



Municipalities for Climate Innovation Program

Guide for Integrating Climate Change Considerations into Municipal Asset Management



ACKNOWLEDGEMENTS

This guide is based on the input and best practices from 11 municipalities participating in the Federation of Canadian Municipalities' Climate and Asset Management Network (CAMN) and the former Leaders in Asset Management Program (LAMP), including:

- Saint John, NB
- Fredericton, NB
- Ville de Saint-Quentin, NB
- Bromont, QC
- Halton Hills, ON
- Guelph, ON
- Kitchener, ON
- Kenora, ON
- Selkirk, MB
- Cowichan Valley Regional District (CVRD), BC
- Nanaimo, BC

These communities represent varying geographies, populations, service delivery responsibilities, and are affected by a cross section of the hazards experienced by municipalities in Canada. Each community has taken a unique approach to integrating climate change into asset management; some communities are still in the early stages of their process, or have only focused on an individual service area, while others have looked at how climate change could affect all of their services.

FCM's Municipal Asset Management Program's Technical Working Group also provided input for this guide. The guide was prepared by Kerr Wood Leidal Associates Ltd.

Canada 

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Find out more about our program, tools and training at fcm.ca/climateinnovation

ABOUT THIS GUIDE

The Federation of Canadian Municipalities commissioned this guide under the Municipalities for Climate Innovation Program (MCIP).

Integrating climate change into asset management is not easy. Climate change and its implications for municipal services and infrastructure are complex. The intention of this guide is to provide a clear roadmap that municipalities can use to understand the issues and systematically build climate resiliency into asset management policies, plans and practices. It is intended for use by municipal staff who need to understand how to address climate change in asset management processes. A companion video and information briefs have been developed, which are intended to help elected officials and the public understand what the issues are, and why they are important.

The guide is focused on integration of climate change within infrastructure levels of service and/or risk management frameworks, because these are the components of asset management most directly impacted by climate change. There are also important implications for costs of service and financial planning over asset lifecycles, which are also addressed in the guide. Some communities may choose to approach these issues as part of their climate change or community sustainability strategies, while others may do so through their asset management programs. Regardless of the approach, the principles and practices described in this guide can be applied.

The guide consists of the following six sections:

1. **Enhancing Community Resilience through Service Delivery**—Sets the context for the guide, which links community resilience and service delivery to the more focused topics of levels of service and risk management from a climate change perspective.
2. **Integrating Climate Change Considerations into Decision Making**—Describes the rationale and benefits of integrating climate change considerations into municipal decision making.
3. **The Framework**—Introduces a single process for integrating climate change in the development of levels of service and risk management frameworks.
4. **Entry Points**—Describes four different approaches for using this framework, depending on whether you are beginning from the ground up, focusing on levels of service, focusing on risk management, or adapting an existing framework to integrate climate change considerations.
5. **Step by Step through the Framework**—Provides a systematic process that practitioners can follow for developing or revising the infrastructure risk and level of service components of their asset management programs.
6. **A Call to Action**—Provides advice on how to get started, informed by 15 key lessons learned from participating CNAM and LAMP municipalities.

Each chapter includes examples from practice leaders, incorporating municipal approaches, lessons learned, and tools.

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CHAPTER 1

Enhancing Community Resiliency through Service Delivery

Impacts of Climate Change on Municipal Services

A Changing Climate

Climate change may be a global problem, but it is often municipalities facing the biggest impacts of extreme weather events. Climate change projections in Canada include:

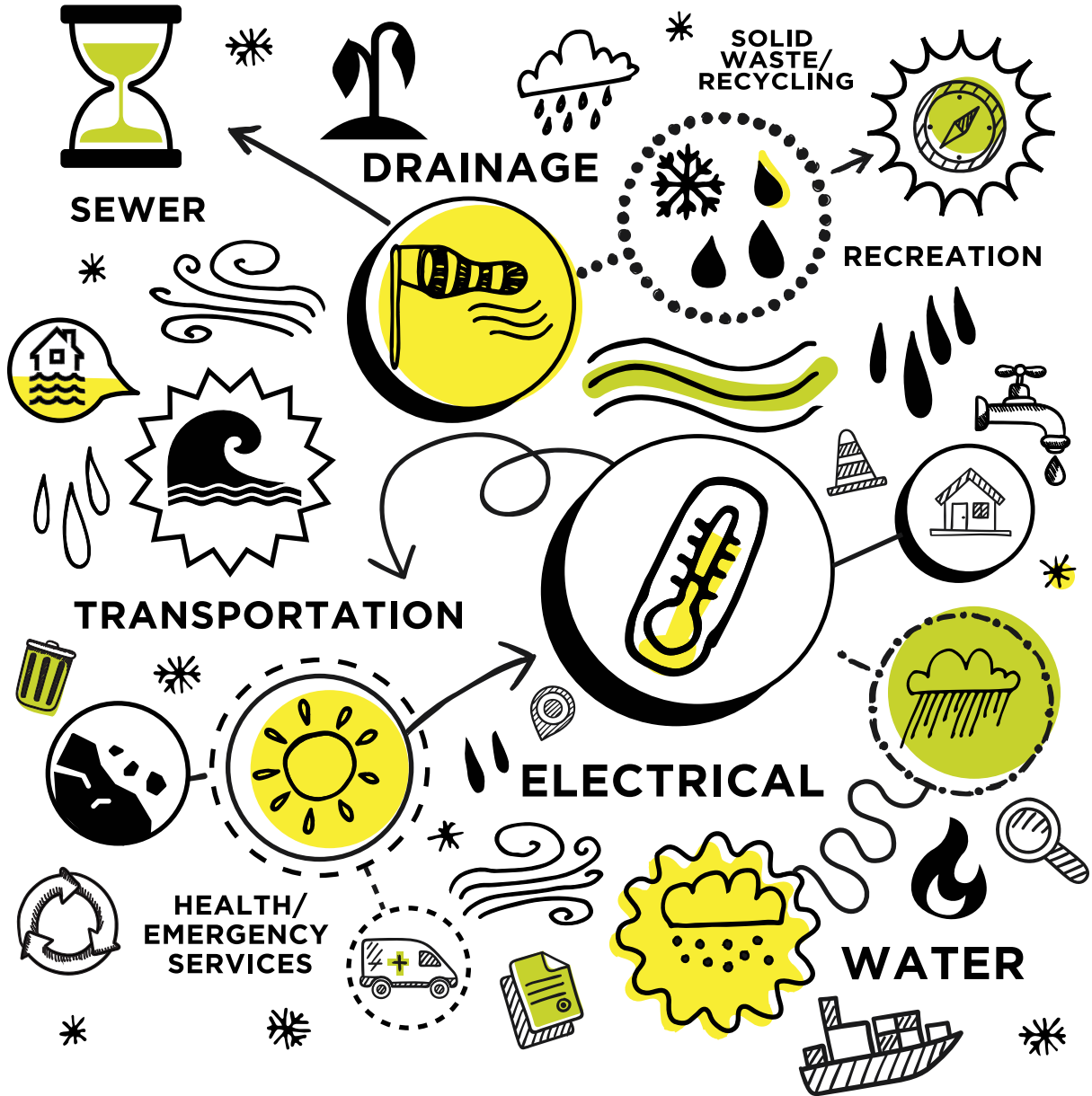
- **warmer summer temperatures** with hotter and more extreme heat days in the summer;
- **warmer winter temperatures** causing more winter precipitation to fall as rain;
- **more precipitation and intense storms** throughout the year;
- **less rain and longer droughts** during the summer months;
- **increased frequency and amount of ice** during the winter months;
- **summers stretching later** in the year;
- **sea level rise.**¹

These changes affect municipalities in different ways, depending on their location, the services they provide, and the engineered and natural systems they employ in delivering services.

Climate change hazards most frequently experienced across Canada are described on the next page. While this isn't an exhaustive list, it does provide a snapshot of many services and hazards that municipalities can expect to encounter more frequently in the future.

¹ Vancouver Coastal Health, *Moving Towards Climate Resilient Health Facilities for Vancouver Coastal Health* (Lower Mainland Facilities Management, 2018), 10.

Typical Canadian Hazards by Service Area





Municipality in Action

Fredericton



River Watch 2019:
Are you Prepared?

The City of Fredericton is faced with finding innovative ways of combatting river and coastal flooding that hits the City every winter, like raising the roads so they are out of the flood plain zone.

They are using an adaptive approach to mitigate the effects of flood risks on both municipal infrastructure and residential properties, illustrating how compromises between drainage, transportation, and emergency services are being negotiated in an effort to ensure that the most critical services remain reliable when the City depends on them. Public communication is an important part of this process.

For example, they use parking areas for detention or conveyance of flood waters. City staff have reached out to residents to discuss flood challenges, and released a paper addressing many specific ways that Fredericton is prioritizing its services in long-term planning, asset renewal, and emergency planning. They are working with the public to confirm that protecting buildings and providing continuity of major transportation routes is a greater priority during a flood than providing convenient parking.² Two important questions bring asked as part of the process are:

1. *How do we mitigate against the worst impacts of major flooding?*
2. *How do we prioritize our spending?*

*As a way of helping community members stay informed on rising river flooding, the City of Fredericton has created a “River Watch” page on their municipal website for the public to access, which is updated frequently. They are also using communication to reinforce the need for moving forward in a measured way as they build flood resilience, which could take years and possibly decades. **#GetPrepared***

City of Fredericton, NB

² http://www.fredericton.ca/sites/default/files/frederictons_flood_challenge.pdf

► Enhancing Community Resiliency through Service Delivery

Delivery of Services

The ways in which a community is vulnerable depend on factors such as the services provided, local industry, population, historical planning decisions, community health, area, and geographic location. These changes to our climate impact major community-owned and operated assets (both built infrastructure and natural assets), and often affect the conditions within which these assets operate in ways that were not anticipated when design occurred. As a result, we need to understand the impacts and limitations of our assets, which could result in a change in how we deliver services to the community.

Municipalities provide a wide variety of services that support the people, the future, and the environmental health of communities. By assessing and managing risk, as well as levels of service, through a climate change lens, communities become more resilient.

Natural Assets

Climate change impacts natural assets such as wetlands, creeks, deltas, foreshore areas, parks, forests, and groundwater aquifers by upsetting the equilibrium under which they developed. Rising sea levels, more intense and frequent storms and more severe droughts can cause radical changes in physical and biological systems.³

Built Assets

Climate change impacts infrastructure assets such as transportation systems, buildings, water systems, wastewater systems, marine infrastructure, drainage and flood protection systems, solid waste facilities, and electrical systems. The frequency and severity of extreme weather events amplifies risks that these assets will be overtaxed and possibly even fail. As the reliability of infrastructure systems decrease, it becomes more difficult and costly to attain desired levels of service targets.

³ Asset Management BC, *Climate Change and Asset Management: A Sustainable Service Delivery Primer*, (www.assetmanagementbc.ca), 2.



Community Resiliency

Municipal resiliency improves by reducing short and long-term risks resulting from climate change. A resilient community can adapt quickly and effectively when faced with chronic stresses or acute shocks such as climate change impacts (e.g., severe storms, flooding, or melting permafrost). To achieve resiliency, it is necessary to have a holistic understanding about community vulnerabilities as well as how systems are dependent on each other.⁴ Addressing risks keeps costs stable and avoids a reliance on resources that are not sustainable. Incorporating climate change and sustainability considerations into both levels of service and risk management frameworks enables consistent and proactive decision making, ultimately improving resiliency.

Integrating climate change in asset management enables local governments to:

- identify and align priorities;
- increase decision making transparency;
- involve and educate stakeholders;
- improve asset investment efficiency by minimizing undesirable outcomes of investment decisions;
- increase adaptive capacity;
- measure progress towards actionable climate objectives and identify potential trade-offs; and,
- develop and implement a set of adaptation measures to ensure communities can continue to thrive in a changing climate.

For more of an introduction on resiliency, see FCM's guide on Building Sustainable and Resilient Communities with Asset Management.

⁴ Green Municipal Fund, *Building Sustainable and Resilient Communities with Asset Management: An introduction for municipal leaders* (Federation of Canadian Municipalities, 2018), 2.

Risk and Levels of Service Defined

Managing infrastructure related risks and levels of service are the most difficult parts of asset management. Introducing climate change to these processes may feel daunting. This Guide breaks the process into small, measured steps.

For small communities, this will likely mean taking a more general and subjective/qualitative approach during your first iteration of the process. Larger communities generally need to invest more in information systems to manage the quantity and complexity of assets.

More on entry points is described in Chapter 4.

What is Risk?

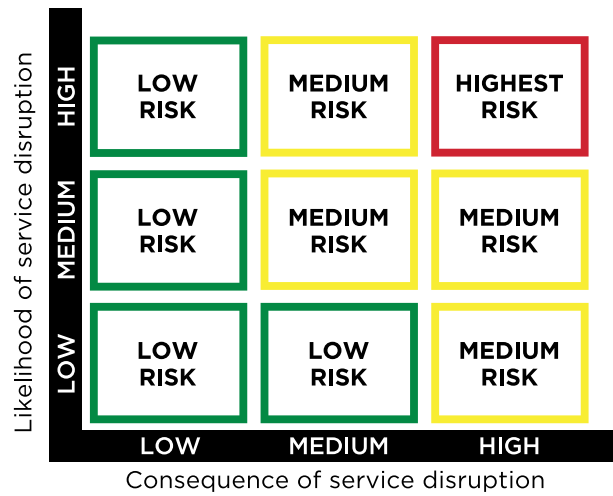
Risk is the potential for undesirable outcomes resulting from an incident, event, or occurrence. This is made up of the consequence and likelihood of a service disruption or asset failure.

To assess the risks to service delivery in our communities we need to understand the potential hazards assets could be exposed to, vulnerabilities that may exist, and the probability that a hazard could exploit a vulnerability and the associated impacts and consequences.⁵

For example, increased precipitation with undersized drainage infrastructure could result in localized flooding. The impacts and consequences of flooding can vary significantly: from low, if it were to occur in a parking lot or field, to high, if it were to occur in a populated area or prevent access for emergency services (e.g. loss of life or property).

A commonly used risk matrix is illustrated below.

Figure 1: Risk Matrix



There are many definitions and perspectives used when evaluating climate risks—what’s important is deciding on an approach, with shared terminology, and using it consistently within your municipality. Vulnerability is often used as a lens for assessing risk, and focuses on the susceptibility of an asset to the impact of a hazard. In terms of people and communities, this can be described as the degree to which an individual or group is unable to cope with the impact of hazards. The concept of vulnerability is applicable across sectors and communities.

For example, the City of Saint John’s approach to understanding climate change vulnerabilities involves compiling specific examples of incidents or events, such as freezing and flooding, and analyzing the risk through the simple formula of risk = probability x consequence. City staff using this approach can prioritize strategies for managing climate change risks.

⁵ Envision, *Sustainable Infrastructure Framework Guidance Manual 3rd edition* (Washington DC: Institute for Sustainable Infrastructure, 2019), 170-171.

What are Levels of Service?

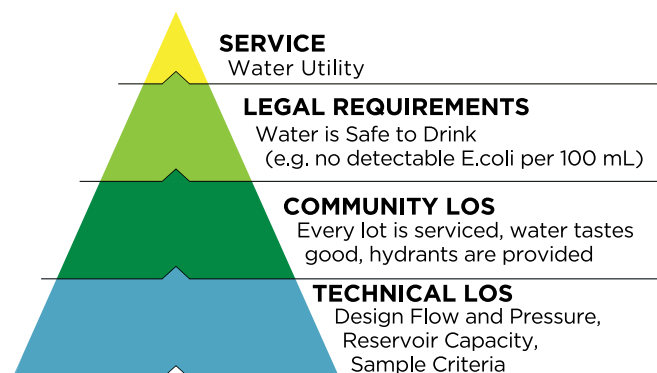
Levels of service are specific parameters that describe the extent and quality of services that the municipality provides to users.

This dictates the need for infrastructure, resources (e.g., staff time, funding, or materials), and ultimately the costs of providing the services. Factors that influence levels of service include local conditions, priorities of decision makers, regulations set by provincial, territorial and federal governments, and customer expectations. Levels of service can generally be described in the following ways:

- **Regulatory** – Does the service comply with applicable laws?
- **Capacity/Availability** – Is there adequate capacity to meet the needs of users?
- **Safety** – Is the system safe for workers and the public?
- **Quality** – Does the service meet quality standards? How good is it?
- **Reliability** – Is the service reliable? How often is it interrupted?
- **Sustainability** – How does the service provide for quality of life, leadership, resource use, natural environment, and resiliency?

The pyramid below illustrates the layers associated with levels of service. The municipality can track and measure the delivery of a service based on legal requirements, community expectations and needs, and operational requirements. If the municipality is not meeting a commitment, it may have to be reconsidered or more funding may be reallocated to hit this commitment. Community expectations are an important factor when assessing levels of service, costs and risks over the lifecycle of assets.⁶

Figure 2: Levels of Service Pyramid



6 AIM Network, *A Workshop on Getting Started with Asset Management Planning* (Atlantic Infrastructure Management Network, Fall 2018)



Municipality in Action

The biggest climate change hazards affecting Saint-Quentin are heavy rainfall, more frequent forest fires, harsher and less predictable winters, and drought.



The City began integrating climate change considerations into risk management in 2015 to determine how best to address these hazards; however, their commitment to sustainable community planning can be seen much earlier though the Green Municipal Plan developed in 2008.

Saint-Quentin has asset management policies, an inventory, a corporate program and an action plan (with clear priorities) in place. They have moved forward with tangible actions in GHG emission reduction: a new biomass system, building retrofits, and fleet electrification.

They are now looking at how to manage impacts on the environment and to stakeholders through solutions such as securing a potable water source for residents, preparing an emergency management plan that incorporates climate change considerations, and preparing a climate change plan.

Saint-Quentin's initiatives over the last decade have all come together under the umbrella of climate action and asset management. They have demonstrated tangible results in climate mitigation and adaptation which supports their ability to deliver municipal services in a more resilient way.

Saint-Quentin, NB



CHAPTER 2

Integrating Climate Change Considerations into Decision Making

How is Climate Change Affecting Infrastructure?

Infrastructure is facing different conditions than those for which it was designed due to climate change. In past practices, infrastructure decisions relied on historical information. This means that our existing infrastructure was built to perform well in a climate that no longer exists and may not provide the levels of service needed in the future.

Climate-related risks are different than many other risks. Time horizons are longer and affect a broader range of built and natural. Traditional risk management approaches, which rely on historical information to estimate the probability of future events, are no longer reliable for climate-related risk management without significant modification.

The design of new infrastructure should consider how climate change will affect life-cycles in the present and in the future. The performance of existing assets must also be reassessed in light of climate change.

Canadian municipalities are facing infrastructure challenges including:

1. Rapid growth in cities and declining populations in rural communities.
2. Rapidly changing service needs caused by demographic changes (e.g., aging population).
3. Changing health, safety, and environmental laws and standards that reflect our ever-increasing understanding of the related risks.
4. Historical underinvestment in asset renewal.

Asset management allows municipalities to plan for community sustainability and resiliency. This is done by proactively managing assets through their full lifecycle to deliver services now and in the future. It helps ensure the long-term affordability of services, and achievement of GHG emission targets and other sustainability targets. Finally, it often reduces deficits over the life of an asset and debt while attracting business and investment to the municipality.⁷

⁷ Green Municipal Fund, *Building Sustainable and Resilient Communities with Asset Management: An introduction for municipal leaders* (Federation of Canadian Municipalities, 2018), 2.

How do Adaptation and Mitigation Strategies Play a Role?

Climate change makes natural hazards more severe, persistent, and irreversible. By planning for these changes within a risk management framework, the severity or frequency of damage to infrastructure or loss of its service can be decreased through adaptation, and the rate and magnitude of climate change can be reduced through mitigation. Planning for climate change within a levels of service framework enables municipalities to deliberately and effectively maintain the quality and extent of service delivery.

The best approach is to involve the combination of both adaptation and mitigation strategies, also known as Low Carbon Resilience (LCR).⁸ It is important that practitioners and decision-makers take the initiative to consider LCR approaches within both levels of service and risk management frameworks. Although it is difficult to negotiate trade-offs and minimize conflicts between competing climate change objectives, utilizing an LCR approach can offer greater benefits and co-benefits.

LCR Examples

1. Transit-oriented development decreases tailpipe emissions and increases resident's resilience through enhanced mobility.
2. Green features such as green roofs, vegetated boulevards, and rain gardens reduce urban heat and absorb stormwater and can also fix atmospheric carbon.
3. Protection and restoration of natural assets such as forests and foreshores contribute to reduced flood risks with co-benefits for watershed integrity, human health, and the survival of biodiversity in a changing climate.⁹



Municipality in Action



The City of Saint John has experienced a cultural shift with respect to climate change, likely due to significant flooding, freeze/thaw cycle changes, and ice storms which are becoming more frequent and severe.

In May, Council demonstrated their commitment to taking a local leadership role when they adopted a Climate Change Action Plan alongside the unanimously signed Declaration on Climate Change.

This has been a catalyst for piloting Saint John's vulnerability and risk assessment, as well as developing mitigation and adaptation strategies. In response, the electrical substation, as well as the water and wastewater pumping station, will be relocated to improve resilience. The harbor sea will also be raised by 1.5 m in recognition of recent flooding and anticipated sea level rise.

⁸ IPCC, *Climate Change 2014: Impacts, Adaptation, and Vulnerability* (IPCC Working Group II, 2014).

⁹ Deborah Harford and Christopher Raftis, *Low Carbon Resilience: Best Practices for Professionals* (SFU Adaptation to Climate Change Team, 2018).

Saint John, NB Mitigation

Climate change mitigation is a set of actions taken to prevent or reduce climate change, generally by decreasing greenhouse gas emissions. The focus is on preventing the need for costly adaptation measures in the long term. Mitigation can be accomplished through:

- Avoidance: measures taken to avoid creating impacts from the outset;
- Minimization: measures taken to reduce the duration, intensity, or extent of impacts that cannot be avoided;
- Abatement: measures taken to rehabilitate degraded ecosystems; or
- Offsetting: measures taken to compensate for any residual adverse impacts.¹⁰

Adaptation

Adaptation is a set of actions taken to reduce the impacts from climate change, for example by protecting facilities and infrastructure that may be vulnerable to hazards such as flooding and wildfire. The focus is on altering how we live to reduce the harmful effects of climate change. To do this we need to understand where we are most vulnerable.

Sea Level Rise

Coastal communities must contend with a significant increase in maximum sea levels over the next 50 to 100 years, which is well within the lifecycles of assets such as buildings, dikes, sea walls, and wastewater and stormwater infrastructure. The implications for some municipalities are enormous. Planning to address sea level rise involves a combination of mitigation and adaptation measures:

Mitigation: Reduce GHG emissions to slow or stop sea level rise. Through planning and design for buildings and transportation infrastructure, municipalities can contribute to national and international efforts to curtail the use of fossil fuels that drive climate change, which in turn causes glaciers to melt and run into the world's oceans.

Adaption: Develop or enlarge sea walls, dikes, and vegetation (e.g., green shores) to protect the land from sea level rise. Municipal, regional, and provincial governments can address the impacts of sea level rise by relocating assets at the end of their useful lifespans. However, in many cases the scale and cost of the required construction will impose a large burden on taxpayers.

Why Integrate Mitigation and Adaptation?

It is important to integrate mitigation and adaptation¹¹ because:

1. Mitigation and adaptation strategies aim to achieve the same goal—reduced exposure to climate change impacts. This means the solutions are interrelated. Proactive, holistic planning can increase benefits of both strategies, improve cost-effectiveness, avoid conflicts, and help manage trade-offs.
2. Aligning climate adaptation and mitigation strategies can enhance the effectiveness of both strategies, avoid risks, and generate economic, ecological, and social benefits.
3. Climate change impacts infrastructure levels of service and risks. Through the inclusion of climate change into the levels of service and risk management frameworks, the municipality's response to climate change improves. Through implementation of both mitigation and adaptation strategies, it reduces fear of the unknown, higher consequences of climate change, and planning that focuses on short term outcomes and does not anticipate long-term outcomes.
4. Municipalities have limited budgets and must prioritize a range of actions that can be applied practically and cost-effectively, which typically includes a combination of mitigation and adaptation measures.

10 Envision, *Sustainable Infrastructure Framework Guidance Manual 3rd edition* (Washington DC: Institute for Sustainable Infrastructure, 2019), 13.

11 Adapted from the Climate Change and Cities Second Assessment Report of the Urban Climate Change Research Network: Summary for City Leaders (2015)

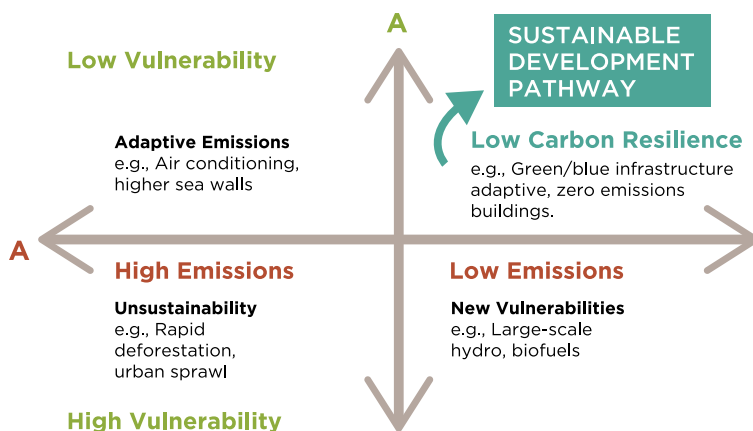
► Integrating Climate Change Considerations into Decision Making

- Municipalities need meaningful GHG emissions tracking and reduction objectives in order to prepare strategies to mitigate the effects of climate change.
- Holistic approaches that consider both quantitative and qualitative costs and benefits of integrating mitigation and adaptation strategies should be compared to stand-alone strategies so decisions can be made based on local priorities and evidence-based data.
- Both mitigation and adaptation strategies will contribute to the efficient management of municipal assets over their lifespans.

How to Integrate Mitigation and Adaptation Strategies

Integration can be achieved by¹²:

- Starting as early as possible basing it on scientific evidence.
- Engaging and applying solutions across disciplines, sectors (energy, waste management, water treatment, infrastructure, health, and consumption) and all levels of governance.
- Providing clear short, medium, and long-term goals and establishing the commitment for these goals in your municipality’s asset management policy.
- Identifying implementation opportunities, create budgets, provide clear roles and responsibilities of key personnel, and create concrete measures for the assessing process.



* Harford, Deborah. (2020). *Integrated Climate Action for BC Communities Initiative. Adaptation to Climate Change Team, Simon Fraser University.*

12 Grafakos, Stelios & Pachteau, Chantal & Delgado, & Landauer, Mia & Lucon, Oswald & Driscoll, Patrick. (2017). Integrating mitigation and adaptation: Opportunities and challenges.



Municipality in Action



The City of Guelph’s Strategic Asset Management Policy (2018) details their principles and general framework for asset management. This includes clear direction on managing risks, including understanding vulnerabilities, developing strategies and taking actions related to both climate change mitigation and adaptation.

To implement this Policy, the City tackled technical levels of service as part of their asset management planning process. They have prepared a corporate levels of service framework, within which climate change has been integrated using climate-related key performance indicators. Using this framework, staff from across the corporation were involved in intensive workshops to document level of service statements for all 17 service areas. Staff were engaged early, and the work plan was integrated with Guelph’s budgeting process, resulting in buy-in throughout the project. The strong communication plan and methodology, developed at the onset of the project, was critical to success. This process took a little over a year to complete.

Recognizing that their journey is one of continuous improvement, Guelph’s levels of service framework is scheduled for review annually and anticipates refinements to the process during the next round of updates. Next steps include rolling up the City’s technical levels of service into public levels for outward facing communication, capturing and managing data and tools, and creating reports that present key performance indicators in a meaningful and value-focused way.

City of Guelph, ON

CHAPTER 3

The Framework

Overview of the Framework

In asset management, service levels and risk are interrelated. For example, reliability is an important characteristic of most municipal services, which is often expressed as a level of service. Reliability also can be expressed in terms of the risk that a service will be interrupted by an asset failure or an event such as severe weather. Considering both levels of service and risks in a single process is efficient and helps to identify synergies that may yield relatively simple solutions to the complex problem of climate change.

An important lesson learned from Canadian municipalities is to **establish a clear process and framework early on**. “One size doesn’t fit all” says Adam Smith from the City of Kenora with respect to frameworks. The City of Selkirk and the CVRD both created custom approaches that were hybrids of existing, more complicated, models. They felt existing tools and frameworks, while helpful to reference, were ultimately too complicated for their needs. Their experience has taught them that spending extra time up front developing a process pays off. Ensuring that your municipality has a clear, repeatable process that staff and Council understand and buy into is key. The framework presented in guide was developed with these municipal experiences in mind.

A general process for integrating climate change in the management of infrastructure levels of service and risks is presented below:

The overarching purpose of this process is to answer to the following questions:

1. *How will climate change impact our municipality?*
2. *How will it affect our ability to deliver municipal services?*
3. *How do we prepare for the future?*

Figure 3: Climate Change Framework for LOS and Risk Management

Identification

- Services
- Assets
- Climate Change Hazards
- Current Levels of Service
- Other Regional and Local Climate Change Data and Projections

Assessment

- Climate Change Implications on Levels of Service
- Gaps between Current and Committed Levels of Service
- Climate Change Implications on Risk

Prioritization

- Strategies to Address Level of Service Gaps due to Climate Change
- Strategies to Mitigate or Adapt to Climate Change Risk

Management

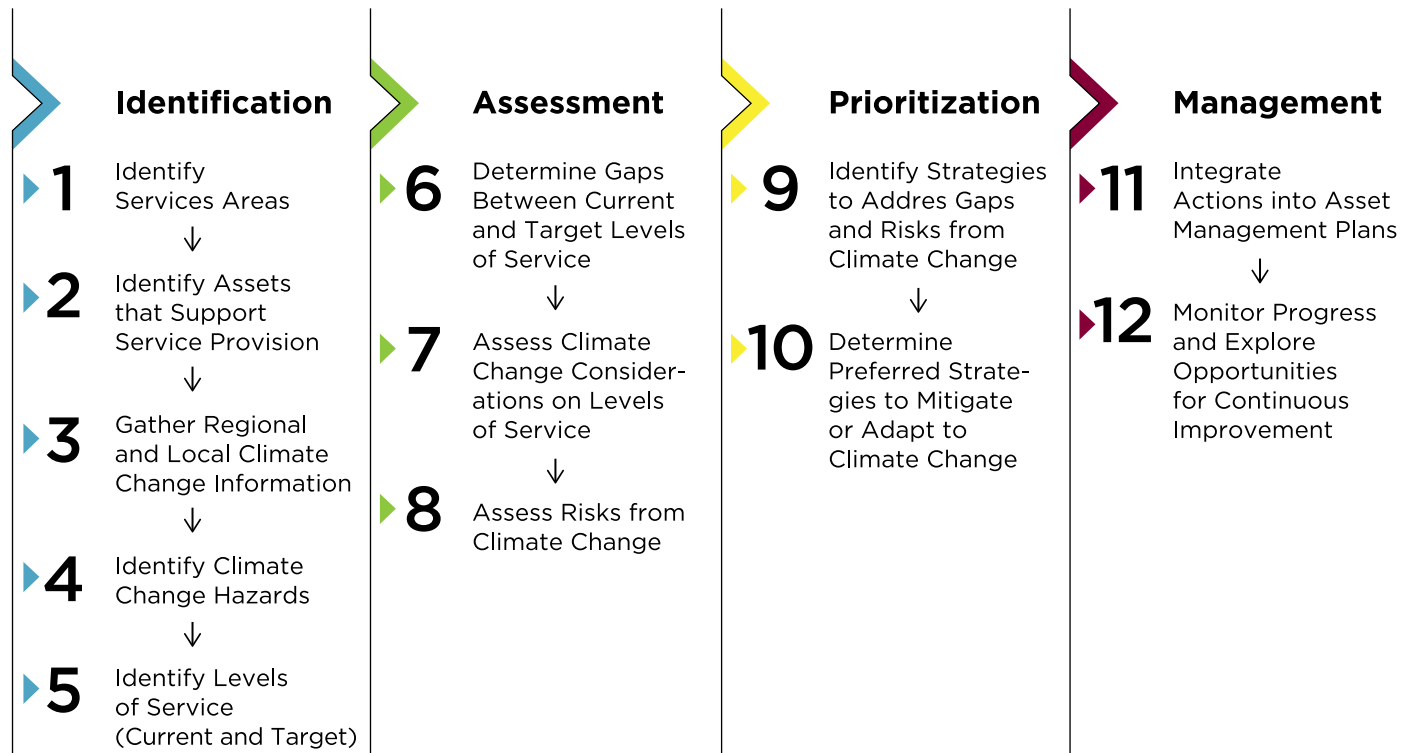
- Preparation of Service Delivery Plans
- Monitoring
- Continuous Improvement



CHAPTER 4

Entry Points

This guide encourages you to consider a shared framework for climate change integration, beginning at the entry point most appropriate for your municipality's needs. This could be the first time you've tackled the subjects of asset management and/or climate change, an addition or adjustment to an existing approach or framework developed as part of your asset management program, or a separate initiative integrated within your community sustainability or climate change strategy.





Municipal Staff in Action



Samir Yammine has been working with the City of Saint John to tackle climate change for over 20 years. His role began as the Energy Manager, and has evolved to the Manager of Asset and Energy Management.

Saint John was an early adopter of a Municipal Efficiency Energy Program, which reduced the City's energy costs by almost \$2.5 million and cut 9,400 tonnes of carbon emissions under Samir's leadership.

Samir believes that there are still significant opportunities that will support City targets. He is working towards solutions with the City's team by taking an integrated approach to asset management and climate change.

Saint John was new to asset management in 2016 and has quickly moved forward. The City's entry point for climate integration is to focus on risk management as part of the Climate Change Action Plan. This began with a vulnerability assessment of drainage infrastructure (as a pilot) which resulted in a corporate methodology for assessing and mitigating climate change risks and vulnerabilities to improve infrastructure resilience.

They have remained directly aligned their asset management program—from the draft risk framework and its recommended use for climate assessments in the 2017 Asset Management Roadmap, to direction for climate integration in the 2018 Asset Management Policy.



ments in the 2017 Asset Management Roadmap, to direction for climate integration in the 2018 Asset Management Policy.

Saint John, NB

There are four possible entry points for using the framework, with the related pathways described below:



1. Begin from the ground up

1-5

This involves preparing a linked risk and levels of service framework that considers climate change.

6-8

9-10

Rather than letting concerns over volume of work stymie getting started, a logical first step may be to select one or two service areas for piloting your process. And a first iteration of implementing the process may include completing only steps 1-5 described in Chapter 5 of the guide. Your objective is to ultimately complete all 12 of the **how to** steps, but think of it as a phased approach.

11-12



2. Start with levels of service

1-5

If you are interested in documenting and assessing levels of service based on climate change considerations, follow steps 1-7 described in Chapter 5 of the Guide. You may also consider steps 11 and 12. You may choose this approach because you have already completed an infrastructure risk assessment that incorporates climate change, or doing both at once seems daunting.

6-7

You can use this process to evaluate all of your levels of service, or only those that will be affected by climate change.

Most municipalities undertake levels of service analysis distinctly from their risk processes, particularly when developing an asset management program, simply because of the level of effort required. Often these steps are, at least in part, undertaken back-to-back. However, keep in mind that there will be overlap.



1-4

3. Focus on risk management

8

9-10

If you are interested in assessing and managing risk based on climate change considerations, follow steps 1-4 and 8-10 described in Chapter 5 of the Guide. You may also consider steps 11 and 12.

You may choose this approach because you have already developed an infrastructure levels of service framework that incorporates climate change, or doing both at once seems daunting.

You can use this process to evaluate all of your risks, or only those that will be affected by climate change.

Some municipalities chose to assess risk for all service areas at once, while others are focused on a subset of service areas or selected a pilot service to begin with. Taking manageable steps enables you to focus on continuous improvement within your capacity to achieve meaningful results.

For example, the Cowichan Valley Regional District undertook a Climate Risk Assessment as part of their Asset Management Strategic Plan. In contrast, the City of Saint John is currently undertaking a risk evaluation as part of their Climate Change Adaptation Plan, but they are using a framework that is consistent with their Asset Management Policy. They tested their climate risk assessment through a pilot focused on drainage.



3-4

4. Adapt an existing framework

7-8

9-10

If you already have an asset management framework in place and would like to adapt it to consider climate change, follow steps 3-4, 7-10 described in Chapter 5 of the Guide. If you're only focused on levels of service you can skip step 8-9, and if you're only focused on risk you can skip step 7. You may also consider steps 11 and 12 if this isn't part of your existing framework.

Remember, you are specifically targeting your assessment to assessing service delivery through a climate change lens. You may find it helpful to quickly review the full guide to confirm that these steps will fully meet your needs or to identify other steps you will need to take.

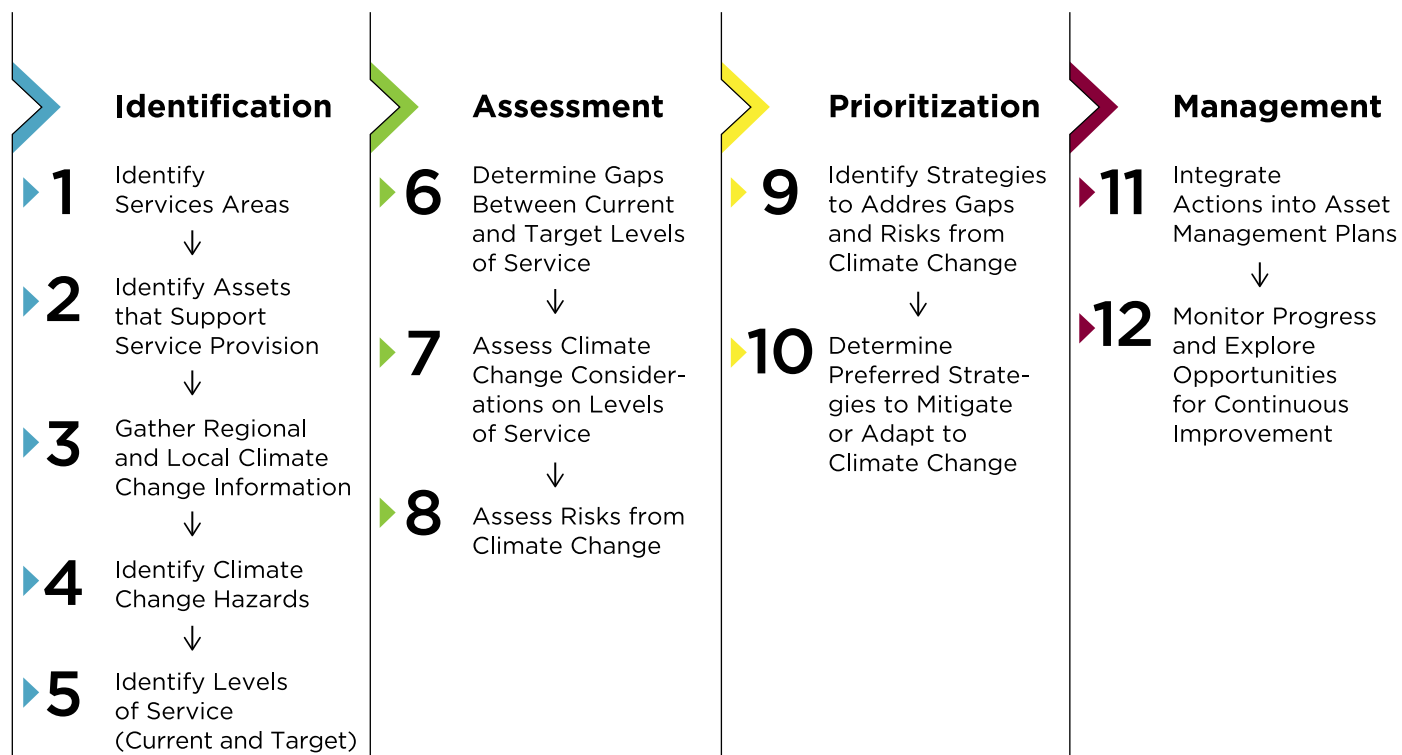
CHAPTER 5

Step by Step through the Framework

This section of the Guide describes how to develop infrastructure levels of service and risk frameworks that incorporate climate change. Each step is described below, along with examples and lessons learned.

Climate change resiliency “becomes an embedded value in a local government when it is integrated across all aspects of decision-making, and when there is a commitment to evaluate alternatives with a long-term perspective that aims to benefit both current and future citizens.”¹³

Figure 4: Steps for Integrating Climate Change and Asset Management



¹³ Green Municipal Fund, *Building Sustainable and Resilient Communities with Asset Management: An introduction for municipal leaders* (Federation of Canadian Municipalities, 2018), 4.

Before You Begin

There are five key things common among municipalities that have undergone this process for consideration prior to embarking on this climate change response process:

1. They formalize a process that everyone understands and buys into;
2. They agree on definitions at the start of the process, but remember to keep it simple;
3. They clarify roles and responsibilities for all contributors up front;
4. They engage staff from all levels of the organization; and,
5. They obtain external support where appropriate.

Small municipalities, and those stretched for resources, will likely need expertise beyond what's available in-house. In particular, some of the early steps such as gathering climate change information can be quite intensive. As part of your municipality's project scoping phase, consider where you may need external support. It could include:

- Building internal knowledge from external examples and tools, either through programs like ICLEI—Local Governments for Sustainability's (ICLEI Canada) 'Training the Trainers' or by seeking out examples from municipalities similar to yourself;
- Collaborating with a partner organization such as an educational institution or neighbouring local government, such as the Prairie Climate Centre (PCC) or the Pacific Climate Impacts Consortium (PCIC);
- Contacting the Canadian Centre for Climate Services Support Desk; or,
- Hiring an expert to provide the most up-to-date industry knowledge as well as additional capacity to your team.

For many communities, this is a key to success.





Municipality in Action



The City of Selkirk's award-winning Climate Change Adaptation Strategy (CCAS) provides a comprehensive, practical and cost-effective plan for beginning to address the impacts of climate change on municipal services and citizens. This work has been integrated into the City's Capital Asset Management Program (CAMP), as well as existing business planning processes, to support clear actions for adaptation over the next 50 years. Selkirk's CCAS was adopted in May of 2019 and the City is now beginning to implement the tactics laid out.

*Selkirk participated in FCM's Climate and Asset Management Network group which offered peer learning opportunities, training and funding to integrate climate change and sustainability goals into infrastructure decision making. This was a catalyst for the City's **collaboration with the University of Winnipeg's Prairie Climate Centre (PCC)** to develop the CCAS. The PCC is a national leader in the interpretation, communication, and activation of climate change data; they were the City's climate experts. PCC and City staff researched and prepared a process to bring the best available climate data and local knowledge together. The framework they developed is illustrated to the right.*

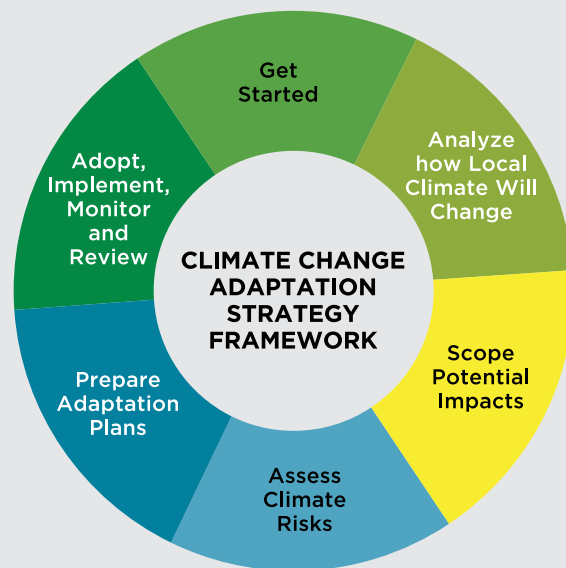
*This unique approach brought together Selkirk's CAMP team along with City service experts to form a CCAS team. The team participated in a series of climate adaptation planning workshops that were led by PCC. They used a **"season by season" and "service by service" approach** to incorporate climate change into risk management. In other words, they focused on understanding how each climate change hazard would impact a service (as opposed to an asset class) which allowed staff from all levels and departments to identify the different*

consequences—and do this for each season.

One of the key take-aways from their experience is that there is a lot of climate data out there, and much of it is extremely complex. It is important to not get overwhelmed by the amount, but to gather and collect information—maybe consult with an expert like PCC—and then take some time to step back and think “so what does this mean?” It was critically important for Selkirk staff to take time in the workshops with both service experts and climate experts, to think about what this meant for the City—and specifically service delivery.

Selkirk's advice to other municipalities is to build your own program—don't buy a plan—and borrow frequently. Climate change is not a technical problem. They feel that it is critical that climate change adaptation and asset management gets baked into every aspect of business, so that you can stop thinking about it, and it becomes something that happens naturally—it will become the norm. And just get started!

Selkirk, MB



IDENTIFICATION

The identification phase in the process explores the existing services provided to your community, the level at which you currently provide those services, the infrastructure assets that enable service delivery, and the climate change hazards that threaten these services. Regional and local climate change knowledge is also included here in support of decision making. The identification phase encompasses Steps 1 to 5 in the process.

1 Step 1: Identify Service Areas



In these early stages of identification, consider the following question: ***What services does the municipality provide to the community?***

To answer this:

1. Use bylaws, budgets, and service plans as a reference.
2. Consider the following categories as a starting point:
 - a. Water
 - b. Sewer
 - c. Drainage
 - d. Recreation
 - e. Health/Emergency Services
 - f. Transportation
 - g. Solid Waste/Recycling
 - h. Electrical
 - i. Others?
3. Document each area within which your municipality provides service, and add a second layer of granularity where required (e.g., for water, do you provide both supply and treatment services?)

2 Step 2: Identify Assets that Support Service Provision



Consider the following question for each service area you identified in Step 1: ***What built or natural assets are required to deliver these services?***

To answer this:

1. List the assets within each service area.
2. Use capital plans and asset registers as reference, as needed.

The idea is not to create a complete inventory of all assets, but to link assets to services in general groupings. If you end up with assets in your inventory that aren't linked to a service then they are likely excess assets.

An example is provided below which you can use as a starting point for this step.

Table 1: Asset Examples by Service Area

Service Area	Assets
Water	Wells, reservoir, treatment facilities, pump stations, water mains, service connections, hydrants
Sewer	Sewer mains, manholes, service connections, pump stations, treatment facilities, outfalls
Drainage	Catch basins, manholes, culverts, storm mains, open channels/ditches, wetlands, detention ponds
Recreation	Community buildings, parks, equipment
Health/Emergency Services	Hospital, ambulances, fire hall, fire trucks, ambulance station and police station
Transportation	Bridges, roads, trails, curb and gutter, sidewalk, road signs, streetlights, traffic lights, buses, light rail
Solid Waste/Recycling	Trucks, landfill, recycling depot
Electrical	Transmission lines, transformers, generators, lighting, telecommunications



Municipality in Action



The City of Bromont is in the early stages of their climate change response process and recognize that climate change is far more complex than simply variations in the weather. Key questions they have raised for consideration when gathering climate data include:

3. *What is the most reliable data? Most available?*
4. *What measurement units are being used/most useful (e.g., days of extreme heat, violent rainfall, freeze-thaw cycles)?*
5. *How will forecasts be selected?*
6. *Should the most optimistic or pessimistic scenarios be used?*

Bromont, QC



Municipality in Action



In 2015, the City of Kitchener partnered with the University of Waterloo and together assessed over 20+ years of severe weather data, historical trends, future climate projections and weather forecasting. Gaps in the data are being identified, and temperature and precipitation rates analyzed. The intention is to prepare for these events proactively by considering climate impacted levels of service and the implications for municipal assets.

Moving forward, Kitchener is exploring how best to bring sustainable practices to a variety of municipal assets, as well as looking at how to utilize performance data. Specific work activity projects are created in their work management system to better understand the impacts of adverse weather events. Furthermore, they are working to engage stakeholders more fully into levels of service discussions.

Kitchener, ON

3 Step 3: Gather Regional and Local Climate Change Information



Consider the following questions:

- **What climate projection data is available regionally and locally?**
- **What can we learn from the available information, as a basis for action or decisions?**

To answer this:

1. Look at trends and predictions from climate data, as well as historical weather events, to understand how they impact natural and built assets.
2. Place a high priority on the most recent projections published by authoritative sources that are based on downscaled global climate models that include your community.
There are a variety of sources for climate change information available and being used by communities across Canada, both federal and regional. Appendix C includes a list of climate change resources for consideration, including major organizations that provide support and information.

The Canadian Centre for Climate Services (CCCS), a website hosted by the Government of Canada, provides a wide range of information resources and assistance in using them. One of the portals CCCS supports is ClimateData.ca which is a collaborative collection of the up-to-date climate data in easy to use formats and visualizations. Climate Network with Environment Canada also provides historical climate data from across Canada.

The City of Selkirk used the Climate Atlas of Canada, a web-based science and education portal hosted by the Prairie Climate Centre and the University of Winnipeg. A similar west coast organization is the Pacific Climate Impacts Consortium, a regional climate service centre at the University of Victoria that provides practical information about the Pacific and Yukon, while Ouranos provides climate services in Quebec.

While it may seem overwhelming to begin with, remember to start small and add details over time as needed through a continuous improvement process. This may be an ideal time to enlist external support if you do not have in-house expertise.



Municipality in Action

In order to identify the effectiveness of current services provided, the City of Nanaimo brought together focus groups asking what the level of service is today for parks/trails, and then what level it should be at. The City also hosted community engagement workshops with residents on how levels of service relate to their parks and trail systems specifically. They realized that the public is interested in learning more about service provision, cost, and sustainability.

Commitments can now be established, and monitoring will continue to ensure the City is meeting the needs of the community through exceptional, sustainable service delivery.

Nanaimo, BC



4 Step 4: Identify Climate Change Hazards



Consider the following question: **Which climate change hazards impact your municipality?**

To answer this:

1. Brainstorm recent or recurring hazards that your community is exposed to, flagging the approximate frequency and impact of each.
2. Identify any existing climate change studies that are relevant to your community to better understand the direct or indirect impact these hazards have.

Consider also a general scan of the potential impacts on infrastructure and services which you will be able to elaborate on in Steps 7 and 8. The checklist in Appendix B could be used, and adjusted as necessary based on your circumstances, to assist in identifying how climate change can affect your municipality.

Hazards are physical events or phenomenon that may have a negative impact, such as habitat damage, injury or loss of life, economic disruption. Climate-related hazards include:



Erosion



Landslides



Drought



Flooding



Sea Level Rise



Storm Surges



Permafrost Degradation



Extreme Temperatures



Wildfire



Hailstorms



High Winds



Severe Weather

5 Step 5: Identify Levels of Service (Current and Target)



Consider the following questions:

- **How would you describe the levels at which a service is currently being provided?**
- **Is this different from your target, or committed, level for providing this service?**
- **How do you currently measure the delivery of this service?**
- **Does climate change affect the delivery of each service, and if so, then how?**

Note that there is an important distinction between the service you are actually providing customers and the objective or target levels you are working towards providing service at. If this is your first time tackling levels of service, focus first on the service customers are actually receiving, from a community perspective (i.e. customer facing as opposed to internal/technical levels).

Few municipalities have established a complete set of service levels for all of the services they provide. Not all levels of service are quantitative, but it is important that they are measurable. One important measure is the subjective community member experience with the services provided, which is often assessed through complaints.

There are a number of organizations across the country that have recently developed levels of service tools and delivered workshops on how to use these tools. Customer levels of service, tailored to smaller communities, was the focus for the Atlantic Infrastructure Management Network, Asset Management BC, and the Northwest Territories Association of Communities. Technical levels of service, tailored to larger communities, was the focus for Asset Management Ontario. The Institute of Public Works Engineering Australasia's NAMS Plus and the International Infrastructure Management Manual were also referenced by CAMN and LAMP municipalities as helpful frameworks. For more details on how to identify and assess levels of service, see the links in Appendix C or contact these organizations.

To answer these questions:

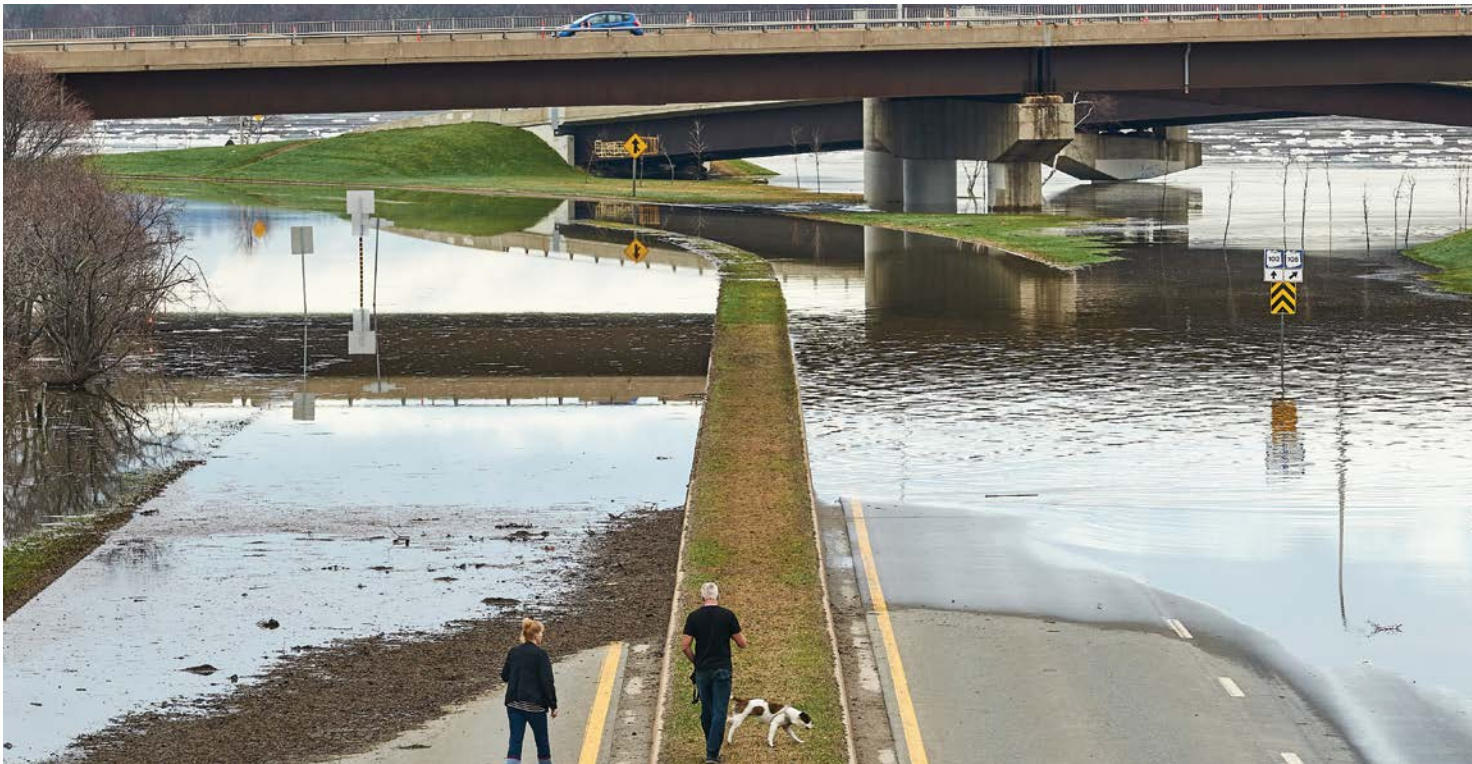
1. Identify current levels of service for each service area (i.e., water, drainage, etc.) based on the following service categories:
 - a. **Regulatory** – *what is required by law?*
 - b. **Capacity/Availability** – *does the system have adequate capacity?*
 - c. **Safety** – *is the system safe for workers and the public?*
 - d. **Quality** – *does the service meet quality standards? How good is it?*
 - e. **Reliability** – *is the service reliable? How often is it interrupted?*
 - f. **Sustainability** – *how does the service provide for quality of life, leadership, resource use, natural environment, and resiliency?*
2. Document how is this currently being measured (e.g. direct measurement, customer survey, complaint, internal review, etc.).
3. Identify the level of service objective or target you are either formally or informally working towards. This could be described in a community document or be a level that Council has set.
4. Discuss with your team what is working well about community member expectations of services, and what could be done better.

This process takes time and input from a multi-disciplinary group of staff that represent all departments within your municipality.

Table 2 includes drainage level of service examples for safety and reliability service categories, on a 4 point scale from low to very high. The intention would be to select the level that's most reflective of your current situation and adjust the descriptor as needed.

Table 2: Sample Drainage Levels of Service

Drainage		
Service Categories	Safety	Reliability
Service Indicator	Buildings are protected against flooding	Streets are not susceptible to flooding
Example Levels of Service	Low 1 Many areas and/or critical services are exposed to significant flood risk, but do not have adequate flood protection.	Flooding due to overflow and/or backup is frequent and significant (i.e., sufficient to potentially harm residents, damage property and/or limit access to critical community services such as hospitals, police, fire, etc.)
	Moderate 2 All critical areas of the community have adequate flood protection, but some other areas of the community exposed to significant flood risk do not have adequate flood protection.	Flooding due to overflow and/or backup is frequent but not significant (i.e. no harm to residents, no damage to property and/or limit access to critical community services such as hospitals, police, fire, etc.).
	High 3 Nearly all areas of the community exposed to significant flood risk have adequate flood protection.	Flooding due to overflow and/or backup is infrequent and not significant (i.e. no harm to residents, no damage to property and/or limit access to critical community services such as hospitals, police, fire, etc.).
	Very High 4 All areas of the community exposed to significant flood risk have adequate flood protection.	Flooding due to overflow and/or backup rarely occurs.



ASSESSMENT

The assessment phase in the process explores general gaps in our ability to provide services, and how our ability to provide services may be compromised as a result of climate change. Through integrating climate change into our evaluation, we can begin to assess the hazards, define impacts to current and future operating conditions, and assess possible vulnerabilities and their associated risks. This phase encompasses steps 6 to 8 in the process.

6 Step 6: Determine Gaps Between Current and Targeted Levels of Service

Consider the following questions:

- ***Have you been meeting established levels of service (i.e., is the current performance more or less than the service level commitment)?***
- ***Can current performance be sustained over time?***

By evaluating your services, you can determine the gaps between current performance and your committed levels of service. This will also help inform how the gaps can be overcome, for example if current commitments need to be reconsidered.

To answer these questions:

1. Flag all service levels where the current performance (i.e. current level of service) is more or less than the level of service commitment. How does this compare to past performance (if records are available)? Start first by focusing on gaps that you know are exposed to climate impacts, and if desired then move onto other gaps for your community. In other words, how are the hazards your community is currently experiencing affecting your ability to deliver services today.

2. Flag all service levels where there is a probable future gap in service delivery. Changes in land use, population, economic changes, immigration, and other demographics can all have implications on the level of service. However, for the purposes of this activity focus first on how climate change may affect your ability to provide services into the future.

The example in Table 3 can be used as a framework for documenting and assessing municipality's levels of service. Focus on the first four columns; this will be built upon in Steps 9 and 10. If your community already has documented levels of service, and you are now adding to that process by focusing specifically on climate change gaps, then this process will be quite targeted.

Table 3: Sample Levels of Service Matrix

Service Characteristic	Current Level of Service	Level of Service Commitment	Performance Gap?	Options and/or Recommended Action to Address Gap	Estimated Lifecycle Cost	Timeframe
Regulatory	<i>Discharges comply with statutory requirements</i>	<i>Minimum Level of Service</i>	No			
Capacity/ Availability	<i>Stormwater infrastructure is accessible for servicing lots throughout the service area</i>	<i>Some areas of the community do not have the opportunity to connect to the drainage system (but want/ need to).</i>	No			
Safety	<i>Buildings are protected against flooding</i>	<i>Nearly all areas of the community exposed to significant flood risk have adequate flood protection.</i>	<i>All critical areas of the community have adequate flood protection, but some other areas of the community exposed to significant flood risk do not have adequate flood protection.</i>	<i>Upgrade drainage assets to provide adequate capacity during design flood events so that all areas of the community exposed to significant flood risk have adequate flood protection.</i>	\$3M	5 years
Reliability	<i>Streets are not susceptible to flooding</i>	<i>Flooding due to overflow and/ or backup is infrequent and not significant (i.e. no harm to residents, no damage to property and/ or limit access to critical community services such as hospitals, police, fire, etc.).</i>	<i>Flooding due to overflow and/ or backup is frequent but not significant (i.e., no harm to residents, no damage to property and/ or limit access to critical community services such as hospitals, police, fire, etc.).</i>	<i>Do nothing</i>	\$0	N/A
Environmental	<i>Providing the service generates a low environmental impact</i>	<i>Minimal reductions in GHG emissions (compared to baseline).</i>	No			



Municipality in Action



The Town of Halton Hills is working to develop and implement climate change adaptation and mitigation measures relating to service levels. One area of focus is centred around sustain-

ability service levels, and in particular closing gaps by achieving GHG emissions targets for transportation systems, as well as facilities.

For example, their existing energy management program addresses energy use and carbon emissions associated with Town facilities and is being expanded to include fleet vehicles and employee commutes. They are taking action to eliminate carbon emissions associated with their operations through new net-zero construction, deep energy retrofits, green vehicle procurement, and a renewable energy supply. As part of the process, Halton Hills has hosted workshops on levels of service, held public consultation sessions on risk assessment and climate change adaptation planning, and carried out vulnerability assessment on facilities.

While the Town is identifying and closing gaps in their strategy for how to best integrate climate change considerations into a levels of service framework, challenges are being addressed along the way:

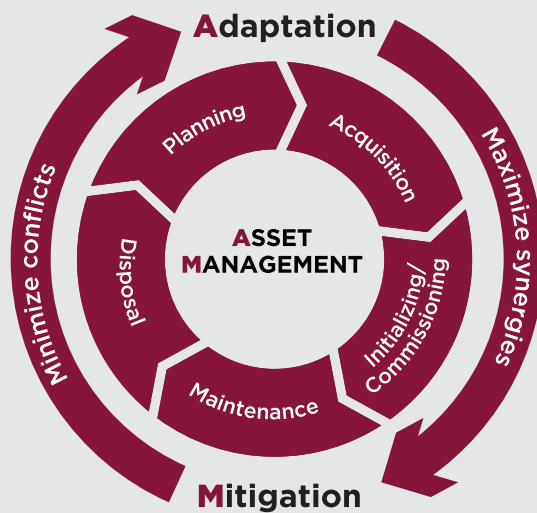
3. *Creating the awareness of “why alignment and integration is important” over and beyond the asset management planning regulatory requirements in Ontario.*
4. *Bringing all the pieces of the puzzle together to come up with a common decision-making framework;*
5. *Taking all available data and linking it to climate change and then relating this to levels of service in a structured manner.*

The Town of Halton Hills has since taken action:

1. *They have integrated Climate Change and Asset Management under one department reporting to the CAO’s Office to ensure there are synergies and minimize conflicts between the two programs.*
2. *They have adopted an Integrated A+M approach that will not only consider adaptation and mitigation measures to combat climate change but also integrate whole lifecycle asset management strategies and financial planning.*

Halton Hills, Ont

AN INTEGRATED A+M APPROACH



7 Step 7: Assess Climate Change Considerations on Levels of Service



Consider the following questions:

- **How does climate change affect levels of service?**
- **Where are you most vulnerable?**

Several of the risks assessed in Step 8 may also have levels of service implications. There is no need to duplicate the work of assessing the climate change scenarios in this section; these can be addressed in the strategies developed through either path.

To answer these questions:

1. Refer back to the hazards identified in Step 4. Consider how frequently your community experiences each hazard to assess how these are relevant to your municipality's ability to deliver services. Consider:
 - a. Exposure: whether infrastructure systems will be impacted in some way by climate change
 - b. Sensitivity: an evaluation of how the functionality of the infrastructure system will be impacted
 - c. Adaptive Capacity: the ability of the infrastructure system to adjust to potential impacts
2. For each hazard, describe where your municipality is vulnerable. For example, which services and, consequently, which build and/or natural assets are likely to be affected by climate change based on their exposure, sensitivity, and adaptive capacity?
3. What are the implications for your infrastructure, organization, and systems? Refer back to the climate projection data gathered in Step 3 to assess how this will change over time. Future vulnerabilities should also be noted.
4. Identify the top 3-5 vulnerabilities for your municipality.



Vulnerability refers to a weakness in the ability of a person, structure, or natural system to respond to a force, such as a hazard. A community's vulnerability to a hazard can be addressed by developing adaptation strategies that strengthen infrastructure, support local ecosystems, and build community awareness and preparedness. A community with less vulnerabilities is more resilient.

Vulnerabilities may be experienced with any of the following systems: drinking water, sewer, drainage, community buildings, energy, communication, food systems/agriculture, native plants, community health, families, aging population, local economy, habitat (animals, fish and plants), recreation, housing, industry and jobs, transportation, forests. Think about what a service is most sensitive to as well as your ability to adapt.

For example, climate change can increase the frequency and amount of ice in a community. This can make the community more vulnerable: impacting safety (and the risk of liability due to slips and trips), increasing stress on assets (for example street trees directly through ice but also indirectly from higher salt exposure). In turn, this triggers the need to for a change in practice: increase the frequency of maintenance to road and sidewalk surfaces during winter months. The result is an increased level of service (affecting both staff resources and material use), potential environmental impacts from salt use, and a higher budget.

Example 1: Urban Flooding

If precipitation levels exceed the capacity of the existing drainage system, flooding can occur. In major events drainage systems may rely on transportation networks like roads to convey flows. If the system is not sized for extreme events the stormwater could overwhelm the system resulting in flooding on private property.

1. What storm events were used to inform the design of the existing drainage system?
2. Where in the drainage system do systemic capacity issues already exist?
3. How might those storm events change with the impacts of climate change?
4. How is the land use expected to change?
5. How will future development be impacted?

To tackle this, some communities are updating their IDF curves to incorporate climate change projections. The City of Kitchener did this as part of their Stormwater Master Plan, based on the projections that the University of Waterloo produced.

Example 2: Extreme Heat

Extreme heat events can cause increased demands on numerous community services including emergency services; energy and recreation (individual and community cooling access (e.g., air conditioners, tree-shaded areas, pools); transportation systems; and, water for hydration (people, animals, and plants).

1. Where heat events used to inform the design of the community systems?
2. How might the frequency and duration of extreme (greater than 30°C) heat events change with the impacts of climate change?
3. How might those changes impact services?
 - a. Employer risk: Health and safety regulations, codes, and standards for worker exposure
 - b. Community design to provide easy access to heat-relief and drinking water, decrease heat absorption, retention, and release (e.g., urban trees, minimise concrete surfaces, green roofs)

8 Step 8: Assess Risks from Climate Change



Consider the following questions:

- **What are the infrastructure-related risks (consequence and likelihood)?**
- **How could this impact service delivery?**
- **How could climate change impact the standards that inform infrastructure design in the future?**

If you have skipped Steps 6 and 7, begin this step by considering where your community is most vulnerable to climate change because this directly relates to risk. Risks do not have to be negative; they can also result in positive outcomes. For example, warmer winters on average may reduce the costs of snow removal and the quantities of sand that need to be applied to streets and removed from catch basins and storm drains.

Several of the service levels assessed in Step 7 may also have risk implications. Where an issue is related to both risk and levels of service, it should be identified and adequately treated under one step or the other. There is no need to duplicate the work of assessing the climate change scenarios in this section; these can be addressed in the strategies developed through either path.

To answer these questions:

1. For each hazard, identify consequences of climate change on your services where their delivery is interrupted temporarily or permanently? Consider:
 - a. Will people be affected?
 - b. Will property be affected?
 - c. What services could be affected?
 - d. What existing controls are in place? Will they remain in place over time? If so, consider the consequence of the hazard with the controls in place.

A sample consequences table is presented in Table 5 illustrating a 1-5 scale (insignificant to catastrophic).

Asset management has traditionally used an asset-first perspective in risk assessments. However, assessing risk from an event, or hazard, perspective is becoming more common. This shift in approach is key when evaluating climate risks. For example, instead of identifying an asset such as a bridge and then assigning the asset a risk rating, consider the hazard that impacts the community, for example flooding. In such a case you are assessing the consequence of the flood, and the likelihood that this will disrupt a service, for example access into or out of a community. There could be one or more assets tied to that hazard, for example the bridge, nearby pump stations, etc.

2. Identify the likelihood of a such an event or occurrence. A sample likelihood table is presented in Table 6 illustrating a 1-5 scale (rare to almost certain).
3. Using a risk table, determine the risk rating.

$$Risk = Consequence \times Likelihood$$

Infrastructure systems are often interconnected and depend on one another. Sometimes they can affect other jurisdictions, or other jurisdictions could be relying on you for services. Discuss any cascading impacts of high-risk areas for major infrastructure systems. For example, if there was a reservoir dam failure from an earthquake leading to a loss of a community's drinking water source and damage to downstream land and infrastructure, who would be impacted, and how?¹⁴

14 Asset Management BC, Climate Change and Asset Management: A Sustainable Service Delivery Primer, www.assetmanagementbc.ca.



Municipal Staff in Action



Jessica Angers, the Manager of Corporate Asset and Project Management with the City of Guelph, has implemented quarterly reporting on key levels of service projects and phases through these three steps:

1. *Collecting information internally*
2. *Looking outward—reaching out to Cornell University and the general public*
3. *Summarizing and refining levels of service based on information gathered from Steps 1 & 2.*

Jessica is utilizing the plan, implement and evaluate methodology through her steps.

Through her experience with this work, Jessica learned that in person meetings and phone conversations are the most effective method for creating buy in. She also noted that the process of documenting and assessing all service areas simultaneously was a much larger undertaking than she had anticipated; it was a full time role in conjunction with her other capital planning responsibilities. Jessica shares this advice to those getting started: begin with an area of successes (inferred by available data) and don't bite off more than you can chew.



City of Guelph, ON

Based on the sample consequences and likelihood tables, a risk matrix is presented in Table 7 illustrating a 1-25 scale (low to extreme). Table 8 provides an example of risk assessment outcomes from urban flooding according to drainage services, health/emergency services and transportation based on a low, medium, high scale (1-3).

4. Are any risks unacceptable? This involves setting a threshold for your risk rating. Very generally, this could mean that you decide that any high risks, and possibly the medium risks identified, are considered unacceptable. If you use a more detailed risk table as shown in Table 7, with risks rated between 1 and 25, it could mean that any risks 10 and above are considered unacceptable. Therefore, action would be needed to address these risks by taking steps to eliminate or lower the risk to below a 10 through mitigative action (where possible).

There are a number of frameworks being referenced and used by CAMN and LAMP communities to assess risk. If you're looking for more details regarding a risk assessment process consider PIEVC—which has been developed specifically for assessing climate-related risks; ICLEI—has a workbook centered around changing climates; and the IIMM—which outlines a traditional asset management approach to risk.

Table 5: Sample Consequences Table

Consequence	Public Health/ Safety	Financial	Service Interruption	Regulatory
Insignificant 1	Nil	Insignificant (<\$10k)	< 4 hours	No consequence
Minor 2	Minor injuries/ illness	<\$100k	up to 1 day	Report violation
Moderate 3	Severe injuries/ illness	\$100k to \$500k	1 day to 1 week	Ministry review, possible order
Major 4	Major injuries to multiple parties, possible death	\$500k to \$1 million	1 week to 1 month	Financial penalty
Catastrophic 5				

Table 6: Sample Likelihood Table

Likelihood	Descriptor	Frequency of Occurrence
Rare 1	May occur only in exceptional circumstances	Beyond 20 years
Unlikely 2	Could occur at some time	Within 10 to 20 years
Possible 3	Will probably occur at some time	Within 5 to 10 years
Likely 4	Will probably occur in most circumstances	Within 1 to 5 years
Almost Certain 5	Expected to occur in most circumstances	Within 1 year

Table 7: Sample Risk Matrix

Likelihood	Consequence				
	Insignificant (1)	Minor (2)	Moderate (3)	Major (4)	Catastrophic (5)
Rare 1	L (1)	L (2)	L (3)	M (4)	M (5)
Unlikely 2	L (2)	M (4)	M (6)	M (8)	H (10)
Possible 3	L (3)	M (6)	H (9)	H (12)	H (15)
Likely 4	M (4)	M (8)	H (12)	H (16)	E (20)
Almost Certain 5	M (5)	H (10)	H (15)	E (20)	E (25)

Table 8: Sample Urban Flooding Risk Assessment

Service Area	Vulnerability	Implications	Consequence	Likelihood	Risk Rating
Drainage	Community buildings and housing susceptible to damage during flooding	High volume or blockage; undersized resulting in sedimentation and overtopping	Medium (2): potential flood damage to structures or pooling on properties near undersized culverts	Low (1)	Low 2
Health/ Emergency Services	Access to emergency services could be delayed during flooding	Road washout; lack of access to services, delayed emergency response	High (3): could delay emergency response	Medium (2)	Medium 6
Transportation	Minor thoroughfares Street are susceptible to flooding	Traffic delays; flooding and damage to road structure	Medium (2): traffic delays and rerouting to major roads	Medium (2)	Medium 4



Municipality in Action



The CVRD is currently conducting climate risk assessments and has identified over 100 infrastructure assets that are vulnerable to climate change impacts, across 12 asset systems.

All staff, from operations to senior management, were engaged from the beginning of the process and used workshops for education and buy-in.

Having a simple framework, and definitions that everyone agrees on has been key. The project team determined that although none of the existing frameworks they reviewed met all of their project criteria, the ICLEI Canada tools provided a good starting point for modification. These tools were used and adapted to develop a custom process for CVRD—an asset system vulnerability and risk assessment that was conducted using this four-step process:

5. Identify Exposure
6. Vulnerability Assessment
7. Risk Assessment
8. Risk Management

Three of these four steps have been completed to date. The CVRD's project team recognized that they didn't have the resources to complete assessments for all asset systems at once. Focusing on their most vulnerable systems first—water and sewer—has enabled them to test the process and build internal capacity before assessing other asset systems such as fire halls, recreation centres, recycling centres, parks, and trails.

As a next step, they will be developing a Corporate Risk Management Framework that defines what risks should be managed and who is responsible, and risk data management procedures. They will also run climate risk assessments for other systems.

CVRD notes the following recommendations for those undertaking a similar journey:

- A quality risk assessment needs input from all levels of staff management through to operations.
- As new data becomes available, the risk assessments should be updated or reviewed annually.
- You can't really prioritize climate risks without looking at ALL risks—hence the need for a corporate framework.

Cowichan Valley Regional District, BC



PRIORITIZATION

The prioritization phase explores strategies to address gaps between current levels of service and commitments that have been made by the municipality, as well as preferred strategies to manage climate change risks. This phase encompasses Steps 9 and 10 in the process.

It is unlikely that you have the resources available to address all service delivery gaps at once or mitigate all municipal risks from climate change. Addressing gaps in services and minimizing risks as a result of climate change impacts will require making tough decisions.

9 Step 9: Identifying Strategies to Address Gaps and Risks due to Climate Change



Consider the following questions:

- ***What possible strategies can be used to address current and future level of service gaps?***
- ***How can climate change risks be managed? Are there ways to be more proactive in accomplishing this?***

To answer these questions:

1. Prioritize the identified gaps (with LOS gaps and key risks being combined) from high to low. Consider your most critical assets and keep them in the forefront of your mind, thinking about how many people may be affected, and how seriously they may be affected.
2. Discuss actions that could be taken to address gaps, including options previously developed and costed in master plans or other studies. Think about:
 - a. Ways to meet the municipality's needs without new infrastructure
 - b. If doing nothing is acceptable
 - c. The level of municipality input required
 - d. Preventative work compared to reactionary work
 - e. Co-benefits of response decisions

When evaluating potential options for addressing gaps, the value of considering non-capital solutions cannot be underestimated. Changing operations and maintenance practices, temporary protection measures,

communication regarding risks, disposal of assets, demand management, and sometimes doing nothing are all key strategies to be considered.

3. For each unacceptable LOS gap or risk (beginning with the top 5-10), identify potential solutions such as creating new assets, developing an O&M strategy, disposing of assets, demand management and doing nothing.

You can build on the example in Table 3, focusing on the last three columns.

As presented in Asset Management BC's Primer on Climate Change and Asset Management, here are a few examples for climate change mitigation and adaptation:

Mitigation

- Supporting low-emissions fleet and transportation options
- Improving energy efficiency of new and existing facilities
- Protecting/enhancing natural assets through planning and land policies and bylaws

Adaptation

- Increasing system redundancy for system resilience
- Increased O&M of culverts to improve resilience towards flooding
- Increasing drinking water storage capacity

10 Step 10: Determine Preferred Strategies to Mitigate or Adapt to Climate Change



Consider the following question: ***What is the preferred, or optimum strategy, for each unacceptable risk or LOS gap?***

To answer this question:

1. Describe what options are best for the community. Look at effectiveness, feasibility, equitability, flexibility, or similar values that are important to your municipality.
2. Flag options that are the most financially feasible, including assessment of lifecycle cost.
3. Evaluate the implications for risk over the full lifecycle of the asset.

Remember that your preferred strategies can be those you feel are most appropriate to tackle immediately, or consist of a combination of both short and longer term actions. Addressing climate change is not a one time task, and so you will want to review your strategies on a cyclical basis to ensure they still make sense given available data, align with your municipality's vision, and are appropriate from a lifecycle costing perspective.

Prioritization enables municipalities to make decisions regarding¹⁵:

- Where and when to invest in adaptation to climate change hazards and vulnerabilities
- Where to invest in capital or operational measures to manage risk and increase resilience
- Where to accept changes to levels of service
- How to minimize investment costs while maintaining levels of service and managing risk
- How to compare climate change risks to other risks
- How and where to invest in mitigating climate change, such as most cost-effectively reduce greenhouse gas emissions



15 Asset Management BC, *Climate Change and Asset Management: A Sustainable Service Delivery Primer*, (www.assetmanagementbc.ca), 10.

MANAGEMENT

The management phase in the process explores how to integrate actions into asset management plans, strategies for monitoring progress over time, and beginning a journey of continuous improvement. This phase encompasses steps 11 and 12 in the process.

11 Step 11: Integrate Actions into Asset Management Plans

Consider the question: *How do you move from planning into action?*

Now that you have a prioritized list of measures you need to take, the next phase of the process is to identify what actions will be required, by when, who is responsible, at what cost, and how will they accomplish actions. This can be incorporated into your corporate or service-specific asset management plan(s), or in some cases through the action plan for your corporate

asset management strategy. Components may also belong in your corporate climate change strategy. It may be as simple as a table detailing the municipality’s top 10 priorities based on the assessment process undertaken. However, it could be that you develop a more detailed service delivery plan or risk management plan that becomes a core component of your asset management plan when it’s next updated. Remember, at the end of the day we are trying to achieve action, so your output should be in whatever form is going to be the most useful to your municipality.



Municipality in Action

Fredericton

“Balancing what we need, what we can provide, and what the public expects” are all important considerations when preparing a service delivery plan.

Fredericton, NB

Actions (What)

Actions should fall directly from the preferred strategies to mitigate or adapt to climate change risks. Begin with a list small enough that it’s practically actionable given the municipality’s resources, and the planning horizon you will be working within. You can always add actions once the first list is complete. Some of these actions could be related to capital projects, others will be further studies, and others still could be stakeholder meetings or securing grant funding.

Justification (Why)

The risk and LOS analysis completed in Steps 1-10 should fully describe the justification for each of the selected actions. An important part of this is leveraging Council’s existing policies and strategies. Do not re-invent the wheel, if climate action and sustainable infrastructure policies already exist, utilize them in your level of service and risk management frameworks. If there are gaps pertaining to climate change, update the policies and frameworks that are already in place. If there are none, then start by creating them.

CONTINUED ON NEXT PAGE

Integrating climate change into levels of service and risk management is a practical approach to managing liability and risks. The more established, documented, and published levels of service frameworks can provide a policy defense to local governments. Incorporating extreme weather events and climate change in inspection and maintenance programs provides a reasonable standard of care requirement. It shows due diligence on the trade-offs between the costs of providing a level of service and the associated risks.

Timeline (When)

Regular evaluation periods vary depending on municipality. Typically, short-term plans are implemented annually, medium-term plans are implemented every three years and long-term plans are implemented every 5 years. Policies are generally renewed every five years. Incorporating climate change into your frameworks and policies is a continuous improvement process.

Responsibility (Who)

Although the core team, at the least, should be involved throughout the planning process, this step is where thoughts can be translated into successful action. Identify the core team and any champions in management before implementing a project or program. Within your

team, invest in early and regular collaboration between designers, contractors and operators which will help prevent design conflicts, reduce change orders, and result in easier, faster, and less costly projects.

Implementation (How)

What resources are required to take action? This includes finances as well as people.

Consider the cost be of taking the identified actions. Little can happen without a budget! And part of preparing a budget is ensuring that the business case is presented clearly based on the justification.

Staff resources are the other key component of implementation. While you will have clear champions, they should be leading the process but drawing on a larger network for implementation. Engage staff from across departments and levels so everyone can bring their expertise and knowledge to the table. This builds buy-in and also prevents errors caused by lack of awareness or assumptions. When the team is given an environment to collaborate and share their ideas, innovative and sustainable solutions can be more readily achieved.¹⁶ Remember to take the time to provide new staff with an orientation to the process.

Key Components of an Action Plan

Actions	Justification	Timeline	Responsibility	Resources	Budget
What steps need to be taken? <ul style="list-style-type: none"> • Consultation • Plans • Strategy implementation • Monitoring • Review 	Why is this important? How does it support Council's existing policies, strategies, or Strategic Plan?	When does it need to be done by? Do we have a way to monitor progress?	Do we have goals, buy-in, and priorities? Who is responsible for implementation?	Who is a part of the project team? Do we need an expert?	Do we have a way to monitor budget? Are there pressures on the long-range capital budget?

¹⁶ Envision, *Sustainable Infrastructure Framework Guidance Manual 3rd edition* (Washington DC: Institute for Sustainable Infrastructure, 2019).



Municipality in Action



The City of Kenora staff have recognized the need for continuous improvement in asset management planning, data

gathering and management, and in decision making.

Kenora has an asset management framework in place and has included climate change risk as part of the document. The process identifies risk—what constitutes a risk, formalized risk assessment process—and the degree of information and data competencies required. It also includes risk management—deciding what actions need to be taken to achieve “low regret” situations and implements a strategy to adapt accordingly.

The remaining challenge is how to effectively use the risk reports which are generated by the AMP software and the considerations of those climate variables within capital decision-making.

The next steps are to draw from their background studies and frameworks to focus on prioritization and management. The City is looking to keep the process simple as they adapt due to the nature of being a smaller community. The momentum from work completed to date will kick start the solutions and actions specific to the vulnerabilities that have been identified.

Kenora, ON

12 Step 12: Monitor Progress and Explore Opportunities for Continuous Improvement



Consider the following questions:

- **How are you doing?**
- **What should you be doing differently?**

Monitoring and evaluation are methods for supporting continuous improvement. The intent should be to make it easier for time for users and decision makers to understand what is working well and what should be done differently.

To answer these questions:

1. Develop a plan to monitor the progress of implementation and the effectiveness of both adaptation and mitigation measures.
2. Establish a process for reviewing frameworks and processes, along with set timelines for doing so. This is also an opportunity to reconsider internal capacity and when to move forward with additional service areas, etc.
3. Set out a record keeping system, if that hasn't been established already. Ensure all key players have access to core components of the program, and that new information is documented in a timely manner.
4. Finally, communicate accomplishments.



CHAPTER 6

A Call to Action

Canada is warming up twice as fast as the rest of the world, and municipalities across the country are facing the biggest impacts. Historical trends can no longer be used to predict future scenarios, and what used to be infrequent extreme weather occurrences are now common. We are being challenged in our ability to deliver services, with the capacity of our infrastructure being stretched in unprecedented ways. As the providers of local services, our residents and businesses rely on us to manage these services reliably and sustainably.

When it comes to making a real change, municipalities are in the driver's seat. Municipalities influence roughly half of Canada's GHG emissions and are the focal point when it comes to building long-term climate resilience in their communities.

The climate affects almost everything about how we design, build, and live in our cities. We have a huge opportunity as aging infrastructure across the country reaches the end of its useful life to ensure new investments are made with the future of our communities in mind.

It is a crucial time for municipal leaders to assess and reaffirm their commitments and take concrete actions to become more resilient. This Guide can be used as a tool for taking some concrete steps forward. To assist your community through this journey, 15 key lessons learned have been assembled from municipalities across the country that are engaged in actions focused on integrating climate change with asset management.

LESSONS LEARNED

Take a service perspective;

5. Agree on a shared set of definitions at the start of the process, using layman's terms wherever possible;
6. Establish a clear process and framework early on, keeping in mind that your community is unique and the approach you take will be as well;
7. Select a champion;
8. Use workshops generously for education and buy-in;
9. Ensure broad engagement with staff (operations through senior management);
10. Collaborate across departments;
11. A significant investment of staff time is needed for success;
12. Good climate information is key for risk management framework analysis;
13. Consider external support where appropriate (e.g., aligning yourself with experts who can speak to the impacts of climate change and translate them into relevant, local consequences);
14. Connect levels of service and risk to asset management and corporate processes;
15. Partnering with the right people is very important;
16. Leading into action can be a challenge;
17. For long term success focus on a roadmap for action including a plan for rolling out year by year (and put it into the annual budget process); and,
18. Seek out funding from outside sources.



Municipality in Action

Fredericton

Gerald Beaulieu, an artist commissioned by the City of Fredericton in 2016, installed 11 wooden posts of different heights along the river near Westmorland Street Bridge. These posts have copper plates to mark peak water levels of historic spring floods.

The spring flood of 2018 displaced hundreds of New Brunswickers and caused tens of millions of dollars in damage. Gerald has returned to his work after the devastating spring flood of 2018 to mark the new flood records.

Gerald's artwork also links the implications of flooding to municipal services. The art is an effective means of engaging the public in dialogue about the impacts of climate change on reliability of roads, parking facilities, and risk of damage to buildings at low elevations.¹⁷



City of Fredericton, NB



Municipality in Action

On Monday, April 1, 2019, the City of Nanaimo Council Members officially declared a climate emergency for the purposes of identifying and deepening their commitment to protecting the economy, eco-systems, and community from global warming. They voted unanimously on the following four policies:

1. *That all funds in the Regional Emissions Reduction Reserve be moved to a new reserve fund for the purpose of supporting projects, plans and initiatives that reduce the City of Nanaimo's community wide CO₂ emissions to between 50% to 58% below 2010 levels by 2030, and between 94% and 107% below 2010 levels by 2050.*

2. *That the framework, strategies and actions, and implementation of City of Nanaimo Community Sustainability Action Plan be updated to reflect the target goal, based on the information contained in the latest Intergovernmental Panel on Climate Change report, of limiting global warming to 1.5°C.*

3. *That correspondence be sent to the Regional District of Nanaimo requesting the addition of 20,000 annual public transit hours to improve public transit service delivery within the City of Nanaimo and develop transit routes that connect our local system with inter-regional connections.*

4. *That correspondence be sent to the Honourable George Heyman, provincial Minister of Environment and Climate Change Strategy, requesting that province reinstate the production of the Community Energy and Emissions Inventory Reports or dedicate grant funding to be used for their creation.*



City of Nanaimo, BC

17 Ed Hunter, "Artist makes 'bittersweet' Fredericton return to mark historic spring flood", CBC News, October 16, 2018, <https://www.cbc.ca/news/canada/new-brunswick/watermark-spring-flood-art-beaulieu-1.4863892>.



APPENDIX A

Glossary of Terms

Abbreviations

Below are some abbreviations used in this guide:

CAMN Climate and Asset Management Network

FCM Federation of Canadian Municipalities

LAMP Leaders in Asset Management Program

LOS levels of service

Glossary of Terms

Below are some commonly used terms referenced in this guide:

1. An **asset** is an item, thing or entity that has potential or actual value to an organization. The value can be tangible or intangible, and financial or non-financial. An organization may choose to manage its assets as a group, rather than individually, to accommodate its needs and achieve additional benefits. Such groupings of assets may be organized by asset type, asset system or asset portfolio. (Source: ISO 55000:2014)
2. **Climate change adaptation** refers to actions taken to help communities and ecosystems cope with changing climate conditions. (Source: United Nations Framework Convention on Climate Change, 1992)
3. **Climate change mitigation** refers to a human intervention to reduce the sources or enhance the sinks of greenhouse gases. (Source: United Nations Framework Convention on Climate Change, 1992)
4. **Consequence** refers to the result or effect of an action or condition. (Macmillan Dictionary, 2019)
5. **Exposure** refers to the state of being in a place or situation where there is no protection from something harmful or unpleasant. (Oxford Dictionary, 2019).
6. **Hazard** refers to a physical event of phenomenon that may have a negative impact, such as habitat damage, injury or loss of life, economic disruption. Negative impacts from hazards can be reduced through adaptation strategies.
7. **Impact** refers to the strong effect on something or someone.
8. **Infrastructure** refers to the physical assets developed and used by a municipality to support its social, cultural and economic services. (Source: LAMP Municipalities, 2017)
9. **Levels of service** are the parameters, or combination of parameters, that reflect the social, political, environmental, and economic outcomes that the organization delivers. The parameters can include safety, customer satisfaction, quality, quantity, capacity, reliability, responsiveness, environmental acceptability, cost, and availability (Source: ISO 55000:2014)

10. **Likelihood** refers to a qualitative assessment that is subjective with little objective measurement; low, medium, or high.
11. **Natural Assets** in a municipality are the stock of natural resources or ecosystems that is relied upon, managed, or could be managed by a municipality, regional district, or other form of local government for the sustainable provision of one or more municipal services. (Source: Defining and Scoping Municipal Natural Assets, Municipal Natural Assets Initiative, BC, 2017)
12. **Resilience** is the capacity to recover quickly from difficulties (Oxford Dictionary, 2018). A resilient community has the capacity to survive and adapt to chronic stresses and acute shocks, like population growth or decline, aging populations, influxes of new immigrants, economic swings, or climate change impacts like severe storms, flooding or melting permafrost. (Source: Building Sustainable and Resilient Communities with Asset Management, FCM 2018)
13. **Risk** refers to the product of likelihood and consequence.
14. **Threat** refers to something that is likely to cause damage or danger.
15. **Vulnerability** refers to a weakness in the ability of a person, structure, or natural system to respond to a negative force, such as a hazard. A community's vulnerability to a hazard can be addressed by developing adaptation strategies that strength infrastructure, support local ecosystems, and build community awareness and preparedness.



APPENDIX B

LOS Checklist for Climate Impacts

The following checklist provides a sample of common impacts that local government infrastructure systems experience due to climate change. It is based on information presented in Asset Management BC's Climate Change and Asset Management: A Sustainable Service Delivery Primer.

Common Impacts of Climate Change on Local Government Infrastructure Systems

Sewer Impacts

- Exceeded capacity caused by increased inflow and infiltration (may lead to surface surcharging and basement flooding)
- Changes in the characteristics of wastewater effluent
- Flooding that affects buildings, tankage, and housed process equipment

Health/Emergency Services Impacts

- Higher demand for emergency services
- Damage or flooded emergency services structures
- Longer response times
- Reduced aide capacity

Transportation Impacts

- Road damage caused by erosion, landslides, and embankment failure
- Road damage caused by more frequent thawing/freezing of soil
- Road washout caused by overflowing culverts and storm sewers
- Causeways, bridges, and low-lying roads have a high risk of being inundated or damaged

Drainage Impacts

- System capacity exceeded more frequently
- Failure of drainage systems and dikes causing property and infrastructure damage
- Increased pumping (which increases energy costs)

Recreation Impacts

- Stress on vegetation and water restrictions for built water features caused by drought
- Loss of trees due to drought, windstorms and pests (e.g. MPB)
- Higher demand on parks and water features by increased temperatures
- Changes to water quality of lakes or rivers which may affect recreational use
- Increased erosion and decreased slope stability

Solid Waste/Recycling Impacts

- Increased odour and pests during warmer summers and winters
- More landfill leachate during winter months
- Flooding to critical infrastructure or collection routes
- Restricted water use (during summer months) for wet site management practices

Water Impacts

- Loss of reliable water sources by drought
- Loss of water and/or reduced source water quality
- System capacity issues and stress on water sources by higher water demands
- Damage to infrastructure from fires and flooding
- Flooding causing water-borne health problems
- Taste/odour problems during summer months
- Reservoir dam failures





APPENDIX C

Additional Resources

The following additional resources were noted by participating CAMN and LAMP communities, and could be helpful as your community navigates through the climate integration process:

Additional Resources	
Asset Management BC BC Framework for Sustainable Service Delivery https://www.assetmanagementbc.ca/framework/	The Framework establishes a high-level, systematic approach that supports local governments in moving toward service, asset and financial sustainability through an asset management process.
Asset Management Toolkit https://assetmanagement.toolkitnwtac.com/	The Northwest Territories Association of Communities' Asset Management Toolkit includes a Levels of Service Template and Guide which is designed to help communities to interpret and adapt the Template to their local context.
Climate Atlas of Canada https://climateatlas.ca/	Combines climate science, mapping and storytelling to bring the global issue of climate change closer to home for Canadians. It is designed to inspire local, regional, and national action that will let us move from risk to resilience.
Climate Data for a Resilient Canada https://climatedata.ca/	Provides high-resolution climate data to help decision makers build a more resilient Canada. The goal of this portal is to support decision makers across a broad spectrum of sectors and locations by providing the most up to date climate data in easy to use formats and visualizations.
Canadian Centre for Climate Services www.canada.ca/climate-services	Works with users to understand climate change concepts, trends, and guidance on how to use climate information in decision-making. CCCS provides access to climate experts to find, interpret and apply historical and future climate information.
International Council for Local Environmental Initiatives (ICLEI) https://www.icleicanada.org/	ICLEI Canada works with a wide-variety of stakeholders from across government, industry, academia and the NGO community to build more sustainable, low-carbon, energy efficient, climate-ready communities through peer exchange, partnerships and capacity building.

Additional Resources (continued)	
<p>Institute for Sustainable Infrastructure Envision Framework https://sustainableinfrastructure.org/envision/</p>	<p>A framework that provides the guidance needed to initiate this systemic change in the planning, design and delivery of sustainable and resilient infrastructure. It outlines sustainability metrics for infrastructure projects to help users assess the extent to which their project contributes to conditions of sustainability across the full range of social, economic, and environmental indicators.</p>
<p>Institute of Public Works Engineering Australasia (IPWEA) https://www.ipwea.org/home</p>	<p>IPWEA provides regular continuing professional development, conferences, technical publications, and the chance to be involved in committees addressing technical issues for those who deliver public works and engineering services to communities. This includes the International Infrastructure Management Manual which has guidance on risk as well as levels of service.</p>
<p>Municipal Metrics Catalogue https://amontario.ca/municipal-metrics-catalogue_2/</p>	<p>This catalog provides Councils and Municipal Staff across Ontario with a reference to metrics used by other Municipalities to manage their infrastructure and meet asset management-related standards and regulations. The intent is to help choose the Level of Service metrics that best align with corporate objectives as well as other indicators or technical measures to support decision-making.</p>
<p>NAMS Canada https://www.namscanada.org/</p>	<p>NAMS Canada is an affiliate of IPWEA and assists Canadian and North American local governments and public works entities improve the way they manage their public infrastructure assets. They have tools for both risk and levels of service.</p>
<p>Pacific Climate Impacts Consortium https://www.pacificclimate.org/</p>	<p>A regional climate service centre at the University of Victoria that provides practical information on the physical impacts of climate variability and change in the Pacific and Yukon Region of Canada.</p>
<p>Prairie Climate Centre http://prairieclimatecentre.ca/</p>	<p>The Prairie Climate Centre is committed to making climate change meaningful and relevant to Canadians using an evidence-based perspective through maps, documentary video, research reports, and plain-language training, writing, and outreach. Their Climate Atlas tool is available for those seeking information about climate change and its impacts.</p>
<p>Public Infrastructure Engineering Vulnerability Committee (PIEVC) https://pievc.ca/</p>	<p>PIEVC's Vulnerability Committee leads a national initiative to determine and mitigate the engineering vulnerability of Canadian public infrastructure to the impacts and risks of current and future climate. Its goal is to ensure civil infrastructure projects are considering the impacts of climate change.</p>



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