Morrison Hershfield now Stantec

BC HOUSING CLIMATE RISK ASSESSMENT FRAMEWORK (CRAF) TOOL

BC HOUSING

2024 CANADIAN CONSULTING ENGINEERING AWARDS
CATEGORY: F. Special Projects

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BC HOUSING CLIMATE RISK ASSESSMENT FRAMEWORK (CRAF) TOOL

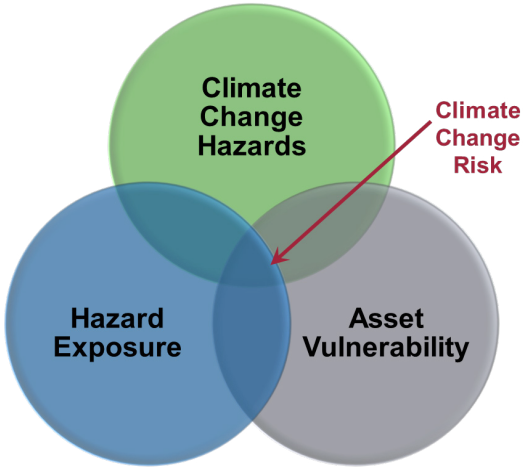
Location:	British Columbia
Completed By:	2023
To Be Entered in Category:	F. Special Projects
Firm Name:	Morrison Hershfield now Stantec
Role in the Project:	Prime Consultant, Climate Risk Assessment, Tool Development, User Guide Documentation and Stakeholder Engagement
Owner/Client:	BC Housing

SUMMARY

Integrating climate considerations into asset planning and budgeting across portfolios can be complex. Morrison Hershfield now Stantec developed a portfolio-scale Climate Risk Assessment Framework tool that allows BC Housing to apply a standardized approach to integrating climate risk and resilience at its assets across the province. This first-of-its-kind tool can be used to assess site viability for new development, development proposal scoring across sites, and prioritization and budgeting of risk mitigation strategies, and it has potential for future expansion to additional climate risks and communities.

Q.1
INNOVATION

The rapid acceleration of the climate crisis highlights the urgent need to address the highest climate risks, prioritizing vulnerable populations. However, integrating climate considerations into asset planning and budgeting across portfolios can be complex. It requires an understanding of site-specific climate risks, which often necessitates costly and lengthy climate risk assessments on a property-by-property basis to effectively prioritize risk mitigation actions.



BC Housing partnered with Morrison Hershfield now Stantec to develop a Climate Risk Assessment Framework (CRAF) tool to support a consistent approach to prioritization and decision-making across regions and assets. The tool addresses an unmet need for a portfolio-level climate risk screening tool for assessing risks to BC Housing's existing properties, new development sites, and potential acquisitions.

The CRAF tool was developed to identify the highest climate risks at a selected site within one of eight defined regions within the province. It aligns with recognized frameworks including the PIEVC Protocol and BC's Strategic Climate Risk Assessment Framework.

With a goal of achieving balance between comprehensiveness and ease of use, the CRAF tool focuses on six priority climate risk categories projected into the 2050s and 2080s, including extreme heat events, extreme rainfall and flooding, emergency power, wildfire risk, wildfire smoke, and general air quality.


General Air Quality


Wildfire Smoke


Wildfire Risk


Extreme Heat Events

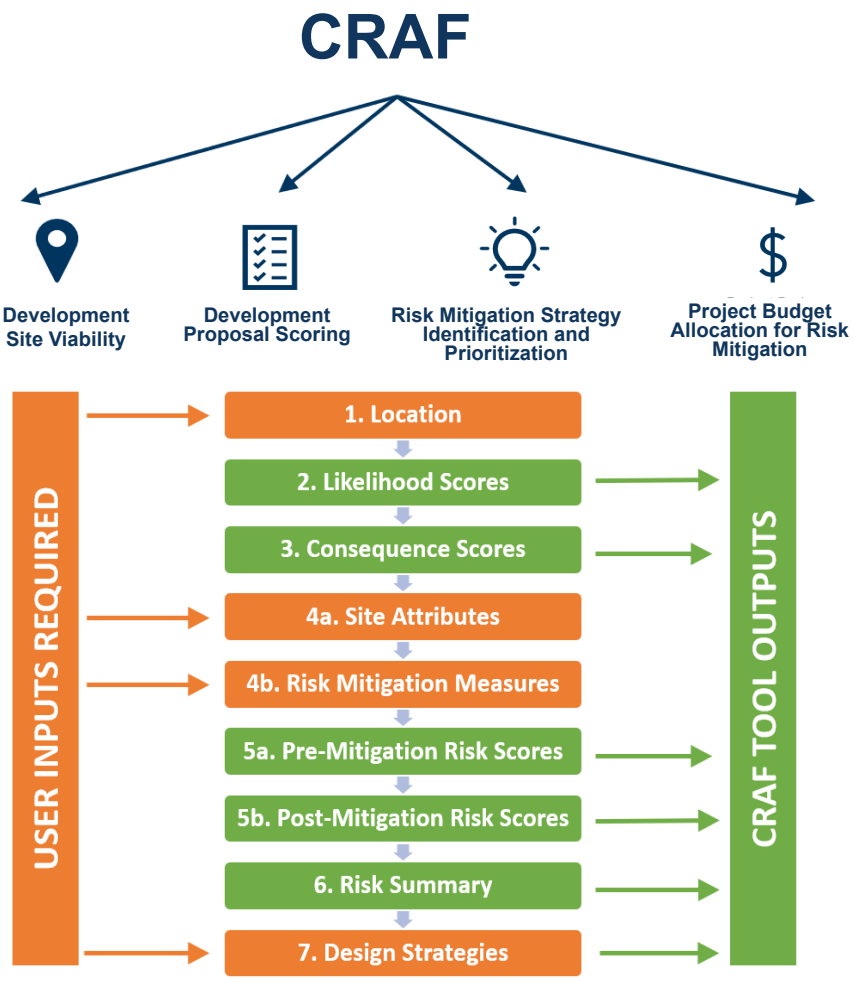

Emergency Power


Flooding & Rainfall

Using a regional archetype approach with user-defined site-specific customization, the tool evaluates climate hazard likelihood and assesses consequences across four weighted categories: Properties and Assets, Site and Environment, Social and Programming, and Health and Safety.

In contrast to a standard one-off approach to climate risk assessments, the CRAF tool enables a portfolio-scale review of the highest climate risks and potential climate adaptation approaches. This facilitates rapid comparisons of relative climate vulnerability across sites, and a user-guided sensitivity analysis of the effect of implementing different climate risk mitigation measures at a specific site.

Overall, the CRAF tool provides the type of assessment that large portfolio owners, such as BC Housing, seek for supporting their project planning and budgeting, with a level of site-specificity and customization that is not currently available through any other resources, such as off-the-shelf online platforms. The CRAF tool is in its first iteration and is being piloted on BC Housing projects to identify optimization opportunities. The tool is designed to be flexible to allow for future enhancements, such as including data for additional communities, connecting to external climate data sources, focusing on specific asset classes, or customizing for community needs.



Q.2

COMPLEXITY

The integration of climate change risk and resilience into portfolio-scale asset management is a complex challenge due to competing priorities and budgets, variations in property types and geographies, and individual building characteristics. BC Housing's Climate Resilience Assessment Framework (CRAF) tool was developed to be a user-friendly Excel-based workbook that enables consideration of climate-associated risk in planning, acquisition, and development projects in more than 160 locations across the province.

The CRAF tool further simplifies the complexity of climate risk assessments by providing clear guidance for users to follow a four step process (location, consequence scores, site attributes, risk mitigation measures) to determine the level of risk at a site to select climate hazards that include: Flooding & Rainfall, Extreme Heat Events, Wildfire, Wildfire Smoke, Emergency Power, and General Air Quality. Data for archetypal sites have been prepopulated to enable a high level risk assessment with minimal inputs based on defaults that provide an overview of typical risks for a regional location.

At each step, a simple set of required or optional user inputs are identified. These are used to augment the prepopulated data for site-specific customization of the risk assessment. The resulting risk scores can be used to inform the selection of climate risk mitigation strategies from a set of prioritized actions provided for each climate hazard, by building feature and project type. Asset managers and project teams can compare climate risk scores across properties and calculate the effect of implementing recommended mitigation measures to the highest risks.

For example, on the Location tab, users are guided through a brief (five to ten minute) process to determine flooding and wildland-urban interface wildfire risk specific to the site. On the Site Attributes tab, users select 'yes' or 'no' to identify the relevance of nine characteristics, such as whether the site is in a remote area or services vulnerable clientele. The Risk Mitigation Measures tab offers 16 yes/no options for potentially applicable adaptation strategies to the six climate hazards. Selection of any of these factors will affect the risk score based on the relative adaptative capacity or sensitivity of each one.

1. Location → 2. Likelihood Scores → 3. Consequence Scores → 4a. Site Attributes → 4b. Risk Mitigation Measures → 5a. Pre-Mitigation Risk Scores → 5b. Post-Mitigation Risk Scores → 6. Risk Summary → 7. Design Strategies

1.0 CRAF Tool – Site-Specific User Inputs

Select Municipality:	100 Mile House
Enter Site Name / Address:	Site Name / Address
Region (Location):	Cariboo (Williams Lake)
BCH Region:	Northern

Coastal Flooding

Flood Return Period	Year		
	Baseline	Future	
	2030	2050	2080
10-year	N	N	N
100-year	N	N	N

River Flooding

Flood Return Period	Year		
	Baseline	Future	
	1980-2019	2020-2060	2061-2100
100-year	N	N	N
200-year	N	N	N

Wildfire Risk Class

Map Grid ID	Fire Threat Rating Period	Site Colour Estimation	Fire Threat Rating Estimation
	2021	No colour identified	

2.0 CRAF Tool – Likelihood Scores

Climate Risk Category	Climate Hazard Indicator	Likelihood Score (/5)		
		Baseline	2050s	2080s
Flooding & Rainfall	Floodplain level, coastal flooding	1	1	1
Flooding & Rainfall	Floodplain level, riverine flooding	1	1	1
Flooding & Rainfall	50-year 1-hour rain	3	3	4
Flooding & Rainfall	50-year 1-day rain	3	4	4
Extreme Heat Events	Annual Tmax	3	4	5
Extreme Heat Events	Days Tmax >35C per year	1	2	4
Extreme Heat Events	Days Tmax >30C per year	3	5	5
Extreme Heat Events	Days Tmin >18C per year	1	2	3

3.0 CRAF Tool – Consequence Scores

Climate Risk Category	Consequence Category	Consequence Definition	Consequence Score (/5)
Flooding & Rainfall	Structure and Systems	Replacement of multiple systems required immediately	4
	Site and Environment	Major damage but short-term impact, or minor long-term damage on site landscaping or services	3

4a. CRAF Tool – Consequence Modifiers

Site-specific attributes can *increase* the consequence:

Climate Risk Category	Consequence Category	Risk Factor	Site Attribute	Y/N Selection
Flooding & Rainfall	Site and Environment	Runoff	Site is on watershed runoff pathway	N
	Site and Environment	Groundwater	Site is within a groundwater area of concern, or local water table level is high	N
	Social and Programming	Accessibility	Site is remote and emergency services could take > 6 h to arrive	Y

Climate Risk Category	Initial Consequence Score (/5)	Consequence Score w/ Site Attributes (/5)
Flooding & Rainfall	3.5	3.6

4b. CRAF Tool – Consequence Modifiers

Risk mitigation measures can *reduce* the consequence:

Climate Risk Category	Consequence Category	Risk Factor	Design-Specific Risk Mitigation Measure	Y/N Selection
Extreme Heat Events	Structure and Systems	Cooling	Full/partial cooling is provided in units	N
	Structure and Systems	Cooling	Cooling system can accommodate temperatures over 30C, or can be expanded to add cooling capacity for at least common spaces (e.g., areas of refuge)	Y

Climate Risk Category	Consequence Score w/ Site Attributes (/5)	Consequence Score w/ Site Attributes + Risk Mitigation Measures (/5)
Extreme Heat Events	3.8	3.7

5. CRAF Tool – Pre- and Post-Mitigation Risk Scores

Pre-mitigation risk scores:

Climate Risk Category	Likelihood Score (/5)			*Consequence Score (/5)	Risk Score (/25)			Risk Rating		
	Baseline	2050s	2080s		Baseline	2050s	2080s	Baseline	2050s	2080s
Flooding & Rainfall	3.0	4.0	4.0	3.6	10.7	14.2	14.2	Medium	High	High
Extreme Heat Events	2.0	3.3	4.3	3.8	7.6	12.3	16.1	Medium	High	High
Wildfire Risk	5.0	5.0	5.0	5.0	25.0	25.0	25.0	Extreme	Extreme	Extreme
Emergency Power	3.5	3.3	3.3	2.4	8.3	7.9	7.9	Medium	Medium	Medium
General Air Quality	3.0	4.0	4.0	2.3	6.9	9.2	9.2	Medium	Medium	Medium
Wildfire Smoke	5.0	5.0	5.0	2.7	13.5	13.5	13.5	High	High	High

Post-mitigation risk scores:

Climate Risk Category	Likelihood Score (/5)			*Consequence Score (/5)	Risk Score (/25)			Risk Rating		
	Baseline	2050s	2080s		Baseline	2050s	2080s	Baseline	2050s	2080s
Flooding & Rainfall	3.0	4.0	4.0	3.6	10.7	14.2	14.2	Medium	High	High
Extreme Heat Events	2.0	3.3	4.3	3.6	7.2	11.7	15.3	Medium	Medium	High
Wildfire Risk	5.0	5.0	5.0	4.8	23.9	23.9	23.9	Extreme	Extreme	Extreme
Emergency Power	3.5	3.3	3.3	2.2	7.5	7.2	7.2	Medium	Medium	Medium
General Air Quality	3.0	4.0	4.0	1.9	5.8	7.8	7.8	Low	Medium	Medium
Wildfire Smoke	5.0	5.0	5.0	2.2	11.1	11.1	11.1	Medium	Medium	Medium

6.0 CRAF Tool – Risk Summary

Risk Scores and Levels without Risk Mitigation Measures

Climate Risk Category	Risk Score (/25)			Risk Rating		
	Baseline	2050s	2080s	Baseline	2050s	2080s
Flooding & Rainfall	10.7	14.2	14.2	Medium	High	High
Extreme Heat Events	7.6	12.3	16.1	Medium	High	High
Wildfire Risk	25.0	25.0	25.0	Extreme	Extreme	Extreme
Emergency Power	8.3	7.9	7.9	Medium	Medium	Medium
General Air Quality	6.9	9.2	9.2	Medium	Medium	Medium
Wildfire Smoke	13.5	13.5	13.5	High	High	High

Risk Scores and Levels with Risk Mitigation Measures

Climate Risk Category	Risk Score (/25)			Risk Rating		
	Baseline	2050s	2080s	Baseline	2050s	2080s
Flooding & Rainfall	10.7	14.2	14.2	Medium	High	High
Extreme Heat Events	7.2	11.7	15.3	Medium	Medium	High
Wildfire Risk	23.9	23.9	23.9	Extreme	Extreme	Extreme
Emergency Power	7.5	7.2	7.2	Medium	Medium	Medium
General Air Quality	5.8	7.8	7.8	Low	Medium	Medium
Wildfire Smoke	11.1	11.1	11.1	Medium	Medium	Medium

For each climate risk category and for each consequence category, resilient design strategies are provided for user reference.

Resilient design strategies have been adopted from BC Housing's Climate-Ready Housing Design Guide and the Climate Resilience Guidelines for B.C. Health Facility Planning and Design.

7.0 CRAF Tool – Resilient Design Strategies

Applies (High or Extreme Risk)	Climate Risk Category	Consequence Category	Design Category	New	Retrofit	Site	Potential Benefit	Resilient Design Strategy
Y	Flooding & Rainfall	Structure and Systems	Structural/Envelope	✓			High	Design basements and structure below flood construction level to be waterproofed and watertight.
Y	Flooding & Rainfall	Structure and Systems	Structural/Envelope	✓			High	Design structure to withstand hydrostatic and impact loads, or if the basement level is allowed to be inundated to release pressure, ensure that flood cleanup protocols are established and implemented.
Y	Flooding & Rainfall	Structure and Systems	Site and Storm/Sewer	✓	✓		Medium	Increase roof drainage and rainwater leader design by an additional 20% above current bylaw
Y	Flooding & Rainfall	Structure and Systems	Planning/Architectural	✓			Medium	Avoid flat roof areas; where flat roof areas exist, ensure drainage exceeds current bylaw/code
Y	Flooding & Rainfall	Site and Environment	Site and Storm/Sewer			✓	High	Develop a landscaping plan that includes strategies such as rain gardens, bioretention ponds, permeable pavement, and onsite detention strategies.
Y	Flooding & Rainfall	Site and Environment	Planning/Architectural	✓		✓	High	Locate main habitable areas and mechanical/electrical rooms above-ground and do not build in high flood risk areas.
Y	Flooding & Rainfall	Site and Environment	Site and Storm/Sewer	✓	✓	✓	High	Minimize stress on municipal stormwater infrastructure and nearby waterways by designing for on-site stormwater infiltration and retention based on future climate conditions.
Y	Flooding & Rainfall	Site and Environment	Site and Storm/Sewer			✓	High	Use site grading to direct water away from buildings, and permeable paving materials to improve rainwater infiltration capacity.
Y	Extreme Heat Events	Structure and Systems	Mechanical	✓	✓		Medium	Incorporate low carbon cooling options (active and passive) to mitigate carbon emissions while achieving desired thermal comfort criteria based on future climate conditions
Y	Extreme Heat Events	Structure and Systems	Structural/Envelope	✓	✓		High	Design the building envelope to meet the highest step of the Energy Step Code.
Y	Extreme Heat Events	Structure and Systems	Structural/Envelope	✓	✓		Medium	Consider materials that increase the insulative value of the envelope while minimizing embodied carbon.
Y	Extreme Heat Events	Structure and Systems	Planning/Architectural	✓			High	Implement passive cooling and passive heat gain reduction strategies including orientation, shape, cross-ventilation, exterior shading, operable windows, optimized window-to-wall ratios, high performance glazing, enhanced insulation, light coloured exterior.
Y	Extreme Heat Events	Structure and Systems	Mechanical	✓	✓		Medium	Design modular mechanical systems that can be modified or upgraded to adjust to future climate conditions.
Y	Extreme Heat Events	Structure and Systems	Mechanical	✓	✓		Medium	Zone building cooling to accommodate different thermal loads.
N	Extreme Heat Events	Site and Environment	Site and Storm/Sewer			✓	Medium	Plan to include deciduous trees at south and west sides of building for shade.
N	Extreme Heat Events	Site and Environment	Site and Storm/Sewer			✓	Medium	Develop a landscaping plan that includes non-invasive, native, drought-tolerant plants and smart irrigation strategies.
Y	Extreme Heat Events	Health and Safety	Mechanical	✓	✓		High	Use future climate conditions for designing HVAC systems to maintain thermal comfort and safety.
Y	Extreme Heat Events	Health and Safety	Mechanical	✓	✓		Medium	Design active cooling for all common areas for refuge.
Y	Extreme Heat Events	Social and Programming	Planning/Architectural	✓	✓		Medium	Determine whether there is an opportunity to use the building as a community cooling centre during heat waves.
Y	Wildfire Risk	Structure and Systems	Planning/Architectural	✓	✓	✓	High	Incorporate fire resistant roofing and cladding materials, improve fire resistance at building entry doors, ensure safe egress, and provide access for fire department vehicles on the site.

Q.3

SOCIAL AND/OR ECONOMIC BENEFITS

In the last five years, British Columbia has experienced increasingly extreme effects of climate change, including heat domes, flooding, intense cold, and record-breaking wildfire seasons. These have resulted in billions of dollars of property damage, relocation of entire communities, regional economic impacts, and hundreds of lives lost. Vulnerable populations are often the most severely affected. Of the 619 deaths attributed to the 2021 heat dome, 99% occurred in residences, and 70% were seniors.

Addressing the climate crisis is therefore one of BC Housing's strategic priorities. This can be integrated across the portfolio, through identifying and prioritizing risk mitigation and climate resilience measures; however, it is challenging to undertake this type of initiative at scale.

The CRAF tool streamlines the climate risk assessment process by evaluating the potential consequences of the most material future climate hazards on typical building systems, sites and local environment, and people. In support of BC Housing's mission, the scoring for consequences is weighted toward health, safety, social benefits, and programming. Risk scores are adjusted to account for factors such as emergency service accessibility and remoteness, vulnerability of residents, provision of areas of refuge, or moisture and mold resistance.

Outcomes and co-benefits of the CRAF tool include:

- **improved resident health and safety**
- **reduction of long-term Operations & Maintenance costs**
- **maintaining standards of service**
- **guiding the direction of BC Housing's policies and priority actions**

Further, there is an opportunity to customize the tool to be population-specific, such as incorporating First Nations priorities and values.

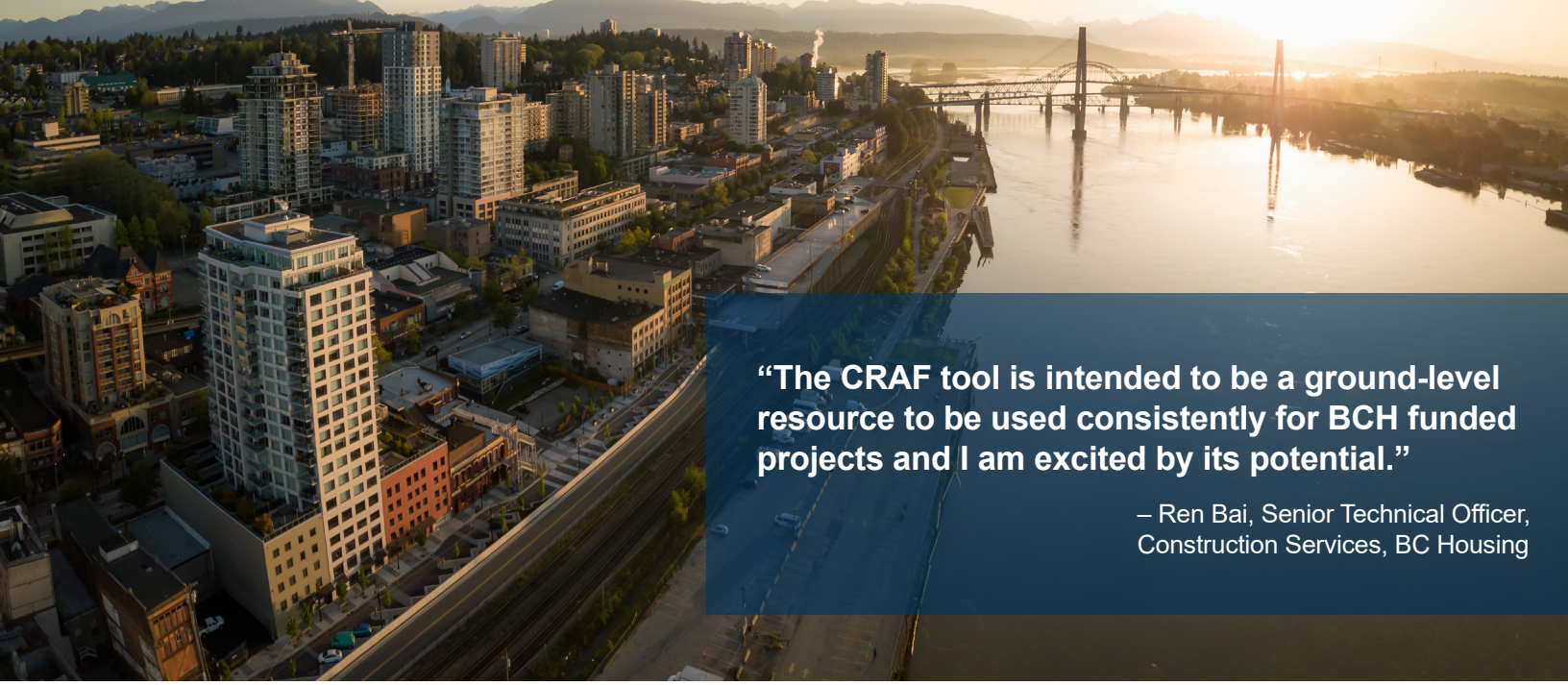
Q.4
ENVIRONMENTAL BENEFITS

The CRAF tool's purpose is to support resilience to future climate change risks. With tool applications including property acquisition and due diligence reviews, operational and asset management reviews, and project prioritization, BC Housing can strengthen its ability to manage climate impacts and enhance resilience across the portfolio.

The CRAF tool's primary function is to identify the highest climate change risks, allowing users to consider potential consequences of an increasingly warm climate and associated hazards on BC Housing's clients, assets, and communities. This includes not just site impacts, but also the potential effects of extreme events on the surrounding environment. For example, extreme rainfall events could result in site-level flooding, resulting in stormwater runoff to the local environment. With insight and planning supported by the CRAF tool, potential negative impacts could be mitigated through strategies such as prevention of contamination and onsite stormwater management systems or enhanced onsite fire protection to suppress the spread of wildfires.

Nature-based solutions to support both climate change mitigation and adaptation are a core resiliency strategy and have been incorporated into the CRAF tool. Sample measures include:

- low impact development and landscaping to minimize stormwater runoff
- reducing the risk of fuel oil or gas spills due to high water levels
- limiting stress on nearby waterways by designing for future climate conditions
- using permeable paving materials to improve rainwater infiltration capacity
- planting deciduous trees at south and west sides of buildings for shade
- vegetation management for non-invasive, native, drought-tolerant plants



“The CRAF tool is intended to be a ground-level resource to be used consistently for BCH funded projects and I am excited by its potential.”

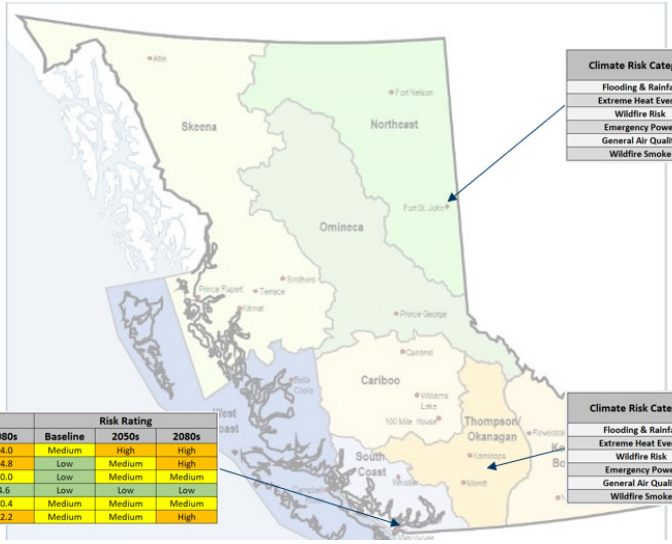
– Ren Bai, Senior Technical Officer, Construction Services, BC Housing

Q.5

MEETING CLIENT’S NEEDS

Climate change associated risks are significantly affecting the safety, livability, and operating and repair costs for residential buildings across BC. Heat waves, flooding, wildfires, and poor air quality are examples of how these risks manifest. As climate change increases the severity and frequency of extreme events, governments and organizations such as BC Housing are actively seeking ways to evaluate, plan and mitigate against these risks to protect residents, communities, and buildings.

BC Housing identified a need for a user-friendly tool to provide high-level climate risk assessment for over 160 locations across BC. The CRAF tool enables a high-level climate risk screening approach that may be implemented early in project lifecycles to provide consistency in assessment and comparison of climate related risks and prioritization of resilience projects across BC Housing’s assets and locations.



Climate Risk Category	Risk Score (/25)			Risk Rating		
	Baseline	2050s	2080s	Baseline	2050s	2080s
Flooding & Rainfall	14.0	14.0	17.5	High	High	High
Extreme Heat Events	4.6	7.4	13.9	Low	Medium	High
Wildfire Risk	10.0	17.5	20.0	Medium	High	Extreme
Emergency Power	6.9	6.9	7.7	Medium	Medium	Medium
General Air Quality	6.9	8.1	9.2	Medium	Medium	Medium
Wildfire Smoke	10.8	12.2	12.2	Medium	High	High

Climate Risk Category	Risk Score (/25)			Risk Rating		
	Baseline	2050s	2080s	Baseline	2050s	2080s
Flooding & Rainfall	10.5	14.0	14.0	Medium	High	High
Extreme Heat Events	5.6	9.3	14.8	Low	Medium	High
Wildfire Risk	5.0	7.5	10.0	Low	Medium	Medium
Emergency Power	2.3	3.8	4.6	Low	Low	Low
General Air Quality	6.9	8.1	10.4	Medium	Medium	Medium
Wildfire Smoke	8.1	9.5	12.2	Medium	Medium	High

Climate Risk Category	Risk Score (/25)			Risk Rating		
	Baseline	2050s	2080s	Baseline	2050s	2080s
Flooding & Rainfall	10.5	14.0	14.0	Medium	High	High
Extreme Heat Events	12.0	16.7	18.5	High	High	High
Wildfire Risk	25.0	25.0	25.0	Extreme	Extreme	Extreme
Emergency Power	2.3	2.3	2.3	Low	Low	Low
General Air Quality	9.2	10.4	10.4	Medium	Medium	Medium
Wildfire Smoke	13.5	13.5	13.5	High	High	High

The tool offers a streamlined and economical approach to assist BC Housing with assessing site viability, developing proposal scoring for new developments, risk mitigation strategy identification and prioritization, and project budget allocation for risk mitigation and climate-focused projects. As CRAF tool becomes embedded in organizational processes, it is expected that additional applications may be discovered and additions to the tool implemented.

Through implementing this tool, BC Housing will benefit by improving resident health and safety, reducing long-term Operations and Maintenance costs, maintaining standards of service, and guiding the direction of policies and actions.

BC Housing is supportive of sharing the tool with other government agencies as part of a collaborative approach to addressing province-wide strategic climate adaptation.

CANADIAN CONSULTING Engineer
For professional engineers in private practice

2024 Canadian Consulting Engineering Awards Project Owner Form

I am authorized, on behalf of (INSERT ORGANIZATION NAME) BC Housing Management Commission, to confirm and consent to the following relating to (INSERT PROJECT NAME) BC Housing Climate Risk Assessment Framework Tool, being submitted to the 2024 Canadian Consulting Engineering Awards by (INSERT SUBMITTING FIRM(S) NAME) Morrison Hershfield (now Stantec):

- The project was completed to our satisfaction;
- The submitting firm(s) performed duties as described in their submission;
- We are not, and do not expect to be, in litigation with the submitting firm(s) regarding the project being submitted

I also acknowledge and agree to the following:

- Submitted projects will be evaluated by a panel of jurors who are engineering experts and/or have expertise relevant to the judging criteria;
- The decision of the panel will be accepted as final;
- The submitting firm(s) whose projects are selected for an award by the jury will be notified in Q2 of 2024
- Winning projects will be announced publicly in Q4 during an awards gala hosted by the Association of Consulting Engineering Companies – Canada (ACEC)
- Videos and descriptions of the winning projects will be produced for the awards gala by ACEC and will be available to the submitting firms, owners and clients upon request following the gala.
- Following the awards gala, winning projects will be publicized through, but not limited to, the following:
    - *Canadian Consulting Engineer* magazine and website
    - ACEC publications and website
    - ACEC #20DaysofExcellence social media campaign
    - Press releases issued by ACEC
- Submitting firms may also publicize the winning projects
- The entire project entry will be archived on the *Canadian Consulting Engineer* website, whether it was selected as a winning project or not.

Name: Ren Bai

Position: Manager, Development Construction Projects

Company: BC Housing Management Commission

Address: #1701 - 4555 Kingsway

City: Burnaby Province: BC Postal Code: V5H 4V8

Tel. 236-886-2909 E-mail: rbai@bchousing.org

Signature: _____ Date: April 8, 2024

2024 Canadian Consulting Engineering Awards Consent Form

For a project entry to the 2024 Canadian Consulting Engineering Awards to be considered complete, the following documents must be included with the submission:

- This form, completed and signed by an individual on behalf of the entering consulting engineering firm(s).
- A completed and signed project owner consent form.
- A completed and signed client consent form (if not the same as the project owner).

TO BE COMPLETED BY AN INDIVIDUAL SIGNING ON BEHALF OF THE ENTERING COMPANY (COMPANIES).

I (We) confirm that this entry complies with the contest rules and that the information submitted is accurate.

I (We) also agree to accept as final the decision of the panel of jurors.

I (We) consent to having the entire project entry archived on the *Canadian Consulting Engineer* website, whether it is selected as a winning project or not.

Name: Ren Bai

Position: Manager, Development Construction Projects

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Signed _____

Date April 9, 2024 April 8, 2024

now