.6**). Due to limited points of egress, evacuation congestion could be experienced across much of the community, and dense forests lining many roadways could result in non-survivable conditions during wildfires. We used this assessment of treatment need to start conversations with partners about specific project areas for this CWPP in fall 2022 and early 2023. After considering feasibility and potential benefits, portions of Shawnee Road, Santa Clara Road, Hiawatha Trail, Algonquin Road, Seminole Road, Picutus Road, Nambe Road, Mount Falcon Road, Cameyo Road, and High Drive were selected as high priority project areas for roadside fuel treatments.

Table B.5. *Methodology for ranking potential need for roadside treatments to mitigate fire hazards along roadways in the IHFPD.*

Need for roadside fuel treatment	Conditions
Highest	• Non-survivable conditions (flame lengths >8 feet) under 60th percentile fire weather conditions and major to extreme evacuation pinch points (congestion ratio ≥2) OR • Non-survivable conditions (flame lengths >8 feet) under 90th percentile fire weather conditions and extreme evacuation pinch points (congestion ratio ≥3)
High	• Non-survivable conditions (flame lengths >8 feet) under 60th percentile fire weather conditions • Moderate evacuation pinch points (congestion ratio >1 to <2)
Moderate	• Non-survivable conditions (flame lengths >8 feet) under 90th percentile fire weather conditions • Moderate evacuation pinch points (congestion ratio >1 to <2)

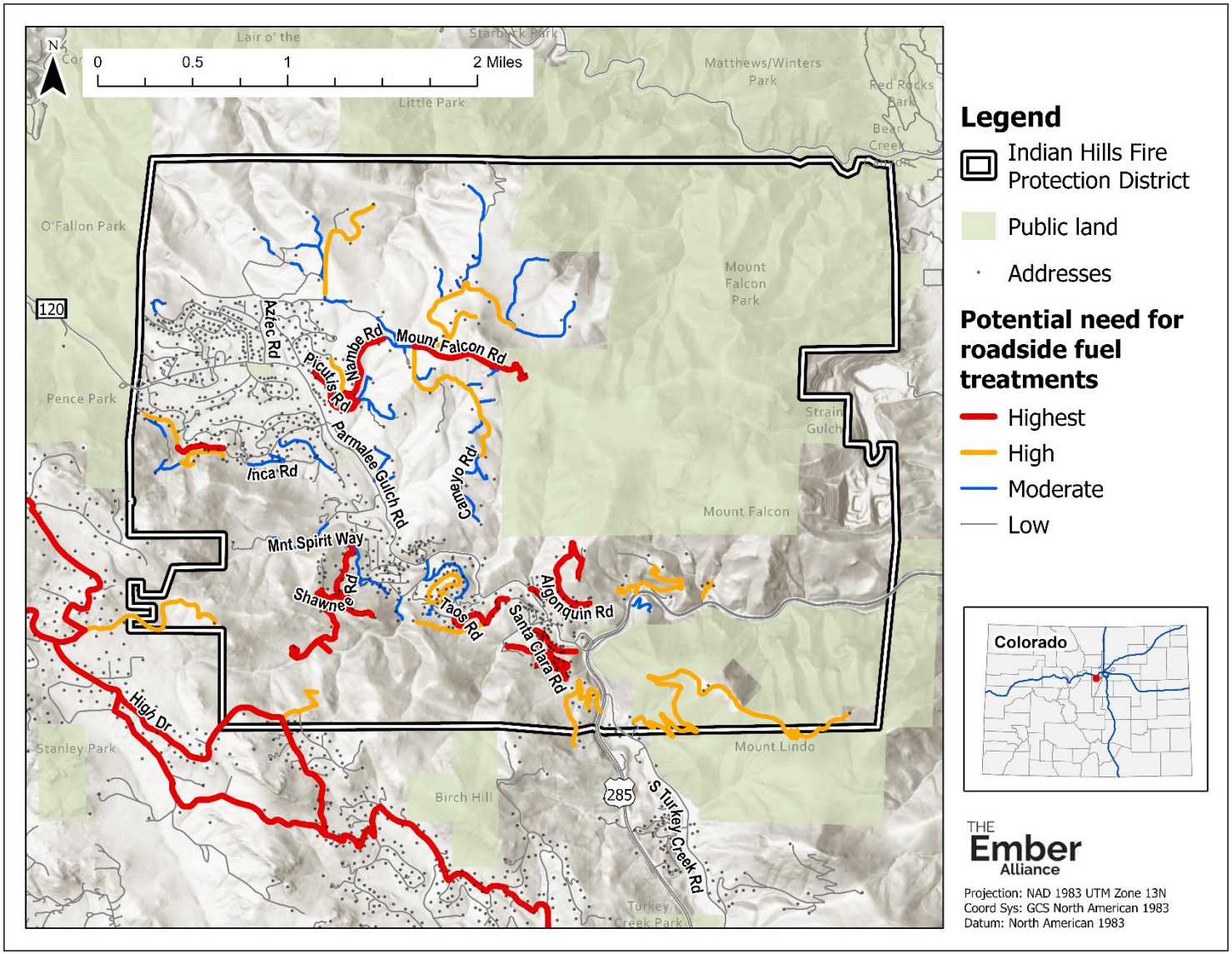


Figure B.16. *Potential need for roadside fuel treatments in and around IHFPD based on potential fire behavior and evacuation congestion. Our fire behavior analyses occurred at the scale of 0.2 acres (30 x 30 meters), so locations of potential treatment areas are approximate.*

Table B.6. *Total length and names of road segments potentially in need of roadside fuel treatments in the IHFPD.*

Potential Need for Treatment	Highest	High	Moderate
Total length of road segments (miles)	27.6	21.2	16.2
Road names	Adahi Road Algonquin Road Hiawatha Trail High Drive Inca Road Lone Peak Trail Mounta Falcon Road Nambe Road Picutis Road Salugi Road Santa Clara Road Seminole Road Shawnee Road South Bear Mountain Drive South Valley Drive Stanley Park Road Taos Road Wyandotte Road	Brookmont Road Cameyo Road Cherokee Road Chris Drive Falcon Wing Road Game Trail Inca Road Lakota Road Matoskah Road Picutis Road Raven Gulch Road Road to Mount Lindo Cemetery	Cameyo Road Cheyenne Road Falcon Wing Road Giant Gulch Road Hopi Road Inca Road Lakota Road Mountain Spirit Way San Isabel Road Shawnee Road Talon Trail Zuni Road

Stand-Scale Fuel Treatments

We created topographic units for assessing the potential need for stand-scale fuel treatments by delineating small watersheds (i.e., an area of land where all precipitation falling in that area drains to the same location) and subdividing these into three hillslopes—one on each side of a stream or river and one above the headwaters of the watershed (**Figure B.17**). We delineated hillslopes in ArcGIS using a modified version of the WEPP Hillslope Toolbox, which is based on TOPAZ (Topographic Parameterization Software) from the USDA Agricultural Research Service.

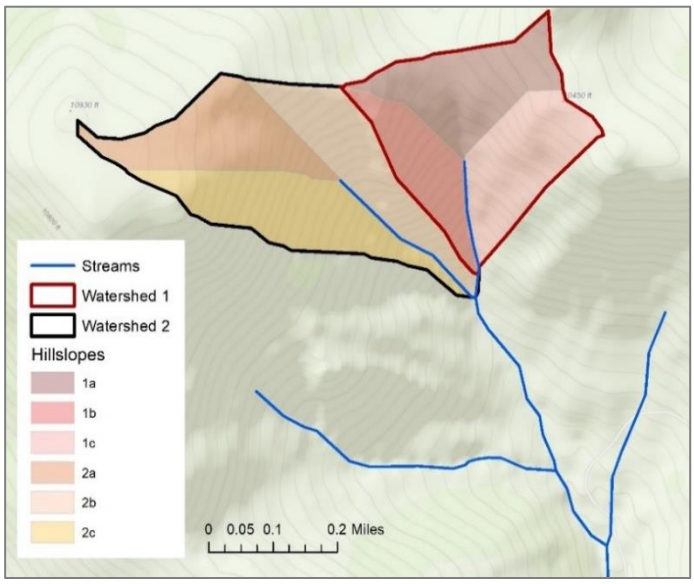


Figure B.17. *Depiction of small watersheds and their subdivided hillslopes.*

We used 30 m resolution digital elevation models from the U.S. Geological Service, and delineated hillslopes with a critical source area of 62 acres (25 hectares) and a minimum source channel length of 330 feet (100 meters). Critical source area is the minimum allowable area above the head of a first-order channel, and minimum source channel length is the minimum length of a channel used to delineate watersheds. Hillslopes were also split by Hwy 74, Parmalee Gulch Road, and US 285 because stand-scale fuel treatments often occur on one side of a major road at a time, and we refined boundaries of stands to separate areas that were primarily forested from those that were primarily grasslands or shrublands. Areas that were less than 20 acres in size were combined with adjacent hillslopes to result in potential treatment areas in size from 20 to 260 acres—reasonable sizes for forest management projects in the WUI.

We assessed the potential need for fuel treatments in each hillslope based on predicted fire behavior, potential exposure of homes and other values to short-range ember cast and/or radiant heat, presence of priority roadside fuel treatments (**Table B.7**; **Figure B.18**). In fall 2022 and early 2023, TEA, IHFR, and representatives from land management agencies and other partner groups met to refine project areas and assign project leads. Partners included representatives from the Colorado State Forest Service, Jefferson County Open Space, Jefferson Conservation District, Denver Mountain Parks, Geneva Glen, Olinger Mount Lindo Cemetery, and Xcel Energy. We delineated project areas based on the assessment of potential need for fuel treatments, the location of previous fuel treatments and planned future work, potential funding sources, and other feasibility considerations such as access and slope. Unfortunately, much of the forested area in IHFPD is too steep for thinning, inaccessible, and too dense for prescribed burning.

Table B.7. *Methodology for ranking potential need for stand-scale fuel treatments to mitigate fire hazards within and adjacent to the IHFPD.*

Prioritization category	Maximum weight		Highest	High	Moderate
Potential exposure of homes or other values at risk to short-range ember cast and/or radiant heat from the hillslope (60th percentile fire weather)	15%	Cutoff	≥1 homes		0 homes
		Weight	15		0
Presence of priority roadside fuel treatment (non-survivable evacuation pinch point)	25%	Cutoff	At least highest priority roadway	At least one moderate or high priority roadway	No priority roadways
		Weight	25	13	0
Percent active crown fire (90th percentile fire weather)	25%	Cutoff	≥15%	5 - <15%	<5%
		Weight	25	13	0
Percent area with flame lengths > 11 feet (60th percentile fire weather)	25%	Cutoff	≥70%	45 <70%	<45%
		Weight	25	13	0
Average conditional burn probability (90th percentile fire weather, average prediction under 25 mph ESE winds and 25 mph WNW winds)	10%	Cutoff	≥2.0%	1.5 - <2.0%	<1.5%
		Weight	10	5	0
Overall priority (sum of values)		Cutoff	≥46	31 – 45	14 – 30

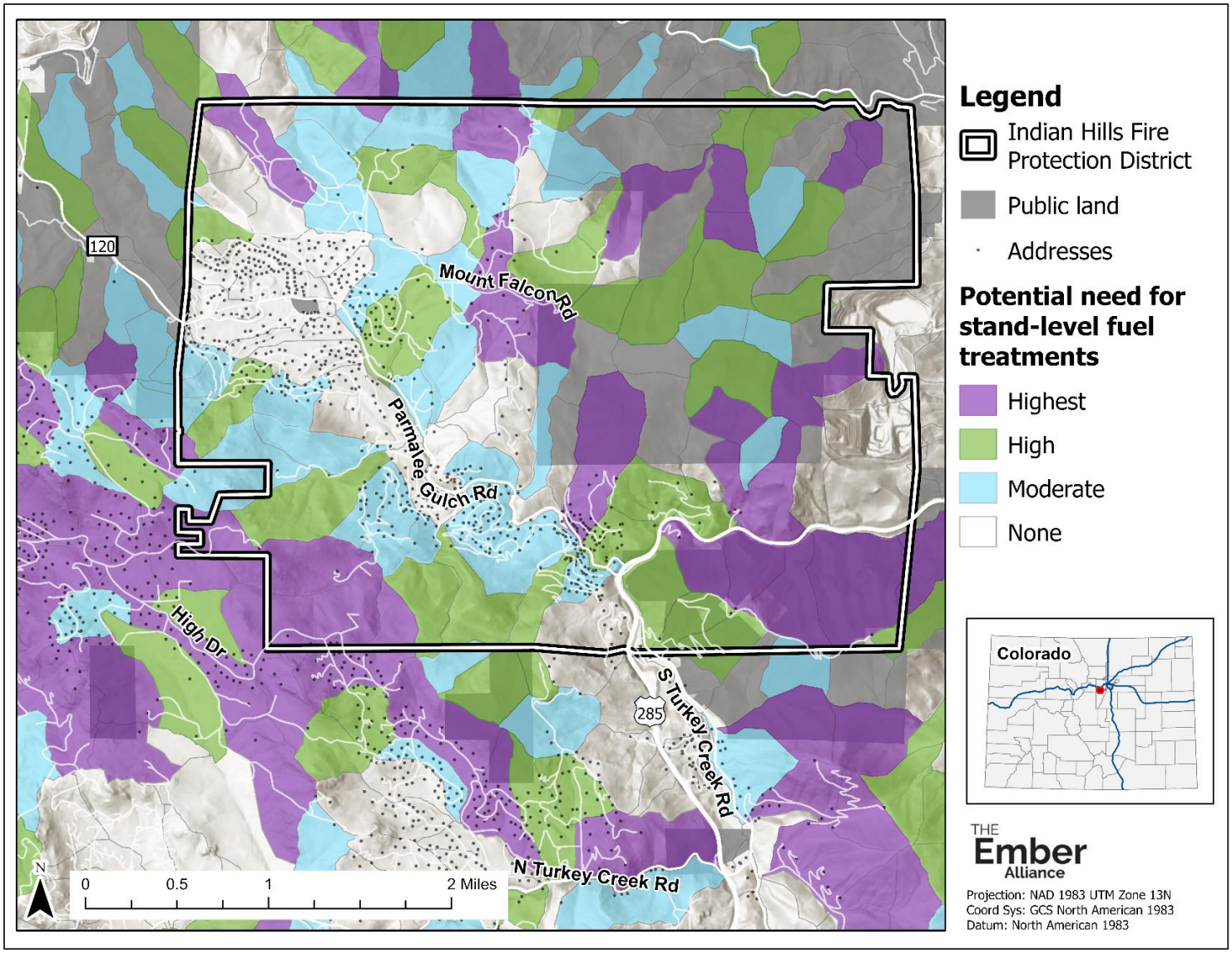


Figure B.18. *Potential need for stand-scale fuel treatments based on predicted fire behavior, structure exposure to wildfires, and the presence of priority roadside fuel treatments in and around the IHFPD.*

Appendix C. Community Survey Methods and Results

Community Survey Distribution

The community survey was shared with all property owners of the IHFPD. Property owners were able to take the survey online via links sent out in emails and shared within the community. Paper surveys were also distributed at events and at the fire station. The survey was open from August 16, 2022, to October 1, 2022.

Results and Interpretation

Results from the survey were compiled and analyzed for themes, correlations, and other important information. Forty-six people responded to the survey.

Understanding and support for mitigation:

- 98% of property owners believe that their community in Indian Hills is at risk to wildfire.
    - 98% of residents are confident in their knowledge of preparing their home or business for wildfire.
    - Over 90% of residents support tree removal on their private property, in open spaces, and along roads for wildfire protection.
    - 73% and 75% of residents support broadcast and pile burning, respectively.
- In summary, a large majority of residents believe that their community is at risk to wildfire and that they know how to prepare their personal property for wildfire. Residents are more supportive of tree removal than prescribed fire.

Level of concern around wildfire impacts:

- 92-96% of respondents are moderately or very concerned about personal safety if their community experiences wildfire. These concerns include receiving timely and accurate information on local wildfires, the ability to evacuate safely and promptly, and losing lives due to wildfire.
- 83% of respondents are moderately or very concerned about wildfire damaging their property.
    - 85% of respondents were moderately or very concerned about the loss of insurance coverage.
    - 87% of respondents were moderately or very concerned about post-fire erosion and flooding.
- 67-76% of respondents were moderately or very concerned about losing their ways of life during and after a wildfire.
    - 76% of respondents were concerned that wildfire smoke would reduce air quality.
    - 73% were concerned that wildfire would impact their livelihoods.
    - 72% were concerned that wildfire would decrease the aesthetic value of where they live.
    - 67% were concerned that wildfire would result in a loss of recreational opportunities.
- 79% were moderately or very concerned about damage to wildlife habitat.
- In summary, people were the least concerned about experiencing a loss in recreational opportunities (67%) and most concerned about receiving timely and accurate information

during a fire. Respondents tended to be moderately concerned about the loss of their way of life and very concerned about personal safety.

Mitigation and education activity:

- 91% of residents have cut trees or limbs near structures on their property to mitigate wildfire risk.
    - 47% of residents said that they have limited means to disposing of vegetation they removed. 68% of residents said that inexpensive access to vegetation disposal following mitigation work would help them to reduce wildfire risk on their property.
    - 63% of resident respondents said that they have limited time to complete vegetation removal work compared with 41% who said they lack financial resources to complete the work. 48% of residents said that it would be helpful to have assistance in reducing vegetation around their property and 45% said it would be helpful to have guidance on vegetation reduction strategies for their property specifically.
    - 78 and 84% of resident respondents say they annually remove organic debris from their roofs/gutters and under their balcony, respectively.
- 63% of respondents received information on local wildfire issues from the Indian Hills Fire Protection District.
    - 82% of respondents have signed up for emergency notifications during wildfire incidents with Lookout Alert.
    - 58% of respondents have created an evacuation plan for their family, pets, and livestock.
    - 57% of respondents would like to learn about mitigation through one-on-one site visits at their houses.
    - 55% would like a program from IHFPD on preparedness, such as Ready Set Go.
    - 48% would like a one-hour presentation on wildfire risk, mitigation, and evacuation planning.
- 90% prefer communications via email, and most remaining individuals prefer Facebook.

Cross-section connections:

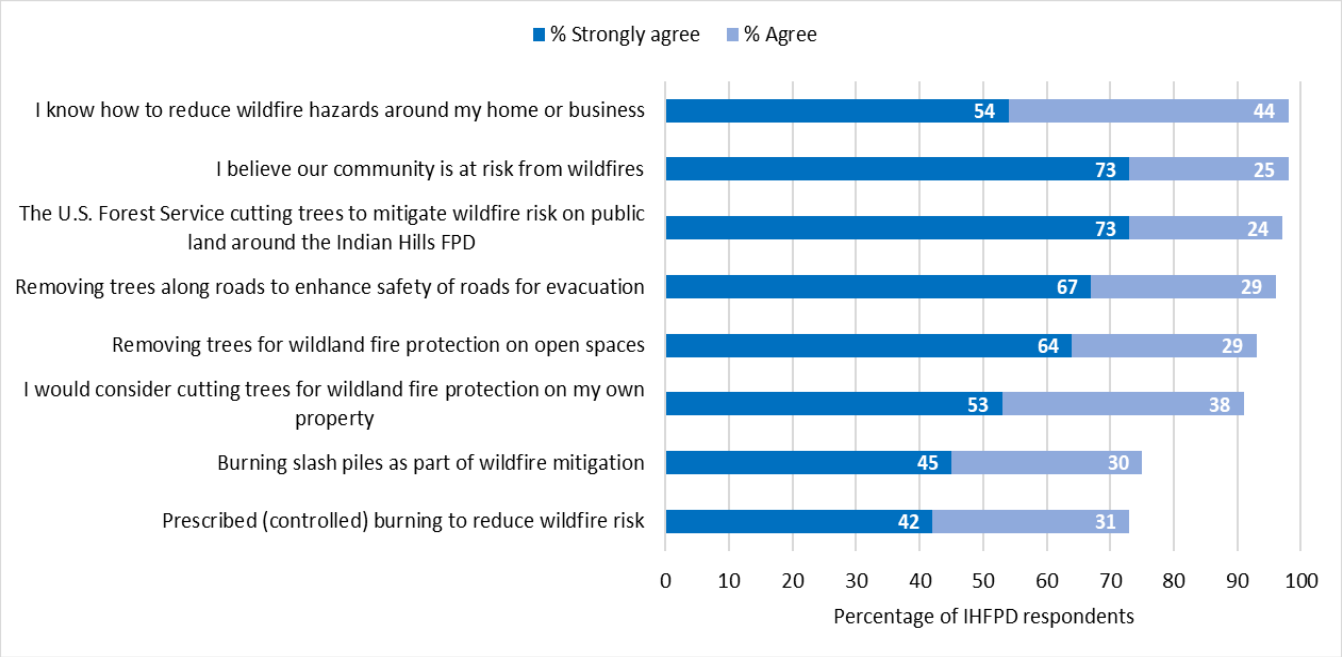
- There is no strong correlation between level of concern around wildfire and support for mitigation activities. Many people had a high level of concern and strong support for mitigation activities, but those who had low levels of concern did not lack support for mitigation, and those who didn't support mitigation still held high levels of concern.
- There is no correlation between a respondent's level of concern around wildfire and how much mitigation activity they have already taken.
- There is no correlation between a respondent's understanding of fire risk and their concern about fire impacts.

These results indicate that there is a disconnect between people's understanding of fire risk and the action they take in response to that. Most property owners are aware of the danger where they live and do not need to be educated on that, but connecting the reduction in danger to their action and to community action may be important. Discussing loss of life, signing up for Lookout Alert to receive timely and accurate information regarding wildfires, and evacuation preparedness and planning may be the useful motivators when conducting outreach in the community. Discussing loss of life and loss of insurance may be the most useful motivators when conducting outreach in the community. Email and Facebook will be the most useful tools in connecting with the community on a regular basis.

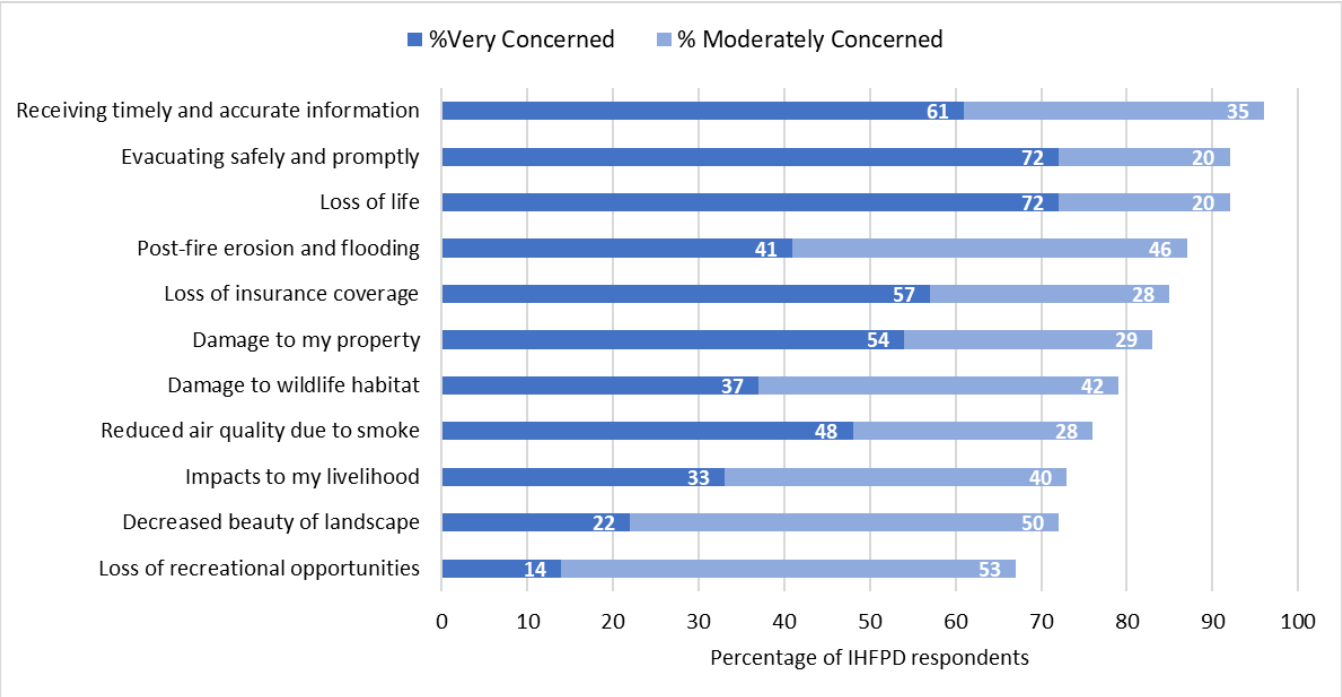
Questions and Responses

The following charts show all the questions asked in the survey in the order they were presented, and the responses received by the 46 respondents.

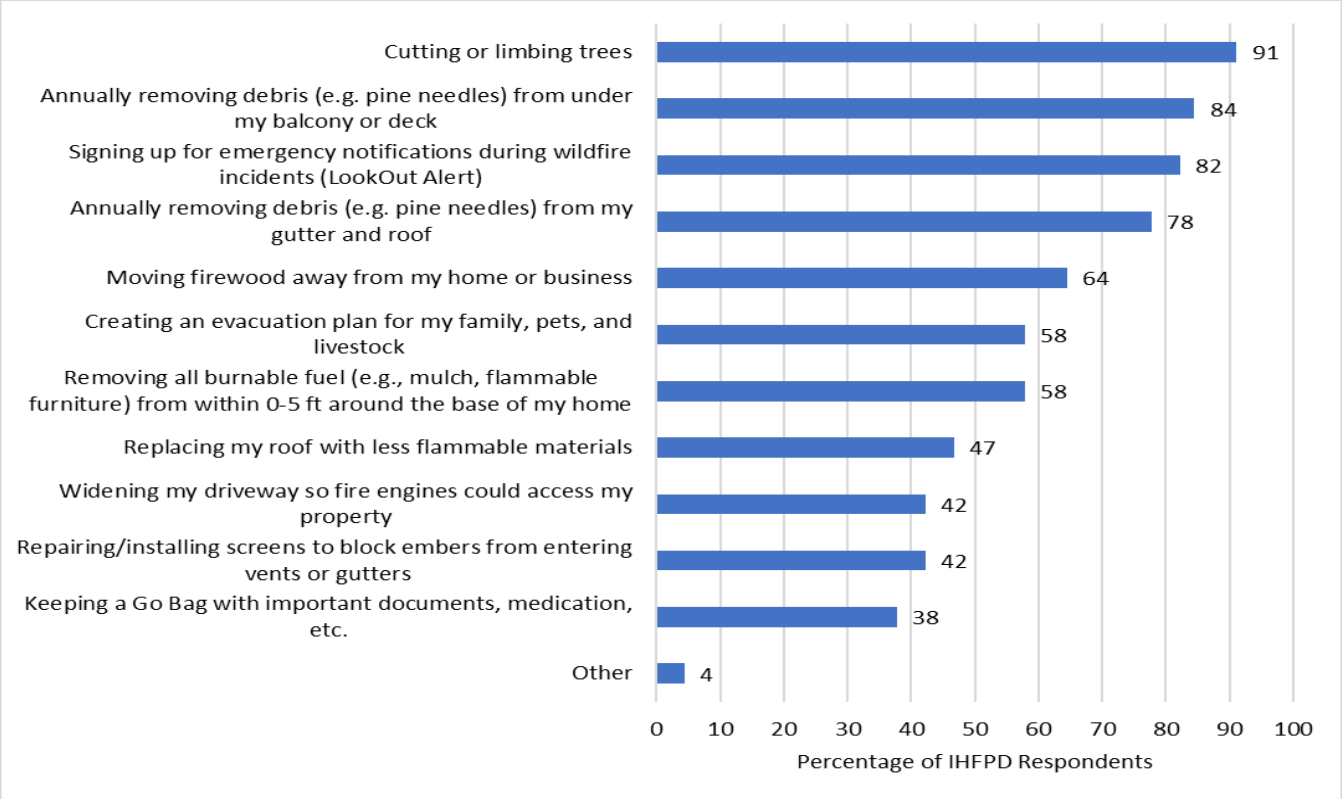
Residents Level of Agreement Regarding Wildfire



Residents Level of Concern – Wildfire Issues



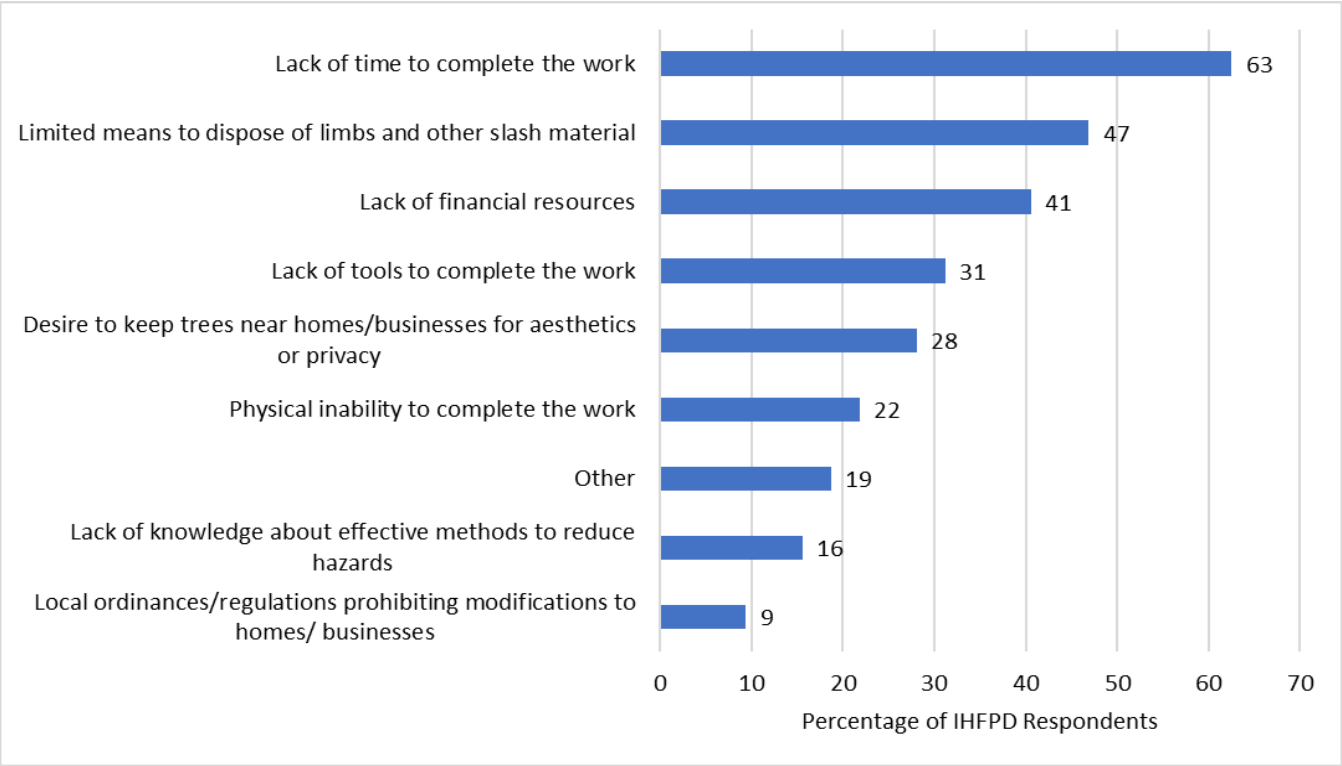
Mitigation Activities Already Taken by Residents



Other responses provided:

- Own lot only, no structure
- I have new asphalt roofing on all structures

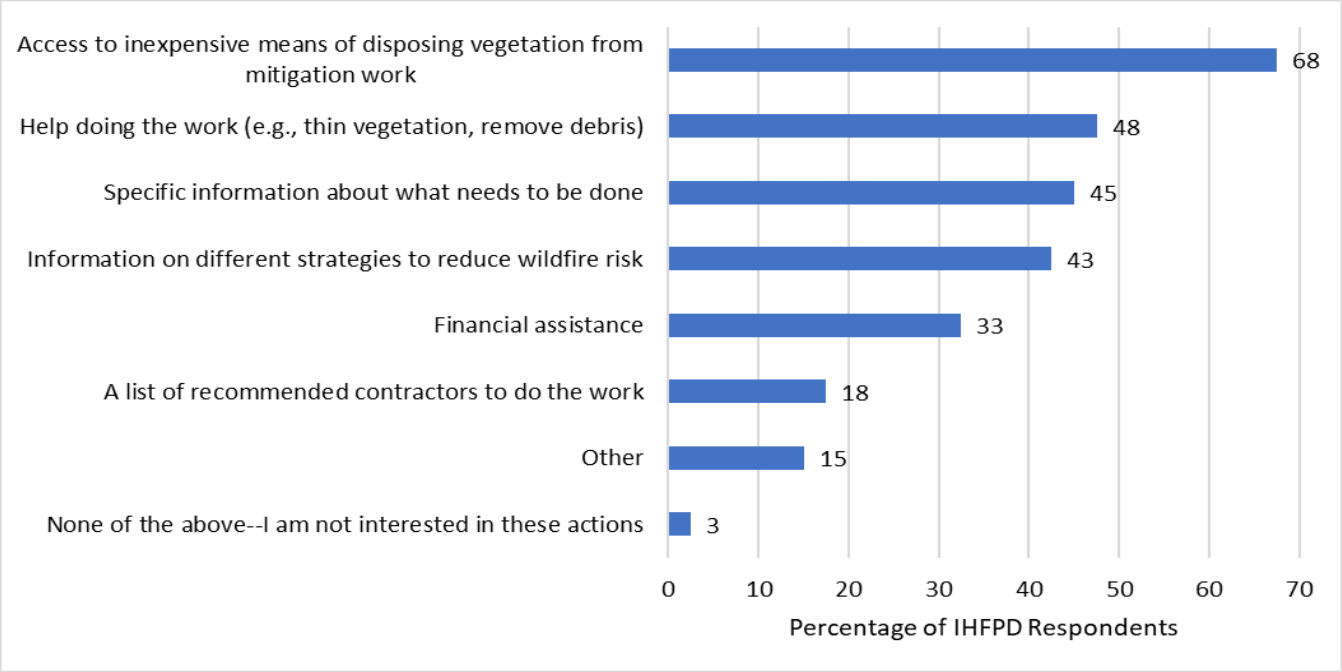
Obstacles to Performing Wildfire Mitigation



Other responses provided:

- House too close to property line on one side and neighbors won't allow any trees to be cut
- Empty lot/dead trees mostly removed
- Need chipping program to remove fuel from my property
- Not enough space on property to do things like have firewood out of the way
- Lack of community engagement from fire department, no chipping service
- People who own land need to maintain property

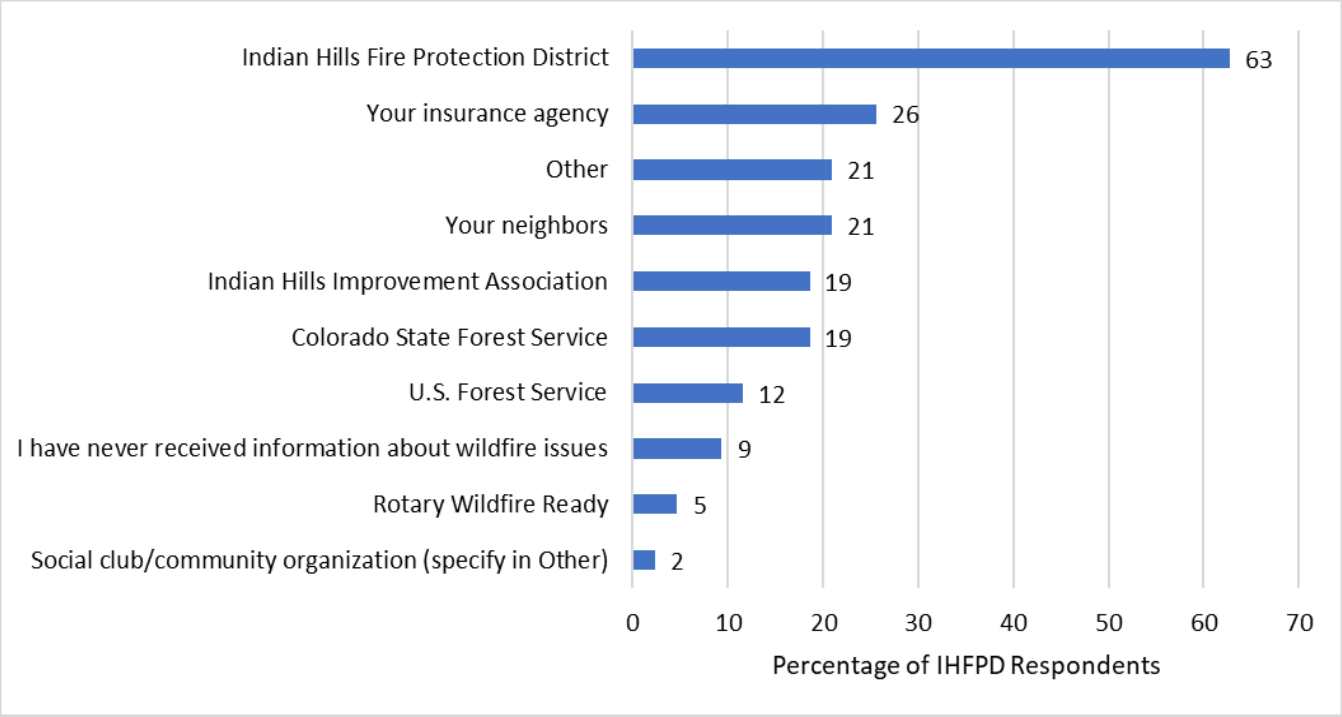
Incentivizing Residents to Perform Mitigation



Other responses provided:

- Vacant property owner management
- Vacant Property owners and required classes for first time residents regarding just what a tinder box we live in

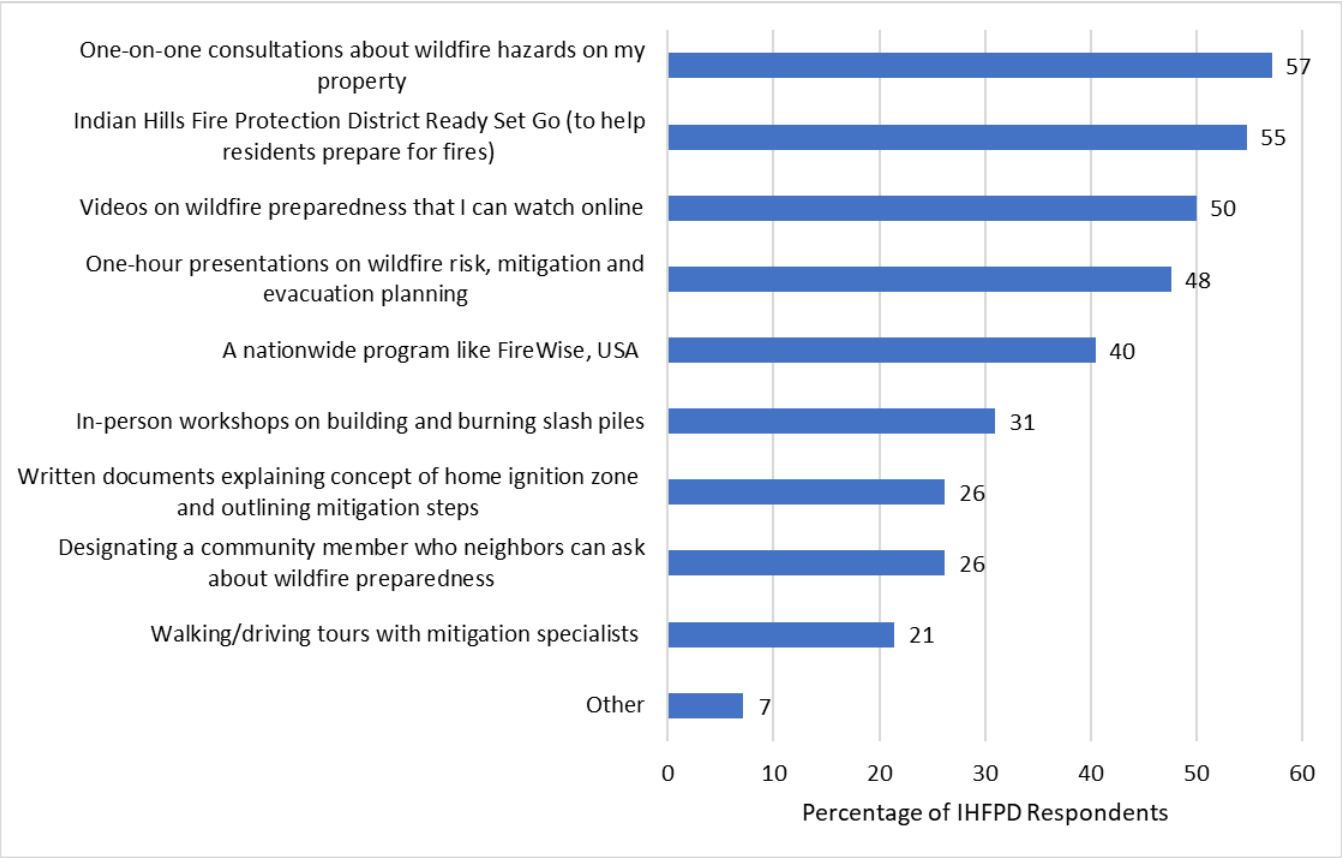
How Residents Receive Information About Wildfire Mitigation



Other responses provided:

- Surrounding fire departments
- I have received material from IHIA and IHFR only by attending meetings
- Jeffco sheriff
- CFFM - Danny Showers
- Community FB group and IndianHillsColorado.com

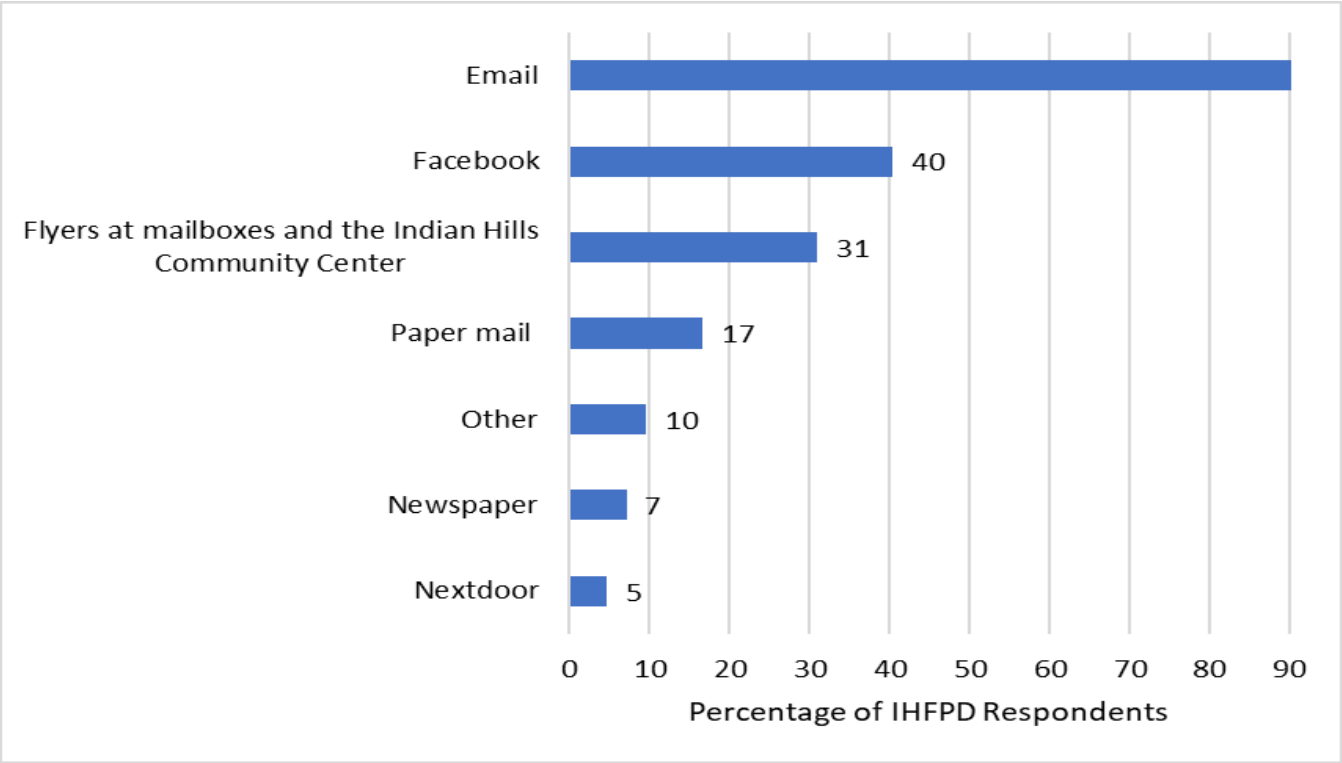
Preferred Education Programs/Resources by Residents



Other responses provided:

- Mandatory classes by relators selling property to new comers
- Home assessments
- Mandating realtors to have 1st time residents certified on how to live in an alpine desert

Preferred Method to Communicate Wildfire Information to Residents



Other responses provided:

- Poster at Post office on communication board
- IndianHillsColorado.com and IHFR.org
- Twitter

Appendix D. Indian Hills Water District Fire and Pressure Flow Rates

Effect of planned system upgrades from IHWD Master Plan on fire flow

Zone 1				
Hydrant #	Location	Fire flow rate (GPM)	Flow Pressure (PSI)	Supply Line size
10	Taos Rd.	1500	20	6"
9	Upper Seminole	1500	80	8"
8	Lower Seminole	1500	110	8"
5	Taos/Santa Clara	1500	70	6"
6	Geneva Glen	1300	20	6"
7	Post Office	1500	80	6"
4	Hiawatha	900	20	4"
3	Wyandotte	450	20	4"
2	Brookmont	520	20	8"
1	South Turkey Creek Rd.	700	20	8"

Zone 2				
Hydrant #	Location	Fire flow rate (GPM)	Flow Pressure (PSI)	Supply Line size
13	Messiah Mtn.	1375	20	8"
22	Kiowa/Otowi	600	20	8"
21	Kiowa	1500	47	8"
19	Inca Ln.	1350	20	6"
20	Wheel-Inn Cottages	1500	55	8"
17	Hollyhock Ln.	1200	20	6"
16	Honeysuckle Ln.	1500	20	6"
18	Tansey Ln.	1400	20	6"
14	Ute Rd.	1500	30	8"
15	Shawnee/Anahina	1200	20	6"
11	Five Points	1300	20	6"
12	Cheyenne Rd.	1300	20	8"

Zone 3				
Hydrant #	Location	Fire flow rate (GPM)	Flow Pressure (PSI)	Supply Line size
34	Upper Isoleta	1500	50	6"
33	Lower Isoleta	1500	65	6"
32	Navajo	825	20	4"
31	Inca	1500	50	10"
30	San Isabel	1350	20	8"
29	Matterhorn	1250	20	6"
28	Elementary school	1500	77	6"
27	Firehouse	1500	70	6"
26	Aztec	1500	25	6"
25	Aztec/ Shoshone	1125	20	6"
23	Commanche/Oh-Kay	1300	20	6"
35	Parmalee Elementary	1500	35	6"
24	Picutis	800	20	6"

* Fire flow through pumper nozzle. Individual hydrant fire flow is limited to 1500GPM from orifice restrictions. Multiple hydrants can be opened to achieve higher fire flow rates where flow pressure is above 20PSI.

Fire Hydrant Flow Rates: 2021 First Test Results

Zone 1				
Hydrant #	Location	Static pressure (PSI)	Fire flow rate (GPM)	Flow Pressure (PSI)
10	Taos Rd.	75	908	36
9	Upper Seminole	86	478	10
8	Lower Seminole	125	771	26
5	Taos/Santa Clara	125	1025	46
6	Geneva Glen	96	856	32
7	Post Office	141	1047	48
4	Hiawatha	125	828	30
3	Wyandotte	73	338	5
2	Brookmont	92	370	6
1	South Turkey Creek Rd.	156	302	4

Zone 2				
Hydrant #	Location	Static pressure (PSI)	Fire flow rate (GPM)	Flow Pressure (PSI)
24	Picutis	8	262	3
22	Kiowa/Otowi	32	338	5
21	Kiowa	64	676	20
19	Inca Ln.	64	605	16
20	Wheel-Inn Cottages	94	605	16
17	Hollyhock Ln.	96	565	18
16	Honeysuckle Ln.	112	678	26
18	Tansey Ln.	110	624	22
14	Ute Rd.	122	326	6
15	Shawnee/Anahina	120	580	19
11	Five Points	132	624	22
12	Cheyenne Rd.	148	421	10
13	Messiah Mtn.	188	441	11

Zone 3				
Hydrant #	Location	Static pressure (PSI)	Fire flow rate (GPM)	Flow Pressure (PSI)
34	Upper Isoleta	98	776	34
33	Lower Isoleta	110	882.6	44
32	Navajo	80	704	28
31	Inca	50	809.6	37
30	San Isabel	72	375.6	8
29	Matterhorn	58	265.7	4
28	Elementary school	100	728.6	30
27	Firehouse	128	882.6	44
26	Aztec	120	461	12
25	Aztec/ Shoshone	110	548	17
23	Commanche/Oh-Kay	123	638	23

2021 Second Test Results

	Zone 1		
Hydrant #	Location	Static pressure (PSI)	Notes
10	Taos Rd.	75	
9	Upper Seminole	59	replace nozzles
8	Lower Seminole	127	needs oiled
5	Taos/Santa Clara	123	replace right hose nozzle
6	Geneva Glen	94	
7	Post Office	143	
4	Hiawatha	124	replace left hose nozzle
3	Wyandotte	74	replace pumper nozzle
2	Brookmont	95	
1	South Turkey Creek Rd.	156	replace nozzles

	Zone 2		
Hydrant #	Location	Static pressure (PSI)	Notes
24	Picutis	6	
22	Kiowa/Otowi	28	
21	Kiowa	60	replace pumper nozzle
19	Inca Ln.	65	replace left hose nozzle
20	Wheel-Inn Cottages	90	replace left hose nozzle
17	Hollyhock Ln.	96	
16	Honeysuckle Ln.	113	slight leak from nozzles
18	Tansey Ln.	110	
14	Ute Rd.	120	replace right hose nozzle
15	Shawnee/Anahina	115	
11	Five Points	128	replace pumper nozzle
12	Cheyenne Rd.	150	
13	Messiah Mtn.	188	

	Zone 3		
Hydrant #	Location	Static pressure (PSI)	Notes
34	Upper Isoleta	93	
33	Lower Isoleta	107	
32	Navajo	84	
31	Inca	50	
30	San Isabel	72	
29	Matterhorn	60	
28	Elementary school	106	
27	Firehouse	125	
26	Aztec	124	replace nozzles
25	Aztec/ Shoshone	103	
23	Commanche/Oh-Kay	124	needs oiled