ASSESSMENT OF WATER RESOURCES TO SUPPORT A REVIEW OF ONTARIO'S WATER QUANTITY MANAGEMENT FRAMEWORK: LESSONS LEARNED

Submitted to:

Government of Ontario
Ministry of the Environment, Conservation and Parks
Standards Development Branch
7th Floor, 40 St Clair Avenue West
Toronto, ON M4V 1M2

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Project Number: 180107
Submission Date: 14 February 2019

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1. INTRODUCTION

The Ontario Water Resources Act provides for the protection of surface water and groundwater, and includes tools that focus on water quantity management:

- PTTW requirement for water withdrawal exceeding 50,000 litres on any day,
- Prohibitions on specific water taking activities, such as water used for water bottling (moratorium),
- Water charges for highly consumptive industrial and commercial uses.

The Ministry of the Environment, Conservation and Parks (MECP) works cooperatively with other ministries and agencies to manage water quantity in Ontario. The Ministry's policy for water quantity management is to ensure the fair sharing, conservation and sustainable use of the surface and groundwater in the province.

Water is vital to the health and integrity of our ecosystems and communities. Drought conditions in some areas of Ontario in 2016 have intensified concerns related to Water Security, particularly in light of projected population and economic growth, cumulative effects of water takings and the anticipated impacts of climate change.

In December 2016, the Ministry implemented a two-year moratorium on new or increasing groundwater taken for water bottling under Ontario Regulation 463/16 (Taking Groundwater to Produce Bottled Water) made under the Ontario Water Resources Act.

During the moratorium, the Ministry is undertaking a number of projects to increase the understanding of the current and future state of water quantity resources, broadly throughout Ontario and more locally in selected vulnerable areas to help inform policy, programs and decisions that will enhance water quantity management in Ontario.

Throughout the process the Ministry desires improved support for evidence-based decision-making. Specifically, the question is "What is the scientific evidence that supports the need for potential changes to Ontario's current water quantity management framework, namely policies and programs, to protect and conserve water quantity resources in the province, and to manage potential water security issues?" (RFB#6792).

1.1 PURPOSE

The purpose and objective of this Lessons Learned summary was to compile the insights gained from the information gathered and the analysis done through the science review, the jurisdictional review the series of workshops with water managers and the consultation process with the Water Quantity Protection External Working Group. This process allowed for potential gaps to be identified and preliminary recommendations to be made in order to inform the Ministry's evaluation of Ontario's water quantity management framework including consideration of climate change, changing land use, population growth and the cumulative effects of these factors as well as multiple takings.

1.2 SCOPE OF WORK

A discussion of Ontario's water quantity management framework and the findings of a science review (Task 1) and a review of best management practices in other jurisdictions (Task 2) for a number of specified topics, tools, approaches, issues and considerations was completed. Furthermore, a series of three workshops (Guelph, Kingston and Toronto) with Ontario's Water Managers (Task 3) provided additional insight on the value and potential suitability of some of the tools and approaches used in other jurisdictions to address any identified gaps in Ontario's water quantity management framework. In addition to these three tasks, there was a consultation process with a Water Quantity Protection External Working Group, an assembly of provincial stakeholders. This document provides the insights gained by BluMetric from the information collected and analysis done through these tasks.

The Science Review (Task 1) reviewed the literature for the following thematic topics and related approaches, tools and considerations (items in brackets refer to the deliverables listed in the Agreement document between MECP and BluMetric Environmental Inc.):

- Water Quantity Assessment (D1.1 a)
- Scientific Data Needs (D1.1 b)
- Sustainability of Water Resources (D1.1 c)
- Water Permitting and Allocation (D1.1 d)
- Water Security (D1.1 e)
- Climate Change, Population Growth, and Changing Land Uses (D1.1 f)
- Cumulative Effects (D1.1 g)
- Environmental Flow Needs (D1.1 h)

- Use of Numerical Models (D1.1 i)
- Takings by Water Bottlers (D1.1 j)

The Jurisdictional Review (Task 2) considered the following thematic topics and related approaches, tools and considerations:

- Area Based Approaches (D2.1 a)
- Integrated Management and Cumulative Effects (D2.1 b, c and e)
- Adaptive Management (D.2.1 d)
- Ecosystem Protection (D2.1 f)
- Priority of Water Use (D2.1 g)
- Conflict Resolution Mechanisms (D2.1 g)
- Collaborative Approaches (D2.1 h)
- Drought and Stress Management (D2.1 e and i)
- Managing Groundwater Used By Water Bottlers (j)

The thematic topics and related approaches, tools, and considerations are highly integrated both from a science and jurisdictional review perspective. Therefore, further integration is needed in terms of the discussion herein. For each of the thematic topics noted above the following evaluation questions were considered:

- What are the existing approaches and tools used in Ontario?
- Based on lived experience of water managers attending the workshops using Ontario's existing approaches and tools what are the strengths, limitations and challenges?
- How do Ontario's approaches and tools compare with other jurisdictions' and best science practices?

Figure 1 shows the methodology and approach taken in terms of the lens used for the analysis and discussion of the thematic topics as per the outcomes from the two reviews. This methodology and approach was presented to Ontario's Water Managers at each of the three workshops. Ways where Ontario's practice should be improved is based, in part, on relevant input from Ontario's Water Managers and early input from the Water Quantity Protection External Working Group. Finally, the overarching approach, rational and justification for identifying gaps and for suggesting preliminary recommendations to enhance Ontario's water quantity management framework is also based on the Organization of Economic Cooperation and Development (OECD) "Health Check" elements (OECD, 2017). The OECD *"Health Check" for*

Water Resources Allocation provides useful guidance on assessing current allocation arrangements.

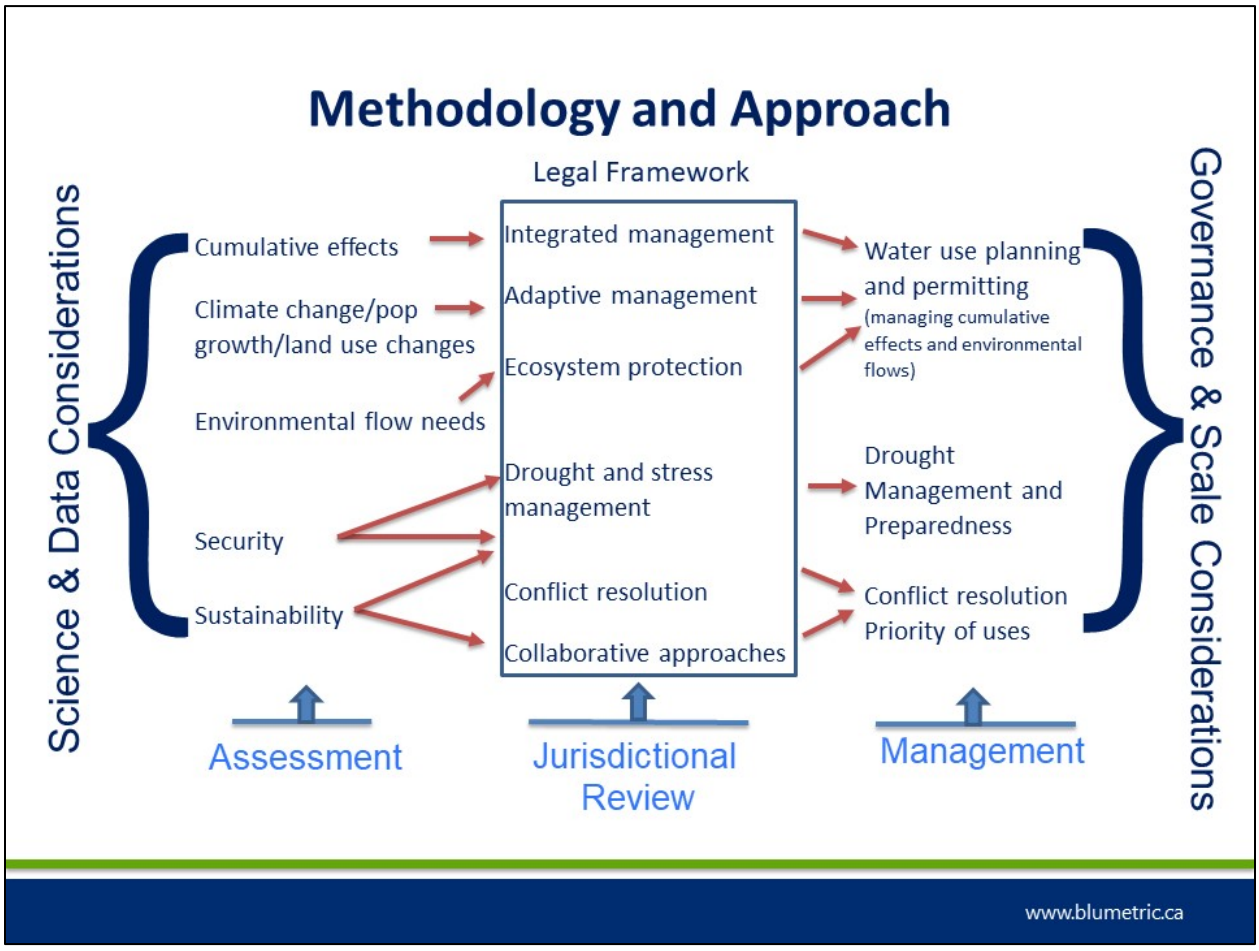

Figure 1: Analysis methodology and approach

1.3 OVERARCHING CONSIDERATIONS

In consultation with the Ministry, the following considerations were considered important in evaluating Ontario's current framework:

- Ontario has not vested ownership of water and manages water use based on common law and riparian rights and it is assumed that this will not change.
- Ontario manages large water takings using a permit system, where permits are issued to specific individuals for a finite period of time. Ontario also has a "permit by rule" system (i.e., EASRs) for lower risk water takings. Permits cannot be traded among individuals. Permit trading relies on a system of water rights, which Ontario does not have and it is assumed that this will not change.
- The future state of water resources in Ontario may be different than today, considering Climate Change, climate variability, population changes, and changing land use. The focus of the evaluation is on the suitability of Ontario's framework to deal with future scarcity and drought risks, rather than flooding.
- Ontario is a large, diverse province with a range of conditions related to managing water quantity; for example, with respect to: assessment / management needs; environment / water resources settings; water supply and demand (anthropogenic and natural).

2. SUMMARY OF THE RESULTS OF THE ANALYSIS

The following is a high level summary of the analysis of each thematic topic as per the Scope of Work described above. In this analysis, Water Quantity Assessment is seen as the foundational thematic topic. It is therefore summarized in more detail in order to provide context for the other thematic topics and subtopics.

2.1 WATER QUANTITY ASSESSMENT

Ontario is widely recognized as being "water-rich" compared to other jurisdictions. This is not only true because it has an abundance of fresh water including the Great Lakes, which contains one fifth of the world's fresh surface water, but also because in most parts of the province, one can typically access even greater amounts of good quality groundwater. However, in spite of the noted abundance of fresh water in Ontario, there are some areas of the province that have experienced water shortages.

Assessment of water quantity at different scales including municipal (Source Water Protection Water Budgets) and watershed scales (e.g. Whiteman's Creek GRCA and Innisfil Creek NVCA), has been undertaken in some parts of Ontario. However, such assessments have not always been as effective as they might have been and in some cases have been constrained by a lack of sufficient good quality data. Good quality, long-term records of climate (particularly precipitation), river flows, reservoir levels and groundwater levels are vital to ensure that current assessments of available freshwater resources are accurate. Unfortunately, in many parts of Ontario, the existence and maintenance of long-term, good quality environmental records is limited.

According to the World Meteorological Organization (WMO, 2012), water as a basic necessity is often difficult to value in absolute economic terms, but around the world as competition for water increases, water information grows in value. Because the cost of government programmes must be properly justified, it is becoming very important to demonstrate the benefits of hydrological information and analysis. Benefit-to-cost ratios for hydrological data collection of up to 40:1 have been cited (that is, the value of the information is forty times its cost of collection). Benefit-cost ratios in the range 5 to 10 seem to be generally plausible, with values of 9.3 and 6.4 being found in studies in Canada (WMO, 2012). Information specific to Ontario was not found as part of the Science Review. However, Ontario's Water Managers indicated that the value of Ontario's existing hydrological information could not be over stated and better integration and analysis of the existing data is critical in some priority areas where low water conditions or interference effects from multiple and/or significant takings are regularly experienced. Regardless of the actual numerical values, water managers in all countries and at all levels subscribe to the view that good quality hydrological and hydrogeological information is an essential prerequisite for wise decision-making in water resources management. Clearly, when drawing up programmes for water resources assessment, which are often publicly funded, it is important to relate the cost (and therefore the scope and extent) of modelling and analysis to the benefits that are likely to be realized by the wider community.

In light of the economic constraints that need to be considered, it is important to note that a water quantity assessment relies on a full understanding of all the water flows and storages in the aquifer, watershed or subwatershed under consideration. In addition, the process of water quantity assessment involves developing as complete an understanding as possible of these flows and stores and their interrelationship over time. This is the only way to estimate what sustainable surplus flows may be made available for human or other uses, as both sources and systems will

change over time due to climate change, population growth, land use changes and other human interventions.

The best science and scientific practice in completing water quantity assessments is best described by the World Meteorological Organization (WMO, 2012). Figure 2 shows an overarching approach and framework modified from WMO (2012) for a water quantity assessment and development process.

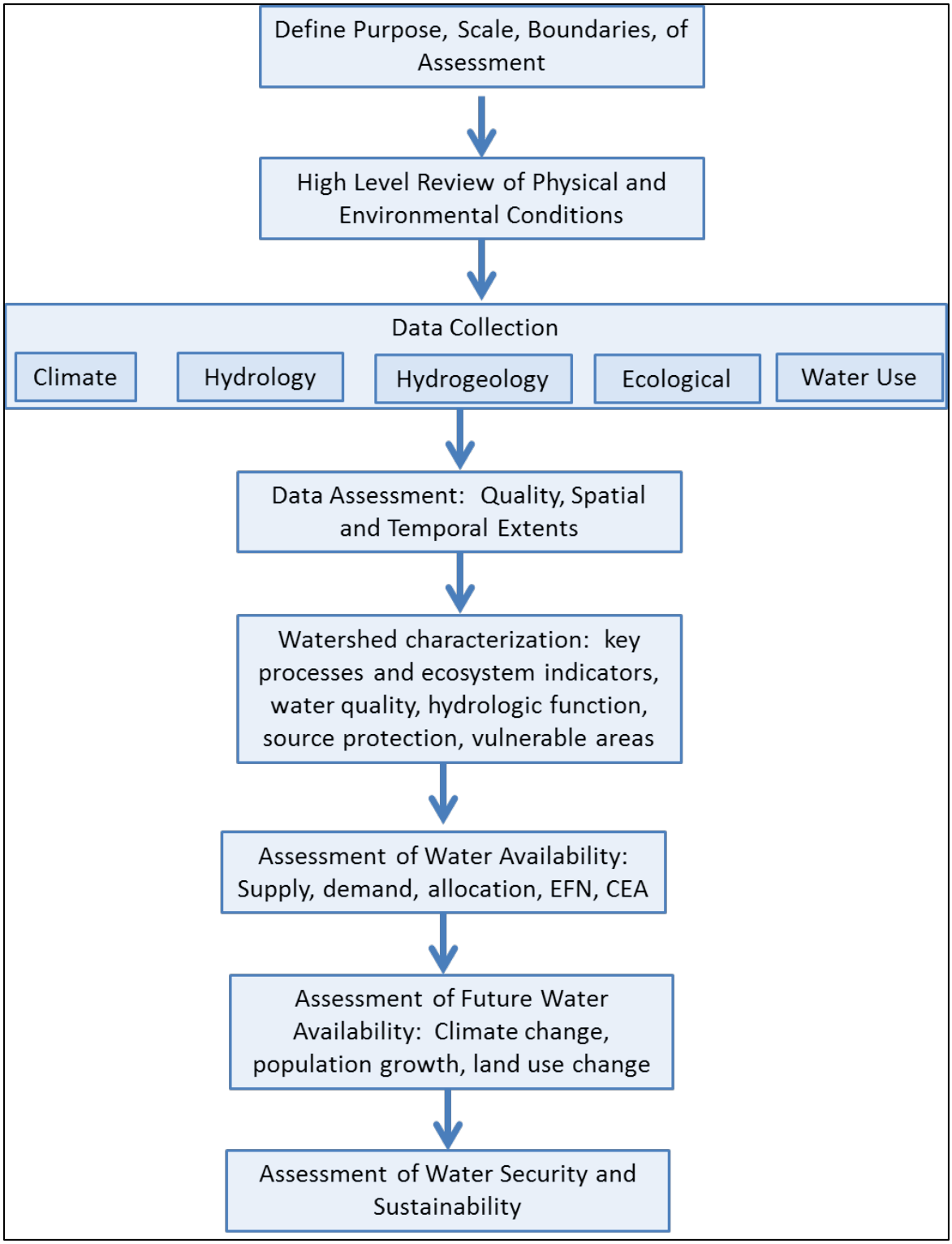

Figure 2: Overarching approach framework modified from the World Meteorological Organization (WMO, 2012) water quantity assessment development process

In summary, the following factors and criteria should be used as guiding questions that need to be answered before selecting an approach for an area:

- What is the general objective of the assessment? Hydrological/hydrogeological forecasting, assessing human influences on the natural surface water and groundwater flow regimes, assessing the impacts of climate change and population growth or etc.?
- What is the spatial scale of assessment? Watershed, river reach, reservoir, aquifer or etc.?
- What data is available with regard to type, length and quality of data?
- What are the driving hydrological and hydrogeological components? Runoff, daily average surface water discharges, monthly average groundwater discharges or etc.?
- What are the main types of water resources? Surface water, groundwater or both?
- What are the climatic and physiographic characteristics of the considered area?
- What is the hydrogeologic environment including consideration of where the groundwater resources are found for example, is it in fractured bedrock, is it karst bedrock, or in unconsolidated overburden, is the aquifer confined or unconfined?
- What is the level of expertise available?
- Is it possible to transpose the data available for a smaller subwatershed of the overall catchment or for neighboring catchments?
- Is it possible to update the considered approach conveniently on the basis of current meteorological, hydrological and hydrogeological conditions?
- What are the main sources of uncertainty and how could they be adequately quantified? Climatic uncertainty, uncertainty in climate change projections, uncertainty in rainfall runoff model parameter values?

Furthermore, in Ontario, in areas covered by specific land use related acts such as the Oak Ridges Moraine (ORM), Niagara Escarpment and the Greater Golden Horseshoe (GGH) other specific questions include where are the hydrologic features, what are the hydrologic functions and where are the water resource systems?

In Ontario water quantity is both assessed as part of the process to obtain a Permit to Take Water (PTTW) and protected under the Clean Water Act (CWA, 2006).

The CWA was introduced by the Province of Ontario to identify threats to drinking water quantity and quality and to develop source protection plans to manage those threats. However, it is noted that these source protection plans are limited to municipal water supplies. In priority areas where regular water shortages are documented, Tier 3 models could be extended beyond the current assessment area.

The three types of approaches (empirical, water balance and numerical models) for water quantity assessment identified above are all currently used in Ontario in support of the CWA and PTTW process.

The most important factor used in defining these three types of approaches is the scale at which they could be applied. In fact, in the approaches proposed for water resources assessment, three terms are typically used to describe different spatial scales. These are site (local) scale, watershed and regional scales. These terms reflect the fact that site or local scale water flow systems have short-term responses to seasonal and anthropogenic (e.g. pumping) stresses while watershed and regional scale water flow systems have much broader and longer-term responses.

2.1.1 Scientific Data Needs

In Ontario, the following data exists to complete water quantity assessments:

MECP

- High Use Watershed maps, including AquaResource (2005) *A Method for Assessing Water Use in Ontario Watersheds*
- Clean Water Act Assessment Reports, Water Quantity Stress Assessments, and Water Budgets (Tier 1, Tier 2, and Tier 3)
- Provincial Groundwater Monitoring Network
- Water Taking Reporting System
- Permit to Take Water data (IDS, individual permit files)
- Cumulative effects studies (e.g., Carden Plain)

MNRF (Surface Water Monitoring Centre)

- Flow data
- Ontario Flow Assessment Tool (OFAT)
- Ontario Low Water Response
- GIS water related data layers including watershed boundaries, topography, land cover and forested areas

MNDM (OGS)

- Groundwater and geological data, models, and mapping

Other (CAs, municipalities)

- Oak Ridges Moraine Conservation Plan – water budgets
- Lake Simcoe Conservation Plan – water budgets and environmental flow targets
- Individual CA water budgets (GRCA – Whiteman's Creek; NVCA – Innisfil Creek)

As noted above, Ontario's Water Managers indicated that the value of Ontario's existing hydrological information could not be over stated and that better integration and analysis of the existing data is critical in some priority areas where low water conditions or interference effects from multiple and/or significant takings are regularly experienced or reported. Figure 3 graphically presents the relationship between complexity, data needs and scale of assessment with respect to what approaches can be reasonably considered in different scenarios.

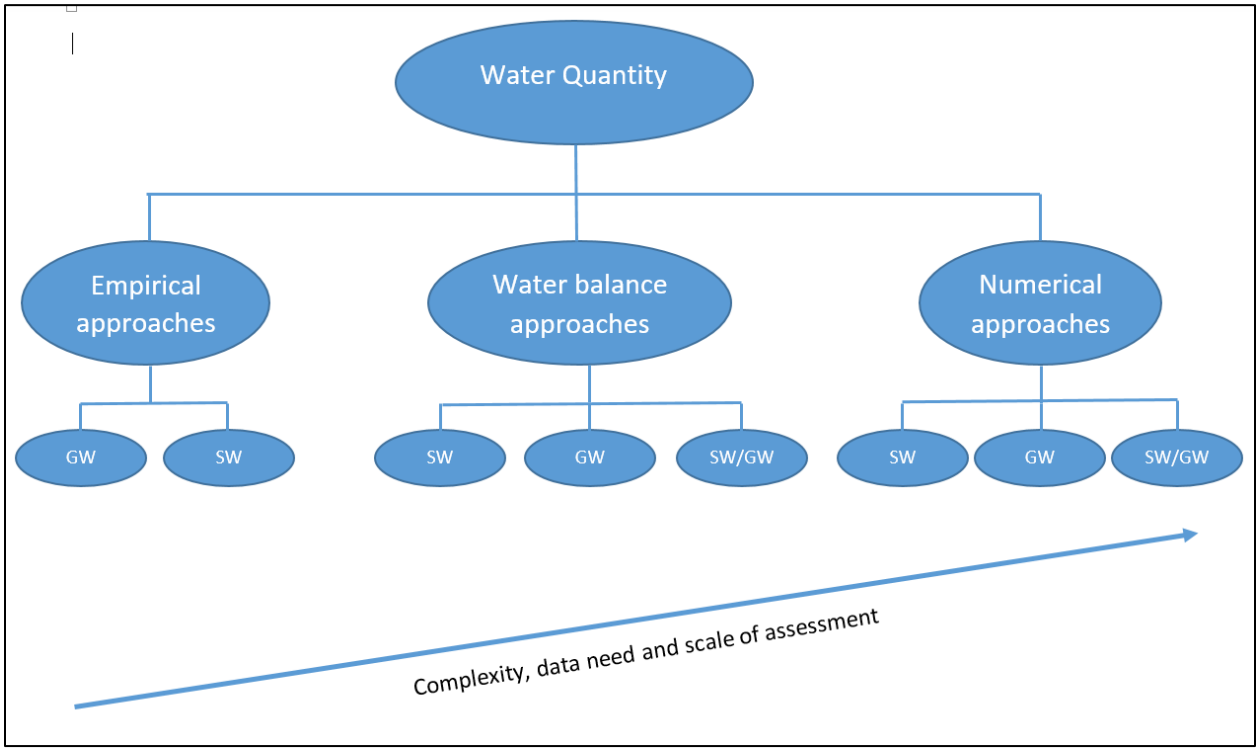

Figure 3: Main Categories of the Approaches used to Assess Water Quantity

The Kansas High Plains Aquifer Atlas (http://www.kgs.ku.edu/HighPlains/HPA_Atlas/) is an example of how existing data in priority areas could be integrated and analyzed. This example is a state managed program which is free of charge to the public. An Ontario example would be the the York-Peel-Durham-Toronto (YPDT) coalition and the Conservation Authorities Moraine Coalition (CAMC) (https://oakridgeswater.ca/). The YPDT-CAMC Groundwater Management Program was created to build, maintain and provide to partnered agencies the regional geological and hydrogeological context for ongoing groundwater studies and management initiatives within the partnership area. Local water managers of these programs have indicated that the two most important data sets in the ongoing assessment of groundwater sustainability are the borehole logs and long-term water level monitoring.

Potential considerations for improvement in Ontario include inter-agency database integration (i.e. integration of the data listed above), enhancement of the Provincial Groundwater Monitoring Network (PGMN) in priority areas including incorporating private background monitoring wells, improved currency of the Water Taking Reporting System (WTRS) and transparency in the analysis of the available data including water levels and water takings.

2.1.2 Use of Numerical Models

Numerical models are used to assess the Cumulative Effects of Climate Change, population growth and land use change based on projected future conditions in a way that is not possible when using either of the other approaches noted in Figure 3. In Ontario, Source Water Protection (SWP) implementation under the Clean Water Act (2006) has resulted in extensive use of numerical models to develop water budgets and assess the risk or stress (quality and quantity) to municipal (communal) water supplies. The capture zone and/or zone of influence (WHPA/ WHPA-Q1) of municipal water supplies are generally coincident with areas where hydrologic data is more abundant both spatially and temporally. Models in Ontario are most often built on a watershed or subwatershed scale where water quantity issues have been noted or the CWA requires them (e.g. Whiteman's Creek, Innisfil Creek and Tier 3 model for Guelph and Orangeville). It should be noted thought that while the use of numerical models for water quantity assessment has increased, empirical and water balance approaches are also widely used in Ontario. For example, the PTTW water program typically relies on an empirical approach with respect to the use of data and the evaluation of permit applications. In comparison, the process by which watersheds were designated as being High or Moderate Use Watersheds (AquaResource, 2005), could be considered an example of a water balance approach with respect to scale, type of data and methodology used.

In other jurisdictions as noted for Ontario, models are largely used for predictive purposes in terms of assessing the Cumulative Effects noted above and in determining Environmental Flow Needs (EFN). These jurisdictions have significant amounts of hydrologic and ecological (fish) data because of on-going concerns associated with prolonged and/or frequent water quantity concerns or concerns related to Environmental Flow Needs for the local ecosystem (e.g. Michigan). In most jurisdictions, the lived experience is that the complexity of the system, varying amounts of quality data, technical understanding and agency capacity to reliably use integrated model(s) as intended was noted as being a significant issue in terms of keeping the model updated and calibrated as new data becomes available.

Some Ontario Water Managers expressed a desire to see the Tier 3 models in their area expanded and updated to incorporate new information and to account for the Cumulative Effects of updated projections with respect Climate Change, population growth and changing land use.

In general, the use of sophisticated numerical models should be used for screening purposes and/or be limited to priority areas where significant amounts of spatial and temporal data exists for a number of input parameters and where Cumulative Effects and EFN are considered a priority. As discussed in Section 2.1 the intrinsic or perceived value of the ecosystem, including specific features supported by groundwater as well as groundwater resources used for municipal water supplies is values based. How an area such as a watershed is deemed to be a priority area and therefore requiring a detailed water quantity assessment including the use of numerical models needs the input and decision making of local stakeholders. Ontario, through the implementation of the CWA, has declared that protecting water resources on which communities rely is a high priority with respect to both water quality and quantity.

2.1.3 Water Permitting and Allocation

The riparian system of water rights in use in Ontario, was born out of English common law (the legal framework derived from custom and judicial precedent rather than statutes), is most prevalent in Eastern North America, and limits water use to landholders with riparian land (land that abuts a water body) (Getches *et al.*, 2015). Riparian rights are typically attached to the land; therefore, non-use of water does not extinguish right. Associated with this doctrine, is the principle of reasonable use, which means that a riparian landowner may make reasonable use of water so long as that use does not impede upon the reasonable use of another downstream user. New uses for water may begin at any time, so long as that use is considered *reasonable* (The National Agricultural Law Centre, 2016). As a result, jurisdictions that are historically grounded in a riparian system typically have enacted some type of permitting system – e.g., regulated riparianism. Through permitting systems, the regulated riparian doctrine allows a central agency to have control over who may use water, how much they may use, and when they may use it (The National Agricultural Law Centre, 2016). The regulated riparian doctrine allows for both surface and groundwater to be considered and incorporated into a permitting system and it allows for jurisdictions to take into account future use and potential benefits to society before water is used. Minnesota is a good example of where the rule of *reasonable use* is in place and it is a jurisdiction that is similar to Ontario in terms of the legal and policy framework and permitting structure.

Ontario's Water Managers noted that riparian rights can sometimes be in conflict with existing permitted takings in High Use Watersheds and/or areas with a high density of PTTW in some reaches of creeks or streams which is assessed to be over allocated during times of high water

demand, for example during periods of low precipitation when irrigation is common practice (May-September). It is noted that water allocation under these conditions would be better assessed on a scale that is greater than a site (local) scale for example, the Innisfil Creek subwatershed scale.

2.1.4 Area Based Approaches

In Ontario, a good example of an area based approach to managing water quantity is in the Innisfil Creek subwatershed. This is a voluntary management approach to coordinate water takings among irrigators that draw from a common surface water resource which is a precipitation driven flow system with limited to no groundwater baseflow.

Minnesota is a good example of where an area based approach that manages groundwater takings that may impact surface water features. Minnesota's Groundwater Management Areas (GWMA) is a water allocation planning and management tool for groundwater taking (Minnesota Statute 103G.287). The Department of Natural Resources assesses the risk of an additional groundwater taking, including the risk to surface water.

Ontario should consider this type of area based approach in areas where groundwater takings may have an impact on a locally significant surface water feature, for example the Norfolk Sandplain or Whiteman's Creek.

2.2 Integrated Management and Cumulative Effects

In Ontario Integrated Management and Cumulative Effects are considered through the permitting process and under the Clean Water Act and Source Protection. The permitting application process requires consideration of groundwater surface water interaction but is only assessed on a local (site) scale (500 m radius). An integrated management approach would be advisable in areas or watersheds where surface water and groundwater interaction are measurable (e.g. Norfolk Sandplain) but fall outside the mandate of the CWA and Source Protection.

All approaches use models, are basin scale, and have high to moderate data needs. Typically they prioritize where the Cumulative Effects needs to be assessed for example Source Protection Tier 3 Models in Ontario.

Data resolution (temporal and spatial) is a universal issue and this is the same in Ontario. In some cases, CE model outputs are used in risk screening for water taking decision making on an ongoing basis (e.g. England), but this is not currently the case in Ontario. Notably, Michigan's Water Withdrawal Assessment Tool uses a threefold model system focused on groundwater, stream flow, and fish impacts to make assessments. Minnesota has the ability to designate groundwater protection areas and apply a sustainability standard to combat integrated risks. Michigan and Minnesota, as signatories to the Great Lakes St. Lawrence River Basin Sustainable Water Resources Compact, must consider Cumulative Effects in appropriation decisions. New Zealand -Waikato Region considers Cumulative Effects in water taking at length, including formal recognition for Indigenous uses and values in assessments.

Consumptive water use data (actual water takings) in real time (or close to real time) is needed to assess CE. In Ontario, we have self-reported actual water taking since 2011, but this type of data is not universally available and is only reported on an annual basis.

Ontario's Source Protection approach and the use of a High Use Watershed screening tool are similar to how Minnesota designates groundwater protection areas. However, the High Use Watershed approach needs to be updated on a regular basis for it to maintain relevance, for example every five years. In addition, based on the example of Minnesota, Ontario could benefit from the application of a sustainability standard to combat risks from Cumulative Effects. For example, linking assessment of the impact of proposed groundwater takings with Ontario's Low Water Response program data or conversely de-coupling consideration of groundwater takings from Level I, II or II requirements where it is not technically warranted.

2.3 ADAPTIVE MANAGEMENT

Adaptive management in the context of water withdrawal is predominantly about the flexibility to adjust water allocation limits and withdrawal assessment processes in times of uncertainty. This process is not always explicitly labeled as 'adaptive management'. Under Ontario's PTTW program, permits expire after a period generally not exceeding 10 years, and the results of any required monitoring programs must be submitted for review when submitting an application for renewal. One of the standard terms and conditions of PTTWs is that there is no guarantee that the permit will be renewed upon expiry. Based on the five focused jurisdictions in Task 2, adaptive management generally appears minimally in other jurisdictions' legislation; provisions for adaptive management in these jurisdictions are also usually not overly detailed, and there are

limited enforcement mechanisms. According to Curran and Mascher (2016), water law regimes have historically not provided tools for adaptive management, as they were designed in a water management era focused on providing water users with security of water use and facilitating development. However, they note that jurisdictions are more recently undertaking law reform that attempts to remedy this historic inflexibility in water management, recognizing that in many hydrological systems the volume of water available for consumption is decreasing at the times of highest demand, and that minimum environmental flows are a precursor to a healthy ecological system. Current and Mascher (2016) go on to compare the regulatory approaches taken by the state of New South Wales in Australia and the province of British Columbia in Canada to incorporate the tools of adaptive management and to address fixed entitlements to use water in favour of more responsive and watershed-specific management approaches.

In Florida, explicit adaptive management protocols have been outlined for certain activities or areas, and in Michigan, adaptive management is limited to incorporating changes through the process of water withdrawal assessment and water user committees. Finally, Minnesota has the authority to limit or cancel permits to protect the public interest and requires Local Water Supply Plans to be updated on ten-year cycles and used as an assessment tool when viewing changes to allocation. In Ontario, the Minnesota approach to adaptive management could be considered in the context of both the Ontario Low Water Response program for surface water and the High Water Use Watershed designation and screening tool. In both instances, a requirement of a Local Water Supply Plan on a watershed or area basis where water shortages are regularly experienced or reported could be considered a mandatory requirement for the local Water Managers.

Florida annually develops a list of priority streams. Waters are listed by the state on the Minimum Flows and Levels (MFL) Priority Water Body List, and each district is required to establish minimum flows and levels for the water bodies in question. Florida's explicit adaptive management protocols have been outlined for certain activities or areas; mitigation banks are noted as an innovative approach to offset adverse impacts of certain activities. This approach could be piloted in some areas of Ontario.

2.3.1 Climate Change, Population Growth and Changing Land Use

In Ontario, projections of climate change, population growth and changing land use are incorporated into the development of water budgets under the CWA. Additionally, in southern Ontario, applications for subdivisions under the Planning Act will generally not be approved

unless a water quantity assessment demonstrates that long-term water demands can be met. There is general acknowledgement among many jurisdictions around the world that population growth, changing land use and particularly climate change may have serious implications for water supply and demand; however, many challenges exist in attempting to develop accurate and realistic projections of these changes. In the United Kingdom, the effects of population growth, land use change and climate change on water demand are forecasted using micro-component modeling of household demand. In contrast to national or global scale models, this approach allows water demand to be simulated at a local scale, by modeling the end-use of water by customers. Ontario should explore the potential applicability of the United Kingdom's micro-component modeling approach to the province, as it may be a useful means of estimating the impacts of water conservation efforts and incentives.

2.4 Environmental Flow Needs and Ecosystem Protection

In Ontario, protecting natural functions of aquatic ecosystems is a regulatory requirement through the Water Taking and Transfer Regulation, s.4 that the MECP must consider when reviewing PTTW applications. Applications for Category 3 surface water PTTWs require an in-stream minimum flow or water level requirements to be determined through a site-specific assessment. The five focus jurisdictions assessed in Task 2 also all consider in-stream flow needs, but only in Michigan is the flow need connected specifically to ecosystem or fish needs. The Instream Flow Incremental Methodology (IFIM) is a concept that has historically been used in many environmental flow needs assessments, particularly in the United States, and which accounts for human uses of, and value placed on, water. The incorporation of local knowledge into an approach similar to IFIM warrants consideration in Ontario, where the site-specific nature of environmental flow needs is recognized and appreciated.

2.5 Water Security

The growing worldwide attention on water security[1] is shared by the Province of Ontario. Projected population growth, economic growth, cumulative effects from changes in land uses and increased takings, and climate change with the projected intensification of drought

[1] Water security is interpreted in this report as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, and for preserving ecosystems in a climate of peace and political stability (United Nations-Water, 2013)

conditions, collectively will impact Ontario's water resources in the future. The Province should prepare to manage the challenges and opportunities associated with these impacts. These changes, some anticipated and some already realized, may affect not only the health and integrity of Ontario communities, but also its ecosystems. Given the nature of these pressures on water resources in Ontario, there are significant challenges to managing water use and water quantity, particularly when it comes to implementing appropriate and effective legislative and policy changes. However, water security has not been a province wide concern in Ontario. As noted above, Ontario is for the most part a "water rich" jurisdiction. Water security has become a more salient issue where a population has relied upon an easily accessible (low cost) resource such as a limited extent shallow aquifer (e.g. Quinte) or over allocated surface water feature (e.g. Innisfil or Norfolk). These areas could be considered priority areas from a policy framework review perspective.

In these areas, the MECP should coordinate with the Ontario Geological Survey (OGS) investigations to help in the characterization of local flow systems and potential alternative water supplies. The OGS should partner with local agencies such as Conservation Authorities or municipalities to instrument boreholes that intercept regional aquifers with water level loggers for long term water level monitoring and integrate these wells into the PGMN.

2.5.1 Drought and Stress Management

Ontario's Low Water Response program is the primary approach to drought and stress management. However, one notable example of proactive drought planning has been completed for Innisfil Creek subwatershed and the model is worthy of consideration in other potentially stressed or "at risk"/ "high water use" areas of the province. In the workshops a need and desire for proactive drought management plans was raised. However, while the threshold approach in the Ontario Low Water Response program was appreciated, it was recognized that a drought management plan needs to be in place before a Level III is declared. In addition, it was also pointed out that characterizing the flow system is imperative before declaring a Level III as the response may or may not need to include groundwater restrictions. Also, appropriate thresholds to measure groundwater decline during times of drought need to be evaluated. The water level data from the PGMN may or not be adequate both from a spatial and temporal perspective in some areas. However, there may be monitoring wells used by other agencies or organizations to establish background water levels. These monitoring wells could augment the PGMN monitoring wells.

Similar to Ontario, drought and stress management is an explicit concern noted throughout other jurisdictions. Many have drought plans which outline a wide range of action plans for times of shortage, drought thresholds, flow releases, monitoring and reporting, as well as conservation measures for the restriction of water allocation that are specified in either statutes/legislation, policy and/or in the drought plan. Each of the drought plans are context specific. Minnesota and Florida have the most up-to-date drought plans. In Michigan, stress areas are identified in legislation as a part of "zones of risk".

2.5.2 Priority of Water Use

In Ontario, through the PTTW program, new takings cannot adversely impact existing users. In addition, riparian rights exist, which can complicate prioritization of water takings.

Prioritization of water use is employed in Minnesota, New Zealand, and Florida, each of which assign priority to different water users in times of shortage/stress. Montana does have a water use priority system which is based on "first in time, first in right" and even higher priority is given to those who appropriated prior to 1973, the time of a key legislative change.

Ontario should require that watersheds proactively develop a prioritization scheme on a local scale with stakeholder involvement, as it is value-based and may change over time, and which should also be revisited and reassessed on a regular basis.

2.6 Sustainability of Water Resources

Guidance and policies in Ontario's PTTW program recognizes the importance of ensuring the sustainability of water resources on a site/ local scale, though there is often a lack of the necessary data and tools for conducting a sustainability assessment on a regional scale with the exception of areas where water budgets and stress assessments for municipal supplies have been completed under Source Water Protection. Most jurisdictions assessed in the jurisdictional review similarly make references to sustainability, but with little specific guidance on making such assessments; in contrast, California requires its Groundwater Sustainability Agencies to adopt Groundwater Sustainability Plans, in which "road maps" are outlined for achieving long term sustainability. Development of suitable tools and approaches for achieving sustainability requires intensive data collection and modelling efforts, as is the case for Waterloo Region's approach to management of its groundwater resources.

2.6.1 Collaborative Approaches

Under the current provincial water quantity management framework, there is limited, true collaboration required with the public in Ontario, with some level of collaboration across different levels of government for PTTWs. Some examples of collaborative approaches in Ontario are noted in the Innisfil Creek and Big Creek subwatersheds where irrigators have collaboratively developed an Integrated Water Management Strategies and Proactive Drought Management Plan. The stakeholders obtained funding, retained technical expertise resulting in the characterization of the flow system (including under climate change scenarios), and gained a detailed understanding of local water demand between permitted takers and ultimately coordinated water takings during low flow periods. To date in Ontario, collaborative approaches have largely pertained to surface water resources.

In comparison, more extensive collaborative processes are adopted in the decision-making process under the Clean Water Act through local Source Protection Committees. Many of the jurisdictions assessed in Task 2 appeared to allow for collaborative measures in the decision-making process for water allocation, though whether this indicates an ongoing growing trend of increased public/stakeholder inclusion is unknown. A wider adoption across Ontario of the approach used by the Innisfil Creek Water Users Association should be considered, in which key stakeholders are assembled to develop strategies for collaborative water sharing.

2.6.2 Conflict Resolution Mechanisms

Ontario's Environmental Review Tribunal is one of the key conflict resolution mechanisms for water quantity-related disputes. PTTWs also generally include complaints reporting requirements, in which the permit holder must report to the MECP about any complaints received regarding their water taking activities. It was observed that the five jurisdictions studied in more detail in Task 2 all have some sort of dispute/conflict resolution mechanisms in place through legislation or policy, with Montana and New Zealand each having dedicated water/environmental courts for the adjudication of water rights. Due to the significant investment in time and resources when disputes are escalated to the Environmental Review Tribunal, some Water Managers in the Task 3 Workshops indicated that the creation of a lower level, dedicated water court for the province warrants consideration.

2.7 MANAGING GROUNDWATER USE BY WATER BOTTLERS

Ontario currently deals with water takings by water bottlers in a different manner from other takings (i.e. the 2-year moratorium on new or increased groundwater takings for water bottling, development of a guidance document outlining stricter rules for water takings by existing permitted water bottling facilities, etc.). The distinction placed on water bottlers compared to other, similarly-sized withdrawals may be difficult to rationalize from a strictly scientific perspective. This is demonstrated in part by the general lack of impact assessment methods in the scientific literature that are uniquely and exclusively applicable to water bottling operations. It was also found that in many other jurisdictions, water bottlers are not recognized as a distinct user type. In contrast, Michigan and Florida have adopted explicit regulations and thresholds for water bottling operations, giving consideration to both the volume of water proposed for extraction, as well as the transfer and ultimate destination of the water. Michigan also allows the municipality in which the water extraction is taking place to charge a fee per volume of water extracted. While there is a lack of consensus about whether additional requirements should be imposed on water takings for the purpose of water bottling (see Appendix B of the Task 3 report), Ontario's current water management framework may benefit by allowing for a municipally-determined water withdrawal fee for such operations, due to the commodification of groundwater resources.

3. SUMMARY

Based on the OECD (2017) "Health Check" criteria for water resource allocation, Ontario's water quantity management framework is for the most part 'healthy' with a few notable exceptions:

- In Ontario, it is debatable if there are accountability mechanisms in place for the management of water resource allocation that are effective at the aquifer, watershed or regional scale;
- Except for a few locations, the general availability of water resources (surface and groundwater, as well as alternative sources of supply) and possible scarcity is relatively well-understood. However, in some priority areas understanding the long term sustainability of the water resources requires additional temporal and special data for trending analysis;

- While issues of Environmental Flow Needs (EFN) and sustainable use is to be considered on a local scale, Ontario does not have a water taking limit ("cap") that reflects in situ requirements and sustainable use beyond the local scale or municipal supply through Source Protection;
- Ontario's arrangements for dealing with exceptional circumstances such as drought (OLWR), are somewhat limited in that only surface water is considered, independent consideration of groundwater and an understanding of the watershed (scale) flow regime is not included in the management approach;
- Although there are effective mechanisms for monitoring and enforcement, with clear and legally robust sanctions, enforcement is often an issue during short lived drought conditions;
- There is not clear justification why water bottling requires additional scrutiny when compared to other commercial water takings, this is not consistent with an evidence based approach;
- Ontario could improve the general understanding around water entitlements with respect to riparian rights and existing permitted takers;
- While charges for water taking exist based on purpose, they are not necessarily reflective of the impact of the taking on resource availability for other users and the environment; and
- Area based approaches for water allocation have been piloted through voluntary co-operation among water takers reliant on a limited surface water resource (e.g. Innisfil Creek and Big Creek), however these efforts could be greatly enhanced if policy tools were in place to allow for reallocation among the water takers.

In addition to these gaps noted above the following issues should be noted:

- Assessments should have the flexibility to be completed on an area basis in addition to a site/ local basis;
- Developers should prepare a local water supply plan as part of an application for development; and
- Data related to the ability to complete water quantity assessment should be enhanced including consistency (spatial and temporal) and more accessible through centralized databases and portals.

4. RECOMMENDATIONS

The following provides both a summary of recommendations from above as well as a selected number of recommendations noted to be priorities in terms of having the greatest short and long term benefit.

4.1 SUMMARY RECOMMENDATIONS

The following recommendations are drawn from the thematic topics discussed above:

- The self-reported actual water taking data that was collected in Ontario since 2011 should be made universally available;
- Ontario should apply a sustainability standard to combat risks from Cumulative Effects to surface water and groundwater resources;
- Minnesota's approach to Adaptive Management could be considered in the province in the context of both the Ontario Low Water Response program for surface water and the High Use Watershed designation and screening tool;
- Ontario should consider piloting Florida's approach in some areas of the province, in which an annual list of priority streams is developed, and minimum flows and levels for these streams are established;
- With respect to forecasting the effects of population growth, land use change and climate change on water demand, Ontario should explore the potential applicability of the United Kingdom's micro-component modeling approach to the province;
- The incorporation of local knowledge into Environmental Flow Needs assessments, in a manner similar to that used in the Instream Flow Incremental Methodology (IFIM), warrants consideration in Ontario;
- In areas where the population relies upon an easily accessible (low cost) resource, the MECP should coordinate with the OGS' investigations to help in the characterization of local flow systems and potential alternative water supplies;
- A proactive drought management plan developed collaboratively by local water takers needs to be in place on a watershed scale so that when Level III conditions exist, required action can be taken immediately rather than waiting for the Low Water Committee as activated by the Ontario Water Directors committee (MNRF, MECP, OMAFRA and OMMAH) to determine that Level III conditions exist as recommended by the local Water Response Team;

- The collaborative approach used by the Innisfil Creek Water Users Association, in which irrigators collaboratively developed and own an Integrated Water Management Strategies and Proactive Drought Plan, should be considered for wider adoption across Ontario; and
- The creation of a lower level, dedicated water court should be considered for handling water-related disputes before they are elevated to the Environmental Review Tribunal.

4.2 PRIORITY RECOMMENDATIONS

The following are the priority recommendations:

- The level of assessment required for water bottling specifically versus other commercial takings should be re-visited and re-evaluated. The level of assessment should be proportional to potential impacts and not necessarily linked to the specific purpose of the taking;
- Ontario Low Water Response should incorporate groundwater thresholds and uncouple reduction requirements between surface water and groundwater where not technically justified;
- High Use Watersheds, as originally recommended, should be regularly re-assessed;
- Ontario's water quantity assessment related data currently exists between several ministries and agencies. Efforts should be made to centralize and present the data in usable forms for assessment purposes through a universally accessible portal. For example, static water levels within key regional aquifers flow in priority creeks and rivers, climate data, reported water taking and well records could be shared on line through aggregate analysis. Specific data sets could be downloaded through data sharing agreements;
- For some areas in the province where specific water quantity management issues exist (over allocation of surface water features during irrigation season or high use watersheds where concerns with respect to sustainability have been expressed), Ontario should consider enhancing existing data sets and developing an on line water resource analysis tool similar to the Kansas High Plains Aquifer Atlas (http://www.kgs.ku.edu/HighPlains/HPA_Atlas/). It would provide needed transparency and information when evaluating potential new water takings; and

- Implementation of policy tool such as Area Based Assessments, Adaptive Management, proactive drought management plans, integrated watershed management plans that consider Cumulative Effects and Environmental Flow Needs is strongly encouraged, and would allow for broader adoption of voluntary coordination of water takings such as those testing in Innisfil Creek and Big Creek.

Respectfully submitted,
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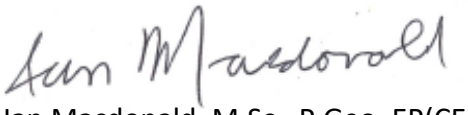

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