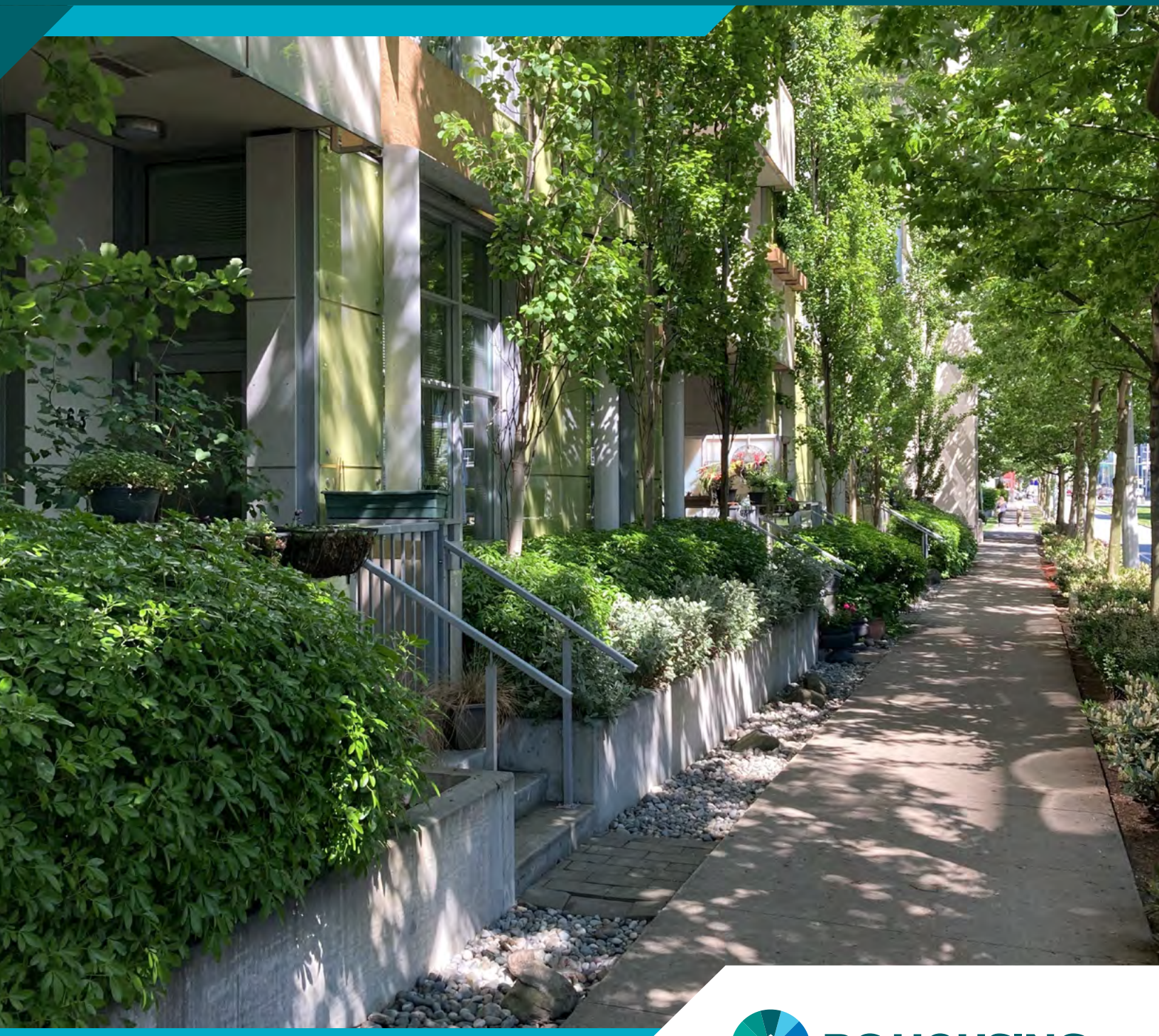
Realizing Resilient Buildings in B.C.

Discussion Paper: Recommendations to realize more resilient buildings in B.C.



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- BC Housing
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Summary

Climate change is driving an increase in extraordinary events and stresses. These challenges offer valuable insights into the shifting conditions we must consider when designing buildings across British Columbia. As extreme weather and environmental impacts intensify, they reveal an urgent need not only for new, resilient buildings but also for strengthening the structures that serve as homes and workplaces for millions of British Columbians.

Buildings are structures within a system that supports entire communities. As such, improving building resilience includes addressing structures, sites, and occupant support during adversity. Extreme heat, wildland urban interface fires, wildfire smoke, flooding, storms and power outages, drought and short-term water supply shortage, earthquakes, and stresses such as gradually changing sea level, temperature and precipitation all place new requirements on how buildings are designed, built and maintained, and how these spaces can support occupant resilience.

This document identifies key barriers and enablers to realizing more climate- and earthquake-resilient buildings in British Columbia. The process involved reviewing and summarizing existing research and analysis on the subject, and engaging multiple knowledge holders across the buildings landscape in the province and Canada. Recognizing that Indigenous Peoples in B.C. are uniquely and disproportionately impacted by heatwaves, wildfires, flooding, and other climate- and seismic-related hazards, a separate supplementary paper was developed. This paper starts to identify and document known barriers and enablers of resilient buildings that are specific to Indigenous Peoples and communities.

Barriers and enablers to more resilient buildings emerged across five key areas. It is important to highlight a significant enabler is the current resources that are being invested into decarbonization of buildings across B.C., with investments from all levels of government, the development industry, professionals in the buildings industry, non-profit housing providers, and more. While investing in decarbonization is vital to achieve our climate targets, it is equally important to ensure those investments are going into buildings that will support resilience to the changing climate–ensuring they are climate compatible. The five key areas of barriers, enablers, and recommendations include:

Data and Information: Understanding, Identifying, Disclosing and Communicating Risk

The first enabler focuses on improving the understanding and identification of climate and seismic hazard risk, coupled with enhancing information sharing and disclosure of that risk. The first step in taking action is creating an aligned view of climate risk across building sector actors and consumers. Risks will need to use reliable, standard information and be communicated across scales, including multiple actors across the building sector, government and the public to ensure consistency and to improve collective understanding of the risks.

Awareness and Capacity: Expanding Labour, Industry, Owner, Government Capacity on Resilience

Expanding knowledge across labour, industry, owners and government will support more effective integration of resilience into buildings through professional development, knowledge sharing, supportive expert networks, and more. Increased awareness of risks may encourage owners and governments to seek improved resilience measures, particularly if it impacts asset value, occupant demand, or operating costs. General skill development and recruitment are also critical to address labour shortages.

Policy Development: Building Market Demand for Resilient Buildings

Building market demand for resilient buildings takes time. There are regulatory and non-regulatory tools to support this, starting with ensuring frameworks encourage resilience, supporting communities with design parameters, demonstrating leadership through public procurement, and fostering innovation in construction techniques and contracts.

Financial Mechanisms: Improving Investment and Financing Opportunities

While some resilience measures are simple and cost-effective, most require investment by developers, owners, and/or occupants. Government financial support, better cost-benefit analysis tools, and expanded investment mechanisms will be essential (along with policy changes such as the Residential Tenancy Act noted under "Building Market Demand").

Social Capacity: Integrating Social Resilience into Building Design, Retrofit, Programming

Social connectivity enhances resilience in buildings and neighbourhoods. When neighbours are connected, they are better equipped to support each other during hazard events—especially for those who are more vulnerable due to health challenges or socio-economic factors. This can be promoted through design changes (e.g., open air corridors, rooftop amenities) and operational programming.

Thirty-seven recommendations are identified that include multiple sub-components.[1] To implement these, significantly expanded efforts and leadership are required by the Province, with collaboration and responsibility shared across many actors. Ultimately, realizing more resilient buildings will enable places where:

- People can care for themselves, their neighbours and communities during adversity
- People are protected from the elements in comfort and security now and for future generations
- Buildings have longevity, are safer, more durable and livable, and protect public and private investments

[1] Recommendations were developed between 2022 and 2023. Recent initiatives have advanced some of these recommendations, and these updates are noted where applicable. As progress continues, updates to this initial work will help all actors to understand the advancements being made and their roles in furthering resilient buildings in B.C.

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List of Recommendations

1. Introduction

Buildings across B.C. are being tested under a changing set of conditions due to climate change. In June 2021, temperatures soared up to 20°C above normal during the western heat dome, leading to 619 heat-related deaths.[2] During the same period, the Lytton Creek wildfire spread rapidly destroying most buildings in the town of Lytton, leaving thousands of people displaced. In November 2021, an atmospheric river led to floods and landslides at a scale that made it the costliest natural disaster in B.C.'s history. These events forced 20,000 people to leave their homes.[3] They also took a significant physical and emotional toll on people who suffered in many different ways. There were also large financial costs, including substantial insured damages. Furthermore, uninsured losses were estimated to be in the range of $10 to $17 billion in cost to government.[4]

These extraordinary events were made more likely because of climate change. They provide an indication of the changing conditions that we must consider when designing new buildings. They also highlight the importance of improving the resilience of existing buildings that will continue to be our homes and workplaces for decades to come.

In a 2023 poll of Canadians conducted for the Task Force for Housing and Climate, over four in five Canadians (84%) believe in the importance of developing new housing that is resilient to climate change impacts. British Columbians were among those expressing the highest levels of concern about addressing climate change in housing.[5]

Proactively incorporating resilience measures into buildings now and throughout their lifespan reduces post-event financial impacts to society. This approach could make for more efficient infrastructure investment if incorporated into lifecycle planning. This would help to produce long-term jobs and provide savings to all levels of government. In addition, it would increase comfort and wellness, as well as reduce displacement and psychological impacts of events, and saves lives.[6]

[2] Government of Canada. Accessed November 2022. Surviving the heat: The impacts of the 2021 western heat dome in Canada.

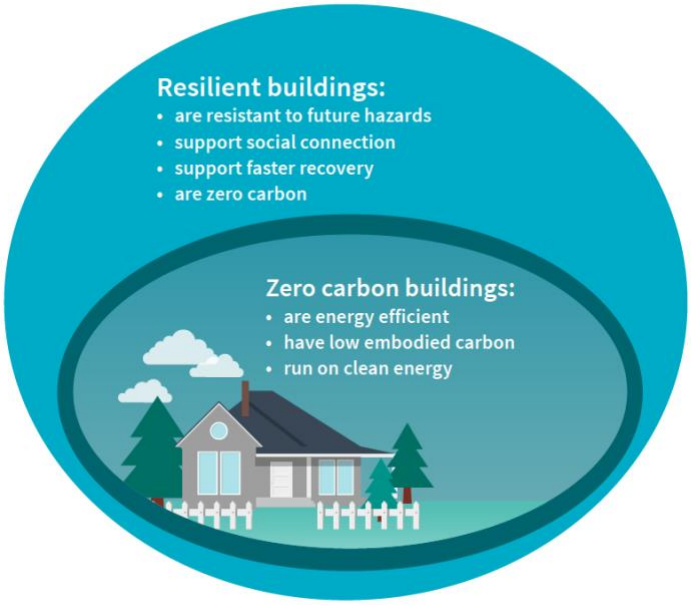
[3] University of Victoria. Accessed December 2022. Scientists link 2021 B.C. floods to human-induced climate change.

[4] Lee and Parfitt. 2022. Canadian Centre for Policy Alternatives. A climate reckoning, The economic costs of BC's extreme weather in 2021.

[5] Abacus Data for the Task Force for Housing and Climate. Accessed December 2023. Housing and Climate Polling Questions September 2023. Housingandclimate.ca

[6] Armstrong and Nasr. 2022. NRC. Delivering Climate Responsive Resilient Building Codes and Standards: A Canadian Perspective.

Significant investments are being directed toward the necessary goals of housing affordability and achieving carbon neutrality for all buildings in B.C. by 2050. At the same time is essential to consider that these buildings must keep people safe and healthy in the face of new hazards and risks. Many Canadians believe that it is important to address housing affordability without compromising Canada's climate goals.[7] These investments must prioritize synergies that achieve both carbon neutrality and resilience in buildings. This could have the effect of avoiding potential losses in value while ensuring they support people and are compatible with future conditions.



1.1 Purpose of this Project

The purpose of this project is to identify barriers and enablers to resilience measures for climate-related hazards and earthquakes in buildings in the B.C. context. Undertaking this step in the context of substantial cross-sector engagement supports a larger goal to advance the dialogue among organizations across the province. This dialogue focuses on the big actions and investments needed to improve the resilience of our buildings to increasing hazards. The intention is that this would result in benefits for the province as a whole.

The key project deliverables are two-fold. First, this discussion paper provides overarching recommendations to overcome the key barriers to realizing more resilient buildings. Second, a toolkit for B.C. local governments provides guidance on the tools and potential roles local governments can employ to support increased uptake of resilience measures.

This discussion paper is intended for a broad audience. It provides a distillation of the complexity of the challenge we are facing to improve the resilience of buildings across B.C. The recommendations highlight the need for multiple actors to be involved and support the transition. In particular they emphasize the important role of the federal and provincial governments. The second deliverable is intended primarily for provincial government as a stepping stone towards supporting improved understanding and support of Indigenous led-resilience in the building sector. It also aims to foster an improved understanding of and response to the specific barriers faced by Indigenous communities. The third deliverable is specifically intended for a local government audience.

This project is one of many initiatives underway to support resilience in buildings. BC Housing's Mobilizing Building Adaptation and Resilience (MBAR)[8] program is a knowledge and capacity-building project to mobilize change in the building sector. Numerous stakeholders have been involved over several years to identify

[7] Abacus Data for the Task Force for Housing and Climate. Accessed December 2023. Housing and Climate Polling Questions September 2023. Housingandclimate.ca

[8] BC Housing Research Centre. Mobilizing Building Adaptation and Resilience (MBAR). Accessed December 2022.

resilient measures for buildings and to begin testing them through pilot projects. The current project builds on findings from the MBAR program and other relevant initiatives.

This discussion paper presents the recommendations developed for the Realizing Resilient Buildings in B.C. project, highlighting roles for various levels of governments and other stakeholders to address broad, systematic barriers that hinder the implementation of resilient buildings.

1.2 Scope of this Project

This project reviewed barriers and enablers to more resilient buildings across all of B.C., including all contexts from urban to rural and remote communities. Although the focus was particularly on residential, public sector, and mixed-use buildings, the findings are generally applicable to most building types. The research was conducted in the context of natural hazards of most relevance to B.C., given the anticipated changes resulting from climate change, and include:

Extreme heat

Flooding: Coastal and Riverine/Lake

Flooding: Pluvial

Wildland Urban Interface Fires

Wildfire smoke and air quality

Storms and power outage

Drought and short-term water shortage

Earthquake

The research also considered climate-related stresses such as gradually changing sea level, temperature, and annual precipitation.

This document will discuss achieving increased resilience in buildings, which involves:

- Building and site design strategies
- ongoing maintenance and operational strategies
- Systems that enhance occupants' capacity to respond to threats, hazards and events

Broader community-scale and area-scale planning strategies are not included.

In addition to increasing resilience, building decarbonization is a related and essential focus for society. Although this discussion paper does not focus on achieving carbon neutral buildings. It considers and highlights the opportunities for synergies with achieving carbon neutral buildings.

1.3 Resilience in Buildings for Indigenous Communities

To support this project, a supplemental paper focused on understanding the unique barriers and enablers faced by Indigenous communities. The measures address climate-related hazards impacting buildings and homes of Indigenous Peoples in B.C. This work involved a review of known barriers from other engagement processes and Indigenous-led initiatives. Additionally, it included interviews with First Nations knowledge holders, to understand what has supported climate-resilient community buildings. The goal was to understand past successes and learn about First Nations-specific barriers and enablers for resilient buildings. While some specific barriers and enablers are referenced in this document, the main outcome of this work is a stand-alone document. This document aims to guide BC Housing and Provincial efforts to build deeper relationships with Indigenous Peoples and communities. The shared objective is to support enhanced Indigenous capacity through continued engagement.

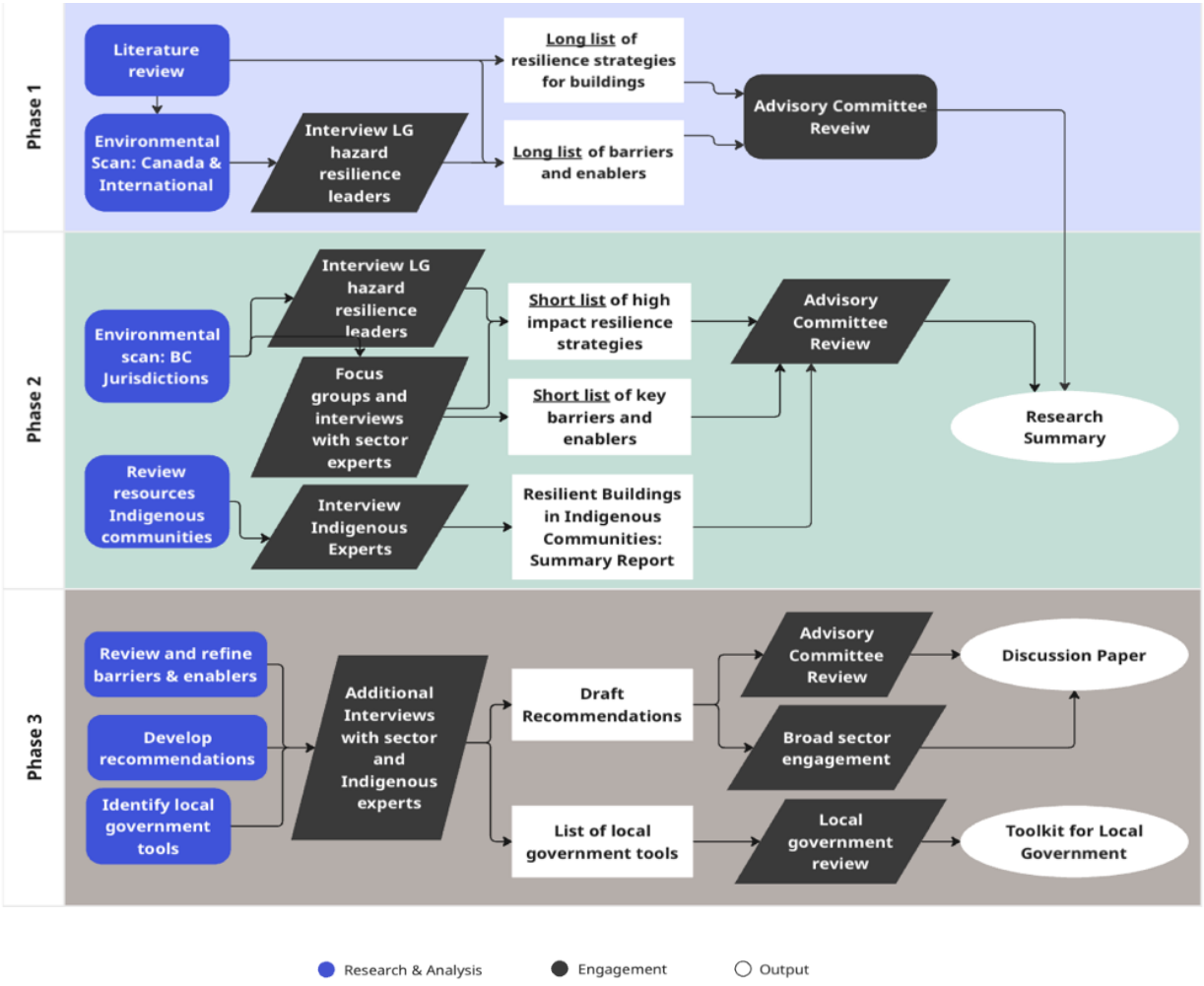
Indigenous Peoples include First Nations, Métis, and Inuit. The term Indigenous is used in international contexts, specifically the United Nations Declaration on the Rights of Indigenous Peoples. This is established as a framework for B.C. through the *Declaration on the Rights of Indigenous Peoples Act* (Declaration Act). Each of these groups are distinct with specific rights, interests, cultures, and histories. The supplemental paper has a strong focus on First Nations contexts, as there are more than 200 distinct First Nations in B.C. with historic and present-day implications with the colonial reserve system. This is an important and complicated dynamic to unpack. First Nations in B.C. have seven distinct language families and 36 languages with distinct cultures and governance systems. First Nations are also rights and title holders in B.C. While the interviews for the supplemental paper focused on First Nations contexts, future research should aim to bring in the perspectives of Métis and Inuit Peoples in B.C. This discussion paper incorporates some considerations for First Nations contexts based on the initial research and engagement conducted. Care has been used to ensure each of these terms are used correctly given the specific contexts in each section of this discussion paper.

1.4 Research Approach

The project was undertaken in three phases (see Figure 1). The first phase included a broad jurisdictional scan and literature review of the barriers and enablers associated with improving climate resilience of new and existing buildings. This was followed by the second phase, which involved applying the initial research findings to the B.C. context. This phase involved focus groups and interviews with a broad selection of experts and knowledge holders. The purpose of these two phases was to capture key findings and lessons from current research and experience about barriers and enablers to improve the resilience of buildings in general. Then, these findings were reviewed with B.C. representatives to identify the barriers and enablers that are specific to the B.C. context. The final phase involved analysis of findings and development of recommendations. These recommendations were then presented to and vetted by a broader selection of government and stakeholder representatives. At each step throughout the process, a project Advisory committee provided valuable insights that informed and helped guide the process and findings.

This project sought to build on the body of work already underway and completed in this field. The starting point for the evaluation of barriers and enablers was an extensive list of strategies identified and vetted through previous projects (see Appendix A for a list of sources for the strategies). The phase 1 literature and jurisdiction reviews provided insights on barriers and enablers experienced generally, or in other jurisdictions (see Appendix B for a list of sources for the literature and jurisdiction review). Engagement with sector experts and knowledge holders in phases 2 and 3 helped to apply the barriers and enablers to a B.C. context (see Appendix C for a list of organizations engaged). Throughout the project, attention was paid to identifying barriers that apply in different contexts across B.C., and to considerations for equity and reconciliation.

Figure 1. Overview of project activities, engagement, and outputs



2. What is a Resilient Building?

2.1 Understanding resilience

Canada's draft National Adaptation Strategy provides a vision for climate resilience in Canada: *"All of us living in Canada, our communities, and the natural environment are resilient in the face of a changing climate. Our collective adaptation actions enhance our well-being and safety, promote justice, equity, and reconciliation with Indigenous Peoples, and secure a thriving natural environment and economy for future generations."*[9] Building on and reframing this definition, resiliency can also be described as the ability of a community to

- Be able to care for themselves
- To help neighbours that need support
- To prepare now so that future generations do well in the face of adversity

How do we apply these concepts to a building? Buildings provide the following core functions: shelter, comfort, security, and privacy. To be resilient, buildings must continue to provide these functions in the face of current and future hazards and adversity. Resilient buildings must also include future hazards and adversity that we have not yet experienced but are possible in our shifting climate and seismic contexts.

Here is a **definition of a resilient building** that has been developed through the course of this project, building from literature and participant input. A resilient building:

- Enables people to care for themselves, their neighbours and communities in the face of adversity, including the chronic and acute effects of climate change and natural hazards
- Protects people from the elements, provides comfort, security and privacy for current and future generations
- Has longevity, is safer, more durable and livable, supports a quicker recovery, and protects public and private investments

2.2 Resilient buildings support people and communities

The definition above highlights that buildings are structures in a system that supports a whole community. In the scope of this project, improving building resilience includes considering the physical structure of the buildings. It also includes how the buildings and sites support occupants in the face of adversity.

The Coroner's Report on the B.C. 2021 Heat Dome extreme heat event found that most people who died from heat-related illness, died at home. Buildings play an integral role in either compounding the hazard threat from climate-related and seismic hazards and stresses or reducing the potential impacts. Buildings can be designed to enhance social connections that facilitate preparedness and post-event responses.

As buildings are updated and redeveloped, it is critical that these efforts advance equity. Equity is one of the guiding principles in Canada's draft National Adaptation Strategy. Equity includes prioritizing populations and communities at greater risk of climate change impacts. "*As we build systems and solutions that are more climate resilient, we have the opportunity to address systemic inequities that make people vulnerable*."[10]

[9] Government of Canada. 2022. Canada's National Adaptation Strategy.
[10] Government of Canada. 2022. Canada's National Adaptation Strategy.

In considering what impacts may occur and how to reduce them, it is crucial to include a variety of perspectives. It is particularly important to hear from individuals likely to be disproportionately impacted during disruption. For example, in heat events, needs range substantially for a given temperature, from thermal comfort and productivity for some, to significant safety issues for others. Varied needs must be considered for support systems as well, such as refrigeration of medication and access to power for medical devices.

2.3 Alignment with zero-emission buildings

Efforts are underway and progress is taking place to improve building energy efficiency in BC. Steps are being taken toward all buildings being carbon neutral by 2050. While significant investments of resources are being directed toward this essential goal, it is paramount to consider that these investments are for buildings. These buildings need to support people in the face of different hazards and risks than have been experienced in the past. These investments must prioritize synergies that achieve both carbon neutral and resilient buildings, otherwise known as "climate compatible buildings." This avoids potential losses in value when assets don't meet the needs of the future within their expected lifespan. It also supports people to weather future conditions. Table 1 provides examples of how resilience can be factored into zero-emission building strategies.

Table 1. Examples of transforming zero-emission strategies into resilient zero-emission strategies

Zero-emission building strategies	Resilient zero-emission building strategies
Energy efficient building envelopes and mechanical systems	• Improve airtightness, and include good ventilation and air filtration effective for wildfire smoke • Prioritize older buildings with more vulnerable occupants
High-efficiency electric heating	• Include high-efficiency cooling systems • Add backup power • Prioritize cooling in units or in rooms on site for populations more vulnerable to heat in units (e.g., reduced mobility, elderly, certain medical conditions)
On-site renewable energy	• Add energy storage or backup power suitable for use during future hazard events
Passive heating and cooling designs	• Include options for active heating and cooling in preparation for more extreme conditions • Add space for larger mechanical systems
Low-carbon building materials	• Materials are resistant to all hazards identified by local risk assessment (fire, flood, wind, snow, earthquakes, etc.)
Energy and water conservation	• Plan for backup sources for power outages or periods of drought • Increase occupant awareness of alternative options
Site planning preserves and enhances natural carbon sinks	• Plan for trees and ventilation to provide cooling effects, areas of respite and social connection, water management during high precipitation or drought periods

Zero-emission building strategies	Resilient zero-emission building strategies
Redevelop sites to enable higher density, walkable, accessible and complete communities	• Redevelop sites in a manner that increases social connection, providing continuity of community and avoiding displacement from redevelopment

2.4 Key terms and concepts

The following list clarifies the meaning and significance of key terms used in this work:

Barrier: An obstacle that impedes the implementation of a strategy. For this project, barriers are grouped into four categories: technical, skills and capacity; political and regulatory; economic and financial; social and informational.

Climate compatible: Resilient and net zero by 2050.[11]

Enabler: Something that makes the strategy possible by creating the right environment for change. This may be a policy, program, regulatory framework, network, tool, or other element that reduces or eliminates barriers.

Hazard: An event or condition with the potential to cause harm. Climate-related hazards are those associated with the climate and affected by climate change. Earthquakes are geological hazards.

- ***Chronic***: Physical hazards that result from longer-term shifts in climate patterns (e.g., consistently lower snowpack year-after-year contributing to annual droughts).
- **Acute**: Physical hazards that are event-driven (e.g., extreme weather events such as an extreme heat event or flood).[12]

Equity: "Equity refers to achieving parity in policy, process and outcomes for historically and/or currently underrepresented and/or marginalized people and groups while accounting for diversity. It considers power, access, opportunities, treatment, impacts and outcomes."[13]

Social vulnerability: "The characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard" (Wisner et al., 2004, p. 11). Disproportionately impacted is often used instead of vulnerability to remove the connotation of inherent sensitivity.

[11] Chopik C., Stewart C. Designing the Path to Climate Compatibility. Accessed December 2023.
[12] Adapted from Task Force on Climate-related Financial Disclosures. 2017.
[13] University of British Columbia. Equity and inclusion glossary of terms. Accessed December 2022.

3. Resilient Buildings in the B.C. Context

3.1 Seismic and climate risks of relevance to buildings in B.C.

Emergency Management B.C. lists over 50 hazards of relevance in the province depending on location.[14] These include technological hazards such as cyberterrorism and accidental hazards such as chemical spills. Natural hazards make up a third of the list. Many of these are influenced by climate change and can be referred to as climate-related hazards. Earthquakes, another natural hazard, are also included in the scope of this review.

There are active faults in the Pacific Northwest that place B.C. in a moderate to high-risk earthquake zone. Earthquakes are probabilistic events that may or may not occur within the lifespan of a building. Although the frequency of earthquakes in B.C. are relatively low compared to other regions that are quite active (e.g., Chile and Japan), B.C. is at risk of experiencing three different types of earthquakes:

- An offshore subduction earthquake up to a Magnitude 9, which would likely affect a very large area of southwest B.C.
- A moderate depth "in-slab" earthquake of Magnitude 7+ that would likely affect a large area around its epicentre
- A shallow "crustal" earthquake of Magnitude 7+ that would affect a smaller local area around its epicentre

The relative infrequency of earthquakes poses a challenge for B.C., as the public awareness and concern for the occurrence is quite low relative to other regions where earthquakes are experienced more often. The severity and consequence of such an event depends on many factors. One scenario examined the impact of a 6:16 am 6.8 Magnitude earthquake centered just off the coast of Vancouver. It estimated that over 2,000 'red-tagged' buildings would collapse or sustain complete damage. A further 12,600 'yellow-tagged' buildings would sustain extensive damage but continue to be habitable with temporal or spatial restrictions.[15] In this scenario, it is estimated that there would be over 2,000 injuries and nearly 100 fatalities. There would also be over 40,000 people displaced for up to 90 days and over 4,500 people displaced for 180 days. The Insurance Bureau of Canada estimates that a Magnitude 9 earthquake in southwest B.C. could have a financial impact of almost $75 billion.[16]

Climate-related hazards once seemed to be future risks. However, they have more recently become highly relevant to people across B.C. as the frequency and severity of these hazards are already being experienced. It should be noted however, that the experience ranges significantly across the province. Communities across B.C. will be exposed to different hazards and at different levels of hazard intensity or threat now and in the future. Communities will also have diverse sensitivities both physically and socially, and will have different levels of capacity to adapt.

[14] Government of BC. Accessed November 2022. Know the hazards in your community.

[15] Natural Resources Canada. 2022. Exercise Coastal Response 2022: Scenario Earthquake and Potential Impacts Overview Document.

[16] Natural Resources Canada. Accessed November 2022. Earthquake hazards and risks.

To evaluate the barriers and enablers to realizing resilient buildings across B.C., the first step was to identify a set of climate-related hazards that present significant risks to B.C.'s buildings. In 2019, the Province assessed 15 climate-related hazard event scenarios for their risk to B.C. To do so, they rated the likelihood the scenario would occur in 2050 and the severity of potential consequences. This provided an overall indication of risk across all geographies, sectors and contexts in B.C.[17] A subset of these risks is relevant to buildings (including severe wildfire season, heat wave, seasonal and long-term water shortage, and moderate and severe flooding). In addition to climate hazard scenarios identified through the provincial risk assessment, this project identified climate-related hazards through work in this field to date, including:

- Pacific Climate Impacts Consortium Plan2Adapt projected conditions and impacts for regions throughout B.C.[18]
- BC Housing MBAR design discussion primers [footnote 5]
- B.C. Health Authorities Climate Resilience Guidelines for BC Health Facility Planning and Design[19]

Table 2 outlines the seismic and climate-related parameters identified as most relevant to buildings in B.C. Along with examples of anticipated changes to climate parameters due to climate change and their potential impacts on buildings, these parameters set the context for evaluating barriers and enablers for more resilient buildings.

These examples are not exhaustive; rather, they provide a framework for the types of considerations that need to be taken into account as buildings across B.C. are built or renovated over the coming years. Relevant hazards and their potential impacts need to be identified and assessed at a local scale.

[17] Government of BC. 2019. Preliminary strategic climate risk assessment.

[18] Pacific Climate Impacts Consortium. Accessed November 2022. Plan2Adapt.

[19] Energy & Environmental Sustainability (EES) and Integral Group. 2020. Climate Resilience Guidelines for BC Health Facility Planning and Design, Version 1.1.

Table 2. Anticipated changes to climate parameters and potential impacts for buildings[20]

Parameter	Hazard	Examples of impacts to buildings and occupants	Design and operation strategies to address impacts
Temperature and precipitation	 Extreme heat	• Overheating of building systems • Increased electrical load needs for cooling • Increased morbidity and mortality as indoor spaces overheat	• Active cooling, heat pumps • Grid resilience • Vegetation to provide cooling • Install misting capabilities in outdoor respite areas • Exterior shading and other passive cooling strategies to reduce load on the grid
	Gradual increase in temperature and average relative humidity	• Change in heating and cooling demand • Increased indoor humidity and fungal (i.e., mold) growth	• Passive cooling design, exterior shades, heat pumps • Vegetation to provide cooling • Model window to wall ratio, use appropriate window technology • Materials that perform well with high-humidity
	Cold snaps, snowfall, ice, ice storms, freeze/thaw cycles	• Rain on snow increases load on roof • Power outages may increase • Frozen or ruptured pipes • Mobility impacts • Stormwater drainage issues	• Backup power / storage • Maintenance schedule and manual for emergency backup systems with budget for inspections • Consider projected snow loads in roof design, including assemblies, snow sliding between structures, protecting mechanical equipment • Materials that perform well in high humidity and freeze-thaw conditions

[20] C40 Cities. Accessed January 2023. City climate hazards.

Parameter	Hazard	Examples of impacts to buildings and occupants	Design and operation strategies to address impacts
Flooding	 Flooding: Pluvial  Flooding: Coastal and Riverine/Lake Gradual Sea Level Rise; Landslide	• Access and egress to building may be temporarily reduced or blocked, especially to underground parking • Flooded basements damage contents and structure, risk to occupants (electrical shock, mould growth) • Elevators and mechanical rooms below flood level may be impacted and non-functional • Hydrostatic pressure may cause damage to the building • Sewer overflows may occur • Increased corrosion on building materials and erosion of foundations • Damage to structures from debris in coastal floodwater striking building • Salt water intrusion into groundwater reducing durability of underground infrastructure • Impact from waves causes building damage • Occupants may not have insurance coverage for flood, or may only cover some types of flood damage	• Build above flood construction levels, with setbacks as defined by site • Account for floodwater “short-cuts” (shafts, vents, conduits) • Install backflow valves • Install heavy-duty sump pumps at lowest point, with backup power • Protect below-grade foundation walls from water ingress (continuous fully-reinforced membrane) • Mould-resistant materials • Site permeability and water detention • Maintain sewer and stormwater pipes in good condition to minimize infiltration • Right-size infrastructure for density and future rainfall • Disconnect downspouts where suitable
Wildfire	 Wildland Urban Interface Fires	• Disruption of utilities (power outages, water shut off, etc.) • Damage to buildings and contents, potentially irreparable • People are displaced for long period of time; contaminated sites delay redevelopment • Increased insurance premiums and potentially reduced coverage • Affected areas more susceptible to flooding and landslide	• Underground power lines • Fire-rated building materials • Vegetation management (e.g., fire resistant varieties, no vegetation next to structure) • Combustibles management (e.g., store propane tanks away from buildings)

Parameter	Hazard	Examples of impacts to buildings and occupants	Design and operation strategies to address impacts
	 Wildfire smoke and air quality	• Decreased indoor air quality • Decreased opportunities for occupants to exercise outdoors	• Envelopes well sealed with filtration on ventilation system • Close outdoor air intakes during smoke event • Storage and stockpiles of enhanced filters (e.g., carbon, MERV 14, HEPA)
Water scarcity and drought	 Drought and short-term water shortage	• Reduced source of potable water • Increased watering restrictions (e.g., Sunshine Coast extreme drought conditions 2022)	• Water conservation programs with occupants • Non-potable water reuse systems with onsite treatment for toilets, irrigation, etc. • Potable water storage on site • Drought-tolerant vegetation • Rainwater retention techniques
Wind	 Storms and power outage	• Damage to building from debris and trees falling • Power outages increase • Damage or loss of roof and enclosure elements	• Choose trees and vegetation resilient to wind and undertake proactive pruning and maintenance • Backup power • Mitigate load with aerodynamic structures, building anchorage, reduced wind tunnel effects for entrances • Anticipate higher wind loads for solar installations • Avoid rooftop equipment, or ensure rated for extreme wind with necessary tie downs

Parameter	Hazard	Examples of impacts to buildings and occupants	Design and operation strategies to address impacts
Earthquake	 Earthquake	• Irreparable damage to the building, immediate evacuation • Damage to utilities servicing the building • Fire following earthquake is a significant risk • Injury and death to occupants • Loss of elevator function and access/egress	• Performance-based seismic design • Consult microzone seismic mapping • Increased requirements for buildings in areas of high hazard threat. • Integrate motion instrumentation • Retrofit existing “soft stories” • Manual operation of all exits / entrances • Emergency manuals, kits, training, alerts and information • Ensure rooftop equipment has necessary tie downs • Reinforce pipe joints and bracing

3.2 Climate change policies and responsibilities relevant to buildings in B.C.

Resilient building measures span scales and realms of authority, and have a complex web of stakeholders:

- Land use planning determines whether buildings are sited in hazard-exposed areas
- Local authority policies and regulations dictate design parameters
- Federal and provincial policy and regulation influences design and implementation of programs
- Political and economic contexts set bounds on what is possible
- The development and construction industry must implement all the measures

Federal government

Codes and standards: Canada's national model codes provide technical requirements for new buildings, alterations to existing buildings, and the demolition of existing buildings. Although B.C. adopts its own building code, the national model codes provide a baseline from which provinces may adapt or amend to suit regional needs. In 2020, B.C. signed an agreement to harmonize provincial building codes with the national code. The National Energy Code of Canada for Buildings is also an important reference document. There are upcoming changes that will include requirements for operational carbon intensity in the code (9.36 and NECB) and limits on embodied carbon.

There are substantial initiatives being led by the National Research Council of Canada and the Standards Council of Canada. These seek to better integrate resilience to climate change and extreme events into building codes and standards. Key steps include:

- A new approach to climatic design data that incorporates the impacts of climate change
- National guidance on wildland urban interface design and flood-resilient construction
- Updated National Building Code (NBC) references to standards (e.g., CSA S478 for durability of buildings)
- Ongoing policy discussions to develop solutions for overheating and urban flooding
- The identification of 36 strategies to improve inclusion of climate change into standards

The first alterations building code is also being developed, a code specifically for buildings undergoing renovations. In the first version, the alterations code will only focus on improving energy efficiency. All of these efforts are ongoing and it will be several years before substantive changes are completed.

Climate strategy: In relation to increasing the resilience of buildings, federal policy is guided by the Pan Canadian Framework on Clean Growth and Climate Change, which has commitments to invest in climate-resilient infrastructure, and to develop climate-resilient codes and standards. The recently released draft National Adaptation Strategy (Fall 2022) provides an overarching direction and goals for work to increase resilience in Canada. It introduces action planning areas that are complementary to provincial, territorial, local government and Indigenous action already underway. The Canada Green Buildings Strategy outlines goals and strategies to achieve net-zero buildings. It also highlights climate resilience as part of the core goals for both new buildings and retrofits.[21]

[21] Government of Canada. July 2022. Discussion paper: The Canada green buildings strategy.

First Nations governments

Codes: There is a lack of regulatory clarity over buildings on First Nations land. First Nations governments can incorporate by reference the National Building Code or its equivalent into their own laws. Communities that have established Land Code have an opportunity to set their own building laws and housing expectations. Despite enforceability being a constraint, they often reference the BC Building Code as a requirement.[22] In Land Code communities, there are various community-driven pathways for building code use on reserve lands. These include the adoption of codes through subdivision or zoning laws. Treaty First Nations can establish their own regulatory framework for buildings, and may choose to reference the BC Building code. Technical Safety BC administers the *Safety Standards Act*. It provides safety oversight through permits, licenses and certifications where First Nations have determined to apply this act.

Climate strategy: First Nations communities are already leading and driving climate action initiatives and policies throughout the province. In 2022, the BC Assembly of First Nations released a Climate Strategy and Action plan that outlines 20 urgent calls for climate action. It also outlines pathways, strategies and actions. Strategies include:

- Establishing and maintaining culturally appropriate, energy-efficient, and resilient housing and buildings
- Addressing systemic inequities of housing security for First Nations on and off reserve
- Strengthening First Nations management and capacity to build homes and buildings in their own self-determined ways[23]

Provincial government

Codes: The provincial government is responsible for the regulation of building and construction in B.C. Through legislation, the Province creates municipalities and empowers them with certain delegated authority. The B.C. *Building Act* gives the Province sole authority to establish requirements through provincial building regulations like the BC Building Code (with the exception of Vancouver which has its own Vancouver Building Bylaw). This serves to bring greater consistency to technical requirements for new construction and renovations across B.C. This provides consistency in application of building standards. However, it also constrains municipalities from establishing their own technical standards to achieve resilient buildings, unless it is an unrestricted matter.

Unrestricted matters: Select matters have been deemed "unrestricted" in the Building Act. This allows local governments to establish technical requirements that differ from the BC Building Code. Unrestricted matters of relevance to this report include those defined in:

- Development permit areas (LGA 488)
- In relation to wildfire (where requirements for building form, exterior design and finish vary)
- In relation to promoting energy or water conservation or the reduction of greenhouse gas emissions

[22] The Nisga'a Nation, the first to negotiate a modern day comprehensive treaty in BC, establishes its own building regulations under s. 69 of its Final Agreement Act. The same framework is applicable to the self-governing nations of Westbank and Sechelt under their respective federal self-government agreements.

[23] First Nations Leadership Council. 2022. BC First Nations Climate Strategy and Action Plan.

- In relation to protecting development from hazardous conditions other than wildfire such as flooding, mud flows, torrents of debris, erosion, land slip, rock falls, subsidence, tsunami, or avalanche

In some cases, construction is desired on land likely to be subject to flooding, mud flows, debris flows or related hazards. In these cases, a building official can require a report from a qualified professional demonstrating it can be safely built. The building official can also refuse to issue a building permit if the building is not constructed according to the recommendations from the qualified professional. The Building Act also unrestricts measures for buildings on a defined flood plain below the flood level.

Both the Province and Codes Canada have mandates to create an energy efficiency code for alterations to existing buildings by 2024.[24] The Province is developing an Existing Buildings Renewal Strategy. It will consider regulatory options to ensure buildings are more energy efficient, lower carbon and resilient to events like earthquakes, wildfires, heat waves, and floods.

Risk assessment and strategy: In 2019, the government released a preliminary strategic climate risk assessment to help better understand the climate-related risks in B.C. Building from this, the government developed the Climate Preparedness and Adaptation Strategy (Actions for 2022-2025). The strategy includes a focus area on climate-ready infrastructure and buildings. Initiatives identified include developing new climate resilience design standards and guidance for provincial public sector organizations, and supporting BC Housing's MBAR knowledge and capacity building project. The Province is also currently updating the provincial flood strategy. In its draft form it includes a focus on four program areas:

- Understanding flood risks
- Strengthening flood risk governance
- Enhancing flood preparedness, response and recovery
- Investing for flood resilience

A provincial disaster and climate risk and resilience assessment is underway at the time of writing with a scheduled completion date later in 2024. Regional assessments across the province are planned to begin in 2025.

Priority on housing affordability: The Province has identified housing affordability as a priority. It has been advancing a number of initiatives to improve affordability through supply, improving the development approvals process, and more. In the fall of 2023, the Province introduced the *Housing Supply Act*. Its aim is to increase the pace of development through Provincially-established housing targets for municipalities with the highest demand and projected growth. The *Strata Property Act* was also recently amended to prevent strata corporations from restricting rentals.[25] Bills 44 and 47 were passed in Fall 2023. They require local governments to:

- Shift their planning process to an up-front framework
- Pre-zone land to meet their housing needs
- Reduce the use of rezoning processes for small-scale multi-unit housing (Bill 44) and transit-oriented development areas (Bill 47)

[24] Canadian Commission on Building and Fire Codes. 2020. Final report – Alterations to existing buildings.

[25] Magre, Visram and Sawyer. 2022. New legislation seeks to expand housing supply in British Columbia.

Bill 44 requires local governments to allow for increased density on lots currently zoned for single family homes or duplexes. It also requires that they update Official Community Plans every five years in a manner that reflects projected housing needs. The small-scale multi-unit housing policy (SSMUH) is introduced through changes to the Local Government Act and Vancouver Charter. An exemption from the requirements of the SSMUH legislation can be sought in writing from the Province. This is possible provided the local government has obtained a report in which a qualified professional certifies that: increasing the density would increase the threat or risk from the hazardous conditions, and the threat or risk from the hazardous condition cannot be practically mitigated.

Local governments

Development approvals: Local authorities play an important role in shaping communities, including the building and renovation process. For local governments, the role is largely defined by the *Community Charter* and *Local Government Act* (LGA), except in Vancouver which operates under the *Vancouver Charter*. The LGA provides the authority for local governments (municipal and regional) to develop tools and requirements, including:

- Regional growth strategies
- Official community plans
- Zoning bylaws
- Density bonusing
- Development variance permits
- Development permits
- Development cost charges
- Subdivision and development control bylaws

Local governments have considerable discretion on how these tools are deployed. This can result in widely varying processes in different communities, and added complexity for the development industry. Many local governments use the discretion of the rezoning process to achieve sustainable buildings standards and receive community amenity contributions (including affordable housing/ daycares, etc.) that are not provided for by provincial statute. While this may contribute to more resilient communities, it results in a patchwork of standards across the province. This leads to uncertain, lengthy and costly development approvals as identified in the 2019 Development Approvals Process Review study undertaken by the Province. [26] [27]

Administering codes: The *Community Charter* enables local governments to adopt building bylaws that establish how the provincial building codes are administered and enforced locally. Through the use of building permits, local governments confirm whether new construction meets provincial health and safety standards, and keep records. There are 162 municipalities in B.C. that vary widely in size, political leanings and levels of awareness of climate change and building resilience. To achieve resilient buildings in B.C., strategies need to be relevant to a diverse range of communities.

Risk assessment and strategy: Local authorities have been actively undertaking efforts to better understand local climate-related risks. They have also been working to develop climate adaptation strategies that better

[26] Note that part of the stated intention of the new provincial legislation (2023) to introduce Bill 44 is to reduce the need for rezoning processes to streamline housing approval.

[27] Pinna Sustainability Inc. and Gary Penway Consulting. 2019. Development approvals process review – Final report from a province-wide stakeholder consultation.

prepare communities for risks presented by the changing climate. The modernized Emergency Program Act, the Emergency and Disaster Management Act (EDMA) requires specifics related to undertaking risk assessments. Some are also leading in integrated and complementary approaches to address mitigation and adaptation that maximize co-benefits, minimize potential conflicting policies, and streamline the process.

Concerns about "downloading": As discussed above, several responsibilities are delegated from the provincial to local governments to be managed on a more local scale. However, there are often cited concerns about "downloading" of responsibilities when it is not accompanied by sufficient resources. This leaves important issues to be addressed with already limited and strained local government budgets and capacity. Recently, the Union of BC Municipalities (UBCM) highlighted the issue of dike responsibility through a resolution (September 2022). The resolution demands the provincial government take back responsibility for dikes and significantly increase funding for flood preparedness and mitigation.[28]

3.3 Who else is involved in new and renovated buildings

In addition to governments that provide the regulatory and policy frameworks outlined above, there are numerous key actors involved in the building development and renovation.

The **design and development industry** involves a number of different contributors, including

- Developers
- Architects
- Landscape architects
- Engineers
- Building code consultants
- Building envelope professionals
- Environmental professionals
- Construction contractors
- Project managers
- Skilled trades
- Construction labourers
- and more

The residential development sector in B.C. is very large, providing substantial numbers of jobs to British Columbians. Industry participants are responsible for:

- Securing land and financing for development
- Navigating local government approval processes
- Paying development fees
- Undertaking all aspects of the design, engineering and construction
- Ensuring all standards are met to successfully complete the project

Many risks are borne by the development industry.

Several of these professions are regulated in B.C., and have designated certification, registration or licensing bodies that manage this. They also provide guidelines and standards that professional members must adhere to. In 2018, the Province introduced the *Professional Governance Act*, and the accompanying Office of the Superintendent of Professional Governance, These provide a consistent framework for the governance of self-regulated professions, with an initial focus on the natural resources sector. Engineering and Geoscientists BC (EGBC) is one professional organization that has undertaken numerous initiatives to support incorporating climate change considerations into professional practice.[29]

[28] Hoekstra and Fumano. 2022. UBCM delegates call on province to take back dike responsibility.

[29] EGBC. Climate and Sustainability. Accessed 2023.

Financial, legal and real estate industries, including:

- Financial institutions and lenders
- Lawyers
- Realtors
- Home inspectors
- Appraisers

are involved to enable the transfer of ownership, and to provide capital for building, renovation and mortgages. They also invest in building portfolios and have Environment, Social and Governance (ESG) reporting requirements.

Insurance companies play an increasingly important role in buildings. Regardless of what can be built, if it cannot be insured, it will be difficult to sell or occupy. Insurance companies need to have confidence that a building has durability and longevity. There may also be risk aversion associated with new or novel approaches to building. In B.C., the *Homeowner Protection Act* states that all home builders are required to offer new home warranties to homeowners. These provide specific coverage for two-, five-, and ten-year periods (e.g., HVAC-related systems have a 2-year warranty, while materials used in the building process have a 10-year warranty).

Utilities provide energy to power and heat buildings. Utility reliability, policies and rates and building code energy efficiency and zero carbon requirements can influence the types of energy used to heat and power buildings. With increasing intensity and frequency of storms, utilities are responding to more storm events—for example, BC Hydro reported a tripling of responses to storms in a five-year period between 2013 and 2017.[30] Increasing density in urban centres and a shift toward electrification also require electrical capacity planning to ensure sufficient power is available for new demands.

Manufacturers and product suppliers provide the materials and equipment that support resilience measures. They are responsible for obtaining certification of building materials and systems and providing warranties.

The **non-profit sector** plays an important role in developing and providing affordable housing options across B.C. This sector is involved in the design, development and ongoing management of facilities, in addition to ongoing programming and support for occupants.

Building owners, managers and strata councils operate buildings once they are occupied. They must address problems encountered as a result of climate change or other disasters; they vary widely in expertise and capacity. More resilient buildings will lessen the burden on building owners, managers and strata councils. However, increased training, education and resources will also be critical to support resilience.

The **public** is involved in new development decisions, and may influence the types of developments that move forward in their communities. The public are also investors and consumers thereby imposing their risk tolerance and preferences. However, given the complexity of the building and development process, the public are not generally well educated on all aspects. This makes it difficult for the public to provide informed input on new developments.

[30] BC Hydro. 2018. The impact wild weather is having on British Columbians and their power.

4. Barriers and Enablers to Resilient Buildings in B.C.

4.1 Primary barriers facing resilient buildings in B.C.

This research project focused on the identification of barriers to more seismic and climate-resilient buildings in B.C. across four broad themes:

- Technical, skills and capacity
- Political and regulatory
- Economic and financial
- Social and informational

As highlighted in the research methods above, the process involved identification of a long list of potential barriers through literature and jurisdictional review. This was followed by refinement through engagement with sector area experts in B.C. The resulting key barriers are presented in Figure 2.

Figure 2. Summary of key barriers

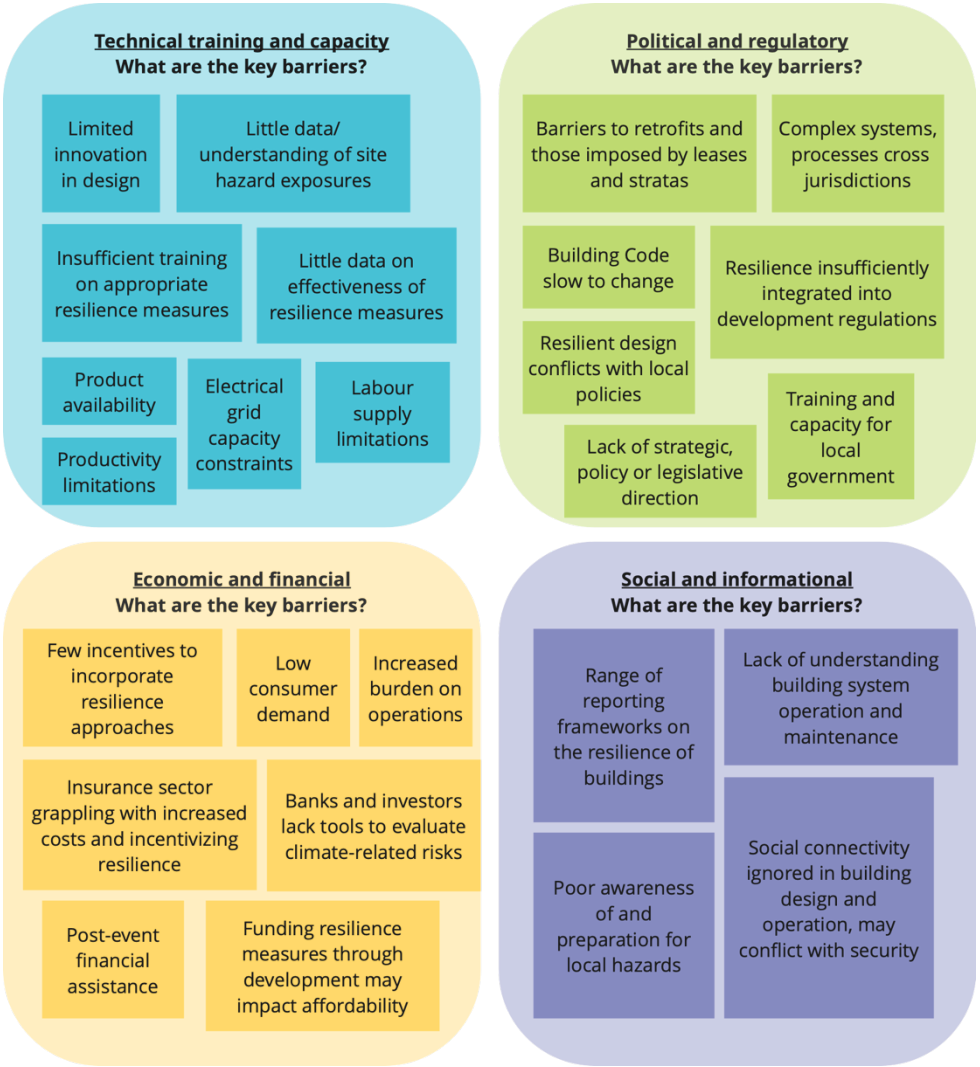


Table 3 expands on each of the key barriers identified above by providing a description of each barrier, and an indication of whether the barrier has particular considerations. Notable considerations are highlighted for barriers that may be more relevant, emphasized or acute in particular circumstances, including:

- Rural or urban environment
- New buildings or existing buildings that need to be retrofitted
- Potentially being in conflict with other design objectives
- Implications for social equity

Refer to Appendix D for a more extensive list of specific barriers and notable considerations. The following text box highlights one example of barriers to implementing more resilient design typologies in new buildings.[31]

Barriers to housing typologies that offer better climate resilience

Varying housing typologies can offer increases in resilience by supporting stronger connections among occupants – helping to build relationships among neighbours that make it more likely they will support each other in the event of a hazardous event. Standard residential typologies in Canada have been built around existing codes. In these codes, low and mid-rise buildings have central double-loaded corridors with exit stairs at each end, and high-rise buildings have scissor stairs. Both of these typologies create units with a single orientation (less access to daylight and natural ventilation). Further, they create dark, poor quality common spaces that do not foster social interaction. Socially-isolated people were at a higher risk of heat-related mortality during the 2021 heat dome event, based on the Coroner's Report.

Two alternative typologies that can improve social interactions are **point access blocks** and **courtyard buildings** with single-loaded outdoor corridors. Although these typologies are common in Europe, Asia and elsewhere, they are not generally found in Canada and the US. This is due to code requirements for two separate exits (in the case of point access blocks), or to floor area disincentives (in the case of single-loaded corridors, where external walkways are often included in floor area, while balconies are excluded).

The Vienna House project, a social housing project currently in development in Vancouver, is implementing a single-loaded corridor design with exterior walkways and a courtyard. In this way, it seeks to maximize opportunities for social interaction in well-lit, safe common areas, helping to build connection and resilience. Approval of this design required additional steps to obtain buy-in from stakeholders, and approval from the City.

[31] Effective August 27, 2024, BCBC includes amendments to enable construction of single exit stair buildings. See also Single Stair Residential Buildings by Public, prepared in 2023.

Table 3. Description of key barriers with indication of considerations for different contexts

Key Barrier	Description	Considerations
Technical Training and Capacity		
1. Lack of data/ understanding of site hazard exposures	Local policy and regulatory bodies, and the building community do not have a strong understanding of the primary site hazard exposures. Sometimes the information is available, but not in an accessible manner, limiting its use. Access to risk data is critical to inform the best cost-benefit resilience strategies, and to justify investments in resilience measures. Furthermore, local authorities vary in their sophistication and approach to climate-related hazard risk assessment and risk mitigation. Many staff interviewed identified the lack of resources to support mapping and data collection and its frequent updating needed to perform fulsome risk management. Where mapping does exist, there may be deterrents from public disclosure due to perceived impacts to land values or to designating floodplains due to the subsequent impact on disaster financial assistance (DFA). The first pillar of the Canadian- and B.C.-adopted Sendai Framework for disaster risk reduction is understanding risk. B.C. local authorities need to work with, and have the support of, senior levels of government to better meet this objective.	Small and rural communities have particularly limited capacity to investigate and understand site hazard exposures, and external technical/subject-matter experts may have less familiarity with the local hazard context.
2. Inadequate data about effectiveness of resilience measures	There is a lack of data demonstrating the effectiveness of resilience measures. Because of this, engineers, building officials or other professionals may feel uncomfortable or unable to review and approve novel designs or products, or have liability concerns (in addition to financial barriers for some new design elements – see following section). Designers may also have difficulty "selling" novel approaches to their clients. The National Research Council has a group focused on researching building materials that can be used as alternative solutions. However, the review and testing process may take years. This could make it difficult to use new innovative materials that are potentially more resilient to hazards.	
3. Limited innovation in design	Due to the typical project delivery sequence used in B.C. (Design - Bid – Build with a single fixed-price general contract), design is completed before engaging a contractor and all subcontractors. Therefore, it lacks the opportunity for integrated design early in the process. This prevents meaningful engagement with contractors and the construction industry. These actors hold significant on-the-ground knowledge about the feasibility, costs and implications of using different approaches. Their potential collaboration in the coordination of the design is limited. This makes it more difficult to adopt innovative approaches that may address climate and seismic resilience. This is because new systems are harder to optimize without detailed input from specialist subcontractors and suppliers.	
4. Insufficient training about appropriate resilience	Ability of building owners, designers, contractors, builders, building officials, and skilled trades to remain abreast of the evolving and increasingly technical field of building and construction is limited. This is especially true when industry is facing labour shortages and cannot make	Access to training is more challenging in rural communities

Key Barrier	Description	Considerations
measures	time needed for additional training when demand is so high. Existing training programs are not very flexible where they need to adapt to meet new skill requirements.	
5. Limitations in productivity	There is a need to close the gap between demand and supply for labour in the building sector through increases in productivity. Historically there have been few large innovations in the building sector and infrequent investments to support these. One example of productivity challenges relates to effectively integrating new and novel approaches. It requires very clear communication between designers, approvers, and the construction team. Drawings are increasingly inconsistent and inadequate. There is a need to standardize to ensure new requirements are clearly communicated and implemented properly.	
6. Labour supply limitations	The labour market outlook is calling for significant shortfalls in bodies due to demographics and significant retraining needs for B.C. workers. In 2022, the shortfall identified in B.C. was 82,000 workers.[32] Looking forward, there are substantial job openings anticipated in the design and construction industries over the coming decade. Adding the layer of needing new skills that support resilient buildings amplifies this challenge. A general understanding of the types of skills needed is developing. However, there has not been an analysis conducted that explicitly considers the gaps in the context of increasing the resilience of buildings. The sector has historically had limited diversity in its workforce. This poses recruitment challenges for attracting and retaining all types of workers.	Rural communities face amplified labour supply and retention challenges
7. Availability of products	Manufacturers of building technology do not often have a local or even national presence, or products are slow to obtain approval from Canadian bodies (e.g., CSA). Local variety in examples of building products may not be available (e.g., exterior shades). This is amplified in remote and northern communities. Current supply chain issues result in long lead times, e.g., currently limited heat pump availability.	Product availability challenges are amplified in more rural communities
8. Electrical grid capacity constraints	Electrical code requirements are interpreted as needing higher capacities than are cost effective to implement. There are also mixed messages about the ability of the grid to meet all the increased load requirements from building electrification combined with electric vehicle charging. Costs to upgrade at neighbourhood scale can be unaffordable, resulting in significant disincentive to upgrade and inequitable distribution of costs.	High growth communities particularly impacted
Political and Regulatory		
9. Complex systems and processes across	In order to support, facilitate and implement more resilient buildings, interventions and actions are needed across many government and non-government organizations. However, there is not a single or central organizing body. There is a lack of overarching strategic direction, policy	

[32] Government of BC. 2022. BC's labour market outlook: 2022 edition.

Key Barrier	Description	Considerations
jurisdictions	or legislation to achieve more resilient buildings. Internal bureaucracy can slow action.	
10. Training and capacity for local governments	Local authorities may not have the technical training and/or capacity to implement hazard-related regulations, guidelines or policies or review the qualified professional reports that may be submitted in hazardous areas. The same is true of members of municipal councils tasked with decision-making on new developments. Reliance on professional due diligence via consultants may add significant costs for smaller local authorities. There is also lack of understanding about the intersection between net-zero buildings and resilience (including seismic resilience) and potential for significant co-benefits.	Rural and smaller communities have particularly limited technical capacity and face higher costs to access external technical capacity
11. Insufficient integration of resilience into development regulations	Currently there are few, if any, well-integrated hazard programs that connect land use planning to building-level resilience requirements. Some local governments are taking steps to address this through existing planning tools (OCPs, DPAs). However, there is no consistency or guidance on the approach to take. Many local governments do not have the capacity to undertake this without more resources and guidance from the Province. There is also infrequent integration of planning and construction with the emergency management cycle including emergency response and recovery planning. Recent SSMUH policy changes prioritize density with an exemption for hazardous lands. The exemption is applicable only if hazard mitigation is impractical. This is a tricky term to define with worsening climate hazard threat over time.	Rural and smaller communities often lack internal capacity to integrate resilience into regulations, and may have less land available for development outside hazard impacted areas
12. Resilient design conflicts with local policies	Incorporating resilience measures in some cases may conflict with local policies. Also, the competition for space on sites is exacerbated by new requirements juxtaposed with affordability. Some examples: • Building to flood construction levels may conflict with height restrictions • Developers may wish to offer more rooftop common amenities in efficient mass timber buildings that have fewer balconies • However, these may conflict with height restrictions or other urban design requirements • Fire smart vegetation management may not allow trees for passive cooling near a building • Shading structures and heat pumps may push into setbacks • Rainwater gardens may compete or conflict with other site plan elements (e.g. parklets or picnic space)	Buildings in rural and remote areas often need backup heating or generators, which can conflict with resilience or climate mitigation goals/ policies
13. Building Codes slow to change	The National Building Code (NBC) is already effective at dealing with some hazards (extreme cold), but weaker at addressing others (heat, driving rain). Changes are needed and acknowledged, but there is a very slow-paced change process. Similarly, an Alterations Code is under development but will face the same constraints. Differences between the BC Building Code (BCBC) and the NBC will be minimized moving forward given the commitments the Province made under the agreement to harmonize codes. See text box above for a description of barriers to	Impact assessments needed to understand impacts on affordability and other areas

Key Barrier	Description	Considerations
	alternative housing typologies that better support social connectivity.[33]	
14. Lack of awareness about voluntary standards or guidelines	Where voluntary standards exist, there is often: • a lack of awareness among developers and builders to use them • a lack of guidance from local governments to point to them • a lack of incentives to comply For example, CSA Z800-18 – Guideline on Basement Flood Protection and Risk Reduction provides guidance to voluntarily make homes safer. However, it is not regularly referenced in local government guidance or requirements.	
15. Barriers to retrofits and those imposed by leases and stratas	In existing buildings, the 2021 heat dome event highlighted the barriers that exist in tenancy leases and strata bylaws barring measures to cool homes. There are also few motivators or regulatory triggers pushing owners to invest in retrofits.	Buildings most needing retrofits may house disproportionate numbers of vulnerable populations, with landlords less able to recover costs
Economic and Financial		
16. Low consumer demand	Poor awareness and understanding of climate-related hazard risk results in low consumer demand for resilience measures. The public typically assumes that new buildings are resilient to natural hazards. In turn, this results in consumers being unwilling to pay more for resilience measures when purchasing or renting buildings.	Rural and small communities may lack the resources to invest in down-scaled localized hazard data
17. Few incentives to incorporate resilience approaches	For a number of resilience measures, up-front capital costs may increase, but there is no clear demonstration on how to monetize the benefits. Where capital costs are not significant, there may be other disincentives, such as space and cost penalties (e.g., where resilience measures require additional floorspace, or require additional development approval review time). Split or diverging incentives mean that the owner / developer / builder may not reap the benefits of the investment. Different barriers exist depending on the ownership situation. For rental and non-profits, rent controls limit financial resources for capital and operating costs.	
18. Banks and investors lack tools to evaluate climate-related risks	Mortgage rates and lending do not reflect hazard exposure of the asset or resilience measures in place. There may also be risk aversion to fund innovation in the building sector that is largely unproven, even though these may reduce risks to climate-related impacts. This may be further exacerbated by a misperception that insurance or government bail-out	

[33] Note that in 2023, the Government of BC proposed a change to the BC Building Code to reduce the risk of overheating in dwelling units ahead of similar work underway for the National Building Code.

Key Barrier	Description	Considerations
	are sufficient to cover the risk. De-risking investment portfolios may be motivated by TCFD and ESG reporting but this is yet to be proven at scale.	
19. Insurance sector grappling with increased costs and incentivizing resilience	Insurance payouts have ballooned in recent years for climate-related events, resulting in necessary changes to insurance rates (particularly in higher-risk areas). There may potentially be a lack of access to insurance in some cases. Further, premiums are not reflecting resilience with some evidence of new resilience measures, such as heat pumps or solar backup power, substantially increasing premiums. Intact Centre is working with insurers to consider changes to insurance premiums that will reflect implemented resilience measures.	Local insurers in rural or small communities may have less resources about climate-related events and associated measures to manage risk and reduce damages
20. Using development to fund resilience measures may impact affordability	In the short-term, first costs for resilience measures may be higher, and without supportive tools, could add to development costs and impact affordability of units. Supportive tools could include a land lift through rezoning to a higher density or different use, or use of other tools.[34]. Longer term these costs are expected to go down, as the benefit of risk reduction is realized.	Slower growing rural or small communities may have limited private capital available to advance investment in more resilient development
21. Increased burden on operations	In addition to the concern over capital investment, some resilience measures may increase the burden of operations and maintenance and training on new systems (e.g., non-potable water systems). Note that, conversely, some resilience measures may reduce maintenance (e.g., metal roofs are more resilient and have less maintenance than shingles).	
22. Post-event financial assistance	If a hazard event occurs and causes damage, Disaster Financial Assistance (DFA) may provide replacement value of the B.C. Assessment value of the structure, not the property. Without financial support from other levels of government, the landowner has few choices but to build back in the same location and likely not to a "build back better" standard. In Grand Forks, relocation was made possible with funding from the Disaster Mitigation and Adaptation Fund (DMAF).	Relocation in dense, highly urbanized areas may not appear cost effective due to property values when compared to investing in risk mitigation (i.e. sea walls).
Social and Informational		
23. Range of reporting frameworks on the resilience of buildings	The multitude of reporting frameworks poses a challenge, creating confusion and complexity, making it difficult to select the most appropriate one. This leads to inconsistency and limited use of the frameworks to date, with none are leading the way. The real estate sector has no incentives or duty to communicate hazard risk.[35]	

[34] Note that with the introduction of Bill 44 and Bill 47, this opportunity through rezoning may be more limited.

[35] Note that in a 2023 report by the BC Financial Services Authority, they recommend property-specific natural catastrophe and climate-related risk disclosure in relation to real estate to improve consumers' awareness of the risks to them and their assets. Accessed December 2023.

Key Barrier	Description	Considerations
24. Lack of understanding of system operation and maintenance	Information is needed to better prepare owners and occupants for maintenance of building systems, including maintenance checklists and schedules, to increase resilience.	
25. Poor awareness of and preparation for local hazards of concern	Information about local hazards of greatest concern to buildings has not been easily accessible to building occupants in the past. This is changing as local governments put more information online and implement informational programs (e.g., FireSmart). Some people may be resistant to access emergency resources shared by government organizations or may disregard them if they are not culturally appropriate/relevant.	Emergency resources may be inaccessible to equity-deserving groups for many reasons (e.g. language, culture, distrust from previous interactions with government)
26. Social connectivity generally excluded from building design and operation and may conflict with security	Social disconnection between building occupants and neighbours reduces their familiarity with and sense of responsibility to each other. Building design often limits opportunities for spontaneous social interaction and fails to provide spaces for community-building. In existing buildings, there is a lack of support for social activity or event planning. There is also a lack of tools that enable communication between building occupants and/or with building management. This further limits resilience enhancing community-building and information exchange that supports better hazard event responses. Further, emphasis on enhancing security may conflict with improving social connectivity. Not only does this constrain occupants from accessing different floors, it even impedes emergency services from accessing floors.	Low-cost rental properties are less likely to have improvements because of the rent increases that may be required to cover additional costs

4.2 Enablers to strengthen resilient buildings in B.C.

Addressing the significant list of barriers identified in the previous section will involve action in a number of areas, all across the spectrum of participants in the building development and renewal space.

Overall enabler: alignment with decarbonization efforts

One key enabler that covers many facets is the attention and effort currently being directed toward decarbonizing buildings and energy systems in B.C., Canada, and worldwide. The Glasgow Financial Alliance for Net Zero (GFANZ) estimates USD 5.2 trillion will need to be directed toward building decarbonization globally to reach net-zero by 2050.[36] These decarbonization efforts require mobilizing many of the same enablers that are needed to support more resilient buildings. To update building designs, materials, technologies, and how they are used, resources are being directed toward training, policy and regulation development, funding mechanisms and more.

Now is the opportunity to ensure investments in decarbonization also build resilience. These will be necessary with the changing conditions we are currently and projected to face over the coming decades and generations.

[36] GFANZ. 2021. Net Zero Financing Roadmap: Buildings Investment and Financing.

Five key enablers

Through the course of this project, numerous enablers were identified and these were grouped into five key enablers that can advance resilience in buildings in B.C.:

Data and information: Understanding, Identifying, Disclosing and Communicating Risk

Improving understanding and identification of climate and seismic hazard risk, and enhancing information sharing and disclosure of that risk, is the first enabler toward more resilient buildings. Communicating risks will become more integrated as the understanding and identification of risks improves. Risks will need to be communicated across scales, including multiple actors across the building sector, government and the public. This will ensure consistency and improve collective understanding of the risks.

Awareness and capacity: Expanding Labour, Industry, Owner and Government Capacity on Resilience

Expanding knowledge across labour, industry, owners and government will support more effective integration of resilience into buildings. This will happen through professional development, knowledge sharing and transfer, supportive networks of experts, and more. Increased awareness of risks may incentivize owners and governments to seek out and value improved resilience measures. This will be especially true if there are known impacts to the asset value, to occupant demand, to operating costs, etc. General skill development, recruitment and retention are also critical to address labour shortages.

Policy development: Building Market Demand for Resilient Buildings

Building market demand for resilient buildings will take time. There are numerous regulatory and non-regulatory tools and strategies that can support the transition. These start with:

- Ensuring regulatory frameworks support rather than hinder resilience
- Providing support for communities to establish appropriate design parameters
- Demonstrating leadership through public sector procurement
- Supporting innovation through construction techniques, methods, and contracting approaches

Financial mechanisms: Improving Investment and Financing Opportunities

Although some resilience measures may be simple and cost-effective, most measures will require investments by building developers, owners, and/or occupants. To achieve broad uptake, government financial support, better tools for cost-benefit analysis, and expanded tools that support investment will be essential (in addition to policy changes such as in the *Residential Tenancy Act* noted under Building Market Demand).

Social capacity: Integrating Social Resilience into Building Design, Retrofit, Programming

Social connectivity plays a critical role in improving resilience within buildings and within neighbourhoods. When people have relationships with their neighbours, they are better positioned to support each other during hazard events. This can have a significant effect on outcomes - particularly for those who are more vulnerable due to health challenges or socio-economic factors. This can be supported through changes in building design (e.g., open air corridors, rooftop common amenities) and through programming during operations.

The need for a package of enablers to address specific hazards: a look at seismic risk

As discussed in section 3, earthquakes present a different risk than climate-related hazards that we are already starting to experience. B.C. has the highest earthquake risk in Canada and experiences thousands of small earthquakes every year[37]. A much smaller number are big enough to get noticed such as the earthquake that affected north-central B.C. in 2012 but resulted in no reported structural damage. People generally have difficulty preparing for events that have low probabilities of occurrence but catastrophic consequences. As a result, there is currently low public demand for enhanced measures to protect buildings from major earthquakes in B.C. relative to areas that experience earthquakes more regularly (e.g., Japan, Chile, Greece).

In addition to low demand, many measures that have a greater potential to address seismic risk involve moderate to high costs.[38] A single enabler, such as an adjustment in insurance rates to incentivize implementing these measures is likely not sufficient to address the scale of barriers. Instead, a more comprehensive package of enablers is needed to advance earthquake resilience measures. For example:

- NBC 2020 includes additional performance requirements for facilities such as hospitals and schools, to require a 'no structural damage' performance level for large and moderate earthquakes respectively. This is a significant post-earthquake performance enhancement from previous codes, but does not extend to other public or private buildings. Continued advocacy to clarify the extent of post-earthquake damage or reduce the post-earthquake damage for all types of new buildings is worthy of consideration.
- The National Building Code buckets areas to apply seismic factors for use in building design. More refined and geographically specific Microzonation mapping exists now in the lower mainland of B.C. However, there are few if any existing tools to require reference of the maps.
- Updates to Canada's building code involve long processes that require careful cost impact analyses of any proposed code changes. A key challenge for these analyses is that new measures will inherently have lower cost effectiveness initially. This will remain until the measure is implemented more broadly, at which point it may become more cost effective.
- Due to lack of public awareness / acknowledgement of the risk, additional incentives are required in B.C. compared to other regions that experience earthquakes more frequently. Public funding to offset additional burden or costs may be needed to implement more costly items.
- Other regions have implemented (e.g., Japan), or are working to implement (e.g., Christchurch and the US Resiliency Council), rating systems that may support increased awareness.
- Insurance packages in Canada tend to be more limited with respect to earthquake coverage. Engagement with the insurance industry to explore expanded coverage is an additional strategy needed in B.C.

This example demonstrates that an integrated package of multiple enablers is needed to advance seismic resilience measures in B.C. It also shows that these may be different than those needed in other regions affected by earthquakes.

[37] Natural Resources Canada. Earthquakes Canada. Accessed March 2024.

[38] BC Housing Research Centre. Seismic events. Accessed September 2022.

Relationship between barriers and enablers

There are numerous initiatives underway in each of the five enabling areas, though there remain gaps to achieving a cohesive shift in how we build and renovate our buildings. Through the course of this project, a set of 32 enabling recommendations were identified. These highlight the big moves that need to happen to collectively address the key barriers identified. In many cases, enabling recommendations address more than one barrier, and in some cases, numerous barriers (for example, expanding government and industry capacity tends to address multiple types of barriers). Conversely, most barriers will require more than one enabler to overcome them. The recommendations are described and expanded on in the next section of this paper.

5. Recommendations

Through the course of engagement in this project, a set of recommendations emerged to advance action in the five enabling areas and address the key barriers identified. There are 32 recommendations identified as "big moves" that may take place over the course of many years, and several more that are identified as "quicker steps" that are already underway. "Quicker steps" may also be initiated in the nearer term to begin addressing barriers and moving all actors toward more climate resilient buildings in B.C.

Each big move is described in more detail, providing:

- The context
- The recommendation
- Co-benefits (where applicable)
- The main actor(s) required to implement the recommendation
- A series of examples and resources that provide further guidance

Quicker steps are briefly highlighted at the end of each section.

5.1 Understanding, Identifying, Disclosing and Communicating Risk

The first enabler of more resilient buildings is improving the understanding and identification of climate and seismic hazard risk. This is coupled with enhancing information sharing and disclosure of that risk. Communicating risks will become more integrated as the understanding and identification of risks improves. Risks will need to be communicated across scales, including multiple actors across the building sector, government and the public. This will ensure consistency and improve collective understanding of the risks. A target in Canada's National Adaptation Strategy is that by 2025, 60% of Canadians, including northerners and Indigenous Peoples, will be aware of the disaster risks facing their household.[39]

Big Move Recommendations

1. Develop public hazard data repository and guidance for disclosure

The first step in planning for resilient buildings is understanding what climate-related and other hazards the site is exposed to. This should include risks today and throughout the lifespan of the project, and their level of intensity. This information forms the basis for risk assessments, for selecting appropriate resilience measures for projects, and for informing the basis for design.

Local hazard information that is needed includes:

- Future floodplain extents
- Heat wave intensity
- Extreme rainfall and snowfall
- Urban / basement flood risk
- Site specific liquefication hazard potential
- Other climate and seismic data

Some of this is currently available (e.g., wildland urban interface risk class maps) and other areas need further development (particularly in relation to extremes). For example, extreme snowfall affects roof design (assemblies, consideration for snow sliding between structures), and location of mechanical equipment. There is evidence in relation to urban flood risk that there is a greater willingness to act on risk reduction activities where known risk is higher. However, the concern is that official hazard maps tend not to be available.[40]

Geospatial information and studies are typically the source for exposure data, though often the information is not readily accessible or is incomplete at the local level. This is due to a lack of awareness about what data is available and where to obtain it. It can also be due to a lack of resources to develop the data, to make it accessible, and to maintain it over time.

Authorities Having Jurisdiction (AHJs) currently have legislative requirements through the Emergency Programs Act (EPA) to complete hazard risk assessments. The current precedent methodology is the BC Hazard and Risk Vulnerability Assessment (HRVA) methodology. It does include recommendations on

[39] Canada's National Adaptation Strategy. Accessed December, 2023.

[40] Sandink and Binns. 2021. Reducing urban flood risk through building- and lot-scale flood mitigation approaches: challenges and opportunities. Frontiers of Water.

potential data and informational inputs. However, it has received criticism for not sufficiently including climate change, Indigenous perspectives on risk, or social capacity and capability information. Technical Safety BC, as an AHJ, is currently updating a safety risk register to include climate impact for their regulated technologies. See also recommendation 5 on integration of HRVA and climate risk assessment processes. The EPA and requirements for local authorities is currently under review.[41]

In addition to lack of awareness and resources to obtain and make data accessible, another key barrier was identified: there is concern that obtaining and sharing hazard data may increase the liability for the AHJ.

Recommendation 1.1: Develop a climate and seismic hazard portal

Develop a portal in partnership with an existing climate hub or enhance the functionality of an existing one to provide a one-stop-shop that collates available hazard and exposure information such as:

- Floodplain mapping
- Geological hazard information
- Sea level rise studies
- Social vulnerability indicators

Ensure the portal links to existing sources of climate projections (e.g., climatedata.ca, PCIC). This recommendation is supported by a recent Insurance Bureau of Canada report that calls for the government to "Create a single source of disclosure data that is open / transparent / reliable and accessible".[42] The first step likely involves a gap analysis of funding availability to support seismic and climate-related hazard data and information needs. This would be followed by coordination among agencies collecting data, consolidating data sources, and providing a portal for dissemination. The portal should be fit for purpose and clearly communicated to the end user. This task is complex. There are many sources of data that may come from numerous different government departments, agencies and local authorities. A clear division of what hazard scale is the responsibility of each government would be necessary as part of the coordination and consolidation steps.[43]

IBC recommended that local authorities be on the forefront of disclosure; though local governments would need resources and support to undertake this. Alternatively, a provincially-led portal can be designed to allow for links and connections between local level data and provincial and regional level data.

Governments are not the only entities accessing and using hazard data. Appraisers, insurers, lenders, etc. are also accessing hazard data from non-quality-controlled sources. Working toward common, maintained sources with the appropriate caveats around inherent uncertainties will ensure the best data and information is being used appropriately. Recent recommendations from the BC Financial Services Authority (BCFSA)

[41] Note that since time of writing, the Emergency and Disaster Management Act came into force (Nov. 8, 2023) and includes new requirements with respect to integrating climate change in risk assessments and collaborating and cooperating with First Nations. Accessed December, 2022.

[42] Chopik and Stewart. 2022. Designing the Path to Climate Compatibility: Climate Risk Disclosure and Action in the Canadian Housing Context.

[43] Note that the current provincial Disaster and Climate Risk and Resilience Assessment is assembling hazard data with the intention of using the ClimateReadyBC portal for disclosure.

support market transparency and natural catastrophe and climate risk disclosure aligned with TCFD. They also support sufficient information being disclosed to consumers to understand property level risk.[44]

End users of the information may require guidance on how and what to use or enabling policies requiring them to use the information provided.

Main actor(s): Federal government (Natural Resources Canada), Provincial government (Ministry of Emergency Management and Climate Readiness), First Nations governments, regional and local authorities would work together to ensure the most up-to-date hazard information is available, IBC

Recommendation 1.2: Develop guidelines on disclosing risk to public

To address concerns about potential liability for disclosing risks, AHJs require clear guidelines on responsibilities to disclose risk to the public. They also require guidelines on how best to do that to counter concern over property value impacts and floodplain designations. The Province can develop clear guidelines and a legal opinion for AHJs on how to publicly disclose climate-related hazard risk and associated legalities and responsibilities. In concert, provide background research on observed impacts of hazard disclosure both positive and negative.

Main actor(s): Provincial government (Ministry of Emergency Management and Climate Resilience, BC Assessment), property appraisal associations, Municipal Insurance Association of BC, Canadian Bar Association

Recommendation 1.3: Maintain maps of wildland-urban interface risk

The Province developed a method and prepared maps of the wildland-urban interface risk for every region of B.C. These maps provide a valuable reference for local authorities to inform land use and development planning, as well as emergency management and recovery planning. Regular maintenance and update of the maps will continue to be invaluable to local governments.

Main actor(s): Provincial government (Ministry of Forests)

Examples or resources

- ClimateReadyBC, an online platform developed by the BC Government to help the public and communities understand disaster and climate risks and find funding and supports to make communities more resilient
- Canadian Centre for Climate Services, includes climate information and a climate services support desk
- Disclosure example at the local authority level – City of Calgary Disaster Risk Explorer
- Earthquake risk scenarios from Natural Resources Canada
- BC's Real Property Division is developing a Risk Mapping Tool (portfolio scale) – could serve as a model for other portfolios
- PCIC data explorer and Plan2Adapt and climatedata.ca

[44] BCFSA. 2023. Natural Catastrophes and Climate-related Risks: Managing Uncertainty and Building Resilience in the B.C. Financial Services Sector. Accessed December 2023.

- NRCan Pathways study – Physical Exposure to Natural Hazards in Canada and Social vulnerability to natural hazards in Canada
- NRC Climate Data and Loads project

2. Provide support to incorporate current seismic and climate data into local design data

Building codes provide a consistent set of standards for new buildings and alterations. They establish minimum requirements for safety, health, accessibility, fire and structural protection of buildings, and energy and water efficiency. Projected changes to the climate will make historical data and information that has previously informed building standards insufficient to meet code objectives going forward. As a result, changes to the data referenced by the code, and to some standards, are necessary. These must address the shifting climate, particularly in relation to more extreme events that have not been experienced historically.

At the national level, there are substantial initiatives being led by the National Research Council of Canada and the Standards Council of Canada. They are working to better integrate resilience to climate change and extreme events into building codes and standards. One key area being addressed is to improve the quality and source of climate data information. This includes the variables currently provided in the National Building Code Division B, Appendix C Climate and Seismic Information for Building Design in Canada. This is expected to be updated for the 2025 version. BC Building Code bulletins can be issued if new data becomes available ahead of National Building Code changes.

Infrastructure Canada is developing a package of supports for transportation, water and public buildings projects. They range from climate-informed codes, standards and guidelines to a climate toolkit and support services.

At the local level, several AHJs provide design parameters for their location that include future climate projections (except with respect to energy modelling for Part 3 buildings, which must adhere to the National Energy Code for Buildings). However, not all communities have the capacity to develop and maintain this. The Pacific Climate Impacts Consortium hosts a Design Value Explorer that provides the opportunity to access projected future change to design variables.[45] Many First Nations governments who have established Land Codes require capacity support to define, establish and maintain regulations and tools. This would help ensure buildings are being designed in accordance with up-to-date and appropriate climate data. National efforts will result in updated climatic design data for locations across Canada. However, there will remain a need to integrate future weather data that is suitable to the local context.

Microzonation mapping and associated guidelines are under development with support from EGBC and the Ministry of Emergency Management and Climate Readiness for the lower mainland. Training and support for application of these maps in current and long-term planning and infrastructure design will be needed. This is in addition to supporting development of microzonation mapping in other locations.[46]

[45] Since the time of writing, climatedata.ca released *Future Building Design Value Summaries*, location-based summaries of the building design values developed by Environment and Climate Change Canada.
[46] Note that since time of writing, the Ministry of Emergency Management and Climate Readiness is planning broad training in 2024 on the microzonation guidelines and map use.

Recommendation 2.1: Provide guidance on maintaining updated local design data

It is recommended that the Province and/or Infrastructure Canada provide guidance suitable for all local governments and, where requested for First Nations governments. This guidance should advise on best practices for:

- The sources of projected data
- Consideration for the selection of climate data to use
- Processes to incorporate it into design requirements
- Ways to effectively communicate the information to builders, designers, and qualified professionals

The Province could also provide or endorse a standardized 2050 climate data set for design teams to use in modelling and analysis of resilience measures (e.g., thermal comfort). It could review and endorse the PCIC Design Value Explorer. Then it could work with local authorities to review and understand if the values are suitable to the local context. Further, training and ongoing support for the application of climate projections, microzonation mapping, or other relevant data will be important for effective implementation.

Co-benefits: Reduces tendency to overdesign where there is insufficient data for future conditions; supports building longevity
Main actor(s): Provincial government (Ministry of Housing), Federal government (National Research Council), Pacific Climate Impacts Consortium, local AHJs

Examples or resources

- National climate responsive building codes report
- Engineer and Geoscientists of B.C. Practice Guidelines
- BC Housing Bulletin - Modelling the Future Climate in Passively Cooled Buildings
- Infrastructure Canada Climate toolkit and support services under development
- Developing climate resilient standards and codes (Infrastructure Canada)

3. Expand forensic accounting of hazard events

Risk assessment relies on estimations and the severity of the impacts or consequences of hazard events. Cost-benefit studies that drive the business case for adoption of measures in design also draw from information about the potential costs of damage or of that avoided. Forensic accounting of events, specifically related to building impacts, would improve the understanding of consequences, costs, and damage. This in turn improves the accuracy of cost-benefit studies and communication about impacts and ultimately risk assessment outcomes. The BC Wildfire Service applies a forensic accounting method after wildfire events. However, this approach is not applied in the same manner for other climate-related events. Information from whole of society, including asset owners, helps to inform our collective knowledge, better equipping us to design for resilience.

Recommendation 3.1: Establish guidelines for forensic accounting

Expand on existing post-event impact assessment efforts to establish a method and guidelines for applying:

- Forensic accounting

- Post-event damage surveys
- Other assessment approaches that contribute post-event building-related data for a wider range of hazard events

Encourage and support AHJs to collect post-event data, including building-specific impacts, by providing resources, guidelines and templates. Existing after-action reporting templates could be updated to include collection of basic impact data. Ensure data collected includes experiences of equity-seeking groups to understand the unique impacts faced. Encourage insurance industry collection of data regarding implemented resilience measures to inform future policy rates that incentivizes effective measures. See next recommendation for integration of findings.

Guidelines should allow for comparison between events and can build on post occupancy evaluations and monitoring studies of existing buildings being completed in the academic sphere. Ultimately, the climate portal discussed above could house forensic findings to help inform design and code changes.

Co-benefits: Supports understanding of more cost-effective measures for resilience; improves understanding of differing impacts for vulnerable populations; avoids cost of inaction
Main actors: Provincial government (lead to build on forensic accounting work by the BC Wildfire Service); Technical Safety BC (provide information on losses based on permit data); Collaborate with IBC and Intact Centre on Climate Adaptation (Intact Centre is underway on work with insurers), First Nation, regional and local governments to gather more data post event

Examples or resources

- Climate Risks – Implications for the Insurance Industry in Canada
- Environment Canada's enhanced Fujita scale damage indicators
- BC Wildfire Service's forensic accounting of post-event damage

4. Improve sharing on post-event climate risks and resilience measure effectiveness

With respect to buildings, the insurance industry is a key player that is engaged in response to seismic or climate-related events. It has the potential to capture valuable information about the impacts of events on buildings, and potentially the effectiveness of different measures in reducing damages. The industry is also adept at evaluating risk, as this is an essential part of establishing appropriate rates and policies. However, any data that may be collected is distributed among numerous private insurance companies. It may not be collected in a standardized manner that can inform climate risk analysis more broadly.

Local, provincial, and First Nations governments may also track the outcomes of hazardous events in relation to government assistance provided, or emergency operation centre activation and activities. However, there is little to no integration of this data across divisions, ministries, organizations, or governments, making it difficult to surmise outcomes and lessons.

Recommendation 4.1: Improve data sharing between government and insurance industry

Establish a partnership between the insurance industry and governments. This could improve data and information sharing with the goal to better understand climate risk, and potentially the effectiveness of resilience measures, in buildings in BC. This may include:

- Developing standardized frameworks or protocols for collecting and sharing data
- Investing in data analytics to better identify patterns in response to seismic or climate-related events
- Establishing collaborative efforts with academic institutions
- Sharing knowledge about risk evaluation methods and practices

With improved data and information sharing, the partnership can also work toward establishing more consistent communication about seismic and climate-related risks. It can also work toward effective mitigation measures with partners and stakeholders more broadly. The data should be brought to the marketplace through stories that motivate people to reduce risk and communicate clear responses for tactical risk reduction.

Main actor(s): Provincial government, First Nations governments, Insurance Bureau of Canada; Technical Safety BC to monitor change in volume of climate-related incidents

Examples or resources

- ICLR and Intact Centre on Climate Adaptation, two industry-funded research groups that operate nationally that could support these efforts
- Canadian Disaster database managed by Public Safety Canada, including historical disaster information from natural hazard events across Canada

5. Select or define a resilience rating system for buildings

Part of building market demand for resilient buildings is providing opportunities to report out on performance relative to a base standard. Currently there are a range of voluntary resilience reporting standards but none that are leading the way. The Task Force for Climate Related Financial Disclosure (TCFD) is gaining momentum as a portfolio-wide reporting tool for organizations. However, it is unlikely to be easily accessible for consumers interested in single buildings. The province and some local governments are advancing mandatory building benchmarking and home energy scores. However, these do not include resilience measures at this time.

On a related note, the Province recently released the Climate Resilience Framework & Standards for Public Sector Buildings (V1). It aims to establish a systematic and consistent approach to improve climate resilience of public sector buildings. Although this is not a rating system, the framework provides portfolio-level assessment suggestions and could serve as an initial step toward future resilience ratings of buildings.

Recommendation 5.1: Create a standard resiliency rating system

Streamline existing resiliency self-assessment rating systems/ report cards for infrastructure and building systems and encourage their use. Promote portfolio-level risk assessment. Collaborate with the real estate industry on training to improve the knowledge and disclosure of risk.[47]

Main actor(s): Province; real estate industry representatives

[47] Note that the BC Financial Services Authority recommended in their 2023 Discussion Paper that property-level risk disclosure be implemented along with scores.

Recommendation 5.2: Include resilience co-benefits with home energy scores

Include resilience co-benefits in anticipated mandatory building benchmarking and home energy scores. Although this would take time to define, it would be an opportunity to build on an existing and related initiative. Engage with Indigenous communities on the need for culturally-appropriate tools for rating resilience, and support emerging Indigenous-led work in this space. Consider resilience training for Energy Advisors already working with communities.

Co-benefits: Aligns with and builds on existing efforts to decarbonize buildings
Main actor(s): Federal Government (streamlining/encouraging a single rating system); Province (work with the real estate industry and organizations with large building portfolios), financial institutions, IBC

Examples or resources

- Task Force for Climate Related Financial Disclosure
- Voluntary Resilience Standards: An assessment for the emerging market for resilience in the built environment
- BC Financial Services Authority, 2023. Natural Catastrophes and Climate-related Risks: Managing Uncertainty and Building Resilience in the B.C. Financial Services Sector
- State of California Natural Hazard Disclosure Statement in real estate transactions

6. Integrate existing frameworks for disaster risk reduction and climate risk assessment

The Emergency Programs Act is currently under review. It requires AHJs to regularly assess hazard risk. To date this has focused on current risk and been largely separate from the climate risk assessment frameworks and standards or protocols such as:

- ICLEI Canada's Building Adaptive and Resilient Communities program (BARC)
- Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC)
- International Standards Organization (ISO)
- The Strategic Climate Risk Assessment Framework for BC[48]

Recommendation 6.1: Integrate HRVA + climate risk assessment frameworks

Improve the integration of the BC Hazard, Risk and Vulnerability Assessment methods and guidebook and the BC Climate Risk Assessment Framework.[49] Provide one single united guidebook tool that includes methods and best practices for assessing current and future vulnerability and risk for local hazards, including climate-related and seismic. Enhance the HRVA online tool to better incorporate climate risk and link to the many existing resources (see recommendations #1, #2 above). Work with First Nations Emergency Services Society to support the development of First Nation specific and appropriate tools to incorporate climate risk into risk assessments. These integrations will also improve the application of the full cycle of emergency management

[48] Note that since time of writing the Emergency and Disaster Management Act (EDMA) has been adopted in B.C.

[49] Note that since the time of writing, the EDMA has been adopted with a clear integration of climate and disaster risk. Guidance is forthcoming from the Ministry of Emergency Management and Climate Readiness in the coming year.

to climate resiliency planning at the building scale (i.e., planning for building evacuation or shelter in place and recovery).

Currently the HRVA tool speaks to social vulnerability. However, this section could be strengthened to help identify equity-seeking groups to meet with and discuss needs pre- and post-hazard events. Further guidance could be developed with disability consultants and groups and seniors. It could identify challenges encountered throughout the emergency management cycle (medications require refrigerators, life support equipment battery life, etc.)[50]

One of the last steps of risk assessment is planning risk management measures and strategies to reduce risk to a tolerable level (as set by the AHJ). The building sector, and BC Housing particularly, have many resources to provide to B.C. building sector professionals that reduce climate-associated hazard risk. There is a good opportunity to integrate these resources into risk assessment guides and tools.

Co-benefits: Combines two risk assessment processes for more informed outcomes; supports improved understanding of social vulnerability
Main actors: Province (Ministry of Emergency Management and Climate Readiness), First Nations Emergency Services Society of BC (FNESS), collaboration with BC Housing, non-profit associations

Examples or resources

- Strategic Climate Risk Assessment Framework for B.C.
- HRVA Companion Guide for the HRVA Tool
- ISO 14091
- ICLEI's BARC program
- PIEVC Protocol

7. Incorporate climate risk assessment into land use planning

The Local Government Act (LGA) currently provides requirements for Official Community Plans to include statements and mapping to place "restrictions on the use of land that is subject to hazardous conditions" (LGA Division 4). It also requires the establishment of development permit areas (DPAs) for the purposes of protecting development from hazardous conditions. The LGA also introduces floodplain specific responsibilities. The Community Charter Section 56 allows for qualified professional review before building permit issuance in the case of:

- "Flooding
- Mud flows
- Debris flows
- Debris torrents
- Erosion
- Landslip
- Rockfalls
- Subsidence
- Avalanche"

Climate-related hazards that are addressed through OCPs and DPAs tend to include overland flooding, urban interface fire areas, coastal flooding and geohazards. At this time, there is no explicit requirement to consider

[50] The newly adopted Emergency and Disaster Management Act includes clear requirements to give special consideration to "individuals who may experience intersectional disadvantage, and vulnerable individuals, animals, places or things."

changing or future hazards (except in the B.C. Flood Hazard Land Use Management Guidelines). However, with changing climate projections, future hazards are critical to consider when undertaking long-range community land use planning. Guidelines in hazard DPAs vary between local governments and only apply when development permit issuance is triggered. Building permit review is more constrained.

Recommendation 7.1: Provide guidelines for climate-related hazards in OCPs and RGSs

Provide guidelines for AHJs to identify and map both current and future climate-related hazards through Official Community Plans and Regional Growth Strategies. Regional growth strategies could identify areas with lower hazard exposure for increased density.

Provide base guidelines for hazard DPAs that reflect best practices and a library of examples of additional guidelines. Include hazards that aren't generally included through OCPs and DPAs as examples (e.g., liquefaction potential, high winds). In addition to guidance for inclusion in OCPs and RGSs, guidance for area plans and the development process are also needed. Build on existing work completed by several municipalities (e.g., Vancouver, Kamloops) and FNESS to provide worksheet templates for AHJs to use in the development application process. These help applicants consider which hazards their site is exposed to, link to climate projections, and identify potential resilient design solutions.

Recommend terms of reference for required qualified professional reports with future projection studies to reference. Consider guidance for communities that do not have capacity to develop and implement DPAs. Consider providing for qualified professional review of a broader set of hazards, in areas identified as high risk, at building permit. Note the related UBCM resolution brought forward by Islands Trust in 2022 "*Therefore be it resolved that UBCM call upon the Province of British Columbia to fund and support the development and integration of climate risk and vulnerability assessments into Official Community Plan review processes.*"

This recommendation is linked with recommendations 1.1 and 1.2 as more guidance on disclosing risk through various planning tools is needed.

Main actor(s): Provincial government (Ministry of Housing), PIBC, EGBC, IBC, local governments

Recommendation: 7.2 Update PIBC climate recommendations

Update the Planning Institute of BC (PIBC) Climate Call to Action from 2017 to include more climate adaptation and resilience focused statements and recommendations. Further, PIBC could provide an increased percentage of outreach, education and webinars on climate risk assessment and planning. These could be at all scales, from Official Community Plans to transportation planning.

Main actor(s): PIBC

Examples or resources

- Risk-based Land-use Guide - Safe use of land based on hazard risk assessment, Natural Resources Canada, 2015, resource for fundamental approaches to risk-based land use planning
- Climate Change Adaptation Resources Pathway (ARP) Land Use, an interactive resource developed by the climate risk institute with a focus on land use planners

- National Research Council guides: Guidelines for Improving Flood-Resistance for Existing Buildings, Climate Resilience Buildings - Guideline for Management of Overheating Risk in Residential Buildings, and the National Guide for Wildland-Urban Interface Fires

8. Establish quicker steps for risk disclosure and communication

The following table lists related initiatives that are underway or that could be advanced in the near future.

8.1	Provide river forecast centre forecasts through more publicly viewed channels such as Drive BC and CBC news. Provide any real-time information from the water survey of Canada (WSC) gauges as possible.	BC Ministry of Emergency Management and Climate Resilience
8.2	Work with Canadian mortgage lenders and appraisers to improve their awareness of climate risk and to access appropriate and best available data.[51] Collaborate with CMHC studies and work underway to support climate data and issues for the residential mortgage and financing sector.	Federal government (CMHC), financial industry, appraisal associations
8.3	Conduct an environmental scan of academia, private sector, public sector, and non-profit sector for actions being taken at all scales. Identify synergies, leverage existing research and resources, and coordinate ongoing improvements in understanding.	BC Ministry of Emergency Management and Climate Resilience

[51] Note that since time of writing, the BC Financial Services Authority has made recommendations regarding transparency and disclosure regarding climate and disaster risk. See report.

5.2 Expanding Labour, Industry, Owner and Government Capacity on Resilience

Expanding knowledge within both industry and government will support more effective integration of resilience into buildings. This can happen through professional development, knowledge sharing and transfer, supportive networks of experts, and more. Improved knowledge of all hazards and future projections can help to avoid unintended consequences that may occur. These might happen when decisions and actions are based on past approaches, singular hazards instead of compound or cascading impacts, and experience. General skill development, recruitment and retention are also critical to address labour shortages.

Big Move Recommendations

9. Raise awareness on benefits of integrating resilience with net-zero buildings

We are asking more and more of our building. In parallel, we are working to streamline regulations and requirements for construction and renovation in response to longer development approval processes. Buildings need to be resilient to a range of shocks and stresses facing society today and in the future. They need to withstand earthquakes, provide efficient recovery, address decarbonization and energy efficiency, all while considering affordability. To date these items have been largely addressed one by one or in silos.

There is an opportunity to engage the planning and building community in integrating requirements and opportunities that provide economies of scale and synergies between these goals. From a menu of actions toward each of these goals, are there items that make good sense to couple together from a design and cost perspective? For example, onsite water management can support multiple objectives, including:

- Reducing strain on the stormwater system
- Providing cooling benefits
- Reducing water consumption for landscaping
- Supporting natural carbon sequestration

There are not sufficient or accessible resources to efficiently review, select and integrate these measures. This either results in missed opportunities or contributes to longer design and development processes where integrated designs are pursued in earnest.

Recommendation 9.1: Establish a working group to align net-zero and resilience objectives

Set up a working group to identify objectives for buildings from resilience to indoor health and social connection to embodied carbon and seismic resiliency. Develop recommendations on the best approaches to integrate these objectives through building design and operations. Integrate findings into messaging on best practices for design, construction, and renovation for practitioners in government and industry. Consider which resilience measures are a priority for each hazard exposure now versus those that could be introduced over time.

Main actor(s): Provincial government (Ministry of Housing, Climate Action Secretariat), in collaboration with professional associations (EGBC, AIBC, PIBC, BOABC), local governments

Recommendation 9.2: Develop decision-making support tools

To accompany the recommendations, develop decision-making support tools that help building owners, designers, and contractors review and select measures suited to their buildings. Highlight cost-benefit information, where available. Link the use of the tool to existing and future retrofit programs being implemented in communities across B.C. Communicate about the multiple objectives, and synergies, to build broader understanding of the nature of resilient buildings among all British Columbians.

Main actor(s): Provincial government (Ministry of Housing, Climate Action Secretariat), in collaboration with local governments, professional associations (EGBC, AIBC, PIBC, BOABC), development industry (UDI)

Recommendation 9.3: Develop an industry standardized assessment tool for buildings

Develop an industry standardized assessment tool to evaluate climate and seismic risk of buildings (inclusive of technical systems). Similar to a fire risk checklist that is undertaken by fire departments, a standardized tool to assess the risk of climate change and seismic hazards could be developed. This could be deployed in concert with energy efficiency assessments, which already have a well-defined process and industry.

Co-benefits: Integrated design that meets multiple objectives more cost-effectively; alignment with decarbonization efforts; increased awareness of resilience measures
Main actor(s): Provincial government, Technical Safety BC, in collaboration with professional associations (EGBC, AIBC, PIBC, BOABC), local governments

Examples or resources

- B.C.'s Fire Prevention Inspection Report
- PIEVC protocol
- Climate Resilient Guidelines for BC Health Facilities
- Pending resource for Public Sector Organizations for climate risk assessment and resilient design solutions for facilities

10. Provide guidance for applying a resilience lens to local government policies

Local governments across the province are at varying stages of planning for and advancing climate- and seismic-resilience in their communities. Some communities with more resources and capacity have completed climate risk assessments, reviewed and updated policies with a climate/seismic lens, and are developing and implementing various programs. Others have not had the resources or capacity to initiate this work. Although these activities must be completed in a manner that is specific to each community, there is an opportunity to provide guidance and associated training. These could outline key strategies, considerations, and tools to advance within local government authority related to each type of hazard for buildings. In addition, providing guidance on how to integrate planning across multiple hazards would also be highly beneficial. Examples of the types of considerations and tools to highlight include:

- Setback and floor space area relaxation opportunities
- Noise considerations
- Common area incentives
- Sump pump and drainage provisions

- Design for cooling
- Biophilic design
- Green rainwater infrastructure
- Rooftop equipment tie downs, etc.

Recommendation 10.1: Develop a provincial toolkit on resilient buildings for local governments

Develop a province-wide toolkit targeted at a local government audience that provides a thorough resource of local government tools that can support resilience in buildings. The toolkit should streamline access to current data, best practices, examples/lessons from other communities, relevant voluntary standards and guidelines to incorporate into local government policies, and more. Note that through this current Realizing Resilient Buildings project, a first version of a local government toolkit is being developed. Work could be done to expand this initial toolkit, shift it into an online forum, and accompany it with training and a peer-to-peer learning network. This would provide ongoing capacity development and training to accompany this key resource.

Local governments would also gain from clear recommendations on incorporating risk assessment findings into land use planning (recommendation 7.1). They would also benefit from understanding how resilience measures intersect with the Energy and Zero Carbon Step Codes.

Main actor(s): Provincial government (Ministry of Housing, Climate Action Secretariat), in collaboration with local governments

11. Establish a team of experts to provide on-call resilience capacity support

In many communities, localized hazard risk information is available and relevant resilience strategies have been developed. However, often a lack of local capacity within AHJs inhibits the analysis of hazard risk and the selection and implementation of locally-appropriate solutions. In some cases, AHJs may have staff who simply need one-on-one guidance. This would help them to better understand relevant hazard risks that may impact local buildings, the relevant strategies available to address those hazards, and options available to adapt these strategies to suit their specific local context. In other cases, AHJs may not have *any* internal capacity, and may be entirely reliant on external support to develop any kind of resilience measures. Other recommendations relate to the development of resources that these resilience experts can connect to (e.g., cost-benefit methods and research on resilience measures).

Recommendation 11.1: Establish a multi-disciplinary team to support AHJs on climate risk and measures

The Province should establish a multidisciplinary team of experts to provide targeted support to help AHJs access climate risk knowledge. They could also support AHJs to identify, prioritize, and develop customized solutions to mitigate hazard risk in their built environments. Experts would be knowledgeable in:

- The information available in a hazard data portal (recommendation #1)
- The processes for hazard/climate risk assessment
- Examples of relevant measures to address risks

Experts at the regional scale could be available largely by phone/video call. This work could build on the emerging Regional First Nations Climate Resilience network being piloted by the BC Climate Action Secretariat.

Co-benefits: Align with decarbonization efforts to communicate opportunities to reduce risk and emissions in tandem
Main actors: Provincial government (Ministry of Emergency Management and Climate Resilience, Climate Action Secretariat), PIBC, BOABC, academic institutions, non-profit organizations, local governments, First Nations governments and organizations. The B.C. local government climate action program (LGCAP) program could be the impetus/developer of the expert program.

Examples of resources

- CleanBC hotline
- 2007 Sustainability Advisors Program
- Fraser Basin Council flood risk Governance report – the four main elements of proposed governance align well with the recommendations in this section
- Coastal First Nations Great Bear Initiative Climate Action Network, where network coordinators support regional climate action coordinators to access resources and advance strategic priorities on their lands and across their territories
- Indigenous Clean Energy's *Bringing it Home* program provides targeted support to Indigenous communities to "engrain energy efficiency for new and retrofitted homes and facilities". While focused on energy efficiency rather than resilience, this model presents a useful example of an approach for providing targeted support for AHJs. It helps them to identify, develop and implement locally appropriate interventions.

Indigenous-led Regional Adaptation Network in B.C.

The Province of BC, under the direction of the Indigenous Climate Action Advisory Group, is funding a new Indigenous-led Regional Adaptation Network. This pilot project will build on the success of the current Great Bear Initiative Climate Action Peer Network. It involves hiring and training Regional Adaptation Coordinators to support Indigenous communities to build resilience to climate change in their communities and across their territories. This Program is currently under development, and expected to take shape in 2023.

12. Enhance climate risk and adaptation in professional competencies and development

Several different designated professionals may be involved in the planning, design, approval and construction of buildings. An evolving understanding of climate risks and mitigation measures is an essential part of each of these roles going forward. There are several self-regulated professions in B.C. related to buildings, and each defines its own professional development programs. These typically involve continuous learning and

earning credits in order to maintain the professional designation. Some professions in B.C. are regulated under the Professional Governance Act (applied science technologists and technicians, engineers and geoscientists, and three other natural resource professions). The PGA requires mandatory continuing professional development programs, but does not prescribe the topics or content of the programs. These learning requirements present a valuable opportunity to ensure professionals are well informed about climate risks and the potential impacts on their work. It will be important to ensure socially/culturally relevant competencies are included. This will ensure equity-seeking groups and Indigenous People's unique skills and values are represented in these tools and support cultural safety for these professionals and communities. Canada's National Adaptation Strategy includes a target that, by 2027, 70% of the members of relevant professional associations have the capacity to apply climate change adaptation tools and information. This also includes the ability to communicate the business case for adaptation measures to their clients or target audiences.

For example, EGBC has been advancing climate adaptation knowledge among registrants for the last decade, including:

- Developing guidelines for climate-resilient infrastructure
- Organizing continuing education events
- Establishing dedicated staff resources to support climate initiatives
- Providing information to members through its website

The landscape is continually changing. Therefore, it is vital that these efforts continue to grow and mature to serve the membership of EGBC and other professional bodies in the building industry.

By incorporating climate and seismic competencies into professional development, members of professional and industry associations are better informed and able to disseminate information more broadly. This may apply at various stages in a building lifecycle – from design and construction, to renovation, to property sale and inspection, to insurance renewal, etc.

Recommendation 12.1: Include risk assessment and response in professional development competencies

Incorporate seismic and climate risk data, assessment, impacts, and response measures as a required part of professional development competencies and credits for professions related to the design, approval, and construction of buildings. CanAdapt is a collaboration between Royal Roads University and the Climate Risk Institute that provides support to professional organizations in this arena. It includes developing a Climate Adaptation Competency Framework. Professional regulatory bodies can continue to build competencies and credits with training through Natural Resource Canada's Building Regional Adaptation Capacity and Expertise Program (BRACE). Encourage cross-disciplinary learning opportunities that bring together designers, policy practitioners and the development and building community.

Main actor(s): Professional regulatory bodies, Province (Office of the Superintendent of Professional Governance), Indigenous Climate Action Working Group (ICAWG)

Recommendation 12.2: Include risk assessment and response in post-secondary program curricula

In addition to integration with professional competencies for existing professionals, it is also recommended that post-secondary programs that lead to these professional designations review and update curricula. This should effectively incorporate seismic and climate risk data, assessment, impacts, and response measures.

Main actor(s): Professional regulatory bodies, post-secondary institutions

Recommendation 12.3: Provide resources and engagement with industry associations

Professionals working with building owners with building owners throughout the lifecycle of a building (e.g., realtors, home inspectors, insurance agents and more) need to be equipped with resources and information to better understand hazards, risks and resilience measures. Provide resources to industry associations linked to building development, retrofit, property transfer, insurance and more to better equip these professionals.

Main actor(s): Provincial government, Industry associations with registered members

Examples or resources

- CanAdapt Climate Adaptation Competency Framework
- USDN equity self-assessment tool
- BRACE program

13. Enhance recruitment, retention and skill development in construction sector

B.C.'s Labour Market Outlook 2022 Edition projects 1,017,000 job openings over the next decade. It also projects that industries related to buildings (professional, scientific and technical services and construction) will make up 22% of these openings. This assessment points to a dire need for workforce development, attraction and retention in these jobs in general.

The recent Industry Trades Certification engagement process highlighted multiple opportunities to support and increase on Indigenous people engaging in the trades. Examples include but are not limited to:

- Provide culturally safe learning opportunities
- Offer distributed learning, where Indigenous People can learn in community, supported by their community
- Engage youth early in trades training through partnering with secondary schools

Recommendation: 13.1 Conduct a skills gap assessment

Conduct an analysis of the skill requirements needed to support more resilient buildings. Use this to inform a gap assessment of the skills and labour needed to support a broad transition to more resilient buildings.

Main actor(s): Skilled Trades BC, Provincial government (Ministry of Post-Secondary Education and Future Skills)

Recommendation: 13.2 Promote broader participation in construction sector

Increase focus on attracting broader participation in industry. The construction industry has initiatives to change the culture of construction sites. They to make them more inclusive and to attract those not traditionally represented, including Indigenous people, women, youth, and new Canadians. To support this, the Province can work with Indigenous organizations to identify resources for training Indigenous youth. Further, the Province can work with the Federal government to increase the value of trades in immigration policy and programs. One example is ensuring skilled trades are eligible for pre-approved immigration programs. Include training for climate-resilient construction in high school and college trades programs, building from past programs. Programs that support retention of construction workers can be further developed.

Main actor(s): Skilled Trades BC, BC Construction Association, Provincial government (Ministry of Post-Secondary Education and Future Skills)

Recommendation: 13.3 Expand micro-credential and micro-training frameworks

The Province released a micro-credentials framework in Fall 2021 to provide opportunities to quickly re-skill or upskill in order to access employment in high demand areas. The BCIT zero-emissions learning centre is looking at micro-credentials for the construction sector. It piloted a micro-credential for zero-emissions vehicles that represented an endorsement additional to standard training. Technical Safety BC is exploring opportunities to provide micro-training for certificate holders on the topics of low-carbon technology and climate risk. These are opportunities to expand to other areas that support more resilient buildings. Professional associations also need to provide credentials or a pathway to them.

Main actor(s): Provincial government (Ministry of Post-Secondary Education and Future Skills), BC Construction Association, Skilled Trades BC, Post-secondary and Trades schools

Recommendation: 13.4 Establish culturally-safe training

Establish continuing learning for Red Seal trades, including culturally-safe and appropriate training for Indigenous People and equity-seeking groups.

Main actor(s): Federal government, Provincial government, BC Construction Association, Skilled Trades BC, Post-secondary and Trades schools

Examples or resources

- What we heard: Indigenous engagement on skilled trades certification in B.C.
- BCCA Apprenticeship in BC program

14. Establish quicker steps for expanding capacity

The following table lists related initiatives that are underway or that could be advanced in the near future.

14.1	Increase the value of trades in federal immigration policies and programs. Take advantage of the recent government priorities of increasing immigration numbers (federally) and expanding housing supply (provincially) to harness rapid action.	Federal government; BC Ministry of Housing
14.2	Support construction industry efforts to increase culturally-safe and appropriate trades training for Indigenous Peoples, and equity-seeking groups. Focus on the recruitment and inclusion of youth, women, and under-represented groups.	BC Construction Association; BC Ministry of Post-Secondary Education and Future Skills
14.3	Provide clear communication to citizens outlining how insurance and Disaster Financial Assistance work following hazard events. Include statistics.	BC Ministry of Emergency Management and Climate Resilience
14.4	Develop region-specific and accessible guidance for property owners to increase resilience of their buildings (e.g., Building climate resilience in the Okanagan: A homeowner's resource guide).	BC Ministry of Housing
14.5	Continue and expand partnerships with third-parties to monitor, confirm, capture and disseminate emerging resilient building design and construction techniques.	BC Ministry of Housing, Engineers and Geoscientists BC
14.6	Prepare a toolkit for Strata Councils on improving strata resilience.	BC Ministry of Housing
14.7	Update EGBC "Guidelines for Mechanical Engineering Services for Building Projects" to include design best practices that support heat pump systems and write member advisories (e.g., EGBC advisory on electrical systems and elevators for Flood Control Levels).	Engineers and Geoscientists BC

14.8	Prepare guidance for mechanical contractors and installers on best practices that support heat pump systems.	BC Ministry of Housing, Engineers and Geoscientists BC
14.9	Develop regional lists of best species to plant, considering risks (e.g., wildland-urban-interface fire, drought) and provide to AHJs.	BC Ministry of Forests

5.3 Building Market Demand for Resilient Buildings

Building market demand for resilient buildings will take time. There are numerous regulatory and non-regulatory tools and strategies that can support the transition. These start with:

- Ensuring regulatory frameworks support rather than hinder resilience
- Providing support for communities to establish appropriate design parameters
- Demonstrating leadership through public sector procurement
- Supporting innovation through construction techniques, methods, and contracting approaches

Mandates for resilience measures in buildings are an important tool. They are especially so when they:

- Are implemented with caution
- Are accompanied by supportive tools and programs that build capacity
- Address financial and socio-economic barriers
- Address inequity

Non-Regulatory Big Move Recommendations

15. Demonstrate leadership in public sector buildings

There remains significant uncertainty among private sector developers and building owners about economic, financial and logistical requirements of constructing or retrofitting buildings for enhanced resilience. This is because, across building typologies, there are relatively few examples of new development or retrofit projects that specifically integrate resilience measures. Without case studies and clearly communicated examples, best practices are slow to emerge. This reduces builders' and property owners' confidence to integrate resilience measures into their projects.

Recommendation: 15.1 Integrate public sector procurement and lessons learned

Demonstrate leadership by integrating resilience into the planning, development, and retrofitting of public sector buildings through procurement rules. Invest in demonstration projects across different building types. Broadly and transparently communicating design challenges, lessons learned, and other project outcomes through educational webinars with industry (e.g., UDI). Include consideration for new materials and assemblies that meet multiple objectives of resilience to identified hazards, decarbonization, and cost-effectiveness.

Main actor(s): Federal government, Provincial government (Citizen's Services, Real Property Division and all public sector organizations procuring buildings), BC Housing, local governments, First Nations governments, post-secondary institutions, BC Building Trades, UDI

Examples or resources

- The Climate Resilience Framework and Standards for Public Sector Buildings provides valuable information and guidance to enable public sector leadership. Although not currently publicly available, it is available to Ministry and Public Sector Organization staff as part of the Environmental, Social and Governance Framework for Capital. The Framework and Standards include "Minimum Resilience Guidelines."

- Climate Resilience Guidelines for BC Health Facility Planning and Design
- Energy efficiency criteria established in the CleanBC Better Buildings program provide a useful model that might be applied to enable and incentivize more resilient public sector construction and retrofits
- Canada Green Buildings Strategy highlights the importance of public sector leadership

16. Establish guidance and resources for community retrofit programs

Most buildings in place today will still be in place by 2050. These buildings need significant investment to meet our collective carbon neutral building goals, as well as improvements to enhance resilience to seismic and climate risks. But this will not happen without substantive support from government programs, coupled with appropriate policies and regulations. Local governments in B.C. are beginning to design and launch strategies to support these upgrades, primarily focusing on decarbonization. Resilience measures have not typically been a core consideration, but could be with proper planning and resources. Furthermore, it is important to consider the tendency for older buildings to house lower income and more vulnerable populations. This results in amplified impacts on these groups because the older buildings face more significant barriers to resilience than new buildings.

Recommendation: 16.1 Provide provincial support for community retrofit programs

Evaluate the feasibility of running a provincial program to support substantive resilient and carbon neutral retrofits in buildings across B.C. Alternatively, develop consistent guidance for establishing a community-scale retrofit program. This program could emphasize the importance of achieving carbon neutral and resilient buildings, while addressing past and existing inequities.

Provide guidance on evaluating where it is appropriate to support retrofits versus where it may be best to support redevelopment. Take into account several factors (zoning designations and density, embodied carbon, operational emissions, occupant displacement and more). An important consideration for a program like this is to accompany a retrofit program with a program for redevelopment. This should focus on areas designated for higher density (e.g., adjacent to major transit zones) that protect tenants (see example of the City of Burnaby Tenant Assistant Program below).

To accompany the guidance, establish a funding program that supports communities to establish and maintain retrofit programs. This should facilitate building retrofits, support industry training, facilitate financing options, and more. Where possible, prioritize support for older buildings housing more vulnerable populations. Investigate and identify appropriate mechanisms to trigger uptake of retrofits at a pace appropriate to align with climate targets. Coordinate program development with the Building and Safety Standards Branch existing buildings strategy that is currently in development.

Main actor(s): Provincial government (Ministry of Environment and Climate Change Strategy, Ministry of Housing), BC Housing, BC Hydro, Zero Emission Innovation Centre (Metro Vancouver), local governments, First Nations governments

Examples or resources

- US Department of Homeland Security's Natural Hazard Retrofit Program Toolkit: A guide for designing a disaster-resilient building retrofit program in your community

- Capital Regional District Residential Energy Retrofit Program

City of Burnaby Tenant Assistance Policy: Development incentives coupled with inclusionary zoning

In order to meet community objectives for increasing density close to major transit corridors, the City of Burnaby supported development projects that in some cases led to the redevelopment of older purpose-built rental projects. Although this met the objectives of higher density and more energy-efficient new buildings, it also resulted in the removal of more affordable rental units and displaced tenants.

In response to criticism, the City introduced a Tenant Assistance Policy (TAP), requiring that tenants of purpose-built-rental buildings be temporarily moved to other buildings at the same rent while their building is redeveloped. Upon completion of the development, those tenants are then allowed to move into the new building at the same original rent level. The TAP also requires coverage of moving expenses and other supports. These units may be counted towards the City's inclusionary zoning requirement for 20% of units in new projects to be affordable rental.

These new requirements are funded by density increases. Therefore, this tool is suitable to situations where redevelopment is deemed more desirable than retrofit of existing buildings in order to meet multiple community objectives.

17. Support innovative materials and technologies

Building science is evolving and new materials and technologies are continually being developed to help meet the changing requirements for new buildings. Building materials and technologies require substantive testing and approvals in order to be approved by certifying bodies and acceptable for use in Canada and B.C. This may delay the availability of products that help buildings meet multiple objectives in the most cost-effective manner.

Manufacturers of building technologies do not often have a local or even national presence, or products are slow to obtain approval from Canadian bodies (e.g., CSA). Local variety in examples of building products may not be available (e.g., exterior shades). This is amplified in remote and northern communities. Current supply chain issues result in long lead times. See also regulatory recommendation to remove barriers in building code for alternative building materials.

Recommendation: 17.1 Conduct an assessment of innovative materials and technologies

Conduct an assessment of building materials that support multiple objectives (resilient, carbon neutral, cost-effective) to identify supply chain constraints and actively seek vendors to obtain certifications to supply to Canada. Review materials being used in other jurisdictions' recovery efforts. For example, Paradise California is rebuilding after a wildfire engulfed the city in 2018. Recently adopted ordinance requirements to reduce wildfire risk coupled with strengthened state requirements for earthquake risks at first led to challenges. However, they resulted in innovative new materials being used. Consider guidelines for better insulation materials and improve awareness of the Living Building Challenge Red List. This list represents materials known to pose risks to human health and provide healthy alternatives.

Main actor(s): Federal government, Provincial government (Ministry of Housing), BC Housing Research Centre, BC Construction Association, Indigenous-led firms and organizations

Recommendation: 17.2 Accelerate approval of resilient materials and technologies

Consider how to accelerate or even directly approve technologies already certified by other bodies such as in the European market (CE). Assist vendors with new technology certified in other regions to get certified in Canada by providing technical support experts; easing on-site field certification, etc. Create a streamlined path for certification of technologies already certified in Europe or the US, where suitable to the BC weather zones. Engage with Indigenous-led firms and organizations seeking to develop production of new materials and technologies suitable to the remote community needs.

Main actor(s): Federal government, Provincial government (Ministry of Housing), BC Housing Research Centre, BC Construction Association, Indigenous-led firms and organizations

Examples or resources

- Paradise California rebuilding efforts led to use of innovative fire-resistant materials that also meet strengthened seismic requirements

18. Innovate through alternative building contracting

The common approach to new building development in BC, particularly for public sector projects, is the use of a Design - Bid - Build project delivery sequence with a single fixed-price general contract (CCDC2). Using this approach, design is completed before engaging a contractor and all subcontractors. This prevents meaningful engagement with contractors and their potential collaboration in the coordination of the design. As a result, it is more difficult to adopt innovative approaches that may address climate and seismic resilience. This is because new systems are harder to optimize without detailed input from specialist subcontractors and suppliers.

For example, if engaged early, subcontractors and suppliers of prefabricated structural or envelope components (e.g., mass timber floors, prefinished exterior wall panels etc.) could develop digital fabrication models. This could be done in parallel to the consultants' design models. The fabrication model can inform the design model, and vice-versa, for an optimized system, leading to more innovative designs to address new design conditions and objectives.

Recommendation: 18.1 Encourage contracting that supports integrated design and delivery

Employing other contracting approaches (e.g. Integrated Project Delivery Contract CCDC5 / 30) with more integrated design processes would allow pre-tendering of key scopes within the project (structure, envelope, glazing, etc.). This may be highly specialized or integral to expediting the construction schedule. Shifting toward this form of contract management in public sector buildings would:

- Provide more opportunities for innovation
- Allow for earlier input from the construction perspective ("buildability")
- Potentially accelerate delivery of projects
- Provide a model for other building development to follow

Upon implementation of an alternative approach, document findings and share broadly with the private sector.

Main actor(s): BC Housing to demonstrate and share best practices, Public sector organizations, BC Construction Association

Examples or resources

- Construction Management (CCDC 5) and Integrated Project Delivery (CCDC 30) contracts

19. Promote resilience in new construction techniques

BC/Canada's construction sector generally has poor productivity trends (flat or negative change), coupled with chronic labour shortages and material supply chain challenges. Innovation and progress are already happening in the area of energy efficiency – more insulation, higher standard of air-sealing, better mechanical ventilation etc. This often creates additional on-site labour in an industry with significant pre-existing productivity issues. Extensive resiliency initiatives that will be required across all buildings (including retrofits) may further exacerbate existing inefficiencies and cost issues.

This points to the need for more standardization, off-site fabrication and a degree of automation. These methods have been more widely employed in Western and Central Europe since the mid-1990s. The off-site construction industry is still small in Canada.

Recommendation: 19.1 Promote prefabricated and modular construction

Promote prefabricated materials and modular construction that incorporate resilience measures. This will require more investment, standardization and increased competition. The Province, in collaboration with industry stakeholders, should review and identify supportive mechanisms. These could promote broader uptake of standardized, off-site fabricated, and automated building techniques that increase productivity and meet emerging low-carbon resilience building objectives. Examples include:

- A strategy to mobilize capital investment to achieve scale and competition, including an increased focus on digital solutions
- Providing certainty and clarity about the future direction of the industry
- Conducting further BC Housing demonstrations and pilot projects
- Incorporat-inge requirements for pre-fabrication in public sector procurement as a stimulus measure (similar to 'Wood First' policies)

Work should also be done to explore local materials and value add opportunities for Indigenous communities, with economic, social, and cultural co-benefits.

Main actor(s): Provincial government (Ministry of Housing), local governments (zoning, prezoning, incentives), BC Construction Association

Examples or resources

- Building Capacity: Local prefab mass timber solutions, SFU Renewable Cities
- Modular construction: From projects to products, McKinsey & Company
- The competitive edge - Growing your business in the future of construction, Vancouver Economic Commission event series

Regulatory Big Move Recommendations

20. Develop Provincial requirements on risk tolerance thresholds

Most townsites, communities, and cities in B.C. have developed in high-hazard exposure areas such as floodplains or alluvial fans. Avoiding hazardous land is the best approach for high-risk land uses. However, existing development patterns and the push for housing supply to increase housing affordability work against retreat from or avoiding development in high-risk areas. This means that housing is likely to require incorporation of risk mitigation measures. These could include flood construction levels, site specific berms, permeability and good drainage, etc. in many communities. Some hazards will require risk mitigation measures at both the building and neighbourhood scale. For example, the urban heat island effect and heat waves can be addressed through building-level interventions and neighbourhood-level actions such as increased vegetation.

When designing risk mitigation measures, there is a threshold to which they are designed - a risk tolerance threshold. The ALARP (as low as reasonably practicable) principle is often applied. However, many AHJs cannot translate that into design-related statements. Each local government and First Nation is being left to establish their own risk tolerance for each hazard. This leads to variations between neighbours and differing levels of residual risk. In some cases, risk management is shared between the AHJ and the building owner/builder (sea dike plus flood control level) and in other cases, the risk management is transferred to the building owner/builder (cooling requirements).

Recommendation: 20.1 Establish provincial minimum risk tolerance thresholds

The Province should establish guidelines for minimum risk tolerance thresholds for development exposed to climate-related hazard risk. It should work with the Federal government and First Nations governments to support minimum risk tolerance thresholds on First Nation lands.

Main Actors: Provincial government (Ministry of Emergency Management and Climate Resilience, Ministry of Housing), Federal government, First Nations governments, local governments, industry

Recommendation: 20.2 Develop guidance for application of risk tolerance thresholds

Develop guidance to accompany risk tolerance thresholds that lists acceptable practices and effectiveness of those practices in reducing risk to align with the tolerance thresholds. Guidance should distinguish practices for new and existing development areas. In particular, provide guidance for simple building types that are more likely to be served by smaller builders with less capacity (e.g., provide a list of acceptable stormwater management measures rather than requiring each project to develop its own stormwater management plan). This may be developed as a template provincially to be localized by local AHJs.

Main Actors: Provincial government (Ministry of Emergency Management and Climate Resilience), Federal government, First Nations governments, industry

Examples or resources

- District of North Vancouver Risk Tolerance for Steep Slopes
- Cheekeye Fan Risk Panel Report

21. Review legislation for barriers to adoption of resilience measures in homes

Current legislation can inhibit some owners and tenants from taking action to enhance household resilience to climate hazards by, for example, installing air conditioners or heat pumps. This relates to stratas. Section 71 of the *Strata Property Act* requires that three-quarters of strata members approve any "significant change in the use or appearance of common property". This may be interpreted to include the installation of air conditioners or heat pumps for individual units. In relation to tenancies, after-action reporting from the 2021 Heat Dome event publicized barriers that tenants faced when trying to cool their homes. Key barriers include the lack of a mechanism for landlords to recover retrofit costs for older buildings (due to the *Residential Tenancy Act*) and building-level electrical load limitations. While Standards of Maintenance Bylaws are clear on minimum temperature levels property owners must maintain, they do not include maximum temperatures.

Rooftop solar panels are one response to achieving energy resilience. However, municipal zoning height regulations or form and character guidelines may prevent them from being installed. Some municipalities, such as the City of North Vancouver, have revised their zoning to allow for solar panels as a permitted height exception in all zones.

Improved awareness of the synergies and conflicts between carbon neutral, energy-efficient and climate- and seismic-resilient building strategies is needed. This also needs to be integrated into consideration of regulatory barriers to ensure we are thinking about climate compatibility in all legislation.

Recommendation: 21.1 Conduct legislation review for resilience barriers in stratas and tenancies

The Provincial government should conduct a review and apply a climate resilience lens to relevant provincial legislation (notably the *Strata Property Act and Regulation* and the *Residential Tenancy Act)*. This work should address any real or potential barriers that limit or create disincentives to implement resilience-enhancing measures (e.g., heat pumps, air conditioning units, triple-glazed windows, solar panels, and more). See resources below for a link to a Lower Mainland Local Government Association resolution on this topic. Further, mechanisms to support regular maintenance of backup power systems and other building assets should be considered in the review. Providing guidance to AHJs on the pathways available to prioritize and address overheating in older, multi-floor rental buildings is also essential.

Main Actors: Provincial government (Ministry of Housing, Residential Tenancy Board), BC Landlords Association, Condominium Home Owners Association

Recommendation: 21.2 Review and update provincial guidance on standards and maintenance bylaws

Review and update the provincial guidance for standards of maintenance bylaws, taking into consideration future climate projections - particularly with respect to extreme heat. Work closely with landlord associations to identify and address barriers to potential new requirements (see also financing enablers and retrofit program enabler).

Main Actors: Provincial government (Ministry of Housing, Residential Tenancy Board), BC Landlords Association

Recommendation: 21.3 Review and update resilience elements in strata depreciation reports

Review and update requirements and guidance to include resilience elements in strata depreciation reports (which are required for every strata under the Strata Property Regulation). Provide templates/guidance on resilience reporting for strata boards.

Main Actors: Provincial government (Ministry of Housing), Condominium Home Owners Association

Recommendation: 21.4 Review and amend local government zoning bylaws

Local governments should review and amend their zoning bylaws for limitations to resilience measures (e.g., to allow solar panels as a permitted height exception in all zones, to allow heat pumps or air conditioners on exterior balconies and roofs, etc.). Local government practitioners need to understand when a development guideline or land use requirement may work for or against resiliency objectives. They also need to know how best to integrate the most pressing hazard risk mitigation elements into developments.

Main Actors: Local governments

Examples or resources

- Strata Depreciation Report Requirements
- Lower Mainland Local Government Association 2023 Resolutions – endorsed R18 "Updating the *Strata Property Act* to include allowances for heat pumps and other mechanical cooling systems"
- City of Vancouver completed report due January 2023
- Vancouver Coastal Health research on Standards of Maintenance Bylaws in BC
- Standards of Maintenance Guide for BC

22. Review electrical utility policies and requirements acting as barriers to resilience

Electrification of buildings is an important strategy for achieving zero-emission buildings, and it can also serve as a means to improve resilience to increasing temperatures and extreme heat events. There are a number of barriers to full electrification of buildings in BC. Several are related to BC Hydro policies (which applies to most of BC, though this may apply to other electrical utilities as well). These include:

- The connection fee structure that may disincentivize a new building, or a building retrofit, from selecting electrification if it triggers a local capacity upgrade - the costs of which are borne by the new or upgraded building(s)
- The rate structure which penalizes buildings that use more electricity, and as a result penalizes electrifying heat sources (e.g., once a building electrifies, charges move into a higher rate class)
- Lack of alignment between local land use / growth planning efforts, and utility network planning leading to insufficient capacity in areas with significant growth
- Slow response times for electrical service connections and upgrades impedes retrofit opportunities
- BC Hydro has much higher connection fees than FortisBC

- Many remote communities in the non-integrated areas and in other areas of the province are currently serviced by diesel generators, this creates barriers for full, low-carbon electrification, and more

Recommendation: 22.1 Advance BC's Building Electrification Road Map Strategies

BC's Building Electrification Road Map identifies a number of strategies to support electrification in buildings, including recommendations to address barriers identified above. Examples include:

- Directing utilities to enable electrification in a manner consistent with Provincial targets as part of their mandate
- Revamping the BC Hydro connection fee structure to encourage rather than disincentivize electrification
- Updating the rate structure to remove higher rates for buildings moving away from fossil fuels

Further, any policy that supports the shift to heat pumps will support reduced demand relative to a shift toward electric boilers or baseboards.

During this broad transition toward building electrification, it will be critical to incorporate considerations for resilience in all policy adjustments and future planning. Rural, remote and northern communities are more likely to be subject to power outages, and ensuring sufficient backup power opportunities should also factor into this policy review. Providing a clean energy source where electricity is currently provided by diesel generators is also a priority. There may also be opportunities to support load balancing, and building-level battery storage, to reduce the need for increasing service capacity or to reduce load variations that may impact rates in future.

Main Actors: Provincial government (Ministry of Energy, Mines and Low Carbon Innovation, Ministry of Environment and Climate Change Strategy), BC Hydro

Recommendation: 22.2 Plan for future electrical capacity linkage to land use planning

It is recommended that the Province and BC Hydro plan for and support transmission and distribution upgrades based on projected future electricity demand. It is also recommended that the Province and utility consider partial funding of these upgrades to ensure that barriers to electrification are not mounted against individual projects. Preparing for and providing sufficient capacity for future loads will negate the practice of trying to minimize electrical demand for projects. This practice can result in the need for upgrades in the near future - adding substantial costs and effort for all parties. It is also recommended that BC Hydro participate in local land use planning processes to provide current information about local system constraints and planned upgrades. Further, it is recommended that it helps to incorporate growth projections into infrastructure upgrade planning (including consideration for areas that have high potential / needs for retrofits, areas with high growth potential, etc.) Where possible, publish this information.

Main actor(s): BC Hydro, BC Utilities Commission, Provincial government (Ministry of Energy, Mines and Low Carbon Innovation), local governments, industry

Examples or resources

- British Columbia's Building Electrification Road Map

23. Advance resilience in the codes and standards process

Initiatives are being advanced nationally to better integrate resilience into the National Building Code (NBC). These include the identification of 36 strategies to improve inclusion of climate change into standards. These efforts are ongoing and will be several years before substantive changes are completed. B.C. has committed to harmonize the BC Building Code with the NBC, thereby adopting new resilience measures as they are addressed in the NBC. While national consistency is laudable, B.C. may wish to act independently to advance resilience matters most pertinent in B.C. more swiftly than the NBC process will achieve. B.C. has taken proactive steps to advance energy efficiency, and to allow taller mass timber buildings prior to the release of the 2020 NBC. An example of B.C. moving more quickly than the NBC is reflected in the 2024 BCBC code change related to overheating limits in dwelling units.[52]

Codes focus on minimizing first costs and ensuring life safety, without sufficiently considering societal long-term costs that are outside the code's stated objectives. New owners do not typically opt to pay for additional resilience measures. This is because they may not realize the benefits during the short time of ownership relative to the life of the building. One strategy is to reference CSA standard S478 for the durability of buildings, which is a very important aspect to support resilience for many reasons. In the context of a world working with a limited carbon budget, there is a strong case to limit lifecycle carbon. Instead, the limited carbon budget could be focused on building durable buildings that can withstand seismic and climate hazards for decades to come. This could reduce the need to continuously repair and rebuild. More durable buildings also mean less degradation for older buildings, and less frequent need to displace people to address repairs or reconstruction.

In addition to durability, another important standard from ASHRAE specifies environmental conditions for thermal comfort. These include temperature and humidity ranges which are currently referenced in the code. This does not set requirements for maintaining temperatures below a specific threshold.

Main actor(s): Federal government (National Research Council), Provincial government (Ministry of Housing Building and Safety Standards Branch)

Recommendation: 23.1 Enable provincial code working groups to inform advocacy

The Province has committed to harmonize the provincial code with the NBC. The new harmonized structure provides greater opportunity for the Province to advocate for updates to the NBC. Establishing working groups informed by a cross-section of experts can help the Province to identify, evaluate, and prioritize requested updates to bring to the national committees. These working groups can also consider need for incentives, industry capacity, and financial mechanisms that could support recommendations. Examples to review include:

- Reviewing and advancing the Code Change Request with respect to point access blocks with a single egress is one type of change that could enable cost savings while climate compatible objectives
- Reviewing and advancing the recommendations for updates to the building code to address flood mitigation outlined in the NRC Guide for Design of Flood-Resistant Buildings

[52] Proposed change to reduce risk of overheating in dwelling units. Accessed December 2023.

- Reviewing the full suite of wildland-urban interface fire measures in the national NRC guide, with input from BC FireSmart committee and consideration for varying local threat assessment
- Reviewing and advocating for full vertical load path and lateral load resistance for Part 9 buildings, with input from the Roofing Contractors Association of BC
- Reviewing potential requirements for backup power for sump pumps, and other foundation drainage performance issues noted in the Builder Guide to Site and Foundation Drainage report to BC Housing
- Review for barriers to allowing alternative building materials
- Identify and approach the Standards Council of Canada for development of national standards

Main actor(s): Provincial government (Ministry of Housing), industry experts, First Nations governments

Recommendation: 23.2 Establish durability as an objective of the Building Code

In addition, referencing the CSA standard S478 (durability in buildings), consideration should be given to making durability of buildings an objective of the building code. This should be advanced at the national level, and consideration should be given to advancing BC Building Code changes ahead of the NBC process. Since the earthquake in Christchurch, New Zealand has begun to shift to include reparability into code objectives in addition to life safety. Durability considerations dovetail well with the planned introduction of embodied carbon to the NBC in the future. One consideration for the durability of buildings, is the need to pair this with "durable zoning". This is where land use supports buildings to stay in place for their lifespan.

Main actor(s): Federal government (National Research Council), Provincial government (Ministry of Housing), local governments

Recommendation: 23.3 Establish overheating thresholds and cooling requirements in code

The BC Coroner's Report Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021 includes recommendation #3(C) that: "The Ministry of Attorney General and Responsible for Housing will ensure that the 2024 release of the BC Building Code incorporates both passive and active cooling requirements in new housing construction, and that the release of the Alterations Code for Energy Efficient, Resilient Buildings explicitly identifies both passive and active cooling standards for existing home renovation." A proposed change to the BC Building Code to this effect was released in 2023. Limiting building overheating that poses health risks, especially to those most sensitive to heat, is also recommended by Canada's Chief Public Health Office. It is recommended that the BC Building Code, and upcoming Alterations Code, address the Coroner's Report and Chief Public Health Office recommendations.

Cooling system design (whether passive or mechanical) should be relying on future summer design temperature files or a factor of change from current temperature. Work needs to be done to review how other jurisdictions are handling limits to overheating and the best approach for B.C. For example, in the U.K., strict limits exist for bedroom overheating which may be appropriate given the projections for warm nights in the future. An improved awareness of operating costs and details vs. capital investment of cooling and/or systems that cool and heat is also needed.

More education and awareness are required to avoid relying entirely on mechanical cooling in new buildings. Mixed-mode cooling that uses natural ventilation to complement mechanical systems has many co-benefits and has been proven to meet stringent overheating limits. Mixed-mode systems can improve indoor air

quality, help reduce airborne pathogens, and reduce lifetime carbon while providing increased system resilience. Design today can ensure the space and conduits for future additions to mechanical cooling capacity are available.

Main actor(s): Federal government (National Research Council), Provincial government (Ministry of Housing), First Nations governments, industry, AIBC, EGBC

Examples or resources

- BC Coroner's Report Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021
- National climate responsive building codes report
- Mobilizing Public Health Action on climate Change in Canada
- EGBC Practice Advisory – Overheating considerations for existing multi-unit residential buildings

24. Identify a mechanism for post-occupancy building management / performance

Context: For several types of building systems, there are no mechanisms for government to monitor, manage, or regulate performance after completing the building permit process. In some cases, this may impact the resilience of a building. Three examples include non-potable water systems, site drainage systems connected to public sewers, and space heating systems. For example, in areas affected by seasonal drought and water shortages, site-based non-potable water systems may reduce the demand on public potable water systems. They may also provide sufficient water for toilet flushing, landscape watering, or other non-potable purposes. However, there is no regulatory mechanism (outside of the City of Vancouver) to monitor or permit these systems to ensure they are being properly and safely operated.

A second example pertains to pluvial flooding risk when a public drainage system is overwhelmed. Underground pipes located on private property that connect the building to the public sewer system are the responsibility of the property owner to maintain. When left unmaintained, these often develop cracks or breaks. These can allow rainwater to infiltrate into the drainage system in large quantities during extreme rainfall events, leading to sewer backups and basement flooding. For buildings with sump pumps, a power outage can also cause flooding if there is no backup power installed with the sump (common in existing buildings).

On reserve lands, there is a lack of capacity for post-construction and post-occupancy site assessments. This contributes to low quality construction and maintenance standards in many communities.

Recommendation: 24.1 Develop health guidelines for non-potable water and regulatory oversight

Develop province-wide guidelines for use of non-potable water using a risk-based assessment process, and provide performance targets for use in project applications and ongoing oversight. This goes beyond the current provincial guidance provided in 2016. Best practices are emerging from other jurisdictions that point to risk-based assessment processes. B.C. can look to these jurisdictions' guidelines as a strong launching point, including the Province of Alberta and US jurisdictions.

Main actor(s): Provincial government (Ministry of Health)

Recommendation: 24.2 Explore regulatory oversight mechanisms for non-potable water systems

Explore and identify a regulatory mechanism in B.C. to provide oversight for the safe and ongoing operation of site-based non-potable water systems (i.e., monitoring and reporting of appropriate pathogens and chemicals). This could build on the oversight program for the City of Vancouver to monitor non-potable water systems, which was established in collaboration with Vancouver Coastal Health. Other local governments do not have the same regulatory mechanism as the City of Vancouver. Therefore, a new mechanism needs to be explored and defined, including considering a role for Technical Safety BC. For regions facing seasonal droughts that put pressure on potable water resources, develop and adopt regional policies that support non-potable water use in buildings.

Main actor(s): Provincial government (Ministry of Housing, Ministry of Health), BOABC, Health authorities, Regional governments, Environmental Operators Certificate Program (EOCP), Technical Safety BC (as applicable)

Recommendation: 24.3 Develop model sewer use bylaw

Develop a model sewer use bylaw that provides clear mechanisms for local governments to manage performance standards of drainage systems connected to public sewer systems. This is also an opportunity for data sharing discussions with the insurance industry. This could help understand the extent of building damage in connection with different rainfall events. Local governments should track and report on flooding events, update sewer use bylaws, and improve monitoring, support for, and/or oversight of private-side sewer connection maintenance.

Main actor(s): Ministry of Housing, Regional governments, BOABC

Recommendation: 24.4 Support capacity for post-construction documentation at handover

Work with ISC's Housing Infrastructure Committee to understand how to support capacity for post-construction, and post-occupancy inspections. This would help ensure high quality construction of new buildings. This may include clarification of responsibilities or new requirements in relation to adequate guidance for maintenance and operation at time of handover. This would ensure resiliency features perform as intended. Additional capacity for ongoing maintenance may also be important.

Main actor(s): Ministry of Health, Health Authorities, Local governments, Provincial government, Federal government, First Nations Housing Infrastructure Committee, industry associations, BOABC

Examples or resources

- Guidance for using non-potable ambient water for domestic purposes in B.C., 2016
- City of Vancouver water systems operating permit program
- Alberta public health guidelines for water reuse and stormwater use
- Metro Vancouver private sewer lateral programs: A study of approaches and legal authority for Metro Vancouver municipalities

- Metro Vancouver Guidebook for non-potable water systems (forthcoming)

25. Quicker steps for building market demand

The following table lists related initiatives that are underway or that could be advanced in the near future.

25.1	Expand Public Sector Organization minimum resilience standards to provide public design standards based on building typology, for both new and existing buildings. These can be further included in procurement policies and approaches of PSOs (as per the Climate Resilience Guidelines for BC Health Facility Planning and Design).	BC Ministry of Environment and Climate Change Strategy
25.2	Prepare seismic upgrade standards for a wider range of public facilities (building on those developed for schools).	BC Building and Safety Standards Branch, Engineers and Geoscientists BC

25.3	Distribute guidance to AHJs to remove barriers to installation of heat pumps.	BC Ministry of Housing
25.4	Develop guidance on backup power systems beyond life safety minimums in the Building Code. Focus on large-scale and battery-provided power and the opportunities and risks. Give special consideration to remote Indigenous communities and life supporting systems for individuals with disabilities. There may be a fire issue that needs to be reviewed. See City of Toronto backup power guidelines for an example.	BC Ministry of Housing, Engineers and Geoscientists BC
25.5	Develop clear guidance on how to interpret when a drain "may" or "may not" be subject to backflow, in relation to the BC Plumbing Code 2.4.6.4.(3). Almost no jurisdictions in Canada have information about the likelihood of a sewer backup. As a result, clearer guidance is required and should err on the side of protecting the building. See the Ontario Auditor General's Report on Reducing Urban Flood Risk (section 4.2.1). See also CSA Z800. Also consider removing the option for a gate valve, as this has been removed in the 2020 NPC.	BC Ministry of Housing
25.6	Develop guidance on interpretation of BCBC 9.14.5.3 and the suitability of allowing infiltration features within 5 metres of building. Currently the interpretation may prevent use of infiltration features in existing neighbourhoods that support stormwater management goals.	BC Ministry of Housing
25.7	Clarify pipe joint support requirements to reduce the range of interpretations, particularly in relation to storm pipes strapped to the exterior of foundation walls. Because the current NPC requirements are vague, there is potential for excess weight to be borne by the pipe when backfill is dropped onto the pipe (recommendation in BNQ 3682-320).	BC Ministry of Housing
25.8	For Coordination Registered Professionals, compile a list of all openings which may require raising or retrofitting in future with respect to flooding risk.	Professional associations

5.4 Improving Investment and Financing Opportunities

Although some resilience measures may be simple and cost-effective, most measures will require investments by building developers, owners, and/or occupants. Investments required may be in the form of:

- Additional design and approval time and costs
- Higher cost of materials or qualified labour (particularly in the shorter term when there may be more limited supply)
- Dedication of valuable floorspace to resilience measures in new developments
- Increased cost of operation or maintenance for equipment or programming that supports resilience

To achieve broad uptake, government financial support, better tools for cost-benefit analysis, and expanded tools that support investment will be essential. As noted earlier in this paper, government costs in response to events can be very large. This supports the investment of government funding into proactively improving resilience and mitigating future losses. Alternative mechanisms that support owner investments can also be explored through private sources (incentives tied to mortgages, premium discounts with insurers, increased resale value).

Big Move Recommendations

26. Expand existing government financial support programs to include resilience measures

Without financial support to advance resilience measures, owners are required to pay extra to incorporate resilience. Meanwhile, other stakeholders benefit from the resulting savings (reduced insurance claims, stability of businesses, improved safety, etc.) As a result, there are is a lack of market forces leading to resilient buildings.

A wide variety of government incentives are available to support building construction and retrofitting in alignment with various housing, energy efficiency, and other policy objectives. Many of these programs are well established and well resourced, with capable staff, clearly defined protocols, and effective end-to-end processes. Expanding programs that address parallel building sector challenges to include resilience measures would leverage existing funding channels, structures, and resources to accelerate building sector resilience. Similarly, existing funding commitments to support better buildings for historically disadvantaged groups and communities might also be expanded to include resilience measures. This is particularly important given the overlap between social inequality and vulnerability to climate and other hazards.

For recovery funding, programs should be reviewed to ensure they support a build back better approach, rather than rebuilding as status quo. This will help avoid leaving new buildings at risk of future events.

Finally, existing programs may tend to focus on owner-occupied buildings, leaving a gap for landlords to implement resilience measures.

Recommendation: 26.1 Strengthen proactive investment business case for government

Undertake an assessment to quantify the savings to governments for investing proactively in resilience measures, rather than reactively in response to disaster events. Use findings to support increased proactive investments in resilience measures. Apply this assessment to recovery programs to ensure a build back better

approach is taken for any rebuilding investments. Proactive investment should consider all types of costs, including capital, space penalties, cost efficiencies, approval process times and more.

Main actor(s): Federal government, Provincial government (Ministry of Emergency Management and Climate Readiness), utilities, local governments, insurance industry

Recommendation: 26.2 Couple resilience with energy efficiency and zero-carbon incentives

Expand parallel building sector funding programs to include and couple resilience measures with energy efficiency and zero-carbon measures, leveraging existing program capacity and structures. One specific example for applying this is providing incentives to install back-up power for sump pumps in existing buildings. This can be an extension of existing energy efficiency and decarbonization incentive programs. See resources below for reference to a recent Local Mainland Local Government Association resolution. It emphasizes the need to update the CleanBC Better Homes program to cover all dwelling types and include climate resilient retrofits.

In tandem, assess opportunities to recalibrate programs and existing funding commitments to advance equity and climate objectives. Notably, this can happen through transfer payments to First Nations governments to advance climate resilience project in their communities, as part of reconciliation measures.

Main actor(s): Federal government (Natural Resources Canada), Provincial government (Climate Action Secretariat), utilities, local governments

Recommendation: 26.3 Support and incentivize resilience in local development approvals

Following from recommendation 10.1, it is further recommended that local governments implement resilience measures in the Provincial guidance that is suited to their local contexts. Local policies that may influence the viability of advancing projects with resilience measures include:

- Building height restrictions
- Limitations regarding roofs
- Gross floor area calculations
- Setback requirements or restrictions that affect use of heat pumps
- External shades or onsite stormwater management
- Noise bylaws, form and character guidelines
- Landscaping requirements or restrictions
- Limitations on housing typologies for multi-family buildings, and more

Local authorities will need the support from the Province to provide guidance and capacity to implement the guidance. Expanding multi-contributor enabling programs like the Clean BC municipal ‘top-ups’ should be explored.

Main actor(s): Local governments, supported by guidance and capacity from the Provincial government (Municipal Affairs)

Examples or resources

- Natural Resource Canada's *Greener Homes Initiative* includes a limited list of resiliency measures that could be significantly expanded
- CleanBC's *Better Homes and Home Renovation Rebate Program* is well established, and could also provide an avenue for municipalities to provide 'top-up' incentives (e.g., City of Saanich or Esquimalt's Heat Pump Top-Up programs) for priority resilience measures that address locally-relevant hazards
- Lower Mainland Local Government Association 2023 Resolutions – endorsed R3 "Incentives for heat pumps and other climate resilient retrofits in multi-residential buildings"
- National Institute of Building Sciences, A Roadmap to Resilience Incentivization

27. Increase building-owner access to capital for resilience enhancing investments

Currently, building owners have limited opportunities to access capital to cover the additional upfront costs of integrating resilience measures into new builds or retrofitting existing buildings. In many cases, developers and building owners understand the business case for resilience measures. However, traditional financing institutions and tools are not well equipped to consider the potential long-term savings from up-front investments in resilience. This issue is further compounded by rising material and construction costs, which increase the capital needed for building projects. Without additional access to capital, developers and building owners will face growing challenges in achieving more resilient buildings or meeting future resilience guidance / code requirements.

Recommendation: 27.1 Increase access to capital for resilience measures

Federal and provincial governments should pursue new ways to increase access to capital, enabling the integration of resilience-enhancing improvements in new builds and retrofit projects. For retrofits, opportunities that avoid renovictions should be considered. These measures may include:

- Establishing low-interest loans to fund resilience improvements, potentially building on a property assessed clean energy approach (PACE+R)
- Adjusting federal accelerated capital cost allowance rules to enhance tax write-offs for capital investments that would improve resilience
- Providing supportive local incentives such as onsite or offsite density bonuses, unused density transfers, tax exemptions, or building permit rebates
- Involving the insurance industry in the discussion
- Funding green bonds to finance the implementation of resilience initiatives
- Creating a revolving fund indexed to performance goals, such as resilience and low carbon outcomes, to provide ongoing financial support as the industry transitions in this direction. This could build on a model like that used by the Toronto Atmospheric Fund (TAF), which has successfully implemented similar initiatives.

Main actor(s): Federal government, Provincial government (Ministry of Housing), utilities, local governments, finance industry

Recommendation: 27.2 Prioritize capital for social housing and those more vulnerable to hazards

Additionally, existing financing and loan programs should be assessed through an equity and vulnerability lens. This would ensure that buildings housing those most vulnerable to climate and other hazards are prioritized in resilience-enhancing funding models. For example, the CleanBC Income Qualified Program could be expanded to include resilience measures in addition to energy savings. Consideration of human health and safety in a climate change context would be the priority. In particular, evaluating and recalibrating programs to streamline financing for social housing.

Main actor(s): Federal government, Provincial government (Ministry of Energy, Mines and Low Carbon Innovation, BC Housing), local governments, construction industry, building owners

Examples or resources

- Through the same mechanism as Canada's Accelerated Investment Incentive, a larger share of investments in specific resilience enhancing measures could be written-off against taxes owed.
- CleanBC's Better Homes Low-Interest Financing Program could be a model for a similar resilience-focused low-interest loan program.
- Vancouver Economic Commission's PACE Financing and Resilience in B.C. report includes a review of best practices for commercial PACE programs throughout the US that support resilience.

28. Develop private sector mechanisms that incentivize resilient measures

Individual homeowners and strata corporations could be encouraged to implement resilience measures if they saw their efforts reflected in private sector mechanisms. These might include insurance premiums, mortgage rates, and increased resale value. Examples provided during engagement revealed that in some cases insurance premiums have increased when resilience or decarbonization measures have been undertaken on a property. The Intact Centre for Climate Adaptation is working with the insurance industry currently to explore opportunities for premiums to better incentivize property measures that increase resilience.

Recommendation: 28.1 Develop a national affordable private flood insurance model

As identified in the *Emergency Management Strategy for Canada: Toward a Resilient 2030*, governments should "engage the private sector to develop an affordable private flood insurance model for the entire population, including clear incentives for mitigation of flood risks." This can also be broadened to include other resilience measures that mitigate risks for other hazards such as earthquakes and wildfires that interface with settlements. In 2022, the Government of Canada Task Force on Flood Insurance and Relocation issued the report Adapting to Rising Flood Risk: An Analysis of Insurance Solutions for Canadians. Alongside the aforementioned work, Indigenous Services Canada and the Assembly of First Nations launched the Steering Committee on First Nations Home Flood Insurance Needs. It seeks to examine needs unique to First Nations on reserve.

Main actor(s): Federal government, IBC

Recommendation: 28.2 Assess lender guidelines and programs for resilience

Undertake an assessment of the benefits to lenders for reducing risk through resilience measures. Drawing from the findings, collaborate with the financial industry to develop lender guidelines and mortgage programs that incentivize resilience measures. Seek opportunities to combine incentives with energy efficiency or decarbonization mortgages. Lender guidelines and accompanying appraisals will require standardized or quality-controlled climate risk information.

Main actor(s): Federal government, financial institutions

Recommendation: 28.3 Assess insurance guidelines and incentives for resilience

For each hazard, undertake a review of insurance policies and premiums. This review could help understand the factors being considered in providing hazard-related insurance, and communicate findings to broadly to support property-specific risk reduction measures. Collaborate with the insurance industry to prepare guidelines or procedures that assess resilience measures and implement insurance incentives. Note that insurance companies are starting to consider these options, such as providing reduced rates if a homeowner completes a FireSmart assessment.

Main actor(s): Federal government, IBC, Provincial government

Examples or resources

- National Institute of Building Sciences, A Roadmap to Resilience Incentivization

29. Develop and communicate a method for resilient cost-benefit analysis

There are barriers to investment in resilience measures for buildings. One is the lack of knowledge and evidence regarding the long-term benefits of these measures in balance with the capital costs associated with implementation. Cost-benefit and return-on-investment study approaches vary and are not well understood by general design project team professionals. Resilience interventions provide a multitude of co-benefits. The value of these is a strong factor in the balance of benefits outweighing costs. Valuation and communication on co-benefits such as health and well-being benefits is needed in concert with CBA methods to increase uptake of the resilience measures. The Institute for Catastrophic Loss Reduction in Canada and the National Institute of Building Sciences in the US have both completed studies. They have demonstrated very positive cost-benefit ratios for multiple different hazards. Not all investments will show a positive cost-benefit outcome to the owner, however. In these cases, additional support through public and private investment mechanisms (described above) are necessary.

Recommendation: 29.1 Establish a standardized cost-benefit methods for resilience measures

A standardized approach to cost-benefit studies of resilience interventions for buildings is needed. Tools or simple to follow methodologies will allow a broader segment of the building sector to introduce these studies into project planning and design decisions. Identify opportunities to spell out the financial equivalents of the co-benefits of resilience interventions to a broader audience.

Engage Indigenous Peoples in understanding co-benefits from a traditional knowledge perspective, and uplift the wisdom and experience that is in place in Indigenous communities.

Main actor(s): Federal government (National Research Council), Provincial government (Ministry of Housing, BC Housing Research Centre)

Examples or resources

- Public Safety Canada is developing a Return-on-Investment Excel-based pilot tool for application to infrastructure
- Estimating the benefits of Climate Resilient Buildings and Core Public Infrastructure
- A cost-benefit analysis of impact-resilient asphalt shingle roofing
- Natural Hazard Mitigation Saves: 2019 Report
- Some work completed by Metro Vancouver to value the health impacts of air quality
- Canadian Climate Institute studies

30. Advance cost-benefit analysis of climate and seismic-resilient measures

There is an increasing collection of information about the strategies that can be employed to improve the seismic and climate-resilience of buildings. However, there are still gaps, and the efforts are often tied to new design and construction. Many of these strategies are cost prohibitive to apply to existing buildings (e.g., use of continuous fully-reinforced membrane waterproofing system on foundations). There is far less understanding of measures that are suitable to implement as retrofits for different building types and regions that face different hazards. In particular, larger buildings can face substantial costs for upgrades and require fulsome cost-benefit analysis to support investment.

Recommendation: 30.1 Promote research and pilots for resilience measures in new construction

Continue to identify pilot projects and opportunities to test resilience measures in new construction through the MBAR project and other public and private sector initiatives. Examples include:

- Specific fire safety testing and analysis for exterior walkways with a goal to better define compliance pathways in the code for courtyard buildings, while reducing construction costs
- Design competitions to explore the potential of new to Canada typologies that unlock smaller sites, promote better social connectedness and mutual aid among residents, and offer better adaptation to a warming climate through natural ventilation
- Support pilot projects for point access blocks

Main actor(s): BC Housing, Post-secondary institutions, Provincial and federal government funding, Public sector organizations

Recommendation: 30.2 Promote research and pilots for resilience retrofits

Focus funding research and pilot projects on the selection, implementation and assessment of seismic and climate-resilient measures in existing buildings. Build from work conducted to date. For example, UBC's report on climate resilience for multi-family residential buildings highlights that the most effective short-term measures should focus on reducing heat gain through high heat gain windows. This includes exterior shading and window upgrades focussing on south and west elevations where resources are limited. Expand lessons to all types of buildings, hazards and regions, and share results. Broaden these types of pilot projects to other

building types across the public sector. Ensure findings are used to inform development or update of incentive programs.

Main actor(s): BC Housing, Post-secondary institutions, Provincial and federal government funding, Public sector organizations

Examples or resources

- UBC Designing Climate Resilient Multi-family Residential Buildings includes recommendations for both new and retrofits
- Urban Land Institute's Resilient Retrofits: Climate Upgrades for Existing Buildings guide

31. Establish a program to incentivize relocation from high-risk areas

Presently, many property owners' residences, businesses, and farms are at high-risk of experiencing climate hazard events (e.g., flooding). This is because they are located in areas with a high degree of hazard exposure. Additionally, many Indigenous communities across B.C. have been located in areas that are exposed to climate hazards, including floodplains. These then pose uneven climate risk to Indigenous Peoples, communities, and infrastructures. The cost of relocating, and the impact of hazard risk exposure on property valuation, presents a financial disincentive for property-owners to relocate from these areas. In the case of flood hazard risk, research suggests that disclosure of designation within floodplain areas has a slight impact on property valuation (- 1 to -4%). On the other hand, the valuation of properties affected by actual flood events is more significantly impacted (-18% to -25%) (Update: The Impact of Flood Hazard on Real Estate Values). Zoning density transfers from hazard impacted lands are one tool for municipalities to offset the economic loss associated with relocation. Disaster Financial Aid provided in the event of a disaster covers a portion of the building and not the land which creates an incentive to rebuild in the same location.

Recommendation: 31.1 Establish a program for relocation before / after event

Learning from Grand Forks, establish a program that supports relocating buildings and infrastructure out of high-risk areas preferably before or after a hazard event (e.g., using Disaster Mitigation and Adaptation Fund (DMAF) or other Federal and Provincial funding). Land use in high-risk areas can be transitioned to a lower-risk option such as recreation. The program may leverage diverse sources of liquidity like advanced cash payments or bridge loans, to facilitate relocation. It should establish a clear financial incentive for relocation.

Main actor(s): Federal government, Provincial government (Ministry of Emergency Management and Climate Readiness), local governments

Recommendation: 31.2 Build partnerships to support Indigenous communities with climate risk assessment

Build relationships and partnership with the Federal Government and Indigenous communities. Seek to understand how to appropriately support Indigenous Peoples and communities to mitigate climate risks on

reserve lands.[53] Work with Land Code communities to understand what tools and supports are needed to enhance climate risk-informed decision-making during land use and building processes.

Main actor(s): Federal government, Provincial government, FNESS, First Nations governments

Recommendation: 31.3 Consider density transfers for relocations

Local governments to consider the potential for density transfers to help off-set the economic loss arising from relocations from hazardous lands.

Main Actors: Local, Provincial and Federal governments; BC Assessment; Real estate industry
Secondary actor(s): ISC, BCAFN, FNESS

Examples or resources

- A 1-in-200-year flood event affected residential, agricultural and commercial properties in the Grand Forks area of the Regional District of Kootenay-Boundary (RDKB). Following this, a flood mitigation program was undertaken. This included the acquisition of land in high-risk flood plain areas. Financed by the federal government's Disaster Mitigation and Adaptation Fund (DMAF), the program sought to acquire and relocate property-owners in order to vacate high-risk areas and facilitate the implementation of physical flood mitigation measures. This approach raised some challenging questions regarding the valuation of properties in flood-prone areas. However, the voluntary buy-out program was largely successful, with over 90% of properties agreeing to relocate.
- There are many examples of buyout programs across the United States as they became ubiquitous following Superstorm Sandy in 2012. See FEMA flood buyout program.

32. Develop quicker steps for finance and investment

The following table lists related initiatives that are underway or that could be advanced in the near future.

32.1	Include resilience measures in the provincial review of the permissible capital recovering approach for landlords.	BC Residential Tenancy Branch
32.2	Support Intact Centre on Climate Adaptation efforts to reflect resilience measures in insurance premiums.	BC Ministry of Emergency Management and Climate Resilience
32.3	Establish concierge services to link grant seekers with the appropriate funding. Incorporate resilience into existing concierge services that exist for energy efficiency.	BC Ministry of Environment and Climate Change Strategy

[53] Federal budget 2022 budgeted $29.6M over three years starting in 2022-2023 to advance the Indigenous Climate Leadership Agenda that will support self-determined action in addressing Indigenous Peoples' climate priorities. In BC, Naqsmist and the BCAFN have joined forces to collaborate with First Nations title and rights holders in co-developing the First Nations Climate Leadership Agenda.

5.5 Integrating Social Resilience into Building Design, Retrofit, Programming

Social connectivity plays a critical role in improving resilience within buildings and within neighbourhoods. Social resilience means people have relationships with their neighbours and are better positioned to support each other during hazard events. This can have a significant effect on outcomes, particularly for those who are more vulnerable due to health challenges or socio-economic factors.

Big Move Recommendations

33. Develop and test innovation in design for social resilience

Buildings are designed primarily to serve economic, functional, or aesthetic goals. Often, the impact of the design on social connectivity (the relationships occupants and building users have with the people around them) is not considered. As a result, many new and existing buildings are designed in ways that make it difficult to build social connectivity. This, in turn, can lead to more negative outcomes for individuals when hazard events occur. While there are general design principles and tools that can be used to enhance social connectivity, building designers are not incentivized to apply them.

Recommendation: 33.1 Promote resiliency in new building designs

Encourage social resiliency in new building designs by offering incentives for innovative approaches and building typologies in the building design process. Specific actions to enhance social resilience in building design might include:

- Developing local government active design guidelines that promote social connection in design
- User-centred design—including prospective occupants in building design phase to integrate a variety of perspectives with varying needs and abilities (example MBAR co-design approach), applicable to cases where prospective occupants are known
- Conducting post-occupancy surveys to inform future projects
- Including operations and maintenance funding for ongoing connectivity activities that integrate with the design intentions for social connection
- Implementing social connectivity modeling (e.g., FLUID sociability tool) in preliminary design phase to inform layout and massing
- Increasing social opportunities in housing through zoning and design guidelines to provide adequate amenity spaces, social interaction opportunities, ample circulation and unenclosed corridors. Existing barriers to these design features such as floor area restrictions or height restrictions preventing rooftop amenity areas should be removed and/or replaced with incentives
- Testing alternative building typologies (e.g., single-loaded corridor, point access block etc.) in public sector design/ pilot examples, and including features that increase day lighting, visibility, outdoor spaces, and safety in common spaces
- Exploring how passive design features can improve social resilience (i.e. shaded, well-ventilated area)
- Seeking a balance between maintaining personal security and improving social connectivity.
- Supporting alternative building ownership models (co-ops, community land trusts, co-housing/ baugruppen etc.)

- Supporting culturally-relevant building projects that reflect local ethnic diversity
- Supporting local, culturally-relevant building projects in Indigenous communities, and supporting Indigenous building champions to scale and replicate their work

Main actor(s): BC Housing, AHJs, Provincial government (Ministry of Housing), BC Non-Profit Housing Association (BCNPHA)

Examples or resources

- BC Housing's Vienna House project applied social connectivity modelling in the design phase to map and estimate the number of social encounters facilitated by the building's courtyard design
- City of North Vancouver Active Design Guidelines
- The Nuxalk Nation developed the West Coast Building Standard, offering a consistent approach for developing energy-efficient, culturally-appropriate, affordable buildings for Indigenous peoples and communities
- BC Housing MBAR co-design project

34. Establish social resilience indicators to inform planning

An equity driven approach to climate adaptation and resilience planning means focusing first on areas of disproportionate impacts. Currently there are few examples of grants and programs for building retrofits targeting homes that house individuals and groups that are likely most impacted by climate change. These people may be more like to be impacted due to health vulnerabilities, age, social isolation, financial capacity and systemic inequities. Planners across social and building silos need to collaborate and rely on both data and needs assessments. This information can help target building types and urban areas for priority program application and to influence the type of interventions most required.

Recommendation: 34.1 Use social resilience indicators to prioritize incentives and investments

Improve the use of spatial information to prioritize areas and building types for incentives and grants for retrofits where social vulnerability is highest. Within the portal being recommended at #1, develop an area catering to information, data, tools and resources to build social resilience through buildings. Special consideration should be given to equity in data issues, the scale and specificity of indicators to hazards, and filling gaps where indicators are not publicly accessible (i.e. health data).[54]

Main actor(s): Federal government (Stats Canada), Provincial government (BC Stats), local governments, Indigenous communities, BCNPHA

Examples or resources

- City of Vancouver project across silos to map equity-seeking areas
- Natural Resources Canada Social Fabric Indicators from the Physical Risks study

[54] The Provincial Disaster Risk and Resilience Assessment has completed research on equity in data and indicators of climate vulnerability. The Provincial assessment targeted for completion in fall 2024 will bring spatial data together that should be accessible following the project.

- Canadian census multiple deprivation index
- Health Authority mapping of Emergency Room visits during hazard events
- Health Authority health vulnerability mapping
- City of Calgary Community Climate Risk Index

35. Raise awareness of climate risks to buildings and effective resilience measures

Several barriers identified highlighted the lack of access to key information among building owners, managers, and occupants that supports improved resilience. Information may be available to experts or those that seek out and research the information. However, it is not readily accessible to those who need it in advance of or during a response to a hazard event. In some cases, information may be available but in limited languages, or limited formats that are not accessible to all audiences. For rental or tenanted buildings, owners and managers do not have the resources at hand to provide to occupants.

Recommendation: 35.1 Develop and provide resources to building owners and managers

To support building owners and managers of tenanted buildings, develop a series of resources to support:

- Improved understanding of climate and seismic risks and responses
- Awareness of implementable resilience measures
- Opportunities for connection between neighbours
- Preparedness kits, and more

Offer training to support effective roll-out of resources in a manner that supports intended audiences. Seek to make them accessible to all occupants, particularly those traditionally underserved by government support systems.

A variety of groups including health authorities, BC Housing and the Ministry of Emergency Management and Climate Readiness are working on resources. Finding a method to integrate or standardized the messaging but keep it region and group specific would avoid duplication and confusion. Information could be provided through established programs such as the energy retrofit program or annual in person workshops for building owners and managers. Informing renters of their rights associated with health and safety before and during climate events is also an identified gap.

Main actor(s): BC Housing, BC Non-Profit Housing Association (BCNPHA)

Examples or resources

- BC Housing's Extreme Heat and Wildfire Smoke information for building managers and owners

36. Support resource programs for social resilience in multi-unit buildings

In existing buildings many occupants and users have weak relationships due to a lack of opportunity for spontaneous encounters or planned activities that facilitate social connection. This contributes to increased isolation. This is especially true for individuals or households with existing health or socio-economic vulnerabilities. In turn, this leads to greater vulnerability during hazard events.

Canada's Emergency Management Strategy 2030 highlights the importance of increasing focus on prevention and mitigation activities (priority 3). It notes that knowledge of risks allows for better preparation, more timely notification of the public. It also contributes to the ability to save lives and reduce the social, economic and health impacts of disaster events.

Recommendation: 36.1 Increase government support for social resilience programs

Governments should actively invest in programming and activities that facilitate social connectivity and relationship building between neighbours. Particular attention should be focused on supporting social programming for buildings where occupants are disproportionately vulnerable to hazards. These investments and program development efforts may include:

- Partnerships with established third parties with knowledge and capacity to develop and deliver social programming
- Incentives or direct support for landlords, strata councils, and other building managers to plan and implement social programming

This recommendation goes hand-in-hand with 33.1: designing buildings or retrofitting them to facilitate social resilience programs. Social resilience programs can also occur outside the building through gardening groups, children's playgrounds, etc.

Main actor(s): Federal government, Provincial government, local governments, BCNPHA, BC Landlords Associations

Examples or resources

- City of Vancouver's *Resilient Neighbourhoods* program provides grant funding and clear guidance and resources for individuals and organizations to map community assets and identify and implement community-building activities in their neighbourhoods.
- Hey Neighbour Collective and Building Resilient Neighbourhoods are two examples of non-profit groups actively working to support these types of initiatives.
- Vancouver Foundation Connect and Engage Reports (2012 and 2017) provide findings from Metro Vancouver about social isolation and loneliness.
- Green Together Toronto is a project carried out by a citizen-based environmental group to test the idea that community-based social marketing could persuade people to improve home energy efficiency.

37. Develop quicker steps for finance and investment

The following table lists related initiatives underway or that could be advanced in the near future.

37.1	Analyze and communicate case studies illustrating the advantages of involving housing providers in the pre-design phase and co-design projects. Communicate best practices for undertaking this form of engagement.	BC Housing

6. Next Steps

6.1 Provincial primary role, shared responsibility

The recommendations presented above make it clear that no one organization is wholly responsible for advancing resilient buildings. Aligned with the Sendai Framework, success requires the provincial government leading risk reduction and resilience efforts, while sharing the responsibility with stakeholders and other governments.[55] Table 4 summarizes the types of roles expected to be played by the main actors in the building industry in B.C., based on the recommendations identified in this discussion paper.

BC Housing has and can continue to play a pivotal role in advancing research and pilot projects. This work supports all of the actors to:

- Better understand the barriers being faced
- To share and communicate findings as new building strategies, design, materials and operational approaches are tested
- To continue building capacity among all actors
- To continue building relationships with Indigenous Peoples and First Nations governments to support resilient buildings across the province

Table 4. Summary of the recommendations based on the roles of the main actors

Main actors	Roles based on discussion paper recommendations
Provincial government	Lead or participate in all recommendations, including: • Develop a public hazard data repository • Expand forensic accounting of hazard events • Improve post-event coordination and collaboration • Demonstrate leadership in public sector buildings • Conduct regulatory review for barriers to resilience measures in stratas and rentals • Provide guidance and funding for local governments on risk assessment in land use planning, retrofit programs, risk tolerance thresholds, and more • Expand financial incentives programs to include resilience • Enhance regional capacity for risk assessment and mitigation • Incentivize relocation from high-risk areas
Federal government	• Select or define a resiliency rating system for buildings • Increase capacity in construction sector, immigration policy • Demonstrate leadership in public sector buildings • Support innovative materials and technologies • Advance resilience in the national codes • Expand financial incentives programs to include resilience • Increase access to capital for resilience measures • Develop private sector mechanisms to incentivize resilience • Conduct cost-benefit analysis on resilience measures • Incentivize relocation from high-risk areas

[55] United Nations. 2015. The Sendai framework for disaster risk reduction 2015-2030.

Main actors	Roles based on discussion paper recommendations
Utilities	• Review policies and requirements that act as barriers to resilience measures • Provide support for community retrofit programs • Expand financial incentives programs to include resilience
Local governments	• Collaborate and share data in relation to risks and hazards • Update review and land use plans, bylaws and policies with climate resilience lens, based on provincial guidance and capacity support • Promote resilience in new construction techniques • Demonstrate leadership in public sector buildings • Provide incentives during development application for resilience measures
Industry associations	• Enhance climate risk and adaptation in professional competencies and development • Enhance recruitment, retention and skill development in construction • Collaborate on and support data collection, information sharing, cost-benefit analysis research, and pilot projects • Participate in and inform development and update of federal, provincial and local policies, regulations and programs • Communicate about resilience policies, regulations and programs with membership
Post-secondary and trades schools, Academia	• Support localizing climate data into design parameters • Support and inform approaches for forensic accounting and data integration • Participate in and lead research on effectiveness of resilience measures • Support research on methods for cost-benefit analysis, and participate in cost-benefits studies • Conduct and share research about social resilience to inform design and programming
Non-profit organizations	• Participate in testing of innovative approaches to resilience • Inform development of resources and programs that support all building occupants in an accessible manner
First Nations governments	It is not the purpose of this discussion paper to identify roles for First Nations governments. However, this paper does identify opportunities for the provincial government and other organizations to engage and partner with First Nations governments and Indigenous-led organizations. This can help support or align efforts that improve resilience of buildings for Indigenous Peoples, including: • BC Housing and the Provincial government can continue to partner with Indigenous Peoples and First Nations governments. This will help understand specific barriers, enablers, and recommendations pertaining to buildings for Indigenous Peoples in BC. • BC Housing and the Province can continue to develop respectful relationships with Indigenous Peoples. To do so, they can build on previous Provincial initiatives to engage Indigenous Peoples in housing policy development.

6.2 Implementation

This is a rapidly evolving area, and numerous initiatives are already advancing on many different levels. During this process and the preparation of this discussion paper, some initiatives were announced by the Province. These initiatives will advance recommendations from this discussion paper in the near term. Figure 3 highlights the leading roles and timing of implementation for each of the recommendations in this paper. Recommendations are divided into immediate, short, medium and longer terms. Each recommendation is numbered and identified by one, or in some cases multiple, organizations to lead or be significantly involved with. Figure 3 also highlights that no one organization is responsible for implementation of the recommendations.

Continued and significantly expanded efforts and leadership are required by the Province. Yet collaboration and responsibility are shared across many actors to advance resilient buildings in the sector. This will enable places where:

- People can care for themselves, their neighbours and communities in the face of adversity
- People are protected from the elements in comfort and security now and for future generations
- Buildings have longevity and are safer, more durable and livable
- Public and private investments are protected

Figure 3. Summary of key actors identified to implement recommendations in the immediate, short, medium and longer terms

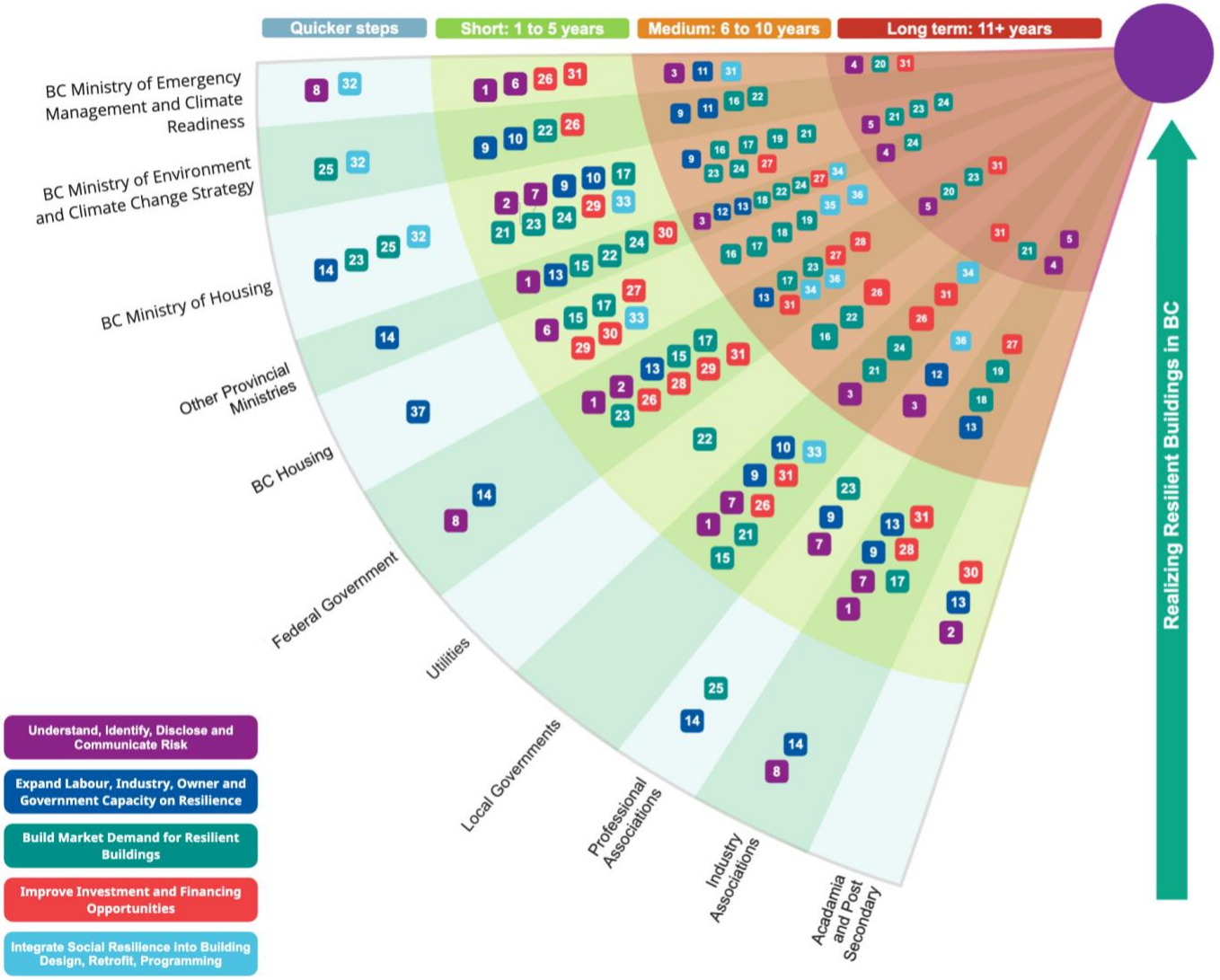


Figure note: Numbers on the chart correspond to the recommendation numbers in this discussion paper.

Appendix A: List of Strategy Sources

Source Name	Source Link (if applicable)
Mobilizing Building Adaptation and Resilience - Design Discussion Primers	https://www.bchousing.org/research-centre/library/residential-design-construction-guides/MBAR
Climate Resilience Guidelines for B.C. Health Facility Planning and Design	https://bcgreencare.ca/resource/climate-resilience-guidelines-for-bc-health-facility-planning-design-2/
Ready to Respond: Strategies for Multifamily Building Resilience	https://toolkit.climate.gov/reports/ready-respond-strategies-multifamily-building-resilience
Flood Resiliency Recommendations	https://www.horizoneng.ca/wordpress/wp-content/uploads/2022/02/Recommendations-Matrix-R9.pdf
Resilient Buildings: Informing Maintenance for Long-term Sustainability Final Industry Report, Project 1.53 (Australia Sustainable Built Environment National Research Centre)	https://www.researchgate.net/publication/330873207_Resilient_Buildings_Informing_Maintenance_for_Long-term_Sustainability_Final_Research_Report_Part_1_Overview_of_losses_from_extreme_events_and_building_maintenance_recommendations
Climate Resiliency Design Guidelines - NYC.gov	https://www1.nyc.gov/assets/orr/pdf/NYC_Climate_Resiliency_Design_Guidelines_v4-0.pdf
RELi 2.0 Rating Guidelines for Resilient Design + Construction	https://www.resilienceshift.org/tool/reli/
Climate Ready Housing Design Guide	https://www.bchousing.org/sites/default/files/media/documents/Climate-Ready-Housing-Guide.xlsx
BC Housing Design Guidelines and Construction Standards	https://www.bchousing.org/projects-partners/asset-management-redevelopment/construction-standards
UBC Climate Resilient Multifamily Buildings	https://planning.ubc.ca/sites/default/files/2020-05/REPORT_UBC_Climate%20Resilient%20Multifamily%20Buildings.pdf

Note: further resources reviewed for the supplemental paper on barriers specific to Indigenous communities.

Appendix B: List of Literature Review Sources

Hazard	Resource Title	Link or source	Source Org
Earthquake	Video series (8-part) on earthquake resilience	https://www.youtube.com/watch?v=6PIwo4Sw_bA	BC Housing
Extreme Heat	Protect Your Home From Extreme Heat	https://www.iclr.org/wp-content/uploads/2020/07/ICLR_Extreme-heat_2020.pdf	ICLR
Extreme Heat	NRC guide to management of overheating risk in residential buildings	https://nrc-publications.canada.ca/eng/view/object/?id=9c60dc19-ca18-4f4c-871f-2633f002b95c	NRC
Extreme Heat	Designing Climate Resilient Multifamily Buildings	https://planning.ubc.ca/sites/default/files/2020-05/REPORT_UBC_Climate%20Resilient%20Multifamily%20Buildings.pdf	UBC
Extreme Heat	Unlocking livable, resilient, decarbonized housing with Point Access Blocks	https://www.larchlab.com/wp-content/uploads/2022/01/Eliason_CoV-Point-Access-Blocks-report_v1.2.pdf	Larch Lab
Extreme Heat	ASHRAE Standard 55-2020 -- Thermal Environmental Conditions for Human Occupancy	ASHRAE 55-2020 | ASHRAE Store (techstreet.com)	ASHRAE / ANSI
Extreme Heat	Vienna House Innovative Affordable Housing Demonstration Project: Study on Building Form Decision	https://viennahouse.ca/about-the-project/research/	BC Housing
Extreme Heat	A Climate Reckoning; The economic costs of BC's extreme weather in 2021	https://policyalternatives.ca/climate-reckoning	Policy Alternatives
Flood	Protect your home from basement flooding	https://www.iclr.org/wp-content/uploads/PDFS/protect-your-home-from-basement-flooding.pdf	ICLR
Flood	Flood Resiliency Recommendations	https://www.horizoneng.ca/wordpress/wp-content/uploads/2022/02/Recommendations-Matrix-R9.pdf	BC Housing
Flood	NRC Guide for design of flood resilient buildings	https://nrc-publications.canada.ca/eng/view/ft/?id=96b3275c-b731-4fa6-847e-e2a9a0f080d8	NRC

Hazard	Resource Title	Link or source	Source Org
Flood	Reducing urban flood risk through building- and lot-scale flood mitigation approaches: challenges and opportunities. Frontiers of Water.	https://doi.org/10.3389/frwa.2021.689202	Frontiers in Water (peer reviewed)
Flood	Wastewater System Inflow/Infiltration and Residential Pluvial Flood Damage Mitigation in Canada	https://www.mdpi.com/2073-4441/14/11/1716	Water (peer reviewed)
Flood	CSA Z800-18 Guideline on basement flood protection and risk reduction	Z800-18 | Product | CSA Group	CSA
Flood	Update: The Impact of Flood Hazard on Real Estate Values	https://www.ebbwater.ca/update-the-impact-of-flood-hazard-on-real-estate-values/	Ebbwater Consulting
Flood	Investigations in Support of Flood Strategy Development in British Columbia; Issue A: Flood Risk Governance	https://www.fraserbasin.bc.ca/_Library/Water_Flood_BC/A-1_Flood_Risk_Governance.pdf	Fraser Basin Council
General	Equity & Inclusion Glossary of Terms - UBC	https://equity.ubc.ca/resources/equity-inclusion-glossary-of-terms/	UBC
General	Standards in Action: Building a Climate Resilient Future		Standards Council of Canada
General	Durham Region Climate Resilience Standard for New Houses.	https://cleanairpartnership.org/cac/wp-content/uploads/2018/05/DRCRSNH-Durham-Region-ICLR-Febrary-2018-Final.pdf	Region of Durham
General	Active Design Guidelines	https://www.cnv.org/City-Services/Planning-and-Policies/Active-Design	City of North Vancouver
General	Connect and Engage	https://www.vancouverfoundation.ca/our-work/initiatives/connections-and-engagement	Vancouver Foundation
General	Estimating the benefits of Climate Resilient Buildings and Core Public Infrastructure (CRBCPI)	https://www.iclr.org/wp-content/uploads/2020/03/SPA-Climate-resiliency-book.pdf	National Research Council/ICLR
General	Delivering Climate Responsive Resilient Building Codes and Standards: A Canadian Perspective	https://www.iccsafe.org/wp-content/uploads/Delivering_Climate_Responsive_Resilient_Building_Codes_and_Stds.pdf	NRC - ICC Global Resiliency Dialogue

Hazard	Resource Title	Link or source	Source Org
General	The governance of climate change adaptation in Canada	https://www.iclr.org/wp-content/uploads/2018/04/cca-climate-change-report-2018.pdf	ICLR
General	Voluntary Resilience Standards: An Assessment of the Emerging Market for Resilience in the Built Environment	https://cadmusgroup.com/wp-content/uploads/2018/08/MCG-Voluntary-Resilience-Standards-Report.pdf	Energy, Kresge and Barr Foundations, 2017
General	Buildings and Climate Change Adaptation: A Call for Action	https://globalabc.org/sites/default/files/2021-02/Buildings%20and%20Climate%20Change%20Adaptation%20-%20FULL.pdf	Global Alliance for Buildings and Construction
General	Climate Ready Housing Design Guide	https://www.bchousing.org/sites/default/files/media/documents/Climate-Ready-Housing-Guide.xlsx	BC Housing
General	The right to be rescued: Disability Justice in an Age of Disaster.		Yale Law Journal:
General	Design Discussion Primers	https://www.bchousing.org/research-centre/library/residential-design-construction-guides/MBAR	BC Housing
General	Canada's National Adaptation Strategy - Draft	https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/national-adaptation-strategy/full-strategy.html	Environment Canada
General	Building Resilience Los Angeles: A Primer for Facilities	https://static1.squarespace.com/static/57dc2456e58c62e05fee0316/t/58177cb7725e25ba06357b20/1477934275541/10-24-2016_BuildingResiliency-LA.pdf	City of Los Angeles
General	Recommendations of the Task Force on Climate-related Financial Disclosures	https://assets.bbhub.io/company/sites/60/2021/10/FINAL-2017-TCFD-Report.pdf	TCFD
General	The Canada Green Buildings Strategy	https://www.rncanengagenrcan.ca/en/collections/canada-green-buildings-strategy	Natural Resources Canada
General	Final report - Alterations to existing buildings	https://nrc.canada.ca/en/certifications-evaluations-standards/codes-canada/codes-canada-publications/final-report-alterations-existing-buildings	National Research Council
General	Development Approval Process Review	https://www2.gov.bc.ca/assets/gov/british-columbians-our-governments/local-governments/planning-land-use/dapr_2019_report.pdf	BC Ministry of Housing

Hazard	Resource Title	Link or source	Source Org
General	GFANZ Net Zero Financing Roadmaps: Buildings Investment and Financing	https://assets.bbhub.io/company/sites/63/2021/10/NZFRs-Buildings-Brief.pdf	GFANZ
General	Designing the Path to Climate Compatibility: Climate Risk Disclosure and Action in the Canadian Housing Context	http://assets.ibc.ca/Documents/Disaster/Designing-the-Path-to-Climate-Compatibility.pdf	Insurance Bureau of Canada
General	Preliminary Strategic Climate Risk Assessment for British Columbia		BC Ministry of Environment
General	Natural Hazard Mitigation Saves: 2019 Report	https://www.nibs.org/projects/natural-hazard-mitigation-saves-2019-report	National Institute of Building Sciences
General	Minimum Climate Resilience Standards for Public Sector Buildings		Ministry of Environment
General	Climate Resiliency Guidance	http://www.bostonplans.org/getattachment/5d668310-ffd1-4104-98fa-eef30424a9b3	Boston Planning and Development Agency
General	UK Housing: Fit for the Future?	https://www.theccc.org.uk/wp-content/uploads/2019/02/UK-housing-Fit-for-the-future-CCC-2019.pdf	UK Committee on Climate Change
Severe Storm/Power Outages	Practical guidance for private-side drainage systems to reduce basement flood risk: addressing critical information gaps.	https://doi.org/10.4224/40002662	National Research Council
Severe Storm/Power Outages	A benefit-cost analysis of impact-resistant asphalt shingle roofing	https://www.iclr.org/wp-content/uploads/2022/04/Benefit-cost-analysis-of-Impact-resistant-asphalt-shingle-roofing2.pdf	Institute of Catastrophic Loss Reduction
Severe Storm/Power Outages	Storm warning: The impact B.C.'s wild weather is having on British Columbians and their power	https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/news-and-features/report-the-impact-wild-weather-is-having-on-british-columbians-and-their-power.pdf	BC Hydro
Severe Storm/Power Outages	Minimum Backup Power Guideline for MURBs	https://www.toronto.ca/wp-content/uploads/2017/11/91ca-Minimum-Backup-Power-Guideline-for-MURBs-October-2016.pdf	City of Toronto

Hazard	Resource Title	Link or source	Source Org
WUI Fire	Fire Resilient Planning for Northern Communities	https://www.csagroup.org/store/product/CSA%20S504%3A19/	Canadian Standards Association
WUI Fire	National guide for wildland-urban-interface fires: guidance on hazard and exposure assessment, property protection, community resilience and emergency planning to minimize the impact of wildland-urban interface fires	https://nrc-publications.canada.ca/eng/view/ft/?id=3a0b337f-f980-418f-8ad8-6045d1abc3b3	National Research Council
WUI Fire	An impact analysis for the National guide for wildland-urban-interface fires	https://nrc-publications.canada.ca/eng/view/object/?id=b40907a1-0214-4cd3-a01a-a233011d0d93	National Research Council

Note: see also the resources reviewed in the supplemental paper on specific barriers faced by Indigenous communities.

Appendix C: List of Organizations Engaged

The following table highlights the organizations that were engaged in the preparation of this paper.

Note: see also the interviews conducted with Indigenous community representatives in the supplemental paper on specific barriers faced by Indigenous communities.

Organization	Format
Multiple Provincial Public Sector Organizations	Provincial climate resilient design guidelines workshop
Ministry of Municipal Affairs, Emergency Planning	Interview
Ministry of Housing, Emergency Management and Planning	Interview
Climate Action Secretariat	Interview
National Research Council of Canada	Focus Group - Technical and Regulatory
Technical Safety BC	Focus Group - Technical and Regulatory
Vancouver Coastal Health	Livable Cities Forum Workshop
Engineers and Geoscientists of BC	Focus Group - Technical and Regulatory
Architects Institute of BC	Focus Group - Technical and Regulatory
Passive House Canada	Livable Cities Forum Workshop
BC Construction Association	Interview
City of Coquitlam	Livable Cities Forum Workshop
City of Dawson Creek	Focus Group - Political and Regulatory
City of Nanaimo	Livable Cities Forum Workshop
City of North Vancouver	Focus Group - Technical and Regulatory
City of Powell River	Focus Group - Political and Regulatory
City of Vancouver	Focus Group - Informational, Social, Equity
City of Vancouver, Urban Design & Sustainability	Interview
City of Vancouver, Seismic Policy	Interview
City of Vernon	Livable Cities Forum Workshop
Northern Rockies Regional Municipality	Focus Group - Political and Regulatory

Organization	Format
Capital Regional District	Livable Cities Forum Workshop; Interview
Regional District of Nanaimo	Livable Cities Forum Workshop
BC Non-Profit Housing Association	Focus Group - Informational, Social, Equity
Social Planning and Research Council of BC	Focus Group - Informational, Social, Equity
Building Resilient Neighbourhoods	Focus Group - Informational, Social, Equity
Disability Advocate	Interview
Quadreal	Interview
Fort Properties Ltd.	Livable Cities Forum Workshop
Innovation Building	Interview
International WELL Building Institute	Livable Cities Forum Workshop
Origen Air	Livable Cities Forum Workshop
Ausenco	Interview
UBC	Livable Cities Forum Workshop

Appendix D: Detailed Summary of Barriers

Technical Training and Capacity

Key Barrier	Specific Barriers [EB] Specific to Existing Buildings [NB] Specific to New Buildings [H-] Hazard-specific	Notable Considerations [R/U] Rural / Urban [C] Conflicts [E] Equity
Labour supply limitations	• Capacity challenges for municipal planning, building inspection and permitting staff, industry • Limited ability of building owners, designers, contractors, builders, building officials, and the supply chain to adapt to the changing regulatory landscape • Increased resilience requirements exacerbate skilled/trained labour shortages • Design and construction teams may not have required breadth of expertise or experience • [EB] Building owners lack expertise to understand the risks and possible responses (especially in strata governance) • [EB] Lack of capacity to apply for/implement external grants or programs to fund building improvements (e.g., access capital for upgrades)	• [R/U] Labour force shortages are amplified in rural areas • [R/U] In small or rural areas, technical/subject-matter experts may have less local expertise and familiarity with the local context. • [R/U] More developed urban areas with less permeable surfaces face specific challenges for urban flooding
Lack of data and understanding of site hazard exposures	• Absent, out-of-date, or inappropriately-scaled Federal/ Provincial hazard exposure mapping for some hazards • Inability to apply findings from one place to another due to differing hazard risk profiles • Uncertainty about anticipated degree of risks and timing of exposure • Understanding of hazard vulnerability also needed to implement appropriate strategies • [EB] Existing processes (e.g., energy audits, building condition assessments) do not typically include a resilience/risk assessment	

	• Missing info required to adjust regionally-specific climate data for various climate change scenarios • [H-Extreme Heat] Thresholds and definition of overheating events are not standard	
Inadequate data about effectiveness of resilient measures	• [NB] Lack of data on emerging resilient building design/approaches challenges engineer's ability to review and approve proposed developments	• [C] Differences in resilience and energy efficiency product specifications (e.g., fire resistance roof coverings, rooftop photovoltaic systems) may inhibit achievement of product use, achievement of mitigation and/or resilience objectives, certification
Insufficient training about appropriate resilience measures	• Training of associated professions and trades needed to adopt changing building practices • Training on resilience measures required for officials responsible for building design review and approvals • [EB] Lack of awareness, training or access to information about why and how to include resilience into retrofits	• [R/U] Heightened challenge in rural areas
Inconsistent and inadequate drawings	• [NB] Construction drawings are increasingly inconsistent and inadequate, making it challenging for builders • Construction process may be extended, sometimes requiring re-doing work, changing budgets due to inadequate communication of specs / drawings	
Electrical grid capacity constraints	• Unnecessarily conservative and restrictive electrical code requirements • Lack of information about grid capacity may lead to misconception of grid load requirements as a barrier • Areas with limited grid capacity tagged for infill and growth may experience barriers to installing heat pumps • High cost of neighbourhood scale transformer/substation upgrades billed	• [E] Assigning costs to upgrade applicant can lead to perverse subsidies (e.g., non-profit housing heat pump retrofit may subsidize future luxury condo development)

	to applicant rather than shared between all users, disincentivizing upgrades • [H-Extreme Heat]: Electrical loads may pose limits for adding cooling infrastructure	
Availability of products	• Arduous CSA approval process discourages international material suppliers • [H-Extreme Heat] Limited local supply of exterior shading products • [H-Interface Fire] Lack of availability of highly fire-resistant and cost-effective building materials as alternatives to stick build (e.g., autoclave aerated concrete being used to rebuild after fire in California is not approved for use in Canada)	

Political and Regulatory

Key Barrier	Specific Barriers [EB] Specific to Existing Buildings [NB] Specific to New Buildings [H-] Hazard-specific	Notable Considerations [R/U] Rural / Urban [C] Conflicts [E] Equity
Disparate resilience efforts at various scales and across disciplines	• Absence of an integrated approach between emergency management, land use planning, community resilience, and building codes • Lack of Fed/Prov guidance or requirements has led to inconsistent efforts across local governments and downloading of responsibilities to local governments with the least resources • Lack of political will, resources, and competing priorities makes local governments reluctant to allocate sufficient resources for resilience measure implementation and enforcement • Land scarcity makes it difficult for local governments to restrict land use in hazard exposed areas with limited resources • Differences between jurisdictions can incentivize a 'race to the bottom' • Local government aversion to risk and fear of liability - amplified by	• [R/U] Land constrained by hazard impacted areas: As pointed out in several interviews, small, rural towns may have significant land constraints with little available land outside hazard impacted areas • [R/U] Competition for grant funding that supports climate resilience enhancing measures may leave rural and remote municipalities at a disadvantage due to capacity challenges • [R/U] Property owners in rural/remote areas may be less used to or amenable to government regulation over how they develop

	inadequate legal guidance on resilience measures, hazards • Lack of guidance or standards for operators to plan and communicate emergency response measures at building scale • No requirement or standard to provide better information on long-term maintenance integral to resilience of buildings (especially re urban flood and wildland-urban-interface fire) • No operational requirements once building is operating: Building code requirements end at occupancy	and maintain their personal properties • [C] Local governments incentivized to enable development, create affordable housing, expand tax base and maintain/increase property values • [C] Local governments may prioritize attracting development, hesitant to have more development requirements than neighbouring communities
Data and mapping limitations	• Lack of resources to support appropriately-scaled mapping and data collection, and frequent updating needed to perform fulsome risk management • Perceived impacts of hazard data disclosure (e.g., floodplain designation) on land values and subsequent impact on disaster financial assistance discourages public disclosure of available data	• [R/U] Smaller communities may lack the resources to invest in down-scaled localized hazard data
Financial assistance post-event	• Lack of clarity in “ownership” of emergencies: jurisdictions and financial cost burden • Increased timeline required to 'build back better' may exceed timeline for available insurance supports for displaced households (e.g., Lytton residents are about to run out of insurance coverage for temporary living costs, but have not yet rebuilt)	
Building Code slow to change	• Building code update required to address several climate-related hazards not sufficiently addressed (e.g., hail, wind from convective storms, wildfire safety, etc.) • Lack of guidance/clarification limiting interpretation of building code in ways that support enhanced resilience measures (e.g., CSA S478 “Durability in buildings” standard referenced in an appendix, not required) • Construction Codes Reconciliation Agreement may limit inclusion of	• [R/U] Rural areas may not have building officials reviewing permits • [E] Impact assessments needed to understand impacts on affordability and other areas

	resilience measures in BCBC that differ from the NBC; however, this simultaneously provides the provinces more power to dictate what is included in the NBC • Building code alone cannot account for variations needed at site / building level / population type / hazard type: other tools also needed • Gaps in enforcement of the building code • Trade-offs between adoption of prescriptive vs. performance-based building codes (higher expertise needed for performance approach: prescriptive code can fill gaps where expertise is lacking, but may limit innovation in resilience)	
Skills and capacity at the local level	• Climate-hazard assessments may be too complex/technical to facilitate informed decision-making • Lack of resource capacity to create and/or implement resiliency standards • DPAs may require assessment by qualified professional, which may not be readily available in all areas	• [R/U] Isolation is a factor in in building-scale emergency response planning for some remote communities • [R/U] Increased cost of construction services and materials in remote communities significantly increases overall cost of more resilient development • [R/U] Lack of building inspectors, qualified professionals, and condition assessors accentuated in remote communities, limiting understanding of building resilience and general quality of new and existing construction
Conflicting and increasing policies and standards	• Legislative constraints, inconsistency of standards and building approval efficiency • Changes to OCP/zoning affects building longevity, may discourage retrofitting for enhanced resilience • Existing standards do not include climate resilience: CSA identified 63 updates required to address climate resilience • Layering of new requirements (e.g., BC Energy Step Code, carbon	• [R/U] Buildings in rural and remote areas often need back up heating or generators, which can conflict with climate mitigation goals/ policies • [C] integrating resilient design considerations into zoning and development bylaws can generate new conflicts for hazard risk mitigation

	reduction targets, etc.) involves changing practices, skills, and materials • Increasing number of policies and standards increases complexity, conflicts with streamlining efforts	
Barriers to retrofits and those imposed by leases and stratas	• [EB] Many resilience strategies are focused on new development, and not practical for existing buildings • [EB] Existing buildings are exempt from new building standards unless specified work is being done • [EB] Landlords have limited opportunities to recover capital inputs in retrofits due to rental caps • [EB] Strata bylaws and leases create a host of barriers. (e.g., banning heat pumps or portable air conditioning units)	• [E] Older buildings in need of retrofits may disproportionately house those most vulnerable to climate-related impacts • [E] Managing tenants during retrofits. Need for a delegation to coordinate / communicate between residents and contractors • [E] Existing buildings most in need of upgrades from equity perspective may be least likely to have a landlord with ability to recover costs • [E] Building occupants, particularly those from disadvantaged groups, are less likely to request upgrades in a tight housing market due to concerns about eviction • [E] Requiring major upgrades may not be economically viable, could result in demolition, redevelopment (renovictions)

Economic and Financial

Key Barrier	Specific Barriers [EB] Specific to Existing Buildings [NB] Specific to New Buildings [H-] Hazard-specific	Notable Considerations [R/U] Rural / Urban [C] Conflicts [E] Equity
Few incentives for developers/	• [EB] Owners with many small buildings but less square footage are less capitalized, less able to afford improvements	

builders/ owners to take risks on novel resilience approaches	• [EB] Owners may have the capital but may not have a business case to recover the costs of the improvements • [DB] Strata owners have varying time horizons (some may move within two-three years, while others may stay in the unit for decades) • [EB] Rental building owners may be deterred from sinking capital they cannot recoup from tenants due to caps on rent increases • Multiple property ownership situations, where property rights may be distributed between various parties and/or tenures, makes pro-active investments complex or unlikely (e.g., retail renters responsible for operations only, have no incentive to improve) • [NB]: Premium on space, especially in dense urban environments, makes it uneconomical to set aside extra space for resilience enhancing measures	
Using development to fund resilience measures	• Requirements are placed on developers at time of rezoning application; requirements often not clear or transparent at outset; difficult for developers to invest in additional measures without sufficient density increase or transfer • Tools are less effective in industrial zoned areas that are often in highly hazardous areas along shorelines	• [R/U] Limited investment in slower growing areas: Communities with slow growth, flat or declining populations may have limited private capital available for investment in development that improves hazard resilience • [E] Tools may add costs to the development, potentially impacting the affordability of the development
Increased burden on operations	• Diversity of information needs and languages • Potential for reducing additional operational expenses in response to hazard events not persuasive enough relative to real or perceived increase in ongoing operational requirements, in addition to the capital costs, that come with some enhanced resilience measures	
Banks and investors lack tools to	• Risk aversion to fund building sector innovations that are largely unproven, even though these may reduce risks to climate-related impacts	

evaluate climate-related risks	• Misperception that insurance or government bail-out are sufficient to cover the risk	
Insurance sector grappling with incorporating climate risk	• Currently, premiums are not reflecting resilience with some evidence of new resilience measures, such as heat pumps or solar backup power, substantially increasing premiums	• [R/U] Local insurers outside urban areas may be less aware of climate-related events and associated measures to manage risk and reduce damages
Range of reporting frameworks on the resilience of buildings	• Climate risks are not included in the standard disclosure process when purchasing a property • Lack of standardized framework for resilience assessment increases uncertainty in approaching and prioritizing resilience improvements	

Social and Information

Key Barrier	Specific Barriers [EB] Specific to Existing Buildings [NB] Specific to New Buildings [H-] Hazard-specific	Notable Considerations [R/U] Rural / Urban [C] Conflicts [E] Equity
Poor awareness and understanding of climate-related hazard risk	• Climate hazard likelihood (e.g., annual exceedance probability, 1:100 years) is widely misunderstood, especially because it is now accelerating and historical experience is less reliable • Lack of consistency between hazard risk assessment approaches and report formatting can further complicate interpretation and responses to hazard risk • Available hazard risk information and materials are often overly technical, lack context-relevant information, and are inaccessible due to language, etc.	• [R/U] Property owners - particularly in rural contexts - may be less likely to understand changing hazard risk due to climate change, more reliant on historical understanding of climate risk • [R/U] Smaller communities may lack the resources to invest in down-scaled localized hazard data • [R/U] Property owners, particularly in rural contexts where owners' local knowledge

	• Where hazards are known, they are challenging to rank and prioritize (per CSA Standards in Action survey) • Lack of consistency between hazard risk assessment approaches and report formatting can further complicate interpretation and understanding of hazard risk • [H-Flood]: Flood source challenging to identify (drainage, stormwater/pluvial, wastewater, infiltration, failure/collapse of drainage pipe, etc.) but each has drastically different solutions	spans multiple generations, may experience greater difficulty updating historical understandings of climate risk
Lack of hazard-risk awareness reduces occupant demand for enhanced resilience	• [H-Seismic] Canadian public not willing to pay a premium for enhanced seismic resilience • Historically low uptake of government and insurance incentive programs • Misconception that hazard mitigation is the government's responsibility • Some highly impactful resilience strategies require neighbourhood collaboration and local government coordination	
Lack of understanding of existing building systems	• Lack of knowledge to maintain systems once in place • Accessibility of building design data makes it harder to plan and be cost effective in future upgrades	
Poor awareness of building systems' resilience to hazards	• Lack of information about a building's resilience features; though these may be at least partially addressed through local government records (they retain design drawings and reports submitted with a building permit application, though may require interpretation by a qualified professional) • Lack of knowledge sharing opportunities to pool together resilience measure implementation lessons	
Lack of awareness	• Nascent voluntary resilience standards market. Where voluntary standards exist, most are in pilot phases or with their first customers, and have many	

about voluntary standards or guidelines	organizations involved	
Social connectivity generally excluded from building design and operation	• Many jurisdictions remain unaware that design can enhance or impede social interaction in buildings • Few jurisdictions have integrated or prioritized social connection in design	
Weak/negative occupant-operator relationships	• [EB] Owners/operators have poor awareness and understanding of occupant's vulnerability • [EB] Owners/operators have a disincentive to engaging occupants in resilience-enhancing approaches, as it may lead to increase in demands from occupants without any mechanisms to pay for the increased costs	• [E] Resilience measures may be costly and would require rent increases to cover these costs; low-cost rental properties are less likely to have improvements as a result