Community Wildfire Protection Plan

Westbank First Nation

June 2020

Frontline
Operations Group

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Westbank First Nation

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June 23, 2020

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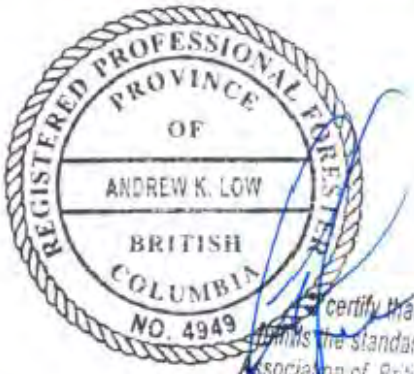

"I certify that the work described herein conforms the standards expected of a member of the Association of British Columbia Forest Professionals and that I did personally supervise the work."

Supervision certification statement

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Acknowledgements

The Frontline CWPP team would like to acknowledge and thank the Syilx people, and Westbank First Nation specifically, for the opportunity to live and work on unceded territory. As a company and as individuals, we believe in the value of traditional rights and practices, particularly as they relate to our area of passion: coexisting with fire. We would also like to thank WFN staff for their patience and support while completing this CWPP. While on the home stretch to completion, everyone's worlds were turned upside down by the global corona virus pandemic, which impacted our ability to maintain momentum to finish the project in a more timely fashion as we adjusted our work and business practices to ensure the health and safety of the team.

Executive Summary

The Community Wildfire Protection Plan (CWPP) has been a foundational element of the Strategic Wildfire Prevention Initiative (SWPI), and now the Community Resiliency Investment (CRI) program and serves to paint the complete wildfire picture for communities in British Columbia. The Westbank First Nation (WFN) has long had a relationship with the surrounding environment, including wildland fire. Most recently during the 2017 fire season, the Philpott Road fire occurred near the Medicine Creek 11 lands, and numerous wildland urban interface fires have occurred in and around Tsinstikeptum 9 and10 over the past decade, including fires at Glenrosa, Rose Valley, Bear Creek and Mount Boucherie. To reframe the wildfire issues faced by the community, and to position WFN leadership to access prevention funding under CRI, WFN retained Frontline Operations Group Ltd. to develop their first CWPP.

As a partial indicator of potential future wildfire activity, a fire history analysis within 2 km of WFN lands has been completed. The occurrence rate of wildfires within this area indicates a gradual decrease in the occurrence of person-caused wildfires. An analysis of four BC Wildfire Service fire weather stations in the surrounding region demonstrates a clearly increasing trend in the number of Fire Danger Class 4 and 5 days per year.

Geospatial analysis of provincial fuel type layers and the provincial strategic threat analysis (PSTA) outputs further characterize the wildfire impacts that WFN continues to face. Although parts of WFN are relatively well-protected by urban development, vineyards and Okanagan Lake, continued emphasis needs to be placed on the responsibilities of land holders to manage their fuel hazards. This includes residential land holders and the steps they can take to manage their landscaping and structure characteristics to make their homes less prone to ignition during a wildfire.

Wildland urban interface wildfire threat assessments were completed on Community Lands where geospatial analysis and fire behaviour modelling was classified as moderate or higher. Based on the threat assessments, nine interface fuel break areas have been proposed in Section 5.1 (Figures 18 – 23), totalling 74.3 ha.

Westbank First Nation will continue to face wildfire pressures, and these should be expected to increase in a changing climate. By maintaining a proactive focus on wildfire prevention and

mitigation efforts, and through continued advocacy at the local and provincial levels, the community can continue to find ways to grow and thrive in an active wildfire environment.

Summary of CWPP Recommendations

	Objective/Priority	Recommendation/ Next Steps	Responsibility/Funding Source

Section 5: Risk Management and Mitigation Factors	Wildfire risk reduction prescriptions and treatments	• Apply for CRI funding to:
		  o develop treatment prescriptions.
		  o develop prescribed burn plans, and
		  o conduct fuel management on the proposed treatment areas.
		• A two-year timeline to prescribe and treat Areas 1 to 7 (55.3 ha) is realistic, with the 2020 CRI funding support ($150,000) from FNESS.
		• Followed by prescription and treatment for Areas 8 and 9 (approx. 19 ha) with a future CRI funding application.
			WFN with CRI funding support

	Public education and outreach	• Apply for CRI funding to:
		  o Initiate FireSmart projects for the proposed neighbourhoods, with FireSmart Community Recognition as the goal.
		  o Hold an annual FireSmart education and wildfire preparedness day,
		• A five-year timeline to undertake FireSmart projects on the seven areas proposed for projects is realistic with appropriate CRI funding support and guidance from FNESS.
			WFN with CRI funding support

	Traditional fire practices	• Reaffirm the knowledge and culture of fire stewardship that has existed since time immemorial. • Reestablish the use of traditional fire practices on WFN lands where it is desirable. • Support Syilx and other Nations who are working to reestablish traditional fire practices.	WFN with CRI funding support
Section 6: Wildfire Response	Wildland firefighting and fire use	• Consider the establishment of a WFN wildland firefighting crew that can: o Assist WKFR with expanded attack, mop-up and patrol activities. o Conduct fuel management and prescribed burning. o Participate in wildland firefighting in other areas of BC as a WFN business venture.	WFN with support from City of West Kelowna. Support from BCWS. Funding sources may include federal and provincial programs and service agreements.

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1 Introduction

The Community Wildfire Protection Plan (CWPP) program was initiated by the Province of British Columbia as a response to key recommendations contained in the Firestorm 2003 Provincial Review (Filmon, Leitch, & Sproul, 2004). The CWPP program is administered by the First Nations Emergency Services Society of BC (FNESS) and the Union of BC Municipalities (UBCM) as a foundational component of the Community Resiliency Investment (CRI) program- a new provincial program[1] intended to reduce the risk and impact of wildfire to communities in BC through community funding, supports and priority fuel management activities in the wildland urban interface (Union of BC Municipalities, 2019). The CWPP program is available to all local governments and First Nations in BC. The Westbank First Nation (WFN) was successful in applying for a CRI grant to complete a CWPP as part of the 2019 CRI intake.

1.1 Purpose

A CWPP identifies wildfire risks to a community, describes the potential impact that wildfire may have on the community, and details recommendations to reduce risk and increase the community's resilience to wildfire threats.

The overarching goal of the CWPP is to define the threat to human life, property and critical infrastructure from wildfires in a given area, identify measures necessary to mitigate those threats and outline a plan of action to implement the measures.

The intended outcome of the CWPP planning process is to provide the community with a detailed framework for further efforts that will:

- reduce the likelihood of a wildfire entering into communities;
- reduce the impacts and/or losses to property and critical infrastructure; and
- reduce negative economic and social wildfire impacts to communities.

1.2 CWPP Planning Process

Upon successful application for funding, WFN selected Frontline Operations Group Ltd. to update the 2011 CWPP. Andrew Low, RPF, and John Davies, RPF, supervised the field

[1] Prior to CRI, Community Wildfire Protection Plans were administered under the Strategic Wildfire Prevention Initiative of the UBCM.

assessments, analysis and report compilation as forest professionals qualified in all aspects of wildland fire management. All consultations with WFN were through Jonathan Ford, AScT.

2 Local Area Description

Westbank First Nation is home to just over 9,000 people, predominantly on Tsinstikeptum 9 and 10 (Statistics Canada, 2017). Westbank First Nation consists of five Indian Reserves (IR):

- IR 8 – Mission Creek
- IR 9 – Tsinstikeptum
- IR 10 - Tsinstikeptum
- IR 11 – Medicine Hill
- IR 12 – Medicine Creek

2.1 CWPP Area of Interest

The area of interest (AOI), as used in CWPP terminology, essentially describes the study area. The UBCM guidance for defining the AOI is rather flexible, ranging from simply the extent of wildland urban interface (WUI) as the minimum, to taking a wider view consisting of the local government's legal boundary. The WUI is any area where combustible wildland fuels (vegetation) are found adjacent to homes, farm structures, other outbuildings or infrastructure. This may occur in the interface where development and fuels meet at a well-defined boundary or the intermix, where development and fuels intermingle and have no clearly defined boundary (Partners in Protection, 2003). For this CWPP the AOI is the entirety of the five WFN Reserves (Figure 1), however, only WFN Community Lands were targeted for site assessment and treatment recommendations.

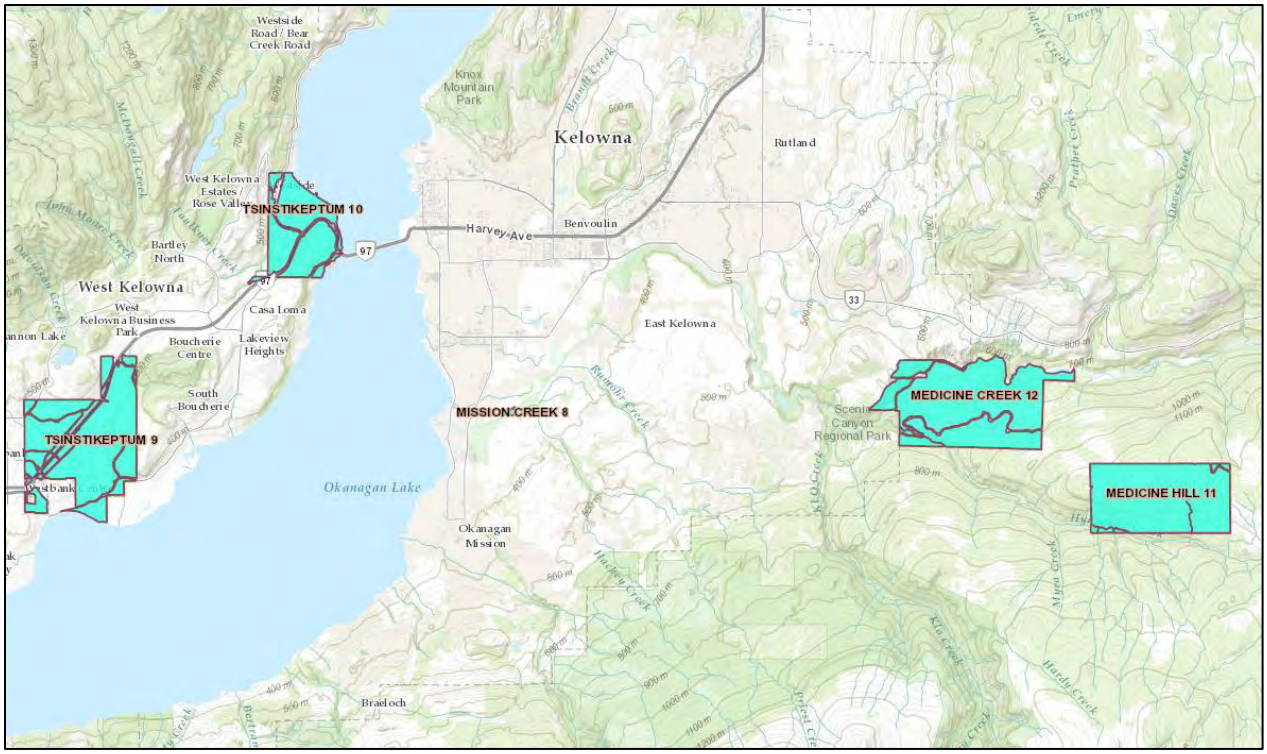

Figure 1 Westbank First Nation lands.

2.2 Community Description

Westbank First Nation is one of eight Okanagan Nation communities within the traditional and unceded territory of the Syilx/Okanagan people. WFN has been self-governing since 2005, whose Local Government consists of one Chief and four Councillors, serving three-year terms. Although WFN reserve lands are bordered by the cities of West Kelowna and Kelowna, the Westbank First Nation is a distinct government who's traditional unceded territories extend well beyond the existing IRs.

WFN lands include an ecologically diverse mix of dry Ponderosa pine and Douglas-fir ecosystems, as well as moist interior cedar-hemlock plant communities in the upper reaches of Medicine Hill. Natural disturbance patterns throughout the central Okanagan reflect this diversity, ranging from frequent stand maintaining to infrequent stand initiating processes. Economically, the diverse ecology of WFN translates into opportunities in tourism, forestry and agriculture.

2.3 Past Wildfires, Evacuations, and Impacts

Wildfires have been a regular and natural disturbance agent in the Okanagan for millennia. In recent years, WFN has felt the effects of several wildfires, ranging from small fast-moving fires that are contained relatively quickly, to prolonged periods of large fires burning in the surrounding area. Most recently the Province of British Columbia, including the Okanagan valley, was subjected to back-to-back record-breaking fire seasons in 2017 and 2018. In both years numerous wildfires threatened various communities leading to mass evacuation alerts and orders.

The environs in and around WFN lands have had its share of wildfires in the WUI, prompting both evacuation orders and alerts – the most recent being the Philpott Road fire northeast of IR 11 – Medicine Hill in 2017. Fortunately, since 2003, which saw the loss of 238 homes on the nearby Okanagan Mountain Park fire, WFN has been spared from the more wide-spread and catastrophic destruction of homes and whole neighbourhoods, as has been the case in other parts of western Canada. This could be partly attributed to public education and efforts to FireSmart local neighborhoods, but there is likely an element of luck as well. A detailed fire history analysis, including fire occurrence and annual area burned within the AOI is provided in Section 4. The more significant wildfires in relation to WFN in recent time are summarized in Table 1.

Table 1 Recent fires of significance in relation to WFN.

Fire Date	Geographic	Fire Size (ha)	Evacuated
August 24, 2017	Philpott Road (K51878)	489.4	1,100 people
June 17, 2016	Westside Road (K50109	0.3	10 homes
August 21, 2016	Bear Creek (K50403)	59.9	105 homes
July 17, 2014	Smith Creek (K50293)	245.6	2,500 people
August 7, 2014	MacKinnon Road (K50446)	25.5	1 home
September 5, 2011	Bear Creek (K50603)	38.7	550 people
July 12, 2010	Seclusion Bay (K50144)	23.7	60 people
July 18, 2009	Rose Valley (K50747)	107.5	12,500 people
July 18, 2009	Glenrosa (K50739)	303.3	
August 16, 2003	Okanagan Mtn. (K50628)	25,635.6	27,000 people
May 7, 1992	Mount Boucherie (K50034)	64.3	100 homes

2.4 Current Community Engagement

Since 2004, as a result of the Firestorm 2003 review, WFN has made efforts to raise WUI fire safety awareness and advocate for mitigation. This has included the completion of several fuel mitigation projects and a FireSmart project on Bayview Court in 2017.

2.5 Linkages to Other Plans and Policies

Several plans and policies exist at the local and provincial levels of government that pertain to the response and recovery of WUI fires, as well as wildfire management in general. The following is a broad survey of the various plans and policies that influence wildfire management.

2.5.1 Local Authority Emergency Plan

Westbank First Nation is party to the Regional District of Central Okanagan Emergency Plan, which is coordinated by the City of Kelowna on behalf of the regional district, the District of Lake Country, the District of Peachland, WFN, Kelowna and West Kelowna (City of Kelowna, 2016). The emergency plan is intended to:

- assist emergency personnel to respond to disasters and major emergencies, such as floods, wildfires, major spills, plane crashes etc.
- establish a centralized assessment and decision-making organization to share regional resources or request assistance from the provincial or federal governments;
- guide post-emergency recovery operations.

2.5.2 Affiliated CWPPs

Adjacent jurisdictions with CWPPs are the District of Peachland (Davies, Coulthard, & Zukanovic, 2012), the City of Kelowna (Pashkowski & Blackwell, 2017), the City of West Kelowna (Low & Davies, 2018) and the Regional District of Central Okanagan (Needoba & Blackwell, 2010). The City of West Kelowna, City of Kelowna and the Regional District of Central Okanagan all share a certain degree of fuel continuity with WFN and a collaborative approach that leverages risk reduction funding across boundaries is best to achieve multiple beneficial outcomes.

2.5.3 WFN Laws, Plans and Policies

WFN membership ratified the Westbank First Nation Self-Government Agreement in 2003, which was enshrined into law in 2005 under the Westbank First Nation Self-Government Act in 2005. The agreement and act enable WFN to govern itself according to their constitution through the enactment of laws, entering into agreements with other levels of government and provision of services and programs on Westbank Lands.

As such, WFN has in place a number of laws and policies that are pertinent to wildfire risk reduction. The Westbank First Nation Fire Protection Law 2005-11 sets forth provisions for open burning, smoke control, fire chief authority and powers, and enables the levy of penalties. The Westbank First Nation Community Plan (2015) speaks to wildfire risk reduction with the following:

- Effectively balance fire mitigation measures with the priority of tree retention
- Continue to manage forested areas within reserve lands to minimize the risk of fire with a priority on tree retention

2.5.4 Higher Level Plans and Relevant Legislation

The Okanagan Shuswap Land and Resource Management Plan (LRMP)[2] was completed in 2001 and relates to Crown land throughout the Okanagan Shuswap Natural Resource District (Province of British Columbia, 2001). The LRMP makes several references to wildfire management and hazard reduction (Table 2), none of which impinge on the ability of local governments to undertake mitigation work. Flowing from the LRMP are orders pertaining to the establishment of resource management zones and old growth management objectives (Province of British Columbia, 2007) and none of these orders impede WFN from pursuing strategic wildfire mitigation efforts. Specific to WFN, these include orders related to:

- basic levels of coarse woody debris (CWD) areas;
- basic and enhanced levels of CWD areas;
- bighorn sheep areas;
- elk areas;

[2] https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/thompsonokanagan-region/okanaganshuswap-lrmp/okanagan_shuswap_lrmp.pdf

- marten areas;
- intensive recreation areas; and
- tourism areas.

Table 2 Wildfire references in the Okanagan-Shuswap Land and Resource Management Plan (2001).

Part 4 Community/Crown Interface (Page CCI 4-1)	
Sec 7	Protect populated areas from forest fire hazards in the wildland – urban interface, and protect the provincial forest from fires originating on contiguous private land.
Sec 7.1	The Ministry of Forests is to coordinate fire hazard reduction in the Interface zone through consultation with the public, licensed tenure holders, affected resource agencies, First Nations, and local government.
Sec 7.2	Where practical, coordinate and implement fire hazard reduction activities with priority areas for prescribed burning for ecosystem enhancement purposes.
Part 4 Ecosystem – Natural Disturbance Type 4 (page NDT4 4-9)	
Sec 10.1	Where practical, return fire to the NDT4a at historical fire cycle intervals by developing and implementing a burn plan that includes restoration and maintenance burning.
Sec 10.3	Develop and implement a plan to modify suppression on naturally occurring wildfires that meet impact prescriptions.
Sec 11.9	Develop a fire management plan for the NDT4a and b.
Sec 11.11	Develop and implement a plan to modify suppression on naturally occurring wildfires that meet impact prescriptions.
Part 4 Mountain Goat Habitat (page Wildlife_Goat 4-3)	
Sec 2.1	Where other resource values are not threatened, enhance early seral foraging opportunities by implementing a "let burn" policy for high elevation wild fires in inoperable areas that are on, or adjacent to, goat winter ranges.
Part 4 - Mule Deer Winter Range (page Wildlife_Mdeer 4-12/)	
Sec 3.4	Where practicable, utilize prescribed burns under specific conditions or mechanical treatments to enhance winter range forage values.

2.5.5 Ministry and Industry Plans

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) has prepared fire management plans for each Natural Resource District in the province, as required by ministry policy. Fire management plans are intended to address all wildfire-related issues within the natural resource district, particularly the desired interaction between resource management concerns and fire suppression requirements. It is important to note that district fire management plans are currently not public documents in the Kamloops

Fire Centre (KFC), although there are examples of District fire management plans elsewhere in the province available on the internet[3].

The current fire management plan for the Okanagan Shuswap Natural Resource District dates from 2015 and carries forward the 2014 wording with updates to spatial data only. The district fire management plan is a brief 15-page document that also includes high-level district mapping according to four broad "priority themes". The mapping themes are as follows:

- Theme 1 – Human Life and Safety
    - WUI areas (high, moderate and low structure density)
    - Evacuation routes and marshalling points
- Theme 2 – Critical Infrastructure and Property (that relates to maintaining Theme 1)
    - Energy generation and transmission, healthcare, first responder facilities, transportation, wildland structures etc.
- Theme 3 – High Environmental Cultural
    - Water resources, species at risk, cultural values
- Theme 4 – Resource Values
    - Ungulate winter range, old-growth management areas, timber, silviculture investments, range management, and visual quality areas

The Westbank First Nation has a Community Forest Agreement (K1P) that includes Crown land area within the West Kelowna municipal boundary. The current Forest Stewardship Plan (FSP) guides the forestry practices on the community forest and replaceable forest license, and identifies the application of the *fire management stocking standards* within 2-km of the WUI (Gill, 2018). The existence of a long-term area-based tenure adjacent to WFN will continue to provide opportunities to undertake mutually beneficial wildfire hazard mitigation for both WFN, West Kelowna and other local government partners.

[3] See Mackenzie Natural Resource District Fire Management Plan 2018 https://www.for.gov.bc.ca/ftp/DMK/external/!publish/Consultation%20Maps/FMP/Mackenzie%20FMP_2018_DRAFT.docx

3 Values at Risk

The BCWS wildfire glossary of terms (2016) describes the term *values at risk* as the specific or collective set of natural resources and human improvements/developments that have measurable or intrinsic worth and that could be destroyed or otherwise altered by fire in any given area. The concept of determining the value of something in relation to some level of wildfire risk is fraught with complication. The BC Forest Practices Board (2012) noted that assigning monetary value to natural resources is difficult and applied inconsistently across the province. This challenge becomes more complicated when considering non-consumptive values such as wildlife habitat. Within the context of the CWPP, values at risk include human health and safety, facilities, services, cultural and natural resources etc. that may be negatively impacted by wildfire. This includes human life, property, critical infrastructure, high environmental and cultural values, and resource values.

3.1 Human Life and Safety

The 2016 Canadian Census indicated that 9,028 people live on WFN lands. During the wildfire season, tourism and seasonal work creates an influx of people into the region. Periods of persistent fire load during this period can have notable impacts on the tourism and agricultural economies.

Wildfire smoke is of particular concern for the health and wellbeing of the public. Among a host of other constituents, wildfire smoke contains particulate matter (PM) which is primarily composed of organic carbon and black carbon components (Naeher, et al., 2007). The size of PM that biomass burning produces is usually fine particles less than 2.5 micrometers (μm), referred to as $PM_{2.5}$ (Duran, 2014).

Although everyone responds to wildfire smoke exposure differently, the BC Centre for Disease Control (2018) identifies the following groups as being most at risk:

- people over 65;
- women who are pregnant;
- infants and small children;
- people with existing chronic respiratory conditions.

3.2 Critical Infrastructure

Publicly and provincially owned critical infrastructure (CI) are assets owned by the Provincial government, local government, public institution (such as health authority or school district), First Nation or Treaty First Nation that are:

- Essential to the health, safety, security or economic wellbeing of the community
- Essential to effective functioning of government
- Assets identified in a Local Authority Emergency Plan Hazard, Risk & Vulnerability and Critical Infrastructure assessment.

3.2.1 Electrical Power

Electricity is supplied to West Kelowna via the BC Hydro 1L244 transmission line (130kV), from Nicola to Westbank Substations (BC Hydro, 2017). The Westbank Substation is located within West Kelowna on Shannon Lake Road, adjacent to Tsinstikeptum Reserve 9. The 2014 Smith Creek Fire burned up to a portion of the 1L244 right-of-way opening (Figure 2). The West Kelowna Transmission Project (WKTP) is intended to supply a redundant transmission system to the Westbank Substation (BC Hydro, 2020).

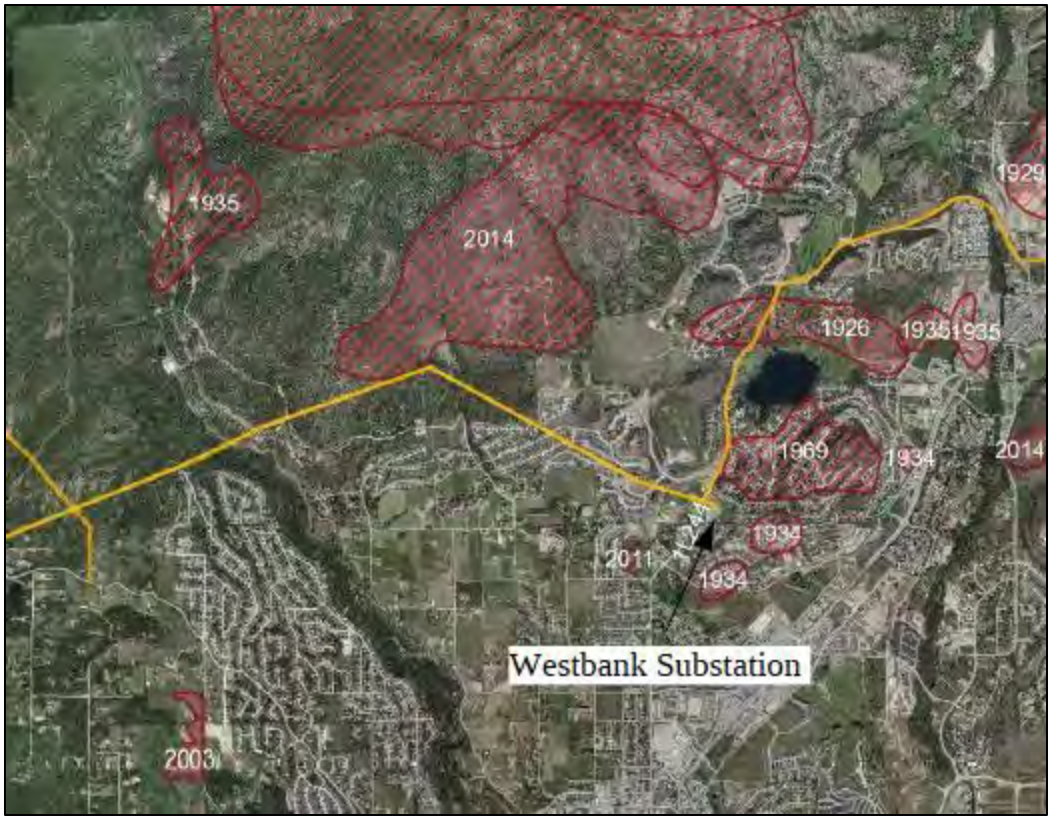

Figure 2 Historical wildfires in relation to the BC Hydro Westbank substation.

A wildfire risk assessment was completed for BC Hydro looking at the various WKTP alternatives. This assessment examined three alternative transmission routes for the WKTP and found Alternative 2 as having a lower fire probability and associated risk (Blackwell, 2019). Subsequently, a new alternative has been brought forward (Alternative 3d) and no decision has been confirmed as of yet.

3.2.2 Communications, Pipelines and Publicly Owned Buildings

Key WFN buildings are listed in Table 3 Key public buildings in WFN.Table 3– most of which are clustered at Quail Lane to the east of McDougal Creek. A transmission pipeline for natural gas, runs through West Kelowna and across Okanagan Lake to Kelowna ((FortisBC, 2009). FortisBC has a corporate emergency response plan for pipeline and electrical emergencies (FortisBC, 2016).

Table 3 Key public buildings in WFN.

Facility	Location
Lindley Building - WFN Government	575 Hwy 97 South
WFN Public Works and Utilities	3500 Red Cloud Way
Youth Centre	1880 Quail Lane
Early Years Centre	1880 Quail Lane
Pine Stadium Ball Park	1900 Quail Lane
Pavilion	1900 Quail Lane
Pine Acres Home	1902 Pheasant Lane
Gymnasium	1920 Quail Lane
Multipurpose Room	1920 Quail Lane
sənsisyustən House of Learning	1920 Quail Lane
Westbank Child Development Centre (WCDC)	3255A Shannon Lake Road
Elders Hall	3255D Shannon Lake Road

3.2.3 Water and Sewage Infrastructure

WFN owns and operates their own water distribution systems and sanitary sewer collection systems. The water systems for Tsinstikeptum 9 and 10 are sourced from Okanagan Lake, from which raw water is chlorinated and pumped into the distribution system. In total, the two reserves rely on approximately 44 km of water mains ranging in size from 100 to 600 mm diameter. Sanitary sewer collection is achieved through 29 km of sewer main, four lift stations and one equalization tank. Wastewater treatment is provided through agreement with RDCO.

3.3 High Environmental and Cultural Values

The Okanagan valley is prized for its ecological and cultural value. Since time immemorial the Syilx have lived here and have shaped the ecology of the landscape. Central to this has been the use of fire and the interdependence of ecological processes and periodic natural and anthropogenic fire.

3.3.1 Drinking Water Supply Area and Community Watersheds

Tsinstikeptum 9 and 10 each draw water from their own deep-water intake in Okanagan Lake for subsequent treatment and distribution. Beyond that, Medicine Hill #11 lies almost entirely within the Mission and Hydraulic Community Watersheds, with Medicine Creek #12 occupying a small sliver of the western boundary of Mission Community Watershed (Figure 3).

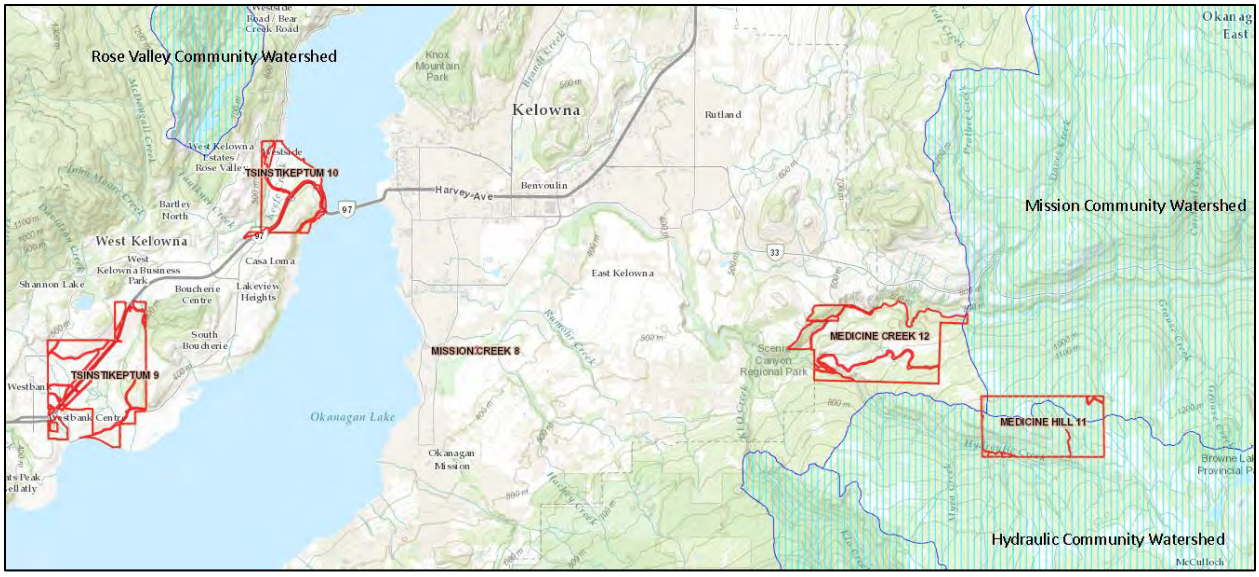

Figure 3 Community watersheds in and about WFN lands.

3.3.2 Cultural Values

Due to an extensive and uninterrupted First Nation presence throughout the Okanagan, wildfire and associated suppression operations have the potential to inadvertently seriously impact or destroy cultural heritage resources.

It can be challenging to navigate the requirements of the Heritage Conservation Act (HCA) during the critical initial attack phase of a wildfire response, but a basic awareness of what to look for can help to ensure that cultural heritage resources aren't impacted by suppression actions. Archaeological sites in British Columbia that date to 1846 or earlier are protected from alteration of any kind by the Heritage Conservation Act (HCA) (1996). The provisions of the HCA apply to archaeological sites located on both public and private land, known and unknown, and are binding on government.

For good reason, the exact locations of known sites and resources are often privileged information, but through agreement and trust, general information regarding areas could be shared. From there, it is incumbent on personnel who are actively working in the field to be able to identify resources so that suppression actions can be planned or altered in such a way as to not to contravene the HCA.

Fire suppression agencies must consult with First Nations to ensure that suppression actions do not inadvertently destroy cultural heritage values. Best practice is for agencies to engage in these consultations as part of their preparedness activities. If this has not occurred or if new

information comes to light after initial consultations, agencies should invite cultural heritage resource experts to liaise directly with fire managers on the ground. If an invitation is not extended in a timely fashion, First Nations leadership should be encouraged to approach the suppression agency and request that cultural heritage resource experts be incorporated into an advisory role for the duration of fire suppression and rehabilitation works.

3.3.3 High Environmental Values

The BC Conservation Data Centre identifies Blue and Red listed vertebrate animals and ecosystem communities in and about WFN lands, as summarized in Table 4 (BC Conservation Data Centre, 2018). A review of DataBC layers indicates that no fisheries-sensitive watersheds are within the AOI.

Table 4 Red and Blue listed species and ecological communities in and about WFN lands.

Vertebrate animals		
Common name	Scientific name	BC List status
Painted Turtle - Intermountain - Rocky Mountain Population	*Chrysemys picta* pop. 2	Blue
Western Screech-Owl, *macfarlanei* subspecies	*Megascops kennicottii macfarlanei*	Blue
Gopher Snake, *deserticola* subspecies	*Pituophis catenifer deserticola*	Blue
North American Racer	*Coluber constrictor*	Blue
Lewis's Woodpecker	*Melanerpes lewis*	Blue
Ecological communities		
common cattail Marsh	*Typha latifolia* Marsh	Blue
hard-stemmed bulrush Deep Marsh	*Schoenoplectus acutus* Deep Marsh	Blue
black cottonwood - Douglas-fir / common snowberry - red-osier dogwood	*Populus trichocarpa - Pseudotsuga menziesii / Symphoricarpos albus - Cornus stolonifera*	Red

* **Red:** Includes any indigenous species or subspecies that have, or are candidates for, Extirpated, Endangered, or Threatened status in British Columbia.

* **Blue:** Includes any indigenous species or subspecies considered to be of Special Concern (formerly Vulnerable) in British Columbia.

3.4 Other Resource Values

The Westbank First Nation entered into a five-year Community Forest Pilot Agreement in 2004, which was solidified into a 25-year (replaceable every 10-years) Community Forest Agreement (CFA) in 2009 (NTITYIX Resources, 2004). The CFA is composed of two blocks: one directly west of West Kelowna and the other to the northwest of Big White. The entire CFA is over 46,000-ha and the 2015/16 harvest level was 74,264 m^3 on a net area of 330.5-ha (NTITYIX Resources, 2016).

3.5 Hazardous Values

Westbank First Nation Lands are not characterized by extensive heavy industry and the potentially hazardous materials associated with such. The extent of the hazardous materials found within the surrounding area are characteristic of many other communities. These include gas stations, natural gas utilities, water treatment chemicals, arena refrigeration systems and agricultural inputs.

4 Wildfire Threat

The following is a summary of the factors that contribute to an understanding of the wildfire threat around a community. These factors include natural fire regime and ecology, Provincial Strategic Threat Analysis, and a local wildfire risk analysis. Risk assessment for wildfire and its impacts to communities considers both the likelihood of a wildfire and the potential consequence associated with that likelihood.

4.1 Fire Regime, Fire Weather and Climate Change

WFN lands are characterized as an active fire environment where conditions often exist during the summer months where there is potential for losses to the public. When assessing the wildfire situation of the region, past conditions offer an indication of potential future conditions in the near term, and climate change scenarios must be incorporated when considering increasing future community resilience.

4.1.1 Fire Regime and Fire Weather

The ecology of WFN lands has been shaped by the occurrence of frequent low-intensity, stand-maintaining natural and historical anthropogenic fires. The majority of the area is classified as Natural Disturbance Type 4 (NDT4), which describes ecosystems adapted to frequent stand-maintaining fire. The NDT classification (Table 5) of an area provides an illustration of the magnitude and frequency of natural disturbance (wildfires and windstorms, predominantly) across the land base.

Table 5 Natural disturbance type classification in British Columbia.

Natural Disturbance Type (NDT)	Description
NDT1	Ecosystems with rare stand-initiating events
NDT2	Ecosystems with infrequent stand-initiating events
NDT3	Ecosystems with frequent stand-initiating events
NDT4	Ecosystems with frequent stand-maintaining fire
NDT5	Alpine Tundra and Subalpine Parkland ecosystems

In terms of natural disturbance, a distinction is drawn between stand-initiating and stand-maintaining events. Stand-initiating events typically terminate the existing forest and induce secondary succession to produce a new forest. Stand-maintaining events serve to keep successional processes stable (Province of British Columbia, 1995). In wildfire terms, high intensity fire behaviour, such as intermittent or continuous crown fire, would be considered a stand-initiating event. Conversely, a low intensity fire surface fire consuming understory fuels while retaining a mature overstory is considered a stand-maintaining event.

These distinctions are important when assessing the wildfire history of an area. The absence of frequent stand-maintaining processes can result in a cascading series of ecological responses, including forest health, habitat, and fuel loading issues. In the NDT4, low-intensity (i.e. surface fire) fire return intervals historically ranged from 4 to 50 years (Province of British Columbia, 1995). Forest protection policies centered around aggressive fire suppression have resulted in a drastically reduced frequency (or absence) of fire in ecosystems that are dependant (i.e. maintained) by frequent, low-intensity surface fires.

Stand-initiating fires (i.e. crown fires) in Ponderosa pine dominated stands were historically rare, with return intervals of at least 150 to 250+ years (Province of British Columbia, 1995). The longer a fire-maintained stand goes without fire maintenance, the greater the likelihood that a future fire occurrence will be a stand-initiating disturbance. From a firefighting standpoint this increasingly deteriorating condition can result in wildfires that require significantly more suppression effort and cost to control.

The provincial fuel type layer was analyzed on WFN lands (Table 6). Of the 2,476 ha of reserve lands, 34% is classified as non-fuel (water, urban, cultivation etc.). Approximately 53% of the wildland fuel is classified C-7 (Ponderosa Pine/Douglas-fir) and O-1 (Grass), which are characteristic of NDT4 ecosystems. The remaining 13% is composed of a mixture of conifer and deciduous fuels, typical of higher elevation areas of the Okanagan and characteristic of a transition from NDT4 sites towards mixed-severity and stand replacement fire regimes.

Table 6 Distribution of CFFDRS - Fire Behaviour Prediction (FBP) System fuel types in WFN.

FBP Fuel Type	Area (ha)	%
C-7 Ponderosa Pine/Douglas-fir	900	36%
Non-fuel (water, urban, cultivation etc.)	838	34%
O-1a Matted/Cut Grass O-1b Standing Grass	419	17%
M-1 Boreal Mixedwood - Leafless M-2 Boreal Mixedwood - Green	190	8%
C-3 Mature Jack or Lodgepole Pine	79	3%
D-1 Leafless Aspen D-2 Green Aspen	38	2%
C-5 Red and White Pine	17	0.7%
	2,482	100%

Four BCWS fire weather station were analyzed for the WFN CWPP (Table 7 and Figure 4): Brenda Mines, Fintry, Ida Bell 3 and West Kelowna. Generally, WFN lands are well represented by the existing BCWS fire weather station locations, particularly with the recent commissioning of the West Kelowna fire weather station.

Table 7 BC Wildfire Service active fire weather stations representative of WFN.

Station Name	Latitude	Longitude	Elevation	Install Date
Brenda Mines	49.8684	-119.9925	1476m	June 14, 1989
Fintry	50.2067	-119.4800	670m	July 13, 1990
Ida Bell 3	49.7672	-119.1241	1261m	August 1, 2004
West Kelowna	49.8832	-119.5695	650m	November 1, 2016

Figure 4 Locations of BCWS fire weather stations analyzed for the WFN CWPP.

For the purposes of CWPPs in BC, fire weather conditions are described in terms of the Fire Danger Class. Fire Danger Class is defined in the Wildfire Regulation and is a rating derived from outputs of the Canadian Forest Fire Weather Index (FWI) System. Although the sole intent of the Fire Danger Class rating scheme is to restrict high risk activities (primarily industrial) occurring on or about forest and grassland areas, the use of Fire Danger Class has been extended to the CWPP realm as a straightforward means of characterizing fire weather conditions in an area represented by a weather station.

Fire Danger Class is determined by comparing the Buildup Index (BUI) to the Fire Weather Index (FWI) in one of three tables presented in the Wildfire Regulation. Each table is specific to one of three broad Danger Regions in BC; WFN is situated in Danger Region 3, along with each of the fire weather stations that were included in this analysis. The actual Fire Danger Classes are numerical ratings 1-5, in ascending order of severity. An illustration of the various inputs and components from which Fire Danger Class is derived is presented in Figure 5.

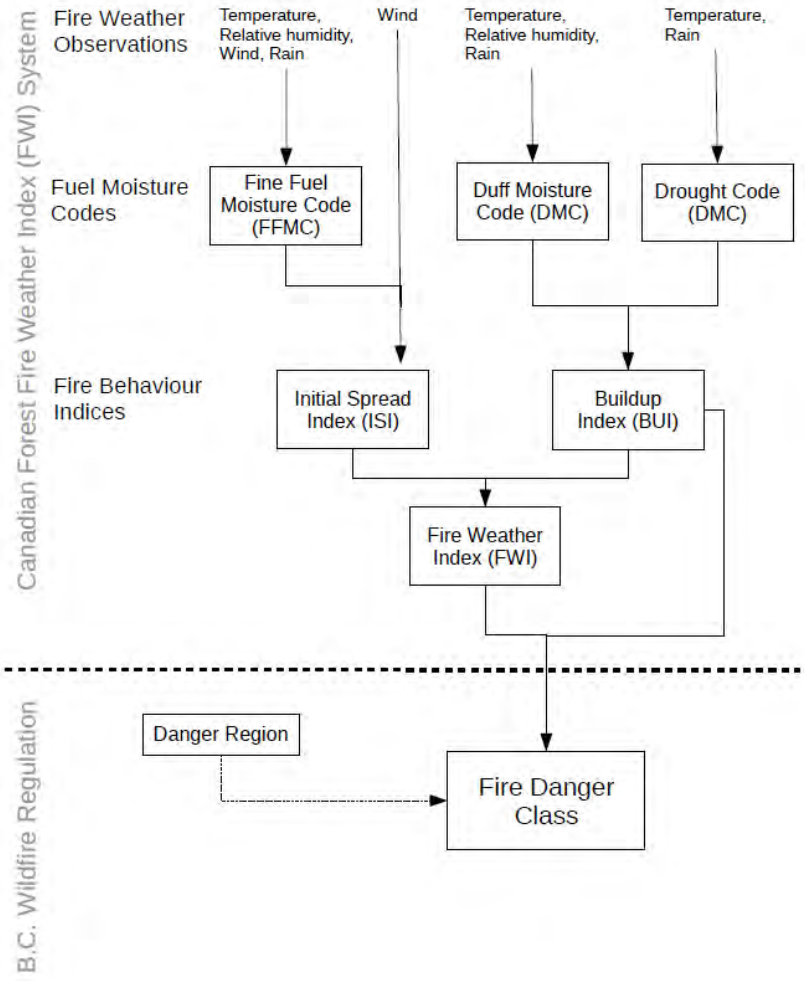

Figure 5 Fire Danger Class methodology.

A Fire Danger Class report for each of the three fire weather stations analysed has been prepared. The Fire Danger Class reports illustrate the number of days per year when the Fire Danger Class was rated 4 or 5. WFN is situated in Danger Region 3, which has the following BUI and FWI ranges for Fire Danger Class 4 and 5:

- BUI: 51 – 201+

- FWI: 17 – 47+

The datasets for the four fire weather stations of interest date back to 1977 (Brenda Mines), 1990 (Fintry), 2004 (Ida Bell 3) and 2016 (West Kelowna) and continue to be in service. Of interest is the increasing linear trend for Fire Danger Class 4 and 5 days for the Brenda Mines, Fintry and Ida Bell 3 stations (Figure 6 to Figure 8). The West Kelowna station (Figure 9) lacks sufficient fire weather history to conduct any trend analyses.

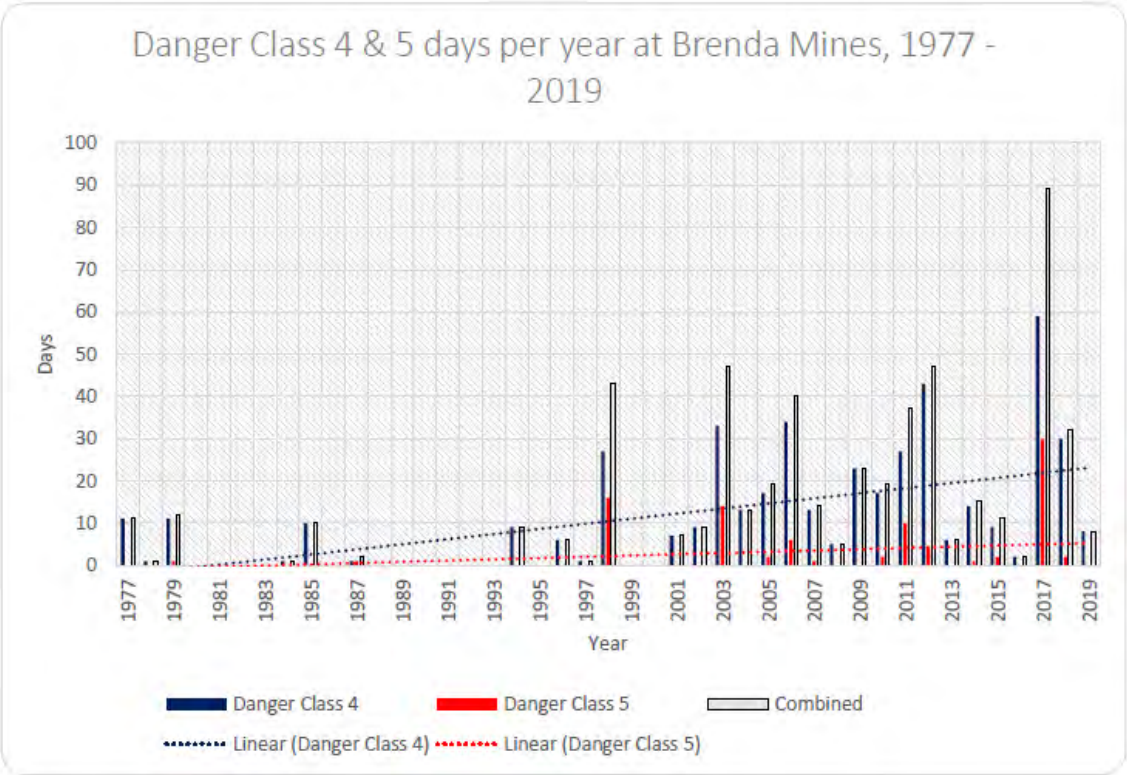

Figure 6 Fire Danger Class 4 and 5 report for the Brenda Mines fire weather station.

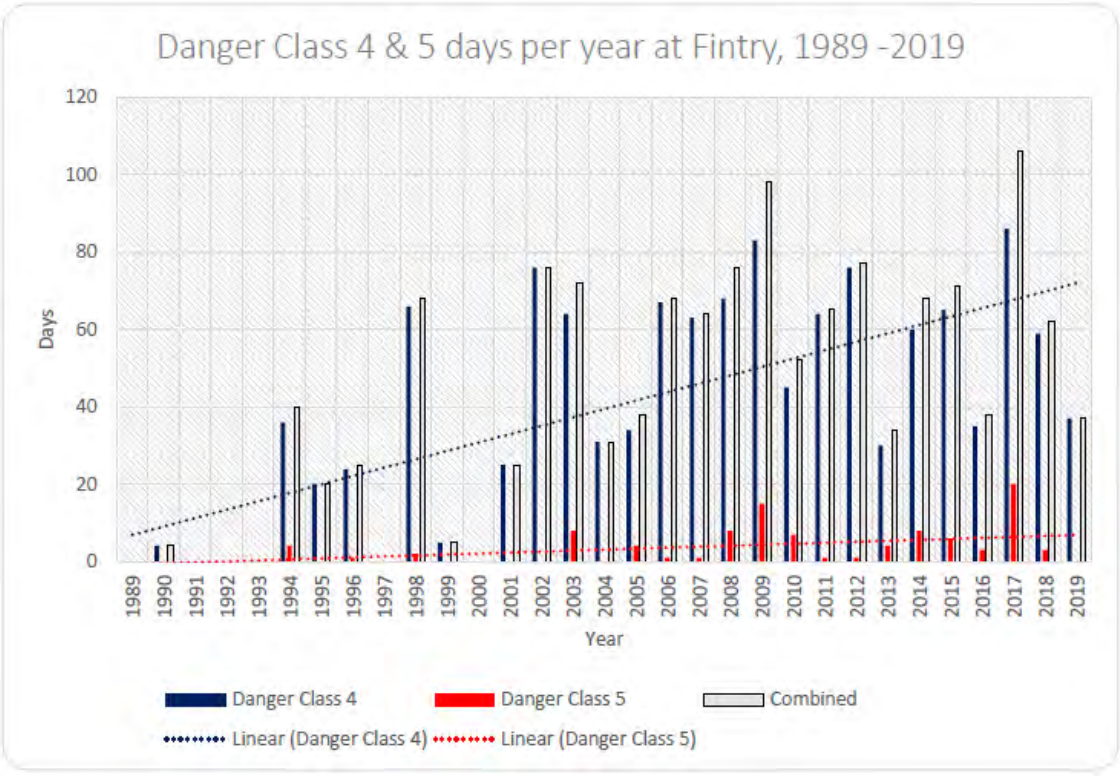

Figure 7 Fire Danger Class 4 and 5 report for the Fintry fire weather station.

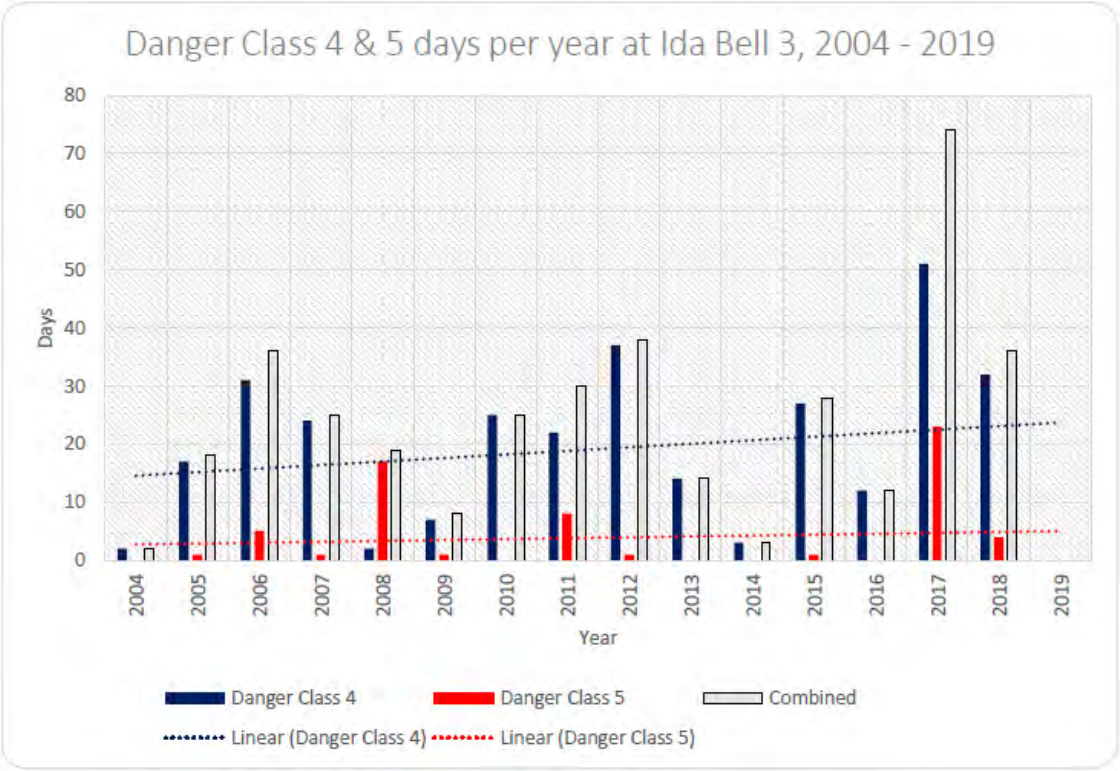

Figure 8 Fire Danger Class 4 and 5 report for the Ida Bell 3 fire weather station.

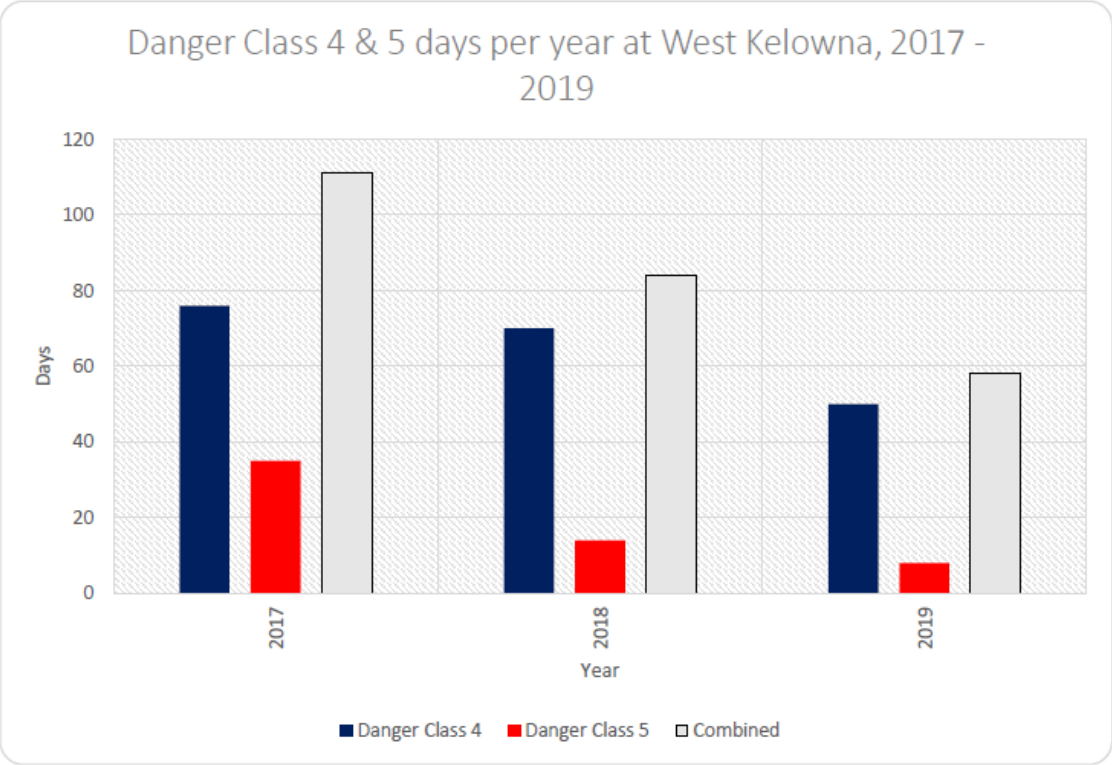

Figure 9 Fire Danger Class 4 and 5 report for the West Kelowna fire weather station.

4.1.2 Climate Change

The Pacific Climate Impacts Consortium (PCIC) is based at the University of Victoria and conducts quantitative studies on climate change and climate variability impacts for stakeholders in the Pacific and Yukon regions. Through analysis and interpretation of a variety of global climate models, PCIC serves to bridge the gap between climate research and practical application for a variety of end users. To do this, PCIC has several analysis tools available, including the Plan2Adapt toolkit, as well as the more detailed Regional Analysis Tool (Pacific Climate Impacts Consortium, 2012).

The future regional impacts of climate change are far from certain and projections are based on the best available models and information. For example, although the range of modelled future summer temperature increase is somewhat broad (Figure 10), the upward trend is conspicuous. Conversely, the range of modelled summer precipitation change (Figure 11) shows a more muddled range of projections. As with any set of models, as more data becomes available and emissions scenarios become more refined, future impacts will be brought into sharper focus.

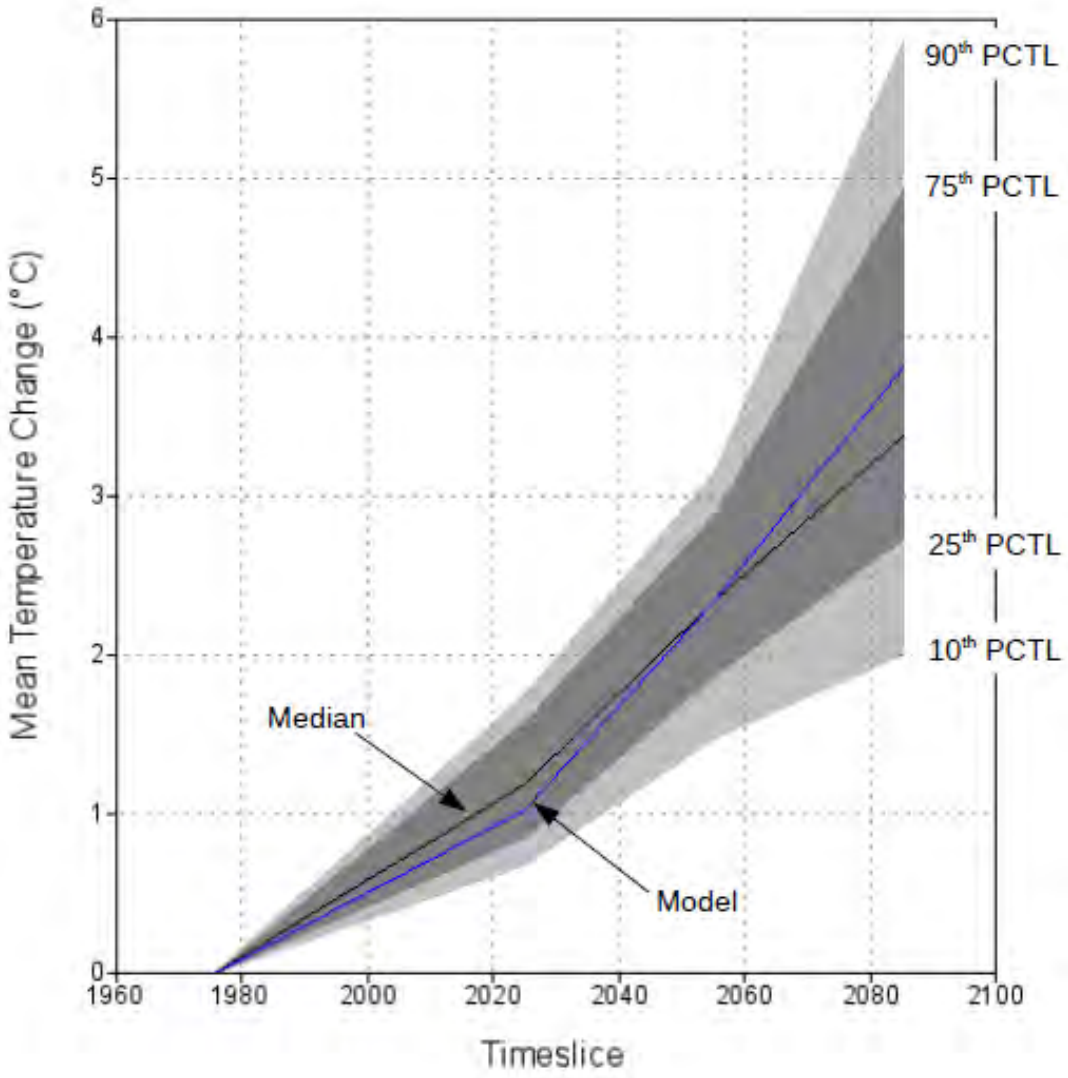

Figure 10 Range of projected summer (June, July, August) temperature change over three time periods (2020's, 2050's and 2080's) for the Central Okanagan. This figure is produced from a set of Global Climate Model (GCM) projections and represents the range of modelled outputs. Figure adapted from Pacific Climate Impacts Consortium, University of Victoria.

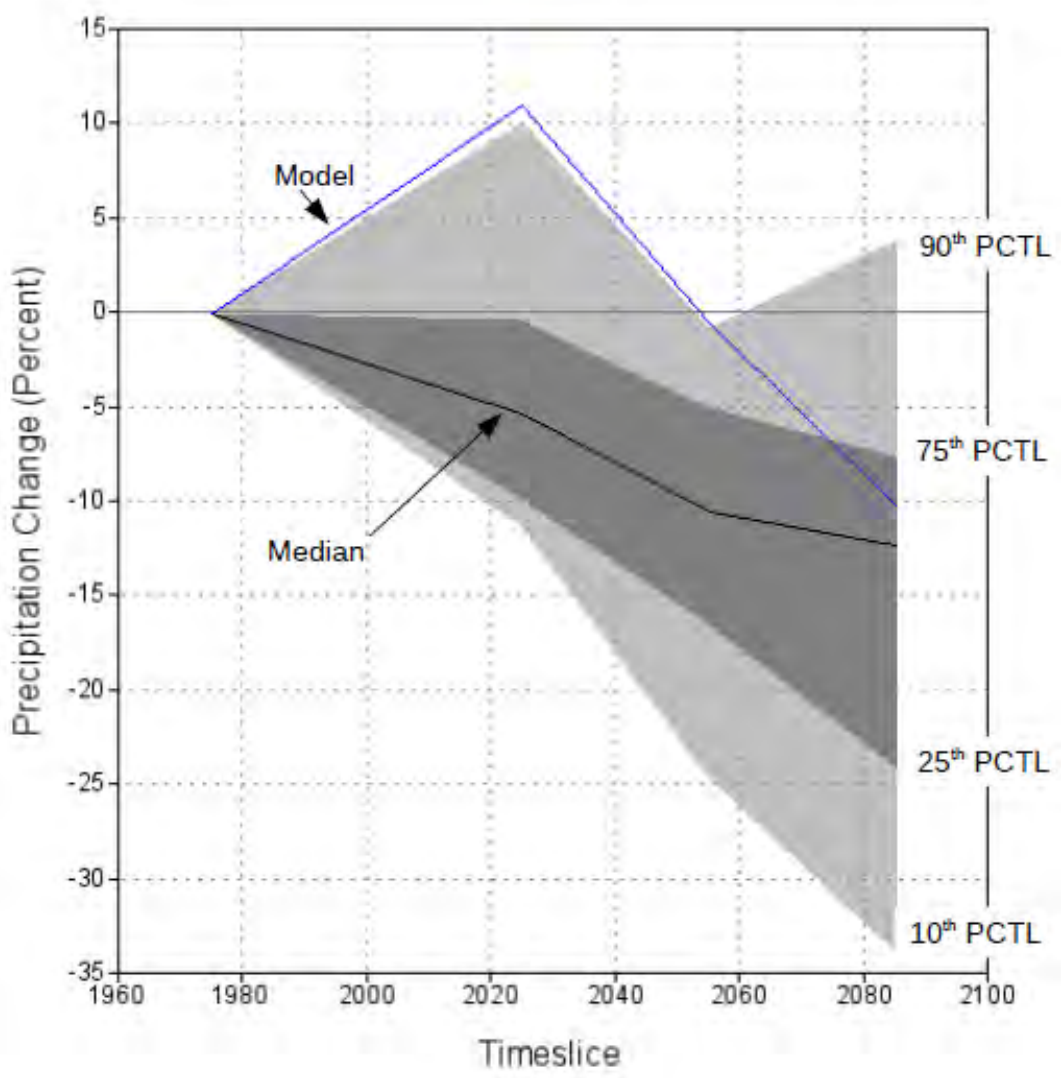

Figure 11 Range of projected summer (June, July, August) precipitation change over three time periods (2020's, 2050's and 2080's) for the Central Okanagan. This figure is produced from a set of Global Climate Model (GCM) projections and represents the range of modelled outputs. Figure adapted from Pacific Climate Impacts Consortium, University of Victoria.

The PCIC (2013) has drafted a set of potential climate impacts for the Central Okanagan in the 2050s, including:

- Increase in hot and dry conditions
- Increase in temperature
- Longer dry season
- High intensity precipitation
- Decrease in snowpack
- Possible changes in vegetation productivity

From a wildland fuel perspective, these impacts could result in a variety of ecological changes. Long term changes in moisture regimes can affect forest health and species distribution. Ecological communities may begin to migrate northwards or to higher elevations as site suitability and disturbance patterns shift. Already dry ecological zones may become drier and more prevalent at higher elevations, making an already fire-prone landscape more extensive.

As some valley bottom areas and exposed slopes around WFN are already characterized by relatively light grass fuels, climate change induced upslope migration of treed areas may have little effect on the overall wildfire threats posed to the WUI. In fact, such a shift might actually confine high-intensity fire to higher elevations over the long term. However, in the wake of ecological migration, dead and downed fuel loading would most likely create a window of time of increased fuel hazard attributable to increased surface fuel loading, something akin to the recent effects of Western pine beetle on Ponderosa pine stands in the area.

4.2 Provincial Strategic Threat Analysis

The Provincial Strategic Threat Analysis (PSTA) is a provincial-scale analysis that attempts to characterize wildfire threat across BC. The analysis combines historical fire density, potential spotting impacts and predicted head fire intensity to produce a wildfire threat score. These scores are grouped into ten threat classes, ranging from 1 to 10, or Nil to Extreme. The PSTA layer is intended to serve as a starting point from which to design and conduct more detailed sampling to further characterize wildfire threat to communities.

To determine the overall PSTA Threat Rating, historical wildfire density, head fire intensity (HFI) and spotting impact are combined using a weighted averaging process. Weights are assigned as 30% fire density, 60% HFI (90th percentile fire weather index (FWI) values) and 10% spotting impact. These weighted values were added together to produce a final fire threat rating and assigned to 10 classes to produce a detailed map of fire threat rating throughout British Columbia.

The 10 threat classes represent increasing levels of overall fire threat (i.e. the higher the number, the higher the threat). PSTA Threat Class 7 is considered to be a threshold and the most severe overall threat classes are Class 7 and higher. Areas of the province that fall into these higher classes are most in need of mitigation.

Areas rated as Class 7 or higher are locations where the fire intensity, frequency and spotting can be severe enough to potentially cause catastrophic losses in any given wildfire season, where those ratings overlap with significant values at risk.

4.2.1 Fire History

Fire history tells the story of the relationships between fire behaviour, landscape ecology, management policy (including fire suppression), human development and other land-use changes throughout the area. WFN lands have a persistent history of wildfire on the landscape. The BCWS maintains a database of wildfires dating back to the early 1900s. Fire history data for fires that occurred prior to 1950 are limited to larger perimeters only and does not include fires that may only have been spot sized. These perimeters have been digitized from a variety of sources, some dating back to linen maps. From 1950 onwards, the wildfire dataset becomes more complete, capturing fires of all size classes and provides a more accurate picture of fire occurrence trends.

The fire history dataset is by no means perfect. Occasionally historical wildfires plot within lakes and there are sporadic discrepancies in information between point layers and perimeter layers for a given fire, but generally the dataset provides an adequate basis from which to conduct a historical fire analysis.

Given the relatively small footprint of the five reserve areas, a 2km buffer was added to the reserve boundaries in order to analyze fire history across the fire environment of WFN lands. In the buffered area between 1950 and 2019 a total of 618 wildfires are recorded in the provincial fire history dataset. The majority of these fires have been person-caused (92%), with the remaining 8% being lightning-caused. The most wildfires in the buffered area in a one-year period occurred in 1979, with 26 total wildfires. The 1970 fire season saw the highest number of lightning fires (5), while the most person-caused wildfires (24) occurred in 1979.

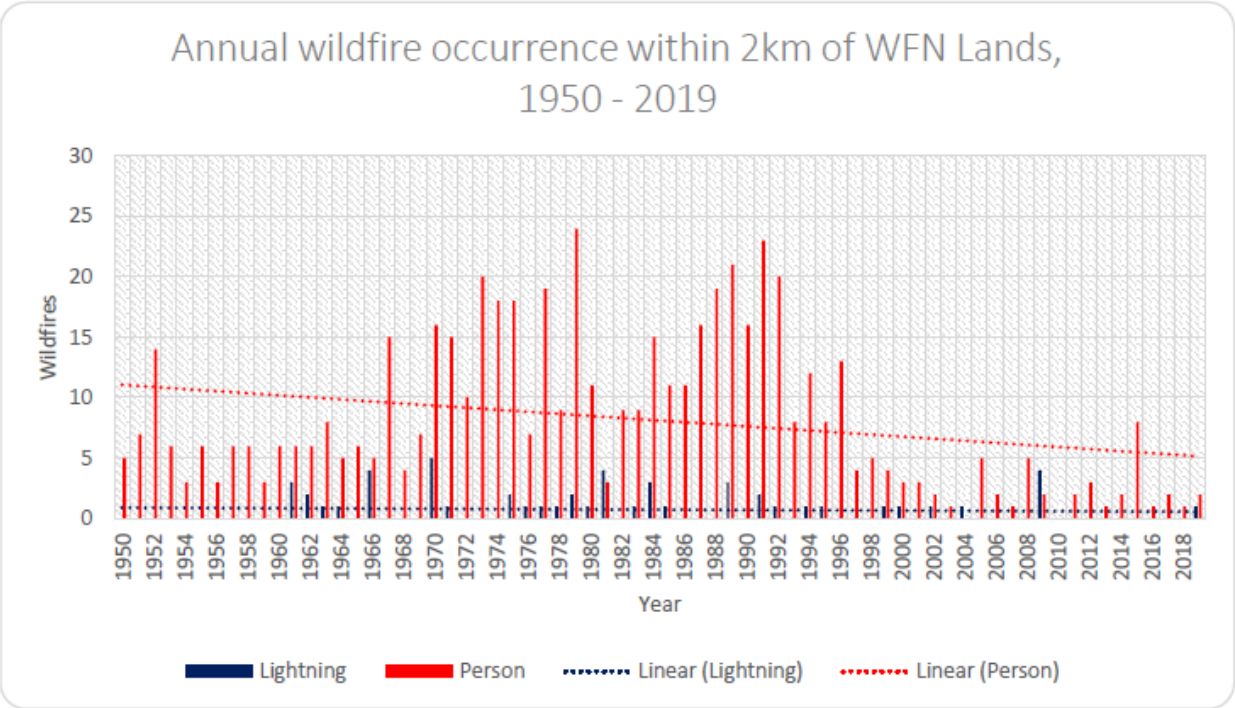

Figure 12 Annual wildfire occurrence (lightning and person-caused) on WFN lands from 1950 to 2019.

When wildfire occurrence since 1950 is graphed for the buffered area we see that the occurrence of lightning-caused wildfires displays a fairly flat linear trend (Figure 12). The annual occurrence of person-caused wildfires displays a gradually decreasing linear trend over the same period.

The total burned area in buffered area, as recorded in the provincial dataset is 975ha. The area burned analysis only includes the actual portion of historic fires clipped to the buffered area. The most area burned in one year within the buffered area occurred in 2003 with 136ha burned, attributable to lightning-caused fires – most of which was the Okanagan Mountain fire. For person-caused wildfires, the highest annual area burned occurred in 1926 with 131ha (Figure 13).

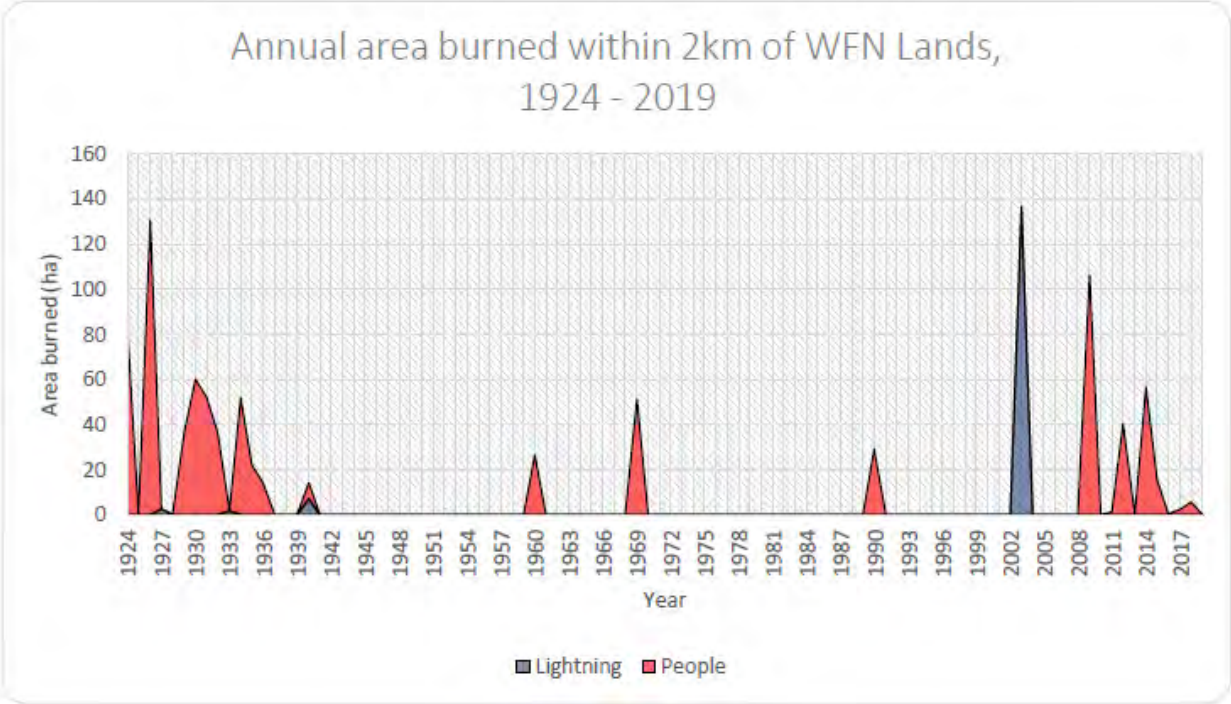

Figure 13 Annual area burned within two kilometers of WFN since 1924.

For interest's sake, the entire fire history dataset for British Columbia has been summarized to help provide additional context to current wildfire issues (Figure 14 and Figure 15). Across the province, the occurrence of person-caused wildfires has displayed a steady decline since the 1970s. Curiously though, lightning fires show a nearly opposite increasing trend. Whether or not there is any more lightning starting fires now than in the 1950s is beyond the scope of this simple analysis, however the hypothesis could be that the increasing trend is reflecting improved wildfire detection capabilities. Similarly, while no definitive reasons for the decreasing trend in person-caused fires has been articulated by the Province, there are undoubtedly attributions to prevention public education campaigns, fire prevention engineering and regulation that can be made. Any decrease in the occurrence of unwanted wildfire is encouraging given the increasing provincial annual area burned trend.

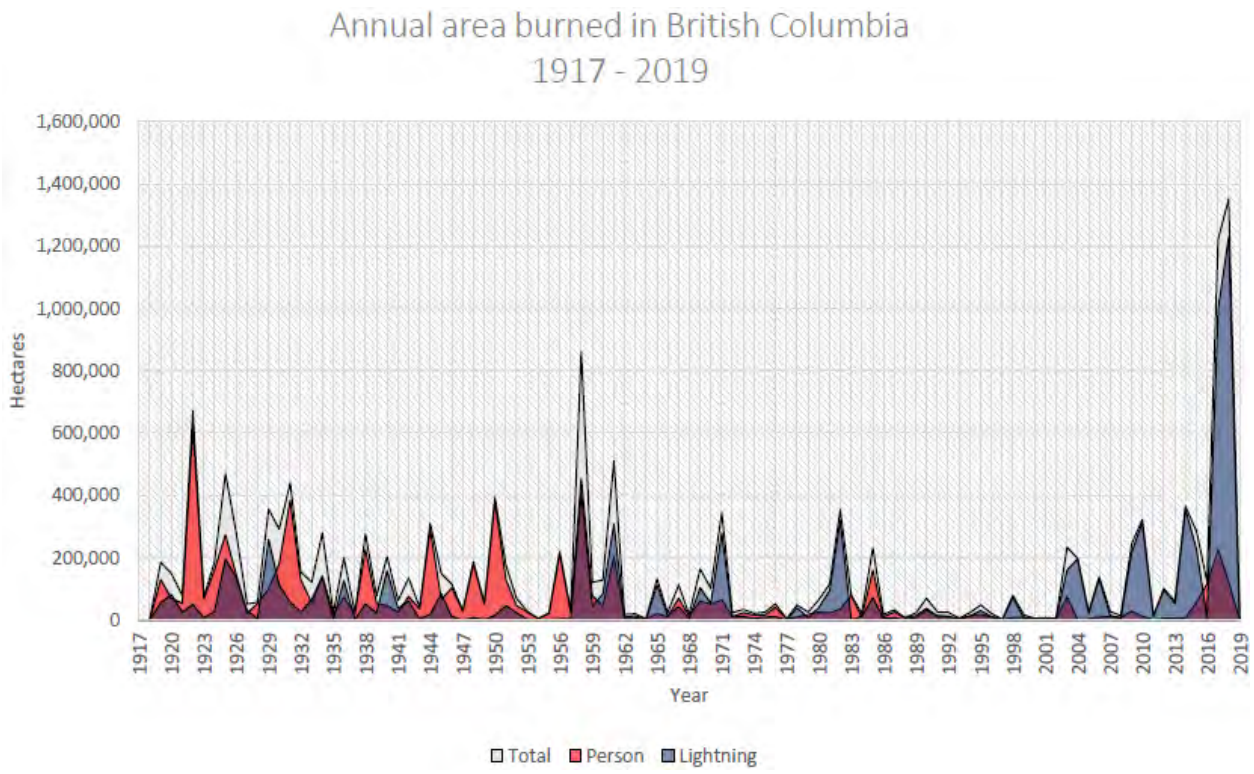

Figure 14 Annual area burned within British Columbia since 1917.

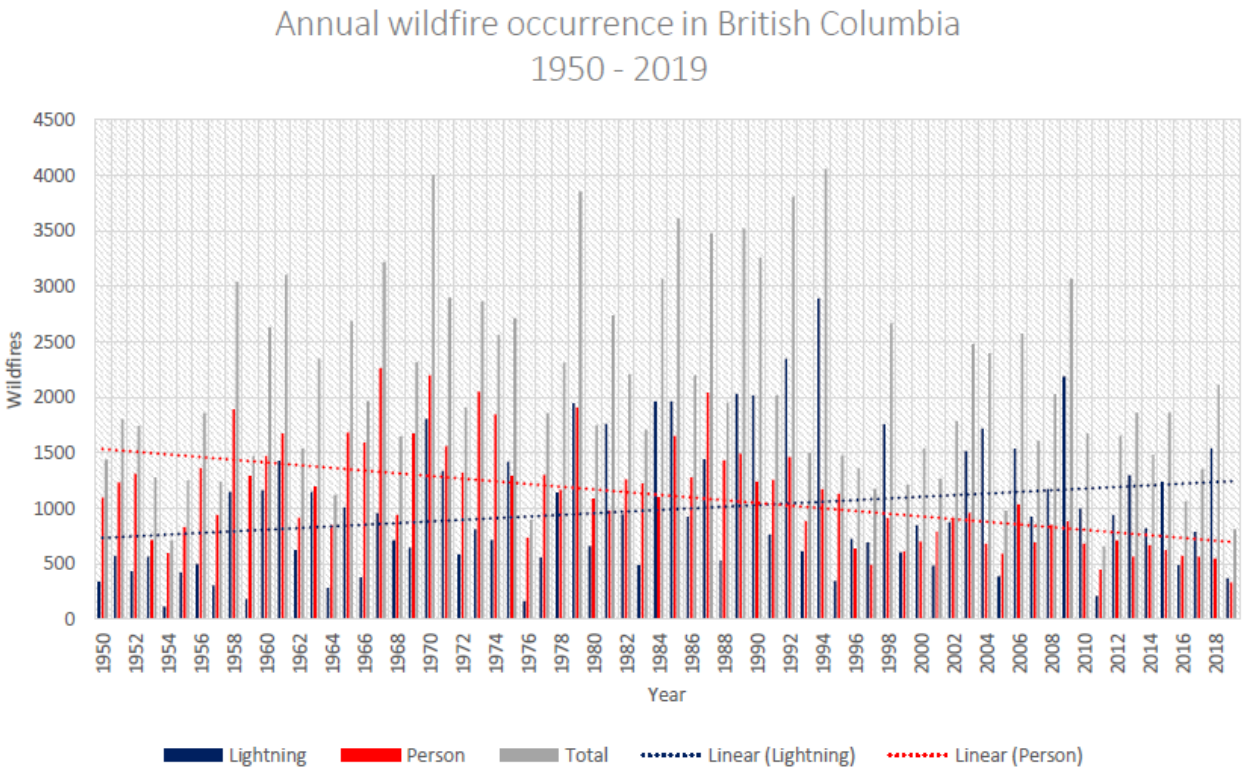

Figure 15 Annual wildfire occurrence in British Columbia from 1950 to 2019.

4.3 Local Wildfire Threat Assessment

The process to assess wildfire threat for the WFN CWPP followed the 2012 WUI Wildfire Threat Assessment guide methodology developed by Morrow et al. (2013). Normally, plot locations are selected through GIS analysis and fire behaviour modeling of the provincial fuel type layer. Specifically, the methodology seeks non-private land polygons with a modelled fire behaviour rating of Moderate or higher that are within 100-m of a structure in the WUI.

The geospatial methodology serves to identify the highest priority areas for field assessment. On Tsinstikeptum 9 and 10, 21 threat assessment plots were completed, while on the east side of the lake, two plots were completed, one each on Medicine Creek 12 and Medicine Hill 11. No plots were installed on Mission Creek 8, owing to the small size (approximately 2 ha), lack of structures, and little to no fuel connectivity with adjacent fuel hazards. The results of the threat assessments are summarized in appendix A1.5 in Table 12. Completed WUI Wildfire Threat Assessment Worksheets and plot photos are located in Appendix 2.

5 Risk Management and Mitigation Factors

When considering the risk of wildland urban interface fires the issue can be viewed in terms of the probable frequency of a fire occurring, and the probable magnitude of the resulting losses. Wildfire occurrence directly relates to fire cause and is the focus of fire prevention planning and education, which is a fundamental element of wildfire management. As discussed in 4.2.4 fire cause in the greater WFN area is attributed predominantly towards people. This fact illustrates the importance of an all-encompassing approach to managing wildland urban interface fire threats: although prevention programs can reduce the occurrence of person-caused fires, we will never be able to completely eliminate the probability of a wildfire occurring, so we also need to attempt to reduce the magnitude of each occurrence and it's associated probable future losses.

5.1 Fuel Management

Managing wildland fuels is one aspect of reducing the wildfire risk to communities in the wildland urban interface. In the drier low-elevation portions of the AOI the predominant fuel type in the interface is C7 Ponderosa Pine Douglas-fir. This fuel type, exemplified in the Interior Douglas-fir and Ponderosa Pine biogeoclimatic zones, is particularly well-suited to certain fuel

management treatments, owing to its typical fire-maintained structure of well-spaced and pruned fire adapted conifer overstory (Figure 16).

Figure 16 Example of a fire-maintained plant community near the southeastern corner of Tsinstikeptum #9. This area was burned by wildfire in 2018. Note the lower branches of the two Ponderosa pines in the foreground that have been scorched and will eventually fall off, effectively self-pruning the trees.

A variety of treatment methods are available for this particular fuel type, depending on treatment intensity, treatment timing, site sensitivity and public support, among other factors. Treatments in the C7 have traditionally been carried out by hand crews, whereby thinning and pruning have been undertaken with a variety of tools and techniques, including power saws, brush saws, pole-pruners etc. (e.g. Figure 17). Debris disposal is typically carried out either through pile and burn, chipping or hauling off-site. These types of hand treatments can be labour intensive, depending on stand density, surface fuel loading and terrain limitations. Hand treatments are well suited to sites with thin and sensitive soils that would be otherwise degraded through ground-based equipment.

Figure 17 A past fuel treatment was carried out on this site above Bayview Court on Tsinstikeptum #10.

Fuel treatments can also be carried out with mechanized equipment, such as feller bunchers and various types of mulchers. Conventional timber harvesting is also a viable form of fuel management in certain timber types, with the added benefit of at least partial recovery of costs through log utilization. The use of machinery enables the land manager to realize higher production rates compared to hand crew treatments alone. Site sensitivities are a significant factor when considering the use of mechanized methods – thin soils, common to lower elevation hot/dry sites can be significantly degraded if treatments are not designed and carried out professionally.

Regardless of the method for reducing fuel loading on any particular forested site, surface fuels must be considered and attended to. During hand falling/bucking or mechanical harvesting, processing, and yarding, surface fine fuel loading can increase with disturbance. In many cases, particularly in Ponderosa pine and interior Douglas-fir stands, the use of low-intensity prescribed fire can be an effective means of both reducing surface fine fuel loads and realizing beneficial ecological fire effects.

Fuel management treatments, particularly on NDT4 sites, should not be viewed as one-time actions. Rather, fuel treatments require periodic maintenance entries to maintain the integrity

and purpose of the treatment area. In the absence of maintenance, or periodic low-intensity fire, treated NDT4 sites will trend back towards pre-treatment structure and conditions.

Fuel breaks on Crown or municipal land immediately adjacent to private land and in close proximity to the wildland urban interface and/or intermix areas, are termed interface fuel breaks. Interface fuel breaks are designed to modify fire behaviour, create fire suppression options and a safe place from which to anchor crews and tactics, and improve suppression outcomes. The dimensions of interface fuel breaks are dependant on the forest/fuel type and associated fire behaviour, but generally this type of fuel break will occupy, at minimum, the WUI 100 zone. The design of an interface fuel break should incorporate existing natural features, where they exist, that offer a similar modification or impediment to fire behaviour. These can be areas of low fuel loading, no fuel loading or a fuel type with less potential fire behaviour.

Fuel breaks created through stand modification are not intended to be impenetrable barriers to fire spread; rather they are intended to modify and decrease fire behaviour. Similarly, the presence of an interface fuel break alone does not ensure the survivability of adjacent structures, especially if those properties are not FireSmart. The combination of a well designed and maintained interface fuel break and adjacent private property and structures that are FireSmart, is a proven method of achieving real risk reduction.

Fuel breaks located beyond interface fuel breaks (i.e. beyond the WUI 100 zone) are termed primary fuel breaks. The location of primary fuel breaks is contingent on land ownership, existing natural and man-made features, fuel types, and prevailing wind patterns. As with interface fuel breaks, primary fuel breaks are intended to modify fire behaviour and create fire suppression options that reduce the risk of high intensity wildfire reaching a community or other built-up areas.

Primary fuel breaks may be located to completely surround a community or be strategically placed upwind of communities and perpendicular to fire season winds. Primary fuel breaks need to have sufficient width and fuel modification to minimize horizontal and vertical fuel continuity to effectively reduce the head fire intensity as a wildfire enters into the fuel break.

As with interface fuel breaks, primary fuel breaks should not be viewed as impenetrable barriers to fire spread. The potential for ember transport and spot fires on the community side

of any fuel break is a very real concern and may negate the effectiveness of any fuel break if not designed and treated in a manner that attempts to reduce this risk.

Nine broad interface fuel break areas are proposed and summarized in Table 8, representing 74.2 ha in total. The proposed treatment areas are appropriate for a combination of fuel management treatment, including thinning from below and pruning, as well as prescribed burning. Giving the predominant location of structures on WFN lands, the nine proposed areas are located on Tsinstikeptum 9 and 10 (Figure 18 to Figure 23).

Table 8 Proposed wildfire risk reduction treatments on WFN lands.

Area ID	Area (ha)	Recommeded Mitigation	
Area 1	6.9	Prescription	Treatment
Area 2	2.1	Prescription	Treatment
Area 3	26.0	Prescription	Treatment
Area 4	7.8	Prescription	Burn Plan
Area 5	4.6	Prescription	Burn Plan
Area 6	2.0	Prescription	Treatment
Area 7	5.8	Prescription	Burn Plan
Area 8	0.7	Prescription	Treatment
Area 9	18.2	Prescription	Treatment & Burn Plan
	74.2		

Figure 18 Proposed treatment areas 1 and 2 on Tsinstikeptum 9.

Figure 19 Proposed treatment area 7 on Tsinstikeptum 9.

Figure 20 Proposed treatment area 8 on Tsinstikeptum 9.

Figure 21 Proposed treatment area 9 on Tsinstikeptum 9.

Figure 22 Proposed treatment areas 3, 4 and 5 on Tsinstikeptum 10.

Figure 23 Proposed treatment area 6 on Tsinstikeptum 10.

5.2 FireSmart Planning and Activities

The FireSmart Canada program is administered by Partners in Protection, a national non-profit association comprised of national, provincial, and local government agencies with fire protection mandates. Modelled after the FireWise Communities USA program in the United

States, FireSmart Canada has developed a comprehensive planning and assessment process to mitigate wildfire hazards to existing communities, as well as guide new development. Although the FireSmart program is primarily focused towards residential homes, the principles have been adapted for application in mixed-use areas, industrial activities and elsewhere. For this reason, although home or house are the terms most often used when describing FireSmart principles, structure or building are equally appropriate and more broadly applicable.

5.2.1 FireSmart Goals and Objectives

The FireSmart program seeks to strike a reasonable balance between the aesthetic values of living in WUI areas with the need to make communities more resilient to the effects of wildfire. At the core of the FireSmart program is the relationship between a home and the surrounding natural areas and whether this relationship can result in the transfer of fire between the two. Hazards are assessed and mitigated by giving priority to the structure and immediate surroundings and then working progressively outwards. This is accomplished through the establishment of three zones around a structure:

- Priority Zone 1a: The area within 1.5m of a building
- Priority Zone 1: The area within 10 m of a building
- Priority Zone 2: The area 10-30 m from a building
- Priority Zone 3: The area 30-100 m from a building

On sites with relatively higher building densities, multiple sets of priority zones invariably overlap. One building's Zone 2 may be an adjacent building's Zone 1 and so forth. This characteristic is common in all but the most rural of WUI settings and speaks to the shared nature of wildfire hazard and collective resilience.

The general goal of FireSmart is to encourage private landowners to adopt FireSmart practices to reduce the fuel hazard and implement other measure to minimize damages to assets on their property from wildfire. These include:

- Reduce the potential for an active crown fire to move through private land.
- Reduce the potential for ember transport through private land and structures.
- Create landscape conditions around properties where fire suppression efforts can be effective and safe for responders and resources.

- Treat fuels adjacent to structures to reduce the probability of ignition from radiant heat, direct flame contact, and/or ember transport.
- Implement measures to structures and assets that reduce the probability of ignition and loss.

Research and post-fire reviews have shown that when values have been constructed, retrofitted or treated in accordance with FireSmart principles, they stand a greater chance of survival compared to those that haven't (Westhaver, 2017) (Partners in Protection, 2003). The spatial scale that determines home ignitions corresponds more to the specific site and characteristics of homes and property than to landscape scale wildfire management and fuel modification strategies (Cohen J. D., 2004). In order to truly reduce the threat of homes and other values being destroyed in wildland urban interface fire disasters, homeowners and governments alike must take deliberate and concerted steps to accurately assess and mitigate hazards.

5.2.2 Key Aspects of FireSmart for Local Governments

The FireSmart program is wholly dependent on interest and participation from residents who live in fire prone environments. Obviously, while local governments can't force residents to take an active interest in any particular cause or issue, they can conduct public education and awareness campaigns and support FireSmart projects, with the goal of building a critical mass of motivated residents who are committed to reducing the ignitability of their homes.

The challenge that local governments continue to face is how to deal with landowners who are either unable or unwilling to mitigate fuel hazards on their property. Publicly funded programs such as FireSmart are not permitted to be used directly for work on private property, and there is little recourse for local governments to compel private landowners to undertake mitigation actions. Even if most homes in a residential area undertake meaningful FireSmart actions, when unmitigated private properties are interspersed among them, the overall threat to mitigated property remains, due to the threat of structure to structure ignition and propagation. Suggested FireSmart activities that have been successful with other local governments are presented in Table 9.

Table 9 FireSmart strategies for communities.

FireSmart Theme	Suggested Activities
Communication, Education & Partnerships	• Host a FireSmart day • Use local government newsletters and social media • Undertake FireSmart Local Representative or Community Champion training • Continue to pursue CRI funding for FireSmart projects • Form a community wide FireSmart committee • Encourage homeowners and/or neighborhoods to undertake FireSmart site assessments and area assessments
Vegetation management	• Develop FireSmart demonstration areas in public spaces, such as parks and municipal facilities • Strengthen landscaping requirements in zoning and development permits to require fire resistive landscaping and replacement of legacy high-flammability plants. • Facilitate treatment debris disposal for landowners
Planning & Development	• Strengthen policies and practices for FireSmart construction and maintenance of public buildings • Maintain the Development Permit Areas for Wildfire Interface in order to require FireSmart exterior finishing, landscaping and professional assessments and recommendations

5.2.3 Priority Areas Within the Area of Interest

WFN could benefit from a program of FireSmart projects, with the goal of achieving FireSmart Canada Community Recognition for a number of neighbourhoods. Based on assessments of WFN, the following neighbourhood areas are suggested for FireSmart Community Recognition projects:

- Elk Road (lower)
- Grouse Road area
- Derrickson Place
- Alexander Place
- Abel Street/Place
- Royal Heights
- Bayview Court (reattempt)

5.3 Community Communications and Education

The following community engagement strategies would be of benefit to WFN and its residents in furthering wildland urban interface fire awareness and education:

- Establish a community wildfire safety page on the WFN webpage, that includes:

- the current CWPP;
- completed FireSmart Community Assessment Reports;
- information for residents on how to conduct their own FireSmart Structure and Site Hazard Assessment Forms, and steps they can take to lower their hazard scores;

- Host wildfire or FireSmart public education workshops or information sessions prior to and during fire season

5.4 Other Prevention Measures

Community Wildfire Protection Plans are expected to adhere to a strict template developed by the provincial government and this template has typically been weighted heavily towards western science and non-Indigenous perspectives. What is typically lost in this method of community wildfire protection planning is the recognition that Indigenous people have been stewards of fire since time immemorial, and that current fire problems are largely rooted in the recent imposition of laws and policies of the federal and provincial government. In this sense, First Nations are best positioned and equipped with traditional ecological knowledge and practices to manage wildfire on their lands and traditional territories.

5.5 Summary of Recommendations

Wildfire risk reduction prescriptions and treatments	• Apply for CRI funding to:
	  o develop treatment prescriptions;
	  o develop prescribed burn plans, and
	  o conduct fuel management on the proposed treatment areas.
	• A two-year timeline to prescribe and treat Areas 1 to 7 (55.3 ha) is realistic, with the 2020 CRI funding support ($150,000) from FNESS.
	• Followed by prescription and treatment for Areas 8 and 9 (approx. 19 ha) with a future CRI funding application.
		WFN with CRI funding support

Public education and outreach	• Apply for CRI funding to:
	  o Initiate FireSmart projects for the proposed neighbourhoods, with FireSmart Community Recognition as the goal.
	  o Hold an annual FireSmart education and wildfire preparedness day,
	• A five-year timeline to undertake FireSmart projects on the seven areas proposed for projects is realistic
		WFN with CRI funding support

	with appropriate CRI funding support and guidance from FNESS.	
Traditional fire practices	• Reaffirm the knowledge and culture of fire stewardship that has existed since time immemorial. • Reestablish the use of traditional fire practices on WFN lands where it is desirable. • Support Syilx and other Nations who are working to reestablish traditional fire practices.	WFN with CRI funding support

6 Wildfire Response Resources

The BC Wildfire Service, as a branch of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), has responsibility to respond to wildfires outside local fire protection areas and to provide assistance to local fire departments on wildfires within their fire protection area, when requested. Fire departments are responsible for their own costs incurred while responding to wildfires within their jurisdiction. Costs incurred by the BCWS to undertake firefighting assistance within a fire department protection area are borne by the Province. In situations where the BCWS requests a fire department to respond to a wildfire outside their fire protection area, the fire department is compensated according to the Inter-Agency Operational Procedures and Reimbursement Rates agreement (The Office of the Fire Commissioner, The Fire Chiefs Association of BC, BC Wildfire Service, 2017).

6.1 Local Government Firefighting Resources

West Kelowna Fire Rescue also provides fire protection for Westbank First Nation under a 15-year agreement signed in 2016 (Westbank First Nation, 2016).

6.1.1 Fire Departments and Equipment

Owing to the frequent occurrence of wildfires within the fire protection area, West Kelowna Fire Rescue is a department that has above average wildland fire experience throughout the ranks. In addition to wildfires within West Kelowna, the department has deployed personnel and equipment to other jurisdictions during regional and provincial emergencies.

West Kelowna Fire Rescue relies on a combination of full-time career staff (41 staff) and paid-on-call members (currently 45). The current complement of apparatus includes the following:

Table 10 West Kelowna Fire Rescue apparatus complement.

Equipment	Type or Description	Quantity
Engine	1	3 (w/ 1 spare)
Engine	2	2
Engine	3	1
Engine	5	1
Ladder	100' platform	1
Tender	1	1
Pumper/Tender	1	1
Rescue	Medium	1
Rescue	Technical	1
Command	F-350 crew cab	3
Utility	n/a	2
Prevention	n/a	3

6.1.2 Water Availability for Wildfire Suppression

Water for fire suppression is referenced in Fire Protection Law 2005-11 (Westbank First Nation, 2005) and the Subdivision Development and Servicing Law No. 2005-15 Design Criteria (Westbank First Nation, 1994), which reflects Insurer's Advisory Organization (since renamed the Fire Underwriters Survey) guidelines on water supply for public fire protection. The following standards are specified for fire suppression water in WFN:

- Maximum spacing between hydrants in residential, commercial and industrial areas is 150 m, generally;
- Hydrants shall be located at road intersections and at property divisions;
- Additional hydrants may be required by the Approving Officer at schools, major multi-family developments, commercial or institutional buildings, or other major developments, consistent with the latest fire flow requirements of the Canadian Underwriters' Association;
- Minimum fire flows of 40 liters/sec. Note: the amount and duration of design fire flows are provided to the Approving Officer for approval prior to final design of the water distribution system;
- Hydrants shall not be located within 3 m of a utility pole, pad mounted transformer or light standard, within 1.5 m horizontally of underground service pipes or open ditches, or within 1 m of the curb line or back of sidewalk.

6.1.3 Access and Evacuation

For the most part, residents in the WUI on Tsinstikeptum 9 and 10 have access to reasonable vehicle evacuation routes, though there are certain areas and characteristics that the community should be aware of. The FireSmart program characterises access/egress routes in terms such as *dead-end access* or *two-way access.* Areas with dead-end access include but are not limited to neighbourhoods in an around Bayview Court/Tomat Avenue and Royal Heights, as an example. Neighbourhoods with two-way, or looped access include Elk, Grouse and Wolf roads, as examples.

6.1.4 Training

Although fire protection services for WFN are provided West Kelowna Fire Rescue through agreement with the City of West Kelowna, this would not necessarily preclude WFN from organizing a small wildland fire crew to perform expanded attack, mop-up or patrol activities on WFN lands. The training to undertake this type of wildland firefighting includes the S-100 Basic Fire Suppression and Safety course, which is a two-day training course that entails one classroom day followed by a practical field day. An annual one-day recertification course is then required to maintain certification.

6.2 Structure Protection

There are recent examples of wildland urban interface fires (e.g. Glenrosa 2009, Seclusion Bay 2010 etc.) where the deployment of structure protection sprinkler systems was not possible or practical during the initial attack. While engaged in the critical initial attack phase of suppression, finite resources are often exclusively dedicated to life safety (i.e. rescues and evacuation) and fire control. The ability to undertake structure assessments, plan and deploy structure protection sprinklers is often not possible during the emergent stages of a developing WUI fire. Structure protection units (SPUs) and SPU crews and specialists are most often deployed to fires that either already or have the potential to become longer duration project fires where extensive areas require SPU capability. In these cases, Type 1 SPU trailers are often deployed.

Homeowners should not solely rely on whether SPU capabilities can be installed on their home in time to save it. Rather, an active and concerted effort needs to be taken by residents to assess and mitigate hazards that affect the ignitability of their homes *before* a wildland urban interface

fire disaster unfolds. It will never be possible to dedicate sprinklers and firefighters to protect every home in BC from wildfire – homeowners need to take action themselves ahead of time.

6.3 Summary of Recommendations

Wildland firefighting and fire use	• Consider the establishment of a WFN wildland firefighting crew that can: o Assist WKFR with expanded attack, mop-up and patrol activities; o Conduct fuel management and prescribed burning ; o Participate in wildland firefighting in other areas of BC as a WFN business venture.	WFN with support from City of West Kelowna. Support from BCWS. Funding sources may include federal and provincial programs and service agreements.

References

ABCFP. (2013, May). *Interim Guidelines - Fire and Fuel Management.* Retrieved July 15, 2018, from Association of British Columbia Forest Professionals: https://member.abcfp.ca/web/Files/policies/Fire_Fuel_Management-Interim_Guidelines.pdf

Auditor General of British Columbia. (2001). *Managing interface fire risks.* Retrieved October 26, 2018, from https://www.bcauditor.com/sites/default/files/publications/2001/report1/report/managing-interface-fire-risks.pdf

Auditor General of British Columbia. (2005). *Joint Follow-up of 2001/2002: Report 1 Managing Interface Fire Risks and Firestorm 2003 Provincial Review.* Retrieved from https://www.bcauditor.com/sites/default/files/publications/2005/report2/report/managing-interface-fire-risks-and-firestorm-2003-provincial-review.pdf

BC Conservation Data Centre. (2018, March 22). *BC Species and Ecosystems Explorer*. Retrieved from Ministry of Environment: http://a100.gov.bc.ca/pub/eswp/

BC Hydro. (2017, December 17). *Bulk Provincial Transmission System.* Retrieved from BC Hydro: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/suppliers/transmission-system/maps/transplt.pdf

BC Hydro. (2017, December 17). *Transmission System BCH DWG. NO. G-T06-0010.* Retrieved January 15, 2020, from BC Hydro Transmissions and Stations Planning: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/corporate/suppliers/transmission-system/maps/transplt.pdf

BC Hydro. (2020, April 12). *West Kelowna Transmission Project*. Retrieved from BC Hydro: https://www.bchydro.com/energy-in-bc/projects/wktp.html

BC Wildfire Service. (2016, July 21). *Wildfire Glossary*. Retrieved January 12, 2020, from https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/glossary#V

BCCDC. (2018). *BC Centre for Disease Control, Smoky skies in B.C. can create health problems for some*. Retrieved November 8, 2018, from http://www.bccdc.ca/about/news-stories/stories/2018-wildfire-smoke

Blackwell, B. (2019, October 24). *Wildfire Risk Assessment for the West Kelowna Transmission Project Resiliency Alternative (1L244).* Retrieved from BC Hydro: https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/projects/west-kelowna-transmission/wktp-resiliency-alternative-wildfire-risk-assessment-october-2019.pdf

Butler, B. W., & Cohen, J. D. (1998). Modeling potential structure ignitions from flame radiation exposure with implications for wildland/urban interface fire management. *Proceedings of the 13th Fire and Forest Meteorology Conference*, 81-86.

Calkin, D. E., Cohen, J. D., Finney, M. A., & Thompson, M. P. (2014). How Risk Management Can Prevent Future Wildfire Disasters in the Wildland-Urban Interface. *Proceedings of the National Academy of Sciences, 111*(2), 746-751.

City of Kelowna. (2016, May 16). *Regional emergency program*. Retrieved January 23, 2020, from https://www.kelowna.ca/city-services/emergency-services/regional-emergency-program

Cohen, J. (2000). Preventing disaster: Home ignitability in the wildland-urban interface. *Journal of Forestry, 98*(3), 15-21.

Cohen, J. (2008). The wildland-urban interface fire problem. *Forest History Today, Fall 2008*, 20-26.

Cohen, J. D. (2004). Relating flame radiation to home ignition using modeling and experimental crown fires. *Canadian Journal of Forest Research, 34*(8), 1616-1626.

Cohen, J., & Saveland, J. (1997). Structure Ignition Assessment Can Help Reduce Fire Damages in the W-UI. *Fire Management Notes, 57*(4). Retrieved from https://www.fs.fed.us/fire/fmt/fmt_pdfs/fmn57-4.pdf#structureignitionassessmentcanhelpreducefiredamagesinthewui

Data BC. (2019, July). *BC Wildfire Active Weather Stations.* Retrieved from Data Catalogue: https://catalogue.data.gov.bc.ca/dataset/bc-wildfire-active-weather-stations

DataBC. (2019). *Data Distribution Service*. Retrieved July 7, 2019, from https://apps.gov.bc.ca/pub/dwds/home.so

Davies, J., Coulthard, M., & Zukanovic, N. (2011, March 31). *Regional District of Okanagan-Similkameen Community Wildfire Protection Plan.* Retrieved November 9, 2018, from http://www.rdosmaps.bc.ca/min_bylaws/Community_Services/Wildfire_Protection_Program/RDOS_CWPP_FINAL.pdf

Davies, J., Coulthard, M., & Zukanovic, N. (2012, August 9). *District of Peachland Community Wildfire Protection Plan.* Retrieved January 23, 2020, from District of Peachland: https://www.peachland.ca/cms/wpattachments/wpID683atID1935.pdf

Duran, S. (2014). *Evidence Review: Wildfire smoke and public health risk.* Vancouver: BC Centre for Disease Control. Retrieved November 9, 2018, from http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/WFSG_EvidenceReview_WildfireSmoke_FINAL_v3_edstrs.pdf

Filmon, G., Leitch, D., & Sproul, J. (2004, February 15). *Firestorm 2003 Provincial Review.* Retrieved December 12, 2019, from Legislative Assembly of British Columbia: http://www.llbc.leg.bc.ca/public/PubDocs/bcdocs/367694/Firestorm_Report.pdf

FireSmart Canada. (2012, June 28). *FireSmart Guide to Landscaping.* Retrieved December 12, 2018, from https://www.firesmartcanada.ca/images/uploads/resources/FireSmart-Guide-to-Lanscaping.pdf

Forest Practices Board. (2012). *Fire Management Planning Special Investigation.* Victoria: BC Forest Practices Board. Retrieved from https://www.bcfpb.ca/wp-content/uploads/2016/05/SIR34-Fire-Management-Planning.pdf

FortisBC. (2004, November 26). *Transmission and Distribution System Development Plan.* Retrieved November 8, 2018, from https://www.bcuc.com/Documents/Proceedings/2010/DOC_24309_B-3-3-2_FortisBC-ResponsesIR-No-1-BCMEU-Appendix-A15.1a.pdf

FortisBC. (2009, March 29). *FortisBC Pipeline System*. Retrieved from https://www.fortisbc.com/NaturalGas/Business/TransportationServiceOption/Documents/WINS_FortisBC_Pipeline_System_Map_2593.pdf

FortisBC. (2011). *Service Areas*. Retrieved November 4, 2018, from https://www.fortisbc.com/About/ServiceAreas/Pages/default.aspx

FortisBC. (2016, December). *Corporate Emergency Response Plan*. Retrieved from Emergency Preparedness: https://www.fortisbc.com/Safety/EmergencyPreparedness/Documents/Corporate_Emergency_Response_Plan_2016.pdf

Gill, D. (2018, May 1). *Forest Stewardship Plan.* Retrieved from NTITIX Resources LP: https://static1.squarespace.com/static/56bf60ec0442623c14dea094/t/5b730d4103ce645179ff0173/1534266701265/2018-2023+FSP.pdf

Lawson, B. D., Stocks, B. J., Alexander, M. E., & Van Wagner, C. E. (1985). A System for Predicting Fire Behaviour in Canadian Forests. *Eighth Conference on Fire and Forest Meteorology 1985* (pp. 6-16). Detroit: Society of American Foresters.

Low, A., & Davies, J. (2018, September 1). *City of West Kelowna Community Wildfire Protection Plan.* Retrieved from City of West Kelowna: https://www.westkelownacity.ca/en/city-hall/resources/Documents/CWPPUpdate-26OCT2018.pdf

Moritz, M., Batllori, E., Bradstock, R. A., Gill, M. A., Handmer, J., Hessburg, P. F., . . . Syphard, A. D. (2014). Learning to coexist with wildfire. *Nature, 515*, 58-66.

Morrow, B., Johnston, K., & Davies, J. (2013, January 24). *Wildland Urban Interface Wildfire Threat Assessments in B.C.* Retrieved June 12, 2018, from http://fness.bc.ca/wp-content/uploads/2017/07/WTA-Guide-2012-Update.pdf

Naeher, L., Brauer, M., Lipsett, M., Zelikoff, J., Simpson, C., & Koenig, J. (2007). Woodsmoke health effects: a review. *Inhalation Toxicology, 19*(1), 67-106.

Needoba, A., & Blackwell, B. (2010, March 1). *Regional District of Central Okanagan Community Wildfire Protection Plan.* Retrieved from Regional District of Central Okanagan: https://www.regionaldistrict.com/media/26895/RDCO_CWPP_FinalWeb_April2010.pdf

NTITYIX Resources. (2004, August 15). *WFN Community Forest*. Retrieved from Westbank First Nation: http://www.ntityixresources.com/wfn-community-forest/

NTITYIX Resources. (2016, April). *Annual Report of Operations.* Retrieved from Westbank First Nation Community Forest Agreement: https://static1.squarespace.com/static/56bf60ec0442623c14dea094/t/57d191d58419c29c4c3ce8f9/1473352150785/2015-16+WFN-CF+WL346_RFL+Annual+Report.pdf

Office of the Fire Commissioner. (2013, December). *Emergency Management BC.* Retrieved January 8, 2020 , from Structure Protection Program (SPP) Training: https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/fire-safety/wildfire/spp-wff1-info.pdf

Pacific Climate Impacts Consortium. (2012, June 1). *Plan2Adapt*. Retrieved January 8, 2020, from https://pacificclimate.org/analysis-tools/plan2adapt

Parminter, J. (1995). Human influence on landscape pattern in the Pacific Region: impacts of burning by First Nations and early European settlers. *Landscape Ecology Symposium, 75th Annual Meeting of the Pacific Division, American Association for the Advancement of Science*. Vancouver.

Partners in Protection. (2003). *FireSmart: Protecting your Community from Wildfire* (2nd ed.). Edmonton: Partners in Protection.

Pashkowski, T., & Blackwell, B. (2017, February 1). *City of Kelowna Community Wildfire Protection Plan.* Retrieved from City of Kelowna: https://www.kelowna.ca/sites/files/1/docs/related/kelowna_cwppupdate_2016_final.pdf

Pinna Sustainability. (2020, February). *Climate Projections for the Okanagan Region*. Retrieved February 15, 2020, from RDOS: https://www.rdos.bc.ca/assets/Uploads/OK-Climate-Projections-Report-Final.pdf

Province of British Columbia. (1995). *Biodiversity Guidebook.* Retrieved April 3, 2017, from https://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/biodiv/biotoc.htm

Province of British Columbia. (2001). *Okanagan Shuswap Land and Resource Management Plan.* Retrieved from Strategic Land and Resource Planning: https://www.for.gov.bc.ca/tasb/slrp/lrmp/kamloops/okanagan/plan/files/oslrmpfull.pdf

Province of British Columbia. (2007). *Plan related legal direction*. Retrieved from Strategic land and resource management plans: https://www.for.gov.bc.ca/tasb/slrp/legal-direction/

Province of British Columbia. (2010, September). *BC Wildland Fire Management Strategy*. Retrieved October 26, 2018, from BC Wildfire Service: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/wildfire-management/governance/bcws_wildland_fire_mngmt_strategy.pdf

Province of British Columbia. (2012, March 30). *FACTSHEET: Prescribed burns and ecosystem restoration burns*. Retrieved October 26, 2018, from Forests, Lands, Natural Resource Operations and Rural Development: https://news.gov.bc.ca/factsheets/prescribed-burns-and-ecosystem-restoration-burns

Quarles, S. L., & Standohar-Alfano, C. D. (2017). *Ignition Potential of Decks Subjected to an Ember Exposure.* Tampa: Insurance Institute for Business & Home Safety. Retrieved October 31, 2018, from http://disastersafety.org/wp-content/uploads/2017/10/Deck-Ember-Testing-Report-2017_IBHS.pdf

Quarles, S., & Smith, E. (2011). *The combustibility of landscape mulches.* Reno: University of Nevada Cooperative Extension. Retrieved October 31, 2018, from https://www.unce.unr.edu/publications/files/nr/2011/sp1104.pdf

Statistics Canada. (2017, November 29). *Focus on Geography Series, 2016 Census - Tsinstikeptum 9 and 10*. Retrieved January 12, 2020, from https://www12.statcan.gc.ca/census-recensement/2016/dp-

pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=5935803&Geo2=PR&Code2=59&Data=Count&SearchText=Tsinstikeptum%2010&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=5935803&TABID=1

Taylor, S. W., & Alexander, M. E. (2016). *Field Guide to the Canadian Forest Fire Behaviour Prediction (FBP) System* (2nd ed.). Edmonton: Natural Resources Canada, Canadian Forest Service, Nothern Forestry Centre.

Union of BC Municipalities. (2019, May 31). *Community Resiliency Investment*. Retrieved November 6, 2019, from https://www.ubcm.ca/EN/main/funding/lgps/community-resiliency-investment.html

Westbank First Nation. (1994). *Design Criteria and Construction Standards and Specifications for Development*. Retrieved from WFN Laws: https://www.wfn.ca/docs/1994-05_wfn_design_criteria_and_construction_standards_public636869620168842301.pdf?LanguageID=EN-US

Westbank First Nation. (2005, February 7). *Fire Protection Law No. 2005-11*. Retrieved from WFN Laws: https://www.wfn.ca/docs/2005-11-fire-protection-law.pdf?LanguageID=EN-US

Westbank First Nation. (2015, November 19). *Westbank First Nation Community Plan*. Retrieved January 2, 2020 , from https://www.wfn.ca/docs/wfn-community-plan.pdf

Westbank First Nation. (2016, May 24). *News release*. Retrieved from Westbank First Nation: https://www.wfn.ca/news/fire-services-agreement-signed-by-westbank-first-nation-and-city-of-west-kelowna.htm

Westhaver, A. (2017). *Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster*. Toronto: Institute for Catastrohic Loss Reduction. Retrieved January 16, 2018, from https://www.iclr.org/wp-content/uploads/PDFS/why-some-homes-survived-learning-from-the-fort-mcmurray-wildland-urban-interface-fire-disaster.pdf

Appendix 1: Local Wildfire Threat Process

A1.1 Fuel Type Attribute Assessment

The issue of fuel type is somewhat more complicated in BC compared to other parts of Canada, owing to the diversity and breadth of ecosystems in this province. Fuel types are a primary input to the Canadian Forest Fire Behaviour Prediction (FBP) System and form the basis for predicting rate of spread, type of fire and fire intensity class (i.e. the primary components of the FBP system). Although FBP fuel types are intended to be viewed qualitatively and not quantitatively, many forest types in BC simply don't represent good fits with the established national FBP fuel types.

The FBP system is an adequate tool for wildfire pre-suppression (i.e. preparedness) and suppression operations. Systems such as FBP are "intended to assist firefighters and officers in estimating potential fire behaviour in constant conditions…" (Taylor & Alexander, 2016). The utility of FBP in quantifying wildfire threat or risk or assessing forest types for the purposes of prescribing long-term fuel management treatments is not well documented or reviewed. An ecological approach to describing wildland fuels provides greater opportunity to describe characteristics related to stand structure and biomass, as it relates to wildland fire behaviour.

The ecology of WFN lands is predominantly characterized by the Interior Douglas-fir and Ponderosa Pine biogeoclimatic zones. The natural disturbance patterns of the IDFxh1, PPxh1 and IDFdm1 have been characterized by historically frequent stand maintaining fires (i.e. fires in the NDT4, as discussed in 4.2) prior to the fire-return interval being interrupted by contemporary forest management and fire suppression policies. Stand maintaining fires are typically low intensity surface burns that consume understory fuels while retaining a healthy green overstory. These frequent fires kept ladder fuels to a minimum and typically resulted in an open, park-like stand structure.

In the absence of periodic low intensity fire in the area, small trees that would have typically been fire-killed have become established, forming thickets and creating ladder fuels and resulting in relatively higher tree densities. Fine fuels, such as dead Ponderosa pine needles, often accumulate at the base of mature trees, resulting in higher fine fuel loading that could produce fire intensity great enough to result in lethal scorching of trees whose thick bark would have otherwise protected the vital phloem and cambial tissues.

The FBP fuel types for most of the WFN interface areas are classified as either Grass or Ponderosa Pine Douglas-fir; termed the O1 and C7 fuel types, respectively (Table 6). The C7 fuel type lends itself well to manual fuel treatments that target the small diameter understory conifers and retains the larger diameter overstory layer. However, a C7 fuel type that undergoes this type of treatment (often referred to as "thinning from below"), ultimately remains a C7 fuel type since the FBP system has limited options for modifying C7 predictions.

At higher elevations, in the MS and ICH zones and certain IDF subzones, C-3 and M-1/2 fuel types are more or less the best (but far from perfect) fit. These areas are more typical of a stand replacement fire regime, whereby high-severity fire results in a relatively higher proportion of tree mortality. Wet belt ecosystems, such as the ICH are notoriously challenging to classify according to fuel type. Often the best option is the M-2 or C-5 fuel types, though these are nowhere near a perfect match. The ICH zone is often typical of a mixed-severity fire regime, whereby examples of both relatively low-intensity and stand-replacing fires can be found on the landscape.

The FBP fuel type distribution for the AOI is presented in Table 6 and a generalized classification of all FBP fuel types, according to spotting potential, is provided in Table 11.

Table 11 Fuel type categories and generalized crown fire/spotting potential.

Fuel Type Categories	Fuel Type - Crown Fire/ Spot Potential
1: C1, C2, C4, M3-M4 (>50% C/DF)	High
2: C3, C7, M3-M4 (<50% C/DF) M1-M2 >50% Conifer	Moderate
3: C5, C6, O1a/b, S1- S3[1] M1-M2 (26-49% Conifer)	Low
4: D1, D2, M1-M2 (<26% Conifer)	Very Low

A1.2 Proximity of Fuel to the Community

Wildland fuels closest to built-up areas usually represent the highest hazard to communities. The common recommended approach (i.e. SWPI, CRI, FireSmart and others) is to reduce fuel hazards from the value or structure outward, ensuring mitigation continuity. Untreated areas adjacent to the value or structure may allow a wildfire to build in intensity and rate of spread, which can increase the risk to the value. To capture the importance of fuel proximity in the local wildfire threat assessment, the WUI is weighted more heavily from the value or structure

outwards. Fuels adjacent to the values and/or structures at risk receive the highest rating followed by progressively lower ratings moving out.

The local wildfire threat assessment process subdivides the WUI into three areas – the first 100 meters (WUI 100), 101 to 500 meters (the WUI 500), and 501 to 2000 meters (the WUI 2000). These zones provide guidance for classifying threat levels and subsequent priorities of treatments (Table 16).

Where fuel treatments are intended to reduce the risk to values in the built environment, the generally accepted practice is to begin treatments at the values and progress outwards. This strategy most often straddles the boundaries between private and public land and requires a coordinated effort to have any meaningful result. When gaps of untreated fuel are left, regardless of land status, the overall effectiveness of adjacent fuel treatments can become reduced or completely negated.

A1.3 Fire Spread Patterns

The BCWS has prepared ISI roses for each of its fire weather stations across the province, with the expectation that they be included in community wildfire protection planning. Similar to a wind rose, the ISI rose uses the direction and magnitude of ISI, which is a numeric rating of expected rate of fire spread that combines the effect of wind and the fine fuel moisture code (FFMC). The ISI roses for Brenda Mines, Fintry and Ida Bell 3 are provided in Figure 24 to Figure 26, though extreme caution is needed when interpreting the plots for anywhere but the immediate station area. No ISI rose for the West Kelowna fire weather station is available from the BCWS at present.

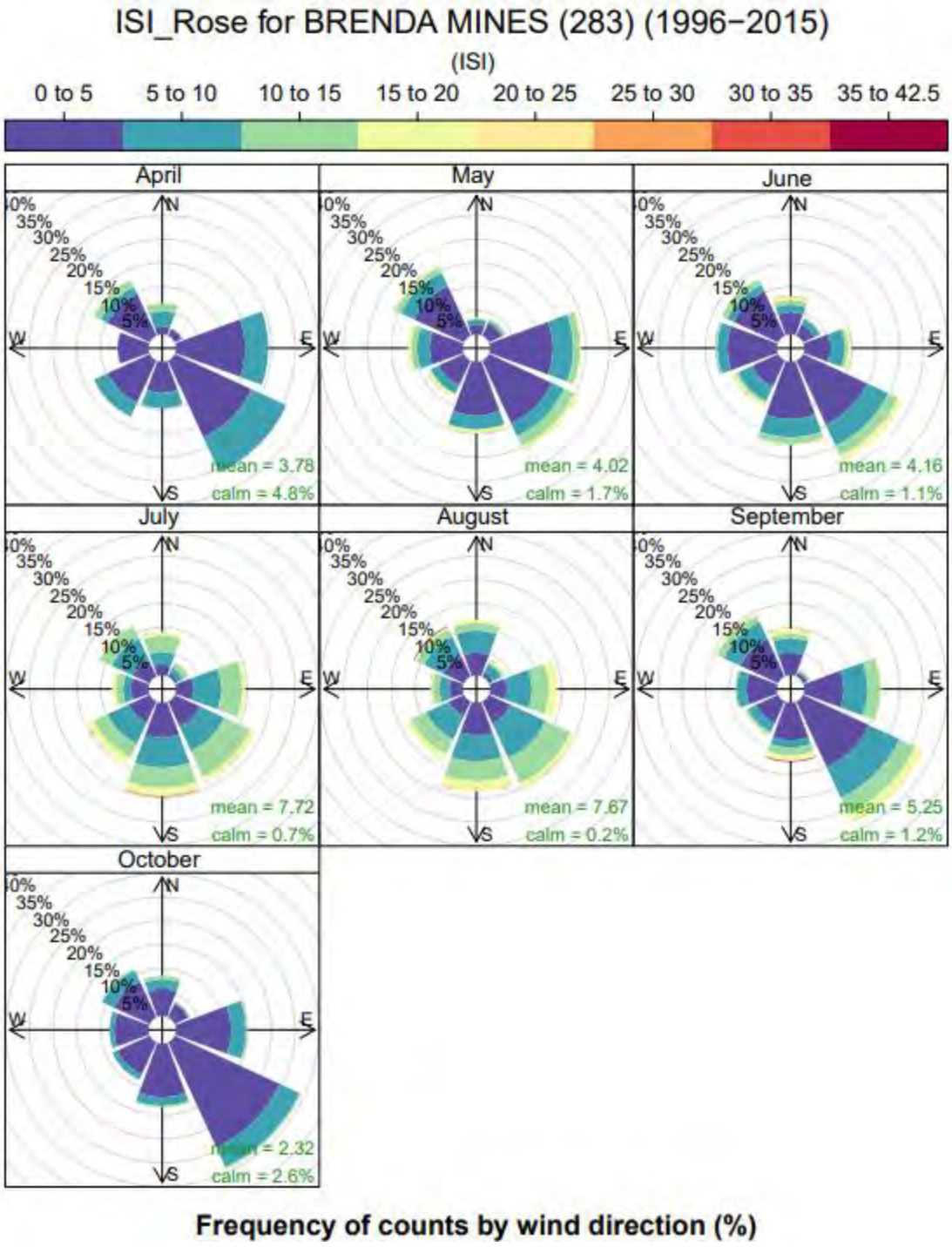

Figure 24 ISI Roses for Brenda Mines.

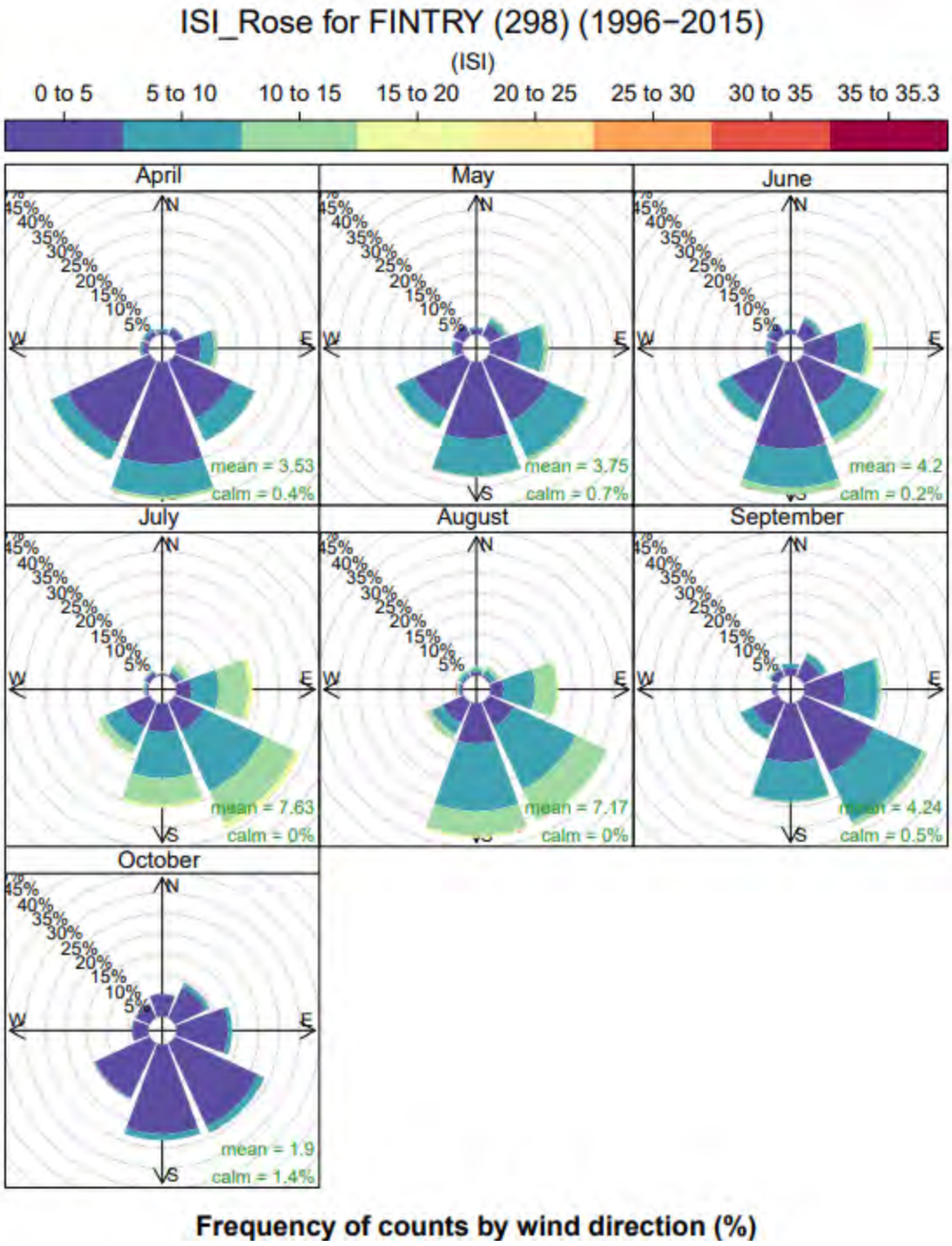

Figure 25 ISI Roses for Fintry.

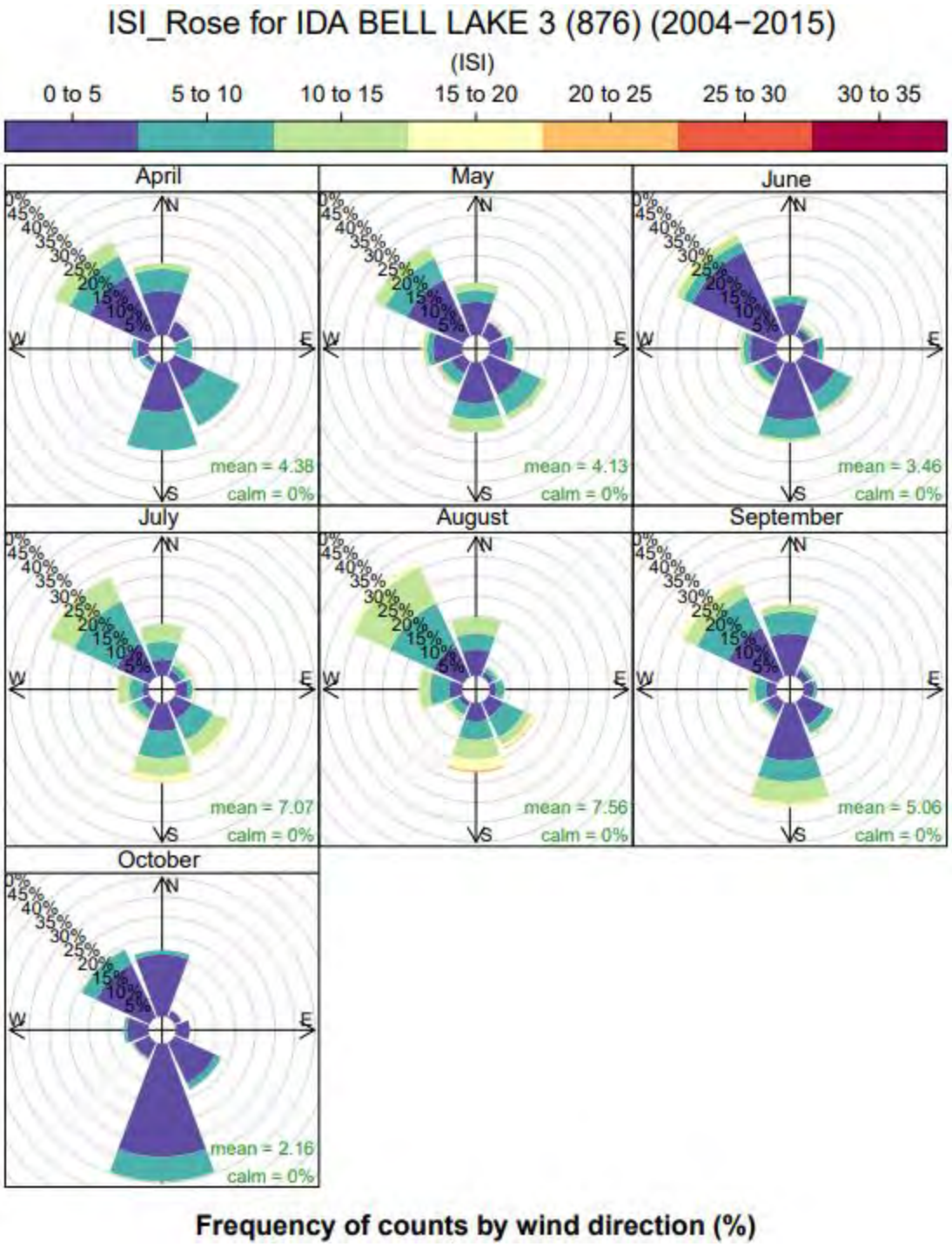

Figure 26 ISI Roses for Ida Bell 3.

A1.4 Topography

In the context of the fire environment, topography refers to the shape and features of the landscape. Of primary importance for an understanding of fire behaviour is slope. When all

other factors are equal, a fire will spread faster up a slope than it would across flat ground. When a fire burns on a slope, the upslope fuel particles are closer to the flame compared to the downslope fuels. As well, hot air rising along the slope tilts the flame uphill, further increasing the ease of ignition of upslope fuels. A pre-heating effect on upslope fuels also contributes to faster upslope fire spread.

Topography influences fire behavior principally by the steepness of the slope. However, the configuration of the terrain such as narrow draws, saddles and so forth can also influence fire spread and intensity. Slope aspect (i.e. the cardinal direction that a slope faces) determines the amount and quality of solar radiation that a slope will receive, which in turn influences plant growing conditions and drying rates.

The 2012 Wildfire Threat Assessment Guide (used for this CWPP) classifies slope slightly differently than the 2017 Wildfire Risk Classification process, but the intended outcome is similar – to characterize slope steepness in terms of how a wildfire will spread and behave on a given slope. The classifications ultimately attempt to reflect the role of slope as a primary input of the Canadian Forest Fire Behaviour Prediction System (FBP), which underpins much of the threat characterization and mitigation work in BC and elsewhere.

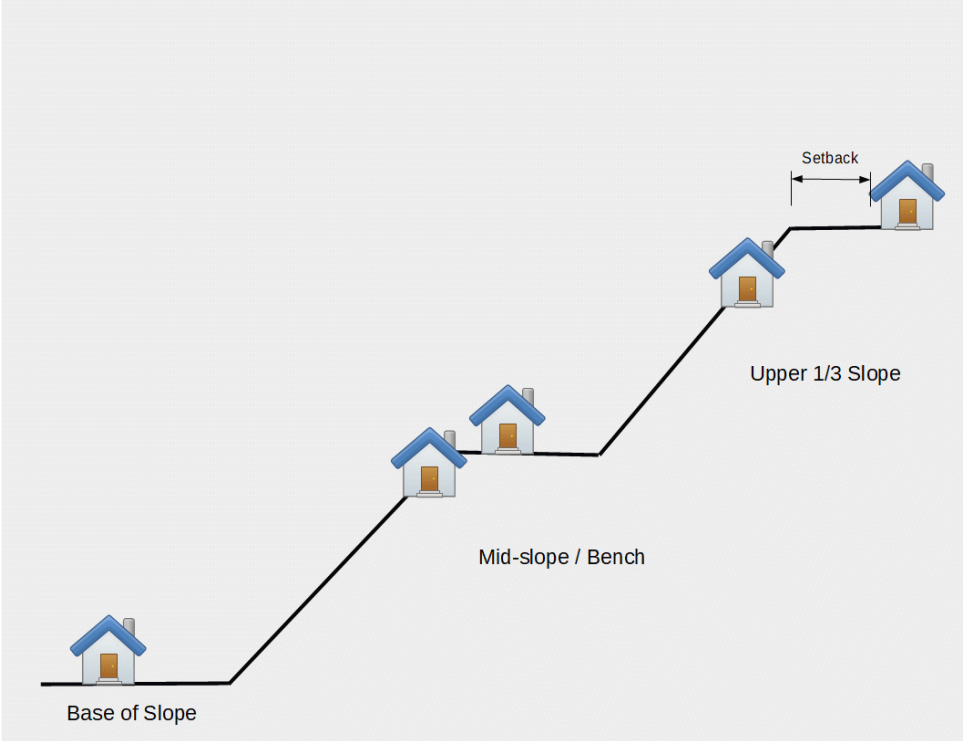

Figure 27 Slope position relative to values at risk.

When structures (i.e. values) are situated on or near a slope, the position of the value in relation to the slope corresponds to the relative WUI threat rating. Where a slope is characterized by continuous and available fuel, values situated at the base of the slope are at less risk than values situated on the mid or upper slope (Figure 27). The risk to values that are situated on slope benches is dependant on the degree to which the value is "set back" from the crest of the slope. Adequate setback is where the value is far enough back from the crest of the slope, such that the value is not subjected to the full effects of upslope fire spread coming up from below. FireSmart Canada broadly defines adequate set back as 10 m for a single-story building, with set back increased proportionally for multi-story buildings (Partners in Protection, 2003). Set back is further illustrated in Figure 28.

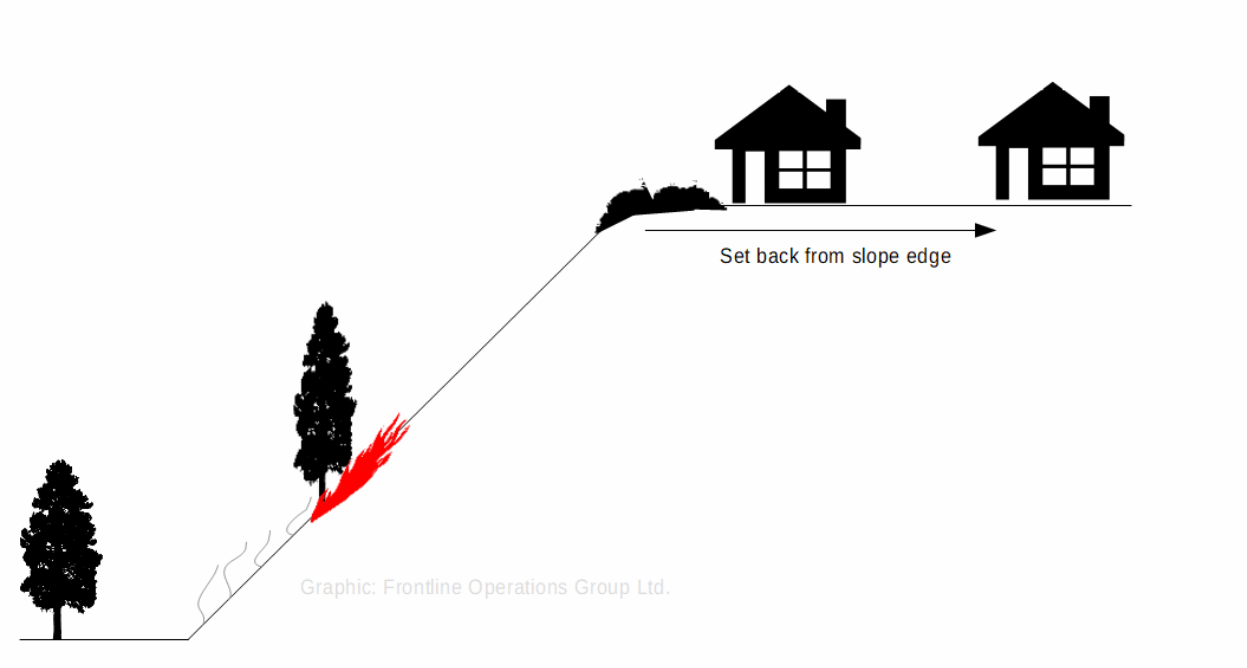

Figure 28 Set back of structures from slope edge in relation to fire behaviour.

A1.5 Local Wildfire Threat Classification

Table 12 WUI wildfire threat assessment worksheet summary and threat classifications.

COLLECTION_DATE	Admin_area	Plot_ID	UTM_Zone	Easting	Northing	Elevation	Fuel_1	Fuel_2	Fuel_3	Fuel_4	Fuel_5	Fuel_6	Fuel_7	Fuel_8	Fuel_9	Fuel_10	Fuel_11	Fuel_Sub_Total	Weather_12	Weather_13	Weather_Sub_Total	Topograpgy_14	Topograpgy_15	Topograpgy_16	Topograpgy_17	Topography_Sub_Total	Wildfire_Behaviour_Threat_Score	Structural_18	Structural_19	Structural_20	WUI_Wildfire_Threat_Score	Total_Wildfire_Threat_Score	Wildfire_Behaviour_Threat_Class	WUI_Threat_Class
01/10/2019	WFN	WFN001	11U	313805	5523743	421	3	5	4	5	2	2	0	5	2	5	3	36	15	10	25	12	10	5	2	29	90	5	9	20	26	116	M	M
01/10/2019	WFN	WFN002	11U	313707	5523524	402	3	5	4	10	5	5	0	5	20	5	3	65	15	10	25	12	5	5	2	24	114	5	9	20	30	144	H	H
01/10/2019	WFN	WFN003	11U	313679	5523261	385	3	5	4	10	2	2	0	7	2	5	3	43	15	10	25	10	1	3	2	16	84	9	9	8	26	110	M	M
01/10/2019	WFN	WFN004	11U	313691	5523396	391	3	5	4	10	10	5	0	7	20	5	3	72	15	10	25	12	5	5	2	24	121	5	9	20	30	151	H	H
01/10/2019	WFN	WFN005	11U	313458	5524037	411	3	5	4	10	5	5	0	5	20	5	3	65	15	10	25	10	1	5	2	15	105	10	5	26	41	146	H	E
01/10/2019	WFN	WFN006	11U	313397	5523912	407	3	5	4	10	2	10	5	10	10	5	3	62	15	10	25	10	1	3	1	15	102	10	5	25	40	142	H	E
01/10/2019	WFN	WFN007	11U	313269	5523957	407	3	5	4	10	2	10	5	10	10	5	3	57	15	10	25	12	12	10	2	36	118	12	5	20	37	155	H	H
01/10/2019	WFN	WFN008	11U	313392	5524593	417	3	5	4	10	5	5	0	7	10	5	3	57	15	10	25	12	12	10	1	35	117	10	5	25	40	157	H	E
01/10/2019	WFN	WFN009	11U	313307	5524272	409	1	5	4	10	5	10	3	7	10	5	3	63	15	10	25	12	12	10	2	36	124	10	5	30	45	169	H	E
03/10/2019	WFN	WFN010	11U	312863	5523613	393	5	5	4	10	5	10	5	7	5	5	3	64	15	10	25	10	1	1	1	13	102	10	5	25	40	142	H	E
03/10/2019	WFN	WFN011	11U	318220	5528638	415	3	5	4	10	2	5	0	7	5	0	3	44	15	10	25	10	1	5	2	18	87	10	5	10	25	112	M	M
03/10/2019	WFN	WFN012	11U	318106	5528507	427	1	5	2	10	5	10	4	5	5	5	3	55	15	10	25	12	5	5	2	24	104	10	5	25	40	144	H	E
03/10/2019	WFN	WFN013	11U	318015	5528422	437	3	5	4	10	2	5	0	7	5	5	3	49	15	10	25	12	5	5	2	24	98	12	5	30	47	145	H	E
03/10/2019	WFN	WFN014	11U	318273	5528428	431	5	5	4	10	2	5	0	5	2	0	3	41	15	10	25	5	5	5	2	17	83	10	5	10	25	108	M	M
03/10/2019	WFN	WFN015	11U	318306	5528295	431	5	5	4	10	2	10	5	5	5	0	3	54	15	10	25	5	10	7	2	24	103	12	5	30	47	150	H	E
03/10/2019	WFN	WFN016	11U	318016	5527810	411	5	5	4	10	5	10	5	5	5	5	3	67	15	10	25	5	10	7	2	24	116	15	5	30	50	166	H	E
03/10/2019	WFN	WFN017	11U	318307	5528039	409	5	5	4	10	2	10	5	7	5	5	3	61	15	10	25	5	10	5	2	22	108	15	5	15	35	143	H	H
03/10/2019	WFN	WFN018	11U	318256	5528757	412	3	5	4	10	2	5	0	10	5	0	3	47	15	10	25	10	1	1	2	14	86	10	5	10	25	111	M	M
03/10/2019	WFN	WFN019	11U	317141	5529363	415	5	5	4	10	5	5	0	7	5	5	3	54	15	10	25	15	12	10	5	42	121	12	5	30	47	168	H	E
03/10/2019	WFN	WFN020	11U	317108	5529298	413	3	5	2	10	5	10	5	5	5	5	3	58	15	10	25	5	10	10	5	30	113	12	5	30	47	160	H	E
03/10/2019	WFN	WFN021	11U	317508	5529936	361	1	5	2	7	5	5	4	7	5	0	3	44	5	10	15	10	1	1	1	13	72	5	5	15	25	97	M	M
06/05/2020	WFN	WFN022	11U	312976	5524129	390	5	5	4	10	1	10	5	10	2	0	3	55	15	10	25	5	5	3	2	15	95	5	3	20	28	123	M	H
05/03/2020	WFN	WFN093	11U	338760	5522697	1208	6	5	2	7	5	10	4	7	5	5	10	66	7	10	17	10	1	1	5	10	26	109	0	0	0	1	110	H	L
06/05/2020	WFN	WFN094	11U	334209	5523871	834	5	4	3	7	7	5	0	10	5	5	5	56	15	10	25	10	1	7	10	28	109	5	10	1	16	125	H	M
06/05/2020	WFN	WFN095	11U	311438	5522487	390	5	5	4	5	2	2	0	10	2	0	5	40	15	10	25	10	1	5	1	17	82	n/a	n/a	n/a	0	82	M	M
06/05/2020	WFN	WFN096	11U	311380	5522509	391	5	5	4	5	2	2	0	15	2	0	5	45	15	10	25	10	1	5	1	17	87	n/a	n/a	n/a	0	87	M	M
06/05/2020	WFN	WFN097	11U	311687	5522552	379	5	5	4	5	2	5	0	15	2	0	5	48	15	10	25	5	10	5	10	30	103	12	5	25	42	145	H	E
06/05/2020	WFN	WFN098	11U	311571	5522659	381	5	5	4	1	1	2	0	0	2	0	5	25	n/a	n/a	0	n/a	n/a	n/a	n/a	0	25	n/a	n/a	n/a	0	25	L	L
06/05/2020	WFN	WFN099	11U	311497	5522627	387	5	5	5	7	5	5	0	15	5	5	5	62	15	10	25	15	5	5	5	35	122	15	5	25	45	167	H	E

Threat Class:
L = Low M = Moderate H = High E = Extreme

Appendix 2: Wildfire Threat Assessment Worksheets and Photos

Note: The WUI Wildfire Threat Assessment worksheets and photos are provided to WFN in a separate document to manage CWPP document size and readability.