AGENDA

COUNCIL WORKSHOP

Tuesday, June 20, 2017
5:00 p.m.
Committee Room, Municipal Hall
355 West Queens Road,
North Vancouver, BC

Council Members:
Mayor Richard Walton
Councillor Roger Bassam
Councillor Mathew Bond
Councillor Jim Hanson
Councillor Robin Hicks
Councillor Doug MacKay-Dunn
Councillor Lisa Muri

NORTH VANCOUVER
DISTRICT

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District of North Vancouver
355 West Queens Road,
North Vancouver, BC, Canada V7N 4N5
604-990-2311
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COUNCIL WORKSHOP

5:00 p.m.
Tuesday, June 20, 2017
Committee Room, Municipal Hall,
355 West Queens Road, North Vancouver

AGENDA

1. ADOPTION OF THE AGENDA

1.1. June 20, 2017 Council Workshop Agenda

Recommendation:
THAT the agenda for the June 20, 2017 Council Workshop is adopted as circulated, including the addition of any items listed in the agenda addendum.

2. ADOPTION OF MINUTES

3. REPORTS FROM COUNCIL OR STAFF

3.1. Climate Change Adaptation Strategy — p. 7-90

File No. 13.6770

Recommendation:
THAT the June 8, 2017 report of the Section Manager – Public Safety entitled Climate Change Adaptation Strategy is received for information.

3.2. Integrated Stormwater Management Plan Framework and Objectives — p. 91-121

File No. 11.5225.50/001

Recommendation:
THAT the Integrated Stormwater Management Plan Framework and Objectives as presented in the June 9, 2017 joint report of the Project Engineer and Section Manager – Engineering Planning and Design is approved.

4. PUBLIC INPUT

(maximum of ten minutes total)

5. ADJOURNMENT

Recommendation:
THAT the June 20, 2017 Council Workshop is adjourned.

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REPORTS

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AGENDA INFORMATION	
☐ Regular Meeting	Date:
☐ Other:	Date:

Dept. Manager | GM/ Director | CAO

The District of North Vancouver
REPORT TO COUNCIL

June 8, 2017
File: 13.6770

AUTHOR: Fiona Dercole, Section Manager Public Safety

SUBJECT: Climate Change Adaptation Strategy

RECOMMENDATION:
THAT the June 8, 2017 report of the Section Manager Public Safety entitled Climate Change Adaptation Strategy is received for information.

REASON FOR REPORT:
To obtain Council's input on the draft Climate Change Adaptation Strategy.

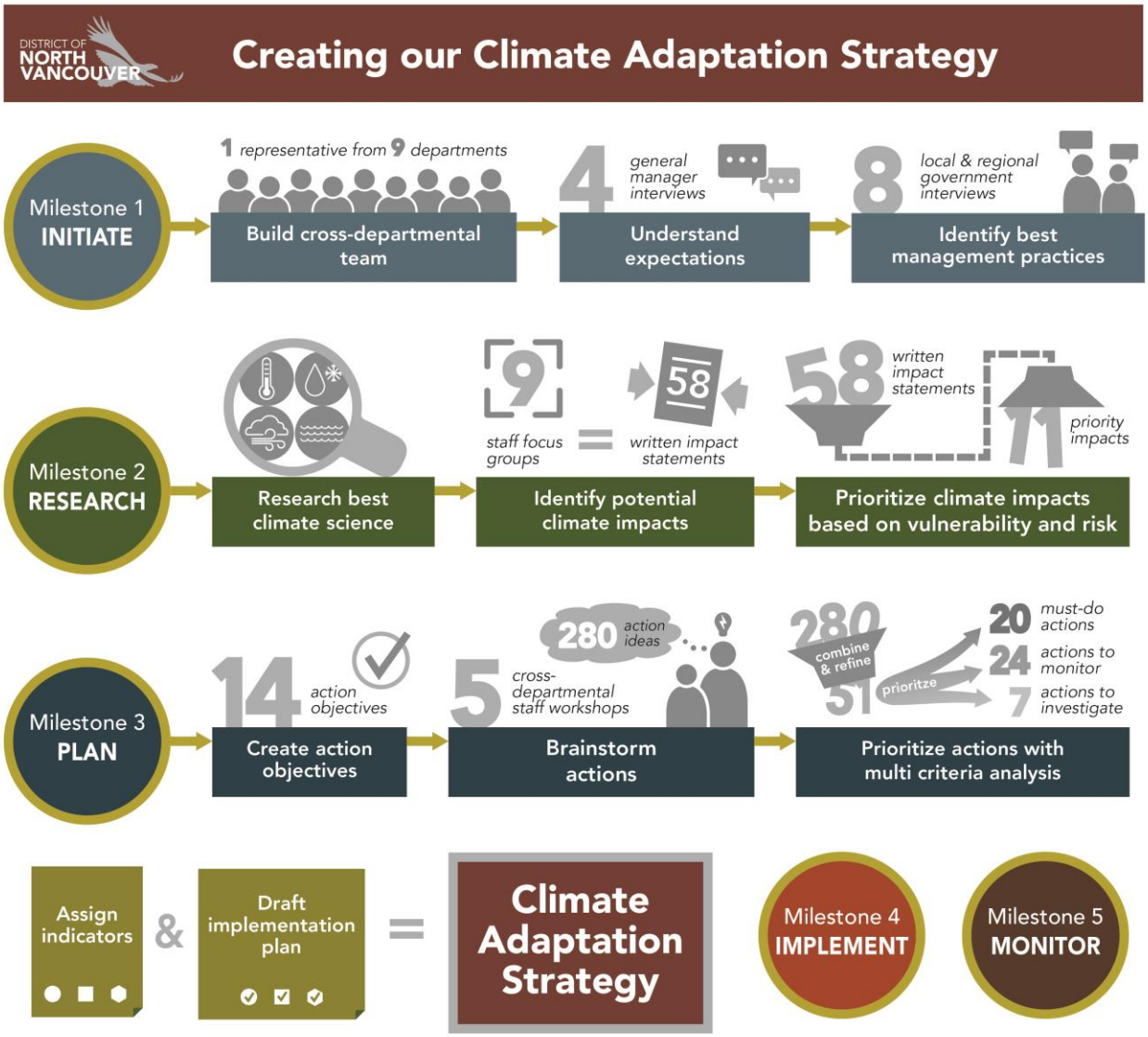
SUMMARY:
A multi-disciplinary staff team have been working together for the past two years, utilizing a reputable planning process to prepare the draft Climate Change Adaptation Strategy (the Strategy, attachment 1). The role of the Strategy is to coordinate District initiatives that support climate change adaptation and to integrate adaptation considerations throughout District activities. The District has a strong tradition of taking action on environmental and public safety issues. The Strategy highlights the effectiveness of existing District programs and outlines twenty priority actions aimed at further reducing the impacts of climate change to people, environment and assets. Adapting to climate change increases social, physical and economic resiliency.

BACKGROUND:
Development of a Climate Change Adaptation Strategy is both an Official Community Plan (OCP) objective and a Corporate Plan priority. In 2015 the District joined other Canadian municipalities in utilizing an internationally-recognized municipal planning process to formally plan for climate change adaptation. ICLEI Canada's Building Adaptive and Resilience Communities (BARC) program provides a structured, five-milestone approach to adaptation planning. On December 7, 2015 Council received a presentation from Staff reporting on Milestones 1 and 2 (Initiate and Research). On October 24, 2016, Council received an information report from Staff regarding the beginning of Milestone 3 (Plan) and outlined 20 proposed *Required Actions*. This current report is the culmination of planning efforts and presents the draft Climate Adaptation Strategy for Council's input. Milestones 4 and 5 (Implement and Monitor) will be ongoing.

EXISTING POLICY:
The Official Community Plan (2011) states the District's commitment to develop a Climate Change Adaptation Strategy and contains several related objectives:

- *adapt proactively to climate change* (10.4)
- *reduce and mitigate the risk associated with natural hazards* (9.4)
- *protect development from hazardous cond*itions (Schedule B)
- *protect the natural environment, its ecosystems and biodiversity* (Schedule B).

ANALYSIS:
The District's climate change adaptation planning process utilized ICLEI Canada's Building Adaptive and Resilience Communities program, consisting of five major milestones. Council's endorsement of the Climate Change Adaptation Strategy will mark the completion of Milestone 3.



☑ **Milestone 1: Initiate** - *Built a cross-departmental Climate Change Adaptation Team; identified key stakeholders; conducted in-depth interviews with General Managers.*

Climate change affects all areas of work, requiring the development of this strategy to use a collaborative, multidisciplinary approach. The District's Climate Change Adaptation Team is comprised of nine experienced Staff members from across the organization, each bringing a unique perspective to the planning process. In-depth interviews were held with the four General Managers to gain understanding of expectations from a senior level.

☑ **Milestone 2: Research**- *Attained the best available climate science; identified impacts specific to the District; completed vulnerability/risk assessment to identify impact priorities.*

Climate modelling for the District was completed by the Pacific Climate Impacts Consortium (PCIC) to better understand how the District's climate may change by the 2050s. Modelling was focused on the 2050s because these are the climatic changes that will be unavoidable, regardless of the extent of global mitigation efforts. An ensemble of twelve global climate models was used to assess projected changes in: temperature; precipitation amounts; precipitation timing; changing precipitation patterns, extreme weather events of greater frequency and severity, and sea level rise. Climate impacts were prioritized based on a comprehensive risk assessment. The risk posed by each climate change impact was assessed by determining the likelihood of the initiating climatic event and the likelihood of an impact caused by the occurrence of the climatic event, as well as the extent of potential consequences. High-risk climate change impacts had high likelihood and consequence, and were thus high priorities.

☑ **Milestone 3: Plan** - *Created an adaptation vision and guiding principles; identified adaptation actions to address impacts; prioritized adaptation actions; determined indicators to monitor progress; drafted implementation plans to carry out each action.*

Vision: We are proactive and resilient, adapting to a changing climate while balancing social, economic, and environmental priorities.

Staff working groups used the results of the vulnerability and risk assessment completed in Milestone 2 to brainstorm primary and supporting actions to proactively respond to the highest risk climate change impacts. Many of the actions support and enhance ongoing work at the District and will focus our efforts to further protect our infrastructure, environment and people. A structured decision-making framework was utilized to prioritize the actions into 20 *Required Actions* (high benefit-to-cost ratio and should be implemented as soon as possible); 24 *Opportunistic Actions* (medium benefit-to-cost ratio and should be implemented when opportunity arises and 7 *Possible Actions* (unknown benefit-to-cost ratio and may be implemented in the future). The Required Actions are grouped into three categories: Governance & Management, Assets & Operations, and Education & Training.

This draft Strategy has been peer-reviewed by a climate change adaptation specialist and professor of physical sciences and found to be comprehensive and pragmatic.

☐ **Milestone 4: Implement** - *determine the best approaches to achieve each action objective, and continually evaluate and revise the implementation plan.*

Most of the adaptation actions build on existing work that is already well-underway. The District has already invested in leading edge asset management and natural hazard management programs. The actions identified in this Strategy can be integrated into existing programs and will assist in elevating, focusing and coordinating work across multiple departments. A draft implementation plan has been created for each action, including assigning a departmental lead, target completion date and reference to relevant documents. The departmental leads identified for each priority action are responsible for implementing actions by incorporating them into departmental plans, asset management plans and financial planning processes.

☐ **Milestone 5: Monitor/Review** - *use indicators to monitor and review implementation progress. Review and evaluate strategy annually, and update strategy every five years.*

To assist in the successful implementation of this Strategy, a list of potential indicators for each priority action is included proposed to help monitor progress over time. The Climate Change Adaptation Team will carry out an annual review and evaluation of the Strategy which includes documenting observed climatic changes or impacts in the District, successfully implemented actions, barriers to the implementation of actions, new sources of funding, and windows of opportunity for climate action. As the Strategy is a living document and the climate is constantly changing, new actions will be identified and implemented through a formal review and update process every 5 years, conducted by the Climate Change Adaptation Team.

Timing/Approval Process:
The work program to develop the Strategy began in 2014 as a multi-year initiative. After incorporating Council's comments, the final draft strategy will undergo graphic design and layout, and then return to Council in July 2017 for formal endorsement.

Concurrence:
The Climate Change Adaptation Team is comprised of experienced staff members from the following departments: Planning, Engineering, Environment, Emergency Management, Fire and Rescue Services, Parks, Corporate Services and Finance.

Financial Impacts:
By investing strategically in adaptation measures the District can avoid or reduce response and recovery costs that would otherwise be incurred. An example is the recent creek hazard mitigation works where the design of the infrastructure included capacity projections for climate change conditions, which will reduce maintenance costs, extend the operational life of the asset, mitigate direct damage losses and protect public safety. Full life cycle costing including climate change is an area of asset management planning currently under development. A key approach to integrating climate change into the asset management planning is by expanding the risk register for each major asset group including natural capital. This strategy provides a structure to guide long term investment in adapting to

climate change, and will be integrated into asset management and financial planning processes.

Liability/Risk:
Proactive climate change adaptation and the implementation of the actions in the Strategy will result in comparatively lower future risk. This is accomplished by anticipating future risks based on best available science and then providing risk specific measures to reduce the community impacts.

Social Policy Implications:
Adaptation planning is central to community resiliency and livability. Several actions identified in the Strategy are specifically aimed at reducing climate-related impacts to vulnerable populations.

Environmental Impact:
Scientific research indicates that climate change will have a profound effect on BC forests and ecosystems. As populations grow and the need for more living space increases, habitat loss and fragmentation continues. As natural habitat area decreases some animal and plant species may not be able to adapt quickly enough to the changing climate. The District possesses many different types of vulnerable ecosystems from saltwater marshes to alpine meadows. As native species fail to adapt quickly there is an opening that is often filled with invasive species that offer little or no ecological or geotechnical benefit. By implementing the actions in the Strategy, the District can buffer the spread of harmful invasive species while giving the preferred native species a better opportunity to thrive.

Conclusion:
The draft Climate Change Adaptation Strategy is the result of a comprehensive, multi-department planning process. Required Actions are the outcome of a risk assessment and structured decision making analysis. Implementing the Strategy will protect assets and the environment, enhance long term liveability and reduce economic losses from direct damage and response and recovery costs. Staff are seeking Council's input before finalizing the plan for formal endorsement.

Respectfully submitted,

F. Dercole

Fiona Dercole
Section Manager, Public Safety

Attachment 1: Draft Climate Change Adaptation Strategy

REVIEWED WITH:

☑ Sustainable Community Dev.	____	☐ Clerk's Office	____	External Agencies:	
☐ Development Services	____	☐ Communications	____	☐ Library Board	____
☐ Utilities	____	☑ Finance	____	☐ NS Health	____
☐ Engineering Operations	____	☐ Fire Services	____	☐ RCMP	____
☐ Parks	____	☐ ITS	____	☐ NVRC	____
☑ Environment	____	☐ Solicitor	____	☐ Museum & Arch.	____
☐ Facilities	____	☐ GIS	____	☑ Other: NSEM	
☐ Human Resources	____	☐ Real Estate	____		

Climate Change Adaptation Strategy
Acting Now for a Resilient Future

District of North Vancouver

June 2017

Executive Summary

Taking effective action on climate change requires both *mitigation* (reducing greenhouse gas emissions) and *adaptation* (preparing for and responding to the impacts of climate change). Adaptation is necessary due to climatic changes that are already occurring, and will continue to occur for some time, regardless of whether or not we mitigate. Changes to precipitation and temperature regimes, and the number and severity of extreme events, are already affecting the livability of the District of North Vancouver. Taking proactive action to adjust to and prepare for changes will not only help prepare the District for ongoing challenges, but will also benefit finances, improve environmental health, and provide a host of community benefits.

The goals of this Climate Change Adaptation Strategy are to:

1) Build upon existing activities that help prepare the District for climate change
2) Identify new initiatives that could strengthen the District's adaptation efforts
3) Integrate climate change adaptation into existing plans and work processes

To inform adaptation efforts, scientific information was compiled regarding climate change in the region. In BC's South Coast region, temperatures have increased by approximately 1.2°C since 1900, and precipitation has increased slightly. In recent years, the District has endured a large number of extreme and unusual climate-related events that have had economic, environmental, and social costs to the community. In 2014 and 2015, the District witnessed several events, including:

- record-setting summer temperatures, including multiple heat-wave warnings;
- extreme drought conditions and low levels of snowfall that dropped reservoir levels;
- large regional wildfires, which resulted in air quality advisories; and
- intense rainfall events that caused flooding and damaged private and public property.

Climate modelling for the District, completed by the Pacific Climate Impacts Consortium, was undertaken to better understand how the District's climate is projected to change Four major categories (or types) of changes that were analyzed, and highlights of the results, are shown below. All changes are for the 2050s, relative to the 1980s (1970-2000) baseline

1. **Temperature change**
   - Average annual temperatures are projected to increase by approximately 2.9°C.
   - The average number of hot summer days (above 30°C) is expected to increase from 2 to 13 days per year.
   - The temperature of extreme hot days, expected to happen once every 20 years (or have a 5% chance of occurring any year), is projected to increase from 33°C to 38°C.
2. **Precipitation change**
   - Average annual precipitation is projected to increase by approximately 5% overall but to decrease by 18% in summer (therefore droughts may increase).

- Precipitation is projected to fall in increasingly extreme events, with 33% more precipitation falling on very wet days (i.e., the wettest 5% of days) and 58% more precipitation falling on extremely wet days (i.e., the wettest 1% of days).
- Snowpacks are projected to decrease by an average of 89%.

3. **Extreme weather**
   - Changes in extremes in precipitation and temperature are related above.
   - Projections of wind are highly uncertain, with both increases and decreases projected by different models.
4. **Sea level rise.**
   - BC Government's guidelines are for a 1.0m increase in sea levels for 2100.

Climate models are inherently uncertain. It is generally wise to prepare for a range of future events and focus on resiliency. A resilient community can prepare for and adjust to a range of possible futures, can function amidst change, and is therefore less vulnerable. Adapting to climate change is more than just preparing for unfamiliar weather and strange shifts in seasons. With deliberate and decisive planning, proactive action can achieve adaptation goals and simultaneously benefit multiple aspects of our community. As with many other preventative measures, investing in climate change adaptation may be costly at first, but it is usually the most cost-effective option over time. For example, building infrastructure to a higher standard requires higher upfront costs but result in lower maintenance costs, longer operational lives, and reduced public-safety costs.

The concept of adaptation is not new to the District of North Vancouver. The District has already been working on many initiatives that support climate change adaptation. This work is ongoing and includes, but is not limited to:

- Risk assessments for natural hazards (e.g., landslides, wildfires, earthquakes, and floods)
- A long-term (40 to 50 years) asset management framework
- The 2011 Official Community Plan (OCP) identifies the need to adapt proactively to climate change through integrating a climate change perspective into infrastructure design and maintenance, ecosystem management and emergency preparedness.
- The 2015-2018 Corporate Plan includes a commitment to take action on climate change through developing and implementing a Climate Change Adaptation Strategy.
- In 2011 the District received the United Nations Sasakawa Award for Excellence in Disaster Risk Reduction, and is recognized as a "Role Model City" as part of the United Nations Resilient Cities Campaign

The District of North Vancouver joined ICLEI's Building Adaptive and Resilient Communities (BARC) program in January 2015 to develop the District's first Climate Change Adaptation Strategy. Because climate change affects all areas of work, an interdepartmental Climate Change Adaptation Team consisting of representatives from nine different District departments guided the development of the strategy. A renowned framework (created by ICLEI) was used to facilitate the planning process that consisted of five major steps:

Milestone 1: Initiate - build a cross-departmental Climate Change Adaptation Team, identify key stakeholders, and conduct in-depth interviews with General Managers.

Milestone 2: Research- attain the best available climate science, identify impacts specific to the District, and complete a vulnerability and risk assessment to identify impact priorities.

Milestone 3: Plan - create an adaptation vision and guiding principles and action objectives; identify adaptation actions to address impacts; prioritize adaptation actions; determine indicators to monitor progress; and draft implementation plans to carry out each action.

Milestone 4: Implement - determine the best approaches to achieve each action objective, and continually evaluate and revise the implementation plan.

Milestone 5: Monitor/Review - use indicators to monitor and review implementation progress. Review and evaluate strategy annually, and update strategy every five years.

Milestones 1 and 2 are outlined above. The District's adaptation vision (Milestone 3) was determined to be:

We are proactive and resilient, adapting to a changing climate while balancing social, economic, and environmental priorities.

Climate impacts were prioritized based on a comprehensive risk assessment. The risk posed by each climate change impact was assessed by determining the likelihood of the initiating climatic event (e.g., drought) and the likelihood of an impact caused by the occurrence of the climatic event (e.g., reduced potable water) as well as the extent of potential consequences. High-risk climate change impacts had high likelihood and consequence, and were thus high priorities. Action objectives were created to describe the intent of the District regarding how each priority climate impact should be addressed. These action objectives then guided the development of adaptation actions. Adaptation actions were organized into *Required Actions* (high benefit-to-cost ratio and should be implemented as soon as possible); *Opportunistic Actions* (medium benefit-to-cost ratio and should be implemented when opportunity arises); and *Possible Actions* (unknown benefit-to-cost ratio and may be implemented in the future).

The Table below outlines the 12 action objectives and the required actions for each. The first 11 objectives focus on specific actions that different District service areas should take, and the final objective relates to supporting adaptation the integration of adaptation actions in different plans, and establishing indicators to monitor progress on all objectives over time.

To achieving the strategy's vision, consistent monitoring and review of the strategy is essential. In order to account and adjust for advances in science, management and public priority the District intends to have the Climate Change Adaptation Team review and evaluate this strategy on an annual basis, and to update the Adaptation Strategy every five years.

Objective 1: Strengthen the District's capacity to respond to and recover from extreme weather events and provide continuity of essential municipal services
Required Action (RA) 1.1: Complete business continuity plans to ensure priority service delivery
RA 1.2: Develop and/or purchase additional technology tools to assist in situational awareness and emergency response communication
RA 1.3: Provide targeted training for clerks to ensure emergency service requests and concerns are responded to in a timely manner
Objective 2: Ensure critical municipal functions are served by robust power systems and alternatives are provided where systems are vulnerable
RA 2.1: Identify critical functions that are vulnerable to power outages and develop priority response and power restoration protocols
RA 2.2: Invest in back up power equipment for critical functions and develop fueling strategy
Objective 3: Increase the resiliency of municipal assets to more frequent and severe extreme weather and sea level rise
RA 3.1: Complete the Integrated Stormwater Management Plan and implement recommendations to maintain watershed health and reduce the impacts of extreme runoff
RA 3.2: Update the Community Wildfire Protection Plan and implement recommendations to strengthen capacity to respond to Wildland Urban Interface fires
RA 3.3: Identify eco-assets, conduct risk assessment under climate change conditions, and include in Asset Management Plan
RA 3.4: Implement recommendations in Debris Geohazard Risk and Risk Control Assessment for debris flood/flow creeks by integrating into Asset Management Plan
Objective 4: Support District residents in proactively managing privately owned property to adapt to more frequent and severe extreme weather, precipitation and temperature changes and sea level rise
RA 4.1: Review and strengthen building and development policies to require consideration of climate change over the life cycle of a structure
RA 4.2: Develop and implement an education and incentive program to encourage more resilient choices for private development design, maintenance, and renewal
Objective 5: Support the long-term health of natural forest ecosystems and fire disturbance regimes
RA 5.1: Proactively manage all District owned forested areas to increase forest resilience, health, and structure and simultaneously reduce other natural hazards
Objective 6: Reduce the spread of invasive organisms
RA 6.1: Implement the Invasive Plant Management Strategy to manage, prevent, treat, and control harmful invasive plants on both public and private land
Objective 7: Restore and protect existing native biodiversity
RA 7.1: Generate area-specific guidelines to acquire sensitive areas, restore existing lands with native species, and increase connectivity between biodiversity hubs, within a Biodiversity Conservation Strategy
Objective 8: Preserve and enhance the viability of ecologically sensitive areas and critical habitat along the foreshore
RA 8.1: Create and implement a Coastal Hazard Development Permit Area to protect people, property, and foreshore ecosystems from coastal impacts
Objective 9: Reduce potable water consumption
RA 9.1: Develop and implement programs for rainwater and grey water collection and recycling
Objective 10: Provide alternative water sources for emergency response
RA 10.1: Plan for the distribution of alternative potable water supply during an emergency
Objective 11: Upgrade the District's preparedness and response to heat waves and poor air quality
RA 11.1: Create more opportunities for heat refuge areas in the District
RA 11.2: Seek opportunities for interagency coordination to minimize adverse health impacts to staff, responders, and the public during heat waves and poor air quality advisories
Objective 12: Support the implementation of adaptation actions
RA 12.1: Assign specific indicators for each adaptation action to help monitor progress
RO 12.2: Integrate Required Actions into existing plans and decision-making processes to increase likelihood of completion

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A Message from Mayor Richard Walton

On behalf of North Vancouver District Council, it is my pleasure to present our initial Climate Change Adaptation Strategy. This District-specific approach to adapting to climate change combines the latest science with regional best practices and applies these to our unique geography. As we prepare for and respond to climate change, this strategy will guide us in building resiliency throughout our organization and community.

If recent years are any indication, the impact of changing climatic patterns on our community will be varied. With prolonged, heavy rainfall and winter flooding, and with summer heat and drought, we are already experiencing the effects of a changing climate in the District. Severe weather-related events are happening more frequently, causing costly municipal response and putting our environment, property, infrastructure, health, and economy at risk. Our Climate Change Adaptation Strategy takes a proactive approach to reducing that risk and protecting the things we, as a community, value.

In addition to fulfilling commitments made in our Official Community Plan, this strategy also supports other key District programs and plans, including the Transportation Plan and the Parks and Open Spaces Strategic Plan. It provides us with the structure to coordinate our efforts at integrating climate change adaptation into our existing policies and programs. As our scientific knowledge evolves, so will our strategy, allowing us to manage future climate change challenges efficiently.

The District is a leader in taking action on environmental and public safety issues and has done a considerable amount of work to adapt to our changing climate, particularly regarding flood, landslide and wildfire risk reduction. There is, however, more to do.

As an organization, we will continue to reduce our greenhouse gas emissions and do our part to slow future climate change. We will respond to the impacts we experience today and prepare for those we expect in the years ahead. To ensure a more resilient future we must act now. This Climate Change Adaptation Strategy will help us prepare for the challenges to come.

Acknowledgments

Leadership from Mayor Walton, Council, and the Executive Management Team supported the entire planning process and greatly contributed to the success of the Climate Change Adaptation Strategy. The District of North Vancouver would like to thank everyone who was involved in the development of this strategy and recognize the following individuals for their commitment to advancing climate change adaptation in the District:

Project Managers

Fiona Dercole, Section Manager Public Safety

Julie Pavey, Section Manger Environmental Sustainability

Sinead Murphy, Adaptation Policy Planner

Climate Change Adaptation Team

Charlene Grant, General Manager Corporate Services

Dan Milburn, General Manager Planning, Properties and Permits

Dorit Mason/Mike Andrews, Director North Shore Emergency Management

Jason deRoy, Assistant Fire Chief, Professional Development and Training

Richard Boase, Environmental Protection Officer

Rozy Jivraj, Section Manager Financial Planning

Steve Ono, Deputy General Manager Engineering Services

Susan Rogers, Manager Parks

Purpose

The role of the Climate Change Adaptation Strategy is to coordinate and integrate District initiatives that support climate change adaptation and to incorporate adaptation considerations and longer-term thinking throughout all District activities. In doing so, the strategy will provide an opportunity to not only enhance the District's adaptive capacity and resiliency, but also reduce the long-term costs and impacts associated with climate change.

With progressive leadership from Mayor Walton and Council, the District has a strong tradition of taking action on environmental and public safety issues. While a considerable amount of work has already been done to help the District adapt to climate change, the knowledge gained through this adaptation planning process has elevated the importance of this work, and new actions have been proposed where the District can further strengthen its efforts.

This strategy's adaptation actions and implementation plans put the District in a position of readiness. The District is proud of its commitment to prepare the corporation and community for future climate-related challenges.

Chapter 1: Introduction

"Adaptation is both possible and cost-effective"

- National Round Table on the Environment and the Economy, 2011

With access to high-quality services, an abundance of local and regional parks, and beautiful mountain and ocean vistas, the District of North Vancouver is recognized as one of the best places to live in North America. A key component of this livability is the District's mild climate: the summers are warm, but not too hot, and the winters are invigorating without being frustratingly extreme. However, the District's climate is changing. The impacts of climate are already affecting many of the features that make this region so livable, and these impacts are expected to increase over the next 40 years.

In recent years, the District has seen extreme rainfall damage infrastructure, severe droughts degrade the environment, and landslides threaten public safety. While these individual events cannot be directly attributed to climate change, climate change has increased the frequency of these types of events and has made them more severe when they do occur. Taking proactive action to adjust to and prepare for changes is critical to protect the District's economy, environment and residents, as well as the identity and livability of the community.

Taking action on climate change requires two simultaneous approaches: **mitigation**[1] and **adaptation**. Mitigation prevents future climate change from happening through actions that reduce greenhouse gas (GHG) emissions. Adaptation manages the consequences of climate change through actions that prepare for and respond to climate-related challenges and takes advantage of potential benefits of climate change. Mitigation is often regarded as the only true solution to climate change that addresses the root cause, but adaptation is also necessary. This is because some amount of further climate change is unavoidable regardless of how much people around the world mitigate, due to GHGs already in the atmosphere. Thus, adaptation is necessary to deal with inevitable impacts as mitigation is necessary to ensure that impacts do not become too severe.

While adapting to climate change is a politically mandated direction for many levels of government, it also makes good sense from a business, environmental, and social perspective. Adapting proactively will not only help prepare the corporation and the community for ongoing challenges, but will also benefit municipal finances, improve environmental health, and provide a host of community benefits such as enriched public spaces and enhanced community well-being. The District recognizes adaptation as an opportunity to increase resiliency by reducing long-term costs through risk-based asset management, proactive environmental management and protection, and enhanced public safety systems

[1] There is a glossary at the end of this document (Appendix C) that defines key and relevant terms.

A host of plans identify adaptation as a critical response to climate change. These include international agreements (e.g., The Paris Agreement and the Sendai Framework for Action); Provincial strategies (e.g., BC's Climate Leadership Plan) and local plans (e.g.,the District's Official Community Plan and Corporate Plan). The District is also working with other municipalities in the lower mainland on adaptation initiatives through a variety of working groups such as the Fraser Basin Council's Joint Program Committee (which focuses on preparing an integrated response to sea level rise) and collaborating with the City of North Vancouver on integrated stormwater management. As such, the District has joined leading cities around the world in developing and implementing a Climate Change Adaptation Strategy to integrate efforts between departments and across all levels of government.

The goals of this Climate Change Adaptation Strategy are as follows:

1) To pragmatically build upon existing District activities that are already occurring (related and unrelated to climate) that can help prepare the corporation and community for climate challenges
2) to identify new initiatives that could be developed to further strengthen the District's adaptation efforts
3) to bring a range of staff and community members together to collaborate on a strategy that addresses the multidisciplinary challenges posed by climate change.

Climate change affects all areas of work, requiring the development of this strategy to use a collaborative, multidisciplinary approach. An interdepartmental Climate Change Adaptation Team consisting of representatives from nine different District departments guided the development of the strategy. Cross-departmental working groups identified climate change challenges and solutions, which helped to bridge any gaps between departments that would otherwise have been missed. An internationally recognized municipal planning process—ICLEI Canada's Building Adaptive and Resilient Communities (BARC) program[2]—was used to facilitate the planning process.

It is imperative that the District take action to reduce the economic, environmental, and social consequences of climate change. Without immediate climate action and adequate long-term planning, these changes will intensify and have significant (and potentially irreversible) impacts.

[2] ICLEI Canada. (2012). Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate change adaptation. Retrieved from: www.icleicanada.org/resources/item/3-changingclimate-changing-communities

The Science of Climate Change

The science to support climate change (often referred to as global warming) is unequivocal.[3] Although year-to-year weather conditions vary, temperatures have exhibit a clear and steady upward trend over the last 150 years, and precipitation patterns have also changed. Recent, human caused (aka anthropogenic) climate change has resulted in unprecedented changes to weather and climate across the world.

Human activities and the subsequent release of greenhouse gas emissions (GHGs) are the primary drivers of recent climate change. GHGs are compounds (such as carbon dioxide, water vapour, and methane) that trap heat in the atmosphere, warming the planet through a natural process called the greenhouse effect. For thousands of years, this process has maintained a favorable temperature for the proliferation of ecosystems and human civilization. However, recent human activities, such as the conversion of forests to cities and agriculture and the burning of fossil fuels for energy production, has increased concentrations of GHGs in the atmosphere. This has trapped more heat in the atmosphere, enhancing the greenhouse effect and causing climatic changes such as temperature increases, shifted precipitation patterns, intensified storms, and sea level rise.

Extreme Weather and Climate Change

The difference between weather and climate is time. Weather refers to atmospheric conditions over a short period of time (minutes to weeks). Climate is how the atmosphere behaves over relatively long periods of time (e.g., 30 years or more). Thus, climate change refers to changes in long-term weather. This includes both averages and extremes.

Extreme weather is defined as a meteorological event that is beyond the normal range of activity.[4] Windstorms, heat waves, and droughts are classified as extreme weather events. Because these events are due to a combination of different factors, including natural variability, an individual weather event cannot be solely attributed to climate change. That being said, scientists have demonstrated that climate change has led to an increase in the frequency and intensity of many of these types of events over time. Usually increase in extreme or unusual events are a greater challenge to plan for than general shifts in overall average temperatures or precipitation amounts. Extreme events are also more uncertain by nature, and harder to model.

[3] Intergovernmental Panel on Climate Change (IPCC). (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from: www.climatechange2013.org

[4] ICLEI Canada. (2012). Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate change adaptation. Retrieved from: www.icleicanada.org/resources/item/3-changingclimate-changing-communities

The Approach

Mitigation and adaptation are the two primary strategies for addressing climate change. Mitigation focuses on reducing GHGss to prevent future climate change from happening, either by reducing emissions (e.g., taking the bus) or improving earth's natural ability to sequester GHGs (e.g., planting trees). Adaptation focuses on preparing for and responding to the impacts posed by climate change, which includes taking advantage of any potential positive impacts (figure 1).

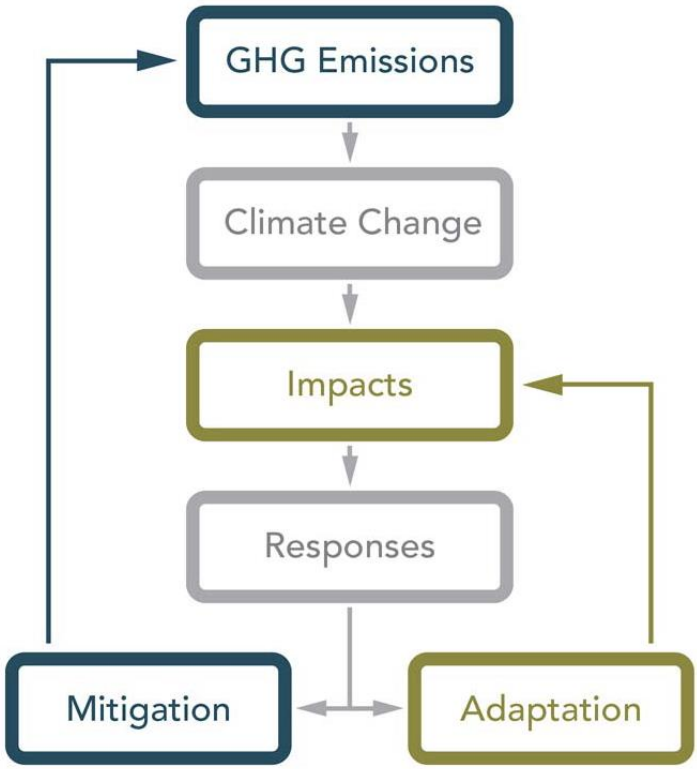


Figure 1 Mitigation actions focus on reducing greenhouse gases to prevent future climate change from happening. Simultaneously, adaptation actions focus on preparing for and responding to the impacts posed by climate change.

A key example of a mitigation approach used in the District is the integration of land use and urban form with transportation planning. Transportation emissions are a major contributor of greenhouse gases. By encouraging use of public transportation, the District can reduce these emissions locally and contribute to global efforts to slow and limit the extent of future climate change. The District has set a target, in the Official Community Plan, to reduce greenhouse gases by 33% by 2030. Other mitigation initiatives include the Green Building Strategy, renewable energy initiatives, energy retrofit projects, waste diversion, and support for low-carbon vehicles.

Climate Change Benefits?

In addition to a wide range of negative impacts, climate change also has the potential to offer benefits. Part of proactive adaptation is recognizing and taking advantage of these potential benefits.

A few potential benefits were identified during the preparation of this strategy. However, the negative impacts of climate change far outweigh and largely counteract any potential benefits that the District could capitalize on. For example, although longer growing seasons could increase urban agriculture potential, this added benefit would likely be counteracted by less favourable agricultural conditions caused by extreme weather, such as seasonally waterlogged soils or decreased water availability. As well, though longer and drier summers could increase summer tourism, winter snowpack could decrease tourism in the winter, likely outweighing summertime tourism benefits.

Consequently, potential benefits were documented but these did not inform the adaptation actions described in this strategy.

Both mitigation and adaptation approaches are needed to become resilient to climate change. On its own, adaptation will not be possible or effective enough to prepare for the global challenges posed by climate change, and mitigation alone will not be able to prevent all climate change from happening or prepare for the impacts that can no longer be avoided. Therefore, an integrated approach to mitigation and adaptation actions is required. Taken together, mitigation and adaptation will avoid the unmanageable and manage the unavoidable, while also reducing the probability of maladaptation and maximizing co-benefits (figure 2).

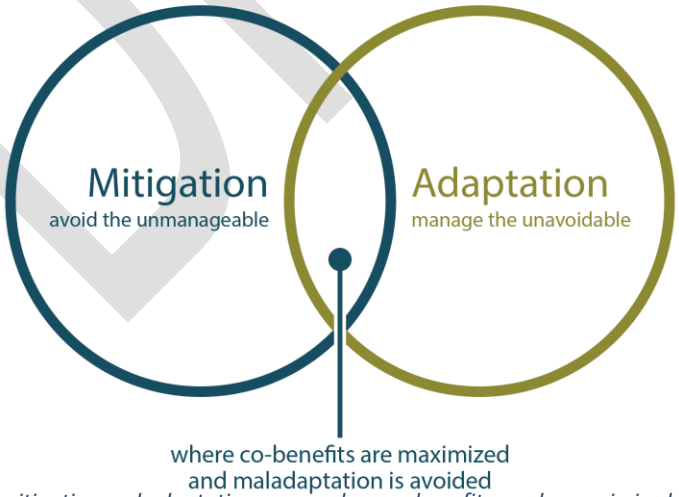


Figure 2 By integrating mitigation and adaptation approaches, co-benefits can be maximized and trade-offs minimized.

Some actions benefit both mitigation and adaptation objectives by providing co-benefits. Increasing the number of street trees, for example, helps to mitigate climate change because trees sequester carbon dioxide and can also keep buildings cool, thereby reducing energy demand for cooling. Street trees also contribute to adaptation by intercepting and filtering stormwater runoff to prevent flooding and improve water quality.

Chapter 2. Past and Future Climate Change in North Vancouver

Globally average air temperatures in the world have increased by approximately 1°C since 1900[5]. In BC's South Coast region, temperatures have increased by approximately 1.2°C over this time period, with winter temperatures (figure 4) increasing faster than summer temperatures (figure 3)[6]. Since 1900, precipitation has increased overall, but winter precipitation has decreased since 1950 (figures 6 and 5). It is important to note that precipitation is much more temporally and spatially variable than temperature (i.e., it varies greatly by location and from year to year), so it is harder to discern clear trends. Variation in both temperature and precipitation can be considerable throughout North Vancouver due to the high levels of precipitation, proximity to the Pacific Ocean and the steep elevational gradients.

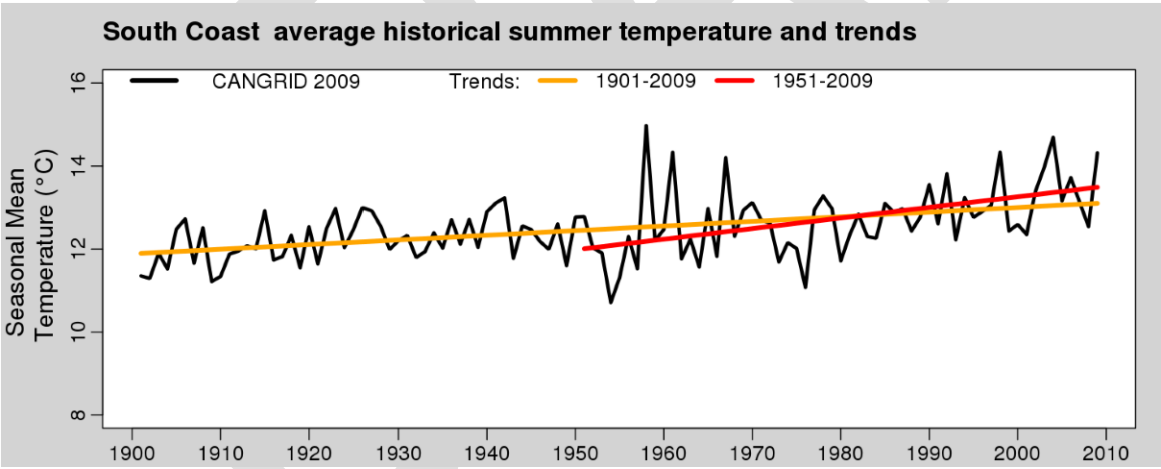


Figure 3 Historical summer temperature time series for the South Coast region of BC. Temperatures have been increasing at a more rapid rate since 1950. (Reprinted with permission from PCIC, 2013)

[5] NASA Goddard Institute for Space Studies (2017). Retrieved from: https://climate.nasa.gov/

[6] PCIC (Pacific Climate Impacts Consortium) (2013). Climate Summary for: South Coast Region. Retrieved from: https://www.pacificclimate.org/sites/default/files/publications/Climate_Summary-South_Coast.pdf

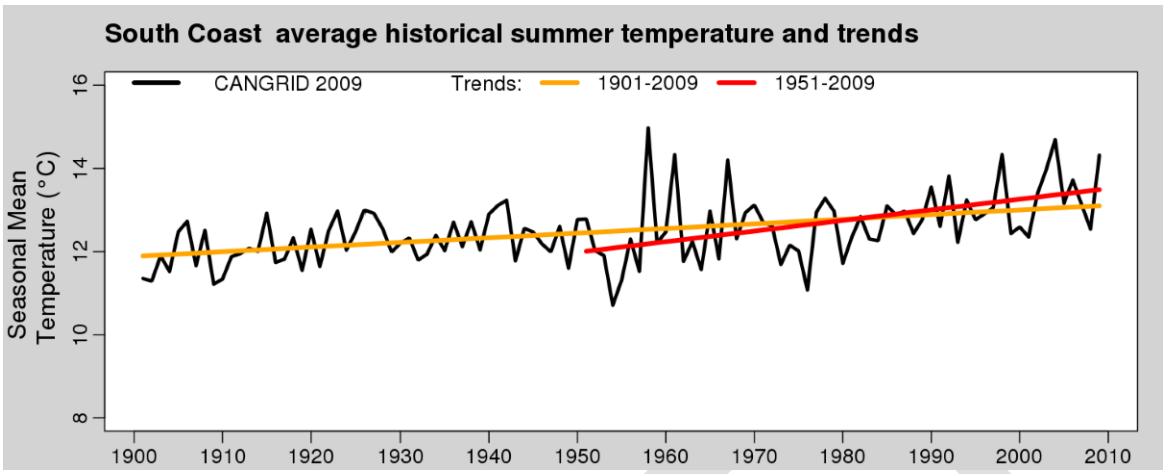


Figure 4 Historical winter temperature time series for the South Coast region of BC. Temperatures have been increasing at a more rapid rate since 1950. (Reprinted with permission from PCIC, 2013)

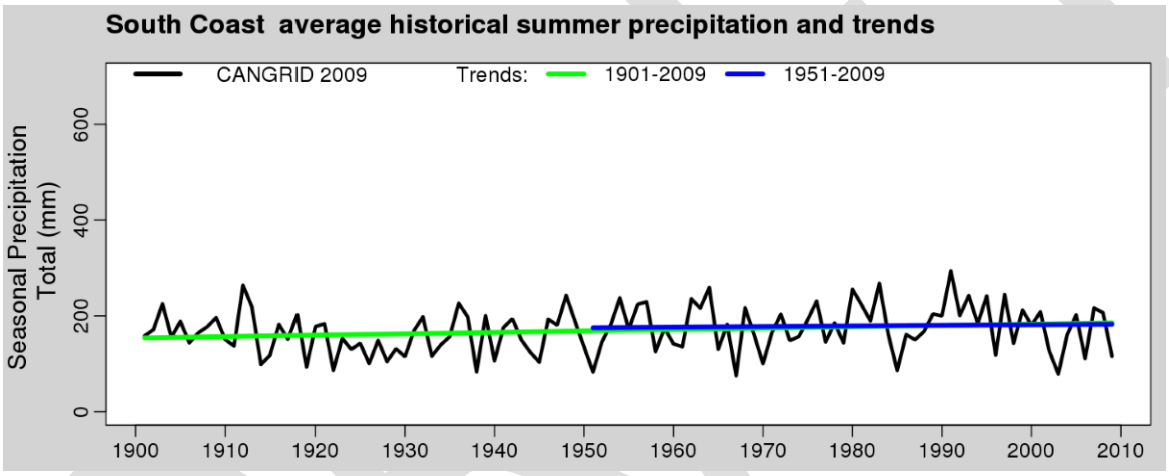
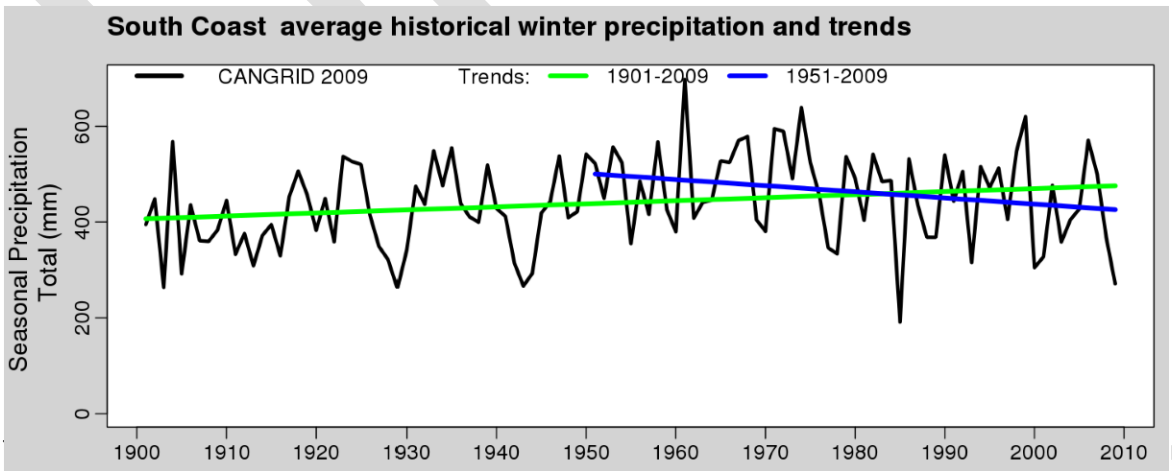


Figure 5 Historical summer precipitation time series for the South Coast region of BC. (Reprinted with permission from PCIC, 2013)



mate often

Figure 6 Historical winter precipitation time series for the South Coast region of BC. Precipitation has increased overall since 1900, but decreased from 1950-2011. (Reprinted with permission from PCIC, 2013)

much less problematic than shifts in extreme climate events. In recent years, the District has endured a large number of extreme and unusual climate-related events that have affected all District departments. These have resulted in high economic, environmental, and social costs to the community. For example, in 2014 and 2015, the District witnessed:

- Record-setting summer temperatures, including multiple heat-wave warnings. These events increased the number of heat-related health issues among District residents, and required responses from health and district professionals.
- Extreme drought condition that dropped reservoir levels to 60% capacity, requiring Level 3 water restrictions to drastically limit outdoor water use in order to conserve drinking water.
- Large regional wildfires, which resulted in air quality advisories.
- Intense rainfall events that caused flooding: in November 2014 flooding occurred as debris mobilized, creeks overflowed and damaged both private and public property
- Unusually low levels of snowfall, which reduced water reservoir levels and impacted winter recreation opportunities.

While the historical weather observations reveal recent trends for how the climate has already changed in the District, climate models provide insight into how the climate may continue to change in the future. Climate modelling for the District, completed by the Pacific Climate Impacts Consortium, was undertaken to better understand how the District's climate is projected to change in the 2050s. This information is briefly outlined below, and detailed in Appendix A: Detailed Climate Projections Summary for the District. Modelling was focused on the 2050s because these are the climatic changes that will be largely unavoidable, regardless of the extent of global mitigation efforts. An ensemble of twelve global climate models (GCMs)[7] was used to assess four types of projected changes. For this ensemble the highest emissions scenario was used, which means that it is assumed that humans continue to burn fossil fuels for the majority of their energy. The major categories (or types) of changes that were analyzed, and highlights of the results, are as follows:

5. Temperature change

- Average annual temperatures in the District are projected to increase by 1.6 to 4.2°C (with a median increase of 2.9°C) in the 2050s, relative to the 1980s baseline.
  - *A larger analysis of the larger South coast region using 30 GCMs and multiple emissions scenarios by PCICprojected that the region will increase by 1.1 to 2.5 °C (with a median increase of 1.7°C) in the 2050s.*[8]
- Temperature increases in North Vancouver are expected to be greatest in summer (+ ~3.6°C) and smallest in the winter (+ ~2.4°C).

[7] Temperature, precipitation, and indices of extremes were determined from an ensemble of 12 Global Climate Models as described at http://www.pacificclimate.org/data/statistically-downscaled-climate-scenarios (i.e., CMIP5 models following RCP 8.5 downscaled with BCCAQ)

[8] PCIC (Pacific Climate Impacts Consortium) (2013). Climate Summary for: South Coast Region. Retrieved from: https://www.pacificclimate.org/sites/default/files/publications/Climate_Summary-South_Coast.pdf

- The average number of hot summer days (above 30°C) is expected to increase from twice per year (baseline) to 13 times per year in the 2050s.
- The temperature of extreme hot days, expected to happen once every 20 years (or have a 5% chance of occurring any year), is projected to increase from 33°C to 38°C.
- Heating demand will decrease throughout the year due to warmer temperatures in the winter, but cooling demands will increase.
- There is a 68% projected decrease in the number of days with ice and a 63% decrease in the number of days with frost, which could lead to an increase in pests and invasive species.
- Agricultural opportunities may increase as a result of warmer temperatures and a longer growing season, but increases in extreme heat and decreases in soil moisture and water availability may hinder agriculture.

6. Precipitation change

- Average annual precipitation in the North Vancouver district is projected to increase by approximately 5%
    - *A larger analysis of the larger South coast region using 30 GCMs and multiple emissions scenarios projected that the region will be 2 to 11% wetter (with a median increase of 6%) in the 2050s*[9].
- The increase in precipitation is projected to fall in increasingly extreme events, with 33% more precipitation falling on very wet days (i.e. the wettest 5% of days) and 58% more precipitation falling on extremely wet days (i.e., the wettest 1% of days).
- Unusually high precipitation events are expected to increase by 19%. These are known as 1:20 year events, or events that have a 5% chance of happening each year.
- Precipitation is projected to increase in winter, summer and fall but to decrease by 18% in summer. Therefore, although overall precipitation is increasing there may be more droughts.
- The maximum length of dry spells (or consecutive dry days) per year is projected to increase from 19 to 23 days, on average.
- Snowpacks are projected to decrease by 89% by the 2050s. Rates of decline will vary from nearly 100% near sea level, to less than 30% at higher elevations (e.g., the tops of Grouse and Seymour mountains).

7. extreme weather

- Changes in extremes in precipitation and temperature are related in the above sections.

[9] PCIC (Pacific Climate Impacts Consortium) (2013). Climate Summary for: South Coast Region. Retrieved from: https://www.pacificclimate.org/sites/default/files/publications/Climate_Summary-South_Coast.pdf

- In addition to precipitation and temperature, extremes in wind were also analyzed. Projections of wind are highly uncertain, with some models indicating significant increases and others significant decreases.

8. <u>sea level rise.</u>

- Changes in sea level are difficult to predict. The BC Government's sea level rise guidelines are to plan for a 1.0m increase in sea levels for 2100 and a 2.0m increase by 2200[10].

Overall, these projected changes describe a future climate for the District that is very different from that we are used to. These climatic changes (figure 7) have the potential to threaten a wide range of District services, ecosystem health, and as a result can impact community livability and identity.

[10] Sea level rise projections were determined from Ausenco Sandwell. (2011). Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use. Report prepared for BC Ministry of Environment. Retrieved from: http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/draft_policy_rev.pdf

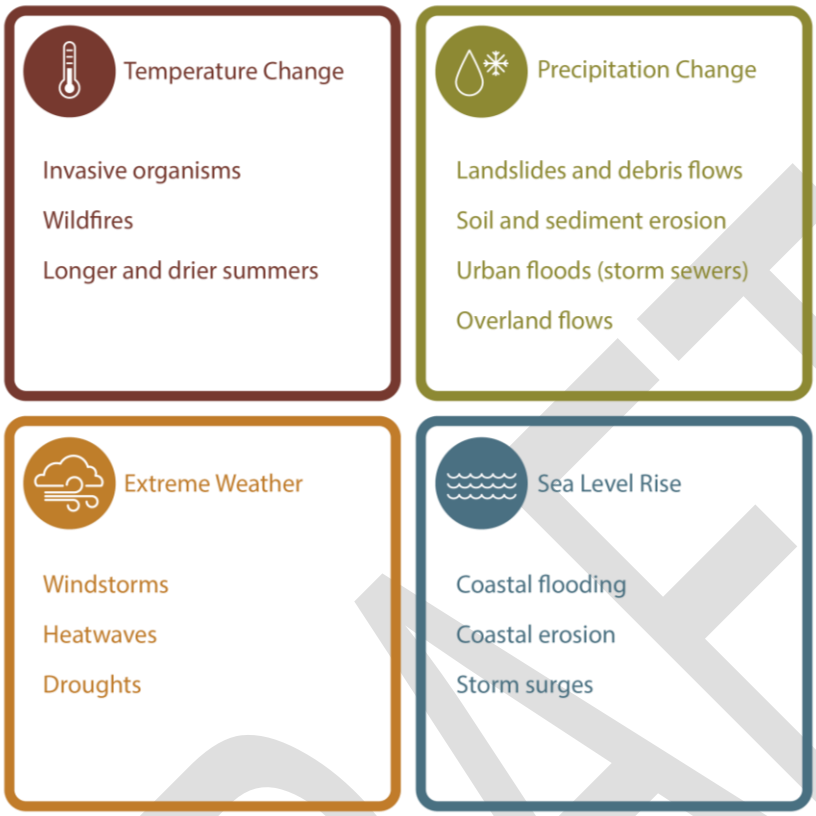


Figure 7 Common climate change impacts that can be expected as a result of four types of climatic change the District will experience.

Understanding Risk and Uncertainty

Historically, planners and engineers look at past conditions and use these to determine what standards to use when designing infrastructure and other systems. As the projections summarized above have illustrated, with climate change the past is no longer prologue for the future, and we need to be ready for conditions and events outside of the range previously experienced. Each climate model uses different parameters to model future change and these projections of change are based on different assumptions of future mitigation, or emission, scenarios (e.g., "business-as-usual" vs. greenhouse gas reductions). As a result, different climate models project different future scenarios and thus the timing and extent of change is relatively uncertain. Climate models are inherently uncertain, and, although they will improve, they are likely to continue to project a range of plausible futures. Furthermore, there are a great number of other sources of uncertainty. Future political priorities, population changes, economic growth are all difficult to predict, and will affect how the District must be planned, designed, operated and maintained.

The different types of projections outlined in this section have different levels of uncertainty associated with them. Climate models are best at projecting long term trends in average conditions over larger areas. There is more certainty in temperature projections than precipitation projections. Sea level rise projections have large associated uncertainties as they rely on temperature projections plus a number of factors related to glacier and ice sheet loss, and also location-specific factors. As an example, projections of regional average temperature change are more certain than extreme precipitation events or sea level projections.

The general public has a different definition of uncertainty than the scientific community. Typically, the majority of people define uncertainty as not knowing, while the scientific community defines it as a measure of how well something is known. The difference between the two interpretations of the word has led to significant confusion when trying to understand what is known about climate change. What is known with certainty is the cause and the direction of climate change. Therefore, while uncertainty is a challenge in adaptation planning, it is not a reason for inaction; it is a reason to prepare even more for the unknown extent and timing of changes that will be experienced. It is generally wise to prepare for a range of events and possible emissions. Therefore, it is a good idea to carefully consider the range of the projected changes, and not just assume that the median value will be what happens. This brings to light the importance of resiliency, or being able to prepare for and adjust to a range of possible futures. A resilient community can function amidst change and is therefore less vulnerable.

Chapter 3. The Opportunity to proactively adapt

Adapting to climate change is more than just preparing for unfamiliar weather and strange shifts in seasons. With deliberate and decisive planning, proactive action can achieve adaptation goals and simultaneously benefit multiple aspects of our community. Adaptation work can highlight the disproportionate climate impacts on vulnerable populations thereby elevating issues of inequality and poverty.

It is estimated that each dollar invested in adaptation now will yield from $9 to $38 of averted damages in the future, depending on factors including the extent of future climate change and rate of population growth[11]. As with many other preventative measures, investing in climate change adaptation may be costly at first, but over time it is usually the most cost-effective option. For example, building infrastructure to a higher standard will require higher upfront costs but result in lower lifetime maintenance costs, longer operational lives, and reduced

[11] National Round Table on the Environment and Economy. (2011). Paying the Price: The economic impacts of climate change for Canada. Retrieved from: https://www.fcm.ca/Documents/reports/PCP/paying_the_price_EN.pdf

emergency response and public safety costs. Other economic benefits of adaptation include increased property and land values.

Figure 4.

Beyond traditional structural infrastructure adaptation solutions, there are many planning and management options that help to reduce vulnerability to climate change. For example, when preparing for sea level rise most people immediately think of large infrastructure solutions such as a sea wall or a dyke. However, ecosystem-based adaptation approaches can focus on conservation, sustainable management, the restoration of green infrastructure (e.g., artificial wetland) and eco-assets (e.g., natural foreshore). In addition to helping people adapt to climate change, this adaptation approach may be less expensive and have many co-benefits for environmental health. For example, ecosystem-based adaptation enhances biodiversity, which boosts ecosystem productivity and the ability of ecosystems to adapt to changing climatic conditions. This type of adaptation also increases the focus and appreciation for ecosystems services, which will lead to increased effort to support natural and adaptable ecosystems. Other strategies may include reorienting development away from areas that are at risk from flooding related to future sea level rise (and thus avoiding the need for flood risk mitigation measures), designing infrastructure that can accommodate flooding, or even relocating existing infrastructure (or even neighbourhoods) to other less vulnerable areas over time.

Adaptation in Context

Adapting to climate change has been recognized at all geographic scales, by all levels of government, as a necessary part of proactively responding to the threat of climate change.

International and Canadian Context

In 2015, along with 186 other countries, Canada endorsed the United Nations Sendai Framework for Disaster Risk Reduction (2015–2030) to reduce mortality, economic losses, and other impacts caused by natural disasters. The Framework states that, "addressing climate change as one of the drivers of disaster risk … represents an opportunity to reduce disaster risk in a meaningful and coherent manner…" [12]

The Agenda for Sustainable Development,[13] which includes a requirement for signatories to "take urgent action to combat climate change and its impacts," was agreed to by 193 countries, including Canada, in 2015.

The 2015 Paris Agreement further advanced climate change adaptation as a global priority. While the Agreement's main goal was to limit global temperature rise to below 2°C, it also set out provisions for adaptation. The Agreement, "establishes a global goal of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal."

Provincial Context

British Columbia's 2010 Adaptation Strategy, Preparing for Climate Change,[14] sets out three strategies to "guide actions to help BC adapt to climate change." The first strategy is to "build a strong foundation of knowledge," the second is to "make adaptation part of government's business," and the third is to "assess the risks and implement priority adaptation actions in sectors."

BC's 2016 Climate Leadership Plan[15] identifies key areas where the Province can take climate action. Though the majority of the 21 actions in the plan are aimed at reducing greenhouse gases to mitigate climate change, the Province is committed to "mandating the creation of 10-

[12] United Nations Office for Disaster Risk Reduction. (2015). Sendai Framework for Disaster Risk Reduction 2015-2030. Retrieved from: http://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

[13] United Nations. (2015). Transforming our world: the 2030 Agenda for Sustainable Development. Retrieved from: https://sustainabledevelopment.un.org/post2015/transformingourworld/publication

[14] British Columbia Ministry of Environment. (2010). Preparing for Climate Change: British Columbia's Adaptation Strategy. Retrieved from: http://www2.gov.bc.ca/assets/gov/environment/climate-change/policy-legislation-and-responses/adaptation/adaptation_strategy.pdf

[15] Province of British Columbia. (2016). The Climate Leadership Plan. Retrieved from: www.gov.bc.ca/ClimateLeadership

year emissions reduction and adaptation plans for provincial public sector operations" to continue to support climate action leadership in the public sector.

Regional Context

Metro Vancouver's Regional Growth Strategy[16] was adopted in 2011 and establishes five goals to "provide the basis for defining matters of regional significance…and guide the future growth of the region." Goal number three is to "protect the region's environment and respond to climate change impacts," with the 2040 vision that "Metro Vancouver and member municipalities meet their greenhouse gas emission targets, and prepare for, and mitigate risks from, climate change and natural hazards."

The District is an active member of the Fraser Basin Council's Joint Program Committee – working together with other municipalities and the province of BC to assess hazards, risk and vulnerabilities then develop a mitigation plan for both coastal flooding due to sea level rise and riverine flooding from the Fraser River.

Adaptation in the District

The concept of adaptation is not new to the District of North Vancouver. The District has already been working on many initiatives that support climate change adaptation. This work is ongoing and includes, but is not limited to:

- Risk assessments for natural hazards (e.g., landslides and debris flows, wildfires, earthquakes, and floods)
- Hazard-specific management plans and implementation strategies (e.g., the Maplewood Flood Risk Management Strategy and the Community Wildfire Protection Plan)
- Hazard and environmental Development Permit Areas to ensure new development and major renovations consider hazards and environmental protection
- Long-term (40 to 50 years) asset management framework
- Geotech-on-Demand program that provides one-on-one qualified professional consulting advice to property owners concerned about slope or creek hazards on their property
- Progressive development standards for buildings, infrastructure, and utilities (e.g., flood construction levels to enhance flood protection and new Intensity Duration Frequency curves based on climate change projections)
- Emergency response and recovery training for staff

[16] Metro Vancouver. (2011). Regional Growth Strategy: Metro Vancouver 2040 Shaping Our Future. Retrieved from: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/RGSAdoptedbyGVRDBoard.pdf

The District's 2011 Official Community Plan (OCP)[17] places significant value on the environment. OCP was developed as an Integrated Community Sustainability Plan, and it incorporates the environment it in its long-term vision: "Inspired by nature, enriched by people." Section 10.4 in the OCP identifies the need to, "adapt proactively to climate change…which means integrating a climate change perspective into our infrastructure design and maintenance, ecosystem management and emergency preparedness." Several other sections within the OCP indirectly reference the consideration of climate change impacts. For example, Section 9.4 of the OCP aims to, "reduce and mitigate the risk associated with natural hazards," and Schedule B guides the implementation of Development Permit Areas to protect development projects from natural hazards such as wildfire, slope, and creek hazards as well as ensure the protection of natural environment and streamside areas.

The District's 2015-2018 Corporate Plan[18] identifies eleven strategic priorities to, "move the District closer to the shared vision of the community expressed in the Official Community Plan, and to fulfill the District organization's mission for service and leadership." Priority 10 includes a commitment to take action on climate change, with the goal of preparing, "for the effects of climate change by reducing greenhouse gas emissions and developing and implementing a Climate Change Adaptation Strategy."

In 2011 the District received the United Nations Sasakawa Award for Excellence in Disaster Risk Reduction. The District is also recognized as a "Role Model City" as part of the United Nations Resilient Cities Campaign; nearly 3,500 cities have joined the campaign.[19] This recognizes the District as a Canadian leader in disaster risk reduction, having made the commitment to continue to analyze and reduce local disaster risk and to inspire and support other cities to increase their own efforts in implementing disaster risk reduction measures.

Proactive adaptation, as set out in this strategy, will help to fulfill the District's commitments and help further its role as a leader in the disaster risk reduction and climate change adaptation fields.

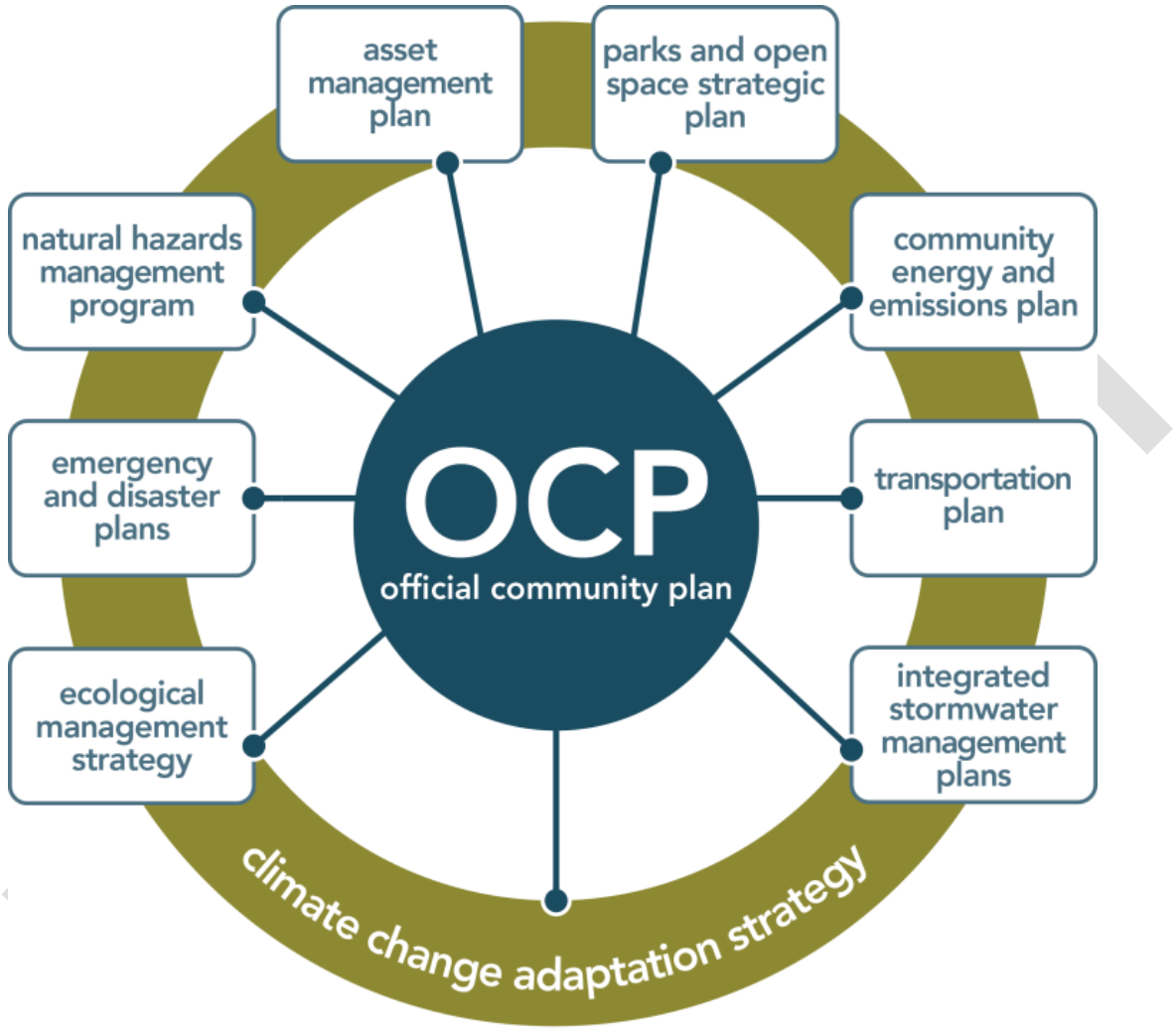
The role of the Climate Change Adaptation Strategy is to coordinate and integrate District initiatives and to incorporate adaptation considerations and longer-term thinking throughout all District activities (figure 8). In doing so, this strategy will provide an opportunity to enhance the District's adaptive capacity and resiliency, and reduce the long-term costs and impacts associated with climate change.

[17] The District of North Vancouver. (2011). Our Official Community Plan for a Sustainable Future. Retrieved from: https://www.dnv.org/sites/default/files/edocs/complete-official-community-plan.pdf

[18] The District of North Vancouver. (2016). 2015-2018 Corporate Plan. Retrieved from: https://www.dnv.org/sites/default/files/edocs/Corporate-plan-2015-2018.pdf

[19] United Nations Office for Disaster Risk Reduction. (2011). Local Government Profile: North Vancouver – Canada. Retrieved from: - http://www.unisdr.org/campaign/resilientcities/home/cityprofile/City%20Profile%20Of%20North%20Vancouver/?id=2237

Figure 8 The Climate Change Adaptation Strategy will inform and support other programs and plans to incorporate adaptation considerations and longer-term thinking throughout all District activities.



Chapter 3: The Planning Process

The District of North Vancouver joined ICLEI's Building Adaptive and Resilient Communities (BARC) program in January 2015 to develop the District's first Climate Change Adaptation Strategy. This followed approval by District Council in November 2013. [20]

[20] Report to Committee Edoc No. 2221578

The BARC program is an internationally recognized planning process that guides municipalities through developing, implementing, and monitoring a Climate Change Adaptation Strategy to proactively prepare for local climate-related challenges. The program provides a structured, five-milestone approach to adaptation planning where each milestone builds off the findings of the previous one (Figure 9). The five milestones of the program are outlined in ICLEI's *Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate change adaptation.*[21]

The BARC program is considered a best practice and has been widely adopted by government organizations in the Lower Mainland and across Canada. Throughout the planning process, the District took every opportunity to tailor each milestone of the BARC program to capture the District's unique situation and priorities.

[21] ICLEI. (2010). Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate change adaptation. Retrieved from: http://www.icleicanada.org/resources/item/3-changing-climate-changing-communities

Figure 9 The tailored planning process used to develop the Climate Change Adaptation Strategy.

Milestone 1: Initiate

The first milestone of the BARC program involved building a cross-departmental Climate Change Adaptation Team, identifying key stakeholders, and conducting in-depth interviews with General Managers from across the organization and other local and regional governments engaged in adaptation planning. Milestone 1 was completed in June 2015.

Milestone 2: Research

The second milestone included researching the best available climate science (see section X and Appendix A))., identifying climate change impacts specific to the District, and completing comprehensive vulnerability and risk assessments to identify climate impact priorities for action planning. Milestone 2 was accomplished primarily through workshops with the Climate Adaptation Team and other senior staff, and was completed in September 2015.

Milestone 3: Plan

The third milestone included creating an adaptation vision and guiding principles and action objectives; identifying adaptation actions to address the priority climate change impacts; prioritizing adaptation actions based on a multi-criteria analysis; forming a list of potential indicators to monitor progress; and drafting implementation plans to carry out each required action.

Milestones 4: Implement

The fourth ongoing milestone is the implementation of the adaptation actions. This will be completed by the relevant District departments, and will also include input from experts and the public at appropriate times. Further collaborative work will be necessary to determine the best approaches to achieve each action objective, and implementation plans will be continually evaluated and revised accordingly (see milestone 5).

Milestones 5: Monitor / Review

The fifth milestone involves using indicators for each priority action to monitor and review implementation progress over time. Baseline data will be regularly collected and analyzed for trends to gauge the effectiveness of adaptation actions and to better understand drivers and barriers to implementation. Climate science and opportunities for adaptation will advance over time. This strategy will be evaluated and reviewed annually, and updated once every five years by the Climate Change Adaptation Team to consider advances in climate science, engineering, and community priorities.

Chapter 4: Taking Action

The following vision and guiding principles helped to direct the development of this Climate Change Adaptation Strategy to meet the challenges of climate change in the District. These were determined by the Climate Change Adaptation Team as part of Milestone 3 of the planning process.

Vision

We are proactive and resilient, adapting to a changing climate while balancing social, economic, and environmental priorities.

Guiding Principles

To achieve this vision, the strategy was guided by the following principles:

- Demonstrate proactive climate leadership
- Actively engage through meaningful collaboration and partnerships
- Foster shared responsibility for climate action
- Commit to ongoing learning and training to support forward thinking
- Consider current climate science, ways of knowing, and best management practices in all decision making
- Use a risk-based approach to manage uncertainty associated with climate change
- Integrate adaptation considerations throughout all District activities

From Climate Impacts to Actions

This strategy focuses on four broad categories of climate change. These were outlined in section 2, and relate to:

1. temperature change
2. precipitation change
3. extreme weather (temperature/precipitation/wind)
4. sea level rise

Understanding each of these types of change and associated uncertainties, cross-departmental working groups considered how these climatic changes will specifically impact the District's infrastructure, environment, staff, residents and responders. Climate impacts were prioritized and actions set under each of these categories.

Climate impacts were prioritized based on the results of a comprehensive risk assessment. The risk posed by each climate change impact was assessed by determining the likelihood of the initiating climatic event (e.g., drought) and the likelihood of an impact caused by the occurrence of the climatic event (e.g., reduced potable water) as well as the extent of potential consequences across five general dimensions: public health and safety, local economy and growth, community and lifestyle, environment and sustainability, and public administration and governance. High-risk climate change impacts were those that had a high combined likelihood

score and high total consequence score and were thus used to focus the District's efforts during action planning.

Table X, below provides a summary of the major impacts expected in the District of North Vancouver. For each impact, the underlying type of change and the effect of that change are also outlined. In the final column action objectives are provided. Action objectives were created to describe the intent of the District regarding how each priority climate impact should be addressed. These action objectives then guided the development of adaptation actions.

Underlying mechanism for change	Effect of change	Priority Climate Impact	Action Objective
extreme weather: temperature, precipitation and wind	More staff responding to and recovering from more frequent and severe (and at times simultaneous) extreme weather events	Delayed delivery of important municipal services	1. Strengthen the District's capacity to respond to and recover from extreme weather events, and provide continuity of essential municipal services
extreme weather: wind	Damaged and/or downed power lines and hydro poles due to more frequent and severe windstorms	More power outages	2. Ensure critical municipal functions are served by robust power systems and alternatives are provided where systems are vulnerable
Precipitation change Temperature change	More frequent events related to dry conditions ((e.g., fires, droughts)	Increased damage to public, private, and recreational property	3. Increase the resiliency of municipal assets to more frequent and severe extreme weather and sea level rise 4. Support District residents in proactively managing privately owned property to adapt to more frequent and severe extreme weather and sea level rise
extreme weather: precipitation Sea level rise Precipitation change	More frequent and severe wet events (e.g., urban/overland/coastal floods, landslides, debris flows, and erosion)		
extreme weather: temperature and wind Temperature change	More frequent and severe dry events (e.g., fires, windstorms)	Increased damage to infrastructure, such as buildings, park facilities, water/sewer systems	
extreme weather: precipitation Changing precipitation	More frequent and severe wet events (e.g., urban/overland/coastal floods, landslides and debris flows, and erosion)		
Temperature change extreme weather: temperature	More frequent and severe wildfires due to warmer, drier weather	Loss of forest ecosystems and tree canopy and subsequent increased risk of landslide and debris flow	5. Support the long-term health of natural forest ecosystems and fire disturbance regimes
Temperature change	Spread of invasive organisms due to warmer, drier weather	Reduced native biodiversity, natural ecosystems less productive or resilient	6. Reduce the spread of invasive organisms 7. Restore and protect existing native biodiversity
Sea level rise	Increased coastal floods, erosion, saltwater intrusion, and storm surges	Decreased quantity and quality of foreshore ecosystems	8. Preserve and enhance the viability of ecologically sensitive areas and critical habitat along the foreshore
Sea level rise	Damage to infrastructure related to rising levels	?	?
Temperature change	More frequent and severe droughts due to reduced	Reduced quantity and	9. Reduce potable water consumption

Precipitation change	summer rain and winter snowpack	quality of potable water	10. Provide alternative water sources for emergency response
Temperature change	More frequent and severe heat waves and wildfires due to warmer, drier weather	More heat-related and air quality-related health issues	11. Upgrade the District's preparedness and response to heat waves and poor air quality
All	NA	NA	12. Support the implementation of adaptation actions

There changes outlined above may impact the District of North Vancouver in many other ways. These include impacts related to:

- Tourism and recreation
- Agriculture and food security
- General health and wellness of people
- Economic development (which relates to most of the impacts noted above)

Other action items could include:

- Performing river flow and flood risk assessments to better understand future flooding with climate change
- Detailed regional SLR mapping
- Complementing the District adaptation strategy with public engagement and input
- Determining vulnerable areas and orienting future development away from these locations
- Updating IDF curves to assist in infrastructure design and management
    - Updating appropriate bylways to incorporate climate considerations
- Detailed water budget analysis – and possibly planning for water storage facilities or water management initiatives

Adaptation Actions

Adaptation actions were then categorized into three different types based on a multi-criteria analysis that evaluated the robustness, ancillary benefits, and available funding sources for each action.

- **Required action** = high benefit-to-cost ratio and most resources for implementation are available. These should be implemented as soon as possible
- **Opportunistic action** = medium benefit-to-cost ratio and resources for implementation are likely available. These should be should be implemented when the opportunity arises or the urgency of the climate impact increases
- **Possible action** = unknown benefit-to-cost ratio and resources to support implementation have not been identified. These

The action objectives and associated adaptation actions are summarized below. They are organized by District service area.

Municipal Services

The District's ability to maintain current day-to-day operations and services is being affected by climate change. Extreme weather events cause staff priorities to be redirected to emergency response and recovery, and other municipal services are delayed as a result.

The following actions focus the District's efforts on continuing to provide high-quality municipal services and demonstrating fiscal accountability while preparing and responding to climate change impacts.

Action Objective 1: Strengthen the District's capacity to respond to and recover from extreme weather events and provide continuity of essential municipal services

Required Action 1.1 (completion target: ongoing)

- Complete business continuity plans to ensure priority service delivery

A business continuity plan for each department is needed to determine how critical each service is. This information should then inform response plans to ensure delivery of priority services. Creating these plans could include the development of simple business impact analysis tools to aid in the development of a protocol for operations continuity.

To ensure priority service delivery, the District could also improve its understanding about the capacity of local responders who live on the North Shore and develop a formal strategy to fill responder positions during an emergency. In addition, the District could facilitate more cross-training between departments (e.g., CUPE and Fire) so that resources can be shifted to any critical functions that may be overwhelmed during an emergency.

Required Action 1.2 (completion target: 2018)

☐ Develop and/or purchase additional technology tools to assist in situational awareness and emergency response communication

The District relies on a number of resources to assist in situational awareness and emergency response communication during and after an emergency. For example, the District uses a supervisory control and data acquisition (SCADA) system for remote monitoring and control of pump stations, tracks municipal vehicle movement via GPS, and has access to the Rapid Notify emergency notification system to communicate efficiently with residents and businesses.

Additional technology tools may be needed to strengthen the District's capacity to respond to and recover from extreme weather events. Further research and option analysis is needed before making investments in technology tools, but the following are some potential options:

- purchase a computerized maintenance management system (CMMS) to report service requests
- contract drone operators to assist in rapid damage assessment
- complete the refinement of the damage assessment program
- develop a tri-municipal operating system or system of systems (geospatial and document sharing platform) to provide situational awareness across all three municipalities on the North Shore, thereby improving efficiency when the Emergency Operations Centre is activated

Required Action 1.3 (completion target: 2017)

☐ Provide targeted training for clerks to ensure emergency service requests and concerns are responded to in a timely manner

Clerks are often the first line of communication with the public. Providing targeted training for clerks on how to respond to public concerns during an emergency will ensure emergency service requests and concerns are responded to in a timely manner**.**

Opportunistic Actions

☐ Update inter-municipal response agreements to enhance resource sharing with City of North Vancouver and District of West Vancouver

☐ Consider additional standing agreements with local service providers to increase availability of equipment for response activities

☐ Include clearly defined emergency response roles in job descriptions and provide associated training programs

- Generate hazard-specific response strategies (for initial response, sustained response and recovery phases) to enhance coordination and expedite response
- Engage in public awareness and education to encourage residents to be prepared for emergency situations

Possible Actions

- Develop an overtime protocol to identify emergency response positions in the union that qualify for overtime and under what situations such costs are recoverable
- Evolve the volunteer program to include volunteers from affiliated municipalities
- Plan for convergent volunteer management for people who want to help but have not previously been trained or screened
- Participate in (or initiate) regional response protocols and/or integrated systems that allow local governments in the lower mainland region to efficiently and effectively share and allocate resources in the event of emergencies

Action Objective 2: Ensure critical municipal functions are served by robust power systems and alternatives are provided where systems are vulnerable

Required Action 2.1 (completion target: ongoing)

- Identify critical functions that are vulnerable to power outages and further develop priority response and power restoration protocols

Energy needs for critical infrastructure and functions that are vulnerable to power outages must be identified and analyzed for interdependencies, co-location, and consequence of loss. Critical road intersections, sewage lift stations, water pump stations, the public works operations center, vulnerable population facilities (such as long-term care facilities, seniors' facilities, daycares), telephones, building and data security, and critical equipment are types of assets that could be vulnerable to power outages.

Once critical infrastructure and functions have been identified, priority response and power restoration protocols must be developed. These protocols could include regularly inspecting and maintaining emergency power sources and updating the priority power restoration list provided to BC Hydro to ensure that critical infrastructure is the top priority.

Required Action 2.2 (completion target: ongoing)

- Invest in backup power equipment for critical functions and develop a fueling strategy

Alternatives for power generation must be provided for vulnerable systems. Systems in municipal buildings that are currently served by backup generators must be analyzed and reprioritized.

Opportunistic actions

- All power generator sets need to include a long-term fueling strategy.

Possible actions

- To contribute to climate mitigation efforts, the District could consider purchasing alternatively fueled (e.g., solar and natural gas) power generator sets.

Infrastructure and Systems

The District is responsible for providing and maintaining approximately $2B worth of community infrastructure and systems (including transportation, sanitary, drainage, and water systems). These assets have long operational lifetimes and will be vulnerable to changing climatic conditions; some are already vulnerable due to changes that have already occurred over the past 50 years. Much of the District's municipal infrastructure was constructed in the 1950s and 1960s and was designed to the standard of the day. Previous renewal and replacement programs were based on the condition of the asset; current programs now consider future demand and capacity.

Changing weather conditions and sea level rise are damaging grey infrastructure (e.g., buildings and park facilities), green infrastructure (e.g., green roofs and rain gardens), and eco-assets (e.g., forests and foreshore ecosystems).

The following actions focus the District's efforts on reducing the direct-damage losses to public and private assets caused by climate change.

Action Objective 3: Increase the resiliency of municipal assets to extreme weather events, changes in precipitation and temperature, and sea level rise

Required Action 3.1 (completion target: ongoing)

- Complete the Integrated Stormwater Management Plan and implement recommendations to maintain watershed health and reduce the impacts of extreme runoff

Stormwater has been managed by directing it to storm sewers and then into streams, creeks, and rivers. However, as the climate continues to change, the volume of stormwater is increasing. This can lead to increased erosion of stream, creek, and river banks, downstream flooding, ecological damage and habitat loss, and decreased water quality. The District is currently developing an Integrated Stormwater Management Plan for each of the watersheds within the District to guide stormwater management, with the goal of balancing land use and development planning with environmental concerns. For shared watersheds that cross municipal boundaries the District is collaborating with the City of North Vancouver. Once these plans are complete, the District should implement recommendations and monitor and review each plan on an ongoing basis to maintain watershed health and reduce the impacts of extreme runoff.

Required Action 3.2 (completion target: 2017)

- Update the Community Wildfire Protection Plan and implement recommendations to strengthen capacity to avoid and respond to wildland urban interface fires

In 2007, the Community Wildfire Protection Plan assessed and made recommendations to reduce wildfire risk in the District. As part of a coordinated effort to reduce wildfire risk, the District implemented most of the recommendations in the plan, including those regarding fuel treatments, development planning, public education, and wildfire suppression response.

Remaining recommendations should be implemented and the plan must be updated to account for an altered forest structure resulting from climate change. Additionally, the plan requires the assessment and maintenance of areas that have been treated, identification of secondary areas that would benefit from treatment, and leveraging learning opportunities from others who have implemented wildfire risk reduction strategies. Once the plan is updated, the administrative and reporting requirements within the Wildfire Hazard Development Permit Area should be amended.

Required Action 3.3 (completion target: 2018/ongoing)

- Identify eco-assets, conduct risk assessment under climate change conditions, and include these in the Asset Management Plan

The District has many eco-assets (e.g., foreshore and wetlands) that reduce the need for grey infrastructure (e.g., sea walls and stormwater drainage systems) and that may cost less to operate and maintain over the long term. The natural environment is also of prime importance to livability, and the District has begun to invest in the protection and enhancement of these eco-assets by integrating them into the same asset management program as grey infrastructure. Work is needed to identify all eco-assets within the District, conduct a risk assessment under climate change conditions to better understand how eco-assets increase resiliency to climate change (and will be impacted by) climate change, and further integrate into the District's Asset Management Plan.

Required Action 3.4 (completion target: Ongoing)

- Implement recommendations in the Debris Geohazard Risk and Risk Control Assessment[22] for debris flood/flow creeks by integrating them into the Asset Management Plan

The Debris Geohazard Risk and Risk Control Assessment (2017) provided an assessment of debris geohazard risk and conceptual risk control options for creeks within the District. The study included 35 creeks prone to debris-related hazards. The majority of the study focused on the urban creeks drained by the District's stormwater management network, to support risk reduction planning for these areas. The risk control assessment summarized options to reduce economic and safety risks to tolerable levels and provided guidance in selecting options to provide the greatest reduction of risk for the lowest life cycle cost. The assessment included risk-control design considerations applicable to all creeks and general guidance for sediment management and the design of culvert inlet debris barriers and trash racks. The next steps are to determine which of the study's recommendations should be implemented, inform and educate identified property owners about debris flood risks and options for risk reduction, and integrate recommendations into the District's Asset Management Plan.

Opportunistic Actions

- Develop and implement an Urban Forest Management Plan that focuses on growing resilient trees (and/or possibly trees better suited for a warmer climate) in urban areas
- Improve the current Inflow and Infiltration program to reduce inflow and infiltration of stormwater into the sanitary sewer system in order to reduce the risk of sewer overflows

[22] Could be good to cite this here

- Increase the permeability of lands wherever possible, by minimizing asphalt and concrete, conserving land, and potentially considering permeable paving materials.
- Consider climate change in the design of municipal infrastructure (e.g., consider passive house principles, building envelope continuity, and green roofs)
- Invest in additional fire suppression equipment, training, and North Shore collaborations to strengthen the capacity to respond to wildland urban interface fires

Possible Actions

- Review the Development Servicing Bylaw and street plant policy to require on-site and off-site landscaping to be resilient to both drought and floods
- Develop and implement a long-term coastal flooding risk management strategy and consider the Green Shores approach to sustainable shoreline development

Action Objective 4: Support District residents in proactively managing privately owned property to adapt to temperature and precipitation changes, more frequent and severe extreme weather, and sea level rise

Required Action 4.1 (completion target: 2018)

- Review and strengthen building and development policies to require the consideration of climate change over the life cycle of a structure

Development projects built today must be able to withstand the climatic changes that it will experience over its entire life cycle. Currently, the District has a number of building and development policies, bylaws, guidelines, and regulations that guide development in the District. These should be reviewed and strengthened to require private projects to consider future climate change over the structure's life cycle. Additional research and analysis is needed to determine the best course of action, but the following are a few examples of building and development policies that could be amended:

- the Creek Hazard Development Permit Area could be updated to require appropriate drainage to accommodate future changes in precipitation
- the Development Servicing Bylaw could include alternative water storage systems

- a comprehensive set of residential guidelines for foreshore development could be created that would emphasize green infrastructure methods and adapt development to sea level rise
- the District could encourage or require passive power sources in private homes and new development to further mitigate climate change by reducing energy use and greenhouse gas emissions
- A 'climate impacts checklist' (or similar assessment) could be required for new developments in order to identify current and potential vulnerabilities, and also proactive adaptation measures

Required Action 4.2 (completion target: 2020)

- Develop and implement an education and incentive program to encourage more resilient choices for the design, maintenance, and renewal of private development

The District has a limited number of educational and incentive initiatives to encourage more resilient choices for the design, maintenance, and renewal of private development. The District's Green Building Strategy includes an incentive program, which permits increases in the maximum floor space for single-family residential buildings when these meet the required building and energy performance baselines. The Geotech-on-Demand program provides one-on-one qualified professional consulting advice to property owners concerned about slope or creek hazards on their property.

Additional education and incentive programs are needed to encourage the public, developers, and architects to make more resilient development choices. For example,

- education programs could be developed to educate contractors, landscapers, and strata corporations about FireSmart siding, roofing and landscaping choices to reduce the risk of fire damage
- incentive programs could be created to encourage homeowners to use green infrastructure, maintain perimeter drainage and upgrade older homes, or receive wildfire risk assessments
- a process to administer incentives (e.g., waived permit fees, fast-tracked applications, and a rebate program) for property owners, developers, and architects who are making more resilient choices could be developed
- additional research into incentives provided by other local governments could be completed

Possible actions

- Densify development in resilient areas and reduce development in more vulnerable areas, or greenfield areas (which will require ongoing resources for proactive adaptation and emergency response)

Parks and Environment

The District possesses a variety of invaluable and irreplaceable ecosystems (eco-assets), from saltwater marshes to alpine meadows, many of which are expected to be significantly altered by climate change.

The health of forested ecosystems is being disturbed by wildfire and insect outbreaks due to warmer and drier weather. More intense precipitation and wind storms are causing higher soil saturations that contribute to tree blowdowns, particularly those trees with shallow roots. Foreshore habitat is being affected by coastal flooding, erosion, and saltwater intrusion due to sea level rise and more frequent and intense storm surges. Over time a phenomenon called “coastal squeeze” is likely to occur, where intertidal ecosystems are lost because sea level rise has left little room between the ocean and coastal development for these ecosystems to adapt by migrating inland.

As temperature and precipitation regimes shift, critical habitats are no longer able to thrive and species are subsequently lost when their habitats are degraded. Many species are unable to adapt fast enough to changing conditions while more robust invasive organisms gain a foothold in the ecosystem and out-compete or exclude native organisms. Additionally, changing climatic conditions are limiting the function and availability of ecosystem services such as water purification, flood mitigation, soil regeneration, and recreational opportunities.

The following actions focus the District’s efforts on building ecological resilience to climate change by supporting natural and adaptable ecosystems.

Action Objective 5: Support the long-term health of natural forest ecosystems and fire disturbance regimes

Required Action 5.1 (completion target: 2018)

- Proactively manage all District-owned forested areas to increase forest resilience, health, and structure, and reduce other natural hazards

The District is reducing the potential for fire to spread rapidly by removing excessive ladder fuels (small trees and brush that can help a fire spread from the ground to the tree canopy) and accumulations of organic materials that build up on the forest floor. The work

is designed to be sensitive to streamside and forested ecosystems. Riparian and wetland areas are flagged before work starts and monitored to limit disturbances as much as possible. After work is completed, a mixture of native deciduous shrubs and smaller trees suitable for site conditions are replanted to help restore the natural biodiversity of the area and replace the non-native ladder fuels that currently elevate wildfire risks. Additional proactive work is required on all District-owned forested sites, including areas beyond the wildfire urban interface, to increase forest resilience, health, and structure, and simultaneously reduce other natural hazards (e.g., the increased risk of landslides following the wildfire season).

Opportunistic Actions

- Strengthen communication and education with the public about the economic, ecological, and social benefits of proactive management of the District's forested areas
- Partner with regional First Nations to explore approaches for understanding and managing forested areas

Possible Actions

- Invest in professional post-treatment monitoring of proactively managed forested areas to assess effectiveness of management approaches

Action Objective 6: Reduce the spread of invasive organisms

Required Action 6.1 (completion target: 2025)

- Implement the Invasive Plant Management Strategy to manage harmful invasive plants on public and private land

The District has been actively managing invasive plants on public land since 1998, and in 2015 developed an Invasive Plant Management Strategy to manage harmful invasive plants on both public and private land. The strategy provides a framework and policy for strategic management of invasive plants in the District to meet the goals of awareness, prevention, detection, treatment, and restoration. Furthermore the strategy provides a prioritized sequence of actions to accomplish its goals and objectives.

Opportunistic Actions

- Create new and align existing policies to support the Invasive Plant Management Strategy (e.g., update the Pesticide Use Control Bylaw to clearly include invasive organisms and standardize the bylaw application form; create a new policy on reporting requirements for priority-listed invasive organisms)

- Develop and implement additional management strategies for invasive organisms not identified in the Invasive Plant Management Strategy (e.g., European cordgrass, European fire ants, and American bullfrogs)

Possible Actions

- Update the invasive species inventory and treatment area mapping in GIS annually
- Integrate response and enforcement options on all lands into GIS

Action Objective 7: Restore and protect existing native biodiversity

Required Action 7.1 (completion target: 2020)

- Within a Biodiversity Conservation Strategy, generate area-specific guidelines to acquire sensitive areas, restore existing lands with native species, and increase connectivity between biodiversity hubs

The District is implementing existing initiatives aimed at restoring and protecting native biodiversity. For example, the District implements a wide range of native species replanting projects to restore native biodiversity, requires that the Natural Environment and Streamside Protection Development Permit Areas support native species growth, and provides fencing and signage for native species protection. Additionally, Action 32 in the Invasive Plant Management Strategy calls for the development of a restoration protocol to ensure native species recover in treatment areas before invasive plants can recolonize.

A number of areas in the District will benefit from additional biodiversity projects. Area-specific guidelines within a Biodiversity Conservation Strategy are needed to identify these areas and recommend management options, such as acquiring sensitive areas, restoring existing lands with native species, or increasing connectivity between biodiversity hubs.

Opportunistic Actions

- Explore opportunities to preserve or salvage native plants currently being destroyed during redevelopment projects
- Partner with local nurseries and other sector stakeholders to promote an annual event where native and adaptable species are available for purchase

Possible Actions

- Perform a detailed assessment regarding past and future changes in soil moisture, and the potential impacts of changes in soil moisture to ecosystems

Action Objective 8: Preserve and enhance the viability of ecologically sensitive areas and critical habitat along the foreshore

Required Action 8.1 (completion target: 2018)

- Create and implement a Coastal Hazard Development Permit Area to protect people, property, and foreshore ecosystems from coastal impacts

A Coastal Hazard Development Permit Area should be developed to protect people, assets, and critical marine and intertidal ecosystems from the coastal impacts of "coastal squeeze," floods, erosion, saltwater intrusion, and storm surges resulting from rising sea level. Within this permit area, estuary preservation, protection, and restoration areas must be identified, designated, and promoted. Once the Coastal Hazard Development Permit Area is adopted, the Environmental Protection and Preservation Bylaw should be updated to remove the aquatic area permit.

Possible Actions

- Incentivize new development away from sensitive foreshore areas
- Over long time periods consider moving infrastructure away from sensitive foreshore areas and/or encouraging different land uses (i.e., recreation) in these areas.

Health and Safety

A key component of the District's high quality of life is its mild climate. However, an increase in extreme events can negatively impact community livability and increase risk to human health and safety.

Hotter and drier weather is increasing the likelihood of more frequent and higher severity wildfires and heat waves. Wildfires increase the concentration of fine particulate matter in the air, reducing air quality and causing asthma attacks, wheezing, and impaired lung function. Wildfires can also indirectly impact health and safety by damaging infrastructure and recreational areas.

Extreme heat waves are increasing the instances of heat-related illnesses, such as heat stroke, sunburn, heat stress, dehydration, and cardiovascular-respiratory illness. Hotter and drier weather is also altering the geographic range of vectors (air, water and food) and increasing the length of the transmission season, resulting in more incidences and wider spread of infectious disease and water- and food-borne illnesses.

Water supply is being impacted by lower winter snowpack and summer precipitation levels and water quality is being affected by increased turbidity in water reservoirs from more intense rainfall events and more frequent landslides at the source. Both result in elevated human health risks.

Vulnerable populations are particularly impacted by climate change because of inadequate shelter, lack of dry clothing and food, health issues, mobility challenges, or limited access to transportation. Emergency responders are also uniquely impacted as a result of larger and simultaneous emergencies caused by climate change, leading to increased psychosocial effects.

The following actions focus the District's efforts on minimizing the impacts of climate change on human health and safety and thoughtfully considering the unique impacts to vulnerable populations.

Action Objective 9: Reduce potable water consumption

Required Action 9.1 (completion target: 2020)

- Develop and implement programs for rainwater and grey water collection and recycling

The District is employing proactive approaches to conserve water: a high-tech irrigation system to manage sprinkling in parks monitors current weather conditions and automatically shuts off when it rains, and a proactive leak detection program continually monitors water systems for leaks, allowing detected leaks to be repaired quickly. As well, the District works with local golf courses to create water use plans that reduce water consumption while maintaining high-quality greens. The District also collaborates with Metro Vancouver on water conservation strategies: during the dry summer months, water restrictions issued by Metro Vancouver are enforced by the District's water conservation officers. These proactive water conservation approaches will continue, and can be enhanced.

The District should further reduce potable water consumption by developing and implementing programs for rainwater and grey water collection and recycling. Rainwater can be collected in rain barrels or rainwater harvesting systems and can be reused to water gardens and other landscape features. Grey water includes waste water from baths, sinks, washing machines, and other kitchen appliances, which can be captured and recycled for non-potable uses such as toilet flushing. Implementing water recirculation systems in water parks and public art features is another opportunity for water conservation. However, the use of reclaimed water is regulated by the BC Building Code and regulatory constraints must be overcome prior to implementing water collection and recycling programs.

Opportunistic Actions

- Apply Water Conservation Development Permit Area guidelines
- Increase the enforcement of water restrictions
- Enhance communication strategies and offer incentives to encourage indoor and outdoor water conservation
- Promote landscaping practices that conserve water and utilize drought resistance plant species

Action Objective 10: Provide alternative water sources for emergency response

Required Action 10.1 (completion target: 2017)

- Plan for the distribution of alternative potable water supply during an emergency

The District is involved in the Regional Engineers Advisory Committee's Provision of Water working group. The District must plan for distribution to ensure that water is supplied to critical infrastructure and the public, especially vulnerable populations, during an emergency. Water treatment training for staff and the public could build community resiliency and relieve pressure on emergency responders to provide drinking water during an emergency.

Action Objective 11: Upgrade the District's preparedness and response to heat waves and poor air quality

Required Action 11.1 (completion target: 2020)

- Create more opportunities for heat refuge areas in the District

When an extreme heat wave advisory is issued by Environment Canada, the North Shore Extreme Heat Initial Response Guideline is implemented. The guide outlines initial steps for how local authorities can respond to extreme heat within the first four to six hours and includes the location of water fill stations, spray parks, and cooling centres across the North Shore. The District should upgrade its preparedness and response to heat waves and warmer summer temperatures by designing additional heat refuge areas that provide public access to shade and drinking water.

For example, the District could:

- review its park design guidelines to increase shade in parks
- provide more shade in urban areas (e.g., overhangs on buildings and above water fountains and rest areas)
- construct additional or expand public access to water parks and drinking water stations

Possible Actions

- Analyze where vulnerable populations are clustered in the District in order to concentrate heat refuge areas in these locations

Required Action 11.2 (completion target: ongoing)

- Seek opportunities for interagency coordination to minimize adverse health impacts to staff, responders, and the public during heat waves and air quality advisories

Though health care is formally the responsibility of the BC Government and the Fraser Health Authority, the District contributes to the health and safety of its residents by providing civic services and long-term planning. To minimize adverse health impacts to staff, responders, and the public during heat waves and air quality advisories, the District will continue to support health and social-support organizations and other sector stakeholders with the distribution of regular public safety messaging using the District's communication channels. To further increase efforts, the District should seek opportunities for interagency coordination on a continual basis.

The District could consider working with other North shore municipalities to acquire and use electronic, portable reader boards on bridges to distribute pre-scripted public safety messaging. Further, the District could consider including a public safety information kit as part of the existing community-building funding for block parties to help build neighborhood resiliency across the District.

Opportunistic Actions

- Update the North Shore Extreme Heat Initial Response Guideline to include specific strategies for vulnerable populations
- Update the District's general communication messaging guide, used by the Communications Department, to include heat waves and air quality advisories

Possible Actions

- Consider the addition of a disclaimer in District event permits that allows for the cancellation of outdoor events during times when temperatures are unusually high, water restrictions are in place, or other times when well-being is at risk

Chapter 6: Moving Forward

This Climate Change Adaptation Strategy identifies required adaptation actions to proactively prepare for climate change and respond to high-risk impacts. To achieve the strategy's vision, successful implementation, continuous monitoring, and regular review of adaptation actions and the strategy itself is essential.

Implementation

The District has many adaptation initiatives already underway, but such initiatives may not be labelled as working towards adaptation. The intent of this Climate Change Adaptation Strategy, therefore, is to leverage existing work and identify new opportunities for enhanced adaptation. Many of the adaptation actions presented in this strategy are interrelated. Many also work toward achieving additional goals identified in other District policies, plans, and strategies. Therefore, all adaptation actions, regardless of lead department responsible for implementation, should be considered together during the implementation phase to enhance cross-departmental and collaborative implementation.

At the end of this Climate Change Adaptation Strategy, a draft implementation plan supports each required action by identifying resources to move adaptation into action. The departmental leads identified for each required action are responsible for implementing those actions by incorporating them into departmental plans, asset management plans, and financial planning processes (e.g., the long-term funding strategy). Other details within the draft implementation plans, such as a completion target, a relative cost, and level of effort, are intended to provide departmental leads with the foundation to carry out each action. However, because the details and prioritization of adaptation actions may change over time, each implementation plan is a living document. Implementation plans are expected to be revised through further collaborative work, facilitated by the department lead, to determine the best approach that will achieve each adaptation action objective.

Implementation Actions

The following actions focus the District's efforts on successful and timely implementation of adaptation actions identified in this strategy.

Action Objective 12: Support the implementation of adaptation actions

Required Action 12.1 (completion target: 2017)

- Assign specific indicators for each adaptation action to help monitor progress.

While a potential list of indicators for each required action is included in this strategy (Appendix B: Potential Indicators for Required Actions), further refinement is needed to assign specific indicators. The majority of indicators are aligned with current District reporting efforts, but a number of new, potential indicators have also been identified.

Possible Actions

- Consider incorporating a rubric or scoring mechanism to monitor progress on each action, and/or to require resources to be applied to actions that are not advancing

Required Action 12.2 (completion target: 2018)

- Integrate Required Actions into existing plans and decision-making processes to increase the likelihood of completion.

Integrating related actions, targets and indicators into existing plans such as the Official Community Plan, Asset Management Plan, Corporate Plan and Long-range Funding Strategy will increase the likelihood of the actions being completed. Alignment with existing decision-making processes such as business case analyses and other programs will ensure efficiency of implementation and maximize co-benefits/synergies.

Opportunistic Actions

- Provide additional staff resources to work with each department on the implementation of adaptation actions
- Identify where equivalencies or options for some adaptation actions may be appropriate
- Provide new, stronger enforcement tools for adaptation actions
- Review all new and revised policies and plans to look for opportunities to address the climate change impacts identified in this strategy

- Ensure all employees are familiar with the Climate Change Adaptation Strategy

Monitor / Review

Indicators help to monitor progress over time. Baseline data should be collected and regularly analyzed for trends to gauge the effectiveness of adaptation actions and better understand drivers and barriers to implementation. Some examples of these drivers and barriers to be aware of include:

Drivers

- Grant funding available for climate change adaptation
- Need for efficient integrated work systems
- Long-range financial planning and asset management planning require DNV to plan ahead
- Public awareness, public support and public pressure

Barriers

- Insufficient resources (e.g., fiscal, technical, and staff capacity)
- Competing or short timelines
- Reduced availability of technology
- Legality and procedural feasibility, including provincial or territorial legislation
- Path dependency
- Lack of integration throughout the organization
- Lack of monitoring and enforcement
- Lack of high-quality data
- Uncertainty
- Behavioral obstacles
- Lack of public awareness or support

Global, regional, and local climate science is advancing rapidly, as are adaptation policies, technologies, and public values and expectations. As a result, the District's understanding of climate change, its impacts, and the opportunities for adaptation are continuously changing. A concerted effort is needed to ensure the District continues to use the best available climate science and management practices in all decision making. The District aims to review and evaluate this strategy on an annual basis and update it every five years.

Annual Evaluation

The Climate Change Adaptation Team will carry out the annual review and evaluation of this strategy. The team will develop a progress report to document observed climatic changes or impacts in the District, successfully implemented actions, barriers to the implementation of actions, new sources of funding, and windows of opportunity for climate action (e.g., leveraging new programs or initiatives). Using the information in the progress report, the team will make any necessary amendments to adaptation actions and their draft implementation plans to ensure successful implementation.

Five-Year Update

The Climate Change Adaptation Team will be responsible for updating this strategy every five years (from the date of initial adoption). Updating the strategy will include acquiring the most recent climate science, reviewing initial climate change impacts, and adding any new impacts to capture observed or recently projected changes. New adaptation actions, implementation plans, and indicators must be developed to address new impacts. All original adaptation actions must be reviewed to document those that have been completed, dropped, or amended to account for changes in risk or to leverage new opportunities.

Chapter 7: Draft Implementation Plans for Required Actions

Below is a detailed table that outlines information regarding the District's 12 objectives and the associated Action Objectives.

Column Legend

- Action type: Governance and Management (G), Assets and Operations (A), and Education and Training (E)

- Funding type identifies if the action's implementation costs are Operational (Op) or Capital (Cap)
- Estimated-cost categories: <$ (< 100,000), $ (< 500,000), $$ (500,000 – 1,000,000), and $$$ (> 1,000,000)
- Effort categories: Low (L), Medium (M), and High (H)

Required Actions		Action Type	Lead	Completion Target	Funding Type	Estimated Cost	Funding Sources	Effort	Implementation	Supporting Documents
Municipal Services										
Objective 1: Strengthen the District's capacity to simultaneously respond to and recover from extreme weather events and provide continuity of essential municipal services										
1.1	Complete business continuity plans to ensure priority service delivery	G	Corporate S. NSEM	2020	Op	<$	Required but not identified	M	Within local control	NA
1.2	Develop and/or purchase additional technology tools to assist in situational awareness and emergency response communication	A	NSEM	2018	Cap and Op	<$	Required and likely to be secured	L	Requires coordination with other jurisdictions	NA
1.3	Provide targeted training for clerks to ensure emergency service requests and concerns are responded to in a timely manner	E	Planning	2017	Op	<$	Required and likely to be secured	L	Within local control	NA
Objective 2: Ensure critical municipal functions are served by robust power systems and alternatives are provided where systems are vulnerable										
2.1	Identify critical functions that are vulnerable to power outages and develop priority response and power restoration protocols	G	Engineering	2018	Cap	<$	Available	L	Requires external approval	NA
2.2	Invest in back up power equipment for critical functions and develop fueling strategy	A	Engineering	2019	Cap	$$	Available	M	Within local control	NA
Infrastructure and Systems										
Objective 3: Increase the resiliency of municipal assets to more frequent and severe extreme weather and sea level rise										
3.1	Complete the Integrated Stormwater Management Plan and implement recommendations to maintain watershed health and reduce the impacts of extreme runoff	G	Engineering Environment	Plan 2017; implement 2027	Cap and Op	$$$	Required and likely to be secured	M	Within local control	NA
3.2	Update the Community Wildfire Protection Plan and implement recommendations to	G	Environment Parks	Plan by 2017; impleme	Cap and Op	$$	Available	L	Within local control	Community Wildfire Protection Plan (Edoc: 857903)

	strengthen capacity to respond to Wildland Urban Interface fires			nt by 2023						
3.3	Identify eco-assets, conduct risk assessment under climate change conditions, and include in Asset Management Plan	A	AMSC	2019	Op	<$	Required but not identified	M	Within local control	Asset Management Plan (Edoc: 2518550)
3.4	Implement recommendations in Debris Geohazard Risk and Risk Control Assessment for debris flood/flow creeks by integrating into Asset Management Plan	A	Engineering	2025	Cap and Op	$$$	Required and likely to be secured	H	Within local control	Debris Geohazard Risk and Risk Control Assessment (Edoc: 2986761)
Objective 4: Support District residents in proactively managing privately owned property to adapt to more frequent and severe extreme weather and sea level rise										
4.1	Review and strengthen building and development policies to require consideration of climate change over the life cycle of a structure	G	Planning	2018	Op	$	Required and likely to be secured	M	Within local control	Maplewood Flood Risk Management Strategy (Edoc: 2979921) Hazard DPAs Development Servicing Bylaw (Edoc:
4.2	Develop and implement an education and incentive program to encourage more resilient choices for private development design, maintenance, and renewal	E	Planning Engineering	2020	Cap and Op	$$	Available	M	Within local control	Green Building Strategy (Edoc:
Parks and Environment										
Objective 5: Support the long-term health of natural forest ecosystems and fire disturbance regimes										
5.1	Proactively manage all District owned forested areas to increase forest resilience, health, and structure and simultaneously reduce other natural hazards	A	Environment	2018	Op	$$	Available	M	Requires external approval	NA
Objective 6: Reduce the spread of invasive organisms										
6.1	Implement the Invasive Plant Management Strategy to manage, prevent, treat, and control harmful invasive plants on both public and private land	A	Policy Plan. Parks	2025	Cap and Op	$$	Available	H	Within local control	Invasive Plant Management Strategy (Edoc: 2576575)

Objective 7: Restore and protect existing native biodiversity										
7.1	Generate area-specific guidelines to acquire sensitive areas, restore existing lands with native species, and increase connectivity between biodiversity hubs, within a Biodiversity Conservation Strategy	G	Environment Parks	2020	Cap	$$$	Required and likely to be secured	H	Within local control	NA
Objective 8: Preserve and enhance the viability of ecologically sensitive areas and critical habitat along the foreshore (e.g., intertidal)										
8.1	Create and implement a Coastal Hazard Development Permit Area to protect people, property, and foreshore ecosystems from coastal impacts	G	Policy Plan. Environment	2018	Cap	$$	Required and likely to be secured	H	Requires external approval	NA
Health and Safety										
Objective 9: Reduce potable water consumption										
9.1	Develop and implement programs for rainwater and grey water collection and recycling	A	Engineering Parks	2020	Cap and Op	$$	Required and likely to be secured	M	Within local control	NA
Objective 10: Provide alternative water sources for emergency response										
10.1	Plan for the distribution of alternative potable water supply during an emergency	A	Engineering NSEM	2017	Cap	<$	Required and likely to be secured	L	Within local control	NA
Objective 11: Upgrade the District's preparedness and response to heat waves and poor air quality										
11.1	Create more opportunities for heat refuge areas in the District	A	Planning Parks Rec Com.	2020	Cap and Op	$$	Available	M	Within local control	NA
11.2	Seek opportunities for interagency coordination to minimize adverse health impacts to staff, responders, and the public during heat waves and poor air quality advisories	E	NESM	3 meetings per year	Op	<$ (NESM)	Available	L	Requires coordination with other jurisdictions	NA
Implementation										

Objective 12: Support the implementation of adaptation actions										
12.1	Assign specific indicators for each adaptation action to help monitor progress	G	Planning	2017	Op	<$	Available	L	Within local control	Appendix B in this Strategy
12.2	Integrate Required Actions into existing plans and decision-making processes to increase the likelihood of completion	G	Planning	2018	Op	<$	Available	M	With local control	NA

Appendix A: Detailed Climate Projections Summary for the District

Climate modelling for the District was completed by the Pacific Climate Impacts Consortium (PCIC) to better understand how the District's climate may change by the 2050s. Modelling was focused on the 2050s because these are the climatic changes that will be unavoidable, regardless of the extent of global mitigation efforts. An ensemble of twelve global climate models[23] was used to assess projected changes in: temperature; precipitation amounts; precipitation timing; changing precipitation patterns, extreme weather events of greater frequency and severity, and sea level rise.[24]

Future projections for the 2050s represent an average of the modelled values over a 30-year period from 2041 to 2070. The 2050 projections are relative to a baseline of the 1980s (1971-2000) and are based on the "business as usual" greenhouse emissions scenario (RCP 8.5). Averages provided are the mean of the global climate model ensemble, calculated over the entire District of North Vancouver boundary, and ranges represent the tenth and ninetieth percentiles of the global climate model ensemble. Seasons are presented as winter (December, January, and February), spring (March, April, and May), summer (June, July, and August), and fall (September, October, and November).

While most of the projected climatic changes described in this summary are generally uniform in areas near sea level, certain climate indices may differ between lower and higher elevations as well as between regions adjacent to the ocean and those further from the shoreline. Maps that document this spatial variability have been provided for some of these climate indices. These maps were created using a regional downscaling approach (BCCAQ) with elevation corrections to achieve 800-metre resolution, and values at individual map cells may differ slightly from actual sites in the District.

Temperature Change (Increasing Temperatures)

Average annual temperature in the District is expected to increase by 2.9°C, with the greatest increase (3.6°C) occurring in the summer months (figure A1). By the 2050s, average daytime high temperatures in September will be hotter than temperatures occurring presently in July and August. In addition, the number of summer days above 25°C (SU) in the District will more than double by the 2050s, from 18 to 44 days per year, on average. In general, valleys and low-lying areas in the District will experience the most summer days above 25°C (50 to 80 days per year) and higher elevations (i.e., Grouse and Seymour mountains) will experience the fewest

[23] Temperature, precipitation, and indices of extremes were determined from an ensemble of 12 Global Climate Models as described at http://www.pacificclimate.org/data/statistically-downscaled-climate-scenarios (i.e., CMIP5 models following RCP 8.5 downscaled with BCCAQ)

[24] Sea level rise projections were determined from Ausenco Sandwell. (2011). Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use. Report prepared for BC Ministry of Environment. Retrieved from: http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/draft_policy_rev.pdf

(<10 days per year) (figure A2). Summer maximum temperatures (TXX) are projected to increase by 3.9°C, while winter minimum temperatures (TNN) will warm by 5.1°C. Similarly, very hot days, expected to occur once every 20 years (RP20Tx), are projected to intensify, rising from 33°C to 38°C by the 2050s.

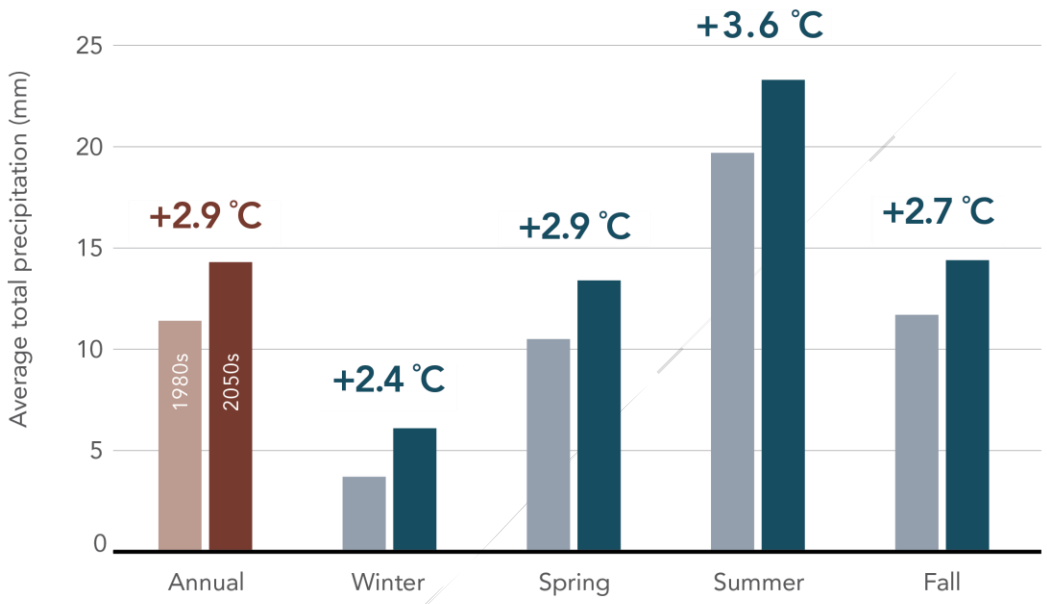


Figure B1. Average annual and seasonal daytime high temperatures in the District.

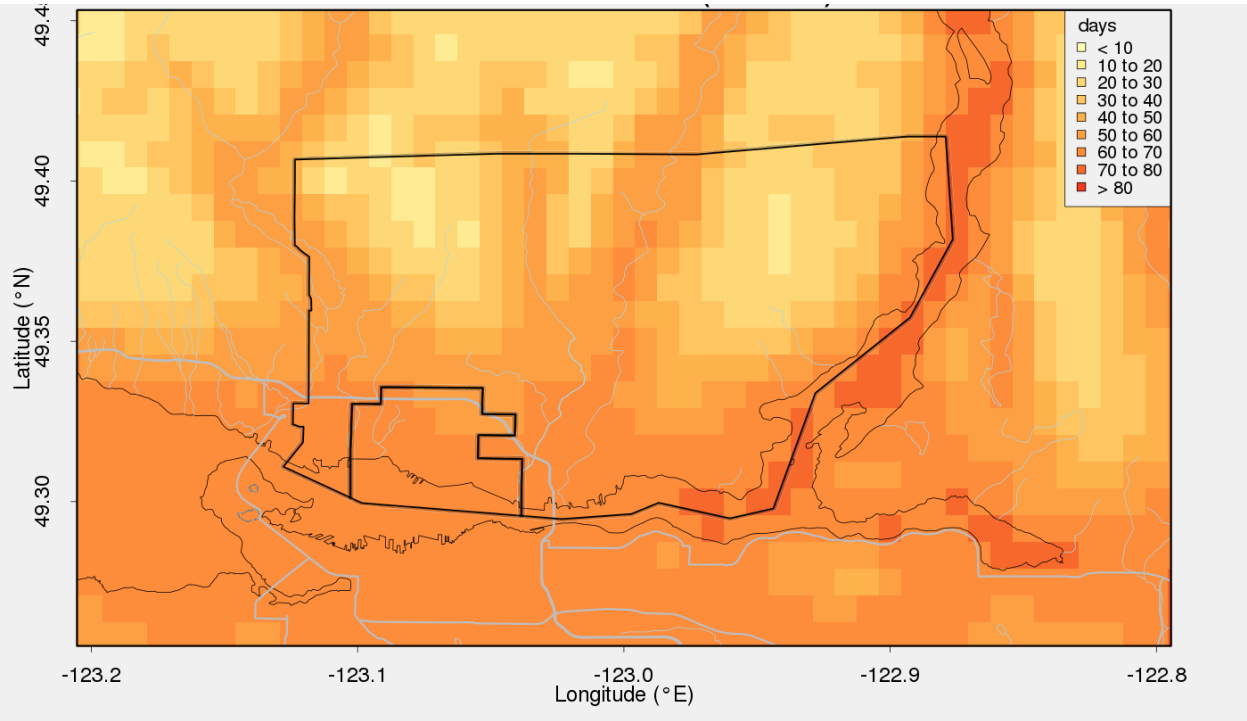


Figure B2. Spatial variability in the number of summer days above 25°C in the District by the 2050s.

Heating and Cooling

By the 2050s, warmer winter, spring, and fall minimum temperatures will result in lower heating demand with 24% fewer heating degree days (HDD), from about 3800 to 2900 days per year. In contrast, warmer summer temperatures are expected to drive greater cooling requirements as cooling degree days (CDD) increase from about 40 to 180 degree days per year. Hot summer days (days above 30°C) (SU30) that occurred only twice per year on average in the past are projected to occur 13 times per year in the 2050s. In addition to these individual hot days, extended periods of hot temperatures associated with heat waves are also expected to occur more frequently.

Ecosystem Impacts

The projected warming has implications for ecosystems in the District, including a 68% reduction in the number of days with ice (ID) and a 63% reduction of days with frost (FD). Fewer ice and frost days will likely increase the potential for pests and invasive organisms to thrive in the District. In addition, the length of the growing season (GSL) and number of growing degree days (GDD) will increase by 29% and 52%, respectively. These changes could improve the growth and productivity of typical plants and crops in the region and allow for new species and varieties to grow; however, seasonally waterlogged soils, decreased water availability, and extreme heat may hinder any crop productivity.

Precipitation Change (Drier Summers and Wetter Winters)

A modest 5% increase in annual total precipitation is projected for the District by the 2050s (figure A3). However, this rain is expected to fall during increasingly extreme events, with 33% more precipitation on very wet days (R95p) and 58% more on extremely wet days (R99p). Events that are expected to occur once every 20 years (RP20p), and which are often associated with flooding, are projected to increase in intensity by 19%.

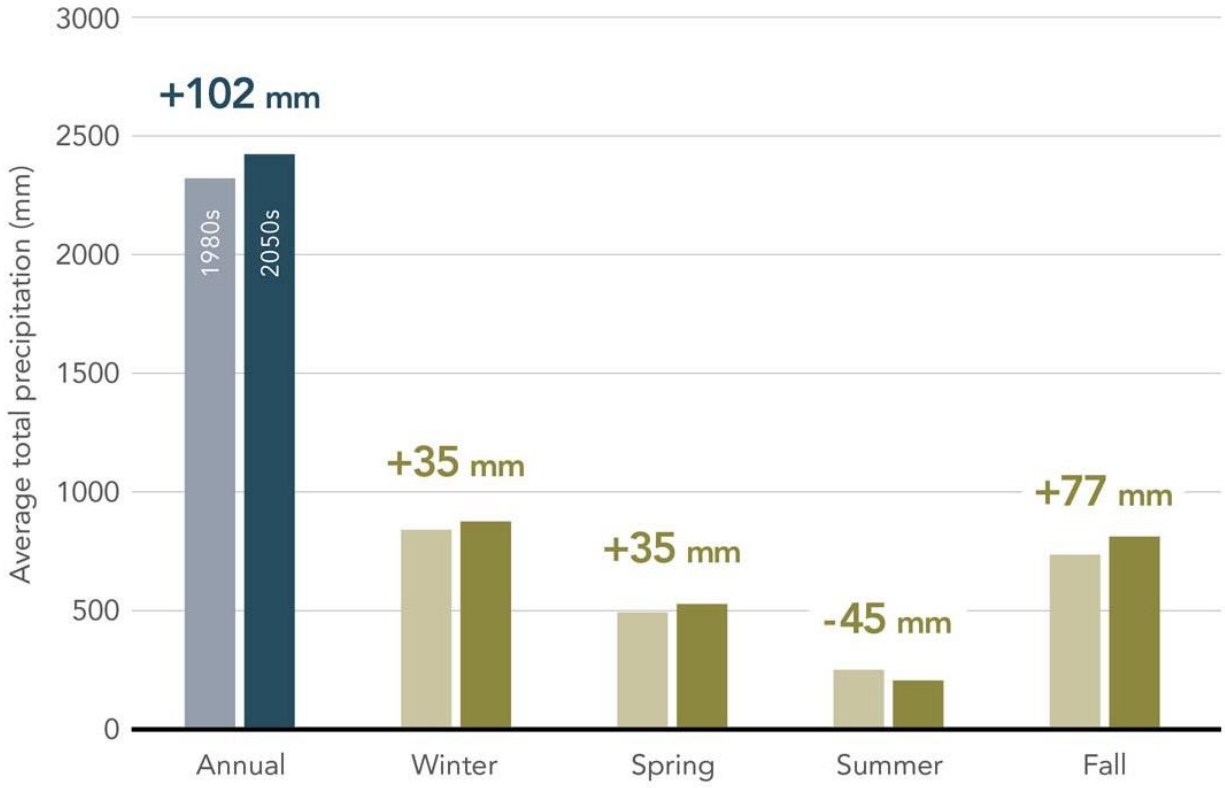


Figure B3. Average annual and seasonal total precipitation in the District.

Precipitation changes vary seasonally, exacerbating the existing differences between the wet and dry months of the year. Projections indicate that winter, spring and fall in the District will see increases in rainfall totals between 4% and 11%. Despite the projected increased intensity of annual wet events (R95p and R99p), the amount of rain in the summer is expected to

decrease by 18%, and the maximum length of dry spells (CDD) in a year (which typically occur in the summer) is projected to increase by 19% (from 19 to 23 consecutive dry days per year, on average).

Snowpack

Precipitation as snow and snowpack are projected to decrease significantly over time. In the District, snowpack is typically highest in the spring months, after snow has accumulated over the winter and early spring, with April 1st snow depth measuring 90 cm on average in the 1980s. Projections indicate that, on average, April 1st snowpack in the District will decrease by 89% by the 2050s. However, the projected changes will differ depending on elevation. At elevations near sea level, where snowpack was low in the past, declines of up to 100% are projected to occur (figure A4). At higher elevations, the projected changes are smaller, with declines of less than 30% on the upper portions of Grouse and Seymour mountains.

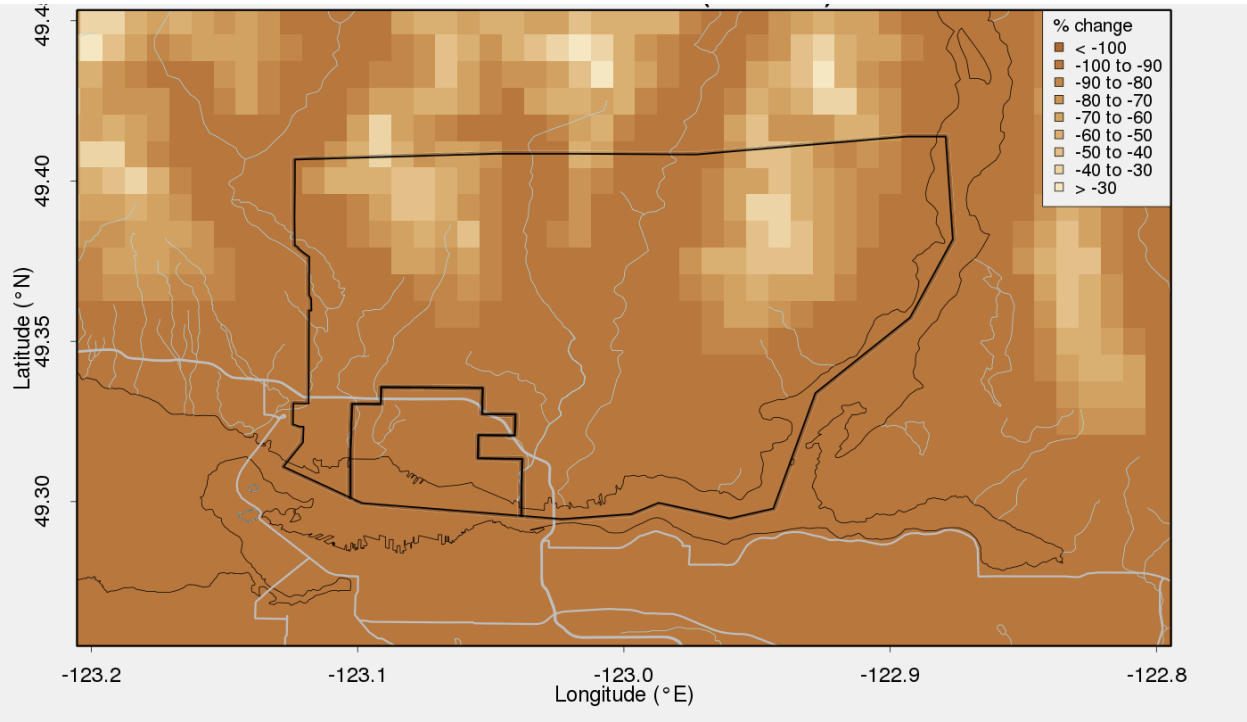


Figure B4. Spatial variability in the percent change in April 1st snowpack in the District by the 2050s.

Extreme Weather (More Frequent and Severe Extremes)

The indices of extremes give an indication of how climate conditions that are currently infrequent will change in frequency and/or intensity in the future. In addition to the

temperature and precipitation extremes mentioned in the sections above, the District could experience an increase in the frequency and severity of windstorms.

Damaging windstorms in coastal BC are often associated with extratropical cyclones from the Pacific Ocean that occur primarily during the fall and winter months. The Intergovernmental Panel on Climate Change (IPCC) states that climate model projections suggest a possible northward shift in the stormtracks of these events in the future, which could lead to increased frequency of extreme winds on the coast.[25] An analysis of climate change in the Georgia Basin[26] found that local projections of wind speeds were mixed, with both increases and decreases possible in the future. In this study, some climate models project extreme wind events to occur up to 2.6 times more often in the 2050s than in the past, while others project they will occur less than 0.1 times as often. Overall, these results imply that the future change in windstorms remains uncertain.

Sea Level Rise

Different climate models show different projections for future sea level rise. Given this model-based uncertainty and the rapid rise in ocean levels observed in the past decades, the BC Government released guidelines[27] in 2011 for evaluating long-term land use planning. In these guidelines, sea level in BC is expected to increase by 0.5 m by the 2050s, 1 m by 2100, and 2 m by the 2200s. Nonetheless, local factors—such as the vertical movement of land (i.e., subsidence or uplift), wind currents, and wave action—greatly influence the extent of sea level rise in a particular area and must be considered when examining local impacts.

Table B1. Past climate indices and projected future changes in the District of North Vancouver.

[25] IPCC. (2013). Chapter 14: Climate Phenomena and their Relevance for Future Regional Climate Change. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from: http://www.climatechange2013.org/images/report/WG1AR5_Chapter14_FINAL.pdf

[26] Murdock et al. (2012). Georgia Basin: Projected Climate Change, Extremes, and Historical Analysis. Retrieved from: https://www.pacificclimate.org/sites/default/files/publications/GeorgiaBasinImpacts_Final.pdf

[27] Ausenco Sandwell. (2011). Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use. Report prepared for BC Ministry of Environment. Retrieved from: http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/draft_policy_rev.pdf

Index	Label	Past (1980s)	Future Change (2050s)	Percent Change (2050s)
Coldest Winter Days	TNN	-13.8 °C	+5.1 (3.4 to 6.9) °C	N/A
Cooling Degree Days	CDD	36 days	+141 (58 to 229) days	385 (212 to 595)%
Dry Spells	CDD	19 days	+4 (0.5 to 7) days	19 (3 to 30)%
Extreme Precipitation (20 Year)	RP20p	121 mm	+23 (7 to 39) mm	19 (6 to 32)%
Extreme Temperature (20 Year)	RP20Tx	33 °C	+5 (3 to 6) °C	N/A
Extreme Wet Day Precipitation	R99p	154 mm	+86 (25 to 175) mm	58 (16 to 127)%
Frost Days	FD	92 days	-58 (-68 to -46) days	-63 (-76 to -50)%
Growing Degree Days	GDD	1467 days	+760 (411 to 1114) days	52 (27 to 78)%
Growing Season Length	GSL	217 days	+64 (43 to 82) days	29 (20 to 38)%
Heating Degree Days	HDD	3834 days	-927 (-1241 to -583) days	-24 (-33 to -16)%
Ice Days	ID	13 days	-9 (-11 to -5) days	-68 (-80 to -48)%
Summer Days	SU	18 days	+26 (16 to 36) days	144 (88 to 200)%
Hot Summer Days	SU30	2 days	+11 (5 to 16) days	550 (250 to 800)%
Warmest Summer Days	TXX	30 °C	+3.9 (2.5 to 4.8) °C	N/A
Wet Day Precipitation	R95p	498 mm	+158 (44 to 272) mm	33 (9 to 59)%

Table B2. Definition of climate indices.

Index	Label	Definition	Example of what the indices could indicate
Coldest Winter Days	TNN	Min temperature of the coldest day in winter	Potential for pests to thrive through the winter
Cooling Degree Days	CDD	Total of the number of degrees above 18°C that occur daily, summed over each day of the year	Energy demand for cooling
Dry Spells	CDD	Number of consecutive days with precipitation less than 1 mm	Reduce reservoir levels and increased wildfire risk
Extreme Precipitation (20 Year)	RP20p	Maximum daily precipitation expected to occur once every 20 years	Potential for flooding after extreme one-day rain events that occur once every 20 years
Extreme Temperature (20 Year)	RP20Tx	Maximum daily temperature expected to occur once every 20 years	Potential for heat stress during extreme one-day heat events that occur once every 20 years
Extreme Wet Day Precipitation	R99p	Total precipitation that falls on the wettest days of the year (i.e., days when precipitation exceeds the 99th percentile of wet days in the past)	Intensity of extreme wet days during the year
Frost Days	FD	Annual count of days where minimum temperature is below 0°C, which may result in frost	Potential for invasives and pests to thrive
Growing Degree Days	GDD	Total of the number of degrees above 5°C that occur daily, summed over each day of the year	Improved plant growth and potential for invasives to thrive
Growing Season Length	GSL	Number of days between the first span of 6 days in spring with daily average temperatures above 5°C, and the first span of 6 days in fall with daily average temperatures below 5°C	Improved productivity of typical plants/crops in the region and new species and varieties
Heating Degree Days	HDD	Total of the number of degrees below 18°C that occur daily, summed over each day of the year	Energy demand for heating
Ice Days	ID	Annual count of days where maximum temperature is below 0°C, which may result in ice	Resource demand for snow and ice removal

Index	Label	Definition	Example of what the indices could indicate
Summer Days	SU	Annual count of days where maximum temperature is greater than 25°C	Typical “summer weather” in the District
Hot Summer Days	SU30	Annual count of days where maximum temperature is greater than 30°C	Potential for heat waves when persistent hot summer days occur
Warmest Summer Days	TXX	Max temperature of the warmest day in summer	Potential for heat stress
Wet Day Precipitation	R95p	Total precipitation that falls on the wettest days of the year (i.e., days when precipitation exceeds the 95th percentile of wet days in the past)	Intensity of wet days during the year

Appendix B: Potential Indicators for Required Actions

	Required Action	Potential Indicators
Municipal Services		
Objective 1: Strengthen the District's capacity to simultaneously respond to and recover from extreme weather events and provide continuity of essential municipal services		
1.1	Complete business continuity plans to ensure priority service delivery	• Development of critical service evaluation matrix • # of business continuity plans • Average time for the delivery of priority services during an emergency
1.2	Purchase additional technology tools to assist in situational awareness and emergency response communication	• Option analysis of potential technology tools • # of staff trained on new technology tools • Average time to notify staff and residents to emergency situations
1.3	Provide targeted training for clerks to ensure emergency service requests and concerns are responded to in a timely manner	• % of clerks who have completed training • Average wait time for emergency service requests and concerns • % of Request for Service cases closed in a timely manner
Objective 2: Ensure critical municipal functions are served by robust power systems and alternatives are provided where systems are vulnerable		
2.1	Identify critical functions that are vulnerable to power outages and develop priority response and power restoration protocols	• Analysis of energy needs for critical infrastructure and functions • Development of protocols for response and power restoration • % of critical infrastructure and functions that are impacted during a power outage
2.2	Invest in back up power equipment for critical functions and develop fueling strategy	• Analysis of current backup power equipment • Development of long-term fueling strategies • # of generators purchased • # of additional fuel systems installed • Frequency of service failure
Infrastructure and Systems		
Objective 3: Increase the resiliency of municipal assets to more frequent and severe extreme weather and sea level rise		
3.1	Complete the Integrated Stormwater Management Plan and implement recommendations to maintain watershed health and reduce the impacts of extreme runoff	• Development of management plans for each watershed • % of recommendations implemented • Proportion of permeable versus impermeable ground coverage • Total asset losses ($) from water and erosion damage • Measurements of stream health (e.g., water velocity, temperature, and clarity; and bank vegetation condition and structure)
3.2	Update the Community Wildfire Protection Plan and implement recommendations to strengthen capacity to respond to Wildland Urban Interface fires	• Updated Community Wildfire Protection Plan • % of recommendations implemented • % of high wildfire risk areas treated • Total asset losses ($) from fire damage

3.3	Identify eco-assets, conduct risk assessment under climate change conditions, and include in Asset Management Plan	• Value ($) of eco-assets • Amended Asset Management Plan • Long term operational and maintenance costs of grey infrastructure
3.4	Implement recommendations in Debris Geohazard Risk and Risk Control Assessment for debris flood/flow creeks by integrating into Asset Management Plan	• % of recommendations implemented • Amended Asset Management Plan • % of high debris flood/flow risk areas mitigated • # of property owners educated about debris flood risks and options for risk reduction • # of culvert blockages • Total asset losses ($) due to debris floods/flows
Objective 4: Support District residents in proactively managing privately owned property to adapt to more frequent and severe extreme weather and sea level rise		
4.1	Review and strengthen building and development policies to require consideration of climate change over the life cycle of a structure	• # of District policies that include climate change considerations • Total financial losses ($) incurred by the public related to climate change • # of new developments that explicitly consider climate risks proactively
4.2	Develop and implement an education and incentive program to encourage more resilient choices for private development design, maintenance, and renewal	• # of residents, developers, architects etc. educated about resilient development • # of incentives offered to the public to encourage more resilience choices • # of professional development activities (for engineers, planners, etc.)
Parks and Environment		
Objective 5: Support the long-term health of natural forest ecosystems and fire disturbance regimes		
5.1	Proactively manage all District owned forested areas to increase forest resilience, health, and structure, and simultaneously reduce other natural hazards	• % of forested areas in the District that are proactively managed • Measurements of forest health (e.g., tree growth, mortality, regeneration, and crown condition; species composition; vegetation diversity and structure)
Objective 6: Reduce the spread of invasive organisms		
6.1	Implement the Invasive Plant Management Strategy to manage, prevent, treat, and control harmful invasive plants on both public and private land	• % of recommendations implemented • Proportion of native versus invasive plants on public and private lands
Objective 7: Restore and protect existing native biodiversity		
7.1	Generate area-specific guidelines to acquire sensitive areas, restore existing lands with native species, and increase connectivity between biodiversity hubs, within a Biodiversity Conservation Strategy	• Analysis of areas that would benefit from biodiversity related projects • Development of a conservation strategy that includes area-specific guidelines • % of sensitive areas that are protected • % of existing lands that are restored with native species • Measures of connectivity between protected and conserved lands

		• Proportion of fragmented versus connected landscapes beneficial for biodiversity
Objective 8: Preserve and enhance the viability of ecologically sensitive areas and critical habitat along the foreshore (e.g., intertidal)		
8.1	Create and implement a Coastal Hazard Development Permit Area to protect people, property, and foreshore ecosystems from coastal impacts	• Identification of sensitive estuary areas • Creation of Coastal Hazard Development Permit Area and guidelines • Total asset losses ($) due to coastal hazards • Measurements of foreshore health (e.g., species diversity; habitat quality; seafloor integrity; and marine food web abundance and diversity)
Health and Safety		
Objective 9: Reduce potable water consumption		
9.1	Develop and implement programs for rainwater and grey water collection and recycling	• # of new water collection and recycling initiatives • Water consumption per capita • District water consumption
Objective 10: Provide alternative water sources for emergency response		
10.1	Plan for the distribution of alternative potable water during an emergency	• Development of a water distribution strategy • # of people with access to potable water during an emergency
Objective 11: Upgrade the District's preparedness and response to heat waves and poor air quality		
11.1	Create more opportunities for heat refuge areas in the District	• % shade coverage • # of drinking water stations • # of heat-related hospitalizations
11.2	Seek opportunities for inter-agency coordination to minimize adverse health impacts to staff, responders, and the public during heat waves and poor air quality advisories	• # of new connections with health and social support organizations • # of heat-related hospitalizations • # of air quality–related health issues
Implementation		
Objective 12: Support the implementation of adaptation actions		
12.1	Assign specific indicators for each adaptation action to help monitor progress	• # of adaptation actions with a refined list of indicators and baseline data • Regular review and updates based on indicator progress

Appendix C: Glossary

This glossary defines terms as they are intended to be interpreted in the context of climate change. *Underlined and italicized* words are terms that are defined elsewhere in the glossary.

Adaptation:

Initiatives or actions in response to actual or projected changes in climate that reduce the effects of *climate change* on built, natural, and social systems and take advantage of potential opportunities.[28] Examples include: modifying building codes to account for future climatic conditions, providing heat refuges during heat waves, and planting drought- and flood-tolerant tree species.

Adaptive Capacity:

The ability of built, natural, and/or social systems to adjust to *climate change* (including climate variability and extremes) by moderating potential damages, taking advantage of potential opportunities, or coping with *consequences*.[29]

Climate:

The average *weather* in a given region over a long period of time, typically 30 years or longer.

Climate Change:

Statistically significant variations in the *climate* that can be caused by natural Earth processes (e.g., volcanic eruptions and ocean currents), external factors (e.g., changes in solar intensity), or by human activity (e.g., greenhouse gas emissions and changes in land use).[30]

Climate Change Impact:

An issue resulting from a *climate change outcome* that has a positive or negative effect. Examples include infrastructure damage, injury, and loss of native biodiversity.

Climate Change Outcome:

A hazard or event that is caused by *climate change.* Examples include: overland and urban floods, windstorms, and the spread of invasive organisms.

[28] ICLEI Canada. (2012). Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate change adaptation. Retrieved from: www.icleicanada.org/resources/item/3-changingclimate-changing-communities

[29] *Ibid*

[30] Intergovernmental Panel on Climate Change (IPCC). (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from: www.climatechange2013.org

Consequence:

The known or estimated social, economic, and environmental concerns resulting from a *climate change impact*. Examples include: increased mental health issues in displaced residents, higher costs of emergency response, and loss of essential *ecosystems services*.

Eco-Assets:

Naturally built environments that provide *ecosystem services.* Examples include: forests, wetlands, and foreshores.

Ecosystem Services:

The benefits people obtain from the natural environment. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreation, and social benefits; and supporting services such as nutrient cycling that maintain favourable conditions for life on Earth.

Extreme Weather Event:

A meteorological event that is rare for a particular time of year and/or place and is beyond the normal range of activity.[31] Examples include: windstorms, heat waves, and droughts.

Green Infrastructure:

Physically built natural environments that provide *municipal services* and *ecosystem services*. Examples include: green roofs, artificial wetlands, and rain gardens.

Grey Infrastructure:

Physically built environments that provide *municipal services*. Examples include: roads, sewers, and buildings.

Likelihood:

The probability of a particular *climate change outcome* or *climate change impact* occurring.

Maladaptation:

Any changes in natural or human systems that do not succeed in reducing vulnerability to climate change but instead increase it.[32] For example, a sea wall can increase vulnerability if there is extensive development behind it. .

[31] ICLEI Canada. (2012). Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate change adaptation. Retrieved from: www.icleicanada.org/resources/item/3-changingclimate-changing-communities

[32] Intergovernmental Panel on Climate Change (IPCC). (2007a). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from: www.ipcc.ch/index.htm

Mitigation:

Policy, regulatory, and project-based measures that help stabilize or reduce greenhouse gas emissions and/or enable natural systems to natural sequester greenhouse gases (e.g., preventing forested areas from being developed into to urban cities). These actions prevent future *climate change* from happening.[33] Examples include: renewable energy programs, energy efficiency frameworks, and land-use policies.

Municipal Services:

The benefits people obtain from the physically built environment. These include provisioning services such as water, sanitation and transportation; regulating services such as flood and disease control; cultural services such as spiritual, recreation, and social benefits; and supporting services such as conservation and restoration of values derived from *eco-assets* that provide *ecosystem services.*

Resilience:

The capacity of a system, community, or society exposed to hazards to adapt, by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure.[34]

Risk:

A measure of the expected outcome of an uncertain event, which is estimated by combining an event's *likelihood* by the expected *consequences*. The concept of risk helps to grapple with *uncertainty* and allows for the comparison of potential impacts.[35]

Uncertainty:

A state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour.[36]

Vulnerability:

[33] *Ibid*

[34] *Ibid*

[35] CNV. (2013). City of North Vancouver Climate Change Adaptation Plan. Retrieved from: http://www.cnv.org/your-government/living-city/climate-action/climate-change-adaptation

[36] Intergovernmental Panel on Climate Change (IPCC). (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from: www.climatechange2013.org

The degree to which a system is susceptible to, or unable to cope with, the adverse effects of *climate change*. Vulnerability is a function of both the *sensitivity* and the *adaptive capacity* of a given system.[37]

Vulnerable Population:

Community members that experience greater impacts compared to the general population. This can result from the inability to move to avoid risks or afford adaptation measures. Examples include: homeless, low-income, youth, and elderly citizens, and outdoor workers.

Weather:

The short term (i.e., minutes to weeks), day-to-day variability in atmospheric conditions (e.g., temperature, precipitation, and wind) in a given region. [38]

[37] ICLEI Canada. (2012). Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate change adaptation. Retrieved from: www.icleicanada.org/resources/item/3-changingclimate-changing-communities

[38] CNV. (2013). City of North Vancouver Climate Change Adaptation Plan. Retrieved from: http://www.cnv.org/your-government/living-city/climate-action/climate-change-adaptation

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☐ Info Package	Date:

Dept. Manager	GM/ Director	CAO

The District of North Vancouver
REPORT TO COUNCIL

June 9, 2017
File: 11.5225.50/001

AUTHOR: Angela Mawdsley, Project Engineer
Stephen Bridger, Section Manager Engineering Planning & Design

SUBJECT: **Integrated Stormwater Management Plan Framework and Objectives**

RECOMMENDATION:
That Council endorse the Integrated Stormwater Management Plan Framework and Objectives as presented in the report of the Project Engineer and Section Manager of Engineering Planning and Design Dated June 9, 2017.

REASON FOR REPOT:
Further discussion on the Integrated Stormwater Management Plan Framework and Objectives for Council endorsement.

SUMMARY:
The primary goal for the ISMP is to improve watershed health. To achieve this, we must continue to mitigate the impacts of stormwater runoff resulting from changes to land use and connect the natural and built environments to protect and enhance social, economic and environmental values of our community. Following a series of scientific studies and public input gathered through workshops, open houses and surveys, staff have prepared nine (9) draft objectives to aid the evaluation of District projects and improve decision making during the ISMP process. A brief description of each objective is provided below.

Environmental:

Objective 1 - Maximize base flows: Base flows come from delayed sources, such as groundwater, and ensure our watercourses have sufficient water to support habitat, food production, water quality, livelihoods, and wellbeing. Base flows are under threat from an increase in impervious surfaces and the displacement of groundwater caused by land use change.

Objective 2 - Maximize fish populations: Local watercourses provide fish spawning and habitat for both local and anadromous fish that travel out into the ocean before returning to our local watercourses. Decreasing ability of our watersheds to maintain healthy fish populations have resulted in the establishment of the Capilano and Seymour fish hatcheries

to ensure natural salmon (coho, stealhead and chinook) can continue to thrive in British Columbia. To minimize the risk to remaining fish populations it is important that we ensure our watercourses provide food, habitat, clean water, and enough flow.

Objective 3 - Maximize riparian ecosystems: Riparian refers to the unique ecosystems that surround the banks of watercourses that produce lush vegetation due to better soil and water availability. Healthy riparian areas have many important functions in our watersheds including the storage of floodwater, reduction of erosion, provision of habitat, and improved water quality.

Social:

Objective 4 - Maximize social-ecological connections: Recreation in our watersheds supports a variety of interests and values and can provide an opportunity to increase education and awareness on the services provided by our watersheds. It is also known that being in and near water increases our personal well-being. Ensuring public access to local watercourses will have long lasting positive impacts on our community and the individuals that visit our watersheds daily.

Objective 5 - Maximize sense of safety and security: It is important that we understand how and where rainwater related hazards such as clear water floods, debris floods and contamination can impact our community and consider designs and standards that minimize risks in a cost effective manner.

Objective 6 - Minimizing impacts on First Nation traditional use activities: The Tsleil-Waututh Nation and Squamish Nation have lived on the North Shore and occupied land surrounding North Vancouver along with the Musqueam Nation and Stó:Lo Nation since beyond recorded history and their intimate knowledge of the lands and waters within their territories has shaped their people and continue to provide traditional use activities. To ensure that our communities can sustain and enhance our cultures, it is important that we care for the waters together.

Economic:

Objective 7 - Maximizing natural assets: The District relies on natural assets for the provision of stormwater conveyance to the Burrard Inlet, the regulation of flows and water quality through natural lands and estuaries, and cultural benefits through outdoor recreation and tourism. Recognizing our natural assets and encouraging designs that provide both ecosystem and municipal services is important for strong sustainability and to minimize negative externalities from development.

Objective 8 - Minimize damage to infrastructure: As rainfall events become more intense and land use changes occur the risk to District infrastructure increases. To minimize damage to infrastructure, it is important that we understand how and where hazards such as peak flows and erosion can impact our infrastructure and consider tiered design standards that serve multiple risk levels in a cost effective manner.

Objective 9 - Minimize institutional costs and conflict: Institutional transaction costs include costs associated with information, coordination and enforcement. When these costs are minimized, institutions are more likely to be efficient and able to achieve their intended outcomes. It is important that local, regional, provincial and federal standards are aligned and not conflicting and that information is shared with other organizations to improve knowledge, efficiency and trust.

BACKGROUND:
By incorporating structure decision making into the ISMP framework, opportunities for improved watershed health can be evaluated and implemented in all areas of business including capital planning, development and maintenance. It also provides an opportunity to communicate decision making and a common understanding about what couldn't be achieved with different alternatives, about what trade-offs were acceptable and about which uncertainties were most important.

EXISTING POLICY:
The ISMP will help the District meet the OCP vision and policies under Section 9.3. In addition, ISMP's are required by the Ministry of Environment under condition 7 of Metro Vancouver's *Integrated Liquid Waste and Resource Management Plan.*

ANALYSIS:
District staff has been completing drainage and stormwater improvement projects for decades. Development of the ISMP will further enhance this work by defining current watershed health objectives, encouraging participation by all staff and communicating decision making.

Timing/Approval Process:
District staff is continually working on the ISMP and presenting the Framework and Objectives to Council for endorsement is the first step. Once the framework and objectives are endorsed, staff can continue with completing watershed implementation plans. Staff will report back to Council as implementation plans progress and for endorsement of recommendations related to policy and bylaw changes.

Concurrence:
The plan is integrated and adaptive by nature and includes an ongoing engagement and monitoring process which has already begun both internally with District staff from all Departments and externally with community members.

Financial Impacts:
Development of the ISMP is funded through the Sewer Utility – Special Watercourses and projects that are identified will be prioritized and included in the existing Sewer Utility Capital Maintenance budget.

Liability/Risk:
ISMP's are required by the Ministry of Environment under condition 7 of Metro Vancouver's *Integrated Liquid Waste and Resource Management Plan.* Implementation of the ISMP is of very low risk and will help mitigate risk from degraded watershed health and hazards.

Social Policy Implications:
Improvement on awareness of values and problems associated with watersheds and management of drainage infrastructure.

Environmental Impact:
Increased awareness on the importance of watershed health through the recognition of social-ecological connections that sustain our community's needs and values..

Public Input:
A summary of the public engagement completed to date is provided in the attached ISMP Framework and Objectives report.

Conclusion:
Development of the District wide ISMP is of paramount importance to improve watershed health and better manage stormwater quantity and quality.

Respectfully submitted,

Angela Mawdsley, Project Engineer
Stephen Bridger, Section Manager Engineering Design & Planning

REVIEWED WITH:

❑ Sustainable Community Dev.	____	❑ Clerk's Office	____	External Agencies:	
❑ Development Services	____	❑ Communications	____	❑ Library Board	____
❑ Utilities	____	❑ Finance	____	❑ NS Health	____
❑ Engineering Operations	____	❑ Fire Services	____	❑ RCMP	____
❑ Parks	____	❑ ITS	____	❑ NVRC	____
❑ Environment	____	❑ Solicitor	____	❑ Museum & Arch.	____
❑ Facilities	____	❑ GIS	____	❑ Other:	____
❑ Human Resources	____	❑ Real Estate	____		

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NORTH VANCOUVER
DISTRICT

District of North Vancouver Integrated Stormwater Management Plan Framework and Objectives

Table of Contents

INTRODUCTION

The District of North Vancouver (District) is uniquely situated at the base of the North Shore Mountains where the land intersects with the water of the Burrard Inlet. Both the mountains and inlet support one another through the supply of rainwater and delivery of freshwater down the mountain slopes where they pick up nutrients and provide aquatic habitat on route to the Burrard inlet. These diverse and abundant watersheds have supported the first inhabitants of this land, the Coast Salish people (Tsleil Waututh Nation, Squamish Nation and Musqueam Nation), since time immemorial.

Today, these watersheds continue to service the Tsleil Waututh Nation, Squamish Nation and Musqueam Nation along with the citizens of the District and City of North Vancouver. Our use and non-use values of the local watersheds range from rainwater conveyance, recreational use, cultural use, drinking water supply, natural habitat and a beautiful place to live. Values that support the vision of the District:

"Inspired by nature, enriched by people."

This ISMP along with future implementation plans will help protect, support and move the community towards this vision.

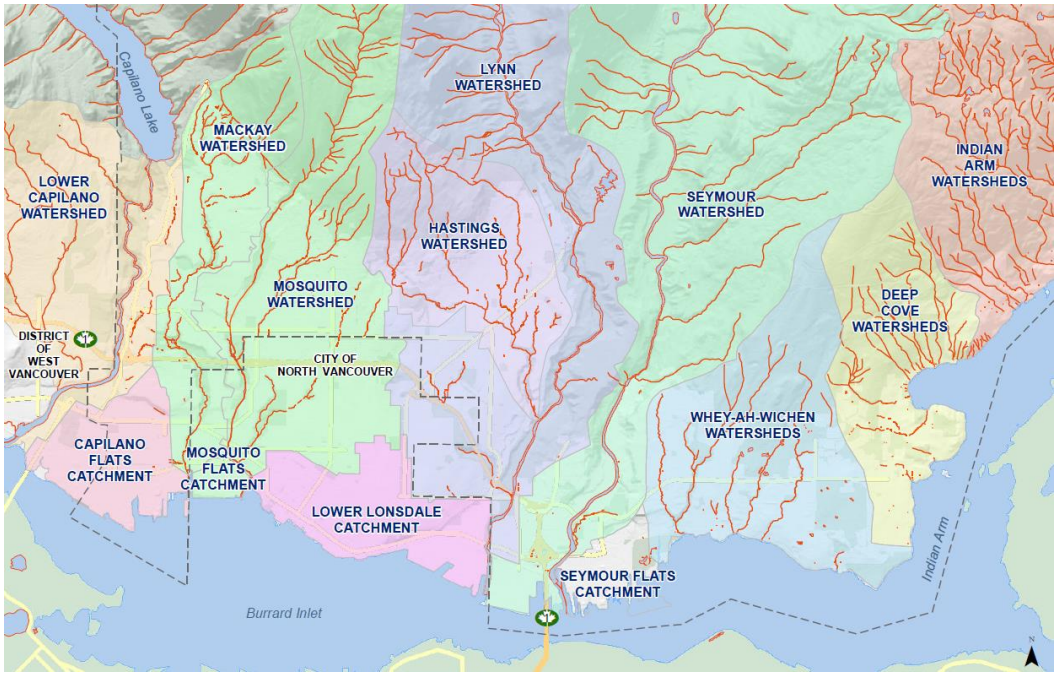


Figure 1: Watersheds in the District and City of North Vancouver

1

PURPOSE

In developed areas, impervious surfaces such as pavement and roofs prevent rain from naturally soaking into the ground. When rain is prevented from soaking into the ground, it flows overland and is collected into drainage infrastructure where it is directed to local watercourses. This overland flow is called stormwater runoff and as we continue to increase the amount of impervious surface in our communities from land use change, we increase the amount of stormwater runoff, decrease the recharge of groundwater, how fast it flows and the pollutants it picks up along the way. Historically, natural forest was harvested and replaced with housing and roads that extended up the mountainside as streams and wetlands were covered over. The traditional approach to dealing with stormwater, piping it as quickly as possible to natural streams or the sea, as the community expanded, has led to negative impacts from disturbing the natural Water Balance. These impacts include:

- Stream bank erosion and flooding;
- Toxic pollution in watercourses;
- Ecological damage and habitat loss;
- Expensive drainage sewer upgrades and maintenance; and
- Insufficient groundwater supply to support stream base flow requirements.

The 2011 Official Community Plan (OCP) is based on compact, complete and connected networks of densified centres. It identifies a slowing trend of community expansion that results in the displacement of natural land and a commitment to mitigate damage to watershed health. However, disturbance to the natural Water Balance (evapotranspiration, runoff, and infiltration) can be expected to increase in the District of North Vancouver as development continues to increase in order to serve a rising population unless effective mitigation measures are applied. The OCP is projecting a population increase of 20,000 people by 2030 and 10,000 net new housing units through mainly higher density developments. Higher density developments should protect the displacement of natural land, however, there are still impacts on the natural water balance through reduced green space, increased impervious surfaces and underground construction. In some cases, single family homes are having a greater impact on the natural water balance than in the past as their lots become smaller through infill and homes and driveways get larger. Basements and underground parking structures are also impacting underground water movement and limiting the amount of infiltrating soil that would otherwise naturally recharge our local watercourses. Other forms of land use change will accompany development through road construction, park transformation and increased access to natural areas and trail networks will also impact the natural water balance.

In addition to our direct impacts on the land, climate change is projected to cause wetter winters and dryer summers. A recent climate change study completed by the District has identified an increase in rainfall by approximately 30% in the lower lands and 35% in the upper lands by 2100.

Therefore, as our communities continue to grow and rainfall events become more intense in the winter and less frequent in the summer, more holistic and integrated planning is needed to better understand the impact of decisions on all social, economic and environmental values.

Integrated Stormwater Management Planning (ISMP) was first envisioned in British Columbia in the 1990s to address observed degradation of watershed values and health as a function of new land development in undeveloped watersheds. This was commonly expressed as a loss of fish and fish habitat in streams due to removal of forested conditions and development of highly impervious landscapes. The concept of ISMPs were formalized in the early 2000s with both the Province and the Greater Vancouver Regional District (Metro Vancouver) creating guideline documents to assist in the creation of plans. At the same time, the Province mandated that all member municipalities prepare ISMPs for watersheds where there was substantial, planned or existing development.

APPROACH

To mitigate the cumulative impacts of stormwater runoff resulting from changes to land use, the proposed ISMP aims to connect the natural and built environments to protect and enhance social, economic and environmental values of our community in essence to move towards the OCP vision. An "aid to thinking" framework is used to identify, understand and balance trade-offs building on the core planning elements identified by the Province: What do we have; what do we want; and how do we get there?

Figure 2: Core elements of the planning process

The framework incorporates an iterative process to support adaptation requirements as environments, needs, values and knowledge change over time. As such, the adopted framework includes a five step process that is transparent, communicates decision making and is continually improved and built upon over time. A description of the process is provided below and illustrated in Figure 3.

Step 1: Identify values and problems
The first step of the framework includes the systematic identification of problems and values through a participatory approach that merges community knowledge and values with scientific findings. This approach helps develop a systematic understanding of what we have, how we have gotten here and what we want.

Step 2: Define objectives and performance measures
The second step includes the identification of planning goals and objectives along with performance measures to identify how to meet the intended objectives. These performance measures are then applied in the third stage to evaluate alternative activities that have been identified. They can also be applied outside the ISMP context to help integrate ISMP objectives in other plans and designs.

Step 3: Develop and evaluate alternatives
The third step involves the identification of various actions or activities relevant to the problems and objectives in our watersheds. By ensuring several alternatives are developed, decision makers can compare a range of solutions based on the trade-offs of estimated consequences and values attributed to each objective.

Step 4: Implement plans
Once solutions have been evaluated, the implementation of these solutions is to be carried out through the ISMP Implementation Plans and supporting programs. The implementation of solutions will also include the development of specific monitoring criteria and indicators which are not part of the region wide *Monitoring and Adaptation Management Plan* but considered relevant for that watershed.

Step 5: Monitor and evaluate
Following the implementation of each ISMP Implementation Plan, ongoing monitoring and evaluation is to carried out and inform values and problems observed post implementation.

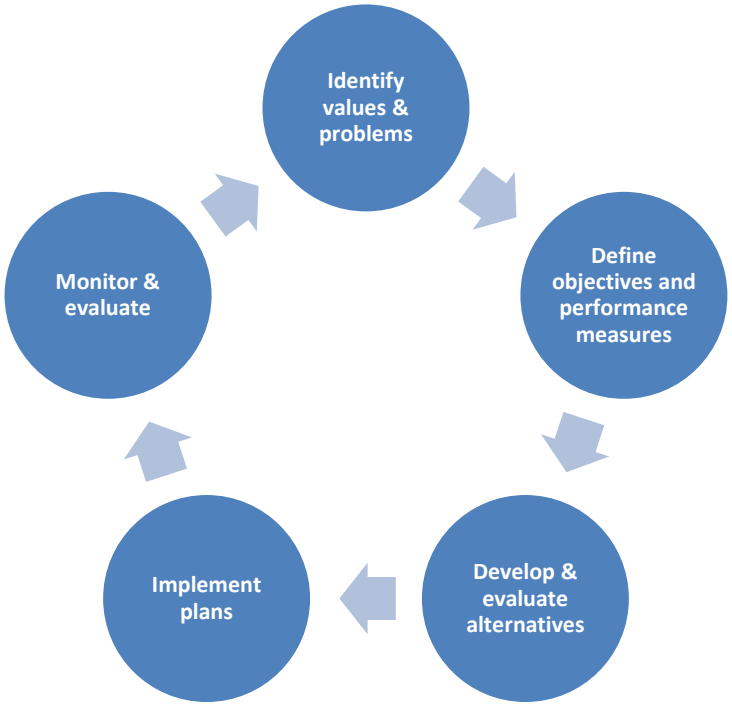


Figure 3: Framework

Given that there are many watersheds within the District's municipal boundaries with unique land use priorities and social-ecological environments, the proposed ISMP aims to inform the policy component of the integrated planning process. Following the adoption of the ISMP, Watershed Implementation Plans for each watershed will be developed to the needs and constraints of individual watersheds through the development of local performance measures, evaluation of alternative activities and monitoring efforts. As such, the ISMP focuses on the identification of values, problems, objectives and supporting programs to carry out the remaining steps at the watershed level.

VALUE AND PROBLEM IDENTIFICATION

Values and problems were identified throughout the District using a participatory approach that integrated the OCP, external public consultation and scientific studies and reports.

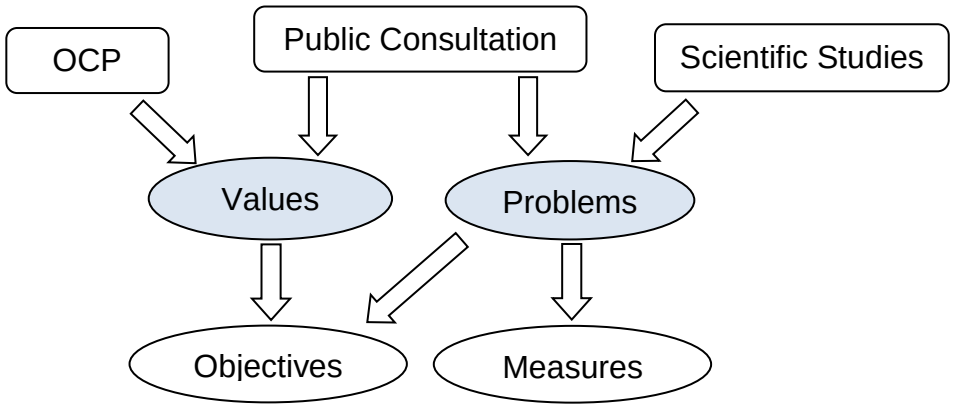


Figure 4: Value and problem inputs and outputs

District OCP

The District's OCP identifies a long term vision for the District that is: "inspired by nature and enriched by people". The plan is intended to help guide District Councils, stakeholders and citizens effect positive change over a twenty-year time horizon. It also includes polices that impact a broad range of municipal affairs and provides ongoing guidance to municipal decision making and operations. The vision, principles and goals identified in the OCP were developed over a 2 year community engagement initiative. Policies directly related to watersheds are identified in section 9.3 and include:

1. Prepare and implement integrated watershed/stormwater management plans for all District watersheds prioritizing watersheds containing key growth areas;
2. Facilitate the protection and enhancement of streams, riparian areas and wetlands;
3. Facilitate the maintenance of fish passage in all streams and restore habitat and connectivity in riparian areas for the District;
4. Encourage measures to infiltrate rainwater onsite, where appropriate, and manage impervious areas to reduce runoff volumes, improve water quality, and recharge groundwater; and
5. Facilitate the protection and maintenance of groundwater levels where appropriate, and manage the amount of groundwater pumped into drainage infrastructure.

Public Consultation

Public input was obtained from a series of open houses, advisory group meetings and workshops with the local streamkeeprs group. These public sessions were held with the City of North Vancouver to coordinate efforts in shared watersheds.

A total of two open houses were held at the beginning of the ISMP process to encourage public interest and identify values and connections citizens had with their local watersheds. Concerns were also identified and citizens shared stories about how the watercourses have changed over time due to land alterations and every day human activities. These initial open houses also provided an opportunity for citizens to sign up to receive ongoing communication around ISMP development.

Feedback from the open houses also identified that citizens were interested in contributing in the development of the ISMPs so combined meetings with the ISMP Advisory group and the Parks and Natural Environment Advisory Committee (PNEAC) were carried out. This approach was also seen as being more holistic and followed the integrated goals of the planning process. These meetings focused on communicating identified concerns and opportunities for collaboration on park, natural environment and watershed objectives. It also provided an opportunity to understand constraints and value conflicts between objectives.

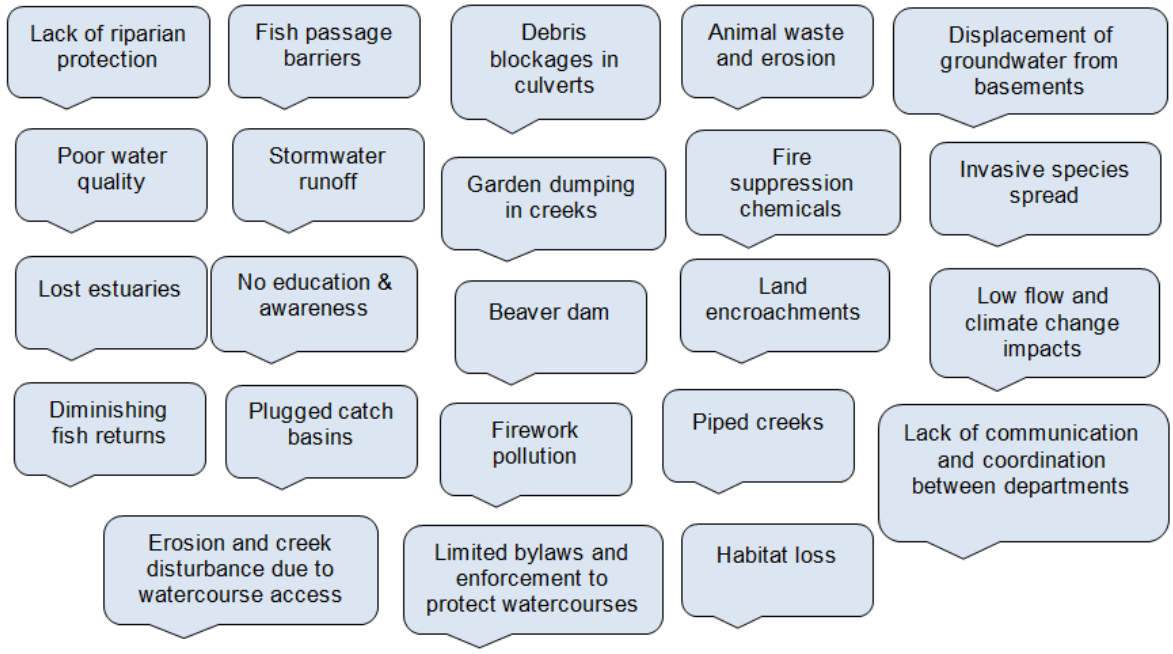
District and City staff also hosted workshops with North Shore Streamkeeper's (NSSK). As active community members, the NSSK have been monitoring, improving and protecting local watercourses for over 20 years. To ensure the planning process compliments their efforts and knowledge, workshops focused on the identification of watershed issues, collaboration and opportunities throughout our communities.

Table 1: Summary of public consultation

Date	Location	Number of Attendees
Open Houses		
February 27, 2014	City of North Vancouver	9
November 25, 2014	District of North Vancouver	22
Advisory Meetings and Workshops		
September 23, 2014	District of North Vancouver	12
February 25, 2015	District of North Vancouver	17
October 29, 2015	District of North Vancouver	10
June 21, 2016	District of North Vancouver	7

In addition to the open houses and advisory meetings, District and City web sites provided ongoing information on the ISMP progress, meeting notifications and contact information for further inquiries. The City also provided an online survey that allowed citizens to provide input at their convenience.

Overall, the public identified a wide array of values associated with local watercourses and watersheds including fish, wildlife, habitat, clean water, open channels, riparian protection, and recreation. These values stem through generations and tell the story of a strong cultural connection to nature here on the north shore. Concerns were also identified and are used to help identify cause and effect relationships specific to our watersheds and human behaviour. Concerns are summarized below.



Scientific Studies

The District has completed several studies to better understand the current state of our watersheds and identify existing and future risks that may impact local values and municipal services.

The first study was to identify the impact of a changing climate on rainfall events on the North Shore. Intensity, duration and frequency curves (IDF curves) are used to estimate rainfall amounts to size infrastructure and identify return periods for storm events (i.e. 100 year rain fall event) and IDF data had not been updated since 1980. To update this information, data was used from rainfall gauges throughout North Vancouver owned by both the District and Metro Vancouver. Climate change impacts were then added to the analysis using an RCP of 8.5 in line with the District's Climate Adaptation Strategy.

Using the newly updated IDF curves, a drainage analysis of municipal infrastructure was carried out using the hydraulic modeling software InfoSWMM. The analysis included modeling scenarios for current and future land use to identify runoff rates and volumes and the corresponding loads for drainage infrastructure such as storm sewers, ditches and culverts. The results of the analysis are currently being assessed and do not identify any immediate concerns regarding existing infrastructure sizing. In the future, the analysis can be broadened to assess the effects of implementing low impact

development techniques and can also include the modeling of watercourses to identify low and peak flow needs.

In accordance with the Regional Monitoring and Adaptation Management Framework required by the Ministry of Environment, the District began its water and aquatic health monitoring in 2015. This includes the monitoring of watercourse flows, water quality and biotic integrity at 27 sites throughout the District. Results from the 2015 monitoring program identified concerns with the following water quality indicators that were more than 5 times above the acceptable limit ("needs attention"):

- E. coli
- Fecal Coliforms
- Dissolved Oxygen
- Copper
- Zinc
- Iron
- Aluminium
- Beryllium
- Conductivity
- Turbidity

Biotic integrity also ranged from very poor to fair which support the water quality results obtained which require us to improve the quality of our drainage effluent and watercourse health to meet regional standards.

Values

To ensure a holistic value-based foundation, the ISMP process has integrated the vision and values of all stakeholders to identify the following values:

Environmental Values

- Protect and restore environmentally sensitive and vulnerable areas
- Preserve the environment and ecosystem functions
- Integrate climate change adaptation into decision-making
- Promote environmental stewardship within our communities and organizations

Cultural, Spiritual and Social Values

- Promote human connections to land and water
- Promote health and wellness
- Respect and protection for indigenous Cultural Heritage
- Reduce the risk of property damage

Economic Values

- Maintain a strong economy and employment opportunities
- Support economic development opportunities
- Integrate efficiency, feasibility and acceptability into decision-making

Problems

To help communicate what the problems are and why the problems are occurring, the development of a problem tree, or problem analysis, was completed using public and scientific information and knowledge. Figure five on the following page shows the cause and effect relationships of watersheds in the District. The main focal problem has been identified as being our inability to implement new methods and approaches in a coordinated manner which has led to continual social-ecological inefficiencies and losses.

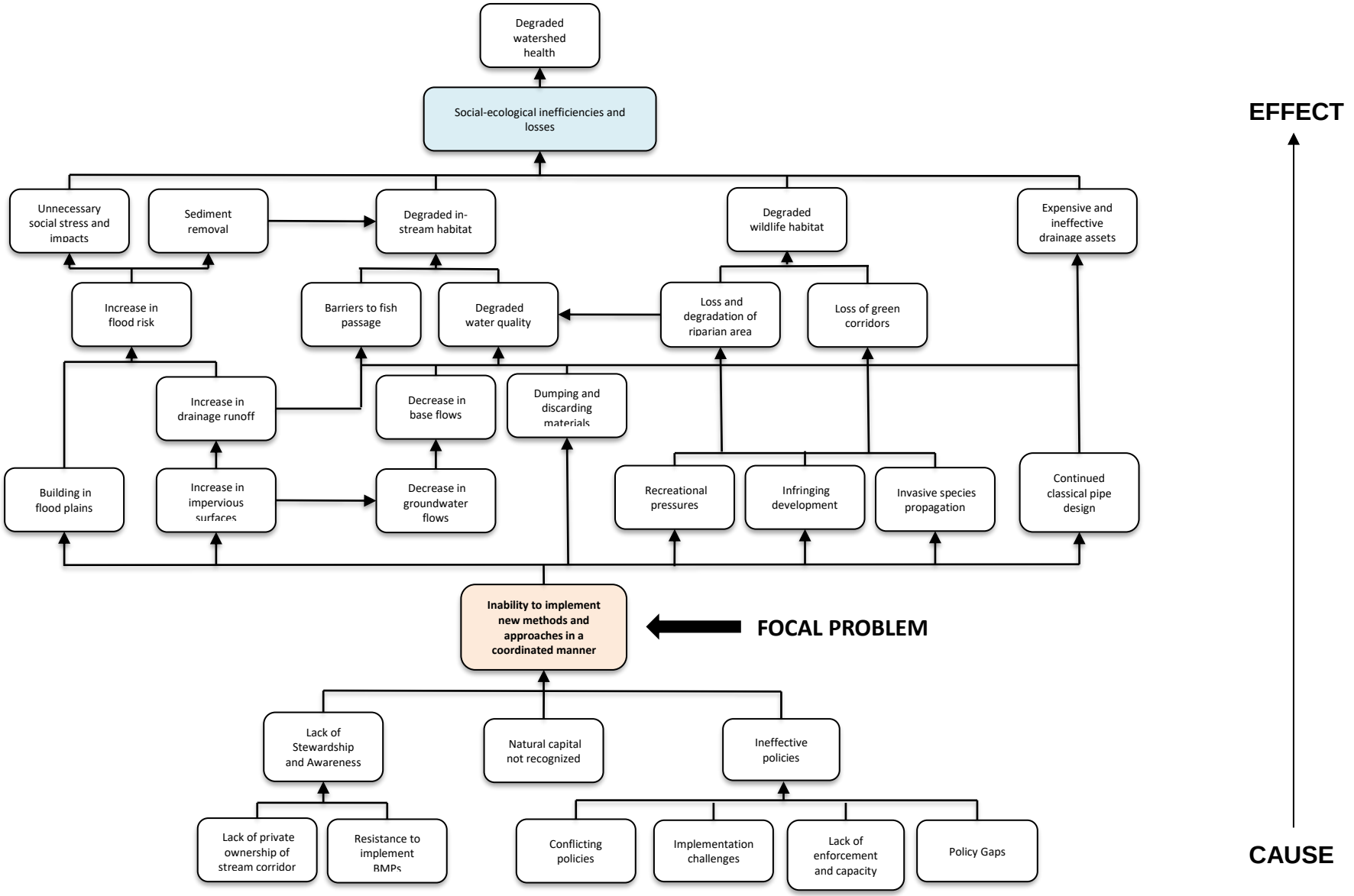


Figure 5: Problem Tree

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OBJECTIVES AND PERFORMANCE MEASURES

Objectives are concise statements of the fundamental interests that could be affected by a decision. They are the things that matter and become the basis for creating and evaluating management alternatives.

Objectives

Using the problem tree we were able to identify preliminary objectives for the watersheds to achieve the overall goal of improved watershed health. Figure six illustrates the goal and primary objectives grouped into the broad areas of environmental, social and economic wellbeing.

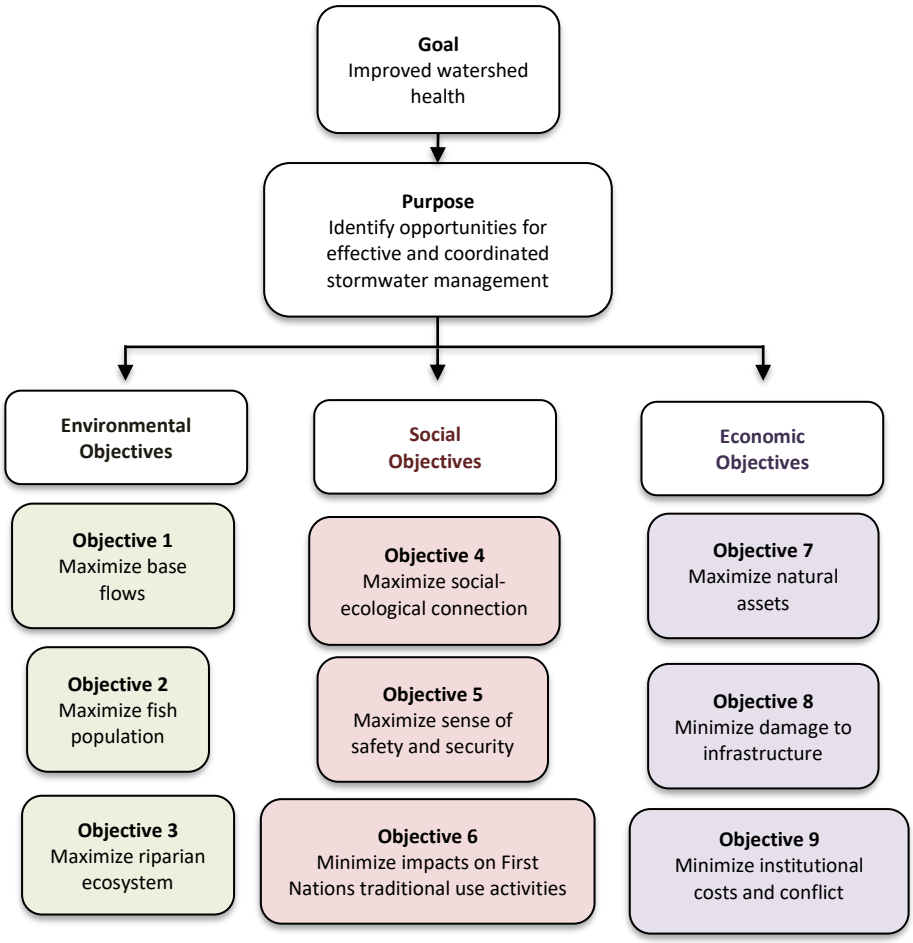
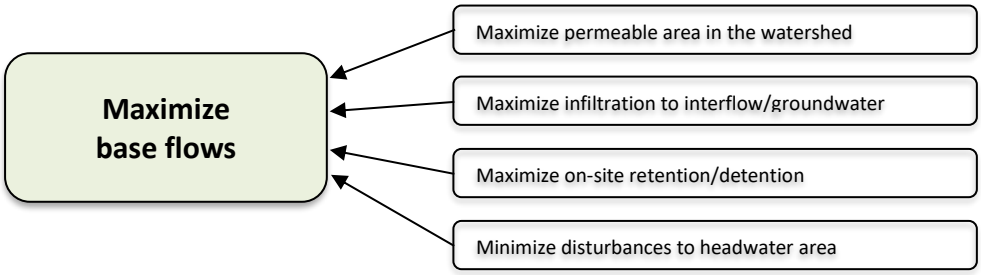


Figure 6: Objective tree

Environmental Objectives and Sub-objectives:

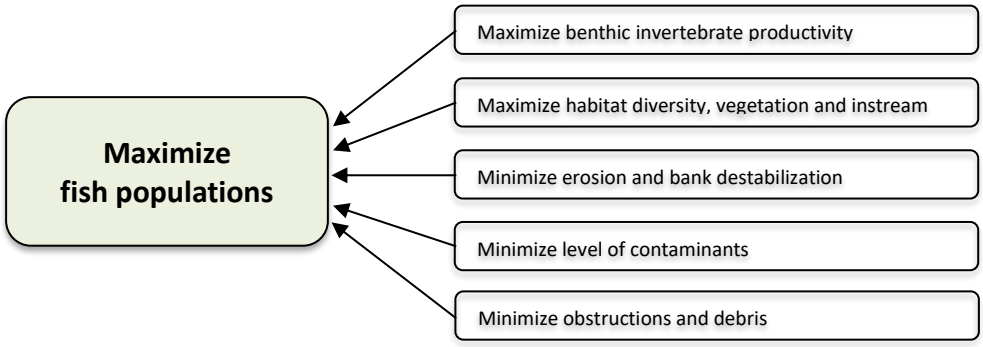
Maximize base flows

Understanding base flow conditions in surface water resources is an important aspect of water management and environmental protection. Base flows come from delayed sources, such as groundwater, and ensure our watercourses have sufficient water to support habitat, food production, water quality, livelihoods, and wellbeing. Here in the District, base flows are under threat from an increase in impervious surfaces and the displacement of groundwater caused by land use change. To mitigate this threat, we can protect the natural environment and mitigate the impacts of land use change by infiltrating rainwater and hold back rainwater to mimic the natural water balance.

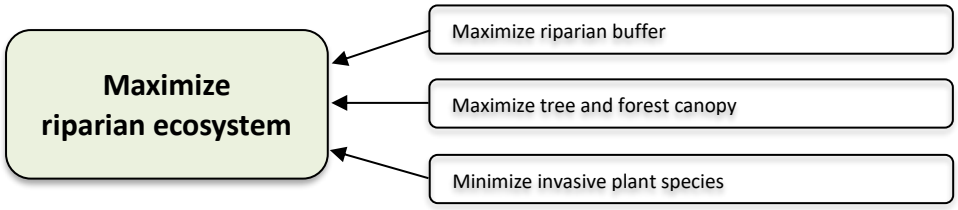


Maximize fish populations

Fish are an important value to North Vancouver through the provision of food, culture, recreation and supporting tourism services. Local watercourses provide fish spawning and habitat for both local and anadromous fish that travel out into the pacific beyond Vancouver Island before returning to our local watercourses. Decreasing ability of our watersheds to maintain healthy fish populations have resulted in the establishment of the Capilano and Seymour fish hatcheries to ensure natural salmon (coho, stealhead and chinook) can continue to thrive in British Columbia. To minimize the risk to remaining fish populations, or tragedy of the commons, it is important that we ensure our watercourses provide food, habitat, clean water, and enough flow. It is also important that we do not increase flows too much causing erosion or block the ability of fish to pass through culverts and other structures.

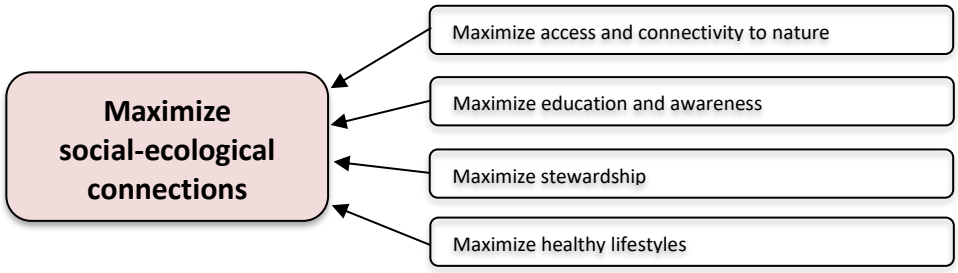


Maximize riparian ecosystem
Riparian refers to the unique ecosystems that surround the banks of watercourses that produce lush vegetation due to better soil and water availability. Healthy riparian areas have many important functions in our watersheds including the storage of floodwater, reduction of erosion, provision of habitat, and improved water quality. To protect our riparian ecosystem we can reduce the amount of development within 45 metres of the high water level, plant native vegetation including trees and remove invasive species.

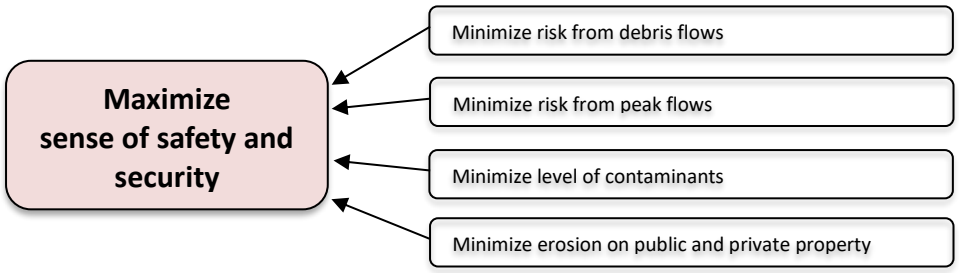


Social Objectives and Sub-objectives:

Maximize social-ecological connection
Recreation in our watersheds supports a variety of interests and values and can provide an opportunity to increase education and awareness on the services provided by our watersheds. It is also known that being in and near water increases our personal well-being. Ensuring public access to local watercourses will have long lasting positive impacts on our community and the individuals that visit our watersheds daily.

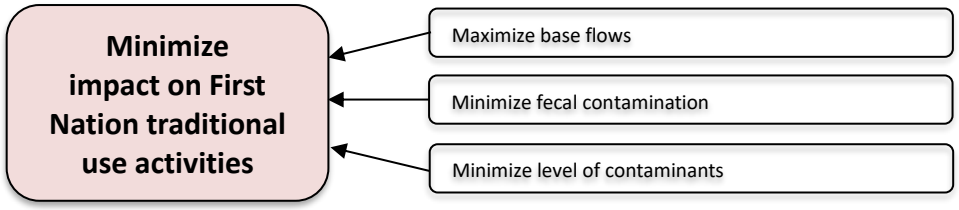


Maximize sense of safety and security
As rainfall events become more intense and we continue to change the land that once absorbed and slowed down that rainwater, we increase our risk to hazards. These hazards are common for communities located in similar environments, however, it is how we develop that can change our level of risk. To improve our safety and security, it is important that we understand how and where hazards such as peak flows and water contamination can impact our community and consider designs and standards that minimize risks in a cost effective manner. This will include the identification of an acceptable level of disruption under certain circumstances or areas.



Minimize impacts on First Nation traditional use activities

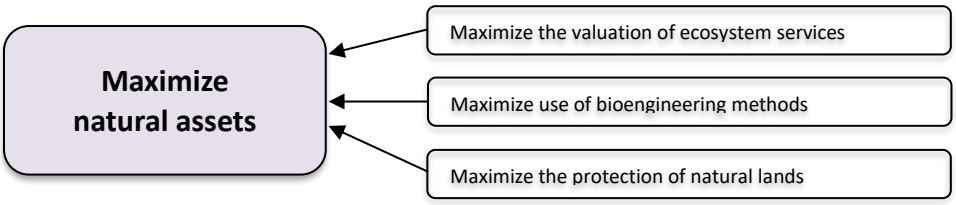
The Tsleil-Waututh Nation and Squamish Nation have lived on the North Shore and occupied land surrounding North Vancouver along with the Musqueam Nation and St□:Lo Nation since beyond recorded history. Their intimate knowledge of the lands and waters within their territories has shaped their people and continue to provide traditional use activities. To ensure that our communities can sustain and enhance our cultures, it is important that we care for the waters together. This includes ensuring there are base flows available in creeks and the removal of fecal and other contaminants in watercourses that are used for traditional activities.



Economic Objectives and Sub-objectives:

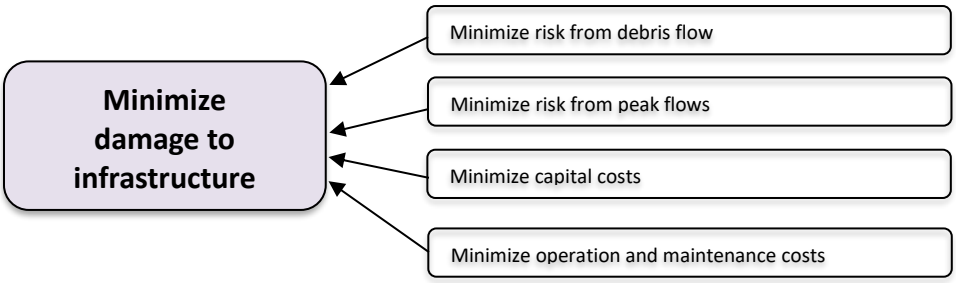
Maximize natural assets

Natural assets are naturally occurring environments that provide municipal services through their naturally occurring ecosystem services (provisioning, regulating, supporting and cultural services). District relies on natural assets for the provision of stormwater conveyance to the Burrard Inlet, the regulation of flows and water quality through natural lands and estuaries, and cultural benefits through outdoor recreation and tourism. Recognizing our natural assets and encouraging designs that provide both ecosystem and municipal services is important for strong sustainability and to minimize negative externalities from development.



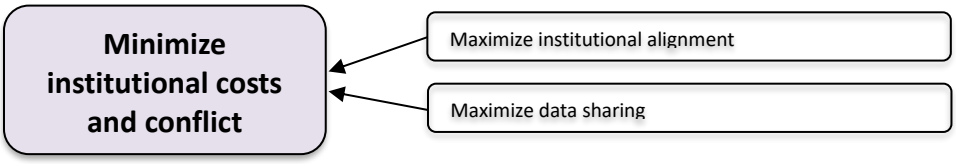
Minimize damage to infrastructure

As rainfall events become more intense and we continue to change the land that once absorbed and slowed down that rainwater, we increase our risk to hazards. These hazards are common for communities located in similar environments, however, designs and development standards can change our level of risk and ability to restore services. To minimize damage to infrastructure, it is important that we understand how and where hazards such as peak flows and erosion can impact our infrastructure and consider tiered design standards that serve multiple risk levels in a cost effective manner. This will include the identification of on site and off site solutions that work together and compliment other services.



Minimize institutional costs and conflict

Institutional transaction costs include costs associated with information, coordination and enforcement. It is considered that when these costs are minimized, institutions are efficient and able to achieve their intended outcomes. To minimize institutional costs and conflict, it is important that local, regional, provincial and federal expectations are aligned and do not describe conflicting standards. It is also important to ensure we share information with other organizations to improve knowledge and trust.



Performance Measures

When making a choice among possible actions, performance measures can be used to consistently estimate and report on how well each alternative will performance in respect to a particular objective. Whereas objectives may be quite broad, performance measures need to be specific because they define how an objective is to be interpreted and evaluated for the purposes of decision making.

Performance measures will be identified in the implementation plan of each watershed as although objectives and their sub-objectives identified in the previous section will be consistent across the District, watersheds may have slightly difference performance measures (or targets) for each sub-objective depending on current conditions and local constraints. For example, Capilano watershed has high groundwater flows making infiltration in some areas unreasonable due to potential risks of daylighting groundwater further downhill. In addition, flows in Capilano River are also controlled by the Capilano dam managed by Metro Vancouver to ensure water supply to Metro member municipalities. Flows can vary in the river from dam operations resulting in less of an impact from peak stormwater runoff rates from land use change caused by development. As such, performance measures related to maximizing base flows will reflect these constraints with modified targets in the Capilano Watershed Implementation Plan.

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Integrated Stormwater Management Plan: Framework and Objectives

Council Workshop

June 20, 2017

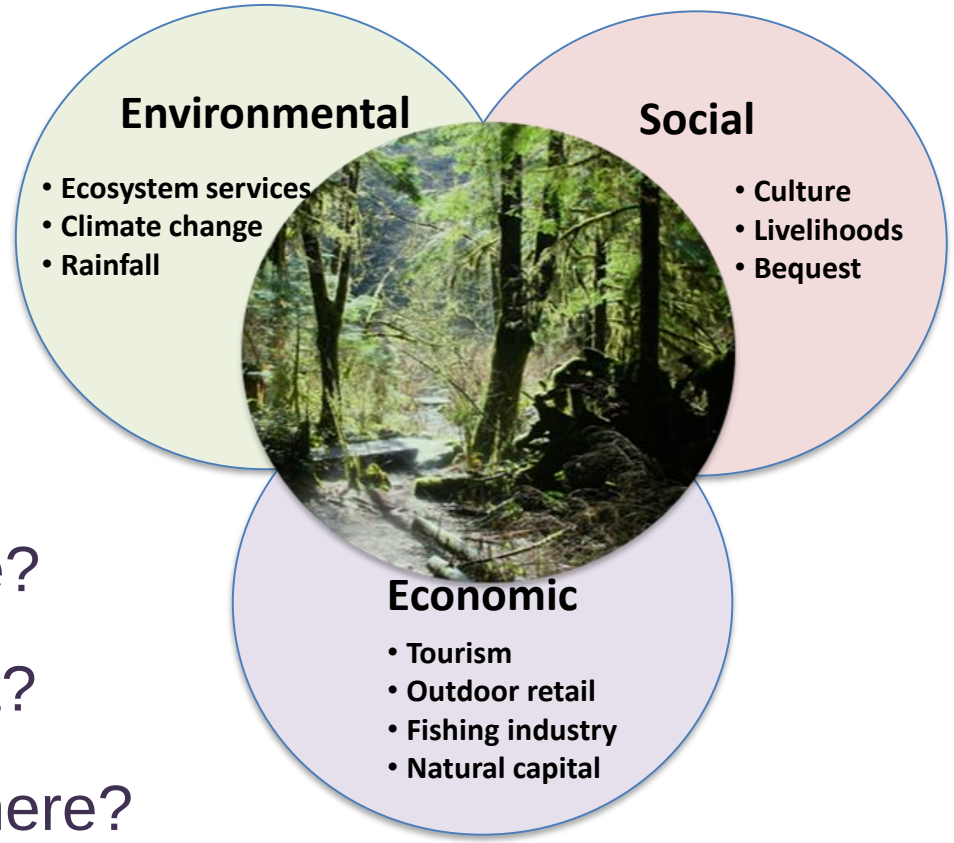
NORTH VANCOUVER DISTRICT

Outline

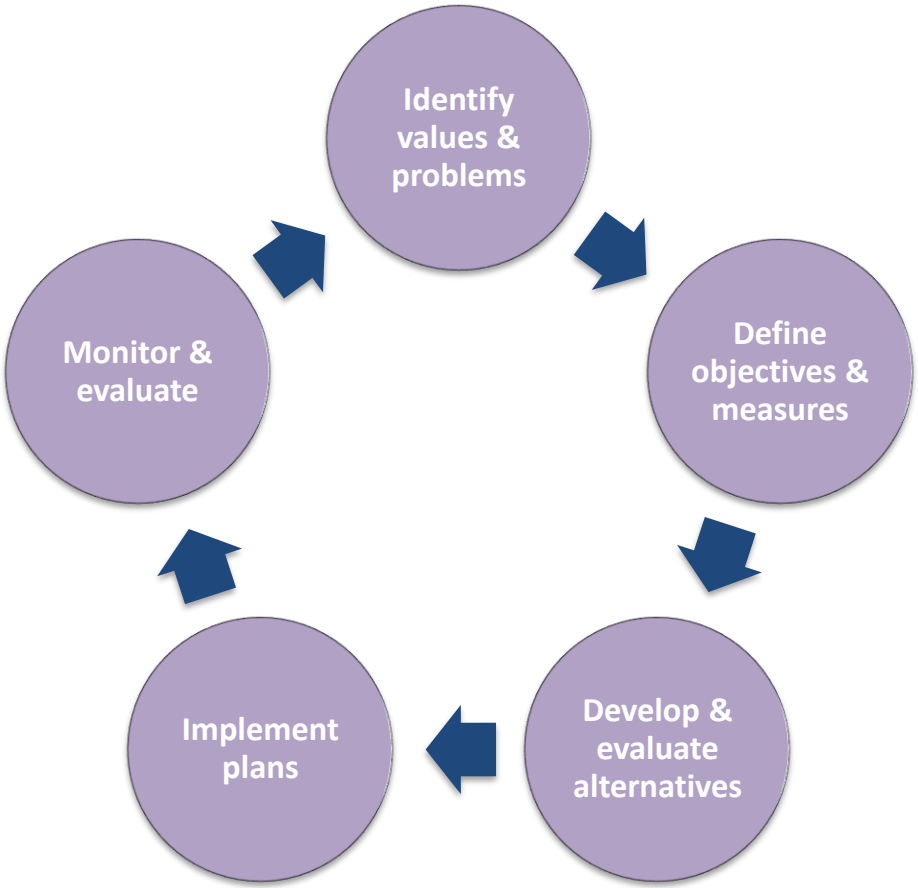
- Fulsome discussion on ISMP objectives for consideration and endorsement by Council

ISMP Requirements

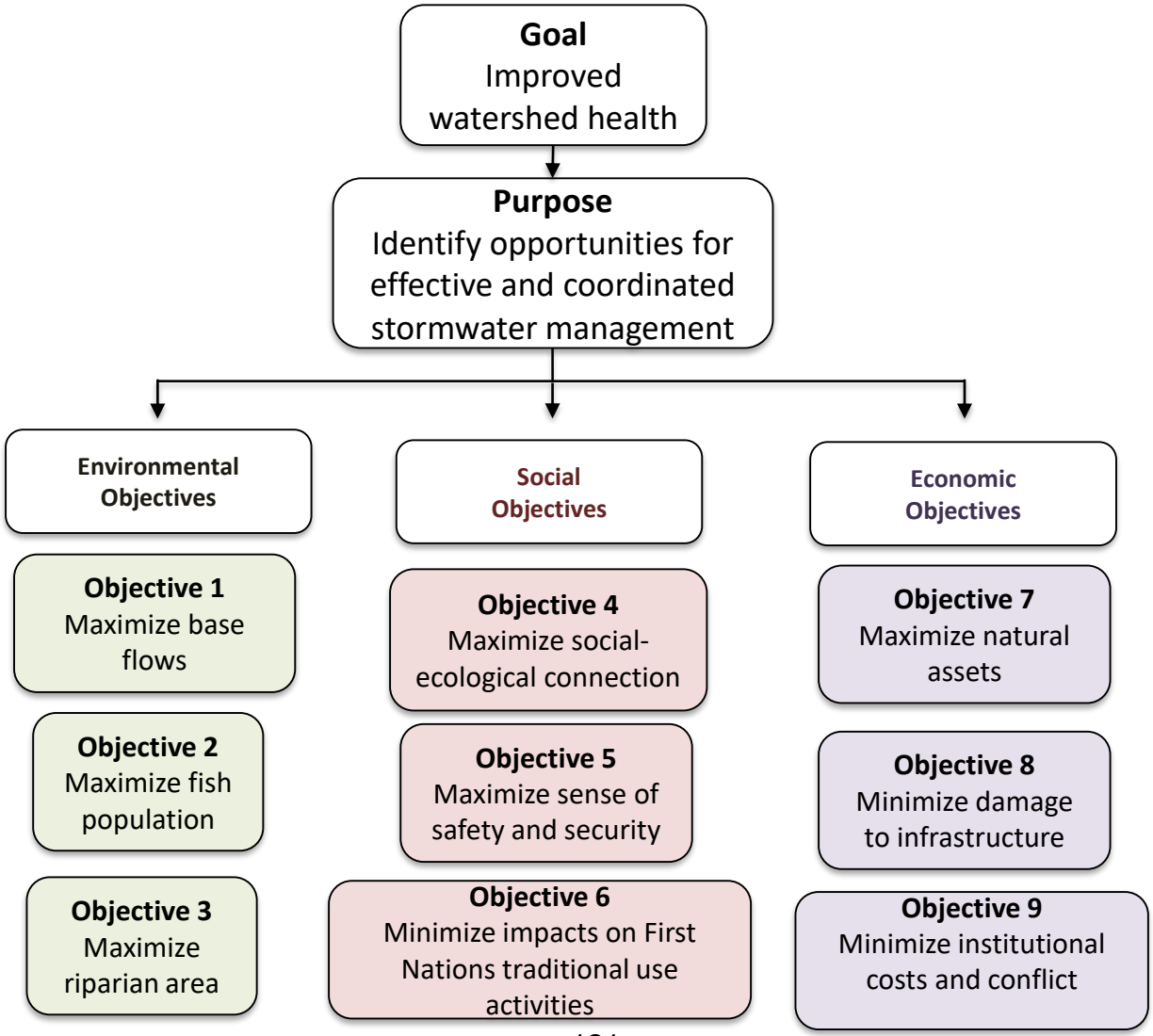
1. Integrative
2. Adaptive
3. Performance based
   - What do we have?
   - What do we want?
   - How do we get there?



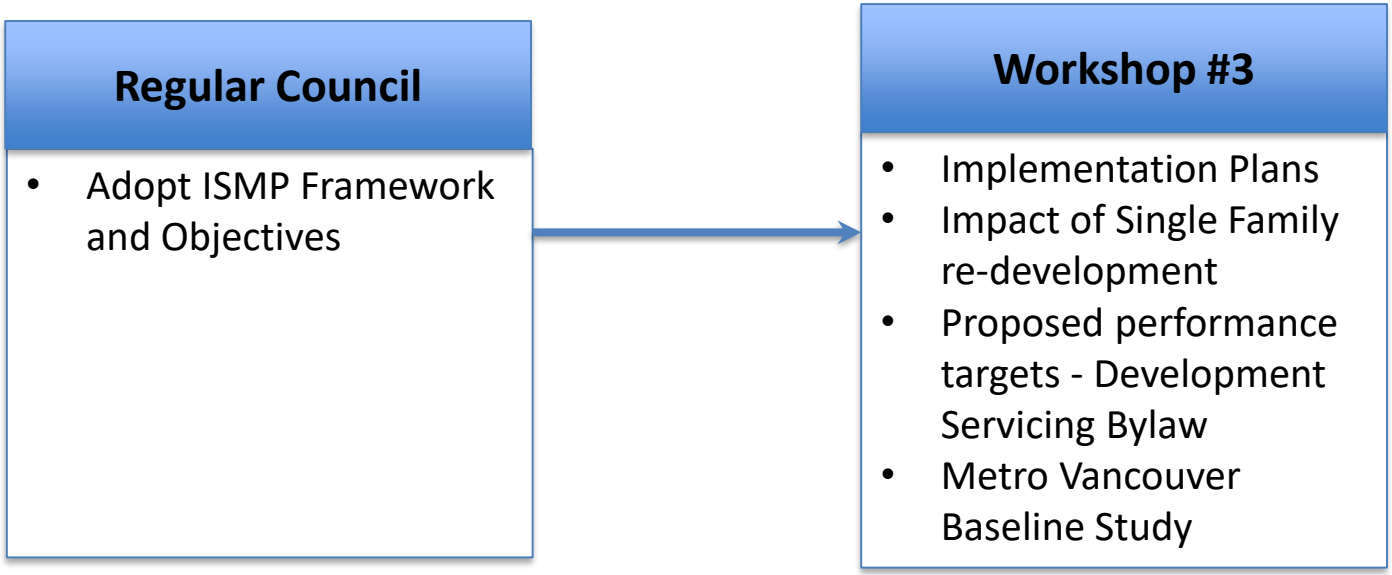
ISMP Framework



ISMP Objectives



Next Steps


Regular Council
• Adopt ISMP Framework and Objectives
Workshop #3
• Implementation Plans
• Impact of Single Family re-development
• Proposed performance targets - Development Servicing Bylaw
• Metro Vancouver Baseline Study