NRCS/San Bernardino County Fire Hazardous Fuels Assessment

A Fire Behavior and Fuels Report

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for
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NTRODUCTION

San Bernardino County Fire Department (BDC) and the Natural Resources Conservation Service (NRCS) contracted with Adaptive Management Services Enterprise Team (AMSET) to perform an evaluation of the hazardous fuels treatments program in the mountain communities of the San Bernardino range. The assessment focused on fourteen projects concentrated in the Lake Arrowhead and Lake Gregory area. These projects are to be used as surrogates to reflect the effectiveness of the fuels treatments area-wide. LANDFIRE data is used to represent the existing condition of the fuel bed, while a modification is made to the LANDFIRE landscape to represent the fuel bed after the proposed fuel modification treatments have been applied. The standards proposed in the Dart Canyon Fuel Modification and Large Parcel Project are used to modify the LANDFIRE data.

The goal of the analysis is to determine at a project level if the fuels treatments are providing for community wildfire protection and to suggest/verify methodologies which could be used to enhance the protection of the local communities. A landscape level evaluation of the effectiveness of the treatments is not part of the analysis, as most projects are focused on community protection, rather than modifying fire behavior at a landscape level.

BACKGROUND

Initial hazardous fuel treatments in the mountain communities were focused on the removal of the dead tree component from the landscape. Dead trees posed a significant hazard to the public, as the weakened trees displayed increasing tendencies to shed limbs and to fall from the stand. Many of the dead tress were directly associated with infrastructure and transportations routes and created a hazardous situation to the general public and private property.

In areas where the level of dead tree removal was significant, a modification to the surface and aerial fuel components created a situation where wildland fire condition in the treatment areas were improved. In other cases, the level of dead tree removal was insufficient to affect the surface fuel properties and therefore did not signifantly impact the modeled surface wildland fire behavior.

In all cases the removal of the dead trees addressed three concerns. Firstly, it mitigated the surface fuel condition which would had developed 10 to 15 years in the future as the trees fell and became part of the surface fuel loads. The removal of the trees from the landscape mitigated the intensity of future fires which would had burned through this heavy surface fuels.

Secondly, the removal of the dead tree reduced the canopy bulk density and ladder fuels within a stand, reducing the ability of a fire to spread through the canopy of the trees under a given set of environmental conditions.

Finally, the removal of the dead trees also addressed the issue of resistance to control and fireline production rates. As large dead material becomes incorporated into the surface fuels, fireline intensity increases and fireline production rates decrease as firefighters are forced to remove more fuels in order to construct fireline. Aerial firefighting resources are also impacted with this increase in fuel loading, as coverage levels from air tankers and helicopters need to increase in order to be effective in checking fire spread. Tables 1 and 2 show the impacts of increasing fuel loading on firefighting activities, with NFDRS model J most representative of the fuel condition had dead tree removal not been undertaken. NFDRS Model G best represents the current condition.

Table 1 Firefighter Production Rates

Resource Type	Timber – Heavy Dead Loading	Timber – Loosely Compacted Litter	Change
Type 1 crew	6	28	+22
Type 2 crew	4	16	+14
Type 3 engine	20	22	+2
Type I dozer (26-40% slope)	9-20 uphill 30-40 downhill	40-65 uphill 90-110 downhill	+31-45 +60-70
Type II dozer (26-40% slope)	7-10 uphill 20-25	30-50 uphill 85-100 downhill	+23-40 +65-75

Table 2 Air Tanker Coverage Rates Based on NFDRS Fuel Models

NFDRS Model	NFFL Model	Coverage Level	Flow Rate Range (gal/sec)
A,L,S	1	1	100-150
C	2	2	151-200
H,R	8		
E,P,U	9		
T	2	3	251-400
N	3		
F	5		
K	11		
G	10	4	401-600
O	4	6	601-800
F,Q	6		
B,O	4	Greater than 6	Greater than 800
J	12		
I	13		

As the initial concern of dead tree removal has largely been addressed the question of how to modify surface fire activity becomes the new priority. In order to affect the surface fire as well as reduce the potential of a fire to move from the surface fuels into the canopy, a different fuels treatment strategy needs to be employed. This strategy requires

that the surface fuel conditions be addressed through a variety of treatments focused on surface fuels and small green tree removal (10" or less).

A standard set of treatment protocols was proposed by BDC and NRCS. The protocols are summarized below:

- All dead trees and brush will be removed and chipped
- Down woody debris will be removed or chipped. Retain 2 pieces per acre of 20" or greater and 20' long dead material.
- Remove all brush within the dip line of residual trees
- Remove trees, 10" and less (marked) within the drip line of the residual trees
- Retain 30% of the live brush within the treatment area
- Prune residual trees to 8' or ¼ of the live tree crown where the 8' standard cannot be obtained.

The analysis focuses on the effectiveness of this proposed treatment standard when compared to the existing landscape, post dead tree removal. The question addressed is does the standard as proposed modify fire behavior to a point where enhanced levels of community protection is achieved.

ANALYSIS

A digital landscape of fourteen project areas and the surrounding environment was developed based on the LANDFIRE data. The objective of the LANDFIRE Project is to provide the spatial data needed to support the National Fire Plan and to accurately identify lands or communities with hazardous fuel build-up or extreme departure from historical conditions (www.landfire.gov). LANDFIRE includes all required information to run the FlamMap (Finney, 1999) a fire modeling tool which analyses fire behavior characteristics across an entire landscape. LANDFIRE data sets include both surface and aerial fuels characteristics, so that an assessment of the crown fire potential can be performed. The resolution of the fuels data from LANDFIRE is 30x30 meter, and represents the coarsest scale of any of the data used in the analysis. The current 40 fuel models found in Rocky Mountain Research Station General Technical Report 153 were selected for this analysis (Scott, Burgan, 2005).

The existing condition fuels data set was verified by a field reconnaissance of the fourteen project areas on August 22 and 23, 2007. The LANDFIRE fuels data was determined reflect the actual conditions on the ground. This data was used to reflect the existing in the analysis. A change to the fuels data file was made based on the fuels modification prescriptions developed by NRCS. The changes to the fuels data is shown in Table 3. This new data set is used to display the changes in fire behavior within the project areas based on the implementation of the proposed fuel modification standards.

Table 3. Modifications to LANDFIRE Fuels Data

Existing Model Number	Model Description	New Model Number	CBD (kg/m^3)	Canopy Cover (%)	CBH (meters)
91	Urban				
93	Agricultural				
98	Open Water				
99	Bare Ground				
102	Low load dry climate grass				
122	Moderate load dry climate grass shrub	121			
123	Moderate load humid climate grass shrub	122			
142	Moderate load dry climate shrub	141			
143	moderate load humid climate shrub	142			
144	Low load humid climate timber shrub				
145	High load dry climate shrub	141			
146	Low load humid climate shrub				
147	Very high load dry climate shrub	142			
149	Very high load humid climate shrub	143			
162	Moderate load humid climate timber shrub	161	0.19	45	2.5
164	Dwarf conifer with understory				2.5
165	Very high load dry climate timber shrub	161	0.19	75	2.5
183	Moderate load conifer litter				2.5
184	Small downed logs		0.06	75	2.5
186	Moderate load broadleaf litter		0.01	45	2.5
187	Large down logs	184	0.07	5	2.5
188	Long needle litter		0.18	55	2.5

MODELING ASSUMPTIONS

The analysis of the fire potential for both the existing condition and the modified landscape was conducted using FlamMap. FlamMap allows for an instantaneous look at fire across the landscape and provides a mechanism for comparing fire behavior outputs between different modeling scenarios. Two different modeling scenarios were evaluated in this analysis using 90^{th} and 97^{th} percentile conditions. The spatial outputs from FlamMap are included as Appendix A.

Weather:

Weather plays a critical role in fire behavior and given such two different weather scenarios are used to evaluate the effectiveness of the fuels treatments. The scenarios are based on the 90^{th} and 97^{th} percentile weather for three weather station (Fawnskin, Rock Camp and Big Pine Flat) A Special Interest Group (SIG) was developed in FireFamily Plus, a fire weather database management program, to incorporated the weather observations from the three stations into a single dataset for the analysis. The distribution of permanent weather stations on the mountain does not provide adequate coverage of Lake Arrowhead and Lake Gregory, as the permanent RAWS stations are clustered on

the Big Bear side of the range. While these station are the most representative of local conditions, they may under estimate temperature and relative humidity characteristics for the lower elevations of the landscape evaluated.

The percentiles used to represent the weather in the analysis are those established by the National Fire Danger Rating System to represent Very High (90th percentile) and Extreme (97th percentile), fire danger. The Energy Release Component (ERC) fire danger index was selected to determine the percentile values. ERC is the preferred fire danger indices for timber dominated fuel types

Table 4 shows the parameters used in FlamMap.

Table 4. 97th and 90th Percentile Modeling Parameters

Component	97th Percentile	90th Percentile
Maximum Temperature	89	86
Minimum Temperature	57	52
Minimum RH	4	11
Maximum RH	25	36
Wind Speed (20')	17	14
1 hour FM	2	3
10 hour FM	2	3
100 hour FM	6	10
1000 hour FM	7	9
Live Herbaceous FM	5	19
Live Woody FM	57	60

Fuel Moisture:

FireFamily Plus was also utilized to determine live and dead fuel characteristics, with the SIG used to consolidate the fuel moisture data. The fuel moisture characteristics are also summarized in Table 4.

In the modeling process live herbaceous fuel moistures were adjusted to 30% in all scenarios. This adjustment is required to address a feature in FlamMap that causes modeling errors for values below 30%. A fuel moisture of 30% is considered fully cured within the model and provides for the greatest fire behavior outputs.

Winds:

FireFamily Plus was also used for the winds analysis. Winds are used in FlamMap to evaluate crown fire potential. The 20' winds, in association with stand characteristics will determine when a fire transitions from a surface fire to a crown fire and if the fire will spread through the crowns or only torch out individual or small groups of trees. The 90th percentile windspeed based upon the SIG is 14 mph while the 97th percentile wind speed is 17 mph.

Wind direction was predominately south to southwest during the modeling period June 1 to September 30. Winds reflected this southerly component 54.5% of the time during the analysis period. As the seasons move towards fall, wind speeds begin to increase and take on a northerly component. This seasonal variation places different communities at higher risk to a fire spreading in alignment with the wind at different times of the year. For the FlamMap analysis it was assumed that the wind was blowing upslope at all locations on the landscape. This assumption leads to the most active burning condition both on fires and within the model.

Outputs:

FlamMap operates similarly to the FARSITE fire spread model without the temporal component. All elements of the fire environment are captured in a digital landscape from which fire behavior outputs are derived. The outputs from FlamMap represent a snapshot in time based upon the landscape, weather and fuel moisture. For this project only flame length and crown fire activity were generated as outputs.

The flame length outputs were classified using GIS into the common classes associated with the "Fire Behavior Characteristics Chart", (Rothermel, 1983). These classifications and limits to firefighting actions are shown in Table 5. Each class of flame length is used to represent increasing resistance to control for firefighters. Flame lengths greater than 11 feet represent an area where the fire exerts extensive control over the physical environment and under which firefighting efforts are normally unsuccessful at the flaming front of the fire. Flame length is a product of many elements, with the selected surface fuel model, fuel moisture, wind and slope driving this output. Flame length refers only to the surface fire, and while it is a precursor to crown fire activity, it does not represent the flame lengths observed during crown fire events.

Table 5. Fireline Intensity Interpretations

Intensity	Flame length	BTU/ft/sec	Interpretations
Low	<4 feet	Less than 100	Direct attack at head and flanks with hand crews, handlines should stop spread of fire
Low-Moderate	4-8 feet	100-500	Employment of engines, dozers, and aircraft needed for direct attack, too intense for persons with handtools
Moderate	8-11 feet	500-1000	Control problems, torching, crowning, spotting; control efforts at the head are likely ineffective
High	> 11 feet	Greater than 1000	Control problems, torching, crowning, spotting; control efforts at the head are ineffective

Crown fire potential was assessed using the Crown Fire Activity function in FlamMap. The outputs are tied to several factors, with surface fire flame lengths, canopy base height, crown bulk density, foliar moisture and 20' wind speed being the most important. The 1999 Finney version of determining crown fire potential was selected for use in this analysis.

Crown fire outputs are classified into three groups:

- Surface fire (no crown fire activity)
- Passive Crown Fire (individual trees or groups of trees supporting fire)
- Active Crown Fire (sustained spread of the fire through the canopy fuels)

Only the timber litter and timber understory fuel models are capable of generating crown fire activity in the model. Brush and grass fuels without an overstory component model as a surface fire under all environmental conditions.

FINDINGS

Fourteen project areas clustered in the Lake Gregory/Lake Arrowhead region of San Bernardino County were selected for inclusion in the evaluation. A landscape file was developed using LANDFIRE data to represent the fuels characteristics for the landscape and a field reconnaissance was conducted to verify that the LANDFIRE data correctly represented the current fuel layer. Only a small portion of the Deer Lodge Park and Krouse/Hall project area displayed a significant difference to the LANDFIRE data. This modification to the landscape is represented by a narrow strip of fuel treatment work along Edgecliff Drive. Given the limited spatial extent of the project, the decision was not to modify the fuels data, as the influence from the untreated fuels in Grass Valley Creek would overwhelm the effects of this treatment in the model.

Existing Condition:

The evaluation of the existing condition indicated that many of the treatment areas retained fire behavior characteristics which could prove hazardous to firefighter and to public safety under the 90^{th} percentile weather conditions. Project areas of particular concern are Deer Lodge Park, Sandra Rose, Mepham and North Road. All of these areas show a modeled crown fire potential of more than 20% of the project area.

This finding was surprising for North Road as during the field evaluation of the project area it did not appear that this area was capable of supporting a large amount of active crown fire. This could be an anomaly in the model, or reflect that the field reconnaissance did not sample areas which could support this type of fire activity.

The tabular outputs for surface and crown fire characteristic are presented in Tables 6 and 7. The spatial outputs for this modeling scenario are in Appendix A.

Table 6. Existing Condition Flame Length – 90th Percentile Weather

NAME	No data	0-4	4-8	8-11	11-20	>20
Blucas	0.0%	85.6%	8.8%	0.0%	4.0%	1.6%
Cumberland	0.0%	70.8%	9.3%	3.6%	8.8%	7.5%
Deer Lodge Park	4.0%	54.7%	2.7%	5.3%	13.9%	19.4%
Duringer	1.4%	90.8%	0.0%	0.0%	7.0%	0.7%
Kronsberg	11.0%	74.0%	1.4%	0.0%	13.7%	0.0%
Kronsberg 2	2.3%	88.4%	0.0%	0.0%	9.3%	0.0%
Lakeside Trailer Park	8.6%	76.3%	3.2%	0.0%	2.2%	9.7%
Lakewood	0.0%	58.1%	20.9%	3.5%	16.3%	1.2%
Lakewood 2	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Mepham	0.0%	74.8%	0.8%	3.4%	4.2%	16.8%
North Road	3.0%	71.2%	1.9%	0.0%	13.0%	10.9%
Redlands Security	0.8%	91.9%	0.8%	0.0%	5.6%	0.8%
Sandra Rose	0.0%	64.1%	6.5%	6.5%	18.7%	4.2%
Skyforest Synod	0.0%	80.8%	7.3%	0.0%	8.3%	3.6%
Thousand Pines	1.6%	93.4%	0.3%	1.2%	1.3%	2.1%
Average – All Projects	2.4%	71.8%	3.3%	2.9%	9.8%	9.9%

Table 7. Existing Condition Crown Fire Activity – 90th Percentile Weather

NAME	No Data	Surface Fire	Passive Crown Fire	Active Crown Fire
Blucas	0.0%	47.2%	48.0%	4.8%
Cumberland	0.0%	44.8%	39.4%	15.8%
Deer Lodge Park	4.0%	30.0%	30.6%	35.4%
Duringer	1.4%	84.5%	6.3%	7.7%
Kronsberg	11.0%	65.8%	12.3%	11.0%
Kronsberg 2	2.3%	74.4%	18.6%	4.7%
Lakeside Trailer Park	8.6%	43.0%	39.8%	8.6%
Lakewood	0.0%	26.7%	60.5%	12.8%
Lakewood 2	0.0%	33.3%	66.7%	0.0%
Mepham	0.0%	41.2%	37.8%	21.0%
North Road	3.0%	50.2%	24.0%	22.7%
Redlands Security	0.8%	54.0%	38.7%	6.5%
Sandra Rose	0.0%	21.7%	55.9%	22.4%
Skyforest_Synod	0.0%	52.3%	37.8%	9.8%
Thousand Pines	1.6%	60.4%	36.0%	2.1%
Average – All Projects	2.4%	43.8%	34.3%	19.5%

As expected there is an increase in fire activity as the weather parameters in the model were made more severe. In the 97th percentile scenario only Duringer, Kronsberg, Lakewood 2, Redlands Security and Thousand Pines modeled active crown fire for less than 20% of the overall project area. Tables 8 and 9 show this increasing fire activity.

It should be remembered that the 97th percentile conditions are very sever and that fire burning under these fairly uncommon conditions will display very active fire behavior outputs.

Table 8. Existing Condition Flame Length – 97th Percentile Weather

NAME	No Data	0-4	4-8	8-11	11-20	>20
Blucas	0.0%	67.2%	3.2%	4.0%	20.8%	4.8%
Cumberland	0.0%	51.8%	7.7%	4.3%	24.2%	12.0%
Deer Lodge Park	4.0%	32.5%	11.8%	7.3%	13.6%	30.7%
Duringer Property	1.4%	88.0%	2.1%	0.0%	0.7%	7.7%
Kronsberg	11.0%	74.0%	0.0%	0.0%	2.7%	12.3%
Kronsberg 2	2.3%	83.7%	0.0%	2.3%	7.0%	4.7%
Lakeside Trailer Park	8.6%	65.6%	5.4%	0.0%	8.6%	11.8%
Lakewood	0.0%	39.5%	2.3%	5.8%	47.7%	4.7%
Lakewood 2	0.0%	77.8%	5.6%	5.6%	11.1%	0.0%
Mepham	0.0%	55.5%	2.5%	8.4%	14.3%	19.3%
North Road	3.0%	59.6%	2.7%	4.9%	7.1%	22.7%
Redlands Security	0.8%	79.0%	4.0%	6.5%	3.2%	6.5%
Sandra Rose	0.0%	34.4%	4.5%	12.7%	32.4%	16.0%
Skyforest Synod	0.0%	66.3%	8.3%	2.6%	15.0%	7.8%
Thousand Pines	1.6%	92.3%	0.0%	0.6%	3.0%	2.6%
Average All Projects	2.4%	56.9%	5.9%	5.0%	12.7%	17.2%

Table 9. Existing Condition Crown Fire Potential – 97th Percentile Weather

NAME	No Data	Surface Fire	Passive Crown Fire	Active Crown Fire
Blucas	0.0%	20.8%	54.4%	24.8%
Cumberland	0.0%	16.1%	45.0%	38.9%
Deer Lodge Park	4.0%	15.3%	30.3%	50.3%
Duringer	1.4%	45.8%	45.1%	7.7%
Kronsberg	11.0%	21.9%	54.8%	12.3%
Kronsberg 2	2.3%	41.9%	51.2%	4.7%
Lakeside Trailer Park	8.6%	14.0%	62.4%	15.1%
Lakewood	0.0%	14.0%	33.7%	52.3%
Lakewood 2	0.0%	22.2%	77.8%	0.0%
Mepham	0.0%	38.7%	21.8%	39.5%
North Road	3.0%	19.6%	45.5%	31.9%
Redlands Security	0.8%	18.5%	64.5%	16.1%
Sandra Rose	0.0%	3.2%	36.7%	60.1%
Skyforest Synod	0.0%	22.8%	54.4%	22.8%
Thousand Pines	1.6%	59.6%	34.2%	4.6%
Average – All Projects	2.4%	26.6%	38.0%	32.9%

All of the projects included in the "Existing Condition" analysis have had some level of treatment. In most cases this consisted of dead tree removal. In cases where large numbers of dead trees were removed, a change to the surface fuels and the associated fire behavior could be detected, (Thousand Pines and Ponderosa Camps). However, in general, dead tree removal cannot be relied on to substantially effect fire behavior within a treatment area and additional fuel modification work should be considered to achieve the level of community protection desired by the BDC and NRCS. Dead tree removal should be considered an initial entry, with follow-up treatment proposed to help mitigate the surface fire characteristics and therefore crown fire potential.

Given that additional fuels modification treatments will be required in many project areas in order to acheieve enhanced community protection in the event of a wildfire, a second analysis was conducted modifying the fuels layer of the landscape to reflect the fuel modification standards as proposed for the Dart Canyon Fuel Modification and Large Parcel Project. By applying these standards to all project areas, it tests the hypothesis that additional treatments have the ability to modify fire behavior more than simple dead tree removal and therefore will provide a greater degree of community protection.

The changes to the ditigal fuels layer are presented in Table 3, and this new landscape file was utilized in FlamMap to derive the outputs found in Tables 11 and 12.

Table 11. Flame Length (feet) Modified Landscape, 90th Percentile Weather

NAME	No data	0-4	4-8	8-11	11-20	>20
Blucas	0.00%	96.00%	0.00%	0.00%	0.80%	3.20%
Cumberland	0.00%	90.05%	0.00%	0.00%	2.49%	7.47%
Deer Lodge Park	4.04%	68.40%	0.74%	0.16%	5.26%	21.40%
Duringer	1.41%	90.14%	0.70%	0.00%	5.63%	2.11%
Kronsberg	10.96%	75.34%	1.37%	1.37%	5.48%	5.48%
Kronsberg 2	2.33%	88.37%	0.00%	4.65%	2.33%	2.33%
Lakeside Trailer Park	8.60%	82.80%	0.00%	0.00%	1.08%	7.53%
Lakewood	0.00%	98.84%	0.00%	0.00%	0.00%	1.16%
Lakewood 2	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%
Mepham	0.00%	81.51%	1.68%	0.00%	0.00%	16.81%
North Road	3.00%	73.62%	0.16%	0.00%	6.64%	16.59%
Redlands Security	0.81%	94.35%	0.00%	0.00%	4.03%	0.81%
Sandra Rose	0.00%	96.26%	0.00%	0.25%	0.00%	3.49%
Skyforest Synod	0.00%	93.78%	0.00%	0.00%	2.07%	4.15%
Thousand Pines	1.56%	95.57%	0.82%	0.00%	0.82%	1.23%
Average – All Projects	2.40%	82.57%	0.52%	0.13%	3.33%	11.07%

Table 12. Flame Length (feet) Modified Landscape, 97th Percentile Weather

NAME	No data	0-4	4-8	8-11	11-20	>20
Blucas	0.0%	96.0%	0.0%	0.0%	0.0%	4.0%
Cumberland	0.0%	88.5%	1.6%	0.0%	0.0%	10.0%
Deer Lodge Park	4.0%	62.6%	6.5%	0.0%	0.2%	26.7%
Duringer	1.4%	89.4%	1.4%	0.0%	0.0%	7.7%
Kronsberg	11.0%	75.3%	1.4%	0.0%	1.4%	11.0%
Kronsberg 2	2.3%	88.4%	0.0%	0.0%	4.7%	4.7%
Lakeside Trailer Park	8.6%	79.6%	3.2%	0.0%	0.0%	8.6%
Lakewood	0.0%	98.8%	0.0%	0.0%	0.0%	1.2%
Lakewood 2	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Mepham	0.0%	81.5%	0.0%	0.8%	0.8%	16.8%
North Road	3.0%	73.5%	0.3%	0.0%	0.6%	22.6%
Redlands Security	0.8%	94.4%	0.0%	0.0%	0.0%	4.8%
Sandra Rose	0.0%	96.3%	0.0%	0.0%	0.2%	3.5%
Skyforest Synod	0.0%	92.7%	1.0%	0.0%	0.5%	5.7%
Thousand Pines	1.6%	95.1%	0.5%	0.1%	1.1%	1.6%
Average – All Projects	2.4%	80.2%	2.6%	0.0%	0.5%	14.2%

The outputs for Crown Fire Potential area presented in Tables 13 and 14.

Table 13. Crown Fire Potential, Modified Landscape, 90th Percentile Weather

NAME	No Data	Surface Fire	Passive Crown Fire	Active Crown Fire
Blucas	0.0%	96.0%	0.0%	4.0%
Cumberland	0.0%	89.8%	0.2%	10.0%
Deer Lodge Park	4.0%	68.6%	0.7%	26.7%
Duringer	1.4%	90.1%	0.7%	7.7%
Kronsberg	11.0%	75.3%	2.7%	11.0%
Kronsberg 2	2.3%	88.4%	4.7%	4.7%
Lakeside Trailer Park	8.6%	79.6%	3.2%	8.6%
Lakewood	0.0%	98.8%	0.0%	1.2%
Lakewood 2	0.0%	100.0%	0.0%	0.0%
Mepham	0.0%	81.5%	1.7%	16.8%
North Road	3.0%	73.6%	0.8%	22.6%
Redlands Security	0.8%	94.4%	0.0%	4.8%
Sandra Rose	0.0%	96.3%	0.2%	3.5%
Skyforest Synod	0.0%	93.8%	0.0%	6.2%
Thousand Pines	1.6%	94.7%	2.2%	1.6%
Average – All Projects	2.4%	82.4%	1.0%	14.2%

Table 14. Crown Fire Potential Modified Landscape, 97th Percentile Weather

NAME	No Data	Surface Fire	Passive Crown Fire	Active Crown Fire
Blucas	0.0%	96.0%	0.0%	4.0%
Cumberland	0.0%	89.8%	0.2%	10.0%
Deer Lodge Park	4.0%	68.6%	0.7%	26.7%
Duringer	1.4%	90.1%	0.7%	7.7%
Kronsberg	11.0%	75.3%	2.7%	11.0%
Kronsberg 2	2.3%	88.4%	4.7%	4.7%
Lakeside Trailer Park	8.6%	79.6%	3.2%	8.6%
Lakewood	0.0%	98.8%	0.0%	1.2%
Lakewood 2	0.0%	100.0%	0.0%	0.0%
Mepham	0.0%	81.5%	1.7%	16.8%
North Road	3.0%	73.6%	0.8%	22.6%
Redlands Security	0.8%	94.4%	0.0%	4.8%
Sandra Rose	0.0%	96.3%	0.0%	3.7%
Skyforest Synod	0.0%	93.8%	0.0%	6.2%
Thousand Pines	1.6%	94.7%	1.8%	2.0%
Average – All Projects	2.4%	82.4%	0.9%	14.3%

In the case of the 90th percentile weather scenario a significant improvement in the crown fire potential occurred. The metric used to measure this change is the increase in the portion of project the area which models as surface fire. Table 16 shows the increasing level of surface fire associated with the post-fuel modification landscape.

This type of analysis can be used to help decision makers in setting priorities for fuel modification projects. Projects which display the greatest positive change in the amount

of surface fire could be considered priority treatment areas, as the greatest change to the fire environment occurs within these treatment units. Based on the data, the Lakewood and Lakewood 2 and Sandra Rose project areas would be considered priority treatment areas. This metric should be considered only one part of a bigger priority setting matrix as other social and political elements may effect the decision making process.

Table 16. Fuel Modification Surface Fire Change, 90th Percentile Weather

NAME	Initial Landscape	Modified Landscape	Change
Blucas	47.2%	96.0%	48.8%
Cumberland	44.8%	89.8%	45.0%
Deer Lodge Park	30.0%	68.6%	38.6%
Duringer	84.5%	90.1%	5.6%
Kronsberg	65.8%	75.3%	9.5%
Kronsberg 2	74.4%	88.4%	10.0%
Lakeside Trailer Park	43.0%	79.6%	36.6%
Lakewood	26.7%	98.8%	72.1%
Lakewood 2	33.3%	100.0%	67.7%
Mepham	41.2%	81.5%	40.3%
North Road	50.2%	73.6%	23.4%
Redlands Security	54.0%	94.4%	40.4%
Sandra Rose	21.7%	96.3%	74.6%
Skyforest Synod	52.3%	93.8%	41.5%
Thousand Pines	60.4%	94.7%	34.3%
Average – All Projects	43.8%	82.4%	38.6%

Table 17 shows the same type of results under the 97th percentile weather scenario. The improvement in the fire environment is even more dramatic under these more severe weather conditions.

Table 17. Fuel Modification Surface Fire Change, 97th Percentile Weather

NAME	Initial Landscape	Modified Landscape	Change
Blucas	20.8%	96.0%	75.2%
Cumberland	16.1%	89.8%	73.7%
Deer Lodge Park	15.3%	68.6%	53.3%
Duringer	45.8%	90.1%	44.3%
Kronsberg	21.9%	75.3%	53.4%
Kronsberg 2	41.9%	88.4%	46.5%
Lakeside Trailer Park	14.0%	79.6%	65.6%
Lakewood	14.0%	98.8%	84.8%
Lakewood 2	22.2%	100.0%	77.8%
Mepham	38.7%	81.5%	42.8%
North Road	19.6%	73.6%	54.0%
Redlands Security	18.5%	94.4%	75.9%
Sandra Rose	3.2%	96.3%	93.1%
Skyforest Synod	22.8%	93.8%	71.0%
Thousand Pines	59.6%	94.7%	35.1%
Average – All Projects	26.6%	82.4%	63.1%

SUMMARY OF FINDINGS

1. Based on the existing LANDFIRE landscape, the removal of dead trees only does not have a significant impact on the overall surface fire spread of wildland fires. This is not unexpected as the fuel models which support the surface fire spread model focuses on the 3 inch and less surface fuels. It is the characteristics of the surface fire which causes crown fire initiation. Table 18 shows flame lengths associated with critical levels of fireline intensity that are associated with crown fire, using Byram's (1959) equation.

   Table 18. Critical Flame Lengths (feet) for Crown Fire Initiation

Foliar Moisture %	Height of Crown Base (feet)			
	6	20	40	66
70	4	8	12	17
80	4	8	13	19
90	4	9	14	20
100	4	9	15	21
120	5	10	17	24

   Since the removal of the dead trees does not significantly impact surface fire characteristics this fuels treatment should be viewed as an initial entry and part of a greater scheme to modify fire behavior through fuel modification treatments. Additional treatments which address the surface fuel and ladder fuel issues (green trees less than 10") are recommended to change the surface fire characteristics and therefore crown fire potential. These treatments will vary in effectiveness based on the intensity of the treatment, however the standards defined in the Dart Canyon Fuel Modification and Large Parcel Project are significantly intense to moderate surface fire characteristics.

2. The fuel modification standards as presented in this document have the ability to mitigate fire behavior characteristics under both the 90^{th} and 97^{th} percentile weather conditions. While fuel treatments cannot be expected to be effective under all weather conditions (Santa Ana winds for example), there should be reasonable confidence that the treatments as proposed can provide a level of localized community protection.

3. The scope of the treatments as they currently exist on the landscape should not be viewed as mitigating landscape level fire spread. Treatments need to be spatially large in relationship to an approaching fire, in order to have an effect on the overall movement of the fire. Fully implemented fuel modification treatments should however effect localized fire characteristics within the treatment boundaries, thus

providing enhanced opportunities for ground based firefighters or increased effectiveness of aerial retardant

4. A methodology for prioritizing treatment areas available from the analysis based on the level of change in surface fire from the existing condition to the modified fuel condition. Projects which display the greatest overall change between the two environments would be high priority projects for funding. This methodology could be applied to other areas to evaluate the relative effectiveness of fuel modification treatments.

AREAS OF CONCERN

While the in depth analysis was focused on the Lake Gregory, Lake Arrowhead priority areas, several other areas visited during the course of the field reconnaissance are recognized as areas of special concern.

1. Forest Falls. Very poor small tract clearance in the majority of the properties reviewed. Past treatments around the community have not addressed the surface fuels and a significant fire is probable in the canyon. A dominate ridge to the south of the community could be developed into a fuelbreak to help contain a fire from spreading into the community from the areas of high fire frequency along Hwy 38 and the lower elevation areas of the County and San Bernardino National Forest. Recent fire history along the front country has helped to mitigate the potential of a large fire burning into Forest Falls.

   This community is a prime target for Forest Care to address the issues of fuel loading and stand densification on the small lots. The Forest Home Conference Center is a candidate for treatment given that the topography, access and fuel type make it possible to use masticating equipment to create a defensible/survival location.

   In general Forest Falls has many poorly maintained small lots that will serve as a wick to spread fire through the community.

2. Fredalba/Smiley Park – The Old Fire has provided a partial buffer to the communities, however given the position of these developments at the top of the front country escarpment, they are situated in a location that places them at high risk from fires burning out of the front country.

   The south side of the community is most vulnerable, however the South Running Springs project will partially address this issue. Aggressive marketing of the Forest Care authorities to address small lot issues should be considered, if not currently in place.

   The Old Fire burn area will begin to support wildland fire spread again within the very near future, escalating the hazards to these communities.

3. Dart Canyon – The canyon is oriented so that a fire burning on the north facing slopes above Miller Canyon will be directed into the community. The Miller Canyon Hazardous Fuels Treatment project will assist in assist modifying fire behavior characteristics especially in areas along Dart Canyon Road. However, given the orientation of the drainage and the channeling of convective heat through the drainage, it is unlikely that enough fuel modification work can be completed to provide complete community protection. Management by individuals of their own lots would do much to enhance the survivability of the structures located in association with Dart Canyon.

4. Grass Valley Creek, North Lake Arrowhead – The environmental setting is very similar to Dart Canyon with Grass Valley Creek leading directly into the community. The fuel modification work below the residences on Edgecliff Road will provide a level of protection, but firefighters will have difficultly providing direct structure protection along the upper edge of the drainage due to the effects of convective heat from any fire burning actively in the drainage. The Miller Canyon project has the potential to mitigate some fire intensity below the community, but the fuel loading, access and the orientation of the drainage makes performing enough fuel modification work to provide adequate community protection problematic.

PROFESSIONAL JUDGMENT/OBSERVATIONS

1. Forest Care offers an opportunity to address the issue of the effects of forest densification caused by untreated small lots. During reconnaissance of the project areas it became apparent that many residents have not address hazardous fuels issues on their property. This issue increases the likeliness of structure loss during wildfire events as many properties offer ready wicks to move the fire from the wildland vegetation into the adjacent structures.

   Forest Care offers the opportunity to address this critical portion of the landscape where legal authority and cost effectiveness do not make other forms of government intervention appropriate. The methodology used in this analysis could be applied to individual tracts to demonstrate the improved fire environment that could be achieved through the application of specific fuel modification standards.

2. Ownership patterns are not favorable for the NRCS and County Fire to conduct landscape level treatments. A suggested approach would focus the Forest Service efforts on large scale landscape level treatment which have the potential to mitigate fire behavior as it spreads into the mountain communities, while BDC and NRCS focus efforts on direct protection of the community through application of fuel modification standards on large lot and on buffers surrounding high risks neighborhoods and communities. This strategy of working immediately adjacent to improvements would provide for greater survivability of structures and allow for a safer operational space for firefighters

3. Continuing public education is required to address the tendency of individuals to feel that the fire hazard in the mountain communities has significantly decreased as the dead tree removal program comes to an end. As fewer dead trees are obvious in the landscape, the public does not appear aware that a serious fuels/fire issue still exists.

   There is also a need to commute the message of personal responsibility for hazardous fuels management on private property. Several residents stopped and asked when the crews were going to come treat their neighborhood. It appears that there is a lingering sense of entitlement by some residents that it is the responsibility of the federal/state and local government to provide a fire safe environment on their privately owned property. Forest Care is the program which most closely meets this need.

4. While a program such as Forest Care provides a positive and proactive way for property owners to address the hazardous fuel issues, development of a strict fire hazard code enforcement program may be required to force the issue of fire hazard clearance in the mountain communities. While this program may have a negative connotation with the community, it does provide a mechanism to ensure compliance with County/State Public Resource Codes.

SUMMARY

Of the projects evaluated it is apparent that dead tree removal should not be viewed as the sole treatment for addressing wildland fire concerns within the mountain communities. The program did address many concerns regarding public safety, protection of infrastructure and maintenance of travel/evacuation routes, however the level of fuel removal is not sufficient to moderate fire behavior or provide for enhanced community protection.

Dead tree removal is part of a process of improving the wildland fire characteristics and should be viewed as an “initial entry” into an area. While this initial entry was undertaken to address immediate threats to human life and property, follow-up treatments are required if the fuelbed is to be managed in a method that will provide for community protection and greater firefighter success and safety.

Fire behavior modeling demonstrated that the fuel modification standards as proposed in the “Dart Canyon Fuel Modification and Large Parcel Project “ can have a significant impact on both surface fire behavior and crown fire potential. This standard should be viewed as the follow-up treatment to dead tree removal. Through the implementation this or similar treatment standards a greater level of community protection can be achieved.

While the government agencies address fuel reduction needs at the landscape level, Forest Care offers great hope in addressing needs at the individual lot level. The density of the small lots creates a continuous fuelbed which can only be addressed by individual property owners. Treatments by homeowners, if applied in sufficient numbers, could

have a landscape level effect on fire behavior and will provide the greatest level of protection for personal property. The willingness of the communities to adopt the Forest Care program on a broad scale is not currently evident.

Form a landscape level view several points need to be brought forward.

1. The physical setting of the mountain communities above areas of high fire frequency, means that these communities will always be at risk from wildland fire. While the Old Old Fire has provided a brief reprieve from this threat, the fire area is rapidly recovering and will within the next several years be capable of support fire behavior which can threaten the local communities. No amount of fuels treatment can completely mitigate the effects convective heat from a fire spreading upslope at these communities.

2. The Forest Service and the single ownership nature of their land, make them the most capable of addressing landscape level fire activity. Through the implementation of spatially large projects, the ability to interrupt fire spread is most enhanced. It is recommended that the efforts of local government be focused in and immediately adjacent to the communities. These treatments provide the last line of defense in a wildfire situation.

3. The placement of hazardous fuels treatments across the mountain has created a "treatment mosaic" which in theory will interrupt fire spread or moderate fire behavior. However given the wide variety of fuel modification, some individual projects will have little effect on fire behavior.

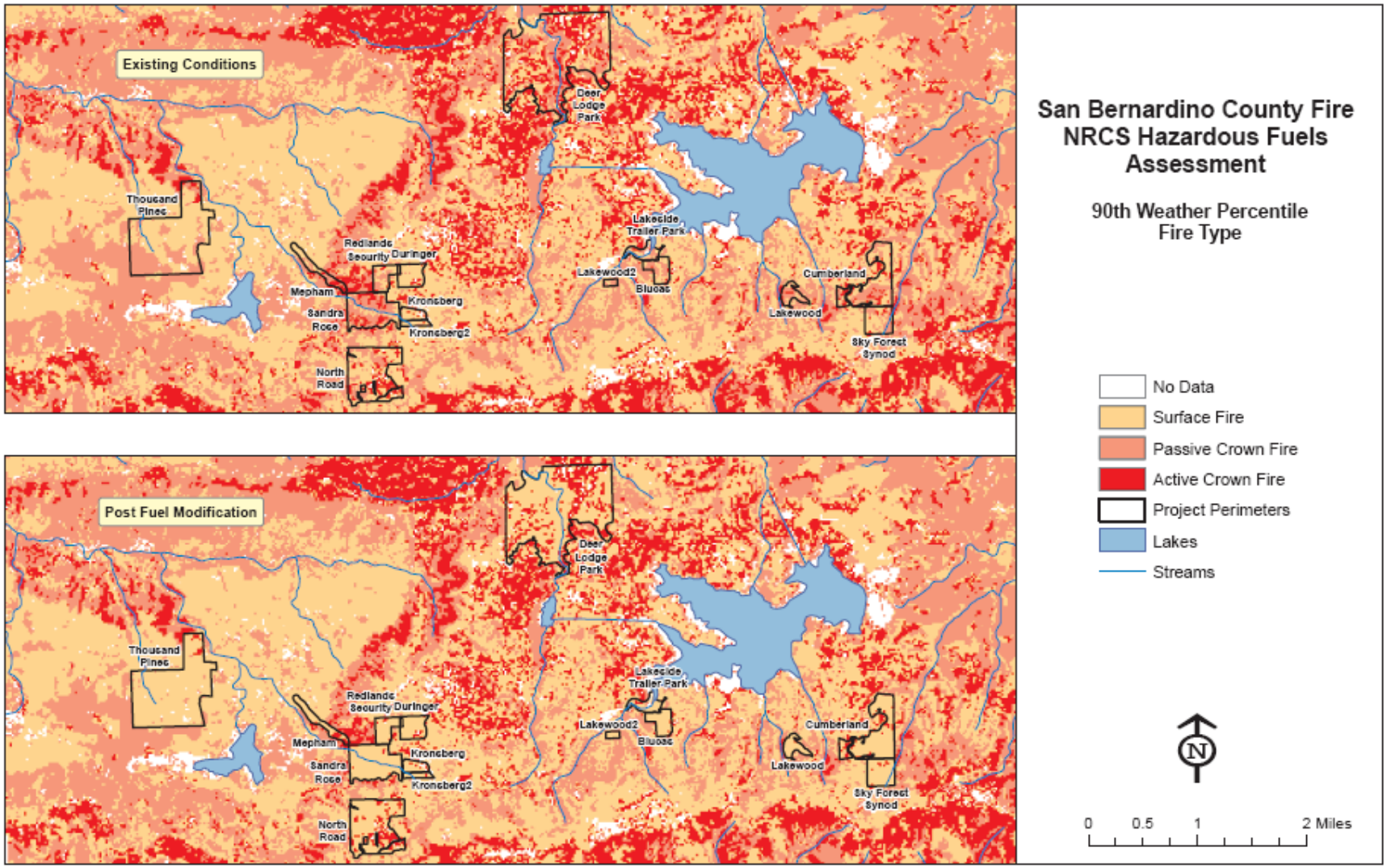
4. Given the degree of variation among all the fuels treatments, (dead tree removal to landscape level fuel modification), it is difficult to provide a "Mountains Communities" level assessment of the success of the hazardous fuels treatment program. It is recommended that if this assessment is to continue it focus on individual "Priority Areas".

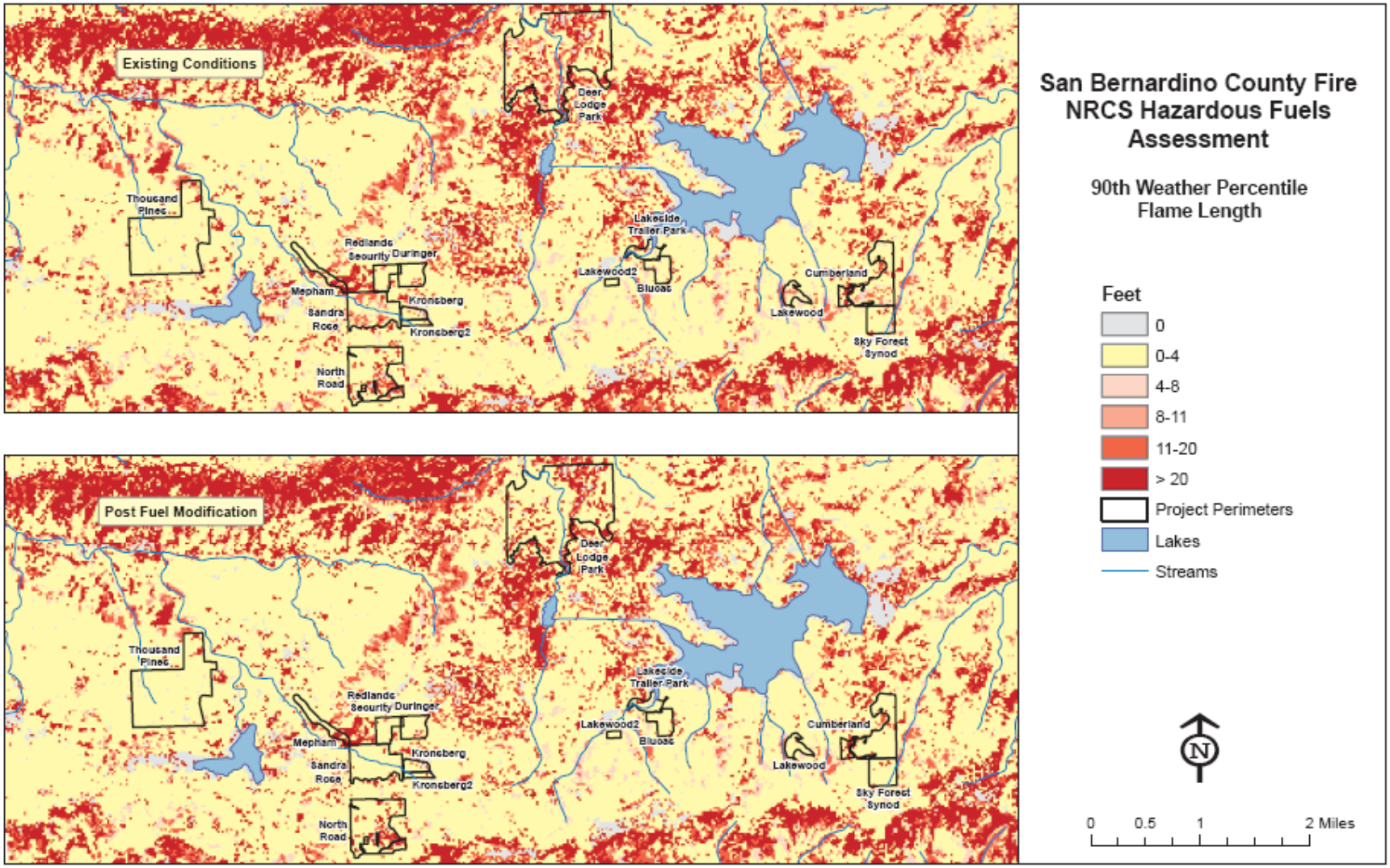
5. The fuel modification standards as presented by the BDC and NRCS are sufficiently intense to moderate fire behavior. There is a need for the MAST agencies to reprioritize treatments focusing on implementation of these or similar treatment standards. Past project areas where agreements for entry still exist, may be one criteria applied for selecting fuels modification projects.

Appendix A

Fire Behavior Output Maps

- Fire Type – 90th Percentile Weather
- Flame Length – 90th Percentile Weather
- Fire Type – 97th Percentile Weather
- Flame Length – 97th Percentile Weather


Existing Conditions
Post Fuel Modification
Thousand Pines
Redlands Security Duringer
Mepham
Kronsberg
Sandra Rose
Kronsberg2
North Road
Deer Lodge Park
Lakeside Trailer Park
Lakewood2
Bluoas
Lakewood
Cumberland
Sky Forest Synod
San Bernardino County Fire
NRCS Hazardous Fuels
Assessment
90th Weather Percentile
Fire Type
No Data
Surface Fire
Passive Crown Fire
Active Crown Fire
Project Perimeters
Lakes
Streams
N
0
0.5
1
2 Miles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Post Fuel Modification
Deer Lodge Park
Thousand Pines
Redlands Security Duringer
Mepham
Kronsberg
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Kronsberg2
North Road
Lakeside Trailer Park
Lakewood2
Blucas
Cumberland
Lakewood
Sky Forest Synod
San Bernardino County Fire
NRCS Hazardous Fuels
Assessment
90th Weather Percentile
Flame Length
Feet
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0-4
4-8
8-11
11-20
> 20
Project Perimeters
Lakes
Streams
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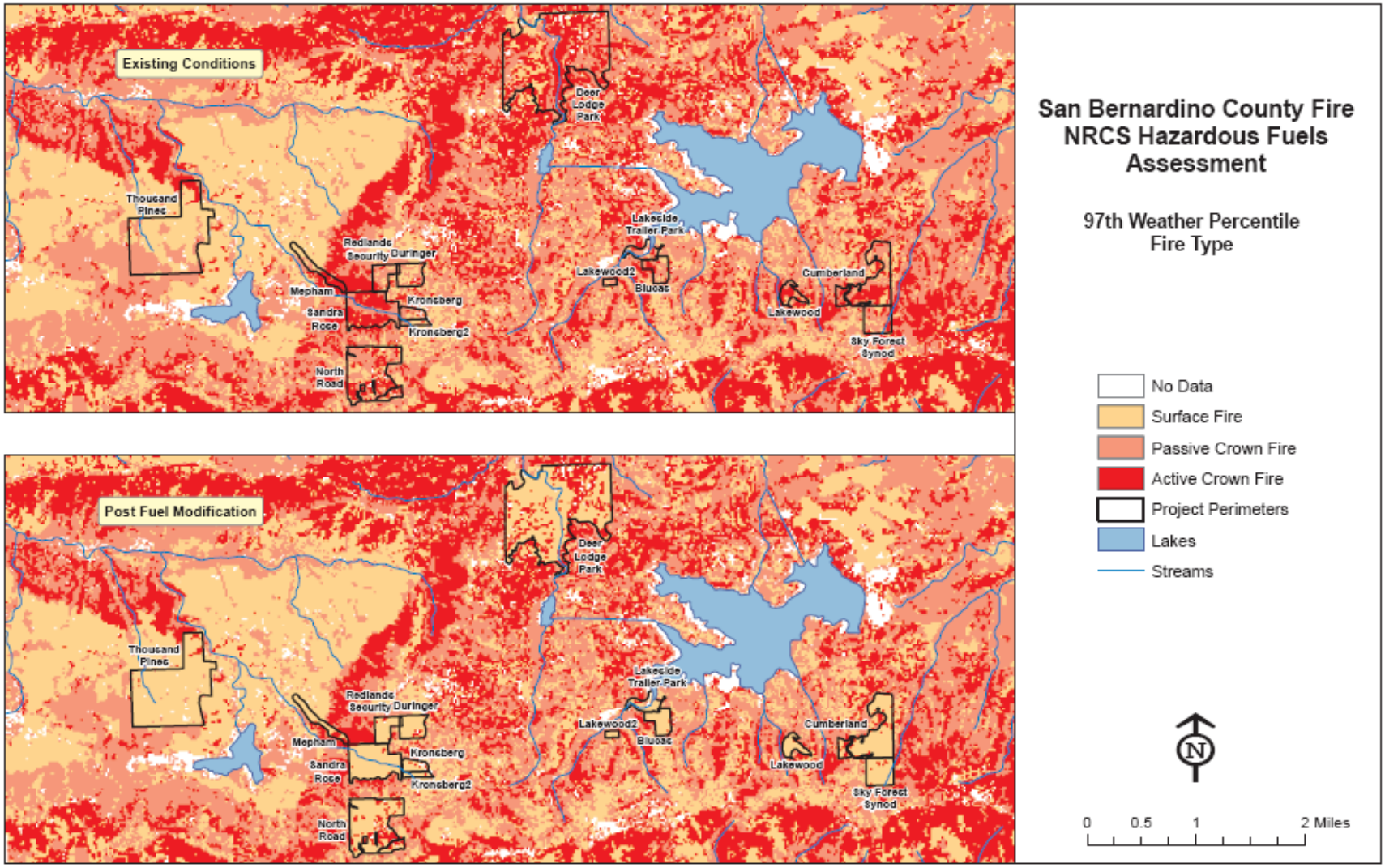
1
2 Miles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Fire Type
No Data
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Active Crown Fire
Project Perimeters
Lakes
Streams
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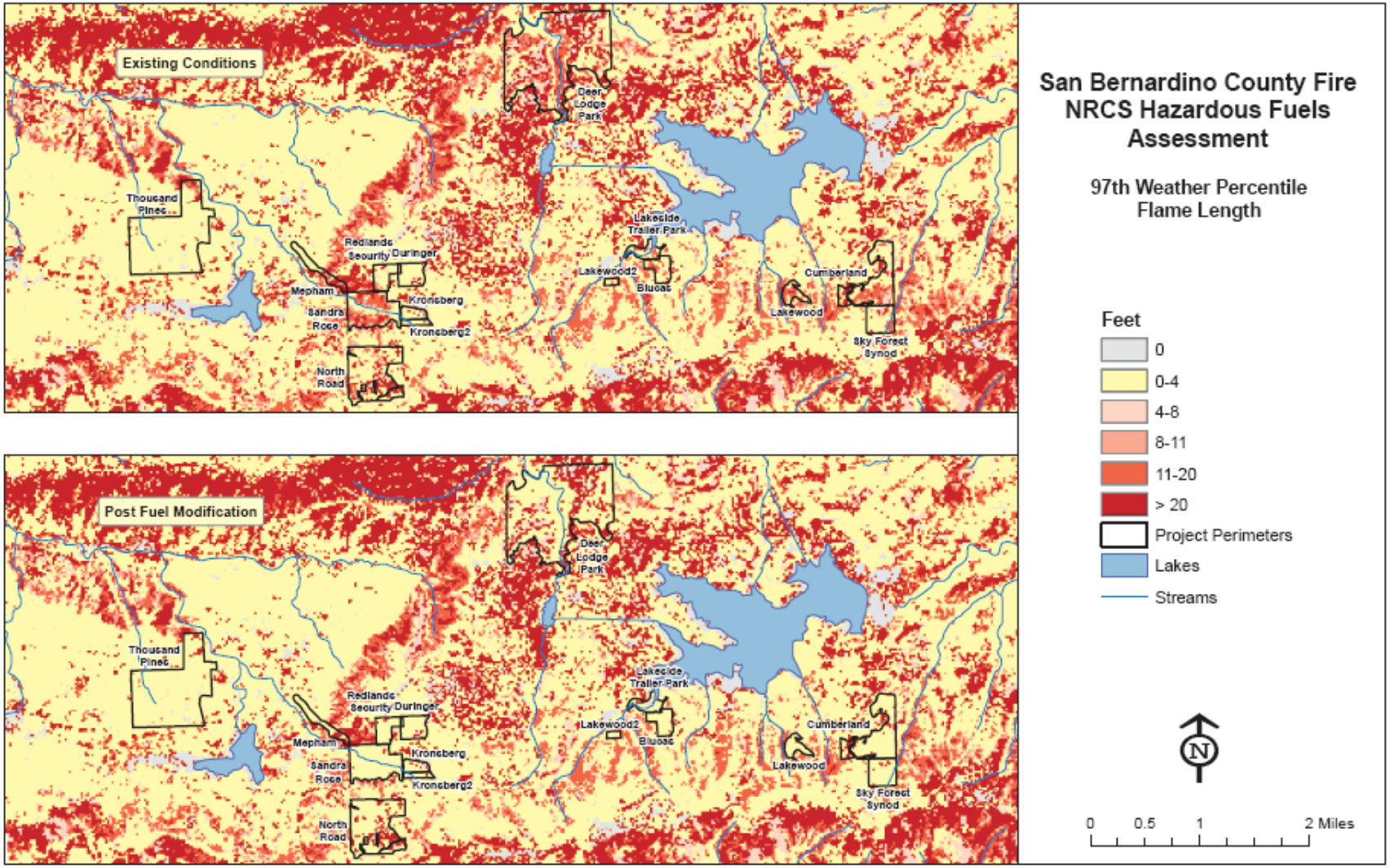
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97th Weather Percentile
Flame Length
Feet
0
0-4
4-8
8-11
11-20
> 20
Project Perimeters
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Streams
N
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0.5
1
2 Miles