REGIONAL DISTRICT OF CENTRAL KOOTENAY

COMMUNITY WILDFIRE PROTECTION PLAN BACKGROUND

PART 3

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1.0 Communication and Education

One of the key elements to developing FireSmart communities and neighbourhoods is cultivating an understanding of fire risk in the wildland urban interface. An effective communication strategy should target elected officials (regional and local governments), structural and wildland fire personnel, appropriate municipal departments (planning, bylaw, and environment), the public and the private sector. The principles of effective communication include:

- Developing clear and explicit objectives, or working toward clear understanding;
- Involving all parties that have an interest in a transparent process;
- Identifying and addressing specific interests of different groups;
- Coordinating with a broad range of organizations and groups;
- Not minimizing or exaggerating the level of risk;
- Only making commitments that you can keep;
- Planning carefully and evaluating your effort; and
- Listening to the concerns of your target audience.

To effectively minimize fire risk in the interface zone requires the coordination and cooperation of many levels of government including the B.C. Ministry of Forests and Range, the Regional District of Central Kootenay, local Municipal government departments, and other government agencies. However, if prevention programs are to be effective, fire risk reduction within interface areas of communities must engage the local residents. This requires a commitment to well-planned education and communication programs that are dedicated to interface fire risk reduction. There is generally a lack of understanding about interface fire and the simple steps that can be taken to minimize risk in communities. Typically, there is either apathy and/or an aversion to dealing with many of the issues highlighted in this report. Public perception of fire risk is often underdeveloped due to public confidence and reliance on local and provincial fire rescue services. Two useful websites that provide links to wildfire education resources and basic fire information include www.efire.org and http://www.pssg.gov.bc.ca/firecom/. Figure 1 shows a screen capture from the City of Chilliwack's public wildfire education website as an example of a clear, navigable and informative public communication method.

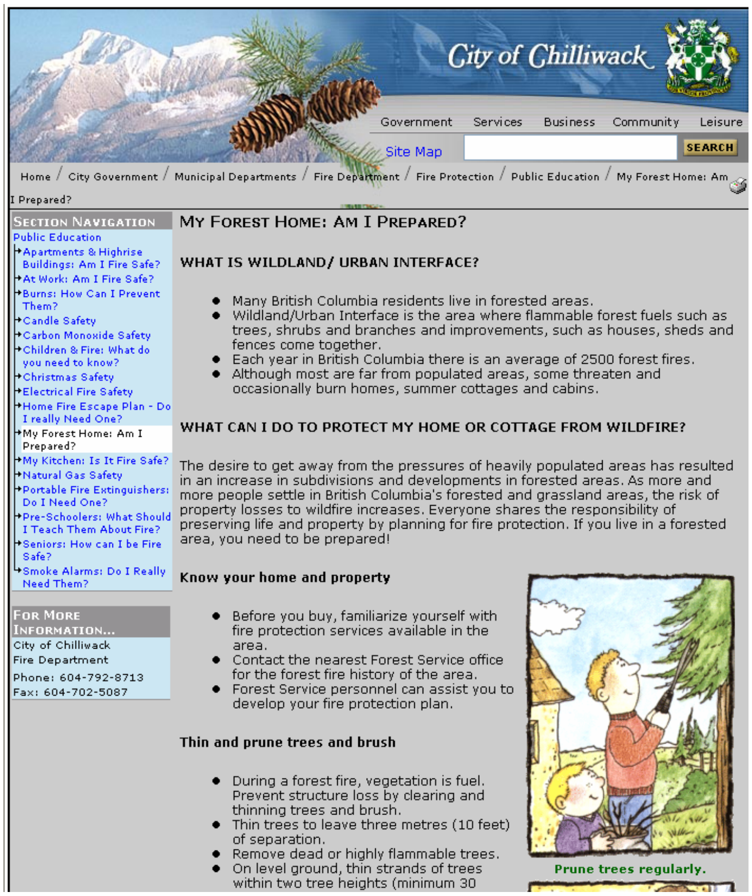

Figure 1. Example of municipal website providing fire education information (http://www.chilliwack.com/main/page.cfm?id=627).

1.1 Target Audiences

Historically, there has been limited understanding of wildland urban interface fire risks within many communities of British Columbia. However, the lessons learned from the 2003 fire season have significantly increased local fire rescue service awareness and local, regional, and provincial organizations have upgraded fire suppression understanding and capability. Despite this, there is limited understanding among key community stakeholders and decision makers. Education and communication programs must target the broad spectrum of stakeholder groups within communities. The target audience should include, but not be limited to, the following groups:

- Homeowners within areas that could be impacted by interface fire;
- Local businesses;
- Municipal councils and staff;
- Regional District of Central Kootenay directors;

- Local utilities; and
- Media.

1.2 Pilot Projects

Pilot projects that demonstrate and communicate the principles of FireSmart and its application to Community Wildfire Protection should be considered. The focus of these pilot projects should be to demonstrate appropriate building materials and construction techniques in combination with the FireSmart principles of vegetation management, and to showcase effective fuel management techniques. Several homes and businesses could be identified by the community to serve a communication and education function that would allow residents to see the proper implementation of FireSmart principles. The fuel treatment pilot should focus on hazardous fuel types identified in the CWPP.

These pilot projects are considered a high priority for the urban interface to provide information on different fire hazard reduction techniques and demonstrate appropriate fire risk reduction methods to the community including municipal staff, community leaders and the public. These demonstration areas will also provide sites for improved public understanding of the methods to mitigate fire risk that can be applied on individual properties.

1.3 Website

Websites are considered one of the best and most cost effective methods of communication available. Fire related information such as fire danger and fire restrictions, as well as fire risk assessment information should be included on any fire protection website. Pictures and text that outline demonstration/pilot projects can also be effective in demonstrating progress and success of fire risk reduction activities. During fire season it is particularly important that wildfire safety related information be posted so that it is easily accessible to the general public.

1.4 Media Contacts, Use and Coordination

Media contact plays an essential role in improving public awareness about fire risk in the community. Interest in wildfire protection can be cultivated and encouraged to improve the transfer of information to the public by more frequent media contact.

Key issues in dealing with the media include:

- Assignment of a media spokesperson for the community;
- Providing regular information updates during the fire season regarding conditions and hazards; and
- Providing news releases regarding the interface issues and risks facing the community.

1.5 Other Methods

Educational information and communication tools need to be stakeholder specific. To establish effective communication within target groups, spokespersons who can best establish communication ties and provide the educational information required should be selected. The following subsections outline potential communication methods for specific stakeholder groups.

1.5.1 Homeowners

- Conduct surveys and consult the public to ascertain current attitudes.
- Designate spokespersons to communicate to this group and establish a rapport.
- Establish community information meetings conducted by spokespersons.
- Mail out informational material.
- Provide FireSmart hazard assessment forms and information.
- Provide signage at trailheads and other prominent locations.

1.5.2 Government Ministries, Municipal Officials, Disaster Planning Services, Utilities

- Develop material specific to the educational needs of the officials.
- Present councils with information and encourage cooperative projects between municipalities.
- Establish memoranda of understanding between agencies.
- Appoint a spokesperson to communicate to the groups and help foster inter-agency communication.
- Raise awareness of officials as to the views of the public regarding interface risks in their community.

1.6 General Messages

Education and communication messages should be simple yet comprehensive. The level of complexity and detail of the message should be specific to the target audience. A complex, wordy message with overly technical jargon will be less effective than a simple, straightforward message. A basic level of background information is required to enable a solid understanding of fire risk issues. Generally, messages should have at least the following three components:

1. Background Information
    - Outline general issues facing interface communities.

- Communicate specific conditions in the community that cause concern.
- Provide examples of potential wildfire behaviour in the community.
- Provide examples of how wildfire has affected other communities.
- Explain the effects that a wildfire could have upon the community.
- Convey FireSmart principles.

2. Current Implementation and Future Interface Planning
    - Provide information on the current planning situation.
    - Explain who is involved in interface planning.
    - Explain the objectives of interface wildfire planning.
    - Explain the limitation of firefighting crews and equipment in case of a wildfire.
    - Outline the emergency procedure during a wildfire.

3. Responsibilities and Actions
    - Outline the responsibilities of each group in reducing wildfire hazards.
    - Explain the actions that each group may take to meet these responsibilities.

2.0 Structure Protection

2.1 FireSmart

Another important consideration in protecting the wildland urban interface zone from fire is ensuring that homes can withstand an interface fire event. Often, it is a burning ember traveling some distance (spotting) and landing on vulnerable housing materials, rather than direct fire/flame (vegetation to house) contact, that ignites a structure. Alternatively, the convective or radiant heating produced by one structure may ignite an adjacent structure if it is within close proximity. Structure protection is focused on ensuring that building materials and construction standards are appropriate to protect individual homes from interface fire. Materials and construction standards used in roofing, exterior siding, window and door glazing, eaves, vents, openings, balconies, decks and porches are primary considerations in developing FireSmart neighbourhoods. Housing built using appropriate construction techniques and materials is less likely to be impacted by interface fires.

While many communities established to date in BC were built without significant consideration with regard to interface fire, there are still ways to reduce home vulnerability. Changes to roofing materials, siding, and decking can ultimately be achieved through long-term changes in bylaws and building codes.

The FireSmart approach has been adopted by a wide range of governments and is a recognized template for reducing and managing fire risk in the wildland urban interface. The most important components of the FireSmart approach are the adoption of the hazard assessment systems for wildfire, site and structure hazard assessment, and the proposed solutions and mitigation outlined for vegetation management, structure protection, and infrastructure. Where fire risk is unacceptable, the FireSmart standard should, at a minimum, be applied to new subdivision developments and, wherever possible, the standard should be integrated into changes to, and new construction within, existing subdivisions and built up areas.

2.1.1 Roofing Material

Roofing material is one of the most important characteristics influencing a home's vulnerability to fire. Roofing materials that can be ignited by burning embers increase the probability of fire related damage to a home during an interface fire event.

In many communities there is no fire vulnerability standard for roofing material. Homes are often constructed with unrated materials that are considered a major hazard during a large fire event. In addition to the vulnerability of roofing materials, adjacent vegetation may be in contact with roofs, or roof surfaces are covered with litter fall and leaves from adjacent trees. This increases the hazard by increasing the ignitable surfaces and potentially enabling direct flame contact between vegetation and structures.

2.1.2 Building Exterior - Siding Material

Building exteriors constructed of wood are considered the second highest contributor to structural hazard after roofing material. Wood siding within the interface zone is vulnerable to direct flame or may ignite when sufficiently heated by nearby burning fuels. Winds caused by convection will transport burning embers, which may lodge against siding materials. Siding materials, such as wood shingles, boards, or vinyl are susceptible to fire. Brick, stucco, or heavy timber materials offer much better resistance to fire.

2.1.3 Balconies and Decking

Open balconies and decks increase fire vulnerability through their ability to trap rising heat, by permitting the entry of sparks and embers, and enabling fire access to these areas. Closing these structures off limits ember access to these areas and reduces fire vulnerability.

2.1.4 Combustible Materials

Combustible materials stored within 10 m of residences are also considered a significant issue. Woodpiles or other flammable materials adjacent to the home provide fuel and ignitable surfaces for embers. Locating these fuels away from structures helps to reduce structural fire hazards.

2.2 Planning and Bylaws

There are two types of wildfire safety regulations most commonly used by local governments: Type 1) regulations that restrict the use of fire; and, Type 2) regulations that restrict building materials, require setbacks or restrict zoning. While most municipalities have bylaws for Type 1 regulations, Type 2 regulations are not as common. However, these regulations are an important contributor to wildfire risk reduction. Several Type 2 policy options are generally available to local governments. These primarily include:

- Voluntary fire risk reduction for landowners (building materials and landscaping)
- Bylaws for building materials and subdivision design
- Covenants requiring set-backs and vegetation spacing
- Site assessments that determine the imposition of fire protection taxes
- Education
- Zoning in fire prone areas
- Treatments on private and public land (commercial thinning, non-commercial mechanical thinning, clear-cut commercial harvesting or prescribed burning)

There are two prominent issues that may be corrected through the bylaw process. Unrated roofing materials contribute significantly to fire risk. In the short term, a resolution to this issue is difficult given the significant cost to homeowners. However, over the long-term, altering building codes or bylaws to encourage a change in roofing materials when roof replacement of individual residences is required is generally a viable option.

The second prominent issue relates to the creation of large setbacks between buildings and the forest. Where forest trees encroach onto balconies and building faces, the potential for structure ignition is greater and may result if more houses being engaged by fire, thereby reducing firefighter capability to successfully extinguish both wildland and structural fires throughout a community. These two suggestions represent only a fraction of the changes that can be considered and more can be identified on a community specific basis by completing a thorough review of current bylaws as they relate to fire risk.

Local governments have an important role in managing community fire hazard and risk. Through the Local Government Act, Development Permit Areas authorize local governments to regulate development in sensitive or hazardous areas where special conditions exist.

For example, Development Permit Areas can be designated for such purposes as:

- Protection of the natural environment;
- Protection from hazardous conditions;
- Protection of provincial or municipal heritage sites;
- Revitalization of designated commercial areas; or
- Regulation of form and character of commercial, industrial and multi-family residential development.

As a land use planning tool, the establishment of Development Permit Areas for interface fire hazards could protect new developments from wildfire in the urban interface. For the purpose of fire hazard and risk reduction a development permit may:

- Include specific requirements related to building character, landscaping, setbacks, form and finish; and
- Establish restrictions on type and placement of trees and other vegetation in proximity to the development.

2.3 Sprinklers

As part of the Firestorm 2003 Provincial Review, the provincial government responded to the interface fire issue by purchasing mobile sprinkler kits that can be deployed during interface fires. Given the value of the interface in many communities, it is appropriate to consider employing a sprinkler system in these areas. Training may be required to ensure appropriate deployment and use during an interface fire emergency.

2.4 Joint Municipality Cooperation

Interagency cooperation on issues related to resource capacity, training, mutual aid, and equipment sharing is common practice in BC. An expanded role for this relationship could include developing community based communication and education tools for use at a regional scale. Currently, many municipalities are developing in house standards and materials to improve public awareness. A more unified approach could improve efficiency, create consistent messages, and more broadly inform the public of interface fire issues and risk.

2.5 Structured FireSmart Assessments of High Risk Areas

The WRMS provides a tool to identify specific areas of high risk within municipalities The WRMS provides a sound scientific framework on which to complete more detailed local neighbourhood risk assessments.

3.0 Emergency Response

The availability and timing of emergency response personnel often dictates whether interface fire protection is successful. Well-planned strategies to deal with different and difficult interface fire scenarios are part of a comprehensive approach to addressing interface fire risk. In communities where the risk is considered low, emergency response alone may be considered an adequate management response to protect the community. As risk increases so too should the level of emergency response. Emergency response alone may not be an adequate management strategy to develop depending on the level of risk.

Unlike static emergencies (*e.g.* landslides), fires are dynamic and situations can change dramatically over short periods of time, potentially overwhelming resources. Therefore, it is important to consider a wide range of issues including, but not limited to, evacuation strategies, access for emergency vehicles and equipment, management of utility hazards associated with hydroelectric and gas infrastructure, and the reliability and availability of key fire fighting infrastructure during a fire event.

3.1 Access and Evacuation

The 2005 Berkley landslide emergency in the District of North Vancouver highlighted some of the difficulties associated with access and evacuation. Parked cars blocked the way for fire and emergency response personnel, dead end roadways made turning equipment around difficult, and evacuation of residents was complicated by the size and requirements of the emergency response.

In any emergency, evacuation is a critical function of emergency services. Given that a forest fire is a dynamic event, evacuation planning is considered of critical importance. Fire Departments must be prepared for evacuation of the sick, disabled, and the elderly when dealing with a wildland fire emergency. This issue adds complexity to any emergency situation.

Evacuation of residents and access for emergency personnel is an important consideration in any community. It is particularly important in neighbourhoods with limited access and with forest fuels in close proximity to homes. Evacuation can be further complicated by smoke and poor visibility, creating the necessity for traffic control. Where this is likely to be the case, establishing secondary or alternate evacuation routes is essential.

In addition to the evacuation of residents, safety of firefighting personnel is a major consideration. Where access in one-way in and out, there is the potential for resources to be isolated or cut off. Defence of neighbourhoods with poor access is secondary to safety considerations.

3.2 Fire Response

Fire suppression efforts in municipalities are constrained by the ability of firefighters to successfully defend residences with:

- Contiguous fuels between the forest and adjacent homes;
- Steep slopes of greater than 35%; and
- Human caused fuel accumulations and fuel tanks adjacent to homes.

Close proximity of fuels to homes and vulnerable roofing material are the two most significant factors that reduce the ability of firefighters to defend residences. During ember showers, multiple fires can ignite on vulnerable roofs within the wildland urban interface. Fuel continuity can provide a pathway for fire between the forest and homes. A lack of fuel breaks between houses and forest is likely to increase suppression resource requirements. While there will always be a limited ability to protect homes from extreme fire behaviour, or to modify fuels and topography, communities do have control over issues such as defensible space and home construction materials, and can make changes to reduce community vulnerability to fire.

Residences and businesses on steep slopes are vulnerable to increased fire behaviour potential and should be the immediate focus of initial attack if there is a fire start within these areas. Flame length and rate of spread will increase on these slopes, resulting in suppression difficulty and increased safety issues for both wildland and structural fire fighters.

Another significant issue that could affect emergency response is the impact of smoke on critical infrastructure such as fire departments and hospitals. Heavy smoke from a large fire could force evacuation of these facilities depending on their location.

In the event of forest fire, municipalities rely heavily on the MOFR to action fires in the forests within the community. During periods of high fire load throughout the Province, resources of the MOFR can be stretched thin. Often high fire activity is concentrated in the interior of the Province and availability of aircraft and equipment can be limited on the coast. In steep heavily forested terrain, the most effective method of fire control is generally air tanker action or bucketing with water from a helicopter. Therefore, under extreme fire conditions it may be appropriate for some municipalities to retain a contract helicopter on standby. This may substantially improve the community's probability of containing a fire during the most severe part of the fire season, and may provide the MOFR with the time necessary to mobilize equipment and resources from other parts of the Province.

4.0 Training Needs

The events of the 2003 fire season increased municipal awareness with regard to necessary training and equipment improvements. The division between local fire departments/rescue services and the MOFR Protection Branch has narrowed through improved training and communication. Training is fundamental to managing interface fire risk. Crossover abilities between provincial wildland fire and municipal structural fire personnel will enhance and improve the collective agency response to wildland urban interface fire. Therefore, all management strategies designed to protect the wildland urban interface should be supported by an adequate level of training to ensure emergency response addresses both wildland and structural fire.

All municipal firefighters should be trained in the S-100 Basic Wildland Fire Fighting course on a yearly basis. This is carried out by instructors endorsed by the B.C. Forest Service.

In general, it is recommended that:

- The S-100 course instruction be continued on an annual basis;
- Municipal Parks outside staff be given the S-100 course on an annual basis;

- A review of the S-215 course instruction be given on a yearly basis;
- The S-215 course instruction be given to new career staff and Paid On-Call officers on an ongoing basis; and
- Incident Command System training be given to all career and Paid On-Call officers.

Although not a true course, it is also recommended that municipal fire departments meet with the B.C. Forest Service meet prior to the fire season to review the Incident Command System structure in the event of a major wildland fire. This is based on the suggested training from above.

5.0 Vegetation (Fuel) Management

Vegetation management is considered a key element of the FireSmart approach. Given public concerns, vegetation management is often difficult to implement and must be carefully rationalized in an open and transparent process. Vegetation management should be strategically focused on minimizing impact while maximizing value to the community. For example, understory thinning or surface fuel removal may suffice to lower fire risk. In situations where the risk is high, a more aggressive vegetation management strategy may be necessary. Vegetation management must be evaluated against the other elements outlined above to determine its necessity. Its effectiveness depends on the longevity of treatment (vegetation grows back), cost, and the resultant effect on fire behaviour.

5.1 Principles of Fuel Management

5.1.1 Definition

Fuel management is the planned manipulation and/or reduction of living and dead forest fuels for land management objectives (*e.g.,* hazard reduction). It can be achieved by a number of methods including:

- Prescribed fire;
- Mechanical means; and
- Biological means.

5.1.2 Purpose

The goal is to proactively lessen the potential fire behaviour, thereby increasing the probability of successful containment and minimizing adverse impacts. More specifically, the goal is to decrease the rate of fire spread, and in turn fire size and intensity, as well as crowning and spotting potential (Alexander 2003).

Fire triangle

Fire is a chemical reaction that requires three main ingredients:

- Fuel (carbon);
- Oxygen; and
- Heat.

These three ingredients make up the fire triangle. If any one is not present, a fire will not burn.

Fuel is generally available in ample quantities in the forest. Fuel must contain carbon. It comes from living or dead plant materials (organic matter). Trees and branches lying on the ground are a major source of fuel in a forest. Such fuel can accumulate gradually as trees in the stand die. Fuel can also build up in large amounts after catastrophic events, such as insect infestations or disease.

Oxygen is present in the air. As oxygen is used up by fire, it is replenished quickly by wind.

Heat is needed to start and maintain a fire. Heat can be supplied by nature through lightning. People also supply a heat source through misuse of matches, campfires, trash fires, and cigarettes. Once a fire has started, it provides its own heat source as it spreads.

5.1.3 Forest Fuels

The amount of fuel available to burn on any site is a function of biomass production and decomposition. Many of the forest ecosystems within British Columbia have the potential to produce large amounts of vegetation biomass. Variation in the amount of biomass produced is typically a function of site productivity and climate. The disposition or removal of vegetation biomass is a function of decomposition. Decomposition is regulated by temperature and moisture. In wet maritime coastal climates the rates of decomposition are relatively high when compared with drier cooler continental climates of the interior. Rates of decomposition can be accelerated naturally by fire and/or anthropogenically by humans.

A hazardous fuel type can be defined by high surface fuel loadings; high proportions of fine fuels (<1 cm) relative to larger size classes, high fuel continuity between the ground surface and overstory tree canopies, and high stand densities. A fuel complex is defined by any combination of these attributes at the stand level and may include groupings of stands.

5.1.4 Surface Fuels

Surface fuels consist of forest floor, understory vegetation (grasses, herbs and shrubs, and small trees), and coarse woody debris that are in contact with the forest floor (Figure 2). Forest fuel loading is a function of natural disturbance, tree mortality and/or human related disturbance.

Surface fuels typically include all combustible material lying on or immediately above the ground. Often roots and organic soils have the potential to be consumed by fire and are included in the surface fuel category.

Surface fuels that are less than 12 cm in diameter contribute to surface fire spread; these fuels often dry quickly and are ignited more easily than larger diameter fuels. Therefore, this category of fuel is the most important when considering a fuel reduction treatment. Larger surface fuels greater than 12 cm are important in the contribution to sustained burning conditions, but are often not as contiguous and are less flammable because of delayed drying and high moisture content, when compared with smaller size classes. In some cases where these lager size classes form a contiguous surface layer, such as following a windthrow event or wildfire, they can contribute an enormous amount of fuel, which will increase fire severity and potential for fire damage.

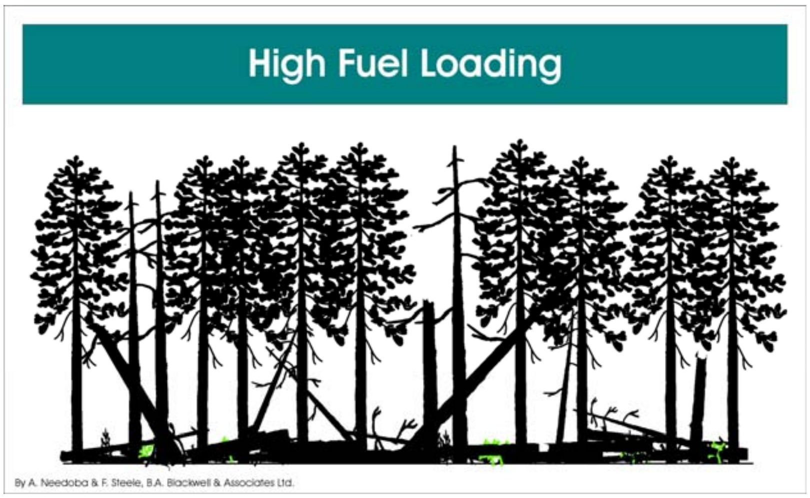

Figure 2. High surface fuel loading under a forest canopy

5.1.5 Aerial Fuels

Aerial fuels include all dead and living material that is not in direct contact with the forest floor surface. The fire potential of these fuels is dependent on type, size, moisture content, and overall vertical continuity. Dead branches and bark on trees and snags (dead standing trees) are important aerial fuel. Concentrations of dead branches and foliage increase the aerial fuel bulk density and enable fire to move from tree to tree. The exception is for deciduous trees where the live leaves will not normally carry fire. Numerous species of moss, lichens, and plants hanging on trees are light and flashy aerial fuels. All of the fuels above the ground surface and below the upper forest canopy are described as ladder fuels.

Two measures that describe crown fire potential of aerial fuels are the height to live crown and crown closure (Figure 3 and Figure 4). The height to live crown describes fuel continuity between the ground surface and lower limit of the upper tree canopy. Crown closure describes the inter-tree crown continuity and reflects how easily fire can be propagated from tree to tree.

In addition to crown closure, tree density is an important measure of the distribution of aerial fuels and has significant influence on the overall crown and surface fire conditions (Figure 5). Higher stand density is associated with lower inter tree spacing, which increases overall crown continuity. While high density stands may increase the potential for fire spread in the upper canopy, a combination of high crown closure and high stand density usually results in a reduction in light levels associated with these stand types. Reduced light levels accelerate self-tree pruning, inhibit the growth of lower branches, and decrease the cover and biomass of understory vegetation.

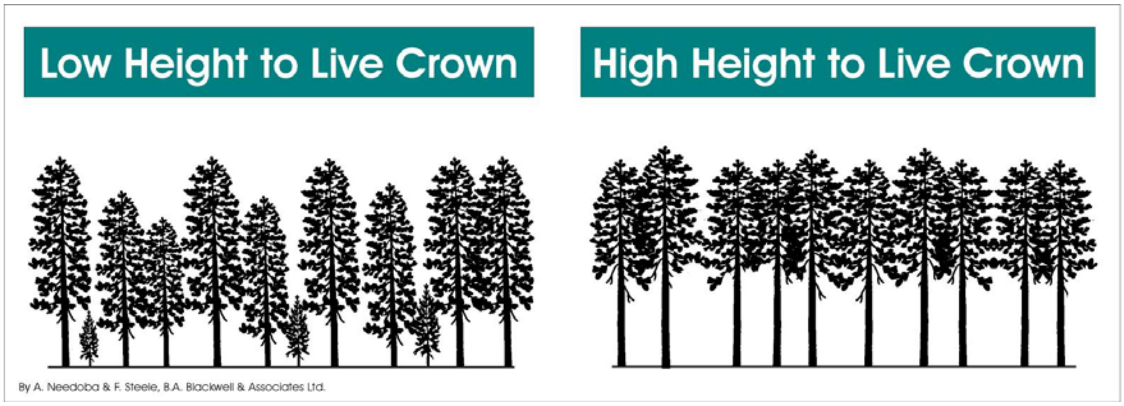

Figure 3. Comparisons showing stand level differences in the height to live crown.

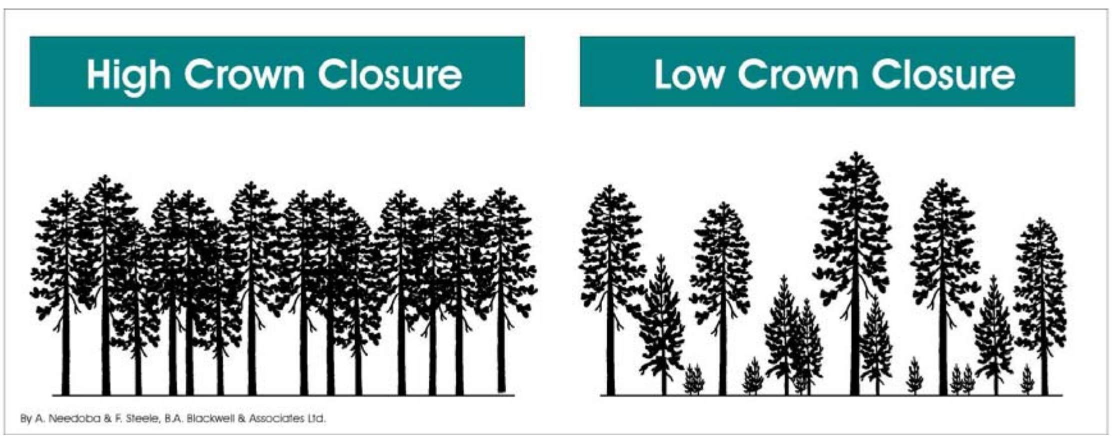

Figure 4. Comparisons showing stand level differences in crown closure.

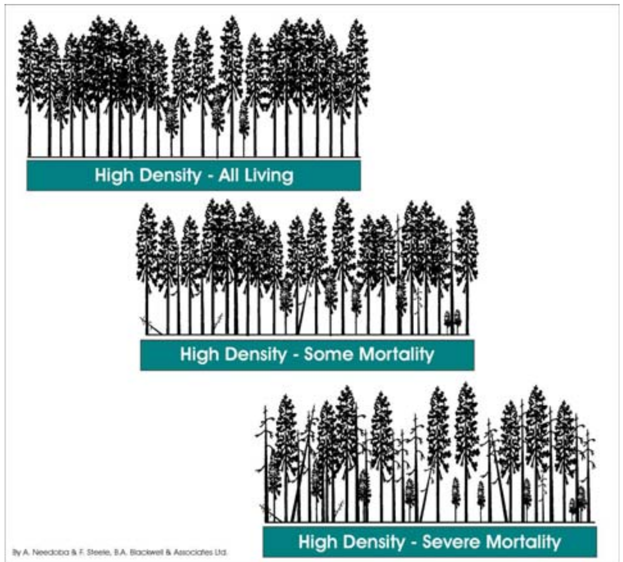

Figure 5. Comparisons showing stand level differences in density and mortality.

Thinning is a preferred approach to fuels treatment (Figure 6) and offers several advantages compared to other methods:

- Thinning provides the most control over stand level attributes such as species composition, vertical structure, tree density, and spatial pattern, as well as the retention of snags and coarse woody debris for maintenance of wildlife habitat and biodiversity.
- Unlike prescribed fire treatments, thinning is comparatively low risk, is not constrained to short weather windows, and can be implemented at any time.
- Thinning may provide marketable materials that can be utilized by the local economy.
- Thinning can be carried out using sensitive methods that limit soil disturbance, minimize damage to leave trees, and provide benefits to other values such as wildlife.

The following summarizes the guiding principles that should be applied in developing thinning prescriptions:

- Protect public safety and property both within and adjacent to the urban interface.
- Reduce the risk of human caused fires in the immediate vicinity of the urban interface.

- Improve fire suppression capability in the immediate vicinity of the urban interface.
- Reduce the continuity of overstory fuel loads and related high crown fire risk.
- Maintain the diversity of wildlife habitat through the removal of dense understory western hemlock, western red cedar, amabilis fir, Douglas fir and other minor tree species.
- Minimize negative impacts on aesthetic values, soil, non-targeted vegetation, water and air quality, and wildlife.

The main wildfire objective of thinning is to shift stands from having a high crown fire potential to having a low surface fire potential. In general, the goals of thinning are to:

- Reduce stem density below a critical threshold to minimize the potential for crown fire spread. Target crown closure is less than 35%;
- Prune to increase the height to live crown to a minimum of 2.5 meters or 30% of the live crown (the lesser of the two) to reduce the potential of surface fire spreading into tree crowns; and
- Remove slash created by spacing and pruning to maintain surface fuel loadings below 5 kg/m^2.

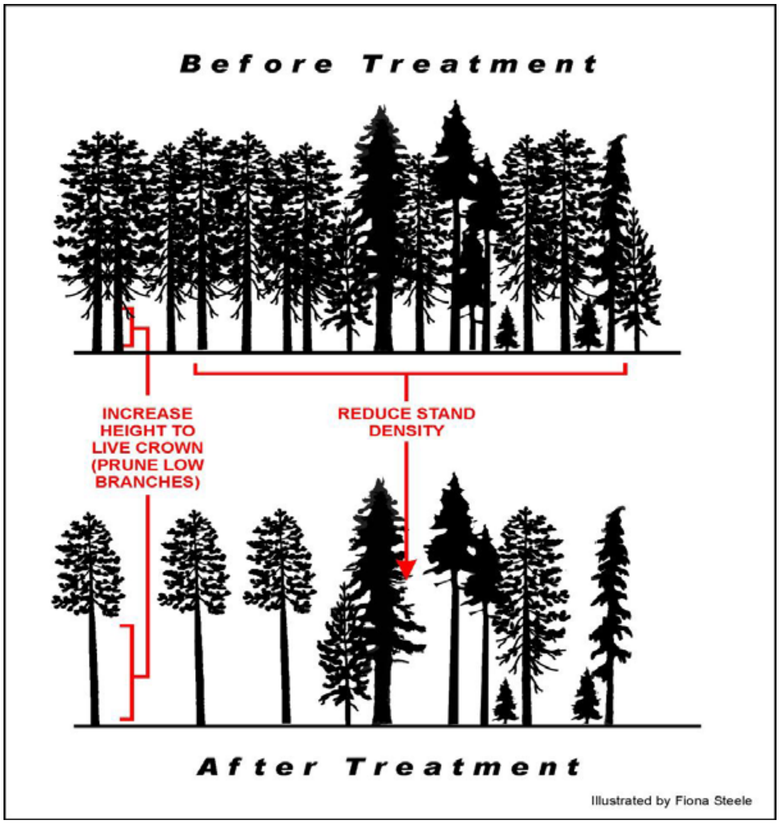

Figure 6. Schematic showing the principles of thinning to reduce stand level hazard.

5.2 Mountain Pine Beetle and the Impact on Forest Fuels

Similar to many communities in B.C., the RDCK is experiencing an outbreak of Mountain Pine Beetle. Lodgepole pine is particularly susceptible to attack by Mountain Pine Beetle and is one of the major wood species harvested in the region.

From a fire perspective the current outbreak is a concern as it contributes surface fuels that accelerate fire spread and fire intensity allowing fires to move more easily into the crowns. The intimate relationship and critical role that bark beetles and fire play in natural succession of lodgepole pine forests has been well documented. These forests, which occupy millions of hectares in the Pacific Northwest, are generally even aged stands younger than 100 years old. This is a result of periodic wildfires which follow high mortality from bark beetle attacks (Fellin 1979; Mitchell and Martin 1980; Koch 1996; Price 1991; Schowalter et al. 1981). These forests have adapted to these natural rotations, which tend to repeat every 100 years. Recent examples illustrating this cycle include the 1988 wildfires in Yellowstone National Park, the 1961 wildfire in the Bitterroot National Forest in Montana, and fires in Washington and Idaho in 1994.

Mountain pine beetle outbreaks occur mainly in mature forests, which are 80-150 years old. The outbreaks subside when most of the large diameter trees are killed. The dead trees then fuel subsequent fires, which regenerate the stand (Amman 1990; Fellin 1979; Geiszler et al. 1980; Price 1991). It has been hypothesized that these two agents of disturbance interact to maintain the structure and function of pine forests. Fire regulates forest regeneration in space and time, which is necessary for the pine beetle, and the pine beetle regulates the turnover of patches of dead trees conducive to burning (Schowalter et al. 1981).

In the past, agents of disturbance were viewed as a threat to the health of the valuable forest resource. Therefore standard policy has been to suppress all wildfire and eliminate forest pests. In pine forests, this has resulted in unstable forests, which are increasingly susceptible to physical and biological stresses.

Mountain Pine Beetle mortality results in an initial short-term increase in stand level fire hazard when trees are in the red-attack stage and for some time into the grey-attack stage while fine fuels are still present in the canopy. Trees enter the red-attack stage approximately one year following infestation and turn grey approximately three years following infestation. As needles and small branches fall from the canopy and decompose, stand level fire hazard decreases. After approximately ten years, the fire hazard begins to increase as bark begins to slough off the standing dead trees (Manning *et al.* 1982). Hazard then drops again until the beetle killed trees begin to fall (approximately 20 years), at which point the fire hazard rises to high or extreme depending on the quantity and arrangement of fuel that results from the falling trees (Manning *et al.*, 1982).

Figure 7 shows a representation of the potential succession of fire hazard status following beetle attack in a healthy stand. The healthy stand is represented with 35 to 45% crown closure and has a low fire hazard. The initial phase of pine beetle attack is the death of overstory trees with retained needles and small branches (red-attack and early grey-attack stages). In this phase the standing dead trees input fine fuels to the forest floor (attacked stand) and the stand is a high to extreme fire hazard. The loss of overstory tree foliage increases light levels to the forest floor surface and results in a flush of understory vegetation including new seedlings that regenerate naturally (understory release). This flush depends on a number of factors but is primarily a function of available light, nutrients, moisture and the existing seed bank and plant community. In general, fire hazard is lower during this phase. Over time, seedlings begin to dominate the understory forming a contiguous sapling layer (seedling dominance) and bark begins to slough off the standing dead trees (Seedling Dominance and Bark Sloughing). During this period, hazard is thought to be elevated again due to the input of fine fuels to the forest floor. After this phase, there may be a period of reduced fire hazard before the standing dead timber begins to fall on a large scale. However, once the dead trees fall in large numbers, they create high inputs of surface fuel (represented by the Young Pine Stand with Snags Falling). This is most likely when the stand has reached its highest hazard with the combination of a contiguous fuel load from the surface of the forest floor up and into the overstory canopy. These characteristics yield a stand that is now highly susceptible to stand replacement crown fire.

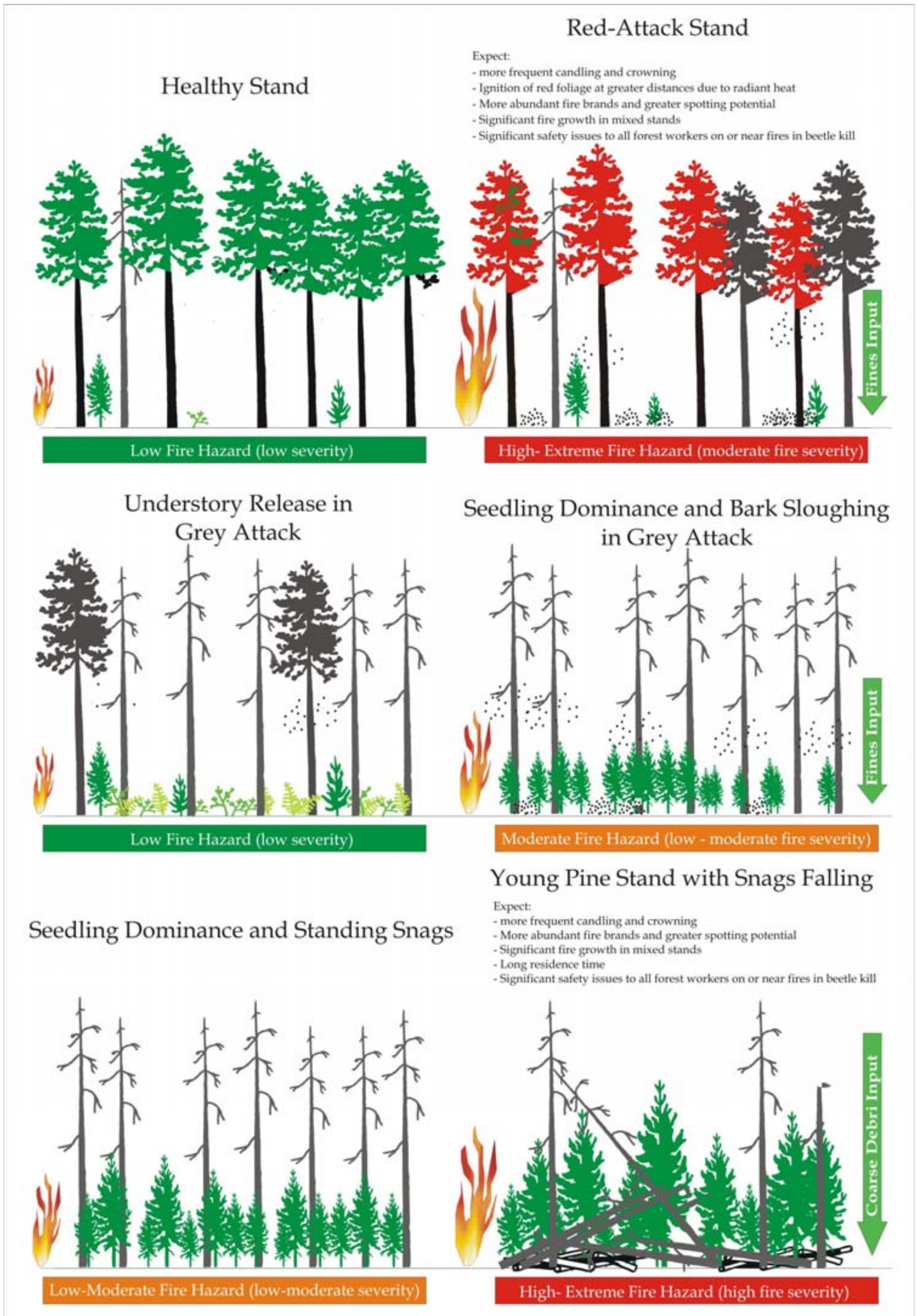

Figure 7. Diagrammatic representation of fire hazard succession following mountain pine beetle attack. In this diagram, 'fire hazard' refers to the potential fire behaviour, regardless of weather-influenced fuel moisture content. Assessment is based on physical fuel characteristics, such as fuel arrangement, fuel load, condition of herbaceous vegetation, and presence of elevated fuels. The high, moderate and low imply approximations for rate of spread, headfire intensity and crown fraction burned. 'Fire Severity' refers to the effect of fire on plants. It is dependant on intensity and residence time of the burn. An intense fire may not necessarily be severe.

Figure 8. Blowdown and breakage of dead pine contributes to fuel loading.

Modelling projections of the Mountain Pine Beetle outbreak (Eng 2004) suggest that, over the next 15 years, the forests in the RDCK will experience significant mortality of lodgepole pine in the absence of any intervention (falling and burning or control through harvest). Based on the discussion above, it is expected that surface fuel loads will increase over the next 20 years and landscape level fire hazard in pine dominated forests around the community will peak between 30 and 40 years. Any harvest within close proximity to communities, or tree removal within 2 km of communities, should target mature lodgepole pine to reduce the overall landscape level susceptibility. Any prescribed fuel treatments and/or creation of firebreaks should focus on the removal of lodgepole pine. Taking this approach will help to reduce the overall landscape level hazard and potentially limit the size and distribution of the forecasted outbreak.

5.3 The Principles of Landscape Fuelbreak Design

Fuelbreaks can be defined as strategically placed strips of low volume fuel where firefighters can make a stand against fire and provide safe access for fire crews in the vicinity of wildfires, often for the purpose of lighting backfires. Fuelbreaks act as staging areas where fire suppression crews could anchor their fire suppression efforts, thus increasing the likelihood that fires could be stopped, or fire behaviour minimized, so that the potential for a fire to move fluidly through a municipality and into the interface is substantially reduced. The principles of fuelbreak design are described in detail in Appendix 2.

Communities must be sensitive to visual concerns and public perception. Therefore, specific area treatments or other manual/mechanical methods are most desirable. A fuel treatment is created by reducing surface fuels, increasing height to live crown and lowering stand density through tree removal (Figure 9). Fuelbreaks can be developed using a variety of prescriptive methods that may include understory and overstory fuel removal, timing of treatment, synergistic effects with other treatments, and placement on the landscape.

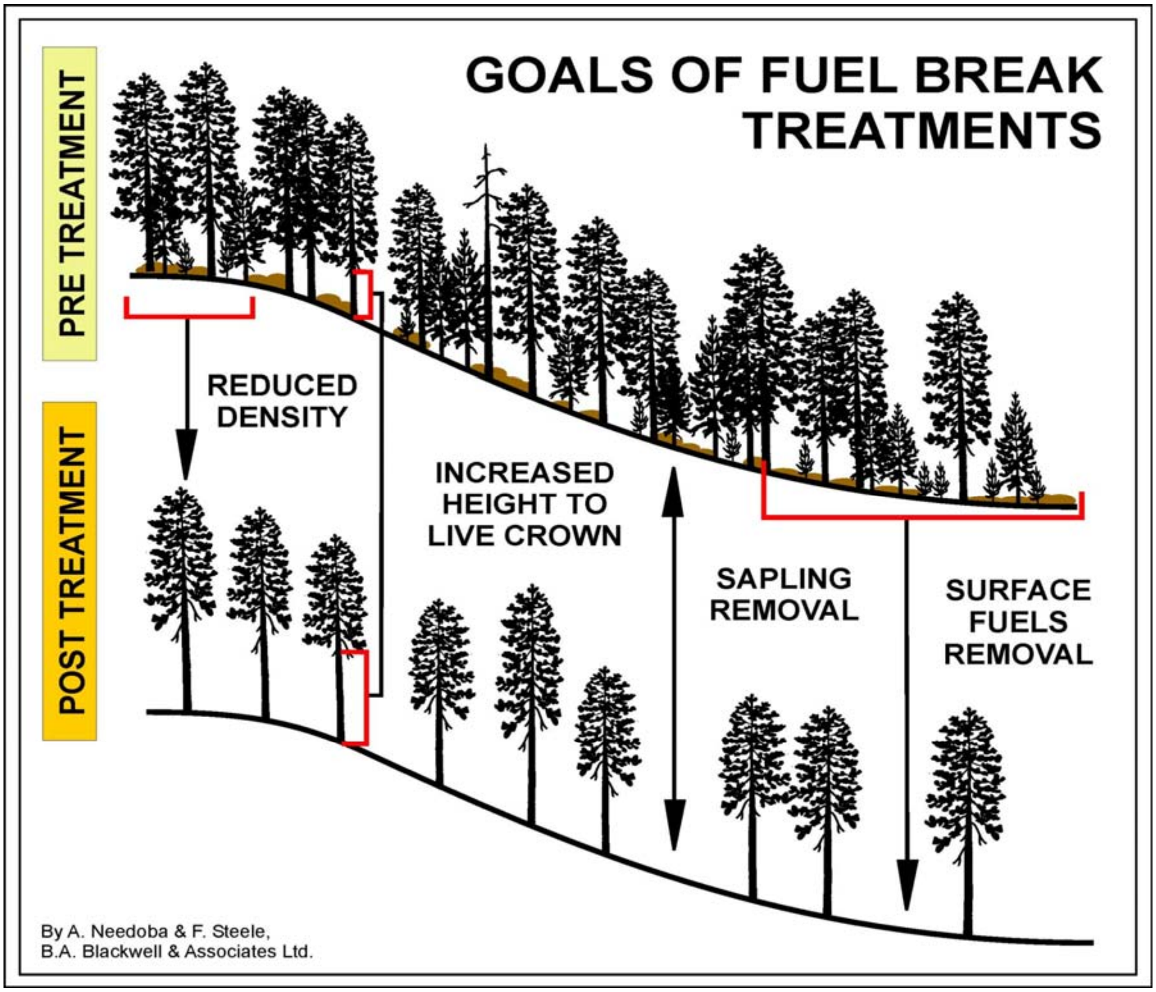

Figure 9. Conceptual diagram of a shaded fuelbreak pre treatment and post treatment.

When developing fuelbreak prescriptions, the CFFDRS fuel type classification for the area and the potential fire behaviour must be considered in order to predict the change in fire behaviour that will result from altering fuel conditions. The identification of potential candidate areas for fuelbreaks should be focused on areas that will isolate and limit fire spread, and provide solid anchors for fire control actions. The search for candidate areas should be conducted using a combination of aerial photographs, Terrestrial Resources Information Mapping (TRIM), topographic maps, and personal field experience.

Prior to finalizing the location of fuelbreaks, fire behaviour modeling using the Canadian Fire Behaviour Prediction system (FBP) should be applied to test the effectiveness of the size and scale of proposed treatments. These model runs should include basic information from fieldwork pertaining to the fuel types, height to live crown base, crown fuel load, surface loads, and topography. The model runs should be used to demonstrate the effectiveness of treatments in altering fire behaviour potential.

Treatment prescription development must also consider the method of fuel treatment. Methods include manual (chainsaw), mechanical, and pile burning or any combination of these treatments. To be successful, manual treatments should be considered in combination with prescribed burning of broadcast fuels or pile and burn. Mechanical treatments involve machinery and must be sensitive to ground disturbance and impacts on hydrology and watercourses. Typically, these types of treatments reduce the overstory fuel loads but increase the surface fuel load. The surface fuel load must be removed in order to significantly reduce the fire behaviour potential. Increased surface fuel load is often the reason that prescribed burning or pile and burn are combined in the treatment prescription.

Final selection of the most appropriate fuelbreak location will depend on a number of factors including:

- Protection of recreation and aesthetics;
- Protection of public safety;
- Reduction of potential liabilities;
- Minimizing future suppression costs;
- Improved knowledge;
- Impacts on visual quality;
- The economics of the treatments and the potential benefits;
- Treatment cost recovery;
- The impact of treatments on the alteration of fire behaviour; and
- Public review and comment.

Fuelbreaks should not be considered stand-alone treatments to the exclusion of other important strategies already discussed in this plan. To be successful, municipalities need to integrate a fuelbreak plan with strategic initiatives such as structure protection, emergency response, training, communication and education. An integrated strategy will help to mitigate landscape level fire risk, reduce unwanted wildland fire effects and the potential negative social, economic and environmental effects that large catastrophic fires can cause.

5.3.1 Maintenance

Once a municipality commits to the development of a fuelbreak strategy, decision makers and municipal staff must recognize that they are embarking on a long-term commitment to these types of treatments and that future maintenance will be required. Additionally, the financial commitment required to develop these treatments in the absence of any revenue will be high. A component of the material to be removed to create fuelbreaks has an economic value and could potentially be used to offset the cost of treatment, thereby providing benefits to municipalities and the local economy.

Fuelbreaks require ongoing treatment to maintain low fuel loadings. Following treatment, tree growth and understory development start the process of fuel accumulation and, if left unchecked, over time the fuelbreak will degrade to conditions that existed prior to treatment. Some form of follow-up treatment is required. Follow-up is dependent on the productivity of the site, and may be required as frequently as every 10 to 15 years in order to maintain the site in a condition of low fire behaviour potential.

6.0 Post Wildfire Rehabilitation Planning

Wildfires have immediate short and long-term impacts on the social, economic and environmental values of an interface community. In steep environments, post fire impacts (*i.e.* removal of ground cover) can result in an elevated risk of landslides and debris flows. Within watersheds, post fire impacts can include increased nutrient and sediment flow into reservoirs. These impacts can be reduced or avoided through the development of post fire mitigation plans and effective response following fire. In communities that have identified risk of landslide and debris flow, it is appropriate to consider the development of a post fire rehabilitation plan that will guide actions following a fire event.

Emergency rehabilitation and restoration activities are intended to mitigate some of the damage caused by suppression actions, as well as some of the potential soil erosion and landscape level impacts caused by precipitation events on burned slopes following a fire. Post fire impacts are dependent on a complex relationship between fire severity, ecosystem type, slope and soils. A stable watershed is defined by intact vegetation, forest floor and soil where sedimentation is limited. Consequently, watershed stability could be severely impacted after a major fire disturbance.

Advanced planning (pre-planning) for post-fire stabilization and rehabilitation is a relatively new concept in BC. However, the purpose of pre-planning is to facilitate a rapid post-fire assessment and response to ensure rehabilitation is completed before any storm events occur that might trigger undesirable post-wildfire effects. Assembling information in advance will subsequently allow for the rapid refinement of planned strategies for emergency stabilization, and short and long-term rehabilitation.

Pike and Ussery (2005) outline the key considerations when pre-planning for post-wildfire rehabilitation. They are listed as follows:

- Keep planning simple, clearly define terms and match goals to planned activities.
- Consider landform characteristics.
- Identify key community values.
- Determine priority areas for action.

- Clarify jurisdictional issues.
- Predict areas most susceptible to post-fire erosion.
- Understand the triggers for undesirable post-fire conditions.
- Learn from existing experience.
- Develop risk-based strategies.
- Match techniques with needs.
- Think long-term.
- Consider proactive approaches to reducing risk.
- Identify training and communication needs.

The primary goal of post wildfire rehabilitation planning is to prepare for a strategic, effective and rapid post-wildfire response (Pike and Ussery 2005). Although some post-burn scenarios can be forecast, the focus of the plan should be on information gathering rather than outcome prediction and preparation for all possible events. There are three categories of stabilization/rehabilitation: i) short term emergency stabilization; ii) rehabilitation of fire suppression related effects; and iii) long-term watershed rehabilitation.

Given the need for quick action and the substantial resources that are often required for post-fire stabilization and rehabilitation, it is important to match the intensity of these activities with the level of risk to key watershed values. The most comprehensive stabilization and rehabilitation activities should be directed at the areas with the highest values at risk. It is also important to consider the potential risk to watershed values from access, machinery, and materials in post-fire interventions.

Pre-planning should identify priority areas in watersheds for fire suppression and post-fire stabilization/rehabilitation based on the results of a risk/consequence assessment. Similar to wildfire planning, post fire response should consider a risk-based approach to assessing potential hazards from fire and post-fire conditions, and the potential consequences of such hazards on key community values.

Rehabilitation plans for communities must consider the potential for negative effects on areas downstream of the fire site and address accompanying inter-jurisdictional issues (such as damage to highways, railways, community infrastructure and/or private property). Slope stability, erosion potential and sediment transport all influence post wildfire susceptibility and impacts. High intensity rainfall events, even of relatively short duration, on areas with water repellent soils have been shown to increase flooding and accelerate erosion.

A list of qualified professionals with expertise in post-fire assessments, risk analyses and emergency stabilization and rehabilitation should be developed. It is important to have a list of professionals at hand to facilitate a rapid response to emergencies. This list should be updated annually. The administrative and financial policies and procedures for retaining contract services in emergency situations should also be in place and well understood.

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