Hazardous Tree Reduction Draft Environmental Impact Statement (DEIS)
East Bay Hills, CA

Fire Behavior Commentary; June 17, 2013

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I. SUMMARY

I was asked to evaluate the Hazardous Tree Reduction Draft Environmental Impact Statement (herein referred to as "the DEIS") and provide feedback regarding fire behavior and fuel treatment options. This feedback includes assessment of the fire behavior modeling in the FEMA proposal, the alternatives considered, the efficacy of the proposed alternative selected, and the potential fire behavior and landscape impacts post-treatment.

I have reviewed all available components of the East Bay Hills DEIS for Hazardous Fire Risk Reduction and the East Bay Regional Park District (EBRPD) Wildfire Hazard Reduction and Resource Management Plan (WHRRMP). The discussion that follows also includes other reference material pertaining to fuels and fire behavior. These are cited in the References section (Appendix B).

Opinions and conclusions included in this document are based on the above sources of information, standard accepted fire behavior modeling methodology and procedures, and professional experience and observations.

II. SCOPE AND SPECIFIC ISSUES

Scope

This report focuses on the proposed fuel treatments described in the 2013 East Bay Hills Hazardous Fire Risk Reduction Draft EIS. A synopsis of the specific issues to be addressed in Section IV is provided below.

Specific Issues to be Addressed:

Detrimental effect of the proposed fuel treatments in the DEIS on wildfire hazard mitigation.

The immediate effect of the proposed fuel treatments will be to reduce the potential for torching, crown fire, and spotting. However, the proposed treatments will also increase the surface fuel loading substantially by converting non-fuels (standing trees) into surface fuels (lop-and-scatter treatment of branches). In the absence of any continued long-term maintenance beyond what is specified in the DEIS, it is my opinion that this change in fire hazard is temporary, valid only for a short period of time post-treatment, and trades one problem for another.

Removing all eucalyptus, Monterey pine, and acacia trees will be a severe site disturbance. Such catastrophic site disturbances that include extensive canopy removal do not favor the less invasive native species such as oak or bay trees, but rather favor more invasive species. As noted above, this phenomenon has been documented on numerous mechanical fuel treatments in the California Bay Area that are similar to actions proposed in the DEIS. In my opinion, that without further long-term maintenance that includes extensive planting of other species, the proposed actions will not differentially favor native species, but will simply favor invasive, highly flammable brush species, both native and non-native, leading to dangerous, intense, and destructive wildfires. It is further my opinion that the actions proposed in the DEIS will lead to dangerous, intense and destructive wildfires. The net effect is essentially trading one fire hazard for another, at a significant dollar cost and detriment to the local ecosystems.

The DEIS states that removal of the tree canopy would increase the amount of rainfall that reaches the ground, rather than being intercepted by trees, and also acknowledges that precipitation reaching the ground by fog drip during the summer months, up to 10 inches annually, would be reduced or eliminated. The DEIS does not acknowledge the critical impact the reduced precipitation from fog drip would have on fire danger and the greater potential for catastrophic fires due to reduced summer precipitation. This is a serious omission that incorrectly downplays the impact of tree canopy removal.

Effect of depositing up to 24 inches of eucalyptus mulch on the ground surface.

The DEIS justifies depositing up to 24 inches of mulch, primarily from eucalyptus trees, on the ground surface based on research involving decomposition and fire hazard posed by no more than 6 inches of mulch. It fails to acknowledge research that highlights the high potential for spontaneous combustion in deeper accumulations of mulch, the difficulty of fire suppression in such fuels, the severe long-term damage to soils by the intense heating in mulch and wood chip fires, and the documented spotting danger posed by mulch and other forms of masticated fuels. In my opinion, deposition of this much woody material on the surface of the ground in any form does not follow sound fire management practices and has the net effect of increasing surface fuel loads.

Issues with fire behavior modeling conducted for the DEIS.

Fire behavior modeling conducted for the DEIS (FlamMap) included an assessment of the no-treatment alternative and the chosen, aggressive treatment alternative involving removal of all eucalyptus, Monterey pine and acacia trees. No modeling was done to assess the effectiveness of any alternative, less aggressive strategy – the Combined Alternative Program (DEIS, 3.3.1.4) in particular – nor any longer-term post-treatment fire hazard conditions. FlamMap has powerful features that facilitate determining the optimum fuel treatment strategy, and timing of treatments, for an area. Contrary to this, the FlamMap modeling in the DEIS was done *after* the chosen alternative was designed and selected.

Additionally, none of the fire behavior modeling in the DEIS addressed the Vesta model developed by Australian researchers specifically for use in eucalyptus fuel types. This is a serious oversight considering the majority of the proposed hazard reduction work involves eucalyptus.

In my opinion, FlamMap was used in the DEIS simply to justify the chosen alternative, not to compare alternative strategies and determine the optimum fuel treatment strategy.

Further, FEMA could not, or would not, provide the data used for fire behavior modeling. This made independent assessment of alternative strategies, and comparison of those to the “no-Treatment” option and the chosen option, impossible.

Failure of the proposed action to meet all mandatory FEMA criteria.

The proposed action fails to meet all of the mandatory criteria as specified by FEMA’s Hazard Mitigation Program grant programs (DEIS, Section 2.2). In particular, for reasons described further in this document, it is my opinion they do not meet specific requirements for long-term effectiveness in reducing wildfire risk.

Viability and feasibility of an alternative hazard mitigation strategy.

The EBRPD fuel treatments for many polygons, planned and supported in part by the FEMA grant, use a less aggressive approach than the chosen fuel treatment strategies of the UC Berkeley or City of Oakland, and are similar to the Combined Alternative Program rejected in the DEIS. The proposed EBRPD treatments cost approximately $4,444/acre compared to over twice that cost per acre for the proposed UC treatments, and over three times that for the Oakland treatments. Given that, and the numerous detrimental factors of the proposed actions (UC-Oakland) in the DEIS, it is my opinion that the Combined Alternative Program approach is clearly a preferable alternative to the actions proposed by the UC and City of Oakland. It meets all FEMA’s mandatory criteria, accomplishes FEMA’s stated hazard reduction objectives, follows sound forestry practices, does not result in an increase in invasive brush species post-treatment, deposits far less flammable woody material on the treatment sites, and is more economically sound.

III. INTRODUCTION

Terminology

For the purpose of the discussion to follow, clarification of some basic fire behavior terminology is provided below. Fire behavior terminology was adapted from NWCG, 2012. Fuel treatment descriptions were from Section 3 of the DEIS.

<u>*Fire Behavior Terminology*</u>

Fire Behavior - The manner in which a fire reacts to the influences of fuel, weather, and topography. Fire behavior is further described by the following types of fire propagation:

Ground Fire – Fire that consumes the organic material beneath the surface litter ground, such as a peat fire. Spread is primarily by smoldering combustion with low spread rates.

Surface Fire – Fire that burns loose debris on the surface, which includes dead branches, leaves, and low vegetation.

Torching – The burning of the foliage of a single tree or a small group of trees, from the bottom up.

Crown Fire – A fire that advances from top to top of trees or tall shrubs more or less independent of a surface fire. Crown fires are sometimes classed as running or dependent to distinguish the degree of independence from the surface fire. Dependent crown fires are by far the most common form of crown fire, as the conditions required to sustain a crown fire independent of a supporting surface fire are very unusual.

Spotting – Behavior of fire producing sparks or embers that are carried by the wind and which start new fires beyond the zone of direct ignition by the main fire.

Crown Base Height – The vertical distance from the ground surface to the lowest available crown fuels.

Fireline Intensity – The product of the available heat of combustion per unit of ground and the rate of spread of the fire, interpreted as the heat released per unit of time for each unit length of fire edge. The primary unit is Btu per second per foot (Btu/sec/ft) of fire front.

Flame Length – The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface), an indicator of fire intensity.

Fuel Model – Simulated fuel complex for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

Rate of Spread – The relative activity of a fire in extending its horizontal dimensions. It is expressed as rate of increase of the total perimeter of the fire, as rate of forward spread of the fire front, or as rate of increase in area, depending on the intended use of the information.

Wildland/Urban Interface (WUI) – The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

<u>Fuel treatment terminology and descriptions</u>

Canopy removal – The removal of all large trees to greatly reduce or eliminate overstory (crown) fuels.

Limbing – The removal of all branches of a tree to a specified height for the purpose of eliminating vertical fuel continuity (ladder fuels) and reducing or eliminating the risk of torching or crown fire.

Thinning – Selective removal of a portion of the trees, often favoring the removal of smaller trees, to create a more open stand of larger trees and reduce horizontal continuity of crown fuels.

Proposed Actions – For the purpose of this document, this term describes the proposed actions in the DEIS wherein eucalyptus, Monterey pine and acacia trees would be eliminated from treatment areas. Woody debris from removed trees up to 24 inches dbh would be mulched and spread over 20% the ground surface to a depth of up to 24 inches. Trees larger than 24 inches dbh would be cut to 20-30 foot lengths and left intact on the site as woody debris. Branches of trees larger than 24 inches would be lopped and scattered on the site. The stated objective is to leave all downed material on site (DEIS, 3.4.2).

Combined Alternative Program – The hazard fuel treatment method referenced in 3.3.1 of the DEIS, which includes: removal of brush and surface fuels; removal of lower tree limbs; species-neutral removal of small trees and understory trees to remove ladder fuels, increase tree spacing and maintain shade to suppress brush and grass; removal of eucalyptus debris that falls off trees after a freeze; keeping grass short by mowing or grazing. This treatment methodology is sometimes referred to as the “Selective Thinning Alternative” (Lozeau, 2013, pers. comm.).

Hazard Mitigation and Fuel Management

The primary purpose of hazard fuel treatments in WUI areas is to change the potential fire behavior in a way that lessens the destructiveness of wildfires and provides less dangerous working conditions for firefighters. A basic tenet of wildland fuel management is to use various tools, models and data to determine the optimum treatment type and frequency, given site conditions, desired post-treatment conditions, and economic and other constraints. Fuel treatment can consist of mechanical treatment, prescribed fire, herbicide application, or a combination of these.

Wildland Fire Behavior Modeling

In Rothermel (1972) described a means of modeling wildland surface fire spread and intensity through a set of mathematical equations and quantitative, stylized fuel models. This system became known as BEHAVE (Rothermel, 1981) and has been a central component in fire behavior modeling for the past several decades. Like any model, BEHAVE has its inherent assumptions and limitations, and is intended as simply an approximation of real-world fire behavior that must be validated by observation and experience (Stratton, 2006). BEHAVE is a deterministic model, consisting of numerical inputs and outputs, and for many years was primarily a tabular model.

In 2007, Australian researchers produced a system, known as Vesta, which was developed specifically for assessing fire behavior in eucalyptus fuel types (Gould et al., 2007). Vesta was developed based on extensive field research in which 104 fires were set in eucalyptus forests to study fire behavior under an array of variables.

Vesta determines a separate hazard rating for surface and near-surface fuels and bark fuels. It then determines the rate of spread based on surface and near-surface fuel characteristics, and fuel moisture. Rate of spread and firebrand production are directly related to surface and near-surface fuels, as well as bark fuels. Finally, the surface fuel hazard rating is combined with the bark hazard rating and wind speed to determine the spotting potential. Vesta’s real strength is that it is the only fire behavior prediction system that is specific to eucalyptus fuel types.

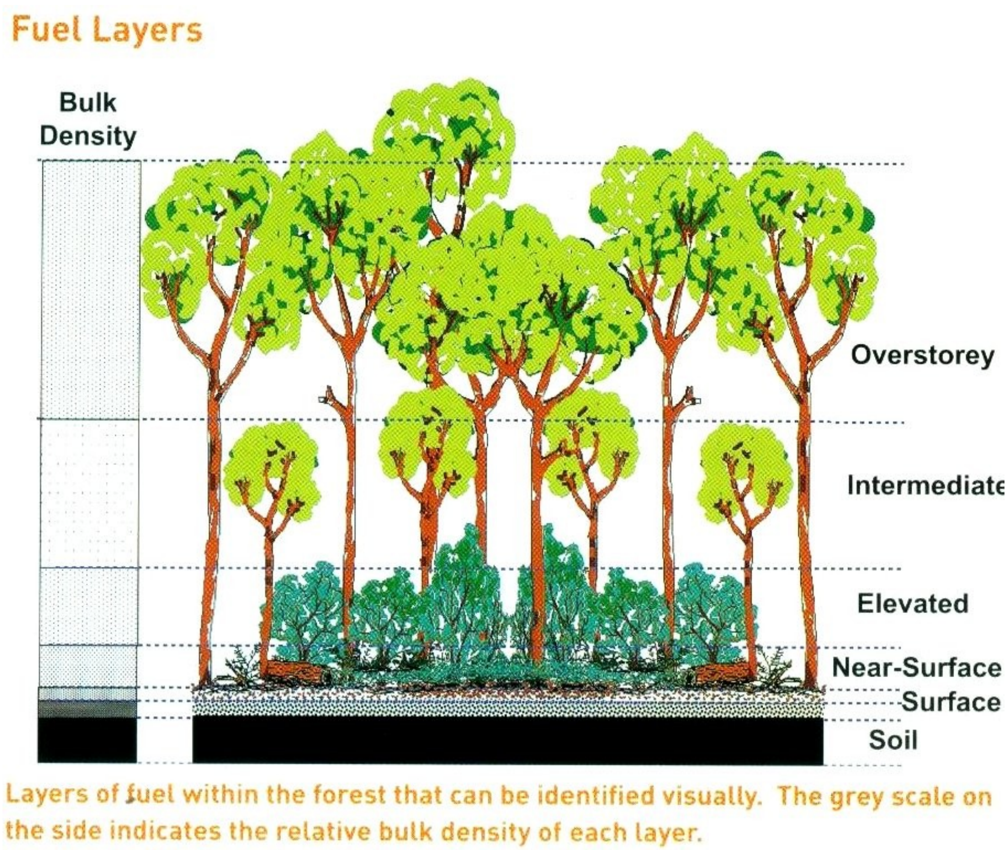

Figure 1. Fuel Layers in eucalyptus forests. From Vesta, 2008.

Spatial Wildland Fire Analysis and Modeling

The growth in the prevalence of geographic information systems (GIS) and associated data enabled the development of spatially-based fire growth models that simulated fire spread and fire behavior across a landscape. Unlike BEHAVE, these spatially-based models consider all the various combinations of inputs at each point in a digital landscape in assessing fire growth and behavior. The two prevalent spatially-based fire modeling systems are FARSITE, which simulates fire growth in a temporally and spatially variable environment, and FlamMap, which displays potential fire behavior across an entire landscape for a given set of spatially-variable inputs. Both FARSITE and FlamMap also have the capability to produce a variety of tabular and graphical outputs as well.

FARSITE and FlamMap are not models per se, but rather a system of models that provides a variety of types of outputs. Each incorporates BEHAVE for surface fire modeling, along with several other fire behavior and fuel moisture models to enable assessment of crown fire and spotting, and fuel treatment planning (Rothermel, 1991; Van Wagner, 1993; Albini, 1981; Stratton, 2006).

Critical Thresholds for Initiation of Crown Fire

Crown fire has two stages of development. The first is initiation wherein surface fire spreads into tree canopies (crowns) via vertical ladder fuels. This is commonly known as torching. The second phase is propagation of fire through the crown fuels. This requires critical measures of wind, slope, or both to occur (Van Wagner, 1977 and 1993).

There are three critical thresholds that must be met for crown fire to occur. First, there is a critical minimum surface fireline intensity needed to initiate crown fire for a given crown base height. This critical threshold increases exponentially with increasing crown base height (Fieldhouse, 2003). Second, continued propagation of a crown fire front typically is dependent on surface fire. Third, there is a critical threshold of crown spacing for a given wind speed. Above this critical crown spacing, propagation of a crown fire front will not occur (Schaaf et al., 2007).

Fuel Treatment Planning – FlamMap

FlamMap allows the user to display potential fire behavior in a spatially variable environment, and provides useful tools for planning fuel treatments. FlamMap allows the user to quantify the impacts of varied landscape-level fuels treatments (Finney, 2006). FlamMap also enables the user to compare the effect of different fuel treatments on potential fire behavior (hazard), and FlamMap's Treatment Optimization Model helps determine the optimum fuel treatment objective, and treatment timings, to minimize fire spread in a given project area (USDA Forest Service, 2012).

In addition to FlamMap, other companion tools area available – the Forest Vegetation Simulator and its Fire and Fuels Extension (FVS-FFE) provides a means of visualizing proposed fuel treatments. Another tool, MAGIS helps assess operational constraints related to maintenance of treatments. A project currently nearing completion, OptFuels, incorporates fire modeling capabilities of FlamMap, vegetation simulation capabilities of FVS-FFE, and land management components of MAGIS into a comprehensive tool for fuel treatment planning and management (Jones and Chung, 2011).

IV. DISCUSSION OF SPECIFIC ISSUES IN THE DEIS

Detrimental effect of the proposed fuel treatments in the DEIS on wildfire hazard mitigation.

<u>High-disturbance impact of the proposed fuel treatments</u>

The immediate effect of the proposed fuel treatments will be to reduce the potential for torching, crown fire, and spotting. However, this is only a temporary reduction in fire hazard. Removing all eucalyptus, Monterey pine, and acacia trees will be a severe site disturbance. Such catastrophic site disturbances do not differentially favor less invasive native species, but rather favor more invasive species (Kerns, 2005; Owen, 2010). Martinson et al. (2008) pointed out that common hazard reduction treatments involving mechanical thinning or prescribed fire often result in the invasion of non-native species.

Further, the proposed treatments would convert non-fuels (standing trees) into available surface and ground fuels though a combination of mulching woody material and lop-and-scatter treatment of branches. This introduces a very significant amount of fuel onto the ground surface that was not there pre-treatment and creates a new fire hazard posed by the heavy accumulation of wood chips and other woody debris that was not present previously.

In other fuel treatments in the Bay Area similar to the proposed actions, canopy removal in similar vegetation types in fact encouraged rapid invasion of the treated sites by aggressive exotic species such as English ivy, acacia, *vinca* sp., French broom, and Himalayan blackberry (URS, 2009). The National Park Service (NPS) also states that treating eucalyptus fuels in California necessarily entails continued site maintenance, including planting native species, to avoid site invasion by aggressive non-native species (NPS, 2006).

It is my opinion that, in the absence of any continued long-term maintenance beyond what is specified in the DEIS, the stated reduction in fire hazard is temporary and only valid for a short period of time post-treatment. The proposed actions will cause severe site disturbance that will not differentially favor native species as claimed, but will favor aggressive, invasive non-native species. Without further long-term maintenance that includes fuel reduction and extensive planting, the proposed actions will result in development of brush fields with characteristics much like native chaparral, leading to dangerous, intense, and destructive wildfires. The net effect is essentially trading one fire hazard for another – at a significant economic cost, detriment to the local ecosystems, and endangerment to the public.

Impact of overstory removal on rainfall, fog drip and site conditions

The DEIS (5.6.2.3) states that the amount of precipitation reaching the ground surface will increase after the proposed actions are implemented, largely due to less rainfall being intercepted by tree canopies. This will happen largely in the winter months when rain is most prevalent. The DEIS also states that canopy removal will result in decreased precipitation that reaches the ground during the dry summer months due to drastic reduction or elimination of fog drip. According to the DEIS, precipitation from fog drip is an important source of water in the summer months, producing up to 10 inches of precipitation each year. The DEIS also correctly states that sunlight reaching the ground surface will greatly increase after canopy removal, increasing the peak daytime temperatures.

The DEIS fails to mention that the combination of reduced precipitation and increased temperatures in the summer months will increase fire danger on treated areas. Thus, the fire danger will actually increase after the proposed actions are implemented. This is a serious and critical omission from the DEIS.

It is my opinion that removal of the canopy will result in hotter, drier conditions on treated sites that will support more intense fire spread with flame lengths well in excess of the stated FEMA objective of less than eight feet.

Increased fire intensity in post-treatment vegetation

The stated goal of the DEIS is to reduce wildfire hazard to acceptable levels by converting the current vegetation mix to one comprised largely of oaks, bays, grasses, and chaparral. As pointed out in the URS report (2009), in the absence of any post-treatment re-vegetation plan, all possible vegetation types for the treatment areas need to be considered. These include grasslands, chaparral, shrub/scrub communities, and oak-bay forests.

Per the Hills Emergency Forum, expected flame lengths in plant communities in the area are as follows:

Table 1. Fire hazard associated with six plant communities of the East Bay Hills.

Species	Flame Length Range, ft.	Average Flame Length, ft.
Eucalyptus	6-21	13.5
Monterey Pine	2-16	9
Acacia	Not stated	---
Mixed hardwoods (incl. oak and bay)	1-34	17.5
Brush	14-69	41.5
Grasses	12-38	25

Source: http://www. hillsemergencyforum.org/MgmtRecmdtn. html

The stated acceptable hazard level is defined in the DEIS by surface fires having flame lengths of no more than eight feet. However, the vegetation that the DEIS states will result from the proposed actions would result in median flame lengths that are significantly greater than 8 feet, and maximum flame lengths many times the stated DEIS objective of eight feet. Clearly, if the objective is to reduce reducing the average flame length to less than 8 feet, the proposed actions fail to accomplish this goal and in fact have the net effect of increasing the long-term wildfire hazard in treated areas.

Variance of proposed actions from standard hazard reduction practices in eucalyptus vegetation types

In Australia, where eucalyptus forests are widespread and comprise much of the native vegetation, hazard reduction treatments do not entail total canopy removal. Rather, the typical treatment is reduction of surface fuels, usually by prescribed fire (Bradstock et al. 2012). In eucalyptus forests, the greatest hazards are intense surface fires and long-range spotting from bark. Reducing surface fuels has been found to be greatly successful in reducing these hazards, as well as minimizing the potential for crown fire.

Further, it has been found that eucalyptus trees actually help *reduce* fire hazard by breaking up turbulent flow dynamics of strong winds and reduce the hazard from flying embers. “Clear cutting gum barks reduces safety from firestorms, both along the Urban Wildland Interface as well as internal defensible space areas where they assist with high-risk ground fuel mitigation” (Lofft, 2010). For this reason, taller eucalyptus trees such as blue gum are now used for wind and fire protection in many locations.

The DEIS cites no evidence to support the contention that tree thinning and surface fuels management is not a viable alternative to the proposed actions, and in fact acknowledges that thinning and removal of understory fuels is an acceptable approach to fire hazard mitigation (DEIS, Section 3.3.1). The approach of thinning and surface fuel treatment, outlined in the DEIS under the Alternative Treatment Program, has been used successfully by the EBMUD in adjacent properties for years, and has been increasingly favored by EBRPD as well. Further, The DEIS completely ignores widely accepted hazard reduction practices in eucalyptus forests of Australia.

In my opinion, the DEIS fails to justify the proposed actions as a better option than one based on thinning and surface fuel reduction. Moreover, the proposed actions in the DEIS completely ignore, and deviate substantially from, widely accepted hazard reduction practices in eucalyptus and would actually *increase* the fire hazard in the long-term.

Effect of depositing up to 24 inches of eucalyptus mulch on the ground surface.

Effects of mulch on remaining vegetation

The DEIS justifies depositing up to 24 inches of mulch and wood chips on the ground surface based on research involving decomposition and fire hazard posed by no more than 6 inches of mulch. It fails to acknowledge the detrimental effect a 24-inch depth of mulch will have on the remaining vegetation. Appleton and French (1995) recommended no more than 2-3” depth of mulch in landscaping to minimize detrimental effects on the remaining trees. 24 inches is far in excess of this. In contrast, the DEIS claims that the mulch generated by the proposed actions will actually preferentially favor native plant growth, yet fails to provide any scientific evidence of this. The research publications cited in the DEIS describe depths of no more than 12. 5 cm (5 inches).

Fire hazard posed by wood chips

Wood chips and mulch pose a significant fire hazard in and of themselves. The Ohio Dublin Villager noted that mulch fires are common in landscaping (2013), and mulch fires can pose a serious risk of devastating fires (Escobar, 2013). As previously pointed out by the URS Corporation in their report to FEMA (2009), "Studies have shown that mulch layers actually can pose a fire risk depending upon the type of material, the depth of the mulch, and the climate at the mulch site.” Studies have demonstrated that ignition by cigarettes or matches can result in a subsurface smoldering fire in a variety of mulch materials 4 inches deep (Steward et al. 2003).

Deep accumulations of mulch are also highly susceptible to spontaneous combustion. Fire Engineering describes the potential for catastrophic fires posed by spontaneous ignition in mulch piles (Finucane, 2008). This same article also noted the greater ignition potential of mulches high in oil. When a pile of wood chips spontaneously ignited in Everett, WA, the pile continued to smolder for months and workers battled flare-ups 24 hours a day (Chircop, 2013). In Phoenix, AZ, smoke from a mulch fire burning for an extended period of time caused health concerns to the point that a nearby high school was forced to relocate classes (Bierman and Stout, 2013). Fires that ignite through spontaneous combustion or by other means of ignition may smolder and spread beneath the surface for days before being detected, making suppression of those fires extremely difficult and time-consuming.

With hot, dry weather and strong winds, mulch fires – particularly those not yet detected – pose a serious threat to surrounding wildlands. In 2012, the Lower North Fork Fire in Colorado originated from a prescribed burn of masticated fuels (essentially a coarse mulch) varying from 3-6” in depth. In subsequent days of patrol and mop-up, the burn appeared to be cold and dead. The fourth day post-burn, a strong, dry wind caused these “cold” fuels to begin actively burning again, resulting in an catastrophic escaped wildfire that destroyed 23 homes and killed three people (Bass, 2012).

Given the warmer, drier conditions on the treated sites after canopy removal, the high oil and volatile chemical content of eucalyptus fuels, and the frequent occurrence of strong winds in the proposed treatment areas, it is my opinion the deposition of eucalyptus mulch outlined in the DEIS will pose a very significant fire hazard for a number of years post-treatment.

Soil damage caused by mulch fires

Another issue with the extensive mulch deposition proposed in the DEIS is the potential for long-term damage to soils by mulch fires. Fires burning as smoldering combustion in mulch fuels expose underlying soils to intense, prolonged heat. This potential for excessive, lethal soil heating is very real and particularly problematic when soils are dry (Busse et al., 2005). Fires in mulch and ground fuels burn slowly and release a significant amount of heat in doing so (Frandsen and Ryan, 1986). Heating of the soil from mulch fires can damage roots of plants on the site (Stephens and Finney, 2001). Smoldering surface combustion causes more long-term damage to the soil itself by killing beneficial microorganisms in the soil and by actually altering the physical characteristics of soil – much like kiln-fired clay. This effectively sterilizes the soil, reduces water infiltration (DeBano, 1999), and leads to excessive runoff and erosion (Hungerford et al., 1991).

The DEIS fails to address the very real risk of permanent soil damage and other deleterious effects on vegetation posed by smoldering mulch fires. This risk is exacerbated even further by the warmer, drier conditions expected with canopy removal and the high oil and volatile chemical content of eucalyptus mulch.

Failure of the proposed action to meet all mandatory FEMA criteria.

The proposed action fails to meet all of the mandatory criteria as specified by FEMA’s Hazard Mitigation Program grant programs (DEIS, Section 2. 2). In particular, the proposed actions are a one-time treatment, with follow-up actions limited to herbicide application to reduce eucalyptus stump sprouting. Nowhere does the DEIS address longer-term (5-10 years or more) maintenance to keep the fire hazard from increasing due to invasion by native and non-native brush species. Two of the specific criteria which are not met by the proposed actions:

> "Alternatives to a proposed action must also meet these criteria to be eligible for funding. To be eligible for funding, the proposed action or alternative must:
>
> 3. Be cost effective and able to substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster, consistent with 44 CFR §206.434(c)(5) and related guidance
> 5. Provide for long-term effectiveness and benefits (between 5 and 10 years, depending on the type of action)."

For reasons previously discussed in this report, the proposed actions fail to meet the required criteria specified by FEMA as they relate to reducing future risk and providing for long-term effectiveness. .

Issues with fire behavior modeling conducted for the DEIS.

Fire behavior modeling conducted for the DEIS (FlamMap) included assessments of the no-treatment alternative, the proposed alternative involving removal of all eucalyptus, Monterey pine and acacia trees, and the connected actions of the EBRPD. The fire behavior modeling included in the DEIS is incomplete, vague, and fails to demonstrate the proposed actions are preferable to any alternative action, including the Combined Alternative Program (section 3.3.1.4).

Fire modeling is incomplete

For the proposed treatment areas, no modeling was done to assess the effectiveness of any alternative, less aggressive strategy – the Combined Alternative Program in particular. This treatment alternative was simply dismissed as expensive and difficult without any evidence to support this claim. In fact, the fire modeling Rice conducted for the DEIS (2011) showed that the a number of EBRPD treatments, which are similar to the Combined Alternative Program, are very effective in reducing fire intensity to acceptable levels (flame lengths below 4 feet) and in minimizing or eliminating the potential for torching or crown fire (DEIS, Appendix M-2, pp. 17-39). The DEIS failed to acknowledge this in eliminating the Combined Alternative Program from consideration. This is puzzling in that the DEIS incorporated the EBRPD hazard reduction plan as a viable part of the overall strategy of reducing wildfire hazard in the East Bay Hills, yet the Combined Alternative Program, similar to the proposed actions in many polygons of the EBRPD's plan, was not considered in DEIS.

The modeling of post-treatment conditions presented in the DEIS is invalid because it modeled a state of vegetation and fuels that is irrelevant in the long term. Modeling done for post-treatment conditions shows in many cases that the proposed actions do in fact reduce the fire hazard to acceptable levels as specified in the DEIS. However, these conditions exist only immediately post-treatment. Wildland fuel complexes are inherently dynamic. Several critical factors will change over time that in turn will change the fire hazard, both in nature and degree of severity. The modeling as presented in the DEIS did not assess any potential conditions of the proposed treatment sites 5-10 years in the future, and thus fails to show that one of the key FEMA criteria for funding – long-term effectiveness – will be met. The DEIS clearly states that the intended vegetation mix that will exist upon completion of these projects is an oak, bay, chaparral, and grasses environment, this is the environment that should have been modeled rather than one immediately post-treatment that was only very transitory, and would not exist for more than a few months after the current trees are removed.

Fire and fuels discussion minimizes the hazards inherent in mulch depositions

Further, there was little mention in any of the fire and fuels discussion about the potential and real fire hazard posed by the extensive areas of mulch, up to 24 inches deep. As standing, live trees, eucalyptus trunks and large branches are not available as fuel. However, under the proposed actions, they would be ground up and redistributed onto the ground surface, thereby making them available as fuels. One of the stated objectives of the DEIS is to reduce the fuel load, and this action would actually *increase* fuel loads. The only mention of fire potential in mulch from the proposed actions is limited to one paragraph in section 5.2.1.

Though mulch fires cannot be modeled per se in any of the existing fire modeling systems, the fire modeling and related discussion of fire and fuels in the DEIS did not adequately address the increase in fuel loading due to mulching, the very real potential for mulch fires, nor their potentially deleterious impacts on the treatment sites and surrounding areas. This is a very significant omission in assessing the post-treatment fire hazard and efficacy of the proposed actions.

Vesta model not considered

The Vesta model was developed by Australian researchers specifically for use in eucalyptus fuel types (Gould et al., 2008 and 2009). Unlike the U.S. fire modeling systems (BEHAVE, FlamMap, FARSITE), Vesta addresses the unique characteristics of eucalyptus fuels and provides a system for assessing fire behavior in these fuels.

The fire modeling presented in the DEIS did not include any assessment using Vesta, and did not even mention the existence of Vesta, which has been in use since 2007. While FlamMap can provide a general idea of the spatial distribution of fire behavior, it does not include any fuel models involving eucalyptus fuels. Thus, it must necessarily be used with caution and a great deal of adjustments based on user experience.

There is a definite difference in how Vesta handles spotting and how the U.S. fire modeling system does so. In both cases, there is a rising column of hot air that initially comes from an intense surface fire. Once the base of the tree crown ignites, it adds to the intensity and vertical lift of the firebrand, which eventually is lofted above the tree tops and carried some distance by wind.

In the U.S. system (which FlamMap, BEHAVE and other programs use), the firebrand is generated in the tree canopy low in the crown fuels, then lofted vertically. Surface fuels initiate the process, but most of the fire dynamics happen in the burning tree crown.

In Vesta, the firebrand is generated mostly from surface and near-surface bark fuels, and to a lesser extent by near-surface and elevated fuels (see attached diagram). Spotting is strongly tied to a factoring of surface fire spread rate and wind, which generates the surface fire intensity necessary for vertical rise. However, unlike the U.S. model, the tree canopy does not significantly contribute to firebrand production. Its primary role is in adding to the intensity of the rising column of hot air and keeping the piece(s) of bark burning.

The omission of modeling using Vesta is a serious oversight considering the majority of the proposed hazard reduction work involves eucalyptus. The Vesta model is considered state-of-the-art science in eucalyptus fuel types, and its omission in the DEIS fire modeling calls into question many of the conclusions in the DEIS that are based on fire hazard assessment using only the U.S. models.

Fire modeling was not done to determine the optimum treatment(s)

FlamMap has powerful features that facilitate determining the optimum fuel treatment strategy (Treatment Optimization Model), and timing of treatments, for a given area. Alternative strategies can also be assessed and compared with FlamMap. Other available tools previously mentioned in this report allow for consideration of economic and other constraints in determining optimum fuel treatments. This is a standard approach to fuel management – identifying objectives, and developing treatment strategies to best meet those objectives.

The fire modeling in the DEIS goes counter to this. The FlamMap modeling in the DEIS was done *after* the chosen alternative was designed and selected. No modeling was done to proactively determine the appropriate strategy. In my opinion, FlamMap was used in the DEIS simply to justify the chosen alternative, not to compare alternative strategies and determine the optimum fuel treatment strategy. Had fire modeling with FlamMap been done to assess alternative treatments, such as the Combined Alternative Program, it would have been clear that the proposed actions are not the only viable fuel reduction actions, and other actions might in fact be more effective and appropriate in meeting the stated goals for hazard reduction.

Fire modeling results are vague and possibly erroneous

The fire modeling outputs from the Anchor Point work are vague and do little to support the proposed actions. In Table 5.2.2 in particular, there are many cases where the fire hazard actually *increases* after treatment. No additional or corrected information was issued following a May 16, 2013 request for clarification of this from Anchor Point (Grassetti, 2013, pers. comm.). Therefore, one can reasonably conclude that the proposed actions will actually increase fire hazard in many cases.

Additionally, no numerical results were provided in Table 5.2.2. Instead, the reader is provided flame length categories with qualitative descriptions (Low, Moderate, High, Extreme) with no explanation of how these categories were defined. Therefore, the reader has no way of knowing what any of these classifications actually mean, making it impossible to properly ascertain whether the project objectives were met.

Given the many, significant shortcomings and omissions in the fire modeling, and subsequent discussion of fire and fuels, the DEIS as a whole should be invalidated. The fire modeling provided in the DEIS is core to the DEIS justifying that the proposed actions will accomplish the objectives of the grant, and it fails to do this.

Inability to conduct additional fire behavior modeling to evaluate alternative treatment strategies not considered by the DEIS

In order to conduct fire behavior modeling for the proposed alternative not chosen, or to determine parameters of other alternative fuel treatment strategies, the same data must be used as was used for the modeling included in the DEIS. FEMA has been unable or unwilling to provide data requested to properly analyze this DEIS. Despite a timely FOIA request, FEMA has failed to provide any of the documents or data that were requested from FEMA. This includes opinion documents from consulting agencies, updated/corrected fire modeling documents, and the electronic files that were used to run the fire modeling simulations.

The methodologies for three different fire modeling reports were described in some detail in the DEIS. However, the time and effort it would take to re-create these data would be prohibitively excessive, given the short period for comment. Thus, it was not possible to examine the chain of facts and logic FEMA used to construct the DEIS, and difficult to validate that FEMA's conclusions were warranted based on the inputs used. That FEMA did not provide the requested data files for fire behavior modeling made independent assessment of alternative strategies, and comparison of those to the "no-Treatment" option and the chosen option, impossible.

In fact, in FOIA documents received in earlier requests, the URS Corporation clearly stated that the UC projects made little sense from a fire risk mitigation perspective, and that the US made assertions that were not supported. In light of this this one document that surfaced, one has to wonder how many others exist came to similar conclusions but were not released.

This in and of itself should invalidate the DEIS as NEPA requires that source documents be made available, but they were not.

Viability and feasibility of alternative hazard mitigation strategies.

Reasonable alternatives to the proposed actions were not considered in the DEIS and received only cursory discussion. No data or analyses were provided to support the dismissal of any of these alternatives. While the DEIS dismisses alternative approaches to the proposed UC methodology (proposed actions), in fact EBRPD and the East Bay Municipal Utility District (EBMUD) are planning on using many of these alternative approaches on their properties. It is puzzling that within the same document an approach is argued to be unfeasible and too expensive yet accepted as feasible and economically viable elsewhere in the same document. If thinning, and ladder fuel removal meet the fire hazard mitigation objectives for one agency, they should also do so for other agencies.

The DEIS dismisses removal of ladder fuels as expensive, and sometimes difficult on steep slopes. There are two issues with this statement. First, the proposed actions involve extensive logging activities on these same slopes. The degree of tree removal proposed on steep slopes would itself have a significant destabilizing effect on soils and itself lead to erosion. Second, no economic analysis was provided as to why removal of ladder fuels would be "expensive" and no comparison of any cost estimates was provided to support these claims.

The URS Corporation (2009) did not agree with FEMA's assertion that thinning and ladder fuel removal was not a feasible treatment. The 2009 URS report to FEMA stated, "The UC accurately cites increased costs and a longer time period to implement as reasons that this alternative is not preferred, but the UC does not provide information that demonstrates that the increased costs or longer implementation period make this alternative infeasible. This alternative would not be as effective as the proposed project at reducing the fire hazard. However, this alternative would reduce the fire hazard and would thus meet the purpose and need. This alternative should be evaluated in future NEPA documents. "

Ultimately, the stated objective of the DEIS is to reduce fuel loads. In the case of the UC projects, the surface fuels – as well as aerial fuels and woody material – would in fact not be removed, but instead be chipped and scattered on-site. By comparison the Combined Alternative Program approach advocated by HCN would cause these fuels to actually be removed, thereby accomplishing what the DEIS says needs to be done.

V. EFFICACY OF AN ALTERNATIVE STRATEGY

<u>Efficacy of alternative treatments in meeting the hazard reduction goals of the grant</u>

Some of the EBRPD and ongoing EBMUD fuel treatments (proposed and connected treatments) planned and supported in part by the FEMA grant use a less aggressive approach than the proposed actions advocated by the UC and City of Oakland, are similar to the Combined Alternative Program (DEIS, 3.3.1) rejected in the DEIS, and effectively accomplish the stated goals of the FEMA grant.

Economic viability of the Proposed Alternative Treatment

The EBRPD treatments cost approximately $4,444/acre compared to over twice that cost per acre for the proposed UC and City of Oakland treatments, and over three times that for the Oakland treatments:

Table 2. Allocated funding and treatment costs per acre.

Project Area	Actions	Grant Funding, $	Matching Funding, $	Total Funding, $	Treated Acres	Cost per Acre, $
UC Strawberry Canyon	Proposed	450,000	150,000	600,000	56	10,714
UC Claremont Canyon	Proposed	350,000	116,000	366,000	43	10,840
Oakland	Proposed	1,329,018[1]	443,006	1,772,024	121.9	14,536
EBRPD	Proposed[2]	1,800,000	600,000	2,4000,000	540.2	4,444

1. Assuming the same cost per acre for Frowning Ridge as for Strawberry and Claremont, the UC would spend a total of $1,998,000 to treat Frowning Ridge, of which 75%, or $1.498m would come from Oakland. EBRPD is getting paid for treating 51.9 acres for Oakland, which based on an average cost per acre for the rest of the EBRPD projects (540.2 acres/$1.8m equals $3,333/acre + 25% matching, or $4,444/acre). This leaves Oakland with:

$3,000,000 starting
less UC Frowning $1,498,000
less EBRPD 51. 9 $172,982
Net to Oakland is $1,329,018 for 121. 9 acres, plus 25% matching=$1,772,024 total or $14,536/acre

2. EBRPD's vegetation management methods are based on its Wildfire Hazard Reduction and Resource Management Plan (EBRPD 2009) and follow the same treatment methodology as Connecting areas described in the DEIS.

Figure 2. *Figure V-5* from EBRPD Wildfire Hazard Reduction and Resource Management Plan. These photos demonstrate the reduction in hazardous brush fuels achieved by treatments comparable to the Combined Alternative Strategy.

Figure 3. *Figure V-9, b* from EBRPD Wildfire Hazard Reduction and Resource Management Plan. These photos demonstrate the reduction in surface fuel continuity and elimination of ladder fuels achieved through treatments comparable to the Combined Alternative Program. For the "Low Fire Hazard" scenario (right), surface fires would be of low intensity and trees would not be susceptible to torching or crowning. Further, reduced eucalyptus bark on the ground surface and lower tree trunks minimizes the risk of spotting.

<u>The Combined Alternative Program is a more effective and more viable treatment methodology than no-action or the proposed actions</u>

The stated goal of the DEIS is to reduce wildfire hazard by treating hazardous fuels. While the proposed actions would reduce the risk of torching, crown fire and spotting immediately post-treatment, this approach would not necessarily reduce the fire hazard in the long term. It would introduce new hazards from increased surface fuel on treatment sites, hotter, drier conditions, and invasion of flammable, aggressive exotics. Even if the vegetation in the treatment areas eventually did revert to a more native state, this does not come without significant fire hazards. As previously discussed, the native plant communities of the East Bay Hills, and of the western U.S. in general, carry significant fire hazards as they are almost universally fire-adapted or fire-dependent. In considering the average flame lengths shown in Table 1 for each of the native and non-native plant communities prevalent in the vicinity, it is clear that even with periodic maintenance, the resultant fire hazard would be well in excess of the stated objective of the DEIS.

In considering all the factors discussed in this report, the Combined Alternative Program is the best alternative for accomplishing that objective. Figure 3 provides a dramatic example of the fuel complex resulting from the Combined Alternative Approach as described in the DEIS. This approach reduces the fire hazard immediately post-treatment, and long-term, by:

- Maintaining the overstory, providing increased precipitation during the dry summer months and reducing understory growth through shading

- Minimizing understory fuels, thereby minimizing surface fire flame lengths to well below four feet and minimizing or eliminating the potential for torching, crown fire and spotting

- Removing ladder fuels, eliminating vertical fuel continuity and minimizing or eliminating the potential for torching, crown fire, and spotting

Recommendation for the Combined Alternative Program approach to fuel treatments

Given the demonstrated effectiveness of treatments similar to the Combined Alternative Program, and the lower cost per acre associated with such treatments, as well as the numerous detrimental factors of the proposed UC and City of Oakland actions in the DEIS, it is my opinion that the Combined Alternative Program approach is clearly a preferable alternative. It meets all of FEMA's mandatory criteria, follows sound forestry practices, is consistent with current accepted hazard fuel reduction practices for eucalyptus, does not result in an increase in invasive brush species post-treatment, deposits far less flammable woody material on the treatment sites, and is more economically sound.

The Combined Alternative Program approach should be used as the preferred action on all areas to be treated in order to meet the stated objectives of the DEIS in reducing the fire hazard in the East Bay Hills. Additionally, to maintain a lower level of wildfire hazard, periodic maintenance should be performed following the approach of the Combined Alternative Program. This is necessary to prevent accumulation of surface and ladder fuels over time (Agee et al., 1973)

In my opinion, more reasonable and economically responsible alternatives have been dismissed or ignored in this DEIS. Based on the factors discussed in this document, it is my opinion that the DEIS as written is fatally flawed and should be retracted. Until a thorough and balanced assessment of treatment strategies and alternatives can be conducted, no further actions should be pursued beyond the planned actions currently being implemented by the EBRPD.

VI. APPENDICES

Appendix A – References
Appendix B – Professional and Educational Background

Appendix A – References

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Appendix B – Professional and Educational Background

Expertise

My primary areas of expertise are fire behavior analysis, wildland fire program management, hazardous fuel response and mitigation planning, and wildland fire operations. I have served as Fire Behavior Analyst (FBAN) and Long Term Analyst (LTAN) on numerous large, complex wildland fires. I have extensive experience working on incidents with complex suppression and management strategies, and with a diversity of land management and public safety considerations.

I have 26 years of experience in wildland fire and emergency services with federal, state, and local government fire organizations. This includes a breadth of wildland fire experience ranging from initial attack to support of large, complex fire organizations as an FBAN and LTAN, and prescribed fire and fuels management.

My fire behavior knowledge and expertise includes broad experience in wildland fire investigations, including origin and spread analysis, fire behavior and movement in complex terrain, firefighter burnover investigations, and fire loss litigation cases. I have helped teach a national-level course, Advanced Fire Behavior Interpretation (S-590), for 12 years.

I possess extensive expertise in the use of geographic information systems, analysis of spatial information, and geospatial fire analysis and interpretation. In particular, I have performed numerous complex analyses of fire behavior, potential fire growth, forensic fire behavior analysis, and hazard fuel treatment effectiveness. For this, I made extensive use of tools that include FARSITE (Fire Area Simulator), FlamMap, FireFamily Plus, BEHAVE, FSPro (Fire Spread Probability) and RERAP (Rare Event Risk Analysis Process).

My experience in fire program management includes five years as the Wildland/Urban Interface (WUI) program coordinator for my current employer, and five years as the Rural Fire Coordinator for the state of Montana. In both of these positions, I worked with teams and working groups in hazard mitigation and pre-response planning, and in coordinating response to large, complex WUI wildfire incidents.

Professional Experience

I am currently a Battalion Chief with the Poudre Fire Authority (PFA) in Ft. Collins, CO. In my current role, I oversee the daily operations of a Battalion covering approximately 120 square miles with complex planning and emergency response needs that include structural fire suppression in urban, suburban and rural areas; WUI operations; whitewater rescue; mountain rescue; and emergency medical response.

Prior to that, I served nine years as a Captain. In that role, I supervised and managed the operations of an emergency response crew, served as the Operations liaison of the WUI Team, manage the department's Wildland Incident Qualification System for 140 personnel, and was part of the core hazmat response and planning team.

For nine years previous to my position as Captain, I served as Firefighter, Driver/Operator, and EMT with the PFA.

From 1990 to 1995, I was the state-wide Rural Fire Coordinator with the Montana Dept. of Natural Resources (DNRC) based in Missoula, Montana. I was the primary liaison between local and county fire organizations and the various state and federal agencies in the state of Montana.

From 1988 to 1990, I was a fuels technician, engine boss, and firefighter with the USFS on the Clearwater National Forest, ID.

From 1987 to 1995, I served as a volunteer firefighter and EMT with the Missoula Rural Fire District in Missoula, MT.

Education

I received a Master of Science degree from the University of Montana, School of Forestry, in 1995. My degree was in Forestry, with emphasis in wildland fire management. Thesis topic: GIS Applications in Wildland/Urban Interface Fire Management and Planning in Missoula County, MT. 198pp.

I received a Bachelor of Science degree in Botany from the University of California, Davis 1980.

Professional Affiliations

I served for five years as a subject matter expert as a member of the National Wildfire Coordinating Group (NWCG) Fire Behavior Subcommittee (2007-2012).

I currently serve on the Core Fire Science Advisory Committee, an interagency group providing fundamental guidance and oversight to the national fire behavior research needs in the U.S.

Fire Experience

I have worked on over 200 wildland fires in my career as a firefighter, fireline supervisor, and Fire Behavior/Long Term Analyst.

My experience as FBAN and LTAN includes two to three week assignments on large, complex fires burning under extreme conditions:

Fire	Agency	State	Year	Size	Duration
High Park	U.S. Forest Service	CO	2012	136 mi^2	3 weeks
Station	U.S. Forest Service	CA	2009	250 mi^2	7 weeks
Zaca	U.S. Forest Service	CA	2007	375 mi^2	6 weeks
Day	U.S. Forest Service	CA	2006	255 mi^2	5 weeks
Bar Complex	U.S. Forest Service	CA	2006	164 mi^2	4 weeks
Hayman	U.S. Forest Service	CO	2002	215 mi^2	3 weeks
Clear Creek	U.S. Forest Service	ID	2000	322 mi^2	12 weeks
Cerro Grande	U.S. Forest Service and National Park Service	NM	2000	73 mi^2	4 weeks

Qualifications – Wildland Fire

I currently maintain the following fire line qualifications, per the National Wildfire Coordinating Group (NWCG) Incident Qualification System:

Fire Behavior Analyst - 12 years.
Division/Group Supervisor - 14 years.
Strike Team/Task Force Leader- 16 years.
Engine Boss - 22 years.
Incident Commander, Initial Attack - 21 years.
Firefighter, Type 1 and 2 (advanced and basic) – 24 years.

Other Qualifications

I currently maintain additional qualifications:
Hazardous Materials Technician - past 7 years.
Swift Water Rescue Technician I - past 7 years.
EMT-A, Basic Emergency Medical Technician - past 21 years.

Additional Training

As a part of achieving and maintaining my wildland fire qualifications, I have successfully completed the following NWCG (National Wildfire Coordinating Group) courses:

S-590	Advanced Fire Behavior Interpretation (1999)
S-300	Incident Commander, Extended Attack (1997)
S-339	Division/Group Supervisor (1997)
I-300	Intermediate Incident Command System (1997)
S-234	Firing Methods and Procedures (1997)
S-330	Strike Team/Task Force Leader (1997)
RX-90	Prescribed Fire Burn Boss (1997)
S-490	Advanced Fire Behavior Calculations (1994)

I-347	Demobilization Unit Leader (1994)
S-300	Incident Commander Extended Attack (1993)
J-346	Situation Unit Leader (1993)
J-348	Resource Unit Leader (1993)
S-336	Fire Suppression Tactics (1992)
S-205	Fire Operations in the Wildland/Urban Interface (S-215)
S-260	Fire Business Management (1989)
I-220	Basic Incident Command System (1988)
S-211	Portable Pumps and Water User (1988)
S-212	Power Saws (S-212)
S-230/231	Single Resource Boss/Engine Boss (1988)
S-270	Basic Air Operations (1988)
S-130/190	Basic Wildland Firefighter, Intro. to Wildland Fire Behavior (1988)

Teaching

Advanced Fire Behavior Interpretation, S-590. 2002, 2004, 2006, 2008, 2010. Two-week course. Lesson instruction and student mentoring.

NWCG Firefighter Safety Refresher, national curriculum. Conducted two Unit Lessons on fire behavior, and human factors in fire behavior, for the national course curriculum. Distributed on DVD. 2008 and 2009.

Intermediate Wildland Fire Behavior, S-290. 2000, 2002, 2003, 2005. 32-hour course. Lead Instructor.

Introduction to Fire Behavior Calculations, S-390. 2002, 2004, and 2005. 24-hour course. Lead Instructor.

Advanced Wildland Fire Behavior Calculations, S-490. 1999, 2001, 2003. 40-hour course. Lead instructor.

Fire Operations in the Wildland/Urban Interface, S-215. 2003, 2004. 32-hour course).

Firing Methods and Procedures, S-234. 2001 and 2003. 24-hour course.

Single Resource Boss/Engine Boss, S-230/231. 2002. 32-hour course.

Annual Safety Refresher training for local county, state, and U.S. Forest Service personnel. Annually since 2001.

Other Presentations

International Fire Behavior and Fuels Conference; Spokane, WA. Extreme Fire Behavior. 2010.

Colorado State University, Forestry Dept. ; Ft. Collins, CO. Extreme fire behavior and critical fire weather. Invited guest lecture for upper-level Fire Management courses. 2003, 2004, 2009 and 2010.

U.S. Forest Service, Arapaho-Roosevelt NF; Ft. Collins, CO. Critical Fire Weather. Training session for US Forest Service seasonal personnel (2 hrs). 2007.

Annual Wildland Fire Refresher Training; Tahoe NF, CA. Human factors, line officer roles, and tactical decision making exercises for US Forest Service Fire Staff personnel. 2007.

Southern CA Training Officer's Association; Orange County, CA. Presentation on human factors and the fire environment (2 hrs). 03/2007.

Fire Behavior Analyst Workshop, Missoula, MT. Two presentations – FBAN involvement in investigations, and a case study of the Day Fire in S. CA (4 hours total). 2007.

Montana DNR Line Officer Workshop; Helena, MT. Organized and presented training on implications to line officers of firefighter burn over incidents on wildfires. 05/2006.

Redding (CA) Wildland Fire Workshop. Human factors on wildland fires (2 hrs). 2006.

Wildland Fire Safety Summit, Pasadena, CA. Presentation on the interaction of human factors and fire behavior (1 hr). 2006.

Canadian Forest Service, Fire Behaviour Specialist course; Hinton Training Centre, AB. Keynote address. 2006.

Wildland Fire Safety Summit; Missoula, MT. "Fire Behavior vs. Human Behavior: Why the Lessons from the Cramer Fire Matter" (1.5 hrs). 2005.

Regional Hotshot Crew Workshop, Southwest Region, U.S. Forest Service. Presentation of fire behavior and human factors in wildland fire fatalities. 2005.

Colorado State University, Forestry Dept.; Ft. Collins, CO. Wildland fire behavior and the fire environment; guest lecture for an upper-level Fire Management course. 2003 and 2004.

American Planning Association conference; Denver, CO. Facilitator for a field training session for wildland/urban interface planning and hazard mitigation. 2003.

Colorado Mitigation Conference; Denver, CO. Weather, Climate, and Fire Behavior – the effect of short-term and long-term atmospherics on fuels, firefighter safety, and risk. Panel discussion. 2002.

Publications – Primary and Contributing Author

Close, K. 2006. 20 Minutes at H-2: Linear Decision Making in an Exponential Fire Environment. In: Proc. 9th Wildland Firefighter Safety Summit; 2006 April 25-27, Pasadena, CA. Intl. Assoc. of Wildland Fire, Hot Springs, SD.

Close, K. 2005. Fire behavior vs. Human Behavior: Why the Lessons from Cramer Matter. In: Butler, B. W., et al. Eds. 2005. Wildland Firefighter Safety Summit – Human Factors; 2005 April 26-28; Missoula, MT. Intl. Assoc. of Wildland Fire, Fairfax, VA.

Interior West Fire Council. 1998. "Fire Management Under Fire – Adapting to Change." K. Close and R. Bartlette, eds. Proceedings of the 1994 Interior West Fire Council meeting and symposium, Coeur d'Alene, ID, 1-3 November, 1994. ISBN: 1-887311-02-5.

Close, K. and R. Wakimoto. 1995. Geographic Information Systems: Applications in Wildland/Urban Interface Fire Management Planning in Missoula County, MT. M. S. Thesis. School of Forestry, University of Montana, Missoula, MT. 198 pp.

Close, K, and R. Wakimoto. 1993. GIS Applications in wildland/urban interface fire planning: the Missoula County (Montana) project. In: 7th Annual Symposium on Geographic Information Systems in forestry, environmental and natural resource management. Feb. 15-18, 1993. Vancouver, BC. Pp 131-140.

Donoghue et al. 2003. Accident Investigation Factual Report: Cramer Fire Fatalities (U.S. Forest Service, 0351-2M48-MTDC). Provided fire behavior input to the main report, and authored Appendix C - Fire Behavior and Weather (24 pp.).

Graham, R.T., Technical Editor. 2003. Hayman Fire Case Study. Gen. Tech. Rep. RMRS-GTR-114. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 396 pp.

National Wildfire Coordinating Group (NWCG). 2008. Fire Behavior Analyst/Long Term Analyst task book revision. Provided input and content for a major revision of task books (national-level training criteria) for Fire Behavior Analysts and Long Term Analysts.

Walsh Environmental Scientists and Engineers, LLC. 2006-2009. Provided fire behavior and weather content for comprehensive Community Wildfire Protection Plans for the communities of Coal Creek Canyon, Evergreen, Fairmount, Golden, Golden Gate, Indian Hills, Inter-Canyon, and Clear Creek County.

Special Projects

Fire behavior of the McIntyre Hut and Bendora Fires on January 18, 2003 (Canberra, Australia). Expert witness on fire behavior for the Norton Rose law firm (representing the Australian Capital Territory government). Case pending.

Origin and spread of the EID and Cigarette Fires. Expert witness for a legal firm (McLachlan, McNab and Hembroff) in fire behavior, providing extensive and detailed analysis of the spread and behavior for two fires burning in proximity to each other. 2009. Case pending.

Growth and fire behavior of the Witch and Guajito fires. Expert witness for Travelers Insurance (Denenberg Tuffley, LLP), regarding the 2007 Southern California Fires. Analysis of fire behavior and spread from multiple ignitions. 2008-2009.

Burroughs v. U.S, "X" Fire. Expert witness, fire behavior. Assessment of fire origin, behavior and spread. 2008.

Brown and James, LLP. Expert witness, fire behavior and structural ignition from wildland fires. 2008.

U.S. Attorney's Office, District of Montana. *Backfire 2000 et al. vs. U.S. Government.* Expert witness, fire behavior. Provided comprehensive fire behavior analysis and re-construction of the fire chronology. 2005-2006.

Community Wildland Fire Protection Plans. Assisted in development of plans for multiple local jurisdictions in Colorado, primarily in providing fire behavior assessment. 2006-2009.

Larimer County, CO. Completed a federal matching-funds grant project involving the research, analysis, and development of practical applications for local WUI response, pre-planning, and hazard assessment for the northern Front Range of Colorado. 2006.

U.S. Forest Service, National Office. Cramer Fatality Investigation Team. Provided a detailed re-construction of the fire behavior leading to two firefighter fatalities; made several recommendations for organizational improvement that were implemented from this. 2003.

U.S. Forest Service, Rocky Mountain Research Station. Review Panel, Hayman Fire Case Study. Contributed input regarding fire behavior and fire suppression operations for a comprehensive written review of the Hayman Fire of 2002.

U.S. Forest Service, Angeles NF. Leona Fire arson investigation. Expert witness, fire behavior, and testimony in Los Angeles District Court. 2004.

Montana DNRC. Missoula, MT. Ryan Gulch Fire investigation. Expert witness, origin and fire behavior assessment. Analysis to determine the likely ignition location based on detailed fire behavior modeling and analysis. 2001.

National Park Service, National Office. Monument Fire Entrapment Investigation Team, Pecos National Historic Monument, NM. Provided detailed fire behavior analysis to the investigation of a firefighter entrapment. 2001.