RESILIENT RETROFITS FOR A MULTI-HAZARD REALITY

Enhancing Safety and Comfort in Homes

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Building Resilient Communities Conference, November 20, 2024 – Penticton, BC

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Land Acknowledgement

We respectfully acknowledge that we are visiting the **unceded lands of the Syilx Okanagan people**

Image credit: **Okanagan Nation Alliance** (syilx.org/wellness/our-programs-and-services)

When we are talking about populations at risk to climate impacts, First Nations communities are disproportionately at risk (e.g., **81% of reserves are exposed to flooding**) (Chakraborty et al 2022)

Overview

1. About Partners for Action (P4A)
2. Why retrofit buildings for climate adaptation?
3. What we did: Develop a database of multi-hazard resilient retrofits
4. Select findings: How can we prepare our homes and buildings?
5. Lessons learned – and feedback from you, please!

Partners for Action

A research initiative that seeks to **empower Canadians** to become **flood resilient** by promoting **awareness and preparedness actions** that are **inclusive** and **evidence-based**

With founding support provided by:

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Farm Mutual Re
Collaborate. Empower. Succeed.

Contact: p4a.info@uwaterloo.ca

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FACULTY OF ENVIRONMENT

Partners for Action

- Advancing flood resilience in Canada in the face of climate change and extreme weather through **community-engaged and applied** approaches

- Applying an **equity lens** to climate action and adaptation work

An initiative of the Faculty of Environment

UNIVERSITY OF WATERLOO

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SCAN HERE

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Cameron McGlade-Bouchard

Monika Mikhail

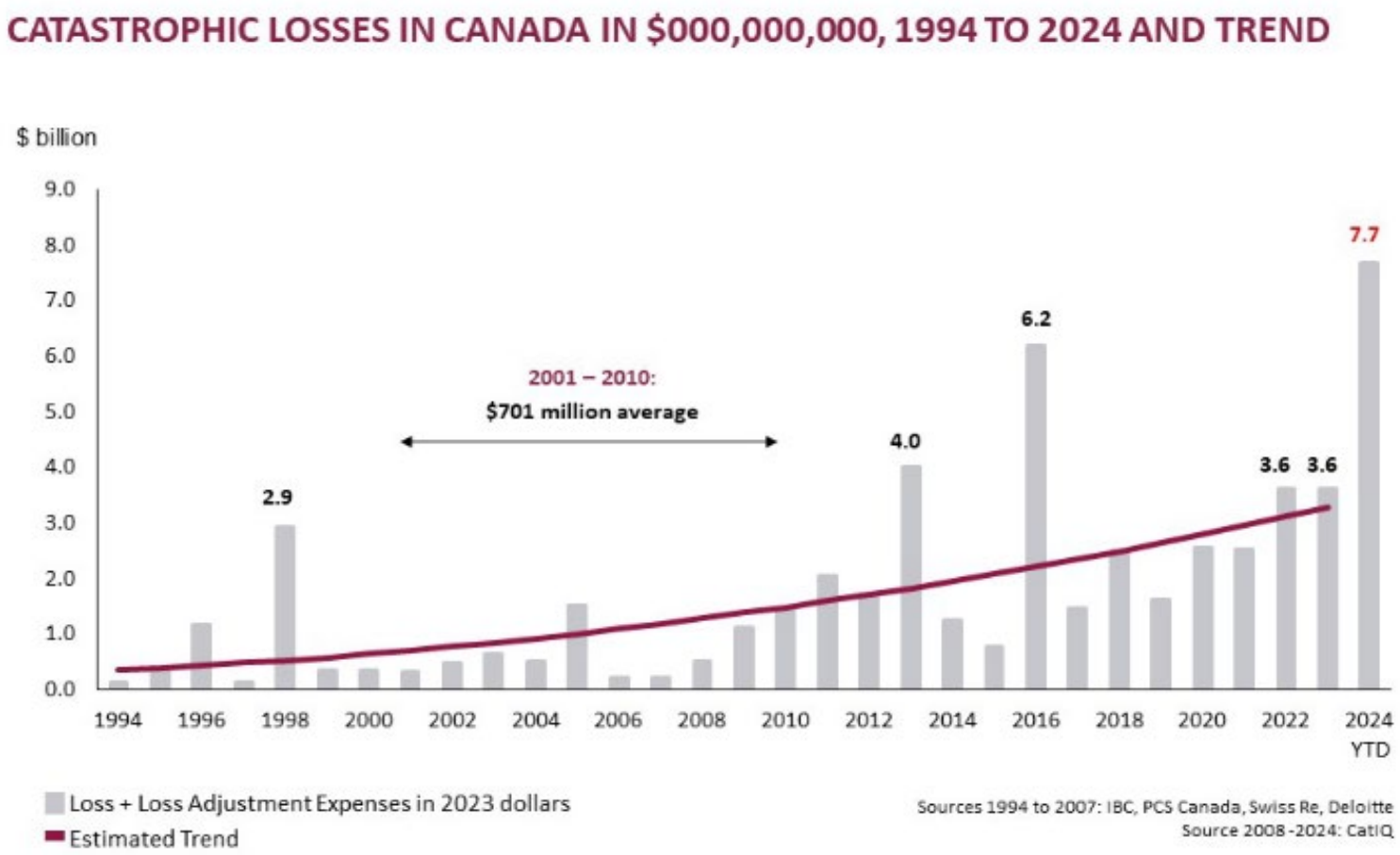
Devon Jones

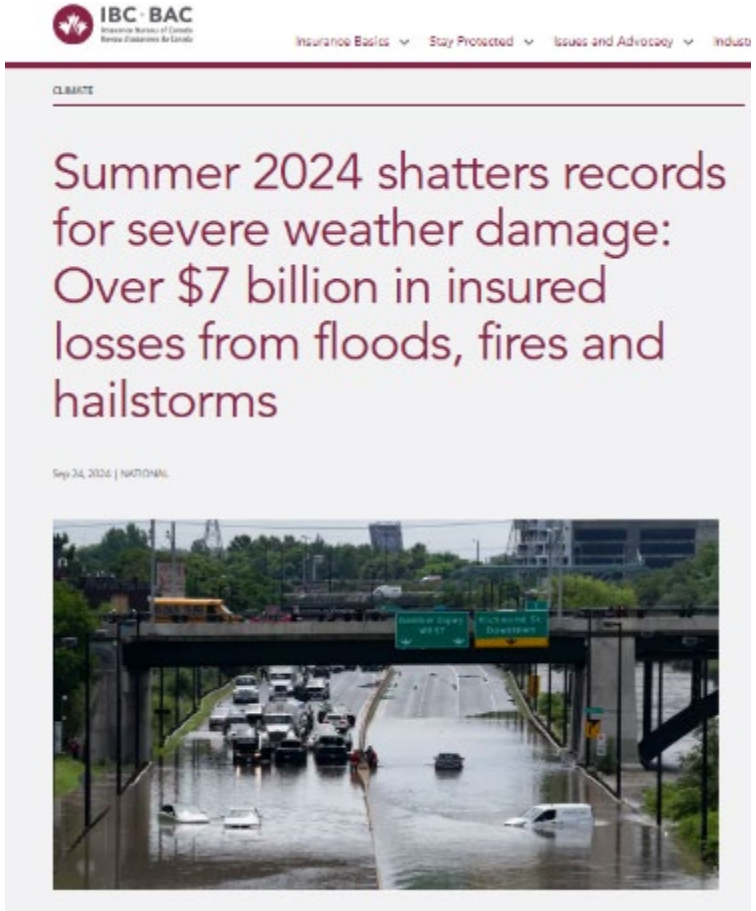
Why retrofit buildings for climate adaptation?

Maligne Lodge in Jasper, AB (July 2024)

Source: Banff-Canmore Visitor Centre via Facebook cited in Energi Media (2024)

Climate hazards in Canada





(2024a)

Sources: Insurance Bureau of Canada (2024b)

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What we did (Part 1): Develop a framework & for handling the complexity of a multi-hazard reality

Research Questions

What are prevalent climate hazards that buildings need to adapt to?

How do hazards affect buildings?

- Define building archetypes and components
- Research how each hazard affects buildings
- Categorize impacts by building component

What will help protect buildings and their inhabitants against multiple hazards?

- Create a framework for organizing information
- Research retrofit measures for each hazard
- Summarize in plain language
- “Rate” each measure (Cost / Labour / Time)

How do measures for one or more hazards relate to each other?

- Identify relationships among measures (Conflicting / Coordinating / Complementary)

The evolution of this work

Sept - Dec 2022

Research initiated by Halifax Regional Municipality (HRM) & research agenda developed

Jan - July 2023

Database developed; draft published online for HRM (restricted access)

Oct 2023

Results and database shared with network & via Climate Caucus-P4A Local Resiliency Series Webinar

May – Sept 2024

National Research Council Canada (NRC) engaged P4A to further develop the database for the Resilient Residential Retrofits (R^3) Program

Oct 2024

New website created & R^3 database made public (beta)

Nov - Dec 2024

Collect feedback
How is it to navigate?
What is missing / wrong?

Jan – Mar 2025

Officially launch climateresilientretrofits.ca

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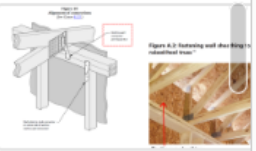
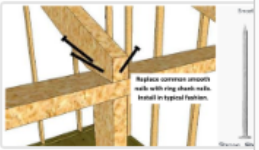
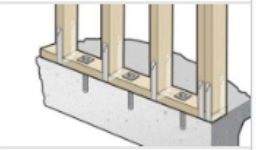
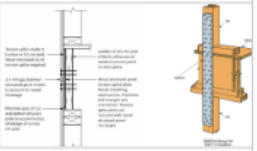
What we did (Part 2): Created a database of multi-hazard resilient retrofits – a unique tool that handles complexity

Multi-Hazard Resilient Retrofits Database

Hide fields | Filter | Group | Sort | ···

	Retrofit/Measure	ID#	Building Area	Hazard(s)	Problem	Adaptation Objective (Concise)	Images
1	Roof to wall connection (additional connectors)	EW1	Building Structure - Roof	Extreme wind	Wind uplift	Create continuous load path	
2	Roof to wall connection (nails only)	EW2	Building Structure - Roof	Extreme wind	Wind uplift	Create continuous load path	
3	Sill plate connection to foundation	EW3	Building Structure - Walls Building Structure - Foun...	Extreme wind	Wind uplift	Create continuous load path	
4	Wall to wall connections	EW4	Building Structure - Walls	Extreme wind	Wind uplift	Create continuous load path	
5	Sill plate connections to framing	EW5	Building Structure - Walls	Extreme wind	Wind uplift	Create continuous load path	

37 records

Airtable | View larger version

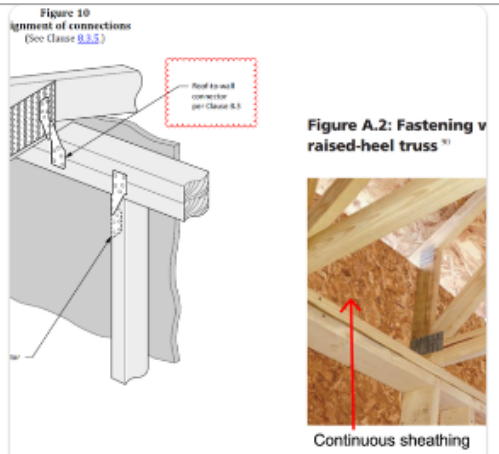
Multi-Hazard Resilient Retrofits Database: Pop-Up

Retrofit/Measure

Roof to wall connection (additional c

ID#	EW1
Building Area	Building Structure - Roof
Hazard(s)	Extreme wind
Problem	Wind uplift
Adaptation Objective (Concise)	Create continuous load path

Images



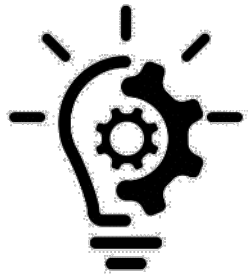
EW1 - Roof to Wall Connection.PNG

Objective Description (comprehensive)	Need to provide continuous load transfer of wind uplift force to foundation or part/complete building can be damaged.
How retrofit addresses the objective	Roof failures during high wind event typically begin at this connection. Typical 3 toe nailed connection required is not done properly (smaller nails, split wood, less than 3). Options include; engineering connectors (hurricane ties, truss screws), raised heel trusses with continuous sheathing, or connections design to meet 3.7 kN uplift force

"Ratings" (General, Relative)

Cost (Material)

Time / Effort



Expertise (Complexity)

Invasiveness

Energy Use / Emissions

"Ratings" (General, Relative)

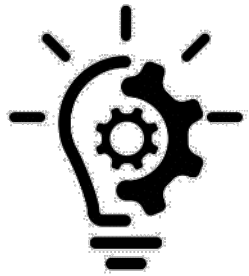
Cost (Material)

$ = < $500

$$ = $500-$5000

$$$ = > $5000

Time / Effort



Expertise (Complexity)

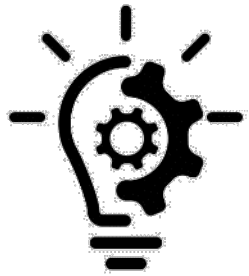
Invasiveness

Energy Use / Emissions

"Ratings" (General, Relative)

Cost (Material)

Time / Effort



Expertise (Complexity)

Invasiveness

Energy Use / Emissions

🕒 = small / little effort with little planning

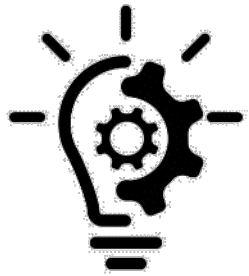
🕒🕒 = mid-size / some effort & planning

🕒🕒🕒 = large / considerable effort & planning

"Ratings" (General, Relative)

Cost (Material)

Time / Effort



Expertise (Complexity)

Invasiveness

Energy Use / Emissions

🔨 = no expertise required

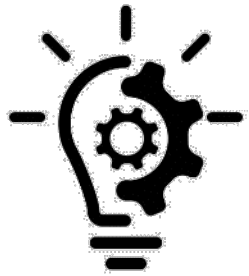
🔨🔨 = some expertise or skills

🔨🔨🔨 = specific expertise or skills

"Ratings" (General, Relative)

Cost (Material)

Time / Effort



Expertise (Complexity)

Invasiveness

Energy Use / Emissions

= no / little disruption

=some or extended disruption to daily life

= major disruption or temporary move required

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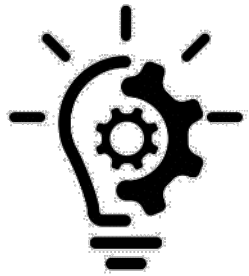
"Ratings" (General, Relative)

Cost (Material)

Time / Effort



Expertise (Complexity)

Invasiveness

Energy Use / Emissions

Increases / decreases

- energy efficiency
- greenhouse gas emissions

The “3 Cs”

Conflicting

A measure that works against another

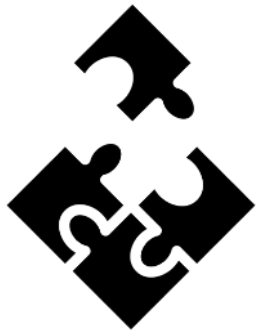
Example: Vegetation can help with extreme heat but also increase wildfire risk

Coordinating

A measure to consider alongside another for practicality and convenience, saving cost and time while addressing one or more objectives / hazards

Example: If doing A, you might as well do B

- Insulation
- Air-sealing / air tightness



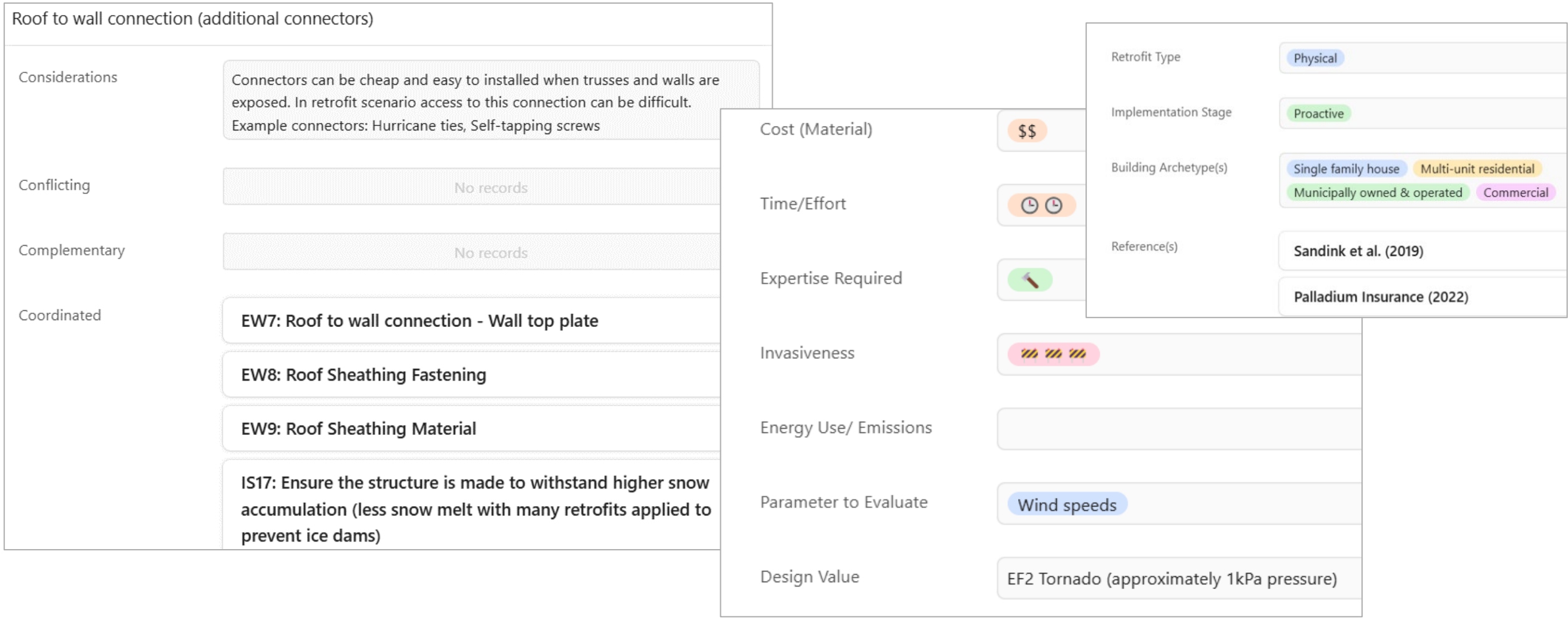
Complementary

A measure that addresses multiple hazards or multiple adaptation objectives

Example: Airtight insulation protects against:

- Extreme Heat
- Wildfires
- Floods
- Snow

Multi-Hazard Resilient Retrofits Database: Pop-Up



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Select findings:
How can we prepare our homes and buildings to be climate resilient?

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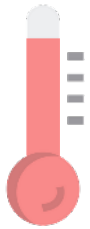
Retrofitting for Extreme Heat Resilience

The Hazard

Increased internal building temperatures



Increased external building temperatures

Impacts

Threats to human health

Adaptation Objective

Reduce heat transfer

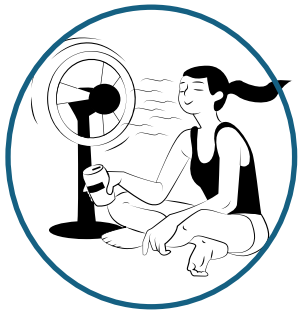
Reduce solar heat gain

Increase airtightness

Increase cooling

Options

Increase shading



Increase ventilation

Create and keep cool air in the building

Use cooling roof and wall materials

Improve energy efficiency

Icons from IconScout

Example Retrofits - Extreme Heat

Image Source: World Economic Forum

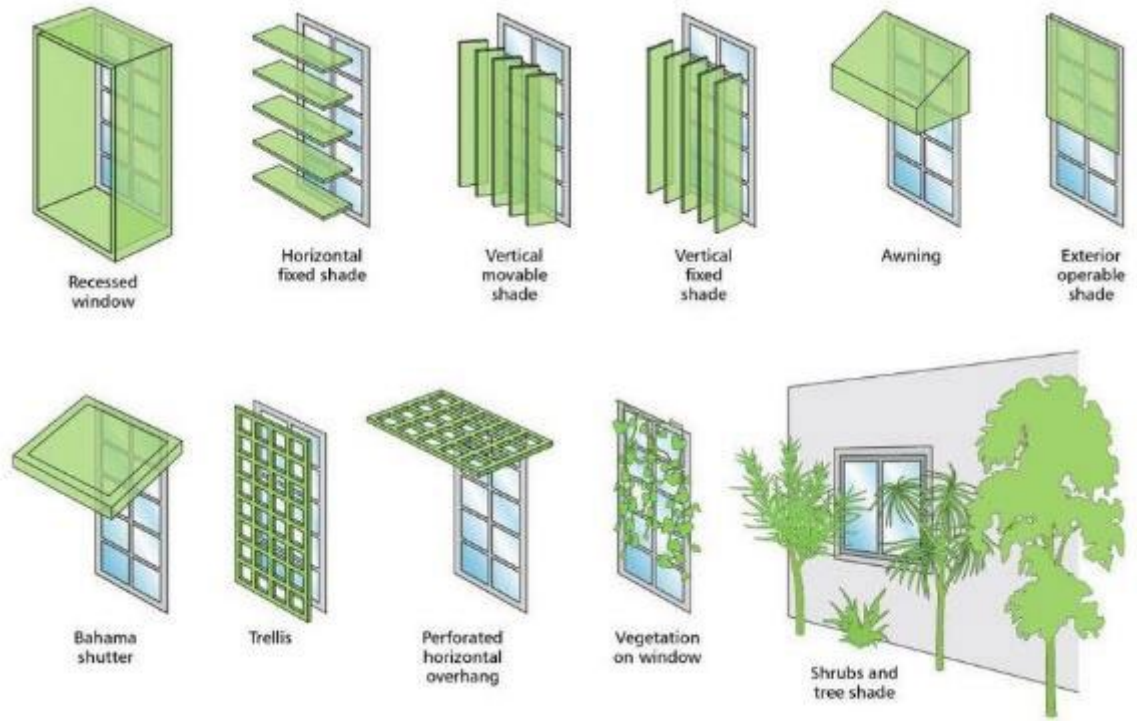


Image Source: Al-Yasiri and Szabo (2021)

Example Retrofits - Extreme Heat

Increase airtightness

Source: EverLog Systems

Increase insulation

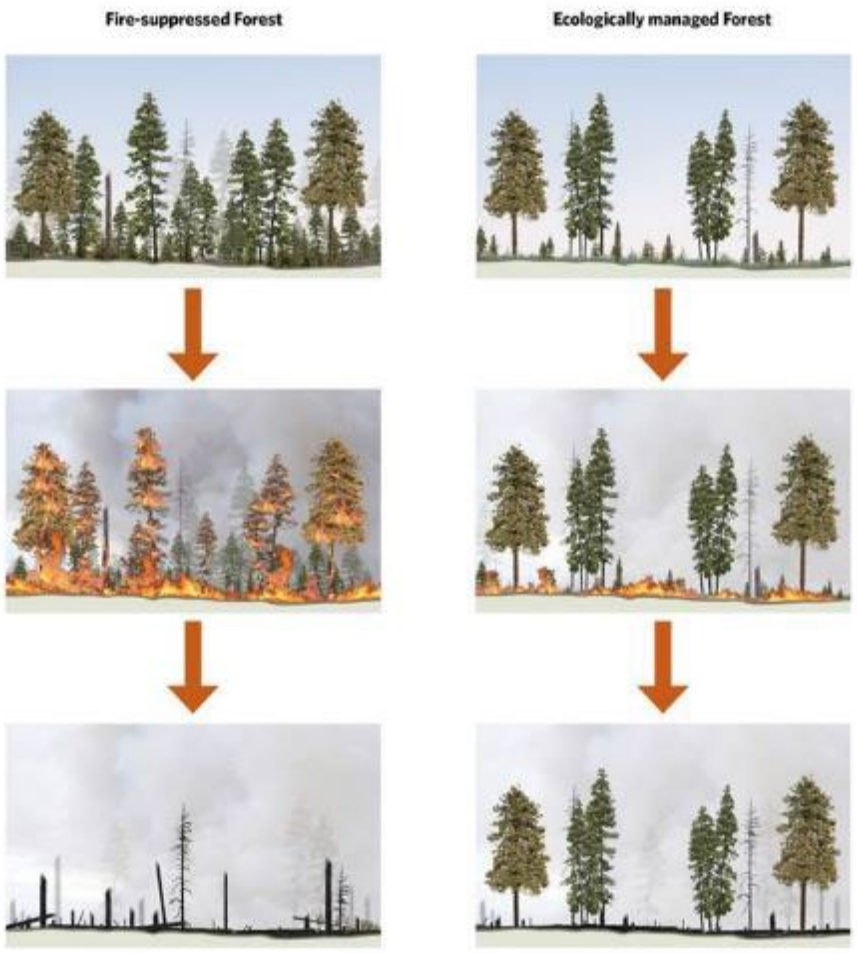
Source: Fine Home Building

Retrofitting for Wildfire Resilience

The Hazard	Impacts	Adaptation Objective	Options
Fires entering buildings	Damage to infrastructure	Prevent building ignition	Reduce use of flammable materials
Fires encroaching on buildings	Bad air quality	Improve air quality	Outdoor maintenance
Poor air quality	Threats to human life and health	Slow wildfire spread	Reduce openings where fires can enter buildings
Fires caused by people		Evacuation measures	Watering natural areas
Fires caused by fallen powerlines			Fire prevention strategies

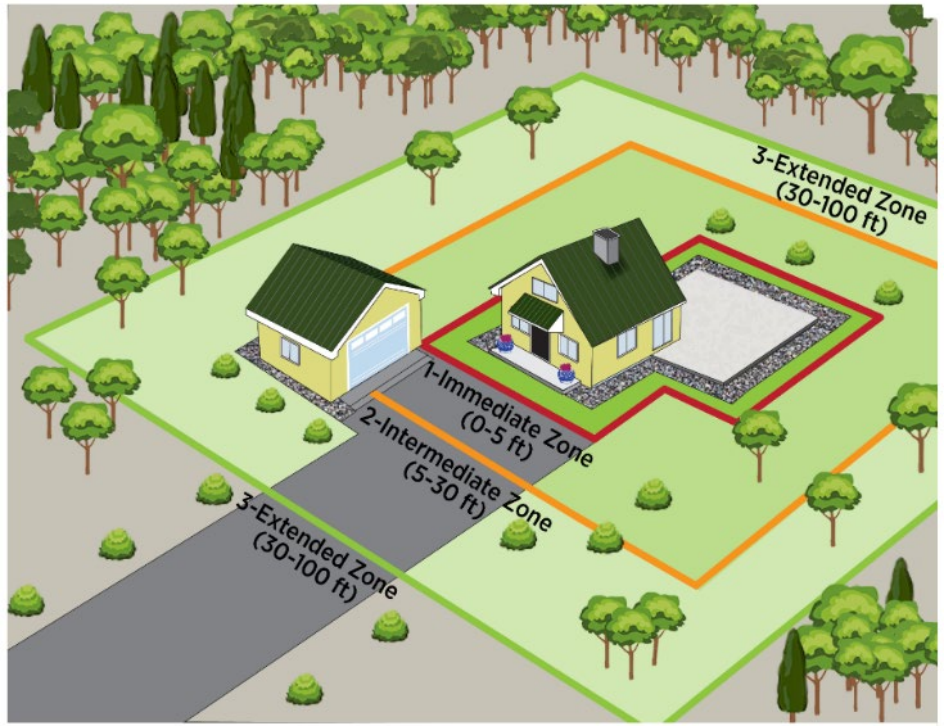
Icons from IconScout

Example Retrofits - Wildfires



Outdoor maintenance

Source: The Nature Conservancy



1 – Immediate Zone (0 to 5 ft):
Install noncombustible ground cover. Use fire-resistant or noncombustible materials for decks, porches, railings, or fences that attach to the home.

2 – Intermediate Zone (5-30 ft):
Plant trees no closer than 30 feet to the home. Space tree crowns 18 feet apart or further on slopes. Trim branches up to 6 to 10 feet from ground and at least 10 feet from structures.

3 – Extended Zone (30-100 ft):
Remove vegetation next to outbuildings. For trees 30 to 60 ft from the home, space so mature canopies are at least 12 feet apart; for 60 to 100 feet from the home, space so tree canopies are at least 6 feet apart.

Defensible zone

Source: Energy.gov

Retrofitting for Flood Resilience

The Hazard

- Pluvial 
- Coastal 
- Riverine 
- Drainage failure 

Impacts

- Structural damage
- Water damage
- Debris damage
- Contamination
- Sewer overwhelming

Adaptation Objective

- Keep water out
- Increase drainage
- Resist flood forces

Options

Dry Floodproofing
Stop water from entering

Wet Floodproofing
Allow water to enter harmlessly

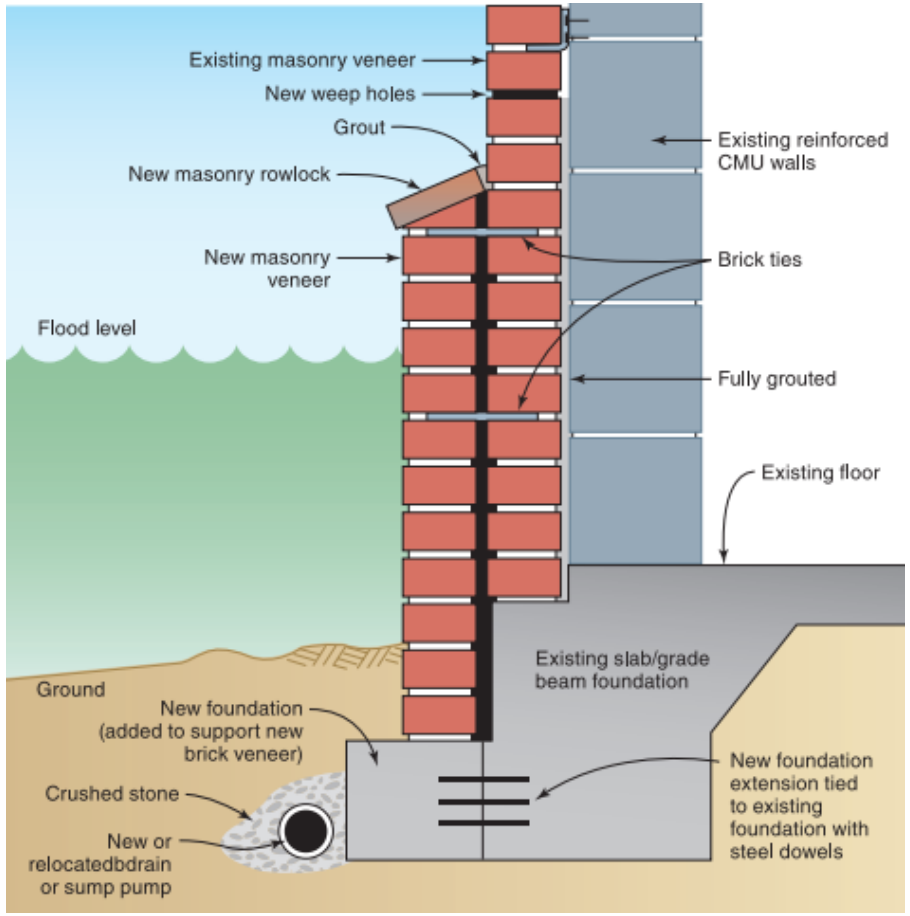
Elevate
Move structure above flood levels

Barrier
Prevent water from reaching the structure

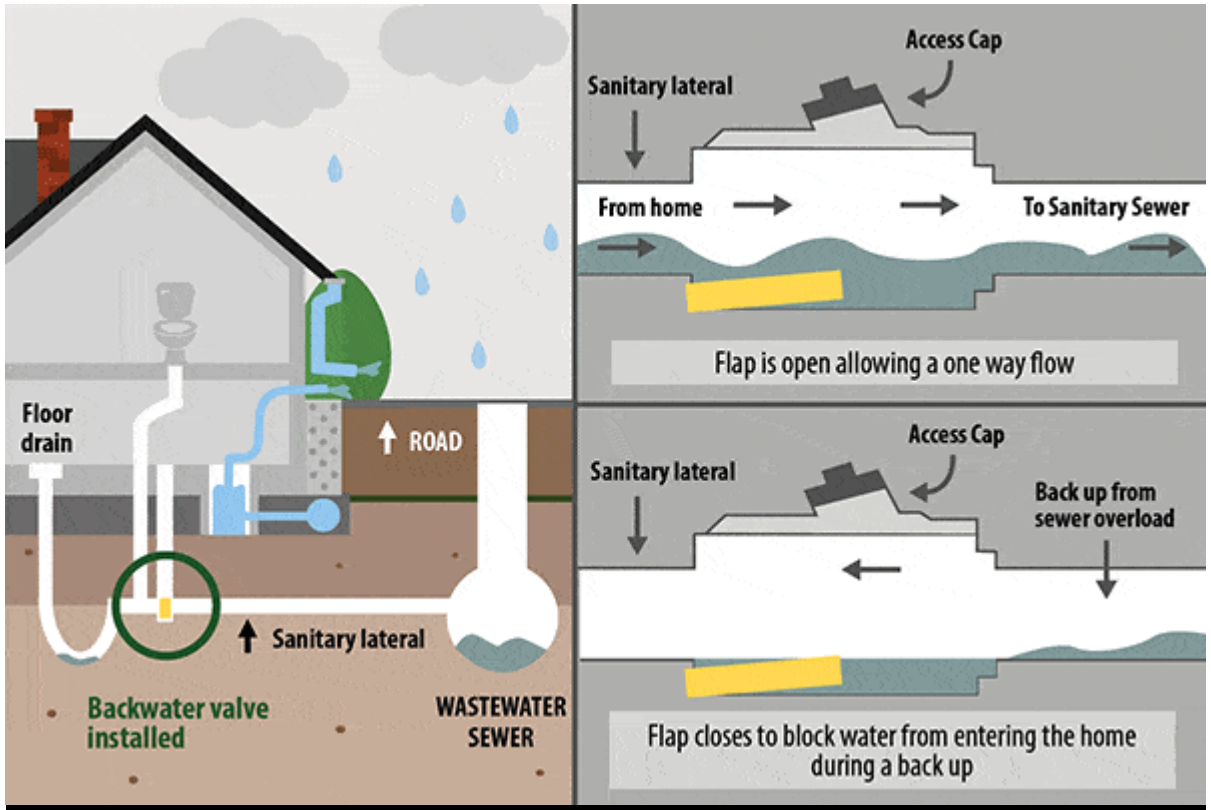
Relocate
Move structure out of the floodplain

Icons from IconScout

Example Retrofits - Flooding



Dry floodproofing

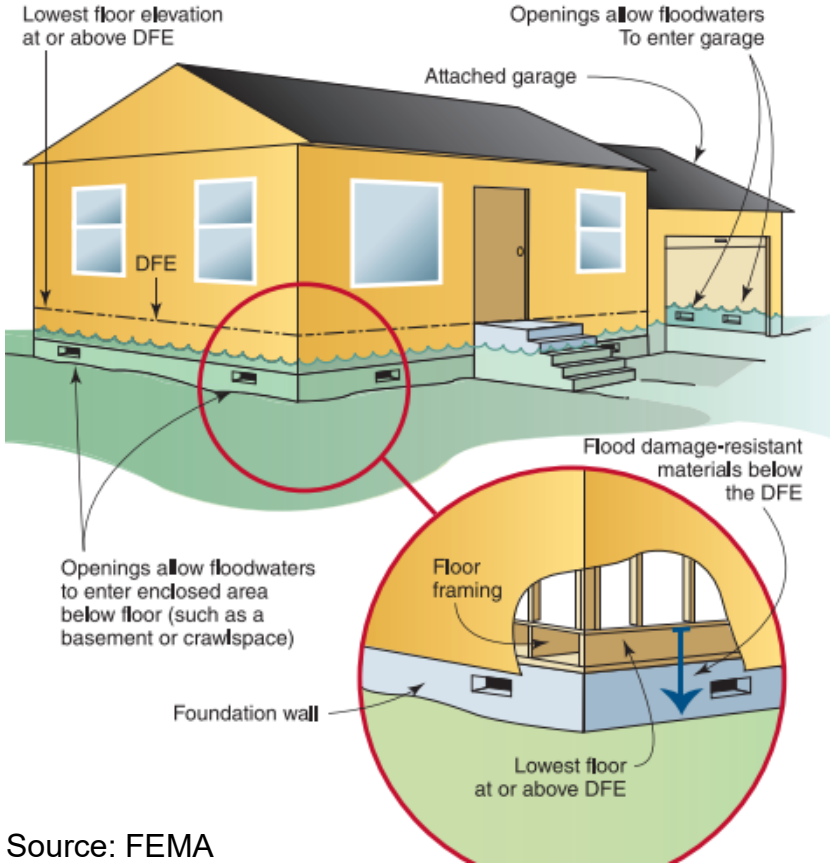


Backwater valves

Source: Out of This World Plumbing Ottawa

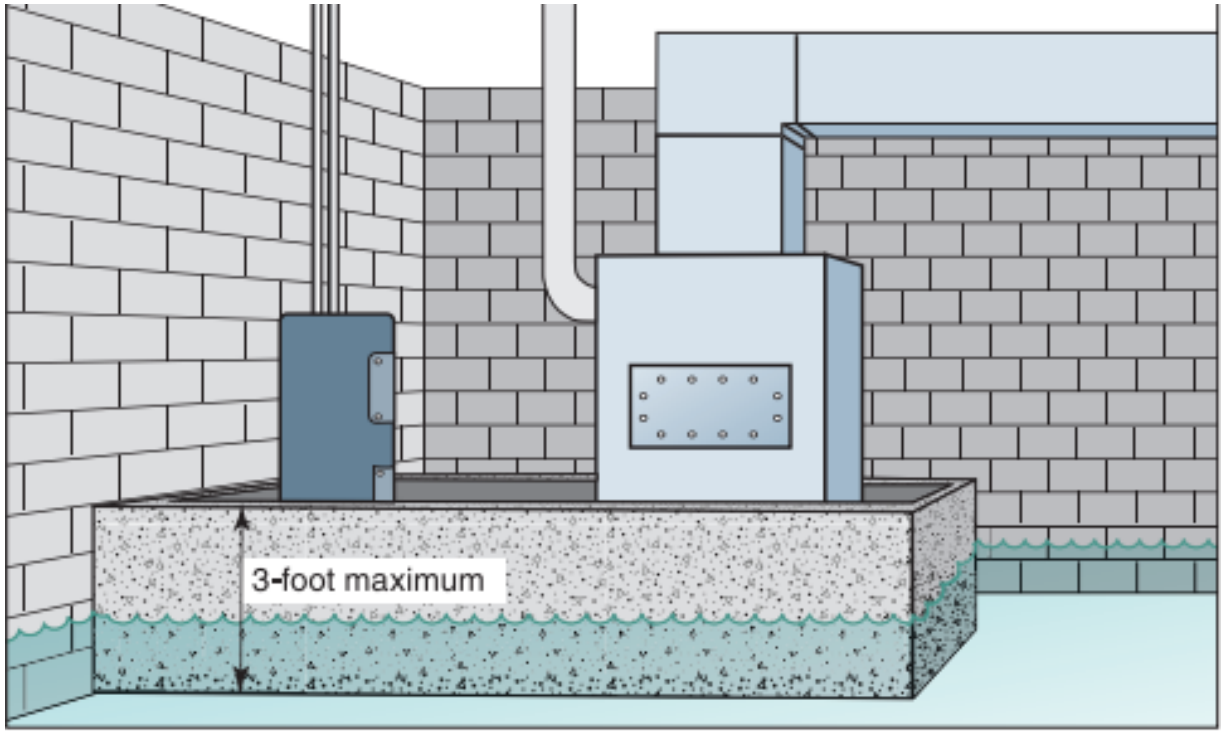
Source: FEMA

Example Retrofits - Flooding



Source: FEMA

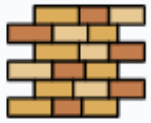
Wet floodproofing

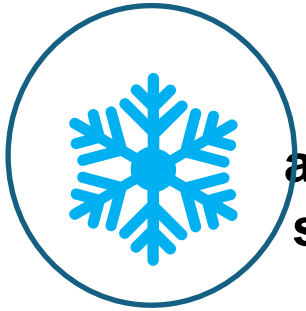


Elevate or protect utilities

Source: FEMA

Retrofitting for Cold Weather Resilience

The Hazard	Impacts	Adaptation Objective	Options
Weathering of masonry 	Leaks	Prevent snow accumulation	Keeping pipes above freezing
Freezing pipes 	Water damage	Prevent frozen pipes	Keeping masonry dry
Hail 	Masonry damage	Prevent ice dams	Removing roof temperature gradient
Ice dams 	Burst pipes	Increase airtightness	Flood adaptation strategies
Meltwater 	Dents in roofs	Enhance structural resilience	Protecting roofs and windows from hail
	Broken windows	Keep water out	
	Flooding		



Icons from IconScout

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Retrofitting for Extreme Wind Resilience

The Hazard

- Lift off foundation 
- Lift forces on roof 
- Flying debris 
- Exterior damage 

Impacts

- Structural damage
- Water penetration
- Objects uplifting
- Roof coming off the building
- Total collapse

Adaptation Objective

- Create continuous load path
- Limit wind damage
- Limit uplift

Options

Secure roof
Improve connections

Anchor to foundation
Secure walls soundly to foundation

Reinforce doors and windows
Allow winds into building

Improve roofing material
Withstand winds and protect interior from elements

Icons from IconScout

What is unique about this work, lessons learned, & feedback from you, please!

Database: Unique features

Synthesizes **information about multiple hazards in one place**

Organized by adaptation objective (+ hazard, building component)

"3 Cs" - Identifies **how measures relate to each other against adaptation measure**. Are they

- **Conflicting (maladaptive)?**
- **Coordinating (do several things to be practical)?**
- **Complementary (one retrofit, multiple benefits**)?

A start at **integrating retrofits for adaptation & mitigation**

Lessons Learned

How to synthesize and convey information to a broad audience

- Information about multiple hazards from different disciplines and sources for different audiences
- Convey technical information accurately, concisely, simply

How to make it dynamic

- Adaptation objective as the backbone of a dynamic database

How to allow for variations among regions, different & new technologies

How to think holistically

- Relationships amongst measures (3 Cs)
- Adaptation with attention to mitigation

Future Work – funding permitting

- **Regularly update** to
  - keep pace with new strategies & technologies
  - upkeep the technical aspects
  - Incorporate feedback
- **Research started that could be continued**
  - enabling initiatives
  - differences for new builds
  - what applies to non-residential buildings
  - funding that communities can access

- If you are experiencing multiple hazards, **how will this tool help you?** What will you search for?
- How is it to navigate?
- What is missing? Confusing? Inaccurate?

Acknowledgements

This research was done in partnership with **Halifax Regional Municipality** in 2022-2023 as part of the HalifACT Climate Action Plan, and with **National Research Council Canada (NRC)** in 2024 for the *Climate Resilient Built Environment Initiative*, in support of delivering the Government of Canada's Adaptation Action Plan, and towards achieving commitments under the National Adaptation Strategy

HalifACT Acting on Climate Together | HALIFAX

National Research Council Canada | Conseil national de recherches Canada

Please Join us for the Inaugural BC Climate Resilience Summit!

Registration & Updates @urbc.ca

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Climate Resilient Retrofits

Adapting Canada's existing building stock to withstand a changing climate

https://climateresilientretrofits.ca

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- If you are experiencing multiple hazards, **how will this tool help you?** What will you search for?
- How is it to navigate?
- What is missing? Confusing? Inaccurate?

Discussion

- What hazard impacts have you experienced?
- When you are planning a renovation or repairs, are you thinking of retrofits for climate hazards?
- Who is most impacted by climate hazards, and why?

Please let us know what you think about ClimateResilientRetrofits.ca!

References

- Chakraborty, L., Thistlethwaite, J., Minano, A. et al. Leveraging Hazard, Exposure, and Social Vulnerability Data to Assess Flood Risk to Indigenous Communities in Canada. Int J Disaster Risk Sci 12, 821–838 (2021). https://doi.org/10.1007/s13753-021-00383-1
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- Partners for Action. (2024). Climate Resilient Retrofits Database-All Hazards. https://www.climateresilientretrofits.ca/all-hazards/

Please let us know what you think about ClimateResilientRetrofits.ca!

"Ratings" Criteria

Cost (Material)	An estimated range of what materials might cost (labour costs vary greatly, so are excluded)	$ = less than $500, $$ = $500-$5000, $$$ = greater than $5000
Time/Effort	An estimate of the overall duration, amount of work, and planning required to complete installation	🕒 = small project/little effort with no or little planning, 🕒🕒 = mid-size project/some effort and planning, 🕒🕒🕒 = large project/considerable effort and planning
Expertise Required	Approximately how much specialized knowledge, skills, and experience are needed, with the caveat that these can vary depending on the complexity of the building and site conditions	The range is between retrofits that could potentially be done by residents to those that require more specialized skills and a contractor. 🔨 = no expertise required, 🔨🔨 = some expertise or skills required, 🔨🔨🔨 = specific expertise or skills required

"Ratings" Criteria

Invasiveness	The degree to which the retrofitting process disrupts or impacts the existing structure, its occupants, and daily life	 = no/little disruption,  =some or extended disruption to daily life,  = major disruption or temporary move required
Energy/GHG Effects	Immediate or obvious energy use, energy efficiency gains, or greenhouse gas emissions. Not accounted for: embodied carbon in products and materials	Example: Insulation usually increases energy efficiency, providing energy savings by reducing the amount of heat or cooling lost. Air conditioners provide cooling needed to prevent heat stroke but require energy and emit greenhouse gases. Heat pumps also cool rooms but do not emit greenhouse gases

Climate hazards in Canada in 2024

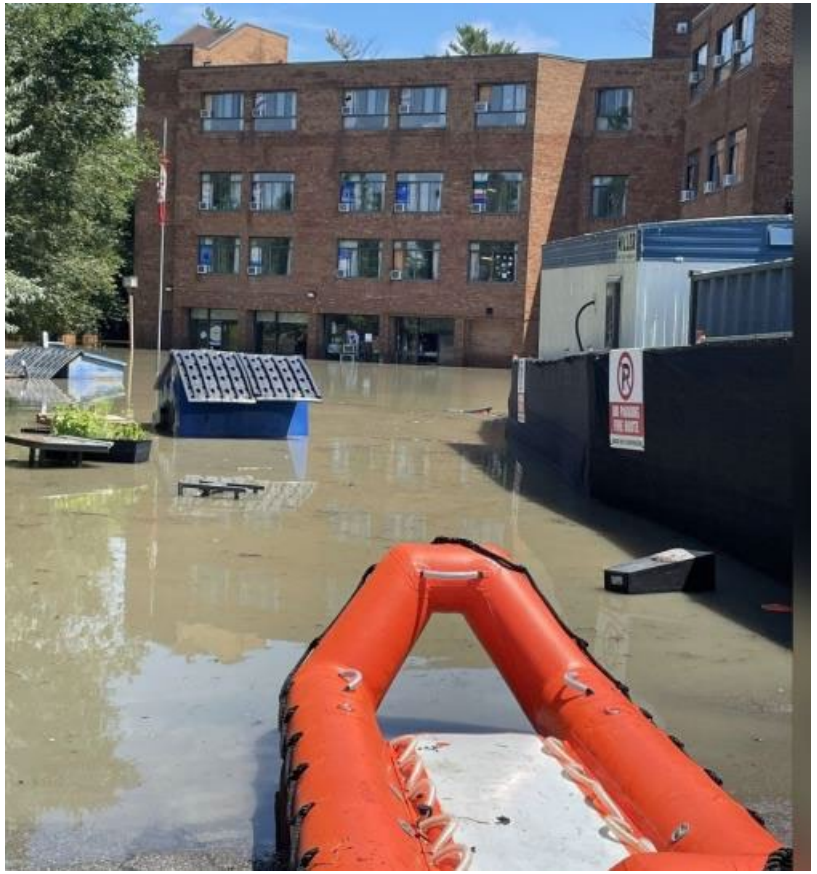
TORONTO | News

Mississauga, Ont., nursing home evacuated of more than 100 residents amid flooding

https://toronto.ctvnews.ca/mississauga-ont-nursing-home-evacuated-of-more-than-100-residents-amid-flooding-1.6968269

"July flash floods in Toronto and southern Ontario caused over **$940 million in insured damage**"

"228,000 insurance claims, a **406% increase** compared to previous 20-year average"



Sources: Insurance Bureau of Canada (2024a,b)

CTV News (2024)

- What parts of the building might you tackle?
- Who has control over what happens on the property?