QUINTE REGION DROUGHT PLAN

FINAL REPORT
FEBRUARY 2021

Summary

Planning for drought in Ontario has become of increasing concern due to the recurrence of droughts, increased development pressure, and anticipated impacts from climate change. Previous work by Quinte Conservation has identified the region to be vulnerable to the impacts of climate change. Some of this vulnerability can be attributed to the high percentage of Quinte Region residents (50 percent of the population) that rely on private wells for water supply. These wells are supplied by a shallow fractured bedrock aquifer with low storage capacity requiring regular replenishment from precipitation to maintain adequate levels of supply.

In 2016, a widespread historic drought was experienced in the Quinte Conservation watershed and across Eastern Ontario. During this event, groundwater levels and wells experienced historically low levels with many residents' wells running dry. Farmers struggled to find alternative supplies to sustain crops and livestock, rural fire protection sources dried up, and low river levels resulted in damaged fish habitat. Municipalities that rely 100 percent on private wells had difficulty obtaining alternative sources of water for their residents.

Learning from the 2016 experience, Quinte Conservation recognized the need to develop a drought management plan that would help local municipalities mitigate and adapt to drought. With the support of municipalities within its watershed, Quinte Conservation obtained funding through the Federation of Canadian Municipalities (FCM). This funding has been used to improve monitoring to deal with drought, assess the potential impacts of climate change, and prepare the following as a drought management plan.

This plan provides an overview of the background information about the Quinte watershed and past impacts from drought. A drought warning plan that follows the protocol of the Ontario Low Water Response Plan is provided, along with amendments, the roles of municipalities, First Nations and all agencies involved. The recommended actions for each level of drought are summarized with the most important actions being added for normal water conditions. These are the actions that need to be taken to adapt to a changing climate and prepare for drought. For residents on private wells the intent is to lessen the potential impact by identifying sources of backup water supply, storage capacity, water conservation, and water recycling.

Actions are also recommended for municipalities to reduce drought impact through their development approval process in accordance with the current Ontario Provincial Policy Statement, under the *Planning Act*, 2020. This policy indicates that the approval of new developments should be based on sustainability in terms of climate change impacts, and should promote both water conservation and water use efficiency.

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1.0 Introduction

Drought is a natural hazard that can have far reaching impacts in a given region. These impacts can vary depending on one's reliance on water and the sensitivity of the ecological resources. Drought may be defined as:

"*a prolonged period of below normal precipitation, stream flow and groundwater levels that can result in disruption of water supply to a range of users*"

The Quinte Region has experienced historic droughts, ranging from minor to severe, and typically occurring over the warmer months of summer and fall. One of the more severe events happened in 2016 when people relying on private wells experienced water supply shortages and local streams and rivers dried to a trickle. Many lessons were learned from this experience; perhaps the most important was that being prepared to deal with drought can help lessen the impacts.

Building on lessons learned in 2016, Quinte Conservation applied for and received funding to help the local watershed residents and municipalities plan for and be better prepared to deal with drought. This funding was provided by the Federation of Canadian Municipalities (FCM) and has been used to improve monitoring of the watershed for drought, analyze the potential impacts of climate change, and prepare the following drought management plan to help watershed residents adapt.

Planning for drought has become of increasing concern due to the reoccurrence of droughts and the onset of climate change. To date the traditional response to drought has been reactive when drought is upon us. The following plan has been prepared to promote a more proactive approach with the intent of preparing for drought to minimize its impacts. This plan provides an overview of the following:

1. Historic drought in the Quinte Region and the impacts and response,
2. Overview of water use, development and drought prone areas,
3. The roles of various agencies involved in drought management,
4. Detection and monitoring of droughts,
5. Actions to be taken to prepare for droughts,
6. Actions to be taken during a drought, and
7. Water use conflicts.

A steering committee was formed to help in the development of the plan and provide input from the various water use sectors. The members included:

Becky MacWhirter – Environmental Coordinator, City of Belleville
Brad Roach – CAO, Tyendinaga Township
Justin Harrow – Director of Planning, Hastings County
John Gooding – Development Coordinator, Prince Edward County
John Thompson – President of Ontario Federation of Agriculture, Prince Edward Chapter
John Wise – Deputy Reeve, Stone Mills Township & Chair of Quinte Conservation
Justin White – Resource Management Coordinator, Ministry of Natural Resources and Forestry
Kyle Stephenson – Hydrogeologist, Ministry of the Environment Conservation and Parks
Leanne Latter – Emergency Planning Coordinator, Hastings County
Lawrence O'Keeffe- Friends of the Napanee River
Matt Richmond – Environmental Manager, Stirling Rawdon Township
Nicole Storms – Environmental Services Coordinator, Mohawks of the Bay of Quinte
Peter Doris – Crops/Environmental Specialist Ontario Ministry of Agriculture and Food
Perry Decola – General Manager of Environmental Services, City of Belleville
Scott Bates – Water Budget Analyst, Ministry of Natural Resources and Forestry
Victor Castro – Water Resources Supervisor – Ministry of the Environment Conservation and Parks

The committee met on three occasions to review work undertaken as part of the program and to discuss the content of this plan. These discussions generally focused on reducing the impacts of drought on residents of the Quinte Region. Minutes of the meetings are provided in Appendix A.

2.0 Quinte Region Water Resources & Drought

The Quinte Region Watershed is home to approximately 130,000 people, covering a diverse landscape that ranges from the Precambrian shield in the north, to the limestone plains of Prince Edward County in the south. While northern regions are drained by large river systems including the Moira, Salmon and Napanee Rivers, Prince Edward County is drained by numerous smaller water courses radiating out from the highlands to the surrounding Lake Ontario and Bay of Quinte. Despite their geologic differences a common characteristic across the watershed is a thin covering of soil above the fractured limestone and Precambrian bedrock. Figure 1 provides an illustration of the watershed showing individual watershed boundaries, main rivers and some larger settlement areas.

2.1 Settlement Areas

Larger urban centres have grown along the shoreline of the Bay of Quinte which serves as a connecting channel to Lake Ontario. All of these centres have access to sustainable municipal water supplies obtained from the Great Lakes which was also used as a means of transportation in the settlement days. These urban areas provide home to approximately half of the regional population and include the Cities of Belleville and Quinte West, and the Towns of Greater Napanee, Deseronto and Picton. The surrounding rural areas comprise the balance of the watershed providing the base for a significant agricultural, forestry and recreational industry as well as home to the remaining 65,000 residents. Much of the rural population is dispersed throughout the region with several smaller urban centres including Madoc, Tweed, Deloro, and Ameliasburgh. These centres are serviced by municipal water supply obtained from groundwater with the exception of Ameliasburgh which obtains supply from a small inland lake (Roblin Lake).

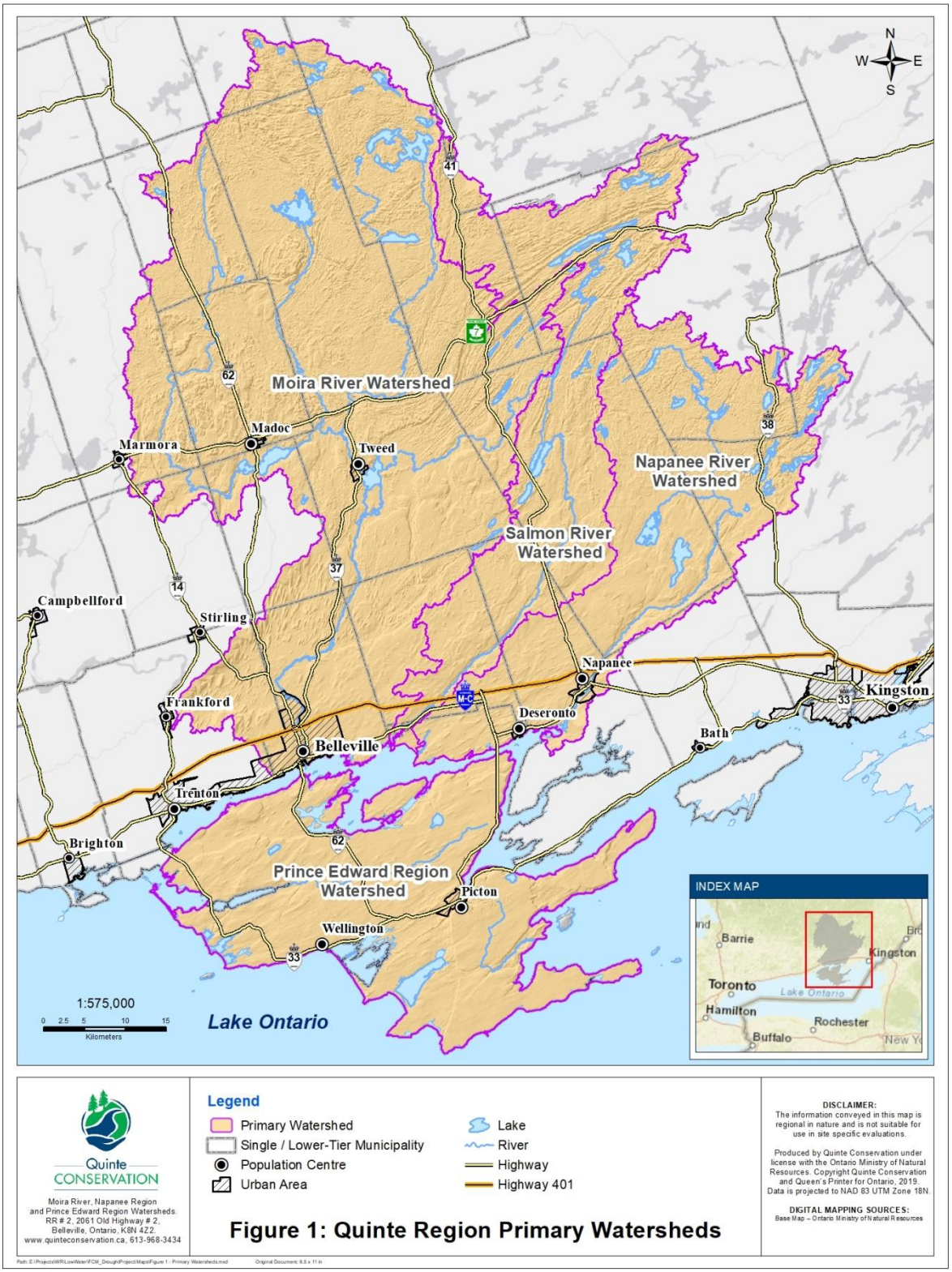
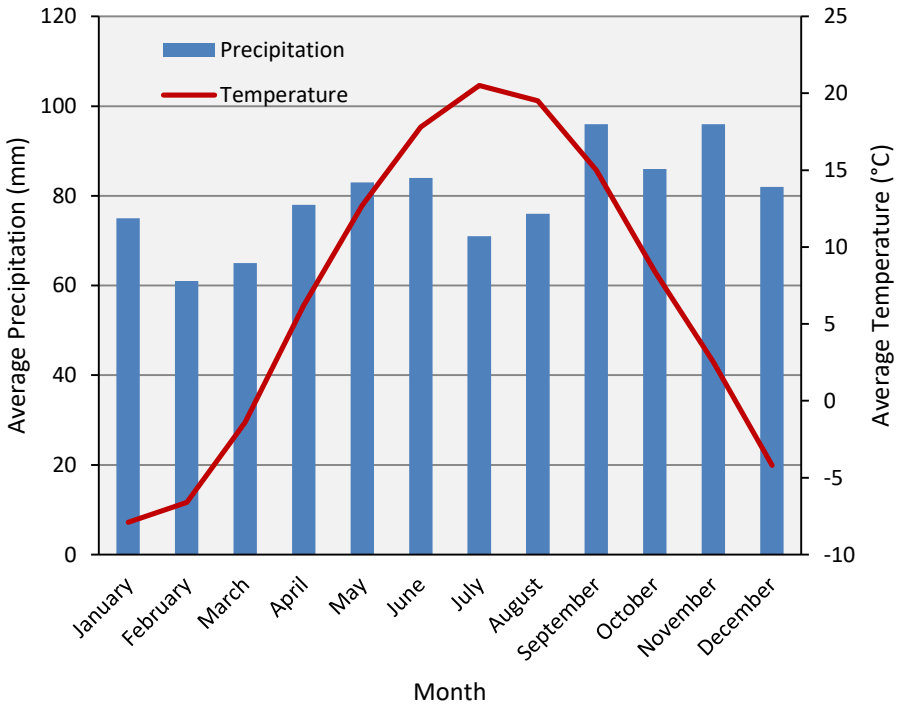


Figure 1: Quinte Region Primary Watersheds

2.2 Climate Conditions

The regional climate is classified as humid continental, part of a larger climate zone which covers the larger Great Lakes St. - Lawrence Lowlands. Such a climate can be characterized by hot summers and cold winters with moderate variation in average monthly precipitation over the course of the year, as illustrated by Figure 2. Humid conditions prevail due to moisture from the large Great Lakes water bodies. This climate provides a relatively long growing season conducive for farming in Canada.

Figure 2: Climagraph for the Quinte Region(1981-2010 Climate Normal)

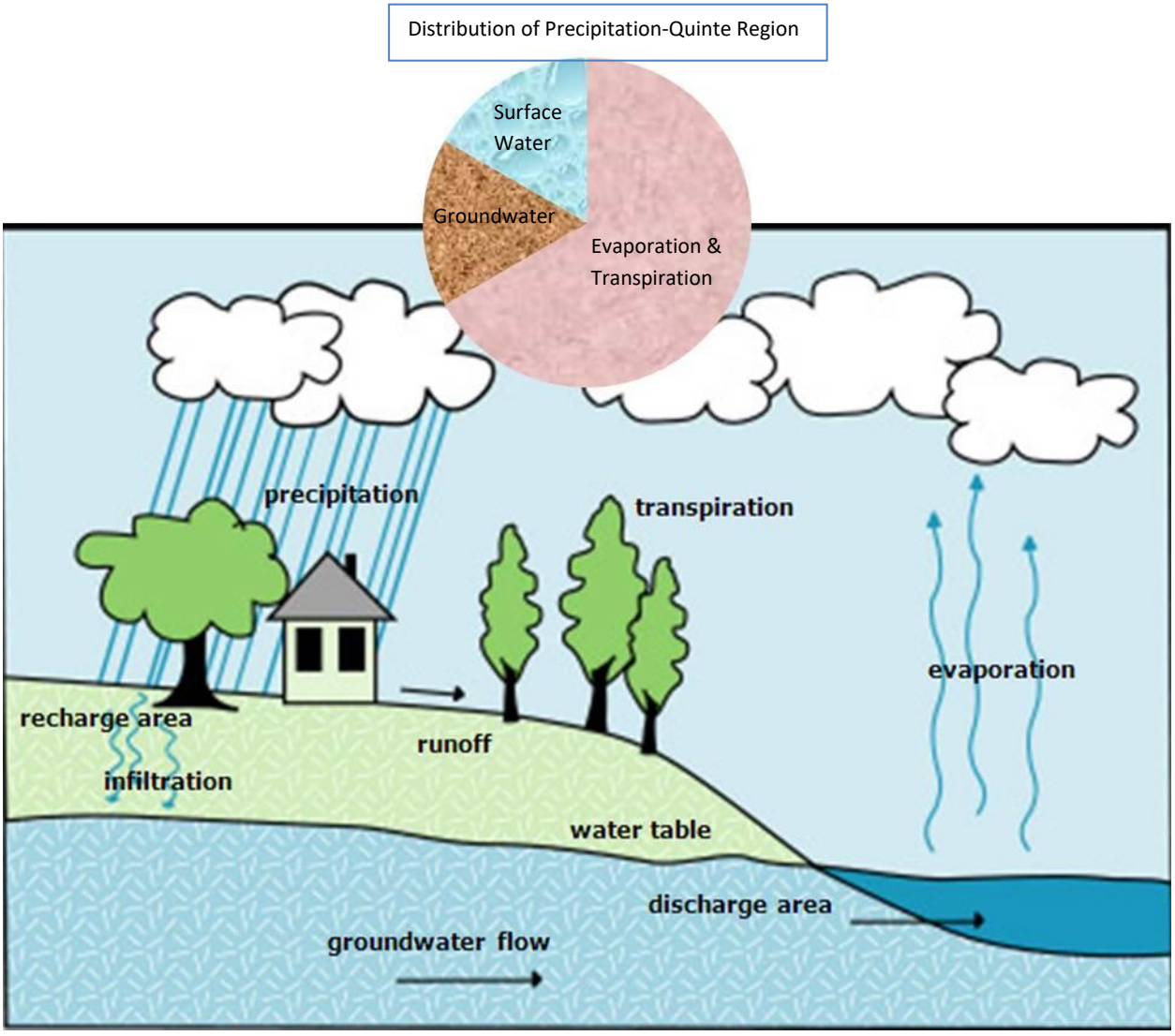


2.3 Water Resources

The Quinte Region is fortunate to be surrounded by numerous beautiful water features including Lake Ontario, Bay of Quinte, large river systems and many small lakes. These large water bodies provide an ample supply of water for municipal drinking water, irrigation, agriculture, industry, manufacturing and recreation. A healthy fish and wildlife population is also supported by this resource. The local First Nation community relies on this resource as sustenance. Sport angling is also a significant recreational industry relying on the local fishery. Groundwater is a significant resource relied on for water supply to the rural population,

agriculture and important base flow to local surface water bodies. The hydrologic cycle, as illustrated by Figure 3, shows the movement of the different phases of water in the region. This cycle is fed by approximately 900 mm annually of precipitation (rain and snow combined) of which the majority (60 percent) leaves the watershed by evaporation and transpiration (Quinte Conservation, 2019). This water consumption is largely driven by temperature as warmer temperatures result in increased rates of evaporation. After accounting for evaporation the remaining water is divided equally between recharge to the underlying groundwater and runoff to streams and rivers.

Figure 3: Quinte Region Hydrologic Cycle



2.3.1 Groundwater

Groundwater in the region is found at relatively shallow depth in the top 10 to 30 metres of the underlying fractured bedrock. In the absence of significant soil cover, recharge to these aquifers is quick and directly from infiltrating precipitation. However, the fractured bedrock (see Figure 4) does not store large volumes of water and regular recharge is required to replenish the supply. In the warmer summer and early fall season much of the precipitation is used to meet the evapotranspiration demand of growing vegetation. During this period the groundwater levels decline until recharge from precipitation returns when the air temperatures cool and the growing season ends. The occurrence of drought can cause the groundwater levels to drop significantly below normal, sometimes resulting in disruption of water supply to residents using private wells. Regular periods of rainfall are required to replenish the aquifers.

Figure 4: Limestone Bedrock near Napanee

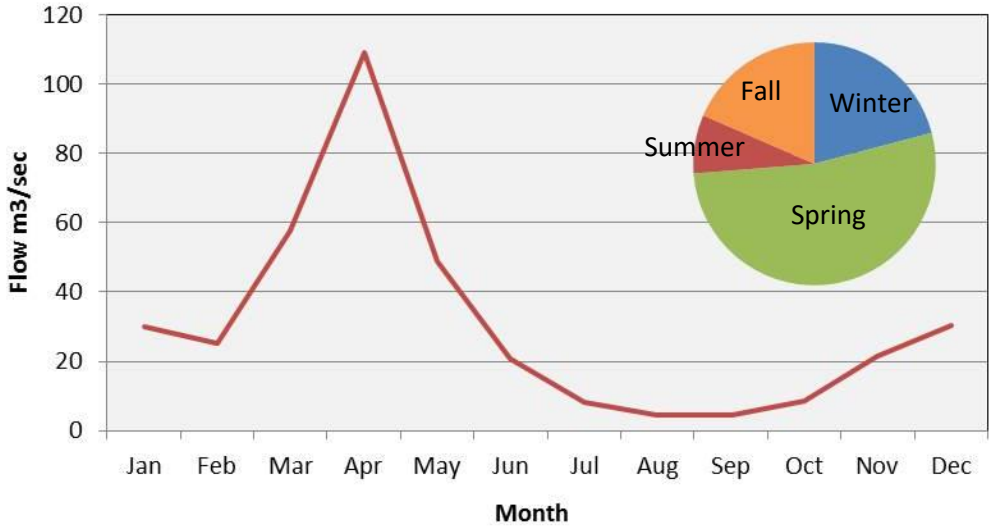
Deeper aquifers, that would be less prone to drought, are generally limited in the Quinte Region. The drilling of wells to depths of greater than 30 metres increases the potential of encountering naturally poor water quality with elevated levels of salt, minerals and natural gas. Such water quality is not considered suitable for normal domestic and agricultural use. Acceptable deep groundwater quality can be found in several areas of the watershed where

wells can be drilled through the limestone into the Precambrian basement rock (zone near the contact between these two formations).

2.3.2 Surface Water

Surface water features of inland lakes and rivers are also fed by precipitation and the hydrologic cycle. The typical pattern of runoff, as illustrated by Figure 5, is high flows in the spring and low levels during the summer months when evapotranspiration rates are high and the base flow contribution from groundwater is reduced. Measurement of stream flow in the region indicates that approximately 60 percent of the annual runoff occurs in the spring months with less than 10 percent in the summer and early fall. This low flow period corresponds with periods of higher water demand in the summer which can result in potential water supply issues.

Figure 5: Hydrograph of the Moira River Flow at Foxboro 1915-2018

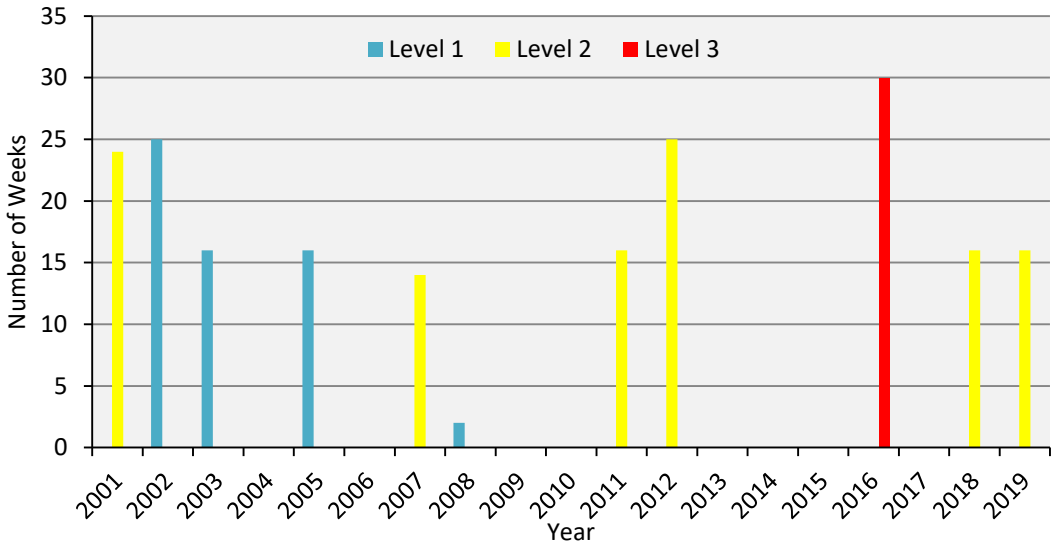


2.4 Drought

The Ontario Low Water Response Program (https://www.ontario.ca/page/surface-water-monitoring-centre) was established in March, 2000 in response to periods of low rainfall and high temperatures that resulted in some of the worst drought conditions in the province. Since the inception of the program, the Ministry of Natural Resources and Forestry records show Quinte watersheds to have ranked amongst the highest in the Province in terms of the number

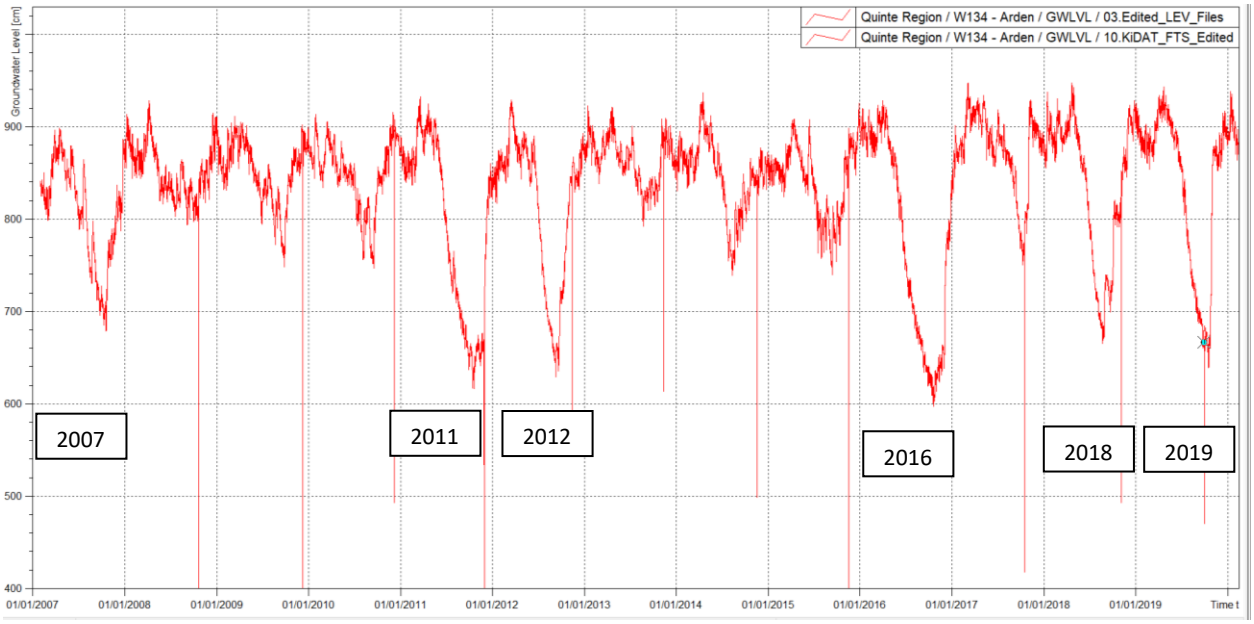
of low water declarations. Low water conditions are declared based on levels of precipitation and stream flow; the least severe being Level 1 and the most severe, Level 3. Since 2000, annual low water conditions have been recorded in the Quinte Region in eleven different years. Six of these years reached a level 2 and one level 3 was declared in 2016. These events, as illustrated by Figure 6, last for an average of 18 weeks with the 2016 event being the most severe totaling 30 weeks. These events all typically occur over late summer and early fall.

Figure 6: Quinte Region Low Water Conditions (2001 to 2019, MNRF Records)



The parameters for declaring low water events are based on the levels of precipitation and streamflow over varying time periods. Groundwater levels are not used as an indicator in this program. However, the monitoring and analysis of ground water levels in the Quinte watershed, using a network of 29 monitoring wells, has shown that there is a close correlation of groundwater to surface water levels. A hydrograph of one well (well number 134) installed into the fractured bedrock aquifer is shown in Figure 7. As shown in the graph the low water years are readily detectable in the levels of groundwater. When compared to Figure 6 this is particularly evident for the level 2 and 3 low water events.

Figure 7: Groundwater Hydrograph – Shallow Fractured Bedrock Aquifer



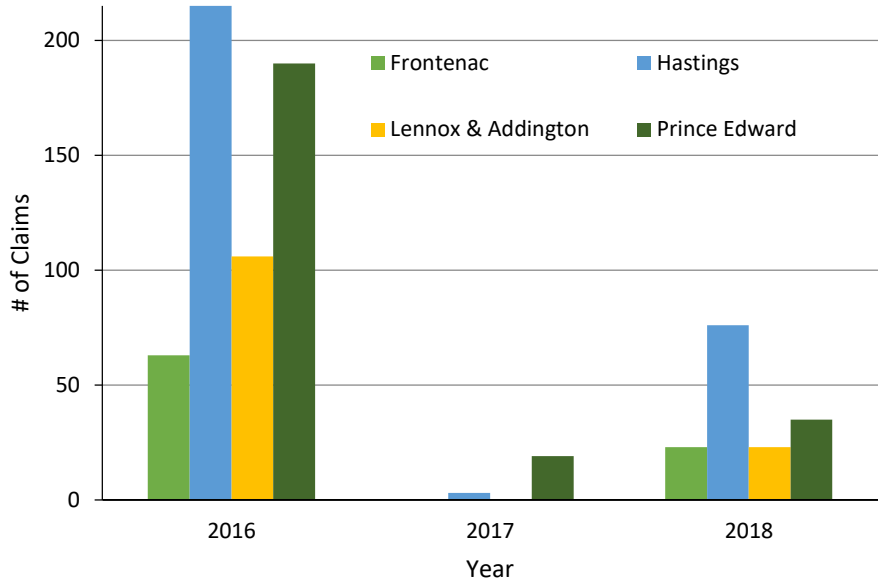
2.4.1 Impacts of Drought

The impacts of drought are wide ranging and can affect everything and everybody in the watershed region. During the 2016 drought several impacts were observed by Quinte Conservation including diminished flows in local stream and rivers impacting fish and wildlife habitat. Plants were impacted with decreased growth and in some cases mortality of trees. The agricultural community was significantly impacted as was evident from the number of crop insurance claims made by local farmers (see Figure 8). The claims, as recorded by Agricorp, were observed to significantly increase during the 2016 drought event with a total dollar value in the order of 17.5 million, not including losses from uninsured crops.

In addition to decreased crop yields many farmers experienced water shortages and were forced to find alternate water supplies for their livestock. Rural residents relying on private wells also experienced shortages and were forced to look to alternate water sources. This need was reflected in the bulk water sales recorded at many municipal water treatment plants throughout the area. The First Nation community reported that this additional demand placed added pressure on their drinking water system. Figure 9 shows an almost 100 percent increase in bulk water sales for 2016 at the Town of Picton Bulk filling station. Records of bulk sales also

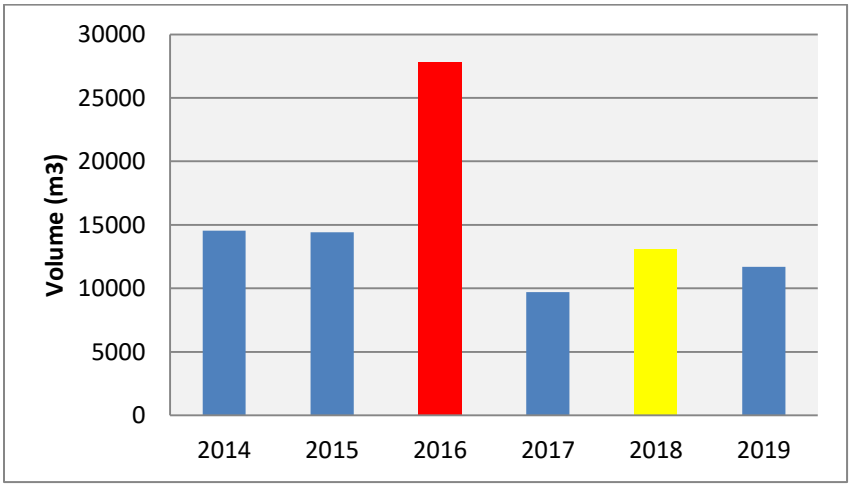
do not reflect the additional time and labor required by users to maintain a level of water supply.

Figure 8: Crop Insurance Claims 2016-2018 (Agricorp)



The use of bulk water filling stations is often dictated by geographic proximity to the users. If one is not near, water users sometimes turn to nearby streams, lakes and rivers as a backup source of water. In some instances this increased demand can contribute to additional stress on the already low levels of these surface water features.

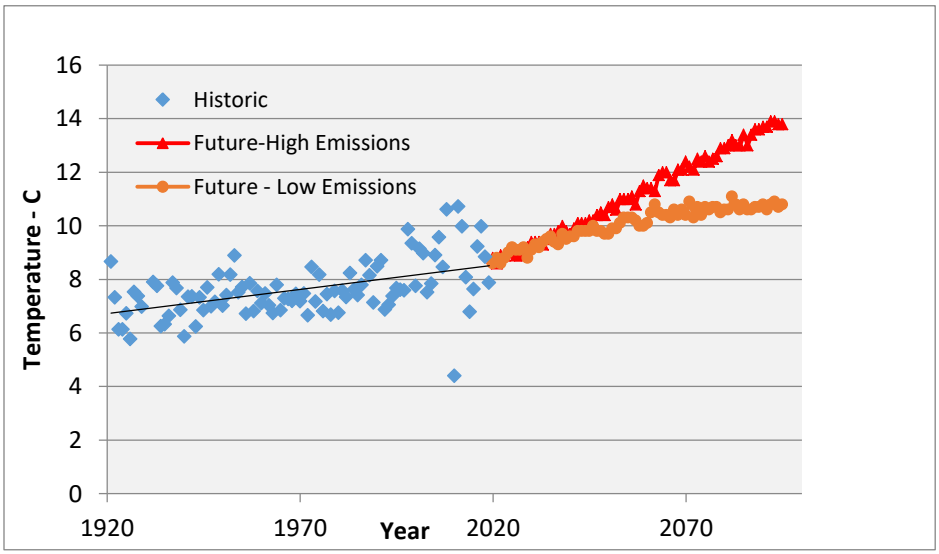
Figure 9: Bulk Water Sales (Town of Picton Municipal Bulk Filling Station)



2.5 Climate Change

Climate change is occurring globally as well as locally in the Quinte Region. The predictions of more extreme weather events have moved from a possibility in the future to happening now. The temperature records for the Environment Canada - Belleville climate station show that there has been a steadily increasing trend since 1920 (see Figure 10). Global climate models (Climate Atlas Canada, 2020) also indicate that this warming trend will continue. High emissions of carbon are predicted to increase temperatures, calling for the need for a change in society to increase the use of low carbon sources of energy.

Figure 10: Belleville Average Annual Temperatures 1920 – 2100



The global climate models also predict that future levels of precipitation are to remain relatively stable for the Quinte Region (Climate Atlas of Canada, 2020). While this stability is good news the trend of warming temperatures may be problematic in consideration of the water cycle. Recall from section 2.3 that approximately 60 percent of annual precipitation is used by evaporation and transpiration. With the predicted increase in temperature there will be a corresponding increase in rates of evapotranspiration. Quinte Conservation has modeled the potential impacts of climate change and predicts an increase in evapotranspiration rates by 10 percent over the next 30 years (Quinte Conservation, 2019). This increase translates to less water available for surface water runoff and groundwater recharge. Such changes can increase the impact of drought and underscore the need to adapt to a changing climate.

3.0 Water Use, Development & Drought Prone Areas

Prior to developing a drought plan it is important to understand the water use in the region currently and in the future. It is also important to understand how development is occurring and what areas of the watershed may be more vulnerable to climate change and drought.

3.1 Settlement Patterns

Land use in the Quinte watershed is a mix of urban, rural, and agricultural intermixed with small hamlets that provide services for surrounding activities. The diversity of land use is largely a result of the physiography and settlement patterns of the region. Larger urban centres have grown along the shores of the Bay of Quinte and include the cities of Belleville and Quinte West and the Towns of Greater Napanee and Picton. These urban areas provide for much of the commercial and industrial development in the region. The First Nation community was amongst the early settlers along the shores of the Bay of Quinte close to bountiful sources of fish and wildlife, timber resource, and fertile land for growing of crops. The surrounding country side supports a vibrant agricultural industry as well as cheese factories, wineries, and craft breweries. Due to the abundance of bedrock near the surface the aggregate industry is also active in these areas with many aggregate quarries as well as a large cement factory near Picton and a roofing shingle aggregate facility near Madoc. The main physiographic regions that influence the settlement can be classified as follows:

Canadian Shield – The northern portion of the Quinte Region, contains vast forests and many small lakes that support an active recreation industry for seasonal residents. Population density is generally low with seasonal increases in the summer.

Limestone Terrain- The area south of the Canadian Shield and north of the Bay of Quinte. The area contains some of the best agricultural land as well as marginal areas. Larger urban centers with associated industry and commercial business are also found in this region.

Prince Edward Region- This area supports a significant agricultural and seasonal recreational/ tourism industry through its productive soils and abundant shoreline along the Bay of Quinte and Lake Ontario. Population density is moderate with several small urban centres and a growing wine and craft brewery industry.

3.2 Population & Growth

Population data was obtained through review of Canada Census records and Conservation Authority apportionment statistics for the Quinte Region. In 2016 the region was home to approximately 130,000 people with half of these people residing in the urban centres (of which the City of Belleville is the largest). The remaining 65,000 people reside in the rural areas with a higher proportion of these residents in the southern municipalities. The population growth rate has been determined through comparison with data from the year 2000 (Canada Census). The population has grown by approximately 8.5 percent or a little more than 0.5 percent per year; in line with growth projections of the Ministry of Finance. However, this rate of growth has not been uniform throughout the area as the population of some municipalities has not changed significantly, whereas others have grown. This trend may be attributed, in part, to the growing retirement age portion of the community which has resulted in a lower number of people per dwelling. The areas showing growth include both urban and rural land use areas.

3.3 Water Use

Water use for the Quinte Region has been determined in reference to uses that require a permit to take water as well as those that do not. This information was taken from the Quinte Region Drought Management Water Budget Report (Quinte Conservation, 2019). The use of water is for providing supply to municipalities and private homes as well as for irrigation (golf courses), agriculture, industry, public (i.e. campgrounds) and remediation. Based on the population distribution and municipally serviced areas, the drinking water supply for residents of the Quinte Region is divided equally between ground and surface water. Many urban centres are supplied by surface water from the Bay of Quinte and Lake Ontario whereas the rural population rely on groundwater from private wells. Smaller settlement areas (Villages of Madoc, Tweed and Deloro) obtain supply from municipal groundwater wells and one small Village (Ameliasburgh) obtains supply from a small inland lake.

Water takings of greater than 50000 litres per day require a permit under Section 53 of the *Ontario Water Resources Act* as administered by the Ministry of Environment Conservation and Parks (MECP). Based on information provided by MECP the location of 62 permitted water takings (current as of the end of 2018) is illustrated by Figure 11.

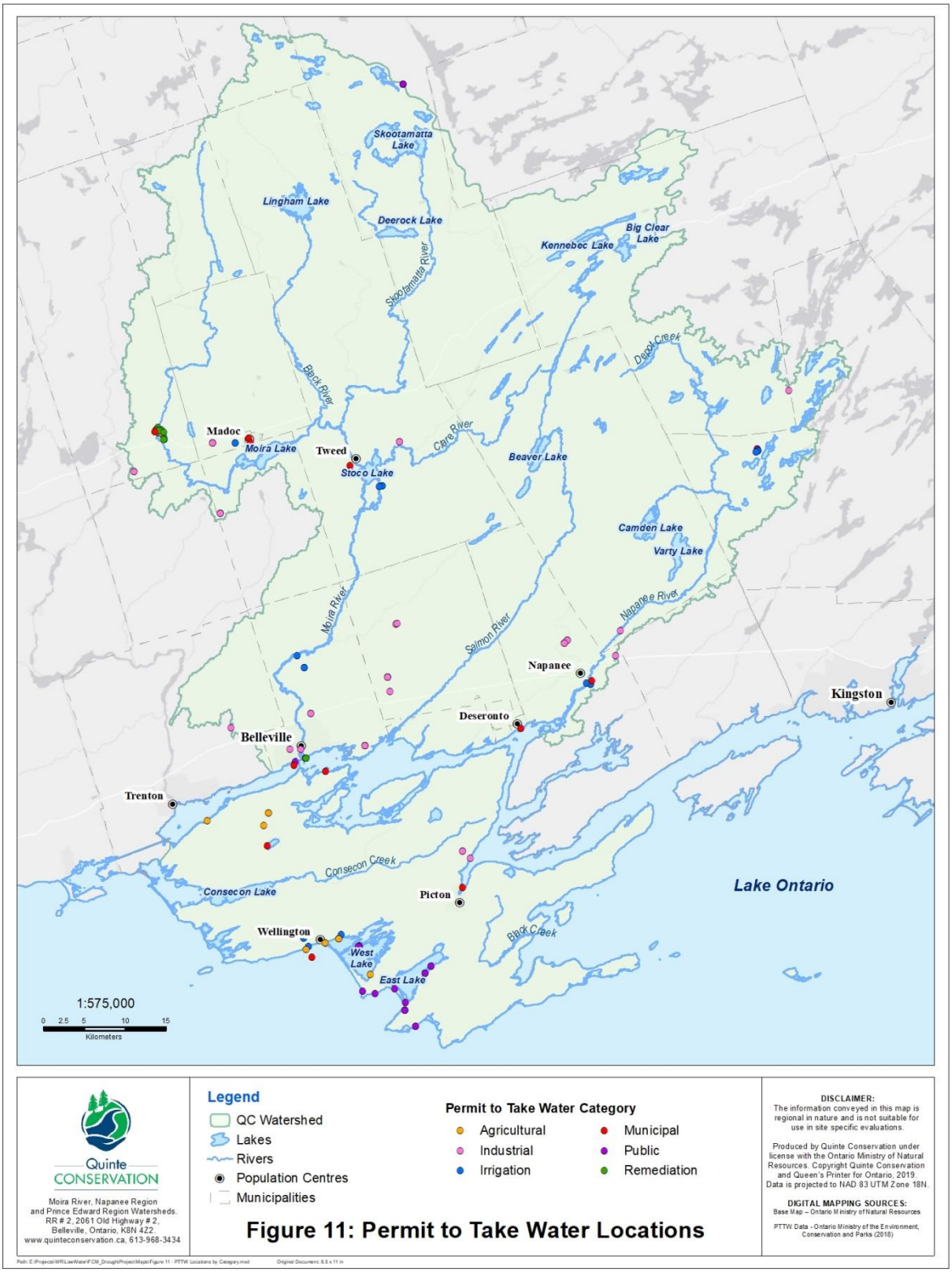
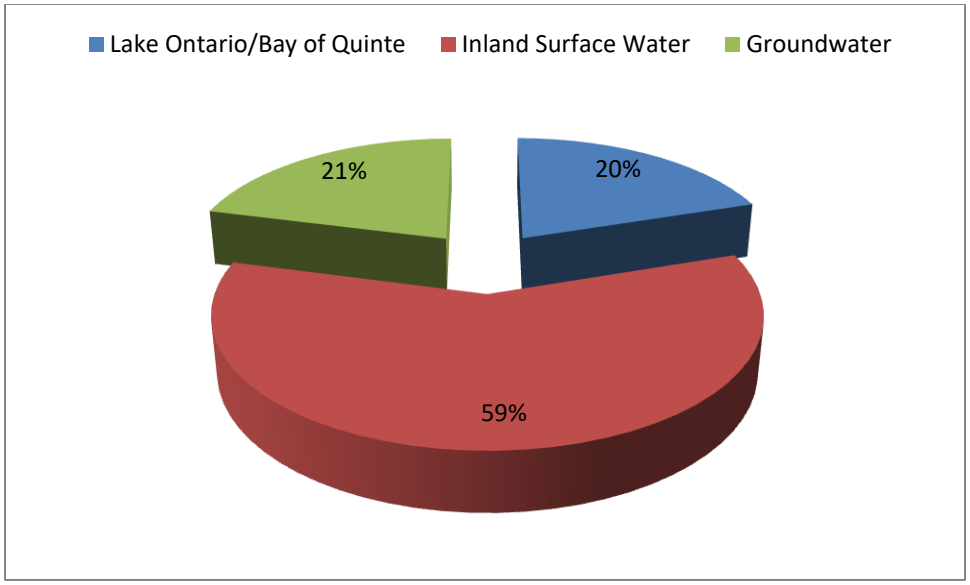


Figure 11: Permit to Take Water Locations

With respect to total water usage the proportion of use from each source is illustrated in Figure 12 showing that takings from groundwater and the Great Lakes (Lake Ontario and the Bay of Quinte) are approximately equal but inland surface water is the largest source for permitted water takings, by far.

Figure 12: Water Use by Source in the Quinte Region (2019)



Further refinement of the water use numbers was completed by considering consumptive demand (water that is not returned to its source). This presents a different picture as much of the Great Lakes water use is returned to its source following treatment at water pollution control plants. Groundwater and inland surface water takings are also reduced considerably when considering consumptive demand however the overall use remains significant as both are important sources of water to Quinte area residents.

The **ground and surface water sources** are used for a range of purposes but can be classified into the following categories; ranked from highest to lowest water use:

1. Remediation,
2. Industrial,
3. Municipal,
4. Private Wells,
5. Irrigation – (Golf courses, etc),
6. Agricultural,
7. Public – (Campground etc.).

The top two permitted water uses, remediation and industrial are related to the dewatering of quarries for aggregate extraction and the remediation of the former Deloro mine site along the banks of the Moira River. Both uses are important to the region. The remediation project helps protect the quality of the water resources and the people and wildlife that rely on them. Aggregate extraction activities provide local employment and raw materials for the construction of vital infrastructure. In spite of the large permitted water takings for these two sectors the actual water takings are typically 25 percent or less of the permitted volumes. Large volumes are intermittently required at these types of facilities in order to maintain dry working conditions following rain or spring snow melt events. However in some cases much of this water is temporarily diverted and subsequently returned to its source. Under drought conditions the water taking at these facilities is typically reduced as the lack of rainfall alleviates the need for pumping.

The municipal and private well water categories mainly represent the potable water usage by Quinte Region residents. Much of the municipal supplies come from **surface water** sources that are resilient to drought (i.e. Great Lakes), however the private wells obtain supply from fractured bedrock aquifers that have a low storage capacity. In consideration of **groundwater** use only, the private well category represents the second highest use of groundwater preceded (considering both permitted and non-permitted uses) by the industrial sector. Under periods of drought the local aquifers do not receive adequate recharge and users of private wells can experience shortages. Many residents are forced to use hauled water for meeting daily demands. The source of the hauled water is often municipal drinking water systems that access the Bay of Quinte or Lake Ontario. With adequate planning and preparation using an alternate source can be incorporated into normal daily lives for periods of short duration in emergency

situations. However, due to geography many municipalities do not have access to this infrastructure or resilient water bodies which increases the risk to impact from drought and requires careful planning to identify necessary backup sources of water.

Similar trends can occur in other sectors that rely on a vulnerable groundwater resource. Some agricultural and golf course operations are able to manage drought through the use of large storage reservoirs that can store water from large spring runoff events for use later in the drier summer months.

3.4 Ecological Water Use

The water resources of the region support more than the drinking and commercial needs of local residents. Fish, wildlife and aquatic insects all rely on this important resource for their habitat. The First Nation community is dependent on these resources to support their harvest of fish, wildlife, and plant life for sustenance and medicinal purposes. Some species are abundant and do well in all water conditions while others are more sensitive to low water conditions and do not thrive under low flow periods with warmer water temperature.

The flow in rivers and streams in the Quinte Region are recorded by a network of stream gauges maintained by the Water Survey of Canada. Some of these gauges have been in existence since 1915, providing a very good baseline for establishing historic stream flow statistics. However many of these gauges are located near the bottom end of their respective watersheds and there may be a time delay in the detection of critical flows in the upper reaches. As previously discussed in Section 2.3.2 the normal flow trend in local streams and rivers is for high flow in the spring runoff season and minimal flow during the later summer and early fall months. During these periods the combination of warmer air temperatures and low flow can create conditions less favorable to intolerant species. Determination of ecological flows is an in depth process for which there is no widely accepted methodology used in Canada and in Ontario. However for the purposes of this exercise the Tessman method (Tessman, 1980, Department of Fisheries and Oceans, 2012) was used to provide an indication of ecological needs. This method indicates that where mean monthly flow is less than 40 percent of mean annual flow then the mean monthly flow can be approximated as representing

ecological needs. Of note is that the methodology may not always represent conditions in the upper reaches of the watersheds due to reliance on stream flow measured at stream gauges in the lower portion of the watersheds. The flow in many of these watersheds is regulated and this methodology does not separate out the regulated portion.

The mean monthly flows for the Quinte's stream gauging stations are listed in Table 1 and represent target flows that are to be used as guide for low flow augmentation.

Table 1: Mean Monthly Flows at Select Stream Gauging Stations (2020) *

Station Name	Period of Record	Station #	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MOIRA RIVER NEAR DELORO	1965-2018	02HL005	3.97	3.42	7.49	13.70	5.13	2.08	0.81	0.39	0.56	1.31	3.63	4.66
MOIRA RIVER NEAR FOXBORO	1915-2018	02HL001	29.90	25.20	57.70	109.00	48.70	20.80	8.33	4.60	4.43	8.67	21.30	30.10
MOIRA RIVER NEAR TWEED	2002-2018	02HL007	30.60	21.20	37.90	65.40	28.20	12.20	6.32	3.38	2.98	6.68	19.90	30.80
BLACK RIVER NEAR ACTINOLITE	1955-2018	02HL003	5.65	4.83	9.50	17.00	7.07	2.85	1.39	1.17	1.43	2.05	4.68	6.57
SKOOTAMATTA RIVER NEAR ACTINOLITE	1955-2018	02HL004	9.19	7.84	15.20	28.20	11.80	4.27	1.79	1.12	1.41	3.03	7.43	10.30
CONSECON CREEK AT ALLISONVILLE	1969-2018	02HE002	1.82	1.68	4.61	4.25	1.43	0.46	0.18	0.08	0.18	0.34	1.18	1.76
NAPANEE RIVER AT CAMDEN EAST	1974-2018	02HM007	10.90	9.97	18.40	26.10	11.30	4.92	2.42	1.86	2.45	3.10	6.55	10.10
DEPOT CREEK AT BELLROCK	1957-2018	02HM002	2.44	2.26	3.14	4.87	2.31	1.26	1.04	0.99	1.04	1.14	1.48	2.29
SALMON RIVER AT TAMWORTH	2002-2018	02HM010	11.20	7.50	11.10	18.80	10.20	4.84	2.90	1.26	0.83	1.12	5.63	10.30
SALMON RIVER NEAR SHANNONVILLE	1958-2018	02HM003	12.40	11.40	22.00	34.70	15.90	6.50	2.74	1.32	1.48	2.53	8.36	13.50

* Units in cubic metres per second

3.4.1 Watershed Model

To evaluate the ability of the reservoirs to augment low flows within the Quinte watershed an existing watershed model (HydroGeoSphere) was reviewed and updated. The model was used to assess the influence of reservoir operation on low flow surface water conditions and ability to augment flows. Aquanty HydroGeoSphere Analytics was contracted to complete this work with a copy of their report provided in Appendix B. Through provision of information by Quinte Conservation the watershed model was enhanced to include Quinte area dams and reservoirs, provincial groundwater monitoring wells, lake bathymetry (water depth) and river networks.

The outcome of this work confirmed that flow in the Quinte Region rivers watershed would be minimal during low flow drought conditions. A review of the 2016 drought conditions revealed that through the use of reservoirs that the flows in local rivers can be enhanced on average 3 fold where reservoirs existed. For the Moira River system the 2016 simulation showed that

flow could be maintained to near the ecological flow limit during the critical months of August and September but was diminished in the fall months. In the case of the Salmon River, a lack of significant reservoirs showed that flows are significantly impacted during drought. The significant storage volume on the Napanee River system as provided by the Depot Lakes helps maintain flow under droughts but not enough to meet ecological flow requirements. This conclusion may be attributed in part to the methodology of how ecological flows were determined through inclusion of regulated flow data. As the flows on the Napanee River system are regulated it is thought that the ecological estimate may be artificially high and that further work is required to refine these numbers.

The potential impacts of climate change were made using the model through a hypothetical increase in evapotranspiration rates of 10%. This scenario indicated that average surface water flow rates across the watershed could decrease by as much as 35%. However, when reservoir operations are factored in results are improved with average decline in flows of 14%. Using the model, the impacts from other simulations were completed by increasing the water holding capacity of reservoirs and lowering the water level in select reservoirs. These scenarios improved flow conditions during the critical summer month period with the largest increase observed for the Napanee River and the lowest on the Salmon River; again attributed to the lack of significant storage reservoirs in this watershed. The ability of the reservoirs to meet ecological flows under a modified reservoir simulation continued to show significant potential on the Moira system but limited for the Napanee and Salmon Rivers. Additional work on refining ecological flows and modeling of hypothetical reservoirs is recommended to assist identifying solutions for low flow augmentation.

3.5 Drought Sensitive Regions

Approximately half of the Quinte Region's population lives in urban centres where water supply is obtained from of the Great Lakes, a resilient water source. The remaining half of the population and the agricultural sector rely on private wells obtaining supply from a fractured bedrock aquifer that is vulnerable to drought. Although the Quinte Region aquifers are considered to be vulnerable to drought; a methodology has been developed to identify areas of the watershed that may be at higher risk to impact from drought than others.

The yield of groundwater wells in the Quinte Region can exhibit a wide range of variability. As a result some wells may fare better than others in times of low water. In general terms deep wells that have a high yield are typically less susceptible than shallow wells of low yield. To assess the distribution of such wells the Ontario Water Well Records for the Quinte Region were reviewed. A vulnerability score of high, medium or low was given to each well record based on well yield and depth. By averaging the scores, an overall vulnerability was assigned to each municipality as illustrated in Figure 13. In reference to the distribution of population relying on private wells, a sensitivity score was assigned to each municipality based on reliance on private wells. By combining the scores for well vulnerability and municipal sensitivity, an overall risk rating for impact from drought was assigned to each municipality. The methodology is generally described as follows:

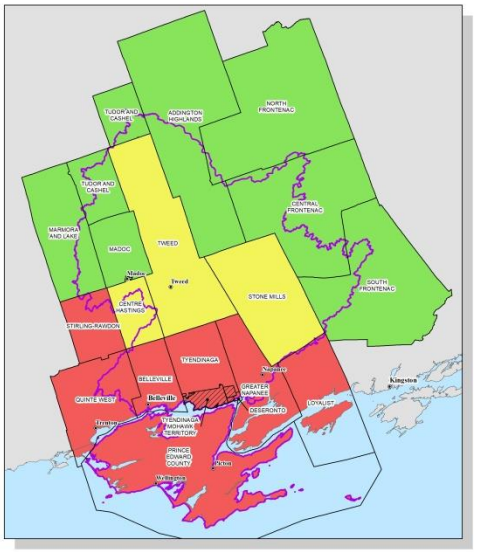
1.) Scoring the vulnerability of wells to drought as high, moderate, and low based on well depth and yield. Shallow wells with low yield scored high; deep wells of high yield had low vulnerability.
2.) The sensitivity of each municipality to drought was scored as high, medium, or low based on the dependence of population relying on private wells for water supply. Municipalities with high dependence on private wells were scored as highly sensitive with a low score assigned to those with greater reliance on the Great Lakes.
3.) An overall risk score was then determined using the following matrix (see Table 2):

Table 2: Drought Impact Risk Matrix

	Municipal Sensitivity		
Well Vulnerability	Low	Medium	High
Low	Low	Low	Moderate
Medium	Low	Moderate	High
High	Moderate	High	High

The results of this exercise are illustrated by Figure 13 showing that areas with high well vulnerability are located in the southern portions of the watershed where wells are shallow and of low yield. Areas with high sensitivity are located in the northern portions of the watershed as these areas cannot access the Great Lakes for water supply and there is a higher dependence on groundwater. The overall risk score indicates areas of high drought impact risk to be spread throughout the region but generally includes those areas with both a high well vulnerability and a high percentage of population that rely on the groundwater for water supply.

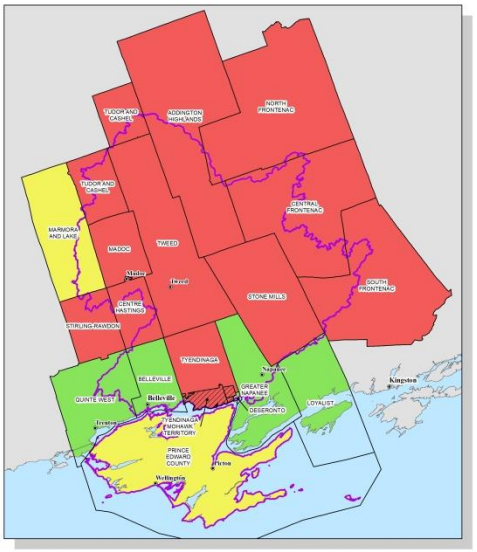
Figure 13: Drought Risk for Municipalities of the Quinte Region



Well Vulnerability

Low Moderate High

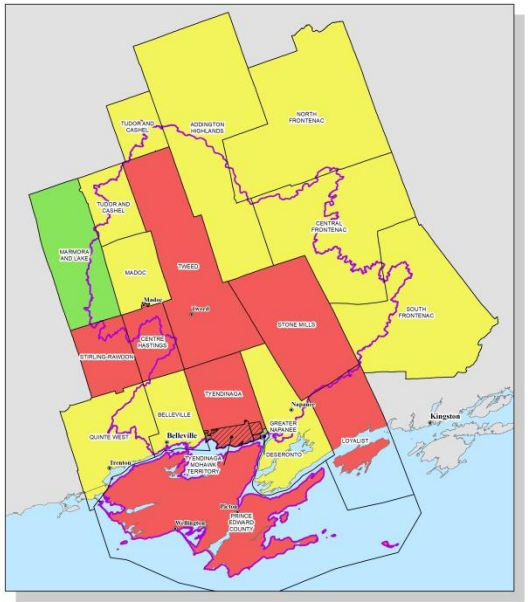
The average vulnerability of private groundwater wells on the basis of well depth and yield. Shallow wells with low a yield are more vulnerable than deep wells with a high yield.



Groundwater Reliance

Low Moderate High

The proportion of the population reliant on groundwater wells as their primary drinking water source. "Low" equals less than 50 percent, "Moderate" equals 50 - 75 percent, and "High" equals greater than 75 percent.



Drought Impact Risk

Low Moderate High

A risk factor taking into account both well vulnerabilty and groundwater reliance. This serves as an indicator of the sensitivity of an area to impacts from drought. See how this factor was calculated below:

Well Vulnerability	Groundwater Reliance		
	Low	Moderate	High
Low	Low	Low	Moderate
Moderate	Low	Moderate	High
High	Moderate	High	High

Quinte CONSERVATION

3.6 Dealing with Drought in the Quinte Region

For Quinte Region residents that rely on private wells and do not have access to a resilient backup water source, such as the Great Lakes, the impact of drought may be significant. The groundwater resources of the region are not favorable for drilling deeper wells into less drought prone aquifers as these aquifers can yield water of poor quality (i.e. salt which is not potable). In situations where supply shortages from groundwater systems are experienced these users must generally turn to the following methods of dealing with drought:

Water Conservation: Implement water conservation and efficiency measures (i.e. repair leaks, install low flow fixtures, etc.),
Storage: Importing water from a drought resilient source (i.e. surface water features that **not** have been impacted by drought),
Water Recycling: Implement methods that recycle water (i.e. recycling of grey water for toilet flushing, use rain barrels to catch water for irrigation, etc.).

In addition to making preparations to deal with drought for existing water users municipalities can help lessen the impact of drought by guiding new development to areas that are less vulnerable to these impacts. Some of the measures that may be considered to help address drought are provided below.

3.6.1 Water Conservation

During a drought, one of the greatest defenses that watershed residents have is water conservation. There are many examples around the world where residents have had to conserve water in the face of extreme drought. One of the most recent was in Cape Town, South Africa, a City of approximately half a million people. Due to a lack of rainfall the City's water reservoir was dangerously close to running dry. The main defense was water conservation and the City was forced to impose strict water conservation measures limiting residents' water use to 50 litres/person/day. The citizens pulled together to ration water and the pressure on the water system was reduced, defying the odds against drought. An illustration of how people can survive on 50 litres/day is provided below in Figure 14. Further tips on how to conserve water and manage a well in times of water shortage are provided in Appendix C.

Figure 14: What Does 50 litres of Water per Day Look Like *

* This is a guide to 50 l per person per day at home work, or elsewhere. Actual use will depend on your appliances and personal preference. Source: www.capetown.gov.za/thinkwater.

3.6.2 Water Storage/Cisterns

In some areas where residents do not have an adequate water supply a cistern or reservoir is used to store hauled water for meeting household water demand. A properly constructed cistern, filled with municipally treated water delivered by an approved water hauler, should provide a safe supply of water. Poorly maintained cisterns are easily contaminated, thus regular maintenance is required through periodic inspection, cleaning, and disinfection. The installation and operation of cisterns must be in accordance with relevant guidelines and the Ontario Building Code. Suitable water treatment equipment is recommended to ensure the safety of the water supply. Appendix C contains a guideline with some suggestions for operating and maintaining a cistern.

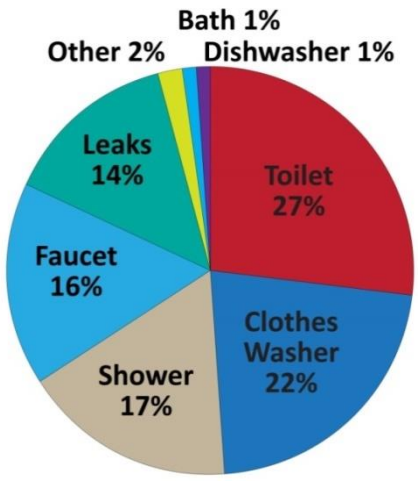
In certain circumstances where low yield wells are being used, a system referred to as a trickle system can be installed to assist in meeting household water demand. In this system water is pumped from the well into a larger storage tank. A secondary pump delivers water from the storage tank to the house to help meet periods of high water demand. As water is used from the tank, fresh water is "trickled" into the tank from the well. The water in the tank is

replenished over the course of the day at a rate the well is able to sustain. This system enables residents to use low flow wells for meeting periods of high demand. In times of more severe water shortages these tanks can also be used like a cistern for the storage of hauled water. Only municipally-treated water is recommended for filling these tanks and such systems must be installed by a qualified professional in compliance with relevant guidelines and the Ontario Building Code.

3.6.3 Grey Water Recycling Systems

The recycling of water in a home can be an easy way to reduce overall water demand. In terms of average daily water use of a home, approximately one third can be attributed to showers and faucets with an additional third for the flushing of toilets as shown in Figure 15. A grey water recycling system enables the recovery of water used from showers and faucets, by holding the grey water in a tank and then reusing it in the flushing of toilets or for outside irrigation. Rainwater harvesting can also be used to supplement this supply. Such a system can result in a reduction of household water demand by one third. The popularity of these systems has been growing and recycling units are now commercially available. However, in all cases the water must be treated prior to reuse and the plumbing from a grey water system must not be connected to the potable water supply system of the house. Such systems must comply with relevant guidelines, and the Ontario Building Code. It is highly recommended that the installation and maintenance be completed by a qualified professional.

Figure 15: Typical Daily Household Water Use



3.6.4 New Development-Hydrogeological Studies

Municipalities can help lessen the impact of drought on its residents by guiding development to areas that are less vulnerable to these impacts. In areas where potential impact is unavoidable it is recommended that such development proceed on the basis of its preparedness to deal with drought. Such preparation would include:

1. The installation of a cistern to allow for use of hauled water supplies when necessary,
2. Incorporation of water efficient fixtures and appliances, and
3. Use of water recycling systems to mimimise water demand.

The Ontario Provincial Policy Statement, under the *Planning Act*, 2020 (herein referred to as OPPS, 2020) promotes reducing the impact from drought through the development approval process. This policy indicates that new development should be approved where it is sustainable in regards to the impacts from climate change and promotes water conservation and water use efficiency (OPPS, 2020, section 1.6.6.1 (c)).

Hydrogeological Studies

Section 1.6.6.2 of the OPPS 2020 recommends preference is given to new development in settlement areas where suitable servicing infrastructure is available. It is important to recognize that not all municipalities have access to municipal servicing; rather many rely on private wells as a means of water supply for both new and existing development. In this regard the OPPS section 1.6.6.1 indicates that planning for water and sewage services in these areas shall ensure that these systems are provided in a manner that:

1. Can be sustained by the water resources upon which such services rely,
2. Prepares for the impacts of a changing climate,
3. Is feasible and financially viable over their lifecycle, and
4. Protects human health and safety, and the natural environment.

Section 1.6.6.4 of the OPSS 2020 further indicates that “the use of private services to accommodate future development may be used provided that site conditions are suitable for the long-term provision of such services with no negative impacts. At the time of the official

plan review or update, planning authorities should assess the long-term impacts of individual on-site sewage services and individual on-site water services on the environmental health and the character of rural settlement areas".

To fulfill the above it may be necessary for municipalities, when considering land development applications, to request a hydrogeological assessment to determine the availability of adequate quantities of ground water and that the proposed use of groundwater is sustainable in the long term. The potential impact from drought requires consideration when reviewing applications for new development.

Provincial Guidelines D-5-4 Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment and D-5-5 Private Wells: Water Supply Assessment, are available for reference when requesting and reviewing hydrogeological studies for proposed developments involving private water supplies and onsite sewage disposal systems.

In determining when a hydrogeological assessment should be requested, the following can be used as a general guide:

1. Areas of known constraint where groundwater quantity or quality may be of concern,
2. Large developments (i.e. subdivisions) or those that propose high water use and are not covered under existing legislation such as the *Ontario Water Resources Act*,
3. A proposed development that is on lands designated as Hamlet or Urban if on partial or no municipal services,
4. The proposed development is in an area constituting 5 or more existing dwellings/lots occupying 4 hectares (10 acres) of land or less within 300m of the new lot boundary.

The objectives of a hydrogeological assessment are to ascertain the availability and long term sustainability of adequate groundwater supply for the proposed development without adverse impact on the water supply of both existing residents and nearby surface water features. The quality of the water must also be demonstrated as complying with relevant drinking water standards (Ontario Regulation 169/03: Ontario Drinking Water Quality Standards) and as suitable for the proposed use.

Hydrogeological assessments must also assess suitability of the terrain for onsite private sewage disposal services in order to demonstrate that the use of such systems will not result in adverse impact on the quality of the water supply for the proposed development or that of existing residents.

Hydrogeological assessments must be completed by a qualified person and be consistent with the relevant guidelines such as those previously mentioned. These assessments must also consider the seasonal fluctuations in groundwater levels that typically occur throughout the Quinte Region and the potential impact from drought. In this regard the testing of aquifer yield is not recommended under periods of high groundwater recharge. Testing should be completed under average water table conditions or preferably, during a low water time of year. This recommendation helps to ensure that residents will have a viable supply of water year around without adverse impact on neighboring wells.

3.6.5 Large Water Takings

In the Province of Ontario any water takings exceeding 50000 litres/day requires a permit to take water with exceptions for domestic uses, watering of livestock or poultry, wetland conservation, construction related water diversion, firefighting and other emergency purposes. These permits are issued by the Ministry of the Environment, Conservation and Parks (MECP) through section 34 of the *Ontario Water Resources Act* and Ontario Regulation 387/04. These permits are not necessarily a guarantee of water supply and the MECP considers application for permits based on risk to the environment and interference with other water users.

Following the drought of 2016 concerns were raised by the public about water security in Ontario. In response to this concern the Province placed a temporary moratorium on new water taking permits for bottled water. During this period a review of the Provincial water quantity management framework was also completed including an assessment of the water resources in select areas of the Province. The Quinte Region was identified as one such study area and the outcome of the review indicated the region as being sensitive to drought and having limited water availability due to the inability of the local geology to store water (MECP, Proposal Paper,2020).

The water quantity study (BluMetric, March, 2019) also concluded that the water resources of the Quinte Region are sustainable under current conditions at the regional scale but not in localised areas due to lack of resiliency to drought conditions. Considering the potential impacts of climate change and lack of drought resiliency, the water resources were predicted as not being sustainable under future conditions.

As an outcome of the review, the Province has identified the following key action items:

1. Establish clear provincial priorities of water use to guide decisions where there are competing demands for water.
2. Update the approach to managing water takings in water quantity-stressed areas.
3. Make water taking data, including data the ministry collects from permitted water takers, more accessible to the public.
4. Give host municipalities more input into water bottling decisions.

To facilitate the above actions regulatory amendments to the water taking regulations are going to be proposed. These amendments were not available at the time this plan was prepared however some of the proposed actions align with the intent of this plan and highlight the need to be prepared to address drought in the Quinte Region and adapt to a changing climate.

Regardless of the outcome of the proposed regulatory changes, Quinte Conservation and municipalities within the region should continue to review and comment on permit to take water applications as they are received. This review is to ensure proposed water takings are sustainable and that the permits to take water contain adequate conditions that require restrictions on water use during periods of drought.

3.7 Priority of Water Use

Decisions about water use restrictions during a drought may be necessary in order to protect sources of water from being depleted. The Ontario Low Water Response Guideline (MNRF, 2010) divides water use into categories of Essential, Important, and Non Essential. When deciding priorities and what each of these uses comprises the ultimate goal is to balance

efficient use, protection of the resource, and equity among users (MNRF, 2010). The order of priority would be highest for essential water use to try and maintain supply throughout a drought. The second highest priority is important water uses, followed by non – essential. Strong consideration should be given to stopping non – essential uses at the first sign of a drought. A description of these uses is as follows:

First Priority - Essential Use:

Water for essential use deals with protecting human and animal life. This constitutes a reasonable supply of water for drinking and sanitation, health care, public institutions and public protection (i.e. wastewater treatment, fire protection, and schools), livestock and for basic ecological function.

Second Priority - Important Uses

These uses support the social and economic well-being of an area. This may include activities that use water that are critical to industrial processes, commercial facilities such as hotels and restaurants and key agricultural crops.

Third Priority- Non Essential Uses

These are uses that could be interrupted for the short term without significant impact such as filling of swimming pools, splash pads, lawn watering, water fountains and car washing. Further information about the different levels of drought, responsibilities and required actions for management of water use during a drought are discussed next under section 4.

4. 0 Drought Plan

The following section describes the components of the Drought Management Plan. This Plan promotes actions to be taken prior to the onset of drought as well as during. There are several components to a Drought Plan however the following basic components have been identified as essential:

1. Role of agencies,
2. Drought warning plan,
3. Actions to be taken before, during and after a drought, and
4. Water use Conflicts.

4.1 Roles

Multiple agencies and groups are involved in the monitoring, planning and response to drought. At the local level, the Low Water Response Team (LWRT) takes the lead in partnership with local municipalities, First Nations and water user groups and provincial agencies. A brief outline of the role of each partner is described below:

Low Water Response Team

- ✓ The formation of this team is coordinated by the Conservation Authority and membership is updated on an annual cycle. The group is intended to be made up of representatives from the various water user groups throughout the watershed. At a minimum this includes agriculture, private business, aggregate industry, tourism and recreation, First Nations, local Interest groups, municipalities, and provincial agencies,
- ✓ Meetings are coordinated by the Conservation Authority who informs the team about low water conditions,
- ✓ Works together to respond and review information about low water conditions to determine when it is appropriate to make a low water declaration,
- ✓ Works with local water users to share information about drought and how to reduce demand to mitigate the effects of drought, and
- ✓ Encourages voluntary water conservation practices through education and public awareness.

Municipalities

- ✓ Participate in the Low Water Response Team and provide information about the condition and level of public water supplies and reserves used for fire protection,

- ✓ Communicate information to residents and water users about low water and promote water conservation and drought preparedness (sample posters in Appendix D),
- ✓ Implement water conservation or restrictions to non-permitted water uses (i.e. less than 50000 litres/day) through education or municipal by-laws,
- ✓ Maintain bulk water filling stations (where such facilities exist and are feasible),
- ✓ Declare and administer state of emergency if deemed appropriate,
- ✓ Enact by-laws concerning the "economic, social and environmental wellbeing of the municipality' and the "health, safety and wellbeing of persons" and having regard to matters already covered under existing provincial statutes (sample bylaws are provided in Appendix E),
- ✓ Establish bylaws to address the need for water restrictions for municipalities with municipal drinking water systems as well as those that do not, and
- ✓ Promote sustainable development in regards to potential drought and impacts from climate change (i.e. development of a resilient water supply and incorporation of water conservation and water recycling measures that minimise potential impact on the water resources)

First Nation

- ✓ Participate in the Low Water Response Team and provide information about the condition and level of public water supplies and reserves,
- ✓ Share information about low water conditions with other water users in the group and promote water conservation actions,
- ✓ Communicate information to residents and water users about low water and promote water conservation and drought preparedness (sample posters in Appendix D),
- ✓ Implement water conservation or restrictions to non-permitted water uses (i.e. less than 50000 litres/day) through education or internal policies,
- ✓ Maintain bulk water filling stations,
- ✓ Declare and administer state of emergency if deemed appropriate,
- ✓ Promote sustainable development in regards to potential drought and impacts from climate change (i.e. development on a resilient water supply and incorporation of water conservation and water recycling measures that minimise potential impact on the water resources),
- ✓ Provide Traditional Ecological Knowledge, leadership and deliver programs that promote conservation and management of the watershed, and
- ✓ Conduct investigations into water use interference complaints and enforce appropriate Legislation and internal policies.

Conservation Authorities

- ✓ Coordinate the Low Water Response Team and provide recommendations regarding the level of low water,
- ✓ Provide environmental expertise, leadership and deliver programs that promote conservation and management of the watershed,
- ✓ Monitor watershed conditions through maintenance and collection of data from a network of monitoring stations,
- ✓ Communicate low water conditions to municipalities, First Nation, and the public,
- ✓ Maintain records of reports from watershed residents regarding impacts from drought,
- ✓ Maintain and operate dams and reservoirs to augment low flows in local streams and rivers, and
- ✓ Promote sustainable development with a focus on climate change and long term water security.

Ontario Ministry of Natural Resources and Forestry (MNRF)

- ✓ Lead drought emergency planning under the Emergency Management and Civil Protection Act,
- ✓ Provides a high-level early warning system to communicate the onset of drought by observing precipitation and stream flow across a broad network of provincial monitoring stations
- ✓ Participate on Low Water Response Team,
- ✓ Assist municipalities in the event of an emergency, and
- ✓ Administer the *Lakes and Rivers Improvement Act*.

Ontario Ministry of Environment, Conservation and Parks (MECP)

- ✓ Participate on the Low Water Response Team,
- ✓ Regulate the taking of water over 50,000 litres/day through the Permit to Take Water Program under the *Ontario Water Resources Act*,
- ✓ Provide communications to permit holders and provide information about water use to the Conservation Authority,
- ✓ Promote sustainable water taking through implementation of water conservation and drought preparedness to permit holders and ensure compliance of permit conditions,
- ✓ Conduct investigations into water use interference complaints and enforce appropriate legislation,
- ✓ Administer the Conservation Authorities Act,
- ✓ Administer Water Quantity Risk Assessments under the Clean Water Act,

- ✓ Administer the Water Taking and Reporting System,
- ✓ Administer the Provincial Groundwater Monitoring Network,
- ✓ Administer the Provincial Water Well Information System,
- ✓ Administer Drinking Water emergency plans under the Emergency Management and Civil Protection Act, and
- ✓ Provide funding for Conservation Authority programs.

Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA)

- ✓ Participate on the Low Water Response Team,
- ✓ Communicate with user groups regarding low water conditions and promote water conservation and drought preparedness,
- ✓ Assist with coordination of local agricultural representation on the Low Water Response Team,
- ✓ Work with local farm community, agricultural advisors and OMAFRA on promoting and disseminating information to help farmers manage through periods of drought and low water resources with agricultural extension and outreach,
- ✓ Coordinate an internal adverse weather committee to monitor drought,
- ✓ Promote agricultural business risk programs including, agricultural production insurance such as crop insurance via AgriCorp, and
- ✓ Administer an internal severe weather protocol.

Ontario Ministry of Municipal Affairs and Housing (MMAH)

- ✓ Administer the Municipal, Planning, and Building Code Acts, and
- ✓ Administer the Disaster Recovery Assistance for Ontarians and Municipal Disaster Recovery Assistance programs (drought is not eligible but in extreme emergency instances MMAH would play a supporting role).

Ontario Ministry of the Solicitor General

- ✓ Administer the Emergency Management and Civil Protection Act,
- ✓ Administer Ontario Regulation 380/04, and
- ✓ Administer the Provincial Emergency Operations Centre.

Water User Groups

- ✓ Appoint representatives to participate on the Low Water Response Team and report information about water levels, shortages or supply problems,
- ✓ Share information about low water conditions with other water users in the group and promote water conservation actions,

Water User Groups (cont'd)

- ✓ Take action to conserve water during a drought, and
- ✓ Promote drought preparedness amongst the user groups.

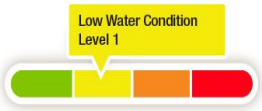
Federal Government – (Environment Canada & Water Survey Canada)

- ✓ Operate and maintain a network of climate and stream gauging stations throughout the watershed.

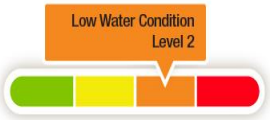
4.2 Drought Warning Plan

The low water response program and warning plan was originally established for the Province of Ontario in response to severe drought events and a need for a methodology to warn the citizens of Ontario of the onset and occurrence of drought. This program ranks low water conditions based on levels of precipitation as well as flow in local streams and rivers using the four levels as described below:

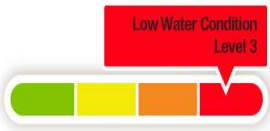
Normal – Watershed conditions are normal and not in a low water condition. This is the time to make improvements in water efficiency by upgrading fixtures, repairing leaks and planning for an alternate source such as through the installation of a cistern/ tank.



Level 1- Potential for water supply problems has been identified. This condition is managed through existing programs of Conservation Authorities, municipalities and other provincial agencies. It is the first indication of potential water supply problems and the focus is water conservation. A voluntary 10% reduction in water consumption is requested.



Level 2- Minor water supply issues may be encountered and there is the potential for major supply problems. A Level 2 condition is managed through Conservation Authorities, municipalities and other provincial agencies. Water conservation is requested to increase to 20 % and include restrictions on non-essential uses.



Level 3- Means a serious problem and potential for failure of the water supply to meet demand. Restrictions on water use may be imposed by municipalities or under the *Ontario Water Resources Act*. A 30% reduction or more in water consumption is requested.

4.2.1 Low Water Thresholds

The threshold levels for precipitation and stream flow are provided in Table 3 including recommended tools and actions for each level.

Table 3: Low Water Level Triggers, Tools and Actions

Level	Trigger	Tools	Actions
Level 1: Potential water supply problem	• Precipitation is less than 80% of the 3 month or 18 month monthly averages • Stream flow is less than 70% of the average summer flow	• 10% reduction in water use among all sectors. • Public education	• WRT Meeting • Promote conservation in sectors • Media releases, communication materials
Level 2: Minor water supply issues and potential major supply problems	• Precipitation is less than 60% of the 1, 3 or 18 month monthly averages • Stream flow is between 50-70 % of the average spring or summer flow	• 20% reduction in water use among all sectors. • Public education • Municipal bylaw water restrictions	• WRT Meeting • Promote conservation in sectors • Notify emergency response coordinator • Document conservation efforts and impacts • Consider priorities if progression to a Level 3
Level 3: Failure of water supply to meet demand	• Precipitation is less than 40% of the 1, 3 or 18 month monthly averages • Stream flow is less than 30% of the average spring or summer flow	• 20% reduction in water use among all sectors • Public education. • Municipal bylaw water restrictions • Regulated reduction in permitted takings and enforcement	• WRT makes recommendation to declare Level 3 • Documentation of impacts, conservation compliance and priorities for water use restrictions

4.2.2 Monitoring for Drought

To monitor water conditions Quinte Conservation collects data from a network of monitoring stations throughout the watershed at the locations illustrated by Figure 16. This monitoring network includes:

- 12 stream gauging stations operated by Water Survey of Canada
- Weather data from 6 Environment Canada weather stations,
- A network of rain gauges operated by Quinte Conservation,
- Citizen Scientist operated monitoring stations (i.e. rain gauges),
- 29 Provincial Groundwater Monitoring Wells with soil moisture monitoring at three of these sites,
- Snow survey routes and 4 automatic snow survey stations
- 12 automatic lake level monitoring stations.

The available technology at these monitoring stations ranges as some are operated manually while others report data in real time via satellites or phone lines to the Quinte Conservation computer network. The period of record for these stations is also variable with some stations dating back to 1915 and others as recent as 2020.

4.3 Drought Action Plan

The drought action plan is activated by Municipal and First Nation Councils when these Councils are notified that a low water condition has been issued by the Low Water Response Team. The CAO, CEMC, and/or Fire Chief will notify Council of the low water declaration and activate the plan upon direction from Council. Actions recommended under normal conditions are to be incorporated into usual business.

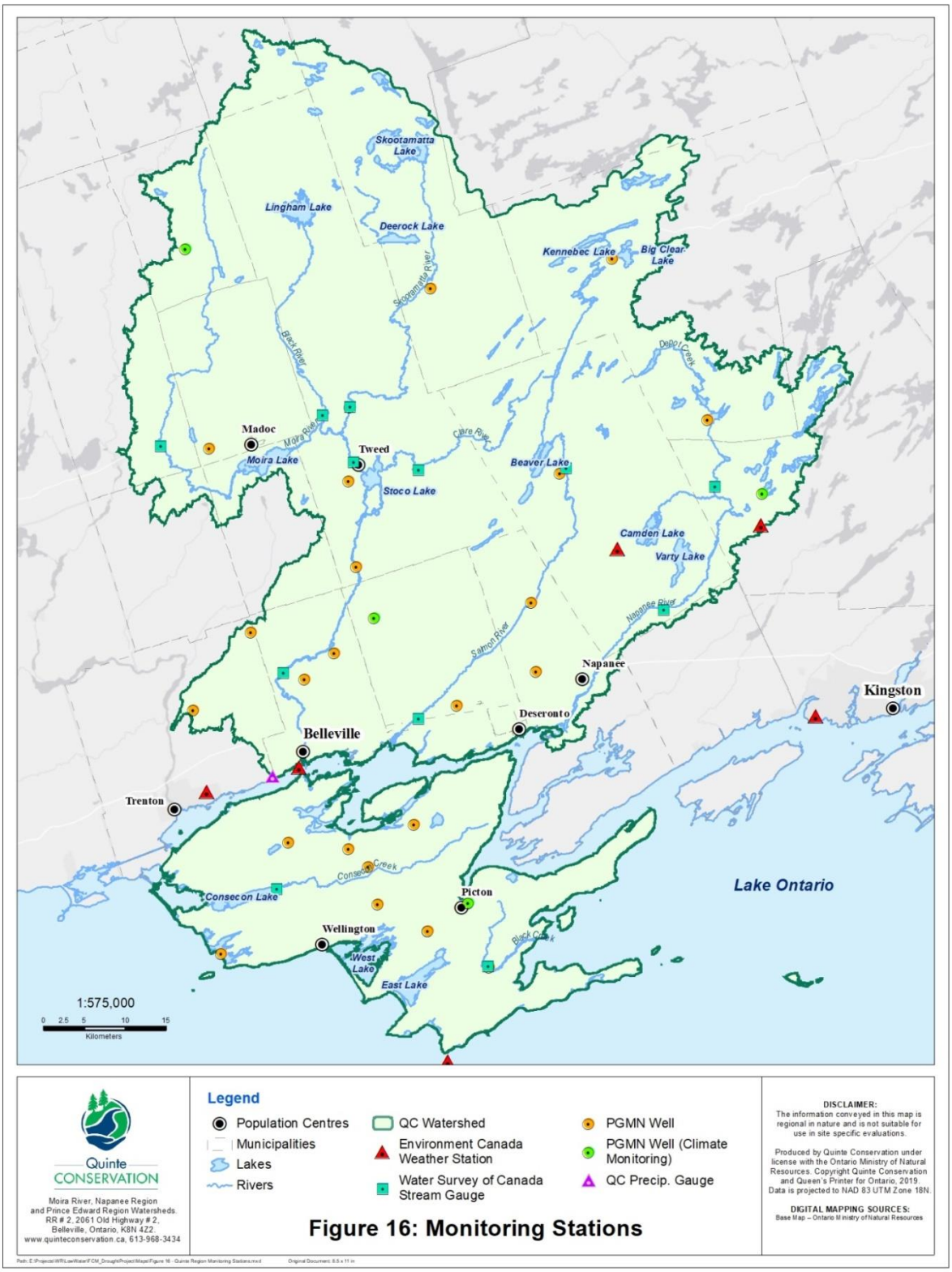


Figure 16: Monitoring Stations

4.3.1 Normal Conditions Action Plan

Under normal conditions it is the ideal time to make changes to existing operations and prepare for drought. Such preparation can help reduce the impact from drought and allow for easy implementation of actions under Level 1, 2, or 3 low water conditions. Some recommended actions for the different groups are as follows:

All

1) Prepare and update brochures and online media with information related to water conservation and drought (completed in collaboration with all watershed partners),
2) Prepare and update social media and contact lists for dissemination of information during a low water event,
3) Plan and identify locations of alternate water taking for residents to use during a drought. Prepare a map showing the location of these sources. Avoid identifying locations that could interfere with fire protection or ecological function if it is a water course. Verify suitability of water courses with the Conservation Authority and provincial agencies,
4) Develop a contingency plan for backup sources of water for fire protection,
5) Establish and implement water restriction bylaws for implementation during periods of low water (see Appendix E),
6) Promote development that is serviced by a water supply that is viable over the long term. In accordance with the Provincial Policy Statement 2020 new development should be approved where it is sustainable in regards to the impacts from climate change and promotes water conservation and water use efficiency,
7) Where possible, direct new development to settlement areas where suitable servicing infrastructure is available,
8) Approval of new development on private wells should give consideration to long term water supply and preparation for drought through installation of a suitable water storage system. Where necessary promote appropriate groundwater testing at a representative time of the year to confirm availability of water supply for both existing and future residents,
9) Promote water conservation and recycling in both existing and new development, and
10) Apply best management practices to stormwater management such as stormwater attenuation and re-use, water conservation and efficiency and low impact development.

Municipalities with Municipal Water and First Nation with Central Water Facilities

1) Undertake a regular inspection program to detect and repair leaks in water distribution systems. A water metering program to assist in pin pointing areas where leaks may be occurring will also help in successful implementation of such a program,

2) Conduct preventive maintenance to minimise potential breaks and water waste,
3) Review drought vulnerable water supplies and ensure measures are taken to reduce potential impacts. Measures could be a review of depth of water intake, increase in water storage, etc.
4) Establish a contingency plan that outlines measures to take in the event of water shortage and to identify alternate water sources. Such plans could include a water conservation plan and implementing a hauled water system,
5) If hauled water systems are going to be implemented investigate agreements with nearby municipalities with access to a drought resilient water source and the capacity to provide water,
6) Develop a list of businesses and services to help mitigate the impact of drought (i.e. bottled water, water storage tanks, well drillers, pump contractors etc,), and
7) Investigate the availability of water haulage contractors to transport water in times of drought.

Municipalities and First Nation with Private Wells

1) Investigate sources of alternate water supply and how residents will access these. This could include identification of reservoirs or temporary reservoirs replenished with hauled water,
2) Arrange for agreements with adjacent municipalities to allow for access by residents or water haulage contractors, and
3) Identify and implement water efficiencies in Municipal operations.

Quinte Conservation

1) Maintain water levels in reservoirs and keep dam infrastructure in good working order,
2) Develop an education program to promote water conservation and recycling through changing people's water habits and consumption rates,
3) Keep municipalities informed of current conditions and seasonal forecast for drought,
4) Keep monitoring network operating and in good working condition,
5) Develop promotional materials for use during low water conditions, and
6) Keep the Low Water Response Team list up to date and maintain regular communications with the group.

4.3.2 Level 1 Drought Action Plan

Level 1 low water declaration indicates that there may be a potential water supply problem and helps provide early warning to watershed residents and the need to begin water conservation. Upon declaring or receiving notice of a Level 1 low water condition, the following actions are to be taken:

Municipalities & First Nation

1) Participate on the Low Water Response Team and report conditions regarding local public water supplies and fire protection capacity,
2) Inform Council of the low water condition including any correspondence and media releases from the Conservation Authority,
3) Initiate a public notification plan to share information about low water conditions, conservation, and recommended water use reduction by 10 percent. This information should promote awareness about essential and non-essential uses and provide tips on how to decrease water consumption,
4) Post notices about the low water condition in municipal buildings and at bulk water filling stations and provide to parties interested in posting these notices (i.e. schools, churches, campgrounds and other recreational use properties) – see Appendix D,
5) Verify that the map of any alternate water sources available for the public is up to date. If this includes surface water features consult with Conservation Authority and provincial agencies, and
6) Verify that any agreements with surrounding municipalities for providing bulk water supply are up to date and in place.

Quinte Conservation

1) Monitor watershed conditions and complete calculations to assess level of low water and ecological flow conditions,
2) Coordinate meeting of the Low Water Response Team to review/discuss conditions and provide recommendations regarding the declaration of a level 1 condition,
3) Prepare press releases and circulate to media, municipal members and public,
4) Post notice of low water condition on Quinte Conservation website and social media feeds along with tips on water conservation and how to deal with drought,
5) Update list of water users based on input from provincial agencies,
6) Review dam operations to prepare for and/or continue low flow augmentation using reservoirs, and
7) Participate and/or coordinate information sessions to help share information and answer questions.

Provincial Agencies

1) Participate on the Low Water Response Team and provide provincial input on conditions and recommended water conservation,
2) Report up to date information on permit holders and water takings, and

3) Communicate to permit holders and water user groups about low water conditions and the importance of water conservation and recommended 10% reduction.

Water User Groups

1) Participate on the Low Water Response Team and report information about water use and local conditions, and
2) Report back to users on low water conditions and conservation requirements,

4.3.3 Level 2 Drought Action Plan

A Level 2 low water declaration indicates that there may be minor water supply problems and there is potential for a serious water supply issue. Upon declaring a Level 2 low water condition the same actions as Level 1 apply in addition to the following recommended actions:

Municipalities & First Nation

Same actions as for Level 1 with additional actions as follows:

1) Continue public notification plan to share information about water conservation, encourage voluntary reduction of water use by 20 percent. **Strongly** discourage non-essential water uses,
2) Post Level 2 notice about the low water condition in municipal buildings and at bulk water filling stations and provide to parties interested in posting these notices (i.e. schools, churches campgrounds and other recreational use properties)-see Appendix D,
3) Update and provide map of alternate water sources for use by public. If this includes surface water features consult with the Conservation Authority and Provincial Agencies,
4) Implement water restriction by laws where deemed appropriate (see Appendix E), and
5) Where possible or in co-operation with the Conservation Authority, plan and implement a public information session to share information about low water conditions, water conservation, and a question and answer period.

Quinte Conservation

Same actions as for Level 1 with additional actions as follows:

1) Hold a meeting with the Low Water Response Team to obtain up to date information on local water supplies. Share and exchange information about low water conditions and calculations. Provide the group a recommendation on moving into a Level 2 low water condition,
2) Document water conservation efforts and water supply conditions as reported by the Low Water Response Team,

3) Provide press release regarding Level 2 conditions with the message regarding voluntary 20 percent water use reduction and **strongly** discourage non-essential water use,
4) Monitor ecological flow conditions and initiate and/or continue low flow augmentation using reservoirs, and
5) Participate and/or coordinate information sessions to help share information and answer questions.

Provincial Agencies

Same actions as for Level 1 with additional actions as follows:

1) Communicate to permit holders and water users groups about low water conditions and the importance of 20 percent water conservation and **strongly** discourage non-essential water use.
2) Participate in information sessions to help share information and answer questions.

Water User Groups

Same actions as for Level 1 with additional actions as follows:

1) Communicate to water user groups about low water conditions and the importance of 20 percent water conservation and **strongly** discourage non-essential water use.
2) Participate in information sessions to help share information and answer questions.

4.3.4 Level 3 Drought Action Plan

A Level 3 low water declaration is the highest level of low water and indicates escalating drought conditions with water supply failing to meet demand. Prior to declaring this level a review of the following is to be completed:

- Records of water conservation efforts taken at the first 2 levels of low water and that user groups have taken these measures,
- Any bylaws that were implemented to restrict non-essential uses,
- Social and economic impacts that have arisen from the low water conditions and restrictions, and
- Recommended priorities and restrictions on water use.

A Level 3 declaration can only be made when moving up from a Level 2 low water condition.

Upon declaring a Level 3 low water condition, the same actions as the first two levels are required in addition to the actions listed below. Actions that promote the supply of water from resilient sources instead of those impacted by drought should be considered. Such efforts will help alleviate problems and promote resilient environmental, economic and social conditions.

Municipalities & First Nation

Same actions as for Levels 1 and 2 with additional actions as follows:

1) Review and implement priorities for water use reductions to achieve a 30 percent reduction,
2) Discuss the need for mandatory water restrictions and where necessary, revise or implement water use restriction bylaws – see Appendix E,
3) Intensify public notification plan to share information about water conservation, and **strongly** encourage water conservation to achieve 30 percent reduction in water use. Continued emphasis on eliminating non-essential uses and provide tips on how to decrease water consumption-see Appendix D,
4) Review and update map of alternate water sources for use by public. If this includes surface water features consult with the Conservation Authority and Provincial Agencies,
5) Review assistance/support programs to assist water user groups impacted by drought,
6) Where feasible or in co-operation with the Conservation Authority, plan and implement a public information session to share information about low water conditions and assist citizens,
7) Promote actions to assist residents, businesses and neighbours (if applicable) in need of water, and
8) If deemed necessary review and or declare a state of emergency.

Quinte Conservation

Same actions as for Levels 1 and 2 with additional actions as follows:

1) Hold a meeting with the Low Water Response Team to review conditions and discuss the declaration of a Level 3 low water conditions,
2) Review actions taken under Levels 1 and 2 as well as information provided by water user groups. Review essential and non-essential water use priorities and based on input from the Low Water Response Team, provide recommendation for mandatory water restrictions if needed,
3) Intensify public notification and press releases regarding Level 3 conditions with the message regarding 30 percent water use reduction and mandatory water restrictions if deemed necessary,
4) Document water conservation efforts and water supply conditions,
5) Continue monitoring of ecological flow conditions and low flow augmentation using reservoirs, and
6) Participate and/or coordinate information sessions to help watershed residents.

Provincial Agencies

Same actions as for Levels 1 and 2 with additional actions as follows:

1) Participate in discussions with the Low Water Response Team and municipalities to assist in decisions required to achieve the desired reduction in water use,
2) If deemed necessary enforce restrictions on permitted water taking permit holders to achieve the required 30 percent water use reduction and **strongly** discourage non-essential water use,
3) Provide information about support programs to assist user groups impacted by drought,
4) Participate in information sessions to help share information and answer questions, and
5) Provide assistance to municipalities if they have declared a state of emergency.

Water User Groups

Same actions as for the levels above with additional actions as follows:

1) Provide input on water use restrictions and reductions to achieve the 30 % reduction,
2) Participate in information sessions to help share information and answer questions.

4.3.5 Post Drought Actions

Following the recovery from a drought the following actions are recommended:

Municipalities, First Nation, Low Water Response Team and Conservation Authority

- Based on recommendation of the Conservation Authority and Low Water Response Team a press release and public notification are to be issued to advise of normal conditions.

All Groups and Agencies

1) Review the impacts of the drought and the effectiveness of the Plan through consideration of the following:
    a. efficiency and effectiveness of communications, information, actions and monitoring,
    b. effectiveness of the water conservation targets, and
    c. effectiveness of maintaining ecological flows.
2) Based on review make updates or revisions to the plan as necessary,
3) Recognise groups or individuals that demonstrated strong water conservation and stewardship activities, and
4) Continue to maintain and protect the water resource through implementation of actions under the Normal Condition Plan.

4.4 Water Use Conflicts

Implementation of voluntary and mandatory water conservation measures conflict may give rise to conflict. This was evident during the 2016 drought event when Quinte Conservation received many calls reporting water users not following recommended actions or taking water from locations that are not normally used. Such can occur more frequently when multiple users are using the same water source within a given region such as in areas that are serviced by private wells. Due to the variability of fractured bedrock some wells are more vulnerable to drought than others and this may be reflected in the water use by individual property owners. To help resolve such conflicts the following actions in order of preference are recommended:

1) Strong public education programs and media releases to ensure everyone is aware of water conditions and the need to conserve water and share the resource. Such programs should aim to help local residents develop an understanding of the water resources of the Quinte area and an appreciation of drought,

2) Adequate bylaws (for non-regulated water use) that help provide guidance on how water use is to be restricted in an effort to promote water conservation. Permits to take water issued by the MECP shall contain adequate conditions that require restrictions on water use under drought conditions,

3) Enforcement of bylaws when necessary to ensure that the rules are being followed. Such enforcement could be a tiered system starting with a warning and progressing to different levels of fines subject to the level of low water conditions, and

4) Investigation by MECP Provincial officers in the event of a water well interference complaint or in possible violation of permit holders for regulated water takings.

5.0 Drought Plan Consultation

Public, municipal and First Nation consultation was held to obtain input on the project and the drought planning process. The activities were conducted simultaneously and the results of both are summarized below.

5.1 Public Consultation

Public consultation was initially planned to coincide with the World Water Day event in March of 2020. This consultation was to consist of three public open houses held throughout the watershed in Napanee, Bloomfield and Belleville. The intent of the open houses was to display poster boards about the project, deliver a brief presentation and obtain input through both verbal discussion and a written survey questionnaire.

Due to the Covid -19 Pandemic all meetings were cancelled and the public consultation was moved online to the Quinte Conservation website. This consultation was conducted over the summer until the end of September 2020 and included elements described below.

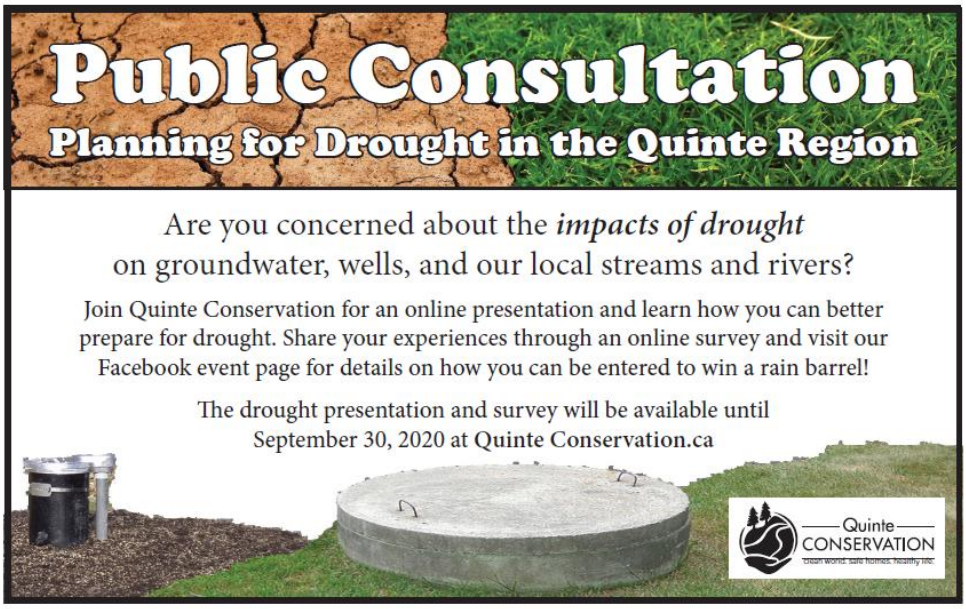
5.1.1 Project Video

A short video about the project was prepared and hosted on the Quinte Conservation website together with a survey questionnaire for watershed residents to provide comments about the project. Both were posted on the website until September 30, 2020. A copy of the presentation is provided in Appendix F.

5.1.2 Advertising for Public Consultation

Newspaper

The following newspaper ad was run in local newspapers over the public consultation period.



The above ad was run in the following newspapers with corresponding dates:

- Napanee Beaver, August 17th and September 14 th, 2020,
- Frontenac News, August 27th and September 3rd, 2020,
- Picton Gazette, August 17th and September 14 th, 2020,
- County Guide, September 3rd and 24 th, 2020,
- Tweed News, August 24th and September 7th, 2020, and
- Community Press, September 3rd and 24th, 2020.

Radio

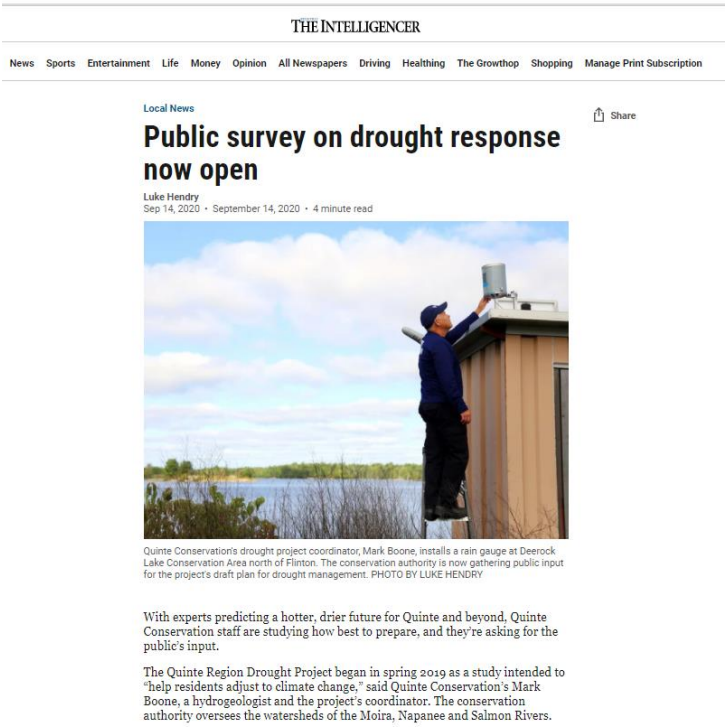
Radio ads promoting the online public consultation were run on 5 different local radio stations during August and September,2020:

- Cool 100 fm and 95.5 Hits fm - Weeks of August 17th and September 14th , 2020,
- Mix 97 fm and CJBQ am - Weeks of August 24thand September 21st, 2020, and
- 91 X - Weeks – August 21 st to September 30th, 2020.

A copy of the radio ad scripts is provided in Appendix F.

Press Coverage

Additional coverage about the project was provided by the press with articles in the Belleville Intelligencer and Community press in September of 2020 as shown below.



THE INTELLIGENCER

News Sports Entertainment Life Money Opinion All Newspapers Driving Healthing The Growthop Shopping Manage Print Subscription

Local News

Share

Public survey on drought response now open

Luke Hendry
Sep 14, 2020 • September 14, 2020 • 4 minute read

Quinte Conservation's drought project coordinator, Mark Boone, installs a rain gauge at Deerock Lake Conservation Area north of Flinton. The conservation authority is now gathering public input for the project's draft plan for drought management. PHOTO BY LUKE HENDRY

With experts predicting a hotter, drier future for Quinte and beyond, Quinte Conservation staff are studying how best to prepare, and they're asking for the public's input.

The Quinte Region Drought Project began in spring 2019 as a study intended to "help residents adjust to climate change," said Quinte Conservation's Mark Boone, a hydrogeologist and the project's coordinator. The conservation authority oversees the watersheds of the Moira, Napanee and Salmon Rivers.

Community Bulletin Boards (digital)

Digital ads were present on the following community bulletin boards during the public consultation period over the months of August and September 2020:

www.lnquinte.ca

www.greenquinte.com

Social Media

A social media campaign was conducted over the months of August and September, 2020 consisting of a total of 24 posts, 10 on Facebook and 14 on Twitter. A total of 909,430 users were reached with 10,933 impressions and 218 engagements.

While there were fewer posts to Facebook than Twitter the Facebook campaign was slightly more successful with an average circulation and view count of around 500 per post. With a total circulation of 5,491 and 5,022 views, the total engagement number was 127. A Facebook event was also run during this time and reached an additional 390 users. To enhance this engagement a draw for a free rain barrel was held with the successful contestant awarded the prize on October 14, 2020.

The Twitter campaign consisted of 14 posts and although the impressions (totaling 5,442) and engagements (totaling 91) were less than those of the Facebook campaign, the reach per post averaged 6,200 users and totaled a staggering 85,921 users. The highest reach for a post during this campaign was 7,911 users.

Websites

The Quinte Conservation website at www.quinteconservation.ca is where the public consultation was conducted by providing details about the project, a link to the project video, drought survey and other drought/low water resources. This information remained on the home page of the website from April to September 30, 2020. The advertising campaign as described above provided links or directed the public to the website for participation in the survey.

5.1.3 Drought Project Survey Questionnaire

From the online consultation a total of 70 responses were provided in the form of completed survey/questionnaires. The responses were generally positive about the project, however concern was expressed about future development in areas with little water, large water takings in drought prone areas, the need for studies to show that adequate water is available and the need for more public education to improve awareness about the water resource, drought and climate change.

One of the questions on the survey related to how information about climate change and drought should be shared with the public. From the responses it appears a multi-pronged

approach is required to communicate with the public. This includes – social media, newspaper, radio, internet, public meetings and interaction with community interest groups.

Overall there was general support for the project with a call for increased public awareness. A copy of the survey and results are provided in Appendix F.

5.2 Municipal & First Nation Consultation

Input from Municipal and First Nation staff on the project was provided by members of the steering committee as well as through circulation of the draft plan to the 18 municipalities within the Quinte Conservation watershed. This circulation was directed to the administrative heads of all municipalities in July 2020 with a follow up completed in October 2020.

Comments were received from the First Nation community and 9 or 50% of the municipalities within the Quinte watershed. Some of the municipalities that responded had no concerns or comments. A total of 33 questions or comments were provided with answers reported directly back to the corresponding municipality. Appendix G contains a summary of the comments.

The comments received ranged from questions regarding data sources to what the implications of the plan would be. Others called for more detail for which the draft plan was amended in order to clarify or provide additional information. Many comments were in support of the project and complimented the work achieved by the Drought Steering Committee. Overall, there was general support for the Plan and it was indicated to be a good resource for reference in times of drought as well as for updating of Official Plans. Recommendations were also provided on how to improve the Plan and were incorporated accordingly.

References

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Department of Fisheries and Oceans, Research Document 2012 Review of approaches and methods to assess Environmental Flows across Canada and Internationally. (Environment Canada Canadian Rivers Institute University of New Brunswick, Fredericton, New Brunswick).

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Appendix A:

Drought Committee Meeting Minutes

DROUGHT STEERING COMMITTEE MEETING # 1 MINUTES

Prepared By: Mark Boone

Meeting Time: October 30th, 2019 at 10:00am

Location: Quinte Conservation large boardroom

Attendees: Andy Margetson (phone), Becky MacWhirter, Brad Roach, Christine McClure, Justin Harrow, John Gooding, John Thompson, John Wise, Kyle Stephenson, Lawrence O'Keefe, Leanne Latter, Matt Richmond, Nicole Storms, Scott Bates (phone), Victor Castro.

Regrets: Perry Decola, Peter Doris

Summary: The purpose of the meeting was to provide an overview of the drought management project, background information about the Quinte Region Water Budget, and to initiate discussions about Drought Management Plans.

Project Overview

- The Drought Management Project is funded through the Federation of Canadian Municipalities as part of the Municipalities for Climate Innovations Program. The total funding is $ 250,000.
- The main objective of the project is to help municipalities and watershed residents adapt to climate change though preparation of drought management plans and share information about the changing climate.
- There are several components of the project which include:
    - Improving monitoring to forecast droughts,
    - Install lake level gauges which may act as storage reservoirs,
    - Engage citizen scientists to help monitor the climate and share knowledge,
    - Improve communications about watershed monitoring and climate change,
    - Develop a drought management plan template for implementation by municipalities,

- Discussion included the engagement of citizens in reporting dry wells or drought conditions,
- The question was asked is there a way to assess the susceptibility of wells to drought. The answer was generalised by indicating that shallow wells are more prone than deeper wells.
- Future development applications should be reviewed in view of future climate/drought conditions.
- It was mentioned that crop insurance programs maintain a network of rain gauges that could be utilized. One of these gauges is located on a committee member's property.

Quinte Region Water Budget

- An overview of the Quinte Region water budget was provided. This work was an update of that completed under the Source Water Protection program and included:

    - A review of the water budget for average climate conditions (1981-2010), the 2016 drought year, and future climate conditions (2011-2040),
    - Determination of the water budget using a GIS model to calculate evapotranspiration, direct runoff, and groundwater recharge,
    - Approximately 2/3 thirds of annual precipitation is used by evapotranspiration leaving one third available for runoff and groundwater recharge (of which 8% recharges the deeper groundwater aquifers)
    - Review of water demand for the various water use activities of the Quinte Region was provided including the MECP Permit to Take Water Database,
    - The potential hydrologic stress was reviewed based on surface water catchments through determination of monthly water demand for both surface and groundwater,
    - Areas of potential hydrologic stress were identified and appear to correlate with locations of permits to take water. Increasing levels of stress were noted for the drought scenario.
    - An assessment of future climate conditions indicated increased temperature will result in increased evapotranspiration and reduced quantities of both groundwater recharge and surface water runoff (approximate 10% reduction). These changes are predicted to result in hotter and drier summers.
- Discussion was held over the permits to take water and if the values used in the assessment were representative of actual. A limitation was those permits that indicated the water source as from both surface and groundwater as certain assumptions had to be made. The MECP committee members indicated that they could provide more information about these permits to refine the assessment.
- The water budget work is being peer reviewed and when comments are received updates will be completed and this document will be available as a resource to assist in drought planning.

Drought Management Planning

- An overview of potential things to consider in a drought management plan was provided which includes:
    - Drought forecasting,
    - Identification of alternate water sources,
    - Water uses restriction bylaws,
    - Water conservation,
    - Future development ,
    - Environmental protection.

- Discussion was held regarding the need for and effectiveness of water use restriction bylaws. It was indicated that the best approach would be public education as opposed to bylaw restrictions as in small municipalities it is difficult to enforce these rules. The engagement of citizen scientists and public stewardship groups was thought of as a potential means of spreading the word about drought and informing residents about water conservation. However, bylaws are needed in some cases where public education is not effective.

- The content of bylaws and authority of municipalities to restrict private water well users and taking of water for livestock watering was discussed. More research into the authority of municipalities to do this is required.
- The MECP committee members indicated that the permits to take water contain provisions to promote water conservation as well as some restrictions that are tied to the level of low water conditions for the region.
- Discussion was held regarding the use of lakes as reservoirs to augment flows in rivers. The installation of lake gauges are intended to help with this process however a review of environmental flow requirements in the local waterways needs to be completed. A consultant may be engaged to complete this review as part of the drought project.
- Recommendation was provided to look at other existing drought management plans. This will be completed.
- Discussion was held regarding the inclusion of the requirements to declare a state of emergency in a drought plan. It was indicated that the provincial regulations have limitations in regards to states of emergency as a drought is not recognised a natural hazard. This was thought not to apply to municipal drinking water systems but has limitations in regards to private well users. Further research is required as to the rights of private well users as well as how to declare a state of emergency in the midst of a drought. The availability of water for fire protection also needs be considered for areas that are vulnerable to drought.
- The consideration to drought and drought sensitive regions needs to be considered in regards to plans for future development in order to reduce the vulnerability of future residents to impact from drought. Other municipalities in the region are completing reviews of servicing options for future development with consideration to communal servicing and cluster developments. A committee member indicated that private services subdivisions are on the down turn and that hydrogeological studies are being requested in support of severance applications.
- A committee member asked of the other members who represent municipalities if they have completed climate change adaptation plans. This member offered to share the results of a recently completed plan to help benefit other residents of the Quinte Region.

Next Steps

- Committee members are encouraged to communicate their thoughts of the content of a drought plan or any other items related to drought.
- Quinte Conservation is to work on the development of a draft drought management plan template.
- The draft is to be circulated in advance of the next committee meeting which is to be scheduled for the spring of 2020.
- **Do not hesitate to reach out should you have any questions, concerns or comments regarding the project.**

Thank you for participating and contributing to this important initiative!

DROUGHT STEERING COMMITTEE MEETING # 2 MINUTES

Prepared By: Mark Boone

Meeting Time: May 26, 2020 - 10:00-11:30 am

Location: Via online Zoom Meeting

Attendees: Becky MacWhirter, Brad Roach, Christine McClure, John Gooding, Kyle Stephenson, Lawrence O'Keefe, Leanne Latter, Matthew Richmond, Scott Bates, Victor Castro, Peter Doris, Dustin Carey (FCM) Brad McNevin.

Regrets: Perry Decola, John Wise, John Thompson, Justin Harrow, Nicole Storms, Justin White.

Summary: The purpose of the meeting was to provide an update on the drought management project, including action items from meeting number 1, summary of public consultation, and an overview of the draft Drought Management Plans.

Action Items from Meeting Number 1

- The results of additional work completed to identify drought vulnerable areas throughout the watershed was presented. This included a review of the assessment of well vulnerability, groundwater reliance and overall drought impact risk on a municipal boundary scale.
    - A question was asked if the drought risk mapping could be shared and the answer was yes as this mapping is to be included as part of the public consultation and Drought Plan.
- Additional research was completed into the ability of Municipalities to pass bylaws that restrict the water use of private wells. It was found that Municipalities may pass such bylaws if it is in the broader interest of the public within the municipality. However such bylaws must not interfere with Provincial jurisdiction.
    - A question was asked if this would apply to agricultural takings from surface water for the watering of livestock. Discussion indicated that such a taking would not be any different than the use of a private well for domestic purposes and that such uses are not regulated by the Ontario Water Resources Act. A member of the committee is to review this and provide additional input as to whether such municipal bylaws can restrict agricultural takings for watering of livestock. Such information is to be included in the plan to clarify what municipal bylaws can and cannot do.
- A low flow optimisation study has been started to evaluate the use of reservoirs in the Quinte watershed for augmenting low flows. This project is being completed by a research and development firm called Aquanty. A pre-existing model called hydrogeosphere is being used for this work.

- The installation of Lake and Precipitation Gauges is to continue this summer. The data from these gauges as well as the Water Survey Canada stream gauges will be shared with the public through a mapping utility on the Quinte Conservation website.
- An updated list of Permits to Take Water was provided by MECP. This list is to be reviewed and compared with those used by Quinte Conservation in the original water budget work.

Public Consultation

- Plans for consultation were made to hold three public meetings in the latter part of March of this year. These meetings were to be held throughout the watershed in Napanee, Prince Edward County and Belleville. However due to the current Pandemic all meetings were cancelled. To continue with consultation a survey about the project was posted on the Quinte Conservation website to allow for public input.
- At the time of this meeting Quinte Conservation had received 20 responses to the survey. The responses on the survey were generally positive and shared with the committee.
- One of the questions on the survey related to how information about climate change and drought should be shared with the public. A common response was through the use of various types of media such as radio, tv, newspapers, website and social media. In view of the current pandemic there is uncertainty if public in person meetings can be held to allow consultation with the public. Therefore to proceed, Quinte Conservation is going to produce a short video about the project to be hosted on the Quinte Conservation website. An advertising campaign though radio, newspaper and social media will be conducted to promote the project and ask for input through the Quinte Conservation website. This campaign is to be conducted over the summer months until September. The comments are to be reviewed and incorporated into the drought plan.

Draft Drought Plan

- An overview of the content of the draft drought management plan was provided including information about dealing with drought in the Quinte Region, priority of water use, and the roles and actions of the various agencies involved in drought planning/response.
    - A question was asked about the drilling of wells deeper as a means of trying to obtain more water. The fear is that such wells could intercept water of unacceptable quality (i.e. salt). It was reported that there are restrictions on the levels of salt in new wells as specified in Ontario Regulation 903. If the levels are above this limit then the well must be decommissioned. This information is to be added to the drought plan. Additional information about managing your well in your well in times of drought is also to be added to the Plan and may include MECP fact sheets in the appendices of the plan.
    - A question was asked about the availability of groundwater for new development and the testing requirements for severances. A committee member indicated that such testing was completed near her personal home which include monitoring of the wells, however that the testing was completed in the spring when the water table is high. Discussion of this type of testing was held and it was indicated that this is not representative of at least average conditions. The wording of the drought plan is to include a description of when such testing should be completed.

- A question was asked why agricultural irrigation was listed as an important water use as opposed to essential. Explanation was provided that important uses relate to the economic and social wellbeing of an area whereas essential uses are restricted to those related to drinking water, health protection and fire protection.
- Discussion was held about uniform application of water conservation measures throughout the watershed during a drought event. It was indicated that such restrictions should be watershed wide but also that water uses from sources that are more sustainable shouldn't be penalised. Such differences would need to be communicated carefully through the municipal communication process.
- MNRF indicated that they have been reviewing the low water response program and have completed work on emergency management measures during a drought event. This information is to be shared with Quinte Conservation for consideration in the drought plan. Additional consultation with the Community Emergency Management Coordinators group may be required to discuss such measures. Further contact with the Municipal fire chiefs is also to be conducted to discuss contingency plans for alternate water sources during a drought.

Next Steps

- Lake and Rain Gauge Installation over the summer months,
- Public Consultation over the summer months,
- Update of the draft drought plan,
- Drought Committee Meeting Number 3 in October of 2020 to discuss public consultation and updated plan,
- **Do not hesitate to reach out should you have any questions, concerns or comments regarding the project.**

Thank you for participating and contributing to this important initiative!

DROUGHT STEERING COMMITTEE MEETING # 3 MINUTES

Prepared By: Mark Boone

Meeting Time: November 25, 2020 - 10:00-11:30 am

Location: Via online Zoom Meeting

Attendees: Becky MacWhirter, John Gooding, Kyle Stephenson, Lawrence O'Keefe, Leanne Latter, Matthew Richmond, Scott Bates, Victor Castro, John Wise, John Thompson, Brad McNevin.

Regrets: Perry Decola, Justin Harrow, Brad Roach, Nicole Storms, Peter Doris, Justin White.

Summary: The purpose of the meeting was to provide an update on the drought management project, including the results of public consultation, municipal staff input and next steps.

Action Items from Meeting Number 1

- Proceed with public and municipal staff consultation and lake level gauge installation.

Public Consultation

- Initial plans for public consultation were to hold three public meetings in the latter part of March of this year. These meetings were to be held throughout the watershed in Napanee, Prince Edward County and Belleville. However due to the current Pandemic all meetings were cancelled.
- Public consultation was conducted online (Quinte Conservation website) over the summer months until the end of September. This included preparation of a short video about the project and a questionnaire for watershed residents to provide comments about the project.
- To promote the project radio ads were run on 4 different local radio stations over August and September. Newspaper ads were run in the Napanee Beaver, Frontenac News, Picton Gazette, County Guide, Tweed News and the Community Press. Promotions were run on social media including a draw for a rain barrel. Additional coverage about the project was provided by the press with articles in the Belleville Intelligencer and Community press.
- A total of 70 responses were provided in the form of completed questionnaires. The responses were generally positive about the project, however concern was expressed about future development in areas with little water, large water takings in a drought prone areas, the need for studies to show that adequate water is available and the need for more public education to improve awareness about drought and climate change.
- One of the questions on the survey related to how information about climate change and drought should be shared with the public. From the responses it appears a multi pronged

approach is required to communicate with the public. This includes – social media, newspaper, radio, internet, public meetings and interaction with community interest groups.

- A section on public consultation will be added to the Drought Plan

Municipal Consultation

- The draft drought plan was circulated to municipal staff for comments in July and September for input. Approximately half of the municipalities provided comments which were generally positive.
- Discussion was held over the definition of drought and based on input from the committee the definition of drought for this project was determined as follows:
  "A prolonged period of below normal precipitation, stream flow and groundwater that can result in disruption of water supply to a range of users".

- One of the municipal comments was in regards to proving more detail regarding hydrogeological studies as to when, how and where these studies should be requested. It was generally indicated that this would be beyond the scope of the drought project but discussion with the group indicated that there may be good examples of hydrogeological testing guidelines out there that could be reviewed and possibly considered. A section on hydrogeology testing will be added to the drought plan.
- Other municipal comments provided expressed concern regarding specifying the time of year for hydrogeological studies. This is an important consideration for drought prone areas as testing wells at the high time of year (i.e. spring) may not provide a reasonable representation of the future water supply at other times of the year.
- A concern was also expressed regarding messaging during low water conditions. The intent of the plan was to provide a guide for how these messages are delivered. The messaging from the low water response team is delivered on a watershed wide basis, however it is understood that messaging form municipalities may differ and this would be determined on an individual basis.
- Municipalities that did not provide feed back are to be contacted.

Monitoring Equipment

An update on monitoring equipment (lake and precipitation gauges) was provided. A demonstration of the water level viewers website was attempted but could not be shown. A link to this viewer was sent out to the group for viewing.

General Questions/Comments

A question/comment was asked about cisterns and grey water if such systems were permitted under the building code and what the maintenance requirements might be to ensure that people using these systems are not drinking unacceptable water.

- A section is to be added to the drought plan to specify more detail about these systems including maintenance requirements.

A question/comment was made about the proposed changes to the Conservation Authorities Act and if this would impact the Conservation Authorities ability to implement the drought program.

- It was indicated that this project was funded through the Federation of Canadian Municipalities and that letters of support were provided by member municipalities to access the funding. Discussion was held regarding the proposed changes and the specification of core mandate programs which may not include drought. Delivery of programs outside the core mandate will require an MOU with each individual municipality.

Some discussion was held about large water takings and the need to consider agricultural use. It was indicated that municipalities don't always have the legal ability to request hydrogeological studies for such takings. Large takings over 50000 litres/day are the responsibility of the MECP.

Next Steps

- Finalise plan by including public and municipal comments,
- Add information about watershed model and reservoir operations,
- Add additional detail about hydrogeological studies,
- Approach municipalities that have not commented,
- Send the Plan out to municipal councils in January.
- **Do not hesitate to reach out should you have any questions, concerns or comments regarding the project.**

Thank you for participating and contributing to this important initiative!

Appendix B:

Watershed Model Report

Assessment of Reservoir Influences on Low Surface Water Flow Conditions in Quinte Region Watersheds

Report Submitted to:

Quinte Region Conservation

Production Date: Feb 18, 2021

aquanty
HYDROSPHERE ANALYTICS

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Waterloo, ON, N2L 5C6

TABLE OF CONTENTS

1.0 SUMMARY

This project has focused on upgrading the HydroGeoSphere (HGS) model for the Quinte region watersheds (Figure 1), and then applying the model towards an assessment of reservoir influences on low surface water flow conditions, and to develop optimization strategies to mitigate low flow conditions.

The following tasks have been completed as part of the project.

- Update the 3D finite element mesh for the Quinte HGS model.
- Add dams and reservoirs to the model.
- Add PGMN wells to Quinte model (coinciding with a parallel MECP project).
- Upgrade river network representation in the model.
- Review 3D permeability-field mapping.
- Assemble climatology data for historic (2011 – 2018) reanalysis and model calibration.
- Conduct 2011 – 2018 daily transient calibration simulations.
- Evaluate model performance via visual and statistical metrics.
- Evaluate the sensitivity of down stream surface water flow rates to individual and multiple dam operations.
- Evaluate the sensitivity of surface water flows to droughts of increasing severity.
- Evaluate the influence of modified reservoir management on surface water flows during drought conditions.

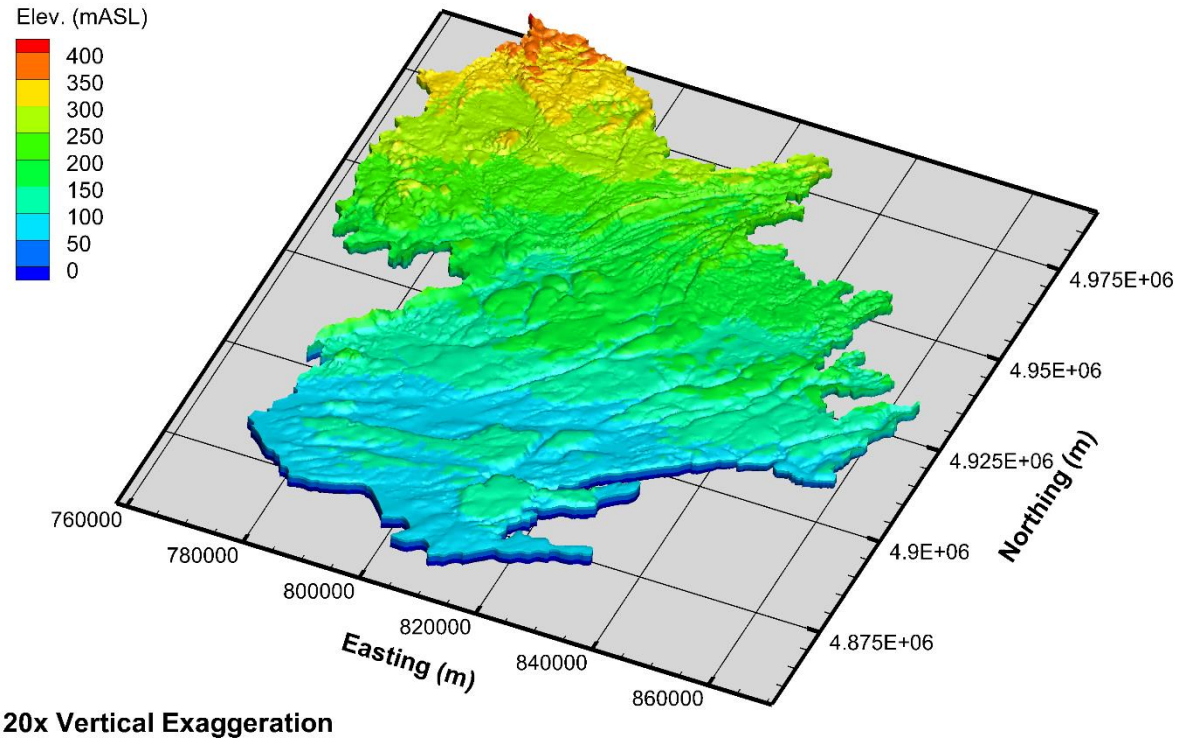

Figure 1. Three-dimensional perspective of the HydroGeoSphere model for the Quinte Region Conservation Authority management area. Note that part of the neighbouring Cataraqui Conservation Authority management area is also incorporated into the model domain.

2.0 BACKGROUND

Climate change impacts are being observed in the Great Lakes basin. Some of the most evident impacts include warmer water, changing precipitation patterns, decreased snow and ice coverage and increased evaporation (Hunter et al., 2015, Austin and Coleman, 2007). Dynamic changes in surface water and groundwater, and their interaction, are part of the hydrologic implications of climate change. Building a fully integrated surface water-groundwater model that can consider the full hydrologic cycle under a wide range of weather conditions will facilitate a better understanding of potential climate change impacts on water resources and will provide information to help with developing adaptation and resiliency strategies.

Groundwater is a key component of the entire hydrologic cycle. Climate impacts to groundwater impact ecosystem health in the Great Lake basin and many facets of Ontario's society and industry, as it is well known that groundwater is heavily relied upon. For example, prolonged droughts can significantly reduce groundwater discharge into streams, which is detrimental to stream levels, surface water temperatures, and aquatic habitats; as well as lowering regional groundwater levels which affects human and agricultural water supply.

Due to its inherent complexity, groundwater changes are influenced and buffered by several factors, such as precipitation, snow melt, evaporation, transpiration, interactions with surface water, and subsurface heterogeneity. Up until recently, incorporating all the aspects of the hydrologic cycle into a modelling tool that can capture the behavior of the groundwater component of the system in regions with complex subsurface hydrostratigraphy, such as the watersheds of the Great Lakes region in Southern Ontario, has not been feasible. However, with advances in computational methods/capacity, and availability of improved data collection networks (climate, surface water and groundwater), it is now possible to construct fully integrated groundwater – surface water simulation tools for watershed scale (~5,000 to 10,000 km^2) investigations.

It is the objective of this project to develop a fully integrated surface water – groundwater model for the Quinte region watersheds with the HydroGeoSphere (HGS) software platform, and then apply the HGS model towards an assessment of how reservoir management can influence low surface water flow conditions. This project expands upon previous work where a HGS model for the Quinte region was constructed as part of the HGSRT experimental forecasting platform for Southern Ontario.

3.0 MODEL DEVELOPMENT

3.1 Watershed Boundary

The model boundary for the Quinte watershed was updated to fully cover the area of the watersheds managed by Quinte Conservation. Figure 2 shows a comparison of the Ontario Tertiary watersheds dataset and the watershed areas managed by the conservation authority.

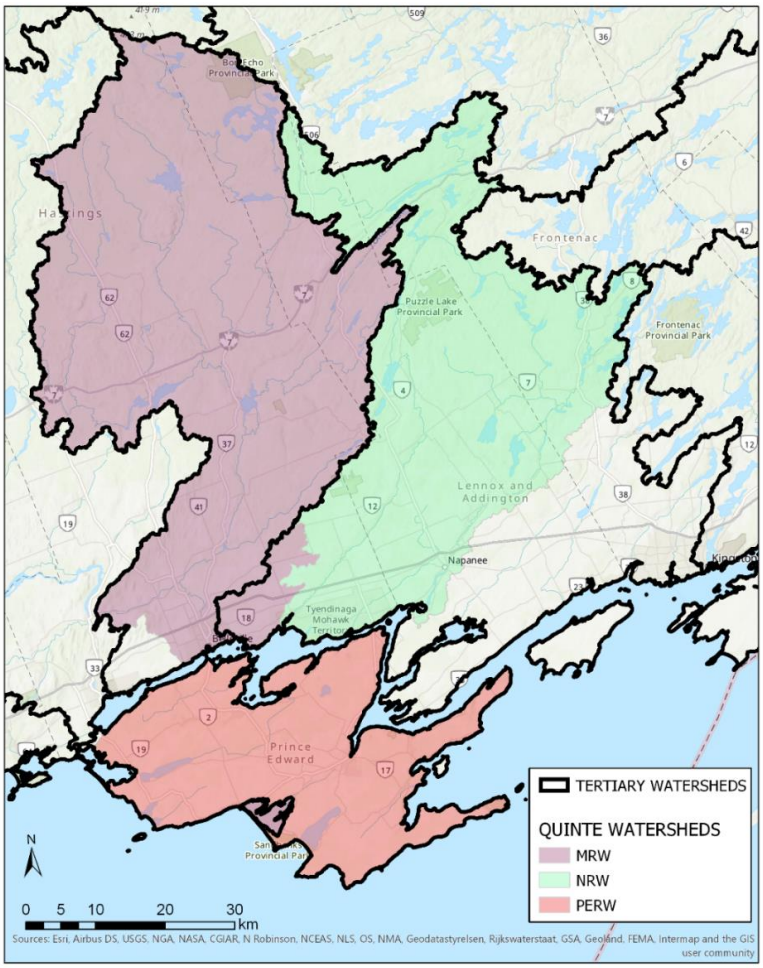

Figure 2: Map comparing watersheds from the Ontario Tertiary Watersheds dataset (black outlines) with coverage areas of watersheds managed by Quinte Conservation (shaded areas). MRW: Moira River, NRW: Napanee River, and PERW: Prince Edward County watersheds.

The updated Quinte model boundary (Figure 3) was created by merging the Ontario Tertiary watersheds so that the Quinte watersheds were fully contained. After merging the outlines from the tertiary watersheds the vector data was manually modified to connect into one area that includes the Bay of Quinte between Prince Edward County and the mainland.

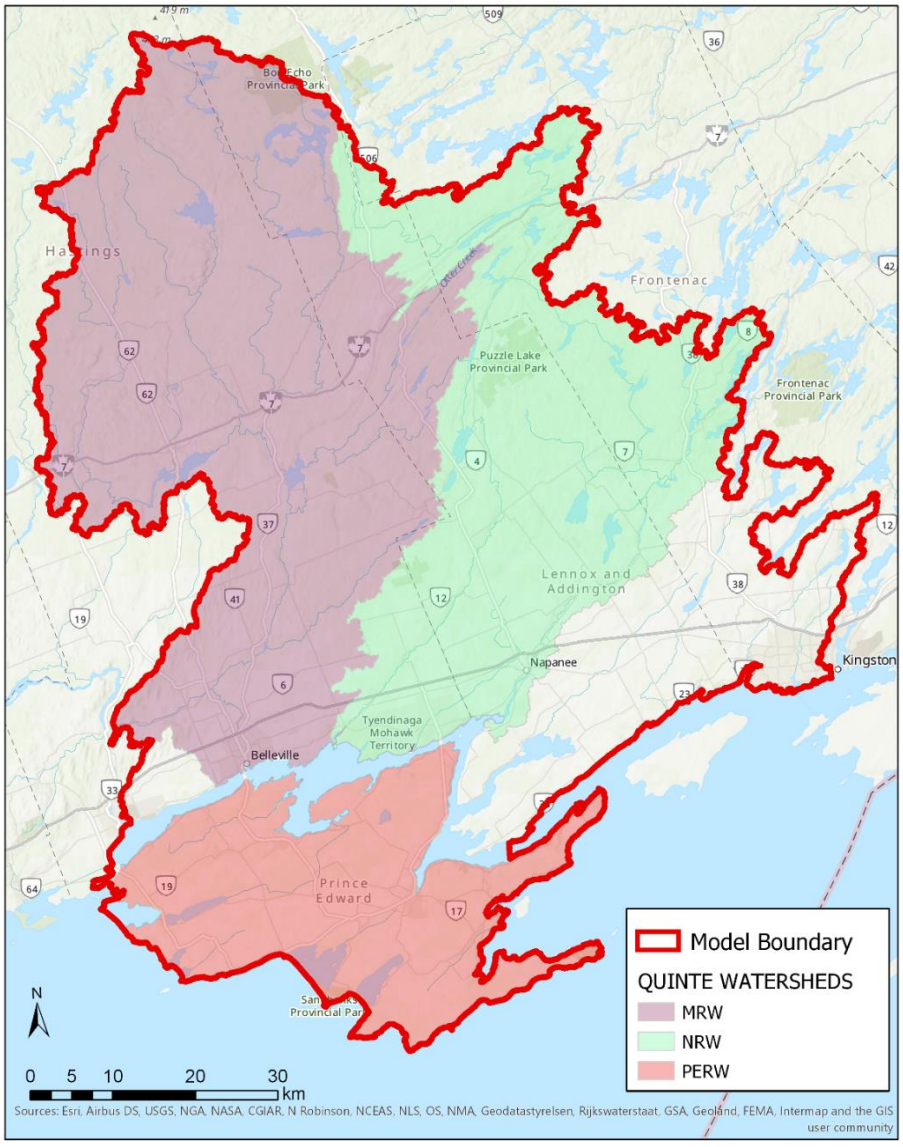

Figure 3: Map showing the model boundary (red outline) created by modifying the Ontario Tertiary Watersheds dataset to create one boundary that encloses all the Quinte watersheds (shaded areas). MRW: Moira River, NRW: Napanee River, and PERW: Prince Edward County watersheds.

3.2 Digital Elevation Model (DEM)

The updated DEM used the Ontario Integrated Hydrology dataset DEM stitched together with the NOAA bathymetry for the bay between Prince Edward County and the mainland and inland lake bathymetry provided by Quinte Conservation. The final stitched version (Figure 4) of the DEM is at 30m resolution in UTM 17N projection.

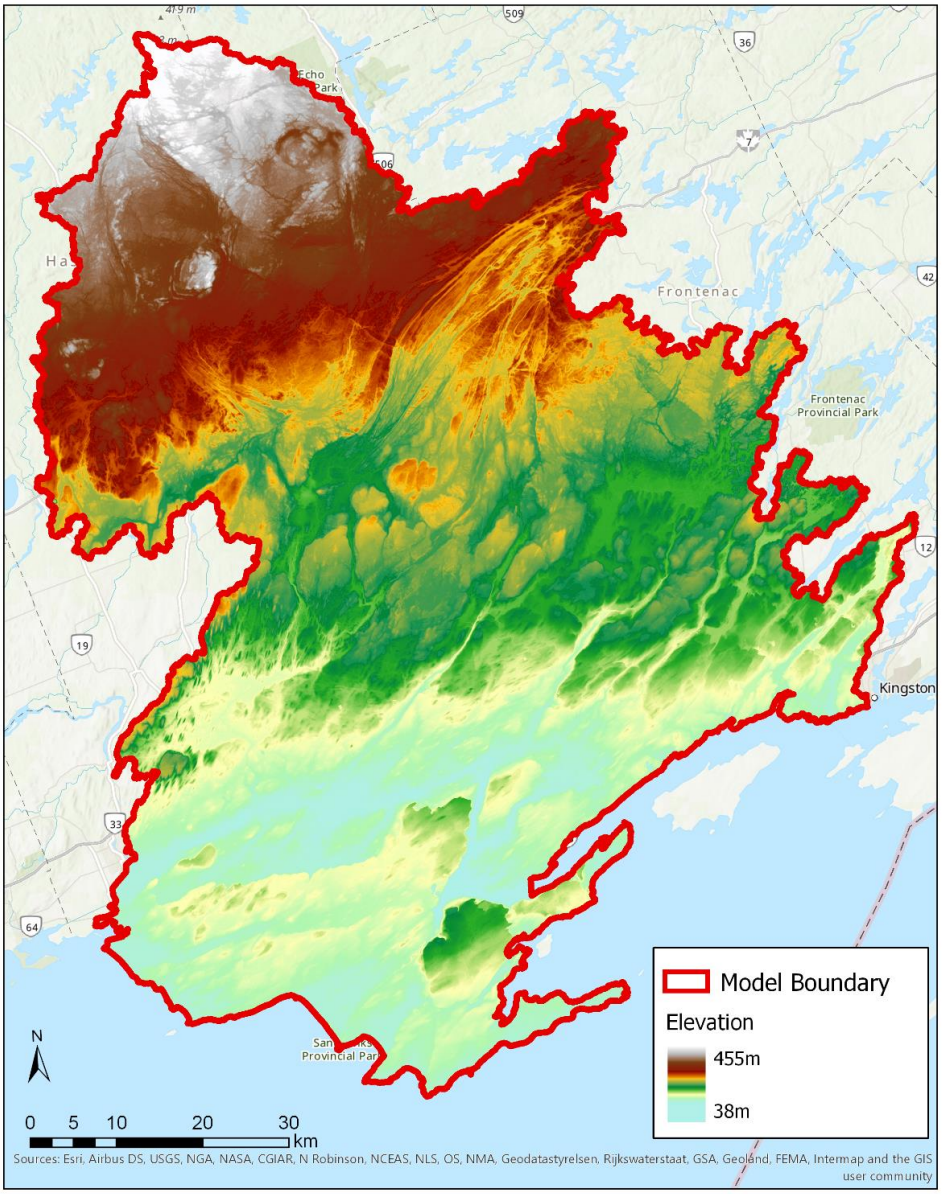

Figure 4: Stitched Ontario Integrated Hydrology DEM, NOAA bathymetry, and inland lake bathymetry from Quinte Conservation. Resolution 30m in UTM 17N.

3.3 Inland Lake Bathymetry

The bathymetry raster for the 12 inland lakes incorporated into the model (Figure 5) was generated using data for the water body outlines, depth contours and reference elevations provided by Quinte Conservation. These contours were then converted to a depth raster using the topo-to-raster tool in ArcGIS with the water body shapefile as the interpolation boundary. The depths were then referenced against the provided reference elevation (Table 1) for each lake to create an elevation raster, which was then stitched into the DEM. In the case of Roblin Lake and Stoco Lake, no reference elevation was provided, so an elevation for the shoreline was chosen based on the DEM. Lake bathymetry is presented in Figure 6, Figure 7, and Figure 8.

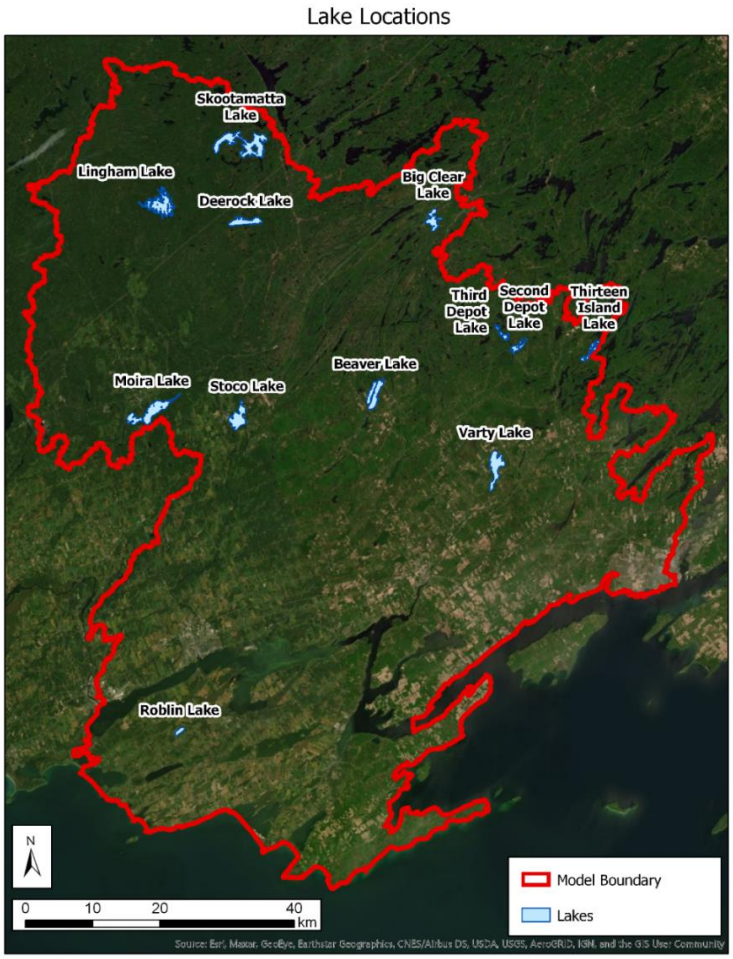

Figure 5: Locations of lakes with bathymetry to add to DEM.

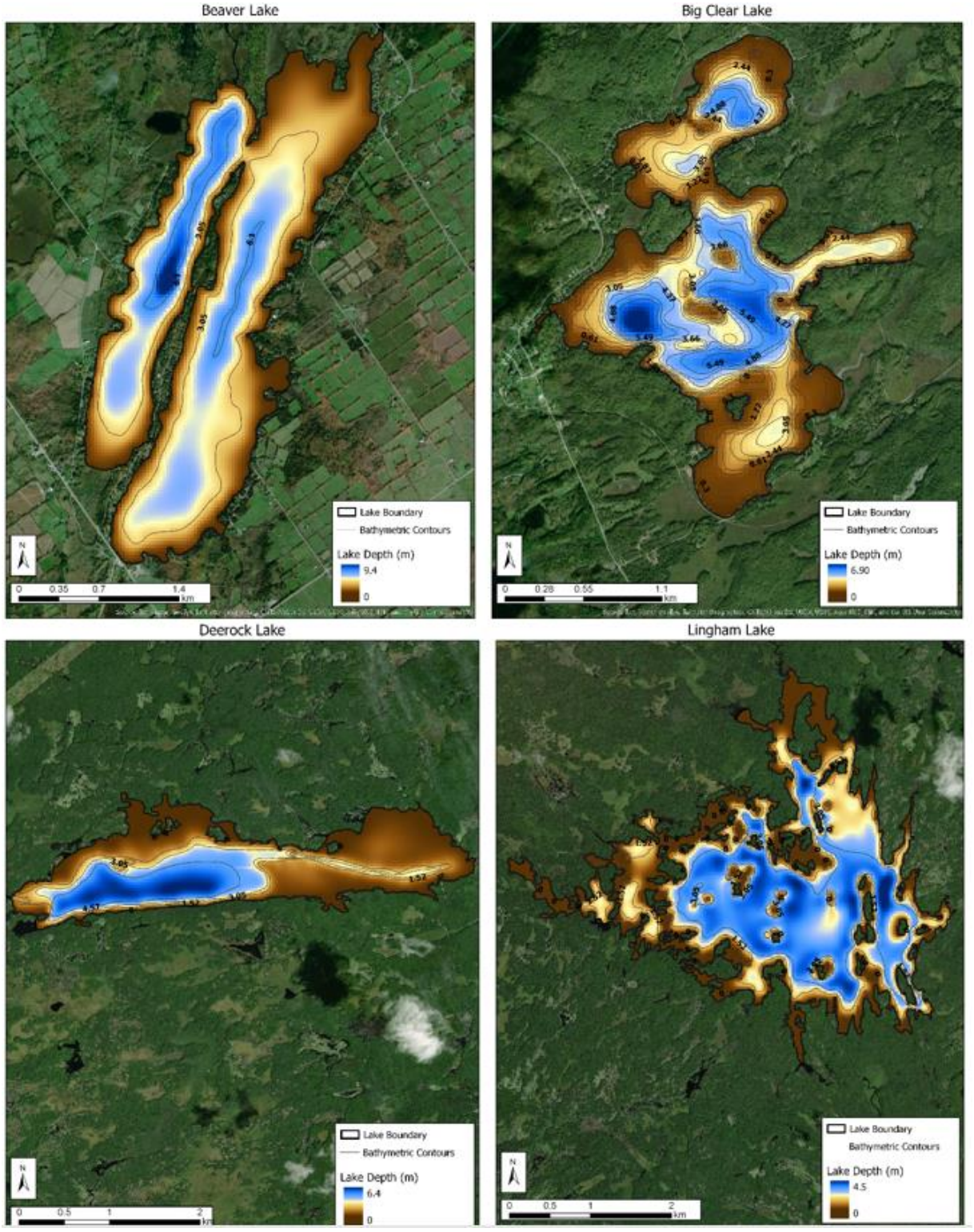

Figure 6: Bathymetry for Beaver Lake, Big Clear Lake, Deerock Lake, and Lingham Lake.

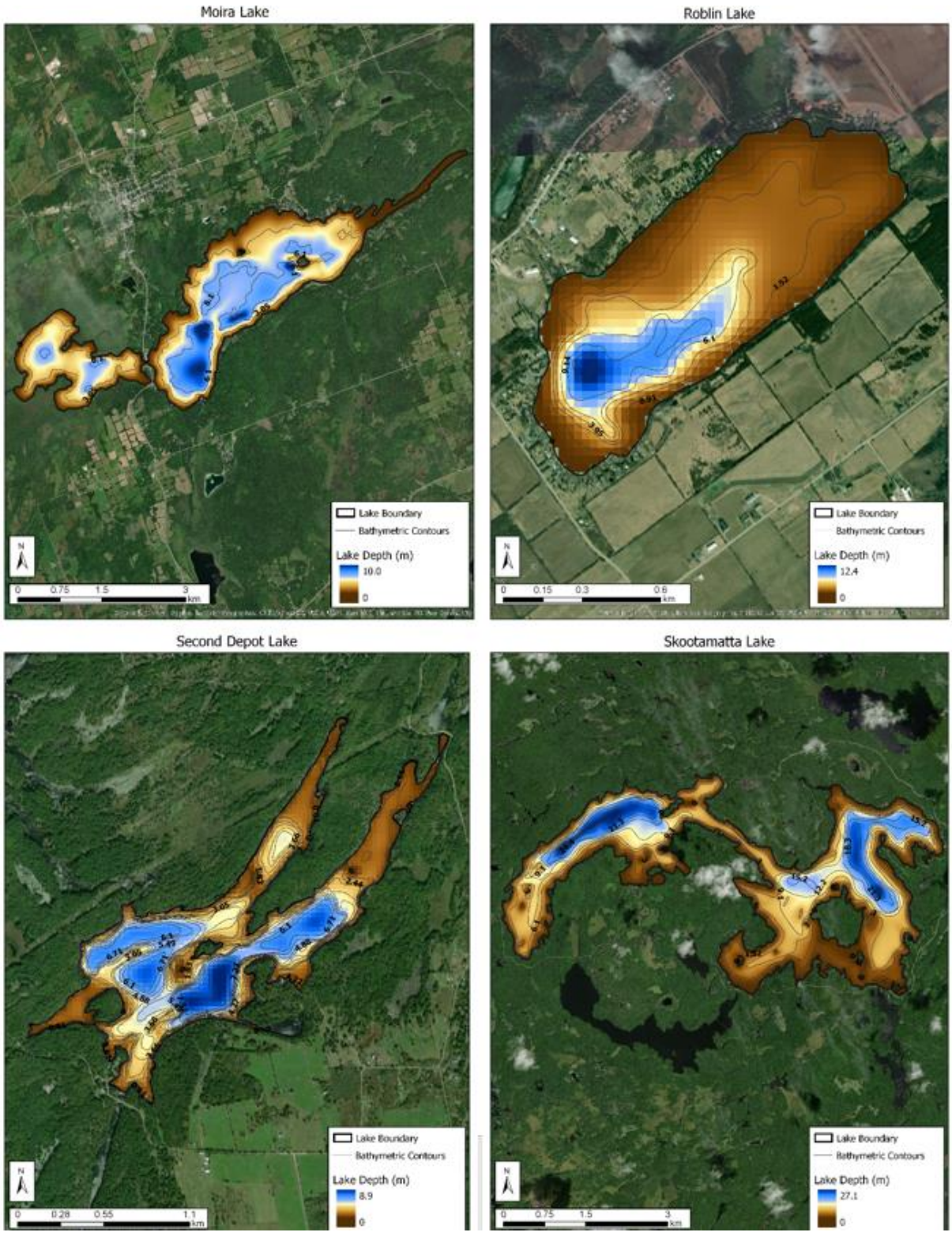

Figure 7: Bathymetry for Moira Lake, Roblin Lake, Second Depot Lake, and Skootamatta Lake

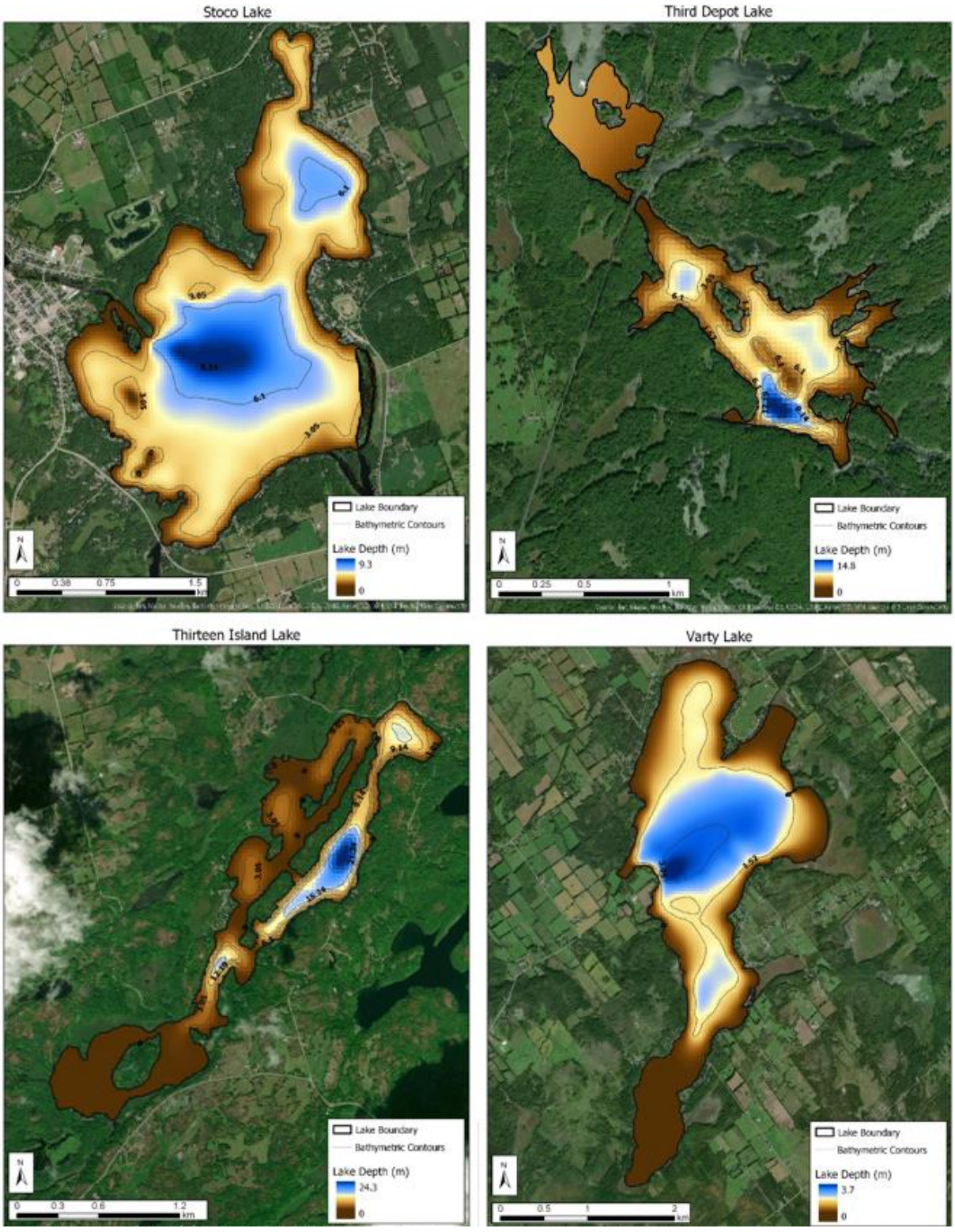

Figure 8: Bathymetry for Stoco Lake, Third Depot Lake, Thirteen Island Lake, and Varty Lake.

Table 1: Reference Elevations for Quinte inland-lake bathymetry. Values in "Reference Shoreline Elevation (m)" were provided by Quinte Conservation. The DEM-based shoreline elevation values were extracted from on the Ontario Integrated Hydrology DEM.

	Lake/Reservoir/Dam	Reference Shoreline Elevation (m)	Elevation from DEM (m)
1	**Beaver**	167.0	
2	**Big Clear (Arden Dam)**	196.6	
3	**Deerock**	259.1	
4	**Lingham**	278.0	
5	**Moira (Downey's Weir)**	154.8	
6	**Roblin**	unknown	111.0
7	**Second Depot**	158.3	
8	**Skootamatta**	289.6	
9	**Stoco (Caton's Weir)**	unknown	131.9
10	**Third Depot**	167.0	
11	**Thirteen Island**	150.6	
12	**Varty**	141.5	

3.4 Dam Locations

The dams (Figure 9) provided by Quinte Conservation were processed and included as control points for mesh generation. The dataset contains 43 dams which were built into the finite element mesh; however, only a subset of these, which are associated with the 12 inland lakes, currently have their operational hydraulic characteristics configured into the model. HGS facilitates reservoir simulation via either time varying controls on spillway elevation or numerical boundary conditions that treat the reservoir as offline water storage. In the case herein, boundary conditions were used to control the reservoirs, with water accumulation governed by a specified minimum surface water depth threshold (so that a minimum flow can be maintained), specified live (active) storage capacity, and a maximum accumulation rate. Water release is controlled by a user-specified time-series (time vs. release rate) data set, with release being contingent on water availability in the reservoir.

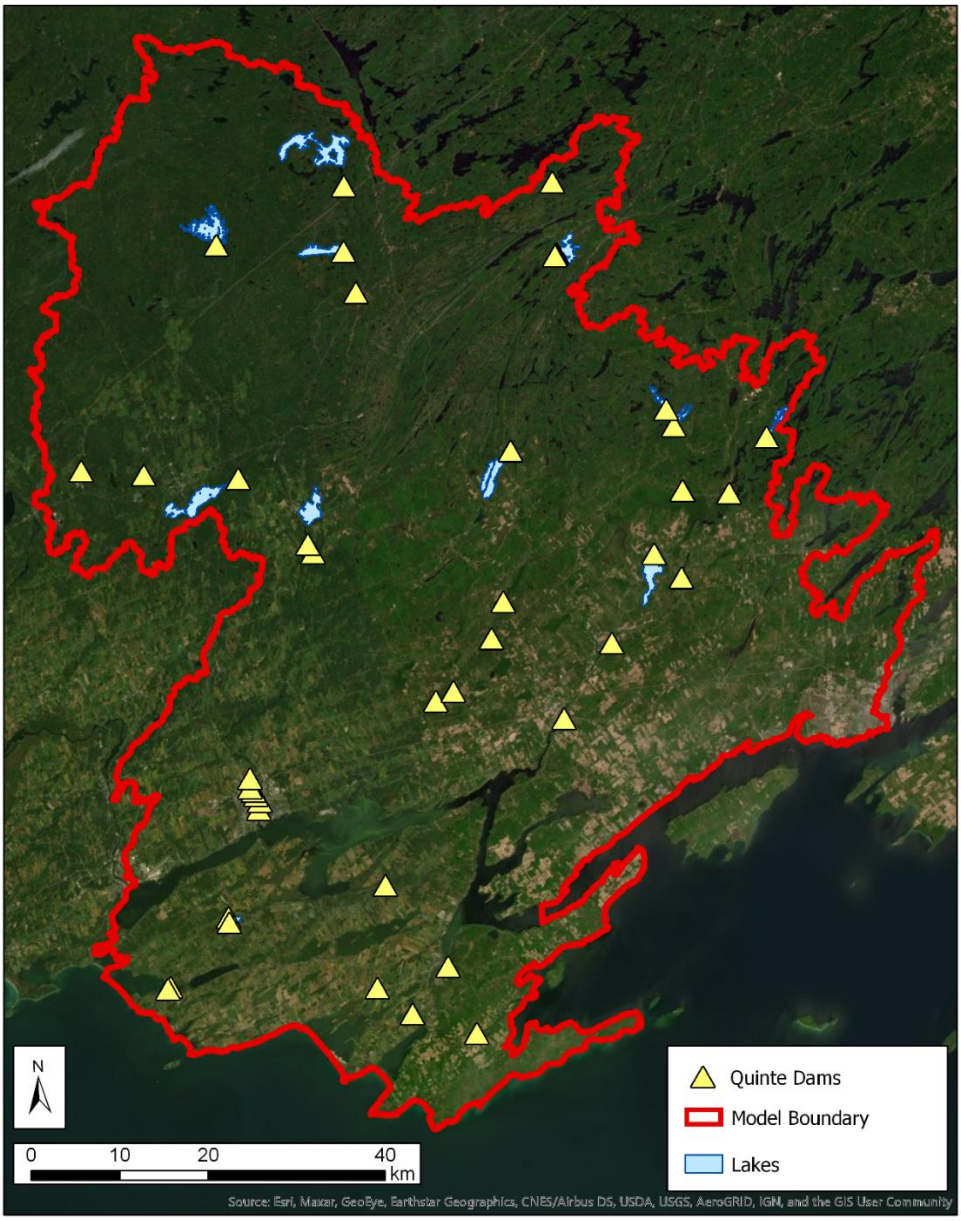

Figure 9: All dam locations provided by Quinte Conservation.

3.5 Well Locations

All PGMN wells that fall within the boundary were built into the model finite element mesh. This includes wells that are currently monitored as well as those that are not. There are 33 PGMN wells that fall within the model boundary (Figure 10).

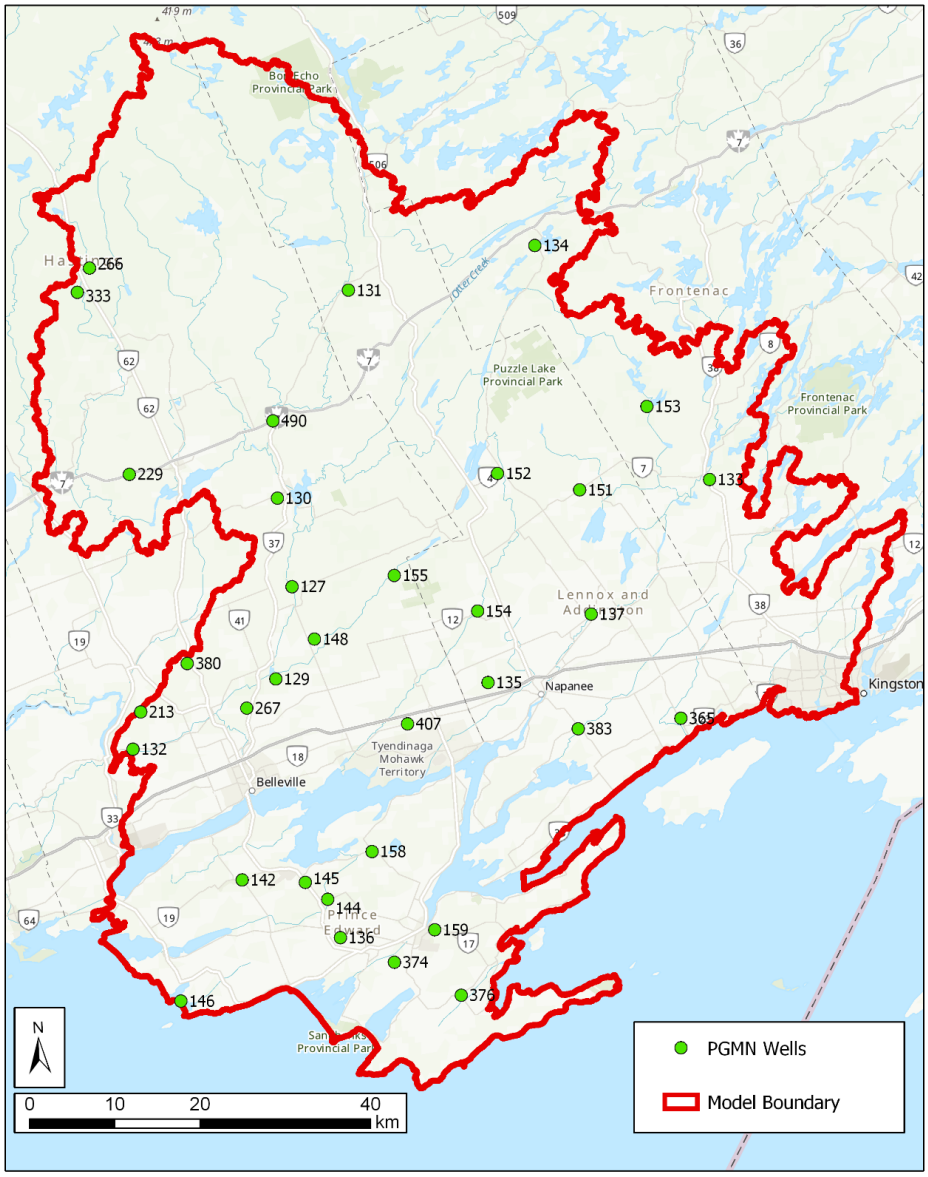

Figure 10: Locations of all PGMN wells within model boundary. PGMN Well ID is W0000 and the map label number. Example: on the map, well 152 is PGMN Well ID W0000152.

3.6 Stream Geometry Update

Streams geometry was obtained from the Ontario Integrated Hydrology Dataset. Streams of Strahler Order 2 or higher that fell within the model boundary were exported and saved in UTM 17N projection for use in FEM generation (Figure 11).

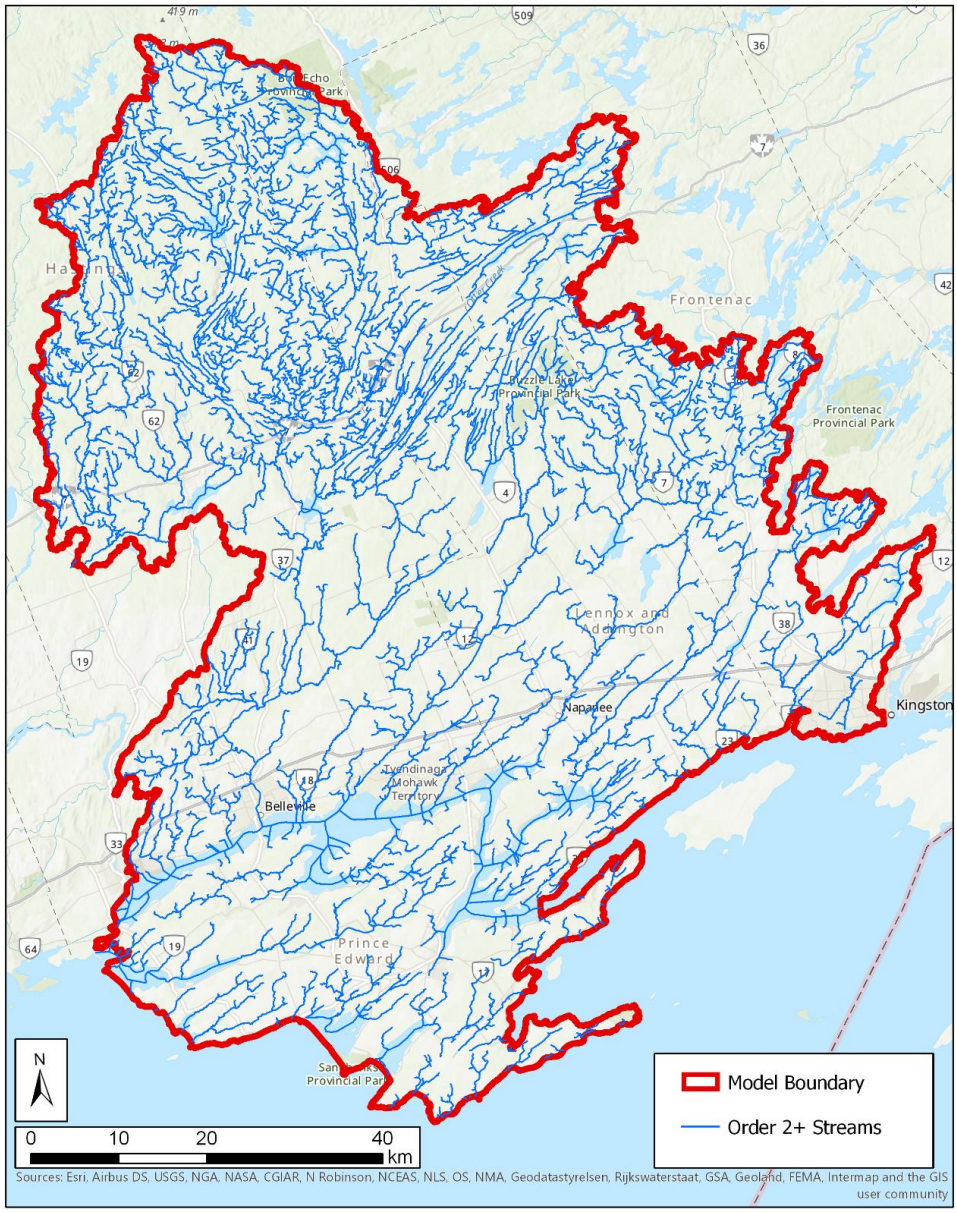

Figure 11: Strahler Order 2+ Streams from Ontario Integrated Hydrology Dataset.

3.7 Mesh Update

The following data were used as spatial resolution control features for mesh generation:

- Splines:
  - Lines:
    - Watershed boundary

        - Streams (Strahler Order 2+, cleaned to remove any vertices less than 10m apart)
    - Points:
        - PGMN well locations
- Property polygons:
    - 100m buffer zone around PGMN well locations
    - Outlines of 12 inland lakes

Edge length maximum restrictions were:

- Watershed boundary: 500m
- Streams: 200m
- Dams: 100m
- Inland Lakes: 300m
- Overall: 5km

The final version of the mesh (Figure 12) has 73,049 triangular nodes and 143,990 triangular elements per sheet. In total, there are fifteen 3-D subsurface layers in the model and one 2-D surface domain layer, which makes for 17 mesh sheets and a total of 1,241,833 nodes.

3.8 Subsurface

Description of the subsurface configuration is provided in detail in Frey et al. (2019), since the starting point for the Quinte model hydrostratigraphy was the regional HGS model that has been made publicly available by the Geological Survey of Canada (https://doi.org/10.4095/321042). The model subsurface consists of three soil layers, with spatially varying hydraulic properties derived from the Soil Landscapes of Canada v3.2 database (https://sis.agr.gc.ca/cansis/nsdb/slc/v3.2/index.html), five quaternary hydrostratigraphic layers, and seven underlying layers composed of Phanerozoic and Precambrian bedrock. Geographic extent of the hydrostratigraphic units is presented in Figure 13.

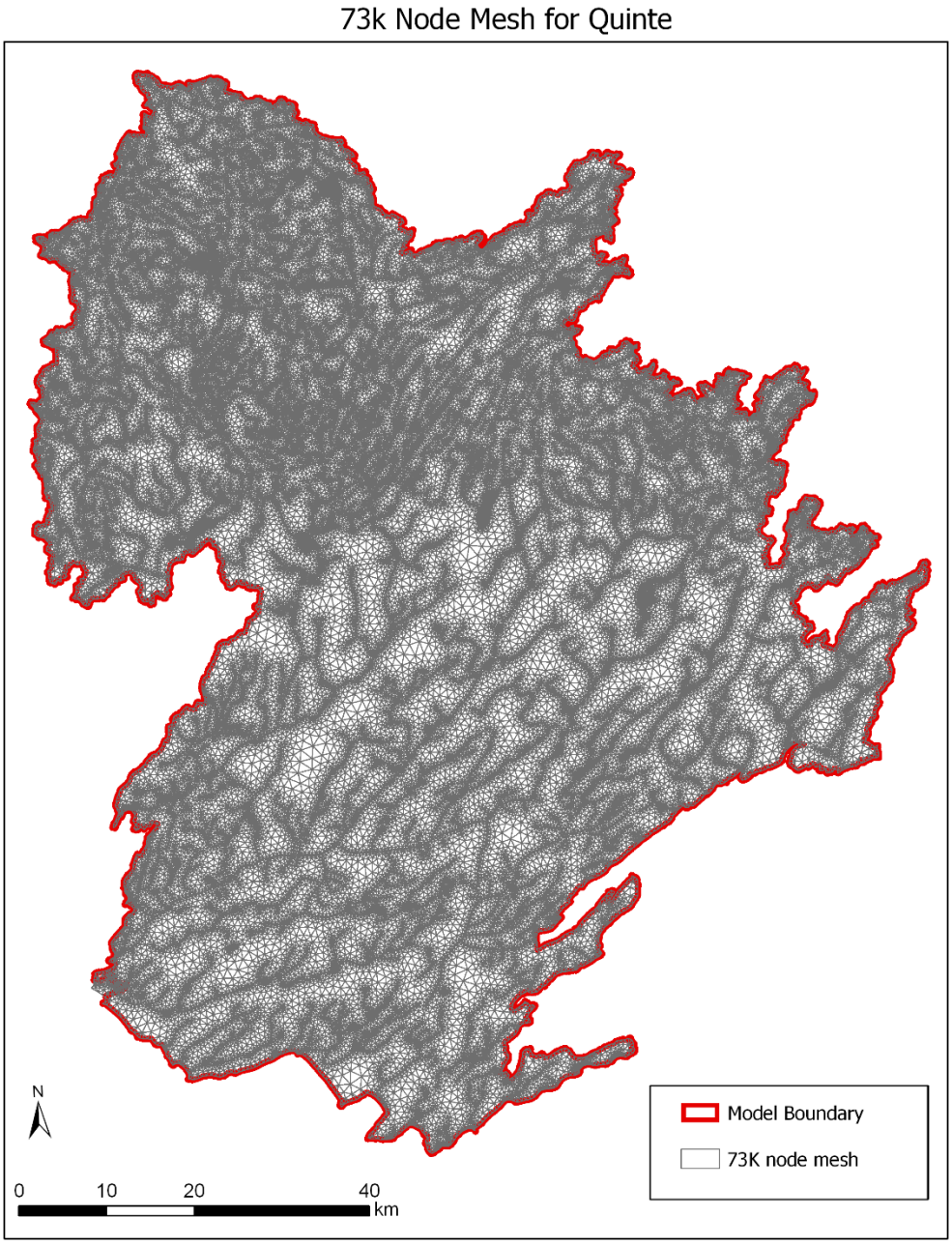

Figure 12: Updated mesh for Quinte. Each mesh sheet contains 73,049 nodes and 143,990 elements.

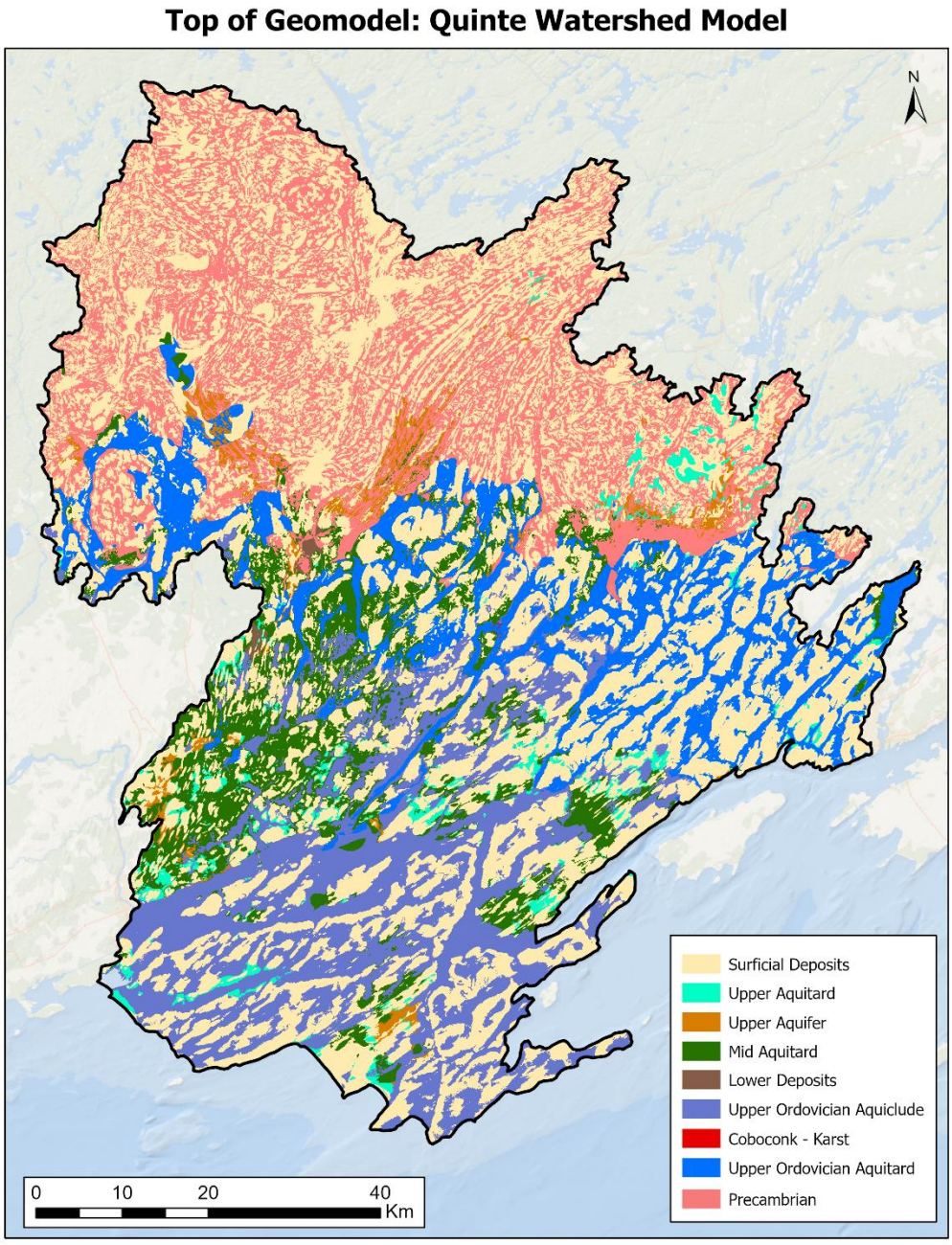

Figure 13. Geographical extent of the Quaternary (Surficial Deposits, Upper Aquitard, Upper Aquifer, Mid Aquifer, and Lower Deposits), Phanerozoic, and Precambrian hydrostratigraphy within the model domain.

3.9 Additional HGS Model Development Activities

In addition to the data update, the model has been subjected to additional calibration and validation testing. Currently, the 1D surface water network (Figure 14) has been updated, the spatially varying hydraulic conductivity fields (Figure 15) have been reviewed and adjusted during model calibration, and a time varying head boundary condition (Figure 16) has been configured to reflect the influence of seasonally varying water levels in Lake Ontario on groundwater heads in the Quinte watersheds. Additionally, 12 dams have been configured into the model to capture the influence of surface water management on surface water flow rates.

The model has been tested for its ability to reproduce average annual surface water flow rates and groundwater heads using monthly normal (long term average) climate forcing data (Figure 17). The monthly normal forcing approach and the associated dataset is outlined in Erler et al. (2019). An example of the monthly normal simulation results is presented in the simulated vs. observed hydrographs depicted in Figure 18. While not directly related to the project, it is important to note that the monthly normal simulations provide the initial condition (i.e. the starting point for surface water levels and groundwater heads) required for the daily transient simulations upon which model statistical performance metrics in this work are calculated. Accordingly, the key metric required of the monthly normal simulations is visual reproduction of seasonal variability, as that verifies model sensitivity to the main seasonal hydrologic drivers (snow-melt, ET, and rainfall cyclicity). Furthermore, when the simulated and observed hydrographs show similar magnitudes, it confirms that the model is capturing the main components of the overall water balance, and that the evapotranspiration parameterization is suitable to start testing a more refined (in this case daily) level of model temporal resolution.

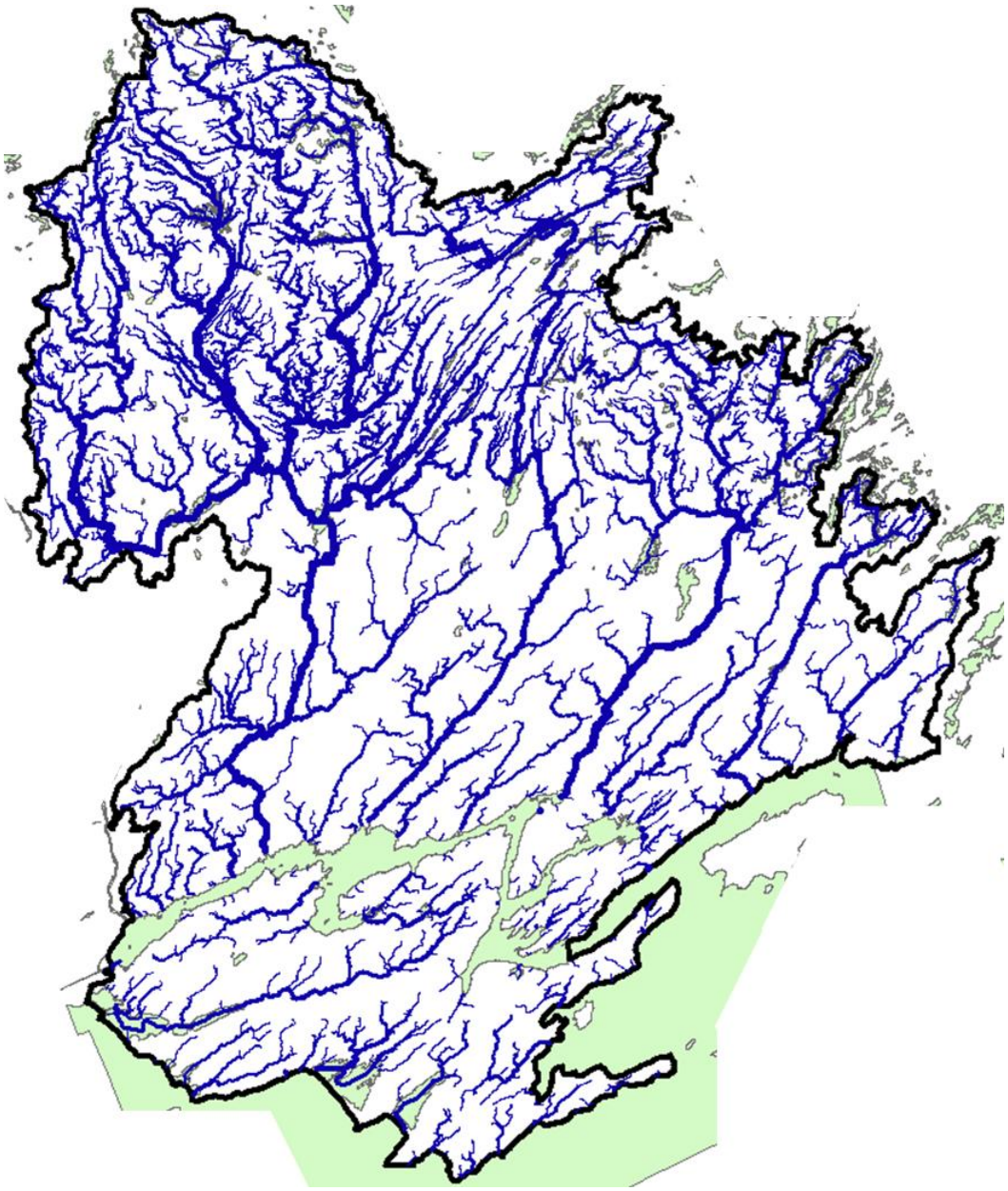

Figure 14. One-dimensional surface water network embedded into the Quinte HGS model.

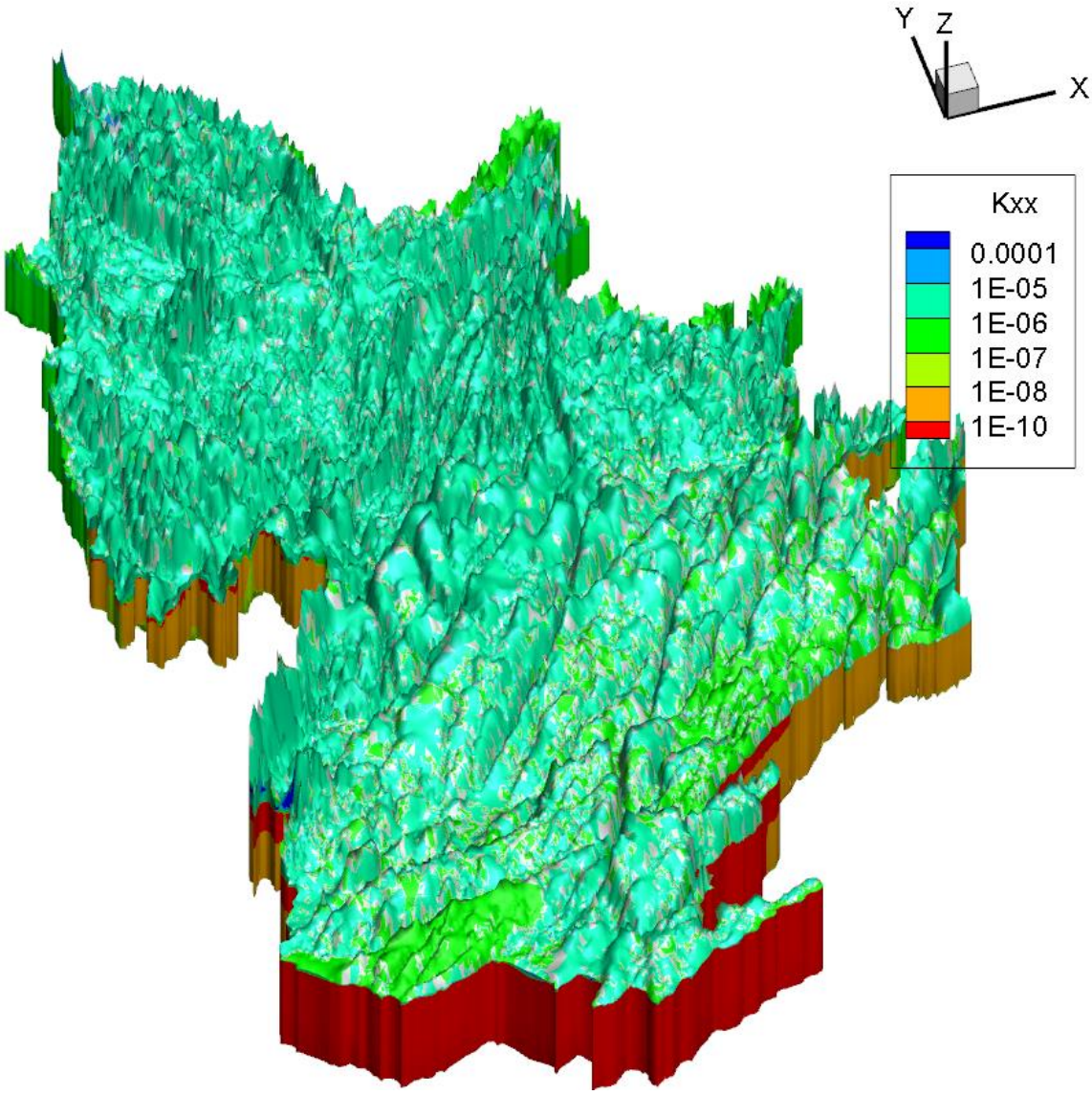

Figure 15. Spatially varying hydraulic conductivity field in the Quinte HGS model.

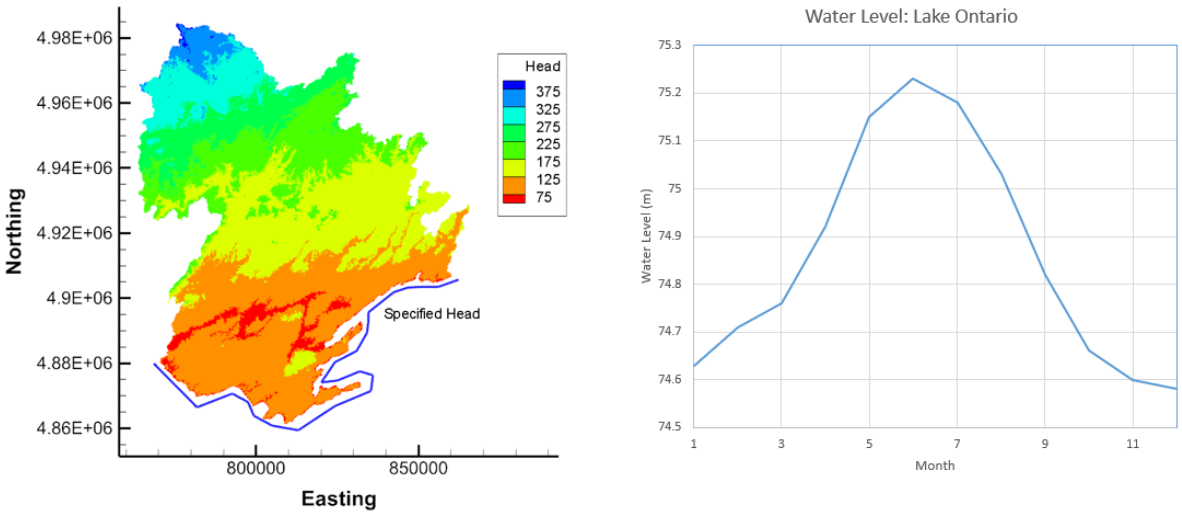

Figure 16. Time-varying head boundary condition configured into the Quinte HGS model to reflect seasonally varying water levels in Lake Ontario.

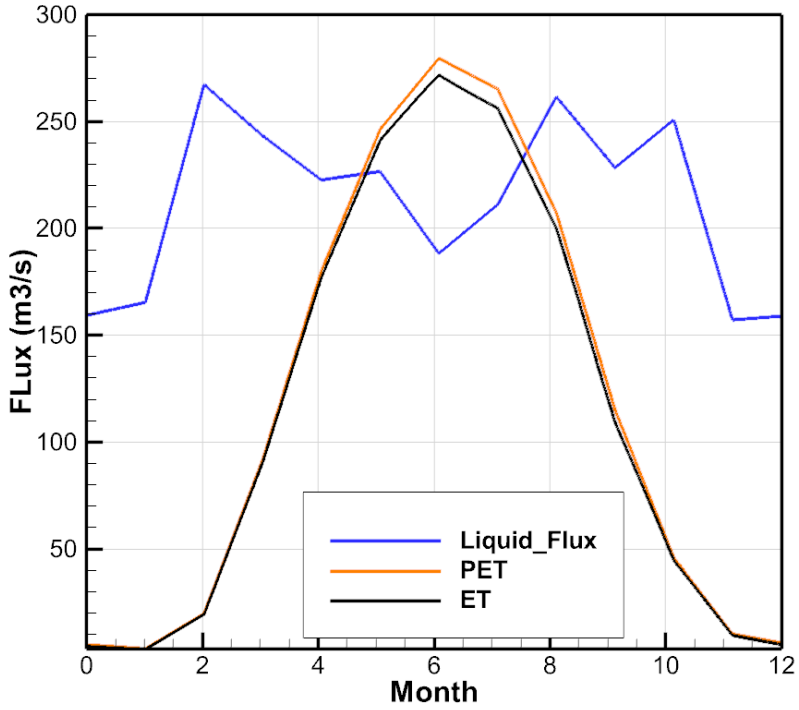

Figure 17. Climatological monthly normal forcing data for the HGS model spinup, along with simulated evapotranspiration rates for a one-year climate cycle.

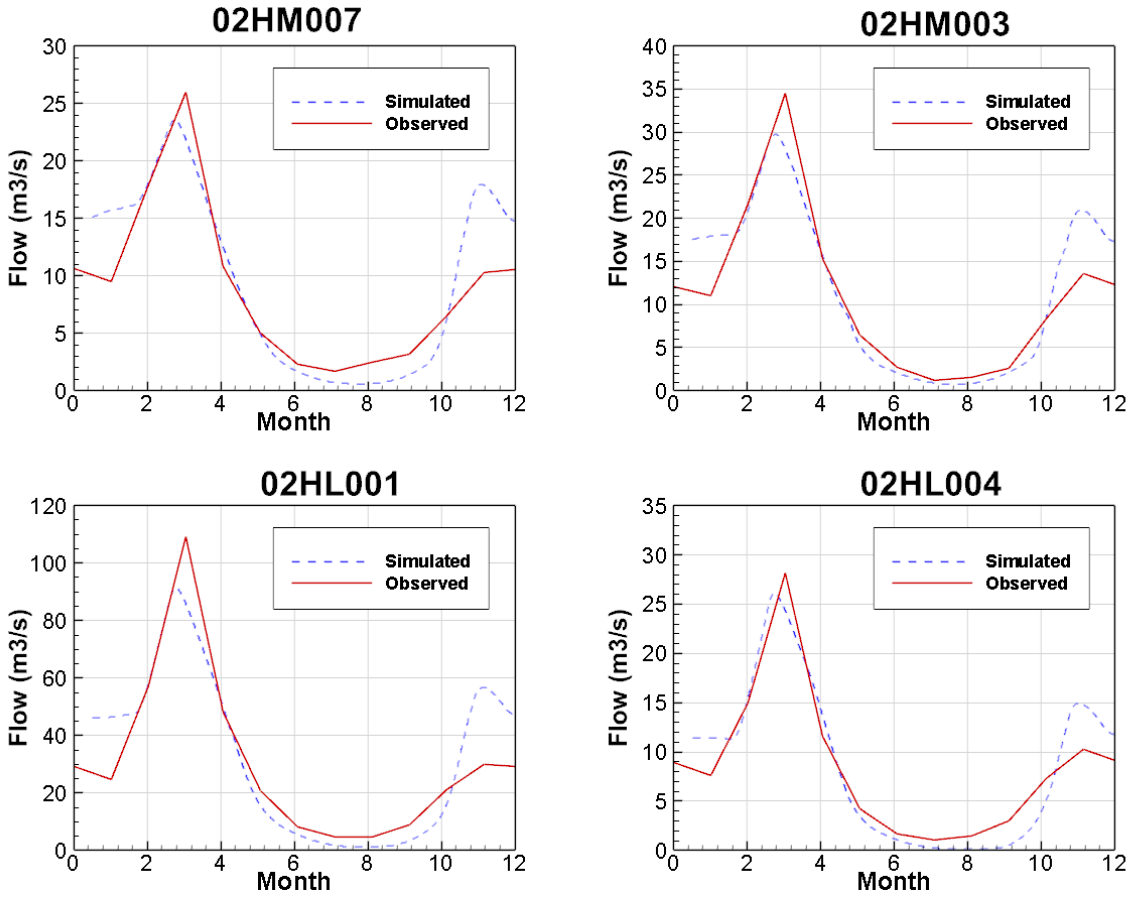

Figure 18. Representative monthly normal hydrographs showing simulated vs. observed flow conditions at four Water Survey of Canada Hydrometric Stations. Note that in total there are 16 hydrometric stations configured in the HGS model.

4.0 CLIMATOLOGY

Considerable effort has gone into assembling the daily liquid water influx (snowmelt + rainfall) and potential evapotranspiration datasets required as HGS model forcing. These datasets cover the model domain with approximately 2 km resolution, extend from Jan 1, 2011 to Dec 31, 2017 with daily temporal resolution, and are suitable for providing the climate forcing boundary conditions for the calibration and validation simulations.

4.1 Liquid Water Forcing (LWF)

The LWF (Liquid Water Forcing) dataset used in the HGS atmospheric forcing boundary condition is based on the total precipitation data from NRCan (McKenney et al., 2011) and bias-corrected snow water equivalent (SWE) from SnoDAS (King, Erler, Frey, & Fletcher, 2020). The NRCan dataset has 1/60 deg. (approx. 2 km) spatial resolution and daily temporal resolution from 1997 to 2018. It is based on station/rain gauge data that is interpolated using the ANUSPLIN algorithm with elevation correction. The gauge data is derived from quality-controlled ECCC meteorological stations, with snowfall data corrected for gauge undercatch. Snow data for 2011 and onwards is derived from SnoDAS (SNOw Data Assimilation System) with 1km spatial resolution and daily temporal resolution from 2011 to present in Ontario; it assimilates in-situ snow depth data and snow extent from remote sensing. In order to ensure SnoDAS data is optimized for the study purposes in Southern Ontario, it was bias-corrected using a Random Forest machine learning approach trained against provincial snow surveys (measuring SWE).

Total Precipitation and SWE were interpolated to a grid covering all of southern Ontario at 1 km resolution in UTM 17N projection. LWF was computed for the period from Jan. 1st 2011 to Dec. 31st 2017 by subtracting daily SWE differences from daily precipitation totals. Average LWF for the entire period is presented in Figure 19 (left).

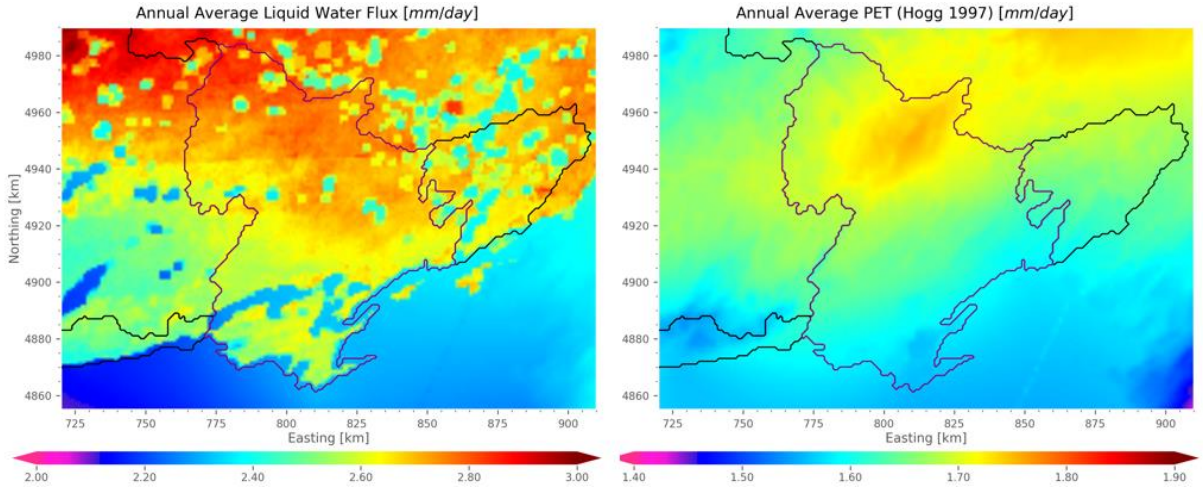

Figure 19. (Left panel) 2011 to 2018 average spatial distribution of liquid water flux (LWF) over the model domain. (Right panel) 2011 – 2018 average spatial distribution of potential evapotranspiration (PET) over the model domain.

4.2 PET Estimation

As evapotranspiration is the primary stressor on surface water and groundwater resources during summer months, and especially during summer droughts, effort was made to ensure the most suitable PET dataset was used was used as model forcing. Spatially distributed PET was computed on the same grid as the NRCAN precipitation dataset using daily minimum and maximum temperature (T_{min} and T_{max}) from the NRCan dataset (same resolution/period as the precipitation data) and solar radiation from the Elora Research station (UGuelph) and the UTM (U of T Mississauga) climate station.

The most physically rigorous method of computing PET is the Penman-Monteith formulation, which also requires radiation, wind and humidity data. While solar radiation can be interpolated over larger areas, wind and humidity generally cannot. Therefore, the following approximate methods have been investigated for developing a spatially distributed PET dataset for the Quinte watersheds: Priestley-Taylor (P-T), Hargraeves, Hogg (1997; used by NRCan), and Thornthwaite. All of which require temperature data, with P-T also requiring solar radiation data.

While additional solar radiation stations can be added later, currently, Elora and UTM are the only locations in the vicinity of the Quinte watersheds where solar radiation is available for the entire period of interest (2011-2018) – with relatively few gaps.

Figure 20 shows the comparison between the PET methods at the two station locations (using climate data from the stations). It is evident that P-T and Hargreaves are generally close to P-M, while Thornthwaite and Hogg -based PET fall below the P-M PET values. Also shown is the significance of the wind and radiation terms, as well as a P-M calculation with estimated long-wave (LW) radiation. The reason for the latter is that net radiation is often unreliable and it is preferable to only rely on downwelling solar radiation, which was done here.

Gridded fields of potential evapotranspiration have been derived using the Hogg, Hargreaves and Priestley-Taylor methods. For the latter, downwelling solar radiation from the two stations has been interpolated to the same grid as the LWF data; the other methods rely only on temperatures from the NRCan dataset. It was found that the Hargreaves and P-T methods lead to relatively dry hydrologic conditions in the HGS model due to the fact that long-term average PET values are only 10% and 20%, respectively, smaller than LWF, which does not leave enough water to supply adequate streamflow. Based on testing, as well as water balance analysis, the Hogg method appears to yield the most plausible PET values (approx. 65% of LWF). Therefore, gridded daily PET values based on the Hogg method have been chosen to drive the daily transient HGS simulations (Figure 19). The Hogg method is based on estimating the water vapor deficit in the wind term from diurnal minimum and maximum temperature and representing the radiation term as a function of temperature (Hogg 1997).

A timeseries of PET (Hogg) and LWF averaged over the Quinte watersheds and aggregated into monthly values is shown in Figure 21. The spring freshet peaks in LWF and the strong seasonal cycle in PET are clearly visible. Furthermore, the difference of LWF and PET is shown as a proxy of water deficit; since actual ET closely follows PET, this approach should give a very good indication of net water

forcing to the surface and subsurface. In particular, the summers of 2012 and 2016 stand out as being very dry, and hence make for an ideal time interval to evaluate the role that reservoirs have in supporting surface water flow during drought conditions. The year of 2014, on the other hand, stands out as a relatively wet year, with a large spring freshet peak and only a small water deficit in summer.

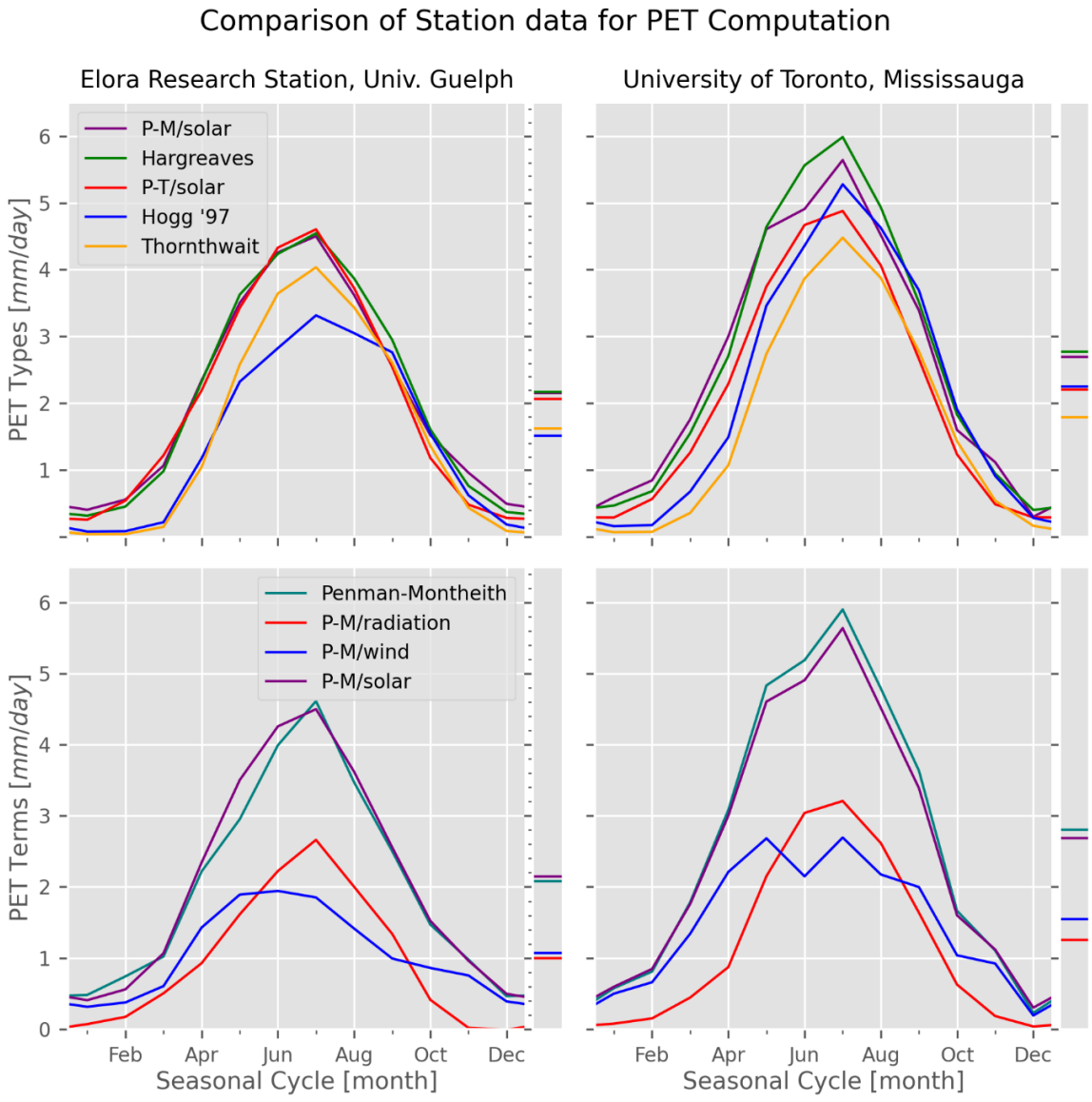

Figure 20. (top row) Comparison of different PET estimation methods at the Elora (left) and UTM (right) stations; (bottom row) the radiation and wind/aerodynamic terms of Penman-Monteith PET, as well as a comparison of P-M calculated with just solar radiation (estimated LW radiation; 'solar') vs. full net radiation; P-M and P-T in the top row only use solar radiation (estimated LW). The vertical bars on the right-hand side of each panel show the annual average of each variable.

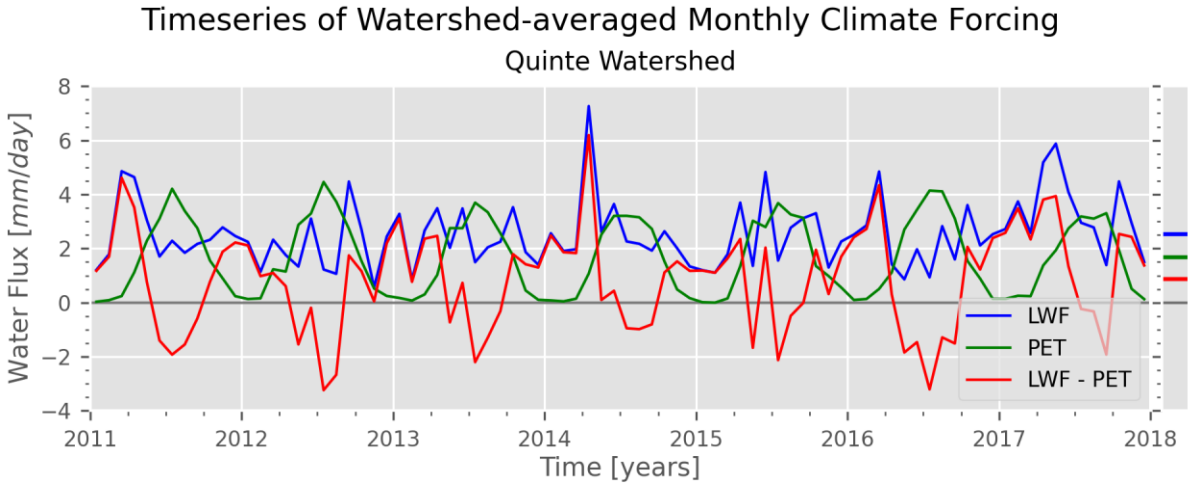

Figure 21. Temporal variability of watershed-average liquid water forcing (LWF) and potential evapotranspiration (PET), used as climate forcing data for the model, over the 2011 to 2018 simulation interval. Also shown (in red) is the LWF – PET as a proxy for water deficit. The vertical bar on the right-hand side shows the long-term average of each variable.

5.0 MODEL PERFORMANCE

5.1 Surface Water

The model's ability to simulate surface water flow conditions was evaluated based on daily conditions between Jan 1, 2011 and Dec 31, 2017 at 16 Water Survey of Canada hydrometric gauging stations across the model domain (Figure 22). When assessing model performance, it is important to note that dam operations were not incorporated in the model. Also, there were six different model configurations evaluated that collectively incorporate a range of parameterizations for soil water retention, subsurface permeability, PET, and depression (rill) storage (Table 2). In Table 2, simulation 141 refers to MERRA2 PET being used instead of PET derived from the Hogg method. MERRA2 PET has been derived from the MERRA2 global reanalysis (https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/) and represents a coarse resolution (~50 km) perspective of climate conditions across the model domain. MERRA2 was used in order to evaluate the relative performance of coarse resolution model-based PET (e.g. MERRA2) to station-based PET calculations (e.g. the Hogg data used here).

Table 2. Description of the six different model configurations that were considered in the model performance evaluation.

Simulation	Description
140	Base Case: Hogg PET
141	Base Case: MERRA2 PET scaled to 90%
142	140 + increased soil drainage (van Genuchten (1980) alpha parameter increased by 50% for soil layers)
143	142 + hydraulic conductivity for Quaternary hydrostratigraphy and the top bedrock hydrostratigraphy increased by a factor of 10
144	143 + increased evapotranspiration
145	144 + increased model rill storage (from 1 mm to 5 mm) to represent increased topographic depression storage

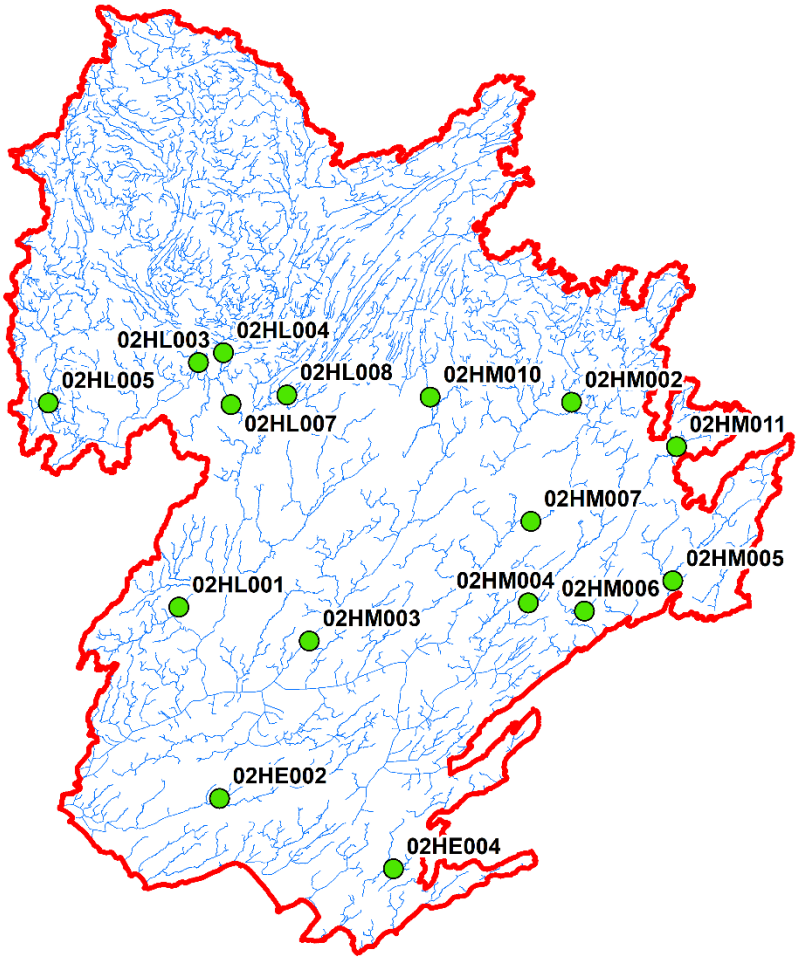

Figure 22. Location and identifier code for the 16 Water Survey of Canada hydrometric stations used to evaluate model surface water simulation performance.

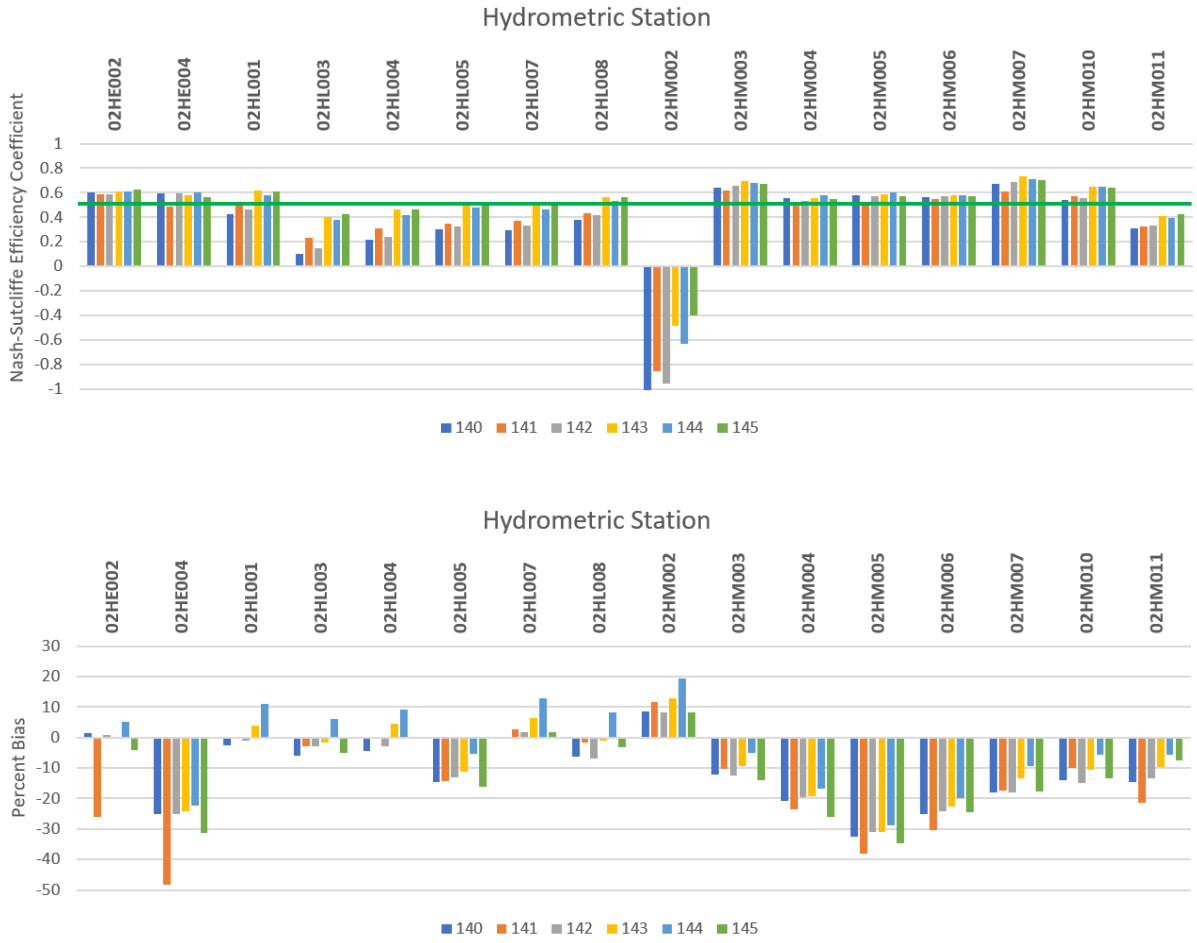

Figure 23. Nash-Sutcliffe model efficiency (NSE) coefficient (top frame) and Percent Bias (bottom frame) for the six different model configurations tested during the performance evaluation. Performance metrics represent daily comparison of simulated versus observed flow rates at sixteen hydrometric gauging stations.

Statistical model performance is presented in Figure 23, with the Nash-Sutcliffe model efficiency (NSE) coefficient (top panel) used to assess deviations between simulated vs. observed variability, with a value of 1 indicating a perfect match, and a value of 0 indicating that the model has the same predictive ability as the mean of the observed data. Percent bias is presented in the bottom panel of Figure 23, and it represents the relative difference between average simulated and observed values,

with positive values indicating the model overestimates flow and negative numbers indicating the model underestimates flow.

Overall, the model's ability to reproduce surface water flow rates can be considered satisfactory, with simulation no. 145 having a NSE value greater than 0.5 at 12 of the 16 hydrometric stations, and a NSE value greater than 0.4 at 15 of the 16 stations. At one of the 16 stations (02HM002) the NSE value is less than 0, which, from visual inspection of simulated vs. observed flow at that location (Figure 24), can be largely attributed to the lower peak flow and higher baseflow in the observed data relative to the simulated data. This deviation is consistent with the expected effects of not having reservoir operations fully represented in the calibration simulations, as the reservoirs act to reduce peak flow and increase baseflow. When the results from station 02HM002 are compared to those from 02HM007 (the best performing station), it is apparent that 02HM007 has less influence from reservoir operations, as the alignment and magnitude of both high and low flow conditions is closer between simulated and observed data. This result is not unexpected given that station 02HM002 is just downstream from Second Depot Lake and Third Depot Lake which are both controlled, whereas 02HM007 is on a higher order reach further downstream and has less influence from individual reservoirs.

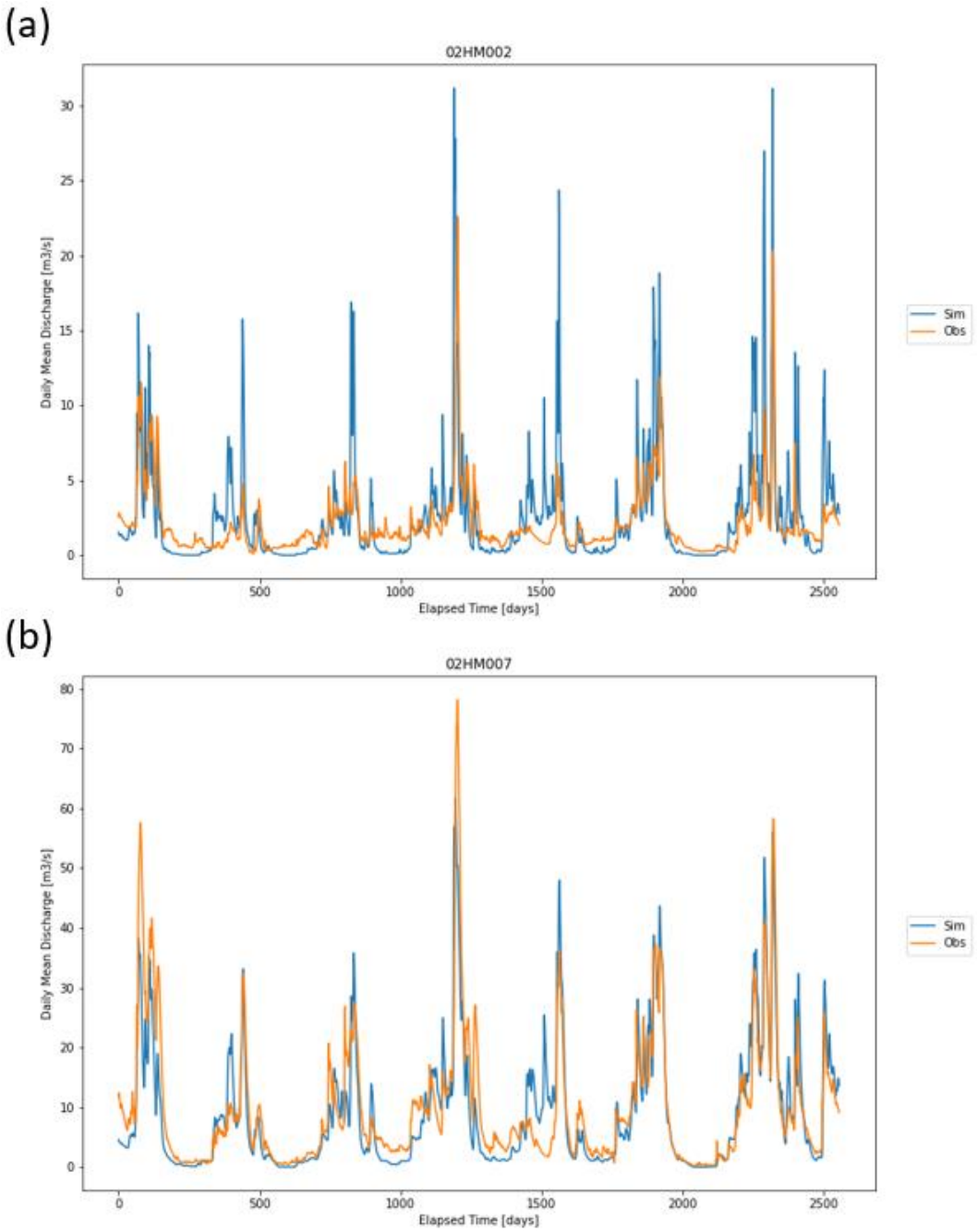

Figure 24. Simulated versus observed surface water flow rates at the hydrometric station with the (a) lowest, and (b) the highest NSE values. Note that Day 0 represents January 1, 2011 and the time series extends to Day 2555, which reflects December 31, 2018.

5.2 Groundwater

The model's ability to simulate groundwater levels was evaluated based on daily conditions between Jan 1, 2011 and Dec 31, 2017 at the location of 31 Provincial Groundwater Monitoring Network (PGMN) wells across the model domain. While there is a total of 34 PGMN wells implemented into the HGS model, only the wells with continuous data records were compared against model results. It is also important to note that groundwater extraction was not incorporated into the model, and hence localized influences on groundwater levels from pumping are not reflected in the model results.

At 24 of the 31 PGMN wells used for model evaluation, the difference between simulated and observed water levels was less than 5 m, with the average difference being -3.6 m, thus indicating that the model slightly overpredicts groundwater levels (Figure 26). When using mean sea level as the datum, the linear correlation between simulated and observed groundwater levels at the 31 wells is 0.99 (Figure 27).

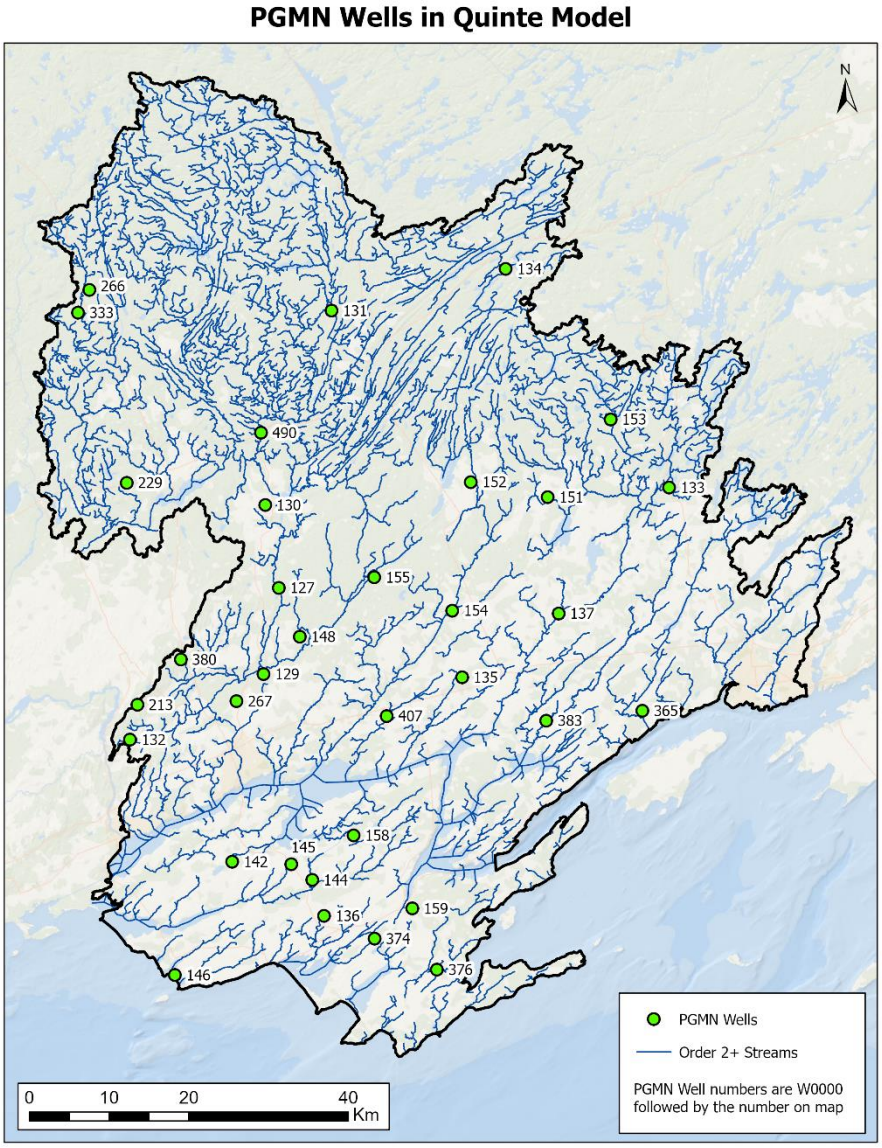

Figure 25. Location of the 34 Provincial Groundwater Monitoring Network (PGMN) wells that were implemented into the HGS model.

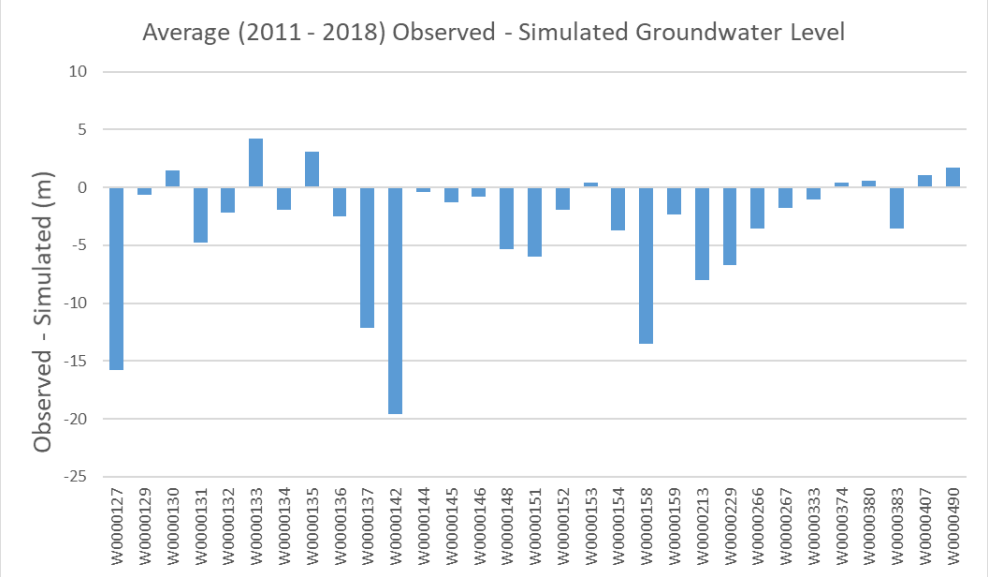

Figure 26. Difference in long term (2011 – 2018) daily average observed and simulated groundwater levels in the 31 PGMN wells used to evaluate model performance.

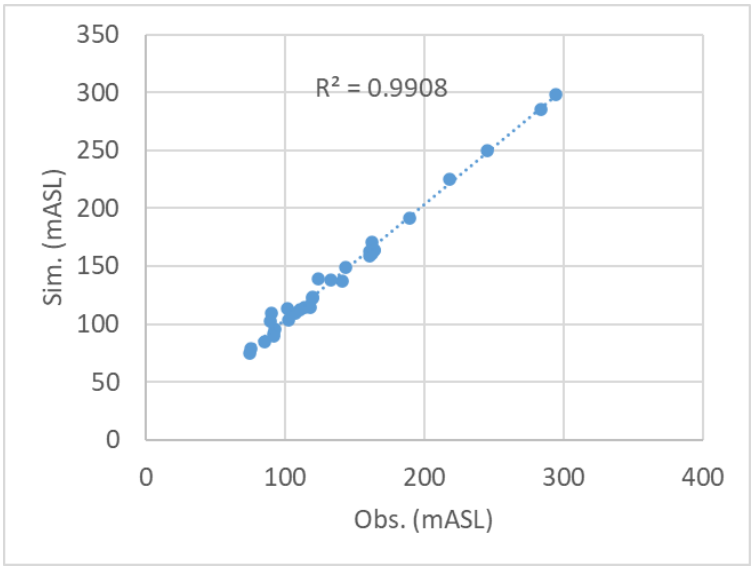

Figure 27. Linear correlation between simulated and observed groundwater levels relative to mean sea level.

6.0 WATERSHED MANAGEMENT SCENARIO SET 1

6.1 Scenario Set 1 Description

Assessment of the influence that reservoir operations have on baseflow conditions was conducted for the summer of 2016 under exceptionally dry conditions in the Quinte region. For the first set of watershed management scenarios, reservoir storage was derived from existing literature, and in the case where literature guidance was unavailable, from theoretical storage calculations made based on estimated max – min water levels combined with lake/reservoir surface area. The total live reservoir storage, as well as the fill rate and release rate for each reservoir considered in the first set of reservoir management scenarios are presented in

Table 3. The fill rate was determined based on the expectation that each reservoir would be completely filled during the late winter – early spring time interval, while the release rate was determined based on the expectation that reservoir supply would be used on a continuous basis from July 1st to October 30th to augment low flow conditions. As evident in the simulated summer flow conditions presented in Figure 24, flow rates in major rivers (i.e. the Napanee River where station 02HM007 is located) can approach 0 during summer months in dry years, whereas spring flow conditions are consistent in their ability to supply enough water to fill the reservoirs. As the first set of reservoir simulations did not use the finalized reservoir storage capacities, it is considered here to be a test of the Quinte region surface water systems sensitivity to dam/reservoir operation. The finalized reservoir storage

capacities, as well as intentionally modified capacities, are presented in Scenario Set 2.

In the simulations, each of the three major river systems within the model domain (Moira, Salmon, and Napanee) and their associated reservoirs are deemed to function independently of each other. Hence a single model simulation can be used to assess the influence of three different reservoir operation plans (one for each river system). Accordingly, the five different simulations described in Table 4 represent 15 different reservoir operation plans across the three rivers. In each scenario, simulated surface water flows at a cascading set of hydrometric stations within each of the three river systems are assessed, with map based depictions of the individual reservoir activity associated with scenario 4 presented in Figure 28, and scenario 5 presented in Figure 29. In scenarios 1 and 2, all reservoirs were active during the summer months, and it was only the fill schedule that was adjusted. In scenario 3, all reservoirs were again active, and it was the hydraulic criteria upon which reservoir filling is dependent that was adjusted; which in this case refers to the minimum water depth required downstream of the reservoir before water can be withdrawn to fill the reservoir.

Table 3. Storage capacity, maximum fill rate, and maximum release rate for the 12 reservoirs incorporated into the model.

	Lake/Reservoir/Dam	Live Storage (m^3)	Fill Rate (m^3/s)	Release Rate (m^3/s)
1	**Beaver**	16578001	3.095	1.599
2	**Big Clear (Arden Dam)**	8525900	1.592	0.822
3	**Deerock**	6900000	1.288	0.666
4	**Lingham**	26630100	4.971	2.568
5	**Moira (Downey's Weir)**	20010000	3.735	1.930
6	**Roblin**	1315600	0.246	0.127
7	**Second Depot**	2300000	0.429	0.222
8	**Skootamatta**	16628346	3.104	1.604
9	**Stoco (Caton's Weir)**	17422000	3.252	1.680
10	**Third Depot**	3571900	0.667	0.345
11	**Thirteen Island**	1036123	0.193	0.100
12	**Varty**	6070000	1.133	0.585

Table 4. Overview of the five different dam operation scenarios that have been evaluated in the first set of reservoir evaluation simulations.

Scenario	Description
Base	Without Dams or Reservoirs
S1	Storage On: March 1st, Storage Off: April 30th, Release On: July 1st , Release Off: Oct. 30th
S2	Storage On: Jan 1st, Storage Off: April 30th, Release On: July 1st , Release Off: Oct. 30th
S3	Same as S1+ Head Control Increased
S4	Caton & Arden & Thirteen Island Dams
S5	Downey & Arden & Depot Dams

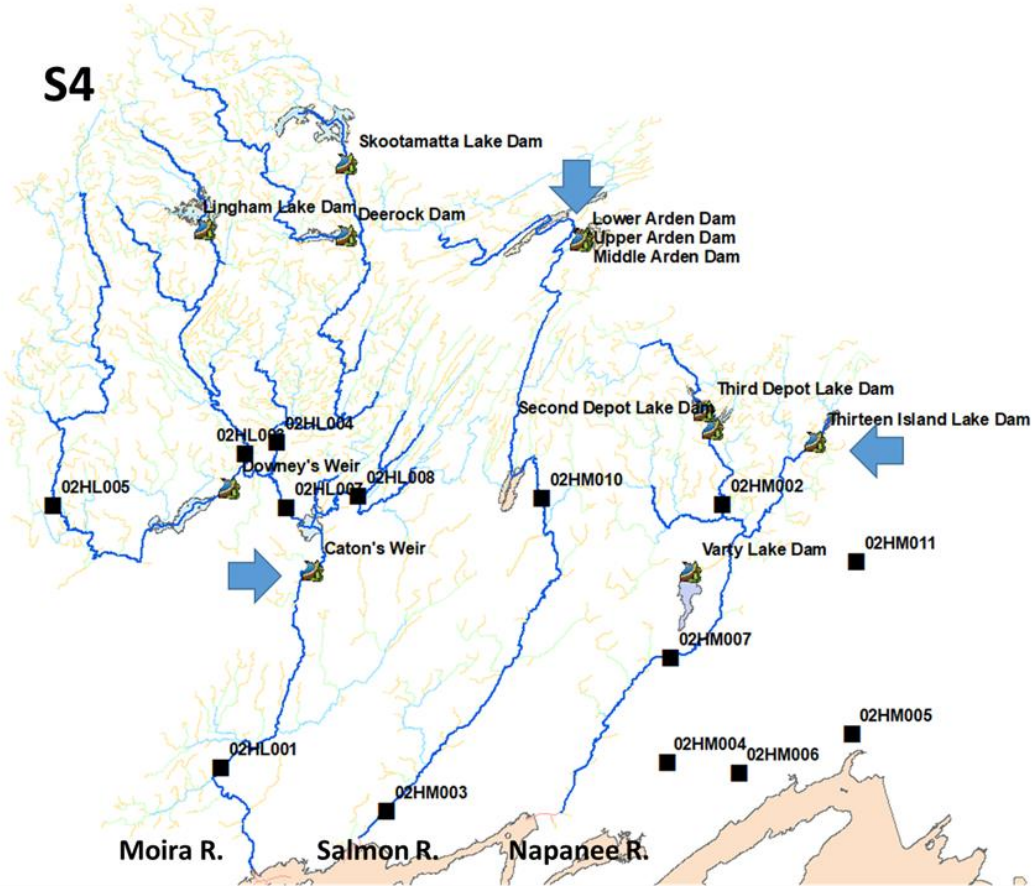

Figure 28. Location (blue arrows) of the reservoirs/dams active for evaluation **scenario 4** in the Moira, Salmon, and Napanee River systems.

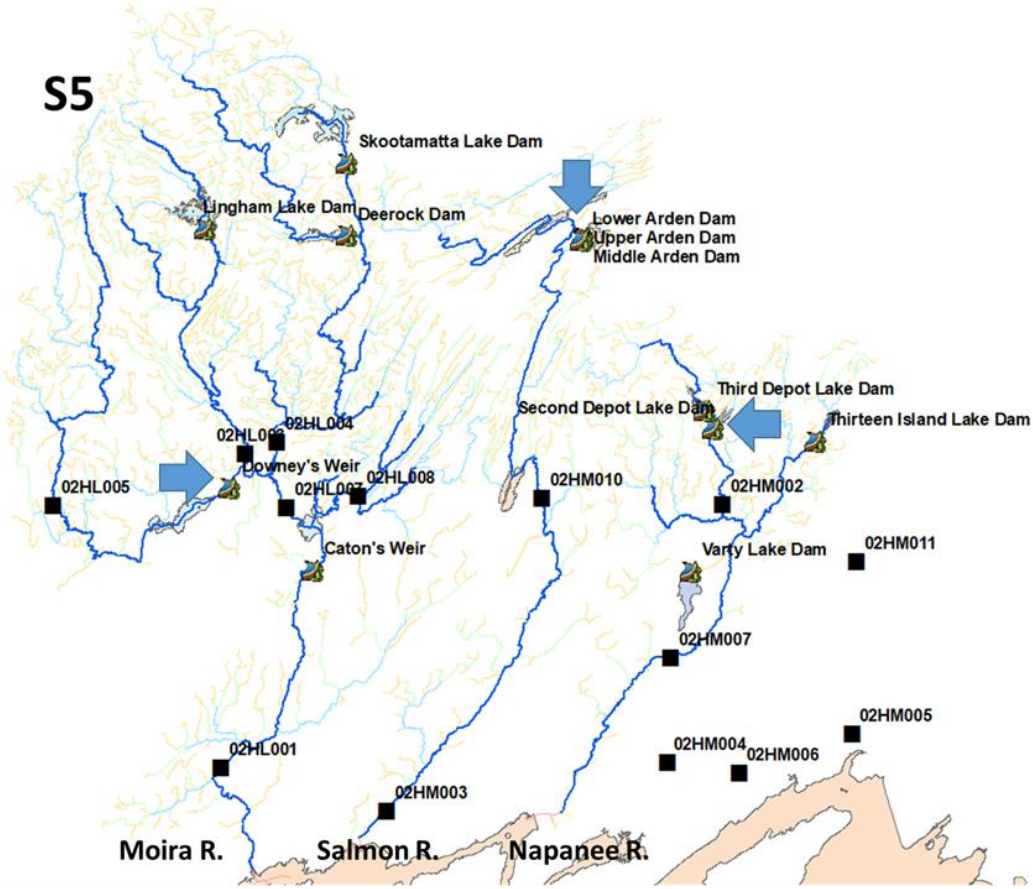

Figure 29. Location (blue arrows) of the reservoir/dams active for evaluation **scenario 5** in the Moira, Salmon, and Napanee River systems.

6.2 Scenario Set 1 Results

Simulation results for the Moira River system are presented in Figure 30. At the hydrometric station furthest downstream (02HL001) the five active reservoirs considered in this work (Skootamatta Lake, Lingham Lake, Deerock, Moira Lake-Downey's Weir, and Stoco Lake-Caton's Weir) collectively contribute approximately 7 m^3/s to surface water flow under the scenario where all reservoirs are completely drained over the July to November time frame. In the scenarios where Caton's Weir

and Downey's Weir are operated individually, the associated reservoirs each contribute approximately 2 m^3/s to flow at 02HL001. Further upstream, at station 02HL004 which is affected by the operation of the Skootamatta Lake and Deerock Lake Dams, the reservoirs contribute just over 2 m^3/s of flow for the July to November time frame. Further to the West, at station 02HL003 where flow is influenced by the operation of Lingham Lake Dam, the reservoir contributes approximately 2 m^3/s from July to November. While somewhat obvious from the base case condition depicted in Figure 30, it is important to note that without reservoir contribution to surface water flow, the Moira River system would have critically low or zero flow during the peak of the 2016 drought. As shown by the fully-integrated surface water – groundwater simulations, groundwater contribution to baseflow is effectively non-existent during the summer of 2016.

In the Salmon River, the Arden Dam system (Upper, Middle, and Lower) were grouped together as a single entity and were the only operational control to influence downstream flows. At station 02HM010 as well as further downstream at station 02HM003, Arden Dam contributes approximately 0.8 m^3/s, with the magnitude of flow shown to fluctuate in response to a small precipitation event in mid August combined with a decline in PET demand towards the end of the growing season (Figure 31).

In the Napanee River, the four operational reservoirs (Second Depot, Third Depot, Thirteen Island, and Varty Lake) collectively add approximately 0.5 m^3/s to flow at station 02HM002, and between 0.2 and 0.6 m^3/s at station 02HM007. The relatively wide variability in flow rates at station 02HM007 highlights that sections of the

Napanee River behave as losing-streams in the model, and hence saturation and groundwater levels in the hydrostratigraphy surrounding the streams can influence the volume of surface water infiltrating into groundwater. When Thirteen Island Lake is considered independent of the other reservoirs, it is shown to have little influence on downstream flows until mid-October, at which point in time, flow rates at station 02HM007 increase in magnitude disproportionately greater than the instantaneous amount of water being released from Thirteen Island Lake. While perhaps such a response seems implausible, with the fully integrated surface water – groundwater simulation it highlights that the continuous release of water from Thirteen Island Lake throughout the dry summer worked to maintain groundwater levels and soil moisture levels in the hydrostratigraphy in the vicinity of the stream, which then prompted a more rapid surface water recovery in the fall, when PET demands decline. Like in the Salmon River, the influence of the mid August precipitation event is also seen on flows in the Napanee River (Figure 32).

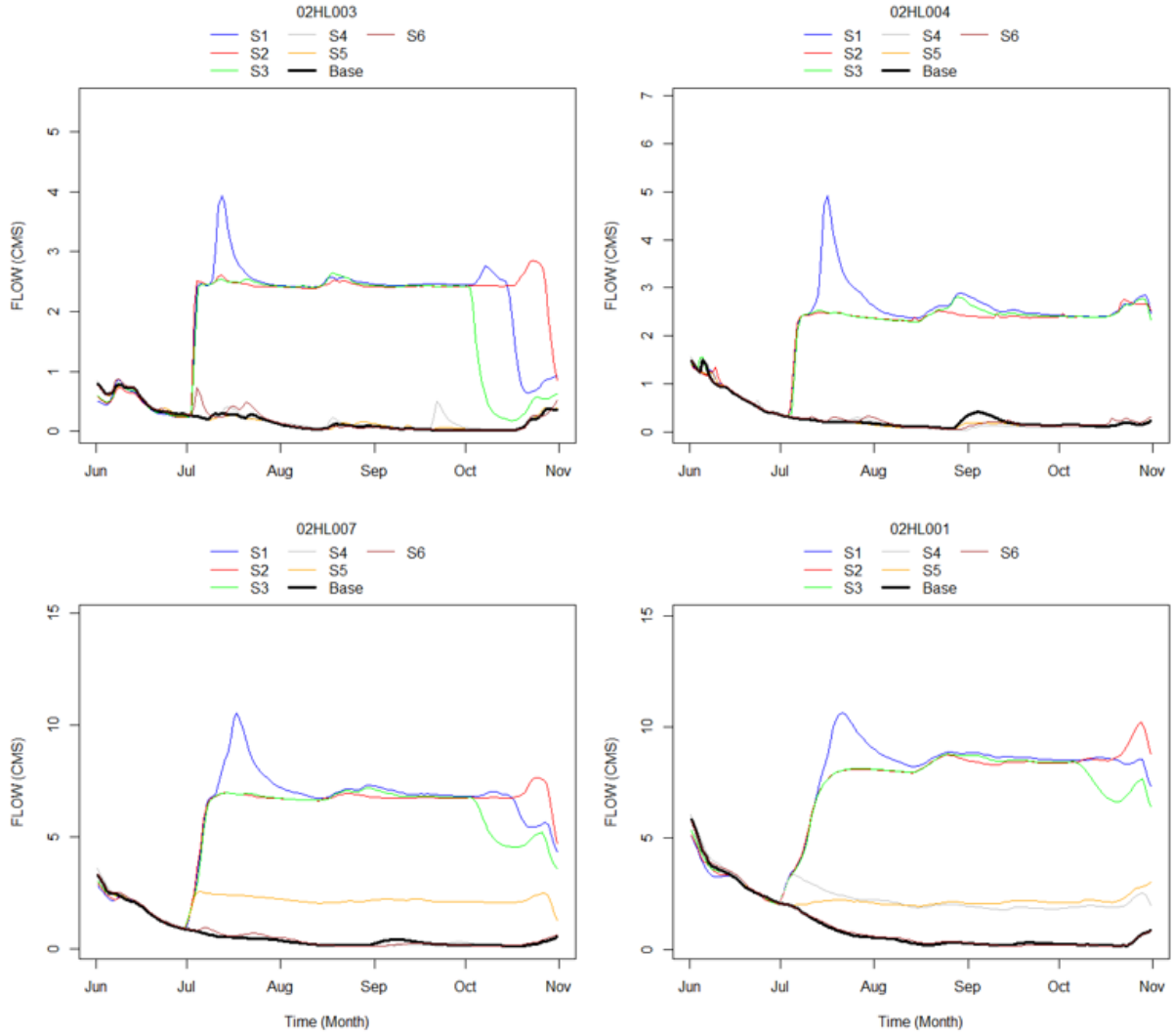

Figure 30. Simulated flow rates at hydrometric stations located along the **Moira River**, during the June to November 2016 time interval, for the **first set of reservoir evaluation scenarios**.

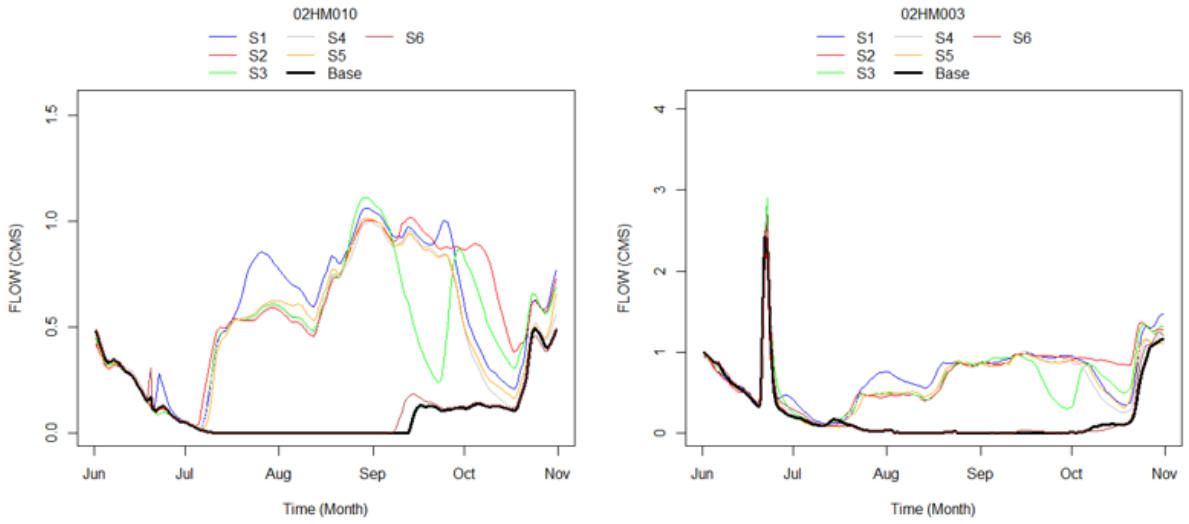

Figure 31. Simulated flow rates at hydrometric stations located along the **Salmon River**, during the June to November 2016 time interval, for the **first set of reservoir evaluation scenarios**.

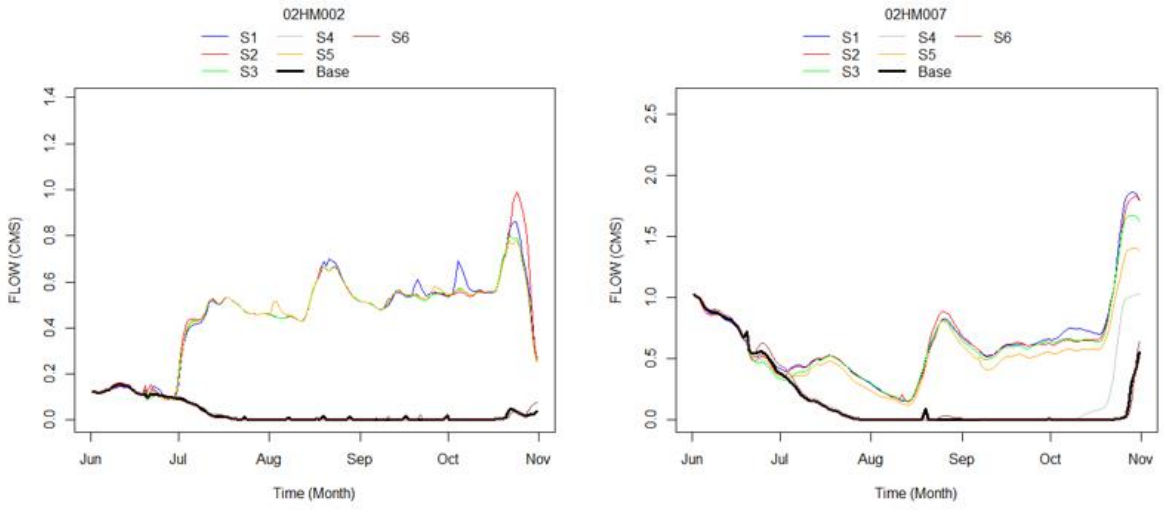

Figure 32. Simulated flow rates at hydrometric stations located along the **Napanee River**, during the June to November 2016 time interval, for the **first set of reservoir evaluation scenarios**.

7.0 WATERSHED MANAGEMENT SCENARIO SET 2

7.1 Scenario Set 2 Description

Scenario set 2 incorporates updates to the individual reservoir storage capacities following a review of results from scenario set 1 by Quinte Conservation staff. In addition, scenario set 2 also includes five hypothetical storage scenarios established for Deerock, Moira, Second Depot, Stoco, and Third Depot Lakes, the inclusion of Kennebec Lake as a reservoir feature with 0.3 m of active storage, and consideration of a scenario where potential evapotranspiration (PET) in 2016 was increased across the model domain by 10 % to test the sensitivity of the surface water system to drought even more severe than that experienced in 2016. A detailed description of the reservoir management regime associated with scenario set 2 is presented in

Table 5. It should be noted that in scenario set 2 the reservoirs are assumed to all be full prior to the scheduled May 1st to Oct 30th, 2016 release of live storage. The description of the individual scenarios and their identifier code that corresponds with the figures in the results section is presented in Table 6.

Table 5. Water surface elevation, storage capacity, and release rate (from July 1 to Oct 30) for the 12 lakes/reservoir/dams under the reference condition, and the modified condition for Deerock, Moira, Second Depot, Stoco, and Third Depot Lakes, as well as the hypothetical storage and release rate for the Lake Kennebec operation scenario.

Lake/Reservoir/Dam		Reference Condition				Modified Condition			
		Elevation		Storage	Release Rate	Elevation		Storage	Release Rate
		Low	High			Low	High		
		mASL	mASL	(m^3)	(m^3/s)	mASL	mASL	(m^3)	(m^3/s)
1	**Beaver**	164.40	167.05	16578001	1.07	-	-	-	-
2	**Big Clear (Arden Dam)**	196.30	196.90	2368300	0.15	-	-	-	-
3	**Deerock**	256.03	259.08	7500000	0.48	256.03	259.38	12861953	0.83
4	**Lingham**	276.42	278.42	19720100	1.27	-	-	-	-
5	**Moira (Downey's Dam)**	154.40	154.70	2560826	0.16	154.40	155.00	5121652	0.330
6	**Roblin**	111.00	112.20	1315600	0.08	-	-	-	-
7	**Second Depot**	156.90	157.50	1040000	0.07	154.00	157.50	6100000	0.39
8	**Skootamatta**	289.09	289.63	8566901	0.55	-	-	-	-
9	**Stoco (Caton's Dam)**	138.30	138.60	1686000	0.11	138.30	138.90	3372000	0.22
10	**Third Depot**	164.30	167.00	5346700	0.34	164.00	167.00	5666400	0.36
11	**Thirteen Island**	150.46	151.00	895441	0.06	-	-	-	-
12	**Varty**	140.80	141.30	3049174	0.20	-	-	-	-
13	***Kennebec**	-	-	1540868	0.10	-	-	-	-

* Hypothetical scenario where 0.3 m of water storage is utilized in Lake Kennebec.

Table 6. Lake/dam/reservoir operation, and potential evapotranspiration conditions, considered in the second set of watershed management scenarios.

Scenario	Description
Base	No reservoir operation
Base + 10 %	No dam/reservoir operation and PET increased by 10 %
S10	Reference dam/reservoir operation (per Table 5)
S11	Reference dam/reservoir operation and PET increased by 10 %
S12	Reference dam/reservoir operation and Lake Kennebec operation added
S13	Modified dam/reservoir operation for structures 3, 5, 7, 9, 10 (per Table 5)

7.2 Scenario Set 2 Results

Time series graphs depicting surface water flow for the June 1st to October 1st 2016 time interval are shown in Figure 33 for the Moira River, Figure 34 for the Salmon River, and Figure 35 for the Napanee River. Average flow rates for the July 1 to October 1, 2016 time interval (summer of 2016), for each of the surface water gauging stations shown in the aforementioned figures, are presented in Table 7.

As the results presented in Table 7 show, when reservoir influences on surface water flow rates are considered, flow rates during the summer of 2016, on average across the model domain, increased by a factor of 3 (i.e. comparing S10 to the Base scenario). Broken down for the three major rivers during the summer of 2016, the Moira R. realized 1.8 times more flow, the Salmon R. realized 1.4 times more flow, and the Napanee R. realized 6 times more flow because of the reservoirs along their respective reaches.

For the scenario where PET is increased by 10 % and reservoir influences are not considered, average flow rates across the model domain decline by 35 % (i.e. comparing Base+10% to the Base scenario); and when reservoir influences are considered, flow rates decline by 14 % (i.e. comparing S11 and S10).

When the modified reservoir operation condition is compared against the reference condition described in Table 5 (i.e. comparing S13 to S10), across the model domain there is a 20 % increase in average flow rates during the summer of 2016; and when broken down for the three individual river networks, the Moira R. experiences a 16 %

increase and the Napanee R. experiences a 61 % increase, while the Salmon R. experiences no change because there are no modified reservoirs along it's course.

When Lake Kennebec is incorporated into the Salmon R. surface water management (i.e. S12), downstream flow rates are shown to increase by 28 % during the summer of 2016 (i.e. comparing S12 and S10).

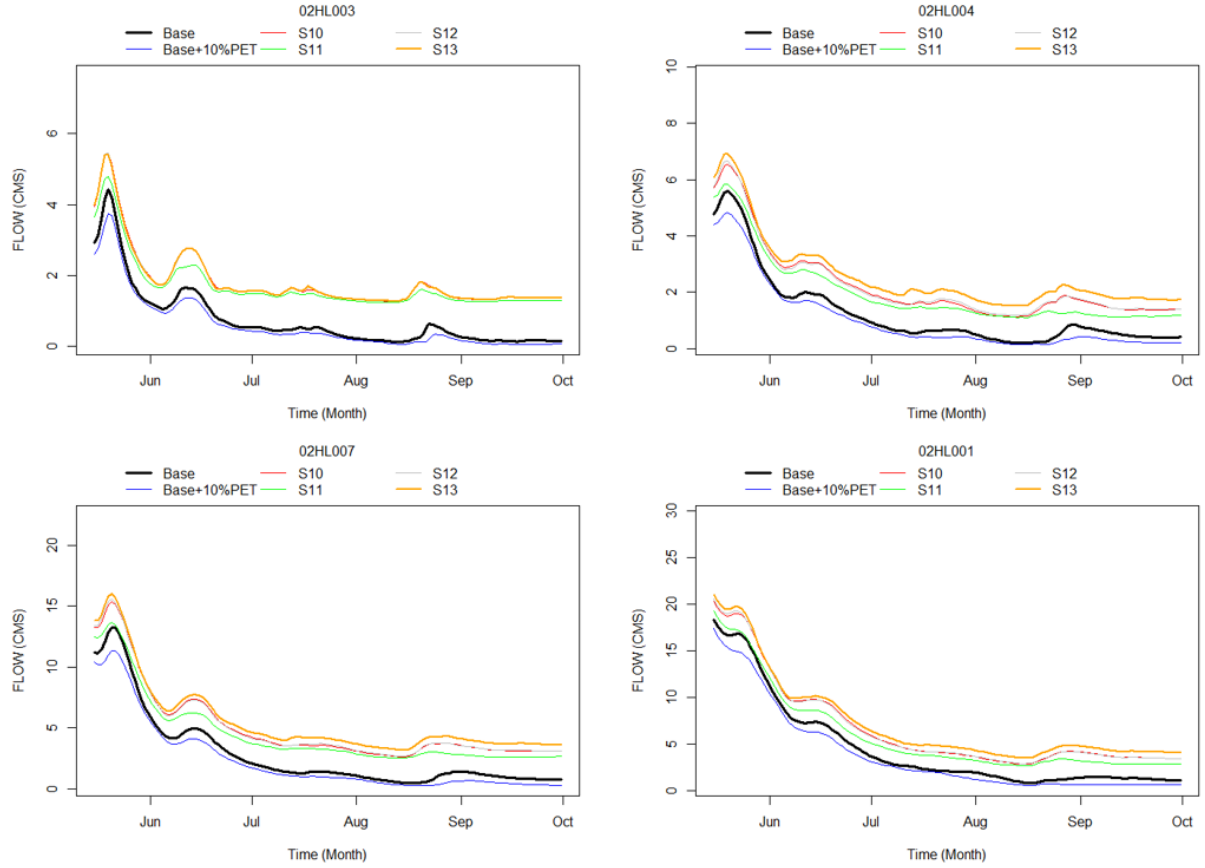

Figure 33. Simulated flow rates at hydrometric stations located along the **Moira River**, during the June to October 2016 time interval, for the **second set of reservoir evaluation scenarios**.

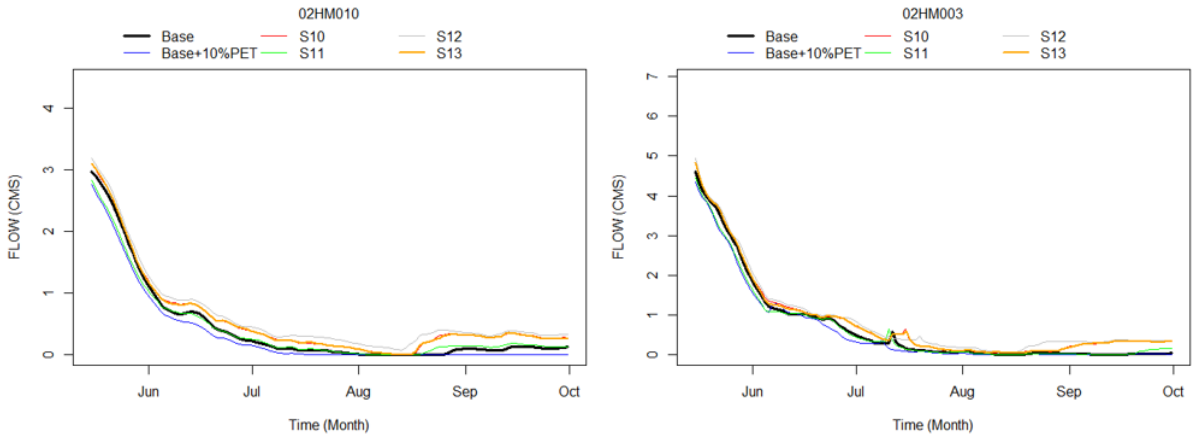

Figure 34. Simulated flow rates at hydrometric stations located along the **Salmon River**, during the June to October 2016 time interval, for the **second set of reservoir evaluation scenarios**.

Test

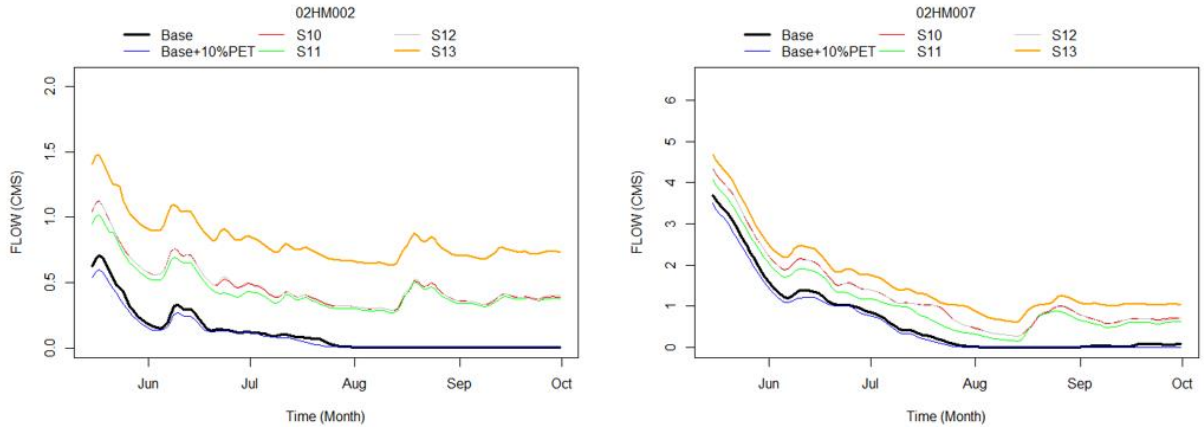

Figure 35. Simulated flow rates at hydrometric stations located along the **Napanee River**, during the June to October 2016 time interval, for the **second set of reservoir evaluation scenarios**.

Table 7. Mean flow rates for the July 1st to October 1st 2016 time interval for the six different scenarios outlined in Table 6.

River	Gauge	Mean Flow Between July 1st and October 1st ($m^3 s^{-1}$)					
		Base	Base+10 %	S10	S11	S12	S13
Moira	02HL003	0.30	0.20	1.43	1.36	1.44	1.44
	02HL004	0.51	0.32	1.49	1.27	1.52	1.87
	02HL007	1.07	0.67	3.32	2.90	3.34	3.86
	02HL001	1.68	1.17	3.84	3.29	3.85	4.47
Salmon	02HM010	0.07	0.01	0.22	0.10	0.29	0.21
	02HM003	0.14	0.11	0.30	0.15	0.37	0.29
Napanee	02HM002	0.03	0.02	0.38	0.36	0.38	0.73
	02HM007	0.13	0.09	0.75	0.61	0.75	1.08

8.0 SUMMARY

In this work, a fully-integrated surface water – groundwater model for the Quinte region watersheds has been developed and validated for its ability to reproduce surface water flow rates over a continuous time interval spanning from January 1, 2011 to Dec 31, 2018, with daily temporal resolution. The model carries high spatial resolution both in the surface (maximum of 200 m nodal spacing along all Strahler 2+ rivers and streams), and in the subsurface (15 soil/hydrostratigraphic layers). In total, 13 active reservoirs have been configured into the model to reflect the influence of surface water controls on low flow conditions. Results from simulations with the reservoirs active demonstrate how the reservoirs play a crucial role in maintaining surface water flow across the region during drought conditions, as well as the relative influence of individual vs. collective reservoir operation. The impact of drought conditions even more severe than those experienced during the summer of 2016 was tested with the model by scaling potential evapotranspiration to be 10% higher than realized 2016 conditions. Furthermore, the unique ability of the model to capture groundwater – surface water interactions has identified that water released from reservoir storage can infiltrate into groundwater, raise antecedent moisture and groundwater levels in hydrostratigraphy within the vicinity of the rivers, and in turn speed up surface water recovery time following summer low-flow conditions.

While the model has only been applied towards a relatively small number of reservoir efficacy assessments in the work herein, it is well configured to address a wide range

of additional questions pertaining to surface water and groundwater resources in the Quinte region.

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Appendix C:

Water Conservation Tips,

Managing Your Well in Times of Shortage &,

Using a Cistern for Residential Water Supply

Quinte CONSERVATION

Conserving Water

Why Conserve Water?

In some areas of Ontario, we use fresh water faster than it can naturally be replenished. This can lead to long-term water shortages. Water conservation practices can save thousands of litres of water per person per year. Saving water is in the best interest of you, your family, the environment and the community - for today and for the future.

With simple changes to current home and business practices we can reduce water consumption by 40% or more. The best way to conserve water is to be aware of how you are using it.

Water Use

The average Canadian household uses over 500,000 litres of water per year, with some estimates showing at least 50% of water use is unnecessary and wasteful. The average person in Ontario uses 285 litres of water a day. In the summer months, 50% of household water is used in the lawn and garden.

The greatest water uses in an average home are:

- toilet (45%)
- showers (30%)
- laundry (20%)
- drinking and cooking (5%)

Saving Water Outdoors

- Only water your lawn if it needs it; if it springs back when you step on it, it does not need watering
- Cut grass to a higher level (5 - 8 cm) to reduce evaporation
- Water vegetable gardens in the morning, near the roots, and by hand

Quinte CONSERVATION
a member of Conservation Ontario

For more information
www.quinteconservation.ca
(613) 968-3434 or (613) 354-3312

Administration Office
2061 Old Hwy. 2, RR # 2
Belleville, ON
K8N 4Z2

- Do not let children play in running water - consider buying a kiddy pool or water toys
- Use a pool cover on your pool when not in use to reduce evaporation
- Install rain barrels on the gutter downspots to catch storm water and use it to water your flower and vegetable gardens or wash the car
- Increase water retention in soil by adding compost or peat and mulching around trees and shrubs to retain moisture
- Only water shrubs and trees once a week if there is no natural rainfall
- Use native grasses and plants in your garden as they require less water
- Pull planters into the shade to avoid the hot afternoon sun
- Plant shade trees to shelter your home and garden from hot sun
- Improve your soil with compost and autumn leaves so it's more nutritious and holds water better
- Set sprinklers to water the lawn, not sidewalks and driveways
- Install a shut-off valve on your hose so it only runs when in use
- Wash the car near your garden or lawn to water your plants at the same time
- Check your sprinkler or irrigation systems regularly for any leaks and fix them
- Wash cars for safety only, (windshield, windows and headlights) using a bucket
- Wash pets outdoors in an area of the yard that needs water
- Use a broom, not a hose to clean off your driveway

Saving Water in the Kitchen

- Install a low-flow faucet aerator - this will reduce water flow by 25-50%
- Soak dishes in soapy water before washing by hand
- When washing dishes, use the least amount of detergent possible - this minimizes rinse water needed
- Fill a bowl with water to wash fruits and vegetables
- Wash only full dishwasher loads
- Load dishes into the dishwasher without rinsing
- Keep a pitcher of water in the fridge rather than running tap water until it is cool enough to drink
- Insulate pipes carrying hot water
- Do not use running water to thaw meat or other frozen foods - defrost food overnight in the refrigerator or by using the defrost setting on your microwave
- Use the right size pot for the job - an oversized pot means more water being heated and more energy being used to do it

Saving Water in the Bathroom

- Turn the tap water off while brushing your teeth, shaving or washing your face
- Install a low-flow shower head
- Use the minimum amount of water needed for a bath by closing the drain and only filling the tub one-third full
- Check the toilet for leaks: add blue food colouring to the tank and wait 15 minutes, if the bowl is blue, there is a leak
- Install low-flow toilets as they account for 45% of indoor water use
- If the toilet flush handle frequently sticks in the flush position, letting water run constantly, replace or adjust it
- When waiting for the shower water to warm up, collect the cold water that precedes the hot in a large bucket then use this water for watering plants or other uses
- Don't flush things down the toilet to dispose of them - throw tissues and other bathroom waste in the garbage can

Learn How to Manage Water Consumption During a Drought

If you own or rent

- Repair all leaks from faucets and toilets;
- Install toilets, dishwashers, shower heads and other low-consumption devices;
- Comply with municipal water use restrictions (eg, lawn watering, car wash);
- Do not let water run unnecessarily. When not using water, turn off the tap. It is a very bad habit to let the water run while you brush your teeth for example;
- Choose drought-resistant plants and trees;
- Use the washing machine or dishwasher only when loaded to capacity.

If you are a farmer

- Regularly check your irrigation system for leaks;
- Irrigate in the evening or late in the day when temperatures are lower and the loss due to evaporation will be lower;
- Avoid irrigating in windy weather;
- Use rain gauges to measure the amount of rain your crops receive;
- Make sure your irrigation system is watering at a rate that allows the soil to absorb water well.
- Identify backup water sources for watering livestock in times of drought,
- Create onsite storage to assist in storing rainwater, spring runoff and/or hauled water during times of drought.

If you work in the manufacturing sector

- Establish a water conservation program;
- Evaluate factory operations;
- Determine ways to increase efficiency.

Prepare for a Drought

Collect water in case of emergency

- Set up a water-rationing plan. In the event of a water cut, it is necessary to ration the water. Severe drought can last for weeks or even months, but by keeping and rationing the water properly, you and your family can hold for several weeks with bottled water:

- Keep at least 4 Liters of water per day per person at home. Note that some people need more water than others, such as children, lactating women, and sick or injured people. This water should only be use as a last resort. Make sure each member of your family knows how much water they are allowed to use in case of drought. If the situation

becomes critical and you do not have enough drinking water, do not ration the water to the point of becoming dehydrated.

- Install a rainwater recovery system. Collect some of the rainwater to enjoy more. It is possible to reuse the rainwater to water your garden or to clean. This will reduce your water bill by the same amount, even if no drought occurs. It is easy to install a rain collector:
    - Get a water tank. They are found in gardening stores, they can generally contain several hundred liters. Get several if you also intend to conserve water.
    - Place the water tank under a gutter and direct the rainwater in it.
    - If you do not have a gutter, place the water tank under a roof edge where water flows when it rains. Rainwater is not to be used for consumption and not a source connected to the household plumbing system.

Advice

Reuse the water. When possible, reuse the water instead of throwing it away. Water can be wasted in different ways in a home. Rather than letting the water run down the drain, get it back to make good use of it. Place a bucket in the shower or sink to catch the water that you let flow in this way. You can then use this water to water the plants rather than using the garden hose or even to flush the toilet.

Managing your water well in times of water shortage

Source: Ministry of the Environment Conservation and Parks - PIBS 3784e

These tips have been prepared as a reference to help private well owners and groundwater users improve existing water supplies or correct groundwater supply problems. In case of water shortage, property owners should assess all available information before determining the best course of action.

These tips have been prepared as a reference to help private well owners and groundwater users improve existing water supplies or correct groundwater supply problems. In case of water shortage, property owners should assess all available information before determining the best course of action.

Bedrock
: Solid rock underlying loose material.

Overburden
: Looser material overlying the bedrock.

Aquifer
: Any geological formation or material capable of yielding water in usable quantities either in the bedrock or the overburden.

All Ontario residents need an adequate water supply that is available at a constant and dependable rate. There are two principal water sources: groundwater, which includes wells and springs; and surface water, which includes natural and manufactured lakes, rivers and streams.

When a well is to be built, an examination of all available water well and hydrogeological records is necessary to determine the most suitable groundwater source.

Wells must be properly installed and maintained to ensure a continuous, safe supply of water.

Wells Regulation 903

Regulation 903 under the *Ontario Water Resources Act* prescribes the minimum construction requirements for the water well industry in Ontario and outlines the roles and responsibilities required of licensed well contractors and well technicians including private well owners in supporting the regulation.

With respect to all activities related to the proper construction of wells, it is recommended that you consult a licensed well contractor. Please consult the Ministry’s list of Ontario’s licensed water well contractors available on the ministry’s website or by contacting the Water Well Help Desk.

Before finalizing a contract with a well contractor, make sure that he or she has a valid licence issued by the Ministry of the Environment and Climate Change, will construct the well in full compliance with *Regulation 903 Wells*, maintains sufficient insurance, and the well technicians hold a valid license with the proper prescribed class(es) for the work involved.

It is also highly recommended that you select a well contractor who can provide reference checks with previous clients in your area, and is willing to sign a written contract.

Groundwater

Groundwater is formed when rain or other precipitation infiltrates the soil and moves down until it reaches the point of saturation. Water fills in the porous spaces between grain particles and fractures in rock. The upper surface of the zone of saturation is called the water table. The depth of the water table depends on the nature of geological materials, the season and the slope of the ground.

The water table level varies from less than a metre below the surface to more than 50 metres. In the zone of saturation, any geological material or formation that is capable of yielding water to wells in usable quantities is called an aquifer. Aquifers may be found in the bedrock as well as in the overburden overlying the bedrock. In the overburden, aquifers consist of materials such as sand and gravel. A coarse saturated gravel formation makes a good aquifer, while a very fine sand and silt formation is indicative of a poorer aquifer that yields water slowly. Aquifers vary in thickness and size. Some may be able to meet the water needs of only a few households, while others can supply entire communities with water.

Water shortages

Water shortages can be caused by a number of different things, including human activities, increased usage and climatic conditions. Often, water shortages are the result of too little precipitation over an extended period of time, usually a season or more. Other climatic factors such as higher than normal temperatures, high winds and low humidity can exacerbate the situation. In periods of water shortage, water levels in shallow wells can have large fluctuations due to climatic conditions. Ground water levels are usually highest during April, as a result of precipitation, and then gradually decline until late September or October. Shallow wells are most vulnerable in dry weather conditions. In extreme cases, water tables will drop below the bottom of the well, resulting in complete loss of water supply.

Questions and answers

The following questions and answers have been prepared to help well owners assess their ground water systems. This information is essential for dealing with groundwater shortages, and gives some options for remediation and/or relief.

Should the top of my well be visible?

A well must always be visible to ensure easy access if remedial work to the pump, or other emergency work, must be done immediately.

You should determine the exact location of the well if you do not already know where it is. This will help when you need to replace any pumping or other equipment. It is advisable to have the casing raised to a minimum height of 40 cm above the ground surface.

How can I measure my well's performance?

The best way to monitor your well's performance is to measure the depth of the water from the top of the well. Regular water level measurements and records will help you analyze any future problems. Record this information, and keep it near your pressure system for quick access.

Measure depth to water (metre/cm, feet/in)

Example:

Date: Jan 1, 1991 – **Depth:** 10m
Date: Feb 1, 1991 – **Depth:** 10m

Is it okay to add surface water or rain water to my well?

Adding water to your well is not recommended. It could contaminate your supply, and will not alleviate your water shortage problems during drought conditions.

If you have added any water of unknown quality, or suspect the quality of the water in your well, you should have the water tested immediately to make sure it is safe to drink.

If I increase my pump size, will my supply of water increase?

You can increase pump size for increased water supply, but it is essential that the pump should not exceed the maximum safe pumping capacity of the well or the specific height to which the pump must raise water.

If your pump is the correct size, and operating properly, replacing it with one that is too large may cause severe damage to the well. This is particularly true in small diameter drilled wells.

Putting a pump with increased pumping capacity into a large-diameter dug or bored well will not provide more water. It will only provide the same amount of water at a faster rate, and your water supply will remain unchanged.

What about the depth to the pump intake in my well?

By knowing the exact depth of your well, as well as the depth of the pump intake, you can maximize the performance of your well. You should keep a record of this important information near your pressure system.

You may find that your pump intake is located too far above the bottom of the well. Lowering it will provide more draw down during pumping, providing more available water. Note: The pump intake should not be lowered to the very bottom of the well.

What should I do if my well is not providing as much water as usual?

If this is the first time you have experienced a water shortage you should check your pump and pressure system for mechanical failure. You should also check your water level, and start keeping a record of water levels in your well.

If you have experienced water shortages in the past, try to remember if they happened during local or regional dry conditions. If not, water shortages may indicate problems associated with your well or pump/pressure system or to the size of the aquifer that your well taps into.

There is more than one well on my property. Why would they have been built?

Previous owners may have experienced water shortages or problems with their existing well(s), and replaced or added to their supply of wells.

How can I obtain water well records for the wells on my property?

If your well was reported to the ministry, you can get a copy of the record from the Ministry of the Environment and Climate Change. The well record search request forms are available on the Government of Ontario Central Forms webite (type "wells" in the search bar) or by contacting the ministry's Water Well Help Desk at 1 888 396-9355. A search fee applies to all requests.

Once you have the records for a well, note the information on its construction, the static water level at the time of construction, the specific capacity of the well and the pump setting depth. Then note any changes that have occurred since it was built. The information contained in your record may serve as good baseline information in the assessment of your site specific conditions.

How can I be sure the pump and pressure system in my well are functioning properly?

You should have your pump and pressure system checked regularly by a licensed well contractor, and repaired if necessary, to ensure they are not the source of your water shortage problem. The age and condition of your pump and pressure system may directly affect the supply of water from your well. It is advisable to also check your distribution system (water lines) for leaks, clogging, etc.

I'm using more water than I used to. Could this affect my water supply?

Yes. Water shortages are sometimes a direct result of increased water usage. When a well is built there is a calculated maximum safe yield that it can produce. Pump and pressure systems are selected to match the specific capabilities of the well. If water demand increases, and exceeds the maximum safe yield of the well, problems are likely, including water shortages. You can find out if this is the cause of the problem by checking the well's static water level.

Could my water shortage be the result of increased use of water in the area?

You can ask your nearest Ministry of the Environment and Climate Change regional office for information about increased water takings in your area. But first make sure that:

- your water shortage is not caused by local or regional climatic conditions
- you have not increased your own water consumption
- you have eliminated your pump/ pressure system as the cause
- you have eliminated any other possible causes of your water shortage as identified above
- you have confirmed that your static water level is lower than normal

Could the remedial work I've done on my well affect its water supply?

Remedial work such as the replacement of a pump, changes to the pump setting depth or to the diameter of the well (liner installations), or well rehabilitation (screen work) - can have an effect on your water supply. You may want to check with your licensed well contractor to establish whether any water yield changes could be expected as a result of the work.

What about work in the vicinity of my well?

Development in the vicinity of your well, such as paving or building construction, could affect the ground surface around your well the ability of the ground to absorb water may be impaired.

If I need a new well to provide more water, what type of well should I construct?

If you need to build a second or replacement well you should review water well records and other hydrogeological information for your area. This will give you essential information such as depth to water pumping test data and static water levels, which in turn will help you determine the type of well you should build.

Will deepening my existing well provide more water?

In some circumstances making your existing well deeper can provide more water. You may find additional groundwater and also provide additional draw down. However, caution should be exercised if the area is known to have poor quality natural water at depths lower than high

quality fresh water. If this is the case, deepening the well and penetrating a formation with poor quality water may cause contamination to the freshwater formation. This could make your well unusable and cause wider contamination of a previously high quality aquifer, as well as have long term impacts on other wells in the area.

What are my responsibilities regarding wells on my property?

Well owners are obliged to maintain all wells on their properties. If a well is not being properly maintained, the well owner must have it plugged and sealed in accordance with *Regulation 903*. Secure caps and lids must be maintained on the top of any well which is not plugged. If you are unsure of the condition of the well cap or lid, have it inspected by a licensed well contractor and replaced or upgraded if necessary. This is to help protect and preserve ground water resources and minimize safety risks. *Regulation 903* details all requirements regarding well construction, maintenance and abandonment.

How do I measure the static water level in my well?

Important: do not pump water for several hours before you measure your well's static water level, or you will get a false reading.

Measure the water level with a survey tape or electrical measuring tape especially designed to measure water levels. You can make a home-made electrical measuring tape by using plain electrical wire with both ends exposed. Connect an ohmmeter to the upper end of the wire, and lower the wire into the well. When the bottom end of the exposed wire penetrates water it will move the meter at the upper end, because a closed circuit has been created. Mark this point on the wire with a small piece of tape. Then remove the wire from the well, and measure from the bottom of the wire to the exact point where the meter moved. This will tell you where the water level is below the top of the casing. If you repeat the process and obtain the same measurements, the water level is static. If the water level is moving up or down, continue to measure until you have at least two consecutive identical water levels.

This electrical device should be used only for measuring water levels in a well and should not be connected to any other electrical device or outlet.

Remedial options to consider during periods of drought

Implement water conservation practices. A thorough review of your water consumption practices and an assessment of all the components in your pressure and plumbing system may show where significant savings and improvements are possible. Efficiencies can be realized by all water consumers, whether their uses are domestic, commercial or agricultural.

Lower your pump or pump intake deeper into the well. Before making any adjustment to the pump intake depth, you should check your pump's specifications, or consult a licensed well

contractor, to determine the maximum recommended depth and pumping rate for your well. Lowering the intake depth could directly affect the pumping rate and efficacy of your pump.

Change your pump. If your existing pumping equipment cannot achieve the recommended pumping rate, consider a larger pump. It is very important, however, that the larger pump should not exceed the maximum safe pumping rate for the well. Too large a pump could cause irreparable damage to your well. A qualified pump supplier or well contractor should be consulted to determine your specific needs.

Increase pressure tank size. A larger (or additional) pressure tank will provide additional water storage in the pressure system. This additional storage may provide sufficient water during a dry period.

Rehabilitate your well. If, before drought conditions existed, your well exhibited decreased yield while maintaining its static water level, it could be an indication of partial plugging of the bottom of your well. This is particularly true of drilled wells or drilled wells with screens. A well contractor familiar with the different causes of well plugging and rehabilitation methods will tell you what is needed, possibly including pre-treatment pumping tests and water analysis.

Deepen the existing well. If your area is experiencing water shortage as a result of drought conditions, before making the decision to deepen your well you should review water well records and/ or hydrogeological information for your immediate area. They will help you establish whether fresh water aquifers exist at depths below the depth of your well. Water well records are available by contacting the Water Well Help Desk.

Put in a temporary above-ground water storage tank. If your water shortage or increased shortage needs are temporary, an above-ground water storage tank can provide short term relief. Be sure to check that the source of the water to be stored is potable, and test it at regular intervals. Frost protection for above ground storage tanks and temporary water lines may be necessary during cold periods.

Construct a new well. If you have done remedial work on your well and continue to experience water shortage problems, you may consider building a new well. Before deciding on a new well you should review water well records and/or hydrogeological information for your area in order to locate additional aquifers on your property.

Safety issues

If you will be doing any work in or around your well you should be aware of several important safety issues:

- Never enter a well pit without taking safety precautions – A well pit is an enclosed and confined space where natural gases can displace oxygen. Entering such a well pit could result in suffocation. Also, if natural gases such as methane are present, explosions can occur.

- Secure well covers and/or caps must be replaced after any work has been conducted on a well – It is essential that wells are properly covered to prevent accidents and injury.
- Turn off all electrical power going to your well, pump and pressure system or pump house before measuring the water level to avoid the risk of shock or electrocution.
- Ensure good ventilation – Methane gas can be explosive, so if your well water contains methane gas, there must be good venting to the outside atmosphere for the entire pressure system.

Additional information sources

You can obtain a copy of *Regulation 903* from the e-Laws website or by calling Publications Ontario at 1-800-668-9938. The following information sheets are available from the Ministry of the Environment and Climate Change Web site or by calling its Public Information Centre:

- The protection of water quality in drilled wells
- The protection of water quality in bored and dug wells
- The protection of water quality in jetted, or driven point wells
- Important facts about water well construction

For further information about wells contact the Water Well Help Desk at 1-888-396-9355 (Toll Free in Ontario) or your nearest Ministry of the Environment and Climate Change office listed in the blue pages of your telephone directory.

You can also call the ministry's Public Information Centre at 1-800-565-4923 or 416-325-4000 or visit the ministry's website.

Source: Ministry of the Environment Conservation and Parks - PIBS 3784e

Using a Cistern for Residential Water Supply

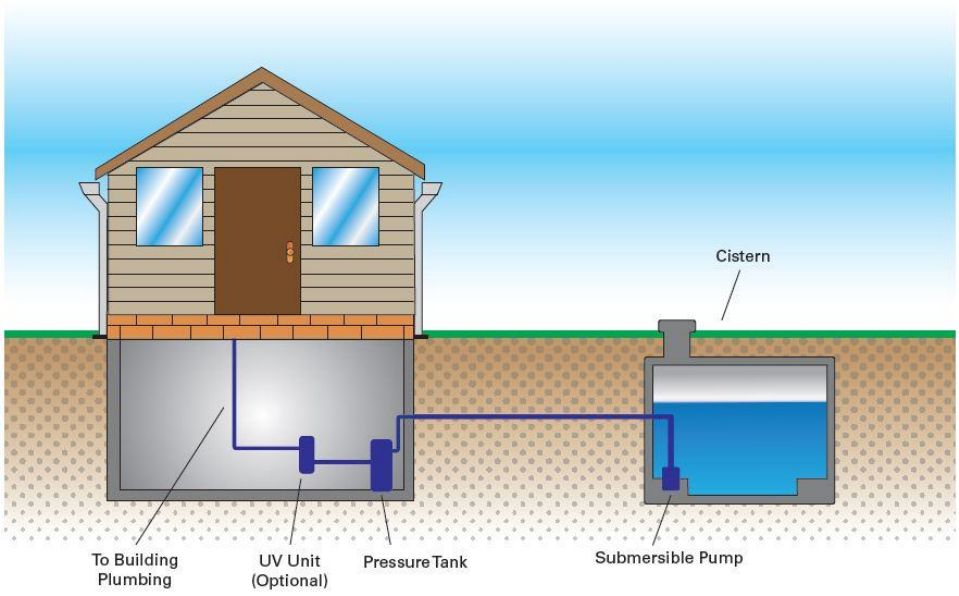
In some areas rural residents require the use of cisterns to allow the storage of hauled water to meet their water needs. A properly constructed cistern filled with municipally treated water by an approved water hauler should provide water that is safe. The use of a cistern will require periodic inspection, cleaning and disinfection. The local Health Unit and Municipal building officials should be consulted in regards to the use, operation and maintenance of a cistern. The following general information has been provided.

Cistern Container

All systems that receive transported water must ensure that the storage container, e.g., cistern, water tanks or reservoir, is constructed using materials, including the surface coating, that do not contain any impurities that could dissolve into the drinking water. It must be maintained in a manner that prevents surface water and other foreign materials from coming into contact with the treated water.

Ensure that the cistern is not connected to the rainwater drain system, as contaminants from the roof will contaminate the cistern water. Cisterns should also have a screened vent to allow proper pressure within the tank and prevent insects or vermin from entering the vent. Since some cisterns are below ground, common weaknesses in cistern construction include improperly installed vents or below ground level cracks or damage due to improperly protected cistern covers. Vents and covers are above ground and are vulnerable to damage by cars and snow removing equipment. A cistern must be installed by a qualified contractor and follow relevant codes such as the Canadian Standards Association (B126 Series-13).

Figure 1 – Typical outside cistern



To prevent water from freezing, cisterns are usually buried below the frost line or located inside of a heated building such as the basement of a home. Cisterns must have an access point, a water tight lid, a fill point and a vented overflow pipe. Cisterns need to be sized according to anticipated demand and keeping in mind that the longer water is stored the greater the risk of stagnant water and potential microbiological contamination.

Testing & Inspection

Keeping water safe will require periodic testing and inspection, cleaning and disinfection of the cistern. The water from a cistern should be tested seasonally for microbiological potable water quality in accordance with the instructions and service provided by the local Health unit.

- Inspect the cistern annually (without entering) for sediment, bio-film (slimy coating), debris, cracks and seepages, improper fitting lids and broken vent screens. Check the cistern opening and the area around the cistern to ensure there are no cracks or damage which could allow surface contamination to enter the cistern. Also ensure the ground around the cistern slopes away from the hatch and any vents, and that the hatch seal is in good condition and prevents surface water or vermin from entering the cistern.
- Test the water after the following:
    - Any repairs,
    - The water has not been used for an extended period of time,
    - After flooding,
    - Change in surrounding land use and,
    - If there is a change in water clarity, color, odour or taste.
- Stop drinking the water if the testing results indicate the water is unsafe. Inspect the cistern and correct any problems and retest the water. If the resampling indicates the water remains unsafe then the cistern may need to be cleaned and disinfected (see procedure below).
- Chronic unsafe test results may indicate the need to install proper water treatment equipment. This must be done by a qualified professional.

Operation and Maintenance

Always maintain a cistern in a state that will prevent the entrance of bugs, rodents and surface runoff. Filling with a source of municipally treated water by an approved water hauler should provide clean safe water. However cleaning and maintenance is required and may include the following:

- Cisterns should be emptied and cleaned every few years as sediment may collect and biofilms may form over time, causing bacteria to grow in the cistern. The cleaning frequency depends on the source water quality and whether the cistern is only used seasonally, in which case it is recommended you disinfect annually with chlorine. The local health unit should be consulted regarding how to best clean and disinfect a cistern (a possible method is

provided below). **Under <u>NO Circumstances</u> should an untrained person enter a cistern, see Safety Alert Below.**

- Disinfect the cistern after a cleaning has been performed or any of the following activities:
    - If the cistern has or may become contaminated,
    - If water testing indicate the cistern is contaminated,
    - If an inspection indicates that there is reason for concern.
- Disinfection of a cistern should be completed following the guidelines of the local Health Unit. This is typically done by adding the proper amount of household bleach and mixing in the system by a method such as described below.
- Do not direct rainwater into the cistern. The bacteria from bird and animal droppings, dust, leaves and residues from roofing materials can contaminate the cistern.

Although treatment may not be necessary, it is recommended that Point of Entry (POE) treatment units be installed. POE equipment, most commonly ultraviolet (UV) treatment, is designed to provide primary disinfection. It is installed at or near where the water enters a building or water system and is connected to the plumbing associated with that building or structure.

Possible Cleaning and Disinfection Guideline for Private Residential Cisterns

1. Consult with the local Health Unit and/or hire a qualified professional to perform this task.

2. Drain the drinking water cistern completely. Do NOT use a sewage hauler to pump out the drinking water cistern.

3. Wash all internal surfaces. Use a pressure washer with a mild, food-grade detergent to remove all dirt from the interior of the drinking water cistern (see Safety Note below).

4. Examine all seals, surfaces and the floor for signs of cracks and leaks.

5. Rinse the inside of the cistern with potable drinking water to remove the remaining dirt, debris and detergent residue.

6. Discard all rinse water.

7. Follow the disinfection or sanitization procedures below.

Disinfection Procedure

1. Disconnect all water treatment equipment such as water filters and softeners from the cistern.

2. Fill the cistern half full with potable water.

3. Add chlorine to the cistern to achieve a 20 mg/L chlorine solution strength in the water. If using unscented household bleach (5.25%), add 400 ml of unscented household bleach into the cistern for every 1000 L of water cistern total volume.

4. Add more potable water to the cistern until it is full.

5. Run water through the taps until you can smell the chlorine. Do not run chlorinated water through water treatment equipment (e.g., softeners, carbon filters, reverse osmosis systems). Contact your equipment manufacturer/dealer for more information.

6. Leave the chlorinated water in the cistern and piping for 24 hours. Water MUST NOT BE CONSUMED during this process. This water should not be used for laundry or bathing. An alternative supply of drinking water, such as bottled water, should be used. .

7. After 24 hours, drain the chlorinated water from the cistern and flush the drinking water system with potable water. See below for “Disposing of Heavily Chlorinated Water”.

9. Fill the cistern with potable water.

Disposing of Heavily Chlorinated Water

Flush the tank or cistern by pumping the water through an outside hose. Dispose of the chlorinated water away from grass, shrubs, trees and other sensitive plants until the strong smell of chlorine disappears. Make certain that the water does not enter a natural watercourse. Do not dispose of rinse water or heavily chlorinated water in an onsite wastewater treatment system. Consult a public health officer for acceptable disposal options of significant volumes (i.e. more than household use) of highly chlorinated water

Important Safety Note:

Do not enter any cistern or tank as there may be dangerous concentrations of hazardous gases or insufficient oxygen that could result in death. All cisterns or tanks should be considered a “confined space,” which poses severe dangers to human or animal life. No one should enter a cistern to perform maintenance unless they are properly trained in confined space entry and properly equipped with the air testing, ventilation and rescue equipment. Proper confined space entry procedures should be used at all times. No matter how clean the cistern or tank may appear, these dangers are not able to be detected by human sight or smell. The homeowner should only undertake those activities that do not require entry into the cistern or tank. For example, after emptying, the walls may be washed down with a garden hose, wand or a pressure washer, while working from outside the tank. The wash water can be removed using a submersible pump and discharged into an open outside area. This may have to be done more than once to adequately remove settled material.

Appendix D:

Low Water Posters

NOTICE:

A *LOW WATER STATEMENT* IS IN EFFECT.

LOW WATER CONDITION
Level 1

LEVEL 1 - **CAUTIOUS** use of non essential water
reduce water consumption by 10%

Reduce water use for lawn care.

Turn off running water when not in use.

Reduce water use for vehicle care.

Reduce shower times.

Quinte CONSERVATION

QuinteConservation.ca

Every DROP COUNTS - REDUCE YOUR USE -

NOTICE:

A *LOW WATER STATEMENT* IS IN EFFECT.

LOW WATER CONDITION
Level 2

LEVEL 2 - **REDUCE** non essential water use
reduce water consumption by 20%

Limit water use for lawn care.

Turn off running water when not in use.

Limit water use for vehicle care.

Reduce shower times.

Quinte CONSERVATION

QuinteConservation.ca

Every DROP COUNTS
- REDUCE YOUR USE -
#WATERCONSERVATION

NOTICE:

A *LOW WATER STATEMENT* IS IN EFFECT.

LOW WATER CONDITION
Level 3

LEVEL 3 - **STOP** non essential water use
reduce water consumption by 30%

Stop water use for lawn care.

Turn off running water when not in use.

Stop water use for vehicle care.

Reduce shower times.

Quinte CONSERVATION

QuinteConservation.ca

Every DROP COUNTS
- REDUCE YOUR USE -

Appendix E:

Sample Water Restriction Bylaws-

Private Wells & Municipal Water

Sample Water Restriction Bylaw-Private Wells

THE CORPORATION OF THE [redacted]

By-Law No. 3[redacted]

A BY-LAW TO REGULATE THE TIME, MANNER AND NATURE OF USE OF THE SUPPLY OF WATER FROM PRIVATE WELLS, CISTERNS, LAKES AND IN BULK FORM FROM A MUNICIPAL DRINKING WATER SYSTEM DURING A LEVEL 3 LOW WATER CONDITION FOR PROPERTIES LOCATED IN THE [redacted] WHICH ARE NOT SERVICED BY THE CORPORATION [redacted] MUNICIPAL DRINKING WATER SYSTEMS

WHEREAS many of the [redacted] inhabitants obtain drinking water from private wells, cisterns, lakes or in bulk form from the municipal drinking water systems;

WHEREAS the supply of natural water is an interconnected system that can be negatively affected by a low water condition (drought) and affect the available supply of drinking water of all inhabitants of the municipality;

WHEREAS in the interest of protecting the health, safety, and well-being of the inhabitants of the municipality the Council deems it necessary to restrict the unnecessary or cosmetic use of the municipality's water resources;

AND WHEREAS the *Municipal Act, 2001*, Revised Statutes of Ontario Chapter 25, as amended, provides Council may pass such by-laws and make such regulations for the health, safety, and well-being of the inhabitants of the municipality

AND WHEREAS Council in the public interest deems it necessary and expedient to regulate the time, manner and nature of the use of the supply of water for properties located within the [redacted] during a Level Three (3) drought condition enacts this By-Law;

NOW THEREFORE THE COUNCIL OF THE CORPORATION OF THE [redacted] HEREBY ENACTS AS FOLLOWS:

1. DEFINITIONS

Definitions for the purpose of this By-Law:

1.1 "Corporation" shall mean the Corporation of [redacted].

1.2 "Council" shall mean Municipal Council of the Corporation of the [redacted]

1.3 "Ontario Low Water Response Program" shall mean the Provincial program intended to monitor precipitation and streamflow data in the Province and provide a framework for responding to local low water levels conditions and administered locally by the Quinte Conservation Authority or the Low Water Response Team;

1.4 "Owner" shall mean and include the registered owner of a property, a lessee, tenant, mortgagee in possession or any person, organization or corporation, assessed tenant, occupant or any person having an interest whether equitable or legal in the land otherwise in charge of the property, acting as the authorized agent of the owner;

1.5 "Serviced" shall mean properties receiving drinking water distributed by the Corporation of the [redacted] municipal systems.

1.6 "Water" shall mean, for the purposes of this by-law, the supply of water from wells, cisterns, storage tanks, lakes, water bodies, streams or in bulk from the [redacted] municipal system.

1.7 "Water Response Team" shall mean the subgroup assembled by Quinte Conservation Authority in response to a low water level condition as provided for in the Ontario Low Water Response Program;

2. WORDS AND PHRASES

2.1 Where words and phrases used in this By-Law are defined in the *Municipal Act* but not defined by this By-Law, the definitions in the *Municipal Act* shall apply to such words and phrases.

3. WORD USAGE

3.1 As used in the By-Law, words used in the present tense include the future, words used in the masculine gender include the feminine and neuter; and the singular number includes the plural and the plural the singular.

3.2 The headings and subheadings used in this By-Law shall be deemed to be inserted for convenience of reference.

4. RESTRICTIONS

4.1 No person shall, when a Level Three (3) condition is declared by the Water Response Team under the Ontario Low Water Response Program,

4.1.1 Permit, allow or cause to permit the outdoor use of water, such the watering or sprinkling of any lawn, garden, tree, shrub or other outdoor plant, vegetation or washing of any vehicle, driveway or building, at any time except in accordance with the provision of Section 5 and 6 of this By-Law;

4.1.2 fill or top off or cause to be filled up or topped off a swimming pool at any time except in accordance with the provision of Section 5 and 6 of this By-Law;

4.1.3 hinder or obstruct, or cause or procure to be hindered or obstructed the Corporation, or any of its officers, contractors, agents, servants or workers, in the exercise of any of the powers conferred by this By-Law;

4.1.4 let off or discharge water so that the water runs wastefully;

4.1.5 being owners, tenants, lessees and occupants of any house, building or other place, improperly waste water or, without the consent of the Corporation, sell or dispose of the water;

4.1.6 Permit, allow or cause to permit the outdoor use of water, such the watering or sprinkling of any lawn, garden, tree, shrub or other outdoor plant, vegetation or washing of any vehicle, driveway or building at any time during the restricted period or times pursuant to Section 7 of the By-Law;

5. WATER SUPPLY REGULATIONS

5.1 No person shall use water for the purpose of outdoor watering by hose, pipe or attachment at any time during a Level Three (3) drought condition except as provided for hereunder:

5.1.1 all owners, tenants, lessees and occupants of any properties with municipal addresses of an even number shall be permitted to conduct outdoor water use and fill or top off a swimming pool only on even calendar days of the month between the hours of 6:00 a.m. and 10:00 a.m. and between the hours of 6:00 p.m. and 10:00 p.m.

5.1.2 That all owners, tenants, lessees and occupants of any properties with municipal addresses of an odd number shall be permitted to conduct outdoor water use and fill or top off a swimming pool only on odd calendar days of the month between the hours of 6:00 a.m. and 10:00 a.m. and between the hours of 6:00 p.m. and 10:00 p.m.

6. EXCEPTIONS

6.1 Notwithstanding Section 5, outdoor water use is permitted at any time for the following:

6.1.1 newly planted replacement sod, trees, ornamental shrubs and newer gardens while being installed and during the following 24 hours after the completion of installation;

6.1.2 lawns being treated with any pesticide, herbicide spray or fertilizer which requires water while being treated and during the next following 24 hours after the application;

6.1.3 newly laid sod on any property for a period of two weeks after the sod is first laid.

6.1.4 agricultural production and livestock watering purposes;

6.1.5 municipal firefighting purposes;

6.1.6 mixing of building materials, provided the quantity and manner is reasonable;

6.1.7 any holder of a valid Permit To Take Water issued by the Province pursuant to the *Ontario Water Resources Act*.

7, ADDITIONAL RESTRICTIONS

7.1 The Chief Administrative Officer or his/her designate may invoke additional restrictive measures beyond these contained in this By-Law. Such additional restrictions shall be enforced under the authority of this By-Law.

7.2 No person shall take, or permit the taking, of bulk water from [redacted] Lake for transport to another area.

8. VALIDITY AND SEVERABILITY

8.1 If any term or provision of this Bylaw or the application thereof to any person shall to any extent be held to be invalid or unenforceable by any court or tribunal having jurisdiction, the remainder of this Bylaw or the application of any provision of this Bylaw to all persons other than those to whom it was held to be invalid or enforceable, shall not be affected thereby and each term and provision of this Bylaw shall be separately valid and enforceable to the fullest extent permitted by law;

8.2 Whenever any reference is made in this By-Law to a statute of the Legislature of the Province of Ontario, such reference shall be deemed to include all subsequent amendments to such statute and all successor legislation to such statute.

9. PENALTIES

9.1 Any person who contravenes any provision of this By-Law is guilty of an offence and the offence is hereby designated as a continuing offence.

9.2 A person convicted of an offence contrary to the provisions of this By-Law is liable to a fine of no less than $500 and no more than $10,000 for each day or part of a day on which the offence occurs or continues provided that the total daily fines for the continuing offence shall not exceed $100,000.

10. ENFORCEMENT

10.1 This By-Law shall be enforced by a Municipal Law Enforcement Officer of the Corporation of the [redacted] or any other officer appointed for the purposes of enforcing this By-Law.

11. SHORT TITLE

11.1 This By-Law shall be cited as the LOW WATER CONDITION WATER RESTRICTION BY-LAW (NON-MUNICIPAL WATER SERVICED AREAS).

12. FORCE AND EFFECT

12.1 This By-Law shall take effect and become in full force and effect pursuant to the provisions and regulations made under the *Municipal Act*, Revised Statutes of Ontario 2001, as amended.

[redacted] third time and finally passed this 11th day of August, 2016.

[redacted]

R[redacted]

[redacted]

Sample Water Restriction Bylaw-Municipal Water

THE CORPORATION OF THE [redacted]

By-Law No. 3[redacted]

A BY-LAW TO REGULATE THE TIME, MANNER AND NATURE OF USE OF THE SUPPLY OF WATER FOR PROPERTIES SERVICED BY THE CORPORATION OF THE [redacted] MUNICIPAL DRINKING WATER SYSTEMS

WHEREAS [redacted] is responsible for the operation and management of the County's municipal drinking water systems;

AND WHEREAS the *Municipal Act, 2001*, Revised Statutes of Ontario Chapter 25, as amended, provides Council may pass such by-laws and make such regulations for the health, safety, and well-being of the inhabitants of the municipality;

WHEREAS the *Municipal Act, 2001*, Revised Statutes of Ontario Chapter 25, Section 425, as amended, provides that municipalities may pass By-Laws for the supply, control, shutting off and distribution of public utilities such as drinking water;

AND WHEREAS Council in the public interest deems it necessary and expedient to from time to time regulate the time, manner and nature of the use of the supply of water for properties serviced by the Corporation of [redacted] municipal drinking water systems;

NOW THEREFORE THE COUNCIL OF THE CORPORATION OF THE [redacted] HEREBY ENACTS AS FOLLOWS:

1. DEFINITIONS

Definitions for the purpose of this By-Law:

1.1 "Corporation" shall mean the [redacted].

1.2 "Council" shall mean Municipal Council of the [redacted]

1.3 "Ontario Low Water Response Program" shall mean the Provincial program intended to monitor precipitation and streamflow data in the Province and provide a framework for responding to local low water levels conditions and administered locally by the Quinte Conservation Authority or the Low Water Response Team;

1.4 "Owner" shall mean and include the registered owner of a property, a lessee, tenant, mortgagee In possession or any person, organization or corporation, assessed tenant, occupant or any person having an interest whether equitable or legal in the land otherwise in charge of the property, acting as the authorized agent of the owner;

1.5 "Serviced" shall mean properties receiving drinking water distributed by the Corporation of the [redacted] municipal systems.

1.6 "Water" shall mean, for the purposes of this by-law, the supply of water from the [redacted] municipal system.

1.7 "Water Response Team" shall mean the subgroup assembled by Quinte Conservation Authority in response to a low water level condition as provided for in the Ontario Low Water Response Program;

2. WORDS AND PHRASES

2.1 Where words and phrases used in this By-Law are defined in the *Municipal Act* but not defined by this By-Law, the definitions of the *Municipal Act* shall apply to such words and phrases.

3. WORD USAGE

3.1 As used in the By-Law, words used in the present tense include the future, words used in the masculine gender include the feminine and neuter; and the singular number includes the plural and the plural the singular.

3.2 The headings and subheadings used in this By-Law shall be deemed to be inserted for convenience of reference.

4. RESTRICTION

4.1 Where notice has been given by the County, or when a Level Three (3) condition is declared by the Water Response Team under the Ontario Low Water Response Program, no person shall,

4.1.1 Permit, allow or cause to permit the outdoor use of water, such the watering or sprinkling of any lawn, garden, tree, shrub or other outdoor plant, vegetation or washing of any vehicle, driveway or building, from the Corporation of [redacted] drinking water system through a hose, pipe or other attachment at any time except in accordance with the provision of Section 5 and 6 of this By-Law;

4.1.2 fill or top off a swimming pool at any time except in accordance with the provision of Section 5 and 6 of this By-Law;

4.1.3 hinder or obstruct, or cause or procure to be hindered or obstructed the Corporation, or any of its officers, contractors, agents, servants or workers, in the exercise of any of the powers conferred by this By-Law;

4.1.4 let off or discharge water so that the water runs wastefully;

4.1.5 being owners, tenants, lessees and occupants of any house, building or other place supplied with water from the waterworks, improperly waste the water or, without the consent of the Corporation, lend, sell, or dispose of the water, give it away, permit it to be taken or carried away, use or apply it to the use or benefit of another, or to any use and benefit other than the person's own or increase the supply of water agreed for;

4.1.6 altar any meter placed upon any service pipe or connected herewith, within or without any building or other place, so as to lessen or alter the amount of water registered; or

4.1.7 lay or cause to be laid any pipe or main to communicate with any pipe or main of the waterworks or in any way obtain or use the water without the consent of the Corporation;

4.1.8 Permit, allow or cause to permit the outdoor use of water, such the watering or sprinkling of any lawn, garden, tree, shrub or other outdoor plant, vegetation or washing of any vehicle, driveway or building from the Corporation of the C[redacted] drinking water system through a hose, pipe or other attachment at any time during the restricted period pursuant to Section 7 of the By-Law;

5. WATER SUPPLY REGULATIONS

5.1 No person shall use water for the purpose of watering by hose, pipe or attachment at any time except as provided for hereunder:

5.1.1 That all owners, tenants, lessees and occupants of any properties serviced by the Corporation of the [redacted] drinking water system with municipal addresses of an even number shall be permitted to conduct outdoor watering and fill or top off a swimming pool on even calendar days of the month between the hours of 6:00 a.m. and 9:00 a.m. and between the hours of 6:00 p.m. and 9:00 p.m.

5.1.2 That all owners, tenants, lessees and occupants of any properties serviced by the Corporation of the [redacted] drinking water system with municipal addresses of an odd number shall be permitted to conduct outdoor watering and fill or top off a swimming pool on odd calendar days of the month between the hours of 6:00 a.m. and 9:00 a.m. and between the hours of 6:00 p.m. and 9:00 p.m.

6. EXCEPTIONS

6.1 Notwithstanding Section 5, outdoor water use is permitted for the following:

6.1.1 newly planted replacement sod, trees, ornamental shrubs and newer gardens while being installed and during the following 24 hours after the completion of installation;

6.1.2 lawns being treated with any pesticide, herbicide spray or fertilizer which requires water while being treated and during the next following 24 hours after the application;

6.1.3 newly laid sod on any property for a period of two weeks after the sod is first laid;

6.1.4 mixing of building materials, provided that the quantity and manner is reasonable;

6.1.5 for municipal operational purposes;

6.1.6 agricultural production and livestock watering purposes.

7, ADDITIONAL RESTRICTIONS

7.1 The Chief Administrative Officer or his/her designate may invoke additional restrictive measures beyond those contained in this By-Law. Such additional restrictions shall be enforced under the authority of this By-Law.

7.2 In the event that any portion of the water works system is disabled, damaged, unable to function or for any other reason, the Chief Administrative Officer or his designate may, at his sole discretion, curtail the use of water and prescribe the manner in which water may be used.

7.3 Due to system operational conditions no person shall fill or top off a swimming pool at any time within the [redacted] water supply systems;

8, REPEAL

8.1 By-law 551-2000 is hereby repealed.

9. VALIDITY AND SEVERABILITY

9.1 If any term or provision of this Bylaw or the application thereof to any person shall to any extent be held to be invalid or unenforceable by any court or tribunal having jurisdiction, the remainder of this Bylaw or the application of any provision of this Bylaw to all persons other than those to whom it was held to be invalid or enforceable, shall not be affected thereby and each term and provision of this Bylaw shall be separately valid and enforceable to the fullest extent permitted by law;

9.2 Whenever any reference is made in this By-Law to a statute of the Legislature of the Province of Ontario, such reference shall be deemed to include all subsequent amendments to such statute and all successor legislation to such statute.

10. PENALTIES

10.1 Any person who contravenes any provision of this By-Law is guilty of an offence and the offence is hereby designated as a continuing offence.

10.2 A person convicted of an offence contrary to the provisions of this By-Law is liable to a fine of no less than $500 and no more than $10,000 for each day or part of a day on which the offence occurs or continues provided that the total daily fines for the continuing offence shall not exceed $100,000.

11. ENFORCEMENT

11.1 This By-Law shall be enforced by a Municipal Law Enforcement Officer of the Corporation of the [redacted] or any other officer appointed for the purposes of enforcing this By-Law.

12. SHORT TITLE

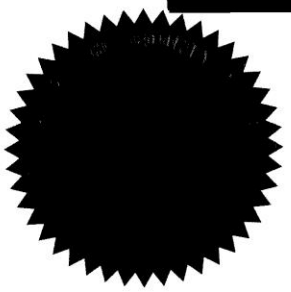
12.1 This By-Law shall be cited as the LOW WATER CONDITION WATER RESTRICTION BY-LAW (SERVICED AREAS).

13. FORCE AND EFFECT

13.1 This By-Law shall take effect and become in full force and effect pursuant to the provisions and regulations made under the *Municipal Act*, Revised Statutes of Ontario 2001, as amended.

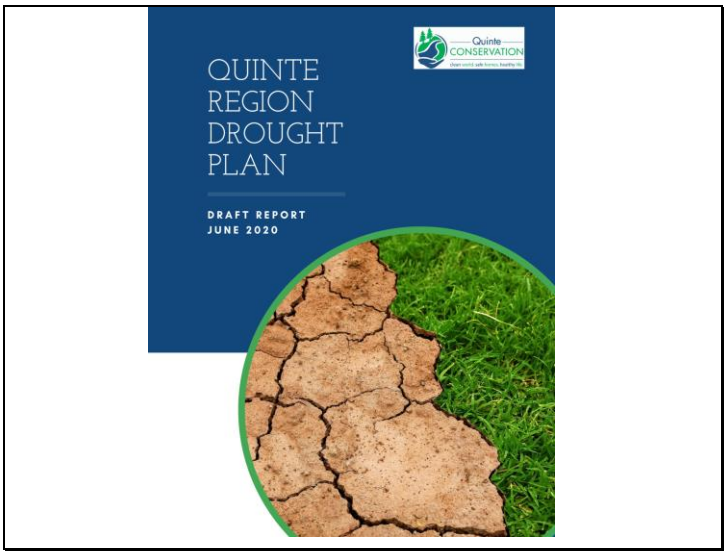
R[redacted]rd time and finally passed this 11th day of August, 2016.

[redacted]

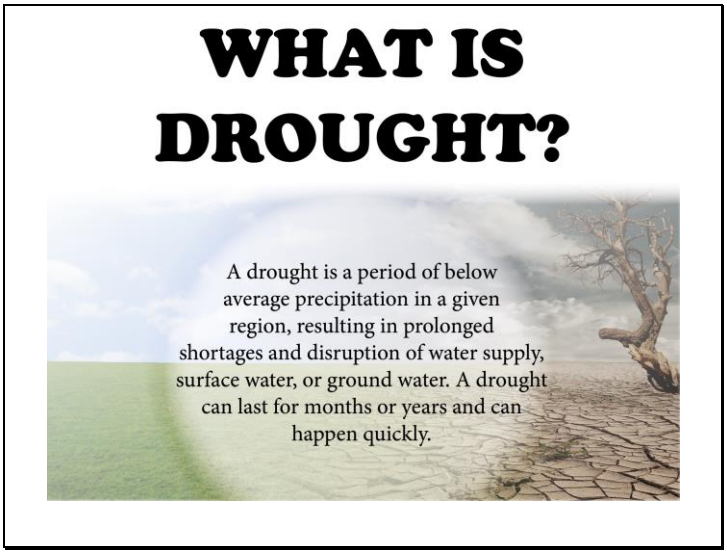


Appendix F:

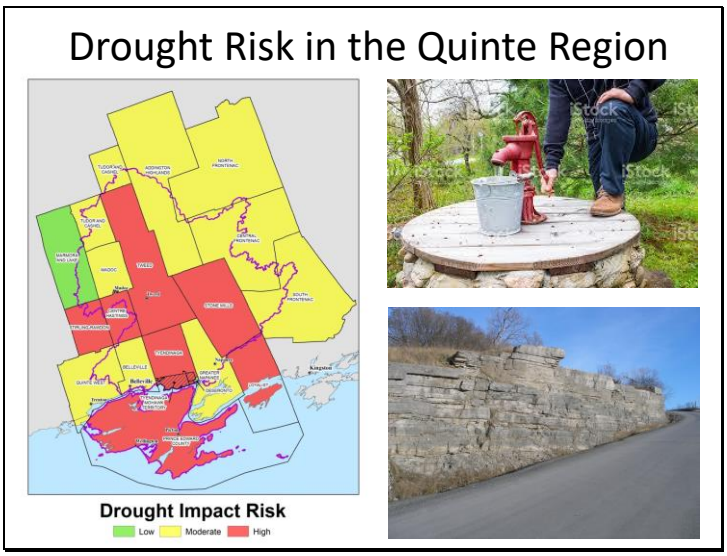
Public Consultation



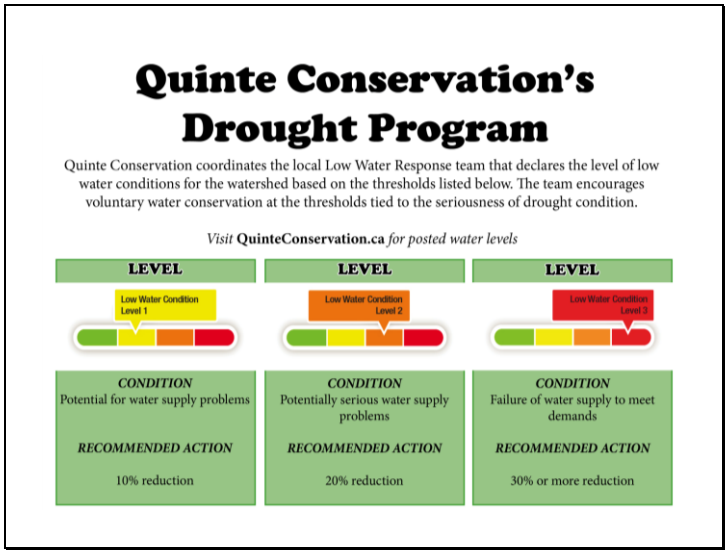
Hello There. Thank You for stopping by to watch this short presentation about the Quinte Region Drought Management Project. My name is Mark Boone and I am the hydrogeologist at Quinte Conservation. Over the past year Quinte Conservation has been working on a drought management plan to help Quinte Region residents prepare for drought and adapt to Climate Change. This presentation describes some of the background information that was considered in preparing the plan and what we are proposing to include. The need for this plan became evident in the summer 2016 when the Quinte Region endured one of the most severe droughts.



First off – Just what is drought ? Drought has many different meanings to different people depending on how they use water. However the general definition of drought can be defined as period of abnormally dry weather that can result in a disruption of water supply, low water table and dry streams and rivers. Droughts can last for months or years and the onset can be quick.

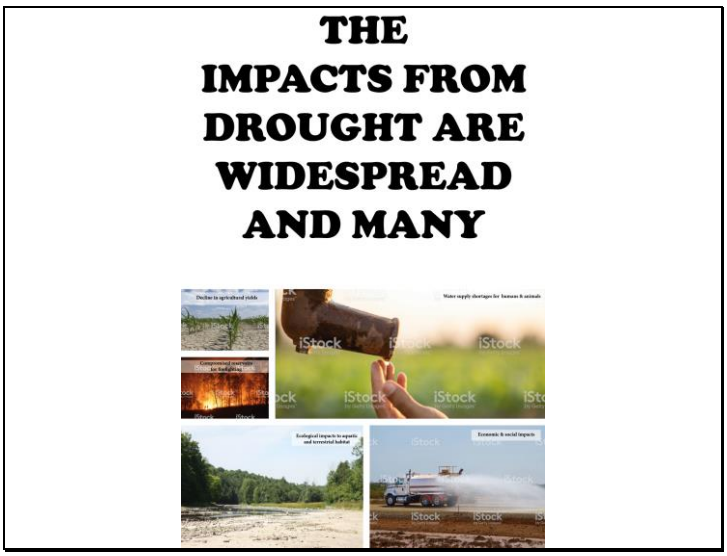


Why is drought important in the Quinte Region ?
Planning for drought in the Quinte region is important for many reasons but perhaps two of the biggest are that half of the population (60000 people) rely on private wells for water supply and second is that the local aquifers are susceptible to drought and require regular recharge from precipitation in order to maintain supply.



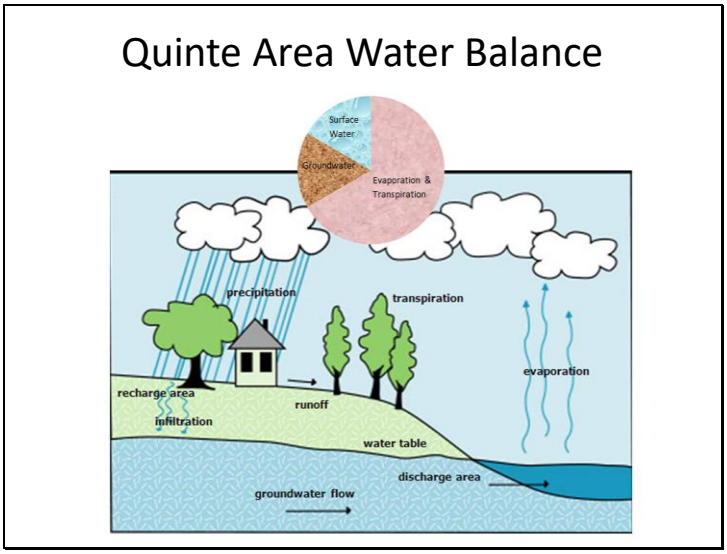
What is Quinte Conservation currently doing about drought ?

Quinte Conservation currently coordinates the local Low Water response team that declares the level of low water conditions for watershed based thresholds. These levels are based on stream flow and precipitation levels in the watershed and range from a level 1 to 3 with level one indicating the onset of drought and the potential for water supply problems. Level 3 is the highest level of drought and is an indication that there may be a failure of water supply to meet demand. With each level of warning there is recommendation to conserve higher amounts of water. Since the beginning of this program in 2001 Quinte conservation has issued notices of low water conditions in more than half of the years.



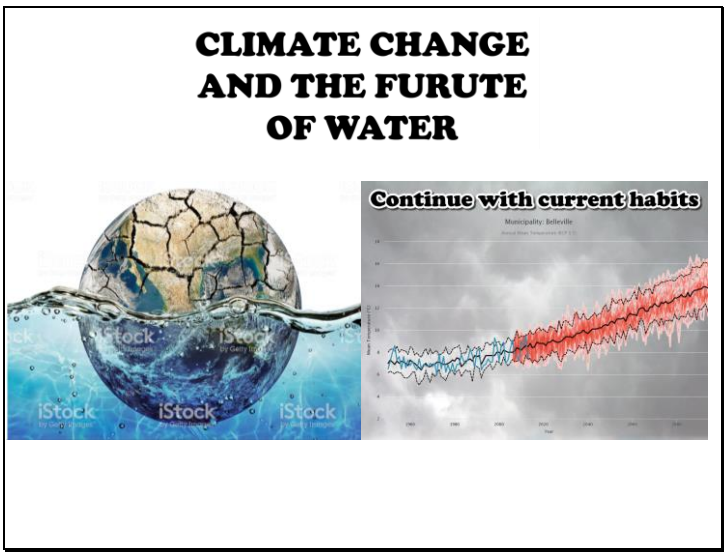
Impacts of Drought

The Quinte Region reached a level 3 drought in 2016 which was one of the worst droughts experienced in the Quinte region. This drought lasted over the summer months into the fall - local streams and rivers dried up making it difficult for fish to survive and reservoirs used for fire protection were depleted. Farmers struggled to grow crops and finding sufficient supply to water their livestock. Likewise with 50 % of residents in the Quinte Region relying on private wells for water supply many experienced severe water shortage and were forced to find alternate water supplies with many turning to hauled water. These impacts were wide ranging throughout the watershed and felt by many including economic hardship.



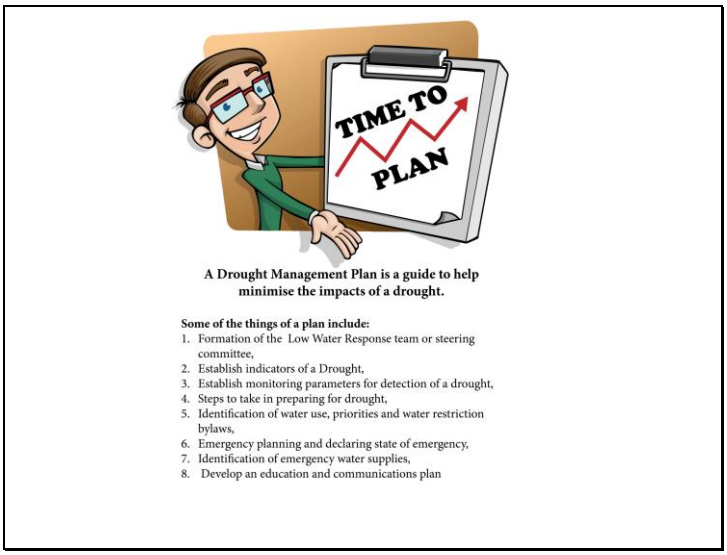
How much water do we have ?

The local climate has historically shown that annually the area receives 3 feet of precipitation (rain and snow combined). On a watershed wide basis this is a lot of water. However in consideration to the natural water cycle 60 % of this water is consumed by evaporation and local vegetation. This part of the water cycle is driven by temperature of the climate for which there is little control.



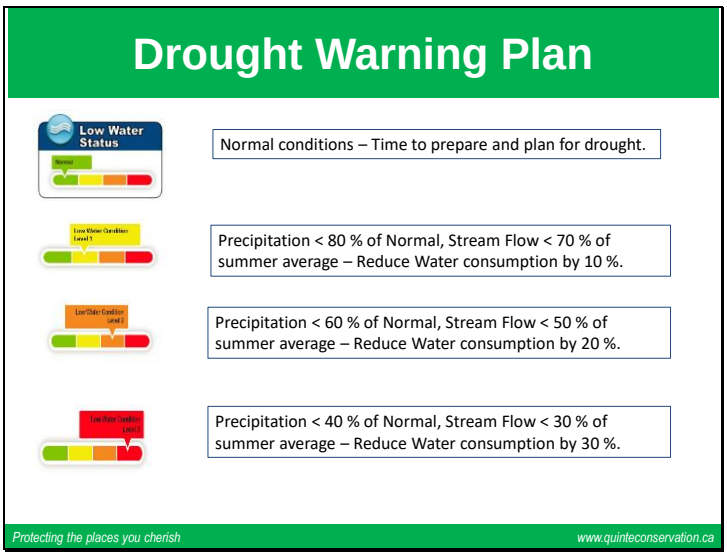
Future Climate

Now we know that temperature drives the water cycle and consumes a lot of water how is climate change and future climate conditions going to affect the local water supply. Projections for the Quinte Region are for annual precipitation amounts to stay about the same but temperatures are predicted to increase. This may result in an increase in the amounts of both evaporation and water used by vegetation meaning less water available to the watershed.

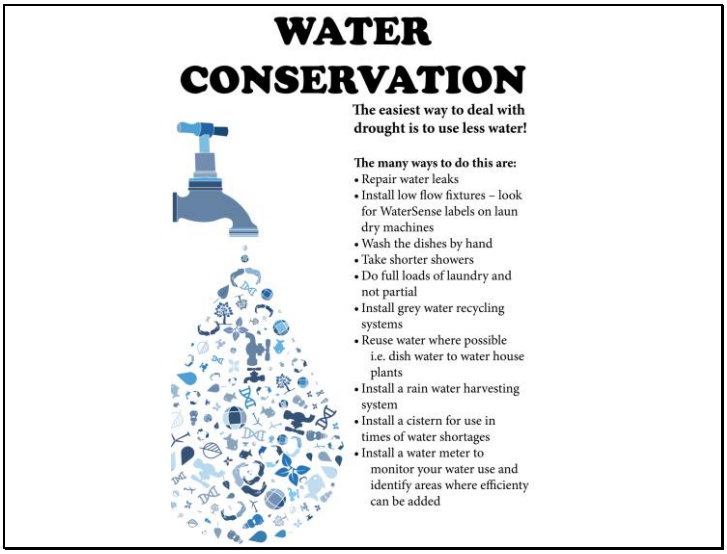


Time to Plan

Based on the historic occurrence of drought in the Quinte Region and possible future changes to local climate conditions now is the time to start planning for Drought. A draft of the drought plan has been prepared and we are seeking your input. The plan includes an outline of many things such as the roles and responsibilities of agencies involved in drought, actions that need to be taken before, during and after a drought, priorities of water use during droughts, how droughts are monitored and how these different levels of drought are to be communicated to the public.

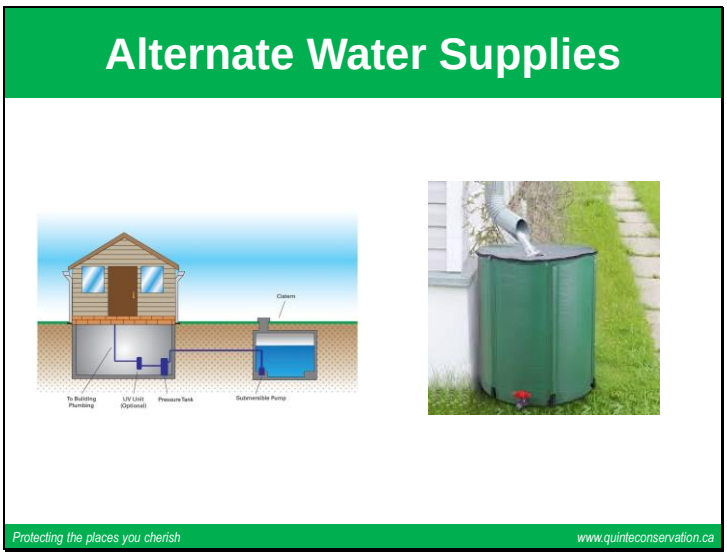


Perhaps the biggest part of the plan is the adding a fourth level to the levels used under the current low water response program that was discussed earlier. This fourth level is for normal conditions. This level is perhaps the most important level of the plan in that it promotes preparation for drought to ease the impact of drought as opposed to reacting to a drought after it happens.



Water Conservation

One of the easiest ways to deal with drought is to conserve water. There are many ways to do this such as installing low flow fixtures, repairing water leaks, doing the dishes by hand, start and stop showers, and reusing water for other purposes such as using grey water for toilet flushing or watering the garden (rain barrels). Managing your garden to improve soil health can also help reduce water demand. These types of measures were used during a major drought in Capetown, South Africa when local residents were asked to reduce water use to 50 litres/per day.



Backup Water Source

In some cases it may be necessary to turn to alternate water supply during periods of severe drought. Rain barrels are an easy way to capture runoff from your roof. For the roof area of an average home this water can amount to approximately 300 gallons for an average rainfall event. Hauling water from a local municipal water plant may also be necessary however consideration to where this water is to be stored will be necessary. This may require the installation of a cistern below ground or in the basement of the home. Such tanks can also be used to collect rain from the roof, however treatment is recommended to ensure the water quality is safe. If you are thinking of taking water from local streams, rivers or lakes please remember that low water levels can seriously harm the local fish and wildlife population.

Future development

When considering future development the long term water security must be considered prior to approving new development. Such development should be directed to areas where there is a secure water supply that is sustainable in regards to the impacts from climate change and promotes water conservation and water use efficiency. If you are considering purchasing a new home make sure to check what the water source is and the ability meet your needs over the course of the year.

Thank you for taking the time to watch this short video. We would like to invite to please take a moment and provide us some input by completing the online survey found here on the quinte conservation website. If you have questions or would like to discuss more please don't hesitate to call or email me. Slide 1

Radio Advertisement

Commercial Title: Drought Management Project – 30 Second Ad

****: Starboard Communications - Cool 100, OJ 95.5, Quinte Broadcasting – Mix 97 FM, CJBQ AM.**

Sound Effects: WATER RUNNING IN RIVER - **UNDER COPY**

MUSIC: INSPIRING

FEMALE: ***TOGETHER…WE CAN WORK TOWARDS ENSURING SAFE AND AVAILABLE WATER*.**

QUINTE CONSERVATION IS HOLDING AN ONLINE PUBLIC CONSULTATION ON PLANNING FOR DROUGHT AND WOULD LIKE TO HEAR FROM YOU!

CONSERVING WATER PROTECTS THIS VITAL RESOURCE AND HELPS US ADAPT TO THE EFFECTS OF CLIMATE CHANGE.

FILL OUT A DROUGHT SURVEY AND LEARN MORE ABOUT THE PROJECT AND SIMPLE WAYS YOU CAN CONSERVE WATER AT HOME… BECAUSE EVERY DROP COUNTS. FOR MORE INFORMATION VISIT QUINTE CONSERVATION DOT CA

CLIENT NAME: Quinte Conservation
CREATED BY: GS
DATE WRITTEN: 08/20/20
Killer Tracks file: Click here to enter text.

PRODUCT: Drought presentation
LENGTH: 30
RUN DATES: a.s.a.p.-09/30/20
Click here to enter text.

Anncr: serious. Music bed: mid-tempo	Drought….it can impact groundwater, wells and our local streams and rivers. Quinte Conservation invites you to participate in a public consultation on planning for drought in the Quinte region. Watch the online presentation and learn how you can better prepare for drought. Share your experiences through an online survey and check out Quinte Conservation's Facebook page to enter a draw to win a rain barrel. Quinte Conservation is committed to helping residents and municipalities adapt to a changing climate. Head to <quinte conservation dot ca> today to participate.

QUINTE REGION DROUGHT MANAGEMENT PLAN – COMMENT FORM

Name (optional): _____

E-mail (optional): _____

1.Do you think it is important to plan for future droughts and adapt to potential impacts from climate change ?

Yes / No

2.Do you think water conservation and reuse is an adequate way of addressing drought?

Yes / No

3.Do you rely on a private well for your water supply ?

Yes / No

4.If yes to the above do you have a cistern as part of the water supply system or for use as a backup ?

Yes / No

5.If No to the above do you plan on installing a cistern ?

Yes / No

6.Do you have access to a backup water supply such as a municipal filling station ?

Yes / No

7.If no to the above would a designated municipal filling station help to address water shortages in times of drought ?

Yes / No

8.Do you think bylaws or regulations are required to restrict private well usage during times of drought ?

Yes / No

9.Do you think that maintaining environmental flows in local streams and rivers is important during times of drought ?

Yes / No

10.Do you think Quinte Conservation needs to do more (i.e. create more dams to store water) to allow low flow augmentation to help in times of drought ?

Yes / No

11.Do you think more public awareness is required to help improve the understanding of drought and climate change ?

Yes / No

12.What is the best way to provide communications about climate change/ drought ?

13. Are you interested in participating in an online forum about climate change and the drought project?

14.Please provide any additional comments which have not been previously addressed:

_____

_____

_____

_____

_____

Public Consultation- Results of Online Survey hosted on the Quinte Conservation Website

1. **Do You Think It Is Important To Plan For Future Droughts And Adapt To Potential Impacts From Climate Change?**
   97 % of respondents said Yes

2. **Do You Think Water Conservation And Reuse Is An Adequate Way Of Addressing Drought?**
   65 % of respondents said Yes
3. **Do You Rely On A Private Well For Your Water Supply?**
   82 % of respondents rely on private wells

4. **Do You Have A Cistern As Part Of The Water Supply System Or For Use As A Backup?**
   87 % of respondents **do not** have a cistern

5. **Do You Plan On Installing A Cistern?**
   93 % of respondents **do not** plan on installing a cistern

6. **Do You Have Access To A Backup Water Supply Such As A Municipal Filling Station?**
   50% of respondents have access to a municipal filling station

7. **Would A Designated Municipal Filling Station Help To Address Water Shortages In Times Of Drought ?**
   40% of respondents indicated access to a municipal filling station would help in times of drought

8. **Do You Think Bylaws Or Regulations Are Required To Restrict Private Well Usage During Times Of Drought?**
   55 % of respondents said Yes

9. **Do You Think That Maintaining Environmental Flows In Local Streams And Rivers Is Important During Times Of Drought?**
   96 % of respondents said Yes

10. **Do You Think Quinte Conservation Needs To Do More i.e. Create More Dams To Store Water To Allow Low Flow Augmentation To Help In Times Of Drought?**
    71 % of respondents said Yes

11. **Do You Think More Public Awareness Is Required To Help Improve The Understanding Of Drought And Climate Change?**
    96 % of respondents said Yes

12. **AreYouInterestedInParticipatingInAnOnlineForumAboutClimateChangeAndTheDroughtProject**
    54 % of respondents said Yes

13. What Do You Think Is The Best Way To Provide Communications About Climate Change Drought?

Wide range of answers most common – 1. Social media, 2. Newspaper, 3. Radio, 4. Internet (website), 5 Public meetings, 6. Community interest groups.

General Comments on Drought Project:

- Concerned about number of tourists renting air B&Bs and not taking water conservation serious. i.e laundry, multiple showers, kids running through sprinklers etc.
- Need ways to promote elimination of grass lawns in favour of natural flora.
- Financial incentives needed to help with installation of cisterns, rain barrels, etc.
- Need information and promotion of how to use greywater for toilet flushing.
- Stop approving industrial farms in the region.
- The government needs more control and rules about water taking for large farms and livestock.
- Just moved here and have no idea if I need a cisterns or where municipal filling stations are. Need a don't know option for questions on survey.
- More public education is required. Hard to understand that water supply is an issue in Prince Edward County which is surrounded by water.
- More hauled water systems means more trucking on our roads,
- People need to adapt their lifestyles to use less water. Something that becomes normal behaviour once one learns to live with less water,
- Drawing down water from upper lakes to keep flows up is damaging to the upper lakes,
- Although drought has impact vegetation our well has been fine,
- Need more local monitoring of rain and evapotranspiration,
- Shore wells are an issue in terms of sharing water with an increased number of residents living on smaller lakes,
- Concerned with high volume water users . The Quinte region is a sensitive area and Quinte conservation needs to be more vocal when commenting to the Ministry of the Environment for approval of large volume water takers in drought prone regions.
- Very pleased that Quinte Conservation has undertaken this initative,
- Need more than water conservation and re-use to address drought. More green infrastructure will help such as rain gardens, green roofs, permeable driveways and appropriate land use planning to protect streams and hazard lands,
- Need to enforce bylaws that restrict water use,
- Future development needs to planned better to consider the water resource and to avoid conflict between residential and industrial land uses
- Have noticed a reduction in water supply over the recent past years. There needs to be incentives to help people install cisterns. With all the new development and resulting changes to how water flows because of these developments there is bound to be a decrease in flows in local streams and rivers.
- Large rain barrels and cisterns work,

- Need to ensure future development is appropriate. We live in an area where we have little water and use rain barrels to get by during the dry months. However new development is still being approved in our area.
- Water is a natural resources and should be made available for profit at the risk of people not having enough water for domestic purposes,
- Building permits should be subject to water supply whether it be from a well, rainwater harvesting or cistern.
- More regulations are required to ensure that residents on wells share the resource. More conflict resolution is needed to help when some have dry wells while others use water wastefully.
- This area once had many dams that powered mills. Over time the clearing of the land reduced the water table and subsequently the flow in the rivers. These olds dams need to be rebuilt to help store the spring water to replenish low flow in the summer months.
- Water supply is important and is definitely impacted by drought in this Region. Management of the water resource is necessary. Happy the Quinte Conservation is undertaking this initiative.
- Don't know why the rivers having been running so low in the last few years. The filling station in Napanee has a huge line up for bulk water. Want to know why this is happening.
- Recommend using lakes for supplementing low flow in the summer months. Specific calculations for Beaver Lake were provided.
- We use rain barrels and don't run out of water. Would like to hear what local farmers think about water ruse, drought and climate change.
- Stop allowing development of environmentally protected areas and agricultural land. Need a Provincial Plan stop these piece meal band aid policies.
- Regulations are a good idea but difficult to enforce. Cost benefit of enforcement is not effective. Money would be better spent of educating the public about the costs of drought.
- Need more bylaws and regulations and fees for those who use groundwater for business.
- Conservation Authorities need to be the lead agency on drought and funded to do so.
- Need to control urbanisation better to protect the water resources and flooding.
- More communications from Municipalities required to help people find out where filling stations are located,

  Hard to conserve on farm water use and you can't restrict how much water animals drink or sanitation requirements. Crop spray also has definite requirements.

Appendix G:

Municipal Staff Consultation

Municipal Consultation On Draft Drought Plan

From: Mark Boone
Sent: July 6, 2020 4:02 PM
To: mwallace@pecounty.on.ca; cao-treasurer@tweed.ca; charliem@quintewest.ca; ssilver@loyalist.ca; tchoinard@centrehastings.com; tbennett@marmoraandlake.ca; cmartin@deseronto.ca; rcallery@greaternapanee.com; clerk@addingtonhighlands.ca; cmacmunn@centralfrontenac.com; tax@madoc.ca; cao@northfrontenac.ca; ncarbone@southfrontenac.net; cao-treasurer@stirling-rawdon.com; bbrooks@stonemills.com; clerk@tudorandcashel.com; clerk@tyendinagatownship.com; rbovay@belleville.ca; pinej@hastingscounty.com; County of Frontenac (kpender@frontenaccounty.ca); County of Lennox and Addington (lkeech@lennox-addington.on.ca)
Cc: Brad McNevin; Christine McClure
Subject: Quinte Mark Boone <MBoone@quinteconservation.ca>Region Draft Drought Plan for Municipal Comment
Attachments: Quinte Region.Draft Drought Plan.06.07.2020.pdf

Hi All:

I hope this email finds you all safe, well, and adapted to the current times. A little more than a year has passed since Quinte Conservation started a Drought Management Project, funded through the Federation of Canadian Municipalities (FCM) – Municipalities for Climate Innovation Program. This project runs until February of 2021 with the aim of assisting the 18 Quinte watershed municipalities in adapting to climate change through the preparation of a drought management plan for promoting drought preparedness. Over the past year many accomplishments have been made which include the following:

1.) Formation of a 16 member drought steering committee to help guide the project (members are comprised of municipal staff, municipal council, provincial agency staff, representatives of First Nations, Ontario Federation of Agriculture, and the Friends of Napanee River).
2.) A review of the Quinte Region Water Budget has been completed to include a forecast of the impact on the local water budget from climate change,
3.) Improved instrumentation of the watershed has been started and is ongoing with the installation of automatic recording lake level and rain gauges throughout the Region,
4.) A project has been initiated to review the operation of dams on lakes that may be used as reservoirs to augment low flows during periods of drought,
5.) Public Consultation on the drought management project was initiated but was forced to be postponed due to Covid -19. Consultation has moved online and we will be promoting comments on the Project through advertisement during the month of August,

6.) A Draft of the Quine Region Drought Management Plan has been prepared and is being circulated to you for input.

The attached Draft Drought Plan has a summary of the local Quinte conditions, future impacts from climate change, and recent history of the Region in dealing with drought. The first 3 sections of the report provide the background information with section 4 containing the roles and actions of the various agencies in dealing with drought. The action plan follows the levels of drought as assigned through Ontario Low Water Response Program. A significant component of the plan is promoting actions to be taken under normal conditions (no low water). This is perhaps one of the most important components that foster emergency preparedness to minimise potential impact. It would be appreciated if you could take a moment to review the plan and let me know of your thoughts or concerns. Of particular interest to you may be the role of Municipalities and associated actions in dealing with drought.

With the current dry conditions being experienced throughout the Quinte Region the adoption of this plan would be ideal. However it is not anticipated that the plan will be finalised until this Fall following the completion of Public Consultation. Once this consultation has been completed a section summarising the results will be added to the plan.

We will keep you informed of the project status and should you have any questions please do not hesitate to contact me. Please provide comments by the end of July, 2020, prior to our intensifying of Public Consultation in August.

Best Regards,

Mark

P.S. If you require a word copy of the Draft Plan for providing comments please let me know.

Mark Boone, P.Geo
Hydrogeologist
www.quinteconservation.ca
www.quintesourcewater.ca
http://twitter.com/quinteca
mboone@quinteconservation.ca

Results of Municipal Consultation

1.Section 2.3: Data source for precipitation and temperature for Quinte region - where and how was it measured?

Answer-This data was provided by Natural Resources Canada and it was interpolated from actual measurements at climate stations throughout the Region (typically Environment Canada including station at the belleville water plant). The output shown in the graph is an average for the region as determined using our Quinte region GIS water budget model.

2. Environmental Services has been collecting historical precipitation data at the Water Treatment Plant weather station (2 Sidney St., Belleville) since 1923. Our co-op students transcribed the handwritten logs into Excel this past year and we are happy to share it with Quinte Conservation if it would be helpful.

Answer-If this is different then what we access through the Environment Canada station we would be happy to receive. Thank you for doing this. This data has been incorporated and we are very grateful that the period of record extends back to the 1920's as this is useful. We understand that this station may be on the move ?

3.What data sources were used in climate change modeling for the Quinte Region? Staff wants to better understand the extent to which local data was used. Can you shed some light on that from the modeling that QC did in 2019? The section on climate change in the plan mentions your 2019 work and references data from Environment Canada - Belleville climate station and the Climate Atlas of Canada which uses Natural Resources Canada data as I understand it. Do you have any background reports that would answer this question that I could share with staff?

Answer-Future climate data was also provided by Natural Resources Canada. These future projections are based on global climate models. I have attached our water budget report which goes into detail about how this was done (it is still draft but basically close to being final). For future climate projections we used the intermediate emission scenario as opposed to the high (trying to be optimistic. I hope this helps.

4.Figure 12 is initially confusing because the red slice of the pie graph is labeled Surface Water which would include the Great Lakes – can it be changed to Inland Surface Water? Might also be helpful to define surface water up in section 2.3.

Answer-Very good point and thank you we will incorporate this change.

5. The Engineering and Development Services have No comments but the plan will inform their future work.

6. The Communications department are on board with the concepts and recommendations presented in the report. They also edited the plan and had some suggestions if you're interested – see attached.

Answer - I will review this input and incorporate.

7. Report states that drought may be defined as "a prolonged period of below normal precipitation and stream flow that can result in disruption of water supply to a range of users". Please clarify where the

definition of drought being used originates. Is this the definition that you would like Municipalities to be consistent with in planning policy documents? Is this the same definition that the Low Water Response Team (LRT) currently uses when assessing low water conditions?

Answer -The definition of drought was developed by the Quinte Region Drought Committee and has been modified as follows: “A prolonged period of below normal precipitation, stream flow and groundwater that can result in disruption of water supply to a range of users". This is a broad definition that can apply to a range of activities. Municipalities may choose to use this or something more specific depending on the application.

8.Throughout the report there is reference to urban areas along the BQ and Great Lakes, though Wellington has been left out as an urban centre. If the intention is to focus solely on communities along BQ, then the wording should be modified to clarify, alternatively Wellington could be included in the listings.

The plan is for the entire Quinte Watershed Region and not specific to any one region. Wellington is considered to be an urban area with municipal services.

9.Page 28 – Municipalities: The second bullet requires some revision to wording to make sense.

Noted and thank you.

10. Drought Plan L2 Low Water Condition – there is reference to implementation of municipal bylaws for water restrictions during a L2 low water condition. Consideration should be made to modify this recommendation to instead suggest an assessment of DWS operational impacts of implementing water restrictions upon declaration of a L2 low water condition.

The plan is more general in nature and provides guideline to promote water conservation and preparation for droughts. It would be anticipated that municipalities would conduct independent reviews in house prior to implementing water restrictions. This is in consideration of the range and resiliency of the different drinking water systems across the region.

11.From an operational perspective, it is not always practical to implement water restrictions, particularly in systems that have a more resilient water source. While it can sometimes be necessary to support source water impacts, in order to maintain functional operations within drinking water system (treatment and distribution), and to adhere to water quality compliance requirements and aesthetic objectives it is necessary to produce and circulate fresh water within the system. While there are some controls that can be put in place on the treatment end of the process to reduce production, there are limits to this to maintain proper function based on the capacity of the treatment equipment. Additionally, within the distribution system it is important to ensure that the water remains potable and within regulative limits. Reducing water use can often mean that additional hydrant flushing to circulate and replenish water in the distribution system is necessary to maintain chlorine residual levels and control production of disinfection by-products (THMs/HAAs). This is a challenging consideration for municipalities as water use equates to revenue, while flushing to maintain water quality is lost revenue. To address these concerns and challenges while balancing the consideration of drought, I recommend that water restrictions be mandatory only at declaration of a L3 low water condition, and where possible/feasible/practical based on the municipality’s assessment in a L2 low water condition.

The intent of the plan is not to restrict municipalities in maintaining an acceptable level of water quality. Individual municipalities know their drinking water systems and measures that can be implemented to conserve water without impacting on drinking water quality. The plan promotes efficiency for the wise use of water and not wasting of this precious resource.

12.In Section 3.6, Dealing with Drought in the Quinte Region, the report recommends that, "in areas where potential impact is unavoidable it is recommended that such development proceed on the basis of being prepared to deal with drought". The previous sections outline the County of Prince Edward as having a high Drought Impact Risk based off of High well vulnerability and Moderate Groundwater reliance. The report is recommending "Hydrogeological assessment of new development on private wells may also be required to ensure that the proposed use of groundwater is sustainable in the long term". It would appear the intent would be for the Municipality to request a hydrogeological review for all new development on private services; can QC confirm this or provide an adequate review trigger for when a hydrogeological assessment would be triggered for a Municipality that scores High for Drought Impact Risk (i.e. is reviewing a new well in close proximity to 5 existing residential wells within 300 metres still an appropriate threshold or should hydrogeological assessments be required for all private wells?).

The plan will be modified to include limited detail regarding hydrogeological studies. This will include a recommendation for when hydrogeological studies should be requested. However this will be general in nature and municipalities may need to review this on a case by case basis.

13.Section 4.1 outlines the roles of each partner. Municipalities are outlined as the partner to, "promote sustainable development in regards to potential drought and impacts from Climate Change" - does QC have any examples of such sustainable development that should be considered? Any detailed information to assist the Municipality in implementing the Action Plan items would be useful.

This section was adopted from the Provincial Policy Statement 2020. In the face of a changing climate and future water shortages, municipalities will be forced by mother nature to consider the impacts of climate change on new and existing development. The background information in the plan includes a summary of how drought has been impacting the Quinte Region and what the potential impacts of climate change may be (i.e. increased frequency and longer duration of drought). This is recommended as being considered when reviewing applications for new development. Many municipalities are implementing measures to promote sustainable development, however one that is a good example would be the City of Guelph. This municipality relies on groundwater for municipal water supply. Recognising that this supply is finite the municipality actively promotes water conservation in both new and existing development.

14.-4.3.1 Normal Conditions Action Plan, All – It is recommended that to ensure consistent messaging, media products (brochures, online media, etc.) be developed by QC and shared with municipalities. These could include sections of the documentation that allow for municipalities to add personalized information about the areas but are developed around the same details and consistent information shared by QC and the steering committee.

The intent of the plan was to provide a guide for how these messages are delivered. The messaging from the low water response team is delivered on a watershed wide basis, however it is understood that messaging from municipalities may differ and this would be determined by each municipality on an individual basis. Quinte Conservation is available to assist however communications needs to be a collaborative effort.

15.-4.3.3 Level 2 Drought Action Plan, Municipalities – QC should lead any and all public information sessions with respect to the drought conditions to ensure consistent messaging. Municipalities should play a supporting role in this activity when deemed necessary.

This needs to be a joint effort requiring collaboration between municipalities and relevant agencies involved in drought response. The intent of the plan is to promote working together which will help improve awareness.

16. I have a concern about specifying the time of year for completion of hydrogeological studies.

Recommendations of the drought committee were to discourage testing of wells for hydrogeological assessments under high water table conditions. This recommendation was provide din view of the seasonal fluctuations of the water table throughout the region and the sensitivity to drought. Based on this information it can be concluded that testing of wells during the spring (high water table) does not take into account seasonal fluctuations and is not always representative of year around conditions.

17. I have concerns about messaging around droughts during low water events and that all messaging may not be the same.

The intent of the plan was to provide a guide for how these messages are delivered. The messaging from the low water response team is delivered on a watershed wide basis, however it is understood that messaging from municipalities may differ and this would be determined by each municipality on an individual basis. Quinte Conservation is available to assist however communications needs to be a collaborative effort. The overall goal during periods of drought is to promote water conservation and wise use of water.

18. Discussion regarding ground water and aquifers on page 22 – are there aquifers in our region that are in danger of not recharging?

Generally speaking I would say no for the typical average year. However the current trend and predictions of impact from climate change indicate a higher potential for drought. In the past these droughts have occurred over the drier summer and early fall months. During these events and time periods the recharge to local aquifers is diminished and municipalities that use groundwater for supply rely on the water that is stored in the aquifer. If there is insufficient water storage in the aquifer, recharge from rain is then required or there is a danger of wells running dry. This has happened to

many residents in some parts of the watershed and these people have had to turn to sources of hauled water during a drought to meet their needs.

The intent of the drought plan is to promote preparedness, so that Municipalities and watershed residents have the necessary infrastructure and means of dealing with drought ahead of time as opposed to reacting to it in the middle of a drought.

19. If some are showing evidence of not recharging or in case of this possibility, are there items in the plan addressing what is to be done in these situations.

Yes. The plan promotes preparation for dealing with drought through identification of a backup water supply, installation of cisterns or a means of storing water during a drought. Water conservation and water recycling are also promoted as important ways of dealing with drought. If residents can reduce their daily water demand their ability to deal with water shortages will be improved in times of need. The plan also recommends that drought be considered when municipalities are considering future development.

20. Plan should include a link between aquifers with low or threatened recharged when issuing permits

Agree. A map has been prepared showing areas with higher potential to impact from drought. Representatives of the local MECP have participated on the drought steering committee and are aware of this mapping and project. It is specified in the plan that the MECP consider drought when it is reviewing applications for permits to take water.

21.How to reduce impact on aquifers by getting everyone involved – education opportunities to encourage people to learn

Ongoing public awareness is required to help watershed residents be informed about the local conditions and help share information with them on how to protect groundwater (both quantity and quality). Quinte Conservation delivers programs that help reach out to watershed residents, however Municipalities may be able to help with this by hosting information on websites as well as distributing information to local residents. Further recommendations for a co-operative effort to deliver information to watershed residents during a drought are a component of the Plan. As part of the drought project an online public consultation yielded 70 surveys from the public. The majority indicated that more public awareness is required to inform residents about drought and the potential impacts from climate change.

22. Should these address water requirements for agricultural use during drought and their irrigation systems?

The plan does address agricultural water use during droughts. There are priorities of water use assigned for the different stages of drought with the highest priority given to water use for humans and animals (i.e. livestock). Water for irrigation is not given as high of a priority but is considered important due to the potential economic impact from loss of crops.

23. I think the plan is well done and am thankful to the committee that has done all of this work.

24.I really like the education throughout the document including water conservation and priority water use.

25.I really like how the plan has an "Action Plan" for each level – This will be very useful to municipalities and emergency response teams.

26.Who participates on the low water response team from Centre Hastings?

Municipal staff and councillors are circulated on the correspondence from the low water response team. Prior to drought season Quinte Conservation confirms membership on the Low Water Response Team.

27. The Township of Stone Mills Official plan is being updated to conform to policies of the 2020 provincial Policy statement that came into effect May 1, 2020. Does specific reference to the Quinte Conservation drought plan need to be incorporated in the municipal Official Plan to strengthen its policies.

The Quinte Region Drought Plan is not binding but it may serve as a useful resource and reference to back up policies of the official plan.

28. Clarification about water use categories and discussion on page 21 is required,
The categories of water use in the Quinte region with listing by order of highest to lowest water use considered both surface and groundwater sources. However when surface water use is taken out the equation the highest use of groundwater is for industrial purposes followed by private wells. As this may be confusing the wording the plan has been revised to provide better clarity.

29. Analysis of drought sensitivity was completed based on municipal boundaries. Will more specific conclusions be included within the report to summarise each municipality geographic area as opposed to north and south,
Due to the regional scale of this project the scoring was done based on municipal boundaries. More detail is not going to be completed however this mapping is meant to help identify areas of the watershed more sensitive then others.

30. No problem with water conservation, water recycling and use of cisterns from a municipal perspective – particularly in the lot creation stage of development (plan of subdivision & consent). However specific mapping commentary and recommendations form the drought plan will be needed to inform conditioning included.

31. Recommend that 2 bylaws be established- one that applies to municipalities with urban serviced areas (water and sewer) and a second one for areas of private wells and septic systems. This should be consistent for all municipalities within the Quinte Conservation watershed.

We concur with this recommendation and examples of bylaws for the two different scenarios were included in the drought plan. Different municipalities have varying levels of comfort with such bylaws and the ability to enforce.

32. Messaging about water conservation and drought needs to be done collaboratively so messaging is consistent across the watershed.

We concur with this recommendation.

32. Mapping of alternate water sources available for public use could be included on official plan schedule.

We concur with this recommendation.

33. Great to quantify a requested reduction in water use for different levels of drought. But is it possible to simplify for members of the public (i.e. reduce flushing toilet, stop watering lawns, etc.)

We concur with this recommendation. Brochures and messaging about drought contain tips on how to save water. This information is available on our website and handouts that can be used by municipalities.