

Addendum:

Understanding the Potential Flood Risk of Current and Future Provincial Land Use Policy: Policy Review and Case Study Analysis by Big River Analytics

Date: July 15, 2026

Addendum Partner Ministries: Emergency Management and Climate Readiness; Housing and Municipal Affairs; and Water, Land and Resource Stewardship

Background

This addendum to Understanding the Potential Flood Risk of Current and Future Provincial Land Use Policy (the Report) provides updated information and clarification resulting from an inter-ministry review. It is intended to address identified gaps, out-of-date information and ensure alignment with provincial priorities related to housing, climate resilience and risk reduction.

As part of implementing the B.C. Flood Strategy, the Ministry of Water, Land and Resource Stewardship (WLRS) engaged Big River Analytics to examine the increasing risks of flooding and the challenges associated with current flood risk management practices, including the role of provincial land use policies in British Columbia. This Report comes at a time when the B.C. government is working to increase housing supply to meet current and anticipated population needs, while also addressing the growing impacts of climate change and development pressure in flood prone areas. The B.C. government is committed to supporting the timely delivery of housing, while also ensuring that communities are safer and more resilient by guiding new development away from high-risk flood areas.

Updates and Clarifications to the Report

Due to the passage of time and subsequent policy changes by the B.C. government and local governments, some content in the 2024 report is no longer current.

For example, the case study findings related to the City of Kelowna's growth, bylaws, and floodplain management do not reflect updates completed since 2024, including recent Official Community Plan (OCP) amendments and revised planning tools. Since the Report was drafted, Kelowna has adopted more modern and robust flood risk management policies, including engineering upgrades, enhanced hazard monitoring, ecosystem-based mitigation, major capital investments, and integration of flood resilience into climate and land use planning frameworks. Other local governments identified in the Report may have also updated their policies since the Report was drafted in 2024.



Similarly, since the Report was finished, many local governments across the province have updated their OCPs and zoning bylaws, as required under the B.C. government's housing legislation. This includes incorporating updated housing needs calculations, a longer-term planning horizon, and ensuring there is enough planned and zoned capacity to accommodate the identified housing need.

In some cases, local governments have used this opportunity to implement a range of other changes including updating Development Permit Areas, strengthening policies for hazardous conditions, or in some cases incorporating new flood mapping. For the most accurate information about current local policies and requirements, readers are encouraged to contact their local government.

There have also been changes to some of the funding programs mentioned in the Report. Because of this, information such as what's available, who is eligible, and the goals of the programs may no longer be accurate or up to date. Current information related to provincial funding programs can be found on the B.C. government's [Emergency Management Financial Supports webpage](#).

The B.C. government continues to work closely with the federal government to advocate for expanded, predictable, and more flexible flood resilience funding programs to support communities in both structural and non-structural risk reduction efforts.

Finally, the findings and interpretations contained in the Report reflect the professional opinions and perspectives of the authors. They do not necessarily represent the positions, policy direction, or current priorities of the B.C. government.

1 October 2024

Understanding the Potential Flood Risk of Current and Future Provincial Land Use Policy

Policy Review and Case Study Analysis

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Prepared for
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Land, and Resource Stewardship**
Water, Fisheries, and Coast Division

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Abbreviations

ATR	Additions to Reserve
B.C.	British Columbia
BCBC	British Columbia Building Code
CEPF	Community Emergency Preparedness Fund
DPA	Development Permit Area
EAD	Expected Annual Damage
FCL	Flood Construction Level
FDRP	Flood Damage Reduction Program
FHALUMG	Flood Hazard Area Land Use Management Guidelines
FLNRORD	Ministry of Forests, Land, Natural Resource Operations and Rural Development
LGA	Local Government Act
MIABC	Municipal Insurance Association of B.C.
MBE	Minimum Building Elevation
MOU	Memorandum of Understanding
NHC	Northwest Hydraulic Consultants Ltd.
NIBS	National Institute of Building Sciences
NFIP	National Flood Insurance Program
NRCan	National Resources Canada
OBWB	Okanagan Basin Water Board
OCP	Official Community Plan
OLRS	Okanagan Lake Regulation System
ONA	Okanagan Nation Alliance
RDCO	Regional District of Central Okanagan
RDNO	Regional District of North Okanagan
RDOS	Regional District of Okanagan-Similkameen
TOA	Transit-Oriented Area

Key Concepts

Design Flood

A design flood is a hypothetical flood that is simulated to evaluate discharge and water levels under specific environmental conditions. Design floods can be used to assess flood protection measures and disaster preparation plans. Flood levels include expected flood probabilities, typically given as 20-year (5% annual exceedance property), 100-year (1%), and 200-year (0.5%) floods. A 1:200 year flood event has a 0.5% chance of occurring every single year, and a 12.5% chance of occurring at least once in a typical 25 year mortgage term. Design floods are based on flood frequency analysis, which is a statistical evaluation of previously-recorded floods, thus as more data are incorporated into the flood frequency analysis, the design flood will change.

Expected Annual Damage (EAD)

Expected annual damage in the context of flood risk refers to the average monetary loss or damage that is anticipated to occur each year due to flooding. It is calculated by estimating the potential flood damage across different flood scenarios, each with a specific probability of occurrence, and then averaging these outcomes over time.

Flood risk

Flood risk is a combination of hazard (likelihood and severity of floods), exposure (presence of people or assets in flood-prone areas), and vulnerability (susceptibility to harm and recovery capacity).

Flood risk management strategy

A flood risk management strategy is a comprehensive plan designed to manage and mitigate the risks associated with flooding to safeguard communities, economies, and ecosystems. The strategy may employ policies, regulations, or coordinated actions to reduce the likelihood and impact of floods. These strategies are typically developed by government agencies or regional planning bodies in collaboration with stakeholders.

Flood Hazard Area Land Use Management Guidelines (FHALUMG)

The FHALUMG are a set of guidelines created by the provincial government for use by local governments, land use managers, and approving officers when optionally developing flood risk strategies. These guidelines define minimum standards for flood protection across local government, defining requirements for development in flood-prone areas and specifying floodplain management practices such as setbacks and construction levels.

Flood Construction Level (FCL)

To keep assets above projected water levels, flood construction levels specify minimum vertical distances of development above streams and water bodies. Following Provincial guidelines in British Columbia, flood construction levels are frequently established via a 0.6-metre freeboard—a vertical distance to account for local differences in water level and modelling uncertainties—on top of design flood levels. Engineers and Geoscientists BC mandates that its members take into account the effect of climate change when designing flood works, although the amount of the factor of safety to be incorporated into design for climate change is not mandated.

Freshet

Freshet refers to high river discharge commonly seen during spring due to snow melt and increasing precipitation.

Land use policies

Definitions of land use policies vary widely in the context of flood protection. In this report, land use policies represent measures relating to the regulation of land via zoning, development permits, designation of floodplains, strategic land uses, and urban planning measures. Structural measures to address flood risk such as dams, dikes, stormwater system design, and building standards will not be covered.

Moral hazard

A moral hazard refers to a situation where one party is more likely to take risks because they do not have to bear the full consequences of those risks. For example, Federal and Provincial Disaster Financial Assistance programs create a moral hazard by enabling local governments to develop in high-risk flood areas knowing they will receive aid if a disaster occurs, thereby reducing their incentive to implement risk reduction measures.

RCP8.5

The Representative Concentration Pathway 8.5 is a high greenhouse gas emission scenario, often referred to as the “business-as-usual” or “worst case” scenario and characterized by a lack of global efforts in emission mitigation. RCP8.5 would increase the earth’s energy balance by 8.5 watts per square metre on the earth’s surface by the end of the 21st century compared to pre-industrial levels. This is estimated to increase average global surface temperatures by 2.6 °C–4.8 °C by 2100. RCP8.5 leads to comparable changes in global mean temperatures as the SRES A1FI scenario from previous modelling efforts, as well as the SSP5-8.5 scenario from the most recent updates.

Types of Flood Risk Strategies

Adaptive strategies refer to adjusting current practices to changes in flood risk to reduce damages. This includes, for example, enforcing building setbacks and flood control levels. In alignment with the PARA framework (protect, avoid, retreat, and accommodate) referenced in the B.C. flood strategy (Action 2.7, Province of British Columbia, 2024a), adaptive strategies would be included in the “protect” and “accommodate” categories.

Mitigative strategies refer to moderating the cause of large or frequent flooding to reduce damages. This includes the protection of riparian areas and bio-retention ponds, regulating runoff, and limiting erosion. In the PARA framework, mitigative strategies would be included in the “avoid” and “retreat” categories. Flood risk management frequently involves a mix of adaptive and mitigative strategies.

Executive Summary

The Ministry of Water, Land, and Resource Stewardship commissioned this report to assess increasing flood risk and investigate barriers in flood risk management within the context of land use policy, especially as this risk pertains to expanding housing development in British Columbia. The report addresses four research questions:

1. Which B.C. government land-use policies have the potential to decrease or increase flood risks in areas with flood hazards?
2. Based on a local case study, what is the impact of flooding quantified through the exposure and damage costs of housing units?
3. What policy amendments or guidance could be prioritized to further understand or reduce those risks?
4. What existing policies and/or guidance could be more effectively used or revised to further reduce risk to people living in flood hazard areas?

Methods and Findings

This report uses a policy analysis to review current land-use policy tools, available resources for governments at various levels, and the delegation of flood management responsibilities. The report then employs a case study focused on municipalities in the Okanagan Basin to evaluate the implementation and effectiveness of flood policies, the impact of different land-use policies on flood risk, and the additional flood risk projected under expected housing growth.

Governance of Flood Risk and Implementation of Land-Use Policies

Research Question 1: Which provincial land-use policies can increase or decrease flood risks?

The provincial government provides local governments with three main resources to support local land-use planning with respect to flood risk: Flood Hazard Area Land Use Management Guidelines, the B.C. Building Codes, and diverse funding streams for research or flood risk reduction purposes. Neither the provincial guidelines nor flood-related building codes (or lack thereof) are mandatory for local governments to follow, and both documents fall short of international standards and best practices for flood risk management. Funding streams support expensive projects such as managed retreat from flood-prone areas,

however, selected municipalities still lack basic flood risk tools such as flood strategies or up-to-date flood bylaws.

In the event of a flood, damages are largely covered through a combination of flood insurance as well as federal and provincial disaster financial assistance. Approximately 12% of residential properties in B.C. are potentially uninsurable, making them dependent on disaster financial assistance (The Geneva Association, 2020). Federal and provincial disaster financial assistance poses a moral hazard by permitting local governments to develop in high-risk flood areas without incentivizing risk reduction. The nature of flood insurance in Canada is expected to change with the launch of the National Flood Insurance Program in 2025.

Impact of Land Use Policy on Flood Risk

Research Question 2: Based on a local case study, what is the impact of flooding quantified through the exposure and damage costs of housing units?

In the Okanagan Basin, many municipalities fall short of provincial guidelines, which is generally mirrored by higher expected flood risk values. The case study of local jurisdictions in the Okanagan Basin reveals expected annual damages to buildings and contents of almost \$58.9 million attributable to the Okanagan and Mainstem Lakes. Almost half of these expected annual damages can be attributed to Kelowna, alone, at \$23.8 million.

Kelowna is facing substantial additional flood risk in the next 15 years. Kelowna's 2040 growth strategy includes constructing 25,330 new housing units, up to 68% of which could be in floodplains. Expected annual damages for new housing developments are projected to be between \$8 and \$16.4 million depending on building policies and land use decisions. The case study highlights that minimizing added exposure by avoiding development in floodplains is the most effective way to reduce the additional estimated annual damages. However, updating Flood Control Levels and building practices is still valuable, associated with a 9-10% reduction in projected expected annual damage attributable to new housing units.

Policy Recommendations

What existing policies could be more effectively used or what new policy amendments or guidance could be prioritized to further understand or reduce those risks?

Building on the policy review and case study findings, the report recommends a multi-faceted approach involving updates to provincial policies, improved governance structures, revised incentives for risk mitigation, and enhanced support for local governments. The recommendations largely align with the actions outlined in the B.C. Flood Risk Strategy and include:

Improve assessment and communication of flood risks: Conduct comprehensive floodplain mapping to provide up-to-date flood risk information, improve public access to and understanding of flood-related resources, and adopt wholistic risk assessment approaches. This may involve collaboration between all levels of government as well as private sector stakeholders.

Address multi-level governance of flood hazards: Address the discrepancies between the distribution of power, responsibilities, and incentives. This will require investigating the lack of compliance with provincial guidelines, developing and advocating for new risk reduction incentives, supporting proactive initiatives, and updating building codes.

Incentivize best flood risk management practices: Update provincial guidelines to reflect increases in flood risk and promote best practices in flood mitigation. This includes supporting the use of non-structural measures and developing retrofit programs. Substantial funds will be necessary to support proactive flood mitigation such as managed retreat from hazard-prone areas.

Provide resources to local governments and communities: Provide resources to local governments, especially those with limited capacity, and promote integrated flood management planning on a regional level. This includes funding for technical assistance, capacity building, and community engagement. Research solutions specific to the on-reserve contexts in partnership with First Nations governments. Ensure that Indigenous knowledge and perspectives are incorporated into flood risk management strategies.

1.0 : Introduction

Flood events are the most common and expensive type of natural disaster in Canada with average annual losses expected to be \$2.97 billion annually, and B.C. alone faces average annual losses of \$689.4 million per year (Canada Task Force on Flood Insurance and Relocation, 2022). These losses are projected to increase due to the continued development in areas at risk of flooding, combined with increased frequency and severity of flooding due to climate change (Canada Task Force on Flood Insurance and Relocation, 2022).

In the face of increasingly intense and frequent flooding events, policymakers and developers should consider the implications of new policy on flood risk when addressing the provincial housing shortages.

In response to increasing flood risk, the Ministry of Water, Land and Resource Stewardship is interested in assessing the provincial policy tools and data available for flood risk management. To assess the connection between land use policies and flood risk, we investigate the following four research questions:

1. Which Provincial land use policies have the potential to decrease or increase flood risks in areas with flood hazards?
2. Based on a local case study, what is the impact of flooding in terms of exposure and damage costs?
3. What policy amendments or guidance could be prioritized to further understand or reduce those risks?
4. What existing policies and/or guidance could be more effectively used or revised to further reduce risk to people living in flood hazard areas?

We answer these research questions through a combined approach including an analysis of existing policy and a case study in the Okanagan Basin.

We first use a policy analysis to review the land use planning tools available to local, regional, and provincial governments, and the roles that different levels of government play in flood risk management. We also explore the limitations of flood insurance and disaster financial assistance as reactive tools for disaster mitigation.

We then use a case study to investigate how local governments manage flood risk with land use policies and the extent to which these policies impact flood risk. Likewise, we quantify

flood exposure and flood risk for communities along Okanagan Lake. We evaluate the land use policies these local governments use in their flood risk management strategies and the extent to which these communities employ provincial flood hazard land use guidelines.

We quantify the impact that different land use policies can have on flood risk by focusing on the City of Kelowna's 2040 growth strategy, which includes the planned construction of 25,330 new housing units in accordance with the findings from their 2021 Housing Needs Assessment (Official Community Plan Bylaw No. 12300, 2023, City of Kelowna, 2023). We project the additional risk in terms of damage to buildings and contents under different land use policy and planning scenarios.

We also use the case study to investigate how land use policies that are not directly related to flood risk management may also impact local flood risk. We examine Bills 44 and 47, enacted by the provincial government to boost housing development in B.C., and explore their potential implications for flood risk in the region.

Using the findings of this case study and policy analysis, we identify recommendations for the provincial government on how to better leverage existing flood risk policies, what additional land use policies to develop, and what additional research to prioritize and conduct. These recommendations broadly fall under the following four categories and are discussed in detail in Section 4 of the report:

- Province-wide floodplain mapping needs to be conducted for land use management to be effective. Risks need to be understood before they can be reduced
- The current disjointed multi-level governance and the resulting moral hazard—a situation where one party is incentivized to take risks because they do not bear the full consequences—associated with flood risk management needs to be resolved
- The FHALUMG and Provincial flood-related policy need to reflect and incentivize best practices for flood risk management
- Equitable flood risk reduction requires that resources be provided to local governments and communities, especially those with limited capacity

We align our recommendations with the actions outlined in the B.C. Flood Strategy, identifying priorities and opportunities to enhance or improve the actions outlined in the Strategy (Province of British Columbia, 2024a).

2.0 : Flood Risk Management

Key Findings

1. Flood risk management is primarily the responsibility of local governments, but provincial and regional governments provide guidelines, best practices, and flood mapping initiatives. Recent updates to related governance attempt to promote cross-jurisdictional collaboration
 2. Federal and provincial disaster financial assistance creates a moral hazard—a situation where one party is incentivized to take risks because they do not bear the full consequences—by permitting local governments to develop in high-risk flood areas without incentivizing risk reduction
 3. Flooding is challenging to insure and flood insurance is not widely available, affordable, or adequate in B.C. About 12% of residential properties in British Columbia are at high risk of flooding and may be uninsurable (The Geneva Association, 2020)
 4. The Flood Hazard Area Land Use Guidelines include outdated best practices for flood risk management
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To manage flood risks effectively, it is important to first understand the relationship between flood risks, land use policies, and insurance. This section provides a detailed examination of these elements at local, regional, and provincial levels.

2.1 : Flood Risk Assessments

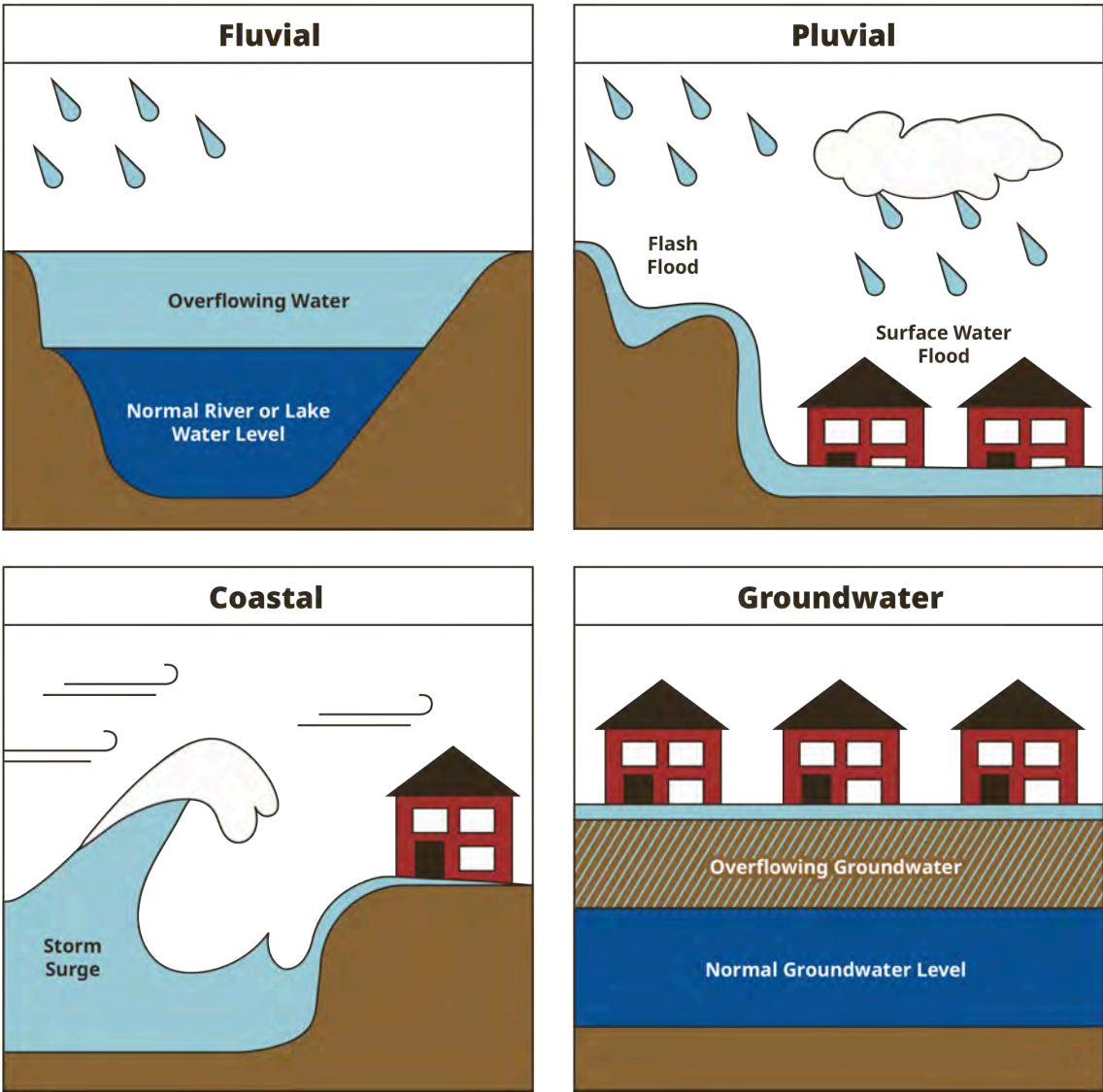
Flood risk assessments are essential tools for understanding and quantifying flood risk, and represent the first step in comprehensive flood risk management. Flood risk assessments use data on various flood types to evaluate risks and may be conducted to assess flood risk management measures, prepare flood response strategies, or calculate flood insurance premiums.

2.1.1 : Types of Floods

Different flood types are associated with different risks. Flood types can broadly be categorized as fluvial, pluvial, coastal, and groundwater (Figure 2.1). Flood types frequently

interact and compound during flooding events. For example, elevated snow runoff during spring combined with high precipitation levels and strong winds can simultaneously lead to fluvial, lake, and groundwater flooding, as observed during the 2017 floods in the Okanagan Basin (Associated Environmental Consultants Inc., 2017).

Figure 2.1: Flood Types



Source: Big River Analytics.

2.1.2 : How are Flood Risks Assessed?

Flood risk assessments predict the risk of flooding for a particular region. Flood risk is commonly defined as a function of three variables: hazard, exposure, and vulnerability:

- **Hazard:** the likelihood that a flood occurs. Hazard is assessed using both historical flood data and projections of future flood frequency and extent under changing climate conditions.
- **Exposure:** the presence of people, assets, or activities in areas that are susceptible to flooding. Exposure can be quantified by comparing the modelled flood extents to maps of existing assets.
- **Vulnerability:** the potential damage to people, infrastructure, or natural systems due to flooding. Vulnerability takes flood exposure, flood mitigation measures, socioeconomic, and the capacity to recover from flood events into account (NHC & IBI Group, 2023). Vulnerability assessments may include a wide range of tangible and intangible damages such as physical damage to buildings, evacuation costs, health effects, and post-flood recovery (NRCan & Public Safety Canada, 2021).

2.2 : Flood Risk Management

Various land use tools are available to federal, provincial, and local governments in B.C. The strategies employed by land use tools can be broadly categorized as mitigative or adaptive, which are frequently and simultaneously used in flood risk management.

Adaptive strategies reduce damages by adjusting current practices to changes in flood risk. These may include enforcing building setbacks and flood control levels. In alignment with the PARA framework (protect, avoid, retreat, and accommodate) referenced in the B.C. flood strategy (Action 2.7, Province of British Columbia, 2024a), adaptive strategies would be included in the protect and accommodate categories.

Mitigative strategies moderate the cause of large or frequent flooding in order to reduce damages. These may include the protection of riparian areas and bio-retention ponds, regulating runoff, and limiting erosion. In the PARA framework, mitigative strategies would be included in the avoid and retreat categories.

In British Columbia, managing flood risk is a collaborative responsibility involving multiple levels of government. Local governments are primarily responsible for mitigating flood risks within their local jurisdictions using land use policies and zoning bylaws. These efforts are

guided and supplemented by regional, provincial, and federal guidelines, strategic frameworks, funding programs, and flood hazard identification resources.

In the B.C. Flood Strategy, the provincial government has identified a new direction for flood governance (2024a). Objectives and anticipated changes to flood risk management include strengthening cross-jurisdictional collaboration, promoting planning on watershed scales, and establishing a First Nations Flood Resilience Advisory Circle (Pathway 2, Province of British Columbia, 2024a); however, these actions are subject to an implementation plan that has not been established.

2.2.1 : Regional and Provincial Tools for Flood Risk Management

In 2003, the provincial government transferred authority relating to non-structural flood mitigation over to local governments by passing Bill 56 (Ministry of Water, Land, and Air Protection). Since then, local governments have been responsible for designating floodplains, establishing flood construction levels, and defining development requirements within floodplains. The main land use tools available to provincial and regional governments include land management plans, flood hazard guidelines for local governments, provincial building codes, and funding programs. These guidelines and land management plans aim to:

- regulate flood hazards on provincial lands; and
- support local governments in identifying local hazards, determining protective measures, and implementing local policies and bylaws.

Regional organizations can also coordinate efforts across local governments to integrate regional land management strategies with local initiatives to manage flood risks more effectively. This coordination is crucial in areas where flood risks cross local or municipal boundaries, requiring a unified approach to flood risk and resource management. The ability of regional districts to initiate flood mitigation strategies is limited by the Local Government Act, since any structural flood protection must be confirmed by the local residents by voting for establishing a service area, effectively agreeing to cover the additional costs.

Regional Land Management Plans

Provincial and regional governmental bodies develop land management plans for provincial public lands that outline objectives and integrate flood risk considerations to offer region-specific strategies. These plans guide resource management activities, including agriculture, forestry, tourism, wildlife, and conservation. In accordance with B.C.'s Declaration Act (2019), land management plans developed after 2019 must be co-developed with First Nations and incorporate Traditional Knowledge.

Within British Columbia, regional land management plans provide objectives for resource management of provincial lands, including guidance for agriculture, mining operations, forestry, tourism, wildlife, and conservation. When applicable, regional land management plans connect the purpose and goals for each resource usage with the associated flood risk. The management plans outline strategies applicable to specific regions and provide guidance to local government bodies regarding the implementation of plans or agreements.

For example, the Okanagan-Shuswap Land & Resource Management Plan (B.C. Land Use Strategy, 2001) describes the current status of monitoring programs, goals, and interim strategies for Mission Creek, the largest watershed in the Okanagan Basin. The Mission Creek Restoration Initiative—developed in partnership with the City of Kelowna—has since advanced these plans and implemented continuous restoration and monitoring efforts (Okanagan Basin Water Board, 2020).

Regional Growth Strategies

Similar to regional land management plans, regional growth strategies aim to inform the development of bylaws and Official Community Plans by outlining development objectives, challenges, and strategies. Regional growth strategies are not used by all Regional Districts, but they provide those facing growth pressures with an opportunity to define potential hazards and mitigation strategies in the context of urban growth management.

For example, in the Okanagan Basin, regional growth strategies address natural hazards and flood risk specifically by:

- Encouraging updates for floodplain and unstable slope maps (Regional District of North Okanagan: Bylaw No. 2500, 2011);
- Promoting the protection of floodplains (Regional District of North Okanagan: Bylaw No. 2500, 2011);

- Advocating for professional site-specific reports for any development in hazard areas (Regional District of Okanagan-Similkameen: Bylaw No. 2770, 2017);
- Discouraging developments in hazard areas (Regional District of Okanagan-Similkameen: Bylaw No. 2770, 2017); and
- Encouraging selected land uses to minimize natural hazards (Regional District of Central Okanagan: Bylaw No.1336, 2013)

Flood Hazard Area Land Use Management Guidelines

The Flood Hazard Area Land Use Management Guidelines (FHALUMG), established by the provincial government, provide recommendations for managing land use in flood-prone regions to minimize risk and enhance resilience (FLNRORD, 2018). These guidelines are intended to be used by local governments, who are in control of their own flood risk strategies. The FHALUMG provide requirements for development in flood-prone areas and standards for necessary floodplain management practices such as setbacks and flood construction levels (FCLs) for different flood types. Local government guidelines within FHALUMG include designated chapters within OCPs regarding hazardous conditions, legal foundations to create and modify flood-related bylaws, and conditions for subdivision approvals in floodplains.

The FHALUMG identify that changing climate conditions are impacting flood hazards via rising sea levels, changes in spring runoff, and decreased predictability of seasonal weather conditions. This highlights the need for up-to-date flood assessments and floodplain mapping.

The FHALUMG is not consistently implemented across local governments, which undermines regional flood resilience. Under provincial law, local governments must only consider guidelines when defining land use plans and adopting flood bylaws (Local Government Act Section 910, 2018). FHALUMG recommendations and standards are not binding and are not required for flood protection within zoning bylaws. Additionally, the Local Government Act states that bylaws regulating floodplain management are optional.

The FHALUMG is outdated and may not reflect the current state of best practices (Alderhill, 2023). The FHALUMG remains largely unchanged since it was first written twenty years ago, with the exception of two amendments: one in 2011 addressing flood hazard areas downstream of a dam, and one in 2018 addressing sea level rise.

As discussed further in Section 4.3.1, the FHALUMG would benefit from a review and update that focuses on transparency, includes best practices, and incorporates Indigenous Traditional Knowledge.

Provincial Building Codes

Building codes can reduce flood vulnerability to buildings and infrastructure. Technical building requirements may include flood construction level requirements, setbacks, or requirements for the location of fixed equipment susceptible to flood damage (e.g., furnaces and electrical panels).

The National Research Council of Canada publishes an updated building code every five years, upon which B.C.'s building code is substantially based. The BC Building Code (BCBC) must align with the model National Building Code except in the case that an update does not serve a legitimate objective for B.C. (Reconciliation Agreement on Construction Codes, 2019).

The BCBC defines technical building requirements that apply to all parts of B.C. except the City of Vancouver and federal lands and reserves (Office of Housing and Construction Standards, 2020; Province of British Columbia, 2024b). Local governments may choose to develop additional requirements if a matter is 'unrestricted.'

The Building Act General Regulation currently lists flood-related building requirements as a temporarily unrestricted matter, meaning that local governments are able to enact technical building requirements for floodplain areas (Office of Housing and Construction Standards, 2020). The provincial government identifies that further collaboration with the federal government is needed to amend the BCBC to achieve better consistency for flood construction requirements while maintaining flexibility for local governments (Office of Housing and Construction Standards, 2020).

The current 2020 National Building Code does not include guidelines for building construction to defend against floods, but updates are promised to focus on flood-resistant design. Under Budget 2024, the federal government is committed to updating the National Building Code to support more climate-friendly housing options, which may include guidance on flood risk resilience (Government of Canada, 2024). The Canadian Board for Harmonized Construction Codes (CBHCC) is coordinating the updates to the National Building Code. The CBHCC identifies assessing the role of the Codes in climate change adaptation, including flood-resistant design as a priority for the 2025 edition of the National Building Code.

The Building and Safety Standards Branch—the branch of the provincial government responsible for the BCBC—undertook two initiatives investigating options for improving flood resiliency through the BCBC:

1. **The Existing Buildings Renewal Strategy** aims to improve the energy efficiency and safety of existing buildings in events like earthquakes, wildfires, and floods. The engagement phase for this Strategy identified requiring a minimum level of floodproofing for existing buildings in the BCBC and the Alterations Code (a code that establishes upgrade requirements for existing buildings) as a high-priority suggested action (Building and Safety Standards Branch, 2023).
2. **The Realizing Resilient Buildings (R2B) Project**, undertaken with BC Housing, seeks to understand barriers and identify enablers for a more climate-resilient building sector. The project is in its early stages, but already identifies key design guidelines (BC Housing, 2023):
 - Living spaces and major electrical components should be constructed above the Flood Construction Level (FCL);
 - Buildings should be set back from natural bodies of water; and
 - Homes in areas at risk of flooding should be built with wet and dry floodproofing, such as waterproof drywall, mould-resistant flooring, and sealed exteriors.

The Building and Safety Standards Branch is no longer pursuing province-specific alterations to existing buildings code, and is now supporting work being done by the federal government.

Federal and Provincial Funding Opportunities

Besides providing information and guidelines, provincial and federal governments can enhance flood risk management by supporting communities with funding opportunities. The additional funds enable local governments to overcome budget constraints—especially in smaller communities with limited tax revenues—while addressing flood risk.

Historical Funding Initiatives

The Flood Damage Reduction Program (FDRP), established in 1975, prompted provinces to sign ten-year General Agreements with the federal government (Bruce, 1976). These agreements provided provinces with funding and support to map, delineate, and designate flood risk areas, and encouraged local authorities to zone according to flood risk. Once these areas were established, the federal and provincial

governments would not build, approve, or finance flood-prone development in these areas, nor would they provide flood disaster assistance for any developments built in these areas after designation. Pressure in the 1990s to reduce spending on flood-related agreements led to a significant decline in funding for these Agreements and finally termination of federal involvement with the program by the end of the decade (Kumar et al., 2001).

Current Funding Sources

More recent funding opportunities are available to First Nations and other local governments to support flood risk reduction projects. These opportunities are offered through several federal and provincial sources. Unlike the initial FDRP, recent funding programs tend to avoid binding participants with supplemental flood protection standards and setting conditions for future eligibility for disaster assistance.

We highlight five such funding programs. Some programs involve competitive applications, while others do not. Project costs are either covered entirely by the provincial or federal government or involve cost-sharing with the local government. Funds cover a variety of initiatives, including research and mapping, land use planning, and structural activities. Several of the programs highlight the value of providing reliable, substantial, and long-term funding.

The provincial **Disaster Resilience and Innovation Funding** program, released in June of 2024, provides \$15 million in its first year and \$25 million in its second year for local government projects that strengthen defenses against natural hazards such as floods (Province of British Columbia, 2024c).

The **Local Government Climate Action Program** is a three-year project from 2024 to 2026 with a capacity of \$76 million. The program provides local governments and Modern Treaty Nations with ongoing funding without a competitive application process to support actions to adapt to the impacts of climate change. In 2024, the provincial government allocated three years of funding to all LGCAP recipients in one lump sum payment to provide more certainty and flexibility (Province of British Columbia, 2024d).

The **Disaster Mitigation and Adaptation Fund** is a ten-year project with a capacity of \$2 billion to support community infrastructure projects. Funding is awarded through a competitive, merit-based contribution program. For example, the city of Grand Forks purchased flood-prone land, relocated residents out of the hazard zone,

and reinforced flood protection and mitigation structures (Infrastructure Canada, 2019).

The **Adaptation, Resilience, and Disaster Mitigation** program was a sub-stream under the B.C. Green Infrastructure umbrella, representing one of four funding streams under the federal Investing in Canada Infrastructure Program. The program aimed to enhance climate change adaptation for floods (B.C. Community Climate Funding, 2024) through cost-sharing between the provincial and federal governments on top of a contribution from the applicant.

The **Community Emergency Preparedness Fund (CEPF)** supports flood hazard and flood risk management programs. For example, the CEPF: Disaster Risk Reduction – Climate Adaptation program funded by the Union of B.C. Municipalities (B.C. Community Climate Funding, 2024) currently supports risk mapping, risk assessments, land use planning, and small structural activities with contributions up to 100% of project costs.

2.2.2 : Local Government Tools for Flood Risk Management

Local governments play a major role in deciding what flood risk management strategies to implement, if any, in their communities. Land use tools available to local governments broadly include land use plans, flood-related bylaws, and land acquisition in flood-prone areas.

Land Use Plans

Land use plans designate areas for specific purposes, such as residential, commercial, or conservation zones, while considering potential risks including flooding. Land use plans can guide development in flood-prone areas, limiting construction and promoting resilience.

Local governments in British Columbia develop OCPs that define long-term land use policies that guide local objectives related to sustainability, transportation, housing, and flood risk management. Once an OCP is adopted, new bylaws and works must comply with the OCP (Province of British Columbia, 2023). OCPs may encourage low-impact development and green infrastructure for future planning.

Development Permit Areas (DPAs)

Certain areas in OCPs may be designated as development permit areas (DPAs), where property owners must apply for a development permit before subdividing land, adding new buildings, or altering existing structures. These DPAs may be designated due to

hazardous conditions or to achieve goals in alignment with climate change mitigation or environmental conservation. The OCP must outline the special circumstances or objectives for the DPA.

Bylaws

In alignment with their land use plans, local governments can implement bylaws to control development in flood-prone areas, enforce building standards for construction and drainage, and identify FCLs and necessary setbacks. Many local governments include language in their bylaws that allows for site-specific deviation from the restrictions in the bylaws, reducing the consistency by which these standards are enforced. Bylaws relevant to flood hazards can take the form of zoning bylaws, subdivision bylaws, and specific land use bylaws to implement the objectives described in the OCP.

Zoning Bylaws

Zoning bylaws define the use of land and structures within a community. This is achieved by specifying permitted usage and varying sizes of land and buildings, outlining structural properties such as building dimensions, and establishing general limits to land usage in selected areas. Permitted usage in floodplains may include prohibiting high-vulnerability uses such as hospitals or emergency services, while allowing low-vulnerability uses such as parks. Development in flood-prone areas can therefore be limited by restricting the usage of land and defining building properties.

Land Use Bylaws

In addition to zoning bylaws, land use bylaws can address supplemental needs and concerns related to floodplains, landscaping, runoff control, and stormwater management. Floodplain bylaws may define additional requirements including FCLs and setbacks in certain areas, although local governments may grant exemptions to these requirements on a case-by-case basis. For example, Vernon's Floodplain Management Bylaw (No. 5896, 2022) includes a clause that allows site-specific exemptions to setback requirements if a qualified professional asserts that flood protection can be achieved through an engineered design. Bylaws pertaining to runoff and stormwater control include regulating the size of impermeable surfaces and encouraging the use of absorbent landscapes and green roofs.

Screening and Landscaping Bylaws

Screening and landscaping bylaws can set further standards regarding the natural environment, such as using specific plant species to promote slope stabilization and

erosion control. Subdivision servicing bylaws may also set additional requirements for flood control and runoff measures during the process of subdividing existing land parcels (FLNRORD, 2018).

Land Acquisition

Land acquisition is an effective method to reduce flood risks by limiting exposure to floods. Local governments can acquire land for flood protection purposes that align with the objectives outlined in the local OCP. These acquisitions may include purchasing undeveloped land as a preventative measure or purchasing developed land and relocating existing structures and populations outside of hazard zones after a recent flooding event.

Land acquisition also provides an opportunity to rebuild riparian zones and wetlands, which further reduces the risk and potential impacts of future flooding (Schindler et al., 2016). In addition to being highly effective in flood risk reduction, scientists have found that acquisition projects have high benefit-cost ratios and improve social outcomes in poorer and more populous areas (Johnson et al., 2020; Zhang et al., 2023).

The efficiency of flood risk reduction measures is frequently limited by jurisdictional boundaries, often limiting measures to areas smaller than individual watersheds. Regional districts, however, oversee larger areas than individual municipalities and can address flood risk by establishing regional parks. While funding for regional districts themselves is limited, regional parks can be established by cooperation and land transfers from municipalities within a regional district, grants for land acquisition purposes, and donations. Objectives regarding conservation, recreation, and flood protection frequently overlap and can be addressed simultaneously by protecting green spaces along water bodies and restoring natural river courses.

Large upfront costs can be a barrier to implementation. Many land acquisition programs rely on funding from the provincial or federal government for the initial buyout (Thistlethwaite, 2023). As seen in Merritt, B.C., lack of this funding can impede the implementation of land acquisition initiatives (Cottar & Wandel, 2024). Some programs also impose ongoing costs to local governments due to the loss of tax revenue and increased maintenance costs, especially when limited acceptance of a buyout program results in a patchwork of vacant and occupied lots (Thistlethwaite et al., 2023).

Although voluntary buyouts are more favourable for public acceptance, municipalities and regional districts have the power to expropriate land if necessary (Local Government Act Section 289, 2018; Community Charter Section 31, 2003). For example, Grand Forks initiated

a buyout program following severe flooding in 2018; although owners of most targeted properties accepted offers from the City, at least three properties were expropriated (Thistlethwaite et al., 2023).

Development and Amenity Cost Charges

Local governments have a range of development financing tools that can be used to fund infrastructure and amenities that are needed to support new developments, including Development Cost Charges (DCCs) and Amenity Cost Charges (ACCs) (B.C. Land Use Planning, 2024). Recent updates to DCCs and DCLs include new categories of infrastructure – fire protection, police, and solid waste and recycling facilities – in addition to existing categories of roads, sewage, water, drainage, and parkland acquisition and improvement. The newly implemented ACCs allow local governments to collect funds for amenities, such as community centres, recreation centres, daycares, and libraries from new development that results in increased population. Funds from new development can be used to pay for the capital costs attributable to projects that are needed to accommodate growth. Capital costs include planning, engineering and legal costs directly related to the work for which a capital cost may be incurred. Long-term operating and maintenance expenses are primarily funded by property taxes.

2.3 : Flood Insurance and Disaster Financial Assistance

Insurance and disaster assistance distribute financial risk and responsibility for flood-related damages, supporting post-flood recovery endeavours, and, ideally, prompting behavioural changes among property owners by emphasizing flood risks and advocating preventive measures.

Flood insurance and disaster financial assistance programs are important post-flood recovery tools but on their own, these programs are not sufficient to handle or address flood risk in B.C. Flood risk reduction measures must also be implemented in conjunction with these programs. Properly designed flood insurance programs can be used to incentivize flood risk reduction at a local government and homeowner level. Disaster financial assistance, however, has been shown to act the opposing way in Canada by promoting increases in flood risk for residential buildings.

In this section, we provide a brief overview of disaster financial assistance and flood insurance in British Columbia. We then provide more detail on the provincial/federal

Disaster Financial Assistance program, flood insurance for local governments, private flood insurance for homeowners, and the National Flood Insurance Program.

2.3.1 : Overview of Flood Insurance and Disaster Financial Assistance

Before 2015, Canada was the only G7 country without overland flood insurance, relying on provincial and federal disaster financial assistance programs to cover associated costs. Escalating expenses covered by these programs, from \$10 million annually in 1970–1995 to \$360 million annually in 2011–2016 (Public Safety Canada, 2017), resulted in federal pressure on the property and casualty insurance industry to offer overland insurance. The 2013 catastrophic floods in Calgary and Toronto underscored the expectation for insurers to cover flood damages, leading to insurers paying an additional \$1.7 billion in uninsured claims solely for the 2013 Calgary floods.

In the event of a flood, damages are currently covered by federal and provincial governments through taxpayer-funded disaster financial assistance programs and, to a lesser extent, private flood insurance. Despite the advent of flood insurance, uninsured flood losses still make up two-thirds of flood-related economic losses, estimated at \$800 million per year in 2016, with 75% of these losses held by homeowners (Swiss Re, 2016). Increasing rates of flood insurance take-up since 2016 may have lessened this gap (Li, 2022).

Canada's current disaster financial assistance framework poses a moral hazard—an incentive that causes an entity to increase its exposure to risk and harm because they do not fully bear the costs of that risk—by permitting construction in high-risk flood areas without incentivizing risk reduction or insurance purchase by homeowners (Canada's Task Force on Flood Insurance and Relocation, 2022). Consequently, federal, provincial, and territorial governments shoulder the bulk of public costs for post-flood recovery and rebuilding efforts.

The federal government is now in the process of moving away from the disaster financial assistance framework and is developing a low-cost National Flood Insurance Program (NFIP) for homeowners without adequate flood insurance protection (Government of Canada, 2024). The goal of this program is to provide a cost-effective approach to disaster recovery for homes already in floodplains. The Task Force on Flood Insurance and Relocation

highlights that complementary incentives for risk reduction need to be designed to improve the effectiveness of new insurance policies (2022).

2.3.2 : Disaster Financial Assistance in B.C.

In B.C., provincial financial assistance for flood damages is regulated under the Compensation and Disaster Financial Assistance Regulation (2022). The province shares the cost of providing financial assistance with the federal government through support formulas outlined by the Disaster Financial Assistance Arrangement (Public Safety Canada, 2017).

Under the current regulation, only costs for which insurance was not readily available are covered. Further, structures knowingly built in designated floodplains are only covered if the structure was determined to have been properly flood-protected. Under the new Emergency and Disaster Management Act, which came into force in 2023, a new regulation is being developed to replace the existing Compensation and Disaster Financial Assistance Regulation.

2.3.3 : Flood Insurance for Local Governments

Under BC's Compensation and Disaster Financial Assistance Regulation, local governments are also responsible for being insured. Local governments can purchase commercial insurance through private or public insurers. The availability of compensation for flood-related damage through insurance for local governments is generally dependent on a risk-adjusted premium. Larger municipalities may choose to self-insure and buy reinsurance for high-cost events. Local governments often insure both for physical damages and for potential claims from private property owners due to damages attributed to unmaintained or inadequate infrastructure (Deschamps et al., 2023).

Insurance for local governments is important because the costs of flood damage to public property usually exceed those associated with private property. As much as 70% of flood-related federal disaster assistance payments are spent on public infrastructure, while 15% is spent on residential losses (Insurance Bureau of Canada, 2019).

Purchasing commercial overland flood insurance for local governments is complicated by high expected losses despite insurance, high premiums, unclear or challenging limitations, and inconsistent application of policies (Deschamps et al., 2023). For example, some private insurers in B.C. refuse to cover municipalities that are within 15 kilometres of a past flood (Deschamps et al., 2023).

Instead of pursuing commercial insurance, almost 90% of B.C. municipalities depend on the Municipal Insurance Association of B.C. (MIABC), a reciprocal insurance pool for overland flood insurance. A reciprocal insurance pool operates by having its members contribute premiums into a collective fund that is used to pay out claims made by any member, with costs and benefits shared among all participants. Together, these municipalities represent 50% of the population of B.C. Approximately 50% of the MIABC municipalities purchase full flood coverage. First Nations governments and communities in B.C. typically either insure themselves (sometimes at the band level to cover members) or are insured through the federal government.

2.3.4 : Private Flood Insurance in B.C.

Private flood insurance is generally available as an add-on to comprehensive home insurance policies. There are three main types of flood insurance add-ons: sewer backup, overland, and coastal or storm surge. Coverage for coastal storm surges remains limited, with only one company offering coverage (Canada Task Force on Flood Insurance and Relocation, 2022; Floodwise, n.d.).

Residential flood insurance take-up has increased steadily since its introduction in 2015. In B.C. in 2021, flood take-up rates were roughly 55% of that of fire insurance, increasing from 39% in 2018 (Li, 2022). The exact conditions, factors, costs, and coverage differ by insurer.

Overland flood insurance can be complicated in terms of economic viability due to the predictable, correlated, and recurring nature of flooding. The predictability of flooding promotes a case where only individuals most exposed to floods purchase flood insurance. Offering insurance in high-risk areas would require large deductibles and capped insurance limits to remain profitable. Another challenge for insurance providers lies in the correlated and recurring nature of floods, meaning that many properties require payouts at the same time in the event of a flood.

Some insurance companies consider areas with inadequate flood protection measures uninsurable or require high coverage limits and/or unaffordable premiums. (Calamai & Minano, 2017). Approximately 12% of residential properties in British Columbia are at high risk of flooding and fall into this category (The Geneva Association, 2020). Only one insurer, the Co-operators, currently provides coverage for homes built on floodplains (Insurance Bureau of Canada, 2024).

Different governments, private sector entities, and insurers use different flood maps and risk models (Calamai & Minano, 2017). Consequently, risk estimates are inconsistent across providers compared to government flood risk assessments.

Insurance costs can be a major barrier to uptake. Costs vary widely depending on factors such as the level of coverage, the risk of flooding in the area, the property's value, and any applicable government subsidies or discounts. Most homeowners at extreme flood risk would only be willing to pay a limited amount (Public Safety Canada & Institute for Catastrophic Loss Reduction, 2024).

Accessing coverage in the event of a disaster can be difficult and limit insurance uptake. Coverage caps can vary by provider and by policy; some overland flood insurances have caps of \$10,000 or \$25,000, which may not cover all losses (Red Dragon Consulting, 2021). Policies also differ in terms and conditions. Some companies require claims for flood losses to be made within 48 hours of the onset of the flood, even when homeowners are under evacuation orders and do not know the extent of the flood damage (Red Dragon Consulting, 2021).

2.3.5 : The National Flood Insurance Program (NFIP)

Under the 2024 Budget, the federal government is committed to partnering with property and casualty insurers to develop a low-cost NFIP for homeowners without adequate flood insurance protection (Government of Canada, 2024). The program will be designed to provide a cost-effective approach to disaster recovery for those who already live in floodplains. Contacts at the Ministry of Water, Land and Resource Stewardship identify that this program is not intended to be a permanent program, and will be phased out over twenty years after a sufficient investment in risk reduction (2024).

In 2022, Canada's Task Force on Flood Insurance and Relocation published their findings on insurance solutions in Canada to inform the development of the NFIP. The Task Force most notably identifies that, given the amount of flood risk in Canada, none of the insurance models scoped by the Task Force can provide affordable insurance and be financially self-sufficient, at least in the short term (2022). Flood insurance is important for resiliency and recovery after a flood and can be a tool to incentivize risk reduction, but insurance will not reduce flood hazard or exposure.

The Task Force highlights that the NFIP must be launched in conjunction with risk reduction and public awareness programs that are designed to reduce risk at all levels. While these

programs may appear expensive, the Task Force contextualizes that the alternative is that costs fall to public DFA programs. As stated by the Task Force: “There is no scenario in which these costs disappear without significant investments to remove or reduce the risk.”

Many findings from the Task Force mirror challenges and opportunities identified in the private insurance market. We highlight the following from the Task Force’s report:

- **Standardization is needed in the market.** As highlighted in 2.3.3, private insurers currently do not use consistent language, coverage options, flood maps, or risk assessments, which limits homeowners’ ability to make informed insurance decisions. Standardization of language and coverage types can reduce confusion, and improving public access to flood maps will improve transparency for how flood risk is assessed by both private and public flood insurance companies.
- **Participation is key.** Having high rates of participation in the NFIP is the only way for the NFIP to effectively distribute risk. Maximizing participation through affordability, incentives, and/or mandates is critical. In Section 2.3.3, we similarly identify that high premiums can be prohibitive to private flood insurance uptake.
- **Access to insurance extends beyond money.** Improving access to flood insurance also requires improving financial literacy around flood insurance, building capacity within community organizations to support housing, and ensuring that the NFIP can adapt to regional or cultural contexts.

3.0 : Case Study

Key Findings

1. Frequent flooding in the Okanagan Basin has prompted extensive floodplain mapping and flood risk assessments, largely conducted by regional bodies supported by provincial funding
 2. Many local governments in the Okanagan Basin belong to and benefit from the Okanagan Basin Water Board, a regional partnership that provides resources to and coordinates flood risk strategies for local governments in the Okanagan Basin
 3. Local governments differ in their implementation of flood risk policies, and not all follow the FHALUMG
 4. Avoiding exposure to flood risk (i.e., not building in floodplains) is the most effective flood risk management strategy
 5. Increased density in urban areas and increased number of basement suites as a result of Bills 44 and 47 may result in increased flood exposure and vulnerability
-

We use a case study of local governments in the Okanagan Basin to quantify the impacts of different flood risk management strategies on flood risk. The case study is broken into the following sections:

- **Context:** This section provides an overview of flooding in the Okanagan Basin, covering its history, recent impacts, flood risk research, major mapping projects since 2017-2018, and post-flood recovery and insurance efforts.
- **Impact of legislation on flood risk:** This section examines the primary land use policies used by municipalities around Okanagan Lake and compares them to provincial standards. It also discusses the potential effects of new provincial housing legislation on flood vulnerability.
- **Quantifying flood risk:** This section assesses exposure and damage costs to dwelling units in the Okanagan Basin. It highlights per-capita damage costs and population impacts for different communities and compares non-structural risk management strategies among municipalities bordering Okanagan Lake.
- **Impact of land use policy on flood risk:** This section evaluates how Kelowna's land use policies affect flood risk. We compare current practices to international

standards and we then project expected annual damages for planned housing growth. The analysis identifies deficiencies in Kelowna's flood policy and demonstrates that while updating policies reduces risk, avoiding floodplain development is significantly more effective.

We combine data and information from several sources to assess and quantify flood hazards, exposure, and vulnerability in the study area. Most importantly, this includes:

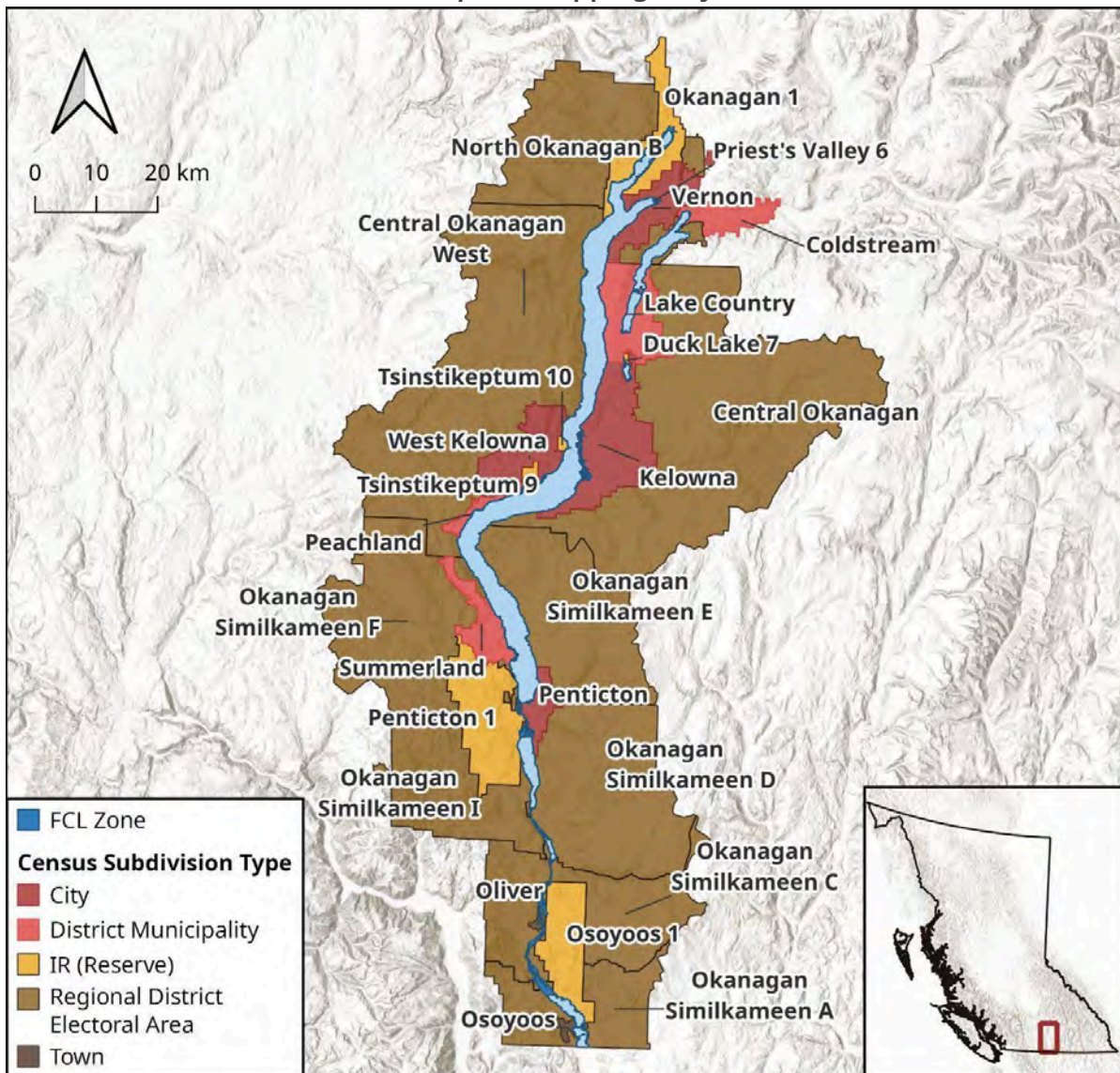
- A review of Official Community Plans, bylaws, development permit areas, and additional local government resources provides information on historical flood risk, flood risk mitigation measures, future population growth, and prospective number and locations of additional housing units
- The Okanagan Mainstem Floodplain Mapping (NHC, 2020a) estimates the spatial extent of hypothetical flooding scenarios via Flood construction levels (FCLs) and FCL zones with freeboard—an additional height above the expected flood level to account for uncertainties and prevent flooding
- Data from the Flood Risk Mapping for the Okanagan Watershed (NHC, 2023), quantified through damage costs and risk for all municipalities in the Okanagan Basin provides impacts for each flooding scenario

The data and values used to project impacts in the Okanagan basin are based on simulations under the high-emission scenario RCP8.5 for mid-century climate conditions. Additionally, all data and modelling used for projections assume updated Okanagan Lake Regulation System (OLRS) operations. This reduces projected damages by adjusting OLRS operations to changing runoff and precipitation due to climate change. Detailed descriptions of the used hydrological and climate models are attached in Appendix B.2.

3.1 : Context: Flooding in the Okanagan Basin

We select the Okanagan Basin, seen in Figure 3.1, as our study area because this region has many local governments and communities that vary in size, population density, resources, flood exposure, and flood risk management strategies.

Figure 3.1: Census Subdivisions in the Okanagan Basin Overlapping Lake and Shoreline Flood Construction Level Zones from the Okanagan Mainstem Floodplain Mapping Project



Source: Statistics Canada boundary files (2023); lake and lake shoreline FCL zones from Okanagan Mainstem Floodplain Mapping (NHC, 2020a); basemap from ESRI. **Note:** Maps of each census subdivision separately can be found in Appendix A.

These differences provide an opportunity to evaluate the effectiveness of different approaches to flood risk management. Recent flooding events have also prompted extensive flood mapping, providing a large amount of data to support our analysis.

The Okanagan Basin has a history of regular flooding, with lake levels exceeding full pool capacity as far back as 1904. Changes such as the channelization of the Okanagan River and dam constructions throughout the 20th century altered flood impacts. Despite water management adjustments, repeated floods led to further changes in dam regulations and river realignments. Recent re-naturalization projects aim to restore the river's original course, improve ecosystem health, and reduce flood risk.

The 2017 and 2018 floods triggered renewed research and protocol reviews. In 2017, persistent rainfall and rapid snowmelt caused widespread flooding in Kelowna and surrounding areas. Okanagan Lake and Kalamalka Lake reached historic levels, causing evacuations and property damage. Authorities permitted strategic discharges through Penticton Dam to manage lake levels, leading to downstream flooding.

In 2018, another intense freshet caused local flooding, but officials successfully predicted and prepared for the flood, mitigating significant damage by preemptively releasing water and removing obstructions from the Mill Creek channel.

We provide a more comprehensive overview of this flooding history in Appendix B.1.

3.1.1 : Flood Risk Research in response to Flood Events

In response to recent floods and increased flood risk from climate change, regional bodies have led studies on flood risk in the Okanagan Basin, supported by provincial funds. These bodies, with greater capacity than smaller local governments, offer specialized expertise, resources, and broader coordination for flood risk management strategies. They provide resources, guidelines, and flood regulations for their areas. The Okanagan Basin is served by three main regional governments and one First Nations Alliance.

- the Regional District of Central Okanagan (RDCO);
- the Regional District of Okanagan-Similkameen (RDOS);
- the Regional District of North Okanagan (RDNO); and
- the Syilx Okanagan Nation Alliance (ONA).

Together, these four bodies also comprise the Okanagan Basin Water Board (OBWB), established “as a valley-wide partnership to identify and resolve critical water issues in the

Okanagan watershed” (OBWBs, 2023). The OBWB does not have regulatory power but provides resources to its constituents and focuses on improving communications between regions.

These regional bodies commissioned three major flood risk mapping projects since the 2017 and 2018 floods:

- **Sylix Okanagan Flood and Debris Flow Risk Assessment** (Ebbwater Consulting Inc., 2019): This assessment evaluates hazards, exposure, and vulnerability in the Okanagan and Similkameen watersheds using a watershed-based approach. It includes detailed risk maps, identifies research gaps, and outlines measures to reduce flood-related risks.
- **Okanagan Mainstem Floodplain Mapping** (NHC, 2020): Initiated by the Okanagan Basin Water Board in response to the 2017 and 2018 floods, this project updates floodplain maps for the Okanagan River and mainstem lakes. It projects flood levels under mid- and late-century scenarios, focuses on dam operation protocols, and simulates future snow runoff and hydrological changes.
- **Flood Risk Mapping for the Okanagan Watershed** (NHC & IBI Group, 2023): Building on previous mapping projects, this study provides comprehensive flood risk assessments, quantifying hazards, exposure, and vulnerability. It reports damage costs, service disruptions, and risks to vulnerable populations and cultural sites, presenting risk values for 200-year and 500-year floods, and Expected Annual Damage (EAD).

We provide a more comprehensive overview of these projects in Appendix B.2.

The flood mapping and risk assessments performed in the Okanagan watershed may not be representative for British Columbia because many regions in B.C. still lack comparable funding and access to flood maps. A 2021 report found that floodplain maps were only publicly available in 57% of 109 surveyed B.C. communities (British Columbia Real Estate Association & University of British Columbia Okanagan, 2021).

3.1.2 : Post-Flood Recovery and Flood Insurance

The 2017 and 2018 floods were costly and impacted many communities throughout southern B.C. The 2017 floods displaced over 1,200 residents and resulted in two fatalities. The 2018 floods impacted over 30 communities across southern B.C., displaced

approximately 6,000 people, and heavily damaged almost 500 homes. As of 2019, the provincial government had spent \$15.6 million on public sector costs and \$2.7 million on private sector costs for the 2017 and 2018 floods (Ebbwater Consulting, 2019). Kelowna alone estimated that the uninsured public infrastructure repair costs from the 2017 freshet floods amounted to \$10.6 million, with \$7.3 million of this funded by the DFA (Newcombe, 2018).

The 2017 and 2018 floods were costly for the federal disaster financial assistance program. In 2023—five years after the floods—the federal government announced two interim payments totalling almost \$152.7 million to British Columbia from the DFA program to assist with flood recovery costs.

Flood insurance coverage is an important post-flood recovery tool to both aid in rapid access to funds and to lessen the burden on taxpayer-funded disaster assistance programs. In 2021, private residential flood insurance take-up in the Okanagan Basin was 60% that of fire insurance¹, slightly higher than the B.C. average of 55% (Li, 2022). The Kelowna region had a slightly higher take-up of 63% (Li, 2022). As of May 2024, we did not find any other specific information that was publicly available on the affordability, adequacy, or comprehensiveness of private or municipal flood insurance coverage in this region.

¹ Flood insurance take-up is estimated as the ratio of the number of flood insurance policies to the number of fire insurance policies.

3.2 : Impact of Legislation on Flood Risk

In this section, we identify the primary land use policies used by municipalities on the shores of Okanagan Lake to reduce flood risk. We compare these policies to the provincial standards described in FHALUMG. We then evaluate the potential flood risk implications associated with Bills 44 and 47.

3.2.1 : Existing Flood Risk Reduction Policies

Municipalities around Okanagan Lake address flood risk via sets of adaptive and mitigative regulations outlined in OCPs and bylaws. While this section discusses strategies according to whether they are primarily adaptive or mitigative, it should be noted that strategies are often both adaptive and mitigative.

Adaptive Flood Risk Strategies

Table 3.1 summarizes the adaptive tools used by the municipalities along Okanagan Lake. The extent of regulations and compliance with provincial regulations vary substantially and the definitions of design floods, usage of freeboards, measurements to identify streambeds, and outlined exemptions all differ between the municipalities. Policy documents generally show little consensus between municipalities as to how strict and complete appropriate flood protection measures should look like.

Table 3.1: Flood Construction Levels, Setbacks, Mapped Floodplains, and Development Permit Areas in the Study Area

Municipality Flood related bylaws	Management Areas (MAs) and DPAs	Okanagan Lake		Other Watercourses		
		FCLs (m)	Setbacks (m)	FCLs (m)	Setbacks (m)	Other Mapped Floodplains
Kelowna <i>OCP Bylaw No. 12300</i> <i>Mill Ck. Bylaw No. 10248</i> <i>Building Bylaw No. 7900</i>	Natural Environment DPA Hazardous Condition DPA Riparian MA	343.66 ^{a,b}	15	1.5 vert. ^c Mill Ck. Floodplains	10–50	Mill Ck. Mission Ck. ^d
West Kelowna <i>OCP Bylaw No. 0300</i> <i>Zoning Bylaw No. 0265</i>	Aquatic Ecosystem DPA	343.66	15	1.5 vert. ^b	7.5–15	–
Penticton <i>OCP Bylaw No. 2019-08</i>	Riparian DPA ^e	–	–	–	–	Penticton Ck. ^d Ellis Ck. ^d
Vernon <i>OCP Bylaw No. 5470</i> <i>Flood Bylaw No. 5896</i> <i>Zoning Bylaw No. 5000</i>	Flood Hazard DPA	344.3 ^f	15	Specific to all mapped floodplains	15	Vernon Ck. B.X. Ck. Kalamalka Lk. ^d
Lake Country <i>OCP Bylaw No. 1065</i> <i>Zoning Bylaw No. 561</i>	Natural Environment DPA Riparian Areas	343.66	7.5	1.5 vert. ^c 393.2 m (Wood & Kalamalka)	7.5–15	Kalamalka Lk. ^d Wood Lk. ^d
Summerland <i>OCP Bylaw No. 2014-002</i> <i>Building Bylaw No. 2022-042</i>	Watercourse DPA Riparian Areas	344.3 ^{a,f}	30	0.6 m above 200-year extent ^e	7.5 ^g	Trout Ck.
Peachland <i>Zoning Bylaw No. 2400</i>	Aquatic DPA	343.75	7.5	1.5 vert. ^{c,h}	15	Peachland Ck. ^d Trepanier Ck. ^d

Source: Mapped floodplains are from the B.C. floodplain map inventories (2015, 2021). All other information in the table is from the indicated bylaws. **Note:** ^aMinimum building elevation (MBE), and not flood construction level.

^bBylaws state that MBE near Okanagan Lake is 343.66m, but also that for sites in floodplains, the MBE is a minimum of 300 mm above the 200-year return peak elevation. ^c“vert” refers to a minimum vertical distance from the natural boundary of a watercourse. ^dFloodplain mapping conducted by RDCO. ^eRiparian DPA for Okanagan Lake is measured 30 metres from 342.18 metres. ^fBylaws refer to 200-year FCL with 0.6 metres freeboard; estimates here are based on Okanagan Mainstem Floodplain Mapping (NHC, 2020). ^gBylaws specify that provincial guidelines on setbacks apply in areas without mapped floodplains; these figures come from the FHALUMG. ^hSummerland’s minimum building elevation for watercourses is specific to those with mapped floodplains; for watercourses without mapped floodplains, Summerland’s bylaws specify that the setbacks—but not explicitly FCLs—found in Provincial guidelines should be used.

Flood Mapping

Recent efforts into flood mapping have provided new insights into local flood risk and necessary changes in land use policies. Some of these updates in flood risk mapping and land use bylaws can ultimately be attributed to shifts in flood risks due to changing climate conditions, most notably felt during the major floods of 2017 and 2018. The Okanagan Mainstem Floodplain Mapping (NHC, 2020), for example, yielded new flood construction levels for Okanagan Lake on the order of 0.7 m higher than previous FCLs, and suggested increases in FCL of between 1.0 and 1.2 m through Penticton and Osoyoos Lake (NHC, 2020). Detailed maps displaying the new flood construction levels and approximate water depths for individual properties under a design flood scenario are provided with the Okanagan Flood Story (OBWB, 2023).

Several municipalities and regional governments have conducted supplemental mapping and risk analysis for several local streams (Table 3.1). Local and regional projects revealed substantial flood risks for surrounding residential, commercial, agricultural, and public areas under projected 200-year flood events. These risks are waiting to be addressed via future updates to the respective bylaws (AECOM Canada Ltd., 2020; Associated Engineering Ltd., 2019; NHC, 2020). Local governments that have yet to enshrine the new proposed 2020 FCLs in bylaw are propagating flood and financial risk by allowing new development to known insufficient and outdated standards.

The City of Kelowna leverages local flood maps of Mill Creek to address flood risk in its floodplain using the Mill Creek Flood Plain Bylaw. This is the only bylaw in our study that imposes restrictions around a specific stream and the associated floodplain. The regulation includes floodplain mapping and mandatory mitigation standards, FCLs, and mandatory setbacks from Mill Creek.

Despite the targeted restrictions of the Mill Creek Flood Plain Bylaw, the current protective measures and previous encroachment of development into the Mill Creek floodplain put numerous assets and individuals at risk in the 2017 floods. In response, Kelowna has initiated the Mill Creek Flood Protection project to rehabilitate riverbanks, upgrade draining, create a partial flood bypass, and supplement water storage areas with the help of \$22 million from the federal Disaster Mitigation and Adaptation Fund (Water Canada, 2019).

Setbacks, Development Permit Areas, and Flood Construction Levels

As seen in Table 3.1, all municipalities except Penticton specify mandatory setbacks from Okanagan Lake of between 7.5 and 30 metres. Kelowna additionally defines a minimum

setback of 50 metres around particular sections of Mission Creek, and all municipalities except Penticton specify a setback of between 7.5 and 15 metres from all watercourses to account for variability in stream flows.

Note that Penticton used to have minimum setbacks of 7.5 m for Okanagan and Skaha lakes, and 30 m for Okanagan River (South Okanagan-Similkameen Conservation Program et al., 2017). It is not clear why these setback requirements were removed.

All municipalities have development permit areas (DPAs) around Okanagan Lake based on the 1976 Okanagan Basin Implementation Agreement which recommended establishing a FCL of 343.66 m, 1.18m above the target upper level for Okanagan Lake. Many municipalities further specify DPAs around other watercourses. Requirements, guidelines, and building restrictions within the DPAs vary by municipality.

All municipalities except Penticton specify FCLs. These FCLs are either measured by vertical distances to stream beds, historical high watermarks, or simulated design flood levels. The City of Penticton repealed previous flood construction levels and additional distances to watercourses from their respective bylaws. Current construction projects rely on professional reviews for floodproofing purposes.

Municipalities with FCLs that reference the most up-to-date flood maps instead of using fixed values have greater flexibility to adapt when new floodplain maps are released. Four municipalities state the flood construction levels explicitly, while two municipalities, Vernon and Lake Country, have integrated general FCLs of 0.6 metres above established 200-year flood levels. In contrast, many explicitly specified FCLs require updating because the latest design flood models of Okanagan Lake project water levels up to 343.86 metres (Northwest Hydraulic Consultants Ltd., 2022), which accounts for higher peak stream and lake levels under future climate conditions.

Not all municipalities' FCL requirements are straightforward, and municipalities do not always clearly identify FCL zones, or the region in which these FCLs apply. For example, Kelowna's bylaws require minimum building elevations (MBE) of 343.66m for buildings "within close proximity to Okanagan Lake shoreline", with no further specification on this proximity. The same bylaw also states that the MBE for watercourses with established floodplain maps should be based on flood elevations, but does not explicitly include Okanagan Lake in its definition of watercourses (Kelowna Bylaw 7900, 1998).

We could not identify any specific restrictions with respect to adaptive flood protection measures for the self-governing First Nations in the Okanagan Basin. Community Plans of

self-governing First Nations bands in the Okanagan Basin emphasize the sustainable use of natural resources, the importance to preserve natural environments, and mission to protect local watersheds for flood risk mitigation. Distinct building or zoning restrictions with regard to flood risk management are missing within the Penticton Indian Band Comprehensive Community Plan (2009), the Westbank Community Plan (2020), and the Okanagan Indian Band Strategic Plan (2020).

Mitigative Flood Risk Strategies

Compared to adaptive strategies for flood risks, large-scale mitigative flood risk strategies are less common within the investigated land use policies of local governments. Preservation of natural stream properties and ecosystems contributes to flood mitigation (Ebbwater Consulting Inc., 2021). In the study area, the Regional Districts of the North Okanagan, Central Okanagan, and Okanagan-Similkameen mention preservation in their regional community plans. OCPs of municipalities, however, lack distinct land use plans such as strategic property acquisitions for the purpose of flood protection. A recent purchase of lake and stream-front property by the City of Kelowna benefits municipal flood protection; however, property-buyout strategies on a larger scale have not yet been presented (City of Kelowna, 2023).

Municipal regulations in the case study area employ various mitigative flood risk strategies, often tailored to specific locations and varying between communities. While some measures directly address flood risk, others primarily target related issues but offer flood mitigation co-benefits.

The mitigative flood risk strategies found within municipal regulations are frequently location-specific and vary between the different communities. While some measures directly address flood risk, others primarily target related issues but offer immediate flood mitigation co-benefits. Measures specifically adopted for flood risk mitigation include Penticton's enhancement of flood forecasting systems and requirement for site grading before new construction projects, as well as Vernon's policy of eliminating hazardous trees (Nahiduzzaman et al., 2021). Initiatives contributing to flood risk reduction through co-benefits include West Kelowna's initiative of seeding and planting trees as well as Kelowna's definition of tree coverage goals and erosion control measures (Nahiduzzaman et al., 2021).

3.2.2 : **Impact Of Future Policy Changes On Flood Risk**

To investigate the potential impact of future policy changes on flood risk, we focus on two new bills implemented by the provincial government: Bills 44 (Housing Statutes [Residential Development] Amendment Act) and 47 (The Housing Statutes [Transit-Oriented Areas] Amendment Act). These bills are intended to address housing challenges in British Columbia through a series of specific amendments. Bills 44 and 47 set requirements for community plans to incorporate changes to zoning and transit-oriented development by June 2024 (Ministry of Housing, 2023).

The Ministry of Housing retained a group of leading economic and planning experts to analyze what impacts the new frameworks for more small-scale, multi-unit homes (SSMUH) and designated transit-oriented areas (TOAs) could have in B.C. This analysis anticipated these changes alone could lead to between 216,000 and 293,000 additional net-new housing units for British Columbians over 10 years.

Bill 44 requires all local governments to zone for, at minimum, secondary suites or an additional dwelling unit in all single-family and duplex residential zones, with exceptions. Inside urban containment boundaries established through a Regional Growth Strategy and in municipalities with populations larger than 5,000 people, single family and duplex zones must allow for 3-6 units of housing, depending on lot characteristics and proximity to frequent bus transit, with exceptions. The bill also requires revisions to OCPs and zoning bylaws to align with updated Housing Needs Reports (HNRs) and to plan and pre-zone for the 20-year total amount of housing communities need. The amendments are supported by provincial policy manuals, site standards, and building designs to encourage building small-scale multi-unit residences. These resources are intended to offer transparent guidance and regulatory frameworks for developers and builders.

Bill 47 facilitates the development of transit-oriented housing. This legislation mandates municipal authorities to designate specific areas near transit hubs as TOAs, which have unique zoning requirements. A full description of zoning regulations associated with different categories of TOAs can be found in Appendix C.

Bills 44 and 47 may result in increased flood vulnerability levels if implemented without careful consideration of how these bills fit into broader flood risk strategies. The consequent urban densification in flood-prone areas may increase municipal exposure and vulnerability to flooding. The Local Government Zoning Bylaw Regulation permits a potential solution to

this problem: an area may be exempt from the zoning outlined by Bill 44 if the land is subject to a hazardous condition wherein the increased densification would increase the risk from the hazardous condition (2023). The local government must obtain a report from a qualified professional stating this. However, for local governments that lack up-to-date flood maps, the capacity to obtain such reports, or the awareness of flood risk in their community, rezoning according to Bill 44 will take effect in floodplains.

Bill 44 also promotes the development of secondary suites. This is frequently implemented by developing basement suites, providing additional low-cost units at a comparatively small investment. However, the costliest impact of climate change affecting Canadians is residential basement flooding (Intact Centre on Climate Adaptation & University of Waterloo, 2022). Even if basements are constructed above flood construction levels, basements suffer the brunt of damage from overland floods and storm/sanitary sewer backups. In single-family homes, the average cost to repair a basement after a flood is over \$40,000 (Government of Canada, 2022). Basement suites put renters at an even greater vulnerability because their entire living space and belongings are impacted in the event of a flood.

Densification as a result of Bills 44 and 47 can prevent potential sprawl into flood-prone sites or resulting degradation of intact ecosystems, thereby curtailing future flood risk. However, Canada's Task Force on Flood Insurance and Relocation highlights that "Canada's densification and development in urban areas already exposed to significant hazard is a major driver of flood risk" (2022). Because so many urban centres already exist in flood-prone areas, further densification increases the value of assets in floodplains and thus the vulnerability to floods.

The provincial government has supported local governments with funding to implement the new policy. This support has provided local governments with the necessary resources to integrate and update local policies to align with new regulations. Bills 44 and 47 were supported by \$51 million to assist local governments with implementing the zoning changes (Ministry of Housing, 2023). Several municipalities in the Okanagan identified that implementing these changes was aided by additional finances and flexible timelines. For example, West Kelowna required three additional staffing positions to address the workload (Lorraine, 2024b); and RDCO considered requesting an extension to better plan how to manage additional density (Lorraine, 2024a). Funding and flexible timelines have helped municipalities incorporate the new bills in meaningful ways while considering how these bills fit into broader land use plans.

3.3 : Quantifying Flood Risk in the Okanagan Basin

In this section, we quantify the impact of flooding through the exposure and damage costs to dwelling units in the Okanagan Basin. To explore the potential impact of flood risk policy on mitigating future risk, we then project potential additional risk attributable to housing growth for Kelowna.

Methods

We investigate regions in and outside of flood construction level (FCL) zones—areas also colloquially called floodplains, where FCLs are recommended by the Okanagan Mainstem Floodplain Mapping (2020a). We focus on 200-year flood event FCLs with freeboard—an additional height above the expected flood level to account for uncertainties and prevent flooding—as estimated in the Okanagan Mainstem Floodplain Mapping (NHC, 2020a).

We then use data from the Flood Risk Mapping for the Okanagan Watershed (NHC, 2023) to evaluate the impact of flooding, quantified through damage and replacement costs as well as impacted populations for all municipalities in the Okanagan Basin. These data rely on climate projections for the mid-century under the scenario RCP8.5 and assume updated Okanagan Lake Regulation System (OLRS) operations, accounting for changes to runoff and precipitation due to climate change.

We assess building repair and replacement costs in terms of expected annual damages (EADs) and as EADs per capita, representing the average yearly financial impact of flooding. EADs offer a practical measure of risk by providing a more consistent and manageable estimate for budgeting and decision-making compared to the rare, extreme damages from a single flood event. We also report the estimated impacts under a 200-year flood event for perspective. We report all building repair and replacement costs in 2023 Canadian dollars and the affected population as counts.

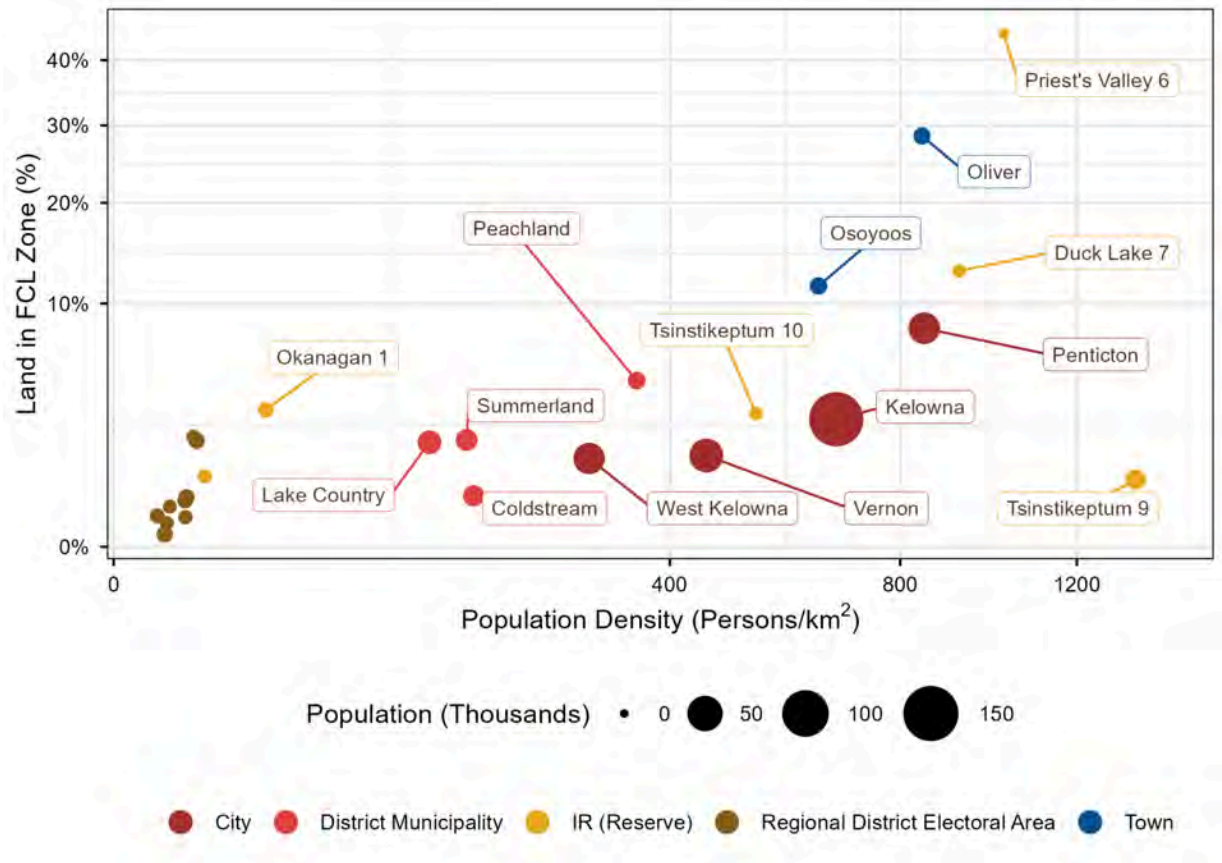
3.3.1 : Flood Hazard and Exposure

Figure 3.1 shows the four cities, seven Indian Reserves, nine regional district electoral areas, four district municipalities, and two towns in the Okanagan Basin that are exposed to flooding from the Okanagan mainstem lakes and Okanagan River.

These census subdivisions vary in terms of potential flood hazard, or the likelihood that flooding may occur within the area. Figure 3.2 shows the exposure to flood hazards as

measured by the percent of land in each census subdivision within the FCL zones for each affected census subdivision.

Figure 3.2: Flood Hazard and Exposure Under Modified Operations



Source: Flood Risk Mapping for the Okanagan Watershed (NHC, 2023). **Note:** The scales of the x- and y-axes are square-root transformed to aid in the visualization of points with smaller values.

To provide additional context on census subdivisions and explore potential connections between flood hazard and population characteristics, we also consider population size and population density for each census subdivision in Figure 3.2. This enables a first overview of flood hazard in the individual census subdivisions, before exploring the nature of hazard and exposure in greater detail in the following chapters.

Four census subdivisions have more than 10% of their land in FCL zones, including two Indian Reserves and two towns. These communities all have populations of less than 20,000 people but have high population densities. Priest's Valley 6 Indian Reserve has 45% of its land in the FCL zone, the largest proportion of all communities, along with the second-highest density of over 1,000 persons per square kilometre of all populations. In

contrast, regional district electoral areas have much lower population densities and lower proportions of land in FCL zones.

3.3.2 : Flood Exposure and Vulnerability

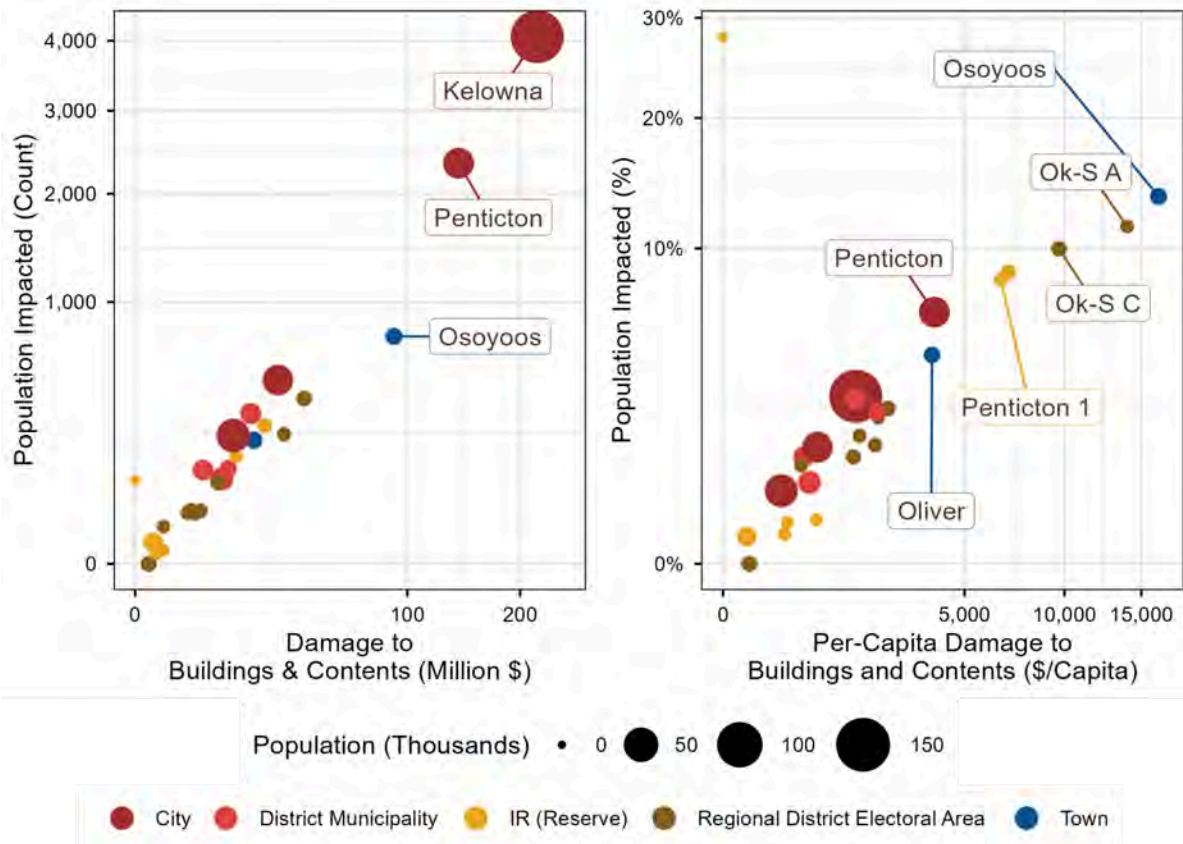
We use two metrics as estimated by the Flood Risk Mapping for the Okanagan Watershed (NHC & IBI Group, 2023) to conduct a more in-depth comparison of flood risk between these census subdivisions: building repair and replacement costs; and affected population.

Larger communities such as cities and towns generally have higher damage costs to buildings and contents and larger affected populations in the event of a 200-year flood than smaller communities such as regional district electoral areas (Figure 3.3). Kelowna, the largest community in the study area, has the highest estimated damage to buildings and contents at \$218 million in a 200-year flood event, followed by Penticton at \$140 million. Kelowna and Penticton also have the largest estimates of impacted populations at 4,064 and 2,331, respectively.

Flood risk can be higher for larger communities due to several factors, including increased urbanization leading to more area covered in impermeable surfaces, higher population density, and often more extensive infrastructure networks. These characteristics can exacerbate the effects of flooding by altering natural drainage patterns and increasing runoff. However, larger communities also tend to have more resources, capacity, and infrastructure in place to mitigate damages and recover from floods.

When controlling for population size, smaller communities frequently have comparable or higher per-capita damage costs and proportion of the affected population compared to the larger cities (Figure 3.3). Kelowna has a per-capita damage cost of \$1,509, lower than 12 of the 25 other communities, and an estimated 2.3% of the population is projected to be affected, lower than eight of the other communities. Comparatively, the town of Osoyoos has the highest per-capita damage costs at \$16,255, and Priest's Valley 6 Indian Reserve has the highest percentage of the population impacted at 28%. This aligns with previous findings that First Nations are often more exposed to flooding (Thistlethwaite et al., 2020; Alderhill, 2023).

Figure 3.3: Estimated Impacts from a 200-Year Flood Event under Modified Operations



Source: Flood Risk Mapping for the Okanagan Watershed (NHC, 2023). **Note:** The scales of the x- and y-axes are square-root transformed to aid in the visualization of points with smaller values. “Ok-S” stands for “Okanagan-Similkameen”.

Per-capita flood risk may be higher for smaller communities due to limited resources and infrastructure for flood risk management compared to larger municipalities. Smaller communities may lack the economies of scale to invest in robust flood protection measures, leaving them more vulnerable to the impacts of flooding events. This aligns with the findings included in the B.C. Flood Strategy “What We Heard” report (Alderhill, 2023).

We then restrict our focus to municipalities directly bordering Okanagan Lake, comparing non-structural risk management strategies discussed in Section 3.2.1 to the estimated risk for each municipality. Table 3.2 shows the EAD, per-capita EAD, and estimated 200-year event impacts in terms of building repair costs for these municipalities, in 2023 dollars. This analysis does not include an evaluation of structural flood risk management measures that these municipalities may use.

Table 3.2: Damage Costs to Buildings and Contents by Municipality

Municipality	Population 2021	200-Year Event Impacts (Million \$)	EAD (Million \$)	EAD per Resident (\$)
Kelowna	144,576	218.23	23.81	164.71
Vernon	44,519	12.97	1.25	28.08
Penticton	36,885	140.00	8.65	234.5
West Kelowna	36,078	27.53	2.57	71.15
Lake Country	15,817	10.12	1.03	65.27
Summerland	12,042	18.04	1.99	165.14
Peachland	5,789	11.71	1.31	226.79

Source: Flood Risk Mapping for the Okanagan Watershed (NHC, 2023). Population estimates are from the 2021 Census of Population.

Municipalities with more stringent flood risk management strategies generally have lower flood risk than municipalities with comparable exposure and capacity but less stringent management. Penticton, with the fewest flood risk protection policies (Table 3.1) of all evaluated municipalities, has the highest per-resident EAD at \$235. In contrast, Vernon, with a similar percentage of land in floodplains (Figure 3.2) but a much more rigorous flood risk management strategy, has an 88% lower per-resident EAD. A similar trend is present when we compare the smaller municipalities of Summerland and Peachland. Summerland's FCLs and setbacks around Okanagan Lake are both more stringent than Peachland's (Table 3.1), and its per-resident EAD is 27% lower than Peachland's. However, Summerland and Vernon both have less percent of their land in floodplains than Peachland and Penticton, respectively (Figure 3.3). In either comparison, we cannot necessarily say that the difference in management strategies causes the difference in risk.

Lake Country has the lowest EAD and per-resident EAD, even when compared to Summerland, which has comparable exposure and more up-to-date FCLs and setbacks for Okanagan Lake (Figure 3.3). This may be attributable to Lake Country's extensive Natural Environment DPA, which entirely covers the FCL zones of Okanagan, Kalamalka, and Wood Lakes, and includes guidelines such as the use of permeable paving materials.

3.4 : Impact of Land Use Policy on Projected Flood Risk

To explore how municipal land use planning may affect flood risk, we conduct an investigation focused on Kelowna. This investigation takes place in two steps:

1. We first investigate Kelowna's current flood policy compared to international best standards and quantify the relationship between these policies and residential flood risk in Kelowna. This helps us identify low-intensity and high-impact future policy scenarios, such as raising the FCL.
2. We then project the potential increase in flood risk associated with the city's planned housing and growth strategy depending on scenarios that consider both exposure (construction in floodplains) and updating flood policy.

Methods

Identical to the previous assessment of flood risk in the Okanagan, we use the data, information, and assumptions from the Okanagan Mainstem Floodplain Mapping (NHC, 2020a) and the Flood Risk Mapping for the Okanagan Watershed (NHC, 2023). We rely on climate projections for the mid-century under the scenario RCP8.5 and assume updated Okanagan Lake Regulation System (OLRS) operations, accounting for changes to runoff and precipitation due to climate change.

In this section, we focus on residential buildings only. Residential building damage serves as a prevalent flood risk indicator due to the widespread availability of data on hazards, exposure, and vulnerability for existing and planned structures. In impact assessments and risk analyses, housing-related damages frequently constitute a substantial proportion of reported and anticipated losses.

We first quantify the relationship between flood policy and flood risk by evaluating the current expected annual damages (EADs) for single-family homes in the City of Kelowna. We use the per-home EADs estimated in the Flood Risk Mapping for the Okanagan Watershed (NHC, 2023). We compare these per-home EADs using different policy-related attributes of each home, such as whether the home was built above Kelowna's FCLs.

We then project future additional risk attributable to new residential buildings in Kelowna based on Kelowna's growth strategy. Methods specific to these projections explained in greater detail in the Section 3.4.2.

3.4.1: Quantifying the Relationship between Flood Policy and Current Housing Risk in Kelowna

Kelowna uses flood construction levels as a land use management tool for flood risk reduction. We identify four limitations in Kelowna's strategy of using FCLs as a primary flood risk reduction policy:

1. Construction in FCL zones (floodplains) is allowed, which increases flood exposure;
2. The FCL around Okanagan Lake is set at a fixed value of 343.66 m, which is 70 cm lower than FCL recommendations according to the Okanagan Mainstem Flood Mapping Report (referred to hereafter as "mapped FCLs") (NHC, 2020);
3. Similar to in the FHALUMG, crawlspaces are exempt from FCLs; and
4. Construction of basements in FCL zones (floodplains) is still allowed.

In Figure 3.4, we quantify the impact of each limitation by comparing EADs for single-family homes that:

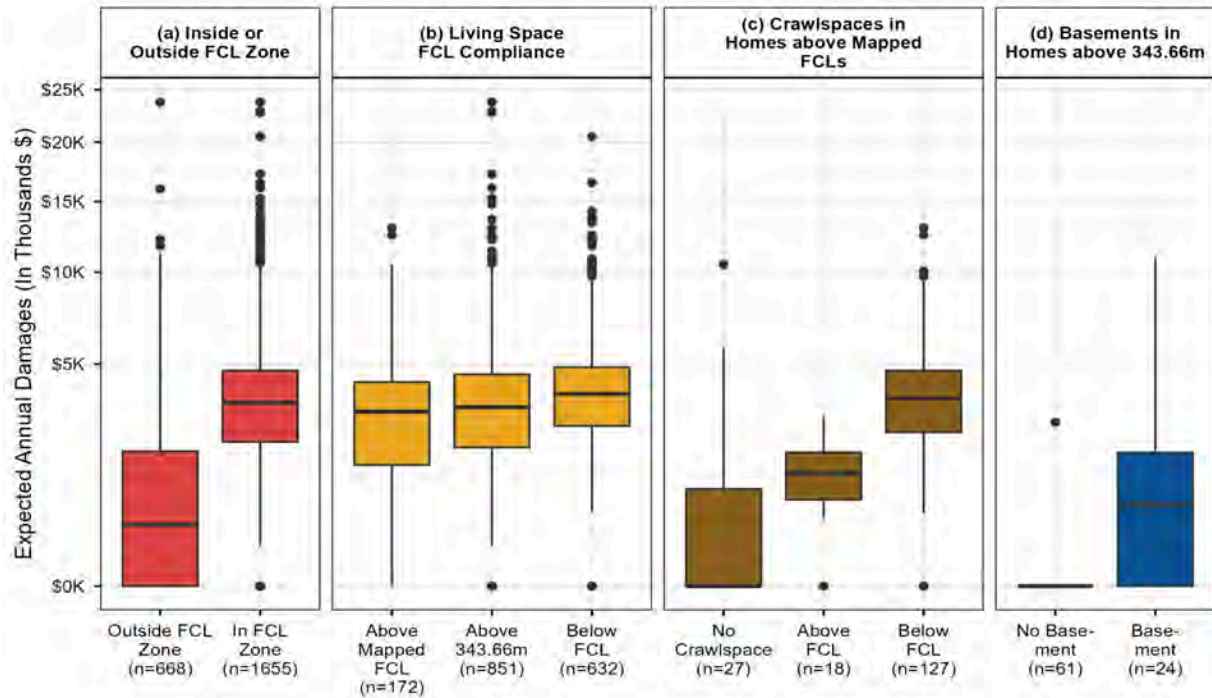
- Meet or exceed international best practices;
- Meet or exceed Kelowna's policies but do not meet international best practices; and
- Do not meet Kelowna's policies.

As seen in Figure 3.4a, EAD is substantially higher for single-family homes in FCL zones than outside FCL zones. The average EAD for single-family homes in the FCL zone is \$3,819, 164% higher than the average EAD of \$1,446 for homes more than 30 metres outside the FCL zone.

As seen in Figure 3.4b, Kelowna's fixed FCL of 343.66 metres reduces flood risk, but FCLs in accordance with the recent Okanagan Lake floodplain mapping reduce risk more effectively. Homes in the FCL zone that are above Kelowna's fixed FCL of 343.66 metres but are below mapped FCLs have a 9% lower average EAD than homes that are below this FCL (\$3,735 vs \$4,093, respectively). However, homes that are above the mapped FCL have a 21% lower average EAD (\$3,234) than homes below Kelowna's fixed FCL.

As seen in Figure 3.4c, crawlspaces in FCLs are associated with higher EADs. Compared to homes in the FCL zone without crawlspaces, homes in the FCL zone with crawlspaces constructed above or below the mapped FCLs have 24% and 274% higher average EAD, respectively (\$1,061 versus \$1,315 and \$3,968, respectively).

Figure 3.4: Expected Annual Damages to Single-Family Homes in Kelowna



Source: Flood Risk Mapping for the Okanagan Watershed (NHC, 2023). **Note:** The scale of the y-axis is square-root transformed to aid in the visualization of points with smaller values. Plot (a): “Outside FCL Zone” includes single-family homes that are at least 30 metres away from the FCL zone. Plot (b): Note that the “Above 343.66 m” category for living space FCL compliance includes buildings that are above 343.66 metres but *below* mapped FCLs as identified by NHC (2020).

Finally, as seen in Figure 3.4d, homes in FCL zones with basements are associated with higher EADs than those without basements. For this comparison, we consider only homes in the FCL zone without crawlspaces and where all living spaces (basements included) are above Kelowna’s FCL of 343.66 metres. Among these homes, those with basements have an average EAD of \$2,109, in contrast to the \$44 average EAD for those without basements.

3.4.2: Projected Risk Attributable to New Housing

Kelowna is one of the fastest-growing communities in B.C. and Kelowna’s growth strategy from 2023 to 2040 includes the construction of 25,330 new housing units to support a population increase of 46,540 people (Official Community Plan Bylaw No. 12300, 2023). To estimate the impacts of additional housing on flood risk we evaluate prospective locations of new housing units, assess exposure to flood hazards, and evaluate additional flood risk under four distinct scenarios.

Projection Methods

We use housing unit counts and population densities from Kelowna's OCP and 20-year servicing plan (City of Kelowna, 2022), which distributes the additional houses across the city via several growth nodes shown in Figure 3.5. The 20-year servicing plan includes 1,495 secondary suites, which we model by assuming that 1,495 of the new single-family dwellings have a basement (simulating a basement suite) and one additional resident.

We consider two policy scenarios according to whether Kelowna updates its FCL-related bylaws to align with the International Residential Codes (IRC) for flood-resistant construction (International Code Council, 2021). Kelowna's bylaws differ from the IRC's in two ways: that their FCL for Okanagan Lake is lower than the FCLs in the most recent flood maps (NHC, 2020), and that crawlspaces can be below the FCL. The policy scenarios are as follows:

- **Current policy:** Kelowna keeps its current flood risk management policies, with an FCL of 343.66 metres in the Okanagan Lake floodplain. Crawlspaces are built at current observed frequencies above or below the FCL.
- **Updated policy:** Kelowna adopts the FCLs recommended in the Okanagan Flood Mapping project (NHC, 2020). Any crawlspaces must be built above these FCLs.

We assume that the updated policy scenario will not have significant costs of implementation, aside from the cost of updating the Design Standards Bylaw No. 7900. Increased construction costs associated with higher FCLs are generally offset by substantially reduced flood insurance premiums (FEMA, 2011; Association of State Floodplain Managers, n.d.). Similarly, below-grade crawlspaces are associated with higher insurance premiums, and crawlspaces in general are more expensive than other foundation types such as slab foundations (Glover, 2023).

We project damages under both policy scenarios under two different levels of exposure:

- **Moderate exposure:** New development occurs evenly across each growth node. Prospective shares ("% in Okanagan Lake FCL Zone") and numbers of new developments in the FCL zone are displayed in Table 3.3: for example, we assume 41% of all new housing units, equivalent to 1845 units, planned for the Downtown Urban Core will be constructed in the FCL Zone.
- **High exposure:** New developments in each growth node are concentrated in FCL zones, reflecting how shoreline property is often highly valued by homebuyers. We assume that all planned housing in growth nodes with any Okanagan Lake FCL

zones (Downtown Urban Centre, Core Central, Remainder of City, Pandosy Urban Centre, and McKinley Beach, as seen in Table 3.3) occurs fully within the FCL zones.

Based on per-building risk estimates from the Flood Risk Mapping for the Okanagan Watershed (NHC, 2023), we then predict (1) the EAD; and (2) the 200-year flood event damage costs to new buildings and contents for residential buildings in Kelowna under each scenario. For all estimates, we include the following predictors:

- Number of residents in the building;
- Building type (multi-family home or single-family dwelling);
- Setback distance from Okanagan Lake (less/greater than 15 metres from shoreline);
- Exposure (in FCL zone, within 30m of FCL zone, farther than 30m from FCL);
- Living space elevation (below fixed FCL, above fixed FCL, above mapped FCL)²;
- Existence of a crawlspace or basement (crawlspace, basement, or neither)³; and
- Crawlspace elevation (below fixed FCL, above fixed FCL, above mapped FCL)³.

These projections focus solely on Okanagan Lake and do not include Mill Creek because no flood risk mapping exists for its floodplain. However, Mill Creek flood risk is substantial—Mill Creek flooding caused significant damage in Kelowna during the 2017 and 2018 floods.

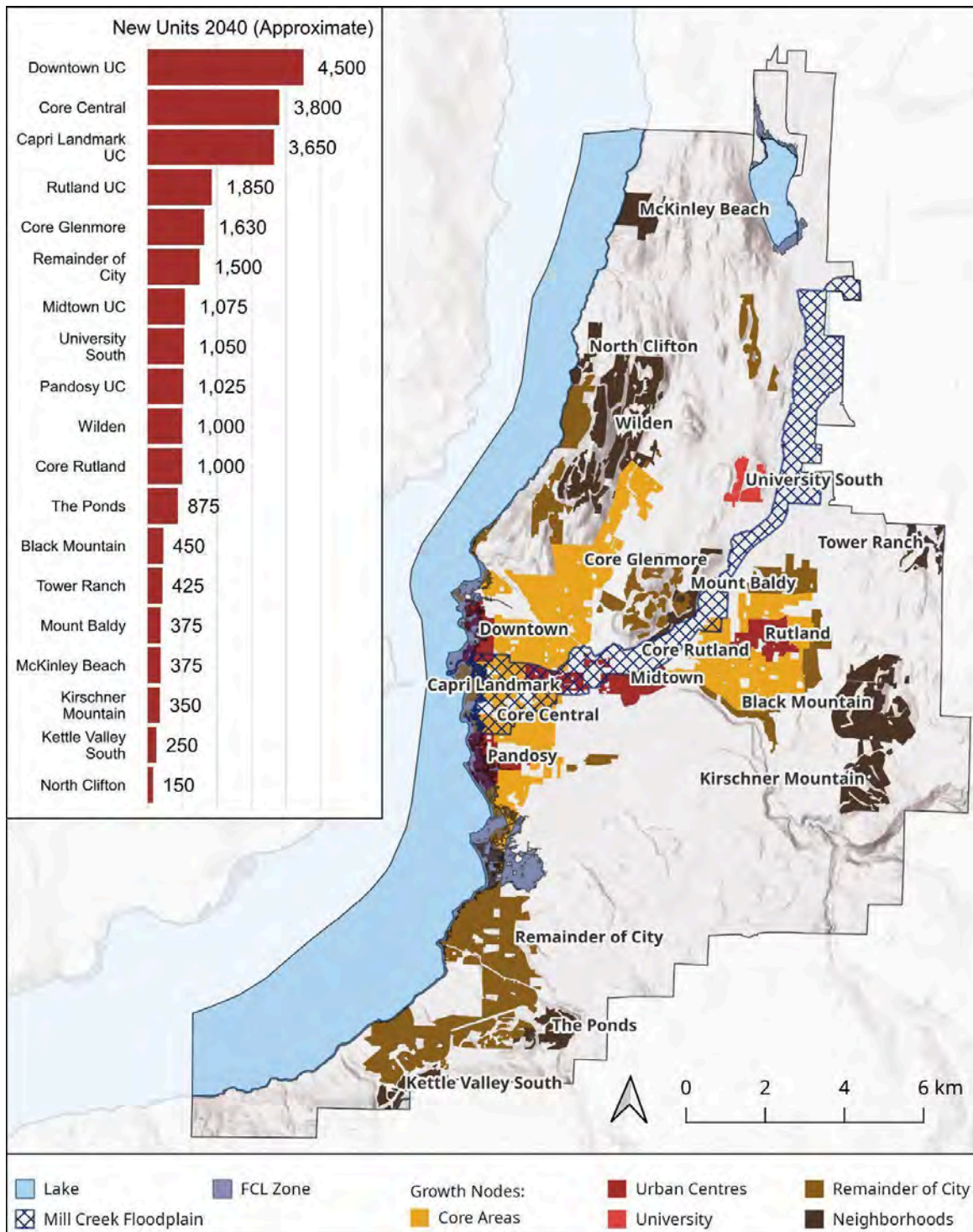
Findings

As seen in Figure 3.5, the City of Kelowna has identified roughly where the new housing units will go, specifying 19 different growth nodes within the city and the number of anticipated new units for each growth node. More than half of the new housing units are planned to be higher-density housing (>85 units per hectare).

Eight of the growth nodes overlap the Okanagan Lake or Mill Creek floodplains (growth nodes included in Table 3.3). Approximately 68% of Kelowna's planned housing growth is projected to occur in these eight nodes. If residential development occurs evenly across each growth node, then 33% of all new housing units will be built on land exposed to flooding (11% in the Okanagan Lake floodplain specifically). Because lakefront property is often highly valued by homebuyers, new housing may be more concentrated in these floodplain. We explore an extreme version of this using the high exposure scenario. It is crucial to note that a large portion of flood risk in Kelowna stems from Mill Creek flooding. This is further discussed in Section 6.

² Modeled as an interaction effect with exposure (in FCL zone, within 30m of FCL zone, farther than 30m from FCL).

Figure 3.5: City of Kelowna Anticipated Residential Unit Distribution, 2040



Source: City of Kelowna's zoning maps and Official Community Plan 2040 (Bylaw No. 12300, 2023); basemap from ESRI. FCL zones from Okanagan Mainstem Floodplain Mapping (NHC, 2020a).

Table 3.3: Flood Exposure and Planned Housing in Kelowna's Growth Nodes

Growth Node	Total Number of New Units (2040 OCP)	% of Land in FCL Zone		Projected Number of Exposed Units in Okanagan Lake FCL Zone	
		Mill Creek	Okanagan Lake	Moderate Scenario	High Scenario
Downtown Urban Centre	4,500	12	41	1,845	4,500
Core Central	3,800	26	12	456	3,800
Capri Landmark Urban Centre	3,650	100	0	0	0
Remainder of City	1,500	0	3	45	1,500
Midtown Urban Centre	1,075	14	0	0	0
Pandosy Urban Centre	1,025	0	50	513	1,025
Core Rutland	1,000	3	0	0	0
McKinley Beach	375	0	1	38	375
Mount Baldy	375	5	0	0	0
Total	17,300	-	-	2,897	11,200

Source: Estimated number of new dwelling units per growth node were sourced from Kelowna's 2040 OCP.

Percents of areas in FCL zones were estimated based on residential zones in Kelowna's permanent growth boundary in each growth node overlaid with the 2040 OCP Mill Creek Floodplain map and Okanagan Mainstem Floodplain Mapping (NHC, 2020a) Okanagan Lake FCL with freeboard. **Note:** "Projected number of exposed units" is the number of units that we assume will be constructed in the Okanagan Lake FCL Zone in our risk projections under the "moderate" and "high" exposure scenarios. These scenarios do not include risk attributable to Mill Creek.

Evaluating damage costs for the new housing units as seen in Table 3.4, we find that exposure—or the amount of new development that occurs in the floodplains—has a considerably higher impact on flood risk than updating FCL policies. Under current policies, the added risk projected under the high exposure scenario is 86% greater than under the moderate exposure scenario. This finding highlights the importance of strategies that avoid development in the floodplain altogether.

The impact of updating FCL policies is still appreciable, particularly in the high exposure scenario. We project that updating FCL policies for both living spaces and crawlspaces notably reduces risk to buildings and contents. Assuming that new housing units are constructed evenly within each growth node, we project an additional \$8.8 million EAD to new housing units and their contents by 2040 attributable solely to Okanagan Lake flood

risk. However, if Kelowna's flood policies are updated, we project \$8.0 million additional EAD, 9% lower than projected under current policy. Actual damages in the event of a flood are likely higher because these estimates focus only on damage to buildings and contents of new housing units, and also do not include damage attributable to Mill Creek flooding.

Table 3.4: Projected Additional Damage Attributable to New Housing Units in Kelowna's Growth Nodes

Growth Node	Current Risk	Projected Risk							
		Current / Moderate		Updated / Moderate		Current / High		Updated / High	
		Added risk (million \$)	% Inc.	Added risk (million \$)	% Inc.	Added risk (million \$)	% Inc.	Added risk (million \$)	% Inc.
Expected Annual Damage (EAD) to Buildings & Contents									
Core Central	6.8	3.2	47	3	43	7.1	104	6.4	94
Downtown UC	4.6	3.6	77	3.2	69	5.3	115	4.8	104
McKinley Beach	0	0.2	-	0.2	-	0.4	-	0.4	-
Pandosy UC	4.1	1.0	24	0.9	22	1.3	33	1.2	29
Remainder of City	2.9	0.8	30	0.8	27	2.2	77	2	70
Total	18.4	8.8	48	8.0	43	16.4	89	14.8	81
Damages to Buildings & Contents in 200-year Flood Event									
Core Central	61.3	31.7	52	28.3	46	56.7	92	52.1	85
Downtown UC	41.8	31.7	76	28.2	68	43.2	103	39.5	95
McKinley Beach	0	1.9	-	1.6	-	3.6	-	3.4	-
Pandosy UC	38.1	8.6	23	7.7	20	10.9	28	10	26
Remainder of City	27.5	9.0	33	7.9	29	17.7	64	16.3	59
Total	168.7	82.9	49	73.7	44	132.1	78	121.3	72

Source: Big River flood risk projections for Kelowna. **Note:** Policy scenarios ("Current" or "Updated") are noted in the first row of the table; exposure scenarios ("Moderate" or "High") are noted in the second row of the table. "% Inc." for each scenario refers to the percent increase in risk compared to the current risk.

4.0 : Recommendations

Overview of Recommendations

1. Flood mapping and flood risk mapping should focus on a wholistic approach, be provincially or regionally coordinated, and results should be made publicly available.
2. The multi-level governance and resulting moral hazard from current flood hazard management practices need to be addressed. This may be assisted through:
 - Mandating the development of flood bylaws compliant with the FHALUMG updated for climate change
 - Conditioning disaster financial assistance on flood risk reduction during the rebuilding process
 - Shifting provincial supports to preventative programs;
 - Including mandatory flood protection standards for residential buildings in the BCBC **or**
 - Limiting development in floodplains altogether
3. Provincial requirements and guidelines should reflect and incentivize best practices for flood risk management. This will require updating the FHALUMG, developing provincial guidelines for retrofit programs, implementing non-structural flood mitigation measures and natural landscape preservation, and developing buyout programs
4. Equitable flood risk reduction requires that resources be provided to local governments and communities, especially those with limited capacity
5. Research and implement flood risk management solutions specific to the on-reserve context in partnership with First Nations governments in B.C.

We combine our findings from the policy analysis and case study to provide a set of recommendations for the provincial government to improve flood risk management in B.C. We focus on existing policies and/or guidance that could be more effectively used to reduce risk to people in flood hazard areas, as well as policy amendments and future research priorities to further understand and reduce flood risks.

We identify which actions outlined in the B.C. Flood Strategy each recommendation aligns with (Province of British Columbia, 2024a). We highlight the actions in the B.C. Flood Strategy

that should be prioritized according to our findings and identify where the scope of certain actions in the B.C. Flood Strategy may be refined.

For each recommendation, we provide our assessment of its priority. Priority levels are assigned based on the urgency and impact of addressing the issue at hand:

- **High priority** recommendations are urgent *and* essential for mitigating significant risks, improving overall resilience, or fulfilling critical strategy goals.
- **Moderate priority** recommendations are urgent *or* essential. These recommendations address less immediate concerns (lower urgency) or involve actions that complement other high-priority initiatives (less essential).
- **Low priority** recommendations address issues with less urgency and impact, often serving as additional enhancements rather than fundamental needs.

4.1 : Improve Assessment And Communication of Flood Risks

Up-to-date mapping is essential for local governments, individuals, and organizations to understand and mitigate their risk. This section includes recommendations for achieving this overarching goal.

4.1.1 : Conduct Province-Wide and Up-To-Date Floodplain Mapping

Priority	High
Issue	Communities use outdated maps to inform flood risk management
Approach	• Provincially coordinate regularly updated floodplain mapping • Delegate to regional or watershed-level organizations • Include changing climate conditions and 200-year flood events
Benefits	• Floodplains can be considered on a watershed level • Reduces burden on communities with limited capacity
Relation to BCFS	Action 1.1: <i>Develop a provincially coordinated floodplain mapping program</i> • Rec: Re-evaluate delegation to local governments Pathway 2: <i>Strengthening Flood Risk Governance.</i>

Priority: High

Conducting province-wide and up-to-date floodplain mapping is critical for effective flood risk management. Reliable flood risk information is essential for informing other policies and ensuring their success. This recommendation aligns with the B.C. Flood Strategy's Action 1.1, which emphasizes the need for a coordinated floodplain mapping program.

Issue

Currently, many local governments depend on outdated maps to inform risk management. Many local governments lack either the capacity to update these maps or the knowledge that these maps must be updated.

Up-to-date flood maps that reflect changing climate conditions as well as regular and extreme flooding events are essential for effective flood risk management. Provincial coordination of floodplain mapping initiatives is needed to develop these maps.

Approach

Flood mapping initiatives should be provincially coordinated and should be repeated regularly. This mapping can be delegated to regional or watershed-level organizations, whether this be regional districts or non-governmental organizations to reduce the burden on both provincial and local governments. This delegation approach was highly effective for floodplain mapping efforts in the Okanagan Basin, as demonstrated by the Okanagan Mainstem Floodplain Mapping project.

Flood maps should be generated using standardized metrics and 200-year floods, modelling multiple types of flood hazards. Floodplain mapping must include the impacts of changing climate conditions into their models to accurately forecast future risk. By incorporating these considerations into flood mapping efforts, communities can better anticipate and prepare for flood events, reducing vulnerability and enhancing resilience.

Benefits

Provincial leadership in floodplain mapping can reduce the current gaps seen in floodplain mapping, particularly between communities of varying population sizes. Provincially-coordinated floodplain mapping initiatives allow floodplains to be considered on a watershed level, and not simply within the limits of a local government. This coordination can still prioritize collaboration with and delegation to other levels of government.

Connection to the B.C. Flood Strategy

This recommendation is in alignment with the BCFS's Action 1.1: *Develop a provincially coordinated floodplain mapping program.*

We recommend reevaluating Action 1.1's delegation of mapping responsibilities to local communities and governments. In our case study, we find that many local governments do not have the capacity or do not prioritize floodplain mapping. Integrated floodplain management through the development of regional or watershed-level organizations may help address this issue. This direction is in alignment with Pathway 2: *Strengthening Flood Risk Governance.*

4.1.2 : Improve Public Access To Flood-Related Resources

Priority	High
Issue	Floodplain maps are not publicly accessible in all communities
Approach	• Ensure free and equitable access to flood risk data • Implement mandatory flood risk disclosures for property transactions
Benefits	• Governments, organizations, and individuals can make informed decisions about flood risk management
BCFS	<i>Action 1.1: Develop a provincially-coordinated floodplain mapping program</i> <i>Action 2.6: Update provincial legislation, regulations, and policies</i> • Leverage collaboration with BCREA and LTSA to reduce the burden on the provincial government.

Priority: High

Improving public access to flood-related resources is important for enhancing awareness and enabling better risk management. However, it is a supporting action that complements the primary focus on developing and updating floodplain maps and risk assessments. Therefore, we assign this recommendation a moderate priority, aligning with the B.C. Flood Strategy's emphasis on accessibility and transparency but not as critical as foundational measures like mapping.

Issue

Up-to-date information on flood risk is not publicly accessible in all B.C. communities. This limits public awareness of risk and, consequently, reduces the likelihood that individuals or local governments will take sufficient measures to protect themselves against flood risk.

Approach

The provincial government should focus on ensuring free and equitable access to flood risk data for everyone in B.C., including public access to existing and new floodplain maps and related datasets.

Expanding provincial investments in B.C.'s LiDAR program can further enhance the availability and accuracy of elevation data, which is essential for flood risk assessment.

Introducing mandatory flood risk disclosures during property transactions is another critical step to improving public awareness. Requiring sellers, real estate professionals, or an independent third party to assess and disclose flood risk information to potential buyers enables individuals to make more informed decisions regarding property purchases in flood-prone areas (Henstra & Thistlethwaite, 2018). Mandatory disclosures also encourage property owners to invest in flood risk management measures, ultimately reducing the overall vulnerability of communities to flood hazards (Federal Emergency Management Agency, 2022).

Benefits

Improving public access to flood-related resources, including comprehensive floodplain maps, practical online resources, and clear documents summarizing flood risk restrictions, can empower individuals, organizations, and local governments to make informed decisions and take proactive measures to mitigate flood impacts.

Connection to B.C. Flood Strategy

In the B.C. Flood Strategy, public access to floodplain maps and related datasets is highlighted under Action 1.1: *Develop a provincially coordinated floodplain mapping program*. We recommend prioritizing two of the goals of this strategy to improve the accessibility and usability of flood risk information:

- Investigate a long-term, stable approach to annually updating a subset of floodplain maps in areas with rapidly shifting flood hazards; and
- Facilitating cross-ministry coordination of floodplain mapping and promoting its use in infrastructure planning by provincial ministries and critical infrastructure providers.

The provincial government has also identified their intention to implement mandatory flood risk disclosures under Action 2.6 of the B.C. Flood Strategy. The provincial government should leverage the Action's proposed collaboration with the British Columbia Real Estate Association and Land Title and Survey Authority of British Columbia to prioritize this implementation while reducing the provincial administrative burden of development.

4.1.3: Conduct Comprehensive and Wholistic Flood Risk Assessments

Priority	Low
Issue	Floodplain maps do not include vulnerability
Approach	Coordinate risk assessments that: • Engage stakeholders to identify & address local values • Include a wide range of data sources, including Traditional Knowledge • Include measures of exposure and vulnerability in risk assessments
Benefits	• Delegation to regional or watershed-level bodies can reduce the burden on both provincial & local governments • Risk assessments provide local governments with informative tools that tie flood hazards to potential consequences
Relation to BCFS	Bill 31: Emergency and Disaster Management Act (2023) Action 1.2: <i>Conduct a province-wide flood risk assessment</i> • Rec: Carefully consider how to store and use Indigenous knowledge • Rec: Include assessments of risk to First Nations assets

Priority: Low

Province-wide flood risk assessments are already underway in accordance with Section 51 of Bill 23: Emergency and Disaster Management Act. The Ministry of Emergency Management and Climate Readiness is currently conducting the Provincial Climate Risk Assessment, and provincial and regional flood and climate risk assessments will follow. The data will be made publicly available within the coming years.

This recommendation complements the work that the provincial government is already conducting. It will be important to include measures of vulnerability in order to fully quantify risk and inform an appropriate allocation of resources.

Issue

Hazard-based flood resources such as floodplain maps can identify where and how frequently floods may occur but fail to consider exposure and vulnerability of assets.

Approach

Flood risk assessment projects need to engage all stakeholders in the study design and decision-making stages, including First Nations and other local governments. This engagement ensures that the flood risk assessments address community values, needs, and concerns, and can encourage community buy-in. Flood Risk Mapping for the Okanagan Watershed (NHC, 2023), for example, includes engagement with First Nations and consequently includes First Nations assets in the risk assessment.

Flood risk assessments should consider a wide range of data sources to provide a comprehensive evaluation. Assessments are often limited to Western scientific approaches, under-representing the knowledge, assets, and values from First Nations experiences and perspectives. Flood risk assessments should use wholistic approaches and should include Indigenous knowledge and values. Collaboration and engagement with Indigenous partners is critical in gaining a more comprehensive understanding of flood dynamics, vulnerabilities, and resilience within a given region.

Benefits

Comprehensive risk assessments such as the Flood Risk Mapping for the Okanagan Watershed project (NHC, 2023) provide local governments with informative tools that more directly tie flood hazards to potential consequences. Provincial coordination or delegation to regional or watershed-level bodies such as the Okanagan Basin Water Board can reduce the burden on provincial and local governments.

Connection to the B.C. Flood Strategy

This recommendation is in alignment with the BCFS's Action 1.2: *Conduct a province-wide flood risk assessment*, and Section 51 of Bill 31: Emergency and Disaster Management Act (EMDA) (2023). We highlight two considerations posed in the What We Heard Report (2022):

- **Assess risk to First Nations assets identified in engagements.** These values may extend beyond the “persons, property, or objects or sites of heritage value” as prescribed in EMDA. For example, the What We Heard report identifies that floods may impact access to traditional foods and medicines (Alderhill, 2023).
- **Carefully plan how to use and store Indigenous knowledge.** Trust is frequently a major issue for First Nations when sharing information with local, provincial, or federal governments (Alderhill, 2023).

4.2 : Address Multi-Level Governance of Flood Hazards

The current distribution of powers, responsibilities, and incentives hinders efficient flood risk management. Local governments are expected to reduce the exposure to flooding hazards and address housing shortages simultaneously, without being bound by provincial legislation on flood risk management standards for new developments.

The nature of damage compensation programs creates a moral hazard—a situation where one party is incentivized to take risks because they do not bear the full consequences—for local governments. If flood damages cross a certain threshold, federal and provincial funds will cover most of the costs. This means that local governments lack incentives to identify floodplains and reduce flood risk. Flood risk management measures are often costly, can reduce income from property taxes such as in the case of land acquisition initiatives, and can reduce the likelihood of financial disaster assistance.

As a result, the legislation and use of flood protection policies vary substantially between local governments, with spotty and varied use of flood protection standards in bylaws in some areas as demonstrated in the case study. This increases exposure and vulnerability to flooding for these communities and leads to continuous encroachment of developments into floodplains.

In this section, we focus on potential approaches to streamlining the roles and responsibilities of different levels of government for flood risk management. Our recommendations focus on provincial measures to eliminate counter-effective measures and promote compliance with existing flood protection policies and guidance.

4.2.1 : Investigate Drivers of Compliance with FHALUMG and Incentivize Development of Flood Bylaws

Priority	High
Issue	Many local governments do not have flood strategies in place; local flood strategies do not always comply with FHALUMG
Approach	• Explore the reasons local governments do or do not develop flood risk management strategies • Investigate impacts of requiring flood bylaws as a condition for disaster financial assistance
Benefits	Creation at a local level still allows local governments to tailor strategies to the characteristics of their communities
BCFS	Mandatory compliance with FHALUMG is not included in the BCFS.

Priority: High

Understanding drivers of flood risk management strategy development and compliance with the FHALUMG is critical in improving flood risk reduction at a local level.

Issue

The use of flood bylaws and their compliance with FHALUMG varies across local governments. It may be that local governments:

- Lack the capacity or funding to develop flood strategies;
- Face pressure from developers and fear legal action;
- Do not have up-to-date flood maps and thus do not know their hazard;
- Face many competing priorities and pressures;
- Are not aware of the potential impacts of flooding in their community; or
- Are facing other pressures or drivers not listed here.

In our case study, we find that the drivers behind flood risk management strategy development are not always clear from a policy analysis alone. For example, the reason that Penticton removed previously established setback requirements is unclear.

Approach

The provincial government should conduct an engagement-based investigation into the drivers behind compliance and noncompliance with the FHALUMG, along with the drivers and barriers of local flood risk management strategy development.

The provincial government should also investigate potential incentives for developing flood strategies. These could include:

- **Conditioning disaster financial aid on the development of flood strategies.** The FDRP (terminated in the 1990s) included similar provisions. Changing the requirements around disaster financial assistance can be an effective strategy for incentivizing action. For example, homeowners are more likely to buy flood insurance if no disaster financial assistance is available otherwise (PSC & ICLR, 2024).
- **Developing funding programs for the development of flood strategies.** This could also include expanding existing funding programs to encompass flood risk management strategy development. This may be a good approach for communities who struggle with limited resources.
- **Create legally-binding flood protection standards for local governments.** This may be an effective strategy to encourage the development of flood bylaws, especially if the reason many communities do not have flood strategies in place is that they are unaware that they need one.
- **Employing community flood risk ratings.** This involves developing a voluntary community rating system that recognizes and encourages floodplain management practices that exceed the minimum requirements of the FHALUMG. Ratings could be attached to applications for infrastructure funding, reduced insurance premiums, or even eligibility for disaster assistance. A similar system exists in the United States and should be investigated further for effectiveness and broader implications, such as impact on property values or use of these ratings by the insurance industry.

These incentives should only serve as a starting point for further research. Investigations should include how to balance compliance and incentives with local accountability and autonomy.

Benefits

Understanding the drivers behind compliance/noncompliance with the FHALUMG along with the development or lack thereof of flood strategies is essential in addressing how more

communities can be encouraged to develop such strategies. This investigation can also reveal potential barriers, inequities, or shortfalls of the FHALUMG that prevent compliance.

Connection to B.C. Flood Strategy

The B.C. Flood Strategy does not currently include actions that align with this recommendation.

4.2.2 : Limit Development In Floodplains

Priority	High
Issue	Continued development in floodplains increases exposure to flooding
Approach	Limit floodplain development, potentially through: • Enforce standards for floodplain development permit areas (DPAs) or setbacks • Explore options to improve compliance with the LGA's prohibition of landfills in floodplain setbacks • Research potential impacts of prohibiting development in floodplains
Benefits	Reducing exposure is the most direct way to reduce flood risk
BCFS	Action 2.6: <i>Update provincial legislation, regulations, and policies</i> Action 2.7: <i>Update provincial technical guidance</i>

Priority: High

Reducing exposure is the most effective way to reduce flood damage. Further development in high-risk areas, especially prior to the implementation of appropriate adaptive strategies that reduce vulnerability, dramatically increases both the exposure and vulnerability to flood risk.

Issue

Continued development in floodplains increases a community's exposure to flooding as seen in our case study. Setbacks from watercourses are not consistently used in OCPs and bylaws, and not all flood or zoning bylaws prohibit development in floodplain setbacks.

Approach

The provincial government should investigate strategies to limit development in floodplains as much as possible. Limiting development on floodplains should focus on vulnerable development specifically, such as housing. Low-vulnerability developments such as campgrounds and parks may still be suitable for floodplains. Limiting high-vulnerability development in floodplains may be facilitated by:

- **Requiring setbacks from watercourses:** The simplest way to reduce exposure is by establishing and enforcing provincial standards for setbacks from watercourses. Setback standards could be subject to small adjustments (down to a specified minimum setback from watercourses) after review by a certified professional to allow for location-specific corrections. Setbacks do not require extensive floodplain mapping and can help protect against flooding and damage from waves.
- **Exploring options to improve compliance with the prohibition of landfills in floodplain setbacks:** To mitigate flood risks associated with landfills, the provincial government could evaluate compliance with existing regulations and develop strategies to enhance adherence. This would involve updating floodplain maps for current and proposed landfill sites, exploring compliance incentives, and addressing economic pressures. This would help preserve floodplain areas' natural flood mitigation capabilities and minimize contamination risks during flood events.
- **Researching potential impacts of prohibiting development in floodplains:** Prohibiting development in floodplains altogether is neither realistic nor equitable. Restricting development in floodplains could impact housing affordability or push development into areas subject to other natural hazards such as wildfire. Further research is needed on the potential impacts of prohibiting development in floodplains on different types of communities across B.C., and the types of competing priorities that communities may have to navigate. This research should include stakeholder engagement, community engagement, and cost-benefit analyses..

Benefits

We find in our case study that exposure—or the amount of new development that occurs in the floodplains—has a considerably higher impact on flood risk than updating FCL policies. Reducing exposure is one of the most effective ways to reduce flood risk.

Connection to B.C. Flood Strategy

In the B.C. Flood Strategy, Action 2.7 emphasizes the need to improve guidance, policies, and support for local authorities, and includes local governments updating OCPs and approving new developments in flood risk areas.

Action 2.6 also identifies the goal of updating provincial legislation, regulations, and policies. We further highlight the need to focus on strategies that reduce exposure by limiting development in floodplains.

4.2.3 : Focus Provincial Supports on Proactive Programs

Priority	High
Issue	The NFIP should not be used as a first line of defense; support for proactive flood risk reduction is still needed
Approach	• Investigate and quantify the impact of existing funding programs • Support proactive flood risk reduction programs • Explore funding for a flood retrofit program
Benefits	• Prevention improves community resiliency & reduces risk
BCFS	Action 4.1: <i>Develop predictable funding programs</i>

Priority: High

Prioritizing proactive programs is essential for mitigating significant flood risks and improving overall resilience. Investing in proactive measures directly addresses urgent needs and fulfills critical strategy goals, making it a high-priority recommendation.

Issue

Compared to reactive flood recovery tools such as flood insurance and disaster financial assistance, proactive programs are often underutilized because they are less urgent and typically require capacity and resources that may not be readily available. Underutilization of proactive programs results in a loss of capital post-disaster, increased strain on emergency services in times of need, and increased risks to human health.

Insurance and disaster assistance programs play a crucial role in flood recovery, but they should not be viewed as the primary defense against flood risk. The development of the NFIP is a significant advancement in enhancing community capacities for post-flood recovery. Nevertheless, it is essential to maintain strong provincial support for proactive flood risk reduction measures.

Approach

The province should continue to prioritize investments in proactive flood risk reduction programs. We identify three ways the provincial government can maintain this priority:

- **Investigating the impact of existing funding programs** such as the Adaptation, Resilience, and Disaster Mitigation program to identify what features of these programs result in the biggest uptake and largest impacts on reducing flood risk. These investigations could include cost-benefit analyses, case studies, and socioeconomic analyses on programs to quantify impacts and identify potential disparities that need to be addressed.
- **Supporting proactive flood risk reduction programs** such as property buyouts, relocation assistance, and designing plans for community-led managed retreat. As noted in Section 2.2.1, the provincial and federal governments both currently offer such programs. The provincial government should continue investment in successful programs, focusing on long-term, sufficient, and stable funding opportunities.
- **Exploring funding for a flood retrofit program** in collaboration with First Nations and local governments. The programs outlined under Section 2.2.1 do not yet target building retrofit. This program could support individuals and small businesses with property-level flood audits and provide cost incentives for retrofits such as sump pumps, electrical system modifications, and backflow valves, all of which can help reduce flood damage. Program design may also consider targeted adaptations and solutions for agricultural producers, since they are frequently located in floodplains. As identified in Recommendation 4.2.5, including incentives connected to the NFIP for participants of this program may further incentivize participation.

Benefits

Prevention helps communities become stronger and protects vulnerable people and assets in flood-prone areas. Being proactive by reducing flood exposure or vulnerability can shield these populations and reduce the demand for disaster assistance and insurance programs.

Proactive programs are crucial for reducing both the need for and costs of reactive measures. Proactive programs additionally mitigate hazards to human health and alleviate the strain on emergency services, ultimately enhancing community resilience and protecting vulnerable populations and assets in flood-prone areas.

Connection to B.C. Flood Strategy

In the B.C. Flood Strategy, this recommendation is highlighted under Pathway 4: Investing for Flood Resilience, and most closely aligns with Action 4.1: Develop predictable funding programs.

4.2.4 : Include Mandatory Flood Protections in the B.C. Building Code

Priority	Moderate
Issue	The Building Act General Regulation lists flood-related building guidelines as temporarily unrestricted
Approach	• Include flood requirements for B.C and National Building Codes, which could include: ○ Recommending against crawlspaces in high-hazard areas ○ Locating mechanical and electrical equipment above the FCL ○ Use wet and dry floodproofing for new builds in floodplains • Advocate on the CBHCC to align federal and provincial efforts
Benefits	Building codes for flood protection results in a \$6 benefit for every \$1 saved
BCFS	Action 2.7: <i>Update provincial technical guidance</i>

Priority: Moderate

The CBHCC has already identified flood-resistant design as a priority for the 2025 National Building Code updates. The BCBC is expected to align with the National Building Codes (Reconciliation Agreement on Construction Codes, 2019). The provincial government takes a primarily advisory and advocacy-based role in national building code reform. While this work will have a significant impact on reducing the vulnerability of buildings in and near flood-prone areas, the priority is listed as “moderate” to highlight the provincial government’s supporting role in advancing work already underway.

Issue

The Building Act General Regulation currently lists flood-related building requirements as a temporarily unrestricted matter. This has led to inconsistent application of flood-resistant building standards, as seen in our case study. The standards in the 2021 IRC surpass those currently being used by local governments in B.C. As a result, B.C. buildings constructed in floodplains may have a higher vulnerability to floods.

Approach

Focus should be placed on including flood-related requirements in the B.C. or National Building Codes. Through our case study, we identify the following technical building requirements. This is not an exhaustive list and a thorough review of BC's building codes is still needed:

- **Recommend against crawlspaces in high-hazard areas:** Section R322 of the 2021 IRC advises against the use of crawlspaces in high-hazard areas due to their susceptibility to more extreme damages in a flood, but includes design standards for crawlspaces in floodplains, if necessary to construct.
- **Locate mechanical and electrical equipment above the FCL:** Section R322.1.6 of the IRC advises that electrical systems and other equipment such as heating and air conditioning units should be located at or above flood construction levels. This can greatly reduce disturbances and the costs of repair in the event of a flood. This recommendation is highlighted in the Existing Buildings Renewal Strategy: Engagement Summary (Building Standards and Safety Branch, 2023).³
- **Build homes in floodplains with wet and dry floodproofing:** The Realizing Resilient Buildings (R2B) project identifies this recommendation. Building homes at risk of flooding with floodproofing measures such as waterproof drywall, mould-resistant flooring, and sealed exteriors can reduce the vulnerability of new builds.

One avenue for pursuing these updates is through advocating on the Canadian Board for Harmonized Construction Codes (CBHCC), who are coordinating the updates to the National Building Code. B.C. is included as a co-chair on the CBHCC, and advocating on this platform can help align federal and provincial efforts toward a common priority.

Incorporating these changes in the BCBC will require further collaboration between the B.C. and federal governments to achieve better consistency for flood construction requirements while still prioritizing flexibility for local governments. This may involve creating uniform minimum standards for regional districts or for jurisdictions within a common watershed.

³ B.C. currently uses the Canadian Electrical Code as the B.C. Electrical Code (Electrical Safety Regulation, 2022), which requires service boxes or other consumer's service equipment to be placed above the flood elevation (rule 6-206, CSA C22.1:21). The terminology of "flood elevation" may not be sufficiently reflective of flood construction levels, which generally include freeboard in addition to the flood elevation level.

Benefits

The National Institute of Building Sciences (NIBS) estimates that adopting building codes for riverine flood protection results in a \$6 benefit for every \$1 invested (NIBS & Multihazard Mitigation Control, 2019).

It should be noted that the Building and Safety Standards Branch—the branch of the provincial government responsible for the BCBC—is of the opinion that development permit areas and floodplain bylaws are more effective for flood risk reduction, and that their role may instead be to develop technical building requirements that can be used by local governments in support of this direction. This direction is supported in our case study, where we find that the most effective way to reduce risk is through limiting exposure.

Connection to B.C. Flood Strategy

In the B.C. Flood Strategy, exploring the formal adoption of nationally recognized standards and design guidelines for addressing flooding is highlighted under Action 2.7: *Update provincial technical guidance*.

4.2.5 : Advocate for Incentivizing Property-Level Flood Protection in the National Flood Insurance Program

Priority Low

Issue NFIP provides an opportunity for incentivizing risk reduction, which can help avoid the moral hazard faced by DFA

Approach

- Advocate for the NFIP to include incentives for property-level flood protection measures
- Coordinate provincial grants to support the installation of property-level flood protection measures
- Research the costs, benefits, and impacts of:
 - Different types of property-level flood protection measures
 - Different mechanisms for incentivizing or requiring property-level flood protection measures

Benefits

- Aligns proactive measures with property-level flood protection behaviours
- Coordinating provincial grants with federal NFIP supports equitable impact on property owners

BCFS Action 2.6: *Update provincial legislation, regulations, and policies*

Priority: Low

Advocating for property-level flood protection incentives in the NFIP is important for encouraging proactive flood risk management behaviours. This recommendation complements high-priority initiatives by promoting resilience at the property level and aligning with broader flood risk management strategies.

Issue

The NFIP should be developed with incentives and deterrents that promote flood risk management behaviour at a property and local government level so that this Program does not face a similar moral hazard to current disaster financial assistance (DFA) programs.

Under DFA programs, if flood damages cross a certain threshold, federal and provincial funds cover a majority of costs. Flood risk management measures are often costly and,

under the old DFA programs, could reduce the likelihood of financial disaster assistance in the event of a flood. As a result, property owners and local governments alike may lack tangible, near-term, or realized incentives to reduce flood risk.

Approach

The provincial government should advocate for the integration of incentives for property owners to reduce flood risk into the NFIP. Incentive programs should offer immediate or direct benefits to homeowners and/or local governments, rather than relying solely on the benefits of flood risk reduction.

The NFIP should incentivize basic floodproofing upgrades. The provincial government has the opportunity to support this through offering grants to property owners. As recommended by the Government of Canada (2022), property-level floodproofing improvements may include but are not limited to:

- Installing sump pumps or backwater valves;
- Installing flood shields or barriers for basement windows and doors; or
- Relocating fixed mechanical or electrical equipment above flood construction levels.

Compared to the previous DFA system, the NFIP provides a unique opportunity to influence property owner behaviour through incentives and requirements, such as:

- Offering lower premiums or higher coverage for properties with floodproofing measures;
- Offering higher coverage for properties with floodproofing features;
- Conditioning coverage on basic floodproofing efforts such as sump pumps; or
- Adding requirements or opportunities to rebuilding after a flood, such as:
 - rebuilding outside flood-prone areas, thereby reducing future flood risk;
 - allowing funds to be used on flood risk management measures during rebuilding; or
 - requiring flood proofing in rebuilt homes for future NFIP eligibility.

The provincial government should research the feasibility, effectiveness, and impacts of these measures before advocating for them to be conditions for NFIP. This research should evaluate:

- The economic costs and benefits of these measures, including potential savings from reduced damage as well as impacts on insurance policies and premiums.

- The impacts on local communities in terms of financial burdens, feasibility, long-term resilience, and acceptance.
- The implications on equity, especially for low-income and marginalized communities, as well as public perception and acceptance.

Benefits

Aligning the NFIP with proactive flood risk reduction measures can significantly enhance property-level flood protection behaviours. By incentivizing property owners to undertake basic floodproofing upgrades, such as installing sump pumps, backwater valves, and flood shields, the overall vulnerability of properties to flood damage can be reduced.

Coordinating provincial grants with the federal NFIP ensures that property owners receive both financial support and incentives, leading to a more positive and equitable impact on homeowners. This approach promotes long-term resilience and acceptance among communities.

Connection to B.C. Flood Strategy

This recommendation is echoed in the Existing Buildings Renewal Strategy: Engagement Summary. The Summary recommends creating a standard to ensure buildings undergoing flood repairs from flood damage are rebuilt with a minimum level of flood resilience.

4.3 : Incentivize Best Flood Risk Management

Practices

Incentivizing best flood risk management practices is essential for enhancing community resilience and reducing flood-related risks in British Columbia.

Updates that integrate the latest scientific knowledge, engineering practices, and climate change considerations, and provide clear direction for land-use managers and approving officers will enhance flood resilience in British Columbia. It will also reduce administrative burdens and ensure sustainable development in flood-prone areas. The provincial government may encourage the local implementation of best practices either through incentives or through updated requirements.

Action 2.7 of the B.C. Flood Strategy identifies several professional practice technical guidelines that need renewal. These include covering the design, construction, and management of flood infrastructure, encompassing dikes, erosion protection works, nature-based solutions, and other flood mitigation measures. The updates will integrate current scientific knowledge, best engineering practices, and considerations related to climate change.

4.3.1 : Review and Update the FHALUMG

Priority	Moderate
Issue	FHALUMG is outdated and does not reflect best practices
Approach	Update the FHALUMG, including the following: • Discuss implications of climate change • Update and actively maintain all included resources • Include guidance for local governments on how to understand flood risk and flood risk data • Include guidance for public communication of flood risk • Recommend that local governments: ◦ Regularly review and update their flood risk management strategy ◦ Use language that refers to current regional flood maps
Benefits	Reduces flood vulnerability by equipping local governments with best tools
BCFS	Action 2.7: <i>Update provincial technical guidance</i> • Rec: Consider climate change; e.g., recommend bylaws refer to most recent floodplain maps Action 3.4: <i>Enhance pre- and post-disaster flood recovery planning</i>

Priority: Moderate

The FHALUMG is a valuable resource for local governments. However, because local governments are not required to comply with the FHALUMG, our case study revealed inconsistent application of the FHALUMG in its current state across local governments. Because of this, Recommendation 4.2.1 should be pursued in conjunction with this recommendation.

Issue

The Flood Hazard Area Land Use Management Guidelines (FHALUMG) has not been reviewed in some time. As found in the policy analysis and in our case study, the FHALUMG does not reflect international best standards, and this results in increased flood risk.

Approach

The FHALUMG must be reviewed and updated to include more stringent requirements for flood-resistant construction within the BCBC. Guidelines in the FHALUMG should be crafted such that local governments are set up to leverage flood data and minimize administrative burden.

We identify the following opportunities for updates, although a comprehensive review of the FHALUMG should take place as well:

- **Recommend referencing flood maps in flood bylaws:** Action 1.1's priority to regularly update floodplain maps in areas with shifting flood hazards means that best-practices FCLs will likely shift regularly. The province should consider recommending in the FHALUMG that local governments reference the most current regional flood maps for FCL requirements, rather than using fixed FCL values in their bylaws. This adjustment would reduce the administrative burden associated with updating flood bylaws when new floodplain maps are released.
- **Discuss risks of including exceptions to the FCL:** Many current FCL bylaws indicate the "underside of habitable area" must be built according to the FCL. This wording allows garages and crawlspaces to be constructed under the FCL and including living quarters above. However, prolonged inundation of these non-habitable areas can compromise the entire structure. The FHALUMG should either recommend that bylaws should state that property grades should be brought up to the FCL, or should include a discussion of this risk, if not.
- **Discuss implications of climate change on FHALUMG and its resources:** Current references to climate change in the FHALUMG are limited to the amendments to Section 3.5 and 3.6 which address coastal flooding. Climate change also impacts the reliability of outdated resources such as old flood maps, and the FHALUMG should include this caveat.
- **Recommend regular review of flood risk strategies:** Local governments should review and update their flood risk strategies regularly. This update could be conducted in conjunction with quinquennial OCP updates as required by Bill 44.
- **Actively maintain all included resources:** The FHALUMG refers to certain websites or resources, such as a government of B.C. webpage for flood maps, that are no longer active. All resources included in the FHALUMG should be checked, maintained and regularly updated.

- **Include guidance for how to understand flood risk:** Flood risk and flood risk data such as flood maps can be complex to understand, especially for local governments with limited capacity where staff play many roles. Including information to inform local governments on what flood risk is, how to interpret flood risk data, and how to understand local flood risk is important in equipping local government officials to make informed decisions for their communities. This step should also include definitions of standard flood frequencies (e.g., defining 100-year, 200-year, and 500-year flood events as standards for newly-developed flood maps) and provide guidance on methods and calculations for analysis purposes (identifying statistical packages and methodological approaches).
- **Include guidance for public communication of risk:** Public communication of flood risk is essential to facilitate community buy-in for flood risk management strategies and to engage community members in property-level floodproofing. Guidance for public communication may include plain-language summaries and supporting materials to improve understanding for homeowners. Providing resources in the FHALUMG for how to distribute this type of information reduces the burden on local governments when developing knowledge dissemination strategies.

Benefits

Updating the FHALUMG can reduce flood vulnerability by equipping local governments with the knowledge and guidance to develop effective flood strategies.

Updating the FHALUMG is not projected to add substantial cost to building construction; the National Institute of Building Sciences projects that increasing foundation construction levels in buildings by one foot increases the overall cost of construction by only 1.7%. Construction above recommended FCLs can also result in lowered insurance premiums and, naturally, significantly lower damage costs in the event of a flood.

Connection to B.C. Flood Strategy

Action 2.7 of the B.C. Flood Strategy identifies technical guidelines for review, and we specifically highlight the importance of updating FHALUMG. We further highlight the importance of connecting this update to the goal of incorporating climate change considerations into codes and standards outlined in Action 3.4: *Enhance pre- and post-disaster flood recovery planning*. The example of referencing the most recent floodplain maps into flood bylaws instead of including fixed FCLs is one way in which this can be done.

4.3.2 : Develop Provincial Guidelines for Building Retrofit Programs

Priority	Moderate
Issue	No national recommendations for mitigating flood risk in existing buildings have been developed in Canada.
Approach	• Develop recommendations and funding programs in partnership with the federal government for building retrofits • Establish provincial funding programs to support building retrofit initiatives
Benefits	Building retrofits increase flood resiliency for existing buildings & infrastructure
BCFS	Action 2.7: <i>Update provincial technical guidance</i> • Rec: Develop guidance for building retrofit Action 4.3: <i>Enhance flood accommodation investments</i>

Priority: Moderate

Priorities should focus on reducing additional exposure through new developments in floodplains. However, this recommendation helps reduce existing vulnerability.

Issue

The National Research Council of Canada identified that Canada does not have any national recommendations for mitigating flood risk in existing buildings (Behm et al., 2021). Neither the BCBC nor the FHALUMG include guidance nor requirements on floodproofing for existing buildings.

Approach

The provincial government should collaborate with the federal government to develop national guidelines for flood-resilience retrofitting. The provincial government should also investigate establishing funds to support building retrofits for flood resilience.

Benefits

Retrofit programs or requirements address the existing buildings to which updated building codes may not apply. NIBS estimates that building retrofit programs for flood resiliency saves \$6 for every \$1 invested (NIBS & Multi Hazard Mitigation Control, 2019).

Connection to B.C. Flood Strategy

This recommendation is in alignment with Action 4.3: *Enhance flood accommodation investments*. The provincial government plans to explore expanding funding to support flood accommodation measures, particularly in communities where relocation is not an option. The BCFS states that this could include flood retrofit funding programs.

This recommendation is also echoed in the *Existing Buildings Renewal Strategy: Engagement Summary*.

The BCFS does not include developing or updating technical guidance for building retrofit programs. We recommend that this development be included under Action 2.7: *Update provincial technical guidance*.

4.3.3 : Explore and Support Non-Structural Flood Mitigation Measures

Priority	Moderate
Issue	Current guidelines focus on structural (e.g., protocols, engineering standards)
Approach	• Coordinate evaluations of non-structural measures • Develop provincial guidelines for non-structural flood mitigation measures • Leverage existing funding programs and include them in flood resources for local governments
Benefits	Non-structural measures reduce overall flood danger
BCFS	Action 4.4: <i>Enhance flood protection investments</i> Action 2.1: <i>Set a new direction for BC's flood governance model</i> Action 2.7: <i>Update provincial technical guidance</i> • Rec: Conduct further research into best practices for non-structural

Priority: Moderate

Exploring and supporting non-structural flood mitigation measures addresses less immediate concerns but complements other high-priority initiatives by providing sustainable and long-term solutions for flood risk reduction. While these measures are valuable for improving resilience and reducing overall flood risks, they serve more as enhancements to existing structural measures rather than fundamental needs. Therefore, this recommendation is assigned a moderate priority.

Issue

The current provincial guidelines focus largely on structural solutions, including protocols and engineering standards. Structural flood measures often postpone or shift flood risks elsewhere without lowering the overall flood danger.

Approach

The provincial government should conduct province-wide or regionally-specific investigations and evaluations of non-structural flood mitigation measures—especially nature-based solutions—to provide local governments with information on effective strategies for flood mitigation.

The provincial government should summarise the findings of these investigations in province-wide or regionally-specific guideline documents, resource guides, or in a section of the FHALUMG.

Considerations should include the potential of agricultural land to contribute to flood mitigation and the development of funds and additional incentives to harness such potential. This could be implemented following the example of Highways England Natural Flood Management Fund (2021).

Targeted guidance can be a valuable tool for local governments across B.C. when designing their own flood strategies. One valuable point of comparison is the RDCO's regional resource guide for non-structural flood mitigation for use by local and First Nation governments in informed decision-making and flood risk management planning (RDCO, 2021). This guide includes many non-structural mitigation options, including for each option:

- The flood depths and flood types that the option protects against
- The effectiveness of the option for risk reduction and resilience during a flood event
- The effects of the option on its surroundings
- The costs of implementation and maintenance

Guidance should also include options on how local governments can financially support these programs. This may be done through provincial or federal funding, or through levies. Alternatively, a levy on property taxes can be imposed across the community to fund non-structural measures, distributing the cost among all property owners. Property-level adjustments could be made for properties with implemented flood mitigation measures.

Provincial funding should also be made available to assist local governments and organizations in establishing non-structural flood mitigation initiatives. This may involve developing new funding programs or leveraging existing funding programs:

- **Expand project eligibility for existing projects:** Many of the funding programs outlined in Section 2.2.1 could be expanded to include supporting non-structural program development.

- **Expand non-flood-related ecosystem restoration initiatives:** The provincial government has several funding initiatives targeted at ecosystem preservation and restoration, but which are not directly tied to flood mitigation. For example, the provincial government invested \$100 million in 2023 in the Watershed Security Fund, a fund used to preserve watershed resilience. Listing these types of resources in flood guideline documents such as the FHALUMG helps local governments identify and access alternative provincial supports.
- **Establish Alternative Land Use Services funding:** local or provincial governments can provide funding for organizations that coordinate ecosystem services projects on privately owned land. Alternative Land Use Services (ALUS) is an organization that runs in other provinces in Canada that links community ecosystem goals with agricultural landowners to fund projects. This strategy can reduce the burden of implementation on local governments while engaging and empowering community members to take an active role in flood risk reduction.

Benefits

Non-structural flood mitigation such as protection of natural river courses and riparian ecosystems reduces projected losses, providing potential for ecological and recreational values. Protection also benefits developments downstream of riparian areas.

Connection to B.C. Flood Strategy

This recommendation is reflected in the B.C. Flood Strategy Action 2.7: *Update provincial technical guidance*. The BCFS highlights that this includes non-structural approaches.

This recommendation is also briefly noted in Action 2.1: *Set a new direction for BC's flood governance model*. This action includes promoting an Integrated Flood Management approach that supports communities to adopt a combination of structural and non-structural approaches. Our recommendation complements this Action by focusing on resources that the province should develop, along with ways to increase the availability and interconnectedness of flood risk management strategy funding programs for local governments.

The BCFS also includes Action 4.4: *Enhance flood protection investments*, which acknowledges the importance of nature-based solutions as a flood protection investment. We highlight the feedback found in the What We Heard Report, which highlights that nature-based solutions not only improve flood resilience but provide ecosystem services such as improved water quality, and also bring back medicinal plants and traditional foods (Alderhill, 2023).

4.3.5 : Explore and Support Requests for Community-Led Managed Retreat from Hazard-Prone Areas

Priority	High
Issue	• Limited provincial guidance exists on managed retreat • Upfront costs of land acquisition are expensive
Approach	Support land acquisition programs, possibly by developing: • Funding pools for land acquisitions • Guidelines for municipalities to design plans for managed retreat • Province-wide buyout program in collaboration with municipalities
Benefits	Buyout programs directly reduce flood exposure
BCFS	Action 4.5: <i>Enhance community-led managed retreat investments</i>

Priority: High

Exploring and supporting requests for community-led retreat is a high priority because it addresses long-term flood risk reduction through strategic relocation. Reducing exposure is the most effective way to reduce flood risk.

Issue

Land acquisition programs can be an effective tool for local governments to reduce flood risk. However, land acquisition programs can be expensive to implement, and generally depend on provincial or federal funding. In B.C., there is limited provincial guidance on how to develop plans for community-managed retreat.

Approach

Community-led managed retreat involves moving people, buildings, and infrastructure from hazard-prone areas to reduce future risks. The provincial government should support community-led managed retreat, possibly by developing:

- Funding pools for land acquisitions;
- Guidelines for municipalities to design plans for managed retreat; or
- Province-wide buyout program in collaboration with municipalities.

Thistlethwaite et al. (2023) outline leading practices for buyout programs. These practices should be evaluated fully for integration into any provincial guidance that is developed. We highlight the following best practices:

- Focus on equity, ensuring that no participant is made worse off. Successful relocation policies include compensation caps that reflect regional pre-flood market values of homes.
- Align with existing disaster assistance policy.
- Remove eligibility for future disaster assistance for individuals in high-risk areas who refuse to accept reasonable buyout offers.
- Do not allow future development aside from low-risk developments such as green spaces in areas where buyouts have taken place.
- Ensure lands obtained under buyout programs are protected from future development with enduring covenants on title that can only be discharged by the province.

Benefits

Land acquisition programs are an effective method for risk reduction because they directly reduce flood exposure and total costs. These programs are especially effective when the capitalized EAD of a property exceeds the market value.

Connection to B.C. Flood Strategy

The B.C. Flood Strategy identifies opportunities for supporting buyout programs under Action 4.5. However, goals under this Action in the B.C. Flood Strategy are limited. We propose that provincial supports of buyout programs could include:

- Collaborating with the federal government to establish a funding pool to support local governments' land acquisition initiatives
- Developing guidelines for local governments to design plans for managed retreat **or**
- Developing and running a province-wide buyout program in collaboration with local governments

The B.C. government will update financial assistance regulations as part of modernizing B.C.'s emergency management legislation. Feedback received during a recent engagement on these regulations is being analyzed and will be considered as options are developed (From Flood Risk to Resilience: a B.C. Flood Strategy to 2035: Strategy, Action 4.5).

4.4 : Provide Resources to Local Governments and Communities

Any potential reforms to provincial land use policies and regulations, whether mandatory or discretionary for adoption by local governments, will impose an additional administrative load on governments. Providing resources to local governments—especially resources that extend beyond application-based funding, such as additional staffing support—can help alleviate this burden and ensure a more equitable and effective implementation of any provincial policy changes at the local level.

4.4.1 : Provide Additional Capacity for Smaller Communities

Priority	High
Issue	Smaller communities don't have the capacity to apply for application-based funding opportunities
Approach	Enhance community capacity through: • Pooling resources into regional or watershed-level hubs • Shared staffing across communities
Benefits	• Equitable & integrated approach to flood risk management
BCFS	Action 2.1: <i>Set a new direction for B.C.'s flood governance model</i> Action 2.4: <i>Promote integrated flood management planning</i> Action 4.1: <i>Develop predictable funding programs</i> • Rec: needs to be developed in conjunction with 2.1 & 2.4

Priority: High

Providing additional capacity for smaller communities is a high-priority recommendation as it addresses a critical gap in flood risk management. Smaller communities are disproportionately vulnerable to flood risks and face significant challenges in accessing and utilizing available funds and developing effective flood strategies. Enhancing their capacity directly impacts their ability to mitigate and manage flood risks, thereby improving overall resilience and ensuring more equitable support across all communities.

Issue

While Section 2.2.1 outlines the resilience funds available to local governments, smaller communities often do not have the capacity to apply for these funds, let alone develop comprehensive flood strategies.

We find in our case study that smaller communities are also often more exposed and vulnerable to flood risk. When controlling for population size, smaller communities frequently have comparable or higher per-capita damage costs and proportion of the affected population compared to the larger cities included in our case study. For example, the town of Osoyoos has the highest per-capita damage costs for a 200-year flood event at \$16,255, compared to Kelowna's much lower per-capita damage cost of \$1,509. Combined with the limited capacity to develop flood strategies or apply for funding to support these strategies, smaller communities will continue to be more adversely impacted by flood risk until this limited capacity is addressed.

Approach

Provincial support for flood risk management and planning needs to extend beyond application-based funding opportunities.

The provincial government should consider enhancing community capacity, potentially through shared staffing across multiple communities. This includes assisting smaller communities and First Nation reserves in accessing research and resilience funds and implementing effective flood risk management strategies.

Capacity could come in the form of pooling resources into regional bodies, such as in the case of the Okanagan Basin Water Board. Staff specializing in assessing funding needs and identifying grant opportunities could enhance funding access for several communities simultaneously. Re-allocation of existing resources and any additional capacity provided could then be used to support initiatives across the region in an integrated and cost-effective manner. Participants of the What We Heard report highlight this value of integrated flood management planning through regional or watershed bodies for leveraging resources (Alderhill, 2023).

Benefits

We find in our case study that regional watershed hubs such as the Okanagan Basin Water Board are invaluable resources for many communities. Dedicated watershed hubs can:

- Pool resources to coordinate and conduct flood mapping.
- Play an active advisory role to local governments, advocating for the importance of developing and implementing flood strategies.
- Coordinate flood risk reduction efforts across local jurisdictions. This coordination can result in more effective flood risk management, especially for non-structural nature-based solutions.
- Facilitate access to funds, especially for smaller, capacity-limited communities.

Connection to B.C. Flood Strategy

This recommendation is in alignment with Action 2.1: *Set a new direction for B.C.'s flood government model*. This Action recommends exploring the establishment of watershed hubs for collaboration and sharing expertise.

The B.C. Flood Strategy also includes goals to reduce funding program requirements to reduce barriers to funding in Action 4.1, but there is limited discussion on how to address capacity limitations for smaller communities and First Nations. As a result, we recommend that Action 4.1 be undertaken in conjunction with Actions 2.1 and 2.4. Watershed hubs can help facilitate accessing provincial funds for capacity-limited communities.

4.4.2 : Research Flood Risk Management Solutions Specific to the On-Reserve Context

Priority	High
Issue	First Nations are more exposed to risk but off-reserve strategies are not effective on reserve
Approach	• Provide targeted funds for: ◦ Flood risk management & preparedness programs on reserve ◦ Capacity to support the development of Nation-specific strategies ◦ Comprehensive on-reserve floodplain mapping • Collaboratively develop flood risk management strategy guidelines specific to the on-reserve context • Address First Nations' loss of land
Benefits	• First Nations-led approach to addressing flood risk
BCFS	Action 4.6: <i>Address First Nations loss of land</i> • Rec: propose proactive improvements to the Additions To Reserve (ATR) process

Priority: High

Researching flood risk management solutions specific to the on-reserve context is a high priority as it addresses critical flood risks unique to First Nations, improving resilience and equity. Tailored strategies are essential for managing significant risks and ensuring effective support for these vulnerable communities.

Issue

First Nations in British Columbia are substantially more exposed to flood risk than other communities (Thistlethwaite et al., 2020). The reserve system imposed by the federal government placed many Nations near watercourses, limiting options for development in low flood-risk areas. Small land parcels limit the possibilities to relocate out of the floodplain.

Additionally, government entities do not always recognize the differences between the off-reserve and on-reserve context, which has in the past led to ineffective structures that do not work on reserve and end up creating more problems (Alderhill, 2023). Certain flood strategies, such as provincial property buyouts, are infeasible considering the on-reserve context.

Approach

The provincial government should provide support to First Nations to further investigate flood risk management strategies that are specific to the on-reserve context. These strategies include some listed in this report, such as conducting regular flood mapping potentially coordinated or conducted through regional watershed hubs.

Provincial support for this initiative should include:

- Targeted funds for flood risk management and preparedness programs;
- Additional capacity for First Nations to develop Nation-specific flood risk management strategies (this may be facilitated through the development of ;
- Comprehensive floodplain mapping research.

The provincial government should also pursue the collaborative development of guidelines for flood risk management targeting the on-reserve context. These guidelines may include distinct regulatory tools such as building codes and standards that address the higher exposure frequently faced by First Nations governments and communities.

Finally, addressing the First Nations' loss of land is one of the most important steps the provincial government can take to support First Nations' flood resiliency. The provincial government should engage the federal government in streamlining the Additions To Reserve (ATR) process for securing replacement lands for floodplains.

Benefits

Because First Nations face disproportionately high flood risk, this recommendation targets improving equity across the province. By creating a more effective and equitable flood risk management framework, the provincial government can better meet the unique needs of First Nations communities.

This recommendation also aligns with BC's Declaration Act (2019) by respecting First Nations' self-determination and governance over their lands and supports reconciliation efforts by providing resources and capacity-building for culturally appropriate solutions.

Connection to B.C. Flood Strategy

This work supports the 2019 Tripartite Emergency Management Memorandum of Understanding (MOU) between the provincial government, the First Nations Leadership Council, and Indigenous Services Canada. This MOU focuses on emergency management for several natural hazards. However, there is an urgent need to enhance focus on flood-specific hazards.

In Action 4.6 of the B.C. Flood Strategy, the provincial government identifies a goal to engage with the federal government to propose improvements to the federal ATR process for securing replacement lands for territory lost to natural disasters.

We identify that Action 4.6 should be updated to streamline the ATR process for securing replacement lands for floodplains, as well. The current approach to improving the ATR process, which focuses on securing "replacement lands for territories lost because of natural disasters," is fundamentally reactive. This strategy forces Nations with substantial portions of their land designated as floodplains to wait until a devastating flood occurs before they can secure replacement lands. This approach underscores the need for a proactive and preventive strategy in flood risk management.

4.4.3 : Use a Phased Approach and Provide Resources when Introducing New Regulations

Priority	Low
Issue	Implementing new regulations can be a burden on local governments
Approach	Provide additional funding or staffing to help local governments implement regulatory changes
Benefits	Allows for more effective implementation of new policy
BCFS	BCFS overall proposes a phased approach Additional resources complement Action 2.6: <i>Update provincial legislation, regulations, and policies</i>

Priority: Low

Low. This is a complementary action to ensure that regulatory changes can be implemented effectively at a local level.

Issue

The implementation of new regulations can be a burden on local governments to integrate into their own policy. This burden can be prohibitive to effective integration, especially for smaller local governments, if no support is available to assist the integration. In our case study, we find that the required changes to OCPs outlined by Bills 44 and 47 required a substantial amount of work for local governments to incorporate. In recognition of this workload, the Province provided a total of \$51M to local governments to support the implementation of this new legislation.

Approach

The provincial government should provide additional funding or staffing to help local governments implement any regulatory changes that take place. This may include funding or staffing to help local governments develop flood strategies if these become mandatory.

Benefits

Flood-management-related changes to policies or regulations will benefit from a phased approach and additional resources for local governments to adapt (Danielson, 2015). Additional staffing or funding for staffing positions may help local governments implement regulatory changes more effectively.

Connection to B.C. Flood Strategy

The BCFS overall will be implemented in a phased approach, which is in alignment with this recommendation.

Recommendations for additional resources at a local level for implementing policy changes complement Action 2.6: *Update provincial legislation, regulations, and policies*. The BCFS does not explicitly mention providing additional funding or resources for local governments following regulation changes, but the provincial government has recently provided such resources for the implementation of Bills 44 and 47.

5.0 : Conclusions and Next Steps

The provincial government is facing the challenges of orchestrating increases in housing stock while simultaneously providing local governments with the tools to identify and minimize the increased flood risk resulting from climate change and housing development in floodplains. This report serves as a resource for land use tools available to the provincial government to mitigate flood risks.

The recommendations provided in this report focus on provincial actions that can improve the availability and accessibility of flood risk data, increase collaboration between multiple levels of government in flood risk management, identify and incentivize best flood risk management practices in local governments, and provide additional resources to capacity-limited communities and governments.

For several of the recommendations in this report, we also include where further targeted research is needed to guide action. Before any major legislative changes take place, we recommend targeted analyses to investigate the projected impacts of the specific changes on the economic and social wellbeing of all communities in B.C.

This report underscores the urgent need for a proactive and collaborative approach to flood risk management in British Columbia. This is well captured by the findings of Canada's Task Force on Flood Insurance and Relocation, stating that "there is no scenario in which these costs disappear without significant investments to remove or reduce the risk." By addressing the gaps in current policies and enhancing the capacity of local communities, the provincial government can support local governments develop effective flood risk management strategies tailored to their unique priorities and needs.

6.0 : Limitations

This section lists the limitations associated with this research.

Types of Flood Mitigation Methods Investigated

We do not include structural practices (stormwater standards, dikes, etc.) in this analysis because the focus of this study is on land use policies for flood risk management. We also limit recommendations to policies related to land use planning. As a result, the report does not focus substantially on the effectiveness of existing flood risk management funds.

Implications Of Case Study Region Selection

Selecting municipalities around Okanagan Lake as a study area for investigating land use policies for flood risk management comes with certain limitations.

First, many regions in B.C. do not have access to flood mapping as comprehensive as the maps in the Okanagan Basin. Publicly available flood maps mean municipalities and insurers may be more aligned in this region than in others. Further, recent flooding in the Okanagan Basin has resulted in increased awareness of flood risk, which may have led to more proactive risk management measures.

British Columbia is also a geographically diverse province and, as such, other regions of B.C. face different types of flood hazards than the lake flooding investigated here for Okanagan Lake. We do not include other local types of flood hazards, such as riverine or creek flooding. The Okanagan Basin is also not exposed to certain flood hazards, such as oceanfront hazards or sea level rise.

Compliance With Local Flood Risk Management Bylaws

While we include a review of existing flood bylaws in our case study, we do not thoroughly investigate the extent to which these bylaws are followed or enforced. Further analysis of compliance with local bylaws may reveal insight into the effectiveness of the current multi-governance structure for flood risk management.

In our case study, for example, many buildings exist in downtown Kelowna in the Mill Creek Floodplain. An investigation into the implementation and timing of regulations with respect to existing structures may provide further insight into compliance.

Selection of Exposure Scenarios

The case study investigates future developments in Kelowna given information on anticipated growth in terms of total housing units and approximate locations of the new housing units through identified growth nodes. We then simulate the exact location of housing units within each growth node using two exposure scenarios:

1. **Moderate exposure scenario:** we adopt the current proportion of land in the Okanagan Lake FCL zone for the distribution of planned units for each specific growth node.
2. **High exposure scenario:** we assume that every unit planned within a growth node overlapping with the Okanagan Lake FCL zone will be built within the FCL zone.

The high exposure scenario assumes an unlikely scenario of extreme development within the floodplain, whereas the moderate scenario assumes a baseline scenario of even distribution across the specific growth node. Within each growth node, only residential-zoned areas are considered as locations for the new housing units. Due to the zoning updates, preference of homebuyers for shoreline property, and the current state of building regulations, the share of future units to be built within the Okanagan Lake FCL zone can likely be found between the two scenarios.

Assumptions And Limitations Of The Flood Mapping Used

The projected risk values in our case study must be considered in the context of other sources of flooding within the study area. Flooding of Mill Creek, specifically, has the potential to significantly increase damages throughout large parts of Kelowna. Table 6.1 displays the share of projected development in the Okanagan Lake FCL zone, for which flood risk was estimated, as well as the share of development in the Mill Creek Floodplain, for which no flood risk estimates exist. The analysis shows that 68% of anticipated development will occur in growth nodes overlapping with either floodplain, resulting in 33% of development to occur within the floodplain assuming an even spatial distribution of developments.

Okanagan Mainstem Floodplain Mapping and Flood Risk Mapping for the Okanagan Watershed projects both investigate RCP8.5. This is generally considered an upper-end, but not unlikely scenario. Most intermediate scenarios project lower emission levels and hence less amplified responses in the climate system. The different climate scenarios that appear close in mid-century projections deviate dramatically in late-century projections.

Table 6.1: Flood Exposure and Planned Housing in Kelowna's Growth Nodes

Growth Node	% of Total New Units	% in Okanagan Lake FCL Zone	% in Mill Creek Floodplain	Total % of Land in Floodplains	Approx. % Exposed Units
Downtown Urban Centre	18	41	12	53	9
Core Central	15	12	26	39	6
Capri Landmark Urban Centre	14	0	100	100	14
Remainder of City	6	3	0	3	0
Midtown Urban Centre	4	0	14	14	1
Pandosy Urban Centre	4	50	0	50	2
Core Rutland	4	0	3	3	0
McKinley Beach	1	1	0	1	0
Mount Baldy	1	0	5	5	0
Total	68	-	-	-	33

Source: Projections of new dwelling units per growth node were sourced from Kelowna's 2040 OCP. Percents of areas in inundation extents and floodplains were estimated based on residential zones in Kelowna's growth nodes overlaid with the 2040 OCP Mill Creek Floodplain map and Okanagan Mainstem Floodplain Mapping (NHC, 2020a) Okanagan Lake FCL with freeboard. **Note:** We include all residential-zoned areas within the permanent growth boundary that fall within Kelowna's identified growth nodes. "% of Total New Units" refers to the total percent of new units for Kelowna that are planned to occur in the specified growth node. "Approx. % Exposed Units" refers to the share of new development projected to occur in either floodplain.

Dam or dike failure is typically not considered in the flood risk mapping. However, for the Mission Creek Flood Mapping, the 200-year flood results in several dike failures. The 200-year flood here is notably higher than the event observed in 2018. Further, it should be noted that the 200-year flood of individual creeks (such as Mission Creek) is not the same as the 200-year flood for reservoirs, specifically Okanagan Lake in this case.

For further assumptions and limitations regarding the Okanagan Mainstem Floodplain Mapping and Flood Risk Mapping for the Okanagan Watershed, please refer to their associated reports (NHC & IBI Group, 2023)

References

- AECOM Canada Ltd. (2020). *Flood mapping and mitigation planning: Mission Creek flood and hazard mapping*. Regional District of Central Okanagan and City of Kelowna. https://www.obwb.ca/docs/RPT1_2020_05_07_60613804_Mission_Creek_Basin_Flood_Mapping_Final.pdf
- Alderhill. (2023). *What we heard report: Summary of First Nations and local government engagements on the B.C. flood strategy intentions paper (Fall 2022)*. https://engage.gov.bc.ca/app/uploads/sites/797/2023/06/Alderhill_WWHR_FINAL_Mar-2023.pdf
- Associated Engineering Ltd. (2019). *Flood mapping project: Peachland and Trepanier Creeks final report*. Regional District of Central Okanagan. <https://www.rdco.com/en/business-and-land-use/resources/Documents/2019-Flood-Mapping-Peachland-Trepanier-Report.pdf>
- Associated Environmental Consultants Inc. (2017). *Review of 2017 flood response: Okanagan Lake Regulation System and Nicola Dam*. Ministry of Forests, Lands, Natural Resource Operations and Rural Development. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/2017_flood_response_report_final.pdf
- B.C. Community Climate Funding. (2024). *CEPF: disaster risk reduction—Climate adaptation*. Province of British Columbia. <https://communityclimatefunding.gov.bc.ca/funding/1e923641-448d-ed11-81ad-002248d51980>
- B.C. Housing. (2024, May 28). *Realizing Resilient Buildings (R2B)*. [https://boabc.org/wp-content/uploads/2024/06/Realizing-Resilient-Buildings-\(R2B\)-A-Toolkit-for-Local-Government-Carriad-Garratt.pdf](https://boabc.org/wp-content/uploads/2024/06/Realizing-Resilient-Buildings-(R2B)-A-Toolkit-for-Local-Government-Carriad-Garratt.pdf)
- B.C. Land Use Planning- Development Finance. (2024). <https://www2.gov.bc.ca/gov/content/housing-tenancy/local-governments-and-housing/housing-initiatives/development-finance>
- Land Use Strategy - Okanagan-Shuswap Land & Resource Management Plan. (2001). https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/thompsonokanagan-region/okanaganshuswap-lrmp/okanagan_shuswap_lrm.pdf
- Behm, R. L., Coulbourn, W. L., Kriebel, D. L., & McKenna, K. K. (2021). *Guidelines for improving flood-resistance for existing buildings*. National Research Council of Canada. <https://doi.org/10.4224/40002709>
- Bill 31: Emergency and Disaster Management Act (2023). https://www.leg.bc.ca/parliamentary-business/overview/42nd-parliament/4th-session/bills/1st_read/gov31-1.htm
- British Columbia Real Estate Association & University of British Columbia Okanagan. (2015). *BC floodplain maps inventory report*. <https://www.bcrea.bc.ca/wp-content/uploads/2015FloodplainMapInventory.pdf>
- British Columbia Real Estate Association & University of British Columbia Okanagan. (2021). *BC floodplain maps inventory report*. <https://www.bcrea.bc.ca/wp-content/uploads/2021-05FloodplainMapsInventory.pdf>
- Bruce, J. P. (1976). The national flood damage reduction program. *Canadian Water Resources Journal*, 1(1), 5–14.
- Building and Safety Standards Branch. (2023). *Existing buildings renewal strategy: Engagement summary*. Province of British Columbia. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/reports/existing_buildings_renewal_strategy_engagement_summary_september_december_2021.pdf

- Calamai, L., & Minano, A. (2017). Emerging trends and future pathways: A commentary on the present state and future of residential flood insurance in Canada. *Canadian Water Resources Journal/Revue Canadienne Des Ressources Hydriques*, 42(4), 307–314.
- Canada Task Force on Flood Insurance and Relocation. (2022). *Adapting to rising flood risk: An analysis of insurance solutions for Canada*. Public Safety Canada.
<https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/dptng-rsng-fl-d-rsk-2022/dptng-rsng-fl-d-rsk-2022-en.pdf>
- City of Kelowna. (2022). *Development Cost Charge Program. 20 -Year Servicing Plan & Financing Strategy*.
https://www.kelowna.ca/sites/files/1/docs/city-hall/20_year_servicing_plan_2022.pdf
- City of Kelowna. (2023). *1.8-acre waterfront lot at the mouth of Mission Creek acquired for a new destination park*.
<https://www.kelowna.ca/our-community/news-events/news/18-acre-waterfront-lot-mouth-mission-creek-acquired-new-destination-park>
- City of Kelowna. (2024). *Flooding*.
<https://www.kelowna.ca/our-community/environment/flooding>
- City of Kelowna Infrastructure Engineering Manager. (2019). *Report to council: Infrastructure funding options*.
<https://kelownapublishing.escribemeetings.com/filestream.ashx?DocumentId=21802>
- Community Charter (2003).
https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/03026_03#section34
- Compensation and Disaster Financial Assistance Regulation, B.C. Reg. 124/95 (2022).
https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/124_95
- Cottar, S., & Wandel, J. (2024). Municipal perspectives on managed retreat and flood mitigation: A case analysis of Merritt, Canada after the 2021 British Columbia flood disaster. *Climatic Change*, 177(3), 50.
- Danielson, L. N. (2015). *Patching the Leaks: Reforming British Columbia's Approach to Property-level Flood Resilience*.
https://summit.sfu.ca/_flysystem/fedora/sfu_migrate/15372/etd8925_LDanielson.pdf
- Deschamps, B., Bourdeau-Brien, M., & Boudreault, M. (2023). *How Can Municipalities in British Columbia and Québec Contribute to Flood Risk Reduction?* Institute on Municipal Finance and Governance.
<https://riisq.ca/wp-content/uploads/2023/02/Flood-Risk-Reduction.pdf>
- Design Standards: Bylaw 7900 (1998).
<https://apps.kelowna.ca/CityPage/Docs/PDFs/Bylaws/Subdivision,%20Development%20and%20Servicing%20Bylaw%20No.%207900/Schedule%204%20-%20Design%20Standards.pdf>
- Ebbwater Consulting Inc. (2019). *Sylix Okanagan Flood and Debris Flow Risk Assessment*. Sylix Okanagan Nation Alliance.
https://www.ebbwater.ca/wp-content/uploads/2022/05/R1_ONA-Synthesis_31Dec2019_lowres.pdf
- ESRI. (n.d.). *World hillshade* [Basemap].
http://services.arcgisonline.com/arcgis/rest/services/Elevation/World_Hillshade/MapServer/tile/%7Bz%7D/%7By%7D/%7Bx%7D.png
- Federal Emergency Management Agency. (2022, July 11). Flood risk disclosure: Model state requirements for disclosing flood risk during real estate transactions. US Department of Homeland Security.
https://www.fema.gov/sites/default/files/documents/fema_state-flood-risk-disclosure-best-practices_07142022.pdf
- Floodplain Management Bylaw No. 5896 (2022).
https://www.vernon.ca/sites/default/files/docs/bylaws/5896_floodplain_management_bylaw.pdf
- Floodwise. (n.d.). *Financial Flood Risk Management*.
<https://floodwise.ca/protect-your-home-business/financial-flood-risk-management/>
- Government of Canada. (2022, March 7). *The cost of floods*.

- <https://www.canada.ca/en/campaign/flood-ready/know-the-risks/cost-floods.html>
- Government of Canada. (2024). *Budget 2024: Fairness for every generation*. Government of Canada.
<https://budget.canada.ca/2024/home-accueil-en.html>
- Henstra, D., & Thistlethwaite, J. (2018). Buyer beware: Evaluating property disclosure as a tool to support flood risk management.
<https://www.cigionline.org/publications/buyer-beware-evaluating-property-disclosure-tool-support-flood-risk-management/>
- Highways England (2021). *Natural Flood Management*. [Measures Booklet].
<https://catchmentbasedapproach.org/wp-content/uploads/2021/03/NFM-Measures-Booklet.pdf>
- Infrastructure Canada. (2019, June 26). *Canada and BC work in partnership to help protect residents and businesses of Grand Forks from disastrous impacts of flooding*. [News Release].
<https://www.canada.ca/en/office-infrastructure/news/2019/06/canada-and-bc-work-in-partnership-to-help-protect-residents-and-businesses-of-grand-forks-from-disastrous-impacts-of-flooding.html>
- Insurance Bureau of Canada. (2019). *Options for managing flood costs of Canada's highest risk residential properties*.
<https://a-us.storyblok.com/f/1003207/x/35d72a63b5/ibc-flood-options-paper-en.pdf>
- Insurance Bureau of Canada. (2024). *Types of home coverage*.
<https://www.ibc.ca/insurance-basics/home/types-of-home-insurance-coverage>
- Intact Centre on Climate Adaptation & University of Waterloo. (2022). *Treading water: Impact of catastrophic flooding on Canada's housing market*.
https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2022/02/UoW_ICCA_2022_02-Treading-Water_Flooding-and-Housing-Market.pdf
- International Code Council. (2021). *International residential code section R322: Flood-resistant construction*.
https://codes.iccsafe.org/content/IRC2021P2/chapter-3-building-planning#IRC2021P2_Pt03_Ch03_SecR322
- Johnson, K. A., Wing, O. E., Bates, P. D., Fargione, J., Kroeger, T., Larson, W. D., Sampson, C. C., & Smith, A. M. (2020). *A Benefit-Cost analysis of floodplain land acquisition for U.S. flood-damage reduction*. *Nature Sustainability*, 3(1), 56–62.
- Kumar, A., Burton, I., & Etkin, D. (2001). *Managing flood hazard and risk: Report of an independent expert panel*. Office of Critical Infrastructure Protection and Emergency Preparedness, Government of Canada.
<https://publications.gc.ca/collections/Collection/D82-70-2002E.pdf>
- Li, B. (2022). *Flood Insurance Take-Up in Canada, 2021*. Catastrophe Indices and Quantification Inc. (CatIQ).
https://public.catiq.com/blog_post/flood-insurance-take-up-in-canada-2021/
- Local Government Act, § Part 26 — Planning and Land Use Management (2018).
https://www.bclaws.gov.bc.ca/civix/document/id/consol21/consol21/96323_30
- Lorraine, C. (2024a, March 25). RDCO staff need more time to implement provincial housing rules. *KelownaNow*.
https://www.kelownanow.com/watercooler/news/news/Okanagan/RDCO_staff_need_more_time_to_implement_provincial_housing_rules/
- Lorraine, C. (2024b, March 25). West Kelowna needs 3 new staff positions to implement housing legislation, says report. *KelownaNow*.
https://www.kelownanow.com/watercooler/news/news/West_Kelowna/West_Kelowna_needs_3_new_staff_positions_to_implement_housing_legislation_says_report/
- McCullough, D. (2017, June 2). Flood 2017: A visual timeline. *KelownaNow*.
https://www.kelownanow.com/watercooler/news/news/Kelowna/Flood_2017_a_photographic_timeline/#fs_135073

- Mill Creek Flood Plain Bylaw No. 10248 (2011). <https://apps.kelowna.ca/CityPage/Docs/PDFs/Bylaws/Mill%20Creek%20Flood%20Plain%20Bylaw%20No.%2010248.pdf>
- Ministry of Forests, Lands, Natural Resource Operations and Rural Development. (2018). *Flood Hazard Area Land Use Management Guidelines*. Ministry of Water, Land and Air Protection and Province of British Columbia. https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/flood_hazard_area_land_use_guidelines_2017.pdf
- Ministry of Housing. (2023). *Small-scale, multi-unit housing + changes to Local Government Act technical briefing*. https://news.gov.bc.ca/files/Housing_Tech_Brief_Nov_01_2023.pdf
- Ministry of Water, Land, and Air Protection (2003). Bill 56: Flood Hazard Statutes Amendment Act. <https://www.bclaws.gov.bc.ca/civix/document/id/lc/billsprevious/4th37th:gov56-1>
- Nahiduzzaman, K. M., Hewage, K., Ishaq, S., Mohammadiun, S., Yousefi, P., Sultana, S. R., Rana, A., & Sadiq, R. (2021). *Analysis of flood resilience policy and planning tools in the Okanagan Valley*. Okanagan Basin Water Board. <https://www.obwb.ca/newsite/wp-content/uploads/OBWB-UBCO-Final-Report-July-23-2021.pdf>
- National Institute of Building Sciences & Multihazard Mitigation Control. (2019). *Natural hazard mitigation saves*. National Institute of Building Sciences. https://www.nibs.org/files/pdfs/NIBS_MMC_MitigationSaves_2019.pdf
- Natural Resources Canada & Public Safety Canada. (2021). Federal flood damage estimation guidelines for buildings and infrastructure. *Government of Canada*. <https://doi.org/10.4095/327001>
- Newcombe, A. (2018). *2017 freshet infrastructure recovery* (Report to Council 1910–10). City of Kelowna. <https://kelownapublishing.escribemeetings.com/filestream.ashx?DocumentId=9309>
- Northwest Hydraulic Consultants Ltd. (2020a). *City of Vernon detailed flood mapping, risk analysis and mitigation Part 1—Upper B.X. Creek*. City of Vernon. https://www.vernon.ca/sites/default/files/docs/engineering/flood-mapping/Final%20Report%20-%20Detailed%20Flood%20Mapping%20-%20Part%201_Reduced.pdf
- Northwest Hydraulic Consultants Ltd. (2020b). *Okanagan Mainstem Floodplain Mapping*. Okanagan Basin Water Board. <https://www.obwb.ca/docs/2020-okanagan-floodplain-mapping-nhc-finalreport-lowres.pdf>
- Northwest Hydraulic Consultants Ltd. (2022). *Supplemental to the Okanagan Mainstem Floodplain Mapping Project: Current operations flood construction levels for Okanagan and Wood-Kalamalka Lakes*. Okanagan Basin Water Board. <https://www.obwb.ca/newsite/wp-content/uploads/2022-okanagan-floodplain-mapping-okanagan-wood-kalamalka-update-nhc.pdf>
- Northwest Hydraulic Consultants Ltd. & IBI Group Professional Services Inc. (2023). *Flood Risk Mapping for the Okanagan Valley Watershed*. Okanagan Basin Water Board. <https://obwb.ca/flood-risk-mapping-for-the-okanagan-valley-watershed/>
- Okanagan Basin Water Board (2023). *Okanagan Flood Story Mapping for Advanced Users*. <https://storymaps.arcgis.com/stories/490f86857234428e908407f978aaebaa>
- Office of Housing and Construction Standards, Province of British Columbia. (2020). *Changes for local governments under Section 5 of the building Act: Appendix to Section B1 of the Building Act Guide*. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/construction-industry/building-codes-and-standards/guides/section_b_appendix_dec_2020_update.pdf
- Official Community Plan Bylaw No. 0300 (2023). <https://www.westkelownacity.ca/en/city-hall/off>

- icial-community-plan.aspx
- Official Community Plan Bylaw No. 1065 (2018).
[https://www.lakecountry.bc.ca/en/business-information/resources/Document-Manager/Bylaws/Official-Community-Plan-\(2018-2038\)-Bylaw-1065,-2018---CONSOLIDATED.pdf](https://www.lakecountry.bc.ca/en/business-information/resources/Document-Manager/Bylaws/Official-Community-Plan-(2018-2038)-Bylaw-1065,-2018---CONSOLIDATED.pdf)
- Official Community Plan Bylaw No. 2014-002 (2015).
https://www.summerland.ca/docs/default-source/default-document-library/2014-ocp---schedule-a-consolidated-to-april-9-20245f60a35cf68d6e33909cff00007e7f94.pdf?sfvrsn=56edcdfb_0
- Official Community Plan Bylaw No. 2019-08 (2019).
<https://www.penticton.ca/sites/default/files/uploads/bylaws/Consolidated%20Official%20Community%20Plan%20Bylaw%20No.%202019-08.pdf>
- Official Community Plan Bylaw No. 5470 (2023).
<https://www.vernon.ca/sites/default/files/docs/bylaws/OCP/Official%20Community%20Plan%20Bylaw%205470%2C%202013.pdf>
- Official Community Plan Bylaw No. 12300 (2023).
<https://apps.kelowna.ca/CityPage/Docs/PDFs/Bylaws/Official%20Community%20Plan%202040%20Bylaw%20No.%2012300/Official%20Community%20Plan%20Bylaw%20No.%2012300%20-%20Kelowna%202040.pdf?v=1B987383FDAF0EE1EC94D0004BA7203E>
- Okanagan Basin Water Board. (2023). *Restoring Mission Creek*.
<https://obwb.ca/restoring-mission-creek/>
- Okanagan Basin Water Board. (2023). *Overview: Okanagan Basin Water Board*.
<https://obwb.ca/overview/>
- Okanagan Indian Band. (2020). *Strategic Plan 2020-2025*.
<https://www.okib.ca/wordpress/wp-content/uploads/2023/07/OKIB-Strat-plan-Dec-2021-updated-2022-09-12.pdf>
- Okanagan Waterwise. (2023). *Our flood history*.
 Okanagan Basin Water Board.
<https://storymaps.arcgis.com/stories/63277d339f1b416195fdc80f59faf742>
- Penticton Indian Band. (2009). *Penticton Indian Band comprehensive community plan*.
https://pib.sproing.ca/wordpress/wp-content/uploads/2023/02/PIBCCP_2012_FINALfinal_web.pdf
- Province of British Columbia. (2023). *Official community plans for local governments*.
<https://www2.gov.bc.ca/gov/content/governments/local-governments/planning-land-use/local-government-planning/official-community-plans>
- Province of British Columbia. (2024a). *From flood risk to resilience: A BC flood strategy to 2035*.
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/integrated-flood-hazard-mgmt/bc_flood_strategy.pdf
- Province of British Columbia. (2024b, March 8). *BC Codes 2024* [News Release].
<https://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/bc-codes/2024-bc-codes>
- Province of British Columbia. (2024c, June 18). New funding program helps protect people, communities from climate emergencies [News Release]. BC Gov News.
<https://news.gov.bc.ca/releases/2024EMCR0031-000950>
- Province of British Columbia. (2024d, July 2). Local Government Climate Action Program.
<https://www2.gov.bc.ca/gov/content/environment/climate-change/local-governments/local-government-climate-action-program>
- Province of British Columbia. (2024e). *Provincial policy manual & site standards: Small-scale, multi-unit housing*.
https://www2.gov.bc.ca/assets/gov/housing-and-tenancy/tools-for-government/local-governments-and-housing/ssmuh_provincial_policy_manual.pdf
- Public Safety Canada. (2017). *2016-2017 Evaluation of the Disaster Financial Assistance Arrangements*.
<https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/vltn-dsstr-fnncl-ssstnc-2016-17/vltn-dsstr-fnncl-ssstnc-2016-17-en.pdf>

- Public Safety Canada & Institute for Catastrophic Loss Reduction. (2024). *Study of Homeowner Willingness to Pay for Flood Insurance – Canadian Homeowners at Extreme Risk*. https://publications.gc.ca/collections/collection_2024/sp-ps/PS9-33-2024-eng.pdf
- Reconciliation Agreement on Construction Codes (2019). <https://www.cfta-alec.ca/wp-content/uploads/2021/08/Construction-Codes-RA-2019.pdf>
- Red Dragon Consulting. (2021). *Investigations in support of flood strategy development in British Columbia: Issue C-3 report: Flood recovery*. Fraser Basin Council. https://www.fraserbasin.bc.ca/_Library/Water_Flood_BC/C-3_Flood_Recovery.pdf
- Regional District of Central Okanagan. (2013). Bylaw No. 1336, *Regional Growth Strategy*. <https://www.rdc0.com/RGS-Bylaw-No-1336---website-version.pdf>
- Regional District of North Okanagan. (2011). Bylaw No. 2500, *Regional Growth Strategy*. https://www.rdc0.ca/sites/default/files/2021-04/BL_2500_C.pdf
- Regional District of Okanagan-Similkameen. (2017). Bylaw No. 2770, *Regional Growth Strategy*. <https://www.rdc0.bc.ca/assets/bylaws/planning/AreaX/2770.pdf>
- Schindler, S., O'Neill, F. H., Biró, M., Damm, C., Gasso, V., Kanka, R., van der Sluis, T., Krug, A., Lauwaars, S. G., Sebesvari, Z., & others. (2016). Multifunctional floodplain management and biodiversity effects: A knowledge synthesis for six European countries. *Biodiversity and Conservation*, 25, 1349–1382.
- South Okanagan-Similkameen Conservation Program, The Real Estate Foundation, Habitat Stewardship Canada, & City of Penticton. (2017). Penticton: A guide to development in sensitive areas. https://osca.org/wp-content/uploads/2017/08/penticton_development_guide_lowres.pdf
- Statistics Canada. (2023). *2021 Census – Boundary Files* [dataset]. <https://www12.statcan.gc.ca/census-recensement/2021/geo/sip-pis/boundary-limités/index-eng.cfm>
- Subdivision and Development Servicing Bylaw No. 2022-042 (2022). https://www.summerland.ca/docs/default-source/default-document-library/1-sds-bylaw-no-2022-042.pdf?sfvrsn=c648cffb_0
- Swiss Re. (2016). *The road to flood resilience in Canada*. https://www.preventionweb.net/files/49295_the-road-to-flood-resilience-in-canada.pdf
- The Geneva Association. (2020). *Flood risk management in Canada: Building flood resilience in a changing climate*. https://www.genevaassociation.org/sites/default/files/research-topics-document-type/pdf_public/frm_canada_web.pdf
- Thistlethwaite, J., Le Geyt, M., Martin, G., Cottar, S., & Whittaker, L. (2023). *Buying out the floodplain: Recommendations for strategic relocation programs in Canada*. University of Waterloo. https://uwaterloo.ca/partners-for-action/sites/default/files/uploads/documents/buyingoutthefloodplainreport_en_1.pdf
- Thistlethwaite, J., Minano, A., Henstra, D., & Scott, D. (2020). Indigenous Reserve Lands in Canada Face High Flood Risk. *Centre for International Governance Innovation*, 159. <https://www.cigionline.org/static/documents/documents/PB%20no.159.pdf>
- Water Canada. (2019, March 19). *Government of Canada Funds Flood Protection Project in Kelowna, B.C.* <https://www.watercanada.net/government-of-canada-funds-flood-protection-project-in-kelowna-b-c/>
- Westbank First Nation. (2020). *I? sc̓kʷl̓h sk̓čʷi?pla?tat i? k̓ach̓la?pusa?x: Comprehensive community plan*. https://www.wfn.ca/docs/westbank_ccp_web.pdf
- Zhang, J., Zheng, H., Zhang, X., Lin, Z., VanLooy, J., &

Kennedy, A. (2023). Strategic land acquisition for efficient and equitable flood risk reduction in the United States. *Climate Risk Management*, 42, 100554.

Zoning Bylaw No. 561 (2007).
<https://www.lakecountry.bc.ca/en/business-information/resources/Document-Manager/Bylaws/Zoning-Bylaw-561,-2007-CONSOLIDATED.pdf>

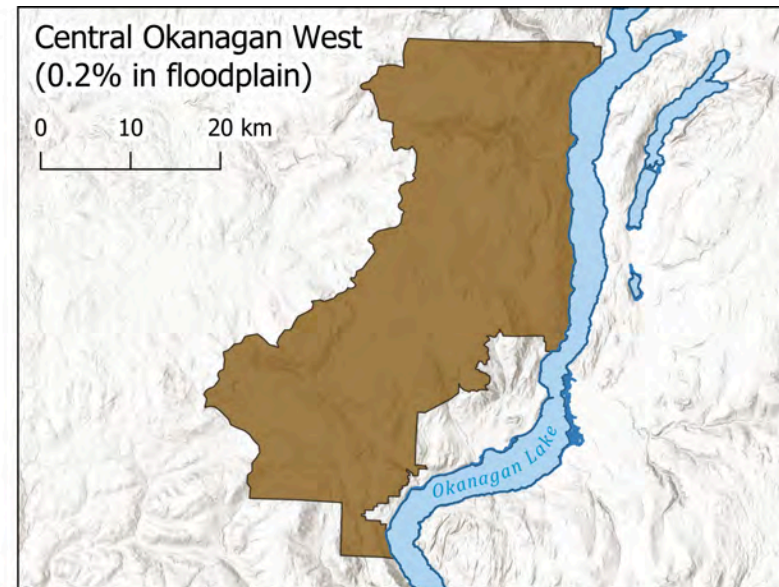
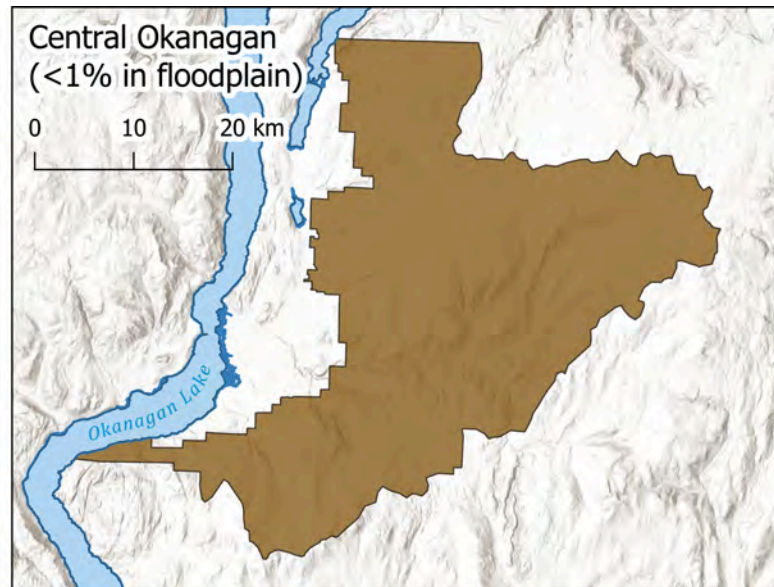
Zoning Bylaw No. 2400 (2023).
<https://peachland.civicweb.net/filepro/documents/89371/?preview=89372>

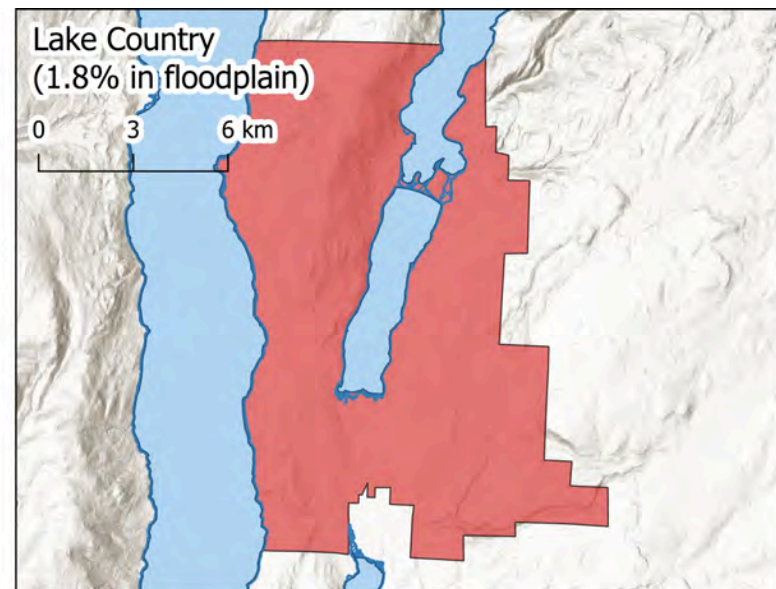
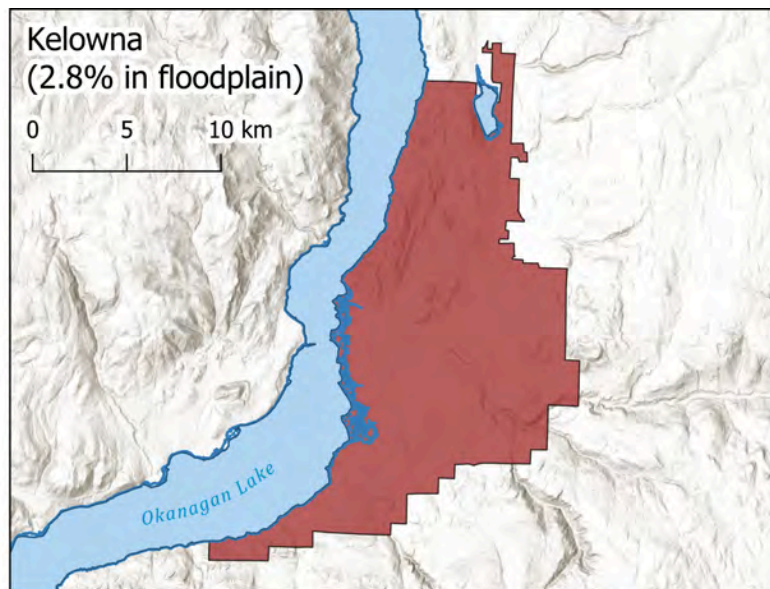
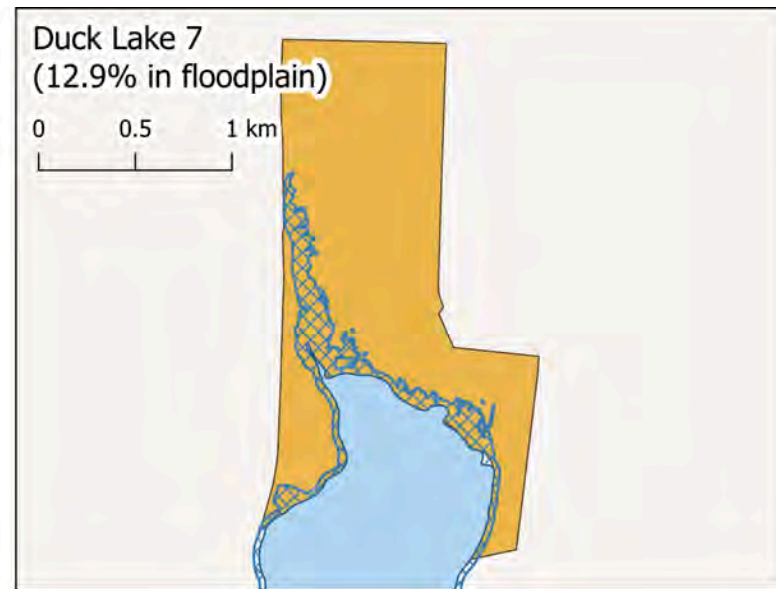
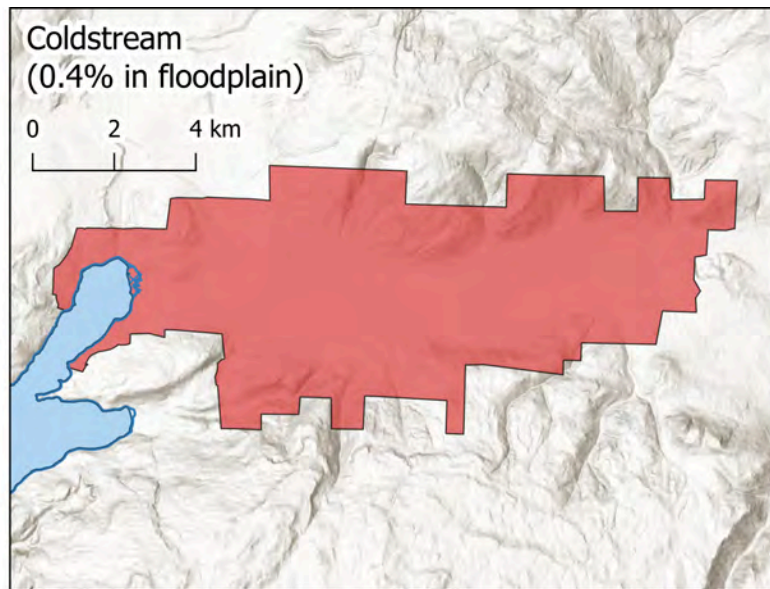
Zoning Bylaw No. 5000 (2003).
<https://www.vernon.ca/sites/default/files/docs/bylaws/introduction.pdf>

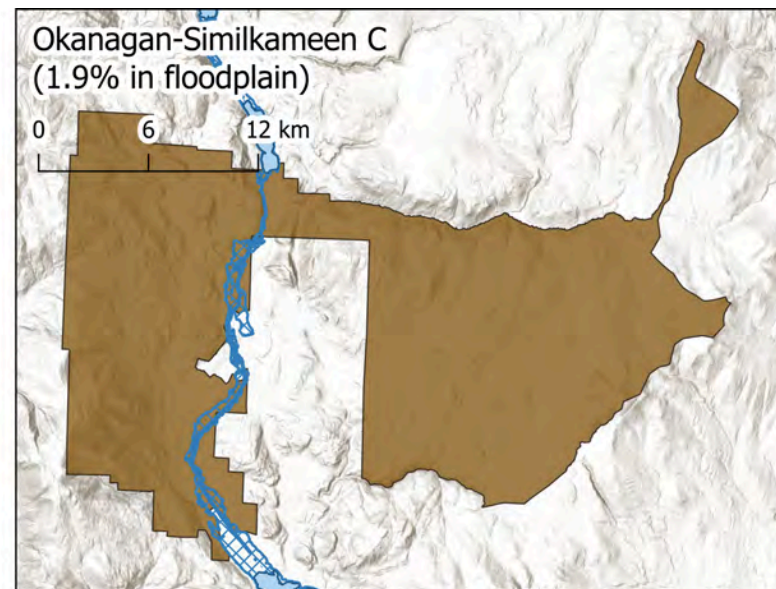
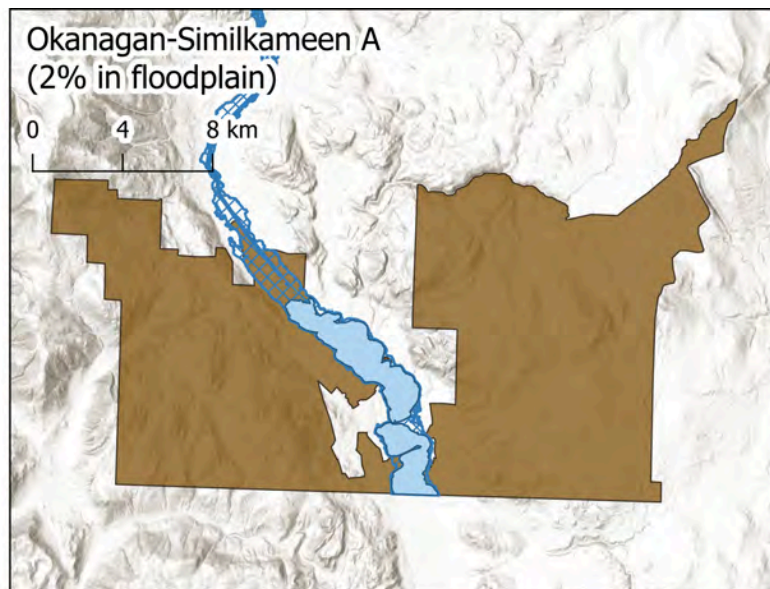
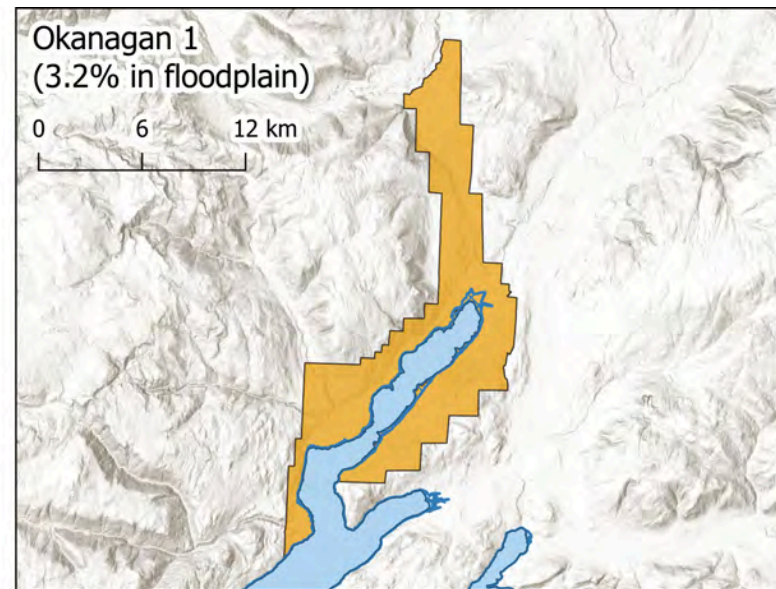
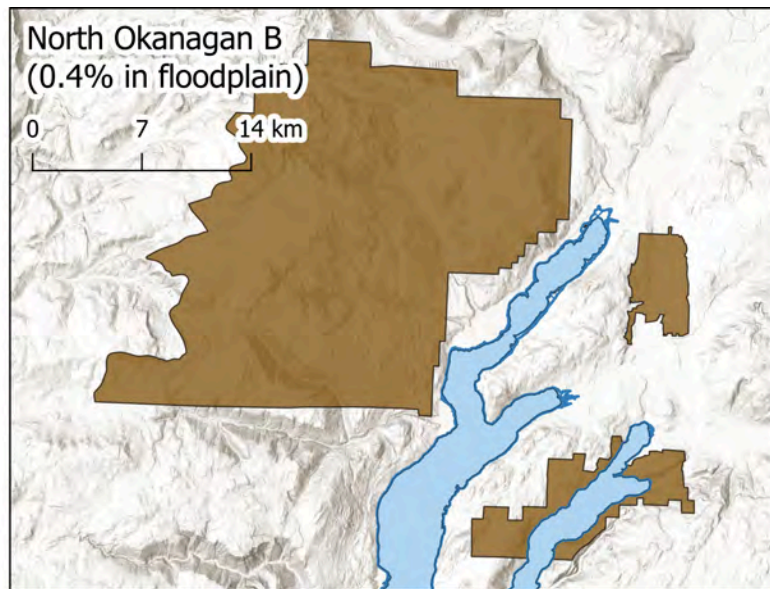
Appendices

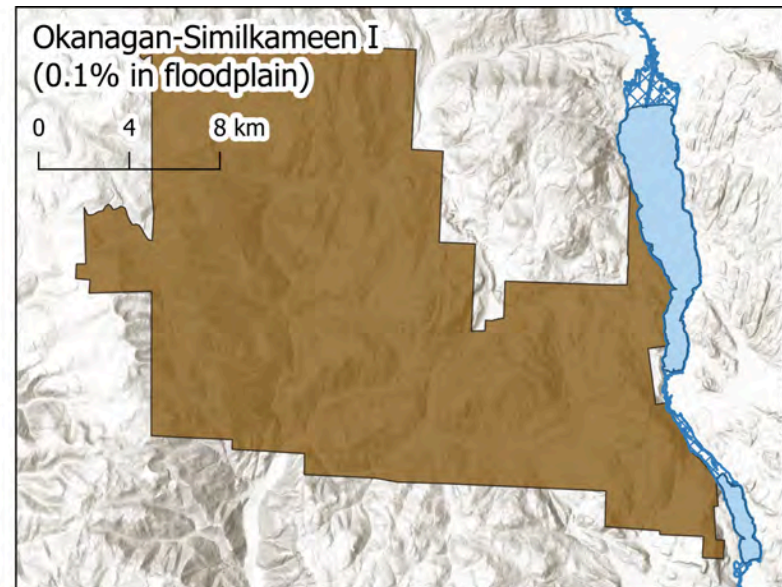
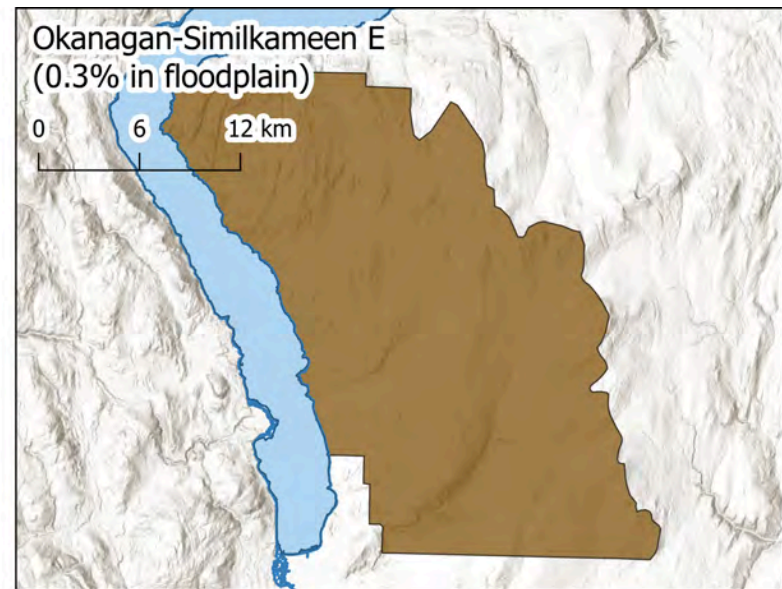
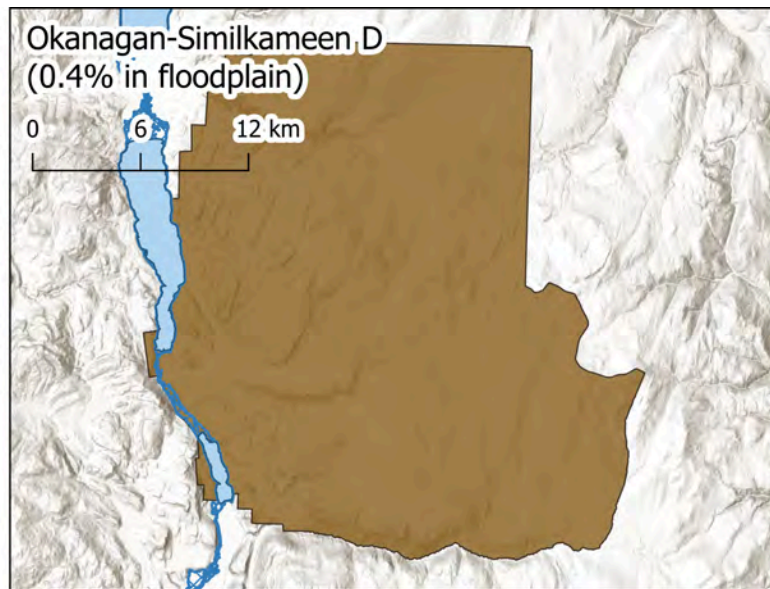
Appendix A: Individual Maps of Census Subdivisions

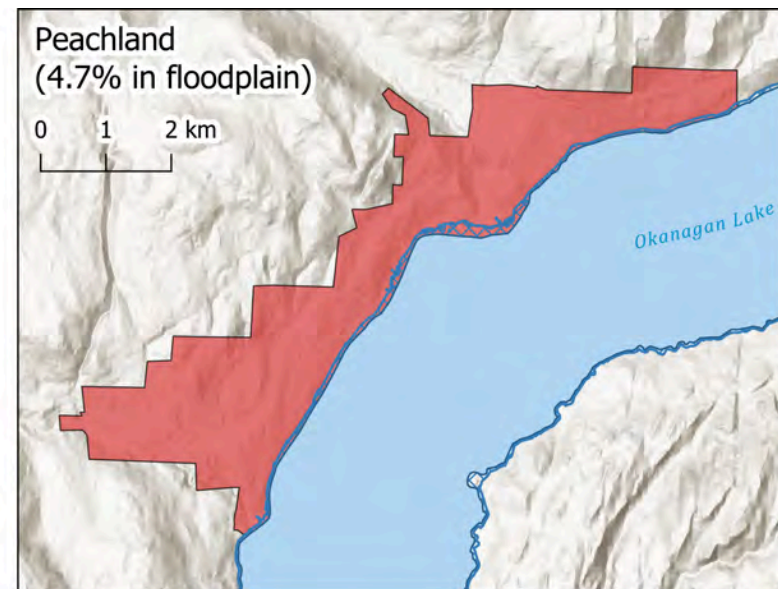
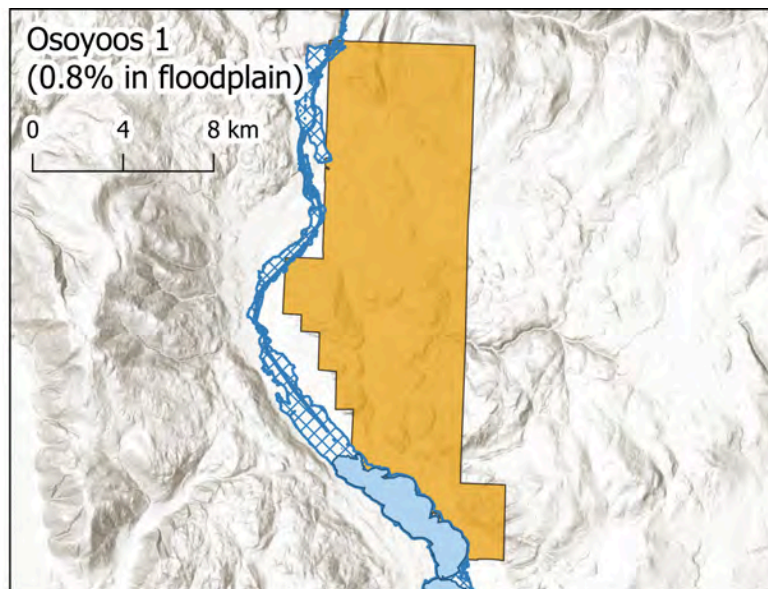
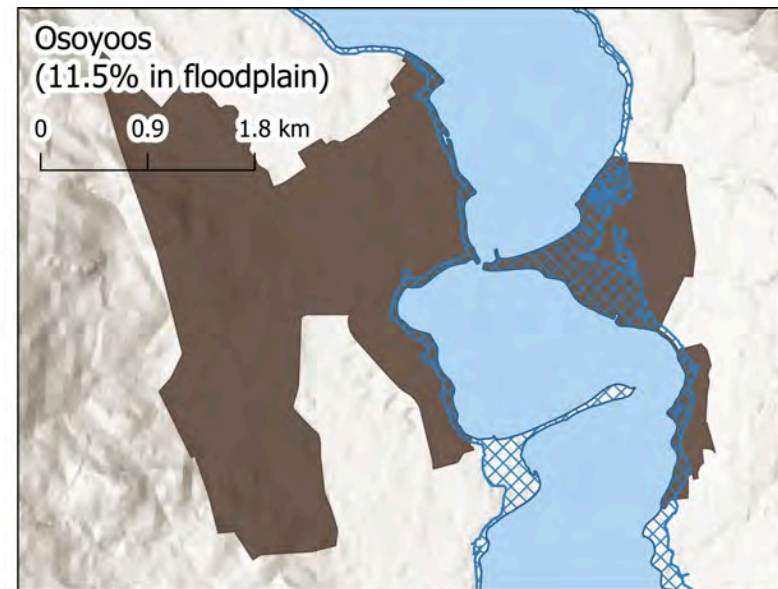
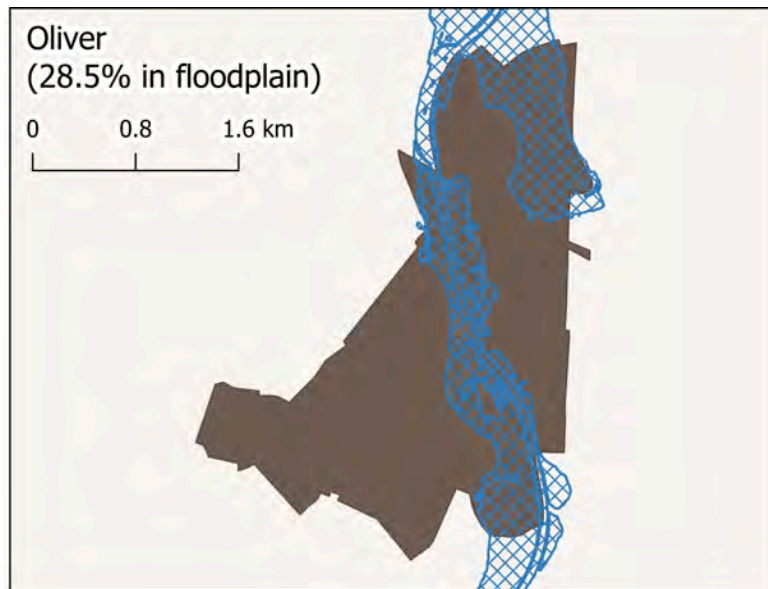
The following maps are the census subdivisions presented in Figure 3.1 with updated FCLs under the Okanagan Mainstem Floodplain Mapping project (NHC, 2020). The maps are arranged in alphabetical order. Each census subdivision is color-coded according to the legend used in Figure 3.1.

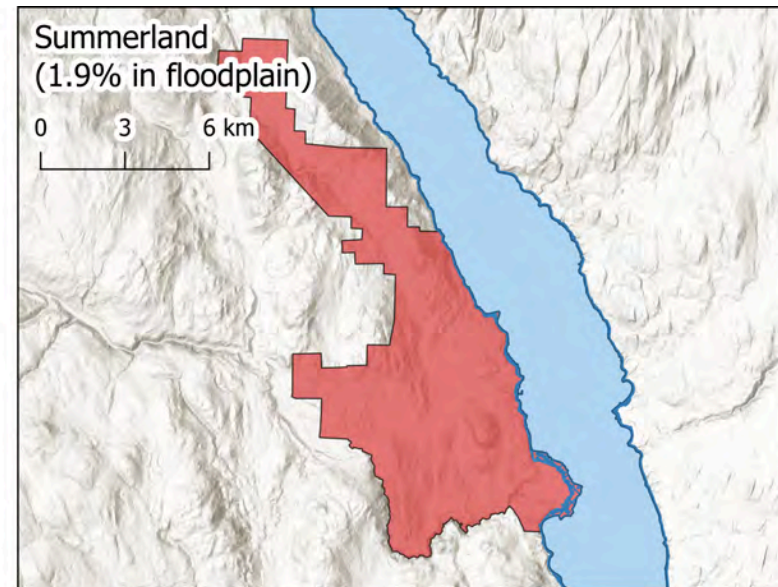
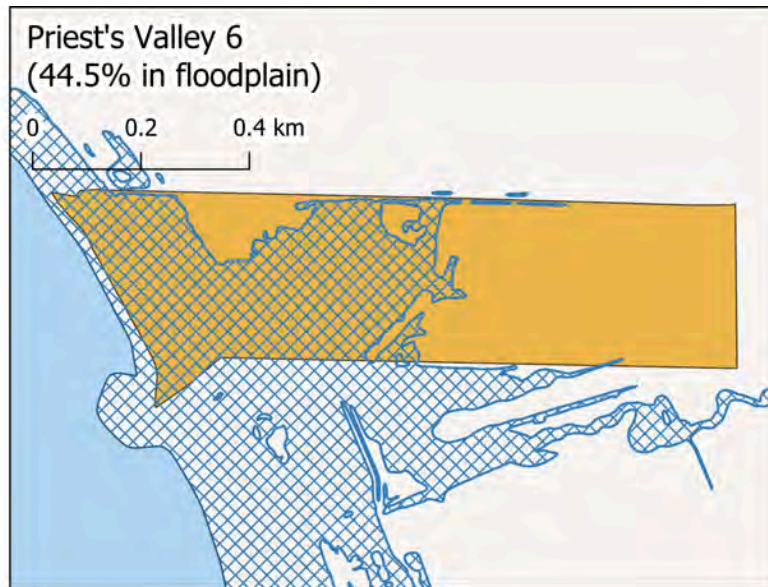
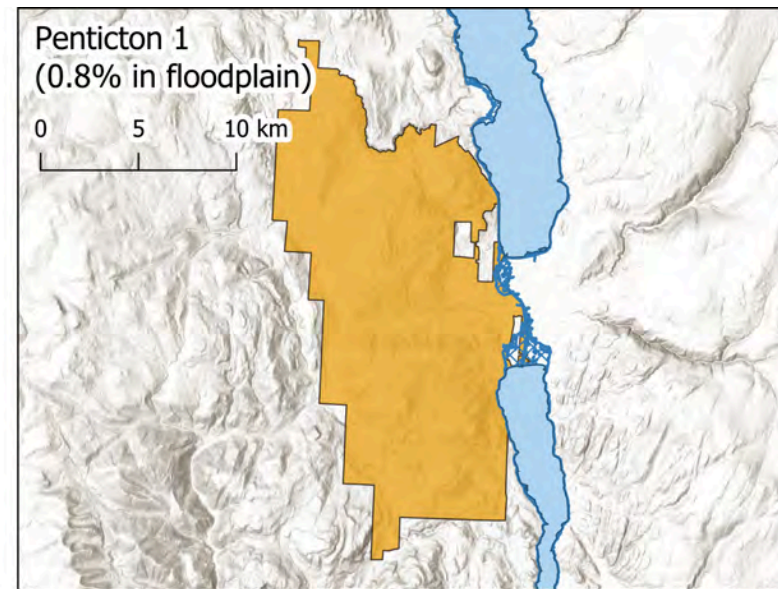
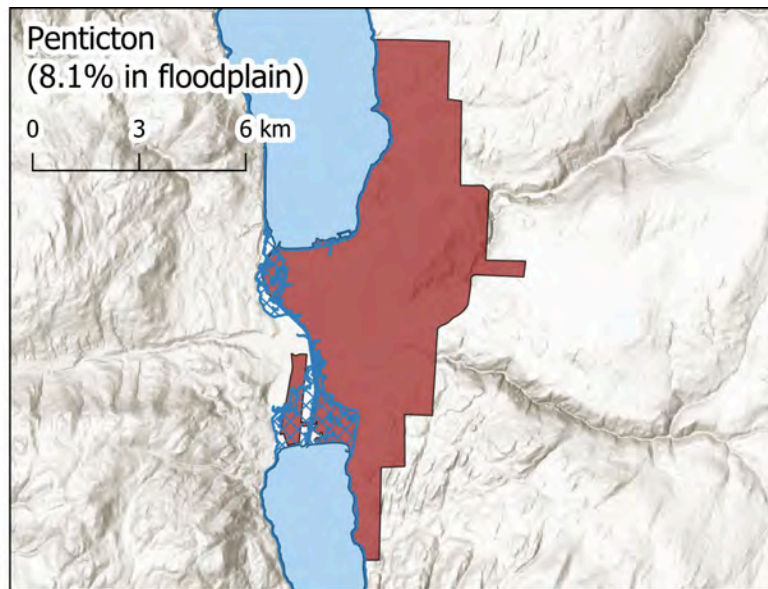


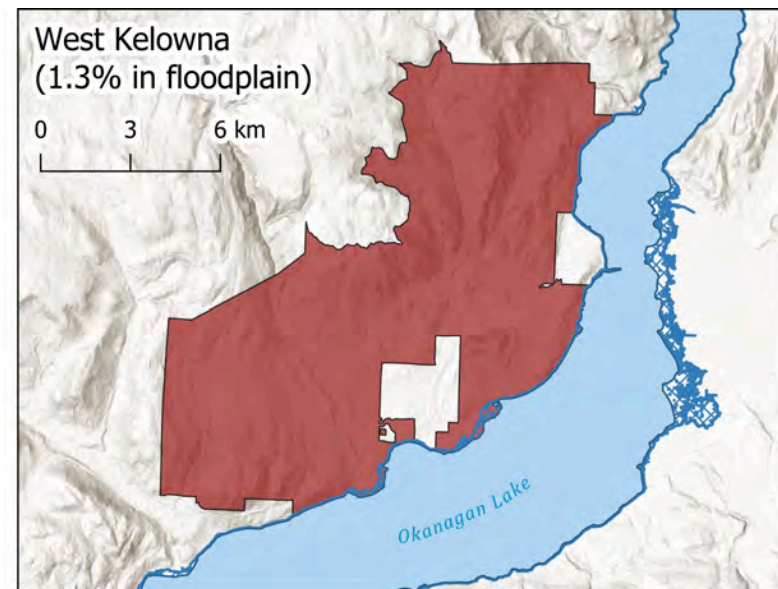
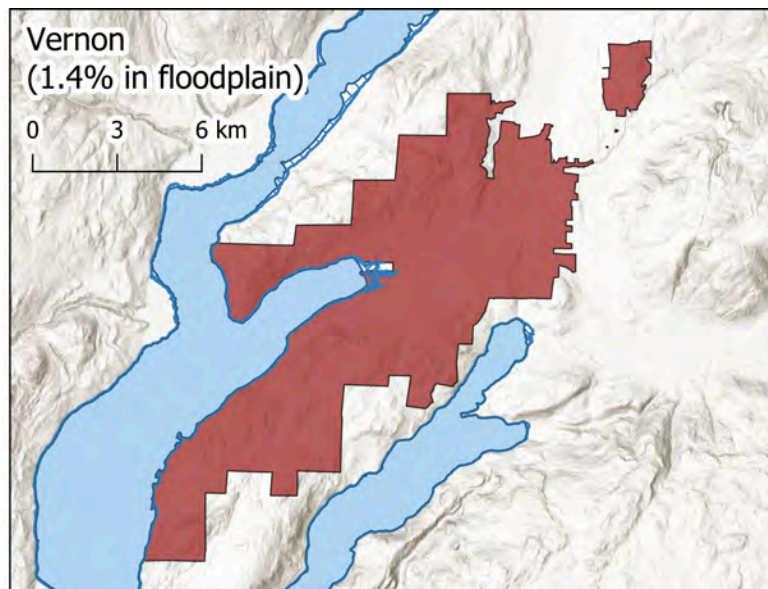
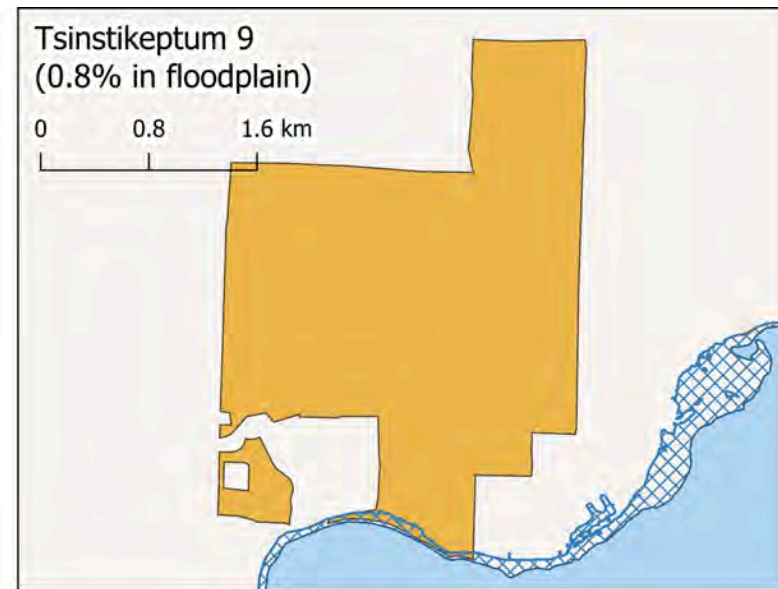
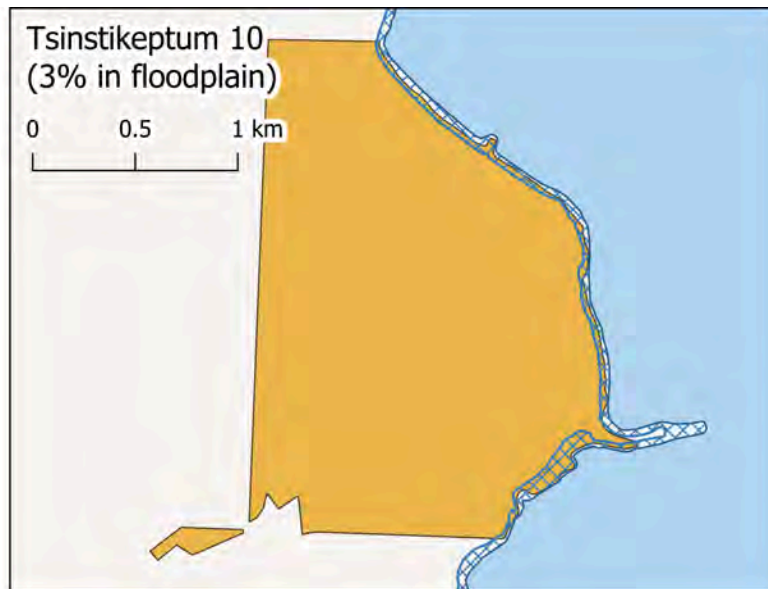












Appendix B : Climate Scenario And Hydrologic Model

B.1 Historical Flooding in the Okanagan Basin

The Okanagan Basin has a long history of regular flooding, with lake levels reported exceeding full pool capacity (342.48 metres, CGVD2013 datum) during floods as far back as 1904 (Okanagan Waterwise, 2023). Channelization of the Okanagan River between Lake Okanagan and Skaha Lake and several dam construction projects changed how subsequent floods would affect the region throughout the 20th century. Despite continuous adjustments to water management protocols and the implementation of new flood mitigation measures, water levels exceeded lake and river channels, resulting in repeated floods. This led to further changes to dam regulations, realignments of the Okanagan River, and new regional regulatory agreements. In a reversal of earlier flood-mitigation measures, re-naturalization projects have attempted to return the river to a path similar to its original course. These efforts seek to improve overall ecosystem health and reduce flood risk in surrounding areas (Okanagan Waterwise, 2023).

The floods of 2017 and 2018 provoked re-investigations of flood protocols and renewed research efforts for the entire region. In May 2017, persistent rainfall and rapid melting of upper-elevation snowpacks led to high flows in creeks and rivers. Widespread flooding of Mill Creek submerged many properties and buildings in Kelowna and led to major disruptions close to downtown Kelowna (McCullough, 2017). Water levels in Okanagan Lake and Kalamalka Lake reached historic levels since dam construction, both exceeding estimated 200-year flood levels.

Because weather and inflow forecasts had underestimated spring runoff, dam operation schedules were unprepared for the flood levels and Okanagan Lake levels rose to 343.25 metres, just 41 centimetres below flood construction levels. Low-lying areas surrounding Okanagan Lake flooded, portions of the Okanagan Indian Band were evacuated, and lake and beach access was restricted due to septic contamination concerns. To lower the lake level, authorities permitted strategic discharges that exceeded design capacity through Penticton Dam into the Okanagan River. This led to flooded properties and basements as well as downstream flooding (FLNRORD, 2017).

In 2018, the Okanagan Basin experienced another intense freshet in spring, with local flooding along several creeks and water levels in Okanagan Lake rising above full pool elevation. Unlike the previous year's flood event, officials predicted the timing and intensity

of flooding and allowed dam operations to prepare by releasing additional water ahead of peak spring runoff (NHC & IBI Group, 2023). While flow volumes in 2018 were similar to 2017, the removal of sediment and flow obstructions in the Mill Creek channel during the 2017 flood recovery process prevented significant flooding in 2018 (City of Kelowna, 2024).

B.2 Research in response to Historical Flooding

In this appendix, we provide an overview of three major projects commissioned by the regional bodies:

- Syilx Okanagan Flood and Debris Flow Risk Assessment, commissioned by the Syilx ONA (Ebbwater Consulting Inc., 2019);
- Okanagan Mainstem Floodplain Mapping, commissioned by the OBWB (NHC, 2020); and
- Flood Risk Mapping for the Okanagan Watershed, commissioned by the OBWB (NHC & IBI Group, 2023).

B.2.1: The Syilx Okanagan Flood and Debris Flow Risk Assessment

The Syilx Okanagan Flood and Debris Flow Risk Assessment (Ebbwater Consulting Inc., 2019) evaluates local and regional hazards, exposure, and vulnerability using an interdisciplinary and wholistic approach. The authors stress the importance of watershed-based perspectives and governance to identify and address flood-related risks. The study includes an assessment of several flood hazards across the Okanagan and Similkameen watersheds with respect to specific likelihoods and consequences of flooding.

The results include detailed risk maps of the two watersheds that highlight subsequent risk in the event of dam failures. The authors also identify a comprehensive list of research gaps, outline best practices, and identify primary measures to reduce flood-related risks rated according to priority and cost of the measure.

B.2.2: Okanagan Mainstem Floodplain Mapping

In 2020, spurred largely by the 2017 and 2018 floods, the Okanagan Basin Water Board collaborated with regional districts, municipalities, and the ONA to initiate floodplain mapping updates for the Okanagan River and mainstream lakes (NHC, 2020). The resulting flood maps focus on Okanagan Mainstem Lakes (Ellison/Duck, Wood-Kalamalka, Okanagan, Skaha, Vaseux, and Osoyoos Lakes) as well as portions of the Okanagan River under several flooding scenarios.

The mapping project includes an investigation of recent flooding events (2017 and 2018) and projected flood levels under mid-century (2041–2070) and late century (2071–2100) scenarios, with an emphasis on dam operation protocols. The project designs Okanagan Lake Regulation System (OLRS) protocols using a multi-stakeholder decision process, aiming to maximize benefits with regard to flood control, irrigation water supply, aquatic ecosystem needs, First Nations interests, and recreational purposes. These protocols include adjustments to future dam operations that account for changing intensity and timing of runoff.

The floodplain mapping projects future climate conditions via ensemble modeling of 50 climate projections and statistical down-scaling to achieve local resolution under the high emission scenario RCP8.5. The resulting temperature projections show significant increases throughout the year, particularly for minimum temperatures, with warming between 5 °C–10°C in the late-century projections. As a result, freezing periods are expected to decline substantially, with mid-century projections at most locations predicting decreases by roughly 50%. Closely linked to changes in temperatures, precipitation levels are generally expected to increase throughout the century, however, with warmer temperatures leading to higher rainfall levels at the expense of decreasing snowfall.

After establishing projected changes in climate conditions, the study then proceeds to assess hydrological changes using the Raven Hydrological Modelling Framework (Craig *et al.*, 2020). The hydrological model includes snow runoff, hydrological routing, and projections of lake levels given the updated dam operation protocols. Resulting lake levels then allow mapping of future flood levels and frequency analyses for specific flood intensities. Lake levels are determined using the hydrological model in addition to wave effects depending on beach topography and a customary additional 0.6 metres freeboard.

Using changing climate conditions as inputs, the hydrological model predicts earlier onsets of spring freshets, rapid snow melt, and intensified rain events, leading to less predictable runoff and increased peak flows. The research project further models maximum lake and river levels using a design flood to provide stakeholders with detailed maps covering the entire Okanagan Lake floodplain. Maximum lake levels for the design flood were set as the higher elevation between two scenarios: lake levels during a 200-year flooding event or recorded levels during the 2017 flood adjusted for changes in climate conditions. For Okanagan Lake, the design flood was set at the observed 2017 levels plus the difference between current and future modeled 500-year flood lake levels. For the mid-century projections, design flood levels are projected to reach 343.86 m. The lake level is

constructed via the observed level of 343.48 metres in 2017 in addition to 0.84 metres due to changing climate conditions minus 0.45 metres due to appropriate adjustments to dam operations. Therefore, the design flood roughly represents a 500-year event, while the recorded 2017 flood represents a 200-year flood under adjusted dam operations or a 20-year flood under current operations by the mid-century (NHC, 2022).

B.2.3: Flood Risk Mapping for the Okanagan Watershed

The Flood Risk Mapping for the Okanagan Watershed (NHC & IBI Group, 2023) builds on the results of the Okanagan floodplain mapping project to provide thorough flood risk assessments for the region. This study provides a range of values and metrics to quantify local and regional flood risk by analyzing hazard, exposure, and vulnerability. The authors evaluate flood hazards based on the OBWB's Okanagan Mainstem Floodplain Mapping project (NHC, 2020).

The value metrics in this project reflect local values and priorities as a result of engagement with key stakeholders when determining the scope of the analysis. The authors quantify vulnerability across physical and economic dimensions, including repair costs, restoration costs, and damage values. In addition to reporting dollar value costs of damage to infrastructure and buildings, the authors express risk in terms of exposed vulnerable populations, service disruptions, and exposed historic, cultural, and archaeological sites.

The results of the flood risk project are risk values for the 200-year and 500-year floods as well as Expected Annual Damage (EAD)—the average loss anticipated from flood-related damages over one year—for each vulnerability metric. The values are based on mid-century projections under the high emission scenario RCP8.5.

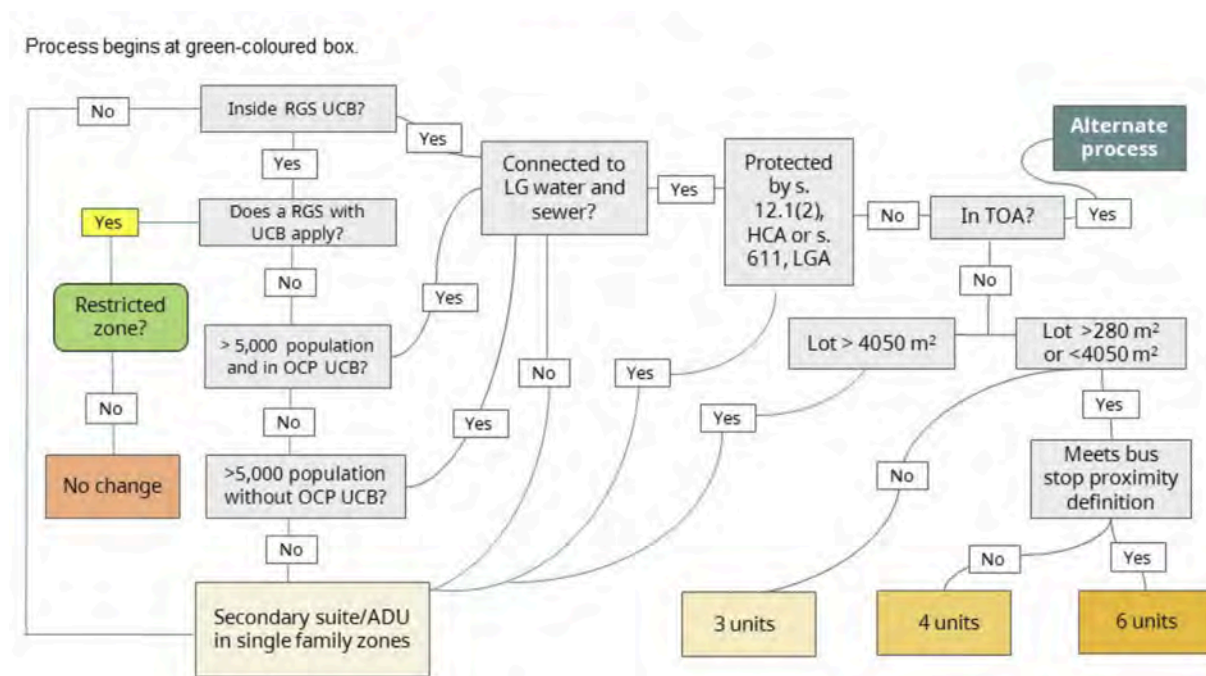
Appendix C : Zoning Regulations for Bills 44 and 47

C1 : Zoning Regulations under Bill 44

In municipalities with populations exceeding 5,000 inhabitants, zoning provisions include authorizing the construction of up to 3 units per lot where the area is <280 m², and up to 4 units per lot for those with areas exceeding 280 m². Regions currently zoned for single-family residences and positioned near transit routes featuring frequent stops, the amendments allow the development of 6 or more units per lot for lots larger than 280 m².

A summary of these amendments can be found in Figure C.1.

Figure C.1: Process Flow Diagram for Identifying Impacted Lots using GIS



Source: Infographic from the Provincial Policy Manual & Site Standards (Province of British Columbia, 2024e).

C2 : Zoning Regulations for TOAs under Bill 47

The zoning regulations classify TOAs into distinct categories, each accompanied by density and height standards. TOA Type 1 in Metro Vancouver permits a higher minimum allowable density (Floor Area Ratio (FAR)) of up to 5.0 and a minimum allowable height of up to 20 storeys for rapid transit hubs situated within 200 metres of the TOA, predominantly intended for condo towers. As the distance from the transit hub increases, the density diminishes, with a maximum FAR of up to 3.0 and a maximum height of up to 8 storeys for rapid transit hubs located between 401 and 800 metres from the TOA. Analogous regulations apply to TOA Type 1B, which concentrates on bus exchanges in Metro Vancouver, wherein higher density and taller buildings are sanctioned in closer proximity to the TOA.

TOA Type 2, which includes locales such as Victoria, Kelowna, and other medium-sized municipalities, features slightly lower density and height allowances compared to TOA Type 1. For bus exchanges within these regions, situated within 200 metres of the TOA, a maximum allowable density of up to 3.5 and a maximum height of up to 10 storeys are prescribed, suitable for mid-rise buildings. As the distance from the transit hub increases to 201 to 400 metres, the permissible density diminishes to up to 2.5, with a maximum height of up to 6 storeys, fostering low-rise and townhouse developments.

TOA Type 3 is designated for predominantly suburban and rural areas, and imposes more stringent density and height criteria. For bus exchanges within these areas, located within 200 metres of the TOA, a maximum allowable density of up to 2.5 and a maximum height of up to 6 storeys are permitted, conducive to low-rise buildings. As the distance from the transit hub increases to 201 to 400 metres, the permissible density further decreases to up to 1.5, with a maximum height of up to 4 storeys, accommodating townhouse developments.