COMMUNITY PLANNING ASSISTANCE FOR WILDFIRE

Recommendations for Greater Bemidji Area, MN

Prepared by:

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About the 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. It is supported through grants from the U.S. Forest Service, the LOR Foundation, and other private foundations. It is a program of Headwaters Economics and Wildfire Planning International.

Author Contact Information

CPAW engages consultants with relevant training and expertise in land use planning, forestry, risk modeling, and fire behavior. This report was written by the following CPAW consultants:

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Acknowledgments

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Cover Photos: Greater Bemidji Area, MN. Photos by CPAW team members Ben Yellin (WPI), Kelly Pohl (HE), Molly Mowery (WPI)

Contents

Introduction

Each year, wildfires affect communities across the United States. These wildfires – both human- and lightning-caused – can have a variety of impacts on communities' built and natural environments. Some of these impacts bring positive ecological outcomes, such as improved forest health and habitats. Other wildfires, however, can have devastating social, economic, and environmental consequences to communities' public and first responder safety, homes and businesses, parks, roads, watersheds, forests, hospitals, and more.

Communities have many options to address and reduce their wildfire risk. The Community Planning Assistance for Wildfire (CPAW) program offers a unique approach to help community stakeholders identify what's at risk in the "wildland-urban interface" (WUI, pronounced "WOO-EE") and determine ways to address this risk through improved land use planning strategies.

❖ Community Planning Assistance for Wildfire

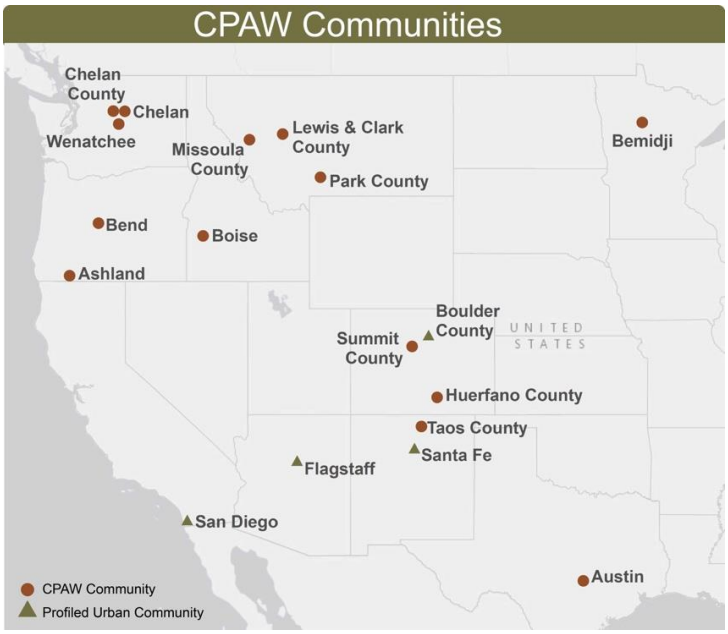

Figure 1. Communities who have been engaged in the Community Planning Assistance for Wildfire program (as of October 2017).

CPAW was established by Headwaters Economics and Wildfire Planning International in 2015 and is funded by the USDA Forest Service, the LOR Foundation, and other private foundations. Since its inception, CPAW has worked with communities of varying sizes, capacities, and geographical locations across the United States.

Community Selection and Services

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 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 its 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

The CPAW community planning process typically 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. Team members also thoroughly review community planning documents to analyze gaps and opportunities for strengthening wildfire policies and regulations. At the end of the process, team members provide the community with a set of voluntary recommendations to more effectively address the WUI through appropriate land use planning strategies. Follow-up implementation assistance may also be available to communities depending on their unique needs and CPAW's program funding.

Figure 2. Community Planning Assistance for Wildfire typical planning process.

CPAW Recommendations

CPAW recommendations are customized to each local community based on a combination of important inputs: community observations and stakeholder feedback, science and 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.

This report provides the Greater Bemidji Area with four recommendations (summarized in Table 2). Each recommendation includes an overview of its importance and relevance. Implementation guidance for staff is also provided. 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 county goals and actions.

❖ Greater Bemidji Area Planning Context

Formed by the City of Bemidji and Northern Township in 2007, the Greater Bemidji Area Joint Planning Board was created to provide planning and zoning services in a 51-square mile expanse known as the Greater Bemidji Area. Priding itself on the "Northwoods feel," residents enjoy living in a natural, amenity-rich area that includes multiple lakes and private, state, and federal forested areas. The Bemidji Fire Department also provides fire protection, fire prevention, technical rescue and emergency services to multiple areas in Beltrami and Hubbard Counties.

Many neighborhoods in Bemidji enjoy access to parks, trails, and forests. (Photo source: CPAW)

The Greater Bemidji Area was accepted into the CPAW program in November 2016 and received assistance over the course of the past year. As an initial step to understand local conditions, team members assembled community information and data, including: geographical information, key demographics, economic trends, fire environment and wildfire history. This section provides a summary of that information.

Geographic Location and Significant Features

Located in northcentral Minnesota, the Greater Bemidji Area encompasses the City of Bemidji and Northern Township. The Greater Bemidji Area's landscape is defined by the headwaters of the Mississippi River and surrounding Lake Bemidji, Lake Bemidji State Park, and heavily wooded areas broken up by pockets of agriculture and urban areas.

Land Area and Ownership

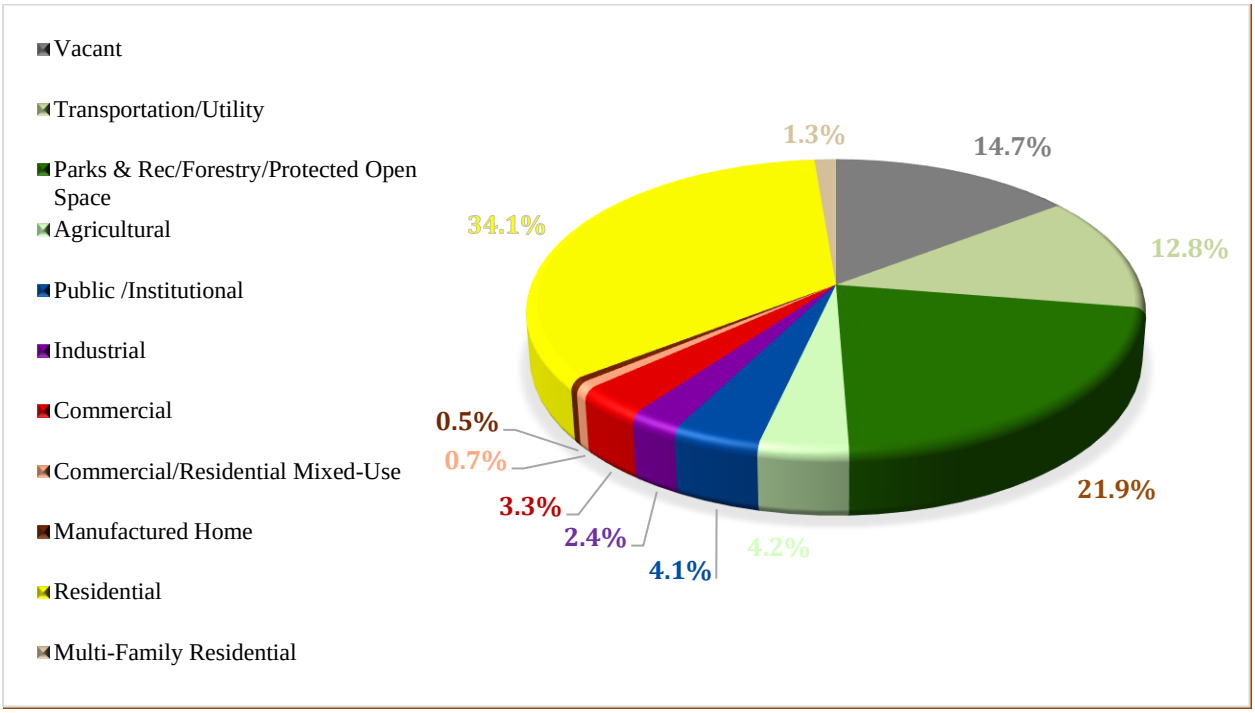

Figure 3. Greater Bemidji Area land area ownership by percent. Source: GBAJPB 2012-2016 Comprehensive Plan

Key Demographics and Economic Trends

Per the 2010 Census, the City of Bemidji has a population of 13,431 residents and Northern Township has a population of 4,657 residents, for a combined total of 18,088. Both areas are experiencing growth as the Greater Bemidji Area continues to become a regional hub for education and health care services. See Table 1 (below) for more demographic and economic trends.

Table 1: Overview of Demographics in Greater Bemidji Area, MN			
Topic	**City of Bemidji**	**Northern Township**	**Notes**
Current population (residents)	13,431	4,657	This is a 12.7% increase for the City of Bemidji and 16% increase for Northern Township since 2000.[a]
Population density (people per sq. mile)	1,011	146	Both areas are higher than the state average of 61.8.[a]
Median age (years)	29	35.4	Beltrami County's median age is 33.3.[b]
Total number of housing units	6,250	2,059	2.5% of housing units in Bemidji and 2.7% of housing units in Northern Township were built since 2010.[b]
Housing units for seasonal, recreational or occasional use	70	204	This accounts for 1.2% and 10% of all housing in Bemidji and Northern Township, respectively.[a]
Median home price	$120,100	$177,100	The median home price in Beltrami County is $148,800.[b]
Median household income	47,059	$68,333	The median household income in Beltrami County is $44,757.[b]
Workforce employment	6,715	2,192	Largest employments industries are education, healthcare, and social assistance.[b]
Poverty rate	21.5%	13%	State poverty rate: 6.8%.[a]

a. U.S. Census Bureau. 2010.
b. U.S. Census Bureau 2011-2015 American Community Survey 5-Year Estimates.

Fire Environment and Wildfire History

Northern Minnesota has a long history of wildfires. One of the most notable and devastating historical fires was the Cloquet Fire, which began on October 12, 1918. By the following day, 450 people were reported dead and 250,000 acres burned. While no area in the state has witnessed similar destruction since the Cloquet Fire, many communities have continued to experience wildfires.

Local wildfires that have occurred in or near the Greater Bemidji Area in recent years include:

- 2016: Lake Hattie Fire occurred in Itasca State Park and burned 365 acres.
- 2016: Fire in North Hubbard County 25 miles south of Bemidji reached 500 acres.
- 2015: The Palsburgh Fire occurred in Beltrami Island State Park that burned 6,000 acres. The fire was started by DNR foresters logging a slash pile lit in November.

- 2013: Green Valley Fire burned 7,100 acres 12 residences, 3 commercial properties and 43 outbuildings. Two residences and 6 outbuildings were damaged. The area, fuels, and weather conditions were similar to Bemidji.
- 2012: North Minnie Fire burned 24,840 acres in Beltrami Island State Forest.
- 2012: Fire on Union Road in Hubbard County forced brief evacuations.
- 2011: The Pagami Creek Fire was started by a lightning strike and burned 92,000 acres in the Boundary Waters.
- 2007: Ham Lake Fire occurred in northern Minnesota in Superior National Forest; 140 structures were burned resulting in $4 million in damages.

Table 3.4 -Summary of Recent Wildland Fire in Beltrami County	
Fires since 2002	584
Average Size (Ac)	42.54
Median Size (Ac)	1
Top 3 Causes	**Number of Incidents**
Debris	227
Arson/Incidiary	221
Misc	60
Suppression Costs	585,856
Permitted Fires Resulting in Wild Fire	65

Source:MN Dept. of Natural Resources. May 1, 2012.

Figure 4. Summary of recent fire in Beltrami County. Source: Beltrami County HMP

The City of Bemidji Fire Department response data shows a record of 269 wildfire responses since 2006. A majority of these fires have been small in nature; however, a few fires have caused significant structural damage/losses including homes, along with evacuations of area residents. The more significant fires required numerous ground and air resources to control/suppress. Resources were provided from local and regional fire departments along with wildland firefighting agencies such as the Minnesota Department of Natural Resources (MNDNR).

According to the Beltrami County Hazard Mitigation Plan, “wildfire is a persistent issue throughout the County.” Figure 4 shows the number and average size of fires in Beltrami County since 2002 along with the top three causes for wildfire incidents. The history of wildfires illustrated in Figure 5 shows the greatest occurrence in the most developed areas and highway corridors.

Fire history data indicate that human-caused fires account for almost 100% of the wildfires that occur within the Greater Bemidji Area.

Vegetation

The Beltrami County Hazard Mitigation plan identifies the predominant vegetation cover in the Greater Bemidji Area as a deciduous and conifer/deciduous forest cover mix. Jack pine and Norway pine are the most predominant tree species. Pockets of mixed grass and brush are also in the area and are the typical fuel components driving spring fires. These vegetation types create conditions that support a typically bifurcated fire season (spring and late summer/fall).

The extensive forest cover in the Greater Bemidji Area is broken up into small parcels by agriculture, typically limiting potential fire size to 10 acres or less. However, the development patterns in the Greater Bemidji Area create a scenario of forest vegetation and development in which even these small fires can cause significant losses.

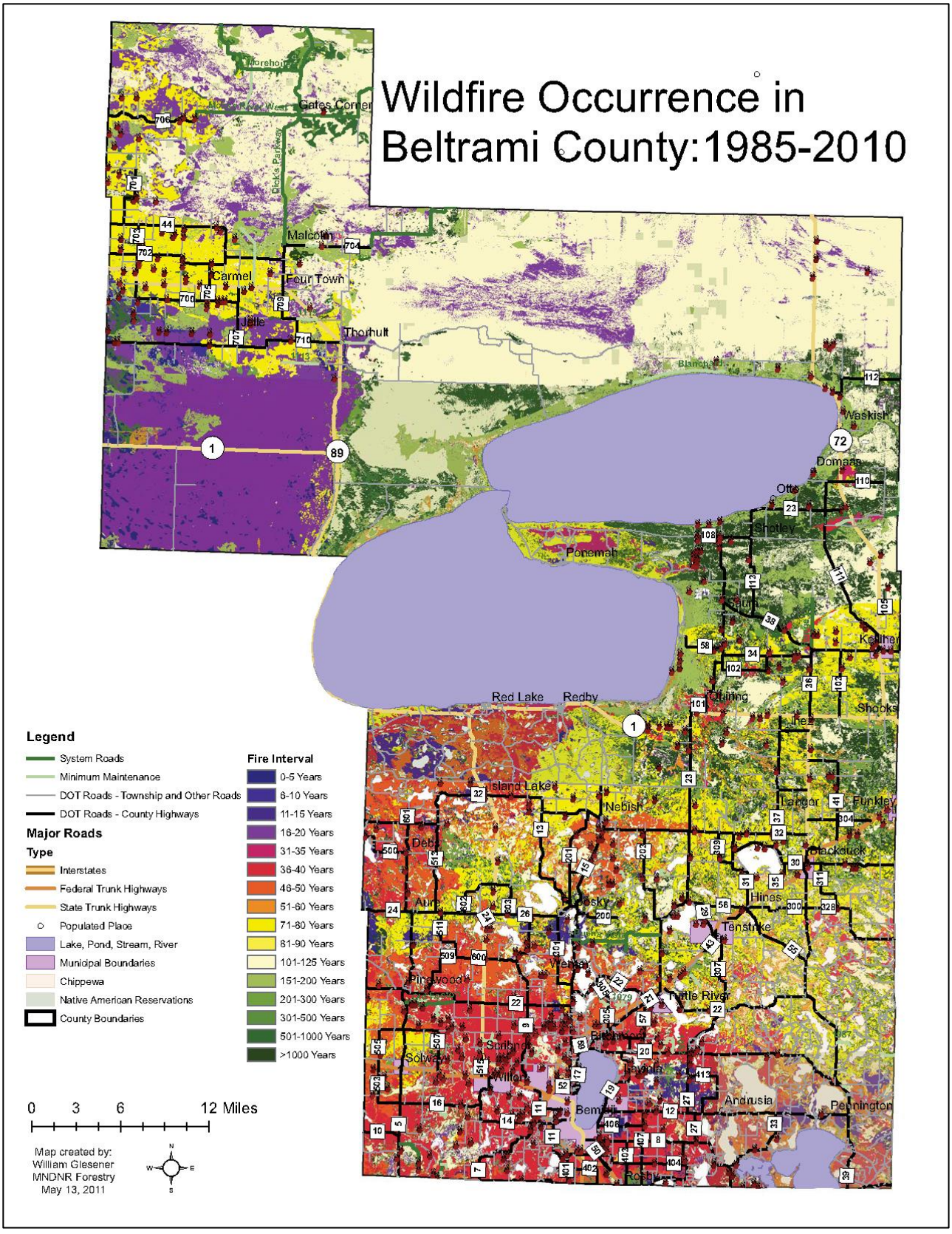

Figure *5*. Wildfire occurrence in Beltrami County. Source: Beltrami County Hazard Mitigation Plan

In addition to understanding the local planning context, CPAW team members gather information through facilitated conversations and meetings with stakeholders, field tours, and internal research. CPAW team members also review and analyze community plans, policies, and regulations to determine their level of effectiveness for community wildfire mitigation. This information is internally compiled into a "WUI Planning Audit" and reviewed with the local steering group. The following section highlights planning challenges and opportunities that emerged in the Greater Bemidji Area during that process.

Local Planning Challenges

- **Ingress and egress constraints.** As a result of earlier development patterns, many developed areas throughout the Greater Bemidji Area have access constraints, such as "one-way-in/one-way-out" roads and narrow roads further constrained by significant increases in parked vehicles associated with seasonal populations. These access constraints hinder safe evacuation and response. Many existing subdivisions do not have an option for a secondary emergency access routes or increasing road widths, and are dependent on other means to effectively address this issue, such as education and preparedness programs. To prevent the creation of additional ingress and egress challenges in new subdivisions, minimum requirements should be established and implemented. Addressing this issue will require the efforts of dedicated fire prevention staff to focus on consistent outreach, education and enforcement programs, as well as the collaborative efforts between Greater Bemidji Area planning staff, the fire department, and the development community to address existing and future developments.
- **Demographic shifts.** The Greater Bemidji Area's population is increasing with new full-time residents, second-home owners, and tourists. The seasonal presence of these populations makes it difficult for engagement and outreach, and they may have limited understanding of wildfire risk or the wildland-urban interface. This lack of local awareness affects building construction and landscaping decisions, ultimately working at odds with other risk-reduction efforts. Typically, this requires the efforts of dedicated fire prevention staff to focus on implementing consistent outreach, education, and enforcement programs.
- **Changes in land uses.** Historically, well-maintained (pruned and thinned) tree plantations dominated the landscape of the Greater Bemidji Area. With a changing forest products market, many of these private plantations have been abandoned and subsequently have become more susceptible to supporting aggressive wildfire. The land use focus is now shifting to development and new subdivisions are being established within these abandoned plantations without wildfire risk-reduction requirements. Unless appropriate development mitigation activities are implemented, such as defensible space and ignition-resistant construction techniques, this will further strain response and suppression capabilities. This will require monitoring and enforcement from planning department staff and fire department prevention staff to ensure effective risk reduction.
- **Conflicting Regulations.** The Greater Bemidji Area currently has a minimum reforestation requirement for any new developments. The ordinance requires that trees be retained or replanted within new developments wildfire mitigation is not considered in this ordinance. This results in higher flammability tree species being planted in locations that will potentially increase the ignition susceptibility of new developments. This is in

direct conflict with wildfire risk-reduction best practices. Alignment of these regulations will require the collaborative efforts between Greater Bemidji Area planning staff, fire department prevention staff, and the local development community.

- **Human-Caused Ignitions.** Almost 100 percent of the ignition source for wildfires in the Greater Bemidji Area is human-caused. The primary human ignition cause is escaped open burning. These escapes are either as a result of non-permitted burning, or permitted burning where the permittee has not taken the appropriate prevention measures.
- **Staff Capacity.** Addressing the wildfire risk-reduction planning challenges that the Greater Bemidji Area faces is an imperative component in effectively mitigating wildfire risk. This will require enough staff capacity to ensure consistent collaborative efforts between trained and knowledgeable Greater Bemidji Area planning staff and dedicated City of Bemidji Fire Department prevention staff in working with the development community and the public.

Local Planning Opportunities

- **Strong Collaborative Relationships and Support.** The existing collaborative relationships between the Minnesota Department of Natural Resources (DNR), the City of Bemidji Fire Department, and the Greater Bemidji Planning Department are very strong. The DNR is very supportive of all of the Greater Bemidji Area and fire department wildfire risk-reduction efforts, and many wildfire outreach and prevention activities are coordinated together. This effort was also increased during the CPAW process, which facilitated a learning exchange among local partners.
- **Leveraging Effective Prevention Programs**. Because the Greater Bemidji Area's ignitions are primarily human-caused, there is a significant opportunity to reduce wildfire risk through future investments in prevention programs. While the local stakeholders already support some wildfire prevention efforts, CPAW recognized the powerful impact that these activities can continue to have with further investment.
- **New Risk Data as Communication Tool.** Science-based risk data, provided by the USDA Forest Service as part of the CPAW process, can be a helpful tool for implementing land use planning activities, education, and outreach. This new wildfire hazard mapping product ranks (low to high) where wildfires are likely to occur within the Greater Bemidji Area, which can serve as a powerful and effective communication tool for different audiences.
- **Timing of Comprehensive Plan Update**. As the Greater Bemidji Area is experiencing growth and development, this is an opportunity to address wildfire mitigation now, before many more homes are added without proper forethought and planning. This coincides with the Comprehensive Plan update, which provides planning staff with a mechanism to guide future growth through thoughtful policies.

Summary of Recommendations for Greater Bemidji Area, MN

Table 2. Overview of Recommendations		
Recommendation	**Summary**	**Key Points**
1. Adopt a Wildfire Risk Assessment	*Integrate a risk assessment map 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.*	• Spatial understanding of wildfire risk helps the community communicate, plan, and develop policies. • As part of CPAW, the USFS Rocky Mountain Research Station (RMRS) has provided the Greater Bemidji Area with a risk assessment that shows wildfire hazard at the landscape level and local level. • The USFS risk assessment includes a spatial definition of the wildland-urban interface.
2. Adopt a Wildland-Urban Interface Code	*Adopt the International Code Council International Wildland-Urban Interface Code (IWUIC) to establish minimum wildfire safety standards for future development in designated wildland-urban interface areas of the Greater Bemidji Planning Area.*	• The Greater Bemidji Area currently has very few references that support wildfire mitigation within their regulatory framework. • Adopting the IWUIC would provide benefits including scientifically-based risk-reduction measures. • Resolution with other local regulations will be required as part of the adoption process.
3. Expand Capacity to Educate, Prevent, and Implement Wildfire Mitigation Activities	*The Bemidji Fire Department, in collaboration with other partners, should expand its capacity to educate, prevent, and implement local wildfire mitigation activities through increased staffing, trainings, and development of programmatic resources and outreach materials.*	• One-third of Bemidji Fire Department fire response calls are for wildfires. • All local wildfires are human-caused, revealing a significant opportunity to invest in prevention, education, and mitigation. • Increasing local capacity can also support the implementation of other CPAW recommendations.
4. Develop and Update Existing Greater Bemidji Area Plans to Account for Wildfire	*Update the Greater Bemidji Area Comprehensive Plan, develop a Community Wildfire Protection Plan, and address long-term post-disaster recovery to acknowledge wildfire's potential impact to the community's natural environment, built environment, and economy.*	• Integrating wildfire policies into local planning documents, such as the Comprehensive Plan, ensures public safety and risk reduction are addressed alongside other planning priorities. • A countywide CWPP has broad benefits for the Greater Bemidji Area, including increased stakeholder engagement, prioritized mitigation activities, and coordination with other plans.

RECOMMENDATION 1: Adopt a Wildfire Risk Assessment

Integrate a risk assessment map 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.

❖ Why This Recommendation Matters

Overview

Ideally, a complete wildfire risk assessment should be developed, including a display of spatially delineated risk classes across the Greater Bemidji Area (i.e., a wildfire risk map). This map should be provided at an appropriate resolution and scale to support land use and regulatory decisions.

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 6).[1]

[1] Scott, J. H.; Thompson, M. P.; Calkin, D. E., 2013. A wildfire risk assessment framework for land and resource management. Gen. Tech. Rep. RMRS-GTR-315. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 83 p.

Figure 6. 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.

Greater Bemidji Area Risk Assessment

Currently, the Greater Bemidji Area does not have a risk assessment that can effectively guide wildfire risk-reduction land use policy or regulation. As a result of a recent collaborative working arrangement between the CPAW program and the USDA Forest Service Rocky Mountain Research Station (RMRS), the RMRS undertook a hazard assessment for the Greater Bemidji Area. As a component of the hazard assessment, the RMRS spatially defined the Greater Bemidji Area's WUI using the SILVIS Lab approach. The resulting hazard assessment tool will be provided in the form of a geodatabase for addition to the Greater Bemidji Area's geomatics servers for use as an ESRI ARC GIS layer.

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).

❖ Implementation Guidance

Implement Hazard Assessments

In order to address the three components of the risk triangle (likelihood, intensity, and susceptibility), two assessment approaches are recommended by CPAW for the Greater Bemidji Area: Landscape-Level Wildfire Hazard Assessment, and Parcel-Level Susceptibility Assessment.

1. Landscape-Level Wildfire Hazard Assessment

To provide an effective decision support tool for the Greater Bemidji Area and its partners, USDA Forest Service Rocky Mountain Research Station (RMRS) staff developed the following wildfire hazard mapping output. A summary of the methodology used to develop these outputs can be found in Appendix A.

This scale (270 m pixel resolution) represents the likelihood (probability) of a fire occurring and 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. The polygon boundaries are based on the U.S. Geological Survey Hydrological Unit Code (HUC) 12 (sub-watershed) boundaries. The following landscape-level hazard assessment is delineated into the following rankings (Figure 7):

- **LOW**- Low burn probability, low intensity
- **MODERATE**- Low burn probability/ high intensity or high burn probability/low intensity
- **HIGH**- High burn probability/high intensity

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. This is typically done by large-scale disturbances such as insect mortality, fires, landscape level mitigation, or development.

Land Use Planning Application: This informs land use planners on the general areas where fires are most likely to occur.

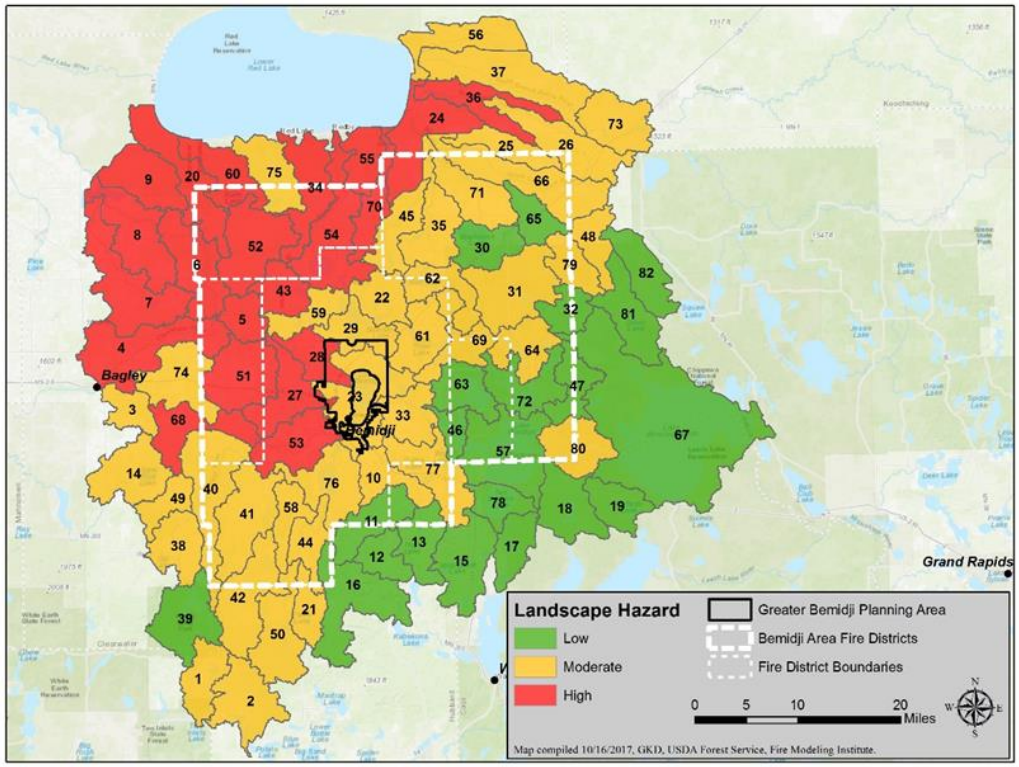

Figure 7. Greater Bemidji Area and Bemidji Area Fire District Landscape Wildfire Hazard Map

2. Parcel-Level Susceptibility Assessment

The Greater Bemidji Area should also consider undertaking parcel-level assessments to complete the susceptibility component of the risk triangle, by providing ignition potential data for individual structures and infrastructure.

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 the Greater Bemidji Area 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 SILVIS labs approach should be used. The SILVIS lab approach originated in the Federal Register[2] report on WUI communities at risk from fire, and Teie and Weatherford's 2000 report[3] to the Council of Western State Foresters on WUI fire risk. This approach focuses on the following inputs:

[2] 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.

[3] Teie, W.C., and B.F. Weatherford. 2000. Fire in the west: The wildland/urban interface fire problem. Rep. to the Council of Western State Foresters, Deer Valley Press, Rescue, CA. 15 p.

1. Housing density
2. Landcover[4]

    a) **WUI Intermix**: Areas with ≥6.18 houses per km2 and ≥50 percent cover of wildland vegetation

    b) **WUI Interface:** Areas with ≥6.18 houses per km2 and <50 percent cover of vegetation located <2.4 km of an area ≥5 km^2 in size that is ≥75 percent vegetated

    c) **Non- WUI Vegetated (no housing):** Areas with ≥50 percent cover of wildland vegetation and no houses (e.g., protected areas, steep slopes, mountain tops)

    d) **Non-WUI (very low housing density):** Areas with ≥50 percent cover of wildland vegetation and <6.18 houses per km2 (e.g., dispersed rural housing outside neighborhoods)

    e) **Non-Vegetated or Agriculture (low and very low housing density):** Areas with <50 percent cover of wildland vegetation and <49.42 houses per km2 (e.g., agricultural lands and pasturelands)

    f) **Non-Vegetated or Agriculture (medium and high housing density):** Areas with <50 percent cover of wildland vegetation and ≥49.42 houses density per km2 (e.g., urban and suburban areas, which may have vegetation, but not dense vegetation**)**

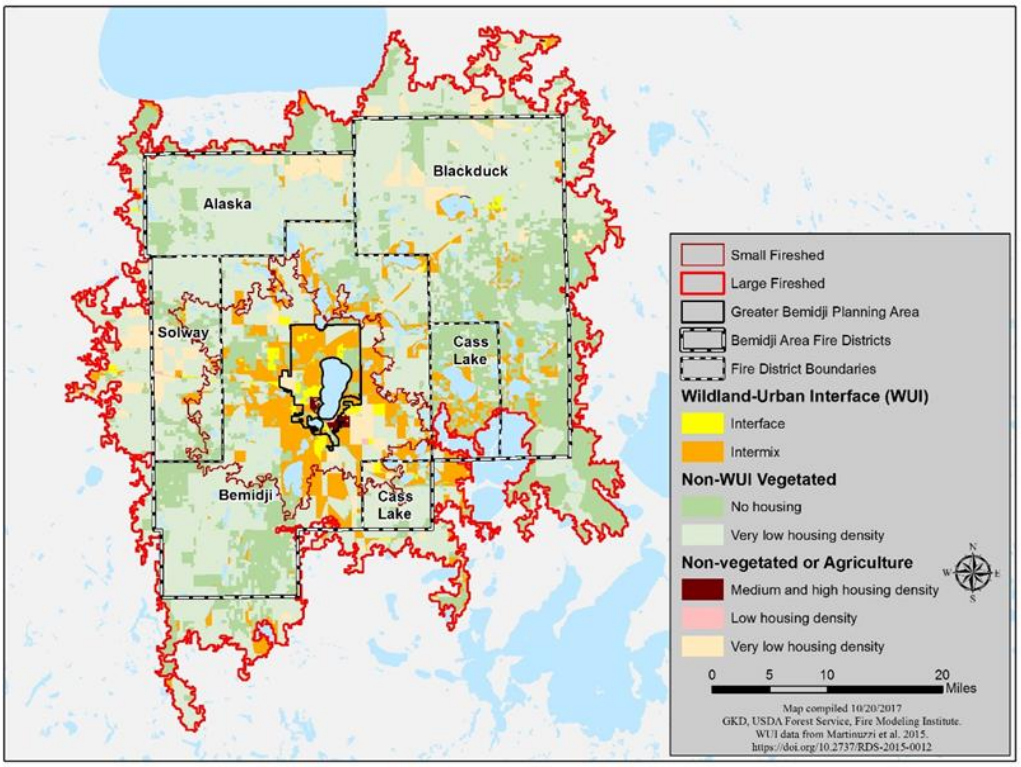

Figure 8. Greater Bemidji Area map of the Wildland Urban Interface and Wildland Urban Intermix

[4] Schlosser, W.E. 2012. Defining the Wildland-Urban Interface: A Logic-Graphical Interpretation of Population Density. Kamiak Ridge, LLC

Use Hazard Assessments to Support Land Use Policy and Regulation

The landscape-level hazard assessment map will be supplied as a geodatabase to the Greater Bemidji Area. This will allow the user to explore a hierarchy of hazard/exposure metrics. For example, when users click on a watershed polygon they will see the elements that contribute to the calculation of the final hazard rating. It will also provide a ranked scale to guide implementation of the WUI Code with regards to the degree of standards that must apply based on hazard. Finally, the spatial identification of the WUI, using the SILVIS Lab approach can provide guidance as to what areas within the GBA that the WUI Code will apply.

If the Greater Bemidji Area implements a Parcel-Level Assessment program, these data can be used as a measure of consequence. For example, an indirect relationship can be established between the number of properties in the WUI that are recorded as mitigated to a specific standard with the reduced consequence (higher ignition resistance) ranking, as opposed to properties that have not been mitigated, which would be recorded as a higher consequence (lower ignition resistance).

Tracking changes in the landscape hazard level and parcel-level assessments over time will provide a measure of success in wildfire risk reduction.

❖ Tips and Additional Resources

The expertise of a GIS specialist will be required to ensure the data are made available to land use planners and the development community in the appropriate format.

The risk assessment tools must also be kept up to date to ensure their relevance and accuracy. The RMRS has developed a best practices document to provide guidance to the Greater Bemidji Area on the methodology for updating the assessment. A minimum default five-year update schedule is recommended, with updates to occur 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.

The hazard assessment outputs should be strongly linked as a decision support tool for implementing the proposed WUI Code and planning policies (as discussed in Recommendations 2 and 4).

RECOMMENDATION 2: Adopt a Wildland-Urban Interface Code

Adopt the International Code Council International Wildland-Urban Interface Code (IWUIC) to establish minimum wildfire safety standards for future development in designated wildland-urban interface areas of the Greater Bemidji Planning Area.

❖ Why This Recommendation Matters

Current Regulations and Codes

Currently, there are very few references that support wildfire mitigation in the Greater Bemidji Planning Area's regulatory framework. The two primary documents that regulate development within the Greater Bemidji Planning Area are the *Greater Bemidji Area Zoning and Subdivision Ordinance* (*Revised June 14, 2017*) and the *Minnesota State Fire Code (2015)* adopted by the City of Bemidji and the Greater Bemidji Planning Area. Additional detail on these references is provided in Table 3 (below).

However, the *Greater Bemidji Area Zoning and Subdivision Ordinance (Revised June 14, 2017)* contains several sections that will likely conflict with the implementation of wildfire risk reduction policies and ordinances. Two examples include: 1) the tree preservation section, which promotes the retention or planting of highly flammable conifer trees adjacent to structures within new developments: and 2) the screening section, which promotes the use of highly flammable "densely planted compact evergreen hedge(s)."

Table 3: Greater Bemidji Area Wildfire Mitigation References	
Greater Bemidji Area Zoning and Subdivision Ordinance	
Section Title	**Section Summary/Comments**
Article IV Section 401 A. Private Roads and Driveways	Places the responsibility of private road maintenance on the property owner "...to ensure adequate service by emergency vehicles…" **This section addresses fire vehicle access; however, it does not specifically address a standard to use and does not address a requirement for more than one access.**
Article X Section 1006. Landscaping Requirements 7. Unattended Vegetation	Every owner and responsible party who fails to keep private property clear of unattended vegetation is in violation of this article and subject to the remedies and enforcement specified herein. **This section indirectly supports the intent of wildfire mitigation; however, the definition of unattended vegetation does not have a specific state or local law to reference.**
Article X Section 1006. Landscaping Requirements 8. Prohibited Vegetation	Every owner and responsible party is in violation of this Ordinance and subject to the remedies and enforcement specified herein if they fail to keep their private property clear of vegetation that: a. That presents a fire hazard; **This section supports the intent of wildfire mitigation; however, it does not define what constitutes a fire hazard, nor what the standard is to reduce the wildfire hazard to an acceptable level.**
Article X Section 1027. Special Provisions for Fire Protection and Safety	The current Minnesota State Fire Code (MN Statutes 299F.011) and reference standards, including all subsequent amendments and updates thereto, shall be required for all commercial site improvements. **This section adopts the "current Minnesota State Fire Code (MN Statutes 299F.011); however, restricts it to commercial site improvements only.**
Minnesota State Fire Code Wildfire Mitigation References	
Section Title	**Section Summary/Comments**
Section 307 Open Burning and Recreational Fires	The fire chief is authorized to order extinguishment if open burning creates a hazardous situation or a required permit has not been obtained. **This section supports wildfire risk reduction by reducing the likelihood of human-caused fires through negligent open burning.**
Section 319 Clearance of Vegetation from Structures	Addresses the clearance of vegetation from structures, provides some guidance in mitigation of vegetation within 30 feet of a structure as well as providing the authority for a fire chief to order additional mitigation out to 100 feet from the structure "because of extra hazardous conditions." **This section is in alignment with some of the standards within the IWUIC; therefore, there would be no conflict if the IWUIC were adopted. However, the IWUIC provided additional mitigation standards that would further reduce structure vulnerability.**
Section 503 Fire Apparatus Access Roads	Requires fire apparatus access to buildings (with exceptions). **This section focuses on structural fire response and does not account for multiple access requirements or evacuation/fire fighter egress routes.**
Section 508 Fire Protection Water Supplies.	Addresses fire protection water supplies for urban structure fire suppression. **This section supports wildfire mitigation; however, it does not specifically address water supply requirements for wildfire response.**
Bemidji Chapter 16 Fire Prevention and Protection Wildfire Mitigation References	
Section Title	**Section Summary/Comments**
16-1 Open burning of leaves	Requires a permit for open burning. **This section allows the tracking and enforcement of open burning activities.**

Opportunity to Adopt a Wildland-Urban Interface Code

To adequately plan for and address wildfire in its built environment, the CPAW team recommends the Greater Bemidji Area Planning Commission adopt the 2015 edition of the International Code Council's International Wildland-Urban Interface Code (IWUIC). The IWUIC is a model code that is intended to supplement other building and fire codes adopted by a jurisdiction.

The IWUIC 2015 edition is organized into seven chapters and eight appendices, as follows:

Chapter 1: Scope and Administration
Chapter 2: Definitions
Chapter 3: Wildland-Urban Interface Areas
Chapter 4: Wildland-Urban Interface Area Requirements
Chapter 5: Special Building Construction Regulations
Chapter 6: Fire Protection Requirements
Chapter 7: Referenced Standards
Appendix A General Requirements
Appendix B Vegetation Management Plan
Appendix C Fire Hazard Severity Form
Appendix D Fire Danger Rating System
Appendix E Findings of Fact
Appendix F Characteristics of Fire-Resistive Vegetation
Appendix G Self-Defense Mechanism
Appendix H International Wildland-Urban Interface Code Flowchart

When adopted in full, the IWUIC provides jurisdictions with a *minimum* set of special regulations for the "safeguarding of life and property from the intrusion of fire from wildland fire exposures and fire exposures from adjacent structures and to prevent structure fires from spreading to wildland fuels, even in the absence of fire department intervention." In other words, the IWUIC serves as a tool to strengthen the likelihood of a structure's survival and reduce reliance on suppression and response resources.

❖ Implementation Guidance

During the CPAW process, team members met with local stakeholders to discuss the potential adoption of the IWUIC. Stakeholders cited several **potential challenges** associated with the adoption of the IWUIC, including:

- Limited staff capacity to administer and enforce another code;
- Uncertainty about any additional costs to the home building market;
- Potential development-community resistance to adoption.

Discussions also revealed **many important benefits** to adopting the IWUIC, such as:

- Ensuring future development is built to a consistent mitigation standard provides a measurable way to address one of the Greater Bemidji Area's hazards.

- Requiring construction standards increases the resilience of structures to withstand wildfire. This also alleviates the Greater Bemidji Area's challenges associated with limited response capacity during times of heavy fire load.
- Adopting a code to specifically address wildfire aligns with other communities across the U.S. that face similar wildfire hazard.
- It establishes a long-term strategy to address challenges associated with rising insurance premiums and reduced coverage. As more states experience property losses from wildfire, some insurance companies have already begun adjusting their rates or dropping customers.

To fully realize the potential benefits of the IWUIC through a successful adoption process, the CPAW team provides the following implementation guidance.

1. Determine the Applicability of the IWUIC

Chapter 1 of the IWUIC, Scope and Administration, states that the provisions of the code shall apply to the construction, alteration, movement, repair, maintenance and use of any building, structure or premises within the defined WUI. (Chapter 4 of the IWUIC, Wildland-Urban Interface Area Requirements, provides requirements specific to subdivisions and structures.)

CPAW recommends that the Greater Bemidji Area amend Chapter 1 to apply only to all future development. Although this will not address existing development, it will reduce the required staff capacity to initially administer and enforce the code. It may also make it easier to adopt due to the application of a fairer standard.

2. Define the Wildland-Urban Interface

Chapter 3 of the IWUIC, Wildland-Urban Interface Areas, provides a methodology to establish and record wildland-urban interface areas based on the findings of fact. Some jurisdictions choose to use this standard language, while others amend this section with their own WUI definition. The Greater Bemidji Area is already in the process of assessing and mapping its wildfire hazard (see Recommendation 1).

CPAW recommends that the Greater Bemidji Area amend Chapter 3 to adopt their own wildfire hazard map based on the available RMRS hazard assessment information. This will provide for a more local reflection of the WUI.

3. Apply the WUI Code Standards Based on the Wildfire Hazard Assessment

Chapter 5, Section 502 of the IWUIC, Fire Hazard Severity, provides guidance for determining the fire hazard severity rankings that will in turn become the criteria for determining the appropriate fuel modification (Chapter 6, Section 603) and ignition-resistant construction (Chapter 5, Section 503) standards to apply. This is general guidance; however, the county will have a new wildfire hazard assessment (see Recommendation 1). CPAW recommends that the Greater Bemidji Area amend Chapter 5, Section 502, to instead use the newly developed wildfire hazard assessment to inform the IWUIC standards using the following process:

A. Determine the Landscape-Level Wildfire Hazard ranking in which the proposed development is located to understand the general likelihood of fire occurring.

If the proposed development is in a landscape with a ranking greater than LOW, then mitigation standards within the IWUIC will apply and proceed to B.

B. Use the following crosswalk (Table 4) to determine the appropriate IWUIC mitigation standards to apply:

Table 4: GBA RMRS Wildfire Hazard/ IWUIC Hazard Crosswalk

Table 603.2 WUI Area (2015 IWUIC)	**Table 603.2 Minimum Required Defensible Space (site/slope adjustment required)[1]**	**RMRS Mitigation Potential equivalent with ICC WUI Code Slope % category[2] Table 502.1 (2012 IWUIC)**			**24.301.181(21) Minimum IR Construction**		
Fuel Model[3]		**≤ 40 (≤ 30)**	**41-60**	**≥ 61**	**Non-Conform[4]**	**Conform**	**1.5x Conform**
Moderate hazard	30 ft.	Mod			IR2	IR3	Not required
High hazard	50 ft.			High	IR1	IR2	IR3
Extreme hazard	100 ft.	High	High	High	IR1	IR1	IR2

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 ICC WUI Code).
(2) The 2012 ICC WUI Code offers 3 slope classifications; however, the RMRS assessment is based on a universal accepted threshold that mitigation and fire behavior is significantly influenced at slopes of 30% or greater. For the purposes of the L&CC recommendations 30% will be used.
(3) "When required by the code official, fuel classification shall be based on the historical fuel type for the area" (Table 502.1- ICC WUI Code).
(4) **Non-conforming** indicates that the minimum slope-adjusted defensible space distances with appropriate mitigation cannot be achieved; as opposed to **conforming** in which the defensible space distances with appropriate mitigation can be achieved.

4. Designate Administration and Enforcement through the Land Use Department

The IWUIC requires the designation of a code official (Section 104), which may be the same or separate from the designated enforcement agency (Section 103). Administration and enforcement of the *Greater Bemidji Area Zoning and Subdivision Ordinance* is delegated to the Greater Bemidji Area Planning Department, while enforcement of the *Minnesota State Fire Code (2015)* is delegated to the City of Bemidji Fire Department.

CPAW recommends that the administration and enforcement of the IWUIC should be under the joint purview of the City of Bemidji Fire Department and the Greater Bemidji Area Planning Department. This would provide consistency with the administration and enforcement of the *Greater Bemidji Area Zoning and Subdivision Ordinance* and the *Minnesota State Fire Code (2015).* If the City of Bemidji Fire Department hires a dedicated Fire Prevention Officer, the administration and authority of the IWUIC could be re-directed to his/her purview.

5. Align Zoning and Subdivision Ordinance with IWUIC

Upon adoption of the IWUIC, the Greater Bemidji Area should consider the best approach to linking the IWUIC with its Zoning and Subdivision Ordinances, as well as the *Minnesota State Fire Code*, to reconcile any potential conflicts and add appropriate references. Conflict resolution language should encourage the use of the more restrictive code with public safety as the primary objective.

CPAW recommends the development language for the adoption of the IWUIC to ensure there is a clear process for resolving conflicts.

6. Supplement Administration Capacity with Approved Qualified Professionals

On-site assessments are not currently required as part of the Greater Bemidji Area's application and development process. Implementation of the IWUIC, however, may require an on-site assessment to verify local hazard conditions. Due to current staff capacity limitations, these on-site assessments can also be performed by contracted qualified professionals on an as-needed basis.

7. Engage at State Level to Incorporate Additional WUI Components

As the Greater Bemidji Area moves a local regulatory framework forward to address its WUI, there is also an opportunity to engage with the State Fire Marshal's Office to provide input and suggestions on amending future state fire codes to further incorporate WUI components. This would promote broad benefits to other Minnesota communities seeking state-level guidance on WUI regulations.

❖ Tips and Additional Resources

Education and Outreach Materials

With the exception of retrofits, the IWUIC does not address existing development or subdivisions that have already been platted and approved. Therefore, there are limitations to the extent of development mitigated by the IWUIC. It will be necessary to consider the adoption of the IWUIC as part of a larger wildfire mitigation risk-reduction strategy that includes education, outreach, and other means to incentivize voluntary mitigation efforts.

A new nine-page Firewise Landscaping in Northeastern Minnesota brochure provides a guide to protecting homes and businesses from wildfire using fire-resistant landscaping and plants. The guide includes a list of local boreal tree and plant species and their relative flammability, which could serve as the basis for future landscaping guidance. Wildfire mitigation literature, videos, and research on home construction techniques are also available for free from the Insurance Institute for Business & Home Safety, and the National Fire Protection Association's Firewise USA™ program. Additional resources are listed under Recommendation 3.

RECOMMENDATION 3: Expand Capacity to Educate, Prevent, and Implement Wildfire Mitigation Activities

The Bemidji Fire Department, in collaboration with other partners, should expand its capacity to educate, prevent, and implement local wildfire mitigation activities through increased staffing, trainings, and development of programmatic resources and outreach materials.

❖ Why This Recommendation Matters

Overview

During the CPAW process, many stakeholders expressed the sentiment that they were a "victim of their own success" when it comes to wildfire awareness. This is because most local wildfires are quickly suppressed before they become a disaster, thanks to the rapid response and resources available from the Bemidji Fire Department and Minnesota Department of Natural Resources. While all stakeholders agree that avoiding disaster is a successful outcome, the unintended consequence is that the public generally does not perceive wildfires to be a significant local concern, nor do they understand the role they play in wildfire ignitions.

This results in a significant public education gap, most notably because 100 percent of local wildfire ignitions in the Greater Bemidji Area are human-caused. This number could be reduced through increased outreach activities such as public awareness campaigns or mitigation incentive programs. While the Bemidji Fire Department services include fire prevention and outreach, minimal time is dedicated specifically to wildfire prevention activities due to limited staff capacity and other important job duties.

To successfully address this need, CPAW recommends that the Bemidji Fire Department increase its capacity by creating a dedicated prevention/mitigation role. CPAW also recommends that fire department staff work in collaboration with other partners, including the Joint Planning Board staff and Minnesota Department of Natural Resources, to support internal staff learning exchanges, develop outreach materials, and increase public awareness.

Bemidji Fire Department Services

The Bemidji Fire Department provides fire protection, fire prevention, technical rescue, and emergency services to 18 local government units in Beltrami and Hubbard counties. Bemidji Fire Department also provides the Bemidji Regional Airport with fire protection and rescue services.

The Bemidji Fire Department provides fire protection, prevention, and technical rescue and emergency services. (Photo source: CPAW)

Bemidji Fire Department is a combination fire department and currently has 48 firefighters and fire officers. Administrative and support functions are performed by the Fire Chief, a paid-on-call (POC) Deputy Chief, two POC Assistant Chiefs, and one POC Training Officer.

In 2016, the Bemidji Fire Department responded to 107 fires: 30 wildland fires, 36 building fires, 16 vehicle fires. This represents a typical year in which approximately one-third of fire-related calls are for wildland fire. The majority of the department's calls are for service calls (e.g., water problems, assist police, animal rescues, unauthorized burning) and rescue and emergency medical services. Total calls for 2016 were 2,195.[5]

Fire Prevention Activities

The Bemidji Fire Department's fire prevention activities are not currently organized within a formal division. Prevention-related activities include fire inspections, public education, and outreach and are performed primarily by the Fire Chief and several other personnel. Activities and accomplishments are outlined in the Bemidji Fire Department's annual report. Due to capacity constraints, a large majority of time is currently allocated to *non*-wildland fire activities. Recent past activities have included age-appropriate fire safety curriculum delivered to schools, Youth Fire-Setting Intervention/Prevention program, and smoke alarm installations. The Department reported participation from more than 5,100 people in fire prevention/education activities in 2016.

Other state and federal partners play an important role in promoting wildfire education. For example, the Minnesota Department of Natural Resources works with local communities through the Minnesota Firewise Project to improve mitigation education, increase access to grant opportunities, promote dry hydrant installation programs, and more.

❖ Implementation Guidance

There are multiple ways that the Bemidji Fire Department and its partners can increase community engagement, public education, and wildfire awareness efforts. The following recommendations are ideally intended to be coordinated, but can be implemented independently depending on funding, staffing, timing, and availability of other resources.

1. Create A Prevention/Outreach Position

In 2011, the City of Bemidji contracted with Emergency Services Consulting International to perform a Feasibility Study for Shared or Cooperative Fire and Emergency Services provided by the Bemidji Fire Department. Included in the study's findings was that the department lacked the appropriate clerical support services to assist in training and education within the department. While the feasibility study primarily addressed operational training needs, stakeholder interviews conducted during CPAW also revealed the need for more clerical and administrative support which would allow existing staff to spend more time on other job responsibilities, including wildfire prevention activities.

[5] Bemidji Fire Department. 2016 Annual Report.

More recently, the Insurance Services Offices (ISO) recommended that the Bemidji Fire Department expand its fire prevention efforts as a potential way to increase points under the Community Risk Reduction section. Gaining additional points would improve the department's overall classification, which in turn would have positive outcomes from the insurance underwriting process and, ultimately, the cost of local insurance premiums.[6]

Given workloads and responsibilities, it's unrealistic that current fire department personnel can take on additional fire prevention duties which include wildfire. Addressing this need would require creating a dedicated position for fire prevention and education. As mentioned above, all of Bemidji's wildfires are caused by human ignitions. To address this challenge, the local population require education on safer methods for debris pile burning, responsible property mitigation techniques, and planning for evacuation safety.

A dedicated position can also perform other related program tasks, such as seeking and facilitating local grant opportunities, conducting Firewise workshops in coordinating with MNDNR, and promoting the development of Community Wildfire Protection Plans. This role would meet both immediate, short-term needs and long-term cultural changes to wildfire.

2. Conduct Internal Learning Exchanges on Wildfire Planning Topics

As part of the CPAW process, team members delivered an internal training to the Joint Planning Board staff. This training focused on core wildland-urban interface concepts, such as wildfire risk, fire behavior and fuels, and risk reduction opportunities through planning. The training also facilitated a learning exchange between the Fire Chief and Joint Planning Board staff through the incorporation of a recent local fire example that highlighted planning challenges and opportunities.

Conducting similar learning exchanges between the Joint Planning Board and Bemidji Fire Department staff in the future will continue to promote understanding across disciplines and the implementation of wildfire planning activities. Fire department and planning staff should consider scheduling this on an annual basis and invite the participation of other partners such as Minnesota Department of Natural Resources and U.S. Forest Service.

Technical handouts can show local examples of Firewise landscaping, such as the home above. (Photo source: CPAW)

3. Collaborate with Partners to Develop Outreach Materials

One of the outcomes from the recent training discussion (referenced above) was the suggestion to develop and provide technical materials to educate developers on Firewise construction techniques. This need was recognized for several reasons:

[6] The Community Risk Reduction section of the Fire Suppression Rating Schedule (FSRS) used by ISO offers a maximum of 5.5 points, resulting in 105.5 total points available in the FSRS. The inclusion of this section for "extra points" allows recognition for those communities that employ effective fire prevention practices. More information is available under the ISO Community Hazard Mitigation website.

- As population is projected to continue increasing in the Greater Bemidji Area, new development activity will occur. This creates an opportunity to promote Firewise construction and landscaping during the building permit process.
- Any future adoption and implementation of wildland-urban interface regulations will also require education. Technical handouts are beneficial to visually explain regulatory standards and potentially reduce other internal code conflicts (see Recommendation 2 for more details).
- Educating new residents and the development community recognizes that multiple stakeholders have a role in wildfire mitigation.

Firewise Minnesota has already developed resources that may be helpful as technical handouts. Working in coordination with the Minnesota Department of Natural Resources, the Bemidji Fire Department and Joint Planning Board should determine whether any materials can be further customized to reflect local planning. Partners should also discuss whether it would be appropriate to provide this information in electronic format on the Greater Bemidji Area Joint Planning Board's Applications webpage as supplemental materials.

4. Increase Wildfire Awareness Through Website, Social Media

General fire prevention and education information for the public is communicated through the Bemidji Fire Department's website and social media, public meetings, school education programs and similar activities. These communication channels are generally focused on fire safety but rarely include references to wildfire mitigation. The public can also find information about current wildfires, weather forecasts, and mitigation resources on the Minnesota Department of Natural Resources website.

The Bemidji Fire Department uses Facebook to promote local wildfire awareness.

The Bemidji Fire Department should add resources and information about wildfire on its website, including links to the Minnesota Department of Natural Resources Firewise and Wildfire Information Center webpages. This is a relatively easy way to promote wildfire education to the public and reinforce the fire department's role in mitigation.

Additional considerations during the web content development process include:

- Be descriptive when including links to other resources. This helps the viewer navigate a page more easily and determine where to go for more information. For example, if including a link to Firewise landscaping, add a sentence on how fire can spread from vegetation to a home.
- Add a visually-compelling or interactive feature item on the home page that engages a resident immediately and directly. For example, a short video or narrated slide show can encourage viewers to stay on the page longer and learn about local wildfire challenges and mitigation strategies.

- Reduce technical jargon and acronyms whenever possible. Terms such as "mitigation," "hazardous fuels," and "wildland-urban interface" can be confusing to the public.
- Coordinate messages with other partners to ensure branding and messages are consistent. This also helps maintain trust and credibility.

❖ Tips and Additional Resources

- **Minnesota Department of Natural Resources** has an active Minnesota Firewise Project website that contains local resources and information for property mitigation, community grants, home assessment tips, and more.
- **Social media support** is available from sources such as the Department of Homeland Security, whose Ready.gov website provides a Wildfire Safety Social Media Toolkit. The toolkit includes sample social media messages with links and additional resources.
- **Wildland-urban interface trainings** for planning, mitigation, evacuation and other topics are available through national organizations, including the Federal Emergency Management Agency and National Fire Protection Association.
- **Local case studies** from wildfires can be an effective way to train and educate others, especially when highlighting when wildfire mitigation worked. A recent mitigation case study from Boulder County, CO during the Cold Springs Fire (2016) may be helpful as an example.

RECOMMENDATION 4: Develop and Update Existing Greater Bemidji Area Plans to Account for Wildfire

Update the Greater Bemidji Area Comprehensive Plan, develop a Community Wildfire Protection Plan, and address long-term post-disaster recovery to acknowledge wildfire's potential impact to the community's natural environment, built environment, and economy.

❖ Why This Recommendation Matters

Overview

The Beltrami County Hazard Mitigation Plan: Update 2013 lists wildfire as the second priority hazard in the county behind structure fire. Priority hazards impact or have the potential to impact the county by causing monetary losses, disrupting lives and business, and potentially injuring people.[7] The CPAW document review process found the current Greater Bemidji Area plans included minimal references to wildfire, or the wildland-urban interface, and only a few references to other natural hazard events.

A comprehensive approach to addressing wildfire's role in the natural environment, built environment, and economy would allow the Greater Bemidji Area to make informed planning decisions. The community's plans, goals, and daily actions signal to the public, industry professionals, and other stakeholders what is appropriate to guide future development and environmental management objectives as the Greater Bemidji Area continues to experience significant growth and longer wildfire seasons. Including goals and objectives related to wildfire in community plans allows wildfire resilience to be incorporated into everyday decisions that reflect the Greater Bemidji Area's values and level of risk tolerance.

❖ Implementation Guidance

1. Update the Greater Bemidji Area Comprehensive Plan

Due to the timing of the Greater Bemidji Area Comprehensive Smart Plan update, the CPAW team accelerated the recommendations process to assist the Joint Planning Board in incorporating wildfire in the plan update. Through a Comprehensive Plan Memo outlining recommended changes to the plan, the CPAW team focused on three overarching recommendations to ensure wildfire language was incorporated into the planning update:

[7] Beltrami Hazard Mitigation Plan: Update 2013; Section III: Hazards (page 38).

Incorporate "Community Safety" into the new mission statement and introductory plan language in Chapter 1.

This promotes future objectives and policies that consider natural hazards including wildfire, community safety, and resiliency. It also helps build public awareness of the role that land use planning can serve in reducing community risks from natural hazards.

Develop new objectives and policies to address the wildland-urban interface.

Adding new wildfire-related objectives and policies to the Greater Bemidji Area Comprehensive Plan update encourages a safer, more resilient community by utilizing land use strategies to address this priority hazard. An identified list of Comprehensive Smart Plan recommendations focused on ways to incorporate community safety into the plan while providing specific recommendations to address the wildland urban interface and community wildfire risk in the plan's goals and objectives. Recommendations were outlined for multiple areas of the plan including land use, community facilities, housing, transportation, parks, trails and open space, natural resources, sustainability, and community culture. Incorporating appropriate wildfire language in the goals and policies of these planning subjects will guide future decisions to ensure environmental, social and economic goals are met. These actions will also strengthen ties to existing and proposed wildland-urban interface regulations outlined in Recommendation 2.

Update the Greater Bemidji Area Action Plan Table to reflect any new wildfire policies.

The new wildfire-oriented policies will require updates to the Greater Bemidji Area Action Plan Table. Reflecting the proposed updates in the action table will assist the Joint Planning Board in tracking actions and progress, create accountability, and allow for the easier revisions of policies in the future.

2. Develop a Community Wildfire Protection Plan

The Minnesota State Hazard Mitigation Plan calls for local responsibility to utilize best management practices for the wildland-urban interface and promotes the creation of countywide CWPPs to identify local wildfire hazards. The Beltrami County Hazard Mitigation Plan also calls for the creation of a CWPP to identify mitigation strategies for fuels reduction and structure hardening practices and to create a community council to oversee the creation of the plan. Additionally, during the two CPAW site visits, it was mentioned that coordination of wildfire mitigation efforts was needed to effectively address the multi-faceted issues in the wildland-urban interface. Following state and county recommendations to properly address wildfire mitigation in the Greater Bemidji Area, efforts should be made to coordinate with local, county, state, and other relevant stakeholders to create a countywide CWPP.

A countywide CWPP will have broad benefits for the Greater Bemidji Area, including potentially increasing stakeholder engagement and facilitating functional, on-the-ground mitigation efforts. Initiating the CWPP development process will require a dedicated group of stakeholders. CPAW encourages the Greater Bemidji Area Planning Staff and City of Bemidji Fire Department to advocate for the formation of a wildfire committee to regularly meet with the goal of creating a countywide CWPP.

As outlined in Recommendation 3, CPAW recommends a dedicated City of Bemidji Fire Department Fire Prevention position that can help advocate for and play a leadership role in the creation of a CWPP. This person can lead wildfire outreach, engagement, enforcement, and mitigation activities. The position can also act as a regional liaison, coordinating with county, state, and federal stakeholders who already have a good working relationship with the Bemidji Fire Department.

While there may be several short-term challenges associated with creating a countywide CWPP, there are many reasons for stakeholders to consider developing a plan at this scale, including:

- A CWPP becomes the "collector" of local wildfire and WUI information and tracks implementation efforts in a coordinated and organized manner.
- A CWPP in compliance with the Healthy Forest and Restoration Act (HFRA) provides an avenue for influencing fuel treatment decisions on adjacent national and state forests, and becomes eligible for federal and state mitigation grant opportunities.
- The development process provides an opportunity for community stakeholders to coordinate actions, knowledge, and funding to support more effective response, training, enforcement, and educational opportunities.
- A CWPP can assist in planning for future growth in WUI areas and supplement current response and mitigation capabilities in the Greater Bemidji Area.

Link to Community Planning Topics

An effective CWPP should link to community planning topics such as transportation and access routes, critical infrastructure, neighborhoods and homes, natural resources, and other uses. Creating links between the CWPP and community planning processes ensures these two dynamic activities remain in sync. CWPP actions should therefore connect to and support the implementation of land use policies and regulations. Recommendation 2 identifies the adoption of a Wildland-Urban Interface Code, which may require cross-referencing and additional details to support implementation. For example, introducing new mitigation standards for future development in the Greater Bemidji Area will require a public outreach and stakeholder engagement effort.

Similarly, including references to a CWPP in the Comprehensive Plan creates a potential foundation for future enforcement mechanisms throughout the Greater Bemidji Area. Referencing CWPP goals and objectives and referring to a wildfire risk map in the Comprehensive Plan also supports a culture of wildfire mitigation throughout the Greater Bemidji Area's land use planning decisions. Any conflicts within the Comprehensive Plan should also be amended to ensure full integration of CWPP goals and objectives into the Greater Bemidji Area's planning process. To the extent possible, the proposed CWPP should also link with the Bemidji State Park Management Plan and State Forestry Management Plans to coordinate fuels management priorities in the area. The necessary stakeholders to form a CWPP council could also form the basis for a Greater Bemidji Area Post-Disaster Recovery Plan, outlining goals, objectives, and priorities of a community recovery process after a wildfire event.

Create an Action Table

A CWPP should include specific deliverables, identify accountability and determine timelines for ensuring continued implementation. One of the key ingredients to successful CWPP implementation is an action table, which helps clearly define the following:

- **Action:** Specific action to be taken.
- **Target Area:** Where it applies—e.g., community at risk, or planning area within community at risk.
- **Lead:** Lead agency responsible and accountable for administration and implementation.
- **Coordination:** Supplementary stakeholders (e.g., county and city agencies and departments) critical to implementation.
- **Timeframe:** Timeframe for implementation, unless this is an ongoing task.
- **Links:** References to other documents, policies, or community planning initiatives.
- **Funding:** Potential funding resources, if necessary for implementation.
- **Follow-Up:** Information on action status updates and accomplishments.

Creating crosswalks from this action table to other Greater Bemidji Area and county actions, such as the identified mitigation actions in the Beltrami County Hazard Mitigation Plan, allow for more detailed wildfire mitigation strategies to be presented while influencing planning actions in and around the Greater Bemidji Area. Prioritization of these actions can assist in achieving broader planning objectives and justify additional sources of funding. Keeping the CWPP frequently updated can also provide elected officials and fire officials with timely information during wildfire events.

3. Incorporate Wildfire into Additional Community Plans

Parks, Open Space, and Trails Plan

The Greater Bemidji Area prides itself on an integrated urban and natural environment that is a major asset for people moving to and visiting the area. The community's reliance on natural areas and "fostering the City as a park" concept, as mentioned in the Bemidji Park, Open Space and Trails System plan, inherently relies on a well-managed ecosystem while not contributing to increased wildfire hazard. Because the community is in a fire-dependent ecosystem, it is critical to promote the alignment of ecological-based fire management and restoration with wildfire mitigation strategies to manage parks and open spaces.

Supporting wildfire mitigation strategies and best practices in the Bemidji Parks, Open Space and Trails System Plan can also raise awareness of wildfire's role and impacts on environmental systems and sensitive areas while strategically mitigating the Greater Bemidji Area's wildfire risk. Incorporating fuel mitigation and defensible space opportunities into open space areas would allow for increased utilization of overgrown forested areas while reducing the risk of wildfire. Strategic placement of multi-functional amenities for public enjoyment and alternative transportation can also double as fuel breaks around communities and critical infrastructure. An example of this practice can already be found with the placement of athletic fields surrounding Bemidji High School creating significant defensible space. These policies should also be reflected in other area plans such as the Greater Bemidji Area Comprehensive Plan and the future CWPP.

Aerial view of Greater Bemidji Area parks. (Image source: 2011 Bemidji Park, Open Space, and Trails System Plan)

❖ Tips and Additional Resources

Minnesota CWPP Examples:

- Multiple counties in northern Minnesota have developed CWPP's including Itasca County, Lake County, and St. Louis County and can be referenced in the development of a CWPP.
- The Minnesota DNR also provides instruction for Community Firewise Mitigation Grants.
- The State of Colorado's Planning for Hazards website contains significant reference materials for developing a CWPP and integrating wildfire into planning documents.

Post-Disaster Recovery Planning Resources

- The Minnesota Disaster Recovery Assistance Framework should be referenced when creating a Post-Disaster Recovery Plan.
- The APA Planning for Post-Disaster Recovery website includes multiple resources for pre-event recovery ordinances.
- The New Mexico After-Wildfire Guide includes a number of resources for post-fire recovery.

Conclusion

This report identifies four key areas where the Greater Bemidji Area can strengthen its approach to wildfire risk reduction through improved policy and regulation. Many CPAW recommendations support one another, and the Greater Bemidji Area should determine its implementation priorities based on timing, capacity, resources, and other local factors. Tips and resources have been offered throughout this report as a helpful starting point. Follow-up implementation assistance may also be available to communities depending on their unique needs and CPAW's program funding.

Existing local partnerships provide an important ingredient for long-term success. (Photo source: CPAW)

General guidance can also be offered to improve the overall success of future implementation efforts:

- **Trainings and Capacity-Building.** Many of the recommendations rely on additional education of staff related to technical topics. Future trainings, such as in-depth courses on the Structure Ignition Zone, can improve internal capacity and reduce reliance on outsourcing. Dedicated positions (such as the Bemidji Fire Department Fire Prevention position) are also critical to sustaining long-term implementation.
- **Public Outreach and Engagement.** Underlying any successful effort to update community plans, policies, and regulations is a concerted approach to engage the public. This component will be essential to moving CPAW recommendations forward, and may include public meetings and presentations on wildfire, information brochures in development applications that illustrate mitigation standards, and one-on-one interactions occurring between fire department and planning staff with residents.
- **Stakeholder Collaboration.** As mentioned throughout the report, collaborating with a number of stakeholders is essential. Stakeholders will vary—where applicable, suggestions to individual agencies and departments have been provided. These suggestions serve as a starting point only and are not intended to limit the participants throughout the collaborative process.

Thoughtful execution of wildland-urban interface policies and regulations also takes time. While these recommendations are purposefully ambitious, it's important to acknowledge that change does not occur overnight. However, with continued commitment to address its wildland-urban interface, these recommendations serve as a long-term roadmap for the community's resilient future. As wildfires continue to affect communities across the United States, CPAW encourages the Greater Bemidji Area to pursue implementation of these recommendations.

CPAW Definitions

Built Fuels- Man-made structures (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.

Community Based Ecosystem Management- With an emphasis on local stakeholder participation, allowing the local community to manage their ecosystem based on the unique characteristics of an area.

Community Wildfire Protection Plan (CWPP)-Established by the 2002 Healthy Forest and Restoration Act, A CWPP is a plan that identifies and prioritizes areas for hazardous fuel reduction treatments 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, and structure protection.

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

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

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 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.

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

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

Embers- A small piece of burning material that can be thrown into the air due to the convective heating forces of a wildfire. Larger embers and flammable materials have the ability to sustain ignition through transport.

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.

Fire Adapted Communities -A group of partners committed to helping people and communities in the wildland urban interface adapt to living with wildfire and reduce their risk for damage, without compromising firefighter or civilian safety.

Fire Effects - The physical, biological, and ecological impacts of fire on the environment.

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

Firewise – Program administered by the National Fire Protection Association which teaches people how to adapt to living with wildfire and encourages neighbors to work together and take action to prevent losses. The program encourages local solutions for wildfire safety by involving homeowners and others in reducing wildfire risks by fostering defensible space and resilient structures for homes and communities.

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

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

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- The characteristics of a home and immediate surrounding area when referring to ignition potential during a fire event.

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

Prescribed Fire- A planned controlled wildland fire that is used to meet a variety of objectives for land managers.

Radiation Heat- Transmission of heat through waves or particles.

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

Resilience- The ability to recover from undesirable outcomes, both individually and organizationally.

Risk- A measure of the probability and consequence of uncertain future events.

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

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 measure 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, resources, system, or geographic area.

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.

Wildfires- Unplanned wildland fires resulting in a negative impact.

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

Wildland Fuels- All vegetation (natural and cultivated).

Wildland Urban Interface (WUI)- 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.

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.

APPENDIX A: Rocky Mountain Research Station Hazard and Exposure Mapping for Bemidji, Minnesota

***Greg Dillon**, USDA Forest Service, Rocky Mountain Research Station, Fire Modeling Institute*

The Fire Modeling Institute (FMI) at the U.S. Forest Service's Rocky Mountain Research Station was engaged by the group of planners and analysts leading the Community Planning Assistance for Wildfire analysis (hereafter, the CPAW team) for the community of Bemidji, Minnesota, to perform some assessments of spatial wildfire hazard and risk for the Bemidji area. This information is not intended to be a central part of the CPAW analysis for Bemidji, but will provide supplemental information that may be useful to local stakeholders. As such, analysts at FMI did not invest time in doing a detailed, locally-calibrated wildfire modeling analysis. Instead we used the results of wildfire simulation modeling done for a broader, national-scale assessment of hazard and risk, and summarized them down to scales relative to wildfire planning in Bemidji. In this document we provide a brief background outlining wildfire hazard and risk terminology and the type of modeling used, and we present results for the Bemidji area.

❖ Background

The literature on wildfire risk assessment consistently outlines three fundamental components needed to assess wildfire risk: likelihood, intensity, and effects (sometimes termed "susceptibility"). 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? Scott et al. (2013) conceptualized this as the wildfire risk triangle (Figure A-1). 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.

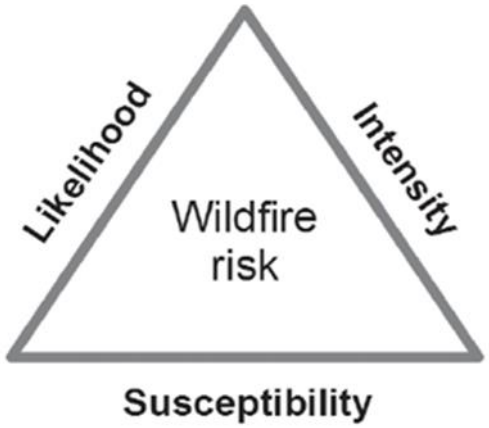

Figure A- 1. Wildfire risk triangle

For the purposes of this analysis, we are focusing 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, 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.

While we don't specifically address the susceptibility side of the triangle in this analysis, we do combine outputs from FSim with housing density data from 2010 U.S. Census (Martinuzzi et al. 2015a) and land use information provided by Beltrami and Hubbard Counties to address two other elements of wildfire risk: *exposure* and *transmission*. Exposure refers to the spatial intersection of wildfire likelihood and intensity with something of value, and is common in risk assessments (e.g., Ager et al. 2012, Scott et al. 2013). In this case, we are looking at the potential housing units exposed to wildfire. Transmission addresses the idea that fires may start in one location, but have consequences somewhere else (Ager et al. 2014). By looking at transmission we can identify the source areas that result in wildfire exposure to homes, and we can identify the interconnectedness of different fire districts and land uses with respect to wildfire.

To evaluate wildfire hazard, exposure, and transmission in the Bemidji area, we drew upon the most recent FSim simulations for the area, completed by the Rocky Mountain Research Station as part of a national effort. For this effort, simulations are run within each of 128 simulation areas across the country, called "pyromes," and outputs are calibrated to historical fire occurrence data since 1992 (Short 2017). We aggregated data from three pyromes in the Bemidji area. We use two 270-m resolution raster datasets from the FSim modeling in our analysis: 1) *burn probability (BP)*, which represents the annual probability of any location burning in a wildfire (i.e., likelihood); and 2) *conditional flame length (CFL)*, which is the average intensity for each pixel in the simulated fires, expressed as flame length in feet (i.e., intensity). A third dataset representing *integrated wildfire hazard* is generated as the product of BP and CFL. We also used point and polygon datasets from the FSim simulations representing simulated fire ignitions and perimeters.

❖ Analysis Areas

Wildfire is inherently a process that operates on the landscape independently of ownership, jurisdictional, or other municipal boundaries. For that reason, we began with jurisdictional boundaries for this analysis, but expanded outward to capture the contributing area from which wildfires might impact those boundaries. Just like a watershed is the land area from which water may drain to a specific point, line, or area, a "fireshed" is a potential source area for wildfires that could impact a particular location (Scott and Thompson 2015).

Based on feedback from the CPAW team and community stakeholders, we chose to create firesheds at two scales for the Bemidji area. The first is based off of the Greater Bemidji Area Planning Boundary (Figure A-2, black outline). To define this fireshed, we found all simulated fire perimeters from FSim that intersected with the planning boundary and used the combined footprint of those perimeters (Figure A-2, red outline).

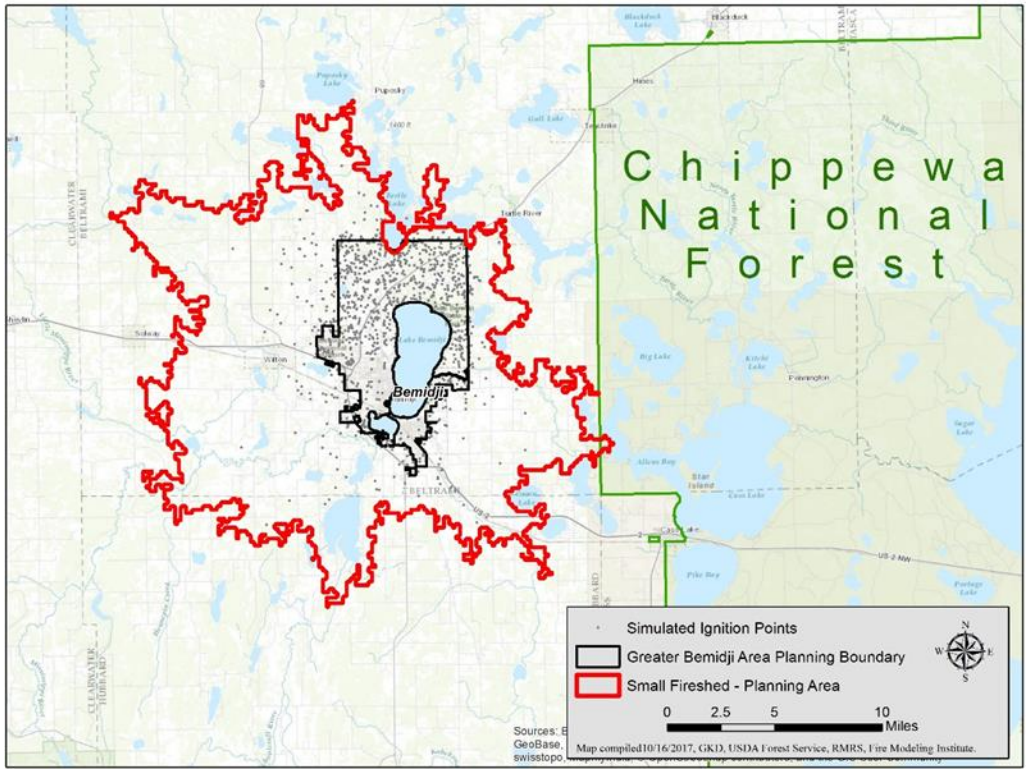

Figure A- 2. Greater Bemidji Planning Area fireshed

The second, broader fireshed is based off of fire district boundaries, and includes the five fire districts surrounding the city of Bemidji (Figure A-3, black outline). Those fire districts are: Alaska, Bemidji, Blackduck, Cass Lake (portions in Beltrami and Hubbard counties), and Solway. To define the fireshed for this area, we similarly identified all simulated fire perimeters from FSim that intersected with the combined fire district area and used the combined footprint of those perimeters (Figure A-3, red outline).

In the case of both firesheds, the simulated fire ignitions (dots in Figures A-2 and A-3) are tightly clustered inside the "target" areas, with only a loose collection of ignitions on the outside that could spread fire into the areas of interest. This tells us that the vast majority of fires in the Bemidji area since 1992 (our historical period against which FSim is calibrated) have been fairly small and haven't spread across large areas. As a result, the firesheds are not much larger than the areas for which they were created (which is in contrast to many areas in the western U.S. where firesheds for a community can extend for many miles outside of the community). By using the complete outer footprint of simulated fires that intersect the Bemidji area polygons, we are extending the fireshed out from what it would be if we just used the simulated ignition points. This is a conservative approach, and acknowledges that fires somewhat larger than those we've seen since 1992 are possible.

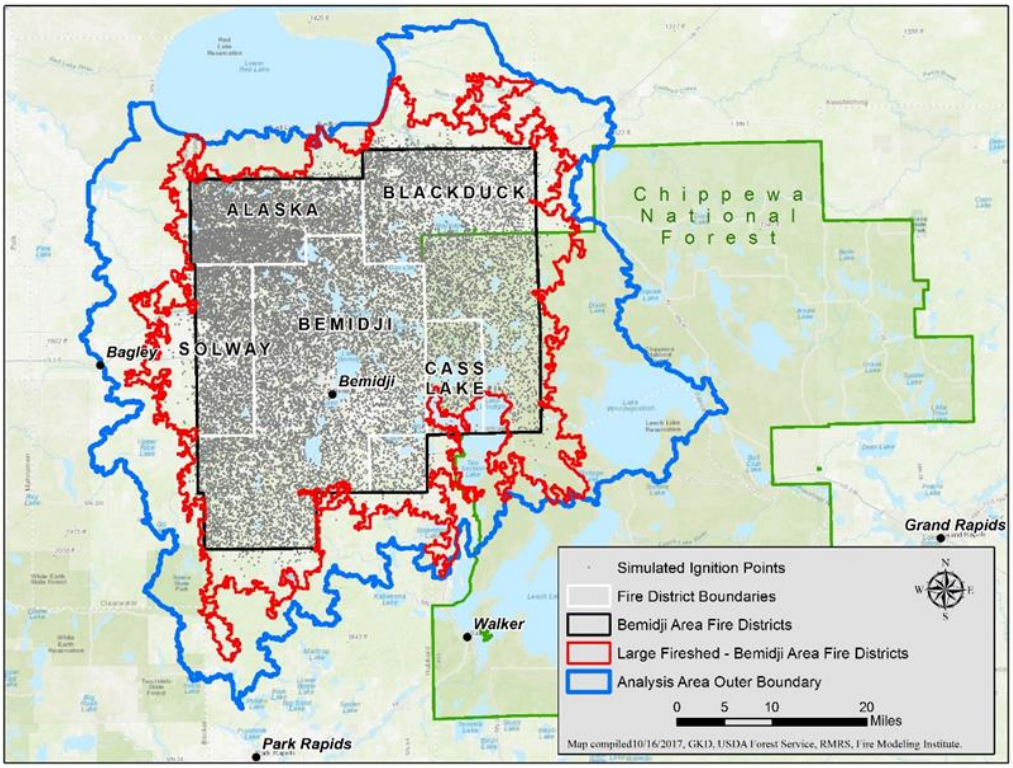

Figure A- 3. Fire district fireshed

❖ Analysis Methods

As noted previously, we used FSim modeling work done for national applications for the purpose of evaluating wildfire likelihood and intensity for this analysis. The data we used were produced in 2016 (Short et al. 2016), and were derived from spatial data representing vegetation and fuel conditions as of 2014 (https://www.landfire.gov/lf_140.php). We acquired the 270m-resolution raster geospatial outputs for three pyromes that intersect the large fireshed for Bemidji, aggregated them, and clipped them down to a 75km buffer around the five Bemidji area Fire Districts. We also acquired the spatial point and polygon datasets for the simulated ignition points and fire perimeters within this 75km buffer area.

To summarize the spatial metrics of likelihood, intensity, and hazard across the entire analysis area, we chose to use subwatersheds from the national USGS Watershed Boundary Dataset (https://nhd.usgs.gov/wbd.html). Subwatersheds are designated by 12-digit hydrologic unit codes, and are often referred to as "HUC12" watersheds. We identified all HUC12 polygons that intersected the larger of our two firesheds, and the outer boundary of those defines our area for FSim data summaries (Figure A-3, blue outline). There are 82 individual subwatersheds within this area, averaging 21,340 acres in size (range: 7,506 to 121,502 acres). 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.

To evaluate housing exposure, we used the 2010 wildland-urban interface (WUI) dataset (Martinuzzi et al. 2015a). This is a polygon GIS dataset that uses U.S. Census data from 2010 and USGS National Land Cover Data from 2006 to map categories of WUI as defined in the

Federal Register (see Martinuzzi et al. 2015b for details). Using census blocks as the primary mapping unit, this dataset depicts areas of interface, intermix, and non-WUI (Figure A-4). Each census block also contains the number of occupied housing units per square kilometer; we use this housing density when calculating wildfire exposure.

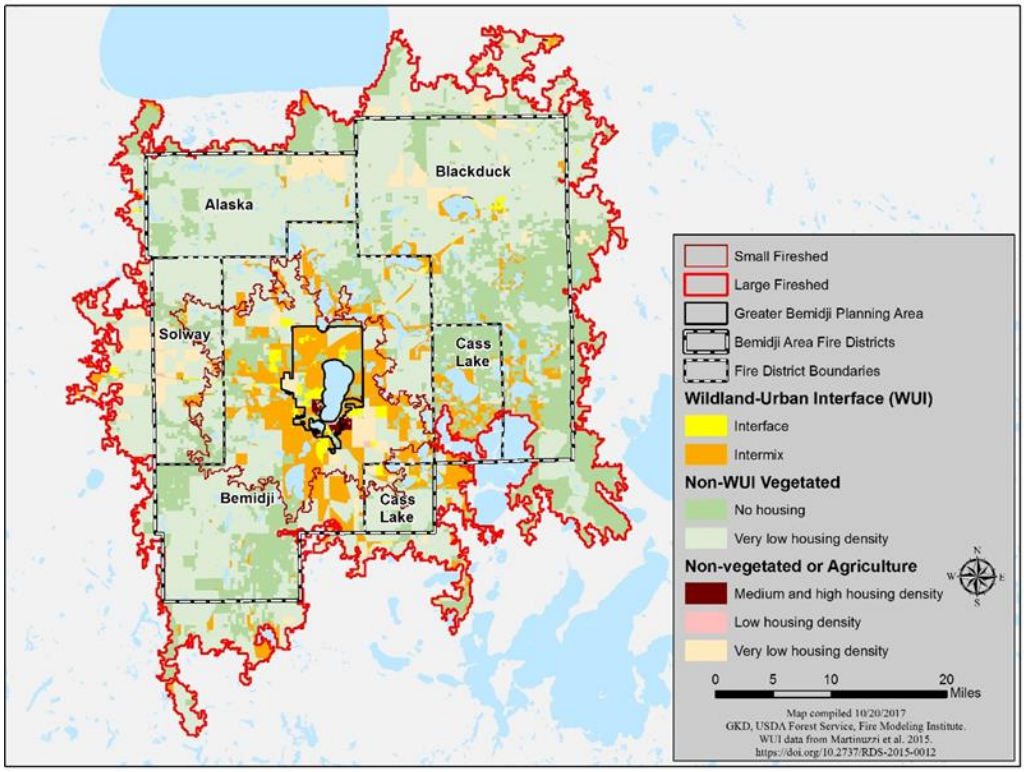

Figure A- 4. Wildland Urban Interface spatial definitions

Additional spatial data for analyzing wildfire transmission came from county-level GIS libraries for Beltrami and Hubbard Counties. Studies on wildfire transmission in the western U.S. often look at movement of fire among major categories of land ownership (generically referred to as "land tenures") such as private lands versus lands under federal, state, and local government management (Ager et al, 2014). Initial inspections of the simulated fires from FSim for the Bemidji area, however, made it clear that most fires in the analysis area occur on private lands. Therefore, we chose to evaluate fire transmission among two different types of land tenure categories more relevant to Bemidji: 1) fire districts; and 2) major categories of land use / jurisdiction (hereafter, just "land use"). We derived the fire district boundaries from township polygons, and the land use categories from parcel data from the two counties (Figure A-5). For areas outside of Beltrami and Hubbard counties where we did not have township polygons and/or parcel data, we just used the county name to identify land tenure.

To do the transmission analysis, we used the simulated fire perimeter data from FSim. Using a tool for ArcGIS called XFire (Ager et al., *unpublished*), we were able to analyze the intersection of several polygon datasets including the simulated fire perimeters, land use, fire districts, and WUI. Because each simulated perimeter stores the coordinates of its ignition point, the XFire tool allows us to identify the source land tenure for each fire, as well as the amount of land area burned in each land tenure category. The output from the XFire tool are matrices of acres burned and housing units affected by each combination of source and destination land tenure. From

these matrices, we calculated the amount of fire that stayed within the originating land tenure (i.e., non-transmitted) and the amount of fire that is outgoing and incoming for each land tenure. We also calculated network statistics that enabled the creation of wildfire network diagrams that illustrate the degree of connectedness and sharing of wildfire among different land tenures (Ager et al. 2015). We performed the transmission analysis for both types of land tenures (fire districts vs. land use) at both the small and large fireshed scales.

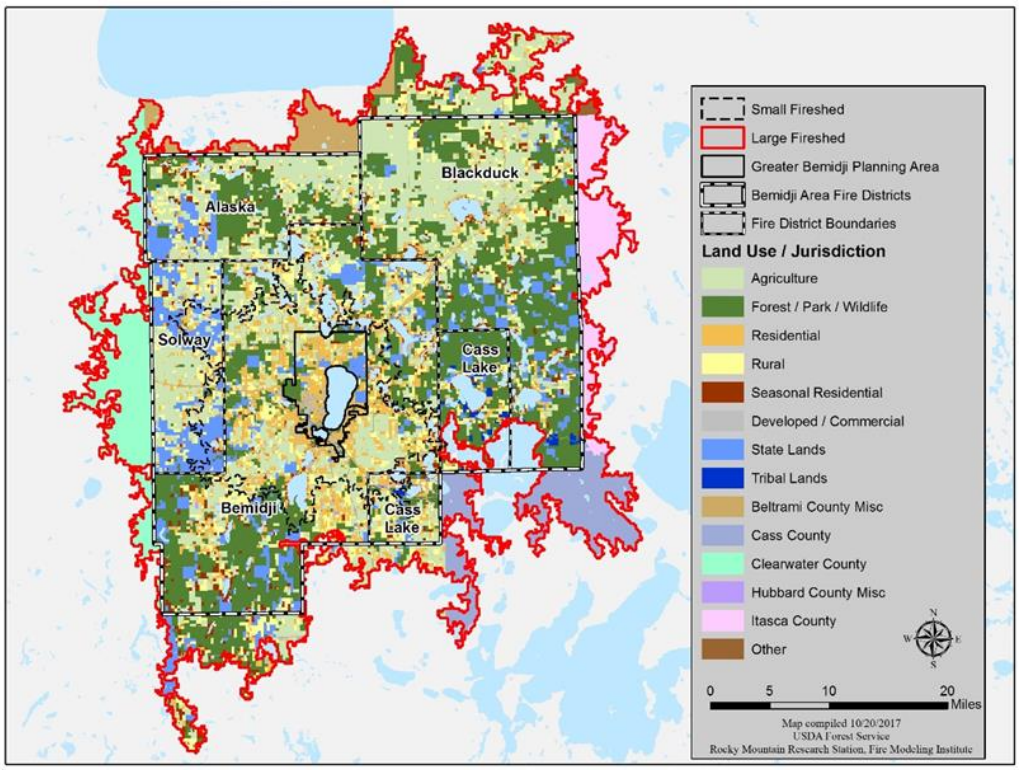

Figure A- 5. Fire transmission map based on land tenure

❖ Results

Wildfire Likelihood

Burn probability from FSim shows a strong gradient of lower values in the southeast part of the analysis area and higher values toward the northwest (Figures A-6 and A-7). BP values at the pixel scale range from 0 to 0.0143 (Figure A-6). These represent the probability that an area (i.e., pixel) will burn, given current landscape conditions and fire management practices; the upper end of this BP range represents about a 1.4-in-100 chance of burning in any given year. Within the range of BP values nationally, the BP in the Bemidji area is very low to moderate

When summarized to HUC12 watersheds, the gradient in BP values is very evident (Figure A-7). We calculated the average BP for each watershed, and classified those into three classes of low, moderate, and high. The classes are relative to the distribution of watershed averages only within the analysis area, and are based on quartiles. Low represents values below the 25th percentile, high represents values above the 75th percentile, and moderate is everything in between. The average BPs for watersheds range from 0.0001 to 0.0050, with a mean of 0.0008. This means, on

average, any *specific location* (i.e., 270-m pixel) has about an 8-in-10,000 chance of burning in any given year.

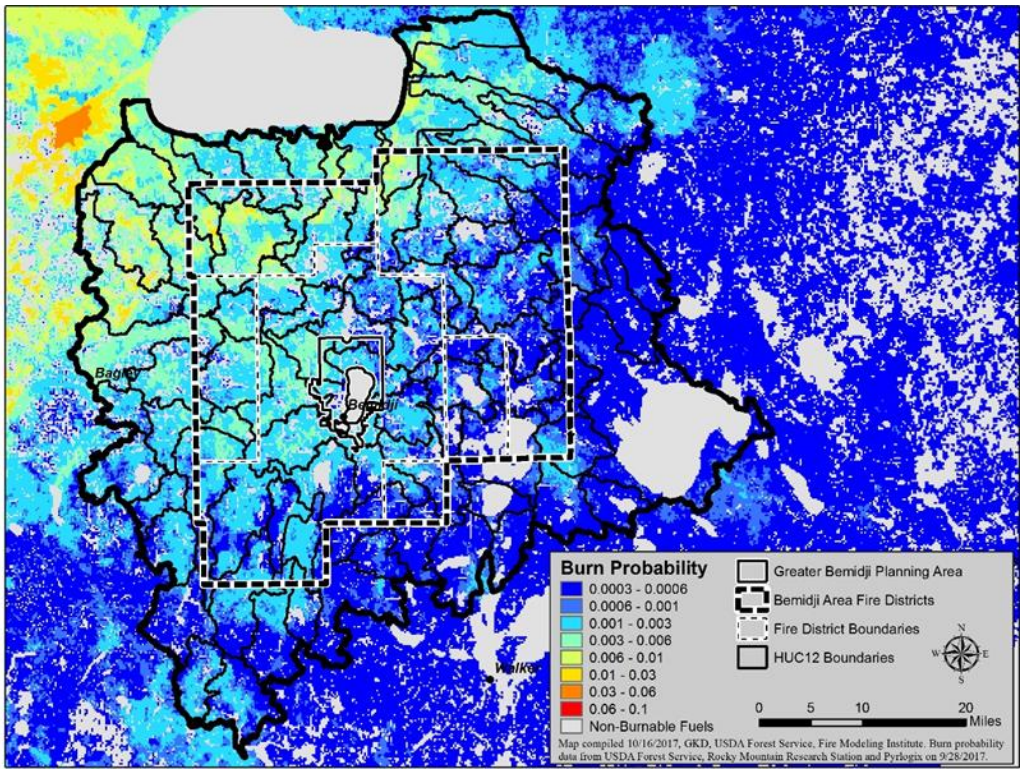

Figure A- 6. Burn probability (FSim 270-m raster output) classified to standard national BP class breaks.

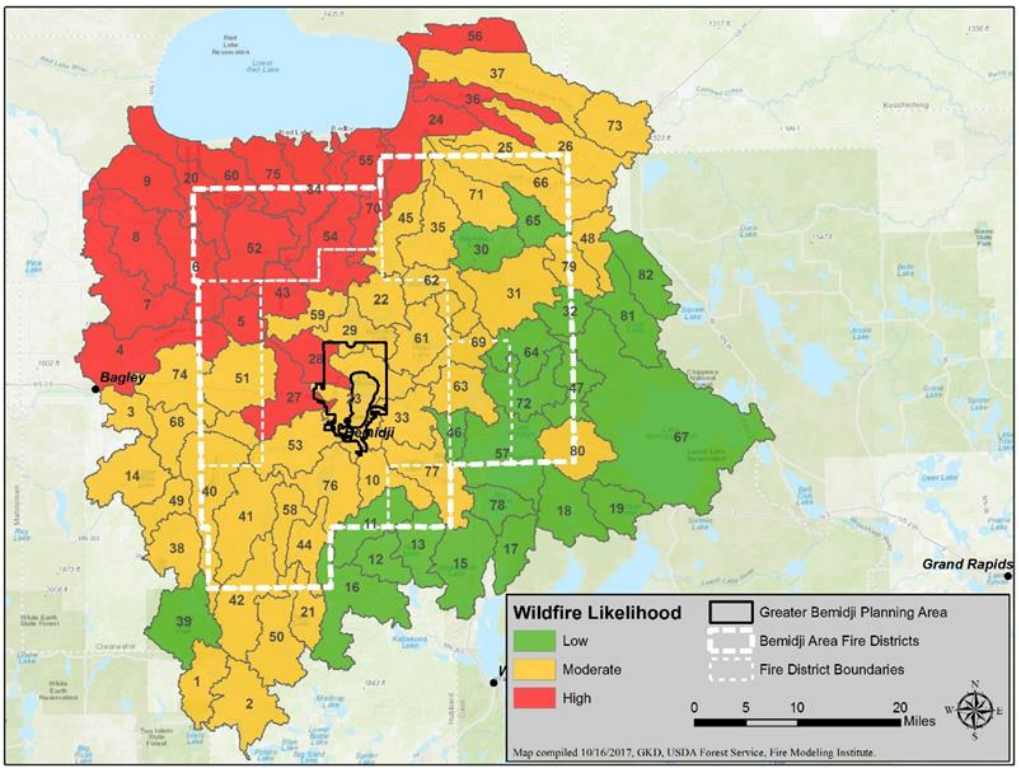

Figure A- 7. Average BP by HUC12 subwatersheds, with classes relative to the distribution of BP values in this analysis area.

Values for all summary metrics by HUC12 watershed are available in Figure A-8.

Number	Name	HUC12	Average CFL (ft)	Average BP	Hazard	Intersects Small Fireshed
1	Dinner Creek	70101060204	8.30	0.0008	0.0066	No
2	Eagle Lake	70101060206	6.20	0.0007	0.0042	No
3	Walker Brook	90203050102	5.61	0.0011	0.0061	No
4	Blair Lake-Clearwater River	90203050103	6.99	0.0027	0.0191	Yes
5	Buzzle Lake	90203050104	8.73	0.0021	0.0184	Yes
6	Clearwater Lake-Clearwater River	90203050105	6.43	0.0033	0.0212	No
7	Ruffy Brook	90203050201	4.28	0.0032	0.0137	No
8	Stenlund Lake-Clearwater River	90203050202	5.23	0.0040	0.0208	No
9	Butcher Knife Creek	90203050203	7.48	0.0050	0.0375	No
10	Headwaters Necktie River	70101020101	5.47	0.0008	0.0046	Yes
11	Bungashing Creek	70101020102	3.83	0.0004	0.0014	Yes
12	Pokety River	70101020103	4.44	0.0004	0.0018	No
13	Necktie River	70101020104	4.83	0.0003	0.0015	No
14	Upper Rice Lake-Wild Rice River	90201080101	4.80	0.0008	0.0040	No
15	Steamboat River	70101020105	4.56	0.0003	0.0015	No
16	Headwaters Kabekona River	70101020201	3.80	0.0004	0.0014	No
17	Crooked Lake	70101020502	7.37	0.0003	0.0025	No
18	Sucker Creek	70101020504	6.95	0.0005	0.0032	No
19	Portage Creek	70101020506	9.19	0.0003	0.0028	No
20	Lower Sandy River	90203020802	7.89	0.0044	0.0350	No
21	Alcohol Creek	70101010303	6.05	0.0008	0.0048	No
22	Three Island Lake	70101010404	8.65	0.0008	0.0067	Yes
23	Lake Bemidji	70101010502	4.34	0.0009	0.0039	Yes
24	Lower Blackduck River	90203020610	5.40	0.0034	0.0185	No
25	Perry Creek	90203020606	4.11	0.0017	0.0068	No
26	Upper North Cormorant River	90203020608	3.81	0.0009	0.0034	No
27	Grant Creek	70101010103	7.44	0.0024	0.0176	Yes
28	Alice Lake	70101010501	7.11	0.0026	0.0187	Yes
29	Turtle Lake	70101010403	4.72	0.0009	0.0043	Yes
30	Blackduck Lake	90203020601	6.00	0.0005	0.0029	No
31	Rabideau Lake-North Turtle River	70101010408	8.88	0.0007	0.0059	No
32	Decker Lake	70101010601	5.64	0.0004	0.0024	No
33	Stump Lake-Mississippi River	70101010503	5.53	0.0009	0.0049	Yes
34	Pike Creek	90203020704	6.26	0.0028	0.0173	No
35	O'Brien Creek	90203020603	6.07	0.0011	0.0065	No
36	Lower North Cormorant River	90203020609	5.20	0.0027	0.0141	No
37	Lower South Branch Battle River	90203020502	5.38	0.0021	0.0112	No
38	Gill Lake-Mississippi River	70101010203	6.27	0.0011	0.0066	No
39	Lake Itasca	70101010201	4.15	0.0004	0.0018	No
40	LaSalle Lake-Mississippi River	70101010205	6.68	0.0014	0.0093	Yes
41	Hennepin Creek	70101010206	5.24	0.0011	0.0056	Yes
42	Birch Creek	70101010301	6.63	0.0008	0.0054	No
43	Long Lake	70101010401	6.57	0.0024	0.0161	Yes
44	Middle Schoolcraft River	70101010305	7.70	0.0012	0.0090	Yes
45	Darrigans Creek	90203020602	6.62	0.0018	0.0120	No
46	Lake Andrusia-Mississippi River	70101010506	3.72	0.0004	0.0013	Yes
47	Kitchi Creek	70101010410	4.29	0.0004	0.0016	No
48	Moose Creek	70101010603	9.51	0.0005	0.0048	No
49	Bear Creek	70101010204	8.58	0.0009	0.0079	No
50	Upper Schoolcraft River	70101010302	6.34	0.0007	0.0042	No
51	Headwaters Grant Creek	70101010102	7.83	0.0019	0.0146	Yes
52	Upper Sandy River	90203020801	7.56	0.0039	0.0293	No
53	Bootleg Lake-Mississippi River	70101010207	8.34	0.0020	0.0164	Yes
54	Mud River	90203020703	7.65	0.0025	0.0190	Yes
55	Gibibwisher Lake	90203020702	8.83	0.0028	0.0247	No
56	North Branch Battle River-Battle River	90203020503	4.61	0.0025	0.0115	No
57	Cass Lake	70101010508	3.61	0.0002	0.0008	No
58	Frontenac Creek	70101010304	4.73	0.0007	0.0034	Yes
59	Little Turtle Lake	70101010402	4.91	0.0015	0.0073	Yes
60	Big Rock Creek	90203020706	5.09	0.0026	0.0135	No
61	Turtle River Lake	70101010405	7.40	0.0008	0.0060	Yes
62	Gull River	70101010406	7.79	0.0007	0.0055	No
63	Big Lake	70101010505	4.10	0.0005	0.0020	Yes
64	North Turtle River	70101010409	8.46	0.0005	0.0038	No
65	Spring Creek	90203020605	3.68	0.0004	0.0014	No
66	South Cormorant River	90203020607	3.90	0.0008	0.0033	No
67	Lake Winnibigoshish	70101010704	3.15	0.0001	0.0005	No
68	Little Mississippi River	70101010104	7.46	0.0018	0.0137	Yes
69	North Twin Lake-Turtle River	70101010407	6.32	0.0005	0.0032	Yes
70	Hay Creek	90203020701	5.05	0.0030	0.0152	No
71	Upper Blackduck River	90203020604	4.36	0.0013	0.0055	No
72	Turtle River	70101010411	5.32	0.0004	0.0022	No
73	Upper South Branch Battle River	90203020501	4.64	0.0008	0.0039	No
74	Headwaters Little Mississippi River	70101010101	5.79	0.0017	0.0096	No
75	Little Rock Creek	90203020705	3.10	0.0023	0.0070	No
76	Lower Schoolcraft River	70101010306	5.40	0.0008	0.0044	Yes
77	Wolf Lake-Mississippi River	70101010504	5.98	0.0006	0.0035	Yes
78	Pike Bay	70101010507	6.34	0.0002	0.0015	No
79	Skimerhorn Creek-Third River	70101010602	9.27	0.0007	0.0061	No
80	Cass Lake Outlet-Mississippi River	70101010701	9.49	0.0007	0.0063	No
81	Third River	70101010604	4.97	0.0002	0.0012	No
82	Dunbar River	90300060202	4.30	0.0002	0.0010	No
	Min		3.10	0.0001	0.0005	
	Max		9.51	0.0050	0.0375	
	Median		5.88	0.0008	0.0056	
	Mean		6.03	0.0013	0.0084	
	St Dev		1.69	0.0011	0.0078	

Figure A- 8. Values for summary metrics of BP by HUC12 watershed.

Wildfire Intensity

Conditional flame length from FSim shows significant variation across the analysis area, but does not follow the same spatial gradient as burn probability (Figures A-9 and A-10). Classifying pixel-scale CFL values into the six Fire Intensity Levels used by FSim (0 to 2 ft, 2 to 4 ft, 4 to 6 ft, 6 to 8 ft, 8 to 12 ft, and greater than 12 ft) shows that all six classes are present in the Bemidji area (Figure A-9).

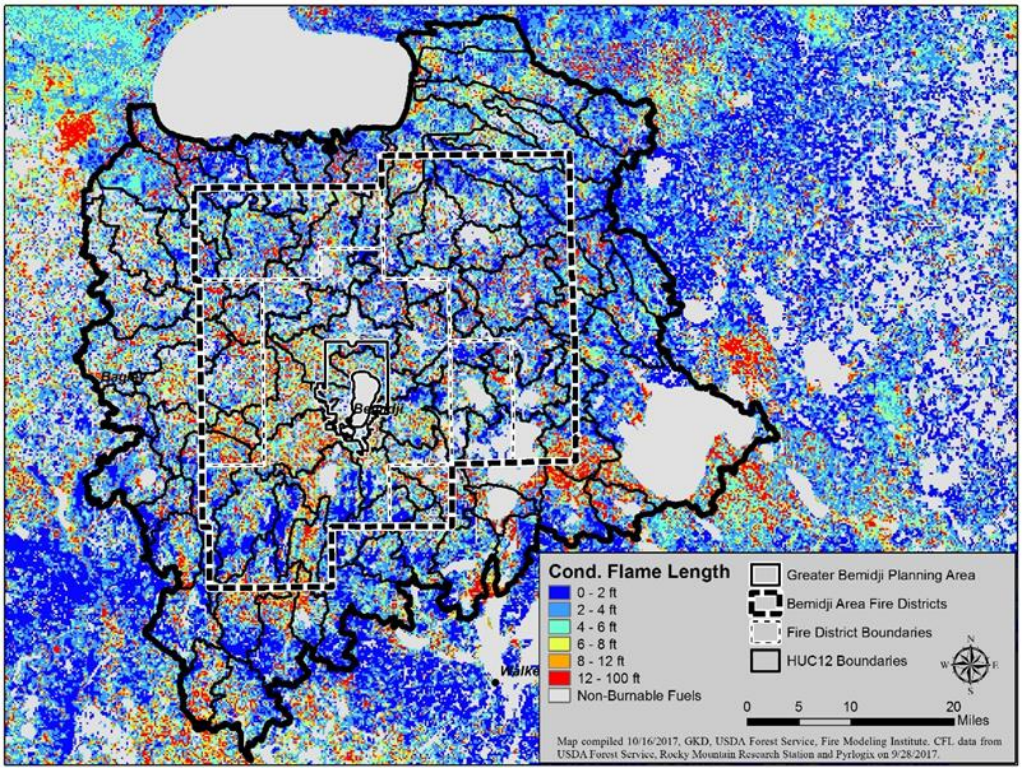

Figure A- 9. Conditional flame length (CFL), a measure of expected fire intensity 270-m raster output from FSim classified to standard flame length categories.

Pixel values range from 0 to 100, and high and low values are spatially interspersed.
As with BP, we summarized CFL values by HUC12 watersheds and classified them into three classes relative to the distribution of watershed CFL averages (Figure 18). The average CFLs for watersheds range from 3.1 ft to 9.5 ft, with a mean of approximately 6 ft. The class breaks based on quartiles are: low to moderate (25th percentile) = 4.64 ft, and moderate to high (75th percentile) = 7.44 ft.

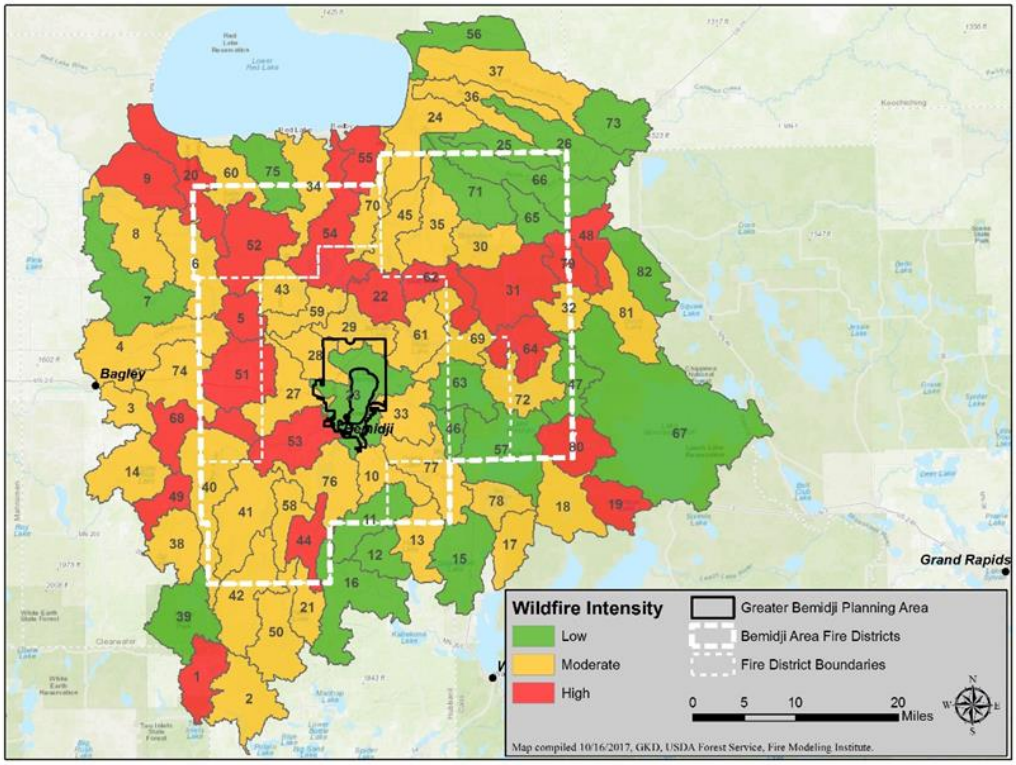

Figure A- 10. Average CFL by HUC12 subwatersheds, with classes relative to the distribution of CFL values in this analysis area.

❖ Wildfire Hazard

Wildfire hazard is an integration of likelihood and intensity, and we calculated it as the product of BP and CFL. We calculated it at both the pixel scale and the HUC12 watershed scale (as average BP x average CFL). In both cases, we classified the product into three classes based on quartiles in the distribution of values in the analysis area (Figure A-11). 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.

Maps of hazard at the pixel scale (Figure A-12) and watershed scale (Figure A-13) show the same general spatial gradient from southeast to northwest that is visible in the BP. The highest wildfire hazard is generally in the northwest part of the analysis area.

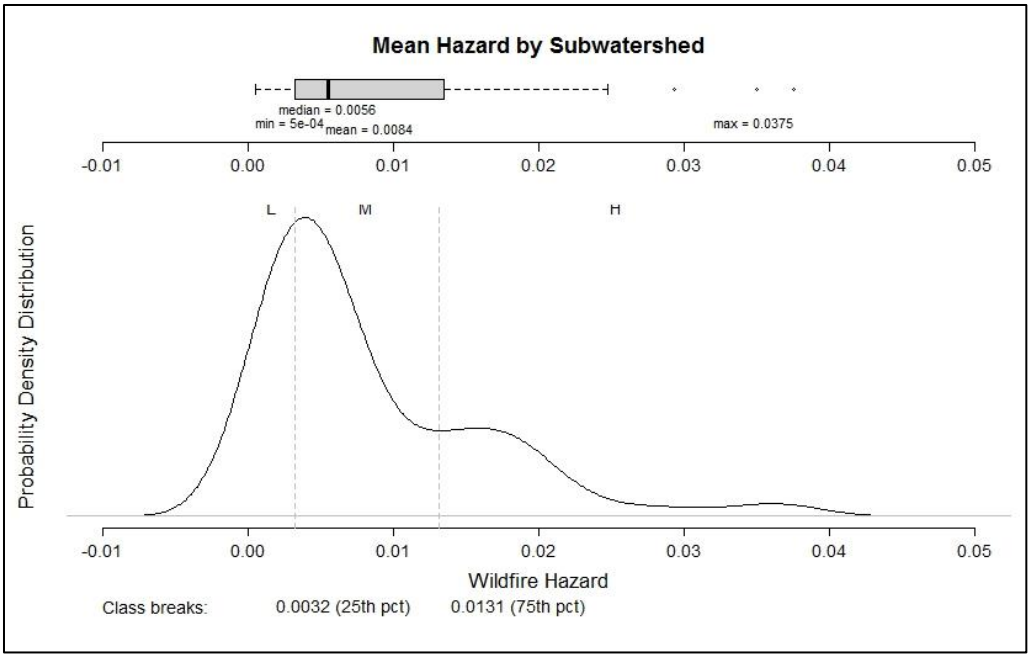

Figure A- 11. The distribution of landscape wildfire hazard values (averages by HUC12 watershed). Simple quartile breakpoints were used to classify hazard into Low, Moderate, and High hazard. The first quartile represents low hazard, the middle two quartiles represent moderate hazard, and the upper quartile represents high hazard. These class designations are relative only to subwatersheds included in the broader Bemidji analysis area.

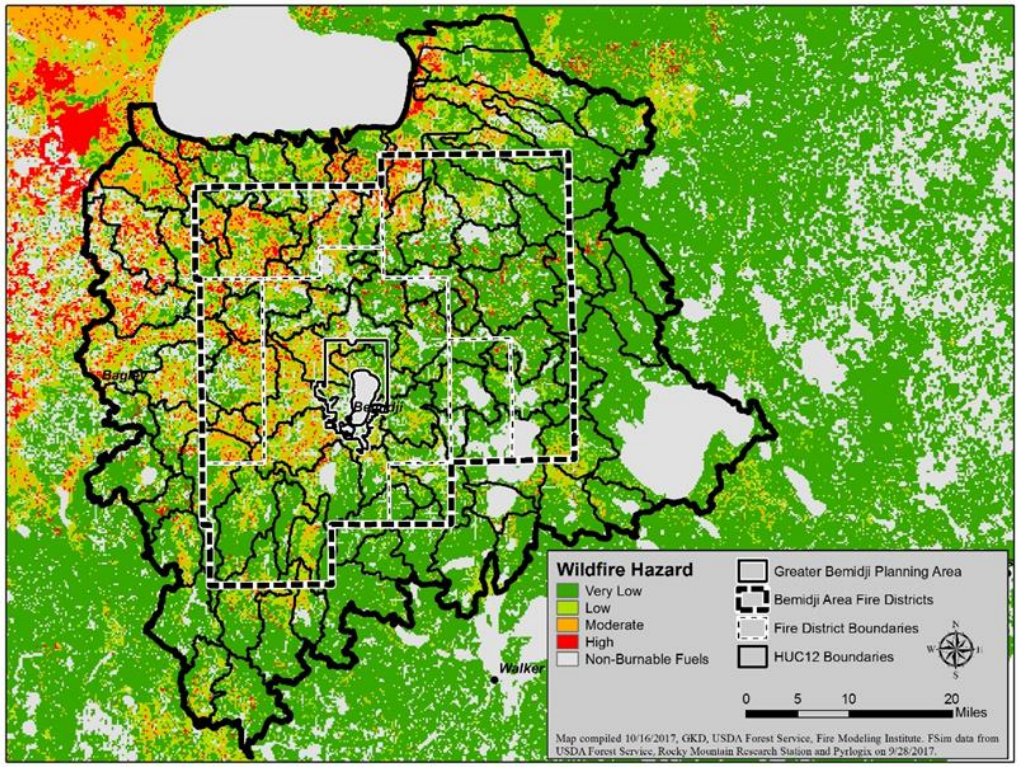

Figure A- 12. Maps of integrated wildfire hazard 270-m raster output, calculated as BP x CFL from FSim.

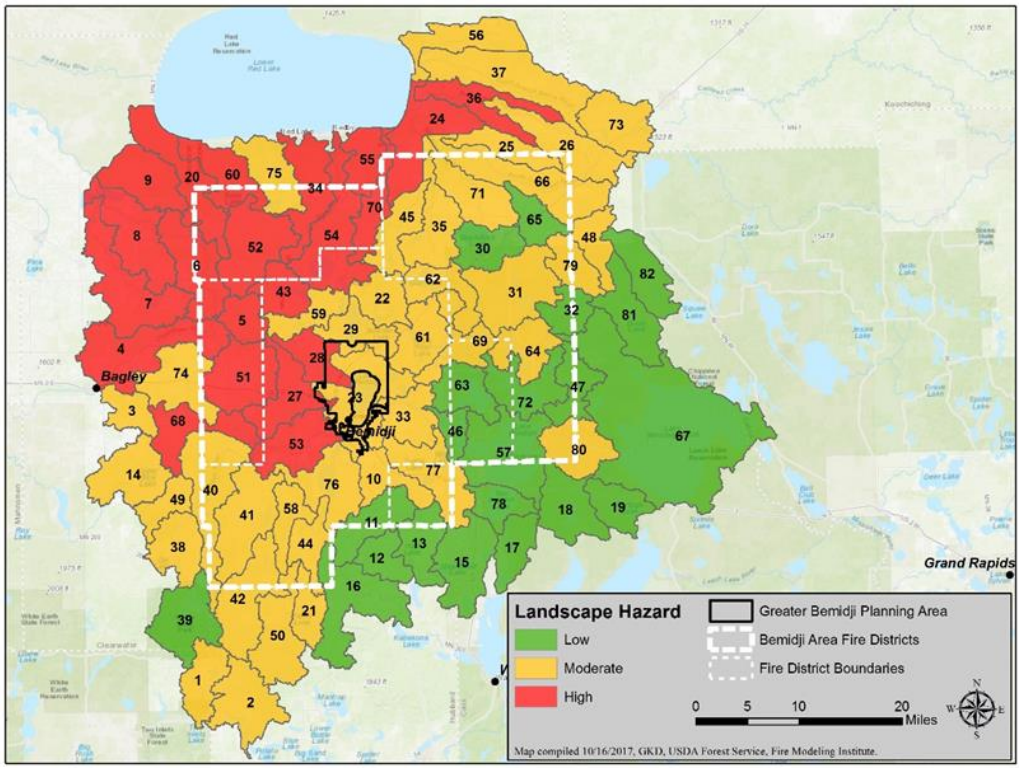

Figure A- 13. Average hazard by HUC12 subwatersheds.

A scatter plot of BP versus CFL is also a helpful way to evaluate the landscape wildfire hazard (Figure A-14). The average hazard value for each watershed is plotted on the graph as the intersection of average BP and average CFL. By doing this, we can see the degree to which each input contributes to the overall wildfire hazard. Hazard is more strongly driven by likelihood at the lower range of BP values (i.e., if likelihood is very low, it doesn't matter as much how high the intensity is), but intensity is more influential at differentiating hazard classes at slightly higher BP values.

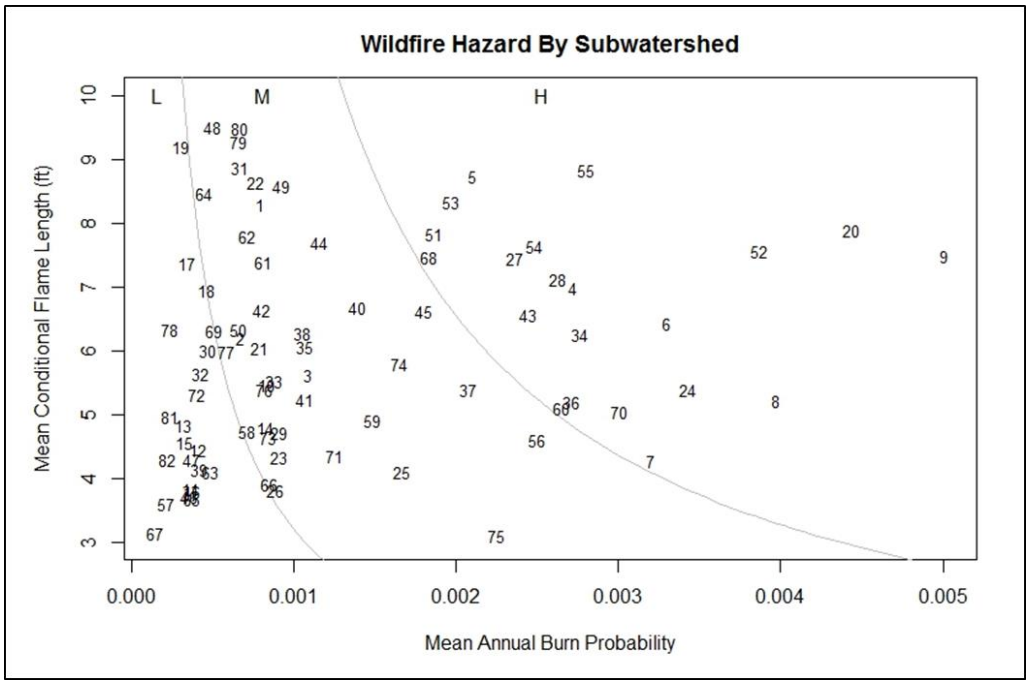

Figure A- 14. Landscape wildfire hazard by HUC12 subwatershed. Hazard is calculated as the product of wildfire likelihood and intensity (in this case, annual burn probability on the X-axis and conditional flame length on the Y-axis). The numbers on the plot correspond to watershed numbers shown on the maps and represent the average burn probability and conditional flame length values for each watershed. The curved lines are breakpoints used to classify hazard into low, moderate, and high hazard. Wildfire hazard increases from lower left to upper right.

Exposure and Transmission: Small Fireshed

The small fireshed for the Greater Bemidji Planning Area is mostly in the Bemidji Fire District (FD), with small areas in the Solway and Cass Lake FDs (Figures A-4 and A-5). Both the extent and density of housing is much greater in the Bemidji FD than the other two (Figure A-4). Correspondingly, the average annual number of housing units exposed to wildfire is much higher in the Bemidji FD (> 9 housing units; Figure A-15a), compared to the other two (< 1 each). A very small amount of housing exposure comes from fires moving between FDs (Figure A-15b; outgoing portion of bars for Cass Lake and Solway), but most exposure to housing units comes from fires starting in the same FD (Figure A-15b; non-transmitted portion of bars).

The annual area burned in each FD is also more or less proportional to the land area of each FD in the fireshed (Figure A-15c). According to the FSim simulations, the portion of the Bemidji FD in this fireshed can expect an annual fire load of roughly 200 acres, compared to about 50 acres in the Solway FD portion, and <10 acres Cass Lake FD portion. As with exposure, most of this burned area is from ignitions within the same FD (Figure A-15d).

The wildfire network for these three FDs (Figure A-15e) shows that the relationships are fairly simple among FDs within this small fireshed. The size of the circle (nodes) coarsely represents the relative amount of fire in each FD, and the thickness of the lines connecting them (edges) reflects the relative amount of fire moving between them. Here we see that the Bemidji FD has more fire than the other two, and that slightly more fire moves between Bemidji and Solway (both directions) compared to movement between Bemidji and Cass Lake.

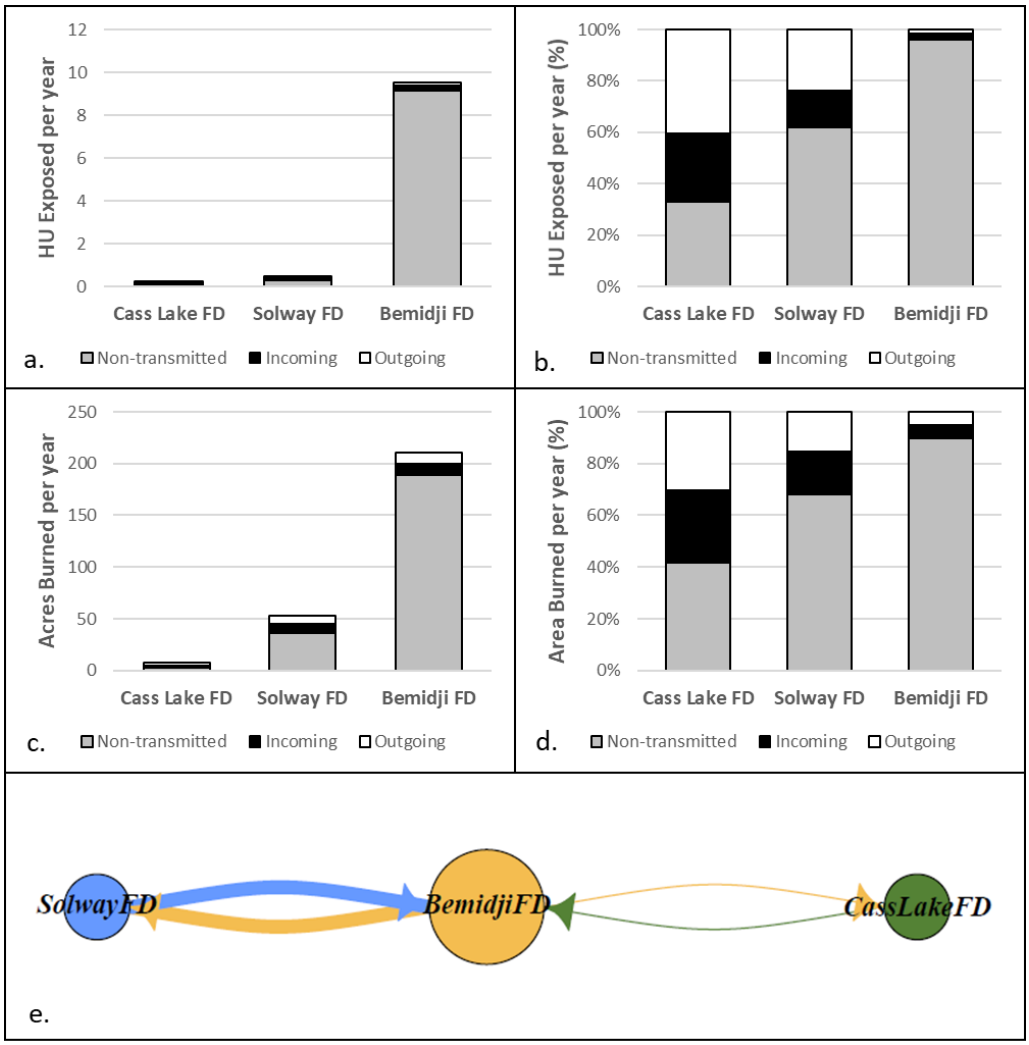

Figure A- 15. Results for wildfire exposure and transmission for fire districts in the small fireshed. Annual housing unit exposure by fire district is shown in upper graphs as number of housing units (a) and proportion of housing units exposed (b). Expected annual area burned by fire district is shown in the lower graphs as acres burned (c) and proportion of acres burned (d). All bar graphs show the amount of exposure or area burned from fires that stay within the fire district in which they ignite (non-transmitted) vs. fires that move between fire districts (incoming and outgoing). The bottom figure (e) is the wildfire network, showing the relative amount of fire in each fire district (size of circles) and amount of fire transmitted between fire districts (size of connecting lines).

While wildfires are highly likely to stay within the same FD they ignited in, the results for transmission among land use show that there is much more movement from one category to another (Figure A-16). The highest annual housing unit exposure occurs in the residential land use (about 5 units), with about half of that coming from fires igniting in other land uses (Figure A-16a). For all land uses except residential, more than half of fires move to a different land use than where they start before resulting in housing exposure (Figure A-16b; outgoing portion of bars).

The residential and agricultural land use categories have the highest expected annual area burned (about 60 acres), followed closely by forest/park/wildlife, rural, and state lands (each with 35 to 45 acres; Figure A-16c). Within each land use category, the amount of outgoing and incoming fire are roughly equal, while the amount of non-transmitted fire is significantly less (Figure A-

16d). The wildfire network for land use categories in the small fireshed underscores the high amount of transmission, with particularly high connectedness among the top five land uses (Figure A-16e).

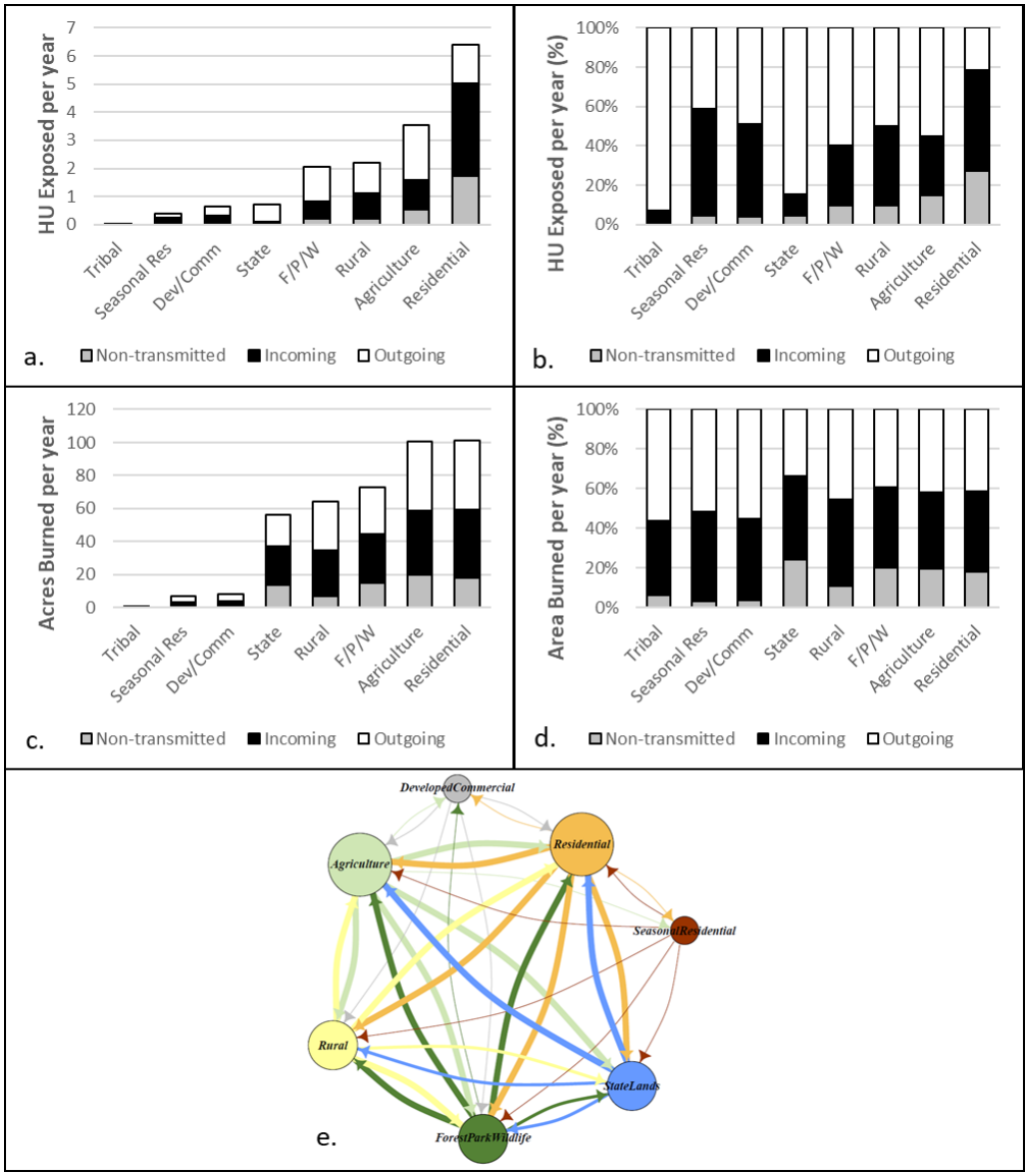

Figure A- 16. Results for wildfire exposure and transmission for land use categories in the small fireshed. Annual housing unit exposure by land use is shown in upper graphs as number of housing units (a) and proportion of housing units exposed (b). Expected annual area burned by land use is shown in the lower graphs as acres burned (c) and proportion of acres burned (d). All bar graphs show the amount of exposure or area burned from fires that stay within the land use in which they ignite (non-transmitted) vs. fires that move between land use (incoming and outgoing). The bottom figure (e) is the wildfire network, showing the relative amount of fire in each land use (size of circles) and amount of fire transmitted between land uses (size of connecting lines).

Lastly, examination of source land use categories for fires burning in each fire district shows that the same top five land use categories account for most of the housing exposure and area burned in all three fire districts (Figure A-17).

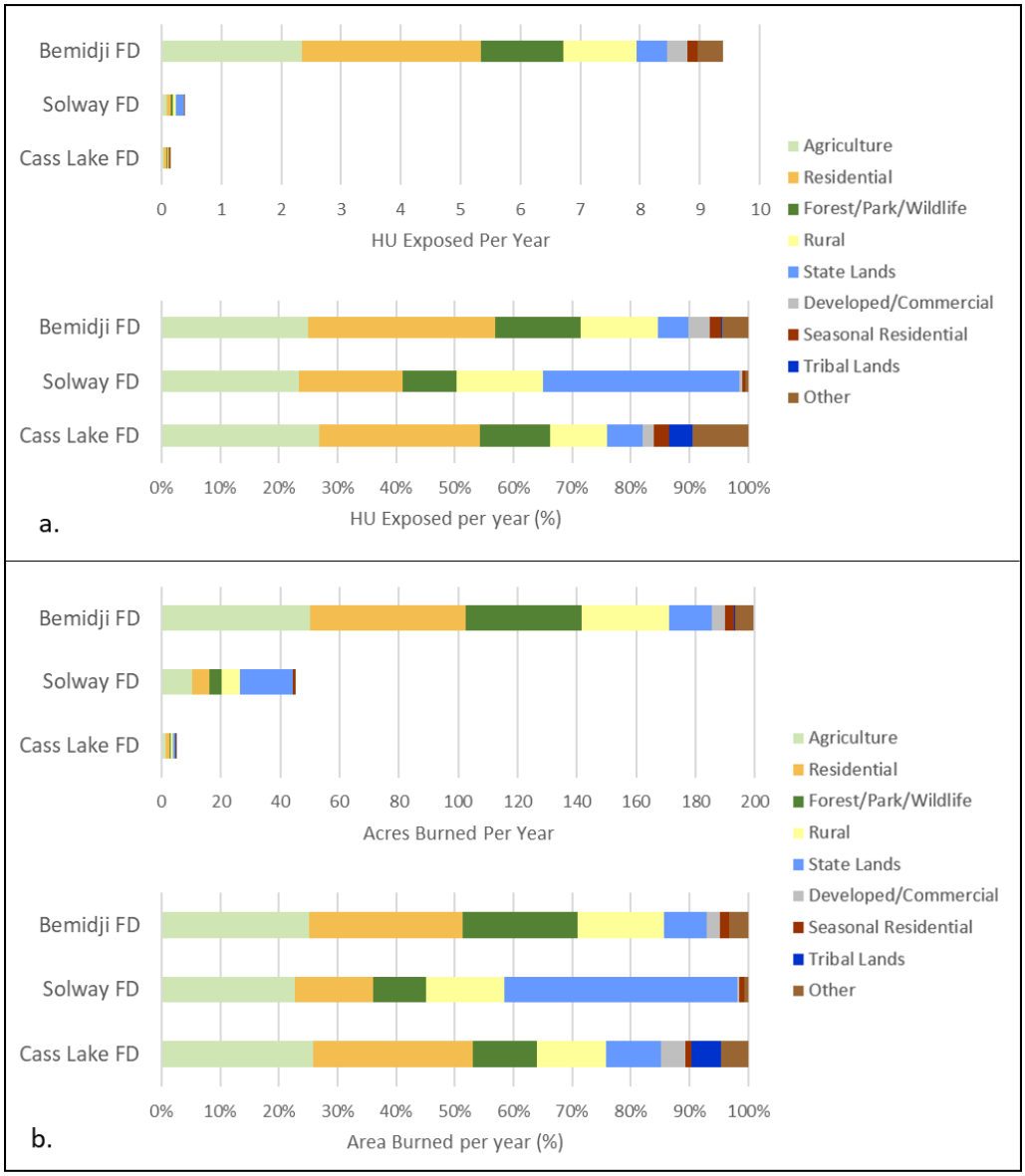

Figure A- 17. Results for wildfire exposure and transmission in the small fireshed, showing the source land use categories for fires burning in each fire district. Annual housing unit exposure is in the upper pane (a), and expected annual area burned is shown in the lower pane (b). All bars in this figure show the amount of exposure or area burned from fires originating in each land use category.

In each case, the proportion of housing exposure or area burned coming from each land use is relatively proportional to its representation on the landscape in respective area of the fireshed (Figure A-5).

Exposure and Transmission: Large Fireshed

The large fireshed for the five fire districts encompasses the entirety of the Alaska, Solway, Bemidji, and Blackduck FDs, and the Hubbard and Beltrami county portions of the Cass Lake FD (Figure A-5). It also includes land outside these five FDs in, clockwise from the north, Beltrami, Koochiching, Itasca, Cass, Hubbard, Becker, and Clearwater Counties. While some of the incoming and outgoing fire represented in our results reflects transmission from and to these outer areas of the fireshed, the focus is on fire occurring within the five FDs.

As with the small fireshed, the vast majority of housing exposure occurs in the Bemidji FD (Figure A-18a). Our analysis indicates an exposure of just over 10 housing units per year in the entire Bemidji FD, only a very slight increase from the exposure expected for the portion of the FD in the smaller fireshed.

Again, almost all of the housing exposure comes from non-transmitted fire (Figure A-18b), which means that fires tend to affect houses in the same fire district in which they ignite.

Unlike the small fireshed, the expected annual area burned within each FD is not proportional to the land area of the FD. Instead, we start to see the spatial pattern of burn probability (Figure A-6 and A-7) come into play. The Bemidji FD still has the highest expected annual area burned at just over 300 acres (Figure A-18c). The next highest area burned is in the relatively smaller Alaska FD, followed by the Solway FD, both of which are in the northwest area of the fireshed that has the highest burn probability. The relatively large Blackduck FD has a much lower expected area burned because of the lower modeled burn probability, with the smaller Cass Lake FD in the southeast having the least amount of expected fire.

While only relatively small amounts of fire are transmitted from one fire district to another, the wildfire network illustrates the connections among fire districts and some outside areas (Figure A-18e). For the Bemidji FD, the outgoing connections are strongest with Hubbard County (outside the fire districts) and the Solway FD, while the incoming connections are strongest from the Solway and Alaska FDs. The Solway FD also has a fairly strong outgoing connection to Clearwater County. Most other connections among nodes in this network are only moderate to weak.

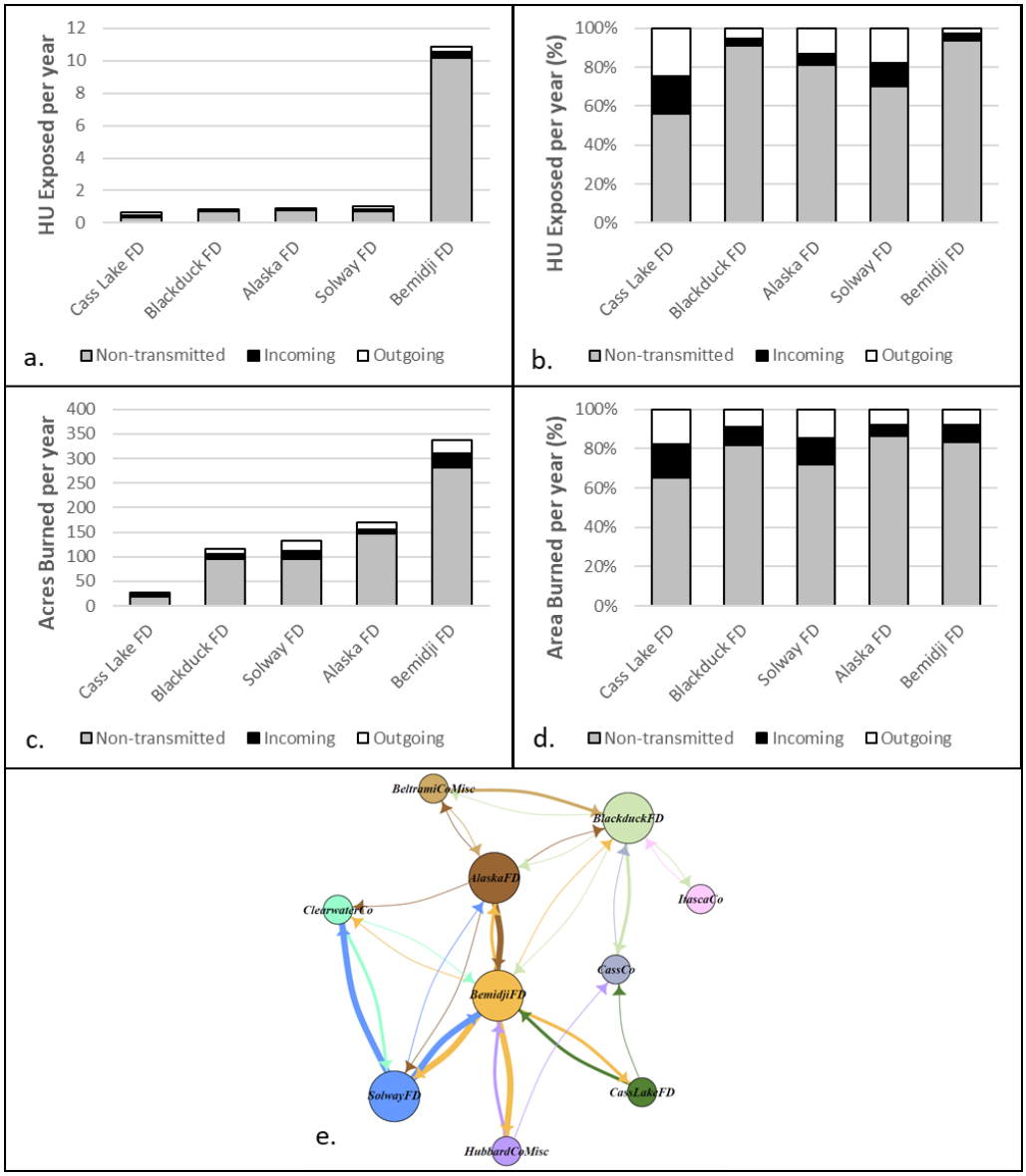

Figure A- 18. Results for wildfire exposure and transmission for fire districts in the large fireshed. Annual housing unit exposure by fire district is shown in upper graphs as number of housing units (a) and proportion of housing units exposed (b). Expected annual area burned by fire district is shown in the lower graphs as acres burned (c) and proportion of acres burned (d). All bar graphs show the amount of exposure or area burned from fires that stay within the fire district in which they ignite (non-transmitted) vs. fires that move between fire districts (incoming and outgoing). The bottom figure (e) is the wildfire network, showing the relative amount of fire in each fire district (size of circles) and amount of fire transmitted between fire districts (size of connecting lines).

The results for housing exposure among land uses within the large fireshed are similar to those from the small fireshed (Figure A-19a and A-19b). Again, most exposure is happening in the residential and agriculture land uses, followed by forest/park/wildlife and rural. Consistent with the exposure analysis by fire district, the total numbers of housing units exposed per year in the large fireshed are barely larger than the numbers from the small fireshed. This means that most potential exposure of houses to wildfire is captured within the small fireshed.

For annual area burned by land use class, the largest amount (at a little more than 200 acres) and the highest proportion of non-transmitted wildfire (about 35%) is found in the forest/park/wildlife category (Figure A-19c and A-19d). Forest/park/wildlife, rural, and state lands all become more prominent players, compared to their rankings in the small watershed, capturing the fact that these land uses all are more represented on the landscape outside of the small fireshed (Figure A-5). Overall, fire is still much more likely to move among different land use categories than fire districts, as evidenced by the high proportions of incoming and outgoing fire for all categories (Figure A-19d) and the generally strong connectedness displayed in the wildfire network (Figure A-19e).

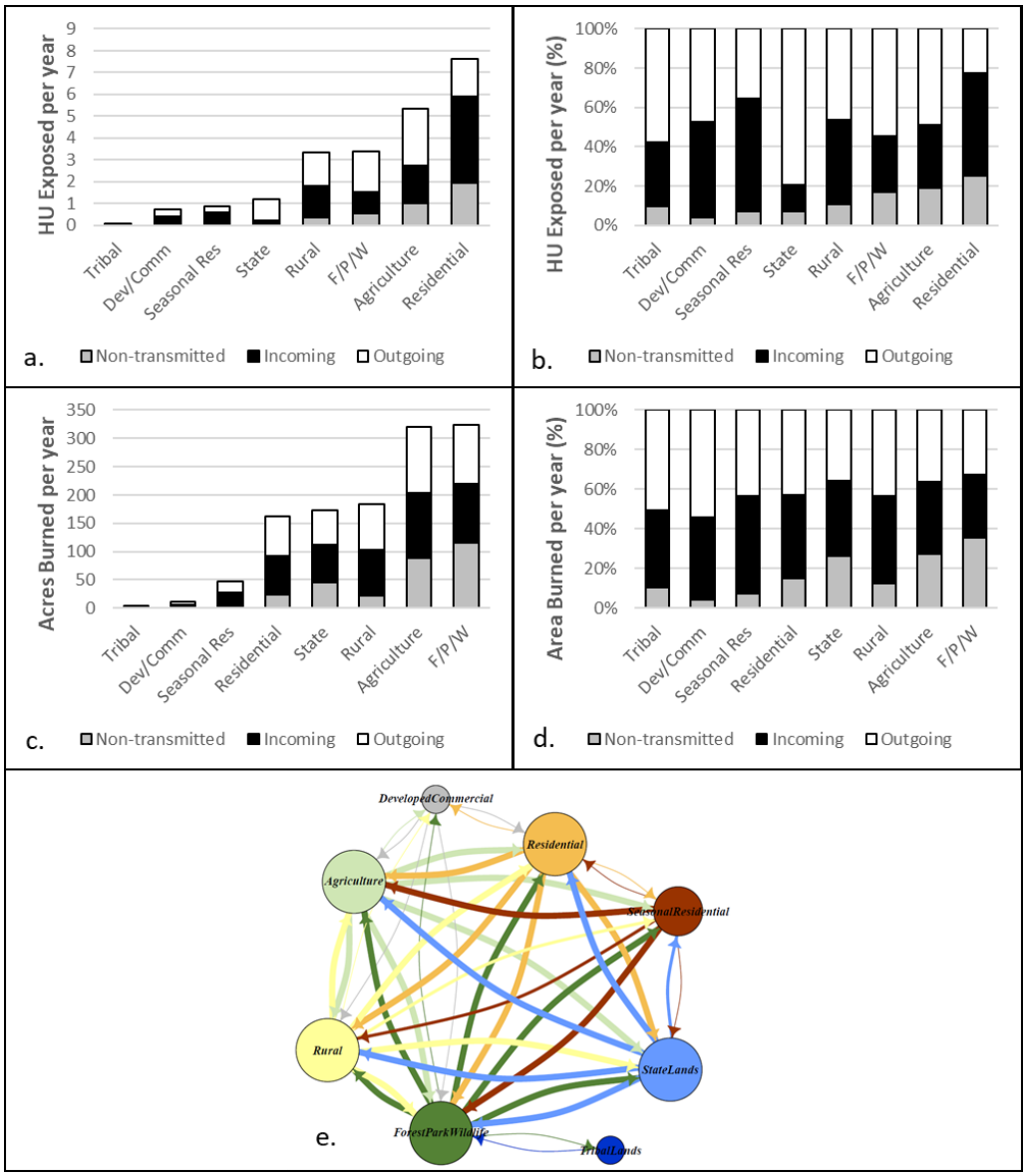

Figure A- 19. Results for wildfire exposure and transmission for land use categories in the large fireshed. Annual housing unit exposure by land use is shown in upper graphs as number of housing units (a) and proportion of housing units exposed (b). Expected annual area burned by land use is shown in the lower graphs as acres burned (c) and proportion of acres burned (d). All bar graphs show the amount of exposure or area burned from fires that stay within the land use in which they ignite (non-transmitted) vs. fires that move between land use (incoming and outgoing). The bottom figure (e) is the wildfire network, showing the

relative amount of fire in each land use (size of circles) and amount of fire transmitted between land uses (size of connecting lines).

Source land use categories by fire district in the large fireshed provide additional support for the similarity in housing exposure sources, but shift in area burned sources, when comparing to the small fireshed (Figure A-20).

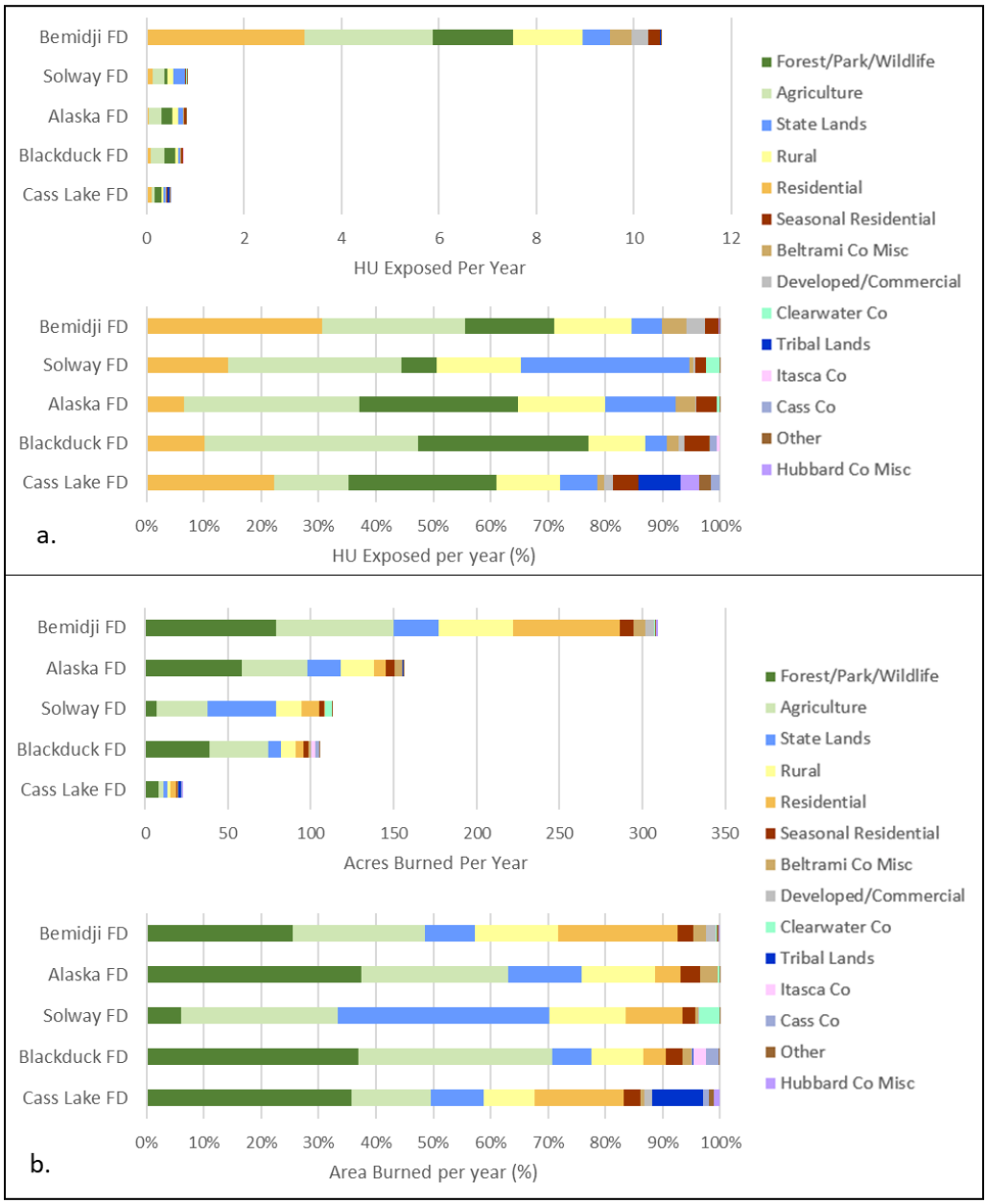

Figure A- 20. Results for wildfire exposure and transmission in the large fireshed, showing the source land use categories for fires burning in each fire district. Annual housing unit exposure is in the upper pane (a), and expected annual area burned is shown in the lower pane (b). All bars in this figure show the amount of exposure or area burned from fires originating in each land use category.

❖ Summary and Conclusions

Leaning heavily on coarse-scale wildfire simulations, this analysis provides a way to gain insight into some elements of wildfire risk in the area around Bemidji, Minnesota. Based on the results presented here, some considerations for successful mitigation of wildfire hazard and exposure could include the following:

- The highest burn probabilities, and therefore hazard, exist in the northern and western portions of the large fireshed. This includes the Solway and Alaska Fire Districts, and the northwest portion of the Bemidji Fire District. These areas can generally expect to see more wildfire than other areas within the fireshed.
- Fires do not tend to move very far from their point of origin and tend not to move across fire district boundaries. Therefore, fire mitigation efforts focused primarily within each fire district can be successful.
- However, the fairly fine spatial arrangement of different land uses and jurisdictions within the analysis area means that wildfires will often move among different land uses, jurisdictions, and ownerships. This will require cooperation among neighboring land owners to mitigate the spread of wildfires.
- Wildfire hazard can be reduced by either reducing the burn probability or conditional wildfire intensity (flame length if a fire should occur), or both. In areas where ignitions are largely human caused, burn probability can be reduced by effective fire prevention programs. Conditional fire intensity can often be reduced through surface fuel reduction efforts.
- Except in the lowest burn probability areas, the difference between moderate and high wildfire hazard is the conditional fire intensity. This means that effective fuel reduction that decreases the likely intensity of fire can result in a decrease in wildfire hazard.
- Exposure of housing units to wildfire is much greater in the Bemidji Fire District than in surrounding areas. Given the relatively small size of fires in this area, the most effective mitigations for housing exposure will be fuel reduction and other firewise efforts in the immediate vicinity of homes.
- The majority of housing exposure within the Bemidji Fire District is concentrated in the small fireshed around the Greater Bemidji Planning Area. Therefore, codes, regulations, and mitigation work focused within this fireshed will address the vast majority of housing exposure concerns. However, future housing development in outlying areas could change this, and should be evaluated periodically.

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