Fire, Fuels and Air Quality

Introduction

This section addresses the following component of the Melvin Butte vegetation project purpose and need:

Reduce fuel loadings and forest vegetation density to lessen the hazard associated with uncharacteristic wildfires to nearby communities and key ecosystem components, such as watersheds, large old trees and wildlife connectivity habitat.

To meet the purpose and need of this project, the Melvin Butte action alternatives are designed to reduce the likelihood of an uncontrolled stand replacement wildfire impacting values at risk. This specialist report is focused on the effects that vegetation management activities described in the action alternatives will have on fire hazard within the project area. Other components of the purpose and need are addressed in other specialist reports and within the main NEPA document.

Management Direction

General direction for the Forest Service as it relates to Fuels Management is directed by Forest Service Manual (FSM) 5150. FSM 5150 directs Forests to initiate fuels treatments in accordance with local land and resource management plans. On the Deschutes National Forest, the Land and Resource Management Plan (Deschutes LRMP), was completed in 1990. In areas within the range of the Northern Spotted Owl, the Deschutes LRMP was amended with the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl and its corresponding Record of Decision and Standards and Guidelines (Northwest Forest Plan). The Northwest Forest Plan requires that Watershed Analyses be completed in Key Watersheds. The Whychus Watershed Analysis (1998), Update (2009), and Updated (2013) respond to these requirements. Fire and fuels management are directed and/or guided by the goals, objectives, standards, and guidelines in all of these plans. Refer to Table ** and the following discussion for an overview of these documents.

Table **: Overview of the Goals, Standards, Guidelines, and Recommendations within the Deschutes National Forest LRMP and the Northwest Forest Plan.

Deschutes LRMP	
Forest Management Goal*: Provide a fire protection and prescribed burning program which is responsive to land and resource management goals and objectives.	
Forest-wide goal: To provide a well-managed fire protection and prescribed fire program that is cost efficient, responsive to land stewardship needs, and resource management goals and objectives	FF-1: Prevention of human caused wildfire will focus on areas of high use and high risk. Identified areas of high use and high risk are: • Recreation use along major travelways and bodies of water during the summer periods • Personal use firewood cutting during late spring and early summer • Large numbers of deer hunters during the fall • Large areas of Beetle Killed pine adjacent to subdivisions and private developments

	• Industrial operations on National Forest Land during summer FF-5: All wildfires will receive a timely and energetic suppression response that minimizes suppression costs plus resource losses, and best meets multiple use standard and guidelines for each management area. Those fires that threaten life, private property, public and firefighter safety, improvements or investments shall be given high priority and suppressed to minimize losses. FF-6: All wildfires will require an appropriate suppression response. FF-9: Burn plans will be prepared in advance of ignition and approved by the appropriate line officer for each prescribed fire. Prescribed burning will conform to air quality guidelines. Burn plans will define an escaped fire. A fire that escapes will be declared a wildfire and the Wildland Decision Support System (WFDSS) will be used to document further action. FF-10: Unplanned ignitions may be managed to meet multiple objectives if (1) consistent with the land management allocation and upon approval of a decision within the WFDSS and (2) the fire is burning within prescription. Normally, prescribed burning will be by planned ignition. FF-11: Levels and methods of fuels treatment will be guided by the resource objectives within the management area. * In May of 2015, the Deschutes National Forest made an administrative change to the glossary of the Land and Resource Management Plan to reflect updated wildland fire management policy and terminology. Management direction with the Land and Resource Management Plan has been reinterpreted to reflect this update.
Management Area Goal: Old Growth	M15-19: Prescribed fire is not appropriate in lodgepole pine stands. In Ponderosa pine and mixed conifer stands, prescribed fire may be used to achieve desired old growth characteristics. It may also be used there to reduce unacceptable fuel loadings that potentially could result in high intensity wildfire. M15-20: Prescribed fire is the preferred method of fuel treatment. However, if prescribed fire cannot reduce unacceptable fuel loadings, other methods will be considered. M15-21: Natural fuel loading will normally be the standard.
Management Area Goal: Scenic Views	M9-27: In Retention Foregrounds slash from a thinning or tree removal activity, or other visible results of management activities, will not be visible to the casual forest visitor for one year after the work has been completed. In partial retention foregrounds, logging residue or other results of management activities will not be obvious to the casual forest visitor two years following the activity. M9-90: Low intensity prescribed fires will be used to meet and promote the desired visual condition within each stand type. Prescribed fire and other fuel management techniques will be used to minimize the hazard of a large high

	intensity fire. In foreground areas, prescribed fires will be small, normally less than 5 acres, and shaped to appear as natural occurrences. If burning conditions cannot be met such that scorching cannot be limited to the lower 1/3 of the forest canopy, then other fuel management techniques should be considered. M9-91: If at any time during the course of the prescribed burn it appears that the objectives for the burn are not being met, all burning will cease.
Management Area Goal: Front Country	M18-34: Prescribed fire may be used to protect, maintain, and enhance timber and forage production. The broadest application of prescribed fire will occur in the Ponderosa pine type. Criteria for using fire are as follows: • To reduce risk of conflagration fire • To increase soil productivity by cycling bound nutrients • To prevent encroachment of less desirable, competing tree species • To increase palatability and cover of desirable forage species • To prepare sites for reforestation M18-35: The lowest cost option [for fuel treatment] which meets the silvicultural, soil, water, and fire objectives should be selected. M18-36. Slash will be treated to minimize chances of large wildfires, but will not be cleared to the point that the forest floor is devoid of all slash and logs. Some slash and larger dead material will be left for ground cover for soil protection, microclimates for establishment of trees, and small mammal habitat. Optimum fuel loadings should be guided by … "Photo Series for Quantifying Forest Residues"… These fuel loadings will be revised when new data, methods, or research indicate that a new profile would improve resource management programs.
Northwest Forest Plan	
Administratively Withdrawn	[Administratively Withdrawn Areas] are identified in current forest and district plans or draft plan preferred alternatives and include recreational and visual areas, back country, and other areas not scheduled for timber harvest
Matrix	Most of the timber harvest will occur on matrix lands. Standards and guidelines assure appropriate conservation of ecosystems as well as provide habitat for rare and lesser -known species

Proposed Forest Plan Amendments

The district recommends ameding the following Standards and Guidelines to meet the purpose and need of the project:

- Management Area Goal: Scenic Views, M9-27
- Management Area Goal: Scenic Views, M9-90

Refer to the *Final Proposed Forest Plan Amendments for the Melvin ButteVegetation Management Project* for more detail.

Whychus Watershed Assessment (1998), Update (2009) and Update (2013)

The Whychus Watershed Assessment (1998), Update (2009) and Updated (2013) prioritizes areas for treatment and guides future management within 12 sub-watersheds on the Sisters Ranger District, including: Upper Indian Ford, Lower Indian Ford, Fourmile Butte, Upper Trout Creek, Lower Trout Creek, Headwaters Whychus Creek, Upper Whychus Creek, Middle Whychus Creek, Lower Whychus Creek, Three Creek, Triangle Hill and Deep Canyon. The Melvin Butte project area falls within the Deep Canyon sub-watershed (see Hydrology section) and also the Cascade Forest Landscape Strategy Area. From the original assessment to the update, this strategy area has risen in priority from 4th to 2nd. This is because there have been sixteen large wildfires in the Sisters Ranger District since 2002 that have reduced mixed conifer habitat, reduced connectivity, and increased the importance of remaining habitat. As it relates to fire and fuels, the Melvin Butte project responds to several of the goals identified for the Cascade Forest Landscape Strategy Area (CFLR):

- Restore forest habitats.
- Aim for a balance of vegetation within each Plant Association Group resulting in a healthy and resilient forest using the historic range of natural variability as a guideline.
- Reduce potential for habitat loss due to stand replacement wildfires in areas where this type of fire behavior is outside the historic natural range of variability and when risks to public safety and large scale loss of property are unacceptable.
- Protect this habitat from loss due to large-scale fires, insects and disease epidemics, and major human impacts so that late-successional ecosystems and biodiversity are maintained.

Additional input from national policies also guides the planning of activities on Deschutes National Forest lands.

National Fire Plan (2000)

In response to catastrophic fire events prior to 2000, the National Fire Plan of 2000 was co-authored by the Forest Service, Department of Interior, and Western Governors Associations to outline operating principles for firefighting readiness, prevention through education, rehabilitation, hazardous fuels reduction, restoration, collaborative stewardship, monitoring, jobs, and applied research and technology transfer. The National Fire Plan is a series of documents with an accompanying budget request that guides fire and fuels management as to how best to respond to recent fire events, reduce the impacts of wildland fires on rural communities, and ensure sufficient firefighting resources in the future. The National Fire Plan is also where direction on reducing immediate hazards to the Wildland Urban Interface (WUI) began. The Melvin Butte Project responds to the following hazardous fuels reduction and restoration elements of the National Fire Plan:

- Hazardous Fuels Reduction- Assign highest priority for fuels reduction to communities at risk, readily accessible municipal watersheds, threatened and endangered species habitat, and other important local features where conditions favor uncharacteristically intense fires.

- Restoration- Restore healthy, diverse, and resilient ecological systems to minimize uncharacteristically intense fire on a priority watershed basis. Methods will include

removal of excess vegetation and dead fuels through thinning, prescribed fire, and other treatments.

Wildland Urban Interface and Community Wildfire Protection Plan

In 2004, the City of Sisters, local fire protection districts, Deschutes and Jefferson Counties, Oregon Department of Forestry, U.S. Forest Service, and the Bureau of Land Management formed a committee to develop a community wildfire protection plan (CWPP) under the direction established by the 2003 Healthy Forest Restoration Act (Project Wildfire 2009). The purpose of the updated 2014 Greater Sisters Country CWPP is to:

- Protect lives and property from wildland fires;
- Instill a sense of personal responsibility and provide steps for taking preventive actions regarding wildland fire;
- Increase public understanding of living in a fire-adapted ecosystem;
- Increase the community's ability to prepare for, respond to and recover from wildland fires;
- Restore fire-adapted ecosystems; and
- Improve the fire resilience of the landscape while protecting other social, economic and ecological values.

The plan outlines a strategy, identifies priorities for action, and suggests immediate steps that can be taken to protect the communities from wildland fire while simultaneously protecting other important social and ecological values. The plan was first revised in May 2006 to include considerations of community growth, seasonal recreation areas, and ingress and egress corridors that were not identified in the initial plan or in the Federal Register (Vol. 66 No 3.). In December 2009, a second revision was drafted to outline updated priorities and action plans for fuels reduction treatments, structural vulnerabilities, and defensible space in the Greater Sisters Country wildland urban interface (WUI). As a result of these revisions, the committee outlined the following goals:

- Reduce hazardous fuels on public lands;
- Reduce hazardous fuels on private lands (both vacant and occupied);
- Reduce structural vulnerability;
- Increase education and awareness of wildfire threat; and
- Identify, improve and protect critical transportation routes

and prioritized the following treatments on public lands:

- All areas where Crown Fire Potential is rated Extreme by the federal agencies within the designated WUI boundary (*with priority given first to the areas within ¼ mile of communities at risk);*
- Within 300 feet of any evacuation route from each Community at Risk;
- For mixed conifer and lodgepole stands which have missed typical fire cycles and still pose threats of potential crown fires to communities, specific fuels treatments shall be accomplished on federal and state lands to reduce and maintain fuel loads to that which can produce flame lengths of less than four feet to provide for effective initial attack and minimize the resistance to control; and

- Although the treatments should focus on areas rated Extreme for Crown Fire Potential, maintenance of previously treated lands is also a top priority where treatment is critical to maintain this status within the CWPP area. Treatment and maintenance of previously treated lands before treatment begins again in other places is an important component of keeping communities safe.

Additionally, the committee determined that the overall WUI boundary would include communities as well as key transportation corridors and seasonal recreation areas with infrastructure, such as Forest Road 16 and the popular Three Creek Lake recreation area. This site specific definition of WUI will be used throughout this document and differs from that defined in the literature related to the structure protection and the home ignition zone (Cohen no date, Cohen 2000). Research related to the WUI as it relates to the home ignition zone was considered but is unrelated to issue of compromised ingress and egress from the Three Creek Lake recreation area.

Interagency Prescribed Fire Planning and Implementation Procedures Guide

Federal prescribed fire programs are guided by the principles of the 1995 *Federal Wildland Fire Management: Policy and Program Review* (USDA, USDI, 1995) and the 2001 update (USDA, USDI, et al, 2001). Federal wildland fire policy is guided by the 2009 *Guidance for Implementation of Federal Wildland Fire Management Policy* (USDA, USDI, et al, 2014). Collectively these principles establish that wildland fire programs be implemented equally, consistently and concurrently, as a means to protect, maintain, and enhance resources. Firefighter and public safety are emphasized as priorities in the planning and implementation of all fire management activities.

The purpose of the PMS 484 is to provide consistent interagency guidance, promote common terms and definitions, and provide standardized procedures, for the planning and implementation of prescribed fire.

The PMS 484 describes what is **minimally** acceptable for prescribed fire planning and implementation. Agencies may choose to provide more restrictive standards and policy direction, but must adhere to these **minimums**.

Interagency prescribed fire program goals are to:
• Provide for firefighter and public safety as the first priority.
• Ensure that risk management is incorporated into all prescribed fire planning and implementation.
• Use prescribed fire in a safe, carefully planned, and cost-efficient manner.
• Reduce wildfire risk to communities, municipal watersheds and other values and to benefit, protect, maintain, sustain, and enhance natural and cultural resources.
• Use prescribed fire to restore natural ecological processes and functions, and to achieve land-management objectives.

National Cohesive Wildland Fire Management Strategy (2014)

As a cohesive strategy, effort was designed as a three-phased process to allow for inclusiveness and understanding of the complexities of managing wildfire risks across the country. Environments are created to foster and sustain stakeholder engagement and increase collaboration between federal, state

and local governments and partner organizations. The best available science was used to develop a National Cohesive Strategy that will help guide the future of wildland fire management.

The strategy vision is to safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire.

The strategy goals are to:

1.) Restore and Maintain Landscapes
2.) Fire-Adapted Communities
3.) Response to Wildfire

Working in conjunction with scientific data analysis, The National Strategy establishes broad, strategic national-level direction as a foundation for implementing programs and activities across the nation. Based on a landscape-level collaborative approach, describing how the Nation can focus future efforts in making strategic investments to reduce the severe effects of wildfire on areas of high risk.

The mission of the Cohesive Fuels Treatment strategy is to lessen risks from wildfires by reducing fuels build-up in federally-managed forests in the most efficient and cost effective manner possible. Four principles guide the strategy: 1) prioritization, 2) coordination, 3) collaboration, and 4) accountability. While all of these principles are important to fuels management, the first principle *prioritization,* provides direction for treatments proposed in the Melvin Butte project area.

Prioritization - The President and the Congress have given clear direction that priority in the fuels treatment program should focus on two key areas. First, priority should be given inside the WUI, places where people have settled in forests, woodlands, shrublands, and grasslands. Here, people, their structures, and their work face the greatest threats. Second, outside the WUI, priority treatments must concentrate on sites where vegetation is most likely to support catastrophic fires that threaten vital resources or locations of particular value to local communities. In addition, non-WUI treatments must be applied to areas where fuel loads could quickly increase to dangerous levels without active management.

In the Melvin Butte project area, the proposed action and action alternatives recommend treatments adjacent to private land that are outside of the designated WUI. Vegetation in these areas could support a wildfire that could threaten vital forest resources, such as the city of Bend's municipal water supply. The Rooster Rock fire, which started in early August of 2010, is an example of how a fire initiating on Forest Service land in this area could easily travel to private land and threaten this resource (Rooster Rock Fire WFDSS Decision; Noonan-Wright et al 2011). Fire behavior during active burning periods was documented as primarily fuels and spot fire driven with flame lengths too high for direct attack (Loomis 2010).

Clean Air Act

Air quality is an important aspect of the central Oregon area. For the most part, air quality conditions are good except during certain times in the winter when temperature inversions create woodstove pollution problems, and certain times in the spring and summer when prescribed burning activities are occurring (1990 LRMP, pg. EIS 2-131).

The 1990 federal Clean Air Act (CAA) is a legal mandate designed to protect human health and welfare from air pollution. Individual states develop programs for implementing the CAA through State Implementation Plans. For this area we utilize the Oregon Department of Forestry (ODF) Smoke Management Plan.

The Oregon Implementation Plan considers local geography and industry to further define how the provisions of the CAA would be implemented through the Oregon Smoke Management Plan. The pollutants thought to affect human health include particulate matter emitted in smoke that is less than 10 microns in diameter (PM 10). The plan includes regional monitoring and regulation of pollutants less than 10 and 2.5 micrometers (PM 10 and PM 2.5) in size. The Forest Service is required by law to follow the directions of the State Forester in conducting prescribed burning in order to achieve strict compliance with all aspects of the CAA by working in conjunction with the Oregon Department of Forestry (ODF) to adhere to the Oregon Smoke Management Plan. The prevention of **Significant Deterioration** provisions of the CAA requires measures, to preserve, protect, and enhance the air quality for areas designated as "Class 1" airsheds (42 U.S.C. 475(d)(2)(B). The closest Class 1 airshed is the Three Sisters Wilderness located 1 mile west of the project area.

A **Smoke Sensitive Receptor Area (SSRA)** is an area designated by the board, in consultation with the Department of Environmental Quality that is provided the highest level of protection under the smoke management plan because of its past history of smoke incidents, density of population or other special legal status related to visibility (OAR-629-048-0140).
The following are potential project area SSRA's: Redmond located 20 air miles and Bend approximately 12 air miles.

In 2005, the ODF Smoke Management Program developed a concept known as the "Best Burn Day Strategy". This strategy helps to reduce the amount of burning necessary on marginal days when a higher likelihood of smoke intrusions exists. Specifically, the "Best Burn Day Strategy" seeks to:

"provide maximum opportunities for land management objectives to be met while maintaining air quality, health standards and visibility objectives. Burning can be managed more effectively with improved coordination, communication, technology, public education, increased utilization of forest fuels and maximizing burning during optimum burning conditions whenever possible" (ODF-SMP, pg. 1).

Fire Behavior Modeling Assumptions, Limitations, and Inputs

Fire Behavior modeling inputs (LANDFIRE 2010: LF 2010 – LF 1.2.0) were downloaded from www.landfire.gov. LANDFIRE delivers seamless landscape-level, geospatial canopy and fuels data products for incorporation into fire behavior modeling software. Methods are based on peer-reviewed science from multiple fields. LANDFIRE products are consistent, comprehensive, and standardized. Efforts were made to field verify and update the data to reflect some of the recent vegetation changes across the modeling area, including the effects from recent fires (i.e., Pole Creek). However, the amount and extent of error is uncertain. Although this approach has limitations, model outputs yield useful information for comparisons of landscape fuel treatments (e.g. pre- and post-treatment effectiveness; Stratton 2004).

FlamMap, a fire behavior mapping and analysis program that computes conditional fire behavior characteristics (flame length, crown fire potential, burn probability, etc.) over an entire landscape, was

used with LANDFIRE to determine fire hazard across the Melvin Butte project area. Fire behavior outputs are considered "potential" because they are conditional on a fire actually occurring (Finney 2006). FlamMap is a state of the art tool used by many researchers and in many studies including, Finney (2006), Stratton (2004), Gerke and Stewart (2006), Stratton (2009), and Ager et al. (2010), to name a few. FlamMap uses eight distinct raster (i.e. "grid") data files (aspect, slope, elevation, fuel model, canopy height, canopy base height, crown bulk density, and crown class) and specific weather and fuel moisture conditions as inputs.

Modeled fire hazard potential provides a "snap shot" of the existing condition for fuels and describes the likelihood of effective fire suppression actions under simulated weather and topography conditions. This metric assumes that there is no connection between adjacent pixels of data and is based on the combination of flame length and crown fire potential. In FlamMap, flame length calculations are based primarily on the surface fire spread models while crown fire activity links surface fire activity with canopy characteristics (Rothermel 1972, VanWagner 1977, Rothermel 1991, Finney et al. 2006). Therefore, combining crown fire activity with flame lengths into one metric provides a comprehensive depiction of the current "hazard" within an area.

In order to determine the effect to air quality resulting from wildfire compared to prescribed fire, an analysis was done with the computer model First Order Fire Effects Modeling (FOFEM). Currently, FOFEM provides quantitative fire effects information for tree mortality, fuel consumption, mineral soil exposure, smoke emissions and soil heating. The assumptions made within FOFEM and in this analysis are as follows:

- Smoke potentially impacts human health through inhalation of Particulate Matter (PM).
- The National Fuel Loading Models (FLM) data set was used for both prescribed burning and wildfires. This data set was masked to areas within the Melvin Butte project area where prescribed fire may occur under each Alternative. The FLM surface fuel classification system (Lutes et al. 2009) was developed by the Missoula Fire Sciences Laboratory to characterize wildland surface fuels. The FLM provide a simple and consistent way for managers to describe onsite fuels for input into the FOFEM model.
- Prescribed burning is conducted under typical spring fuel moisture conditions (1 hour fuels 6%, 10 hour fuels 8%, and 100 hour fuels 10%); wildfires occur under 90th percentile fire season fuel moisture conditions (See Assumptions section for more detail)
- PM outputs under all alternatives are modeled using the existing fuel vegetation profile. Treatment effects (thinning, mastication, harvest, and biomass removal) will ultimately reduce fuel loading and/or arrangement and thus emissions prior to prescribed burning. Using the existing fuel profile, rather than the treated fuel profile, allows for the most conservative comparisons of emissions or a "worst case scenario" approach accounting for temporal variability associated with treatments across the project area.

Indicator and Measurement

The primary purpose of the Melvin Butte project is to decrease fire hazard. There is a need to reduce forest fuel loadings in order to lessen the hazard associated with uncharacteristic and large wildfires threatening nearby communities and key ecosystem components. To indicate how the alternatives affect fire hazard within the Melvin Butte planning area the following measurements are used:

1) Change in fire hazard across the project area. The measure is the amount of area in acres of low, moderate, and high fire hazard when compared to all alternatives.
2) The effect to air quality resulting from high intensity wildfire. The measure is the production of PM 2.5 and PM 10 under wildfire vs. prescribed fire conditions for proposed treatment areas.

What is Fire Hazard?

In regards to wildland fire, there exists a considerable range of definitions for hazard (Hardy C. C., 2005). For the purpose of this analysis, the following definition is used:

Fire Hazard is a fuel complex, defined by volume, type, condition, arrangement, and location that determines the degree of ease of ignition and the resistance to control (NWCG 2014).

This analysis assumes that a fuel complex rated low for fire hazard will not support widespread crown fire and surface fire behavior will be of relatively low intensity under summer like weather conditions. To rate wildfire hazard, the matrix in Table** was used (Valliant, Ager, Anderson, & Miller, 2012).

Table **: Fire hazard matrix for the Popper project area (Vaillant et al. 2012).

Potential Flame Length (ft.)	**Crown Fire Potential**		
	Surface*	**Torching**	**Active**
Less than 4	Low	Low	Moderate
4 – 8	Moderate	Moderate	Moderate
8 – 11	Moderate	High	High
More than 11	High	High	High

*no crown fire potential

Using this matrix, fire hazard is represented as a combination of potential flame length and crown fire activity in which the fuel complex will support during 90th percentile weather conditions.

Weather and Fuel Moisture Inputs

The Round Mountain Remote Access Weather station (RAWS) was selected as the weather station that best represents fuel conditions for the planning area, since it is located at a similar elevation (5,900 feet) to the project area and temperature, relative humidity, and consequently fuel moistures are closely tied to elevation. The Colgate RAWS is closer to the Melvin Butte planning area than the Round Mountain RAWS, but the Colgate RAWS sits at a lower elevation (approximately 3,280 feet) and consequently may underestimate fuel moistures (which would overestimate fire behavior). The modeling inputs used in fire behavior modeling are those representing the 90th percentile "fire season" (July 1 to September 30) conditions from the Round Mountain RAWS from 1996 to 2013. The Round Mountain RAWS has data available from 1988 to 2013, but the most complete data set is available

from 1996 to 2013. Sensitivity analysis of the dead fuel moisture conditions at the Round Mountain RAWS showed very little difference between the 97th and 80th percentile conditions for fuel moisture, indicating a generally receptive fuel bed during a substantial proportion of fire season (see Table *). Dead fuel moistures were conditioned using 90th percentile weather including, humidity and temperature prior to modeling to incorporate the local spatial variability in dead moisture that occurs with topographical influences. As live and herbaceous fuel moistures predicted from RAWS stations are modeled rather than field sampled, the values extracted from the RAWS were increased by 20% to be more in line with live fuel moisture sampled across the forest (National Fuel Moisture Database 2014). Historic gust data, also derived from the Round Mountain RAWS, was used to identify wind speeds in the modeling environment, since average wind speeds derived from RAWS stations represent a 10-minute average taken only once at 1300hrs daily. Research has shown wind speeds that persist for only one minute can produce large fluctuations in flame height, trigger crowning, and throw showers of sparks across a fireline (Stratton, 2004). A northwest wind (315°) was used in the Melvin Butte analysis since most historic large fires in this particular area on the Sisters Ranger District have burned generally in a south easterly direction (see Figure**).

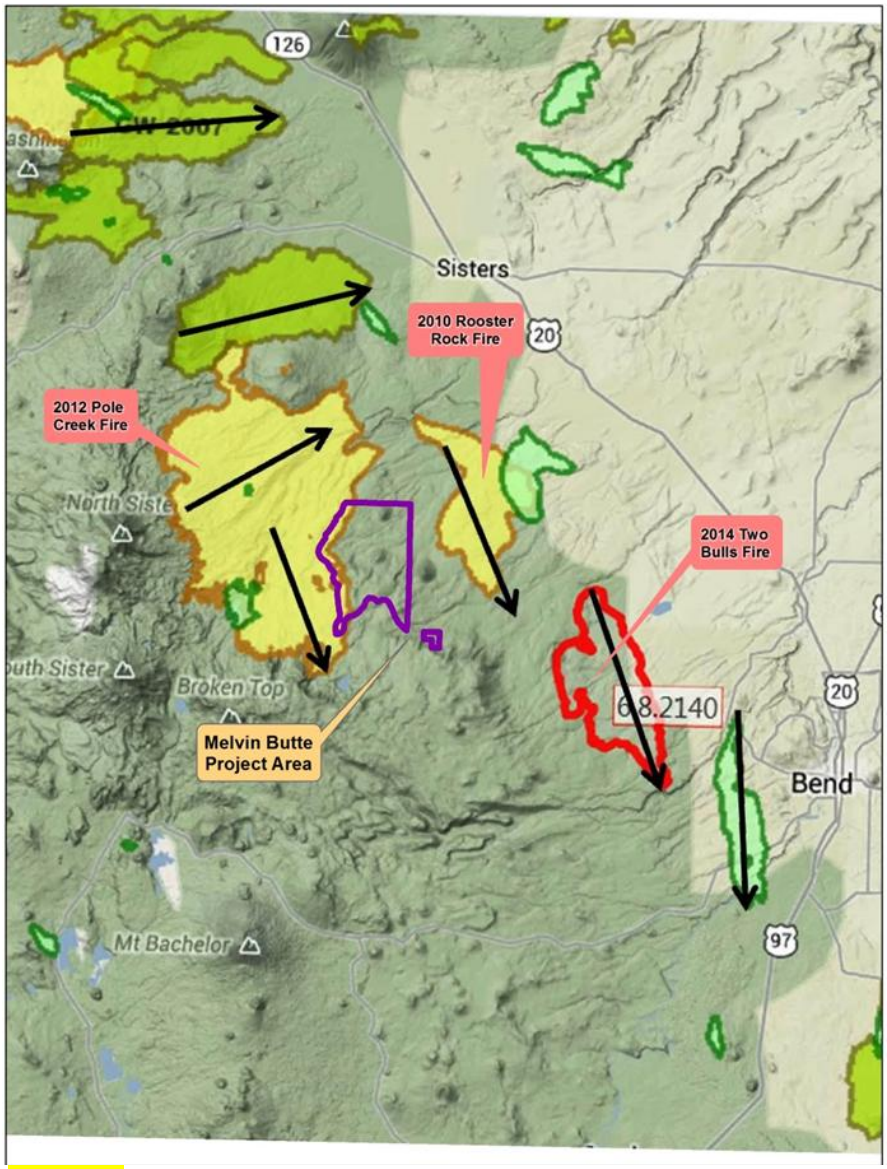

Figure**: Historical fire spread direction, N-S & W-E. One day spread distance of 4 to 6 miles (Stratton, 2014).

Table**: Percentile fuel moisture and winds used to model fire behavior within the Melvin Butte planning area and vicinity.

Variable	80th Percentile	90th Percentile	97th Percentile
1 hour fuel moisture (%)	3	3	2
10 hour fuel moisture (%)	4	4	3
100 hour fuel moisture (%)	8	7	6
Live herbaceous moisture (%)	40	35	35
Live woody moisture (%)	84	83	83
Wind Gust (mph)	22	25	30
Wind direction	Northwest		

Project Area Description

Fire Regime

Fire regimes are used to describe the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects, in a given area or ecosystem (NWCG, 2014). A fire regime is a landscape level reference condition generalization based on fire histories at individual sites. There is no record of a significant fire within the Melvin Butte project boundary in the past 100 years. The national, coarse-scale classification of fire regimes includes five groups:

Fire Regime I: 0-35 years, Low severity

Typical climax plant communities include ponderosa pine, eastside/dry Douglas-fir; where surface fires are most common. Large stand-replacing fire can occur under certain weather conditions, but are rare events (i.e. every 200+ years).

Fire Regime II: 0-35 years, Stand-replacing, non-forest

Includes true grasslands and savannahs with typical return intervals of less than 10 years, with typical return intervals of 10-25 years.

Fire Regime III: 35-100 years, Mixed severity

This regime usually results in heterogeneous landscapes. Large, stand replacing fires may occur but are usually rare events. Such stand-replacing fire may "reset" large areas (10,000-100,000 acres) but subsequent mixed intensity fires are important for creating landscapes' heterogeneity. Within these landscapes a mix of stand ages and size classes are important characteristics; generally the landscape is not dominated by one or two age classes.

Fire Regime IV: 35-100+ years Stand-replacing

Seral communities that arise from or are maintained by stand-replacement fire, such as lodgepole pine, aspen, western larch, and western white pine, often are important components in this fire regime. Dry sagebrush communities also fall within this fire regime. Natural ignitions within this regime that results in large fires may be relatively rare, particularly in the Cascades north of 45 degrees latitude.

Fire Regime V: >200 years, Stand-replacing

This fire regime occurs at the environmental extremes where natural ignitions are very rare or virtually nonexistent or environmental conditions rarely result in large fires.

The Melvin Butte project area is composed of vegetation characterized by Fire Regime II, III, IV, & V as shown in TABLE **& Figure**.

TABLE **: Fire Regimes by acres in project area.

FIRE REGIME	Description	PAG	ACRES	% Forested
I	0- 35 year, frequent low severity	P. Pine	1,109	21%
III	35-100+ years, mixed severity	M. Conifer	3,690	69%
IV	35-100+ years, stand replace severity	LP. Pine	523	10%
V	200+ years, stand replace severity	Hemlock	8	0%
OTHER	Not burnable or Unclassified	Rock /Cinder	44	0%
TOTAL			5,374	100%

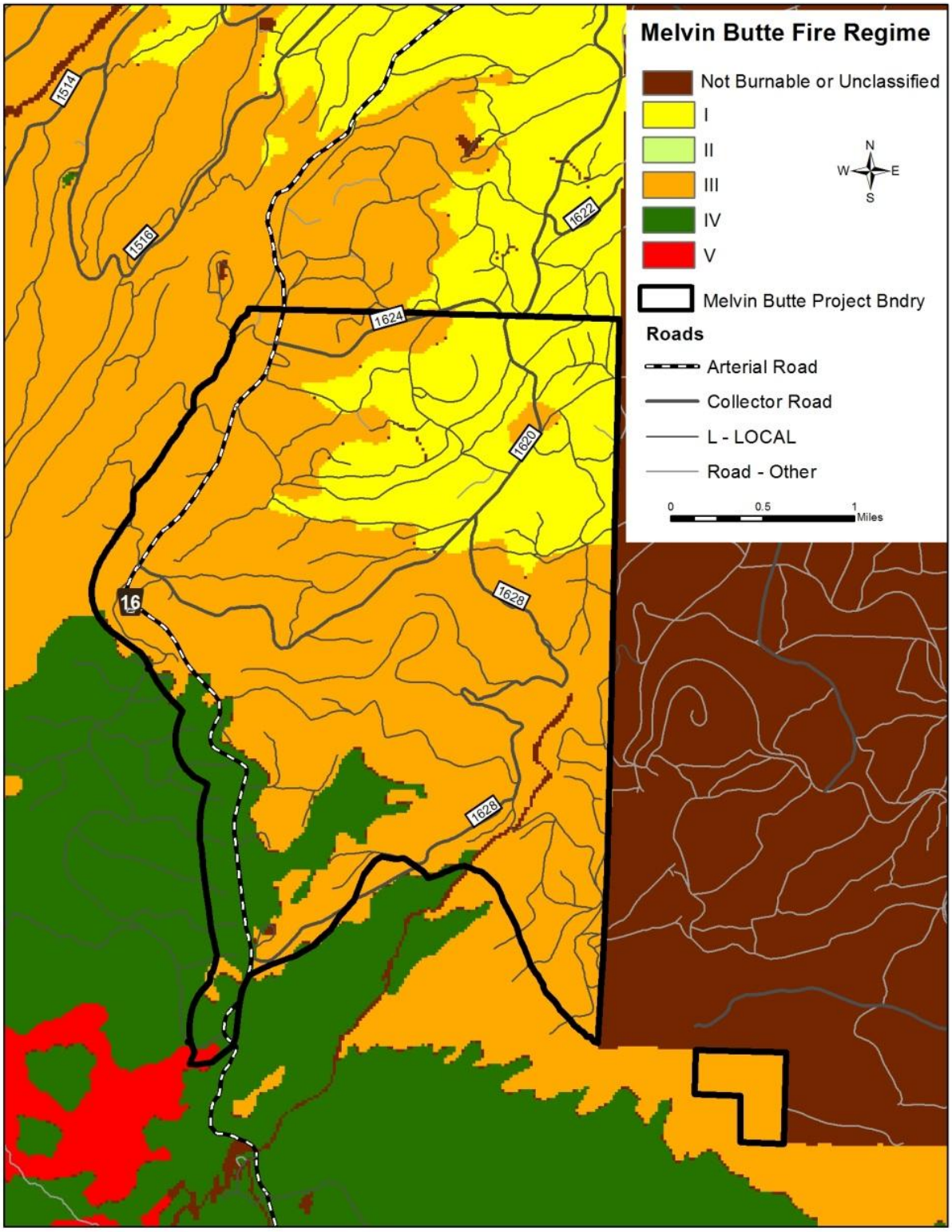

Figure**: Melvin Butte planning area historic fire regimes.

There is no record of a significant fire within the Melvin Butte project boundary in the past 100 years. Prior to the enactment of federal resource management agencies around 1910, approximately 40 to 50 thousand acres of the 1.6 million acre Deschutes National Forest burned annually, primarily in frequent fire adapted ponderosa pine forest type but also in mixed conifer forest type in the upper elevations of the project area. Fires were a mix of low and mixed severity that maintained the structural and compositional stages within the historic range of variability (HRV). Past forest management practices such as regeneration harvest (clear-cutting and over-story removal) and fire exclusion through fire suppression policy have shifted the structural stages outside of the HRV in the Melvin Butte project area. Along with Fire Regime analysis the project uses HRV as a reference framework for historical estimates of forest size-classes (structure) and seral stages, tree species (or lack of) proportional dominance, that may have been present at any given point in time in the past 300 years (see the silviculture section of this environmental assessment for more details pertaining to HRV).

A significant amount of departure from reference conditions affecting resilience occurs in the ponderosa pine, where large diameter open ponderosa pine and mixed conifer plant association groups (Whychus Watershed Analysis). Historically, about 90% of the project area was dominated by large ponderosa pine. Currently, more than 75% of the project area is dominated by trees less than 20 inches in diameter at breast height. Much of this acreage occurs as small blocks of plantations (about 22% of the project area); second growth stands; lodgepole pine stands; or other areas dominated by small trees.

Fire History

Fredrick Colville's 1898 report, "Forest Growth and Sheep Grazing in the Cascade Mountains of Oregon", generally describes vegetation on the eastern slope of the cascades over century ago. Colville described ponderosa pine-dominated forests as "the yellow pine forest, …[in which] the principal species is …Pinus ponderosa. The individual trees stand well apart and there is plenty of sunshine between them." Colville describes the upper range of ponderosa pine forests as "denser, and often contain a considerable amount of Douglas spruce [fir] ….California white fir… with an undergrowth of snowbrush…manzanita…" and the areas dominated by lodgepole pine as "small, thin barked trees easily killed by fire…..set so close together that it is often difficult to ride through them on horseback".

More than a century of human intervention has inadvertently created conditions that have put mixed-conifer forests in the Pacific Northwest at considerable risk. Fire exclusion and past logging and grazing practices have contributed to this problem, as have uncharacteristically large insect outbreaks and severe wildfires (Merschel, Spies, Heyerdahl 2014).

Evolving fire science and recent publications covering fire ecology topics such as fire history, and effects of thinning and burning on fire behavior and fuels is notable and applicable to the Melvin Butte planning area. Hyerdahl et. al. (2012) conducted a fire ring study within the Whychus Watershed concluding that between 1675 – 1850 fires occurred every 8 years on average (range 4 to 16 years). Everett et al.(2000) report on mean fire free intervals of 6.6 to 7 years in dry forest types during the pre-settlement period (1700/1750-1860**)** and lengthened intervals of 3 to 38 years during the fire suppression period (1910-1996). They found a clear shift to a less frequent, but greater severity fire regime, associated with longer recovery intervals (Everett et al. 2000)

Wright and Agee (2004) report mean fire free intervals of 7 to 43 years (1562 to 1995) in dry mesic forests of eastern Washington State. Sampling with Dry forests suggested that historical fires were of low intensity, leaving over story structure intact. The composition and structure of the historical forest was characterized by a preponderance of very large (>100 centimeters or 39.4 inches dbh) ponderosa pine. Mesic forests exhibit a wider range of fire severities, with moderate and occasional high severity fires or crown fires. Fire frequency and size decline dramatically about 1900, coincidentally with increased timber harvesting and fire suppression (Wright and Agee 2004).

Recent large fire occurrence in and around the project area (Figure** & Table**) provides some insight into potential fire behavior and impacts to the Whychus watershed and the Melvin Butte project area.

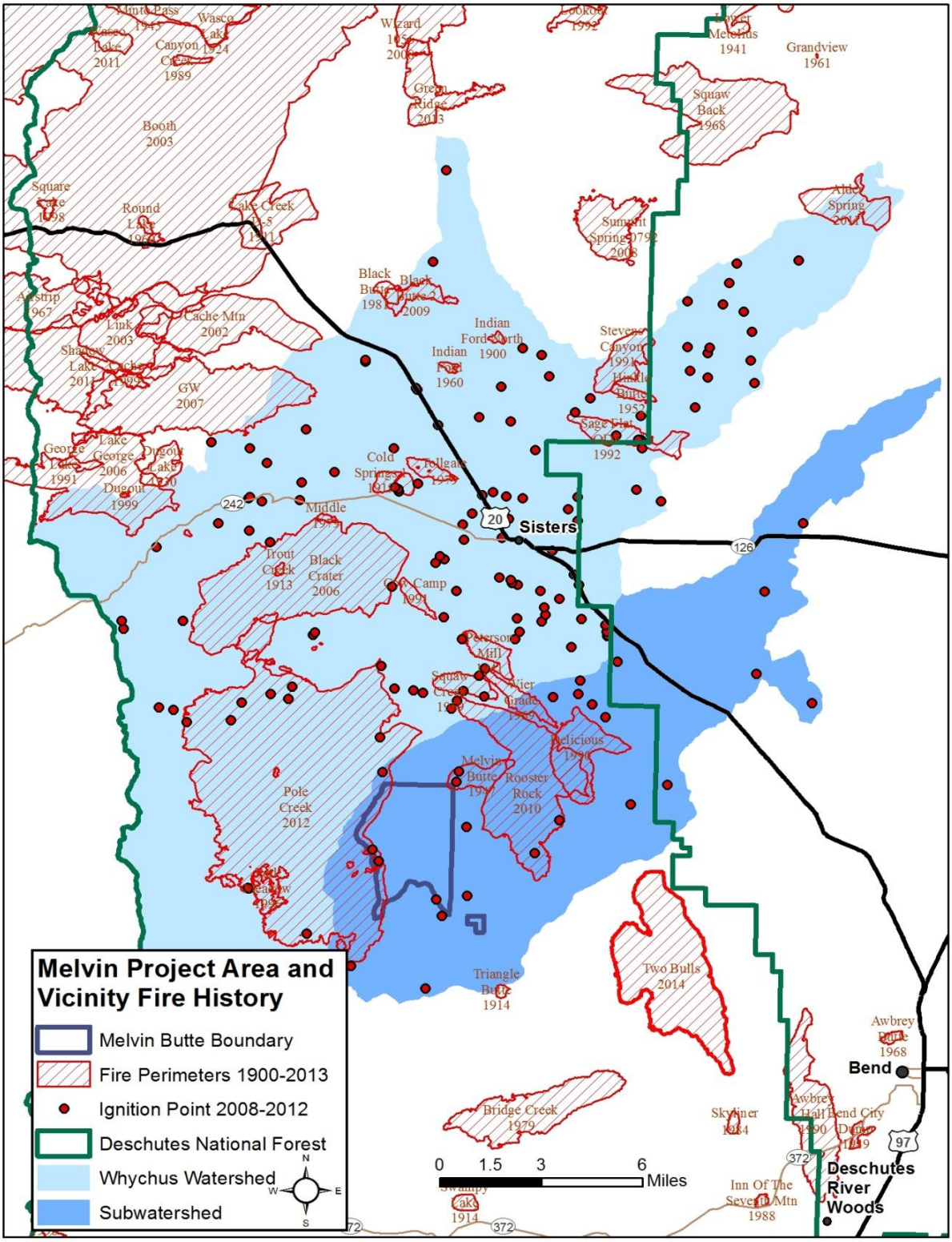

Figure**: Fire occurrence within the Whychus watershed.

Table**: Nine significant fires surrounding the Melvin Butte project area since 2000. The analysis area acres are within the Whychus watershed.

Fire Name	Year	Cause	Fire Acres	Analysis Area Acres
Cache Mountain	2002	Lightning	4,358	43
Black Crater	2006	Lightning	9,411	9,396
Lake George	2006	Lightning	5,537	1,857
GW	2007	Lightning	7,349	954
Stevens Canyon	2008	Lightning	173	76
Black Butte II	2009	Lightning	578	559
Rooster Rock	2010	Human	6,119	6,119
Alder Springs	2011	Human	1,449	1,052
Pole Creek	2012	Lightning	26,119	26,119
TOTAL			**61,093**	**46,175**

The most recent fire of significance is the human caused Two Bulls Fire, June 7th 2014. Beginning as two fires (Figure**) that merged into one, the Two Bulls fire travelled six miles in an afternoon and evening. The northerly wind driven fire prompted immediate evacuations in areas west of Bend. No homes or structures were damaged or lost as a result of this fire. However, equally strong winds out of the west would have likely led to several more subdivisions being impacted by the fire. The fire burned approximately 6,908 acres of mostly private land and cost nearly $5.6 million to suppress. Two Bulls, which was primarily influenced by a strong north wind, occurred three miles east of the Melvin Butte planning area. The fire regime and fuel type are similar to what is found in the Melvin Butte planning area. The Two Bulls fire provides an example of expected spread rates and fire growth.

Figure**: 2014 Two Bulls Fire. Photo by Steve Orange, Sisters Ranger District Timber Sale Administrator.

The second most recent fire of significance is the lightning caused Pole Creek Fire, September 9th 2012, which occurred directly west and adjacent to the Melvin Butte planning area. The Pole Creek fire travelled three to four miles during its first burn period and grew to about 26,119 acres. No homes

or structures were lost, however, notification and evacuation strategies were implemented immediately and key ecosystem habitat was severely impacted. Additionally, the Three Creek Lake recreation area along with the city of Bend's municipal watershed was threatened. This fire (Figure**) burned actively for three weeks in fire regimes I, III, IV & V, produced significant smoke impacts, and cost upwards of $18 million to suppress. Fuels treatments played a significant role in stopping the fires spread to the east, which provided anchor points for fire suppression personnel during containment efforts. The burned area contains similar fire regime and pre fire fuel type to the Melvin Butte project area, thus the Pole Creek fire provides an example of expected spread rates and fire growth.

Figure **: 2012 Pole Creek Fire. Photo taken from Broken Top by Katie Ryan.

The third most recent fire of significance is the human caused Rooster Rock, August 2, 2010, which occurred directly north and east of the Melvin Butte planning area. The Rooster Rock fire travelled three to four miles during the first burn period and grew to about 6,119 acres. This fire burned one structure, threatened numerous other structures and resources of concern, including the city of Bend's municipal watershed (Rooster Rock Fire WFDSS Decision; Noonan-Wright et al 2011). Fire behavior was documented as primarily fuels and spot fire driven with flame lengths too high for direct attack (Loomis 2010; Figure**). Weather at the time of Two Bulls, Pole Creek, and Rooster Rock fires, as

well as forest fuel conditions are representative of events and conditions, respectively, which occur within the Melvin Butte planning area.

Figure **: Head of Rooster Rock fire with two spot fires along the flank. Displays typical fire behavior in Melvin Butte project area vegetation type. Photo courtesy of Mel Gard, archived on Inciweb.

Existing Condition

The Melvin Butte area is characterized by large areas of mistletoe infested ponderosa pine stands with an area of beetle killed lodgepole pine intermixed with dense stands of mixed conifer. Mountain pine beetle epidemics in lodgepole pine forests can leave vast acreages of forest with dead lodgepole pine (Raffa et al. 2008) and the past 30 years on the Deschutes and Fremont-Winema National Forests can serve as an example of the scale of these disturbances. There have been two distinct peaks in activity in the region, one occurring in the 1980s and the other more recently ramping up after 2000, persisting to this day at a distinctly lower level (Shaw. Et al. 2012). Decades of fire exclusion, insect and disease activity, and previous forest management activities, have all contributed to relatively high vertical and horizontal forest fuel loadings. The current landscape condition combined with lightning or a human caused ignition source during typical summer time weather creates an atmosphere where a wildfire could present a high risk to human safety and loss of vital forest habitat.

Forest Fuel Condition and Fire Hazard

The combination of dwarf mistletoe activity (see silviculture section), previous forest management practices, and fire suppression activity over the last 100 years has shaped current vegetative conditions and consequently fuels within the Melvin Butte project area.

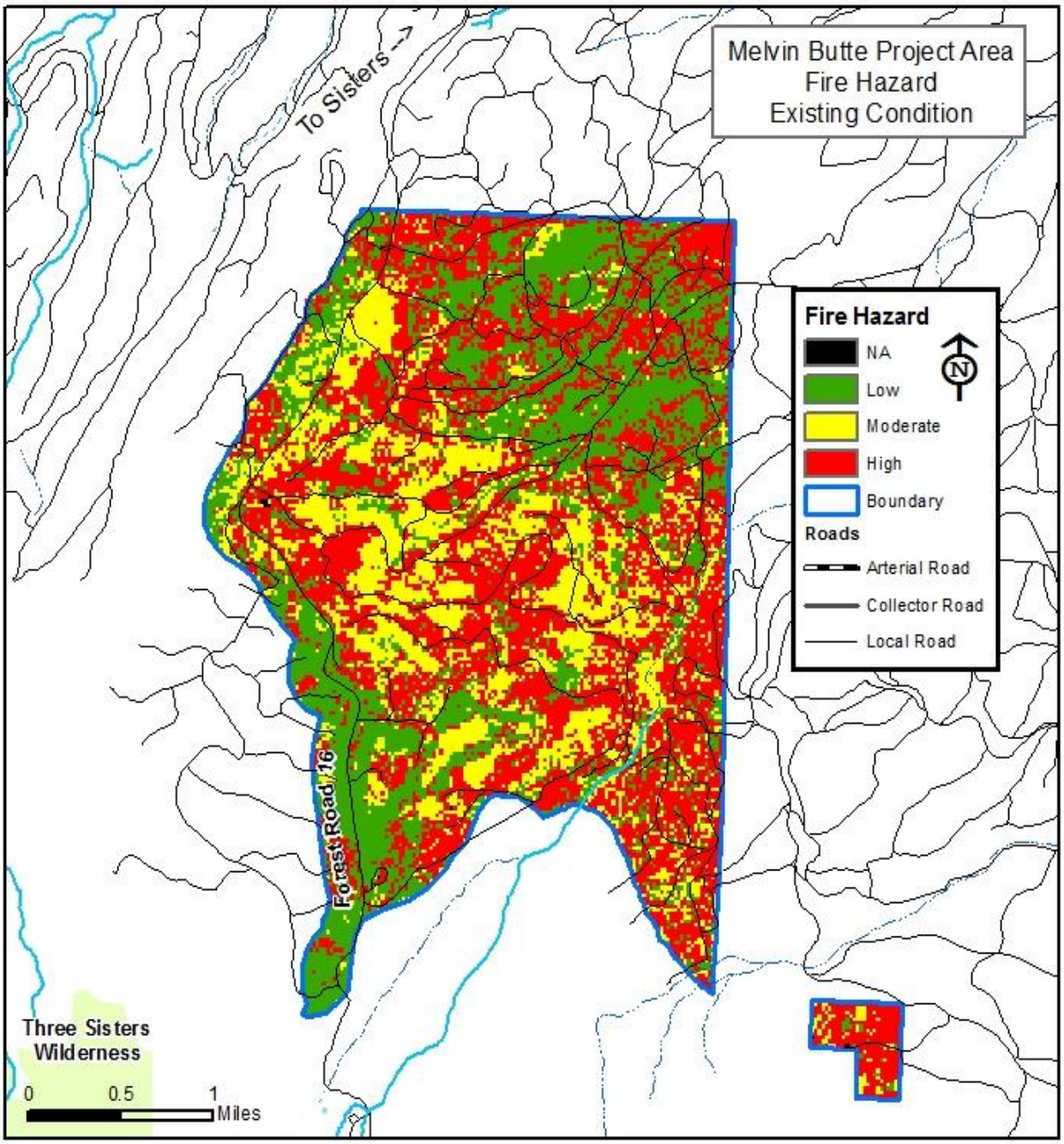

Figure**: FlamMap and GIS modeling display of the existing fire behavior hazard within the Melvin Butte project boundary

Values at Risk

Wildfire in this area could quickly threaten nearby recreational developments, adjacent private timberland, and the Bend Municipal Watershed. Deschutes National Forest fire managers have identified the roadless areas to the south and unburned wilderness areas to the southwest of Melvin Butte as High Risk Exposure Areas. *Firefighter and Public Safety* - High fuel loadings, continuous fuels, poor access and high snag densities classify these areas as safety hazards that increase the risk of exposure for initial attack and/or extended attack firefighting resources. The project area coupled with adjacent vegetation management project areas is bordered by private land, wilderness and roadless areas. From a landscape view, this is one of the few areas where treatments can be implemented on a large enough scale to make a significant change in fire hazard. Public health and air quality degradation would be a concern if wildfire occurred in the Melvin Butte area. The communities of Sisters, Redmond, and Bend experienced six consecutive days of severely degraded air quality during the Pole Creek Fire when the 24-hour average for levels of PM 2.5 (fine particulate matter) remained in the "Very Unhealthy to Hazardous" range (Oregon Health Authority and Oregon Department of Forestry, 2014). Smoke impacts from the Pole Creek Fire were felt across Jefferson and Deschutes Counties, as well as the Willamette Valley.

Forest Road 16 WUI Travel Corridor - Accessible from the town of Sisters, is the primary travel route within the project area to the Three Creek Lake recreation area and is considered WUI due to its critical role as a travel corridor and evacuation route. The Greater Sisters CWPP steering committee expressed great concern over critical transportation routes, such as Forest Road 16, as part of the CWPP planning process and recommended that routes such as these be protected (Project Wildfire 2014). A problem fire, lightning or human-caused could jeopardize ingress to and egress from the Three Creek Lake Recreation area and consequently jeopardize public and fire fighter safety. Because of this, there is an immediate need to reduce and maintain arterial travel corridors. Fire hazard can be explicitly defined in many ways but is fundamentally the state of the fuels as determined by the volume, condition, arrangement, and location (Hardy 2005). For this reason, treating fire hazard must modify fuels in a way that lessens the likelihood of fire ignition, potential damage, or resistance to control (Evans et al 2011).

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The 2012 Pole Creek post fire perimeter includes a section of FS road 16. The two lane paved road was used as a containment strategy called backfiring. Backfire is a tactic associated with indirect attack where fire managers intentionally set fire to fuels inside the control line to slow, knock down, or contain a rapidly spreading fire. Backfiring provides a wide defense perimeter and may be further employed to change the force of a convection column (NWCG, 2014). Although the western side of FS road 16 has received recent fire activity, vertical and horizontal fuel loads are at levels in support of high intensity fire and do not provide an adequate margin of safe egress and ingress to firefighters and the public.

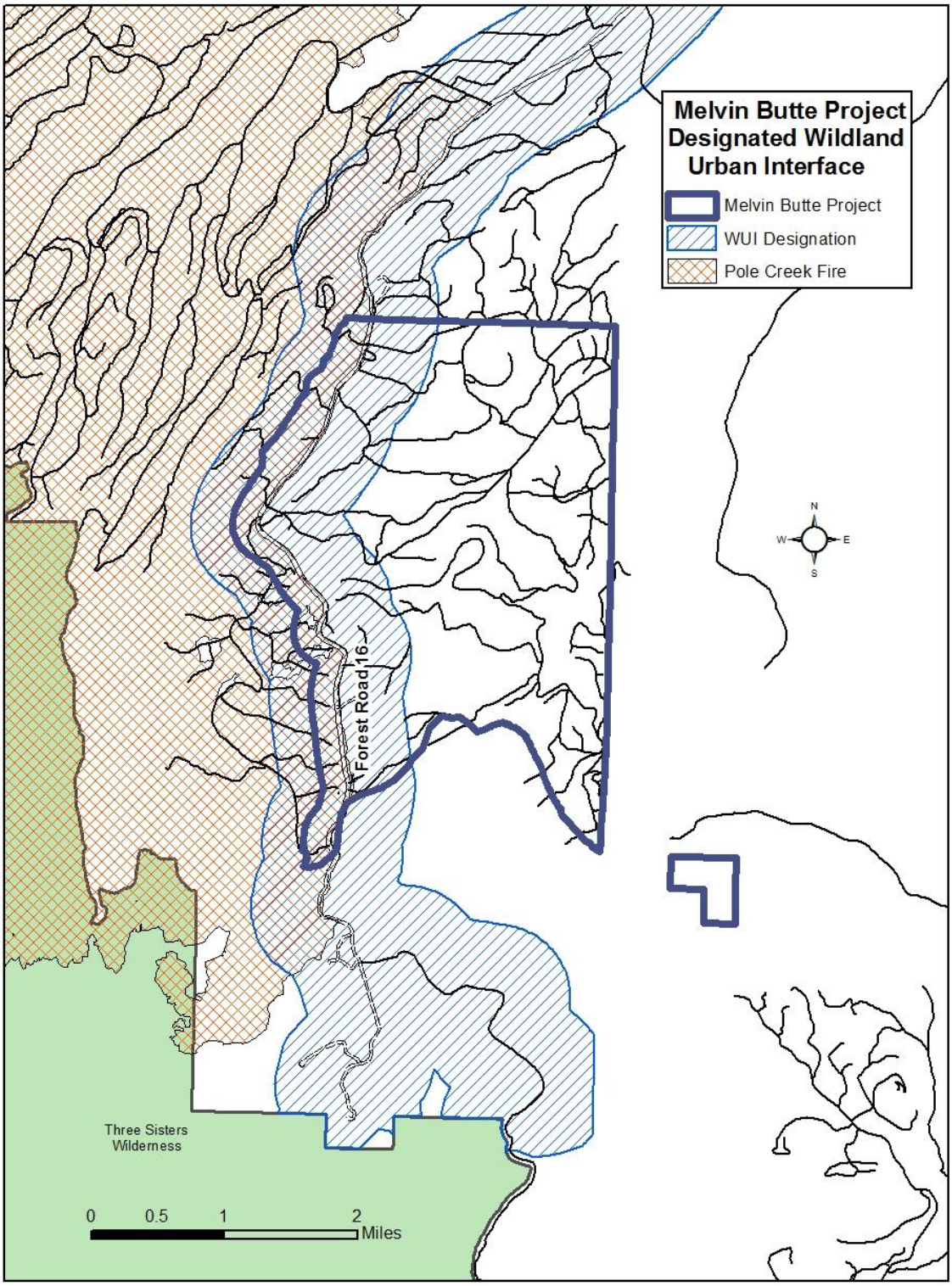

Figure**: Forest Road 16 travel corridor designated as Wildland Urban Interface by the Greater Sisters Country CWPP.

Across much of the Melvin Butte project area, treating the WUI (Figure **) in combination with the surrounding landscape functions will reduce fire hazard, reintroduce fire into fire adapted systems, and improve ecosystem health.

Private Timberlands – The east side of the Melvin Butte planning area is bordered by the "Skyline Forest". The Skyline Forest, currently owned by Whitefish Cascade, is a 33,000 acre (50 sq. mile) tree farm historically known as the Bull Springs Tree Farm. The 2014 Two Bulls Fire burned more than 6,000 acres of the Skyline Forest. Fidelity's Skyline Forest contains an informal system of trails, wildlife habitat and a migration corridor for mule deer and elk moving between summer and winter range (Deschutes Land Trust, 2014).

Recreation Values – Upper and Lower Three Creek Sno-Parks, Triangle Hill Loop and portions of the Windigo Cross District Trail are located within the Melvin Butte project area. All but the Windigo Trail are primary attractions to winter recreationists. Within a mile of the southern portion of the project area boundary there are five trailheads and three campgrounds as described in Chapter 3 of the Melvin Butte EA. This area can attract upwards of 400 recreationists at one time during summer months. Safe and timely evacuations on a one way ingress to and egress from route will be the primary concern if a wildfire were to impact the area.

Bend Municipal Watershed – The Bridge Creek Watershed approximately 3.5 miles south from the project area. Approximately half of Bend's water comes from this area. As seen in Figure**(Historical fire spread direction, N-S & W-E. One day spread distance of 4 to 6 miles (Stratton, 2014)) an established wildland fire occurring in the Melvin Butte project area has high potential to move south and threaten this watershed.

See "Hazard Reduction Strategy and Principles to Protect Values at Risk" within the Project Design section to view values at risk vicinity map.

Project Design

Description of Hazardous Fuels Reduction Activities

Table**: Total project area treatment acres by analysis Alternatives 2 & 3.

Alt. 2 Treatments	Acres	Alt. 3 Treatments	Acres
Prescribed Fire	809	Prescribed Fire	809
Thinning	998	Thinning	1,923
Mixed con. group openings	835	Lodgepole pine imp.	249
Dwarf mistletoe areas	160	Plantation	1,174
Lodgepole pine imp.	249	Scenic View Enhance	240
Plantation	1,174	*Retention Strategy	775
Scenic View Enhancement	240	*No Treatment	229
*Retention Strategy Area	775		
*No Treatment	159		

Alt. 2 Total Acres	4,465	Alt. 3 Total Acres	4,395

*Retention Strategy Area and No Treatment acres were analyzed for treatment. Specialists determined no primary or secondary treatments will occur on these acres thus not included in the Alternative acres for each Alternative.

Small and medium size tree harvest is accomplished by using ground based harvest equipment. Some small tree thinning may be accomplished by hand while utilizing chainsaws. Small tree thinning units, identified as pre-commercial thinning (PCT), are typically plantation treatments thinned at a level desired to meet wildlife and silvicultural objectives.

Activity slash fuel generated from PCT units may be 1) lopped and scattered or 2) piled by machine or by hand and burned or removed as biomass. Ladder fuel reduction (LFR), typically occur in the Thinning, Scenic View Enhancement, Lodgepole pine improvement treatments thinning of small trees up to 8" in diameter in based on silvicultural prescription. Excess slash material remaining with LFR treatment units would be piled by machine or by hand and burned or removed for biomass.

Mowing is proposed as a secondary treatment in both action alternatives to decrease the height of live or dead brush through the mastication (mowing) of brush in stands as needed throughout treatment units within the project area.

Burn only (with small tree thinning permitted to prepare containment lines for holding purposes in EA unit 8) treatment is proposed on 30 acres to re-introduce fire on the landscape and to meet wildlife objectives in both Alternatives 2 & 3.

Prescribed Fire is proposed as a secondary treatment on all acres for each alternative following thinning and mowing activities. All prescribed fire activities would occur when fuels and weather conditions are conducive to achieving planned fuels and resource objectives. Typical underburn conditions occur during spring and fall seasons, however depending on the season, objectives may still be achieved any time of year.

Underburning results in some amount of first order, or short-term, fire effects that include bole scorch, needle scorch, shrub mortality and at times may also result in some tree mortality. These effects depend on many variables such as climatology, stand condition, fuel loadings, fuel moistures, ignition patterns and weather conditions during burn operations.

All proposed treatment units will receive some form of thinning, mowing, and underburning to reduce surface fuel loadings. Fire behavior analysis and professional experience conclude that all successional treatment types achieve desired conditions. Longevity of treatments and other ecological values such as brush response, recruitment of beneficial species, and nutrient cycling indicate that prescribed underburning is the desired treatment over mowing in stands that have been both proposed for mowing and/or underburning. Best available science shows that all intermediate treatments should be accompanied by surface fuel modification, and the most success related to effective fuel reduction is achieved when using prescribed fire for such treatments (McIver et al. 2012; Graham et al. 1999).

Hazard Reduction Strategy and Principles to Protect Values at Risk

As seen in the existing condition hazard rating Figure** high fire hazard exists within the project area. Fire knows no boundaries, once a fire gets established under the current conditions intensities will build quickly with minimal opportunity to contain and protect values at risk. When designing treatments, consideration was put into how fire would travel across the landscape (see Figure** historical fire spread direction in Weather and Fuel Moisture Inputs section). The intent is to maximize treatment effectiveness through strategic placement emphasis towards values at risk. The figure to the right shows the location of strategic roads, campgrounds and trailheads, the Bridge Creek Watershed, and other ownership lands within and adjacent to the Melvin Butte project area.

Road Systems and WUI Corridor

Road systems allow ground suppression forces to access wildfires. Use of major roads in a defensible space is recommended, especially in the WUI where public safety and evacuation is of high concern. Forest Road 16 within the WUI corridor would be cleared of contiguous surface fuel loading up to 250 feet from both sides of the road. Forest Roads 1620, 1624, and 1628 would be cleared of contiguous surface fuel loadings up to 150 feet from both sides of each road where permissible. Snags should not be retained near the roads (within a tree length) that remain open to the public. This strategy allows for safe ingress/egress to and from a fire for fire fighters and ties in with the Greater Sisters Country CWPP Action Plan and Implementation priorities. Consequently, when fuel conditions allow surface fires to gain high intensities and get into the canopies of trees contributing to extreme fire behavior (torching, crowning, and long range spotting), direct attack by ground forces becomes ineffective. Wildland fires under these conditions will cross any road system with such intensity that suppression forces have little chance of containing the fire from the road. Aerial delivery of fire retardant alone will only slow a wildfire for a short period of time. Suppression forces need to quickly utilize the effect of the retardant to contain a wildfire. Roads provide a good area for retardant to be utilized by suppression forces.

Private Timberlands: On the eastern edge of the project adjacent to the Skyline Forest, emphasis would be placed on hazardous fuels reduction by not allowing for wildlife clumps within 600 feet of the private ownership boundary. Downed wood or slash piles should not be retained within 200 feet of the private ownership boundary in order to limit ember production and spotting onto private inholdings in the event of a fire initiating on federal lands.

Key Ecosystem Components: Late Successional Old Growth areas are designated for survey and manage protocols as assigned by the 1994 Northwest Forest Plan. Surveys were not completed within the Melvin Butte project area however, there is an applicable court ruling exemption referred to as Pechman allowing plantations and prescribed fire fuels reduction treatments without pre-disturbance surveys. Pechman (d) states that only trees less than 8 " dbh can be cut and removed as biomass; it also allows prescribed burning. These large old trees are currently at risk from ladder fuel and surface fuel accumulations. The Pechman Exemption would be utilized to treat specific units as displayed in Table** below to protect 541.3 acres of old growth stands. For more information regarding survey and manage see the botany section of this environmental analysis.

Table**: Pechman Exemption treatment units and acres.

Pechman Exemption treatment units proposed

for thinning up to 8" dbh and prescribed fire.	
EA Unit Number	**Unit Acres**
1	3.0
2	6.9
3	34.9
4	46.7
5	4.1
6	112.9
7	11.9
8	29.8
9	54.6
10	126.5
12	.3
13	79.6
14	4.0
15	5.7
17	19.5
84	.9
Total	**541.3**

The absence of fire over the last 100 years combined with the development of shrubs and dense thickets of regeneration in the understory has placed the ponderosa pine stands at high risk of stand replacing wildfire. Reintroduction of fire in these ponderosa pine type stands would be used as needed to achieve the desired conditions. Prescriptions would be developed for low intensity prescribed fire to start a return to historic fire regime conditions. Subsequent prescribed fire entries would be conducted, through time, to create a more fire resilient stand condition which would help in defending private lands and help preserve the ponderosa pine stand type. Interior project area treatments will focus on reducing ladder fuel loadings while utilizing small tree thinning, mowing and prescribed burning treatments designed to reduce surface fire spread rates in and around plantation investments. Emphasis on fuel reduction treatments will also occur directly adjacent to wildlife retention and no treat areas within the project in order to protect the forests wildlife connectivity strategy.

Developed Recreation Sites and Neighboring Bridge Creek Watershed: The recreation assets inside the project area include Upper and Lower Three Creek Sno-Parks, Triangle Hill Loop and portions of the Windigo Cross District Trail. Within a mile and south of the project area recreation sites include Trapper Meadow, Three Creek Lake, Driftwood Campgrounds and Park Meadow; Trapper Meadow, Tam McArthur Rim, Little Three Creek Trailheads. Further south approximately 3 miles away is the Bridge Creek Watershed an important municipal water source supplying the city of Bend. All sites listed are at risk from a crown fire initiating within the project area. Crowning fires are the most intense wildfires and usually produce long range spotting that hampers control efforts. Dense stands of timber support independent crown fires allowing fire to burn through the canopy of the trees independent of the surface fire. Torching and crowning with support of the surface fire is also a common problem during wildfires in denser stands of timber. Breaking up the continuity of the vegetation canopy in timber and in surface fuel loadings through thinning mowing and burning greatly decreases the chance of an active or passive crown fire. By maintaining stands at crown bulk densities of less than 0.10 kg/m^3, active or independent crown fire activity can be limited (Agee, 1996). Thinning from below, leaving dominant and co-dominant trees with thick bark and high crowns

significantly changes the potential for fire to move from surface up into the tree crowns (Fitzgerald, 2002).

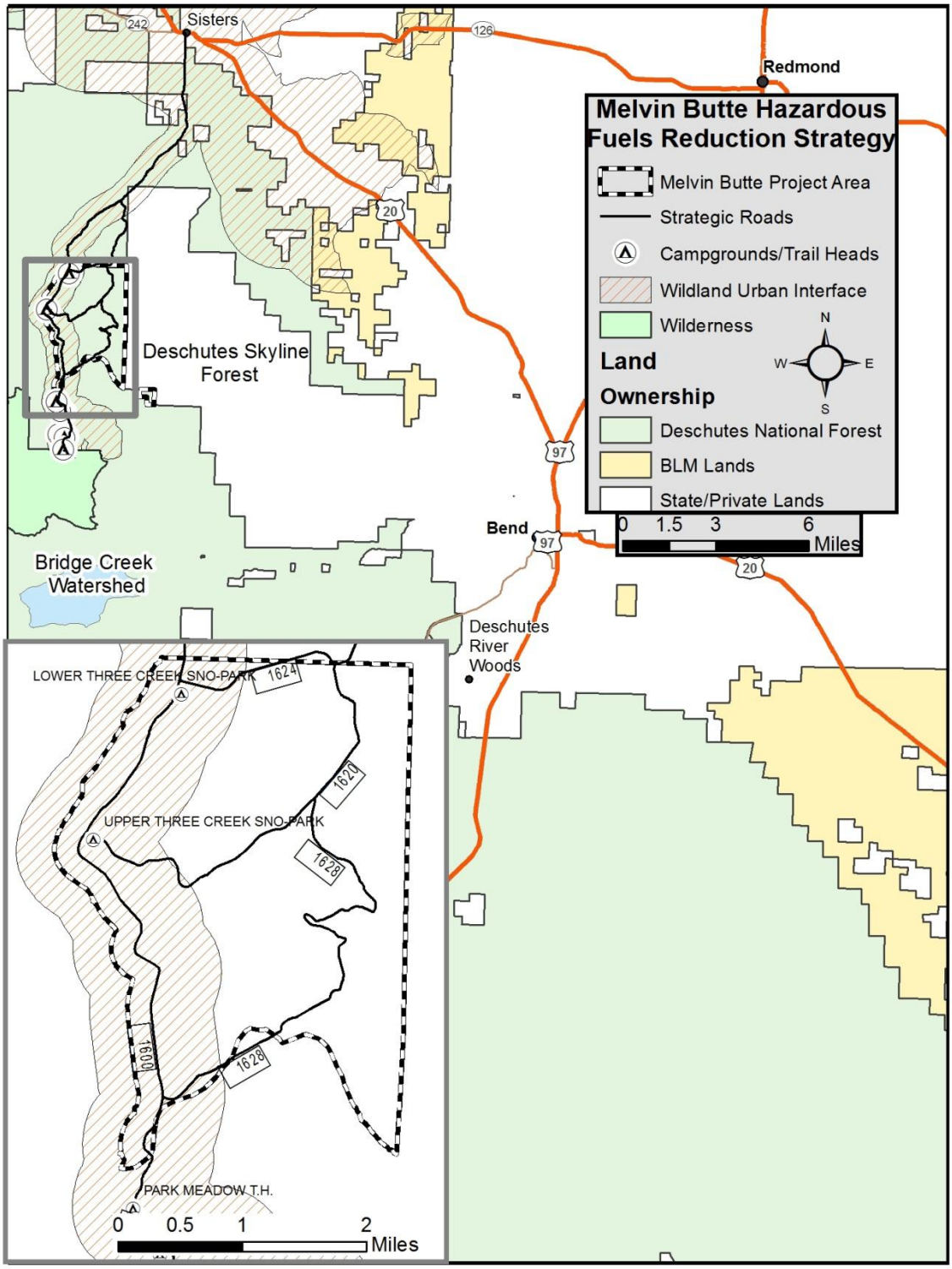

Figure**: Vicinity map of values at risk associated with Melvin Butte Hazardous Fuels Reduction Strategy.

Table** describes principles of fire resistance. Although this table was originally developed for ponderosa pine forests, the principles can be applied to the ponderosa pine dominated mixed conifer stands within Melvin Butte area. Mixed conifer treatments are aimed at reducing canopy base heights and crown bulk density. It is unlikely that these treatments alone would stop rapid moving wildfire displaying extreme fire behavior. However, the treatments will provide a place for firefighting resources to attempt to stop a wildfire through control actions such as backfire or burnout operation.

There are two components to crown fire hazard: crown fire initiation and crown fire propagation. Crown fire initiation is influenced by canopy base heights and surface fuels. Ladder fuel thinning and the reduction of surface fuel height through mechanical mowing will reduce a stands susceptibility to crown fire initiation. Ladder fuel thinning is the removal of sub-merchantable understory trees and shrubs in the lower canopy of the mixed conifer stands. Surface fuel loadings are reduced through piling and burning and ideally biomass utilization and underburning. Mastication is another method to reduce potential surface fire intensities. Mastication reduces the intensities by rearranging the forest fuels.

A stands susceptibility to active crowning (crown fire propagation) is most strongly affected by crown bulk density and, to a lesser extent, foliar moisture content (Scott J. H., 2001). Foliar moisture content is dependent on tree species composition and season, and cannot be modified by forest management except by altering species composition. Crown bulk density can be lowered through over-story thinning and, if the understory is well developed, through ladder fuel thinning.

Table **: Principles of fire resistance for dry forests: adapted from Agee, 2002 and (Hessburg & Agee, 2003) and (Agee & Skinner, 2005).

Principles	Effect	Advantage	Concerns
Reduce surface fuels	Reduce potential flame length	Control easier, less torching[1]	Surface disturbance, less with fire than other techniques
Increase height to live crown	Requires longer flame length to begin torching	Less torching	Opens understory, may allow surface wind to increase[2]
Decrease crown density	Makes tree-to-tree crown fire less probable	Reduces crown fire potential	Surface wind may increase and surface fuels may be drier[2]
Keep big trees of resistant species	Less mortality for same fire intensity	Generally restores historic structure	Less economical; may keep trees at risk of insect attack

[1] Torching is the initiation of crown fire.
[2] Where thinning is followed by sufficient treatment of surface fuels, the overall reduction in expected fire behavior and fire severity usually outweigh the changes in fire weather factors such as wind speed and fuel moisture (Weatherspoon, 1996).

The effects of thinning and burning on fire behavior and fuels have been well studied in the past decade. Evaluating fuel treatments from across the west, the reduction in fire behavior parameters and fuel loading is maximized by the combination of mechanical thinning plus burning (Schwilk et al.

2009). Thinning alone by traditional commercial harvest methods leads to increases in small diameter (<1 inch dbh) surface fuels immediately after treatments (Agee and Lolley 2006), but these fuels decrease to pre-treatment levels within 5 years (Youngblood et al. 2008). Amounts of larger fuels (>1 inch dbh) post-thinning can significantly increase and may not decrease for a long period without the use of prescribed burning. Pre-commercial thinning using mastication equipment can increase total fuel loading and fuel bed depths by as much as two inches, but the magnitude varies by fuels size class (Dodson et al. 2008a). Thinning followed by burning significantly decreases surface fuel loading (Stephens and Moghaddas 2005a, Agee and Lolley 2006, Youngblood et al. 2008, Harrod et al. 2008a) regardless of thinning method.

Canopy closure, canopy bulk density, canopy base height, and surface fuel loading influence torching and crowning fire behavior. Thinning generally reduces canopy closure and canopy bulk density, and increases canopy base height (Stephens and Moghaddas 2005a, Agee and Lolley 2006, Harrod et al. 2007a, Harrod et al. 2007b, Harrod et al. 2008a, Harrod et al. 2009). Burning alone is less effective at altering these characteristics in mature stands (Stephens and Moghaddas 2005a, Agee and Lolley 2006, Harrod et al. 2007b, Harrod et al. 2009, Schwilk et al. 2009), but can reduce surface fuels loading (Youngblood et al. 2008), thereby decreasing surface fire behavior and the potential for fire to move into the canopy. However, burning alone can be effective in young coniferous forests for thinning stands from below, reducing surface fuels, and raising canopy base height (Peterson et al. 2007). Crown fire severity is generally mitigated by fuel treatment (prescribed fire only, thinning only, or combination), as compared to stands with no treatment (Pollet and Omi 2002, Finney et al. 2005).

Treatments may allow for increased solar radiation to reach the forest floor and may result in lower fuel moistures, higher wind speeds, and increased growth of flammable grasses, forbs, and shrubs. These conditions may actually increase the rate of spread and potentially flame lengths and crown damage, if a fire were to occur (Thompson and Spies 2009, Agee and Skinner 2005, Weatherspoon and Skinner 1995, Raymond 2004). However, where thinning is followed by sufficient treatment of surface fuels, the overall reduction in expected fire behavior and fire severity usually outweigh the changes in fire weather factors such as wind speed and fuel moisture (Weatherspoon 1996, Bigelow and North 2012). Additionally, these changes in canopy characteristics and surface fuels were incorporated into the modeling scenario and are reflected in the resulting hazard outputs. As forest conditions are not static, maintenance treatments will be required in order to maintain the previously described effects so that the growth of flammable material is maintained over time.

Fires in low hazard areas could be effectively suppressed using hand crews and direct fireline construction. Moderate and high hazard areas would require heavy equipment such as dozers, and/or aerial methods to effectively suppress a wildfire (NWCG 2006). Moderate and high hazard areas also have an increased likelihood of negative resource and social effects from wildfire such as fire fighter safety, public safety concerns, resource damage, and smoke production. Refer to other sections of this environmental assessment for information related to the effect of wildfire on specific resources.

Desired Condition

Wildfire hazard levels are moderate to high across the project area. Of particular concern is public and firefighter safety during a wildfire event along with the potential negative impacts to ecosystem resources. However, given the project areas adjacency to private lands and the amount of large

wildfires within close proximity high intensity wildfire is not desirable within the planning area. Current fuel loadings, conducive to fire regime intervals and expected fire behavior, within the Melvin Butte project provide few opportunities to effectively manage wildfire. In order to provide opportunities for firefighters to contain a wildfire that originates in the project area or in the adjacent private lands there is a need for discontinuous fuels, which lessen the intensity and resistance to control of wildfire.

From a fuels perspective, the desired future condition would be a mosaic of landscape-scale treatments managed to reduce fire hazard to facilitate suppression of large high intensity wildfires, protect valuable resources, and allow the re-introduction of fire as a disturbance process at lower intensity levels. These conditions tier to the Forest-wide goal for Fire and Fuels management (see Table** in Management Direction section) by being responsive to resource management goals while improving the efficiency of future fire suppression efforts (Deschutes LRMP p 4-73). Specifically, the goals for Fire and Fuels Management include prevention of human caused wildfire in areas identified as high use and high risk including, major travel ways and firewood cutting areas, two major components of the Melvin Butte project area (Deschutes LRMP p 4-73, 4-74). Additionally, these conditions tier to several of the management area goals which encourage the use of prescribed fire to meet resource goals (e.g., timber and forage) and to reduce hazardous fuels (see Table** in Management Direction section; Deschutes LRMP p 4-119, p 4-131, p 4-139, p 4-144, p 4-162). At the stand level, in areas dominated by ponderosa pine and in the WUI, this translates to canopy characteristics and a fuel profile which do not support high intensity fire behavior (i.e., crown fire, high resistance to control, high flame lengths) under severe fire weather conditions. To achieve this state of resiliency, stands should be maintained at a height to live crown that is well above the shrub and seedling components. Shrubs should be maintained at a height and continuity that would reduce the potential for rapid rates of spread and crown fire initiation. Dead and down material should not be overly extensive. Large trees more resistant to fire-induced mortality should be maintained (Agee 2002, Hessburg & Agee 2003). These conditions are supported by the Greater Sisters Country CWPP and Whychus Watershed Assessment and Updates, and can be achieved with a variety of methods including prescribed burning, mowing/mastication, pruning and thinning treatments.

Outside of the WUI, leaving some untreated areas at the landscape scale and providing for within-stand spatial heterogeneity of residual trees and shrubs are important components of treatment which help meet the goals of habitat loss due to stand replacement fire while restoring forest habitats as outlined in the Whychus Watershed Assessment and Updates (see Table** in Management Direction section). These desired conditions highlight the importance of maintaining large trees as well as variable spatial arrangements of residual trees to account for small and large scale variability in the historic range of natural variability (Larson and Churchill 2012, Baker et. al. 2007, Hessburg et. al. 2006).

The desired condition is a fire resilient forest. To meet this goal the fire regime of the entire project area would be in a condition of one where there is a natural or historical range of variability of fire frequency matched with expected severity. To facilitate effective direct attack with hand crews and equipment it is desired that fuel loadings spaced across the project area be reduced to a level that will not support potential flame lengths over four feet during mid-summer wildfire conditions.

<u>Twenty one percent of the Melvin Butte planning area is within Fire Regime I.</u> Within this fire regime surface fires are common and large stand-replacing fires can occur under certain weather conditions,

but are rare events. Fire history studies in nearby pine stands show that the area experienced low-intensity surface fires every 5-20 years and open stands of large, long-lived fire resistant ponderosa pine were typical (Arno, 1996) (Bork, 1984) prior to the 1900's. A recent study performed by Heyerdahl et al. determined that fires occurred every 8 years on average ranging 4 to 16 years. To achieve this goal the desired surface vegetation would be characterized by potential fire behavior represented by Scott and Burgan, 2005 fuel models GS1 and TU1.

Desired post treatment ponderosa pine fuel loadings can be represented by the following photo series: (Maxwell, W.G., Ward, F.R. 1980. Photo Series for Quantifying Natural Forest Residues in Common Vegetation Types of the Pacific Northwest).

PNW-105: 1-PP-2, 1-PP-4, 4-PP-4, or 7-PP-4.

<u>Sixty nine percent of the Melvin Butte planning area is within Fire Regime III.</u> The forest fuel hazard concern in the mixed conifer is crown fire. In mixed conifer treatment units it is desired that crown bulk density be reduced to a level that will not support crown fire under 90th percentile weather conditions. The generally accepted crown bulk density threshold for crown fire is 0.10 kg/m3 (Agee J. K., The Influence of Forest Structure on Fire Behavior, 1996). Variability is both a historical norm and a future restoration goal in many forests with mixed severity fire regimes. Management objectives that aim to capture that variability within and among fuel beds can guide future restoration efforts. Scale of variability for all fuels strata is an important consideration in the planning and layout of restoration activities (Hudec and Peterson, 2012).

Desired post treatment mixed conifer fuel loadings can be represented by the following photo series:

PNW-105: 1-MC-3

<u>Ten percent of the Melvin Butte planning area is within Fire Regime IV.</u> The primary hazard concerns in the lodgepole pine stands is the potential of high surface fire intensities resulting from the large component of dead and down. To achieve this goal the desired surface vegetation would be characterized by potential fire behavior represented by Scott and Burgan fuel model TL1.

Desired post treatment in lodgepole pine fuels loadings can be represented by the following photo series:

PNW-105: 1-LP-2 or 1-LP-3

The desired condition is a wildfire hazard rating of low for the entire project area. It is recognized that it is not feasible to achieve low hazard rating for the entire project area and still satisfy other resource needs. The intent of the action alternatives is to reduce fire hazard over the greatest area possible while balancing other resource concerns and budget constraints. The landscape within the project area should display a mosaic of strategically placed areas with emphasis in travel corridors, and adjacent to private property, wildlife retention areas as well as other no treatment areas to reduce fire hazard.

Effects of Alternatives

Environmental effects are based on the following assumptions:

- Ignitions will continue within the Melvin Butte project area, wildland fire will not be eradicated, and it is not possible to determine the probability of future fire occurrence. The analysis presented assumes that the probability of future fire occurrence within the project area is 100%. In reality, the extent, likelihood, and/or severity of future wildfire is unknown. Assuming that the area *will* burn into the future provides a useful baseline from which to compare the effects of the alternatives. Given the recent fire history of the Sisters Ranger District, this assumption is not implausible.
- This analysis is landscape in scale. As with any landscape analysis, some level of error is to be expected, especially since treatments affect fine scale fuel loading and fire hazard in variable and complex ways (Waltz et al. 2003). Furthermore, there is no way to determine the finite scale at which the utility of this data dissolves. Given that the data was derived from 2012 Landfire satellite imagery, some of the more recent changes resulting from the mountain pine beetle outbreak may not be reflected. Efforts were made to field verify and update the data to reflect some of these recent vegetation changes across the modeling area, including the effects from recent fires (i.e., Rooster Rock) and vegetation management projects (i.e., Sisters Area Fuels Reduction). However, the amount and extent of error is unknown. Although this approach has limitations, model outputs yield useful information for comparisons of landscape fuel treatments (e.g. pre- and post-treatment effectiveness; Stratton 2004). See more detail in the modeling assumptions, inputs and limitations section.
- There are no treatments that will result in completely safe conditions for people, property, or important ecosystem components. Certain unknown combinations of an ignition(s) with vegetation under dry live and dead fuel moistures, high winds, and/or low relative humidity will continue to threaten social and natural resources.
- Public and firefighter safety is the top priority in fire management. Treatments will focus on creating a safe work environment for fire suppression forces.
- Tree mortality and other related resource damage from potential wildfire is not predicted by any of the models used in this analysis and thus is not measured in any quantifiable way. However, qualitative inferences about tree mortality and related resource damage can be inferred from this analysis as vegetation that burns while in a hazardous state (as defined in this analysis) influences a tree's probability of surviving fire (Regelbrugge and Conard 1993, Fowler et al. 2010).
- The full scope of treatment (thinning, piling, pile burning, mastication, prescribed fire, and maintenance of post treatment conditions) is implemented instantaneously through the modeling process. In reality, it may take 2 or more years once thinning is initiated before the first entry of prescribed fire and the timing of secondary maintenance treatments will vary by stand conditions. This will result in variability in fire hazard. The extent and effect of this variability on fire hazard is unknown and not incorporated into this analysis.

- Within the group opening treatments planned within the mixed conifer plant association groups, some assumptions were made to address effects to canopy and fuel characteristics.
    - "Group opening" treatments within the mixed conifer plant association group were assumed to be variable in size, ranging from 1-3 acres (approximate planned size), and were randomly placed where applicable.

  Until marking crews assess each acre of ground, there is no way to spatially determine where the group openings or modified stand conditions will be located. Actual placement of these treatments and modified stand conditions would likely change fire spread and consequently burn probability, but to what extent is unknown.
- "Wildfire" weather and fuel moistures used in FlamMap and the FOFEM simulations utilized 90th percentile "fire season" conditions. "Fire season" is typically defined as the 92 day period between July 1st and September 30th, during which most fires and acres burn. The 90th percentile is defined as the combination of live and dead fuel moisture, temperature, relative humidity, and wind speed on a summer day that is warmer, drier, and windier than 90% of all other recorded days within "fire season". This threshold establishes reasonable conditions for estimating "problem fire" behavior in the modeling environment. The effects of treatments other than the previously mentioned are assumed to cover 100% of the treatment area. Leaving certain areas untreated within units would likely reduce the effectiveness of fire hazard reduction indicated in the analysis, but to what extent is unknown.

No Action – Ecological Trends

The purpose of the Melvin Butte project is to restore resiliency in a historic fire adapted ecosystem and reduce the risk of high intensity wildfire. Without treatments, a fire in the area will place the public, firefighters and ecosystem habitats at increased risk. Treatments are aimed at both providing rapid fire containment options and to prevent high intensity wildfires from threatening values at risk.

Fire Hazard

Direct effects of a no action alternative include the ongoing fire suppression efforts and natural ecosystem degradation that will contribute to an increase in flame lengths and risk of crown fire above historical range of variability resulting in an increase in active crown fire within the analysis area. Even though fuel reduction projects have been conducted within the watershed and with recent wildfire scars the area already is within its range in some respects. If no action was implemented, the continued accumulation of fuels leading to increased surface flame lengths and increased risk of crown fire would negate investments already implemented. The natural decay rate would reduce fuels at a much slower rate than they would accumulate through ordinary pruning and mortality. The higher flame lengths are likely to result in higher scorch heights, greater tree mortality, and greater fire severity than expected for this landscape when utilizing fire regimes as a reference condition. Wildfire would reduce fuels as well as return fire as an ecological process within the project area, however the severity and extent to which the wildfire would occur would fail to meet Forest Plan direction to; Limit acres of habitat damaged by wildfire, retain and enhance key wildlife habitat, reduce risk of large scale wildfire, while maintaining site productivity, place fire tolerant stands on maintenance schedule to meet management objectives, and maintain prescribed fire burning schedule to meet management objectives.

The indirect effects of a no action alternative would result in a shift in species composition, structure, and patterns that would support fire spread from the surface to the crowns over greater portions of the landscape than in the past and projected for the future. No action would result in continued connectivity of understory and overstory vegetation and would include secondary fire effects associated with higher flame lengths, and fire intensities, including soil damage, potential for insect and disease due to fire weakened canopy, cambium kill, loss of the coarse woody debris component, and a loss of fire resilient species. Under a no action alternative, these fire behavior conditions associated with a departed landscape would continue and are likely to increase over time.

The potential for crown fire is the main concern in mixed conifer stands. There is very little that can be done once a crown fire starts (information from "Crown fire behavior and prediction in conifer forests: a state-of-knowledge synthesis", Alexander, Cruz, Vaillant, & Peterson, 2013):

> *Crown Fires Move Fast* – At a minimum, a doubling or tripling in a fire's rate of advance follows the onset of crowning. Wind-driven crown fires have been documented to spread at up to 100 m/min (3.7mph) for several hours and in excess of 200 m/min (7.5mph) for up to an hour. A crown fire initiated in the Melvin Butte project area could threaten life, private property, ecosystem habitat and easily reach the Bend municipal watershed outside the planning area south 3.5 miles away within one burning period.
>
> *Crown Fires are Intense* – A fire can easily quadruple its intensity in a matter of seconds when crowning takes place (e.g., from 3,000 kW/m to 12,000 kW/m). The resulting wall of flame, standing nearly erect, is on average up to two to three times the tree height and emits fierce levels of radiation. Flame fronts commonly exceed 30-45 m in depth. Once a crown fire initiates, suppression resources, including air tankers are ineffective.
>
> *Crown Fires get big quickly* – The area burned by a crown fire is at least four to nine times greater than a surface fire for the same period of time. Assuming unlimited horizontal fuel continuity, crown fires are capable of burning an area of upwards to 173,000 acres with a perimeter length of 100 miles in a single burning period and have done so in the past in similar fuel profiles as present in the Melvin Butte planning area.
>
> *Crown Fires can spot long distances* – Crown fires commonly display high-density, short range spotting (< 50 m). Spotting distances of up to about 1.25 miles, although less common, are frequently seen on crown fires, resulting in normal barriers to fire spread being breached. Many spot fires are simply overrun by the main advancing flame front of a crown fire before they effectively contribute to an increase in the fire's overall rate of advance. Cases of long-distance spotting have been reported of up to 2 miles on the Deschutes National Forest. It would not take much for a crown fire initiated in the Melvin Butte project area to send embers into the adjacent private lands or into the Bend watershed to the south.

A No Action approach to management would prevent the opportunity to reduce hazardous forest fuel loadings thereby increase the potential for crown fire and high intensity wildfire threatening fire fighter and public safety and important values at risk.

Air Quality

Under a no action alternative, smoke emissions associated with a wildfire under the current fuel loadings and stand structure departures within the Melvin Butte analysis area that have not been treated would result in higher particulate emissions than projected for future conditions.

The maximum number of treated acres proposed in the Melvin Butte project area is 4,465 acres. Therefore, under the No Action Alternative, this same number of acres would potentially not receive a prescribed fire treatment. Table* * shows the potential PM production if a wildfire was to burn on these acres under the conditions previously described.

Table **: Estimated total potential Particulate Matter emissions from total acres under wildfire condition without treatments.

Fire condition	**Tons $PM_{2.5}$**	**Tons PM_{10}**
Wildfire – 4,465 total acres	6,204	7,320

Smoke and PM emitted from wildfires within the Melvin Butte project area could impact the communities and outlying areas of Sisters, Redmond, and Bend. This is because under wildfire conditions, there is no ability to limit emissions by burning during favorable atmospheric conditions. It is possible that during a wildfire the air quality and visibility within the Three Sisters Wilderness, a Class 1 Airshed due west of the project area, would also be adversely affected. Recreational sites near and around the Melvin Butte planning area, such as the Three Creek Lake recreation area, Park Meadow Trail, and the Pole Creek Trail could also be adversely impacted by smoke when tourism and recreation are at their highest. The continued deferral of treatment within the project would only exacerbate the negative effects on air quality, when a wildfire does occur.

Air quality issues as a result of a wildfire in this area will result in the high particulate (hazardous to human health) levels for extended durations of 5 days or weeks. As compared to prescribed fire with low particulate levels for 3 to 24 hours. Figure ** shows an example of worst case scenario prescribed fire particulate levels and duration compared with the 2012 Pole Creek Fire particulate levels and duration.

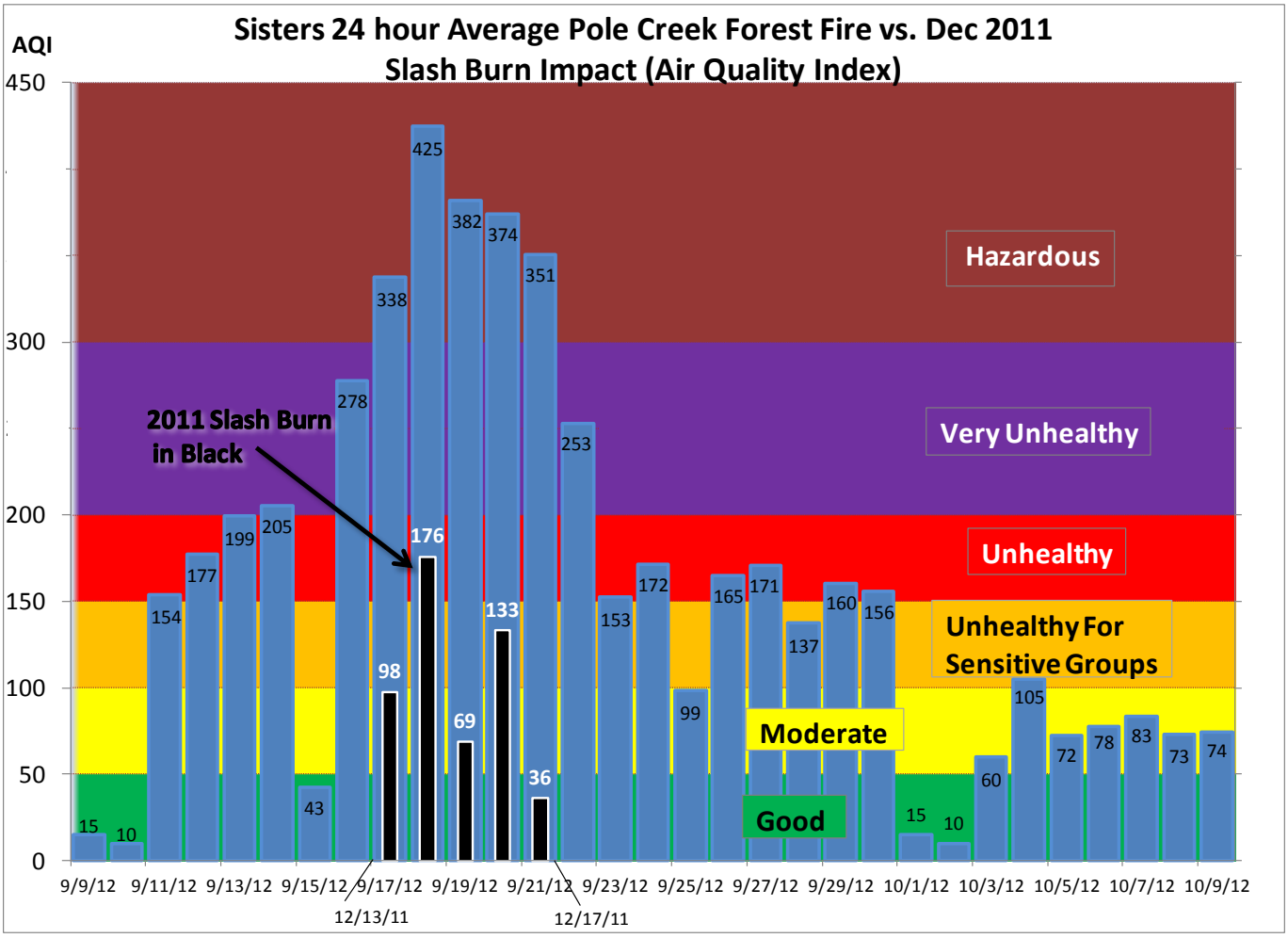

Figure**: Data from Sisters Forest Service nephelometer. Image created by the Oregon Department of Environmental Quality.

Direct and Indirect Effects – Alternative 2 and 3

Fire Hazard

The differences in hazard supported by each alternative are largely determined by the fuel model changes associated with each proposed treatment. In Alternatives 2 & 3, treatment type and associated effects remain static however total number of acres and spatial arrangement is variable, resulting in differences in underlying effects on fire hazard. Table ** and Figures ** below, display the resulting treatment effect of each alternative on fire hazard within the project area and across the treatable acreage. Treatments proposed have the ability to reduce high fire hazard, as compared to the existing condition. The ability to use direct attack allows for a greater probability that unwanted fires can be contained at smaller fire sizes limiting resource damage and potential loss of values at risk.

Alternatives also vary in the treatment of stands infected with dwarf mistletoe, the effect of this on fire hazard is minimal as the variability is related to the treatment of overstory trees only and the goal of

fuels treatment in these areas would not be to modify the overstory. Under Alternative 2, treatments in mixed conifer where fir encroachment is thick surrounding large pine, group openings ranging from 1-3 acres in size would be created and planted to ponderosa pine. In these units, fire hazard outside of these openings would remain high. Under Alternative 3, the fire hazard would drop to low across these units since these Alternatives propose general thinning; i.e. stands would not contain group openings.

The action alternatives provide for two non-significant Forest Plan amendments to meet the purpose and need for action. These amendments are primarily focused on treatments located in the Wildland Urban Interface. Treatments in Foreground areas located along Forest Road 16 would reduce the risk of high intensity stand replacement fire and help maintain old ponderosa pine trees over time. These amendments would help meet the goals stated in the Community Wildfire Protection Plan. Amendments would allow for areas larger than five acres for prescribed burning, increase the number of years for foreground slash cleanup to a five-year period, and increase scorch height of trees. These changes would allow for more effective fuels management and also help meet the scenic values described for these areas over the long-term.

For the purposes of this analysis, fire hazard is specifically defined as the combination of potential flame length and crown fire as defined in Table **and Figures **&**.

Table**: Fire Hazard rating comparison by acres for no action and action alternatives in the Melvin Butte project area.

	No Action 5,375 acres		**Alternative 2 4,465 acres treated**			**Alternative 3 4,395 acres treated**		
Hazard Rating	**Acres**	**%Area**	**Acres**	**%Area**	**Change Acres**	**Acres**	**%Area**	**Change Acres**
UNFORESTED	**44**	**<1%**	**44**	**<1%**	**0**	**44**	**<1%**	**0**
LOW	**1,706**	**32%**	**3,503**	**79%**	**1,797**	**4,211**	**79%**	**2,505**
MODERATE	**1,226**	**23%**	**621**	**14%**	**-605**	**692**	**13%**	**-534**
HIGH	**2,399**	**45%**	**310**	**7%**	**-2,089**	**426**	**8%**	**-1,973**

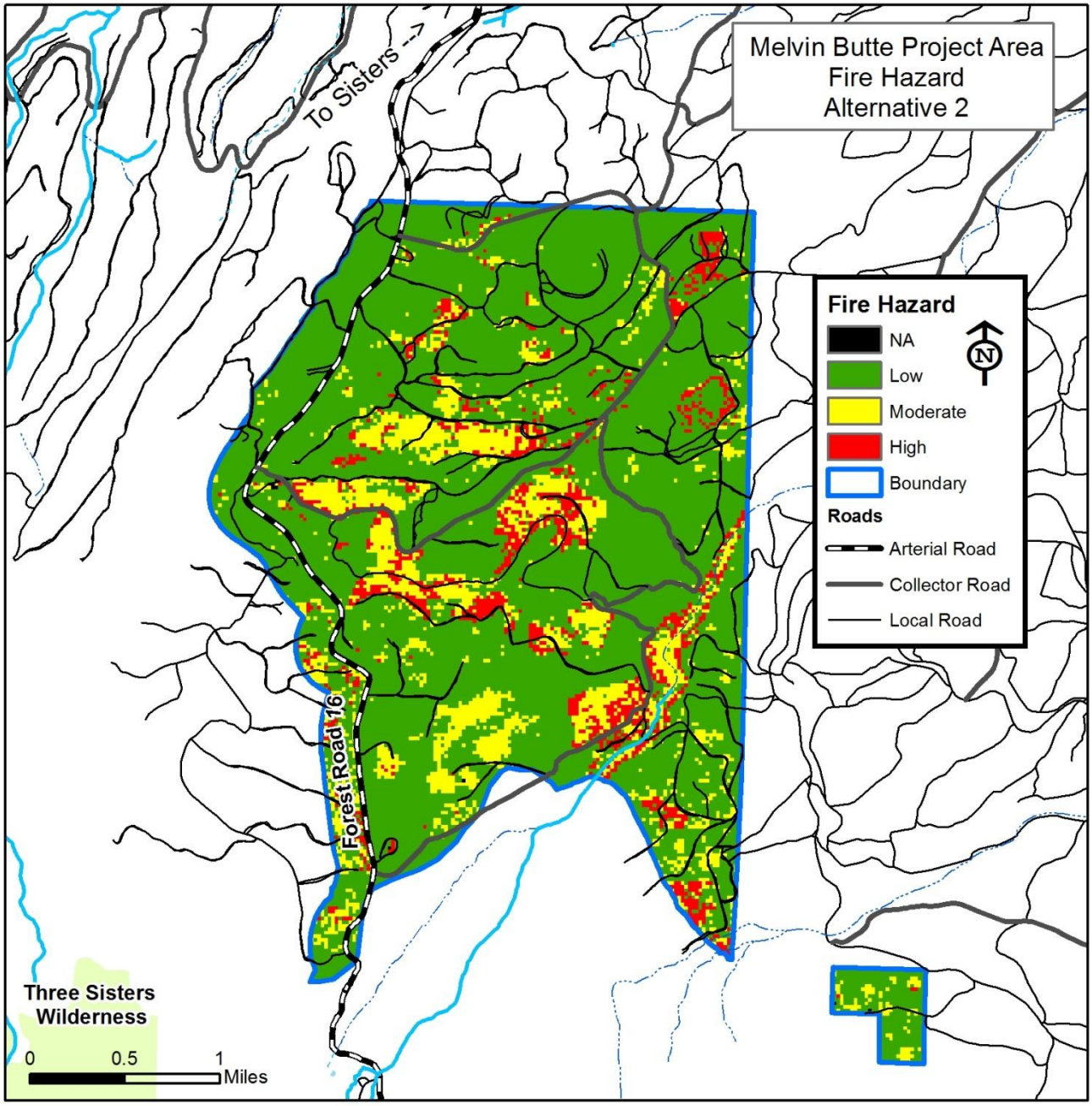

Figure**: Fire hazard across project area under 90th percentile fuel and weather conditions under Alternative 2.

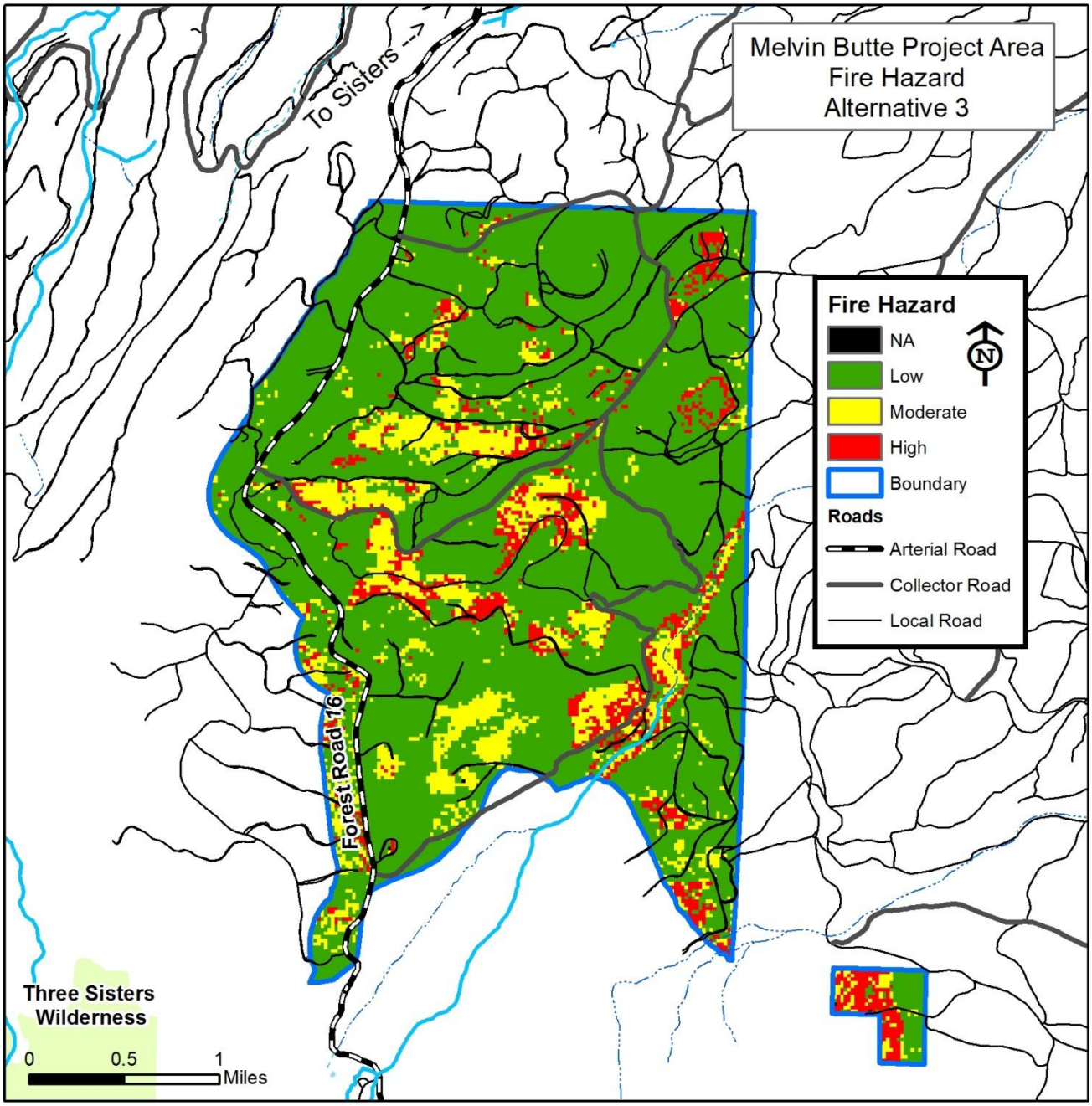

Figure**: Fire hazard across project area under 90th percentile fuel and weather conditions under Alternative 3.

At the landscape scale, the spatial differnces between the Alternatives is subtle, with the exception being the units adjacent to the private property boundary on the southeastern side of the project area. Under Alternative 3, these areas remain threatened. This is primarily due to the conditions that remain hazardous and the direction of fire spread, from north to south (see Figure**Historical fire spread direction in the Weather and Fuel Moisture Inputs section of this report) threatening the project area in the event of a fire start on private property values at risk outside the project area to the south.

Figure** & Figure** compares the fire hazard areas under each Alternative and indicates that treatments would reduce threatened acreage by 47% across the project area. While acres classified as low are not "fire proof", there is reduced likelihood of resource damage and increased likelihood of suppression success if an ignition were to occur.

Air Quality

PM emissions connected with Alternatives 2 & 3 are of concern due to the project area's proximity to several Central Oregon communities (e.g., Sisters, Redmond, Bend municipal watershed and residents in outlying areas) and the Three Sisters Wilderness, a Class 1 air shed.

Under Alternatives 2 & 3, air quality would be affected primarily by PM produced during prescribed burning and pile burning activities. The total area proposed for treatment with prescribed burning under Action Alternatives is 4,465. Comparing this amount of area burned under prescribed fire and wildfire conditions shows the potential reduction in total PM emissions between Action Alternatives and the No Action Alternative (Table **). Results indicate that PM emissions created during wildfire conditions are approximately double that which would be potentially emitted under prescribed fire conditions.

Table **: Estimated total potential PM emissions from Alternative 2 & 3 prescribed fire treatments compared to the same amount of acres consumed under wildfire conditions without treatment.

Fire Condition	**Tons $PM_{2.5}$**	**Tons PM_{10}**
Action Alternatives 4,465 acres prescribed fire	2,868	3,385
Wildfire under No Action 4,465 total acres	6,204	7,320

Cumulative Effects

The cumulative effects boundary for this analysis is defined as the Whychus Watershed boundary shown in Figure **. A fireshed boundary is typically defined by the watershed boundary thus a reasonable boundary for cumulative effects analysis. Adding together management treatment acres plus wildfire acres occurring between 2009 thru 2014 there are approximately 60,000 or 25% of the Whychus Watershed acres recently touched by some form of treatment within the past 5 years.

Past and ongoing treatments in the cumulative effects area are anticipated to have a net positive landscape level effect on fire hazard reduction, using well supported documentation that treatments that reduce surface fuels and ladder fuels lower the susceptibility of forested ecosystems to problem wildfire (Agee and Skinner 2005). Within the last 20 years in this area, numerous fuels related activities have occurred associated with the SAFR, Hwy 20, McCache, Canal, and Underline projects. A total of 21,966 acres within this cumulative effects boundary have received some combination of fuels modifying treatment.

This total includes any area where there may have been or will be treatments where fuels reduction was the primary purpose such as pre-commercial thinning, mowing, and prescribed fire.

There are no other known reasonably foreseeable actions or projects within this cumulative effects area outside of those previously discussed. However, experience with fire suppression in Central Oregon shows that unless acres treated are in the immediate vicinity (less than approximately 1/4 mile) of the area in question, they would have no effect on fire behavior within the project area. Any fire behavior effect from treated acres within a ¼ mile of the Melvin Butte planning area are accounted for in the simulation modeling of predicted fire behavior for each alternative, and are therefore accounted for in the data analysis and reporting of direct and indirect fire behavior effects for each of the Alternatives. Firewood cutting is the primary on-going fuels modifying activity within the project area. This proposed action would mitigate the fire hazard associated with slash left behind by fire wood cutters along with all other special forest product activities.

Proposed treatments cumulatively allow for more opportunities to use prescribed fire in the future across the landscape. Prescribed fire after vegetation treatment reduces the amount of smoke emissions generated by reducing the amount of fuel available for combustion.

All burning activity would be conducted in compliance with the Oregon Smoke Management Plan regulations and restrictions that function to track smoke produced and monitor emissions to ensure that there would be no cumulative effects on air quality (Oregon Revised Statute 477.013). Daily smoke management direction issued by the state can include restrictions on the spacing of prescribed burns and the number of acres permitted to be ignited on a given day in order to manage the potential smoke impacts over a larger area.

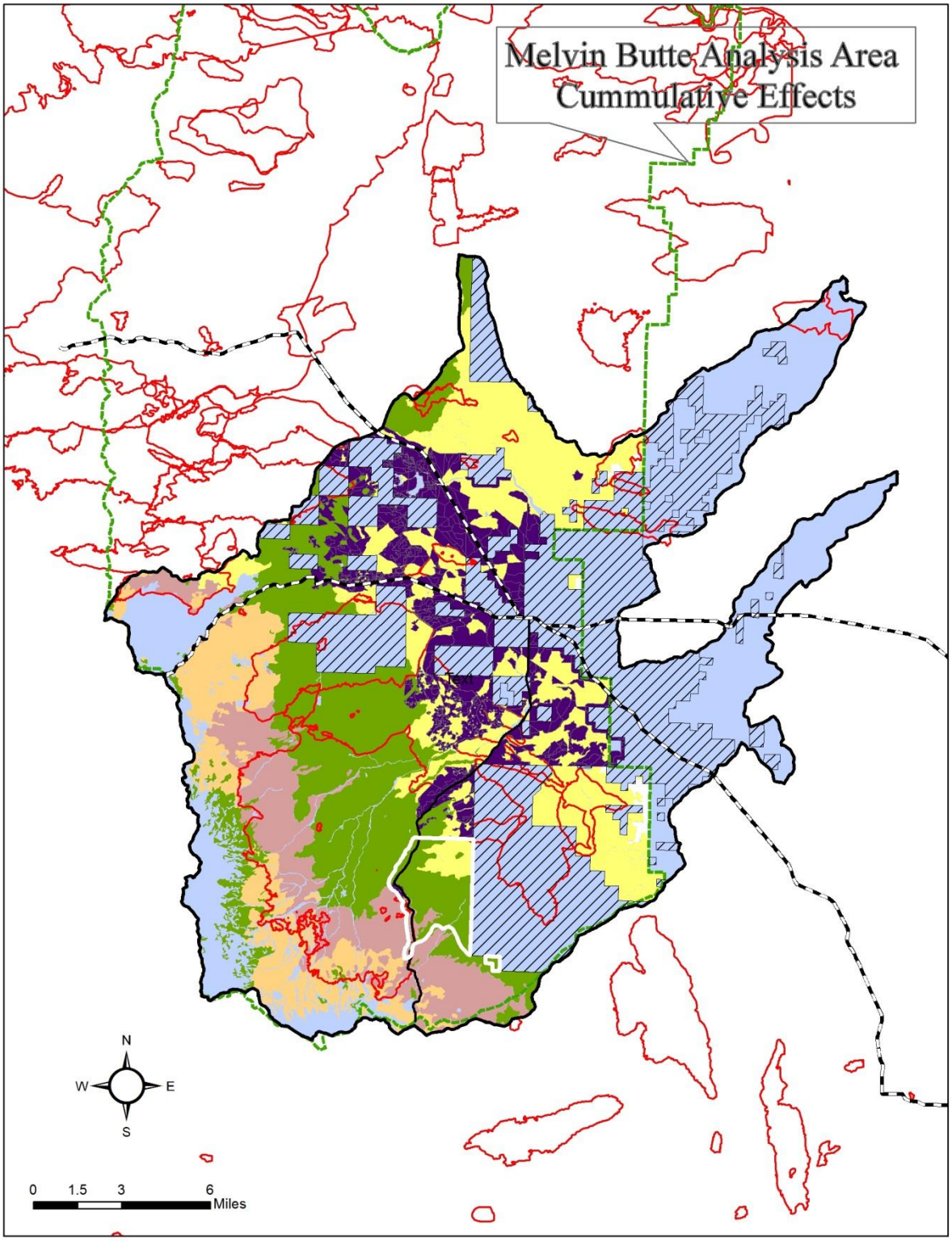

Figure**: Watershed map with Fire Regime, hazardous fuels treatments, large wildfires, and the Melvin Butte project area boundary.

Overall Conclusion

The No Action Alternative would not meet the analysis purpose and need by addressing the issues in the Melvin Butte analysis area associated with fire and fuels on the landscape. The potential for increased fire behavior, increased ladder fuel connectivity, and associated flame lengths and risk of crown fire would result in fire effects not moved toward the purpose and need of forest health and resiliency by reducing fire hazard. The risk to life, property, fire suppression crews, and natural resources would increase due to the widespread potential of crown fire risk and the continued increase of stand density, crown bulk density, ladder fuel connectivity, and fuel loading associated with unmanaged stands in a fire dominated ecosystem.

The action alternatives 2 or 3 would equally meet the objectives of moving this landscape toward structure, composition, and patterns on the landscape within the constraints of reducing the risk of high intensity wildfire to life, property, and fire suppression crews, as well as providing for wildlife habitat, maintaining natural processes, and helping to create and retain a fire resilient ecosystem now and into the future. Utilizing prescribed fire wherever possible would likely result in greater overall success. The ecosystems ability to tolerate fire within historical range of variability and move it toward a resilient future range of variability as a natural process depends on the degree to which the objectives for the Melvin Butte analysis area as well as all other projects achieved on the district. Treating surface fuels, reducing ladder fuels, and opening overstory forest canopies, have been seen to generally produce a more fire-safe forest condition (Brown, Agee, & Franklin, 2004). One effective substitute for natural fires and its infinite number of effects on ecosystems is prescribed fire (Kauffman, 2004). The treatments of forest overstory with selective tree removal is an important initial step in the restoration of forest stands, as these treatments assist in the ability of fire and fuels managers to properly modify fire severities by inputting prescribed burns into the system, affected by decades of fire exclusion and land use. This process is not the final step in the management of wildlands it is only one in a series that continues the trajectory of the affected landscape into the future. Due to the fact that it takes time to accomplish forest restoration, the goal of the planned treatments is to set particular stands on trajectories toward stand structural classes that may be next successionally and contribute to an overall landscape resiliency.

The action alternatives would manage fire behavior with overstory, understory, and ground forest fuel treatments including hand and machine piling, mechanical mowing, in conjunction with prescribed burning to treat fuels in order to facilitate a fire resilient landscape consistent with the historical range of variability as well as setting it up for future range of variability and providing for effective wildfire suppression adjacent to values at risk such as wildlife habitat, recreation assets, private timberlands, while reducing risk of crown fire threatening recreation values and Bend s municipal watershed. Lastly, both proposed actions result in treatments improving safety along Forest Road 16a designated WUI travel corridor, which would enable fire suppression resources to provide additional fire protection and reduce risk to life, property, and natural resources during wildfire events.

The project is consistent with the standards and guidelines as outlined in the Deschutes Forest Plan, as amended, and meets the desired future conditions outlines for the project area. The action alternatives are also consistent with the Clean Air Act and all relevant national and regional guidance.