Survey of Municipal Land Use Planning for Wildfire Risk Mitigation in Alberta

A report prepared for Alberta Agriculture and Forestry

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Project Background

This report presents research conducted in 2020 by researchers from the University of Alberta's Human Dimensions of Hazards Research Group. The study was completed as part of the _Barriers to FireSmart Development in Alberta Research Project_, a partnership between the University of Alberta, Canada Wildfire, FireSmart Alberta, and Alberta Agriculture and Forestry. _Barriers to FireSmart Development_ aimed to uncover obstacles to the integration of land use planning and wildfire disaster risk reduction. The project was funded through a grant from Alberta Agriculture and Forestry's Wildfire Management Science and Technology Group (WMST).

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Executive Summary

Land use planning and development regulations are widely recognized by disaster scientists and policy-makers as essential instruments for reducing the risks and impacts of natural hazards, including wildfire. The FireSmart program attests to the paramount role of the built environment in influencing outcomes of contact with wildfire—two of the seven FireSmart disciplines focus on municipal land use policies (i.e., Legislation) and development regulations (i.e., Development). The devastating impacts of the 2016 Horse River Fire on the Regional Municipality of Wood Buffalo, and the 2011 Flat Top Complex Fire on the Town of Slave Lake, underscore the relevance of maximizing resilience to wildfire through interventions in the built environment.

Community wildfire mitigation has received significant attention from wildfire social scientists. Evidence from studies in Canada and internationally indicate that community wildfire mitigation efforts tend to focus on public education and vegetation management, and actions taken are typically voluntary in nature rather than regulatory. In Canada, activities related to the Legislation and Development FireSmart disciplines remain largely understudied. Little is known about the extent to which land use planning and development regulations are being used by municipalities, which measures are being adopted, and what factors, if any, might be obstacles to the full implementation of all FireSmart disciplines.

In order to address this gap, we designed a descriptive cross-sectional ("snapshot in time") survey focusing on Alberta. Alberta has the second highest average number of wildfires and evacuations among provinces and territories in Canada. The study purpose was two-fold:

1) To assess to what extent municipalities in Alberta are using land use planning policies and development regulations to address wildfire risk; and

2) To survey municipal planning and development professionals about their perceptions of potential barriers to a land use approach to wildfire risk mitigation.

In Spring 2020, we conducted a census of all cities, towns, counties, municipal districts, and specialized municipalities in the Province of Alberta (N = 194). Data were collected using a self-administered online questionnaire. We obtained 114 completed surveys, representing 59% of municipalities in Alberta (excluding villages, summer villages, special areas, and Indigenous communities). Our sample of municipalities was sufficiently representative of the overall study population and the completion rate well above the acceptable rate for institutional surveys. As such, the results about municipalities are generalizable to all municipalities (as defined above) in Alberta.

Characteristics of Study Sample (n = 1114)

- Forest Protection Area municipalities (i.e., "FPA municipalities") made up 33% of our study sample; 75% (n = 38) of FPA municipalities completed our survey.

- 37 municipalities (32% of the study sample) reported a history of wildfire evacuation and/or structural loss due to wildfire since 2000 (i.e., "Wildfire History municipalities"); 54% of Wildfire History municipalities were also FPA municipalities.

- The majority of study participants (76%) perceived wildfire to be a potential threat to their community in any given year (97% from Wildfire History municipalities, 92% from FPA municipalities).

- 61% of study participants reported working in the planning and development sector for 10 years or more; 30% were Registered Professional Planners (RPP) or RPP Candidates.

Key Findings

- A third of municipalities (36%) had completed one or more FireSmart Community Plan documents (*Wildfire Hazard and Risk Assessment*, *Wildfire Preparedness Guide*, *Wildfire Mitigation Strategy*).

  - 32% had completed the *Assessment*; 15% had completed all three documents.

  - Although Wildfire History municipalities were more than twice as likely to have completed a document as were those without a history of wildfire, nearly half of Wildfire History municipalities (46%) did not report having completed a *Wildfire Hazards and Risk Assessment* in spite of their recent exposure to wildfire.

  - 61% of FPA municipalities had completed at least one FireSmart Community Plan document.

  - 53% of municipalities with wildfire evacuation experience (*n* = 17) had completed a *Wildfire Preparedness Guide.*

  - 37% of municipalities that reported structural or infrastructure loss due to wildfire (*n* = 35) had completed a *Wildfire Mitigation Strategy*.

- 51% of *Municipal Development Plans* addressed flooding as a natural hazard while just 30% addressed wildfire; 43% of *Intermunicipal Development Plans* addressed flooding and 18% addressed wildfire.

- 14% of municipalities (27% of Wildfire History and 26% of FPA municipalities) had adopted one or more wildland-urban interface (WUI) model code or standard for development-based wildfire risk mitigation.

  - The most adopted model was the *NFPA 1142 Standard on Water Supplies for Suburban and Rural Fire Fighting* (*n* = 9, 8%).

  - Alberta-specific models had low adoption rates (<6%).

- We collected data on 23 recommended planning and development-related wildfire risk mitigation measures.

  - The most commonly reported planning and development measures adopted by municipalities addressed flammable materials on private property and roadway standards. The most common measures were not necessarily specific to wildfire risk: Regulating fire hazards on private property (68%) and restricting development on steep slopes (53%).

  - Measures that seek to avoid wildfire risk by controlling where development occurs in relation to identified hazards were the least adopted measures (<12% of municipalities).

  - 39% adopted roadway designs affecting emergency vehicle access during wildfire emergencies and 32% adopted standards for availability of water. However, these standards only applied to new developments. Less than half (14%) required existing developments to be retrofitted for water access during a wildfire emergency.

  - 19% of municipalities required fire-resistant materials on all new or significantly renovated public buildings; 25% recommended fire-resistant materials on privately-owned buildings.

  - Policies aimed at protecting critical sites and municipal infrastructure from wildfire, and avoiding exposure to wildfire through controlling where development occurs, had low adoption rates, even among Wildfire History municipalities. Five municipalities (4%) reported prohibiting development in wildfire hazard areas; four municipalities incentivized development outside of wildfire hazard areas, and four municipalities restricted residential density in wildfire hazard areas. Three

Wildfire History municipalities provided at least one publicly-accessible wildfire shelter in the event that residents cannot evacuate.

- We asked study participants to indicate to what extent they perceived 17 factors to be potential obstacles to using municipal planning to mitigate wildfire risk in their community.

    - Fifteen of the 17 items were viewed as a minor, moderate, significant or very significant obstacle by 50% or more of study participants.

    - Local resistance to the idea of constraining development on private property, resistance from developers and builders, lack of financial resources, lack of a clear provincial mandate to address wildfire risk through land use planning, resistance from residents, and the perception that the community prioritized development over wildfire risk mitigation were viewed as obstacles by 80% or more of study respondents.

    - There were notable differences in perceptions of barriers between respondents from Wildfire History municipalities and those from municipalities without a recent history of wildfire. Nine items were viewed as being an obstacle by 80% or more of respondents from Wildfire History municipalities compared to just three items in the non-Wildfire History municipalities sub-samples. Significantly more participants from Wildfire History municipalities perceived resistance from elected officials (+32%), resistance from residents (+25%), and the local view that development and growth are more important than development (+22%) to be obstacles than their counterparts in communities without wildfire experience. Resistance from developers/builders (+14%), lack of a clear provincial mandate (+13%), and uncertainty about appropriate mitigation planning tools (+13%) were also more often viewed as barriers. These differences could be attributed to levels of experience trying to address wildfire risk through planning.

- Fewer than half of study participants (47%) reported having received formal training about the role of municipal planning in mitigating natural hazards. More respondents disagreed (39%) that they had received adequate training about planning for natural hazard mitigation than agreed (16%). The majority of respondents (74%) were interested in receiving additional training with respect to wildfire risk mitigation, particularly in the Wildfire History sub-group (89%).

Implications and Recommendations

The findings from this survey point to a number of intervention opportunities for FireSmart Alberta as well as gaps in knowledge that can be addressed by researchers.

- The data regarding the FireSmart Community Plan suggest that a significant proportion of municipalities in Alberta that are likely at risk of wildfire are not fully engaging with the FireSmart Program. A review of the FRIAA FireSmart Program could help shed light on the dimensions of this shortfall. Additional research should focus on the experiences of municipalities and their needs, as well as solutions.

- Reasons for the low adoption rate of model WUI codes and standards, particularly those developed for Alberta, should be explored to find out if there are problems with the models or if it's simply a lack of awareness that FireSmart Alberta could remedy through a communications strategy.

- Wildfire was addressed in only 30% of *Municipal Development Plans*. FireSmart Alberta may wish to develop a template with Alberta Municipal Affairs to demonstrate how wildfire hazards can be incorporated into MDPs and IDPs, particularly since 78% of MDPs that did not address wildfire are 5 years old or more and therefore ready for review or update.

- The data regarding the FireSmart Community Plan and the low adoption rate of municipal planning measures reliant on wildfire hazard and risk information, in combination with the results regarding

perceived financial, technical and knowledge barriers, indicate that many municipalities do not have the capacity or resources to identify local hazards and risks and therefore to respond with appropriate planning and development regulations. FireSmart Alberta and relevant provincial agencies can collaborate to improve the current support system for municipalities at risk of wildfire forest, grassland and agricultural fires. This includes implementing the recommendations from the Fort McMurray disaster review, and the Alberta auditor general's recent recommendations regarding the creation of a provincial hazard information system.

- Relatively few municipalities are controlling where development occurs in relation to wildfire hazards (macro-level land use planning). Rather, the most adopted measures address vegetation management on private properties (micro-level) and roadway or water standards in neighbourhoods (meso-level). This finding may be related to lack of hazard and risk information, or uncertainty about the legal and technical aspects of wildfire risk mitigation through planning. It may also be related to the perceived barriers regarding cultural attitudes that emphasize short-term economic development and private property rights. More research is needed to understand the dynamics of these decisions and find solutions that can work across contexts.

- Our study findings suggest that wildfire resilience in older developments may be overlooked in some communities. In addition, municipal buildings and critical infrastructure may also be unacceptably vulnerable. These concerns should be further explored by FireSmart Alberta. Municipalities should be encouraged to lead by example by demonstrating FireSmart practices on all municipal properties. FireSmart Alberta should consider introducing an incentive program that funds or awards innovative municipal projects.

- Some of the barriers, such as the lack of a provincial mandate to integrate wildfire risk mitigation into local planning policies, can only be addressed by Government. However, FireSmart Alberta can intervene in other areas. First, study participants identified certain stakeholder groups as creating resistance to a land use approach. Second, certain attitudes and cultural stances appear to play a hindering role. Third, study participants viewed lack of financial resources, and technical and legal information as barriers. FireSmart Alberta should consider its capacity to respond to these barriers, and request additional research if needed.

- A significant proportion of municipal planning and development professionals in Alberta do not feel adequately trained to mitigate wildfire risk through land use planning and development regulations. FireSmart has an opportunity to work with provincial agencies, planning industry partners and planning educators to develop a comprehensive training framework that addresses students and seasoned professionals alike in order to increase confidence and competence. FireSmart materials should be inclusive of urban communities and communities at risk of grassland and agricultural fires.

- While Homeowner Associations (HOAs) are not ubiquitous in Albertan communities, they are a growing trend. FireSmart Alberta should consider an outreach program to HOAs in order to prevent a repeat of the Edmonton–Blackburn Creek HOA situation.

For the first time, this study provides generalizable baseline data about the extent to which municipalities in Alberta are completing FireSmart Community Plan documents, and using specific land use planning and development measures to mitigate wildfire risk. This study also provides insights into barriers to land use planning for community fire-adaptedness. As a number of biophysical, climate and sociodemographic trends converge, it is more imperative than ever that communities located in wildfire-dependent landscapes leverage all available tools to increase their resilience to wildfire and reduce the likelihood of disaster. There are many opportunities for FireSmart Alberta, government and industry partners to intervene in addressing the gaps identified in this report.

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1.0 Introduction

Researchers have observed a number of paradoxes in the way that modern societies live with wildfire (Leone, Tedim, & Zanthopoulos, 2020). Wildfire management professionals are likely well aware of the "wildfire paradox" (Brown & Arno, 1991). The wildfire paradox describes how more than a century of wildfire suppression policies aimed at protecting people and assets have inadvertently resulted in creating greater wildfire risk due to increased fuel loads in the landscape—a condition further exacerbated in Western North America by climate change (Calkin, Cohen, Finney, & Thompson, 2015; Coogan, Robinne, Jain, & Flannigan, 2019).

However, wildfire management professionals may be less aware of the "safe development paradox" (Burby, 2006). The safe development paradox occurs when people enact structural mitigation measures intended to render an area "safe" in the short term, often at the expense of a more comprehensive approach to mitigation. Structural mitigation measures refer to construction or physical alterations to structures or systems, or the use of engineering or technology to avoid or reduce the impacts of hazards (United Nations Office for Disaster Risk Reduction, 2017). While this approach to disaster risk mitigation may work initially, the potential for severe losses over the long term increases as more and more people settle in an inherently risky location while under the illusion that hazards have been addressed (Burby, 2006).

In North America, the illusion of safety created by advanced wildfire suppression technology has arguably facilitated the expansion of urban development in wildfire-dependent landscapes. It may also be one reason why communities with wildfire hazard exposure are often not designed to be resilient to contact with fire. However, there is a growing consensus among wildfire scholars, disaster risk reduction policy-makers and wildfire risk managers that populations living in fire-dependent landscapes should adopt an *adaptive mindset* rather than solely rely on wildfire suppression for protection (Schoennagel et al., 2017; Tymstra, Stocks, Cai, & Flannigan, 2020). Fire adapted communities aim to reduce the likelihood of a wildfire-related disaster by engaging in a comprehensive, multi-stakeholder program of wildfire risk and impact reduction measures with the knowledge that a wildfire could eventually reach a community (Government of Alberta, 2013; Toman, 2013). Only a few studies have examined municipal wildfire mitigation actions in Canada (Harris, McGee, & McFarlane, 2011). Perceptions of barriers to integrating land use planning and wildfire risk mitigation have not been studied in Canada.

This report presents findings from the first provincial survey of municipalities in Alberta on the topic of land use planning and wildfire risk mitigation. The research aimed to capture the extent to which municipalities are using planning policies and development regulations to limit the impacts of wildfire on their communities, and to explore municipal planning and development professionals' perceptions of barriers to a land use planning approach to wildfire risk mitigation.

1.1 Background

Disaster mitigation measures refer to efforts to "eliminate or reduce the impacts and risks of hazards through proactive measures taken before an emergency or disaster occurs" (Public Safety Canada, 2008, p. 1). Although wildfire disaster mitigation in Canada has traditionally relied on suppressing wildfires at the landscape scale (Coogan et al., 2019), there have also been efforts to reduce the vulnerability of communities.

For more than 30 years, FireSmart Canada has encouraged a shared responsibility model of wildfire disaster mitigation in communities located in fire-dependent landscapes (Canadian Forest Service, 2016). Under the FireSmart model, residents, businesses, land owners, industry and municipal governments are encouraged to take responsibility for mitigating wildfire hazards and risk (Government of Alberta, 2013). Through FireSmart's programs, stakeholders participate in a variety of domains of action, called the FireSmart Disciplines: Education, Emergency Planning, Vegetation Management, Legislation, Development, Interagency Cooperation, and Cross Training.

According to the FireSmart model, local governments specifically can take action to mitigate wildfire risk in at least three ways. First, municipal authorities can partner with other agencies and stakeholders to conduct wildfire risk mitigation activities (i.e., Emergency Planning, Interagency Cooperation, Cross Training). Second, municipalities can encourage defensible space strategies on public and private property (i.e., Education, Vegetation Management). And third, municipalities can adopt policies to ensure that the districts, neighbourhoods, buildings, infrastructure, open spaces and other structures within their jurisdictions are not unduly vulnerable to wildfire (i.e., Legislation, Development).

In 2015, 187 countries, including Canada, endorsed the *Sendai Framework for Disaster Risk Reduction 2015–2030* (Godsoe, Ladd, & Cox, 2019). Land use planning and development regulations are identified as a priority area for action under the *Sendai Framework*. A land use planning approach to hazard risk mitigation includes making decisions about where development takes place, the types of uses allowed, development density and layout, roadway design, and landscape and architectural design and materials. Since planning decisions can alter exposure to hazards, influence the vulnerability of people and key infrastructure and services (including emergency operations), modify the actual hazards, and impact recovery from disasters, planning should be viewed as a "constant and continuous element of the risk management cycle" (Sapountzaki, Wanczura, Casertano, Greiving, Xanthopoulos, & Ferrara, 2011, p. 1447). The recent American Planning Association's publication Planning the Wildland-Urban Interface provides an in-depth guide to land use planning for wildfire risk mitigation (Mowery, Read, Johnston, & Wafaie, 2019).

National approaches to community wildfire risk management vary significantly. In France, wildfire risk is assessed by the national government and restrictions placed on local development according to severity of risk (Kocher & Butsic, 2017). In Australia, Canada, and the US, community wildfire risk management is largely left to state and provincial governments,

leading to differing levels of institutional integration between planning and wildfire risk reduction (Gonzalez-Mathiesen, Ruane, & March, 2021; Mowery & Punchard, 2021). The policy and governance aspects of community wildfire risk reduction are understudied in Canada. An international review of wildfire-urban interface (WUI) standards and guidelines noted the absence of such standards in Canada (Intini, Ronchi, Gwynne, & Bénichou, 2017), although since that report was published, a voluntary WUI development standard (CSA S504 Fire Resilient Planning for Northern Communities) was released.

Land use planning and development regulations have been found to be effective at reducing wildfire losses (e.g., Fox, Carrega, Ren, Caillouet, Bouillon, & Robert, 2018; León & March, 2017; Mobley, 2019; Syphard, Brennan, & Keeley, 2014). This is one reason the authors of the Fort McMurray disaster review concluded that, while voluntary FireSmart measures had likely reduced overall impacts, the program "would have [had] a greater protective impact if built into Wood Buffalo's statutory [planning] documents" (Kovacs, McBean, McGillivray, & Pulsifier, 2019, p. 26). Mitigating wildfire risk through planning is also cost-effective. A national U.S. benefit-cost ratio analysis of compliance with the International Wildland Urban Interface Code (IWUIC) found that $4 could be saved for every $1 spent on additional construction and maintenance costs related to IWUIC standards (Multihazard Mitigation Council, 2018). The savings were mostly attributed to the benefits of reduced property loss but also included lowered costs related to insurance overhead and profits, deaths and injuries, and evacuations. Conversely, building according to conventional norms and then retrofitting to increase resilience to wildfire is costly: A study from Australia found that the average cost to retrofit already built homes for wildfire resilience was $24,000 CAD (Penman, Eriksen, Horsey, Green, Lemke, Cooper, & Bradstock, 2017).

While the role of planning and development in community wildfire risk reduction is not disputed, research conducted in Australia, the United States and to a lesser extent in other jurisdictions, including Canada and New Zealand, indicate it is consistently the least adopted of the recommended actions. Efforts tend instead to focus on education and outreach around voluntary measures targeting residents and private property, vegetation management on public lands, and emergency response capacity (Harris et al., 2011; Kocher & Van Butsic, 2017; Muller & Schultz, 2011). When regulatory tools are used, they tend to focus on emergency operations (e.g., egress and water access, restricting open burning during periods of high fire danger) rather than land use planning (Mockrin, Fishler, & Stewart, 2018). In Alberta, an analysis of the FRIAA FireSmart Program, the main funding vehicle for local FireSmart activities, found that just three (1%) of the 365 projects funded between 2014 and 2020 were focused on the Legislation and Development disciplines. The most commonly funded projects addressed vegetation and fuel management (50%), followed grants to develop FireSmart Community Plans (24%) (Gatti, 2021).

Empirical research on municipal land use planning and barriers to a planning approach to wildfire risk mitigation in Canada is lacking. Only a handful of studies have focused on wildfire mitigation actions taken by municipal governments. In a study of wildfire risk mitigation measures in 18 municipalities in Alberta, researchers found few had adopted land use planning

measures and building regulations (Harris et al., 2011). A survey conducted in 2012 collected data about community wildfire mitigation actions from municipal governments with fire departments in communities in Alberta and British Columbia (Labossière & McGee, 2012). While the response rate did not permit generalization to the broader population, the findings from this exploratory study echoed those from studies in non-Canadian jurisdictions with similar planning frameworks and cultures, namely that planning and development regulations were the least adopted of all measures (Buxton, Haynes, Mercer, & Butt, 2011; Muller & Schulte, 2011; Reams, Haines, Renner, Wascom, & Kingre, 2005). In a third study, researchers examined the City of Kelowna's response to wildfire-related losses in 2003. They found the municipality did not change land use planning policies to reduce wildfire risk. Instead, local government allowed for expanded development of the WUI (deScally, deScally, & Senese, 2018). A fourth study looked at innovative mitigation actions taken in two municipalities in British Columbia but did not include planning and development actions (Labossière & McGee, 2017). We could not locate any other studies regarding wildfire mitigation actions taken by municipal governments in Canada.

Given that local governments are responsible for land use planning and therefore play a key role in the FireSmart Legislation and Development disciplines, there is a need for both descriptive research that provides an accurate picture of municipal actions, as well as research to identify factors that influence the adoption of land use planning policies and measures (Labossière & McGee, 2012; McCaffrey et al., 2013). There is also a need to understand planners' perceptions and experiences with land use policies to reduce hazard exposure (Mockrin, Fishler, & Stewart, 2020).

The study presented in this report was designed to address these knowledge gaps. In this report, we provide baseline data about land use planning and development regulations in Alberta. We also present perceptions about barriers to the integration of wildfire risk disaster reduction and land use policies from municipal planning professionals in Alberta.

1.2 Study Purpose

Initially, the primary purpose of this study was to collect data regarding barriers to the integration of wildfire mitigation strategies into land use planning policies and development regulations. The rationale for the study was the perception among wildfire risk managers that Alberta municipalities were not employing land use planning (FireSmart Legislation) and development regulations (FireSmart Planning) for wildfire risk reduction. However, after an initial literature search failed to locate sufficient empirical evidence to support this claim, we expanded the scope of the survey to include uncovering to what extent Alberta's municipalities have integrated wildfire risk reduction into their land use planning and development policies.

1.2.1 Research Objectives

1. To discover to what extent municipalities in Alberta have conducted wildfire risk mitigation through land use planning and development regulations.

2. To discover to what extent municipal planners perceive various factors to be potential barriers to the integration of municipal planning and wildfire risk mitigation in their communities.

1.2.2 Definitions

Key concepts in this study were defined as follows:

- *Barriers* are factors that hinder the consideration or adoption of municipal planning policies and regulations for the purposes of mitigating wildfire risk. We assume that barriers can be overcome whereas limits cannot (Moser & Ekstrom, 2010).

- *Municipalities* refers to cities, towns, counties, municipal districts and specialized municipalities in Alberta.

- *Municipal planning* refers to the variety of land use planning and development tools (e.g., statutory plans, land-use bylaw, development standards) made available to municipalities through Alberta's *Municipal Government Act (MGA)*.

- *Vulnerability* is a multidimensional construct that refers to "the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards" (United Nations Office for Disaster Risk Reduction, 2017).

- *Wildfire risk mitigation* refers to actions (e.g., policies, programs) taken with the intention of reducing a community's direct exposure to wildland fires and/or reducing the impacts of wildfire on life and property. In this report, we are focused on wildfire risk mitigation actions taken by *municipal governments only*—not by residents, the provincial government, or the private sector.

2.0 Study Design and Method

2.1 Study Area

This study focuses on the Province of Alberta. This decision was due to the interests of the research funder, Alberta Agriculture and Forestry.

Wildfires are a natural phenomenon across most of Canada's landscapes. However, Alberta ranks second highest among provinces and territories for average number of fires in a year (Natural Resources Canada, 2020) and for number of evacuation events (Natural Resources Canada, 2019). The Province of Alberta also has the unique distinction of having experienced Canada's costliest wildfire-related disaster. In 2016, the Horse River Fire captured national and international attention when it required the rapid evacuation of nearly 88,000 residents from the remote community of Fort McMurray (Kovacs et al., 2019). While no lives were lost as a direct result of the fire, more than 2,500 buildings were destroyed and the estimated cost of direct damage to Fort McMurray was $5.3 billion (Kovacs et al., 2019). One of the consequences of the Fort McMurray disaster is an increased awareness of the role of urban development in *creating vulnerability* in a process called "disaster risk creation" (Lewis & Kelman, 2012).

The Horse River Fire was an exceptional event. However, wildfire evacuations and losses, as well as the costs of wildfire management have been increasing across Canada for the past 30 years (Natural Resources Canada, 2019; Tymstra et al., 2020). Several trends suggest wildfire vulnerability is a growing concern for Alberta. The concern is based on several factors, including:

- an increase in the number of people and assets exposed to wildfire hazards due to WUI expansion and population growth in remote Indigenous communities (Peter, Wang, Mogus, & Wilson, 2005);

- a changing fire regime in Western Canada that will likely lead to a longer fire season, and more intense and frequent fires (Coogan et al., 2019);

- the rise of mega-fires as a consequence of the wildfire paradox and climate change (Hanes, Wang, Jain, Parisien, Little, & Flannigan, 2019); and

- the lack of comprehensive community wildfire risk mitigation—specifically, land use planning and development regulations are being overlooked as critical mitigation tools in Alberta.

While this latter point was a key finding from the Fort McMurray post-disaster analysis (Kovacs et al., 2019) and has been suggested by limited previous research on municipal wildfire mitigation measures in Western Canada (Harris et al., 2011; Labossiere & McGee, 2012), the lack of empirical evidence for Alberta as a whole was a driving force for this study.

2.2 Study Design

We used a descriptive cross-sectional survey design to assess to what extent municipalities in Alberta were using land use planning policies and development regulations to address wildfire risk, and to survey municipal planners about their perceptions on this topic. This study design offers a snapshot of policies and perceptions *at one point in time*. A summary of the study design is presented in Table 1.

Table 1. Research design at-a-glance

Study Design	Study Populations	Method	Sampling Approach
Descriptive cross-sectional survey	All cities, towns, counties, municipal districts, and specialized municipalities in Alberta (*N* = 194) Municipal planning and development professionals (estimated *N* = 2,100)	Self-administered online questionnaire	Census; email invitation to chief municipal administrators and heads of municipal planning and development

2.3 Study Populations

The original target population ("study population") for this research were primarily municipalities in Alberta that conduct land use planning and are at risk of wildfire. To identify the municipalities that make up the study population ("sampling frame"), we considered two criteria, land use planning activity and wildfire risk, for reasons explained below.

Since our focus was on municipal land use planning, we wanted to include only those municipalities whose land use planning is governed by Alberta's *Municipal Government Act (MGA)*. Therefore, we included all municipality types according to the Alberta Government's classification scheme (Government of Alberta, 2021a) with the exception of villages, summer villages, Special Areas, and Indigenous communities. We excluded First Nations communities, Métis settlements and Special Areas because they are not governed by the *MGA*. Villages and summer villages were excluded because they typically lack staff capacity to perform land use planning (e.g., planning work conducted by contractors), and this lack of capacity would likely lead to nonresponse bias when collecting data. This left 194 cities, towns, counties, municipal districts, and specialized municipalities for potential inclusion in our study population.

We also set out to identify which of the 194 municipalities in Alberta were at risk of wildfire and therefore should theoretically be mitigating wildfire risk through land use planning and development regulations. However, the Alberta Government does not publish wildfire risk information, and there is no single accepted method for assessing wildfire risk to communities in Alberta. Therefore, we decided to include all 194 municipalities as our study population.

Since our survey also sought the perceptions of the study respondents (planners and development professionals working in the 194 municipalities), municipal planning and development professionals were a second study population. The Government of Alberta estimates there are 2,100 "community planners" working in Alberta (Government of Alberta, 2021b).

2.4 Sampling Approach

We obtained a list of all municipalities from the Alberta Municipal Affairs' website (Alberta Municipal Affairs, 2021). Given the small number of municipalities in the study population (N = 194) and its heterogeneity of characteristics (e.g., municipality types, fuel context), as well as the lack of existing baseline data about municipal policies and municipal planning and development professionals' views on this topic, we chose to conduct a census rather than randomly sample the population. This allowed us to collect the maximum number of completed surveys in order to have the option of later stratifying the data according to different categories for various analyses.

2.5 Instrument

The study questionnaire was developed using an iterative process of item generation, item reduction, formatting and testing (pretest and pilot test) in consultation with researchers from the Human Dimensions of Hazards Research Group and hazard risk reduction professionals from FireSmart Alberta, Alberta Agriculture and Forestry, and the Alberta Emergency Management Agency. The questionnaire items were informed by a literature review (Gatti, McGee, & Yusefi, 2019) and discussions with the project team. A respondent could answer a maximum of 46 questions, including branching questions and open-ended questions. Study participants also had the option of skipping questions.

Data were collected about both the municipality and the individual study participant ("units of analysis"). At the organizational level, knowledge questions were used to collect factual data regarding the municipality's characteristics; FireSmart Community Plan; municipal plans, planning tools and wildfire mitigation measures; and wildfire history. At the individual level, we asked respondents about their professional status, history and education; perceptions of various dimensions of wildfire risk; and perceptions of barriers to the adoption of planning measures for community wildfire risk mitigation. For questions that sought data about non-quantitative and named variables, such as evacuation history or planning tools used, the response format was either binary (yes/no) or checklist (check all that apply). For questions collecting data about perceptions, we used a Likert-type format. We asked five open-ended questions in order to capture additional information or allow respondents to provide more details.

A number of measurement and survey design decisions were made to reduce the influence of design on the quality of data (Menold & Bogner, 2016), within the limitations of the online survey software. Question stems and response formats were kept as uniform as possible. Categorical items included an "I don't know" option only when it was plausible that the respondent may not

have the required knowledge to answer the question. Likert-type items were based on discrete points, with each response verbally labelled. We chose to use item-specific response categories over an agree/disagree structure in order to reduce acquiescence, and we displayed Likert-type rating options horizontally. Study questions and wording were reviewed by researchers, and planning and wildfire prevention professionals to increase item reliability.

The questionnaire was accessible in an online format only. The decision not to provide alternative formats was based on the assumption that, as professional employees working for municipal governments, study participants would have access to a computer, the Internet, and any required accessibility devices.

2.6 Recruitment Strategy

In March 2020, we distributed a self-administered online survey to the head municipal administrator, usually the Chief Administrative Officer (CAO), of each municipality. Each municipality was assigned a unique survey link. The list frame was obtained using a publicly-available list of municipal executives published on the Alberta Government's website (Alberta Municipal Affairs, 2021). In response to the feedback from invited participants that the CAOs were heavily engaged in emergency management of the newly emerging coronavirus pandemic, we shifted our recruitment approach to target the top planning and development official in each municipality in April 2020. Names and email addresses for top planning officials were obtained by visiting each municipality's website or contacting each municipality's administration.

Survey response rates have been declining since the 1980s (Dillman, 2014). We employed various strategies to counter nonresponse: personalized emails; emphasis on study purpose and sponsor; appeals to truism; assurances of confidentiality; follow-up reminders; and placement of complex and personal questions towards the end (Daniel, 2012). We also sought to limit non-response bias by individually emailing those study participants who had not yet accessed the survey in the event that we had the wrong contact person or email, the individual was no longer on staff, or our survey software's automated emails had been diverted into spam folders by municipal email servers. In doing so, our goal was to ensure that all sampling elements had received the invitation.

2.7 Data Management

Study data were collected and managed using REDCap electronic data capture tools hosted by the Women & Children's Health Research Institute (Harris, Taylor, Thielke, Payne, Gonzalez, & Conde, 2009). The identities of municipalities and survey respondents were kept confidential. The research was approved by the University of Alberta Research Ethics Board (Pro00097278).

2.8 Analysis

Data were exported from REDCap, and processed and analyzed using Google Sheets spreadsheet software. We collected nominal data (e.g., data used to label variables that do not have quantitative value, such as actions taken by municipalities), ordinal data (e.g., data indicating level of agreement with a statement), and qualitative data (e.g., text responses to open-ended questions). We analyzed nominal and ordinal data according to frequency of responses and proportion (percentage). We also assessed the distribution of ordinal data from Likert-type items by combining response categories and by using a weighted mean score. Qualitative data were summarized in narrative form.

Once we had collected the survey data, we embedded a final variable into our database related to Alberta's Forest Protection Area (FPA). We obtained a list of FPA municipalities from our research partners at Alberta Agriculture and Forestry, and coded the data (yes/no) for all municipalities in our sample. Fifty-one (26%) of Alberta's 194 cities, towns, counties, municipal districts and specialized municipalities lie within or border the Forest Protection Area. In our analysis, we used this categorical data to stratify our sample in order to explore potential differences between FPA municipalities and non-FPA municipalities since, from 2013 to 2017, provincial FireSmart funding was reserved for FPA municipalities. (See *Appendix A* for a map of the Forest Protection Area.)

As a result of the study design, readers of this report are reminded to consider the following points when interpreting the results:

- The study design offers a snapshot of policy and perceptions at one point in time (Spring 2020).

- Data were collected about both municipalities (institutions) and municipal planning professionals (individuals). Data about individual perceptions should not be equated with an institutional perspective.

- All data provided by study participants were self-reported ("subjective"), including data about factual items such as plans, policies and municipal actions.

- Data were derived from a sample of municipalities taken from a study population made up of all cities, towns, counties, municipal districts, specialized municipalities in Alberta, excluding villages, summer villages, Specialized Areas, and Indigenous communities (First Nations communities and Métis settlements). Therefore, any inferences drawn from the results should not be attributed to all communities in Alberta but rather to cities, towns, counties, municipal districts, and specialized municipalities (referred to as "municipalities" in this report).

3.0 Results

After cleaning the data and excluding incomplete surveys, data were retained for 114 surveys (out of 194 invitations). One survey respondent was unable to complete the final nine questions due to technical difficulties but conveyed by email that they wished to have the data included in the survey. The response rate statistics are presented in Table 2. We obtained a 59% completion rate for our survey. Thirteen (7%) municipalities opted out of the survey, 13 (7%) surveys were started but not finished, and 54 (28%) municipalities did not access the survey.

Table 2. Survey response results for all cities, towns, counties, municipal districts, specialized

Completed Surveys	Opted Out	Incomplete Surveys	No Response
114 (58.8%)	13 (6.7%)	13 (6.7%)	54 (27.8%)

Two factors are considered important when evaluating the overall validity of survey results: response rate and representativeness (Baruch & Holtom, 2008). There is no consensus on the minimum response rate for voluntary surveys—suggestions have ranged from 50 to 80% (Baruch & Holtom, 2008). However, there is evidence that response rates for data collected from organizations are significantly lower than those from individuals (Baruch & Holtom, 2008). After conducting a meta-analysis of survey response rate levels and trends, Baruch & Holtom (2008) offer 35-40% as an acceptable completion rate for surveys administered by employees in organizations ("organizational surveys").

We discuss representativeness of municipalities in Section 3.1.1 (*Types of Municipalities* and *Forest Protection Area Municipalities*), and of study participants in Section 3.1.6 (*Professional Status*). Overall, the study sample appears to be adequately representative of the overall study population (i.e., the sample "matches" the population on relevant characteristics). This, combined with the completion rate of 59%, leads us to have confidence that the data about municipalities presented in this survey are generalizable to all cities, towns, counties, municipal districts and specialized municipalities in Alberta. The data collected about study participants' perceptions is not likely generalizable (see Section 3.1.6 for an explanation).

The Results section is organized according to the six sections below.

- 3.1 Sample characteristics
- 3.2 FireSmart Community Plans
- 3.3 Statutory plans
- 3.4 Model codes and standards
- 3.5 Wildfire risk mitigation measures
- 3.6 Perceived barriers
- 3.7 Other data

Results are presented in both narrative and table or chart form. Where applicable, we included the survey questions verbatim beneath tables and figures.

3.1 Sample Characteristics

We collected data about certain characteristics of municipalities in order to assess how representative the sample was of the overall study population, as well as to provide context for some of the results. Sections 3.1.1–3.14 present those results. We also collected information about the study participants (sections 3.1.6–3.1.7).

3.1.1 Types of Municipalities

We categorized municipalities in our sample according to the Alberta Government's classification scheme for municipality types (Government of Alberta, 2021a). We used this data to assess the representativeness of our sample, as well as a potential stratification variable.

Figure 1 depicts the proportion of municipality types in our sample compared to the province-wide study population. Looking at the proportion of municipality types, we find that our sample tracks the overall study population for the types "city", "municipal district", and "specialized municipality". However, our sample was underrepresented in terms of "towns" (-11%) and overrepresented in the category of "counties" (+8%).

Figure 1

Distribution of Municipalities by Type, Study Population vs. Study Sample
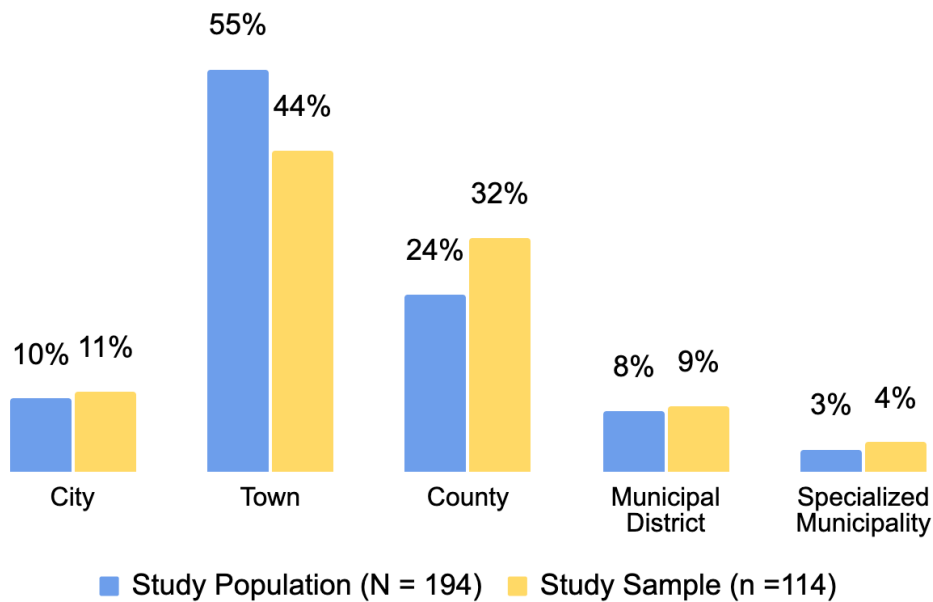
The Alberta Government classifies municipalities according to "types".
Please indicate which type your municipality belongs to.

The discrepancy in proportion of counties and towns could be partially explained by the differences in staffing resources, as well as the higher proportion of FPA municipalities (as explained in the next section). Smaller towns in Alberta do not always have planners on staff, and this may have led to nonresponse. As we heard from one municipality that declined to participate, they may have been unwilling to pay their planning contractor to complete the survey. Also, it is not uncommon for the CAO to also perform the duties of Development Officer. Since CAOs were busy with the coronavirus pandemic during our data collection period, this could have affected participation among towns. Low staffing capacity could also explain why all 13 "opted out" municipalities in our survey were towns, and why 62% and 65% of incomplete surveys and non-responses respectively were from towns. We also found that the two municipalities that had not yet completed a *Municipal Development Plan* were towns (see Section 3.3).

3.1.2 Forest Protection Area Municipalities

The Forest Protection Area is an administrative boundary established by the Forestry Division of Alberta Agriculture and Forestry for the purposes of addressing threats to forests (Government of Alberta, 2020). In 2013, the Forest Resource Improvement Association of Alberta (FRIAA) FireSmart Program was created to administer funding for the FireSmart Program to communities within its jurisdiction. In 2017, the program was opened to all communities in Alberta. Since funding was reserved for FPA municipalities only from 2013 to 2017, we assumed that FPA municipalities would have higher rates of adoption.

There are 51 cities, towns, counties, municipal districts and specialized municipalities in the FPA. The majority of these communities (n = 38, 75%) completed our survey. As a proportion of our study sample, FPA municipalities are slightly overrepresented, representing 33% of our total study sample versus 26% of the province-wide study population. In this report, we refer to this sub-sample as "FPA municipalities". All other municipalities are termed "non-FPA municipalities".

We suspected that we might have greater participation from FPA municipalities since they are more likely to have had contact with the FRIAA FireSmart Program. Indeed, in our survey, 100% of respondents from FPA municipalities reported having heard of FireSmart versus 76% in non-FPA municipalities. Also, as we discuss below, FPA municipalities reported a higher incidence of wildfire experiences. Wildfires likely have a higher salience to municipalities with a wildfire history. These factors could have motivated some FPA municipalities to participate in our survey. The overrepresentation of FPA municipalities in our sample may also partially explain the greater proportion of counties and smaller proportion of towns in our sample as there are more proportionately more counties and municipal districts in the FPA sub-sample (63%) as there are in the overall study population (32%), and proportionately fewer towns (24% in FPA sample versus 55% in study population).

The discrepancies in municipality type and FPA proportion should not be understood as automatically translating into a bias in the results. Rather, it is important to consider these differences in relation to each questionnaire item. For example, if lack of resources or staff

capacity are issues with towns but towns are underrepresented in our sample, then the response to a question about lack of resources or staff capacity as a perceived barrier may be affected by response bias. However, we do not currently have data to show that resources and staff capacity are not also issues with other municipality types.

3.1.3 Wildfire History

Experience with wildfire can lead to a greater awareness of wildfire risk and create momentum for mitigation action (Mockrin et al., 2018). Natural Resources Canada reports that the annual number of evacuations due to wildfires has been rising steadily since 1980, with more than half of wildfire-related evacuations taking place in British Columbia and Alberta (Natural Resources Canada, 2019). We were unable to obtain municipal-level data regarding wildfire evacuations or structural losses in Alberta from either federal (Canadian Forest Service) or provincial agencies (Alberta Emergency Management Agency, Alberta Agriculture and Forestry). Therefore, we collected wildfire history data from study respondents in order to see if wildfire experience was associated with greater mitigation efforts.

Table 3 provides overall results for the full sample, FPA municipalities and non-FPA municipalities. In total, 37 municipalities (32%) in the full study sample reported a history of wildfire since 2000. We refer to this sub-sample as "Wildfire History municipalities" in this report. FPA municipalities reported the highest number ($n = 20$) and percentage (54%) of experiences with wildfire.

Table 3. Wildfire history, sample vs. FPA municipalities vs. non-FPA municipalities

	Sample (n = 114)		FPA Municipalities (n = 38)		Non-FPA Municipalities (n = 76)	
	#	%	#	%	#	%
Wildfire History	37	32%	20	54%	17	15%
No Wildfire History	75	66%	16	43%	58	7%
I don't know	2	2%	1	3%	1	76%
No answer	0	0%	0	0%	0	1%
	114	100%	37	100%	76	100%

Figure 2 provides results based on evacuations and structural losses only. Looking at the full sample, a minority of respondents ($n = 17$, 15%) reported that residents in their municipality had been evacuated due to a wildfire within the previous 20 years. Twice as many municipalities ($n = 35$, 31%) reportedly had structures or infrastructure in their municipality affected by wildfire. Within the FPA sample, 10 municipalities had experienced both evacuation and structural or infrastructure losses due to wildfire. Seventeen non-FPA municipalities reported a history of wildfire, with five reported both an evacuation and structural losses due to wildfire since 2000. When comparing FPA and non-FPA municipalities, we found that 29% of FPA municipalities

reported a wildfire evacuation since 2000 compared to just 8% of non-FPA municipalities. Half of FPA municipalities reported structure or infrastructure impacts versus 21% of non-FPA municipalities.

Wildfire History, Evacuations and Structural Loss (2000–2020)
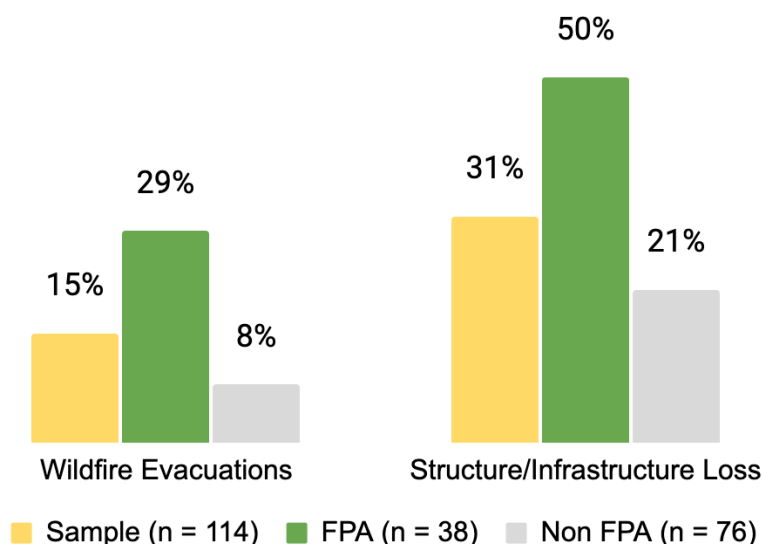
To your knowledge, has your municipality been evacuated due to a wildfire in the last 20 years (2000 to present)? To your knowledge, have structures (e.g., buildings, recreational facilities) or infrastructure (e.g., roads, power lines) in your municipality been directly affected by a wildfire in the last 20 years (2000 to present)?

The results from this survey item indicate that, while municipalities located within the FPA's jurisdiction have significantly more experience with wildfires (50%), municipalities outside of the FPA are not exempt from the impacts of wildfire. Therefore, the FPA administrative boundary should not be used to identify municipalities at risk of wildfire.

3.1.4 Perception of Wildfire Threat

We asked study participants if they perceived wildfire to be a potential threat to their municipality in any given year. Three-quarters (76%) of respondents answered "Yes", 19% answered "No", and 4% responded "I don't know". Ninety-seven percent of participants from Wildfire History municipalities and 92% of respondents from FPA municipalities answered "Yes".

3.1.5 Homeowners Associations (HOAs)

A Homeowners Association (HOA) is a legal entity created by developers of subdivisions or condominiums, and transferred to homeowners after properties are sold. The purpose of a HOA is to maintain aesthetic and other community standards, and to provide services for all

properties within its jurisdiction (Evans, 2015). Through the legal restrictive covenant mechanism, HOAs typically include architectural controls intended to maintain a certain appearance for the neighbourhood. As such, HOAs have the potential to affect their community's vulnerability to wildfire, for better or for worse. Therefore, we were interested in learning which municipalities have HOAs, and we included resistance from HOAs as a barrier item in the questionnaire (Section 3.6).

Nearly 1 in 5 (n = 22, 19%) municipalities reported at least one HOA in their community (Fig. 3). However, the real number could be higher given that 18% of respondents were unsure.

Figure 3

HOAs in Municipality
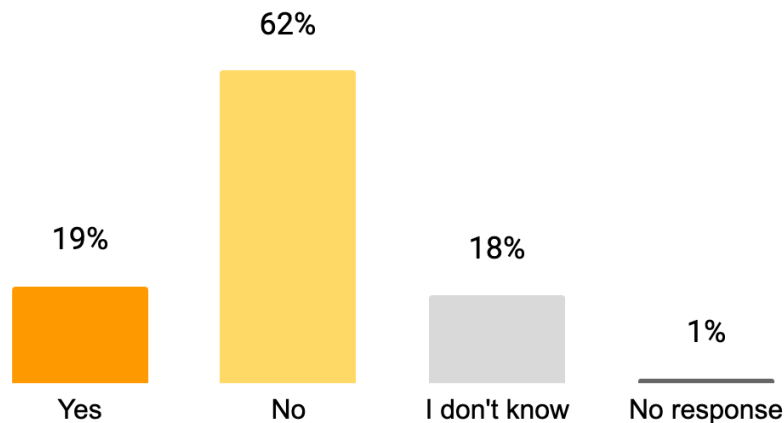
To your knowledge, does your municipality have any neighbourhoods governed by a Homeowners' Association (HOA)?

3.1.6 Professional Status

In both the email invitation and on the consent page of the questionnaire, we emphasized that the intended study participant was a municipal staff person with in-depth knowledge of the municipality's planning and development policies. In order to evaluate if we met our recruitment objective, we collected data regarding professional status and years of experience.

In Canada, there exists "Right to Title" legislation for the planning profession (Canadian Institute of Planners, 2021). In most provinces, including Alberta, individuals must undergo a process of certification in order to obtain the "Registered Professional Planner (RPP)" designation. In smaller communities, particularly where statutory plans are contracted out to private municipal services firms, a development officer or other employee (e.g., CAO) may be responsible for managing development approvals and permits rather than a Registered Professional Planner. The Government of Alberta estimates there are 2,100 "community planners" working in Alberta (Government of Alberta, 2021b). According to the Alberta Provincial Planners Institute (APPI),

there were 729 RPP and 179 RPP Candidate members in 2019, and 70% worked in the Edmonton and Calgary regions (Alberta Professional Planners Institute, 2019). Therefore, an estimated 43% of Alberta's community planners are RPP or RPP Candidates.

In our survey, 34 (30%) respondents reported being a Registered Professional Planner (RPP) or RPP Candidate. This lower percentage is likely a reflection that rural communities are less likely to have a RPP on staff since RPP in Alberta are largely concentrated in the Calgary and Edmonton regions. Smaller rural communities are also more likely to contract planning work to municipal services corporations.

There were 194 study participants, of which 30% were RPP or RPP Candidates. We assume the remainder were planning and development professionals. Put in the context of the estimated 2,100 "community planners" in Alberta (see Section 2.3), our response rate for this study population may be as low as 9.2%. Without having accurate data about the provincial population of municipal planners, we suggest that perceptions are not generalizable to all community planners in Alberta.

3.1.7 Years of Experience

The majority (*n* = 69, 61%) of study participants reported having worked in the planning and development sector for 10 years or more (Figure 4). This finding provides a level of confidence in the survey results insofar that we can assume the study participants were able to accurately respond to factual questions about municipal policies. However, since fewer than one-third (30%) were RPP or RPP candidates, it is more accurate to refer to study participants as "municipal planning and development professionals" rather than "municipal planners".

Figure 4

Years of Planning and Development Experience

No response
4.0%

20+ years
24.0%

0-9 years
35.0%

10-19 years
37.0%
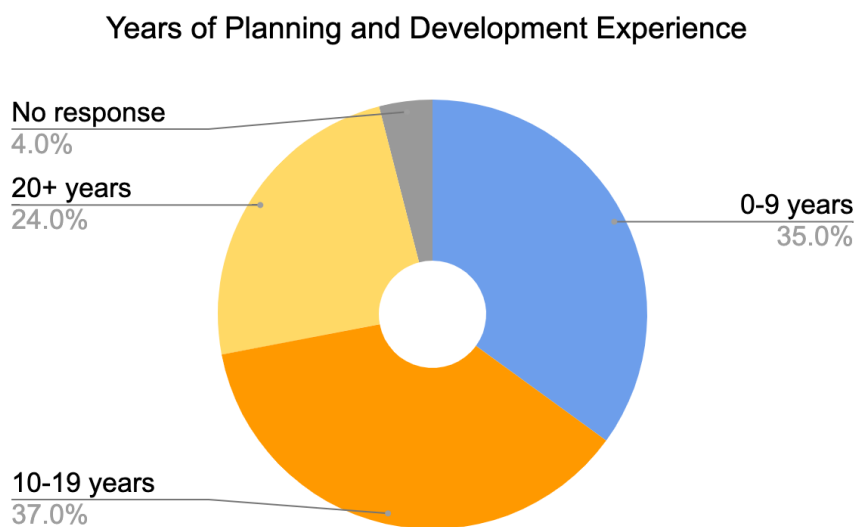
How many years of experience do you have working in the field of land use planning and development?

3.2 FireSmart Community Plans

FireSmart's *Guidebook for Community Protection* (Government of Alberta, 2013) sets out a 4-step process for creating a FireSmart Community Plan:

1. Complete a *Wildfire Hazard and Risk Assessment*;

2. If wildfire hazards and risk are present, assemble a "planning team" made up of specialists who can inform the technical content of the FireSmart Community Plan;

3. Implement a consultation process with key stakeholders; and

4. Develop a *Wildfire Preparedness Guide* and a *Wildfire Mitigation Strategy*.

Municipal governments typically hire consultants to complete these documents. Alberta Agriculture and Forestry and FireSmart Alberta provide guidance to municipalities and their consultants. The Province provides funds on a competitive basis to communities through the FRIAA FireSmart Program (Forest Resource Improvement Association of Alberta, 2021). Recommendations specific to the FireSmart Legislation and Development disciplines are located in the *Wildfire Mitigation Strategy*. We could not locate data regarding the number of FireSmart Community Plan documents completed by municipalities in Alberta. Therefore, we included an item in our questionnaire.

3.2.1 Completion of FireSmart Community Plan Documents

As shown in Figure 5, 36 municipalities (32%) reported having completed the first step of the process, the *Wildfire Hazard and Risk Assessment*, while 27 (24%) had completed a *Wildfire Preparedness Guide* and 24 (21%) had completed a *Wildfire Mitigation Strategy*. Eighteen respondents (16%) were not sure if their municipality had completed any of the documents. Among the 36 municipalities, 20 were Wildfire History municipalities and 20 were FPA municipalities.

Figure 5

Type of FireSmart Community Plan Document Completed
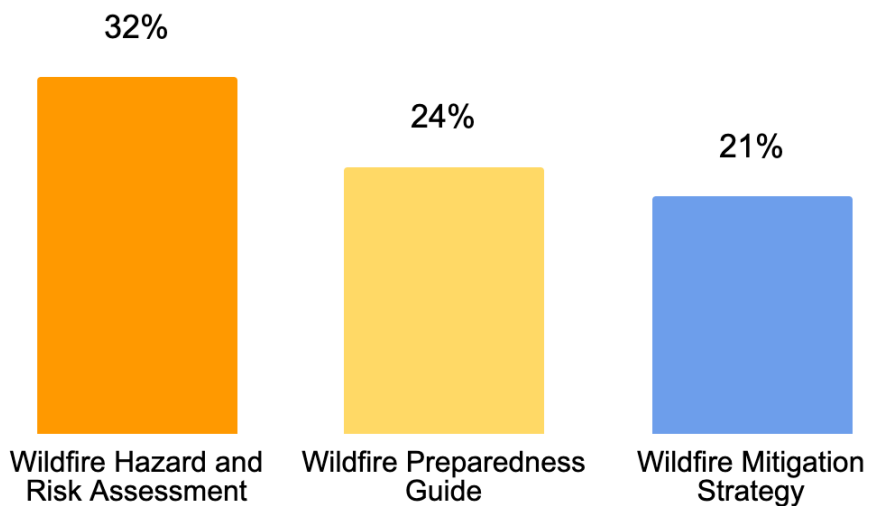
Has your municipality completed or adopted any of the following? (Please check all that apply.)

Figure 6 indicates that 41 municipalities (36%) had completed one or more FireSmart Community Plan documents, 9 municipalities (11%) had completed just one document (mostly the *Assessment*), while 17 (15%) had completed all three documents.

Figure 6

Number of FireSmart Community Plan Documents Completed
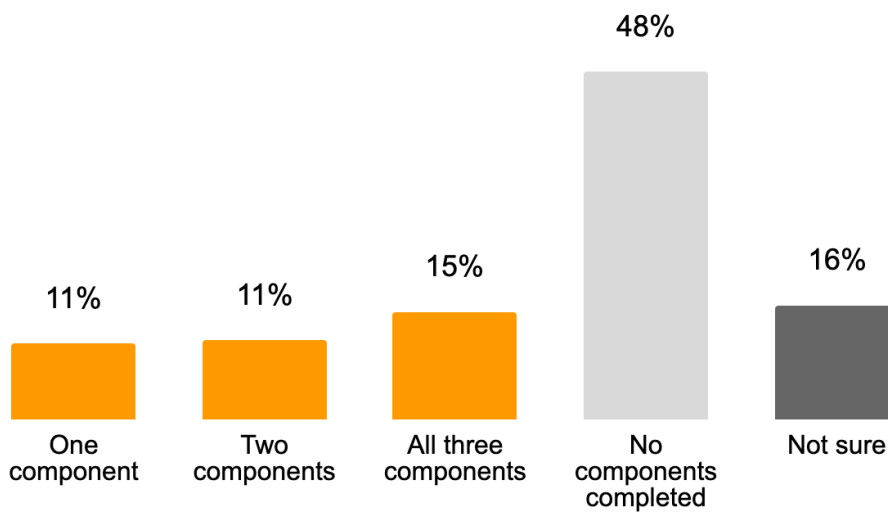
3.2.2 FPA vs. Non-FPA Results

When analyzing results for the 38 FPA municipalities in our sample (Fig. 7), we found that far more FPA municipalities (61%) had completed at least one FireSmart Community Plan document compared to non-FPA municipalities (24%).

Figure 7

FireSmart Community Plans, Sample vs. FPA vs. Non-FPA
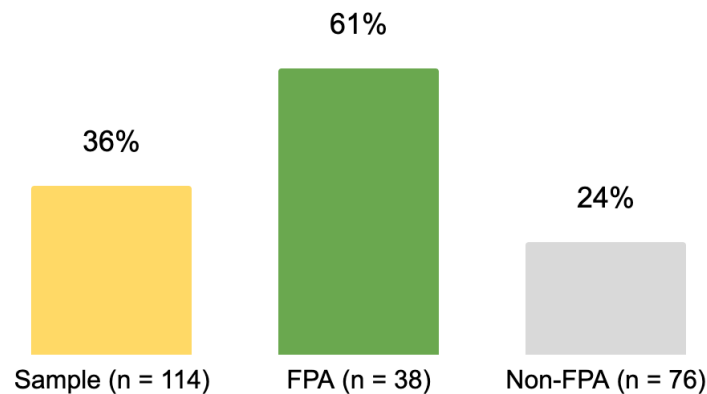
As shown in Figure 8, 53% of FPA municipalities had completed a *Wildfire Hazard and Risk Assessment* compared to 21% of non-FPA municipalities. Forty-seven percent of FPA municipalities had completed a *Wildfire Preparedness Guide* compared to 12% of non-FPA municipalities. And 39% of FPA municipalities had completed a *Wildfire Mitigation Strategy* compared to 12% of non-FPA municipalities. These differences could be partly attributed to the FRIAA FireSmart Program funding policy that focused on FPA municipalities from 2013 to 2017.

Figure 8

FireSmart Community Plan Documents, FPA vs. Non-FPA
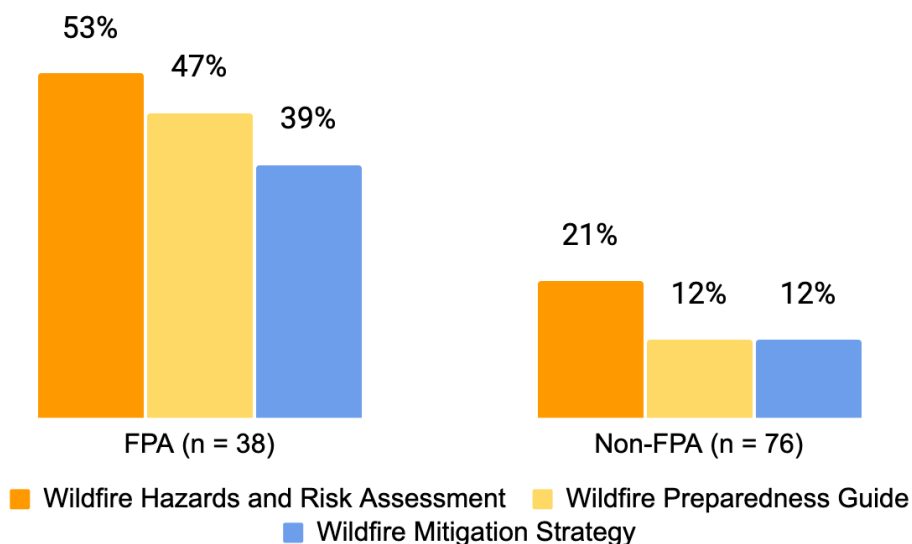
3.2.3 Wildfire Experience vs. Non-Wildfire Experience Results

Based on the literature that suggests wildfire experience leads to mitigation action (Mockrin et al., 2018), we stratified responses to compare Wildfire History municipalities (n = 37, 32%) to municipalities without a reported history of wildfire since 2000 (n = 77, 68%).

As shown in Figure 9, municipalities with wildfire experience were more than twice as likely to have completed wildfire mitigation documents as were municipalities that had not experienced wildfire impacts since 2000. However, even though these municipalities had been previously impacted by wildfire, just a slight majority (54%) have completed a *Wildfire Hazards and Risk Assessment*.

Figure 9

FireSmart Community Plan Documents, Wildfire History vs. No Wildfire History
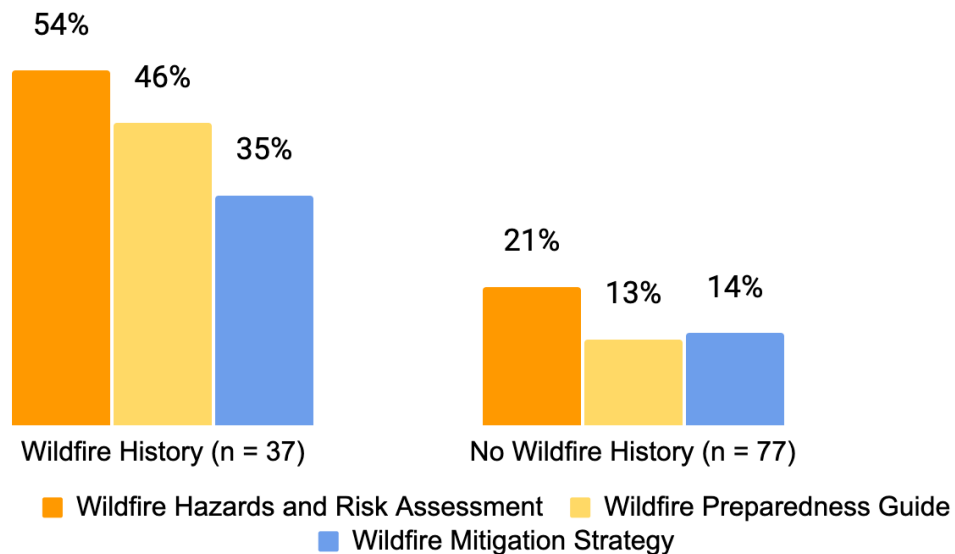
When we looked at just those municipalities that had been evacuated (*n* = 17), 65% had completed a *Wildfire Hazards and Risk Assessment*, and 53% had completed a *Wildfire Preparedness Guide*. Of the 37 municipalities that reported structural or infrastructure loss due to wildfire, 54% had completed a *Wildfire Hazards and Risk Assessment*, and 37% had completed a *Wildfire Mitigation Strategy*.

3.3   Statutory Plans

Each municipality in Alberta is legally required to adopt a Municipal Development Plan (MDP) and, where necessary, a Intermunicipal Development Plan (IDP) (Government of Alberta, 2018) by April 2021 (Alberta Municipal Affairs, 2017). The MDP and IDP are statutory documents that set out the long-term vision for a community. The land use implications of that vision are then operationalized in other statutory documents (e.g., Land Use By-Law, Area Structure Plans, Area Redevelopment Pans, Subdivision and Development Regulations) and through the development permit system (Alberta Urban Municipalities Association, 2021a, 2021b). Municipalities are encouraged but not required to address natural hazards and other risks through these statutory plans. Details regarding municipal development plans can be found in the Alberta Government's *Guidebook for Preparing a Municipal Development Plan* (Government of Alberta, 2018).

3.3.1 Adoption of MDP and IDP

As expected given the April 2021 deadline, most municipalities had already adopted MDPs (*n* = 112, 98%) and IDPs (*n* = 100, 88%).

3.3.2 Natural Hazards Addressed by Statutory Plans

Figure 10 displays data regarding natural hazards addressed by MDPs and IDPs. Among the 112 MDPs, 57 (51%) addressed flooding and 34 (30%) addressed wildfire. Forty-three (38%) of MDPs did not address natural hazards. Just under half (46%) of the 37 Wildfire History municipalities addressed wildfire in their MDPs. Of the 100 municipalities that had completed an IDP, 43% addressed flooding and 18% addressed wildfire. Forty-nine percent reported that their IDP did not address natural hazards.

Figure 10

Natural Hazards Addressed in MDP and IDP
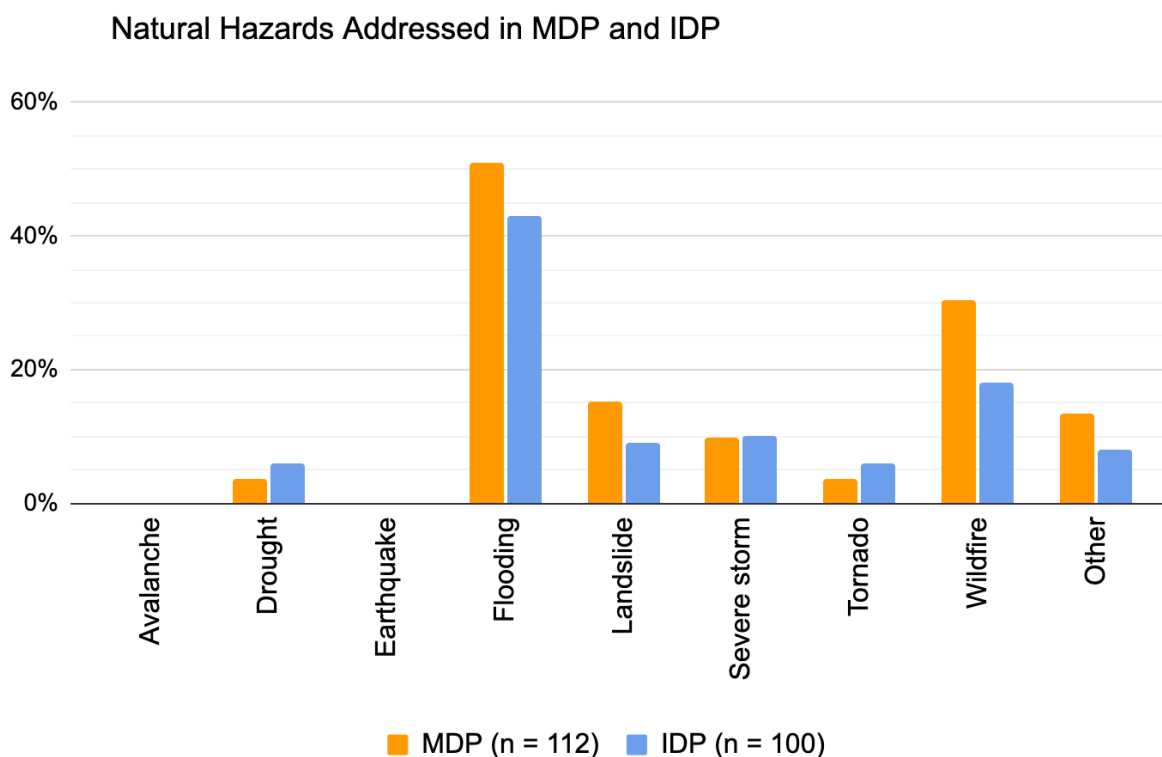
To your knowledge, which of the following natural hazards are addressed by the MDP/IDP? (Please check all that apply.)

The finding that flooding is the most addressed natural hazard in both MDPs and IDPs is not surprising for two reasons. First, flooding is an important hazard in Alberta. And second, flooding has historically received more attention from policy-makers than wildfire (Tymstra et al., 2020). For example, provincially, the Government of Alberta publishes flooding data "[t]o assist communities in keeping Albertans safe and protecting their properties from floods" (Government

of Alberta, 2021c). It also publishes "wildfire status" maps (Wildfire Alberta, 2019) but not hazard and risk maps that can be used for mitigation purposes. These are left to individual municipalities to prepare.

3.3.3 Adoption Date of MDP

Although the Municipal Development Plan is a long-range document, it should be viewed as a "living guide" (Alberta Government, 2018, p. 16). It is best practice to review goals and policies, and to make necessary amendments or to initiate a complete update every 5 to 10 years (Alberta Government, 2018). We asked survey respondents in what year the MDP was adopted in order to assess when plans may likely be revised or updated.

Figure 11 indicates that 27 MDPs (24%) were adopted between 2000 and 2009, and 49 MDPs (44%) were adopted between 2010 and 2015. Fifty-five of the 110 completed MDPs did not address wildfire as a natural hazard. Of those 55 plans, 78% were adopted in 2015 or earlier, indicating that they will likely be up for review soon. Of the 20 Wildfire History municipalities whose MDPs did not address wildfire, 19 were completed in 2015 or earlier. Plans that were five years old or more at the time of this report's publication represent an opportunity for review and possibly inclusion of wildfire as a hazard.

Figure 11

Year MDP Adopted

I don't know/No answer
4.4%

2016–2020
28.9%

2000–2015
66.7%
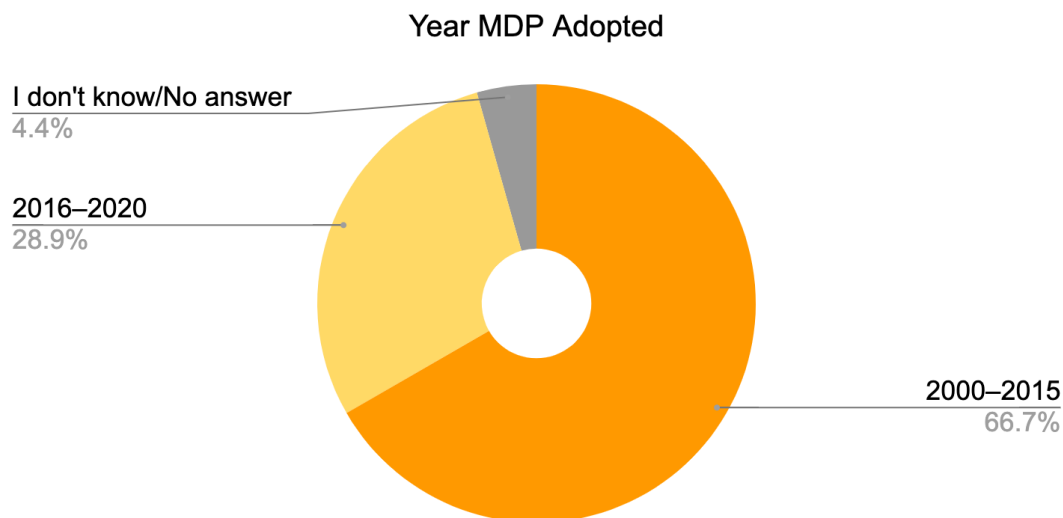
In what year was the MDP adopted?

3.4   Model Codes and Standards

A number of model codes, standards and guidelines have been introduced in order to assist with the mainstreaming of development-related wildfire risk reduction measures in wildland urban interface communities (Intini et al., 2017). These models are meant to facilitate wildfire

risk reduction by providing municipalities with a template for regulations or standards regarding various aspects related to development. We compiled a list of potential codes and standards, including the year they were initially published (Table 4). Three of these models were developed in Canada, including the recent *CSA S504 Fire Resilient Planning for Northern Communities*, released in late 2019. We asked study participants to tell us if their municipality had adopted or adapted a model code or standard for use in their municipality.

Table 4. Model codes and standards

Model Codes and Standards	Author	Current Edition	First Edition
International Wildland Urban Interface Code (IWUIC)	International Code Council	2021	2003
CSA S504 Fire Resilient Planning for Northern Communities	Canadian Standards Association (CSA)	2019	2019
NFPA 1144 Standard for Reducing Structure Ignition Hazards from Wildland Fire	National Fire Prevention Association (NFPA)	2018	2013
NFPA 1142 Standard on Water Supplies for Suburban and Rural Fire Fighting	National Fire Prevention Association (NFPA)	2017	2017
NFPA 1141 Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas	National Fire Prevention Association (NFPA)	2017	2017
ASVA Fire Bylaw Template	Alberta Summer Villages Association	2017	2017
Guideline for Wildfire Protection of Institutional Buildings in Forested Regions in Alberta	Alberta Infrastructure	2013	2013

Table 5 indicates that 22 municipalities (19%) reported having adopted or adapted one or more models, while 55 (48%) chose "I don't know", and 37 (32%) skipped the question entirely.

Table 5. Number of model codes and standards adopted

	Study Sample (*n* = 114)		Wildfire History Sample (*n* = 37)		FPA Sample (*n* = 38)	
	#	%	#	%	#	%
Adopted 1 or more models	22	19%	10	**27%**	10	26%
Did not adopt a model	37	**33%**	9	24%	11	29%
I don't know *(excludes above responses)*	55	48%	18	**49%**	17	45%
Total	114	100%	37	100%	38	100%

Table 6 displays results in order of frequency for the full sample, along with data for Wildfire History municipalities and FPA municipalities. The highest percentage for each model code and standard is emphasized in bold type. Of the 22 municipalities that reported adopting or adapting at least one template, the majority (n = 16, 14%) had adopted a single code while five municipalities (4%) had adopted two codes. One study participant checked all of the codes and standards. However, we could not confirm via a search of their municipal website if these responses were accurate. When comparing the proportions of municipalities from the two sub-samples, we found that Wildfire History municipalities and FPA municipalities have adopted the NFPA standards, IWUIC and Alberta Infrastructure's guidelines for institutional buildings at a slightly higher rate than the full sample.

Table 6. Adoption rates for model codes and standards

	Study Sample (*n* = 114)		Wildfire History Sample (*n* = 37)		FPA Sample (*n* = 38)	
	#	%	#	%	#	%
NFPA 1142 Standard on Water Supplies for Suburban and Rural Fire Fighting	9	8%	3	8%	5	**13%**
Guideline for Wildfire Protection of Institutional Buildings in Forested Regions in Alberta	6	5%	4	**11%**	3	8%
International Wildland Urban Interface Code (IWUIC)	5	4%	4	**11%**	3	8%
NFPA 1144 Standard for Reducing Structure Ignition Hazards from Wildland Fire	5	4%	2	5%	3	**8%**
NFPA 1141 Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas	4	4%	3	**8%**	3	**8%**
CSA S504 Fire Resilient Planning for Northern Communities	2	2%	1	**3%**	1	**3%**
ASVA Fire Bylaw Template	2	2%	2	**5%**	1	3%
To your knowledge, has your municipality adopted or adapted any of the following into its municipal planning policies and development standards? (Please check all that apply.)						

The high number of "I don't know" responses (48%) suggests study participants were not confident about their ability to accurately answer this question. Therefore, the reliability of the responses to this is suspect. In order to validate the accuracy of these responses, a secondary investigation using a different method, such as a content analysis of municipal policies, is recommended.

Overall, the use of development-focused model codes and standards for community wildfire risk reduction in Alberta is low. Adoption is marginally higher among municipalities that have experienced an evacuation or suffered structure or infrastructure loss due to wildfire since 2000,

or that are within the FPA jurisdiction. It is possible that the "newness" of some of the codes (e.g,. first editions appearing in 2017 or later) could be a factor in the low adoption rate. However, the IWUIC, a comprehensive code for WUI communities, was first published in 2003 and, in spite of its availability, only five municipalities reported using it.

3.5   Wildfire Risk Mitigation Measures

We created a list of individual municipal planning measures that could be adopted by municipalities in Alberta to address wildfire risk. The 23-item list was populated using two primary sources that discuss potential mitigation measures: The recently released guide *Planning the Wildland-Urban Interface*, published by the American Planning Association (Mowery et al., 2019) and a published paper by Gonzalez-Mathiesen & March (2018). We did not include measures that municipalities were not authorized to use in Alberta. For example, municipalities do not have the authority to require fire-resistant building materials on private buildings. Building construction is governed by the *Alberta Building Code 2019*, which is modeled after the *National Building Code of Canada 2015* (National Research Council Canada, 2019).

In the questionnaire, individual wildfire risk mitigation items were grouped according to five themes:

1.   Controlling where development occurs

2.   Establishing density and setback limits

3.   Addressing flammable materials

4.   Addressing critical sites and municipal infrastructure

5.   Roads and emergency shelters

3.5.1 All Measures

The results for all of the items are presented in Table 7 according to frequency and proportion of responses for the full sample (*n* = 114). When sorted using this method, we found that the top five reported measures are not wildfire-specific per se. For example, measures to regulate fire hazards on private property (68%), restrict development on steep slopes (53%), specify roadway design standards for emergency vehicle access in new developments (39%), and require a minimum distance between homes and combustible materials stored on private property (36%) are not exclusive to WUI contexts. Many non-WUI municipalities adopt policies to regulate fires and combustible materials on private property as a means of reducing the threat of structural fires, or set roadway standards for emergency vehicle access. Looking at the full list, measures that are not dependent on wildfire hazards and risk information are clustered towards the top. The least adopted were measures that aim to avoid hazards by directing where development occurs in relation to known hazards. Measures such as restricting residential

density in known wildfire hazard areas, incentivizing development outside of wildfire hazard areas, prohibiting development in wildfire hazards areas, and limiting critical infrastructure or public facilities in wildfire hazards areas were adopted by 4–5% of the full sample. Just seven municipalities (6%) had a policy in place that provides land use planning guidance for incorporating mitigation measures into rebuilding efforts after a wildfire.

Table 7. Municipal planning measures used to mitigate wildfire risk

	Questionnaire Item	#	%	Theme
1	Regulates fire hazards such as fire pits, general burning, and accumulation of combustible material on private property (e.g., wood piles, gas tanks)*	77	68%	Addressing flammable materials
2	Restricts development on steep slopes*	60	53%	Controlling where development occurs
3	In new developments, specifies roadway design standards or guidelines for access and egress of emergency vehicles during wildfire emergencies	45	39%	Roads and emergency shelters
4	Requires a minimum distance between residential dwellings and combustible materials stored on private property (e.g., firewood, oil tanks)*	41	36%	Addressing flammable materials
5	In new developments, specifies standards for availability of water for firefighting in the event of a wildfire emergency	37	32%	Roads and emergency shelters
6	Recommends fire-resistant materials on new or significantly renovated privately-owned buildings	29	25%	Addressing flammable materials
7	Requires fire-resistant materials on all new or significantly renovated municipally-owned buildings	22	19%	Addressing flammable materials
8	In new developments, specifies roadway design standards or guidelines for evacuation of residents during wildfire emergencies	22	19%	Roads and emergency shelters
9	In existing developments, retrofits infrastructure in order to ensure availability of water for firefighting in the event of a wildfire emergency	16	14%	Addressing critical sites and municipal infrastructure
10	Requires larger setbacks between buildings and heavily vegetated areas (e.g., forest, urban greenway or park) in new developments	15	13%	Establishing density and setback limits
11	Recommends fire-resistant species of vegetation to be used on private property	15	13%	Addressing flammable materials

12	Recommends fire-resistant species of vegetation to be used on public property	13	11%	Addressing flammable materials
13	In new developments or redevelopments at high risk of wildfire, requires that utility infrastructure be placed underground**	12	11%	Addressing critical sites and municipal infrastructure
14	Requires larger setbacks between buildings in wildfire hazard areas**	9	8%	Establishing density and setback limits
15	In wildfire hazard areas, requires fuel breaks (defined as linear areas of land in which vegetation is substantially reduced in order to more easily control the spread of wildfire)**	8	7%	Addressing flammable materials
16	Restricts subdivision of lands adjacent to wildfire hazard areas**	7	6%	Controlling where development occurs
17	Provides at least one publicly-accessible wildfire shelter in the event that residents cannot evacuate during a wildfire emergency	7	6%	Roads and emergency shelters
18	Provides land use planning guidance for rebuilding should your municipality experience a wildfire disaster	7	6%	Controlling where development occurs
19	Limits or discourages construction of critical infrastructure and/or public facilities (e.g., schools, hospitals, police stations) in wildfire hazard areas**	6	5%	Addressing critical sites and municipal infrastructure
20	Prohibits development in wildfire hazard areas**	5	4%	Controlling where development occurs
21	Directs growth away from wildfire-prone areas by incentivizing development outside of wildfire hazard areas**	4	4%	Controlling where development occurs
22	Restricts residential density in wildfire hazard areas**	4	4%	Establishing density and setback limits
23	Policy to gradually remove existing residential development from wildfire hazard areas (e.g., buy-back scheme)**	0	0%	Controlling where development occurs
* Not solely used for wildfire risk reduction				
** Relies on availability of hazard and risk information				

In the next section, we present the results from the five thematic groups of individual measures that can be taken by municipalities to reduce wildfire risk for the full sample, Wildfire History municipalities, and FPA municipalities.

3.5.2 Controlling Where Development Occurs

This group of items included specific actions that involve controlling where development occurs in relation to hazardous conditions.

As shown in Figure 12, more than half of all municipalities (*n* = 66, 58%) in our study checked at least one measure in this category, while 33 (29%) did not choose a measure, indicating that they have not adopted any of the measures. The remaining (*n* = 15, 13%) responded "I don't know" (an answer choice which automatically excluded all other responses in this series of questions). Wildfire History municipalities and FPA municipalities had slightly higher adoption rates (62% and 66% respectively).

Figure 12

Measures Controlling Where Development Occurs
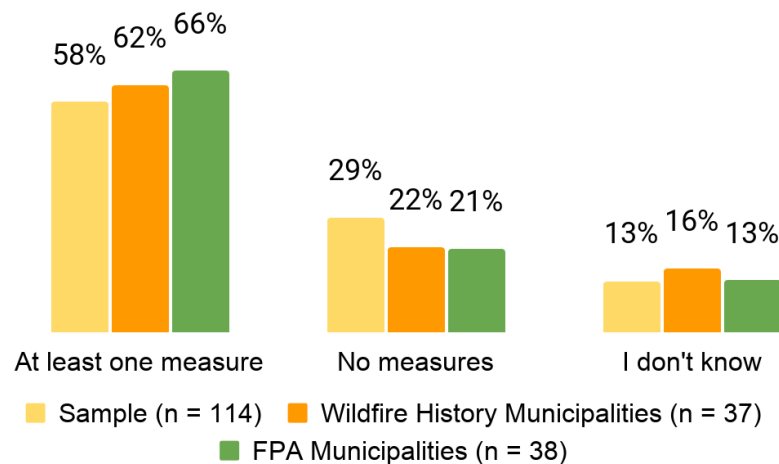
According to Table 8, the most adopted measure by far was restricting development on steep slopes (53%). This was also the second most adopted measure from the full set of items in this section. Again, we note that this policy may be adopted to address landslide hazards in abstentia of wildfire risk, and does not rely on a prior assessment of wildfire hazards and risk. Fewer than 10% of respondents indicated that their municipality had adopted a measure specific to controlling where development occurs in relation to wildfire hazards. No municipality reported a policy to gradually remove existing residential development from wildfire hazard areas.

Table 8. Controlling where development occurs

	Study Sample (*n* = 114)		Wildfire History Sample (*n* = 37)		FPA Sample (*n* = 38)	
	#	%	#	%	#	%
Restricts development on steep slopes	60	53%	22	**59%**	22	58%
Restricts subdivision of lands adjacent to wildfire hazard areas	7	6%	4	**11%**	3	8%
Provides land use planning guidance for rebuilding should your municipality experience a wildfire disaster	7	6%	3	**8%**	2	5%
Prohibits development in wildfire hazard areas	5	4%	3	**8%**	1	3%
Directs growth away from wildfire-prone areas by incentivizing development outside of wildfire hazard areas	4	4%	2	**5%**	2	**5%**
Policy to gradually remove existing residential development from wildfire hazard areas (e.g., buy-back scheme)	0	0%	0	0%	0	0%
I don't know	15	13%	5	13%	6	**16%**

Below is a list of potential municipal planning measures that can be used to mitigate wildfire by controlling where development occurs. Please indicate which measures are included in your municipality's planning policies and development standards. (Please check all that apply.)

3.5.3 Density and Setback Limits

This category of items concerns density and setback limits. Density involves limiting the number of dwellings and structures on a given parcel of land. Setback limits refers to setting distances between where a building can be situated and the edge of a land parcel.

As shown in Figure 13, 19 municipalities (17%) in our study sample had adopted density and setback limits to reduce wildfire risk. Sixty-nine municipalities (61%) had not adopted a measure in this category.

Figure 13

Density and Setback Measures
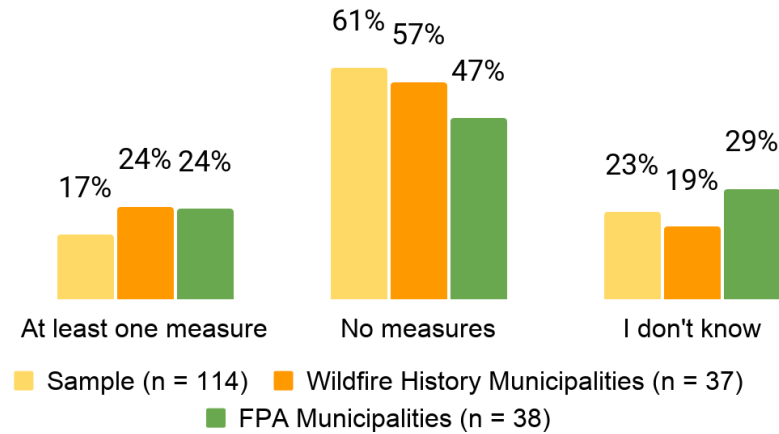
Table 9 displays the frequencies and proportions of responses for the study sample, Wildfire History sample, and FPA sample. In all samples, the most adopted measure was requiring that buildings be set farther back from heavily vegetated areas, such as woodlots and parks, followed by requiring more space between buildings in wildfire hazard areas, and restricting the density of homes in wildfire hazards areas. Wildfire History municipalities and FPA municipalities had higher adoption rates but no measure in this category was adopted by more than 19%. Nearly a quarter (23%) of the sample answered "I don't know" (29% of FPA municipalities).

Table 9. Measures addressing density and setback limits

	Study Sample (*n* = 114)		Wildfire History Sample (*n* = 37)		FPA Sample (*n* = 38)	
	#	%	#	%	#	%
Requires larger setbacks between buildings and heavily vegetated areas (e.g., forest, urban greenway or park) in new developments	15	13%	7	**19%**	7	18%
Requires larger setbacks between buildings in wildfire hazard areas	9	8%	5	**14%**	4	11%
Restricts residential density in wildfire hazard areas	4	4%	3	**8%**	1	<1%
I don't know	26	23%	7	19%	11	**29%**
Below is a list of potential municipal planning measures that can be used to mitigate wildfire by establishing density and setbacks limits. Please indicate which measures are included in your municipality's planning policies and development standards. (Please check all that apply.)						

3.5.4 Flammable Materials

In this category, we asked municipalities to identify which measures they had adopted in order to reduce the amount of flammable materials within their jurisdiction.

Ninety (79%) of municipalities reported having adopted one or more measures aimed at controlling flammable materials; 18 (16%) did not check any items, and 6 (5%) responded "I don't know" (Fig. 14). This group of measures had the highest adoption rates of all five groups.

Figure 14

Measures Addressing Flammable Materials
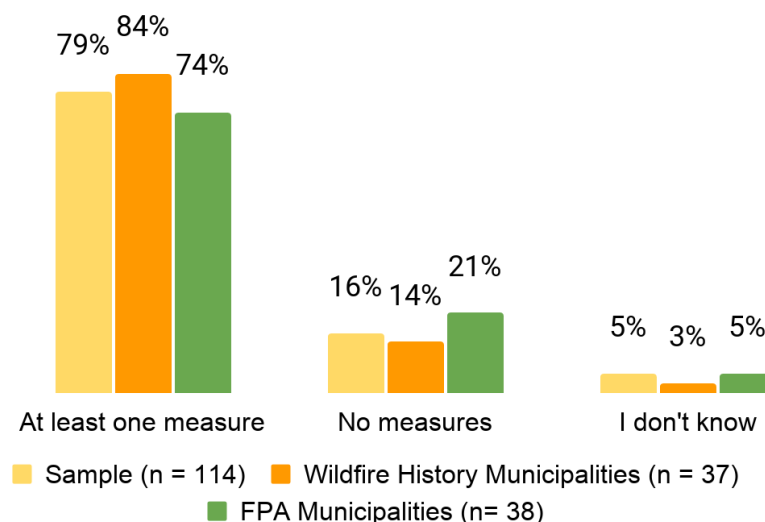
Seventy-seven municipalities (68%) reported regulating fire hazards such as fire pits and wood piles on private property (Table 10). About a third (36%) required a minimum setback between combustible materials and residential dwellings. A quarter recommended that fire-resistant materials be used on new or significantly renovated privately-owned buildings, and one in five had a policy to use fire-resistant materials on municipally-owned buildings. Wildfire History municipalities and FPA municipalities reported a higher adoption for most measures with the notable exception of regulating fire hazards and accumulation of combustible material on private property.

Table 10. Measures addressing flammable materials

	Study Sample (*n* = 114)		Wildfire History Sample (*n* = 37)		FPA Sample (*n* = 38)	
	#	%	#	%	#	%
Regulates fire hazards such as fire pits, general burning, and accumulation of combustible material on private property (e.g., wood piles, gas tanks)*	77	**68%**	23	62%	18	47%
Requires a minimum distance between residential dwellings and combustible materials stored on private property (e.g., firewood, oil tanks)*	41	36%	16	**43%**	11	29%
Recommends fire-resistant materials on new or significantly renovated privately-owned buildings	29	25%	15	**41%**	13	34%
Requires fire-resistant materials on all new or significantly renovated municipally-owned buildings	22	19%	10	**27%**	6	16%
Recommends fire-resistant species of vegetation to be used on private property	15	13%	10	27%	11	**29%**
Recommends fire-resistant species of vegetation to be used on public property	13	11%	7	19%	8	**21%**
In wildfire hazard areas, requires fuel breaks (defined as linear areas of land in which vegetation is substantially reduced in order to more easily control the spread of wildfire)	8	7%	7	**19%**	5	13%
I don't know	6	**5%**	1	3%	2	**5%**

Below is a list of potential municipal planning measures that can be used to mitigate wildfire by addressing flammable materials. Please indicate which measures are included in your municipality's planning policies and development standards. (Please check all that apply.)

* Not only for wildfire risk reduction

As previously mentioned, municipalities in Alberta cannot regulate building materials on private buildings but they can adopt policies to regulate municipally-owned buildings. Indeed, the Provincial of Alberta published the *Guideline for Wildfire Protection of Institutional Buildings in Forested Regions in Alberta* in 2013 for just this purpose (Alberta Infrastructure, 2013). Nevertheless, just 19% municipalities required fire-resistant materials on new or significantly renovated municipally-owned buildings. The proportion was higher among Wildfire History municipalities (27%) but lower in the FPA (16%).

While this group of measures had the highest rates of adoption, the two most commonly adopted measures are not solely aimed at reducing wildfire risk but rather are general precautionary measures adopted by municipalities to reduce the risk of structural fires. Therefore, these results should not be de facto interpreted as the widespread adoption of measures to reduce wildfire risk.

3.5.5 Critical Sites and Municipal Infrastructure

This group of items focused on measures that address the vulnerability of critical sites and populations, such as schools, hospitals and police stations, and of infrastructure within the municipal boundary.

Forty-eight municipalities (42%) had adopted at least one of the measures in this category. Forty-six (40%) responded that their municipalities had not adopted any of the measures; 20 (18%) answered "I don't know" (Fig. 15).

Figure 15

Measures Addressing Critical Sites and Infrastructure
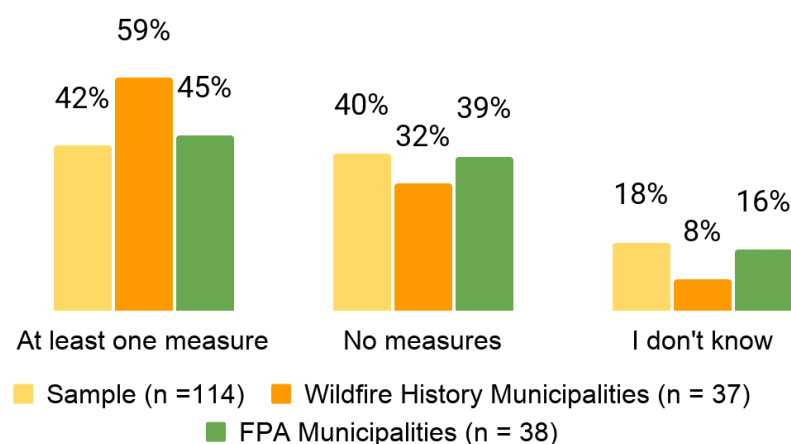
As shown in Table 11, the most common measure was to set standards in *new* developments for accessing water for firefighting in the event of a wildfire emergency (*n* = 37, 32%). However, less than half of this (14%) required that *existing* developments be retrofitted for such purposes. Wildfire History municipalities had higher adoption rates for these measures (49% and 19% respectively) but both Wildfire History and FPA sub-samples reported low adoption rates for measures that limit or discourage critical infrastructure, municipal infrastructure, and public facilities in wildfire hazard areas. In all three samples, 11% reported a measure requiring utility infrastructure to be placed underground in high wildfire risk areas, while measures to limit or discourage the placement of critical infrastructure and/or public facilities in wildfire hazard areas or municipal infrastructure were the least adopted.

Table 11. Measures addressing critical sites and municipal infrastructure

	Study Sample (n = 114)		Wildfire History Sample (n = 37)		FPA Sample (n = 38)	
	#	%	#	%	#	%
In new developments, specifies standards for availability of water for firefighting in the event of a wildfire emergency	37	32%	18	**49%**	13	34%
In existing developments, retrofits infrastructure in order to ensure availability of water for firefighting in the event of a wildfire emergency	16	14%	7	**19%**	4	11%
In new developments or redevelopments at high risk of wildfire, requires that utility infrastructure be placed underground	12	**11%**	4	**11%**	4	**11%**
Limits or discourages construction of critical infrastructure and/or public facilities (e.g., schools, hospitals, police stations) in wildfire hazard areas	6	5%	3	**8%**	1	3%
Limits or discourages extension of municipal infrastructure (e.g., water, roads, sewer) in wildfire hazard areas	3	3%	2	**5%**	1	3%
I don't know	20	18%	3	8%	6	**16%**

Below is a list of potential municipal planning measures that can be used to mitigate wildfire by addressing critical sites and municipal infrastructure. Please indicate which measures are included in your municipality's planning policies and development standards. (Please check all that apply.)

3.5.6 Roads and Emergency Shelter

The fifth group of wildfire risk mitigation actions concerns roadway design standards for firefighting access and evacuation, and public wildfire shelters.

As per Figure 16, 50 municipalities (44%) selected at least one item; 41 (36%) did not choose a measure, and 23 (20%) responded "I don't know". Rates of adoption were higher among Wildfire History municipalities (59%) and FPA municipalities (58%).

Figure 16

Measures Addressing Roads and Emergency Shelter
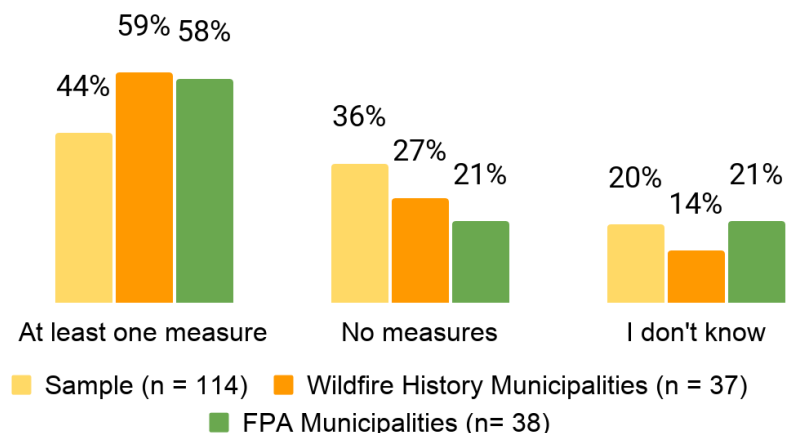
Roadway design standards or guidelines for access and egress of emergency vehicles during a wildfire emergency and for the evacuation of residents were the most commonly adopted measures (Table 12). Seven municipalities (6%) in Alberta reported designating at least one publicly-accessible wildfire shelter in the event that residents cannot evacuate during a wildfire emergency. Among Wildfire History municipalities, nine specified roadway designs for evacuation of residents during wildfire emergencies, and three provided a wildfire shelter.

Table 12. Measures addressing roads and emergency shelter

|	Study Sample (*n* = 114)		Wildfire History Sample (*n* = 37)		FPA Sample (*n* = 38)	
	#	%	#	%	#	%
In new developments, specifies roadway design standards or guidelines for access and egress of emergency vehicles during wildfire emergencies	45	39%	20	**54%**	18	47%
In new developments, specifies roadway design standards or guidelines for evacuation of residents during wildfire emergencies	22	19%	9	24%	10	**26%**
Provides at least one publicly-accessible wildfire shelter in the event that residents cannot evacuate during a wildfire emergency	7	6%	3	8%	5	**13%**
I don't know	23	20%	5	14%	8	**21%**
Below is the final list of potential municipal planning measures that can be used to mitigate wildfire by addressing roads and emergency shelter. Please indicate which measures are included in your municipality's planning policies and development standards. (Please check all that apply.)						

3.6 Perceived Barriers

3.6.1 All Barriers

In this study, we defined barriers as factors that hinder the consideration or adoption of municipal planning policies and regulations for the purposes of mitigating wildfire risk. Barriers can be overcome whereas limits cannot (Moser & Ekstrom, 2010).

We asked study participants to what extent they considered various factors to be obstacles to the adoption of municipal planning tools to mitigate wildfire risk in their community using a single stem question and a 5-point Likert-type response format (Fig. 17). We included an "I don't know" option for those who did not have an opinion on a given item. The 17 items were largely drawn from a recent literature review (Gatti et al., 2019).

Figure 17
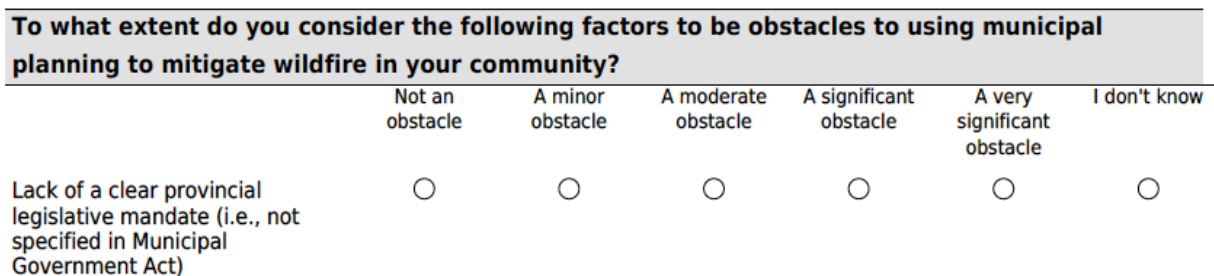
We grouped responses that were positive ("Minor obstacle", "Moderate obstacle", "Significant obstacle", and "Very significant obstacle") into a single category called "An obstacle". This method of analysis emphasizes broad agreement over whether or not an item was perceived as a barrier by the study respondents.

Table 13 presents the results. Measures viewed as an obstacle by at least 80% of study participants are emphasized in bold. Six items were viewed as being an obstacle by 80% or more while nine items were viewed as being an obstacle by 80% or more of respondents from Wildfire History municipalities (Table 14). *Local resistance to the idea of constraining development on private property*, *resistance from developers and builders*, *lack of financial resources*, *lack of a clear provincial mandate to address wildfire risk through land use planning*, *resistance from residents*, and *perception that development was prioritized over wildfire risk mitigation* were viewed as obstacles by 80% or more of study respondents. Looking at the items at the bottom of Table 13, *lack of communication between planning staff and fire department staff* and *perception among planning staff that addressing wildfire is not the responsibility of municipal planners* were viewed as obstacles by about half (55%) of respondents.

Table 13. Perceived barriers

Perceived Barrier Items	Study Sample (*n* = 114)		
	An obstacle[1]	*Not an obstacle*	*I don't know*
Local resistance to the idea of constraining development on private property	**91%**	2%	7%
Resistance from developers/builders	**88%**	7%	5%
Lack of financial resources	**85%**	9%	6%
Lack of a clear provincial legislative mandate (not specified in *MGA*)	**83%**	10%	7%
Development and growth are perceived to be more important than wildfire mitigation	**80%**	13%	6%
Resistance from residents	**80%**	14%	5%
Lack of knowledge about legal aspects of using planning to mitigate wildfire	79%	12%	10%
Uncertainty about which municipal planning tools can be used to address wildfire mitigation	78%	17%	5%
Widespread perception that wildfire risk is low	76%	19%	5%
Wildfire hazards and risk information is hard to interpret for planning purposes	75%	16%	9%
Lack of information about local wildfire hazards and risk	68%	26%	5%
Uncertainty about the link between land use patterns/urban design and wildfire risk and impacts	67%	26%	7%
Lack of communication between planning staff and AB wildfire staff	67%	26%	7%
Resistance from local elected officials	60%	35%	5%
Lack of communication between planning staff and fire dept staff	50%	45%	5%
Perception among planning staff that addressing wildfire is not the responsibility of municipal planners	47%	45%	8%
Resistance from Homeowners Association (HOA)	42%	31%	27%

[1] *Calculated as the sum of all response choices categories: Minor obstacle, Moderate obstacle, Significant obstacle, Very significant obstacle.*

Figure 18 presents responses grouped according to "Minor/Moderate obstacle" and "Significant/Very significant obstacle" for the full sample (*n* = 114).

Figure 18

All Perceived Barriers

Legend: Not an obstacle | Minor/Moderate obstacle | Significant/Very significant obstacle | I don't know
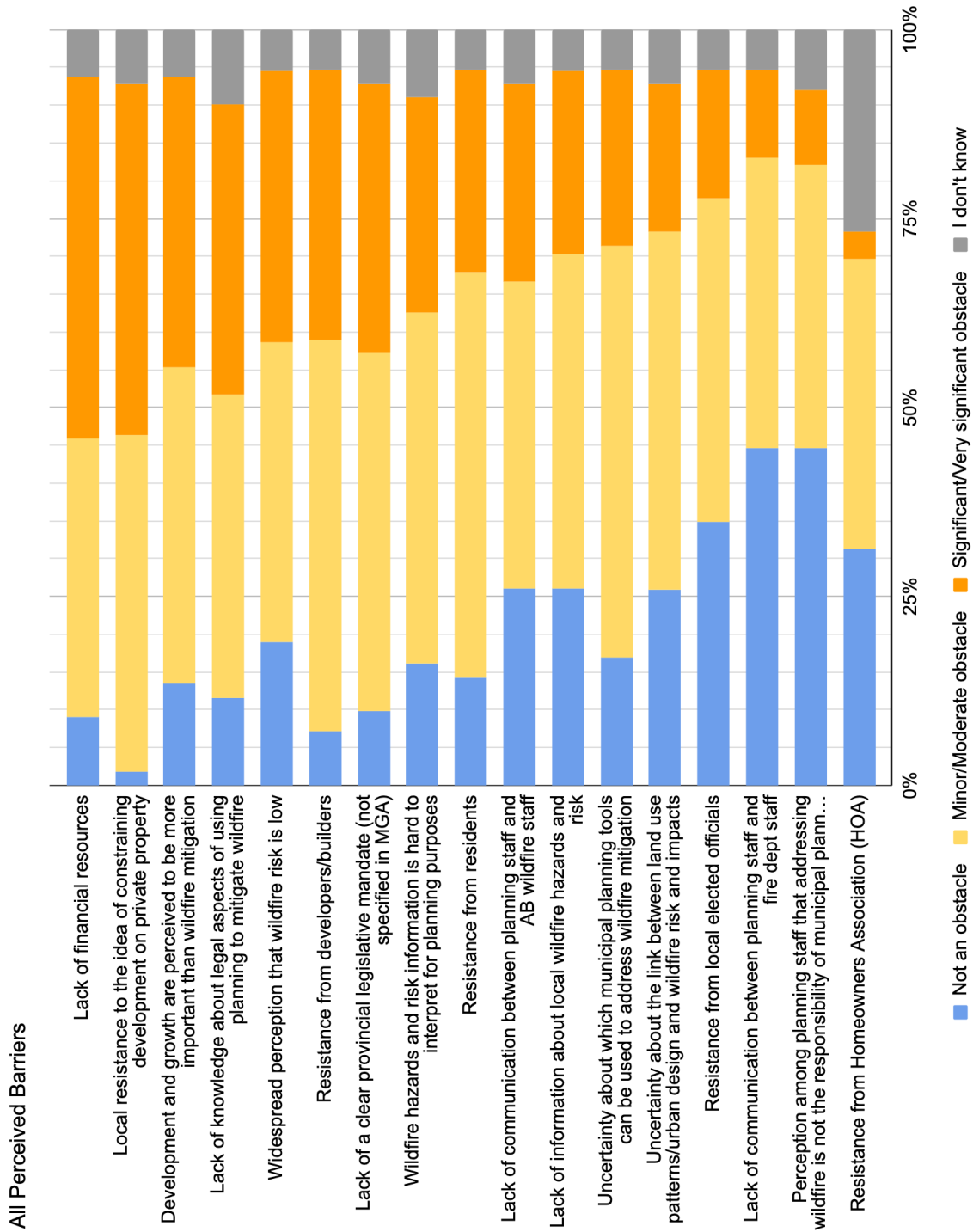
3.6.2 Wildfire History Municipalities versus Non-Wildfire History Municipalities

When comparing Wildfire History municipalities to Non-Wildfire History municipalities, we found significant differences in the results (Table 14). Overall, municipal planning and development professionals from Wildfire History municipalities were more likely to perceive items as limiting factors than those from municipalities without recent wildfire experience. There were large differences in perceptions on certain items between study participants from Wildfire History municipalities and those from municipalities without a recent history of wildfire. For example, 97% of participants from Wildfire History municipalities viewed *local resistance to the idea of constraining development on private property*, *resistance from developers/builders*, and *resistance from residents as barriers* as obstacles compared to 88% of non-Wildfire History municipalities. Ninety-five percent of Wildfire History municipalities perceived the *belief that development and growth are more important than wildfire mitigation* to be a local barrier compared to 73% of non-Wildfire History respondents. And 92% of Wildfire History respondents viewed the *lack of a clear provincial legislative mandate to address wildfire risk through planning* as a barrier compared to 79% of non-Wildfire History respondents. A far greater proportion of respondents from Wildfire History municipalities (81%) perceived *resistance from local elected officials* to be a barrier than from non-Wildfire History municipalities (49%), and these respondents were more likely to view *uncertainty about which municipal planning tools can be used to address wildfire mitigation* as a barrier (86% versus 73%).

Table 14. Perceived barriers, Wildfire History municipalities vs. Non-Wildfire History municipalities

	Non-Wildfire History Municipalities (*n* = 77)	Wildfire History Municipalities (*n* = 37)	% difference between samples
Perceived Barrier Items	*An obstacle[1]*	*An obstacle[1]*	
Local resistance to the idea of constraining development on private property	**88%**	**97%**	+ 9%
Resistance from developers/builders	**83%**	**97%**	**+ 14%**
Resistance from residents	72%	**97%**	**+ 25%**
Development and growth are perceived to be more important than wildfire mitigation	73%	**95%**	**+ 22%**
Lack of a clear provincial legislative mandate (not specified in *MGA*)	**79%**	**92%**	**+ 13%**
Uncertainty about which municipal planning tools can be used to address wildfire mitigation	73%	**86%**	**+ 13%**
Lack of financial resources	**85%**	**84%**	- 1%
Resistance from local elected officials	49%	**81%**	**+ 32%**
Lack of knowledge about legal aspects of using planning to mitigate wildfire	**77%**	**81%**	+ 4%
Widespread perception that wildfire risk is low	74%	78%	+ 4%
Wildfire hazards and risk information is hard to interpret for planning purposes	75%	76%	+ 1%
Uncertainty about the link between land use patterns/ urban design and wildfire risk and impacts	64%	73%	+ 9%
Lack of communication between planning staff and AB wildfire staff	64%	73%	+ 9%
Lack of information about local wildfire hazards and risk	72%	62%	- 10%
Perception among planning staff that addressing wildfire is not the responsibility of municipal planners	45%	51%	+ 6%
Lack of communication between planning staff and fire dept staff	52%	46%	- 6%
Resistance from Homeowners Association (HOA)*	43%	41%	- 2%

[1] Calculated as the sum of all response choice categories: Minor obstacle, Moderate obstacle, Significant obstacle, Very significant obstacle

* 27% responded "I don't know"

The most significant gaps in perceptions between these two sub-samples were *resistance from elected officials* (+32% difference), *resistance from residents* (+25%), *resistance from*

developers/builders (+14%), and *local views that development and growth were more important to the community than wildfire mitigation* (+22%). The *lack of a provincial mandate* was also perceived as a barrier by a greater proportion of respondents from Wildfire History municipalities (+13%), as was *uncertainty about which municipal planning tools can be used to address wildfire mitigation* (+13%). These gaps may be the result of having had experience trying to plan for wildfire disaster risk reduction.

These differences in responses may be in part a reflection of actual experience trying to address wildfire risk and finding the task challenging. For example, responses about uncertainty regarding planning tools could be in part due to previous experience searching for ways to mitigate wildfire due to assessed wildfire hazards and risk. Municipal planning and development professionals from communities that face low or no wildfire risk are not likely to have experience with this issue and therefore may not perceive this as a barrier.

One barrier that was less viewed as a barrier among Wildfire History respondents was lack of information about local wildfire hazards and risk. A potential reason for this result is that 54% of Wildfire History municipalities reported having completed a Wildfire Hazards and Risk Assessment compared to 21% of non-Wildfire History municipalities.

3.6.3 All Barriers: Weighted Ranking

We sorted the barriers in order of most to least perceived barriers using a simple weighted scores ranking method:

$$(number\ of\ responses\ ``Not\ an\ obstacle"\ \times 1)\ +\ (number\ of\ responses\ ``Minor\ obstacle"\ \times 2) +$$

$$(number\ of\ responses\ ``Moderate\ obstacle"\ \times 3)\ +\ (number\ of\ responses\ ``Significant\ obstacle"\ \times 4) +$$

$$number\ of\ responses\ ``Very\ significant\ obstacle"\ \times 5)\ /\ total\ number\ of\ responses\ for\ each\ item$$

The top score (273) was transformed into the number 10, and all other scores adjusted to create a table of weighted scores ranked from 10 for the highest.

This analytic method places more weight on stronger opinions, so that a higher score indicates responses that were skewed more towards the right side of the scale (e.g., "Significant obstacle", "Very significant obstacle"). However, because the data is ordinal rather than interval, the weighted scores should not be viewed as statistically meaningful.

According to this analysis, *lack of financial resources*, *local resistance to constraining development on private property*, and *resistance from developers and builders were perceived* as the strongest barriers among municipal planning and development professionals (Table 15). Compared to the full sample, study participants from Wildfire History municipalities perceived *resistance from residents* and *resistance from elected officials* as more significant barriers, and the *widespread perception that wildfire risk is low* and *lack of information about local wildfire hazards and risk* as less significant barriers.

Table 15. Perceived barrier items

Barrier Item	Sample (n = 114)	Wildfire History Municipalities (n = 37)	Difference between samples
Lack of financial resources	10.0	9.5	- .5
Local resistance to the idea of constraining development on private property	9.7	10.0	+ .3
Resistance from developers/builders	9.1	9.4	+ .3
Lack of a clear provincial legislative mandate (i.e., not specified in Municipal Government Act)	8.9	9.0	+ .1
Development and growth are perceived to be more important than wildfire mitigation	8.9	9.5	+ .6
Lack of knowledge about legal aspects of using planning to mitigate wildfire	8.7	8.6	- .1
Widespread perception that wildfire risk is low	8.4	7.3	- 1.1
Resistance from residents	7.9	9.1	+ 1.2
Wildfire hazards and risk information is hard to interpret for planning purposes	7.8	7.7	- .1
Uncertainty about which municipal planning tools can be used to address wildfire mitigation	7.5	8.0	+ .5
Lack of communication between municipal planning staff and provincial wildfire staff	7.4	7.6	+ .2
Lack of information about local wildfire hazards and risk	7.2	6.5	- .7
Uncertainty about the link between land use patterns/ urban design and wildfire risk and impacts	7.0	7.5	+ .5
Resistance from local elected officials	6.6	7.7	+ 1.1
Lack of communication between municipal planning staff and municipal fire department staff	5.6	5.5	- .1
Homeowners Association (HOA)	5.6	5.4	- .2
Perception among planning staff that addressing wildfire hazards and risk is not the responsibility of municipal planners	5.4	5.9	+ .5

3.6.4 Other Barriers

There were 33 responses to an open-ended question about other factors that inhibit or facilitate wildfire risk mitigation through planning. A number of responses were reiterations of prior mentioned barriers, such as lack of political and public support, competing planning objectives, lack of knowledge on how to use planning as a tool to mitigate wildfire risk, and lack of available

resources. Below is a summary of the main themes and concerns that emerged from the comments that were specifically about barriers and facilitators.

The most common area of focus in the open-ended responses concerned agricultural lands and grasslands. Seven respondents specifically commented that wildfire risk was not perceived to be a significant issue for communities surrounded by grasslands and agricultural lands. Yet grassland fires are common in Alberta and can spread faster than forest fires (McGee, McFarlan, & Tymstra, 2015). The southwest edge of the prairie ecozone has experienced a number of evacuations (Beverly & Bothwell, 2011). Two respondents noted that FireSmart materials seem to be focused on providing advice to forested areas and that guidance is lacking for communities at risk of grassland fires. The emphasis on forest fire threats in FireSmart materials was viewed as potentially giving communities the impression that wildfire risk is only a concern in forested landscapes.

Another respondent wrote that current FireSmart Canada/Alberta vegetation guidelines are geared towards rural areas with low density. The participant's community featured heavily vegetated compact urban development. In the words of the respondent, "if taken literally, [FireSmart guidelines] would mean that not one coniferous tree/shrub should be left standing" within the municipality. While this comment does not address land use planning specifically, it suggests that FireSmart materials should take into consideration the full range of development forms in Alberta (e.g., medium density and compact form, low density suburban form, and very low density or scattered form).

Four respondents focused on the issue of integrating planning practice and wildfire risk reduction practice. One questioned how wildfire mitigation can be integrated into planning since the latter takes a long-term view. For example, planning often takes a 20 or 30 year horizon whereas wildfire risk is viewed as a short-term problem. Three respondents noted wildfire risk mitigation planning recommendations often conflict with other planning and fiscal management goals, such as compact urban form and the planting of drought-resistant native vegetation species. In the words of a respondent: "FireSmart suggests separation distances between buildings, structures, coniferous trees etc. that must be balanced with other needs such as housing." This is a critical point that has been largely overlooked by the literature, with the exception of Whitman, Rapaport and Sherren' (2014) and MacLeod, Hahs and Penman' (2019) examinations of the trade-offs between fire risk and urban forest benefits.

Another point of tension concerns aesthetic preferences. A respondent noted that developers continue to build and market homes that fit a "country" aesthetics (i.e., "log cabins with conifers up against a house"). The issue of aesthetics was also raised by a respondent who noted the conflict between removing vegetation and the desire of residents to live in a forested community setting.

One respondent noted that there is a perception that mitigation costs more to the municipality than rebuilding since the provincial government assists with emergencies and insurance pays for damages. The comment highlights the role of incentives in determining behaviours.

One respondent raised the issue of risk perception, noting that they believed the public and elected officials do not understand wildfire risk and tend to discount it.

Two comments suggested that land use planning and development regulations were less important than other factors, namely building codes and fire codes, and human-caused fires and fuel management, which suggests a need to better explain the connections between land use planning and wildfire risk.

While our survey was primarily focused on barriers to adoption of land use planning wildfire risk mitigation measures, one respondent suggested having to enforce regulations across a large very rural area with scattered structures would be cost-prohibitive. The issue of implementation and enforcement has been raised by researchers (Alexandra et al., 2020; Mockrin et al., 2018).

One participant noted that a main obstacle is the common view that "private landowners should not be told what to do on their own property if it does not directly impact someone else". Public messaging that explains how private structures contribute to wildfire spread in addition to vegetation could help the public accept regulations and limitations.

One study respondent, who emphasized lack of wildfire hazard assessment and lack of funding as barriers, was under the impression that their community could not access FRIAA resources because they were outside of FRIAA's jurisdiction. The issue of spurious barriers was noted in a US study wherein municipal staff identified lack of technical expertise and hazard mapping as obstacles even though free assistance was readily available from the regional fire authority (Hughes & Mercer, 2009).

Most of the comments focused on challenges rather than facilitators. However, study participants emphasized the need for a provincial mandate and the importance of working with local emergency management staff. In the words of one participant, "if we had a clear requirement to tackle it, followed up by easy to implement guidance on what to do, then wildfire mitigation measures would be rapidly implemented".

These open-ended comments are helpful in demonstrating the complexity of community wildfire mitigation through planning. Some of the responses suggest a disconnect between perception and reality, while others point to the important role of culture. The responses indicated numerous gaps in FireSmart materials that can be addressed. It is important to remember that we looked at barriers perceived by land use planning and development professionals, not objective barriers.

3.7 Other Data

3.7.1 Development Pressure

Retrofitting existing building stock and urban infrastructure remains a significant challenge to the aim of fire-adapted communities. However, residential expansion in Western Canada is fairly recent and there are indications that expansion may continue, particularly as "amenity migrants"

increasingly seek to live near national parks and areas rich in natural amenities (Robinson & Stark, 2006). While data is missing about the Canadian context, authors of a study of residential expansion in the United States concluded that 86% of WUI lands available for development in 11 Western states has yet to be developed (Gude, Rasker, & van den Noort, 2008).

We asked municipalities about the likelihood that their municipality would approve new residential construction in the next five years. Nearly three-quarters of respondents answered "Somewhat likely/Very likely" (*n* = 98, 86%) (Fig. 19). When sorting those municipalities with a wildfire history (*n* = 37), we find the answers slightly more skewed towards "Somewhat likely/ Very likely" (89%), with 3% answering "Somewhat likely" and none answering "Not likely".

Figure 19

Likelihood of New Residential Development in Next 5 Years
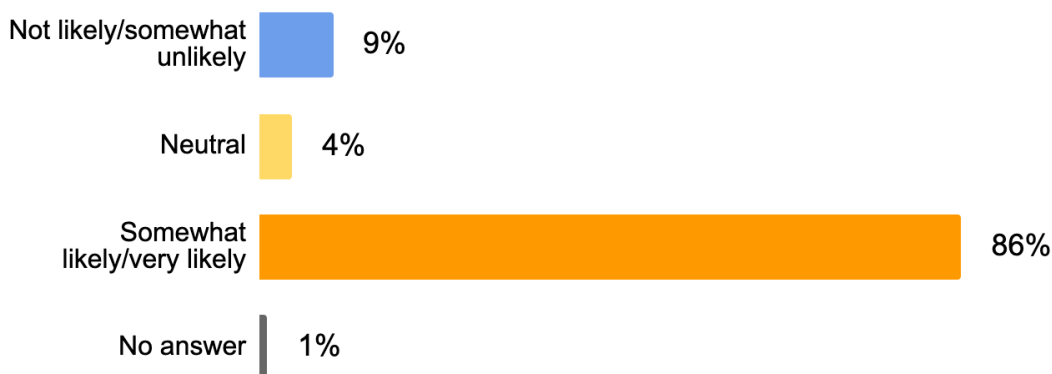
How likely is it that your municipality will approve new residential construction in the next 5 years?

3.7.2 Sources of Information

An important part of FireSmart's mandate is to distribute relevant information to the public. Therefore, we asked study participants to tell us to whom they would turn to for information about using municipal planning tools to mitigating wildfire risk. We provided study participants with a preset list of 12 items, as well as the option to add additional sources of information.

Table 16 displays the results from the full sample. Three-quarters of municipal planning and development professionals would consult FireSmart Canada/FireSmart Alberta (76%) or their municipal fire department (74%) for information. Other top responses included a search of the Internet (68%), the Ministry of Municipal Affairs (56%), planning colleagues (45%), and the Rural Municipalities of Alberta (RMA) (44%). Notably, land use planning professional organizations such as the APPI and CIP were not viewed by the majority of respondents as sources of relevant information about a land use planning approach to wildfire risk reduction.

Table 16. Sources of information

	#	%
FireSmart Canada/Alberta	87	76%
Municipal fire department	84	74%
The Internet	77	68%
Ministry of Municipal Affairs	64	56%
My planning colleague(s)	51	45%
Rural Municipalities of Alberta (RMA)	50	44%
Forest Area wildfire prevention office	46	40%
Alberta Professional Planners Institute (APPI)	42	37%
Association of Urban Municipalities of Alberta (AUMA)	39	34%
Canadian Institute of Planners (CIP)	33	29%
FireSmart consultant (private sector)	33	29%
Association of Summer Villages of Alberta (ASVA)	3	3%
Other	8	7%
I don't know	1	1%
If you were looking for information or guidance about using municipal planning tools to mitigate wildfire, to which sources would you likely turn? (Please check all that apply.		

The seven study participants who answered "Other" provided six additional suggestions in an open-ended question.

Table 17. Other sources of information

| "Other"	#
Alberta Development Officers Association of Alberta (ADOA)	2
Community Planning Association of Alberta (CPAA)	1
Alberta Emergency Management Association	1
National Fire Prevention Association (NFPA)	1
Office of the Fire Commissioner	1
Other provinces (BC in particular)	1

3.7.3 Training and Competence

Our observation of the planning literature is that there is little available technical guidance for planners seeking to address wildfire risk in Canada. Therefore, we asked study participants if they had received prior training about natural hazards, if they found that training to be adequate, and if they were interested in receiving additional training.

Nearly half (47%) reported having received formal training, 33% had not received training, and 16% responded "I don't remember" (Fig. 20). More participants from Wildfire History municipalities and FPA municipalities reported having received training (57% and 55% respectively).

Figure 20

Recall Prior Training About Natural Hazard Mitigation
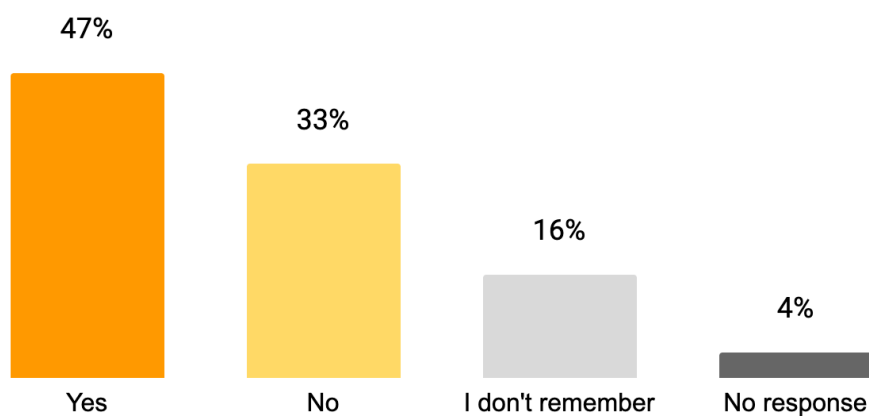
While training to become a planning and development professional, were you taught about the role of municipal planning in mitigating natural hazards (e.g., flooding, landslides, wildfire)?

Figure 21 indicates that a larger percentage of respondents disagreed that they had received adequate training about hazards (39%) than agreed (16%). Forty-one percent neither agreed nor disagreed. Participants from FPA municipalities were more in agreement (29%) while respondents from Wildfire History municipalities had significantly fewer neutral responses (neither agree or disagree), and had the highest rates of disagreement (48%) with this statement.

Figure 21

Have Received Adequate Training About Planning Tools to Mitigate Wildfire Risk
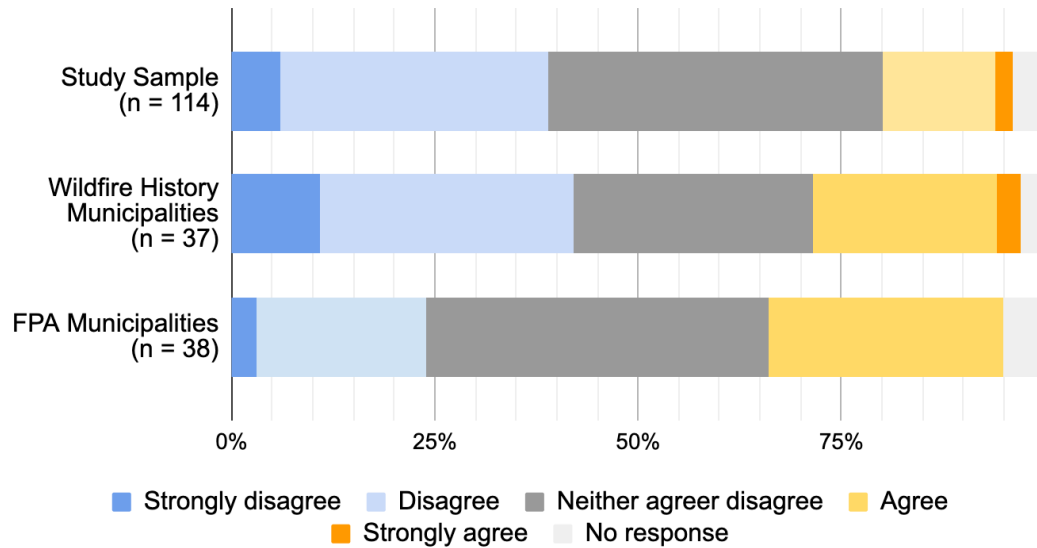
Please indicate your level of agreement with the following statement: "I have received adequate training about using municipal planning tools to mitigate wildfire risk."

The majority of study respondents (74%) were interested in receiving additional training (Fig. 22). The number was significantly higher among respondents from Wildfire History municipalities (89%) and slightly higher among FPA municipalities (79%) respondents.

Figure 22

Interested in Receiving Additional Training
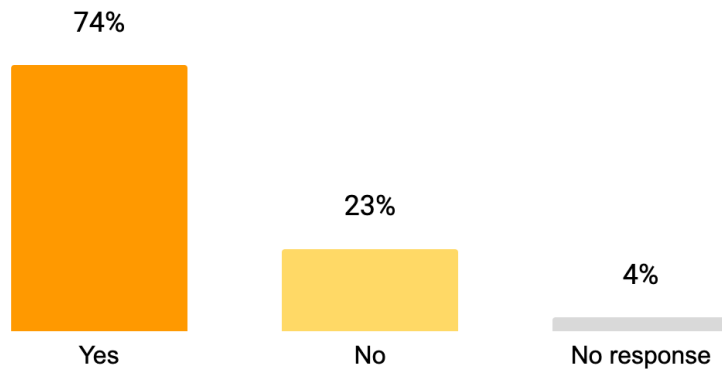
Are you interested in receiving training about how municipal planning can be used to mitigate wildfire risk and impacts?

3.7.4 Influence of Fort McMurray Disaster

Highly publicized disasters often create a "window of opportunity" for action, although evidence suggests that planning continues to be overlooked (Mockrin et al., 2020, 2018). The 2016 Horse River Fire, also referred to as the Fort McMurray Fire, was Canada's costliest disaster related to a natural hazard (Kovacs et al., 2019). We asked study participants to what extent the Fort McMurray Fire influenced their perception of the relevance of land use planning and development standards to wildfire risk.

Roughly a quarter of participants from FPA municipalities (26%) and Wildfire History municipalities (24%) told us the fire had a "Major effect" on their viewpoint (Table 18). Overall, the disaster in Fort McMurray had a significant impact on perceptions among municipal planning and development professionals, with just 14% of all study respondents choosing "It had no effect".

Table 18. Influence of Fort McMurray Fire

	Sample (n = 114)		Wildfire History Sample (n = 37)		FPA Sample (n = 38)	
	#	%	#	%	#	%
It had no effect	16	14%	4	11%	4	11%
It had a minor effect	36	32%	14	37%	11	29%
It had a moderate effect	39	34%	9	24%	13	34%
It had a major effect	21	18%	10	26%	9	24%
No response	2	2%	0	3%	1	3%
Total	114	100%	37	100%	38	100%

To what extent did the 2016 Fort McMurray wildfire change your viewpoint about the importance of addressing wildfire through land use planning regulations and development standards (e.g., decisions about where residential development is allowed to take place, road network patterns, building materials)?

4.0 Discussion

The primary objectives of this survey were to provide a snapshot of the extent to which Alberta's municipalities are using land use planning to mitigate wildfire disaster risk, and to capture municipal planning and development professionals' perceptions of barriers to a planning approach to wildfire disaster risk mitigation. The results from 114 completed surveys (59% of the study population) indicate that land use planning policies and development regulations are being used minimally, and that municipal planning and development professionals perceive a wide range of barriers. The survey data raise additional questions to be addressed by researchers. They also point to a number of opportunities for FireSmart Alberta and other advocates to intervene. In this section, we discuss the most significant findings of our survey.

4.1 FireSmart Community Plans

Although FireSmart Community Plan documents i.e., (*Wildfire Hazard and Risk Assessment*, *Wildfire Preparedness Guide*, *Wildfire Mitigation Strategy*) were not the main focus of our study, their adoption rates can be used as an indication of overall community fire-adaptedness in Alberta. For example, we would not expect municipalities to be employing land use planning for wildfire mitigation, which is arguably more complex and less resourced than the other FireSmart disciplines, if they have not first engaged with the FireSmart Community Plan process. In fact, recommendations regarding Legislation and Development FireSmart measures are typically included in the *Wildfire Mitigation Strategy*, and subsequently adopted.

We found that the majority of municipalities in Alberta (64%) had *not* completed any of the three FireSmart Community Plan documents, and just 15% of municipalities had completed all three. While we do not have sufficient data to make conclusive statements about the adequacy of these completion rates in relation to wildfire risk, we discovered through our survey that 37 municipalities (32% of sample) reported a history of wildfire since 2000. Given their past experience, Wildfire History municipalities have good reason to conduct a *Wildfire Hazards and Risk Assessment* at the very least to determine if a prevention and mitigation response is necessary. Likewise, since municipalities in the Forest Protection Area are located in the boreal forest and tend to be more remote and therefore at greater risk should they come into contact with a wildfire, it is reasonable to assume that FPA communities may be exposed to wildfire hazards and risk, and therefore should be completing FireSmart Community Plans.

However, according to our survey, 46% of Wildfire History municipalities and 47% of FPA municipalities have *not* completed a *Wildfire Hazards and Risk Assessment*. Furthermore, only 53% of municipalities that reported a wildfire evacuation since 2000 had completed a *Wildfire Preparedness Guide*, and just 37% of municipalities with a recent history of structural or infrastructure loss due to wildfire reported having a *Wildfire Mitigation Strategy*. These data suggest that there is a significant proportion of municipalities in Alberta that are likely at risk of wildfire but that are not engaging in the FireSmart Community Plan process.

One reason for this may be that the burden of assessing wildfire hazards and risk falls on municipalities. Since municipalities lack in-house technical capacity to make such assessments, they typically hire a consultant to complete the assessment and other FireSmart Community Plan documents. Although funding is available to all municipalities on a competitive basis through the FRIAA FireSmart Program, lack of financial resources was viewed as a barrier to the integration of planning and wildfire mitigation by 85% of study respondents. We did not ask study participants to provide details about what exactly they need additional financial resources for. More research is needed to understand why such municipalities are not completing FireSmart Community Plan documents. Wildfire management officials may wish to consider these data in light of their knowledge of wildfire hazards and risk across the province in order to evaluate the current framework for supporting community wildfire risk reduction.

4.2 Model WUI Codes and Standards

The authors of the Fort McMurray disaster review recommended that the Government of Alberta "establish a wildland-urban interface wildfire code for the development and construction of new buildings" (Kovacs et al., 2019, p. 30). Since the publication of that report, the Canadian Standards Association (CSA) released a WUI standard, *CSA S504 Fire Resilient Planning for Northern Communities*, in late 2019. Model wildland urban interface (WUI) codes and standards have been available to communities since at least 2003, when the *International Wildland Urban Interface Code (IWUIC)* was first released.

Our research indicates that a minority of municipalities in Alberta (*n* = 22, 19%) have adopted or adapted one or more model WUI codes and standards. Ten of those 22 municipalities reported a history of wildfire since 2000. Two templates were created specifically for Albertan communities but these have been adopted by only a handful of municipalities. Alberta Infrastructure's 2013 *Guideline for Wildfire Protection of Institutional Buildings in Forested Regions in Alberta* has been adopted by six municipalities (three FPA municipalities). The Association of Summer Villages of Alberta (ASVA) *Fire Bylaw Template*, a model funded by the FRIAA FireSmart Program and released in 2017, has been adopted by summer villages in two counties.

The low adoption rates for model codes and standards, particularly those developed specifically for Alberta's communities, should be explored in order to determine how municipalities perceive the utility of existing templates. We did not evaluate the model codes and standards included in our survey but it may be useful to conduct an assessment of the appropriateness of available models for the Alberta context, and then make recommendations to municipalities in partnership with relevant government agencies and disaster risk reduction partners.

4.3 Incorporating Wildfire Hazards into Statutory Plans

Our results indicate that 30% of municipalities had addressed wildfire hazards in their Municipal Development Plans (MDP) while 18% had addressed wildfire in their Intermunicipal Development Plan (IDP). As living documents, the Government of Alberta recommends that

MDPs (and IDPs) be reviewed and potentially amended every five years, and updated every 10 years (Alberta Government, 2018). According to our survey, nearly half (44%) of Municipal Development Plans (MDPs) were between five and 10 years old, and a further 24% were more than 10 years old. Nineteen of the 20 Wildfire History municipalities whose MDPs did not address wildfire hazards were completed in 2015 or earlier.

These data indicate that there may be an opportunity to amend or update MPDs (and IDPs) in municipalities that are at risk of wildfire in the near future. To assist with this objective, a concrete suggestion concerns the current *Guidebook for Preparing a Municipal Development Plan*, published by the Government of Alberta (2018). The *Guidebook* includes two "topic papers" in Appendix B that provide guidance to municipal planners on integrating policies in their MDP about two natural hazards: flooding and steep/unstable slopes (Government of Alberta, 2018, pp. 236-240). We recommend that FireSmart Alberta work with Alberta Municipal Affairs to add a topic paper regarding wildfire hazards to the *Guidebook*, and to promote this new resource to municipalities to ensure that municipalities at risk of wildfire incorporate wildfire hazards into their statutory plans.

4.4 Planning Measures Adopted to Mitigate Wildfire Risk and Barriers

Land use planning and development regulations can be used to minimize exposure to hazards and the impacts of wildfire (Canadian Forest Service, 2013; Gonzalez-Mathiesen & March, 2018; Mowery et al., 2019). However, our research found that the most commonly reported planning measures aimed at mitigating wildfire risk are not WUI-specific measures (e.g., restricting combustible materials on private property, restricting development on steep slopes). They are also not dependent on wildfire hazards and risk information.

These findings support the perception among wildfire management officials that municipalities in Alberta are not using land use planning and development regulations as wildfire disaster risk reduction tools. While we cannot specify what percentage of municipalities in Alberta should be using these tools since their use should be a response to wildfire risk, their lack of use among municipalities at risk, including Wildfire History municipalities, should be further explored. For example, to what extent is the lack of wildfire hazard and risk information preventing municipalities from adopting planning measures to mitigate wildfire? The findings regarding perceived barriers provide additional insights into possible reasons.

In addition to the above findings, the results suggest two additional issues: a potential disparity in policies addressing older and newer development, and vulnerability of municipal buildings and critical infrastructure.

There is some evidence from disaster analyses to suggest that newer developments suffer lower losses to wildfire, possibly due to newer construction techniques, notwithstanding confounding factors such as density and location (Kovacs et al., 2019). Older developments may be situated farther away from the WUI but this does not protect them from wildfires since burning homes themselves are a major source of fire spread (Keely, Safford, Fotheringham,

Franklin, & Moritz, 2009). We found that about twice as many municipalities have standards for availability of water for firefighting in the event of a wildfire emergency in *new* developments but do not require retrofitting in *existing* developments. The disparity is especially great in Wildfire History municipalities, where 49% have standards for new developments compared to 14% that have policies to retrofit existing development. These results highlight a contradiction in policies that could be creating disparate conditions of vulnerability and resilience between older developments and newer developments. A review of policies targeting existing and new developments would be helpful in assessing the scope of this potential disparity.

Municipalities have considerable influence over municipal infrastructure and public buildings. Fire-resilient public buildings, such as libraries, fire and police stations, and recreation facilities represent an opportunity to showcase fire-resilient construction to the public and lead by example—a point stressed by authors of a previous study of municipal wildfire mitigation measures in Alberta (Harris et al., 2011). Furthermore, resistance from developers and the public are less likely to be factors in the decision-making process.

Previous research found that structural mitigation of government buildings was not commonly pursued in Alberta (Harris et al., 2011; McGee et al., 2009), and our survey confirms those findings. Our results indicate that few municipalities are addressing public buildings and critical infrastructure. Six municipalities (5%) limit or discourage the construction of critical infrastructure and sites in wildfire hazard areas, and 22 municipalities (19%) require fire-resistant materials on all new or significantly renovated public buildings. Few FPA municipalities or Wildfire History municipalities have a policy to limit the construction of critical infrastructure or public facilities in wildfire hazard areas. Six communities (5%) in Alberta have adopted the *Guideline for Wildfire Protection of Institutional Buildings in Forested Regions in Alberta*.

The decision-making around wildfire-resilient public buildings and infrastructure is one area that should be explored. In particular, researchers should explore the incentive context (e.g., private insurance, provincial grants, post-disaster financial support) that might positively or negatively influence the construction of public buildings that are fire-resilient. Given the low adoption rates for these measures, FireSmart Alberta may wish to develop specific materials and messaging for municipal governments regarding public buildings and infrastructure. An incentive program that acknowledges or rewards municipal innovation in this regards should also be considered.

4.5 A Need for Training and Technical Planning Resources

Study respondents identified lack of training, and lack of technical and legal resources as barriers to the adoption of planning policies to mitigate wildfire risk.

Lack of training and mentorship regarding land use planning and hazard risk mitigation have been identified as a problem in Canada and other jurisdictions (Asgary, 2004; Bosher, Chmutia, & Von Meding, 2016; Hughes & Mercer, 2009). About a third of respondents in our survey could not remember having been taught about the role of municipal planning in mitigating natural hazards during their training to become planning and development professionals. Perhaps as a

result, only 16% agreed that they had received adequate training about using municipal planning tools to mitigate wildfire risk. While the proportion was higher among participants from Wildfire History and FPA municipalities, nearly half of Wildfire History municipality participants (48%) disagreed they had received adequate training. A large majority (89%) of respondents from Wildfire History municipalities indicated they were interested in receiving more training (compared to 74% for the full sample).

While we did not review all wildfire risk mitigation materials that are available to municipalities for this study, we could not locate any training documents published by Alberta Municipal Affairs, Alberta Emergency Management Agency, the Alberta Provincial Planners Institute (APPI), or the Canadian Institute of Planners (CIP). Training materials are needed to educate planning and development professionals in Alberta on ways to address wildfire risk. The American Planning Association's (APA) *Planning the wildland-urban interface* is an example of a potential outcome of such a partnership. A study of how the current Canadian planning curriculum teaches about natural hazards is also recommended, followed by recommendations for new training materials and outreach. As an example, the Australian state of Victoria initiated an education program for planners aimed at improving their knowledge of wildfire in 2018 (Gonzales-Mathieson et al., 2021).

Our findings regarding barriers also indicate that planning and development professionals in Alberta perceive a lack of resources that explain both the legal and technical aspects of a land use planning approach to wildfire risk mitigation. A large majority of respondents indicated that *lack of knowledge about the legal aspects of using planning to mitigate wildfire risk* (79%), *uncertainty about which planning tools are most appropriate for the task* (78%), and *uncertainty about the link between land use patterns/urban design and wildfire risk and impacts* (67%) are barriers. These items were viewed as barriers by a higher proportion of respondents from Wildfire History municipalities—those individuals who are more likely to have had an opportunity to consider the issue of wildfire. Regarding available FireSmart materials, study participants from municipalities surrounded by agricultural land and grasslands indicated that existing FireSmart materials seem to focus on communities in forested landscapes. Several participants from urban communities with compact urban forms noted that FireSmart recommendations appear to address conditions found in low density, rural communities. These concerns should be addressed in both training and educational materials.

A potential reason for the lack of informational resources in Alberta and in Canada more generally is that the goal of community wildfire protection appears to be championed by wildfire management professionals, not land use planning professionals. There is little institutional integration between then two fields. While integration has not been studied in Canada, a recent study by the Community Wildfire Planning Center, an American non-profit organization that focuses on land use planning for wildfire risk reduction, found that in three out of four WUI states where wildfire is a significant concern, the agencies responsible for wildfire risk reduction do not have land use planners on staff (Mowery & Punchard, 2021). This technical gap also exists in other jurisdictions, including New Zealand (Kornakova & Glavovic, 2018) and within Wildfire Alberta (G. Braid, 2020, personal communication, March 17, 2021).

The findings regarding lack of training and lack of knowledge and informational resources provides FireSmart with an avenue for action. FireSmart Alberta can engage with relevant planning industry associations and other agencies and organizations listed in *Appendix B* in order to address this training and technical knowledge gap. As a precursor to providing updated and targeted materials, we recommend a review of current Canada and Alberta-specific materials that are available to municipal planning and development professionals in Alberta (e.g., Municipal Affairs, FireSmart, Wildfire Alberta, Alberta Emergency Management Agency, Public Safety Canada). We also recommend a review of the broader available scholarly and grey literature to identify other resources in order to compile resources that can be used by municipal planning and development professionals.

4.6 Alberta Government's Role

Balancing conflicting objectives is at the heart of governing collective resources (Sherry, Neale, McGee, & Sharpe, 2019). Land use planning may appear to be a technical process but it is more accurately a social process with technical dimensions. Policy-makers must often address society's "wicked problems"—complex challenges for which there are often no 'correct' solutions (Rittel & Webber, 1973). Land use planners must navigate competing priorities and local vested interests while planning for the (often contested) 'public good'. A further contradiction lies in the fact that long-term statutory plans (e.g., *Municipal Development Plan*) must be approved by local elected officials whose vision may be limited to an election cycle. Government policies have also tended to focus on emergency management and recovery rather than prevention and mitigation. As a result, without a legal mandate from the province to integrate natural hazard risk reduction into land use planning policies, there are few incentives for local governments to trade short-term economic benefits or counter local interests in favour of hazard mitigation planning measures (Burby, 1998).

According to our survey, municipal planning and development professionals are keenly aware of these tensions. Study participants from Wildfire History municipalities largely perceived *local resistance to the idea of constraining development on private property* (97%) as an obstacle in their community. *Resistance from local developers and builders* (97%) and *resistance from residents* (97%), and the local *perception that development and growth are locally more important than wildfire mitigation* (95%) were also nearly unanimously viewed as obstacles among survey participants from Wildfire History municipalities. Notably, the share of participants from Wildfire History municipalities that viewed *resistance from local elected officials* as a barrier was 81% for Wildfire History municipalities compared to 49% among municipalities without wildfire experience since 2000. Perhaps as a result of these perceived barriers, 92% of these respondents perceived the *lack of a clear provincial legislative mandate* as a barrier to the integration of land use planning and wildfire risk reduction.

While planning communities with health and safety in mind is a local responsibility, the complexity of hazard risk reduction appears to be beyond the scope of many municipal governments. There is a lack of in-house technical and legal knowledge which necessitates the need to hire consultants to conduct hazard and risk assessments and mitigation planning. Lack

of financial resources may prevent communities from hiring consultants. Furthermore, it may be that municipal governments view wildfire risk reduction as the purview of the provincial government due to the historic wildfire suppression approach to wildfire risk. Researchers should investigate the capacity and perceptions of municipal government officials in this regard.

The implication that the Government of Alberta could play a more significant role in community wildfire protection is not without precedent. Currently, the provincial government publishes flooding data with the purpose of guiding land use planning (Government of Alberta, 2021), and the *Municipal Government Act* allows the Province to regulate development in floodways (Mbjaiorgu, 2018). This fact was observed by the authors of the Fort McMurray disaster evaluation report conducted in partnership with a large insurer. The authors suggested a greater role for the provincial government in managing wildfire risk, including the introduction of a provincial land use planning mandate (Kovacs et al., 2019). Authors of the 2011 Flat Top Complex incident review recommended that provincial agencies such as Alberta Municipal Affairs develop a "structure protection program" so that provincial wildfire staff can focus on wildfire containment (Flat Top Complex Wildfire Review Committee, 2012, p. 36). Even in jurisdictions with mandates, implementation can be a challenge due to competing pressures (Alexandra et al., 2020; Mockrin et al., 2018).

Other results suggest a greater role for the provincial government beyond legislating a mandate to plan to mitigate wildfire risks. Our survey indicates that municipal planners lack access to basic information about wildfire hazards and risk for their communities. More than half of municipal planning and development professionals viewed *lack of information about local wildfire hazards and risk* as a barrier (68%). In addition to lacking access to hazard and risk information, study participants also indicated that difficulty in *interpreting wildfire hazards and risk information for planning purposes is a barrier* (75%). The problem of translating wildfire risk information into a format and at a scale that can be used by planners has been raised by other researchers (Kornakova & Glavovic, 2018; Mbajiorgu, 2019; Reams et al., 2005). Recently, a 2020 auditor general's evaluation of Alberta's disaster risk-assessment plan recommended that the province implement a provincial hazard assessment program (Alberta Municipal Affairs, 2020), a move that would relieve local authorities from the burden of hiring consultants to conduct a *Wildfire Hazard and Risk Assessment*, and potentially remove an obstacle to the adoption of highly effective land use planning measures that rely on hazard and risk information.

4.7 Homeowners Associations (HOAs)

While less than a quarter of municipalities (22%) reported a Homeowners Association (HOA) within their jurisdiction, HOAs are a growing trend in the Edmonton area (Evans, 2015), and it is possible that they may be increasing elsewhere. Since HOAs have legal control over building design and materials, as well as landscaping, they have the potential to influence vulnerability to wildfire risk. A recent example of this potential was brought to light in Alberta in 2019, when a judge ruled against three homeowners in Edmonton's Blackburne Creek subdivision after their HOA successfully took them to court for installing shaker-style synthetic rubber roof shingles rather than wooden shingles (CBC, 2019). One of the homeowners, a firefighter, had argued

that the pine-shake roof exposed homeowners to unnecessary risk since the subdivision runs along a forested ravine. This anecdotal evidence suggests a need for further research on HOAs and their impacts on wildfire risk, and indicates a possible need for engagement with FireSmart concepts and practices.

4.8 Development Pressure

While we could not find recent data regarding development trends in Alberta's wildland urban interface (WUI) specifically, 86% of respondents from the full sample (89% of Wildfire History municipalities) reported that new residential construction would be "Somewhat likely" or "Very likely" in the next five years. This pace of growth adds urgency to the need to educate municipalities about the potential of land use planning and development to mitigate wildfire risk. Spatial research is needed about land development pressure and trends in Alberta, particularly in regions with wildfire exposure.

4.9 Limitations

Like all research, this study has several limitations. First, all data collected in this survey were self-reported, and therefore should be viewed as subjective rather than objective. Second, the reliability of data from factual questions is based on the study participant's knowledge of their statutory plans. The high number of "I don't know" responses regarding their statutory plans suggests that not all study participants were as familiar with how their MDPs and IDPs address natural hazards as we had anticipated. Therefore, the results of this item should be validated using a different method, such as a content analysis of statutory plans. Third, the results regarding perceptions (e.g., barriers) were from a sample that is not large enough to be considered representative of all planning professionals and therefore are not generalizable. And lastly, since not all municipalities in this survey are likely at risk of wildfire, readers should be careful not to interpret the results in relation to risk, unless noted. Rather, the data in this report provide a snapshot in time of municipal actions, and the perceptions of municipal planning and development professionals.

5.0 Conclusion

The research presented in this report has a number of implications for policy-makers and researchers. Land use planning is not a widely used tool to mitigate wildfire risk in Alberta, including among municipalities with a history of wildfire. In addition, a significant proportion of municipalities, including those with a history of wildfire in the last 20 years and those located in the Forest Protection Area, have not completed community wildfire mitigation documents (e.g., FireSmart Community Plan). These conclusions suggest a need to evaluate the current approach to community wildfire mitigation, particularly when it comes to leveraging land use planning as a mitigation tool.

The results regarding the perceptions of municipal planning and development professionals (e.g., barriers) provide insights into the challenges facing the integration of planning and wildfire mitigation in Alberta as well as point to potential avenues for future research. The results suggest a need to engage with "resistant" stakeholders, such as developers and builders, residents and elected officials. The findings raise questions about the Province's role in relation to funding for municipalities, the availability of hazard and risk assessments, and incentives and disincentives to conduct wildfire risk mitigation. And there is a need to refocus the training and education opportunities for planning and development professionals in collaboration with government agencies and planning industry groups.

This survey provides policy-makers and researchers with important baseline data about municipal government actions to mitigate wildfire risk in Alberta. These results, generalizable to all cities, towns, counties, municipal districts, and specialized municipalities in Alberta, can be used as a benchmark to monitor progress and assess the impacts of policy changes and interventions, such as updated FireSmart guidelines, new training materials for planning and development professionals, and targeted outreach programs. Our study excluded Metis settlements, First Nations reserves and summer villages. Since remote communities may be at higher risk of contact with wildfire, researchers should also study the built environment of these communities in order to determine vulnerability and resilience.

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7.0 Appendices

Appendix A
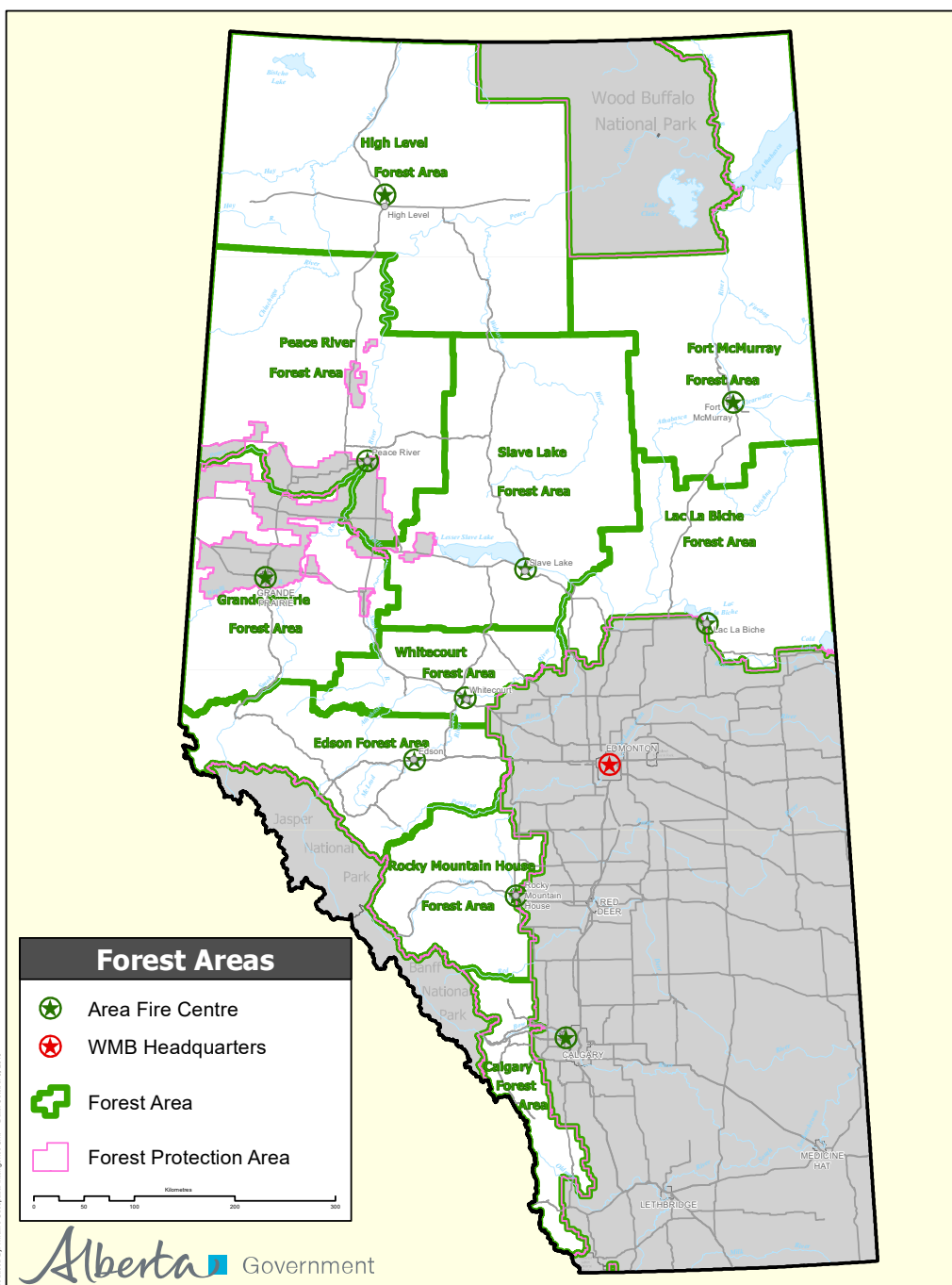
Appendix B

A Planning Approach to Wildfire Risk Mitigation: Relevant Agencies and Organizations

Organizations Representing Municipal Governments	Planning and Development Professional Associations	Disaster Risk Reduction Agencies and Organizations
Alberta Municipal Affairs	Canadian Institute of Planners (CIP)	Public Safety Canada
Association of Urban Municipalities of Alberta (AUMA)	Alberta Professional Planners Institute (APPI)	Alberta Emergency Management Association (AEMA)
Rural Municipalities of Alberta (RMA)	Community Planning Association of Alberta (CPAA)	Alberta Wildfire
Association of Summer Villages of Alberta (ASVA)	Alberta Development Officers Association of Alberta (ADOA)	FireSmart Canada, FireSmart BC, FireSmart Alberta, FireSmart Ontario
	Local Government Administration Association of Alberta (LGAA)	Office of the Fire Commissioner (Alberta)
		Alberta Fire Chiefs Association (AFCA)