



Institute for Catastrophic
Loss Reduction

Building resilient communities



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Fort McMurray Wildfire: Learning from Canada's costliest disaster

September 2019



Image Credit: Alan Westhaver

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Foreword



When the research team gathering information for this report was in Fort McMurray in May 2019, smoke from wildfires near High Level and Slave Lake filled the air.

For some residents who lived through the costliest disaster in Canada's history here in 2016, the sight and smell of smoke still triggers anxiety, according to Red Cross employees who continue to help residents recover. The smoke reminds Albertans that a real threat remains every wildfire season.

This is Zurich's 15th post-event disaster review and the first report on a disaster in Canada. Our previous reports have focused on floods, a peril that affects more people worldwide than any other natural hazard.

With this report, our research expands to study wildfire at a time when fires in Canada continue to cause havoc. According to the Canadian Interagency Forest Fire Centre, 2,500 firefighters have been involved in sustained action to suppress wildfires across the country from year start through early August 2019 – greater than any previous full year in Canadian history.

This report builds on previous research from the Institute for Catastrophic Loss Reduction (ICLR) by providing a comprehensive assessment of resilience actions taken before the fire, during the recovery and after the fire. Together, we set out to uncover new insights leveraging our respective expertise in risk.

We discovered lessons from the 2016 Fort McMurray wildfire by speaking to community members who lived through it. We extend a special thank you to the firefighters, government officials, nonprofit leaders and residents who graciously shared their experiences and insights with us. Without them, this report would not have been possible.

In addition to providing actionable recommendations for building resilience, this report commands and highlights the leadership of Jody Butz, Fire Chief of the Regional Municipality of Wood Buffalo who is helping shift a global mindset from disaster response to one of preparation and resilience.

Chief Butz and others note that the changing climate is accelerating the pace at which fire spreads today – the fire season has grown longer, we see an increase in lightning and forest vegetation is becoming drier – making it harder to rely on traditional fire prevention approaches, such as trimming trees away from homes and businesses. To illustrate this point, wildfires in Alberta destroyed more than 800,000 hectares of wildland between March and June 2019 – five times more than the five-year average for spring fires in Alberta.¹

Now is the time to continue proven resilience recommendations, such as those from FireSmart® Canada. We are working to foster multisector collaboration to reimagine what it means to create fire resilience in Fort McMurray and in other communities at risk.

Best regards,

Saad Mered
Chief Executive Officer
Zurich Canada

¹ See Omstead. (2019) Massive wildfire season has Alberta seeking review of prevention, response strategies.

Executive summary

“You may not control all the events that happen to you, but you can decide not to be reduced by them.”

- Maya Angelou

Fire burned out of control in northeastern Alberta between May 1 and July 4, 2016. The Horse River fire, also called the Fort McMurray fire, burned into Fort McMurray on May 3. Two people were killed in a vehicle collision during the evacuation. Fort McMurray, the largest community in northern Canada, was cut off for one month. An estimated 88,000 people were evacuated. Hundreds of structures were destroyed by fire, including 2,579 homes and other dwellings. The estimated financial impact of the fire was \$8.9 billion in Canadian dollars. And over the next two weeks the fire burned towards the north destroying a lodge on May 16 and threatened Canada's oil sands operations.

Around the same time as the wildfire event, the economy in the community was suffering due to a collapse in oil prices and delays in pipeline construction. Through early 2014 it was widely expected that the international price of crude oil would stay near US\$100 a barrel through 2050 and beyond. Plans were underway to significantly expand production over the next decade and the population of Fort McMurray was expected to double. However, the international price for a barrel of crude petroleum unexpectedly fell in 2014 from a mid-year peak of US\$115 to a year-end low of US\$58. Prior to the 2016 wildfire, the price briefly fell to US\$28. Construction of new oil sands production facilities and exploration were halted indefinitely, with a profound and immediate impact on the local economy dominated by the oil sands industry for the past fifty years.

Three takeaways from this analysis of the 2016 Fort McMurray fire:

1. Damage from the fire would have been much more extensive but for the courageous efforts of firefighters and many others involved in the response. Moreover, many, largely unheralded actions were taken in the months and years prior to the wildfire to enhance the resilience of the community. More than 90 percent of the structures in the area affected survived the fire.
2. The recovery following the fire has been managed to strengthen the community's resilience to loss and damage from future hazards.
3. Nevertheless, we find scope for improvement. The lessons learned are organized around the four priorities for action set out in the Sendai Framework for Disaster Risk Reduction:
 1. Understanding disaster risk
 2. Strengthening disaster risk governance
 3. Investing in disaster risk reduction
 4. Building resilience in recovery

This report follows three years of recovery and through the lens offered by the Sendai Framework for Disaster Risk Reduction.

We offer four recommendations:

1) Learn to live with fire

Wood Buffalo and the Government of Alberta should work to better understand and promote public understanding of the risk of loss from wildfire. This can be achieved by further strengthening partnerships with FireSmart® Canada, community leaders, insurance companies, the Red Cross and others to improve property owner awareness of risk of living with fire. This should include identifying practices for reducing the risk. The Government of Alberta should also invest in research to better understand how to make structures and communities resistant to urban-wildland interface fire. Most importantly, the federal, provincial and territorial governments should implement the Canadian Wildland Fire Strategy as set out in 2016 in the 10-year Review and Renewed Call for Action by the Canadian Council of Forest Ministers.

2) Establish a Wildland Fire Resilience Advisory Committee

The Government of Alberta should establish a Wildland Fire Resilience Advisory Committee. The Committee would bring together stakeholders from many backgrounds to anticipate and prepare for future major fires in the wildland-urban interface. Some participants should include wildland firefighters, local fire officials, oil sands companies, insurers, the Red Cross, FireSmart® Canada, researchers and other stakeholders. The Committee should be ready to support communities affected by fire in the future.

3) Invest in resilience and risk reduction

Wood Buffalo and the Government of Alberta should actively invest in wildfire risk loss reduction. They should aggressively promote all aspects of the FireSmart® program as a strategy to establish a resilient landscape and engage property owners. These efforts need to be sustained and long-term. A provincial code for new development in the urban-wildland interface and local statutory requirements should be enacted. A second major access road for Fort McMurray should be constructed.

4) Develop a pre-hazard major wildfire recovery plan

Wood Buffalo and other communities in the wildland-urban interface should develop a Pre-Hazard Wildfire Recovery Plan. Communities should plan in advance for recovery from future fires, with a focus on the risk of an urban conflagration resulting in extensive loss. Communities should develop a strategy to enhance community resilience in recovery by building back better following a major fire.

The role of insurance in rebuilding Fort McMurray

The widespread use of insurance by property owners injected CA \$3.5 billion into Fort McMurray to support rebuilding and reconstruction. The insurance industry actively worked with the Government of Alberta, Wood Buffalo and others to support a robust recovery. Moreover, the use of replacement cost insurance strengthened the resilience of the community to future hazards. Insurance needs to be an essential element of disaster risk management as was evident when fire burned into Fort McMurray.

Section I: The 2016 wildfire in Fort McMurray

“What fire does not destroy it hardens.”

- Oscar Wilde

A fire ignited on May 1, 2016, seven kilometres southwest of Fort McMurray.² Extensive intervention ultimately brought the fire under control two months later. An estimated 88,000 people were evacuated. Two people were killed in a vehicle collision during the evacuation. Fort McMurray was cut off for one month and some neighborhoods were closed for more than four months. The estimated financial impact of the Fort McMurray wildfire was \$8.9 billion – the costliest disaster in Canadian history.³



Lessons learned from the 2016 wildfire require an understanding of how the fire developed through May, June and early July, but also the context. The fire struck a community located in a forested region that regularly experiences wildfire. The community was also confronted by the recent collapse in oil prices and the long-term implications for investment and employment in the region. Moreover, the fire was driven by extreme weather conditions – hot, dry and windy – and an extraordinary absence of precipitation through the fall and winter. These factors added to the complexity and intensity of the threat.

Environmental, economic and social considerations

Fort McMurray is located in the boreal forest. Fire in the wildland is common in northeastern Alberta. Indeed, the forest requires fire as a natural driver to maintain the health of the ecosystem and rejuvenate the forest.⁴ Fort McMurray is the largest community in Canada located north of 55 degrees latitude and one of the largest located in or near the forest anywhere in the country.

More than 40 percent of Canada is covered by forest.⁵ Forest cover extends across the country.^{5.1} Many Canadians live, work or play in or near the forest.

The oil sands production facilities near Fort McMurray are the most valuable commercial investments in Canada's forests. More than 95 percent of Canada's proven oil reserves are in northern Alberta, including the McMurray Formation in the Athabasca oil sands deposits located near Fort McMurray.⁶ The proven oil reserves in Canada are the third largest in the world. In 1967, Canada's first oil sands production facility opened in Fort McMurray. Over the past 50 years, most of Canada's new crude oil production facilities have been located near Fort McMurray.

Fort McMurray is the largest and one of the fastest growing communities in northern Canada. In 1995, the former City of Fort McMurray merged with Improvement District No. 143 to form the Regional Municipality of Wood Buffalo. The number of people working and living in Wood Buffalo grew rapidly from

50,000 in 2000 to reach 125,000 in 2015. Moreover, prior to the collapse in international oil prices, Wood Buffalo reported that the population might grow to 205,000 by 2028, with most people located in the Fort McMurray.⁷

In 1971, the population of Fort McMurray was 7,000 and many were involved in operating the town's first oil sands production facility.⁸ In 2015, prior to the fire, the population had grown to 82,000.⁹ The 2015 Wood Buffalo municipal census reported that the population in ten rural communities (Anzac, Conklin, Draper, Fort Chipewyan, Fort MacKay, Fort Fitzgerald, Gregoire Lake Estates, Janvier, Marina Lake and Saprae Creek) and the hinterland had increased to 4,000. In addition, more than 38,000 workers were located in project accommodations or work camps across the region. In total, the population of Wood Buffalo in 2015 was 125,000, with 82,000 in Fort McMurray.

2 The description of the Horse River Fire in this report is largely taken from the report for Alberta Agriculture and Forestry Preparedness and Response prepared by MNP LLP – MNP (2017) A Review of the 2016 Horse River Wildfire.

3 See Alam, R. & Islam, S. (2017). Rapid Impact Assessment of Fort McMurray Wildfire; and KPMG. (2017). May 2016 Wood Buffalo Wildfire, Post-Incident Assessment Report

4 See Brandt, J. P., Flannigan, M. D., Maynard, D. G., Thompson, I. D., & Volney, W. J. A. (2013). An introduction to Canada's boreal zone: ecosystem processes, health, sustainability, and environmental issues. *Environmental Reviews*, 21(4), 207–226; and Alexander. (2014) Fire ecology.

5 See CCFM (2019) Overview – Canada's forests.

5.1 See Natural Resources Canada. (2019). The state of Canada's forests report.

6 See Natural Resources Canada (2019) Oil Sands: Economic contributions

7 See Wood Buffalo (2015) The municipal census 2015 report.

8 See Wood Buffalo (2010) 2010 Municipal Census.

9 See Wood Buffalo (2015) The municipal census 2015 report.

Over the past 50 years, Fort McMurray experienced several periods of boom and bust tied to the fortunes of the oil sands industry. The years 2000 through 2014 were a period of rapid expansion. Development in the Fort McMurray area included the Fort Hills Oil Sands Mine, phase 2 and 3 of Canadian Natural Resources' Horizon development, the Hangingstone Project, Sunrise Energy Project and the second phase of the Kearn operation.¹⁰ This contributed to surging employment, significant in migration, retail and commercial development, increased home construction, roadway upgrades and expansion of the airport. The population of Fort McMurray more than doubled between 2000 and 2014. In 2014, personal income per capita in Fort McMurray was more than twice the national average, and it was expensive to build a home, buy food and purchase most other goods.¹¹

In 2013, the Canadian Energy Board reported that the international price of crude oil was expected to remain stable near US\$100 through 2050 and beyond, providing the foundation for a significant expansion of oil production near Fort McMurray.¹² Wood Buffalo reported that the population could increase by 80,000 over the next 10 to 15 years, including 55,000 more people living in Fort McMurray.¹³

In June 2014, the international price of crude oil peaked at US\$115 a barrel before collapsing to close the year at US\$58.¹⁴ Just before the fire in 2016, the price briefly fell to US\$28. Moreover, pipelines required to bring additional production from Fort McMurray to markets across North America and overseas were canceled or delayed. The Canadian Energy Board issued a revised outlook in May 2016, and then again in the fall of 2016, warning that international crude oil prices may be sustained below US\$60 over the next 25 years, with little expected expansion of oil sands operations.^{15, 16} The situation changed significantly during the 18 months before the 2016 fire and the oil sands industry has struggled through the recovery.

Reduced expectations for oil prices resulted in oil companies announcing cuts in investment and exploration plans.¹⁷ This economic shock was beginning to take hold in the community when the fire struck in 2016. This included rising unemployment, out migration and declining property values. These challenges continued throughout the recovery. In 2018, Wood Buffalo reported it's population had declined by 13,345 since 2015; a reduction of more than 10 percent, and the largest ever experienced in the community.¹⁸

The climate and fuel considerations

In 2015, the year before the wildfire in Fort McMurray, the number of fires and area burned was higher than average.¹⁹ The fire season began early. The cost of firefighting for the Government of Alberta was \$400 million, a record high at that time, and more than double the cost from the previous year. Precipitation was very low through the fall and winter.

In 2016, snow cover near Fort McMurray in January and February was well below historic levels and was gone by March. The average temperature was 5 degrees Celsius above seasonal norms throughout the winter and early spring. In late April the region around Fort McMurray was significantly warmer and drier than usual, including predictions that the temperature could exceed 30 degrees Celsius on occasion. Forest fuels were drying quickly. By May 1, the Canadian Fire Weather Index signaled extreme fire risk in northeastern Alberta.

In May 2016, conditions throughout northeastern Alberta were ripe for fire in the boreal forest that surrounds Fort McMurray. There are many factors that impact susceptibility to wildfire including fuel, weather conditions and topography.²⁰ During the spring of 2016 severe burning conditions were anticipated in northeastern Alberta due to high temperatures and relative humidity levels decreasing, creating what are known as "cross-over" conditions, coupled with reduced winter snowfall, early elimination of snow cover and absence of spring rains.²¹

How the fire grew

On May 1, 2016, a wildfire was detected in a forested area about seven kilometres southwest of Fort McMurray. At the time of its detection the fire was about two hectares in size.²² Within two days, the wildfire entered Fort McMurray, becoming a threat to homes, nearby surrounding communities, and the oil sand camps and facilities.²³ Within four days (from May 2 to May 6) the wildfire had increased drastically in size to over 100,000 hectares and was considered to be uncontrollable without help from the weather and change in fuels.²⁴ The fire was a wildland-urban interface fire during its early stages because it involved both wildland fuel and man-made fuels burning at the same time.²⁵

As noted in a report published by MNP in 2017, there were characteristics that made this wildfire particularly difficult to contain within the first burning period.²⁶ These factors included: the relative humidity which dropped from 30 percent to less than 20 percent in under an hour, the temperature increased to over 25 degrees Celsius, and high winds during the middle of the day which intensified the extreme burning conditions.²⁷

At almost the same time the fire was reported, there was another fire burning, known as MMD-004, which was located within the northwest boundary of Fort McMurray. Due to its closer proximity to the urban centre of Fort McMurray the MMD-004 fire was given priority due to its closer proximity to the urban centre of Fort McMurray. That fire was suppressed successfully without damage to surrounding structures although it somewhat delayed suppression of the fire near Horse River.²⁸

10 See The Conference Board of Canada. Moving Forward. The economic impact of rebuilding the Wood Buffalo region's economy. (2017).

11 Ibid.

12 See National Energy Board (2013) Canada's Energy Future 2013.

13 See Wood Buffalo (2015) The municipal census 2015 report.

14 See macrotrends.net <https://www.macrotrends.net/2480/brent-crude-oil-prices-10-year-daily-chart>

15 See National Energy Board (2016a) Canada's Energy Future 2016.

16 See National Energy Board (2016b) Canada's Energy Future 2016 Update.

17 See The Conference Board of Canada (2017) Moving Forward. The economic impact of rebuilding the Wood Buffalo region's economy.

18 See Wood Buffalo (2018a) Census 2018.

19 See MNP (2017) A Review of the 2016 Horse River Wildfire.

20 See Alary, B. (2016) Fort McMurray blaze among most 'extreme' of wildfires; and see Lawson and Armstrong (2008) Weather for the Canadian Forest Fire Danger Rating System.

21 Crossover conditions refer to the point at which the ambient relative humidity is less than, or equal to, the ambient air temperature. Government of Alberta.

22 See KPMG (2017) May 2016 Wood Buffalo Wildfire, Post-Incident Assessment Report.

23 See MNP (2017) A Review of the 2016 Horse River Wildfire.

24 See Alary, B. (2016) Fort McMurray blaze among most 'extreme' of wildfires.

25 See Westhaver, A. (2017) Why some homes survived : Learning from the Fort McMurray wildland/urban interface.

26 The first burning period is until 10am the day after the fire is detected (MNP, 2017)

27 See MNP (2017) A Review of the 2016 Horse River Wildfire.

28 See MNP (2017) A Review of the 2016 Horse River Wildfire.

Overnight on May 2nd, the wildfire jumped the Athabasca River, putting more neighbourhoods at immediate risk. Some residents had already begun to evacuate and the mandatory evacuation for all of Fort McMurray was officially put in place on May 3rd. Some 88,000 people evacuated the region – one of the largest evacuations in Canadian history.²⁹ Evacuees had to leave using the only highway that runs through Fort McMurray, with most evacuees heading south and some fleeing north. Many took shelter in southern communities. Some drove more than 450 kms to Edmonton. Those who travelled north were given refuge at the oil sands work camps or welcomed by the Indigenous communities of Fort McKay First Nation and Fort McMurray First Nation. The hospital in Fort McMurray was evacuated on the evening of May 3rd, with a total of 105 patients and 75 staff moved to staging areas around Fort McMurray and then on to Edmonton.³⁰

While there were the two fatalities previously mentioned resulting from a vehicle collision related to the evacuation, there was no loss of life due to the wildfire directly.³¹ The voluntary re-entry began on June 1 for residents to return to neighbourhoods that were safe and where houses were still habitable.³² This excluded the neighbourhoods of Abasand, Beacon Hill and Waterways due to health concerns. Residents were able to re-enter in Beacon Hill and Abasand on August 31 if their home was not destroyed by the fire. Residents in the Waterways were allowed to return on October 24.

Swiss Re estimates that the community experienced CA \$5.3 billion in direct damage. Almost 70 percent of the direct damage was covered by insurance - CA \$3.6 billion, but some damage was not insured - CA \$1.7 billion. The total financial impact was estimated at CA \$8.9 billion. The impact included direct damage and indirect costs like lost production.³³ The fire destroyed more than 2,579 dwellings, 88,000 people were evacuated from the Region and over 589,000 hectares of forest was burned.³⁴

29 See Government of Alberta. (2017a). Home again: Recovery after the Wood Buffalo Wildfire.

30 See Government of Alberta (2017a) Home again: Recovery after the Wood Buffalo Wildfire.

31 Ibid.

32 Ibid.

33 See MNP (2017) A Review of the 2016 Horse River Wildfire.

34 See KPMG (2017). May 2016 Wood Buffalo Wildfire, Post-Incident Assessment Report.

35 Information describing the timeline is primarily found in the MNP (2017) A Review of the 2016 Horse River Wildfire.

35 Timeline for the Fort McMurray wildfire



May 1 – A small, two-hectare fire was spotted by helicopter at 4:03 p.m. The fire was in a remote location seven kilometres southwest of Fort McMurray. The cause of the fire was not conclusively determined but it appears to have been caused by man. The initial attack began within 19 minutes. The fire grew and one hour later crossed the Horse River. Air tanker support was diverted to attack the fire, with the first drop at 6:33 p.m. A local state of emergency was declared at 10:00 p.m., and a mandatory evacuation was ordered for Prairie Creek, Gregoire and the Centennial Trailer Park.

May 2 – Aerial suppression began at 8:22 a.m. By 10:00 a.m. the area burned was 818 hectares. Dozer guard construction began at 4:30 p.m. By 8:10 p.m. the fire burned up to the Athabasca River, with initial spotting across the river. The area burned was 2,655 hectares. The evacuation order for Prairie Creek and Gregoire Lake Estates was reduced to a voluntary order.

May 3 – Southeast winds pushed the wildfire into Fort McMurray. Spotting began in Beacon Hill and Abasand at 2:31 p.m., and the MacKenzie Industrial Park at 3:05 p.m. The fire crossed highway 63 to approach Waterways at 3:26 p.m. and entered Thickwood at 7:30 p.m. A mandatory evacuation order was issued for all of Fort McMurray at 6:20 p.m. About 88,000 residents evacuated from the region. Hundreds of structures were destroyed.

May 4 – Two people were killed a couple of hundred kilometers south of Fort McMurray in a vehicle collision during the evacuation. The Fort McMurray International Airport – a critical centre supporting the fire management effort – was threatened, but the fire passed by mid-afternoon. By 9:34 p.m. the fire was 12 kilometres from Gregoire Lake Estates and Anzac and the Fort McMurray First Nation. Lightning from the pyrocumulonimbus cloud above the wildfire caused new fires to start up to 40 kilometres ahead of the main fire front.

May 5 – The wildfire continued to threaten Anzac and the Fort McMurray First Nation, but the communities did not experience major damage due to sustained aerial attacks, fireguard and airtanker support. The Fort McMurray First Nation built a fireguard around their community and initiated structural protection in the community.

May 6-18 – Hot, dry and windy conditions continued. The wildfire grew to the north of Fort McMurray threatening oil sands operations, work camps and other values at risk. Suppression efforts focused on protecting high-priority values. On May 16, the fire escaped control and destroyed the Blacksands Executive Lodge at 10:00 p.m. The fire intensified on its northeastern perimeter to threaten the oil sands production facilities. The area burned grew from 156,607 hectares on May 6, to 284,214 hectares on May 16, and 483,084 hectares on May 18.

May 19 – August 2, 2017 – Conditions improved somewhat. The wildfire continued to grow sporadically, and burned from Alberta into Saskatchewan, but the risk to communities and structures in the wildland was greatly reduced. Resources used to suppress the fire peaked on June 3, including 2,197 wildland and municipal firefighters and support personnel, 77 helicopters, airtanker groups involving 18 aircraft, and 269 dozers and other pieces of heavy equipment. The Fort McMurray wildfire was declared under control on July 4. Fifteen months after the fire began, on August 2, 2017, the fire was declared extinguished. Two lives were lost, and there was unprecedented destruction of property. The final area burned was estimated to be 589,552 hectares.

Section II: Understanding disaster risk

“Those who know, do. Those that understand, teach.”

- Aristotle

The foundation for building disaster resilience is found in a sound scientific understanding of disaster risk. Resilience to the impacts and damage from fire in the wildland-urban interface requires knowledge about fire behaviour as it moves through wildland forests. In addition, there is a need to understand how fire can transition from the wildland and enter an urban area – and, how structures ignite and burn if they are located in or near the wildland.

Fort McMurray is a large community in the boreal forest but there are many more. Johnson and Flannigan mapped the Canadian wildland-urban interface.^{35.1} They identified urban, industrial and infrastructure assets located in or near Canadian wildlands. Some people and property are located in the interface in every province and territory.

On average, 7,500 wildfires burn in Canada each year, including hundreds of fires in northeastern Alberta.³⁶ More than 97 percent of the fires are detected and suppressed quickly, before they grow to 200 hectares. Most wildfire losses are the result of a few fires that burn out of control, like the Fort McMurray wildfire.

The majority (60 percent) of the fires in Alberta are the result of human causes. Many ignitions could be eliminated with increased public awareness about fire prevention. Increased use of fire bans and enforcement of transgressions may reduce the hazard. Lightning will bring fire to the wildland, but it is possible to confront human-caused fires.

The wildland fire management process, detection and suppression of fires that threaten communities and values at risk, has been in place for many decades across Canada. Complex processes may be initiated when a wildfire escapes initial attack, but the vast majority of fires are managed through detection and initial response.

The public detect and report most wildfires in Canada (40 percent in Alberta and 50 percent in British Columbia and Ontario).³⁷ Many fires in Alberta (27 percent) are identified by staffed lookout towers, but this approach is no longer used in Ontario, British Columbia and many other parts of Canada. Field staff that undertake ground patrols detect some fires (22 percent in Alberta, none in Ontario and 5 percent in British Columbia). Aerial surveillance is an important method of detection (11 percent in Alberta, 30 percent in British Columbia and 41 percent in Ontario). Some jurisdictions, like British Columbia, have begun using satellite detection. The fire that burned into Fort McMurray was detected by a helicopter crew.

During the fire season, teams of firefighters are positioned across the wildland so they can be rapidly deployed to suppress a fire when it is detected. Teams are on the scene within minutes of detection. Trained firefighters typically use a shovel and other hand tools to build a fireline by removing brush and debris to rob the fire of fuel, or they use water to extinguish the flames. This is effective to contain most fires.

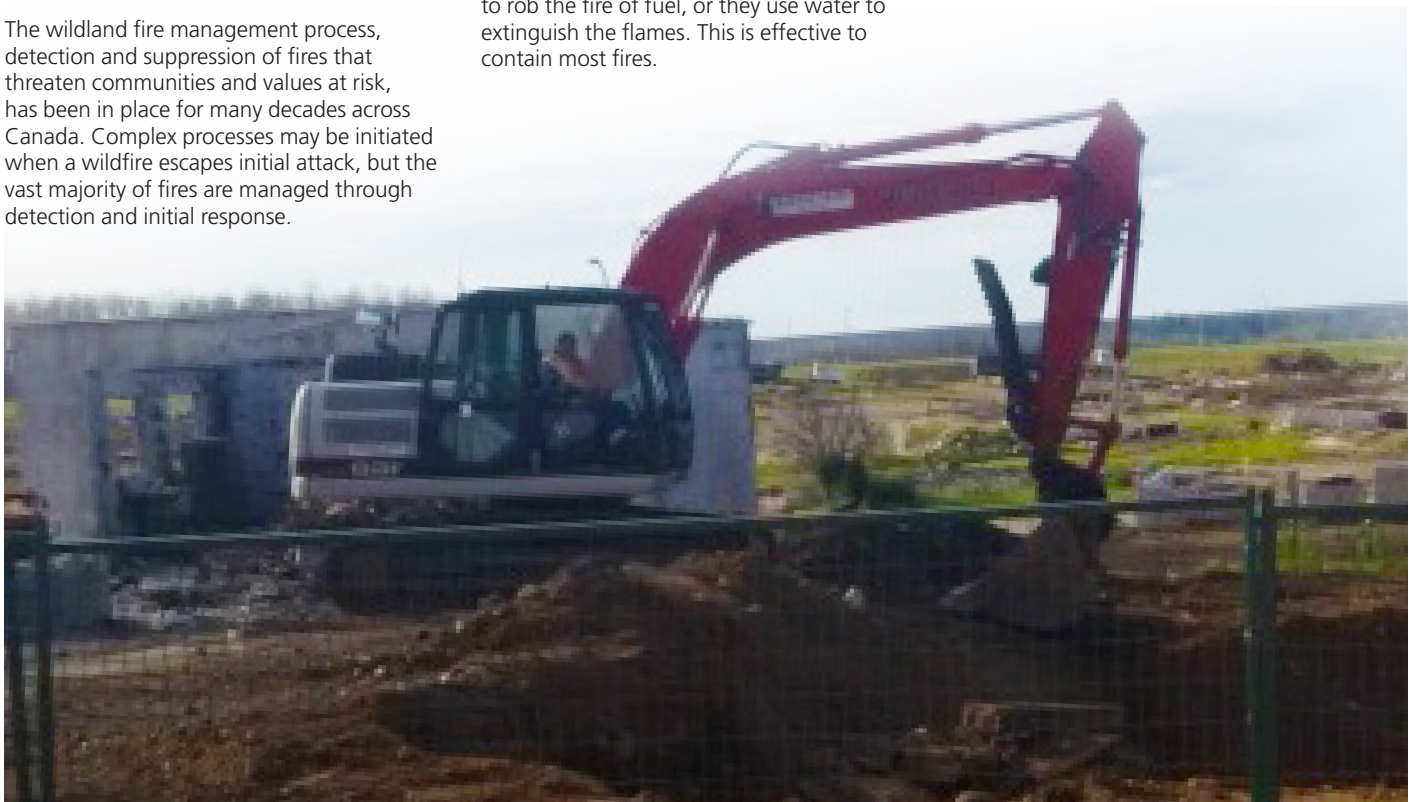
With a larger fire, it may be necessary to use chainsaws to create a fireline. Portable pumps can bring water from holding ponds, rivers and lakes to extinguish the fire. If the fire is very large, planes and helicopters may drop water or retardant. Heavy equipment can be used to clear firelines. The number of firefighters deployed will depend on the size of the fire. The Fort McMurray fire had a peak deployment of 2,197 personnel, 77 helicopters, 18 airtankers and 269 pieces of heavy equipment – one of the largest response efforts ever conducted in Canada.³⁸

35.1 See Johnson and Flannigan (2018) Mapping Canadian wildland-urban interface areas.

36 See CCFM (2005) Canadian Wildland Fire Strategy.

37 See Ault (2014) Wildfire detection in western Canada: Trends and innovations.

38 See MNP (2017) A Review of the 2016 Horse River Wildfire.





Fire behaviour models

The likelihood that the fire may burn out of control is highly dependent on fuel and weather conditions. Forests subject to stress from lack of moisture and insect infestation are more vulnerable to burning. Fire spreads faster in hot, dry and windy conditions. Fire behaviour models have been developed to provide a timely assessment of rapidly changing circumstances.

Fire behaviour analysis helps decision makers respond to a fire in real time. Models predict how effective suppression efforts will be in containing an active fire, the speed and direction of expected growth, intensity and other information to support informed decisions about response tactics and how to deploy personnel and equipment.

The Government of Alberta uses the Prometheus wildland fire growth model. Prometheus is a high-resolution fire behaviour prediction model used to support fire management decisions.³⁹ It uses data about the terrain, fuel types and weather to simulate rate of spread and other fire behavior characteristics. Detailed predictions about the fire perimeter are used to simulate the impact of alternative suppression options and guide decisions about deployment of personnel and equipment.

For nearly 40 years, federal fire researchers in Canada and fire agencies have been working to develop quantitative models to predict the type, spread, intensity and perimeter growth of wildland fires. The Prometheus model was first tested in 2002 and used to provide fire management decision support for the House River fire that threatened the hamlet of Conklin, south of Fort McMurray, the costliest wildfire response in Alberta at that time.^{39.1} A number of enhancements and changes were introduced to the model as a result of its use on the House River fire.

The Alberta Wildfire Coordination Centre used fire behaviour analysis to support the response to the Fort McMurray fire. Fire behaviour specialists are utilized once a fire has begun to burn out of control. Throughout the 2016 Fort McMurray fire, specialists were using the Prometheus wildfire growth simulation model to inform wildfire managers. The simulations closely matched the wildfire's actual behaviour, confirming that this predictive tool works well.

A Review of the 2016 Horse River Wildfire – a report prepared by MNP for the Forestry Division of Alberta Agriculture and Forestry – acknowledged that the fire behavioural analysis was applied effectively to support decisions made in response to the fire. However, the report identified some gaps and inefficiencies. Three opportunities for improvement were derived from the MNP report:

- First, fire behavioural analysis is typically applied once a fire burns out of control. The report identifies scope to use models and analysis to support pre-suppression preparedness decisions. This may include better management of workload and resource needs, support for seasonal transitions and enhancement of briefing materials.
- Second, the models were used predominantly to support daily preparedness plans and tactical decisions. MNP recommends the provision of a daily five-day fire behaviour forecast and briefing to support more strategic, longer-term decision-making.
- Third, MNP recommends that information available during a fire needs to be integrated to better support decision makers, including fire behaviour analysis, weather information and current fire condition.

³⁹ See Tymstra et al (2010) Development and structure of Prometheus: The Canadian wildland fire growth simulation model.

^{39.1} See <https://www.wildfirelessons.net/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=46169668-1577-4316-aae0-c2414fe542e7>

Understanding how homes ignite from wildfires

There appears to be a common misconception among the public at large that wildland fires roll through the forest like an out-of-control bulldozer, meet a built-up area and keep rolling, directly igniting individual structures in the community as they barrel forward. This is not an accurate depiction of how wildland fire enters, then spreads through, a community in the wildland-urban interface.

Typically, embers from the wildfire are blown ahead of the fire front and ignite flammable materials located around structures.⁴⁰ These materials then ignite the structure directly, or something else (like a wood shed or deck) that, in turn, ignites the structure. This is what largely occurred in Fort McMurray, as corroborated in Alan Westhaver's study for the Institute for Catastrophic Loss Reduction (ICLR) – *Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster*.⁴¹

To conduct a forensic analysis before perishable data was destroyed, the Institute was successful in gaining authorization to allow Westhaver behind police cordons to investigate the resistance of homes in Fort McMurray to wildfire. Westhaver was tasked with looking into the reasons why some homes were destroyed while others survived the fire.

Westhaver's main conclusion was that wind-driven embers were the most common source for early home ignitions. This reinforces several decades of research, much of it conducted in the United States, which concluded that it is largely embers – not direct flames or exposure to super-heated gases – that causes most interface fires.^{42, 43} Once a structure begins to burn, fire spreads to nearby structures, leading to a virtually uncontrollable urban conflagration – as it happened in Fort McMurray.⁴⁴

According to the ICLR investigator: "It seems clear that the survival of homes was a function of resistance to ignition, and not a random event or a matter of luck. Beyond doubt, risk mitigation guidelines demonstrated their effectiveness in mitigating risk under the harshest of wildfire conditions. It is the opinion of the author that, had more homes [and the vegetation immediately around the homes] exhibited 'Low' to 'Moderate' overall hazard ratings, the total number of homes surviving at Fort McMurray would likely have been significantly greater."

The understandings gathered by post-event forensic analysis are key, because once there is widespread understanding and acceptance that wildfires are not juggernauts that roll through town uncontrollably – and that structural ignitions from wildfire embers are preventable – then programs such as FireSmart® can be put into place to address the issue of flammability of individual structures, subdivisions and entire communities located in the wildland-urban interface.⁴⁵

Further, research findings can be used to develop wildland-urban interface building codes – or additions to existing building codes – to address wildfire risk. Studies can catalogue features of homes and properties that reduce the risk of fire taking hold, allowing building code officials, homebuilders, insurers, homeowners and others to ensure these features are included in new construction, rebuilds and in the maintenance of existing homes.

Image Credit: Alan Westhaver



40 See 'Untangling the Physics Behind Drifting Embers, 'Firenadoes' and Other Wildfire Phenomena.

41 See Westhaver, A. (2017). *Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster*, Institute for Catastrophic Loss Reduction.

42 See Cohen (2000). Examination of the home destruction in Los Alamos associated with the Cerro Grande fire. U.S.D.A., Forest Service, Rocky Mountain Research Station. Missoula Fire Lab, Missoula, MT.

43 See Quarles, S.L., Y. Valachovic, G.M. Nakamura, G.A. Nader, and M.J. De Lasaux. (2010). Home survival in wildfire-prone areas: Building materials and design considerations. University of California, Agriculture and Natural Resources. Publication 8393.

44 A conflagration refers to an extensive fire that leads to large loss of land or property.
<https://www.lexico.com/en/definition/conflagration>

45 FireSmart® is the premiere national program helping Canadians reduce their wildfire risk and build resilience. More information can be found at www.firesmart.ca

Fire behavior and risk models

Canadians are fortunate to benefit from the sound scientific insight provided by the Canadian Forest Service. Part of the federal government since 1899, the venerable Forest Service is world-renowned for its science-based policy work into the impacts on Canada's forests of soil health, insect infestation, disease, land/forest management, climate change and, of course, fire in the wildland.

The provincial and territorial governments are responsible for the management of renewable resources – including forests. Provincial and territorial agencies also contribute a large body of valuable work towards better understanding and managing Canada's forests. Together, these entities further our understanding of the complex, often inter-related factors, that go into ensuring that Canadian forests remain healthy and viable as a prime venue of both recreational and economic activity in Canada.

As part of this work, forestry agencies make available to governments, researchers, insurers and the general public, a range of high-quality hazard models and maps, information databases and other tools. These include the Canadian Wildland Fire Information System,

which provides easy access to daily maps of fire danger and fire behavior potential based on Canada's Fire Danger Rating System, weather maps, and the Canadian Large Fire Database.⁴⁶ The Canadian Forest Service is also responsible for Canada's Fire Danger Rating System.⁴⁷

Canadian stakeholders have wide access to high quality, easy-to-access science-based tools that allow them to better understand the hazard of wildfire. That being said, there is a dearth of tools – either produced by government forest agencies or by private vendor modeling firms – to understand the likelihood or consequences of fire for their community or property.

Those interested in better understanding the risk (sometimes measured in probability) and impact of fire entering a populated area, have few if any tools to work with to determine, for instance, communities most susceptible at a given time and the possible damage if an interface fire enters town. This gap means that governments at all levels, and insurers underwriting risks in Canadian communities close to the forest, have no solid insight into how a fire situation could play out in a given community, what the potential losses could be

and the amount that should be charged to take on insured risk in these areas. As such, with the Fort McMurray fire still alive in their memories, Canadian insurers do not have the information to determine an actuarially-sound amount to cover the risk that properties could be damaged or destroyed by wildfire. Without loss models, these entities are limited in their capacity to consider their overall exposure to wildfire and whether they may be carrying too much fire risk in a given area.

Yet, it may be argued that it would be difficult and perhaps unrealistic to expect Canada to have a national wildfire risk model when its larger, more populated and more interface fire-experienced southern neighbour has just gotten a model of its own. Risk Management Solutions (RMS), a well-known producer of risk models for the insurance industry and others, only recently launched the first high-definition wildfire model for the contiguous United States, "offering an improvement on the zoning and mapping products currently employed by the insurance industry to evaluate wildfire risk." According to the company, "The RMS Wildfire model is an important tool towards ensuring that wildfire risk can be confidently understood across the (re)insurance industry."⁴⁸



46 See Lee et al (2002) Information systems in support of wildland fire management decision making in Canada; and the CWFIS Datamart can be accessed at <https://cwfis.cfs.nrcan.gc.ca/datamart>

47 Information on the Canadian Forest Fire Danger Rating System (CFFDRS) can be found at <https://cwfis.cfs.nrcan.gc.ca/background/summary/fdr>

48 See RMS Releases U.S. Wildfire High-Definition Model to Empower (Re)insurers to Address Pervasive Wildfire Risk

For governments of all levels, the insurance industry and others to properly understand the risk of loss from wildfire and all that comes with it, it is necessary to have access to high-quality, up-to-date wildfire risk models that utilize the latest understanding of the hazard and the current technology. It would be useful if the Canadian Forest Service would partner with provincial agencies, researchers and private industry to build a wildfire risk model to support decision-makers involved in fire management, public safety and insurance.



Image Credit: Alan Westhaver

Hazard and risk maps

The discussion about the need for Canadian wildfire risk maps essentially follows the same line as the discussion surrounding the need for a national wildfire risk model.

Canadian stakeholders have wide access to quality information about wildfire hazards – including a number of wildfire hazard maps with information on weather, fire behaviour, monthly and seasonal forecasts, and locations of historic fires.

However, at present, essentially nothing exists to help Canadian stakeholders visually gauge the likelihood that fire may occur in a given area, the probabilities of fire entering a community and – if it does – how severe it might be. Presently, calls for such a product are coming in from various quarters.

One may look to California as an example to follow. California probably leads the way in incorporating wildfire threat into how and where new homes are built, requiring builders to follow a wildland-urban interface building code (the only jurisdiction in the world to require this) when building new homes and requiring communities to produce and make publicly available Fire Hazard Severity Zone Maps.

Additionally, under the state's Natural Hazard Disclosure Statement, the seller or transferor of a residential property or his/her agent must disclose whether a property is within a flood, wildfire or seismic hazard zone.⁴⁹ The law applies whether the seller has personal knowledge of the hazard or whether the local jurisdiction has deemed a property to be at serious threat. Disclosure requires that a formal document be filled out and made available to the buyer "as soon as practicable before transfer of title."

The State's wildfire danger maps, however, are not the be-all-and-end-all. In the October 2017 Tubbs Fire, embers from an interface fire entered the city, leading to the incineration of more than 5,600 structures. Many of these buildings were located deep within the urban core of the city, in low-risk or unrated zones away from the area of highest risk.⁵⁰ In the case of Sonoma County, of which Santa Rosa is part, the fire danger maps did not consider the possibility of long ember transport due to the Santa Ana winds.⁵¹ There are currently calls to revisit California's fire maps to correct this oversight.

One important feature in the RMS wildfire model for the United States, is that ember transport is incorporated into the model.⁵² Entities working to produce wildland fire risk maps for Canada would be well-advised to incorporate learnings from California in developing similar products for the Canadian market. Canadian research is available to support development of a wildfire loss model for Canada that considers ember transport.⁵³

49 California's Natural Hazard Disclosure Statement can be viewed at <https://www.nolo.com/sites/default/files/CAHazards.pdf>

50 For more, see *Despite clear risks, Santa Rosa neighborhood that burned down was exempt from state fire regulations.*

51 According to Accuweather "High-speed and dangerous winds that periodically kick up and blow from the mountains to the coast in Southern California are referred to as Santa Ana winds."

52 For more details on RMS's wildfire model and on wildfire modelling in general, see the ICLR webinar "Wildfire catastrophe modeling: Analytics for a new peak peril" at <https://www.youtube.com/watch?v=-i6o4w6kYfE>

53 <https://www.nrcan.gc.ca/forests/resources/research-centres-and-forests/northern-forestry-centre/1348564>

Section III: Strengthening disaster risk governance

*“ If you want to go fast, go alone. If you
want to go far, go together.”*

- African proverb

The number and impacts of disasters are increasing around the world. Effective governance must address the fundamental issues of disaster risk reduction. Disaster risk, the potential for severe alterations in the normal functioning of a community due to hazard events, depends on three issues: the nature and severity of an impacting event (such as a wildfire, flood, typhoon or earthquake); the exposure of the community or society to the event; and their vulnerability, or predisposition to be adversely affected.

The occurrence of wildfires depend on weather conditions, health of the forest, local environmental conditions and human activities. The spread of wildland fires into the urban interface also depends on the nature of the human settlement. The characteristics of weather are changing as are those of the forest and urban scene. With exposure and vulnerability, it is important to project their changes in the future, in relation to other actions and societal changes, and take the right actions to reduce exposure and vulnerability and, hence, disaster risk. This may include active management of development in the wildland-urban interface. Governance needs to consider and address the hazards, exposure and vulnerability. Multiple levels of governance will be involved in preparing for and responding to larger events, from local to national, and across many sectors. This involvement must recognize the multi-dimensional nature and their complex interactions involved in preparing for large incidents.

Although there were very large impacts, the overall costs of the Fort McMurray wildfire on Fort McMurray and surrounding areas would have been much higher if there had not been effective public and private responses through governance mechanisms. This section will review the governance of disaster risk management, at international, national, provincial and local levels, in the Canadian context and the actions taken to address the issues over the last decade and those planned for the future.

Governance is the structures and decision-making processes that enable the government and other organizations to run the country, as well as enabling the administrations and groups that ensure its safety and efficiency.⁵⁴

When considering good and effective governance across the issues of effective collaboration, performance orientation and openness, transparency and integrity, it is important for disaster risk management to consider and integrate all its components: preparedness, response, recovery, prospective and corrective risk reduction. For wildfires, such as the Fort McMurray fire, all levels of governance need to be involved, including several departments or agencies within levels, insurance companies and others in the private sector, and organizations like the Red Cross. For a wildland fire at the urban interface, the forestry and local governance agencies, as well as disaster-response related agencies, are all critical and need to be fully connected. In this section of the report, we examine the effectiveness of the governance of disaster risk management – which is the organization, planning and application of measures preparing for, responding to and recovering from disasters.⁵⁵

International framework for governance of disaster risk management

The overall international framework for governance is set out in the Sendai Framework for Disaster Risk Reduction 2015-2030, which Canada and most countries around the world agreed to and ratified in 2015.⁵⁶ The four priorities for action of the Sendai Framework are: understanding disaster risk, most importantly, understanding that risk depends on events and exposure and vulnerability; strengthening disaster risk governance to manage disaster risk; investing in disaster risk reduction for resilience; and enhancing disaster preparedness for effective response and to build back better in recovery.

The second priority – strengthening disaster risk governance – states, “Clear vision, plans, competence, guidance and coordination within and across sectors, as well as participation of relevant stakeholders, are needed.” There is need to strengthen disaster risk governance and foster collaborations and partnerships. The Sendai Framework sets out important achievements for national and local levels within and across all sectors for national and local disaster risk reduction strategies and plans, for prevention, reduction, and resilience. Land use and urban planning, building codes, environmental and resource management, and health and safety standards are essential parts of disaster risk management. Publicly reported periodic assessments and comprehensive public and community consultations are important, empowering local authorities to work and coordinate with civil society, communities and indigenous peoples. A particular challenge is to address the issues of prevention or relocation, where possible, of human settlements in disaster risk-prone zones.

The Sendai Framework sets global targets which can be grouped as:

- a. Substantially reduce global disaster mortality, the number of affected people globally, direct disaster economic loss and disaster damage to critical infrastructure and disruption of basic services
- b. Substantially increase the number of countries with national and local disaster risk reduction strategies, international cooperation to developing countries, availability of and access to multi-hazard early warning systems and disaster risk information and communicating those assessments to people at risk

The availability of early warning systems and disaster risk information is critical for wildland-urban interface fires. It is important that early warning systems bring together the forecasting inputs of weather and climate, forestry and societal responses.



⁵⁴ See World Economic Forum. (2016). <https://www.weforum.org/agenda/2016/02/what-is-governance-and-why-does-it-matter/>

⁵⁵ <https://www.unisdr.org/we/inform/terminology>

⁵⁶ <https://www.unisdr.org/we/coordinate/sendai-framework>

Roles and responsibilities for disaster risk governance in Canada

Federal government

At the federal level, Public Safety Canada is the lead for emergency response and disaster risk reduction for wildfires and most other disaster events.⁵⁷ The Canadian Forestry Service of Natural Resources Canada is the lead forestry agency and conducts wildfire research at the federal level.⁵⁸

The Canadian Forest Service is involved in research to understand the impacts of climate change on forests and the forest sector, preparing for suitable responses to these impacts (including the assessment of the past, present and future impacts), and identifying options for helping Canada's forest sector adapt.⁵⁹ The Service's Northern Forestry Centre, located in Edmonton, Alberta, undertakes integrated, interdisciplinary research on nationally significant sustainable forest management issues.⁶⁰

The Canadian Forest Service and the Meteorological Service of Environment and Climate Change Canada cooperate in management of the comprehensive Canadian Wildland Fire Information System.^{61, 62} The System provides data and maps of fire danger conditions across Canada, and the Canadian Forest Fire Danger Rating System to assess the role and impact of fire in forest ecosystems.⁶³ The two major subsystems of the danger rating system are the Canadian Forest Fire Weather Index System and the Canadian Forest Fire Behavior Prediction System. They use information based on weather, fuels and topography to predict fire weather, fire occurrence, fire behavior and potential forest fire danger.⁶⁴ The climate research groups of Environment and Climate Change Canada provide projected climate changes in the Canadian Forest Fire Weather Index.⁶⁵ These projections show that higher temperatures in the future will contribute to increased values of the indices and, therefore, increased fire risk. The increase in precipitation that would be required to offset warming for most of the indices exceeds both projected and reasonable precipitation changes.⁶⁶

In addressing wildfires, the Department of National Defence may be asked to aid in emergency response.⁶⁷ With the Fort McMurray wildfire, the Province of Alberta asked the Canadian Armed Forces for assistance on May 4, 2016. Staff, five helicopters and one aircraft were deployed. They shipped freight and carried a total of 367 evacuees to safe areas, and 173 firefighters in and out of the affected area. They also conducted a search and rescue mission, reconnaissance flights over fire-affected areas and provided night flights using technology to monitor the fire. As the fire came under control and after an Alberta assessment, the armed forces participation ended on May 13.

Many wildland fires also affect indigenous people. Indigenous Services Canada's Emergency Management Assistance Program helps communities on reserves access emergency assistance services when threatened by wildfire or other hazards.^{68, 69}



57 <https://www.publicsafety.gc.ca/index-en.aspx>

58 <https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/13497>

59 <https://www.nrcan.gc.ca/climate-change/impacts-adaptations/impacts-forests/13083>

60 <https://www.nrcan.gc.ca/forests/resources/research-centres-and-forests/northern-forestry-centre/1348564>

61 <https://www.canada.ca/en/environment-climate-change.html>

62 <http://cwfis.cfs.nrcan.gc.ca/home>

63 <http://cwfis.cfs.nrcan.gc.ca/background/summary/fdr>

64 <https://cwfis.cfs.nrcan.gc.ca/maps/fw?type=fwi>

65 See Zhang, X., Flato, G., Kirchmeier-Young, M., Vincent, L., Wan, H., Wang, X., Rong, R., Fyfe, J., Li, G., Khari, V.V. (2019): Changes in Temperature and Precipitation Across Canada; Chapter 4 in Bush, E. and Lemmen, D.S. (Eds.) Canada's Changing Climate Report. Government of Canada, Ottawa, Ontario, pp 112-193.

66 See Flannigan et al. 2016 in Canada's Changing Climate Report. <https://changingclimate.ca/site/assets/uploads/sites/2/2018/12/CCCR-Chapter4-TemperatureAndPrecipitationAcrossCanada.pdf>

67 <https://www.canada.ca/en/department-national-defence/services/operations/military-operations/current-operations/operation-lentus.html>

68 <https://www.canada.ca/en/indigenous-services-canada.html>

69 <https://www.sac-isc.gc.ca/eng/1309369889599/1535119888656>

Province of Alberta

The Canadian Constitution Act of 1867 and the 1982 Act amendments define the legislative authorities of the federal and provincial governments. The legislation explicitly recognizes provinces' and territories' constitutional rights to manage their natural resources, including forestry resources.⁷⁰ Each province's legislature can enact laws related to exploring non-renewable resources and developing, conserving and managing non-renewable and forestry resources.

The Alberta Ministry of Agriculture and Forestry promotes sustainable forest management; forest tenure, trade and market access; and wildfire prevention and management.⁷¹ The Alberta Emergency Management Agency (AEMA), under the authority of the province's Emergency Management Act, "leads and oversees all emergency and disaster prevention, preparedness and responses."⁷² The Agency coordinates and brings in the co-operation of all organizations involved in emergencies and disasters and works to ensure that vital public services – such as government services and first responders – are available during a crisis.

Federal-provincial-territorial cooperation on forestry issues

The federal, provincial and territorial governments formally work together through the Canadian Council of Forest Ministers and established the Canadian Wildland Fire Strategy.⁷⁴ This strategy seeks to "balance the social, ecological and economic aspects of wildland fire to deal with both the root causes and the symptoms of current and potential fire management issues."

The Canadian Council of Forest Ministers, based on a report prepared in 2005 by the Assistant Deputy Ministers Task Group, proposed the Canadian Wildland Fire Strategy: A Vision for an Innovative and Integrated Approach for Managing Risk.⁷⁵ The Report calls on federal, provincial, and territorial governments to agree on comprehensive risk management approaches, including an appropriate mix of mitigation, preparedness, response, and recovery, as required to manage wildland fire; and interagency and intergovernmental cooperation and common technical standards, shared across Canada, to improve the efficiency and effectiveness of wildland fire management.

In August 2014, a Governance Model for Canadian Wildland Fire Management Cooperation was agreed to between the Wildland Fire Management Working Group of the Canadian Council of Forest Ministers and the Canadian Interagency Forest Fire Centre. This would be conducted by the Assistant Deputy Ministers (ADMs) of all Canadian provinces and territorial ministries which manage forest fires, and an ADM representing the Canadian Forest Service. They set governance goals of streamlining working structures to improve clarity and accountability, and to reduce overlap and gaps; improving communication among all levels and ensuring consistent and standardized project management, including reporting; and accomplishment of priorities with clear direction and prioritization of work and good management.

The Canadian Interagency Forest Fire Centre is a not-for-profit corporation owned and operated by the federal, provincial and territorial wildland fire agencies. The Centre coordinates sharing resources and information, and mutual aid for wildfire management.

70 <https://laws-lois.justice.gc.ca/eng/const/index.html>

71 <https://www.alberta.ca/agriculture-and-forestry.aspx>

72 <https://www.alberta.ca/alberta-emergency-management-agency.aspx>

73 <https://www.ccfm.org/english/>

74 Canadian Wildland Fire Strategy <https://cfs.nrcan.gc.ca/publications?id=37108>

75 http://cfs.nrcan.gc.ca/bookstore_pdfs/26218.pdf

Other organizations assessments of wildfire management in Alberta

Assessment of wildfire emergency management for Alberta from the Alberta Emergency Management Agency and KPMG

In May 2011, wildfires devastated the Lesser Slave Lake region of Alberta. Almost 15,000 people were evacuated from the region for more than two weeks, with many homes, local businesses and community infrastructure destroyed. This was the second costliest disaster in Canadian history at the time, with insured losses of more than \$700 million.⁷⁶ Following the fire, the Alberta Emergency Management Agency contracted KPMG to prepare a report, called Lesser Slave Lake Regional Urban Interface Wildfire – Lessons Learned.⁷⁷ The report provides insights and learning from the response and recovery efforts and makes an overall recommendation "...to ensure that emergency preparedness, response and recovery systems across the province are consistent with certain principles, including a single, clear command structure for emergency response; emergency response led by a single trained authority; and communities supported to become "whole" again. The report notes that highly effective emergency management depends on clarity in roles and coordination across activities. The report assessed legislation, protocols and procedures and noted that the roles of local and provincial governments and non-governmental organizations were vague and not clearly defined.

Following the Slave Lake wildfire and building on the KPMG report, the Alberta government introduced several changes to Alberta's emergency management system to improve public safety governance.⁷⁸ The Emergency Management Act was amended to support local authorities in regional approaches and to upgrade the alert system, empowering local communities to quickly issue alerts to the public. Roles and responsibilities were clarified among local and provincial partners.

The 2013 flooding in the Calgary area then superseded the Slave Lake fire to become the largest ever disaster loss in western Canada.⁷⁹ Governance issues – including flood plain mapping and control of building in flood plains – have relevance to the management of the risk of loss resulting from wildland fire.

Assessments of governance-related issues for the 2016 Fort McMurray Fire

Following the 2016 Fort McMurray fire, three major reviews were conducted. The Alberta Emergency Management Agency contracted KPMG for a "Post-Incident Assessment Report" (May 2017).⁸⁰ The Regional Municipality of Wood Buffalo contracted KPMG for a report on "Lessons Learned and Recommendations from the 2016 Horse River Wildfire" (July 2017).⁸¹ The Forestry Division, Alberta Agriculture and Forestry contracted the Edmonton-based consulting company MNP to conduct "A Review of the 2016 Horse River Wildfire – Alberta Agriculture and Forestry Preparedness and Response" (June 2017).⁸² These reports provide detailed analysis of the events of the fire – including governmental and community responses and actions – and provide lessons learned and recommendations. Findings and recommendations are summarized below.



76 <http://www.abc.ca/on/disaster/fire/slave-lake>

77 <http://www.aema.alberta.ca/documents/0426-Lessons-Learned-Final-Report.pdf>

78 <https://open.alberta.ca/publications/6555074>

79 Kovacs, P, and D. Sandink, 2013: Best practices for reducing the risk of future damage to homes from riverine and urban flooding. A report on recovery and rebuilding in southern Alberta.

80 <https://www.alberta.ca/assets/documents/Wildfire-KPMG-Report.pdf>

81 <https://www.rmwb.ca/Assets/Recovery/Lessons.pdf>

82 <https://www.alberta.ca/assets/documents/Wildfire-MNP-Report.pdf>

Post-event assessment report (Alberta Emergency Management Agency -KPMG)

The report stated that the Province had “successfully integrated lessons learned from past disasters into its preparedness for, response to and recovery from the 2016 hazard season,” including the relatively quick evacuation, actions to enable earlier re-entry and recovery efforts, communication to residents, rapid damage assessments and major donations from across Canada to provide support. It concluded that: “Overall, Alberta’s Emergency Management Framework, the Alberta Emergency Plan and resources such as the Provincial Operations Centre, Incident Management Teams, Provincial Emergency Social Services and the Provincial Recovery Task Force provided the necessary foundation for a sustained response to one of the most significant disasters in Canadian history.” KPMG recommended that the province should strive to: strengthen and continue investment in emergency management programs; improve public emergency awareness and preparedness; continue to support local authorities with the completeness and comprehensiveness of incident response and evacuation protocols; enhance the use of technology and analytics in emergency management processes; and further operationalize the delivery of emergency social supports.

Some specific recommendations with a focus on governance issues, were:

- **Prevention:** review the legislative framework for emergency management and develop a disaster resiliency strategy.
- **Preparedness:** clarify and document processes for legislative delegation of authority in the Alberta Emergency Plan; develop a Provincial Emergency Evacuation Framework and model to provide enhanced decision-making capabilities at the provincial level; enhance internal communication and key stakeholder interoperability and technology; develop a state-of-the-art Provincial Operations Centre.
- **Response:** mandate local authorities to adopt the Incident Command System; and empower the Office of the Fire Commissioner to coordinate and deploy municipal firefighters.
- **Recovery:** develop recovery plans for resiliency.

The report concluded that the Government of Alberta’s response to the 2016 wildfire met the objectives of Alberta’s Emergency Plan, and “demonstrated increased maturity from past disasters, capitalizing on the experience of professionals that had staffed the Provincial Operations Centre in 2011 and 2013, during the Slave Lake wildfire and the Alberta floods, respectively.” The report also identified areas where resources and supports were stretched.

Post-event lessons learned and recommendations (KPMG- Regional Municipality of Wood Buffalo)

In evaluating the role of the Regional Municipality of Wood Buffalo in the 2016 wildfire, KPMG undertook a review that analyzed the timeliness, processes and effectiveness of municipal emergency management. Each of the scope items was mapped and analyzed (as per the diagram in Figure 1), illustrating the recommendations, enabling a systematic approach for identifying lessons learned and recommendations.

Prevention & Mitigation	Preparedness	Response	Recovery
Sendai Framework for Disaster Risk Reduction	RMWB’s Emergency Management Business Model	Implementation and Operations of the REOC	Transition from Response to Recovery
Eliminate or Reduce Risks to a Future Wildfire Event	Planning and Preparedness Structures	Implementation of the Incident Command System	Effectiveness of the Recovery Framework
Disaster Recovery Legislation, Regulations and Standards	CSA Z1600-14 Emergency and Continuity Mgmt Program	Integration of the Insurance Bureau of Canada	
	RMWN Municipal Emergency Management Plan	Pet Rescue Program	
	Use of Analytical Tools		
	Evacuation Decision Framework		

Figure 1: Framework of Systematic Analysis⁸³

An important recommendation (also in other reviews), was the implementation and enhanced use of the Incident Command System during response – to ensure that the Regional Emergency Operations Centre and emergency management partners have a unified command.

83 <https://www.rmwb.ca/Assets/Recovery/Lessons.pdf>

A Review of the 2016 Horse River Wildfire (MNP-AAF)

The MNP review team included three leading wildfire specialists as lead reviewers. The report was completed in June 2017. The recommendations included that the Planning Section, Alberta Wildfire Coordination Centre, be operational March 1 annually, to provide daily fire behaviour and wildfire occurrence predictions to decision makers and to coordinate situation updates and use multi-day fire behaviour forecasts. In reviewing the fire weather forecasting. The team also concluded there were opportunities to make provincial fire weather forecasts more informative and definitive. Moreover, the provision of forecast products for five days and longer should be undertaken, as well as bringing together observations from Environment Canada weather and other stations. They noted that fire behaviour analysis is an essential tool to help decision makers make more informed judgements, and that Alberta Ministry of Agriculture and Forestry has an excellent model for predicting wildfire growth (Prometheus) which was applied well. The team also identified some gaps and inefficiencies in situational awareness and decision-making that could be filled by better integration of wildfire science.

As noted in other reports, the Incident Command System for the wildland-urban interface response needs to be integrated across the agencies and services involved, including improved airspace management when there are several aircraft being used. The team also recommended that FireSmart® serve as the basis for effective wildfire management in the province, including “community responsibility, multi-agency collaboration and an outcome-based approach to implementing FireSmart® projects,” as well as ensuring that all seven disciplines of FireSmart® are addressed.

Canadian Council of Forest Ministers Wildfire Management Reviews and Recommendations

In 2016, the Wildland Fire Management Group of the Canadian Council of Forest Ministers prepared a 10-year review and called for action on the Canadian Wildland Fire Strategy.⁶⁴ The review noted that the 2005 Strategy stated that among the challenges would be the increasing effects of climate change as well as eroding response capacity. In the 2016 review, the team noted that the frequency of extreme wildfire events in Canada has been increasing, including the 2016 fire in Fort McMurray and more severe impacts. Some other identified challenges and risks include the workforce; public risk and concern; and wildland fire costs. The 2016 Report also identified the following specific actions as critical (with notes on actions):

- Recommit to the Canadian Wildland Fire Strategy (actions “must accelerate”)
- Enhance horizontal collaboration and integration (wildland fire is not just a forestry issue, it is also a significant public safety, climate change, public health and First-Nation community issue);
- Increase investment in innovation (the investment in science and the university-trained people who carry out such work has consistently diminished)
- Enhance prevention and mitigation capability (a “handful” of communities have realized the benefits of successful initiatives to date)
- Enhance commitment to FireSmart® (“the vast majority of communities remain unengaged”)
- Increase preparedness capacity

With respect to governance, the report identified that: “The need for collaboration among land managers, government agencies, local governments and across Canadian wildland fire jurisdictions has become more pressing.” More specifically, they recommended an “increased focus on shared information and information systems, collaborative decision-making and decision-making tools and evidence-based analysis of strategic solutions.”

Alberta Department of Agriculture and Forestry Annual Report 2017-18

The 2017-18 Alberta Department of Agriculture and Forestry Annual Report noted that the 2016 changes to the Forest and Prairie Protection Act included improved tools which helped reduce the number of human-caused wildfires during the 2017 season.⁸⁵ Funding by the Government of Alberta for FireSmart® activities in the province was tripled to \$45 million over three years, to help communities boost their wildfire protection activities. This included \$10.5 million to assist with the implementation of FireSmart® activities in the Regional Municipality of Wood Buffalo. Based on wildfire events and reviews, the government is continuing to take proactive steps to enhance the resiliency of Alberta's communities against the impacts of wildfire. Grants were also provided to the Canadian Partnership for Wildland Fire Science – for wildfire science and technology-related research, education and knowledge exchange and for the development of innovative policies and practices; for Wildfire Operations Research; and for research on the effectiveness of FireSmart® treatments of different fuel types.

Forests and addressing climate change

Forests play a major role in the global and national carbon dioxide cycles. When wildfires occur, there are major emissions of carbon dioxide into the atmosphere and reduced storage capacity, with implications for climate change. The Canadian Council of Forest Ministers produced the Forest Ministerial Progress Report regarding the Pan-Canadian Framework on Clean Growth and Climate Change.⁸⁶ It examines how forest management could be adjusted to increase carbon sinks and reduce greenhouse gas emissions, for example, by improving regeneration of forests after natural disturbances, insect infestations and fire.⁸⁷

A strong record of cooperation

It is important to address wildfire issues through effective governance approaches and models, bringing together all sectors and levels of government, along with the highest quality science, in meeting the challenges together. Fire management is a significant responsibility and firefighting is expensive.

Based on information from reviews and other sources, Canada's forest management agencies are seen to have a strong record of cooperation and are generally well organized to meet the challenges ahead. There are, however, opportunities for further improvements.



85 <https://open.alberta.ca/dataset/3bd2d2b9-6ccd-4d8d-a8a2-a5c15da00c2a/resource/ddda2788-fe47-49e7-b4f3-579c3a56f7ab/download/agriculture-and-forestry-annual-report-2017-2018.pdf>

86 <https://www.cfm.org/pdf/PCF%20Progress%20Report%202018%20EN.pdf>

87 A carbon sink refers to a forest which absorbs more carbon from the atmosphere than it releases. See <https://www.nrcan.gc.ca/forests/topics/climate-change/forest-carbon/13085>

Section IV: Investing in disaster risk reduction

*“An ounce of prevention is worth a
pound of cure.”*

- Benjamin Franklin

The loss and damage experienced in Fort McMurray would have been much worse had it not been for investments in resilience before the fire struck. These actions – in particular actions consistent with FireSmart® recommendations – established a foundation that has supported a robust recovery.



Nevertheless, 88,000 people were safely evacuated. More than 90 percent of homes were saved. The community is recovering, in part because of preparedness and mitigation actions taken before the fire. Many individuals and organizations made wise and largely unheralded investments before the fire to enhance the resilience of the community – actions that are identified through this chapter.⁸⁸

Collectively, the measures for reducing the risk of wildfire losses in Canada are known as FireSmart®. FireSmart® Canada has set out a comprehensive plan for resilience to fire in the wildland-urban interface. The Government of Alberta has been a driving force to develop this program since its inception in 1990. The program is now managed by FireSmart® Canada with funding from the federal, provincial and territorial governments, insurance companies, the Institute for Catastrophic Loss Reduction and others. Some actions consistent with FireSmart® were addressed before the fire and helped to prevent more extensive loss and damage. An increased commitment to FireSmart® for the community going forward will reduce the risk of fire damage in the future.

One of the long-term goals of disaster management is to promote investment in preparedness and mitigation to reduce the need for response and recovery. Relatively small investments before a hazard strikes have the potential to significantly reduce the risk of damage. In practice, however, investing in resilience is often difficult, particularly for government agencies. It is often easier to

direct time and effort to address immediate needs, including response and recovery when disaster strikes. It can be difficult to secure investments to take action in advance to reduce the risk of losses that may occur in the future, even when the expected benefits significantly exceed the costs, in part because many decision makers place great value on immediate costs and excessively discount the benefits of avoided future losses.

Thirty years ago, in 1989, the United Nations launched the international decade for disaster reduction. Canada and other nations participated in the development of a number of subsequent global strategies, including the Sendai Framework for Disaster Risk Reduction.⁸⁹ A recurring theme has been the goal to reduce the expected future cost of response and recovery from disasters through greater protective action in advance. However, Canadian and international evidence show that disaster losses continue to rise at an alarming rate. Investment in resilience remains insufficient. Unfortunately, this was evident with the losses experienced in Fort McMurray. More could have been done before the fire struck.

Investments in preparedness and mitigation typically result in savings many-fold greater than the initial cost. A comprehensive international study found savings of \$3 to \$7 for each dollar invested, on average, with many examples of larger benefits.⁹⁰ Canadian studies consistently confirm the value of investing in resilience including the lower risk of fatalities and injury, reduced damage to buildings and infrastructure, diminished future cost of response and recovery, and increased peace of mind.

FireSmart® Canada has set out a comprehensive approach to protect communities from the risk of wildfire damage. Some actions consistent with FireSmart® were applied successfully in Fort McMurray before the fire and they were effective in preventing additional loss.

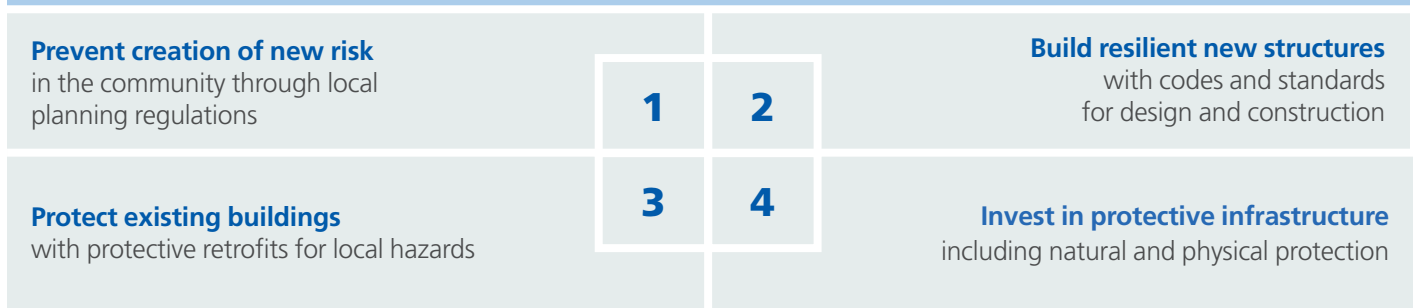
Beyond managing fire risk in the wildland-urban interface, as set out by FireSmart®, Fort McMurray is exposed to a number of other hazards including flood, severe wind and winter storms. Progress has been evident over several decades in understanding the specific actions that can and should be taken to strengthen resilience before the next hazard strikes.

⁸⁸ See the respectful and inspirational statement by Fire Chief Jody Butz made one year after the fire in Wood Buffalo (2017b) Statement by Jody Butz.

⁸⁹ See UNDRR (2019) Sendai framework for disaster risk reduction.

⁹⁰ National Institute of Building Sciences (2017) National Hazard Mitigation Saves.

THERE ARE FOUR CLUSTERS OF ACTION THAT CAN BE USED TO BUILD RESILIENCE AND REDUCE THE RISK OF FATALITIES, INJURIES AND DAMAGE:



Canada provides excellent wildfire suppression but must do even more to manage its communities and landscapes if it is to become more resilient to fire damage in the wildland-urban interface.

All of the actions detailed here align with objectives expressed by the federal government and the Canadian Council of Forest Ministers in the 2005 Canadian Wildland Fire Strategy and the subsequent ten-year update.^{91, 92}

1. Prevent creation of new risk in the community through local planning regulations

Managing the risk of loss involves reducing existing risk but also preventing the creation of new risk. Risk creation can expose new members of the community and increase threat for existing structures. FireSmart® requirements for new development is a powerful mechanism to reduce fire risk creation.

Following the fire, Wood Buffalo commissioned Montane Forest Management to prepare a wildfire mitigation strategy for the region. The report identified planning actions in place before the fire and proposed specific further options to integrate wildfire risk management into the statutes, bylaws and local regulations of Wood Buffalo.⁹³

Actions addressed before the fire included:

- The Municipal Development Plan stating several policy directions
 - Establish a minimum of two access routes, where feasible, in rural communities and urban neighborhoods
 - Promote FireSmart® communities designed in accordance with best practices
 - Ensure that wildfire is a primary consideration in land use decisions
 - Provide fire mitigation information to residents
- Area Structure Plans recognizing wildfire as a development hazard and incorporating recommendations from FireSmart® – Protecting Your Community from Wildfire
- Land use bylaw requiring that campground design and maintenance shall comply with wildland-urban interface recommendations in the FireSmart® manual

- Engineering Services Standards and Development Procedures including many actions
 - Wildfire risk assessments required for all proposed developments adjacent to moderate, high or extreme hazard areas
 - Require access in conformance with National Fire Protection Association standard 1141
 - Require fire-hydrants for all urban developments and rural developments with piped water distribution system and fire pumps driven by diesel engines or electric motors with standby diesel generators
 - Power shall be underground for all urban and rural hamlet applications
 - All vegetation within 100 metres of a development to be treated in accordance with the wildfire risk assessment and/or FireSmart® recommended guidelines.

Planning actions implemented prior to the fire contributed to the resilience of the community. In particular, the Institute for Catastrophic Loss Reduction found that most newer homes in Fort McMurray survived the fire.⁹⁴

However, planning efforts in Wood Buffalo were not consistent across perils that include wildfire, flooding and winter storms.⁹⁵ In addition, actions in place addressed aspects of the FireSmart® recommendations but were not comprehensive. Moreover, while some elements provide guidance, they would have a greater protective impact if built into Wood Buffalo’s statutory documents.

Wood Buffalo’s Comprehensive Planning Branch held a desktop research exercise after the fire to identify specific actions to bring mitigation and avoidance strategies into statutory plans and other planning documents.⁹⁶ The initiative addressed wildfire and other natural hazards that may threaten the community. The objective was to explore mechanisms to integrate mitigation strategies into the statutes. This included a focus on community and subdivision design, vegetation and fuel management, building materials and design, and water supply.

Wood Buffalo’s 2017 Wildfire Mitigation Strategy proposed specific tools for implementation of FireSmart® requirements for development in the Municipal Development Plan, Area Structure Plans, land use bylaw and local building codes. In 2018, Wood Buffalo approved use of the strategy as a guiding document for the community. The objective was to ensure implementation of a more robust plan addressing all seven disciplines of FireSmart®. This commitment will contribute to reduced fire risk in the community and will showcase the power of planning as a tool to promote disaster resilience.

91 CCFM (2005) Canadian wildland fire strategy.

92 CCFM (2016) Canadian wildland fire strategy.

93 The information summarized in this section of the report is based extensively on the analysis prepared by Stew Walkinshaw and his team at Montane Forest Management as set out in the 2017 Regional Municipality of Wood Buffalo Wildfire Mitigation Strategy. The comprehensive report provides detailed, comprehensive and thoughtful information to support local decision makers and other stakeholders.

94 Newer homes were rated with lower structural hazard than older homes, likely because they featured more fire-resistant materials and design features with fewer opportunities for ember accumulation. See Westhaver (2017) Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster.

95 See Walkinshaw (2017) Wildfire Mitigation Strategy.

96 Ibid.

2. Build resilient new structures with codes and standards for design and construction

The quality of home construction is very high across Canada. Current design and construction practices reflect the knowledge of builders about local hazards, consumer needs and buyer expectations. The Institute for Catastrophic Loss Reduction and Montane Forest Management found that most homes in Fort McMurray that survived the fire, and those presently under construction, include several of the fire-resistant structural elements recommended by FireSmart®.^{97,98}

Current practices

Roofing – The majority of homes in Fort McMurray have asphalt or metal roofing resistant to fire, including most or perhaps all new homes. However, a number of older homes in the community have unrated wood-shake roofing and represent an extreme threat to ember ignition.⁹⁹

Eaves, vents and soffits – Modern construction practices to improve energy efficiency also prevent embers from penetrating homes by eliminating openings. Many older homes were built with open eaves, gable vents and other openings offering points of entry for sparks and embers unless they are covered by wire mesh or other protection.

Siding – Fibre-cement, stucco, aluminium and brick siding are identified as fire resistant by FireSmart®. However, many and perhaps most homes in Fort McMurray have vinyl or wood siding and are susceptible to wildfire.

Decks and fences – Decks and fences are common in Fort McMurray, constructed with combustible wood and open undersides susceptible to ignition from embers or ignition by ornamental shrubbery. Some vulnerable decks and fences were included in initial construction while others were installed later by homeowners.

Codes and regulations

Builders determine actual construction design and practices that meet or exceed minimum requirements set out in provincial and territorial building codes and local regulations. Presently, building codes in Canada do not include minimum design and construction requirements for wildfire safety. In 2012, the Canadian Commission on Building and Fire Codes rejected a proposal from National Fire Protection Association (NFPA) Canada and Partners in Protection to establish a wildfire code, advising that this hazard could best be managed through municipal zoning bylaws.¹⁰⁰

A number of communities in Canada have enacted wildfire bylaws regulating construction of new residential development. Communities with development bylaws include Swan Hills, Alberta and several communities in British Columbia – Campbell River, Nelson, the District of North Vancouver, Prince George, Radium Hot Springs, Rural Saanich, Summerland, Rural Vernon and Williams Lake.¹⁰¹ These community bylaws include links to recommendations from FireSmart or other standards.

A national discussion about establishing a wildfire building code re-opened following the fire in Fort McMurray. This was driven by unprecedented destruction of homes, the growing population living in the wildland-urban interface and evidence that the expected area burned by wildfire will increase due to change in the climate.

In 2018, the National Research Council, which is responsible for Canada's national model building code, commissioned the Institute for Catastrophic Loss Reduction, FireSmart® Canada and NFPA Canada to prepare a foundational document as a step toward a national wildfire guide and, ultimately, a code.

As a national wildfire code is developed, Wood Buffalo has been encouraged to take local action. The 2017 Regional Municipality of Wood Buffalo Wildfire Mitigation Strategy recommends a number of construction requirements for new developments to meet FireSmart® guidelines.¹⁰²

- All roofing materials on new, replacement, or retrofitted dwellings, accessory buildings and commercial buildings shall meet a minimum Class "C" ULC (Underwriters Laboratories of Canada) rating or as specified by the development authority.
- All siding materials on new, replacement, or retrofitted dwellings, accessory buildings and commercial buildings within 50 metres of areas susceptible to moderate, high or extreme wildfire behaviour shall use fire-resistant materials extending from ground level to the roofline or as specified by the development authority.

- All exterior deck materials on new, replacement, or retrofitted dwellings, accessory buildings and commercial buildings within 500 metre of moderate, high and extreme wildfire behaviour potential class areas shall use fire-resistant materials or as specified by the development authority.
- All new dwellings, accessory buildings and commercial buildings with exposed undersides and/or with raised decks and porches less than 2 metres from ground level shall be sheathed from the floor level to the ground level with non-combustible materials to prohibit the entry of sparks and embers under the structure.
- All new dwellings, accessory buildings and commercial buildings with exposed undersides and/or raised decks and porches more than 2 metres from ground level shall have and maintain a non-combustible surface cover underneath and for a minimum of 1.5 metres surrounding.
- All fencing on new, replacement or retrofitted residential and commercial properties within 500 metres of moderate, high and extreme wildfire behaviour class areas shall use non-combustible materials within 1.5 metres of the outermost projections of the structure.

In 2018, Wood Buffalo Council approved use of the strategy as guidance for the community. The strategy advises developers concerning the design and construction of new structures and vegetation management. These elements are fully consistent with FireSmart® recommendations.

97 See Westhaver, A. (2017) Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster, Institute for Catastrophic Loss Reduction.

98 See Walkinshaw, S. (2017) Wildfire Mitigation Strategy.

99 Ibid.

100 See The Canadian Press (2012) Building-code changes rejected for wildland fire prone areas.

101 See Kovacs, P. (2018) Development permits: An emerging policy instrument for local governments to manage interface fire risk in a changing climate.

102 See Walkinshaw, S. (2017) Wildfire Mitigation Strategy.

3. Protect existing buildings with protective retrofits for local hazards

Many homes and buildings in Fort McMurray were vulnerable in 2016 due to a combination of vegetation management and the construction of the building. The FireSmart® Homeowners Manual provides specific advice about how these risks can be reduced with relatively little effort or expense.¹⁰³ Increased national funding for FireSmart® awareness would better educate homeowners about the best practices to protect structures in Fort McMurray and elsewhere in the Canadian wildland-urban interface.

Vegetation management on private property

FireSmart®, the Institute for Catastrophic Loss Reduction and others found that the greatest contributor of fire risk for homes in Fort McMurray is a result of vegetation management.^{104, 105} Informed homeowners can significantly reduce this exposure. FireSmart® Canada believes that the greatest opportunity for wildfire risk reduction is within 10 metres of the home – the area described as Zone 1. This area should be free of all material that can easily ignite.

FireSmart® estimates that 50 percent of homes in Canada destroyed by wildfire started with sparks and embers blown up to two kilometres ahead of the wildfire. The Institute for Catastrophic Loss Reduction found this was evident for the fire in Fort McMurray. Wind driven embers likely caused the majority of home ignitions near the urban perimeter triggering the urban conflagration that followed.

A green lawn, a wide range of plants with moist supple leaves and deciduous trees present a beautiful yard and are more difficult to ignite. Evergreen trees and shrubs should be removed if they are within 10 metres of the home. Gravel and decorative crushed rock will not burn. Wood chips and bark mulch will burn and should not be used.

Regular maintenance by homeowners can remove debris and other elements that burn. At a minimum, each spring and fall homeowners should remove all dry twigs, branches and leaves within 10 metres of their home and other buildings. This includes leaves under the deck or on balconies and patios. Firewood should be stacked far away from a home. Burn barrels and fire pits should be located far away from any structures.

FireSmart® Zone 2 is the area 10 to 30 metres from a home. Trees should be spaced at least three metres apart. Deciduous trees are harder to ignite in a wildfire, but evergreen trees can remain if they are regularly trimmed and pruned. Homeowners should remove all branches within two metres of the ground and regularly remove debris from the ground.

Zone 3 is the area 30 to 100 metres from a home. A homeowner will have greater protection if they also maintain the lands further from the home. Increased spacing between trees, trimming lower branches and removal of debris will reduce the intensity and rate a spread of a fire approaching a home.

FireSmart® your home

FireSmart® Canada provides advice about how existing homes can become more resistant to wildfire. Homes should have fire resistant or retardant roofing. There are many options, but homes should not have untreated wood shake roofing. A spark arrestor on a chimney reduces the likelihood that a spark or ember will escape and start a fire. Consider screening gutters with a fine metal mesh so debris does not accumulate bringing fire risk. Screen open eaves and vents so embers cannot enter the home.

Stucco, fibre cement, aluminum and brick siding are fire resistant. Log and timber homes offer good fire protection. FireSmart® warns, however, that untreated wood and vinyl siding offer little protection. Tempered, thermal windows resist radiant heat from an advancing wildfire. Entry and garage doors should be fire rated. Decks should be built with fire-resistant materials and enclosed underneath so debris cannot accumulate. Fences and walkways should be built so they do not create a path to bring fire to homes, by using metal fencing and not using wood chip walkways. Sheds and other buildings should be fire resistant like homes.

Most homes in Fort McMurray have fire resistant roofing, but a few have untreated wood-shake roofing that is extremely vulnerable to burn when confronted by hot embers. Many homes do not have fire-resistant siding. Wooden decks and fencing are common.

FireSmart® commercial buildings

The leadership evident in private industry is an encouraging finding from an assessment of the 2016 fire. In particular, the major energy companies operating near Fort McMurray made extensive investments in wildland fire protection, following the guidance of FireSmart®. These efforts were effective in preventing physical damage. Significant business losses were experienced because most of the workforce was subject to a mandatory evacuation and production was suspended, but successful actions were implemented to protect assets at risk.

The Fort McMurray area has an extensive industrial presence, accounting for more than 95 percent of Canada's proven oil reserves. The oil sands industry had considerable values at stake, and before the 2016 fire, major producers took the threat of wildfire damage to their operations very seriously. Experts were hired to assist with implementation of FireSmart® initiatives to clear debris near buildings, install sprinklers and other protective action.

The commitment to risk reduction through FireSmart® demonstrated by the major oil sands producers provides clear evidence of the potential for significant gains if homeowners and community leaders make a similar commitment. Wildfire is common in northern Alberta, but the 2016 fire demonstrated that many in Fort McMurray did not fully understand the loss potential from wildfire, actions they could take to manage the risk or how to best prepare for the possibility of evacuation. Side-by-side comparisons of homes that survived the fire or were destroyed found that 89 percent of the time the surviving home had substantially lower risk when judged by the FireSmart® criteria.¹⁰⁴ Property owners can reduce the risk of wildfire damage, and the oil sands companies did so.

103 See FireSmart® Homeowners Manual.

104 Ibid.

105 See Westhaver, A. (2017) Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster, Institute for Catastrophic Loss Reduction.

106 Westhaver, A. (2017) Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster, Institute for Catastrophic Loss Reduction.

4. Invest in protective infrastructure including natural and physical protection

FireSmart® sets out a number of measures that are part of the wildland-urban interface protective infrastructure. Three elements include:

- Vegetation management on public property in and around the community
- Ensure a supply of water and fire suppression equipment for firefighters
- Transportation access for firefighters and evacuation options for residents

Vegetation management

Wood Buffalo and Alberta Forestry commissioned Montane Forest Management in 1998 and 2010 to develop a FireSmart® vegetation management plan. These proposals were implemented between 2000 and the onset of the fire. Measures taken before the fire were important to give firefighters some control over aspects of the 2016 fire despite extraordinarily hot, dry and windy conditions. The Institute for Catastrophic Loss Reduction found that fuel buffers at the margin of neighbourhoods investigated were effective in reducing home ignitions due to flames and radiated heat of the fire in the wildland.¹⁰⁷

The 2017 Wildfire Management Strategy provides specific vegetation management advice. Post-fire green islands in Fort McMurray require active fuel reduction and maintenance. Burnt trees within 100 metres of developed areas should be harvested immediately, as they will be more difficult and expensive to remove when they blow down and become overgrown. Effective fuel breaks between the hazardous wildland forests and interface structures include the Syncrude Athletic Park, Fort McMurray Golf Club and Abasand cemetery.

Temporary breaks established during the fire will soon grow back. However, the community can choose that these breaks are further developed and maintained to provide added long-term protection.

In 2017 a Parks Master Plan and Urban Forest Strategy were under development for Wood Buffalo. A field inspection of municipal parks in Fort McMurray by Montane Forest Management found these areas to be well irrigated and maintained, providing excellent fuel breaks. Montane did advise that flammable evergreens close to structures should be removed, wood chips and bark mulch should not be used in municipal parks and warned about wood fences adjacent to some parks.

Martin Alexander advises that that a network of aspen fuelbreaks without any conifer overstory in and around a community will provide protection from wildfires.^{107.1}

Water supply

The 2017 Wood Buffalo Wildfire Mitigation Strategy reports that a supply of water through pressurized fire hydrants was installed throughout Fort McMurray well before the fire and in some of the other service areas in Wood Buffalo. Upgrades were completed in several areas in 2017 and 2018.

Fort McMurray and all of the service areas in Wood Buffalo have overhead fill stations for their water treatment facilities. These were in place before the fire in 2016.

KPMG report that plans were made years before the 2016 fire assuming the use of sprinklers as part of a response strategy.¹⁰⁸ Alberta Emergency Management offered in the early stages of the 2016 fire to provide sprinklers to Wood Buffalo to protect structures threatened by fire, but they were initially turned down. Subsequently, Wood Buffalo requested sprinklers later in the response. Rapid deployment of sprinklers can be an effective tool for reducing damage to buildings. Wildfire planning should include a clear strategy about when sprinklers should be used.

Transportation

Fort McMurray is the northern most of Canada's 50 largest communities, and perhaps the community with the greatest dependence on a single road, Highway 63. A second major road connection for Fort McMurray would provide multiple benefits to the community including increased capacity to cope with future fires. The Government of Alberta completed a study that identified the East Clearwater highway as an alternative evacuation route and second major access route in to and out of Fort McMurray and other communities in Wood Buffalo. Wood Buffalo endorsed development of this highway. But this project has not yet been funded.

Investments were made to improve Highway 63. The highway was expanded to four lanes for its full length from Fort McMurray to Edmonton. This work was completed just before the fire. The community evacuation required as a result of the wildfire would have been much more difficult if the highway had not been improved.

Early completion of the expanded highway helped to save lives. Highway 63 was closed for several days in 1995 because of the fire in the Marianna Lake area. In 2002, the House River fire resulted in periodic closure of the highway over several days. In 2016, a number of closures were imposed as a result of fire. Fire and other hazards have isolated people living in northeastern Alberta.

Fort McMurray and Canada's oil sands production facilities are very dependent on a single road. Montane Forest Management reported that the design and maintenance of roads within the Regional Municipality of Wood Buffalo before the fire were generally adequate to support firefighters. Local roads were of a sufficient width to carry fire apparatus and provide room to turn-around, including all-weather loops on dead-end roads. The Regional Municipality has been considering alternative egress routes for several smaller communities that have only one access route in and out. Fire may block the only route to safety for residents and access for firefighters. The communities identified at risk in the 2017 Regional Municipality of Wood Buffalo Wildfire Mitigation Strategy including Fort McKay, Draper, Sapræe Creek, Janvier, Anzac and Fort Fitzgerald.

Some elements of wildfire protection in place before the 2016 fire included a decade of active vegetation management, installation of a pressurized water supply for fire suppression and completion of the Highway 63 expansion. These investments helped to save lives and protect property. Nevertheless, Fort McMurray remains too dependent on a single highway.

¹⁰⁷ Ibid.

^{107.1} See Alexander (2010) Surface fire spread in trembling aspen during the summer in the boreal forest region of Canada.

¹⁰⁸ See KPMG (2017b) Regional Municipality of Wood Buffalo: Lessons learned and recommendations from the 2016 Horse River wildfire.

Opportunities for improvement

Implementation of the recommendations from FireSmart® will reduce the risk of future fire losses. The Government of Alberta should partner with Wood Buffalo, oil sands companies, insurance companies, the Red Cross and other stakeholders to promote property owner awareness of FireSmart®. This should include training personnel to act as local FireSmart® representatives and work with local community champions to support long-term awareness building.

Alberta and Wood Buffalo should consider introducing financial incentives, perhaps including tax reductions, for property owners that implement FireSmart®. This may include incentives to support the FireSmart® Community Recognition program.

A number of temporary firebreaks were constructed when fighting the fire. Wood Buffalo should convert these into enhanced protection for the community. Investments are required to widen and maintain the fuel breaks to ensure lasting protection.

The Government of Alberta should establish a wildland-urban interface wildfire code for the development and construction of new buildings. Wood Buffalo should adopt the recommendations of Montane the Forest Management set out in the Wildfire Mitigation Strategy, including the proposal to revise its statutory planning documents to formally set out community expectations for new construction.

Development in zones of high risk should be prohibited or protected. This includes fire, flood and other known hazards. Wood Buffalo should require that proposed new development projects include an assessment of the risk of loss from hazards and a plan to manage this risk.

Wood Buffalo is too dependent on a single road – Highway 63. The Government of Alberta should move forward with plans to build the East Clearwater Highway. The highway will provide an alternate evacuation route when future fires burn in northeastern Alberta and better support economic activity.

“Don’t let a disaster go to waste”: Lessons on resilience from the front lines

Resilience Trailblazer: Fire Chief Jody Butz for the Regional Municipality of Wood Buffalo

Like many courageous first responders, Jody Butz, fire chief for the Regional Municipality of Wood Buffalo, exhibits pride, professionalism and perseverance in his duty to protect the community he serves. But it’s his passion for helping to shift a global mindset from disaster response to community resilience that makes him a resilience trailblazer.

In 2019, Zurich, as part of its ongoing research of disasters, began seeking out ordinary people doing extraordinary things to create a culture of resilience.



Chief Butz oversaw operations during the response to the 2016 Fort McMurray fire. He is now in the top spot of the fire department and focused on creating resilience to wildfires, in part by educating firefighters around the world using the lessons learned from Fort McMurray.

One of the key lessons is the importance of having a unified command among the various responders, making sure information is being funneled up to and disseminated back to the teams.

“As a society and responsible agency, we are now paying attention and learning from others,” Butz said. “We are also looking back and asking what we can learn from other disasters, such as the 2011 Slave Lake fire. What did we do there? What did we learn from it?”

The effort to look back is paying off in current events, including the High Level wildfires from March to June 2019.

“We are seeing it in High Level and other fires--unified command. No one is in there fighting over turf. You see the coordination.”

Chief Butz acknowledges that it has taken a few years to really understand what resilience means. Directly after the 2016 fire, it was about letting people get back into the community to rebuild their homes.

After some time and reflection, he said, “Moving forward, resilience needs to be something different. Resilience needs to be having the ability to adapt, absorb and recover from any incident in a timely fashion, and I’m speaking to the individual, the family, the government and the nation. That’s where we are going with resilience.”

He envisions an international think tank where fire departments around the world can tap into each other’s knowledge. He also recognizes that some resources are currently available, including NASA and countries, such as the Netherlands. He’s working to make these connections happen.

On his watch, he has dedicated firefighters focusing to help the community with both fire prevention and response. For example, some of his firefighters go door to door to every home in the region to talk to residents about reducing fire hazards and distribute fire-safety preparedness guides.

“It’s not a matter of if. It will happen again,” Chief Butz said. “What are we going to do? Are we gonna pack up and move? No. We are going to instill a national mindset of resilience.”



Image Credit: Alan Westh...

Section V: Building resilience in recovery

“Experience facing and overcoming adversity is actually one of your biggest advantages.”

- Michelle Obama

An opportunity to build a more resilient community is found in the recovery from an extreme event. Fort McMurray, for example, is better adapted and more resilient to wildfire than it was before the fire struck. Many of the improvements are a direct result of experiencing such a destructive fire. There has been a deliberate and welcome focus on community resilience in the process of recovery. Reconstruction and rebuilding presented an opportunity to build back better. This included better understanding in the community about wildland fire risk, a review of governance and response practices by public and private sector organizations, and investments in fire adapted structures, including a commitment to FireSmart®.



The potential to invest in risk reduction and resilience is always present. But recovery from an extreme event typically increases public and political support for action. Extensive funds may be temporarily available. Stakeholders become aware of the importance of preventing future loss. Experience from large loss events in Canada and elsewhere, like the 2013 flooding in southern Alberta, shows that the strongest support to build back better is during the first 12 to 18 months after a major loss. Commitments made during this period have the potential to result in transformative improvements in resilience. The evidence demonstrates that with time, however, the influence of recovery on resilience efforts will diminish.

The Canadian Wildfire Fire Strategy was established by the Canadian Council of Forest Ministers in 2005 and updated in 2016.^{109, 110} The strategy includes three goals:

- Resilient communities and an empowered public
- Healthy and productive forest ecosystems
- Effective wildland fire response capability

For several decades, the actions of the Government of Alberta have been consistent with the approach ultimately set out in the national strategy. This includes a commitment to detection and suppression of fire in the wildland that may threaten communities and other values at risk. In particular, the province has been the leader in the development of FireSmart® as a tool to empower communities and property owners to reduce the risk of loss from fire in the wildland-urban interface. The local, provincial and national consensus about public safety objectives and best practices provided a strong foundation to achieve greater resilience in the recovery.

109 See CCFM (2005) Canadian wildland fire strategy.

110 See CCFM (2016) Canadian wildland fire strategy.

Many improvements in community resilience are evident in Fort McMurray including three elements summarized here.

- 1. The Wood Buffalo Recovery Task Force**
- 2. The Canadian Red Cross invests in Fort McMurray**
- 3. Insurers rebuild new, more resilient homes**



1. The Wood Buffalo Recovery Task Force

The Wood Buffalo Recovery Task Force was an important initiative contributing to the building of enhanced disaster resilience in Fort McMurray. While the fire continued to burn across northeastern Alberta, the Regional Municipality of Wood Buffalo established a process to manage the recovery. An early and sustained commitment to recovery, including the goal of building back better, was important to the success of the rebuilding effort. The community is now more resilient to the risk of loss from future hazards because of the approach used to manage the recovery.

A first step involved development of a Wildfire Recovery Campaign Plan.¹¹¹ The plan provided a high-level guide to recovery for the region. It identified five action areas – people, environment, economy, rebuild and mitigate – with specific objectives and performance indicators. This document established clear expectations and communicated that transition to the recovery was under way. Moreover, the recovery would be comprehensive, covering a range of issues identified by the community. It was acknowledged that a full recovery would take time.

Indeed, an early objective was to move beyond the goal of a speedy recovery to focus on achieving a stronger and more resilient community.

On June 23, 2016, the Regional Municipality of Wood Buffalo passed a bylaw to clarify that the mayor and council had lead responsibility and accountability for managing the recovery. While many government and non-governmental agencies were involved, it was helpful to clarify leadership for the recovery and rebuilding effort early in the process. A recovery committee was established to advise the mayor and council. A recovery team leader was hired to manage the process.

Dana Woodworth provided early advice to Wood Buffalo about the recovery process and was hired as the Recovery Task Force Team Lead.¹¹² Previously, Mr. Woodworth led the provincial response to the Slave Lake Fire in 2011, as well as the provincial environmental mediation effort for the Southern Alberta Flood in 2013. He was experienced leading wildfire management for the province. This experience and knowledge were critical to the success achieved in Fort McMurray.

The Recovery Team Lead was assigned staff authority over the recovery process, reporting directly to the mayor and council. The Chief Administrative Officer was responsible for running Wood Buffalo and the Recovery Team Lead for managing the rebuilding and reconstruction. This approach was effective for the management of a large disaster like the 2016 wildfire. For this event it was relatively clear when an issue was primarily recovery or an ongoing operational issue. Recovery from

smaller events would have the Recovery Team Lead report to the Chief Administrative Officer or Director of Emergency Management. The scale and scope of the recovery effort following the 2016 fire found it appropriate for the recovery lead to report directly to the mayor and council.

The commitment to FireSmart® was an important success in the recovery. Actions needed to build resilience to loss from wildland-urban interface fire are set out by FireSmart® Canada.¹¹³ Research by the Institute for Catastrophic Loss Reduction and others consistently affirm the benefits and value of the comprehensive approach established by FireSmart®.¹¹⁴

Prior to the 2016 fire some property owners were aware of FireSmart® and implemented the recommended actions. These structures typically experience little or no damage from the fire. Unfortunately, many in Fort McMurray were not aware or did not commit to implementation of the FireSmart® recommendations. These properties were found to be more likely to experience damage from the fire.

111 See Wood Buffalo (2016c) RMWB 2016 Wildfire Recovery – Campaign Plan..

112 See Wood Buffalo (2016a) Recovery Team Lead.

113 See FireSmart® (n.d.) Homeowner's Manual: FireSmart® Begins at Home.

114 See Westhaver (2017) Why some homes survived: Learning from the Fort McMurray wildland/urban interface fire disaster.



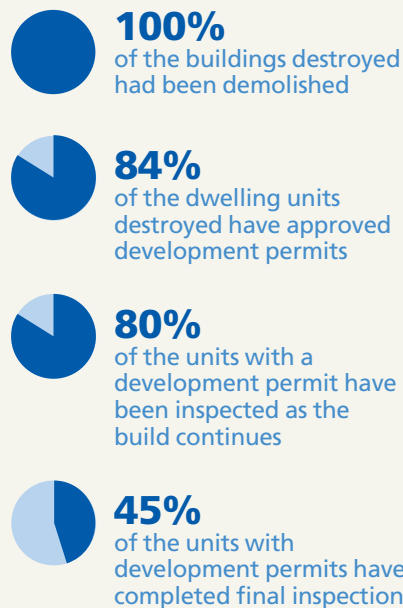
Wood Buffalo commissioned an update of their wildfire strategy following the fire.¹¹⁵ This study provided specific advice, consistent with FireSmart®, to strengthen resilience to wildfire damage throughout the region. Early adoption of the findings allowed Wood Buffalo to access funding from a variety of sources to better protect the community.

Frequent and detailed communication was important to the success of the recovery for Wood Buffalo. A challenge that often limits the success of efforts to increase resilience and reduce risk during recovery is public and political pressure to rebuild quickly. For Fort McMurray, for example, communication helped to manage expectations about the time needed to fully clear away debris, remediate polluted soils, secure building permits and authority, inspect construction and other critical actions to ensure that new buildings comply with current regulations and owner expectations. Experience in other communities recovering from disaster unfortunately includes examples of compromises made to accelerate the recovery. The recovery for Fort McMurray included a deliberate and thoughtful process to provide regular updates and community outreach with specific performance measures and active listening to identify evolving information needs.^{116, 117}

A particular challenge, never experienced before in Canada, involved the rebuilding of a large number of homes, businesses and other structures destroyed by fire. Wood Buffalo report that 1,595 structures were destroyed that include 2,579 dwelling units.¹¹⁸ This includes 1,501 single family homes,

townhouses and duplexes and 94 other structures. The other structures included two buildings with 115 condos, several restaurants, hotels and five structures at the airport.

By June 2019, three years after the fire, our analysis of the Wood Buffalo reports find:¹¹⁹



Some homes will not be rebuilt in the near future due to weakness in the economy. A few homes will not be rebuilt due to concerns about public safety. In the Waterways neighborhood, for example, 33 homeowners were cautioned against rebuilding because of instability in the slope due, in part, to loss of forest cover and the risk of landslide triggered by intense rainfall.¹²⁰ This community was built more than 100 years ago, and it is difficult to rebuild to meet modern construction requirements. Moreover, many in the community are also at risk from flooding.

The recovery process included review options to enhance resilience from the risk of loss due to wildfire and other hazards including flood. There have been at least 15 notable floods in Fort McMurray since 1835, and much of the commercial development of the community has been in zones exposed to flooding.

Extensive development of the lower townsite took place over the past twenty years, while new residential construction shifted to higher ground.

Many years ago, the Alberta government mapped the floodplain for Fort McMurray and most other communities across the province but did not prohibit development in zones of high flood risk. A 2019 analysis by the Globe and Mail identified 730 Fort McMurray structures in the floodplain and 560 in the flood fringe, accounting for 40 percent of the structures in the Lower Townsite and Waterways.¹²¹ The wildfire recovery encouraged further discussion about flood risk management. In particular, 90 percent of the homes in Waterways were destroyed by the fire in 2016 and many of those homes were located in the floodplain.

A result of the discussion about flood risk has been a commitment by Fort McMurray to build flood defense infrastructure to protect businesses, homes and other structures in zones of high flood risk. A major arterial road is presently being elevated to act as a dike. Studies completed in 2017 set out a number of options to protect the community, but the cost will be significant – nearly \$300 million. Wood Buffalo decided that most of the homes destroyed by fire that were located in the current floodplain will be rebuilt and will be protected, and they rejected the alternative of prohibiting rebuilding in the floodplain.

Council considered prohibiting reconstruction but decided to invest in defensive infrastructure.

The absence of a recovery plan in Wood Buffalo’s Municipal Emergency Management Plan was a shortcoming identified by the Wood Buffalo Recovery Task Force.¹²² The recovery would have benefited from planning before a hazard struck. Decisions about governance, sources of funds to support recovery, performance indicators and other issues could have been informed by planning. Nonetheless, Wood Buffalo was successful in engaging consultants with experience managing recovery from a large disaster; familiarity with critical partners in the provincial government and private industry; and with a demonstrated capacity to lead such a complex task.

115 See Walkinshaw (2017) Regional Municipality of Wood Buffalo Wildfire Mitigation Strategy.

116 See Wood Buffalo (2017a) Recovery Task Force – Economic Pillar Progress Updates.

117 See Wood Buffalo (2017b) Recovery Task Force – Mitigate Pillar Progress Update.

118 See Wood Buffalo (2019) Recovery Task Force – Rebuild Pillar Progress Update.

119 See Wood Buffalo (n.d.) Our communities Permits for rebuilding a total-loss structure.

120 See Wood Buffalo (2016) Waterways.

121 McClearn, M. (2019) Fortress McMurray: After decades of building on the flood plain, a city moves to protect itself from its capricious rivers.

122 See Wood Buffalo (2016b) Wildfire Recovery Plan page 35.

2. The Canadian Red Cross invests in Fort McMurray

The Canadian Red Cross made a significant investment to support the recovery of Fort McMurray and establish a more resilient community. The contribution made by the Red Cross is unprecedented for Canada.

A total of \$330 million was raised by the Canadian Red Cross in response to the 2016 wildfire.¹²³ This included almost \$200 million provided by the public and private corporations, \$104 million from the federal government and \$30 million from the Alberta government. The Red Cross raised \$45 million in response to the 2013 flooding in southern Alberta, at the time the largest total ever following a disaster in Canada. While a detailed analysis has not been conducted, it is possible that the funds raised following the 2016 wildfire exceed the combined disaster relief funds raised by the Red Cross from all other disasters in Canada over the past 100 years. By any measure, this was the largest and most diverse disaster response ever conducted in Canada by the Red Cross.

Most of these funds were given in direct financial assistance to cover the immediate needs of 16,000 individuals and families during the evacuation, replacement of household goods, help with rent and mortgage bills, repair and reconstruction of uninsured homes, and projects to enhance community resilience. More than \$50 million was spent to support community groups. Almost \$30 million was provided to support more than 3,000 small businesses. Each measure was the largest ever provided by the Canadian Red Cross.

Red Cross is perhaps best known for its support to those involved in the evacuation. When individuals and families evacuated, many registered with the Red Cross to inform family members and friends that they were safe and facilitate reunion. Friends and family members could be informed and reunited. Supports were put in place to provide shelter, food, basic necessities and information. The Red Cross worked in close co-operation with local governments, the province, disaster response organizations, insurance companies and other stakeholders.

Three specific directions set out in the 2015 Strategy published by the Canadian Red Cross include:¹²⁴

- Reduce vulnerabilities by providing effective and appropriate resources to response and recovery programs.
- Support people in preventing, preparing for and mitigating disasters.
- Improve the capacity of communities and National Societies to assist vulnerable people, particularly to anticipate, cope with, resist and recover from disasters and crisis.

Prior to the 2016 wildfire, the funds available to the Canadian Red Cross for disaster risk management were not sufficient for the organization to be active in recovery. Following the fire, the Red Cross was active in the community championing initiatives like FireSmart® and providing financial assistance to uninsured small businesses and homeowners. The national office has established a new position of Director, Disaster Risk Reduction, further affirming the long-term commitment of the Red Cross to an expanded role beyond supporting individuals and families involved in evacuations.

3. Insurers rebuild new, more resilient homes

Basic insurance coverage for homeowners, businesses and vehicles automatically includes coverage against losses resulting from a fire, including urban and wildland fire. Additional coverage for homeowners and businesses can be purchased to provide protection for risks like flood and water damage. A few in Fort McMurray that chose not to purchase insurance experienced significant losses, including some that lost their home and possessions. Importantly, most homeowners and businesses in Fort McMurray purchase insurance, and most buy replacement cost insurance. Replacement cost insurance coverage assumes in its pricing and coverage that property owners want full protection against the risk of a total loss, not just the depreciated cash value of the home.

The widespread use of insurance contributed to rebuilding a more resilient community following the fire. In particular, replacement cost insurance supported 'new for old'. Hundreds of homes are being built in the community following current design and construction practices, replacing older and more vulnerable homes damaged or destroyed by the fire. New homes are typically more resistant to fire than older homes. Indeed, research commissioned by the Institute for Catastrophic Loss Reduction found that homes and other structures rebuilt by insurers following wildland-urban interface fire losses in Kelowna, Slave Lake and Fort McMurray were more resistant to future fire damage than most of the homes they replaced.¹²⁵

Most homeowners, businesses and vehicle owners in Fort McMurray purchase insurance. Analysis of insurance data provided by CatIQ shows that the 2016 fire resulted in \$3.6 billion in insurance claims paid, including \$3.5 billion paid to residents and businesses located in Fort McMurray.¹²⁶ More than one third of vehicle owners (34 percent), most businesses (58 percent) and almost every homeowner (99.5 percent) that had insurance coverage experienced a loss resulting from the fire that was paid by their insurer.

Some insurance funds were paid while the community was under an evacuation order to support the immediate needs of consumers. Other payments extended over several months and years to support rebuilding and reconstruction efforts. Insurance claims paid supported recovery for the community.



123 See Thurton, D. (2018) Red Cross still helping people in need 2 years after Fort McMurray wildfire.

124 See Canadian Red Cross (2010) 2015 Strategy.

125 See Westhaver (2015) Risk reduction status of homes reconstructed following wildfire disasters in Canada, Institute for Catastrophic Loss Reduction.

126 Catastrophe Indicators and Quantification Inc. (CatIQ) is the leading source of information in Canada concerning insurance loss and exposure information to serve the needs of insurers, reinsurers, the public sector and other stakeholders www.catiq.com.

Replacement cost coverage varies somewhat among insurers, but the basic commitment is to replace or rebuild with materials of similar quality. The consumer is entitled to 'new for old'. If the roof of a home was 20 years old, for example, it was due to be replaced and its depreciated cash value is quite low. If the roof of a home or business with replacement cost insurance was destroyed by the fire, then insurance will include installation of a new roof, not the depreciated value of the roof.

The average home in Canada was built 35 years ago. The cash value of most homes is much lower than the replacement cost. Typically, the older the home the larger the difference between the depreciated cash value and the replacement cost. Since insurance policies typically provide replacement cost coverage, owners with older homes destroyed by fire will be provided with a similar but new home.

Building practices and regulations continuously improve. Indeed, newer homes experienced less damage than older homes in the 2016 Fort McMurray fire. A new home built following the fire in Fort McMurray, will typically be more resistant to fire than the home it replaces. The enhancement will be greatest for older homes. Some improvements will reflect evolving building practices. For example, all new homes built by insurers following fire in Kelowna, Slave Lake and Fort McMurray have fire resistant roofing even if the home that was lost did not. Other changes will result from new regulations or bylaws. In particular, all new homes in Alberta must install a backwater valve to reduce the risk of urban flooding, including the homes rebuilt following the fire in Fort McMurray, even if most of the older homes destroyed in the fire did not have a backwater valve.

The National Household Survey by Statistics Canada found that 4.3 million dwellings in Canada are in need of repairs.¹²⁷ This includes one third (32 percent) of the homes owned in Canada. Few (8 percent) of the homes built within the past ten years were in need of repair, but half (47 percent) of the homes built more than 50 years ago need work. Homes lost in the fire that were covered by replacement cost insurance were replaced by new, more resistant homes regardless the state of repair before the fire.

Reconstruction of hundreds of homes destroyed by the fire is a highly visible element of the role of insurance to rebuild a more resilient community. However, insurance played a much larger role in the recovery. Analysis of data provided by CatIQ shows that insurance companies paid more than 60,000 damage claims as a result of the fire, including 56,000 to residents and businesses located in Fort McMurray. Insurance payments to replace most of the homes destroyed by fire is one element of this coverage.

In addition, almost 32,000 homeowners received payment for other losses including food that spoiled during the evacuation and replacement of refrigerators damaged by food that spoiled during the evacuation. Almost 20,000 vehicle owners received payments for damage and repairs. More than 4,000 small business and large commercial operations located in Fort McMurray were paid more than \$1.3 billion in insurance claims.

A concern that was evident during the recovery involved those who did not purchase insurance protection. Several homeowners, renters and small businesses were uninsured. Many without insurance experienced great hardship.

The Canadian Red Cross provided relief for some of those affected, including \$30 million to support small businesses. Previous extreme events, like the 2013 flooding in southern Alberta, also found that many small businesses did not have insurance protection. The 2018 tornado near Ottawa found that many renters did not purchase insurance.

The Red Cross was able to address some of the issues that arose from the 2016 Fort McMurray fire, but typically do not have the financial capacity to be as involved. Owners of 16 percent of the dwellings destroyed by fire have not applied for a building permit. In part, this is because they did not have insurance or they accepted a cash settlement and have moved away.

Opportunities for improvement

Wood Buffalo and the Government of Alberta should monitor the extent of insurance protection in place for hazards that include wildfire, flooding and urban fire. This should include understanding how homeowners, tenants and small businesses use insurance. Moreover, Alberta and Wood Buffalo should promote the purchase of insurance to ensure the capacity to recover from future hazards.

Wood Buffalo and the Government of Alberta should also establish a mechanism to partner with local builders, insurance companies and other stakeholders to champion resilience in recovery by building back better. Recovery planning collaboration in advance of the next wildfire or flood is critical to build support to relocate exposed properties and implement new construction practices that reduce the risk of future damage. Small investments during reconstruction can significantly increase resistance.

127 See Table 9 in the Canadian Mortgage and Housing Corporation's Canadian Housing Observer (2014) on page 259.



Section VI: Lessons Learned

*“The best time to plant a tree was
20 years ago. The second best time
is today.”*

- Chinese proverb

An opportunity to build a more resilient community is found in the recovery from an extreme event. Fort McMurray, for example, is better adapted and more resilient to wildfire than it was before the fire struck. Many of the improvements are a direct result of the experientweeing such a destructive fire. There has been a deliberate and welcome focus on community resilience in the process of recovery. Reconstruction and rebuilding presented an opportunity to build back better. This included better understanding in the community about wildland fire risk, a review of governance and response practices by public and private sector organizations, and investments in fire adapted structures, including a commitment to FireSmart®.



Three findings from this analysis of the 2016 fire in Fort McMurray:

- Damage from the fire would have been much more extensive but for the courageous efforts of firefighters and many others involved in the response. Moreover, many, largely unheralded actions were taken in the months and years prior to the wildfire to enhance the resilience of the community. More than 90 percent of the structures survived the fire.
- The recovery following the fire has been managed to strengthen the community's resilience to loss and damage from future hazards.
- Nevertheless, we find scope for improvement. The lessons learned are organized around the four priorities for action set out in the Sendai Framework for Disaster Risk Reduction
 - understanding disaster risk
 - strengthening disaster risk governance
 - investing in disaster risk reduction
 - building resilience in recovery.



Understanding disaster risk

Knowledge about fire behaviour, suppression options and why structures burn provide the foundation for effective management of the risk of loss from wildland fire. Wildland fire management in northern Alberta is robust and founded on a sound understanding of best practices.

Hundreds of wildfires in northern Alberta are detected and quickly extinguished each year. A few escape initial attack and grow to threaten communities and values at risk. There is a welcome culture of learning in Alberta from previous notable fires including Chinchaga (1950), Vega (1968), Virginia Hills (1998), Chisholm (2001), House River (2002), Lost Creek (2003), Slave Lake (2011) and Horse River (2016).¹²⁸

Few structures in Canada have been damaged by wildfire over the past 50 years. Implementation of the FireSmart® recommendations should reduce the risk of fire damage. It is important to examine and affirm the FireSmart® recommendations through field studies, like that of Westhaver, when loss events occur, like the 2016 fire in Fort McMurray.

Strengthening disaster risk governance

Disaster governance best practices are set out clearly in international agreements, thereby including the Sendai Framework for Disaster Risk Reduction. We find that these approaches are well established in Canadian practice and were evident in the constructive and effective relationships operating through the response to and recovery from the Fort McMurray fire.

Large disasters require collaboration and response from many agencies, thereby introducing governance risks of duplication, omission and poor coordination. Several evaluations conducted after the fire found that the roles, responsibility and accountability of critical stakeholders – local, provincial, federal, industry, non-governmental agencies – were clearly understood and acted upon during the Fort McMurray fire.

Over the past decade there have been a number of large loss events in Alberta. A post-incident assessment report by KPMG found that the province had successfully integrated many of the lessons learned from past disasters to improve the effectiveness of the response to the 2016 Fort McMurray fire.

Timely sharing of critical information to support better decisions is an emerging challenge for disaster management. Post-event reviews identified specific opportunities to increase information sharing and seek more collaborative decision making.

Investing in disaster risk reduction

Homes recently built in Fort McMurray were less likely to experience damage from the 2016 fire than older structures. We found that guidance from Wood Buffalo contributed to the reduction in fire risk for newer homes. But these efforts would have been stronger had they been integrated into statutory plans and other planning documents.

Most homes in Fort McMurray – and likely all homes built over the past 20 years – have a fire resistant roof, doubled paned glass windows and few openings in eaves, vents and soffits. These features reduce the risk of fire from burning embers. However, many homes have landscaping features that are not fire resistant, such as trees and bushes close to buildings, wood chips, vinyl or wood panel siding, and wooden decks and fences – all of which increase the possibility of loss from wildfire.

FireSmart® sets out comprehensive and detailed advice for homeowners, businesses and communities to protect existing structures in the wildland-urban interface from fire. We found that many property owners, unfortunately, did not demonstrate a commitment to implementing FireSmart® before the 2016 fire. There is scope to improve public awareness and knowledge.

Oil sands companies took steps to protect their assets well before the fire in 2016. We found that these actions were highly effective. The largest losses experienced by these companies resulted from reduced production due to the temporary absence of workers. The companies experienced little direct damage from fire. These companies demonstrated the benefits of committed action to implement FireSmart®.

Building resilience in recovery

Soon after the fire Wood Buffalo established a Task Force to lead the recovery, with a mandate to build back better and create a community more resilient to future hazards. We found the recovery process was effective, with a strong focus on realization of the objectives and goals established by the community. Development of a recovery plan before the fire would have been helpful.

An outpouring of support for the people in Fort McMurray included unprecedented donations to the Canadian Red Cross. The magnitude of support expanded the assistance provided by the Red Cross beyond persons temporarily displaced, to also include replacement of household goods, help with rent and mortgage payments, repair and reconstruction of uninsured homes, and projects to enhance community resiliency.

More than \$3.5 billion was injected into Fort McMurray after the fire by the insurance industry to support rebuilding and reconstruction. Hundreds of new homes and dwellings will replace structures destroyed by fire. These new dwellings are more resistant to loss from future hazards than those that were destroyed as the new buildings comply with current building codes and safety knowledge.

128 See Alexander (2010) Lest we forget: Canada's major wildland fire disasters of the past, 1825-1938.

Section VII: Recommendations

“Never let a good crisis go to waste.”

- Winston Churchill

Since the 2016 fire in Fort McMurray many leaders and several reports have provided thoughtful and detailed recommendations to reduce the risk of loss from future hazards. Readers are encouraged to review the goals set out by the Regional Municipality of Wood Buffalo in their 2016 Wildfire Recovery Plan, the lessons learned identified by KPMG, and recommendations provided by Montane Forest Management, MNP and others. The risk of loss in communities like Fort McMurray located in the wildland - urban interface is increasing. The community benefits from multiple perspectives about options for managing this risk.

This report reflects on the fire in Fort McMurray following three years of recovery and through the lens offered by the Sendai Framework for Disaster Risk Reduction.

WE OFFER FOUR RECOMMENDATIONS:

1. Learn to live with fire

Wood Buffalo and the Government of Alberta should work to better understand and promote public understanding of the risk of loss from wildfire. This can be achieved by further strengthening partnerships with FireSmart® Canada, community leaders, landscapers, insurance companies, the Red Cross and others to improve property owner awareness of risk of living with fire. This should include identifying practices for reducing the risk. The Government of Alberta should also invest in research to better understand how to make structures and communities resistant to urban-wildland interface fire. Most importantly, the federal, provincial and territorial governments should implement the Canadian Wildland Fire Strategy as set out in the 10-year Review and Renewal Call for Action by the Canadian Council of Forest Ministers.

2. Establish a Wildland Fire Resilience Advisory Committee

The Government of Alberta should establish a Wildland Fire Resilience Advisory Committee. The Committee would bring together stakeholders from many backgrounds to anticipate and prepare for future major fires in the wildland-urban interface. Some participants should include wildland firefighters, local fire officials, oil sands companies, insurers, the Red Cross, FireSmart® Canada, researchers and other stakeholders. The Committee should be ready to support communities affected by fire in the future.

3. Invest in resilience and risk reduction

Wood Buffalo and the Government of Alberta should actively invest in wildfire risk loss reduction. They should aggressively promote all aspects of the FireSmart® program as a strategy to establish a resilient landscape and engage property owners. These efforts need to be sustained and long-term. A provincial Code for new development in the urban-wildland interface and local statutory requirements should be enacted. A second major access road for Fort McMurray should be constructed.

4. Develop a pre-hazard major wildfire recovery plan

Wood Buffalo and other communities in the wildland-urban interface should develop a Pre-Hazard Wildfire Recovery Plan. Communities should plan in advance for recovery from future fires, with a focus on the risk of an urban conflagration resulting in extensive loss. Communities should develop a strategy to enhance community resilience in recovery by building back better following a major fire.



Insurance

The widespread use of insurance by property owners injected \$3.5 billion into Fort McMurray to support rebuilding and reconstruction. The insurance industry actively worked with the Government of Alberta, Wood Buffalo and others to support a robust recovery. Moreover, the use of replacement cost insurance strengthened the resilience of the community to future hazards through the replacement of new for old. Insurance is an essential element of disaster risk management as was evident when fire burned into Fort McMurray.

Preparing your business for wildfires

Ideal risk management for wildfires occurs well before an event, so if your location is exposed to wildfires consider taking the following actions to reduce damage from fire, smoke and soot. Embers from the wildfire are blown ahead of the fire front. Wind-driven embers were assessed as being the largest contributor to the ignition of property in the Fort McMurray fire and protecting your landscaping, exterior and interior of the building from them is essential. Newer buildings in Fort McMurray were less likely to experience damage from the 2016 fire than older structures, outlining the value of new building materials and higher fire risk awareness when constructing buildings.

Whenever possible, implement the following recommendations as part of any new project or modification rather than retrofit:

- Understand and reduce wildfire risk: Wildfire risk is a combination of wildfire hazard, exposed assets such as your buildings and contents, and the vulnerability of them to fire. Reduce any of these three aspects whenever possible. Support your local community efforts by preventing the creation of new risk. Follow the local wildland building code, where applicable, or consult other such codes as well as FireSmart® advice (<https://www.firesmartcanada.ca/>) as best practice insights when building new structures. Invest in upgrading and protecting existing buildings.
- Monitor: Monitor for unexpected wildfires all year round, and increase monitoring during the local wildfire season. In case of power or communication outages, have alternative means to monitor wildfire alerts. For example, portable radios and satellite phones. Maintain spare batteries or back-up power for these devices.
- Maintain open space: Provide ca. 10 m of open space between property (including outdoor structures and yard storage) and long grass or desert scrub; and at least 60 meters of open space between property and forested areas. Trees should be more than 10 meters away from a building and spaced at least three metres apart. Deciduous trees are harder to ignite in a wildfire.

- Manage landscape materials and debris: Limit landscaping materials to non-combustible materials. Avoid combustible debris (e.g., trash or vegetation waste) accumulating. Each spring and fall remove all dry twigs, branches and leaves within 10 metres of buildings. This includes leaves under the deck or on balconies and patios.
- Protect building exteriors: Ensure exterior building surfaces, such as roof coverings, wall cladding and glazing, are non-combustible or fire rated and resistant to ignition by embers. Check that open roof drainage gutters are free of foliage and combustible debris.
- Protect building openings: Provide means to keep soot and smoke from entering a building as these can be the biggest causes of damage. Permanently close building openings where possible and use tight fitting, non-combustible doors, shutters or dampers that can be closed when implementing a wildfire plan. Heating, ventilation and air conditioning (HVAC) systems can be a major contributor to smoke damage so ensure that air intake fans can automatically stop on detection of smoke.
- Control yard storage: Limit, or if possible eliminate, yard storage. Locate combustible yard storage at least 30 meters away from buildings and important outdoor structures.
- Support the fire service and protect entrances and exits: Have your site regularly inspected by the fire department and clearly identify and maintain access to water sources; including fire hydrants, swimming pools, water storage tanks, wells, and natural sources such as ponds. Clearly mark each site entrance and ensure it is large enough to accommodate emergency vehicles. Maintain open space around each entrance/exit so burning vegetation is less likely to hamper vehicles entering or leaving to evacuate.

Develop a wildfire emergency and an evacuation plan

Develop a wildfire plan as part of a broader emergency response program for your location. It should include:

- Emergency duties and who should perform them
- An assigned qualified person(s) to trigger the wildfire plan

- Assign people responsible for monitoring weather conditions and warnings, maintaining contact with local authorities and for communications.
- Evacuation procedures, routes and exits that are regularly communicated with employees
- Procedures to account for employees, contractors and visitors
- Emergency equipment for assigned employees
- Regularly scheduled reviews and evacuation drills
- Contact details for emergency services, insurance representatives, as well as suppliers and vendors to contact after a wildfire
- Identify local building materials suppliers, contractors, structural engineers/surveyors, loss adjustors, etc, to aid with recovery. Through contractual agreements ensure priority for servicing after an event.

Appoint a wildfire team, assign emergency duties and provide triggers to start and stop each of the wildfire duties listed below:

- Backing up data
- Shutting down building air intakes
- Closing and sealing building openings
- Moving yard storage and clearing your deck or patio
- Shutting down processes
- Shipping important tools and records off site
- Turning off unnecessary utilities (except fixed fire protection)
- Evacuating the site. Evacuation involves the orderly relocation of people (employees, contractors and other visitors) from an area affected by an emergency to an area designated as a gathering location during an emergency. In the case of a wildfire, the designated gathering location will likely be a remote off-site location.

To learn more about protecting your location to and recover better from wildfires, read the following:

<https://www.zurich.com/en/knowledge/articles/2019/01/preparing-your-business-for-wildfires>

<https://www.zurich.com/en/knowledge/articles/2018/11/after-the-wildfire-steps-to-help-your-business-recover>

The research process

The Post-Event Review Capability (PERC) is a systematic framework for the analysis of a disaster event, focusing on how a specific hazard event became a disaster. The PERC process evaluates the successes and failures in the management of disaster risk prior to the event, disaster response and post-disaster recovery. If the disaster occurred in two different areas with one more badly impacted than the other, PERC can help determine why the impacts were disproportionate. PERC then identifies future opportunities for intervention/action that could reduce the risk posed by the occurrence of similar, future hazard events. PERC uses a system-wide approach to review disasters, analyzing across scales and sectors, and all aspects of the disaster management cycle – prospective and corrective risk reduction, preparedness, response, and recovery. It provides a bird’s-eye view of why the disaster occurred and how resilience might be built. While Zurich’s PERCs to-date have primarily focused on floods, the PERC process/methodology can be applied to review any rapid-onset hazard or shock, natural or non-natural, including wildfires, floods, earthquakes, tsunamis, terrorist attacks, and so on. This is the first PERC report focusing on wildfires, as part of widening our engagement to support a climate-adapted society and support those most impacted. Wildfires, together with drought and flood, are at the forefront of the climate change impacts felt and provide key learnings how to better reduce climate risks and become more resilient to the effects of climate change.

Launched in 2013, Zurich’s Flood Resilience Alliance (<https://www.zurich.com/flood-resilience>) created PERC as part of Zurich’s corporate responsibility program. The Zurich Flood Resilience Alliance is a multi-sectoral partnership between the humanitarian sector, academia and Zurich’s risk experts focusing on finding practical ways to help communities in developed and developing countries strengthen their resilience to flood risk. We work on shifting from the traditional emphasis on post-event recovery to pre-event resilience. Originally five organizations working together, the Zurich Flood Resilience Alliance now comprises of nine members - Zurich Insurance Group working with the civil society and humanitarian organizations Concern Worldwide, the International Federation of the Red Cross and Red Crescent Societies, Mercy Corps, Plan International, Practical Action as well as research partners the International Institute for applied Systems Analysis (IIASA), the London School of Economics (LSE) and the Institute for Social and Environmental Transition-International (ISET).

Common themes appear within the existing body of PERC analyses, with similar points of failure, successes, and capacities in response to hazard events across geographical, social, political and economic contexts. Disasters anywhere on the globe can provide important, broadly applicable lessons learned for where and how resilience can be built.

These lessons learned are critical ‘learning’ is the cornerstone of the resilience-building process. As we know, after the event is before the next event. Learning is not only about information exchange; it also helps strengthen and create networks, allows different stakeholders to deliberate together, builds knowledge and capacity among people and groups, and fosters engagement that can eventually create transformative change. This is needed to avoid rebuilding the same risks or building-up more risk, and to reduce loss and misery in future events, both locally and globally.

PERC is designed to provide a holistic analysis of the disaster at event (e.g., watershed) level, which very often might be trans-regional or trans-national. Consequently, it is not aimed at decision-makers or actors at any specific level, nor is it targeted for specific sectors. PERC provides a bird’s-eye view of critical gaps and opportunities, particularly actionable opportunities, to reduce risk around which disaster practitioners, authorities and advocates can promote, plan, design and execute interventions that are grounded in the local context. PERC is research independent from insurance coverage and products, political reviews, and other vested interests, implemented to understand what happened during the disaster and why.

The research for this report involved interviews with key stakeholders combined with a review of the literature.

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Goals of the Canadian Wildland Fire Strategy

Resilient communities and an empowered public

Inform and engage the public through wildland fire awareness as well as information initiatives and communicate the appropriate response concept to professionals, politicians and the public.

Share responsibility through development of integrated government policies clearly defining the risks, roles, and responsibilities of all constituencies (individuals, communities, industries and governments).

Minimize the risk to public safety and property by developing and implementing a Canadian FireSmart® initiative with distinct components addressing mitigation, preparedness, response and recovery.

Initiate a directed and integrated program of physical and social science research and technology transfer on WUI issues.

Healthy and productive forest ecosystems

Integrate land, forest and wildland fire management policies and practices such that wildland fire management policies and actions are derived from explicit land and forest management objectives. In addition, ensure that land and forest management policies consider the biological, ecological, and physical characteristics of wildland fire.

Reintroduce and/or maintain fire on parts of the landscape by appropriate means, including prescribed fire, with the goal of maximizing biodiversity, ecological integrity and productivity in fire-dependent ecosystems.

Modern business practices

Maintain an economically efficient and world-class wildland fire preparedness and response capability through long-term replacement of deteriorating equipment and infrastructure, implementing Canadian training standards in addition to recruiting and training personnel at universities and community colleges.

Build effective partnerships and innovative institutional arrangements for reducing inter-annual variability of wildland fire management expenditures through the development and use of a Canadian interagency operational preparedness system. Foster effective communication and adaptive management through Canada-wide workshops and information-sharing sessions.

Develop innovative risk- and cost-sharing approaches consistent with insurance principles.

Adopt a culture of continuous improvement in policy and practice by establishing a collaborative analysis group to carry out policy assessments and analyses of level of protection. Initiate a directed program of fire science and innovation coupled with a comprehensive program of technology transfer.

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