The City of Penticton's comprehensive approach to wildfire risk reduction

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ABSTRACT

From 2017 to 2023, British Columbians experienced four record-breaking wildfire seasons, resulting in reduced air quality, mass evacuations and the destruction of homes, properties and livelihoods. Wildfire risk reduction is vital to breaking the sequence of disaster that has befallen such communities as Kelowna, BC in 2003, Ft. McMurray, AB in 2016, and Lytton, BC in 2021. As the City of Penticton ('the City') is located in a wildfire-prone environment, its Fire Department, FireSmart Team and Emergency Program have worked closely together to facilitate a proactive and comprehensive approach towards reducing the impacts of wildfire on Penticton's neighbourhoods, businesses and residents through a variety of wildfire mitigation initiatives. This paper discusses the City's efforts to achieve a holistic wildfire risk management plan through alignment with the seven disciplines of FireSmart and the four pillars of emergency management, namely: the use of education; land use planning and development considerations; vegetation management; emergency planning; and cross training and interagency cooperation. The paper describes the challenges the City has faced, as well its successes, and provides recommendations to help other local authorities reduce the risk of wildfire in their communities.

Keywords: wildfire, FireSmart, wildfire risk reduction, wildfire and emergency management, wildfire and fire services

INTRODUCTION

Wildfires in Canada are not a localised occurrence. Fire plays a necessary role in the ecological process, contributing to forest composition, heterogeneity, regeneration, soil nutrient and carbon cycling.[1–3] Its significance has long been recognised

by Indigenous Peoples, who historically utilised their traditional knowledge of fire as a tool for landscape modification and the rejuvenation of vital cultural resources.[4–6] After the arrival of European settlers, the post-colonial Canadian government criminalised the use of traditional cultural burning under the Bush Fire Act of 1874. Settlers feared and viewed fire as a force of destruction, rather than regenerative; they also saw the prohibition of cultural burning as a mechanism for controlling Indigenous assimilation.[7,8]

The elimination of fire from the landscape led to an interruption in local ecological fire regimes, resulting in the accumulation of dead, over-aged, overstocked, diseased and bug-infested fuels.[9] In addition to outlawing controlled burns, a century's worth of wildfire response and suppression has also contributed to the increased complexities of fire behaviour.[10] These challenges are set to worsen, as climate change is expected to lead to longer fire seasons, thus, resulting in a greater volume of area burned.[11,12] Indeed, British Columbians and Canadians have already observed changes in wildland fire activity as a result of climate change.[13] For example, in the after-action review published in the wake of the 2021 Lytton Wildfire, the record-breaking heat — a by-product of climate change — was identified as a contributing factor to the wildland–urban interface (WUI) disaster.[14]

On average, the Province of British Columbia experiences between 1,600 to 2,000 wildfires annually, with approximately 1.96 Mha burned per year in Canada.[15–17] Although only a small percentage of these fires are considered as interface, WUI fires can be devastating for communities, with many long-term impacts.[18] During the 2016 Fort McMurray wildfire, more than 2,400 structures were destroyed, with 90,000 residents placed on evacuation orders.[19,20] Two years post disaster, the community was still in recovery, having built back only 20 per cent of damaged homes and still addressing secondary impacts.[21]

As urban expansion across Canada is predicted to continue pushing deeper into the WUI environment, the potential for sustained WUI fire disasters increases.[22] In response to this growing threat, the City of Penticton has taken a proactive approach in reducing the potential impacts of wildfire on the community. This paper outlines the measures undertaken by the City since the completion of an updated Community Wildfire Preparedness Plan (CWPP) in 2018. The details highlight the City's demonstrated leadership in wildfire risk reduction (WRR) through their engagement in multiple innovative and progressive initiatives. The discussion will show how these actions align with the seven disciplines of FireSmart and address the four pillars of emergency management.

City of Penticton background

The City of Penticton is located in the southern Okanagan Valley region of British Columbia, on the traditional and unceded territory of the Sylix People in the Okanagan Nation. It is one of two cities in the entire world situated between two lakes — Okanagan and Skaha Lake — and is the largest municipality within the Regional District of Okanagan Similkameen, with approximately 37,000 residents.[23,24] Commonly known for its warm, sunny climate and recreational opportunities, the city is a growing and thriving community with a strong economy driven by tourism and agriculture.[25] The abundance of wineries and access to outdoor recreation, including biking, climbing, boating, hiking and more, makes the city a desirable location to live and visit.

The city primarily falls into the Ponderosa Pine (PP) biogeoclimatic ecosystem classification (BEC) zone, with

interspersing of interior Douglas fir in higher valley elevations.[26] The PP BEC zone is the driest and warmest forested region within British Columbia during the summer months, with the vegetation well adapted to fire as part of its ecology.[27]

Risk management

Being located within a wildfire-prone environment, the city has experienced a number of challenges associated with wildfires in recent years. To develop an informed risk management framework, it is essential to analyse historical events and review the lessons learned.[28] Table 1 provides a summary of notable wildfires within the south Okanagan and surrounding Penticton area during the last 30 years,.

Risk management is a multiparty undertaking, inclusive of both government and resident involvement.[29] The process aims to reduce the impact of hazards on human life, property and the environment. While it is impossible to eliminate the occurrence of wildfires, risk management strategies can help to lessen the consequences.[30] Effective deliverance of a WRR programme requires the understanding of risk, and the various components it comprises.

Risk can be defined as 'the likelihood of an adverse event occurring [hazard] and the magnitude of its consequences [vulnerability]'.[31] In the case of wildfire, risk is determined by the likelihood of a fire occurring and the potential for casualty, destruction, damage, disruption or any other form of loss. Managing risk involves identifying, assessing and prioritising risks, as well as implementing measures to mitigate or reduce them.[32] In the context of WRR, risk management strategies could include measures such as fire prevention, early detection, evacuation planning and prescribed burns.

Hazard and vulnerability refer to the different aspects of risk. Hazard refers to the physical or natural event that could cause harm, such as a wildfire, whereas vulnerability refers to the characteristics of a community or ecosystem that make it more susceptible to harm from a hazard.[33] In the context of avoiding disaster, both elements require equal consideration, as disaster is the result of the interaction of the two. This means a disaster cannot occur if there is no hazard to impact vulnerability; likewise, if there is no vulnerability, the threat of a hazard becomes obsolete.[34,35] The advantages of a vulnerability-considerate approach over a hazard-centric risk management style is a matter of ongoing debate. Hazards are frequently natural phenomenas, over which humans have very little control. Vulnerability, by contrast, tends to be a socially constructed product, and hence more likely to be something that can be deconstructed.[36] In the words of Chmutina and Von Meding:

Table 1: Wildfires of note within the south Okanagan and surrounding Penticton area, 1990–2023

Year	*Fire*	*Size (hectares)*	*Evacuees*	*Structures losses*
1994	Garnet Mountain	4,919	4,000	18
2003	Okanagan Mountain Park	25,636	27,000	238
2020	Mount Christie	2,141	305	1
2021	Thomas Creek	10,597	77 properties	–
2022	Keremeos Creek	7,019	395	–
2023	McDougal Creek	13,500	35,000	189

> '… [by continuing to blame] "nature" and putting the responsibility for failures of development on "freak" natural phenomena or "acts of God", we enable [disaster and risk managers] to accept poor urban planning, increasing socioeconomic inequalities, nonexistent or poorly regulated policies, and lack of proactive adaptation and mitigation.'[37]

In an ideal world, every member of society would make it their personal responsibility to mitigate and prepare for disaster. In reality, however, many people do not do this due to their perception of risk.[38] The City of Penticton's FireSmart team has encountered various public misconceptions contributing to lower WRR engagement. For example, the team has, on a number of occasions, had to re-educate residents on the realistic capacities of local fire response. In the public's mind, because they live in jurisdictional fire boundary, firefighters will always be able to save their property. This trust can lead many people to underestimate the wildfire risk and reduce the likelihood of their taking action to control risk.[39,40]

In essence, the human psychology could be the greatest detriment to cultivating participation in risk reduction actions. As risk perception is shaped by a variety of factors, such as personal experience, external influences and [lack of] knowledge, understanding perspectives and misconceptions is an important element of effective risk management.[41,42] To shape risk perceptions, public education can be a foundational tool to facilitate buy-in towards wildfire preparedness.[43]

PREPAREDNESS

Public education

Public education is a key component of the City of Penticton's WRR framework to foster preparedness engagement. Educational initiatives to provide knowledge and skill sets for reducing risk have at times proven to be more effective in gaining public, rather than enforceable government policy.[44] Addressing the myths surrounding how wildfires ignite and consume structures is a primary focus of the City of Penticton's public education programming. Often, it is the 'wall of fire' that is feared by many, rather than the wind-transported firebrands (or embers). Statistically, structure ignition is more frequently caused by firebrands than by direct flame contact. These flaming materials are transported and transplanted a distance from the fire front, onto combustibles on or adjacent to structures.[45,46] Fire spreads because of the availability of consumable fuels; a wildland fire cannot ignite a home unless the structure and its immediate surroundings allow for combustion.[47] From this understanding, a conception of how wildfire disasters occur is derived, resulting in actionable measures developed to counteract structure ignition.

A majority of wildfire disasters follow a similar pattern that can be summarised as the WUI disaster sequence (Figure 1).[48] First, weather, topography and fuel set the conditions for wildfire to burn. Following the collision of a wildfire with non-FireSmart neighbourhoods, residential fires and conflagration occur, during which resources are quickly overwhelmed and fire-fighting effectiveness reduced. Ultimately, these factors culminate together with the result of mass structure losses or a WUI disaster.[49] Post-disaster studies have that found homes and neighbourhoods with applied WRR principles (ie FireSmart guidelines) had a significantly higher rate of survival when compared with homes left unmitigated.[50,51] This is in direct relation to the fact that structures act as the available fuel source in WUI disasters. While weather and

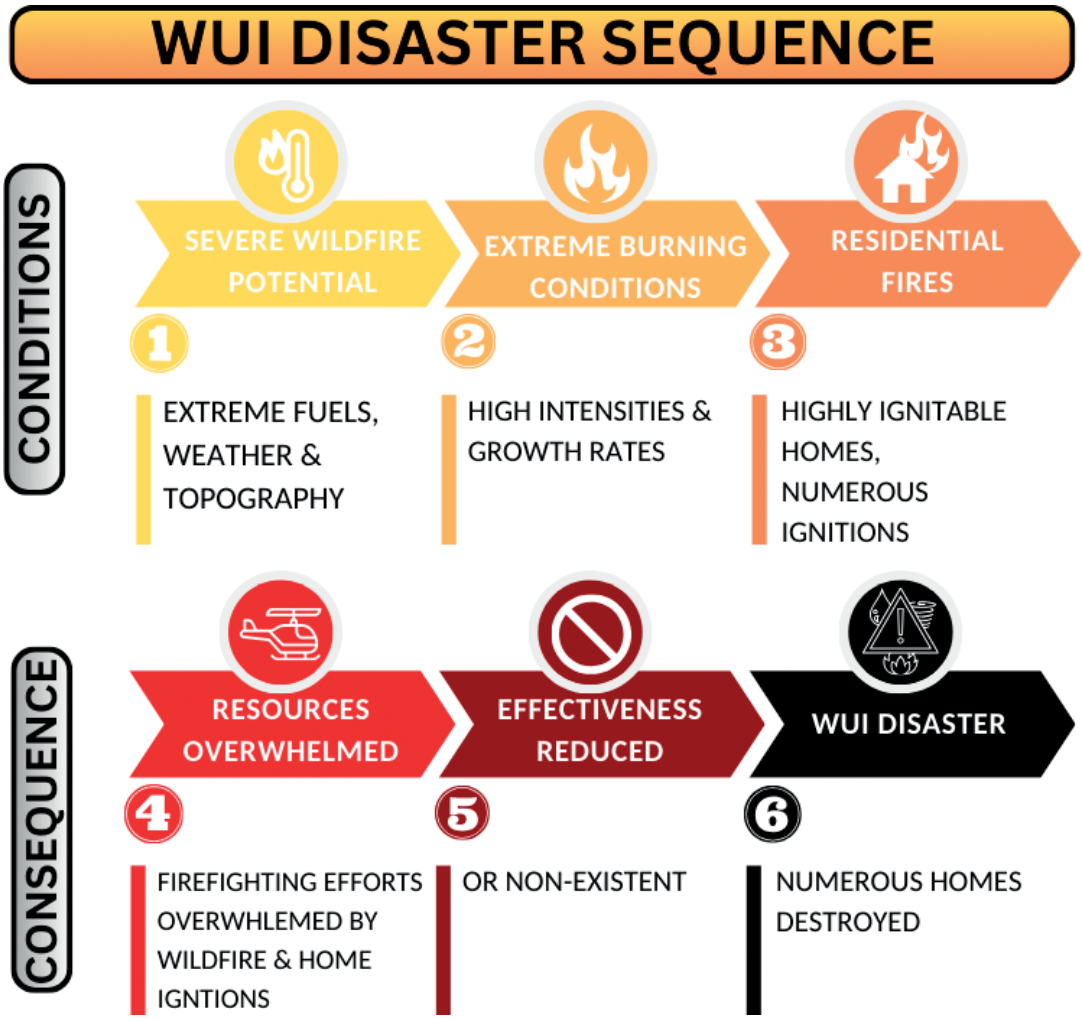

Figure 1 WUI Disaster Sequence

Adapted from: Cohen, J. D. and Westhaver, A. (2022) 'An examination of the Lytton, British Columbia wildland-urban interface fire destruction', available at: https://firesmartbc.ca/wp-content/uploads/2022/05/An-examination-of-the-Lytton-BC-wildland-urban-fire-destruction.pdf (accessed 10th November, 2023)

topography are beyond human control, fuel, however, is an actionable component. Therefore, it can be determined that it is not improved wildfire suppression efforts that are needed to break the wildfire disaster sequence, but rather home ignition mitigation efforts on private property.[52]

Public education plays a vital role in communicating the disaster sequence to community residents. By understanding how disasters occur and the need to prevent the transference of fire from wildland fuel to urban fuel (ie homes), residents can begin to connect to their crucial role in WRR. The work undertaken around residential homes, creating a no-to-low fire environment, will aid in the disruption of the disaster sequence.[53–56]

However, despite the provision of knowledge, creating action among residents can be an arduous task. It is paramount for anyone working in WRR to

understand his or her audience, and the demographics they are dealing with. In Sturtevant and McCaffrey's[57] research, the authors identified several key methods for increasing public buy-in:

- Show people how the mitigation actions are compatible with their lifestyles and values;
- Create a manageable step-by-step guide;
- Provide visual examples — ideally ones that are aesthetically pleasing; and
- Highlight the social benefits as well as the economic advantages — some people are more motivated by one than the other.

The authors also noted that the way information is disseminated can greatly impact public engagement.[58]

Mass media channels have proven effective for establishing general and initial awareness, as well as building WRR programme branding within Penticton. Social media channels, such as Facebook, Instagram and Twitter, can offer a free or cheap option for local WRR programmes to reach the intended members of public. Typically, the Penticton FireSmart team uses their social media accounts to share educational FireSmart graphics and videos, and to advertise current or upcoming WRR programmes. Having a strong connection to the City's internal communication department has also been highly beneficial for the team as they been valuable in assisting with public education and messaging.

In addition to social media, the City's FireSmart team utilises both home and neighbourhood assessments, as well as regular public information sessions, as an opportunity for subject matter experts (ie wildfire mitigation specialists) to interact with residents on a one-to-one basis. Public information sessions have been held at a variety of venues and have addressed a diverse range of demographics through tailor-made presentations. Much success has been had in hosting information sessions with existing groups and committees within the City, such as the senior centres, strata councils and gardening clubs. A noted success of the team is the uptake of FireSmart knowledge among the City's youth. Within their second year of interacting with the schools of District 67, many children and teens are already able to recognise FireSmart Canada's new mascot, Ember the FireSmart Fox,[59] and can recite several key FireSmart messages.

As a local government body, the Penticton FireSmart team has recognised the need for support from other City departments. All employees should be educated on FireSmart and encouraged to look for opportunities to incorporate WRR efforts into their own work. Accessory to internal staff, having support from local officials (ie Mayor and Council, Board of Directors, or Chief and Council) can establish a positive reputation for FireSmart programmes and promote community engagement. [61] For the Penticton team, endorsement from the City, along with operating as part of the local Fire Department, has provided reassurance to the community regarding the credibility of the team and programme.

MITIGATION

A multi-pronged approach to WRR requires proactive mitigation strategies for at-risk communities. 'Mitigation' refers to actions taken to adapt to, eliminate or reduce impacts of wildfire in order to protect communities from loss of life and property, environmental degradation and economic disruption.[61] Mitigation can include both nonstructural (ie land-use planning and building codes) and structural measures (ie vegetation and fuel management).

Land use planning and building development considerations

In British Columbia, the Community Wildfire Resiliency Plan (CWRP) serves as the primary WRR planning mechanism for local governments and First Nations.[62] The CWRP, originally known as the Community Wildfire Protection Plan (CWPP), was introduced as part of the Strategic Wildfire Prevention Initiative in 2004 after the devastating wildfires in 2003. In an effort to introduce a more comprehensive approach towards wildfire, the BC Wildfire Service (BCWS) and the BC FireSmart Committee subsequently updated the CWPP to the CWRP by incorporating the seven FireSmart disciplines.[63]

As noted, the CWRP is a planning tool for local authorities. The key goals are to identify risk, develop resiliency measures and foster collaboration within and across administrative boundaries.[64] The plan can be utilised and incorporated into other related plans, such as official community plans (OCPs), emergency response plans (ERPs), or even urban or community forest plans. The City adopted the first CWPP in 2006, with updates occurring in 2016 and 2018 to account for increased urbanisation and ongoing changes within the forested and grassland landscape. In 2023, the Penticton CWPP was adapted to the new CWRP template to account for the:

- Need to establish whether previous risk mitigation efforts had reduced risk levels;
- Need to create a working and living document that highlights the previous and current mitigation work, and recommendations for the future; and
- Need to align objectives of the Penticton FireSmart and emergency programme with other Fire Department divisions, City departments and BCWS.

Upon completion of the CWRP, several recommendations for action planning were identified. This included the recommendation to adopt a WRR language into the City's OCP, a comprehensive land-use document created by local governments in collaboration with community members; and implement a Wildfire Development Permit Area (DPA) within the high-risk residential neighbourhoods. Building designs are bound to provincial building codes.[65] As of 2023, the BC Building Code has yet to adopt language or enforcement of wildfire-resilient building concepts for communities and neighbourhoods within the WUI. In the interim, Wildfire DPAs allow local authorities to designate specific zones within their jurisdiction to adhere to local building codes in an effort to mitigate against identified hazards.[66] Priority 3 of the Sendai Framework for Disaster Risk Reduction specifically identifies the need for local authorities to revise building codes to foster disaster-resistant structures.[67] Wildfire DPAs provides such a mechanism for communities to reduce structural vulnerabilities through the regulation of structure and neighbourhood design within the WUI.

Experience suggests that it is easier for residents to take action when the composition of their home already meets the majority of the FireSmart principles. The team equates this to the manageability and cost-effectiveness of landscaping, compared with undertaking FireSmart home renovations. As such, vegetation management complements legislation and building considerations by addressing the landscape adjacent to structures.

Vegetation management

The goal of vegetation management is to preemptively alter wildfire behaviour through changes to the local fuel

complex.[68] Vegetation management can be achieved by carrying out two types of methods: (1) residential-scale landscaping and (2) community and landscape-level.[69] This is consistent with recommendations made by researchers expressing the need for both government and public responsibilities for wildfire mitigation.[70]

At the residential scale, residents can decrease their vulnerability to wildfire by incorporating fire-resilient plants and thinning and removing the limbs of coniferous vegetation on their property.[71] The Penticton FireSmart team has worked with residents to provide options for hazardous fuel removal, such as providing green waste bins and covering tipping fees through provincial grant funding. Additionally, the Penticton FireSmart team has worked with local garden centres and nurseries to integrate the FireSmart Plant Tagging programme.[72] The programme serves as an educational tool for residents to recognise fire-resilient plants through the visual aid of identification tags. Furthermore, the Penticton FireSmart team has worked with external stakeholders to provide inclusive landscaping recommendations to the community that account for other values such as retention of native species, biodiversity and water use consumption.

While it is impossible to practically address entire landscapes, local governments do have the ability to shape public municipal or regional lands. The City has approximately 600 ha of sporadically spaced municipal land throughout its jurisdictional boundaries.[73,74] The risk analysis under the 2016 Penticton CWPP identified and prioritised 14 logical treatment units for the City to address (Figure 2). Since then, the City has completed fuel mitigation for all identified parcels and is now transitioning to mitigation maintenance action planning. The City has also worked with the Province's WRR programme to treat unceded crown lands within the municipal boundary. The BC WRR programme, administered through the Ministry of Forests, and BCWS have also been instrumental in fuel-managing several areas outside of the City boundaries, highlighting the importance of interagency cooperation.

It should be noted that there are several methods to approaching landscape-level vegetation management. Mechanical treatment involves the practice of selective trees and ladder fuel removal, with treatment prescriptions best developed by a Registered Professional Forester[75] who understands wildfire behaviour and accounts for environmental and cultural values. Another available mechanism is to utilise fire itself. Reintegrating fire onto the landscape through prescription and/or cultural burning can be an effective, ecologically compatible and cost-efficient tool for communities.[76] Both methodologies can be utilised in conjunction with another and provide multiple ecological benefits, in addition to risk reduction.[77–79] Additionally, it creates defensible space in which firefighters can work more safely and effectively in to suppress wildfires that threaten communities.

As all Canadian communities are located on traditional, and often unceded, Indigenous land,[80] it goes without saying that all local governments should be engaging with their First Nations partners when conducting vegetation management. Indigenous People are stewards of the land and have been the keepers of traditional fire use for millennia; a return to traditional Indigenous knowledge offers an adept solution to mending gaps in reconciliation and WRR practices.[81] Indigenous cultural burning should be seen beyond a sole focus of risk reduction; it is a regenerative practice that seeks to renew the landscape through fire and provide balance to the ecosystem.[82–84]

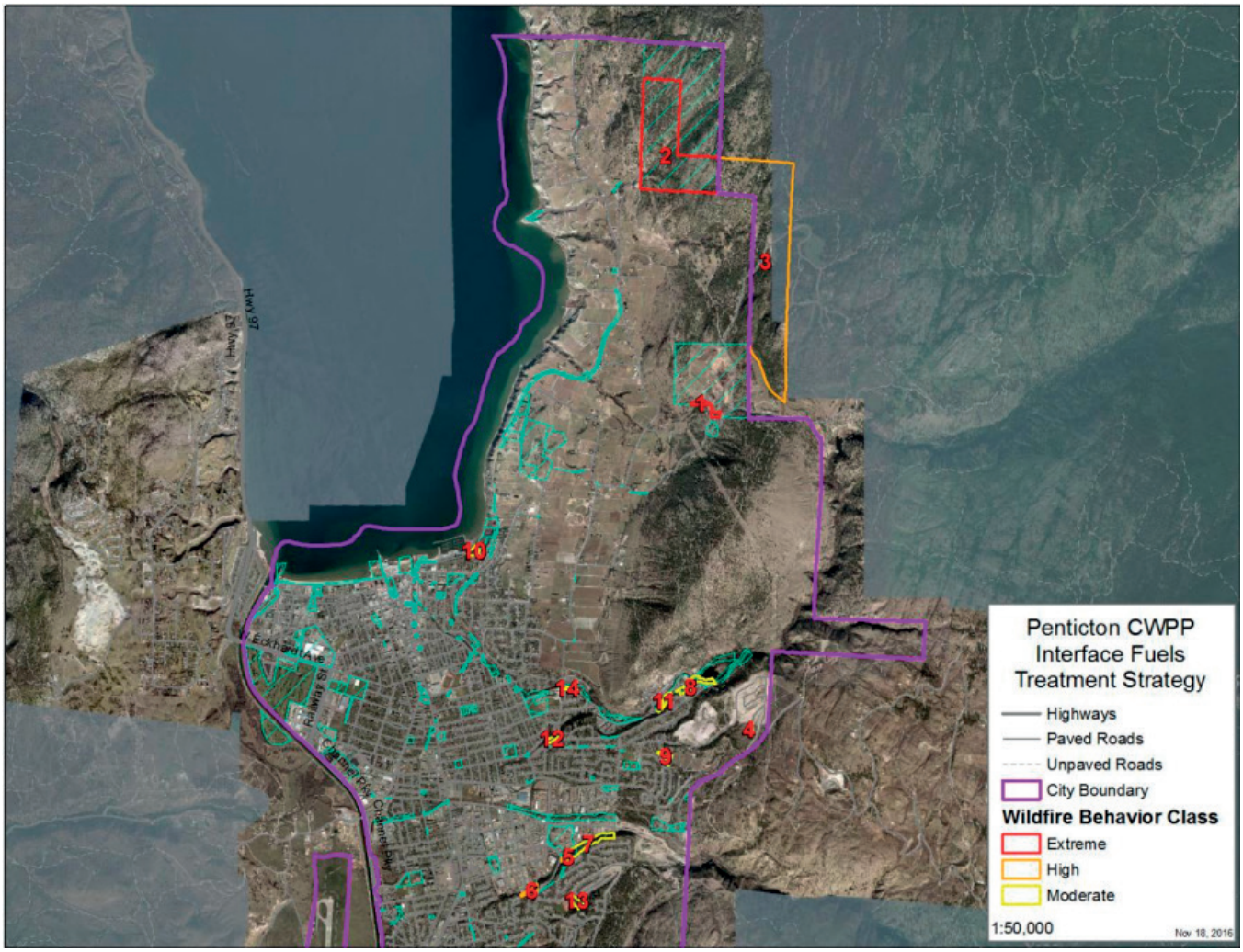

Figure 2 Identified Penticton fuel treatment parcels, 2016 CWPP

RESPONSE

Emergency planning

Despite best efforts to prepare and prevent, emergencies are still likely to occur. Under the BC Emergency Program Act 1996, the Local Emergency Management Regulation and, since November 2023, the Emergency and Disaster Management Act 2023, all local BC authorities must establish an emergency management programme that identifies, plans for, responds to and recovers from hazards.[85] Additionally, BC fire departments have a legal obligation to fulfil their response duties within their jurisdictional boundaries — including in jurisdiction wildfires.[86]

Wildfire ERPs should be a hazard-specific annex of the local overarching All-Hazard ERP. The Wildfire ERP should adopt the wildfire risk analysis, developed through a community's CWRP, along with concepts of operations, organisation and assignment responsibilities, and additional information such as evacuation routes, warning systems and crisis

communications.[87] As part of a holistic approach to WRR, the Penticton Fire Department created a WUI Fire Response Action Plan in 2017 to aid in the protection of the City from wildfire. As of 2023, the plan is being updated to include changes to emergency programme oversight and the integration of emergency operations centre (EOC) pre-planning.

A unique component of the 2017 Penticton WUI Fire Response Action Plan is the development of QR-coded WUI Pre-Incident Planning Maps. The purpose was to create a medium that allowed for instant situational awareness for all out-of-jurisdiction response agencies. These PDF maps can be readily shared via QR code, are geo-based referenced, and are operated on the free downloadable Avenza app. The WUI Pre-Incident Planning Maps identify important information such as topography, land ownership, transportation route types and critical infrastructure (see, for example, Figure 3). They also include important tactical information such as hydrants and water sources, potential safety zones and pinch points, and the wildfire interface zone.

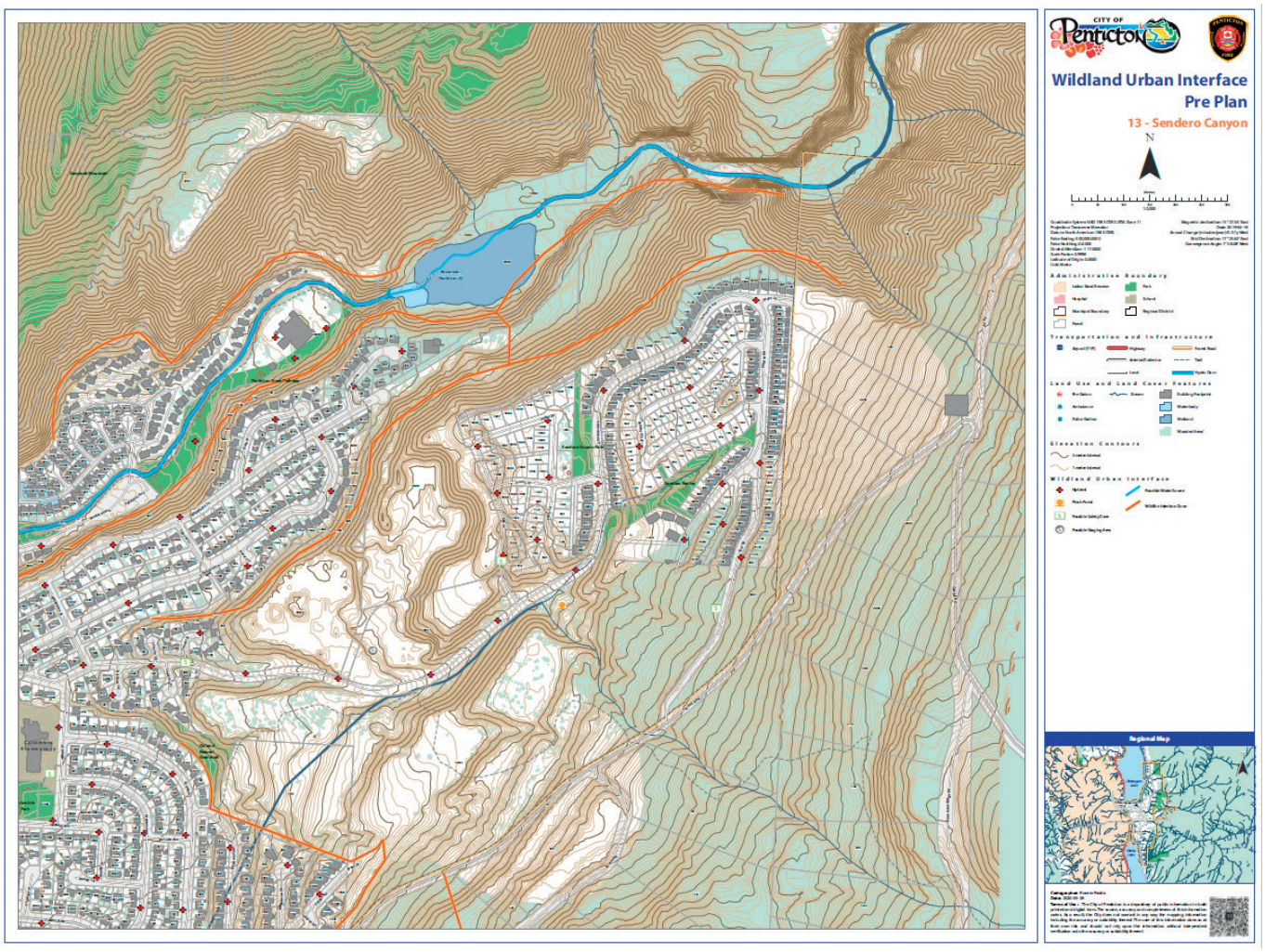

Figure 3 Example WUI pre-plan map — Sendero Canyon, Penticton, BC

Cross-training and interagency cooperation

Cross-training focuses on the sharing of knowledge and skill sets to increase capacity and efficiency within wildfire response. A pioneering contribution to local and provincial wildfire risk reduction was the development of an annual training symposium by Penticton's Fire Chief, Larry Wakinson, along with several of his colleagues. The purpose was to create a forum to reduce the gap in knowledge and experience between structural fire departments and wildland fire response. The results proved effective during the coordinated response to the 2020 Mount Christie wildfire.

At the height of the response, there were over 200 firefighters from 50 fire departments, in addition to the BCWS staff.[88] Many of the responding crews had taken previous training through the WUI symposium, which established advance understanding of multi-jurisdictional response. Coordinated efforts for site-level tactics worked efficiently between BCWS and structural departments, allowing BCWS to focus on wildland fire suppression and municipal fire services to focus on community defence. Despite the aggressive fire behaviour and rapid fire growth, crews were able to utilise their training to protect all but one of the 319 homes within the Heritage Hills community.[89] It should be noted, however, that the single loss was attributed to non-wildfire resilient housing design, and not the capabilities of responding crews.

In speaking with response personnel that attended the Mount Christie wildfire, the benefit of relationship cultivation at the WUI symposium was also noted. Responders observed an established level of trust that fostered better collaboration and teamwork among the various crews. Communication and information sharing flowed freely, resulting in better tactical decision-making and the improved safety of all fire-fighters.

After several successful years of operation, the WUI symposium was adopted by BCWS as provincial curriculum in 2022 and is offered to structural fire departments across the province.

RECOVERY

An important aspect to effective wildfire and risk management is the engagement in shared lessons learned. Lessons learned provide a valuable opportunity to identify best practices and assist in facilitating organisational and WRR adaptability.[90] As the City has evaded widespread wildfire destruction since the 1994 Garnet Mountain wildfire, the City's FireSmart team, along with other emergency management personnel, rely on the considerable learnings from other recent WUI events. It is essential for any WRR programme to take the opportunity to benefit from the experiences of others. Wildfire frequency and intensity are on the rise, and it is only a matter of time before another at-risk community is challenged by a WUI wildfire. To minimise destruction, WRR programmes should consider recommended action items for adoption within their own communities.

CONCLUSION

A 2005 study analysed multiple risk reduction programmes to determine which aspects contributed to programme success. The study noted that risk managers identified four common drivers of effective risk reduction: education, risk assessment, homeowner assistance and regulations.[91] As no single aspect was identified as being more important than any of the others, the findings highlight the need for an all-encompassing risk management strategy.

As such, the City of Penticton and its FireSmart team recognise that wildfire risk reduction requires a multipronged solution, with long-term strategic planning and the implementation of holistic methods. As climate change will impact not only hazards, but also physical, social and economic vulnerabilities, it is vital for communities to address structural inequalities created by political and social structures.[92,93] The City's WRR programme has incorporated the use of the seven disciplines of FireSmart, with notable results in consistent educational programming, the development of risk-reduction legislation, and increasing capacity for effective emergency response.

Lastly, the City's FireSmart team recognises that is rare that any one entity has the ability to manage all aspects of risk, therefore, is a shared responsibility.[94] It is imperative for local authorities and fire departments to lead the charge in their respective communities, and garner engagement from members both internal (ie staff) and external (ie public) to the organisation. Only by working collectively and comprehensively together can communities continue to grow in a sustainable and resilient manner, co-existing with wildfire on the landscape.

References

(1) Johncox, A. S. (2010) 'Wildfire reality: Shifting emergency response to disaster planning in the regional district of central Okanagan', master's thesis, University of Guelph, available at: https://atrium.lib.uoguelph.ca/xmlui/bitstream/handle/10214/22158/Johncox_AnneS_MLA.pdf (accessed 8th November, 2023).

(2) Coogan, S. C. P., Daniels, L. D., Boychuck, D., Burton, P. J., Flannigan, M. D., Gauthier, S., Kafka, V., Park, J. S. and Wotton, B. M. (2021) 'Fifty years of wildland fire science in Canada', *Canadian Journal of Forest Research*, Vol. 51, pp. 283–302.

(3) Flanningan, M., Stocks, B., Turetsky, M. and Wotton, M. (2009) 'Impacts of climate change on fire activity and fire management in the circumboreal forest', *Global Change Biology*, Vol. 15, No. 3, pp. 549–560.

(4) Coogen *et al*., ref. 2 above.

(5) Adlam, C., Almendariz, D., Goode, R. W., Martines, D. J. and Middleton B. R. (2021) 'Keepers of the flame: Supporting the revitalization of Indigenous cultural burning', *Society & Natural Resources*, Vol. 35, No. 5, pp. 575–590.

(6) Vermes, V. (2022) 'The importance of cultural burning in Indigenous communities and their stories', *Land in Literature*, Vol. 6, No. 1, pp. 66–71.

(7) *Ibid*.

(8) Van Vugt, T. (2017) 'Revisioning fire: A study on cultural burning and fire settlement planning', master's thesis, University of Toronto, Canada.

(9) Christianson, A. C., Caverly, N., Diabo, D. A., Ellsworth, K., Highway, B., Joe, J., Joudry, S., L'Hirondelle, L., Skead, W., Vandevord, M. and Ault, R. (2020) 'Blazing the trail: Celebrating Indigenous fire stewardship', FireSmart Canada, Winnipeg, MB.

(10) Busenberg, G. (2004) 'Wildfire management in the United States: The evolution of a policy failure', *Review of Policy Research*, Vol. 21, No. 2, pp. 145–156.

(11) Coogen *et al*., ref. 2 above.

(12) Flanningan *et al*., ref 3 above.

(13) Coogan, S. C. P., Robinne, F-N., Jain, P., and Flannigan, M. D. (2019) 'Scientists' warning on wildfire — a Canadian perspective', *Canadian Journal of Forest Research*, Vol. 49, pp. 1015–1023.

(14) Cohen, J. D. and Westhaver, A. (2022) 'An examination of the Lytton, British Columbia wildland-urban interface fire destruction', FireSmart, available at: https://firesmartbc.ca/wp-content/uploads/2022/05/An-examination-of-the-Lytton-BC-wildland-urban-fire-destruction.pdf (accessed 8th November, 2023).

(15) Coogen *et al.*, ref. 2 above.
(16) BC Wildfire Service (n.d.) 'Wildfire response', available at: https://www2.gov.bc.ca/gov/content/safety/wildfire-status/wildfire-response (accessed 8th November, 2023).
(17) Province of British Columbia (2016) 'British Columbia provincial coordination plan for wildland urban interface fires', available at: https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/provincial-emergency-planning/bc-provincial-coord-plan-for-wuifire_revised_july_2016.pdf (accessed 8th November, 2023).
(18) Xu, Z. and Kooten, G. C. van (2013) 'Living with wildfire: The impact of historic fires on property values in Kelowna, BC', working paper, University of Victoria, Canada.
(19) Westhaver, A. (2017) 'Why some homes survived: Learning from the Fort McMurray Wildland/urban interface fire disaster', ICLR, available at: https://www.iclr.org/wp-content/uploads/PDFS/Westhaver_Fort_McMurray_Preliminary_Aug_2016.pdf (accessed 8th November, 2023).
(20) Mamuji, A. A. and Rozdilsky, J. L. (2019) 'Wildfire as an increasingly common natural disaster facing Canada: Understanding the 2016 Fort McMurray wildfire', *Natural Hazards*, Vol. 98, No. 1, pp. 163–180.
(21) *Ibid*.
(22) Coogan *et al.*, ref. 13 above.
(23) Census Canada (2021) '2021 census of population profile table. City of Penticton', available at: https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=Penticton&DGUIDlist=2021A00055907041&GENDERlist=1,2,3&STATISTIClist=1&HEADERlist=0 (accessed 8th November, 2023).
(24) City of Penticton (2019) 'Official Community Plan Bylaw No. 2019-08', available at: https://www.penticton.ca/sites/default/files/uploads/bylaws/Consolidated%20Official%20Community%20Plan%20Bylaw%20No.%202019-08%20-%20February%2013%2C%202023.pdf (accessed 8th November, 2023).
(25) *Ibid*.
(26) Davies, J. (2016) 'City of Penticton: Community wildfire protection plan', available at: https://www.penticton.ca/sites/default/files/docs/city-services/fire%20services/2021-08-12-PDF-Penticton%20Community%20Wildfire%20Protection%20Plan.pdf (accessed 8th November, 2023).
(27) Meidinger, D. and Pojar, J. (1991) 'Ecosystems of British Columbia', Government of British Columbia, available at: https://www.for.gov.bc.ca/hfd/pubs/docs/bro/bro01.pdf (accessed 8th November, 2023).
(28) Friesen, S. K., Kelsey, S. and Legere, J. A. (2017) 'Defining a risk-informed framework for whole-of-government lessons learned: A Canadian perspective', *Journal of Emergency Management*, Vol. 15, No. 4, pp. 219–231.
(29) McLennan, B. J. and Handmer, J. (2012) 'Reframing responsibility-sharing for bushfire risk management in Australia after Black Saturday', *Environmental Hazards*, Vol. 11, No. 1, pp. 1–15.
(30) Cardona, O. D. (2004) 'The Need for Rethinking the Concepts of Vulnerability and Risk From a Holistic Perspective: A Necessary Review and Criticism for Effective Risk Management', in Bankoff, G., Frerks, G. and Hilhorst, D. (eds) *Mapping Vulnerability: Disasters, Development, and People*, Earthscan, Abingdon, pp. 37–51.
(31) Coppola, D. P. (2021) *Introduction to International Disaster Management*, 4th edn, Butterworth-Heinemann, Oxford and Cambridge, MA.
(32) Public Safety Canada, Government of Canada (2017) 'An Emergency Management Framework for Canada', 3rd edn, available at: https://www.publicsafety.gc.ca/cnt/rsrcs/pblctns/2017-mrgnc-mngmnt-frmwrk/2017-mrgnc-mngmnt-

frmwrk-en.pdf (accessed 8th November, 2023).
(33) Coppola, ref. 31 above.
(34) Cardona, ref. 30 above.
(35) Wisner, B., Blaikie, P., Cannon, T. and Davis, I. (2003) 'The Disaster Pressure and Release Model', in *At Risk: Natural Hazards, People's Vulnerability and Disasters*, 2nd edn, Taylor & Francis Group, Abingdon and New York, pp. 49–86.
(36) Raju, E., Boyd, E. and Otto, F. (2022) 'Stop blaming the climate for disasters', *Communications Earth & Environment*, Vol. 3, No. 1.
(37) Chmutina, K. and Von Meding, J. (2019) 'A dilemma of language: Natural disasters in academic literature', *International Journal of Disaster Risk Science*, Vol. 10, pp. 283–292.
(38) Mileti, D. S. (1999) 'Influences on the Adoption and Implementation of Mitigation', in *Disasters by Design: A Reassessment of Natural Hazards in the United States*, Joseph Henry Press, Washington, DC, pp. 135–154.
(39) Slovic, P. (1999) 'Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield', *Risk Analysis*, Vol. 19, No. 4, pp. 689–701.
(40) Wong, C. M. and Jensen, O. (2020) 'The paradox of trust: Perceived risk and public compliance during the COVID-19 pandemic in Singapore', *Journal of Risk Research*, Vol. 23, No. 7–8, pp. 1021–1030.
(41) Coppola, ref. 31 above.
(42) Slovic, ref. 39 above.
(43) Reams, M. A., Haines, T. K., Renner, C. R., Wascom, M. W. and Kingre, H. (2005) 'Goals, obstacles and effective strategies of wildfire mitigation programs in the wildland-urban interface', *Forest Policy and Economics*, Vol. 7, No. 5, pp. 818–826.
(44) *Ibid*.
(45) Hedayati, F., Bahrani, B., Zhou, A., Quarles, S. L. and Gorham, D. J. (2019) 'A framework to facilitate firebrand characterization', *Frontiers in Mechanical Engineering*, Vol. 5, Art. 43.
(46) Cohen, J. D. (2000) 'Preventing disaster: Home ignitability in the wildland-urban interface', *Journal of Forestry*, Vol. 98, No. 3, pp. 15–21.
(47) *Ibid*.
(48) Calkin, D. E., Cohen, J. D., Finney, M. A. and Thompson, M. P. (2013) 'How risk management can prevent future wildfire disasters in the wildland-urban interface', *Proceedings of the National Academy of Sciences*, Vol. 111, No. 2, pp. 746–751.
(49) *Ibid*.
(50) Cohen and Westhaver, ref. 14 above.
(51) Westhaver, ref. 19 above.
(52) Cohen and Westhaver, ref. 14 above.
(53) *Ibid*.
(54) Vicars, M., Vicars, M. and Associates (2003) 'FireSmart: Protecting Your Community from Wildfire', 2nd edn, Partners in Protection, Edmonton, AB.
(55) Westhaver, ref. 19 above.
(56) Calkin, ref. 48 above.
(57) Sturtevant, V. and McCaffrey, S. (2006) 'Encouraging Wildland Fire Preparedness: Lessons Learned from Three Wildfire eEucation Programs', in McCaffrey, S. (ed.) *The Public and Wildland Fire Management: Social Science Findings for Managers*, US Department of Agriculture, Newton Square, PA, pp. 125–136.
(58) *Ibid*.
(59) FireSmart BC. (n.d.) 'Ember the FireSmart Fox', available at: https://firesmartbc.ca/ember/ (accessed 8th November, 2023).
(60) Lang, E. A., Nelson, K. C. and Jakes, P. (2006) 'Working with Community Leadership to Promote Wildfire Preparedness', in McMaffrey, S. (ed.) *The Public and Wildland Fire Management: Social Science Findings for Managers*, US Department of Agriculture, Newton Square, PA, pp. 137–150.
(61) Public Safety Canada, ref. 32 above.
(62) BC FireSmart (2022) 'Community Wildfire Resiliency Plan Instruction Guide', available at: https://www.ubcm.ca/sites/default/files/2022-11/LGPS_CRI_FCFS%20

2022CWRPInstruction%20Guide.pdf (accessed 8th November, 2023).
(63) *Ibid*.
(64) *Ibid*.
(65) Province of British Columbia (n.d.) 'BC Codes', available at: https://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/bc-codes (accessed 8th November, 2023).
(66) Province of British Columbia (n.d.) 'Development Permit Areas', available at: https://www2.gov.bc.ca/gov/content/governments/local-governments/planning-land-use/land-use-regulation/development-permit-areas (accessed 8th November, 2023).
(67) United Nations International Strategy for Disaster Reduction (2015) 'Sendai Framework for Disaster Risk Reduction 2015-2030', available at: https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf (accessed 8th November, 2023).
(68) Finney, M. A. (2001) 'Design of regular landscape fuel treatment patterns for modifying fire growth and behaviour', *Forest Science*, Vol. 47, No. 2, pp. 219–228.
(69) Davies, ref. 26 above.
(70) Beck, J. and Simpson, B. (2007) 'Wildfire threat analysis and the development of a fuel management strategy for British Columbia', Proceedings of 4th International Wildland Fire Conference, Seville, 13th–17th May, available at: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=c2c60bbc5e55c54598200866cb1ffe7cf99fd1cb (accessed 8th November, 2023).
(71) Vicars and Vicars, ref. 54 above.
(72) FireSmart BC (n.d.) 'FireSmart plant program', available at: https://firesmartbc.ca/landscaping-hub/plant-program/ (accessed 8th November, 2023).
(73) City of Penticton, ref. 24 above.
(74) Davies, ref. 26 above.
(75) US Department of Agriculture (n.d.) 'Mechanical treatment', available at: https://www.fs.usda.gov/managing-land/fire/mechanical-treatment#:~:text=Examples%20of%20mechanical%20treatment%20include,the%20right%20kind%20of%20fire (accessed 8th November, 2023).
(76) Weber, M. G. and Taylor, S. W. (1992) 'The use of prescribed fire in the management of Canada's forested lands', *Forestry Chronicle*, Vol. 68, No. 3, pp. 324-334.
(77) Coogen *et al*., ref. 2 above.
(78) US Department of Agriculture, ref. 75 above.
(79) Beck, J., Parminter, J., Alexander, M., MacDermid, E., Van Nest, T., Beaver, A. and Grimaldi, S. (2005) 'Fire Ecology and Management' in *Forestry Handbook for British Columbia*, 5th edn, Faculty of Forestry, University of British Columbia, Vancouver, BC, pp. 490–525.
(80) Wilson, K. (2018) *Pulling Together: Foundations Guide*, BCcampus, Victoria, BC.
(81) Van Vugt, ref. 8 above.
(82) Adlam *et al*., ref. 5 above.
(83) Vermes, ref. 6 above.
(84) Van Vugt, ref. 8 above.
(85) Province of British Columbia (1995) 'Emergency Program Act: Local Authority Emergency Management Regulation 1995', B.C. Reg. 380/95, available at: www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/380_95 (accessed 8th November, 2023).
(86) Province of British Columbia, ref. 17 above.
(87) Coppola, ref. 31 above.
(88) Ally Emergency Management Inc. (2020) 'Regional District of Okanagan Similkameen 2020 Christie Mountain wildfire — After action report (AAR)', internal document, Joint Regional District of Okanagan-Similkameen and City of Penticton.
(89) *Ibid*.
(90) Friesen *et al*., ref. 28 above.
(91) Reams *et al*., ref. 43 above.
(92) Raju *et al*., ref. 36 above.
(93) United Nations International Strategy for Disaster Reduction, ref. 67 above.
(94) McLennan and Handmer, ref. 29 above.