Climate Resilience Guidelines for BC Health Facility Planning & Design

December 2020 | Version 1.1

Regional Health Authorities

Fraser Health is responsible for the delivery of hospital and community-based health services to over 1.8 million people at more than 300 sites. Fraser Health serves 20 diverse communities from Burnaby to Fraser Canyon, including a diverse multicultural population and approximately 62,000 Indigenous Peoples.

Interior Health is responsible for providing publicly-funded health services to over 800,000 residents at more than 450 sites across 214,000 km^2 of the Southern Interior area. Interior Health's service area includes some of the more rural, remote areas of the province and also some of the fastest growing urban centres.

Island Health provides health care services through a network of over 150 sites, including hospitals, clinics, centres, health units, and long-term care locations. Island Health serves more than 850,000 people on Vancouver Island, the islands in the Salish Sea and the Johnstone Strait, and the mainland communities north of Powell River and south of Rivers Inlet.

Northern Health serves about 300,000 people, many of whom are Indigenous. Northern Health delivers health care services at more than 100 sites across Northern British Columbia, including acute care; mental health and addictions; public health; home and community care services.

Vancouver Coastal Health is responsible for the delivery of community, hospital and long-term care services to 1.25 million people in communities including Richmond, Vancouver, the North Shore, Sunshine Coast, Sea to Sky corridor, Powell River, Bella Bella and Bella Coola. VCH also provides specialized care and services for people throughout BC and is the province's hub of health care education and research.

Other Health Organizations

Providence Health Care provides health care services across 16 sites within the Vancouver Coastal Health region, and is governed by its own, independent Board of Directors. Providence Health Care is the provincial centre for the care of six groups of people with often-intensive health needs: heart and/or lung diseases, kidney diseases, mental illnesses, older populations (residential care, seniors, & geriatrics), HIV/AID, urban health issues (homelessness, drug & alcohol-related issues & malnutrition).

Provincial Health Services Authority plans, manages and evaluates specialized health care services in partnership with other B.C. health authorities, delivering health services to communities around the province on the traditional and ancestral lands of many Indigenous peoples. Provincial Health Services Authority also provides cares and services through specialized hospitals and centres across B.C. such as BC Children's Hospital and BC Cancer.

ACKNOWLEDGEMENTS

This living document is the culmination of more than a year of multi-sector collaboration to develop practice-based guidance for BC Health Authorities: an industry Task Force to develop Resilient Design Strategies with low carbon, seismic and pandemic synergies; a Health Authority Working Group to validate proposed approaches; and, an interdisciplinary Advisory Group to contextualize development. Contact information is here.

The Health Authorities extend their sincerest thanks to and appreciation of all who have contributed to this work.

This document was prepared by Energy & Environmental Sustainability (EES) and Integral Group, with funding provided by the Health Authorities and BC Housing's *Mobilizing Building Adaptation and Resilience* project, and in-kind contributions by Task Force for Resilient Design members. Cover page map: BC Health Care Assistants.

Steering Committee

Mauricio Acosta, Vancouver Coastal Health

Larry Harder, Fraser Health

Project Team

Angie Woo, EES

Robert Bradley, EES

Sara Wollschlaeger, EES

Lisa Westerhoff, Integral Group

Gordon McDonald, Integral Group

Craig Dedels, Integral Group

Health Authority Working Group

Jared Fehr, Interior Health

Tanja Stockmann, Interior Health

Deanna Fourt, Island Health

David Neufeld, Island Health

Rose St. Pierre, Northern Health

Ken Van Aalst, Northern Health

Juli Kennedy, Vancouver Coastal Health

Task Force for Resilient Design

Zlatko Puljic, AME Consulting Group

John Van Der Eerden, Associated Engineering

Remi Charron, BC Housing

Wilma Leung, BC Housing

Clint Low, Bush, Bolman & Partners

Doug McLachlan, IBI Group

Stuart Hood, Integral Group

Mark Porter, Nexii

Warren Knowles, RDH Building Science

Robert Lepage, RDH Building Science

Martina Soderlund, ReLoad Sustainable Design

Shane O'Hanlon, Stantec

Brett Pybus, WSP

Gordon Thomson, WSP

INTEGRAL

BC HOUSING RESEARCH CENTRE

Advisory Committee

Julia Berry (BC Climate Action Secretariat), Archie Riddell (BC Climate Action Secretariat), Linda Varangu (Canadian Coalition for Green Healthcare), Erin Desautels (City of Surrey), Wendy de Hoog (City of Vancouver), Katie McPherson (City of Vancouver), Tamsin Mills (City of Vancouver), Gordon Burrill (CSA Technical Committee on Health Care Facilities), Nick Stark (CSA-Z317.2 HVAC Systems in Health Care Facilities), Robin Snell (CSA Z8003 HCF Design Evaluation), Alex Hutton (EES), Kori Jones (EES), Oona Kerwin (Fraser Health, Population & Public Health), Craig Brown (HealthADAPT Project), Peter Berry (Health Canada, Climate Change & Innovation Bureau), Paddy Enright (Health Canada), Catherine Peacock (Infrastructure BC), George Kyriakelis (Infrastructure BC), Chad Nelson (Infrastructure Canada), Brian Miller (Interior Health), Conor Reynolds (Metro Vancouver, Air Quality and Climate Change Policy Division), Namrata Sheth (Ministry of Citizen Services), Dragana Perisic (Ministry of Health, Capital Services Branch), Geneen Russo (Ministry of Health, Population and Public Health), Nicole Vukosavljevic (Ministry of Municipal Affairs and Housing, Building & Safety Standards Branch), Iain Macdonald (National Research Council), Trevor Murdock (Pacific Climate Impacts Consortium), Kari Tyler (Pacific Climate Impacts Consortium), Jerome Ribesse (Synergie Santé Environnement), Doug Doyle (University of British Columbia), Jennifer Sanguinetti (University of British Columbia), Penny Martyn (University of British Columbia), Ed Rubinstein (University Health Network).

Reviewers

Erik Kaye (BC Climate Action Secretariat), Katie Olthius (BC Climate Action Secretariat), Ghazal Ebrahimi (EES), Sonja Janousek (EES), Jeremy Fyke (Environment & Climate Change Canada), Dion Anggabrata (Asset Risk and Quality, ARQ), Wakako Kimura Thomson (ARQ), Michael Laslo (ARQ), Gavin Lovitt (ARQ), Ken Champoux (Island Health), Joe Ciarniello (Island Health), Rebecca Wareham (Island Health), Scott Williams (Ministry of Municipal Affairs and Housing, Building & Safety Standards Branch), Deborah Harford (SFU, Adaptation to Climate Change Team, ACT), Alison Shaw (SFU, ACT), Ilana Judah (University of British Columbia).

CONTENTS

GLOSSARY

Acute shock (or climate shock): An acute natural or human-made event or phenomenon threatening major loss of life, damage to assets and a building or community's ability to function and provide basic services, particularly for poor or vulnerable populations. Examples include heat waves, extreme storms and storm surge.

Adaptation pathway: A decision-making strategy comprising a sequence of manageable steps or decision-points over time. A planning approach that addresses uncertainty by enabling consideration of multiple possible futures, and allowing analysis/exploration of the robustness and flexibility of various options. Approaches include (i) evaluation of options against criteria; (ii) working back from a desired outcome to present day. (SW Portal)

Adaptive capacity: The ability of an individual or systems (e.g. community, organization) to reduce the effects of climate change including efforts to plan for, respond to, and recover from exposure to climate hazards.

Chronic stress (or climate stress): An ongoing or cyclical natural or human-made event or phenomenon that renders an organization, asset/infrastructure or community less able to function and provide basic services. Examples include prolonged droughts, increasing temperatures, and rising sea levels.

Climate risk management: The process to understand, assess and manage climate-related risks; increase capacity to prepare for and adapt to a changing climate; develop **adaptation** strategies and policies; and prioritize climate resilience planning and decision-making. (BC Climate Action Secretariat, 2021)

C*ompound hazards or risks*: Multiple hazards or risks that occur at the same time, or one after the other. For example, a wildfire event during a heatwave or an overland flood during a pandemic. (Nature Climate Change)

***Exposure*:** The nature or degree to which people or systems are exposed to a climate-related shock or stress.

Future climate projections: The simulated response of the climate system to a scenario of future emissions or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models.

Hazard: A dangerous phenomenon, substance, human activity, or condition. In this context, hazards are caused or made worse by climate change, e.g. extreme weather, wildfires, and storm surges. (MetroVancouver, 2019)

Low carbon resilience (LCR): In this context, the strategic and systematic integration of plans and actions to reduce greenhouse gas emissions and manage climate risks in planning, design and operations.

Net zero emissions (NZE): Reducing emissions from operations to as close to zero as possible; and, balancing out any remaining emissions with an equivalent amount of carbon removal. (Government of Canada, 2020)

Resilience: The capacity to prepare for disruptions, recover from shocks, and grow from a disruptive experience (World Bank, 2021). The capacity of social, economic and environmental systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while maintaining the capacity for **adaptation**, learning and transformation (WHO, 2020).

Resilience of project design is the extent to which a project's assets have considered climate risks in their design, e.g. incorporating appropriate **adaptation** measures as well as accounting for climate risks in the economic and financial analysis demonstrating the viability and value of the project. (World Bank, 2021:6)

Sensitivity: The degree to which people or systems are positively or negatively impacted by climate change.

Vulnerability: The degree to which people or systems are susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes. A function of exposure (in terms of the magnitude, type, and rate of climate variation/change), sensitivity and or capacity to adapt (adaptive capacity).

EXECUTIVE SUMMARY

Climate risks and impacts are material to health capital project delivery today, and to health facility operations from opening day to the end of its service life. At the same time, cascading impacts on health staff and patients, communities and critical infrastructure are material to service plan delivery. As such, reducing climate risks and embedding resilience into capital projects and their communities of care should be carried out at the most effective and cost-efficient junctures in project and service delivery lifecycles: planning and design.

The *Climate Resilience Guidelines for BC Health Facility Planning & Design* is a key step in this direction. The intent is to enable Health Authorities to (i) align the project delivery lifecycle with Provincial policy and legislation; (ii) meet directives to "align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate change risk"; and, (iii) demonstrate public sector leadership in a dynamic context with inherent uncertainty, whether increasing climate shocks and stresses, or evolving policy and regulations.

Using the Resilience Guidelines as a "quick start", capital project and consultant teams are better equipped and resourced to work at the scale and complexity of climate-related challenges to health facilities. The guidelines provide a clear process for identifying and reducing climate risks in planning and design that also contributes to building a body of knowledge for managing residual climate risks in operations. With project-by-project application and iteration, Health Authorities can take further steps toward developing a standard of excellence for capital projects and operations; and, a governance and accountability framework for climate risk and resilience at the portfolio and organization levels.

The guidelines are focused on the basic components of a process that typically involves several project and consultant teams numerous years to deliver: planning, procurement and implementation. Climate risk and resilience are integrated into this process whereby key contextual information is collected, analyzed and presented to inform decision-making, including site and design options.

As such, key components can be modified as appropriate for any major health capital project requiring a business plan including resilient design principles; a hierarchy of resilient design objectives, requirements and compliance measures, and strategies; and, a four-step process to assess climate risk and resilience from concept plan to final project agreement.

Over time, improvements to these and other key components will inform future iterations of the Resilience Guidelines. Key recommendations and next steps point to the work ahead, including closer alignment with reducing greenhouse gas emissions to achieve low carbon resilience.

In parallel, strategic approaches to managing risks to our facilities portfolios and communities of care are enabled though the high level master plan development and implementation process. This approach enables economies of scale in reducing risks, higher returns on resilience investments, and strategic partnerships with other critical infrastructure and service providers. As overarching documents, high level master plans provide a framework and foundation for projects over time as guided by clinical, site and infrastructure master plans.

The Resilience Guidelines are the result of a multi-disciplinary collaboration among over 10 professional service firms in BC, and 25 public sector leaders across Canada. Going forward, it will be maintained as a living document for continuous improvement, ongoing collaboration, and focused contribution to BC's facilities management body of knowledge.

INTRODUCTION

Delivering Health Care in a Changing Climate

Extreme weather events, warming temperatures, shifting precipitation patterns and other climate hazards already pose challenges to health facilities and services across BC. Scientific evidence makes it clear that climate-related disruptions and disasters will increase in frequency, intensity and unpredictability in the coming years, even as we commit to further reduce greenhouse gas emissions and move toward a low carbon economy. Direct and indirect impacts on hospitals, long-term care homes and other types of health facilities are important to consider in planning and design, as are cascading impacts on patients, staff, and communities.

While facilities are built to last for 60 years, their service lives often are extended by decades. As such, facilities will contend with conditions that not only are dramatically different to those in the past but also continue to change over their lifespans. As acute shocks, chronic stresses, novel hazards, and compound hazards change over time, so do vulnerabilities and risks that are material to health facilities and those that they serve.

With a systematic approach to unpacking and tackling our challenges however, health system stakeholders can reduce climate risks at the most effective and cost-efficient inflection points in a facility's lifespan: in planning and design. By taking the time to consider the full spectrum of impacts on services and stakeholders – and the costs and benefits of action even with imperfect or incomplete information – in the first years of a capital project, climate risks can be reduced and better managed over the next 60-100 years of operations (i.e. residual risks). Moreover, a long-term approach to investing in facility resilience can manifest co-benefits for human health and wellbeing, and set off cascading benefits across our dynamic communities of care. Finally, a low carbon approach to reducing risks and embedding resilience from the outset enables projects to achieve the synergies and efficiencies needed to demonstrate public sector leadership and transition to a low carbon economy.

This living document is intended to both capture current best practices and enable continuous improvements through an iterative and collaborative process. Contributors' knowledge, experience and lessons learned are interwoven with foresight (to anticipate needs and challenges) that is informed by climate projections and stress tested with future scenarios (to develop climate-smart solutions). The document necessarily will evolve as new climate projections become available; the status of knowledge and field of practice improves; and, our bar for success is raised as we learn between projects and share lessons as we progress.

This version is focused on new construction and major redevelopment projects that use a design build (or public private partnership, P3) procurement model. Successive iterations are expected to broaden the guidelines' scope and refine its content to reflect the diversity of facility portfolios (e.g. facility archetypes, procurement types); dynamism in health service delivery (e.g. virtual health); and, users' feedback and requests. A "quick start" tool for minor capital projects and existing facilities is available in v1.1 for example (see Key Components).

With these guidelines, Health Authorities will be better able to:

- ✓ Anticipate exposure and reduce impacts of climate hazards on people, services and facilities.
- ✓ Reduce risk of stresses, failures, closures, or evacuations.
- ✓ Maintain critical operations and essential services in the event of a climate shock or stress.
- ✓ Return to normal operations in a fast and efficient manner following an event.
- ✓ Minimize cascading impacts among systems and scales (e.g. building, site, and off-site).
- ✓ Leverage the inherently holistic and multistakeholder approach required to realize synergistic benefits.

The intent of the *Climate Resilience Guidelines for BC Health Facility Planning and Design* ('Resilience Guidelines') is to provide a roadmap for chief project officers, capital planners and project managers, consultant teams, and other key health facility stakeholders to navigate this transition.

Moving Toward Low Carbon Resilience

Provincial policies, legislation and mandates are key enablers for Health Authorities to manage climate risks and minimize greenhouse gas emissions at the scale and complexity of the challenge. A province-wide perspective on climate risks and how they are better managed over time can inform site- and region-level plans and actions.

In alignment with the *Climate Change Accountability Act,* Health Authorities can demonstrate public sector leadership by reducing both climate risks and greenhouse gas emissions in tandem. Managing climate risks to health facilities is a nascent field however; as metrics and targets are not yet developed, Resilient Design Objectives can act as 'North Stars' as we keep working to achieve our emissions reductions targets.

Similarly, synergies among Resilient Design Strategies and low carbon measures can be identified and optimized by carrying out climate risk assessments in coordination with a net zero emissions study to inform development of project design options, requirements, and implementation.

A low carbon resilience approach to planning and design well-positions Health Authorities to "align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate change risk".

Climate Policy, Legislation & Reports

- ✓ The Climate Change Accountability Act (2007)[1] directs the public sector to manage risks to the organization that could reasonably be expected to result from a changing climate and minimize adverse environmental effects with respect to e.g. buildings (owned or leased), and to issue annual reports.
- ✓ The 2020 Climate Change Accountability Report summarizes B.C.'s actions and progress. It is the first to be tabled publicly in the legislature as part of the province's commitment to improve accountability.
- ✓ The Preliminary Strategic Climate Risk Assessment for British Columbia (2019) evaluates the likelihood of 15 climate risk events that could occur in B.C., and the health, social and economic consequences.
- ✓ Managing Climate Risks: An Independent Audit (2018) by the Office of the Auditor General of B.C. found that "the B.C. government is not adequately managing the risks posed by climate change… Treatments have not been occurring in a coordinated manner, nor have they been targeting areas of highest risk... Adaptation needs to be better integrated into policies and decision-making processes."
- ✓ CleanBC (2018) provides a pathway and plan to meet the CCAA legislation.

[1] Formerly titled *Greenhouse Gas Reduction Targets Act*.

BC Health Authority Mandates

- ✓ The 2020/21 Board Mandate Letters direct Health Authorities to "ensure your organization plans to align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate change risk" and to "be prepared to work with government to report out on these plans and activities".
- ✓ In the 2019/20 and 2020/21 Executive Mandate Letters, the Ministry of Health directed Health Authorities to "contribute to address climate change, through working on human health vulnerability assessment and adaptation strategy".

BACKGROUND

According to the Province's 2019 Preliminary Strategic Climate Risk Assessment:

- ✓ The greatest risks to B.C. are severe wildfire season, seasonal water shortage, heat wave, ocean acidification, glacier loss, and long-term water shortage.
- ✓ Other risks that have the potential to result in significant consequences include severe river flooding and severe coastal storm surge, although these events are less likely to occur.
- ✓ Nearly all risk event scenarios (except moderate flooding and extreme precipitation and landslide) would have major province-wide consequences in at least one category.

It is prudent to prepare for expected and unexpected cascading impacts in the near, medium and long-term e.g.:

Health services disruptions and supply chain disruptions: Facilities can expect increased strain as extreme events (e.g. flooding, wildfires, heat waves) lead to an increase in hospital visits by both vulnerable and general populations. Higher operational costs, including increased energy costs and necessary staff overtime, will reduce the ability of facilities to provide care.

Infrastructure damage and energy system impacts: Physical damage to facilities from storms and flooding can threaten building integrity and compromise sanitary conditions. Increases in air contaminants from wildfire activity, pollen and other sources can infiltrate through building envelopes, impacting the ability of HVAC systems to maintain adequate indoor environmental quality. Increasing temperatures and greater variability in conditions will place increased strain on equipment, leading to mechanical failure and unexpected equipment purchases.

Off-site infrastructure and resource demands: Hospitals and other health care facilities rely on the greater community to function effectively, and the changing climate threatens the continuity of many of these functions. Strain on municipal sewer infrastructure from increasing precipitation, for example, can lead to bacterial outbreaks that in turn place additional pressure on hospitals.

Overview of the Resilience Guidelines

Version 1.1 is intended for use by capital project managers and chief project officers, project and consultant teams, and contractors. Goals, objectives, and principles are outlined in Table 1.

Through a *Climate Risk & Resilience Assessment* process that spans typical project phases, the Health Authority and collaborators determines Resilience Objectives, Requirements, and Compliance Measures that are appropriate to a project's context. Using the proposed Resilient Design Strategies as a starting point, project proponents are well-positioned to submit designs that can better ensure climate resilience to facility end-life.

This version is intended for new construction and major redevelopment projects that require Business Plan approval[2] and utilise the Design Build (DB) or Public Private Partnership (P3) procurement model. Subsequent iterations (e.g. v2.0) and supplements[3] will address other project types (e.g. retrofits), procurement types (e.g. Design-Bid-Build, Alliance), and archetypes (e.g. long term care facilities) with a view to reducing climate risks and improving resilience across facility portfolios.

Table 1: *Goals, objectives and principles of the Resilience Guidelines.*

Goals	✓ Enable key stakeholders to better understand climate hazards, impacts and risks to health facilities and services from opening day to facility end-life. ✓ Develop a systematic approach to reduce exposure, cascading impacts, and compound risks. ✓ Provide opportunities and options for capital planners and project managers to embed climate resilience most cost-efficiently and effectively in planning and design. ✓ Reduce residual risks, and develop climate risk management protocols, for operations. ✓ Increase knowledge and capacity to plan and act at the scale of our climate challenge. ✓ Co-create new choices and opportunities with industry partners and collaborators.
Objectives	✓ Enable project teams, consultants and proponents to work with a clear frame of reference. ✓ Provide sufficient information required by consultants to provide assurance that resilience can be embedded from early planning and design to facility end-of-life. ✓ Ensure decision makers better understand the value add and trade-offs.
Principles	✓ Consider multiple levels or scales concurrently (i.e. building, site and off-site). ✓ Anticipate disruptions and changes over time associated with climate shocks and stresses. ✓ Allow for iteration and continuous improvement of the process. ✓ Emphasize 'no regrets'[4] options and adaptation pathways. ✓ Prioritize simple, flexible and durable design strategies. ✓ Cultivate synergies and seek co-benefits to reduce emissions, seismic and pandemic risks.

[2] A project's cost threshold is not defined here to acknowledge that there can be significant variation in cost of design and construction across B.C. (e.g. related to diverse geography, availability of resources, weather conditions, micro-climates and other factors; and, avoid limiting application of the guidelines (e.g. potential of minor capital projects to drive many climate resilient strategies and opportunities).
[3] The Exposure Screening Tool for Minor Capital Projects (v1.1) can be downloaded on Online Resources.
[4] 'No regrets' strategies aim to maximise positive and minimize negative outcomes for communities in climate-sensitive areas such as health, by making climate-related decisions or actions that make sense whether or not a specific climate risk materializes. https://www.wri.org/our-work/project/world-resources-report/no-regrets-approach-decision-making-changing-climate-toward

Using the Resilience Guidelines

As a living document, the Resilience Guidelines will evolve quickly with application and modifications. Each version will reflect material updates that reflect successive projects' successes, lessons and recommendations.

This version provides essential contextual information, a set process, proposed text and comprehensive checklists to project and consultant teams for a "quick start" to reducing risks and embedding resilience into planning and design. More detailed information on the step-by-step process, and other key background information, is available in the Online Resources (see link in the footnotes).

The Resilience Guidelines are designed to (i) enable early involvement, (ii) iteration throughout phases, and (iii) ready-to-use and easy to use for all involved parties, including Health Authorities, Owner's Representatives, and project proponents (both bidding and successful). The general roles, phases involved and areas of responsibility for each party are described in in Table 2 below.

Key Roles and Responsibilities

Health capital project teams rely on the skills, knowledge, experience and networks of the professional services community to plan and design health facilities that are low carbon and resilient to the end of service life.

This and subsequent sections provide text to help set expectations for the Health Authority and consultant teams, ensure an evidence-based and iterative approach, and level the playing field in a competitive context.

Table 2: *Roles, phase and areas of responsibility for parties involved in the Resilience Guidelines.*

Lead Agency	Role in Process	Phases	Key Step / Document
Health Authority	✓ Define Resilient Design Objectives ✓ Set Resilience Targets ✓ Set project performance goals	✓ All Phases	✓ High Level Master Plan ✓ Concept Plan ✓ Business Plan ✓ Exposure Screen
Owner's Representative (Consultant Team)	✓ Review the Authority's goals & objectives ✓ Evaluate options and advise the Health Authority on recommendations to achieve goals and objectives ✓ Define performance requirements for facility ✓ Develop Design & Technical Specifications ✓ Assist Authority in evaluating compliance with requirements (Requirements, Compliance)	✓ All Phases	✓ Climate Risk Assessment
Procurement Advisor	✓ Facilitate project risk analysis ✓ Develop incentives and evaluation tools	✓ Business Plan ✓ Procurement	✓ Resilience Matrix ✓ Scored Elements
Proponents (Bidders)	✓ Propose design options for the project (Resilient Design Strategies)	✓ Procurement	✓ Resilient Design Review
Design-Builder (Successful Proponent)	✓ Design and build the project	✓ Implementation (Design and Construction)	✓ Compliance Audit

Navigating the Resilience Guidelines

Each item below is intended to help project managers bring together key sections, components and resources:

- ✓ The Process Map in Figure 2 below provides an overview of how key sections and components relate.
- ✓ The Checklists in Appendix A are a walk-through of 'what to do' in each project phase.
- ✓ The Design Stages in Table 3 are paired with *Climate Risk & Resilience Assessment* process steps.

Sections

The Resilience Guidelines comprise three sections that align with key Design-Build project phases: **Planning**, **Procurement**, and **Implementation**. Each section comprises sub-sections (*Responsibilities*, *Expected Results & Outputs*, and *Key Information*), and proposes text that may be customized to suit a project's context.

Components

Two cross-cutting components enable a progressive and iterative approach to reducing climate risks and embedding resilience as a project moves through each phase:

1) The *Climate Risk & Resilience Assessment* process: **Step 1: Exposure Screen**, **Step 2: Climate Risk Assessment**, **Step 3: Resilient Design Review**, and **Step 4: Compliance Audit.**
   - Appendix A incorporates the four steps into the Checklists.
   - Table 3 describes the content, intent and expected results of each step in relation to a design stage.
   - A detailed description of the *Climate Risk & Resilience Assessment* process is available online.
2) The hierarchy of Resilient Design **Objectives, Requirements, Compliance Measures and Strategies**.
   - Figure 1 below shows the relationship among the four levels, and provides short descriptions.
   - Appendix A incorporates the four levels into the Checklists.
   - Appendix B proposes Resilient Design Objectives for select climate hazards.
   - Appendix C provides Requirements and Compliance Measures for a *Statement of Requirements*.
   - Appendix D recommends Resilient Design Strategies and synergies as a starting point.

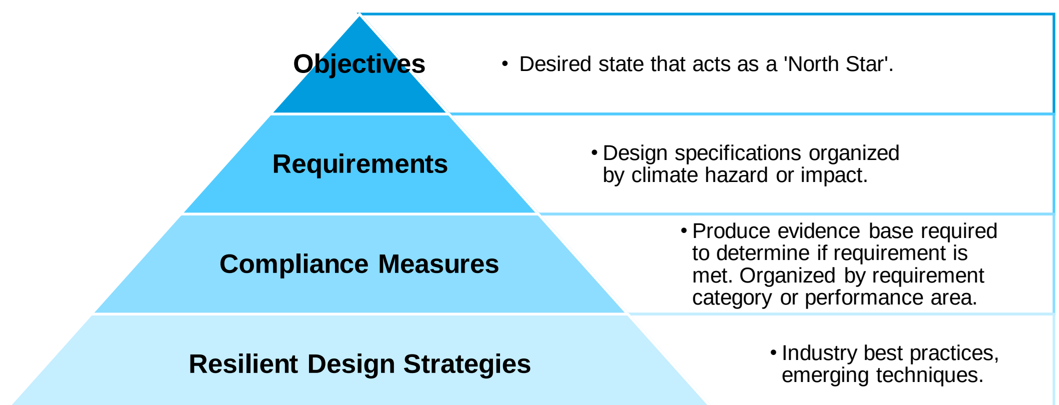

Figure 1: *A Hierarchy of Resilience Objectives, Requirements, Compliance Measures and Design Strategies*

Online Resources

The resources below are online and hyperlinked to provide easy access to more detailed information and tools:

	Title	Brief Description
1	Establishing Design Conditions for Climate Resilient Planning & Design	A methodology that provides design teams with a clear and consistent approach to (i) establish design conditions through the use of future climate data sets and (ii) verify performance of design with future shifted weather files.
2	Greening Strategies for Co-Benefits	An overview of eight evidence-based strategies to achieve health and climate resilience co-benefits at the building, site and neighborhood levels. See the full report and presentation for more information.
3	Process Checklist for using the Guidelines	A set of checklists to help use the Resilience Guidelines, sorted by project phase (Planning, Procurement, and Implementation), also found in Appendix A. The online version is "view only"; save a copy to enable editing.
4	Exposure Screen for Minor Capital Projects	A tool designed for project managers to carry out a quick, high-level screen with stakeholders (e.g. clinical and facility operations) to determine materiality. This version is "view" only; save a copy to enable features such as "edit".
5	Climate Risk & Resilience Assessment	A detailed description of the process. Available online to enable updating as the process is refined with application.
6	Resilient Design Strategies (sortable by hazard or discipline)	This table is in an online version of Appendix B, in spreadsheet format, to enable customization and sorting by hazard or discipline. This version is "view" only, save a copy to enable features such as "sort" or "edit".
7	Acronyms & Glossary	A more comprehensive list of terms related to climate change, project planning, and design.
8	Policy & Legislation Timeline	A graphic timeline of provincial and federal policy and legislation related to climate resilience and adaptation.
9	Contact List for Task Force, Working Group, Advisory Committee & Reviewers	A complete list of individuals that contributed to or reviewed v1.0; sortable by name, organization or email.
10	Additional Resources	List of hyperlinks to related resources, including best practices, climate data, frameworks, reports, and tools. Also provides key sources for each climate hazard.

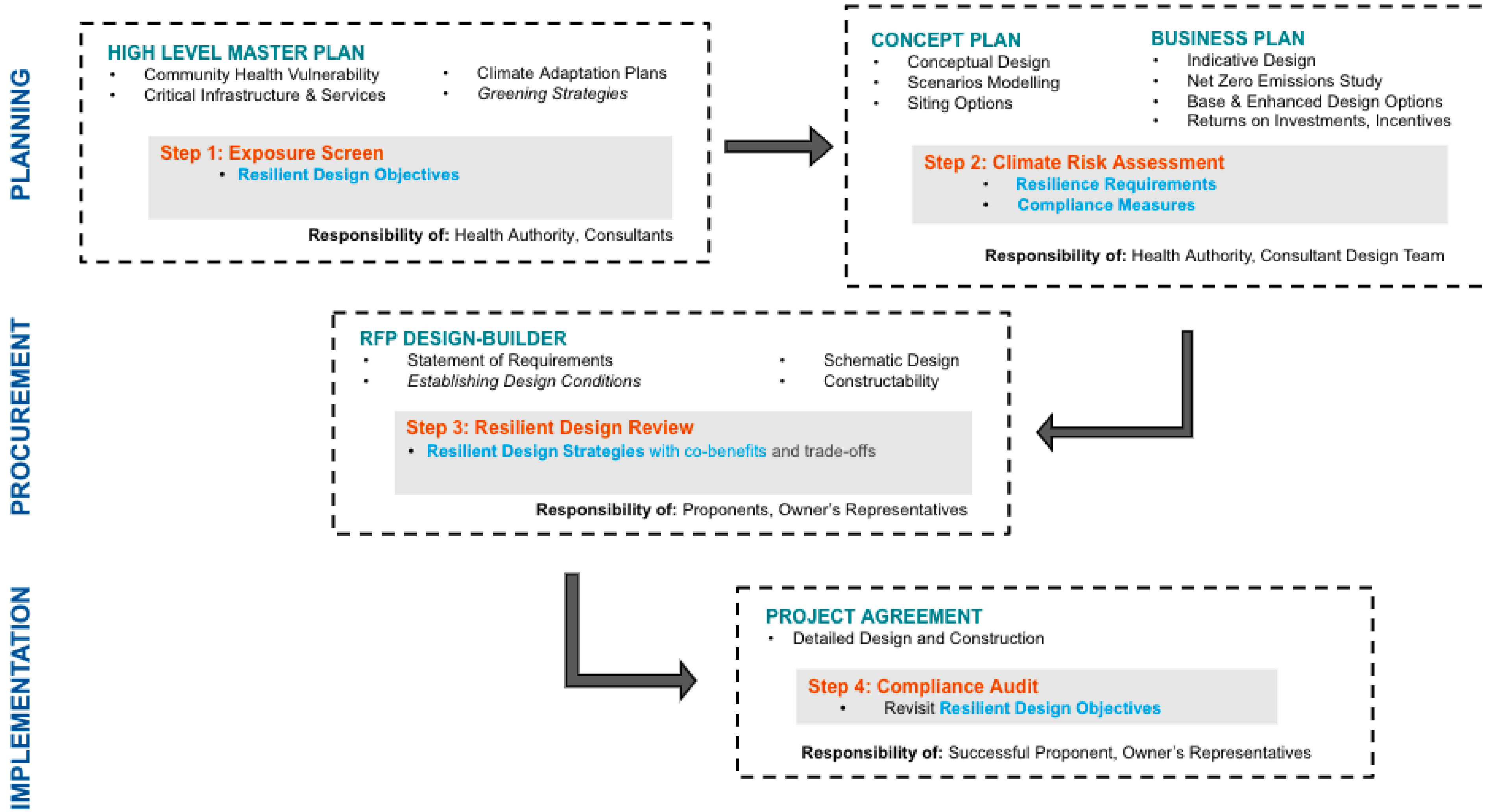

Figure 2: *Process Map of Climate Risk & Resilience Assessment steps, Resilient Design hierarchy levels, and design stages in Planning, Procurement and Implementation Phases.*

Table 3: Embedding the Climate Risk & Resilience Assessment process into each Design Stage.

Design Stage	*Climate Risk & Resilience Assessment* Process
Conceptual Design ✓ Early phase of design. ✓ Architect produces a concept sketch based on a general description of the location; and, gross floor areas and key adjacencies based on the Functional Program. ✓ Construction cost accuracy: +25% to -25%, or Class D estimate.	**Step 1: Exposure Screen** **Informs** site development (High Level Master Plan) in the context a dynamic community and a changing climate, and selection of site options (Concept Plan). The **intent** is to provide information on climate hazards and compound hazards to understand fully potential cascading impacts on the site, health service delivery area and broader health system in the near, medium and long-term. **Results** inform relevant capital projects, clinical and infrastructure master plans; contribute to critical infrastructure interdependency analyses; and, help ensure an allowance in the preliminary budget for climate resilience.
Indicative Design ✓ Identifies the functional requirements and the arrangement of spaces at a proposed site/facility. ✓ Establishes building layouts. ✓ Confirms assumptions informing the Functional Program with a "Test-Fit" (i.e. can be accommodated on the site); and, checks grossing factors. ✓ Establishes building systems. ✓ Construction cost accuracy: +20% to -20%, or Class C estimate.	**Step 2: Climate Risk Assessment** **Informs** development of design options, risk analysis and costing (Business Plan); after approval, informs development of the Statement of Requirements. The **intent** is to obtain a nuanced and fulsome understanding of how sensitive and adaptive are our people, services, assets and infrastructure to climate impacts; and, the likelihood and consequences of impacts on a project's goals and objectives. Utilise information to explore funding streams for enhanced low carbon resilience[5]. **Results:** Resilient Design Objectives are included in the Business Plan. Resilient Design Strategies are costed, and incorporated into design options. The Resilience Matrix facilitates valuation of resilience strategies, development of incentives, and future evaluation of proposals. Requirements and Compliance Measures are embedded in the Statement of Requirements. The Indicative Design sets a low carbon resilience baseline for design options, and detailed design. A foundation for developing adaptation pathways to facility end-life is established.
Schematic Design ✓ Translates the Functional Program into preliminary drawings. ✓ Defines the design intent, site location, general floor layout and description of building system infrastructure. ✓ Construction cost accuracy: +15% to -15%, or Class C estimate.	**Step 3: Resilient Design Review** **Informs** the development of proponents' design(s) at key stages. The **intent** is to validate vulnerability and risk with respect to a proposed design as it is developed. Allow for a productive dialogue on Resilient Design Strategies, synergies and trade-offs at each submital stage. Enable a clear understanding of the Requirements, including how to comply with requirements and achieve incentives. **Results**: Proponents provide Technical Submissions that are resilient by design, compliant with requirements, and positioned to optimize incentives.
Detailed Design ✓ Plans, sections, and elevations are drawn to scale, principal dimensions are noted, the structural system is laid out, and major mechanical and electrical components and distribution routes are located. ✓ Critical interior spaces are drawn and elevated for review. ✓ Construction cost accuracy: +10% to -10%, or Class B estimate.	**Step 4: Compliance Audit** **Informs** how the Design-Builder's design sufficiently reduces climate risks, embeds resilience, and complies with Resilience Requirements. Confirm any equal-or-better alternatives. The **intent** is to ensure that Resilient Design Objectives are met by reviewing the evidence base provided by the Design-Builder using a collaborative and iterative mechanism. The **result** is sufficient information to determine compliance, materiality of residual risks, and implementation of measures (commissioning, operations).

[5] E.g. Energy Efficient Buildings Program that is focused on projects targeting net zero energy.

MANAGING CLIMATE RISKS IN PLANNING & DESIGN

Major capital projects can take many years from inception to implementation. As they are used as precursors to design for project scope and budget setting, Concept and Business Plans are the most impactful and cost-effective opportunities for reducing risks and building resilience over the lifespan of the project.

Identifying hazards and potential risks early in planning and design ensures that appropriate responses can be incorporated at the building, site and off-site (i.e. community and health service delivery area) levels in a way that ensures greatest impact, and well before designs are finalized beyond the point of making reasonable or cost-effective adaptations.

PLANNING

High Level Master Plan

High Level Master Plans are planning projects that include clinical and facilities studies (i.e. Clinical Master Plans and current facilities condition assessments, respectively) to inform Site and/or Facilities Master Plans and accommodate projected service growth over the short-, medium- and long-term. These projects include high level budgets, phased schedules and climate resilience strategies. High Level Master Plans characterize the broader community of care with a review of key characteristics, indicators and trends, such as demographics and population growth.

Purpose

This section focuses on High Level Master Plans as key vehicles for contextualizing climate risks and resilience for a site in relation to its community of care over time. The intent is to provide a comprehensive, fulsome resource to inform multiple capital projects over time. It introduces Resilient Design Objectives (Appendix B), and outlines resilient planning opportunities to better understand, reduce and manage climate hazard exposure, sensitivity and adaptive capacity at the site, community and service delivery scales.

High Level Master Plans characterize a dynamic community of care that is served by a network of critical infrastructure including health facilities, roads and utilities (e.g. water, sewerage, power). Key information about the exposure, sensitivity and adaptive capacity of people, assets and infrastructure at the community and service delivery levels should be included in a review of a community's key characteristics, indicators and trends. A clear benefit is further direction on what to study to inform the next stage of the planning process.

Resilient Design Objectives serve as North Stars for resilience-based requirements, compliance measures and design strategies. Resilient Design Objectives should be integrated into Site Plans, Facility Plans and Project Agreements for optimal cascading benefits from initiation of concept to end of construction. Where possible, they are formulated in relation to Project Objectives with the intent to convey the materiality of climate risks to health service delivery.

Responsibilities

- ✓ The **Consultant Team** develops the High-Level Master Plan based on updated data, information and analysis on climate hazards and risks.
- ✓ **Capital Project Managers** guide the High-Level Master Plan process and coordination with the organization's overall strategic vision and goals.
- ✓ The **Health Authority** sets Resilient Design Objectives in relation to project objectives.

Expected Results & Outputs

The High Level Master Plan is a primary resource for capital project managers and chief project officers at project concept phases. It is the first stop for information on potential climate risks to a project; and, a primary resource for capital planners at the health service delivery area levels.

Key Information

This section provides key information and text to help complete the High Level Master Plan section of the Checklist (Appendix A). Specifically: (i) a request for proposals (RFP) for prime consultant services; and, planning tools and processes to improve understanding of risks and opportunities at the regional level, such as (ii) climate hazard Exposure Screens for people, health services, assets and infrastructure at the community and service delivery area levels; (iii) community health vulnerability maps and *Health Vulnerability Assessments*; (iv) greening strategies to help achieve health and climate co-benefits at the neighborhood scale; and, (v) interactive platforms to inform cost benefit analyses of critical asset and infrastructure resilience.

Prime Consultant – High Level Master Plan

Below is proposed text for a Prime (Architectural) Consultant RFP:

Approach

The most cost-effective approach to reducing impacts on people, health service delivery, and health facilities in the region is a low carbon and climate resilient approach to planning that works to ensure e.g.:

- ✓ Clinical service plan and capital project objectives are met by reducing climate risks and building resilience at the building, health campus and community levels;
- ✓ The Health Authority does its part to reduce future risks and transition to a low carbon economy;
- ✓ Minimal impact by healthcare on ecosystems essential to health and wellbeing.

Low Carbon Resilience Objectives

Clinical Planning & Operations (i.e. patient outcomes, staff health & wellbeing)

- ✓ Ensure thermal comfort and safety of occupants and patients into the future;
- ✓ Reduce local urban heat island effect;
- ✓ Increase external shade and use of trees to provide shade;
- ✓ Ensure indoor environmental quality for occupants into the future;
- ✓ Manage risk of flooding at both the facility and on the site, with consideration of the community members that a facility may need to serve even if the facility itself is not at risk;
- ✓ Ensure the safety of facility occupants while limiting damage to key facility systems and services;
- ✓ Increase ventilation effectiveness;
- ✓ Enable patient-controlled access to outdoor air where possible (e.g. operable windows in common areas);
- ✓ Optimize natural environments and access to nature from within the facility and in close proximity;
- ✓ Ensure flexibility and adaptability of indoor and outdoor spaces in preparation for and response to extreme events;
- ✓ Promote active transportation and occupant movement;
- ✓ Optimize daylighting.

Facility Planning & Operations (i.e. buildings and site infrastructure)

- ✓ Design more responsive, flexible heating and cooling solutions to help buildings adapt to daily and weekly temperature fluctuations based on climate projections;
- ✓ Ensure facility operations can withstand and respond quickly to extreme heat/disruptions with minimal impact on clinical operations;
- ✓ Prioritize passive design to reduce energy and emissions and improve passive survivability;
- ✓ Design high-quality air filtration systems to cope with changing external conditions;
- ✓ Ensure the facility can maintain adequate indoor air quality across different air quality hazard scenarios (e.g. wildfire smoke, pandemic);
- ✓ Regularly assess and communicate indoor and outdoor air quality;
- ✓ Limit widespread contamination of facility services and operations from floodwaters;
- ✓ Limit any added stress on municipal storm water infrastructure and nearby waterways from floodwater, sediment and contaminants;
- ✓ Facilitate efficient and cost-effective restoration following a flood event in design and material choice.

Community Planning & Operations

- ✓ Enabling planning strategies that improve patient and community health (mental, emotional, physical and social) with a well-considered, and evidence-based, approach to expanding green infrastructure for health and climate co-benefits (e.g. lower surface temperatures, improved on-site storm water retention);
- ✓ Using community vulnerability maps to e.g.
- ✓ Pinpoint physiological and social determinants of health that play key roles in climate vulnerability;
- ✓ Identify neighbourhoods or communities that may need more resources or support to cope;
- ✓ Mobilize multi-sectoral efforts to improve community health outcomes.
- ✓ Quantify the costs of action at the site and community levels with estimates provided by e.g. cost consultants for low carbon and resilient strategies.

Deliverables

The Prime Consultant will develop a High Level Master Plan including but not limited to the following:

- ✓ A *Low Carbon Resilience Plan* that:
    - aligns with Health Authority priorities, planning principles and goals related to climate risks, resilience, emissions and energy;
    - addresses current and future infrastructure in the region;
    - synthesizes the two key components below in service of the low carbon resilience objectives.

Climate Risks and Resilience

- ✓ Outline key inputs and outputs of the Climate Hazard Exposure Screen and Climate Risk Assessment carried out by the Consultant team as per the Climate Resilience Guidelines for BC Health Facility Planning & Design (2020).
- ✓ Contextualize climate risks and resilience for the Health Authority-owned facilities in relation to the Master Plan developments' timeframes with key information and insights from the Health Authority, local government and other resources.

- ✓ Outline resilient planning opportunities to better understand, reduce and manage climate hazard exposure, sensitivity and adaptive capacity at the region's sites per the *Climate Resilience Guidelines for BC Health Facility Planning & Design*.
- ✓ Identify low carbon resilience design objectives to guide Clinical Planning & Operations, Facility Planning & Operations and Community Planning & Operations in the region (see examples below).
- ✓ Propose metrics and targets for priority hazard risks in the region.
- ✓ Highlight potential issues or conflicts with meeting projected service growth per the High Level Clinical Service Plans.
- ✓ Indicate synergies and trade-offs among resilient design strategies in relation to emissions reductions pathways.
- ✓ Include cost estimates for key resilient design strategies.
- ✓ Identify opportunities to reduce compound risks (e.g. climate, pandemic) through synergy and innovation in planning and design.
- ✓ Provide green design and green infrastructure options, where human health and climate resilience co-benefits may be achieved, for evaluation and costing per *Greening Strategies for Co-Benefits.*

Emissions and Energy

- ✓ Establishes operational emissions reduction and energy conservation / efficiency targets, as informed by a *Net Zero Emissions Study.*
- ✓ Uses energy modelling and simulation exercises per *Establishing Design Conditions for Health Facility Planning and Design (2020)*.
- ✓ Prioritizes passive design strategies to maximize patient thermal comfort and acoustic quality; and, identifies environmental and health co-benefits of passive design.
- ✓ Develops a high-level decision-support tool for the Project that enables the Health Authority to move towards its 2030 emission reduction targets with the use of Low Carbon Electrification and other emerging best practices for new construction and retrofits in the short, medium and long term, see examples below.
    - Develop energy use intensity (kWh/m2/yr), thermal energy demand intensity (kW/m2/yr), and greenhouse gas intensity (kgCO2e/m2 /yr) baselines and targets for future facility and space utilization changes (n.b. targets to be in alignment with Authority targets).
    - Identify services and equipment that are energy intensive and may have opportunities for future energy recovery (e.g. MRI, CT Scanners).
    - Identify future opportunities for energy recovery and equipment efficiencies; and make recommendation to ensure that the site infrastructure considered future needs beyond the life of equipment.
    - Identify the Energy Step Code requirements and opportunities.
    - Direct future renewable energy assessments that should be pursued as appropriate for the Project location.
    - Direct future energy modelling and simulation exercises to use future shifted weather files per *Establishing Design Conditions for Health Facility Planning and Design (2020*)

Step 1: Exposure Screen

Carry out a climate hazard Exposure Screen at the community, regional or health service delivery level for:

- ✓ People: patients, workforce/staff and community; on- and off-site.
- ✓ Services: health and clinical; on- and off-site.
- ✓ Facilities: assets and infrastructure, including buildings; on- and off-site.

Results and recommendations should inform future projects' Concept Plans, and/or Business Plans (Step 2: Climate Risk Assessment).

Where a regions or health service delivery area does not have a HLMP, or a project does not have a Concept Plan, Step 1 can be customized, repurposed, or combined with Step 2: Climate Risk Assessment as needed.

For updated and fulsome instructions, see the complete process online: Climate Risk & Resilience Assessment.

Community Health Vulnerability Maps

Planners also can use information on community health vulnerability to inform service demand projections in High Level Master Plans and Concept Plans. For example, heat, wildfire smoke and flood vulnerability maps[6] produced by researchers, Health Authorities and others can help to:

- ✓ Pinpoint physiological and social determinants of health that play key roles in climate vulnerability.
- ✓ Identify neighbourhoods or communities that may need more resources or support to cope.
- ✓ Mobilize multi-sectoral efforts to improve community health outcomes.

Such maps can further support collaboration among health system departments and agencies (e.g. facilities management, public health, emergency management, disease monitoring and surveillance), local governments, social housing and others to ensure that public services, such as clean air shelters and cooling centres, are located in areas of highest need and with consideration of health service and facility locations.

Health Canada's *Climate Change and Health Vulnerability Adaptation Assessment Workbook* provides guidance on assessing and planning for adaptation using a community health lens.

Green Infrastructure for Health and Climate Co-Benefits

HLMP should also include information on the use of green infrastructure, green space and urban forest canopy to achieve co-benefits for patients, health workers, and community over a facility's lifespan. See the Resilience Guidelines' companion document *Greening Strategies for Co-Benefits* for illustrations and descriptions of an experiential pathway of green designs from inside a health facility to green space in the surrounding neighbourhoods.

Costs and Benefits of Investing in Critical Infrastructure Resilience

Planners can also use interactive tools to better understand the value of investing in resilience today, as opposed to at the end of critical asset and infrastructure service lives. For example, the BC Climate Action Secretariat, Health Authorities and others piloted in 2019/20 the XDI Globe Cross Dependency Initiative, an interactive and online platform for assessing climate hazard risk for assets and infrastructure (both site and off-

[6] See here for guidance on how to use the vulnerability maps produced by the HealthADAPT project funded by Health Canada.

site) that are critical to health facility functionality, and costing adaptation pathways for on-site health facility assets and infrastructure.

Qualitative information provided by clinical and facility operations staff on the costs of disruptions and discomfort – or, costs of inaction – are important to inform Step 1: Exposure Screen and Step 2: Climate Risk Assessment; risk registers (capital project and operational), annual Climate Change Accountability Reports, and post-occupancy evaluations. The process of collecting information – whether by survey, in interviews, roundtable discussions, or workshops – is in itself an invaluable part of change management[7].

Concept Plan

Purpose

Key concepts, information and framing are required at the project outset to establish a baseline and framework for climate resilience that enable consistency, improvement through iteration, and knowledge transfer as a project moves from concept to construction. This is especially the case as each phase may be overseen by a distinct project and consultant team, and involve key stakeholders including executive sponsors and project boards, procurement advisors, and the Ministry of Health.

Concept and Business Plans are anchored in the clinical service plan and functional program. As project teams explore site locations and develop conceptual and/or indicative designs for the space, it is prudent to also identify natural hazard risks that may disrupt clinical services such that risk reduction and resilience measures can be costed to a reasonable degree of accuracy.

A Concept Plan describes the need for investment and provides a site options analysis. Key service delivery area information such as population growth and demographics (e.g. culture, ethnicity, socio-economic status, age) contextualise the need for future care service. Ministry of Health policy directives (e.g. *Primary and Community Care Strategy*), Health Authority goals and objectives, and Provincial requirements for reducing climate risks and greenhouse gas emissions are embedded to ensure strategic alignment and compliance (e.g. annual reports on plans, actions and progress in reducing climate risks). Cost estimates and funding requirements (e.g. capital, ongoing operating, one-time/start-up costs) are outlined. System reliability, future capacity and redundancy are incorporated into the concept design and the budget as per post-disaster requirements in the *BC Building Code*.

Responsibilities

- ✓ The **Health Authority** prepares the Concept Plan and carries out the Exposure Screen.
- ✓ The **Project Team** secures the capacity and resources required to understand climate risks and develop a conceptual design that reduces risks that are discernible.
- ✓ **Consultants** carry out technical studies and prepare reports that include relevant climate hazards, including environmental reviews, site assessments and geotechnical analyses.
- ✓ **Subject matter experts** (e.g. climate scientists and modellers) provide information and expertise to support interpretation of future climate data for single and compound hazard risks.

---

[7] e.g. ADKAR change management process comprises five levels: Awareness, Desire for change, Knowledge of how to change, Ability to demonstate skills & behaviours, Reinforcement to make it stick.

Expected Results & Outputs

The Health Authority will conduct high level due diligence in alignment with its mandate to reduce human health vulnerability to climate change, and to align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate change risk. Site options and cost estimates in the Concept Plan should account for material climate hazards from opening day to facility end-life. Upon receiving approval to proceed, the Health Authority must ensure that the detailed data, information and analysis required to establish a baseline for design are completed prior to Business Plan initiation.

Specifically, the Concept Plan should reference the Health Authority mandates to reduce human health vulnerability to climate change, and climate risks. The Conceptual Design, project site analysis and other key project elements should include data, information and analysis on likely climate impacts that are material to the project. Technical reports (e.g. mechanical, electrical, civil, structural, geo-technical) should demonstrably incorporate Exposure Screen outputs.

For example, if the Exposure Screen indicates that one or more site options are located in a flood-prone area, then the Concept Plan should explore key considerations for reducing flood hazard exposure from opening day to facility end-life. Supplementary modelling and analyses may involve a high level analysis of how changes in hazard exposure over time are impacted by precipitation; drought (e.g. impact on on-site absorption of heavy rainfall); freeze/thaw (e.g. impact on the viability of potential design strategies such as permeable pavement); erosion; subsidence due to depleted water table; or saltwater intrusion due to sea level rise.

The Concept Plan should also consider potential impacts by or on adjacent areas, such as flooding of a major access road with risk that increases over time.

Key Information

This section provides key information and text to help complete the **Project Checklist: Concept Plan** (Appendix A), and **Step 1: Exposure Screen**.

Step 1: Exposure Screen

What is the Exposure Screen?

The climate hazard Exposure Screen is a tool to help determine and prioritize hazards relevant to a site and its community. This high-level process makes use of available climate and other data at regional and local scales. Note that screens from projects in the same region may be used again on other projects to enable streamlining, especially on minor capital projects.

This process gives an early indication of the project's vulnerability, which is a function of three factors:

- ✓ **Exposure:** The nature or degree to which people or systems are exposed to a climate-related shock or stress (e.g. low-lying coastal buildings are exposed to sea level rise while a hilltop facility is not);
- ✓ **Sensitivity:** The degree to which people or systems are either positively or negatively impacted by changing climate conditions (e.g. individuals with pre-existing respiratory conditions are generally more sensitive to smoke events and older buildings are generally more sensitive to overheating); and
- ✓ **Adaptive capacity:** The ability to prepare for and respond to impacts and consequences (e.g. a system that is already under stress has lower adaptive capacity).

The Exposure Screen ensures that key decision-makers, owners and operators of critical infrastructure are aware of a project's level and type of exposure from opening day and to facility end-life. A project's exposure to relevant climate-related hazards varies based on its location and setting, design features (e.g. orientation, materials), and off-site factors (e.g. public risk reduction measures such as dikes; availability of alternate, locally-based power sources such as a neighbourhood energy utility or micro-grid). Exposure can vary as hazards change, interact and compound. Impacts, vulnerabilities and risks also vary spatially and temporally as a result.

When should the Exposure Screen happen?

- ✓ Immediately upon approval for a project to proceed to the Concept Plan phase.
- ✓ In the development or updating of a High Level Master Plan. Where climate hazard information in existing High Level Master Plans is more than five years out of date, a subsequent Exposure Screen should be carried out due to the continuous improvement of climate science.

Who takes part in the Exposure Screen?

The Health Authority including project team, key project stakeholders, consultants, and subject matter experts.

How are outputs used?

- ✓ Inform the Conceptual Design, project site analysis and other key project elements.
- ✓ Inform location identification, options analysis, conceptual design development, and more accurate construction cost estimates.
- ✓ Technical reports (e.g. mechanical, electrical, civil, structural, geo-technical) demonstrably incorporate Exposure Screen outputs.
- ✓ Subsequent technical studies inform the Business Plan by providing the detailed data, information and analysis required to develop an Indicative Design and a basis for project Resilience Requirements. These ensure that a complete information set is available for both the Step 2: Climate Risk Assessment and follow-up Step 3: Resilient Design Review.
- ✓ The results and recommendations are integrated into the relevant High Level Master Plan to ensure that it contains the most current information.

For updated and fulsome instructions, see the complete process online: Climate Risk & Resilience Assessment.

Business Plan

A Business Plan (or business case) establishes an accurate degree of scope, cost and schedule certainty for the recommended option identified in the Concept Plan[8]. The Business Plan outlines the project rationale, secures the support and participation needed, and provides evidence that the project is a good investment. It aligns clinical programming with a facility's asset and infrastructure needs (e.g. space, utility connections) to meet anticipated operations demands over time.

Approval letters issued by the Treasury Board may request an exploration of additional options to achieve specific outputs such as accelerated and/or deeper reductions in emissions and/or climate risk than currently required or mandated.

Purpose

In our climate reality, key information and strategies for both managing climate risks and reducing emissions must inform the design options, project risk analysis, and budget requests submitted for approval to ensure that health facilities are prepared for climate change and the transition to a low carbon economy.

---

[8] Core Policy and Procedures Manual, BC. See Health Capital Policy Manual (2015) for definitions.

It is most cost efficient and effective to embed climate risk reduction and resilience strategies into early design and costing; and, provide a contingency for uncertainties and new information arising during subsequent phases. This approach enables development of requirements within the approved budget, and adequate resourcing of incentives where needed to exceed the requirements. Importantly, complete and coherent information will better enable projects to meet increasingly climate-progressive local government requirements (e.g. large site redevelopment or rezoning conditions), and support the pursuit of innovation funding streams[9].

Low Carbon Resilience

Key elements in a Business Plan should be informed by (i) a climate risk assessment and (ii) a net zero emissions study carried out in tandem, with a clear schedule for information exhange and deliverables that reflect a coordinated approach. Such a foundation sets up the project to "align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate change risk"[10].

Informed by the assessments, design options are prepared using low carbon resilience as a baseline i.e. designed to minimize climate risks and on-site emissions on commencement day. Whereas the Base Option is "cost-neutral" (i.e. within the capital cost ceiling), the Enhanced Option parameters may include an incremental cost increase that allows for higher levels of resilience, flexibility and robustness in anticipation of increased complexity and uncertainty around compound risks; deeper and/or accelerated emissions reductions, energy conservation savings and energy efficiencies; and, greater innovations to be achieved.

Base and Enhanced Design Options

In the Base Design, major building systems are designed to future climate conditions at facility half-life and build-in flexibility to its end-life to account for uncertainties or unexpected conditions. For example, a facility with a 60 year expected lifespan that opens in the 2020s is designed to the 2050s, has flexibility built-in for the 2080s, and factors in compound risks such as seismic and pandemic. Synergies and co-benefits include e.g. improved occupant health, ecosystem rejuvenation or regeneration, and increased passive survivability.

With a clear understanding of natural hazard risks, building and campus design can then apply a sustainability lens with consideration of e.g. building orientation, envelope design, and other no/low-cost strategies.

The Enhanced Design is designed to achieve net zero on-site emissions on opening day (in the case that the Base Option is not able to achieve this), and positioned to become fully "carbon neutral ready" as the electricity grid reduces fossil fuel generation inputs. The capital cost and life cycle benefits of enhanced features are described and quantified by the Proponent for decision makers.

To move beyond net zero on-site emissions, additional measures should be considered such as further reducing operating costs and emissions (e.g. reduce electrical load with a better building envelope, more energy efficient equipment and systems), and negative carbon emissions (i.e. sequestered carbon and grid reductions for other customers) to facility end-life.

As the Business Plan also includes related public sector leadership commitments such as LEED Gold, Low Carbon Cement and Wood First, the design options analysis also should optimize synergies and co-benefits with sustainability and embodied carbon targets.

---

[9] e.g. Energy Efficient Buildings Program that is focused on projects targeting net zero energy.
[10] 2020/2021 Board Mandate Letters

Responsibilities

- ✓ The **Health Authority** and **Indicative Design Team** prepare the Business Plan.
- ✓ **Procurement advisors** work with the Health Authority, Owner's Representative, and subject matter experts to apply a climate lens to project risk analysis, and develop incentives. Although scored elements typically are developed in the Procurement Phase, resilience scored elements are new and as such are best developed/refined during Business Plan development to ensure sufficient budget.
- ✓ The **Indicative Design Team** carries out the *Climate Risk Assessment* and Net Zero Emissions study.
- ✓ The **Health Authority** carries out pre-workshop activities including key stakeholder engagement.

Expected Results & Outputs

The Business Plan includes:

- ✓ Resilience Objectives validated by Climate Risk Assessment workshop participants.
- ✓ An Indicative Design that establishes a low carbon resilience baseline for Designers and Builders, and a foundation for developing adaptation pathways to facility end-life.
- ✓ Base and Enhanced Design Options, and cost estimates, that include the most important design elements to translate into project requirements to achieve the project Resilience Objectives.
- ✓ A summary report of the climate risk and net zero emissions study results that highlights synergies and trade-offs among design strategies in relation to the Resilience Objectives.
- ✓ A Resilience Matrix and resilience scored elements that are costed and adequately budgeted for.

Key Information

This section provides key information and proposed text to help complete the Project Checklist: Business Plan (Appendix A): Owner's Representative RFP (including climate risk assessment/adaptation consultant)**; Step 2: Climate Risk Assessment;** and Resilience Matrix (with resilience scored elements, scope ladder, and priced adjustments). Table 4 below provides example text of key elements, and related climate risk and resilience components, for integration into a Business Plan.

Table 4. *Examples of climate risk and resilience embedded into key elements of business plan development.*

Key Element (examples)	Climate Risk & Resilience Elements (examples)
Project Vision, Goals & Objectives ✓ Vision: A hospital enabled by e.g. a virtual first strategy to meet the needs of a diverse, growing region. ✓ Key goals e.g. development of a Digitally Enabled facility with virtual care embedded into patient care. ✓ Key objectives e.g. leverage virtual technologies and integrate primary team-based care.	***Project Vision, Goals and Resilience Objectives*** ✓ Vision: A hospital enabled by a virtual-first and low carbon resilience strategy to meet the needs of a diverse, growing region. ✓ Key goals include a Digitally Enabled facility that is Climate Resilient by design to extreme heat, wildfires smoke, and flood risks per best practices; and, Low Carbon as a 100% electric facility by target date. ✓ Key objectives include: ○ Leverage municipal climate adaptation plans, net zero emissions targets, and critical infrastructure to help ensure the low carbon resilience of virtual technologies in the facility's service area. ○ Design for the future adaptability of building systems to accommodate uncertainties and anticipated climate change.

Strategic Alignment ✓ Align with Provincial, Ministry and Authorities' Strategic Priorities. ✓ BC Government is focused on e.g. providing better health care, and investing in a clean-energy future.	***Broader Strategic Alignment*** ✓ The BC Government Ministerial Mandate Letter[11] states that "a better future through fighting climate change" is a foundational principle. ✓ 2020/21 Board Mandate Letters direct Health Authorities to "ensure your organization plans to align operations with targets and strategies for minimizing greenhouse gas emissions and managing climate risk.
Risk Analysis & Quantification ✓ Risk categories that could have an impact on overall cost are assessed. ✓ Risks are described in terms of cause, consequence, existing controls, and mitigating strategies.	***Climate Risks*** ✓ Physical Risks[12] impact our society directly and have the potential to affect the economy. ✓ Transition Risks are associated with an adjustment towards a low carbon economy. These can result in big shifts in asset values or higher costs of doing business. ✓ Procurement Risks (e.g. quantity estimate does not cover new climate risk-related requirements), Scope Risks (e.g. additional off-site city services required to manage future flood risk), IMIT Risks (e.g. climate resilience of critical infrastructure supporting virtual care). ✓ Regulation Risks (e.g. building code change during design, changes in health and safety standards), Financial Risks (e.g. insurance premiums escalate).
Municipal Approvals ✓ Rezoning condition requires e.g. a multi-hazard assessment to reduce risks and inform resilient design.	***Climate emergencies, adaptation plans, emissions reduction targets*** ✓ Contextual information e.g. climate impacts for priority (or "vulnerable") populations, critical services such as mental health, and critical infrastructure such as telecommunications and power. ✓ Community resilience strategies material to service delivery area, (e.g. cooling and clean air shelters).
Project Site Considerations ✓ Geotechnical. ✓ Utilities – suitability of services.	***Site and Off-Site Risks*** ✓ Soil stability, permeability and absorption capacity with respect to projected e.g. increases in storm and rainfall intensity. ✓ Utility assets and infrastructure resilience to compound risks.
Detailed Assessments ✓ Non-financial factors (e.g. environmental, job creation, public health or other socio-economic impacts). ✓ Associated public interest issues (e.g. access, security, safety).	***Climate Risk and Net Zero Emissions Assessments*** ✓ Follow-up technical studies prompted by climate risk assessment recommendations (e.g. stormwater modelling). ✓ Emissions assessment includes analysis of energy conservation measures' potential for synergies and co-benefits (e.g. climate and pandemic resilience).

[11] The Ministerial mandate letter dated November 26, 2020 states "A better future through fighting climate change: In 2018, our government launched our CleanBC climate action plan. CleanBC puts British Columbia on the path to a cleaner, better future by building a low-carbon economy with new clean-energy jobs and opportunities, protecting our air, land and water and supporting communities to prepare for climate impacts. It is every Minister's responsibility to ensure your ministry's work continues to achieve CleanBC's goals".
[12] Task Force for Climate-Related Disclosures: recommended information to include in organizations' mainstream financial filings (i.e. climate-related risks and opportunities in four areas: governance, strategy, risk management, metrics and targets).

Emissions and Energy Targets ✓ GHG emissions and energy targets on Organization and Project levels. ✓ In-scope and operational emissions.	***Low Carbon Resilience*** ✓ A Low Carbon Resilience Plan with (i) Climate Resilience Strategy, and (ii) Emissions (Carbon) and Energy Strategy. ✓ Emissions reduction strategies with climate resilience co-benefits. ✓ Energy conservation measures with low carbon resilience co-benefits. ✓ Out-of-scope and embodied emissions (e.g. anesthetic gas capture, organic waste diversion).
Design Options ✓ Informed by energy study and LEED Gold analysis (i.e. mandatory, strongly recommended credits appropriate for the project).	***Base and Enhanced Design Options*** ✓ Informed by a Climate Risk Assessment and a Net Zero Emissions Assessment, with results integrated into a coherent report that highlights synergies and innovations to be included or considered. ✓ Low carbon resilience is the baseline for Base and Enhanced options. ✓ Design options should ensure ongoing dialogue with utility providers (e.g. district energy, BC Hydro) to understand commitments for GHG intensity reduction and energy transfer opportunities.
Indicative Design Details ✓ Parametric costing estimates (e.g. report, drawings, building systems).	***Resilient Design Strategies*** ✓ All technical reports dedicate a section to Low Carbon Resilience (e.g. mechanical, electrical, civil, and structural). ✓ Resilient Design Strategies Matrix indicating what will/not be included or considered, and providing a brief rationale: o To be included: standard practice and synergistic strategies. o To be considered: enhanced energy and innovative strategies. o Will not be considered: operational strategies.

Prime Consultant – Indicative Design and Options Development

The Prime (Architectural) Consultant oversees, coordinates, and ensures quality control in the development of design options for the Business Plan. As such, overall responsibility for identifying and reducing climate risks to the project while building-in resilience to a changing climate sits with the Prime Consultant.

This section proposes text for the Prime Consultant RFP to help ensure that the Indicative Design team has the skills and experience necessary to set up a low carbon and resilient project for success.

Project Information

Reference documents available to interested proponents include:

- ✓ Climate projections data and reports by Health Authority, local and regional government, scientific and academic institutions, and / or other publicly-available and credible resources.
- ✓ Climate hazard Exposure Screen summary overview by Health Authority.

Scope of Services

The consulting team, led by a Prime Consultant, will include sub-consultants with the following competencies:

- ✓ Delivering climate risk assessment workshops, and developing adaptation pathways.
- ✓ Emissions and energy modelling using future shifted weather files.
- ✓ LEED Gold certification with experience in selecting credits with low carbon resilience co-benefits.
- ✓ Complementary accreditation and standards (e.g. RELi, Envision).
- ✓ Sub-consultants with core competencies in utilizing climate projections data to factor in current and future climate conditions into design (e.g. establish design conditions).

The Prime Consultant will, to the satisfaction of the Health Authority, complete the following tasks:

- ✓ Ensure coordination and timely exchange of key information among consultants, experts and Authority.
- ✓ Carry out a Climate Risk Assessment (see below), and a Net Zero Emissions Analysis, in tandem.
- ✓ Submit a report that outlines:
  - Climate risks and hazards exposure ratings informed by climate projections for the site (using RCP 8.5 climate data and projections into the 2050s and 2080s).
  - A climate risk matrix, including an overview of potential climate hazards, high level vulnerabilities and a risk assessment of severity of consequences relevant to the Health Authority and the project.
  - Resilient design strategies to reduce the identified risks together with the information required by the cost consultant to carry out a Class C cost estimate for the proposed design strategies. Propose strategies for designing systems to the 2050s, and flexibility to the 2080s, per RCP8.5 projections, and using *Establishing Design Conditions for Health Facility Planning & Design (2020).*
  - Co-benefits (e.g. emissions reduction, energy conservation, pandemic) associated with the identified resilient design strategies. Clearly indicate synergies and trade-offs among resilient design strategies in relation to adaptation pathways, and emissions reductions pathways
- ✓ Synthesize and incorporate assessment results and recommendations into design options and costing.
- ✓ Develop at minimum a Base and Enhanced Design Options with low carbon resilience as the baseline.
- ✓ Review climate hazard and risk information in previous and related work, including:
  - High Level Master Plan, Concept Plan, and site condition reports (e.g. survey, geotechnical, environmental, hazardous materials.
  - Climate adaptation strategies and emergency action plans per local and regional governments.
  - Future climate projections data and sector reports (e.g. health, agriculture, PCIC).
  - Exposure Screen results and recommendations (i.e. Authority).
- ✓ Review key resources including:
  - *Climate Resilience Guidelines for BC Health Facility Planning & Design (2020).*
  - *Establishing Design Conditions for Health Facility Planning and Design (2020).*
  - Nature-based solutions, urban forest and green infrastructure strategies in e.g. *Greening Strategies for Co-Benefits (2020*), and *Green Infrastructure for Health* (2018).
- ✓ Identify climate risk information gaps in above-mentioned work (e.g. compound hazard risks material to the project), and propose an approach to address needs and gaps.

Consultant - Climate Risk Assessment / Adaptation Consultant

The consultant is an integral part of the Indicative Design Team.

Key Responsibilities

- ✓ Design and deliver a Climate Risk Assessment workshop, in collaboration with the Health Authority.

- ✓ Ensure the Project Team and Indicative Design Team are primed in advance of the workshop, and prepared to present key information to workshop participants (e.g. site condition, design options, project constraints).
- ✓ Prepare a workshop report within two weeks with an analysis of hazards and compounding hazards, primary and cascading impacts, vulnerability and risks. The analysis and recommended actions to reduce climate risks and embed resilience in Design and Operations are categorized by:
    - Key exposure categories: people, assets and infrastructure, and health services to facilitate the identification of key roles and responsibilities at the department (or business unit) level.
    - Assets and infrastructure are sub-categorized at the building system, site and off-site scales to facilitate development of requirements.
    - Design or operations.
    - Viability such as 'easy wins' and/or 'low hanging fruit', 'further consideration is warranted', and 'prohibitive' (e.g. cost, technical).
    - Level of innovation (e.g. standard in BC *Building Code*, low carbon and resilient to 2050 with flexibility to 2080, or low carbon and resilient to 2080.

Key Competencies

- ✓ Previous adaptation project experience.
- ✓ Experience accessing, summarizing, and working with future climate projections.
- ✓ A minimum of five years of work-related experience.
- ✓ Advanced education in one, or several, of the following fields: engineering, science or planning backgrounds, geology, geochemistry, physics, geophysics, climatology, meteorology, or related field.
- ✓ Knowledge of methods, tools, and approaches to evaluating and mitigating the risks and vulnerability of infrastructure to climate change; such as experience in the application of PIEVC, BARC or Infrastructure Canada Climate Lens assessments, or similar ISO 31000 or ISO 1409x series method application.
- ✓ Understanding of methods and tools used in climate modelling.
- ✓ Experience with similar projects in BC, Canada or in "like" or peer jurisdictions e.g. PNW, California, UK.
- ✓ Experience in the application of climate risk assessments in healthcare sector is strongly preferred.

Step 2: Climate Risk Assessment

What is a Climate Risk Assessment?

The intent of the Climate Risk Assessment is to provide a nuanced and fulsome understanding of climate risks to people, assets and infrastructure, health services at the site and off-site (i.e. community) levels. It will inform the development of Base and Enhanced Design Options for the Business Plan. After Business Plan approval, it will also inform the development of a Statement of Requirements for the market.

More broadly, results and recommendations are shared with key partners and collaborators in both the public and private sector to further reduce risks to health facilities and services.

When should the Climate Risk Assessment happen?

- ✓ The Health Authority begins preparing for the Climate Risk Assessment upon approval of the Concept Plan to ensure sufficient time and resources for completing key steps prior to the workshop.

- ✓ The Indicative Design Team carries out a Climate Risk Assessment workshop during the initial stage of Business Plan development (i.e. shortly after project orientation) to ensure that results inform subsequent activities (e.g. net zero emissions study, design options development, costing).
- ✓ Workshop outputs are completed in time for the Indicative Design Team to develop design briefs to inform the Base and Enhanced Design Options, and for the cost consultant to complete estimates.

Who takes part in a Climate Risk Assessment?

The project team, Indicative Design team, and key stakeholders including:

- ✓ Clinical Planning and Operations
- ✓ Facility Maintenance and Operations
- ✓ Clinical Operations (e.g. physicians, nurses)
- ✓ Kitchen / Food / Laundry Service
- ✓ Local and regional government departments (e.g. planning and development, permitting, engineering, sustainability, parks)
- ✓ Power utilities (e.g. electricity, district energy, microgrid providers)
- ✓ Water and sewerage utilities
- ✓ Internet and Telecommunications utilities
- ✓ Virtual Health
- ✓ Information Management / Information Technology (IMIT)
- ✓ Infection Prevention and Control
- ✓ Population & Public Health / Environmental Health Officers
- ✓ Health Emergency Management BC
- ✓ BC Center for Disease Control (BC CDC)
- ✓ Allied Health, and Support Services
- ✓ PHSA Supply Chain
- ✓ Business Support Services (BISS)

How are outputs used?

The outputs inform Indicative Design (including Base and Enhanced Designs), costing and budget development, and the Business Plan.

For updated and fulsome instructions, see the complete process online: Climate Risk & Resilience Assessment.

Costs and Benefits of Investing in Project Resilience

The project's scored elements, (reverse) scope ladder and priced adjustments typically are developed in the Procurement Phase. As quantifying the cost of climate resilience measures is a nascent practice however, it is recommended to develop and refine novel tools and approaches during Business Plan development to better ensure that cost estimates and budget requests accurately reflect the costs and benefits (along with risks and opportunities associated with the uncertainties inherent to climate change) of minimizing climate risks and investing in resilience at the most cost-effective juncture in project development i.e. Planning Phase.

The Resilience Matrix[13] (see example in

Table **5**) may be used to help (i) meet Resilience Objectives, and (ii) ensure the highest level of resilience is achieved within the capital cost ceiling (i.e. Base Design). The intent of this novel approach[14] is to help the Health Authority establish a baseline for resilience, determine the cost to achieve incremental improvements towards the highest resilience levels, and incorporate a level of resilience to priority hazards into design options. It may be modified to include incremental cost increases (i.e. Enhanced Design).

[13] Proposed by BC Housing's Mobilizing Building Adaptation and Resilience (MBAR) Project
[14] Methodology developed by Infrastructure BC

Table 5. Resilience Matrix Example

Discrete Event/Level	Resilience Objective	Cost Impact Factor (%)	NPV Impact Factor (%)	Importance Modifier (%)	Resilience Credit (RC %)
Heat Wave					
H1	Design is resilient to 2040	0.5%	4%	1.3%	0.65%
H2	Design is resilient to 2050	1%	6%	1.2%	1.2%
H3	Design is resilient to 2060	1.5%	8%	1.1%	1.65%
H4	Design is resilient to 2080	2%	10%	1%	2%

The matrix may be used to engage Proponents to identify what is feasible to include within the budget and provide incentives to produce cost-effective ways of reaching desired resilience objectives at distinct points in time (e.g. opening day, half-life, end-life, extended life). It outlines how climate resilience objectives could be factored into a proposal's overall score, providing a way to account for the future value of including these elements at the outset of the project. The proposed approach would modify the net bidding price where the proposal addresses specified climate resilience measures of importance to the Project.

It provides insight for the Health Authority to determine the Importance Modifier (IM), which can be adjusted by the Health Authority based on NPV and any other factors influencing how important it is to meet that particular standard. The Cost Impact Factor (CIF) is an estimate of the added cost up front, to building to the S1 standard. The IM and CIF combine to determine the Resilience Credit (RC) that would be applied to adjust the overall bid price, thereby incentivizing the proponent to include an efficient selection of desired resilience elements in the Project.

Additional benefits include drawing on the creativity, knowledge and expertise of the proponent to find cost-efficient ways to enhance resilience within project constraints; and advancing best practice in the field so that the knowledge and capacity to include these measures becomes more expected and widespread.

The Resilience Matrix may be used to develop resilience scored elements, reverse scope ladders and priced adjustments.

Set the Baseline

a) The Indicative Design team familiarizes itself with the Scored Element Categories and Objectives, prioritizes each one based on the project's objectives and the site conditions, and incorporates a specific level of resilience into the Indicative Design (e.g. Heat Wave Level H2), noting that:
   - This step is very project specific and depends greatly on the Owner, functional program, and existing site conditions.
   - Hazards may include discrete events (e.g. extreme heat wave, power outage, seismic) and ongoing stressors (e.g. warmer drier summers).

b) The Owner and the cost consultant determine the cost to achieve the higher/highest level for each category of the Resilience Matrix (e.g. from Heat Wave Level S3 to Level S5), noting that:
   - The Owner determines which categories can feasibly be improved from the baseline.
   - Based on the cost estimate, the Owner may select the categories that can be improved with a reasonable incremental cost.

Develop Scored Elements, Reverse Scope Ladder and Priced Adjustments

After completing a) and b) above, the Owner/Authority may then:

c) Decide on the total value of the Climate Resilience Scored Elements[15] (Appendix E), and the distribution of the points among the categories (i.e. weighting), noting that:

- The point distribution can be based on the cost to achieve the maximum in each category.
- The total value of the scored elements or the point distribution does not need to co-relate with the total cost to achieve the maximum in each category.
- Ultimately the points distribution should reflect the Owner's or the Province's priorities.
- The total value of the scored elements should be based on a value the Owner is willing to pay and the level of risk the Owner is looking to reduce beyond the baseline.

d) Develop a Reverse Scope Ladder by ranking the categories and identifying the preferred option, which the bidders would then price in sequence.

e) This allows the Owner to achieve the desired level of resilience while still being under the capital cost ceiling for the project.

f) During the Preferred Proponent stage these items will be incorporated into the final contract and the final contract price.

g) If the proponents have cost pressures to stay below the capital cost ceiling, they will not price the reverse scope ladder.

h) Offer Priced Adjustments to the proponents by presenting all categories and options with a proposed Net Present Value[16] (NPV) adjustment for each.

- This offers the proponents a bidding menu and is similar to a pre-priced change order.
- The Owner provides the additional specifications/scope of work to achieve the desired level or resilience in each categories, and the price (NPV adjustment) the Owner is willing to pay to achieve this level of resilience.
- Bidders can perform a cost benefit analysis and weigh their cost to achieve the greater level of resilience vs the Owner's offered NPV adjustment.
- Bidders accepting the additional scope of work receive the benefit (NPV adjustment) those that do not, receive no adjustment.

i) There is no technical evaluation/assessment of how well the proposed design meets the resilience matrix categories. The selected level of resilience becomes a prescriptive specification.

---

[15] Climate Resilience Scored Elements may be developed and refined on a project-by-project basis with a view to creating a set from which relevant scored elements may be chosen.

[16] Many Resilient Design Strategies can not be easily evaluated on a NPV basis as they do not generate operating budget savings. Moreover, NPV may not be applied easily to individual or discrete strategies.

PROCUREMENT

Purpose

The intent of this section is to create consistency among RFP packages, and create a level playing field for proponents by describing how to ensure Resilient Design Objectives may be met through the competitive phase.

The Procurement Phase is an opportunity for:

Health Authority and Owner's Representative

- ✓ Ensure that the skills, knowledge, experience and networks of the professional services community are brought forward as key competencies.
- ✓ Address outstanding and emergent information gaps and needs.
- ✓ Improve or develop novel approaches to costing and assigning value to Resilient Design Strategies.
- ✓ Better understand constructability, synergies, trade-offs, equal-or-better-than design strategies.
- ✓ Obtain key information required to form the basis of a Compliance Audit.

Proponents

- ✓ Consider undertaking own assessments to do a deeper dive to better understand climate risks to its own design (e.g. PIEVC Protocol, ISO31000, ISO14091).
- ✓ Present equal-or-better options for climate data and information, hazard and risk assessment, design strategies, and compliance measures than prescribed in the RFP package.
- ✓ Review Resilient Design Strategies developed by Proponents per Statement of Requirements prior to Technical Submission.
- ✓ Validate with the Health Authority and Owner's Representative and key stakeholders (e.g. clinical) if intent (i.e. Resilient Design Objectives) is met, and co-benefits (e.g. emissions reduction) are optimised.
- ✓ Learn from other projects' successes, lessons learned, and best practices.

Responsibilities

- ✓ The **Owner's Representative** develops key components of the RFP package (e.g. Statement of Requirements), including Resilience Requirements and Compliance Measures, and supports the Health Authority in RFP evaluation.
- ✓ **Procurement advisors** work with the Health Authority, the Owner's Representative, and subject matter experts to evaluate incentives and other tools (e.g. scored elements, scope ladder).
- ✓ **Proponents** bid on a project per RFP package specifications, informed by Resilient Design Strategies.
- ✓ The **Health Authority** and **proponents** collaborate to ensure compliance to Resilience Requirements.

Expected Results & Outputs

- ✓ The Health Authority's request for proposal package includes, and is not limited to:
    - o Key project elements and proposal requirements specific to climate risks and resilience, emissions and energy.
- ✓ The Health Authority's proposal evaluation package includes, and is not limited to:
    - o Evaluation criteria specific to resilience
    - o Resilience matrix

- Climate resilience scored elements

- ✓ Proponents' RFP Technical Submission includes Step 3: Resilient Design Review outputs.
- ✓ The Health Authority's Resilient Design Objectives are met in Proponents' Technical Submissions.

Key Information

This section provides key information and proposes text to help complete the Project Checklist: Procurement Phase (Appendix A): Prime Consultant – Owner's Representative; Consultant - independent resilience consultant; RFP Design-Builder; Step 3: Resilient Design Review; and, RFP evaluation. Appendix C: Requirements and Compliance Measures proposes text for the Statement of Requirements. Appendix E: Resilience Scored Elements provides examples of a scored element and evaluation criteria for an extreme heat event (facility operations) and rising temperatures (clinical operations).

Prime Consultant – Owner's Representative

The Owner's Representative (or Compliance Team) is a consultant team that develops the Statement of Requirements on the basis of the approved Indicative Design. The Prime (Architectural) Consultant ensures that Resilience Requirements and Compliance Measures (Appendix C) are embedded into all relevant components including major building systems (e.g. envelope, mechanical, electrical) by coordinating the team's input and ensuring quality control. The Owner's Representative plays a key role in evaluating Proponents' submissions (Appendix E).

Consultant – Independent Resilience Consultant

The independent resilience consultant is an integral part of the Owner's Representative team and a key liaison for the Health Authority from Procurement Phase start to Implementation Phase completion at minimum. The consultant ensures key documentation and knowledge transfer to the Commissioning Authority and Asset Manager at minimum.

The role is carried out by one or more individuals over a period of years, and support by the project indirectly (as part of the consultant team) or directly (as part of the project team). It is an essential role given the subject matter expertise, continuity, and time commitment required to ensure that (i) the Resilient Design Objectives, Requirements, and Compliance Measures are sufficiently embedded into the Statement of Requirements issued to the market; (ii) proponents' proposed Resilient Design Strategies meet the intent of the Resilient Design Objectives and Requirements; (iii) the Successful Proponent carries out equal-or-better-than alternatives to the Final Project Agreement; and, (iv) the Commissioning Authority and Asset Manager are sufficiently equipped to ensure that resilience is successfully operationalised and residual risks are manageable to facility end-life.

The independent resilience consultant reports to the Prime Consultant or where necessary to the Health Authority. While the role is distinct from the independent energy consultant (IEC) role, it works in coordination with the IEC toward achieving low carbon resilience with e.g. timely exchange of relevant information and identification of potential synergies and conflicts. The two roles carry forward the results and recommendations from the climate risk assessment and net zero emissions study (Business Plan) through respective processes (e.g. Climate Resilience Schedule, and Energy and Emissions Schedule, development). As such, the two roles enable tracking, validation, coordination and documentation of key information required to achieve a low carbon and resilient facility as the project delivery process progresses through to opening day (i.e. service commencement date).

Key distinctions between the independent resilience and energy consultant roles include consideration of cascading impacts and benefits beyond the project's geographic boundaries and timeframe i.e. broader context (Exposure Screen, High Level Master Plan); integration of climate parameters into technical studies informing site and design options (Climate Risk Assessment, Concept and Business Plans); evaluation of proposed design strategies informed by compound risk scenarios analysis i.e. beyond energy modelling (Resilient Design Review); determination of compliance in relation to Resilient Design Objectives i.e. including clinical operations (Compliance Audit); and, inclusion of residual climate risks into the facility's risk register and facilty condition reports (Operations Phase). The project's post-occupancy report may review and recommend specific areas where the roles may be combined for future projects.

The independent resilience consultant submits quarterly reports during Procurement and Implementation Phases; and, a final report as a key reference document for the Commissioning Authority to ensure that Resilient Design Objectives are met; the Asset Manager to ensure that residual risks are manageable during Operations Phase; and, the Post-Occupancy Evaluation consultant.

The final report is also provided as a key reference to: site leadership, facilities maintenance and operations director and managers, organization risk manager; facility condition report consultant; and, key health system stakeholders including Population and Public Health, and Health Emergency Management BC.

Key Responsibilities

The independent resilience consultant's key responsibilities include, but are not limited to, the following:

- ✓ Contextualize the project's resilience measures with respect to potential synergies and conflicts with plans and actions at local- and regional-levels. Use relevant information in the High Level Master Plan.
- ✓ Summarize critical infrastructure and services interdependencies among the facility-based services, virtual health and telehealth services, and home- and community-based health services.
- ✓ Identify cascading benefits to the service delivery area with respect to reducing exposure and/or sensitivity, and increasing adaptive capacity, of priority populations.
- ✓ Submit independent quarterly reports during Procurement and Implementation; and, a final report within three weeks of Implementation Phase completion.
- ✓ Liaise with the Commissioning Agent and Asset Manager; and, present a summary overview to site leadership, facilities maintenance and operations director and managers, organization risk manager.
- ✓ Ensure that climate risks identified in the capital project risk register are carried forward to the facility risk register (i.e. residual risks to be managed).
- ✓ Update the High Level Master Plan upon Implementation Phase completion with the information above.

RFP Design-Builder

This section comprises proposed text for select sections of the request for proposal (RFP) package (i.e. key project elements, and proposal requirements); proposed information to include in the data room for proponents; and, guidance for RFP evaluation including scored elements. Appendx E provides an example of evaluation points for an extreme heat and warming temperatures scored element. This section also describes Step 3: Resilient Design Review whereby proponents are encouraged to review, validate and align proposed designs in collaboration with the Health Authority and Owner's Representative.

Proposal Requirements

The proposal requirements include key project elements (Climate Risk & Resilience); a statement of requirements; and, scored elements where needed.

Climate Risk & Resilience

A section in the RFP should be dedicated to Climate Risk & Resilience, and include the proposed text below:

- ✓ Each proponents will undertake **Step 3: Resilient Design Review** with the Health Authority and Owner's Representative.
- ✓ List data and information sources pertaining to relevant climate hazards, and compound hazards, used to develop the Proponent's design for the project, including but not limited to Data Room resources.
- ✓ In a separate report, provide a Resilient Design Brief that:
    - Lists Resilient Design Strategies (i) included in the design; (ii) recommended for future consideration; and, (iii) excluded from design, with a brief explanation in table format.
    - Indicates Resilient Design Strategies that (i) address climate risks and impacts (e.g. people, services, assets and infrastructure) identified in **Step 2: Climate Risk Assessment** and **Step 3: Resilient Design Review**; and, (ii) have the potential for synergies, co-benefits, conflicts and trade-offs (e.g. emissions reduction).
    - Notes Resilient Design Strategies that (i) exceed building code requirements and industry standards, including those required by e.g. municipal by-laws or rezoning conditions; and, (ii) are common practice but not yet codified or standardised.
    - Cross-references Resilient Design Strategies with (i) requirements and compliance measures required (e.g. indications on drawings, calculations and narratives) per Statement of Requirements.
    - Describes residual risks to be managed during Operations Phase until facility end-life, with key information required for the facility risk register including: major building systems impacted, order of magnitude cost, lead/responsible.
    - May be used as a basis for **Step 4: Compliance Audit** in the Implementation Phase.
- ✓ Provide an analysis of pathways, and describe implications on capital and operational costs, of:
    - Incorporating all low carbon resilience measures at facility commencement.
    - A phased approach to incorporating low carbon resilience measures over the facility lifecycle.
- ✓ Describe the key opportunities for utilizing future climate projections to inform renewal and replacement plans for the facility, buildings, critical building systems and associated components to end-life including:
    - Adjustments to design criteria, parameters and / or conditions as a result of climate change.
    - Type and extent of design modifications to account for changing climate risks to facility end-life.
    - Climate-related assumptions and risk thresholds that underpin proposed designs.
    - Data and information sources used for proposed designs.
- ✓ Proponents may use formal meetings (such as Collaborative or Special Topic Meetings) to seek clarification on or elaboration of requirements and key documents in the Data Room.

Scored Elements

Resilience scored elements may be developed as incentives where the capital cost ceiling is already established, and/or Resilient Design Objectives may benefit from a supplement to Resilience Requirements. The scored elements are developed in collaboration with procurement advisors and subject matter experts (e.g. energy modeller).

The example in Appendix E was developed to better ensure minimal disruptions to service delivery in the event of a prolonged heat event (i.e. the intent is to support achievement of clinical service objectives). Additional resilience scored elements should be developed for wildfire smoke and air quality impacts, flooding, power outages, and chronic stresses such as snowall and wind/storms.

Data Room

The Health Authority provides background information for all Proponents:

- ✓ **Step 1: Exposure Screen** report.
- ✓ **Step 2: Climate Risk Assessment** workshop report.
- ✓ A reference document list with climate data and information sources for use as starting points.
- ✓ A reference document with Resilient Design Strategies and synergies listed (Appendix D)
- ✓ Summary reports for the climate risk assessment and the net zero emissions study.

Step 3: Resilient Design Review

What is a Resilient Design Review?

After the proponents have been selected and confirmed, a Resilient Design Review is carried out to provide proponents with an opportunity to (i) review climate risks in relation to their proposed designs (using key information from **Step 2: Climate Risk Assessment** and supplementary processes such as PIEVC Protocol or ISO31000, and/or ISO14001), (ii) validate proposed Resilient Design Strategies and adaptation pathways, and (iii) ensure alignment with emissions reduction and/or energy conservation measures with a view to developing a low carbon and resilient design.

The review provides the Health Authority with an opportunity to (i) review any new climate information presented by the proponents that is material to the project; (ii) ensure that the intent of the Resilience Objectives, Requirements and incentives is conveyed clearly to proponents, and (iii) develop low carbon resilience-related key performance indicators to embed into a post-occupancy evaluation scope of work.

As such, the Resilient Design Review adds value to the Procurement Phase as it can:

- ✓ Identify inherently resilient designs, or factors that compel resilient design (e.g. local regulations).
- ✓ Ensure that opportunities to embed resilience are not missed, especially where uncertainty is a significant factor (e.g. pandemic).
- ✓ Validate robust options and flags ineffective solutions early in the design process (30%).
- ✓ Improve a shared body of knowledge for the current and subsequent projects.

The review focuses on proponents' proposed designs, indicates significant deviations from the Indicative Design, and verifies how compliance is achieved. Proponents will have the opportunity to present equal-or-better alternatives to the requirements which are intended to encourage industry innovation and bring progressive resilience strategies to the forefront.

Importantly, this process should be managed such that proponents have ownership of and accountability for the proposed strategies (e.g. a formal assessment report with feedback and recommendations by the Health Authority, contract amendments associated with outcomes), and it does not place undue burden on any party.

When should the Resilient Design Review happen?

- ✓ The review is developed by the independent resilience consultant (Owner's Representative) in the Planning Phase with Health Authority input. It is included in the Statement of Requirements.
- ✓ The review is conducted early in the Procurement Phase (30% design), and may be repeated at subsequent design submittal stages or revisited in Collaborative or Special Topic Meetings.
- ✓ It is completed before the Detailed Design phase, where the Design-Builder demonstrates compliance and verifies that the design sufficiently reduces climate risks and addresses Resilience Requirements.

Who takes part in the Resilient Design Review?

Proponents, Owner's Representative, and Health Authority.

How are outputs used?

The outputs are used to validate / improve proposed design strategies, and to evaluate proposals.

For updated and fulsome instructions, see the complete process online: Climate Risk & Resilience Assessment.

RFP Evaluation[17]

Statement of Requirements

The Health Authority, Owner's Representative and subject matter experts work together to ascertain if Requirements are met and Compliance Measures are satisfactory. Evaluators review submitted information to determine if the Proponent substantially does/not meet the provisions of the RFP and the Final Draft Project Agreement. The independent resilience consultant summarises evaluators' findings in quarterly reports, and provides recommendendations as to what in the process could be improved or modified for future projects.

Considerations may include:

- ✓ Did the Proponent submit the required materials (e.g. per compliance measures)?
- ✓ Did the information submitted indicate the Proponent's understanding of, and ability to meet its obligations under the Final Draft Project Agreement?

Evaluators may request clarification from Proponents (e.g. specify location of indications on drawing) and / or log an issue to be addressed by the Successful Proponent.

Scored Elements

Appendix E provides an example process for evaluating resilience scored elements.

[17] Explanatory notes:
Resilience Enhanced Design (or Design/Build) must still be achieved within Project Budget
Resilience Credit = [Lesser of Cost and NPV Impact Factors] x Importance Modifier
RFP Responses will be evaluated as if Proposed Contract/Tender Price = [100-Sum(RC%)]/100 x Actual Submitted/Tendered Project Price

IMPLEMENTATION

In the Implementation Phase, the Health Authority and the Successful Proponent ("Design-Builder") finalize key aspects of the Final Project Agreement, among other contractual documents**.** It is recommended to consider commissioning activities during the Implementation Phase (i.e. design and construction) as an added level of quality assurance to help ensure that project Resilience Requirements are being met.

Purpose

The purpose of integrating climate risk into this phase is to:

- ✓ Inform if and how the detailed design sufficiently addresses climate risks to the project.
- ✓ Ensure that the project's Resilient Design Objectives, Requirements and/or Targets are met.
- ✓ Evaluate any equal-or-better alternatives to the Resilience Requirements.
- ✓ Follow-up on Resilient Design Brief recommendations, and issues flagged in the Procurement Phase.
    - Identify clearly any residual risks that need to be addressed during Operations Phase.
    - Indicate key elements to include in a Post Occupancy Evaluation.

Responsibilities

- ✓ The **Design-Builder** demonstrates compliance and verifies that the design sufficiently reduces climate risks and addresses Resilience Requirements.
- ✓ The independent resilience consultant (**Owner's Representative**) completes the Compliance Audit.

Expected Results & Outputs

- ✓ The Owner's Representative has sufficient information to determine compliance, materiality of residual risks, and implementation of resilience measures.
- ✓ The Health Authority has a clear understanding of residual climate risks to be managed, and potential associated costs, during the Operations Phase to facility end-life.
- ✓ The Health Authority has the documentation required to manage residual risks within acceptable risk thresholds (e.g. wildfire smoke protocols), and to document performance, over the facility lifespan (e.g. facility condition index, risk register, post occupancy evaluation).
- ✓ Vendor contracts include climate-related requirements. Existing contracts are amended as required.

Key Information

This section provides key information and proposed text to help complete the Project Checklist: Implementation Phase (Appendix A); and, carry out a Compliance Audit.

Consultant – Independent Resilience Consultant

The Owner's Representative's independent resilience consultant carries out the Compliance Audit.

Key Responsibilities

The independent resilience consultant's key responsibilities include, but are not limited to, those listed in Procurement Phase and the following:

- ✓ Track progress and deviations from the Statement of Requirements to end of Implementation Phase.

- ✓ Flag material proposed changes (e.g. Resilience Objectives and Targets, Climate Resilience Schedule), and potential issues (e.g. maladaptation due to modified design), with sufficient lead time for the Health Authority to review and respond.
- ✓ Review proposed changes and supporting justification to determine materiality with respect to achieving intent, and need for the Health Authority to review.
- ✓ Work with the independent energy consultant to determine whether proposed changes to Energy and Emissions Targets, and related design strategies, are material to Resilience Objectives and Targets.
- ✓ Review technical studies, including energy modelling, to identify issues with Resilient Design Strategy implementation and residual risks management.
- ✓ Provide a progress update at each design submittal stage that builds on key information, addresses identified needs and gaps, and incorporates lessons learned from previous stages.
- ✓ Work with the Design-Builder early in construction to plan for commissioning.
- ✓ Integrate synthesized information into the consultant team's end-of-project report. Include a summary of resilience measures and co-benefits, insight into what went well and what should be improved with respect to the process, and recommendations for future projects.
- ✓ Submit a final report within three weeks of Implementation Phase completion.

Step 4: Compliance Audit

What is a Compliance Audit?

The purpose of the Compliance Audit is to (i) inform if and how the detailed design sufficiently addresses climate risks to the project, (ii) ensure that the project's Resilient Design Objectives, Requirements and/or Targets are met, and (iii) evaluate any equal-or-better alternatives to the Resilience Requirements.

The intent is to confirm that the project is being designed, constructed and commissioned in a manner that emphasizes "no regrets" options and adaptation pathways; prioritizes simple, flexible and durable design strategies; and, cultivates synergies and co-benefits.

A feedback loop to inform future projects is extended from previous phases or established at the start of Implementation Phase. The result is sufficient information to determine compliance and any action required.

When should the Compliance Audit happen?

- ✓ The independent resilience consultant (Owner's Representative) develops the Compliance Audit during the Procurement Phase and updates as required at Implementation Phase start.
- ✓ The Compliance Audit is carried out during the Implementation Phase per a pre-determined schedule, including the final design at the construction document stage.
- ✓ Progress updates are provided at each submittal stage, and a final report is submitted within three weeks of Implementation Phase completion, by the independent resilience consultant.

Who takes part in the Compliance Audit?

The Compliance Audit is carried out by an independent compliance auditor. Proponents's design submissions are audited.

How are outputs used?

- ✓ Determine compliance with the Statement of Requirements (Project Agreement).
- ✓ Understand the materiality of residual risks to operations.
- ✓ Confirm implementation of the measures (commissioning).

For updated and fulsome instructions, see the complete process online: Climate Risk & Resilience Assessment.

KEY RECOMMENDATIONS & NEXT STEPS

The Health Authority Working Group, Task Force, Advisory Committee and Reviewers recommend the following areas for further exploration, development, and refinement for future iterations of the Resilience Guidelines:

- ✓ Better integrate emissions reductions and energy to enable bold moves toward low carbon resilience.
- ✓ Customise or supplement with guidance for other project types (e.g. minor capital, existing facilities), procurement types (e.g. Design-Bid-Build, Alliance) and archetypes (e.g. long-term care facilities).
- ✓ Develop a decision-tree for Facilities Management to ensure that portfolios are well-covered.
- ✓ Provide information on quantifying the costs of and returns on investments to better enable budgeting for low carbon resilience (e.g. cost of carbon).
- ✓ Develop metrics and targets for low carbon resilience that more accurately reflect the actual value of synergies, co-benefits and trade-offs.
- ✓ Explore potential for incorporating climate-related disclosures in climate change accountability reports.
- ✓ Define vulnerability and risk thresholds to support prioritization, action plans, and resource allocation.
- ✓ Develop climate resilience assessments that add value to the procurement process, and do not overly burden proponents including sub-contractors.
- ✓ Develop resilience audits (e.g. criteria, checklists), determine key competencies, and seek alignment with complementary tasks and roles including commissioning and independent energy audits.
- ✓ Integrate community health vulnerability assessment processes and results into planning processes.
- ✓ Undertake a deeper dive into virtual health and off-site critical infrastructure / services resilience.

To enable this growing and evolving community to work more quickly and efficiently – with a view to better understanding and working at the scale of our climate-related challenges – future collaboration likely will take a more decentralized, crowd-sourced and web-based form.

APPENDIX A: CHECKLISTS

This master checklist brings together the key sections (Planning, Procurement and Implementation) and components (*Climate Risk & Resilience Assessment* process, and Resilient Design hierarchy) of the *Climate Resilience Guidelines for BC Health Facility Planning and Design (v1.1)*.

NOTE: *Climate Risk & Resilience Assessment* steps (in teal-coloured text) are embedded into the Planning, Procurement, and Implementation phases. If more detail is required on individual *Climate Risk & Resilience Assessment* steps, refer to the complete process document, **online**.

The intent is to enable capital project managers to work efficiently with project teams and consultants to reduce climate risks and build-in resilience through planning and design. Hyperlinks to the corresponding sections of the guidelines are embedded in this checklist to enable easy access to more information and resources.

Project:	**[Project Name]**	**Ref:**	**[Project Number]**
Project Manager:	**[Project Manager Name]**	**Date:**	**[Select Date]**

☐ Getting Started

Before starting this checklist, please check:

Q1. Does this project require a business plan?

- ☐ Yes – if true, proceed.
- ☐ No – if true, (i) refer to your in-house climate resilience or sustainability experts, and (ii) consider completing the **Exposure Screen for Minor Capital Projects**, to determine next steps.

Q2. Is this a Design-Build (DB), P3, or Alliance project?

- ☐ Yes – if true, proceed.
- ☐ No – if true, (i) refer to your in-house climate resilience or sustainability experts, and (ii) consider completing the **Exposure Screen for Minor Capital Projects**, to determine next steps.

Q3. Will a new High Level Master Plan (HLMP) be developed for this facility/region OR is the existing HLMP more than five years out of date?

- ☐ Yes – if true, proceed to the ‘Planning Phases: HLMP’ section of the checklist.
- ☐ No – if true for either, skip ahead to the ‘Planning Phase: Concept Plan’ section of the checklist.

☐ Planning Phase

High Level Master Plan (HLMP)

Responsibility of: *Capital Project Manager & Consultant Team (Health Authority)*

☐ **1.** Into the Request for Proposal (RFP) for Prime (Architectural) Consultant Services, embed requirements:

- ☐ a. Low carbon resilience objectives.
- ☐ b. Low carbon resilience plan comprising: climate risk and resilience, and emissions and energy.

☐ **2.** Carry out **Step 1: Exposure Screen – Community** specifically for (i) People (patients, staff, community); (ii) Services (health and clinical); and (iii) Facilities (assets and infrastructure, including buildings) at the community, regional, or health service delivery level – considering both on- and off-site impacts. Refer to Concept Plan, **Step 1: Exposure Screen – Project** for methodology.

Note: not all communities, regions, or health service delivery areas have a HLMP, and not all projects have a Concept Plan. As such, the exposure screen is required in both the HLMP (community-focused exposure screen) and in the Concept Plan (project-focused exposure screen), if neither are completed for a project, Step 1 should be customized and combined with Step 2: Climate Risk Assessment.

☐ **3.** Use or create community health vulnerability maps to inform service demand projections.

- ☐ a. Utilize Health Canada's *Health Vulnerability Adaptation Assessment Workbook* (when available) for guidance on assessing and planning for adaptation using a community health lens.

☐ **4.** Ensure the HLMP includes information on the use of green infrastructure, green space, and urban forest canopy to achieve co-benefits.

- ☐ a. Refer to the companion document *Greening Strategies for Co-Benefits* for illustrations and descriptions of green designs inside and health facility and in surrounding neighbourhoods.

☐ **5.** Use interactive tools to understand the value of investing in critical asset and infrastructure resilience.

- ☐ a. Obtain qualitative information, examples include (i) the information provided by clinical and facility operations staff on the value of damages and losses that occurred from extreme events, and (ii) the *XDI Globe Cross Dependency Initiative* can be used to both assess climate hazard risks for assets and infrastructure, and costing adaptation pathways.
- ☐ b. This information can be used to inform both **Step 1: Exposure Screen (Community or Project)**, and **Step 2: Climate Risk Assessment**, as well as risk registers, the annual climate change accountability report (CCAR).

☐ **6.** Incorporate findings into the relevant High Level Master Plan to ensure project access to the most updated information, and to influence project planning.

Concept Plan

Responsibility of: *Consultant – Climate Services*

☐ **1.** If required, prepare climate data and interpretations for **Step 1: Exposure Screen – Project**.

Responsibility of: *Capital Project Manager (Health Authority)*

☐ **2.** Ensure **Step 1: Exposure Screen - Community** is complete (relevant within five years, or for a new HLMP) prior to conceptual design development. If incomplete or outdated, then carry out Step 1: Exposure Screen – Project**,** (a) through (d), below.

*Note that this methodology can be adapted for the **HLMP's Exposure Screen – Community** as well.*

- ☐ a. **Complete a desktop review** of publicly-available reference documents relevant to the health service delivery area, making note of data and information gaps to be addressed.

Note: If public data is not sufficient, have climate services consultant prepare required data (see item #1).

- ☐ b. **Identify climate hazards**: document hazards relevant to a project's site and community, adding other natural hazards (e.g. seismic, pandemic) that may compound or amplify the impacts; describe hazards (quantitatively or qualitatively), and annotate with rationale and references.
- ☐ c. **Determine the likelihood** that an event will occur in this decade as a discrete and/or ongoing event; consider changes in hazard exposure (i.e. magnitude, type and variability) to facility half-life and end-life. Consider systems and components that are likely to be replaced (e.g. outdoor generator), and those unlikely to be replaced (e.g. building envelope) before facility end-life.
- ☐ d. **Prioritize hazards:** summarize the outcomes of **Step 1: Exposure Screen - Project** in a table.

☐ **3.** Address data and information gaps identified in **Step 1: Exposure Screen (Community and/or Project)** to inform the Concept Plan that is submitted.

*Note: This data provides a basis for the project Resilience Requirements, ensuring a complete information set is available for **Step 2: Climate Risk Assessment** and **Step 3: Resilient Design Review**.*

- ☐ a. Carry out the required technical studies as identified in **Step 1: Exposure Screen** and prepare technical reports (e.g. mechanical, electrical, civil, structural, geo-technical).

  Note: If necessary, this task can be carried out by the climate services consultant.

- ☐ b. For community- or health service delivery area-level issues that require a broader discussion with subject matter or industry experts, identify potential longer term research studies (e.g. environmental impact/site assessment, geotechnical/soil analysis, landscape/tree analysis).

☐ **4.** Incorporate key information, results and recommendations from **Step 1: Exposure Screen**, and additional technical studies and analysis, into the Concept Plan[18], informing location identification, options analysis, conceptual design development, and more accurate construction cost estimates.

---

[18] In alignment with Health Authority and Ministry of Health mandates to reduce human health vulnerability to climate impacts and to fight climate change, respectively.

Business Plan

Responsibility of: *Capital Project Manager or Chief Project Officer (Health Authority)*

☐ **1.** Upon Concept Plan approval (if applicable), begin preparing for Step 2: Climate Risk Assessment workshop.

Note: the workshop should be completed within the first month of the Business Plan phase; significant advance preparation likely is required.

- ☐ a. Contact climate resilience and/or sustainability staff to determine time and resource availability to support or lead the workshop.
- ☐ b. In the Prime (Architectural) Consultant – Indicative Design Team RFP, include the workshop and key competencies, or determine scope, timeframe and budget required for an independent Climate Risk Assessment / Adaptation Consultant to lead the workshop.
- ☐ c. Integrate into the "Scope of Services" section of the Prime (Architectural) Consultant – Indicative Design Team RFP and the Owner's Representative RFP: (i) list of reference documents; (ii) sub-consultants (e.g. energy modeling); (iii) key deliverables (e.g. climate resilience and emissions reduction strategies); and (iv) design options with Low Carbon Resilience as baseline for Base and Enhanced Design Options (see proposed text).
- ☐ d. Engage stakeholders and identifying potential invitees; develop a workshop primer and assemble key workshop materials; provide input into Indicative Design Team RFP (see above); provide key information to the Design Team and indicate information gaps to be addressed.
- ☐ e. Have the ***Indicative Design Team***: review outputs from **Step 1: Exposure Screen** and information from key reports, policies, and studies in order to address information gaps through additional resources or studies. They should also prepare an inventory of design strategies that may increase resilience and review best practices and cost estimates from peer jurisdictions.
- ☐ f. Have the ***Health Authority's climate resilience or sustainability expert*** draft a workshop primer, containing information on climate hazards, potential impacts on facilities and services, and workshop objectives/expected outputs.
- ☐ g. With the ***Climate Risk Assessment / Adaptation Consultant (Indicative Design Team),*** review and approve the following: workshop invitees; agenda; workshop primer; workshop materials; tools and processes to be used (e.g. stress tests, climate scenarios); and methodology. Ensure the workshop primer is sent to invitees in advance.

It is now time for Step 2: Climate Risk Assessment workshop,
to be completed by the Indicative Design Team, see item #11 (a) through (f), below.

☐ **2.** After **Step 2: Climate Risk Assessment workshop** is complete, the ***Health Authority*** will:

- ☐ a. Evaluate workshop report and recommendations;
- ☐ b. Review Resilient Design Briefs and summary of Resilient Design Strategies to understand how results are factored into design options and costing;
- ☐ c. Support development of the Statement of Requirements in the Procurement Phase, and add the workshop report to the Data Room for review by proponents.

☐ **3.** After **Step 2: Climate Risk Assessment workshop** is complete, the ***Project Manager (Health Authority)*** will:

- ☐ a. Ensure the cost consultant's scope of work includes: (i) cost estimates for Resilient Design Strategies and adaptation pathways for the Base and Enhanced Design Options with reference to asset lifecycles; (ii) cost descriptions in monetary and non-monetary (e.g. occupant health, social cohesion) terms; (iii) lifecycle cost analysis with reference to adaptation pathways to facility end-life.
- ☐ b. Work with procurement advisors to: address climate risks in project risk analysis; and integrate key climate risk information into the submission evaluation process.
- ☐ c. Include a resilience budget line and contingency for the Base and Enhanced Design Options in the Business Plan.
- ☐ d. Work with capital planners to integrate key climate risk information into the High Level Master Plan, Multi-Year Capital Plans and / or 10-Year Infrastructure Plans.
- ☐ e. Work with clinical planners to add climate risk information to Clinical Master Plans.
- ☐ f. Work with asset managers to add climate risks and strategies into the Risk Register.

Responsibility of: *Prime Consultant (Indicative Design Team)*

☐ **4.** Carry out a **Climate Risk Assessment (Step 2)**, and a Net Zero Emissions Assessment, in tandem.

☐ **5.** Ensure coordination and timely exchange of key information among consultants, subject matter experts and the Health Authority.

☐ **6.** Synthesize and incorporate assessment results and recommendations into design options and costing.

☐ **7.** Develop, at minimum, a Base and Enhanced Design Option with low carbon resilience as the baseline.

☐ **8.** Review climate hazard and risk information in previous and related work, including: site and facility plans, climate strategies, climate projections, Climate Risk & Resilience Assessment results, and other relevant or companion documents.

☐ **9.** Identify climate risk information gaps in above-mentioned work (e.g. compound hazard risks material to the project), and propose an approach to address needs and gaps.

☐ **10.** Submit a report outlining climate hazards, vulnerabilities and risks; design strategies to reduce risks (i.e. treatments in design and operations); and co-benefits including emissions reductions. Integrate climate risk assessment consultant's workshop report and recommendations.

Responsibility of: *Consultant - Climate Risk Assessment / Adaptation (Indicative Design Team)*

☐ **11.** Hold the Step 2: Climate Risk Assessment **workshop,** (a) through (f), below, completing the following tasks:

- ☐ a. **Provide Context:** understand implications of climate change on facility; review policy and legal context; present key information, design strategy inventory, and examples of best practices.
- ☐ b. **Identify Hazard Impacts:** generate impact statements through a reflection exercise, identifying climate-related shocks or stresses and their impacts on people, assets and infrastructure, and health services; explore future impacts of compounding hazards, cascading impacts, and critical infrastructure interdependencies by reviewing future climate scenarios for hazards of concern.

☐ c. **Explore Vulnerability:** review climate scenarios, vulnerability criteria and impact statements, score impact statements for vulnerability, take forward all scored statements to the next step.

☐ d. **Evaluate Climate Risks:** prioritize impacts based on the likelihood of occurrence and consequence of impact, assigning a total risk score to each impact; discuss level of risk that is deemed acceptable for the project and adjust budget, scope, and schedule accordingly.

☐ e. **Develop Resilient Design Strategies & Adaptation Pathways:** with Resilience Principles and Resilient Design Objectives as "North Stars" (e.g. allow for change and continuous improvement; prioritize "no-regrets" adaptation pathways; seek synergies and co-benefits).

☐ f. **Next Steps:** ensure follow up actions are assigned to lead person(s), and clear next steps are agreed upon.

☐ **12.** After the workshop:

☐ a. Have the workshop facilitator (***Climate Risk Assessment / Adaptation Consultant***) prepare a workshop report with analysis of hazards, impacts, vulnerability, and risks; and recommended actions to reduce climate risks, within two weeks of workshop.

☐ b. Review workshop report results to inform development of a Resilient Design Brief (to inform the Base and Enhanced Design Option).

☐ c. Coordinate and integrate all inputs and outputs into development of design options and costing.

☐ d. Submit an analysis and summary of Resilient Design Objectives, Strategies and Adaptation Pathways; cost estimates; and an overview of the selection and prioritization process to the Health Authority.

Responsibility of the*:* *Health Authority*

☐ **13.** Develop a Resilience Matrix with Procurement Advisors and Subject Matter Experts:

NOTE: This is typically completed in the Procurement phase, but it is recommended to develop and refine these tools and approaches during the Business Plan development. This ensures better cost estimates and that budget requests accurately reflect the capital cost (and benefits) of minimizing climate risk through resilient infrastructure design.

☐ a. Develop Resilience Scored Elements, as an incentive to exceed requirements: (i) determine Resilience Scored Element categories and resilience objectives; prioritize each category and objective per project objectives and site conditions, as informed by **Step 1: Exposure Screen** results; (ii) develop Resilience Requirements (see Appendix C for an example); (iii) develop evaluation criteria, weighting, and approach, ensuring sufficient point allocation for Resilience Scored Elements

☐ b. Develop Reverse Scope Ladder: rank the categories and identify the preferred option, which the bidders would then price in sequence.

☐ c. Develop Priced Adjustments: offer to the Proponents by presenting all categories and options with a proposed Net Present Value[19] (NPV) adjustment for each.

[19] Many Resilient Design Strategies can not be easily evaluated on a NPV basis as they do not generate operating budget savings. Moreover, NPV may not be applied easily to individual or discrete strategies.

☐ Procurement Phase

Request for Proposal

Responsibility of the: *Owner's Representative and Health Authority*

☐ **1. Incorporate into the Request for Proposal (RFP) for the Owner's Representative**

- ☐ a. Ensure that Resilience Requirements and Compliance Measures are embedded into all relevant components by coordinating the team's input and ensuring quality control.
- ☐ b. Evaluate submissions using the Resilience Matrix to valuate resilience (Appendix E).
- c. Ensure that a qualified independent resilience consultant is included as part of the team.

☐ 2. Incorporate into the Request for Proposal (RFP) for the Proponents:

- ☐ a. Key Project Elements that are necessary for low carbon resilience: Climate Risks and Resilience (see proposed text); Emissions (Carbon) and Energy.
- ☐ b. Proposal Requirements (see proposed text) to ensure that Technical Submissions include sufficient information on the data and information used to inform design, narratives to link climate risk and resilience assessment results to design, and analysis of adaptation pathways and associated costs to facility end-life.

☐ 3. Develop Step 3: Resilient Design Review, to be included in the Statement of Requirements and Proposal Requirements. Resilient Design Strategies and results from the Exposure Screen and Climate Risk Assessment should be included in the Data Room for Proponents to review.

Note: The information generated in the Resilient Design Review will form the basis of **Step 4: Compliance Audit.**

- ☐ a. Review hazards, impacts and risks from **Step 1: Exposure Screen**, supplementary technical studies, and **Step 2: Climate Risk Assessment** in advance of meeting with Proponents.
- ☐ b. Review Resilience Requirements and Compliance Measures included in the Statement of Requirements to enable an informed discussion with proponents.
- ☐ c. Identify and address information gaps with proponents through established mechanisms.

☐ 4. **Incorporate into the Statement of Requirements:** Resilience Requirements (Appendix C) for e.g. general resilience, warming temperatures, air quality impacts, flooding, power outages, and chronic stresses; a requirement to carry out **Step 3: Resilient Design Review**; a requirement to develop design solutions that incorporate Resilient Design Strategies (see Appendix D) and synergies with emissions reductions, and pandemic and seismic resilience.

☐ 5. Proposal Evaluation:

- ☐ a. Review submissions to determine if the Proponent meets provisions of the RFP and the Final Draft Project Agreement.
- ☐ b. Request clarification and / or log an issue to be addressed by the Successful Proponent.

Responsibility of the: *Proponents*

☐ 6. Complete Step 3: Resilient Design Review, as developed by the Health Authority.

- ☐ a. Prepare and submit a narrative with supporting evidence as per the project requirements that summarizes assessment results and supports proposed Resilient Design Strategies.

☐ Implementation Phase

Responsibility of the: *Health Authority and/or Owner's Representative*

☐ **1.** Develop Step 4: Compliance Audit, ensuring:

- ☐ a. It informs if and how the detailed design sufficiently addresses climate risks to the project.
- ☐ b. The project's Resilient Design Objectives, requirements and/or targets are met in the Project Agreement's Design and Construction Schedule.
- ☐ c. Any equal-or-better alternatives to the Resilience Requirements are evaluated.
- ☐ d. It prioritizes simple, flexible, and durable design strategies – cultivating synergies and co-benefits (i.e. opportunities for GHG emissions reductions, seismic and pandemic resilience).
- ☐ e. It addresses Resilient Design Brief recommendations and/or any issues flagged in the Procurement Phase.
- ☐ f. A feedback loop is developed to inform future projects, resulting in information sufficient to determine compliance and any action required – this may look like the incorporation of requests for a third-party reviewer, along with a final report of insights and recommendations for improvement.

Responsibility of the: *Consultant - Independent Resilience Consultant (Owner's Representative)*

☐ **2.** Prepare and submit a final report within three weeks of completion of the Implementation Phase.

☐ **3.** Transfer key documentation and information to the Commissioning Authority and Asset Manager after completion of the Implementation Phase.

Responsibility of the: *Successful Proponent*

☐ **4.** **Complete Step 2: Climate Risk Assessment** if this was not previously conducted or inadequately conducted, at 30% design, prior to the Audit.

APPENDIX B: RESILIENT DESIGN OBJECTIVES

Resilient Design Objectives serve as North Stars for resilience-based requirements, compliance measures and design strategies.

Resilient Design Objectives should be integrated into Site Plans, Facility Plans and Project Agreements for optimal cascading benefits from initiation of concept to end of construction. Where possible, they are formulated in relation to Project Objectives with the intent to convey the materiality of climate risks to health service delivery. It is recommended to consider commissioning activities during the Implementation Phase (i.e. design and construction) as an added level of quality assurance to help ensure that project Resilience Requirements are being met.

See Appendix C for Project Resilience Requirements and Compliance Measures, and Appendix D for Resilient Design Strategies that are aligned with the Resilient Design Objectives below. Note that requirements do not correspond directly to specific objectives, but instead work together to fulfill a range of objectives. In addition, while objectives and requirements are mandatory, Resilient Design Strategies should be considered as examples and a starting point for discussion.

Resilient Design Objectives are organized by those that increase facility resilience in a broad sense, and those that address either acute shocks (i.e. extreme heat, air quality impacts, flooding, and power outage) and chronic stresses (e.g. water shortage and drought, moisture and humidity, freeze/thaw, snowfall and wind).

General Resilience

- ✓ Develop a climate lens for all capital expenditures that incorporates lifecycle costs of facilities under future climate conditions. Offset resilience investments with projected operational costs savings over facility lifespans.
- ✓ Create an inventory of essential supplies (noting shelf life), and verify supply chain resilience during climate stress events.
- ✓ Develop Standard Operating Procedures, and offer frontline staff training on operating facilities and providing health services under climate stress conditions.
- ✓ Work with utilities and local governments to understand regional priorities for critical service provision during new extreme events, such as firefighting, water supply, electrical supply, transportation, and site access.
- ✓ Strengthen partnerships with local and regional governments to improve community resilience by strengthening community health.

Extreme Heat

Prolonged periods of abnormally hot weather, often paired with high humidity, are projected to increase in frequency and intensity as a result of climate change. These conditions place occupants at risk of heat exhaustion, overheating, dehydration, and hyperthermia. Maintaining indoor thermal comfort for patients and staff will become increasingly difficult if the facility has not been designed for future climate conditions. Longer periods of hot temperatures and increased temperature variability may also result in higher operational costs (e.g. energy costs and staff overtime), increased wear on mechanical equipment, and unexpected equipment purchases to supplement heating and cooling needs.

To ensure that health facilities are designed to meet the demands of a warming climate, design teams must implement measures that meet the following Resilient Design Objectives:

- ✓ Ensure thermal comfort and safety of occupants and patients into the future.
- ✓ Ensure facility operations can withstand extreme heat events with minimal impact on clinical operations.
- ✓ Design more responsive, flexible heating and cooling solutions to help buildings adapt to current temperature fluctuations and future increases based on climate projections.
- ✓ Consider future adaptability of building systems to allow systems to be modified or replaced with infrastructure in place to accommodate for anticipated changes based on future climate projections.
- ✓ Prioritize passive design to reduce energy and emissions and improve passive survivability.
- ✓ Reduce local urban heat island effect.
- ✓ Increase external shade and use of trees to provide shade.

Air Quality Impacts

As the climate warms, health facilities will face increases in air-borne contaminants from wildfire activity, atmospheric ozone, pollen and other sources, which can infiltrate through building envelopes and impact the ability of mechanical systems to maintain adequate indoor environmental quality. These contaminants can have serious negative health impacts on occupants, including headaches, asthma, and respiratory irritation. At health facilities, poor indoor environmental quality can also promote bacterial growth and the transmission of infectious diseases.

To limit the impact of wildfire smoke and other air-borne contaminants, and improve indoor environmental quality, design teams must implement measures that meet the following objectives:

- ✓ Ensure indoor environmental quality for occupants into the future.
- ✓ Optimize passive and active ventilation/cooling strategies based on projected days of poor outdoor air quality.
- ✓ Ensure the facility can maintain adequate indoor air quality across different air quality hazard scenarios (e.g. wildfire smoke, pandemic).
- ✓ Design high-quality air filtration systems to cope with changing external conditions.
- ✓ Ensure tight control of different pressure zones.
- ✓ Ensure an airtight building envelope that is maintained over time, and a means to monitor and control the building envelope (e.g. sensors and lights on doors and windows indicating if it is safe to open.
- ✓ Regularly assess and communicate indoor and outdoor air quality.

Flooding

Flooding can be caused by extreme rainfall events that overwhelm local stormwater drainage capacity, and as a result of sea level rise, river overflow, snow melt, system backup, and plumbing failures. These shocks and stresses are anticipated to increase in frequency and severity over time due to climate change, and can lead to building damage, weakened foundations and structural integrity, utility service interruption (including power and sewage systems), and loss of property and equipment. At health facilities, flooding can also result in unsanitary operating conditions, along with negative physical and mental health impacts for facility staff and patients.

To limit the occurrence of flooding at health facilities, and minimize damage and disruption should flooding occur, design teams must implement measures that meet the following primary Project Objectives:

- ✓ Mitigate and manage flood risk at the facility, site and community levels (i.e. site should not flood the community served in extreme events).
- ✓ Ensure the safety of facility occupants while limiting damage to key facility systems and services.
- ✓ Limit widespread contamination of facility services and operations from floodwaters.
- ✓ Limit any added stress on municipal stormwater infrastructure and nearby waterways from floodwater, sediment and contaminants.
- ✓ Facilitate efficient and cost-effective restoration following a flood event in design and material choice.

Power Outage

Building power systems are subject to a number of climate-related threats – high demand for cooling during heat waves may overwhelm the grid, and flooding may down power lines or flood critical infrastructure – and these challenges will only increase in the future. As health facilities must have reliable power supplies to maintain appropriate interior temperatures and ventilation rates, any interruption to these systems can have dramatic consequences on patient care. To enhance the resilience of power supplies at health facilities, and prepare the facilities to meet future electrical demands, design teams must implement measures that meet the following primary Project Objectives:

- ✓ Minimize disruption and ensure continued operations of the facility during a power outage.
- ✓ Ensure the safety of facility occupants during a power outage.
- ✓ Limit damage to key facility systems and services.
- ✓ Reduce reliance on utility providers through on-site renewable energy generation (such as solar PV) and on-site energy storage (such as batteries).

Chronic Stresses

In addition to shock events, health facilities in BC face a range chronic stresses that are more gradual in nature but can still cause major damage over time. For example, in BC’s northern latitudes, warmer winters may lead to more frequent freeze/thaw cycles, which can in turn result in higher rates of weathering of building materials and general moisture damage. While not a comprehensive list of all possible chronic stresses, design teams must implement region-specific measures to achieve the following objectives at a minimum:

- ✓ Design for maximum water efficiency and water reuse to minimize disruption and ensure continued operations during water shortage and/or drought.
- ✓ Limit damage to building materials from moisture and/or humidity ingress.
- ✓ Minimize damage from freeze/thaw cycles.
- ✓ Ensure the facility and site are equipped to manage current and projected snowfall quickly and safely.
- ✓ Limit damage to the facility and potential risks to users that may result from high winds and storms.

APPENDIX C: REQUIREMENTS AND COMPLIANCE MEASURES

This section provides Resilience Requirements to be included in the project's Statement of Requirements (SOR). Design teams will be required to meet the Requirements, as per associated compliance measures.

As addressing climate risk and enhancing resilience is an inter-disciplinary and iterative endeavor, Requirements are presented by climate hazard to help encourage collaboration and cross-pollination of ideas. These include requirements that increase resilience in a broad sense, along with:

a) Warming temperatures and extreme heat

b) Air quality impacts

c) Flooding

d) Power outages

e) Chronic stresses, specifically water shortage and drought, moisture and humidity, freeze/thaw cycles, snowfall, and wind

To better enable design teams to allocate responsibilities, the Resilience Requirements are also linked to generic Requirement Categories:

a) Facility Planning

b) Structural

c) Architectural

d) Mechanical

e) Electrical

f) Facility Configuration and Internal Circulation

g) Envelope and Enclosure

h) Plumbing and Storm/Sewer

i) Landscape

j) Operations

This approach is also used for the Resilient Design Strategies in Appendix D.

General Specifications

#	Requirements	Compliance Measures	Requirement Category
1.01	This section will be read in conjunction with the following sections and schedules: • Design Life Table • LEED Innovation Credit IPpc98: Assessment and Planning for Resilience • Schedule for Energy and Carbon Guarantees • General Resilience • Structural • Architectural • Mechanical • Electrical • Facility Configuration and Internal Circulation • Envelope and Enclosure • Plumbing and Storm/Sewer • Landscape • Operations	N/A	General Resilience
1.02	Owner's Representative Team to provide definitions and interpretations of the following (at a minimum): • Climate hazard • Climate impacts • Design criteria / conditions / parameters • Future climate projections data / Future projections of climatic design data • Implementation (or adaptation) pathway • Risk Threshold • Resilience Objectives for the project	Submit a list of definitions and interpretations.	General Resilience
1.03	Data and information sources for priority climate hazards and future projections data include at minimum: • Relevant Health Authority resources including: i) Climate Hazard Exposure Screen ii) Climate Hazard Reference Document Summary iii) Climate Risk Assessment report iv) Net Zero Emissions Assessment • Preliminary Strategic Climate Risk Assessment for BC (CAS, 2019)	N/A	General Resilience
1.04	Information sources for the Climate Resilience Assessment Workshop methodology include at minimum: • Climate Resilience Guidelines for BC Health Facility Planning & Design • Climate Lens (Infrastructure Canada) • NYC Climate Resiliency Design Guidelines (v4.0 or later)	N/A	General Resilience
1.05	Future climate projections for priority hazards will inform the design, development and renewal strategies of the facility, buildings (including orientation, exposure and materials selection), critical building systems and their associated components, through to end life.	N/A	General Resilience
1.06	Carry out a Climate Resilience Assessment Workshop, as outlined in the Climate Resilience Guidelines for BC Health Facility Planning and Design, to: • Build knowledge and competence. • Better understand climate vulnerability and risks. • Present new data and information from technical studies. • Help proponents to understand project specifications, including the intent and expected outputs. • Reinforce importance of Resilience Requirements to the Health Authority. • Validate the inputs and outputs of the climate hazard Exposure Screenings and the Climate Risk Assessment (including design strategies), and identify improved or additional strategies to reduce risks and build resilience, from a builder and constructability perspectives. • Prioritize design strategies and adaptation pathways that reduce climate risks and increase resilience to facility end life. • Present equal-or-better solutions to the project specifications. • Inform Schematic and Detailed design stages. • Identify any gaps or questions for the Health Authority and/or Owner's Representatives to address.	Submit a narrative that describes how project will achieve the objectives listed within this requirement.	General Resilience

General Specifications (continued)

1.07	Exterior and interior designs will seek to achieve health and climate co-benefits by prioritizing green design strategies described in the following: • Greening Blocks: Practical Design Interventions to Integrate Health and Climate Resilience Co-Benefits 2019. • Green Infrastructure and Health Guide 2018. • Healthy Built Environment Linkages Toolkit 2018. • Climate2050 Health and Well-Being Roadmap (Metro Vancouver).	Submit a narrative that describes how project will achieve health and climate co-benefits by prioritizing green design strategies.	General Resilience
1.08	Design Team to design the facility to: • Give priority to efficient use of resources, protection of health and indoor environmental quality. • Take advantage of efficiencies and innovations achieved through integration of systems and scheduling of climate resilience measures in accordance with facility half-life and full-life to minimize operational and lifecycle costs for the Owner (for example in relation to utilities). • Take advantage of alternative sources of energy such as passive solar, and on-site power generation and opportunities for waste heat recovery. • Ensure that no materials are used on the interior of the facility that are detrimental to human health.	Submit a narrative that describes how project will achieve the objectives listed within this requirement.	General Resilience
1.09	Design conditions used for sizing the above building systems are to be based on the year 2050 climatic design data (RCP8.5) and weather file conditions produced by PCIC. For the purposes of designing for cooling conditions (i.e. 97.5% or 99% percentile summer temperature depending on location and class of facility as per CSA 317.02), as well as allowance for future provisions, the following climatic design data and weather files for dry bulb and wet bulb temperatures and enthalpies will be used: • Year 2050 • Year 2080	N/A	General Resilience
1.10	For determined capacity of the equipment that will be designed/installed in future (associated with facility end life), the Design Team will use future climate projections provided via the Owner from a reputable source, such as the Pacific Climate Impacts Consortium (PCIC).	Submit confirmation of source for future climate projections used for design.	General Resilience
1.11	Where component and system design life are shorter than the design life of the facility, the Design Team will plan and construct a flexible adaptation pathway as per future climate projections, such that they can be readily replaced, upgraded, added to or retrofitted through to component and assembly end life.	Submit a narrative of flexible adaptation pathway that outlines equipment replacement, upgrade, additions and/or retrofits.	General Resilience
1.12	Develop an *Asset Management Plan* that includes guidance for the following in future climate conditions: • Maintenance • Renewals • Operations Integrate this plan with the facility's Building Information Modelling (BIM) processes.	Complete an *Asset Management Plan* with narratives and annotated drawings as appropriate.	Facility Planning
1.13	Develop a *Building Durability Plan* consistent with CSA 478 that includes consideration of future climate projections. Within this document: • Produce a design life table specifying component lifespans to indicate durability and longevity. • Indicate where components achieve longer service lifespans.	Complete a *Building Durability Plan* with tables and annotated drawings as appropriate.	Facility Planning
1.14	Develop a Contractor Quality Management Plan that demonstrates: • How construction materials will be kept dry throughout the construction process. • How products that will be contained within the building envelope will be kept dry before being sealed in place. • How dust and contamination of construction will be managed.	Complete a *Contractor Quality Management Plan* with narratives and annotated drawings as appropriate that identify management approaches for both moisture and dust.	Facility Planning
1.15	Provide a building envelope design that is informed by hazard exposure analysis and future climate projections to facility end life.	N/A	Envelope & Enclosure
1.16	Ensure the building envelope minimizes thermal bridging.	Submit annotated drawings as appropriate.	Envelope & Enclosure
1.17	As part of building enclosure commissioning, conduct air barrier testing and specify minimum leakage for building envelope.	As part of the commissioning process, submit compliance reports for air barrier testing.	Envelope & Enclosure

Warming Temperatures & Extreme Heat

#	Requirements	Compliance Measures	Requirement Category
2.01	Develop an Extreme *Heat Management Plan* that demonstrates: • How the project has considered future climate projections based on data provided by climate science authorities (e.g. PCIC). • How future weather files have been used to augment energy modelling. • Minimum and maximum temperature ranges for critical and non-critical areas of the facility. • Measures in place to ensure overheating hours do not exceed acceptable limits over facility design life. • Overall approach to temperature regulation (e.g. active and passive shading).	Submit an *Extreme Heat Management Plan* with narratives and annotated drawings as appropriate, including modelling results using future weather files.	Facility Planning
2.02	Conduct a modelling study to identify opportunities to minimize sensible cooling demand, including but not limited to: • Exterior shading (passive and active) capable of blocking 100% of solar gains between the months of March and September. • Appropriate window-to-wall ratios. • Enhanced insulation. • Enhanced glazing that minimizes incident solar radiation.	Submit modelling results with narratives and annotated drawings as appropriate that summarize measures included to minimize latent cooling demand.	Facility Planning
2.03	Design conditions for 1%, 2.5% and 5% defined by CSA Z317.2 concerning 'airflow and design parameters during facility catastrophic events management' shall be strictly 'enthalpy based' peaks, extrapolated for PCIC weather files that provide hourly based dry bulb and wet bulb conditions.	N/A	Mechanical
2.04	Equipment and plant(s) sizing for catastrophic event management mode, CSA Z317.2-15 Section 6.16 applies. Use Figure 3 ('airflow and design parameters for catastrophic events management') for all Type A Health Care Facilities with the following exception(s): Type I areas to maintain 100% of the airflow; and Type 1 and Type 2 areas are operating on 100% outdoor air systems.	N/A	Mechanical
2.05	Size and design facility cooling systems (i.e. chiller plant and ventilation air handling unit equipment and plants) to maintain required thermal comfort using weather files (RCP8.5) for the year that is 30 years from facility commencement date. Use future weather files provided by the Owner, if available, and / or access the most updated files available from public resources such as Environment & Climate Change Canada (ECCC) and the Pacific Climate Impacts Consortium (PCIC).	Submit confirmation of source for future climate projections used for design.	Mechanical
2.06	Design and construct the facility's main infrastructure (including but not limited to ductwork and piping network, and terminal units and associated coils such as VAV boxes) for facility commencement day to be sized for future climate conditions, using future weather files that are relevant to facility end life.	Submit a narrative that describes how opening day equipment will be made relevant to facility end life.	Mechanical
2.07	Allow for mechanical cooling equipment upgrades to end of facility life to account for changing climatic conditions. Ensure there is adequate space allocated for future upgrades in mechanical rooms and on the roof.	Submit a narrative that describes the potential equipment upgrade pathway for 2050 and 2080, and include annotated drawings showing the locations allocated for future equipment.	Mechanical
2.08	Provide means of passive cooling strategies to reduce demand on cooling plant and other infrastructure, ensuring that these strategies are economically practical.	Submit narrative of approach to passive design, including annotated drawings as appropriate.	Envelope & Enclosure
2.09	Ensure that landscaping reduces the local urban heat island effect and enhances resilience to extreme heat through: • Master-planning of greenspace • Layout and form that encourage airflow • Heat- and drought-tolerant planting Based on the above, highlight how greenspace has reduced cooling loads and how vegetation has provided outdoor areas of respite from high temperatures.	Submit landscaping plan and plant list, with narratives and annotated drawings as appropriate.	Landscape

Air Quality Impacts

#	Requirements	Compliance Measures	Requirement Category
3.01	Develop an *Air Quality Management Plan* that demonstrates: • Overall approach to maintaining indoor air quality to account for current conditions (i.e. business-as-usual, wildfires smoke, pandemic). • Maximum levels of indoor air contaminants in critical and non-critical areas of the facility. • Measures in place to ensure levels of indoor air contaminants do not exceed acceptable limits over facility design life.	Submit an *Air Quality Management Plan* with narratives and annotated drawings as appropriate.	Facility Planning
3.02	Design air handling units and HVAC systems to accommodate additional sections and/or filters (e.g. activated carbon, MERV 14 at a minimum) capable of removing smoke particulate during wildfire smoke events. Ensure spaces are programmed to allow for adequate storage of additional filters. Develop operations and maintenance protocol for filter storage, inspection & replacement.	Submit a narrative that describes approach to enhancing filtration during wildfire smoke events, including annotated drawings as appropriate.	Mechanical
3.03	Design facility to include common interior spaces (e.g. lobbies) that may be converted expediently to 'refuge areas' with cool and clean air. Equip these areas with dedicated HVAC systems sized for 100% outdoor air capacity that may accommodate community surge for up to 14 days during extended periods of wildfire activity.	Submit a narrative that describes approach to providing 'refuge areas' with cool and clean air, including annotated drawings as appropriate.	Facility Planning
3.04	Limit exfiltration and infiltration of air, wildfire smoke, fine particulate matter (<2.5PM) and other air pollutants through materials of the assembly, joints in the assembly, joints in components of the wall assembly, and junctions with other facility elements, including the roof.	Submit a narrative that describes approach to limiting exfiltration and infiltration through assembly, including annotated drawings as appropriate.	Envelope & Enclosure
3.05	Where possible, locate air intakes on north and east facades and in a protected locations to minimize intake of contaminants (i.e. avoid pollutants near air intake locations, including plantings, parking areas, garbage disposal bins, and others).	Submit annotated drawings showing and describing air intake locations.	Mechanical
3.06	For perimeter zones (i.e. zones that are subject to outdoor air conditions), size ventilation rate to the greater requirement of CSA Z317.2 air change rates or the air change rate necessary to meet the facility end life cooling requirement.	Submit a narrative that describes approach to maintaining appropriate ventilation rate for perimeter zone, including annotated drawings as appropriate.	Mechanical
3.07	Provide atomizing humidification systems complete with RO system feed and UV recirculation sterilization to achieve 40 to 60% relative humidity (RH) in all areas of the facility requiring humidification, noting that RH ranges are a function of room temperature ranges (see CSA Z317.2); systems are centralized; and, localized humidification is not acceptable.	Submit a narrative that describes approach to achieving a 40-60% relative humidity range.	Mechanical
3.08	All regularly used exterior entrances to the facility will have a vestibule as specified. These vestibules will: • Use doors that will be motion-sensor activated by push-button controls, and equipped with manual override controls located on the inside and outside of the doors, to be activated in the event of adverse outdoor air quality. • Provide double entries for high traffic areas, such as emergency rooms and loading bays, to minimize smoke and particulate matter ingress in the event of adverse outdoor air quality. • Provide means to control pressure differential between building, vestibule and exterior. • Be positively pressurized relative to atmospheric pressure to minimize infiltration. • Be designed as not to impede wayfinding, and movement by wheelchairs and stretchers, such that the intended function is preserved when slower-moving people use the entrance.	Submit annotated drawings showing approach to vestibule design, and include a narrative of how pressurized vestibules will be tested in different seasons by pressure sensor or by tracer smoke.	facility Configuration & Internal Circulation
3.09	Conduct whole building air leakage testing prior to occupancy to ensure leakage is under 1.27L/m2 @ 75 Pa. In conjunction with this test, conduct an infrared scan to identify potential leakages and complete duct leakage testing.	As part of the commissioning process, submit compliance report with modelling results, including narratives and annotated drawings as appropriate that summarize measures included to reduce air leakage. For infrared scan, include photographic evidence that the scan as been conducted.	Envelope & Enclosure
3.10	Monitor and communicate indoor air quality to staff. Monitor and communicate outdoor air quality to staff and patients.	Submit a narrative that describes how air quality will be continuously monitored and communicated.	Operations

Flooding

#	Requirements	Compliance Measures	Requirement Category
4.01	Conduct a risk assessment to determine site-level flood risk, along with any existing requirements (e.g. flood construction levels or FCL, minimum elevations): • For urban (pluvial) flooding: Review local government documents for locally downscaled future climate data. Review the Provincial Stormwater Planning Guidebook for additional information on managing rainfall issues. • For riverine (fluvial) flooding: Review Provincial and regional flood maps and evaluate the highest magnitude freshet flood events for present day, 2050 with climate change, and 2100 with climate change. • For sea level rise: Review local government documents and the Provincial Sea Level Rise Adaptation Primer, which recommends taking the following numbers into account for sea level rise: 0.5m for 2050, 1m for 2100 and 2m for 2200. Evaluate sea level rise needs alongside storm surge effect.	Complete a risk assessment report detailing the kinds of flooding the project is at risk of, as well as the sources of information used to derive conclusions..	Facility Planning
4.02	Develop a *Flood Management Plan* that demonstrates: • Overall approach to flood mitigation (e.g. resist flooding, accommodate flooding). • Current flood construction level (FCL) and design to withstand anticipated pressure. If resisting flooding: • Design basement structure and envelope to ensure they are waterproofed and/or watertight. • Consider back-up measures if flooding occurs. If accommodating flooding: • Locate and/or protect of key systems (i.e. electrical, mechanical) and services (e.g. elevator pits, circulation, back-up power). • Identify areas that can be repurposed before, during and after flooding (e.g. for retention). • Plan to minimize effort and reduce time associated with water removal and clean-up (e.g. site grading, pumps, water-resistant materials). • Specify suitable materials in flood area for easy cleaning, repair or replacement. • Ensure occupant safety and critical hospital functions during flood events.	Complete a *Flood Management Plan* with narratives and annotated drawings as appropriate	Facility Planning
4.03	Develop a *Stormwater Management Plan* for the site that demonstrates how the project will: • Limit post-development 10-year flow rate from on-site discharged to the off-site storm sewer will be no greater than the 10-year pre-development flow rate, with pre-development flow rate based on 2014 IDF curves and post-development flow rate based on 2100 IDF curves to account for climate change. • Ensure that infiltration, capture and conveyance systems account for adjusted climate projections based on 100-year IDF curves for end of facility life. Where site-specific updated future IDF curves do not exist, add 20% to rainfall intensity for a nominal factor of safety. • Ensure proper site drainage so that rain, snowmelt and freeze/thaw is prevented from entering the building and from pooling on site, typically achieved through increased soil infiltration, decreased impervious surfaces, and grey infrastructure such as retention tanks. • Capture and 'treat' 90% of average annual rainfall volume on site. • Limit transference of sediment and contamination to neighbouring sites.	Complete a *Stormwater Management Plan* with narratives and annotated drawings as appropriate, including modelling results using IDF curves.	Facility Planning
4.04	Incorporate waterproofing strategies into below grade concrete in accordance with geotechnical conditions, and demonstrate how the project team will: • Reduce water infiltration directly adjacent to the buildings foundation, especially if a below grade structure is present. • Apply moisture and vapour barriers to prevent moisture problems. • Design for service life of the building. • Ensure verification during construction. • Ensure coordination with all other building systems and penetrations.	Submit a narrative that describes waterproofing strategies, including annotated drawings as appropriate.	Envelope & Enclosure
4.05	Use site grading to direct water away from buildings, and permeable paving materials to improve overall rainwater infiltration capacity of the site.	Submit landscaping plan with narratives and annotated drawings as appropriate.	Landscape
4.06	Account for future climate projections in the design of roof drainage and rainwater leaders. Capacity of design should be increased by an additional 20% above current municipal bylaw requirements.	Submit annotated drawings showing roof drainage system and highlighting capacity.	Envelope & Enclosure

Power Outage

#	Requirements	Compliance Measures	Requirement Category
5.01	Develop an Emergency Power Supply Management Plan that identifies: • Power requirements for different parts of the facility, including clinical functional and inpatient rooms. • Critical and non-critical loads throughout the facility, including building systems. • Approach to providing back-up power and fuel to allow the facility to operate for at least 72 hours in the event of an emergency, as per CAN/CSA Z32. • Approach to ensuring redundancy in back-up power (i.e. minimum of two back-up power systems and required fuel). • Approach to ensuring that back-up power sources are resilient to climate-related hazards (e.g. extreme heat events, flooding).	Complete an *Emergency Power Supply Management Plan* with narratives and annotated drawings as appropriate.	Facility Planning
5.02	Conduct pre-development modelling and post-development testing to ensure the efficacy of back-up power systems: • Within the energy model, simulate a power outage and demonstrate building conditions under this scenario (e.g. power usage, temperature). • Ensure that interior temperature does not exceed defined maximum temperatures for different areas of the facility (as per ASHRAE 55) under future climate scenarios (e.g. RCP 8.5 in 2050). • Test generators per recommendation of manufacturers.	Submit modelling results with narratives and annotated drawings as appropriate that summarize building conditions during a power outage. Submit commissioning reports for generator testing.	Electrical
5.03	Conduct a site-wide renewable energy feasibility study to assess power supply, availability and renewable energy options. At a minimum: • Ensure facility is 'solar-ready' (i.e. designed to accommodate the installation of solar panels, even if it doesn't take place at time of construction) and place mechanical equipment placed at north end of roof to minimize shading of panels. • Ensure site structures are solar-ready and are designed for access to a power supply. • Ensure facility is 'battery-ready' (i.e. design for easy installation of batteries in the future) by considering future space and location requirements for on-site battery storage.	Submit study results with narratives and annotated drawings as appropriate.	Facility Planning
5.04	Ensure building management systems (BMS) and/or electrical infrastructure is designed to allow for segregation of loads.	Submit a narrative that describes the approach to load segregation.	Electrical
5.05	Design electric vehicle (EV) charging infrastructure on the site to facilitate power sharing (i.e. capable of sharing the energy storage in EV batteries with the facility when needed).	Submit a narrative that describes the approach to power sharing.	Electrical
5.06	Provide Level 3 EV charging infrastructure in 50% of ambulance parking stalls.	Submit annotated drawings showing EV charging infrastructure locations.	Electrical

Chronic Stresses: Water Shortage & Drought

#	Requirements	Compliance Measures	Requirement Category
6.01	Develop an Emergency Water Shortage Plan that demonstrates: • Risk assessment of compromised water supply and/or lower water pressure under different future climate scenarios. • Water use survey of operational needs by department, along with formalized hierarchy of use under constrained conditions. • Water conversation measures to reduce demand. • Based on risk assessment and survey results, identify appropriate amount of on-site storage for potable and process water, including potential for rain/grey water systems.	Complete an *Emergency Water Shortage Plan* with narratives and annotated drawings as appropriate, including modelling results using future weather files.	Facility Planning
6.02	Provide landscape plans that demonstrate how the project will reduce potable water used for irrigation, covering topics such as maintenance, water availability, and irrigation methods. If used, all extensive green roof areas are to have low maintenance requirements and be appropriate for the micro-climate of each roof area.	Submit landscape plans with narratives and annotated drawings as appropriate that highlight strategies for potable water used for irrigation.	Landscape
6.03	For all planting at the project, select plants that are non-invasive and drought-tolerant, and that generate limited pollen. All plant selections should be appropriate for the current and projected micro-climate conditions of the site. For optimal health and climatic co-benefits (e.g. urban heat island effect reduction), selections should enhance natural canopy at the site an incremental rate of 10% per year until 40% coverage is attained.	Submit plant list that explains plant selection, along with narrative illustrating pathway towards 40% natural canopy coverage.	Landscape

Chronic Stresses: Moisture & Humidity

#	Requirements	Compliance Measures	Requirement Category
7.01	Ensure chiller plant is sized to account for future humidity loads and rather than historical conditions. Consider alternate methods of dehumidification (e.g. desiccation) to reduce loads on the chiller.	Submit a narrative that describes the approach to managing humidity loads, including annotated drawings as appropriate.	Mechanical
7.02	Design for relative indoor humidity of between 40% and 60%, using future climate projections to guide design.	Submit a narrative that describes the approach to maintaining relative indoor humidity between the specified range.	Mechanical
7.03	Demonstrate how condensation will be passively managed throughout the building envelope and under future climate conditions over the lifespan of the facility (i.e. without need for mechanical systems under power outage).	Submit a narrative that describes the approach to managing condensation, including annotated drawings as appropriate.	Envelope & Enclosure

Chronic Stresses: Freeze/Thaw

#	Requirements	Compliance Measures	Requirement Category
8.01	In areas where permafrost is a consideration, carry out a study of impacts to permafrost due to climate change and document overall approach to permafrost management and ensuring structural stability: • Keep soil frozen • Keep soil thawed • Isolate project from active layer	Submit permafrost study results with narratives and annotated drawings as appropriate that summarize measures to ensure structural stability.	Structural
8.02	Use high-performance insulation and air sealing to eliminate the escape of heat from conditioned areas. Locate exhaust away from enclosure materials which are susceptible to high humidity micro-climates.	Verify high-performance insulation at time of construction, working closely with contractor to ensure that proper materials and practices are used.	Envelope & Enclosure

Chronic Stresses: Snowfall

#	Requirements	Compliance Measures	Requirement Category
9.01	Conduct a site-wide snow study that includes all buildings and demonstrates: • How the project has considered historic and future snowfall projections (i.e. likely range of snowfall increase or decrease). • How the project will account for changing properties of future snowfall (e.g. heavier/wetter snowfall in some areas). • For locations where snowfall is projected to increase, how the building design will account for increased snow loads; In this, do not assume that a current safety factor (e.g. 1.25 for buildings classified as 'post-disaster') amounts to future-proofing for extreme events. • Consideration of snowfall impacts of beyond the facility, including localized flooding, transportation disruptions, etc. • Consideration of the impacts of wind exposure and snow drifting, and how to protect pedestrian movement and ensure that all spaces remain accessible.	Submit snow study results with narratives and annotated drawings as appropriate.	Facility Planning
9.02	Develop a site-wide *Snow Management and Safety Plan* that demonstrates: • Approach to ensure that snowfall is quickly cleared to allow safe access and movement around the site. • Confirmation of whether the facility has its own equipment/resources or will rely on an external contractor. • Identification of locations where snow will be stockpiled. • Approach to addressing snow and icicles falling off roofs, and potentially creating a hazard for pedestrians and blocking entrances. The Plan should include: • Whether snow can be safely removed from the roof in a timely manner. • Confirmation that the Plan does not create unbalanced snow loads. • Occupational health and safety and fall protection requirements. • How and when retrofit structural evaluations and strengthening are required when a roof is found to need frequent snow/ice removal. • Barrier placement to protect the public, if required.	Complete a *Snow Management and Safety Plan* with narratives and annotated drawings as appropriate.	Facility Planning
9.03	Where required for safety and not addressed by alternative approaches, include snow melting systems for critical entry points (e.g. helipads, loading bays). In exterior sloped areas (e.g. ramps), include radiant heating, hydronic heating systems, or heat tracing, ideally sourced from waste heat.	Submit annotated drawings showing snow melting system locations and features.	Architectural

Chronic Stresses: Wind & Storms

#	Requirements	Compliance Measures	Requirement Category
10.01	Conduct a site-wide wind study that includes all buildings and demonstrates: • How the project has considered present and future wind velocities based on data provided by climate science authorities (e.g. PCIC), noting that wind projections will vary greatly; In this, do not assume that a current safety factor (e.g. 1.25 for post-disaster buildings) amounts to future-proofing for extreme events. • Assumed forces and wind pressures for base building design, cladding design, sections and roofs. • Potential hazard areas and features (e.g. trees, overhangs). • Measures in place to keep building materials and site elements (e.g. lighting, signage, exterior shades, canopies) secure, so that they do not become projectiles during extreme wind events. • Areas where impact-resistant materials could be used. • Implications for rooftop equipment and renewable energy systems (e.g. solar PV). • If wind study results are more onerous than the BC Building Code, this study will take precedence.	Submit wind study results with narratives and annotated drawings as appropriate that summarize measures to mitigate wind risk.	Facility Planning
10.02	If wind speed thresholds (to be defined) are projected to be exceeded, include site-level measures to protect pedestrians (e.g. wind breaks, buffers) and access areas (e.g. loading docks, door assemblies, vestibules, ambulance bay).	Submit narrative and annotated drawings as appropriate.	Architectural
10.03	When locating equipment on the roof cannot be avoided, all rooftop equipment is to be constructed to withstand the year 2050 wind loads as per future climate projections. Approaches to include installation of protective barriers and bolting down of all equipment.	Submit narrative and annotated drawings as appropriate.	Mechanical

APPENDIX D: RESILIENT DESIGN STRATEGIES

Throughout the development of the Resilience Guidelines, the Task Force has generated a fulsome list of potential Resilient Design Strategies to increase health facility resilience to climate change. These are based on industry best practices and emerging approaches, and represent the current state of industry knowledge in BC. While objectives and requirements are mandatory, Resilient Design Strategies should be considered as examples and a starting point for discussion. Design teams are encouraged to push the envelope with innovative strategies and approaches, and to share their successes and insights to help move the industry forward.

These design strategies are linked to the most applicable hazard, and most likely requirement category, scale, and lead team. [20] This is supplemented with a high-level overview of potential synergies and conflicts with other Health Authority goals and objectives, including reducing GHG emissions (i.e. per legislated and / or project targets) and increasing seismic and pandemic resilience. Note that strategies for reducing emissions may vary regionally (e.g. depending on how electricity is generated).

Warming Temperatures & Extreme Heat

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Explore opportunities to emphasize role of the facility as a cooling centre and/or community resilience hub.	General Resilience	Off-site	Owner/Operator	Neutral	Positive	Positive
Allow extra space, pipe, coil or ductwork allotment for future mechanical cooling equipment.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Carefully consider the tension between over- and under-sizing equipment. Use modular and/or scalable mechanical units for critical equipment, functions or areas.	Mechanical	Building	Mechanical	Neutral	Neutral	Neutral
Ensure that mechanical systems can provide real-time feedback that allow the end user to manually modulate the system.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Explore opportunities for thermal storage through a separate heat exchanger, using tanks, earth or groundwater. For example, pull cool air through the ground (i.e. 'earth tubes') via the air handling unit.	Mechanical	Building	Mechanical	Positive	Neutral	Neutral
Increase sewage retention tank capacity for heat recovery storage.	Mechanical	Building	Plumbing	Positive	Neutral	Neutral
Ensure that pipes are easy to access for future upgrades and include provisions for future connections (e.g. flanges, tied-in valves).	Mechanical	Building	Plumbing	Neutral	Positive	Positive
Reserve space adjacent to buildings and across the site for future mechanical equipment.	Mechanical	Site	Architect	Neutral	Neutral	Neutral
Include passive design measures that encourage natural ventilation (e.g. use both high and low windows).	Facility Configuration & Internal Circulation	Building	Architect	Positive	Neutral	Positive
Provide exterior shading (both passive and active), especially for glazing on south and west facades.	Facility Configuration & Internal Circulation	Building	Architect	Positive	Neutral	Neutral
Where appropriate considering future climate conditions, employ thermal mass strategies for passive cooling.	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Neutral	Positive
Include operable windows in strategic locations for back-up cooling and night purge, noting that night purge will become less effective over time as overnight temperatures increase.	Facility Configuration & Internal Circulation	Building	Architect	Positive	Neutral	Positive
Create internal corridors and atriums that are self-shading.	Facility Configuration & Internal Circulation	Building	Architect	Positive	Neutral	Neutral
Orient buildings and open spaces to maximize passive cooling (e.g. layout and form that encourages natural airflow).	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Neutral	Positive

20 Resilient Design Strategies (by discipline) are available for download here.

Warming Temperatures & Extreme Heat (continued)

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Provide dedicated storage room(s) for critical spare parts and supplies (e.g. chiller components, filters).	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Positive	Positive
Design for future flexibility during extreme events (e.g. using the parkade for storage of supplies, using the lobby for an influx of patients).	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Positive	Positive
Use high-albedo building materials (e.g. white materials for roofs).	Envelope & Enclosure	Building	Architect	Positive	Neutral	Neutral
Permit high window-to-wall ratios (WWR) only where shown to be critically needed, balancing the need for natural light.	Envelope & Enclosure	Building	Architect	Positive	Neutral	Neutral
Where solar gain and overheating are a concern and have not been addressed with external shading options, use high-efficiency triple-glazed windows with low solar heat gain coefficients to improve thermal comfort.	Envelope & Enclosure	Building	Envelope	Positive	Neutral	Neutral
Use biophilic design to complement cooling strategies and promote positive health outcomes for occupants.	Landscape	Building	Architect	Neutral	Neutral	Neutral
Utilize local, heat- and drought-tolerant planting, and low-pollen trees to optimize shading across the site.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Minimize heat absorbing surfaces in open spaces with low-pollen planting.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Provide exterior areas of respite under tree canopy.	Landscape	Site	Landscape Architect	Neutral	Neutral	Positive
Inventory and reduce areas that contribute to the urban heat island effect.	Landscape	Site	Landscape Architect	Positive	Neutral	Neutral
Utilize high-albedo paving on walkways and parking areas.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Classify rooms as critical and non-critical, and develop and implement a temporary cooling load shedding strategy for extreme heat events.	Operations	Building	Owner/Operator	Neutral	Neutral	Neutral
Transfer waste heat not utilised by facilities to other building or community partners.	Operations	Off-site	Owner/Operator	Positive	Neutral	Neutral
Draft agreements to the local government to establish numerous cooling centres and/or spaces of refuge to prevent facility overload.	Operations	Off-site	Owner/Operator	Neutral	Positive	Positive

Air Quality Impacts

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Use desiccant, oversized chillers to achieve dehumidification under high external humidity conditions.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Use enhanced sealing for filters and bypass systems to eliminate gaps that reduce effectiveness. Plan for duct air leakage testing and commissioning.	Mechanical	Building	Mechanical	Neutral	Neutral	Positive
Allocate space both near equipment and elsewhere in the building for storage and stockpiles of enhanced filters (e.g. carbon, MERV 14, HEPA).	Facility Configuration & Internal Circulation	Building	Architect	Neutral	Neutral	Positive
Consider significantly enhanced airflow capability for 'pandemic mode'.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Consider displacement or separate system for outside air ventilation to improve ventilation effectiveness. Intention is to deliver highest quality air close to people and removing contaminants out of breathing zone.	Facility Configuration & Internal Circulation	Building	Mechanical	Positive	Neutral	Positive
Design for colder months by including mechanical ventilation via high-efficiency ERVs to allow higher levels of outside air in peak influenza season. Ensure that system does not contribute to cross-flow contamination.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Design for outbreak zones that include 100% outside air, reduced air changes, ultraviolet sanitization and high-performance filtration.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Allow for 100% recirculation capacity or 'wildfire mode' that can be employed for short periods of time, which requires that the building is almost leak free and ventilation system has carbon filter capability.	Facility Configuration & Internal Circulation	Building	Mechanical	Negative	Neutral	Positive
Use natural ventilation for extended periods of year (i.e. spring, summer, fall), which is made possible in buildings with high-performance insulation. Provide operable windows in patient rooms, to cut mechanical supply to the room but still allow for room exhaust. Provide a red light/green light system at the window to warn when it should not be opened (e.g. high smoke or wind events).	Facility Configuration & Internal Circulation	Building	Mechanical	Positive	Neutral	Positive
Use non-recirculating air systems where possible with high levels of heat recovery,	Facility Configuration & Internal Circulation	Building	Mechanical	Positive	Neutral	Positive
Minimize sources of pollutants near air intake locations, including plantings, parking areas, garbage disposal bins, and others.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Provide generous outdoor spaces with ample trees and planting to improve local air quality. Consider providing cover in select areas for meetings and meal breaks and to encourage people to use outside spaces. Note the importance of ensuring adequate fuel breaks and/or omitting trees in areas where wildfires are a concern.	Landscape	Site	Landscape Architect	Neutral	Neutral	Positive
Focus on low-pollen trees and plantings to minimize allergens.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Explore opportunities to clean filters (e.g. roll filters, including grade of pre-filters to deal with smoke and pollen particulate).	Operations	Building	Mechanical	Positive	Neutral	Positive
Allocate space for storage of extra personal protective equipment (e.g. masks) to enable expansion of triage efforts.	Operations	Building	Owner/Operator	Neutral	Positive	Positive
Provide space for oxygen tanks and other key supplies in interior refuge areas to help them serve as flexible treatment areas.	Operations	Site	Owner/Operator	Neutral	Neutral	Positive

Where further explanation or detail is required, refer to Online Resources.

Flooding

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Explore whether the building is at high risk of flooding. If high, determine whether below-grade floors should be included into design at all (i.e. survivability test). Dovetail with site selection and site programming.	General Resilience	Building	Architect	Neutral	Positive	Neutral
Wherever possible, locate key services (e.g. electrical rooms, back-up power) on higher floors at little risk of flooding. Locate electrical room, unit substation, generator and fuel on a floor above future flood construction level.	General Resilience	Building	Architect	Neutral	Positive	Neutral
Review vulnerability of traffic routes to flooding or other extreme events.	General Resilience	Off-site	Owner/Operator	Neutral	Positive	Positive
Review local regulations that may inhibit ability to address flooding (e.g. parking bylaws/requirements, setback requirements, accessibility requirements). Note that there is time to address conflicts with regulations before 2030/2050.	General Resilience	Off-site	Owner/Operator	Neutral	Neutral	Neutral
Ensure elevator controls and all major electrical components are placed above the flood construction level to avoid flooded areas and inspect elevators after a flood.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Ensure hydraulic elevator machine rooms are located above the flood construction level to prevent flooding, and install locking systems (e.g. float switch systems) to prevent elevator cabs from descending below lowest floor or base flood level.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Separate electrical panels for parkade and for levels above future flood construction level (FCL). Allow for safe shut-off of systems below FCL in case of a flood.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Protect electrical equipment with waterproof enclosures.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Include measures to protect below grade exterior foundation walls from moisture ingress. Consider holistic approaches, including the use of continuous fully-reinforced membrane waterproofing system and concrete waterproofing ad-mixture (including construction cold-joint waterproofing and at all mechanical or electrical service penetrations through the below-grade foundation walls). Provide accessibility for future repairs.	Envelope & Enclosure	Building	Envelope	Neutral	Positive	Neutral
Where necessary, select higher performance, water-resistant building materials to reduce damage to building structure, envelope and interior finishes. Ensure that materials are also mould-resistant.	Envelope & Enclosure	Building	Envelope	Neutral	Positive	Neutral
Identify any rooftop mechanical systems at risk of flooding. Ensure to fix any roof leaks when adding new rooftop equipment. Ensure all mechanical equipment is placed on pedestals/curbs higher than perimeter scuppers.	Envelope & Enclosure	Building	Mechanical	Neutral	Neutral	Neutral
Provide additional potable water storage or additional water treatment capacity to ensure potability of supply during flood events. Look for locations to store water conveniently (e.g. on the roof coupled with seismic damper) to provide continued access to potable water under conditions where the water supply has been contaminated.	Envelope & Enclosure	Building	Plumbing	Neutral	Positive	Neutral
Reinforce underground walls to withstand the pressures from floodwaters (if feasible), and include removable barriers or flood proof doors or gates at all entrances below the FCL. Note need to 'tank' structures below FCL.	Envelope & Enclosure	Building	Structural	Negative	Neutral	Neutral
Account for 'short cuts' for floodwaters to and within a building (e.g. shafts, soil gas vents, electrical conduits). Consider performance of area drains in landscaped plazas below future flood construction level.	Plumbing & Storm/Sewer	Building	Envelope	Neutral	Neutral	Neutral

Flooding (continued)

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Install heavy-duty duplex sump pumps at the lowest point of the floor, with back-up power supply and regular testing. Using pump controllers, alternate lead and lag pump on a regular basis (e.g. quarterly) to distribute excess wear and lessen chance that pumps will burn-out during a major flood event.	Plumbing & Storm/Sewer	Building	Plumbing	Neutral	Neutral	Neutral
Install check valves or backflow valves in third pipe, storm and sanitary sewer lines. Install check valves in the body of any below grade floor drains and/or permanently seal any floor drains that are no longer required. Note that backflow valves on sanitary systems must be specified as 'normally open' to allow air flow during normal conditions.	Plumbing & Storm/Sewer	Building	Plumbing	Neutral	Neutral	Neutral
Slope lower level towards a dedicated location to allow for pumping of flood water (e.g. parkade vent shaft). Identify potential for use of existing programming (parking) as detention.	Plumbing & Storm/Sewer	Building	Structural	Neutral	Neutral	Neutral
Conduct topological site survey and grading review to better understand stormwater flows.	Plumbing & Storm/Sewer	Site	Landscape Architect	Neutral	Neutral	Neutral
Review maps of historical streams and watercourses, many of which are now piped, to better understand water flow on and near the site.	Plumbing & Storm/Sewer	Site	Landscape Architect	Neutral	Neutral	Neutral
Install on-site sanitary and storm holding tanks in event the municipal system is compromised. Determine design requirements for sizing the sanitary holding tank.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Positive	Positive
Coordinate efforts to establish a continuous physical barrier to floodwater inundation (e.g. structural barriers harmonised across multiple developments) to better protect the surrounding area.	Plumbing & Storm/Sewer	Off-site	Owner/Operator	Negative	Neutral	Neutral
Coordinate with regional strategies to address loss of services at sites at risk of flooding or other extreme events.	Plumbing & Storm/Sewer	Off-site	Owner/Operator	Neutral	Positive	Positive
Carry out dye testing to determine off-site capacity of the storm and sanitary systems.	Plumbing & Storm/Sewer	Off-site	Owner/Operator	Neutral	Neutral	Neutral
Install native vegetation and green infrastructure (e.g. rain gardens, infiltration swales, green roofs, rainwater harvesting, daylighted streams and constructed wetlands) to improve water detention, conveyance, and ground permeability. Use flood- and contamination-resistant species where possible.	Landscape	Site	Landscape Architect	Positive	Neutral	Neutral
Incorporate landscape features such bioswales with native plants to absorb and redirect water on-site. Identify surface flow paths from local plans to avoid inadvertently interrupting these paths.	Landscape	Site	Landscape Architect	Positive	Neutral	Neutral
Where appropriate considering site geology, use permeable paving materials and slope grade away from structures to improve overall rainwater infiltration capacity of the site, reducing the pressure on sewer systems.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Design site stormwater conveyance away from structures for increased volumes and flows.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Ensure downspouts are directed to rock pits (where geology allows) or detention facilities and away from backfill zones. Ensure rainwater volumes are not directly conveyed to the storm sewer systems, except where stormwater systems are designed to accommodate flows.	Landscape	Site	Plumbing	Neutral	Neutral	Neutral
Program space in the planning phase for storage of temporary flood barriers close to where they will be used.	Operations	Building	Architect	Neutral	Positive	Neutral

Power Outage

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Provide back-up power to cooling systems at a minimum for priority service areas and priority process loads.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Provide back-up power for building management control systems.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Consider potential decrease in solar photovoltaic feasibility during wildfire smoke events.	Electrical	Building	Electrical	Neutral	Neutral	Neutral
Ensure that multiple types and sources of back-up power are available.	Electrical	Building	Electrical	Positive	Positive	Neutral
Include structured attachments for solar photovoltaic equipment to account for increased wind loads and to ensure panel will not lift off during extreme events.	Electrical	Building	Electrical	Neutral	Positive	Neutral
Incorporate demand management and load sharing for critical loads.	Electrical	Building	Electrical	Positive	Positive	Neutral
Explore the use of hybrid system for back-up power generators (i.e. not entirely reliant on fuel or solar). Where this is not appropriate, design for more flexible and robust diesel fuel generator systems.	Electrical	Building	Electrical	Positive	Positive	Neutral
If not incorporated upfront, provide rough-ins for solar photovoltaic equipment to ensure facility is 'solar-ready'.	Electrical	Building	Electrical	Positive	Neutral	Neutral
Zone spaces throughout the facility as critical and non-critical to minimize required back-up power.	Electrical	Building	Electrical	Positive	Positive	Neutral
Provide increased space near generators for more fuel storage.	Electrical	Building	Architect	Negative	Positive	Neutral
Review the feasibility of using battery storage. If not feasible, plan to accommodate future use of battery storage and decreased use of fossil fuels.	Electrical	Site	Electrical	Positive	Neutral	Neutral
Encourage flexibility in power management through load shedding and time-of-day usage.	Electrical	Site	Owner/Operator	Positive	Positive	Neutral
Explore the use of neighbourhood roofs for solar power generation for the facility via 'lease arrangements', with mandates to supply the facility during an emergency.	Electrical	Off-site	Owner/Operator	Positive	Positive	Neutral
Adapt building programming to better accommodate power outages.	Operations	Building	Electrical	Neutral	Positive	Neutral
Educate operators on what loads are included on back-up power, looking to CSA 282 for what is considered vital, conditional, delayed and normal.	Operations	Building	Electrical	Neutral	Positive	Neutral
Implement weekly testing of back-up power systems as per CSA Z32, and provide training for staff on this process.	Operations	Building	Owner/Operator	Neutral	Positive	Neutral
Use portable generators to power extended treatment areas and triage spaces only where other options are not feasible. Note challenges of portable generators, such as infection control issues, safety issues and potential fire hazards, security issues and potential theft, and required maintenance of generators.	Operations	Site	Owner/Operator	Negative	Positive	Neutral

Chronic Stresses: Water Shortage & Drought

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Identify appropriate amount of water storage based on projected drought scenarios.	Plumbing & Storm/Sewer	Building	Plumbing	Neutral	Neutral	Neutral
Identify locations for non-potable water storage on site.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Neutral	Neutral
Consider rainwater collection systems as a source of non-potable water and passive cooling during water shortages.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Positive	Neutral
Advocate for the use of and/or introduce purple pipe system for wastewater reuse (specifically clean reverse osmosis 'waste' water) that can supplement non-potable uses.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Neutral	Neutral
Install outdoor water fixtures capable of operating on water pressure (i.e. without electricity) in a location easily accessible to building occupants and community members.	Plumbing & Storm/Sewer	Site	Plumbing	Neutral	Positive	Neutral
Make use of drought-tolerant species in landscaping.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Explore the use of drip irrigation instead of sprinklers.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral
Explore the use of collected rainwater for irrigation.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral

Chronic Stresses: Moisture & Humidity

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
In window and façade design, emphasize the four Ds: deflect, drain, dry and durability.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Ensure materials that may be subjected to high humidity conditions or liquid are chosen based on material and assembly performance, as proven by either testing or from prior evidence of success in similar conditions.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Ensure that details and junctions of envelope components allow for adequate drainage and drying. Combine robust air barrier with external insulation, and locate the structure on the interior of the enclosure to reduce thermal bridging and condensation potential.	Envelope & Enclosure	Building	Envelope	Positive	Neutral	Neutral

Chronic Stresses: Freeze/Thaw

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Set foundational piles below the future projected active permafrost layer on deeper levels of permafrost or bedrock, ensuring to include thermal breaks so that piles do not thaw frozen soil.	Structural	Site	Structural	Neutral	Positive	Neutral
In areas with permafrost, design facility to 'float' on the permafrost. This could possibly be achieved using a system of 'thermosiphons', with the permafrost overlain by an 'active' layer that thaws and freezes through the seasons, while the 'permanent' layer below is perpetually frozen.	Structural	Site	Structural	Neutral	Positive	Neutral
In areas that will be subject to increased freeze/thaw, minimize use of permeable, hard building materials (e.g. exposed concrete, brick).	Architectural	Building	Architect	Neutral	Positive	Neutral
Locate mechanical exhaust away from any roof or wall surfaces or eaves, as escaping warm air can carry moisture that exacerbates freeze/thaw challenges.	Mechanical	Building	Mechanical	Neutral	Neutral	Neutral
Include small roof overhangs to prevent moisture ingress into building materials, recognizing that large overhangs can increase vulnerability to extreme wind.	Envelope & Enclosure	Building	Envelope	Neutral	Neutral	Neutral

Chronic Stresses: Snowfall

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Account for extreme snowfall events, even in areas where total snowfall may be decreasing. The amount of precipitation in extreme events will increase and so the amount that will fall as snow will increase. Consider that warmer temperatures will result in wetter, heavier snow.	General Resilience	Site	Owner/Operator	Neutral	Neutral	Neutral
Account for accompanying extreme wind events with snow fall as appropriate.	Structural	Building	Structural	Neutral	Neutral	Neutral
Determine early on whether to retain snow or let it slide off of the roof and design for those intended conditions.	Structural	Building	Architect	Neutral	Neutral	Neutral
Design roof geometries and appurtenances to consider extreme snowfall events, including the risk of snow dropping from one roof structure to another, which can cause major damage after periods of heavy accumulation.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Locate mechanical equipment indoors for protection and ease of servicing.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Consider protection of roof assemblies to allow for increased snow removal and access to equipment.	Architectural	Building	Architect	Neutral	Neutral	Neutral
For snow sliding off of roof, ensure no roof penetrations or roof feature restrain the snow which could lead excessive loads on these elements.	Envelope & Enclosure	Building	Architect	Neutral	Neutral	Neutral
Look at effects of ponding water above the exterior wall from ice damming.	Envelope & Enclosure	Building	Envelope	Neutral	Neutral	Neutral
Look at ice curl if snow is allowed to slip off of roof to a colder eave section which can push the wall below.	Envelope & Enclosure	Building	Architect	Neutral	Neutral	Neutral
Ensure that roof drainage systems consider future precipitation and snowfall projections.	Plumbing & Storm/Sewer	Building	Plumbing	Neutral	Neutral	Neutral

Chronic Stresses: Wind & Storms

Design Strategy	Requirement Category	Scale	Lead Team	Impact on GHG Emissions Reductions	Impact on Seismic Resilience	Impact on Pandemic Resilience
Mitigate increased wind load using aerodynamically efficient structures to reduce deflection and resonance, including curved corners, minimized eave overhangs and better foundation design.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Ensure that building attachment details are capable of withstanding stronger winds, focusing on anchorage between different elements (e.g. floors to walls, cladding to building).	Architectural	Building	Architect	Neutral	Neutral	Neutral
Consider wind pressure and wind tunnel effects when selecting the location and design of the main entrance.	Architectural	Building	Architect	Neutral	Neutral	Neutral
Avoid rooftop/exterior equipment wherever possible, making use of larger penthouses and/or louvres to protect equipment.	Mechanical	Building	Mechanical	Neutral	Neutral	Neutral
Ensure rooftop equipment and renewable energy systems (e.g. solar PV) are designed to withstand extreme wind or precipitation.	Mechanical	Building	Electrical	Neutral	Positive	Neutral
Select impact-resistant building materials, external claddings and glazing where continuous load path may be insufficient to protect the structure (e.g. heat soaked glazing).	Envelope & Enclosure	Building	Envelope	Neutral	Neutral	Neutral
Consider topography and landscape details that can help to mitigate high winds. Design the site with wind breaks and buffers to help people can get safely from transit and parking to the building.	Landscape	Site	Landscape Architect	Neutral	Neutral	Neutral

APPENDIX E: RESILIENCE SCORED ELEMENTS

The example below may be modified for other regions in BC (e.g. heat warnings with region-specific temperature thresholds).

Requirements

Provide information and documentation specific to the evaluation of the Climate Resilience Scored Element. Address the requirements below. Include text and drawings providing information as noted below.

A. Heat Resiliency – Warmer Temperatures

Provide a narrative and drawings proposing solutions that respond to the climate projections for the future, according to the Pacific Climate Impact Consortium predicted 2050 and 2080 weather files, including:

- ✓ Warmer average temperatures with higher highs, increased variability, earlier starts to the Spring and Summer seasons, and longer duration of warm periods.
- ✓ Meeting interior comfort requirements on tropical nights (nights where the temperature does not drop below 20 °C).

Provide energy model results that verify targets for relative humidity and indoor air temperature as described in Section 7.5 of Schedule 3 to the Final Draft Project Agreement are met in the future climates of 2050 and 2080.

The submission, including drawings, narrative, and energy model outputs, should:

- ✓ Demonstrate the degree to which the proposed design maintains indoor temperature and relative humidity requirements described in Section 7.5 of Schedule 3 to the Final Draft Project Agreement for the New Tower in each of the following design scenarios:
  - RCP8.5 future climate of 2080 with design temperatures:
    - i) Dry Bulb: BCBC 2018 + 6.3 °C
    - ii) Wet Bulb: BCBC 2018 + 5.9 °C
  - RCP8.5 future climate of 2050 with design temperatures:
    - i) Dry Bulb: BCBC 2018 + 5.2°C
    - ii) Wet Bulb: BCBC 2018 + 5 °C
- ✓ Include outputs from the energy model, a new proposed Energy Target (if required) and a summary prepared in accordance with Appendix P and section 3.2.1.8 of Appendix B to this RFP incorporating the proposed solutions and using each of:
  - The current climate; and
  - The design temperatures in Dry Bulb temperatures (i) above.
- ✓ Energy model outputs for relative humidity, indoor air temperature and peak air temperature for all CAN/CSA Z317.2 Type 1 rooms and the most critical LDRP Room and Medical Inpatient Room, including the number of hours where the outputs do not meet the Final Draft Project Agreement requirements and durations when the temperature is above 26 °C, 28 °C and 30 °C for the following scenarios for the 2050 weather file:
  - A power outage in which the New Tower is operating on vital power for the hottest two weeks of the year;
  - A power outage in which there is no electricity available to the hospital for a period of two days during the hottest two weeks of the year; and

- During tropical nights, with power available.

If future renovations are required to address the Pacific Climate Impact Consortium predicted 2080 weather file, include an estimate of the costs of any required future work, design information in a level of detail adequate to verify the estimate of costs, to a class D level, as well as the timing of when that work will be required.

B. Heat Resiliency – Extreme Heat Waves

Provide a narrative, including any drawings, models, or other information required, proposing provisions that will help maintain the ability of staff to perform their duties without disruption as a consequence of heat and the expectation that heat will lead to an increased number of hospital visits when either (i) or (ii) below is released by Environment Canada:

i) A heat warning (average of today's 14:05h temperature and tomorrow's forecasted high is ≥ 34 ℃ at Abbotsford or ≥ 29 ℃ at Vancouver); or

ii) A special weather statement for hot weather (when temperatures ≥ 32 ℃ are expected for at least two consecutive days at Abbotsford, Hope or Pitt Meadows weather stations).

Evaluation Criteria and Weighting

A. Heat Resiliency – Warmer Temperatures (9 points)

Objective: The goal of this element is to incent the incorporation of resiliency against warmer temperatures, particularly during the summer months, into the design of the building.

The building design will be scored on the following measurements/statements:

- ✓ The extent to which the design demonstrates that it is able to meet indoor temperature, relative humidity and energy requirements for the facility in climates based on the Pacific Climate Impacts Consortium predicted 2050 and 2080 weather files.
- ✓ The extent to which the submission demonstrates that the design is able to maintain design interior temperature and relative humidity ranges for the scenarios in 5.1.a.iii in Appendix B of this RFP.
- ✓ The extent to which the design demonstrates that it is able to maintain design interior temperatures during tropical nights (nights in which the temperature does not drop below 20 °C.
- ✓ Net present cost of future renovation, if required, to accommodate the future climate of 2080.

Evaluation Approach

Points will be awarded as follows:

Scenario	Requirements
PCIC predicted 2050 weather file	✓ Meets future climate of 2050 design requirements (Dry Bulb = BCBC 2018 + 5.2 C, Wet Bulb = BCBC 2018 + 5 C).
PCIC predicted 2080 weather file	✓ Meets future climate of 2080 design requirements (Dry Bulb = 2050 requirement + 1.1 C, Wet Bulb = 2050 requirement + 0.9 C).
PCIC predicted 2050 & 2080 weather files	✓ Meets future climate of 2050 design requirements, and includes future renovations to meet the requirements of 2080 .
PCIC predicted 2050 weather files	✓ Tropical Nights Reduction (13 rooms). ✓ Type 1 Rooms (11 total). ✓ Most Critical LDRP Room (1 total). ✓ Most Critical Medical Inpatient Room (1 total).
PCIC predicted 2050 weather files	✓ 48 hours power outage during the hottest two weeks of the year.
PCIC predicted 2050 weather files	✓ Out of temperature compliance reduction for 48 hours power outage during the hottest two weeks of the year. ✓ Type 1 Rooms (11 total). ✓ Most Critical LDRP Room (1 total). ✓ Most Critical Medical Inpatient Room (1 total).
PCIC predicted 2050 weather files	✓ Essential power only during the hottest two weeks of the year.
PCIC predicted 2050 weather files	✓ Out of temperature compliance reduction for essential power only during the hottest two weeks of the year. ✓ Type 1 Rooms (11 total). ✓ Most Critical LDRP Room (1 total) ✓ Most Critical Medical Inpatient Room (1 total).

B. Heat Resiliency – Extreme Heat Events (1 points)

Objective: The goal of this element is to incent the incorporation of provisions to maintain the health, well-being and productivity of staff and accommodate additional hospital visits when a heat warning (the average of today's

14:05h temperature and tomorrow's forecasted high is ≥ 34 ℃ at Abbotsford or ≥ 29 ℃ at Vancouver) or a special weather statement for hot weather (when temperatures ≥ 32 ℃ are expected for at least two consecutive days at Abbotsford, Hope or Pitt Meadows weather stations) is released by Environment Canada.

The building design will be scored on the following measurements/statements:

- ✓ Provisions to protect the health, well-being and productivity of staff, particularly those exposed to the outdoor environment.
- ✓ The extent to which the space is adaptive, to enable the treatment of patients with complications due to extreme heat.
- ✓ Other provisions that enable the hospital to operate efficiently during extreme heat waves.

Evaluation Approach

Protect health, well-being and productivity of staff
Submission demonstrates that the design includes provisions to protect the health, well-being and productivity of staff. Examples include (but not limited to): o Inclusion of shade in outdoor areas where staff may frequent. o Provisions in the design to prevent disruptions to building services due to heat.
Space that is adaptive to enable treatment of patients with complications due to extreme heat
Submission demonstrates that the design will offset the strain on the emergency department from extreme heat. Examples include (but not limited to): o Areas that are adaptive to prevent exposure to direct sunlight. o Appropriate equipment to enable treatment of complications.
Efficient Operation
Submission identifies other provisions that will enable the hospital to operate efficiently during extreme heat waves. Examples include (but not limited to): o Considerations for inpatients' and visitors' needs during an extreme heat wave such as availability of water. o Passive building design elements. o HVAC systems control and integration.