Village of Tahsis
Community Wildfire Protection Plan

Strathcona Regional District

Submitted by
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Submitted To
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T A H S I S

C O M M U N I T Y W I L D F I R E P R O T E C T I O N P L A N

Considerations for Wildland Urban Interface Management in the Village of Tahsis, British Columbia

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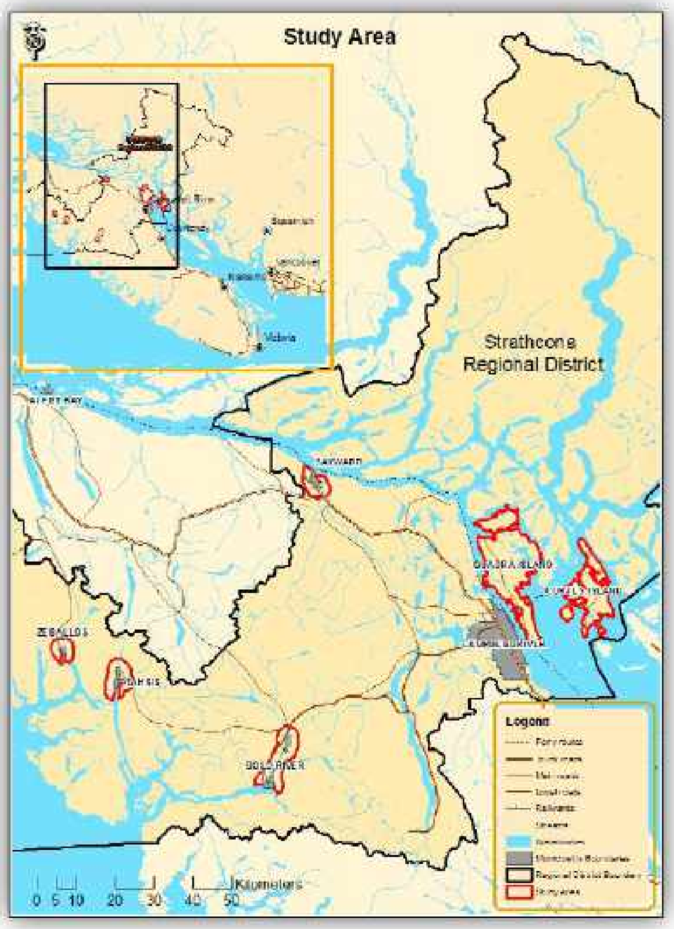
1.0 Introduction

In 2009 B.A. Blackwell and Associates Ltd. were retained to assist the Strathcona Regional District in developing Community Wildfire Protection Plans (CWPP) for six communities shown in Map 1:

- Village of Gold River,
- Village of Tahsis,
- Village of Zeballos,
- Village of Sayward,
- Cortes Island,
- Quadra Island.

Within the study areas, the assessment considered important elements of community wildfire protection that included communication and education, structure protection, training, emergency response, and vegetation management.



Map 1. Overview of Strathcona Regional District Community Wildfire Protection Plan areas.

The social, economic and environmental losses associated with the 2003 and 2009 fire seasons emphasized the need for greater consideration and due diligence in regard to fire risk in the wildland urban interface (WUI). In considering wildfire risk in the WUI, it is important to understand the specific risk profile of a given community, which can be defined by the probability and the associated consequence of wildfire within that community. While the probability of fire in coastal communities is substantially lower when compared to the interior of British Columbia, the consequences of a large fire are likely to be very significant in communities given access and evacuation constraints, population size, topography, values at risk, and environmental considerations.

The CWPPs will provide the communities with a framework that can be used to review and assess areas of identified high fire risk. Additionally, the information contained in this report should help to guide the development of emergency plans, emergency response, communication and education programs, bylaw development in areas of fire risk, and the management of forest lands adjacent to the community. Six separate reports have been developed, one for each community.

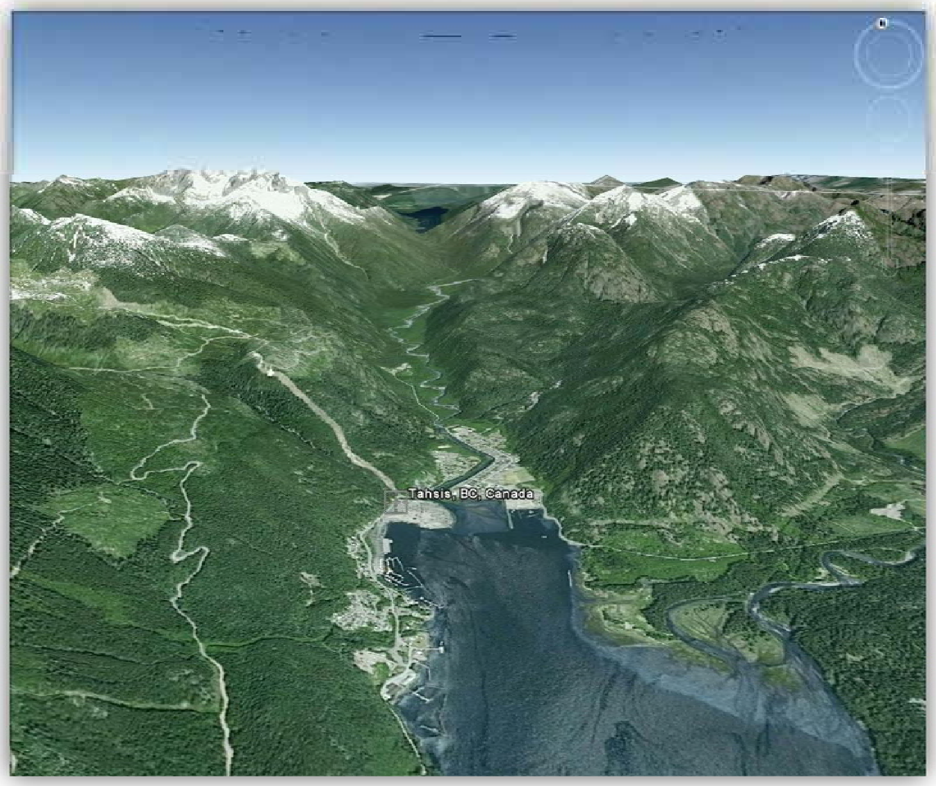
The scope of this project included three distinct phases of work:

- **Phase I** –Assessment of fire risk and development of a Wildfire Risk Management System (WRMS) to spatially quantify the probability and consequence of fire.
- **Phase II –** Identification of hazardous fuel types and issues related to wildfire in the communities.
- **Phase III –** Development of the Plan, which outlines measures to mitigate the identified risk through structure protection, emergency response, training, communication and education, and fuel treatments.

2.0 TAHSIS

2.1 Study Area

The Village of Tahsis (referred to as the Village or Tahsis in this document) is located at the end of Tahsis Inlet (Map 2). Access to the community is limited to Head Bay Rd from Gold River along a 65 km gravel road. The study area for the community includes the 823 ha within the community border and an additional 2 km buffer around this border for a total area of 4970 ha.



Map 2. Looking towards Tahsis up Tahsis Inlet. Head Bay Rd runs east towards Gold River.

2.2 Topography

Tahsis is located in a valley bottom at the head of an inlet. Tahsis River, which flows south from Woss Lake, runs through the centre of the community. A second river, the Leiner River, is located near the north east edge of the community. The Village is bordered by moderate to steep slopes. Karst topography is common in the area, making it a popular destination for cavers. In regards to suppression efforts, the steep rocky terrain places constraints on fire detection and fire crew access. Rock fall along the western border of the community is a concern; maintaining forested slopes here helps safeguard the houses below from falling debris.

2.3 Population

As of 2006, Tahsis has a population estimated at 366 people[1]. BC statistics data indicates that the population has declined by 39.0% between 2001 and 2006. As of 2006, there were 195 occupied private dwellings and 406 dwellings in total.

Tahsis is a residential community with most structures located in two main centres, along the Tahsis River and along the western side of Tahsis Inlet. The local economy is comprised primarily of forestry, fishing, and hunting related activities, educational services, and retail and trade services serving the local community (Table 1).

Table 1. Summary of employment by sector for Tahsis.

LF by industry	Population 15 years and over, North American Industry Classification System 2002								
	Both sexes			Male			Female		
			BC			BC			BC
Total labour force 15 years and over	200	100.0%	100.0%	110	100.0%	100.0%	95	100.0%	100.0%
Industry - Not applicable	-	0.0%	1.5%	-	0.0%	1.3%	-	0.0%	1.7%
All industries	195	97.5%	98.5%	110	100.0%	98.7%	90	94.7%	98.3%
Agriculture, forestry, fishing, hunting	50	25.0%	3.4%	55	50.0%	4.4%	-	0.0%	2.4%
Mining and oil & gas extraction	-	0.0%	0.9%	-	0.0%	1.4%	-	0.0%	0.3%
Utilities	-	0.0%	0.5%	-	0.0%	0.7%	-	0.0%	0.3%
Construction	10	5.0%	7.5%	10	9.1%	12.4%	-	0.0%	2.0%
Manufacturing	15	7.5%	8.5%	10	9.1%	11.9%	-	0.0%	4.7%
Wholesale trade	-	0.0%	4.1%	-	0.0%	5.3%	-	0.0%	2.9%
Retail trade	15	7.5%	11.2%	-	0.0%	9.4%	15	15.8%	13.1%
Transportation & warehousing	10	5.0%	5.2%	-	0.0%	7.4%	10	10.5%	2.6%
Information & cultural industries	-	0.0%	2.6%	-	0.0%	2.9%	-	0.0%	2.4%
Finance & insurance	-	0.0%	3.8%	-	0.0%	2.7%	-	0.0%	5.0%
Real estate & rental & leasing	-	0.0%	2.3%	-	0.0%	2.3%	-	0.0%	2.3%
Professional, scientific & tech. services	-	0.0%	7.3%	-	0.0%	7.6%	-	0.0%	6.9%
Management of companies & enterprises	-	0.0%	0.1%	-	0.0%	0.1%	-	0.0%	0.1%
Admin. & support, waste m'gement & remediation	10	5.0%	4.4%	-	0.0%	4.6%	-	0.0%	4.1%
Educational services	25	12.5%	6.9%	10	9.1%	4.5%	15	15.8%	9.5%
Health care & social assistance	-	0.0%	9.6%	-	0.0%	3.3%	10	10.5%	16.4%
Arts, entertainment & recreation	-	0.0%	2.3%	-	0.0%	2.2%	10	10.5%	2.4%
Accommodation & food services	20	10.0%	8.1%	10	9.1%	6.0%	15	15.8%	10.3%
Other services (exc. public admin.)	-	0.0%	4.9%	-	0.0%	4.3%	-	0.0%	5.6%
Public administration	25	12.5%	5.0%	-	0.0%	5.0%	20	21.1%	4.9%

2.4 Infrastructure

Infrastructure in Tahsis includes water supply related buildings and equipment, Captain Meares Elementary School, recreation centre, fire hall, sewage plant, RCMP office, public dock, municipal office and yard, BC Hydro substation and transmission lines, library, and health

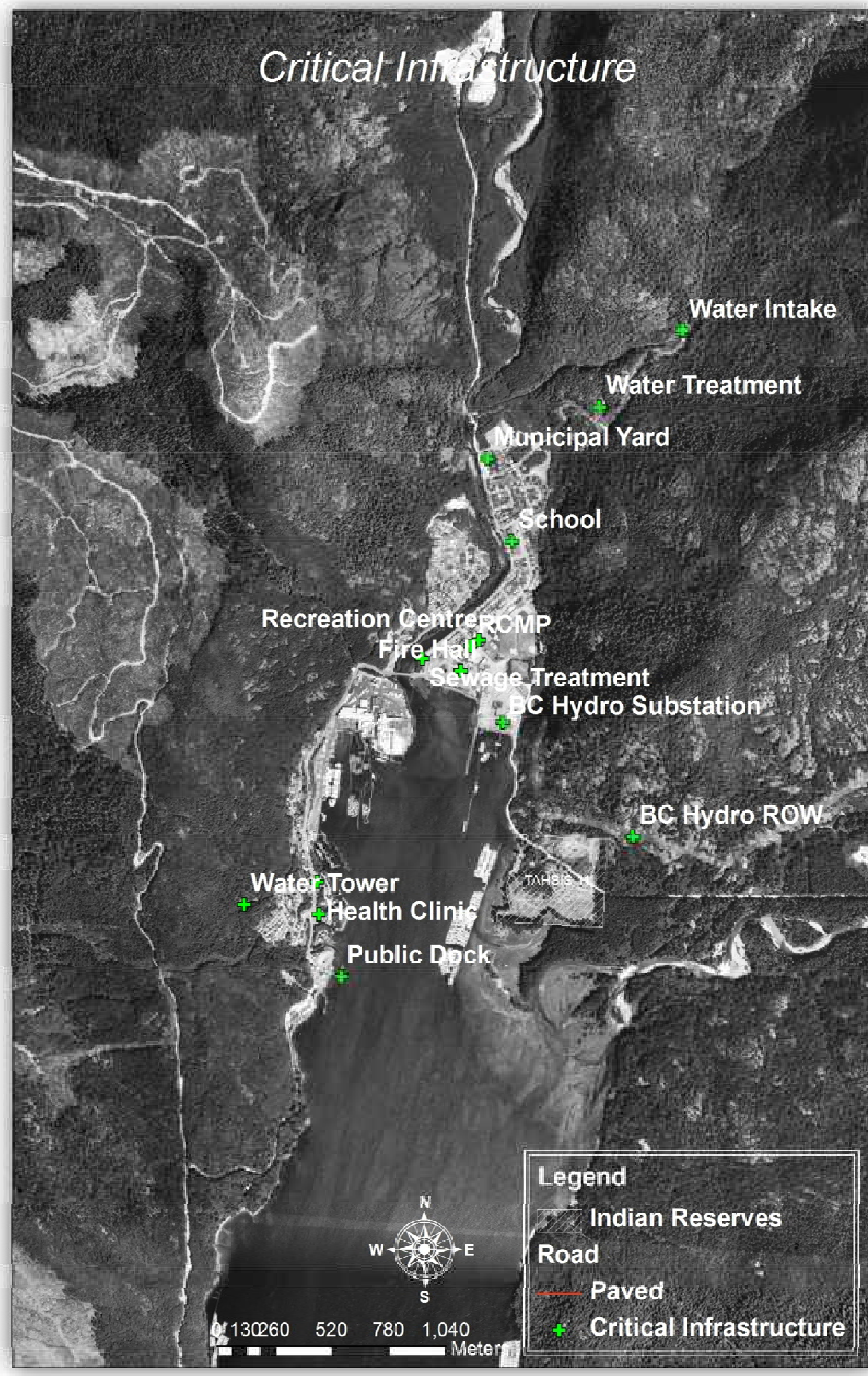
[1] http://www.bcstats.gov.bc.ca/data/cen06/profiles/detailed/59025030.pdf

centre (Map 3, Figure 1). Most of these structures are located within the main centre of the community, and the primary risk to them is via spotting. Water infrastructure is in the interface area and power supply is dependent upon wood poles, which are vulnerable to surface and crown fires. Buildings near the water intake are sheathed in vinyl siding, making them vulnerable to ignition. The public dock and other private and commercial docks will be important water egress (exit) points. Wooden pilings and other structures are often preserved in creosote which makes them vulnerable to spotting.

Figure 1. Critical infrastructure - BC Hydro substation (right) and flammable vegetation around sewage treatment plant in Tahsis (left).

BC Hydro transmission lines service the community and are extremely vulnerable to wildfire as they run through contiguous forested fuels. Loss of this infrastructure would result in loss of power to the community for potentially many weeks or months until new poles were put in place. This would cause considerable financial and personal hardship for the Village's businesses, and residents. Key facilities dependent upon electrical supply should consider installing backup generators. In the event of upgrades to key infrastructure, the use of fire resistant materials should be considered to reduce vulnerability to wildfire. The link below is for a BC Hydro press release and summarizes the impact a wildfire had upon BC Hydro power supply from Heffley Creek (Kamloops) to Valemount 250 km away during the McLure and Strawberry Hills fires of 2003.

http://www.bchydro.com/news/articles/press_releases/2003/bc_hydro_facilities_significantly_impacted_by_forest_fires2.html



Map 3. Critical infrastructure in the Village of Tahsis.

2.5 Environmental Values

One species at risk occurs in the study area according to the Conservation Data Centre species at risk occurrences (the species occurrence is masked; therefore information on the species is not accessible). The study area is defined by the regional climate of the Coastal Western Hemlock very moist maritime (CWHvm1, vm2) and the Mountain Hemlock windward moist maritime (MHmm1). The water supply for the Village is from McKelvie Creek. The Village depends upon the natural hydrological functions of the watershed to positively influence water quality, quantity, and timing of flows. Loss of forest cover in this watershed could have significant negative impacts upon all of these functions. Old forests are common around Tahsis and contribute to the environmental values present.

3.0 Fire Environment

3.1 Fire Weather

The Canadian Forest Fire Danger Rating System (CFFDRS), developed by the Canadian Forestry Service, is used to assess fire danger and potential fire behaviour. The BC Ministry of Forests, Mines and Lands (MFML) maintains a network of fire weather stations during the fire season that is used to determine fire danger on forestlands within the community. The information is commonly used by municipalities and regional governments to monitor fire weather information provided by the MFML Protection Branch to determine hazard ratings and associated fire bans and closures within their respective municipalities. Key fire weather parameters summarized as part of the analysis include:

- Days above Danger Class Rating IV and V: The Danger Class Rating is derived from fire weather indices and has 5 classes: 1) Very Low Danger; 2) Low Danger; 3) Moderate Danger; 4) High Danger; and 5) Extreme Danger.

- Drought Code: The Drought Code represents the moisture in deep, compact organic matter with a nominal depth of about 18 cm and a dry fuel load of 25 kg/m^2. It is a measure of long-term drought as it relates to fire behaviour.

It is important to understand the likelihood of exposure to periods of high fire danger, defined as Danger Class IV (high) and V (extreme), in order to determine appropriate prevention programs, levels of response, and management strategies. Fire danger within the study area can vary from season to season but is generally relatively low to moderate. The study area lies on the west coast of Vancouver Island. The climate is wet and humid, with cool summers and winters that are relatively mild.

Figure 2 is a compilation of available weather station data within the Coastal Western Hemlock very moist biogeoclimatic unit (CWHvm) (representative of the study area) that dates back to 1900 and provides a summary of the total number of Danger Class III, IV and V-days from May through to August of each year. This compilation shows that fire danger can fluctuate substantially between years. On average there are 5 days in the fire season in Danger Class V. Typically, the most extreme fire weather occurs in early August.

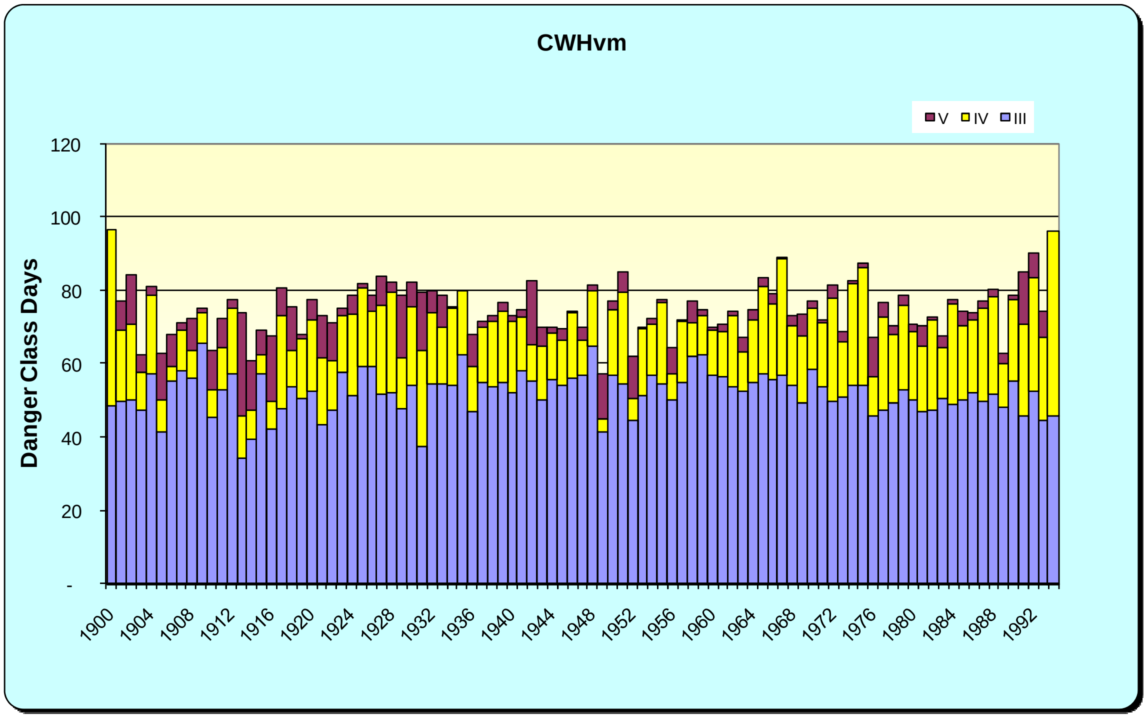


Figure 2. Seasonal variability (May-August) in the number of Danger Class III, IV and V-days within the study area as described by the regional climate of the CWHvm.

A summary of historic drought codes provides a similar comparison to danger class days (Figure 3). A drought code that exceeds 300 is considered high and is associated with increased suppression effort and mop up. A drought code exceeding 425 is considered extreme. Based on monthly averages by drought code classes, drought codes are not high or extreme in June and are only high 1.4 days in July. In August, 3.6 days are high and 1 day falls in the extreme category. In September, the drought code is on average high for 4.5 days and extreme for 1 day (Table 2). The low number of high and extreme days in July reflects the wet maritime climate of the study area. Even during summers, moisture levels remain high, in part due to fogs that are common during the summer months.

Table 2. Days in high and extreme classes for drought codes during the fire season. Data is from Zeballos weather station located in the CWHvm (1970-1995).

Drought Code Class	Month			
	June	July	August	September
High	0	1.4	3.6	4.5
Extreme	0	0	1	1

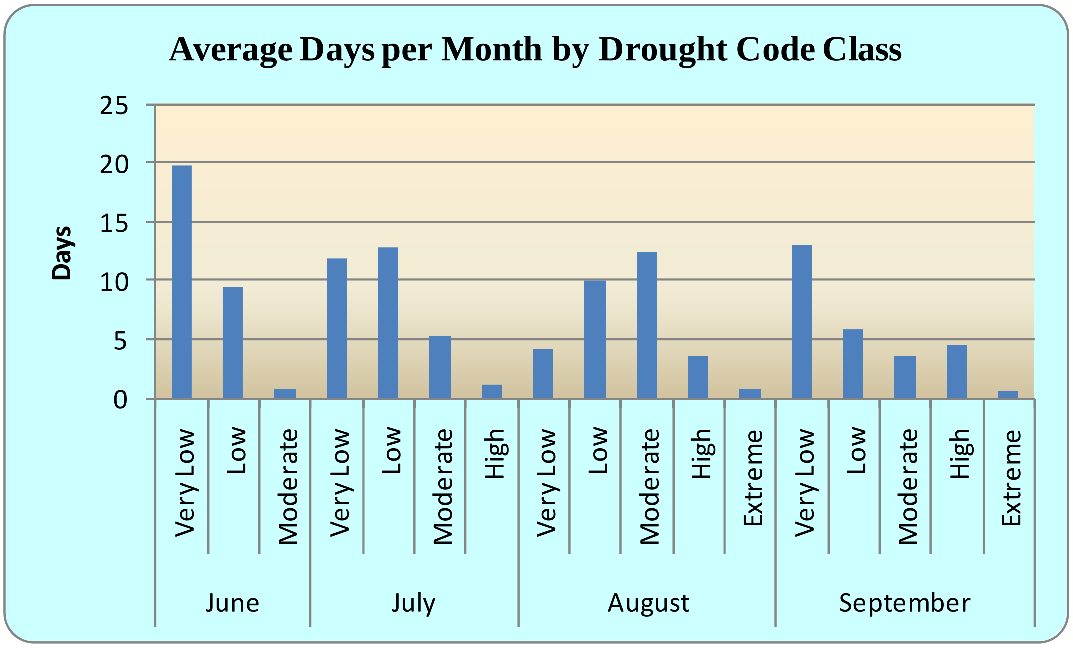


Figure 3. Average number of days by month where drought code class is very low (0-79), low (80-189), moderate (190-299), high (300-424), and extreme (>425). Data is from Zeballos weather station located in the CWHvm (1970-1995).

3.2 Fuels

Fuel classification was based on the CFFDRS (Canadian Forest Fire Danger Rating System) and a summary of fuel type attributes collected in the field. Where Vegetation Resource Inventory (VRI) data or other forest cover data was not available for the study area, forest fuel polygons were typed in ESRI's GIS mapping program ArcGIS 9.31 using colour and black and white orthophotographs or Bing Maps (© 2010 Microsoft Corporation). In some areas, available orthophotographs were quite old (1996). This has resulted in data that does not reflect the current state of the fuels as changes that have occurred through land use are not reflected. Furthermore, due to the pixel size of some of the orthophotos, crown architecture was not clearly identifiable, which precluded accurate assessment of species mixes in the stands. In these cases, adjacent forest cover data or VRI, and field stops were relied on to determine species mix. However, the major important delineations based on species being deciduous or coniferous were possible in all cases using the orthophotos.

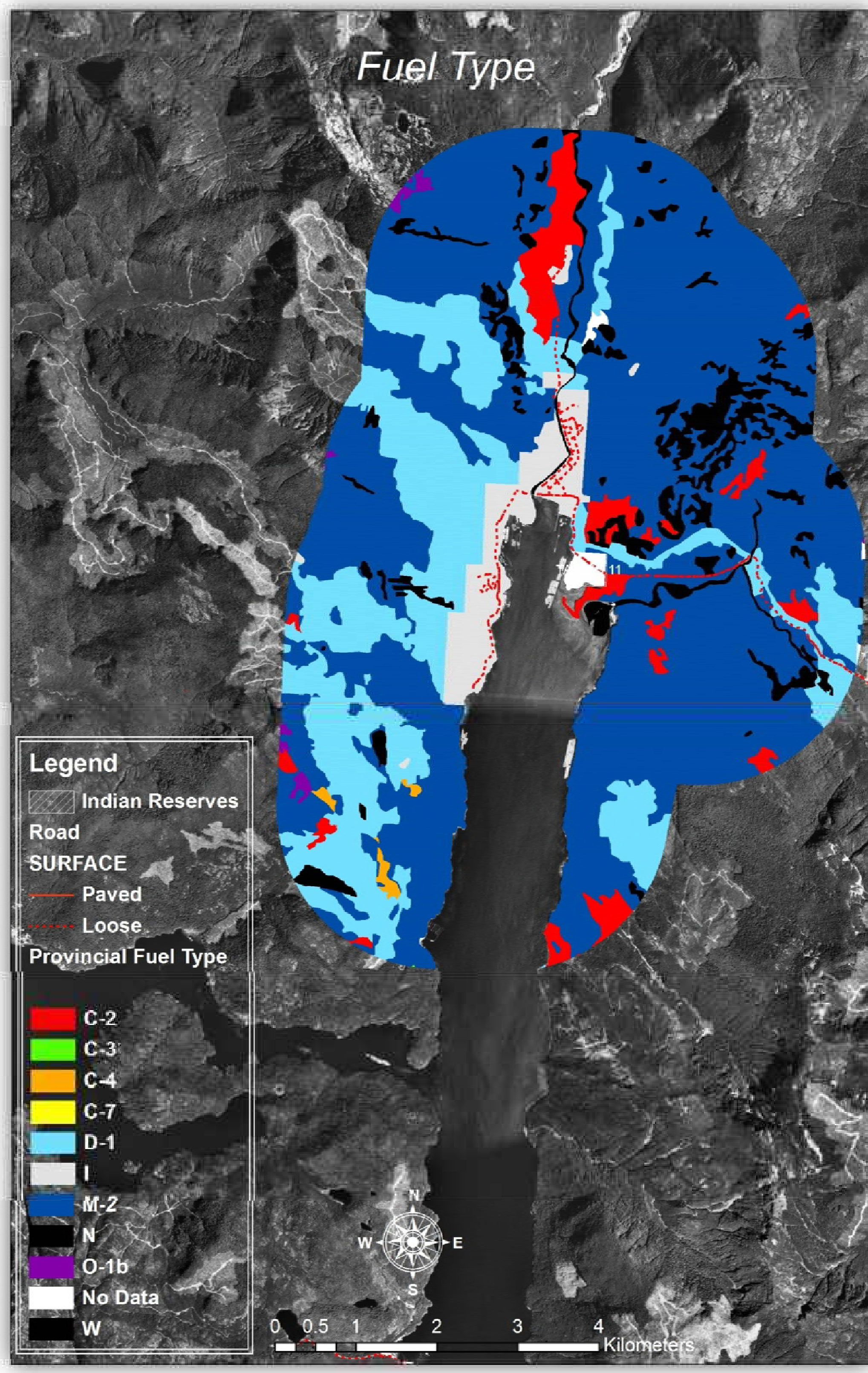
To attribute the fuel polygons and aid in polygon delineation, stand and fuels data were collected during field work. Field checks were primarily located in the wildland urban interface. In total, 20 field checks were completed. This data was incorporated into existing fuel typing for the region. For each fuel type identified in the field, a best approximation of the CFFDRS classification was assigned and was supported with a summary of detailed attributes. The Ministry of Forests, Mines and Lands fuel typing was improved upon and adjusted to incorporate local variation (Map 4 and Map 5).

Table 3 summarizes the fuel types and areas. A description of each fuel type shown in the study area is provided in Appendix 1. The description details the general characteristics of the fuel type (i.e. stand characteristics) as well as the burn difficulty. Representative photos are also included. In general the high priority fuel types in terms of dangerous fire behaviour are C2, C4, and C3 as indicated by the hazard level in Table 3.

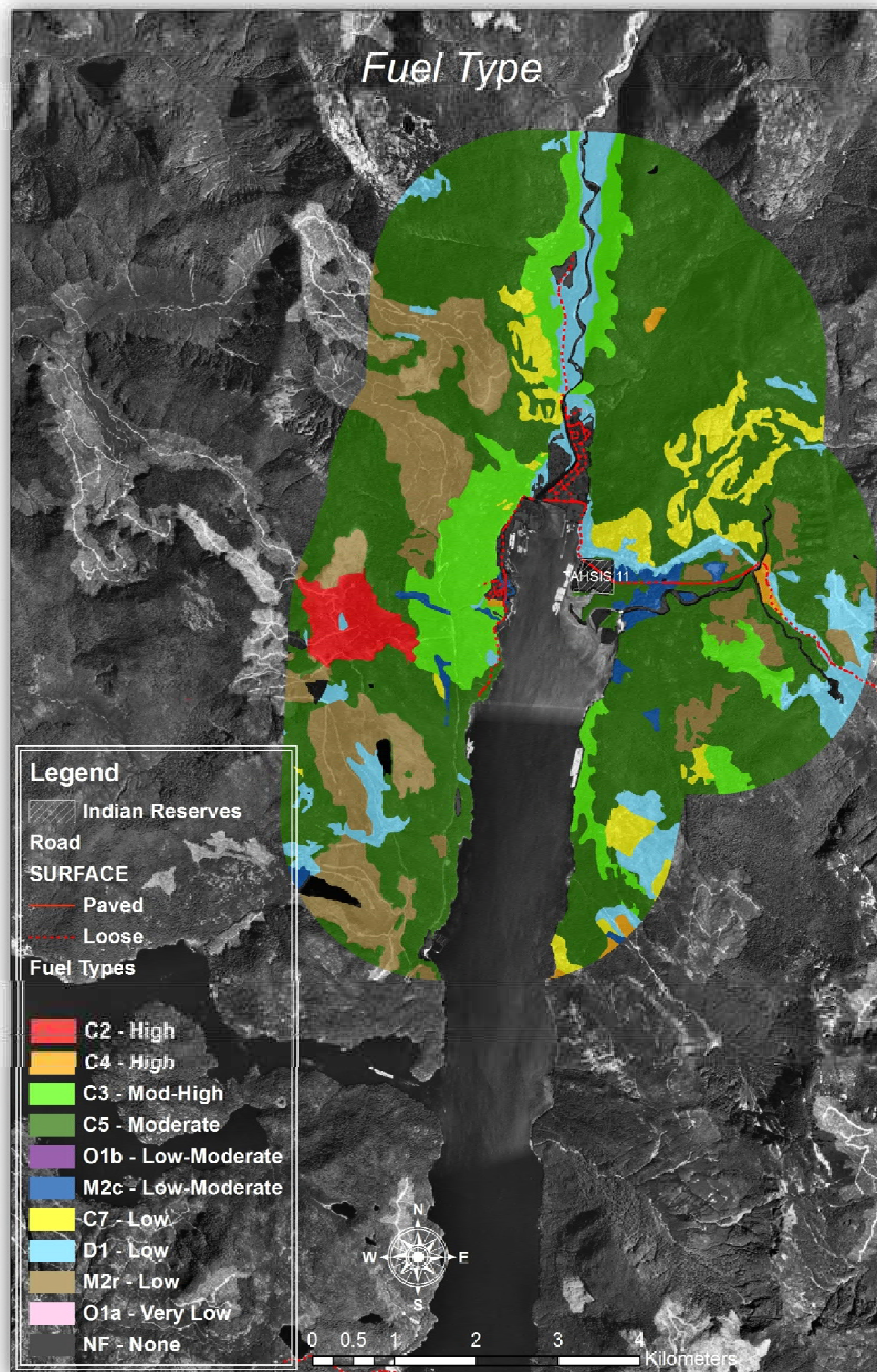
Table 3. Fuel types in the study area.

	Fuel Type											
	C2	C3	C4	C5	C7	D1	M2c	M2r	NF	O1a	O1b	Grand Total
Hazard Level	High	Mod-High	High	Moderate	Low	Low	Low-Moderate	Low	None	Very Low	Low-Moderate	
Area (ha)	103.0	476.1	22.4	2780.1	252.4	384.6	65.4	689.0	196.7			4969.6
% Total	2.1	9.6	0.4	55.9	5.1	7.7	1.3	13.9	4.0	0.0	0.0	100.0

Map 4 and Map 5 show the original provincial fuel types for the study area and the new updated fuel types that more closely represent expected fire behaviour. The original fuel types under represented the fire behaviour in the study area and in many cases were missing data. D1 and M2 fuel types represent deciduous and mixed coniferous forests respectively. These forest types are clearly not common in the study area. This is reflected by the updated fuel types. The high amount of C5 (56%) represents the abundance of mature and old forests in the study area.



Map 4. Provincial fuel types for the study area.



Map 5. Updated fuel types for the study area and relative hazard for each type.

3.3 Historic Ignitions

The MFML fire reporting system was used to compile a database of fires back to 1950 in the study area. Map 6 shows the ignition locations. The average number of fires per year by decade is as follows: 1950-59 – 0.4; 1960-69 – 0.3; 1970-79 – 0.2; 1980-89 – 0.1; 1990-1999 – 0; 2000-08 – 0.2. The most significant fire year in recent history was 1948 when a fire spread along much of the currently inhabited area along the western shore of Tahsis Inlet and up the Tahsis River. The total fire size was 579.8 ha (Map 6).

Table 4 summarizes the fires that have occurred between 1950 and 2008 in the study area by size class and cause. The total number of fires during this period was 12, of which 92% were the result of human causes. The remaining 8% of fire ignitions were lightning caused. Eighty-three percent of all fires that burned between 1950 and 2008 were smaller than four hectares, while 2 fires were greater than 10 hectares.

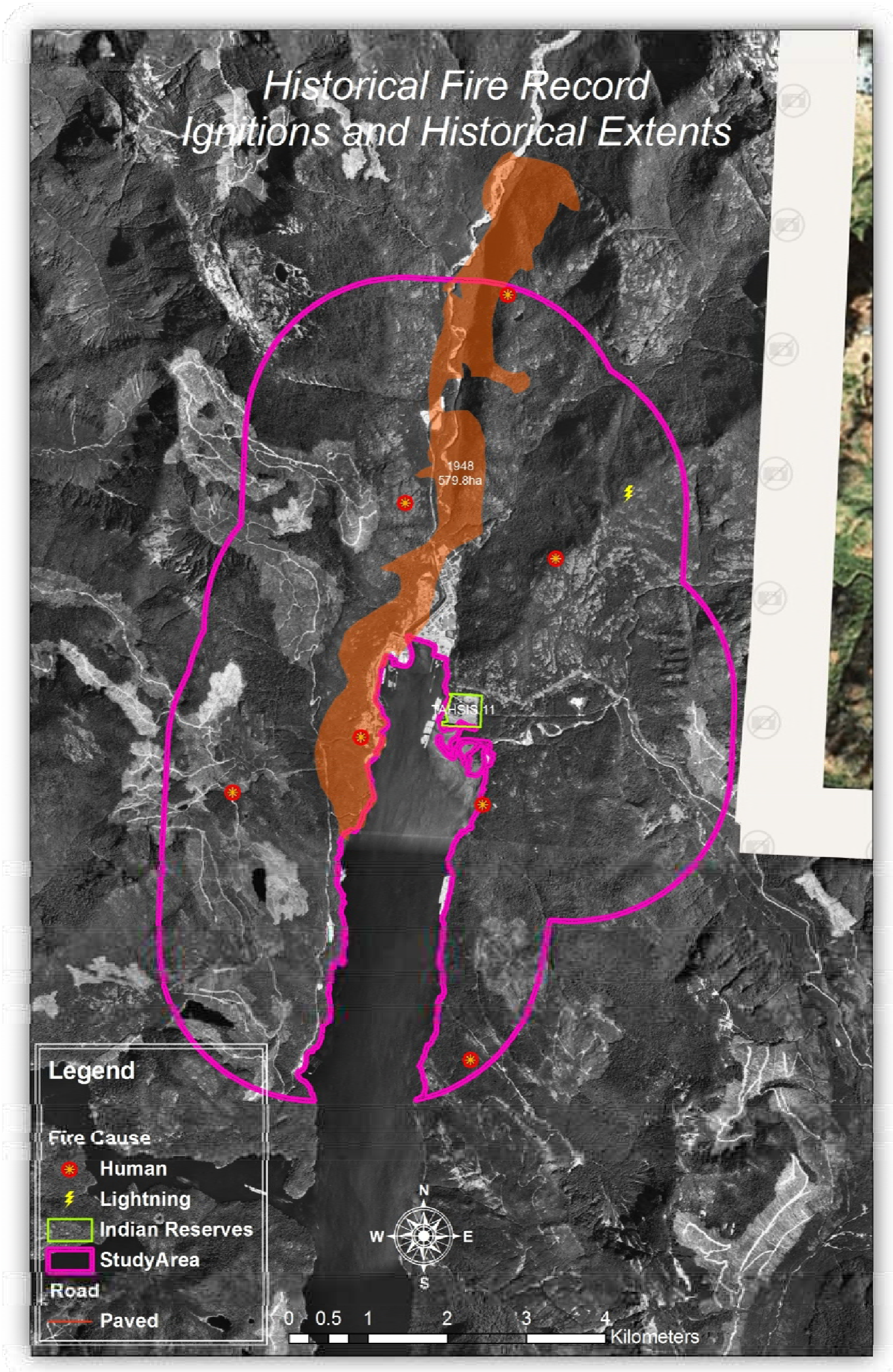
Table 5 summarizes fire cause by decade. Through the time of record, human caused fires have far out-numbered those caused by lightning. On average, there have been 2 fires each decade (minimum 0 in the '90s and maximum 4 in the '50s). However, not all fire occurrences within the study area are reported to the MFLM, so the figures presented here are probably an underestimation of the actual number of fires.

Table 4. Provincial data fire history summary within the study area from 1950 - 2008.

Size Class (ha)	Total Number of Fires	% of Total	Lightning Caused	Human Caused
<4.0	10		1	9
4.0-10.0				
>10.0	2			2
Total Fires	12		1	11

Table 5. Provincial data summary of fire cause within the study area.

Decade	Campfire	Equipment Use	Fire use	Incendiary	Juvenile fire setter	Lightning	Misc.	Smoker	Grand Total
1950								4	4
1960			1					2	3
1970						1		1	2
1980								1	1
1990									
2000							2		2
Total			1			1	2	8	12



Map 6. Historical fire record and fire extents for the study area.

4.0 The Wildland Urban Interface

The classical definition of wildland urban interface (WUI) is the place where the "*forest meets the community*". Other configurations of the WUI can be described as intermixed. Intermixed areas include smaller, more isolated developments that are embedded within the forest. An example of an intermixed interface is shown in Figure 4.

In each of these cases, fire has the ability to spread from the forest into the community or from the community out into the forest. Although these two scenarios are quite different, they are of equal importance when considering interface fire risk. Within the Village of Tahsis, the probability of a fire moving out of the community and into the forest is equal to or greater than the probability of fire moving from the forest into the community. Regardless of which scenario occurs, there will be consequences for the Village and this will have an impact on the way in which the community plans and prepares for interface fires.

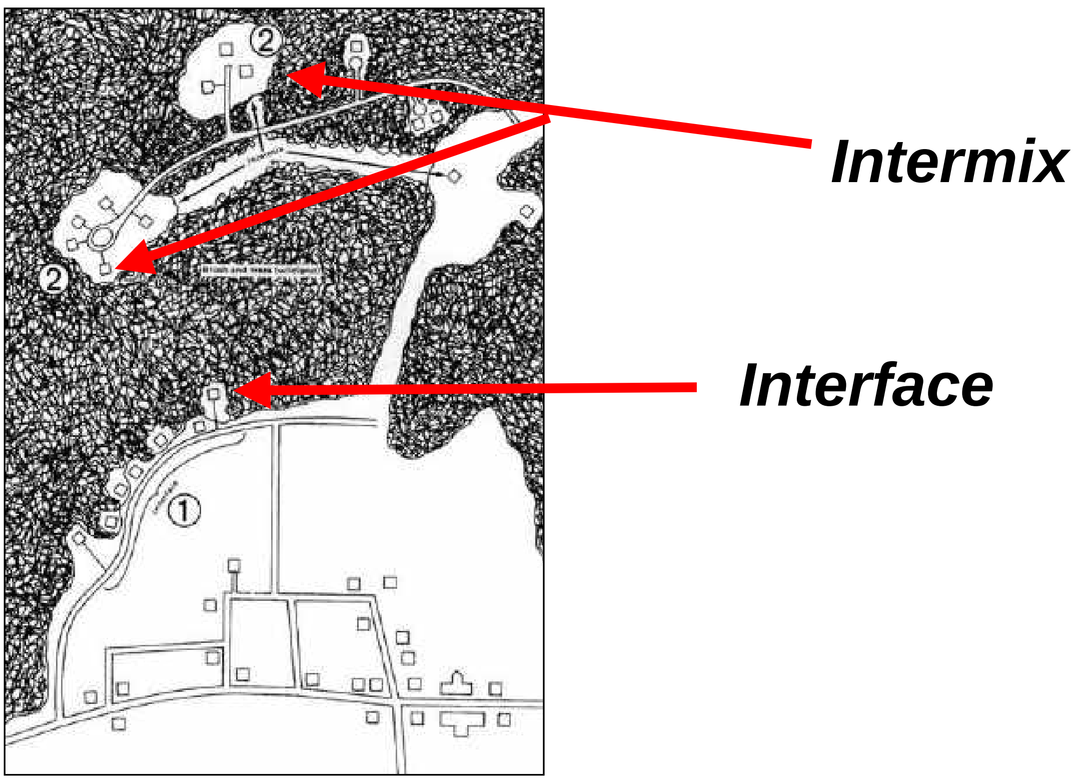


Figure 4. Graphical example showing variation in the definition of interface.

4.1 Vulnerability of the Wildland Urban Interface to Fire

Fires spreading into the WUI from the forest can impact homes in two distinct ways: 1) by sparks or burning embers carried by the wind or convection that start new fires beyond the zone of direct ignition (main advancing fire front) and alight on vulnerable construction materials (*i.e.* roofing, siding, decks etc.) (Figure 5); 2) through direct flame contact, convective heating, conductive heating or radiant heating along the edge of a burning fire front (burning forest) or through structure-to-structure contact. Fire can ignite a vulnerable structure when the structure is in close proximity (within 10 meters of the flame) of either the forest edge or a burning house (Figure 6).

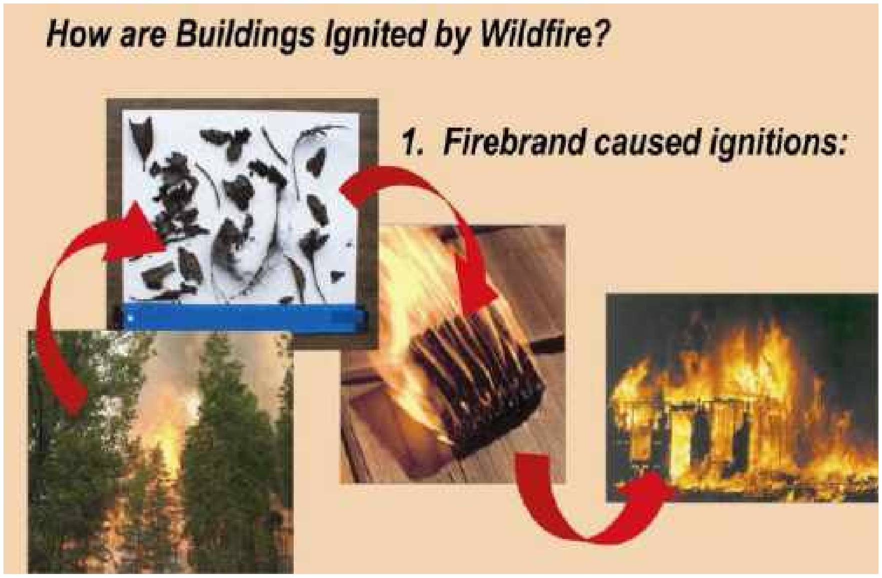


Figure 5. Firebrand caused ignitions: burning embers are carried ahead of the fire front and alight on vulnerable building surfaces.

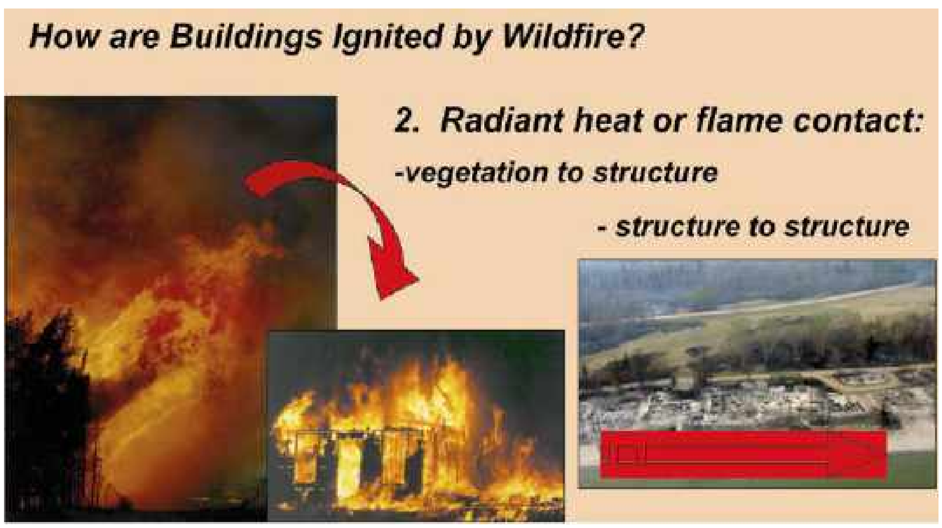


Figure 6. Radiant heat and flame contact allows fire to spread from vegetation to structure or from structure to structure.

The wildland urban interface continuum (Figure 7) summarizes the main options available for addressing WUI fire risk in the Community Wildfire Protection Planning process.

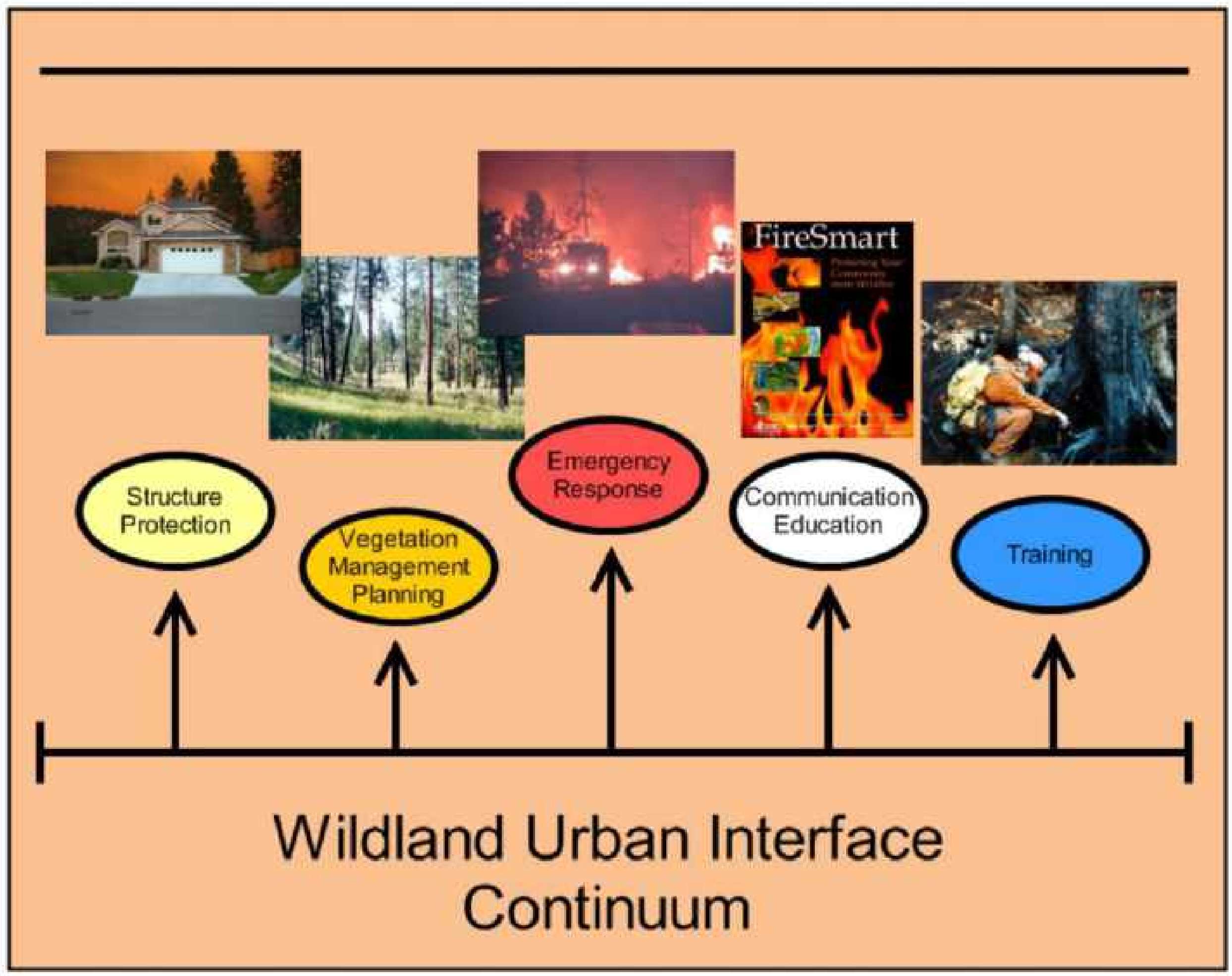


Figure 7. Wildland urban interface continuum.

The appropriate management response to a given wildfire risk profile is based on the combination and level of emphasis of several key elements:

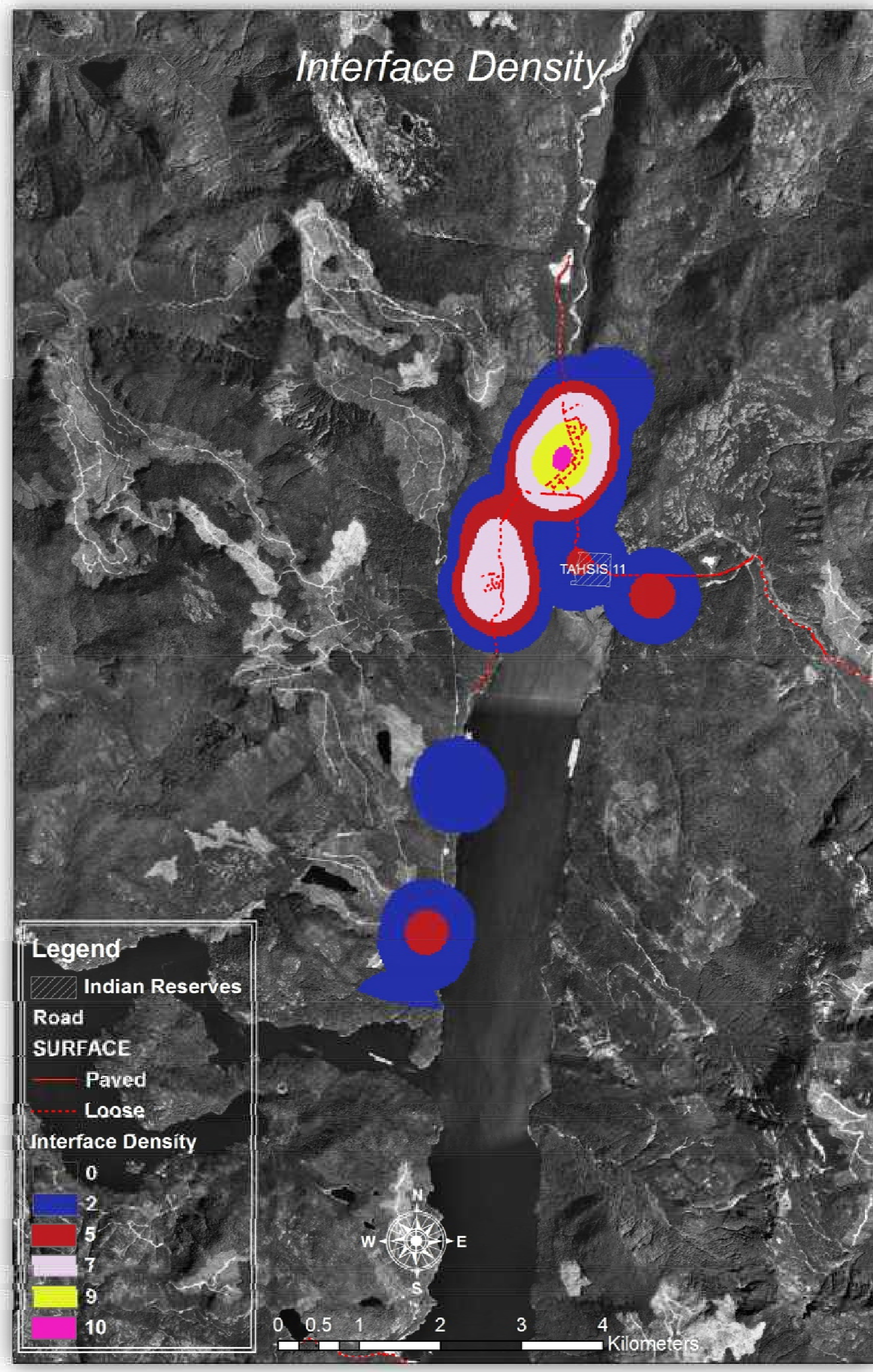
- Communication and education.
- Emergency response.
- Training.
- Structure protection.
- Vegetation management.

For example, in an interface area with a high-risk profile, equal weight may be given to all elements. Alternatively, in this same high-risk example, active intervention through vegetation management may be given a higher emphasis. This change in emphasis is based on the values at risk (consequence) and the level of desired protection required. In a low risk situation the emphasis may be on communication and education combined with emergency response and training. In other words, a variety of management responses is appropriate within a given community and these can be determined based on the Community Risk Profile as presented in Section 5.0.

Map 7 shows the primary interface in the study area, all of which is located within the community boundary. The delimited areas are in higher density zones (Table 6). The areas, where development abuts the forest are the primary interface areas of concern. The main centre of the community has good setbacks from forest edges, and the main concern in these areas is spotting into the community from a forest fire.

Table 6. Density classes used to identify settlement patterns in the study area (number of structures per km²).

Description	Rating
Urban (>500/km^2)	10
Developed (251-500/km^2)	9
Mixed (51-250/km^2)	7
Isolated (11-50/km^2)	5
Undeveloped (1-10/km^2)	2
None (not shown on map)	0



Map 7. Map of settlement density classes.

4.2 Community Watersheds

The water supply for Tahsis is the community watershed in McKelvie Creek drainage (Map 8). The community has ongoing concerns related to development in its watershed and has concerns related to a major fire and possible implications for water supply. One concern noted by the community is potential contamination of the water supply by fire retardants. The following paragraph is taken from a recent peer reviewed compendium. Additional sources were reviewed in the literature and support the summary presented below.

> Fire retardants used in wildfire suppression are generally ammonium phosphate or ammonium sulphate based with other chemicals to reduce corrosion. Retardant use has been shown to elevate NH_4^+, PO_4^{3-}, and NO_3^- concentrations in water but only for short periods of time (< 1 hour). Ferrocyanides are one of the commonly used chemicals used to reduce rust associated with the main retardants. This family of chemicals is one of the main concerns in regards to water quality. In the presence of UV radiation, decomposition of this chemical can occur resulting in cyanide ion release. However, the concentrations are unlikely to result in toxic levels unless soils are coarse and organic content is low[2].

In summary, the effects of retardants appear to be of limited time frame with little potential impact upon drinking water. However, as the authors note research on the topic is limited. While the impact of fire suppressants upon these wells may be minimal or non-existent, fire suppression should favour water over chemical suppressants if fire behaviour permits.

Another threat related to wildfire in the Tahsis watershed is the potential of a wildfire to remove extensive amounts of forest cover depending upon fire severity and intensity. The orthophotos of the steep slopes of the watershed reveal past slope failures and slides have occurred, a large wildfire could negatively impact slope stability.

The removal of tree cover has multiple effects upon watershed hydrology. By reducing tree cover, interception of precipitation by trees is reduced. This has several implications: The immediate response of heavily deforested watersheds is a larger increase in the volume of stream flows following a precipitation event than would be seen in pre-disturbance conditions. The timing of the flow changes as well, and tends to occur more quickly after the precipitation falls. The increase in volume occurs as tree crowns intercept a large percentage of precipitation and much of this (30% in summer) intercepted water evaporates. Water that does reach the

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[2] Information in this section is taken directly from:

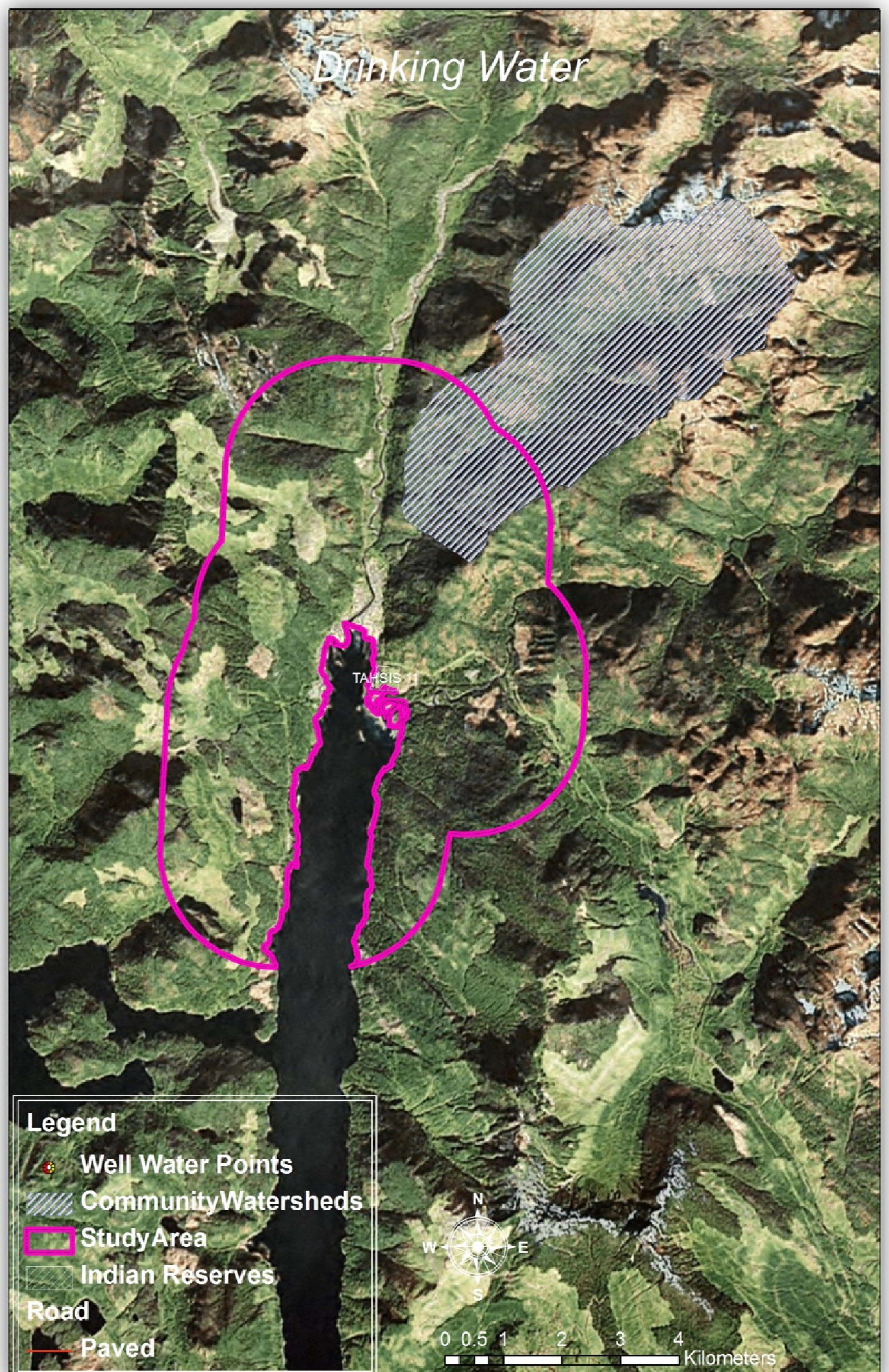
Pike, R.G., M.C. Feller, J.D. Stednick, K.J. Rieberger, M. Carver. 2009. Chapter 12- Water Quality and Forest Management [Draft]. *In* Compendium of Forest Hydrology and Geomorphology in British Columbia [In Prep.]R.G. Pike *et al.* (editors). B.C. Ministry of Forests, Mines and Lands Research Branch, Victoria B.C. and FORREX Forest Research Extension Partnership, Kamloops, B.C. Land Management Handbook (TDB). URL: http://www.forrex.org/program/water/PDFs/Compendium/Compendium_Chapter12.pdf forest floor and infiltrates the forest floor is taken up by vegetation and becomes part of transpiration losses (70% of total losses). In deforested areas, transpiration is limited to understory vegetation once re-established, and evaporation is also lower. Additionally, in heavy precipitation events, the infiltration capacity of soils may be exceeded, resulting in overland flow of water rather than recharging subsurface groundwater. A decrease in the time to peak flow following rainfall may also occur because of changes in hydrological functions, potentially due to increased surface runoff and decreased evaporation.

An increase in snow packs is also observed in areas where forest cover has been reduced. This occurs because much of the snow intercepted by tree canopies sublimates or evaporates. Melt water runoff from these systems is also more rapid as they are more exposed to intense solar insolation during the spring than areas where forests provide shade.

These effects upon flow may be positive or negative depending on the characteristics of the community watershed. In watersheds where the increase in volume can be captured in reservoirs, water availability may increase. However, the flashiness of these systems is often detrimental to water management objectives as most runoff volume occurs over a relatively shorter time period and may result in higher rates of erosion, transportation and subsequent deposition of materials in reservoirs. In systems where snow pack melt water occurs earlier in the season, water shortages may occur during the driest summer months.

Landslides may also increase and expose soils to greater rates of erosion and transportation combined with increased surface runoff, both these factors can contribute to increased turbidity. Increases in turbidity are commonly associated with elevated occurrence of gastrointestinal infections, as the suspended particles make water treatment problematic as they help protect protozoa and bacteria. High turbidity reduces water quality by raising the formation of disinfection by-products (DBPs).

In summary, the effects of a wildfire upon water quality have the potential to have negative impacts upon water quality, quantity and timing of flows. The amount of crown cover lost, amount of organic soils lost, and other ecosystem attributes affected by wildfire that influence hydrological functions will be important in determining post fire impacts and subsequent rehabilitation requirements.



Map 8. Tahsis community watershed in the study area.

5.0 FireSmart

One of the most important areas in respect to forest fire ignition and the damages associated with a wildfire is adjacent to buildings and homes. We often consider wildfire an external threat to our residences; however in many cases fire can originate as a house fire and spread into the interface. In both cases, fire coming from the forest to a building or spreading from a building to the forest, the home or business owner can take steps to reduce the potential for this occurring. There are two main avenues for FireSmarting a home: 1) change the vegetation type, density, and setback from the building (Fuel Treatments) and 2) change the structure to reduce vulnerability to fire and reduce the potential for fire to spread to or from a building. FireSmarting buildings is discussed in greater detail in 9.2.1.

5.1 Fuel Treatments

An effective method of reducing how easily fire can move to and from a home is by altering the vegetation around the home. The following information in this section is taken from FireSmart (Partners in Protection 2002).

Priority Zone 1 is a 10 m fuel free zone around structures (Figure 8). This ensures that direct flame contact with the building cannot occur and reduces the potential for radiative heat to ignite the building. While creating this zone is not always possible, landscaping choices should reflect the use of less flammable vegetation such as deciduous bushes, herbs and other species with low flammability. Coniferous vegetation such as juniper or cedar bushes and hedges should be avoided, as these are highly flammable. Try to keep vegetation in this zone widely spaced and well setback from the house.

Priority Zone 2 extends from 10-30 m from the structure. In this zone, trees should be widely spaced 5-10 m apart, depending on size and species. Tree crowns should not touch or overlap. Deciduous trees have much lower volatility than coniferous trees, so where possible deciduous trees should be preferred for retention or planting. Trees in this area should be pruned as high as possible especially where long limbs extend towards buildings. This helps prevent a fire on the ground from moving up into the crown of the tree or spreading to a structure. Any downed wood or other flammable material should also be cleaned up in this zone to reduce fire moving along the ground.

Priority Zone 3 extends from 30-100 meters from the home. The main threat posed by trees in this zone is spotting, the transmission of fire through embers carried aloft and deposited on the building or adjacent flammable vegetation. To reduce the threat, cleanup of surface fuels as well as pruning and spacing of trees should be completed in this zone (Figure 9).

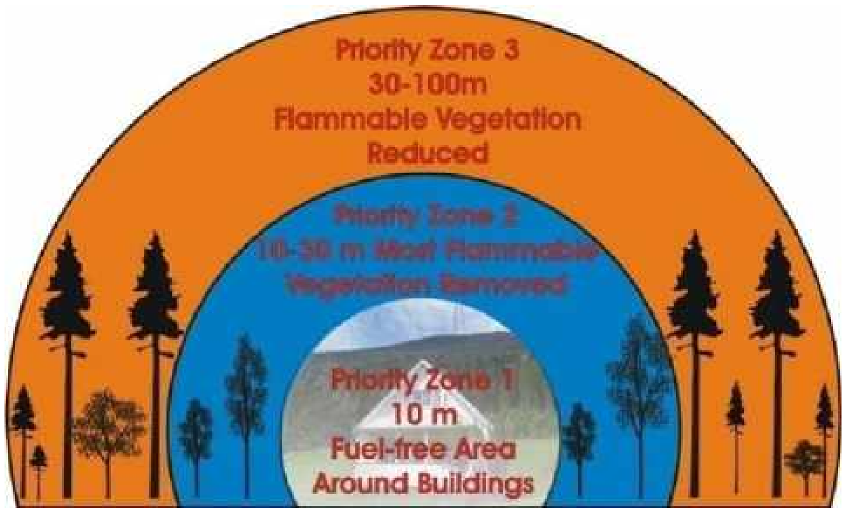


Figure 8. Diagram depicting FireSmart Zones.

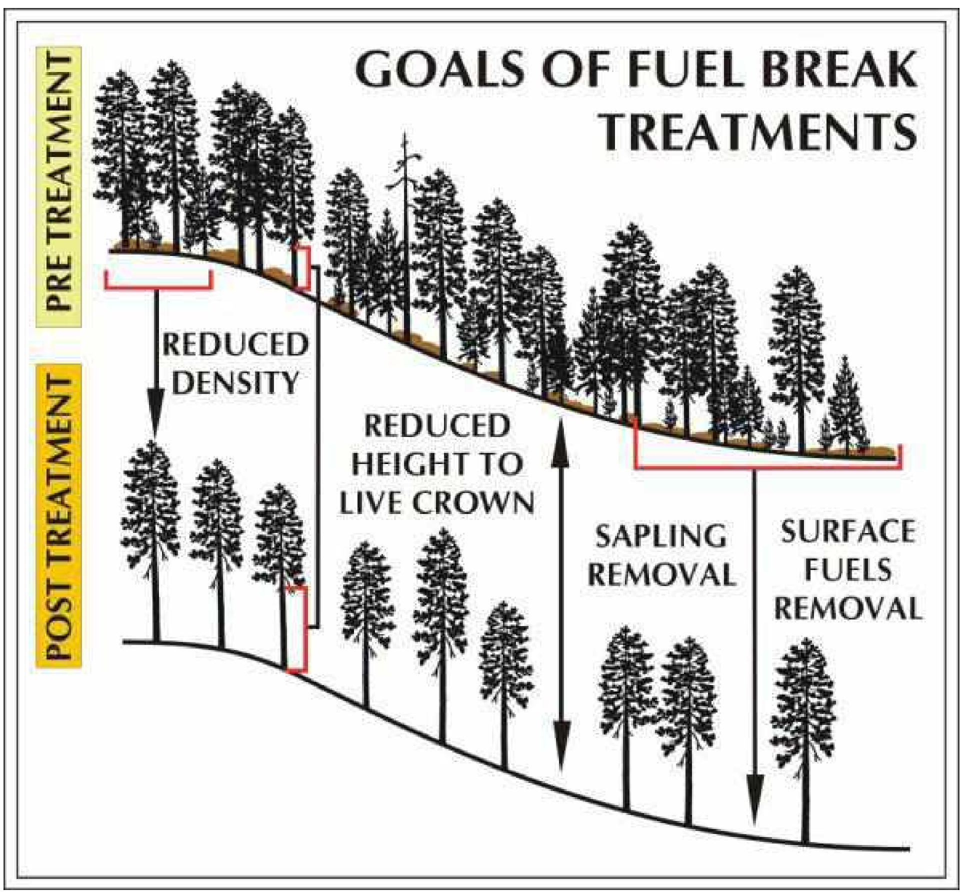


Figure 9. Example of fuel reduction 30-100 m from buildings.

6.0 Community Risk Profile

The Wildfire Risk Management System (WRMS) developed in support of this plan identified that Tahsis has a low to moderate probability of wildfire (Map 9) with moderate to high consequences. The areas of highest consequence are located where interface density is higher and the wildland urban interface occurs. Public safety, as well as important values, facilities and structures, may be severely impacted by a major fire in the area. Areas with Moderate to High Probability and Consequence are primarily located in the most heavily settled areas near hazardous fuel types. These results combined with additional knowledge of the community help to identify the areas where risk reduction should be concentrated. Risk reduction is not limited to fuel management. It includes structure protection, education and communication, training and emergency response: the weighting of these depends upon the characteristics of the community. Indeed, as over 90% fire ignitions in Tahsis are human caused, reducing human caused ignition through education and communication might be one of the most effective means of reducing risk.

The WRMS system is based upon a spatial model developed in a Geographic Information System (GIS) format. Individual polygons are weighted for each subcomponent (Figure 10). Using algorithms, the subcomponents are combined to produce component weightings which are then further processed to derive probability and consequence ratings.

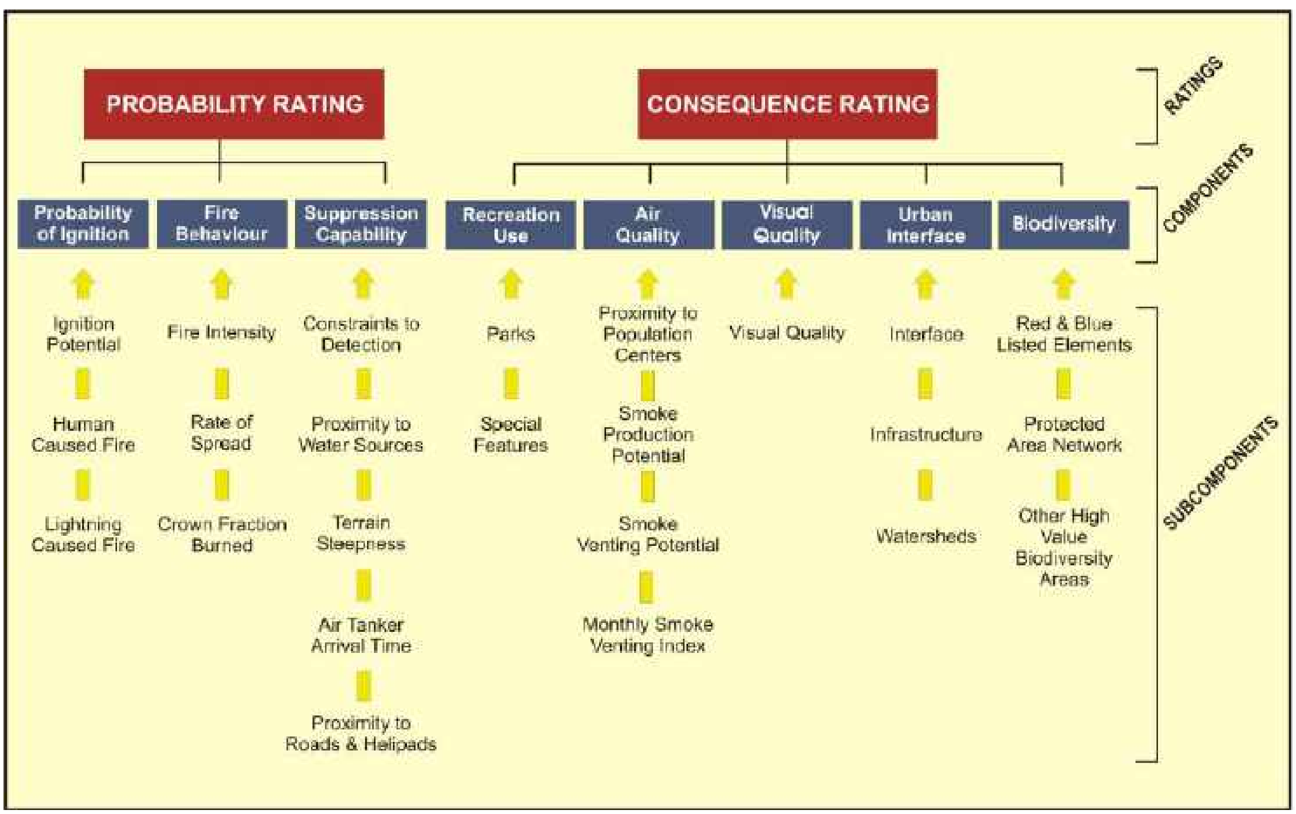
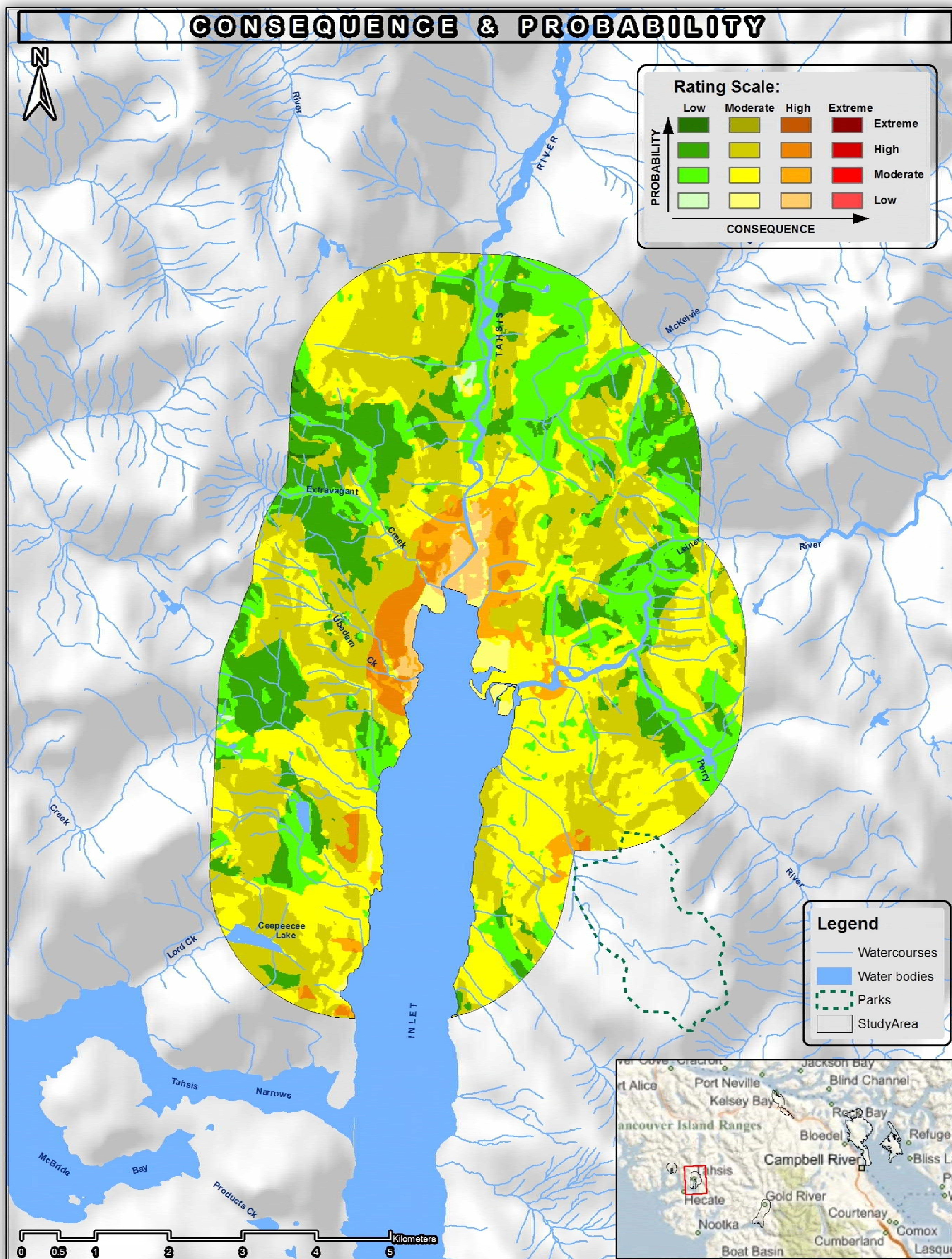


Figure 10. WRMS structure used to calculate final probability and consequence ratings.



Map 9. Final overlay of probability and consequence from the Wildfire Risk Management System.

7.0 Community Wildfire Protection Planning Process

Figure 11 demonstrates how the development of a community risk profile is addressed by the individual elements of the CWPP planning process. The end result is the implementation of recommendations using the various planning tools to lower wildfire risk faced by a community. The Action Plan in section 8.0 specifically addresses the five elements of a CWPP that contribute to risk reduction (below the yellow box in Figure 11). It makes specific recommendations (planning tools) on how risk can be reduced by making changes to these five elements.

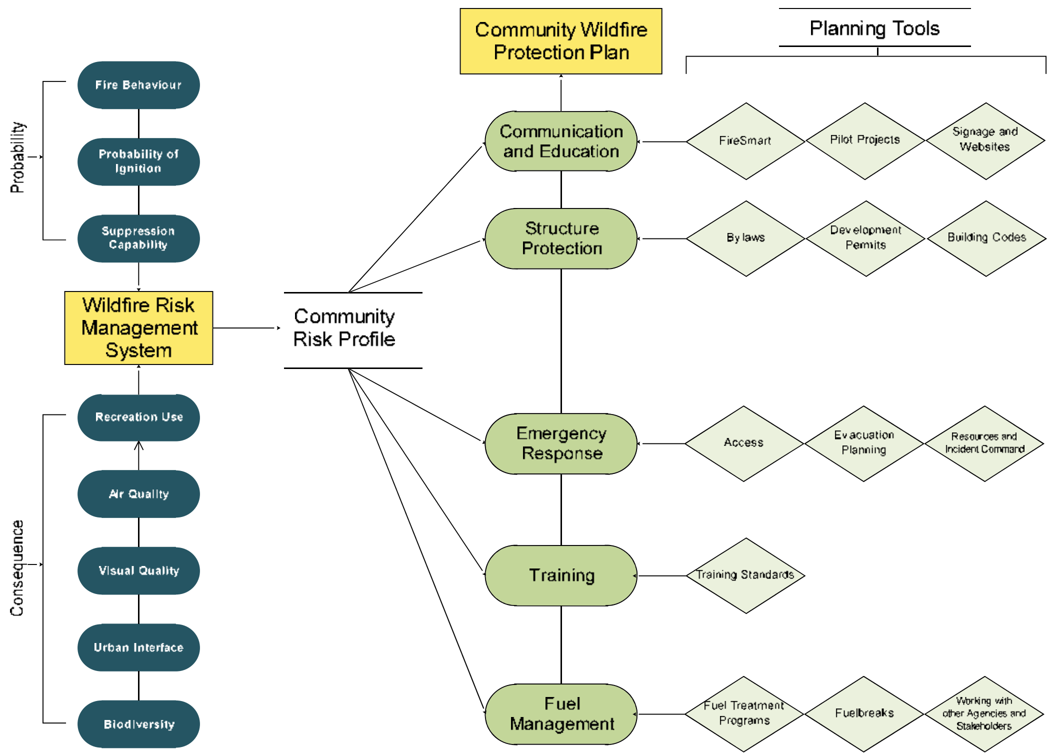


Figure 11. The planning structure that translates the community risk profile into actions to reduce the risk faced by the community.

8.0 Action Plan

The Action Plan consists of the key elements of the Community Wildfire Protection Plan and provides recommendations to address each element. Each of these elements is further explained in Section 9.0 Community Wildfire Protection Planning Background, which provides generic background information to support the Action Plan. Section 8.0 is intended to provide general information about each element considered in community wildfire protection planning; it is not intended to provide information specific to the community.

8.1 Communication and Education

8.1.1 Objectives

- To work diligently to reduce ignitions during periods of high fire danger.
- To educate residents and businesses on actions they can take to reduce fire risk on private property and on public property.
- To establish a sense of homeowner and visitor responsibility for reducing fire hazards.
- To raise the awareness of elected officials as to the resources required and the risk that wildfire poses to communities.
- To make residents and businesses aware that their communities are interface communities and to educate them about the associated risks.
- To increase awareness of the limitations of Tahsis and provincial fire fighting resources to encourage proactive and self-reliant attitudes.
- To develop a community education program in the next two years.
- To enhance Tahsis' and the SRD's websites to better communicate wildfire protection planning to the community, and evacuation response during a wildfire event in the next two years.
- To improve fire danger and evacuation signage in the next two years.

8.1.2 Issues

- Human caused ignitions are responsible for 92% of the fires in Tahsis.
- Currently there is no information on Tahsis' website related to wildfire or FireSmart.
- Signs that indicate fire danger rating are lacking on major routes through the community.

8.1.3 Recommendations – TAHSIS

Recommendation 1: Tahsis should consider working with the SRD, other municipalities in the SRD, and the MFML to develop a regional approach to enhancing education and communication. Public education programs could be enhanced by: 1) integrating a unit of "FireSmart" and wildfire safety into the elementary school curriculum for local children; 2) creating a "FireSmart" sticker program where Fire Department members attend residences and certify them as meeting "FireSmart" guidelines.

The program should emphasize that most fires around Tahsis are human caused and that reducing these ignitions will significantly contribute to the safety of the community.

Recommendation 2: Tahsis should consider displaying and distributing information to participants of the Great Walk. This would help ensure that current and future visitors are aware of the risk of wildfire to the community, the role human ignitions play in fire risk, and could highlight the importance of forests to the community.

Recommendation 3: The standard for website information about fire should include an outline of community fire risks and fire danger. Information should include fire bylaws, campfire bans and wildfire hazard ratings updated during the fire season. The SRD and the communities should work to produce web-based information that can be hosted on the SRD website and linked to the individual community websites.

Recommendation 4: Tahsis in conjunction with Zeballos and Gold River should use the Record (an independent newspaper serving the North Island) to communicate fire danger to the community and region. They should continue to use this and other local media such as pamphlet mailouts to deliver FireSmart educational materials and to communicate information on fire danger during periods of high and extreme fire danger. Tahsis Information Centre should be used to communicate fire danger and fire restrictions to tourists visiting the area.

Recommendation 5: Signage consisting of current fire danger, campfire bans and general warnings regarding fire safety should be posted at the entrance and exit of the community on Head Bay Rd to ensure residents and especially tourists are aware of current conditions.

Recommendation 6: The Fire Department should work with the SRD and the Chamber of Commerce to educate the local business community, particularly businesses that depend on forest use (*i.e.*, tourism and recreation) on FireSmart preparation and planning. The CWPP should be presented to the community and used to highlight the risks facing Tahsis and areas where risk reduction can be undertaken in the community by businesses.

8.2 Structure Protection

8.2.1 Objectives

- To adopt a FireSmart approach to site and structure hazard assessment and structure protection.
- To develop policy tools to adopt FireSmart standards over the next five years.

8.2.2 Issues

- Many homes in the community are currently empty. Detection of an accidental or arson caused ignition may be delayed which increases the risk of fire spreading to the wildland.
- Lack of a regular bylaw officer to enforce bylaws translates into unenforceable bylaws.
- Many homes do not meet the FireSmart structure hazard standards for interface fire safety.
- Currently there is no fire vulnerability standard for roofing materials used in the community. In addition to the vulnerability of roofing materials within the community, adjacent vegetation is often in contact with roofs, roof surfaces are often covered with litter fall and leaves from nearby trees, and open decks are common. See examples in Figure 12, Figure 13 and Figure 15.
- Siding and roofing material used on critical infrastructure in some cases does not meet FireSmart recommendations (Figure 14).
- 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 the building code or bylaws to encourage a change in roofing materials when roof replacement of individual residences is required may be a solution.
- 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 (Figure 13).
- Structure setbacks from forest edges are largely absent, which facilitates fire transmission to or from residences (Figure 15).

Figure 12. Unrated roofing material present on some buildings within the wildland urban interface.

Figure 13. A home with firewood directly adjacent to the structure that increases vulnerability to spotting.

Figure 14. Water supply structure with vinyl siding.

Figure 15. St. Joseph's building with no setback to forest vegetation and flammable landscaping.

8.2.3 Recommendations – TAHSIS

Recommendation 7: Where homes and businesses are built immediately adjacent to the forest edge, Tahsis and the SRD should consider incorporating building setbacks into bylaw with a minimum distance of 10 m when buildings border the forest interface.

Recommendation 8: Tahsis should conduct a FireSmart hazard assessment of the community to educate residents on the hazards that exist on their properties and how to mitigate those hazards.

Recommendation 9: Tahsis and the SRD should review the availability of a bylaw officer to help municipal officials enforce bylaws.

Recommendation 10: The community and the SRD should investigate the policy tools available for reducing wildfire risk within the community to create and/or review and revise existing bylaws to be consistent with the development of a FireSmart community. These include voluntary fire risk reduction for landowners, bylaws for building materials and subdivision establishment, covenants for vegetation setbacks, delineation of Wildfire Development Permit areas, incentives such as exclusion from a fire protection tax, and education.

Recommendation 11: Tahsis and the SRD should consider requiring the use of roofing materials within new subdivisions that are fire retardant with a Class A and Class B rating. They should consider obtaining legal advice regarding the implementation of building requirements that are more restrictive than the BC Building Code. While restrictions to rated roofing are not supported in the Code at this time, there are several communities which have undergone or are undergoing various processes (e.g., lobbying, legal opinion, declaration of hazard by Fire Chief) to enact roofing bylaws within their Wildfire Development Permit areas.

Recommendation 12: Tahsis should upgrade the vulnerable structures associated with critical infrastructure to meet FireSmart standards.

Recommendation 13: Debris adjacent to critical infrastructure, such as power poles to the water supply, should be removed and chipped or burned prior to the fire season.

Recommendation 14: The SRD should consider working with the Building Policy Branch to create a policy structure that would enable communities in the SRD to better address wildland urban interface protection considerations for buildings.

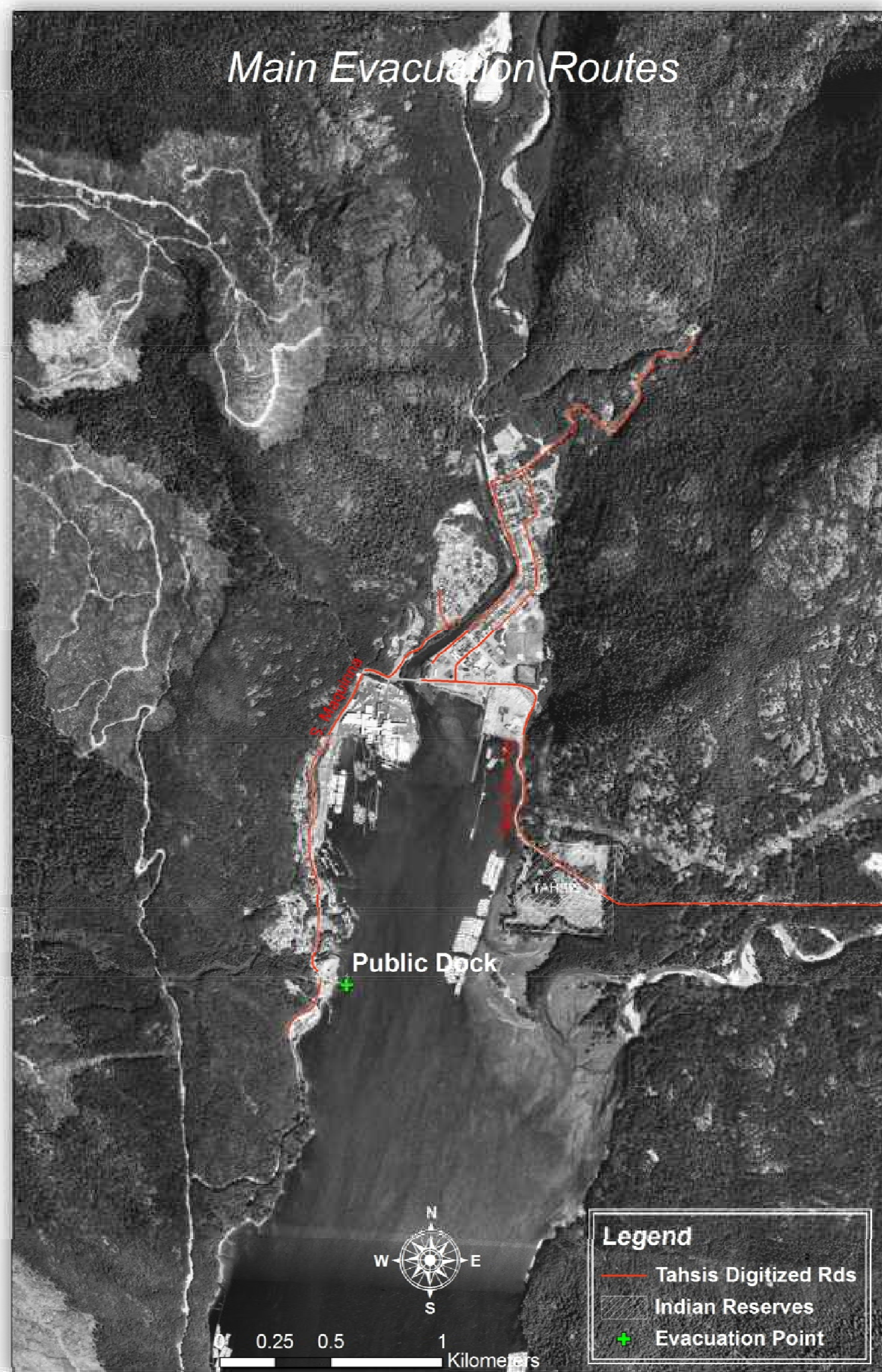
8.3 Emergency Response

8.3.1 Objectives

- To develop an emergency response plan that enables effective evacuation, improves firefighter suppression capability and maintains firefighter safety.
- To review the community evacuation plans in the next 12 months.
- Over the next 12 months, to develop a contingency plan in the event that smoke requires evacuation of critical emergency services facilities.

8.3.2 Issues

- Evacuation of residents and access for emergency personnel is an important consideration given the amount of forest fuels in close proximity to many homes on the west side of Tahsis Inlet. Tahsis has one main access/egress route that runs through heavily forested terrain. Head Bay Rd is a gravel road. The main roads and access and evacuation route available to motor vehicles and emergency responders are highlighted with red in Map 10. Smoke and poor visibility can further complicate access, creating the necessity for traffic control in some locations.
- It cannot be overstated that in the event of a wildfire, many deaths are the result of vehicle accidents or fire related deaths during evacuation. The single narrow, winding egress route increases the likelihood of accidents. As only one egress route exists, one accident on this road could block all evacuation efforts.
- In addition to the evacuation of residents, safety of fire fighting personnel is a major consideration. Under extreme fire conditions it may be difficult for the Fire and Rescue Service to access specific areas such as the houses along the west side of Tahsis Inlet. Defence of these locations would be secondary to safety. Other than this area, most parts of the community have multiple egress and access routes.



Map 10. Overview of access routes in the study area.

8.3.3 Recommendations – TAHSIS

Recommendation 15: A formal communication structure should be established with the MFML so that information regarding fires in the region is communicated to Tahsis in a timely manner. This might be best achieved through joint cooperation with the SRD, other SRD communities and the MFML.

Recommendation 16: Consideration should be given to further developing a community evacuation plan. Appropriate evacuation routes should be mapped, considering Disaster Response Routes (DRR). Major evacuation routes should be signed and communicated to the public. This should include docks and other marine egress routes. In addition, alternative emergency responder access should be considered.

Recommendation 17: Marshalling points should be identified and signed and communicated to the public. Pre-planning for evacuation from these points should be completed prior to a wildfire event in order to identify and correct deficiencies and provide safe, efficient egress for the community.

Recommendation 18: The use of the public dock as an evacuation centre via boats and barges should be reviewed. This is vital to ensure that evacuation procedures and limitations are identified and addressed prior to a wildfire event.

Recommendation 19: As part of the evacuation plan, the community should develop strategies to quickly identify and clear car accidents that block or impede traffic during evacuation efforts.

Recommendation 20: Creation of a second evacuation route between Tahsis and Zeballos should be considered. This would also serve as a secondary route in the case of other natural disasters that close existing evacuation routes. Tahsis, Zeballos, and the SRD should coordinate a feasibility review in conjunction with the Provincial Emergency Program.

Recommendation 21: During a large wildfire it is possible that critical infrastructure within Tahsis could be severely impacted by smoke. It is recommended that contingency plans be developed in the event that smoke causes evacuation of the community's incident command centres. Tahsis should co-operate with provincial and regional governments to identify alternate incident command locations and a mobile facility in the event that the community is evacuated.

8.4 Training/Equipment

8.4.1 Objectives

- To ensure adequate and consistent training for firefighter personnel and to build firefighter experience.
- To train all Fire Department personnel to the provincial standard (S100 and S215) on an annual basis.
- To ensure adequate equipment is available for wildfire suppression crews.

8.4.2 Issues

- Tahsis Volunteer Fire Department volunteers have received no training to Ministry of Forests, Mines and Lands standards.
- Tahsis has no off road truck for fighting interface fires and their pumper truck is 33 years old.
- Access to the water treatment facilities is limited to 4x4 due a steep and narrow road.
- Tahsis Volunteer Fire Department currently has no wildland firefighting equipment and personal protective equipment for personnel.
- Volunteer numbers for the Fire Department (11 in total) are decreasing with often only 3-4 members available to respond to an emergency situation.

8.4.3 Recommendations – TAHSIS

Recommendation 22: The following training should be considered: 1) The S100 course training should be continued on an annual basis; 2) A review of the S215 course instruction should be given on a yearly basis; 3) The S215 course instruction should be given to Fire Chiefs and Deputies; and, 4) Incident Command System training should be given to Fire Chiefs and Deputies.

Recommendation 23: The Fire Department should meet with the MFML prior to the fire season to review the incident command system structure in the event of a major wildland fire. The review should include designated radio channels and operating procedures. This could be coordinated with Zeballos and Gold River.

Recommendation 24: The Fire Department should seek funding to purchase a sprinkler kit to erect in the Village during a wildfire event or be incorporated in a mobile equipment cache. http://www.ubcm.ca/assets/Services~and~Awards/Documents/structural-protection-units-technical-specifications.pdf

Recommendation 25: The SRD and Tahsis should seek funding to acquire a 4x4 truck with compressed air foam (CAF) system for accessing and fighting wildfires in areas that are within village boundaries such as the waters supply infrastructure.

Recommendation 26: The community should consider reviewing its existing inventory of interface firefighting equipment to ensure that items such as large volume fire hoses, portable pumps and firefighter personal protection equipment (PPE) are adequate to resource the interface area. Fire Department personnel should have correct personal protective equipment and wildland fire fighting tools. Hoses, pumps and other equipment should be compatible with MFML wildland firefighting equipment.

Recommendation 27: Tahsis should consider working with Gold River, Zeballos, and the SRD to coordinate the creation of a sub-regional mobile cache of wildland firefighting equipment (ie one cache for Gold River, Tahsis and Zeballos). This would reduce the cost of purchasing and maintaining the cache and provide additional resources in the event of a wildfire.

Recommendation 28: Tahsis should continue to encourage long-term and new residents to join the volunteer fire department using Tahsis website, mailouts and the Record to encourage residents to join. It is acknowledged that demographics make this increasingly difficult in Tahsis.

Recommendation 29: Formal mutual aid agreements should be established with MFML to ensure that adequate resources and manpower support are available in the event of a wildfire.

8.5 Vegetation (Fuel) Management

Fuel management is an important tool in addressing fire risk. It should be noted however that the favorable fire weather due to summer rainfall and fogs in the study area translates into a moderate probability of fire. As a result, fuel treatments are a lower priority in Tahsis than other mitigation measures. Fuel treatments should be considered in areas where current setbacks to structures and critical infrastructure are inadequate. Fuel treatments in these areas will reduce fire severity and create adequate setbacks to reduce transmission of fire via radiant heat. They will also help reduce the probability of a fire moving from a structure into the wildland and threatening adjacent homes. For fuel breaks on community margins to be successful, FireSmarting of buildings is an essential risk mitigation tool as spotting from the wildland onto structures will occur during a large interface fire. For example, some building associated with water treatment have asphalt roofing but vinyl siding. While these buildings have adequate setbacks from forested edges, the siding material is flammable which places the buildings at risk.

8.5.1 Objectives

- To proactively reduce potential fire behaviour, thereby increasing the probability of successful suppression and minimizing adverse impacts.
- To work with BC Hydro to ensure rights-of-way act as fuel breaks.
- To reduce the hazardous fuel types (C2, C3, C4) found within and adjacent to Tahsis (Figure 16).

8.5.2 Issues

- Land in Tahsis is primarily provincially owned (93.3%). The remaining lands are private (4.2%), with a small component of Municipal owned reserve lands (1.9%) (Table 7). The majority of the Priority 1 fuel types are located on public property in Tahsis (Map 11). Of the 53.7 ha of Priority 1 fuels identified in the study area, 17.7 ha are on public land. Eighteen percent of the Priority 1 fuels are located on lands with unknown ownership. These require further clarification as to ownership. Private lands account for 16.9 ha of Priority 1 fuels and cannot be treated using public funding sources.

Table 7. Land ownership within the study area (taken from Provincial Ownership data).

	Ownership					
	First Nations	**Municipal**	**Private**	**Public Land**	**Unknown**	**Grand Total**
Area (ha)	**0**	**97**	**210**	**4639**	**28**	**4974**
Percent	0.0	1.9	4.2	93.3	0.6	

- The WRMS developed in support of this plan identified that the core area of Tahsis is at moderate risk from wildfire. In addition, there are areas of high wildfire probability located in the immediate proximity of the majority of intermix. Public safety, and many of the important values, facilities and structures, may be severely impacted by a major fire.

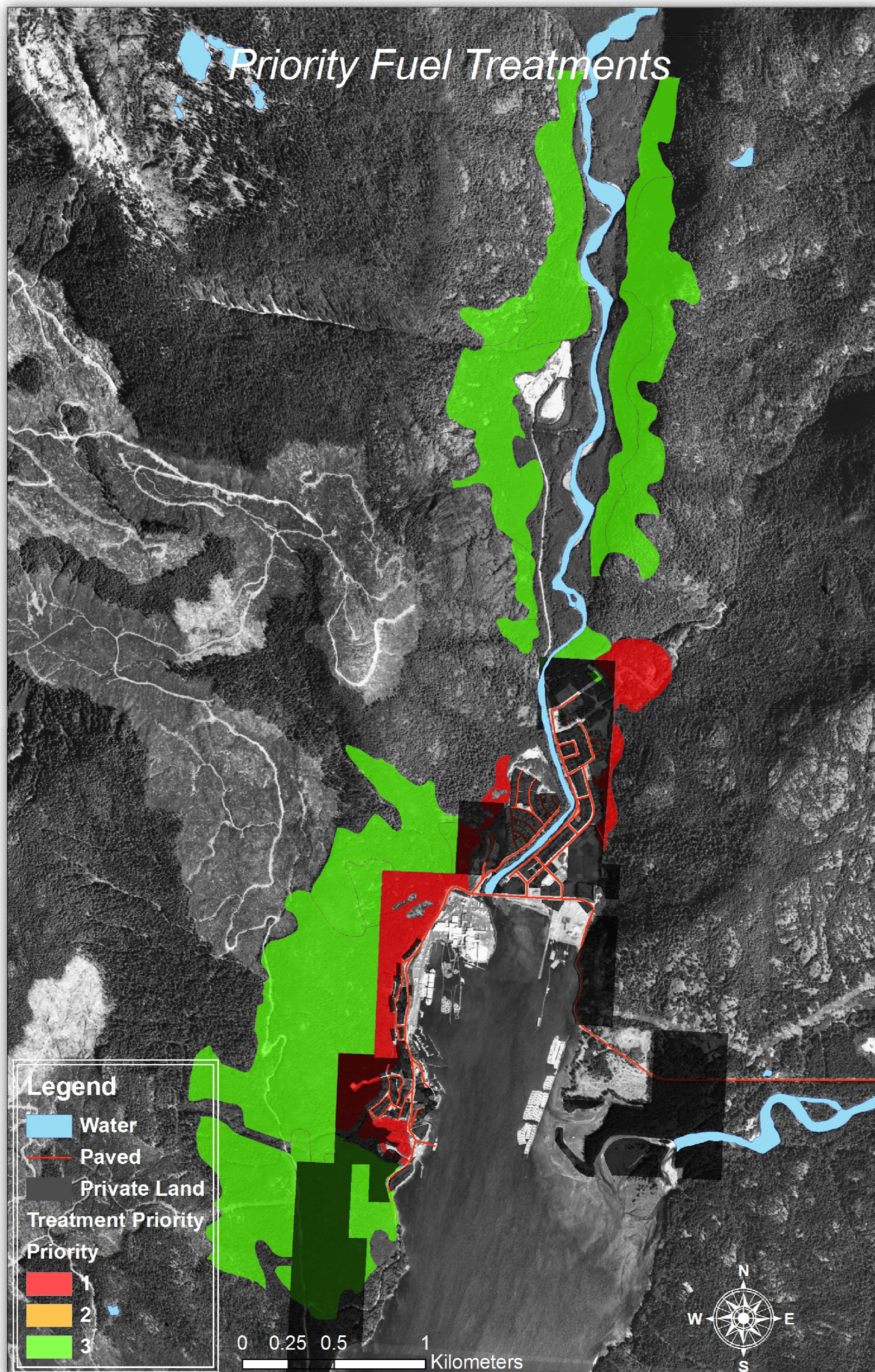
- To identify fuel types for prioritization in the study area (Map 11), fuel types C2, C3, and C4 located within 100 m of structures were identified. These were classified as Priority 1. Additional polygons were added manually based upon fuel type and location adjacent to structures or critical infrastructure. Polygons close to the wildland urban interface (WUI) that were lower in terms of treatment priority based on either fuel type or distance to structures were classified as Priority 2. Priority 3 fuel types were identified as having hazardous fuel types but are further out from the WUI. These may be used in constructing larger fuel breaks if necessary.

Table 8. Areas located on crown lands classified as Priority 1, 2, and 3 fuels.

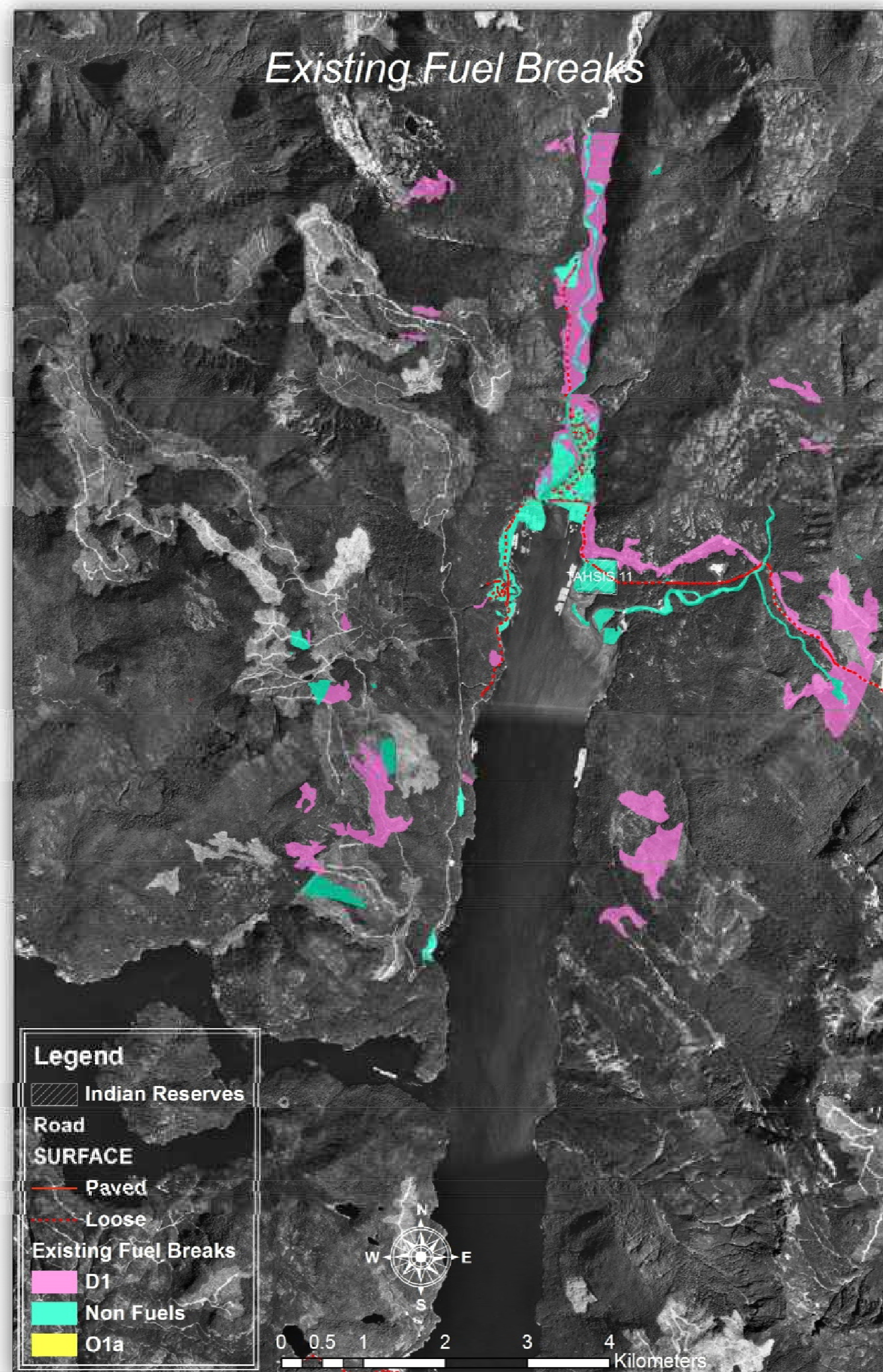
Priority Rating	Ownership					
	First Nations	Municipal	Private	Public Land	Unknown	Grand Total
1	0	1.3	16.9	17.7	18.0	53.7
2	0	0.0	0.0	0.0	0.0	0.0
3	0	9.7	32.6	294.3	0.0	336.7
Totals	0.0	11.0	49.5	312.0	18.0	390.5

- There are several existing natural fuel breaks within Tahsis including deciduous and low herbaceous shrub fuel types (refer to Map 12). Fuel treatments within hazardous fuel types adjacent to these areas will enhance the effectiveness of these existing fuel breaks on the landscape.

Figure 16. Photo of hazardous fuel type in the study area.



Map 11. Priority Fuel Polygons which show private lands shaded black in the study area (Prior to subsequent fuel treatment reduction, property ownership must be established in the field – this map is not and should not be interpreted as a legal survey).



Map 12. Existing fuel breaks where deciduous, non fuels, water, or O1a short grass/wetland occurs.

8.5.3 Recommendations – TAHSIS

Recommendation 30: Where hazardous fuel types in Tahsis are located on private property, the Village should work with private property owners to ensure they understand the importance and principles of FireSmart. Tahsis should investigate ways to support residents reducing fuels, making homes FireSmart and raising awareness of ignition hazards.

Recommendation 31: A number of high hazard areas immediately adjacent to or embedded in Tahsis have been identified and should be the focus of a progressive thinning program that is implemented over the next five to ten years. Thinning should be focused on the highest Priority 1 fuels identified in Map 11. A qualified professional forester (RPF), with a sound understanding of fire behaviour and fire suppression, should develop treatment prescriptions. Any treatments that take place on sloped sites must be prescribed with consideration given to slope stability. Where slope stability may be an issue (such as above the western border of the wildland urban interface), a Professional Geotechnical Engineer should review the treatment prescriptions.

Recommendation 32: Tahsis work with BC Hydro to ensure that: 1) transmission infrastructure can be maintained and managed during a wildfire event; and 2) the right-of-way vegetation management strategy includes consultation with the community and the Fire Department so that wood waste accumulations or vegetation do not contribute to unacceptable fuel loading or diminish the ability of the right-of-way to act as a fuel break.

9.0 Community Wildfire Protection Planning Background

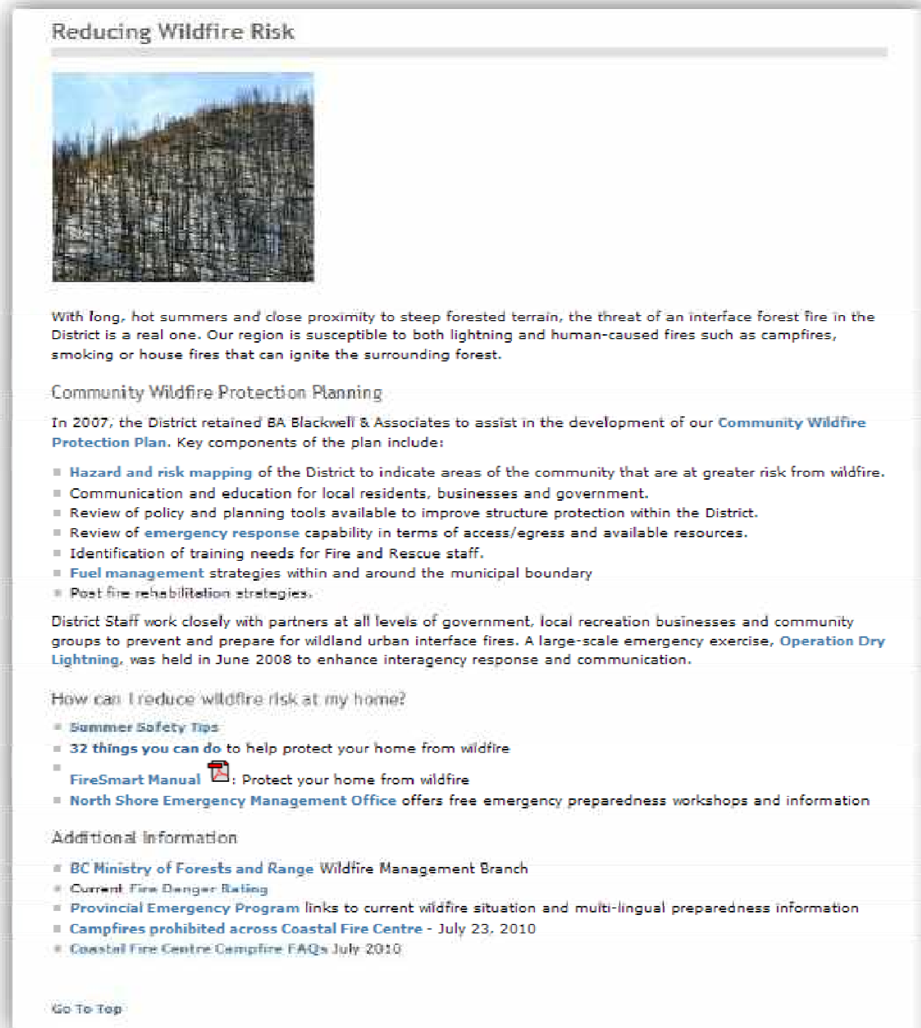
9.1 Communication and Education

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 Village 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, Mines and Lands, the Strathcona Regional District, local government departments, and other government agencies. However, if prevention programs are to be effective, fire risk reduction within interface areas of the study area 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 17 shows a screen capture from the District of North Vancouver public wildfire education website as an example of a clear, navigable and informative public communication method.



Reducing Wildfire Risk

With long, hot summers and close proximity to steep forested terrain, the threat of an interface forest fire in the District is a real one. Our region is susceptible to both lightning and human-caused fires such as campfires, smoking or house fires that can ignite the surrounding forest.

Community Wildfire Protection Planning

In 2007, the District retained BA Blackwell & Associates to assist in the development of our Community Wildfire Protection Plan. Key components of the plan include:

- Hazard and risk mapping of the District to indicate areas of the community that are at greater risk from wildfire.
- Communication and education for local residents, businesses and government.
- Review of policy and planning tools available to improve structure protection within the District.
- Review of emergency response capability in terms of access/egress and available resources.
- Identification of training needs for Fire and Rescue staff.
- Fuel management strategies within and around the municipal boundary
- Post fire rehabilitation strategies.

District Staff work closely with partners at all levels of government, local recreation businesses and community groups to prevent and prepare for wildland urban interface fires. A large-scale emergency exercise, Operation Dry Lightning, was held in June 2008 to enhance interagency response and communication.

How can I reduce wildfire risk at my home?

- Summer Safety Tips
- 32 things you can do to help protect your home from wildfire
- FireSmart Manual : Protect your home from wildfire
- North Shore Emergency Management Office offers free emergency preparedness workshops and information

Additional Information

- BC Ministry of Forests and Range Wildfire Management Branch
- Current Fire Danger Rating
- Provincial Emergency Program links to current wildfire situation and multi-lingual preparedness information
- Campfires prohibited across Coastal Fire Centre - July 23, 2010
- Coastal Fire Centre Campfire FAQs July 2010

Go To Top

Figure 17. Example of municipal website providing fire education information (http://www.dnv.org/article.asp?a=3814&c=44).

9.1.1 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;
- Tahsis council and staff;
- SRD directors;
- Local utilities; and
- Media.

9.1.2 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 Village, 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 Village 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.

9.1.3 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.

9.1.4 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 Village;

- 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.

9.1.5 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.

9.1.5.1 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.

9.1.5.2 Government Ministries, SRD and Tahsis 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.

9.1.6 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 behavior 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.

9.2 Structure Protection

9.2.1 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.

9.2.1.1 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 may be 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.

9.2.1.2 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.

9.2.1.3 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 by enabling fire access to these areas. Closing these structures off limits ember access to these areas and reduces fire vulnerability.

9.2.1.4 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.

9.2.2 *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 setbacks 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 in more houses being engaged by fire, thereby reducing firefighter ability 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.

9.2.3 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.

9.2.4 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.

9.2.5 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.

9.3 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.

9.3.1 Access and Evacuation

Tahsis' location and proximity to the forest make evacuation and access for emergency responders a critical factor to plan in the event of a wildfire.

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 which is common in the Village. 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. 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 fire fighting 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.

9.3.2 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 firefighters.

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 MFML to action fires in the forests within the community. During periods of high fire load throughout the province, resources of the MFML 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 MFML with the time necessary to mobilize equipment and resources from other parts of the province.

9.3.3 Water Supply

In an emergency response scenario, it is critical that a sufficient water supply be available. The Fire Underwriters Survey summarizes their recommendations regarding water works systems fire protection requirements, in *1999 Water Supply for Public Fire Protection,* which can be accessed online at http://www.scm-rms.ca/TechnicalResourceLibrary_e.asp. Some key points from this document include the need for:

- Duplication of system parts in case of breakdowns during an emergency;
- Adequate water storage facilities;
- Well distributed hydrants, including hydrants at the ends of dead-end streets; and
- Piping that is correctly installed and in good condition.

Water works planning should always take worst-case-scenarios into consideration. The water system should be able to serve more than one major fire simultaneously, especially in larger urban centers.

9.4 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 MFML 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;
- 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 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.

9.5 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.

9.5.1 Principles of Fuel Management

9.5.1.1 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.

9.5.1.2 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 anyone 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.

9.5.1.3 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.

9.5.1.4 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 18). 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.

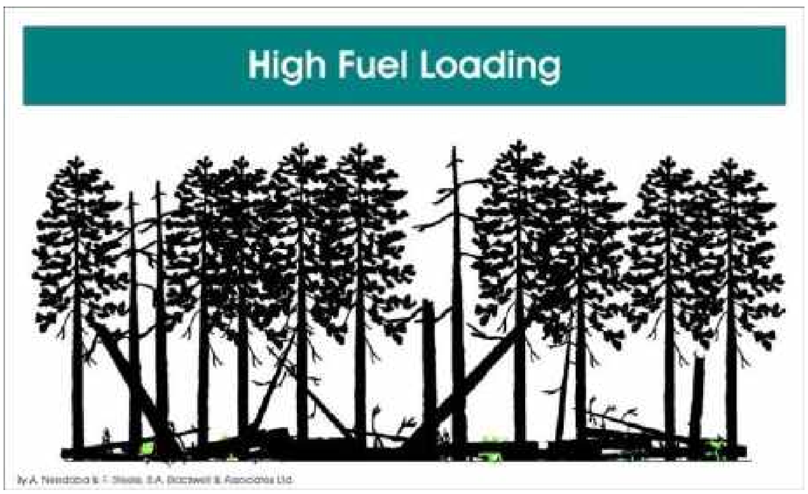


Figure 18. High surface fuel loading under a forest canopy

9.5.1.5 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 19 and Figure 20). 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 21). 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.

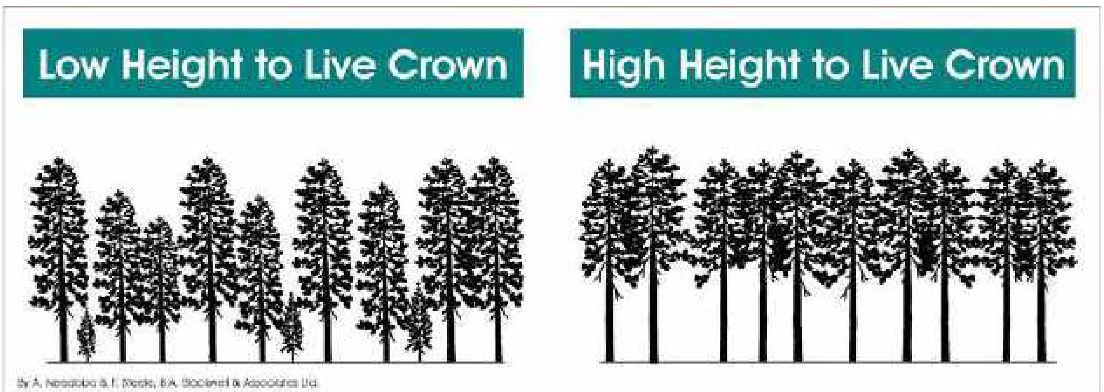


Figure 19. Comparisons showing stand level differences in the height to live crown.

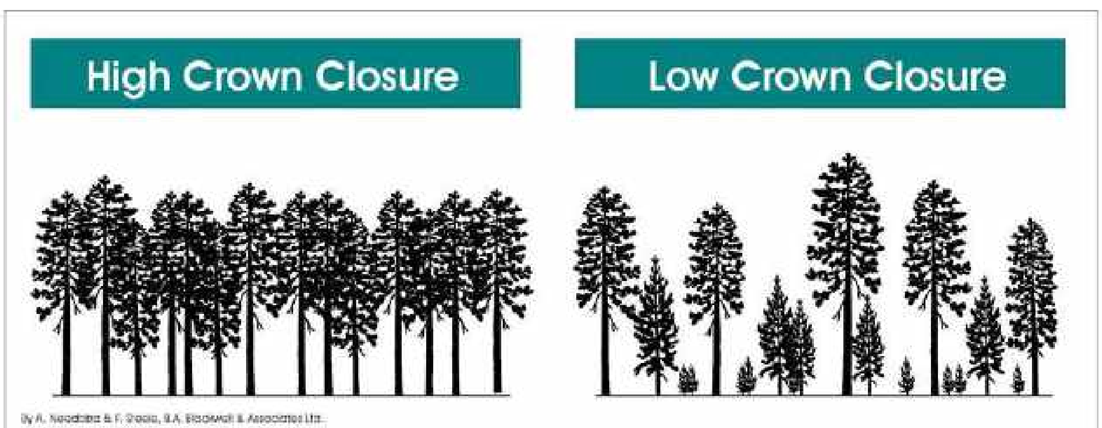


Figure 20. Comparisons showing stand level differences in crown closure.

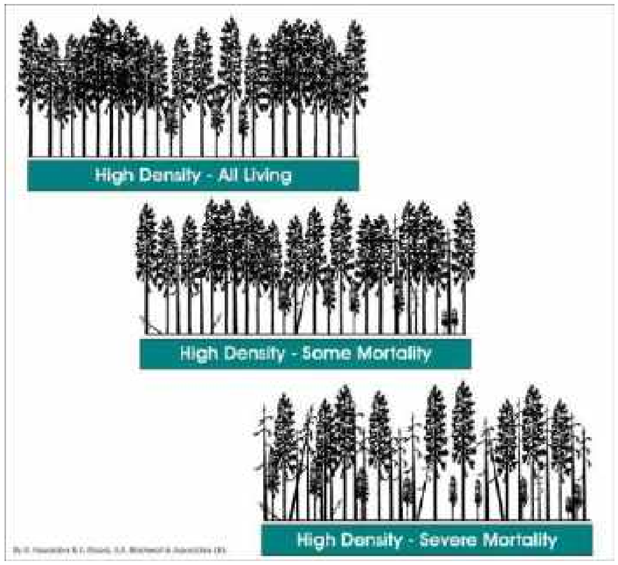


Figure 21. Comparisons showing stand level differences in density and mortality.

Thinning is a preferred approach to fuels treatment (Figure 22) 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.

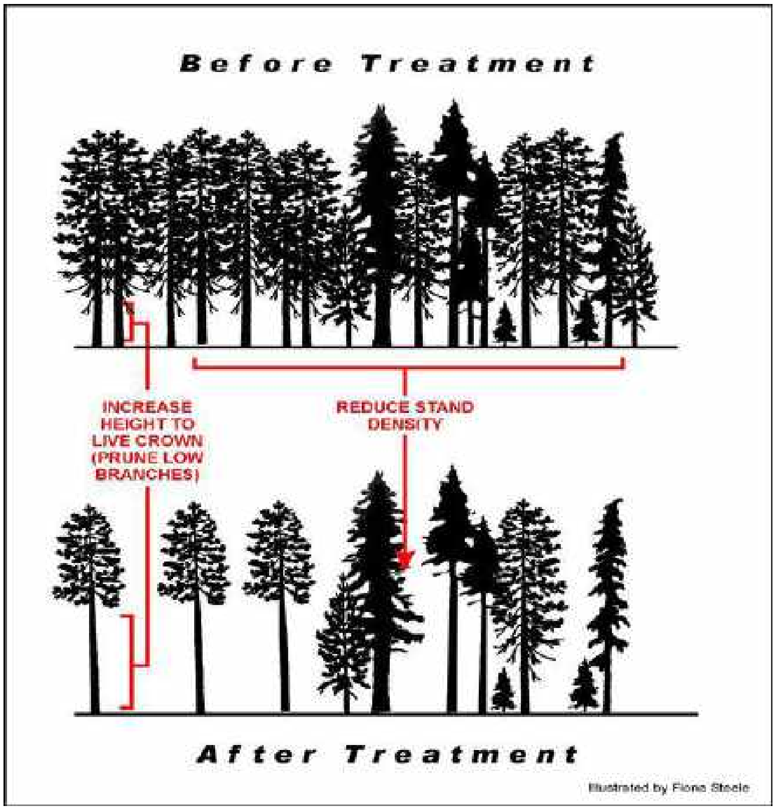


Figure 22. Schematic showing the principles of thinning to reduce stand level hazard.

9.5.1.6 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.

Fuel treatments must be designed to 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 23). 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.

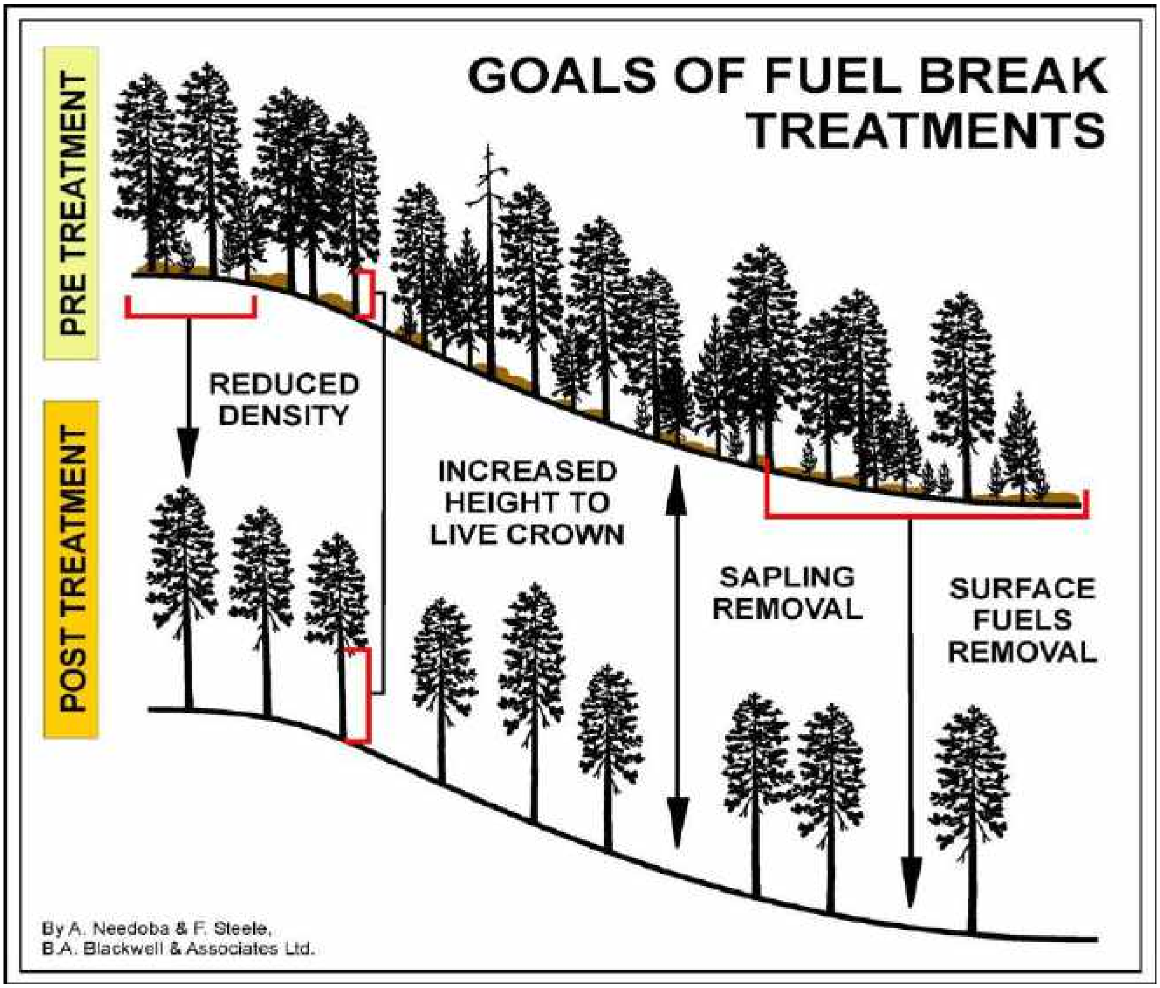


Figure 23. Conceptual diagram of a shaded fuelbreak pre treatment and post treatment.

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.

9.5.2 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.

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Appendix 1 – Fuel Type Descriptions

Fuel Type Descriptions

The following is a general description of the dominant fuel types within the study area.

C2 fuel type

Structure Classification	Pole sapling
Dominant Tree Species	*Pseudotsuga menziesii* (Douglas-fir), *Thuja plicata* (western redcedar), *Tsuga heterophylla* (western hemlock)
Tree Species Type	> 80% Coniferous
Understory Vegetation	Low (< 50% cover)
Age	30 – 40 yrs
Height	10 – 25 m
Stand Density	>1200
Crown Closure	80 – 100 %
Height to Live Crown	Average 2 m
Surface Fuel Loading	< 5 kg/m^2
Burn Difficulty	High; however, with a high potential for extreme fire behaviour and active crown fire.

Figure 24. Example of a densely stocked, pole-sapling C2 fuel type.

C3 fuel type

Structure Classification	Late pole sapling to late young forest
Dominant Tree Species	*Pseudotsuga menziesii* (Douglas-fir), *Thuja plicata* (western redcedar), *Tsuga heterophylla* (western hemlock)
Tree Species Type	> 80% Coniferous
Understory Vegetation	Low (< 50% cover)
Age	40 – 80 yrs
Height	20 – 35 m
Stand Density	700 – 1,200 stems/ha
Crown Closure	40 – 100 %
Height to Live Crown	Average 8 m
Surface Fuel Loading	< 5 kg/m^2
Burn Difficulty	Moderate; however, if fire is wind driven then there is a high potential for extreme fire behaviour and active crown fire.

Figure 25. Example of evenly stocked, moderate density second growth stand – classified as a C3 fuel type.

C4 fuel type

Structure Classification	Pole sapling
Dominant Tree Species	*Pseudotsuga menziesii* (Douglas-fir), *Thuja plicata* (western redcedar), *Tsuga heterophylla* (western hemlock)
Tree Species Type	> 80% Coniferous
Understory Vegetation	Low (< 25% cover)
Age	20 – 40 yrs
Height	10 – 25 m
Stand Density	700 – 2000 stems/ha
Crown Closure	40 – 80 %
Height to Live Crown	Average 4 m
Surface Fuel Loading	< 5 kg/m^2
Burn Difficulty	Moderate to high; however, if fire is wind driven then there is a high potential for extreme fire behaviour and active crown fire.

Figure 26. Example of a moderate to high-density second growth stand of red cedar and Douglas-fir classified as a C4 fuel type.

C5 fuel type

Structure Classification	Mature and old forest
Dominant Tree Species	*Pseudotsuga menziesii* (Douglas-fir), *Thuja plicata* (western redcedar), *Tsuga heterophylla* (western hemlock)
Tree Species Type	> 80% Coniferous
Understory Vegetation	Moderate (> 40% cover)
Average Age	> 80 yrs
Average Height	30 – 40 m
Stand Density	700 – 900 stems/ha
Crown Closure	40 – 100 %
Height to Live Crown	Average 18 m
Surface Fuel Loading	< 5 kg/m^2
Burn Difficulty	Low; however, if fire is wind driven then there is a moderate potential for active crown fire.

Figure 27. Example of mature forest of Douglas fir and western red cedar – classified as a C5 fuel type

C7 fuel type[2]

Structure Classification	Young forest to mature forest
Dominant Tree Species	*Pinus contorta* (lodgepole pine), *Pseudotsuga menziesii* (Douglas-fir), *Thuja plicata* (western redcedar), *Tsuga heterophylla* (western hemlock)
Tree Species Type	> 80% Coniferous
Understory Vegetation	Variable depending on site quality and moisture availability
Average Age	20 – 80 yrs
Average Height	10 – 30 m
Stand Density	Variable, typically less than 500 stems/ha
Crown Closure	20 – 40%
Height to Live Crown	Average 4 m
Surface Fuel Loading	< 5 kg/m^2
Burn Difficulty	Low; however, if fire is wind driven then there is a moderate potential for active crown fire.

Figure 28. Example of an open Douglas-fir and Arbutus forest – classified as a C7 fuel type.

D1 fuel type

Structure Classification	Pole sapling to mature forest
Dominant Tree Species	*Populus trichocarpa* (cottonwood), *Acer macrophyllum* (bigleaf maple), *Alnus rubra* (red alder)
Tree Species Type	> 80% Deciduous
Understory Vegetation	High (> 90% cover)
Average Age	> 20 yrs
Average Height	>10 m
Stand Density	600 – 2,000 stems/ha
Crown Closure	20 – 100 %
Height to Live Crown	< 10 m
Surface Fuel Loading	< 3 kg/m^2
Burn Difficulty	Low

Figure 29. Moist rich site dominated by red alder – classified as a D1 fuel type.

M2c fuel type

Structure Classification	Pole sapling, young forest, mature and old forest
Dominant Tree Species	*Pseudotsuga menziesii* (Douglas-fir), *Thuja Plicata* (western redcedar), *Tsuga heterophylla* (western hemlock), *Populus trichocarpa* (cottonwood), *Acer macrophyllum* (bigleaf maple), *Alnus rubra* (red alder)
Tree Species Types	Coniferous 20-80% / Deciduous
Understory Vegetation	variable
Average Age	> 20 yrs
Average Height	> 10 m
Stand Density	600-1500 stems/ha
Crown Closure	40 – 100 %
Height to Live Crown	6 m
Surface Fuel Loading	< 5 kg/m^2
Burn Difficulty	Moderate; however, if fire is wind driven then there is a high potential for extreme fire behaviour and active crown fire.

Figure 30. Mixed fir/cedar/sword fern site with a deciduous component of red alder and big leaf maple – classified as an M2 fuel type.

O1b fuel type

Structure Classification	Shrub/Herb
Dominant Tree Species	None
Tree Species Type	
Understory Vegetation	High (> 90% cover)
Average Age	<20 yrs
Average Height	<3 m
Stand Density	<50 stems/ha
Crown Closure	<20%
Height to Live Crown	
Surface Fuel Loading	< 3 kg/m^2
Burn Difficulty	Low

Figure 31. Volatile shrub dominated fuel type – classified as O1b.

O1a fuel type

Structure Classification	Herb/shrub
Dominant Tree Species	None
Tree Species Type	
Understory Vegetation	High (> 90% cover)
Average Age	< 10 yrs
Average Height	< 1m
Stand Density	< 50 stems/ha
Crown Closure	< 20%
Height to Live Crown	
Surface Fuel Loading	< 3 kg/m^2
Burn Difficulty	High

Figure 32. Low volatility Herb/shrub dominated fuel type – classified as O1a.

M2r fuel type

Structure Classification	Coniferous Regeneration
Dominant Tree Species	Variable
Tree Species Type	>80% coniferous
Understory Vegetation	Moderate (> 70% cover)
Average Age	< 20 yrs
Average Height	< 1-10 m
Stand Density	< 1000 stems/ha
Crown Closure	< 30%
Height to Live Crown	<1m
Surface Fuel Loading	< 3 kg/m^2
Burn Difficulty	Moderate

Figure 33. Low (Moderate) volatility coniferous regeneration dominated fuel type – classified as M2r.

Appendix 2 – Principles of Fuel Break Design

The information contained within this section has been inserted from “The Use of Fuelbreaks in Landscape Fire Management” by James K. Agee, Benii Bahro, Mark A. Finney, Philip N. Omi, David B. Sapsis, Carl N. Skinner, Jan W. van Wagtendonk, and C. Phill Weatherspoon. This article succinctly describes the principles and use of fuelbreaks in landscape fire management.

> The principal objective behind the use of fuelbreaks, as well as any other fuel treatment, is to alter fire behaviour over the area of treatment. As discussed above, fuelbreaks provide points of anchor for suppression activities.
>
> - Surface Fire Behaviour
>
> Surface fuel management can limit fireline intensity (Byram 1959) and lower potential fire severity (Ryan and Noste 1985). The management of surface fuels so that potential fireline intensity remains below some critical level can be accomplished through several strategies and techniques. Among the common strategies are fuel removal by prescribed fire, adjusting fuel arrangement to produce a less flammable fuelbed (e.g., crushing), or "introducing" live understory vegetation to raise average moisture content of surface fuels (Agee 1996). Wildland fire behaviour has been observed to decrease with fuel treatment (Buckley 1992), and simulations conducted by van Wagtendonk (1996) found both pile burning and prescribed fire, which reduced fuel loads, to decrease subsequent fire behaviour. These treatments usually result in efficient fire line construction rates, so that control potential (reducing "resistance to control") can increase dramatically after fuel treatment.
>
> The various surface fuel categories interact with one another to influence fireline intensity. Although more litter and fine branch fuel on the forest floor usually results in higher intensities, that is not always the case. If additional fuels are packed tightly (low fuelbed porosity), they may result in lower intensities. Although larger fuels (>3 inches) - are not included in fire spread models, as they do not usually affect the spread of the fire (unless decomposed [Rothennel 1991]), they may result in higher energy releases over longer periods of time when a fire occurs, having significant effects on fire severity, and they reduce rates of fireline construction.
>
> The effect of herb and shrub fuels on fireline intensity is not simply predicted. First of all, more herb and shrub fuels usually imply more open conditions. These should be associated with lower relative humidity and higher surface windspeeds. Dead fuels may be drier - and the rate of spread may be higher - because of the altered microclimate compared to more closed canopy forest with less understory. Live fuels, with higher foliar moisture while green, will have a dampening effect on fire behaviour. However, if the grasses and forbs cure, the fine dead fuel can increase fireline intensity and localized spotting.

- Conditions That Initiate Crown Fire

A fire moving through a stand of trees may move as a surface fire, an independent crown fire, or as a combination of intermediate types of fire (Van Wagner 1977). The initiation of crown fire behaviour is a function of surface fireline intensity and of the forest canopy: its height above ground and moisture content (Van Wagner 1977). The critical surface fire intensity needed to initiate crown fire behaviour can be calculated for a range of crown base heights and foliar moisture contents, and represents the minimum level of fireline intensity necessary to initiate crown fire (Table 1); Alexander 1988, Agee 1996). Fireline intensity or flame length below this critical level may result in fires that do not crown but may still be of stand replacement severity. For the limited range of crown base heights and foliar moistures shown in Table 3, the critical levels of flame length appear more sensitive to height to crown base than to foliar moisture (Alexander 1988).

Table 1. Flame lengths associated with critical levels of fireline intensity that are associated with initiating crown fire, using Byram's (1959) equation.

Foliar Moisture Content (%)	Height of Crown Base in meters and feet			
	2 meters	6 meters	12 meters	20 meters
	6 feet	20 feet	40 feet	66 feet
	M ft	M ft	M ft	M ft
70	1.1 4	2.3 8	3.7 12	5.3 17
80	1.2 4	2.5 8	4.0 13	5.7 19
90	1.3 4	2.7 9	4.3 14	6.1 20
100	1.3 4	2.8 9	4.6 15	6.5 21
120	1.5 5	3.2 10	5.1 17	7.3 24

If the structural dimensions of a stand and information about foliar moisture are known, then critical levels of fireline intensity that will be associated with crown fire for that stand can be calculated. Fireline intensity can be predicted for a range of stand fuel conditions, topographic situations such as slope and aspect, and anticipated weather conditions, making it possible to link on-the-ground conditions with the initiating potential for crown fires. In order to avoid crown fire initiation, fireline intensity must be kept below the critical level. Managing surface fuels can accomplish this such that fireline intensity is kept well below the critical level or by raising crown base heights such that the critical fireline intensity is difficult to reach. In the field, the variability in fuels, topography and microclimate will result in varying levels of potential fireline intensity, critical fireline intensity, and therefore varying crown fire potential.

- Conditions That Allow Crown Fire To Spread

The crown of a forest is similar to any other porous fuel medium in its ability to burn and the conditions under which crown fire will or will not spread. The heat from a spreading crown fire into unburned crown ahead is a function of the crown rate of spread, the crown bulk density, and the crown foliage ignition energy. The crown fire rate of spread is not the same as the surface fire rate of spread, and often includes effects of short-range spotting. The crown bulk density is the mass of crown fuel, including needles, fine twigs, lichens, etc., per unit of crown volume (analogous to soil bulk density). Crown foliage ignition energy is the net energy content of the fuel and varies primarily by foliar moisture content, although species differences in energy content are apparent (van Wagtendonk et al. 1998). Crown fires will stop spreading, but not necessarily stop torching, if either the crown fire rate of spread or crown bulk density falls below some minimum value.

If surface fireline intensity rises above the critical surface intensity needed to initiate crown fire behaviour, the crown will likely become involved in combustion. Three phases of crown fire behaviour can be described by critical levels of surface fireline intensity and crown fire rates of spread (Van Wagner 1977, 1993): (1) a passive crown fire, where the crown fire rate of spread is equal to the surface fire rate of spread, and crown fire activity is limited to individual tree torching; (2) an active crown fire, where the crown fire rate of spread is above some minimum spread rate; and (3) an independent crown fire, where crown fire rate of spread is largely independent of heat from the surface fire intensity. Scott and Reinhardt (in prep.) have defined an additional class, (4) conditional surface fire, where the active crowning spread rate exceeds a critical level, but the critical level for surface fire intensity is not met. A crown fire will not initiate from a surface fire in this stand, but an active crown fire may spread through the stand if it initiates in an adjacent stand.

Critical conditions can be defined below which active or independent crown fire spread is unlikely. To derive these conditions, visualize a crown fire as a mass of fuel being carried on a "conveyor belt" through a stationary flaming front. The amount of fine fuel passing through the front per unit time (the mass flow rate) depends on the speed of the conveyor belt (crown fire rate of spread) and the density of the forest crown fuel (crown bulk density). If the mass flow rate falls below some minimum level (Van Wagner 1977) crown fires will not spread. Individual crown torching, and/or crown scorch of varying degrees, may still occur.

Defining a set of critical conditions that may be influenced by management activities is difficult. At least two alternative methods can define conditions such that crown fire spread would be unlikely (that is, mass flow rate is too low). One is to calculate critical windspeeds for given levels of crown bulk density (Scott and Reinhardt, in prep.), and the other is to define empirically derived thresholds of crown fire rate of spread so that critical levels of crown bulk density can be defined (Agee 1996). Crown bulk densities of 0.2 kg m^{-3} are common in boreal forests that burn with crown fire (Johnson 1992), and in mixed conifer forests, Agee (1996) estimated that at levels below 0.10 kg m^{-3} crown fire spread was unlikely, but no definitive single "threshold" is likely to exist.

Therefore, reducing surface fuels, increasing the height to the live crown base, and opening canopies should result in (a) lower fire intensity, (b) less probability of torching, and (c) lower probability of independent crown fire. There are two caveats to these conclusions. The first is that a grassy cover is often preferred as the fuelbreak ground cover, and while fireline intensity may decrease in the fuelbreak, rate of spread may increase. Van Wagtendonk (1996) simulated fire behaviour in untreated mixed conifer forests and fuelbreaks with a grassy understory, and found fireline intensity decreased in the fuelbreak (flame length decline from 0.83 to 0.63 m [2.7 to 2.1 ft]) but rate of spread in the grassy cover increased by a factor of 4 (0.81 to 3.35 m/min [2.7-11.05 ft/min]). This flashy fuel is an advantage for backfiring large areas in the fuelbreak as a wildland fire is approaching (Green 1977), as well as for other purposes described later, but if a fireline is not established in the fuelbreak, the fine fuels will allow the fire to pass through the fuelbreak quickly. The second caveat is that more open canopies will result in an altered microclimate near the ground surface, with somewhat lower fuel moisture and higher windspeeds in the open understory (van Wagtendonk 1996).

- Fuelbreak Effectiveness

The effectiveness of fuelbreaks continues to be questioned because they have been constructed to varying standards, "tested" under a wide variety of wildland fire conditions, and measured by different standards of effectiveness. Green (1977) describes a number of situations where traditional fuelbreaks were successful in stopping wildland fires, and some where fuelbreaks were not effective due to excessive spotting of wildland fires approaching the fuelbreaks.

Fuelbreak construction standards, the behaviour of the approaching wildland fire, and the level of suppression each contribute to the effectiveness of a fuelbreak. Wider fuelbreaks appear more effective than narrow ones. Fuel treatment outside the fuelbreak may also contribute to their effectiveness (van Wagtendonk 1996). Area treatment such as prescribed fire beyond the fuelbreak may be used to lower fireline intensity and reduce spotting as a wildland fire approaches a fuelbreak, thereby increasing its effectiveness. Suppression forces must be willing and able to apply appropriate suppression tactics in the fuelbreak. They must also know that the fuelbreaks exist, a common problem in the past. The effectiveness of suppression forces depends on the level of funding for people, equipment, and aerial application of retardant, which can more easily reach surface fuels in a fuelbreak. Effectiveness is also dependent on the psychology of firefighters regarding their safety. Narrow or unmaintained fuelbreaks are less likely to be entered than wider, well-maintained ones.

No absolute standards for width or fuel manipulation are available. Fuelbreak widths have always been quite variable, in both recommendations and construction. A minimum of 90 m (300 ft) was typically specified for primary fuelbreaks (Green 1977). As early as the 1960's, fuelbreaks as wide as 300 m (1000 ft) were included in gaming simulations of fuelbreak effectiveness (Davis 1965), and the recent proposal for northern California national forests by the Quincy Library Group (see web site http://www.qlg.org for details) includes fuelbreaks 390 m (0.25 mi) wide. Fuelbreak simulations for the Sierra Nevada Ecosystem Project (SNEP) adopted similar wide fuelbreaks (van Wagtendonk 1996, Sessions et al. 1996).

Fuel manipulations can be achieved using a variety of techniques (Green 1977) with the intent of removing surface fuels, increasing the height to the live crown of residual trees, and spacing the crowns to prevent independent crown fire activity. In the Sierra Nevada simulations, pruning of residual trees to 3 m (10 ft) height was assumed, with canopy cover at 1-20% (van Wagtendonk 1996). Canopy cover less than 40% has been proposed for the Lassen National Forest in northern California. Clearly, prescriptions for creation of fuelbreaks must not only specify what is to be removed, but must describe the residual structure in terms of standard or custom fuel models so that potential fire behaviour can be analyzed.