

Moving towards climate resilient health facilities for Vancouver Coastal Health

Lower Mainland Facilities Management, Pinna Sustainability, & Pacific Climate Impacts Consortium (PCIC)

2018

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Lower Mainland Facilities Management

Moving Towards Climate
Resilient Health Facilities for
Vancouver Coastal Health

October 2018

ACKNOWLEDGMENTS

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Angie Woo (LMFM Energy & Environmental Sustainability, Climate Resilience & Adaptation Lead) served as Project Manager, leading the project team, overseeing the work of consultants and editing the final report.

The project team included Kori Jones (LMFM Energy & Environmental Sustainability, VCH Energy Manager) and Florrie Levine (LMFM Planning & Projects, LGH Acute Care Facility Project Manager & VCH Coastal Planning Lead), with support from Susan Scrivens (VCH Perioperative Services Clinical Planner, LGH Acute Care Facility).

The consulting team included 1) Gillian Aubie Vines (Pinna Sustainability) as lead report writer and workshop facilitator; 2) Trevor Murdock and Stephen Sobie (Pacific Climate Impacts Consortium, PCIC) as scientists responsible for climate modelling, analysis and data interpretation; and 3) David Hohenschau (EcoPlan International) as map creator.

VCH COMMUNITIES OF CARE AND CLIMATE PROJECTIONS MAPS

The non-linear scales used to represent each dataset were developed for communication purposes only. In most cases the data distributes more heavily towards the centre of each range, requiring finer increments towards the centre of the distribution and coarser increments towards the extremes.

These indicators are computed using a set of 12 Global Climate Models (GCMs), based on the internationally recognized “business as usual” GHG emissions scenario (Representative Concentration Pathway 8.5, or RCP8.5), and statistically downscaled to the ~10-km grid of the ANUSPLIN historical dataset. Bias correction using the high-resolution (~800 m) climatology was performed to produce the data for each indicator. See the Pacific Climate Impacts Consortium (PCIC) website for more information on the GCMs, ANUSPLIN, the BCCAQ statistical downscaling method, and PRISM (<https://pacificclimate.org/>). For more information on climate scenarios, models and indicators, please see the Methodology section of the Climate Projections for Metro Vancouver report (<http://www.metrovancouver.org/services/air-quality/AirQualityPublications/ClimateProjectionsForMetroVancouver.pdf>).

LIST OF ACRONYMS

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers	IDF	Intensity, Duration and Frequency
BCBC	BC Building Code 2012	IPCC	Intergovernmental Panel on Climate Change
FMBOK	Facilities Management Body of Knowledge	LMFM	Lower Mainland Facilities Management (LMFM or Facilities Management)
FMO	Facilities Maintenance and Operations	PCDS	Pacific Climate DataSet
GHG	Greenhouse Gas	PCIC	Pacific Climate Impacts Consortium
GIS	Geographic Information Systems	VCH	Vancouver Coastal Health
HVAC	Heating, Ventilation and Air Conditioning	WHO	World Health Organization

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BELLA BELLA
 1 RW Large Memorial Hospital
 2 Bella Bella Staff Housing

BELLA COOLA
 3 Bella Coola General Hospital

PEMBERTON
 4 Pemberton Health Centre

WHISTLER
 5 Whistler Health Care Centre

POWELL RIVER
 6 Powell River General Hospital
 7 Willingdon Creek Residential Care
 8 Evergreen Extended Care

SQUAMISH
 9 Squamish General Hospital
 10 Squamish Community Health Centre
 11 Community Mental Health Services
 12 Hilltop House

SECHELT
 13 Sechelt Hospital
 14 Shorncliffe Residential Care
 15 Totem Lodge
 16 Sechelt Community Health Center
 17 Home Health Unit

GIBSONS
 18 Sumac Place Mental Health Tertiary
 19 Community Health Center

VANCOUVER

- | | |
|---|--|
| 47 Detwiller Pavilion Mental Health | 76 Jim Pattison Pavilion |
| 48 Koerner Pavilion Acute Care Hospital | 77 Heather Pavilion |
| 49 Purdy Pavilion Residential Care | 78 Health Centre (to be demolished) |
| 50 Djavad Mowafaghian Centre for Brain Health | 79 Gordon & Leslie Diamond Health Care Centre |
| 51 St Johns Hospice UBCH | 80 Fairmont Medical Building |
| 52 Pacific Spirit Community Health Centre | 81 Eye Care Centre |
| 53 West End Mental Health Team | 82 Doctor's Residence |
| 54 Heart Centre Offices | 83 Child Care Centre |
| 55 Three Bridges Community Health Centre | 84 Leon Judah Blackmore Pavilion |
| 56 Inner City Youth Program | 85 Blusson Spinal Cord Centre |
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| 64 Strathcona Mental Health Team | 93 Center for Concurrent Disorders / Aboriginal Wellness |
| 65 CHEOS Research Offices | 94 Mental Health Emergency Services Program |
| 66 Northeast Mental Health Team | 95 Robert And Lily Lee Family Community Health Centre |
| 67 Kitsilano-Fairview Mental Health Team | 96 Beulah Gardens |
| 68 Jack Bell Research Building | 97 GF Strong |
| 69 Robert H.N. Ho Building | 98 Westside Mental Health Team |
| 70 Willow Pavilion | 99 Evergreen Community Health Centre |
| 71 Tzu Chi Institute | 100 George Pearson Centre |
| 72 Skin Care Centre | 101 Dogwood Lodge |
| 73 Research Pavilion | 102 South Community Health Office |
| 74 Medical Student Centre | 103 Southview Ambulatory Clinic |
| 75 Mary Pack Arthritis Centre | 104 South Mental Health Team |



KEY TO FACILITY LABELS

X:Y,Z

X = Building Number
 Y = (C)ommunity, (A)cute, (R)esidential
 Z = (O)wned, (L)eased, (P)3

- 13:C,O
- 14:R,L
- 15:C,L
- 16:A,O
- 17:R,O
- 18:R,O
- 19:C,L

VCH HEALTH CAMPUSES AND BUILDINGS

Coastal Community of Care

Vancouver Community of Care

Richmond Community of Care

NORTH SHORE

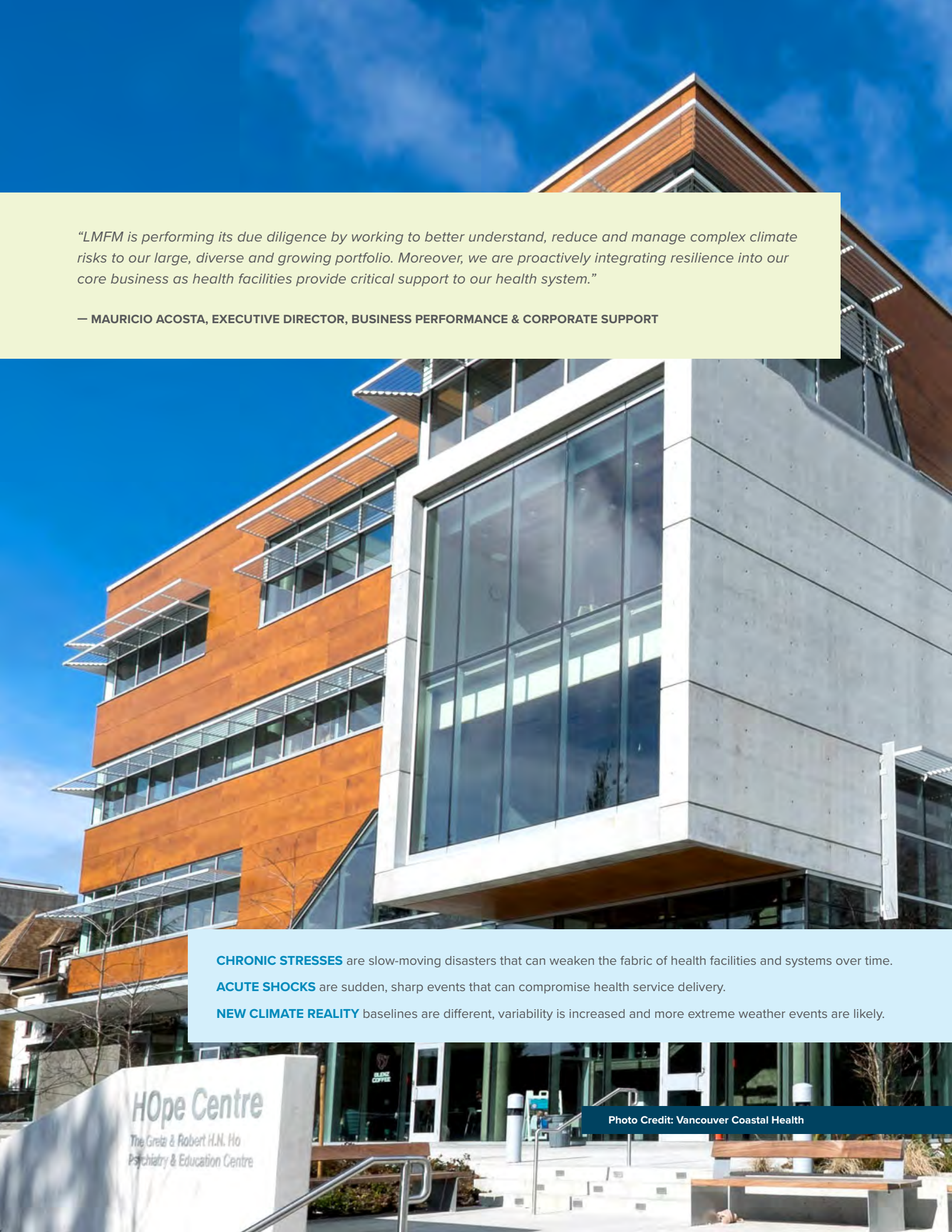
- 20 West Vancouver Community Health Centre
- 21 Lions Gate Hospital
- 22 Evergreen House
- 23 HOpe Centre
- 24 Public Health Parkgate Comm. Health Centre
- 25 Health Connection Clinic
- 26 Central Community Health Centre
- 27 Margaret Fulton Adult & Child Day Centre
- 28 North Shore Mental Health
- 29 North Shore Hospice
- 30 John Braithwaite Community Centre
- 31 Northmount Medical Laboratory
- 32 North Shore Comm. Dialysis Unit
- 33 Berkley Care Centre
- 34 Cedarview Lodge
- 35 Magnolia House Residential



RICHMOND

- 36 Richmond Hospital
- 37 Public Health
- 38 Primary Health Care Services
- 39 6100 Bowling Green
- 40 Bridge House Mental Health Crisis
- 41 8100 Granville
- 42 Home Health Ambulatory Clinic
- 43 Lion's Park Housing
- 44 Horizon House
- 45 Kinsman Mental Health Day Programs
- 46 Fentiman Site Replacement Project (RLM)





“LMFM is performing its due diligence by working to better understand, reduce and manage complex climate risks to our large, diverse and growing portfolio. Moreover, we are proactively integrating resilience into our core business as health facilities provide critical support to our health system.”

— MAURICIO ACOSTA, EXECUTIVE DIRECTOR, BUSINESS PERFORMANCE & CORPORATE SUPPORT

CHRONIC STRESSES are slow-moving disasters that can weaken the fabric of health facilities and systems over time.

ACUTE SHOCKS are sudden, sharp events that can compromise health service delivery.

NEW CLIMATE REALITY baselines are different, variability is increased and more extreme weather events are likely.

HOpe Centre

The Greta & Robert H.N. Ho
Psychiatry & Education Centre

Photo Credit: Vancouver Coastal Health

Executive Summary

Rising temperatures, shifting precipitation patterns, and [extreme weather events](#) are already affecting Vancouver Coastal Health (VCH) and our Communities of Care. [Chronic stresses](#) and [acute shocks](#) are creating a “[new climate reality](#)” for health facilities and service delivery, and **reshaping our working context**.

With this series of reports, Lower Mainland Facilities Management (LMFM) demonstrates forward-thinking public sector leadership; positions health authorities to meet legislated requirements for addressing [climate risk](#) and reducing emissions; and, enables major infrastructure projects to assess climate [resilience](#).

Climate projections for the overall **VCH region** and **11 health facilities** inform our understanding of how trends, weather extremes and year-to-year variations will [impact our ability to support critical health services delivery](#) reliably and cost-effectively in our facilities and communities.

By providing context for our **new climate reality**—such as record-breaking **wildfires**, “**high health risk**” **air quality** and prolonged **heat waves** experienced in 2017 and 2018—this report enables LMFM to better ensure **operational excellence** in step with key collaborators.

To illustrate how **impacts can differ significantly** between the region and a facility, among facilities, and over time, the main report focuses on the VCH region as a whole and on three facilities in particular. For example:

- Maintaining **indoor thermal comfort and air quality across the VCH region** will be most challenging for patients and staff in facilities designed and operated to past climate conditions.
- The increase in the number of days above 30°C will be dramatic at every site, with the greatest percent change at **Richmond Hospital** with **28 days per year above 30°C by 2080** compared to only one day in the past.
- **Lions Gate Hospital** will experience the **greatest increase in tropical nights** per year from 0 nights in the past to 26 nights per year by 2080.
- Managing heavy rain loads will become more challenging with **increased storm intensity** and **overland flood risk**, including in **Squamish**.

Significant opportunities exist today to take a strategic and integrated approach across the VCH facilities portfolio to reduce [risks](#) and increase resilience, including:

- Develop a **climate lens** for new construction and major redevelopment projects that uses 2050 climate projections at minimum to inform design parameters.
- Optimize equipment and building systems to 2020 climate projections today to better ensure that critical functions are supported during shocks and stresses.
- Engage health system stakeholders in resilience planning—including public health, risk management and emergency preparedness—**to build resilience across the VCH health system**.
- Monitor progress in reducing impacts and increasing resilience at the health facility and health system levels.

Information provided in this document adds to our **Facilities Management Body of Knowledge** enabling senior leadership, capital project managers and operational staff to **make better-informed decisions** on how to prepare for the changes we experience already, and to **plan for expected and unexpected changes** during our facilities’ lifespans. The intention is to influence the **design and operations** of our facilities, and inform our discussions with **key institutional and project partners**. Strategic collaboration across our health system on resilience planning will further improve our ability to provide **reliable patient care today and into the future**.



1.0 Introduction

This section reviews the content of and context for this report including evolving climate policy, building codes and bodies of knowledge.

BOX 1: 2018 BC CLIMATE CHANGE ACCOUNTABILITY ACT

In 2018, the Climate Change Accountability Act replaced the 2007 Greenhouse Gas Reduction Targets Act. The following excerpts are relevant to adaptation:

PART 1.1 – PREPARING FOR CLIMATE CHANGE Reports on climate change risks and progress

4.1 Beginning with a report for the 2020 calendar year, and continuing with a report for every subsequent even-numbered calendar year, the minister must prepare and make public, as soon as reasonably practicable for each year, a report respecting

- (a) a determination of the risks to BC that could reasonably be expected to result from a changing climate,*
- (b) the progress that has been made toward reducing those risks,*
- (c) the actions that have been taken to achieve that progress, and*
- (d) the plans to continue that progress.*

SECTION 12 (2) REGULATIONS

[T]he Lieutenant Governor in Council may make regulations [p]rescribing categories of information that public sector organizations must provide to the minister for use in preparing the minister's public report under section 4.1.

Rising temperatures, shifting precipitation patterns, and extreme weather events are already affecting Vancouver Coastal Health and our Communities of Care. **Chronic stresses** and **acute shocks**—such as unprecedented heat, wildfires and floods in 2017 and 2018—are creating a “**new climate reality**” (or “new normal”) for critical infrastructure including hospitals, roads and utilities. In response, new standards and requirements affecting the public sector are emerging, such as the *2018 BC Climate Change Accountability Act* (Box 1), *2016 BC Climate Leadership Plan*¹ and the *National Building Code* (Box 2). These are **reshaping the working context** for LMFM and key collaborators, such as municipalities and social housing, and the **professional workforce** including engineers, architects and planners. Approaches to **risk and disaster management** are also evolving to meet our new climate reality (Appendix 6).

Global [climate model](#) projections offer clear insights into current and future operating conditions. These include:

Warmer summer temperatures,
with hotter and more
EXTREME
heat days in the summer

WARMER winter temperatures,
causing **MORE** winter
precipitation to fall as **RAIN**

**More precipitation,
more intense storms**

during fall, winter and spring months

LESS rain, **LONGER** droughts
during the summer months

**Warmer nights and summers
stretching later in the year**

Our interpretation of global [climate projections](#) indicates that our health facilities’ ability to support health service delivery may be compromised during floods, high winds, wildfires and heat waves, and resulting water and energy restrictions (Figure 1). In addition, our communities may experience increased health risks due to a lack of clean air and water, heat stress, and new water-, air-, and vector-borne diseases that thrive in our warmer climate. This may result in greater, more complex and unforeseen demands for health services that strain under-prepared health facilities and systems.

LMFM has the opportunity to build resilience into our new and existing facilities, and to deepen collaboration with other climate-sensitive health system “building blocks” (Figure 3), ensuring we are able to meet current and future health service needs.

Moreover, as VCH shifts health service delivery from facilities to virtual care, the interconnectedness among public service providers will become more important than ever. Improving our resilience will require **strengthening** cross-sector relationships, **aligning** knowledge and capacity, and **collaborating** in new ways to achieve our vision of being “**leaders** in promoting wellness and ensuring care by focusing on quality and innovation.”²

CHRONIC STRESSES are slow-moving disasters that can weaken the fabric of health facilities and systems over time.

ACUTE SHOCKS are sudden, sharp events that can compromise health service delivery.

NEW CLIMATE REALITY baselines are different, variability is increased and more extreme weather events are likely.

¹ BC committed to “mandating the creation of 10-year emissions reduction and adaptation plans for provincial public sector operations.” (page 41) https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/clp/clp_booklet_web.pdf

² <http://www.vch.ca/about-us/strategy>

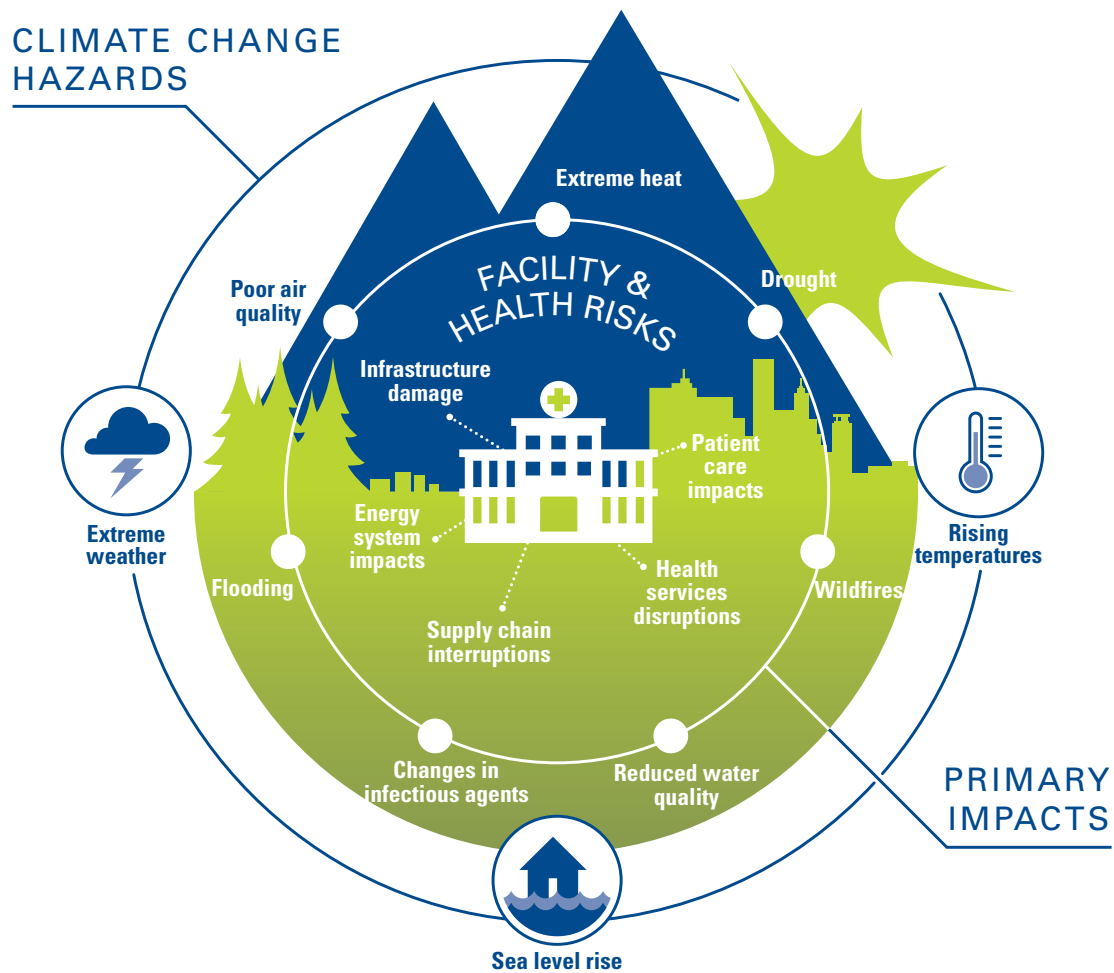


Figure 1: Climate Risks and Impacts to Health Facilities, Service Delivery & Communities.³ Climate hazards include stresses, such as rising temperatures, and shocks, such as extreme weather. These result in primary impacts including extreme wildfires, poor air quality and changes in infectious agents such as mosquitoes and ticks. Cascading impacts⁴ on critical infrastructure - including health facilities, power and water utilities, and roads - can disrupt health service delivery and patient care.

“Climate change has been identified as one of the biggest global health threats of this century and this is expected to pose greater health risks to Canadians from increases in the frequency and magnitude of extreme weather events in years to come. It is critical, therefore, that the planning, design and construction of health care facilities respond to this threat in reducing health impacts from climate change to our communities for the short, medium and long term.”

— NOOR ESMAIL, CHIEF PROJECT OFFICER & EXECUTIVE DIRECTOR, LIONS GATE & RICHMOND HOSPITALS REDEVELOPMENT PROJECTS

³ BC Climate Action Secretariat, [Climate Impacts on Health Facts Sheets](#).

⁴ Globally, cities are working to better understand the cascading impacts of climate change on critical infrastructure through [simulation modeling](#) and [cost-benefit analyses](#).

1.1 Climate Change and Health Facilities

Facilities designed and operated according to design parameters based on historical data (Figure 2a) are not resilient to today's climate, let alone tomorrow's climate.

Climate change has already caused current conditions to be warmer than in the past. As a result, **projections for the year 2020 better describe current conditions than historical, measured data.** This trend is expected to continue over time (Figure 2b), resulting in a new climate reality. As most of the VCH facilities portfolio is over 50 years old, and major health infrastructure can expect to be operational for approximately 80 years, it is important that climate projections inform decisions for existing and new infrastructure.

This report contributes to the **Facilities Management Body of Knowledge (FMBOK)** by providing a foundation for **strategically and systematically** reducing risks and increasing resilience as **building codes, industry standards and legislated requirements** evolve. Designing to current and future climate parameters is markedly more cost effective than reacting to climate shocks and stresses. **New design parameters** (Figure 2b) are intended to illustrate three concepts: **optimal** design parameters for today's climate are different from those published in building codes based on historical values only; a portion of those parameters is **no longer suitable** for design; and, **evolving conditions through time** must be considered.⁵

BOX 2: BC BUILDING CODE AND NATIONAL BUILDING CODE OF CANADA

The 2012 BC Building Code (BCBC) notes that “**climate is not static**”. Moreover, “as past and ongoing greenhouse gas emissions are expected to alter most climatic regimes in the future, **buildings will need to be designed and operated to adequately withstand ever-changing climate loads**”. See Appendix 3 for relevant excerpts, and Appendix 4 for BCBC and ASHRAE parameters that can be addressed today.

The BCBC is informed primarily by the **National Building Code** (or “model building code”), which is updated periodically to reflect evolving conditions, knowledge and best practices. In 2016, National Research Canada and Infrastructure Canada launched a five-year initiative to **integrate climate resilience into building and infrastructure design, guides and codes**.⁶ Currently, work is underway to develop **new climate design data** that incorporate potential impacts from expected rain, wind and snow loads; and **new guidelines** to address **overheating** in buildings, building design for **flooding** resilience and **wildfire-urban interface** design. Starting in 2025, **new model building codes** will provide a climate lens on buildings, wastewater and stormwater infrastructure, bridges and roads.

In 2014, the BC Ministry of Transportation and Infrastructure (MOTI) issued guidance for adapting public infrastructure (Appendix 5). In June 2018, Infrastructure Canada released general guidance for conducting a **climate lens assessment** on public infrastructure projects.⁷ *Climate Change Resilience Principles* and a recommended methodology support a **risk management approach** to anticipate, prevent, withstand, respond to, and recover from a climate change-related disruption or impact (Appendix 6).

⁵ S. Sobie, T. Murdock, R. LePage, and D. Lapp.

⁶ https://www.nrc-cnrc.gc.ca/eng/achievements/highlights/2018/climate_resiliency.html

⁷ <https://www.infrastructure.gc.ca/ait-format/pdf/guidelines-lignes-directrices/climate-lens-general-guidance-2018-05-28.pdf>

CLIMATE DESIGN PARAMETERS - PAST

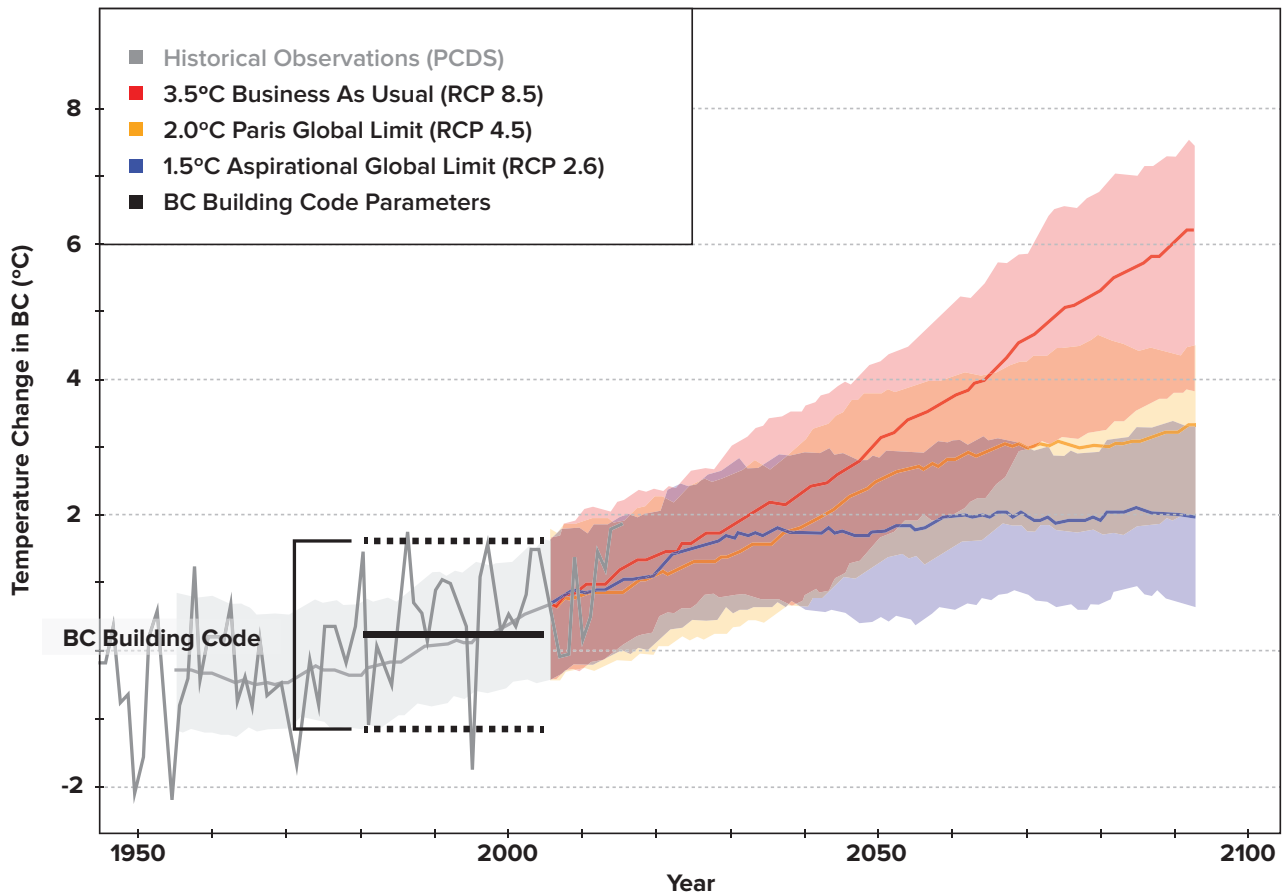


Figure 2a: This graph shows the variation in average annual temperature for BC in the future, as compared to observations of the past (in grey). All values shown are relative to the 1971-2000 historical baseline. Red, blue and orange lines show future projections for three GHG emissions scenarios.⁸ The climate models' projected temperature change demonstrates that appropriate design parameters need to accommodate the range of anticipated temperature change. "BC Building Code"⁹ (in black) indicates a temperature range for building design as per the 2012 BC Building Code Appendix C tables and the 2015 National Building Code (Appendix 3). Values are based on the solid line. Dashed lines illustrate the concept of a range.

BOX 3: BC GREENHOUSE GAS EMISSIONS (GHG) TARGETS

The province of British Columbia has set the following [GHG reduction targets](#):

- By 2030 and for each subsequent calendar year, BC greenhouse gas emissions will be at least 40% less than the level of those emissions in 2007;
- By 2040 and for each subsequent calendar year, BC greenhouse gas emissions will be at least 60% less than the level of those emissions in 2007;
- By 2050 and for each subsequent calendar year, BC greenhouse gas emissions will be at least 80% less than the level of those emissions in 2007.

In addition, the minister may, by order, establish greenhouse gas emissions targets for individual sectors.

CLIMATE DESIGN PARAMETERS - NEW CLIMATE REALITY

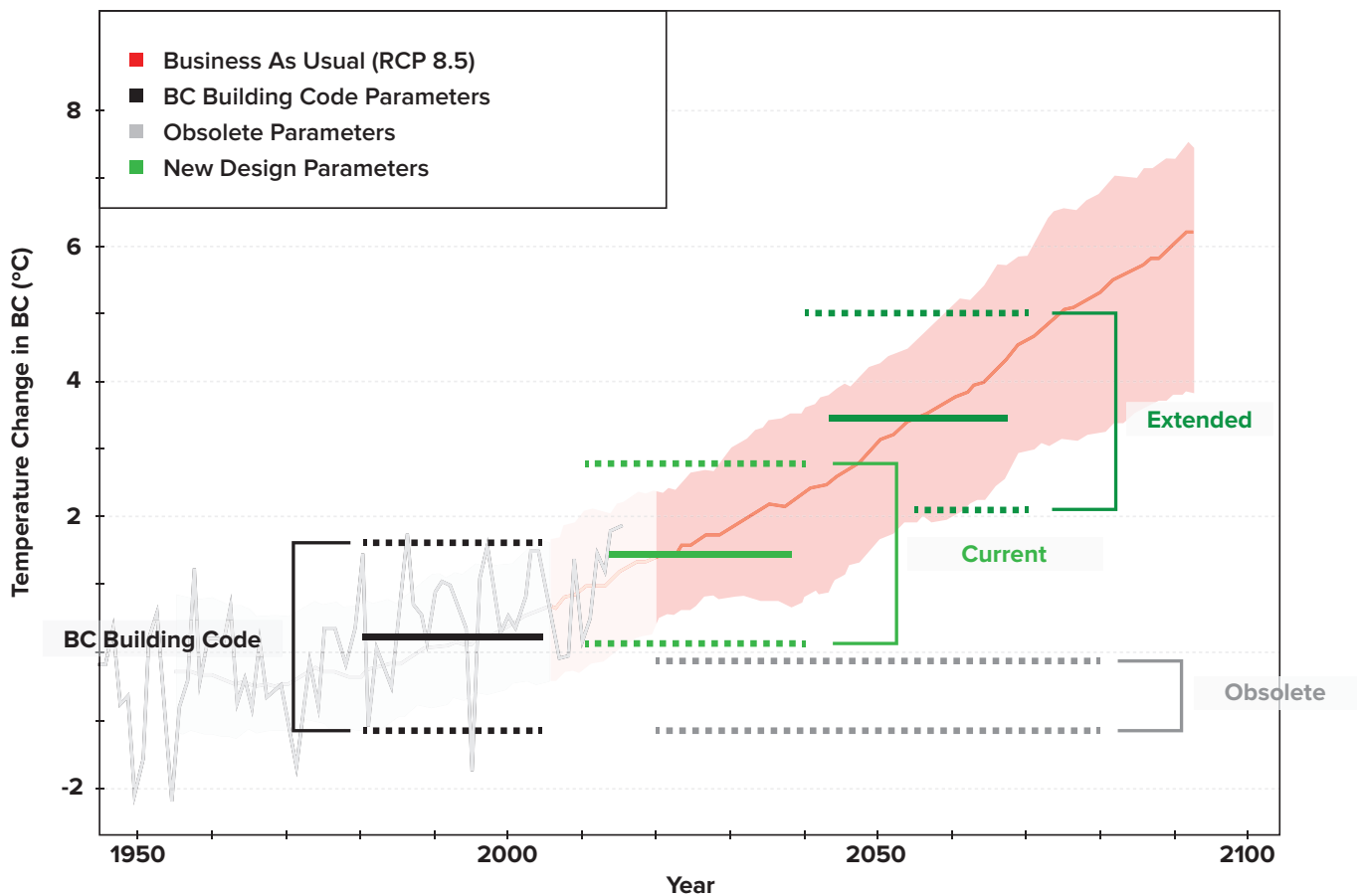


Figure 2b: This graph shows recommended shifts in design parameters to account for the fact that future climate will provide a wider range of temperatures that are beyond our current design scope. “Obsolete” parameters indicate a portion of the “BC Building Code Parameters” range that already is not optimally suited for current conditions. “Current” parameters indicate a more appropriate temperature range (up to 3°C above the 1971-2000 historical baseline) for optimizing equipment and building systems such that they are able to maintain indoor thermal comfort today. “Extended” parameters indicate a range of temperature change (up to about 5°C above the 1971-2000 historical baseline) for designing and operating infrastructure expected to perform over a lifespan extending to 2050 and 2080. The solid green horizontal lines indicate median temperatures within “Current” and “Extended” temperature ranges that are indicated by dashed lines.

“Acute care facilities typically have an approximate 80-year life span and require significant investment to build and maintain. Therefore, it behooves us as facility managers to plan and design our new facilities to operate within the changing climate conditions we expect.”

— FLORRIE LEVINE, PROJECTS & PLANNING, VCH COASTAL

⁸ The climate projections are based on a set of 12 Global Climate Models following three different greenhouse gas emissions scenarios, known as Representative Concentration Pathways (RCP). RCP8.5 is a “business as usual” scenario with little greenhouse gas emissions reduction until the end of the century and corresponds to about 3.5°C of warming above pre-industrial levels globally by the end of the century. RCP4.5 roughly lines up with the global targets agreed upon at the 2015 United Nations Convention on Climate Change in Paris, and about 2°C warming globally above pre-industrial levels. RCP2.6 is described as the “aspirational global limit” as it roughly corresponds to about 1.5°C warming above pre-industrial levels globally by the end of the century, a level that several nations including Canada have agreed would be preferred.

⁹ “BC Building Code Parameters” correspond with the 1981-2005 period for temperature and precipitation.

1.2 Why this Report was Developed

LMFM manages over a hundred facilities from Richmond to Bella Bella on behalf of Vancouver Coastal Health, and provides a wide range of services to support the delivery of health care. The 2017 **VCH Environmental Sustainability Policy** (Appendix 10) states that it will:

- Act as a **leader** with respect to environmental stewardship while **engaging the healthcare community** in a collaborative approach towards sustainability.
- [Ensure] that **financial investments will balance quality, cost and sustainability**. In addition, the longterm **life cycle costs of capital will be assessed**.

In order to ensure high levels of care, minimize cascading impacts on health services, and control operational over-runs, LMFM is joining other leading organizations working to understand how climate change will pose a risk to operations. This work offers information to:

- Design and operate health facilities to be fully operational under “new climate reality” conditions.
- Identify, reduce and manage risks, liabilities, and costs related to operational strains and failures.
- Reduce the burden on emergency response by improving preparedness to climate shocks and stresses.
- Enhance our reputation, allowing us to attract and retain talent that provides reliable care over time.

BOX 4: CLIMATE IMPACTS ON OUR HEALTH FACILITIES

BC Health authorities’ FMO shared their front-line perspectives in a 2018 survey:

“Climate change is having an impact here, now. It is critical that health care facilities be prepared and resilient. In the absence of extra safety factors added to hospital infrastructure, climate impacts will undoubtedly put our patients at risk. Our vigilance in preparedness is imperative to ensure we are able to care for the most vulnerable people in our society.” — **ADAM HELFER, VCH FMO**

“The winter of 2016–17 was the most severe for snowfall in over 10 years. The anticipated heat for spring-summer arrives earlier each year. Whereas 10 years ago we would not have to start our chillers until early May, we are now having to prepare to have them operational as early as late March.”

— **FRASER HEALTH FMO**

“Wildfires burned close to our location in the past three years. This required air quality filters in the air handling unit and other precautions for the facility.”

— **NORTHERN HEALTH FMO**

“Recent summer seasons have seen sustained air quality impacts due to wildfires on the mainland [and] high temperatures inside residential care facilities. Rain events have led to leaks [and] difficulty dealing with run-off water.”

— **ISLAND HEALTH FMO**

“All the plant staff stepped up [to help during the 2017 wildfires]. They were very dedicated to patient care, even though their personal lives were being impacted as their homes were under evacuation orders or alerts.”

— **INTERIOR HEALTH FMO**

This work advances ongoing efforts by LMFM to better understand health facilities' climate hazard [exposure](#), [vulnerability](#) and capacity, co-create [adaptation](#) options, and develop indicators for monitoring and evaluation. This **adaptation cycle** is a collaborative and iterative mechanism for **developing knowledge and options** that may inform each project life cycle stage: **site planning, facility planning, design, construction, occupancy and post-occupancy** (see the *2017 LMFM Project Delivery Guide*). Enhanced knowledge will:

- Provide a common baseline and platform for projects.
- Build staff capacity to engage with consultant teams and key collaborators.
- Inform decision-making from an integrated risk management perspective.

“We can no longer simply rely on FMO’s efforts to respond to extreme weather events. We need to build inherently resilient facilities, equipped with the systems, tools, and processes required to face changing weather patterns.”

— WAKAKO KIMURA THOMSON, DIRECTOR, ASSET RISK AND QUALITY: TECHNICAL SERVICES

Resilience options that **optimize health and low-carbon co-benefits** are being explored and piloted with key collaborators with the aim to develop climate resilience guidelines for health infrastructure design and operations. It complements other work being completed within BC’s health system, for example:

- VCH and Fraser Health **Population and Public Health** are mapping population vulnerability to extreme heat, ground-level ozone, wildfire smoke and flooding/sea level rise in 2018.
- Interior Health shared its frontline experience with and **preliminary costs of the 2017 wildfire response** in the Canadian Health Engineering Society magazine (Appendix 9).
- Island Health completed an engineering-based assessment of a regional facility in 2017. In 2018, the BC Climate Action Secretariat¹⁰ launched a pilot project to **map the facility’s interdependencies with utility and transportation networks** in collaboration with BC Hydro, regional government and Ministry of Citizen Services.
- BC Centre for Disease Control issued **guidance for local response to extreme heat and wildfire** events in 2017.¹¹
- Health Emergency Management BC and LMFM are collaborating on **integrated risk assessment-based agreements at the facility level**.

The broader context for this ongoing work includes initiatives undertaken by key collaborators, for example:

- The BC Climate Action Secretariat is undertaking a **provincial [climate risk](#) assessment** to provide an overview of key risks and priorities, as recommended by the BC Auditor-General in February 2018.¹²
- The National Research Council is working with health facilities, including VCH and Fraser Health facilities, in four provinces to develop **evidence-based guidance for effectively reducing wildfire smoke impacts**.
- Metro Vancouver is developing a *Climate 2050 Strategic Plan* to **transition our region to a low carbon future while increasing health, well-being and prosperity**. It will apply a “climate lens” to all policies and actions to inform emissions reductions and adaptation measures in the coming years.¹³

¹⁰ <https://www2.gov.bc.ca/gov/content/environment/climate-change>

¹¹ <http://www.bccdc.ca/health-info/health-your-environment/air-quality>

¹² http://www.bcauditor.com/sites/default/files/publications/reports/Climate_Change_FINAL.pdf

¹³ <http://www.metrovancouver.org/services/air-quality/climate-action/climate2050/Pages/default.aspx>

In addition, the World Health Organization (WHO) offers an operational framework to provide **guidance for health systems to increase capacity for protecting health in an unstable and changing climate**. The framework outlines key components that enhance the climate resilience of a health system. Recognizing there are **strong connections** between the various building blocks of health systems, LMFM developed future scenarios to explore interdependencies and areas of shared interest (Appendix 7).



Figure 3: The World Health Organization's (WHO) Operational Framework for Climate Resilient Health Systems.¹⁴ The "Climate Resilient & Sustainable Technologies and Infrastructure" building block includes medical equipment and building systems in VCH facilities.

"Climate change and our new normal will bring increased asthma, more virulent allergens, medical emergencies from heat stress, and the spread of water- and vector-borne diseases. I believe climate change is our biggest global health threat, and we need to step up."

—SUSAN SCRIVENS, VCH PERIOPERATIVE SERVICES CLINICAL PLANNER, LGH ACUTE CARE FACILITY

¹⁴ The original image was modified with the permission of the WHO.

BOX 5: CLIMATE IMPACTS ON OUR HEALTH SYSTEM

Poor outdoor air quality impacted the thermal comfort of patients and staff during extreme heat and wildfire events in July and August. Windows in patient rooms stayed closed as **wildfires in every region of BC** pushed Air Quality Health Index¹⁵ ratings off the chart (i.e., 10+ or **Very High Health Risk**) and resulted in a regional Air Quality Advisory¹⁶ (including for fine particulate matter, or PM2.5, and ground-level ozone) that lasted an **unprecedented 11 days in a row**. In another part of the health system, strained cooling systems **impacted medical research** samples. A critical service provider to the health system, BC Hydro,¹⁷ noted that “[July] had the most days ever—14 days—with peak hourly demand exceeding 7,000 megawatts. This is a continuation of a trend of higher demand in July as a result of climate change. From 2015 to 2017, **[peak demand was] more than five times the average** from [2010 to 2014].”

A massive surge in visits to doctors and in prescriptions [has] been linked to the “terrible air quality” caused by wildfires [and] the longest continuous [air quality] advisory on record [for Metro Vancouver and the Fraser Valley]. [On the] North Shore, authorities expect [a] 120 percent increase in daily physician visits and an 80 percent rise [in] asthma prescription medications dispensed at pharmacies, according to the BC Centre for Disease Control.

— THE NATIONAL POST (AUGUST 21, 2018)¹⁸

*Providing health care in heat waves presents challenges. Acute demand soars, doubling requests for consultations and increasing inpatient admissions. Moreover, many hospitals are poorly designed to cope with heat. **More sophisticated responses [than increased air-conditioning] that incorporate heat resilience into design are required.** To construct [hospitals] today that are not resilient to climate change represents a **poor investment** and condemns generations of users to misery.*

— THE LANCET JOURNAL OF PUBLIC HEALTH (AUGUST 4, 2018)¹⁹

“We are generally all aware of climate change, but for me, the speed of change and frequency of extreme weather events is the unknown. This report provides great insight and we have due diligence to utilize these findings to ensure our facilities are moving towards climate resilience”.

—ROBERT BRADLEY, DIRECTOR, ENERGY & ENVIRONMENTAL SUSTAINABILITY

¹⁵ <http://www.env.gov.bc.ca/epd/bcairquality/readings/aqi-table.xml>

¹⁶ <https://bc.ctvnews.ca/air-quality-advisory-expanded-to-include-ozone-haze-1.4064389>

¹⁷ https://www.bchydro.com/news/press_centre/news_releases/2018/heat-wave-leads-to-record-breaking-electricity-use.html

¹⁸ <https://nationalpost.com/news/local-news/wildfires-2018-medical-issues-surge-as-air-quality-advisory-becomes-longest-on-record/wcm/da798c80-3b1c-4b29-b0c4-2e1e5108ef05>

¹⁹ <https://www.thelancet.com/action/showPdf?pii=S0140-6736%2818%2930434-3>

1.3 Developing Projections and Preliminary Impacts

The **climate projections and hazard maps** presented in this report were developed by the Pacific Climate Impacts Consortium (PCIC)²⁰ using historical temperature and precipitation data from across our health region, along with an ensemble of 12 global climate model projections, to produce locally relevant “statistically downscaled and bias corrected” projections. These **models describe “business as usual” and “best case” scenarios** (Figure 2a), based on how well society reduces greenhouse gas emissions in years to come.

The projections are averaged over the 12 climate models and a 30-year period. Ranges are provided to help understand the range of projected change and to describe future [climate variability](#).

In Section 3, regional values are given that reflect averages across all VCH Communities of Care (not only in the Lower Mainland, as shown in the climate hazard maps). All “Past” maps refer to the time period 1971–2000, and all “Future (2050)” maps refer to the time period 2041–2070.

The projections were used by EcoPlan International to develop the **VCH Communities of Care maps**. The non-linear scales used to represent each dataset were developed for communication purposes only. In most cases, the data distributes more heavily towards the centre of each range, requiring finer increments towards the centre of the distribution and coarser increments towards the extremes.

Climate projections were shared in a series of **three workshops with a diverse group of health system stakeholders**, facilitated by Pinna Sustainability (Appendix 7). Participants provided input on which indicators are most relevant for designing and operating health facilities, and how projected changes may have an **impact on providing health services** to the public. Health facility and health system participants included:

Acute Care Facilities

- Lions Gate Hospital Acute Care Facility - VCH Clinical Planning
- Richmond Hospital - Client Relations & Risk Management

Lower Mainland Facilities Management

- Senior Leadership Team
- Lions Gate Hospital Acute Care Facility Business Plan Project Team
- Asset Risk and Quality: Technical Services
- Facilities Maintenance & Operations
- Energy & Environmental Sustainability

VCH & Fraser Health Population and Public Health

VCH Regional Programs and Services

- VCH Transformation Office
- Regional Client Relations & Risk Management
- Regional Critical Care & Medicine
- Regional Trauma, Emergency
- BC Patient Safety & Learning System
- Physician Quality

Health Emergency Management BC

- BC Climate Action Secretariat** - Climate Risk Management

“An organization with a strategic approach to climate change has the ability to attract and retain environmentally mindful staff, who care about people and their communities. They want to work with an organization with similar values, actively pursuing an effective response to climate change.”

— KORI JONES, VCH ENERGY MANAGER

²⁰ <https://pacificclimate.org/>

1.4 Report Contents

A selected number of standard climate and building code indicators are offered in this report that, when read together, illustrate how our climate will change over time and impact health service delivery across the region.

- **Section 2: Climate Impacts on Facilities** identifies likely impacts of climate change and makes preliminary recommendations for addressing impacts on VCH facilities.
- **Section 3: Climate Projections** offers a description of how our climate is expected to change over time, and insight into our “new climate reality” for temperature and precipitation. This section focuses on three Hospitals (Lions Gate, Squamish, and Richmond) to illustrate how projections compare between specific facilities.
- **Section 4: Strategic Recommendations** offers high-level recommendations for further action.
- **Technical Appendix 1: Maps** includes all VCH Communities of Care maps produced by EcoPlan in consultation with PCIC.
- **Technical Appendix 2: Tables** provides data for 11 health facilities / locations: Bella Bella, Bella Coola, Dogwood Pearson, Downtown East Side, Lions Gate Hospital, Powell River, Richmond, Sechelt, Squamish, UBC Hospital and Vancouver General Hospital.

For easy reference, the following table offers a summary of indicators of particular relevance to climate-sensitive health system audiences.

Table 1: Relevant Indicators for Select Health System Building Blocks

Area of Interest	Relevant Indicator
Health Infrastructure	<ul style="list-style-type: none"> - Days Above 25°C - Cooling Degree Days - Heating Degree Days - Hot Design Temperature (BCBC 97.5) - Hottest Day - Wettest Day of the Year - Wettest 5-Day Period of the Year - Wettest Days (R95P & R99P) - 1-in-20 Wettest Day
Public Health	<ul style="list-style-type: none"> - Days Above 25°C - Days Above 30°C - Tropical Nights - Growing Season Length
Emergency Preparedness	<ul style="list-style-type: none"> - Wettest Day of the Year - Wettest 5-Day Period of the Year - Wettest Days (R95P & R99P) - 1-in-20 Wettest Day



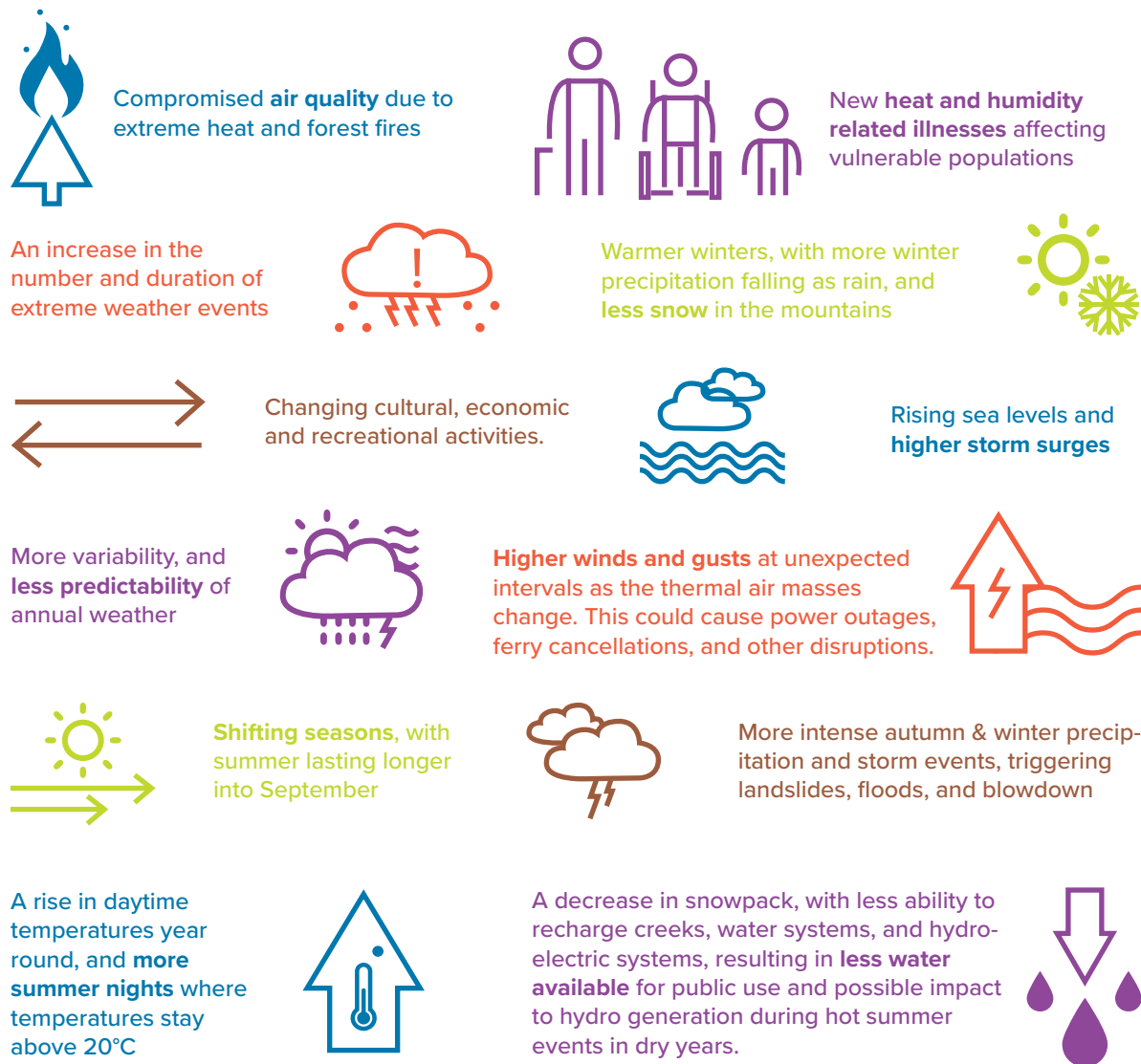
2.0 Climate Impacts on Facilities

This section offers a high-level overview of future climate projections, and insight into potential impacts on health facilities and the health system.

Photo Credit: Vancouver Coastal Health

2.1 Impacts and Recommendations

Our ability to support health services over time is dependent on our facilities being able to operate under “new climate reality” conditions. Based on the projected changes in temperature, precipitation, and indicators of extremes (Section 3), workshop participants (Appendix 7) identified potential climate-related risks:



In order to manage these stresses, the systems that enable facilities to function every day will need to be strengthened. These include:

- Patient care
- Power and fuel supply
- Stormwater & flood management
- Ventilation
- Clean water supply
- Supply chain management
- Heating and cooling
- Human resources
- Facilities maintenance & operations

Health facility and health system participants reviewed future climate projections and considered two “new climate reality” scenarios (developed by Pinna Sustainability) focused on **Lions Gate and Richmond Hospitals**. Participants from maintenance and operations, planning and projects, clinical planning and consultant teams offered their perspectives on health facility operations and service delivery in an **extreme heat scenario**. Health system participants from public health, risk and emergency management, and patient and physician care offered their regional perspectives on service delivery in an **extreme flood scenario**.

The content below is intended to provide highlights from the three workshops. Participants identified that facilities will struggle to meet patient care demands while being challenged to maintain optimal operational conditions. Projected impacts and preliminary recommendations are not intended to be comprehensive.

A more fulsome and detailed account of the workshops and participants’ input is available in Appendix 8.

2.1.1 PROJECTED IMPACTS

Likely impacts on **patient care** include increases in hospital visits that would strain facilities and **frontline staff capacity** to provide care. Future patient surges may result from vulnerable populations being affected by extreme conditions, including:

- Increased new vector-borne diseases such as Lyme Disease or West Nile virus among the general population.
- Increased gastro-intestinal illnesses during flood events.
- Decreased air quality and an increase in respiratory illness.
- Increase injury due to climate induced disasters and ‘accidents’.

Additionally, home and community care may be compromised when transportation or utility networks are damaged, rendering home and community programs unable to support community wellness. These stressors will also deplete facility resources, and when combined with low [community resilience](#) and preparedness, could result in the public seeking fresh water and food, or clean and cool air in our facilities, and thus potentially exceeding our capacity to provide care.

Buildings systems will experience challenges with **heating, ventilation and cooling** as complexity, frequency and duration of climate related shocks and stresses increases. Rises in air contaminants from sources including heat related ozone, wildfire activity, and other sources will reduced outdoor air quality, infiltrate into facilities through building systems or envelopes, and strain ventilation systems. Longer hot temperature periods and increased temperature variability may result in higher operational costs (e.g., energy costs and staff overtime), increased wear on equipment (e.g., chillers), and unexpected equipment purchases to supplement heating and cooling needs. Poorly-performing building systems may also compromise patient care due to reduced indoor thermal comfort or air quality, affecting patient health and the ability of frontline staff to extend care.

Regional increases in demand and reductions of supply of **power, electricity and water** will likely increase competition for these resources over time. As the **reliability and quality of these critical supplies are dependent on third parties’ resilience and prioritization of health facilities**, future shortages would strain facilities management.

Climate-driven causes include:

- A reduced snowpack can have a negative impact on energy supply across our province, and water supply across the region.
- Increased precipitation in extreme events can cause increased turbidity and reduced water quality (e.g., bacterial outbreaks).
- Rising temperatures can cause warmer municipal water supply, reducing usability.

Additionally, current emergency preparedness requirements (which call for 72 hours of back up supplies) will likely be inadequate during future emergencies.

Likely impacts to **stormwater management** on and around health facilities include long summer dry spells that reduce water retention capacity of soils, increased intensity and frequency of autumn storm activity, and higher flow rates in rivers and creeks. Bacterial outbreaks linked to **combined sewer overflows** will increase where municipal water and sewerage capacity is not sufficient for higher or unprecedented volumes during extreme events.

2.1.2 PRELIMINARY RECOMMENDATIONS

The preliminary recommendations below are excerpted from Appendix 8 and should be considered with Strategic Recommendations in Section 4.

- 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.
- **Understand future energy demand and availability** during extreme events, and develop on-site clean energy supplies for base and emergency power where possible. Plan for non-critical load shedding when energy supply is constrained and demand is higher.
- Design **high-quality air filtration** systems to cope with changing external conditions.
- Design **more responsive, flexible heating and cooling solutions** to help buildings adapt to daily and weekly temperature fluctuations based on climate projections.
- **Retain stormwater on-site** to increase redundancy, ensure supply and reduce impacts on municipal systems and provide water for other facility systems. Complement with **green infrastructure** and emphasize **health co-benefits**.
- 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** for 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.



3.0 Climate Projections: a “New Climate Reality”

This section describes our “new climate reality” by providing climate projections for the VCH region and three facilities.

Indicators for 11 health facilities / locations in the three VCH Communities of Care are available in *Technical Appendix 2: Tables*. These facilities / locations are: Bella Bella, Bella Coola, Dogwood Pearson, Downtown East Side, Lions Gate Hospital, Powell River, Richmond, Sechelt, Squamish, UBC Hospital and Vancouver General Hospital.

Seven temperature and six precipitation indicators were selected for inclusion in this report based on their ability to provide insight into how physical and social systems may be affected by climate stresses and shocks over time. For each indicator, a description of projected changes by 2020, 2050, and 2080 is provided.

3.1 Temperature

Temperatures are rising year-round, lengthening the warm season on both ends.²¹ Projections indicate that by 2050, September will have similar average summer temperatures to the month of August historically.²² Similarly, the cold season will end earlier, with future March temperatures similar to past April temperatures. The longer warm season will also be accompanied by hotter summer temperatures. By 2050, Vancouver temperatures for July will be comparable to July temperatures experienced in San Diego in the past (1971–2000). The indicators below offer more detail into how warmer temperatures will affect our facilities, patients, and communities.

DAYS ABOVE 25°C

About this indicator

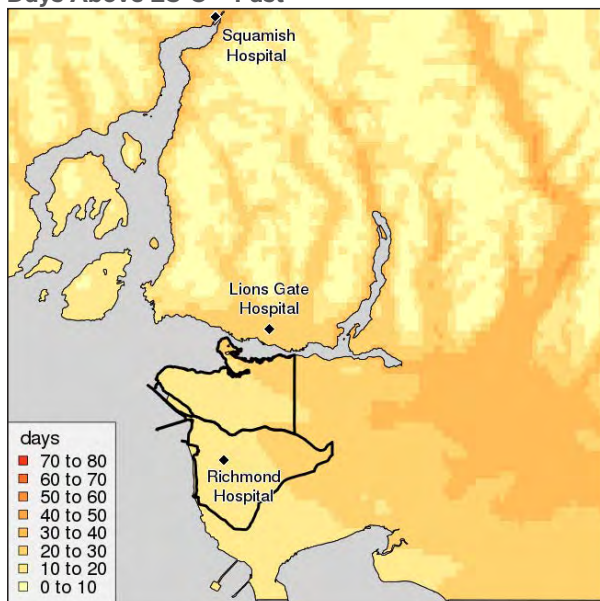
Days Above 25°C measures how many days reach temperatures over 25°C in any one year. This indicator is important to facilities as they are required to maintain an internal temperature below 25°C.

Projections

In the past, the **VCH region** as a whole experienced **12 days a year** with temperatures above 25°C. We can expect significantly more in the future: models project on average 20 days above 25°C by 2020, **31 days by 2050**, and 48 days by 2080. In other words, we can expect **four times the number of days warmer than 25°C by 2080** than in the past.

While the **number of days above 25°C differ at Richmond, Lions Gate, and Squamish Hospitals in the past** (16, 24, and 32 respectively), projections show that all three sites will experience approximately **90 days above 25°C by 2080**. This marks a **significant change from the past**, and will impact operational costs. For example, facilities will require more cooling to keep internal temperatures below 25°C. The map for summer days below shows that the number of hot days are projected to be highest in the southeastern reaches of the Lower Mainland portion of the VCH region.

Days Above 25°C – Past



Days Above 25°C – Future (2050)

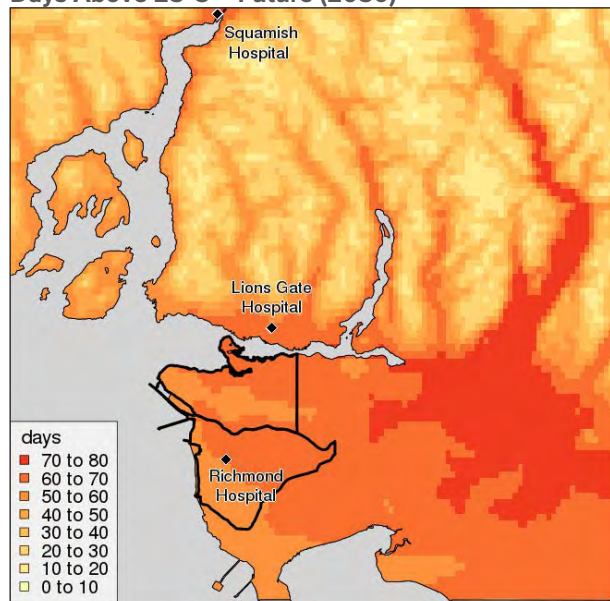


Figure 4: Days Above 25°C – Past and Future (2050)

²¹ <http://www.env.gov.bc.ca/soe/indicators/climate-change/temp.html>

²² See Figure 3 in the *Climate Projections for Metro Vancouver* report.

DAYS ABOVE 30°C

About this indicator

Days Above 30°C indicates how many days reach temperatures over 30°C in any one year. This indicator is important to public health and facilities, as mortality rates jump when temperatures are at or near 30°C, and facilities may experience a surge in patient visits due to heat stress (Box 5).

Projections

In the past, the **VCH region** as a whole experienced on average approximately 2 summer days above 30°C per year. We can expect significantly more in the future. Models project more than double the number of days above 30°C by 2020, 9 days by 2050, and **18 days by 2080** on average for the region (and 5, 12, and 27 days by 2020, 2050, and 2080 for the Lower Mainland portion of the region shown on the maps, on average).

The increase in the number of days above 30°C is **dramatic at every site**. On average, **Squamish Hospital** experienced 6 days above 30°C in the past, and by 2080, is expected to experience **41 days above 30°C** on average. **Richmond Hospital** experienced only 1 day with temperatures above 30°C in the past on average, but by 2080 this is projected to **increase to 28 days** with these extreme temperatures.

Baseline temperatures at different sites matter, as they speak to what people are used to, and what temperatures may trigger patient surges at facilities. While the increase in days above 30°C is less than the increase in days above 25°C, this is a significant indicator for communities and for facilities as they prepare for future heat-related patient surges.

The maps below illustrate that there will be an increase in days above 30°C, most noteworthy in mountain valleys and to the southeast.

Days Above 30°C – Past



Days Above 30°C – Future (2050)

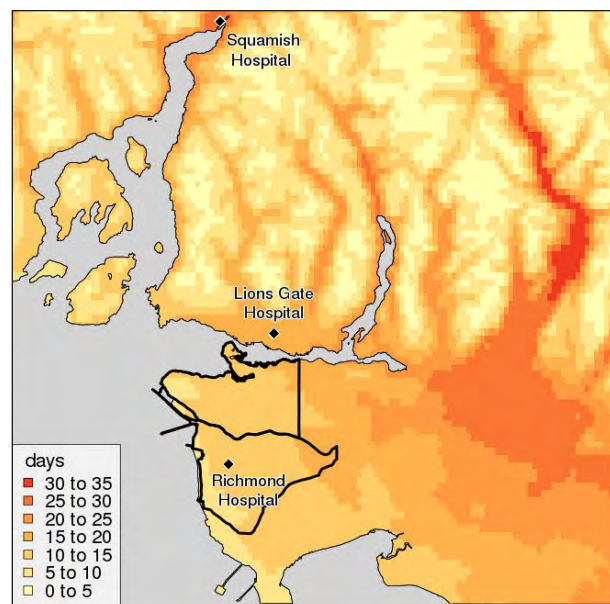


Figure 5: Days Above 30°C – Past and Future (2050)

HOT DESIGN TEMPERATURE (BCBC 97.5)

About this indicator

Hot Design Temperature refers to the **9th hottest daytime high temperature of the year**, usually experienced during the summer months.²³ This is an indicator of extreme temperatures averaged over a 30-year period. Certain BC Building Code (BCBC) and ASHRAE variables can be addressed by climate projections (Appendix 4). Hottest Day (TXX) is the annual hottest day of the year and warms by similar amounts as Hot Design Temperature (BCBC 97.5), as shown in Table 3 below.

Projections

The past Hot Design Temperature for the **VCH region was 24°C in the past**. This value may seem cool compared to the values at sites, but it takes into account temperatures at high elevations, as well as in the hot valleys and lowlands where health facilities are located. This regionally-averaged Hot Design Temperature is projected to warm to 26°C by 2020, **28°C by 2050**, and 30°C by 2080.

At Richmond Hospital, the past Hot Design Temperature was 26°C. By 2020, this is expected to increase to 28°C, and to 30°C by 2050. **By 2080, all health facilities are expected to experience increases over 6°C from past Hot Design Temperatures**, resulting in a future where our facilities will be expected to keep hospitals below 25°C while external temperatures soar routinely to 32°C in Richmond, 33°C at Lions Gate, and 35°C in Squamish (about 9 days per year on average).

Table 3: Hot Temperatures (SU25, SU30, BCBC 97.5, TXX) at Health Facilities

	Lions Gate				Richmond				Squamish			
	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days Above 25°C	24 days	17 days (11 to 24)	39 days (21 to 58)	67 days (39 to 97)	16 days	17 days (9 to 25)	43 days (24 to 64)	73 days (45 to 105)	32 days	16 days (10 to 21)	35 days (17 to 51)	59 days (35 to 88)
Days Above 30°C	2 days	4 days (3 to 6)	14 days (6 to 22)	32 days (15 to 55)	1 day	2 days (1 to 4)	10 days (4 to 16)	27 days (10 to 54)	6 days	7 days (4 to 10)	18 days (9 to 27)	35 days (18 to 56)
BCBC 97.5	27°C	2°C (1 to 2)	4°C (2 to 5)	6°C (4 to 9)	26°C	2°C (1 to 2)	4°C (3 to 5)	6°C (4 to 9)	29°C	2°C (1 to 3)	4°C (2 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	30°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 9)	29°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 9)	32°C	2°C (1 to 3)	4°C (3 to 5)	6°C (5 to 9)

²³ The 97.5th percentile is the 9th hottest day of the year as $365 \text{ days} \times (100-97.5)/100 = 9.125$.

Figure 6: Hot Design Temperature (BCBC 97.5) – Past

The maps below show a similar trend for increasing temperature is projected at the other VCH sites across the region.

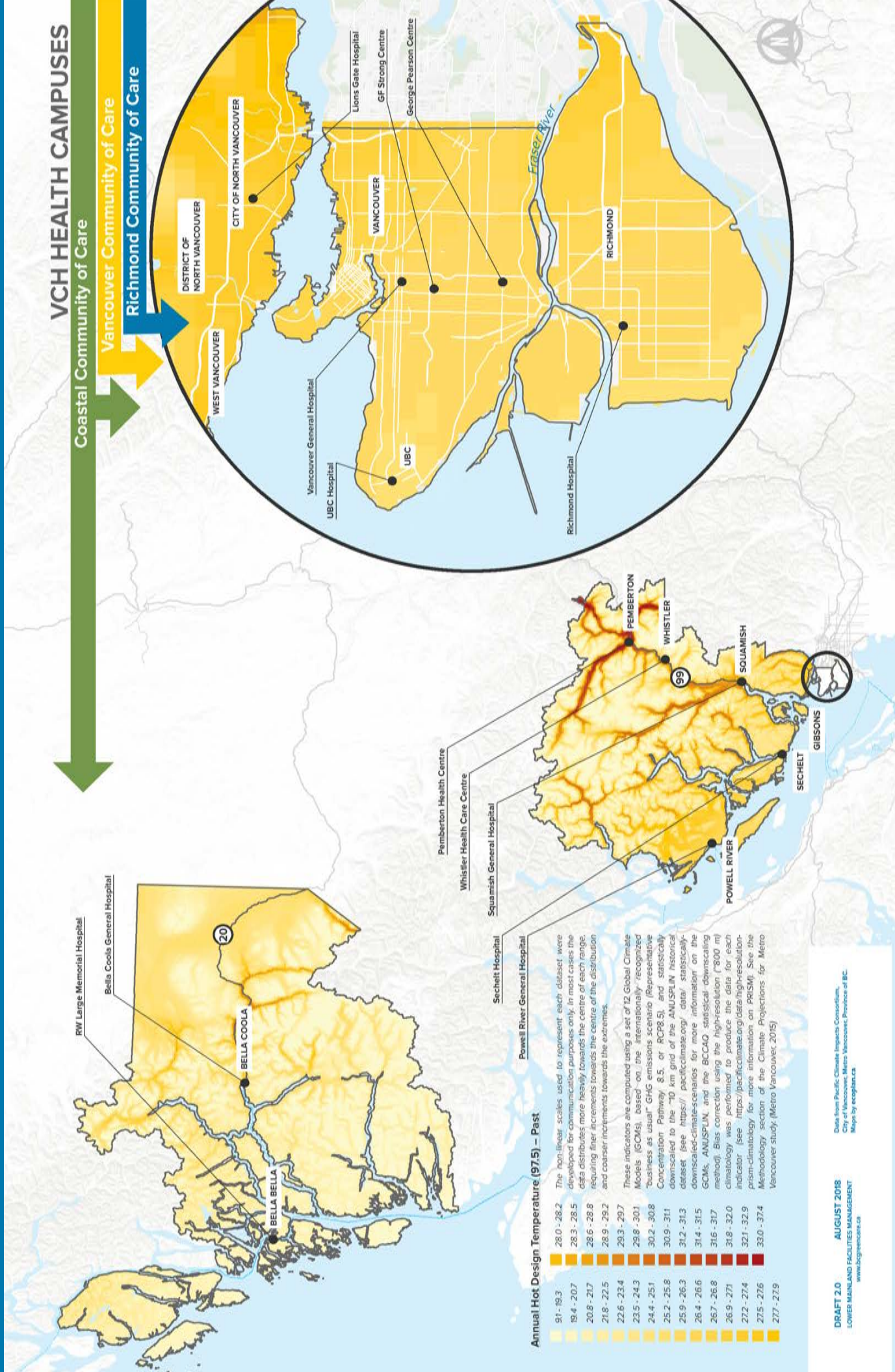
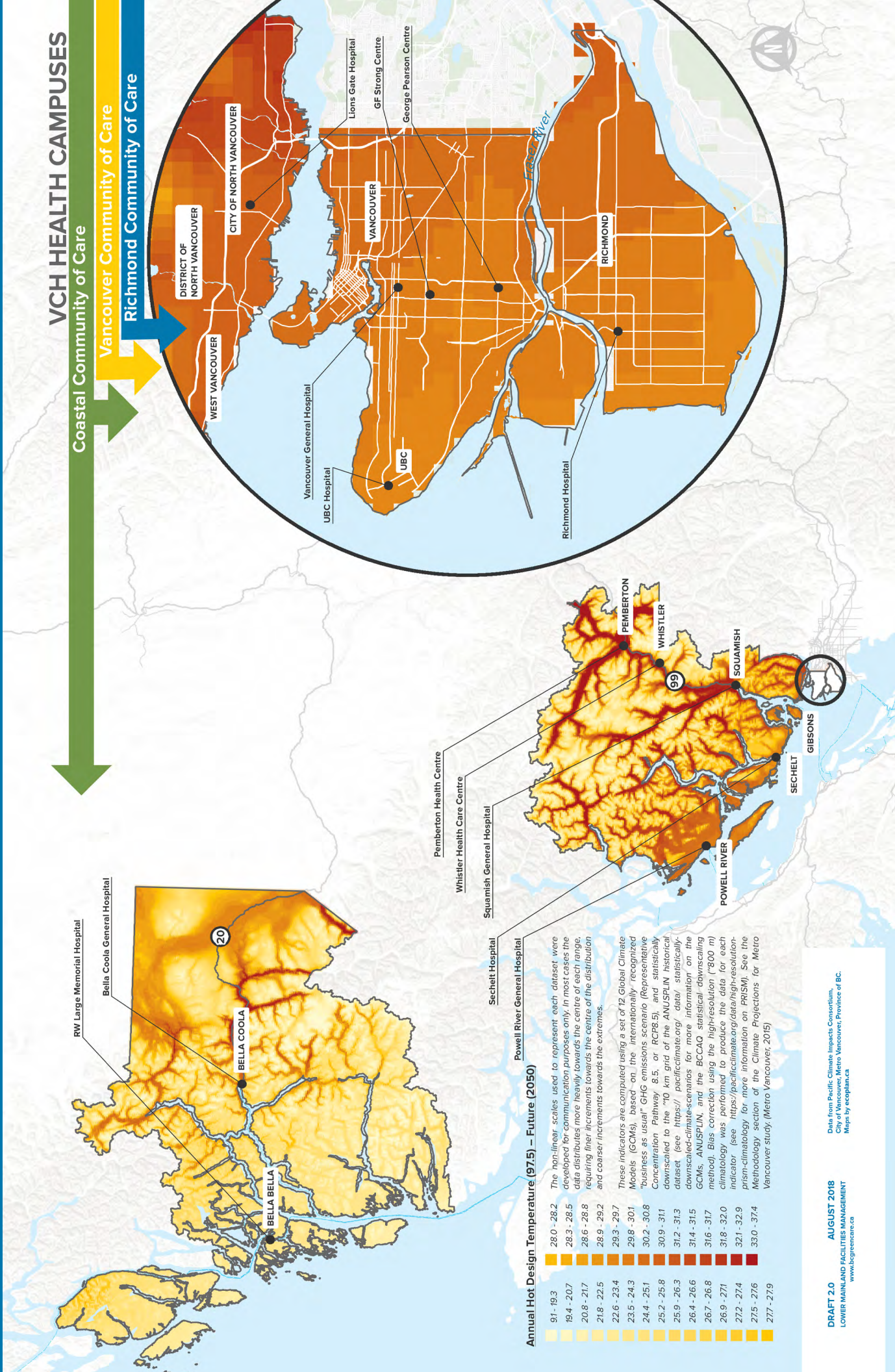


Figure 6: Hot Design Temperature (BCBC 97.5) – Future (2050)



VCH HEALTH CAMPUSES

Coastal Community of Care

Vancouver Community of Care

Richmond Community of Care

RW Large Memorial Hospital

Bella Coola General Hospital

20

BELLA COOLA

BELLA BELLA

Pemberton Health Centre

Whistler Health Care Centre

Squamish General Hospital

Sechelt Hospital

Powell River General Hospital

PEMBERTON

WHISTLER

99

SQUAMISH

POWELL RIVER

SECHELT

GIBSONS

DISTRICT OF NORTH VANCOUVER

CITY OF NORTH VANCOUVER

WEST VANCOUVER

Vancouver General Hospital

UBC Hospital

UBC

VANCOUVER

Lions Gate Hospital

GF Strong Centre

George Pearson Centre

RICHMOND

Richmond Hospital

BOX 6: DEGREE DAYS

Degree Days measures temperature above a threshold in a location and the length of time this condition persists. This measure is useful in understanding the **required heating and cooling loads of a facility in relation to the climatic conditions**. A degree day compares the outdoor temperatures recorded for a location to a standard base temperature (i.e., 16°C). The further the temperature is from the base temperature, the higher the number of degree days accumulated. Space heating is correlated with Heating Degree Days (HDD), when the temperature is below the base temperature, and space cooling is correlated with Cooling Degree Days (CDD), when mean temperature is above the base temperature (see Appendix 2 for a plain language definition).

COOLING DEGREE DAYS

About this indicator

To determine the number of Cooling Degree Days in a year, the number of degrees that the daily temperature is over 18°C for each day is added to give a total value.

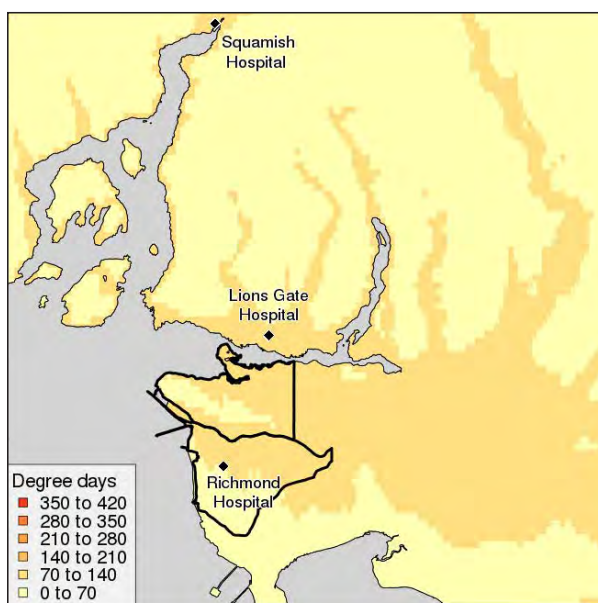
Projections

The baseline average of this indicator is 25 Cooling Degree Days in the past. The large relative increase is partly due to a low historical baseline.

Facilities with cooler temperatures will experience larger relative changes as Cooling Degree Days increase. For example, **Richmond Hospital** experienced about **70 Cooling Degree Days**, and by 2080, it will **increase considerably to 570 Cooling Degree Days** (Table 4 below). Total Cooling Degree Days will be higher at sites where temperatures are already warmest. For example, Lions Gate Hospital, with about 90 Cooling Degree Days in the past, will have about 590 Cooling Degree Days by 2080. Increases in cooling demand will be felt in all facilities over time, and mark a **significant departure in operations** for some facilities that have not had to cool in the past.

The maps illustrate an across-the-board increase in Cooling Degree Days in areas where facilities are located.

Cooling Degree Days – Past



Cooling Degree Days – Future (2050)

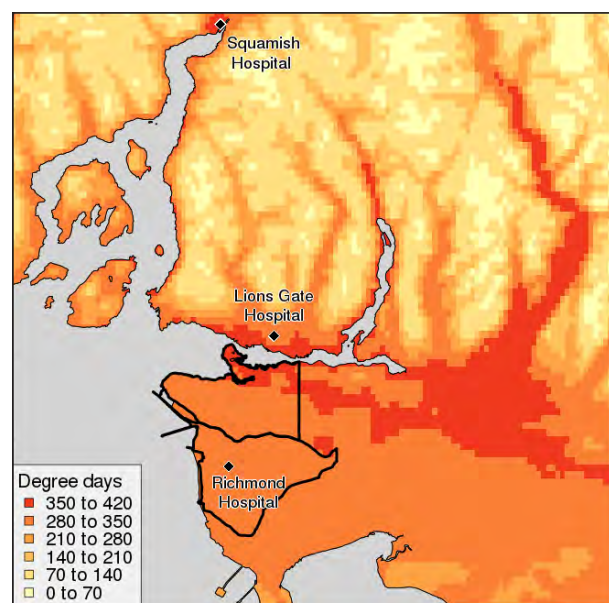


Figure 7: Cooling Degree Days – Past and Future (2050)

HEATING DEGREE DAYS

About this indicator

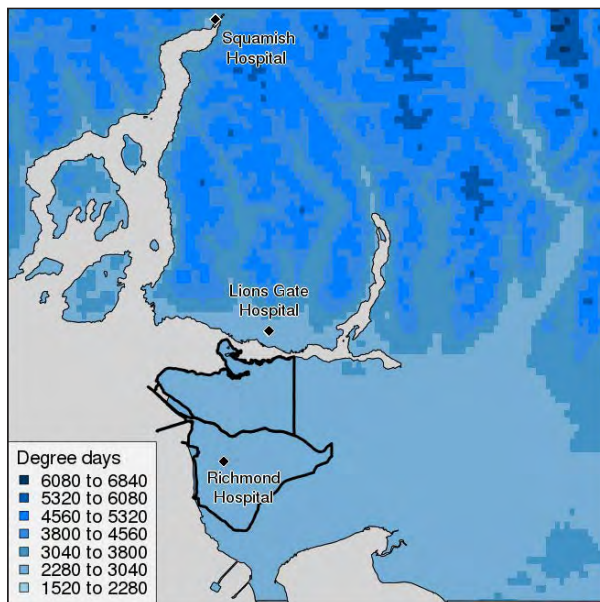
Heating Degree Days refers to the number of degrees that a day's average temperature is below 18°C, and is used to estimate the amount of energy used to heat buildings. To determine the number of Heating Degree Days in a month, the number of degrees that the daily temperature is below 18°C for each day is added to give a total value.

Projections

In the past, the VCH region has experienced many more Heating Degree Days compared to Cooling Degree Days. The past annual average of Heating Degree Days is 4,974. Heating Degree Days are projected to decrease with time throughout the region. The current **building code instructs to take current climate into account** (Box 2), which means we should be designing buildings for today using fewer Heating Degree Days in our designs. Planning future facilities, with 80+ year lifespans, would require us to **design new buildings to use 30% less heating demand across the region**. Each of the health facilities' reductions in Heating Degree Days are roughly 15% by 2020, almost 30% by 2050, and **over 40% by 2080**. This marks a significant reduction in heating load by mid-century.

The maps below illustrate a decrease in Heating Degree Days throughout the region, including where facilities are located. Table 4 provides ranges of change in Cooling and Heating Degree Days for each facility.

Heating Degree Days – Past



Heating Degree Days – Future (2050)

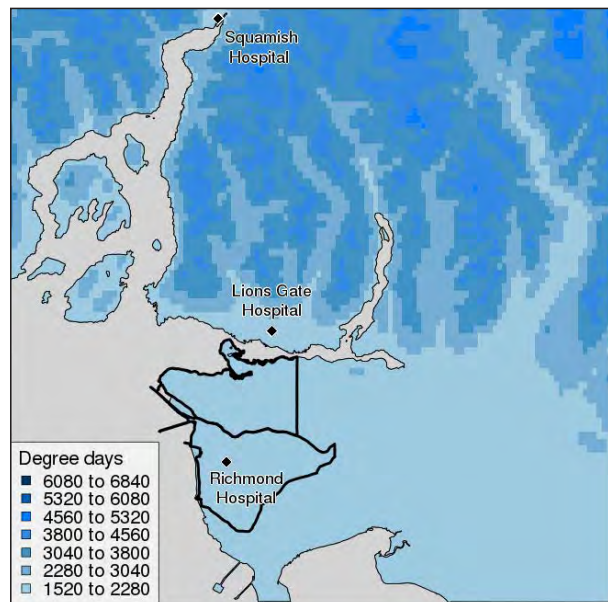


Figure 8: Heating Degree Day – Past and Future (2050)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) at Health Facilities

	Lions Gate				Richmond				Squamish			
	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	90	90 degree days (50 to 130)	250 degree days (120 to 420)	500 degree days (260 to 780)	70	90 degree days (50 to 120)	250 degree days (120 to 410)	500 degree days (260 to 770)	90	80 degree days (50 to 110)	230 degree days (100 to 390)	460 degree days (230 to 730)
HDD	2830	-16% (-20 to -11)	-29% (-38 to -19)	-44% (-56 to -32)	2790	-16% (-20 to -11)	-29% (-39 to -19)	-44% (-57 to -32)	3190	-14% (-18 to -10)	-26% (-35 to -19)	-41% (-51 to -31)

TROPICAL NIGHTS

About this indicator

Tropical Nights refers to the number of times in a year when the **nighttime low temperature is greater than 20°C**. This indicator is important, as a series of tropical nights reduces the ability of buildings to cool passively at night, increasing cooling load and energy use during warm spells. Tropical Nights can also **reduce the ability of patients to heal**, and can cause heat stress.

Projections

In the past, the VCH region experienced zero nighttime lows warmer than 20°C, on average. By 2080, it is expected that the region may experience an average of five Tropical Nights a year, with considerably higher increases in the Lower Mainland, particularly toward the end of the century.

Health facilities will experience a modest increase in Tropical Nights (between 3 to 7) by 2050, but there will be a **noteworthy increase in the occurrence of Tropical Nights by 2080**. Of the facilities focused on in this report, **Lions Gate and Richmond will experience the greatest increase** in Tropical Nights by 2080 (26 and 25 nights respectively). The trend is similar at other facilities that are at lower elevations throughout Metro Vancouver. The increase in Tropical Nights at Squamish Hospital, while still considerable (16 nights per year on average by 2080), is less than at these locations.

GROWING SEASON LENGTH

About this indicator

Growing Season Length is an annual indicator that counts the number of days between the first span of at least six days with a daily average temperature warmer than 5°C and the first span after July 1st of six days with temperature colder than 5°C. It measures the length of the growing season for native crops, and **points to a longer and warmer season**.

Projections

In the past, the VCH region had an average of 169 days in the growing season. We can expect that on average 27 days will be added to the growing season by 2020, 52 days by 2050, and **84 days by 2080, resulting in a nearly year-round growing season of 253 days on average**. This is important, as it affects the **production and dissemination of pollen**, which matters to those who suffer from seasonal allergies. We may expect demand for health services to increase.

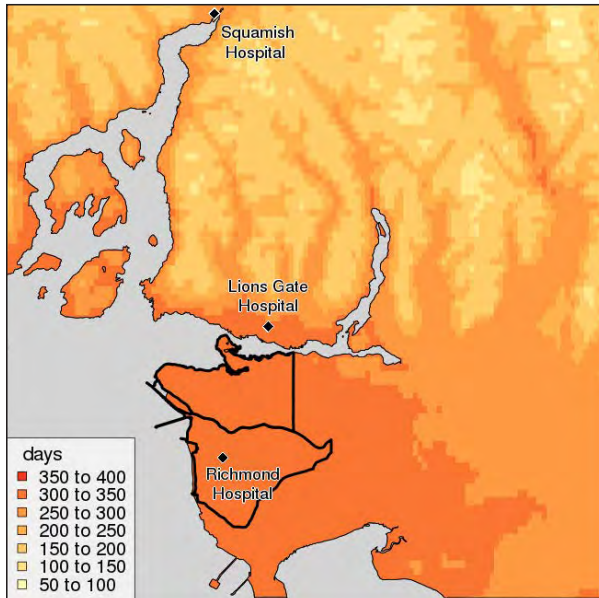
Health facilities with colder baseline temperatures will experience the greatest increase in Growing Season Length.

Table 5: Tropical Nights (TR) and Growing Season Length (GSL) at Health Facilities

	Lions Gate				Richmond				Squamish			
	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR (days)	0.1	0.8 (0.1 to 1.4)	7 (0.9 to 18)	26 (5 to 57)	0	0.4 (0 to 0.8)	6 (0.4 to 16)	25 (5 to 57)	0	0.2 (0 to 0.2)	3.4 (0.2 to 10)	16 (2 to 42)
GSL (days)	308	23 (15 to 28)	41 (31 to 47)	51 (47 to 58)	310	21 (14 to 27)	38 (29 to 44)	48 (42 to 54)	273	28 (22 to 38)	51 (38 to 62)	75 (63 to 86)

The maps below illustrate that the increase in Growing Season Length will be most dramatic at low to medium elevations, skirting the slopes of mountains. This is because, while all regions will experience an increase in Growing Season Length, the warmer temperatures at middle elevations tip these regions over the threshold to start accumulating growing season days.

Growing Season Length – Past



Growing Season Length – Future (2050)

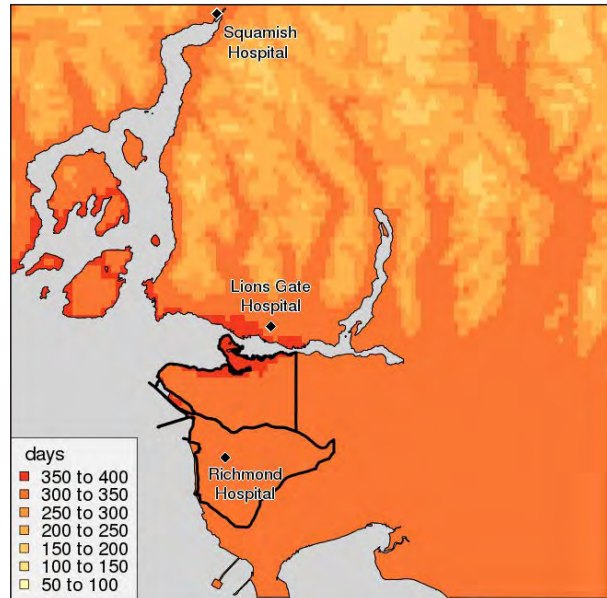


Figure 9: Growing Season Length – Past and Future (2050)

3.2 Precipitation

Precipitation patterns are projected to **change across the region**. While total annual increases will be modest, precipitation will be **redistributed across the season**, with wetter winters and drier summers. Additionally, extreme precipitation indicators project rain (and potentially snow) to increasingly fall during intense storms. The extreme precipitation indicators below will be important to planners and site managers grappling to understand the “new climate reality”.

The **increase in the quantity of precipitation and intensity of storm events** outlined by the indicators below will be **compounded by sea level rise and future king tide events**. While not addressed in this report, LMFM and VCH will need to consider the **cumulative impacts** of these events in planning for maintenance, upgrades, and new infrastructure.

TOTAL & SEASONAL PRECIPITATION

About this indicator

Total Precipitation is all precipitation summed over a month, season, or year, including rain and snow. This is a high-level indicator of how precipitation patterns can expect to change.

Projections

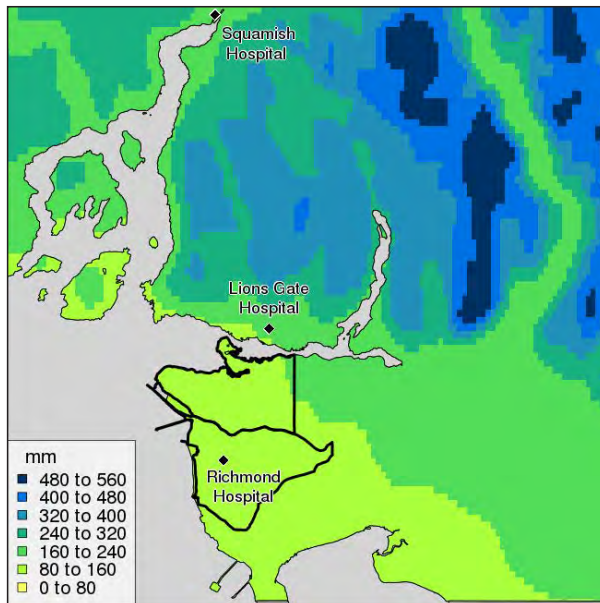
While total annual precipitation only increases modestly by 4% by 2050, we can expect considerable changes in when rain falls, and in the intensity of those events. The largest percentage increase in rainfall is expected to occur during the **autumn season**, increasing by **20% by 2080**. Models indicate winter and spring precipitation will both increase as well.

Summer, already our region’s driest season, may experience on average 15% less rain by 2050, and **23% less rain by 2080**. Projections also indicate that the VCH region will experience **longer stretches of dry days in summer** (11% longer by 2050, and 25% longer by 2080 on average). VCH facilities receive water from regional water sources, so **as drought conditions increase** over time, the health sector may experience **shortages for sterilization, sanitation, and human consumption**.

Percentage changes to Total and Seasonal Precipitation are similar at Lions Gate, Richmond, and Squamish, and facilities across the whole region.

The maps below show the amount of precipitation projected, and indicate that the wetter areas are expected to experience the largest increases in total precipitation amounts.

Summer Precipitation – Past



Summer Precipitation – Future (2050)

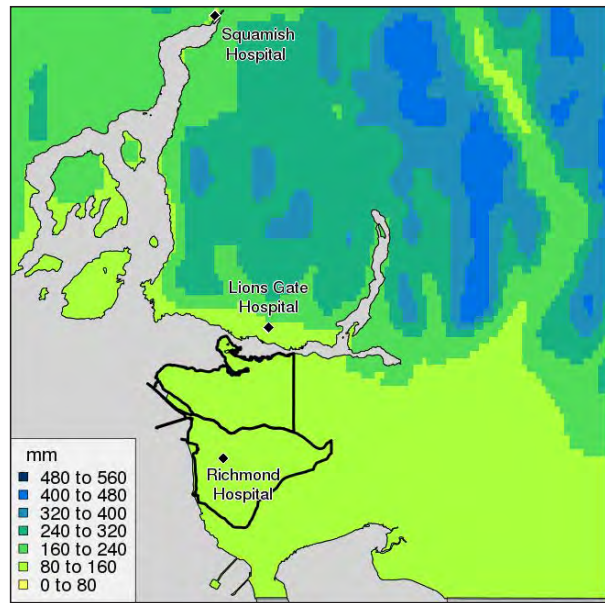


Figure 10: Summer Precipitation – Past and Future (2050)

Table 6: Total Seasonal and Annual Precipitation at (PR) at Health Facilities

	Lions Gate				Richmond				Squamish			
	Past (mm)	2020 Change (percent)	2050 Change (percent)	2080 Change (percent)	Past	2020 Change (percent)	2050 Change (percent)	2080 Change (percent)	Past	2020 Change (percent)	2050 Change (percent)	2080 Change (percent)
Spring	354	2% (-4 to 10)	5% (-4 to 13)	9% (1 to 17)	248	2% (-4 to 10)	5% (-4 to 12)	8% (0 to 16)	460	2% (-4 to 10)	5% (-3 to 12)	10% (3 to 17)
Summer	168	-8% (-28 to 5)	-16% (-35 to 3)	-23% (-51 to -2)	121	-8% (-28 to 4)	-16% (-37 to 3)	-23% (-50 to -3)	197	-8% (-26 to 8)	-15% (-34 to 3)	-22% (-49 to 1)
Fall	493	2% (-5 to 11)	9% (-2 to 23)	17% (8 to 36)	354	2% (-5 to 11)	9% (-3 to 24)	16% (7 to 35)	726	2% (-5 to 11)	11% (-2 to 24)	19% (9 to 36)
Winter	572	4% (-2 to 11)	3% (-3 to 11)	11% (0 to 24)	413	4% (-2 to 11)	3% (-3 to 11)	11% (0 to 24)	802	4% (-2 to 12)	4% (-4 to 10)	11% (-1 to 24)

BOX 7: EXTREME PRECIPITATION

Managing precipitation at facilities will become increasingly difficult as increased seasonal precipitation also means **more intense storm events**. The indicators below show that more rain will be falling in shorter periods of time, bringing **increased risks from flooding**. As more intense extreme events become the norm across the region, conditions that trigger emergency management will need to be incorporated into normal site-level operating conditions, and both facility and emergency managers will need to prepare for new challenges that variability will bring.

WETTEST DAY OF THE YEAR

About this indicator

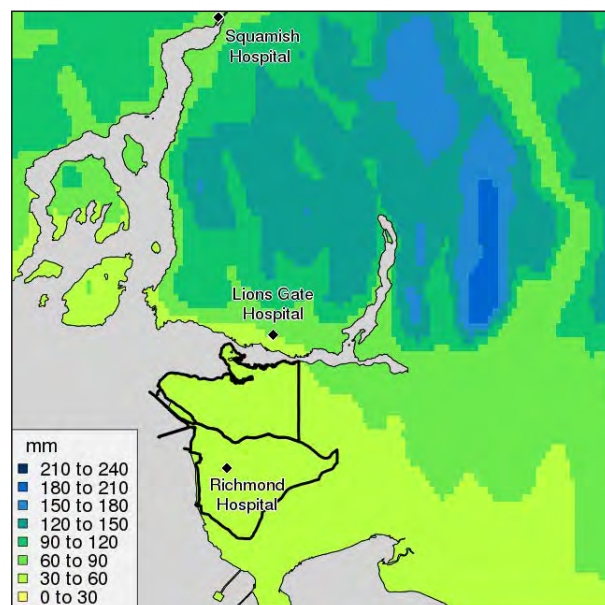
Wettest Day of the Year is the largest amount of rain that falls on any single day in the year, on average. This is an indicator of **extreme annual precipitation**.

Projections

Models project that the **increase in precipitation seen across the autumn, winter, and spring seasons will be concentrated into the wettest days**. The wettest single day of the year is expected to deliver 11% more precipitation by 2050, and **22% more by 2080**. Baseline values for single-day maximum precipitation differ at each of the health facilities, while the future percent changes are in line with regional averages.

Low-lying areas that currently experience less rain will experience the largest changes, due to their relatively lower baseline conditions.

Wettest Day of the Year – Past



Wettest Day of the Year – Future (2050)

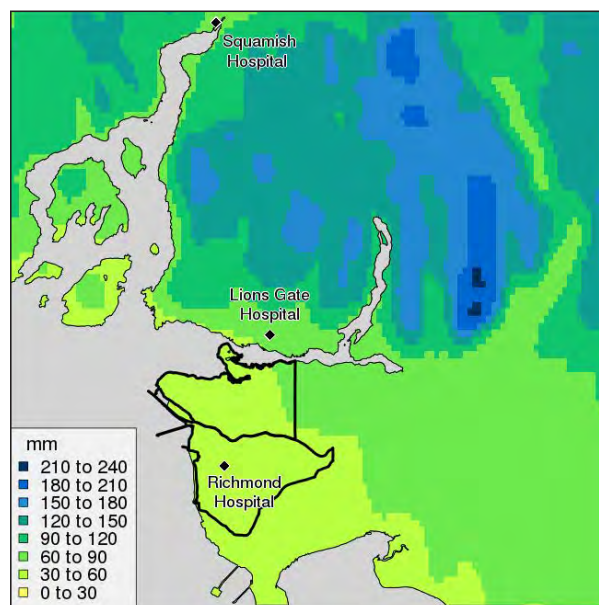


Figure 11: Wettest Day of the Year – Past and Future (2050)

WETTEST 5-DAY PERIOD OF THE YEAR

About this indicator

Wettest 5-Day Period of the year precipitation describes the largest amount of rain that falls over a period of five consecutive days in the year, on average. This offers insight into storm intensity, and will be **important for stormwater management at facilities**.

Projections

The increased precipitation will be more concentrated into the wettest days of the year. The Wettest 5-Day Period precipitation is projected to increase by **9% by 2050**, and **19% by 2080** for the VCH region. Percentage changes at facilities are in line with VCH regional projections.

WETTEST DAYS (R95p & R99p)

About this indicator

The 95th-percentile precipitation indicator (R95p) points to the total amount of rain that falls on the wettest days of the year, specifically on days when precipitation exceeds a threshold set by the annual 95th-percentile of wet days during the baseline period (1971–2000). Similarly, the 99th-percentile Wettest Days (R99p), refers to days when precipitation exceeds a threshold set by the annual 99th-percentile of wet days during the baseline period. These indicators measure how much total annual precipitation falls during these heavy events, which is a combination of both **how often these events occur and the size of these events**.

Projections

The wettest periods in our region are projected to become wetter. The precipitation on days that exceed the baseline 95th-percentile threshold are projected to produce 56% more precipitation by 2080. Most of this increase is due to those wet days becoming more frequent in the future. Percentage changes at the health facilities are in line with these VCH regional projections. This same trend is amplified for 99th-percentile Wettest Days, as larger 99th-percentile events with almost double the amount of rain during these largest downpours by 2080. We can expect both **more frequent and more intense storms** in the future, with **more rain falling during extreme downpours**.

The maps on the next two pages illustrate that extreme precipitation is expected to increase throughout the region, with the largest total increases in the areas that already experience large precipitation events.

Figure 12: Wettest Day Precipitation (R95P & R99P) - Past

The maps below illustrate that the wettest locations will continue to get wetter over time, and Richmond will experience similar amounts of rain as Vancouver on the Wettest Days.

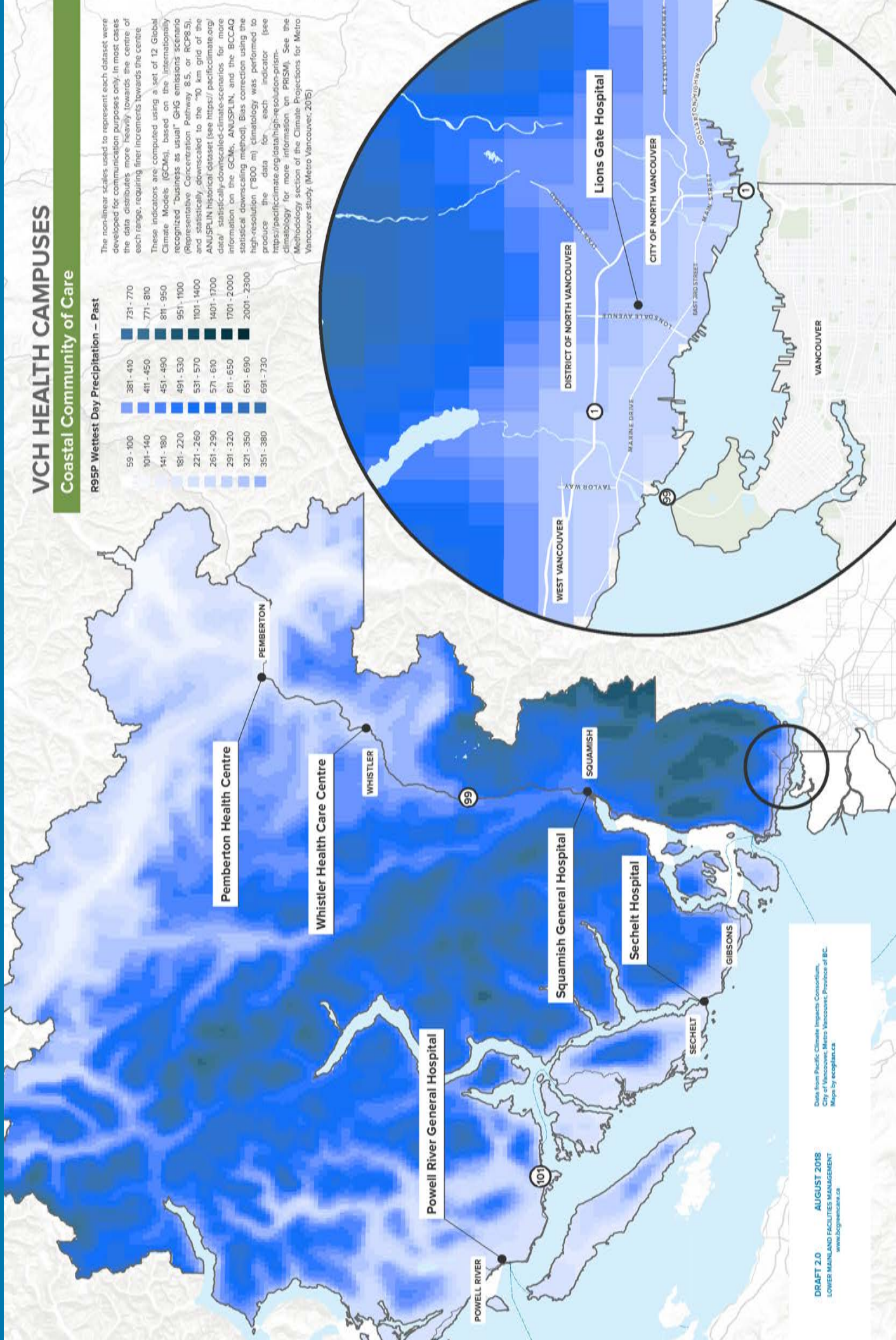
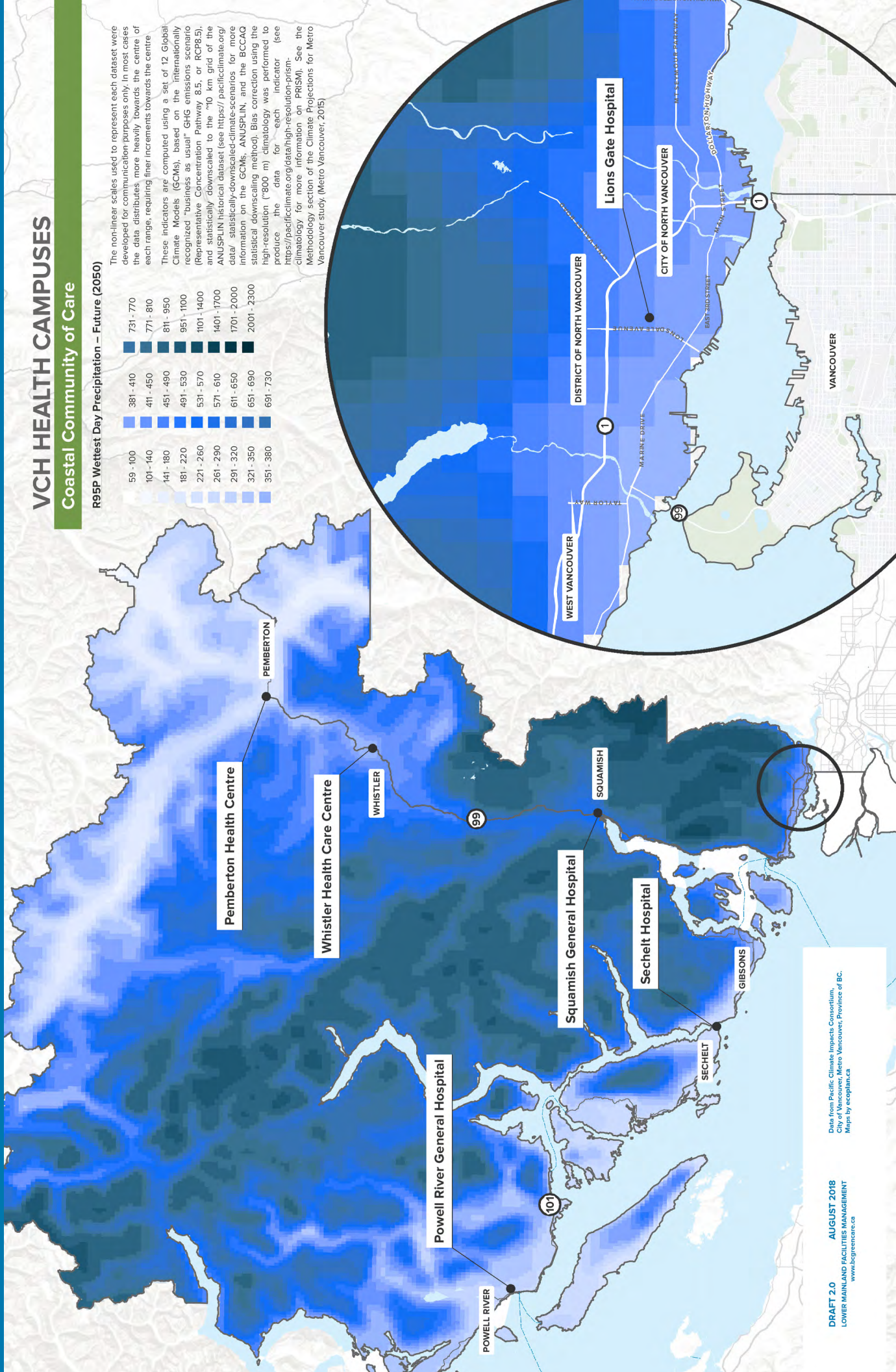


Figure 12: Wettest Day Precipitation (R95P & R99P) - Future (2050)



Data from Pacific Climate Impacts Consortium,
City of Vancouver, Metro Vancouver, Province of BC.
Maps by ecoplain.ca

1-IN-20 WETTEST DAY

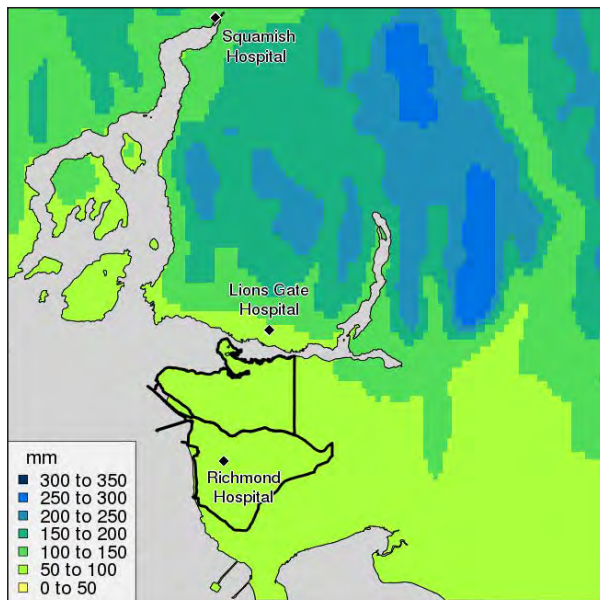
About this indicator

The 1-in-20 Wettest Day is the day so wet that it has only a 1-in-20 chance of occurring in any given year. That is, there is a 5% chance in any year that a 1-day rainfall event of this magnitude will occur. This indicator is useful when planning for future building and stormwater infrastructure, and also important to emergency managers.

Projections

More precipitation is expected to fall during the 1-in-20 (or 5% chance) wettest day extreme storm events. In the future, 1-in-20 Wettest Day events could be about **28% more intense by 2080**. Changes at the health facilities indicate that the wetter areas will become increasingly wetter over time, and indicate we should expect **year-to-year variability in precipitation levels**. The maps illustrate that the wettest regions will continue to get wetter over time, particularly on the North Shore.

1-in-20 Wettest Day – Past



1-in-20 Wettest Day – Future (2050)

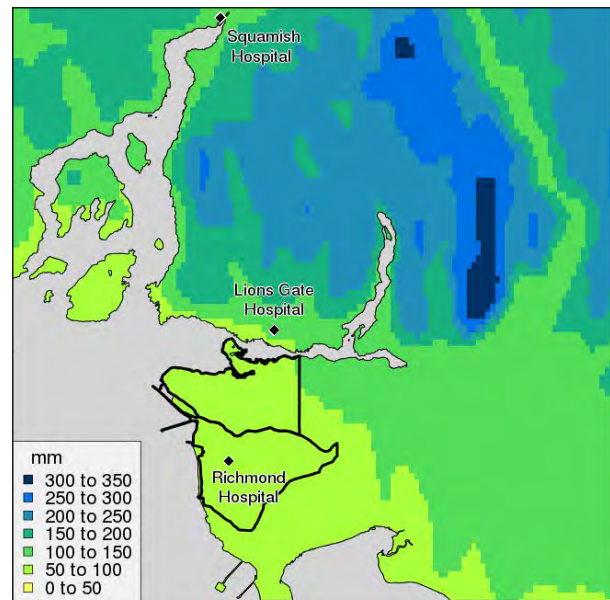


Figure 13: 1-in-20 Wettest Day – Past and Future (2050)

Table 7: Regional Extreme Precipitation for VCH Communities of Care

Indicator Description	Indicator Name	Past (mm)	2020 % Change (range)	2050 % Change (range)	2080 % Change (range)
Wettest Day of the year precipitation	Rx1day	77	5% (-1 to 12)	11% (5 to 21)	22% (14 to 35)
Wettest 5-Day Period of the year precipitation	Rx5day	185	4% (-1 to 12)	9% (4 to 16)	19% (14 to 27)
Precipitation on wet days	R95p	457	13% (0 to 27)	28% (7 to 52)	56% (37 to 72)
Precipitation on very wet days	R99p	136	19% (2 to 28)	47% (19 to 90)	98% (58 to 139)
1-in-20 Wettest Day	RP20 PR	112	8% (1 to 17)	16% (7 to 25)	28% (18 to 45)





4.0 Strategic Recommendations

This section highlights key opportunities to reduce risks and increase resilience of health facilities, and to broaden the conversation across our health system.

4.1 Use a Climate Lens for New Construction and Major Redevelopment Projects

There is a significant opportunity to improve resilience with new construction and investments in infrastructure. A climate lens for all large capital projects would include:

- A lifecycle cost analysis with operational costs for a facility's lifespan.
- A GHG inventory template to capture emissions associated with new infrastructure.
- Design specifications that address social and physical system risks associated with future climate.
- A requirement that relevant updated climate-influenced building standards and best practices have been taken into account during design and procurement.
- A site-wide training and information session about this project at each VCH health facility.
- Regular training for site staff involved in the day-to-day operation of the physical plant, including a table-top exercise to document the current level of preparedness.

4.2 Optimize Existing Equipment and Building Systems with 2020 Projections

Update existing and design new building systems by using 2020 projections to reset baselines and establish range limits that reflect actual loads:

- Collect, analyze and share relevant data and information before, during and after shocks and stresses at the facility and regional levels.
- Apply a climate lens to existing risk registers as a key mechanism for integrating [climate risk management](#) into day-to-day operations.
- Share insights and lessons learned with site administration to support adjustments required to ensure operational excellence.
- Train facility maintenance and operations staff to utilize a variety of forecast tools (e.g., wildfire smoke) and guidance for best practices (e.g., air filters), and set up a feedback mechanism to continuously improve effectiveness.

4.3 Conduct Site-Level Resilience Assessments for Existing Facilities

Much of the infrastructure that is currently in place will be challenged under “new climate reality” conditions. Improving existing sites will require:

- Incorporating key climate risk information into an inventory of owned and leased facilities, and resilience measures into asset risk registries.
- Conducting a high-level review of facilities to determine universal deficiencies and potential improvements.
- Conducting in-person facility assessments as a first step in developing site adaptation plans that inform capital and retrofitting cycles.
- The inclusion of contracted sites on the VCH facilities map for full documentation of all VCH sites.

4.4 Engage Health System Stakeholders in Resilience Planning

Preparing our health system for the changes ahead will take significant leadership and coordination between VCH operational units, and also with external partners. Embedding resilience into the VCH health system will require:

- Internal communications on climate change to share “new climate reality” projections and enhance education on climate change.
- Engagement with leadership to explore opportunities to reduce climate risks and liability.
- Inter-organizational working groups to advance resilience planning across VCH Communities of Care.
- Engagement with government and utilities to further information-gathering and create support for action on climate adaptation.
- Close coordination with community partners (e.g., utilities, municipal and regional governments, grassroots organizations) to organize response plans for shared infrastructure.

4.5 Support Improved Community Resilience

As VCH shifts health service delivery towards virtual care, supporting improvements in community resilience will become increasingly important, and may require:

- Developing public education mechanisms for building resilience at home.
- Developing a public communication protocol and delivery plan to relay messages in advance of and during future extreme events.
- Supporting and participating in inter-agency collaboration to identify and reduce community vulnerabilities.
- Working with community partners to ensure social and physical infrastructure is in place to support our “new climate reality”.

4.6 Develop Additional Climate Indicators for the Health Sector

Stakeholders recommend that future work include indicators and interpretation to support more detailed resilience work. The following topics were recommended for additional climate projection reporting:

- Summer cooling (temperature): Explore Cooling Degree Days using lower thresholds that are more appropriate to the health sector.
- Winter cooling (temperature): Facilities require winter cooling when outdoor temperatures rise above 15°C. For example, in spring and autumn, the outdoor air temperature (OAT) threshold for turning on the chiller and cooling towers is approximately 15°C for the Vancouver Community of Care. Future work should include projections for the number of autumn, winter, and spring days with air temperatures above site-specific daily temperature thresholds for each facility.
- Air quality: Diminishing outdoor air quality will increasingly impact facilities’ indoor air quality and their communities’ health and wellbeing. As the frequency, intensity, and duration of wildfires, “smoke days”, and stagnant conditions²⁴ are expected to increase over time in BC, we may see increased patient surge linked to particulate pollution from wildfire smoke and ground-level ozone. Projections at the local community level on the frequency and duration of Air Quality Advisories due to poor air quality events, and projections of expected concentration levels, may assist in determining the magnitude of future impacts on each facility from ambient air quality. Guidance on reducing smoke ingress and contamination (e.g., odours) of health facilities is needed.
- Wind/storminess: Changing wind intensity and direction have an impact on design and landscaping at facilities and in communities. Thresholds for wind need to be explored to inform design guidelines. Future projections would be based on the wind variables in the BC Building Code and ASHRAE.
- Snow loads: The combination of rising winter temperatures with increases in precipitation is likely to result in very little snow loading by the end of the century, however, between now and then we may experience years with heavy, wet loads on exterior structures. Projections for the number of heavy snowfall events per year will be needed.

²⁴ <https://www.theweathernetwork.com/news/articles/canada-in-2030-climate-change-commitments-up-in-the-air-carbon-dioxide-air-quality-humidity-pollen-allergies/111767> Moving Towards Climate Resilient Health Facilities | 46

Appendix 1: Terms and Definitions

The terms below and their descriptions are drawn from multiple sources including the IPCC,²⁵ 100 Resilient Cities,²⁶ the World Health Organization,²⁷ and BC Housing.

Acute shocks (or climate shocks): 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. Acute shocks are sudden, sharp events that threaten a city, including: earthquakes, floods, disease outbreaks, terrorist attacks. Climate shocks are acute shocks related to weather, including extreme heat events (or "heat waves"), storms (e.g., ice, snow, and wind), and storm surge from oceans and rivers.

Adaptation: A change in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Chronic stresses (or climate stresses): A chronic (ongoing or cyclical) natural or human-made event or phenomenon that renders a building or community less able to function and provide basic services, particularly for poor or vulnerable populations. Chronic stresses are slow-moving disasters that weaken the fabric of a city. They include: high unemployment, overtaxed or inefficient public transportation system, endemic violence, chronic food and water shortages. Climate stresses are chronic stresses caused by climate change, and include prolonged droughts, increasing temperatures, rising sea levels, and ocean acidification.

Climate change: Any change in the climate over time, generally decades or longer, whether due to natural variability or as a result of human activity.

Climate extreme: The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as "climate extremes".

Climate variability: Trends in variation in climate on all temporal and spatial scales beyond that of individual weather events. Extreme weather (e.g., storms, extreme temperatures) and climate events (e.g., droughts) are part of climate variability trends.

Climate model: A numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions, and feedback processes.

All data in this report assumes a "business as usual" pathway because global commitments are as yet insufficient to meet the agreed or ideal targets. For data corresponding to RCP4.5 and RCP2.6, please refer to the *Climate Projections for Metro Vancouver* report here: <http://www.metrovancouver.org/services/air-quality/AirQualityPublications/ClimateProjectionsForMetroVancouver.pdf>

²⁵ <http://www.ipcc.ch/>

²⁶ <https://www.100resilientcities.org/resources/>

²⁷ <http://www.who.int/globalchange/publications/building-climate-resilient-health-systems/en/>

Climate projection: 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. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized.

Climate-resilient health systems: The ability to anticipate, respond to, cope with, recover from, and adapt to climate-related shocks and stresses, so as to bring sustained improvements in population health, despite an unstable climate.

Climate-sensitive health outcome: Any health outcome whose geographic range, incidence, or intensity of transmission is directly or indirectly associated with weather or climate.

Climate risk: The potential loss of life, injury, or destroyed or damaged assets that could occur to a system, society or a community in a specific period of time, as a result of a climatic shock or stress.

Climate risk management: An approach to identify hazards and impacts associated with both climate variability and climate change, and provide tools for decision-making in response. Climate risk management aims to reduce negative impacts through “climate-informed decisions”, which couple information about the climate system and meteorological conditions with the known associations to health outcomes. The approach incorporates this knowledge into decision-making on planning, forecasting, systems management, and geographic or spatial targeting, or risk management interventions. Climate risk management encourages handling of current climate-related risks as a basis for managing and building capacity to address more complex, long-term risks associated with climate change.

CLIMDEX: The CLIMDEX project aims to produce a suite of in-situ and gridded land-based global datasets of indices representing the more extreme aspects of climate. There are 27 core indices (the “ETCCDI” indices) that are calculated for the globe using the RCLIMDEX/FCLIMDEX software. (<https://www.CLIMDEX.org/>).

Community resilience: The potential loss of life, injury, or destroyed or damaged assets that could occur to a system, society or a community in a specific period of time, as a result of a climatic shock or stress.

Exposure: The character, magnitude, and rate of change of climate change impacts to which the system is exposed.

Extreme weather event: An event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations.

Health system: All the organizations, institutions, and resources that are devoted to producing actions principally aimed at improving, maintaining, or restoring health. Health systems involve numerous stakeholders from individuals and communities to government at local, subnational, and national levels. The health system is recognized by WHO to be made up of six key building blocks: (i) leadership and governance; (ii) health workforce; (iii) health information systems; (iv) essential medical products and technologies; (v) financing; all of which lead to (vi) service delivery. The goal of a health system is to deliver effective preventive and curative health services to the full population, equitably and efficiently, while protecting individuals from catastrophic healthcare costs.

Impacts: Consequences, outcomes, or effects on natural and human systems. In this report, the term is used primarily to refer to the effects on natural and human systems of extreme weather and climate events, and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

Infrastructure strains: Situations in which health system infrastructure is negatively impacted by stresses, but does not exhibit failure. For example, extreme heat may lead to indoor temperatures that are habitable, but in excess of the desired set-point (straining the capacity of the cooling system). In contrast, indoor temperatures resulting in patients needing to be evacuated might be considered an infrastructure failure.²⁸

“New climate reality”: This term is intended to convey that climate conditions today and in the future (i.e., health facility lifespans) are considerably different from past conditions. In this report, “new climate reality” describes an operating context whereby baselines are different from the past, increased variability is expected, and more extreme weather events are likely. This term is less likely to be misinterpreted than a similar term, “new normal”.^{29, 30, 31}

Passive survivability: A building’s ability to maintain healthy, liveable conditions in the event of extended loss of access to external sources of power or water, or in the event of extraordinary heat spells, storms or other extreme events.

Resilience: The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning and transformation.

Resilient building: A building that is designed and managed to maintain critical operations and functions in the face of a shock or stress, and return to normal operations in a fast and efficient manner, in order to maintain healthy, liveable spaces for its occupants.

Risk: The potential for an uncertain event or trend to have adverse consequences on lives; livelihoods; health; property; ecosystems and species; economic, social, and cultural assets; service provision (including environmental services); and infrastructure.

Sensitivity: The degree to which a system could be affected adversely or beneficially by climate change.

Vulnerability: Degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes; a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity.

²⁸ Extreme Heat Risks and Impacts on BC’s Health Facilities: a background report (LMFM, 2018)

²⁹ <https://www.nature.com/news/extreme-weather-events-are-the-new-normal-1.22516>

³⁰ <https://www.cbc.ca/news/canada/british-columbia/shifting-climate-baselines-in-b-c-get-ready-for-the-new-normal-1.4149150>

³¹ <https://www.theguardian.com/environment/2017/dec/28/climate-change-2017-warmest-year-extreme-weather>

Appendix 2: Climate Indicators in Plain Language

These plain language descriptions were developed primarily by Pinna Sustainability for this report.

Days Above 25°C: Days Above 25°C measures how many days reach temperatures over 25°C in any one year. This indicator is important to facilities as they are required to maintain an interior temperature below 25°C.

Days Above 30°C: Days Above 30°C indicates how many days reach temperatures over 30°C in any one year. This indicator is important to public health and facilities as mortality rates jump when temperatures are at or near 30°C, and facilities experience a surge in patient visits due to heat stress.

Hot Design Temperature (BCBC 97.5): Hot design temperature refers to the 9th hottest daytime high temperature of the year, usually experienced during the summer months. This is an indicator of extreme temperatures over all elevations, and is averaged over a 30-year period. Hottest Day (TXX) is the annual hottest day of the year and warms by similar amounts as Hot Design Temperature (BCBC 97.5).

Degree Days: Degree Days measure the difference between the daily outdoor temperature and the base temperature of a facility, where the base temperature represents the balance point where no cooling or heating is required. The further the daily temperature is from the base temperature the higher the number of degree days are calculated.

For example, if a facility has a base temperature of 18°C and the daily outside temperature reaches 22°C there is a 4°C difference above the base temperature for that day. This represents 4 Cooling Degree-Days (CDD) and indicates cooling was required. If on another day the outside temperature reaches 14°C there is a 4°C difference below the base temperature for that day, representing 4 Heating Degree-Days (HDD) and indicates heating was required.

Degree Days are useful in understanding the required cooling and heating loads of a facility in relation to daily temperature variances throughout the year. To determine the number of Degree Days for a month or year, the number of degrees that the daily temperature is above or below the base temperature for each day are added to give a total value.

Cooling Degree Days: Cooling Degree Days refers to the number of degrees that a day's average temperature is above 18°C, and is used to estimate the use of air conditioning to cool buildings. To determine the number of Cooling Degree Days in a year, the number of degrees that the daily temperature is over 18°C for each day is added to give a total value. Lower thresholds will cause relative increases in numbers, though projected relative changes are not expected to vary significantly.

Heating Degree Days: Heating Degree Days refers to the number of degrees that a day's average temperature is below 18°C, and is used to estimate the amount of energy used to heat buildings. To determine the number of Heating Degree Days in a month, the number of degrees that the daily temperature is below 18°C for each day is added to give a total value.

Tropical Nights: Tropical Nights refers to the number of days in a year when the nighttime low temperature is greater than 20°C. This indicator is important, as a series of hot nights reduces the ability of buildings to cool passively at night, increasing cooling load and energy use during warm spells. Tropical Nights can also reduce the ability of patients to heal, and can cause heat stress.

Growing Season Length: Growing Season Length is an annual indicator that counts the number of days between the first span of at least six days with a daily average temperature greater than 5°C and the first span after July 1 of six days with temperature less than 5°C. It measures the length of the growing season for native crops, and points to a warmer baseline where new illnesses are able to thrive.

Total & Seasonal Precipitation: Total Precipitation is all precipitation summed over a month, season, or year, including rain and snow. This is a high-level indicator of how precipitation patterns can expect to change.

Wettest Day of the Year: Wettest day of the year is the largest amount of rain that falls on any single day in the year, on average.

Wettest 5-Day Period of the Year: Wettest 5-Day Period of the year precipitation describes the largest amount of rain that falls over a period of 5 consecutive days in the year. This offers insight into storm intensity, and will be important for stormwater management at facilities.

Wettest Days (R95p & R99p): The 95th-percentile Wettest Days precipitation indicator (R95p) points to the total amount of rain that falls on the Wettest Days of the year, specifically on days when precipitation exceeds a threshold set by the annual 95th-percentile of wet days during the baseline period (1971–2000). The same definition is true for 99th-percentile Wettest Days (R99p), though refers to days when precipitation exceeds a threshold set by the annual 99th-percentile of wet days during the baseline period. This indicator measures how much total annual precipitation falls during these heavy events, which is a combination of both how often these events occur and the size of these events.

1-in-20 Wettest Day: The 1-in-20 Wettest Day is the day so wet that it has only a 1-in-20 chance of occurring in any given year. That is, there is a 5% chance in any year that a 1-day rainfall event of this magnitude will occur. This indicator is useful when planning for future building and stormwater infrastructure, and also important to emergency managers.

Appendix 3: Climatic and Seismic Information for Building Codes

The following text is excerpted from the *BC Building Code Appendix C - Division B, Climatic and Seismic Information for Building Codes*.

CHANGING AND VARIABLE CLIMATES

Climate is not static. At any location, weather and climatic conditions vary from season to season, year to year, and over longer time periods (climate cycles). This has always been the case. In fact, evidence is mounting that the climates of Canada are changing and will continue to change significantly into the future. When estimating climatic design loads, this variability can be considered using appropriate statistical analysis, data records spanning sufficient periods, and meteorological judgment. The analysis generally assumes that the past climate will be representative of the future climate.

Past and ongoing modifications to atmospheric chemistry (from greenhouse gas emissions and land use changes) are expected to alter most climatic regimes in the future despite the success of the most ambitious greenhouse gas mitigation plans. Some regions could see an increase in the frequency and intensity of many weather extremes, which will accelerate weathering processes. Consequently, many buildings will need to be designed, maintained and operated to adequately withstand ever-changing climatic loads.

Similar to global trends, the last decade in Canada was noted as the warmest in instrumented record. Canada has warmed, on average, at almost twice the rate of the global average increase, while the western Arctic is warming at a rate that is unprecedented over the past 400 years. Mounting evidence from Arctic communities indicates that rapid changes to climate in the North have resulted in melting permafrost and impacts from other climate changes have affected nearly every type of built structure. Furthermore, analysis of Canadian precipitation data shows that many regions of the country have, on average, also been tending towards wetter conditions.³² In the United States, where the density of climate monitoring stations is greater, a number of studies have found an unambiguous upward trend in the frequency of heavy to extreme precipitation events, with these increases coincident with a general upward trend in the total amount of precipitation. Climate change model results, based on an ensemble of global climate models worldwide, project that future climate warming rates will be greatest in higher latitude countries such as Canada.³³

³² Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (Eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp., 2007.

³³ American Society of Heating, Refrigerating, and Air-conditioning Engineers, *Handbook of Fundamentals*, Chapter 14 – Climatic Design Information, Atlanta, GA, 2009.

Appendix 4: BC Building Code and ASHRAE

The building code and standards variables below can be addressed with climate projections for temperature and precipitation. BCBC Annual Average Total Precipitation and CLIMDEX Annual Precipitation (PR) are identical. Hottest Day (TXX) is the annual hottest day of the year and warms by similar amounts as Hot Design Temperature (BCBC 97.5). See Appendix 2 for definitions in plain language.

BC BUILDING CODE 2012

Cool Month Design Temperature 2.5%
Cold Month Design Temperature 1.0%
Warm Month Design Temperature 97.5%
Heating Degree Days (18°C)

Annual Maximum Daily Precipitation
Annual Average Total Precipitation
50-Year Return Period Daily Total Precipitation

ASHRAE

Heating Dry Bulb Temperature 0.4%
Heating Dry Bulb Temperature 1.0%
Cooling Dry Bulb Temperature 99.6%
Cooling Dry Bulb Temperature 99.0%

Average Annual Max Dry Bulb Temperature
Average Annual Min Dry Bulb Temperature
5-Year Return Period Daily Max Temperature
5-Year Return Period Daily Min Temperature

Maximum Annual Total Precipitation
Average Annual Total Precipitation
Minimum Annual Total Precipitation
Standard Deviation Annual Total Precipitation
5-Year Return Period Daily Total Precipitation

Appendix 5: Adapting BC's Transportation Infrastructure

The content below is a key example of how BC is adapting public infrastructure to improve climate resilience.³⁴

ADAPTING BC'S TRANSPORTATION INFRASTRUCTURE

To ensure transportation infrastructure is resilient and adapted to the effects of climate change, including extreme weather events, we must look beyond historical information to future trends and what they might mean for British Columbia. With contributions from key partners such as the Pacific Climate Impacts Consortium (PCIC) and Engineers Canada and their Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol, the Province has undertaken initiatives to evaluate and address potential effects of climate change on transportation infrastructure, such as roads and bridges. Additional guidance and examples for including climate change considerations in transportation infrastructure engineering design work have been developed in collaboration with Engineers and Geoscientists British Columbia (EGBC). These activities will ensure BC's transportation infrastructure remains resilient, reliable, effective and efficient—and adapted to future climate conditions.

Transportation Infrastructure Engineering Design

The Ministry of Transportation and Infrastructure requires that potential impacts of climate change be considered in transportation infrastructure engineering design, so that BC's transportation infrastructure is adapted to climate changes. A climate language primer was also developed to clarify concepts and principles typically used in climate sciences.

- [Technical circular: climate change and extreme weather event preparedness and resilience in engineering infrastructure design \(PDF\)](#)
- [BCMOTI Design Criteria Sheet \(DOC\)](#)
- [Climate Language Primer \(PDF\)](#)

Highway Transportation – Best Practices & Vulnerability Studies

Through a number of climate and extreme weather vulnerability studies, the Province has developed best practice guidance to address potential climate change impacts on BC's highway infrastructure, ensuring a resilient transportation system adapted to extreme weather and other climate change effects.

- [B.C. highway infrastructure – best practices for addressing climate change adaptation \(2014\) \(PDF\)](#)
- [Review of B.C. Highway Vulnerability Assessments and other assessments \(2014\) \(PDF\)](#)
- [Highway 5 – Coquihalla Vulnerability Assessment \(2010\) \(PDF, 6.7MB\)](#)
- [Highway 16 – Yellowhead Vulnerability Assessment \(2011\) \(PDF, 3.5MB\)](#)
- [Highway 20 – Bella Coola Vulnerability Assessment \(2014\) \(PDF, 2.5MB\)](#)
- [Highway 37A – Stewart Vulnerability Assessment \(2014\) \(PDF, 2.5MB\)](#)
- [Highway 97 – Pine Pass Vulnerability Assessment \(2014\) \(PDF, 2.5MB\)](#)
- [Analysis of Climate Change Projections for the Ministry of Transportation and Infrastructure Highways Risk Assessment \(2014\) \(PDF, 2.7MB\)](#)
- [Engineering Analysis Report for the Climate Change Engineering Vulnerability Assessment \(PDF, 9.4MB\)](#)

³⁴ <https://www2.gov.bc.ca/gov/content/transportation/transportation-environment/climate-action/adaptation> (accessed on August 15, 2018).

Appendix 6: Applying a Climate Lens to Canada's Infrastructure Projects 2018

The content below is a key example of how the federal government is adapting public infrastructure to improve climate resilience.³⁵ This excerpt is reproduced verbatim.

As part of the Investing in Canada plan, applicants seeking federal funding for new major public infrastructure projects will now be asked to undertake an assessment of how their projects will contribute to or reduce carbon pollution, and to consider climate change risks in the location, design, and planned operation of projects.

The Climate Lens will help infrastructure owners design better projects by assessing their opportunities to reduce carbon pollution and identify when they should be adapting project design to better withstand impacts of climate change (e.g., severe weather, floods, sea-level rise, etc.). A General Guidance document has been prepared to explain the required approach, define the scope of the assessment, and identify the specific information that must be submitted to Infrastructure Canada.

At the planning and design stage, project applicants will now need to assess whether their projects will increase or decrease greenhouse gas emissions. As a second component, they will need to consider ways to incorporate structural or system changes that will help their new infrastructure withstand the potential impacts of climate change and continue to perform reliably. Over time, the goal is to have climate change considerations become a core part of Canada's infrastructure planning.

The Climate Lens assessment is a requirement of the Investing in Canada plan bilateral agreements being signed between Infrastructure Canada and the provinces and territories. It will apply to projects with a total estimated cost of over \$10 million, as well as any project that deals with climate change resilience or greenhouse gas mitigation. The Lens also applies to all projects under the recently launched Disaster Mitigation and Adaptation Fund and certain Smart Cities Challenge winning proposals.

The Climate Lens encourages improved choices by project planners consistent with shared federal, provincial and territorial objectives in the Pan-Canadian Framework for Clean Growth and Climate Change.

³⁵ <https://www.canada.ca/en/office-infrastructure/news/2018/06/backgrounder-applying-a-climate-lens-to-infrastructure-projects.html> (accessed on August 15, 2018). See also Engineers Canada's commentary: <https://engineerscanada.ca/news-and-events/news/federal-government-climate-lens-a-game-changer-for-canadas-infrastructure>

Appendix 7: Climate Resilient Health Facilities and Health Systems Workshops

WORKSHOP 1: TOWARDS CLIMATE RESILIENT HEALTH FACILITIES (APRIL 2018)

This workshop introduced a review of how climate change affects project design and delivery, and how climate projections can be integrated into our various work streams. Participants were invited to share information about how current and future work parameters will need to be adjusted to address the impacts of a changing climate. Participants were emailed workshop materials that included a project primer.

Objectives:

1. Gather reflections on preliminary impacts that have emerged from the group to date.
2. Explore how an extreme climate scenario would impact the ability of our staff to respond to a future situation.
3. Review our short-list of climate indicators and projections, and gather information on climate thresholds of interest to inform our next steps.

Participants:

LMFM Senior Leadership Team

Mauricio Acosta - Executive Director, Business Performance & Corporate Support

Rob Bradley - Director (Acting), Energy & Environmental Sustainability

Noor Esmail - Director, VCH Coastal & Richmond, Planning & Projects

Cathy Massey - Director, Clinical & Equipment Planning

Lions Gate Hospital Acute Care Facility Business Plan

Florrie Levine - Planning Lead, VCH Coastal & LGH ACF Business Plan Project Manager

Susan Scrivens - VCH Perioperative Services Clinical Planner

Mark Swain - Mechanical Engineer, Rocky Point Engineering

Joe Stano - LEED Consultant, Kane Consulting Partnership

Knut Boeck - Architect, dys architecture

Richmond Hospital

Ian Kerr - Manager, Planning & Projects

Jennifer Hunter - Patient Flow & Care Transitions

Asset Risk and Quality: Technical Services

Brian Postlethwaite - Asset Lifecycle Manager

David Marier - Facilities Integrity Program Manager

Facilities Maintenance & Operations

Mark Doucette - VCH Coastal, Business Initiatives & Support Services (BISS)

Energy & Environmental Sustainability

Kori Jones - Energy Manager, VCH

Alex Hutton - Energy Manager, PHSA PHC

Angie Woo - Lead, Climate Resilience & Adaptation

Subject Matter Experts & Facilitation Support

Gillian Aubie Vines - Principal, Pinna Sustainability

Cariad Garratt - Principal, Pinna Sustainability

Trevor Murdock - Pacific Climate Impacts Consortium

PRIMER

BACKGROUND

Climate risks and impacts already affect health facilities and services in the 3 VCH Communities of Care (Attachment 1). While extreme events and their local effects (Appendix 1) are high-profile and widely acknowledged, climate shocks and stresses are more frequent, complex and significant than are reported in BC's headline news. Utilizing regional climate projections (Appendix 2), LMFM's 2016 resilience assessments of acute care facilities highlighted risks and recommendations for Sechelt, Squamish and Lions Gate Hospitals (Appendix 3).

LMFM plays a critical role in ensuring that health system facilities (interior and exterior) enable and safeguard high quality, reliable and continuous health service delivery. As such, VCH buildings and infrastructure need to be appropriately designed and maintained for a continually-changing climate today — not just for a different climate in a distant future. The LGH Acute Care Facility (ACF) redevelopment project is a prime opportunity to lead in planning for a resilient built environment within our new climate reality. This reality includes longer high-temperature periods and heavier precipitation loads that strain existing infrastructure, buildings and systems — and result in cascading impacts on service delivery.

Climate-smart planning and design goes beyond current practices, building codes and standards to integrate climate projections into key decisions and design thresholds. Climate-informed operations and maintenance further reduces strains on service delivery and patient outcomes.

Purpose

Our project breaks new ground with its focus on health facilities and health systems. This report is the first step of an inclusive and iterative process to integrate climate-resilient planning throughout the VCH health facilities portfolio and health system. This workshop will review how climate change affects project design and delivery, and how climate projections can be integrated into our various work streams. Including representatives from Clinical Planning, Planning & Projects (P&P), Facilities Maintenance & Operations (FMO), Asset, Risk & Quality (ARQ), Energy & Environmental Sustainability (EES) and the LGH ACF design team, workshop participants will be invited to share information about how current & future work parameters will need to be adjusted to address the impacts of a changing climate (Appendix 4).

By July 2018, it is intended that this work will provide LMFM with:

- future climate projections specific to the 3 VCH Communities of Care;
- a high-level summary of impacts on health facilities, including how changing climate thresholds may affect how we plan, design, operate and maintain our facilities;
- an overview of cascading impacts on health services.

Next steps will include engagement with other health system stakeholders including population and public health, disease control, emergency management, health informatics and insurance to achieve a more fulsome understanding of VCH health service delivery needs in a changing climate.

Team

Led by Angie Woo, Climate Resilience Lead with support from Florrie Levine, P&P LGH ACF Project Manager, this project will add significant and unique value to the Facilities Management Body of Knowledge (FMBOK). With key support from the team behind three regional climate reports, including Metro Vancouver and Capital Regional District, consultants to this project include:

- Pacific Climate Impacts Consortium (VCH climate projections);
- Pinna Sustainability (workshop facilitator & report writer);
- Ecoplan International (VCH maps & report graphics).

WORKSHOP 2: TOWARDS CLIMATE RESILIENT HEALTH FACILITIES (MAY 2018)

This follow-up workshop invited participants back to:

- Gather reflections on preliminary impacts that have emerged from the group to date.
- Review our short-list of climate indicators and projections, and gather information on climate thresholds of interest to inform our next steps.
- Explore how an extreme climate scenario would impact the ability of our staff to respond to a future situation.

“New Climate Reality” Scenario A: Extreme Heat & Lions Gate Hospital

The year is 2035. Temperatures have been over 30°C for the last three weeks, with several days near 40°C, and most evenings staying above 25°C. VCH has had a heat health warning in effect since day two of the heat wave. Lions Gate Hospital began experiencing a sharp increase in visits for schizophrenia, mood disorders and neurotic disorders (e.g., anxiety, panic and stress) after four days. Public health officials have advised everyone to stay in air-conditioned indoor locations, and to check in often on neighbours (especially elderly, young and chronically ill).

With this heat, there has been an increase in personal air conditioning and BC Hydro’s capacity to deliver electricity to the Metro Vancouver region is being compromised, resulting in rolling brownouts across the province. Additionally, we have had an active wildfire season, with 200+ fires burning around the province, including a small fire on Grouse Mountain. Across the region, the back country is closed for recreational use, reducing natural areas offering respite from the heat.

The Air Quality Health Index on the North Shore and up the Sea to Sky corridor has been above level 10 (“very high” health risk) for five weeks. Due to the high concentration of ground level ozone, fine particulate matter and nitrogen dioxide in the air, health advisories are in effect: everyone should reduce or reschedule strenuous activities outdoors (especially for those who experience symptoms such as coughing and throat irritation); and anyone with heart or breathing problems should avoid strenuous activities outdoors.

Metro Vancouver is at Stage 4 Water restrictions, which is the highest level and is only activated in cases of significant emergencies (e.g., water system infrastructure, such as transmission lines and treatment plants, are impacted). All outdoor water use is prohibited (washing and watering); moreover, personal water use is limited to 50 liters per day.

Group A

Step 1: Define successful operations under this scenario

Step 2: Describe what action was taken to enable health system resiliency under these climate conditions

Group B

Step 1: Define operational failure under this scenario

Step 2: Describe what actions were not taken to enable health system resiliency under these climate conditions

WORKSHOP 3: TOWARDS CLIMATE RESILIENT HEALTH SYSTEMS (JUNE 2018)

This workshop included participants from other health system building blocks³⁶ to:

- Review climate projections for VCH Communities of Care.
- Explore how an extreme climate scenario would impact critical parts of the health system.
- Identify potential opportunities for alignment and collaboration.

“New Climate Reality” Scenario B: Extreme Flood & Richmond Hospital

The year is 2035. A large fall storm event has coincided with a king tide, and a dike has breached along the north arm of the Fraser River. Water is now flowing in at the location of the dike breach and this is causing flooding along Gilbert Road and at Richmond Hospital (RHS), and over much of the region west and north of the Hospital. Over 850 staff provide services at the Hospital, and 600+ work in community-based residential and home health care (i.e., RHS Community, Minoru and Lions Manor).

In addition, there is intense rainfall at this time. Regional pump systems are being overwhelmed by the flood waters, and there is 1 meter of standing water at the Hospital site and the surrounding area as a result. Moreover, high winds associated with the storm have knocked down power transmission lines and there are power outages all over the city.

With critical infrastructure underwater, drinking water has been contaminated with sewage and agricultural runoff, posing health risks to the Hospital’s community. Richmond has had one of the fastest growing populations in BC and among the fastest growing seniors population for many years, with more than 70% of acute care admissions comprising seniors.

Members of the public are starting to display signs of gastro-intestinal illness, and the unreasonably warm temperatures this season bring threats of new vector and water borne disease.

As a health system, our goal is to be able to fulfill VCH’s mandate with minimal service disruption under “new climate reality” conditions: to plan, deliver, monitor, and report on health services, which include population and public health programs, high quality community based health care and support services, acute hospital care, as well as improved productivity and performance.

Group A

Step 1: Define successful operations under this scenario

Step 2: Describe what action was taken to enable health system resiliency under these climate conditions

Group B

Step 1: Define operational failure under this scenario

Step 2: Describe what actions were not taken to enable health system resiliency under these climate conditions

³⁶ See Figure 3: WHO Operational Framework for Climate Resilient Health Systems.

Participants:

Population and Public Health

Dr James Lu - Medical Health Officer, Healthy Built Environment Team, VCH

Dr Lisa Mu - Medical Health Officer, Fraser Health

Laura Chow - Healthy Built Environment Team, VCH

Dr Michael Brauer - Professor, UBC School of Population and Public Health

Jessica Vu - PhD Student, UBC School of Population and Public Health

VCH Regional Programs and Services

Paddy Assenheimer - VCH Transformation Office, Green Leader

Darren Kopetsky - Regional Director, Client Relations and Risk Management

Jackie Murray - Regional Program Planning Leader, Critical Care & Medicine

Ruby Syropiatko - Regional Trauma, Emergency

Kim Steger - BC Patient Safety & Learning System, Green Leader

Phillipe Lang - Manager Physician Quality, Green Leader

Nicole Li - Physician Quality Improvement & Assessment

Lions Gate Hospital Acute Care Facility Business Plan

Florrie Levine - Planning Lead, VCH Coastal & LGH ACF Business Plan Project Manager

Susan Scrivens - VCH Perioperative Services Clinical Planner

Richmond Hospital Redevelopment Project

Richard Dillon - Director - Client Relations & Risk Management

Health Emergency Management BC

Scott Blessin - Lower Mainland Manager, Community & Residential

Sean McCune - Providence Health Care, Acute Services

Margaretha Lundh - A/Manager, Recovery

BC Climate Action Secretariat – Climate Risk Management

Julia Berry - Senior Policy Analyst, Adaptation

Appendix 8: Impacts and Actions

The table below summarizes workshop participants' thinking on impacts and preliminary actions. This list outlines preliminary actions necessary to prepare VCH facilities for robust and resilient operations over time, and is not intended to be comprehensive. The impacts and recommended actions should be considered alongside those resulting from other work conducted by LMFM's *Climate Resilience & Adaptation Program*.

Likely Impacts	Recommended Actions
<p>Patient Care</p> <ul style="list-style-type: none"> • Increase in hospital visits from vulnerable population suffering from climate-related stress. • Increase in new, unfamiliar air- and vector-borne diseases in the region. • Increase in the number and frequency of community members seeking refuge at VCH facilities equipped with power, cooling, water, and food. • Transportation disruptions challenging delivery of community health care, resulting in more hospital visits. • Increase in multi-system failures at sites that are not climate resilient, including facility closures during extreme events. 	<ul style="list-style-type: none"> • Create partnerships with local and regional governments to improve community resilience by reducing pressure on the health system and strengthening community health. • Provide exterior shading/covered areas at hospitals to support access during high-volume periods. • Ensure robust information management systems to track service delivery and the distribution of food, water, and critical supplies to home-care patients. • Work across VCH and with regional partners to plan for hospital evacuations required during critical system failures.
<p>Ventilation</p> <ul style="list-style-type: none"> • Compromised air quality across the region with increased forest fire activity and more heat-related ground-level ozone. • Indoor air quality with increased levels and types of contaminants. • Air filters requiring changing more frequently, pushing hospitals to store a ready supply of stock. • Ventilation systems requiring more energy and resources to ensure operational levels are maintained. 	<ul style="list-style-type: none"> • Design high-quality air filtration systems to meet air quality requirements. • Assess ventilation systems in existing facilities expected to be operational through 2050 and beyond.
<p>Heating and Cooling</p> <ul style="list-style-type: none"> • Buildings overheating more frequently, and requiring additional cooling. • With more variability in winter temperatures, buildings may require chillers to be used year-round, increasing operational costs. 	<ul style="list-style-type: none"> • Design resilient buildings to manage heat gains and losses in alignment with projected climate change and without increasing impacts on operating costs (passive guidelines). • Design more responsive, flexible heating and cooling solutions to help buildings adapt to daily and weekly fluctuations in temperature based on new climate data.

Likely Impacts	Recommended Actions
<p>Heating and Cooling</p> <ul style="list-style-type: none"> Increasing mechanical wear and requiring earlier replacement by operating HVAC equipment over longer seasons with higher temperature variability. Operating HVAC equipment at maximum stress level for an extended period of time increasing the possibility of failure. 	<ul style="list-style-type: none"> Offset resilience investments with projected operational costs savings over facility lifespans. Design specific HVAC systems such as decentralized heat pumps for hospital areas with specific HVAC requirements (e.g., operating room, neonatal, sterilization).
<p>Power and Energy Supply</p> <ul style="list-style-type: none"> Increasing cooling loads during warmer summers will likely increase energy costs. While heating energy use will likely decrease, cooling will increase, and annual costs will likely increase due to variable temperatures and the higher costs. Summer cooling needs will likely align with an increased demand for cooling across the province. Summer energy supply may become a challenge for our province, as hydropower capacity is decreased due to reduced snowpack and receding glaciers that feed storage reservoirs. With increasing electrical loading during climate stress events, more back-up energy may be required. 	<ul style="list-style-type: none"> Understand future energy demand and availability during extreme events, and develop on-site clean energy supplies for base power where possible. Explore low-carbon district energy systems for new health facilities where possible. Plan for load shedding when energy supply is constrained and electrical demand is higher. Enhance building automation systems to suit building-occupant needs on a daily or even hourly approach.
<p>Clean Water Supply</p> <ul style="list-style-type: none"> Increased stress on the provision of safe drinking water from regional and municipal water systems as health facilities compete with other water users. Diminished ability to provide care with increased turbidity, reduced water quality, and potential lack of supply, as sterilization, dialysis, medical device reprocessing equipment, drinking, washing, and bathing, etc. is compromised. 	<ul style="list-style-type: none"> Ensure a steady supply of clean water for health care facilities across the region, including capacity and redundancy required for cooling systems. Review filtration, grey-water treatment and/or on-site storage of clean water to ensure adequate supply. Where municipal water is used for cooling equipment, such as coiling coils for heat-prone areas, produce a capital investment plan to reduce risk exposure.
<p>Supply Chain</p> <ul style="list-style-type: none"> Restricted supply of critical resources to health care facilities, including: water, energy, food, medical supplies, building supplies (air filters). Building supplies for capital projects may be scarce or unavailable due to regional and global transportation limitations. 	<ul style="list-style-type: none"> Create an inventory of essential supplies, noting shelf life, and verify supply chain resilience during climate stress events. Consider on-site production and/or redundancy when supply chains are susceptible to climate stress.

Likely Impacts	Recommended Actions
<p>Stormwater Management and Flooding</p> <ul style="list-style-type: none"> • After long dry summers with minimal rain, soils may be unable to accept an increase in the intensity and flashiness of autumn storms, likely resulting in increased flooding along rivers, creeks, and streams, especially in floodplains. • Flooding of municipal storm sewer systems not sized for higher volumes during extreme events (extreme precipitation, run-off, and sea level rise). 	<ul style="list-style-type: none"> • Ensure all critical system infrastructure in VCH facility locations near floodplains are safe from rising floodwaters. • Retain stormwater on sites, where possible, to reduce impacts on municipal systems and provide water for other facility systems. • Partner with municipal governments to complement stormwater management with green infrastructure to handle the impact of larger flows. • Consider flood risks when determining locations of new facilities, including movement of patients, staff, and critical supplies. • Prevent backflow by protecting hospital plumbing system connection points from overflowing municipal sewer pipes.
<p>Human Resources</p> <ul style="list-style-type: none"> • Transportation system failures may cause patients and staff to be unable to travel to and from health care facilities across the region. • Longer/more frequent episodes of climate stress may: <ul style="list-style-type: none"> - Deplete staff resources. - Prevent staff from coming to work. - Increase overtime costs for clinical and maintenance staff struggling to deliver health services. 	<ul style="list-style-type: none"> • Develop Standard Operating Procedures and offer training for how to operate the hospital under climate stress conditions. • Work with local and regional governments to improve community resilience and reduce impacts to the health system. • Develop geographically and skill-based call-out procedures and systems to support staff management during emergency events.
<p>LMFM</p> <ul style="list-style-type: none"> • Without changes to building infrastructure, building operating costs will increase. • Communities may rely more heavily on health facilities during future climate stress events. 	<ul style="list-style-type: none"> • Develop a climate lens for all capital expenditures that incorporates lifecycle cost analysis (capital and operational) of facilities under future climate conditions. • Determine expectations for building lifespan for each project as early as possible, and plan building systems to meet future climate conditions. • Leverage land assets to maximize resilience and community co-benefits. • Collaborate with engineers on updating intensity-duration-frequency curves to better plan health facility infrastructure. • Work with utilities and local governments to understand regional priorities for essential service provision during extreme events, such as firefighting, water supply, electrical, transportation, and site access. • Conduct planning for critical supplies to ensure facilities can offer care for longer than the current 72-hour requirement.

Appendix 9: Interior Health's Wildfire Response 2017

Published in the *Canadian Healthcare Facilities Journal* in Winter 2017,³⁷ this figure illustrates preliminary costs associated with a specific climate-related event.



³⁷ Canadian Healthcare Facilities, 2017. Journal of Canadian Healthcare Engineering Society, In The Face Of Fire, Winter/Fall 2017. <https://www.ches.org/>

Appendix 10: VCH Environmental Sustainability Policy 2017

The *VCH Environmental Sustainability Policy*³⁸ is “a formal, clear, concise, and non-negotiable statement directing staff decision-making”. Renewed in 2017, the policy states that VCH will:

- Act as a leader with respect to environmental stewardship while engaging the healthcare community in a collaborative approach towards sustainability.
- Develop and adopt sustainable best practices and processes in all operations and departments.
- Achieve the legislated greenhouse gas reduction targets contained in relevant provincial legislation (Box 3)
- Incorporate environmentally-sound techniques (including energy and water conservation, space utilization management) in their decision-making processes.
- [Ensure] that financial investments will balance quality, cost and sustainability. In addition, the longterm life cycle costs of capital will be assessed.
- [Seek out] progressive partnerships with health organizations, governmental agencies, non-governmental organizations and businesses to expand capacity and integrate sustainability into healthcare operations, initiatives and programs; and strengthen partnerships through a commitment to open and transparent decision-making processes that balance economic, social and ecological imperatives.

³⁸ http://vch-connect/policies_manuals/lmc/FM/Documents/envirosustain.pdf



Lower Mainland Facilities Management

Technical Appendix 1:

VCH Communities of Care, Buildings
and Campuses (Maps)

October 2018

NOTE: VCH COMMUNITIES OF CARE MAPS

Data for these maps were provided by the Pacific Climate Impacts Consortium (PCIC), City of Vancouver and Facilities Management. Maps are by ecoplan.ca.

Technical Appendix 1: Maps provides climate hazard maps (for the past and future) that are specific to all VCH Communities of Care (Map 1 series) and one sub-region Coastal (South) Community of Care (Map 2 series). These maps are interpreted from data provided by PCIC (see note below). Additional maps for the Vancouver Community of Care (Map 3 series) are based on 2015 data provided by the City of Vancouver.

Certain BC Building Code (BCBC) and ASHRAE variables can be addressed by climate projections (see Appendix 3), such as “Warm Month Design Temperature 97.5%” (or BCBC 97.5). Hottest Day (TXX) is the annual hottest day of the year and warms by similar amounts as Hot Design Temperature (BCBC 97.5) (see Table 3). BCBC Annual Average Total Precipitation and CLIMDEX Annual Precipitation (PR) are identical. See Appendix 2 for plain language definitions.

These indicators are computed using a set of 12 Global Climate Models (GCMs), based on the internationally recognized “business as usual” GHG emissions scenario (i.e. Representative Concentration Pathway 8.5, or RCP8.5), and statistically downscaled to the ~10 km grid of the ANUSPLIN historical dataset. Bias correction using the high-resolution (~800 m) climatology was performed to produce the data for each indicator.

For more information, please refer to the Methodology section of the Climate Projections for Metro Vancouver report.

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BELLA BELLA
 1 RW Large Memorial Hospital
 2 Bella Bella Staff Housing

BELLA COOLA
 3 Bella Coola General Hospital

PEMBERTON
 4 Pemberton Health Centre

WHISTLER
 5 Whistler Health Care Centre

POWELL RIVER
 6 Powell River General Hospital
 7 Willingdon Creek Residential Care
 8 Evergreen Extended Care

SQUAMISH
 9 Squamish General Hospital
 10 Squamish Community Health Centre
 11 Community Mental Health Services
 12 Hilltop House

SECHLT
 13 Sechelt Hospital
 14 Shorncliffe Residential Care
 15 Totem Lodge
 16 Sechelt Community Health Center
 17 Home Health Unit

GIBSONS
 18 Sumac Place Mental Health Tertiary
 19 Community Health Center

VANCOUVER

- 47 Detwiller Pavilion Mental Health
- 48 Koerner Pavilion Acute Care Hospital
- 49 Purdy Pavilion Residential Care
- 50 Djavad Mowafaghian Centre for Brain Health
- 51 St Johns Hospice UBC
- 52 Pacific Spirit Community Health Centre
- 53 West End Mental Health Team
- 54 Heart Centre Offices
- 55 Three Bridges Community Health Centre
- 56 Inner City Youth Program
- 57 Pender Community Health Clinic
- 58 Naomi/Salome Research
- 59 INSITE (Supervised Injection Site)
- 60 Vancouver Intensive Supervision Unit
- 61 Drug Users Resource Centre
- 62 Downtown Community Health Centre
- 63 Sheway YMCA Pregnancy Outreach
- 64 Strathcona Mental Health Team
- 65 CHEOS Research Offices
- 66 Northeast Mental Health Team
- 67 Kitsilano-Fairview Mental Health Team
- 68 Jack Bell Research Building
- 69 Robert H.N. Ho Building
- 70 Willow Pavilion
- 71 Tzu Chi Institute
- 72 Skin Care Centre
- 73 Research Pavilion
- 74 Medical Student Centre
- 75 Mary Pack Arthritis Centre
- 76 Jim Pattison Pavillion
- 77 Heather Pavillion
- 78 Health Centre (to be demolished)
- 79 Gordon & Leslie Diamond Health Care Centre
- 80 Fairmont Medical Building
- 81 Eye Care Centre
- 82 Doctor's Residence
- 83 Child Care Centre
- 84 Leon Judah Blackmore Pavilion
- 85 Blusson Spinal Cord Centre
- 86 Banfield Pavillion
- 87 BC Operational Stress Injury
- 88 Raven Song Community Health Centre
- 89 Vancouver Detox Centre
- 90 Berman House Residential
- 91 Hamber House Youth Day Treatment
- 92 Kettle / Camille House
- 93 Center for Concurrent Disorders / Aboriginal Wellness
- 94 Mental Health Emergency Services Program
- 95 Robert And Lily Lee Family Community Health Centre
- 96 Beulah Gardens
- 97 GF Strong
- 98 Westside Mental Health Team
- 99 Evergreen Community Health Centre
- 100 George Pearson Centre
- 101 Dogwood Lodge
- 102 South Community Health Office
- 103 Southview Ambulatory Clinic
- 104 South Mental Health Team



KEY TO FACILITY LABELS

X:Y,Z

X = Building Number
 Y = (C)ommunity, (A)cute, (R)esidential
 Z = (O)wned, (L)eased, (P)3

VCH HEALTH CAMPUSES AND BUILDINGS

Coastal Community of Care

Vancouver Community of Care

Richmond Community of Care

NORTH SHORE

- 20 West Vancouver Community Health Centre
- 21 Lions Gate Hospital
- 22 Evergreen House
- 23 HOpe Centre
- 24 Public Health Parkgate Comm. Health Centre
- 25 Health Connection Clinic
- 26 Central Community Health Centre
- 27 Margaret Fulton Adult & Child Day Centre
- 28 North Shore Mental Health
- 29 North Shore Hospice
- 30 John Braithwaite Community Centre
- 31 Northmount Medical Laboratory
- 32 North Shore Comm. Dialysis Unit
- 33 Berkley Care Centre
- 34 Cedarview Lodge
- 35 Magnolia House Residential



RICHMOND

- 36 Richmond Hospital
- 37 Public Health
- 38 Primary Health Care Services
- 39 6100 Bowling Green
- 40 Bridge House Mental Health Crisis
- 41 8100 Granville
- 42 Home Health Ambulatory Clinic
- 43 Lion's Park Housing
- 44 Horizon House
- 45 Kinsman Mental Health Day Programs
- 46 Fentiman Site Replacement Project (RLM)



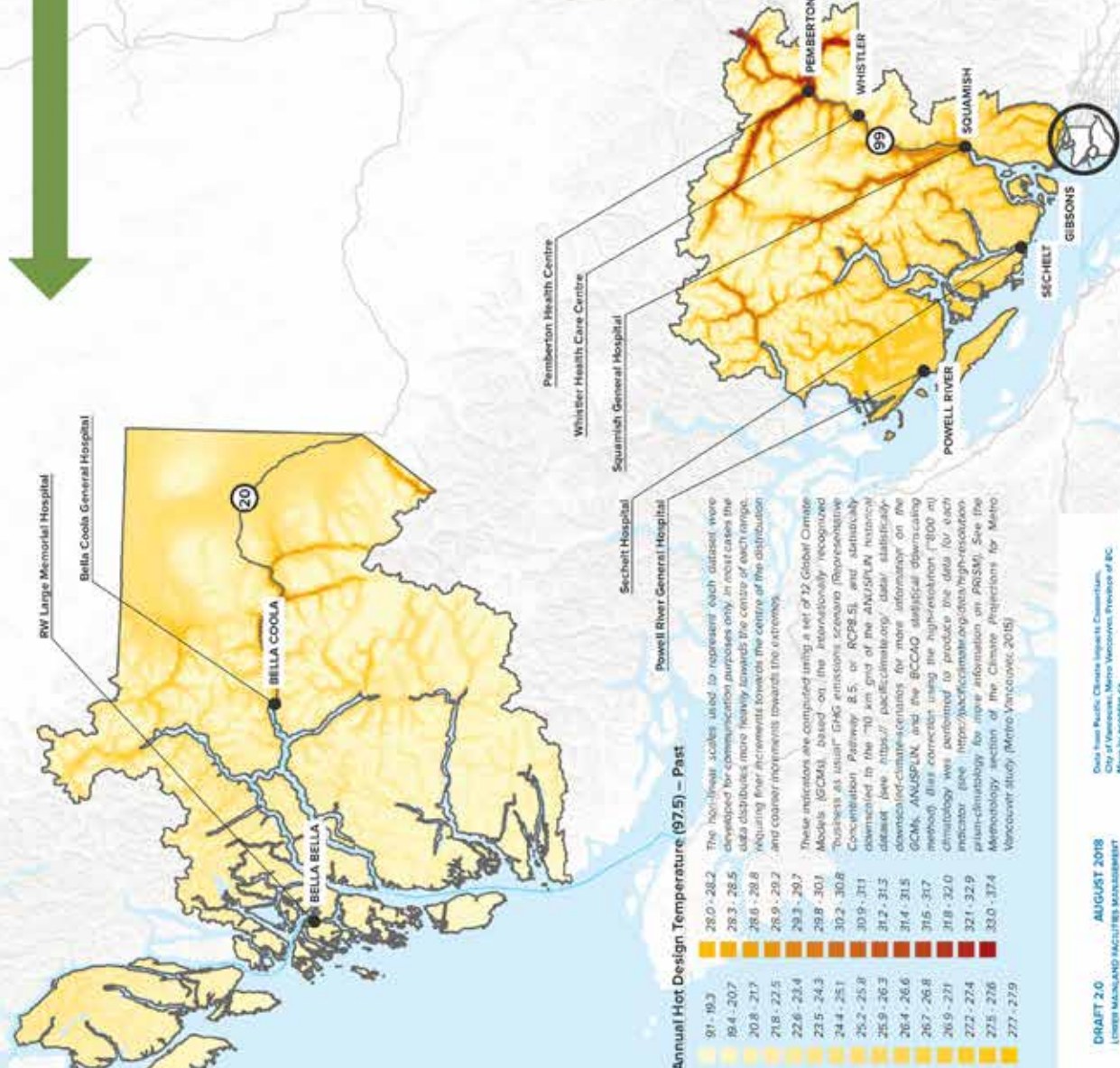
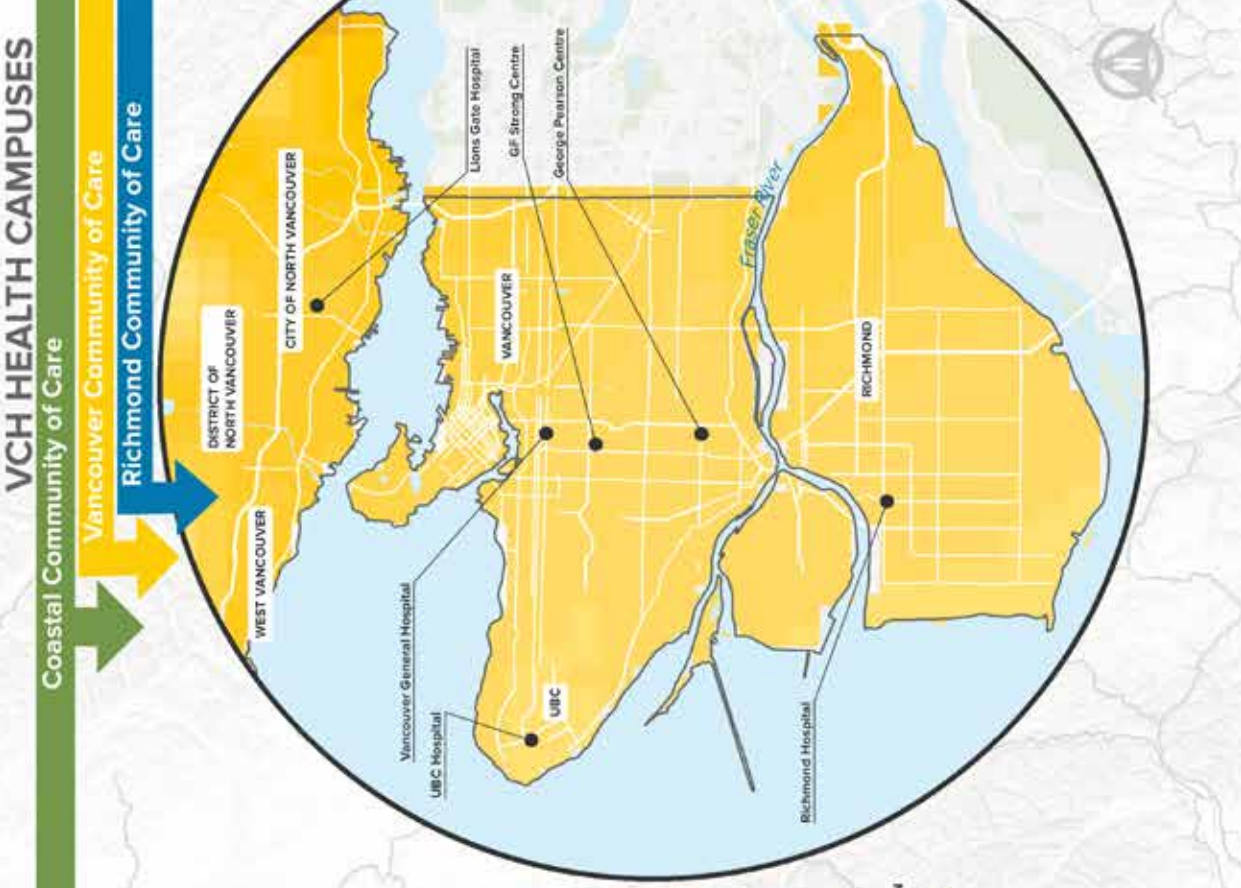
Map 1a VCH Annual Hot Design Temperature (BCBC 97.5) - Past

VCH HEALTH CAMPUSES

Coastal Community of Care

Vancouver Community of Care

Richmond Community of Care



Annual Hot Design Temperature (97.5) - Past

91 - 19.3
19.4 - 20.7
20.8 - 21.7
21.8 - 22.5
22.6 - 22.4
22.5 - 24.3
24.4 - 25.1
25.2 - 25.8
25.9 - 26.3
26.4 - 26.6
26.7 - 26.8
26.9 - 27.1
27.2 - 27.4
27.5 - 27.6
27.7 - 27.9
28.0 - 28.2
28.3 - 28.5
28.6 - 28.8
28.9 - 29.2
29.3 - 29.7
29.8 - 30.1
30.2 - 30.8
30.9 - 31.1
31.2 - 31.3
31.4 - 31.5
31.5 - 31.7
31.8 - 32.0
32.1 - 32.9
33.0 - 37.4

These indicators are computed using a set of 12 Global Climate Models (GCMs), based on the internationally recognized "business as usual" GHG emissions scenario (representative Concentration Pathway, RCP 8.5, or RCP8.5), and statistically downscaled to the 70 km grid of the ANUSPLIM historical dataset (see [https://vancouver.ca/health-recreation/urban-climatology-for-more-information-on-PRISM](https://pacificclimate.org/data/statistically-downscaled-climate-scenarios-for-more-information-on-the-GCMs, ANUSPLIM, and the BCCAQ statistical downscaling method that connects the high-resolution (~800 m) indicator (see <a href=)). See the meteorology section of the Climate Projections for Metro Vancouver study (Metro-Vancouver, 2015).

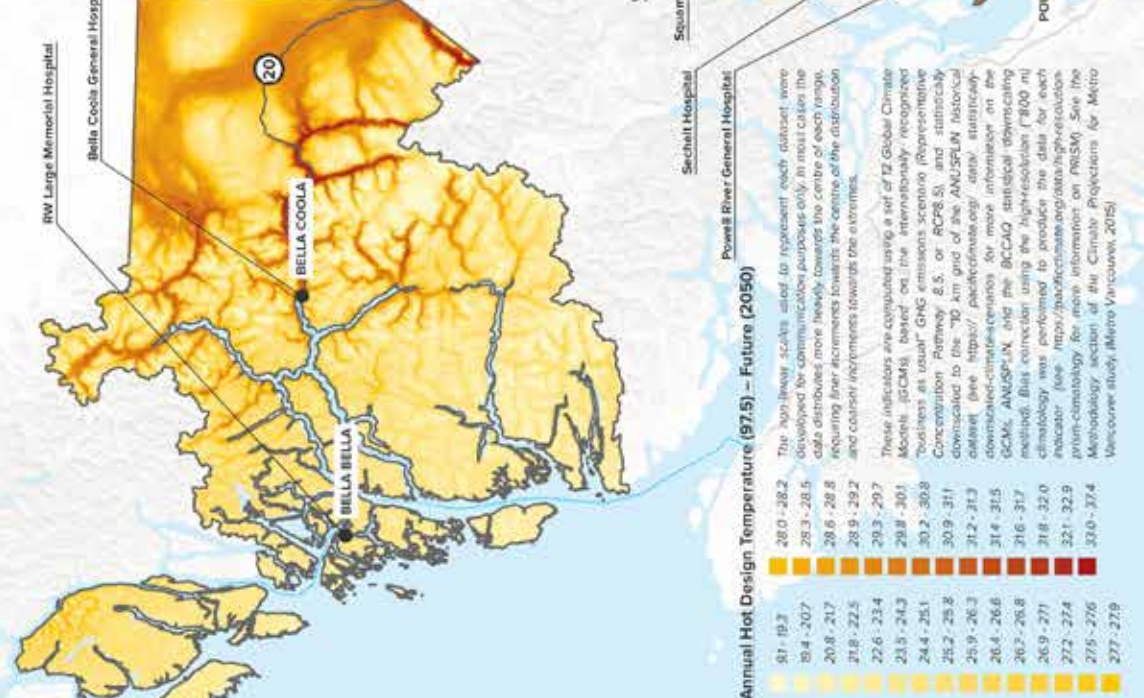
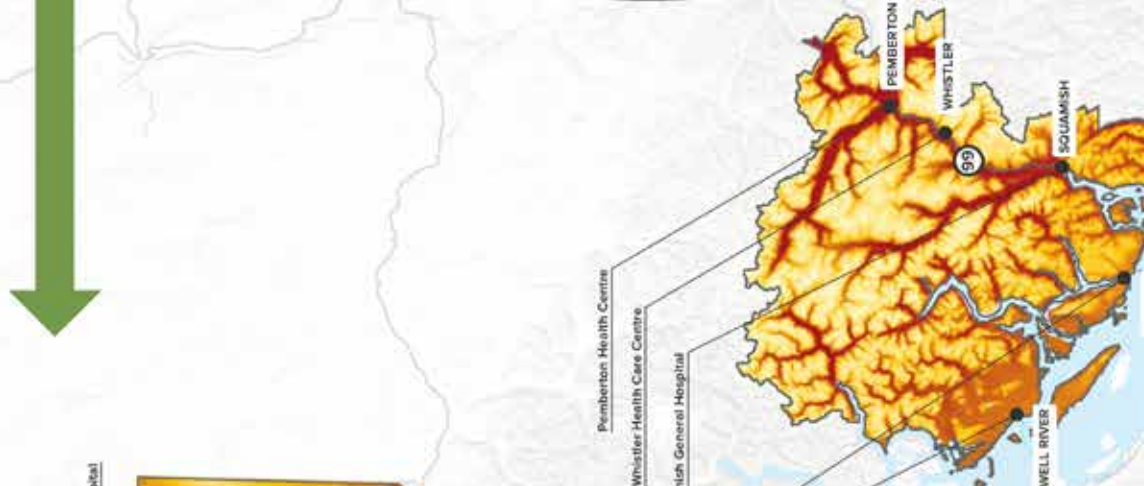
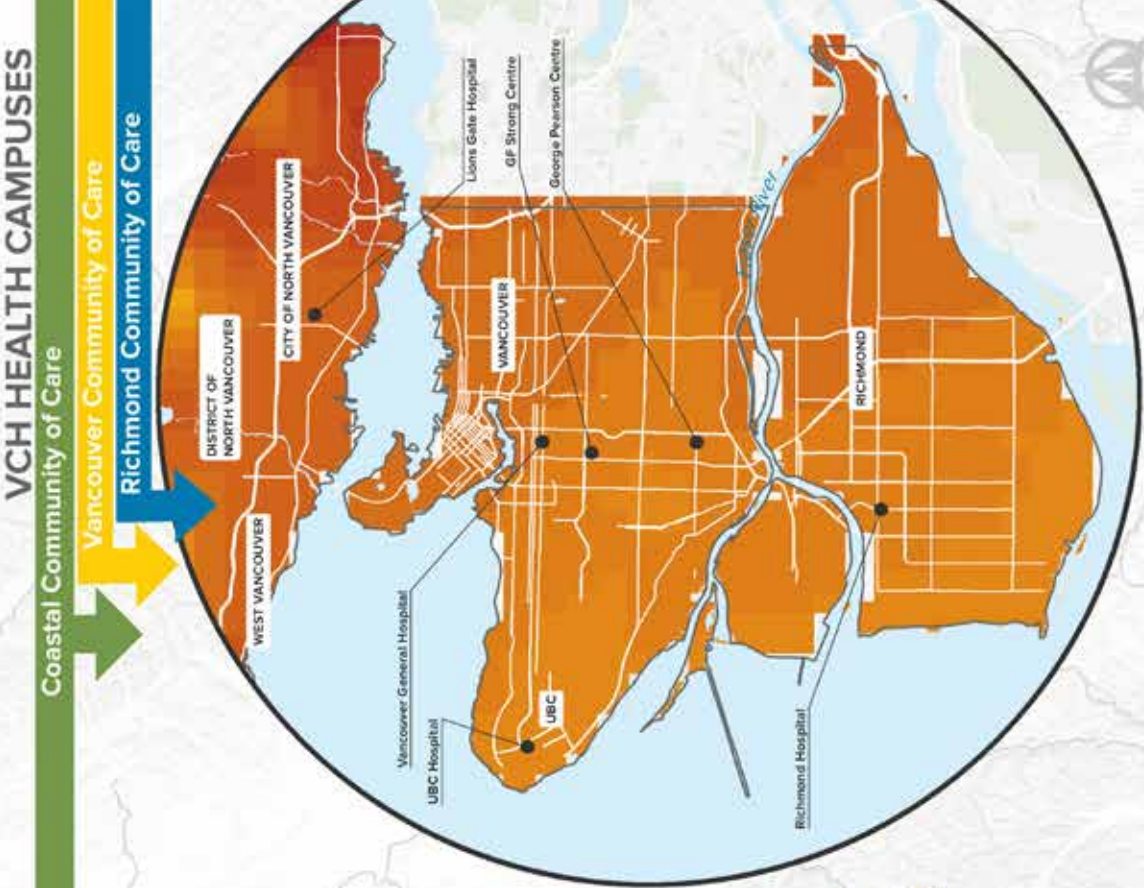
Map 1b VCH Annual Hot Design Temperature (BCBC 97.5) - Future (2050)

VCH HEALTH CAMPUSES

Coastal Community of Care

Vancouver Community of Care

Richmond Community of Care



Annual Hot Design Temperature (97.5) - Future (2050)



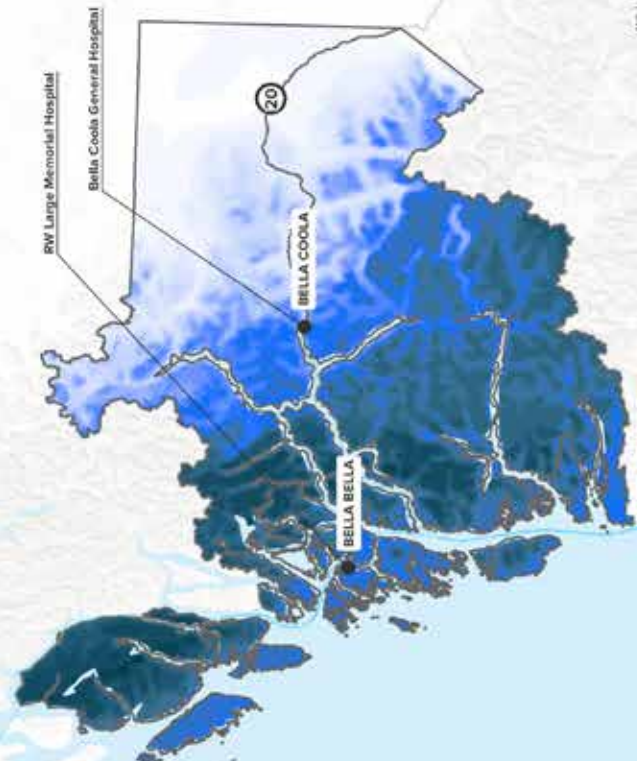
Map 1c VCH R95P Wettest Day Precipitation - Past

VCH HEALTH CAMPUSES

Coastal Community of Care

Vancouver Community of Care

Richmond Community of Care

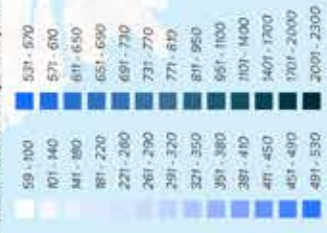


RW Lange Memorial Hospital
Bella Coola General Hospital

20

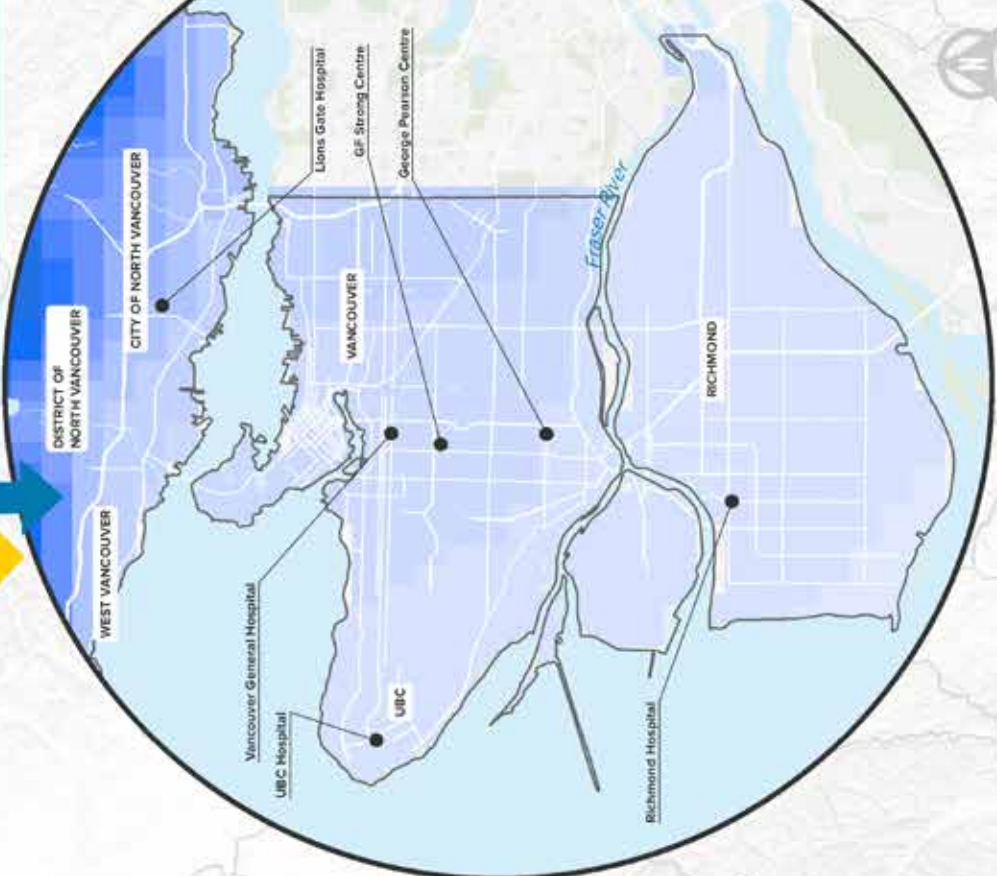
BELLA BELLA
BELLA COOLA

R95P Wettest Day Precipitation - Past



The non-linear scales used to represent each dataset were developed for communication purposes only. In most cases the data distributes more heavily towards the centre of each range, requiring finer increments towards the centre of the distribution and coarser increments towards the extremes.

These indicators are computed using a set of 12 Global Climate Models (GCMs), based on the internationally recognized "business as usual" GHG emissions scenario (Representative Concentration Pathway 8.5, or RCP8.5), and statistically downscaled to the 70 km grid of the ANUSPLIM historical dataset (see <https://pacificclimate.org/data/statistical-downscaled-climate-scenarios> for more information on the GCMs, ANUSPLIM, and the BCCAQ statistical downscaling method that connects the high-resolution (~800 m) indicator (see <https://vancouver.ca/health-recreation/patient-clinology> for more information on PRISM). See the Meteorology section of the Climate Projections for Metro Vancouver study (Metro-Vancouver, 2015).

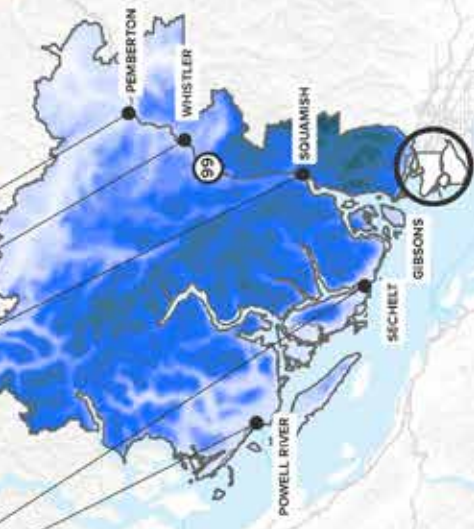


DISTRICT OF NORTH VANCOUVER
CITY OF NORTH VANCOUVER
VANCOUVER

WEST VANCOUVER
UBC
Lions Gate Hospital
G.F. Strong Centre
George Pearson Centre

Vancouver General Hospital
Richmond Hospital

Pemberton Health Centre
Whistler Health Care Centre
Squamish General Hospital
Powell River General Hospital

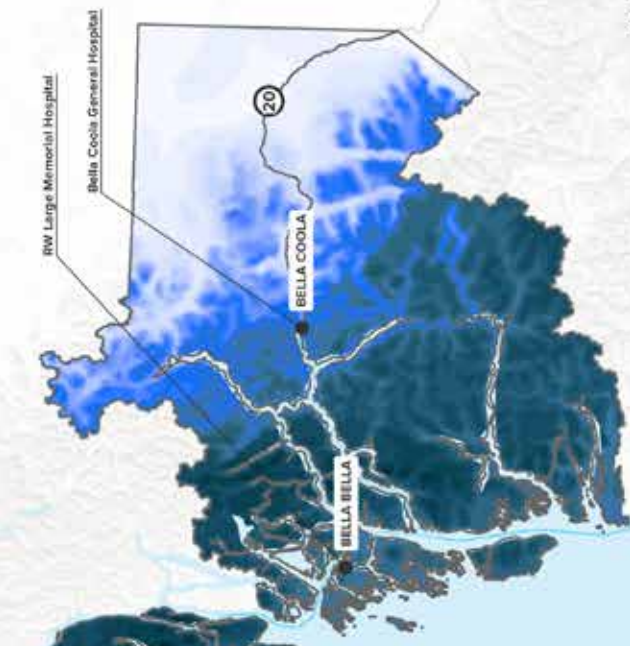


99

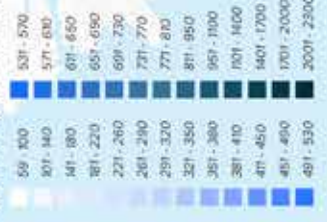
PEMBERTON
WHISTLER
SQUAMISH
GIBSONS
SECHART
POWELL RIVER

Map 1d VCH R95P Wettest Day Precipitation - Future (2050)

VCH HEALTH CAMPUSES

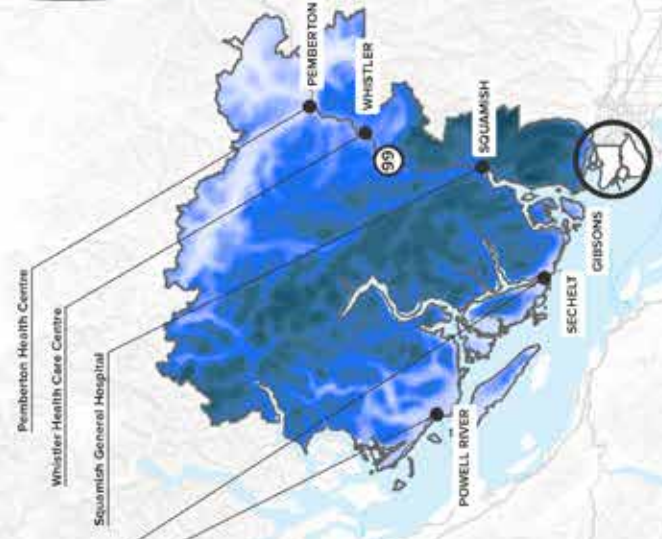
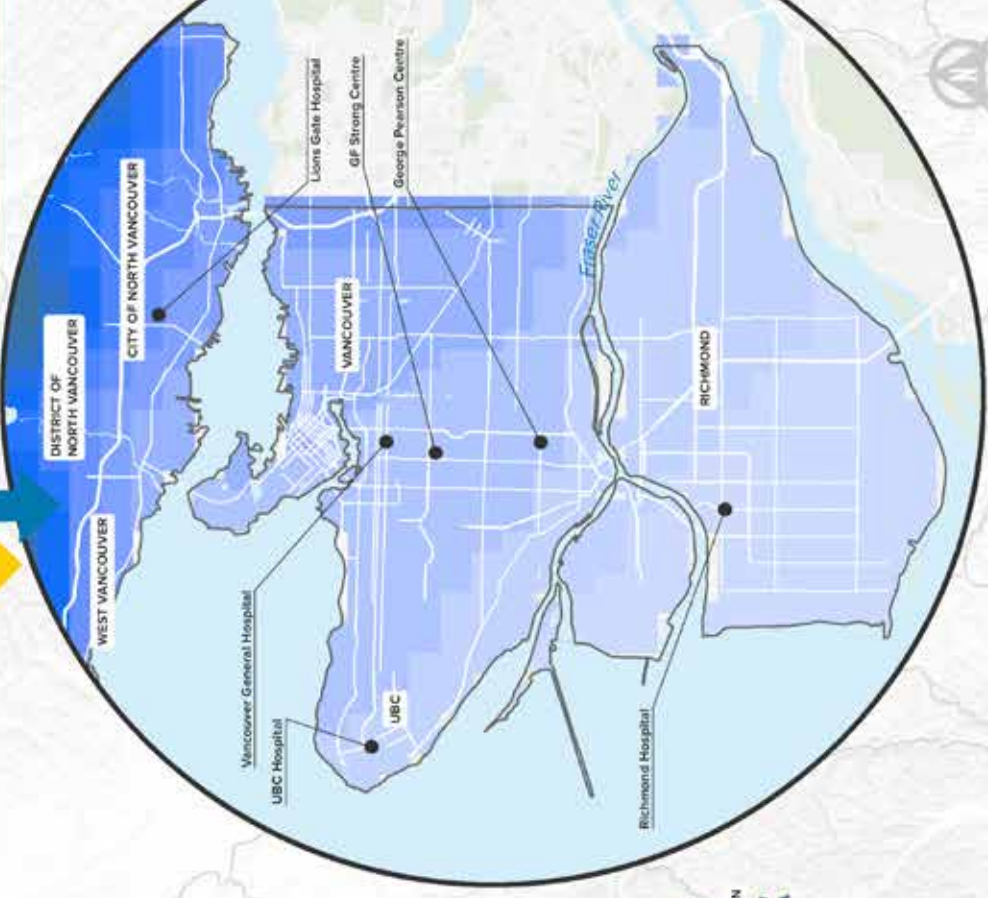


R95P Wettest Day Precipitation - Future (2050)



The non-linear scale used to represent each dataset were developed for communications purposes only. In most cases the data distributes more heavily towards the centre of each range, requiring finer increments towards the centre of the distribution and coarser increments towards the extremes.

These indicators are computed using a set of 12 Global Climate Models (GCMs), based on the internationally recognized "business as usual" GHG emissions scenario (Representative Concentration Pathway 8.5, or RCP8.5), and statistically downscaled to the 70 km grid of the ANUSPLIN historical downscale-comparisons for more information on the GCMs, ANUSPLIN, and the BCCAQ statistical downscaling method). Bias correction using the high-resolution (800 m) climatology was performed to produce the data for each indicator. (See <https://aahc.ca/healthcare/data-high-resolution-prism-climatology> for more information on PRISM). See the Methodology section of the Climate Projections for Metro Vancouver study (Metro Vancouver, 2015).



Data from Pacific Climate Impacts Consortium, City of Vancouver, Metro Vancouver, Province of BC. Map by ecoplaza.ca



VCH HEALTH CAMPUSES AND BUILDINGS

Coastal Community of Care

PEMBERTON

4 Pemberton Health Centre

WHISTLER

5 Whistler Health Care Centre

POWELL RIVER

6 Powell River General Hospital
7 Willingdon Creek Residential Care
8 Evergreen Extended Care

SQUAMISH

9 Squamish General Hospital
10 Squamish Community Health Centre
11 Community Mental Health Services
12 Hilltop House

SECHELT

13 Sechelt Hospital
14 Shorncliffe Residential Care
15 Totem Lodge
16 Sechelt Community Health Center
17 Home Health Unit

GIBSONS

18 Sumac Place Mental Health Tertiary
19 Community Health Center

KEY TO FACILITY LABELS

X:Y,Z

X = Building Number

Y = (C)ommunity, (A)cute, (R)esidential

Z = (O)wned, (L)eased, (P)3

NORTH SHORE

20 West Vancouver Community Health Centre	28 North Shore Mental Health
21 Lions Gate Hospital	29 North Shore Hospice
22 Evergreen House	30 John Braithwaite Community Centre
23 Hope Centre	31 Northmount Medical Laboratory
24 Public Health Parkgate Comm. Health Centre	32 North Shore Comm. Dialysis Unit
25 Health Connection Clinic	33 Berkley Care Centre
26 Central Community Health Centre	34 Cedarview Lodge
27 Margaret Fulton Adult & Child Day Centre	35 Magnolia House Residential

WEST VANCOUVER

20:C,L

TAYLOR WAY

1

MARINE DRIVE

22:C,L

21:C,L

23:C,L

30:C,N

29:C,L

24:C,L

25:A,O

26:A,O

27:A,O

28:C,O

31:C,L

LYNN VALLEY ROAD

32:R,O

33:R,O

LONSDALE AVENUE

EAST 3RD STREET

CITY OF NORTH VANCOUVER

MAIN STREET

1

35:C,L

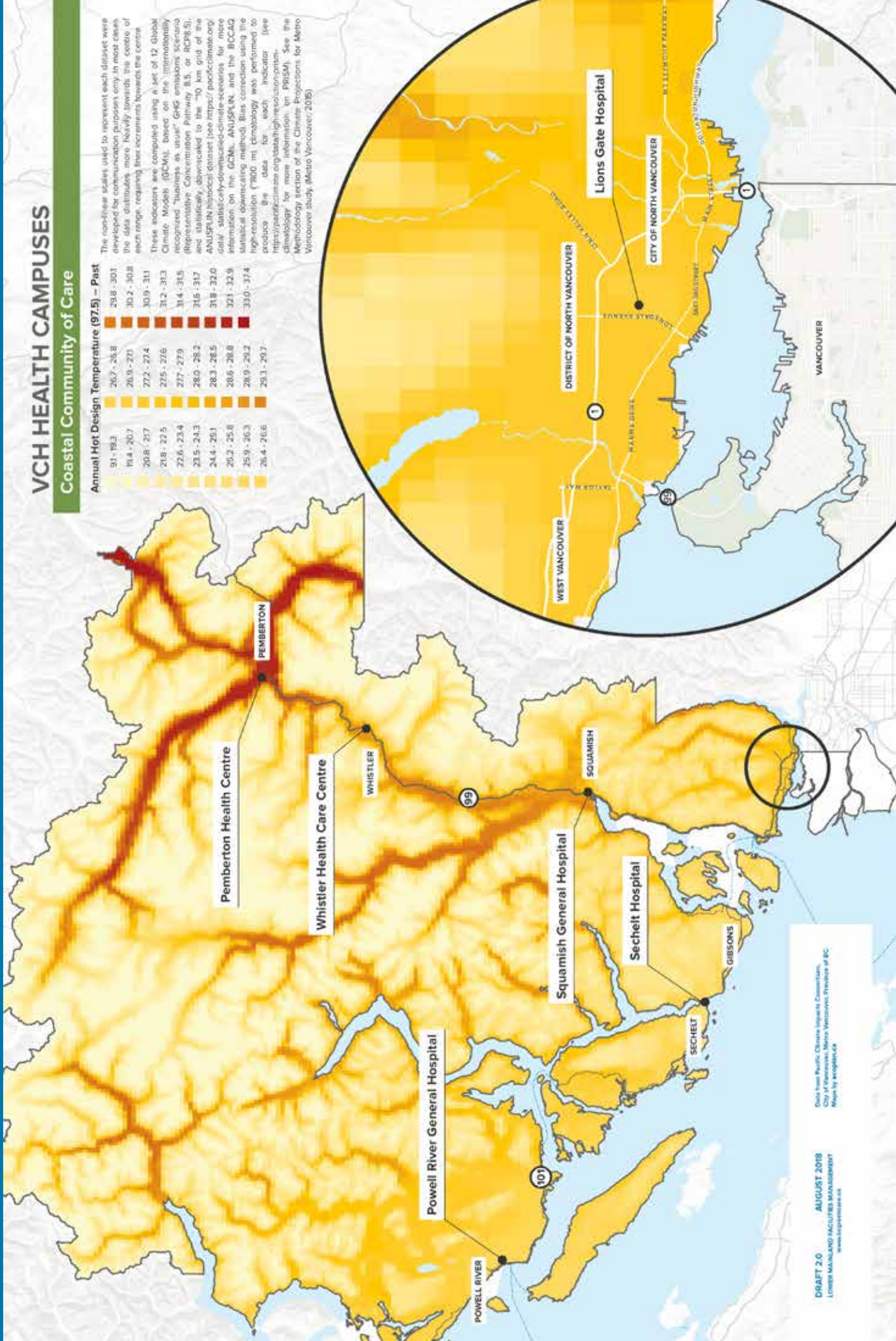
DOLLARTON HIGHWAY

34:R,O

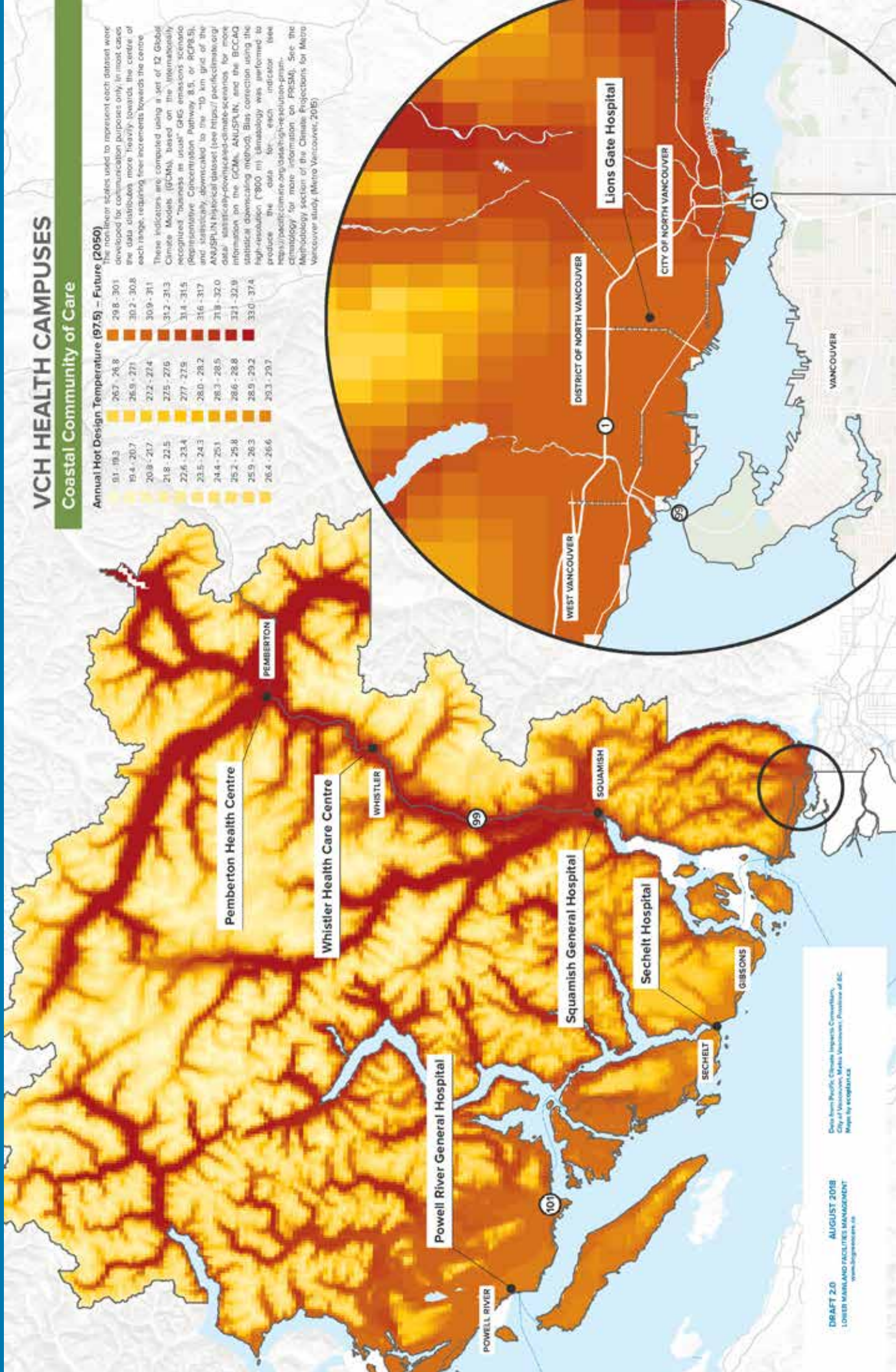
MT SEYMOUR PARKWAY

VANCOUVER

Map 2a Coastal (South) Annual Hot Design Temperature (BCBC 97.5) - Past



Map 2b Coastal (South) Annual Hot Design Temperature (BCBC 97.5) - Future (2050)



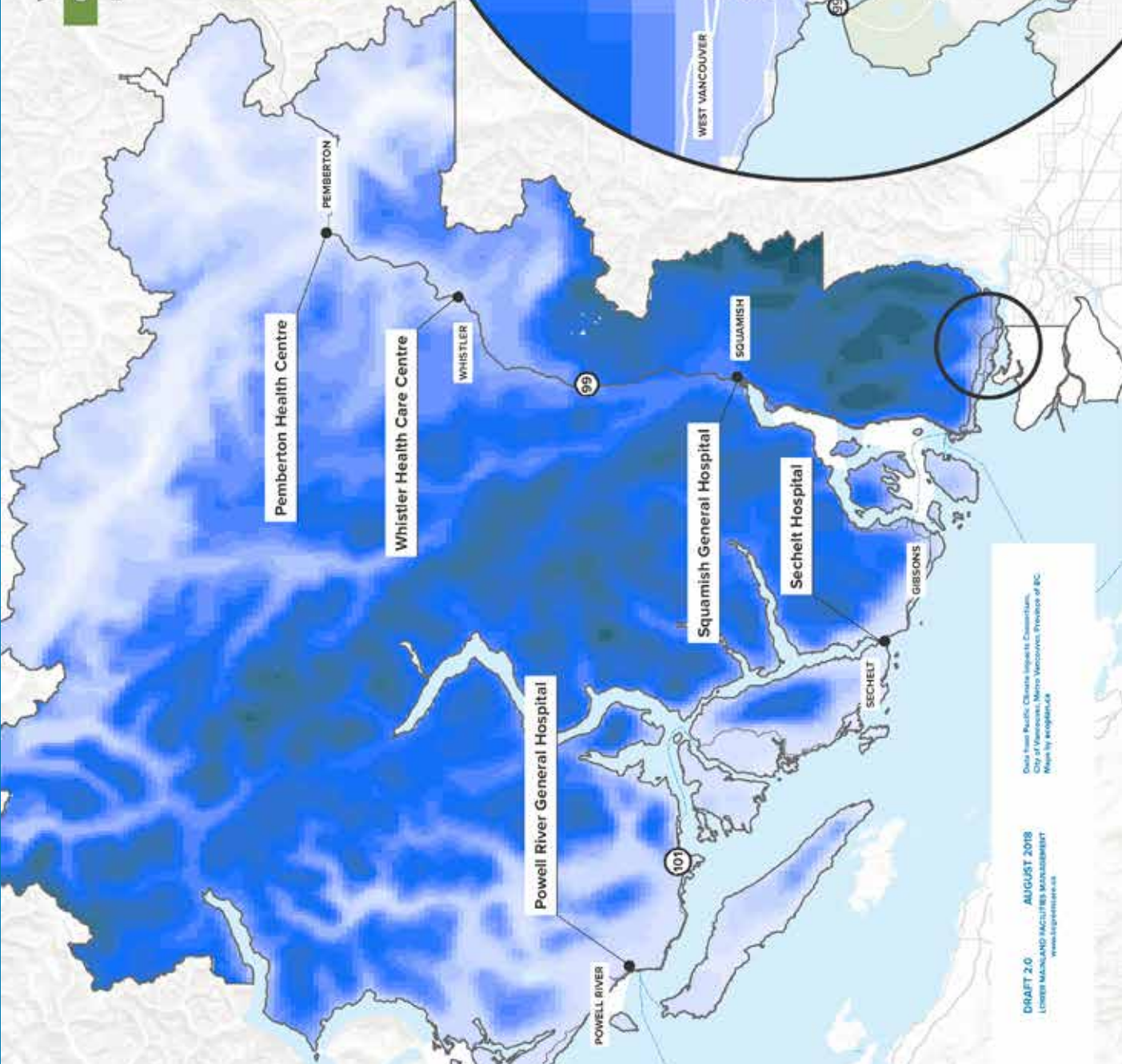
VCH HEALTH CAMPUSES

Coastal Community of Care

R95P Wettest Day Precipitation - Past

The non-linear scales used to represent each dataset were developed for communication purposes only. In most cases, the data illustrates more heavily towards the centre of each range, requiring less increments towards the centre.

These indicators are computed using a set of 12 Global Climate Models (GCMs), based on the internationally recognized "business as usual" GHG emissions scenario (Representative Concentration Pathway B3, or RCP8.5), and statistically downscaled to the 10 km grid of the ANUSPLIN hospital dataset (see <https://pacificclimate.org/data/statistically-downscaled-climate-scenarios> for more information on the GCMs, ANUSPLIN, and the BCCAQ statistical downscaling method). Bias correction using the high-resolution (700 m) climatology was performed to produce the data for each indicator (see <https://pacificclimate.org/data/high-resolution-climate> for more information on PRISM). See the methodology section of the Climate Projections for Metro Vancouver study (Metro Vancouver, 2018).

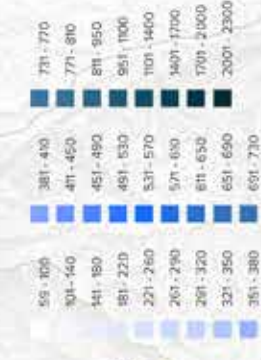


Data from Pacific Climate Impacts Consortium, City of Vancouver, Metro Vancouver, Province of BC, and the Department of Environment.

VCH HEALTH CAMPUSES

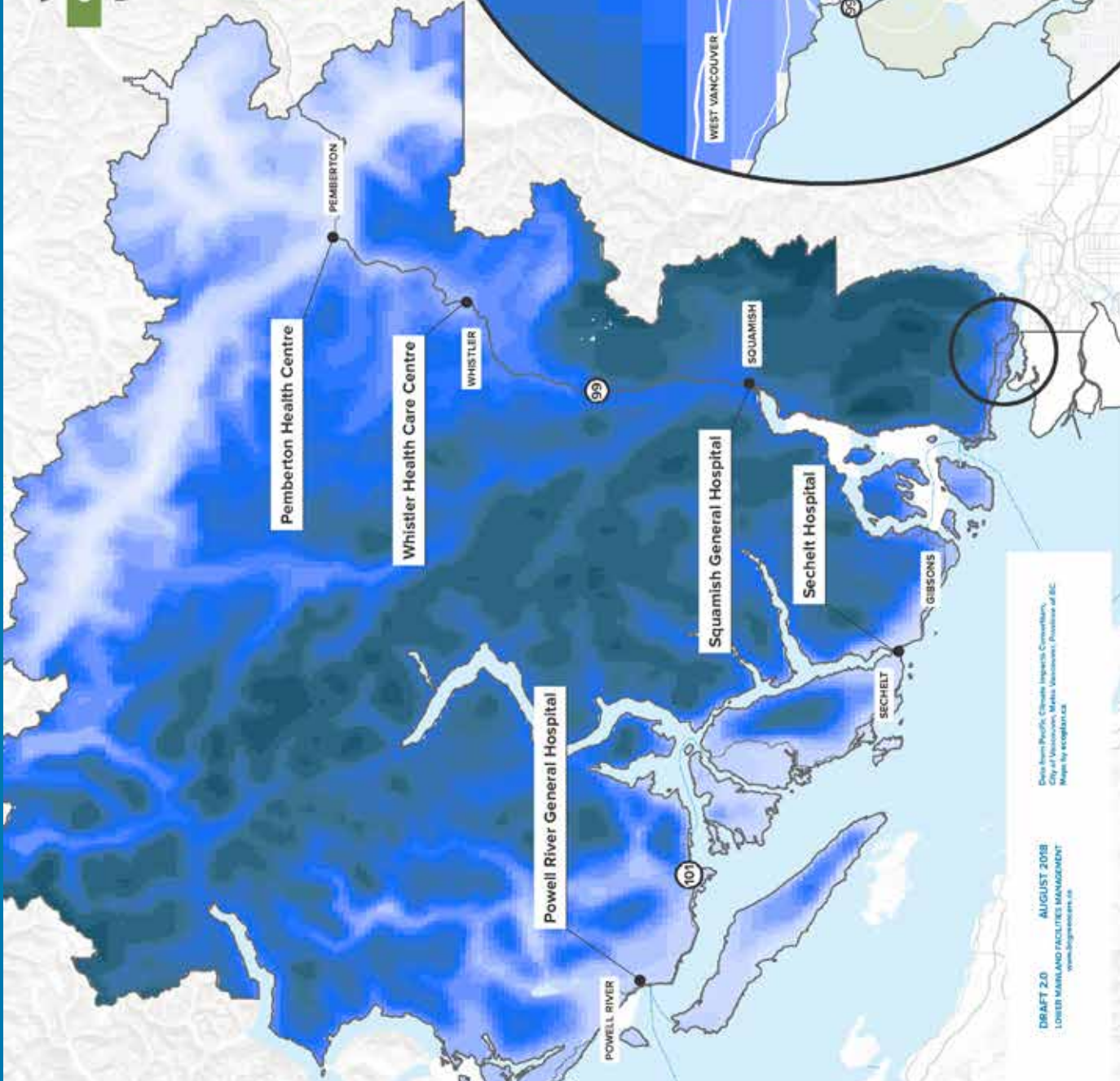
Coastal Community of Care

R95P Wettest Day Precipitation - Future (2050)



The non-linear scales used to represent each dataset were developed for communication purposes only. In most cases, the data distributed more heavily towards the centre of each range, resulting in increments towards the centre.

These indicators are computed using a set of 12 Global Climate Models (GCMs), based on the internationally recognized "business as usual" GHG emissions scenario (Representative Concentration Pathway 8.5, or RCP8.5), and statistically downscaled to the 10 km grid of the ANUSPLIN historical dataset (<http://climate.mcgill.ca/anosplin/>) for more information on the GCMs, ANUSPLIN, and the BCCARQ statistical downscaling method. Bias correction using the high-resolution (800 m) climatology was performed to produce the data for each indicator (<http://pacificclimate.org/data/high-resolution-bias-correction/>). For more information on PRISM, see the Methodology section of the Climate Projections for Metro Vancouver study, Metro Vancouver, 2015).

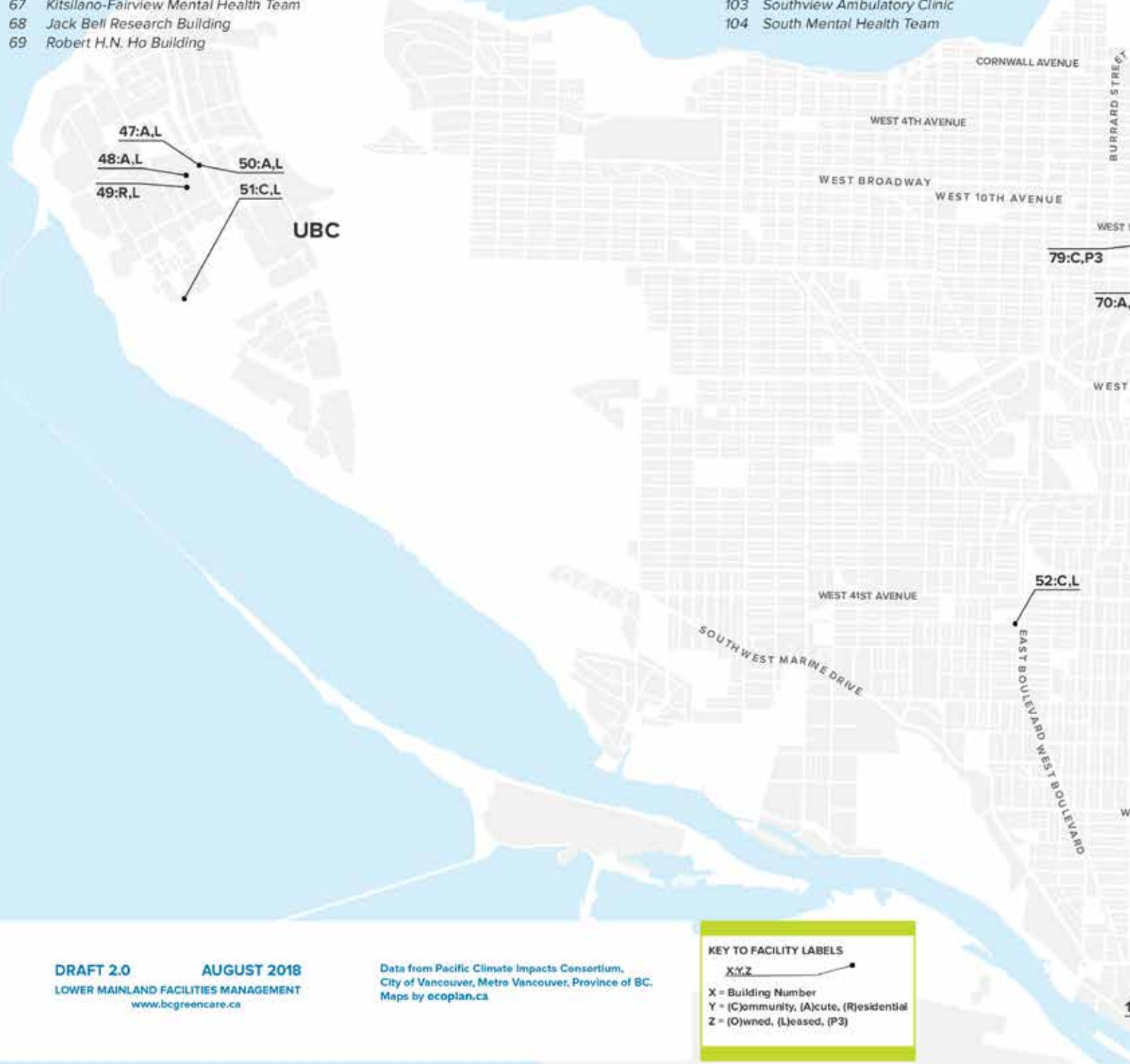


Data from Pacific Climate Impacts Consortium, City of Vancouver, Metro Vancouver, Province of BC. Map by scottbruce.ca

- 47 Detwiller Pavilion Mental Health
- 48 Koerner Pavilion Acute Care Hospital
- 49 Purdy Pavilion Residential Care
- 50 Djavad Mowafaghian Centre for Brain Health
- 51 St Johns Hospice UBCH
- 52 Pacific Spirit Community Health Centre
- 53 West End Mental Health Team
- 54 Heart Centre Offices
- 55 Three Bridges Community Health Centre
- 56 Inner City Youth Program
- 57 Pender Community Health Clinic
- 58 Naomi/Salome Research
- 59 INSITE (Supervised Injection Site)
- 60 Vancouver Intensive Supervision Unit
- 61 Drug Users Resource Centre
- 62 Downtown Community Health Centre
- 63 Sheway YMCA Pregnancy Outreach
- 64 Strathcona Mental Health Team
- 65 CHEOS Research Offices
- 66 Northeast Mental Health Team
- 67 Kitsilano-Fairview Mental Health Team
- 68 Jack Bell Research Building
- 69 Robert H.N. Ho Building

- 70 Willow Pavilion
- 71 Tzu Chi Institute
- 72 Skin Care Centre
- 73 Research Pavilion
- 74 Medical Student Centre
- 75 Mary Pack Arthritis Centre
- 76 Jim Pattison Pavilion
- 77 Heather Pavilion
- 78 Health Centre (to be demolished)
- 79 Gordon & Leslie Diamond Health Care Centre
- 80 Fairmont Medical Building
- 81 Eye Care Centre
- 82 Doctor's Residence
- 83 Child Care Centre
- 84 Leon Judah Blackmore Pavilion
- 85 Blusson Spinal Cord Centre
- 86 Banfield Pavilion
- 87 BC Operational Stress Injury
- 88 Raven Song Community Health Centre
- 89 Vancouver Detox Centre

- 90 Berman House Residential
- 91 Hamber House Youth Day Treatment
- 92 Kettle / Camille House
- 93 Ctr. for Concurrent Disorders / Aboriginal Wellness
- 94 Mental Health Emergency Services Program
- 95 Robert And Lily Lee Family Comm. Health Centre
- 96 Beulah Gardens
- 97 GF Strong
- 98 Westside Mental Health Team
- 99 Evergreen Community Health Centre
- 100 George Pearson Centre
- 101 Dogwood Lodge
- 102 South Community Health Office
- 103 Southview Ambulatory Clinic
- 104 South Mental Health Team



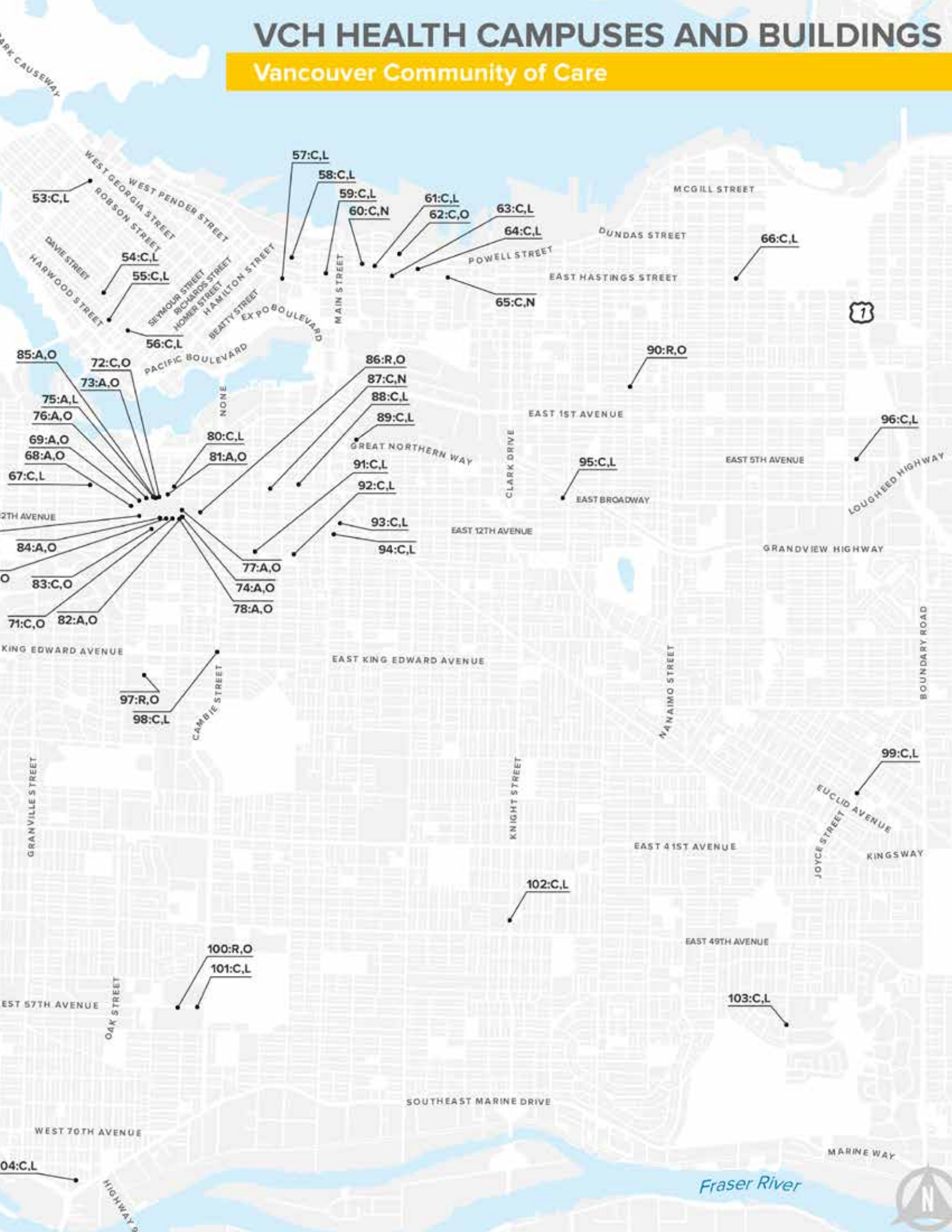
KEY TO FACILITY LABELS

X.Y.Z

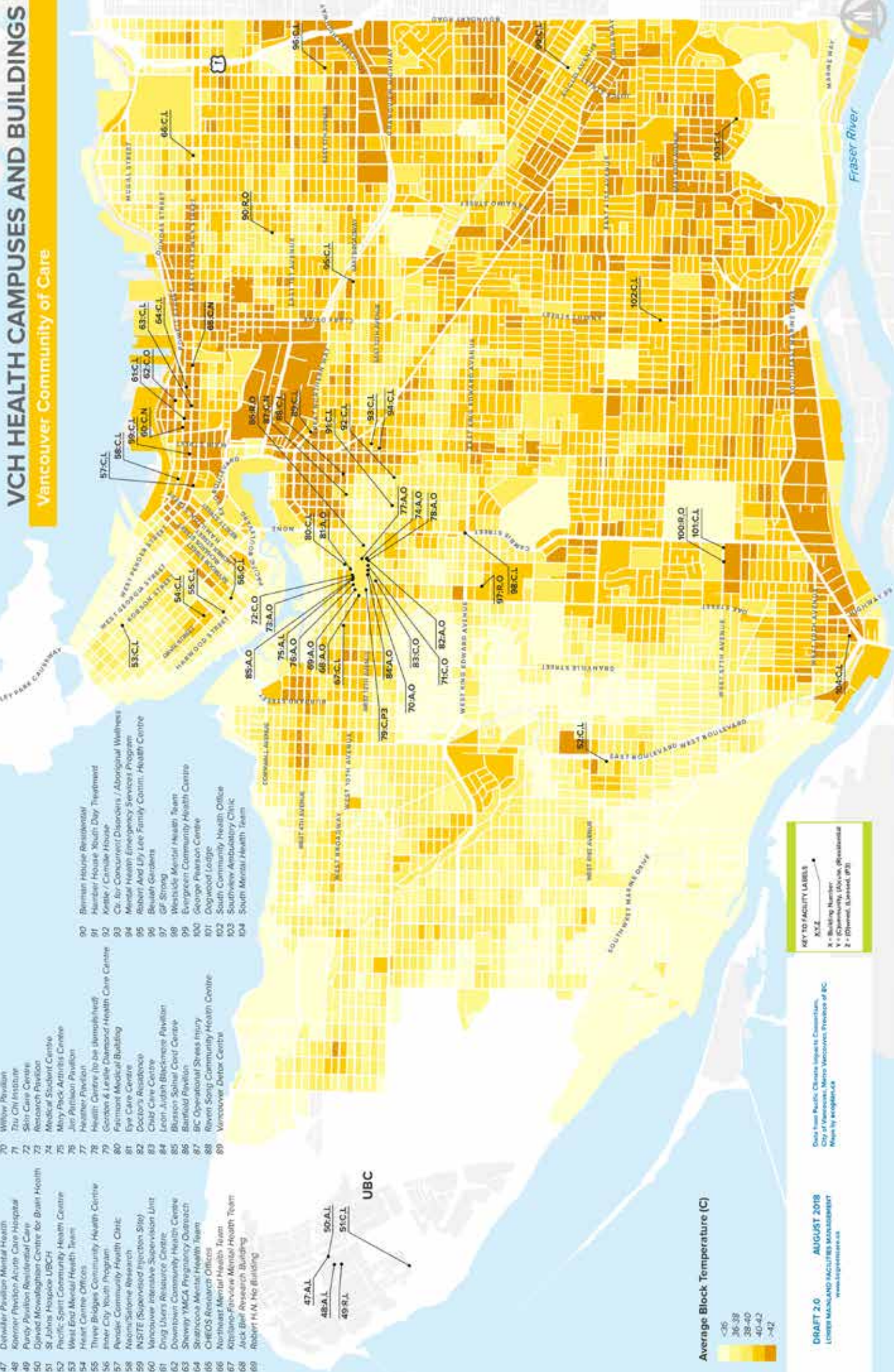
X = Building Number
 Y = (C)ommunity, (A)cute, (R)esidential
 Z = (O)wned, (L)eased, (P3)

VCH HEALTH CAMPUSES AND BUILDINGS

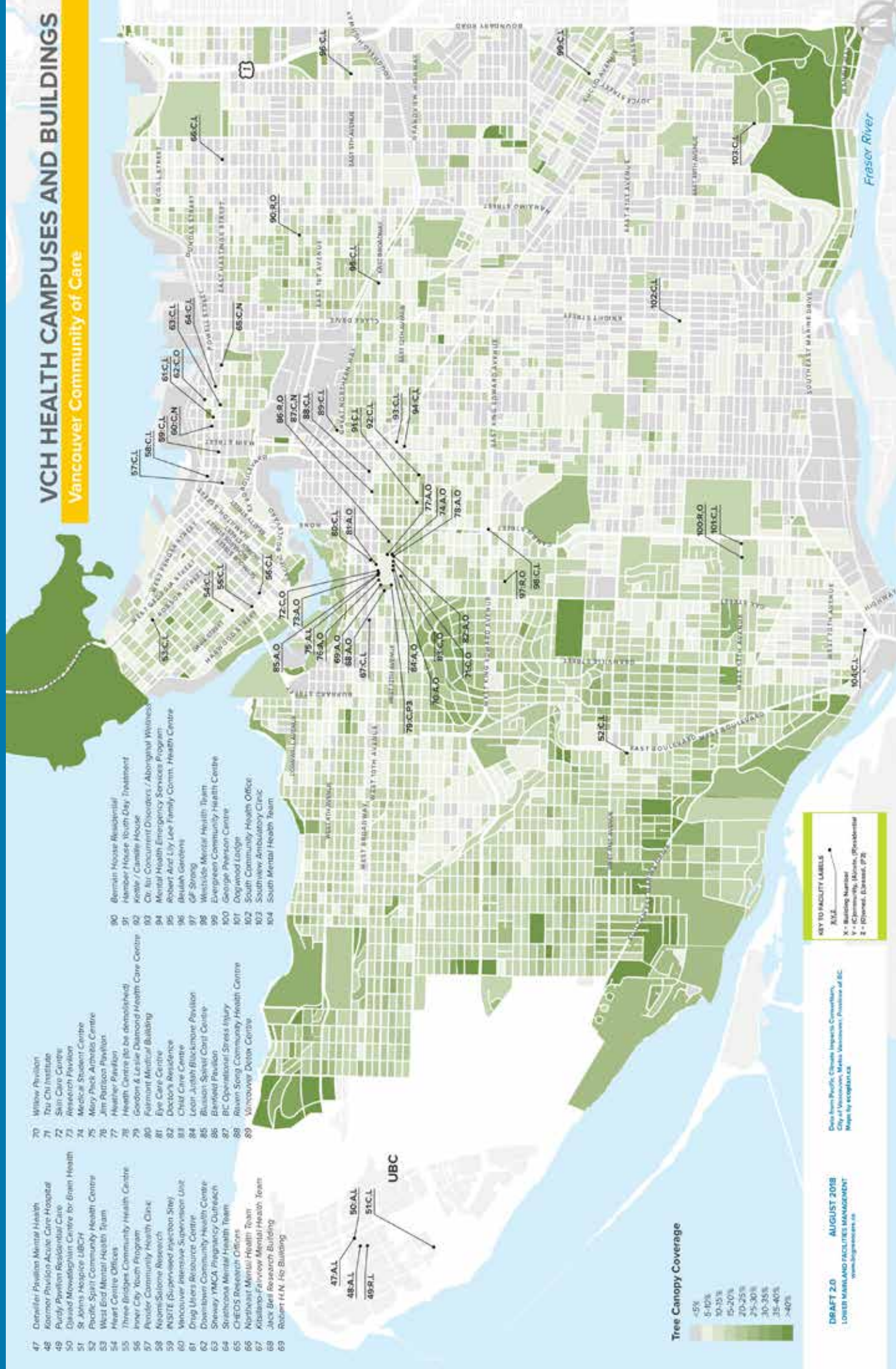
Vancouver Community of Care



Map 3a Vancouver Community of Care - Block Temperature (2015)



Map 3b Vancouver Community of Care - Tree Canopy (2015)



VCH HEALTH CAMPUSES AND BUILDINGS

Vancouver Community of Care

- 47 Doreen Pavilion Mental Health
- 48 Astor Pavilion Acute Care Hospital
- 49 Pudy Pavilion Residential Care
- 50 David Mowat Pavilion for Brain Health
- 51 St Johns Hospital UBC
- 52 Pacific Spirit Community Health Centre
- 53 West End Mental Health Team
- 54 Heart Centre Offices
- 55 Three Bridges Community Health Centre
- 56 Inner City Youth Program
- 57 Powder Community Health Clinic
- 58 KvaesoSalome Research
- 59 INSITE (Superseed) Injection Site
- 60 Vancouver Intensive Supervision Unit
- 61 Drug Users Resource Centre
- 62 Downtown Community Health Centre
- 63 Sheway YMCA Pregnancy Outreach
- 64 Strathcona Mental Health
- 65 CHEDS Research Office
- 66 NorthWest Mental Health Team
- 67 Kitano-Fairview Mental Health Team
- 68 Jack Bell Research Building
- 69 Robson H.N. Ho Building

- 90 Berrain House Residential
- 91 Humber House Youth Day Treatment
- 92 Kowe / Canille House
- 93 Dr. Iur Concurrent Disorders / Aboriginal Wellness
- 94 Mental Health Emergency Services Program
- 95 Robert Act-Ly Lee Family Comm. Health Centre
- 96 Bruden Gardens
- 97 GP Strong
- 98 Westside Mental Health Team
- 99 Evergreen Community Health Centre
- 100 George Pherson Centre
- 101 Dogwood Lodge
- 102 South Community Health Office
- 103 Southview Ambulatory Clinic
- 104 South Mental Health Team

Tree Canopy Coverage

- <math>< 5\%</math>
- 5-10%
- 10-25%
- 25-30%
- 30-35%
- 35-40%
- >40%

KEY TO FACILITY LABELS

- 90 R.O. Building Number
- X - Demolished
- 2 - (B) - Demolished, (R) - Residential, (P) - Professional

Data from Pacific Climate Impacts Consortium, City of Vancouver, Metro Vancouver, Province of BC. Map by ecoplans.ca

DRAFT 2.0 AUGUST 2018
LOWER METRO AND FACILITIES MANAGEMENT
www.ecoplans.ca

Map 3c Vancouver Community of Care - Flood Hazard (2015 and 2100)

VCH HEALTH CAMPUSES AND BUILDINGS

Vancouver Community of Care



- 47 Dewdney Pavilion Mental Health
- 48 Renner Pavilion Acute Care Hospital
- 49 Pardy Pavilion Residential Care
- 50 David McSwiggan Centre for Brain Health
- 51 St. Johns Hospital UBCH
- 52 Pacific Spirit Community Health Centre
- 53 West End Mental Health Team
- 54 Heart Centre Offices
- 55 Three Bridges Community Health Centre
- 56 Inner City Youth Program
- 57 Providence Community Health Clinic
- 58 Metrolink Research
- 59 NSITE (Inspirational Innovation Site)
- 60 Vancouver Intensive Supervision Units
- 61 Drug Users Resource Centre
- 62 Downtown Community Health Centre
- 63 Shewry YWCA Pregnancy Outreach
- 64 Strazsaca Mental Health Team
- 65 CHOS Research Offices
- 66 Northland Mental Health Team
- 67 Kitzilano-Finlayson Mental Health Team
- 68 Jack Bell Research Building
- 69 Abbotsford M.N. Ho Building

- 90 Berman House Residential
- 91 Hurstler House South Day Treatment
- 92 Kriller / Cromie House
- 93 Cx. for Concentration Disorders / Aboriginal Walkways
- 94 Mental Health Emergency Services Program
- 95 Robert And Lily Lee Family Comm. Health Centre
- 96 Blethen Gardens
- 97 GP Strong
- 98 Westside Mental Health Team
- 99 Evergreen Community Health Centre
- 100 George Pearson Centre
- 101 Dogwood Lodge
- 102 South Community Health Office
- 103 Southview Ambulatory Clinic
- 104 South Mental Health Team

Sea Level Rise
 Flood Hazard Extent, year 2100

DRAFT 2.0 **AUGUST 2018**
 LOWER MAINLAND FACILITIES MANAGEMENT
www.lmfmanagement.ca

KEY TO FACILITY LABELS

KXZ
 X = Building Number
 Y = Community (A=Uxway, B=Kitsilano, C=Downtown, D=West, E=PS)

Data from Pacific Climate Impacts Consortium,
 City of Vancouver, Metro Vancouver, Province of BC
 Map by geographics

Lower Mainland Facilities Management

Technical Appendix 2:

Climate Indicators for VCH
Facilities / Locations (Tables)

October 2018

NOTE:

Technical Appendix 2: Tables provide climate projections for 11 VCH health facilities / locations. Tables 3-7 offer additional consolidated information to supplement interpretations provided in Section 3 of the Lower Mainland Facilities Management: Moving Towards Climate Resilient Health Facilities for Vancouver Coastal Health report.

Certain BC Building Code (BCBC) and ASHRAE variables can be addressed by climate projections (see Appendix 3), such as “Warm Month Design Temperature 97.5%” (or BCBC 97.5). Hottest Day (TXX) is the annual hottest day of the year and warms by similar amounts as Hot Design Temperature (BCBC 97.5) (see Table 3). BCBC Annual Average Total Precipitation and CLIMDEX Annual Precipitation (PR) are identical. See Appendix 2 for plain language definitions.

In some cases, the average projected precipitation change throughout the century changes direction rather than uniformly increasing or decreasing with time. This is because decadal precipitation variability is large relative to the projected change (compare the ranges to projected values). This is particularly true for individual sites compared to regions (i.e. the noise relative to signal increases when considering a point rather than a regional average) and for locations with very large precipitation amounts (such as Bella Bella).

A key take away from these cases is the overall pattern and range of change. For example, the projected increase of 4% on average in Bella Bella by 2050s and 6% by 2020s should not be interpreted as a decrease because the range of change in both cases is around 15% and the projected increase by the end of the century is 11%.

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BELLA BELLA / RW LARGE MEMORIAL HOSPITAL

Table 3: Hot Temperatures - Bella Bella

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	1 day	2 days (1 to 3)	8 days (2 to 12)	21 days (6 to 33)
Days above 30°C	0 days	0 days (0 to 0)	1 day (0 to 1)	2 days (0 to 2)
BCBC 97.5	22°C	1°C (1 to 2)	3°C (1 to 4)	5°C (3 to 6)
CLIMDEX (TXX) Hottest Day	25°C	1°C (1 to 2)	3°C (1 to 4)	5°C (3 to 6)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Bella Bella

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	4	10 degree days (5 to 14)	50 degree days (10 to 80)	140 degree days (50 to 230)
HDD	3420	-14% (-16 to -10)	-26% (-35 to -18)	-41% (-51 to -29)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Bella Bella

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0	0 (0 to 0)	0.1 (0 to 0.2)	1 (0 to 1.5)
GSL	298	30 (20 to 38)	47 (32 to 60)	57 (47 to 69)

Table 6: Total Seasonal Precipitation - Bella Bella

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	671	1% (-9 to 7)	4% (-4 to 10)	8% (-3 to 18)
Summer	457	-3% (-16 to 9)	-8% (-27 to 11)	-14% (-34 to 10)
Autumn	945	5% (-1 to 13)	15% (5 to 28)	22% (12 to 35)
Winter	902	6% (-4 to 15)	4% (-1 to 13)	11% (-2 to 24)

Table 7: Extreme Precipitation - Bella Bella

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	85	7% (0.5 to 14)	16% (8 to 23)	24% (10 to 37)
Wettest 5-day period of the year precipitation	Rx5day	194	6% (-2 to 13)	15% (2 to 26)	21% (8 to 32)
Precipitation on wet days	R95p	597	15% (3 to 30)	31% (19 to 45)	53% (29 to 72)
Precipitation on very wet days	R99p	177	22% (-6 to 48)	56% (23 to 79)	100% (48 to 139)
1-in-20 wettest day	RP20 PR	133	6% (-4 to 16)	20% (11 to 32)	30% (9 to 56)

BELLA COOLA GENERAL HOSPITAL

Table 3: Hot Temperatures - Bella Coola General Hospital

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	9 days	7 days (4 to 10)	19 days (7 to 34)	37 days (16 to 60)
Days above 30°C	1 day	1 day (1 to 2)	5 days (2 to 11)	14 days (4 to 24)
BCBC 97.5	24°C	2°C (1 to 3)	4°C (2 to 5)	6°C (3 to 8)
CLIMDEX (TXX) Hottest Day	28°C	2°C (1 to 3)	4°C (2 to 5)	6°C (3 to 8)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Bella Coola General Hospital

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	15	20 degree days (10 to 30)	70 degree days (30 to 140)	180 degree days (70 to 300)
HDD	4830	-11% (-13 to -8)	-21% (-27 to -14)	-33% (-41 to -23)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Bella Coola General Hospital

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0	0 (0 to 0)	0.2 (0 to 1)	2 (0 to 5)
GSL	186	25 (16 to 31)	48 (32 to 64)	78 (57 to 91)

Table 6: Total Seasonal Precipitation - Bella Coola General Hospital

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	356	2% (-6 to 10)	6% (-1 to 13)	11% (2 to 22)
Summer	224	-4% (-16 to 11)	-9% (-31 to 9)	-16% (-40 to 12)
Autumn	756	4% (-3 to 11)	13% (5 to 24)	21% (9 to 32)
Winter	658	5% (-2 to 15)	3% (-3 to 12)	9% (-7 to 25)

Table 7: Extreme Precipitation - Bella Coola General Hospital

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	69	7% (2 to 11)	15% (7 to 23)	24% (9 to 36)
Wettest 5-day period of the year precipitation	Rx5day	159	6% (-3 to 15)	14% (0 to 26)	20% (4 to 33)
Precipitation on wet days	R95p	428	14% (3 to 30)	30% (17 to 53)	55% (28 to 88)
Precipitation on very wet days	R99p	132	27% (-8 to 48)	59% (21 to 102)	98% (48 to 149)
1-in-20 wettest day	RP20 PR	113	4% (-7 to 22)	14% (1 to 26)	24% (5 to 38)

LIONS GATE HOSPITAL

Table 3: Hot Temperatures - Lions Gate Hospital

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	24 days	17 days (11 to 24)	39 days (21 to 58)	67 days (39 to 97)
Days above 30°C	2 days	4 days (3 to 6)	14 days (6 to 22)	32 days (15 to 55)
BCBC 97.5	27°C	2°C (1 to 2)	4°C (2 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	30°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 8)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Lions Gate Hospital

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	90	90 degree days (50 to 130)	250 degree days (120 to 420)	500 degree days (260 to 780)
HDD	2830	-16% (-20 to -11)	-29% (-38 to -19)	-44% (-56 to -32)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Lions Gate Hospital

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0.1	0.8 (0.1 to 1.4)	7 (0.9 to 18)	26 (5 to 57)
GSL	308	23 (15 to 28)	41 (31 to 47)	51 (47 to 58)

Table 6: Total Seasonal Precipitation - Lions Gate Hospital

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	354	2% (-4 to 10)	5% (-4 to 13)	9% (1 to 17)
Summer	168	-8% (-28 to 5)	-16% (-35 to 3)	-23% (-51 to -2)
Autumn	493	2% (-5 to 11)	9% (-2 to 23)	17% (8 to 36)
Winter	572	4% (-2 to 11)	3% (-3 to 11)	11% (0 to 24)

Table 7: Extreme Precipitation - Lions Gate Hospital

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	59	4% (-2 to 13)	8% (-1 to 22)	18% (6 to 28)
Wettest 5-day period of the year precipitation	Rx5day	139	2% (-4 to 14)	7% (-2 to 19)	17% (10 to 27)
Precipitation on wet days	R95p	324	11% (3 to 21)	25% (8 to 51)	49% (28 to 65)
Precipitation on verywet days	R99p	95	12% (-3 to 29)	41% (-1 to 101)	89% (35 to 144)
1-in-20 wettest day	RP20 PR	92	10% (-5 to 32)	12% (-2 to 31)	25% (7 to 37)

POWELL RIVER GENERAL HOSPITAL

Table 3: Hot Temperatures - Powell River Hospital

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	18 days	14 days (8 to 22)	35 days (17 to 55)	61 days (34 to 86)
Days above 30°C	1 day	3 days (2 to 5)	10 days (4 to 16)	24 days (11 to 48)
BCBC 97.5	26°C	2°C (1 to 2)	4°C (2 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	30°C	2°C (1 to 2)	4°C (3 to 5)	6°C (4 to 8)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Powell River Hospital

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	60	70 degree days (50 to 90)	200 degree days (90 to 320)	410 degree days (210 to 320)
HDD	3070	-14% (-19 to -11)	-27% (-36 to -18)	-42% (-53 to -31)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Powell River Hospital

Indicator	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0	0.2 (0 to 0.3)	3 (0 to 7)	14 (2 to 35)
GSL	289	29 (22 to 38)	52 (41 to 59)	68 (60 to 77)

Table 6: Total Seasonal Precipitation - Powell River Hospital

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	251	2% (-7 to 10)	4% (-3 to 14)	8% (1 to 15)
Summer	140	-7% (-21 to 8)	-14% (-34 to 6)	-22% (-48 to 0)
Autumn	366	3% (-6 to 12)	11% (0 to 24)	19% (9 to 35)
Winter	433	5% (-1 to 12)	4% (-3 to 9)	12% (-1 to 25)

Table 7: Extreme Precipitation - Powell River Hospital

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	40	5% (0 to 13)	12% (7 to 19)	23% (13 to 30)
Wettest 5-day period of the year precipitation	Rx5day	97	3% (-2 to 10)	9% (2 to 16)	19% (12 to 29)
Precipitation on wet days	R95p	229	13% (3 to 29)	29% (10 to 48)	55% (40 to 73)
Precipitation on very wet days	R99p	65	23% (2 to 43)	58% (33 to 114)	117% (69 to 192)
1-in-20 wettest day	RP20 PR	56	12% (-1 to 26)	18% (7 to 32)	28% (19 to 37)

SECHELT HOSPITAL

Table 3: Hot Temperatures - Sechelt Hospital

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	15 days	13 days (7 to 19)	33 days (17 to 53)	61 days (33 to 91)
Days above 30°C	1 day	3 days (2 to 4)	9 days (3 to 14)	23 days (9 to 45)
BCBC 97.5	26°C	2°C (1 to 2)	4°C (2 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	29°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 9)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Sechelt Hospital

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	60	80 degree days (50 to 100)	220 degree days (100 to 360)	440 degree days (220 to 690)
HDD	2900	-15% (-20 to 11)	-28% (-38 to -19)	-44% (-57 to -33)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Sechelt Hospital

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0	0.5 (0 to 1)	6 (1 to 16)	23 (4 to 52)
GSL	309	26 (16 to 33)	43 (39 to 49)	52 (45 to 59)

Table 6: Total Seasonal Precipitation - Sechelt Hospital

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	235	2% (-6 to 9)	4% (-6 to 12)	7% (-1 to 15)
Summer	119	-8% (-29 to 6)	-17% (-38 to 3)	-24% (-53 to -3)
Autumn	332	2% (-6 to 11)	10% (-2 to 23)	18% (8 to 36)
Winter	419	5% (-2 to 13)	4% (-3 to 9)	11% (-2 to 24)

Table 7: Extreme Precipitation - Sechelt Hospital

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	38	3% (-1 to 10)	9% (1 to 20)	18% (7 to 30)
Wettest 5-day period of the year precipitation	Rx5day	92	3% (-1 to 13)	8% (1 to 16)	18% (11 to 26)
Precipitation on wet days	R95p	207	13% (3 to 30)	26% (4 to 51)	54% (40 to 72)
Precipitation on very wet days	R99p	60	13% (-6 to 28)	41% (7 to 90)	95% (55 to 151)
1-in-20 wettest day	RP20 PR	53	9% (0 to 22)	12% (0 to 28)	24% (16 to 44)

SQUAMISH HOSPITAL

Table 3: Hot Temperatures - Squamish Hospital

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	32 days	16 days (10 to 21)	35 days (17 to 51)	59 days (35 to 88)
Days above 30°C	6 days	7 days (4 to 10)	18 days (9 to 27)	35 days (18 to 56)
BCBC 97.5	29°C	2°C (1 to 3)	3°C (2 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	32°C	2°C (1 to 3)	4°C (3 to 5)	6°C (5 to 9)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Squamish Hospital

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	90	80 degree days (50 to 110)	230 degree days (100 to 390)	460 degree days (230 to 730)
HDD	3190	-14% (-18 to -10)	-26% (-35 to -19)	-41% (-51 to -31)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Squamish Hospital

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0	0.2 (0 to 0.2)	3.4 (0.2 to 10)	16 (2 to 42)
GSL	273	28 (22 to 38)	51 (38 to 62)	75 (63 to 86)

Table 6: Total Seasonal Precipitation - Squamish Hospital

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	460	2% (-4 to 10)	5% (-3 to 12)	10% (3 to 17)
Summer	197	-8% (-26 to 8)	-15% (-34 to 3)	-22% (-49 to 1)
Autumn	726	2% (-5 to 11)	11% (-2 to 24)	19% (9 to 36)
Winter	802	4% (-2 to 12)	4% (-4 to 10)	11% (-1 to 24)

Table 7: Extreme Precipitation - Squamish Hospital

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	79	4% (-2 to 13)	9% (1 to 21)	20% (9 to 34)
Wettest 5-day period of the year precipitation	Rx5day	193	3% (-1 to 15)	9% (1 to 18)	19% (14 to 29)
Precipitation on wet days	R95p	467	13% (-2 to 25)	28% (5 to 55)	54% (35 to 72)
Precipitation on very wet days	R99p	135	17% (-8 to 32)	50% (10 to 111)	106% (54 to 157)
1-in-20 wettest day	RP20 PR	118	8% (-4 to 25)	14% (0 to 29)	29% (10 to 46)

DOWNTOWN EAST SIDE (DTES) / 1ST & CLARK HEALTH, HOUSING & SOCIAL ENTERPRISE CENTER

Table 3: Hot Temperatures - Downtown East Side

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	22 days	20 days (11 to 27)	44 days (24 to 63)	73 days (44 to 105)
Days above 30°C	2 days	4 days (2 to 5)	13 days (5 to 21)	32 days (14 to 60)
BCBC 97.5	27°C	2°C (1 to 2)	4°C (3 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	30°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 9)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Downtown East Side

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	90	100 degree days (60 to 140)	270 degree days (130 to 450)	530 degree days (280 to 820)
HDD	2710	-16% (-21 to -11)	-29% (-39 to -20)	-45% (-57 to -33)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Downtown East Side

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0.1	0.8 (0 to 1)	9 (1 to 22)	30 (7 to 65)
GSL	312	22 (17 to 27)	38 (29 to 44)	48 (42 to 53)

Table 6: Total Seasonal Precipitation - Downtown East Side

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	316	2% (-4 to 10)	5% (-3 to 13)	9% (1 to 17)
Summer	149	-8% (-29 to 5)	-16% (-35 to 3)	-22% (-50 to -2)
Autumn	441	2% (-5 to 11)	9% (-2 to 24)	17% (8 to 36)
Winter	512	4% (-2 to 11)	3% (-3 to 11)	11% (0 to 24)

Table 7: Extreme Precipitation - Downtown East Side

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	54	5% (-2 to 13)	9% (1 to 22)	18% (5 to 28)
Wettest 5-day period of the year precipitation	Rx5day	126	3% (-4 to 14)	7% (-3 to 19)	17% (9 to 27)
Precipitation on wet days	R95p	287	11% (2 to 20)	25% (7 to 52)	50% (29 to 65)
Precipitation on very wet days	R99p	84	13% (-2 to 35)	43% (13 to 105)	91% (50 to 148)
1-in-20 wettest day	RP20 PR	86	11% (-5 to 31)	12% (-4 to 33)	23% (4 to 38)

DOGWOOD PEARSON / DOGWOOD LODGE & GEORGE PEARSON CENTER

Table 3: Hot Temperatures - Dogwood Pearson

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	17 days	18 days (10 to 25)	43 days (24 to 63)	73 days (44 to 105)
Days above 30°C	1 day	3 days (1 to 4)	10 days (4 to 17)	28 days (10 to 55)
BCBC 97.5	26°C	2°C (1 to 2)	4°C (3 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	29°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 9)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Dogwood Pearson

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	70	90 degree days (50 to 130)	250 degree days (120 to 410)	500 degree days (260 to 770)
HDD	2810	-16% (-20 to -11)	-28% (-38 to -19)	-44% (-56 to -32)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Dogwood Pearson

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0	0.4 (0 to 1)	6 (0 to 17)	25 (4 to 57)
GSL	309	22 (16 to 28)	38 (27 to 44)	49 (44 to 55)

Table 6: Total Seasonal Precipitation - Dogwood Pearson

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	283	2% (-4 to 10)	5% (-4 to 12)	9% (0 to 16)
Summer	136	-8% (-28 to 4)	-16% (-36 to 3)	-23% (-50 to -3)
Autumn	402	2% (-5 to 11)	9% (-3 to 24)	17% (8 to 36)
Winter	466	4% (-2 to 11)	3% (-3 to 11)	11% (0 to 23)

Table 7: Extreme Precipitation - Dogwood Pearson

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	49	5% (-2 to 14)	9% (0 to 22)	18% (6 to 29)
Wettest 5-day period of the year precipitation	Rx5day	115	3% (-4 to 13)	7% (-3 to 19)	17% (8 to 26)
Precipitation on wet days	R95p	259	11% (0 to 22)	24% (8 to 48)	49% (32 to 68)
Precipitation on very wet days	R99p	75	14% (-2 to 32)	47% (15 to 111)	95% (48 to 154)
1-in-20 wettest day	RP20 PR	77	10% (-4 to 29)	11% (-4 to 31)	22% (2 to 38)

UBC HOSPITAL / ST JOHNS HOSPICE

Table 3: Hot Temperatures - UBC Hospital

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	15 days	17 days (9 to 25)	42 days (24 to 63)	73 days (44 to 104)
Days above 30°C	1 day	2 days (1 to 4)	9 days (3 to 15)	26 days (9 to 63)
BCBC 97.5	26°C	2°C (1 to 2)	4°C (2 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	29°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 9)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - UBC Hospital

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	60	90 degree days (50 to 120)	240 degree days (110 to 400)	480 degree days (250 to 750)
HDD	2830	-16% (-20 to -11)	-28% (-38 to -19)	-44% (-57 to -32)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - UBC Hospital

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0	0.5 (0 to 1)	6 (0 to 16)	24 (5 to 54)
GSL	307	23 (17 to 29)	41 (28 to 48)	52 (48 to 60)

Table 6: Total Seasonal Precipitation - UBC Hospital

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	279	2% (-4 to 10)	5% (-4 to 12)	8% (0 to 16)
Summer	134	-8% (-29 to 5)	-16% (-36 to 3)	-23% (-51 to -2)
Autumn	394	2% (-5 to 11)	10% (-3 to 24)	17% (8 to 36)
Winter	461	4% (-2 to 11)	3% (-3 to 11)	11% (-1 to 24)

Table 7: Extreme Precipitation - UBC Hospital

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	47	4% (-1 to 14)	9% (0 to 21)	18% (6 to 28)
Wettest 5-day period of the year precipitation	Rx5day	112	3% (-4 to 13)	7% (-2 to 19)	17% (9 to 26)
Precipitation on wet days	R95p	251	11% (1 to 22)	26% (8 to 49)	51% (30 to 68)
Precipitation on very wet days	R99p	73	16% (-8 to 39)	46% (11 to 109)	94% (49 to 158)
1-in-20 wettest day	RP20 PR	74	10% (-3 to 29)	11% (-3 to 31)	23% (6 to 39)

VANCOUVER GENERAL HOSPITAL

Table 3: Hot Temperatures - Vancouver General Hospital

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	18 days	19 days (11 to 26)	44 days (24 to 63)	73 days (44 to 105)
Days above 30°C	1 day	3 days (2 to 4)	11 days (4 to 18)	29 days (11 to 57)
BCBC 97.5	26°C	2°C (1 to 2)	4°C (3 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	29°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 9)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Vancouver General Hospital

Indicator	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	80	100 degree days (50 to 130)	260 degree days (120 to 430)	520 degree days (270 to 800)
HDD	2750	-16% (-21 to -11)	-29% (-39 to -20)	-45% (-57 to -33)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Vancouver General Hospital

Indicator	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0.1	0.6 (0 to 1)	8 (1 to 20)	29 (6 to 63)
GSL	311	22 (16 to 28)	39 (28 to 44)	48 (45 to 55)

Table 6: Total Seasonal Precipitation - Vancouver General Hospital

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	305	2% (-4 to 10)	5% (-4 to 13)	9% (1 to 16)
Summer	146	-8% (-29 to 5)	-16% (-35 to 3)	-22% (-50 to -2)
Autumn	429	2% (-5 to 11)	9% (-2 to 24)	17% (8 to 36)
Winter	499	4% (-2 to 11)	3% (-3 to 11)	11% (0 to 24)

Table 7: Extreme Precipitation - Vancouver General Hospital

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	53	4% (-2 to 13)	9% (1 to 22)	18% (5 to 28)
Wettest 5-day period of the year precipitation	Rx5day	123	3% (-4 to 14)	7% (-3 to 19)	17% (8 to 26)
Precipitation on wet days	R95p	279	11% (0 to 21)	24% (8 to 50)	50% (30 to 67)
Precipitation on very wet days	R99p	82	15% (-3 to 39)	45% (17 to 107)	91% (51 to 150)
1-in-20 wettest day	RP20 PR	85	10% (-5 to 31)	12% (-4 to 32)	21% (3 to 37)

RICHMOND HOSPITAL

Table 3: Hot Temperatures - Richmond Hospital

	Past	2020 Change (range)	2050 Change (range)	2080 Change (range)
Days above 25°C	16 days	17 days (9 to 25)	43 days (24 to 64)	73 days (45 to 105)
Days above 30°C	1 day	2 days (1 to 4)	10 days (4 to 16)	27 days (10 to 54)
BCBC 97.5	26°C	2°C (1 to 2)	4°C (3 to 5)	6°C (4 to 9)
CLIMDEX (TXX) Hottest Day	29°C	2°C (1 to 3)	4°C (3 to 5)	6°C (4 to 9)

Table 4: Cooling Degree Days (CDD) and Heating Degree Days (HDD) - Richmond Hospital

	Past (degree days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
CDD	70	90 degree days (50 to 120)	250 degree days (120 to 410)	500 degree days (260 to 770)
HDD	2790	-16% (-20 to -11)	-29% (-39 to -19)	-44% (-57 to -32)

Table 5: Tropical Nights (TR) and Growing-Season Length (GSL) - Richmond Hospital

	Past (days)	2020 Change (range)	2050 Change (range)	2080 Change (range)
TR	0	0.4 (0 to 1)	6 (0.4 to 16)	25 (5 to 57)
GSL	310	21 (14 to 27)	38 (29 to 44)	48 (42 to 54)

Table 6: Total Seasonal Precipitation - Richmond Hospital

	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Spring	248	2% (-4 to 10)	5% (-4 to 12)	8% (0 to 16)
Summer	121	-8% (-28 to 4)	-16% (-37 to 3)	-23% (-50 to -3)
Autumn	354	2% (-5 to 11)	9% (-3 to 24)	16% (7 to 35)
Winter	413	4% (-2 to 11)	3% (-3 to 11)	11% (0 to 24)

Table 7: Extreme Precipitation - Richmond Hospital

Indicator Description	Indicator	Past (mm)	2020 Percent Change (range)	2050 Percent Change (range)	2080 Percent Change (range)
Wettest day of the year precipitation	Rx1day	43	4% (-1 to 14)	9% (0 to 23)	19% (6 to 30)
Wettest 5-day period of the year precipitation	Rx5day	102	2% (-5 to 12)	7% (-3 to 19)	17% (8 to 26)
Precipitation on wet days	R95p	225	11% (3 to 21)	23% (8 to 47)	49% (29 to 69)
Precipitation on very wet days	R99p	65	15% (3 to 37)	50% (9 to 123)	100% (47 to 172)
1-in-20 wettest day	RP20 PR	68	9% (-5 to 31)	12% (-5 to 32)	23% (2 to 43)