United States Department of Agriculture

Forest Service

San Bernardino National Forest

San Bernardino, California

November 2016

Fire and Fuels Report

Grass Valley Fire Restoration Project

San Bernardino National Forest, San Bernardino County, California

November 3, 2016

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REGULATORY FRAMEWORK

Forest Service Manual Direction

The following are excerpts relevant to the Proposed Action.

CHAPTER 5140 – FIRE USE

5140.1 - Authority

The National Forest Management Act of October 22, 1976 (16 U.S.C. 1600 et seq.), (FSM 5101.1, para. 3), the Wilderness Act of September 3, 1964 (16 U.S.C. 1131, 1132), and the Clean Air Act, as amended (42 U.S.C. 7401 et seq.) (FSM 5101.2, para. 3) are applicable to the use of fire on National Forest System lands. These acts are summarized in FSM 5101.

5140.2 - Objectives

To meet fire management objectives fire use includes the deliberate application of fire to Wildfires by resource managers (prescribed fire), and managing unplanned ignitions for resource benefit.

1. To use fire from planned or unplanned ignitions in a safe, carefully planned, and cost-effective manner to benefit, protect, maintain, and enhance National Forest System resources.

2. To alter fuel profiles so that public and firefighter safety is improved and communities, infrastructure, and other values-at-risk are less vulnerable to impacts from wildfire.

3. To reduce future fire suppression costs and unwanted effects.

4. To restore natural ecological processes.

5. To achieve desired conditions and attain management objectives adopted in approved forest land and resource management plans (FSM 1920).

5140.3 - Policy

Overarching policy applicable to the use of fire is set out at FSM 5103. The following fire use policies apply on all National Forest System lands:

1. Use Wildfire fire to protect, maintain, and enhance resources and, as nearly as possible, allow Wildfire fire to function in its natural, ecological role.

2. The Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide is Forest Service policy (incorporated by reference).

3. The Interagency Wildfire Fire Use Planning and Implementation Procedures Reference Guide is Forest Service policy (incorporated by reference).

4. Review all prescribed fires declared a wildfire using procedures contained in FSH 1409.18, section 12 and the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide. A "peer review" process or other review processes may be used if the escape does not meet the threshold for damage or injury associated with FSH 1409.18, section 12. The peer review process must, at a minimum, address the escape prescribed fire review elements within the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide.

5141 - FIRE USE PLANNING

5141.1 - Fire Use in Forest Land and Resource Management Plans

1. Document the broad direction for the Forest fire program in a readily accessible reference.

2. Ensure the Forest fire direction tiers to the interagency strategy for implementation of the federal Wildfire fire policy, found in FSM 5103.

5142 - PRESCRIBED FIRE

Administrative Burning is exempted from the requirements of FSM 5140 (FSM 5140.5). This type of burning should adhere to local government debris burning requirements where applicable and follow additional requirements as determined by the Forest Supervisor or other delegated line officer.

5142.1 - Developing Prescribed Fire Burn Plans

Prepare a site-specific Prescribed Fire Plan for each prescribed fire in advance of the ignition. Where complexity is low and conditions are consistent, a programmatic burn plan may be developed and used.

5143 - WILDFIRE FIRE USE

See the Wildfire Fire Use complexity and risk determination procedures found in Wildfire Fire Use Implementation Procedures Reference Guide, referenced in FSM 5108.

5144 - SMOKE MANAGEMENT

Include air quality considerations (FSM 2580) as an integral part of the fire use program.

1. Coordinate fire use applications with appropriate air quality specialists and Federal, State, Tribal, air pollution control district or county regulatory authorities to ensure compliance with their regulations.

2. When multiple Wildfire fire events are occurring within an airshed or any airshed is impacted by ongoing Wildfire fire events, fire managers should consider the incremental impact to air quality which their management actions might cause.

5145 - FIRE USE ORGANIZATION

See the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide and the Interagency Wildfire Fire Use Planning and Implementation Procedures Reference Guide is Forest Service policy referenced in FSM 5108.

5147 - FUEL TREATMENT EFFECTIVENESS

5147.1 - Assessing and Reporting

All wildfires which start in or burn into a fuel treatment that has been completed within the last ten years (within the last three years in the Southern Region) must have a fuel treatment effectiveness assessment report completed. Document the assessment, utilizing the fuel treatment effectiveness assessment report template that can be completed and upwardly reported at the following website: http://www.nwportal.fs.usda.gov

All fuel treatment effectiveness assessment reports must be submitted within 90 days of control of the fire.

CHAPTER 5150 - FUEL MANAGEMENT

This chapter provides direction on fuel management, the practice of evaluating, planning, and treating Wildfire fuel to support land and resource management objectives (see FSM 5105 for the full definition of fuel management and other terms). Methods used for controlling flammability and reducing the resistance to control may include mechanical, chemical, biological, or manual means, including the use of prescribed fire.

5150.2 - Objective. 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.

5150.3 - Policy. Integrate fuel management and fire management programs in support of resource management objectives.

1. Use an interdisciplinary approach to integrate fuel management planning into all appropriate activities.

a. Identify, through an economic analysis, the most cost-efficient fuel profile to meet resource management direction in support of the fire protection program. Consider a full range of fuel management alternatives, including no treatment. Fuel management activities must be responsive to long-term site productivity, utilization opportunities, and air quality considerations.

b. Where a management activity, such as timber sales, thinning, or road construction, contributes to an unacceptable fuel profile, modify that activity to reduce its incremental contribution to the fuel profile.

c. On lands where repetitive management activities will occur, evaluate the projected fuel profile to determine the most cost-efficient time(s) of entry and the level of treatment(s).

2. Manage fuel in accordance with fire management direction in the forest land and resource management plan.

a. Expend funds for fuel management only for the purpose of resource protection. Do not allow such expenditures to exceed the expected cost plus net value change that might occur without treatment.

b. Where the planned treatment meets other resource management objectives, such as site preparation for reforestation, identify the benefits and costs in the economic analysis to determine appropriate funding needs (FSM 5152).

3. Follow the safety requirements in FSH 6709.11, Health and Safety Code Handbook, and FSH

5109.32a, Fireline Handbook (FSM 5103).

5151 - FUEL TREATMENT. Initiate fuel treatment in accordance with the forest land and resource management plan and the fire management action plan. Establish priorities for treatment of fuel in the forest plan.

5151.1 - Methods of Fuel Treatment. Consider the following treatment options, in the priority listed, when developing fuel management direction and plans.

1. Utilization. Use methods that reduce unwanted fuel through improved harvest techniques or through higher utilization standards. Favor utilization when the cost of onsite treatment equals the cost of removal for utilization.

2. Rearrangement. Redistribute fuel onsite to a condition that is less hazardous, or that enables more rapid deterioration or more effective disposal.

3. Removal. Remove unwanted fuel offsite for further utilization, storage, or disposal.

4. Disposal. Reduce or eliminate unwanted fuel onsite. Methods include manual, mechanical, chemical, biological, and prescribed fire treatments and their necessary associated activities.

5. Conversion. Replace hazardous fuel with less flammable fuel or fuel that offers less resistance to suppression.

6. Nontreatment. Where appropriate, identify if and when fire program costs plus anticipated net value changes do not justify fuel treatment.

7. Interim Protection. Provide protection on an interim basis only when the hazard of newly created fuel cannot be abated in a timely manner and where:

a. An analysis of hazard and risks fully supports the cost-effectiveness of interim protection.

b. Treatment takes place as soon as practical following creation of the hazard.

8. Supplemental Protection. Use supplemental protection only if the economic analysis indicates that this is the most cost-efficient means of mitigating the fire hazard until deterioration of fuel makes such protection unnecessary. Supplemental protection may be justifiable in limited situations as part of an overall land management strategy. When justified, the responsible line officer must annually review and approve its continued use.

5152 - ECONOMIC ANALYSIS. Include economic criteria in the decision process for evaluating proposed fuel treatment programs and activities (FSH 5109.19), and for selecting the practices used to perform fuel treatment. Use conventional economic evaluation procedures to determine the most cost-efficient alternative (FSM 1970).

5153 - REPORTS. Report fuel treatment accomplishments in accordance with management attainment report reporting procedures (FSH 6509.11k).

5154 - FUEL TREATMENT AGREEMENTS. Follow the direction in FSM 1580, FSM 3170, FSM 6531, and FSH 1509.11 for developing cooperative agreements with other parties for fuel treatment work both on and off National Forest System lands.

Forest Plan Direction (2005)

The following excerpts emphasize Forest Plan fire and fuels management policy applicable to the project.

The Arrowhead Place Program Emphasis – Fire and Fuels Related Policy

In the Forest Land Management Plan (LMP), the Forest is divided into a series of geographical units called “Places” with similar landscape character. This project is located within Arrowhead Place. Forests and woodlands are here abound with Coulter pine, canyon live oak, and black oak with scattered stands of juniper and single-leaf pinyon pine in the northeast section of the Place. At the higher elevations, Jeffrey pine, ponderosa pine and incense cedar are present. Bigcone Douglas-fir occupies drainages within the chaparral-covered hillsides and mountain dogwood occupies shaded stream corridors at the higher elevations. Large acreages of dense conifer forest on both national forest and private land have been affected by high tree mortality related to drought, and the threat of Wildfire fire in the rural/urban interface is a significant concern. The Old Fire of 2003 destroyed a large number of homes in the Cedar Glen-Hook Creek area, illustrating the unprecedented fuels problem. Over a dozen communities are located here, and the number of residents living within the national forest boundary is one of the highest in the nation.

Desired Condition

The Arrowhead Place is maintained as a natural appearing landscape that functions as a recreation retreat setting with seasonal influences. The built environment is that of a mountain village with the dominant material of wood and stone accents. Chaparral and forested areas are managed to provide fire protection for adjacent communities, recreation areas and wildlife

habitat. Habitat conditions for threatened, endangered, proposed, and sensitive species are improving over time; invasive nonnative species are reduced. Accurate national forest boundaries are reestablished and maintained. Heritage resources are identified, protected, and interpreted through establishment of tribal partnerships. A wide variety of recreation uses will be promoted, where appropriate and environmentally sustainable.

Program Emphasis

Community protection from Wildfire fire is of the highest priority. It will be emphasized through public education, fire prevention, and fuels management. Forest health projects will be implemented to remove dead trees and reduce stand density that will result in a more natural pattern of low intensity fires and return intervals. In addition, these projects will focus on returning forest ecosystems to a more healthy condition. Reforestation projects will maintain tree diversity.

The Grass Valley Project is designed to achieve the following goals outlined in the Forest Plan:
Goal 1.1 - Community Protection (LMP Part 1, p. 19) Improve the ability of southern California communities to limit loss of life and property and recover from the high intensity Wildfire fires that are a natural part of this state's ecosystems.
Goal 1.2 - Restore Forest Health (LMP Part 1, p. 20) Restore forest health where alteration of natural fire regimes has put human and natural resource values at risk.
Goal 1.2.1 - Fire Regime I (0-35 years - low severity) (LMP Part 1, p. 23) Reduce the potential for widespread losses of montane conifer forests caused by severe, extensive, stand replacing fires.
Goal 1.2.2 - Fire Regime IV: 35–100+ years – stand replacement (LMP Part 1, p. 26) Reduce the number of acres at risk from excessively frequent fires while improving defensible space around communities.

Strategies – Fire and Fuels Related Policy

LMP Program Strategy and Tactics, Fire 2 - Direct Community Protection, and Fire 5, Fuel Breaks and Indirect Community Protection (LMP, Part 2, page 155):

Fire 2 - Direct Community Protection

Reduce the fire threat to communities using mechanical treatments, prescribed fire and herbicides. Identify and schedule for treatment the high-risk and high-value acres near communities, including the installation of Wildfire/Urban Interface (WUI) Defense and Threat Zone vegetation treatments. Highest priority should be given to those evacuation routes, Wildfire/Urban Interface Community Defense and Threat Zones and communication site areas with substantial drought and insect-killed vegetation that present a significant threat to life and property in entire communities. Other general national forest priorities will be determined by a process such as fireshed assessment consistent with community protection plans.

Fire 5 - Fuelbreaks and Indirect Community Protection

Maintain the existing system of roadside fuelbreaks and fuelbreaks along watershed boundaries to minimize fire size and the number of communities threatened by both fires and floods.

Consider constructing new fuelbreaks on land outside of wilderness or other special designations.

- Consider an opportunistic approach to fuels management. Take advantage of areas that have burned, and wherever possible connect areas burned in Wildfire fires to forest health and wildlife habitat improvement projects, as well as fuelbreaks to maintain multiple lines of community defense and to minimize future Wildfire fire patch size.
- Reduce the fire threat to communities using mechanical treatments, prescribed fire and herbicides.
- Pre-plan fire suppression activities to minimize the use of locations with known invasive nonnative species.

Standards and Guidelines

S7: There are extensive areas within and adjacent to the national forests of southern California meeting the definition of Wildfire/Urban Interface (WUI) as described in the Healthy Forests Restoration Act of 2003. WUI (as defined by the Act) is a variable width up to 1.5 miles from communities at risk or as defined in individual community fire protection plans. This forest plan further identifies a direct protection buffer (WUI Defense Zone) and an indirect protection buffer (WUI Threat Zone) that fall within the broader definition WUI. A WUI Defense Zone is the area directly adjoining structures and evacuation routes that is converted to a less-flammable state to increase defensible space and firefighter safety. The WUI Threat Zone is an additional strip of vegetation modified to reduce flame heights and radiant heat. The Threat Zone generally extends approximately 1.25 miles out from the Defense Zone boundary. Yet, actual extents of Threat Zones are based on fire history, local fuel conditions, weather, topography, existing and proposed fuel treatments, and natural barriers to fire and community protection plans, and therefore could extend well beyond the 1.25 mile. The two zones together are designed to make most structures more defendable. Following are the minimum and maximum widths for the WUI Defense Zone by general vegetation type:

Vegetation	Min Width (ft) WUI Defense Zone	Max Width (ft) WUI Defense Zone
Grass	50	100
Chaparral	100	300
Forests	300	1,500

S8: Community protection needs within the WUI Defense Zone take precedence over the requirements of other forest plan direction, including other standards identified in Part 3 of the forest plan. If expansion beyond the 300-foot minimum width of the defense zone is needed due to site-specific conditions, projects will be designed to mitigate effects to other resources to the extent possible.

S37: Design and manage fuel treatments to minimize the risk that treated areas will be used by unauthorized motorized and mechanized vehicles. Mitigate impacts where such use does occur.

Appendix K - Guidelines for Development and Maintenance of WUI Defense and Threat Zones (LMP, Part 3, pages 81-83)

Prospectus for Fuelbreak Construction - Most of the planned fuelbreaks are also along roads and ridgetops and are proposed for limiting Wildfire fire patch size. Most fuelbreaks are constructed with machinery. Some are built by hand or by using prescribed fire. Herbicides may be used to kill resprouting chaparral and then fire used to maintain the fuelbreak over time. Fuelbreaks are sometimes constructed near communities to provide some level of future protection in cases where land ownership patterns or topography limit the applicability of the Wildfire/Urban Interface Defense and Threat Zones concept.

ANALYSIS METHODOLOGY

This analysis is based primarily on relevant, existing fire and fuels research and analysis from various sources, and models and compares pre-treatment and post-treatment potential wildfire behavior changes concerning wildfire control difficulty, or resistance to control.

The FireFamily Plus computer program was used to determine historical weather and fuel moisture conditions at the 90th percentile level specific to the analysis area during standard fire season from June through October. The 90th percentile represent the top ten percent of the very high (90^{th}) fire weather days. The intent of modeling fuel behavior is to show relative changes in fire behavior between various vegetation types/fuel models. The outputs are not absolutes and are dependent on the assumptions and limitations of data collection methods and individual models. The outputs allow for comparison of changes associated with different levels of fuel treatments. Fire behavior was modeled using the FVS-FFE computer program to demonstrate the changes to potential fire behavior characteristics for comparison of behavior conditions and a detailed model description is in the vegetation report.

The FVS-FFE runs show potential 90^{th} in season wildfire behavior using existing fuel load conditions in 2016, and potential wildfire behavior in years 2026 and 2036 after mechanical treatment in 2017 and subsequent prescribed burning. A prescribed burning prescription was used to model fuel reduction when subsequent pile burning of surface fuels are completed in 2018, 2021, and 2031; and prescribed fire underburning are completed in 2020 and 2030.

Fire Behavior Definitions:

Flame Length is a measurement of the average distance from the base of the flame to its highest point and is an indicator of the relative ease to which a fire can be successfully suppressed by firefighting resources.

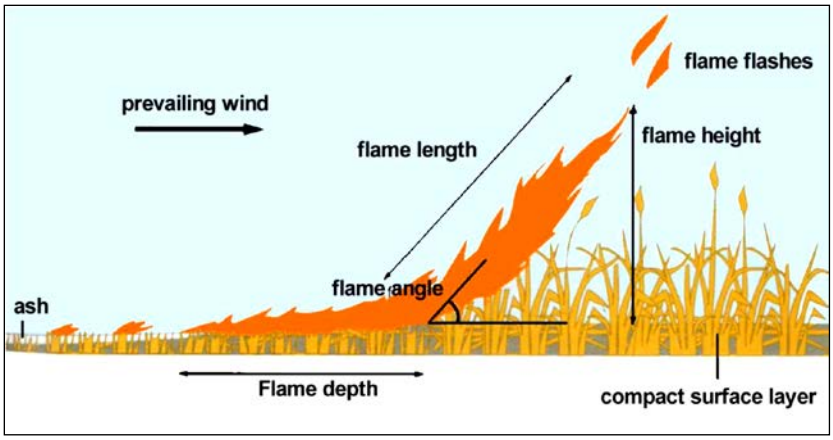


Figure 4. Depiction of flame length as measured from the midpoint of the active flaming zone to the average tip of the flames.

Fireline Intensity is a measurement of the rate of energy release per unit length of the flaming front, and is an indicator of potential fire intensity/severity.

Rate of Spread (ROS) is a measurement of the speed at which the flaming front advances measured in chains per hour (1 chain=66 feet) and is an indicator of the relative ease at which the fire can be successfully contained.

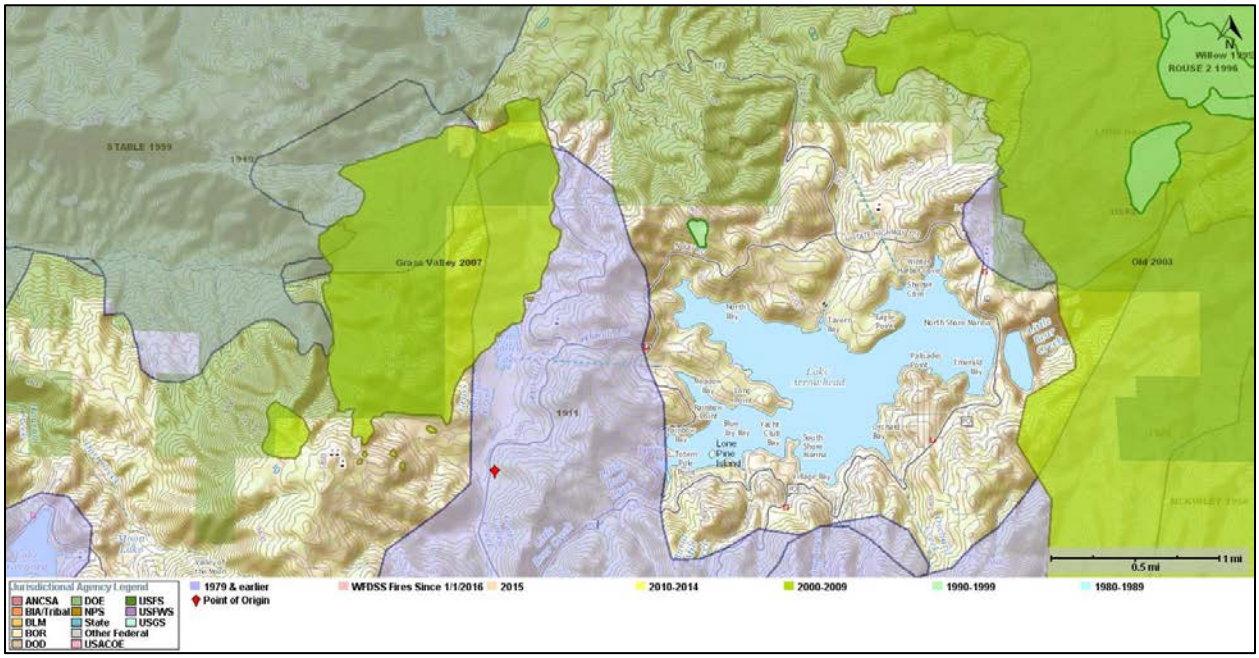
AFFECTED ENVIRONMENT

Existing Condition

Fire History

The Grass Valley Fire of 2007 was an uncontrolled Wildfire fire that substantially altered vegetation communities and substantially increased fuel loading in areas. The fire occurred at a time of year and under conditions which resulted in heightened levels of mortality and increased severity. Portions of the project area burned in 1911, 1919 and 1959 prior to the 2007 Grass

Valley fire. Northwest and north in 1919 and 1959, east in 1911, Figure 1.



Vegetation and Fuels

Vegetation in the proposed project area is comprised of the following:

- Annual Grasses and Forbs
- Bigcone Douglas-Fir
- Black Oak
- Canyon Live Oak
- Coulter Pine
- Douglas-Fir - Ponderosa Pine
- Great Basin - Mixed Chaparral Transition
- Lower Montane Mixed Chaparral
- Mixed Conifer – Pine
- Non-Native/Ornamental Grass
- Ponderosa Pine
- Scrub Oak
- Upper Montane Mixed Chaparral

Forty-four stand exam plots were measured in the proposed project area during March, 2015. Fuels data collected were based on visually estimating site conditions compared to representative fuel models displayed in Scott, Joe H.; Burgan, Robert E. 2005 (Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model). Fuel model radius plots are ½ acre in size or the plot radius equals 83.25’ (visual estimate). The data was inputted into the FVS-FFE model and Tables 2 shows the data split-out by treatment level (see Table 2 under Environmental Consequences, Proposed Action below). The heaviest surface fuel loading is in the 12”+ diameter size class of dead and downed trees.

ENVIRONMENTAL CONSEQUENCES

No Action

Under the no action alternative dead and dying trees would continue to increase surface and standing dead fuel loading over time, Figure 2 below. The FVS-FFE model was used with environmental inputs based on 2016 existing fuel load conditions burning under in-fire-season 90th percentile wildfire burning conditions. The following 90th percentile weather and fuel moisture burning conditions were used for the FVS-FFE model run and the fire behavior outputs are shown in Table 1.

Wildfire Weather and Fuel Moisture Conditions

The Rock Camp RAWS is the nearest, most representative weather station (nearest to the project area) and data from the station was used for determining fire behavior outputs displayed below. Ten years of in fire season data from 2006-2015 were used to determine 90th percentile wildfire weather conditions.

Location: Rock Camp, California
Latitude: 34° 17' 17" Longitude: 117° 12' 45"
Elevation: 4,900 feet above sea level.

Fire Season Wildfire Burning Conditions – 90th Percentile
(May 1 through October 31)
Temperature = 78* f
20 ft. wind = 13 mph
Fuel Moistures

- 1 hr TLFM = 2% (1)
- 10 hr TLFM = 3%
- 100 hr TLFM = 5%
- 1000 hr TLFM = 6%
- Live Herbaceous Moisture = 30%
- Live Woody Moisture = 70%
- Duff = 20%

(1) TLFM – Time Lag Fuel Moisture – Time needed under specified conditions for a fuel particle to lose about 63 percent of the difference between its initial moisture content and its equilibrium moisture content. If conditions remain unchanged, a fuel will reach 95 percent of its equilibrium moisture content after four timelag periods.

Potential Wildfire Behavior

Under existing conditions all proposed treatment level areas would produce flame lengths from six to ten feet, Table 1. Flame lengths longer than four feet would increase fire suppression complexity, or resistance to control, the implications of which are explained in detail below under proposed action direct and indirect effects. The probability of torching ranges from 32-

57% and is a percentage indicator of how much of the forest stand may be damaged or killed by trees burning in the simulated wildfire.

Table 1. 2016 Potential Wildfire Behavior in the Proposed Project Area.

Proposed Treatment Level	Flame Length Surface (feet)	Canopy Base Height (feet)	Probability of Torching (percent)	Torching Index (miles per hour)	Crown Index (miles per hour)
Existing Condition with Wildfire Fire Simulated in 2016					
1	6	5	34%	5	52
Existing Condition with Wildfire Fire Simulated in 2016					
1a	9	21	40%	40	38
Existing Condition with Wildfire Fire Simulated in 2016					
3	9	23	57%	40	19
Existing Condition with Wildfire Fire Simulated in 2016					
4	10	7	37%	9	27
Existing Condition with Wildfire Fire Simulated in 2016					
4a	10	2	32%	0	9

Proposed Action

See Chapter 2 for a detailed description of the proposed action.

Direct, Indirect and Cumulative Effects

The FVS-FFE runs show potential 90th in season wildfire behavior using existing fuel load conditions in 2016, and potential wildfire behavior in years 2026 and 2036 after mechanical treatment in 2017 and subsequent prescribed burning. A prescribed burning prescription was used to model fuel reduction when pile burning of surface fuels are completed in 2018, 2021, and 2031; and prescribed fire underburning are completed in 2020 and 2030. For planning purposes the following prescribed burning weather and fuel moisture conditions were used for the FVS-FFE model run and the fire behavior outputs are shown in Table 3. Fuel moistures used for model simulations may be higher than typical conditions. During project implementation a project specific burn plan will be approved that will specify individual burning unit prescribed burn fuel moisture and weather conditions.

Prescribed Burning Weather and Fuel Moisture Conditions

Prescribed Fire Burning Conditions
FVS Season of Burning = 4 Fall
TEMP = 60 f
20 ft. wind = 7 mph
Fuel Moisture

1 hr TLFM = 8%
10 hr TLFM = 11%
100 hr TLFM = 14%
1000 hr TLFM = 16%
Live Herbaceous Moisture = 30%
Live Woody Moisture = 108%
Duff = 30%

Post Treatment Fuel Loading Reduction

The FVS-FFE model calculates that average treatment level (TL) surface fuel loads would be about 61 tons per acre (TPA) in 2016 with a range of 60 to 63 TPA. After mechanical and prescribed burning treatments are completed average treatments level surface fuel loads would be about 29 TPA in 2021 with a range of 13 to 57 TPA.

For TL 1, TL 1A and TL 4A fuel loading would be less than 20 tons per acre and the most fuel loading would be in the duff and litter size classes. Duff and litter are important in minimizing soil erosion and for minimizing water quality impacts.

For TL 3 and TL 4 the 12"+ fuel loading (downed logs) is higher and would benefit wildlife in the Eagle and Spotted Owl PAC's. Retaining downed woody debris in larger size classes would maintain suitable habitat for these species, as well as the prey base.

Tables 1. Existing and Post Treatment Surface Fuel Loading in the Grass Valley Treatment Levels (TPA – Tons per Acre).

Proposed Treatment Level 1 – Based on 3 Sampling Plots		
Fuel Size	**2016 Average Tons Per Acre (TPA)**	**2021 Average Tons Per Acre (TPA)**
Duff TPA	16.8	9.8
Litter TPA	2.3	1.5
1" – 3" TPA	2.4	0.2
3" – 5.9" TPA	0.7	0.0
6" – 11.9" TPA	0.8	0.2
12" + TPA	36.1	0.9
Surface Herbaceous TPA	0.3	0.3
Surface Shrub TPA	0.5	0.6
Total TPA	**60.0**	**13.4**

Proposed Treatment Level 1a – Based on 12 Sampling Plots		
Fuel Size	**2016 Average Tons Per Acre (TPA)**	**2021 Average Tons Per Acre (TPA)**
Duff TPA	16.8	9.9
Litter TPA	1.9	4.2
1" – 3" TPA	2.7	0.7
3" – 5.9" TPA	0.8	0.2
6" – 11.9" TPA	1.4	0.8

12" + TPA	37.5	1.4
Surface Herbaceous TPA	0.3	0.3
Surface Shrub TPA	0.5	0.5
Total TPA	**61.8**	**17.8**

Existing Condition Proposed Treatment Level 3 – Based on 4 Sampling Plots		
Fuel Size	**2016 Average Tons Per Acre (TPA)**	**2021 Average Tons Per Acre (TPA)**
Duff TPA	16.8	13.1
Litter TPA	0.6	0.4
1" – 3" TPA	2.8	2.0
3" – 5.9" TPA	0.7	0.5
6" – 11.9" TPA	1.9	1.0
12" + TPA	39.9	27.7
Surface Herbaceous TPA	0.2	0.2
Surface Shrub TPA	0.4	0.4
Total TPA	**63.4**	**45.3**

Proposed Treatment Level 4 – Based on 16 Sampling Plots		
Fuel Size	**2016 Average Tons Per Acre (TPA)**	**2021 Average Tons Per Acre (TPA)**
Duff TPA	16.8	15.7
Litter TPA	1.7	1.5
1" – 3" TPA	2.6	2.4
3" – 5.9" TPA	0.8	0.7
6" – 11.9" TPA	1.2	1.1
12" + TPA	37.2	34.9
Surface Herbaceous TPA	0.3	0.3
Surface Shrub TPA	0.6	0.6
Total TPA	**61.2**	**57.2**

Proposed Treatment Level 4a – Based on 3 Sampling Plots		
Fuel Size	**2016 Average Tons Per Acre (TPA)**	**2021 Average Tons Per Acre (TPA)**
Duff TPA	16.8	9.7
Litter TPA	1.3	1.3
1" – 3" TPA	2.4	0.2
3" – 5.9" TPA	0.7	0.1
6" – 11.9" TPA	0.8	0.4
12" + TPA	36.1	1.1
Surface Herbaceous TPA	0.3	0.7
Surface Shrub TPA	0.7	0.7
Total TPA	**59.2**	**13.9**

Surface fuel loading would be reduced six times after treatments are completed between 2017 and 2026 and after prescribed fire treatments are completed would range from 14-40 TPA. After treatments, surface fuels would re-accumulate but remain lower than if no treatments occur. A prescribed burning prescription, above, was used to model fuel reduction when subsequent pile burning of surface fuels are completed in 2018, 2021, and 2031; and prescribed fire underburning are completed in 2020 and 2030.

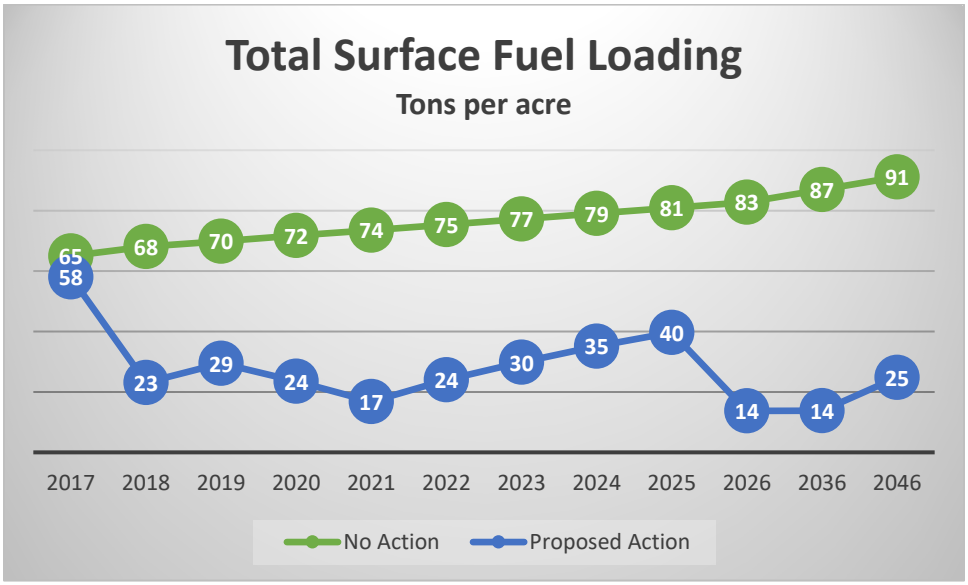


Figure 2. FVS simulated harvest in 2017 by thin from below, with pruning up to 1/3 of the crown. Pile burning of surface fuels are completed in 2018, 2021, and 2031; and prescribed fire underburning are completed in 2020 and 2030,

Masticated Fuels Fire Behavior

Currently there are no established fire behavior fuels models available for masticated fuels and research into the problem is ongoing. In post treatment masticated fuels, based on field observation data from Kreye, Jesse K. et. al. (2013) flame lengths would be approximately 2-6 feet, rate of spread 0.2-11 chains per hour and fireline intensity is unavailable.

Wildfire Behavior Before and After Treatment

Potential wildfire flame length during the first several years after prescribed fire treatments are completed would be low due to the reduced surface fuels from the prescribed burning. Flame lengths would increase over time during the re-accumulation of surface fuels including the accumulation of new, heavier dead and down woody debris and shrub growth. In addition, the probability of torching increases over time, and average crown base height decreases because natural and artificial regeneration would occur post treatments. Reforestation is proposed as a restoration activity under the proposed action and the small trees would increase surface fire behavior until the trees are tall enough to resist torching. Therefore, there is not a substantial

reduction in potential wildfire fire behavior several years after treatments are completed as would be the case in other fuels reduction projects. This is because the project restores a burned landscape, and tree planting (natural and artificial) were added to the FVS-FFE model and the model shows the small trees increasing fire behavior, Table 3. Flame lengths in wildfire scenarios in 2026 and 2036 would average about 6 feet. The probability of torching would average about 38% in 2026 and 2036 and range from 20 to 51%.

Table 3. Potential 2016 and 2026, 2036 Post Treatment Wildfire Behavior. The FVS-FFE model runs are based on the 90th percentile in-fire-season fuel moisture and weather conditions shown above.

Proposed Treatment Level	Flame Length Surface (feet)	Canopy Base Height (feet)	Probability of Torching (percent)	Torching Index (miles per hour)	Crown Index (miles per hour)
Existing Condition with Wildfire Fire Simulated in 2016					
1	6	5	34%	5	52
Ten to Twenty Years with Wildfire Fire Simulated in 2026					
1	3	12	20%	33	259
Twenty Plus Year with Wildfire Fire Simulated in 2036					
1	5	11	48%	33	137
Existing Condition with Wildfire Fire Simulated in 2016					
1a	9	21	40%	40	38
Ten to Twenty Years with Wildfire Fire Simulated in 2026					
1a	7	26	39%	198	130
Twenty Plus Year with Wildfire Fire Simulated in 2036					
1a	7	28	35%	215	119
Existing Condition with Wildfire Fire Simulated in 2016					
3	9	23	57%	40	19
Ten to Twenty Years with Wildfire Fire Simulated in 2026?					
3	7	8	40%	55	79
Twenty Plus Year with Wildfire Fire Simulated in 2036?					
3	7	12	34%	95	53
Existing Condition with Wildfire Fire Simulated in 2016					
4	10	7	37%	9	27
Ten to Twenty Years with Wildfire Fire Simulated in 2026					
4	7	8	51%	7	178
Twenty Plus Year with Wildfire Fire Simulated in 2036					
4	7	11	44%	20	105
Existing Condition with Wildfire Fire Simulated in 2016					
4a	10	2	32%	0	9
Ten to Twenty Years with Wildfire Fire Simulated in 2026					
4a	4	8	41%	107	168
Twenty Plus Year with Wildfire Fire Simulated in 2036					
4a	5	17	31%	156	96

Wildfire Resistance to Control

The ability to control wildfires can be characterized by how a fire will burn or fire behavior. Topography and weather are factors on which humans have little effect but, fuels can be altered through vegetation/fuels treatments or natural processes such as fire (rapid) or decomposition (very slow). Resistance to control is a relative measure of the capabilities of firefighting resources to contain a wildfire. Firefighting resources have enhanced fireline production rates as fuel loading and fuelbed depth decrease. Increased fireline production rates and changes to lower fireline intensities allow both ground based handcrews, mechanized (fire engines and dozers) and aerial suppression (fixed wind air tankers, water/retardant dropping helicopters) resources to be more effective.

The Hauling Chart is a tool for measuring the safety and potential effectiveness of various fireline resources given a visual assessment of active flame length. It was so named because it infers the relative intensity of the fire behavior to trigger points where hauling various resources to or away from a fire should be considered. When making fire suppression tactical decisions near values at risk (homes), or on fuel breaks where containment action is feasible, firefighters mostly base their decisions on anticipated fire intensity or flame lengths.

Firefighters can take suppression action on the ground when flame lengths are up to four feet (Fireline Intensity of 100 Btu/ft/sec). Flame lengths from four to eight feet cannot be suppressed by handcrews and mechanized equipment such as dozers, engines, and retardant aircraft can be effective. Flame lengths that are eight feet or above present serious control problems and suppression actions taken at the head of the fire will probably be unsafe and ineffective.

Table 4. Hauling Chart Interpretation.

Flame Length (Feet)	Fireline Intensity (Btu/ft/sec)	Interpretation
0-4	0-100	Persons using handtools can generally attack fires at the head or flanks. Handline should hold the fire.
4-8	100-500	Fires are too intense for direct attack on the head by persons using handtools. Handline cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
8-11	500-1,000	Fires may present serious control problems such as torching, crowning, and spotting. Control efforts at the head of the fire will probably be ineffective.
11+	1,000+	Crowning, spotting, and major runs are common, control efforts at the head of the fire are ineffective.
Source: Fireline Handbook, National Wildfire Coordinating Group, 2006; Rothermel 1983; principally adapted from Andrews and Rothermel 1982.		

All of the vegetation types/fuel models in the project area would produce flame lengths above four feet under wildfire conditions. Masticated fuels would probably burn with flame lengths from two to six feet and average around four feet. Ground based firefighting resource generally are unable to work safely near and contain flames greater than four feet in length and wildfires

fires would burn with high intensity and quickly grow in size and become large fires that are difficult to control.

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