

Pathways to Sustainable, Integrated Urban Water Management for Ontario Municipalities: Diagnostic and Toolkit

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Abstract

Ontario municipalities face increasing challenges to the sustainable provision of urban water services in light of growing populations, climate change, and aging infrastructure. The conventional approach to water management has led to growing stressors related to high energy usage, quantity and quality of water, increasing uncertainty about future conditions, infrastructure failure, strained ecosystems, and increasing urbanization. Transitioning towards a more sustainable, integrated water management approach will support municipalities in addressing complexities and uncertainties related to these changing conditions and provide cost-effective and resilient infrastructure, livable and secure communities for current and future generations.

The objective of this research is to help municipal water managers to navigate sustainable, integrated water management in the context of the Ontario regulatory framework and multiple high priority issues – climate change, infrastructure renewal, environmental degradation, urban growth. A diagnostic and toolkit were developed to first assess where a municipality is situated on a spectrum of sustainable, integrated water management and then to identify and recommend appropriate existing frameworks and tools which can be employed for strategic and incremental progress.

Evaluating municipalities based on actions versus outcomes was noted as a potential short-coming of the approach, however, this was considered a tradeoff for enabling a high-level, rapid assessment based on readily available information. It was noted that completing the diagnostic is in of itself a useful exercise to highlight interconnections and progressive activities which are already underway, while still identifying room for improvement. Recommendations for further development and implementation are discussed.

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1.0. Introduction

Water management in cities has been constantly evolving to address new challenges. Water is essential for life and sustaining the urban economy, livelihoods, quality of city life, and has shaped urban growth. Conventional water management involves meeting regulatory requirements for safe drinking water, meeting ever growing water demands through centralized potable distribution, collecting, treating and discharging wastewater, and collecting and draining stormwater to reduce risks to urban flooding.

The current approach to water management in Ontario has served well to date in terms of public health and safety and economic development, and made improvements in terms of environmental impacts. However, with growing stressors related to high energy requirements, climate related stresses on quantity and quality of water and increasing uncertainty about future conditions, infrastructure failure, strained environments and ecosystems, and increasing urbanization, weaknesses in this approach are becoming apparent.

The paradigm shift towards more integrated, sustainable water management yield multiple benefits:

- Cost efficient and economically viable in the long-term – in viewing all waters a resource for local use can save on money in treating and pumping water and supportive of full-cost recovery;
- Reduce impact on local waterways and ecosystems by reducing loadings and withdrawals;
- Citizens are more engaged in surrounding environment and understand risks;
- Reduce conflict between users through established mechanisms for allocation and cooperation;
- More green space for natural habitat and citizen enjoyment in urban areas;
- Integrated planning addresses cumulative risks from climate change, population pressures, and aging infrastructure;
- Greater resilience in water, wastewater, and stormwater infrastructure systems;
- Reduced impact on natural watershed features through recognition of impact of land use planning on water quality and quantity (CVCa 2016).

It is internationally accepted that integrated, watershed-scale water management is an effective and necessary approach to managing water resources, however there are challenges in transitioning from the conventional approach (Mitchell, Priddle, et al. 2014) (Nicklow, Boulos and Muleta 2004). The urban water landscape is a diverse mix of human-engineered and ecological systems, highlighted in Figure 1, which are traditionally managed by different departments or authorities, and not necessarily through a lens of climate change, uncertainty, sustainability, or integration. Conflicting stakeholder objectives, entrenched viewpoints, complex interpersonal histories, funding difficulties, and uncertainties with ever-changing conditions are common constraints which need to be overcome prior to benefits being realized (Nicklow, Boulos and Muleta 2004).

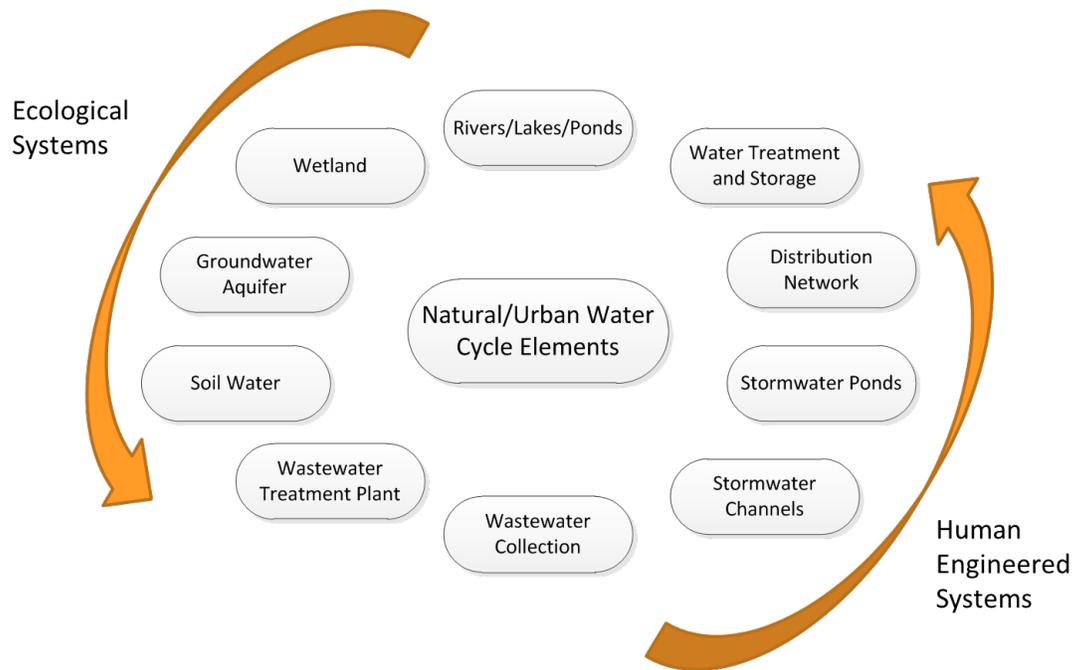


Figure 1: Urban Water System as a mix of human-engineered and natural systems

Many municipal water managers recognize the need to evolve their current approach to water management, but given the current regulatory framework in Ontario and the many competing priorities it can be difficult to chart a course. Particularly at this point in history when there is a large infusion of federal funding for infrastructure improvements to address the derelict infrastructure, it is critical to ensure investments are supporting next generation water management approaches (Maas 2017).

There exist multiple frameworks outlining the paradigm shift and steps to take, as well as tools related to climate change risk and vulnerability and decision-support for project evaluation considering uncertainty, social and environmental impacts. The objective of this research is to help municipalities assess where they are in terms of sustainable water management holistically, and what existing frameworks and tools are recommended as most appropriate to apply for continued progress. The intended audience is municipal water managers (operators, designers and planners) and agencies which support their management, completed with the support of a third-party. Three (3) case studies of Ontario municipalities to assess the utility of the diagnostic and toolbox, and make recommendations for future development and implementation.

Following the introduction, a Literature and Background Review which was used to inform the development of the diagnostic and toolkit is presented in **Section 2**, the Approach for the diagnostic and toolkit are presented in **Section 3**, Results and Discussion in testing and refining the diagnostic is presented in **Section 4**, and followed by Recommendations in **Section 5**, with Conclusions presented in **Section 6**. The diagnostic and toolkit template are presented in **Appendix A**, additional literature review is presented in **Appendix B**, and the completed diagnostic for the three case studies are presented in **Appendix C**.

2.0. Literature and Background Review

2.1. Drivers for the Evolution of Urban Water Management

In the Province of Ontario there are more than 440 municipalities, each with unique water management considerations depending on its water source, the city size, layout, location, and economic and recreational activities. There are a range of inter-related risks to urban water systems associated with climate change, population stressors, and aging infrastructure. Identifying risks and vulnerabilities is a key step in municipalities understanding how to begin to make management decisions and investments which are more in line with achieving sustainable, integrated water management for the benefit of the triple bottom line.

There is conclusive evidence that climate change is occurring and will continue to occur despite the success of global initiatives to reduce GHG emissions due to the fact that greenhouse gases have already accumulated in the atmosphere (Boyle, Cunningham and Dekens 2013) (Ligeti, Wieditz and Penney 2007). Climate has been gradually changing and over a historical 60 year period (1948-2008), in Ontario the average annual temperature has increased by 1.4°C (MOECC 2011). Predictive modelling and research carried out by climate scientists from a range of institutions suggest an intensification of the hydrologic cycle and the following trends for future climate in Ontario with the increase in global temperature:

- Warmer winters in the north and hotter summers in the south;
- An overall slight increase in average annual precipitation;
- Increase in frequency of intense rainfall;
- Increase in extreme events, such as drought, wind, heat waves, ice storms, and tornados;
- Reduced ice cover leading to accelerated evaporation and decline in lake levels and algal blooms in fresh water; and
- Increased variability in weather year to year.

(MOECC 2011) (GLSLCI 2012) (Chiotti, Tonto and Perun 2012) (TRCA 2009) (Simonovic and Peck 2009) (K. Jusek 2015)

Climate change will impact both water quantity and quality, as highlighted in the preceding list, and effects have already begun to be experienced across Ontario over the last decade, such as extreme weather leading to major flooding in Toronto (2005, 2011, and 2013) and lower lake levels and algal blooms in Lake Erie (MOECC 2011). In addition, it is becoming more frequent to deal with a series or simultaneous extreme weather events – extreme heat, flooding, power outage – which may affect an entire region which can put extreme strain the infrastructure and human operations of urban water systems and support networks (CVC 2016).

Aging infrastructure and population growth are compounded by the effects from climate change. Investments in infrastructure renewal have been lacking which has left today's and future water managers with the task of replacing a large slug of assets reaching their end of useful life. Challenges in infrastructure management are linked to limited information collected and maintained on the basic information of assets, condition, level of service with respect to main function as well as triple bottom

line impacts, and plans for regular upkeep and timely maintenance, and lack of budgeting to finance life-cycle infrastructure management and integration into long-term planning.

Urban growth changes the nature of the hydrologic cycle, reducing impervious area, increasing temperature of runoff, permanent changes to the landscape which alters flow peak and duration to waterways, buffer zones and riparian areas, not to mention wildlife habitats such as forests and wetlands, recreational greenspace and agricultural land (Maksimovic, Kurian and Ardakanian 2015). In addition, expanding populations require more water and lead to an increased concentration of wastes and emerging contaminants. According the Statistics Canada, almost 90% of Canada’s population growth has been located in metropolitan areas and by 2011 only 18.9% of Canadians lived in a rural area (CVC 2016) (Statistics Canada 2017). Cities and their urban water systems are especially vulnerable to the impacts of climate change because of the loss of natural features which would buffer some of the hydrologic impacts and the concentration of populations which are dependent upon the built environment (Ligeti, Wieditz and Penney 2007) (K. Jusek 2015).

These impacts from climate change, aging infrastructure, and population growth are felt across the urban water cycle – including in drinking water source and treatment, water distribution, wastewater collection and treatment, stormwater collection and treatment, natural waterways and landscape, and new technology and innovation. For more details on how each of these areas are impacted, refer to **Appendix B**.

2.2. Key Elements of Sustainable, Integrated Water Management

A number of more holistic and integrative concepts and paradigms for water management and service delivery have been developed over the past several decades in light of increasing complexities in water management and to bridge the gaps in conventional, siloed approaches. These paradigms are put into practice as frameworks. Frameworks are a conceptual structure used to apply a systematic approach to address complex challenges (Conservation Ontario 2010). The use of frameworks supports a systems thinking approach. A systematic approach is suitable for addressing complex problems, such as sustainable water management. Through taking a high-level view, an integrated approach can be developed which leverages key connections and allows decision-makers to take advantage of co-benefits and better mitigate or anticipate unintended consequences (ESCAP Publication Team 2017).

As shown in Table 1, there are a number of paradigms which support integrated, holistic water management – they are generally complementary and/or overlapping and the differences tend to be related to the scale or location they are applied.

Table 1: Summary of Dominant Sustainable, Integrated Water Management Paradigms

Paradigm/Concept	Brief Description
Integrated Water Resources Management (IWRM)	Integrated water resources management (IWRM) is an ecosystem-based approach that highlights the watershed as the management unit, upstream-downstream and groundwater-surface water interactions, interconnections of water with other natural resources and the environment, three pillars of sustainability (environmental, social, economic), and stakeholder engagement

Paradigm/Concept	Brief Description
	in the planning process (Mitchell, Priddle, et al. 2014). IWRM has emerged in light of the increasing complexity, uncertainty, and conflict in water management that conventional approaches were no longer able to adequately address (FitzGibbon and Plummer 2004) (CCME 2016).
Multi-Use Water Services (MUS)	The MUS management perspective is a holistic approach to “planning and management of the urban environment as it maximizes ecosystem services, minimizes environmental footprint and increases cities’ adaptive capacity to changing climate, demographic and socio-economic conditions” (Maksimovic, Kurian and Ardakanian 2015). By assessing the “blue” and “green” services in the urban environment – such as flood protection, water supply, recreational water, climate regulation, woodlands – and recognizing the multiple benefits and services which those functions can perform, more efficient, livable and adaptive communities can be achieved (Maksimovic, Kurian and Ardakanian 2015).
One Water	A One Water approach considers the water cycle as an integrated system, recognizing the interconnectedness of surface water and groundwater supply, stormwater, wastewater, and energy and seeks to mimic the natural hydrologic cycle with the watershed. It allows municipal water managers and cities to better coordinate development of land and water resources in a manner which optimizes return for public health, the economy, and the environment (CVC 2016). This approach can also be applied at different scales (regional, city, or utility level). The implementation of One Water following the framework aims to build on aspects already covered by municipal plans, such as drinking water supply reliability, climate change adaptation, green infrastructure, and wastewater infrastructure resilience. This approach is becoming more population among municipalities over the past decade (CVC 2016) (Brown & Caldwell 2017).
Water Security	Water Security is considered an emerging concept compared to the more well-established holistic water paradigms. Water security is defined as “the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies” (Grey and Sadoff 2007). Water Security can be broadened to include different elements of water in society, including national, household, economic, urban, environmental, and resilience to water-related disaster (Asian Development Bank 2016). Taking a water security perspective helps decision-makers to see connections between human actions which impact the environment, such as pollution of waterways and land use changes, and broader environmental limitations, and create a basis for holistic water management. It also highlights the role of governance in water management. (Global Water Partnership 2012) (Dunn and Bakker 2009).

Paradigm/Concept	Brief Description
Total Water Management (TWM)	TWM is a framework of principles and practices of sustainable water resources management for all water services developed by the American Water Works Association (AWWA). It highlights the need to work together with different actors to balance business and environmental objectives, and work within the democratic political system with the rule of law and mixed public and private economic system. Common elements of this integrated planning approach include water conservation measures to control the growth in demand, and the diversification of supplies to reduce supply risks (Grigg 2008). Key principles include balances competing uses through efficient allocation by planning and managing dynamically; adapting to changing conditions and local and regional variations; and use of coordination and conflict resolution to reach decision, with participation of all units of government and stakeholders (Grigg 2008).

In general, when a municipality has made an intention to move forward on a sustainable path, it is useful to have an overarching framework as a foundation on which to provide ongoing structure and guidance (Welch 2010). As each municipality has different needs, capacity, and are at different stages in terms of implementing measures aimed at sustainable, integrated water management, not all municipalities may choose to follow the same approach – there are multiple pathways to achieve the same goal. Literature from all contexts emphasizes that holistic water management is not a prescriptive, one-size-fits-all model. Instead, these various paradigms focusing on integration provide a framework to assess the context – local resources, needs, and capacities – and reframe the community’s relationship with water and other resources to identify opportunities for multiple benefits (van Koppen, Moriarty and Boelee 2006) (Maksimovic, Kurian and Ardakanian 2015).

Once a framework is selected, its principles and structure can act as a touch point when uncertainty arises, and a range of more specific tools can be employed for more detailed decision-making and activities. For example, the IWRM as an overarching set of principles, and use of Triple Bottom Line when making specific decisions (Welch 2010).

Regardless of the paradigm or overarching framework selected, from reviewing a range of resources a number of recurring themes and key concepts emerged. A number of key concepts were also identified that have become ubiquitous in conversations around sustainable water management and recur in the range of popular holistic water management paradigms presented. The key aspects of the reviewed paradigms and their implementation frameworks include:

- Watershed scale basis and/or connection
- Visioning and strategic planning
- Identifying information and information gaps
- Defining scope, boundaries, and level/extent of integration and therefore key players
- Active stakeholder engagement and communication of results
- Integrating uncertainty into planning and decision-making process

- Iterative, stepwise, phased/staged, incremental steps
- Monitoring and evaluation – including new metrics not currently being monitored or measured
- Balance between providing direction and not being too general and not being overly prescriptive
- Flexibility to be applied at different scales, and will result in different outcomes depending on the needs/context
- Key concepts and principles:
 - Risk Management
 - Resilience
 - Adaptive Management
 - Precautionary Principle
 - Integration
 - Sustainability
 - Cumulative Effects
 - Scale of Governance

The considerable overlap in key themes and key concepts highlights that regardless of the framework selected to suit the municipalities particular context, culture, or challenges, that as long as key components are incorporated it will advance the system on the pathway towards sustainability. A description of each of the key concepts is provided in **Appendix B**.

2.3. Evolution of Water Management and Spectrum of Sustainability

This section provides an overview of the spectrum for sustainable water management based on a review of literature and some of the practices which characterize different states of urban water management. To understand the present and where water management is headed, it is best to review the context of the past and what lead to the current approach to water management, from which we are in transition to a more holistic, ecological-based approach to water management. Figure 2 highlights a spectrum of approaches to water management. Other spectrums reviewed which reflect the same principles include 1) Grey Infrastructure Approach, 2) Grey-Green Infrastructure Approach, and 3) One Water Approach, which highlights the different stages of advancing on a sustainability spectrum through the stormwater management lens (CVCa 2016).

Urban Water Transition Phases

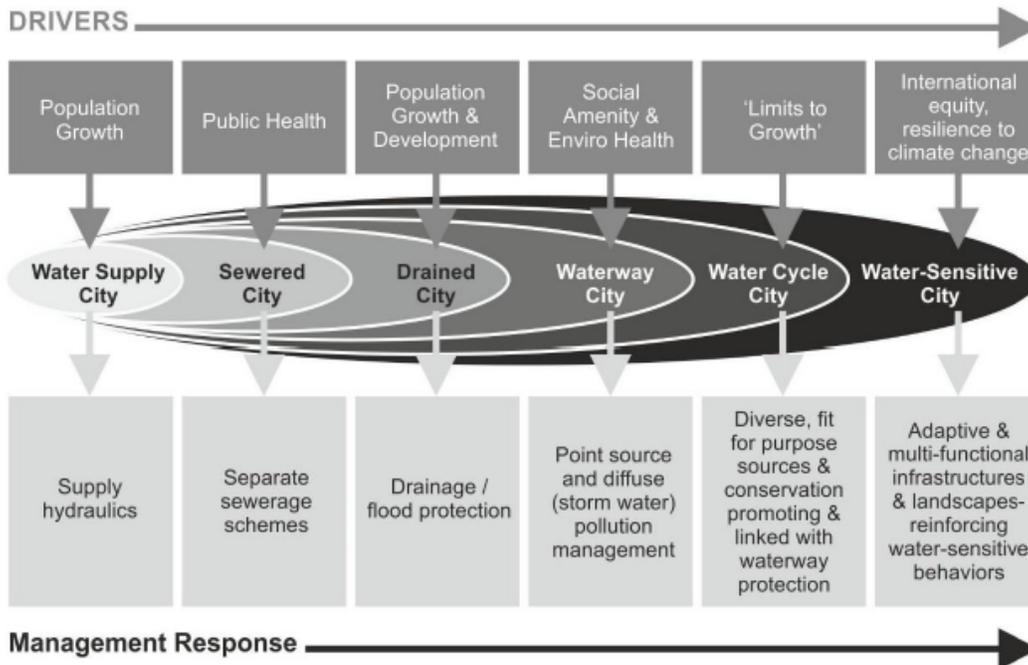


Figure 2: Urban Water Management Stages Based on Drivers (Global Water Partnership 2012)

In Ontario, over the past century there has been an increasing integration of land-use considerations, and watershed management into urban water management. This resulted in a transition from a ‘Water Supply’ through to a ‘Drained City’ for the majority of municipalities in Ontario. Further, water management has continued to evolve in reaction to growing awareness of our impacts on the natural environment (CCME 2016). In Ontario, the conventional approach to urban water management still dominates municipal water management, although there are some cities which have continued to progress along the scale and feature characteristics of ‘Waterway’ and ‘Water Sensitive’ cities¹.

In transitioning along the spectrum for water management, the priority of pollution control, limits to growth, climate change adaptation, and long-term sustainable development, new approaches are needed. This includes more decentralized and semi-centralized systems – water systems which serve a smaller, localized population. Satellite wastewater treatment facilities can address servicing to new subdivisions or business parks and provide a local source of recycled water for a range of designated uses (Gikas and Tchobanoglous 2009) (K. Jusek 2016). Decentralized approaches also include the use of green infrastructure over traditional grey infrastructure for both conveyance and treatment of storm and wastewaters (Wang, et al. 2006). These arrangements result in enhanced citizen engagement with

¹ Note, this report is focused on Ontario municipalities, which does not include First Nation communities. Water management in many First Nations falls under a different jurisdiction than neighbouring municipalities, and conditions are generally much poorer, resulting in more limited access to basic drinking water and sanitation services (Phare 2009).

water management as individuals play a more active role in utilizing different water sources for different uses and maintaining individual systems. Overall less energy is required to treat and move water around the urban area since water of lower qualities and potentially nutrients are re-used locally, since source separation is more feasible at this scale (Libralato, Ghirardini and Avezzù 2012). There is more flexibility in supplying successive population growth, versus attempting to meet all urban expansion with the same centralized sources (Libralato, Ghirardini and Avezzù 2012) (Krebs 2016).

In transitioning along the spectrum to a 'One Water Approach' or 'Water-Sensitive City', shifts in policy and management perspectives include:

- Sectoral to integrated management
- Top down to stakeholder and demand responsive change
- Supply fix to demand management
- Command and control to more cooperative or distributive forms of governance
- Closed, expert-driven management organizations to more open, transparent and communicative bodies

(Conservation Ontario 2010)

Table 2 outlines for different aspects of the urban water cycle aspects what this looks like in practice. This was compiled from a range of sources which describe a transition from current to more progressive management practices.

Table 2: Key Differences between Conventional and Integrated Approaches to Urban Water Management (Mukheibir, Howe and Gallet 2014)

Aspect of urban water management	Conventional approach	Integrated approach
Overall approach	Integration is by accident. Water supply, wastewater and stormwater may be managed in the same agency as a matter of historical happenstance, but physically the three systems are separated	Physical and institutional integration is by design. Linkages are made between water supply, wastewater and stormwater, as well as other areas of urban development, through highly coordinated management
Collaboration with stakeholders	Collaboration = public relations. Other agencies and the public are approached when approval of a pre-chosen solution is required.	Collaboration = engagement Other agencies and the public search together for effective solutions
Choice of infrastructure	Infrastructure is made of concrete, metal or plastic	Infrastructure can also be green including soils, vegetation and other natural systems
Management of stormwater	Stormwater is a constant that is conveyed away from urban areas as rapidly as possible	Stormwater is a resource that can be harvested for water supply and retained to support aquifers, waterways and biodiversity
Management of human waste	Human waste is collected, treated and disposed of to the environment	Human waste is a resource and can be used productively for energy generation and nutrient recycling
Management of water demand	Increased water demand is met through investment in new supply sources and infrastructure	Options to reduce demand, harvest rainwater and reclaim wastewater are given priority over other sources
Choice of technological solutions	Complexity is neglected and standard engineering solutions are employed to individual components of the water cycle	Diverse solutions (technological and ecological) and new management strategies are explored that encourage coordinated decisions between water management, urban design and landscape architecture
Based on Pinkham (1999) – adapted by ICLEI (2011)		

These concepts and paradigm shifts while ideologically harmonious, are not without challenges in implementation. Review of challenges to new approaches was essential for identifying existing tools which can help with the transition. Genres of tools needed include those that can help with governance integration, financial and management arrangements, new valuation methods for water services. More detailed discussion of barriers is provided in **Appendix B**.

2.4. Metrics for Evaluating Sustainability

In order to evaluate sustainable, integrated water management, a set of indicators are required. Indicators and metrics can help decision-makers and water managers by providing feedback on status against an established scale, such as a river water quality single-value indicator measured by laboratory analysis that can provide information on suitability for drinking water (Global Water Partnership 2012).

When used in this sense, quantitative, measurable indicators are common in the water industry and are well integrated into permitting and daily operations. However, when considering broader objectives relating to sustainability and measuring more abstract or indirect impacts of a given action, developing adequate indicators can be a challenge. Indicators in this case will help inform on the progress of a process towards a goal and may require new information to be monitored and analyzed (Global Water Partnership 2012). Examples of categories of indicators which can be applied are those that are *qualitative* – cannot be presented as numbers, *leading* – indicators which predict the outcomes of a process, and *directional* – indicators specify whether or not a condition is improving (Global Water Partnership 2012).

The Pressure-State-Response model, developed by the OECD (1997), is another common approach to developing environmental or sustainability indicators, meaning that they “focus on trends in the environment, the stresses that impact the ecosystem, the response of ecosystem change and societal actions to prevent or reduce stress” (Bond et al. 2005a, 6 in (Dunn and Bakker 2009). This has been consolidated into the DPSIR method: “a chain of causal links starting with ‘driving forces’ (economic sectors, human activities) through ‘pressures’ (emissions, waste) to ‘states’ (physical, chemical and biological) and ‘impacts’ on ecosystems, human health and functions, eventually leading to political ‘responses’ (prioritization, target setting, indicators)”. The framework is useful for providing a structure to determine the indicators needed to enable feedback to decision makers on various policies and their impacts (Kristensen 2004).

Defining the scale or scope of the area under evaluation for sustainable, integrated urban water management is an important consideration in the context of the Pressure-State-Response model, as for example, cause-effect relationship difficult to discern at areas greater than 2500 km² (Global Water Partnership 2012). In addition to the scale, it is important to contextualize the timeframe for analysis of indicators. For example, agricultural best practices to manage nutrients may take decades before benefits are seen, compared to management practices which can be implemented and changes observed over a much shorter timeframe (Van Meter and Basu 2017).

The key characteristics of good indicators include: easy to access; easy to understand; timely and relevant; reliable and consistent; credible, transparent, and accurate; developed with the end user in mind (Dunn and Bakker 2009). Additionally, typically what is measured and reported on is something that is within the control of the water managers to affect change on, and defined in ways that are understandable, meaningful and measurable (Global Water Partnership 2012).

The weighting of a number of indicators to assign a total score which can be compared to a scale is a key consideration for the development of metrics. There are arguments for equal weighting of indicators (approximately 12-15) since the relative importance of each indicator to sustainable, integrated water management is not necessarily known and complex formulas can potentially obscure the results. Alternatively, a dashboard approach to a set of indicators was highlighted as useful and is one way to avoid a weighting a set of indicators, in that the decision-maker or water manager learns over time how to assign relative weights given a changing set of conditions. The dashboard approach describes information that is compiled to be as simple as possible, avoids redundancy by eliminating highly

correlated variables, and keeps the number of indicators or ‘gauges’ on the dashboard to a minimum (Global Water Partnership 2012).

Validation of indicators to test their robustness before broadly disseminated is recommended. This can be done by using a sensitivity analysis by applying to a range of case studies, ideally using well-known case studies. This will help evaluate the performance, relevance, and accuracy of the indicators in describing the study area (Global Water Partnership 2012).

The implementation of the indicators may need to be interpreted by expert staff prior to being delivered to decision-makers, or can be designed to be carried out in a self-assessment format. For example on the former, politicians/decision-makers who invested in non-point pollution prevention for nutrient management will need to have a good understanding of the indicators which can inform of success or failure of an intervention. If data is taken out of proper context, it can lead to faulty conclusions about the efficacy of a policy or program, and possibly misinform future and decision-making. There are also several examples of self-assessment based on an index or set of indicators as it related to sustainable water management locally. The Federation of Canadian Municipalities (FCM) makes use of self-evaluation such as the “asset management readiness scale” to be eligible for funding. It provides a common method for assessing progress or level of adoption across diverse municipalities. The results of the completing the exercise of a readiness scale are to help assess the current state against a progressive scale, in order to optimize where to invest resources and effort (FMCa 2017).

2.5. Policy Context in Ontario for Water Management

This section will review the policy context and regulatory framework for municipal water management in Ontario to highlight the constraints and opportunities for municipalities to advance towards more sustainable, integrated water management. Municipal water management choices are made to meet various water needs such as protect public health, and the environment. The choices are made by key-decision makers in municipal government influenced by the regulatory framework - rules, regulations, best practices, institutional factors, incentives, etc. (Grigg 2008). There is no explicit regulation requiring municipalities to holistically plan and enact sustainable, integrated water management. Since this approach to water management crosses over traditional water sectors, the current organization of provincial government bodies would not lend itself well to an overarching, top-down approach to sustainable, integrated water management. In addition, it is ultimately the municipality that is responsible for maintaining safe and reliable urban environment in its provision and handling of water in its jurisdictional boundaries.

A review of the existing water management regulatory framework in Ontario is necessary context to determine what progress is associated with meeting requirements of regulations and what progress is necessary for the municipality to drive from a grass roots level – and therefore additional support and guidance is required. Table 3 provides a summary of the aspects of the regulatory framework which shape water management in Ontario and how they support or limit sustainable, integrated urban water management. Detailed discussion on these aspects are included in **Appendix B**.

Table 3: Aspects of the Ontario Regulatory Framework Influencing Sustainable Water Management

Aspect of the Regulatory Framework	Summary of Influence of Sustainable Water Management
Municipal	
Municipal Water Management	<p>Water and wastewater systems in Ontario are owned and primarily managed by the municipality, both single, upper and lower tiers (CVCa 2016). Various provincial legislation, such as the <i>Municipal Act</i> and the <i>Ontario Water Resources Act (OWRA)</i>, have given municipalities the authority to design, build, finance, own, and operate water, wastewater, and stormwater systems (OSWCA 2001). In cases where there are multiple tier local governments, responsibilities are delineated. Municipalities also can enact local by-laws to effectively manage their water systems through pollution prevention programs, sewer-use bylaws, and encourage beneficial behaviours, such as conservation and efficiency. Through the Official Plan, land use management is undertaken by the municipality. Long-term planning and ongoing investment are required to ensure long-term sustainability and meeting service requirements. Innovation is more limited due to the risks to public health, although risk of inaction to adapt to address new threats is also a reality (e.g. lawsuits due to negligence to maintain stormwater systems) (CVCa 2016). Municipal water management involves meeting provincial regulations as well as filling in the gaps with local programs and policies to address local concerns.</p>
Provincial	
Provincial Policy Statement (PPS)	<p>The PPS is administered under the under the Planning Act (1990) by the Ministry Municipal Affairs and Housing. It is the main mechanism in which the province influences planning as all single tier and regional level municipal Official Plans must be consistent with the objectives in the PPS (Summers, Plummer and FitzGibbon 2003) (Hanna, Webber and Slocombe 2007) (Binstock 2010). The 2014 PPS includes progressive measures relating to water conservation and use efficiency, consideration for hazards associated with climate change, optimization of existing infrastructure, promotion of green infrastructure, and that watershed as a meaningful scale for integrated and long-term planning.</p>
Growth Plan for the Greater Golden Horseshoe (GGH), 2006	<p>This is a comprehensive land-use planning policy for the GGH Region of Southern Ontario and designates communities for growth over the next 20 years. This plan has forced communities to strategically plan for water supply and management of growth (intensification of built-up areas versus green-field development) to accommodate ambitious growth targets, and provided justification for more innovative and progressive approaches to water management (conservation and efficiency, protection of natural heritage, water reuse planning) (Binstock 2010) (Jusek and McDermott 2015).</p>
Ontario Water Opportunities and Conservation Act (WOA), 2010	<p>The objectives of the WOA are to create opportunities for innovative water technologies and the development of the clean-tech sector in Ontario (through the organization WaterTAP), forms the framework for the province to set conservation targets and Sustainability Plans for municipalities. WaterTAP has been successfully implemented, and the Act has provided the platform for other Ontario water agencies to pilot, test, and demonstrate innovative</p>

	approaches (MOECCd 2017). Sustainability Plans – which included a focus on asset management, financial plans, conservation plans, risk assessment, and long-term planning – is unlikely to come into effect (ECOa 2017). It is noted that the WOA has a provision for Ontario Building Code (OBC) for the Minister of the Environment to review the OBC standards for water conservation every five years (Abouchar and Vince 2011).
Safe Drinking Water Act (SDWA), 2002	Under the MOECC, O. Reg 170/03 under the SDWA provides the framework for the provision of safe, sustainable drinking water through a multi-barrier approach and makes the owner, the municipality, responsible for meeting the regulation. The province must approve and issue permits (DWWPs) and licenses (MDWL) for drinking water systems for municipalities, in addition to a drinking water quality management system (DWQMS) which includes an approved Operational Plan, accredited Operating Authority, Financial Plan (O.Reg. 453/07) and Permit to take Water (PTTW) (Abouchar and Vince 2011). It is noted Financial Plans vary significantly in their robustness, and do not necessarily feature fully cost recovery (a target under two pieces of legislation that never came into effect: Sustainable Water and Sewage Systems Act, 2002 (SWSSA) and WOA, 2010 Sustainability Plans).
Clean Water Act (CWA), 2006	The CWA resulted in the development of extensive source water protection (SWP) and was the result of the emphasis on the multi-barrier approach to drinking water which was promoted since the E. coli outbreak in Walkerton Ontario in 2000. The landmark achievement of this newest watershed management initiative is the increased integration into land-use planning, since under the Clean Water Act, Official Plans must be consistent with approved source protection plans (Plummer, de Grosbois, et al. 2011). The noted limitation is the elevation of drinking water above other water services of the watershed (Mitchell, Priddle, et al. 2014, Conservation Ontario 2010).
Ontario Water Resources Act (OWRA), 1990	The OWRA has broader focus on provisions for impacts on environmental water quality and quantity. For the municipal water manager this translates to permits for water takings (Section 34) and environmental compliance approvals (ECAs) for ‘sewage works’ which includes both wastewater and stormwater treatment systems and infrastructure (Section 53) (CVCa 2016). Recent provincial activities in this area has been revisiting rules around groundwater taking by water bottling companies, with a review of protecting groundwater considering climate change and future demands (MOECCd 2017). The OWRA sets the stage for considerations for multiple users and impact on the environment.
MOECC Supportive Documents	Supportive documents which heavily influence design of infrastructure and local design guidelines include: <ul style="list-style-type: none"> • Stormwater Management Planning and Design Manuel (2003) • Design Guidelines for Drinking-Water Systems (2008) • Design Guidelines for Sewage Works (2008) • the “Blue Book”, Water Management: Policies, Guidelines, Provincial Water Quality Objectives (1994) • Water and Energy Conservation Guidance Manual for Sewage Works (2011)
Nutrient Management Act, 2002	This is a critical piece of the provincial regulatory framework administered through the MOECC to highlight for its role in the urban water cycle – as nutrients covered under this act include sewage biosolids (non-agricultural source

	materials (NASM)). O. Reg. 267 under this Act includes the management, land application and storage of agricultural source materials (ASM), including manure, and NASM applied to agricultural lands as a nutrient to improve crops. Proper nutrient management is part of a multi-barrier approach to safe drinking water, but also has implications for the natural environment and impact on downstream waters (MOECCb 2016).
Asset Management Guidance and Upcoming Regulation	Asset Management Plans are intended to help extend the life of existing infrastructure assets, allow for regular re-investments to ensure optimal functioning of water systems, and inform decisions on capital planning and budgeting to optimize investments. There is an asset management planning guide provided by the Ontario Ministry of Infrastructure, <i>Building Together: A Guide for Municipal Asset Management (2012)</i> , and upcoming legislation under development which will regulate Asset Management Plans (AM Plans), under the Infrastructure for Jobs and Prosperity Act, 2015 (ECOa 2017) (MOIa 2017). As a result of these efforts and the provincial government requiring an asset management plan to obtain funding, the majority of Ontario municipalities have asset management plans, and it is anticipated the new regulation will bring more consistency to them (ECOa 2017) (MOIa 2017). Climate change and sustainability considerations are inherent but not clear how they will be incorporated.
Environmental Assessment Act, 1990	Most municipal infrastructure projects related to water, wastewater, stormwater (in addition to roads and transit) individual projects and master plans are carried out under the municipal class environmental assessment (Class EA) process. The Class EA process features some elements of integration with formalized public consultation and the municipality can choose to exceed the minimum requirements. The screening criteria laid out in the EA also reflects a more balanced approach by requiring each alternative be evaluated based on social, environmental, and economic metrics (MEA 2011) (Shrubsole 2004). The Class EA process is a natural mechanism to integrate considerations for climate change and integration of different urban waters and watershed planning. With the legal framework established through the EA Act, the public are still responsible for participating and demanding sustainable solutions. The municipality has a role to play in educating the public on the full implications of different options and demonstrate why the lowest cost option is not always preferred.
Green Energy Act, 2009	The Green Energy Act under the Ontario Ministry of Energy has legislation for public agency reporting energy use and plans for conservation. O. Reg. 397/11, Energy Conservation and Demand Management Plans, requires municipalities report annually and publish on their websites their energy use and greenhouse gas emissions. As of 2014 municipalities have been required to develop a 5-year conservation plan, to be updated every 5 years starting in 2019 (Ontario Ministry of Energy 2017). The benefits of this benchmarking exercise with respect to sustainable, integrated water management is to highlight opportunities for energy reduction through water efficiency and alternate processes and technologies, since water and wastewater services make up a significant portion of municipal energy demand (ECO 2017).
Ontario Building Code, 1992	The Ontario Building Code (OBC) provides important context for the ease of implementation of innovative water management techniques, such as water reuse systems, and water conservation and efficiency. For example,

	municipal by-laws can be over-ridden by the OBC, therefore it can act as a real constraint to advancing aspects of sustainable water management (York Region 2016).
Watershed	
Conservation Authorities (CA)	CA's were established in 1946 and under the Conservation Act (1990), today the majority of municipalities in Ontario are within the jurisdiction of one or more of these watershed authorities. The CA responsibilities are diverse and include protection of water resources both quantity and quality, conducting and supporting watershed studies, and programs to protect life and property from natural hazards such as flooding and erosion (Mitchell, Priddle, et al. 2014). Building on the watershed planning experience, CA's are playing a key role in source water protection planning outlined in the CWA (MNRF 2015). CAs' work with municipal water managers, the province and other stakeholders in support of an integrated approach to water management across the watershed beyond the boundaries of the urban water system (Mitchell, Priddle, et al. 2014)The aim of watershed planning is to characterize major environmental features and functions in order to improve and maintain environmental health. Strategies related to management include cumulative effects, increasing natural cover, environmental stressors, and on a smaller scale to determine servicing needs and development constraints (CVCa 2016). Funding and sufficient authority and jurisdictional challenges has been an ongoing challenge to the successful practice of IWM by CAs. There is currently a review of the CA Act which may impact this.
Federal	
Federal Policies and Influence	The federal government influences municipal water management through providing some guidelines on water quality standards, broad incorporation of international agreements such as climate change commitments (Paris Agreement on Climate Change and the United Nations Sustainable Development Goals, incorporated under the Sustainable Development Act), international agreements relating to the Great Lakes, water management under federal jurisdiction including fisheries, First Nation Reserves, and navigation, and through the criteria on federal funding for infrastructure. (Government of Canada 2017) (MOECC 2017) (ECO 2017). The federal government influences the priorities and environment for decision making in Ontario but ultimately the provincial government historically has been the main authority of water management decisions affecting municipal water management. The federal government could potentially have more influence through funding tools by setting criteria to obtain grants that reflect forward-looking priorities – such as net zero energy for WWTPs, innovative technologies, climate change resilience, and/or sustainability metrics (e.g. EVISION, LEED) (OCWA 2016).
Other	
Not-for-Profits, Industry Associations, etc.	These organizations fill a number of niches to advance and support the sector – through creating networks to support knowledge sharing, resources to support implementation of best practices, and funds and support to pilot innovative approaches. Some key organizations include the Canadian Water Network, WaterTAP, Ontario Clean Water Agency, Council of Canadian Ministers of the Environment, Ontario Water Works Association, Great Lakes St. Lawrence Cities Initiative, etc.

3.0. Approach

The following sections provide an overview of justification for developing a diagnostic and toolkit, the methodology for developing and refining the diagnostic and toolkit, and an overview of the key characteristics of the diagnostic and toolkit. A template of the Diagnostic and Toolkit is provided in **Appendix A**.

3.1. Justification for Developing a Screening Level Assessment and Toolkit

There are many competing objectives and many different tools and frameworks available to support a range of sustainability related objectives for municipal water management – those mandated as part of regulation and those that are not. The tools that are not mandated exist because there is a gap between what is required and what is generally accepted to be the direction of water management that will result in more secure, reliable, and resilient systems, will be cost-effective, and lead to thriving urban spaces and surrounding environments. The default settings for municipal water management in Ontario (following only regulations, not going above and beyond in terms of collaborations or extra considerations) will not lead likely to a future-looking, evolved water system. That is not to say within the existing regulatory framework it is not possible, it just will take more initiative, vision, and effort.

This approach of assessing at a high-level where a municipality is on a sustainability spectrum can help to identify the most applicable overarching framework to apply and specific tools to help move in the right direction. Becoming more integrated and sustainable is a process. Finding ways to change behaviours, shift culture, and incorporate new information and considerations into planning and infrastructure decisions, will help move in that direction. A guiding framework can act as a touch point as more detailed processes as tools are applied, data collected, etc. The diagnostic could be revisited in the future to re-evaluate status and identify next steps, or the implementation of an overarching framework could be used as the future touch-point for providing direction. Refer to Figure 4 for a visual representation of this interaction between tools and frameworks.

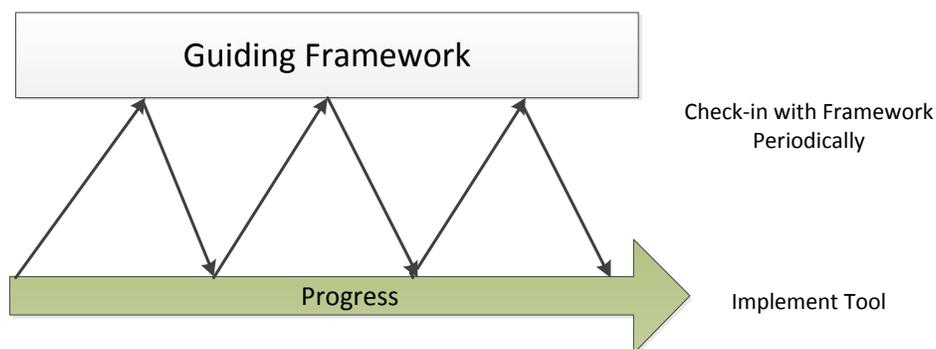


Figure 4: Visual representation of interaction between tools and frameworks to support holistic water management

3.2. Methodology for Development of Diagnostic and Toolkit

A broad-based literature review of progressive water management trends locally and globally was completed to inform the need for and development of the diagnostic. A literature review was also

completed to contextualize the Ontario water management regulatory framework to create a customized spectrum upon which to measure progress. For example, certain progressive elements of sustainability frameworks, such as a multi-barrier approach to drinking water on a watershed basis, are part of Ontario legislation through the Source Protection Planning under the Clean Water Act (2006). Additionally, while protecting public health is paramount, this diagnostic builds into the sustainability spectrum the baseline assumption that public health and adequate supply are being met due to the requirements of the regulatory framework. Further, it is assumed that each successive progression on the sustainability spectrum builds on previous accomplishments. For example, as new practices such as water reuse and green infrastructure are introduced, protection of public health and safety will continue to be kept at the forefront of regulatory development as they are in leading jurisdictions.

Building the sustainability spectrum within the Ontario regulatory context allowed for the identification of platforms and gaps which a municipal water manager can work within and build on existing tools. The toolkit was compiled through the international water management literature and Ontario policy context review. The toolkit does not represent an exhaustive list, but includes reputable frameworks and tools utilized in similar contexts and those specifically catered to the Ontario and Canada context. Inclusion of tools and frameworks at this stage should not be seen as full endorsement of tools, they are those that upon review have merit to certain applications and scenarios, to be determined on a case-by-case basis.

Once drafted, the diagnostic was refined through trialing successive municipal examples based on publicly available information, including plans, policies, and news stories. This allowed for the opportunity to test the robustness and applicability on a range of different conditions, to ensure the results reflect what is expected and characteristics are grouped adequately, and duplication is limited. Discussion of the insights gained from trialing municipal case studies through the diagnostic are discussed in more detail in Section 4: Results and Discussion and Section 5: Recommendations.

3.3. Overview of Diagnostic and Toolbox

The implementation of the diagnostic/toolbox has three stages: 1) High level characterization, 2) Sustainable, Integrated Water Management Diagnostic, 3) Review of status and recommendation of framework and tool. Figure 5 provides an overview of how the process is recommended to be carried out.

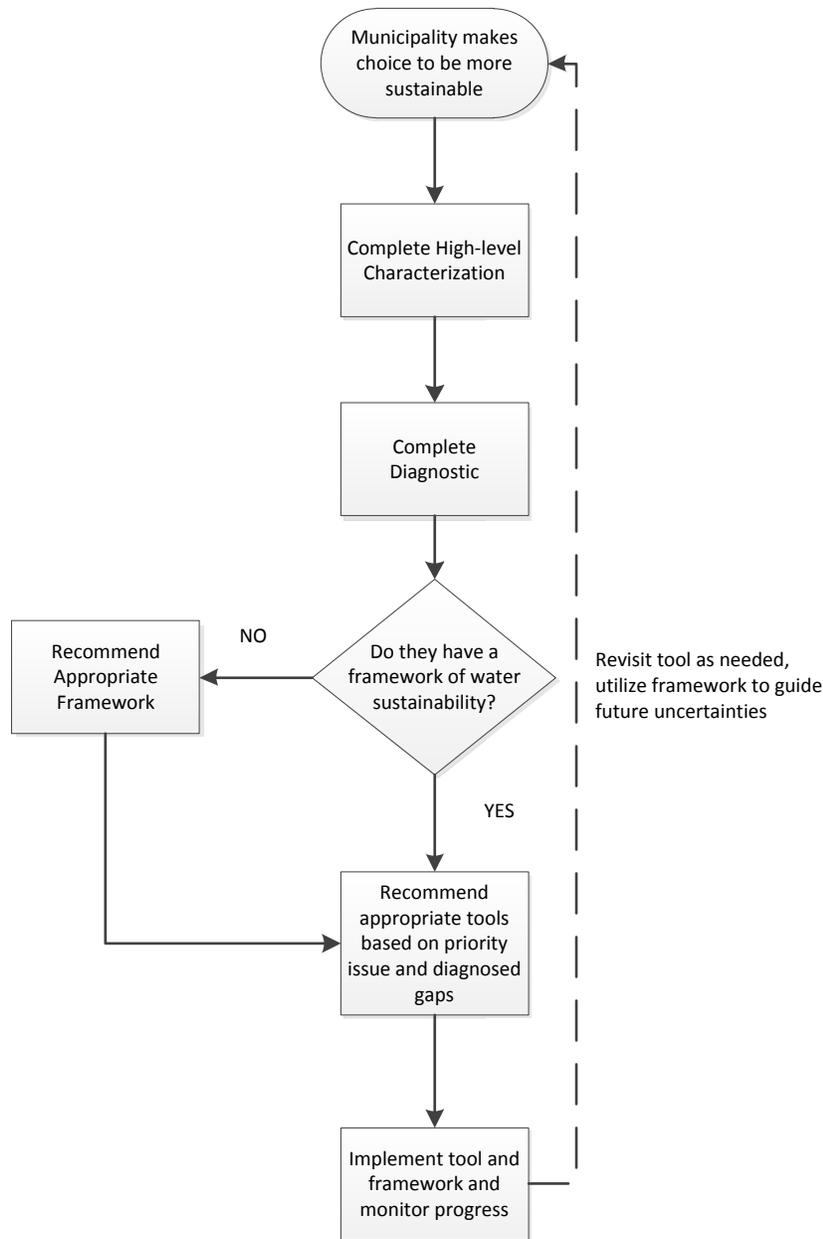


Figure 5: Decision Tree for Completing the Diagnostic

First, the high-level characterization includes basic scoping of the municipality, key motivators for sustainability/innovative approaches (flooding, sustainable supply, etc.), and basic characteristics (including tier, population, etc.). It is noted that since this is a tool for municipal water managers, the diagnostic is focused on the urban boundaries for sustainable water management as this is their scope of influence. Since it is broadly accepted that the watershed is the most appropriate scale for sustainable water management, the tool attempts to highlight the opportunities for connections across jurisdictional boundaries. This stage helps provide context for the interpretation of the results of the screening assessment and in the selection of tools and frameworks which match the priority issue area of a given municipality.

After the high-level characterization, the diagnostic is organized as a matrix of ‘categories’ against the ‘sustainability spectrum’ for each category. The categories and sub-groupings span traditional water management services areas such as drinking water and wastewater and stormwater, but also include land use, natural waterways, governance characteristics, etc. The categories and subcategories are presented in Table 4. The ‘sustainability spectrum’ consists of evaluative questions for one of three stages for each category. The first ranking is considered the baseline conditions for Ontario municipalities, the second is beyond the baseline, and the third represents a more sustainable, integrated approach. Each category has a set of evaluative questions or outcomes under each of the three levels of the spectrum. These serve as descriptors and indicators of what it means to be at that level. Due to the high-level nature of this assessment process, the indicators assess actions, plans and strategies, and qualitative assessments of current status, rather than directly measuring outcomes – such as water quality parameters, water quantity, and ecosystem health metrics.

Table 4: Categories and Sub-categories for Diagnostic

Category	Subcategory
Water Supply and Distribution	Water Source, Water Supply Planning Approach, Conservation and Efficiency, Water Distribution
Wastewater Collection and Treatment	Handling of Wastewater Treatment, Wastewater Planning Approach, Wastewater Collection
Stormwater Management	Stormwater Management Approach, Stormwater Collection Infrastructure
Natural Urban Water (surface)	Management Approach
Landscape	Land Use Management Approach
General Planning Approach	Planning Approach
Governance	Culture supportive of innovative approaches and/or sustainability in policies, Corporate leadership on sustainability, Institutional Roles and Organizational Structure/ Administration of Services
Public Engagement	Utility outreach, Public attitudes
Monitoring	Asset Management, Additional water quality monitoring
Infrastructure	Approach to Infrastructure
Financial Management	Financial Management
Climate Change	Approach to climate change, Energy supply

Finally, in analyzing the results of the diagnostic a review of the scoring and toolkit is completed. With 23 categories including subcategories, and a maximum score of between 1 and 3, the maximum score is 69. An equal weighting of each criteria is assigned as each subcategory was considered to be equally weighted when assessing the influence on sustainable, integrated water management. An analysis of the count of the occurrences of each different score assigned is also completed. When analyzing how a municipality scored, a visual review of the spread of the scoring on each category can provide insight to

the tools and frameworks which would best fill in the gaps in the current approach. The information from the high-level screening is also weighed in the review and factored into the key words input for the searchable toolkit. Appropriate frameworks and then tools are recommended, with justification for selections documented. Refer to **Appendix A** for a template of the Diagnostic and Toolkit.

4.0. Results and Discussion

4.1. Municipal Case Studies

4.1.1 City of Guelph

The City of Guelph is a single-tier municipality located in southwest Ontario and currently has a population of approximately 130,000 people, planned to grow to a total population of approximately 191,000 by 2041 (AECOM and Golder Associates Ltd. 2014). The City of Guelph is one of Canada's largest municipalities that rely on groundwater for its water supply. The City's wastewater discharges to a sensitive river, with limited and regulated assimilative capacity in the Grand River Watershed. Thus, both water conservation and high quality wastewater treatment are priorities in light of a growing population. A strong sense of environmental activism and community preference for sustainable, local supply options has also served as a driver for the City to consider wastewater reuse (da Silva, et al. 2017). The community also noted through the recent development of the Water Efficiency Strategy that innovation is a high priority when looking at water efficiency and conservation measures (C3 Water and Gauley Associates Ltd. 2016). Further, with recent years of drought, there is additional pressure to look to alternative sources of water for tasks such as lawn watering and irrigation. For continuous improvement, the Guelph City Council has made this a priority by setting a goal "to use less energy and water per capita than any comparable Canadian city" through its 2007 Strategic Plan and Community Energy Initiative (City of Guelph 2017).

4.1.2 York Region

The Regional Municipality of York (York Region) is located in the Greater Toronto Area (GTA). It is an upper tier municipality that has nine (9) lower tier or local municipalities including Georgina, East Gwillimbury, Newmarket, Aurora, Whitchurch-Stouffville, Richmond Hill, Markham, King and Vaughan. York is the wholesale provider of treated water and also collects and treats wastewater for lower-tier municipalities. It is one of the fastest growing areas in Canada with a current population of over 1 million, with an expected population increase to 1.79 million by 2031 (York Region 2011). The Region of York straddles two Great Lakes watershed divide – Lake Ontario to the south and Lake Huron (via Lake Simcoe) to the north and has unique features such as the Oak Ridges Moraine. As a result, York Region is subject to additional regulatory restrictions for growth and development including the Oak Ridges Moraine Conservation Act (2001), Greenbelt Act (2005) and Places to Grow Act (2005).

York Region does not have direct access to Lake Ontario and is supplied water through long-term agreements with the City of Toronto and the Region of Peel for the purchase of treated drinking water sourced from Lake Ontario (88%) with the remainder of water obtained from Lake Simcoe and regional groundwater wells (York Region 2016). For wastewater, the Region has a long-term agreement and shared infrastructure with Durham Region and Peel Region, as well as local wastewater treatment plants. Recent plans to upgrade the southeast collector for meeting growing flows from population

growth resulted in the MOECC requiring York Region to engage in conservation and efficiency planning. This led to the development of the target of no new water supplies by 2051 by leveraging innovative technology for wastewater reuse and water conservation, and the adoption of a One Water Approach to water and wastewater planning and management.

4.1.3 City of Kitchener

The City of Kitchener is located in southwest Ontario in the Grand River Watershed, with a current population of just under 250,000 people, projected to grow to over 300,000 by 2031 (City of Kitchener 2017). The City is a lower-tier municipality, serviced for water and wastewater by the Region of Waterloo. The Region supplies the City by surface water from the Grand River (25%) and local groundwater wells (75%) – serving an integrated urban system (IUS) interconnecting the City of Cambridge, City of Waterloo, and City of Kitchener, as well as some of the nearby townships (Stantec Consulting 2015). As a lower-tier, the City of Kitchener owns and operates local water, wastewater, and stormwater distribution/collection systems. The Region operates wastewater treatment, and the City of Kitchener wastewater is treated at the Kitchener WWTP, discharging to the Grand River. The City of Kitchener has a reputation for environmental leadership, with progressive plans and management in place regarding urban forestry, subwatershed planning, and stormwater management. The City of Kitchener was among the first Ontario municipalities to adopt a stormwater utility for a more direct funding source for stormwater management, completed an Integrated Stormwater Management Master Plan, and has conducted a number of subwatershed plans which guide local development in the Official Plan. The City also has a long-standing Strategic Plan for the Environment to complement the City’s broader Strategic Plan (City of Kitchener 2017).

4.2. Diagnostic Results

The following Table 5 summarizes the recommendations from each municipality which was trialed on the diagnostic². Refer to **Appendix C** for the full diagnostic evaluation of each municipality.

Table 5: Summary of Results of Diagnostic Trialing

Municipality	Municipality Tier	Priority Issue	Score (out of 69)	Recommended Resources	
				Framework	Tool(s)
City of Guelph	Single	Population Growth	54	One Water Framework	-WEF Reuse Roadmap -PIEVC Protocol
York Region	Upper	Population Growth	52	One Water Framework (Existing)	-WEF Reuse Roadmap -“Green Infrastructure Asset Management Planning”
City of Kitchener	Lower	Resilient, Sustainable Community	49	Sustainable Municipal Water Management framework	-PIEVC Protocol -International Infrastructure Management Manual, 2015

² Results were not reviewed with municipal representatives at the time of writing; this is recommended for future.

The three municipalities trialed were all considered to be relatively progressive in Ontario, and overall the higher rankings were considered to be reasonable and representative. The City of Guelph has a reputation for environmental progress, but it was not until the completion of the evaluation that it became evident that there are many progressive activities underway with respect to land and environmental management which have co-benefits for urban water sustainability. York Region was expected to be top ranking for the fact that an integrated, sustainable water management framework has been adopted, One Water. However, through the completion of the diagnostic, it was revealed that top-down regulatory requirements have driven much of the progress in this area, and due to the two-tier division of responsibilities there is still room for improvement with respect to coordinating innovative stormwater management and water efficiency implementation across the lower tier municipalities. Kitchener has made advances and progress in the areas within its jurisdiction – namely stormwater management and land-water management through subwatershed plans.

The recommendations were tailored based on considerations for the priority issue areas, existing organizational structure of planning and management approaches, as well as identified areas of weakness in the diagnostic. The One Water Framework was already implemented in York, and the flexibility of its approach was determined to be a good fit for Guelph. The City of Kitchener required additional support in clearly creating connections to progressive environmental activities to the broader urban water cycle, and therefore the Sustainable Municipal Water Management Framework tool by Great Lakes St. Lawrence Cities Initiative was recommended. Kitchener already undertakes some tracking of progress of their Strategic Plan on the Environment for water resources, and the recommended framework is intended to take existing practices to the next level and support a holistic approach for water management. The results highlight that in applying the same process, a range of different recommendations are generated for each municipality.

4.3. Discussion of Revisions Recommended to Process

Through the process of trialing first the City of Guelph followed by York Region and City of Kitchener, several observations were made and adjustments recommended which would help strengthen the diagnostic and toolkit.

4.3.1 Municipality Tier

As highlighted, there are different tiers of municipalities in Ontario each with different responsibilities for urban water management. The single tier municipality has the greatest ease of integration of water management. In completing the Guelph case study, it was noted that the different jurisdiction of upper and lower tier municipalities would affect how the evaluative questions for the spectrum could be answered – for example, upper tier municipalities do not typically have authority over stormwater management, and therefore, the evaluative questions needed to accommodate this so as to not skew the results when comparing between municipalities (note – comparison between municipalities is only for the purpose of the tool development). In making adjustments for York Region (upper tier) and City of Kitchener (lower tier) an effort was made to create questions which evaluated actions for which the municipality under review had control over while not implying duplication of efforts. For example, for

the City of Kitchener, evaluating their participation in water supply planning and supporting implementation of conservation and efficiency efforts rather than their lead role in these endeavors (which is under the jurisdiction of the upper tier).

This diagnostic is slanted towards what actions that individual municipality can do when working towards achieving more sustainable water management in order to focus on tangible activities and progress which can be controlled. This approach highlights that all municipalities have a role to play and can make progress in this area. It became clear through the evaluation that working with the other tier municipalities and connecting the watershed are critical to achieve the objectives of sustainable, urban water management. Recommendations for future improvement therefore include how this tool can be implemented to enhance collaboration between different overlapping parities in water management – e.g. encouraging tiers to work together to for example coordinate on stormwater management or climate change adaptation.

4.3.2. Additional Categories

A more traditional approach was ultimately selected for the categories, that is – choosing categories along conventional sectoral/disciplines. This is compared to frameworks reviewed which do not adhere to discipline categories, but instead describe services such as water pollution reduction, recreation, etc (GLSLCI 2012). While the approach chosen is inherently less integrated, it helped with ease and relative efficiency of carrying out assessment.

Due to the integrated, overlapping nature of the aspects of categories and how they are evaluated, managing repetition was a challenge in refining the diagnostic. For example, stakeholder participation, 50-year planning cycle and source water protection were topics which are repeated originally in multiple categories. The categories and evaluative questions were reviewed for unnecessary repetition, but in some cases repetition was necessary to capture linkages. Furthermore, since this is intended to be conducted by a third-party for water managers and not the consumption of the general public, it was decided that it does not need to be oversimplified and some repetition was acceptable.

Trialing the municipal examples provided an opportunity to ensure key principles identified in the literature review for sustainable, integrated water management discussed in Section 2 are captured in evaluative questions. Adaptive management was one of those principles for which the general planning approach was modified to more explicitly capture. Instead of just highlighting aspects of adaptive management, it is beneficial to also have evidence that the municipality has made an effort to mainstream this approach in a range of activities relating to water management. Additionally, it was determined that the existing ‘monitoring’ category provides insight into how adaptive governance is implemented and/or could be supported.

York Region has a complex geography and system layout which it became clear the screening questions did not sufficiently capture. Therefore, additional questions were added to the screening stage to help characterize and contextualize the municipality. These included source water, wastewater receiver, and proximity to water bodies, as well as a map of the municipality showing watershed boundaries. Other

screening questions for future consideration could be related to major industries in the City or in the same watershed which may impact water management.

4.3.3 Adjustments to Sustainability Spectrum Evaluative Questions

In carrying out the evaluations, one task was to confirm that the evaluative questions were consistent across the categories in terms of aligning along the sustainability spectrum. With a ranking of 1 representing meeting the baseline requirements for the Ontario regulatory framework, 2 aligning with a waterways city which goes beyond base requirements, and 3 representing the target state in terms of integrated, sustainable water management. A few revisions were noted, for example, 'fit-for-purpose' water use was categorized under 2 on sustainability spectrum as informed through a compilation of literature, but is considered quite progressive in Ontario. This was reviewed and adjusted to better reflect conditions in Ontario by adding the qualifier of 'some examples of' to the evaluative question.

It was found that the three-point scale is somewhat restrictive for accurately capturing the progress of a municipality for a given category. The adaptation adopted was when a municipality meets criteria under two adjacent categories, the previous category is selected and the key items not covered under the next level highlighted. Notes under 'evidence' provided additional details and half-points were assigned. As the diagnostic is intended as a high-level screening as a tool for decision-makers adding additional gradations was not considered necessary and potentially could serve to further complicate the evaluation and introduce more bias.

The approach in evaluating status on the sustainability spectrum for the range of categories based on past evidence and plans and policies moving forward has some limitations. That is, categories were assessed based on an action and qualitatively assessed state and represent 'leading' indicators. This is in contrast to evaluating the state or impacts, as seen in some of the Pressure-State-Response models such as DPSIR discussed in Section 2.4. Therefore, there is a risk that a plan outlining the intention of making progress and actions to achieve it does not necessarily result in the desired outcomes. However, since indicators for sustainable, integrated water systems are not universally applied in Ontario municipalities, this was considered a tradeoff for enabling a high-level, rapid assessment based on readily available information. It is noted that the link between having plans and policies in place and the culture and practice of adaptive management and monitoring can provide some insight into the likelihood of these actions resulting in desired outcomes. This highlights that all the categories need to be considered as a whole, rather than simply reviewing the final total score.

The toolkit currently includes tools which include benchmarking for water and wastewater systems, such as the National Water and Wastewater Benchmarking Initiative – Utility Management Model. Augmenting the toolkit to fill this need to support the development of more robust, holistic indicators to quantifiably assess the state of sustainable, integrated water management would be beneficial is a recommendation moving forward. As discussed previously, sustainability metrics for water management is an evolving field, and must go beyond basic parameters such as drinking water quality.

4.3.5 Observations on Existing Municipal Planning Processes

Since the evaluative questions mainly referenced plans and policies, it became evident that there are a number of plans in place and there is a constant cycle of renewal and updates. Overall, this reflects an adaptive management approach, but perhaps more harmonization would better support an integrated, One Water approach. For example, the 2008 Water/Wastewater Servicing MP rates do not necessarily reflect those outlined in the 2016 WSMP update – some harmonization is required so as to not oversize pieces of an integrated whole.

While the incorporation of an overarching framework for sustainable, integrated water management may seem like adding another layer of planning activities, it is really a process of more efficiently carrying out existing planning processes and reduce duplication of efforts. Additionally, in reviewing the governance categories, it was noted that implementing a holistic framework adds value in that it remains in place despite staffing and corporate leadership changes.

5.0. Recommendations

This section summarizes the recommendations for how this diagnostic be implemented to achieve the objective of advancing the sustainability of Ontario municipal water systems. Additionally, broader actions and consideration for uptake at the provincial government level which can support movement in this area are highlighted.

First, upon trialing the diagnostic on a range of municipal case studies it is recommended that the diagnostic be carried out in a facilitated workshop format with a range of water managers representing key decision-makers across the different disciplines and practice areas. In going through the process, not only was it noted that insight from staff would help in carrying out the assessment and increasing the accuracy of the results, the process of reviewing each of the elements of the holistic urban water cycle was very informative. For example, when considering a municipalities water management, a certain set of disciplines are usually called to the table from water and wastewater departments, and when considering a holistic approach, it can be easy to overlook the natural heritage, stormwater, and energy initiatives which are underway which are part of the equation. The exercise itself is useful to see the many connections and activities that are already underway which support an integrated, sustainable approach. A facilitated workshop by a third-party organization is also recommended to offer some unbiased insight to the evaluation. This can be done by a pre-screening and have the workshop participants augment or clarify the results. Some aspects of the diagnostic, in particular related to governance, culture, and utility outreach are subjective and potentially sensitive subject areas could benefit a mediator to interpret and translate the discussion onto the sustainability spectrum. Noting again however, that the diagnostic evaluates what is being done, not how effective it is at achieving its outcome.

The second recommendation is regarding the task of providing stand-alone guidance while still addressing immediate challenges and opportunities, such as taking advantage of climate change funding. Arguably the most important part of completing the diagnostic process is understanding the baseline conditions and in selecting a suitable guiding framework. The framework is intended to be used

as a touch-point through which to view current and future challenges, without having outside forces alone set the agenda. However, the reality of municipalities is unless there is strong internal motivation, allocating the time and money to complete the diagnostic and implement measures in this area may not come about without external funding opportunities, such as Green Funds or Climate Change Innovation Program by the Federation of Canadian Municipalities. These funds can act as an impetus to make progress towards more sustainable, integrated water systems. Selecting a tool which is in line with 1) funding requirements, 2) a key issue area, and 3) addressing an area of weakness for a municipality can leverage this opportunity to take action.

A recommendation for further development of the diagnostic and toolkit is consideration for its future use. Currently it has been designed as a one-time assessment to provide a snapshot of current status and recommend a guiding integrated water framework to put into practice for future evaluation of progress in this area. If the diagnostic were to become a document for public consumption such as for accountability tracking, it is recommended additional metrics be added to visually track progress over time and the interface be streamlined so it is more interactive and user-friendly.

Finally, given the existing regulatory context, the objective of the diagnostic is to recommend a guiding framework for a systematic approach to sustainable water management as well as tools for immediate action in line with current key priorities and opportunities (e.g. funding). The diagnostic is currently set-up as an activity initiated by the municipality. However, there are other ways in which the diagnostic could be initiated. Future work could include discussions with the MOECC for potential opportunities to integrate into existing planning processes, official guidance and tools, or creation of new requirements. For example, requiring a version of the diagnostic be completed prior to receiving provincial funding would provide incentive to completing an assessment for the state of sustainability and integration of urban water systems. Mainstreaming considerations for the whole urban water cycle through formal incorporation into the EA process or the Provincial Policy Statement are possible methods to support the completion of the diagnostic in order to make progress in sustainable water management and select the most appropriate guiding framework and tools. It will be important for the provincial government to support efforts in this area, without being overly prescriptive in the methods, as literature has demonstrated that there are multiple pathways to achieving sustainable, integrated water systems.

6.0. Conclusions

This research reviewed and synthesized data on sustainable, integrated municipal water management and arranged in a format that is actionable for making meaningful progress in this area. Transitioning towards a more forward looking, integrated water management framework will support municipalities in addressing complexities related to climate change, urbanization, and aging infrastructure and provide livable, thriving, and secure communities for current and future generations. The result of the research was the development of a diagnostic process for making progress towards more sustainable, integrated urban water systems customized to a specific community. It focuses on assessing current status and the process itself is an integrative exercise for a municipality and provides useful insights. The outcomes are a recommendation for a broader framework which can guide and track progress and a tool which can be applied in the near term for more immediate progress. The diagnostic was tailored for Ontario

Municipalities and was refined based on three Ontario case studies, although it could be modified to be applied more broadly. It is recommended that a third party complete the diagnostic and validate the results in a workshop format. The research and results highlight that there are many pathways to achieving sustainable water management for municipalities, and there are multiple existing tools and resources to support this progress and take action ahead of provincial regulatory requirements.

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References

- Abouchar, Juli, and Joanna Vince. 2011. *Ten years after Walkerton - Ontario's drinking water protection framework update*. Toronto: Willms & Shier Environmental Lawyers LLP.
- AECOM and Golder Associates Ltd. 2014. *Final Report Water Supply Mater Plan*. Guelph: Prepared for the City of Guelph.
- Asian Development Bank. 2016. *Asian Water Development Outlook 2016: Strengthening Water Security in Asia and the Pacific*. Manila: Asian Development Bank .
- Baker, LA. 2009. *Introduction*, in L.A. Baker (Ed), *The Water Environment of Cities*. New York: Springer.
- Bakker, Karen, and Christina Cook. 2011. "Water Governance in Canada: Innovation and Fragmentation." *International Journal of Water Resources Development* 27 (2): 275-289.
- Bakker, Karen, and Diana Allen. 2015. *Canadian Water Security Assessment Framework: Tools for Assessing Water Security and Improving Watershed Governance*. Waterloo: Canadian Water Network.
- Binstock, Matt. 2010. *Moving Toward a Soft Path Approach? A Case Study of Water Management in Guelph, Ontario*. Toronto: Canadian Institute for Environmental Law and Policy.
- Boyle, Jessica, Maxine Cunningham, and Julie Dekens. 2013. *Climate Change Adaptation and Canadian Infrastructure: A Review of the Literature*. Winnipeg: International Institute for Sustainable Development, 40.
- Brown & Caldwell. 2017. *Blueprint for One Water; Project #4660*. Water Research Foundation.
- C3 Water and Gauley Associates Ltd. 2016. *2016 Water Efficiency Strategy Update, Version 5.0*. Guelph: Prepared for the City of Guelph.
- Carter, Nicole, Reid D Kreutzwiser, and Rob de Loe. 2005. "Closing the circle: linking land use planning and water management at the local level." *Land Use Policy* 22: 115–127.
- CCME. 2009. *Canada-wide Strategy for the Management of Municipal Wastewater Effluent*. Whitehorse: Canadian Council of Ministers of the Environment.
- CCME. 2006. *Municipal Wastewater Effluent in Canada*. Ottawa: Canadian Council of Ministers of the Environment.
http://www.ccme.ca/files/Resources/municipal_wastewater_effluent/mwwe_general_background_e.pdf.
- CCME. 2016. *Summary of Integrated Watershed Management Approaches in Canada*. Ottawa: Canadian Council of Ministers of the Environment.

- Cervoni, Laura, Andrew Biro, and Karen Beazley. 2008. "Implementing Integrated Water Resources Management: The Importance of Cross-Scale Considerations and Local Conditions in Ontario and Nova Scotia." *Canadian Water Resources Journal* 33 (4): 333–350.
- Cheng, Frederick Y, and Nadita B Basu. 2017. "Biogeochemical hotspots: Role of small water bodies in landscape nutrient processing." *Water Resources Research* 5038–5056.
- Chiotti, Q, F Tonto, and M Perun. 2012. *Ontario Regional Adaptation Collaborative Project Weather and Water Information Gateway Gaps Analysis Report*. Prepared for Association of Canadian Educational Resources for the Weather-Water Information Gateway Project, co-funded by the Ontario Ministry of Natural Resources and Natural Resources Canada.
- City of Guelph. 2017. *Water Efficiency Strategy*. April 26. <http://guelph.ca/plans-and-strategies/water-efficiency-strategy/>.
- City of Kitchener. 2017. *Environment*. <https://www.kitchener.ca/en/livinginkitchener/Environment.asp>.
- Conservation Ontario. 2010. *Overview of Integrated Water Management in Ontario and Water Management Framework*. Newmarket: Conservation Ontario.
- CSA. 2015. *CAN/CSA-B128.1-06/B128.2-06 (R2016)*. <http://shop.csa.ca/en/canada/plumbing-products-and-materials/canca-b1281-06b1282-06-r2016/inv/27024892006>.
- CVC. 2016. *Developing an Integrated Risk Management Framework to Support One Water in Municipalities*. with University of Guelph, McMaster University, University of Toronto Faculty of Law, Dalhousie University, Zizzo Allan Demarco, Mississauga: Credit Valley Conservation Authority.
- CVC. 2016. *Water Sustainability Planning: A Guide for Water Management in Ontario*. Mississauga: Credit Valley Conservation Authority.
- CWN. 2015. *Canadian Water Network*. <http://www.cwn-rce.ca/>.
- da Silva, Allegra, Joe Griffey, Kim Jusek, Mia Smith, Emily Stahl, and Stewart Neil. 2017. "Chapter 3: Strategic Planning and Concept Development." In *Water Reuse Roadmap*, by Vijay Sundaram. Alexandria: Water Environment Federation.
- Donofrio, J, Y Kuhn, K McWalter, and M Winsor. 2009. "Water-sensitive Urban Design: An Emerging Model in Sustainable Design and Comprehensive Water-Cycle Management." *Environmental Practice* 11 (3): 179-189.
- Dunn, Gemma, and Karen Bakker. 2009. *Canadian Approaches to Assessing Water Security: An Inventory of Indicators*. Vancouver: University of British Columbia.
- ECO. 2017. *Every Drop Counts: Reducing the Energy and Climate Footprint of Ontario's Water Use*. Toronto: Environmental Commissioner of Ontario.

- ECOa. 2017. *Chapter 4: Can Asset Management Improve Energy Efficiency in "Every Drop Counts: Reducing the Energy and Climate Footprint of Ontario's Water Use"*. Toronto: Environmental Commissioner of Ontario.
- Environment Canada. 2016. *Residential Water Use in Canada*. February 16. <https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=7E808512-1>.
- Environmental Registry. 2016. *Policy Proposal Notice: Consultation on Proposal for Municipal Asset Management Planning Regulation*. July 19. <https://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTI5MTU1&statusId=MTk1NTY3>.
- ESCAP Publication Team. 2017. *Integrated Approaches for Sustainable Development Planning: the Case for Goal 6 on Water and Sanitation*. Bangkok: United Nations Economic and Social Commission for Asia and the Pacific.
- Faal, Jojob, Alan Nicol, and Tucker Josephine. 2009. *RiPPLE Briefing Paper: Multiple-Use Water Services (MUS): Cost-effective water investments to reduce poverty and address all the MDGs*. Addis Ababa, Ethiopia: Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region (RiPPLE) .
- FCM. 2017. *Funding for Canadian Municipalities*. August 31. <https://fcm.ca/home/funding/funding-for-canadian-municipalities.htm>.
- FitzGibbon, John, and Ryan Plummer. 2004. "Chapter 5: Drinking Water Source Water Protection: A Challenge for Integrated Watershed Management." In *Canadian Perspectives on Integrated Water Resources Management*, by Dan Shrubsole, 84-102. Cambridge, Ontario: Canadian Water Resources Association.
- FMCa. 2017. *Municipal Asset Management Program*. August 10. <https://fcm.ca/home/programs/municipal-asset-management-program/funding-mamp.htm>.
- Gikas, Petros, and George Tchobanoglous. 2009. "The Role of Satellite and Decentralized Strategies in Water Resources Management." *Journal of Environmental Management* 90: 144-152.
- Global Water Partnership. 2012. *Proceedings from the GWP Workshop: Assessing Water Security Indicators with Appropriate Indicators*. Stockholm: Global Water Partnership.
- GLSLCI. 2012. *Sustainable Municipal Water Management: Measuring Progress and Reporting Publicly*. Toronto: The Great Lakes and St. Lawrence Cities Initiative Green Cities Initiative.
- Government of Canada. 2017. *Achieving a Sustainable Future: A Federal Sustainable Development Strategy for Canada*. August 5. <http://fsds-sfdd.ca/index.html#/en/goals/>.
- Grey, David, and Claudia W Sadoff. 2007. "Sink or Swim? Water Security for Growth and Development." *Water Policy* 9: 545-571.

- Grigg, N.S. 2008. *Total Water Management: Practices for a Sustainable Future*. Denver: American Water Works Association (AWWA).
- Hanna, Kevin S, Steven M Webber, and Scott D Slocombe. 2007. "Integrated Ecological and Regional Planning in a Rapid-Growth Setting." *Environmental Management* 40: 339–348.
- Jusek, Kim. 2015. *Climate Change Adaptation for Ontario Municipal Water Management*. McMaster University, Hamilton: Completed for McMaster University SEP 709 as part of Masters of Engineering and Public Policy.
- Jusek, Kim. 2016. *Short Paper: Merits and Drawbacks on the Degree of Centralization in Urban Water Services*. Dresden: Completed as part of Masters of Engineering and Public Policy, UNU FLORES Course: Rethinking Infrastructure for Multi-Use Services.
- Jusek, Kimberly, and Leigh McDermott. 2015. "Municipal Water Reuse in Ontario – Review of Current Status and Future Feasibility." *Prepared for Ontario's 2015 Water Conference and Trade Show hosted by OWWA, OMWA, & OWWEA*. Toronto: Ontario Water Works Association.
- Krebs, Peter. 2016. "Lecture 3: Wastewater Treatment." *Course: Rethinking Urban Infrastructure for Multi-Use Water Services*. Dresden: University of United Nations (UNU) Institute for Intergated Management of Material Fluxes and of Resources, October 24.
- Kristensen, Peter. 2004. *The DPSIR Framework*. Denmark: National Environmental Research Institute, Department of Policy Analysis, European Topic Centre on Water, European Environment Agency.
- Libralato, Giovanni, Annamaria Volpi Ghirardini, and Francesco Avezzù. 2012. "To Centralise or to Decentralise: An Overview of the Most Recent Trends in Wastewater Treatment Management." *Journal of Environmental Management* 94: 61-68.
- Ligeti, E, I Wieditz, and J Penney. 2007. *Cities Preparing for Climate Change: A Study of Six Urban Regions*. Toronto: Clean Air Partnership.
- Maas, Tony. 2017. *Smart, Strategic, Investments for Urban Water Sustainability: Seizing Canada's Infrastructure Moment*. Forum for Leadership on Water.
- Maksimovic, Cedo, Mathew Kurian, and Reza Ardakanian. 2015. *Rethinking Infrastructure Design for Multi-Use Water Services*. Springer.
- May, B., and R. Plummer. 2011. "Accommodating the challenges of climate change adaptation and governance in conventional risk management: adaptive collaborative risk management (ACRM)." *Ecology and Society Online* 47. Accessed November 21, 2015. <http://www.ecologyandsociety.org/vol16/iss1/art47/>.
- MEA. 2011. *Municipal Class Environmental Assessment*. Municipal Engineers Association.

- Metcalf & Eddy. 2014. *Wastewater Engineering: Treatment and Resource Recovery, 5th Edition*. McGraw-Hill.
- Ministry of Municipal Affairs and Housing. 2014. *2014 Provincial Policy Statement*. Toronto: Ontario Government.
- Mitchell, Bruce. 2005. "Integrated water resource management, institutional arrangements, and land-use planning." *Environment and Planning A* 37: 1335-1352.
- Mitchell, Bruce, Charles Priddle, Dan Shrubsole, Barbara Veale, and Dan Walters. 2014. "Integrated water resource management: lessons from conservation authorities in Ontario, Canada." *International Journal of Water Resources Development* 30 (3): 460–474.
- MNRF. 2015. *Conservation Authorities Act Review Discussion Paper*. July 20. <https://www.ebr.gov.on.ca/ERS-WEB-External/displaynoticecontent.do?noticeId=MTI1Mzgx&statusId=MTg4ODg5>.
- MOECC. 2017. *Canada Ontario Great Lakes agreement*. July 16. <https://www.ontario.ca/page/canada-ontario-great-lakes-agreement>.
- MOECC. 2011. *Climate Read: Ontario's Adaptation Strategy and Action Plan 2011-2014*. Toronto: Ontario Ministry of the Environment and Climate Change. <http://www.ontario.ca/document/climate-ready-adaptation-strategy-and-action-plan-2011-2014>.
- MOECC. 2014. *Policy Review of Municipal Stormwater Management in Light of Climate Change - Summary Report*. Toronto: Ontario Ministry of Environment and Climate Change.
- MOECCa. 2017. *Class EA for Municipal Infrastructure Projects*. June 26. <https://www.ontario.ca/page/class-ea-municipal-infrastructure-projects>.
- MOECCb. 2016. *Nutrient Management on Farms*. June 19. <https://www.ontario.ca/page/nutrient-management-farms>.
- MOECCc. 2017. *Source Protection*. July 16. <https://www.ontario.ca/page/source-protection>.
- MOECCd. 2017. *Ministry of the Environment and Climate Change: Minister's Annual Report on Drinking Water 2016*. March 31. <https://www.ontario.ca/page/ministry-environment-and-climate-change-ministers-annual-report-drinking-water-2016>.
- MOI. 2017. *Building together - Guide for municipal asset management plans*. July 16. <https://www.ontario.ca/page/building-together-guide-municipal-asset-management-plans>.
- MOIa. 2017. *Discussion Paper - Potential Municipal Asset Management Planning Regulation*. July 16. <https://www.ontario.ca/page/discussion-paper-potential-municipal-asset-management-planning-regulation>.

- Mukheibir, Pierre, Claire Howe, and Danielle Gallet. 2014. *What's getting in the way of a 'One Water' approach to water services and planning: An analysis of the challenges and barriers to an integrated approach to water.* WATER.
- Nicklow, John W, Paul F Boulos, and Misgana K Muleta. 2004. "Management of Urban Watersheds." In *Comprehensive Sewer Collection Systems Analysis Handbook for Engineers and Planners*, 8-1-8-27. Pasadena: MWH Soft, Inc.
- OCWA. 2016. *Ontario Clean Water Agency Annual Report.* Toronto: OCWA.
- Ontario Ministry of Energy. 2017. *Conservation for Public Agencies.* April 20. <http://www.energy.gov.on.ca/en/green-energy-act/conservation-for-public-agencies/>.
- OSWCA. 2001. *Drinking Water Management in Ontario: A Brief History.* Ontario Sewer and Watermain Construction Association.
- Pahl-Wostl, Claudia, Louis Lebel, Christian Knieper, and Elena Nikitina. 2012. "From applying panaceas to mastering complexity: Toward adaptive water governance in river basins." *Environmental Science & Policy* 23: 24-34.
- Phare, Merrel-Ann S. 2009. *Denying the Source - The Crisis of First Nations Water Rights.* Vancouver: Rocky Mountain Books.
- Plummer, Ryan, Andrew Spiers, John FitzGibbon, and Jack Imhof. 2005. "The Expanding Institutional Context for Water Resources Management: The Case of the Grand River Watershed." *Canadian Water Resources Journal* 30 (3): 227–244.
- Plummer, Ryan, Danuta de Grosbois, Rob de Loe, and Jonas Velaniskis. 2011. "Probing the integration of land use and watershed planning in a shifting governance regime." *WATER RESOURCES RESEARCH* 47: 13.
- Ramin, Vida. 2004. "The Status of Integrated Water Resources Management in Canada." In *Canadian perspectives on integrated water resources management*, by Dan Shrubsole, 1-32. Cambridge, Ontario: Canadian Water Resources Association.
- Renault, Daniel. n.d. *Generalities on Multiple Uses of Water Services.* Food and Agriculture Association (FAO).
- Rouillard, J J, K V Heal, T Ball, and A D Reeves. 2013. "Policy integration for adaptive water governance: Learning from Scotland's Experience." *Environmental Science & Policy* 378-387.
- Roy, A. H, S. J Wenger, T. D Fletcher, C. J Walsh, A. R Ladson, and W. D Shuster. 2009. "Impediments and Solutions to Sustainable, Watershed-Scale Urban Stormwater Management: Lessons from Australia and the United States." *Environmental Management* 344-359.

- Sedlak, David. 2014. *Water 4.0: The Past, Present, and Future of the World's Most Vital Resource*. New Haven: Yale University Press.
- Shrubsole, Dan. 2004. *Canadian perspectives on integrated water resources management*. Cambridge, Ontario: Canadian Water Resources Association.
- Shrubsole, Dan. 1992. "The Grand River Conservation Commission: History, Activities, and Implications for Water Management." *The Canadian Geographer* 36 (3): 221-236.
- Simonovic, S, and A Peck. 2009. *Water Resources Research Report: Updated Rainfall Intensity Duration Frequency Curves for the City of London Under the Change Climate*. London: The University of Western Ontario Department of Civil and Environmental Engineering.
- Smith, H M, K L Blackstock, G Wall, and P Jeffrey. 2014. "River basin management, development planning, and opportunities for debates around limits to growth." *Journal of Hydrology* 519: 2624–2631.
- SOWC. 2015. *Partnering to accelerate water innovations through real-world demonstration*. <https://sowc.ca/about/what-we-do/>.
- Srinivasan, Veena, Meena Palaniappan, John Akudago, Michael Cohen, and Juliet Christian-Smith. 2012. *Multiple-Use Water Services (MUS): Recommendations for a Robust Sustainable Approach*. Oakland California: Pacific Institute.
- Stantec Consulting. 2016. *Region of Waterloo and City of Guelph Environmental Impacts Study for Residential Water Softeners*. Region of Waterloo and City of Guelph.
- Stantec Consulting. 2015. *Region of Waterloo Water Supply Master Plan*. Kitchener: Region of Waterloo.
- Statistics Canada. 2017. *Canada goes urban*. July. <http://www.statcan.gc.ca/pub/11-630-x/11-630-x2015004-eng.htm>.
- Summers, Robert, Ryan Plummer, and John FitzGibbon. 2003. "The Influence of Sub-Watershed Plans on the Ontario Planning Process." *Canadian Water Resources Journal* 28 (3): 375-394.
- Trapp, Jan Hendrik. 2015. "Innovative de- and semi-centralized water infrastructures – opportunities for water supply and wastewater companies." Braunschweig: 5th International Symposium - RE-WATER. Accessed October 24, 2016. http://re-water-braunschweig.com/wp-content/uploads/2015-11-02_1200-Opportunities-water-companies_20150906-Trapp_FINAL.pdf.
- TRCA. 2009. *Preparing for the Impacts of Climate Change on Stormwater and Floodplain Management: A Review of Adaptation Plans and Practices*. Mississauga: Toronto and Region Conservation Authority.

- U.S. Geological Survey. 2017. *The USGS Water Science School*. February 16.
<https://water.usgs.gov/edu/qa-home-percapita.html>.
- van Koppen, Barbara. 2012. *Multiple Water Use Services Scoping Study Synthesis*. Rockefeller Foundation.
- van Koppen, Barbara, Patrick Moriarty, and Eline Boelee. 2006. *Multiple-Use Water Services to Advance the Millennium Development Goals. Research Report 98*. Colombo, Sri Lanka: International Water Management Institute.
- Van Meter, K J, and N B Basu. 2017. "Time lags in watershed-scale nutrient transport: an exploration of dominant controls." *Environmental Research Letters* 1-11.
- Vörösmarty, C. J., A. Y. Hoekstra, and S. E. Bunn. 2015. "What scale for water governance?" *Science* 349 (6247).
- Wang, L, W D Wang, Z G Gong, Y L Lui, and J J Zhang. 2006. "Integrated management of water and ecology in the urban area of Laoshan district, Qingdao, China." *Ecological Engineering* (27): 79-83.
- WaterTAP. 2017. *WaterTAP Technology Acceleration Project*. <http://watertapontario.com/>.
- WaterTap, SOWC, OCWA. 2016. *Enabling sustainability, resilience, and innovation in water infrastructure: roundtable with the honorable Amarjeet Sohi Federal Minister of Infrastructure and Communities*. WaterTap, Southern Ontario Water Consortium, Ontario Clean Water Agency.
- Welch, Cheryl. 2010. *The Green Utility: A Practical Guide to Sustainability*. Denver: American Water Works Association.
- York Region. 2011. *Long Term Water Conservation Strategy*. Vaughn: Regional Municipality of York.
- York Region. 2016. "The Regional Municipality of York Water and Wastewater Master Plan." York Region.

Appendix A: Diagnostic and Toolkit Template

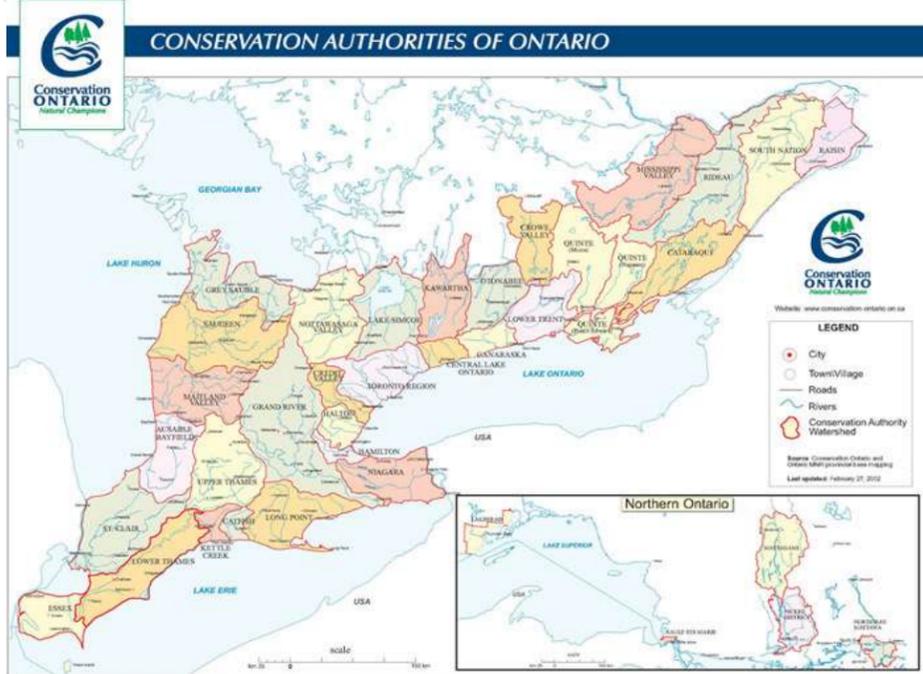
Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance
 Result: Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress
 Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management
 Look at past evidence and plans and policies moving forward

Date Completed:
 By:

Key Questions to Characterize Community:

Municipality:											
Population:	<10,000	10-50,000	50-100,000	100-250,000	250-500,000	500,000-1,000,000	1-2,000,000	>2,000,000			
Tier:	Single	Upper	Lower								
Description of responsibilities	(e.g. WW Treatment, SW etc.)										
Key Priorities:	Flooding	Population Growth	Water Efficiency	Cost/Financing	Environmental Protection (Need for)	Reliable, Secure Supply	Resilient, Sustainable Community	Climate Change	Aging infrastructure	Public Health	Other?
Root Cause	(climate change, pop growth, aging infrastructure)	(Natural Resource limitations, discharge quality/quantity, climate change)	(Natural Resource limitations, aging infrastructure)	(Aging Infrastructure, climate change mitigation/adaptation, "we have no problems with current approach, but want financial sustainability")	(Natural Resource limitations, discharge quality/quantity, climate change)	(Natural Resource limitations, discharge quality/quantity, climate change)	(Climate change)	(related to flooding, environmental limitations, aging infrastructure, costs, sustainability, environmental limitations)	Financing, climate change, public health	Aging Infrastructure, costs, meeting basic needs	
Watershed:	_____										
Water Source:	_____										
Wastewater Receiver:	_____										
Proximity to water bodies	_____										
Location in watershed:	_____										



Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

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 Look at past evidence and plans and policies moving forward
 Where a municipality meets criteria under two adjacent categories, the previous category is selected and the key items not covered under the next level highlighted

Sustainability Spectrum:

1	2	3
"Sewered/Drained City"/ Meeting ON Regulatory Requirements for public/ environmental health ON Baseline Grey Infrastructure Approach	"Waterway/Water Cycle City"/ Limits to Growth/Social Amenity and Environmental Health Beyond Baseline Grey-Green	"Water Sensitive City", One-Water Approach, Resilience to Climate Change Sustainable-focus, Integrated One Water

(Brown et al., 2009)
me
(CVC)

Diagnostic and Evaluative Questions:

Sustainability Status Indicators/ categories		Evaluative question	Evidence from public record (attitude/action)	Rank
Category	Aspects to be Managed			one to three

Water Supply and Distribution	Municipal Supply Source	1) One source; SW or GW (no concern if local or imported); conflict on use/allocation and/or constrained supply	2) two source types; e.g. SW, GW; local; some examples of fit-for-purpose supply (residential RWH, GWR, irrigation with untreated water)	3) >3 sources; incl. non-conventional sources (RWH, Reclaimed wastewater, etc.); local supply; supply of different water quality (fit-for-purpose)	
	Water Supply Planning Approach	1) Supply-side approach to meet demands, water quality and operations meets SDWA requirements, single-use water, limited consideration for water conservation measures, conventional technology options, single future scenario, 25 year timeframe, , baseline SWP carried out. If Lower Tier: "Not my jurisdiction"; Does not provide input to water supply planning beyond mandated practices (SDWA, CWA and SWP) or actively support conservation measures, resistance to innovative or unconventional technology options	2) Demand management + supply management, incorporation of conservation and efficiency impacts, primarily single-use water, source planning includes evaluation of energy demands of treatment, chemical use, reliability; use of scenario planning, 50 yr. timeframe, traditional sources prioritized, thorough SWP carried out and actively engaged in implementation If Lower Tier: Active engagement with Upper Tier water supplier in long-term planning, active participation in conservation and efficiency measures and environmental education.	3) Demand management predominantly - incl. fit for purpose, optimizing existing infrastructure before expanding/upsizing, linked to broader watershed management (other users), scenario planning including climate change consideration, alternative water sources (RW, SW, WW reuse) employed for range of applications, 100 yr. time frame considered, consideration of water cycle through SWP in sourcing water and balancing treatment needs/reliability, and maintaining resilience; considerations for impacts from climate change on water quality and quantity If Lower Tier: Very engaged with Upper Tier water supplier in working towards innovative solutions for whole of cycle water management including natural heritage restoration and protection (above and beyond SWP), and engaging community in advanced efficiency, conservation, and alternative water sources for beneficial use.	
	Conservation and Efficiency	1) enforce building code updates, outdoor lawn watering by-law, fixed fee rate structure, limited outreach material	2) Outreach programs, efforts to measure and reduce non-revenue water, reduce per capita demand through indoor/outdoor by-laws, education and incentives (rebates), volumetric based rate structure - tangible targets set and record of success - And/or supports jurisdiction which drives this agenda	3) 2+ comprehensive plan which is integrated into other urban waters planning, support for fit-for-purpose reuse of water (GWR, RWH), smart/real-time monitoring; coordinate efforts with other Tiers for implementation	
	Water Distribution	1) water delivered achieves pressure and quality requirements, as established by the SWDA and local design targets; reactive approach upgrades and maintenance; UFW at >20% (see AM for more about approach)	2) proactive approach to watermain and distribution infrastructure, promotion of product such that use of bottled water is minimized; UFW <15%; coordination between different tiers and disciplines for construction; optimize energy usage of pumps	3) 2+, UFW <10%, GIS-platform to engage with customers and address issues quickly, use of DSS and smart systems to optimize pumping for energy efficiency	
Wastewater	Handling of Wastewater Treatment	1) treat and discharge to environment, meet minimum environmental quality guidelines	2) treat, recover biosolids, discharge to environment such that it does not significantly degrade the environment and consideration for impacts to reuse according to measured and regulated parameters, use of modelling assimilative capacity, energy efficiency optimization of processes	3) treat, recover biosolids/biogas for energy/water, discharge to environment such that it does not significantly degrade the environment (incl. acute and chronic/cumulative impacts), above and beyond regulated parameters, modeling of assimilative capacity, pollution prevention programs integrated into treatment approach (residential/industrial source control) through enforced sewer use bylaw; net-zero for energy use; address emerging contaminants	
	Wastewater Planning Approach	1) Increase capacity of WWTP and collection system and upgrade treatment systems as population grows; centralized treatment, single future, does not consider conservation/efficiency, does not control I/I as evidenced by regular sewer backups, overflows, and by-pass events, 25-year planning horizon or less	2) Focus on optimization of treatment plant for capacity and treatment to meet growth and effluent restrictions, incorporation of reducing flows through I/I reduction programs (separate combined sewers) and water efficiency, pilot testing of new technologies through innovative partnerships, enforce sewer use by-law, tie-into watershed plans and downstream impacts, use of modeling programs to inform planning; some overflow events and flooding in extreme conditions; 50 year planning horizon	3) 2+ inclusion of semi-centralized/decentralized treatment, reuse of water, energy, biosolids, nutrients, greenhouse gas reduction in collection system, integration of water/SW planning, focus on pollution prevention (update sewer use by-law), consideration for climate change resiliency, advanced use of modelling to assist with planning; consider 100 year planning window	
	Collection Infrastructure	1) expand and upsize sewer infrastructure as needed based on expanding population and failure, upgrade when roads are scheduled for upgrade.	Sewer by-law to not only protect treatment processes and receiving environment, but to protect integrity of collection infrastructure through reducing corrosive components and to reduce production of odors and GHG emissions; maintenance programs to extend lifespan; coordination construction upgrades with other public infrastructure	3) 2+ support efficiency programs and stormwater management to reduce need to upsize infrastructure (across discipline/jurisdictional boundaries); sewer mining for decentralized water reuse	

Sustainability Status Indicators/ categories						
Category		Evaluative question			Evidence from public record (attitude/action)	Rank
Stormwater	Stormwater Management Approach	1) Convey water out of city; urban flood protection from property damage; developed piecemeal with population growth/new developments	2) Flood protection but also protection of local rivers (quality and quantity - erosion), infiltrate and manage onsite (lot level solutions) to protect water balance and contribute to protection of local rivers; informed by watershed planning	3) Mimic natural water cycle, city-wide review of stormwater management, connect to watershed plans and upstream/downstream communities, protect property from flooding and protect natural environment from erosion/non-point pollutants, integrate into watershed planning, WW and water planning, retain and reuse locally, planning policies to support GI options before grey, and innovative management approaches to asset inventory and maintenance, and financing; ecological corridors and GI network		
		(If Upper Tier, "not their jurisdiction")	(If Upper Tier, "make an effort to work with other tier to coordinate and support efforts across lower tiers)	(If Upper Tier, "Active participant on plans and policies to support unified approach to SW management and GI policies across lower tiers)		
	SW Infrastructure	1) Mainly 'grey' or engineered infrastructure, including concrete drainage systems and some end of pipe controls	2) Mainly grey in core areas, with more lot level GI practices in new developments, including rain gardens, rain barrels, and wet/dry ponds.	3) Complimentary grey-green systems through urban area, use of LID including green roofs, urban trees, swales, parkland, and pollution prevention; network of GI, not only one-offs		
Natural Urban Water (surface)	Management Approach	1) under jurisdiction of CA, abide by flood zones/buffer zones, seen as source of water, conveyance for stormwater, dilution of wastewater, transportation (possibly) - human centred	2) Seen as amenity for recreation and tourism, protected from erosion and contamination for upholding recreational use, and other urban function discussed above; viewed as an asset (property value, tourism related income) and a risk (flooding)	3) Part of larger natural ecosystem, requiring quality and quantity and buffer riparian zones respected and protected from human development and heavy use, in addition to cultural/aesthetic value and functional uses for water, wastewater and stormwater; restoration investments made (daylighting streams, integrating into SWM planning); monitoring and addressing quality/quantity issues including cumulative effects		
Landscape	Land Use Management Approach	1) Landscape and environmental features dealt with as necessary under provincial regulations (e.g. protected moraine or wetlands), not managed as multi-functional assets impacting the water cycle; greenfield development rampant	2) carry out sub-watershed plans, coordinate with CA, land use policies (e.g. Official Plan) identify and protect key hydrologic features (wetlands, forests, park land) for their role in GW recharge, habitat, and flooding/social amenity in development; urban intensification; conservation viewed as a trade-off; implement drinking water SWP measures; understanding the connection between land use practices (impermeable, salts, nutrients) and downstream water quality impacts and water availability impacts	3) 2+ promotion of urban agriculture, urban forests and parkland, green infrastructure, green roofs/walls, and active planning and management by the city in maintaining the health of these features/ecosystems (wildlife, use and pollution management); urban intensification with prioritization on protecting hydrologic features; recognizing as multi-benefits vs trade-offs; source water protection for all sources - natural/ecosystem flows in addition to drinking water, downstream impacts (over and above baseline SWP); tie-into broader watershed through inventory of resources and users; resources: waterways, wetlands, fish and wildlife, endangered species, cultural and recreational resources and users: commercial navigation, potable water supply, agriculture, etc.)		
General Planning Approach	Planning Approach	1) Planning exercises for new infrastructure and development follow the Class EA process (discipline lead), conventional solutions considered and evaluated with cost as the primary consideration	2) Studies follow the Class EA process, consider more innovative solutions and methods for arriving at solutions including enhanced public participation, recognize complexity of planning decisions related to aging infrastructure, growth, climate change; time frame of 50 yrs.	3) Studies and planning activities consider full water cycle impacts, incorporate discipline integration and multi-functional/multi-benefit infrastructure solutions and follows an established integrated water management framework/approach, build on EA approach and use more sophisticated decision making tools (e.g. triple bottom line) and methods to deal with uncertainty (adaptive management, staging with monitoring, vulnerability risk assessments, iterative), planning considers innovative approaches such as nutrient trading; time frame of 100 yrs.		
	Culture supportive of innovative approaches and/or sustainability in Policies	1) Council approved strategic plan/official plan comments on striving to have a healthy environment to extent PPS requires it; pushback on rate increases	2) strategic plan and official plan comments on protecting water quality and quantity and some restrictions on land use; environmental and sustainability initiatives undertaken by municipality	3) strategic plan and official plan sets bold targets/goals with respect to water and environmental sustainability and restrictions on land use; environmental/sustainability strategy implemented and monitored to track and report progress, includes decision-support , to support implementation of strategic plan objectives		

Sustainability Status Indicators/ categories						
Category			Evaluative question		Evidence from public record (attitude/action)	Rank
Governance	Corporate Leadership on Sustainability	1) Outlook on water services is to provide safe, affordable water and wastewater services, prevent flooding to protect public health and private and public	2) Outspoken on key issues relating to pressing challenges (potentially associated with climate change, limited supply, etc.)	3) Collaborate/innovative partnerships (other muni's, conservation authorities, universities, industry, other), mayor/top water managers outspoken on the related issues (climate change, reuse, etc.); work with province to progress regulations and develop policies and guidelines to support direction (e.g. rainwater harvesting guides and planning, energy reduction)		
	Institutional Roles and Organizational Structure/ Administration of Services	1) Conventional siloed approach, centralized authority, limited collaboration/innovation partnership - initiated by others where exist, routine approach to water servicing	2) Work across disciplines and jurisdictional lines, enhanced public participation and dialogue, some innovative partnerships with distributed management; still clear lines of responsibility; have position for sustainability coordinator and some key staff champions	3) Adopting a One Water Approach to services within own jurisdiction, and reaching across jurisdictional lines to support integrated, holistic planning; majority of staff support and buy-into this approach and have adapted duties to match it; potential decentralized/PPP in play to administer projects		
Outreach/ communication/ public engagement/ stewardship	Utility Outreach	1) Baseline interaction with public/stakeholders for billing, EA process, council approval, and website with access to regulatory reporting and some studies; more interaction with industry than residential population, minimum public participation and interaction in strategic planning	2) Substantial public education and outreach programs on annual water quality reports, capital plans, studies, and some on pollution prevention and efficiency programs, more engagement with public through detailed website and social media avenues for customer questions and feedback; real-time updates on pertinent water related info (e.g. flood risks, drought risk/water restrictions); enhanced public participation and dialogue	3) Strong, modern social media presence and outreach programs related to water cycle, water and energy conservation, pollution prevention in addition to regulatory reporting and study summaries (and detailed reports); real-time monitoring and feedback for optimizing customer behaviour and reporting issues (EPCOR, DC Water); demonstration projects		
	Public Attitudes	1) priority is for low water cost; adversarial relationship between key industrial users and utility	2) priority is for reassurance that *key issue* is being handled properly to protect the nature of their community, their environment, and water resources for their safety and health	3) Supportive of and demanding of more innovative solutions to protect resources at large for long-term sustainability; accept that may come with personal sacrifices in terms of behaviour and costs; key industrial users have productive relationship with utility		
Monitoring	Asset Management	1) baseline asset management employed, updated recently to access provincial funding - have an inventory of major water and wastewater assets; no level of service (LOS) and only age/material based condition information; used to prioritize capital upgrades and variable funding for maintenance activities; reactive to breaks and failures	2) enhanced asset management strategy including tracking, inventory of major water, WW, and SW with basic info on LOS; Some inventory of GI parks, trees, etc. but no LOS; AM plans reported and built into other planning process in addition to annual maintenance programs and capital upgrades/replacements. Integrated into GIS and databases; budget forecasting highlights annual investment required (not 100% met)	3) Detailed inventory of assets, including green infrastructure, with risk assessments for vulnerability to climate change and metrics on energy efficiency and triple bottom line indicators; use of smart technology and innovative approaches; key data is accessible and used for rehab, replacement and broader planning programs. View people as assets, invest in human capital; annual re-investment fulfilled		
	Water related Monitoring	1) Baseline monitoring for regulatory reporting on water takings, drinking water source quality, wastewater discharged, effluent quality; treatment and distribution operations monitored in SCADA	2) Baseline + more detailed analysis of different water user types and their per capita usage, UFW/non-revenue water, stream flow, stream quality, environmental indicators, interpretation of changes/trends	3) 2+ use of smart systems and innovative approaches to gather and interpret utility data on energy usage, water usage, quality in the system and environment, and feed into programming on land use, customer usage, infrastructure planning and staging		
Infrastructure	Approach to Infrastructure	1) conventional engineering approach of conservative, grey, conventional approaches based on demonstrated past efficacy or familiarity	2) Predominantly conventional approaches, grey, engineered technology, with infusion of some innovative approaches such as lot level green infrastructure, new water/wastewater technologies; predominantly centralized big investments favoured over smaller scale optimization/rehab projects	3) Mix of conventional grey and green technologies for managing urban water cycle, recognition of multi-purpose infrastructure, infrastructure planned with uncertainty built in - staged approaches, more decentralized than large-scale centralized projects; multiple smaller scale projects		
Financial Management	Financial Management	1) estimates of capital costs and recurring costs (operating) are the main considerations for cost benefit analysis and heavily influence decision-making; rudimentary financial planning to meet regulatory requirements, not achieving full-cost recovery, dependence on prov/fed grants and loans (non-innovative programs or meeting baseline requirements)	2) More balanced approach to cost-benefit analysis which attempts to incorporate social and environmental externalities; more advanced financial planning that strives to achieve full-cost recovery through rate increases to user fees and new rate structures (volumetric and fixed, stormwater fee, polluter pays) and other market-based approaches for allocating between different users, engages in partnerships with other agencies to optimize services and costs, accesses innovative grants (FCM green municipal fund, etc.)	3) triple bottom line approach and full integration of social and environmental aspects of infrastructure and decision making alongside economic costs, user fees and planning support full-cost recovery, active participation in innovative/PPP to efficiency deliver services and equitably share costs, access innovative grant programs to advance sustainable practices; including cost recovery mechanisms and business model approach through reclamation of nutrients from wastewater, or valuation of wastewater treatment for ecosystem services highlighting favorable environmental benefits, polluter pays, creativity in creating market for resources - such as nutrients, biosolids, creation of ecosystem services payments.		
Climate change	Approach to climate change	1) No serious consideration for climate change in infrastructure planning or strategic plans; limited council support/staff support; recognition of value of energy efficiency for cost-savings	2) Recognition of climate change and need to address both mitigation and adaptation pieces; moderate council/staff support; considerations for climate change evident in planning and infrastructure decisions	3) Climate change adaptation plan and mitigation strategies well established, full council and staff buy-in and climate related decisions integrated into all decision-making		
	Energy Supply	1) Supply by Prov-Regional, some priority on energy efficiency, some emergency generators; no emphasis on renewables; energy reporting through regulation (green energy act), but no measures to actively reduce.	2) Supply by Prov-Regional, effort to support resilience of electrical system from weather related hazards, standby power plan sufficient to meet min level of service for set period of time, some support and focus on renewables for municipal water-related assets; policies and benchmarking programs to measure progress in reduction of energy use in w/ww sector	3) Supply by Prov-Reg and local renewable sources and district/local power, protection of key electrical supply and backup to water related facilities, use of renewable energy sources at water facilities. Benchmarking for tracking continuous improvement; net-zero WW facilities		
Other	+/-	other notes/aspects not covered but contribute or detract from sustainability				0

Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance

Result: Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress

Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management

Sources: Look at past evidence and plans and policies moving forward
adapted from many but categories mainly from Brown et al., 2009

Sustainability Spectrum:

	1	2	3	
	"Sewered/Drained City"/ Meeting ON Regulatory Requirements for public/ environmental health	"Waterway/Water Cycle City"/ Limits to Growth/Social Amenity and Environmental Health	"Water Sensitive City", One-Water Approach, Resilience to Climate Change Sustainable-focus, Integrated One Water	(Brown et al., 2009) me (CVC)
	ON Baseline Grey Infrastructure Approach	Beyond Baseline Grey-Green	One Water	
Score	23	24-46	46-69	
Total Score:	49			
Count:	Count of 1= 0	Count of 1.5 = 0	Count of 2= 0	Count of 2.5= 0
			Count of 3= 0	

Analysis:

Recommended Framework:

Recommended Tool:

Toolkit

	Tags	Description	Complements.../or use when
General decision making support for more sustainability, complexity, integration:			
Ecosystem Services Payment	financial, evaluation, watershed	This approach is to better capture and quantify environmental considerations for the purposes of evaluation but also for the purpose of full-cost recovery. Ecosystem services include dilution, nutrient uptake, etc.	To support evaluation processes, such as a decision-matrix or cost-benefit analysis, to better quantify and account for ecological costs in land use planning and setting prices for users
Decision Matrix (typical from EA process, also referred to as a multi-criteria assessment)	sustainability, evaluation	Decision Matrices are typical of an EA process is a traceable, structured approach to incorporating social, environmental, and economic criteria. A weighting and rating system allows a set of options to be ranked. The criteria selected and weighting can alter how progressive this approach is, e.g. weighting economic considerations above other factors is not progressive unless they incorporate environmental and social benefits	To support frameworks through the project-to-project decision-making - from high level to detailed
Sensitivity Analysis using linear programming, monte carlo simulation (for scenarios)	evaluation, uncertainty, modeling	The use of these evaluation methods can help to assess multiple scenarios and factors and optimize for the expected set of conditions, but providing information on different top ranked solution if condition(s) change. This helps inform how robust a given solution is and how sensitive it is for a range of factors	To support frameworks through the project-to-project decision-making - from high level to detailed, but more useful at detailed stage
triple bottom line	sustainability, evaluation, financial	An approach to accounting which includes considerations beyond the financial bottom line, to include social and environment. Commonly referred to as P3 accounting: people, planet, profit. This concept has been around since the early 90s and typically incorporated into a business setting.	Can be mainstreamed and applied to all decision-making processes that involve financial evaluation. Combination with cost-benefit analysis can help to quantify social and ecological elements
Adaptive Management	governance, process, uncertainty, climate change	Learning by doing approach that builds in staging, monitoring and evaluation, and iterative re-evaluation. A useful approach to planning and decision-making in the face of uncertainty imposed by climate change and other stressors	Recommended under all overarching frameworks as a main tenant, but particularly useful in gridlock around an issue relating to climate change.
Envision Sustainability Rating for Infrastructure	sustainability, evaluation	Developed by Institute for Sustainable Infrastructure, this rating system can be applied to the design of new civil infrastructure to ensure sustainability. A rating is assigned, similar to a LEED certification which can be used to help promote the project and approach to the public. This rating is less well-known in Ontario/Canada	Best used within a broader framework and mandate for sustainability, but can also be a first step to introducing these concepts to a municipality for relatively low commitment exposure and one-off adoption of these principles
LEED Green Buildings	Sustainability, evaluation	The focus of the Green Building Council's LEED is on green buildings - with respect to energy, waste, and water use. It provides a framework and incentive for municipalities to implement innovative water technologies for reuse and conservation, which can potentially then be scaled out in policies and programs once familiarity has been gained.	Best used within a broader framework and mandate for sustainability, but can also be a first step to introducing these concepts to a municipality for relatively low commitment exposure and one-off adoption of these principles
National Water and Wastewater Benchmarking Initiative	evaluation	This initiative is deals with tracking a range of water and wastewater indicators to allow municipalities to compare against themselves and other municipalities to track progress and set targets.	participate, access to compare how measure up in various aspects compared to other municipalities with similar contexts
Other			

	Tags	Description	Complements.../or use when
Smart Systems	water efficiency, monitoring and evaluation, management	Investigate opportunities for more sophisticated mechanisms for data analytics - both amount and type gathered and tools to do so. Such as more advanced metering infrastructure (AMI) to help manage water consumption, leak detection, integration of SCADA and WQ data, and real-time data interfaces. The use of AI can help combine a set of technologies to help utility management be more proactive rather than reactive. Investigate innovative options through OCWA and WaterTap	
Scenario Planning	Uncertainty, planning	The use of different future scenarios to anticipate a range of likely outcomes relating to, for example, population size, water demand, energy costs, ecological costs, etc.	Can be used in conjunction with sensitivity analysis and other evaluation methods, as well as visioning exercises in frameworks, and long-term planning exercises where there is uncertainty; used in cost-benefit analysis where different futures are compared to the baseline
Mainstreaming	Policy, governance	Cross-cutting area of concern, such as climate change or holism, will be incorporated into every existing process. In this way, the issue of concern will be addressed.	This does not necessitate the creation of a new planning process, but requires each department/staff to add a new consideration to their work
The Cities Solutions Hub (CSH) of the Resilience Exchange	climate change, adaptation, resilience, ideas	The Cities Solutions Hub (CSH) of the Resilience Exchange is a place where urban "solutions" (tactics, initiatives, or projects) can be publicly posted online for others to apply to their own project. https://cities.sphaera.world/boards/climate-change-adaptation-of-urban-infrastructure	This can be accessed to gain inspiration and ideas around climate change adaptation and resilience beyond Ontario
The Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR)	climate change, adaptation, vulnerability, ideas	OCCIAR is a not-for-profit, university-based resource hub, based out of Laurentian University. Communicates the latest climate change research, liaising with various partners from across Canada to encourage adaptation, and aiding in the development and application of tools to assist with municipal and sector-based adaptation. Resources include climate change adaptation community of practice (COP), case studies, tools and frameworks, datasheets, reports and climate data survey. (http://www.climateontario.ca/index.php)	Access for a range of tools and resources related to climate change, trusted alternate source of information and for exploring resources and options
Frameworks to Guide Progress			
The Natural Step	framework, sustainability, financial	The natural step is a framework for applying a systems approach which includes 'backcasting from sustainability principles', ABCD (awareness of vision, baseline, creative solutions, and decide on priorities) approach. Within it are also tools to help apply the framework, such as strategic life-cycle costing. This framework is well established	This framework is best used to create a shared vision of sustainability that can be referred back to at key junctures. While this framework is more commonly used for business sustainability, the principles have been applied to a utility or municipality.
Sustainable Municipal Water Management framework	framework, sustainability, ideas	Developed by the Great Lakes and St. Lawrence Cities Initiative under the Green Cities Transforming Towards Sustainability (Green CITTS) program. This framework sets out six principles and twenty-five milestones to work towards. Indicators indicate by a 3 colour system how the city is doing on a given indicator and shapes indicate progress and milestones. It is a voluntary framework that a city can undertake and repeat to track progress and have public accountability and engagement. It is intended for cities along the Great Lakes which are part of the organization, but could be adopted more broadly.	This organization offers support from more of a political perspective as it is a binational coalition of mayors and other local leaders. Its tools and resources can be used if public engagement and non-specialist engagement (e.g. city council) is a priority. There are examples of other cities, such as Durham Region, which can be reviewed as an ON example.

	Tags	Description	Complements.../or use when
Climate Ready Infrastructure and Strategic Sites Protocol (CRISSP)	framework, climate change, risk, ideas	Developed by the Great Lakes St. Lawrence Cities Initiative (GLSLCI) through the Climate Change Adaptation program in partnership with AECOM and University of Michigan is a relatively simple low-cost approach to assess the vulnerability of their assets to extreme weather by utilizing available data and municipal staff's own knowledge of their facilities and infrastructure. The CRISSP is a step-by-step process to assemble a team, gather relevant information on hazards and climate data, identify municipal infrastructure, facilities and sites located in extreme weather hazard zones, and perform a vulnerability assessment on them. A key aspect of the CRISSP is a Risk Matrix tool that takes users through a series of critical questions to assess the vulnerability of municipal facilities, sites or infrastructure. The GLSLCI Climate Change Program and community of practice (Municipal Adaptation and Resiliency Service), includes a climate change adaptation best practices library and practical steps to be implemented in small and large cities.	In the case that a formal asset management program is not in place, to gain a high level overview of vulnerabilities of assets where it has not yet been done on a holistic basis, or for one set of infrastructure to help prioritize adaptation measures and future studies
A Practitioner's Guide to Climate Change Adaptation in Ontario's Ecosystems (Version 1.0) (2011)	framework, climate change, risk, adaptation	Developed by the Ministry of Natural Resources (MNR), in collaboration with Ontario Centre for Climate Impacts and Adaptation Resources (OCCIAR). This guide introduces a framework to assist natural resource management practitioners to mainstream climate change into decision-making and operations, and, where necessary, to develop new policies and management approaches. It describes tools and techniques for understanding the potential vulnerabilities and risks of a changing climate on natural systems in Ontario and a process to support adaptive management. While many of the tools described in this guide can be used by other sectors, it is not a tool intended for use for developing municipal or infrastructure related climate change action plans. The guide is focussed on adaptive planning and management of social-ecological systems, such as parks, forest management unit, fisheries management zone	This framework may be best used for management specifically if climate adaptation to urban parkland or natural areas are the primary concern.
CCME Implementation Framework for Climate Change Adaptation Planning at a Watershed Scale (2015)	framework, climate change, adaptation, watershed	CCME framework emphasizes a process of adaptive management and mainstreaming of climate adaptation with the following steps: Increase Knowledge, Assess Vulnerability, Assess Future Risk, and Identify Adaptation Solutions, Implement, Monitor and Adjust.	This framework is emphasized for management at the watershed scale, so best completed in collaboration with local conservation authority
CCME Tools for Climate Change Vulnerability Assessments for Watersheds (2013)	framework, climate change, vulnerability, watershed, risk	This CCME compendium of tools was prepared for use by technical experts, adaptation planners and resource managers to develop climate change vulnerability assessments of water quantity and water quality at a watershed scale.	Applicable when more in-depth background and review of vulnerability assessments is required or desired. 2015 CCME framework for adaptation planning builds on this for implementation.

	Tags	Description	Complements.../or use when
ICLEI Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation (2014)	climate change, framework	Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation is a compendium of resources that provides a milestone based framework to assist local governments in the creation of adaptation plans to address the relevant climate change impacts associated with their communities. Although climate change adaptation is a complex process, this guide aims to provide a straightforward methodology to adaptation planning using a five-milestone approach. Municipalities can get support in implementing this methodology with one-on-one help from ICLEI Staff if they join the Building Adaptive & Resilient Communities (BARC) Program. As participants of this Program, municipalities have full access to an Online BARC Tool.	This tool is a more general framework for community climate change adaptation; municipal water management can also be integrated into this framework as part of a more holistic approach, or this methodology could be applied to the urban water cycle and adaptation of the community and utility that is required. Access to the online tool and supports may be attractive to municipalities seeking additional support
Functionality-survivability-sustainability (FSS) framework	framework, ideas	This framework was developed for a PhD by Jyoti Kumari Upadhyaya at the University of Windsor. This research presents a three-pronged framework focusing on the functionality-survivability-sustainability (FSS) aspects for sustainability assessment for stormwater infrastructure as its example. Existing sustainability assessment tools focus mainly on the functional aspects of environmental, social and economic performance separately with emphasis on reducing resource use, and do not capture the changing demands and issues comprehensively. Infrastructure sustainability is defined as the ability of the system to function well and be able to survive complex and emerging stressors without increasing resource consumption, impacting people's health and well-being, and be able to manage for changing circumstances.	
Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol	climate change, risk, vulnerability, framework	Developed by Engineers Canada in partnership with Natural Resource Canada. PIEVC Protocol involves five step Public Infrastructure Engineering Vulnerability Committee (PIEVC) protocol to assess the vulnerability of buildings, roads and associated structures, stormwater and wastewater systems, and water resources. % steps include 1) Project Definition, 2) Data Gathering & Sufficiency 3) Risk Assessment 4) Engineering Analysis 5) Conclusions & Recommendations. The results of a PIEVC Protocol assessment inform decision-makers to a level that is adequate to develop cost-effective recommendations that adapt the highest risk components to improve their resilience to climate impacts in ways other assessment tools may not.	The protocol assists in the mainstreaming of climate risk assessment into existing and new infrastructure decision-making. Well regarded tool, which can be integrated into asset management, but requires a detailed set of information to carryout, and may be more difficult for smaller, less resourced municipalities - although not deemed prohibitive
Municipal Risk Assessment Tool (MRAT)	framework, climate change, risk	insurance Bureau of Canada (IBC) developed the tool to help communities reduce flooding caused by sewer backups. MRAT is now owned and operated by Tesera Systems Inc. MRAT is a web-based assessment tool that calculates the probability of municipal sewer and stormwater infrastructure failures based on municipal infrastructure, current and future climate, actual weather events, to help prioritize infrastructure investments.	Similar to PIEVC Protocol, but owned by Tesera Systems, so if outsourcing work rather than completing internally, may be appropriate. Complement to a more holistic water framework, as this is specific to stormwater and sewer systems.

	Tags	Description	Complements.../or use when
CVC Developing an Integrated Risk Management Framework to Support "One Water" in Municipalities (2015)	framework, climate change, sustainability, risk, ideas, integration	To support municipalities as they make the move to integrated water management and water sustainability planning, the University of Guelph in partnership with Credit Valley Conservation (CVC), McMaster University and Dalhousie University conducted a project in 2014-2015 to identify and remove some of the barriers that prevent municipalities from adopting a "One Water" approach. The report is structured by a framework that illustrates the basic components municipalities need to consider when aiming for a One Water approach. The components of the proposed framework, which includes sections on legislation and governance, the watershed approach, asset management practices, integrated risk assessment, innovative green infrastructure technology, and integrated financial planning.	This framework and resource is very comprehensive with multiple suggested tools within it, best used by municipalities which require/desire substantial guidance
National Water and Wastewater Benchmarking initiative – Utility Management Model	benchmark, sustainability, asset management, integration	Carried out by AECOM, this annual benchmarking initiative measures aspects of water, wastewater, and stormwater systems to indicate performance of the participating utilities within the contexts of productivity, reliability, labour, environment, financial efficiency and infrastructure reliability as these pertain to sustainability. There are around 50 utilities which participate in water/wastewater reporting, and around 30 for stormwater utilities. The goal is for continuous improve quality and performance. now serves as the national standard for water and wastewater utility benchmarking in Canada, and provides network and information base to identify opportunities for improvement.	This data can be used by reviewing the public report for comparison purposes (several years old), or through participation to augment asset management program. Inherent in the metrics are some which relate to sustainability and can be used to track year to year progress
Integrated Modelling Tools	integration, modelling	Looking for opportunities to capture integrated impacts in existing models, and also to put into practice new models which better capture integrated effects	Complements existing master planning processes which utilize models for water, wastewater, and stormwater, and rivers. Investigating opportunities to apply integrated modelling and/or integrating considerations for other elements of the urban water cycle
Building Together – Guide for Municipal Asset Management Plans	asset management, framework	This Ontario Ministry of Infrastructure guide outlines the reasoning and steps for creating a municipal asset management plan. An AM plan with the features outlined in this report is now required to be eligible to apply for provincial funding, and upcoming regulation is expected to legislate AM plans, similar to this guide. (https://www.ontario.ca/page/building-together-guide-municipal-asset-management-plans)	Combine with sustainability metrics, climate change risk and vulnerability assessments, and green infrastructure asset management (CVC)

	Tags	Description	Complements.../or use when
CVC Water Sustainability Planning Guide	framework, sustainability, integration, stormwater, watershed	A detailed document which focuses on how municipal water service providers can take a One Water approach, which considers municipal water management from a watershed perspective. Provides help to municipalities with collaborative planning for growth, aging infrastructure, and climate change; integrating water, wastewater, and stormwater infrastructure and services; applying innovative technology and practices. Builds on existing asset management and financial reporting lifecycles analysis practices, and helps municipalities integrate provincial plans (e.g. SWP) with municipal scale initiatives (Official Plans, watershed studies), with a focus on developing water sustainability plans to optimize stormwater infrastructure. Town of Oakville has undertaken one pre-emptively (sustainability plans under WOA 2010 not regulated)	Highlights that elements of sustainability plans are already covered off in existing planning practices – this helps link them. Good justification for the approach – identify cost-effective solutions and helps to prioritize investments, and reveals risks. Emphasized multiple benefits through One-Water Approach. Detailed plan that assists with adopting One-Water Approach when more guidance is sought and there is commitment to adopting a One Water approach.
Integrated Water Resources Management (IWRM) Framework	integration, ideas, watershed, framework	IWRM framework is well established and there are multiple organizations which provide guidance documents on carrying out IWRM - including the Global Water Partnership, United Nations. The broad steps include reviewing and setting national goals, water resources assessment, water resources policy/strategy, development of an IWRM implementation plan, action of implementation, monitoring and evaluation of progress, and repeat in a cyclical fashion. (http://www.un.org/waterforlifedecade/iwrm.shtml)	This general resource will provide important overarching guidance to the principles and broad considerations on a water basin basis -broader than the boundaries of the municipality. This provides an overarching framework and is recommended to be used in conjunction with finer scale tools for advancing with tangible progress
Water Management Framework for Ontario – Conservation Ontario	integration, watershed, framework	Developed by Conservation Ontario as a guide to integrated water management in Ontario - a framework tailored to the Ontario context was developed. Integrated Watershed Management is defined as: managing human activities and natural resources in an area defined by watershed boundaries aiming to protect and manage natural resources and their functions today and into the future. Under the umbrella of IWM, the water management framework is intended as a practical guide that assists agencies with a mandate for water management to work together to fulfill their collective mandates to ensure a sustainable water resource for the Province of Ontario. The framework involves the following cyclical steps: overarching principles, characterization of the system, monitoring, current and future uses, assessments (quantity/quality/natural infrastructure), managing uncertainties, desired management approach via different management instruments, implementation plan.	Use when working closely with CA and desire to focus on IWM approach. There is a detailed guide and tools to carry out work outlined in the framework, including a water budget overview.

	Tags	Description	Complements.../or use when
Multi-use Water Services	integration, framework	MUS has been developed over time and can be applied to a range of contexts. In an international development context to improve provision and efficiency of water services. The general framework can be used to guide decision-making for a more integrated approach to water management focused on service provision. It includes: introducing MUS concept to water users and service providers, situational assessment, visioning and strategic planning, fitting the financial framework, implementation of MUS interventions, support to continuous service provision and repeat. The framework also highlights the need for complementary work in the 'enabling environment' - including evidence-based advocacy on potential and barriers to this approach, and capacity development for enabling environment for integration.	MUS supports a more bottom up approach to implement IWRM principles; provides a framework which can be applied to a smaller scale and in that way can be less daunting, although there are trade-offs for a smaller scope (e.g. applied to city scale vs watershed)
DRAFT WEF Water Reuse Roadmap	integration, reuse, framework, ideas	The reuse roadmap was developed by industry experts on the implementation and practise of reuse. This document outlines the concept of IWRM and One water which support water reuse, best practices for strategic planning and concept development, regulatory development, treatment technologies, and financing. Available Fall 2018	Recommended when water reuse is under consideration and to gain guidance and ideas; can be used within the context of a larger One Water or IWRM framework specifically for implementing reuse.
DRAFT Framework for Evaluating Alternative Water Supplies: Balancing Cost with Reliability, Resilience and Sustainability	integration, uncertainty, framework, climate change, sustainability, water supply, reuse	A practical framework for evaluating water supply projects within the context of integrated water supply planning that addresses the concepts of sustainability, resiliency and reliability along with cost and traditional criteria. The Framework provide guidance on selecting system measures that could be employed to evaluate water resources system performance; identifying and prioritizing risks and uncertainties that should be incorporated into water supply plans; describe the database management and modeling tools that could be adopted depending on the nature of the systems to be analyzed; and describe options for methods to facilitate investigation of alternatives for water supply projects and portfolios, and graphical displays of results across a wide range of possible future conditions. The Framework provides methods and strategies useful for evaluating traditional as well as alternative water supplies.	This is a comprehensive framework which outlines an approach and a range of tools - to be carried out primarily on an assessment of water supply - but with an integrated approach. Despite being comprehensive, still be situated within a broader, overarching watershed based, One Water framework for a range of water services (not just supply). Modelling, risk assessment, and costing tools described in this tool could be applied to other contexts - storm and wastewater infrastructure and natural systems.
Water Security	integration, framework, risk	The water security framework is an emerging framework to assess the sustainability of water on a range of different scales, including municipal. Water security is a new framework but focuses on adequate quality and quantity for ecosystem and human health and economy with acceptable levels of risk. There are varying dimensions of water security: water resources, ecosystem health, human health, infrastructure, governance.	This is an alternate framework that may resonate more if risk management and more severe conditions are faced by a given municipality. To be used as a guiding framework, complemented by risk management tools

	Tags	Description	Complements.../or use when
One Water framework	integration, framework, sustainability, climate change	The One Water framework is a framework to consider all urban water together and merge existing planning and management structures, and develop new policies where necessary to bridge the gap. One Water incorporates a watershed based approach but is more oriented at urban waters of storm, wastewater and drinking water and energy which is attractive to the municipal scale water manager. The Water Research Foundation created a document which is the One Water Blueprint and outlines a basic framework which includes: setting the foundation, establishing direction, developing the framework, implementation - all the while incorporating stakeholder input and feedback loops.	This is an overarching framework well-suited to the municipal scale government, and provides a great deal of flexibility. Simple in concept, with less 'baggage' than IWRM
MOECC Water and Energy Conservation Guidance Manual for Sewage Works (2011)	efficiency, reuse, climate change, ideas	This document is a MOECC document which provides information on how to optimize water and energy efficiency and provides the most comprehensive set of information provided by the Ontario government on wastewater reuse.	More detailed water reuse information in USEPA Water Reuse Guidelines 2012. This can be used within a broader framework for concrete project ideas and guidance
DPSIR model (drivers, pressures, states, impacts, responses)	framework, cumulative effects, sustainability	DPSIR model (drivers, pressures, states, impacts, responses) to undertake an ecosystem-based approach and to account for cumulative effects. The framework is seen as giving a structure within which to present the indicators needed to enable feedback to policy makers on environmental quality and the resulting impact of the political choices made, or to be made in the future. According to the DPSIR framework there is a chain of causal links starting with 'driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritisation, target setting, indicators). Describing the causal chain from driving forces to impacts and responses is a complex task, and tends to be broken down into sub-tasks, e.g. by considering the pressure-state relationship	This is helpful to understand cumulative effects, and link/incorporate sustainability indicators to policy making.
CMHC Guidelines for Residential Rainwater Harvesting Systems Handbook (2012)	reuse, stormwater, design	This document provides a summary of the regulatory context and design for residential rainwater harvesting systems. It was developed with input across Canada. This document is aimed at a wide audience, including homeowners, engineers, architects, contractors, developers, regulators, as well as members from municipal, provincial and federal levels of government. Background information on each aspect of a RWH system is discussed, and relevant clauses from existing codes and regulations, standards and guidelines are presented, as well as additional design criteria derived from recent field experience and international best practices for rainwater harvesting. The city of Guelph has a strong municipal program for supporting rainwater harvesting, and the Guelph RWH manual can also be referenced for Ontario specific examples: City of Guelph Residential Rainwater Harvesting Design and Installation Best Practices Manual Version 2.0	To be used to support implementation of holistic water frameworks. Review City of Guelph as an example of a city-wide program to support rainwater harvesting
CVC developing a "Green Infrastructure Asset Management Planning"	stormwater, framework, green infrastructure, asset management	This document is currently under development by the Credit Valley Conservation Authority in support of alternative approaches to stormwater management.	Use in combination with other asset management programs and planning, and overarching sustainability, one water frameworks to support implementation phase and including GI

	Tags	Description	Complements.../or use when
International Infrastructure Management Manual, 2015	asset management, framework	This resource has to be purchased, but provides an industry standard for asset management, based on the ISO 55000 Asset Management Standards. This manual provides guidance on a range of areas, including strategic planning and policy, risk management, assessing and managing infrastructure resilience	Use to support the development of an asset management program, and/or for specific guidance on risk management and resilience - in conjunction with other resources coming from climate change adaptation advocacy groups (tools identified under climate change and vulnerability assessments).
Municipal Benchmarking Network Canada (MBNCanada)	asset management, information	This is a voluntary program, which previously was Ontario Municipal Benchmarking initiative, now national, provides reports publicly, currently includes 16 municipalities in 6 provinces, covering 37 service areas, 670 measures, so that progress can be tracked and support continuous improvement and evidence based decision-making. Use for information purposes, to support AM program, and/or join as a member. http://mbncanada.ca/	Complements existing asset management, can provide information on types of indicators to assess

Appendix B: Background Information Supporting Diagnostic Development

Drivers for Evolution of Water Systems

Drinking Water Source and Treatment

With climate change, the municipal water source may become compromised due to pollution, reduced water availability, or both. For example, the E.coli outbreak in Walkerton in 2000 can be tied to extreme weather whereby consecutive days of above average rainfall facilitated pathogen transport (Chiotti, Tonto and Perun 2012). In general, Health Canada has found that high-intensity precipitation events double the likelihood of waterborne disease outbreaks, likely due to the increased transport and connectivity of organic contaminants and suspended solids carrying bacteria from agricultural areas to water supplies (Health Canada 2005 in (CVC 2016)). Depending on the drinking water source, increased temperatures and land use changes may lead to seasonal and/or long-term reduction of water availability and quality due to changing input into the aquifer/surface water, and may necessitate investment in new water sources and/or more advanced water treatment. Changing climate conditions, such as increased temperatures and more frequent and intense rainfalls, contribute to algae blooms. Land use practices which remove hydrologic features such as wetlands reduce these nutrient sinks from the landscape (Cheng and Basu 2017). Algae blooms affect taste and odor but also can produce toxins which require treatment processes and operations that conventional WTPs may not be equipped with – posing a risk to public health.

Water quantity will also be stressed with growing populations. While expanding and upsizing drinking water treatment and are not new activities for municipalities, traditional sources may be stressed due to the compounding effects of climate change and potentially a significant cost as a large portion of infrastructure will require replacing due to deterioration and priorities may need to be made due to years of inadequate funding. Uncertainty around water quantity may lead to an increasing need for municipal water conservation and efficiency efforts. Growing population may also lead to an increase in abundance and concentration of emerging contaminants (e.g. pharmaceuticals, hormones, etc.) in drinking water supplies, which will require more advanced source water protection and pollution prevention, and advanced water treatment (CVC 2016) (Sedlak 2014).

Selection of new drinking water supplies and treatment options will increasingly be considered in the context of climate change mitigation, as well as adaptation to changing realities. The Environmental Commissioner of Ontario (ECO) recently released a document called: Every Drop Counts: Reducing the Energy and Climate Footprint of Ontario's Water Use. This outlines that Ontario municipal water and wastewater represented 38% of municipal energy use and 32% of municipal GHG emissions, based on reviewing energy reporting data from O.Reg. 397/11 under the Green Energy Act (ECOa 2017). Water treatment represents approximately 25% of the 36% of total urban water GHG emissions based on 2011 normalized data (ECO 2017).

Water Distribution

Urban water systems depend upon reliable energy supply to maintain operation of treatment plants and pumping stations, and account for up to one half of the municipalities energy use (MOECC 2011). Electricity transmission and distribution lines are susceptible to the effects of extreme weather which in turn doubly impact urban water systems, as seen in the 2003 region-wide blackout and 2013 ice storm (Ligeti, Wieditz and Penney 2007). This may lead to an increase in efforts related to emergency power and contingency plans. As outlined in the ECO introduced above, based on 2011 normalized data, water distribution pumping represents approximately 25% of GHG emissions of urban water management (ECO 2017).

Growing population, including intensification of core areas will necessitate upgrades to distribution infrastructure, which may include piping, booster pumping stations, and storage. The need for upsizing may conveniently coincide with the need to update aging infrastructure. However, it may be difficult to make informed decisions when limited information is available for asset management – although this will likely improve as Asset Management Plans become regulated (MOIa 2017). Infrastructure, particularly buried infrastructure of the distribution and collection networks, that is in a poor state of repair and near the end of its useful life is more susceptible to catastrophic failure and flooding, costly repairs to adjacent public and private infrastructure, and threats to public health and safety (CVC 2016). Physical degradation and outdated capacity can lead to infrastructure failure, the result of which is often more expensive than the maintenance, renewal and even replacement may have been (CVC 2016).

Up to 30% of treated water can be lost due to leaking infrastructure or through the treatment process and maintenance of the system – unaccounted for water (UFW). This represents an inefficient use of energy and water resources. Distribution systems are pressurized to ensure that if there is a breach in the network, water flows out rather than in. However, some research has indicated that increasing pressure to offset the risk of leaks from 105 psi to 123 psi increased risks of pipe breaks by 6-fold (from 1 to 6 breaks per 100 km of piping) (Ambrose et al. 2010 in (CVC 2016)). Pipe breaks not only affect the local area of the break but can compromise the system by wasting water and allowing contaminated water to flow back into the treated water distribution network.

Water Collection (Wastewater and Stormwater)

Wastewater and stormwater collection systems are designed based on historical weather data from intensity-frequency-duration (IDF) curves, which no longer are representative of current and future climate conditions. New approaches, such as incorporation of low impact development (LID) strategies and green infrastructure will be helpful to mitigate and prevent urban flooding, sewer overflows, and basement flooding (Maksimovic, Kurian and Ardakanian 2015). Unfortunately in Ontario, these practices are not broadly established in all municipalities. The use of living green infrastructure could also help mitigate some of the water quality issues that increasingly arise in the concrete drainage networks, related to algae growth from increased temperature from urban runoff (changing land use) and intensification. Increased temperatures due to climate change and warm infiltrated stormwater runoff can also exacerbate the growth of biofilms in sewers which produces hydrogen sulfide gas, which is

harmful to human health and can accelerate corrosion of collection infrastructure (CVC 2016) (Nicklow, Boulos and Muleta 2004).

Increased intensities of precipitation events along with aging infrastructure which allows for infiltration of rainwater, and growing populations which put pressure on existing infrastructure, contribute to wastewater treatment by-pass events and sewer backups leading to basement flooding. Basement flooding in recent years became the leading reason for insurance payouts, over fires, at an estimated value of \$1.7 billion per year across Canada ((IBC 2012 in (CVC 2016)). As well as risks to collection infrastructure from infiltration, sewage exfiltration or leaking is a concern for protecting drinking water aquifers and the distribution network. A recent study in Guelph, “Ontario found 90% of the city’s 22 drinking water wells contained at least one sewage-derived contaminant and 45% of the wells exhibited human enteric viruses derived from sewage exfiltration (Allen 2013)” (CVC 2016).

Wastewater and Stormwater Treatment

Due to increasing stress on ecosystem from climate change and from growing populations, existing levels of wastewater treatment may be insufficient to maintain ecosystem health and quality of downstream water supplies. In addition, urban runoff under changing weather patterns may pose a risk to natural water bodies, and additional investment may be needed to mitigate stormwater quality.

Despite accounting for growth and changes in consumption behaviours, much of the planning for future water supplies is based on the assumptions of present conditions. However, the large water infrastructure deficit, the energy costs, as well as potential future environmental regulations for water takings and effluent discharges (as influenced by growing populations and climate change) may very well alter the landscape of water management in the future. What is considered economically, environmentally, and politically sustainable today may not be considered as such in the future. For these reasons, that there are sufficient drivers to necessitate the consideration of more sustainable, integrated water management including new approaches such as green infrastructure, water reuse, and more holistic planning in Ontario to address current and future municipal water supply management challenges (Jusek and McDermott 2015). Natural water bodies have assimilative capacities – indicating the amount of nutrients and degradation that can be accommodated without detrimental effects on aquatic life. As population grows, eventually more stringent treatment will be required to meet assimilative capacity requirements.

As outlined in the ECO introduced above, based on 2011 normalized data, wastewater treatment and pumping accounts for approximately 50% of GHG emissions from urban water management (ECO 2017). Of the treatment processes, activated sludge aeration, which is typical of secondary level treatment plants, is the largest energy consumer accounting for 55.6% (ECO 2017) (Metcalf & Eddy 2014). As new and more stringent requirements for meeting wastewater effluent standards are introduced, in part because some of the dilution and blending will increasingly be reduced due to growing volumes of wastewater from growing cities, energy costs and GHG emissions will increasingly be considered in decision-making processes.

Costly upgrades to WWTPs will have to consider increasing resilience to weather related events and emerging contaminants. Wet weather flows currently result in sewer by-pass events which allow for untreated sewage to bypass treatment plants that are at capacity. Additionally, WWTPs were historically built in flood plains and themselves can be flooded and unable to treat incoming wastewater. These events can have significant impacts on downstream communities and aquatic wildlife. Conventional WWTP processes do not remove many emerging contaminants which pass through unabated to the natural waterways. There are uncertain impacts on human health given the low concentrations, but measurable impacts have been seen on aquatic wildlife. “A surface water study found that 80% of 139 streams sampled across 30 U.S. states contained a wide range of CECs, believed to be from residential, agricultural and industrial sources (Kolpin et al. 2002)” (CVC 2016).

Natural Waterways and Landscape

Changes in land use associated with growing populations and expanding urban areas have impacts to the urban water cycle, most directly observed through the impact on stormwater management. Increased urban cover without the integrated use of green space is less permeable generally hotter (black asphalt roads, roofs) and increases runoff volumes and peak runoff rates to receiving water bodies after a rain event. Potential impacts to natural waterways which stormwater discharges to may see increased erosion, sediment loading and temperatures. This could pose a flooding risk to downstream communities, negatively impact aquatic wildlife and habitats, in particular cold water species (CVC 2016). Urban waterways are typically used for recreational or navigational purposes, and the changes to stormwater drainage patterns could degrade the quality of the waterway for other purposes (Maksimovic, Kurian and Ardakanian 2015).

In addition, outdated flood plain maps in Ontario pose a risk to municipal and private infrastructure as they flood maps may not reflect the increasing threats associated with climate change and land use changes. Invasive species are also an increasing risk associated with changing climate. Warmer weather supports species which damage vegetation. Loss of urban forests and vegetation will further exacerbate challenges of climate change and urban water systems related to temperature, slowing down storm runoff, and the urban heat island effects (Maksimovic, Kurian and Ardakanian 2015). Additionally, warmer waters and increased human traffic and development have introduced invasive species to fresh water systems such as the Great Lakes. Zebra mussels and quagga mussels have been particularly challenging to drinking water intakes in the Great Lakes.

New Technology and Innovation

New technology, such new and optimized forms of treatment and ‘smart systems’ which use data analytics and artificial intelligence to optimize operation, have a role to play in influencing and supporting decision-making around sustainability in urban water systems. New water treatment technologies – such as membrane aerated biofilm reactor (MABR) – can drastically reduce energy for the most energy consumptive treatment process in wastewater treatment through a significantly more efficient oxygen transfer process than conventional aeration for activated sludge. Additionally, the increasing cost-effectiveness and reliability of improvements in membrane technology enables

wastewater treatment plants to increase capacity in the existing footprint and more effectively remove contaminants to support subsequent water reuse while protecting public health and the environment (Metcalf & Eddy 2014). While technology itself is not a driver, having reliable, affordable, and proven technology innovations readily available can help support sustainable actions and management in practice.

Recurring Principles for Sustainable, Integrated Water Management

Risk management is a method of identifying the consequences of certain occurrences, their probability and severity, and using this information to prioritize actions to mitigate damage or harm. It is well established in water management through the establishment of regulatory drinking water and environmental water quality standards, and is an appropriate tool to apply in the face of uncertainty, such as climate change adaptation (May and Plummer 2011).

Resilience is increasingly used in the context of climate change adaptation for urban water systems, and is defined by the IPCC as “ability of a system and its counterparts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner” (Boyle, Cunningham and Dekens 2013). With respect to urban water systems, resilience can refer to the physical water infrastructure and the management and operations of the water system and the respective ability to adapt to changing conditions without catastrophic loss (Boyle, Cunningham and Dekens 2013) (K. Jusek 2015). Resilience can be increased through protocols, such as emergency response plans, and through infrastructure design, such as green infrastructure.

Due to the uncertainty of climate change and aging infrastructure, whereby historical conditions are not necessarily a predictor of the future conditions, adaptation measures and decision-making related to climate change need to be flexible and learning-oriented (May and Plummer 2011). **Adaptive management** is decision-making framework in the context of uncertainty which focuses on systematic learning, collaboration, and knowledge generation by allowing “learning by doing” (May and Plummer 2011). The adaptive approach to governance is manifested in staged water projects, monitoring and evaluation, and iterative planning processes, and policies flexible to future amendment (Conservation Ontario 2010).

The **precautionary principle** states that: “Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation” (United Nations, 1992 in (Government of Canada 2017)). That is, the absence of complete scientific evidence to take precautions does not mean that precautions should not be taken, particularly when there is a change of irreversible damage (Government of Canada 2017). This principle with respect to sustainable water management can be framed as a ‘no regrets’ philosophy that results in actions which have benefits regardless of the outcomes of future uncertainties, such as climate, population, and/or economic changes (GLSLCI 2012).

Integration of disciplines in urban planning for engineered and natural water systems, and land use management is generally accepted as a means to handle complexity and connectivity and managing diverse objectives and interests (Hanna, Webber and Slocombe 2007). Integration of infrastructure and

the planning of it can allow for increased efficiencies for multiple beneficial uses as well as identify tradeoffs or unintended consequences. For example, utilizing stormwater onsite can offset potable water demands but also impact solids removal in the wastewater collection system. In practice, integration can include developing links and coordination between organizations and policies sectors, stakeholder participation, developing shared understanding of issues, agendas and program choices, and conflict resolution mechanisms (Smith, et al. 2014) (Carter, Kreutzwiser and de Loe 2005).

The basic premise of **sustainability/sustainable development** is balancing environmental, social, and economic interests and tradeoffs for current and future generations (Government of Canada 2017). With respect to urban water systems, sustainability results in decision-making and investments will aim to maximize the benefits and minimize the negative impacts to economic prosperity, social equity, and cultural vibrancy, and ecological resilience of the municipality and watershed. Approaches to capture social and environmental costs and benefits more fully and quantitatively have their limitations, but are an essential component of managing urban water systems in a sustainable manner. Examples of existing decision making tools that support this are Triple-Bottom Line and evaluating 'delayed costs' of infrastructure upgrades.

Cumulative Effects is an important concept in sustainable urban water management as it helps draw connections between small-scale, individual actions and their eventual consequence at a large scale. For example, fertilizing lawns, salting driveways, excessive water use, and using personal care products which contain microbeads are individual actions which when practiced by a large, urban population represent a significant magnitude. Sustainable, holistic urban water systems are increasingly focused on non-point forms of pollution, and distributed or decentralized water management as centralized approaches are increasingly expensive (Libralato, Ghirardini and Avezzi 2012).

The final recurring principle/concept is managing water at the appropriate scale and empowering that level of authority to successfully implement policies, referred to as **jurisdiction best-placed**. The most appropriate and effective scale of water management has long been debated (Vörösmarty, Hoekstra and Bunn 2015). In general, a nested approach is recommended which supports policy development at all scales – e.g. provincial, conservation authority/watershed, and municipal – but implementation is carried out at the smallest, most local scale feasible. This allows for a coordinated approach but to be successful requires adequate funding, human resources and legal authority at the level of implementation (Conservation Ontario 2010).

Barriers to Progressing on Sustainable, Integrated Water Management

Challenges with implementing IWRM are related to a number of factors, including barriers related to coordination and participation, the scale of implementation, stakeholder capacity, and education (Cervoni, Biro and Beazley 2008). This can be attributed to the fact that in many jurisdictions, including Ontario, aspects of sustainability such as IWRM plans and watershed plans, are not enforced and are required to be up taken into municipal land use planning documents, namely the Official Plan, to be enacted (Mitchell 2005). Increasing integration across existing policy regimes and institutions has proven challenging as this requires reconciliation of different sets of rules, knowledge, approaches and values that can be deeply divided (Rouillard, et al. 2013). Ontario conservation authorities that have been

involved in watershed management, and while some success has been seen in implementing IWRM, fragmentation and funding represent ongoing challenges (Cervoni, Biro and Beazley 2008) (Plummer, Spiers, et al. 2005).

When looking at introducing for example, water reuse and municipally supplied non-potable water, it becomes evident that the existing regulatory framework for ensuring public and environmental safety has gaps. For example, in Ontario, there are not currently established design standards, permitting processes and water quality guidelines for non-potable water and for a range of approved uses (Jusek and McDermott 2015). For green infrastructure and decentralized systems, some of the major challenges are related to new monitoring and maintenance schemes needed to ensure systems are operating properly to meet public health and environmental objectives (Krebs 2016). This framework results in a shift in distribution of costs. For example, the majority of costs in a decentralized system (e.g. residential grey water system) are borne by the homeowner and become prohibitively high unless the various water utilities recognize the co-benefits to their systems and offset the costs to homeowners. This introduces the need to develop new public utilities or public-private partnerships (P3s) to manage maintenance and operation services of new satellite and distributed facilities (Trapp 2015).

Another challenge is in the limitations in the conventional design standards and guidelines to credit the contribution of, for example, the use of green roofs to the design of stormwater conveyance systems (Roy, et al. 2009). These new approaches work in tandem with the established centralized systems which are already installed, and require new accounting methods to incorporate avoided costs. Calculation and incorporation of avoided costs is the world of water efficiency and conservation, but is generally less well understood. It can be difficult to calculate the value of avoided costs for distributed infrastructure which represents a small demand in relation to the large capacity and capital costs of the centralized system (Mukheibir, Howe and Gallet 2014). Furthermore, the installation of a non-potable distribution network or dual-plumbing is most affordable at the time of construction, rather than retrofitting at a later date. Therefore, the use of decentralized or semi-centralized water facilities is optimal for new developments as a start (Libralato, Ghirardini and Avezzi 2012) (Gikas and Tchobanoglous 2009).

In general, there is a need in Ontario for an improvement in the valuation of water services – both conventional urban water system services and ecological and cultural water services. An integrated approach can help to capture and communicate to customers and water users the full cost of the provision of urban water services. This can provide a basis for employing economic instruments such as polluter pays, and market-based approaches for valuing ecosystem services (Conservation Ontario 2010). In general, the principle of the internalization of costs of a good or service over their lifespan from design to disposal, including externalities, is fundamental to sustainable development (Government of Canada 2017). Therefore, water managers at a range of levels need to develop new financing frameworks to reflect sustainable management. Regulatory approaches which ban certain activities which are known to cause harm, such as zoning mechanisms which designates where certain land use activities can occur or sewer use by-laws which put limits on what can be put down the sewer are examples of command and control approaches. The use of market-based approaches allow for more consumer choice in which the consumer can determine how much they are willing to pay to continue

utilize large volume of water or carry out a given harmful activity. An example of this is water rates which are volumetric based or stormwater fees which are based on impervious surface cover. A water user/customer can choose to implement actions to lower their fees or pay the price of keeping the status quo, and the funds generated from this can be used for restoration, for example. Both these approaches are well-established and broadly used, but there are opportunities expand these programs to be more protective. The challenge is in gaining political leadership and support due to the unpopularity of getting people to pay for something they used to receive for free (Stantec Consulting 2016).

Municipal Jurisdiction in Water Management

Water and wastewater systems in Ontario are owned and primarily managed by the municipality, both single tier, upper tier (counties and regional municipalities) and lower tier (cities, towns, townships, and municipalities) (CVCa 2016). Municipalities implement provincial and federal legislation and deliver water-related services. Various provincial legislation, such as the *Municipal Act* and the *Ontario Water Resources Act (OWRA)*, have given municipalities the authority to design, build, finance, own, and operate water, wastewater, and stormwater systems (OSWCA 2001). Over time, a significant number of responsibilities have been 'downloaded' on municipal governments. Under the Ontario *Municipal Act* the roles and responsibilities are divided between upper and lower tier municipalities. Upper tier municipalities, such as York Region, Region of Waterloo, Niagara Region, are responsible exclusively for water production, treatment, storage, and sometimes sewage treatment and collection, stormwater collection and drainage (CVCa 2016). Lower-tier municipalities are typically responsible for water distribution and collection systems, and sometimes stormwater based on legislated assignment of roles (CVCa 2016). Single Tier Municipalities, such as Guelph, have jurisdiction over all of the above and are perhaps have lower barriers for integrated, sustainable water management.

Design of municipal water systems relies upon local design standards, municipal environmental assessment processes, and provincial guidance and approval for treatment systems. Typically, design standards rely on historical information for engineering design, including for local precipitation to generate intensity-frequency-duration (IDF) curves for sizing stormwater and wastewater collection systems. Engineered water systems are designed with safety factors and include redundancies in case of failure, therefore a degree of uncertainty and an acceptable amount of risk is inherent in urban water systems design.

Through the *Municipal Act* and *Planning Act*, Ontario municipalities gain authority to create by-laws and protocols related to land-use planning and water management decisions (e.g. sewer use by-laws, development restrictions, etc.). Municipalities have the power to practice source control or pollution prevention through sewer use by-laws which control which substances are allowed to be discharged to the sewers and WWTP (CCME 2006). For the by-law to be effective, it must be adequately enforced.

The primary land use planning instrument at the municipal level is the Official Plan. The main mechanism in which the province influences planning is through the Provincial Policy Statement, for which Official Plans must be consistent with (Summers, Plummer and FitzGibbon 2003) (Hanna, Webber

and Slocombe 2007). Official Plans typically integrate results of watershed planning to protect significant hydrologic features. The potential conflict between the further integration of watershed planning and municipal land use is related to the trade-off between ecological and financial benefits, whereby ecologically detrimental development may generate large revenue for the developers and municipality (Binstock 2010).

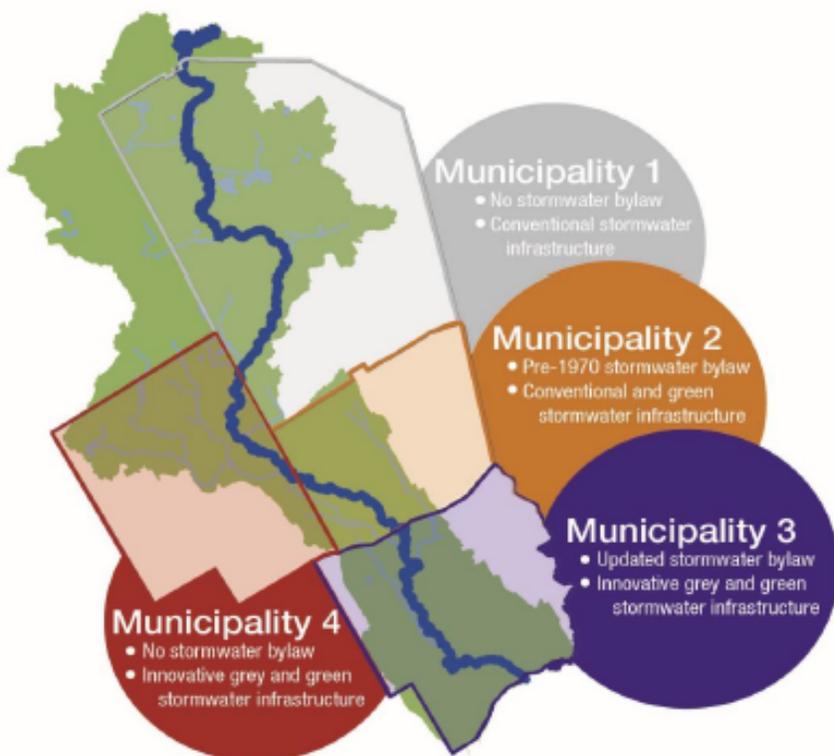
Municipalities undergo regular long-term reviews of water and wastewater system planning, such as master plans, to guide capital investment plans. Typically, master plans are carried out for water supply, wastewater treatment, water/wastewater servicing, and stormwater management, although the latter is a more recent trend. Natural heritage master plans, biosolids master plan, and community energy plans, and watershed plans may also be completed. Asset Management Plans are in addition to and in support of/supported by other master planning processes. They are going to become more standardized in their components due to upcoming regulation, but in general are intended to provide further insight into operating and maintenance, renewal and replacement costs of existing infrastructure. Current Asset Management Plans vary and in general stormwater systems have received significantly less attention than water and wastewater systems.

The adoption of innovative practices in the water sector is historically slow in Ontario municipalities. Lack of innovation stems from a risk adverse culture. This is because the consequences of failure to protect public health, the natural environment or property, are significant. New initiatives to pilot and demonstrate new technologies are one important piece to supporting sustainable water systems. Innovation in governance and policy is still required to truly support progress towards sustainable management.

On the other hand, failing to implement solutions to keep pace with growing challenges can lead to another set of risks. As the municipality is authorized to manage the urban water infrastructure and service delivery, this comes with risk of potential liability for failure – flooding, contamination of supply, etc. – that impacts private property and public health. As outlined above, the province is in the process of supporting municipalities in better managing their existing assets through upcoming regulation on asset management, this will help mitigate some risk associated with failure of aging infrastructure for which the municipality could be liable. Currently there is limited guidance to Ontario municipalities on best practices and/or requirements for adapting to climate change which presents an increasingly high consequence risk for municipalities. For example, Thunderbay lost a legal battle in tort law for failure to enforce downspout disconnections which contributed to basement flooding and was required to make a payout. Despite the fact policies were put in place by the city, lack of maintenance of infrastructure and enforcement of programs resulted in the court finding the city negligent in their standard of care (CVCa 2016).

From this it is clear that the municipality is working in a framework of meeting regulatory requirements and room to innovate and implement more stringent policies. For example, development of local stormwater utilities to finance stormwater management more effectively, developing guidelines for residential rainwater harvesting, and installing smart metering to manage water demands.

It is also evident that the municipality will have multiple entities to coordinate with – neighbouring and overlapping municipalities (upper/lower tier), conservation authorities, the provincial government, and



possibly the federal government. Figure B-1 from the CVC provides an example of this overlapping jurisdiction with respect to storm water management. Municipalities engage in a number of planning processes and it will be important for the provincial government/individual municipalities to determine if new planning processes are warranted, or if existing processes should be conjoined to support sustainable water management.

Figure B-1: Example of varying guidelines and standards across different municipalities (CVCa 2016)

Provincial Policy Framework

As can be expected, politics have a role to play in terms of influencing which issues related to sustainable water management receive attention, and the lens through which the sustainable water management agenda is advanced. Today, Climate Change has come to the fore on the political stage with the Paris Agreement under the United Nations Framework Convention on Climate Change taking place in late 2015 and increasingly expensive natural disasters across the country – wildfires, flooding, ice storms, algae blooms – to name a few. This has influenced the funding which has been made available at the federal level. The provincial government has since developed a Climate Change Action Plan, the Environmental Commissioner of Ontario (ECO) is attempting to connect all aspects of the municipal water sector to energy, and the province has now adopted a carbon-trading program (ref my Climate Change paper). The new liberal government’s approach to infrastructure investment has also caused the industry to consider the large deficit in funding and investment in infrastructure throughout the 1980s and 1990s, making way for renewed focus on asset management planning to make the best use of existing infrastructure before installing new infrastructure (MOI 2017). This has opened the door for conversations around connecting to climate change adaptation and mitigation, green infrastructure, and new management approaches, but has yet to be fully realized in term of top-down mandatory measures.

Municipal authority to manage water systems stems from and must meet the requirements set out in provincial legislation. The provinces have been granted jurisdiction over water management in the Constitution Act 1867 (CVC 2016). To manage water, municipalities rely on multiple government departments to develop legislation and administer programs (Ministry of Natural Resources and Forestry, Ministry of Environment and Climate Change, Ministry of Food and Agriculture, Ministry of Municipal Affairs and Housing, Ministry of Infrastructure, etc.). Some of the key legislation relating to municipal water management and discussion on how it supports or hinders progress towards sustainable water management principles is presented in this section. It is noted that traditionally water policies and programs are single-issue oriented, and practitioners must work across different ministries and regulations as water and environmental resources governance is shared across different agencies (conservation Ontario, 2010). In addition, while municipalities can go over and above regulation, and there are provincial mechanisms to require this through the permit and approvals process and individual class EA process, mainly municipalities shape their water management around meeting provincial regulations.

- Provincial Policy Statement (PPS)
- Growth Plan for the Greater Golden Horseshoe (GGH) (2006)
- Ontario Water Opportunities and Conservation Act (WOA), 2010
- Safe Drinking Water Act (SDWA), 2002
- Clean Water Act (CWA), 2006
- Ontario Water Resources Act (OWRA), 1990
- MOECC Supportive Documents
- Nutrient Management Act, 2002
- Asset Management Guidance and Upcoming Regulation
- Environmental Assessment Act, 1990
- Green Energy Act, 2009
- Ontario Building Code, 1992

It is worth noting that a number of regulations and Acts which would have been never were brought into action, in part due to the politics of the time or the transition of government. In the era of fiscal conservatism, emphasis on sustainable financing of water systems and full cost-recovery was put forth but never fully implemented – the Ontario Sustainable Water and Sewage Systems Act (SWSSA, 2002) and Sustainability Plans were also never fully brought into effect which would have supported this initiative (Ontario WOA, 2010) (Abouchar and Vince 2011).

Provincial Policy Statement

The *Planning Act* (1990) under the Ministry Municipal Affairs and Housing empowers municipalities to make zoning decisions including placing conditions on development approvals such as specifying water management and conservation measures. The Provincial Policy Statement (PPS), which is issued under the Planning Act, is the main mechanism in which the province influences planning as all single tier and regional level municipal Official Plans must be consistent with the objectives in the PPS (Summers, Plummer and FitzGibbon 2003) (Hanna, Webber and Slocombe 2007) (Binstock 2010). The most recent

2014 PPS has several progressive measures cited including support for water reuse through “promoting water conservation and water use efficiency, including stormwater attenuation and re-use” (1.6.6.7.e), emphasizing planning authorities consider increased hazards associated with climate change, optimization of existing infrastructure, promotion of green infrastructure, and that “the watershed is the ecologically meaningful scale for integrated and long-term planning.” (CVC, int risk and PPS 2014). Thus, there is opportunity and existing support for municipalities from the PPS through their Official Plans to support more sustainable water management practices.

The following are sections of the PPS relating to sustainable urban water management:

1.6 Infrastructure and Public Service Facilities

1.6.1 *Infrastructure, electricity generation facilities and transmission and distribution systems, and public service facilities shall be provided in a coordinated, efficient and cost-effective manner that considers impacts from climate change while accommodating projected needs.*

Planning for infrastructure, electricity generation facilities and transmission and distribution systems, and public service facilities shall be coordinated and integrated with land use planning so that they are:

- a) financially viable over their life cycle, which may be demonstrated through asset management planning; and
- b) available to meet current and projected needs.

1.6.2 *Planning authorities should promote green infrastructure to complement infrastructure.*

1.6.3 *Before consideration is given to developing new infrastructure and public service facilities:*

- a) the use of existing infrastructure and public service facilities should be optimized; and
- b) opportunities for adaptive re-use should be considered, wherever feasible.

1.6.6 Sewage, Water and Stormwater

1.6.6.1 Planning for *sewage and water services* shall:

- a) direct and accommodate expected growth or development in a manner that promotes the efficient use and optimization of existing:
 1. *municipal sewage services* and *municipal water services*; and
 2. *private communal sewage services* and *private communal water services*, where *municipal sewage services* and *municipal water services* are not available;
- b) ensure that these systems are provided in a manner that:
 1. can be sustained by the water resources upon which such services rely;
 2. is feasible, financially viable and complies with all regulatory requirements; and
 3. protects human health and the natural environment;
- c) promote water conservation and water use efficiency;
- d) integrate servicing and land use considerations at all stages of the planning process; and
- e) be in accordance with the servicing hierarchy outlined through policies 1.6.6.2, 1.6.6.3, 1.6.6.4 and 1.6.6.5.

1.6.6.7 Planning for stormwater management shall:

- a) minimize, or, where possible, prevent increases in contaminant loads;
- b) minimize changes in water balance and erosion;
- c) not increase risks to human health and safety and property damage;
- d) maximize the extent and function of vegetative and pervious surfaces; and
- e) promote stormwater management best practices, including stormwater attenuation and re-use, and low impact development.

2.2 Water

2.2.1 Planning authorities shall protect, improve or restore the *quality and quantity of water* by:

- a) using the *watershed* as the ecologically meaningful scale for integrated and long-term planning, which can be a foundation for considering cumulative impacts of development;
- b) minimizing potential *negative impacts*, including cross-jurisdictional and cross-*watershed* impacts;
- c) identifying water resource systems consisting of *ground water features, hydrologic functions, natural heritage features and areas, and surface water features* including shoreline areas, which are necessary for the ecological and hydrological integrity of the *watershed*;
- d) maintaining linkages and related functions among *ground water features, hydrologic functions, natural heritage features and areas, and surface water features* including shoreline areas;
- e) implementing necessary restrictions on *development and site alteration* to:
 1. protect all municipal drinking water supplies and *designated vulnerable areas*; and
 2. protect, improve or restore *vulnerable surface and ground water, sensitive surface water features and sensitive ground water features, and their hydrologic functions*;
- f) planning for efficient and sustainable use of water resources, through practices for water conservation and sustaining water quality;
- g) ensuring consideration of environmental lake capacity, where applicable; and

- h) ensuring stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces.

2.2.2 *Development and site alteration* shall be restricted in or near *sensitive surface water features and sensitive ground water features* such that these features and their related *hydrologic functions* will be protected, improved or restored.

Mitigative measures and/or alternative development approaches may be required in order to protect, improve or restore *sensitive surface water features, sensitive ground water features, and their hydrologic functions*.

(Ministry of Municipal Affairs and Housing 2014)

Growth Plan for the Greater Golden Horseshoe (GGH)

Growth Plan for the Greater Golden Horseshoe (GGH) (Growth Plan, 2006) is a comprehensive land-use planning policy for the GGH Region of Southern Ontario and designates communities for growth over the next 20 years. Some of the municipalities designated to grow which are reliant on groundwater,

including the City of Guelph and Region of Waterloo, considered large scale water infrastructure projects such as pipelines to the Great Lakes or expansion of existing infrastructure to meet longer term future demand. When comparing more drastic and large-scale future water supply options for municipalities, such as intra-basin water transfers, alternative water sources such as water reuse and enhanced conservation may become a more attractive option for securing local water supply, particularly in light of the uncertain impacts of climate change and the future political landscape for transfers within the great lakes watersheds (Binstock 2010) (Jusek and McDermott 2015).

Ontario Water Opportunities and Conservation Act, 2010

The objective of the Ontario Water Opportunities and Water Conservation Act (WOA, 2010) is to create opportunities for innovative water technologies supported through the marketing and business development support of WaterTap to support the development of a water clean-tech sector in Ontario. As well, it included the authority to the MOECC to establish municipal water conservation targets and the framework for Municipal Water Sustainability Plans, which promote an integrated approach to drinking water, stormwater and wastewater management. The Sustainability Plans include a focus on asset management, financial plans, conservation plans, risk assessment, and long-term planning (CVCa 2016). Within the WOA may be the opportunity to affect water pricing, which is significant as it may support reuse as a lower-cost water supply option. However, while the organization Water Technology Acceleration Project (WaterTAP), was created, no legislation has been enacted to mandate municipal Sustainability Plans.

It is unlikely that the Sustainability Plans portion of the Act will be pursued, as the effort for integrated asset management was taken up by the Ministry of Infrastructure under the forthcoming Asset Management Regulation under Infrastructure for Jobs and Prosperity Act, 2015 (ECOa 2017). The broader focus on all infrastructure and incorporation of strategic asset management into infrastructure planning decisions is beneficial for sustainable water management, there is overall less integration specifically on water management that Sustainability Plans would have offered (ECOa 2017). As Sustainability Plans are not to be enacted, this Act will primarily impact municipalities indirectly through the promotion and increasing prevalence of innovative water technology companies in Ontario. The WOA was intended to be what the *Green Energy Act* was to the energy sector, although it is unclear what concrete actions with respect to this will come to pass (ref Brenda, but also referenced in (MOECCd 2017). Other regulations intended to be borne out of the Act were requiring public agencies – including municipalities – to prepare conservation plans and achieve established conservation targets. It is noted that the WOA has a provision for Ontario Building Code (OBC) for the Minister of the Environment to review the OBC standards for water conservation every five years (Abouchar and Vince 2011).

Today WaterTAP has more than 900 companies engaged, reported that companies they work with grow up to 40% faster, and they have supported more than 28 million in economic growth (WaterTAP 2017). In line with innovation, the Province of Ontario's Showcasing Water Innovation program has invested \$17 million dollars in support of 32 projects. This investment enabled communities to test innovative approaches to sustainable water management (MOECCd 2017). The WOA also has provided the

platform for Ontario government agencies such as the Walkerton Clean Water Centre and Ontario Clean Water Agency to test, pilot and demonstrate technology solutions of 70 technology companies in water treatment facilities across the province (MOECCd 2017).

Safe Drinking Water Act, 2002 and Clean Water Act, 2006, Ontario Water Resources Act, 1990

The Safe Drinking Water Act (SDWA), Clean Water Act (CWA), and the Ontario Water Resources Act (OWRA) are three important umbrellas for the majority of regulations which impact municipal water systems, which is under the jurisdiction of the Ontario Ministry of the Environment and Climate Change (MOECC). Ontario has a robust, multi-barrier approach and comprehensive regulatory framework to protect municipal drinking water ranking the highest in Canada under Ecojustice's Canada's Drinking Water Report Card (MOECCc 2017). Under the MOECC, O. Reg 170/03 under the SDWA provides the framework for the provision of safe, sustainable drinking water and makes the owner, the municipality, responsible for meeting the regulation. The province must approve and issue permits (DWWPs) and licenses (MDWL) for drinking water systems for municipalities, in addition to a drinking water quality management system (DWQMS) which includes an approved Operational Plan, accredited Operating Authority, Financial Plan and Permit to take Water (PTTW) (Abouchar and Vince 2011). Financial Plans featuring full cost recovery³ was intended to be enacted under the Sustainable Water and Sewage Systems Act, 2002 (SWSSA). Unfortunately, this Act never came to pass and regulations required to enforce full cost recovery were never developed, and as a result Financial Plans required under the SDWA (O.Reg. 453/07) vary in their makeup and full-cost recovery is not common (Abouchar and Vince 2011). The CWA resulted in the development of source water protection (SWP) and was the result of the emphasis on the multi-barrier approach to drinking water (Plummer, de Grosbois, et al. 2011). Both the CWA and SDWA were borne out of the Ontario Walkerton crisis in 2000 in which 7 people died and thousands made sick by improper operation and oversight of a municipal drinking water system that resulted in a shift in drinking water governance (Shrubsole 2004).

SWP is organized at the watershed scale by conservation authority, which appoint locally organized, multi-actor source water protection committees (Plummer, de Grosbois, et al. 2011). The SWP Committees identify and make plans to mitigate existing and potential threats to drinking water quality and quantity. The landmark achievement of this newest watershed management initiative is the increased integration into land-use planning, since under the Clean Water Act, Official Plans must be consistent with approved source protection plans (Plummer, de Grosbois, et al. 2011). While there has been some uptake of watershed plans in the Official Plans over the years, until source water protection planning under the CWA there was no legal authority to do so, so this is considered an achievement and move towards more integrated water management (Plummer, de Grosbois, et al. 2011). While SWP offers an opportunity to enforce elements of IWRM and One Water at the watershed scale and promotes more holistic, integrated water management, the narrow focus on drinking water reflects the provincial government trend in issuing single-issue legislation which is a challenge for implementing

³ Costs would have included source protection costs, operating costs, financing costs, renewal and replacement costs and improvement costs associated with extracting, treating or distributing water to the public, etc. (Abouchar and Vince 2011), ideally including social and environmental externalities.

IWRM (Mitchell, Priddle, et al. 2014, Conservation Ontario 2010). The majority of Source Protection Plans were approved by the MOECC by 2015 (MOECCc 2017).

The OWRA has broader focus on provisions for impacts on environmental water quality and quantity. For the municipal water manager this translates to permits for water takings (Section 34) and environmental compliance approvals (ECAs) for ‘sewage works’ which includes both wastewater and stormwater treatment systems and infrastructure (Section 53) (CVCa 2016). Recent provincial activities in this area has been revisiting rules around groundwater taking by water bottling companies. A two-year moratorium has been put in place as well as increases in cost of withdrawals during which time the ministry will investigate groundwater in Ontario and review and make recommendations for protecting groundwater considering climate change and future demands (MOECCd 2017).

In addition to regulations, there are a number of guidance provided by the MOECC which provide design guidelines and recommendations for design of treatment systems, for example, Stormwater Management Planning and Design Manual (2003), Design Guidelines for Drinking-Water Systems (2008), and Design Guidelines for Sewage Works (2008) (Jusek and McDermott 2015). There is also a broader guidance document which has set the tone for water management more broadly called the “Blue Book” (1994 Water Management: Policies, Guidelines, Provincial Water Quality Objectives). The Blue Book addresses surface and groundwater from a quality and quantity perspective to be satisfactory and protective for aquatic life, recreation, fair sharing among users, and sustainability of the resource (CVCa 2016). All of the above guidelines are often referenced in municipal design guidelines, and broadly adhered to. While this results in broad compliance with regulations, particularly drinking water, they may stifle innovation and fail to fully incorporate climate change and more innovative practices. For example, in light of the increased provincial focus on climate change, there have been numerous calls to upgrade the 2003 Design Manual to incorporate more low-impact development, green infrastructure, and clear guidance on how to incorporate climate change (K. Jusek 2015) (MOECC 2014). The MOECC also generated a document which provides some guidance for energy and water efficiency of wastewater treatment plants, Water and Energy Conservation Guidance Manual for Sewage Works (2011). This document provides the main form of guidance on water reuse from the Ontario government.

Nutrient Management Act, 2002

There are a number of land management regulations in place to protect health and the environment – specifically water quality. The Environmental Protection Act broadly covers the discharge of contaminants into the environment whereupon an adverse effect may be experienced, and these often can relate to natural waters (CVCa 2016). The *Nutrient Management Act 2002* is a critical piece of the provincial regulatory framework for its role in the urban water cycle – as nutrients covered under this act include sewage biosolids (referred to as non-agricultural source materials (NASM)). The management, land application and storage of agricultural source materials (ASM), including manure, and NASM applied to agricultural lands as a nutrient to improve crops is covered under O. Reg. 267. There are different types of plans or documents which a farmer may be required to have under the Act,

either a nutrient management strategy (NMS), nutrient management plan (NMP) and non-agricultural source material plan (NASM) (MOECCb 2016).

Improper nutrient management (e.g. application, storage) can lead to excess of nutrients dissolved in groundwater or surface waters through leaching or runoff leading to contamination by pathogenic bacteria or contribute to algae blooms which can affect on-farm or municipal drinking water supplies and aquatic wildlife (MOECCb 2016). The Nutrient Management Act was introduced as part of Ontario's overhaul of drinking water management after the Walkerton Inquiry to incorporate a multi-barrier approach and reducing the potential for water and environmental contamination from some agricultural practices, and is supportive of principles of holistic, sustainable water management.

Asset Management

Asset Management Plans are intended to help extend the life of existing infrastructure assets, allow for regular re-investments to ensure optimal functioning of water systems, and inform decisions on capital planning and budgeting to optimize investments. There is an asset management planning guide provided by the Ontario Ministry of Infrastructure, *Building Together: A Guide for Municipal Asset Management (2012)*, and upcoming legislation under development which will regulate Asset Management Plans (AM Plans), under the Infrastructure for Jobs and Prosperity Act, 2015 (ECOa 2017) (MOIa 2017).

Since the Ontario Municipal Infrastructure Strategy in 2012, Ontario requires a municipality applying to capital funding to have an AM Plan and situate the proposed project within it (CVCa 2016) (MOIa 2017). While the majority of municipalities have some form of AM Plan in place today, 95% up from 40% in 2012, the content and comprehensiveness of AM Plans in place ranges widely (CVCa 2016) (ECOa 2017) (MOIa 2017). Infrastructure Asset management and renewal has been an ongoing challenge and represents a large expense and large risk to municipalities. Canada and Ontario face large infrastructure deficits due to an extended period of limited investment in infrastructure renewal and rehabilitation, as shown in Figure B-2.

CHART 1

Ontario Per Capita in Net Public Capital Stock

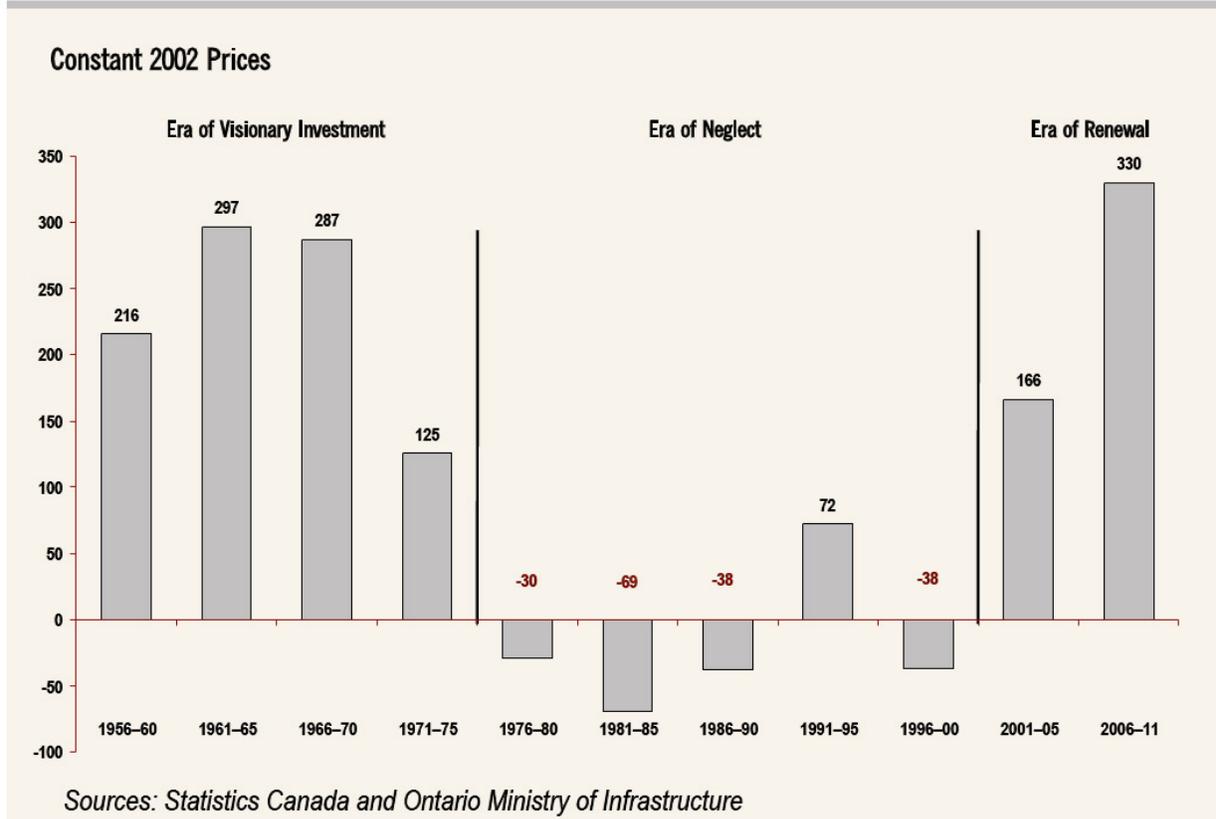


Figure B-2: Investments in Public Infrastructure over the past several decades (MOI 2017)

The Federation of Canadian Municipalities 2016 Canadian Infrastructure Report Card indicated that 29% and 35% of water and wastewater infrastructure respectively is categorized as fair to very poor condition. The infrastructure deficit to repair and upgrade this infrastructure is approximated at \$88.5 billion (Maas 2017).

The main focus on existing AM Plans is on roads and bridges – the visible infrastructure – while water-related services are typically out of sight (ECOa 2017). Some of the key short-comings of developing reliable AM Plans is sufficient quantity of accurate, current, relevant data (CVCa 2016) (FMCa 2017). The goal of an AM Plan is to maintain an acceptable level of service (LOS) at the lowest life-cycle cost while operating at an acceptable level of risk (CVCa 2016).

Currently major components of AM Plans in Ontario include the state of local infrastructure, expected levels of service (defined by each municipality), asset management strategy, and financing strategy including user fees (ECOa 2017).

AM Plans to be integrated into long-term planning and budget considerations are required to consider future demands of that infrastructure and its life-cycle, including population growth, economic changes,

and local climate changes (FMCa 2017). Aging infrastructure intensifies risks associated with climate change and urbanization and therefore these two factors are key in determining the required level of service (CVCa 2016). Need for tools to help identify risk in light of climate change, for example PIEVC. The current and proposed AM Plans in Ontario do not assess energy consumption.

The proposal for regulating and bringing some standardization to asset management plans will be beneficial to Ontario municipalities with respect to sustainable water management (MOIa 2017). The Environmental Commissioner of Ontario made recommendations for the proposed regulation to include energy costs and greenhouse gas emissions, include green infrastructure, and other impacts from climate change to support more sustainable water management (ECOa 2017).

FLOW recommends performance based asset management for communities, e.g. performance targets related to water use, effluent quality, energy consumption, and GHG emissions, to better assess long-term adequacy of existing infrastructure and identify opportunity to maximize its potential utility (Maas 2017).

The proposed regulation is now closed for comments, but noted a couple key points which are consistent with sustainable, integrated urban water management:

- “The importance of asset management planning to ensure the long-term sustainability of infrastructure assets...
- Integrating asset management planning with other municipal and provincial plans and policies
- Good infrastructure planning incorporates environmental sustainability
- Infrastructure is increasingly seen as a tool to address environmental concerns such as water quality, green space, urban forest cover, air quality, and climate change mitigation; and
- Environmental sustainability principles and climate change adaptation are essential considerations in planning for the long-term sustainability of infrastructure assets.”

(Environmental Registry 2016)

[Environmental Assessment Act](#)

Under the Ontario *Environmental Assessment (EA) Act* (1990), a process for carrying out environmental assessments and public consultation is provided (CVCa 2016). Most municipal infrastructure projects related to water, wastewater, stormwater (in addition to roads and transit) individual projects and master plans are carried out under the municipal class environmental assessment (Class EA) process. This is a self-assessment process for municipalities to effectively meet the requirements of the EA Act in protecting the environment through the planning, design, construction, operation, maintenance, rehabilitation and retiring of infrastructure more efficiently by eliminating the need for specific approval by the provincial government under the EA Act. The Municipal Engineers Association (MEA) reviews the Class EA every five years to ensure it is up to date with changing needs (MOECCa 2017). Municipal projects which are complex, innovative, and lack precedent would require an Individual EA to meet the need for more extensive stakeholder engagement to support project success. Examples of this would be for future municipal wastewater reuse projects. For example, through the Individual EA process, the Upper York Lake Simcoe Region has identified a water reclamation facility with the potential for future

water reuse as the preferred option for wastewater management, with implementation prior to 2031 and the MOECC is still reviewing this proposed plan (LSRCA, 2015 in (Jusek and McDermott 2015)). The Individual EA process is much longer than a Class EA process.

Typically, Master Plans are carried out for municipal water management for water and wastewater servicing and stormwater drainage under the Class EA process, and through that process individual capital projects are identified. Some forms of municipal work, such as replacements and upgrades on an existing site do not require extensive EA work (e.g. Class A or A+ EA). Other projects, such as the development of a new treatment facility, require more extensive EA work (e.g. Class C EA). Master Plans inform and are informed by land-use plans, strategic plans, preparation of capital works and operating budgets, and the final design of individual projects (CVCa 2016). However, typically water, wastewater, and stormwater plans are created independently of one another and are bounded by municipal boundaries. They are not required to assess impacts beyond municipal boundaries on the broader watershed such as cumulative impacts of land-use changes or capacity of receiving water body (CVCa 2016). The lack of integration is likely a result of the way municipalities are structured and the divisions of jurisdiction (e.g. upper and lower tier), but also within departments whereby water and wastewater are separated, in addition to integration not being mandated (CVCa 2016).

The Class EA process features some elements of integration with formalized public consultation and the municipality can choose to exceed the minimum requirements. The screening criteria laid out in the EA also reflects a more balanced approach by requiring each alternative be evaluated based on social, environmental, and economic metrics (MEA 2011) (Shrubsole 2004). The Class EA process is a natural mechanism to integrate considerations for climate change and integration of different urban waters and watershed planning.

The Master Planning process is similar to that of a watershed/subwatershed planning process. It consists of five phases:

1. Identify the problem opportunity
2. Identify reasonable alternative solutions
3. Identify methods of implementation of alternative solution
4. Compile all relevant information into an environmental study report
5. Implementation and monitoring

(CVCa 2016)

With the legal framework established through the EA Act, the public are still responsible for participating and demanding sustainable solutions. The municipality has a role to play in educating the public on the full implications of different options and demonstrate why the lowest cost option is not always preferred.

Green Energy Act

The Green Energy Act under the Ontario Ministry of Energy has legislation for public agency reporting energy use and plans for conservation. O. Reg. 397/11, Energy Conservation and Demand Management Plans, requires municipalities report annually and publish on their websites their energy use and

greenhouse gas emissions. As of 2014 municipalities have been required to develop a 5-year conservation plan, to be updated every 5 years starting in 2019 (Ontario Ministry of Energy 2017). The benefits of this benchmarking exercise with respect to sustainable, integrated water management is to highlight opportunities for energy reduction through water efficiency and alternate processes and technologies, since water and wastewater services make up a significant portion of municipal energy demand (ECO 2017). The development of an energy conservation and demand management plan implores municipalities to set conservation goals and targets, test conservation measures and renewable installations, and assess costs and benefits. This process can assist in setting energy reduction goals, sharing best practices for energy saving opportunities, and measuring progress. While the policy does not set targets, it reflects an adaptive approach whereby the information gathered will help the province to develop and enhance policies and programs in the future.

Ontario Building Code Act, 1992

The Ontario Building Code (OBC) provides important context for the ease of implementation of innovative water management techniques, such as water reuse systems. Recent updates (2012) of the OBC are more supportive of rainwater harvesting and greywater reuse in homes, defining different qualities of water which may be used for different applications, referring to the CSA guidelines for dual-plumbing, and requiring less cumbersome provisions (Despins, 2014 in (Jusek and McDermott 2015). The OBC refers to CAN/CSA-B128.1/B128.2, “Design and Installation of Non-Potable Water Systems”, which complements a new CSA Group standard (developed after the 2012 OBC update) CSA B128.3 – “Performance of Non-Potable Water Treatment Systems”. Both standards target manufacturers and other users of non-potable water reuse products and used for conformity assessment between products (CSA 2015). If a reuse application falls within the scope of the OBC and applicable municipal by-laws, no additional permission or approvals are required for the homeowner or building owner to proceed. If the application falls outside the outlined parameters, a variance may be obtained from the municipality which puts more liability on the municipality (Jusek and McDermott 2015).

Conservation Authorities

The majority of municipalities in Ontario are within the jurisdiction of one or more watershed authorities, Ontario Conservation Authorities (CA), as shown in Figure B-3. The CA responsibilities are diverse and include protection of water resources both quantity and quality, and programs to protect life and property from natural hazards such as flooding and erosion (Mitchell et al., 2014). CAs’ work with municipal water managers, the province and other stakeholders in support of an integrated approach to water management across the watershed beyond the boundaries of the urban water system (Mitchell et al., 2014). Since the establishment of conservation authorities in 1946, and today under the *Conservation Authorities Act* (1990), their priorities, activities, and funding have evolved, but their role as collaborators between different stakeholders has been consistent and growing in the face of complex challenges.



CONSERVATION AUTHORITIES OF ONTARIO

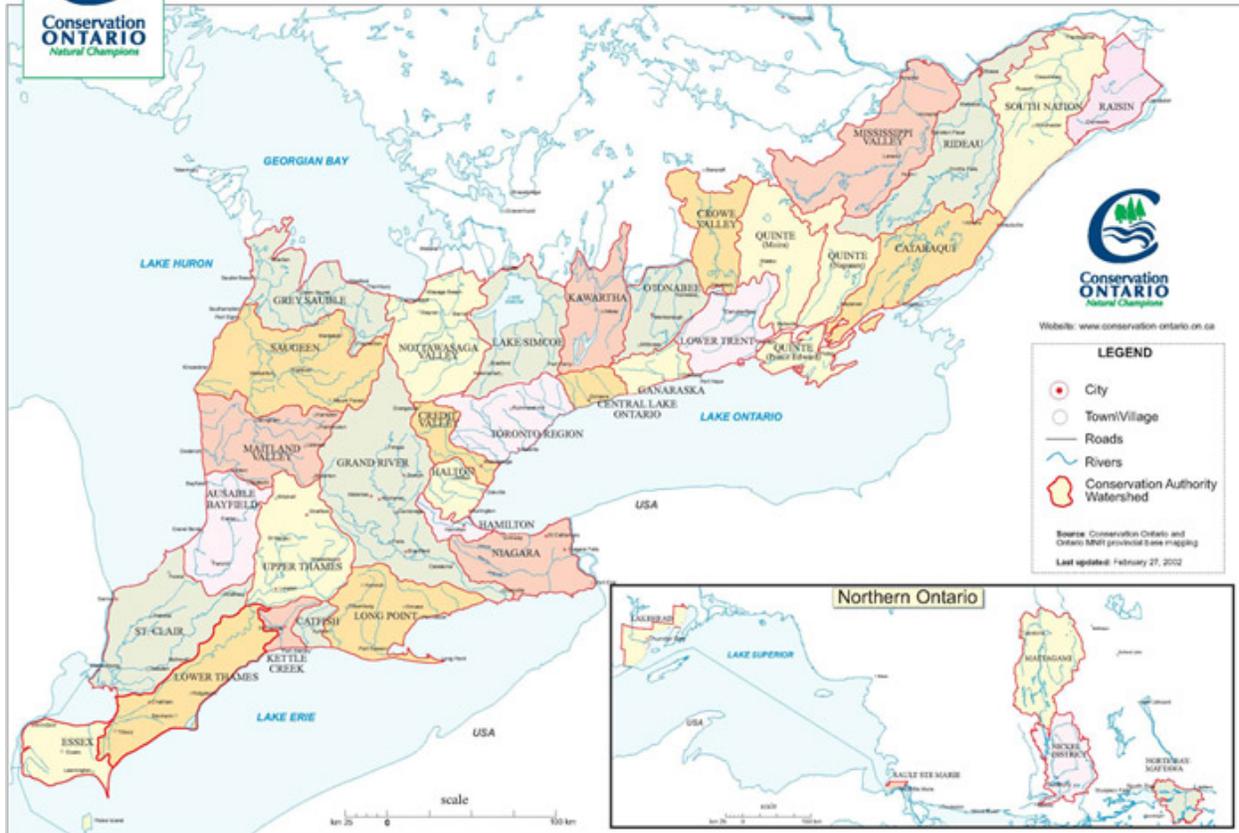


Figure B-3: Ontario Conservation Authorities (Conservation Ontario 2010)

Conservation Authorities have been leading the charge on integrated water management through their watershed-based approach (Conservation Ontario 2010). Watershed scale planning and studies released by the province as guidance tools began in the 1990s. Throughout this time many watershed and subwatershed studies were completed (Conservation Ontario 2010). The aim of watershed planning is to characterize major environmental features and functions in order to improve and maintain environmental health. Strategies related to management include cumulative effects, increasing natural cover, environmental stressors, and on a smaller scale to determine servicing needs and development constraints (CVCa 2016). Watershed and subwatershed plans to inform land-use reflect adaptive management and monitoring to evaluate solutions and revising periodically based on actual functionality and impact of management measures (CVCa 2016). Upper and lower-tier municipalities can gain insight from watershed plans through watershed-wide policy and directives, and subwatershed plans can provide guidance on local environmental issues or development to lower-tier municipalities (CVCa 2016).

Watershed planning may be undertaken in partnership with municipalities and the CA. Key documents by the provincial government include:

- *Water Management on a Watershed Basis: Implementing an Ecosystem Approach; Subwatershed Planning; and, Integrating Water Management Objectives into Municipal Planning Documents (1992)* – Provided early information on preparing, implementing watershed and subwatershed plans.
- *An Evaluation of Watershed Management in Ontario (1994)* – Key to this work was the establishing of the scientific components of watershed and subwatershed plans and a refinement of the watershed/subwatershed process.
- *Watershed Management in Ontario: Lessons Learned and Best Practices (2003)* – This report describes advance made in watershed management since the early 1990's and illustrates key finding with the use of case studies. Most importantly was the distinction made between watershed management (now referred to in this document as IWM) and watershed planning.

(Conservation Ontario 2010)

In addition, CA's deliver programs for municipalities in their watershed including review and commenting on growth and development plans, zoning and bylaws – all from the watershed perspective (CCME 2016). Building on the watershed planning experience, CA's are playing a key role in source water protection planning outlined in the CWA (MNRF 2015). They are the responsible agencies supporting the local multi-stakeholder committees carrying out the provincial SWP program and will be responsible alongside municipalities and the province in implementing the plans (CCME 2016). As well, Conservation Ontario with assistance from the Ontario Ministries of Natural Resources and Environment and Fisheries and Oceans Canada released three main documents (plus a summary report) entitled “Integrated Watershed Management: Navigating Ontario's Future (2010)” (CCME 2016). This research provides a useful study of the progress on IWM, the work that has been completed to date in this area, identifies barriers and tools for moving forward to support IWM planning and decision-making (CCME 2016).

The role of CAs is currently under review to review their role and functions with the *Conservation Authorities Act Review Discussion Paper, 2015* (MNRF, 2015). Funding and sufficient authority and jurisdictional challenges has been an ongoing challenge to the successful practice of IWM by CAs. Funding is predominantly sourced from municipal tax-levies and other innovative partnerships or fees for conservation areas and campgrounds. Work related to the SWP under the CWA has been funded by the provincial government (CCME 2016). Due to this funding structure, some municipalities, such as the Toronto and Region Conservation Authority and the Grand River Conservation Authority, have comparatively larger budgets than some of the watersheds with smaller populations (MNRF 2015). This review and potential adjustment of the *Conservation Authorities Act* may be an opportunity to officially integrate considerations for climate change such as adaptation of urban water systems, since CAs help bridge the gap between the various water planning authorities and can allow for opportunities to achieve multiple objectives such as addressing nutrient loading on receiving waters and reducing potable water demand through wastewater reuse or rainwater harvesting, and more formally acknowledge the key role that conservation authorities play (K. Jusek 2015).

Federal

Canada is a decentralized federated state as outlined in the constitutional arrangement whereby provinces have considerable powers. On the topic of the environment and water, there is no clear authority in the Constitution on jurisdiction, indicated the need for federal-provincial cooperation and coordination (Bakker and Cook, *Water Governance in Canada: Innovation and Fragmentation* 2011) (Phare 2009). In this arrangement, there is a need for balance between harmonization (standardization of laws, rules and norms) and subsidiary (delegation of decision-making and policy implementation to the lowest-appropriate scale); in Canada the relationship has been more of a subsidiary relationship (Bakker and Cook, *Water Governance in Canada: Innovation and Fragmentation* 2011). While this is beneficial for addressing more localized concerns across a large nation, it has resulted in limited data-gathering, standard-setting and enforcement (Bakker and Cook, *Water Governance in Canada: Innovation and Fragmentation* 2011). There are not enforceable Canada-wide water quality or health-based standards due to the delegation of powers and the federal governments more limited role in water management. Health Canada has health-based drinking water quality guidelines which are recommended to be the basis for provincial water quality standards, but they are not enforceable (ref). The 1987 *Federal Water Policy* by Environment Canada was seen as a positive initiative to indicate the government's commitment to water management and to protect and enhance water quality and ensure efficient use of resources – unfortunately most of the policy was never implemented (Bakker and Cook, *Water Governance in Canada: Innovation and Fragmentation* 2011).

The Federal Sustainable Development Act (2008) provided the legal framework for the Federal Sustainable Development Strategy, updated on a regular basis by Environment Canada. This provides a platform to incorporate Canada's international commitments such as the United Nations Sustainable Development Goals by 2030 and the Paris Agreement on Climate Change. This Act also resulted in Canadian environmental sustainability indicators (CESI) to support monitoring of baseline conditions and progress (Government of Canada 2017). There are several water-related indicators related to water quantity and quality, but due to the federal governments more peripheral involvement in municipal water management, it is unclear the role this will play for Ontario municipalities.

The federal government is involved in several federal-scale initiatives which impact urban water management in Ontario. Formally, the Canadian government has jurisdiction over international waters (as part of the International Joint Commission for US-Canada boundary waters), fisheries, navigation, and federal lands (including First Nations reserves). Where a municipality intersects with the federal jurisdiction, more consideration may be paid to the respective impacts to for example, navigation or fisheries in their local water management decisions. When a pollutant represents a broad risk, the Canadian Environmental Protection Act (1999) can be exercised using the national risk management approach to manage these at the source to mitigate input into the environment more broadly (CCME 2009).

Most of Ontario lies in the Great Lakes watershed and will be impacted by regulations pertaining to it. These include:

- 2014 Canada-Ontario Agreement (COA) on Great Lakes Water Quality and Ecosystem Health outlines the provincial-federal collaboration for implementing commitments of the Great Lakes Water Quality Agreement (GLWQA), most recently amended in 2012.
- Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement (2005) which is an agreement between multiple states and provinces to protect water resources by setting a standard on approved water uses and takings from the Great Lakes basin.

(MOECC 2017).

Federal Funding is another way in which the federal government influences the enabling environment for sustainable municipal water management. The federal government is investing over \$180 billion in infrastructure over the next decade, \$570 million to Ontario (Maas 2017) (ECOa 2017). This is a critical influx of money and investment into municipal infrastructure which will shape the next 50 years or more of communities and water management approaches.

The Federation of Canadian Municipalities (FCM) is another source of federal funding to municipalities, with recent programs aiming to support specific initiatives relating to sustainability, energy and water efficiency, and innovative projects. The Green Municipal Fund and recently the Municipal Climate Innovation Program (recently introduced at \$175 million over 5 years) represent opportunities to make investments in climate change adaptation planning, climate change mitigation, and a host of other sustainability and forward-looking measures to yield environmental and public health benefits that may otherwise not be prioritized through conventional capital budgeting and traditional funding streams (FCM 2017).

This section highlights that the federal government influences the priorities and environment for decision making in Ontario but ultimately when push comes to shove, historically the provincial government is the main authority of water management decisions affecting municipal water management. The federal government could potentially have more influence through funding tools by setting criteria to obtain grants that reflect forward-looking priorities – such as net zero energy for WWTPs, innovative technologies, climate change resilience, and/or sustainability metrics (e.g. EVISION, LEED) (OCWA 2016).

Other Influential Bodies

In addition to the provincial, federal, and municipal governments, there are a number of organizations which influence urban water management through the infrastructure, equipment, and technology and management approaches they provide/promote.

Ontario Clean Water Agency (OCWA) and WaterTAP, the Southern Ontario Water Consortium (SOWC), and the Canadian Water Network are key cross-cutting organizations helping advance. OCWA has evolved over time and is now an operational enterprise agency as of 1993 with a mandate to provide water and sewage works and related services to protect public health and the environment, and encourages conversation (OCWA 2016). OCWA's main role in the municipal water management world is providing operation and maintenance to municipal water systems (water and wastewater), but due to its wide reach and influence across the province has also become a strategic player for supporting more

sustainable, innovative practices. WaterTAP was created in 2010 under the Ontario Water Opportunities Act and is a non-profit which supports emerging and established Ontario-based water companies to grow to support Ontario as a hub for water technology and innovation. SOWC works on the other side of whereby they connect private companies with academic researchers to accelerate and commercialize innovative water technologies (WaterTAP 2017). The SOWC cuts across traditional water sectors and works in the area of watershed monitoring and data platform, drinking water, wastewater, ecotoxicology, and sensors (SOWC 2015). The Canadian Water Network (CWN) is another non-profit that has evolved over time which helps support the dialogues and the culture of looking forward, connecting researchers with municipalities, and supporting governance innovations for more sustainable systems (CWN 2015).

The Canadian Council of Ministers of the Environment (CCME) is also a Canada-wide initiative which provides support to municipal decision-making. This is done through the development of resources, and guidelines and aquatic wildlife benchmarks for ecosystem health. It is noted that the CCME has no legal authority for provinces or municipalities to comply to their standards (Bakker and Cook, Water Governance in Canada: Innovation and Fragmentation 2011).

These organizations have a broad reach, work together to support innovation and technology development by connecting municipalities with emerging technology companies to pilot technologies and conduct research. They host joint workshops that bring researchers, municipal end-users, and technology companies together to discuss industry trends, innovation adoption and how to reduce barriers, on topics such as Net Zero WWTPs, Smart Water Systems, and Infrastructure Funding, and CWN Blue Cities Annual Conference (OCWA 2016).

Professional associations, university partnerships, and environmental NGOs provide a great deal of tools and resources to support municipal water management, particularly on cutting edge matters that are ahead of legislation – relating to climate change risk assessment and adaptation, sustainability metrics and frameworks – that are not formalized in provincial legislation. Key organizations and their respective tools and resources are summarized in the toolbox and include the Great Lakes and St. Lawrence Cities Initiative.

Existing Industry Organizations, practitioners and equipment suppliers are key influencers and play an important role in influencing water management decisions. Due to the culture of risk aversion that has persisted in the water industry, particularly the drinking water sector, the role of selecting vendors for equipment which have a strong reputation, have local representation and for which the municipality has a positive working relationship with cannot be understated. Industry organizations are increasingly becoming more integrated, but historically have been segregated along discipline lines, such as the Ontario Water Works Association (OWWA) with a primary focus on drinking water, and the Water and Environment Association of Ontario (WEAO) is primarily focused on wastewater. It should be noted that these organizations are tied into larger North American based groups, American Water Works Association (AWWA) and Water and Environment Federation (WEF) which have members and represent industry trends across a much wider audience. These organizations provide a large number of industry standards and resources which are widely used. In the United States, there are also organizations

dedicated to the advancement of water reuse (e.g., Water Environment and Reuse Federation) and AWWA has adopted a One Water and a Total Water Solutions stream to complement more traditional committee focus areas, and has an annual Sustainable Water Management Conference to share best practices.

Established vendors and practitioners have some advantage in keeping pace with industry trends and ahead of the curve, but also more limited incentive to stray from tried and true approaches. More likely, new vendors and companies will spring forth to fill the gap to provide services, for example, related to green infrastructure or AOP, etc. It should be noted that while this research is focused on the more organizations and groups focused on sustainable, integrated water management, the group of industry professionals which participate in OWWA and WEAO make up the majority of the water industry.

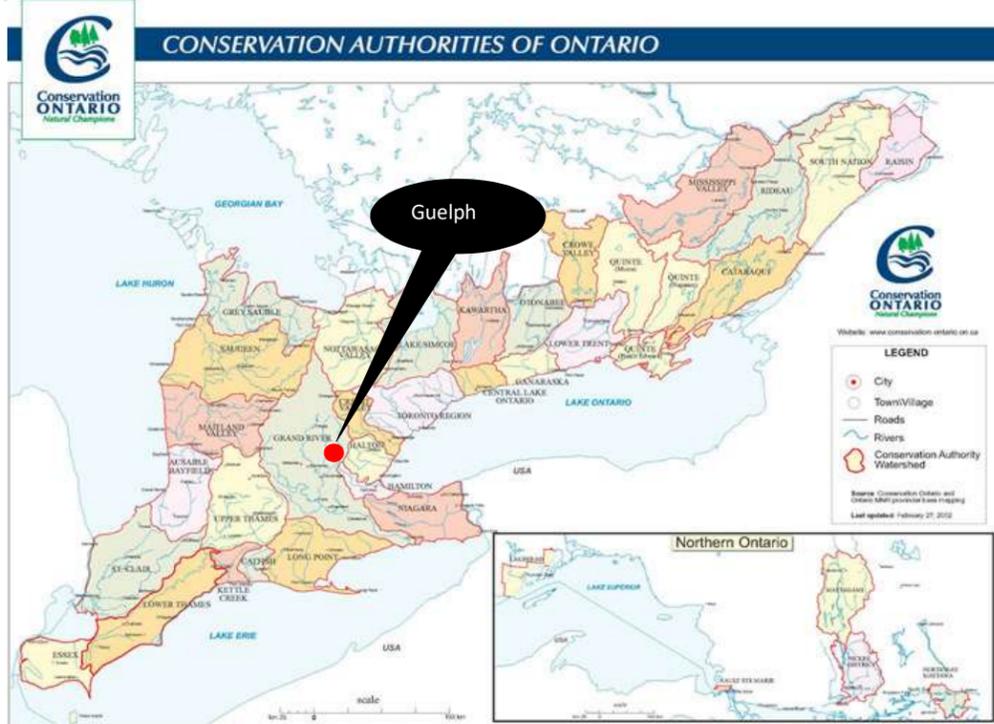
Appendix C: Completed Diagnostics for Three Case Studies

Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance
 Result: Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress
 Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management
 Look at past evidence and plans and policies moving forward
 Date Completed: 6-Aug-17
 By: Kim Jusek

Key Questions to Characterize Community:

Municipality:	City of Guelph										
Population:	<10,000	10-50,000	50-100,000	100-250,000	250-500,000	500,000-1,000,000	1-2,000,000	>2,000,000			
Tier:	Single	Upper	Lower								
Description of responsibilities	All urban water tasks										
Key Priorities:	Flooding	Population Growth	Water Efficiency	Cost/Financing	Environmental Protection (Need for)	Reliable, Secure Supply	Resilient, Sustainable Community	Climate Change	Aging infrastructure	Public Health	Other?
Root Cause	(climate change, pop growth, aging infrastructure)	(Natural Resource limitations, discharge quality/quantity, climate change)	(Natural Resource limitations, aging infrastructure)	(Aging Infrastructure, climate change mitigation/adaptation, "we have no problems with current approach, but want financial sustainability")	(Natural Resource limitations, discharge quality/quantity, climate change)	(Natural Resource limitations, discharge quality/quantity, climate change)	(Climate change)	(related to flooding, environmental limitations, aging infrastructure, costs, sustainability, environmental limitations)	Financing, climate change, public health	Aging Infrastructure, costs, meeting basic needs	
Watershed:	Grand River Watershed										
Water Source:	Groundwater										
Wastewater Receiver:	Speed River, tributary to the Grand River										
Proximity to water bodies	Speed and Eramosa Rivers cut through city										
Location in watershed:											



Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance
 Result: Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress
 Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management
 Look at past evidence and plans and policies moving forward
 Where a municipality meets criteria under two adjacent categories, the previous category is selected and the key items not covered under the next level highlighted

Sustainability Spectrum:

1	2	3
"Sewered/Drained City" / Meeting ON Regulatory Requirements for public/ environmental health ON Baseline Grey Infrastructure Approach	"Waterway/Water Cycle City" / Limits to Growth/Social Amenity and Environmental Health Beyond Baseline Grey-Green	"Water Sensitive City", One-Water Approach, Resilience to Climate Change Sustainable-focus, Integrated One Water

(Brown et al., 2009)
me
(CVC)

Diagnostic and Evaluative Questions:

Category	Sustainability Status Indicators/ categories	Evaluative question	Evidence from public record (attitude/action)	Rank
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Aspects to be Managed

one to three

Water Supply and Distribution	Municipal Supply Source	1) One source; SW or GW (no concern if local or imported); conflict on use/allocation and/or constrained supply	2) two source types; e.g. SW, GW; local; some examples of fit-for-purpose supply (residential RWH, GWR, irrigation with untreated water)	3) >3 sources; incl. non-conventional sources (RWH, Reclaimed wastewater, etc.); local supply; supply of different water quality (fit-for-purpose)	-Guelph has multiple ground water supply wells from multiple different aquifers, and supports some fit-for-purpose use, and reuse of the water supply (rainwater harvesting, greywater reuse). This increase some resiliency to climate change, but would be greater if sources were further diversified . -in the past, considerations for a water pipeline to the Great Lakes motivated the City to focus on conservation and local supply. Future supply plans look to new groundwater sources, surface water supply and wastewater reuse. Further considerations for water supply is beyond city limits (5km radius) -Source: Water Supply Master Plan (2014) -rank: 2 based on current set-up; future plans put in place will bring to 3	2
	Water Supply Planning Approach	1) Supply-side approach to meet demands, water quality and operations meets SDWA requirements, single-use water, limited consideration for water conservation measures, conventional technology options, single future scenario, 25 year timeframe, , baseline SWP carried out.	2) Demand management + supply management, incorporation of conservation and efficiency impacts, primarily single-use water, source planning includes evaluation of energy demands of treatment, chemical use, reliability; use of scenario planning, 50 yr. timeframe, traditional sources prioritized, thorough SWP carried out and actively engaged in implementation	3) Demand management predominantly - incl. fit for purpose, optimizing existing infrastructure before expanding/upsizing, linked to broader watershed management (other users), scenario planning including climate change consideration, alternative water sources (RW, SW, WW reuse) employed for range of applications, 100 yr. time frame considered , consideration of water cycle through SWP in sourcing water and balancing treatment needs/reliability, and maintaining resilience; considerations for impacts from climate change on water quality and quantity	-Guelph has a progressive Water Supply Master Plan (WSMP) which that captures elements of levels 2 & 3. -heavy focus on demand management through conservation and efficiency program. Guelph includes considerations for fit-for-purpose supply through the efficiency programming - though currently RWH and GWR represent a small offset in residential water demands -scenario planning employed, though primarily based on achieving water efficiency; SWP Tier 3 Water Budget analysis tests sustainable taking of water from ground water and impact on other sub-watersheds and environmental impacts of water of surface water supply options, but no explicitly review of impacts from climate change (although . -wastewater connected through evaluation of water reuse as potential water supply -Some connection to land use through SWP and mention of urban growth forecasts from the Ontario Growth Plan; protection of natural heritage features identified but covered under other plans identified and referenced in the WSMP. -Source: 2014 WSMP	2
	Conservation and Efficiency	1) enforce building code updates, outdoor lawn watering by-law, fixed fee rate structure, limited outreach material	2) Outreach programs, efforts to measure and reduce non-revenue water, reduce per capita demand through indoor/outdoor by-laws, education and incentives (rebates), volumetric based rate structure - tangible targets set and record of success	3) 2 + comprehensive plan which is integrated into other urban waters planning, support for fit-for-purpose reuse of water (GWR, RWH), smart/real-time monitoring	-Ranked as 3 - Guelph has a very progressive, active water efficiency program - which reflects their priority issue of population growth and constrained supply. -started to implement a range of initiatives, and this is integrated into supply planning. Started real-time monitoring for customers. Always room for continued growth, but no identified deficiencies -Source: 2016 Water Efficiency Strategy Update	3
	Water Distribution	1) water delivered achieves pressure and quality requirements, as established by the SWDA and local design targets; reactive approach upgrades and maintenance; UFW at >20% (see AM for more about approach)	2) proactive approach to watermain and distribution infrastructure, promotion of product such that use of bottled water is minimized; UFW <15%; coordination between different tiers and disciplines for construction; optimize energy usage of pumps	3) 2+, UFW <10%, GIS-platform to engage with customers and address issues quickly, use of DSS and smart systems to optimize pumping for energy efficiency	-Guelph utilized a more sophisticated metric for water loss in the WSMP other than the % UFW; The Infrastructure Leakage Index (ILI) is the ratio of current annual real losses (CARL) to the unavoidable annual real losses (UARL), which measures how well the system is being managed for control of real losses - the aim is to get the ILI as close to 1 if water is scarce/expensive, and typically otherwise lie between 1.5 and 2.5 - based on traditional UFW - losses around 12% - City's Leak Detection & District Meter Area (DMA) program for detecting background leaks (larger water loss than main breaks) -promotes drinking tap water -included in 2008 Water/Wastewater Servicing Plan budget for optimizing energy efficiency of pumping (\$150k) -Source: 2014 WSMP, 2008 Water/Wastewater Servicing Plan	2

Sustainability Status						
Category	Indicators/ categories	Evaluative question		Evidence from public record (attitude/action)	Rank	
Wastewater	Handling of Wastewater Treatment	1) treat and discharge to environment, meet minimum environmental quality guidelines	2) treat, recover biosolids, discharge to environment such that it does not significantly degrade the environment and consideration for impacts to reuse according to measured and regulated parameters, use of modelling assimilative capacity, energy efficiency optimization of processes	3) treat, recover biosolids/biogas for energy/water, discharge to environment such that it does not significantly degrade the environment (incl. acute and chronic/cumulative impacts), above and beyond regulated parameters, modeling of assimilative capacity, pollution prevention programs integrated into treatment approach (residential/industrial source control) through enforced sewer use bylaw; net-zero for energy use; address emerging contaminants	-completes/reviews assimilative capacity modelling completed (speed river is a sensitive receiver, and flows greater than current WWTP capacity will require more stringent effluent standards. Work closely with GRCA to monitor impacts -source control measures acknowledged, not clear extent to which put into practice -As reported in 2008, the WWTP cogeneration facility will simultaneously generate both electricity and useful heat to power the plant. Upgrades to the cogeneration facility will supply the WWTP with one third of the power it requires to operate along with standby power for critical processes in the event of a power failure. Generating green energy to power the WWTP. The WWTP will generate approximately 4,020,000 kWh annually or enough energy to power 469 homes each year. will offset around 3,500 tonnes of greenhouse gas emissions that would be produced from non-renewable, fossil fuel based energy sources. The anticipated savings in electrical costs are estimated to be approximately \$300,000 annually -energy efficiency planned, not clear if implemented - but cogen facility above -has biosolids master plan, generates biosolids (lystek) and land applies, but program not as efficiently operated as could be (in part due to regulatory challenges) -Source: 2009 Wastewater Treatment Master Plan, 2006 Biosolids Master Plan	2.5
	Wastewater Planning Approach	1) Increase capacity of WWTP and collection system and upgrade treatment systems as population grows; centralized treatment, single future, does not consider conservation/efficiency, does not control I/I as evidenced by regular sewer backups, overflows, and by-pass events, 25-year planning horizon or less	2) Focus on optimization of treatment plant for capacity and treatment to meet growth and effluent restrictions, incorporation of reducing flows through I/I reduction programs (separate combined sewers) and water efficiency, pilot testing of new technologies through innovative partnerships, enforce sewer use by-law, tie-into watershed plans and downstream impacts, use of modeling programs to inform planning; some overflow events and flooding in extreme conditions; 50 year planning horizon	3) 2+ inclusion of semi-centralized/decentralized treatment , reuse of water, energy, biosolids, nutrients, greenhouse gas reduction in collection system, integration of water/SW planning, focus on pollution prevention (update sewer use by-law), consideration for climate change resiliency, advanced use of modelling to assist with planning; consider 100 year planning window	-Rank as 2 but cover some aspects of 3, solidly working towards 3 -50 year plan -considers water efficiency impacts, and has optimized plant processes to delay expansion; pilot test new treatment processes -because stringent requirements, have been innovative and had high quality effluent for some time -highlights working with Grand River water managers (tie-into watershed), reducing flows through I/I and water efficiency programs, investigate satellite WTPs, detailed investigation of urban reuse of treated effluent, review of sewer by-law, and climate change adaptation have all been identified as recommended studies from the MP. -source: Wastewater Treatment Master Plan 2009	2
	Collection infrastructure	1) expand and upsize sewer infrastructure as needed based on expanding population and failure, upgrade when roads are scheduled for upgrade.	Sewer by-law to not only protect treatment processes and receiving environment, but to protect integrity of collection infrastructure through reducing corrosive components and to reduce production of odors and GHG emissions; maintenance programs to extend lifespan; coordination construction upgrades with other public infrastructure	3) 2+ support efficiency programs and storm water management to reduce need to upsize infrastructure (across discipline/jurisdictional boundaries); sewer mining for decentralized water reuse	-mention of conservation measures and I/I reduction as important, but preferred strategies are to upsize due to I/I (in addition to aging, intensification) -construction to be coordinated with water, SW, and road upgrades for cost efficiency Source: 2008 Water/Wastewater Servicing Plan	1
Stormwater	Stormwater Management Approach	1)Convey water out of city; urban flood protection from property damage; developed piecemeal with population growth/new developments	2) Flood protection but also protection of local rivers (quality and quantity - erosion), infiltrate and manage onsite (lot level solutions) to protect water balance and contribute to protection of local rivers; informed by watershed planning	3) Mimic natural water cycle, city-wide review of stormwater management, connect to watershed plans and upstream/downstream communities, protect property from flooding and protect natural environment from erosion/non-point pollutants, integrate into watershed planning, WW and water planning, retain and reuse locally, planning policies to support GI options before grey , and innovative management approaches to asset inventory and maintenance, and financing; ecological corridors and GI network	-The SWM Master Plan explores, evaluates and identifies innovative approaches to manage stormwater runoff using low impact development and water sensitive urban design for both new construction and existing developed areas. WSUD defined as is the management of urban water streams (water supply, wastewater and stormwater) to minimize and treat pollution, reduce potable water use, and match different water sources and uses e.g. collecting and using rainwater where appropriate. -to protect local river ecology and protect against urban flooding -The 2010 Draft Official Plan Update in particular has extensive policy regarding stormwater management and groundwater protection, the Natural Heritage System and objectives for implementing LID -City has a Growth Management Study, and SWM Master Plan highlights the challenges of intensification of built up areas for SWM and outlines options for mitigating -The SWM Master Plan approach is to integrate flood control and stormwater drainage with opportunities to improve and protect groundwater and surface water quality and the natural environment. - The SWM Master Plan integrates aspects of flood control, groundwater and surface water quality, natural environment and system drainage issues into a cohesive City-wide strategy -study included climate change assessment, looked into nutrient offset program - For new development, the City of Guelph will be incorporating LID requirements and guidelines as part of an updated Stormwater Management Policy. For existing neighbourhoods, LID practices would be considered stormwater quantity and quality retrofits and could be implemented within both public and privately owned lands in varying degrees based upon the land use, development form, soil infiltration capacity and the willingness of land owners to modify their property. BUT, noted that majority of upgrades recommended are traditional grey infrastructure (storm sewers)	2.5

Sustainability Status						
Category	Indicators/ categories	Evaluative question		Evidence from public record (attitude/action)	Rank	
		(If Upper Tier, "not their jurisdiction")	(If Upper Tier, "make an effort to work with other tier to coordinate and support efforts across lower tiers)	(If Upper Tier, "Active participant on plans and policies to support unified approach to SW management and GI policies across lower tiers)	N/A	
	SW Infrastructure	1) Mainly 'grey' or engineered infrastructure, including concrete drainage systems and some end of pipe controls	2) Mainly grey in core areas, with more lot level GI practices in new developments, including rain gardens, rain barrels, and wet/dry ponds.	3) Complimentary grey-green systems through urban area, use of LID including green roofs, urban trees, swales, parkland, and pollution prevention; network of GI, not only one-offs	Plans for more widespread GI are being introduced, but not currently the state of infrastructure.	2
Natural Urban Water (surface)	Management Approach	1) under jurisdiction of CA, abide by flood zones/buffer zones, seen as source of water, conveyance for stormwater, dilution of wastewater, transportation (possibly) - human centred	2) Seen as amenity for recreation and tourism, protected from erosion and contamination for upholding recreational use, and other urban function discussed above; viewed as an asset (property value, tourism related income) and a risk (flooding)	3) Part of larger natural ecosystem, requiring quality and quantity and buffer riparian zones respected and protected from human development and heavy use, in addition to cultural/aesthetic value and functional uses for water, wastewater and stormwater; restoration investments made (daylighting streams, integrating into SWM planning); monitoring and addressing quality/quantity issues including cumulative effects	-The Natural Heritage Action Plan will create an implementation framework for Official Plan policies regarding the natural heritage system and watershed planning. This will include the identification and development of recommendations, strategies and guidelines that would assist staff to maintain, enhance and restore natural heritage, surface water and ground water features within the City. -rivers are valued but not enough evidence found to push to 3 - in part due to substantial work needed in stormwater management upgrades	2
Landscape	Land Use Management Approach	1) Landscape and environmental features dealt with as necessary under provincial regulations (e.g. protected moraine or wetlands), not managed as multi-functional assets impacting the water cycle; greenfield development rampant	2) carry out sub-watershed plans, coordinate with CA, land use policies (e.g. Official Plan) identify and protect key hydrologic features (wetlands, forests, park land) for their role in GW recharge, habitat, and flooding/social amenity in development; urban intensification; conservation viewed as a trade-off; implement drinking water SWP measures; understanding the connection between land use practices (impermeable, salts, nutrients) and downstream water quality impacts and water availability impacts	3) 2+ promotion of urban agriculture, urban forests and parkland, green infrastructure, green roofs/walls, and active planning and management by the city in maintaining the health of these features/ecosystems (wildlife, use and pollution management); urban intensification with prioritization on protecting hydrologic features; recognizing as multi-benefits vs trade-offs; source water protection for all sources - natural/ecosystem flows in addition to drinking water, downstream impacts (over and above baseline SWP); tie-into broader watershed through inventory of resources and users; resources: waterways, wetlands, fish and wildlife, endangered species, cultural and recreational resources and users: commercial navigation, potable water supply, agriculture, etc.)	-Guelph has 2013-2032 Urban Forest Management Plan, first adopted in 2006 - to protect urban trees which provide a number of services, including flood protection and air quality and other social and environmental benefits - Plan provides the guiding principles, vision and strategic goals for the entire 20 year period as well as a more detailed breakdown of the recommendations for the first Five-Year Management Plan. Recommends establishing a green infrastructure asset valuation as part of monitoring program -Natural Heritage Action Plan (NHAP) creates an implementation plan for protecting natural resources as part of complete healthy communities. The plan will create a framework for the City's Official Plan policies specific to the natural heritage system and watershed planning. The NHAP will include the identification and development of recommendations, studies and guidelines to maintain enhance and restore natural heritage, surface water and ground water features in Guelph. -Natural Heritage System (Official Plan Amendment 42), update to Official Plan to make more protective of key moraine (aquifer recharge site) and construction adjacent to natural heritage features. "One of the City's most valuable assets is its natural heritage system", "How the City protects, maintains, enhances and restores its natural heritage system is part of an environment first approach for managing the natural heritage features and areas in the city" "Together, these elements represent the city's biological, hydrological and geological diversity, support ecological and hydrologic functions, provide connectivity, support populations of indigenous species, and sustain local biodiversity." -source: Urban Forest Management Plan (2012),	3
General Planning Approach	Planning Approach	1) Planning exercises for new infrastructure and development follow the Class EA process (discipline lead), conventional solutions considered and evaluated with cost as the primary consideration	2) Studies follow the Class EA process, consider more innovative solutions and methods for arriving at solutions including enhanced public participation, recognize complexity of planning decisions related to aging infrastructure, growth, climate change; time frame of 50 yrs.	3) Studies and planning activities consider full water cycle impacts, incorporate discipline integration and multi-functional/multi-benefit infrastructure solutions, build on EA approach and use more sophisticated decision making tools (e.g. triple bottom line) and methods to deal with uncertainty (adaptive management, staging with monitoring, vulnerability risk assessments) , planning considers innovative approaches such as nutrient trading; time frame of 100 yrs.	-Based on review of Water Supply Master Plan, Wastewater Treatment Master Plan, Stormwater Master Plan, and Urban Forestry Master Plan, SWP which included more detailed studies because of reliance on Groundwater and identified as high risk highlight that other elements of urban water management are considered in each discipline study. Still somewhat siloed, but clear consideration. Examples of adaptive management in interactions of MPs, but climate change risk assessment not completed (check - community action plan) -solutions included are conventional and innovative -studies such as one through the water efficiency department - water softener - assess impacts to whole water cycle.	2.5

Sustainability Status		Indicators/ categories		Evaluative question		Evidence from public record (attitude/action)		Rank	
Category									
Governance	Culture supportive of innovative approaches and/or sustainability in Policies	1) Council approved strategic plan/official plan comments on striving to have a healthy environment to extent PPS requires it; pushback on rate increases	2) strategic plan and official plan comments on protecting water quality and quantity and some restrictions on land use	3) strategic plan and official plan sets bold targets/goals with respect to water and environmental sustainability and restrictions on land use	investigate and execute the necessary steps to optimize existing and develop new water supplies, with a focus on local sustainability. City Council provided direction in 2003 "That the focus of the Water Supply Master Plan establish a sustainable water supply to regulate future growth". This direction emphasizes the need for water supply to be sustainable. Public response to the 2007 WSMP helped shape that definition of sustainable to refer to available local water supplies, which included local groundwater and surface water sources. The utmost importance was placed on water conservation and as a result, the City of Guelph has become a renowned leader in water conservation and demand management in Canada. Council has made this a priority by setting a goal "to use less energy and water per capita than any comparable Canadian city" through its 2007 Strategic Plan and Community Energy Initiative. -Amendments made to Official Plan to be more protective of environmental features Source: 2009 WSMP	3			
	Corporate Leadership on Sustainability	1) Outlook on water services is to provide safe, affordable water and wastewater services, prevent flooding to protect public health and private and public	2) Outspoken on key issues relating to pressing challenges (potentially associated with climate change, limited supply, etc.)	3) Collaborate/innovative partnerships (other muni's, conservation authorities, universities, industry, other), mayor/top water managers outspoken on the related issues (climate change, reuse, etc.); work with province to progress regulations and develop policies and guidelines to support direction (e.g. rainwater harvesting guides and planning, energy reduction)	Mayor Farbridge wins national award for leadership in sustainability (2014): Mayor Farbridge has led the city in achieving a number of sustainability milestones, including achieving the highest residential waste diversion rate of any municipality in Ontario; protecting nearly a quarter of the city's land from development through the Natural Heritage System; doubling bike lanes; and reducing per capita energy use and greenhouse gas emissions – all during a period of significant population growth -developed a rainwater harvesting, greywater reuse, and Blue Built Home policies and programs for water efficiency and fit-for-purpose water. -multiple examples of collaboration between Universities, research organizations (SOWC), GRCA, and neighbouring municipalities - e.g. Region of Waterloo to combine resources for innovative studies (e.g. water efficiency)	3			
	Institutional Roles and Organizational Structure/ Administration of Services	1) Conventional siloed approach, centralized authority, limited collaboration/innovation partnership - initiated by others where exist, routine approach to water servicing	2) Work across disciplines and jurisdictional lines, enhanced public participation and dialogue, some innovative partnerships with distributed management; still clear lines of responsibility; have position for sustainability coordinator and some key staff champions	3) Adopting a One Water Approach to services within own jurisdiction, and reaching across jurisdictional lines to support integrated, holistic planning; majority of staff support and buy-into this approach and have adapted duties to match it; potential decentralized/PPP in play to administer projects	-confirm with Emily at City -Single tier municipality lends to more collaborative approach, see consideration for other disciplines in each discipline specific initiative - e.g. natural heritage protection for groundwater aquifers -have not formally adopted an overarching, integrated water framework, although they do put some of these principles into practice	2			
Outreach/ communication/ public engagement/ stewardship	Utility Outreach	1) Baseline interaction with public/stakeholders for billing, EA process, council approval, and website with access to regulatory reporting and some studies; more interaction with industry than residential population, minimum public participation and interaction in strategic planning	2) Substantial public education and outreach programs on annual water quality reports, capital plans, studies, and some on pollution prevention and efficiency programs, more engagement with public through detailed website and social media avenues for customer questions and feedback; real-time updates on pertinent water related info (e.g. flood risks, drought risk/water restrictions); enhanced public participation and dialogue	3) Strong, modern social media presence and outreach programs related to water cycle, water and energy conservation, pollution prevention in addition to regulatory reporting and study summaries (and detailed reports); real-time monitoring and feedback for optimizing customer behaviour and reporting issues (EPCOR, DC Water); demonstration projects	-strong outreach program, in particular related to water conservation. Website provides digestible study summaries of key findings, and more detailed reports. Room to grow in real-time monitoring and feedback, although initiatives being developed, such as smart-metering and apps; room to grow in implementation of sewer use bylaw	2.5			
	Public Attitudes	1) priority is for low water cost; adversarial relationship between key industrial users and utility	2) priority is for reassurance that *key issue* is being handled properly to protect the nature of their community, their environment, and water resources for their safety and health	3) Supportive of and demanding of more innovative solutions to protect resources at large for long-term sustainability; accept that may come with personal sacrifices in terms of behaviour and costs; key industrial users have productive relationship with utility	-public in Guelph and Council are progressive and demand innovative solutions for advancing environmental sustainability -based on my experience, key industries - Linamar, Sleemans are engaged on sustainability, water efficiency has good handle on industrial water users	3			
Monitoring	Asset Management	1) baseline asset management employed, updated recently to access provincial funding - have an inventory of major water and wastewater assets; no level of service (LOS) and only age/material based condition information; used to prioritize capital upgrades and variable funding for maintenance activities; reactive to breaks and failures	2) enhanced asset management strategy including tracking, inventory of major water, WW, and SW with basic info on LOS; Some inventory of GI - parks, trees, etc. but no LOS; AM plans reported and built into other planning process in addition to annual maintenance programs and capital upgrades/replacements. Integrated into GIS and databases; budget forecasting highlights annual investment required (not 100% met)	3) Detailed inventory of assets, including green infrastructure, with risk assessments for vulnerability to climate change and metrics on energy efficiency and triple bottom line indicators; use of smart technology and innovative approaches; key data is accessible and used for rehab, replacement and broader planning programs. View people as assets, invest in human capital; annual re-investment fulfilled	*note, based on history and plans - more detail on level of investment? See ECO, replace 1.5% of infra per year? 2008 Water/Wastewater Servicing Plan includes asset management plan for linear infrastructure - both water and wastewater Asset Management inventory currently includes information regarding the installation date of the linear infrastructure; this was reviewed to determine a basis for scheduling upgrades to the existing system. As the database is updated to include condition assessment information, these priorities should be revisited to confirm the timing of required works. -approach of asset management has been to assess sustainable infrastructure funding to maintain operation of infrastructure now and into the future. No clear mention of climate change or other sustainability metrics for evaluating infrastructure -urban forestry master plan recommends a tree inventory (not clear if implemented) -City developed more formal asset management program in 2016, and council approved corporate asset management plan and policy in March 2017. The infrastructure backlog is estimated at about \$500 million: \$220 million in tax-supported infrastructure (e.g. roads and parks) and 271 million in rate-supported infrastructure (e.g. water, wastewater and stormwater). New program, but seems to be robust	2			

Sustainability Status						
Category	Indicators/ categories	Evaluative question		Evidence from public record (attitude/action)	Rank	
	Water related Monitoring	1) Baseline monitoring for regulatory reporting on water takings, drinking water source quality, wastewater discharged, effluent quality; treatment and distribution operations monitored in SCADA	2) Baseline + more detailed analysis of different water user types and their per capita usage, UFW/non-revenue water, stream flow, stream quality, environmental indicators, interpretation of changes/trends	3) 2+ use of smart systems and innovative approaches to gather and interpret utility data on energy usage, water usage, quality in the system and environment, and feed into programming on land use, customer usage, infrastructure planning and staging	-do some additional WQ monitoring in rivers (in addition to GRCA) -introducing pilot programs for smart household monitoring of water use -not aware of widespread use of smart systems at user level or by municipality	2
Infrastructure	Approach to Infrastructure	1) conventional engineering approach of conservative, grey, conventional approaches based on demonstrated past efficacy or familiarity	2) Predominantly conventional approaches, grey, engineered technology, with infusion of some innovative approaches such as lot level green infrastructure, new water/wastewater technologies; predominantly centralized big investments favoured over smaller scale optimization/rehab projects	3) Mix of conventional grey and green technologies for managing urban water cycle, recognition of multi-purpose infrastructure, infrastructure planned with uncertainty built in - staged approaches , more decentralized than large-scale centralized projects; multiple smaller scale projects	-predominantly centralized approach for wastewater; a number of wells that supply directly to distribution system distributed throughout city -the city's leading example of focus on demand reduction emphasizes the cost-savings of smaller scale projects, saving the city X\$ per year	2.5
Financial Management	Financial Management	1) estimates of capital costs and recurring costs (operating) are the main considerations for cost benefit analysis and heavily influence decision-making; rudimentary financial planning to meet regulatory requirements, not achieving full-cost recovery, dependence on prov/fed grants and loans (non-innovative programs or meeting baseline requirements)	2) More balanced approach to cost-benefit analysis which attempts to incorporate social and environmental externalities; more advanced financial planning that strives to achieve full-cost recovery through rate increases to user fees and new rate structures (volumetric and fixed, stormwater fee, polluter pays) and other market-based approaches for allocating between different users, engages in partnerships with other agencies to optimize services and costs, accesses innovative grants (FCM green municipal fund, etc.)	3) triple bottom line approach and full integration of social and environmental aspects of infrastructure and decision making alongside economic costs, user fees and planning support full-cost recovery, active participation in innovative/PPP to efficiency deliver services and equitably share costs, access innovative grant programs to advance sustainable practices; including cost recovery mechanisms and business model approach through reclamation of nutrients from wastewater, or valuation of wastewater treatment for ecosystem services highlighting favorable environmental benefits, polluter pays, creativity in creating market for resources - such as nutrients, biosolids, creation of ecosystem services payments.	-The City continues to implement water conservation programs to reduce demands within a Council approved cost-benefit framework that compares the cost to implement water reduction programs to the cost for developing new municipal water supplies, with consideration for the added benefits of also deferring wastewater treatment infrastructure and incurring energy savings. (WSMP) -recently (2017) introduced a fee through Guelph Hydro bill (with water/wastewater) for stormwater fee to help recoup and meet investment needs (4\$ per bill in 2017) - and there is a stormwater credit program if property owners invest in reducing runoff. General rate increases, put Guelph in the average of Ontario municipalities	2
Climate change	Approach to climate change	1) No serious consideration for climate change in infrastructure planning or strategic plans; limited council support/staff support; recognition of value of energy efficiency for cost-savings	2) Recognition of climate change and need to address both mitigation and adaptation pieces; moderate council/staff support; considerations for climate change evident in planning and infrastructure decisions	3) Climate change adaptation plan and mitigation strategies well established, full council and staff buy-in and climate related decisions integrated into all decision-making	Through the Climate Change Office, have cross-departmental Energy, Water and Climate Change (EWACC) staff working group to deal with all City climate change and sustainability initiatives; support adaptation for resilience to climate vulnerabilities. Leads the City's efforts in climate mitigation, adaptation and sustainability. -Updated Emergency Response Plan with climate vulnerabilities in mind -not clear evidence of a thorough vulnerability risk assessment - but covered off in stormwater master plan	3
	Energy Supply	1) Supply by Prov-Regional, some priority on energy efficiency, some emergency generators; no emphasis on renewables; energy reporting through regulation (green energy act), but no measures to actively reduce.	2) Supply by Prov-Regional, effort to support resilience of electrical system from weather related hazards, standby power plan sufficient to meet min level of service for set period of time, some support and focus on renewables for municipal water-related assets; policies and benchmarking programs to measure progress in reduction of energy use in w/ww sector	3) Supply by Prov-Reg and local renewable sources and district/local power, protection of key electrical supply and backup to water related facilities, use of renewable energy sources at water facilities. Benchmarking for tracking continuous improvement; net-zero WW facilities	-Guelph has a Community Energy Initiative and a Corporate Energy Management Plan and has set bold targets for reduction of energy use - e.g. reduce energy use by 25% by 2031 -Guelph Hydro has invested in a district energy plan with thermal energy - "Guelph is the first city in North America to announce and pursue a long-term plan for a city-wide thermal energy network" - to supply 50% of Guelph's heating needs - strategic plan developed and some issues with the private company commissioned to develop local renewable energy supplies - has slowed progress, now mostly owned and under direction of Guelph. Next steps unclear. -Guelph meets Ontario Regulation 397/11 to report on energy consumption and greenhouse gas emissions on an annual basis and have an energy conservation and demand management plan - Guelph also reports on renewable energy production -not yet net-zero but undertaking studies with SOWC to advance net-zero facilities -increase in renewables, solar on one water tower and operations building	2.5
Other	+/-	other notes/aspects not covered but contribute or detract from sustainability				

Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance

Result: Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress

Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management
Look at past evidence and plans and policies moving forward

Sources: adapted from many but categories mainly from Brown et al., 2009

Sustainability Spectrum:

	1	2	3	
	"Sewered/Drained City"/ Meeting ON Regulatory Requirements for public/ environmental health ON Baseline Grey Infrastructure Approach	"Waterway/Water Cycle City"/ Limits to Growth/Social Amenity and Environmental Health Beyond Baseline Grey-Green	"Water Sensitive City", One-Water Approach, Resilience to Climate Change Sustainable-focus, Integrated One Water	(Brown et al., 2009) me (CVC)
Score	23	24-46	46-69	
Guelph Total Score:	54			
Count:	Count of 1= 1	Count of 2= 10	Count of 2.5= 6	Count of 3= 6

Analysis: Guelph scored high overall, with the vast majority of scores 2 or over, and just over 50% of score over 2.5. This is anticipated based on Guelph's reputation as a progressive, environmentally focused City. Despite carrying a range of activities in support of a sustainable, integrated water management approach, there is no overarching water framework. Progress in this area is guided by leadership in the municipality and public demanding sustainability - both of which lead to creativity and going beyond baseline requirements. Constraints in water supply and effluent discharge quality have also created innovative conditions in this municipality and contribute to a progressive score. Particularly because Guelph is considering a One Water approach, a more detailed framework to guide process on this may be valuable. Corporate strategic plan – framework for sustainability/One Water? Guelph has many great plans and initiatives – not always aware of from just the water supply world. Important to make direct links to each of affected areas – an overarching framework would help to tie-connections and ensure considerations for all are being made. In some cases, such as Guelph this may be done through existing Stormwater asset management has already been identified as an area that needs improvement, and Guelph has implemented a fee for these services and recently completed a stormwater management master plan.

Framework: The frameworks under consideration include the One Water framework and the GLSLCI Sustainable Water Management Framework. These are both appropriate as they provide flexibility to implement a simplified program that will create linkages between programs already carried out, and provide opportunity to support further integration.

One Water Framework

Recommended Tool: The tools under consideration are related to Guelph's interest in pioneering reuse in Ontario and also those related to vulnerability assessment of infrastructure to climate change as this was identified as an area of relative weakness. For reuse, the WEF Reuse Roadmap would be a useful resource, and the WRF Framework for Evaluating Alternative Water Supplies: Balancing Cost with Reliability, Resilience and Sustainability would provide detailed guidance on techniques to fairly evaluate water reuse compared to traditional supply sources. Since the WSMP was just updated, the more detailed framework is not recommended, but may be recommended at the time of the WSMP update (~2019). For assessment of infrastructure resilience, the PIEVC Protocol is a robust framework to quantify the risks for a group of assets, such as SW infrastructure to help prioritize upgrades, and could be incorporated into water asset management.

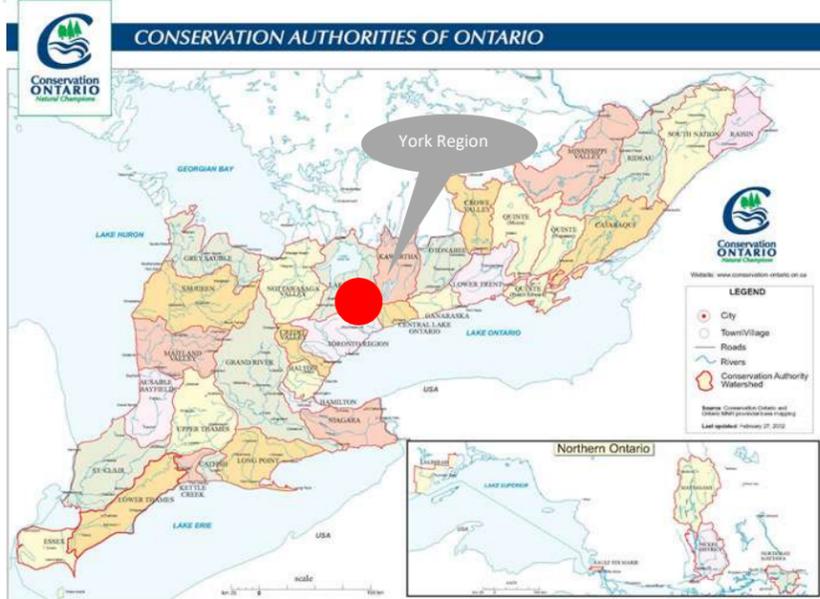
WEF Reuse Roadmap
PIEVC Protocol

Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance
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 Look at past evidence and plans and policies moving forward
 Date Completed: 11-Aug-17
 By: Kim Jusek

Key Questions to Characterize Community:

Municipality:	York Region										
Population:	<10,000	10-50,000	50-100,000	100-250,000	250-500,000	500,000-1,000,000	1-2,000,000	>2,000,000			
Tier:	Single	Upper	Lower	*Includes 9 lower-tier municipalities							
Description of responsibilities	(e.g. WW Treatment, SW etc.) Water and wastewater treatment trunk distribution and collection										
Key Priorities:	Flooding	Population Growth	Water Efficiency	Cost/Financing	Environmental Protection (Need for)	Reliable, Secure Supply	Resilient, Sustainable Community	Climate Change	Aging infrastructure	Public Health	Other?
Root Cause	(climate change, pop growth, aging infrastructure)	(Natural Resource limitations, discharge quality/quantity, climate change)	(Natural Resource limitations, aging infrastructure)	(Aging Infrastructure, climate change mitigation/adaptation, "we have no problems with current approach, but want financial sustainability")	(Natural Resource limitations, discharge quality/quantity, climate change)	(Natural Resource limitations, discharge quality/quantity, climate change)	(Climate change)	(related to flooding, environmental limitations, aging infrastructure, costs, sustainability, environmental limitations)	Financing, climate change, public health	Aging Infrastructure, costs, meeting basic needs	
Watershed:	Several different, including Lake Simcoe and Region Water Conservation Authority										
Water Source:	Groundwater, surface water from Lake Ontario (via wholesale purchase from City of Toronto or Peel Region for southern lower tier municipalities), surface water from Lake Simcoe										
Wastewater Receiver:	Lake Simcoe and Lake Ontario										
Proximity to water bodies	North borders Lake Simcoe, otherwise land-locked, rivers drain to Lake Ontario and Lake Simcoe, includes oak ridges moraine										
Location in watershed:											



Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

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 Where a municipality meets criteria under two adjacent categories, the previous category is selected and the key items not covered under the next level highlighted

Sustainability Spectrum:

1	2	3
"Sewered/Drained City"/ Meeting ON Regulatory Requirements for public/ environmental health ON Baseline Grey Infrastructure Approach	"Waterway/Water Cycle City"/ Limits to Growth/Social Amenity and Environmental Health Beyond Baseline Grey-Green	"Water Sensitive City", One-Water Approach, Resilience to Climate Change Sustainable-focus, Integrated One Water

(Brown et al., 2009)
me
(CVC)

Diagnostic and Evaluative Questions:

Category	Sustainability Status Indicators/ Categories	Evaluative question	Evidence from public record (attitude/action)	Rank
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Aspects to be Managed

one to three

Water Supply and Distribution	Municipal Supply Source	1) One source; SW or GW (no concern if local or imported); conflict on use/allocation and/or constrained supply	2) two source types; e.g. SW, GW; local; some examples of fit-for-purpose supply (residential RWH, GWR, irrigation with untreated water)	3) >3 sources; incl. non-conventional sources (RWH, Reclaimed wastewater, etc.); local supply; supply of different water quality (fit-for-purpose)	-currently, surface water from Lake Simcoe-based Georgina water system, Lake Ontario (88% of supply through agreements with Region of Peel and City of Toronto) and stand-alone local groundwater are utilized. -Through York Region's 2016 Water and Wastewater Master Plan and the Long Term Water Conservation Strategy Update, water reuse has been identified as an essential component in meeting the Region's ambitious 2051 target of reducing per capita water consumption to 150 litres per day. Furthermore, it is a critical measure in safeguarding valuable water supplies in the Lake Simcoe watershed. Use of non-potable/alternative water supplies to meet non-potable demands part of strategy for new developments, but not primary focus. (Water Conservation Update, 2016). -there are plans to incorporate wastewater reuse that are put in motion, but not currently practising - likely to be the first Ontario municipality to do so however -note - innovated out of requirement by MOECC, from water efficiency strategy as project purpose: "Development, completion and submission of the LTWCS to the Ministry of the Environment on March 31, 2011 is required to fulfill Conditions of Approval for both the Southeast Collector Trunk Sewer for additional sewer flow capacity and the Intra-basin Transfer initiative to supply drinking water from Lake Ontario to the communities of Aurora, Newmarket and East Gwillimbury.	2
	Water Supply Planning Approach	1) Supply-side approach to meet demands, water quality and operations meets SDWA requirements, single-use water, limited consideration for water conservation measures, conventional technology options, single future scenario, 25 year timeframe, , baseline SWP carried out.	2) Demand management + supply management, incorporation of conservation and efficiency impacts, primarily single-use water, source planning includes evaluation of energy demands of treatment, chemical use, reliability; use of scenario planning, 50 yr timeframe, traditional sources prioritized, thorough SWP carried out and actively engaged in implementation	3) Demand management predominantly - incl. fit for purpose, optimizing existing infrastructure before expanding/upsizing, linked to broader watershed management (other users), scenario planning including climate change consideration, alternative water sources (RW, SW, WW reuse) employed for range of applications, 100 yr time frame considered, consideration of water cycle through SWP in sourcing water and balancing treatment needs/reliability, and maintaining resilience; considerations for impacts from climate change on water quality and quantity	-through water conservation strategy, goal of no new water by 2022, and all water needs are met at 2011 supply by conservation and demand management. -very integrated with water efficiency plan - efficiency plan considers different scenarios - degrees of water demand reduction, with most stringent being no new water, and use of reuse - embrace the Soft Path approach -not a 100 yr planning time frame, but very ambitious 50 yr timeframe therefore considered to be ranked as 3 -mention that DW will meet applicable regs, and that non-potable water will meet applicable standards (future) for intended use (long-term water conservation strategy) -benefits of the lake simcoe water servicing strategy (over using Lake ON for increases in demand) Diversity of Supply - Interconnection between Lake Simcoe and Lake Ontario supplies provides redundancy in the event of a disruption to either supply; Water Quality - Shorter water age (water age = the time it takes for water to travel from a source to the consumer); Climate Change and Energy Efficiency - Minimizes energy consumption as a result of less pumping; Water Balance - Intra-basin water transfer from Lake Ontario to Lake Simcoe is minimized -note - water/wastewater MP doesn't mention soft path approach, introduces One Water Approach -The Made-in-York One Water approach is inspired by an emerging concept in the water industry with an aim to unlock the value of more innovative thinking and integrated decision making on water management and the water cycle. Through this approach, the Region is on route to capitalize on cross-functional integration benefits, practice innovation to realize the value of treated wastewater as a resource, and maximize the sustainable use of existing resources (referred as infra-stretching in this document) (w/ww MP doc) Sources: 2016 W/WW Master Plan, Vision 2051 Strategy, and 2011 Long-term Water Conservation Strategy	3

Sustainability Status						
Category	Indicators/ Categories	Evaluative question	Evidence from public record (attitude/action)	Rank		
	Conservation and Efficiency	1) enforce building code updates, outdoor lawn watering by-law, fixed fee rate structure, limited outreach material	2) Outreach programs, efforts to measure and reduce non-revenue water, reduce per capita demand through indoor/outdoor by-laws, education and incentives (rebates), volumetric based rate structure - tangible targets set and record of success	3) 2+ comprehensive plan which is integrated into other urban waters planning, support for fit-for-purpose reuse of water (GWR, RWH), smart/real-time monitoring	-have long-term water conservation strategy, 40 year period -focus on efficiency for last 10 years -comprehensive list of actions - residential, ICI, leak detection, education programs -To be effective in reaching targets - need to have cooperation of local municipalities - this is a constraint to achieving objectives -source: long-term water conservation strategy (2011) - update on 2007 strategy -as part of individual class EA for the upgrade of a southeast sewage collector, the Region must implement and update every 5 years a water efficiency master plan, and imposed general water efficiency requirements. Note, there is a regulatory requirement to implement and report progress to the MOECC on water efficiency	2.5
	Water Distribution	1) water delivered achieves pressure and quality requirements, as established by the SWDA and local design targets; reactive approach upgrades and maintenance; UFW at >20% (see AM for more about approach)	2) proactive approach to watermain and distribution infrastructure, promotion of product such that use of bottled water is minimized; UFW <15%; coordination between different tiers and disciplines for construction; optimize energy usage of pumps	3) 2+, UFW <10%, GIS-platform to engage with customers and address issues quickly, use of DSS and smart systems to optimize pumping for energy efficiency	-as part of the Water Efficiency Strategy Distribution Leakage Detection was undertaken via an "International Water Association water audit and water balance of the municipal and regional distribution system was undertaken and a pro-active leak detection and repair program was initiated", and mention support to local municipalities in leak reduction -based on 2017 annual report on long-term water conservation strategy, weighted average for 2015-non-revenue water is 15% *energy efficiency optimization of pumps no specifically mentioned, although generally discussed in water supply approach and covered under energy reporting, discussed in energy section	2
Wastewater	Handling of Wastewater Treatment	1) treat and discharge to environment, meet minimum environmental quality guidelines	2) treat, recover biosolids, discharge to environment such that it does not significantly degrade the environment and consideration for impacts to reuse according to measured and regulated parameters, use of modelling assimilative capacity, energy efficiency optimization of processes	3) treat, recover biosolids/biogas for energy/water, discharge to environment such that it does not significantly degrade the environment (incl. acute and chronic/cumulative impacts), above and beyond regulated parameters, modeling of assimilative capacity, pollution prevention programs integrated into treatment approach (residential/industrial source control) through enforced sewer use bylaw; net-zero for energy use; address emerging contaminants	-York Region straddles a Great Lakes watershed divide - the Lake Huron (Lake Simcoe) and Lake Ontario watershed, so servicing strategies have been developed to minimizing transfer of water between these watersheds - as per regulation -phosphorus credits/trading investigated with Lake Simcoe and Region CA to achieve objectives under the Lake Simcoe Protection Act, 2008 as well as advanced wastewater treatment to achieve low P levels including the use of membranes -not a pronounced focus on net-zero facilities, bio solids management, nor municipal pollution prevention programs. Progressive focus is on freeing capacity of existing infrastructure (York-Durham Sewage System) - although mention of use of energy recovery from WWTPs -majority of wastewater goes to Lake Ontario at the Pickering WWTP co-owned with Durham Region (85%), 10% goes to Peel Region WWTP for Vaughn, and remaining is by local WWTPs (7) in the north part of the Region -improving significantly WWT, but still strides to be made	2.5
	Wastewater Planning Approach	1) Increase capacity of WWTP and collection system and upgrade treatment systems as population grows; centralized treatment, single future, does not consider conservation/efficiency, does not control I/I as evidenced by regular sewer backups, overflows, and by-pass events, 25-year planning horizon or less	2) Focus on optimization of treatment plant for capacity and treatment to meet growth and effluent restrictions, incorporation of reducing flows through I/I reduction programs (separate combined sewers) and water efficiency, pilot testing of new technologies through innovative partnerships, enforce sewer use by-law, tie-into watershed plans and downstream impacts, use of modeling programs to inform planning; some overflow events and flooding in extreme conditions; 50 year planning horizon	3) 2+ inclusion of semi-centralized/decentralized treatment , reuse of water, energy, bio solids, nutrients, greenhouse gas reduction in collection system, integration of water/SW planning, focus on pollution prevention (update sewer use by-law), consideration for climate change resiliency, advanced use of modelling to assist with planning; consider 100 year planning window	-long-term water conservation and I/I reduction strategy -planning and approvals underway for new WWTP with a state-of-the-art water reclamation centre to support water reuse and return water taken from Lake Simcoe to its watershed; -sewage part of a dual-region initiative for part of servicing - York-Durham Sewage System -note - innovated out of requirement by MOECC, from water efficiency strategy as project purpose: "Development, completion and submission of the LTWCS to the Ministry of the Environment on March 31, 2011 is required to fulfill Conditions of Approval for both the Southeast Collector Trunk Sewer for additional sewer flow capacity and the Intra-basin Transfer initiative to supply drinking water from Lake Ontario to the communities of Aurora, Newmarket and East Gwillimbury. -Implementation of One Water Approach -water/wastewater master plan update is a progressive document, but also showed limited discussion/evaluation of scenarios and advanced modelling tools	2.5
	Collection infrastructure	1) expand and upsize sewer infrastructure as needed based on expanding population and failure, upgrade when roads are scheduled for upgrade.	Sewer by-law to not only protect treatment processes and receiving environment, but to protect integrity of collection infrastructure through reducing corrosive components and to reduce production of odors and GHG emissions; maintenance programs to extend lifespan; coordination construction upgrades with other public infrastructure	3) 2+ support efficiency programs and storm water management to reduce need to upsize infrastructure (across discipline/jurisdictional boundaries); sewer mining for decentralized water reuse	-as outlined above, focus on reducing I/I to extend life of infrastructure, not a strong emphasis observed for sewer use by-law, and likely challenges in enforcing due to local municipalities needing to also cooperate and comply. -sewer by-law for sanitary and storm sewers, comprehensive and some council documents indicating greater enforcement, but not clear link to reducing corrosion -by-law doesn't include chloride (known to accelerate corrosion) -local municipalities also have their own by-laws, so have to meet both	1.5

Sustainability Status						
Category	Indicators/ Categories	Evaluative question		Evidence from public record (attitude/action)	Rank	
Stormwater	Stormwater Management Approach	1) Convey water out of city; urban flood protection from property damage; developed piecemeal with population growth/new developments If Upper Tier: See below	2) Flood protection but also protection of local rivers (quality and quantity - erosion), infiltrate and manage onsite (lot level solutions) to protect water balance and contribute to protection of local rivers; informed by watershed planning If Upper Tier: see below	3) Mimic natural water cycle, city-wide review of stormwater management, connect to watershed plans and upstream/downstream communities, protect property from flooding and protect natural environment from erosion/non-point pollutants, integrate into watershed planning, WW and water planning, retain and reuse locally, planning policies to support GI options before grey, and innovative management approaches to asset inventory and maintenance, and financing; ecological corridors and GI network If Upper: see below	N/A	2
		If Upper Tier, "not their jurisdiction"; Primary involvement/concern is protection of infrastructure in built-up areas	If Upper Tier, "make an effort to work with other tier to coordinate and support efforts across lower tiers"; Concern for impacts on integrity of water sources (GW recharge, surface water infrastructure/quality, flooding of w/ww assets, inflow to sanitary sewers	If Upper Tier, "Active participant on plans and policies to support unified approach to SW management and GI policies across lower tiers"; facilitation between lower-tier municipalities and conservation authorities to harmonize approach on stormwater management as it related to impacts on various systems - e.g. increase use of non-potable water impacts water supply but not necessarily wastewater flows.	-Stormwater management is not the jurisdiction of York Region - does not take leadership on guidance on this issue -York Region partners with the Lake Simcoe Region Conservation Authority and Toronto Region Conservation Authority on stream bank protection and in-stream erosion control - mainly to protect infrastructure in those locations -new integrated approach to water management, One Water Approach, includes considerations for stormwater management and use. -through SWP interested in maintaining recharge of groundwater wells, and general land-use planning that York Region has jurisdiction over	
	SW Infrastructure	1) Mainly 'grey' or engineered infrastructure, including concrete drainage systems and some end of pipe controls If Upper Tier: "No comment on type of infrastructure, jurisdiction of lower tier municipalities"	2) Mainly grey in core areas, with more lot level GI practices in new developments, including rain gardens, rain barrels, and wet/dry ponds. If Upper Tier: "Strategies and studies highlight benefits of green infrastructure; up to lower tier municipalities to adopt and implement"	3) Complimentary grey-green systems through urban area, use of LID including green roofs, urban trees, swales, parkland, and pollution prevention; network of GI, not only one-offs If Upper Tier: "Direction from strategic plans and Official Plan promote green infrastructure for the multi-functional benefits and services they provide, requiring compliance and supporting implementation at lower tier levels"	-see above, efficiency plans and SWP from W/WW MP highlight need to protect land for services they provide for water supply protection -some of the Provincial Regulation - Oak Ridges Moraine Conservation Act and Greenbelt Act would enforce some of the aspects of 3 (requiring compliance), although no evidence of a network or more strategic approach to stormwater management was found.	2
Natural Urban Water (surface)	Management Approach	1) under jurisdiction of CA, abide by flood zones/buffer zones, seen as source of water, conveyance for stormwater, dilution of wastewater, transportation (possibly) - human centred	2) Seen as amenity for recreation and tourism, protected from erosion and contamination for upholding recreational use, and other urban function discussed above; viewed as an asset (property value, tourism related income) and a risk (flooding)	3) Part of larger natural ecosystem, requiring quality and quantity and buffer riparian zones respected and protected from human development and heavy use, in addition to cultural/aesthetic value and functional uses for water, wastewater and stormwater; restoration investments made (daylighting streams, integrating into SWM planning); monitoring and addressing quality/quantity issues including cumulative effects	-enhanced protection under Official Plan due to unique environmental features which are to be protected: Oak Ridges Moraine Conservation Act and Greenbelt Act, and Lake Simcoe Protection Act -the Oak Ridges Moraine is the headwater source for 65 river system, notably the Don, Rouge, Humber, and Holland Rivers -due to meeting requirements of these Acts, York Region ranks high in this category of natural heritage protection and enhancement -however, major rivers are not considered to have good water quality.	1.5

Sustainability Status Indicators/ Categories					
Category	Indicators/ Categories	Evaluative question	Evidence from public record (attitude/action)	Rank	
Landscape	Land Use Management Approach	1) Landscape and environmental features dealt with as necessary under provincial regulations (e.g. protected moraine or wetlands), not managed as multi-functional assets impacting the water cycle; greenfield development rampant 2) carry out sub-watershed plans, coordinate with CA, land use policies (e.g. Official Plan) identify and protect key hydrologic features (wetlands, forests, park land) for their role in GW recharge, habitat, and flooding/social amenity in development; urban intensification; conservation viewed as a trade-off; implement drinking water SWP measures; understanding the connection between land use practices (impermeable, salts, nutrients) and downstream water quality impacts and water availability impacts	3) 2+ promotion of urban agriculture, urban forests and parkland, green infrastructure, green roofs/walls, and active planning and management by the city in maintaining the health of these features/ecosystems (wildlife, use and pollution management); urban intensification with prioritization on protecting hydrologic features; recognizing as multi-benefits vs trade-offs; source water protection for all sources - natural/ecosystem flows in addition to drinking water, downstream impacts (over and above baseline SWP); tie-into broader watershed through inventory of resources and users; resources: waterways, wetlands, fish and wildlife, endangered species, cultural and recreational resources and users: commercial navigation, potable water supply, agriculture, etc.)	-43% of land in York Region designated as agricultural or specialty crop plans (Holland Marsh) and 69% is protected under the Ontario Greenbelt and Oak Ridges Moraine Acts -haven't seen a natural heritage master plan (like Guelph did, maybe bc upper tier) -The Region's key major landform is the Oak Ridges Moraine, a height of land running east and west that separates two major watersheds. Streams and rivers in the northern portion of the Region flow to Lake Simcoe, which lies in the Lake Huron watershed, while those in the south drain to Lake Ontario. The moraine's underlying geology makes it an important source of groundwater recharge. Straddling two watersheds, it is the headwater source of 65 river systems. In the southern watershed these include the Don, Rouge and Humber rivers; and in the northern watershed, the Holland, Black and Maskinonge rivers. -constraints on servicing as a result of these plans - such as only servicing with water or ww, and not the other, and extending lake-based servicing -Lake Simcoe Phosphorus Offset Program through water quality trading -more limited success on progress for programs under the Regional Green Strategy - including increase number of trees and shrubs planted annually and number of hectares of environmental lands secured (in addition to maintaining percentage of lands subject to environmental protection policies (as reported in 2017 strategic plan progress update)	3
General Planning Approach	Planning Approach	1) Planning exercises for new infrastructure and development follow the Class EA process (discipline lead), conventional solutions considered and evaluated with cost as the primary consideration 2) Studies follow the Class EA process, consider more innovative solutions and methods for arriving at solutions including enhanced public participation, recognize complexity of planning decisions related to aging infrastructure, growth, climate change; time frame of 50 yrs	3) Studies and planning activities consider full water cycle impacts and follows an integrated water management framework/approach, incorporate discipline integration and multi-functional/multi-benefit infrastructure solutions, build on EA approach and use more sophisticated decision making tools (e.g. triple bottom line) and methods to deal with uncertainty (adaptive management, staging with monitoring, vulnerability risk assessments, iterative), planning considers innovative approaches such as nutrient trading; time frame of 100 yrs	-vision 51 includes guiding principles for meeting long-term servicing needs by adapting to trends -includes guiding principles which highlight adaptive and flexible approach, efficiency and conservation, collaborative and innovative, accessible and inclusive, creative and innovative, preventative, resilient, sustainable -annual reports on strategies (e.g. strategic plan, conservation plan) -Implementation of development related initiatives must be completed in partnership with the nine local municipalities as planning approvals is a two-tiered system as is water and wastewater infrastructure (water efficiency MP). - Maximize partnerships with local municipalities and utilities for the cost-effective delivery of York Region's water conservation and efficiency programs -One Water Approach, and metrics upon which options were evaluated featured aspects of triple bottom lone approach - evidence of attempts at more integrated approach	2.5
Governance	Culture supportive of innovative approaches and/or sustainability in Policies	1) Council approved strategic plan/official plan comments on striving to have a healthy environment to extent PPS requires it; pushback on rate increases 2) strategic plan and official plan comments on protecting water quality and quantity and some restrictions on land use; environmental and sustainability initiatives undertaken by municipality	3) strategic plan and official plan sets bold targets/goals with respect to water and environmental sustainability and restrictions on land use; environmental/sustainability strategy implemented and monitored to track and report progress, includes decision-support , to support implementation of strategic plan objectives	-Vision 51 includes guiding principles for meeting long-term servicing needs by adapting to trends -includes guiding principles which highlight adaptive and flexible approach, efficiency and conservation, collaborative and innovative, accessible and inclusive, creative and innovative, preventative, resilient, sustainable -mentions adaptive management with flexible to repurpose infrastructure and adjust to new technology etc. -annual progress reports posted for progress on strategic plan, which fits into the Vision 51 longer-term planning - including a easy to interpret key regional performance indicators handout. -main drawback is that it took regulatory push to adopt more progressive approaches, although these systems are now in place	3
	Corporate Leadership on Sustainability	1) Outlook on water services is to provide safe, affordable water and wastewater services, prevent flooding to protect public health and private and public 2) Outspoken on key issues relating to pressing challenges (potentially associated with climate change, limited supply, etc.)	3) Collaborate/innovative partnerships (other muni's, conservation authorities, universities, industry, other), mayor/top water managers outspoken on the related issues (climate change, reuse, etc.); work with province to progress regulations and develop policies and guidelines to support direction (e.g. rainwater harvesting guides and planning, energy reduction)	-vision 51 strategy recognizes the need for ongoing leadership , building on water conservation legacy -used a back-casting approach to develop vision through the Soft Path principles -mention of the soft path in water efficiency strategy: The strategic decision to take a new approach led to the use of "Soft Path" to establish a long term vision for water conservation and efficiency in the Region. The Soft Path approach involved engaging stakeholders throughout the Region to develop a vision for a water future. The collective vision of "No New Water" evolved from public engagement and consultations. The definition of no new water reflects the aspirational goal for 2051. The application of Soft Path is unprecedented in a large, two-tier municipality with nine autonomous municipalities such as York Region. -now there is corporate leadership on this, but took top-down direction from province to require it (when major upgrades to infrastructure were being considered/sought approval)	3

Sustainability Status						
Category	Indicators/ Categories	Evaluative question		Evidence from public record (attitude/action)	Rank	
	Institutional Roles and Organizational Structure/ Administration of Services	1) Conventional siloed approach, centralized authority, limited collaboration/innovation partnership - initiated by others where exist, routine approach to water servicing	2) Work across disciplines and jurisdictional lines, enhanced public participation and dialogue, some innovative partnerships with distributed management; still clear lines of responsibility; have position for sustainability coordinator and some key staff champions	3) Adopting a One Water Approach to services within own jurisdiction, and reaching across jurisdictional lines to support integrated, holistic planning; majority of staff support and buy-into this approach and have adapted duties to match it; potential decentralized/PPP in play to administer projects	-vision 51 highlights need for integration of services, mention in Long-term water cons strategy that it strives to integrate with the Regional Official Plan and Sustainability Strategy -A multi-disciplinary and integrated approach was employed to develop the LTWCS. Project management was the responsibility of Regional staff with guidance and support provided by local municipal staff -Challenges associated with the Regional-Municipal water supply system; their strategies plans recommend that the Region utilize the Regional-Municipal Water and Wastewater Steering Committee to facilitate co-ordination of planning, leakage detection, asset management, flushing programs and other system related matters, and to work to standardize the type of information collected -new development is a big opportunity to employ cons measures - such as dual plumbing and water efficient landscaping - but that this jurisdiction is with the local municipalities -One Water Approach has recently been adopted, which builds off of the Soft Path approach. However, there are still challenges with implementing this -partnerships with neighbouring upper/single tier municipalities for water/wastewater servicing, and with conservation authorities	2.5
Outreach/ communication/ public engagement/ stewardship	Utility Outreach	1) Baseline interaction with public/stakeholders for billing, EA process, council approval, and website with access to regulatory reporting and some studies; more interaction with industry than residential population, minimum public participation and interaction in strategic planning	2) Substantial public education and outreach programs on annual water quality reports, capital plans, studies, and some on pollution prevention and efficiency programs, more engagement with public through detailed website and social media avenues for customer questions and feedback; real-time updates on pertinent water related info (e.g. flood risks, drought risk/water restrictions); enhanced public participation and dialogue	3) Strong, modern social media presence and outreach programs related to water cycle, water and energy conservation, pollution prevention in addition to regulatory reporting and study summaries (and detailed reports); real-time monitoring and feedback for optimizing customer behaviour and reporting issues (EPCOR, DC Water); demonstration projects	-Decent website with key information summarized and visual tracking, to help tell a story, and also full documents provided for reference and further information and searchable page for all environment related info -appear to have active conservation outreach program, more detailed reports more difficult to find -suspect due to size, city websites may have more traffic and be default location to check information	2
	Public Attitudes	1) priority is for low water cost; adversarial relationship between key industrial users and utility	2) priority is for reassurance that *key issue* is being handled properly to protect the nature of their community, their environment, and water resources for their safety and health	3) Supportive of and demanding of more innovative solutions to protect resources at large for long-term sustainability; accept that may come with personal sacrifices in terms of behaviour and costs; key industrial users have productive relationship with utility	-public likely active historically when oak ridges moraine protection plan and lake simcoe protection act came into play. Currently, the public perception challenge will be accepting wastewater reuse	2.5
Monitoring	Asset Management	1) baseline asset management employed, updated recently to access provincial funding - have an inventory of major water and wastewater assets; no level of service (LOS) and only age/material based condition information; used to prioritize capital upgrades and variable funding for maintenance activities; reactive to breaks and failures	2) enhanced asset management strategy including tracking, inventory of major water, WW, and SW with basic info on LOS; Some inventory of GI - parks, trees, etc. but no LOS; AM plans reported and built into other planning process in addition to annual maintenance programs and capital upgrades/replacements. Integrated into GIS and databases; budget forecasting highlights annual investment required (not 100% met)	3) Detailed inventory of assets, including green infrastructure, with risk assessments for vulnerability to climate change and metrics on energy efficiency and triple bottom line indicators; use of smart technology and innovative approaches; key data is accessible and used for rehab, replacement and broader planning programs. View people as assets, invest in human capital; annual re-investment fulfilled	-mention in Vision 51 of investment in infrastructure to maintain a good state of repair -there is a Region of York AM Plan, but also, each local municipality has an AM Plan -early stages development - meeting baseline outlined in Ministry of Infrastructure guidance document, difficult to find on website -York Region participates in the Municipal Benchmarking Network - whereby a range of data are recorded on an annual basis and results of other municipalities are compiled in a report on an annual basis to support policy making, evaluating programs and identifying trends.	2
	Water related Monitoring	1) Baseline monitoring for regulatory reporting on water takings, drinking water source quality, wastewater discharged, effluent quality; treatment and distribution operations monitored in SCADA	2) Baseline + more detailed analysis of different water user types and their per capita usage, UFW/non-revenue water, stream flow, stream quality, environmental indicators, interpretation of changes/trends	3) 2+ use of smart systems and innovative approaches to gather and interpret utility data on energy usage, water usage, quality in the system and environment, and feed into programming on land use, customer usage, infrastructure planning and staging	-mentioned use of enhanced monitoring of water use, leakages etc. in the water efficiency master plan -regulatory environmental indicators would be required to be met, and more innovative programs, such as water reuse piloting will include more enhanced monitoring, not clear if there is additional environmental monitoring undertaken beyond regulatory requirements and innovative initiatives	2
Infrastructure	Approach to Infrastructure	1) conventional engineering approach of conservative, grey, conventional approaches based on demonstrated past efficacy or familiarity	2) Predominantly conventional approaches, grey, engineered technology, with infusion of some innovative approaches such as lot level green infrastructure, new water/wastewater technologies; predominantly centralized big investments favoured over smaller scale optimization/rehab projects	3) Mix of conventional grey and green technologies for managing urban water cycle, recognition of multi-purpose infrastructure, infrastructure planned with uncertainty built in - staged approaches, more decentralized than large-scale centralized projects; multiple smaller scale projects	-there is an emphasis on larger scale infrastructure investments, but there is also emphasis on water conservation and I/I reduction which help offset large infrastructure expansions.	2

Sustainability Status						
Category	Indicators/ Categories	Evaluative question		Evidence from public record (attitude/action)	Rank	
Financial Management	Financial Management	1) estimates of capital costs and recurring costs (operating) are the main considerations for cost benefit analysis and heavily influence decision-making; rudimentary financial planning to meet regulatory requirements, not achieving full-cost recovery, dependence on prov/fed grants and loans (non-innovative programs or meeting baseline requirements)	2) More balanced approach to cost-benefit analysis which attempts to incorporate social and environmental externalities; more advanced financial planning that strives to achieve full-cost recovery through rate increases to user fees and new rate structures (volumetric and fixed, stormwater fee, polluter pays) and other market-based approaches for allocating between different users, engages in partnerships with other agencies to optimize services and costs, accesses innovative grants (FCM green municipal fund, etc.)	3) triple bottom line approach and full integration of social and environmental aspects of infrastructure and decision making alongside economic costs, user fees and planning support full-cost recovery, active participation in innovative/PPP to efficiency deliver services and equitably share costs, access innovative grant programs to advance sustainable practices; including cost recovery mechanisms and business model approach through reclamation of nutrients from wastewater, or valuation of wastewater treatment for ecosystem services highlighting favorable environmental benefits, polluter pays, creativity in creating market for resources - such as nutrients, biosolids, creation of ecosystem services payments.	-vision 51 cites fiscal responsibility, states implementing full cost accounting, exploring innovative financial tools and funding models -York Region along with the City of Barrie participated in a water quality trading (phosphorous) program. As a market-based approaches, is not an alternative solution; it works in conjunction with, pollution control regulations. Water Quality Trading builds on current industry practices and usually complements other government tools, some that are regulatory in nature and others that are voluntary, such as agricultural stewardship programs. In theory it allows for dischargers to meet environmental objectives at lower cost and with more flexibility than other types of regulations - with funding through the Ontario Showcasing Water Innovation grant -more innovative practices demonstrated and being developed, such as through market development for reclaimed wastewater -challenges have been experienced with limitations on scientific knowledge of water needs for ecosystems and the large scope of water sources given the size of the Region of York; furthermore, they have not developed a way to put a value to conserved water in terms of wastewater treatment, water source protection, etc., so there is a bias towards conventional solutions	2
Climate change	Approach to climate change	1) No serious consideration for climate change in infrastructure planning or strategic plans; limited council support/staff support; recognition of value of energy efficiency for cost-savings	2) Recognition of climate change and need to address both mitigation and adaptation pieces; moderate council/staff support; considerations for climate change evident in planning and infrastructure decisions	3) Climate change adaptation plan and mitigation strategies well established, full council and staff buy-in and climate related decisions integrated into all decision-making	-mention of need to develop and implement corporate climate change action plan (could not find one yet though) -Through the One Water Action Plan, one subject area is to develop climate change adaptation and mitigation strategies. In this is states: "the Region is involved with the International Council for Local Environmental Initiatives Canada, which is an association of local governments committed to improving environmental sustainability. The Council developed the Building Adaptive and Resilient Communities Tool. This tool provides an innovative means of climate change adaptation planning consistent with the One Water approach. It is modelled on a five-milestone framework that leads local government practitioners through the climate change adaptation planning process. York Region is committed to using this framework to address climate change adaptation. - York Region is already engaged in making its water services more adaptive and resilient through the Long-term Water Conservation Program and Inflow and Infiltration Reduction Strategy. The Region has also developed a White Paper on climate change impacts in the Region.	2
	Energy Supply	1) Supply by Prov-Regional, some priority on energy efficiency, some emergency generators; no emphasis on renewables; energy reporting through regulation (green energy act), but no measures to actively reduce.	2) Supply by Prov-Regional, effort to support resilience of electrical system from weather related hazards, standby power plan sufficient to meet min level of service for set period of time, some support and focus on renewables for municipal water-related assets; policies and benchmarking programs to measure progress in reduction of energy use in w/ww sector	3) Supply by Prov-Reg and local renewable sources and district/local power, protection of key electrical supply and backup to water related facilities, use of renewable energy sources at water facilities. Benchmarking for tracking continuous improvement; net-zero WW facilities	-have mapping on website of energy use - including specifically for water/wastewater facilities, over time and broken down by each facility - GHG, electricity use and natural gas - as part of O.Reg. 397/11 -practice energy recovery from wastewater, and have demonstrated a decrease in energy use and GHG emissions since 2012 -The 2015 Water and Wastewater Energy Roadmap focused on the energy efficiency of water and wastewater assets. The Roadmap identifies potential cost-effective energy efficiency projects, establishes a progress measurement process and increases the energy efficiency of the Region's water and wastewater facilities.	2

Other +/- other notes/aspects not covered but contribute or detract from sustainability

Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance

Result: Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress

Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management

Sources: Look at past evidence and plans and policies moving forward
adapted from many but categories mainly from Brown et al., 2009

Sustainability Spectrum:

	1	2	3
	"Sewered/Drained City"/ Meeting ON Regulatory Requirements for public/ environmental health ON Baseline Grey Infrastructure Approach	"Waterway/Water Cycle City"/ Limits to Growth/Social Amenity and Environmental Health Beyond Baseline Grey-Green	"Water Sensitive City", One-Water Approach, Resilience to Climate Change Sustainable-focus, Integrated One Water
Score	23	24-46	46-69
Total Score:			52
Count:	Count of 1= 0	Count of 1.5= 2	Count of 2= 11
		Count of 2.5= 6	Count of 3= 4

Analysis: York scored high overall, with the vast majority of scores 2 or over, and just under 43% above 2.5

This is anticipated based on York Region's recent adoption of a One Water Approach, focus on conservation and efficiency, population pressures, and unique Provincial Regulatory Framework (Lake Simcoe Protection Act, Oak Ridges Moraine Conservation Act, Greenbelt Act).

Despite having an overarching framework for sustainable, integrated water management approach, there were some notable limitations and challenges, mainly due to the division of responsibilities between upper and lower tier municipality, and the very large geographic area and population covered

Progress in this area was through a top-down push when upsizing of infrastructure was proposed to meet new growth - this forced the municipality to implement I/I control and long-term water efficiency strategy

Constraints in water supply and effluent discharge quality and geography have also created innovative conditions in this municipality and contribute to a progressive score, such as leading work on water reuse in the province of Ontario

The Vision 51 document to act as a longer-range strategic plan guidepost is progressive, and allows for tracking of progress on some sustainability related metrics.

Have identified a climate change adaptation framework (ICLEI) that they are in the beginning stages of implementing for their climate change programming.

Stormwater management and watershed planning were not encountered frequently in the review, if at all; this may be a result upper tier and its jurisdiction

York has started to implement more progressive planning and strategies, but general sense that conventional approaches still dominate and there is a number of challenges to overcome, some due to shear scale, related to making progress

Recommended

Framework: The Municipality of York already has adopted the One Water Approach - previously used the Soft Path to develop the guidance of the long-term conservation strategy.

It is recommended that York continue to utilize this framework, but to expand its discussion/linkages to better incorporate stormwater management (beyond the scope of I/I and better support integrated approach for GI across local municipalities, and better connect water impacts to Conservation Authority initiatives and land-use; all of which can be incorporated under the scope of the One Water Approach as a next stage

One Water Framework

Recommended Tool: The tools under consideration are related to York Regions work pioneering reuse in Ontario, and addressing apparent weakness in the area of natural urban waterways, approach to collection infrastructure management

For reuse, the WEF Reuse Roadmap would be a useful resource, and the WRF Framework for Evaluating Alternative Water Supplies: Balancing Cost with Reliability, Resilience and Sustainability would provide detailed guidance on techniques to fairly evaluate water reuse compared to traditional supply sources. These tools can be referenced to help guide continued development of policies and future evaluation of alternative water supply sources.

WEF Reuse Roadmap

It is expected that the low score on collection infrastructure may be due to limited information on their programming - and more limited asset management information available.

It may be a consideration to strengthen their overall asset management approach and address gaps in some of the stormwater and natural waterways evaluation by providing more regional support for Green Infrastructure policies.

The Region has some natural heritage related planning, but to put in context of GI for water management could be beneficial.

CVC developing a “Green Infrastructure Asset Management Planning”

Finally, challenges inherent in the scale of York Region highlight that tools to support coordination with lower-tier municipalities may be needed

mainstreaming or implementation of smart systems could be considered

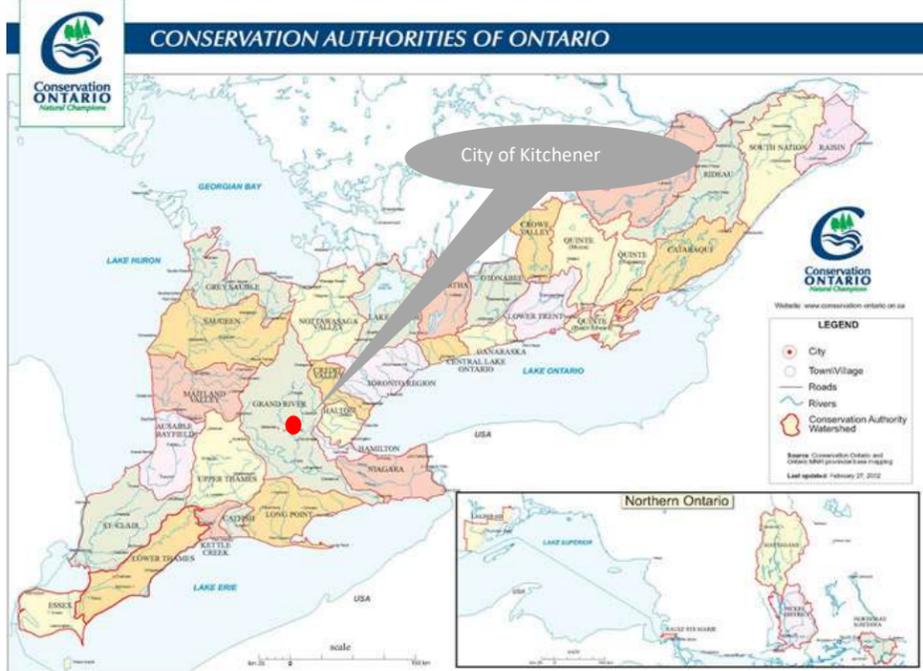
Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance
 Result: Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress
 Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management
 Look at past evidence and plans and policies moving forward

Date Completed: 11-Aug-17
 By: Kim Jusek

Key Questions to Characterize Community:

Municipality:	City of Kitchener										
Population:	<10,000	10-50,000	50-100,000	100-250,000	250-500,000	500,000-1,000,000	1-2,000,000	>2,000,000			
Tier:	Single	Upper	Lower								
Description of responsibilities	(e.g. WW Treatment, SW etc.)		Stormwater, water distribution, wastewater collection, land management								
Key Priorities:	Flooding	Population Growth	Water Efficiency	Cost/Financing	Environmental Protection (Need for)	Reliable, Secure Supply	Resilient, Sustainable Community	Climate Change	Aging infrastructure	Public Health	Other?
Root Cause	<i>(climate change, pop growth, aging infrastructure)</i>	<i>(Natural Resource limitations, discharge quality/quantity, climate change)</i>	<i>(Natural Resource limitations, aging infrastructure)</i>	<i>(Aging Infrastructure, climate change mitigation/adaptation, "we have no problems with current approach, but want financial sustainability")</i>	<i>(Natural Resource limitations, discharge quality/quantity, climate change)</i>	<i>(Natural Resource limitations, discharge quality/quantity, climate change)</i>	<i>(Climate change)</i>	<i>(related to flooding, environmental limitations, aging infrastructure, costs, sustainability, environmental limitations)</i>	<i>Financing, climate change, public health</i>	<i>Aging Infrastructure, costs, meeting basic needs</i>	
Watershed:	Grand River										
Water Source:	Groundwater, surface water (Grand River), supplied wholesale by Region of Waterloo										
Wastewater Receiver:	Grand River										
Proximity to water bodies	Grand River passes through City										
Location in watershed:											



Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance
 Result: Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress
 Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management
 Look at past evidence and plans and policies moving forward
 Where a municipality meets criteria under two adjacent categories, the previous category is selected and the key items not covered under the next level highlighted

Sustainability Spectrum:

1	2	3
"Sewered/Drained City"/ Meeting ON Regulatory Requirements for public/ environmental health ON Baseline Grey Infrastructure Approach	"Waterway/Water Cycle City"/ Limits to Growth/Social Amenity and Environmental Health Beyond Baseline Grey-Green	"Water Sensitive City", One-Water Approach, Resilience to Climate Change Sustainable-focus, Integrated One Water

(Brown et al., 2009)
me
(CVC)

Diagnostic and Evaluative Questions:

Category	Sustainability Status Indicators/ categories	Evaluative question	Evidence from public record (attitude/action)	Rank
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Aspects to be Managed						
one to three						
Water Supply and Distribution	Municipal Supply Source	1) One source; SW or GW (no concern if local or imported); conflict on use/allocation and/or constrained supply	2) two source types; e.g. SW, GW; local; some examples of fit-for-purpose supply (residential RWH, GWR, irrigation with untreated water)	3) >3 sources; incl. non-conventional sources (RWH, Reclaimed wastewater, etc.); local supply; supply of different water quality (fit-for-purpose)	Supply source is Region of Waterloo (GW and SW); wholesale buyer from Region of Waterloo; promotion of rainwater harvesting through REEP and LEED buildings	2
	Water Supply Planning Approach	1) Supply-side approach to meet demands, water quality and operations meets SDWA requirements, single-use water, limited consideration for water conservation measures, conventional technology options, single future scenario, 25 year timeframe, , baseline SWP carried out. If Lower Tier: "Not my jurisdiction"; Does not provide input to water supply planning beyond mandated practices (SDWA, CWA and SWP) or actively support conservation measures, resistance to innovative or unconventional technology options	2) Demand management + supply management, incorporation of conservation and efficiency impacts, primarily single-use water, source planning includes evaluation of energy demands of treatment, chemical use, reliability; use of scenario planning, 50 yr. timeframe, traditional sources prioritized, thorough SWP carried out and actively engaged in implementation If Lower Tier: Active engagement with Upper Tier water supplier in long-term planning, active participation in conservation and efficiency measures and environmental education.	3) Demand management predominantly - incl. fit for purpose, optimizing existing infrastructure before expanding/upsizing, linked to broader watershed management (other users), scenario planning including climate change consideration, alternative water sources (RW, SW, WW reuse) employed for range of applications, 100 yr. time frame considered, consideration of water cycle through SWP in sourcing water and balancing treatment needs/reliability, and maintaining resilience; considerations for impacts from climate change on water quality and quantity If Lower Tier: Very engaged with Upper Tier water supplier in working towards innovative solutions for whole of cycle water management including natural heritage restoration and protection (above and beyond SWP), and engaging community in advanced efficiency, conservation, and alternative water sources for beneficial use.	-partakes in water supply planning to the extent that demand information is incorporated and role in water efficiency, source water protection, and natural heritage management -conservation promotion is through Kitchener Utilities - regular information provided, but not very innovative, but practical. -City of Kitchener works closely with the Region of Waterloo in planning and is regularly consulted and provides input.	2
	Conservation and Efficiency	1) enforce building code updates, outdoor lawn watering by-law, fixed fee rate structure, limited outreach material	2) Outreach programs, efforts to measure and reduce non-revenue water, reduce per capita demand through indoor/outdoor by-laws, education and incentives (rebates), volumetric based rate structure - tangible targets set and record of success - And/or supports jurisdiction which drives this agenda	3) 2 + comprehensive plan which is integrated into other urban waters planning, support for fit-for-purpose reuse of water (GWR, RWH), smart/real-time monitoring; coordinate efforts with other Tiers for implementation	-Region of Waterloo drives water conservation campaigns and redirects to Region website which includes outdoor water use by-laws, education and rebates, City of Kitchener is focused on indoor leaks and water usage.	2
	Water Distribution	1) water delivered achieves pressure and quality requirements, as established by the SWDA and local design targets; reactive approach upgrades and maintenance; UFW at >20% (see AM for more about approach)	2) proactive approach to watermain and distribution infrastructure, promotion of product such that use of bottled water is minimized; UFW <15%; coordination between different tiers and disciplines for construction; optimize energy usage of pumps	3) 2+, UFW <10%, GIS-platform to engage with customers and address issues quickly, use of DSS and smart systems to optimize pumping for energy efficiency	-slightly above average with respect to management of water distribution and leak management and coordination with upper tier municipality. UFW around 18% (ROW WSMP), not aware of city initiatives for optimizing energy management (all pumps and reservoirs operated by ROW).	2
Wastewater	Handling of Wastewater Treatment	1) treat and discharge to environment, meet minimum environmental quality guidelines	2) treat, recover biosolids, discharge to environment such that it does not significantly degrade the environment and consideration for impacts to reuse according to measured and regulated parameters, use of modelling assimilative capacity, energy efficiency optimization of processes	3) treat, recover biosolids/biogas for energy/water, discharge to environment such that it does not significantly degrade the environment (incl. acute and chronic/cumulative impacts), above and beyond regulated parameters, modeling of assimilative capacity, pollution prevention programs integrated into treatment approach (residential/industrial source control) through enforced sewer use bylaw; net-zero for energy use; address emerging contaminants	-ROW has sewer use by-law, City of Kitchener does not have a different one, Region owned City of Kitchener WWTP services the majority of the City of Kitchener, so some awareness that this is where waste is discharged. Work with ROW as needed	2
	Wastewater Planning Approach	1) Increase capacity of WWTP and collection system and upgrade treatment systems as population grows; centralized treatment, single future, does not consider conservation/efficiency, does not control I/I as evidenced by regular sewer backups, overflows, and by-pass events, 25-year planning horizon or less	2) Focus on optimization of treatment plant for capacity and treatment to meet growth and effluent restrictions, incorporation of reducing flows through I/I reduction programs (separate combined sewers) and water efficiency, pilot testing of new technologies through innovative partnerships, enforce sewer use by-law, tie-into watershed plans and downstream impacts, use of modeling programs to inform planning; some overflow events and flooding in extreme conditions; 50 year planning horizon	3) 2+ inclusion of semi-centralized/decentralized treatment, reuse of water, energy, biosolids, nutrients, greenhouse gas reduction in collection system, integration of water/SW planning, focus on pollution prevention (update sewer use by-law), consideration for climate change resiliency, advanced use of modelling to assist with planning; consider 100 year planning window	-ROW features the characteristics outlined, City of Kitchener operates local collection system	2
	Collection infrastructure	1) expand and upsize sewer infrastructure as needed based on expanding population and failure, upgrade when roads are scheduled for upgrade.	Sewer by-law to not only protect treatment processes and receiving environment, but to protect integrity of collection infrastructure through reducing corrosive components and to reduce production of odors and GHG emissions; maintenance programs to extend lifespan; coordination construction upgrades with other public infrastructure	3) 2+ support efficiency programs and stormwater management to reduce need to upsize infrastructure (across discipline/jurisdictional boundaries); sewer mining for decentralized water reuse	-no evidence that there is more sophisticated approach to collection infrastructure than the baseline	1

Sustainability Status						
Category	Indicators/ categories	Evaluative question		Evidence from public record (attitude/action)	Rank	
Stormwater	Stormwater Management Approach	1) Convey water out of city; urban flood protection from property damage; developed piecemeal with population growth/new developments	2) Flood protection but also protection of local rivers (quality and quantity - erosion), infiltrate and manage onsite (lot level solutions) to protect water balance and contribute to protection of local rivers; informed by watershed planning	3) Mimic natural water cycle, city-wide review of stormwater management, connect to watershed plans and upstream/downstream communities, protect property from flooding and protect natural environment from erosion/non-point pollutants, integrate into watershed planning, WW and water planning, retain and reuse locally, planning policies to support GI options before grey, and innovative management approaches to asset inventory and maintenance , and financing; ecological corridors and GI network	-the City of Kitchener has recently created a stormwater utility in 2010 to fund stormwater infrastructure, has recently completed (2016) an Integrated Stormwater Management Master Plan which encourages more green infrastructure and begins to assess level of service. Integration of Asset Management Plans for Stormwater which includes long-range forecast and planning direction for many of the specific policy items and recommendations (i.e. ponds, OGS and stream rehabilitation). Fundamentally integrate the Level of Service (LOS) model as detailed within the existing Asset Management Report.	2.5
		(If Upper Tier, "not their jurisdiction")	(If Upper Tier, "make an effort to work with other tier to coordinate and support efforts across lower tiers)	(If Upper Tier, "Active participant on plans and policies to support unified approach to SW management and GI policies across lower tiers)		
	SW Infrastructure	1) Mainly 'grey' or engineered infrastructure, including concrete drainage systems and some end of pipe controls	2) Mainly grey in core areas, with more lot level GI practices in new developments, including rain gardens, rain barrels, and wet/dry ponds.	3) Complimentary grey-green systems through urban area, use of LID including green roofs, urban trees, swales, parkland, and pollution prevention; network of GI, not only one-offs	-City is innovative with respect to stormwater management, although still has room to grow in terms of more uptake of alternative solutions -has undertaken several innovative projects, including sediment reuse from cleaning out storm pond/urban creek, and piloting/showcasing permeable pavement and green roofs, and partnering with local organizations to showcase effectiveness of onsite stormwater management	2.5
Natural Urban Water (surface)	Management Approach	1) under jurisdiction of CA, abide by flood zones/buffer zones, seen as source of water, conveyance for stormwater, dilution of wastewater, transportation (possibly) - human centred	2) Seen as amenity for recreation and tourism, protected from erosion and contamination for upholding recreational use, and other urban function discussed above; viewed as an asset (property value, tourism related income) and a risk (flooding)	3) Part of larger natural ecosystem, requiring quality and quantity and buffer riparian zones respected and protected from human development and heavy use, in addition to cultural/aesthetic value and functional uses for water, wastewater and stormwater; restoration investments made (daylighting streams, integrating into SWM planning); monitoring and addressing quality/quantity issues including cumulative effects	-city has undertaken restoration efforts of stream areas and has been progressive with respect to natural environment management, such as Filsinger Park stream naturalization project and undertakes monitoring of urban stream quality (e.g. chloride from road salts) -the Integrated Stormwater Master Plan included considerations for health of local rivers -coordinate and work with the GRCA -Kitchener's sub watershed planning program began after the successful completion of the Strasburg Creek master watershed plan -- the first watershed	3
Landscape	Land Use Management Approach	1) Landscape and environmental features dealt with as necessary under provincial regulations (e.g. protected moraine or wetlands), not managed as multi-functional assets impacting the water cycle; greenfield development rampant	2) carry out sub-watershed plans, coordinate with CA, land use policies (e.g. Official Plan) identify and protect key hydrologic features (wetlands, forests, park land) for their role in GW recharge, habitat, and flooding/social amenity in development; urban intensification; conservation viewed as a trade-off; implement drinking water SWP measures; understanding the connection between land use practices (impermeable, salts, nutrients) and downstream water quality impacts and water availability impacts	3) 2+ promotion of urban agriculture, urban forests and parkland, green infrastructure, green roofs/walls, and active planning and management by the city in maintaining the health of these features/ecosystems (wildlife, use and pollution management); urban intensification with prioritization on protecting hydrologic features; recognizing as multi-benefits vs trade-offs; source water protection for all sources - natural/ecosystem flows in addition to drinking water, downstream impacts (over and above baseline SWP); tie-into broader watershed through inventory of resources and users; resources: waterways, wetlands, fish and wildlife, endangered species, cultural and recreational resources and users: commercial navigation, potable water supply, agriculture, etc.)	completion of the Strasburg Creek master watershed plan -- the first watershed plan in the province. There are also 4 other sub watershed plans which have been completed and inform planning and development in the Official Plans and secondary plans -have a growth management strategy to complement the official plan and environmental targets to meet Ontario GGH Growth Plan -have a Natural Heritage System Plan and the New Official Plan policies aim to strike a balance between protection of the Natural Heritage System while providing opportunity for growth and development. These Official Plan policies provide protection based on each one's particular feature's significance and sensitivity. -Features categorized as Core Natural Heritage Features are afforded the greatest level of protection and are designated Natural Heritage Conservation, which generally prohibits development. -Features identified as Significant Wildlife Habitat, Significant Landforms and Ecological Restoration Areas also place limitations on development within and adjacent to; requiring further studies to determine whether development within the feature is appropriate and how it should occur. -Features identified as Supporting Natural Heritage Features, such as Natural Linkages and Corridors, help contribute to the overall ecological integrity and connectivity of the Natural Heritage System. It is intended that these features and their functions will be conserved and enhanced. -detailed urban forestry plan and emphasis on park management, -Environmental Impact Studies/Reports are to be completed throughout the city and in sub watershed planning areas to ensure effects to natural areas are minimized or avoided.	3

Sustainability Status Indicators/ categories		Evaluative question		Evidence from public record (attitude/action)	Rank	
Category						
General Planning Approach	Planning Approach	1) Planning exercises for new infrastructure and development follow the Class EA process (discipline lead), conventional solutions considered and evaluated with cost as the primary consideration	2) Studies follow the Class EA process, consider more innovative solutions and methods for arriving at solutions including enhanced public participation, recognize complexity of planning decisions related to aging infrastructure, growth, climate change; time frame of 50 yrs.	3) Studies and planning activities consider full water cycle impacts, incorporate discipline integration and multi-functional/multi-benefit infrastructure solutions and follows an established integrated water management framework/approach, build on EA approach and use more sophisticated decision making tools (e.g. triple bottom line) and methods to deal with uncertainty (adaptive management, staging with monitoring, vulnerability risk assessments, iterative) , planning considers innovative approaches such as nutrient trading; time frame of 100 yrs.	-progressive planning and strategic plans, including Strategic Plan for the Environment which supports the Strategic Plan and focuses on multi-benefits.	2.5
Governance	Culture supportive of innovative approaches and/or sustainability in Policies	1) Council approved strategic plan/official plan comments on striving to have a healthy environment to extent PPS requires it; pushback on rate increases	2) strategic plan and official plan comments on protecting water quality and quantity and some restrictions on land use; environmental and sustainability initiatives undertaken by municipality	3) strategic plan and official plan sets bold targets/goals with respect to water and environmental sustainability and restrictions on land use; environmental/sustainability strategy implemented and monitored to track and report progress, includes decision-support , to support implementation of strategic plan objectives	-progressive planning and strategic plans, including Strategic Plan for the Environment which supports the Strategic Plan and focuses on multi-benefits. Tracks information on a range of environmental indicators, including environmental resources, land and growth management, and natural heritage system. This has been ongoing since 1992. Ambitious aspirations and progress is tracked, could be more actionable vs just aspirational.	3
	Corporate Leadership on Sustainability	1) Outlook on water services is to provide safe, affordable water and wastewater services, prevent flooding to protect public health and private and public	2) Outspoken on key issues relating to pressing challenges (potentially associated with climate change, limited supply, etc.)	3) Collaborate/innovative partnerships (other muni's, conservation authorities, universities, industry, other), mayor/top water managers outspoken on the related issues (climate change, reuse, etc.); work with province to progress regulations and develop policies and guidelines to support direction (e.g. rainwater harvesting guides and planning, energy reduction)	-there is substantial environmental focus however, the City is not necessarily very outspoken on key issues -did lead in the provinces on the development of the Stormwater Utility. Kitchener's fleet operations have maintained an environmental management system registered to the ISO 14001 standard since 2008 -- a practice that keeps us on the leading edge of municipalities in the province in terms of environmental due diligence.	2.5
	Institutional Roles and Organizational Structure/ Administration of Services	1) Conventional siloed approach, centralized authority, limited collaboration/innovation partnership - initiated by others where exist, routine approach to water servicing	2) Work across disciplines and jurisdictional lines, enhanced public participation and dialogue, some innovative partnerships with distributed management; still clear lines of responsibility; have position for sustainability coordinator and some key staff champions	3) Adopting a One Water Approach to services within own jurisdiction, and reaching across jurisdictional lines to support integrated, holistic planning; majority of staff support and buy-into this approach and have adapted duties to match it; potential decentralized/PPP in play to administer projects	-some documentation and recent reports (integrated stormwater master plan) highlight the need for integrated approach to land and water management, and other city services/objectives. But not clearly outlined or states as such, and still holds conventional structure for staff	2
Outreach/ communication/ public engagement/ stewardship	Utility Outreach	1) Baseline interaction with public/stakeholders for billing, EA process, council approval, and website with access to regulatory reporting and some studies; more interaction with industry than residential population, minimum public participation and interaction in strategic planning	2) Substantial public education and outreach programs on annual water quality reports, capital plans, studies, and some on pollution prevention and efficiency programs, more engagement with public through detailed website and social media avenues for customer questions and feedback; real-time updates on pertinent water related info (e.g. flood risks, drought risk/water restrictions); enhanced public participation and dialogue	3) Strong, modern social media presence and outreach programs related to water cycle, water and energy conservation, pollution prevention in addition to regulatory reporting and study summaries (and detailed reports); real-time monitoring and feedback for optimizing customer behaviour and reporting issues (EPCOR, DC Water); demonstration projects	-above average engagement with public by City of Kitchener (which deals with planning), but more limited/conventional outreach by the Kitchener Utility (water/sewer servicing).	1.5
	Public Attitudes	1) priority is for low water cost; adversarial relationship between key industrial users and utility	2) priority is for reassurance that *key issue* is being handled properly to protect the nature of their community, their environment, and water resources for their safety and health	3) Supportive of and demanding of more innovative solutions to protect resources at large for long-term sustainability; accept that may come with personal sacrifices in terms of behaviour and costs; key industrial users have productive relationship with utility	-there is not a particularly pressing water issue for the city of Kitchener, and the motive would be on developing a liveable city and nice park space and natural environment -water rates have been raise significantly, described in video to explain why needed to address underground infrastructure	2
Monitoring	Asset Management	1) baseline asset management employed, updated recently to access provincial funding - have an inventory of major water and wastewater assets; no level of service (LOS) and only age/material based condition information; used to prioritize capital upgrades and variable funding for maintenance activities; reactive to breaks and failures	2) enhanced asset management strategy including tracking, inventory of major water, WW, and SW with basic info on LOS; Some inventory of GI - parks, trees, etc. but no LOS; AM plans reported and built into other planning process in addition to annual maintenance programs and capital upgrades/replacements. Integrated into GIS and databases; budget forecasting highlights annual investment required (not 100% met)	3) Detailed inventory of assets, including green infrastructure, with risk assessments for vulnerability to climate change and metrics on energy efficiency and triple bottom line indicators; use of smart technology and innovative approaches; key data is accessible and used for rehab, replacement and broader planning programs. View people as assets, invest in human capital; annual re-investment fulfilled	-Grey infrastructure management plan/strategy appears to be in its infancy -Integration of Asset Management Plans for Stormwater which includes long-range forecast and planning direction for many of the specific policy items and recommendations (i.e. ponds, OGS and stream rehabilitation). Fundamentally integrate the Level of Service (LOS) model as detailed within the existing Asset Management Report. This is more advanced than in most cases.	1.5

Sustainability Status						
Category	Indicators/ categories	Evaluative question		Evidence from public record (attitude/action)	Rank	
	Water related Monitoring	1) Baseline monitoring for regulatory reporting on water takings, drinking water source quality, wastewater discharged, effluent quality; treatment and distribution operations monitored in SCADA	2) Baseline + more detailed analysis of different water user types and their per capita usage, UFW/non-revenue water, stream flow, stream quality, environmental indicators, interpretation of changes/trends	3) 2+ use of smart systems and innovative approaches to gather and interpret utility data on energy usage, water usage, quality in the system and environment, and feed into programming on land use, customer usage, infrastructure planning and staging	-monitoring for water usage (basic water metering), and water quality in urban streams	2
Infrastructure	Approach to Infrastructure	1) conventional engineering approach of conservative, grey, conventional approaches based on demonstrated past efficacy or familiarity	2) Predominantly conventional approaches, grey, engineered technology, with infusion of some innovative approaches such as lot level green infrastructure, new water/wastewater technologies; predominantly centralized big investments favoured over smaller scale optimization/rehab projects	3) Mix of conventional grey and green technologies for managing urban water cycle, recognition of multi-purpose infrastructure, infrastructure planned with uncertainty built in - staged approaches, more decentralized than large-scale centralized projects; multiple smaller scale projects	- rhetoric and some action and support for green infrastructure and its multi-purpose benefits -but predominantly conventional approach in practice and planned.	2
Financial Management	Financial Management	1) estimates of capital costs and recurring costs (operating) are the main considerations for cost benefit analysis and heavily influence decision-making; rudimentary financial planning to meet regulatory requirements, not achieving full-cost recovery, dependence on prov/fed grants and loans (non-innovative programs or meeting baseline requirements)	2) More balanced approach to cost-benefit analysis which attempts to incorporate social and environmental externalities; more advanced financial planning that strives to achieve full-cost recovery through rate increases to user fees and new rate structures (volumetric and fixed, stormwater fee, polluter pays) and other market-based approaches for allocating between different users, engages in partnerships with other agencies to optimize services and costs, accesses innovative grants (FCM green municipal fund, etc.)	3) triple bottom line approach and full integration of social and environmental aspects of infrastructure and decision making alongside economic costs, user fees and planning support full-cost recovery, active participation in innovative/PPP to efficiency deliver services and equitably share costs, access innovative grant programs to advance sustainable practices; including cost recovery mechanisms and business model approach through reclamation of nutrients from wastewater, or valuation of wastewater treatment for ecosystem services highlighting favorable environmental benefits, polluter pays, creativity in creating market for resources - such as nutrients, biosolids, creation of ecosystem services payments.	-City of Kitchener has utilized innovative funding such as FCM for implementing green practices. -full cost recovery still a target, aggressive rate increases to address aging infrastructure	2
Climate change	Approach to climate change	1) No serious consideration for climate change in infrastructure planning or strategic plans; limited council support/staff support; recognition of value of energy efficiency for cost-savings	2) Recognition of climate change and need to address both mitigation and adaptation pieces; moderate council/staff support; considerations for climate change evident in planning and infrastructure decisions	3) Climate change adaptation plan and mitigation strategies well established, full council and staff buy-in and climate related decisions integrated into all decision-making	-The City of Kitchener is proud to be a part of the ClimateActionWR collaboration that has championed the development of Waterloo Region's first-ever community action plan on climate change. The City of Kitchener endorsed the plan in 2013 and made a commitment to a community Greenhouse Gas (GHG) reduction target of 6 per cent below 2010 levels by 2020. -this has been met by broad council support Kitchener's fleet operations have maintained an environmental management system registered to the ISO 14001 standard since 2008 -- a practice that keeps us on the leading edge of municipalities in the province in terms of environmental due diligence. -main focus on mitigation rather than on adaptation	2.5
	Energy Supply	1) Supply by Prov-Regional, some priority on energy efficiency, some emergency generators; no emphasis on renewables; energy reporting through regulation (green energy act), but no measures to actively reduce.	2) Supply by Prov-Regional, effort to support resilience of electrical system from weather related hazards, standby power plan sufficient to meet min level of service for set period of time, some support and focus on renewables for municipal water-related assets; policies and benchmarking programs to measure progress in reduction of energy use in w/ww sector	3) Supply by Prov-Reg and local renewable sources and district/local power, protection of key electrical supply and backup to water related facilities, use of renewable energy sources at water facilities. Benchmarking for tracking continuous improvement; net-zero WW facilities	-has started to explore alternative energy sources *-Region of Waterloo has more comprehensive energy management related to water services	1.5
Other	+/-	other notes/aspects not covered but contribute or detract from sustainability		Source: City of Kitchener website		

Diagnostic of Degree of Sustainable, Integrated Water Management/Sustainability Index

Objective: Screening exercise to identify tools and frameworks to apply to municipalities to assist in continuing to progress along a sustainability spectrum; raise awareness, identify priorities wrt water management governance
 Sense of where fall on sustainability spectrum, suggestions on overarching frameworks and tools to progress, recommendation on monitoring activities and regular reassessment to track progress

Note: While the watershed is the scale for IWRM, this tool is focused on urban boundaries for sustainable water management
 Look at past evidence and plans and policies moving forward

Sources: adapted from many but categories mainly from Brown et al., 2009

Sustainability Spectrum:

	1	2	3
	"Sewered/Drained City"/ Meeting ON Regulatory Requirements for public/ environmental health ON Baseline Grey Infrastructure Approach	"Waterway/Water Cycle City"/ Limits to Growth/Social Amenity and Environmental Health Beyond Baseline Grey-Green	"Water Sensitive City", One-Water Approach, Resilience to Climate Change Sustainable-focus, Integrated One Water
Score	23	24-46	46-69
Total Score:	49		
Count:	Count of 1= 1	Count of 1.5 = 3	Count of 2= 11
			Count of 2.5= 5
			Count of 3= 3

(Brown et al., 2009)
me
(CVC)

Analysis: Kitchener scored overall high, with a score of 49.5, and the majority of scores over 2, majority scores of 2
 This was somewhat surprising, but reflects the City of Kitchener's leadership in environmental practices and more progressive stormwater management
 Despite carrying a range of activities in support of a sustainable, integrated water management approach - particularly related to land and stormwater management, there is no overarching water framework.
 Progress in this area is guided by leadership in the municipality in protecting green spaces, the Region of Waterloo leads innovation in water/wastewater treatment
 Constraints in water supply and effluent discharge quality have also created innovative conditions in this municipality and contribute to a progressive score
 Continued coordination with the Region and Conservation Authority, in contributing to water/wastewater management, and providing leadership in stormwater management are important roles of the Kitchener

Corporate strategic plan – framework for sustainability/One Water? Guelph has many great plans and initiatives – not always aware of from just the water supply world. Important to make direct links to each of affected areas – an overarching framework would help to tie-connections and ensure considerations for all are being made. In some cases, such as Guelph this may be done through existing corporate leadership and management, but since people move around, having a policy and strategic/action plan built in is critical for continuity.

Asset management, energy management, and collection infrastructure approach were identified as areas for improvement. The city is very strong on climate change mitigation, less strong on adaptation and resilience planning was evident

Recommended Framework: The frameworks under consideration include the ICLEI Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation, CCME Implementation Framework for Climate Change Adaptation Planning at a Watershed Scale (2015), Sustainable Water Management Framework, and the GLSLCI Sustainable Water Management Framework.

The ICLEI framework is more broad and has the focus on climate change adaptation, which the City of Kitchener could use some improvement on, and the GLSLCI can be incorporated into existing programs like Strategic Plan on the Environment which has a ranking for water resources - and could help to create broader connections for whole of cycle water management
 The Sustainable Water Management Framework can complement existing efforts - such as the Strategic Plan for the Environment to help demonstrate connections of urban water cycle and the track progress holistically

Sustainable Water Management Framework

Recommended Tool: The tools under consideration are related to vulnerability assessment of infrastructure to climate change as this was identified as an area of relative weakness and general asset management

For assessment of infrastructure resilience, the PIEVC Protocol is a robust framework to quantify the risks for a group of assets, such as collection/distribution infrastructure to help prioritize upgrades, and could be incorporated into water asset management as that program develops through regulatory requirements - and complement a climate adaptation framework for promoting more sustainable water management. Builds on success in stormwater management area

Participating in national benchmarking programs may help to provide baselines and metrics to evaluate future success - such as National Water and Wastewater Benchmarking initiative

PIEVC Protocol

National Water and Wastewater Benchmarking initiative

International Infrastructure Management Manual, 2015