COMMUNITY PLANNING ASSISTANCE FOR WILDFIRE

**FINAL RECOMMENDATIONS FOR**

# PINETOP-LAKESIDE, AZ
# 2019

COMMUNITY PLANNING ASSISTANCE FOR WILDFIRE


**PREPARED BY:**

*Wildfire Planning International, LLC*
*Wildland Professional Solutions, Inc.*

# ABOUT

## *Community Planning Assistance for Wildfire Program*

The Community Planning Assistance for Wildfire (CPAW) program works with communities to reduce wildfire risks through improved land use planning. The CPAW program is a joint partnership between Headwaters Economics and Wildfire Planning International. It is funded by grants from the USDA Forest Service and private foundations.

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## *Acknowledgments*

CPAW relies on collaboration with local stakeholders to provide meaningful feedback throughout the process. Our team would like to thank the agencies, organizations, and individuals who contributed their time to our CPAW activities in the Pinetop-Lakeside community, including: Pinetop-Lakeside Community Development Department, Pinetop Fire District, Timber Mesa Fire and Medical District, USDA Forest Service Apache-Sitgreaves National Forest, Arizona Department of Forestry and Fire Management, Navajo County and University of Arizona Cooperative Extension. Any omissions from this list are are not intended to reflect the value of other participants.

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Cover photos provided by CPAW.

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# ACRONYMS

| | |
|---|---|
| AZ FAC | Arizona Fire Adapted Communities |
| AZWRAP | Arizona Wildfire Risk Assessment Portal |
| CCR | Covenants, Conditions, Restrictions |
| CPAW | Community Planning Assistance for Wildfire |
| CWPP | Community Wildfire Protection Plan |
| DMA | Disaster Mitigation Act |
| FEMA | Federal Emergency Management Agency |
| HIZ | Home Ignition Zone |
| HMP | Hazard Mitigation Plan |
| HOA | Homeowners Association |
| IBHS | Insurance Institute for Business and Home Safety |
| ICC | International Code Council |
| IWUIC | International Wildland-Urban Interface Code |
| MOU | Memorandum of Understanding |
| NFPA | National Fire Protection Association |
| NWCG | National Wildfire Coordinating Group |
| PDM | Pre-Disaster Mitigation |
| RMRS | Rocky Mountain Research Station |
| SIZ | Structure Ignition Zone |
| SME | Subject Matter Expert |
| SRS | Secure Rural Schools |
| SCWPP | Sitgreaves' Communities Wildfire Protection Plan |
| TMFMD | Timber Mesa Fire and Medical District |
| USDA | United States Department of Agriculture |
| USFS | United States Forest Service |
| WUI | Wildland-Urban Interface |

# INTRODUCTION

In 2018, more than 25,000 structures were destroyed from wildfires that occurred in the United States.[1] This staggering figure is a result of several factors, including long-term changes to the fire environment and landscapes, and increased exposure of development in areas known as the wildland-urban interface (WUI, pronounced “WOO-EE”).

Wildfires in the WUI can threaten communities in different ways (Figure 1). Dispersed, rural development patterns on the edge of a community can experience wildfire from adjacent wildland areas. Suburban and urban areas with more dense development may be subject to home-to-home ignitions. Embers can make contact with any development pattern, and likewise wildfires can quickly overwhelm local fire protection resources.

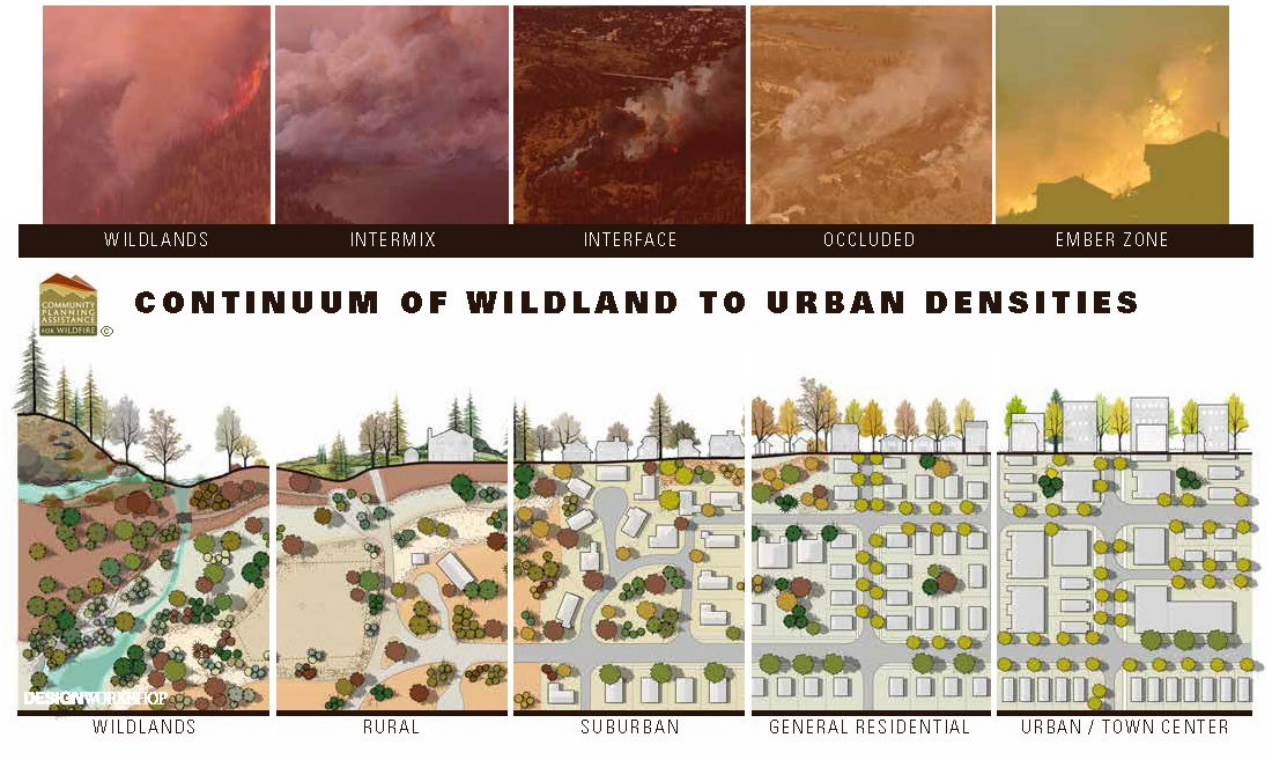


*Figure 1. Communities in the wildland-urban interface can be affected by wildfire in different ways, depending on their development patterns and other factors of wildfire susceptibility.*

[1] National Interagency Coordination Center 2019 Annual Wildfire Statistics Report

Development location and density of structures are just two features that contribute to how a wildfire may affect a community. Other influences include the type of land use, landscaping decisions at the property and community scale, choice of building materials and construction, access and egress, available resources for response, and level of preparedness. These factors form the basis for how land use planning decisions can shape WUI communities.

Communities have a variety of planning tools available to address challenges associated with the WUI (Figure 2). These tools include plans and policies (e.g., growth management plans, neighborhood plans, open space management plans), and codes and regulations (e.g., subdivision regulations, landscaping ordinances, steep-slope ordinances, zoning codes, building codes, and wildland-urban interface codes).

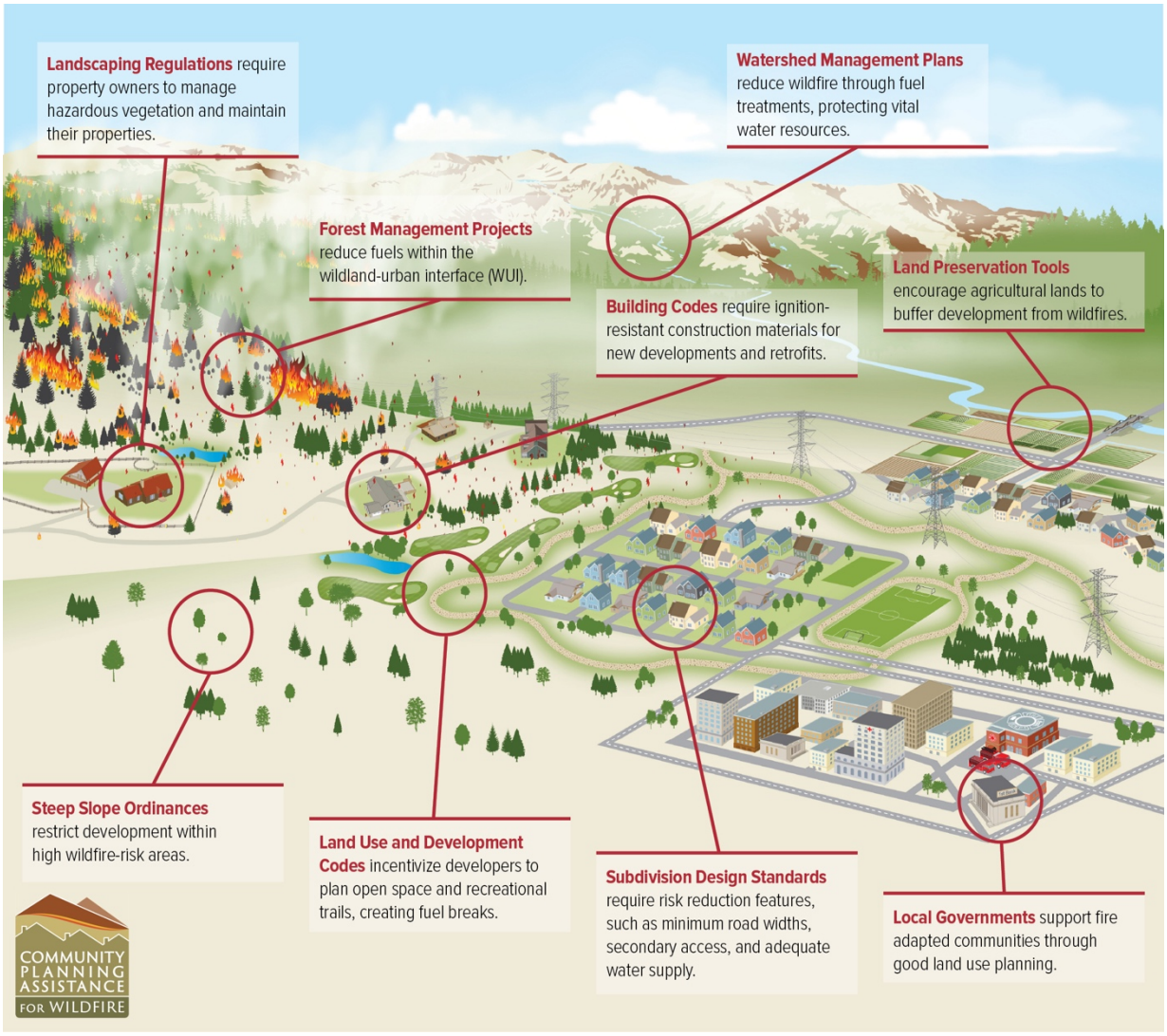


*Figure 2. Examples of different policy and regulatory options available to communities when planning for wildfire.*

## *Community Planning Assistance For Wildfire*

Identifying appropriate land use planning tools to result in more resilient WUI communities was the catalyst for the Community Planning Assistance for Wildfire (CPAW) program. The CPAW program helps communities make more informed decisions about current and future development to better integrate wildfire-resilience into the planning process. CPAW was established by Headwaters Economics and Wildfire Planning International in 2015 and is funded by the USDA Forest Service and private foundations. Since its inception, CPAW has worked with communities of varying sizes, capacities, and geographical locations across the United States (Figure 3).

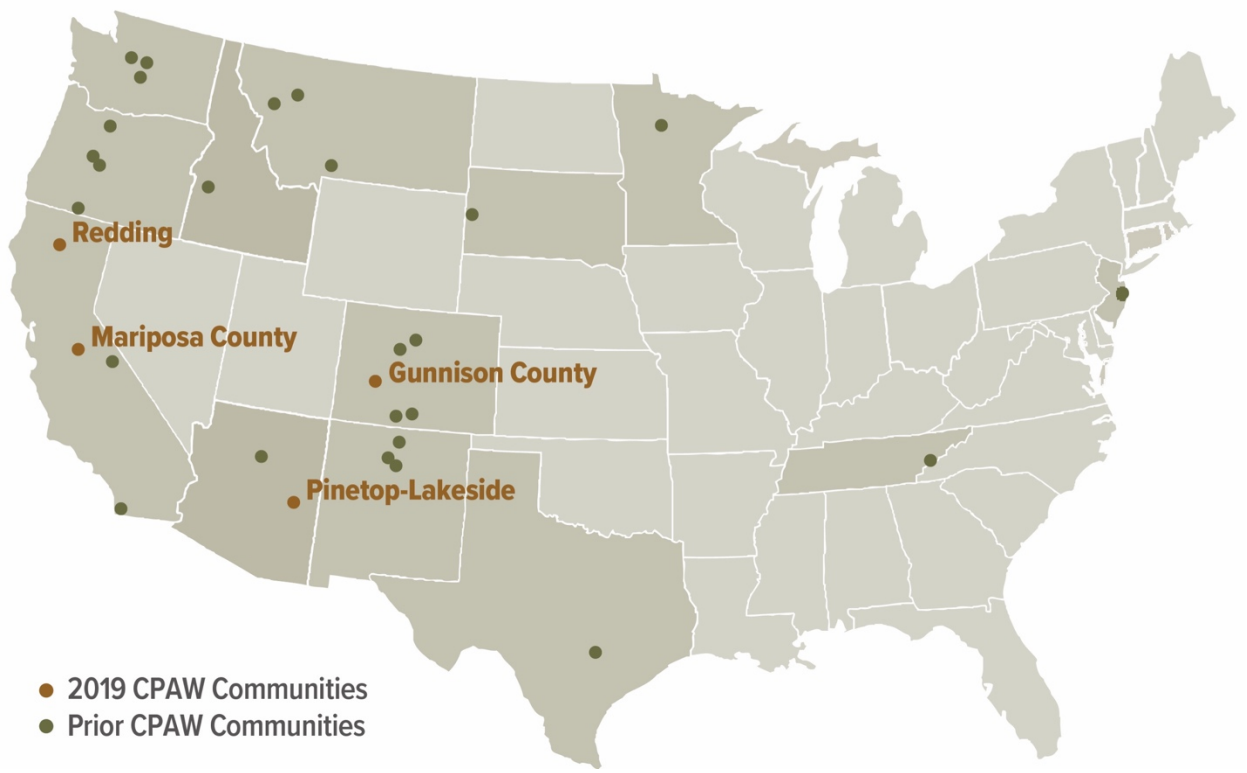


*Figure 3. In 2018, Pinetop-Lakeside was one of four communities selected to receive customized technical assistance during the 2019 calendar year.*

Communities voluntarily apply and are competitively selected to participate in the program on an annual basis. Communities must show commitment and engagement from both the planning and fire departments/districts to reflect the collaborative nature required for CPAW success. If selected, communities receive customized technical consulting services from CPAW's team of professional land use planners, foresters, risk modelers, and researchers. Specific services vary based on community needs, and may include capacity-building trainings on WUI planning topics, risk modeling and spatial analysis, guidance on wildfire mitigation plans and policies, and other strategies to address local wildfire risk.

### *Stakeholder Engagement*

Community members engaged in the process play a critical role to project success. While services are provided at no charge to the community, each community signs a Memorandum of Understanding with CPAW to outline the mutual understanding of roles and responsibilities and

project commitments. CPAW teams engage with a variety of local stakeholders who may serve as steering group members, local experts, or interested parties. These stakeholders provide valuable input and feedback, represent diverse wildfire and community development interests, and act as communication channels to other local groups.

### *CPAW Process and Recommendations*

The CPAW community planning process occurs over the course of one year. During that time, CPAW team members meet with stakeholders to discuss local issues, conduct several field tours to learn about unique wildland-urban interface and wildfire mitigation challenges, and provide presentations to help the community understand CPAW's program goals (Figure 4). Team members also review community planning documents to identify gaps and opportunities for strengthening wildfire policies and regulations. The CPAW team delivers a final set of recommendations by the end of the assistance year. Follow-up implementation assistance may also be available to communities depending on their needs and CPAW's program funding.

*Figure 4. Team members discuss the upcoming field tour route in Pinetop-Lakeside during their first site visit.*

CPAW recommendations are customized to each local community based on field visit data gathering, stakeholder feedback, research, science, best practices, and national expertise in planning, forestry, hazard mitigation, and wildfire risk reduction. All recommendations are voluntary. Local governments retain sole authority for the decision to implement any recommendations delivered by CPAW.

## *Pinetop-Lakeside Planning Context*

The Town of Pinetop-Lakeside is a small, rural community located in the southern portion of Navajo County in east-central Arizona (Figure 5). It was founded in 1984 when the neighboring towns of Pinetop and Lakeside merged and incorporated as one town. Today it is one of seven incorporated communities in the county, where the City of Holbrook serves as the county seat. State Route 260 traverses directly through the middle of Pinetop-Lakeside, connecting the town to the City of Show Low, the county's largest incorporated community, and the White Mountain Apache Indian Reservation, home to the federally recognized White Mountain Apache Tribe.


*Figure 5. Pinetop-Lakeside is in the southern portion of Navajo County, Arizona.*

Pinetop-Lakeside is a popular summer resort and second-home community for Arizona desert residents. It is widely recognized for its extensive tourism and recreational activities, proximity to the world's largest stand of ponderosa pine, and many other scenic attractions. The town is surrounded by mountains, national forests, and the extensive White Mountain Apache Reservation which includes attractions such as the Hon-Dah Casino Resort and Conference Center and the Sunrise Park Resort. Pinetop-Lakeside is also noted for its golf courses, large network of multi-use trails, and popular recreational facilities at Woodland Lake Park.[2] Although it has less than 5,000 year-round residents, these amenities result in a dramatic influx of seasonal residents and visitors to the community with an estimated population of 30,000 during summer months.[3]

## *Geographic Location and Significant Features*

Navajo County is divided into two distinct parts by the Mogollon Rim, an escarpment defining the southwestern edge of the Colorado Plateau. The high country in the northern part of the county is characterized by arid, desert-like conditions with mesas and plateaus, while the southern part surrounding Pinetop-Lakeside is characterized by rugged mountains with moderate to steep slopes; numerous lakes, rivers, and streams; and lands heavily wooded with pinon, juniper and ponderosa pine, high-altitude grasses, shrubs, and brush.[4]

Pinetop-Lakeside is situated in the White Mountains and in the tall pines of the eastern portion of the Apache-Sitgreaves National Forests, which encompass over two million acres of mountain country and vast forestlands to the south and west of town (Figure 6). Though technically two separate forests, Apache and Sitgreaves are managed by the U.S. Forest Service as one unit. The elevation of the region ranges from 3,500 feet to nearly 11,500 feet at the summit of Mount Baldy, the highest point in the White Mountains and the fifth-highest point in the state. This mountainous area stretches mostly east, but a little south, and meanders to the east as far as New Mexico. Much of the range, including Mount Baldy, is also within the White Mountain Apache Reservation with several canyons that run north-south toward Pinetop-Lakeside.[5]

Pinetop-Lakeside is located at an average elevation of 6,900 feet.[6] Four primary watercourses are located within the town: Billy Creek, Porter Creek, Show Low Creek, and Walnut Creek. The remaining watercourses are primarily small ephemeral washes.[4]

*Figure 6. Development in Pinetop-Lakeside has occurred within a natural ponderosa pine forest environment.*

[2] Community Profile for Pinetop-Lakeside. Arizona Commerce Authority. 2019.
[3] Navajo and Apache County Sitgreaves Communities' Wildfire Protection Plan. June 2016
[4] Navajo County Multi-Jurisdictional Hazard Mitigation Plan. Section 2: Community Overviews. 2017.
[5] The Town of Pinetop-Lakeside Website. Accessed on April 25, 2019. Available at: https://www.pinetoplakesideaz.gov/272/Mogollon-Rim-of-Arizonas-White-Mountains
[6] Community Profile for Pinetop-Lakeside. Arizona Commerce Authority. 2019.

## Land Area, Ownership, and Distribution

Pinetop-Lakeside's current incorporated town limits occupy approximately 10.7 square miles.[7] The majority of land in the town is privately owned, with a few public parcels scattered through the community. Most developed lands and the town's commercial districts are centered along the State Route 260 corridor. Existing and continuing development of paved roads, utilities, communication centers, schools, hospitals, and public buildings add to the community's infrastructure.[3] Most lands surrounding the community are owned by the U.S. Forest Service and the White Mountain Apache Tribe, including vast amounts of preserved forestland in the Apache-Sitgreaves National Forests.

Historical trends in commercial and residential development were outlined in the 2001 Pinetop/Lakeside and Navajo County Regional Plan. Growth areas for the town included infill in existing neighborhoods, specifically within the downtown area, in addition to along major transportation corridors, in commercial and industrial districts, and in master planned developments. Recreation/open space and low-density residential are the primary land uses; however, there are planned higher-density residential and commercial developments located generally near the town center.[3] Pinetop-Lakeside's 2015 General Plan expresses the challenge of determining how development can best be accommodated without degrading community character, and notes that the town encourages a balanced land use pattern that respects the environment, private property rights, and preservation of community character.[8] The town's Future Land Use Map shows that most planned development will follow recent trends of mostly infill in existing neighborhoods and along or adjacent to State Route 260.

## Key Demographics and Economic Trends

Pinetop-Lakeside's year-round population has remained steady in recent years, growing by only 84 residents between 2010 and 2017.[9] This slow population growth is anticipated to continue well into the future with current projections indicating the town will have slightly more than 5,000 people by 2050.[10] Table 1 describes several key demographic characteristics of the community with additional notes, including comparisons to county and statewide statistics.

Pinetop-Lakeside maintains a well-planned rural business atmosphere with a strong, year-round tourism industry and a diversified economy that is oriented toward providing trade and services for tourists, recreation-seekers, and residents. Mount Baldy and Sunrise Park Resort attract skiers from around the world and Pinetop-Lakeside provides much of the lodging, hospitality, and retail infrastructure that serves this growing market.[11] Other leading industries significant to the local economy include education, health care, and social assistance, which collectively make up 36.3% of occupations in the town.[12]

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[7] Ibid.
[8] Town of Pinetop-Lakeside General Plan. 2015.
[9] U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates.
[10] Arizona State Demographer's Office. Sub-County Population Projections, 2016 Edition.
[11] The Town of Pinetop-Lakeside Website. Accessed on April 25, 2019. Available at: https://www.pinetoplakesideaz.gov/179/Economic-Development
[12] U.S. Department of Commerce. 2018. Census Bureau, American Community Survey Office, Washington, D.C, as reported in Headwaters Economics' Economic Profile System (headwaterseconomics.org/eps).

| TABLE 1. DEMOGRAPHIC AND ECONOMIC OVERVIEW | | | |
|---|---|---|---|
| Statistic | Pinetop-Lakeside | Navajo County | Arizona |
| Total Population | 4,299[a] | 107,902[a] | 6,809,946[a] |
| Population Density | 318[b] | 10[b] | 45.2[b] |
| Median Age | 51.1[a] | 35.9[a] | 37.2[a] |
| Housing Units | 3,677[a] | 57,638[a] | 2,941,894[a] |
| Median Home Value | $251,186[c] | $115,100[a] | $193,200[a] |
| Median Household Income | $61,444[a] | $38,798[a] | $53,510[a] |
| Poverty Rate | 18.2%[a] | 23.7%[a] | 17%[a] |
| Unemployment Rate | 2.5%[d] | 7.7[d] | 4.6%[d] |

Data Sources:

a. U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates.
b. U.S. Census Bureau. 2000.
c. Neighborhood Scout. April 2019. https://www.neighborhoodscout.com/
d. Arizona Office of Economic Opportunity. March 2019.

## *Fire Environment and Wildfire History*

The Town of Pinetop-Lakeside is situated largely within a fire-dependent ecosystem of primarily Ponderosa Pine and Pinyon Pine-Juniper forest types. Since European settlement, 64 % of the vegetated ecosystems within the Navajo County WUI, including Pinetop-Lakeside, is reported to be significantly altered (Vegetation Condition Class 3) from its historical fire regime (fire frequency and fire intensity) due to human influence[3]. This has created a condition of "unnatural" fuel build-up, resulting in more intense wildfires that are more difficult to suppress. Historical weather conditions indicate that there have been several days where the potential for a catastrophic fire event would have been likely, if an ignition source had been present under those conditions. Several large wildfires in recent history have exceeded local suppression capabilities and threatened or significantly impacted communities near Pinetop-Lakeside[4] (Table 2 and Figure 7).

| TABLE 2. SIGNIFICANT RECENT WILDFIRES | | | | |
|---|---|---|---|---|
| Date | Fire Name | Size (acres) | Start Location | Community Impacts |
| June 2016 | Cedar Fire | 46,000 | Southwest of Show Low | Pre-evacuation notices in Show Low and Pinetop-Lakeside; many residents self-evacuated as a result of the notices; significant economic impact to Pinetop-Lakeside and Show Low as reflected through a sales tax decrease |

| TABLE 2. SIGNIFICANT RECENT WILDFIRES | | | | |
|---|---|---|---|---|
| Date | Fire Name | Size (acres) | Start Location | Community Impacts |
| | | | | immediately following the fire (June and July); impacts continued through the entire remaining year |
| June 2011 | Wash | 400 | SH 277 & 377, NE of Heber-Overgaard | Power shutdown to Heber-Overgaard, Clay Springs, and Pinedale areas; SR 260, 277, and 377 closures |
| June 2011 | Willow | 213 | 1 mile north of Bear Canyon Lake | Threat to outlying residences and power lines |
| May 2011 | Wallow | 538,049 | Bear Wallow Wilderness | 4 commercial buildings destroyed; 36 outbuildings destroyed and 1 damaged; 32 residences destroyed and 5 damaged; estimated cost of losses at $109 million |
| May 2011 | Club | 13.5 | East Bucksprings Road, Pinetop | Pinetop Country Club threatened |
| June 2006 | Potato Complex | 6,262 | 10 miles northwest of Heber-Overgaard | $3,706,000 in suppression costs |
| August 2003 | Red Knoll Fire | 186 | 5 miles east of Carrizo | $116,400 in suppression costs |
| June 2002 | Rodeo-Chediski Fire | 468,640 | Near the Town of Cibecue/Chediski Mountain, Ft. Apache Reserve | 4,500 homes threatened, 450 homes destroyed in Navajo, Apache, Coconino, and Gina counties; approximately 30,000 people evacuated; Presidential disaster declaration; $26 million in disaster aid; $1,418,717 in state costs and $1,093,574 in federal costs |
| June 1999 | Rainbow Fire | 5,000 | Navajo and Gila counties | 2,000 homes and 30 businesses threatened; 15 homes and 13 outlying structures destroyed; 100 people evacuated; $185,774 in state costs |

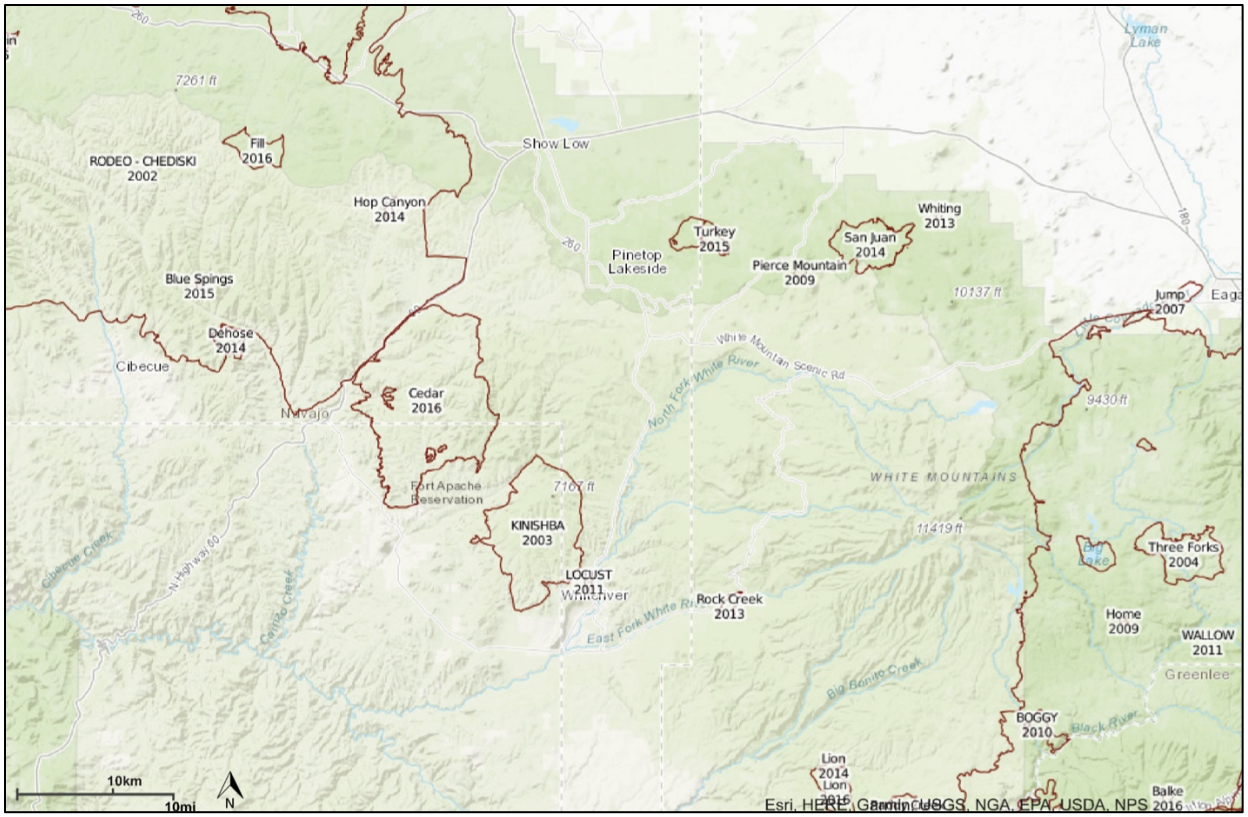


*Figure 7. Map of recent resource benefit fires and wildfires near the Town of Pinetop-Lakeside*[13]

## Pinetop-Lakeside Community Analysis

CPAW identified challenges and opportunities related to wildfire and land use planning in Pinetop-Lakeside. These findings help inform which type of recommendations may be most effective, and to anticipate any potential barriers that could be encountered during the implementation process.

### Local Planning Challenges

- The town's seasonal and transient populations increase significantly during summer months, which overlaps with fire weather patterns.
- Infrastructure (water supply and access) is challenged, with limited resources and options to increase access in existing communities, and long-term municipal water supply concerns further impacted by coordination challenges to improve fire water supply in existing communities.
- Staff capacity within the Community Development Department is limited, making it difficult to expect that new mitigation activities will be added to current responsibilities.

[13] Arizona Department of Forestry and Fire Management. Accessed July 12, 2019. Available at: https://arizonawildfirerisk.com/Map/Public

- Commonly occurring weather and forest fuel conditions present a significant potential for catastrophic wildfire threat from outside the town administrative boundaries, with only the ignition component missing during these conditions. This requires the town to rely on the priorities and constraints faced by Navajo County, private, National Forest, and Fort Apache Indian Reserve land managers.

## *Local Planning Opportunities*

- Although growth is happening at a relatively slow pace, future annexations may result in new development, giving the town an opportunity to implement wildfire measures that reduce risk.
- Both the Community Development Director and the Pinetop Fire Chief are highly engaged, well-trained, and active in promoting the importance of wildfire resilience and forest health. This is coupled with strong informal working relationships between the Pinetop Fire District, the Timber Mesa Fire and Medical District, and the town's community development director.
- In addition, the town and fire districts have a collaborative relationship with the Arizona Department of Forestry and Fire Management, and participate in other efforts such as the Arizona Fire Adapted Communities Network.
- Community engagement is high, as evidenced by the growing number of recognized Firewise USA® sites and strong local participation in the annual Firewise Community day (Figure 8).


*Figure 8. Residents interact with different agencies and local businesses to learn about wildfire safety during the annual Firewise Community Day. Credit: Kirk Webb*

# SUMMARY OF RECOMMENDATIONS

The 2019 CPAW report for Pinetop-Lakeside provides the town with four recommendations (Table 3) to implement the most appropriate tools for addressing local conditions and opportunities. Each recommendation includes an overview of its importance and relevance, implementation guidance for staff, and tips or additional resources. Many aspects of the recommendations are related to one another; where applicable, recommendations are cross-referenced. As staff consider CPAW recommendations, they may further refine the concepts to ensure alignment with other community planning priorities.

**TABLE 3. OVERVIEW OF RECOMMENDATIONS**

| Recommendation | Summary | Key Points |
|---|---|---|
| 1. Define the Wildland-Urban Interface (WUI) and Implement a WUI Risk Assessment Program | Clearly define Pinetop-Lakeside's wildland-urban interface and integrate hazard assessment mapping as a component of the decision support tool for land use policies and regulations. Consider the implementation of a spatially delineated risk assessment program by incorporating property-specific assessment information. | • A wildfire hazard assessment provided by CPAW can be used to enhance previous efforts; the updated assessment identifies the town's hazard and delineates the WUI at local scale, as well as provides general guidance on mitigation difficulty at the parcel level.<br>• The town can use the mitigation potential map to inform implementation of the proposed §17.96 *Revised Forest Health and Wildland-Urban Interface Fire Risk Reduction*.<br>• The hazard assessment can be further supported through the inclusion of parcel-level hazard assessment data to produce a complete wildfire risk assessment. |
| 2. Develop Coordinated Approach to Guide Wildfire and Land Use Planning Decisions | The Town of Pinetop-Lakeside, in collaboration with the Pinetop Fire District, Timber Mesa Fire and Medical District, and other stakeholders, should develop a coordinated approach to guide wildfire and land use planning decisions by developing a localized addendum to the county CWPP and linking appropriate plans. | • Five primary types of plans currently direct or inform wildfire mitigation, forest health, and related activities in the Town: Community Wildfire Protection Plan, Hazard Mitigation Plan, General Plan, Regional Plan, Firewise Assessments.<br>• Plans vary in detail, scope, and timeframe and there is a general lack of direction to meaningfully track and implement activities.<br>• CPAW recommends that the town and Pinetop Fire District lead the development of a CWPP addendum to provide local stakeholders with a go-to resource for wildfire planning at a more focused scale and address the needs of the town and fire districts. |

| TABLE 3. OVERVIEW OF RECOMMENDATIONS | | |
|---|---|---|
| Recommendation | Summary | Key Points |
| 3. Update and Align Regulations to Decrease Susceptibility of Development to Wildfire | Adopt §17.96 *Revised Forest Health and Wildland-Urban Interface Fire Risk Reduction,* with recommended modifications, to comprehensively reduce risk to the built and natural environment. Align this chapter with other regulations to reduce duplication and reconcile conflicts. | • Current regulations emphasize fire protection through hazardous vegetation management and improved response capabilities, which supports the maintenance of a healthy urban forest, as well as public and first responder safety.<br>• Enforcement of these regulations are largely complaint-driven and limited by town staff capacity.<br>• Effective wildfire risk reduction regulations must include building construction requirements.<br>• The proposed chapter, §17.96 *Revised Forest Health and Wildland-Urban Interface Fire Risk Reduction*, expands the scope of regulations to include applicable provisions of the International Wildland-Urban Interface Code (IWUIC), and helps the town achieve its goals to become a fire-adapted community.<br>• CPAW recommends that the town adopt the revised chapter §17.96 with additional modifications. |
| 4. Formalize an Implementation Process to Address Capacity Challenges | Collaborate and coordinate with the Pinetop Fire District and the Timber Mesa Fire and Medical District to develop a formal process for roles and responsibilities in engaging in parcel-level risk assessments, technical input, and regulation enforcement. | • The town, Pinetop Fire District, and the Timber Mesa Fire and Medical District currently have an excellent informal working relationship with regards to wildfire mitigation.<br>• The town's current staffing capacity is challenged in supporting a wildfire mitigation program that will effectively reduce wildfire risk.<br>• The fire districts do not currently have a formal role, or the authority, to engage in the town's development review process or wildfire regulation enforcement, but they are willing to engage in this capacity.<br>• The CPAW team recommends that the town and the fire districts work together in formalizing an agreement that defines the roles and relationship of each of the organizations related to wildfire mitigation.<br>• Changes to some town code language may be necessary to provide the appropriate authorities to the fire districts. |

# RECOMMENDATION 1

## *Define the Wildland-Urban Interface (WUI) and Implement a WUI Risk Assessment Program*

Clearly define Pinetop-Lakeside's wildland-urban interface and integrate hazard assessment mapping as a component of the decision support tool for land use policies and regulations. Consider the implementation of a spatially delineated risk assessment program by incorporating property-specific assessment information.

## *Overview*

Initial observations by the CPAW team, along with input from local subject matter experts (SMEs), suggest that wildfire risk to the Town of Pinetop-Lakeside originates from both within the townsite and outside its administrative boundaries. The surrounding fuel, weather, and topographical conditions under county or federal jurisdiction present a significant fire threat to the community. For this reason, the CPAW team and local SMEs determined that it is most appropriate to undertake a hazard assessment at the county scale in order to appropriately capture these conditions.

### *Current Wildfire Risk Assessment Methodology and Process*

Currently, Navajo County (including Pinetop-Lakeside) uses a methodology for defining the WUI and assessing the wildfire risk that is outlined in the Updated Navajo and Apache County Sitgreaves Communities' Wildfire Protection Plan (2016).[3] This methodology is consistent with the Arizona Wildfire Risk Assessment Portal (AZWRAP) methodology and the methodology described in the Arizona State Forester's *Identifying Arizona's Wildland/Urban Interface Communities at Risk: A Guide for State and Federal Land Managers* (ASFD 2007) document.

In addition to the AZWRAP assessments, both the Town of Pinetop-Lakeside and the Pinetop Fire District undertake property-specific hazard assessments. These two assessments are conducted using different methodology and focus. The Pinetop Fire District conducts these assessments using the National Fire Protection Association (NFPA) Wildfire Hazard Severity Form Checklist, which assesses both the structure and the surrounding environment. The town conducts defensible space assessments only.

### *What is Wildfire Risk?*

Wildfire risk can be visualized as a triangle consisting of three components:

1. Likelihood of a wildfire occurring based on topography, weather, and ignition patterns; this can also include ignition sources from hazardous land uses (e.g., sawmills or propane storage facilities);
2. Predicted intensity of a wildfire (usually measured in flame length) based on vegetation type and weather conditions;

3. Susceptibility of values (for land use planning purposes, values consist of communities, structures, and infrastructure).

Together, these components complete the wildfire risk triangle (Figure 9).


*Figure 9. Components of the wildfire risk triangle*

Land use planning largely focuses on mitigating the susceptibility portion of the wildfire risk triangle. There are two important susceptibility inputs that should be evaluated to appropriately determine wildfire risk in the context of land use planning:

- The location and density of structures and infrastructure;
- The ignition potential of individual structures and infrastructure.

Implementing this recommendation will provide clear definition of Navajo County's wildland-urban interface and integrate a hazard assessment map as a component of the decision support tool for land use policies and regulations. The further incorporation of a property-specific assessment system to complement the hazard assessment with a built environment susceptibility component will provide a comprehensive risk assessment.

### *USFS Risk and Hazard Assessment*

As part of the CPAW program, the USFS Rocky Mountain Research Station (RMRS) provides wildfire risk and hazard assessment support. After assessing the current need, the CPAW team engaged the RMRS to undertake an updated and refined countywide hazard assessment (likelihood and susceptibility) to support this project. As a component of the hazard assessment, the RMRS is also undertaking the SILVIS lab's approach to spatially defining the WUI in Navajo County.

### *Parcel-Level Susceptibility Assessments*

Individual Parcel-Level Assessments complete the risk triangle by providing the susceptibility component. This focuses on assessing each structure and the immediate surroundings, or Structure Ignition Zone (SIZ). Within the Town of Pinetop-Lakeside, these assessments are currently being undertaken through two separate processes by both the Town of Pinetop-Lakeside and the Pinetop Fire District.

## *Implementation Guidance*

As part of the CPAW process, RMRS staff engaged with local wildfire risk SMEs to achieve three main objectives:

1. Validate the RMRS spatial fuels layers.
2. Explore RMRS tools that can be used to develop countywide hazard mapping products to better support land use planning and other wildfire risk reduction efforts.
3. Spatially define the WUI.

This collaborative engagement was undertaken in the form of workshops in which local subject matter experts worked with RMRS staff and CPAW team members to determine the appropriate parameters and tools that would be useful in supporting local risk-reduction efforts.

As a result of this collaborative work, RMRS has calibrated the spatial fuel layer and developed a methodology to provide spatial hazard assessment support to the implementation of land use planning policy and regulations.

### *Wildfire Hazard Assessments and Mapping*

To provide an effective decision-support tool for the county and its partners, RMRS developed the following wildfire hazard mapping outputs. Three maps are provided at two scales: the Landscape-Level Wildfire Hazard (180 m pixel resolution), Local Wildfire Hazard (60 m pixel resolution) which includes ember zones, and Mitigation Potential (30 m pixel resolution). A summary of the methodology used to develop these outputs can be found in Appendix A.

### *Landscape-Level Wildfire Hazard*

This scale (180 m pixel resolution) represents the likelihood (probability) of a fire occurring and the intensity of the fire at the landscape level based on the inherent landscape characteristics including broad existing vegetation, biophysical settings, fire regimes, and fire histories. To provide the assessment in a format that is easily interpreted by the expected users (public, developers, land use planners), the pixelated display was summarized to polygon boundaries based on the U.S. Geological Survey Hydrological Unit Code (HUC) 12 (sub-watershed) boundaries. The landscape-level hazard assessment (Figure 10) is delineated into the following rankings:

- MODERATE
- HIGH
- VERY HIGH

The factors influencing these rankings can be used to determine the potential landscape-level exposure that a development will be subject to. The ranking at this scale is difficult to change at the local/parcel level. Mitigation affecting change at this scale is typically done by large-scale disturbances such as insect mortality, fires, or landscape-level mitigation.

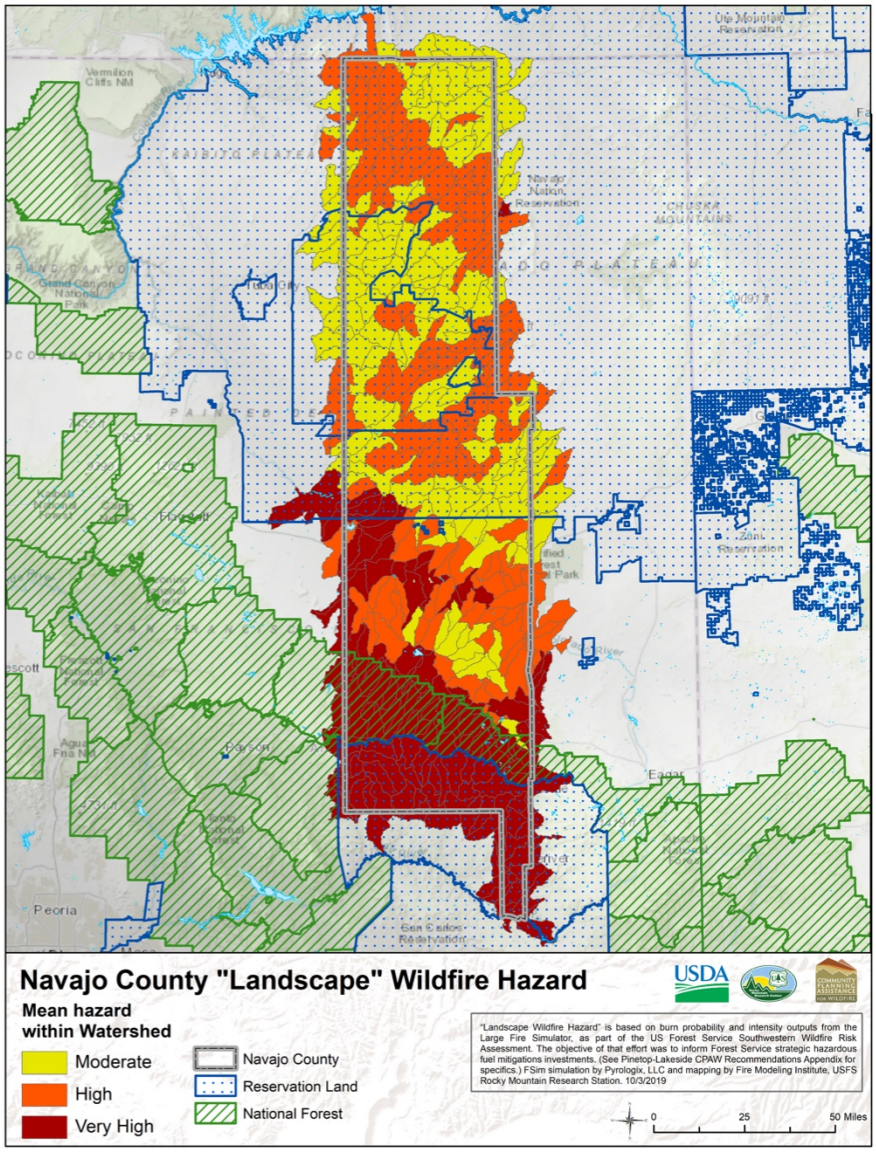


*Figure 10. Navajo County Landscape Wildfire Hazard Map*

**Land Use Planning Application:** This application informs land use planners on the general areas where fires are most likely to occur and where collaborative, multi-agency, large-scale fire management planning and mitigation are necessary.

## *Local-Level Wildfire Hazard*

This scale (60 m pixel resolution) is based on an extreme event (worst fire days). To provide the assessment in a format that is easily interpreted by the expected users (public, developers, land use planners), the pixelated display was summarized to polygon boundaries based on the catchment boundaries within the HUC 12 boundaries (Figure 11). This does not show the likelihood of a fire occurring but does show where fires are likely to burn at high intensity. For example, a fire that starts in an area where the local hazard is high can spread fast and burn at high intensity creating significant wildfire exposure to any structures in the area. The same rankings used at the landscape scale are used at this local scale:

- MODERATE
- HIGH
- VERY HIGH

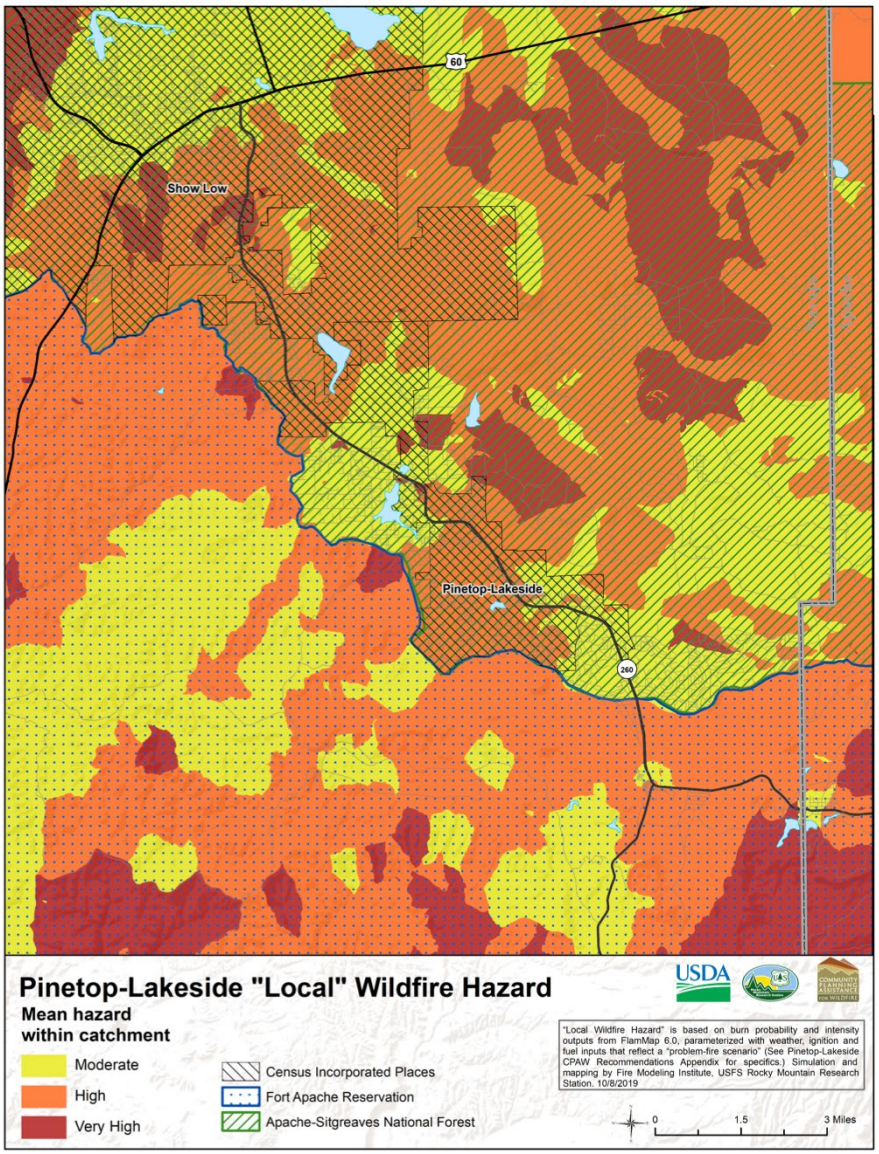


*Figure 11. Pinetop-Lakeside Local Wildfire Hazard Map*

**Land Use Planning Application:** This application informs land use planners on the relative worst-case (hottest, driest, windiest days during a fire season) wildfire exposure (radiant, convective, and ember) that can be expected in any given polygon where development exists or is planned.

### *Mitigation Difficulty*

The Mitigation Difficulty component (30-meter pixel resolution) uses the life form (grass, shrubs, trees), slope, and crown fire potential to classify the potential mitigation success of any given 30-meter pixel on the map (Figure 12). This is represented by nine categories (Table 4).

**TABLE 4. MITIGATION DIFFICULTY CLASSES AND DESCRIPTIONS**

| Class | Characteristics | Mitigation Discussion |
|---|---|---|
| 1 | Sparsely vegetated, or developed, with potential for ember impact | Barren ground/water/developed/ sparse vegetation or land that lies within potential spotting distance of a wildfire. Mitigation will involve appropriate structure ignition zone and structure construction. |
| 2 | Herbaceous on a shallow slope (<15%) | Fires are typically easier to suppress in these areas. However, high winds combined with dry conditions lead to potentially dangerous, fast-moving, high-intensity fires. Mitigation may involve a combination of irrigation, mechanical (mowing) treatment, frequent burning, and fuel breaks in conjunction with appropriate structure ignition zone and structure construction. |
| 3 | Herbaceous on moderate slope (≥15 to <30%) | Harder to construct fuel breaks, increased difficulty in mechanical (mowing) treatment, increased potential for erosion, increased rate of spread and intensity may make frequent burning and other mitigation more difficult. Focus should be on appropriate slope setbacks, structure ignition zone, and structure construction mitigation. |
| 4 | Herbaceous on steep slope (≥ 30%) | Significant challenges in fuel break construction, unlikely option for mechanical (mowing) treatment, significant potential for erosion, high rate of spread and intensity potential may make frequent burning and other mitigation difficult. High winds combined with short-term drying conditions lead to potentially dangerous fast-moving fires with fire fighter access concerns. Mitigation potential may involve a combination of frequent burning and fuel breaks in conjunction with slope setback, appropriate structure ignition zone, and structure construction. |
| | Shrub on shallow slope (<15%) | Fires are typically harder to suppress than grassfires in these areas. High winds combined with dry conditions lead to potentially dangerous, fast-moving, high-intensity fires with fire fighter access |

| TABLE 4. MITIGATION DIFFICULTY CLASSES AND DESCRIPTIONS | | |
|---|---|---|
| Class | Characteristics | Mitigation Discussion |
| | | concerns. Mitigation may involve a combination of frequent burning and fuel breaks in conjunction with appropriate structure ignition zone and structure construction. |
| 5 | Shrub on moderate slope (≥15 to <30%) | Harder to construct fuel breaks, increased difficulty in mechanical (mastication) treatment, increased potential for erosion, increased rate of spread and intensity may make prescribed burning more difficult. Focus should be on a combination of appropriate mechanical treatment and burning, slope setbacks, structure ignition zone, and structure construction mitigation. |
| 6 | Shrubs on steep (≥30%) slopes | Significant challenges in fuel break construction; unlikely option for extensive mechanical (mastication) treatment. Significant potential for erosion or slope instability resulting from treatments is a likely mitigation challenge. Increased rate of spread and significant intensity may make prescribed burning more difficult. Focus should be on a combination of appropriate mechanical treatment and burning, slope setbacks, structure ignition zone, and structure construction mitigation. |
| | Tree on shallow slope (<15%) | Open canopy must be maintained to prevent increased crown fire potential. Surface fuels must be treated/maintained in a state that reduces the chances of fast-moving surface fires. Mitigation should also include appropriate slope setbacks, structure ignition zone, and structure construction mitigation. |
| 7 | Tree on moderate slope (≥15 to <30%) | Open canopy must be maintained to prevent increased crown fire potential, which may be more difficult due to the slope. Surface fuels must be treated/maintained in a state that reduces the chances of fast-moving surface fires. Increased potential for erosion or slope instability resulting from treatments can be a mitigation challenge. Mitigation should also include appropriate slope setbacks, structure ignition zone, and structure construction mitigation. |
| | Tree on shallow slope (<15%) with potential for crown fire | Dense canopy needs to be thinned to reduce crown fire potential. Surface fuels must be treated to reduce risk of fast-moving surface fires. Mitigation should also include appropriate structure ignition zone and structure construction mitigation. |
| 8 | Tree on moderate slope with potential | Dense canopy needs to be thinned to reduce crown fire potential, which may be more difficult due to the slope. Surface fuels must be treated to reduce risk of fast-moving surface fires. Increased potential for erosion or slope instability resulting from treatments can be a |

| TABLE 4. MITIGATION DIFFICULTY CLASSES AND DESCRIPTIONS | | |
|---|---|---|
| Class | Characteristics | Mitigation Discussion |
| 8 | for crown fire (≥15 to <30%) | mitigation challenge. Mitigation should also include appropriate slope setbacks, structure ignition zone, and structure construction mitigation. |
| | Tree on steep slope (≥30%) | Open canopy must be maintained to prevent increased crown fire potential, which can be significantly difficult due to the slope. Surface fuels must be treated/maintained in a state that reduces the chances of fast-moving surface fires. Significant potential for erosion or slope instability resulting from treatments is a likely mitigation challenge. Mitigation should also include appropriate slope setbacks, structure ignition zone, and structure construction mitigation. |
| 9 | Tree on steep slope (≥30%) with potential for crown fire | Dense canopy needs to be thinned to reduce crown fire potential, which may be extremely difficult if not prohibitive due to the slope. Surface fuels must be treated to reduce risk of fast-moving surface fires. A very high potential for erosion or slope instability resulting from treatments is a likely mitigation challenge. Mitigation should also include appropriate slope setbacks, structure ignition zone, and structure construction mitigation. |

**Land Use Planning Application:** This informs land use planners on the general potential success and challenges of mitigation when aligning with the mitigation requirements of the Wildland-Urban Interface regulatory requirements.

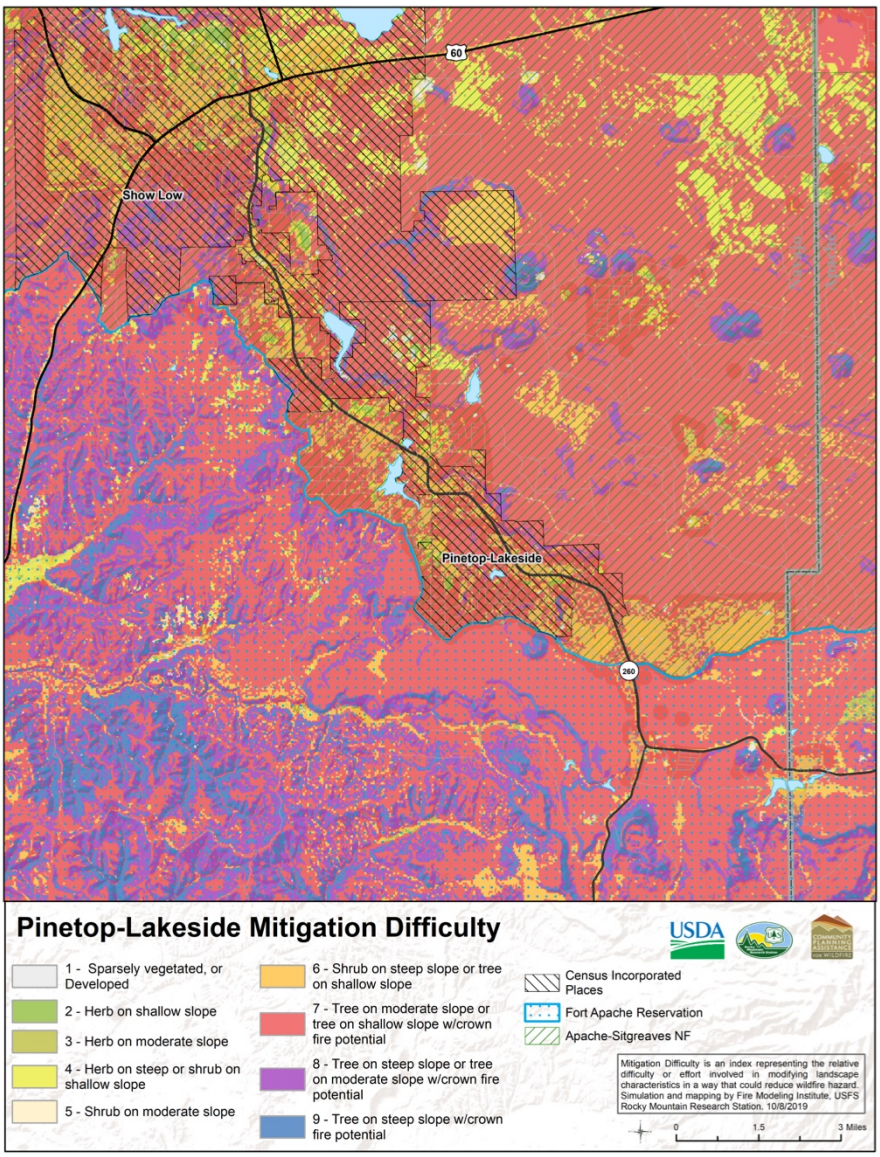


*Figure 12. Pinetop Lakeside Mitigation Difficulty Map*

## *Parcel-Level Assessment*

Although the two current parcel level assessment processes that are undertaken separately by the town and the fire district are based on similar concepts, they each use different methodologies and scope. The town and the fire districts should consider collaboration on developing or adopting a single assessment that addresses the needs of both organizations. In developing or adopting this tool, consideration should be given to:

- Incorporating the assessment of structure component susceptibility.
- Reflecting the most current best practices.
- Collecting data in a format that can: be easily tracked, integrate with and inform the mitigation difficulty and local hazard assessment maps, and provide meaningful risk reduction direction to property owners and land managers.

## *Defining the WUI*

A general WUI definition used across all policies, plans, and regulations should account for the "set of conditions" where vegetation (wildland fuels) and structures or infrastructure (built fuels) are influenced by weather and topography to allow fire to ignite and spread through the WUI environment. To provide the basis for a true understanding of the risk that Navajo County faces, the WUI should be more accurately defined as:

*Any developed area where conditions affecting the combustibility of both wildland and built fuels allow for the ignition and spread of fire through the combined fuel complex.*

In order to provide a spatial reference in defining the WUI, the CPAW/ RMRS team modified SILVIS lab's approach for spatially defining the WUI. The SILVIS lab approach originated in the Federal Register[14] report on WUI communities at risk from fire. This approach was modified by the CPAW/RMRS team to the following parameters:

- **WUI Intermix**: Areas with ≥1 house per acre and ≥50 percent cover of wildland vegetation.
- **WUI Interface:** Areas with ≥1 house per acre and ≤50 percent cover of vegetation and within 1.5 mi of area with >= 75% wildland vegetation.
- **Non-Vegetated (low and very low housing density):** Areas with ≤50 percent cover of wildland vegetation and 0-8 houses per acre.
- **Non-Vegetated (medium and high housing density):** Areas with ≤50 percent cover of wildland vegetation and ≥8 houses density per acre.
- **Vegetated:** Uninhabited areas and wildland vegetation > 50% cover

Based on these definitions, the developed areas within the Town of Pinetop-Lakeside and surrounding developed areas of the county have all been classed as **WUI Intermix** (Figure 13).

[14] USDA and USDI. 2001. Urban wildland interface communities within vicinity of Federal lands that are at high risk from wildfire. Federal Register 66:751–777.

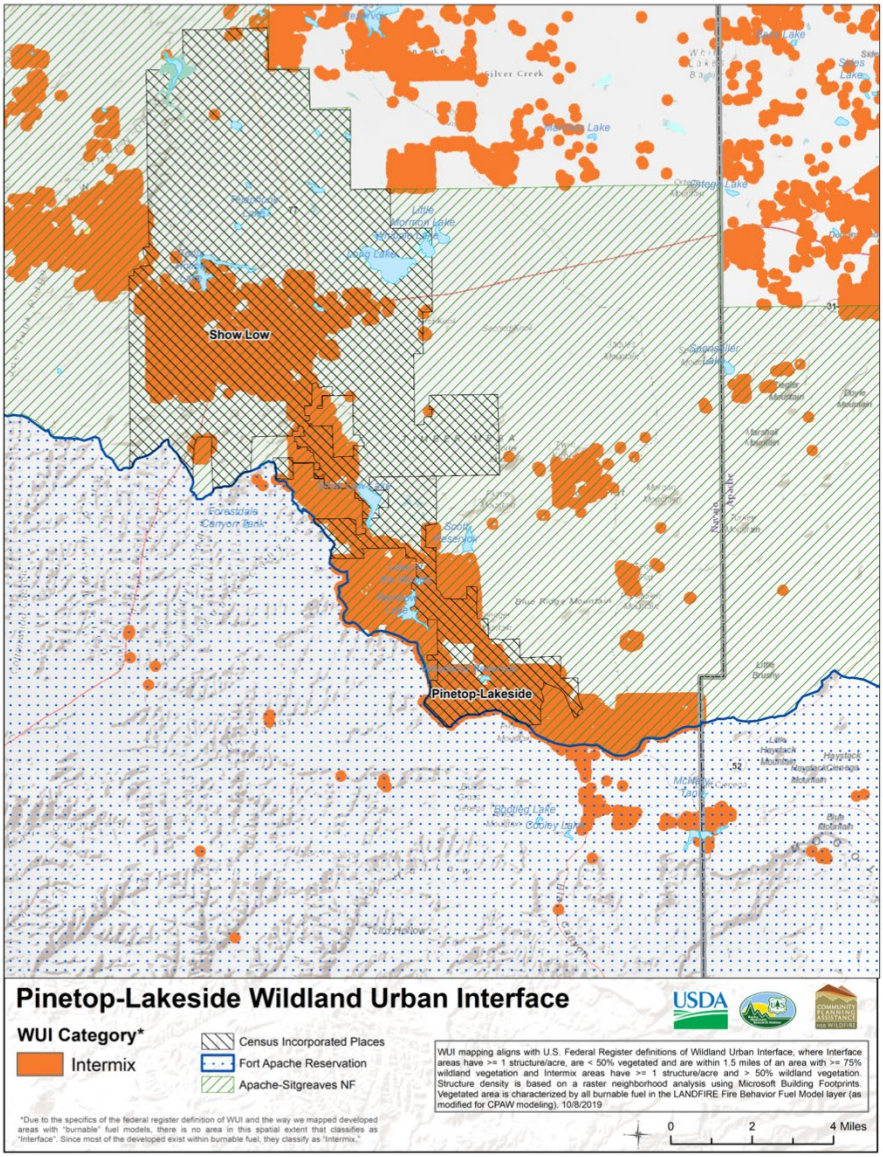


*Figure 13. Navajo County Map of the Wildland Urban Interface and Wildland Urban Intermix*

## *Using the Hazard Assessment to Support Land Use Policy and Regulation*

The landscape- and local-scale maps, as well as the mitigation potential wildfire exposure maps, will be supplied as a geodatabase to the town. This will allow the user to explore a hierarchy of hazard/exposure metrics including all of the elements described above. For example, when a user clicks on a watershed polygon or mitigation pixel, the user will see the elements that contribute to the calculation of the final hazard rating. The display of pixel-level model outputs at finer display scales will also provide the ability for end-users to examine the spatial variability of factors contributing to hazard and exposure with any watershed. The local-scale map and mitigation-potential map will provide the opportunity for planners to appropriately assess a future or existing development area for wildfire exposure and require the appropriate mitigation. It will also provide a ranked scale to guide implementation of a wildland-urban interface code with regards to the degree of standards that must apply based on exposure and mitigation and whether the area is within the ember zone.

## *Tips and Additional Resources*

The resulting hazard-assessment tool will be provided in the form of a geodatabase for addition to the town and fire district's geomatics servers as an ESRI ARC GIS layer. For the data to be made available to land use planners and the development community, the expertise of a GIS specialist will be required to ensure it is in the appropriate format for access and consumption by these groups.

The hazard assessment tools must be kept up to date to be relevant. A minimum default five-year update schedule is recommended, unless updates are required to occur sooner, based on the following:

- Significant wildland fire activity;
- Significant fuel management activity;
- Significant forest health impacts, or other disturbances that alter large-scale vegetation structure;
- Significant urban growth.

A best practices document (Appendix A) provides guidance to the town and county on the methodology for updating the assessment. The hazard-assessment outputs should be strongly linked as a decision support tool for implementing the proposed WUI requirements and planning policies.

# RECOMMENDATION 2

## *Develop Coordinated Approach to Guide Wildfire and Land Use Planning Decisions*

The Town of Pinetop-Lakeside, in collaboration with the Pinetop Fire District and other stakeholders, should develop a coordinated approach to guide wildfire and land use planning decisions by developing a localized addendum to the county Community Wildfire Protection Plan and linking appropriate plans.

## *Overview*

Pinetop-Lakeside has five primary types of plans that direct or inform wildfire mitigation, forest health, and related activities. Some of these plans are hazard-specific, such as the Updated Navajo and Apache Sitgreaves' Communities Wildfire Protection Plan (SCWPP), while others are land use documents that address how growth and development in the WUI may need to accommodate wildfire concerns, such as the Town of Pinetop-Lakeside General Plan. These five plans are highlighted in Table 5.

**TABLE 5. OVERVIEW OF RELEVANT WILDFIRE PLANNING DOCUMENTS**

| Plan Title | Date | Purpose/Overview |
|---|---|---|
| Updated Navajo and Apache County Sitgreaves' Communities' Wildfire Protection Plan (SCWPP) | 2016 | • Meets requirements set forth in the Healthy Forests Restoration Act of 2003.<br>• Takes a holistic approach to wildfire by planning for fire adapted communities.<br>• Contains recommended actions for fuel reduction, improving protection capability, reducing structural ignitability and improving public education and outreach. |
| Navajo County Multi-Jurisdictional Hazard Mitigation Plan (HMP) | 2017 | • Meets requirements of the Disaster Mitigation Act of 2000 for eligibility of applicable disaster assistance and hazard mitigation funding.<br>• Guides and coordinates hazard mitigation activities and decisions for future land use.<br>• Includes wildfire mitigation measures such as enforcement of zoning and building codes and education to increase awareness of town's forest health requirements. |
| Town of Pinetop-Lakeside General Plan | 2015 | • Meets state requirements for general plans.<br>• Includes goals and implementation policies for forest health, environmental protection, and fire protection. |

| TABLE 5. OVERVIEW OF RELEVANT WILDFIRE PLANNING DOCUMENTS | | |
|---|---|---|
| Plan Title | Date | Purpose/Overview |
| Pinetop-Lakeside & Navajo County Regional Plan | 2001 | • Referenced as an addendum to the town's General Plan.<br>• Extensively addresses wildfire and forest health as issues that affect planning and growth. |
| Community Site Assessments (various) | n/a | • Neighborhood assessments conducted by local fire district.<br>• Assessments identify local vulnerabilities, including structural and landscaping features, access limitations, and evacuation routes. |

## *Analysis*

Each plan listed in Table 5 varies in terms of its scope related to wildfire and land use planning, scale and corresponding level of detail for applicable policies, actions or mitigation measures, and the time horizon for implementation. For example:

- The SCWPP contains broad information and actions that meet the needs of communities and landscapes in two counties (Navajo and Apache), with many actions targeted for completion within several years;
- The HMP addresses multiple hazards across multiple jurisdictions within Navajo County, with many actions designed to occur within 10 years or less;
- The General Plan contains policies and implementation measures for the Town of Pinetop-Lakeside with no specified timeline;
- Recommendations in Community Site Assessments address local conditions within individual neighborhoods within the town or county and identify short-term, voluntary completion of actions to successfully receive Firewise USA® recognition status.

Some of these plans may overlap in their intent and recommended implementation items, but do not always contain references or links to one another. For example, the General Plan calls for implementation measures to encourage remediation of unhealthy forest areas, local education, and compliance with applicable town codes, while the SCWPP promotes education and fuel treatments/improved forest health; neither plan references the other. Similarly, the HMP prioritizes the enforcement of fire mitigation and WUI ordinances in Pinetop-Lakeside as a mitigation measure, but there is no clear link to other plans as part of future implementation.

Plans also differ in terms of whether there are any stated protocols for tracking and monitoring. Some plans are legally required to be updated within a certain time period (General Plan, HMP); others may not have a designated requirement, such as the SCWPP, but do contain a recommended monitoring section.

In sum, there are multiple plans that contain information, policies, and actions/mitigation measures to address wildfire risk reduction through land use planning and other mechanisms in the Town of Pinetop-Lakeside. However, there is no clear sense of how these plans are connected or which plan serves as the primary resource to direct activities. Further, there is a general lack of direction to meaningfully track and implement activities.

# Implementation Guidance

To address the challenge of multiple plans with varying content, combined with different scales and implementation timeframes, CPAW recommends that the Town of Pinetop-Lakeside works with the Pinetop Fire District and Timber Mesa Fire and Medical District (TMFMD) to lead the development of an addendum to the SCWPP. An addendum would provide local stakeholders with a go-to resource for wildfire planning at a more focused scale and address the needs of the town and fire districts. This would serve as an actionable plan to coordinate and prioritize needed resources, such as code enforcement. CWPPs are also beneficial to the USDA Forest Service in helping prioritize landscape-level treatments in or near communities.

## SCWPP Addendum

Content in a SCWPP addendum should address the following needs:

- Incorporate the new wildfire hazard assessment provided by CPAW and describe its local implications for mitigation activities (see Recommendation 1);
- Develop and prioritize actions for Pinetop-Lakeside and the fire districts, including a comprehensive and detailed action plan that identifies roles and responsibilities, timeframe for actions, estimated costs and available resources (e.g., grants);
- Ensure topics such as evacuation planning of neighborhoods are included;
- Link with applicable town and fire district plans, including the General Plan and Regional Plan, Multi-Jurisdictional Hazard Mitigation Plan, and Community Site Assessments.

The production and implementation of an addendum requires the establishment of a local working group. Currently, a multi-jurisdictional coordination group meets regularly to evaluate forest conditions and community fire restrictions. This group could act as a consultative group for a future CWPP addendum, with the potential addition of other entities based on a holistic planning approach, such as the Arizona Fire Adapted Communities (AZ FAC) steering group.

The SCWPP addendum should be reviewed on an annual basis and comprehensively updated every five years. This cycle can also coincide with the federally-required update of the HMP.

## Plan Linkages and Alignment

As other town and fire district plans get developed or updated, they should be reviewed for alignment with the SCWPP (and addendum). This avoids duplication of actions but reinforces where policies support wildfire mitigation. For example, the General Plan should reference the SCWPP as the primary instrument to implement wildfire and forest health policies.

# Additional Resources

## Secure Rural Schools Act: Title III – County Funds

The Secure Rural Schools and Community Self-Determination Act (SRS Act) was signed into law in 2000. The SRS Act was most recently reauthorized by P.L. 115-141 and signed into law by the President on March 23, 2019. This reauthorization extended the date by which SRS Title III projects (County Funds) must be initiated to September 30, 2020. The date by which Title III

funds must by obligated is also extended to September 30, 2021. Authorized uses of Title III funds include the following activities[15]:

> (1) To carry out activities under the Firewise Communities program;
>
> (2) To reimburse the participating county for search and rescue and other emergency services, including firefighting and law enforcement patrols;
>
> (3) To cover training costs and equipment purchases directly related to the emergency service
>
> **(4) To develop and carry out community wildfire protection plans (CWPP).**

Many counties in the west have utilized Title III funding for CWPP implementation, including counties in Colorado and Oregon. Navajo County has elected a 5% allocation for Title III of the total SRS funds available. In 2016, the county utilized Title III funds for the revisions of the CWPP, as noted by Mary Springer, the emergency manager at the time. In 2018, the USDA reported that Navajo County received approximately $47,500.[16]

The amount of Title III funds allocated nationally to counties has decreased annually since 2008, whereby counties must account for a diminution of monies when budgeting to utilize Title III funds. However, amendments to Title III in 2019 authorize the funds to be used not only for CWPP development but also implementation. It is recommended that Pinetop-Lakeside consider this county funding as a source for further updates and implementation of its CWPP. Additional information about funding allocation and documentation for Title III – County Funds is available at the USDA Forest Service webpage: www.fs.usda.gov/main/pts/countyfunds.

[15] USDA Forest Service Secure Rural Schools Reauthorization webpage: www.fs.usda.gov/main/pts/home (Last updated: April 15, 2019)

[16] USDA Forest Service Rural Schools Title III Regional Summary: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd622642.pdf

# RECOMMENDATION 3

## *Update and Align Regulations to Decrease Susceptibility of Development to Wildfire*

Adopt §17.96 *Revised Forest Health and Wildland-Urban Interface Fire Risk Reduction,* with recommended modifications, to comprehensively reduce risk to the built and natural environment. Align this chapter with other regulations to reduce duplication and reconcile conflicts.

## *Overview*

The Town of Pinetop-Lakeside currently regulates wildfire hazard on undeveloped and developed parcels within its jurisdiction, based on the following provisions:

- **Access.** Subdivisions must provide two separate and distinct access points; street design standards also include requirements for cul-de-sacs, dead-ends, private access and driveways, and grades (§§16.24.060-.080).
- **Utilities.** All existing and new utility lines adjacent to or within new residential or commercial subdivisions or other areas to be developed within the town shall be installed underground (§16.24.160).
- **Vegetation Management.** Lands within the town are subject to required and recommended approaches to modify areas within a three-zone approach, including the removal or maintenance of combustible materials and vegetation on or near buildings. Undeveloped parcels must meet fuel modification standards (§17.96).
- **Water.** Design and construction of any and all facilities relating to the supply, storage, transmission, treatment and distribution of potable water within or outside of any subdivision must meet with the written approval of the water provider and Pinetop Fire District or Timber Mesa Fire and Medical District (§16.24.140).[17]

The town does not currently have any requirements to address the threat of wildfire hazard to existing or new structures (i.e., requirements for building construction and materials). Several local homeowner associations (HOAs) have architectural standards and guidelines in place, which may require construction materials and landscaping requirements, but these are not regulated by the town.

[17] Timber Mesa Fire and Medical District was formerly referred to as the Lakeside Fire District. §16.24.140 still refers to Lakeside Fire District but this report has updated this for clarity.

## Analysis

Current regulations emphasize fire protection primarily through the management of hazardous vegetation and improved response capabilities. These regulations align well with objectives to maintain a healthy urban forest and support public and first responder safety.

However, enforcement of current fire protection and forest regulations is complaint-driven, and primarily focuses on ensuring that vacant/undeveloped parcels and new development comply with §17.96. Enforcement is limited by staff capacity within the planning department. As a result, compliance within the three-zone approach for vegetation management is likely significantly less than 100% effective.

Reliance only on vegetation management for wildfire risk reduction, without any construction requirements, leaves structures more susceptible to the effects of direct flame contact, radiant heat, or convective heat (embers). Research from the Insurance Institute for Business and Home Safety (IBHS) and the USDA Forest Service also shows the importance of structural requirements in reducing structure loss.

## Implementation Guidance

The CPAW team recommends that the town develop a more comprehensive approach to its regulation of wildfire that considers both the natural *and* built environment. Any new regulations should also align with existing standards, as discussed below.

### Adopt §17.96 Revised Forest Health and Wildland-Urban Interface Fire Risk Reduction

During the CPAW process, members of the Forest Health Committee shared a draft version to update current §17.96 *Forest Health and Fire Protection*. The revised chapter, §17.96 *Revised Forest Health and Wildland-Urban Interface Fire Risk Reduction* (draft December 28, 2018), expands the scope of regulations to include applicable provisions of the International Wildland-Urban Interface Code (IWUIC), and helps the town achieve its goals to become a fire-adapted community.

CPAW recommends that the town adopt the revised chapter, with the following modifications:

<u>Replace IWUIC Fire Hazard Severity Rating with CPAW Hazard Assessment Tools</u>

The proposed chapter references the IWUIC Fire Hazard Severity methodology to determine appropriate mitigation requirements. The critical fire weather threshold within this rating does define all of Pinetop Lakeside as “Extreme”; however, within the local environment, it does not account for the differences between heat transfer (radiant, convective, conductive) exposure of individual structures. The chapter also proposes a standard application of the IWUIC Ignition Resistant Class 3 (IR 3) construction requirement for all new construction and additions. This is the lowest level of requirement in the IWUIC, which is intended to address mitigation in areas expected to be exposed to “embers only.” This level of mitigation, however, is not considered adequate to address radiant or convective heat exposure that is typical in community perimeters or “intermix” areas.

Heat transfer exposure and general mitigation guidance can be better demonstrated using the CPAW generated “Local Wildfire Hazard” and “Mitigation Difficulty” maps to support land use planning and regulation within the town. The use of the wildfire hazard assessment for guiding

the application of revised §17.96 will link required mitigation actions to expected wildfire exposure (see Recommendation 1). The town should consider integrating the newly developed wildfire hazard assessment to determine the appropriate application of the revised §17.96 and the IWUIC (2018) through the following process**:**

A. Determine the Local Level Wildfire Hazard summarized ranking in which the proposed development is located to understand the likelihood of the building exposure to high-intensity fire.

B. Determine the Mitigation ranking (0 to 9) of the parcel in which the proposed development is located and the parcel(s) immediately adjacent to it.

C. Use the following table (Table 6) to determine the appropriate IWUIC mitigation standards to apply.

**TABLE 6: TOWN OF PINETOP-LAKESIDE CPAW MITIGATION POTENTIAL/ IWUIC HAZARD CROSSWALK**

| Local Wildfire Hazard | Table 603.2 Minimum Required Defensible Space (site/slope adjustment required)[1] | CPAW Mitigation Difficulty and Slope % category | | | 24.301.181(21) Minimum IR Construction | | |
|---|---|---|---|---|---|---|---|
| | | **<15** | **15≤ to <30** | **>30** | **Non-Conform[2]** | **Conform** | **1.5x Conform** |
| Moderate | 30 ft. | 1, 2, 4 | 1, 2, 3, 5 | 4 | IR 1 | IR 2 | IR 3 |
| High[3] | 50 ft. | 6 | 7 | 6 | IR 1 (N.C.) | IR 2 | IR 2 |
| Very High | 100 ft. | 7 | 8 | 8, 9 | IR 1 (N.C.) | IR 1 | IR 2 |

Table Notes:

(1) “Distances are allowed to be increased due to site-specific analysis based on local conditions and the fire protection plan” (Figure 603.2- 2012 IWUIC)

(2) **Non-conforming** indicates that the minimum slope-adjusted defensible space distances with appropriate mitigation cannot be achieved from the structure to vegetative fuels, or minimum water supply requirements cannot be achieved; as opposed to **conforming** in which the defensible space distances with appropriate mitigation and minimum water supply requirements can be achieved.

(3) High hazard is also used where non-conforming structures are present within 50 ft of the primary structure.

N.C. = requires rated Non-Combustible materials; including tempered glass.

Regarding specific content of the revised chapter, §17.96 *Revised Forest Health and Wildland-Urban Interface Fire Risk Reduction* (draft December 28, 2018), the CPAW team recommends the language and content changes outlined in Table 7, below.

**TABLE 7. SUGGESTED MODIFICATIONS TO PROPOSED §17.96 *FOREST HEALTH AND FIRE PROTECTION***

| Reference | Current Proposed Language | CPAW Suggested Modification | Rationale/Comments |
|---|---|---|---|
| Throughout 17.96 | Use of "proscribed" | Change to "prescribed" | "proscribed" is analogous with "prohibited"; it appears that the intention is to "require" or "prescribe" in this context. |
| 17.96.020 | Refers to the "Town's designated WUI areas" | Add the suggested WUI definition (Recommendation 1) and refer to all of the lands within the town's entire administrative boundary. | The entire town is subject to impacts from wildfire. |
| 17.96.030 | Building IWUIC ignition-resistant construction, water supply and access standards are not included in the "Approach" language. | Include building IWUIC ignition-resistant construction, water supply and access standards in the "Approach" language. | This presents a comprehensive approach to structure ignition zone (SIZ) mitigation. |
| 17.96.060 | This section does not reference the IWUIC year. | Reference the IWUIC 2018; specifically require:<br>• Ignition-resistant construction in accordance with section 501 and referencing CPAW recommendation Table 6<br>• Fire flow water supply in accordance with sections 402 and 404 with a local amendment for a minimum of 1,500 gpm, or alternatives as guided by NFPA 1142<br>• Access in accordance with section 403. | This is the most up-to-date IWUIC. |
| IWUIC (2018)<br>Sec. 504.7, 505 and 506<br>17.96.120 | IR 1 construction does not specifically reference slot-type deck construction; IR 2 and IR 3 construction do not reference appendage and projections (e.g., decks) requirements. | Amend §17.96.120 to require additional mitigation (over and above IWUIC) to appendages and projections specific for slot-type deck surfaces where:<br>• Deck joists must be constructed of non-combustible material, or the horizontal top surface be capped with non-combustible material. | Recent IBHS research indicates that the top surfaces of joists supporting slot-type deck surfaces are highly vulnerable to ignition from embers. |

| TABLE 7. SUGGESTED MODIFICATIONS TO PROPOSED §17.96 *FOREST HEALTH AND FIRE PROTECTION* | | | |
|---|---|---|---|
| Reference | Current Proposed Language | CPAW Suggested Modification | Rationale/Comments |
| IWUIC (2018)<br>Sec. 504, 505 and 506<br>17.96.120 | IR 1, IR 2, or IR 3 construction do not specifically reference wooden fences. | Amend §17.96.120 to require additional mitigation (over and above IWUIC) to require any section of fencing within ≤ 5 feet of the structure to be constructed of non-combustible material. | Recent IBHS research indicates that combustible material (including fences) within five feet of the furthest extent of a structure result in a significant structure vulnerability. |
| IWUIC<br>Sec. 506<br>17.96.120 | IR 3 construction does not include requirements for a vertical non-combustible surface for a minimum of 6 inches above finished and landscaped grade, patios, and decks. | Amend §17.96.120 to require additional mitigation (over and above IWUIC) to require a minimum of 6 inches vertical non-combustible surface above finished and landscaped grade, patios, and decks. | |
| 17.96.080 | Immediate Zone | Add: Maintain bare mineral soil, or install non-combustible surface (e.g., rock, concrete, flagstone, pavers) in this zone and underneath all attachments, projections, and underfloor areas. | Combustible material under attachments and projections (e.g., decks), or open foundations result in a significant structure vulnerability. |
| 17.96.080 (1) | Intermediate Zone-Propane tanks | Add: Clear vegetation to 10 feet away from large stationary propane tanks. | Important to specify a distance to ensure that radiant heat from a wildfire does not cause the propane tank to vent and subsequently create a significant ignition source. |
| 17.96.080 (5) | Intermediate Zone-Tree placement | Replace text with: Deciduous trees only should be planted within 30 feet of the edge of a structure. Tree placement should be planned to ensure the conifer mature canopy is no closer than 30 feet to the edge of the structure. Retained mature conifer canopy must be no closer than 10 feet of the edge of the structure. Remove all juniper species within 30 feet of the edge of the structure. | Juvenile conifer trees can present a significant radiant heat vulnerability to structures if they are within 30 feet. Most individual mature conifer trees can be mitigated appropriately to minimize radiant heat exposure. Juniper species are highly flammable and should not be retained or planted within 30 feet of a structure. |

## *Reconcile Regulatory Conflicts*

There are potential conflicts between achieving wildfire risk reduction goals and meeting the requirements of §17.92 *Landscaping Regulations*. Recent amendments were made by the Town Council to §17.92, however these changes were not made to directly address wildfire hazard. Several provisions may create confusion. For example, §17.92.050.C.2. *Maintenance* states "any plant materials dead, dying or hazardous shall be replaced within thirty days." The term "hazardous" is not clearly defined and may be confused with trees that are considered fire hazards.

Further, there is no reference to §17.96 or requirements to address vegetation or fuel modification for wildfire hazard. For example, the requirement that the Town Forester shall visit a site with the developer to determine which trees should be removed (§17.92.040) should contain references to §17.96 and §16.28.030.D.1. *Submittal Requirements for a Stewardship Plan* and state which provisions prevail in the case of any conflict.

## *Streamline Definitions*

As part of the adoption of a revised §17.96, staff should perform a comprehensive review of other chapters that have wildfire-related terms and definitions. CPAW recommends cross-referencing all definitions to §17.96 to avoid duplication that may inadvertently lead to errors, omissions, or inconsistencies during future revisions. Table 8 provides a crosswalk between §16.04 and §17.96 to highlight several existing inconsistencies that should be addressed as part of any amendments or revisions. Many of the definitions in §16.04 currently only refer to §16.20 *Mountainside Development*. Other sections that use terms in Table 8, such as §17.92 *Landscaping Regulations*, should also align with the current or revised §17.96.

**TABLE 8. CROSSWALK OF EXISTING DEFINITIONS FOR WILDFIRE-RELATED TERMS**

| Term | §16.04 Definitions for Subdivisions | §17.96 Definitions for Fire Protection and Forest Health | Consistency in Definitions | Comments |
|---|---|---|---|---|
| Basal area | X | X | Yes | Defined in Subdivisions but not used in provisions |
| Canopy Closure | - | X | n/a | |
| Defensible space | X | - | n/a | |
| Director | X | X | Yes | |
| Forest Health Committee | - | X | n/a | |
| Fuel modification | X | X | Yes | |
| Ladder fuels | X | X | Yes | |

| TABLE 8. CROSSWALK OF EXISTING DEFINITIONS FOR WILDFIRE-RELATED TERMS | | | | |
|---|---|---|---|---|
| Term | §16.04 Definitions for Subdivisions | §17.96 Definitions for Fire Protection and Forest Health | Consistency in Definitions | Comments |
| Non-fire-resistant vegetation | X | X | Partial | |
| Remove or Removal | - | X | n/a | Term is used in both Titles, but only defined in 17.96 |
| Responsible Person | - | X | n/a | |
| Survivable Space | - | X | n/a | |
| Trees | - | X | n/a | Term is used in both Titles |
| Urban-wildland interface | X | X | Yes | Defined in Subdivisions as "urban-wildlife interface" |
| X = term is defined<br>- = term is not defined<br>n/a = not applicable | | | | |

Several of these terms may no longer be relevant as part of the adoption of a revised §17.96, such as "survivable space." In addition, terms should be reviewed for accuracy and relevance, such as "wildland-urban interface." This definition should align with Recommendation 1. Finally, many **new terms may need to be added**, such as: fuel loading, structure ignition zone, fire behavior, fire intensity, fire severity, wildfire hazard, and wildfire risk.

### *Promote Coordination with Homeowner Associations*

Covenants, conditions, restrictions (CCRs), architectural standards and guidelines, and similar bylaws for HOAs are legal instruments that are not administered or enforced by the town. However, the Pinetop Fire District has indicated that several HOAs are interested in ensuring that their local bylaws aligned with best practices for wildfire risk reduction. The Pinetop Fire District has offered to review and provide feedback on these local bylaws. This process provides an opportunity for the fire district to help align its recommendations to HOAs with any future changes to the town's wildfire hazard regulations, including new structural requirements. This promotes a smooth transition to new regulations and can increase buy-in from local residents.

## Additional Resources

Resources for wildfire definitions are available at no charge from several different sources, including:

- ICC International Wildland-Urban Interface Code (2018)
- NFPA Standards: 1141 (2017), 1142 (2017), 1144 (2018)
- NWCG Glossary of Terms: www.nwcg.gov/glossary/a-z
- CPAW has also provided a list of definitions in Appendix B

# RECOMMENDATION 4

## *Formalize an Implementation Process to Address Capacity Challenges*

Collaborate and coordinate with the Pinetop Fire District and Timber Mesa Fire and Medical District to develop a formal process for roles and responsibilities in engaging in parcel-level risk assessments, technical input, and regulation enforcement.

## *Overview*

Currently, the town, Pinetop Fire District, and Timber Mesa Fire and Medical District are providing public outreach and property hazard assessments to help residents reduce local wildfire risk. These organizations also benefit from a collaborative working relationship that has been developed over time. These working relationships to address local outreach needs, such as informal activities between the Pinetop-Lakeside Community Development Director and Pinetop Fire Chief, have not been formalized and are instead based on the initiative and motivated personalities of the individuals currently in their respective positions.

The Community Development Director is the sole individual responsible for overseeing and conducting parcel-level wildfire assessments, as well as site inspections, development application review, plan review, code enforcement, and the numerous other duties required of land use planning and building code enforcement. The Pinetop Fire District also engages in parcel-level wildfire assessments, public outreach, fuel treatment planning, prescribed fire, and other wildfire mitigation activities within its district, including town jurisdictional boundaries. The Fire Chief has a staff to support its mitigation activities, and has expressed a willingness to formalize and expand its current relationship with the town to coordinate mitigation, including parcel-level assessments, application and plan review, and enforcement.

Currently, there are no formal agreements between the town and each fire district to officially define their individual roles in wildfire mitigation or compel these organizations to work together. While the working relationship is very positive and productive, formalizing a relationship can help clarify roles, increase efficiencies, and promote a more coordinated approach to mitigation and outreach with residents.

## *Implementation Guidance*

The CPAW team recommends that the town and fire districts work together in formalizing an agreement that defines the roles and relationship of each of the organizations related to wildfire mitigation.

## *Develop a Memorandum of Understanding*

As each organization is governed and funded separately, CPAW recommends the development of a memorandum of understanding (MOU) that outlines each organization's roles and responsibilities related to the following tasks:

- Public, resident, and development community outreach and education
- Development application review
- Plan review
- Parcel-level wildfire hazard assessments
- Wildfire compliance inspections
- §17.96 Forest Health and Wildland-Urban Interface Fire Risk Reduction Code Enforcement.

The MOU can address the outreach and education, development application review process, plan review process, and parcel-level wildfire hazard assessment by establishing a protocol for when and how each of these agencies performs specific duties.

## *Formalize Fire Districts' Authority*

The town currently has limited capacity to administer and enforce a more robust set of wildfire regulations as recommended in this report. Providing the fire districts with the authority to administer and enforce regulations would help alleviate this challenge. Service agreements that require enforcement of the municipal code(s) should ensure that this authority is formally granted. For example, language may have to be adjusted in §15.04.160 (Building Code Enforcement) and §17.96 to provide authority to the fire district to enforce compliance of the regulations. Additional administrative roles formalized through a service agreement may also be appropriate to codify.

# CONCLUSION AND NEXT STEPS

Planning for wildfires is a dynamic process. Pinetop-Lakeside has multiple upcoming opportunities to update plans, revise or adopt new ordinances, and re-evaluate their applicability across the town. While some of these local opportunities can be undertaken immediately, others may take more time to fully develop and implement.

This report is intended to serve as a roadmap for the Town of Pinetop-Lakeside and its partner fire districts in guiding a wildfire risk reduction process through appropriate land use planning strategies based on the following recommendations:

1. Define the Wildland-Urban Interface (WUI) and Implement a WUI Risk Assessment Program.
2. Develop coordinated approach to guide wildfire and land use planning decisions.
3. Update and Align Regulations to Decrease Susceptibility of Development to Wildfire.
4. Formalize an Implementation Process to Address Capacity Challenges.

CPAW recommendations were developed at a specific point in time, and it's important to recognize that as local and state conditions progress, so too may the implementation details of each recommendation. Moreover, these recommendations are purposefully ambitious in nature, and it's important to acknowledge that change does not occur overnight.

However, pressing issues of increasing wildfire risk and safety, changes in insurance coverage, the need to maintain healthy landscapes, and other local factors may necessitate swift action. This occurs against a backdrop of fire history that has affected the entire surrounding county along with the high potential for a catastrophic fire to occur in Pinetop-Lakeside. With a previous track record of collaboration, Pinetop-Lakeside and the Pinetop Fire District are well-positioned to conduct forward-thinking wildfire planning activities in a coordinated and effective manner.

# APPENDIX A: HAZARD ASSESSMENT

**Eva Karau**, USDA Forest Service, Rocky Mountain Research Station, Fire Modeling Institute

## 1. Overview

The U.S. Forest Service's Rocky Mountain Research Station (RMRS) collaborated with the group of planners and analysts leading the Community Planning Assistance for Wildfire (CPAW) effort for Pinetop-Lakeside, AZ, to provide spatial wildfire hazard assessments to support CPAW recommendations for wildfire planning codes and regulations.

In this analysis we used current wildfire hazard and risk science to inform our fire behavior modeling, data analysis, and mapping methods. We provide two evaluations of wildfire hazard—one intended as a broad-scale decision support tool, and one that incorporates customized fire behavior modeling informed by wildfire management experts from the community of Pinetop-Lakeside. Ancillary products include a community-scale wildland-urban interface map, and a spatial index that characterizes wildfire mitigation difficulty. This report details those methods and describes all map products, beginning with a brief background of wildfire hazard and risk terminology.

### *Background – Wildfire Hazard and Risk*

How likely is it that a place will burn? How hot is it likely to burn? And, at different fire intensity levels, what would the effects be on something we care about? These questions describe the three fundamental components needed to assess wildfire risk: likelihood, intensity, and effects (sometimes termed "susceptibility"). Scott et al. (2013) conceptualize this as the wildfire risk triangle (Figure A1). If we can gather quantitative information on all three legs of this triangle, then we can quantify the risk to the thing we care about.


*Figure A1. Wildfire Risk Triangle*

For the purposes of this analysis, we focus on two sides of the wildfire risk triangle: *likelihood* and *intensity*. Together, those two pieces of information represent wildfire *hazard*. To map likelihood and intensity across a landscape, we use outputs from two different, but related, fire behavior models. The fire modeling application most often used for large-scale landscapes is called the Large Fire Simulator, or FSim (Finney et al. 2011). FSim draws upon weather and fire occurrence data from recent decades to generate statistically possible weather for 10,000 or more simulated fire seasons. Within each of these simulated years, ignitions are placed on the landscape informed by observed fire occurrence patterns, fires are spread using spatial data for fuels, topography, and simulated weather, and a set of many thousand possible fire perimeters is generated.

Whereas FSim provides a synoptic, "landscape scale" assessment of fire behavior and estimates annualized probabilities of the occurrence and intensity of large fires, another model, FlamMap (Finney 2006), computes a localized and specialized view of potential fire behavior under a specific set of environmental conditions. If a user parameterizes FlamMap for environmental conditions representative of when problem wildfires have occurred, fire behavior outputs represent a "problem fire" scenario at a "local scale." Including characterizations of wildfire hazard at both landscape and local scales affords a two-pronged assessment of potential fire behavior; we see what kind of fire behavior we could experience under a range of conditions that have occurred in recent history, and we also get a picture of fire behavior that could occur under extreme conditions.

## 2. Wildfire Hazard Characterization for Pinetop-Lakeside

Wildfire hazard is a measure of the likelihood that an area will burn and the likely intensity of the burn, given that a fire occurs. For Pinetop-Lakeside, we present two evaluations of wildfire hazard: landscape level and local level.

## Landscape-Level Wildfire Hazard – Modeling and Maps

For the purpose of evaluating wildfire likelihood and intensity for the landscape-level analysis, we used FSim modeling work completed for the Region 3 of the U.S. Forest Service (Southwestern Wildfire Risk Assessment). The Region 3 assessment was intended to inform a Forest Service strategic hazardous fuel mitigations investment strategy, and the modeled data reflect that objective. Though CPAW objectives do not align directly with those of R3, we chose to incorporate the FSim data, as it is readily available and reliably reflects broad-scale fire behavior patterns in the region. At the scale of these data, only large disturbances will make noticeable changes in landscape burn probability patterns.

Pyrologix LLC conducted the FSim simulations using spatial input data that reflects fuel conditions as of 2012. For our landscape wildfire hazard assessment, we acquired the 180m-resolution FSim modeling outputs, extracted for a rectangular spatial extent surrounding Navajo County.

### Landscape-Level Summary Zone

To summarize the spatial metrics of likelihood, intensity, and hazard for the landscape-level analysis, we chose sub-watersheds from the national USGS Watershed Boundary Dataset (https://nhd.usgs.gov/wbd.html) as the polygon summary unit. Sub-watersheds are designated by 12-digit hydrologic unit codes, and are often referred to as “HUC12” watersheds. The HUC12 summary unit is commonly used to summarize landscape attributes; is devoid of administrative boundaries; and is based on the areal extent of surface water draining to a point. Using a summary unit is important because an individual spot on the landscape will have an individual value, but that one spot is inevitably impacted by the values of its neighbors. Summarizing the raster FSim outputs and the derived hazard index to these polygons allows for broad-scale patterns to emerge that may not be immediately visible in the raw pixel datasets.

### Landscape Wildfire Likelihood

Landscape Fire Likelihood, or burn probability (BP), is the FSim-modeled annual likelihood that a wildfire will burn a given point or area. It is calculated as the number of times a pixel burns during a simulation, divided by the total number of iterations. The landscape-level burn probability map represents the average of all 180-m pixel values within each sub-watershed, classified into four levels, with the chance of a wildfire occurring during any given fire season increasing with each level (Figure A2).

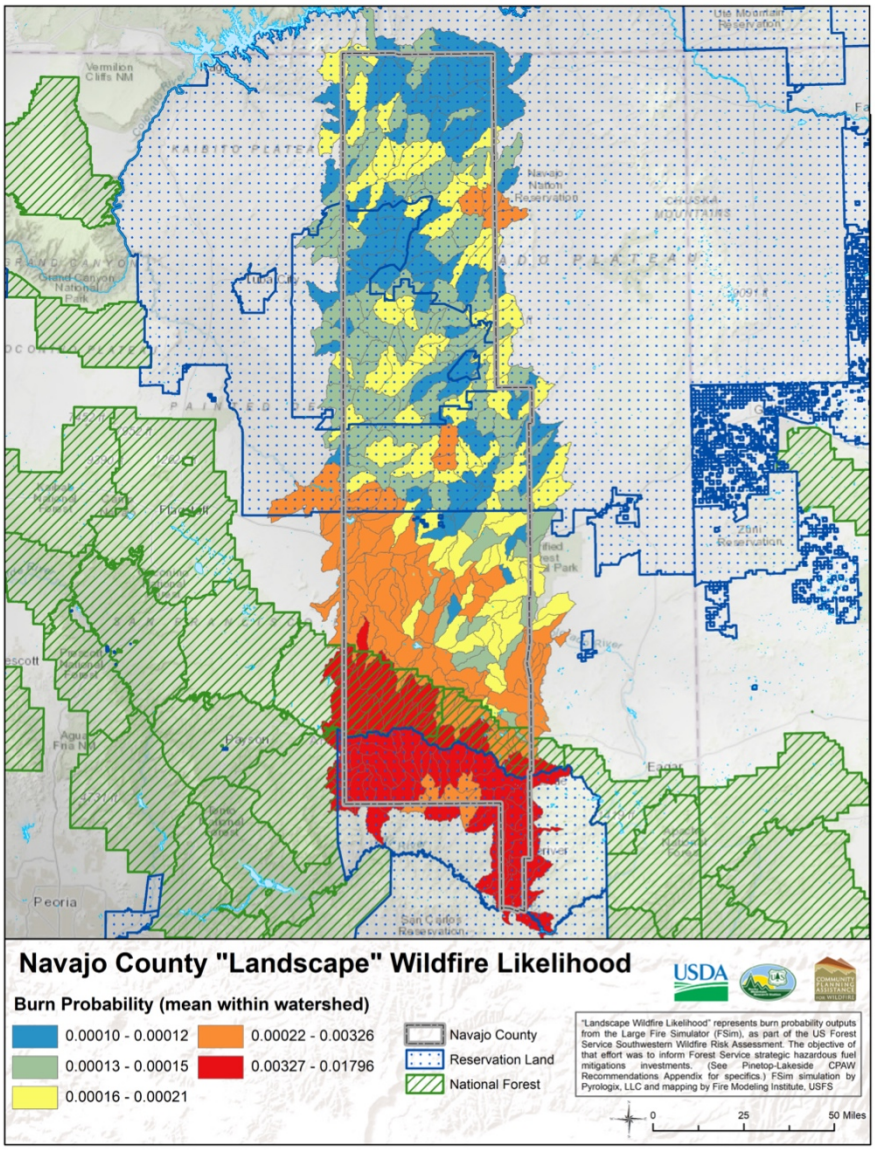


*Figure A2. Navajo County burn probability map*

## *Landscape Wildfire Intensity*

FSim can apportion burn probability into fire intensity levels (FILs) and produce estimates of the probability of a certain flame length level (FLP), given a fire burns a pixel. Following Scott et al. (2013), Conditional flame length (CFL) is the sum of all flame length probabilities that FSim simulated for each 180-m pixel, weighted by a flame length category midpoint:

$$CFL = \sum_{i=1}^{n} FLP_i * FL_i$$

where $FLP_i$ is the conditional probability of FIL$_i$ and $FL_i$ is the flame length that characterizes FIL$_i$. We summarized the pixel-level CFL values within sub-watersheds by calculating the average CFL for each sub-watershed polygon. Map classes represent ranges of conditional flame length (in feet) (Figure A3).

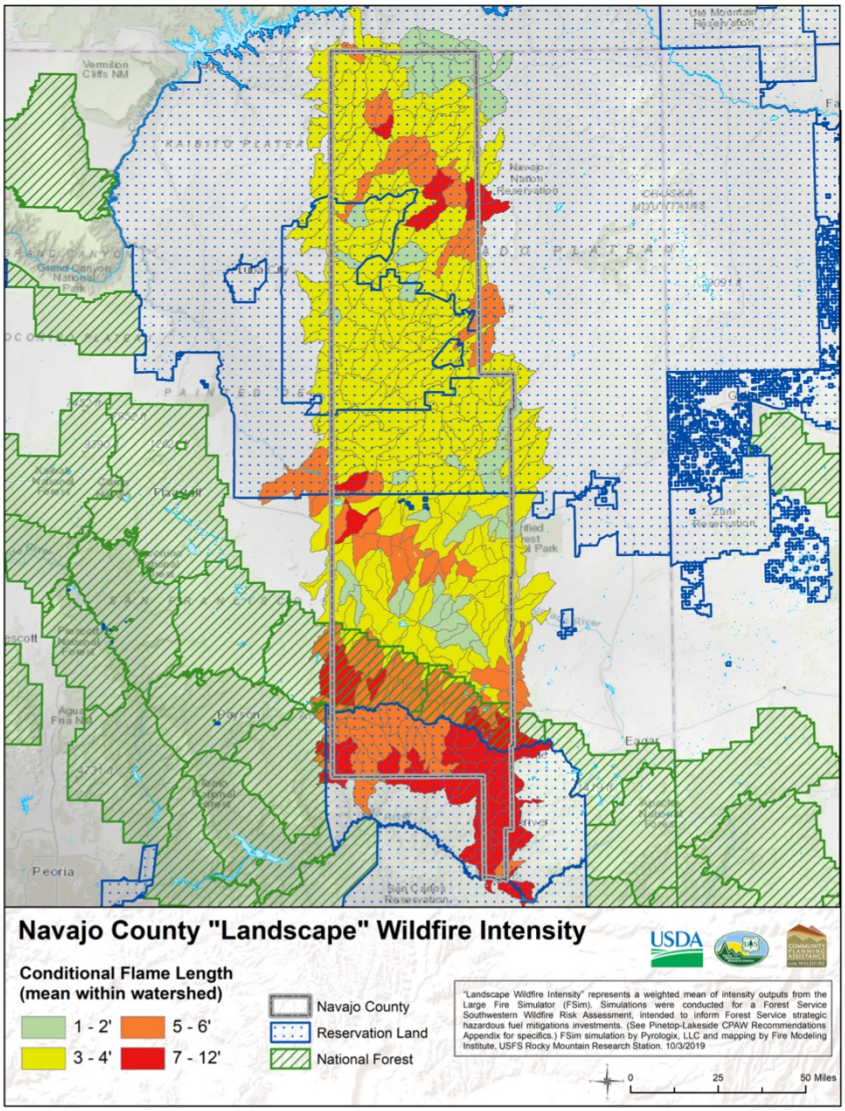


*Figure A3. Navajo County conditional flame length map*

## Landscape Wildfire Hazard

Wildfire hazard is an integration of likelihood and intensity, quantified as the product of burn probability (BP) and conditional flame length (CFL). We calculated hazard at the pixel scale and then summarized values to the HUC12 sub-watershed scale by calculating the mean hazard in each sub-watershed polygon. We then classified the values into three classes (Moderate, High, and Very High) based on quantiles in the distribution of values in the analysis area (all sub-watersheds that intersect with the Navajo County boundary) (Figure A4). The actual numeric values of hazard are less directly interpretable than BP or CFL. Instead, they provide a relative depiction of hazard across a landscape.

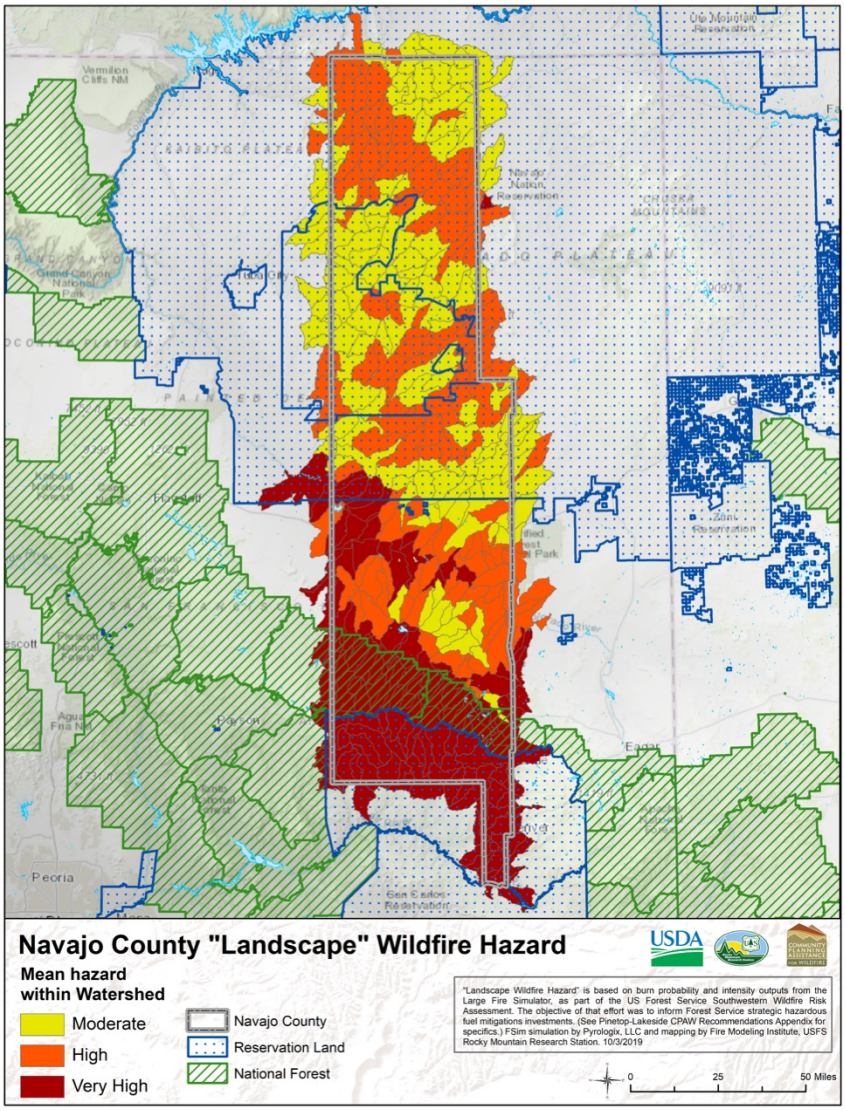


*Figure 12*

# *Local Level Wildfire Hazard – Modeling and Maps*

## *FlamMap Model Initialization*

For the local-level hazard assessment, we used FlamMap 6.0 to model wildfire behavior within a ~3.5-million-acre simulation extent surrounding the community of Pinetop-Lakeside (Figure A5). We initialized the Minimum Travel Time (MTT) module within FlamMap with ~17,000 fire ignitions, using:

- WindNinja (embedded in FlamMap) to generate 60-m resolution wind vectors,
- a maximum simulation time of 480 minutes per ignition (equating to an 8-hr burn period),
- a calculation resolution of 60-meters,
- an interval for Minimum Travel Paths of 500-meters, and
- a 0.02 spotting probability.

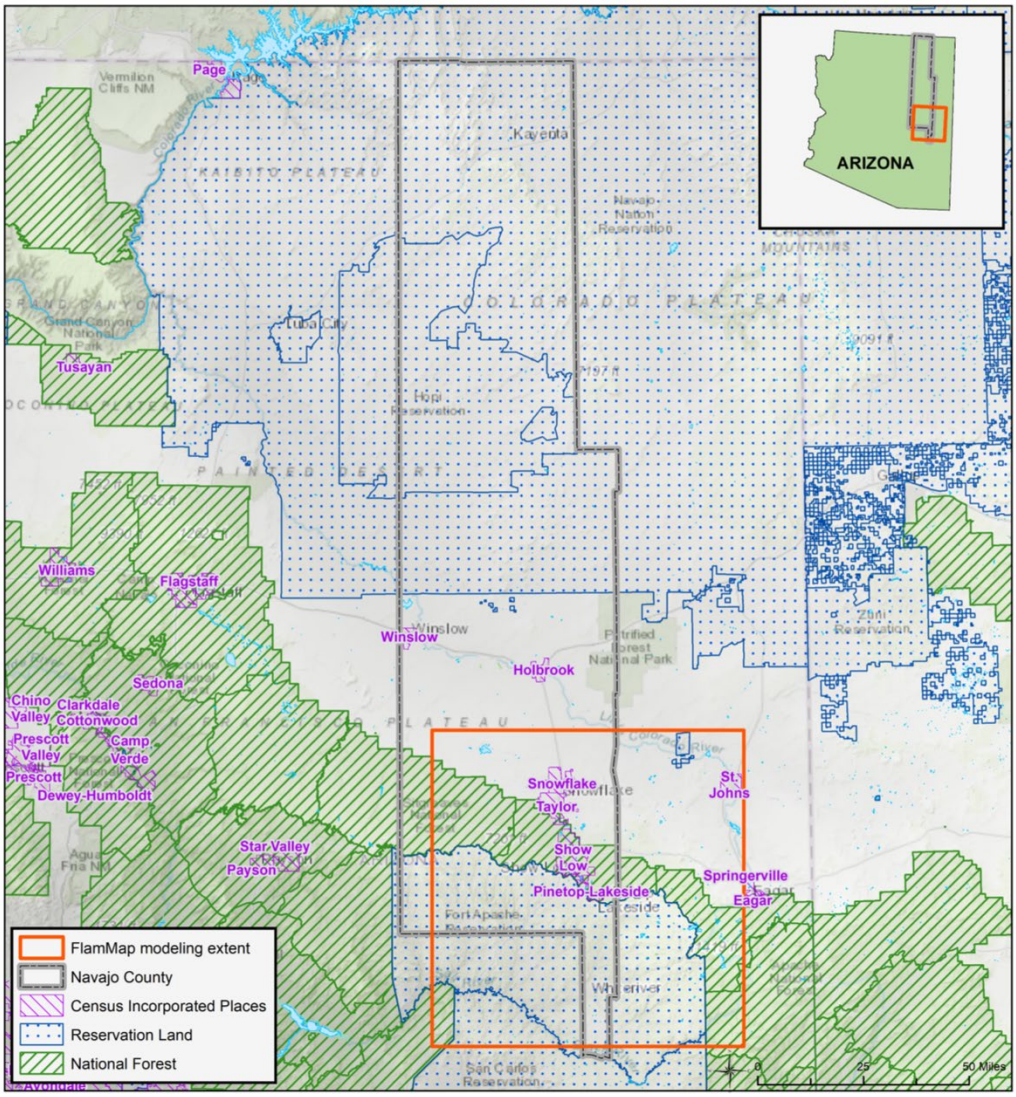


*Figure A5. Pinetop- Lakeside local level hazard assessment modeling extent*

We executed the simulation twice using the same spatial fuel and topography input layers, but varying the weather and fuel moisture conditions depending on elevation and fuel type. We then merged the outputs into a final set of raster and vector maps to characterize “problem fire” hazard. We used the flame length probability output file to generate burn probability, conditional flame length, and hazard metrics and spatial layers.

**Wind, Weather and Fuel Moisture Parameters**

FlamMap needs information regarding fuel moisture, wind, and weather to parameterize a simulation. Based on information from subject matter experts (SMEs) gleaned during our site visits, as well as evaluation of records from weather stations the Pinetop-Lakeside vicinity, we chose to base our weather and wind-related modeling inputs on records from five Remote Automated Weather Stations (RAWS): Lakeside, Heber, Greer, Hopi, and Navajo Monument (Figure A6).

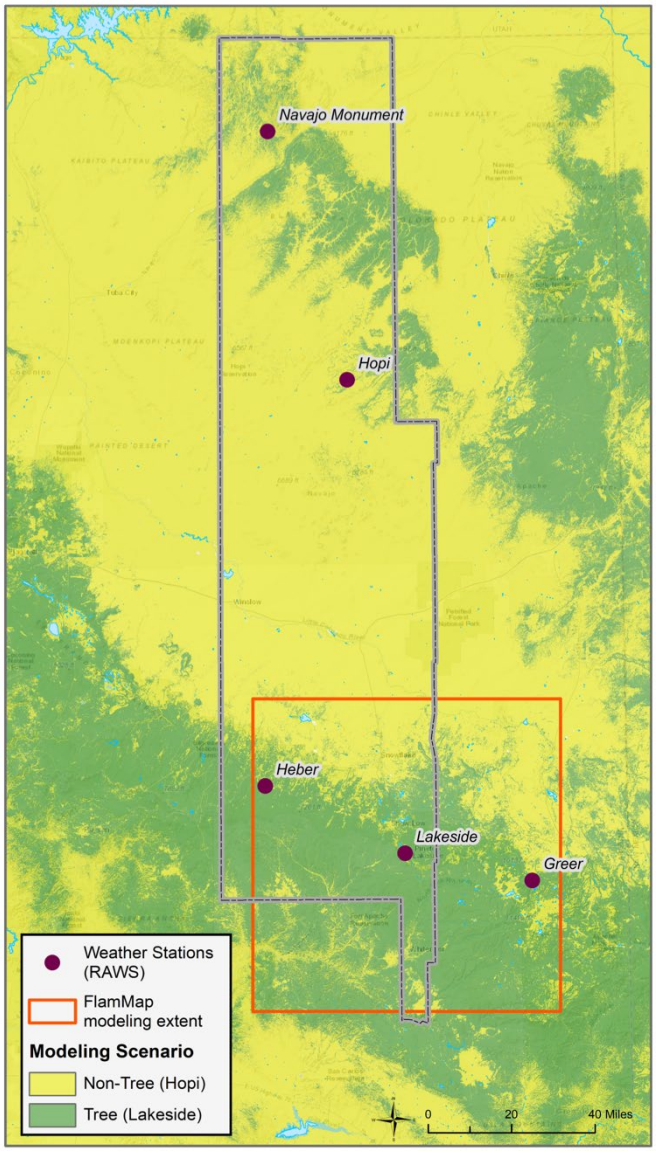


*Figure A6. RAWS weather station locations and scenarios used for the Pinetop-Lakeside FlamMap modeling*

Since the area surrounding Pinetop-Lakeside includes a mix of high- and low-elevation fuel types exposed to a range of wind and weather conditions, we chose to run two simulation scenarios to account for some of the climate and fuels variation. We based the scenarios on life form (forested vs. non-forested) and elevation: the “Tree” scenario includes all areas that are either forested (as mapped by a LANDFIRE Existing Vegetation raster layer) or are greater than 1900 meters in elevation, and the “Non-Tree” scenario is everywhere else (non-forested and with elevation less than 1900-m) (Figure A6). For fuel moisture parameterization, we chose the Lakeside RAWS to represent the “Tree” scenario and Hopi RAWS to represent the “Non-Tree” scenario.

Our FlamMap modeling objective for the local wildfire hazard assessment was to represent a “problem fire” scenario. To choose a time period for fuel moisture estimates and the weather records used for fuel moisture conditioning, we evaluated trends in the Energy Release Component (ERC—a fire danger metric with higher values indicating seasonal dryness trends in

large fuels, especially in timbered areas) to find conditions that would represent potential for "problem" fire activity. For the "Tree" scenario, we selected June 13-18, 2002, as the fuel conditioning period, as those are the days preceding the Rodeo-Chediski fire with record-setting ERCs (Figure A7). For the "Non-Tree" scenario, we selected June 19-24, 2006, as ERCs exceeded the 97th percentile during this period (Figure A8). We selected initial fuel moisture settings for both modeling scenarios and all fuel categories using relationships established in FireFamilyPlus (Bradshaw 2018) (Table A1).

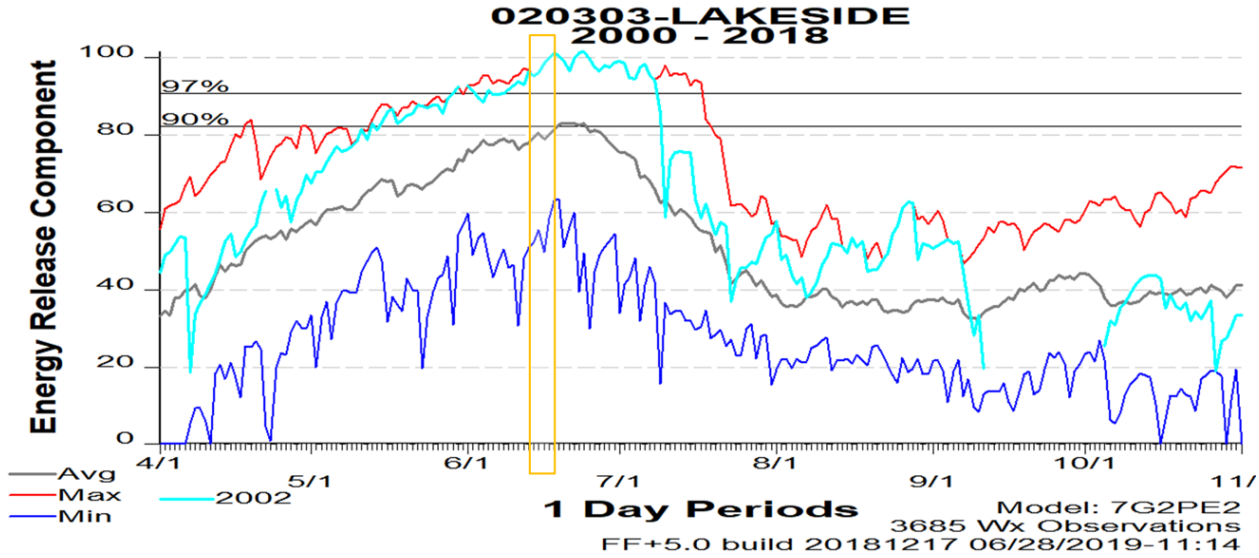


*Figure 13*

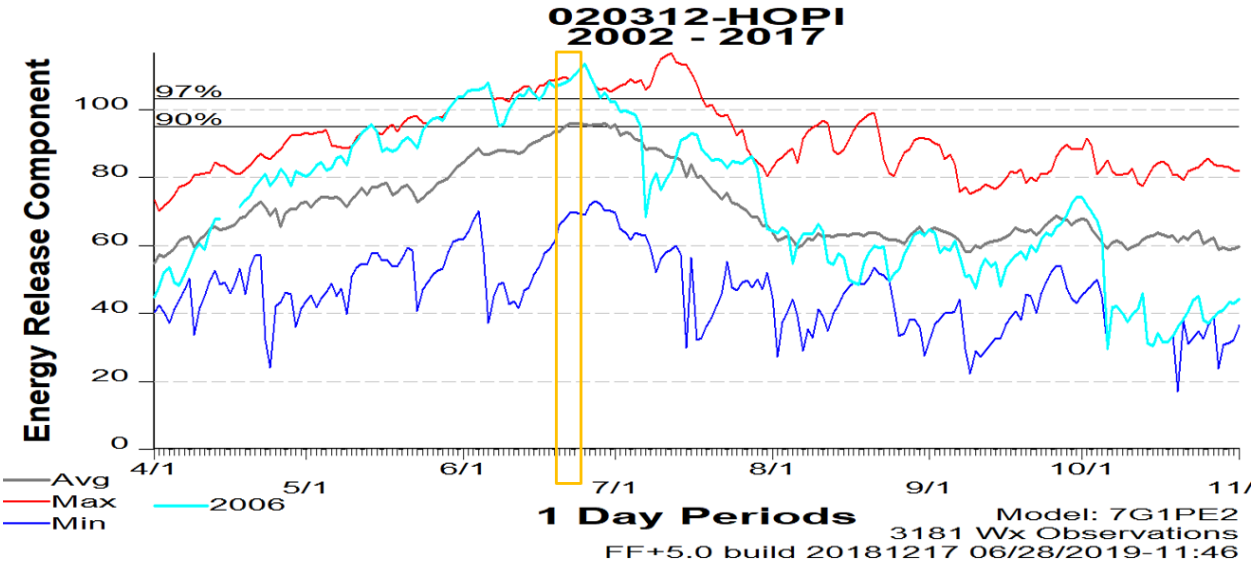


*Figure A8. 14*

Table A1. Initial fuel moisture values for FlamMap modeling (%)

| | RAWS/Modeling Scenario | |
|---|---|---|
| **Fuel Category** | **Lakeside/ "Tree"** | **Hopi / "Non-Tree"** |
| 1-hr | 2 | 2 |
| 10-hr | 2 | 2 |
| 100-hr | 3 | 3 |
| Herb | 80 | 50 |
| Woody | 100 | 70 |

Local SMEs reported that the Pinetop-Lakeside winds are predominantly from the southwest. We analyzed wind roses for 10-minute average and gusts for seasons we assumed to represent pre-monsoon (01APR-30JUL) and monsoon (01JUL-15OCT) conditions for Lakeside, Heber, Hopi, and Navajo Monument RAWS. We found that SSW winds were predominant for all combinations, with the exception of the Navajo Monument RAWS (which recorded predominantly WSW winds and Hopi RAWS) with a SW predominant direction (Table A2). Considering SME input and the wind rose information, we selected SSW as the wind direction with which to parameterize the FlamMap modeling for both “Tree” and “Non-Tree” scenarios.

Table A2. Predominant wind directions recorded at weather stations in the Pinetop-Lakeside vicinity

| | | 10 Minute Average | | Gusts | |
|---|---|---|---|---|---|
| **Modeling Scenario** | **RAWS** | **01 APR – 30 JUN** | **01JUL – 15OCT** | **01 APR – 30 JUN** | **01JUL – 15OCT** |
| "Tree" | Lakeside | SSW | SSW | SSW | SSW |
| | Heber | SSW | SSW | SSW | SSW |
| "Non-Tree" | Hopi | SW | SW | SW | SSW |
| | Navajo Monument | WSW | WSW | WSW | WSW |

We selected different initialization wind speeds for the “Tree” and “Non-Tree” scenarios because RAWS in the “Tree” scenario areas recorded speeds that were generally slower than those at stations in the “Non-Tree” areas (Table A3). We selected the 97th percentile wind speeds recorded in the pre-monsoon season: 18 mph and 26 mph for “Tree” and “Non-Tree” scenarios, respectively.

Table A3. 97th percentile wind speeds recorded at weather stations in the Pinetop-Lakeside vicinity (mph)

| Modeling Scenario | RAWS | 01APR -30JUN | 01JUL - 15OCT |
|---|---|---|---|
| "Tree" | Lakeside | 17 | 13 |
| | Greer | 18 | 13 |
| | Heber | 15 | 13 |
| "Non-Tree" | Hopi | 26 | 20 |
| | Navajo Monument | 15 | 13 |

**Spatial input file layers**

FSim and FlamMap fire modeling systems require a set of raster geospatial layers that characterize landscape topography (elevation, slope, and aspect) and fuels attributes (fuel model, canopy cover, canopy height, crown base height, and crown bulk density). A local-level analysis allows for fine-scale modifications of the landscape file (surface and canopy fuel attributes) to represent the current landscape conditions with more accuracy than is possible in a broader-scale analysis. We acquired 30-meter resolution fuels and topography spatial data from LANDFIRE Remap (LF 2.0.0) and we modified those layers to reflect SME input about local conditions.

During review of draft simulation results at the July 2019 stakeholder meeting, SMEs were concerned that model results underestimated wildfire hazard in urban areas. Native LANDFIRE surface and canopy fuels data characterized much of the urban area as “Developed” and therefore coded those pixels with a “non-burnable” surface fuel model with no canopy fuels. Because so much of the area in Pinetop-Lakeside neighborhoods is forested with ponderosa pine, for the final round of modeling we made the following changes to spatial input layers, with the intention of better representing model inputs and consequent fire behavior:

- In areas within 1 km of structures (as represented by Microsoft Building Footprints), with pixels with surface fuel model coded as 91 (Developed, Non-burnable), TL3, TL5, or TL6:
    - Surface fuel model was changed to a Ponderosa Pine Timber Litter fuel model (TL8; Scott and Burgan 2005). This change allowed FlamMap the opportunity to simulate surface and/or crown fire, given conducive wind and fuel conditions. Because much of this area is developed, we acknowledge that many of the pixels impacted by this change will represent structures, which will not necessarily exhibit fire behavior akin

to that represented in a TL8 fuel model. We proceeded with the modification because there currently exists no standard fuel model to represent structures, yet we know that fire could travel through these areas. We considered this method an acceptable approach to approximate fire behavior, given available data and modeling limitations.

- In areas within 1 km of structures (as represented by Microsoft Building Footprints), with pixels with surface fuel model coded as 91 (Developed, Non-burnable):
    - Pixel values for the input rasters representing canopy fuels characteristics (canopy cover, canopy base height, canopy height, canopy bulk density) were assigned the value of the raster cell of the nearest neighbor in that canopy raster category, using the ArcGIS Nibble tool (ESRI 2017). See Figure A9 (a. and b.) for an example of the "before and after" representation for the canopy cover raster.
- In areas modified as described above, we delineated major roads with surface fuel model as 91 (Non-burnable) canopy fuel grids as 0 (no canopy present). We included this step to render roads as an impediment to fire behavior, as in native LANDFIRE data.

With the modifications to spatial input layers described above, modeled wildfire hazard in urban/suburban Pinetop-Lakeside neighborhoods increased in extent and magnitude (Figure A9 c. and d.)

LANDFIRE Remap (LF 2.0.0) represents circa 2016 ground conditions and accounts for disturbances that occurred prior to satellite image collection. To render the LF 2.0.0 landscape current to 2019 conditions, we did our best to incorporate fuel disturbances occurring after 2016 into our FlamMap input landscape.

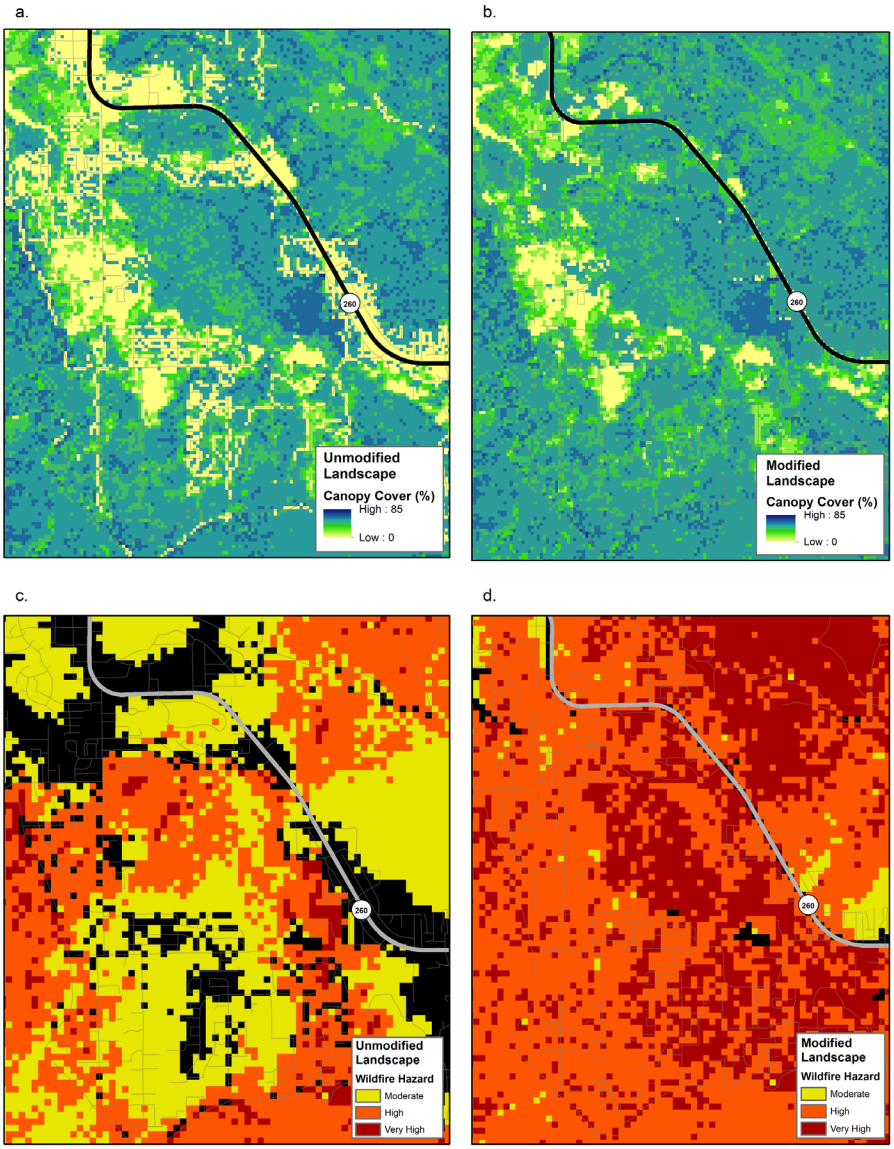


*Figure A9. Modified modelled wildfire behavior for urban/suburban neighborhoods.*

Because we used the LANDFIRE Total Fuel Change Tool (LFTFC 2019) to implement the fuel modifications, we created a raster file to spatially delineate fuel disturbances following the framework used by LANDFIRE, whereby each disturbance is classified by type (fire, mechanical add, mechanical remove, wind throw, insects-disease, exotics), severity (low, moderate, or high), and time since disturbance (1 year, 2-5 years, or 6-10 years). We delineated disturbances as follows:

- Wildfires – We obtained burn severity data from Rapid Assessment of Vegetation Condition (RAVG; https://fsapps.nwcg.gov/ravg/) for fires that occurred in 2017 and 2018. We used the RAVG Canopy Cover Percent Change layer to assign fire severity levels, pixels with canopy loss:
    - less than 25% were assigned low severity,
    - between 26-75% were assigned moderate severity, and

- greater than 75% were assigned high severity.

For 2017 and 2018 fires not included in the RAVG database, we gathered fire perimeters from the Wildfire Decision Support System (WFDSS; https://wfdss.usgs.gov/wfdss.) Because we did not have specific information about fire severity for these fires, we assigned all pixels within the perimeter to moderate severity.

- Mechanical treatments and prescribed fires – We obtained polygon data delineating hazardous fuels and timber activities from the U.S. Forest Service Forest Activity Tracking System and the National Fire Plan Operations and Reporting System to account for fuels treatments that impacted U.S. Forest Service and U.S. Department of Interior lands, respectively. We included treatments completed in 2017 and 2018 and coded them with disturbance type and severity level for the LFTFC disturbance file, guided by conversations with a local USFS Fire Management Officer (Table A4.)

Table A4. Mechanical treatments and prescribed fires incorporated into LFTFC disturbance file

| Disturbance Type | Description | Severity |
|---|---|---|
| **Fire** | Burning of Piled Material | high |
| | Jackpot Burning - Scattered concentrations | moderate |
| | Planned Treatment Burned in Wildfire | moderate |
| | Wildfire - Natural Ignition | moderate |
| | Wildlife Habitat Prescribed fire | moderate |
| **Mechanical Add** | Chipping of Fuels/Mastication | low |
| | Piling of Fuels, Hand or Machine | low |
| | Rearrangement of Fuels | low |
| **Mechanical Remove** | Broadcast Burning | high |
| | Commercial Thin | high |
| | Compacting/Crushing of Fuels | moderate |
| | Group Selection Cut | moderate |
| | Precommercial Thin | high |
| | Pruning to Raise Canopy Height and Discourage Crown Fire | moderate |
| | Range Control Vegetation | low |

| | | |
|---|---|---|
| | Range Cover Manipulation | low |
| | Recreation Removal of hazard trees and snags | low |
| | Salvage Cut (intermediate treatment, not regeneration) | high |
| | Shelterwood Establishment Cut | moderate |
| | Single-tree Selection Cut | low |
| | Special Products Removal | low |
| | Thinning for Hazardous Fuels Reduction | high |
| | Tree Release and Weed | low |
| | Wildlife Habitat Mechanical treatment | moderate |

We added the 2017 and 2018 disturbance information (coded as described above) to the LANDFIRE Remap FDist (Fuel Disturbance) file and implemented LFTFC to generate the fuels layers necessary for FlamMap modeling.

**Ignitions**

Using the MTT module, FlamMap generates fire perimeters from a set of ignition points. We parameterized Pinetop-Lakeside FlamMap simulations with a fire list file that includes random start locations, along with locations influenced by local fire occurrence. First, we created an ignition density grid based on locations of wildfires that burned between 1992 and 2017 (Short 2018) within the modeling extent. We then generated 2,901 ignition points using a method that weights selection based on the density grid, so that areas with historically higher ignition density values were more likely to produce points. Next, we generated 14,606 completely random points and finally combined all points (17,507) to comprise the FlamMap fire list file.

## *Local-Level Summary Zone*

To summarize the spatial metrics of likelihood, intensity, and hazard for the local-level analysis, we used catchments from the USEPA and USGS National Hydrography Dataset Plus V2 (https://www.epa.gov/waterdata/nhdplus-national-hydrography-dataset-plus). Catchments are local-level drainage areas and typically subdivide HUC12 watersheds into smaller polygon units. Using a summary unit is important, because an individual spot on the landscape will have an individual value, but that one spot is inevitably impacted by the values of its neighbors; summarizing the raster FlamMap outputs and the derived hazard index to these polygons allows for broad-scale patterns to emerge that may not be immediately visible in the raw pixel datasets.

## *Local Wildfire Likelihood*

Local Fire Likelihood, or burn probability (BP), is the FlamMap-modeled likelihood that a wildfire will burn a given point or area. It is calculated as the number of times a pixel burns during a simulation, divided by the total number of iterations. Because we parameterized FlamMap with a "problem fire" scenario, BP from our FlamMap run represents those specific conditions. The local level burn probability map represents the average of all 60-m pixel values within each catchment, classified into four categories (based on quantiles), with the chance of a wildfire occurring during any given fire season increasing with each class level (Figure A10).

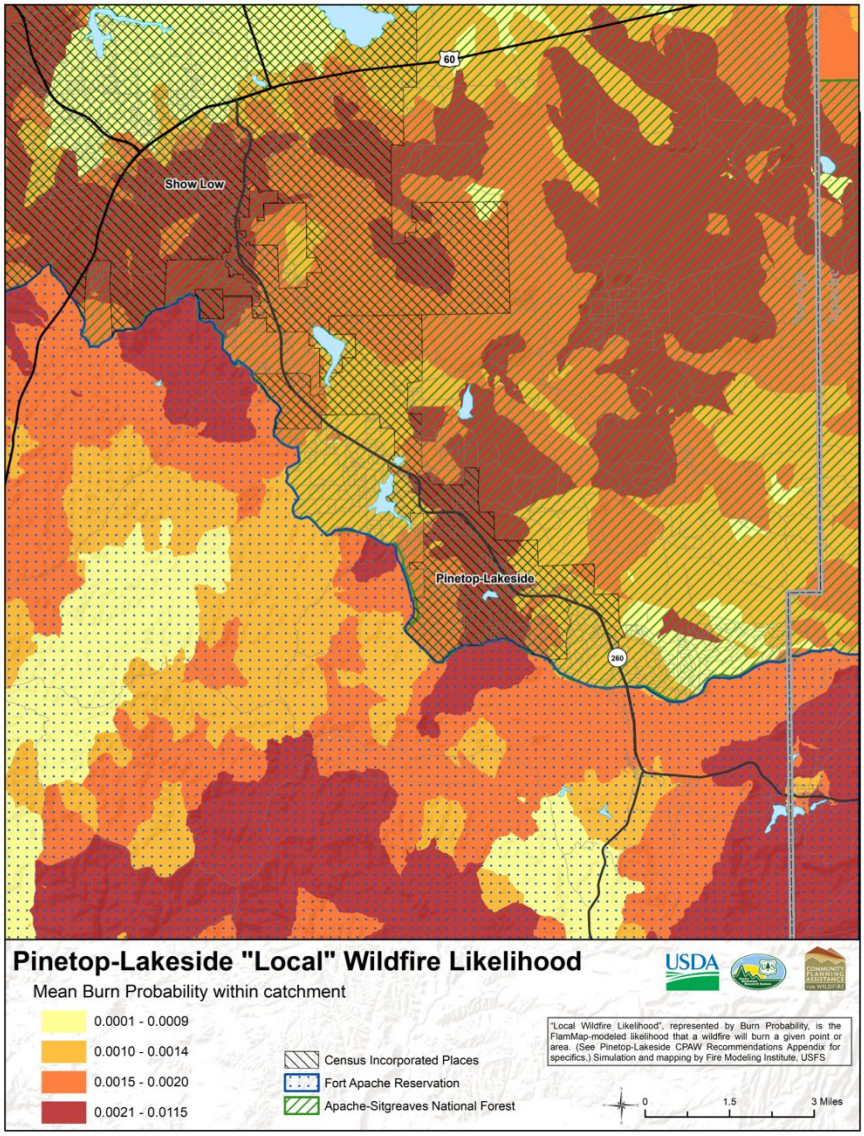


*Figure A10. Pinetop-Lakeside mean burn probability likelihood*

## *Local Wildfire Intensity*

Like FSim, FlamMap can apportion burn probability into wildfire intensity levels and produce estimates of the probability of a certain flame length level, given a fire burns a pixel. Local Conditional Flame Length (CFL) is the average of all flame length probabilities that FlamMap simulated for each 60-m pixel, calculated as in the Conditional Flame-Length equation. We summarized the pixel-level CFL values within catchments by calculating the average CFL for each catchment polygon. Map classes represent ranges of conditional flame length (in feet) (Figure A11).

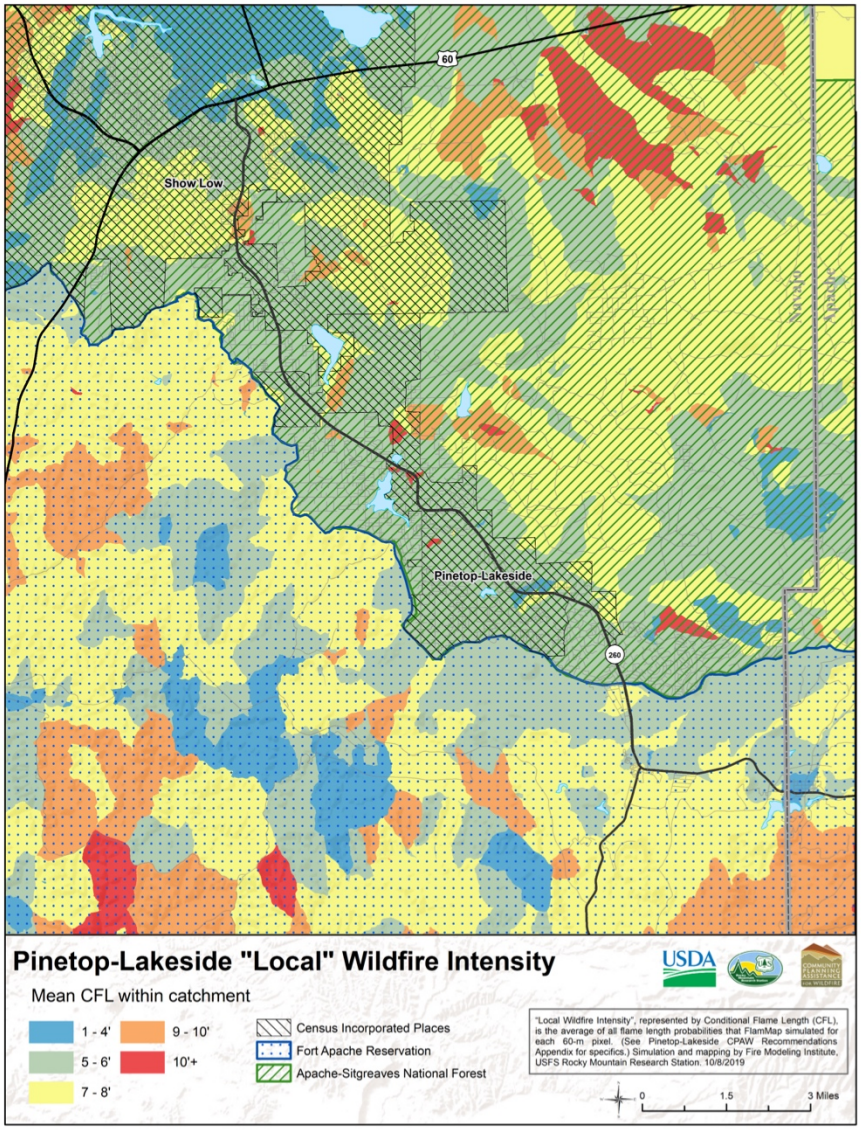


*Figure 15map*

## *Local Wildfire Hazard*

Wildfire hazard is an integration of likelihood and intensity, and we calculated it as the product of BP and CFL. We calculated local hazard at the pixel scale and then summarized values to the catchment scale by calculating the mean CFL in each catchment polygon. We then classified the values into three categories (Moderate, High, and Very High) based on quantiles in the distribution of values in the analysis area (Figure A12). The actual numeric values of hazard are less directly interpretable than BP or CFL. Instead, they provide a relative depiction of hazard across a landscape.

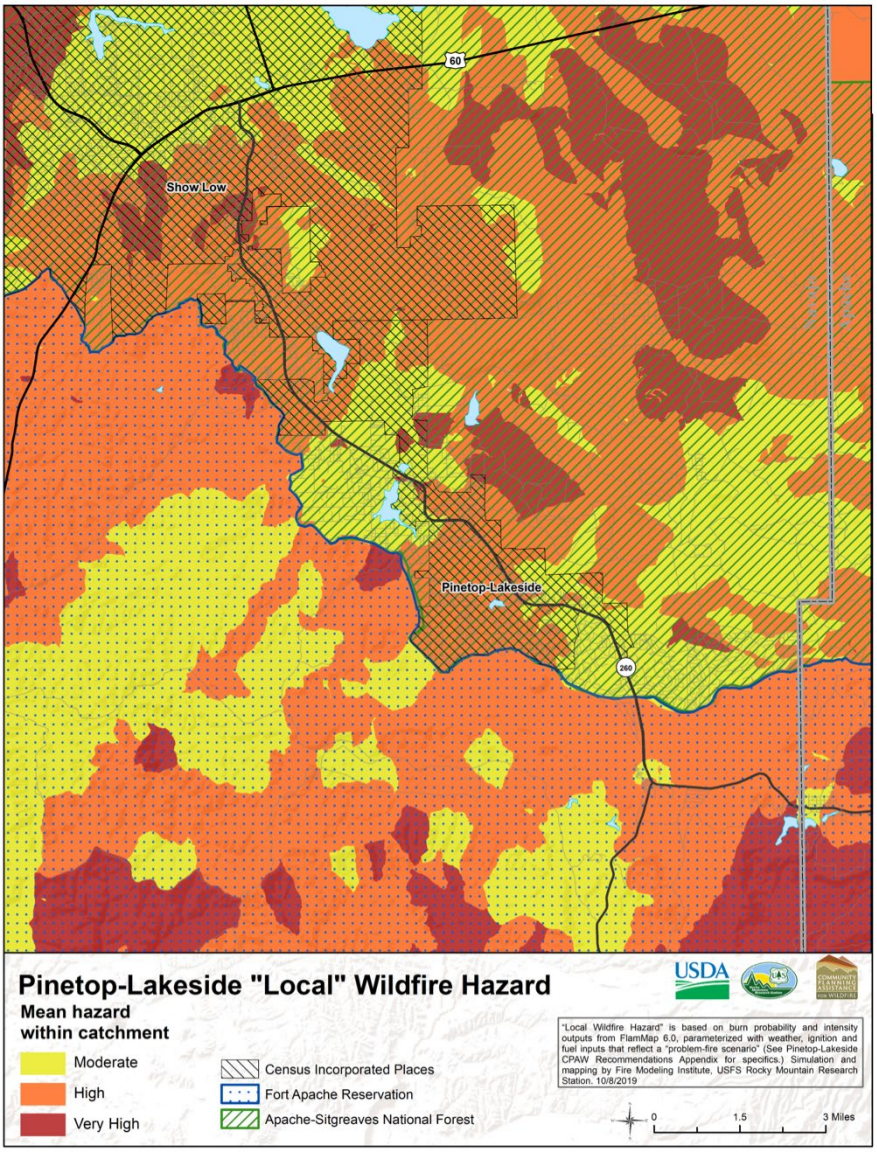


*Figure A12. Pinetop-Lakeside local wildfire hazard assessment map*

# 3. Wildland Urban Interface Zones

We mapped categories of structure density integrated with wildland vegetation to characterize where structures are in or near burnable vegetation in the area surrounding Pinetop-Lakeside (Figure A13).

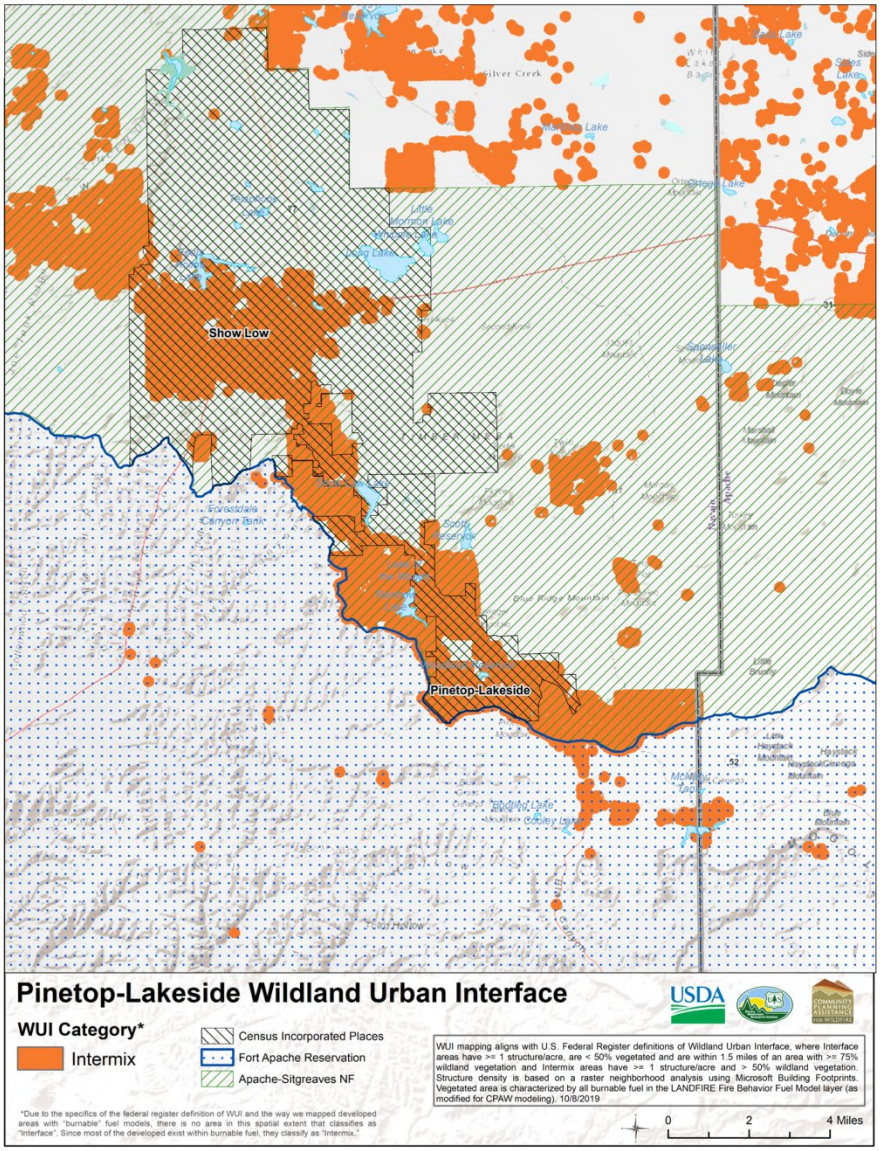


*Figure A13. Pinetop-Lakeside wildland-urban interface map*

Though we generally followed methods that mimic Federal Register Wildland Urban Interface (WUI) definitions as adapted by Martinuzzi et al. 2015, we customized our WUI mapping to represent rural developed areas with more precision. To avoid bias introduced when using a summary zone for population density calculations, we used an approach based on structure locations to create a structure density surface (Bar-Massada et al 2013.), using Microsoft Building Footprint polygons (converted to points) to represent individual structures.

We defined wildland vegetation as anything that is classed with a “burnable” fuel model in the same fuel model raster data that we used in our FlamMap modeling. Non-burnable fuel model categories include urban, snow/ice, agriculture, water, and barren surfaces. To quantify the percentage of vegetation within an area, we used the ArcGISFocal Statistics tool (ESRI 2017) to calculate the percentage of burnable fuel within a 40-acre moving window around each pixel, and assign that value to the center pixel. We reclassified the percent vegetated raster into three categories: greater than 50%, less than or equal to 50% and greater than or equal to 75%, to then build the vegetation density categories necessary for Federal Register WUI classes.

Structure density and vegetation raster layers were combined to map the WUI, with the map categories as described in Table A5. One modification that we made to rules outlined in Martinuzzi et al. 2015 was to include the “Vegetated Very Low Density” category with the WUI Intermix category. This decision reflects the Federal Register statement that “intermix exists where structures are scattered throughout a wildland area” (USDA and USDOI 2001) and our intent to include isolated structures in rural areas as WUI. Because we mapped developed areas with a vegetated and thus burnable fuel model (typically TL8, Ponderosa Pine litter), all WUI was classified as Intermix for the Pinetop-Lakeside mapping spatial extent.

Table A5. Description of mapping ruleset for Wildland Urban Interface zones

| **WUI Category** | **Structure Density Description** | **Structure Density Range (structures/ac)** | **Vegetation Description** |
|---|---|---|---|
| Interface | Very Low to High Density | >= 1 | Wildland vegetation <= 50% and within 1.5-mi of area with >= 75% wildland vegetation |
| Intermix | Very Low to High Density | >= 1 | Wildland vegetation > 50% |
| Non-Vegetated | Medium or High Density | > 8 | Wildland vegetation <= 50% |
| | No, Very Low, or Low Density | 0 - 8 | |
| Vegetated | Uninhabited | 0 | Wildland vegetation > 50% |

Though the scientific community is still working on a way to quantify the probability of wildfire ember impact to structures, in the Pinetop-Lakeside mapping extent with fuels mapped as described for our FlamMap modeling, virtually every structure is within a distance from wildland fuels that could produce embers. Since the entire community could possibly be impacted by embers, we did not include an “ember zone” as it would add no substantial value to the final WUI map.

# 4. Mitigation Difficulty

As a complement to the landscape and local wildfire hazard assessments, we calculated an index that characterizes the relative difficulty or effort involved in modifying landscape characteristics in a way that could reduce wildfire hazard. To create the components necessary to map mitigation difficulty, we developed three 30-meter resolution spatial datasets, as follows:

Vegetation Life Form – We integrated the fuel model data set (initially built to parameterize our FlamMap modeling) with the Fuel Vegetation Type (LANDFIRE 2.0.0) data set to produce four life form classes: 1. Barren/Developed/Sparsely Vegetated/ Irrigated Agriculture, 2. Grass, 3. Shrub, and 4. Tree.

Slope – We classified the same slope dataset that was used to parameterize our fire behavior modeling landscape (LANDFIRE 2.0.0) into three classes: 1. Steep slopes - Slopes greater than or equal to 30%; 2. Moderate slopes – slopes greater than or equal to 15% and less than 30%; and 3. Shallow slopes – slopes less than 15%.

Crown Fire Activity – We used the Crown Fire Activity (CFA) raster output layer from our FlamMap modeling to represent potential for crown fire. The logic used in calculating CFA within FlamMap takes into account the potential for fires burning in surface fuels to transition into tree crowns, and then it uses mapped tree crown characteristics and modeled wind speeds to determine whether that pixel could experience passive (fire is limited to individual tree torching) or active (fire spreads through crowns from tree to tree) crown fire. For the mitigation index, we collapsed the CFA raster into two categories: 1. No crown fire potential; 2. Potential for either passive or active crown fire. As with other FlamMap outputs for Pinetop-Lakeside, we selected CFA values for the appropriate modeling scenario zones ("Tree" and "Non-Tree") to create the CFA grid for mitigation difficulty analysis.

Working with the CPAW Fire Behavior Analyst, we integrated the spatial layers described above to create map categories representing the difficulty to mitigate wildfire hazard and general mitigation guidance within the Pinetop-Lakeside mapping extent (Figure A14). Map classes range from 0 to 9, increasing with difficulty to mitigate wildfire hazard:

**1 – Sparsely vegetated or developed:**

Barren ground, sparse vegetation, or developed surfaces.

**2 – Herbaceous on a shallow slope:**

Fires are typically easier to suppress in these areas. However, high winds combined with dry conditions lead to potentially dangerous, fast-moving, high-intensity fires. Mitigation potential may involve a combination of irrigation, mechanical (mowing) treatment, frequent burning, and fuel breaks in conjunction with appropriate structure ignition zone and IR structure construction.

**3 – Herbaceous on moderate slope:**

Harder to construct fuel breaks, difficulty in mechanical (mowing) treatment, increased potential for erosion, increased rate of spread, and intensity may make frequent burning more difficult. Focus should be on appropriate slope setbacks, structure ignition zone and IR structure construction mitigation.

**4 – Herbaceous on steep slope:**

Fires are typically harder to suppress than grassfires in these areas. High winds combined with dry conditions lead to potentially dangerous, fast-moving, high-intensity fires with fire fighter access concerns. Mitigation potential may involve a combination of mechanical (mastication) treatment, moderately frequent burning, and fuel breaks in conjunction with appropriate structure ignition zone and IR structure construction.

**4 – Shrub on shallow slope:**

Harder to construct fuel breaks, difficulty in mechanical (mastication) treatment, increased potential for erosion, increased rate of spread, and intensity may make frequent burning more difficult. Focus should be on a combination of appropriate mechanical treatment or burning, slope setbacks, structure ignition zone and IR structure construction mitigation.

**5 – Shrub on moderate slope:**

Open canopy must be maintained to prevent increase crown fire potential. Surface fuels must be treated/maintained in a state that reduces the chances of fast-moving surface fires in conjunction with appropriate structure ignition zone and IR structure construction mitigation.

**6 – Shrub on steep slope:**

Open canopy must be maintained to prevent increased crown fire potential, which may be more difficult due to the slope. Surface fuels must be treated/maintained in a state that reduces the chances of fast-moving surface fires. Mitigation should also include appropriate slope setbacks, structure ignition zone and IR structure construction mitigation.

**6 – Tree on shallow slope:**

Dense canopy needs to be thinned to reduce crown fire potential. Surface fuels must be treated to reduce risk of fast-moving surface fires. Mitigation should also include appropriate structure ignition zone and IR structure construction mitigation.

**7 – Tree on moderate slope:**

Dense canopy needs to be thinned to reduce crown fire potential, which may be more difficult due to the slope. Surface fuels must be treated to reduce risk of fast-moving surface fires. Mitigation should also include appropriate slope setbacks, structure ignition zone and IR structure construction mitigation.

**7 – Tree on shallow slope with potential for crown fire:**

Dense canopy needs to be thinned to reduce crown fire potential, which may be more difficult due to the slope. Surface fuels must be treated to reduce risk of fast-moving surface fires. Mitigation should also include appropriate slope setbacks, structure ignition zone and IR structure construction mitigation.

**8 – Tree on moderate slope with potential for crown fire:**

Dense canopy needs to be thinned to reduce crown fire potential, which may be more difficult due to the slope. Surface fuels must be treated to reduce risk of fast-moving surface fires. Mitigation should also include appropriate slope setbacks, structure ignition zone and IR structure construction mitigation.

**8 – Tree on steep slope:**

Dense canopy needs to be thinned to reduce crown fire potential, which may be more difficult due to the slope. Surface fuels must be treated to reduce risk of fast-moving surface fires. Mitigation should also include appropriate slope setbacks, structure ignition zone and IR structure construction mitigation.

**9 – Tree on steep slope with potential for crown fire:**

Dense canopy needs to be thinned to reduce crown fire potential, which may be more difficult due to the slope. Surface fuels must be treated to reduce risk of fast-moving surface fires. Mitigation should also include appropriate slope setbacks, structure ignition zone and IR structure construction mitigation.

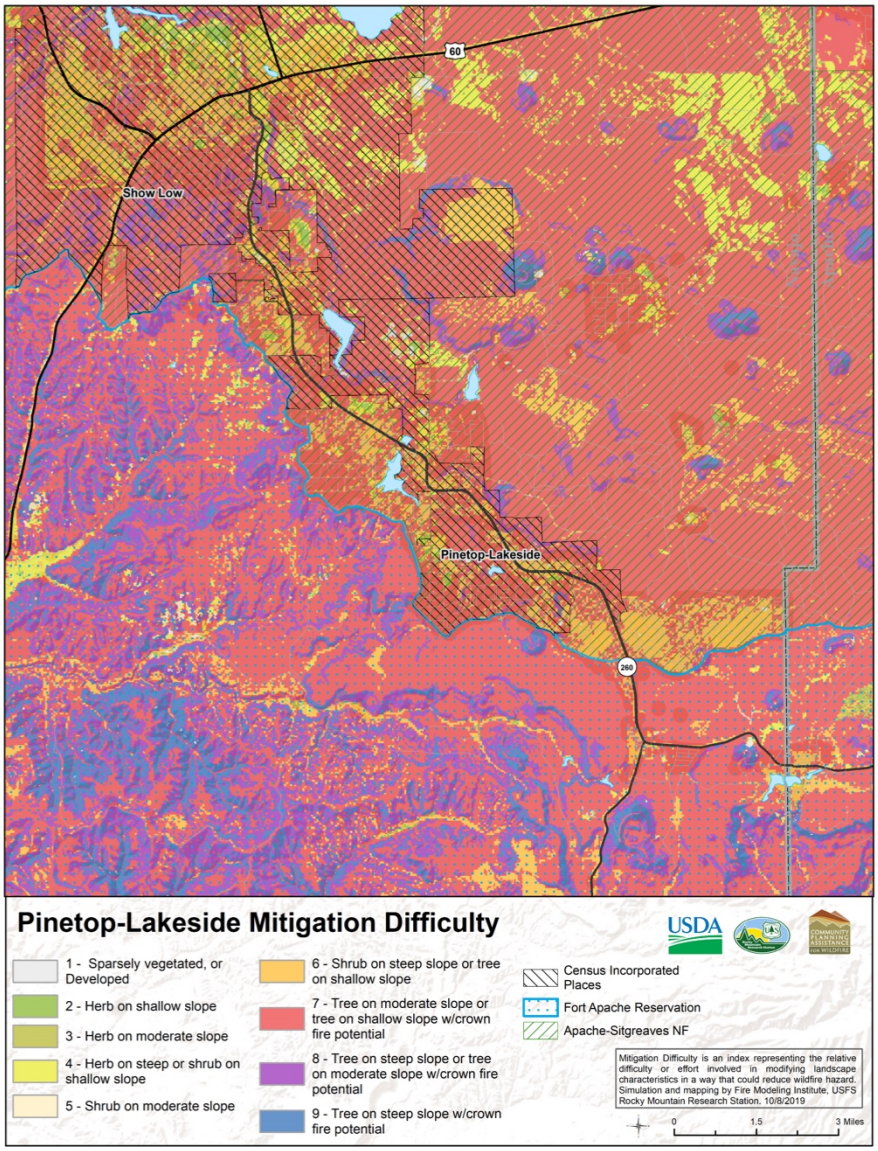


*Figure A14. Pinetop-Lakeside mitigation difficulty map*

# 5. Final Considerations

In this report, we presented two complementary representations of wildfire hazard for the area surrounding Pinetop-Lakeside, AZ. The landscape-level assessment addresses the question of "what is the annual chance of a fire occurring?" anywhere on a landscape. As such, this part of the assessment sets the context for a broad picture of wildfire hazard. The local-level assessment used a more focused approach to model fire behavior under a "problem fire" scenario. It brings the benefit of integrating local stakeholder input that customizes the modeling landscape and represents the potential for local fire behavior at a finer spatial resolution. The local hazard map indicates where wildfire could cause a problem in a community, given the specific set of weather conditions selected for our modeling scenarios.

We encourage users to consider hazard assessment as "living data." Now that we have established the methodology for mapping the local wildfire hazard, there is opportunity for local

analysts to implement the methods on updated or modified datasets, either to refine the current picture of hazard or to compare current vs. past assessments to assess progress toward landscape changes that decrease hazard in the community.

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# APPENDIX B: DEFINITIONS

The following list of definitions is intended to aid understanding of terms associated with CPAW recommendations.

**Aerial Fuels -** Standing and supported live and dead combustible materials not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, cones, bark, and vines.[18]

**Built Fuels -** Combustible structures, including buildings and infrastructure.

**Burn Probability -** The probability or effect of a wildland fire event or incident, usually evaluated with respect to objectives.

**Burn Severity -** A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts.[19]

**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 government, local fire department, other stakeholders and federal land management agencies managing land in the vicinity of the planning area. A Community Wildfire Protection Plan (CWPP) identifies and prioritizes areas for hazardous fuel reduction treatments and recommends 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 recommends measures to reduce structural ignitability throughout the at-risk community. A CWPP may address issues such as wildfire response, hazard mitigation, community preparedness, or structure protection—or all the above.[20]

**Conduction Heat -** Transfer of heat through direct contact of material.

**Convection Heat -** The movement caused through the rising of a heated gas or liquid.

**Critical Facilities -** FEMA defines critical facilities as "facilities/infrastructure that are critical to the health and welfare of the population and that are especially important following hazard

[18] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[19] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[20] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.

events. Critical facilities include, but are not limited to, shelters, police, fire stations, and hospitals." In addition, CPAW recognizes emergency water pumping stations, egress routes, communication facilities, and backup power supplies as critical facilities.

**Crown Fire -** A fire that advances from top to top of trees or shrubs more or less independent of a surface fire. Crown fires are sometimes classed as running or dependent to distinguish the degree of independence from the surface fire.[21]

**Defensible Space -** The selection, location, grouping, and maintenance of vegetation on the property in such a manner that the opportunity for fire to burn directly to a structure is minimized.[22]

**Ecosystem-Based Fire Management -** The incorporation of the natural or desired ecological role of fire into the management and regulation of a community's natural areas.

**Effects -** The anticipated benefits and losses associated with exposure to a hazard or event, in this case fire.

**Embers -** *See firebrand.*

**Exposure -** The contact of an entity, asset, resource, system, or geographic area with a potential hazard. Note: In incident response, fire responder exposure can be characterized by the type of activity.[23]

**Fire Adapted Community (FAC) -** A human community consisting of informed and prepared citizens collaboratively planning and taking action to safely coexist with wildland fire.[24]

**Fire Effects -** The physical, biological, and ecological impacts of fire on the environment, or the physical, safety, health, social, and economic impacts of fire on humans and human development. This is often expressed as first order (immediate effects) and second order (subsequent effects as a result of first order effects).

**Fire Intensity -** Commonly referred to as fire line intensity, this is the amount of heat energy that is generated by burning materials.

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[21] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[22] National Fire Protection Association. 2018. NFPA 1144: *Standard for Reducing Structure Ignition Hazards from Wildland Fire.* Available at https://catalog.nfpa.org/NFPA-1144-Standard-for-Reducing-Structure -Ignition-Hazards-from-Wildland-Fire-P1414.aspx?icid=B575.
[23] Thompson, Matthew P., Tom Zimmerman, Dan Mindar, and Mary Taber. 2016. *Risk Terminology Primer: Basic Principles and A Glossary for the Wildland Fire Management Community.* Gen. Tech. Rep. RMRS- GTR-349. Fort Collins, Colo.: USDA Forest Service Rocky Mountain Research Station. Available at www.fs.usda.gov/treesearch/pubs/50912.
[24] Fire Adapted Communities Coalition. 2018. "What is a Fire-Adapted Community?" Available at https://fireadapted.org.

**Fire Weather -** Weather conditions that influence fire ignition, behavior, and suppression.[25]

**Firebrand -** Any source of heat, natural or human made, capable of igniting wildland fuels; flaming or glowing fuel particles that can be carried naturally by wind, convection currents, or by gravity into unburned fuels.[26]

**Firewise USA -** A program administered by the National Fire Protection Association that teaches people how to adapt to living with wildfire and encourages neighbors to work together and take action to prevent losses. Some communities have applied the term "firewise" more broadly to refer to wildfire mitigation activities.

**Frequency -** The number of occurrences of an event per a specified period of time.

**Fuel Treatment -** Manipulation or removal of fuels to reduce the likelihood of ignition or to lessen potential damage and resistance to control (e.g., lopping, chipping, crushing, piling, and burning).[27]

**Fuels -** All combustible materials in the wildland-urban interface, including but not limited to vegetation and structures.[28]

**Ground Fuel -** All combustible materials below the surface litter, including duff, tree or shrub roots, punky (rotted) wood, peat, and sawdust, that normally support a glowing combustion without flame.[29]

**Hazard -** Any real or potential condition that can cause damage, loss, or harm to people, infrastructure, equipment, natural resources, or property.[30]

**Hazard Reduction -** Coordinated activities and methods directed to reduce or eliminate conditions that can cause damage, loss, or harm from real or potential hazards.

**Home Ignition Zone (HIZ) -** Also see *structure ignition zone.* The area where the factors that principally determine home ignition potential during extreme wildfire behavior (high fire

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[25] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[26] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[27] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[28] National Fire Protection Association. 2018. NFPA 1144: Standard for Reducing Structure Ignition Hazards from Wildland Fire. Available at https://catalog.nfpa.org/NFPA-1144-Standard-for-Reducing-Structure -Ignition-Hazards-from-Wildland-Fire-P1414.aspx?icid=B575.
[29] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[30] Thompson, Matthew P., Tom Zimmerman, Dan Mindar, and Mary Taber. 2016. *Risk Terminology Primer: Basic Principles and A Glossary for the Wildland Fire Management Community*. Gen. Tech. Rep. RMRS- GTR-349. Fort Collins, Colo.: USDA Forest Service Rocky Mountain Research Station. Available at www.fs.usda.gov/treesearch/pubs/50912.

intensities and burning embers) are present. The characteristics of a home and its immediate surroundings within 100 feet comprise the HIZ.[34]

**Hydrophobic Soils -** Resistance to wetting exhibited by some soils, also called water repellency.[31]

**Infill Development -** Development characterized by development or redevelopment of undeveloped or underutilized parcels of land in otherwise built-up areas, which are usually served by or have ready access to existing infrastructure and services.

**Infrastructure -** The basic physical structures and facilities (e.g., buildings, roads, and power supplies) needed for the operation of a community.

**Initial Attack (IA) -** A preplanned response to a wildfire given the wildfire's potential. Initial attack may include sizing up, patrolling, monitoring, holding action, or suppression.[32]

**Ladder Fuels -** Fuels that provide vertical continuity between strata, thereby allowing fire to carry from surface fuels into the crowns of trees or shrubs with relative ease. They help initiate and assure the continuation of crowning.[33]

**Landscape Scale -** A large spatial scale, which addresses multiple land uses, ecosystem services, and conservation objectives. Landscape-scale approaches focus on achieving multiple environmental, economic, and social objectives across the defined area.

**Mitigation -** The act of modifying the environment or human behavior to reduce potential adverse impacts from a natural hazard. Mitigation actions are implemented to reduce or eliminate risks to persons, property, or natural resources, and can include mechanical and physical tasks, specific fire applications, and limited suppression actions.[34]

**Natural Hazard -** Source of harm or difficulty created by a meteorological, environmental, or geological event.

**Preparedness -** Activities that lead to a safe, efficient, and cost-effective fire management program in support of land and resource management objectives through appropriate planning and coordination.[35]

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[31] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[32] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[33] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[34] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[35] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.

**Prescribed Fire -** Any fire intentionally ignited by management actions in accordance with applicable laws, policies, and regulations to meet specific objectives.[36]

**Prevention -** Activities directed at reducing the incidence of fires, including public education, law enforcement, personal contact, and reduction of fuel hazards (fuels management); actions to avoid an incident, to intervene for the purpose of stopping an incident from occurring, or to mitigate an incident's effect to protect life and property.[37]

**Radiation Heat -** Transmission of heat through waves or particles.

**Residual Risk -** Risk that remains after risk control measures have been implemented.

**Resiliency -** The ability to prepare and plan for, absorb, respond, recover from, and more successfully adapt to adverse events.[38]

**Risk -** A measure of the probability and consequence of uncertain future events.[39]

**Risk Acceptance -** A strategy that involves an explicit or implicit decision not to take an action that would affect all or part of a particular risk.

**Risk Assessment -** A product or process that collects information and assigns values (relative, qualitative, quantitative) to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making.

**Risk Assessment -** Product or process that collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making.[40]

**Risk Avoidance -** A strategy that uses actions or measures to effectively remove exposure to a risk.

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[36] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[37] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[38] National Academies of Sciences. 2018. "Resilience at the Academies." Available at www.nationalacademies.org/topics/resilience.
[39] Thompson, Matthew P., Tom Zimmerman, Dan Mindar, and Mary Taber. 2016. *Risk Terminology Primer: Basic Principles and A Glossary for the Wildland Fire Management Community*. Gen. Tech. Rep. RMRS- GTR-349. Fort Collins, Colo.: USDA Forest Service Rocky Mountain Research Station. Available at www.fs.usda.gov/treesearch/pubs/50912.
[40] Thompson, Matthew P., Tom Zimmerman, Dan Mindar, and Mary Taber. 2016. *Risk Terminology Primer: Basic Principles and A Glossary for the Wildland Fire Management Community*. Gen. Tech. Rep. RMRS- GTR-349. Fort Collins, Colo.: USDA Forest Service Rocky Mountain Research Station. Available at www.fs.usda.gov/treesearch/pubs/50912.

**Risk Based Decision Making -** A decision making process that relies on the identification, analysis, assessment, and communication of wildland fire risk as the principal factors in determining a course of action to improve the likelihood of achieving objectives.

**Risk Communication -** An exchange of information with the goal of improving the understanding of risk, affecting risk perception, or equipping people or groups to act appropriately in response to an identified risk.

**Risk Management -** A comprehensive set of coordinated processes and activities that identify, monitor, assess, prioritize, and control risks that an organization faces.

**Risk Mitigation -** The application of measures to alter the likelihood of an event or its consequences.

**Risk Perception -** Subjective judgment about the characteristics and magnitude of consequences associated with a risk.

**Risk Reduction -** A decrease in risk through risk avoidance, risk control, or risk transfer.

**Risk Transfer -** A strategy that uses actions to manage risk by shifting some or all of the risk to another entity, asset, resource, system, or geographic area.

**Structure Fire -** Fire originating in and burning any part or all of any building, shelter, or other structure.[41]

**Structure Ignition Zone (SIZ) -** *Also see home ignition zone.* The area around a specific structure and associated accessory structures, including all vegetation that contains potential ignition sources and fuels.[42]

**Suppression -** A wildfire response strategy to "put the fire out" as efficiently and effectively as possible while providing for firefighter and public safety.[43]

**Surface Fire -** A fire that burns loose debris (e.g., dead branches, leaves, and low vegetation) on the surface of the ground.[44]

**Surface Fuel -** Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low-stature living plants.[45]

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[41] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[42] National Fire Protection Association. 2018. "NFPA 1: Fire Code Fact Sheet." Available at www.nfpa.org/Assets/files/AboutTheCodes/1/ NFPA1_Fact%20Sheet.pdf.
[43] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[44] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[45] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.

**Urban Conflagration -** A large, destructive fire that spreads unimpeded by fire suppression efforts or barriers, destroying large areas of structures and infrastructure.

**Values -** Items identified by a community as having measurable or intrinsic worth that could be negatively impacted by a wildfire. Values include property, structures, physical improvements, natural and cultural resources, community infrastructure, and economic, environmental, and social values.[46]

**Values-At-Risk -** Those ecological, social, and economic assets and resources that could be impacted by fire or fire management actions.

**Vulnerability -** The physical feature or attribute that renders values susceptible to a given hazard.

**Wildfire -** An unplanned wildland fire, including unauthorized human-caused fires and escaped prescribed fire projects. Wildfire management objectives may vary based on site-specific circumstances and conditions.[47]

**Wildfire Hazard -** The combination of the likelihood of a fire occurring and the intensity of the fire. Also refers to the wildland or built fuels present in a given area, or the combustibility of a given fuel type or fuel complex in general.

**Wildfire Risk -** The wildfire hazard plus the addition of the factors that contribute to susceptibility, or the impact of a wildfire on highly valued resources and assets.

**Wildfires -** Unplanned wildland fires resulting in a negative impact.

**Wildland -** An area in which development is essentially nonexistent, except for roads, railroads, power lines, and similar transportation facilities. Structures, if any, are widely scattered.[48]

**Wildland Fire -** Any non-structure fire that occurs in vegetation or natural fuels. Wildland fire includes prescribed fire and wildfire.[49]

**Wildland Fuels -** All vegetation (natural and cultivated).

**Wildland-Urban Interface (WUI) -** Any developed area where conditions affecting the combustibility of natural and cultivated vegetation (wildland fuels) and structures or

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[46] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[47] USDA Forest Service. 2009. Guidance for Implementation of Federal Wildland Fire Management Policy. February 13. Available at www.nifc .gov/policies/policies_documents/GIFWFMP.pdf.
[48] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.
[49] National Wildfire Coordinating Group. 2018. "Glossary A-Z." Available at www.nwcg.gov/glossary/a-z.

infrastructure (built fuels) allow for the ignition and spread of fire through the combined fuel complex.

**Wildland-Urban Interface Hazard -** Combustibility of the wildland or built fuels, fuel type or fuel complex.

**Wildland-Urban Interface Risk -** The WUI hazard accounting for factors that contribute to the probability and consequences of a WUI fire.