



Associated Engineering



FINAL REPORT

Best Practices Approaches for Mainstreaming Climate Change into Water Management

July 2019



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Executive Summary

The Government of Canada and the Federation of Canadian Municipalities (FCM) have selected and fund 12 not-for-profit organizations to deliver projects to 72 municipalities across Canada, strengthening their resilience to the effects of climate change. One of these projects is spear-headed by All One Sky Foundation (AOS), working with the Edmonton Metropolitan Region (EMR) including: City of Spruce Grove, City of Leduc, Town of Devon, Town of Stony Plain, City of Edmonton, Strathcona County, City of St. Albert, and City of Wetaskiwin. This project focus is on water management strategies which refers to ways in which municipalities in the EMR can directly or indirectly influence water supply and demand to minimize the risk of future potential imbalances.

This report provides a summary of researched information of approaches that other jurisdictions have used for managing climate risk to water security, as well as informing the EMR on the current and relevant municipal, provincial, and federal regulatory framework.

The regulatory review is intended to assist municipalities in identifying opportunities and potential barriers for action towards climate resilience in water security within the current regulatory context. Municipalities have a unique opportunity to play a (local) regulatory role in water security, where provincial and federal regulations fall short, through the application of bylaws. This review demonstrated that while the province provides strong guiding principles for water security (e.g., Water For Life Strategy), formal water regulations provide limited specific protections for water quality and riparian/floodplain areas - two areas currently within the local land-use zoning jurisdiction of municipalities. Watershed and source water protection is voluntary for municipalities, and these activities can have significant long-term benefits for municipalities, including water security, water treatment cost reduction (through improved raw water quality), and climate change adaptation. Municipalities therefore have flexibility to implement bylaws and best management practices for the betterment of source water protection and water efficiency.

Through our research and interviews with other jurisdictions in Canada, we found four common themes arise from the water management and security information:

1. Source Water Protection
2. Water Efficiency
3. Communication and Education
4. Collaboration and Resource Coordination

This report provides a synopsis of the four themes and describes resources and activity examples that have been undertaken or are currently conducted by the various jurisdictions. Furthermore, two peer-learning sessions were conducted with staff of the City of Toronto, City of Barrie, City of Calgary, and Capital Regional District (Victoria) where stories of water efficiency, climate change adaptation strategies on water management, and community sustainability on water consumption were shared. An interview with EPCOR was also conducted and valuable information on water efficiency, treatment, and climate change adaptation

was provided. The communities receive treated water from regional systems who in-turn receive treated water from EPCOR.

Further to the Canadian content, we have conducted research on water management in United States cities that have been dramatically impacted by climate change. The U.S. Environmental Protection Agency has collectively provided comprehensive guidelines and tools for all municipalities in the U.S. to use; these tools range from infrastructure evaluation and risk assessment to policy implementation.

Based on the findings, the EMR is encouraged to take strong action on source water protection and water efficiency. The municipalities in Alberta have flexibility within the current regulatory environment to implement beneficial water management strategies. Given that the EMR is located within the North Saskatchewan River basin, the EMR will have impacts on its watershed. As such, the EMR should collaborate with the local scientific community and not-for-profit organizations identified in this report, as well as EPCOR, to identify synergies and work collectively on climate change adaptation strategies for the betterment of the community and the environment.

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1 Introduction

1.1 OBJECTIVE

The Government of Canada and the Federation of Canadian Municipalities (FCM) have selected and fund 12 not-for-profit organizations to deliver projects to 72 municipalities across Canada, strengthening their resilience to the effects of climate change. One of these projects is spear-headed by All One Sky Foundation (AOS) working with the Edmonton Metropolitan Region (EMR) including: City of Spruce Grove, City of Leduc, Town of Devon, Town of Stony Plain, City of Edmonton, Strathcona County, City of St. Albert, and City of Wetaskiwin.

In October 2018 AOS conducted a workshop with the EMR, and together they identified top priority impacts for action. These impacts relate to water security which identifies the importance of balancing supply and demand under the lens of a changing climate: changes in water availability in lakes and rivers, changing local ecosystems, and increased storminess. Identifying best practices was one of the outcomes of the discussion and was proposed for coordinated action.

The **objective** of this study is to identify applicable best practices or approaches for mainstreaming climate change into municipal water management.

1.2 PROJECT FOCUS

The project focus is on water management strategies which are ways in which municipalities in the EMR can directly or indirectly influence water supply and demand to minimize the risk of future potential imbalances.

The Organisation for Economic Co-operation and Development (OECD) indicated in their “Water Security for Better Lives, A Summary for Policy Makers”, published in 2013, that achieving water security objectives means maintaining acceptable levels of four water risks:

1. Risk of shortage (including droughts): lack of sufficient water to meet demand.
2. Risk of inadequate quality: lack of water of suitable quality for a particular purpose.
3. Risk of excess (including floods): overflow of the normal confines of water systems or destructive accumulation of water.
4. Risk of undermining the resilience of freshwater systems: exceeding the coping capacity of the surface and groundwater sources.

Water Management, simply put, is about “reducing and avoiding water risks”. However, does the current regulatory framework provide support or guidance to local municipalities in achieving water security? If there is such regulatory framework, what are the support mechanisms, and how does the regulatory framework benefit or guide local municipalities to mainstream climate resilience considerations into the existing municipal policies, plans, programs and procedures? If not, what can local municipalities do? This report provides a summary of researched information of approaches that other jurisdictions have used for

managing climate risk to water security, as well as informing the EMR on the current relevant municipal, provincial and federal regulatory framework.

1.3 TASKS UNDERTAKEN

The two main project tasks are listed in the following:

1. Understanding the existing regulatory framework for water management. This work included the identification of relevant regulations to water management with a high-level scan to include policies around:
 - Management of water supply quantity and quality;
 - Demand management such as water conservation and reuse,
 - Prevention and risk management for extreme events such as drought or floods,
2. Research examples of approaches/best practices for managing climate risks to water security. This work included literature reviews for selected jurisdictions to compile readily available information, as well as Associated Engineering corporate data sources of applied best management practices. Key personnel in selected jurisdictions (within Canada and outside of Canada), government, and associations were interviewed.

1.4 VOICED CONCERNS

During our project kick-off meeting, we asked the Advisory Committee the following questions:

1. What does water security mean to your community?
2. What are some of the challenges you are facing in water management in the context of climate uncertainties?

The overall discussion concerning water security is summarized in the following:

- North Saskatchewan River water quality is impacted by various events such as spring runoff or heavy rainstorms causing excess colour and sediments. The general concern about these events is exacerbated by changing climate or extreme climate events such as floods, heavy precipitation, and drought.
- The communities receive treated water from regional systems who in-turn receive treated water from EPCOR. The concern is that if the water treatment plant is damaged by floods, or treatment is impeded due to the extreme weather events, how this would impact the ability of the communities to receive potable water. What is the back-up plan for the community and for EPCOR?

On the water demand side, there are water use restrictions during dry periods (e.g., alternate days for lawn watering), but water restrictions have not been actively implemented yet as there are no consistent water shortage concerns in the region. Overall, the municipalities have less concern with river water quantity than quality.

2 Regulatory Reviews

A literature review and interviews were conducted to assemble information on how the current regulatory framework provides support or guidance to the local municipalities in achieving water security. In the absence of regulation, alternative ways to achieve climate resilience through non-regulatory bodies were reviewed as well. This review is intended to assist municipalities in identifying opportunities and potential barriers for action towards climate resilience in water security within the current regulatory context.

Municipalities have a unique opportunity to play a (local) regulatory role in water security, where provincial and federal regulations fall short, through the application of bylaws. This review demonstrated that while the province provides strong guiding principles for water security (e.g., Water For Life Strategy), formal water regulations provide limited specific protections for water quality (non-point source pollution - reference [Section 2.2.2](#)) and riparian/floodplain areas - two areas currently within the local land-use zoning jurisdiction of municipalities.

2.1 WATER SUPPLY REGULATION

The current regulatory framework for water management is shaped by the history of regulations and land development of western Canada ([Figure 2-1](#)). Settler values have informed the rules around water use and protection, specifically values of individual rights and commoditization. Historically, settlers had rights to water from riparian areas on their lands. In the late 19th century the federal government asserted ownership over resources to achieve fair division; such resources included fishing (fisheries)¹ and water diversion². The federal Crown's ownership over water (in terms of diversion) was passed to the provincial Crown in the early 20th century ([Figure 2-1](#)).

The provincial Crown set up a system of water licencing based on a First In Time, First In Right principle, which is still in place today under the Water Act. This principle resulted in many older first licences issued for agricultural uses, but generally overlooked indigenous water users. Water diversion (licenced supply) was historically the focus of water management.

In the last 15 years, public concerns about water use and sustainability have led the province to develop the Water For Life Strategy (2003), a policy tool to help the province address limits to the available water supply and quality in the face of increasing population and economic growth. The strategy outlines water licencing priorities, as well as priorities for drinking water and wastewater treatment funding. Water for Life is not a regulatory policy, but it was an important first step into the direction of management of water in a watershed context. The province recognizes source water protection as critical to achieving the goals of the strategy, but does not currently have a regulatory framework to enforce these. The current Water Act does

¹ The *Fisheries Act* (1868) originally regulated fishing, but was updated in 1970 to include fish habitat and pollution prevention.

² *Northwest Irrigation Act* (1894) evolved to the *Alberta Natural Resources Act* (1931) and the *Water Resources Act* (1931), which later became the *Water Act* (2000).

Figure 2-1

WATER SECURITY: REGULATORY FRAMEWORK

Over decades of climate change, we've recognized that the health of our watersheds is impacted by three key factors: water quality, riparian area management, and water volume.

Our regulatory framework was developed over hundreds of years, and addresses some (but not all) aspects of watershed health.



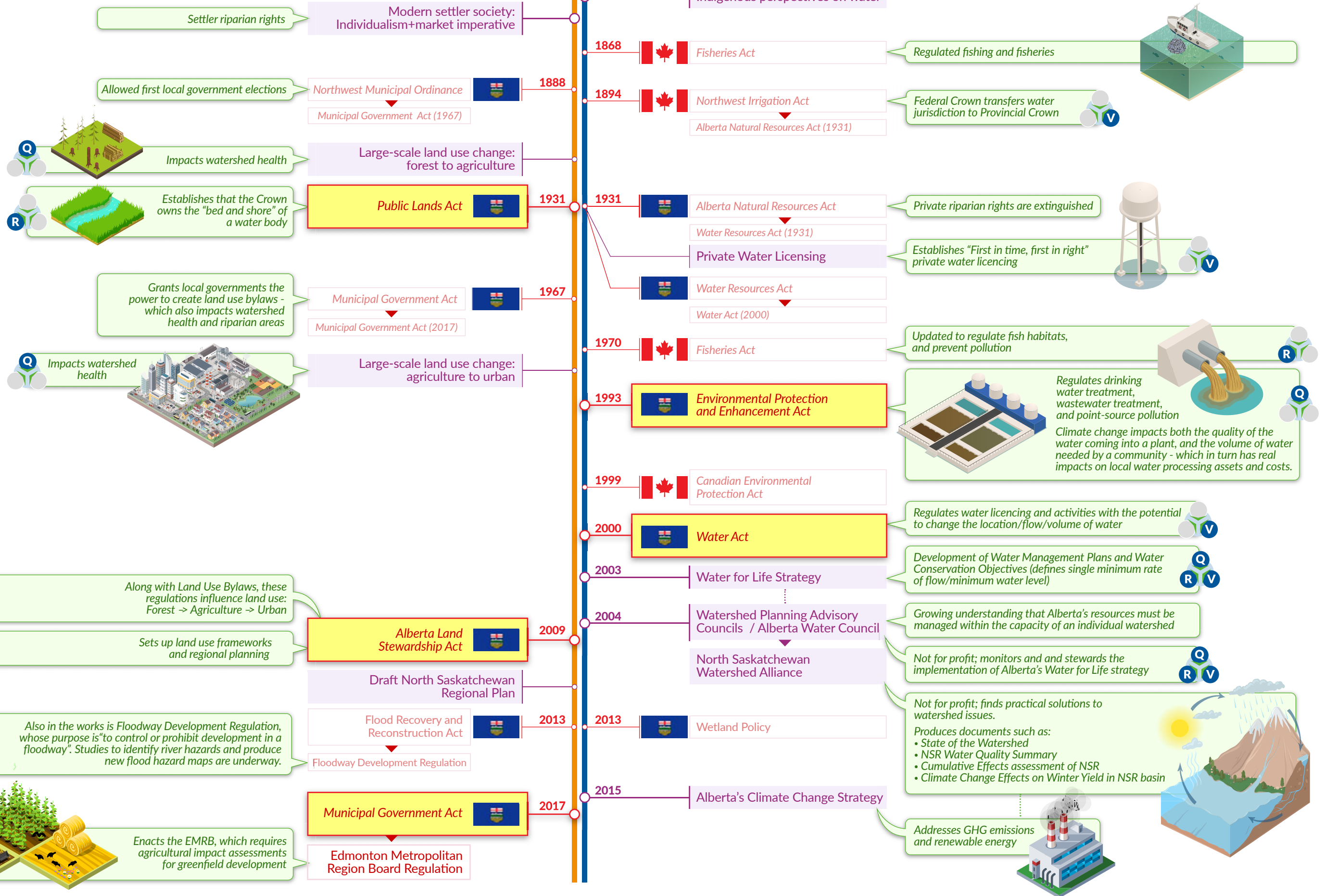
Look for icons of the above graphic to see which of the three issues are addressed by the various entities.



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Land Issues and Regulations

Water Issues and Regulations



not directly apply environmental protection principles such as environmental sustainability; precautionary principle; cumulative impacts; and inter-generational equity³.

Water volume/supply is only one component of water management and is anticipated to be influenced by climate change through several different avenues, such as increased and more severe flood/droughts, reduced annual snowpack, glacier melting, changing rainfall patterns, and evapotranspiration (with rising temperatures). Current provincial dialogue around climate change is generally focussed on mitigation, through reduction of greenhouse gas emissions and investing in alternative energy sources. The current water licencing system does not directly address uncertainty due to climate change. However, the Watershed Planning Advisory Councils (WPACs), in particular the North Saskatchewan Watershed Alliance (WPAC for the watershed where the EMR is located), have produced reports that outline anticipated climate change impacts.

Regulatory requirements for water management on municipalities are generally constrained to water treatment and wastewater treatment, relative to current approvals ("what must municipalities do"):

- Water treatment: licence holders must comply with Water Act diversion licence use and reporting conditions; water treatment standards must adhere to Environmental Protection and Enhancement Act Approvals.
- Wastewater treatment: discharge water quality regulated by the provincial Environmental Protection and Enhancement Act Approvals and the federal Fisheries Act Wastewater Systems Effluent Regulation.
- Land-use planning/development: broadly adhere to the Alberta Land Stewardship Act, the Municipal Government Act's (MGA's) Edmonton Metropolitan Regional Board approvals, and the Wetland Policy.

Water supply infrastructure must meet the Provincial Standards and Guidelines for Municipal waterworks⁴. In addition, AEP provides guidelines for best practices for municipal waterworks⁵. The Guidelines contain several sections relevant to water security. For example, the source water protection section outlines some basic principles on how watershed management can help address raw water quality issues (see section 2.2.2 below). Raw water storage is described to deal with unreliable water supply and to reduce raw water turbidity. Best practices for distribution system design to address varying demands are also included. These standards and guidelines therefore provide ample opportunity for municipalities to integrate best practices into their water supply systems and management to increase resilience to climate change.

³ Environmental Law Centre (2013). Comments on Water Conversation.

http://elc.ab.ca/Content_Files/Files/ELC_Comments_re_AB_Water_Conversation.pdf. Accessed March 25, 2019.

⁴ Alberta Government 2012. Standards and guidelines for municipal waterworks, wastewater and storm drainage systems. Part 1 Standards for municipal waterworks of a total of 5 parts.

⁵ Alberta Government 2012. Standards and guidelines for municipal waterworks, wastewater and storm drainage systems. Part 2 Guidelines for municipal waterworks of a total of 5 parts.

2.2 REGULATION TO PROTECT WATER QUALITY

2.2.1 Point Source Pollution

Two other important components of water management have only recently been added to this discussion and are only partially protected by current regulations: water quality, and riparian/watershed health. Water quality is greatly influenced by point source pollution and non-point source pollution. Point source pollution is generally regulated through the Fisheries Act (by prohibiting the release of deleterious substances to fish-bearing water bodies) and the Environmental Protection and Enhancement Act (EPEA). Through EPEA Approval renewals, the province sets discharge water quality expectations for various industries and municipal wastewater, typically on a project and receiving waterbody-specific basis (e.g., by requiring a Water Quality Based Effluent Limits study). The EPEA Approvals are enforceable at one single location and in that way are distinct from source water protection plans or watershed management plans, which develop goals for water quality at a watershed or sub-watershed scale.

2.2.2 Non-Point Source Pollution

Non-point source pollution is a major concern for water quality and is not directly regulated⁶. Non-point source pollution and cumulative sources of pollution are mainly a result of land use changes and threaten safe, secure drinking water supply in Alberta. Land-use changes happen at the regional scale as well as the local scale. The MGA gives municipalities authority over local land-use decisions, and the authority to implement bylaws, including Zoning and Land-Use Bylaws. Large-scale land-use change tends to have significant negative impacts on water quality, particularly conversion of forested lands to agriculture, and of agricultural lands to urban lands. Two provincial regulations apply directly to land-use management in the EMR: the Alberta Land Stewardship Act and Municipal Governments Act (ALSA and MGA, [Figure 2-1](#)). In addition, agricultural land conversion in the central region faces new scrutiny under the Edmonton Metropolitan Region Board Regulation (new Regulation under the 2017 Municipal Governments Act).

While municipalities often do not have jurisdiction over land uses in the watersheds that supply their drinking water, they can influence decision making by partnerships. For example, they can participate in the development and implementation of Watershed Management Plans led by WPACs and source water protection plans that address multiple pressures in the entire watershed on the shared water resources. The North Saskatchewan Water Alliance (NSWA) has developed a State of the Watershed Report⁷ and completed extensive engagement with watershed stakeholders to identify key issues in watershed health. The NSWA then developed an Integrated Watershed Management Plan (IWMP)⁸ to address these pressures. One of the key action items of the Plan is the promotion of comprehensive source protection planning in the watershed to ensure safe drinking water.

⁶ Environmental Law Centre, Water For Life Comments; North Saskatchewan Watershed Alliance, Water Quality Studies 2014.

⁷ North Saskatchewan Watershed Alliance, State of the North Saskatchewan Watershed Report. 2005.

<https://www.nswa.ab.ca/resource/the-state-of-the-north-sask-river-watershed-report/>.

⁸ North Saskatchewan Watershed Alliance, Integrated Watershed Management Plan. 2009. <https://www.nswa.ab.ca/resource/nsr-integrated-watershed-management-plan-iwmp/>.

Watershed and source water protection is voluntary for municipalities, but these activities can have significant long-term benefits for municipalities, including water security, water treatment cost reduction (through improved raw water quality), and climate change adaptation. The NSWA identified land-conversion and non-point source pollution as major threats to watershed health. These are both items where municipalities can play a major role in addressing water security gaps in the provincial regulatory framework.

2.2.3 Wetlands and Riparian Health

An important interface between land and water regulations is the Wetland Policy (under the Water Act and Public Lands Act). This provincial policy mainly focuses on protection of wetland function moving forward; it provides tools through which wetland restoration can be administered but does not regulate the restoration of historical wetland loss. Environmental consequences of historic wetland and riparian degradation in the central region include, among others: loss of natural water storage (flood and drought mitigation), loss of water filtration services, and loss of erosion protection.

The province recognizes the watershed-level value of riparian/wetland restoration and provides funding and other incentives for municipalities to partake in restoration activities (e.g., Watershed Restoration and Resilience Program). For example, the province is currently working on a wetland banking program, by which proponents can apply for funds to pay for wetland restoration projects with compensation dollars from wetland disturbance projects. The compensation cost/requirements under the Wetland Policy are more severe in regions with more relative historic wetland loss; however, the province does not require municipalities to restore wetlands or riparian areas.

Coordination between municipalities upstream and downstream of important natural capital is critical to the protection of important water security resources; municipalities should not only rely on other provincial or federal agencies to protect watersheds. Opportunities are outlined in Source Water Protection Plans, including protecting headwaters, restoring wetlands historically disturbed or lost, and protecting narrow riparian habitat where still available on the prairie landscape.

Disturbance within the flood plain is area where riparian protection is required. Floodplain development and regulation relate directly to water security due to increased impermeable surfaces which increase the severity and velocity of surface water flows, allowing for less filtration/infiltration and reducing overall watershed health and water quality. Following the 2013 flooding in southern Alberta, the province passed the Flood Recovery and Reconstruction Act, and began developing the Floodplain Development Regulation. The overall goal is to restrict new development within floodplains and manage current development within floodplains. This type of provincial control over fine-scale municipal development poses jurisdictional challenges. Flood Hazard Mapping has been completed for many of the communities along rivers; however enforcing development restrictions in these areas is challenging. As well, the flood-prone zones for rivers would be expected to change over time. Currently, the suitability of 1:100 flood level targets for infrastructure design are being called into question given climate change impacts on frequency and severity of extreme weather events.

Municipalities have an opportunity to make local land-use zoning decisions that affect development close to riparian areas; some municipalities have already undertaken this type of land-use management strategy (examples provided below). The Water For Life Strategy and Stepping Back from The Water⁹ documents both provide lots of guidance for municipalities on proactive land-use management decisions to protect wetlands, floodplains, and riparian areas. Actions could include:

- a) Restricting certain types of development in flood-prone areas and developing flood hazard maps and associated bylaws to govern activities in flood plains. This zoning could refer to-- and would be supported by-- the Water Act. **Example:** Town of Stony Plain (Land Use Bylaw 2576-LUO-17¹⁰ references development restrictions within the Atim Creek floodplain ["Flood Risk Area", Figure 3.2.0]).
- b) Restricting specific development and activities in riparian areas and reviewing all projects in these zones to determine 1. justification for why a particular development needs to be located in sensitive river valleys altogether, and 2. mitigation measures to reduce impacts. **Example:** City of Edmonton (North Saskatchewan River Valley Area Redevelopment Plan, Bylaw 7188¹¹ which protects a large riparian area through the City – all development within this bylaw area is scrutinized by several City departments).
- c) Enacting buffer areas around wetlands and shorelines, in some cases converting buffer areas to municipal reserve. **Example:** Lac La Biche (Environmental Reserve Bylaw Draft¹²; Environmental Reserve Encroachment Policy¹³, and wetland policy under the Municipal Development Plan Bylaw 07-006).

Another example where municipalities can play a key role is through Alternative Land Use Services (ALUS) Canada. ALUS Canada is a charitable organization who works closely with local municipalities and farmers to improve their agricultural land practices for the purpose of improving or restoring natural infrastructure such as wetlands, riparian habitat as part of source water protection. ALUS is working with fourteen municipalities across Alberta on this initiative. Currently, Parkland County is working closely with ALUS Canada in the Modeste and Strawberry watersheds.

2.3 WATER DEMAND

Controls for water demand (i.e., conservation and re-use) is not currently driven by regulatory requirements for water users with existing licences. Rather, these activities are generally voluntary for municipalities.

Provincial and federal regulations allow for much flexibility and freedom for municipalities to implement bylaws and water use restriction programs as appropriate for their communities.

The Alberta Urban Municipalities Association (AUMA) recommends that all communities pass bylaws that allows the municipality to control water usage during times of scarcity¹⁴, regardless of their current water supply. This is a legal tool that is available to municipalities. Another option is to investigate whether water

⁹ Government of Alberta, Stepping back from the water: a beneficial management practices guide for new development near water bodies in Alberta's settled region. 2012. <https://open.alberta.ca/dataset/1c70eb43-a211-4e9c-82c3-9ffd07f64932/resource/6e524f7c-0c19-4253-a0f6-62a0e2166b04/download/2012-steppingbackfromwater-guide-2012.pdf>.

¹⁰ <https://www.stonyplain.com/en/work/resources/Documents/Land-Use-Bylaw-2576-LUO-17.pdf>

¹¹ https://www.edmonton.ca/residential_neighbourhoods/plans_in_effect/North_Saskatchewan_River_ARP_Consolidation.pdf

¹² <https://www.laclabichecounty.com/home/showdocument?id=8650>

¹³ <http://216.21.137.218/home/showdocument?id=1671>

¹⁴ <https://auma.ca/advocacy-services/programs-initiatives/water-management/water-conservation/legal-tools>

usage peaks at unsustainable rates during the summer (compared with constant usage throughout the year), and then implement programs of outdoor water use restrictions accordingly. Several communities within the EMR have already implemented these types of water use restrictions, as described in the State of Knowledge Summary, October 30, 2018 report prepared by All One Sky with the EMR Climate Resilience Exchange Session¹⁵.

2.3.1 Water Re-Use

Alberta Environment and Parks recognizes the need for the development of “appropriate regulations and water quality and technical standards or guidelines to facilitate the safe use of reclaimed wastewater”. Although such standards and guidelines have been published at the national level, the Government of Alberta states that “reclaimed wastewater from any source cannot be used inside buildings or for other domestic applications in Alberta” (Government of Alberta, 2012, in AEDA 2013¹⁶). However, Alberta has passed the 2010 Alberta Guidelines for Rainwater Harvesting, which allows the reuse of water collected from roofs.

Alberta Municipal Affairs has released a fact sheet titled “Alternative Solutions Guide for Reclaimed Water Reuse”. This fact sheet provides clarification on how stakeholders should proceed with developing proposals for obtaining approvals of water reuse applications, indicating that individuals must obtain a variance under the Safety Codes Act, and a variance by the technical administrator of the equipment used for the application. In short, the regulatory framework for reuse of water for municipal use is not yet fully developed for wide-spread implementation.

3 Best Management Practices

3.1 METHODOLOGY

In this section, we have compiled a series of available information through literature reviews on municipalities and cities within Alberta, across the country, and outside of Canada. In preparation for the peer learning sessions, we conducted phone interviews with various cities across the country to discuss the following:

1. What has your community done in terms of climate change resiliency in the context of water security?
2. What are the some of the challenges faced and how are they being overcome?

We interviewed representatives of various agencies and associations, who have their best interest in this geographic region, to provide an external view of best management practices and standards. We interviewed EPCOR to provide a synopsis of



¹⁵ All One Sky, October 30, 2018. Edmonton Metropolitan Region Climate Resilience Exchange: State of Knowledge Summary.

¹⁶ Alberta Economic Development Authority (AEDA) 2013. Water Reuse in Alberta: Summary Report. prepared by Sustainable and Regional Development Committee.

their initiatives on water security and climate change preparedness. In addition, we drew on our current and past project experience to provide further information and discussion of on-going water security concerns and climate impacts.

Table 3-1 below lists the municipalities/cities, agencies, and associations whom we have contacted and/or researched. These cities/municipalities were selected to provide varying perspectives from across the country and outside of Canada with the consideration of geographic and climatic differences. Specifically, some of the municipalities and cities in United States, are experiencing more extreme weather affecting both water quality and quantity. Learnings from these areas provides valuable examples that could be implemented in the EMR.

Table 3-1:
List of Researched Municipalities/Cities, Agencies and Associations

Canadian Municipalities	Outside of Canada
City of Calgary	Victoria, Australia
Regional Municipality of Wood Buffalo	Bozeman, Montana
City of Kelowna	Faribault, Minnesota
Cowichan Valley Regional District	Fort Collins, Colorado
Capital Regional District – Victoria, BC	Nebraska
Metro Vancouver, BC	North Kentucky
City of Barrie, Ontario	Salt Lake City, Utah
City of Toronto, Ontario	Southern Nevada
Agencies and Associations	
North Saskatchewan Water Alliance	
Alberta Water Council	
Alberta Environment and Parks	
ALUS Canada	

The on-line literature reviews were conducted on water supply and demand as the two main subjects. Water supply was considered in the context of source water protection affecting water quality and quantity through local and regional best management practices (BMPs). These require the collective effort among governments, private businesses, and the general public. Water demand was discussed in the context of water usage by the general public, industries, and businesses.

3.2 FINDINGS

3.2.1 Canadian Cities

Through our interviews and literature research, we found that various types of BMPs applied to both water supply and demand. In general, the discussion on water supply was focused on protecting the water source from contamination, whether it is surface water or groundwater. On the water demand side, the discussion was focused on reducing water consumption, and alleviating the demand on the overall water production system. Our research showed that climate impacts do not change the effort/initiatives that are already in place, but rather further drive urgency to increase resources due to the increased concerns with climate hazards.

The following sections provide a [synopsis of the common themes of BMPs](#) prominent in the literature reviews and interviews implemented by other jurisdictions. The implementation of these BMPs by other jurisdictions were observed to be delivered through a combination of bylaws, local government actions/activities/initiatives, programs, public engagement/communications, toolkits, manuals, and guidelines. BMPs have been identified and implemented for the cities/municipalities based on their regional needs.



A common theme of water security is focused on source water protection. This theme is common regardless of changing climate; however, the sense of urgency is elevated when the subject of water security is coupled with climate risks and uncertainties. As such, the message of anti-degradation, enhancing or improving degraded resources, restoration of existing natural environment, and preservation

to retain resources at current state or better are at the forefront of discussion. Source water protection is an important initial step to the multibarrier approach (mainly in treatment and distribution) to prevent contamination from affecting drinking water source.

For example, concerns with source water quality after wildfires are significant in jurisdictions where fire depressant chemicals and ash in surface water runoff reaches natural water systems that serve as community source water. In the Capital Regional District (CRD) on Vancouver Island (including Victoria), major resources are allocated to fire watch and fire prevention as their potable water treatment system currently does not include filtration. Other concerns pertaining to climate change impacts include contamination from overland floods, river floods, and low river flows that impact the source water quality.

Alberta Environment and Parks defined source protection as, "to control or minimize the potential for introduction of chemicals or contaminants in source waters, including water used as a source of drinking water, and watershed management planning is the first barrier in the multi-barrier/source-to-tap approach."

The Toronto and Region Conservation Authority (TRCA) have a strong source protection approach for their drinking water; source water protection is a crucial part of their multi-barrier approach to protect drinking water. Source water protection in Ontario is enforced by the Clean Water Act established in 2006 that required the identification of key intake protection zones for surface water and groundwater sources, definition of water quality and quantity risks to the water sources and the development and implementation of mitigation measures. This enforcement in source protection also incorporates climate change impacts on the source water and how it will impact future water budgets (i.e., impacting the hydrogeological cycle).

In the effort of protecting the source water, the City of Calgary conducted a watershed study to better understand the hydrological characteristics, magnitude, and boundary of the watershed that provides source water for the Calgary metropolitan area. Similar to CRD, wildfire has significant impact on water quality and is ranked as top source water safety risk.

Another risk to source water quality is non-point source pollution resulting from many diffuse sources such as runoff from human activities on urban and agriculture land. The negative impact on river water quality can be exacerbated if the river system is already stressed due to climate impacts. Low Impact Development has been implemented in many jurisdictions to address non-point source pollution. These BMPs include permeable pavements, storm ponds, bioswales, absorbent land scape, green roofs, and rain gardens provide pre-treatment of stormwater. These BMPs have mechanisms to store excess water and filter out contaminants before the storm water drains back into rivers/lakes. To address non-point source pollution, Fort McMurray, in the Regional Municipality of Wood Buffalo, Alberta, is implementing a Total Loading Plan to monitor storm water pollutant loading into the Athabasca and Clearwater Rivers from various land uses within the city limits. The outcome of this data is to support future upgrades of the storm water control systems and to identify strategies to improve stormwater quality.



In rural areas and along major rivers, natural assets such as wetlands are important for filtering contaminants. River banks armoring and restoration also guard against river quality degradation during flood events. In flood events, river bank wash-outs add suspended solids to the river that require further filtration in water treatment processes. Various jurisdictions do not have potable treatment capability to filter out the excess contaminants, and may not have the resources to update such treatment system; therefore more emphasis is placed on protecting the quality of the source water.



Theme 2: Water Efficiency

Reducing the water demands and being efficient with water consumption is another common theme of water security. Rural and urban communities in Alberta have grown at an average rate ranging between 0.5 % and 11% over the last 10 years (Alberta Government, Municipal Population List). Our research showed that communities are

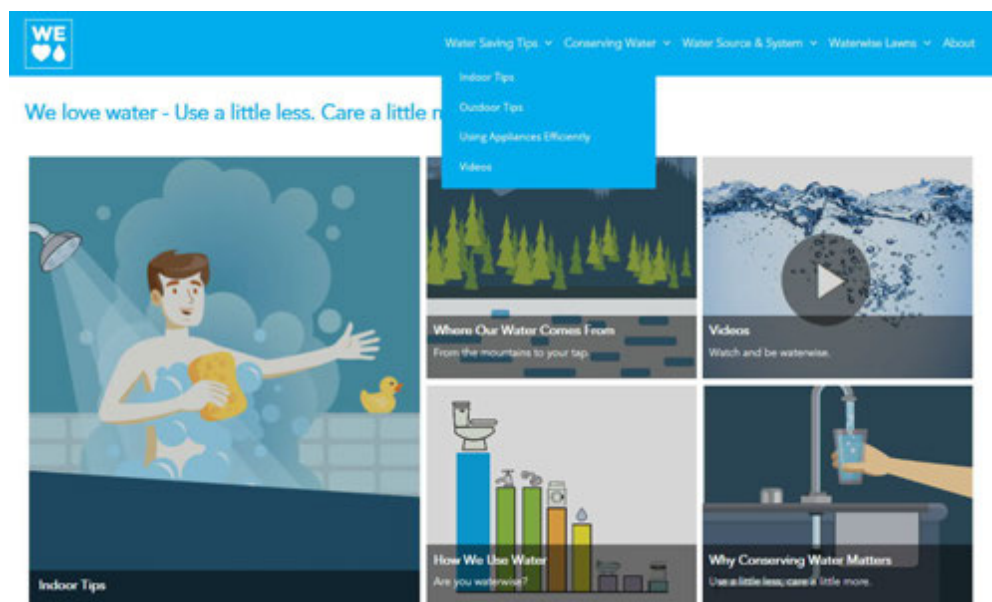
concerned that climate change impacts such as drought and floods will be affecting the quantity and quality of water supply. In response to the increasing water demand, communities have implemented strong water conservation programs to reduce water consumption, alleviate water production demand, and water withdrawal from the natural system. It is also observed that on-going water conservation initiatives such as drought management have been placed with higher priority with climate change impacts.

The Capital Region Southwest Water Services Commission and Capital Region Parkland Water Services Commission are mainly concerned with water quantity, i.e., with the concern that they may not be able to meet the demands of their members. They have concerns with lower river flows and drought conditions; therefore, they have initiated conversations with the municipalities on water conservation. Water conservation BMPs would also help to delay future upgrades or construction of new pipelines.

The Calgary Metropolitan Region Board members are recognizing the potential impact of future climate change specifically on drought conditions and low river flow conditions. Associated Engineering is currently working with members to review current water consumption data, water loss, and effectiveness of water conservative initiatives implemented in the last 10 years. This information is forthcoming in late 2019 as the project is on-going.

Almost all cities in Canada and the U.S. have implemented some form of conservation through water restrictive use, education, and public awareness. Specifically, in areas where drought is a main concern, there is more extensive information and education on the different stages of restrictive use with the onset of potential drought conditions. Other web sites, such as the one shown below (Figure 3-1), offer interactive information including tips, videos, and educational information mainly to curb careless water consumption behaviour. The messaging is often geared towards having the public take ownership of one's action and the consequences that these actions have on water resources. In addition, there are bathroom fixtures rebate programs implemented by the cities across Canada to replace high flow fixtures with low flow ones. In some cities, these rebate programs extend to washing machine replacements. Technologies on low flow fixtures are also implemented in commercial and institutional buildings to reduce overall consumption in these high use areas. As such, these initiatives are becoming standard practices, as can be seen in green buildings such as LEED rated buildings.

Figure 3-1:
Metro Vancouver Website Educating on Water Efficiency



<http://www.metrovancouver.org/welovewater/Pages/def>

Another BMP to reduce water consumption noted in other jurisdictions is metering water consumption and using a tiered water rate system to incentivise reduction in water consumption. Communities who have no metering or have a flat rate system were observed to have higher water consumption in liters per capita per day.

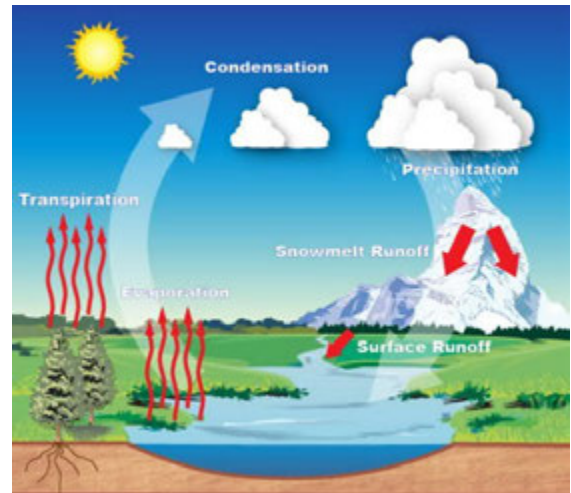


Theme 3: Communication and Education

behavioural change, resource funding, and rationalizing policy change and implementation with political support.

The subject that was commonly discussed in our research is to communicate and educate on the basics of hydrologic cycle and how climate change impacts this cycle to better inform the public and government agencies on water management and security. Often this information is communicated for the purpose of incentivising

Numerous studies and climate models have shown that increased air temperature and modified precipitation patterns as a result of climate change will impact stream flows, lake levels, groundwater recharge and discharge, which in turn impacts water quality and quantity¹⁷. Associated Engineering is currently working with Alberta Innovates and Alberta Environment and Parks to review climate impacts on Alberta's river flows and its impact on water treatment plant's ability to produce water and meeting the demands of the communities across Alberta. The results are forthcoming in late 2019, as the project is on-going.



Across the various jurisdictions that we reviewed, a commonly discussed topic is: Where is water being used, and how much and in what proportion? Through this discussion, the jurisdictions drew upon information from climate models to show potential impacts on freshwater supply and how it could impact water quality.

For example, in the Okanagan, British Columbia, several jurisdictions have collaborated with other local government, and provincial agencies to engage in a comprehensive assessment of water balance. The intent is to address the climate risks and growing demands. With this level of education and information, water security related programs can be rationalized and designed with political support and funding in place.

In the Toronto area, the TRCA developed Source Protection Plans that rely on various approaches to communicate and educate on incentive programs, land use planning approaches, and tools and instruments available for public use. The TRCA implemented community outreach programs that have been implemented on a neighbourhood scale to communicate and educate residents about various topics of sustainability, one of them includes water conservation for residential use. The program has proved to be successful with community engagement and empowering the local residents in a mature neighbourhood to continue this initiative for a long-term change.

The City of Calgary is implementing a drought management program internally that entails recognition of warning signs, and reporting internally and publicly. Part of this program includes an emergency response plan in the event of an extreme drought event. Further outreach programs will be implemented to educate the public on drought impacts and water efficiency.

¹⁷ <https://changingclimate.ca/CCCR2019/chapter/6-0/>



Theme 4:
Collaboration and
Resource
Coordination

Program implementation processes that we have observed in other cities/jurisdiction are often conducted in collaboration with various technical and non-technical participants that are not limited to local government, provincial or federal government. Collaborative efforts with non-governmental groups such as water protection coalition/alliance/interest groups, and academia (e.g., University of

Guelph, University of Alberta) who work closely with municipalities and local government to establish plans for source watershed protection and management are often more effective and comprehensive. For example, the City of Calgary works in collaboration with the University of Regina and the local watershed association to better understand future climate impacts. The TRCA works with various NGOs and property developers to develop long term relationships and an understanding of water sustainability goals within the community.

Many jurisdictions have an overarching document or framework to communicate goals, objectives, tasks/strategies within the various levels of government and participants. The collaboration efforts often apply to the following tasks:

- Identify an urgency to act;
- Establish goals and objectives;
- Conduct assessment to identify risks and prioritize impacts;
- Identify targets and timeline of meeting the targets;
- Identify metrics for comparison and measurement of success;
- Include design checklist, handbook, examples, tools, and references of technologies to enhance the plan;
- Establish monitoring requirements and reporting;
- Establish communication avenue with the public through public engagement, education, and reporting;
- Provide comparative discussion, and identify gaps; and
- Report on an annual basis to show progress and improvements, if any.

Champions and leadership groups are identified to ensure commitment, continuity and actions are being undertaken with noted improvements. Active participants with clear roles and responsibilities are also defined. This is clearly voiced in jurisdictions such as City of Barrie, City of Calgary, and TRCA, who have all created specific task forces to ensure success in the water security program. Similar to City of Edmonton, City of Barrie has embarked on the Building Adaptive and Resilient Communities (BARC) by developing and implementing a Climate Change Adaptation Strategy Plan. The City of Barrie has developed three implementation groups:

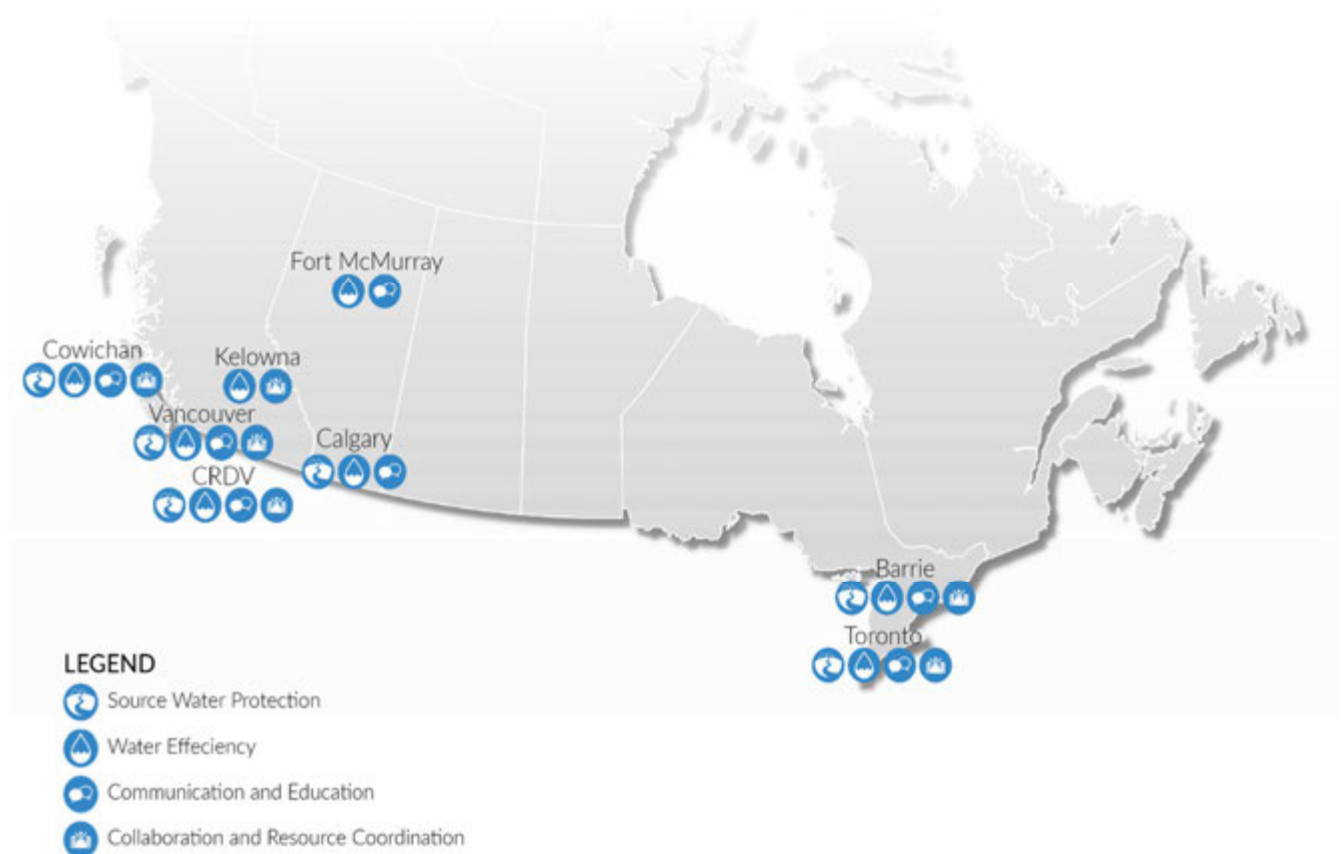
1. Project Team - lead the development of the adaptation strategy and provide research and consultation.
2. Adaptation Team - contribute to adaptation planning effort and provide overall strategic direction.
3. Stakeholder Advisory Group - provide sector-specific knowledge, input, and advice from the community perspective.

Retaining human resources to ensure completion of tasks and continuity of effort is one of the challenges discussed with other jurisdictions. There are many people who are passionate about this subject but are sometimes disappointed because of lack of monetary and human resources; however, these challenges are inconsequential as long as they are supported from within their government. Support in this discussion includes resources (financial and human), and timely and effective communication between different levels of government. The lack of support would risk the initiatives to be postponed, delayed or cancelled. To mitigate this risk, committees and tasks force are deliberately formed to ensure accountability and responsibility for long term success of the program.

3.2.2 Summary of Findings

Figure 3–2 provides a visual summary of the four themes discussed above for the Canadian cities that we researched. In addition, Table 3–2 in Appendix A provides the details of the initiatives/BMPs implemented in the Canadian cities. BMPs have been implemented for the cities/municipalities based on their regional needs. References are listed with the sources (web addresses) where further details can be found.

Figure 3-2:
BMPs Applied in Various Canadian Cities



3.2.3 US Cities

There is no shortage of information from the U.S. EPA on water resilience to address water security issues. The U.S. EPA has developed numerous websites that provide a vast amount of information and resources from the basic understanding of climate change, its impact on water resources and communities, to a tool kit to assess vulnerabilities, economic tools to assess costs and benefits, emergency response planning, and training. Creating Resilient Water Utilities (CRWU) is one of the initiative programs that provides drinking water, wastewater and stormwater utilities with the practical tools, training and technical assistance to increase resilience to extreme weather events. CRWU's goals is to assist water sector utilities by promoting a clear understanding of potential long-term adaptation options. A document, *Adaptation Strategies Guide for Water Utilities, 2015*¹⁸ includes BMP strategy benefits for:

1. Drought management
2. Water quality degradation
3. Floods
4. Ecosystem changes
5. Service reliability, demand and use

The above is also supplemented with sustainability briefs on green infrastructure and water demand management.

Figure 3-3: US Regions



US EPA developed a database of case studies to demonstrate implementations of BMPs conducted by cities across US to address local climate issues faced by water and wastewater utilities¹⁹. We have selected cities from the case study database mainly from Southwest, Midwest, and Great Plains shown on [Figure 3 -3](#) for the reason that these areas are experiencing extreme climate impacts that is characteristics of Alberta's

¹⁸ https://19january2017snapshot.epa.gov/sites/production/files/2015-04/documents/updated_adaptation_strategies_guide_for_water_utilities.pdf

¹⁹ <https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=03d35ca84b5944f8b3ab59bf3a981462>

future climate condition. Climate modeling conducted in 2017 for the City of Edmonton Vulnerability Risk Assessment showed that the climate characteristics for the region around Edmonton in 2050's to 2080's would be similar to areas in central Montana and western South Dakota.

The selected case studies ([Appendix B](#)) that are relevant to this study are:

1. Bozeman, Montana
2. Salt Lake County, Utah
3. City of Faribault, Minnesota
4. Fort Collins Utilities, Colorado

4 Discussion with EPCOR

Based on our initial conference call with the EMR, there was a general interest in knowing more about EPCOR's plan in addressing climate uncertainty for potable water treatment. We conducted a brief interview with EPCOR and summarized the discussion in this section. The discussion was mainly on relevant initiatives that EPCOR is implementing or planning to address climate change risk on the water treatment facilities and the treatment process in the context of extreme floods (high river flows and overland flows), low river flows, and potential changes in water quality.

EPCOR provided the following overview of their climate change and resiliency initiatives.

a) Source Water Protection

EPCOR first prepared a Source Water Protection Plan (SWPP)²⁰ for Edmonton in 2008 and the most recent update was completed in 2017. The SWPP assesses the risks to Edmonton's source waters, including changes to water quality and quantity. In this report, EPCOR discussed the effects of climate change on the water supply in terms of its quality and quantity. The report continues to discuss alternative sources of water supply such as lakes and groundwater in the region.

EPCOR's source water protection goals are to:

- Ensure clean and adequate water supplies;
- Ensure minimal effects of operations on water quality and aquatic ecosystem health to the receiving water bodies.

A large focus on EPCOR's SWPP is discussing the state and health of the North Saskatchewan River Basin using natural green infrastructure in the basin, and how land use has an effect on water quality in the River.

In 2017, EPCOR prepared a summary report, EnviroVista Report²¹ that promotes environmental leadership and protection of the environment while ensuring that future generations have access to clean and safe water while facing changing climate. This report also contains initiatives that EPCOR has been involved in regarding the topic of water security and climate change.

²⁰ <https://www.epcor.com/products-services/water/Documents/source-water-protection-plan.pdf>

²¹ https://www.epcor.com/learn/efficiency-conservation/envirovista-champion-report/Documents/EnviroVista_2017_Final.pdf

b) Water Efficiency

Operationally, EPCOR addresses water efficiency through system water losses through monitoring and controlling water losses in the distribution system. Water losses are tracked and addressed.

Various tools, events, and notifications are used to emphasize reduction in residential and commercial water use (discussed in the next point). Water usage trends are monitored regularly to ensure the conservation program is meeting operational objectives as well as customers' needs. EPCOR has seen excellent progress in the long-term trends on water consumption per capita. While population has steadily increased from 1971-2017, in-city average day demand has leveled off (with year-to-year fluctuations) and total per capita water use has been on the decline since the early 1980s. In 2017, the total per capita water use was 286 litres per person per day (L/p/d). Residential water use was 184 L/p/d.

c) Communicate and Educate

EPCOR conducted various educational and communication programs including:

- Events focused on educating customers and promoting water efficiency.
- Notifying schools and subsidized housing operators and sent conservation information packages.
- Promoted conservation initiatives during Environment Week, Canada Water Week and World Water Day.
- Promoted conservation and water efficiency information through social media channels, bill inserts, and updating efficiency information and tools on EPCOR's website to help customers reduce their water use.
- Supplied online tools and resources for teachers and students that support education around water and wise water use: Esmart Kids²², Water Quest²³.
- Hosted a discussion forum to educate and inform industry and stakeholders on the importance of source water protection.

d) Collaboration and Resource Allocation

This initiative is supported through strong research and monitoring both inside and outside of EPCOR:

- EPCOR has partnered with Dr. David Sauchyn of the University of Alberta to overlay future climate change scenarios onto historic flow rate data to project a range of possible future water supply scenarios for the decades ahead. This would build upon previous EPCOR-supported research that examined historical variability and generated a 900-year weekly flow reconstruction of the North Saskatchewan River.
- EPCOR is supporting the forWater Network which will review source water protection for communities like Edmonton that depend on source water originating from forested landscapes. Climate change associated disturbances such as wildfires and floods are causing increasingly variable or deteriorated water quality which is challenging water treatment plants. This network of researchers will examine forest management practices in the context of drinking water treatment and source water protection.

²² <http://smarkkids.epcor.ca>

²³ <http://smarkkids.epcor.ca>

- EPCOR has partnered with the University of Waterloo on a project to characterize organic matter in source water, which plays an important role in water treatment processes and can challenge the ability to generate clean drinking water. Climate change and extreme weather events, such as droughts and floods, can have a large impact on organic material in source water.
- EPCOR contributes to the Water Research Foundation funded project entitled: Real-life Enterprise Resilience. The goal of this project is to provide a practice-led resource for water utility managers to identify, assess and establish tolerance levels to a full range of business risks, including risks impacted by climate change.
- EPCOR has provided funding to ALUS Canada and the North Saskatchewan Watershed Alliance to support research on evaluating the health and importance of riparian areas in the Modeste and Strawberry Creek watersheds. Wetlands and vegetated areas have an important role in flood mitigation, and currently there is limited knowledge of the health of riparian areas in the North Saskatchewan River Basin.
- Beginning in 2018, EPCOR is contributing \$1 million per year for the next four years towards funding and supporting an integrated, efficient and effective water quality monitoring program of the North Saskatchewan River and its tributaries. This program will fill data gaps regarding EPCOR's source water and aid with predicting changes to water quality in the future.
- EPCOR has completed work on its Climate Change Adaptation Strategy. This strategy includes a summary of the current state of knowledge on changes in water quality and quantity in the North Saskatchewan River, and provided an adaptation strategy for operations and a research strategy to better understand and predict the impacts of climate change.
- Research on forecasting Edmonton and region water demand under climate change scenarios is underway at the University of Alberta.
- EPCOR has worked to engage the community by sponsoring conferences and initiatives such as serving as title sponsor of the UN Intergovernmental Panel on Climate Change 2018 Cities and Climate Change Science Conference held in Edmonton in March of 2018.
- EPCOR has also supported Bob Sandford, the EPCOR Chair in Water and Climate Security at the United Nations University Institute for Water and Environment and Health for a number of years. Bob has worked to translate scientific research outcomes for decision makers to use to craft timely and meaningful public policy and to bring international examples to bear on local water issues.

In addition to the above four themes, EPCOR is implementing the following plans to further guard against changing climate:

1) River Flood Resiliency Plan

EPCOR is developing a River Flood Resiliency Plan to minimize the damage to both water treatment plants during large flood events in the North Saskatchewan River. The Government of Canada and the Province of Alberta have announced grant funding (March 2019) to support these flood mitigation upgrades. EPCOR has a \$1.6 billion plan for flood protection action over the next 20 years plus additional protection of the Rosedale and E.L. Smith Water Treatment Plants underway.

2) Stormwater Integrated Resource Plan

EPCOR has built a risk-based approach to identifying the parts of Edmonton that have the highest risk of impacts due to stormwater flooding. They have also engaged the public to understand Edmontonians' priorities and incorporate those into our focus on flood mitigation efforts. Their report details Edmontonians' top priorities and EPCOR's proposed risk model which shows what areas of the city require attention, based on safety, environment, social, and financial risks due to flooding.

3) Water Emergency Exercise Plans

EPCOR continues to lead the initiative to develop and implement a drinking water emergency exercise plan for the Edmonton and region water system in participation with key stakeholders including Alberta Health Services, Alberta Environment and Parks, Alberta Emergency Management Agency, City of Edmonton and the Regional Water Customer Group. Since 2014, EPCOR have conducted four "Troubled Water" tabletop exercises, with two taking place last year.

Two working groups were created in late 2017 to focus on the challenge of providing an emergency drinking water supply in the event of a widespread drinking water quality issue or loss of supply. EPCOR has developed a working plan for providing an emergency drinking water supply in such an event.

4) Long-Term Plan

EPCOR is developing a long-term plan for the Water Treatment Plants that will address anticipated growth in demand, changes in source water quality, evolving regulatory requirements and climate change driven fluctuations well into the future.

5 Peer Learning

As previously indicated, we conducted a phone interview in preparation for the peer learning sessions. The selected interviewees are:

1. City of Barrie, Ontario. Katie Thompson, katie.thompson@barrie.ca
2. Toronto and Region Conservation Authority, Toronto, Ontario
 - a. Jennifer Stephens, jennifer.stephens@trca.ca
 - b. Sonya Meek, sonya.meek@trca.ca
3. City of Calgary, Alberta.
 - a. Pamela Duncan, pamela.duncan@calgary.ca
4. Capital Regional District of Victoria, British Columbia. Kristi Wilson, kwilson@crd.bc.ca
5. Metro-Vancouver, British Columbia. Brent Burton. Brent.Burton@metrovancouver.org
6. Cowichan Valley Regional District. Kate Miller. kmiller@cvrd.bc.ca
7. ALUS Canada, Alberta. Christine Campbell. ccampbell@alus.ca

The interview log is found in [Appendix C](#). The peer learning sessions were held on May 27 and 29, 2019. Those who participated in the sessions from the above lists were City of Barrie, Toronto and Region Conservation Authority, City of Calgary, and Capital Regional District of Victoria (CRDV). Their presentation slides except for CRDV, which was held as an interview format, are found in [Appendix D](#).

6 Additional Resources

The following provides a description of other resources that the EMR can access to help build alliance and collaborate with, as well as obtain valuable information to support policy change.

6.1 NON-GOVERNMENTAL GROUPS

Non-governmental groups that are relevant to this discussion are the North Saskatchewan Watershed Alliance (NSWA), Alberta Water Council (AWC), and Alberta Urban Municipalities Association AUMA. These groups have a vested interest in the health of the natural water system and ecology, and our drinking water system. They also have the relevant scientifically-supported resources that can help inform municipalities.

The NSWA has prepared an integrated watershed management plan (IWMP) as described in Section 2.2.2 above. Many actions identified in the IWMP are geared towards municipalities, as they have the local decision-making power for land use planning and watershed protection. Municipalities can obtain resources from NSWA that assist in “doing the right thing” for watershed health and thereby water security. These resources include, amongst others:

- Information on best management practices.
- Scientific knowledge on watershed health, water quality and quantity and areas of highest concern.
- Tools for public engagement and watershed health education.
- Opportunities to participate in sub-watershed studies and watershed stewardship activities.
- Funding opportunities for restoration of natural assets.

Municipalities can also be directly involved on the NSWA board or can participate in NSWA events and forums.

The Alberta Water Council (AWC) is a province-wide forum established by the Province of Alberta under “Water for Life” to address province-wide issues of water management. The AWC provides a forum for stakeholder collaboration and development of recommendations to advance the goals of safe, secure drinking water, health aquatic ecosystems and reliable, quality water supplies for a sustainable economy. The AWC is currently completing two projects that are highly relevant to water security, i.e., the projects on source protection planning²⁴ and drought management²⁵ and AWC has recently completed a project on water conservation, efficiency and productivity²⁶. These projects involved reviews of and success stories in other jurisdictions and provide recommendations on best practices for ensuring safe and secure water supplies. Municipalities are represented on the AWC through AUMA, Rural Municipalities of Alberta (RMA) and City of Edmonton, and thereby have a strong voice on the types of project AWC takes on and the opportunity to contribute to project teams.

²⁴ <https://awchome.ca/Projects/CurrentProjects/ProtectingSourcesDrinkingWater/tabid/217/Default.aspx>

²⁵ <https://awchome.ca/Projects/CurrentProjects/Multiyeardrought/tabid/214/Default.aspx>

²⁶ <https://awchome.ca/Projects/CEP/tabid/209/Default.aspx>

The AUMA represents urban municipalities including cities, towns, villages, summer villages and specialized municipalities in Alberta. They advocate the interests of the members to provincial and federal orders of government. In 2014, the AUMA published an update report²⁷ that presents a plan for adopting water conservation, efficiency and productivity with the intention to achieve the goals of the Water for Life Strategy.

The AUMA encouraged a water conservation target for the municipalities of 30% improvement in overall water consumption in all sectors. In this report, new targets are set to be achieved by 2020: Alberta's urban municipal sector will achieve an average per capita residential water use of 195 liters/person/day and a total per capita water use of 341 litres/per/day. Municipalities can work with the AUMA to achieve this new target with the following planned actions:

1. AUMA member municipalities holding a water license(s) for municipal use will report water use data through the Government of Alberta's (GoA) Water Use Reporting System.
2. AUMA member municipalities will share water use information with the AUMA so that the AUMA may report on the aggregate water use and water savings of the urban municipal sector.
3. Work with the GoA to track and report on contributions of urban municipalities as a whole to the goals of the province's Water for Life Strategy.
4. The AUMA will continue to partner with the GoA and other organizations to develop tools and share information to assist municipalities to achieve water conservation, efficiency and productivity, to measure their own water use and water loss, and to set targets for these.
5. AUMA member municipalities will continue to take action to increase water conservation by users, efficiency of water distribution system, and productivity of water and wastewater treatment systems, so as to contribute to the urban municipal sector collectively achieving its water use and water loss targets.
6. The AUMA will advocate that the Government of Canada resume the Municipal Water and Wastewater Survey program as it provides a valuable benchmark for assessing the efforts of municipalities across the country and the effectiveness of water and wastewater management policies from other jurisdictions.

The AUMA is planning to renew the targets and actions of this plan in 2020. Associated Engineering contacted the AUMA on this project and inquired of their progress and whether there are any updates that can be shared with the municipalities. The AUMA did not provide such information prior to submission of this report. Associated Engineering will provide an e-mail of notice to All One Sky upon receipt.

6.2 DESIGN STANDARDS AND GUIDELINES

There is a plethora of existing resources (not government regulated) which have been used and implemented as industry design standards or best management practices for water management. These resources pertain to designs, operations, and maintenance. These best management practices include the following example categories:

- water efficiency;
- water conservation;
- spill response plan; and
- water leakage management.

²⁷ https://www.auma.ca/sites/default/files/Advocacy/Document_library/80674_2014_cep_plan.pdf

The Envision Rating System that was developed in the US by the Institute for Sustainable Infrastructure has been used since 2014 on promoting sustainable designs in various types of infrastructure projects that are not building centric. Infrastructure projects include stormwater management, treatment, transportation, conveyance systems of sewer and potable water, and telecommunications. This rating system is utilized to rate projects and third-party verification is conducted by the Institute of Sustainable Infrastructure to achieve recognition for its application of appropriate BMPs for social and environmental sustainability. Relevant to water management, Envision is inclusive of wetland protection, riparian buffer, groundwater and surface water pollution prevention, brownfield restoration, and water reuse opportunities. Similar to the LEED rating system, which is intended for buildings, both rating systems have emphasis on pre-development and post-development stormwater preservation, pre-treatment consideration, rainwater storage and harvesting, and water efficiency. Specifically, with LEED, many cities have adopted BMPs from this rating system as the standard performance specification.

Overall, municipalities are responsible for planning, operating and maintaining the urban stormwater system and have significant influence over land development and natural capital protection. The above resources can be brought into discussion and applied where suitable for building resilient communities in the context of water security.

7 Recommendations

Based on the information gathered for this study, the following recommendations are provided to the EMR for consideration to mainstream climate resilience into Water Management:

- Take strong actions on source water protection and water efficiency through implementation of bylaws, education, and community engagement. There are no regulatory restrictions to source water protection or water efficiency that would prevent municipalities from engaging the communities from implementing these tools; municipalities have plenty of flexibility to implement local bylaws to engage and curb behaviour in terms of water consumption and source water protection.
- With the expectation of an increasing population in the EMR, a strong policy on water efficiency or conservation would reduce on water demand.
- Advocate for green infrastructure collectively with AUMA and ALUS Canada to deliver the message that green infrastructure is valuable in flood management and provides a positive impact on source water quality. Through AUMA, create a discussion forum with land developers to educate on long term positive investment on sustainable development. This form of discussion provides an open conversation to help each other to understand climate risks and its social, economic and environmental impact. An example is to host a discussion forum with known green developers to understand what BMPs they have implemented, and lessons learned.
- Conduct frequent discussions with EPCOR to share relevant information and concerns, identify potential issues, and collaborate to resolve issues. This allows for open communication amongst the EMR and EPCOR on climate resiliency such as flood protection of the water treatment plant, or alternative water source other than the North Saskatchewan River.

- Many cities in the U.S. are currently experience water shortage and water quality issues due to the change in climate. It would be prudent to look to our southern neighbours for relevant resiliency strategies to avoid potentially “reinventing the wheel”. As well, there are lessons to be learned from their “mistakes” to avoid going down the same path.
- A noteworthy resource that provides some basic implementation discussion points is: Mainstreaming Climate Change Adaptation in Canadian Water Resource Management²⁸. This report is a collaboration between the Canadian Climate Forum (formerly CFCAS), the Canadian Water Resource Association, and Toronto and Region Conservation Authority with significant contributions by provincial, municipal and aboriginal governments, watershed agencies, academia, businesses and ENGOs from across Canada.

²⁸https://www.researchgate.net/profile/Marc_Nelitz/publication/274721606_Mainstreaming_adaptation_to_climate_change_in_Canadian_water_resource_management_A_review_of_the_state_of_practice_and_identification_of_opportunities_for_action/links/5528b5e50cf29b22c9bcb2bb/Mainstreaming-adaptation-to-climate-change-in-Canadian-water-resource-management-A-review-of-the-state-of-practice-and-identification-of-opportunities-for-action.pdf?origin=publication_detail

REPORT

Closure

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.




on behalf of

Sarina Loots, P.Bio.
Environmental Scientists



Juliana Tang, M.Sc., P.Eng., LEED AP, ENV SP
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Sustainable Design Specialist

ASSOCIATED ENGINEERING QUALITY MANAGEMENT SIGN-OFF	
Signature: _____	
Date: _____	2019-07-15





APEGA Permit to Practice P 3979
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Appendix A - BMPs from Canadian Cities

Table 3-2
Example of Activities/ BMPs Applied in Canadian Cities

City/Region	Theme			
	 1 Source Water Protection	 2 Water Efficiency	 3 Communication and Education	 4 Collaboration and Resource Coordination
City of Calgary	Source Water Protection Portal https://www.calgary.ca/UEP/Water/Pages/Watersheds-and-rivers/Source-Water-Protection.aspx	Climate Resilience http://www.calgary.ca/UEP/ESM/Pages/Energy-Savings/Climate-Change.aspx	Educational Partners & Youth Programs https://www.calgary.ca/UEP/Water/Pages/Youth-education/Other-School-and-Community-Programs.aspx	
	Source Water Protection Plan https://www.calgary.ca/UEP/Water/Documents/Water-Documents/Source-Water-Protection-Plan.pdf	Water Conservation -Business Tips https://www.calgary.ca/UEP/Water/Pages/Water-conservation/Business-customers/Industrial-Commercial-Institutional-(ICI)-Customers.aspx	Water - Educational Resources https://www.calgary.ca/UEP/Water/Pages/Youth-education/Teacher-Resources.aspx	
	Low Impact Development https://www.calgary.ca/UEP/Water/Pages/Watersheds-and-rivers/Erosion-and-sediment-control/Low-Impact-Development.aspx	Water Conservation - Indoor Tips https://www.calgary.ca/UEP/Water/Pages/Water-conservation/Indoor-water-conservation/Water-Efficient-Fixtures-residential.aspx	Water Tours in Calgary (#yycwatertours) https://www.calgary.ca/UEP/Water/Pages/Water-and-wastewater-systems/Tours-water-and-wastewater/Water-Treatment-and-Wastewater-treatment-tours.aspx	
	Rain Water Harvesting https://www.calgary.ca/UEP/Water/Pages/Water-conservation/Lawn-and-garden/Rain-barrels/Green-Calgary-Rain-Barrel-Sales.aspx		Information About the Climate Change https://www.calgary.ca/UEP/ESM/Pages/Energy-Savings/Climate-Change.aspx	
Cowichan Valley Regional District	Protecting Water Supply (Surface and Groundwater) https://www.cvrdb.ca/2159/Water-Supply	New Normal Cowichan A Multi-phased Project to Take Action on Climate Adaptation https://www.cvrdb.ca/2101/Climate-Change	Water Balance Tool https://cvrdb.waterbalance-express.ca/	Official Community Plan No. 2500 Outlines, Policies, and Objectives that Should Utilize BMPs https://www.cvrdb.ca/DocumentCenter/View/567/Appendix-G-Bylaw-Section-17bidd
		Water Use Restrictions http://cvrdbnewnormalcowichan.ca/water-use-restrictions/	DroughtSmart for Home http://cvrdbnewnormalcowichan.ca/drought-tools-for-home/	Cowichan Basin Water Management Plan. BMPs for Water Efficiency with Water Infrastructure Improvements https://www.cvrdb.ca/DocumentCenter/View/76414/CBMP-cvrd-actions-Nov-26-2015
Metro Vancouver Area	Stormwater Source Control Design Guidelines 2012 http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/StormwaterSourceControlDesignGuidelines2012.pdf	Water Wise Conservation https://vancouver.ca/home-property-development/conserving-and-protecting-water.aspx	Waterwise Lawn Care Guide http://www.metrovancouver.org/services/water/conservation-reservoir-levels/waterwise-lawn-care/Pages/default.aspx	Integrated Stormwater Management Plans Lessons Learned to 2011 L http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/ISMP_Lessons_Learned_April_2012.pdf
	Single Lot Residential Development for On-site Stormwater Management http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Region-WideBaselineOnsiteStormwaterManagement-Feb2017.pdf	Drinking Water Management Plan http://www.metrovancouver.org/services/water/WaterPublications/DWMP-2011.pdf	"We Love Water" Initiative http://welovewater.ca/	Monitoring and Adaptive Management Framework for Stormwater Integrated Liquid Waste and Resource Management http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Monitoring_Adaptive_Management_Framework_for_Stormwater.pdf
	Best Management Practices Guide for Stormwater http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/BMPvol1a.pdf	Drinking Water Conservation Plan http://www.metrovancouver.org/services/water/WaterPublications/DrinkingWaterConservationPlan.pdf		
City of Kelowna		Water Smart Program https://www.kelowna.ca/city-services/water-wastewater/water-conservation		Okanagan Groundwater Monitoring Project https://www.obwb.ca/news/wp-content/uploads/2013/09/groundwatermonitoring_complereport.pdf
		Landscape Irrigation Guide https://www.kelowna.ca/sites/files/1/docs/city-services/2010-05-03_landscape-irrigation-guide-web_brochure.pdf		
		Landscape Water Efficiency https://www.kelowna.ca/city-services/water-wastewater/water-conservation/outdoor-water-conservation/landscape-water		
Capital Regional District - Vancouver Island	Protection of Leech Water Supply Area https://www.crd.bc.ca/service/drinking-water/watershed-protection/leech-protection	Climate Change Projections - 2017 https://www.crd.bc.ca/docs/default-source/climate-action-pdf/reports/2017-07-17_climateprojectionsfortheCapitalRegion_Final.pdf	Water Conservation Program (Home) https://www.crd.bc.ca/education/water-conservation/at-home/household-water-use	CAP Annual Reports https://www.crd.bc.ca/docs/default-source/crd-document-library/annual-reports/environmental-protection/climate-action-program/2017-climate-action-year-in-review.pdf?sfvrsn=2e2f11ca_2
	LID Practices https://www.crd.bc.ca/education/water-conservation	Climate Action Program (CAP) https://www.crd.bc.ca/about/what-we-do/sustainability/climate-change-a-priority	Water Conservation Program (Business) https://www.crd.bc.ca/education/water-conservation/at-work/audits-technical-services	
		Regional (CRD) Climate Action https://www.crd.bc.ca/docs/default-source/climate-action-pdf/2015_carip_survey_crd.pdf?sfvrsn=81415aca_8	School Programs & Resources https://www.crd.bc.ca/education/school-programs	
		CRD Corporate Climate Action http://www.rmwb.ca/living/Services-and-Utilities/Water/Water-Conservation-Tips.htm		

Table 3-2
Example of Activities/ BMPs Applied in Canadian Cities

City/Region	Theme			
	 1 Source Water Protection	 2 Water Efficiency	 3 Communication and Education	 4 Collaboration and Resource Coordination
RMWB		Metering http://www.woodbuffalo.ab.ca/living/Services-and-Utilities/Water/Metering.htm	Conservation Tips http://www.rmwb.ca/living/Services-and-Utilities/Water/Water-Conservation-Tips.htm	
		Meter Upgrades http://www.woodbuffalo.ab.ca/living/Services-and-Utilities/Water/Meter-Upgrades.htm		
City of Toronto	The City's Wet Weather Flow Master Plan https://www.toronto.ca/services-payments/water-environment/managing-rain-melted-snow/the-citys-wet-weather-flow-master-plan/	How to Use Less Water (Online Information) https://www.toronto.ca/services-payments/water-environment/how-to-use-less-water/	Sustainable Neighbourhood Action Program (SNAP) https://trca.ca/conservation/sustainable-neighbourhoods/	Provincial Flood Forecasting and Warning Program https://www.ontario.ca/law-and-safety/flood-forecasting-and-warning-program
	Stormwater Management Programs and Projects https://www.toronto.ca/services-payments/water-environment/managing-rain-melted-snow/what-the-city-is-doing-stormwater-management-projects/other-stormwater-management-projects/	MyWaterToronto Online Tool (To view your water use by day, week, month or year) https://www.toronto.ca/services-payments/water-environment/how-to-use-less-water/mywatertoronto/	TRSPA Water Balance Tool https://trca.ca/conservation/drinking-water-source-protection/trspa-water-balance-tool/	
	Watershed Management https://trca.ca/conservation/watershed-management/	Be Water Smart Videos https://www.youtube.com/playlist?list=PLp11YxeHNp3lCCXMF1Wc2PJaRVpLuFp	Climate Change https://trca.ca/conservation/climate-change/	
	Source Water Protection: Clean Water Act. https://www.ontario.ca/laws/statute/06c22			
City of Barrie	Lake Simcoe Watershed Protection Plan https://www.barrie.ca/Living/Environment/Documents/Lake%20Simcoe%20Protection%20Plan%20Part%201.pdf	Barrie Climate-Change-Adaptation-Strategy https://www.barrie.ca/Living/Environment/Conservation/Documents/Barrie-Climate-Change-Adaptation-Strategy.pdf	Source Water Protection Training https://www.barrie.ca/Living/Environment/Conservation/Pages/Source-Water-Protection.aspx	Barrie Climate-Change- Implementation Plan https://www.barrie.ca/Living/Environment/Conservation/Documents/Implementation%20Plan%20-%20Climate%20Change%20Adaptation%20Strategy%202018.pdf
	Lake Simcoe Phosphorus Protection Strategy https://www.barrie.ca/Living/Environment/Documents/Lake%20Simcoe%20Phosphorus%20Reduction%20Strategy.pdf	Toilet Rebate Program https://www.barrie.ca/Living/Environment/Conservation/Documents/Toilet-Rebate-Guidelines%202019.pdf		
	Lake Simcoe Protection Act https://www.ontario.ca/laws/regulation/r09219	Disconnect to Protect Rebate Program https://www.barrie.ca/Living/Environment/Wastewater-And-Sewers/Documents/Disconnect-to-protect-brochure.pdf		

Appendix B - Case Studies from US Cities

CITY OF BOZEMAN, MONTANA

Background

The city of Bozeman, Montana provides drinking water services to approximately 38,000 people. Snowpack melt captured in the Sourdough and Hyalite watersheds reaches the 22 million gallons per day (MGD) Sourdough Water Treatment Plant via local creeks and serves as the city's primary water source. In addition, an infiltration gallery and a 3.5 MGD water treatment plant delivers groundwater from the Lyman Creek Spring.

Challenges

Drought and wildfire are the two primary climate threats to the city of Bozeman, both of which have the potential to increase with a changing climate. The city of Bozeman is concerned that future droughts will impact management and allocation of their local water resources. Droughts also have the potential to impact water quality because of their tendency to increase the occurrence of blue-green algae. Wildfires in the Sourdough and Hyalite watersheds have the potential to negatively impact water quality due to erosion that can increase turbidity, sedimentation and metal concentrations. Direct damage to equipment, specifically the Hyalite Reservoir and its intake, is also a concern related to wildfire.

Planning Process

To better understand the vulnerabilities of its drinking water infrastructure and operations, the city of Bozeman assessed potential climate change impacts using the U.S. Environmental Protection Agency's (EPA) Climate Resilience Evaluation and Awareness Tool (CREAT). The CREAT assessment brought together individuals from EPA and various departments within the city of Bozeman to think critically about potential climate impacts, prioritize assets and consider possible adaptation options.

Resilience Strategies and Priorities

The city of Bozeman considered the potential consequences of drought, water quality changes and wildfires on their drinking water assets and operations. To assess each of these potential threats, the city considered how potential adaptive measures would help lower consequences. The table below summarizes how adaptation options were grouped into two packages: those that provided the highest potential return on investment, and those that are included in their Integrated Water Resource Plan (IWRP).

Case Study: Water and Wastewater Utilities Planning for Resilience

Type	Resilience Strategies
Highest return on investment	Community outreach related to Sourdough Creek to improve surface water quality
	Fire management activities surrounding Hyalite Creek to reduce the frequency and severity of wildfires
	Lake water management of Lyman Creek Spring to improve groundwater recharge
	Demand management of Hyalite Creek to increase water availability
	Rationing of Hyalite Creek to increase water availability
	Groundwater models including use of a monthly water balance model
IWRP	Demand management of water resources to increase water availability
	Hyalite Lake water resource acquisition to increase water production
	Lyman land acquisition for expansion or relocation of treatment plant
	Utilize alternate water supplies to improve groundwater recharge

Contact Information

For more information regarding the city of Bozeman's resilience planning, contact Jill Miller at jmiller@bozeman.net or Lain Leoniak at lleoniak@bozeman.net.

JORDAN VALLEY WATER CONSERVANCY DISTRICT (JVWCD) SALT LAKE COUNTY, UTAH

Background

Created under the Water Conservancy Act in 1951, the Jordan Valley Water Conservancy District (JVWCD) provides drinking water and wholesale water retail services to about 700,000 people primarily located in cities and improvement districts within Salt Lake County, Utah. JVWCD currently delivers approximately 90 percent of its municipal water to cities and water districts on a wholesale basis, with the other 10 percent being delivered to unincorporated regions of the county. JVWCD has a contractual agreement to deliver treated water to Salt Lake City and Sandy City, which are both located beyond JVWCD's service boundaries. The district also delivers untreated water to irrigators in Salt Lake and Utah Counties. Approximately 90 percent of JVWCD's water is sourced from the Provo River System, which includes the Provo River itself, several Uinta Mountain lakes, Deer Creek and Jordanelle reservoirs, and snowmelt from the Wasatch Mountains. The remaining water supply is derived from groundwater sources located primarily in the southeastern portion of the Salt Lake Valley.

Challenges

JVWCD is principally concerned with the impacts of drought conditions and water quality degradation issues on water quality supply and demand. The district is concerned that an increased incidence of drought-like conditions will decrease the quantity of snowpack, leading to water supply and demand issues within its wholesale and retail service areas. Drought is also particularly impactful on JVWCD's water supply because more than half of its water is delivered within a three-month timeframe. Similarly, JVWCD is troubled by the potential impact of harmful algal blooms on its source water reservoirs, which may negatively impact water quality and lead to a strained water supply. Both drought and water quality issues will impact JVWCD's most critical assets, including its water treatment plant and source water reservoirs.

Planning Process

To evaluate the resilience of its drinking water service system to drought conditions and water quality degradation issues, JVWCD used the U.S. Environmental Protection Agency's (EPA's) [CREAT](#). The assessment brought together individuals from JVWCD and EPA staff to think critically about potential vulnerabilities, priority assets, and strategies for strengthening infrastructure and operational resilience within JVWCD's entire service area.

Resilience Strategies and Priorities

Based on its previous experiences with water supply and demand issues, JVWCD has already taken action to improve its overall resilience. These measures have included performing an advanced metering infrastructure (AMI) upgrade, completing an upgrade to its supervisory control and data acquisition (SCADA) system, constructing an additional finished water reservoir at its main water treatment plant, developing a climate change management plan, and implementing two water conservation initiatives to date. Using the results of the CREAT assessment, JVWCD was able to evaluate the performance and costs of several potential drought management and water degradation strategies that, if implemented, could further strengthen the operational resilience of the system.

Case Study: Water and Wastewater Utilities Planning for Resilience

Type	Resilience Strategies
Current Measures	Implementation of AMI upgrade incorporating customer feedback
	Upgrade to SCADA system
	Construction of Jordan Valley Water Treatment Plant reservoir
	Development of climate change management plan
	Implementation of water conservation initiatives (1997-2010 and 2010-2017)
Potential Adaptive Measures	Adjust water rights timing
	Treat Casto and Dry Creek springs for additional water supply
	Diversify water supply portfolio
	Perform conservation measures to achieve 25% reduction in demand by 2025
	Create drought contingency plan
	Increase utilization of source water rivers
	Incorporate potable reuse
	Increase water conservation goal by up to an additional 5 percent
	Support efforts to maintain Utah Lake as a secondary municipal and industrial water supply
	Develop the Bear River Water Supply Project for surface water resource acquisition

Contact Information

For more information regarding JVVCD's resilience planning, contact Jeff King, Security and Emergency Response Coordinator, at JeffK@jvwcd.org.

Case Study: Water and Wastewater Utilities Planning for Resilience



CITY OF FARIBAULT, MINNESOTA

Background

The City of Faribault provides wastewater services to residential and industrial customers in Faribault, Minnesota, which is located about one hour south of Minneapolis, Minnesota. About 50 to 60% of all wastewater flow is from industrial customers, including a laundry facility and a food packaging plant. The water reclamation facility (WRF) is designed to treat an average flow of approximately 3.5 million gallons per day (MGD) and a peak wet weather flow of 7 MGD.

Challenges

The WRF is located near the confluence of the Straight River and Cannon River and is at risk of flooding. The City previously experienced issues related to overflows and bypass as well as infiltration and inflow (I&I) from heavy precipitation events. The WRF was impacted by previous flooding events due to high river levels. During a flooding event in 2010, the WRF was inundated and taken completely offline for approximately two weeks due to a damaged siphon box through which all flows are conveyed under the Straight River to the WRF. During that time, a temporary above-ground collection system had to be constructed to convey the wastewater from the City to the WRF for treatment. Following that flooding event, WRF assets were relocated away from the river, however flooding concerns still exist if the river re-channels within the floodway. It is expected that floodwaters could still damage infrastructure assets at their new locations.

Planning Process

To better understand the resilience of their wastewater infrastructure and operations to extreme flooding, the City of Faribault assessed potential impacts of environmental change and extreme weather events using the U.S. Environmental Protection Agency's (EPA's) [CREAT](#) and enhanced resilience through long-term planning using EPA's *Planning for Sustainability Handbook*. The assessment brought together individuals from the City of Faribault, state agencies and EPA staff to think critically about potential impacts, priority assets, and possible resilience strategies.

Resilience Strategies and Priorities

Based on experience with prior intense precipitation events, the City of Faribault has already taken action to protect their WRF from flooding and improve their overall resilience to extreme weather impacts. Using CREAT results, the City was able to evaluate the performance and costs of two priority actions that, if implemented, will provide additional protection to the facility: constructing a berm and building streambank stabilization. The City will continue to use the CREAT results and the information from EPA's *Planning for Sustainability Handbook* to conduct additional long-term infrastructure and financial planning. See the table below for all potential measures that were considered.



Case Study: Water and Wastewater Utilities Planning for Resilience

TYPE	RESILIENCE STRATEGIES
Priority Potential Resilience Measures	Permanent berm
	Streambank stabilization
Other Potential Resilience Measures	Watershed partnership
	I&I reduction program
	Accelerate or prioritize reconstruction program
	Opportunistic relocations of components
	Emergency alert system
	Promote in-cycle re-use (industrial customers)
	Adjustable fees during stress periods
	Incentives for limiting use (restaurants)
	Collaborate with watershed planning efforts
	Identify green infrastructure improvements

Contact Information

For more information regarding the City of Faribault's resilience planning, contact Travis Block at tblock@ci.faribault.mn.us.

Case Study: Water and Wastewater Utilities Planning for Resilience



FORT COLLINS UTILITIES, COLORADO

Background

Fort Collins Utilities (FCU) provides drinking water and wastewater services to approximately 131,000 residential customers and various large water users in Fort Collins, Colorado. FCU also sells excess raw water to large agricultural users. Average daily production for the Water Treatment Plant (WTP) is 25 million gallons per day (MGD); over 50 MGD is possible in the summer months. FCU is served by two main surface water sources: the Cache la Poudre River and Horsetooth Reservoir.

Challenges

FCU is concerned with climate change threats that would present water quantity and quality issues for their service area. FCU is especially concerned about water quality issues caused by flooding, particularly flash flooding on burned landscapes following wildfires. Following the 2012 High Park Fire and a subsequent flash flood, FCU made a decision to shut down the Poudre River intake for three months due to uncertainty concerning changes to water quality from high turbidity and sedimentation events. FCU considered how climate change may increase the severity or frequency of these threats, and assessed the impacts of a worst case scenario where both the Poudre River and Horsetooth Reservoir sources would be compromised simultaneously from a water quality event following a wildfire.

Planning Process

FCU engaged in a series of webinars and an in-person meeting to conduct a climate change risk assessment using the U.S. Environmental Protection Agency's (EPA) Climate Resilience Evaluation and Awareness Tool (CREAT). The assessment brought together individuals from Fort Collins and EPA staff to think critically about potential climate impacts, priority assets and possible adaptation options. FCU has conducted previous climate change planning for their utility and with other city organizations, and used the CREAT assessment to build on and complement existing efforts.

Resilience Strategies and Priorities

For this assessment, FCU assessed the consequences from a wildfire threat to the Cache La Poudre River and Horsetooth Reservoir. FCU developed four adaptation plans in CREAT: existing adaptation measures are grouped into a "Current Measures" adaptation plan, while three other adaptation plans--All Potential Wildfire Measures, Source Watershed Protection and Management, and Water Treatment Plant Improvements--contain adaptation measures that would provide additional protection to FCU's assets from climate change threats in the future. Cost data for the potential adaptation plans were drawn from FCU's Master Plan.

FCU has requested funding to implement or further investigate adaptation options that will protect utility assets and operations from climate change-related impacts, including water quantity and quality issues driven by drought, wildfire, and floods. Increasing raw water storage is a priority adaptation option for FCU, as it has dual benefit to reduce consequences from both water quantity and quality issues. See the table below for all potential adaptive measures that were considered.



Case Study: Water and Wastewater Utilities Planning for Resilience

Type	Resilience Strategies
Source watershed management and protection	Improve the partnership with the Coalition for the Poudre River Watershed to reduce the consequences from water quality threat and prioritize forest management
	Improve early warning system for detecting high turbidity in water
	Partnership with the U.S. Forest Service–Arapaho Roosevelt for improved watershed protection
Water treatment plant improvements	Additional 10 million gallon (MG) finished water storage
	Enhance treatment capabilities to treat the lower quality Poudre River source
All potential wildfire measures	Improve the partnership with the Coalition for the Poudre River Watershed to reduce the consequences from water quality threat and prioritize forest management
	Improve early warning system for detecting high turbidity in water
	Partnership with the U.S. Forest Service – Arapaho Roosevelt for improved watershed protection
	Additional 10 MG finished water storage
	Enhance treatment capabilities to treat the lower quality Poudre River source
	Additional 8,100 acre-feet raw water storage

Contact Information

For more information regarding Fort Collins Utilities' resilience planning, contact Donnie Dustin at ddustin@fcgov.com.

Appendix C - Interview Log

Interview Logs

Name of Municipality/City	Location	Water Source	Contact	Types of Program	Where Are They Now?	What Have They Done?		What More To Do?		What Are the Successes?	What Are Some Challenges Faced?	How Do You Overcome the Challenges?	Other Advice	Peer-to-Peer Attendance
						Water Supply	Water Demand	Water Supply	Water Demand					
City of Barrie	Barrie, Ontario	Groundwater and Lakes	Katie Thompson, P.Geo, Risk Management Official	Climate Change Adaptation Strategy, Climate Change Implementation Plan	City described that the implementation is in its early days as they have just finished their strategy document in 2017	Water security principles follows the Ontario Clean Water Act with vision to build resiliency and redundancy in the system. Strong program to protect water source.	Low Impact Development that is near implementation in their engineering standards.	"Knock off the list" from their implementation plan and mitigation activities			"Naysayers - people who are not in agreement with climate science and would not participate.	Using their internal communication group to communicate the idea of resiliency and not concentrate on human impacts on climate change.	Use technical community to provide the required technical background. Clearly identify goals and objectives	Yes
					They have form an Adaptation Team that identifies key champions for various departments to foster collaboration, accountability, and reporting status.		Green buildings such as LEED silver is endorsed by the Council and will be incorporated into their policy.	Continue and improve communications internally and external with public.		Lack of resources to help apply for funds, or people to do the work.	Allocating specific champions with timelines and duties to ensure the work continues to meet the objectives in the Implementation Plan.	Use intermediate level champions as senior management are too busy to make sure work gets done.		
							Strong water conservation policy that is built into their low water resource program. In the event of a drought, it triggers by-laws for water usage.	Continue to work with the champions to ensure the work is getting done.						
ALUS	NGO			Promote sustainable agriculture, wildlife and natural spaces.	Working with NSWA on Modeste Natural Infrastructure Project - restoring wetland, conserving and protect natural infrastructure to protect water source.	Government of Alberta (GOA) has identified the Modeste watershed as a priority for flood and drought mitigation as well as important area affecting water quality for central Alberta.					Challenges include land use conflict between crop use and water use. Political issues where municipalities have by-laws that are counter intuitive eg. establishing road allowances that does not account for natural infrastructure. Water Act approval takes a long time to obtain. Lack of funding from GOA to help with the restoration and education.	Education and communication with landowners and municipalities and GOA. Continue the discussion and aware of the importance of timing, resources required, and setting policy in place that does not conflict with natural infrastructure conservation.		
						Implemented agriculture BMPs such as promoting functions of riparian areas to improve water quality, trap sediment, build banks, dissipate flow and ice energy. Increasing buffers between agriculture and streams/water bodies.								
Capital Regional District	Southern Vancouver Island and the Gulf Islands	Sooke Lake Reservoir	Kristi Wilson Demand Management Coordinator at Parks & Environmental Services	Water demand management / water conservation, reduction in sanitary system loading.	A number of initiatives are underway. Refer to "Climate Action Revenue Incentive (CARIP) Public Report for 2016" (https://www.crd.bc.ca/docs/default-source/climate-action-pdf/reports/2016-climate-action-revenue-incentive-program-report.pdf?sfvrsn=7c8538ca_4_).	Water source is a large lake, recharged by groundwater, situated in a watershed that has been protected since the turn of the century (no access, no recreation, no industrial use). CRD is relatively secure on the supply side, and no major initiatives have taken place.	Numerous water conservation initiatives: water restriction bylaw, extensive public messaging through workshops, radio, and other means (in addition to water conservation, messaging has resulted in a reduction in sanitary system loading); engagement with the restaurant and hospitality sectors as well as industry to lower water use; offering of free water audits and free certification; promotion of lower-flow appliances; etc. (see "Climate Action Revenue Incentive (CARIP) Public Report for 2016").	Climate Change Adaptation Strategy for Regional Water Supply area is in the works. Incorporating climate change into infrastructure planning has not been a focus at CRD to date, but it's beginning to change (on a list of things to do in 2019).	New ideas are needed to re-engage the public and various groups, as the results of previous efforts are beginning to plateau. Incorporating climate change into infrastructure planning has not been a focus at CRD to date, but it is beginning to change (on a list of things to do in 2019).	Water conservation messaging has been very effective: significant change in water consumption has been observed since enacting conservation programs in early 2000s (CRD has been growing at a rate of 1%, reduction in per capita water use has decreased at a rate of 1.5% per year).	1. Results of previous water conservation messaging efforts are beginning to plateau, and CRD is looking for new ideas to re-engage the public. 2. One recent effort (reduction of cooling appliances through a bylaw) has failed due to a conflict with the provincial building code. More interjurisdictional coordination and planning is required.	Currently working on determining this. No solution yet.	Yes - Kristi would be interested in learning from others as well	
Cowichan Valley Regional District	Duncan, British Columbia	Cowichan Lake, Holland Lake, Shawnigan Lake, Stocking Lake. 50% of residents rely on private GW wells.	Kate Miller Manager, Environmental Services	Water conservation	A number of initiatives are underway. Refer to Table 3-2.	At a macro scale, CVRD looked at downscaled climate projections for the three major ecoregions the region is located in. On a granular level, looked at opportunities within distribution areas (utility and public space components, as 50% of residents rely on private wells), tightened up systems in terms of delivery under the asset management strategies. Fastest growing areas with already approved development have no water supply, so looking at interbasin transfer, or transfer for fire flows.	Extensive public messaging, changing of the community normal (see the "New Normal" website) through social marketing (ex. "be ashamed of yourself if you have a green lawn in a drought"), supporting neighbourhood champions. CVRD recognizes that government is just one entity, which can provide a framework or a structure, but there are other decision makers, whether regulatory or not. CVRD is focused on partnerships and considers the significance of community participation to be paramount.	Continuing to involve more stakeholders in conversations around water, cancelling long-standing water licenses (Industry, agriculture).	Communicating much more concretely that water conservation is important, fostering the "new normal" mentality, continuing to involve more stakeholders in conversations around water.	Current initiatives underway have been successful in managing both the supply and the demand aspects.	After years of drought and public messaging about conservation, CVRD is starting to see exhaustion within the user group. Whenever the next level of conservation is pursued, there's typically good adherence for the first year, but in year 2 and 3, people start using more water. When it comes to stakeholder involvement, the "lets not leave anybody behind" message has changed to "there will be losers and winners", and these are very awkward conversations, especially when producers' or industry members' water licenses have to be revoked.	Currently working on determining this. The "New Normal" website is part of the solution currently being implemented.	Start creating the long-term record of climate change as early as possible, as it can help with decision-making prior to encountering emergency situations. Start communicating to all stakeholders early that water resources cannot be taken for granted.	Yes
Metro Vancouver	Burnaby, British Columbia	Regional district includes 23 municipalities, local governments, and rural areas - water sources vary	Brent Burton Lead Senior Engineer (Strategic infrastructure planning, management and resiliency)	Many are in place. Focus of conversation was on potable water and liquid waste services.	A number of initiatives are underway. Refer to Table 3-2.	Liquid waste: - A number of new WWTPs have been designed with anticipated sea level rise, wave action incorporated in the design. Stormwater: - MetroVan doesn't have a direct role in stormwater, except in a few cases where a drainage area crosses municipal boundaries. MetroVan is responsible for providing advice and information to its regional members. To that end, MetroVan developed IDF curves for member use. Water: - Completing a long-term water supply strategy that will align water storage needs for the next century. Additionally, currently in project definition for a new intake (second intake in Coquitlam), to enable withdrawals at a much lower water level than now. Water storage increase initiatives are also underway in order to reduce future demand increments.	MetroVan has implemented a lot of conservation initiatives in the past. Average per capita consumption dropped by more than half since earlier in the century. Peak day demand, often driven by summer infrastructure, has been decreased through a number of education campaigns, plumbing code changes, changes in the way people live (densification, reduction of residential lawns, reduction in days of allowable residential sprinkling from 3 to 2, etc.). A new drinking water conservation plan replaced previous short-term response plans as it became apparent that the need to be conservative with water use applies year-round, and not just during dry periods.	Continue with current initiatives.	Continue with current initiatives.	Water conservation messaging and measures.	MetroVan recognizes that 15-20% of the per capita demands can be managed with metering, however, currently, residential metering is performed by each member municipality as they see fit (some are fully metered, while others are partially or not at all metered). Education campaigns need to adjust messaging to address the fact that although people live in a rainforest, the summers are very dry and water conservation is very important.	Currently working on determining this.	1) Recognition that there's uncertainty is important. Scenario-based planning approach should be used to remain flexible and resilient. There should be an adaptive management "check-in" every 5-7 years, to integrate latest information to confirm course. 2) In terms of drought response, MetroVan learned from California, Portland, and other areas to the south that extreme drought measures should not be implemented too frequently, otherwise the public will get fatigue and people will stop responding as well. 3) It's important to have the elected officials who appreciate the importance of climate change as it applies to water management.	Yes
Metro Vancouver	Burnaby, British Columbia	Regional District includes 23 municipalities, local governments, and rural areas - water sources vary	Robert Hicks Senior Engineer (Policy, Planning and Analysis)	Many are in place. Focus of conversation was on stormwater.	Follow up on the "Integrated Stormwater Management Plans - Lessons Learned to 2011". Refer to Table 3-2.	Only discussed the "Integrated Stormwater Management Plans - Lessons Learned to 2011".	What followed from "Integrated Stormwater Management Plans - Lessons Learned to 2011" remains unclear. It is currently being revised. Robert suggested we contact Steven Judd with the City of Port Moody.	Only discussed the "Integrated Stormwater Management Plans - Lessons Learned to 2011".	Determine level of service going forward - instead of planning infrastructure around flow capacity, which is unpredictable, look at building to static capacity and accommodating changes another way (no basement, no underground parking, etc.)	Robert suggested we contact Steven Judd with the City of Port Moody.	Lack of clarity around what needs to be done and responsible parties.	Robert suggested we contact Steven Judd with the City of Port Moody.	Look at the context of governance - nuances that allowed the initiative to go ahead, or trip up the initiative. Example: initiatives that require multiple stakeholders and levels of government may be tougher to implement.	N/A
City of Calgary	Calgary, AB	Bow River and Elbow River	Pamela Duncan	Implement various types of programs. See Table 3-2. Internally, they have a monitoring team to observe drought on Bow River. This information is not public facing.	See Table 3-2. Some other highlights include increasing collaboration that brings people together and information exchange. Utility is leading this discussion. Wildfire is a concern for water quality upstream of the City. Working with Bow River Basin Council on source water quality protection.	See Table 3-2. Source water protection is crucial and focused. Update to the Water Demand Management Model - they have a new model that runs demand scenarios with better customer segmentation, climate data and economic data.	See Table 3-2. Water conservation and collaboration with other municipalities to have a common water utilization plan. Other programs include Leak Campaigns, Peak Day Campaigns, Yard Smart Program, Concertation and Education Programs.	Water Security Strategy (in-progress) - The intent is to build greater synergies among plans related to water efficiency, source watershed protection, drought management, climate change, infrastructure planning, and regional servicing.	Drought Management Plan - Water Utility has started a detailed Drought Risk and Vulnerability Assessment. This builds on the Climate Change Adaptation Plan. The risk and vulnerability assessment will underpin a larger step-wise process to identify key drought mitigation and response strategies in a Corporate Drought Management Plan that will be developed by the end of the 2019-22 business cycle.	- Limitations of climate, hydrological and operations modeling information. Limited ethical feasibility and economic analysis of non-tradition water supply options. Co-ordination between all plans. Lacking of specific co-ordination of data eg. population forecasts.	Developing an overall guiding document under a Water Security Strategy so that they have shared outcomes for all plans and there is a roadmap to an "optimized portfolio" of supply and demand options.	Key is to collaborate internally and externally to facilitate proactive planning and information exchange. One example is the Drought Monitoring Team that City co-ordinate. Another is something called the "Major Water Users Meeting for the Bow River" that AEP, TransAlta, Irrigation Districts, City of Calgary hold during the irrigation season. As well as collaboration with the Bow River Working Group.	TBA	
								Water Long Range Plan (in-progress) - This plan identifies the City of Calgary's water supply system through the projection of future water demands and identification of future water supply system requirements and associated capital investments. Considers traditional infrastructure assets only: Water treatment plants (WTP) and a complex network of underground pipes, water mains, reservoirs and pump stations. Our current water long range plan is from 2011. The update is going to be initiated in 2019.	Stormwater Use and Water Reuse (in-progress) - The City initiated a rainwater and stormwater reuse program to have another mechanism available for watershed management. The scope of the initiative is to enable rainwater and stormwater reuse for internal plumbing and irrigation. This will ensure that proposed reuse systems are effective at managing risks associated with public health, environmental protection, and prevent cross contamination into The City's water infrastructure. The program will also ensure that The City is compliant with provincial regulations for approving water reuse systems. The City is working closely with the Province on this as they develop the future Provincial policy on water reuse.					
Toronto and Region Conservation Authority	Toronto and Region	Various including Lake Ontario	Sonya Meek	Sustainable Neighbourhood Action Program (SNAP)	10 years since program was implemented						Mass-marketed projects only get 10-20% of population and tend to get early adopters; therefore, created locally tailored programs	Created integrated neighbourhood plans with park renewal and green infrastructure		

Appendix D - Peer Learning

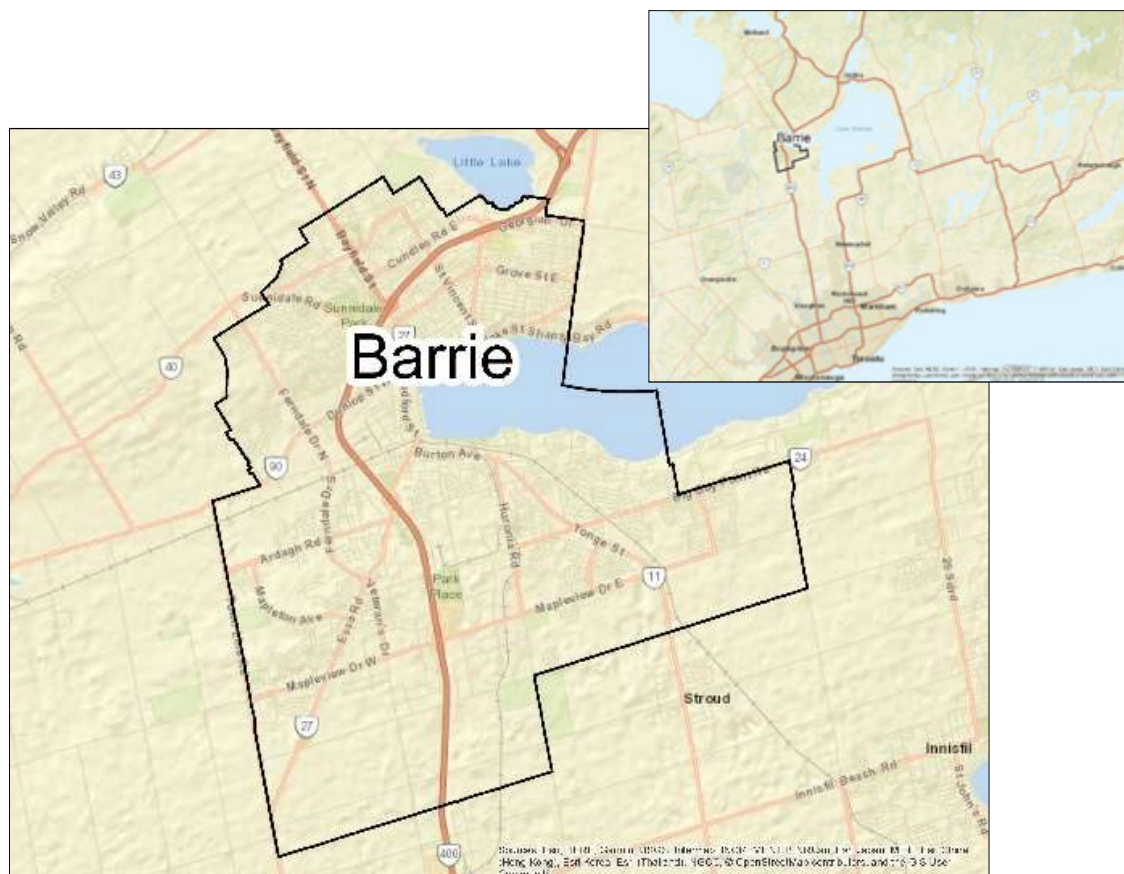
CITY OF BARRIE

Climate Change Adaptation Strategy

Katie Thompson, P.Geo &
Steven Holden HB.Sc
May 27, 2019



Barrie, Ontario



- Population: 150,000+
- On the shores of Kempenfelt Bay, Lake Simcoe
- 1.5 hours North of Toronto
- A designated Growth Centre under the Ontario Places to Grow Act



Why is Barrie Taking Action?



Dunlop at Kidds Creek, June 9, 2005



Flooding Lakeshore, June 24, 2014



High Winds, June, 2014



Ice Storm, March, 2016





Responding to climate change is a two-part approach



Climate Change Mitigation

- Barrie has taken several measures to become more sustainable:
 - Joining the Partners for Climate Protection in 2001
 - Green House Gas Inventory and Community Energy Plan (2006)
 - Energy Management Plan (2012-2017).
 - “Save Adam” Energy Awareness Program
 - Adoption of LEED silver as a standard for new buildings
 - Solar Panels on Operations Centre Roof, etc.
 - Electric Vehicle Charging Stations (Waterfront and Library)



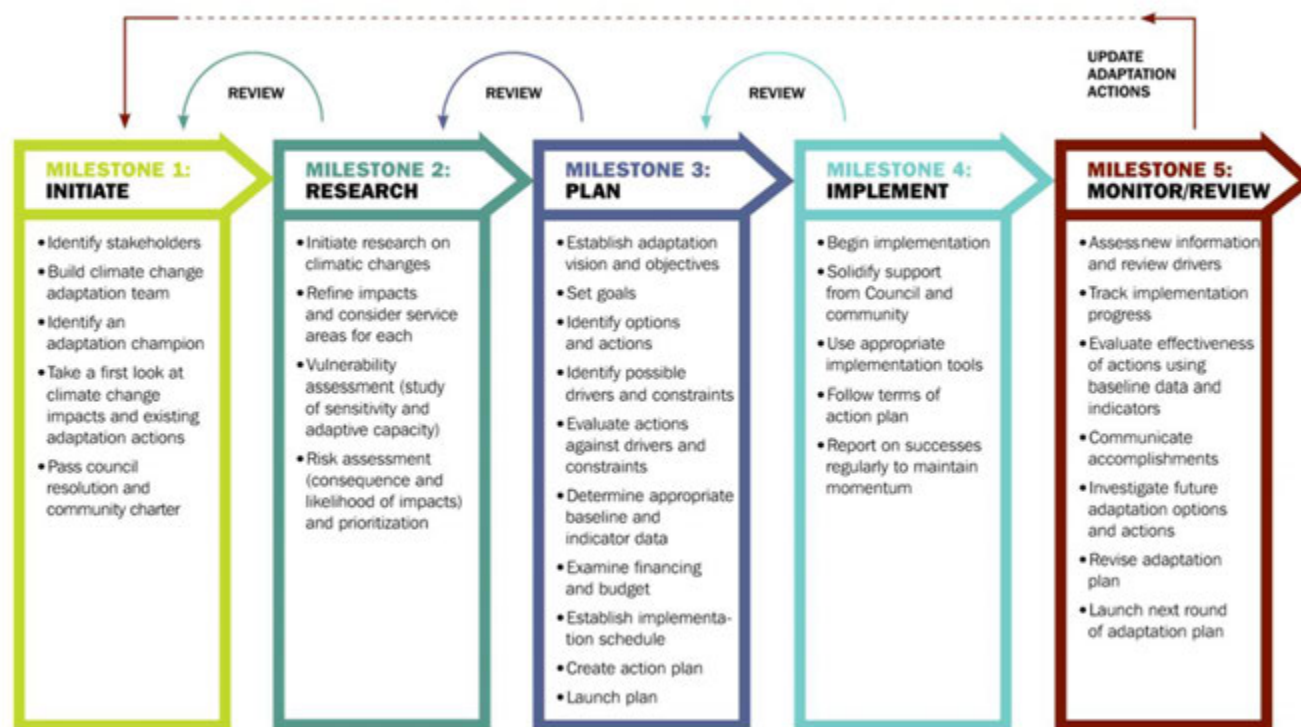
Climate Change Adaptation

- Framework for a Climate Change Strategy 2015
- Adaptation Planning began in June 2016
- Purpose: Reduce the risks climate change poses to Barrie's physical, economic, social, and ecological systems
- Developed through extensive consultation with municipal staff, community stakeholders/experts, and the general public



Building Adaptive and Resilient Communities

- National program for Canadian communities



Planning Team

Project Team

- Lead the development of the Adaptation Strategy
- Provided research and consultation

Adaptation Team

- Core group contributing to the adaptation planning effort
- Provided overall strategic direction for the project.

Stakeholder Advisory Group

- Provided sector-specific knowledge, input, and advice from a community perspective



A Changing Climate

Climate Variable	Projected Changes	Consequences
	<p>Annual temperature: In a high emission scenario (A2), the City of Barrie can expect to experience an average annual temperature change of 1.5°C in the 2020s, 3°C in the 2050s, and 4.8°C in the 2080s.</p> <p>Hot days: In a high emission scenario (A2), the City of Barrie can expect an increase in the number of hot days (days where the temperature > 30°C) to 49 days in the 2080s.</p>	<p>↑ extreme warm days; ↑ freeze/thaw cycles;</p> <p>↑ invasive species; energy shortages; longer growing seasons; heat waves; ↑ frost free days</p>
	<p>Annual precipitation : In a high emission scenario (A2), the City of Barrie can expect to experience an average annual precipitation increase of 26.8 mm in the 2020s, 72.9 mm in the 2050s, and 106.3 mm in the 2080s.</p> <p>Water Temperature: Water temperature in Lake Simcoe increased 2°C between 1980-2009. In a high emissions scenario (A2), water temperatures in Lake Simcoe can expect to increase by 2.6°C.</p>	<p>↑ precipitation; ↑ flooding; ↑ changing lake water temperature; ↑ early ice cover break-up dates</p>
	<p>Increase of IDF (intensity, duration, frequency) of extreme events is expected. This means an increase in the estimated time between occurrences of extreme events (i.e. heavy rainfall) and the intensity of extreme events are projected to increase in the future (higher amount of rain falling mm/h).</p>	<p>↑ extreme precipitation and flooding; ↑ wind, hail, snow, and ice storms; ↑ more frequent, more intense, extreme rainfall events</p>



Assessment of Risks

- Vulnerability refers to the susceptibility of a given City department to harm arising from climate change impacts.
- It is a function of:
 1. A department's sensitivity to climate change impacts
 2. Its capacity to adapt, or cope, with those impacts

		Sensitivity: Low → High				
		S1	S2	S3	S4	S5
Adaptive Capacity Low ↓ High	AC1	V2	V2	V4	V5	V5
	AC2	V2	V2	V3	V4	V5
	AC3	V2	V2	V3	V4	V4
	AC4	V1	V2	V2	V3	V3
	AC5	V1	V1	V2	V3	V3



VISION

Barrie will adapt to changing climate conditions and embrace new opportunities to remain a vibrant, healthy, and sustainable waterfront community.

MISSION

The City of Barrie will demonstrate leadership by taking progressive and innovative steps to achieve the vision of the Climate Change Adaptation Strategy. We have a responsibility to anticipate and prepare for potential impacts of climate change on our community. The City is committed to taking action in the face of uncertainty.



Goals

Cross Cutting Actions

Goal 1: Maintain Public Health and Safety

Goal 2: Minimize Risks to Buildings and Properties

Goal 3: Strengthen Infrastructure Resilience

Goal 4: Help Local Businesses and the Tourism Industry Adapt to Changing Conditions

Goal 5: Protect Biodiversity and Enhance Ecosystem Functions

Goal 6: Minimize Disruption to Community Services

Goal 7: Build Community Resilience



Climate Change Adaptation Strategy



- Final Strategy completed in March 2017
 - 7 Goals and 1 set of Cross-Cutting Actions,
 - 59 identified Actions
- Council endorsement in April 2017
- Milestones 1, 2, and 3 awarded




Implementation Plan



- Comprised of 48 Action-Specific Action Plans (ASAPs) across 7 Goal Categories and 1 set of Cross-Cutting Actions
 - Answers: who, what, where, when and why for each priority action
 - Includes reporting data collection template and framework
- Council Endorsed April, 2018
- Milestone 4: Implement awarded














Goal Summary Page



GOAL 3: STRENGTHEN INFRASTRUCTURE RESILIENCE

Recent climate events have offered insight into what continued changes might mean for Barrie's infrastructure: increased intensity of rainfall, runoff, and erosion leading to wash-outs on roads, shoulders, and bridges; more frequent freeze-thaw cycles, soil instability, and ground movement causing damage to roads, sidewalks, and underground infrastructure; and more extreme weather events resulting in direct physical damage to infrastructure. Recognizing that climate change will strain Barrie's critical green and grey infrastructure, the City is committed to strengthening the resilience of its infrastructure systems to climate change and other non-climatic factors (e.g. land-use changes, population growth, aging infrastructure) to prevent disruptions of essential services and ensure the safety of the community.

	ACTION NAME	PRIORITY	QUICK WIN	MITIGATION CO-BENEFIT	PEOPLE'S CHOICE
3.1	Increase staff and/or resources to maintain and preserve road surfaces.	2			
3.2	Increase natural/forested areas within sub-watersheds with high surcharge and flooding.	1			
3.4	Manage a comprehensive operations, maintenance, and inspection program for stormwater infrastructure.	2			
3.5	Conduct stormwater drainage area inspections to identify areas of potential risk for debris blockage and dams.				
3.6	Improve sediment and erosion control from construction activities through improved inspections, reporting, and operational controls.	1			
3.7	Develop an inspection policy for high risk infrastructure to identify any damage from major storm and extreme weather events.	2			
3.8	Investigate and apply methods of incorporating climate change considerations into infrastructure (grey, green, and urban forests) asset management.	1			

- Separates each ASAP by Goals
- Provides overview of priority actions from Adaptation Strategy
- Identifies:
 - Priorities
 - Quick-Wins
 - Mitigation Co-Benefits
 - People's Choice



Action Specific Action Plan- ASAP

ACTION 3.2

**Increase
natural/forested areas
within sub-watersheds
with high surcharge
and flooding**

1. Background Information	
Objectives	<ul style="list-style-type: none"> • Increased resilience of forest ecosystem • Increased business and tourism benefits • Natural stormwater management • Improved air quality • Reduction in Urban Heat Island effect • Improved food security
Action Description	The City of Barrie will investigate and implement opportunities to increase natural areas and forest in sub-watersheds, as well as strengthen the protection of watercourse corridors.
Action Rationale	Natural and forested areas have various hydrological benefits including attenuating stormwater flows. This is one way to make improvements within sub-watersheds that experience flooding.
Supporting Actions from Adaptation Strategy	N/A
Potential Partnerships or External Resources	Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority; local businesses; neighbourhood associations; FruitShare Barrie; local nurseries and growers; business owners (e.g. golf courses); Trees Canada
Associated Plans and Strategies	City of Barrie Built Boundary Community Improvement Plan and other improvement plans; Intensification Area Urban Design Guidelines; Parks and Recreation Strategic Master Plan; Comprehensive Stormwater Management Master Plan; Urban Forestry Strategy



Action Specific Action Plan- ASAP

ACTION 3.2

**Increase
natural/forested areas
within sub-watersheds
with high surcharge
and flooding**

2. Municipal Leads	
Lead Department	Engineering –Parks Planning; Roads, Parks & Fleet – Parks & Forestry
Supporting Department(s)	Planning & Building Services – Planning Services; Engineering – Infrastructure Planning

3. Timeline	
Estimate Start Date	2019
Estimated Duration	Ongoing
Frequency of Implementation	Ongoing

4. Current Status/Practice	
N/A	



Action Specific Action Plan- ASAP

ACTION 3.2

Increase natural/forested areas within sub-watersheds with high surcharge and flooding

5. Action Plan Tasks				
Tasks	Suggested Start Date	Estimated Initial Cost	Estimated Ongoing Cost	Responsible Department
Explore incentives for the development community to encourage more green space.	2019	Staff time	N/A	Planning & Building Services
Explore opportunities for boulevard trees and increased naturalization in public areas.	2019	TBD	TBD	Engineering – Parks Planning/ Road, Parks & Fleet – Parks & Forestry
When securing land due to critical drainage concerns, consider developing naturalized spaces in high priority areas.	2020	N/A	TBD	Engineering – Infrastructure Planning; Parks Planning
Seek strategic land donations.	2020	Staff time	Staff time	Engineering— Parks Planning/ Legal Services



Action Specific Action Plan- ASAP

ACTION 3.2

**Increase
natural/forested areas
within sub-watersheds
with high surcharge
and flooding**

6. Measuring Success			
ID	Indicator	Does Baseline Data Exist? If yes, where?	Department responsible for measuring progress
3.2.1	Inventory of current natural areas and forest cover	Yes, GIS data based on air photos	GIS

7. Additional Notes/Comments
N/A



Community Engagement

Pop-Up Events

- Farmers Market
- Community Centres
- Recreation Centres

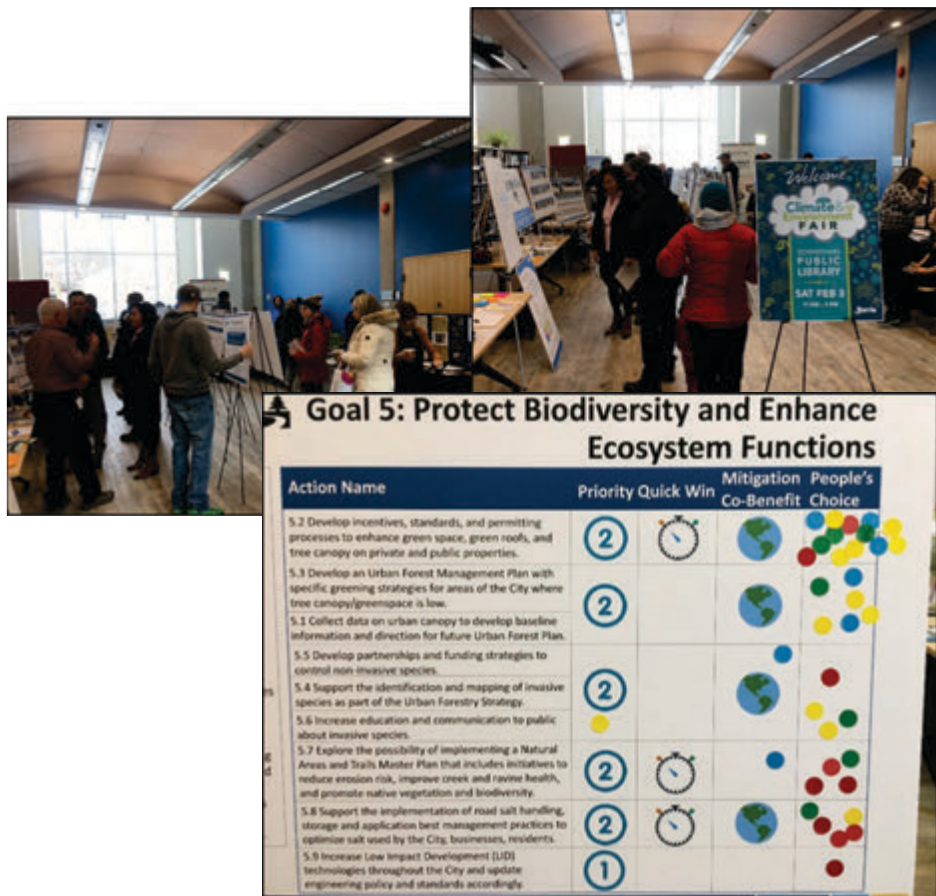
Open House

Climate and Environment Fair

- Partner Organization Booths
- Prize Wheel
- Hot Chocolate (+140 attendees)

Online Engagement

- Project Webpage
- Social Media Promotion
- Online Survey



Tracking Implementation

Meeting with Departments to identify progress to date:

- On-Track
- In-Progress
- Not yet Started
- Complete

Barriers to Implementation

Quick Wins

Pain Free Reporting



What's Next

- 2019 Task Implementation
- Work Planning for 2020 tasks
- Develop Annual Reporting framework
- Launch new website
- Achieve Milestone 5: Monitor/Review





Contact Information

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Steven.Holden@Barrie.ca

(705) 739-4420 x 5179

Thank You



Source Water Protection



Legend

Intake Protection Zone (IPZ) Well Head Protection Area (WHPA)

- Intake Protection Zone 1
- Intake Protection Zone 2
- WHPA-A (100m Radius Offset from Municipal Well)
- WHPA-B (2 Year Capture Zone)
- WHPA-C (5 Year Capture Zone)
- WHPA-D (25 Year Capture Zone)



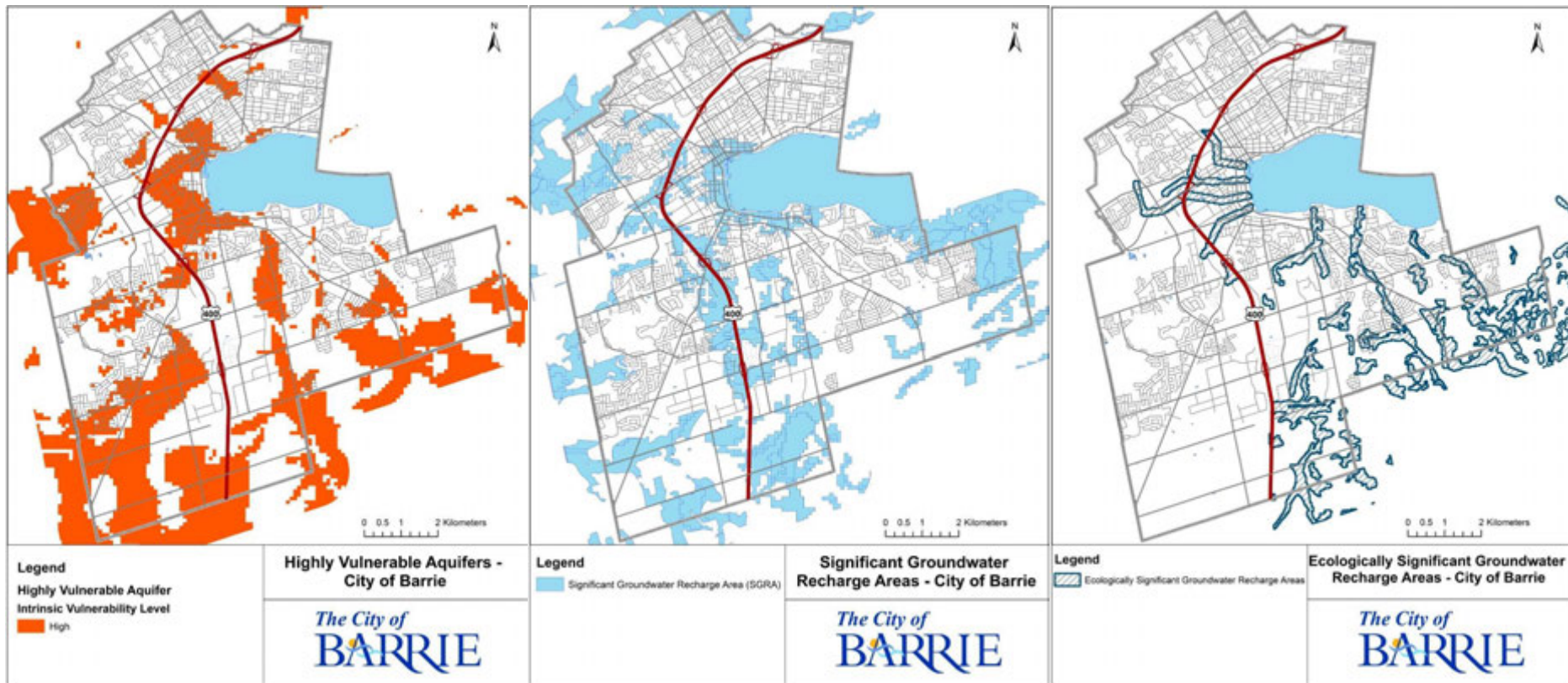
Legend

Water Budget

- WHPA-Q1
- WHPA-Q2



Source Water Protection



DRINKING WATER SOURCE PROTECTION

Our Actions Matter



Turning Policy into Action: A Showcase of Collaborative Initiatives to Protect Sources of Drinking Water in the Greater Toronto Area

May 27, 2019

Jennifer Stephens, Manager

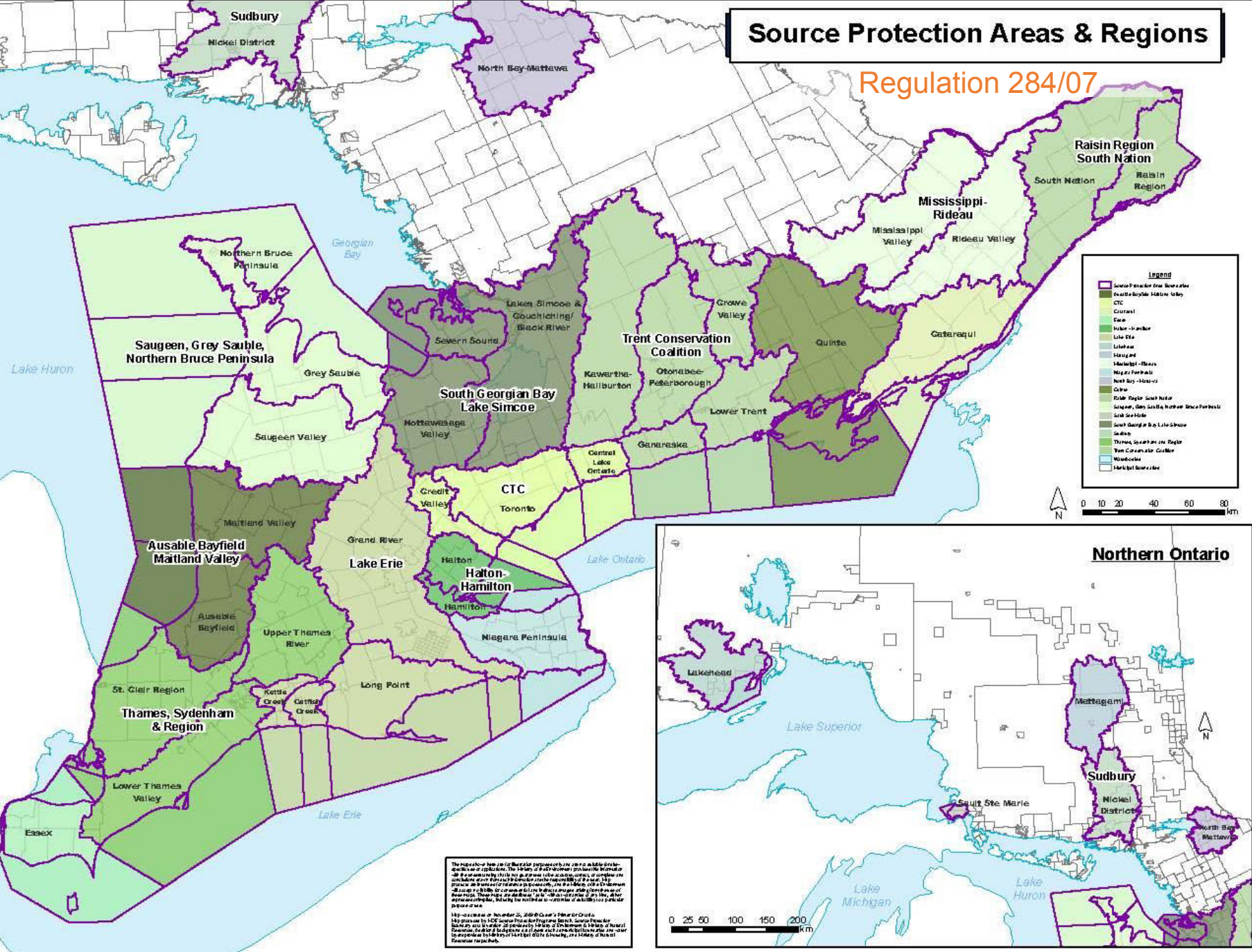
Edmonton Metropolitan Region – Peer Learning Event

Multi-Barrier Approach – Drinking Water Protection



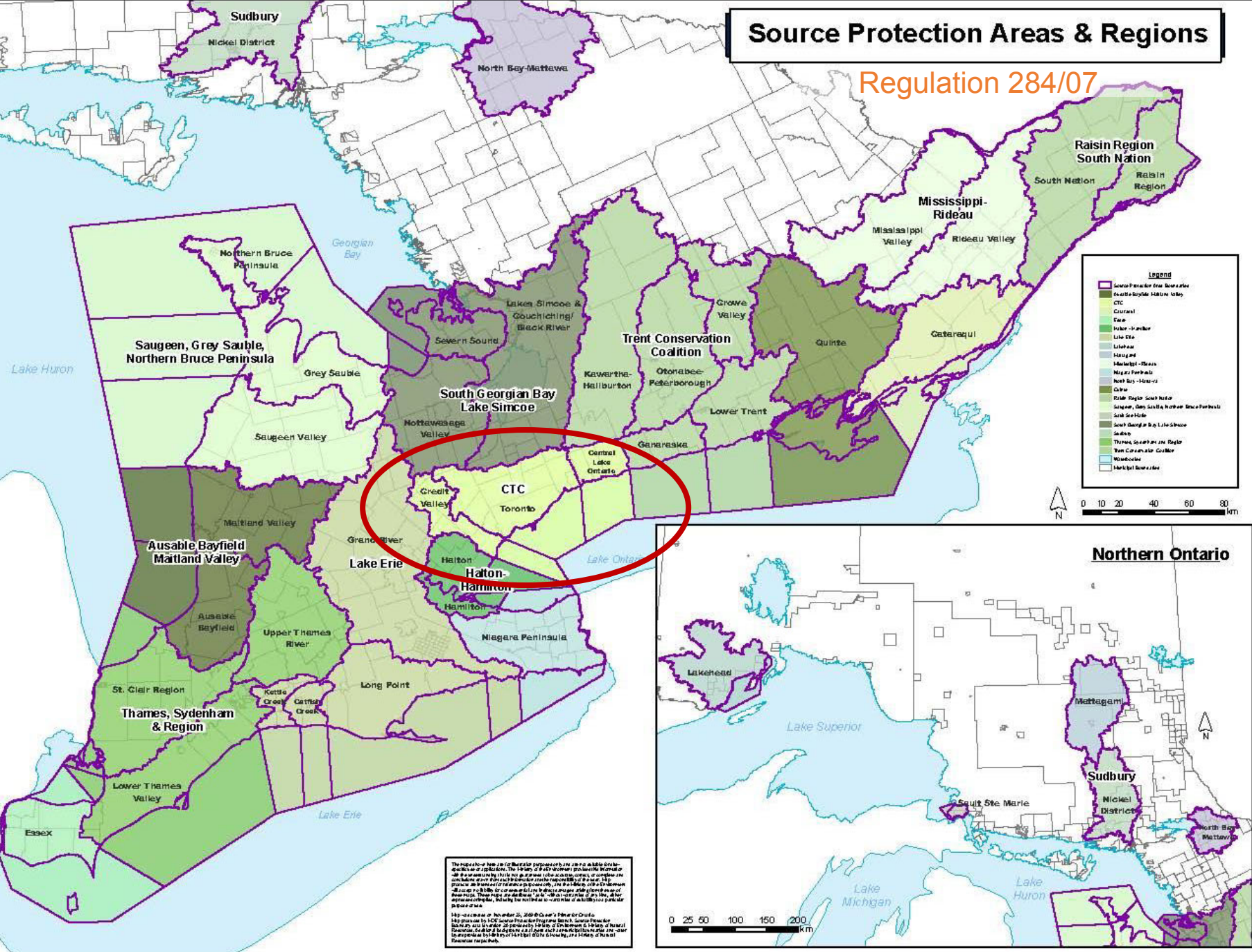
Source Protection Areas & Regions

Regulation 284/07

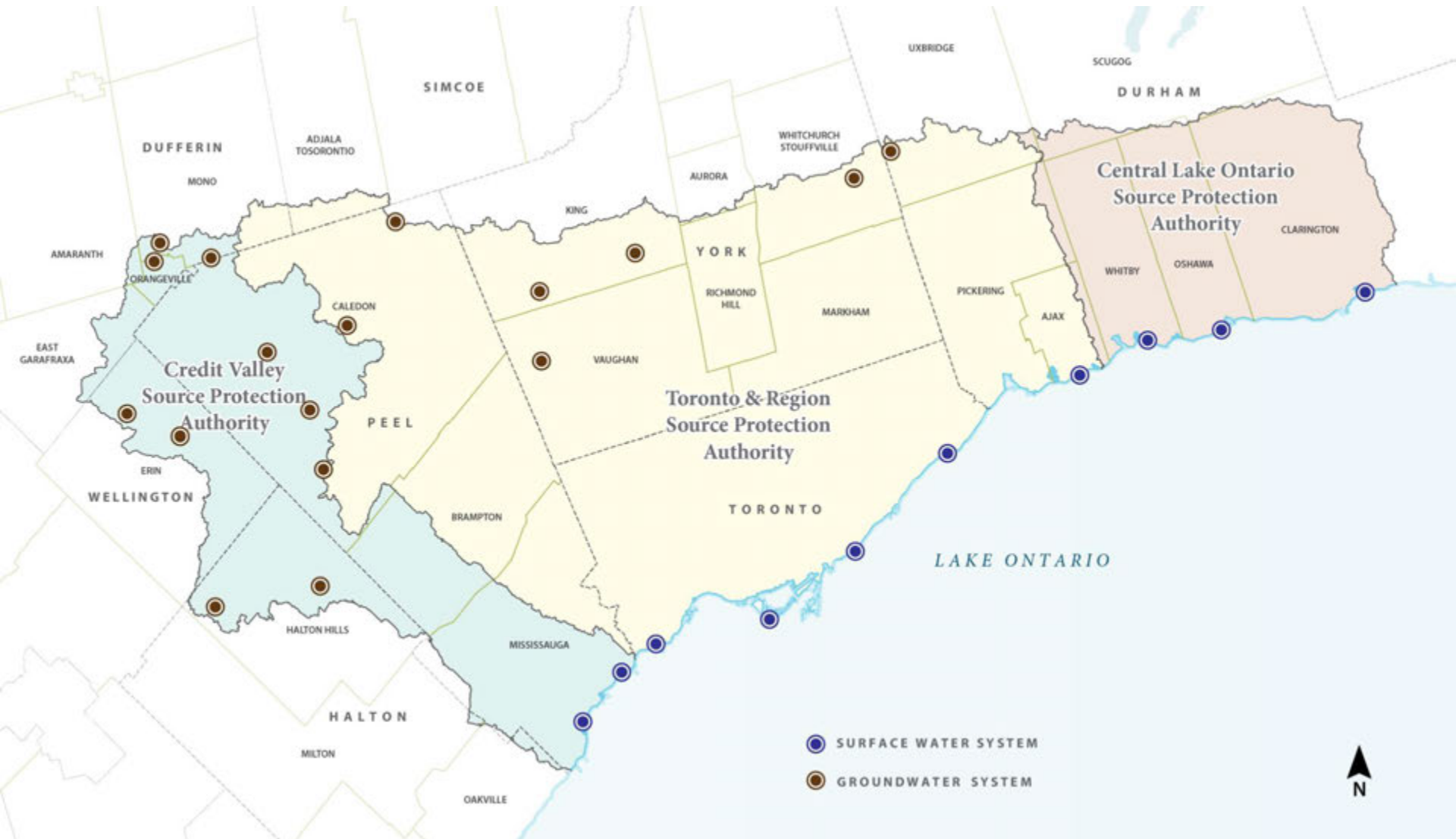


Source Protection Areas & Regions

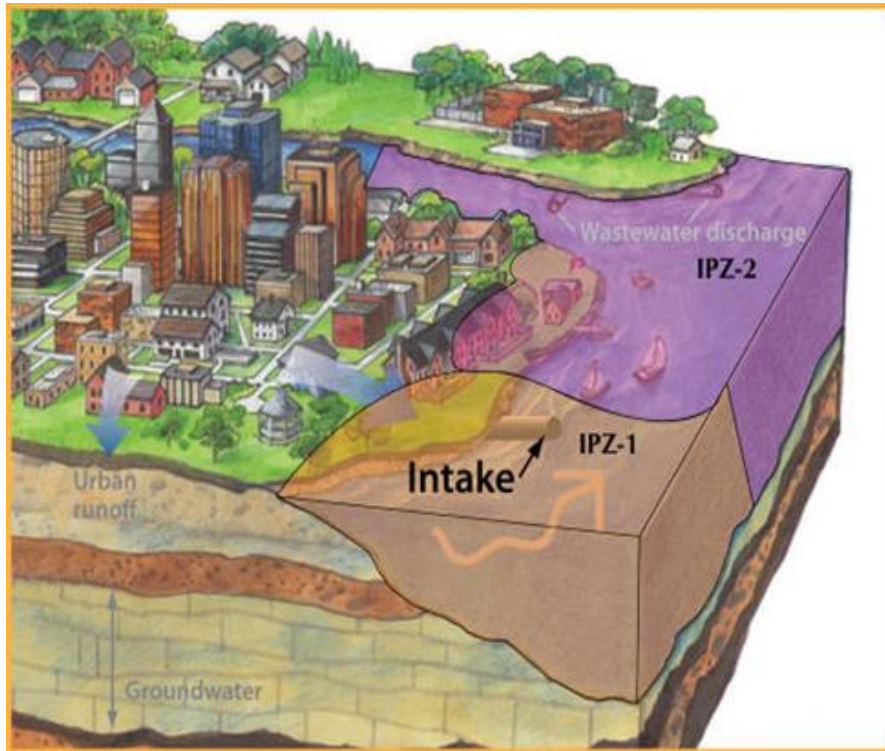
Regulation 284/07



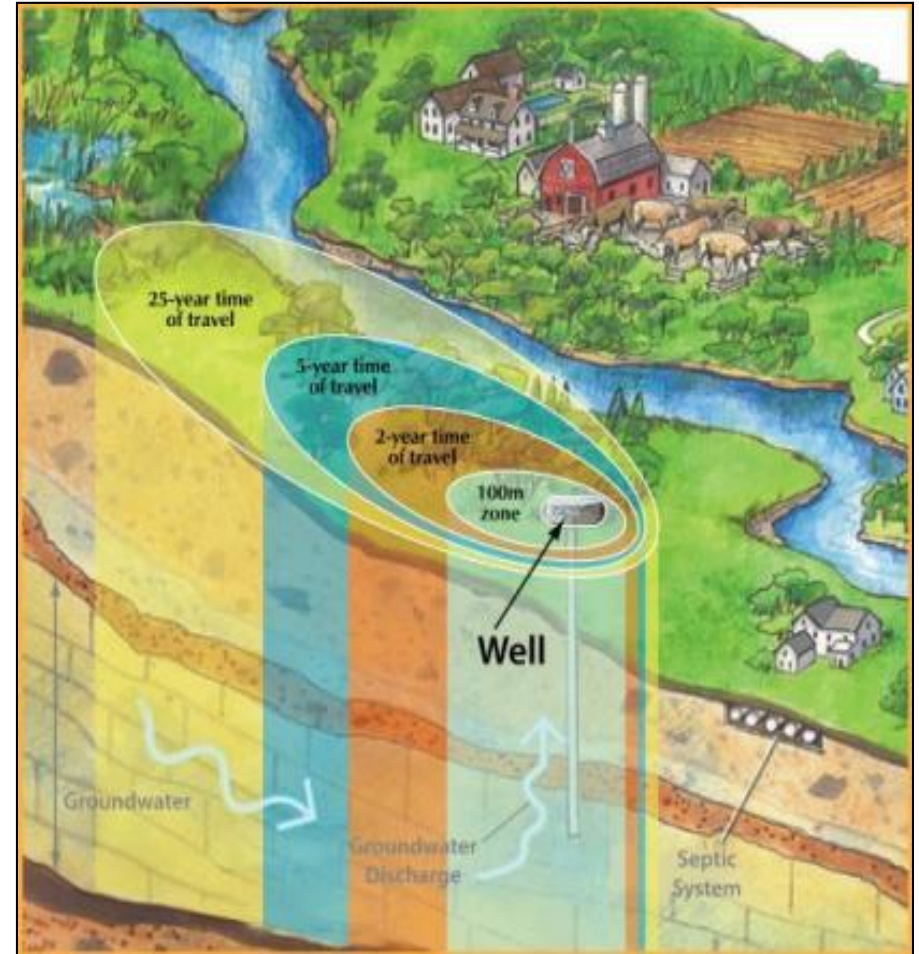
Credit Valley – Toronto & Region – Central Lake Ontario (CTC) Source Protection Region



Vulnerable Areas under the *Clean Water Act*, 2006



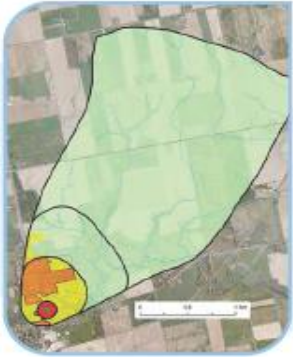
Intake Protection Zones
(Surface Water)
(Water Quality)



Wellhead Protection Areas
(Groundwater)
(Water Quality)

Water Quality Risk Assessment

Vulnerability Score



- Depth of aquifer
- Composition of the soil above the aquifer

X

Hazard Score



- Likelihood of release
- Volume
- Mobility
- Toxicity

=

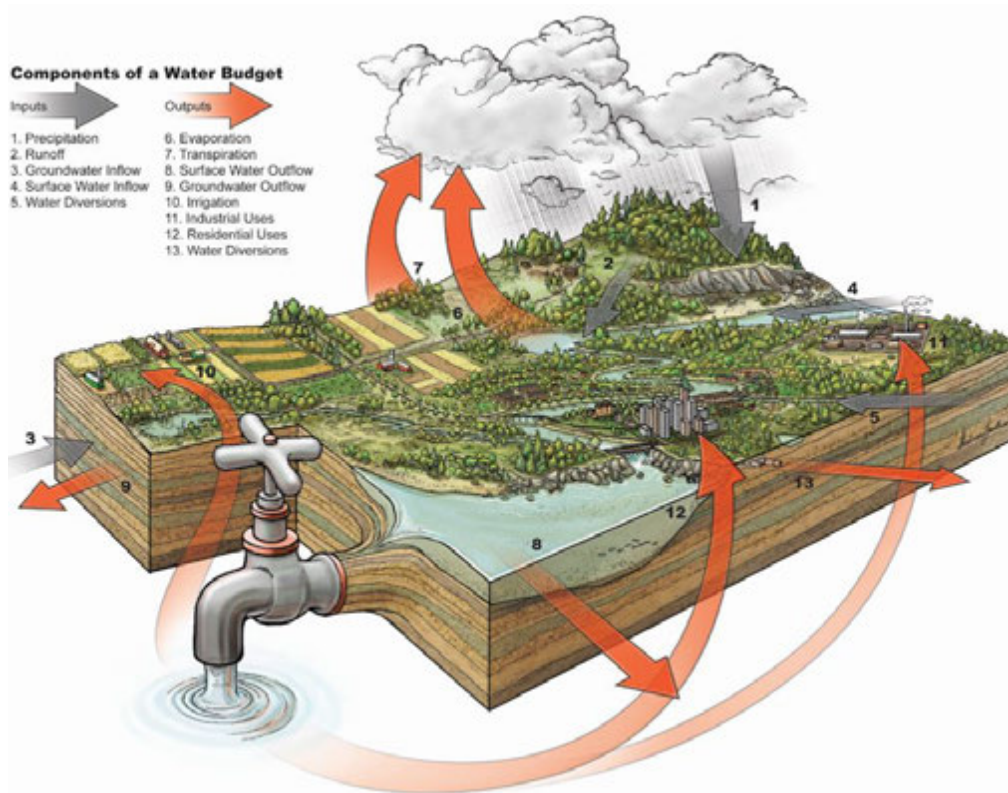
If score is greater than 80, than risk is **SIGNIFICANT**

Incorporating Climate Change in Drinking Water Source Protection Water Quality Risk Assessment

To provide municipalities, Source Protection Authorities, and Source Protection Committees with a **practical and consistent approach** to assess their drinking **water sources** for considerations of **local climate change impacts** (based on future and historical trends).



Water Budgets



- The flow of surface and groundwater systems;
- How water enters and leaves a watershed;
- How much water is stored within the watershed;
- How much water is available for human consumption; and
- How much water is required for natural heritage systems (i.e., aquatic life and wetlands).

Tiered Water Budget Process

Tier 3:

3D GW Flow or Continuous SW Flow Model
(Water Quantity Risk Assessment)

Tier 2:

3D GW Flow or Continuous SW Flow Model
(Refined: Supply, Demand, Stress Assessment)

Tier 1:

GIS Water Budget or Equivalent
(Supply, Demand, Stress Assessment)

Conceptual Water Budget
(Characterization & Visualization)



Drinking Water System



Subwatershed

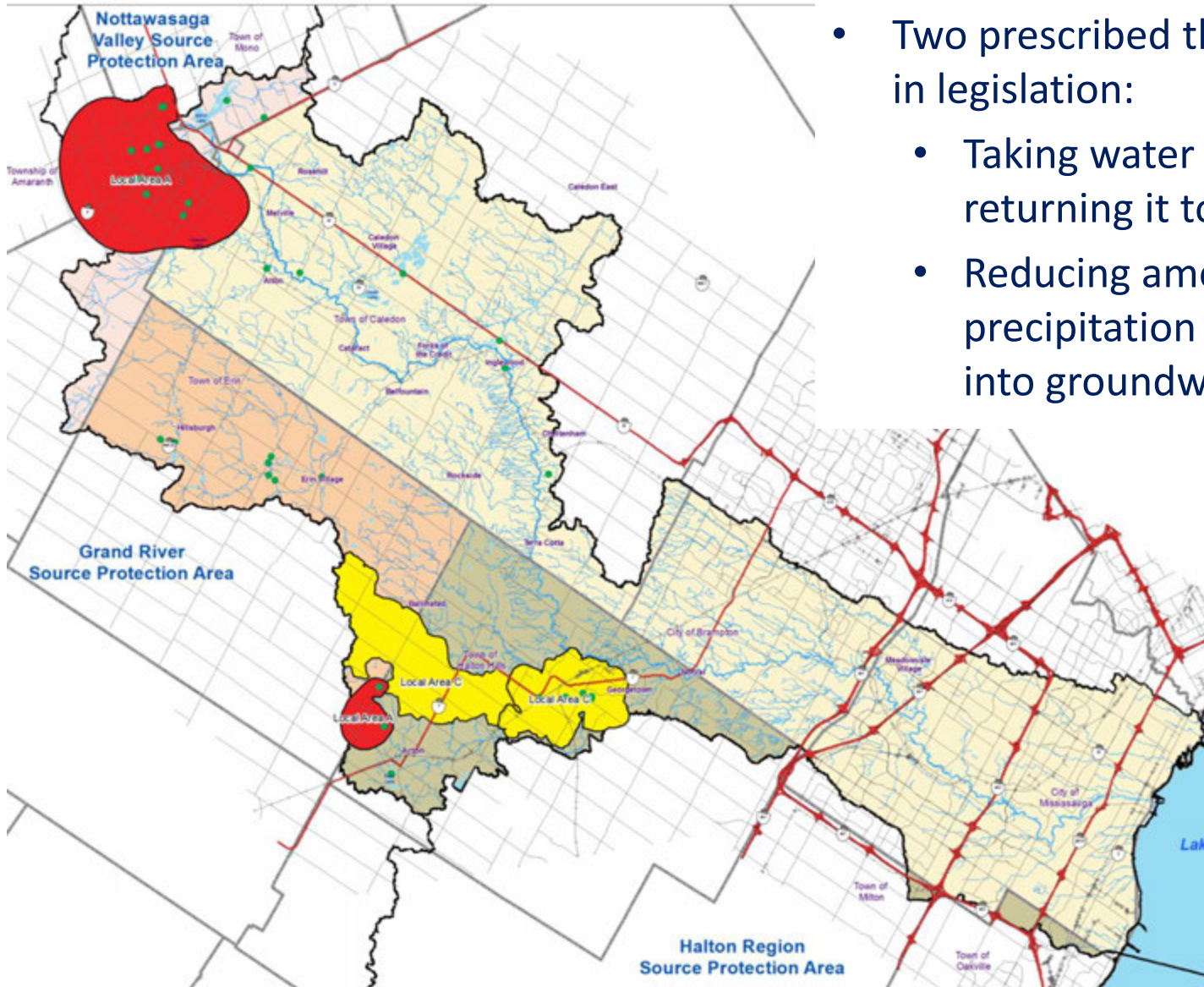


Subwatershed



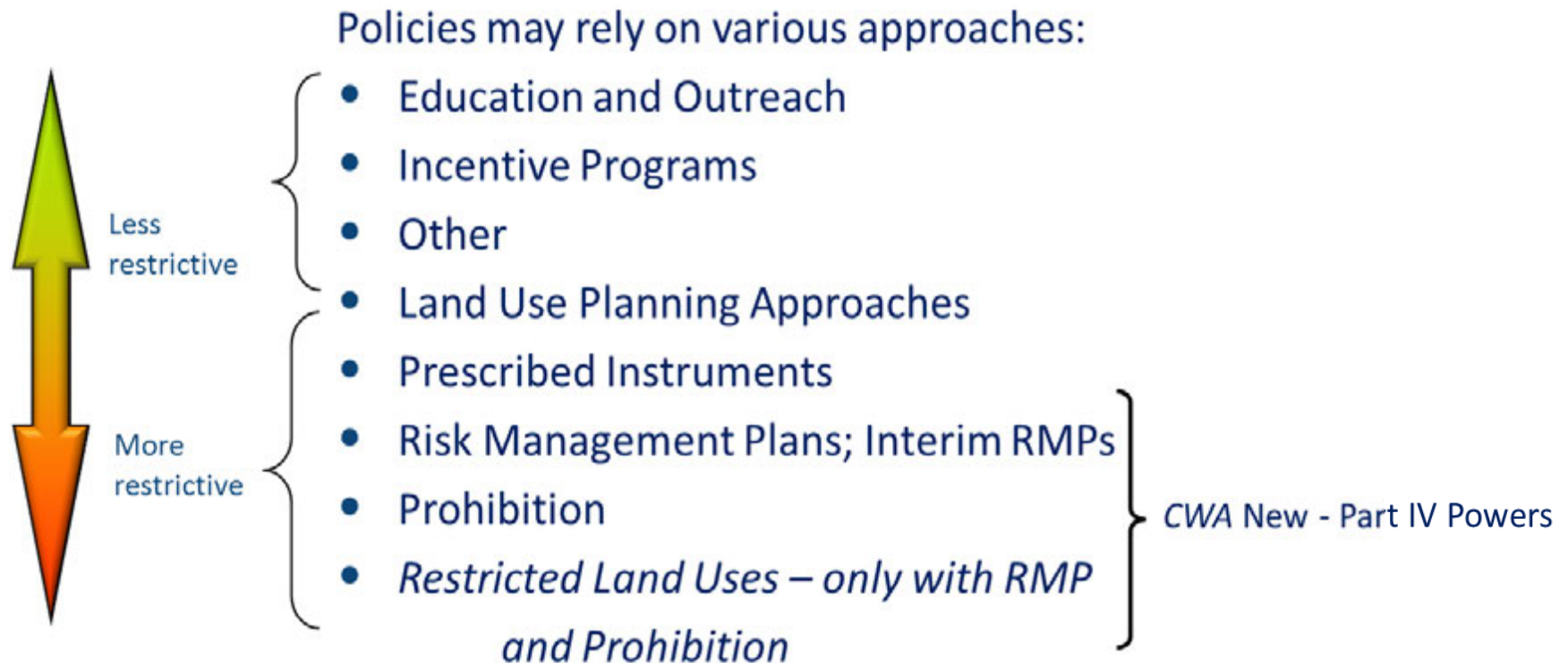
Watershed

Wellhead Protection Areas (Water Quantity)



- Two prescribed threat activities in legislation:
 - Taking water without returning it to same source
 - Reducing amount of precipitation that moves into groundwater

Source Protection Plans (www.conservationontario.ca)



Policy: Specify Action (Water Conservation Plans)

Municipalities responsible for the production, treatment, and storage of water, who have a municipal well and/or whose residents are served by a municipal water supply within the Tier 3 Water Budget WHPA-Q1 **shall develop** and/or **update** Water Conservation Plans to ensure they are an effective tool to support sustainable water quantity by reducing consumption and therefore the demand for water.



Water Conservation Planning

- Home and Yard;
- Commercial and Institutional Businesses;
- Industry;
- Purchasing; and
- Transportation.



Policy: Education and Outreach

Municipalities responsible for the production, treatment, and storage of water and/or with jurisdictional lands within a Tier 3 Water Budget WHPA-Q1 identified as having significant water quantity threats **shall undertake the following education and outreach initiatives** to help ensure water supplies are protected and increase the effectiveness of water conservation efforts in their jurisdictions to reduce consumption and demand by:



Policy: Education and Outreach (cont'd)

- 1) Implementing education and outreach programs to ensure that property owners and businesses are aware of:
 - a) their role in protecting water supplies and conserving water;
 - b) actions that can be taken to protect water supplies and use less water.



Education and Outreach (Video)

- Rain Barrels
- Outdoor Chores
- Lawn Watering
- Kitchen
- Gardening
- Bathroom



Policy: Specify Action (Joint Municipal Water Supply Management Model)

The municipalities that share a water source within a Tier 3 Water Budget WHPA-Q1 identified as having significant water quantity threats **shall develop** a Joint Municipal Water Supply Management Model, and implement within 3 years from the date the Source Protection Plan takes effect.

This management model shall facilitate the planning and management of water supply sources to ensure sustainability of a long term water supply in each municipality and ensure that water quality and quantity is maintained or improved such that activities cease to be, or do not become, significant drinking water threats in the WHPA-Q1.



Policy: Specify Action Aquifer Recharge

Within a Tier 3 Water Budget WHPA-Q2 with a significant risk level, the municipality shall develop and implement actions to be taken and an implementation schedule, to ensure that an activity which reduces aquifer recharge ceases to be a significant water quantity threat; **such actions may include:**



Policy: Specify Action Aquifer Recharge

- a) reviewing options to **maximize aquifer recharge**;
- b) delivering an **education and outreach** program to inform property owners about actions that can be taken to protect aquifer recharge (e.g., site grading, rain gardens). The program may include incentives (such as rebates) to encourage best management practices;
- c) requiring the **use of Low Impact Development** in new development or retrofits; and
- d) passing a by-law to require **downspout disconnection**.



Low Impact Development

- manage runoff with distributed, small-scale controls
- Mimic pre-development hydrology through:
 - Minimizing impervious cover
 - Preserving natural drainage features and patterns
 - Filter, harvest, evapotranspire, detain and infiltrate stormwater as close to its source as possible.



LID Structural SWM Best Practices

<http://sustainabletechnologies.ca>

- Rainwater Harvesting
- Green Roofs
- Absorbent Landscaping
- Vegetated Filter Strips
- Enhanced Grass Swales
- Soakaways, Infiltration Trenches and Chambers
- Bioretention/Rain Gardens
- Permeable Pavement
- Dry Swales/Bio-swales
- Perforated Pipe Systems



Protecting our Drinking Water Sources

Stakeholder Engagement (Municipal Sector)

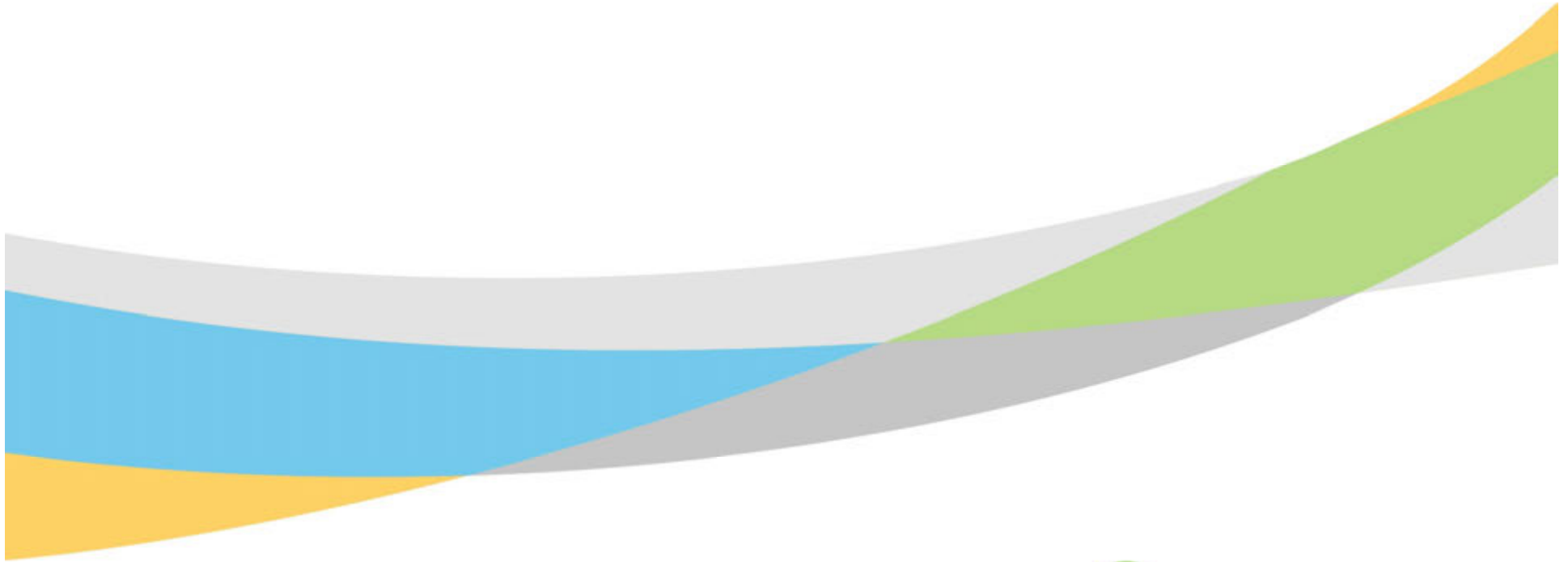


Thank-you!

www.ctcswp.ca

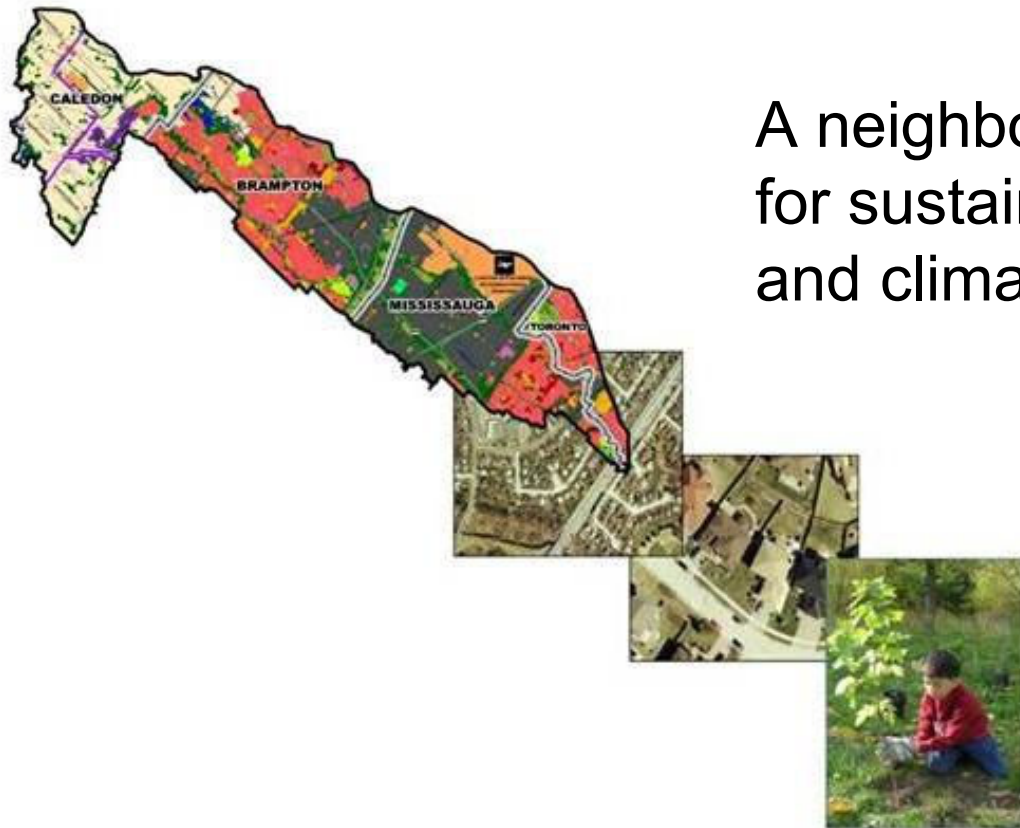


Sustainable Neighbourhood Action Program (SNAP)



May 27, 2019

Sustainable Neighbourhood Retrofit Action Plan (SNAP)



A neighbourhood-based solution for sustainable urban renewal and climate action.

- ✓ Brings efficiencies
- ✓ Draws strong community support
- ✓ Builds innovative partnerships for implementation

Multiple Sustainability Objectives

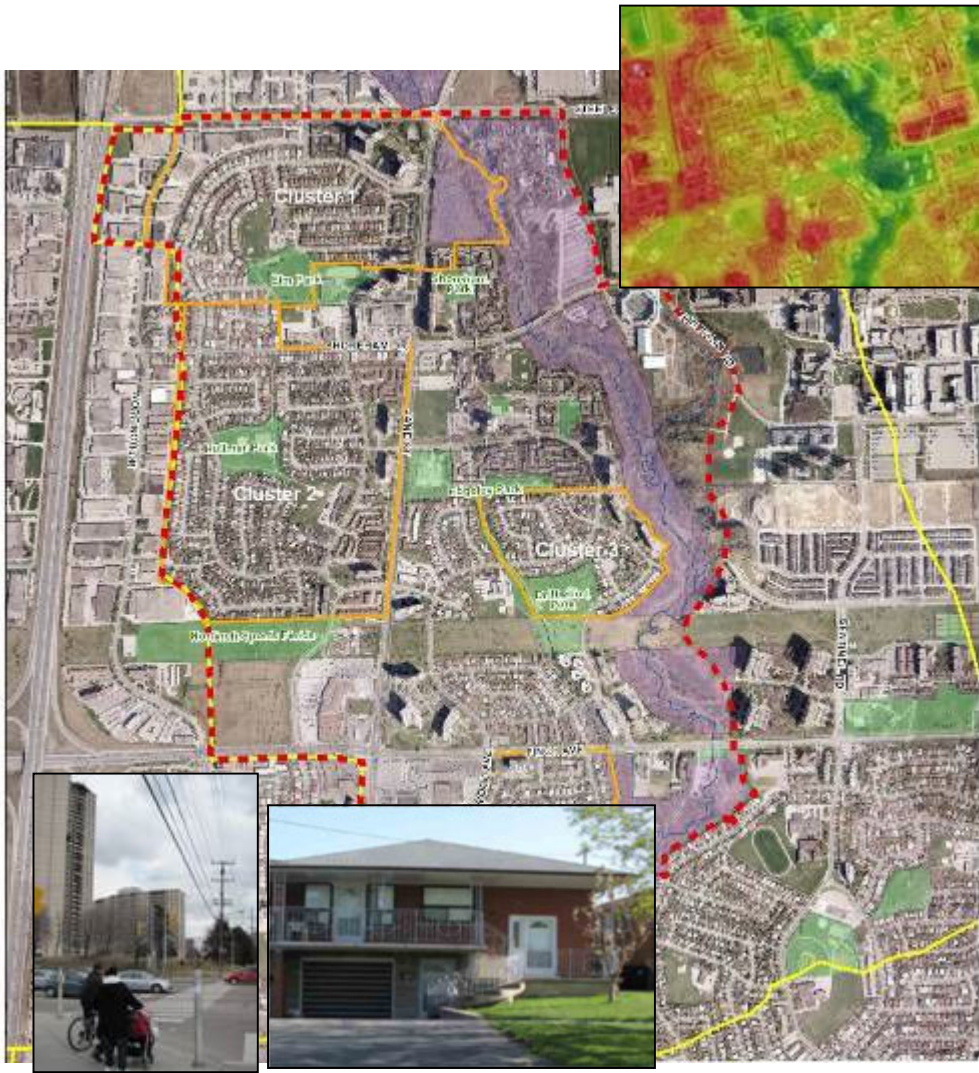
- Guided by existing municipal plans, watershed plans and other interests etc.
- ***Inspired*** by the local community



Collaborative: Empowering participants to become leaders



Example – Black Creek SNAP, Toronto



Initial focus:

- Basement flood risk reduction
- Black Creek subwatershed health
- Urban forest health
- Heat stress, vulnerable populations
- Job training, income and food security are top of mind interests

Black Creek SNAP

Growing Food and Green Opportunities

1. Stormwater Management & Basement Flooding Prevention

2. Urban Forest Enhancement

3. Energy Conservation

4. Food Production Supported by Rain Water Harvesting

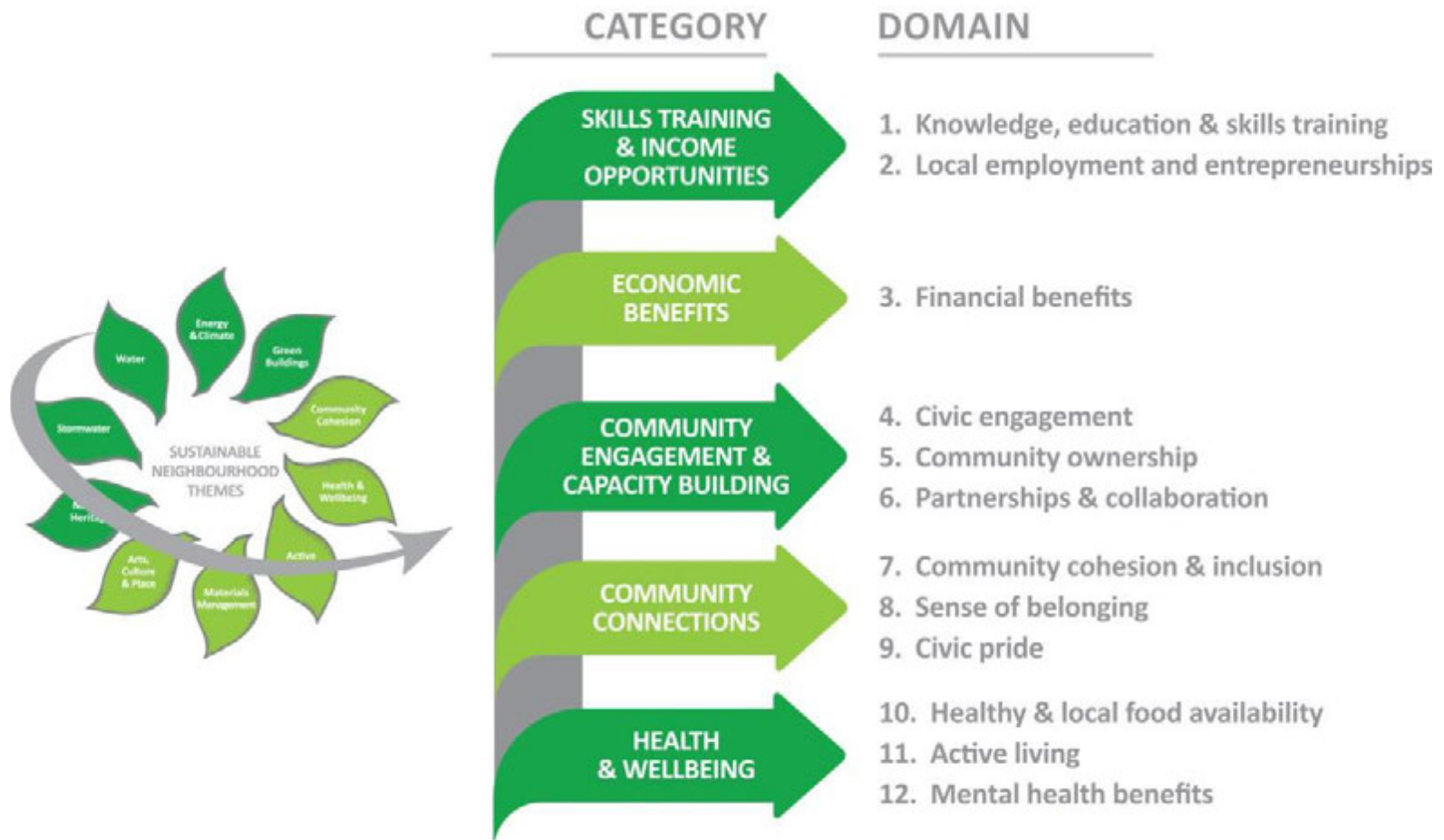
Green
Jobs



Typical SNAP Action Areas



SNAP Socio-Economic Indicator Domains

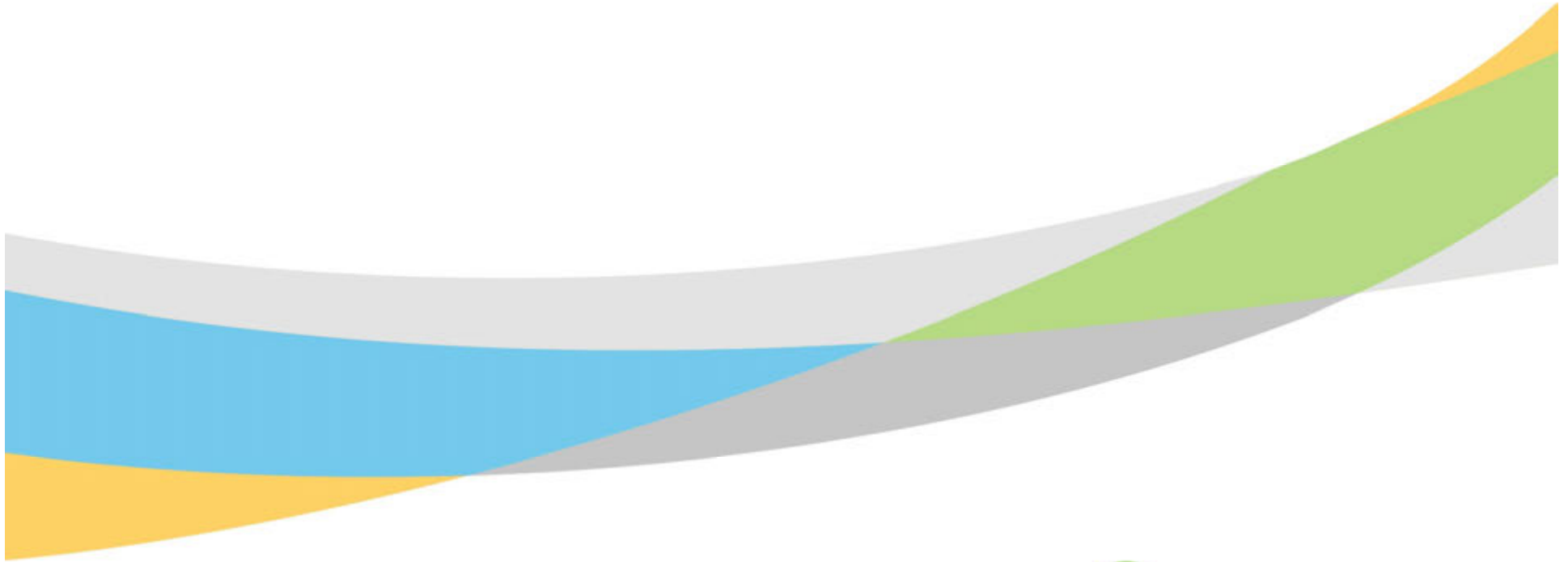


SNAP Program Partners



And hundreds more partners...

...community groups, businesses, utilities etc.



www.trca.ca



Building Calgary's Water Security Strategy – Source Water Protection & Drought Management Planning

Pamela Duncan & George Roman
The City of Calgary Water Resources
Watershed Planning

Overview

- Background: Calgary's Water Services & Climate Risks (5 min.)
- Source Water Protection Planning (5 min.)
- Drought Management Planning (5 min.)
- Questions (10 min.)

3 Lines of Service



Water Treatment and Supply



Wastewater Collection and Treatment



Stormwater Management

~1.4 million people served

~1300 staff

Calgary's Climate Resilience Strategy

Includes:

- Climate Resilience Strategy
- Climate Mitigation Action Plan
- Climate Adaptation Action Plan

Available at:

https://www.calgary.ca/UEP/ESM/Documents/ESM-Documents/Climate_Resilience_Plan.pdf



Climate Impacts to the Watershed



Water availability

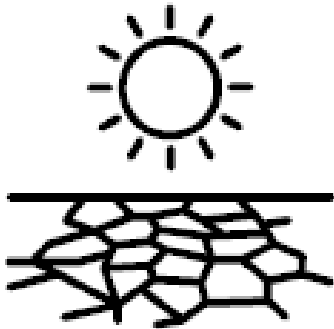
- *How and when* we receive precipitation will change making water management and storage more important
- Decreased river flow due to glacier melt and an earlier spring

More extreme precipitation events

- Summers will be drier with higher risk of drought
- Heat waves and drought elevates the risk of forest fires impacting water quality
- Precipitation will fall with greater intensity increasing concerns of flooding and water quality



Background: Climate Change Risks to the Water Utility



Multi-year-drought



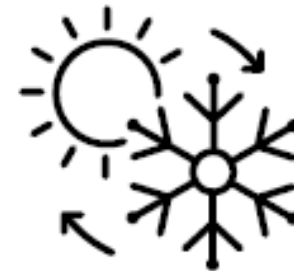
Wildfires



Intense summer storms



Major river flooding



**Freeze-thaw
weathering**

Calgary

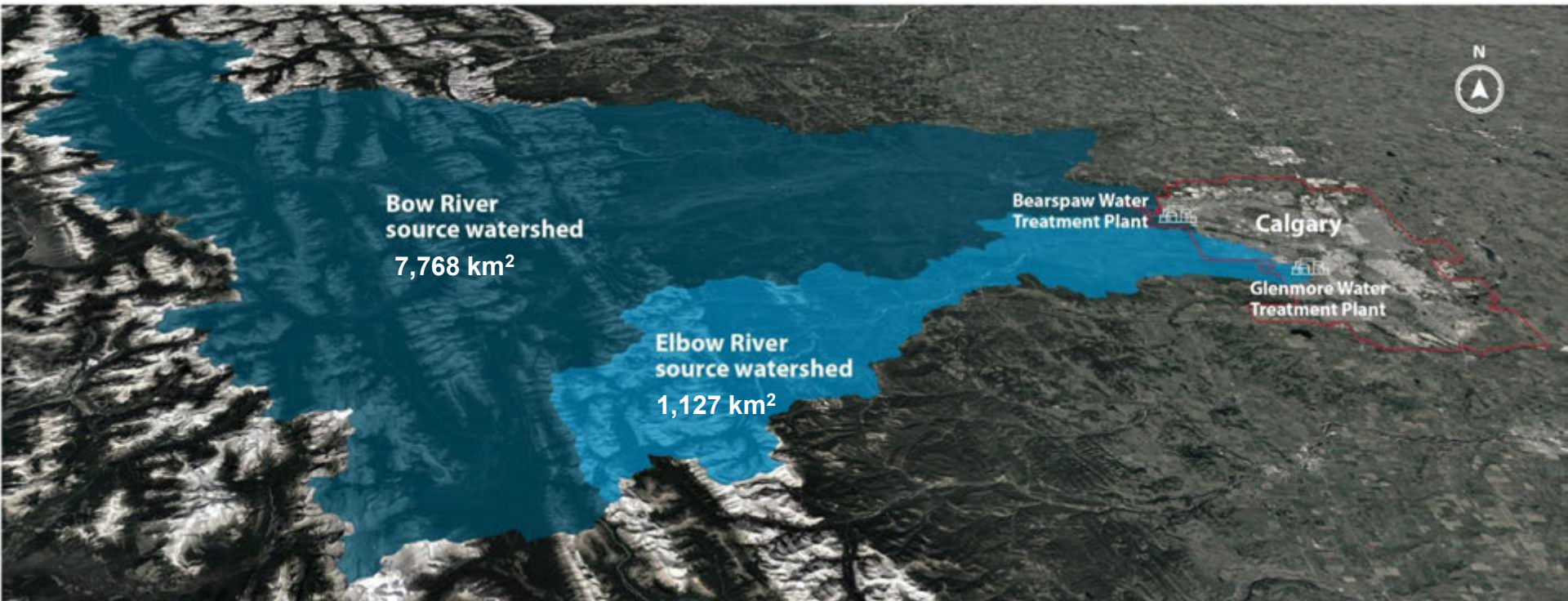


Source Water Protection Plan

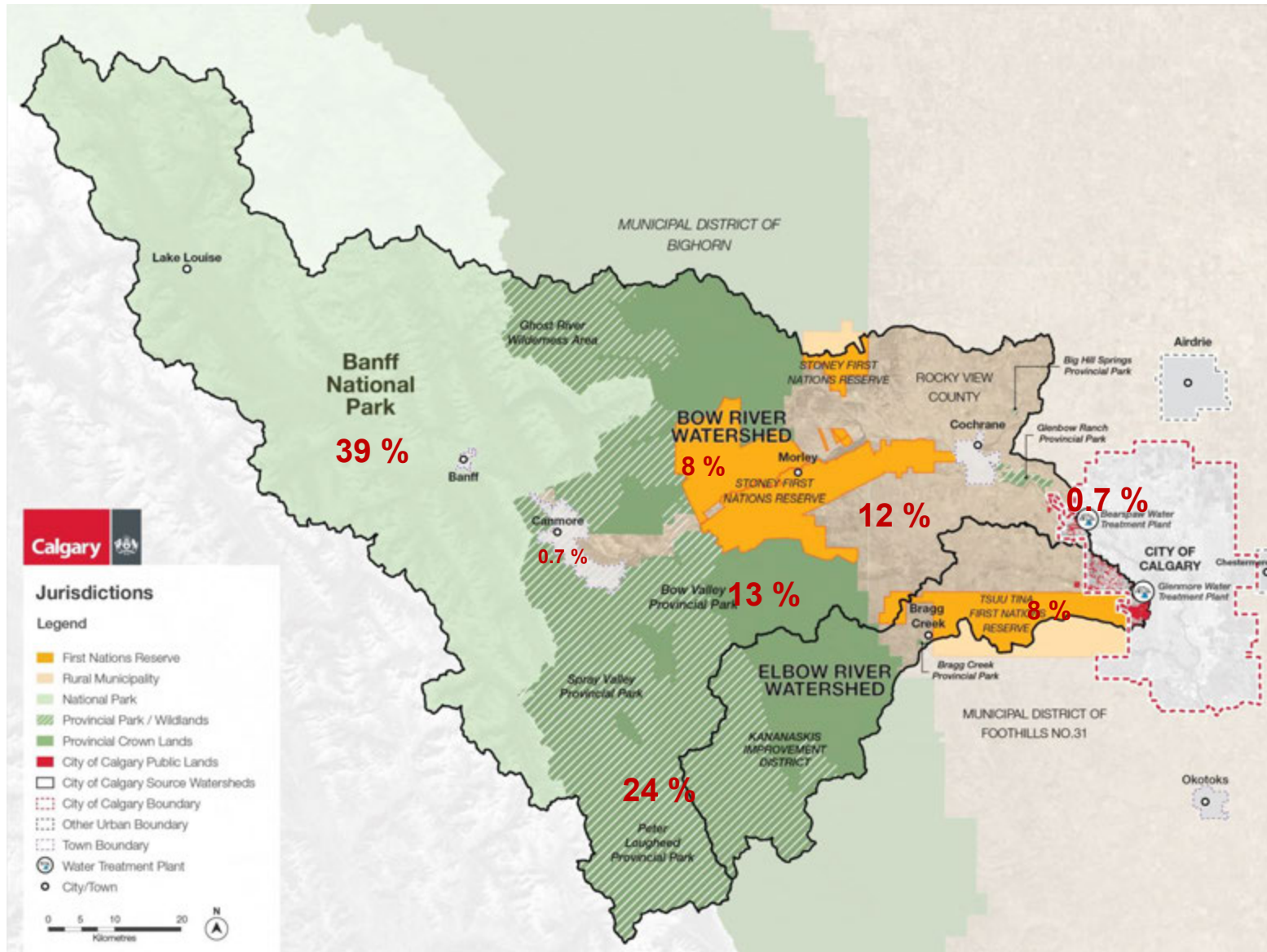
Protecting our source watershed through proactive collaboration

Available online at: <http://www.calgary.ca/UEP/Water/Documents/Water-Documents/Source-Water-Protection-Plan.pdf>

Background: Calgary's Source Watersheds

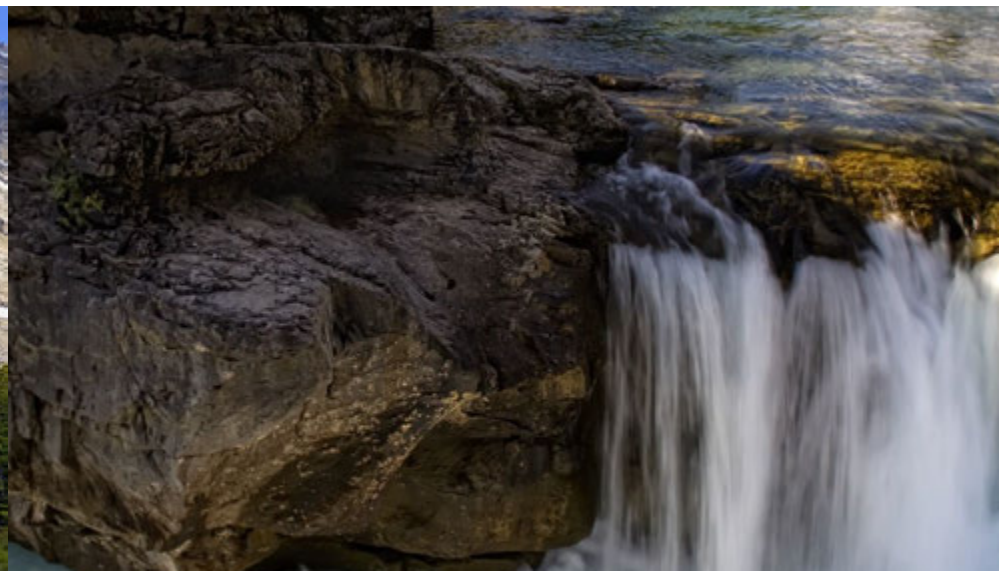
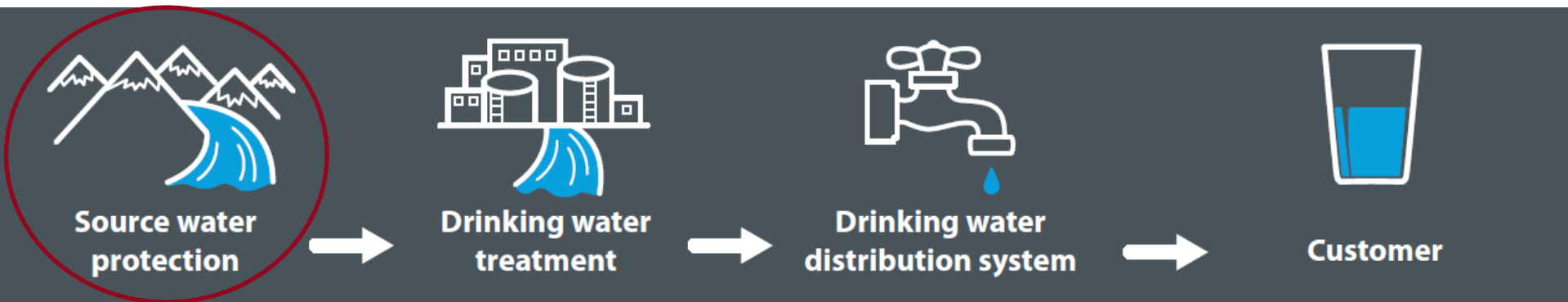


Calgary's Source Watersheds: Jurisdictions



What is Source Water Protection?

Source water protection: The first barrier in a multiple barrier approach to providing clean, safe drinking water



“Our source watersheds continue to provide clean, high quality water to the region, through proactive stewardship and management.”



Wildfire in our Watershed

- Wildfires are common in our source watersheds
 - In 1910 >4,000 km² burned in SW Alberta

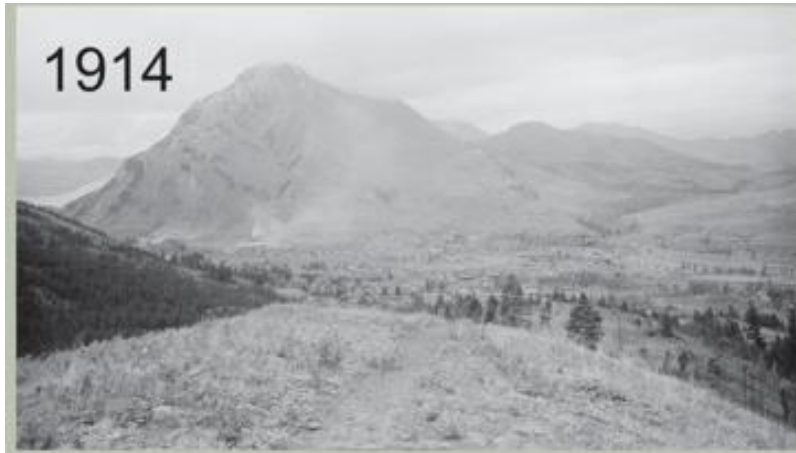


Photo Documentation by: Mountain Legacy Project, 2016

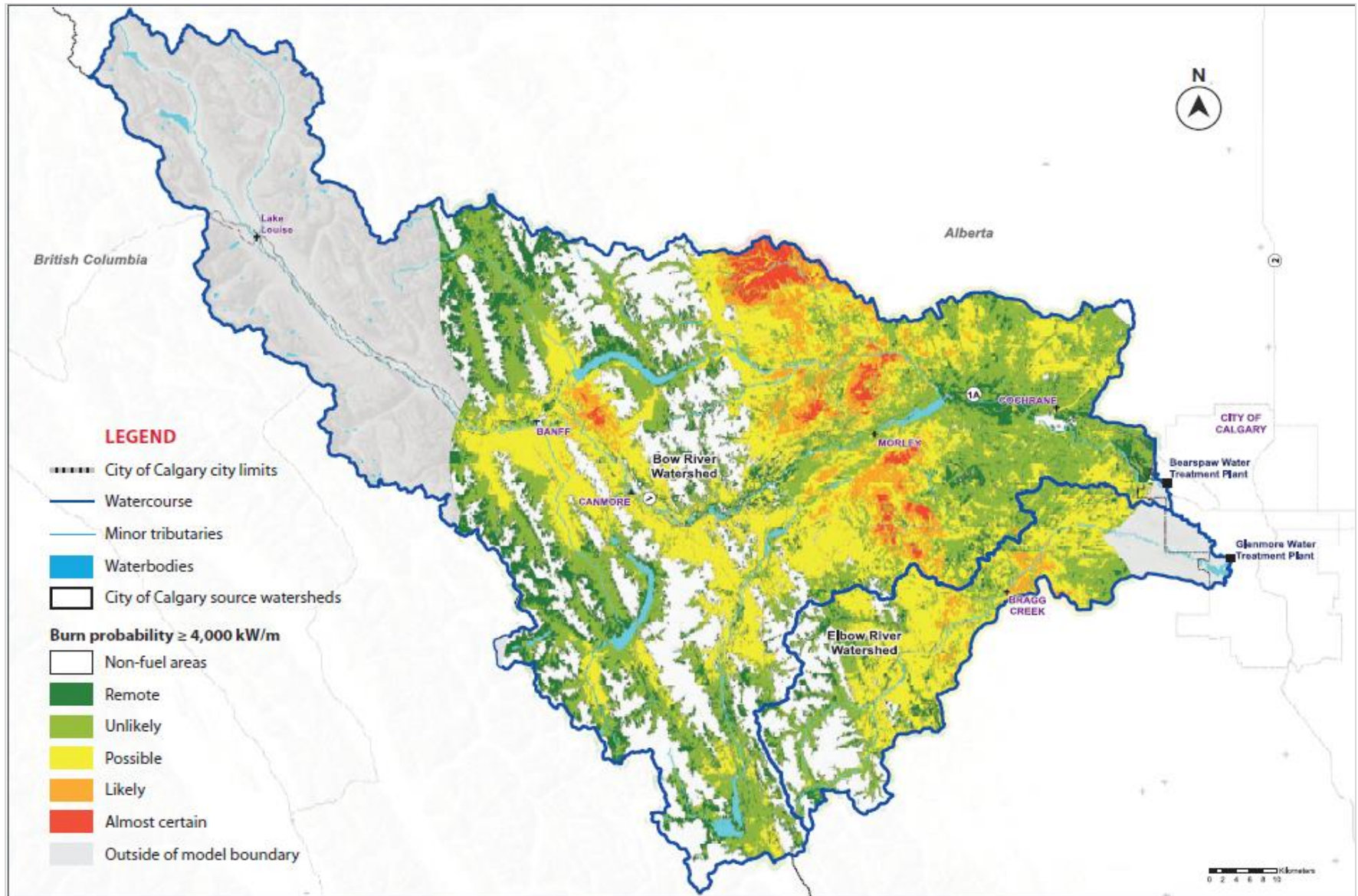
- Local fire cycle beginning again?
 - Wildfires near Banff in 2017
 - Wildfire SW of Bragg Creek, 2018
 - Grass fire in Cochrane, 2018

Wildfire forces Sunshine Village to close again as hot, dry weather persists

BILL KAUFMANN Updated: July 31, 2017



High Intensity Burn Probabilities in Our Watersheds



“Megafires” on the Rise?

- Megafires = extraordinary size, complexity
- Climate Change = ↑ megafires
- In 2017 & 2018, more area burned in B.C. than previous 30 years



Fort McMurray Wildfire, 2016

Wildfire Impacts on Water Quality

- Significant water quality change after widespread fire
 - e.g., Organics, Nutrients, Sediment, Pathogens, Metals
- Could pose considerable treatment challenges
- Ranked as a top source water/drinking water safety risk



Cameron Falls, Waterton Park, AB (Pristine)



Same Location, Post-2017 Wildfire



Projects to Assess & Mitigate Wildfire Risks

- Ongoing research partnerships with academics (2013-present)



UNIVERSITY OF
ALBERTA



UNIVERSITY OF
WATERLOO

- Pilot research on treatment of ash-affected water (2018)
- Wildfire-Source Water Task Force (2019)



History of Drought

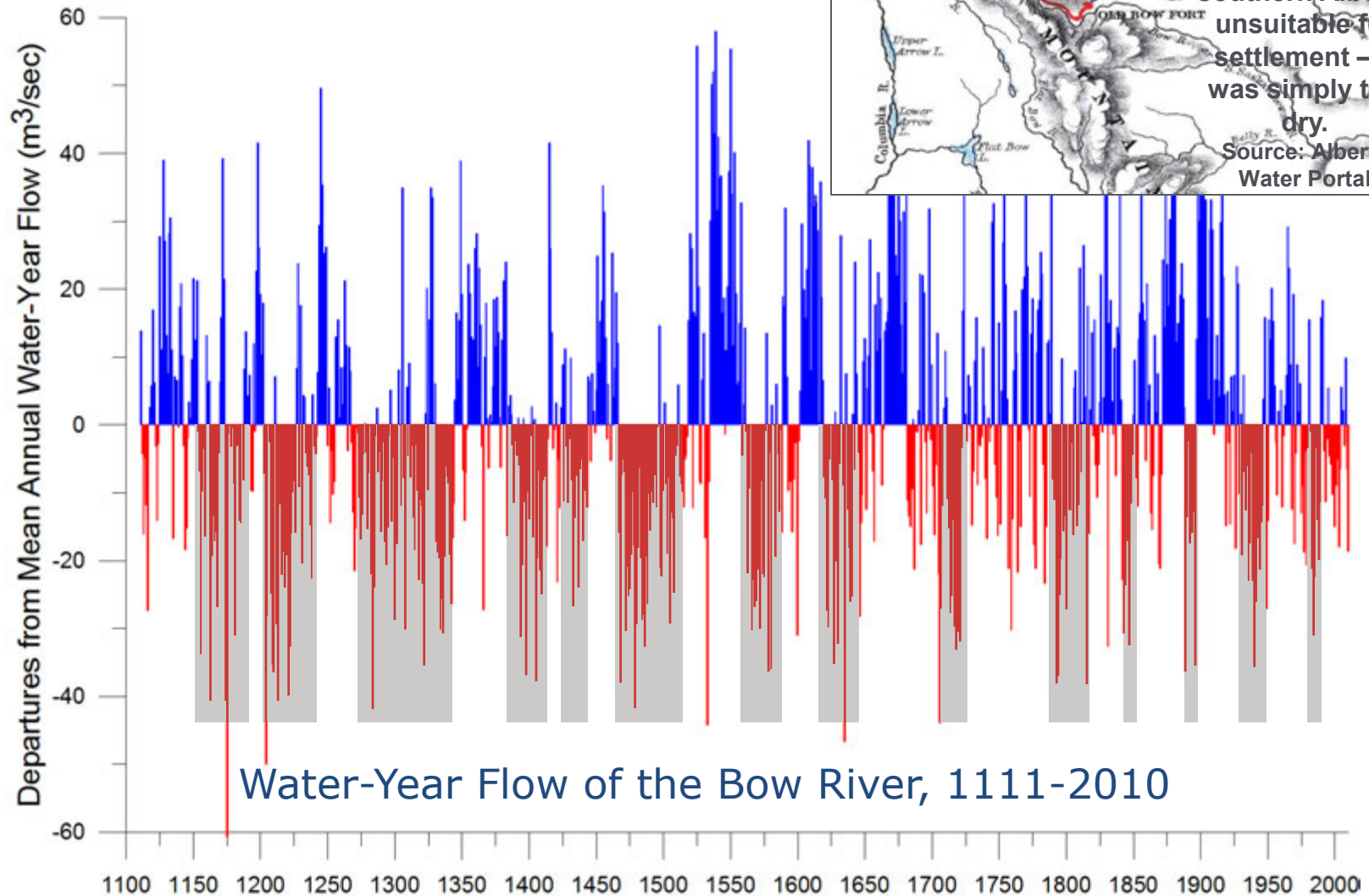


Dust Bowl – Drought of the 1930s



Recent Droughts in Southern Alberta

History of Drought



Phase 1 - Drought Response:

- Established Drought Monitoring Team and early warning system
- Escalating phases to co-ordinate operational response and communication

Phase 2 - Drought Resiliency:

- Increase emphasis on drought policy, strategies and preparedness
- Risk and Vulnerability Assessment

Drought Response



Normal/Dry



Advisory



Restrictions



Emergency

Dry Conditions / Normal
Operations²²

Increase Readiness

Supply and Demand Actions

Water Rationing

Recognition of initial dry
conditions

No water shortages are
anticipated

Watershed conditions
continue to decline

Future water shortage may
occur

Prepare for restrictions

Drought jeopardizes
municipal supply and
environmental flows

Outdoor restrictions required
to avert projected or current
City shortage

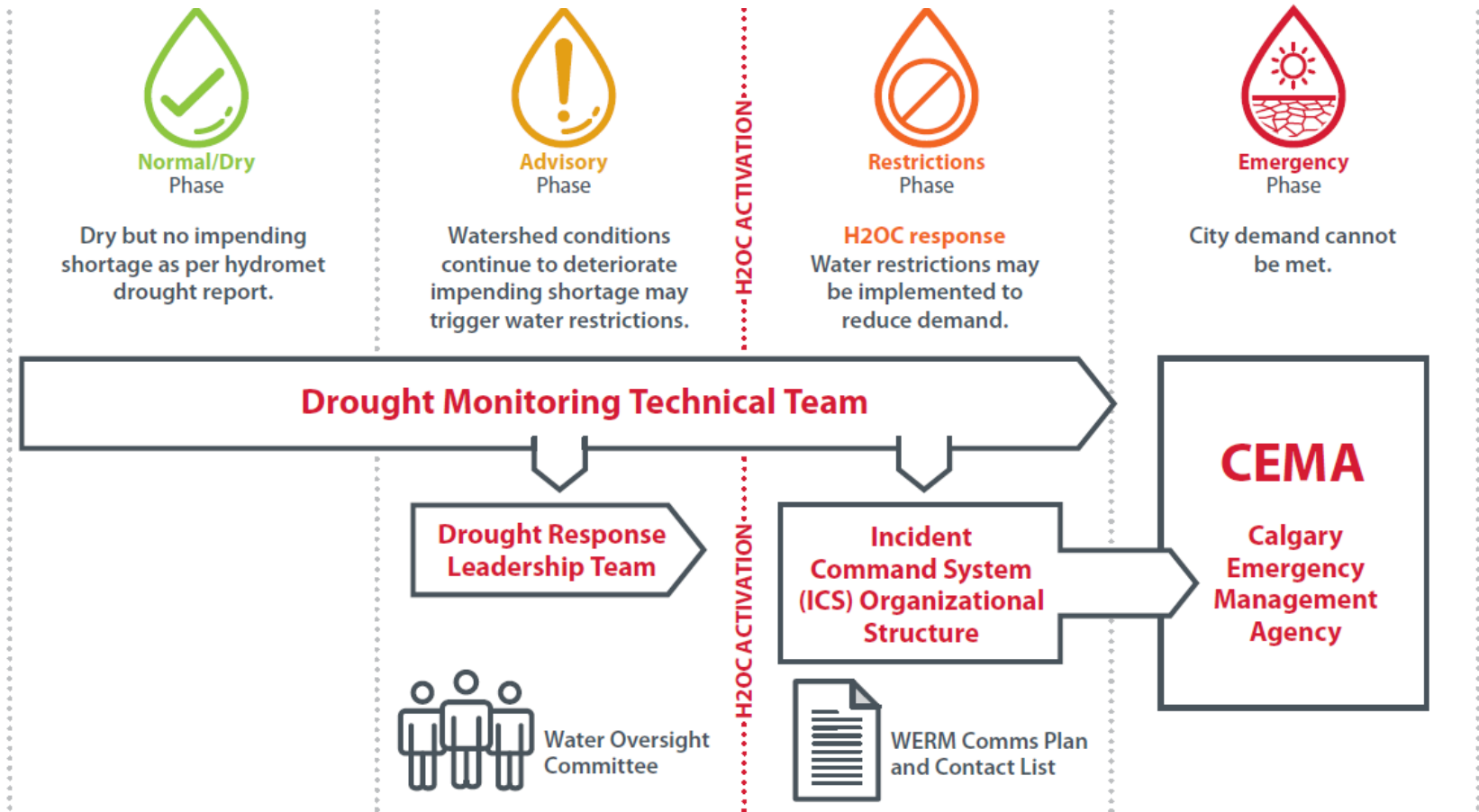
State of local emergency

City demand cannot be met.

Total outdoor ban and indoor
rationing



Drought Governance



Drought Resiliency

Improved operational co-ordination across the Utility and the Corporation

Objective:
Immediate Preparedness

Technical analysis supports our drought decisions

Objective:
Understand our Risks and Vulnerabilities

We have the right tools at the right time for future drought response

Objective:
Optimized drought supply and demand portfolio

We're in this together

Objective:
Collaboration across Municipal, Provincial, Industry and Academia

We are accountable to our citizens and customers

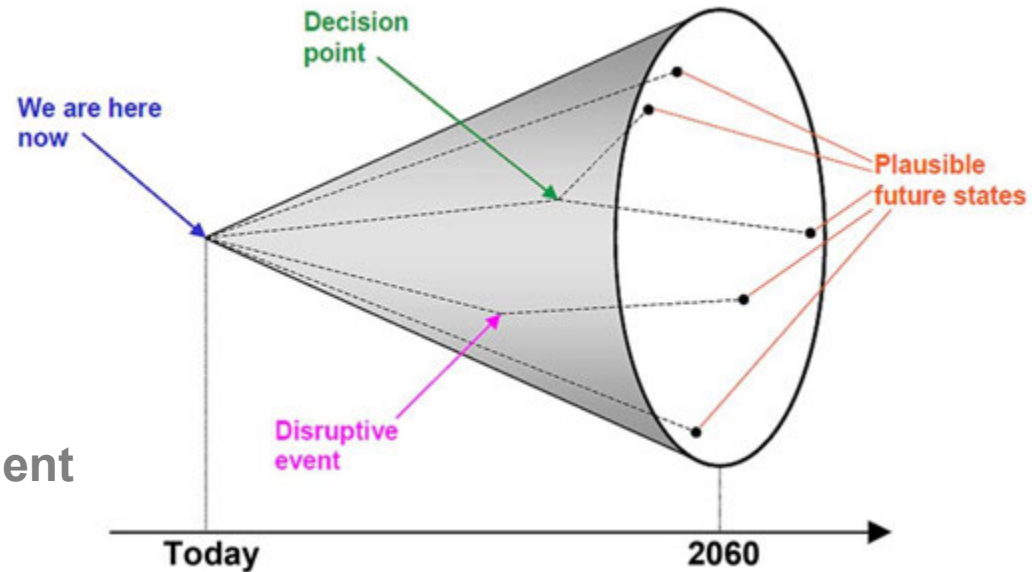
Objective:
Education and Communication


Response

Resiliency

Addressing an Uncertain Future:

- Drought Scenarios
- Risk and Vulnerability Assessment
- Mitigation and Response Actions
- Public and Stakeholder Engagement



A scenic landscape photograph showing a wide river in the foreground, reflecting the warm, orange light of a sunset. The river flows from the bottom left towards the right. The middle ground is filled with a dense forest of evergreen trees, with a layer of lower, green shrubs in front of them. In the background, a range of mountains is visible under a sky with soft, orange and yellow clouds. The overall mood is peaceful and natural.

Thank You! Questions?