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Introduction

This report describes the Leonia Restoration Project area as it relates to fire and fuels. In particular it addresses current and expected fire behavior and effects of the alternatives on forest fuels, which were analyzed in detail based on the recommendations of the project interdisciplinary team.

The goal of the project is to trend the landscape towards a natural condition, one where vegetative attributes and natural disturbance agents (fire) are intact and functioning within a historic range. Specifically:

- Reduce surface fuels and crown densities to create a fire environment more in sync with a natural fire regime condition class.
- Create and maintain open stands where early seral, more fire-resistant species such as ponderosa pine dominate in all age classes; characteristics that better resist insects, disease and high intensity/severity wildfire than the current condition.
- Utilize prescribed fire in stands that were historically formed and maintained by fire.

This is not specifically a fuels reduction project; however, actions to restore natural fire regimes and vegetative structure and composition, such as removal of undesirable and overstocked tree species and the utilization of prescribed fire, would result in reduced fuels and would be expected to modify fire intensity and severity to the residual forest resources. Within the project area is dry-site old growth; generally large diameter, tall, dominant ponderosa pine and a few Douglas-fir and larch. The activities of this project are designed to retain this structure (which is becoming vulnerable due to a heightened potential for intense and severe fire as described throughout), allowing it to thrive into the future.

Proposed activities were designed to achieve the aforementioned project goals. Specific actions which would have a direct or indirect effect on the fire and fuels resource (as summarized in the environmental consequences section of this report) include: timber harvest, biomass utilization, prescribed fire, and road management.

Due to the goals and actions associated with the project and project alternatives, this report focuses on the current and desired conditions as related to the stand characteristics associated with low-intensity surface fire, which is favorable from a fire and fuels management perspective. The environmental consequences of each action being proposed, based on commonly used indicators of fire behavior, are provided as well. In addition, an analysis of air quality was completed and included within this document, as clean air is mandated by environmental law (air quality is affected by prescribed burning and wildfire). A Fire Regime Condition Class (FRCC) analysis was completed, and briefly summarized in this report; the more detailed findings are available in the project file for review.

Regulatory Framework

There are four guiding documents that establish the direction for fire management. These documents provide the framework for fire management and provide specific goals, standards, and objectives for implementing a fire management program. Fire handbooks, guides, research, and technical papers provide further direction.
**IPNF Forest Plan**

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**IPNF Forest Plan**

The IPNF Forest Plan objective is to implement efficient fire protection and fire use programs based on management objectives, site-specific conditions, and expected fire occurrence and behavior. The Forest Plan uses the term “Fire Use” in reference to management ignited fire, or prescribed fire. However, the term has evolved with implementation of the Federal Wildland Fire Management Policy and Program Review. ‘Wildland Fire’ is any non-structure fire that occurs in the wildland. Fire for Resource Benefit is the management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in predefined geographic areas. The Idaho Panhandle Forest Plan (1987) provides direction for the use of fire for resource benefits dependent on the Management Area (MA). The Forest Plan also provides for ‘Prescribed Fire’ – any fire ignited by management actions to meet specific objectives – NEPA requirements, a prescribed fire plan, and consultation with Fish and Wildlife Service and the public being complete. The following are the key standards for fire management on the forest as described in the 1987 Idaho Panhandle National Forests Plan:

- Human life and property will be protected.
- Fire will be used to achieve management goals according to the direction identified in management areas.
- Activity fuels will be treated to reduce their potential rate of spread and fire intensity so the planned initial attack organization can meet initial attack objectives.
- Fuel management fund expenditures are prioritized by: natural fuels that threaten human life and property, unfunded activity fuel projects, and areas where fuels or potential fire behavior is a threat to management area objectives.

The primary objective for the fire suppression and fuels management program at the National level is firefighter and public safety; firefighters are to take no suppression action on a fire unless safety has been provided for first (NWCG Fireline Handbook 2006).

Management response for an unplanned ignition generally ranges from aggressive suppression of unwanted fires to management as a wildland fire use event. However, in this area, wildland fire use is not approved; it is within the county defined wildland-urban interface where it has been determined that the risks to life and resources are too great to let a wildfire burn uncontrollably.
The primary Forest Plan Management Areas within the Leonia project area include goals to manage land for timber production within Grizzly Bear habitat and big game winter range (Management Areas 2 and 3). According to the Forest Plan (1987), any suppression strategy can be taken in this management area – confine, contain, or control.

- The Confine strategy generally means to limit fire spread to a pre-determined geographic area – it is often used on the Bonners Ferry Ranger District where fires for resource benefits are not allowed due to management area constraints, but risks to resources is low due to the fire’s location or where engaging firefighters directly on the fire presents safety concerns and risk to resources is low.

- Containment of a fire generally means to surround a fire with a control line as needed to check the fire spread against current and expected weather and fire behavior.

- Control of a fire is to complete control line around the entire perimeter and any spot fires, to burn out any unburned material adjacent to those lines and to cool down hotspots and immediate threats to the control line so that the line can hold under foreseeable conditions.

Prescribed fire is to be used as needed to meet silvicultural objectives and the objectives of the management area.

**Forest Service Manual**

Forest Service Manual (FSM) 5105 (see project file) defines fuel as combustible wildland vegetative materials, living or dead. The objective of fuel management as stated by FSM 5150.2 is to identify, develop, and maintain fuel profiles that contribute to the most cost-efficient fire protection and use program in support of land and resource management direction in the Forest Plan. Methods used for controlling the flammability and intensity of a fire may include mechanical, chemical, biological, or manual means, including the use of prescribed fire and wildland fire use (FSM 5150).

**Policy**

The “Federal Wildland Fire Management Policy and Program Review” was chartered by the Secretaries of the Interior and Agriculture in 1995 to examine the need for modification of, and addition to, Federal fire policy. The Review and Update of the 1995 Federal Wildland Fire Management Policy (January 2001) remains the primary statement of interagency wildland fire policy. Until now, the Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy (June 20, 2003) (Modification in 2008) has provided direction for implementation of that policy. The Fire Executive Council recently issued the Guidance for Implementation of Federal Wildland Fire Management Policy (February 13, 2009), which updates and replaces the June 20, 2003 document. These documents are available for review online.

Fire suppression policy from the early 1900s until the late 1970s has been that of total suppression. The policy was modified to identify the importance of fire in balancing vegetation cycles within the temperate forest. The review recommended a set of consistent policies for all Federal wildland fire management agencies.
In adopting the policy, the Federal Agencies now recognize the role of wildland fire as an essential ecological process and natural change agent that will be incorporated into the planning process (USDI and USDA 2001a). The severe wildfire seasons in recent years throughout the country have made it clear to many that fire cannot be excluded from fire-dependent ecosystems. On the other hand, because of developed areas, and commercial forests, fire cannot be fully restored to its historic character without potentially severe consequences to humans, except perhaps in a few of the largest wilderness areas. The policy stresses human life as the first priority, property and resource values being the second priority. As proposed, fuels reduction and vegetation management would address these issues as described further on in this document. In conjunction with mechanical treatments, the proposed action would utilize prescribed fire to not only reduce surface fuels, but reintroduce fire where it has been excluded.

**National Fire Plan and 10-Year Comprehensive Strategy**

The National Fire Plan (NFP 2000) originated after the record-breaking wildfire season of 2000. President Bush requested a national strategy for preventing the loss of life, natural resources, private property, and livelihoods in the wildland/urban interface. Working with Congress, the Secretaries of Agriculture and Interior jointly developed the National Fire Plan (www.fireplan.gov) to respond to severe wildland fires, reduce their impacts on communities, and assure sufficient firefighting capabilities for the future. The National Fire Plan (2000) includes five key points:

- Firefighting/ preparedness
- Rehabilitation and restoration of burned areas
- Reduction of hazardous fuels
- Community assistance
- Accountability

The NFP is a long-term commitment based on cooperation and communication among federal agencies, states, local governments, tribes and interested publics. The federal wildland fire management agencies worked closely with these partners to prepare a 10-Year Comprehensive Strategy. The four goals of the 10-Year Comprehensive Strategy are to:

- Improve fire prevention and suppression
- Reduce hazardous fuels
- Restore fire-adapted ecosystems
- Promote community assistance

This project would specifically address the latter three goals.

**Air Quality Regulatory Framework**

Smoke from wildfire or prescribed fire contains air pollutants, including fine particulate matter, which can cause health problems, especially for people suffering from cardiopulmonary illnesses (Smoke Management Guide for Prescribed and Wildland Fire 2001). Particulate concentrations that exceed health standards may occur for several miles downwind of wildfires or prescribed burns. Smoke from burning forest debris may impact Class 1 airsheds, diminishing scenic vistas.
Clean Air Act

The framework for controlling air pollutants in the United States is mandated by the 1970 Clean Air Act (CAA), as amended in 1977 and 1990 (42 U.S.C. §7401 et seq.). In 1999, minor revisions addressed visibility in sections 7491 and 7492. These changes were published on July 1, 1999 as the Regional Haze Rules (64 FR 35741). The CAA was designed to “protect and enhance” the quality of the nation’s air resources. The Act encourages reasonable Federal, State and local government actions for pollution prevention. State Implementation Plans (SIPs) are developed by each state to implement the provisions of the CAA. The SIPs describe the State’s actions to achieve and maintain the “national ambient air quality standards” (NAAQS) established by the EPA (Environmental Protection Agency) for specific pollutants. In 2006, the EPA tightened the 24-hour standards for fine particles (PM 2.5) lowering it from 65 µg/m³ to 35 µg/m³. If a community or area does not meet or “attain” a particular standard, it becomes a non-attainment area and must demonstrate to the public and EPA how it will meet standards in the future – as stated, this airshed is in attainment. For more information on the CAA visit: http://www.epa.gov/air/caa/

Montana/Idaho Airshed Group

Boundary County is in Airshed 11 of the Montana/Idaho Airshed Group – the coordinated operations of this group being critical in accomplishing land management objectives while minimizing cumulative impacts of smoke from prescribed fire activities conducted by its members. Members of the Airshed Group enter all the burns they would like to accomplish for that calendar year during the pre-season within an internet based reporting system. During the burn season, members propose burns for the subsequent day and then the monitoring unit (along with the Idaho Department of Environmental Quality) considers all the proposed burns along with expected dispersion and ventilation and existing air quality to determine burn recommendations. These procedures limit smoke accumulations to legal, acceptable limits. The Bonners Ferry Ranger District strictly complies with these procedures.

Within Airshed 11 there are no areas of concern, non-attainment areas, or Class 1 airsheds. Class 1 areas include Forest Service and Fish and Wildlife Service wilderness areas over 5,000 acres that were in existence before August 1977 and National Parks in excess of 6,000 acres as of August 1977. Designation as a Class 1 area allows only very small increments of new pollution above existing air pollution levels. The nearest Class 1 airshed is in the Cabinet Mountains in western Montana – southeast of the project area. The Libby airshed impact zone is approximately 45 miles east.

Analysis Area

One of the indicators for the fire and fuels resource is the Fire Regime Condition Class – to measure departure from a natural condition class – which is a landscape measure. The analysis area for fire regime condition class analysis and the indirect and cumulative effects for the fire and fuels resource is larger (by acreage) than the proposed treatment units, as fire and fire behavior is not limited to unit boundaries but is dictated more by the position on the landscape, especially aspect and terrain and its influence on weather and wind patterns, forest types and fuel continuity, and natural fuels breaks (bare ridges, creeks, rocky outcrops, etc.). The area was selected based on these factors – it is just over 3000 acres in size, whereas the maximum treatment area is approximately 615 acres. This area is defined by drainages, ridges and aspect – all of which affect fire movement. The west boundary is Gable Creek; the north boundary is the ridge north of Leonia Knob, and the east and south boundaries are the Kootenai River and
Boulder Creek. The area within is primarily a south aspect with slight gradations from west to east (see project file map FIRE_042). Specific modifications to the fire behavior and fuels which would occur from implementation of an action alternative (i.e. changes in fuel loading and structures and how those changes affect factors such as flame length) are described at the treatment level where those changes would occur. The timeframe used for the analysis dates back approximately 120 years, as fire history data is available to the late 1800s.

**Methodology**

The existing condition of fire and the fuels, as well as the environmental consequences and comparison of the alternatives associated with the Leonia fire analysis area were determined using archived fire history data, GIS coverages and associated attributes, stand exams, as well as from data collected within the project area and utilized in fire behavior prediction models.

**Field Data**

Site specific data for the analysis area was collected to determine existing fuels characteristics such as fine and heavy fuel loads and canopy base heights. Site visits for fuels conditions were done on several occasions, beginning in the fall of 2009. Fuels transects to sample down woody fuels were implemented using Brown’s transect protocol (1974) as well as Grahams coarse-woody debris transects (et al 1994). Photo points recorded by latitude and longitude were also collected in order to revisit certain locations for post-treatment monitoring. The field data was computed and used where needed for modeling purposes to assess expected fire types, potential fire intensities and behavior and to corroborate fuel model information and other model results.

Fire history estimates specific to drier forests on the Bonners Ferry Ranger District (see vegetation report) were found to be similar in the Leonia area based on field reviews. Although there can be uncertainty associated with utilizing fire history generalizations for specific forest types (Baker 2006), such as to say that low-elevation ponderosa pine stands on dry-sites burned with a frequency of low-intensity fire every 20-40 years (for example), fire managers have a solid idea that low to moderate severity fire (and even patches of high severity fire) did burn quite regularly across the lower elevation Douglas-fir/ponderosa pine stands in the Idaho Panhandle. Historic fire data, since the time of settlement of the Moyie and Kootenai Valleys, is mapped and dates to the late 1800s. Along with that information, tree ages of species known to regenerate following fire disturbances were used to create a fire timeline across the Leonia landscape. All field notes are available in the project file (documents FIRE_030 through FIRE_040).

**Landfire National Data Products**

LANDFIRE (Landscape Fire and Resource Management Planning Tools Project) is a five-year, multi-partner project producing consistent and comprehensive maps and data describing vegetation, wildland fuel, and fire regimes across the United States. LANDFIRE National data is based on peer-reviewed science and relies on methodologies from remote sensing, ecosystem simulation, vegetation and disturbance ecology, predictive landscape mapping, landscape simulation, and fire behavior and effects modeling. The landscape-scale geospatial products are useful for prioritizing and planning hazardous fuels reduction and other ecosystem restoration projects. Available layers for this region include data which is difficult to measure in the field, specifically canopy bulk density. It is derived from field referenced CBD estimates from plot data and computed using canopy fuel estimation software. LANDFIRE canopy bulk density data was imported into ArcMap for an initial review for applicability to the project area; in corroborating
with other research and reference material for these forest types, it was deemed an appropriate tool to help describe the canopy bulk density for the current condition.

**Fire Regime Condition Class – Standard Landscape Model**

FRCC analysis takes into account factors related to the different biophysical settings (primary environmental descriptors and vegetation characteristics) and the proportion of each associated with the landscape being analyzed. Each biophysical setting is defined by a reference fire frequency, (the methodology for this is described in the FRCC Guidebook v. 1.3.0 2008), reference fire severity to the main vegetative components and reference vegetative structural classes. The specific and detailed processes and assumptions used to analyze the Fire Regime Condition Class (FRCC) for the Leonia area are available in the FRCC report in the project file (FIRE_028).

**Fire Behavior Modeling**

Several computer-based models are available for predicting surface fire behavior, and some predict the potential for crown fire. Many different programs incorporate the same underlying surface fire behavior model which was described in *A mathematical model for predicting fire spread in wildland fuels* (Rothermel 1972). Use of these models can help managers identify areas of hazardous fuels and associated high fire behavior and set priorities for management or suppression tactics during a wildfire. As with all models, capabilities vary and assumptions and limitations exist, but knowledge of fuels, weather, and other site specific conditions, as well as accuracy of model input data can provide for useful fire behavior predictions. For more information on these models, see project file document FIRE_041.

**NEXUS v2.0 & BehavePlus v4.0.0**

*NEXUS 2.0* is crown fire hazard analysis software that links separate models of surface and crown fire behavior to compute indices of relative crown fire potential. It is intended that NEXUS be used to compare crown fire potential for different stands, and to compare the effects of alternative fuel treatments on crown fire potential (the purpose of its use for this project). NEXUS includes several visual tools useful in understanding how surface and crown fire models interact. Inputs to the model include those necessary for surface fire behavior prediction models – fuel model (either the original 13 or the 40 new dynamic), fuel moistures, mid-flame windspeed and slope; it also includes canopy fuel data – canopy base heights, canopy bulk density, total canopy fuel load and foliar moisture content.

In addition to NEXUS, BehavePlus4 was used to specifically model expected surface fire behavior using a simple analysis based on the same model inputs of fuels, weather and topography as was used in NEXUS. Although several measures are available with BehavePlus4, the model was specifically used to model surface flame lengths by fuel model.

**Fire and Fuels Extension to the Forest Vegetation Simulator**

The Forest Vegetation Simulator (FVS) is used by forest managers to predict the effects of various vegetation management actions on future forest conditions. It uses actual stand exam data to predict forest growth and decline over time. The Fire and Fuels Extension (FFE) of FVS was used in this analysis to describe the existing condition and the effects of the alternatives on fuels conditions and fire behavior into the future, in essence, to provide an example of how long it is expected that management actions associated with the alternatives (specifically, thinning and burning) would be effective, and the desired conditions maintained, for each indicator measured.
Current fuels characteristics provided in the main output file of FVS (species composition, stand densities, canopy base heights, canopy bulk density, and other fuel characteristics) were compared to on-the-ground observations to ensure the model usefulness in this analysis.

**Air Quality**

*First Order Fire Effects Model (FOFEM v5.0)*

The First Order Fire Effects Model (FOFEMv5) is not a fire behavior prediction model, but rather it quantifies those effects that are immediately realized during a wildfire, such as mortality, fuel consumption, soil heating, and smoke emissions. Site specific data such as forest type, fuel loading by fuel size class, season of burning, fuel moisture, expected mortality, and expected consumption of materials is required by the model to predict emissions.

FOFEM v.5.0 was used to compare smoke impacts of a wildfire burning under the current conditions as well as burning in the landscape which has been treated and compares the emissions due to wildfire and prescribed fire based on the different methods of treating the fuels or leaving the stands untreated. For activity estimates, the model is most accurate at predicting emissions from underburning and tends to overestimate emissions from pile burning. As only 19 of 615 acres are being proposed for piling and pile burning, and pile burning generally produces less emissions than underburning (less fuels consumed overall, less duration of smoldering), all acres proposed for treatment were modeled as an underburn.

These fire behavior and effects models are part of a suite considered the standards in the industry (visit [www.fire.org](http://www.fire.org) for more information, FFE-FVS can be found at [www.fs.fed.us/fmsc/fvs](http://www.fs.fed.us/fmsc/fvs)); they are used nation-wide by nearly all fire management agencies. Though there are more complex models providing the user with spatial data across large landscapes affecting large numbers of citizens or municipal watershed – utilization of those types of models are outside of the scope or need of the Leonia project. These models are sufficient to describe the current condition and comparing those with the potential effects of the alternatives being analyzed here.

**Affected Environment**

**Desired Conditions**

Post-fire effects may be detrimental or desirable depending on when and where fires occur and the nature of fire in relation to resources (such as old growth), infrastructure (such as railroads, powerlines, or water supplies), the wildland urban interface, and the management area objectives. Wildfires occurring in the project area during the hot and dry summer months could burn with high intensities leading to severe post-fire effects to resources (timber, specifically old growth, soils, aquatics) and create creating control problems and potentially unsafe conditions for firefighting resources.

According to the IPNF Forest Plan, a desired condition is a sustainable forest system; in terms of fire management this means life and property are the highest priority and desired fire behavior is surface fire with low flame lengths.

When planning an activity, the intent is to either maintain a desired condition, or to trend towards it. This is a forest health and restoration project, and for the drier pine and Douglas-fir stands in North Idaho, activities to bring these landscapes back in the range of pre-European influenced...
conditions often coincide with fire hazard reduction. To restore fire regimes, vegetative structures and the role fire played in these specific forest types, foresters and fire managers work towards similar objectives – reduced surface fuels, ladder fuels and crown fuels in order to mitigate the potential for widespread crowning fire.

It is important to note that if an area is outside of the desired condition – it may take more than one entry to bring it within the range of desired results. The specific desired conditions for fire and fuels are described as follows.

**Fuel characteristics: type, loading, structure, and continuity**

Desired fuel characteristics for this project are those that contribute to surface fire behavior rather than torching or crown fire behavior. Less intense desired surface fire behavior generally occurs when surface fuels are light, there are minimal ladder fuels, and overstory crowns are spaced to minimize fire spread from tree to tree. Fire behavior fuel models, developed by Rothermal (1972) and Albini (1976), and as described in Aids to Determining Fuel Models for Estimating Fire Behavior (Anderson 1982) are used in fire behavior prediction modeling for their physical description of the fuel loading, fuel bed depth, and fuel moisture at which fire will not spread to estimate potential fire behavior. In addition to the original 13, used to model fire behavior during the “severe period of the fire season when wildfires pose greater control problems and impact on land resources” (Anderson 1982), 40 dynamic fuel models were developed (Scott and Burgan 2005) and they are not limited for use to the severe part of the fire season. Since the new 40 provide more specific fuels characteristics, they were used to describe the surface fuels for this project.

The desired timber fuel model is one with light timber litter in the surface fuels where low flame lengths and slow rates of spread would be expected. From the viewpoint of fuels management, a mix of fuel models GS1 and TL3, across this landscape best fit with the desired condition. Timber litter is generally light, native grasses and small shrubs drive a low-intensity surface fire and the continuity is broken so that spread is generally slow; flame lengths are manageable by firefighting resources (for TL3 surface flame lengths are usually less than 2 feet).

Desired crown fuels are such that tree crowns are spaced in order to reduce the likelihood of fire movement through the crowns in order to minimize overstory mortality and other resource damage. In addition, the vertical arrangement of the canopy is such that ladder fuels (which propagate surface fire into the crowns) are minimal, in order to minimize torching. Once ladder fuels are mitigated, the remaining overstory would consist of species most fire resilient for the site, with canopy structures lifted off the forest floor.

Although all forest habitat types in northern Idaho have experienced fire, certain species are more desirable from a fire management perspective. For the areas proposed for treatment within the Leonia project area, these specifically include western larch and ponderosa pine, and to a lesser extent Douglas-fir. These tree species are generally early seral depending on forest type (Smith and Fischer 1997), are adapted to fire as they require openings and ample sunlight for regeneration, and they are long-lived with the highest fire resistance of local tree species. They are better adapted to survive low intensity surface fire over species such as western redcedar, lodgepole pine, grand fir, and western hemlock; and are desired across this landscape. In addition, it is generally the older, largest trees in a stand that are the most fire resistant, as pointed out in scoping comments (Agee and Skinner 2005) – this is a restoration project and as such would focus on removing the smaller, more fire intolerant species and follow with prescribed fire. These activities coincide with fire hazard reduction goals.
**Fire Regime Condition Class**

The desired condition is a landscape where fire regimes are within a condition class 1 (0-33% departed from historic natural range), or trending in that direction, and the risk of losing key ecosystem components to fire is low. A natural condition is one that native species are adapted to and where soil and hydrologic conditions are in sync (Interagency Fire Regime Condition Class Guidebook v1.3.0 2008). The dominant forest types within the fire analysis area are just over one-half dry-forest (ponderosa pine/Douglas-fir), and moist forest (grand fir, cedar/hemlock) with a very small amount of cool-moist lower subalpine forest. Each has a natural historic fire regime, ranging from low and mixed-severity to a mixed-high severity for the moist forest types. Different factors – absence of historic fire, insects and disease and other post-European influences (see Vegetation Report) – have led to a departure in Fire Regime Condition Class across the analysis area. Restoring the fire severity/frequency and vegetative structure classes where they have become departed is desired for the overall health of the landscape.

**Fire behavior**

*Fire type and crown fire potential*

Certain fire behavior characteristics are more desirable from the perspective of minimizing severe fire effects. Extreme fire behavior – torching, spotting, crowning – affect the ability of fire managers to successfully meet the goals of fuels management and fire suppression as directed in the Forest Plan. Safe direct attack suppression by any resource (firefighter, dozer, aerial resource) is limited once flame lengths reach 11 feet (NFES 2165 – NWCG 2006, p. B-59).

Additionally, wide-spread crown and high-intensity surface fires can be damaging to forest resources, such as timber (specific to the project area would be old-growth). In the event of a wildfire, desired fire behavior would be surface fire – 4 foot flame lengths or less. Fuel treatments would decrease surface, ladder, and crown fuels such that lower surface flame lengths would be expected to prevent fire from reaching the canopy through torching (Strom and Fulé 2007), and if torching into the canopy did occur, spaced tree crowns would make spread from tree to tree unlikely. Following an initial mechanical treatment, utilizing prescribed fire is considered one of the best methods to reduce surface fuels and modify fire behavior (Graham et al 1999; Pollet and Omi 2002) and trends toward restored fire regimes where fire has been absent beyond reference conditions.

**Existing Conditions**

This portion of the document describes the current state of the analysis area as it relates to fire and fuels. This includes the different forest types and how fire influenced the growth, development, and renewal of each historically and how post-European influence, such as fire suppression, introduced insects and disease, and timber harvest, has likely contributed to the condition of the fuels and expected fire behavior related to those conditions. Fire history and the current fire regime condition class are also described.
Fuel characteristics: type, loading, structure, and continuity

Due to slope, aspect, and associated terrain and vegetation, it is possible that several different fuel scenarios were present historically.

Fuel Models (used for fire behavior modeling)

Based on data gathered in the Leonia area (including the photo shown below), the current fuel models (those used for modeling the existing condition and no action alternative) are most represented by a mix of Fuel Model GS2 and TU5. GS2 is a grass/shrub model where the main carrier of a surface fire would be a moderate load of grass and shrubs. Fire intensities can be high – in the 6-10 foot flame length range and fire spread is quick through the fine dead fuels. There tends to be little residence time or smoldering of the flame because fuels are light, but tree mortality and extreme fire behavior is a concern where fuel conditions support torching or crowning (Scott and Burgan 2006).

TU5 is a moderate to high-load timber litter fuel model, where timber litter, such as branchwood and large woody material occurs throughout, being the main carrier of a surface fire. This fuel model also has the potential for high fire intensity, especially during a hot/dry fire season and severity to residual forest resources can be a concern as residence time and smoldering plays a larger part due to the increased amount of woody material (Scott and Burgan 2006).

The main fuels characteristics associated with these fuel models are moderate loads of timber litter with a noticeable continuity in the larger down-woody material (>3’’), especially near root-rot pockets. Shrub and grasses are generally continuous and regenerating shade-tolerant trees are abundant, contributing to the ladder fuels.

Previously Untreated Stands

The Leonia proposed treatment area is primarily dry habitat types for North Idaho forests; early-seral species (those that would inhabit a site following a disturbance such as large-scale clearcutting or stand-replacing fire) include ponderosa pine and western larch. Without fire or some other disturbance mechanism to keep fuels from building up and shade tolerant species from taking over (Douglas-fir replacing ponderosa pine and grand fir replacing white pine and larch (Neuenschwander et.al 1999)), the stand progresses to a climax stage where fire intensities are outside of a natural range. Such is the case for the majority of the Leonia project area. Fire, which has been described as historically common to some of this landscape, has been removed. Fuels in all levels have increased, thus so has expected fire behavior. Surface fuels include heavy timber litter from fallen trees due to insects, diseases and other density induced mortality.

Previously treated stands – prescribed fire and harvest operations

Much of the Leonia project area was underburned in 2000, without prior treatment such as thinning (approximately 300 acres). Because the stand was not mechanically treated first, the prescribed fire had to be accomplished at a time where mortality to the overstory would be minimal, while also trying to kill most of the ladder fuels and advance Douglas-fir regeneration while consuming surface fuels – the window on when this could have been accomplished would have been narrow. Often, in order to kill the understory, the fire has to be conducted at a time when the mortality to the overstory may also be too high (due to density in an untreated stand, fire often moves from the surface through the regeneration and into the overstory tree) Inversely, in order to minimize crown scorch and mortality in the desirable mature trees, it may be difficult to get a fire hot enough to kill the understory (high mortality in understory trees also creates a
surface fuel hazard as this material falls to the ground) (Agee and Skinner 2005). In instances, surface fuels were well consumed, but over the larger area a great amount of down woody material still remains and overall the fuels management objectives were not obtained.

Past harvest activities that reduced canopy, ladder, and surface fuel loadings have created a discontinuity in fuels thus reducing fire intensities. As is most evident in Units 1 and 9, past thinning activities kept the largest trees on site, which are the most fire-resilient – as they have the tallest crowns and thicker bark (Agee and Skinner 2005). In addition, past treatments adjacent to the proposed units, specifically those just north of Unit 9, have maintained more acres in the early seral stages, providing for the regeneration of more fire adapted species such as western larch – which are more likely to survive even intense fires than climax species such as grand fir (Smith and Fischer 1997).

**Basal Accumulation**

After long periods of fire exclusion, litter and duff from dropped needles and bark build-up (as much as 3–4 feet horizontally) around the bases of trees; in the presence of fire, this can cause injury to the roots and stems (Hood 2010). Where moisture is limiting to decomposition in the drier forest types, such as this lower elevation southern exposure, this accumulation is especially evident. Coupled with an increased duff layer, the surface fuels directly adjacent to the boles of large-crowned trees tend to remain quite dry, even in the presence of active precipitation due to interception by the canopy. During the hot, dry summer months these mounds of duff are particularly ignitable. Not only that, but in the presence of fire it has been found that deep duff tends to smolder, increasing residence time of fire, consuming almost all the duff down to mineral soil (Hood 2010).

Regardless of past activity, basal accumulation is a reality and a concern in the project area, as it is especially accumulated around the larger-older trees due to massive crowns and numerous branches continually shedding needles and cones. Because of this “maintaining old trees and perpetuating large-diameter trees is an increasing concern” (Hood 2010).

**Coarse woody debris (CWD) and 1, 10 and 100 hour fuels**

Coarse-woody debris (dead standing and downed pieces > 3” in diameter) is an important component of a healthy ecosystem. Animal life processes, site productivity and protection, as well as fire, are important components of coarse-woody debris most commonly discussed by forest managers (Brown, Reinhardt, Kramer 2003). Observations of past fire behavior shows that small woody material, less than 3” in diameter, has the most substantial influence on fire behavior (such as spread rates and fire intensity) and can be estimated using broadly accepted fire behavior models (Brown et al 2003). However, large woody fuels can contribute to large fire development and high fire severity; minimizing fire severity in the watershed is a priority for vegetation treatment. The greater the fuel loading of this large material (and dependant on the size and decay rate), the greater the influence on fire severity (effects to soil, water, other forest resources) – this is generally due to smoldering and persistent burn periods (Brown et al 2003).

![CWD averaged in tons/acre](image)

<table>
<thead>
<tr>
<th>Coarse Woody Debris &gt;3” diameter material</th>
<th>Current</th>
<th>Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11.5</td>
<td>6.6 – 13.2</td>
</tr>
</tbody>
</table>

Decay rates for dead, down woody material are generally lower on dry sites than they would be on moister sites, especially in the absence of fire (Brown et al 2003). Although the amount of
CWD throughout the project area varies (ranging from 1 ton/acre to 30 tons/acre), the average is 11 tons/acre in areas proposed for treatment (project file document FIRE_002d).

Recommendations by Graham et al. (1994) are 6.6-13.2 tons/acre for drier sites, such as those dominated by ponderosa pine and Douglas-fir. These recommendations are for desirable biological benefits – from a fuels management perspective this needs to be balanced with an acceptable fire hazard level (Brown et al 2003). Considering fuels that contribute to higher-intensity fire, CWD on all treatment sites should be reduced to levels within, but at the lower end of the ranges. Crowning out, spotting, and torching are greater where heavy CWD has built-up in a forested environment (Brown et al 2003).

Fine fuels are continuous throughout, in the form of twigs, small branches, live and dead brush and grasses, cones and pine needles. As mentioned, these fine materials would contribute to the overall fire spread, especially on the drier sites where the forest floor is littered with ponderosa pine needles and the dominant surface vegetation is pine grass and brush.

Data for small diameter fuel loadings were gathered from the project area in each stand; the following table shows the averages by fuel size class for the current condition.

Table 1 – Current woody surface fuels; data averaged for all the treatment areas

<table>
<thead>
<tr>
<th>Surface Fuel Loads</th>
<th>(Tons/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woody Fuels</td>
<td></td>
</tr>
<tr>
<td>&lt;3” diameter</td>
<td>4.7</td>
</tr>
<tr>
<td>&gt;3” diameter</td>
<td>11.5</td>
</tr>
<tr>
<td>Total Woody Surface Fuel</td>
<td>16.2</td>
</tr>
</tbody>
</table>

Canopy Base Heights & Canopy Bulk Density

Canopy base height (CBH) is the lowest height above the ground where there is a sufficient amount of canopy fuel to transition a fire from the surface fuels into the tree crowns (Scott and Reinhardt 2001). Therefore, low canopy base heights are a critical factor in determining crown fire potential. Treatments to reduce fire hazard should focus on removing some or all of the ladder fuels and other vegetation that contributes to a low canopy base height, especially where reducing crown fire initiation is a priority (Agee and Skinner 2005).

Canopy base heights were estimated across the project area from on-site observations, and for areas in a fire behavior fuel model TU5 are as low as 1 foot (see example Figure 1 and refer to Table 2). On the patchy untreated moist sites the average is low due to the structure and species composition of the stands – dense understory vegetation of mostly cedar and hemlock with low growing crowns. Douglas-fir habitat types, which are drier, tend to have greater variation in stand structure due to small openings in the canopy, but canopy base heights are still low and fall within the average used (5 feet) due to the tall shrubs and understory trees. In all areas proposed for treatment, structures exist where fuel continuity has created the potential for fire to propagate from the surface to the crowns of the overstory trees.
Canopy bulk density (CBD) is the mass of available fuel per unit of canopy volume (kg/m³) – the bulk property of a stand, not an individual tree (Scott and Reinhardt 2001). It is a difficult canopy characteristic to measure directly (short of cutting down the trees); however, good estimates are available and were used for this project. Canopy bulk densities were estimated from a combination of LANDFIRE national data for the project area as well as comparing site-observations to available research such as the *Stereo photo guide for estimating canopy fuel characteristics in conifer stands* (Scott and Reinhardt 2005).

Typical dense, moist stands with large climax species (specifically cedar and hemlock which have large branches all the way down to the forest floor) can have a very high CBD – some of the greatest CBD are around 0.30 kg/m³ (Keane et al. 2005), but this only occurs on a small proportion of the project area (Unit 5). For the collective area, canopy bulk densities are in the range of 0.10-0.20 kg/m³ in the dense, previously untreated areas.

Scott and Reinhardt (2001) describe the criteria necessary for active crown fire: Mass-flow rate is defined by Van Wagner (1977) as the rate of fuel consumption through a vertical plane within the fuel bed and it is a product of CBD and spread rate. CBD affects the critical spread rate needed to sustain active crown fire. If the mass-flow rate falls below a certain threshold, active crowning is not possible. Therefore, the lower the canopy bulk density, the lower the potential for active crown fire. The current canopy bulk density is displayed in the table below. It is assumed that treatments that remove overstory trees would also effectively lower the CBD – for example, if 50% of the canopy fuels are removed, then it is assumed the canopy bulk density is decreased by 50% on average. However, we acknowledge this relationship can vary quite a bit depending on species removal, as some species obviously have much more mass in the canopy than others.

<table>
<thead>
<tr>
<th>Canopy Base Height (feet)</th>
<th>Canopy Bulk Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5</td>
<td>0.10 - 0.20</td>
</tr>
</tbody>
</table>

Crown fires, especially those that cover large landscape areas, are generally severe. This is often due to the level of overstory mortality and very extreme intensities and heat generated with them. Large crown fires are generally referred to as stand-replacing – very little vegetation survives in
the wake of a crown fire (Pollet and Omi 2002). Although management activities have been implemented within some individual stands in the project area, across the larger contiguous landscape where treatments are currently being proposed, fuel characteristics are such that a crown fire could be supported. The build-up of vegetation has led to an increased risk for uncharacteristic fire (crown fires) (Pollet and Omi 2002). One of the goals of the proposed action is to reduce the vulnerability of the project area to severe fires.

**Fire regimes & history**

Fire is an essential form of disturbance across all forests of the Northern Rockies (Smith and Fischer 1997), vegetative structure, function, and processes depend on it. Several local conifer species are dependent on fire for regeneration – including ponderosa pine, western larch, western white pine, and lodgepole pine. Fire regimes are formed based on three things – patterns of fire frequency, fire severity, and size (Smith and Fischer 1997).

There are three types of fires that occur in forested ecosystems (Zack and Morgan 1994):

- **Lethal fires** – fires that are stand replacing, removing 90%+ of the live tree dominant upper canopy layer across >90% of the stand across a large, relatively uniform scale. These are commonly crown fires that burn with high severity. Local examples of these types of fires are the Sundance and Trapper Peak fires in north Idaho in 1967 that together burned over 80,000 acres in a short time period during drought conditions.

- **Non-lethal fires** – fires that kill 10% or less of the dominant tree canopy. A much larger percentage of small understory trees, shrubs, and forbs may be burned back to the ground line.

- **Mixed severity fires** - fires that commonly burn with variable severity across the landscape, producing irregular, patch mosaics; killing more than 10%, but less than 90% of the dominant overstory tree canopy. Fire regimes are considered variable – a short return interval non-lethal fire may occur with occasional long interval lethal crown fires.

In the Western United States, millions of acres of forests have accumulations of fuels that are much greater than historical conditions – due to various forms of fire exclusion (Peterson et al. 2005).

The fire atlas shows a landscape fire occurred in 1889 near and within the fire analysis area of this project; field observations suggest the fire may have covered an even greater portion of the dry-forest stands in the treatment area than the atlas depicts; shown in Figure 2 (note the outline expanding south of the 1889 fire boundary where field data suggests a fire occurred in this area as well – see document FIRE_036. This might not encapsulate all the area that burned in ’89, but shows it more representative to the treatment area). Outside of the project area, larger fires burned later than 1889, such is 1910 and the early 1920s along the Moyie and Kootenai Rivers. The fire atlas (with records through the mid-1930s) shows larger fires on the district by area burned, but provides little other information (fire cause, weather, etc.).

In the dry-forest fire regimes low-intensity fire would have been most prominent. However, occasional stand replacing fires would have also occurred, at least in patches, as is suggested in recent publications on the issue (referenced in Crist et al 2009) and evident by field visits.
indicating regeneration of seral species on these habitat types. Ponderosa pine and western larch requires disturbance (often fire) for nutrients, growing space and sunlight for regeneration (Smith and Fischer 1997) (Franklin et al 2006). Field observations, as well as aerial photography (year 1936) show that past fires have been of mixed severity with some areas of stand replacement. There are no records of large fires, low, mixed or severe, since the mid-1920s across the Leonia, Boulder and Katka Mountain landscape.

More recent fire records have been kept from 1941 to present and include information on fire size, legal location, and fire cause – in addition to minimal fire size, there have been few fire starts in the project area since 1941. Many more fires ignited just beyond the boundary of the project area, and had these fires not been successfully suppressed, it can be concluded that at least some of them could have burned uncontrolled into and through the project area.

Of the ignitions that have occurred in or near the project area, approximately 60% were known to be lightning caused and 20% human caused. Although landscape scale fires have occurred in this area, all of the more “recent” fires occurring since the onset of advanced fire suppression, have resulted in very little acres burned. Thus, it is plausible that successful fire suppression has modified this area to some degree. The larger-scale fire events that have occurred on this landscape were considerably more variable in size than any type of management that has occurred since. Because of fire suppression and the limitation on openings created through timber management at the landscape scale, research such as Agee (1999) suggests that fuels are homogenized at a high level. In the drier stands where fires occurred on a more frequent basis historically, one interval showed 21 years, another 36 years, and yet another burned in 1889 yet showed no other fire into the 1940s – fuels have built up and large scale fires are likely overdue on much of this landscape.

See Fire History Map on the following page.

Role of Fire in Douglas-fir and ponderosa pine stands

Often times, restoration projects are driven by the argument that fire exclusion has radically modified forest conditions in drier Douglas-fir and ponderosa pine forests such as this one. While this is true in many of the dry forest landscapes in the southwestern part of the United States, which burned on a very frequent of fire frequency of every few years to a couple decades, there is much evidence to suggest drier forests in the Northern Rockies experienced greater variability in both frequency of fire and severity of fire when it did occur (Crist et al 2009, Smith and Fischer 1997, Baker and Ehle 2001). Stand-replacing fires did occur and could be expansive; though they mostly occurred on north facing steep slopes (treatments under Alternative 2 would occur on south facing moderate slopes averaging approximately 30%). Frequent cycles of high-severity fire have been observed to produce brush fields (Smith and Fischer 1997), and since this area is not, it is more likely that the frequent fires were of low-intensity with some areas of mixed and high-severity (the latter two evident from the different age classes). Other evidence suggesting that stand replacement fire was occurring, but not widespread is the occurrence of old growth – fires likely burned hot enough to mitigate competition, but not enough so to lead to widespread mortality in these larger, fire-resilient trees (evident by fire scars). Agee and Skinner (2005) add:

“The large ponderosa pines all across the West in pre-fire-exclusion times attest to the fire resistance of those forests, which commonly burned over the centuries under severe fire weather as well as under more benign weather. Current stands with fire resistant species, treated to reduce fire hazard, are also capable of surviving wildfires in worst case fire weather.”
See the Vegetation Report for more information on the effects of fire on vegetation.
Figure 2 – Fire History: Boulder/Katka Area
Environmental Consequences

Three Alternatives were analyzed in detail to determine their effects on fire and fuels, specifically, expected and potential fire behavior and fire hazard reduction, as well as fire regime condition class (a discussion on potential mortality is included as well). The effects of the alternatives on timber, old-growth and other vegetative forest resources are disclosed in the vegetation and old-growth report.

The No-Action alternative (Alternative 1) is in essence the same as the current condition. The Preferred Alternative (Alternative 2) would modify fuels and vegetation on the greatest number of acres (615). Alternative 3 (or the “No-Roads” Alternative) would treat just over 1/3 the acres as Alternative 2, and only include the units immediately upslope of the main Katka road. Effects for all alternatives were analyzed into the future, as fuels and forest conditions are dynamic.

Effects common to all alternatives

Fuel accumulation

Regardless of the alternative chosen, fuel build-up will be continuous in the Leonia project area as vegetation grows, matures and dies. The No Action alternative would not address the current condition and the area would be at an elevated potential of undesirable fire behavior due to increased fire intensity associated with higher fuel loads into the future. An action alternative would focus on fire regime improvements, reducing fuels in the near-term and an assessment for future entries would be needed as treatment which reduce fuels are known to lapse due to surface fuels accumulation and other stand changes (Agee 2002). Obviously forest type and other environmental and human factors would affect the rate at which that occurs.

Probability of ignition and wildfires

Probability of ignition is strongly related to fine fuel moisture, air temperature, shading of surface fuels, and an ignition source (Graham, McCaffrey, Jain, 2004). Implementation of an action alternative would not affect the likelihood of lightning strikes; regardless of the alternative chosen, ignitions would still be expected across the proposed action area. However, in a stand that is opened up to the elements (such as a commercially thinned stand), the chance for a fire start from an ignition source may increase due to increased surface temperatures and humidity; there is generally a warmer and dryer microclimate in more open stands (Graham et al 2004) (Agee and Skinner 2005).

Dense stands, such as those with no record of past management or fire, generally have more shading of the surface fuels and higher relative humidity and air temperature (thus, higher surface fuel moistures) (Graham et al 2004). The chance for ignitions would be high under hot and dry conditions, but where shaded, the probability of ignition may be lower when the weather is moderate (late spring and early summer). These shaded stands will still burn – when they do there will be more fuel for a fire to consume and build fire intensity. The proposed action would aim to mimic the surface fuels and open structure of a forest maintained by fire. Even with a slightly elevated chance of a fire start in treated areas under the proposed action, fire spread would be expected to decrease. In the case there is an ignition and resulting wildfire, spotting that accompanies crown fire would be reduced because of modified surface, ladder, and canopy fuels.
Regardless of the actions taken within the Leonia project area, wildfires will still occur. No matter the management implemented, we are not fire proofing forests. The reasons we suppress fires are the same reasons management activities to modify vegetation are being proposed. Large-scale uncharacteristic and potentially severe fires are undesirable and a pro-active measure to mitigate possible negative effects, and safety concerns to the public and firefighters, makes sense across this particular landscape (wildland urban-interface, old growth).

**Influence of topography and fuels on weather and fire behavior**

There are two contributing factors to wildfire behavior that cannot be controlled by forest managers, regardless of the action taken or alternative chosen for this project – the topography (elevation, aspect, parent material, etc.) of the project area and the daily and seasonal weather contributing to fire danger.

The orientation of the project area to the general wind direction may aid in fire spread to the northeast. Strong winds are generally associated with cold fronts, which can have an effect on fire behavior due to shifts in wind direction and downdrafts. As mentioned, more open stands created with fuels reduction and other types of vegetation treatments would generally have greater surface winds than adjacent dense stands (Agee and Skinner 2005), affecting fire intensities based on that factor alone, yet the effect of the increased wind on fire behavior is generally offset by the reduction in the fuel load.

Slopes in the proposed treatment area range from approximately 20-60%. Slope is a large contributor to fire behavior and spread – without wind, the greatest fire spread (in uniform fuels) would be in the direction of maximum slope. Due to slope, radiant and convective energy transfer provides sufficient heating of the fuel ahead of the fire front to produce a flame front supporting more rapid upslope fire spread (Butler et al 2007). Regardless of alternative, the slopes and aspects in the project area will contribute to the general north and east fire spread for this landscape.

**Direct and Indirect Effects**

**Fire Analysis Indicators**

Research, including Baker et al. 2006, suggests the purpose of accomplishing restorative work in pine stands is to replace the potential for widespread crown fire behavior with surface fire behavior. There are three ways of accomplishing this:

1. Decrease surface fire behavior
2. Decrease the chance that crown fire will initiate
3. Decrease the risk of sustained crown fire

Restoration projects in dry-stands to implement a cycle of fire where it has been excluded and modifies species and structure classes more consistent with pre-suppression, generally reduces crown fire hazard, accomplished by reducing surface, ladder and crown fuels.

Three indicators were used to evaluate the direct and indirect fire resource effects of the alternatives. **Fire Regime Condition Class (FRCC)** was utilized as a tool determine the alternatives effectiveness on development and maintenance of a low-intensity and frequent fire-regime. In addition, based on the key issues of old growth and dry-forest vegetation, fire behavior indicators such as **Fire Intensity** (measured by surface flame lengths) and probable **Fire Type**
(surface and crown fire – passive, active or conditional). Scott and Reinhardt (2001) provide definitions for passive and active crown fire:

Passive crown fire is one in which individual or small groups of trees torch, but solid flame is not consistently maintained in the canopy. Active crown fire is one in which the entire surface/canopy fuel complex becomes involved, but the crowning phase remains dependent on heat from the surface fuels for continued spread. Greatly increased radiation and short-range spotting of active crown fires lead to spread rates much higher than would occur if the fire remained on the surface.

A torching situation is generally defined as one where tree crowns of larger trees are ignited by surface fire flames or flames from smaller burning trees reaching the larger trees. Canopy base heights and foliar moisture are critical for torching potential (Agee and Skinner 2005). The torching index (TI), a measure determining the wind necessary to initiate torching, is calculated by conditions of surface fuels, fuel moisture, and windspeed. Torching is sensitive to surface flame length, understory development and ladder fuels, and crown structure. Management actions that modify these processes would change the predicted value of the torching index and the probability of torching within a forested stand.

Crown fires are by general rule very destructive to forest resources as they move quickly and most means of firefighting are ineffective at controlling them (Scott and Reinhardt 2001). The crowning index (CI) is the wind necessary to support active crowning fire. Fuel structures which support crown fire – ladder fuels and a high canopy fuel load would result in a low CI, while fuel structures such as minimal surface and ladder fuels and spaced tree crowns would result in a high CI (very high winds would be necessary to support crown fire).

All indicators listed above need to be considered in conjunction with one another. Effective fuel treatments reduce flame lengths, intensity and the occurrence of crown fire under nearly any weather scenario (Vaillant et al 2009). For example, expected flame lengths may steadily increase as surface fuels begin to accumulate from in growth, falling needles, branches and bark, as well as from mortality in the residual trees. However, if ladder fuels are not present and the canopy fuels are spaced, the potential for torching and active crown fire may remain low.

Fire Regime Condition Class

The fire analysis landscape is moderately departed from a natural condition (condition class 2) under the current condition; approximately 64% departure. Individually, the moist and small amount of high elevation biophysical settings are individually departed to a condition class 2 as well, however, the driest sites are currently departed to a condition class 3 (departed 71% from a natural condition).

Management actions to improve landscape condition class include putting fire on the ground in areas where the lack of fire (mainly due to successful fire suppression) has contributed to a departure in vegetative condition or fire effects. Alternative 2 and 3 would both include actions to modify vegetative structure more in sync with reference conditions for the biophysical settings within the landscape; prescribed fire would also be utilized with the initial entry and future entries to trend towards a more natural condition class. Therefore, both action alternatives would result in an improved landscape condition class rating. However, Alternative 3 would treat fewer acres; therefore the improvement is not as great as would be realized if Alternative 2 is chosen.

Overall, the FRCC ratings for this analysis are:

- Current Condition (Alternative 1): Landscape FRCC 2 – Departure 64%
The greatest factor in an improved condition class for Alternatives 2 and 3 as compared to Alternative 1 (current condition) is a decrease in the length of fire return interval due to prescribed fire activities. One cycle of fire would move the interval in the right direction and as future cycles are implemented, that departure would keep decreasing, improving the overall FRCC rating across the landscape.

The FRCC analysis describes the sensitivities, uncertainties, limitations and specific assumptions used for this particular modeling scenario. See the project file (document FIRE_028).

**Fuels**

Modification of the fuels from the current condition to those expected following treatment would affect all the indicators because harvest would remove canopy fuels as well as some ladder fuels and prescribed fire would decrease ladder and surface fuels. The expected fuels/vegetative modifications following implementation of each alternative are summarized in the table to follow. These fuel characteristics were used as inputs to the fire behavior models described earlier in this report in order to measure the indicators selected for comparison of the direct and indirect effects of each project alternative.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Small Woody (tons/acre)</th>
<th>CWD (tons/acre)</th>
<th>CBH (feet)</th>
<th>CBD (kg/m3)</th>
<th>Acres of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – No Action</td>
<td>4.7</td>
<td>11.5</td>
<td>5</td>
<td>0.10-0.20</td>
<td>0</td>
</tr>
<tr>
<td>2 – Preferred</td>
<td>1.5</td>
<td>7</td>
<td>20</td>
<td>0.05-0.10</td>
<td>616</td>
</tr>
<tr>
<td>3 – No Roads</td>
<td>1.5</td>
<td>7</td>
<td>20</td>
<td>0.05-0.10</td>
<td>221</td>
</tr>
</tbody>
</table>

*The target is a mix of GS1 and TL3, respectively. Estimates of small woody fuel loads for Alternative 2 & 3 were derived from these Fuel Models.

**Basal accumulation**

Alternative 1

Alternative 1 proposes no action to reduce surface fuels, including needles, shedding bark, fallen branches and cones; the material which builds up around the base of trees. In addition, no overstory would be removed, so the build-up would continue on top of what is already there. The hazard associated with basal accumulation, primarily fine-root mortality and prolonged smoldering next to the tree bole would be perpetuated – basal accumulation would get deeper without a mechanism to reduce it.

Alternatives 2 and 3

Approximately one-third to one-half the canopy would be removed, mitigating additional basal accumulation on approximately the same amount where trees are harvested. Design features (included near the end of this report) would remove accumulation not integrated into the soil horizons prior to underburning as to minimize smoldering next to the bole of residual pine. Consumption of this material during slowly executed prescribed fire activities would reduce the build-up that currently exists (Swezy and Agee 1991). Duff moisture levels are usually higher in the spring and evidence suggests spring burns consume less fuels, thus less chance for prolonged...
smoldering and ensuing mortality to old pine trees (Hood 2010). Late-fall burns can also be successful, if moistures are high enough and clearing around the base of old-pines occur – damage to residual trees may be less in the fall if taking into account fuel levels (less fuels in the fall) (Swezy and Agee 1991). Burning during either season can be successful at reducing this accumulation and minimizing mortality if design features are followed (at the end of this report).

Fire Behavior
The following section summarizes the expected fire behavior modeled under fire danger scenarios typical of a hot and dry day during the local fire season (typically mid-July through September). We model it this way because that is the time when fires are known to cause the greatest resistance to control – when the potential for extreme fire behavior can threaten firefighters, the public and infrastructure – allowing managers to notice changes and make a comparison of the effectiveness of fuels reduction activities. Specific environmental and physical assumptions used for fire behavior modeling are available in the project file (document FIRE_041).

Fire Intensity – Surface flame lengths

Alternative 1 – No action

Expected surface flame lengths would be approximately 4-9 feet (the high end of the range is where fuels are most similar to a TU5 fuel model, the low end is in areas where surface fire is driven by moderately-tall dead pine grasses and low shrubs – GS2).. Not only does this limit firefighting capabilities in the event of a wildfire (NWCG 2006), the current structure of these stands means surface fire could very likely become passive and active crown fire. The generally continuous nature of the intermediate trees and dense brush creates a ladder between the surface fuels and the canopy fuels. When the surface flame lengths are great enough to reach these ladder fuels, fire has an avenue to reach the canopy. Once there, tight spacing of the overstory means fire could move through the canopy. The likelihood, based on fuels observations, is that a fire would burn patchy (low, moderate, to high intensity); some areas would experience high-intensity fire reaching the crowns, openings would not and may act as a fuel break for torching and crown fire to drop back down the surface.

The driest sites have a slightly different structure than the typical dense stand (fuels all the way from the forest floor to the tops of the canopy). For the most part, these stands are south facing and the surface fuels are generally more open to the elements such as wind and solar radiation. Increased sunlight to the surface fuels means there is generally a greater load of grasses and brush than a heavily shaded north-facing stand, providing more fine fuels to carry surface fire. This creates a different fire environment and in some cases, fire would move even quicker through these stands in addition to being a bit more exposed (Pollet and Omi 2002).

Alternatives 2 (Preferred Alternative) and Alternative 3 (No Roads)

Both action alternatives propose prescribed fire (Underburning on nearly 600 acres and pile burning on almost 20 acres for Alternative 2 and Alternative 3 proposes 200 acres and 20 acres, respectively); prescribed fire following thinning activities has been shown to have the greatest reduction on fire hazard (Graham et al 1999). By decreasing dead woody fuel loadings in the surface fuels in this manner, the fuel model would be modified to best represent a TL3 model – light timber litter. Under the same weather scenario as modeled for the current condition, the surface flame lengths decrease to between 1-2 feet under the canopy, but in open patches where surface fuels are most similar to a GS1, they could get as high as 5 feet. However, fuels
treatments would remove the majority of the ladder fuels raising the canopy base heights to a level where surface flame lengths would not be able to move into the tree crowns.

**Fire Type and Crown Fire Potential**

The key in treating the crown fuels by harvesting overstory trees is to effectively reduce the canopy bulk density to a level where active crown fire is not possible or the chances are significantly reduced (Scott and Reinhardt 2001). In effect, the fire spread rate needed in order to sustain active crown fire is thus at an unrealistically high level.

Even if crown fire initiation (torching) were to occur, harvest of the overstory trees would effectively space tree crowns, reducing the likelihood of fire spread from one tree to the next as shown in the increased crowning index (wind necessary to sustain active crown fire) in the proposed action as compared to the current condition (no action). Depending on intensity, thinning from below can effectively change fire behavior by reducing crown densities, increasing crown base heights, and changing species compositions to lighter crowned and fire-adapted species (Graham et al. 1999). Under Alternative 2, canopy cover would be reduced by roughly half, resulting in a large increase in canopy base heights to a level where the probability of torching approaches zero. In addition, as described in Finney (2001), in order to modify fire, the greatest reduction in fire severity and overall size occurs when treatment units limit fire spread in the heading direction of the fire – Alternative 2 would best accomplish this. The No Action alternative would not address canopy base heights and canopy bulk densities, thus the potential for torching and crown fire would be higher.

**Alternative 1 (No Action)**

In the pre-treatment scenario, or current condition, the primary types of fire based on surface fuel loading and canopy fuel characteristics would be **passive and active crowning** (torching, group torching and active crown fire). Surface flame lengths are predicted at 4-9 feet, though it is unlikely with the fuels arrangements that a fire would stay in the surface. Critical flame lengths (those necessary to initiate flame movement into the canopy) are between 3-4 feet and the critical CBD is 0.15 kg/m$^3$ (current flame lengths predicted at 4 feet at the low end and most of the denser areas are at least 0.15 kg/m$^3$). For the current condition, the TI is very low ranging from 0 miles/hour in fuel model TU5 to 6.5 mph in fuel model GS2 (specific inputs in document FIRE_041).

**Alternative 2 (Preferred Alternative) and Alternative 3 (No Roads)**

For the post-treatment area in both action alternatives, the modification to the fuel models, overall surface fuel loadings and canopy fuel structures changes the fire type as predicted for the current condition, or Alternative 1, from a passive or active crown fire to a **surface fire**. The void between the reach of a 1-5 foot surface flame length and the base of the canopy would be at least 15 feet in most places. This void would make a torching or crowning situation unlikely, except under very high winds, and even then torching would be incidental due to the residual structure. The TI increases considerably to approximately 52 mph in the light grass fuel model (GS1) to an unrealistic 405 mph where surface fuels driving a fire are similar to a TL3 – light load fuel model. If a fire were able to reach the canopy, unlikely but still probable in a GS1 scenario, it would take a wind of 32 miles/hour to keep the fire in the crowns (crowning index). Inputs on weather (fuel moistures and winds) and slope were the same used for Alternative 1.

*Fire Behavior Summary by Alternative*
The treated units would be expected to have surface fuel characteristics similar to more than one fuel model (most represented by patches of GS1 and TL3), just as the pre-treatment stands would have varied fuels (most represented by GS2 and TU5). Thus the outputs represent a combination of the two as well.

![Fire Behavior Summary](image)

**Figure 3 – Fire behavior summary by indicator and alternative**

**Severity: probability of tree mortality from a wildfire**

In recent fire seasons (since the early 2000s) there have been increasing opportunities for fire managers to evaluate the effectiveness of fuels treatments on wildfire severity – specific to tree mortality. In a study by Prichard et. al (2010), it was found that 73% of large-diameter trees (<20cm diameter at breast height) survived in thin and prescribed burn units as compared to only 36% of the large trees in thin only units and 29% in control stands (no thinning or thinning and burning). The study found that although thinning only treatments did little to reduce tree mortality in the event of a wildfire following treatment, thinning followed by burning was very effective at mitigating wildfire severity. The study area was the North Cascades, near Winthrop, WA – not the Idaho Panhandle – however, study site climate was similar as were general forest types and species mix: multi-age stands of Douglas-fir, ponderosa pine, lodgepole pine and occasional western larch, Engelmann spruce and grand fir. This project proposes similar activities of thinning followed by prescribed burning on all acres.

**Effectiveness of treatments into the future**

If one of the action alternatives is selected for this project, then fuels on as many as 615 acres would be reduced in the near future; crown fuels reduced through harvest, ladder fuels reduced by slashing, biomass removal, or burning, and surface fuels would also be utilized for biomass, and reduced through prescribed burn activities. However, observation and general knowledge of forest succession tells us that the benefits of one entry treatment would not last indefinitely. In fact, there is evidence that the benefits of an initial treatment can wane as early as a decade in very productive forests where fuels build up quickly (Agee and Skinner 2005). Vegetative growth (fuels) tends to be slower on dry southerly exposed sites, so it is likely the effects of one entry would last beyond a decade – evidence from Yosemite National Park indicates that most natural
fires stop at old fire boundaries 15-years old (Agee and Skinner 2005). The next series of graphs display predicted effectiveness of this one entry of thinning followed by burning on the fire behavior measures described up to this point – in this case flame lengths reduced out to 35 years.

**Figure 4 – Surface flame lengths: Non-treated (Alt 1) vs. thinning and underburning (Alt 2 & 3)**

Crown characteristics (crown base heights, spacing and canopy bulk density specifically) influence whether or not a fire can move through the crown (Pollet and Omi 2002). When ladder fuels are treated and the canopy base heights raised the probability of torching immediately decreases and stays that way until regeneration becomes established enough to fill the void between the surface and canopy fuels.

**Figure 5 – Probability of torching: Non-treated vs. Thinning & underburning**
The proposed treatments would focus on spacing the tree crowns to a point where fire spread from one tree to the next becomes virtually impossible, even if fire had an avenue to get into the crowns, except under rare conditions (see document FIRE_016). The increase in the crowning index could remain effective for decades into the future, until regeneration becomes incorporated enough into the mid and overstory as to facilitate fire spread.

Figure 6 – Winds needed to sustain crowning: Non-treated vs. Thinning & underburning

An important consideration for treatment is the trade-off between reducing crown fire potential and increasing potential surface fire rates of spread. Thinning the canopy reduces the moderating effects of the overstory on windspeed, contribute to drying of fuels. In the case of a wildfire this may contribute to increased rates of spread at the surface, even though the crown fire threat has been mitigated (Reinhardt et al. 2008). The trade-off is that crown fire is generally much more destructive, uncontrollable and severe to forest resources, such as old growth timber, than surface fire.

**FRCC**

The No Action alternative would have no benefit on FRCC in the present because it provides no method for moving the landscape towards a natural range of departure, as Alternatives 2 and 3 do. As each year passes the departure would be expected to increase, especially due to a departed fire frequency. This is true for the action alternatives as well, unless a wildfire or similar management, characteristic to the landscape, is planned and implemented in the future. A scenario which would implement prescribed fire 20 years following the initial implementation of Alternative 2 resulted in another 3% trend towards a natural condition class (see project file document FIRE_006b). A continued cycle, along with any natural fire would move the fire occurrence closer to the historic average and would be expected to move more acres into characteristic structure classes.

**Air Quality**

Potential smoke impacts from prescribed burn activities and wildfires include reduced visibility and increased levels of particulate matter and other pollutants in the short-term. General winds would be expected to disperse smoke out of the area, though short-term impacts could be realized.
in the immediate vicinity of the burning activities, as well as in the communities of Bonners Ferry and Moyie Springs, Idaho, as smoke settles in the evening.

Alternative 1 proposes no activities; therefore smoke impacts are not associated with this alternative. Under the current condition, the only sources of smoke would be associated with wildfires, burning on private land, or dispersed and intermittent camp fires. Smoke associated with a wildfire under the current condition of the project area could result in potential impacts to adjacent residents and communities – those impacts are summarized by the amount of small particulate matter produced – which is shown in the table which follows.

Activity and natural surface fuels would be consumed through pile burning (on only 19 acres) and prescribed underburning. Burning of fuels releases particulate matter into the atmosphere and can compromise air quality to some degree. Pile burning generally occurs in the fall, when such activities have less of a negative effect on air quality. Because of the arrangement of the fuels in piles, they tend to burn efficiently which reduces smoldering (a lot of smoke is produced during the smoldering phase of combustion) (Smoke Management Guide for Prescribed and Wildland Fire 2001). Spring burning is generally more limiting and many restrictions make for short burning windows. Smoke impacts from underburns are addressed in a burn plan (a document required before prescribed burns are conducted) – actions to limit smoke impacts include adjusting fuel loads, utilizing the weather (such as desired winds for dispersion), and controlling fuel consumption through fuel moistures (greater consumption with dry fuels).

Table 4 – PM 2.5 emissions in tons/acre and total tons by alternative

<table>
<thead>
<tr>
<th>Forest Type &amp; Activity</th>
<th>Emission in Tons/Acre</th>
<th>Total Acres</th>
<th>Total Emissions of PM 2.5 (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1 - No Action</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alternative 2 – Harvest/Burn</td>
<td>0.80</td>
<td>616</td>
<td>492</td>
</tr>
<tr>
<td>Alternative 3 - Harvest/Burn</td>
<td>0.80</td>
<td>221</td>
<td>177</td>
</tr>
</tbody>
</table>

Although it is estimated that nearly 500 tons of small particulate matter would be emitted from project related activities under the preferred alternative, it is important to note that not all activities occur at the same time and impacts would be spread out over many days and potentially 2 or more burn seasons.

The following table summarizes the amount of particulate matter (<2.5µm) released in the treatment area during a wildfire by forest type for the alternatives.
Table 5 – Total wildfire emissions following Alternative implementation

<table>
<thead>
<tr>
<th>Wildfire</th>
<th>Emissions (PM 2.5) T/A</th>
<th>Total Emissions (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire burns just the area defined by the preferred alternative w/out treatment</td>
<td>0.77</td>
<td>477</td>
</tr>
<tr>
<td>Fire burns entire fire analysis area without treatment activities</td>
<td>0.77</td>
<td>2357</td>
</tr>
<tr>
<td>Alternative 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire burns just the area defined by the preferred alternative after treatment</td>
<td>0.32</td>
<td>197</td>
</tr>
<tr>
<td>Fire burns entire fire analysis area following treatment activities</td>
<td>0.68</td>
<td>2076</td>
</tr>
<tr>
<td>Alternative 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire burns just the area defined by Alternative 3 after treatment</td>
<td>0.32</td>
<td>71</td>
</tr>
<tr>
<td>Fire burns entire fire analysis area following treatment activities</td>
<td>0.74</td>
<td>2256</td>
</tr>
</tbody>
</table>

A wildfire would not be expected to burn only the acres associated with the proposed action – no more and no less – the table above was used solely for comparison among the alternatives.

It is plausible that fire extent could be much greater if it were to burn in the area if the No Action alternative were chosen – especially during a period of very-high to extreme fire danger with the current fuels conditions. As fire knows no artificial boundaries drawn on a map, the chance of a wildfire burning beyond the extent of the project area would be probable with many weeks of burning and prolonged impacts to this and other communities down-wind of the fire. Smoke impacts could be greater overall than what is presented in the above tables.

Cumulative Effects

Past, Present, and Reasonably Foreseeable Actions

The table that follows summarizes the past, present and any reasonably foreseeable actions that have occurred or are expected to occur in the analysis area. If cumulative impacts to the fire and fuels resource are expected in combination with project alternatives, an explanation is provided.
Table 6 – Past, present and reasonably foreseeable actions

<table>
<thead>
<tr>
<th>Action</th>
<th>Past</th>
<th>Present</th>
<th>Reasonable Foreseeable</th>
<th>May have cumulative effects</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber harvest</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>Past timber harvest has modified fuels. In areas that were managed as even-aged, regeneration adds a different dimension to the fire hazard. As the young trees age and become part of the understory they can propagate fire into the overstory (OS) trees. However, the OS is generally spaced as to limit fire spread through the crowns. Most effects of past timber harvest would be very long term and realized in the future; they would be similar to those described for this project. A schedule of future management for these areas would help mitigate effects.</td>
</tr>
<tr>
<td>Prescribed (Rx) burning for fire restoration and fuels treatment</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>Past burning was beneficial in mitigating some surface and ladder fuels. Introducing fire would contribute to a more natural condition class in stands where the role of fire from fire suppression activities has been removed. In addition, Rx fire consumes hazardous fuels and results in new herbaceous undergrowth (thus, a short-term increase in surface fuels which would cure out and contribute to fuel load near the end of summer and into the fall).</td>
</tr>
<tr>
<td>Tree planting</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>Small potential. No short term effects to fire and fuels. As planted trees age and grow they become part of the “ladder” fuels in the stand. Precommercial thinning would have decreased the hazard associated with this.</td>
</tr>
<tr>
<td>Action</td>
<td>Past</td>
<td>Present</td>
<td>Reasonable Foreseeable</td>
<td>May have cumulative effects</td>
<td>Explanation</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>------</td>
<td>---------</td>
<td>------------------------</td>
<td>-----------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Public activities and recreation: firewood cutting, driving roads,</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Unlikely</td>
<td>The potential for cumulative effects is slight; however, any increase in forest use could result in an increase in fire risk (human ignited fires). May have an effect on air quality, especially any activity where vehicles produce emissions, though to what degree is uncertain.</td>
</tr>
<tr>
<td>camping, snowmobiling, hunting, hiking, berry picking, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road construction</td>
<td>X</td>
<td></td>
<td></td>
<td>Unlikely</td>
<td>More roads creates greater access for fire managers, however it also provides greater access for the public. Any road construction would be followed by obliteration upon project completion.</td>
</tr>
<tr>
<td>Road decommission</td>
<td>X</td>
<td></td>
<td></td>
<td>Unlikely</td>
<td>Road decommissioning can affect response times for suppression resources; delayed action could allow fire activity to increase. For the most part, decommissioning related to this project would have little effect on access because the roads recommended for decommission are not currently drivable.</td>
</tr>
<tr>
<td>Road maintenance</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Allows for improved access for fire resources in the event of a fire.</td>
</tr>
<tr>
<td>Wildfires</td>
<td>X</td>
<td></td>
<td></td>
<td>X (Unknown)</td>
<td>Past wildfires would have modified fuel structures and species compositions, affecting fire behavior. A potential effect in the case of high-severity fires is an environment for double-burn as dead trees fall over and create a surface fuel hazard.</td>
</tr>
<tr>
<td>Fire suppression</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Fire suppression removes the role fire would play in an ecosystem without human involvement – this may impact forest fuel composition and loading, as well as fire return intervals, which in turn affect the departure from natural conditions and modify the expected fire behavior into the future. Effects of past suppression described in existing condition.</td>
</tr>
<tr>
<td>Action</td>
<td>Past</td>
<td>Present</td>
<td>Reasonable</td>
<td>Foreseeable</td>
<td>May have cumulative effects</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
<td>---------</td>
<td>------------</td>
<td>-------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Trail Maintenance: Kootenai River Walk trail</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Unlikely</td>
</tr>
<tr>
<td>Pre-commercial timber stand improvement</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spraying herbicides to control and prevent noxious weeds under the Bonners Ferry Noxious Weed Control Project EIS</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Unlikely</td>
</tr>
<tr>
<td>North Zone Roadside Salvage EA: project is in planning phase</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Action</td>
<td>Past</td>
<td>Present</td>
<td>Reasonable</td>
<td>May have cumulative effects</td>
<td>Explanation</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>------</td>
<td>---------</td>
<td>------------</td>
<td>----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Mining activities and various prospects</td>
<td>X</td>
<td></td>
<td>Unlikely</td>
<td></td>
<td>Very little effect expected, however, necessary protection of the mine could potentially affect tactical decisions in the case of initial attack or a large project fire in the area.</td>
</tr>
</tbody>
</table>

The next two pages provide more detail and also expands on the information shown in the past, present and reasonably foreseeable table above, as related to cumulative effects.

*Timber Harvest and Other Management*

Of the more than 3000 acres in the fire analysis area, only 3 small mining claims are considered private land. There is no private timber company, state, Bureau of Land Management (BLM), private other, or other ownerships within the project area. Therefore, although there is a history of past timber harvest, it is not wide-spread or intensive. Within the treatment areas, only a small amount of past harvest is observable (from activities within the past 30 years), mostly in parts of proposed Unit 1, 3, 4 and 9 (for only about 40 acres of thinning or regeneration harvest), but some salvage has also occurred. Outside of the proposed treatment units, many acres have been harvested through the above methods as well as with uneven-aged and commercial thinning prescriptions. More recent projects (since 1990) have included the Gable Creek, Caboose Creek, Gable-McGinty, Katamount and Ice Creamed Salvage – for roughly 2/3 of the larger fire analysis area since 1977. Evidence of past pile burning is minimal.

None of the past timber harvest activities on National Forest System Lands within the project area had fuels reduction as the primary purpose and need. Sanitation treatments removed dead and dying trees – mostly those affected by insects and disease or damaged in ice storms. As the removal was generally intermittent, this would have done little to aid in the development of seral species where they are being lost in the system (too little opening in the canopy). Older logging (prior to 1960), which is evident in places, removed some larger size-class individuals – this prior activity does not appear to be widespread in the area proposed for treatment. There is research suggesting fire suppression in conjunction with historic thinning operations has contributed greatly to the current dense structure and fire hazard of ponderosa pine stands in the Northern Rockies (Naficy et al. 2010).

If the project is implemented, we would not expect wildfire spread to be limited to the proposed treatment or project area boundaries. Previous and future treatments that reduced fuels overall while also providing for the establishment of seral species (see Vegetation report) play an important role in how fire will move through this area. As fire moves from stand to stand, intensity and crown fire potential either increases or decreases depending on stand characteristics – if a crown fire moves into a stand that does not have crown structures that can support crown
Fire, the fire would be forced to drop to the surface fuels (recent past thinnings would apply). However, regeneration harvests that are two or more decades removed from the time of entry have fuel structures (advancing regeneration) that in time would contribute to crown fire potential if left without further management (Agee and Skinner 2005).

As mentioned, additional vegetation treatments would be necessary to mitigate hazardous fuels and crown fire potential into the future – in the proposed treatment area, in areas treated previously and likely in areas that would remain untreated upon implementation of this project. Forests are in a constant state of flux, and succession is continually moving stands either towards or outside the range of desired conditions; in western forests, productivity generally exceeds decomposition (Reinhardt et al. 2008). Without a means for fuels reduction (natural or prescribed), the normal cycles of forest growth and development will ensure the accumulation of fuels into the future. These activities can include precommercial thinning, continued biomass utilization, piling & burning, and prescribed fire, along with many other activities not proposed for this project but could be considered in the future (mastication, chipping, etc.). The silvicultural prescriptions should include a schedule of future entries for fire benefit fuels reduction purposes.

**Continued fire suppression and future wildfire**

Every summer, thunderstorms bring lightning which ignites fires across the district. There have been just a handful of recorded ignitions in the fire analysis area over the past 70 years (fire records from 1941-2010), though it is probable some fires went undetected – extinguished naturally either by weather or lack of fuels. Many more started just outside the boundary. In addition, this area is used by locals and forest visitors for recreation and other purposes – both lightning and human caused fires most certainly will occur within and adjacent to the project area into the future. Treatments may be effective at reducing fire behavior and severity, but not necessarily a reduction in occurrence (especially in the long run - the assumption being that eventually fires will occur as conditions eventually warrant) (Reihnardt et al. 2008).

This project is within the wildland urban interface of Boundary County, thus fire suppression is the appropriate management response for unplanned ignitions. Although fire is considered a valuable tool for restoring fire adapted ecosystems and as a means for fuels reduction, wildfire is unwanted in particular forested areas, such as where there is a threat to life and property or where there is the potential for damaging effects to old growth timber. Therefore, it is reasonable to assume that the current strategy of total control fire suppression will continue in this area into the future.

In fire dependent ecosystems it is important to acknowledge that in the long run fire suppression, even if necessary for protection of life and property, may be undesirable due to aforementioned reasons (FRCC, fuel accumulation, insects and disease, etc.). This makes fuel hazard reduction even more important – if over the long-run we continue to suppress fires, but will be unable to ensure the prevention of large fire occurrence and development, then reducing the potential severity when it does occur may save ecosystem elements conditioned to historical fire (Reinhardt et al. 2008). Management activities are being designed to initiate an improvement trend, the hope being that when a wildfire does occur, the disturbance and effects on resources and ecosystem components would be more in sync in relation to a historic range and scale.

Fire exclusion on moist to moderately moist sites, together with selective harvesting of seral species such as white pine due to blister rust, has likely had a negative effect on the number of conifers resistant to root diseases (Smith and Fischer 1997). Insects and diseases have contributed to the modifications of this landscape over the past century (see Vegetation report). Thus, as
vegetation changes, the way forests respond to disturbances like fire should be expected to change. A noticeable cumulative effect on fuels and fire behavior in the stands and on landscapes are the dead and dying trees falling and contributing to heavy surface fuels. The impacts of fire exclusion on drier sites have been thoroughly discussed throughout this document.

The effects of no action on wildfire behavior have been described throughout this document. In the cumulative sense, modeling suggests a continued inaction to lessen fire hazard means an increasing potential for high fire intensities and severities until at some point in time a large stand-replacing fire occurs, leaving the landscape in a post-replacement state. A large wildfire event would be expected to affect the fire regime condition class for any alternative, but just how would depend on several factors — fire scale, timing, post-fire severity, and the resultant forest structure.

**Agricultural and Private Burning**

Open burning season is from October 21st to May 9th annually and many rural residents choose this time to burn ditch lines, brush, timber litter and other woody and herbaceous materials on their land; outside of this timeframe, a permit is required from the Idaho Department of Lands. Though the actual burn activities on private lands would not overlap in time or space, impacts from the smoke produced from them may. As local air quality would continue to be affected by private land burning during the open season into the future, project specific burning would be accomplished in accordance with the impacts from these other smoke sources.

**Travel Management**

A roads analysis process conducted during the planning process for this project indicated the need for continued evaluation of the Forest Service road system in the Boulder Bear Management Unit (see the Wildlife report), in which the Leonia project area is a part of. During the process, a few roads associated with the project were identified for storage. When a road is stored it is made impassible by motorized vehicles (including high-clearance four-wheel drive pickups, motorcycles, and 4-wheelers) and hydrologically inert. Methods to accomplish this are numerous and include berms, gates, installation of waterbars, pulling culverts and ditch-relief systems, planting native grasses and vegetation, etc. Roads that are stored remain part of the road system and if it is determined that they are needed in the future, for instance in the case of an emergency (large project fire), they can be reopened and made drivable.

**Changing Climates**

As related to climate change, there is a level of uncertainty that exists in regard to the effects of changes on forested ecosystems (Millar 2007), including the occurrence of fire, as well as the intensity and severity of fire if it does occur. Some fire managers speculate that lightning ignited fires in the western United States could become more prevalent as we experience longer and hotter summers, thus a longer season for thunderstorm development. Some historical studies suggest forested ecosystems tend to experience stand-replacing fires when associated with warmer climate periods (Pierce et al 2004). Research is ongoing in this field. If fire seasons in the west were to become longer, it is expected there would be more days for large fire development.
Design Criteria and Mitigation

Measures to mitigate fire hazard

Harvest activities create surface fuels in addition to what is on the ground at the time of harvest. Depending on the intensity of the harvest, this additional fuel is generally continuous, and can contribute to high surface fire intensities and an avenue for rapid fire spread through the stand in the case of a fire. This material is often smaller limbs and tops of trees – the smaller the material the greater the surface area to volume ratio (dries out quick and readily ignitable during high fire danger). Therefore, thinning and logging is usually associated with a risk of increased fire hazard in the surface fuels (Graham et al. 1999).

a. In order to mitigate the increased fuel loading and fire hazard, management activities need to include a method to remove some of these fuels or break up the continuity. For this project, excess activity fuels need to be treated in order to minimize the hazard. There are several methods that can be used to accomplish this – some are more effective at reducing fire hazard than others, but all would accomplish the objective and all would be used to some degree if one of the action alternatives are implemented:

- Biomass utilization;
- Grapple-piling followed by pile burning;
- Prescribed underburning;
- Timing of treatment is also critical:
  Avoid leaving slash during fire season (July-September). Slash may be left during the wet season and over the winter months (see Soils specialist report Design Criteria).

Estimated Effectiveness: High

Thinning and harvest operations which include a method of utilizing or reducing activity created surface fuels are effective at accomplishing fuels reduction objectives (Graham et al. 1999). Overwintering will help compact fuels as snow and ice settles on them – compacted fuel will burn with a lower rate and intensity versus those which are not because of the supply of air.

Underburning can lead to some residual tree mortality, smoke impacts, and soil and other resource damage; season of burn and burning outside of the parameters outlined in a prescribed fire burn plan can contribute to severe fire effects to residual forest resources (Swezy and Agee, 1991).

a. Leave-tree protection

- In order to minimize scorch, heat damage to the cambium and small tree roots near the surface, clear woody fuels and rake back basal accumulated needles and pine cones around the base of residual overstory following harvest to the desired radius
  - Ponderosa pine, western larch, Douglas-fir – 6-10 feet

b. Season of prescribed fire

- Prescribed fire opportunities would be limited during spring bear season (April 1 through June 15); therefore the greatest opportunity for prescribed burning the treatment area would be in the fall.
- Prescribed burning when duff moistures are high (100% or greater) to minimize smoldering in the ground and surface fuels.

Estimated Effectiveness: Moderate to High
Empirical data from previously implemented underburns on local dry-sites (Douglas-fir, ponderosa pine) suggest the aforementioned species have a high probability of survival of a prescribed underburn when leave trees are protected in this manner (examples specifically include Moyie Place Unit 11 – leave trees were protected and an underburn followed – mortality to residual timber was <10%). Burning under higher moisture conditions seems to be the best option when reintroducing fire to minimize injury to old ponderosa pine (Hood 2010); this occurs more readily in the spring but can be accomplished in the fall as well following a rainy spell, especially if accompanied by leave-tree protection and a slowly conducted underburn.

Estimated Effectiveness:

c. Prescribed fire under approved burn plan
   • It is required that all prescribed fire activity is accomplished in accordance of a line officer approved burn plan. This would minimize the chance for an escaped burn, minimize resource damage, and keep a fire under control as analyzed for in NEPA while meeting prescribed fire goals (which are outlined in the silvicultural prescription as well as the burn prescription).
   • When followed, a prescribed burn plan also helps minimize impacts to air quality.

Estimated Effectiveness: High
Parameters, such as desired winds, weather, fuel moistures, logistics, resource needs, communications, safety and medical plans and other factors outlined in the burn plan are designed to provide a guide for fire managers to successfully implement a controlled burn.

Measures to protect Air Quality

a. Coordination with Idaho/Montana Airshed Group, burning only on days approved by the EPA (not burning on marginal or poor air quality days);
b. Burn on days when dispersion is forecasted to be favorable for burning, especially near communities;
c. Notify local agencies and adjacent private landowners of burning activities.

Estimated Effectiveness: High
The coordinated efforts of the Airshed Group have helped mitigate smoke impacts to local communities. Notification of local agencies disseminates information to the public, especially those who may be adversely affected by smoke.

Regulatory Consistency

Forest Plan compliance occurs through efficient fire protection and fire use to help accomplish land management objectives (Forest Plan, Chapter II, pages 10 and 38). Forest Plan Standards for fire management are listed below:

1. Fire protection and use standards are specified by management area. Cost effective fire protection programs will be developed to implement management direction based on on-site characteristics that effect fire occurrence, fire effects, fire management costs and fire caused changes in values.
2. Fire Management will be guided by the following Forest-wide standards:
   a. Management area standards.
   b. Human life and property will be protected.
   c. Fire will be used to achieve management goals according to direction in management areas.
   d. Management area standards will be used in Escaped Fire Situation Analysis as a basis for establishing resource priorities and values.
   e. The appropriate suppression response for designated old-growth stands in all management areas, except in wilderness, will result in preventing the loss of old growth.
   f. Activity fuels will be treated to reduce their potential rate of spread and fire intensity so the planned initial attack organization can meet initial attack objectives.
   g. Forest Fuel Management Fund expenditure priorities are:
      i. Natural fuels that pose a threat to human life and property
      ii. Unfunded activity fuel projects
      iii. Areas where fuels/fire behavior is a threat to management area objectives

Following is a description of how each alternative meets Forest Plan standards. This project does not determine Forest Fuel Management expenditure priorities, so compliance with standard 2g would not be addressed. However, within a project treatment area, activity fuels are prioritized for management (i.e. pile burning or underburning of fuels) where they pose a risk to life, property, and resources.

**Alternative 1 (No Action)**
This alternative would take no action to protect resources from severe fire effects associated with a high-intensity fire (specifically passive and active crown fire) over a larger spatial scale than likely occurred when fires burned pre-European influences in the Katka area. The No Action Alternative would not use prescribed fire to help meet the goals of the management areas within the analysis area. It would not help develop cost-effective fire programs because it is reasonable to expect more intense fire behavior than in treated stands, thus control would be more difficult and likely require a greater number and type of suppression resources, as well as uncalculated losses to forest resources, including old growth (though suppression will continue to protect forest resources, standard 2d and 2e).

The continued lack of fuels and fire management would be inconsistent with the Forest plan goals, objectives, and standards because of the continued trend in undesired fire behavior.

**Alternative 2 (Proposed Action)**
This alternative would be consistent with the Forest Plan as it proposes to use prescribed fire to help meet the goals of the management areas within the analysis area (standard 2a, 2c). This alternative would take action to reduce potential flame lengths, fire intensities and crown fire behavior on over 600 acres, likely reducing fire behavior potentials on adjacent acres as well. In the event of a wildfire, a low resistance to control increases safety to public and firefighters in the area (standard 2b). The reduction of fuels would also help the initial attack organization meet their suppression objectives, as activity fuels would be treated in order to reduce fire intensities that allow for safe direct attack (standard 2f). This alternative would help develop cost-effective fire programs by reducing potential intensities of wildfires and therefore the costs of controlling potential wildfires (standard 1).
This alternative proposes to reduce fuels and modify fire intensities across the most acres; therefore, it better meets the goals, standards and objectives of the Forest Plan, as well as other regulatory documents such as the National Fire Plan – as the proposed action specifically addresses vegetative modifications which would reduce natural and activity created fuels in the wildland urban interface. It also addresses firefighter and public safety, as the proposed action would reduce expected fire intensities and the potential for crown fire (unwanted fire) and promotes community assistance through utilization of the fuels (biomass) removed as a result of project activities. It would treat the most acres utilizing prescribed fire; recent research suggests landscape-scale fuel modifications, such as prescribed fire, are the most effective way to modify the behavior and growth of large fires (Finney 2001). Management areas direct the continuation of fire suppression under this alternative (goals to prevent loss of old growth, standards 2d and 2e and meet suppression objectives 2f).

**Alternative 3 (“No Roads” Action Alternative)**

This alternative would be consistent with the Forest Plan as it proposes to use prescribed fire to help meet the goals of the management areas within the analysis area (standard 2a, 2c). This alternative would take action to modify vegetative structures to reduce the potential for high severity fire while modifying structure and utilizing fire in order to trend the Leonia landscape towards an improved fire regime condition class. The reduction of fuels would be an achieved outcome of project activities and would help the initial attack organization better meet suppression objectives, as activity fuels would be treated in order to reduce fire intensities that allow for safe direct attack (standard 2b and 2f) and prevent the loss of old growth (standard 2d and 2e) This alternative would help develop cost-effective fire programs by reducing potential intensities of wildfires and therefore the costs of controlling potential wildfires (standard 1).

This alternative proposes to modify vegetation and implement prescribed burning, which would effectively reduce fuels and expected surface fire and crown fire potential across approximately 220 acres in the wildland urban interface. Because it would treat just over 1/3 the acres as the proposed action, and general unit layout would leave large areas untreated, it would not meet the goals, standards and objectives of the Forest Plan to the degree of which the preferred alternative would. However, Alternative 3 would still contribute towards the intent of the Idaho Panhandle National Forests Land and Resource Management Plan, as well as the National Fire Plan.

**Summary**

Natural disturbance processes, in particular for Leonia, those which contributed to the development of dry-site old growth, are necessary components of forest management practices. The current condition is such however, that letting natural processes (such as fire – arguably one of the most important ecosystem processes missing in many forest systems today) burn freely without any type of fuels and vegetative manipulation could be considered irresponsible, as we would expect a greater amount of resource damaging crown fire than low-intensity surface fire. Allowing fires to burn without any pre-treatment may actually lead to a greater reduction in the forest components that would perpetuate under a natural fire regime (such as large fire resistant seral species integral to dry-site landscapes in north Idaho). Although these forests have adapted with all kinds of fire (low, mixed and high-severity), the scale on which each type of fire is occurring is shifting. Agee and Skinner (2005) may have summarized it best:

“While the impacts of thinning and burning can be predicted, and may have some negative environmental impacts, these impacts need to be evaluated against the option of
In general, a project designed to improve forest health and restore missing structures and processes will generally coincide with fire and fuels objectives. This is because a healthy forest landscape is one where fire regimes, fire frequencies, and potential fire severities are within a natural condition class or moving in that direction. Trending stands towards a more natural fire regime, means establishing systems that flux with fire in a more natural way; forest health treatments should be evaluated on whether they allow ecosystems to persist in association with disturbance, including human disturbance (DellaSala et al. 1995). Utilizing current research and empirical data (what has worked and what has not) will only improve forest managers’ abilities to implement actions more closely mimicking natural disturbances, especially in areas where letting natural disturbances, such as fire, go uncontrolled is really not practical (wildland urban interface).

Vegetation treatments that reduce fuels will not stop wildfires (Finney and Cohen 2003). However, modifying or removing the vegetation (fuels) that contribute to high fire-severity, such as heavy dead and down wood, ladder fuels, and dense canopy fuels, while incorporating fire back into the system would reduce potential mortality in residual large, mature trees and help create fire-resilient stands (Agee and Skinner 2005).

Both of the action alternatives, especially the preferred alternative, would meet the goals of the Leonia project as stated in the introduction. Implementation of Alternative 2 would result in a decrease in potential for extreme fire behavior (uncharacteristic fire) on several hundred acres with just a single entry, even more if you factor in the benefits of reducing potential high-intensity fire and its movement from stand to stand and beyond the treated areas. Alternative 2 (the preferred alternative) would result in the greatest reduction of fuels, reduced fire behavior and intensities and improvement trend of the Fire Regime Condition Class of this landscape.

References


Interagency Fire Regime Condition Class Guidebook Version 1.3.0 June 2008


