Quinte Region Drought Management Project

Water Budget

Final Report

Prepared October, 2019

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1. Introduction, Purpose and Objectives

Quinte Conservation (QC) has received funding through the Federation of Canadian Municipalities to assist residents of the Quinte Region in adapting to the impacts of Climate Change. Such impacts are varied and have manifested in the form of extreme weather events ranging from severe flooding to more prolonged periods of drought. This was particularly evident of the summer and fall of 2016 when the Quinte Region experienced one of the most severe droughts on record. During this event water levels in local rivers and streams dried up and residents relying on private wells ran out of water. Municipalities were required to act quickly in order to assist the impacted residents. Building on lessons learned from this experience the overall purpose of the project is to provide a plan that will better prepare member municipalities in adapting to drought and shortages of water supply.

In order to provide the necessary background and science for the development of drought management plans the following report provides an overview of the water budget for the Quinte Region. This work builds on previous activities that were undertaken as part of the Source Water Program (Quinte Conservation Assessment Report, Approved July 2014). The focus of the previous work was to conduct water budgets on a watershed and subwatershed scale in an effort to identify potential water use issues with an emphasis on Municipal water supplies. This exercise indicated low water stress for the majority of the Quinte Region, with the exception of some localised areas of higher groundwater use.

In spite of the generalisations provided by the previous work it is apparent that during prolonged periods of low precipitation (as experienced in 2016) the potential for shortages in water supply exists. To help with understanding the current conditions a review has been completed of the water budget for the region using a simple GIS Water Budget model that calculates groundwater recharge from precipitation after accounting for evapotranspiration. Surface water use was also reviewed in comparison to stream gauge data from a network of local stream gauging stations. This work considered average climate conditions, a drought scenario and prediction of future impacts from climate change. An overview of the process and results is provided below with a map of the Quinte Region illustrated by Figure 1.

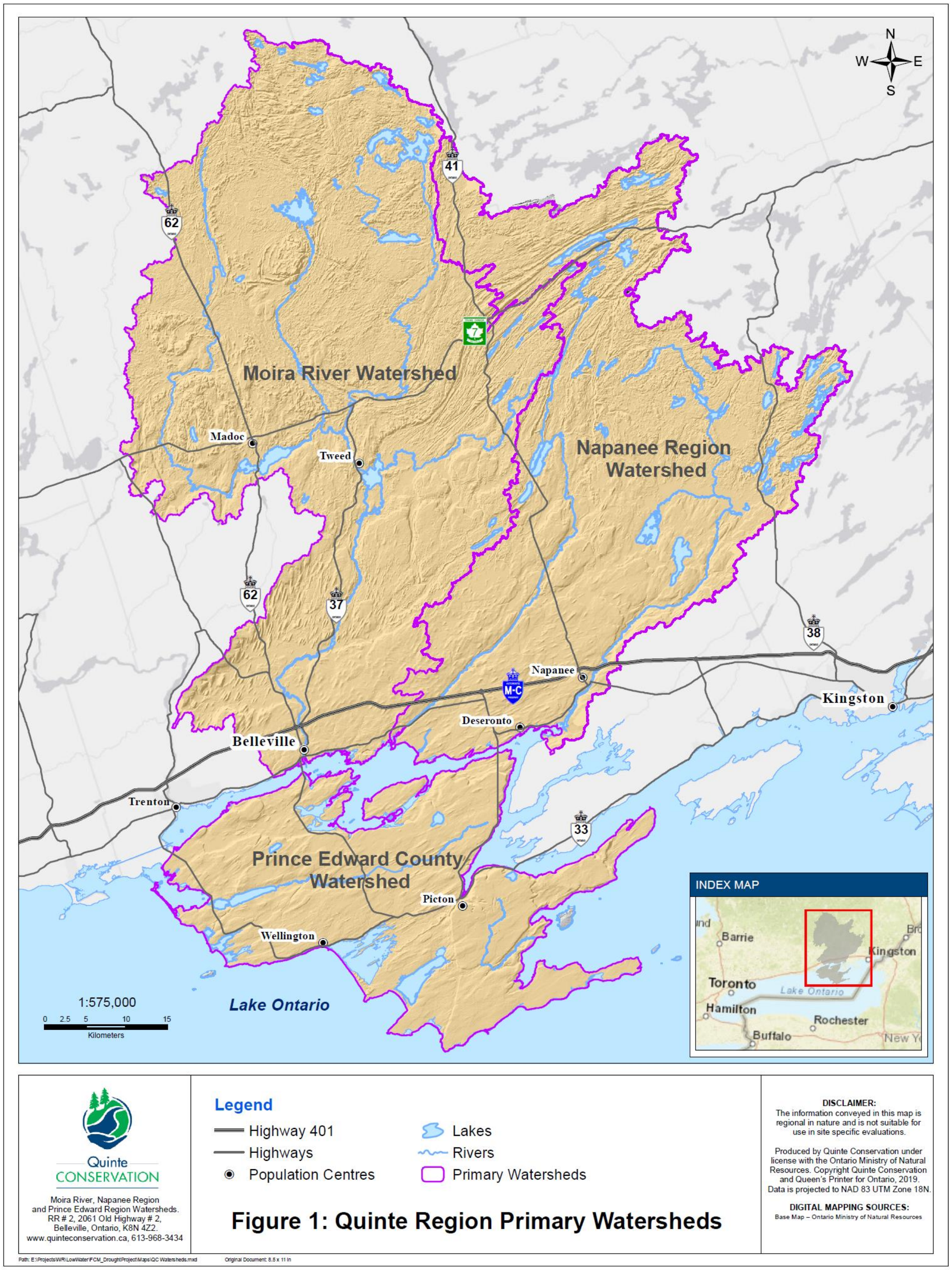


Figure 1: Quinte Region Primary Watersheds

2. Overview of Quinte Conservation

Quinte Conservation (QC), one of Ontario's 36 Conservation Authorities, is located in eastern Ontario. The Authority was formed from the grouping of three separate conservation authorities referred to as the Moira River, Napanee and Prince Edward Region Conservation Authorities. Collectively these 3 regions cover 6200 square kilometres with QC properties including over 30000 acres of land ranging from small parcels at some of the 39 water control structures, to large tracts of over 1,000 acres, many with significant natural features.

Approximately 130,000 people live within the study area, of which approximately half reside in small to medium sized urban centres such as the City of Belleville, and Towns of Napanee, Picton, and Deseronto. The water supply for these larger urban centres is predominantly surface water from the Great Lakes. The balance of the population live in rural areas where groundwater is the primary source of water supply for domestic, commercial and agricultural needs. This includes several small urban areas serviced by Municipal groundwater supply (i.e. Villages of Tweed, Madoc and Deloro).

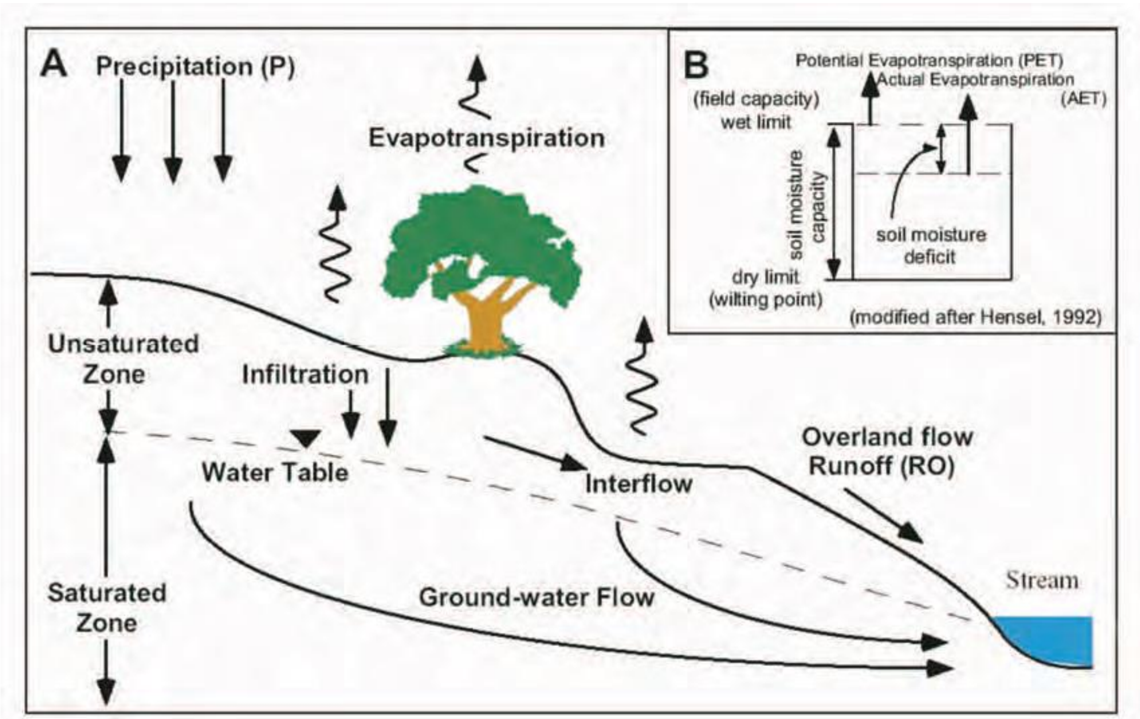
The physical geography of the Quinte Region is varied ranging from the rugged highlands of the Precambrian shield in the north to areas of flat and low relief on the limestone plains at the south along the shores of the Bay of Quinte and Lake Ontario. Soils are predominantly at shallow depth above Paleozoic Limestone and Precambrian bedrock with some localised areas of greater soil depth in the vicinity of glacial deposits including ridges of sand and gravel in esker formations and a Kame moraine along the south western boundary of the Moira river watershed. Land cover is also varied with areas of dense forest in the north and increasing amounts of cleared agricultural land moving to the southern areas of the watershed and Prince Edward County.

Land use includes forestry, agriculture and some industry located in larger urban centres such as the City of Belleville. The prevalence of bedrock close to the surface has resulted in the development of many quarries for the production of aggregate, cement as well as asphalt granules used in the manufacture of shingles. These soil conditions and moderate climate have also been discovered as ideal for the cultivation of grapes which has supported the development of many wineries in the Prince Edward Region. The abundance of shorelines on the Bay of Quinte and Lake Ontario are also a large tourist attraction with many seasonal tourists enjoying the natural beauty and resources of the region.

2.1 Water Budget Components

A water budget is a scientific method of accounting for the amount of water in a watershed and how it travels through this area. Water budgets account for the various components of the water cycle (see Figure 2) as well as the use of this water as it moves through the cycle. An understanding of this cycle as it applies locally is crucial for the management and protection of existing and future water resources.

Figure 2: Water Budget Components



Previous work on the Water Budget (Quinte Conservation, 2006) indicates the annual water budget (1971-2000 period) for the Quinte Region may be expressed by equation 1 as follows:

Precipitation	– Evapotranspiration	= Runoff (Surplus) (1)
919 mm	– 550 mm	= 369 mm

From this equation it can be seen that a large component (60%) of the water that enters the region is lost to evapotranspiration. The remaining water is available for either travel overland into rivers, lakes, and streams, or for seepage into the ground to become part of the groundwater system. Once in the ground, the water continues to move and eventually discharge to surface water bodies; important for maintaining water levels and temperatures in our rivers and streams during the warmer and dry summer months. When more water comes into the watershed than leaves, the levels in our lakes, wetlands, and groundwater rise. This increases the amount of water storage. In the opposite situation when more water leaves than enters, a deficit exists and the levels in storage decline. In the Quinte Region this phenomenon occurs over the course of a year with high water levels in the spring after snow melt and decreasing levels in the summer months when potential evapotranspiration exceeds actual evapotranspiration.

A review of the current and future status of the water budget has been undertaken in consideration of the various components of the hydrologic cycle in respect of:

- 1981 – 2010 climate normal period
- 2016 Drought Year
- 2011 – 2040 future climate projection

This exercise requires development of an understanding of the flux of the various water budget elements, listed below, and how the physical features of the watershed affect them.

- Climate
- Land Cover
- Topography
- Geology/Physiography
- Groundwater
- Surface Water
- Water Use

2.2 Conceptual Understanding

For the Quinte Region the basic water budget equation 2 can be expressed as follows:

$$P = RO + ET + GWR \quad (2)$$

Where;

P = Precipitation (snow and rain), ET = Water evaporated and transpired,

RO = Runoff over the ground surface, GWR = Infiltration to the water table (recharge).

The above is a relatively simple way to represent the natural water budget equation without consideration to things like water use. To expand on this the water budget equation may be expressed as follows:

$$P + ANTH_{in} – ET – ANTH_{out} = \text{Change in Storage} \quad (3)$$

Where;

P	= Precipitation
$ANTH_{in}$	= Human inputs such as waste discharges
ET	= Evaporation and transpiration
$ANTH_{out}$	= Human removals or abstractions

The individual components of the water budget equations can be simulated through the use of regional surface and groundwater flow models. However, regional groundwater flow models do not exist for the Quinte Region and as such a GIS model was developed that considered land use/ cover, ground slope, and soil permeability to estimate the evapotranspiration, runoff, and recharge rates. The following section of the report describes methodology, data sources and how each of these different components was estimated.

3. Methodology & GIS Model

To assist in determining the water budget a GIS model has been developed to spatially represent the use of groundwater across the region and the distribution of groundwater recharge. The methodology for this process is provided below which generally involved:

1.) Determination of the natural water budget across the study area,

2.) Partitioning of the surplus water (water available after accounting for evapotranspiration) between groundwater recharge (infiltration) and direct runoff (surface runoff) on a monthly and annual time scale &,

3.) Evaluation of the permitted and consumptive ground and surface water usage across the watershed,

4.) Calculation of potential ground and surface water stress,

This work was completed in accordance with the Ministry of the Environment Water Budget and Water Quantity Risk Assessment Guidelines (March 30, 2007). An outline of the methodology is presented below. The Main data sets used are summarized in Table 1.

3.1 Scale

The spatial scale of this work was based on sub watershed areas as defined by gauged catchments and quaternary level watershed boundaries provided by the Ministry of Natural Resources and Forestry. There are a total of 24 sub watersheds of which 14 are gauged. Figure 3 illustrates the subwatershed areas.

To allow better discretization of the watershed a 1 square kilometre gridded surface was imposed over the watershed boundaries in GIS to allow evaluation of the water budget for each grid based on climate, physical conditions and water use. Calculations were completed on both a monthly and annual time scale.

3.2 Climate (Evapotranspiration)

The climate of the Quinte Region was evaluated using Environment Canada climate station data for which spatial models for which were developed by Natural Resources Canada-Canadian Forestry Service (McKenney et al, 2019). For the purposes of this work both monthly precipitation and temperature data from the climate normal period of 1981-2010 and 2011-2040 period was reviewed and

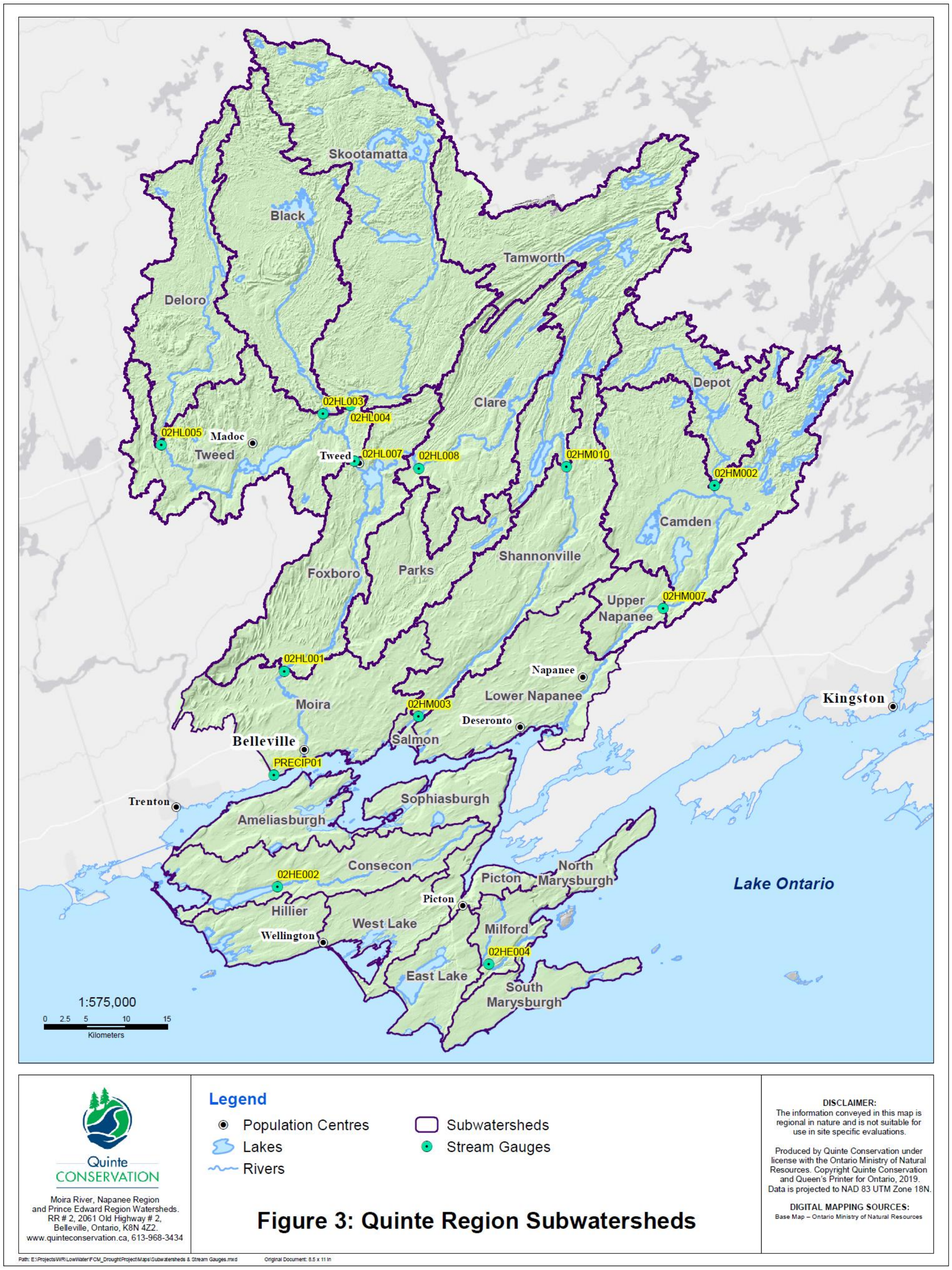


Figure 3: Quinte Region Subwatersheds

Table 1: Data Sources

Data set	Source	Use in this study
Climate Data	Natural Resources Canada, Environment Canada	Precipitation & Temperature
Precipitation	Lower Trent, Mississippi, and Quinte Conservation Authorities	2016 rainfall amounts and distribution
Soil Moisture Holding Capacity	Agriculture & AgriFood Canada & MECP	Calculation of Actual ET
Soils & Quaternary Geology	Ontario Geological Survey	Runoff / Recharge Estimates & ET
Digital Elevation Model	Ministry of Natural Resources & Forestry	Runoff / Recharge (slope calculations)
Land Cover	Ministry of Natural Resources & Forestry	Runoff / Recharge
Stream Flow Data	Water Survey of Canada	Runoff & Derived ET
Permit to Take Water Database	MECP	Water Use
Ontario Water Well Records	MECP	Water Use
Agricultural Water Use	OMAFRA	Water Use
Canada Census'16	Canada Census	Water Use

incorporated into the GIS water budget model. Note, for the future climate conditions, outputs form various models were provided, however a composite of the models for North America using a moderate estimate of future emissions and population growth was chosen (climate change scenarios).

For drought conditions the year 2016 was chosen as a drought scenario to review impact on the water budget. Local Environment Canada climate station data and rain gauge data from Quinte Conservation, the Water Survey of Canada, and neighbouring Conservation Authorities were interpolated in GIS to prepare monthly maps of temperature and precipitation across the watershed.

Using the GIS model, evapotranspiration was calculated using the Thornthwaite Method (1955) and a soil moisture balance. The spatial distribution of soil types and water holding capacities of these soils were applied as taken from mapping by Agricultural Canada and Soil Surveys of Prince Edward, Hastings, and

Lennox and Addington Counties (1948, 1962-63). The following water holding capacities were assigned to the various soil groups:

- Shallow Soil over Rock 25 mm
- Sand, Sandy Loam 100 mm
- Clay loam 200 mm
- Clay 250 mm

3.3 Partitioning of Surplus Water

Following the determination of the natural water budget the precipitation that remains after evapotranspiration and soil moisture requirements, is available for either direct runoff or infiltration to the ground. To determine the division of this water into runoff and infiltration, a coefficient was developed through application of MOE methodology (MOE Hydrogeological Technical Information Requirements for Land Development Applications April, 1995).

This method gives consideration to ground slope, land cover, and soil permeability. A partitioning factor is assigned individually to 3 parameters: slope, soil permeability, and land cover. The sum of the three factors is the infiltration coefficient that is applied to the surplus water. To estimate the spatial distribution of recharge and direct runoff, GIS coverage for the gridded surface was generated through application of the MOE methodology. An overview of the methodology for the three main components (slope, land cover & soil permeability) is as follows:

3.3.1 Determining Slope Factor

A 10 m digital elevation model (DEM) was used for determination of the slope across the study area by three classes as listed below:

Category	Slope Range
Flat Land:	0 - 1.5%
Rolling Land:	1.5 - 3%
Hilly Land:	> 3%

Given the range of slope in the QC watershed compared with the ranges provided in the MOE Methodology (1995), the coefficients were interpolated to cover the slope classes of the study area. For each slope category, the coefficient at the midpoint of the slope range was taken as representative of the entire category. In the case of hilly land, the midpoint was chosen between the slope values of 3 and 9%. The corresponding factor was then taken off the curve as illustrated by Figure 4 showing graphically the relationship between slope and the factor.

Accordingly, the interpolated factors used in this study are listed below.

Category	Recharge Factor	% Watershed Area
Flat Land:	0.175	39.2
Rolling Land:	0.125	24.1
Hilly Land:	0.075	36.7

Figure 4: Slope Class Determination

3.3.2 Determining Soil Permeability Factor

The second component of the partitioning factor is soil type and permeability. The three classes of soil based on their permeability with respective factors as follows:

Soil Type	Recharge Factor	%Watershed Areas
Tight impervious clay:	0.1	36.9
Medium combinations of clay and loam:	0.2	53.9
Open Sandy loam:	0.4	9.2

Based on the surficial geologic mapping of the study area, soil permeability factors were assigned to the individual soil types by simplifying the permeability values into high, medium and low.

3.3.3 Determining Land Cover Factor

Land cover is the third category for which a partitioning factor is assigned. Based on the MOE guidelines, 2 types of land use were adopted:

Land Cover	Recharge Factor	% Watershed Area
Cultivated land	0.1 (low)	37.5
Woodland:	0.2 (high)	62.5

Land cover mapping from the Ministry of Natural Resources & Forestry was used to delineate areas for assigning the appropriate coefficients to areas of low and high cover.

3.3.4 Infiltration Factor

Considering the three variables: slope, soil permeability, and land cover, there are 18 potential combinations (3 x 3 x 2) across the study area. By summing the factors from each of the three components (slope, soil type, & land cover) an overall infiltration factor was assigned to each pixel.

Following this method the maximum and minimum coefficients were determined as 0.775 and 0.275 respectively. Using the long term annual runoff in the Moira River watershed at 366 mm (1931-2000) the maximum infiltration could be calculated by this methodology as 283 mm/yr and the minimum at 100 mm/yr. Such rates are comparable with those of a coarse sand and gravel at the high end and a clay or clayey silt on the low side (MOE, 1995).

The amount of direct runoff was determined as the amount of surplus water remaining after infiltration was considered. The sum of the products of this methodology should confirm equation 2.

3.4 Groundwater Recharge/Supply

Evaluation of the potential for groundwater stress requires an understanding of the volume of groundwater supply being used. In a general sense this can be defined as a sum of recharge and net horizontal flow of groundwater into the respective watershed. At this level of work, only the volume of recharge was considered for conservative purposes. To determine recharge the GIS water budget model was used to calculate the volume of precipitation that is available for infiltration. The proportion of this infiltration that ultimately recharges the aquifers was then estimated based on data from a network of monitor wells located throughout the watershed.

In reference to Water Budget Guidelines (2007) the volume of average annual groundwater recharge derived from the GIS model was further refined by dividing this volume equally over 12 months. For safety a reserve of 10% was subtracted from this volume prior to comparing the supply against water use. The resulting ratio of supply to use was then compared against thresholds, as defined in the Guidelines to assign the level of potential hydrologic stress as significant, moderate, or low.

3.5 Surface Water Supply

To evaluate surface water stress the volume of supply was taken directly from stream gauge data for the 1981-2010 period recorded by the Water Survey of Canada (WSC) and provided in Appendix A. The location of stream gauges is illustrated by Figure 3 which also illustrates the catchment areas for these gauges. For the catchment areas where gauges do not exist quaternary level watersheds as determined by the Ministry of Natural Resources were used.
In accordance with the water budget guidance the surface water supply is estimated based on the median flow of each month after subtraction of the 10th percentile flow (as a reserve) for the same month. The resulting volume is then compared with the use for the corresponding watershed to assign a significant moderate or low stress level. The flow for ungauged catchments was established through prorating to catchments of similar characteristics.

3.6 Water Demand

The monthly water demand was assessed based on review of both permitted and non-permitted takings. This included review of municipal, private, agricultural as well as other permitted and non-permitted takings. Detailed information on this inventory is discussed further in this report. Consumptive factors were assigned to the water use to provide an estimate of the volume of water that is used and not directly returned to the source in a reasonable period of time. Actual water use numbers were also applied where available.

3.7 Watershed Stress

Potential hydrologic stress was evaluated through calculation of the ratio of water supply to demand for both ground and surface water. For surface water this assessment was completed on a monthly basis and groundwater was completed for both monthly and annual time periods. To be conservative a reserve is subtracted from the supply of both ground and surface water volumes prior to calculating the ratio. The ratio is then compared against thresholds to define the level of stress as significant, moderate, or low in accordance with the Water Budget Guidelines (2007).

4. Water Budgets

The water budget for the Quinte watershed region on a long term annual and monthly basis was evaluated as described above and presented below. The general results are described with break down on the available volumes of both surface and groundwater discussed in subsequent sections of this report.

4.1 Climate

The long term water budget for the Quinte Region (1981-2010) is presented in Table 2 and Figure 5. The precipitation and temperature values have been determined based on climate modelling of Natural Resources Canada with the GIS model used to calculate potential and actual evapotranspiration. The mean monthly values of each parameter was determined using the GIS model and to provide illustration of the annual distribution of temperature, precipitation, and actual evapotranspiration in Figures 6, 7, and 8. The Water Budgets for the 4 largest gauged catchments (Consecon-02HE002, Moira-02HL001, Napanee-02HM007, and Salmon-02HM003) are summarised in Appendix B.

From the mapping it can be seen that on an annual basis the climate over the Quinte region varies with warmer temperatures in the south (2.5 degrees warmer) and slightly more precipitation in the east and southeast. Corresponding to this distribution the evapotranspiration also follows the trend of temperature with increased amounts in the south (approximate difference of 130 mm between the maximum and minimum values).

In comparison to previous water budget work for the 1971-2000 period, the average annual temperature has increased by 0.4 degree Celsius resulting in increased amounts of evapotranspiration. However, the amount of precipitation has also increased which has offset increased evapotranspiration. A graphical representation of the water budget, as illustrated by Figure 5, indicates that during the summer months a deficit exists as potential evapotranspiration exceeds the actual amount. During this period water storage is relied on to meet water demand of the plants, animals and humans living in the watershed. However prolonged periods of storage depletion can lead to drought.

4.2 Evapotranspiration (Calculated & Derived)

To confirm the accuracy of the actual evapotranspiration (AET) calculated using the GIS model, a derived AET value was calculated using the precipitation and stream flow data for the same climate period. This is done by rearranging equation 3 and subtracting runoff (as measured at stream gauges) from precipitation as follows:

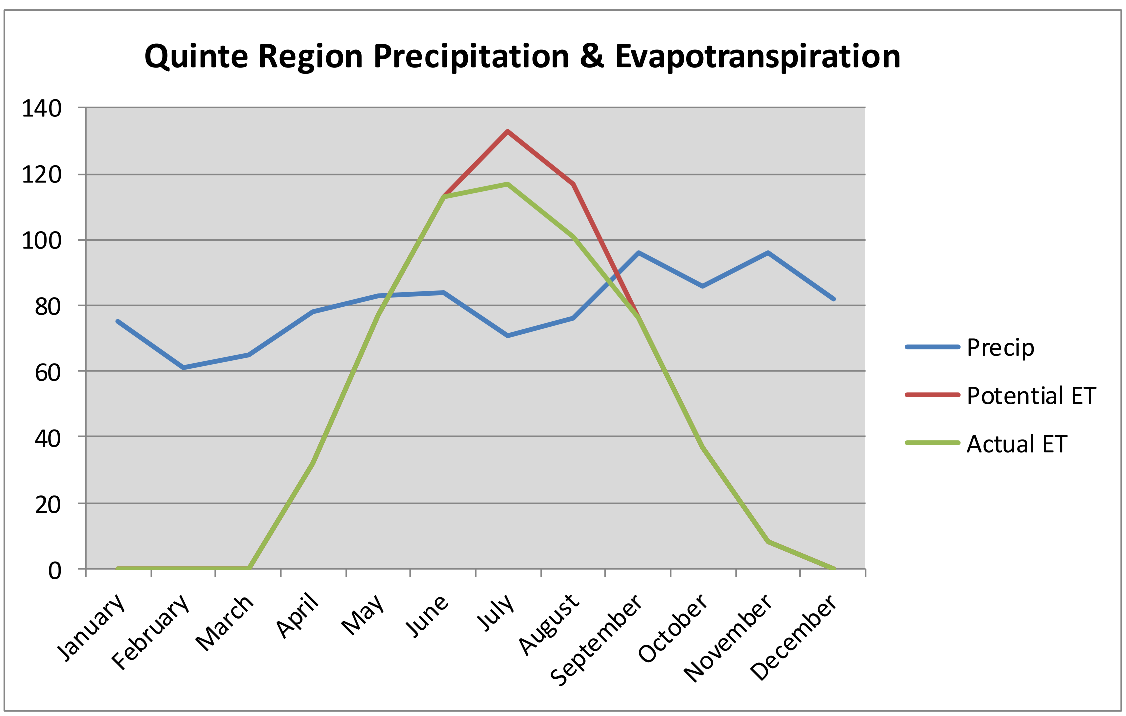
$$\text{Derived ET} = \text{Precipitation} - \text{Runoff} \qquad (4)$$

Table 2: 1981 – 2010 Average Temperature, Precip, ET - Quinte Region

Month	Average Temperature (°C)	Average Precipitation (mm)	Avg PET (mm)	Avg AET (mm)
January	-7.9	75	0	0
February	-6.6	61	0	0
March	-1.4	65	0	0
April	6.2	78	32	32
May	12.7	83	77	77
June	17.8	84	113	113
July	20.5	71	133	117
August	19.5	76	117	101
September	15.0	96	76	76
October	8.4	86	37	37
November	2.5	96	8	8
December	-4.2	82	0	0
Annual	**6.9**	**952**	**594**	**562**

PET = Potential Evapotranspiration, AET= Actual Evapotranspiration
Calculated by Thornthwaite Method 1955

Figure 5: Quinte Region Precipitation & Evapotranspiration (1981-2010)



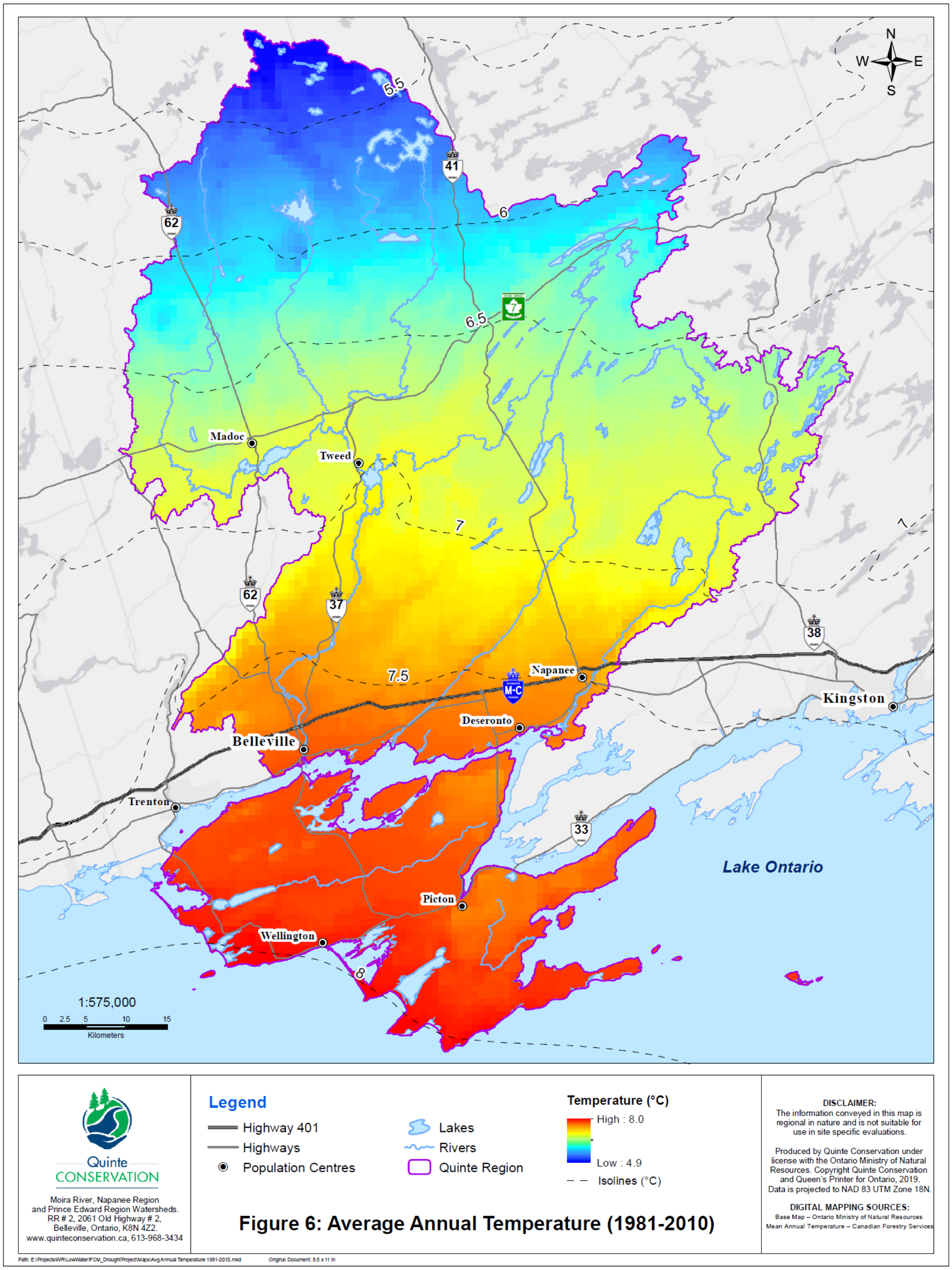


Figure 6: Average Annual Temperature (1981-2010)

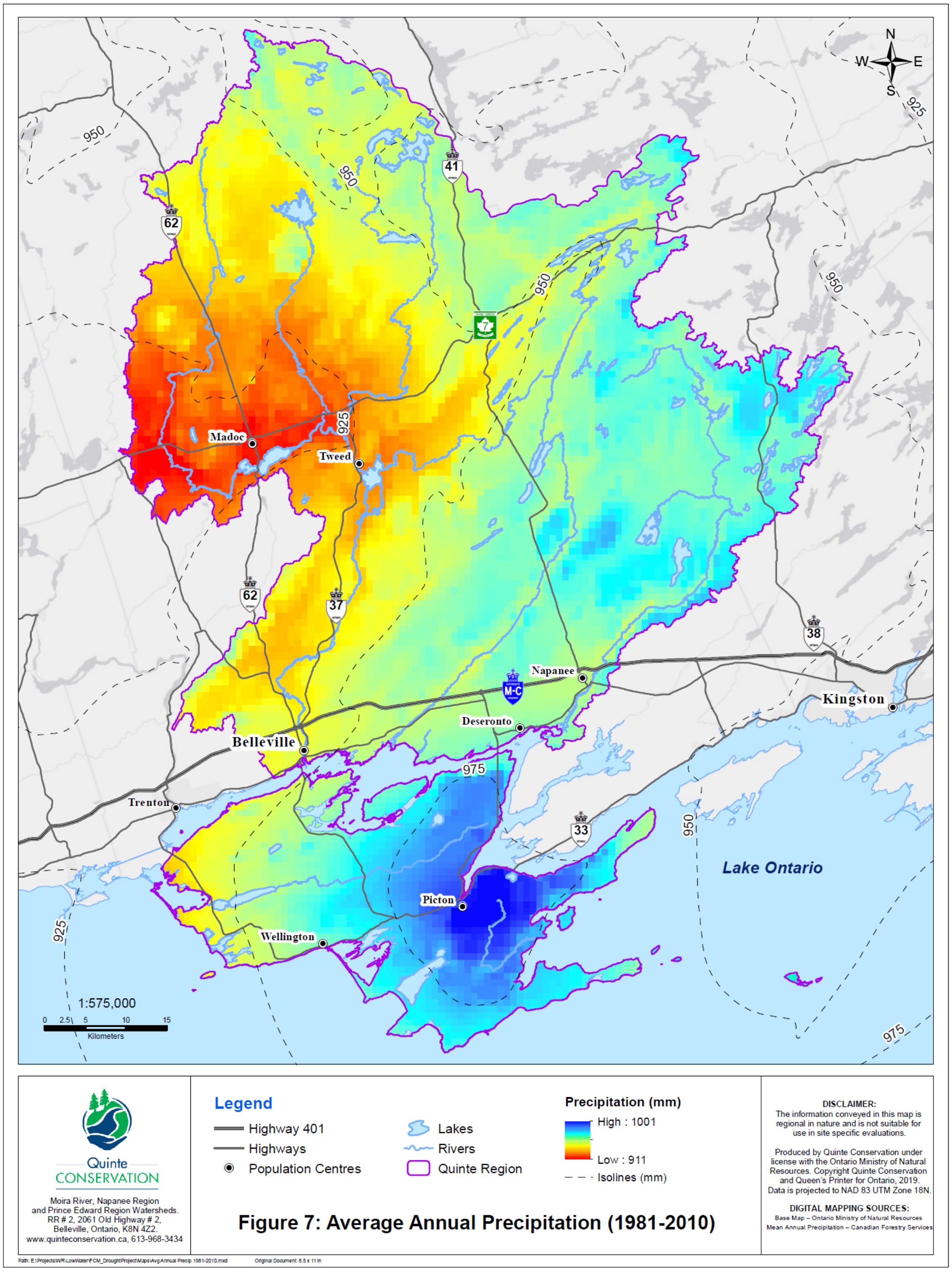


Figure 7: Average Annual Precipitation (1981-2010)

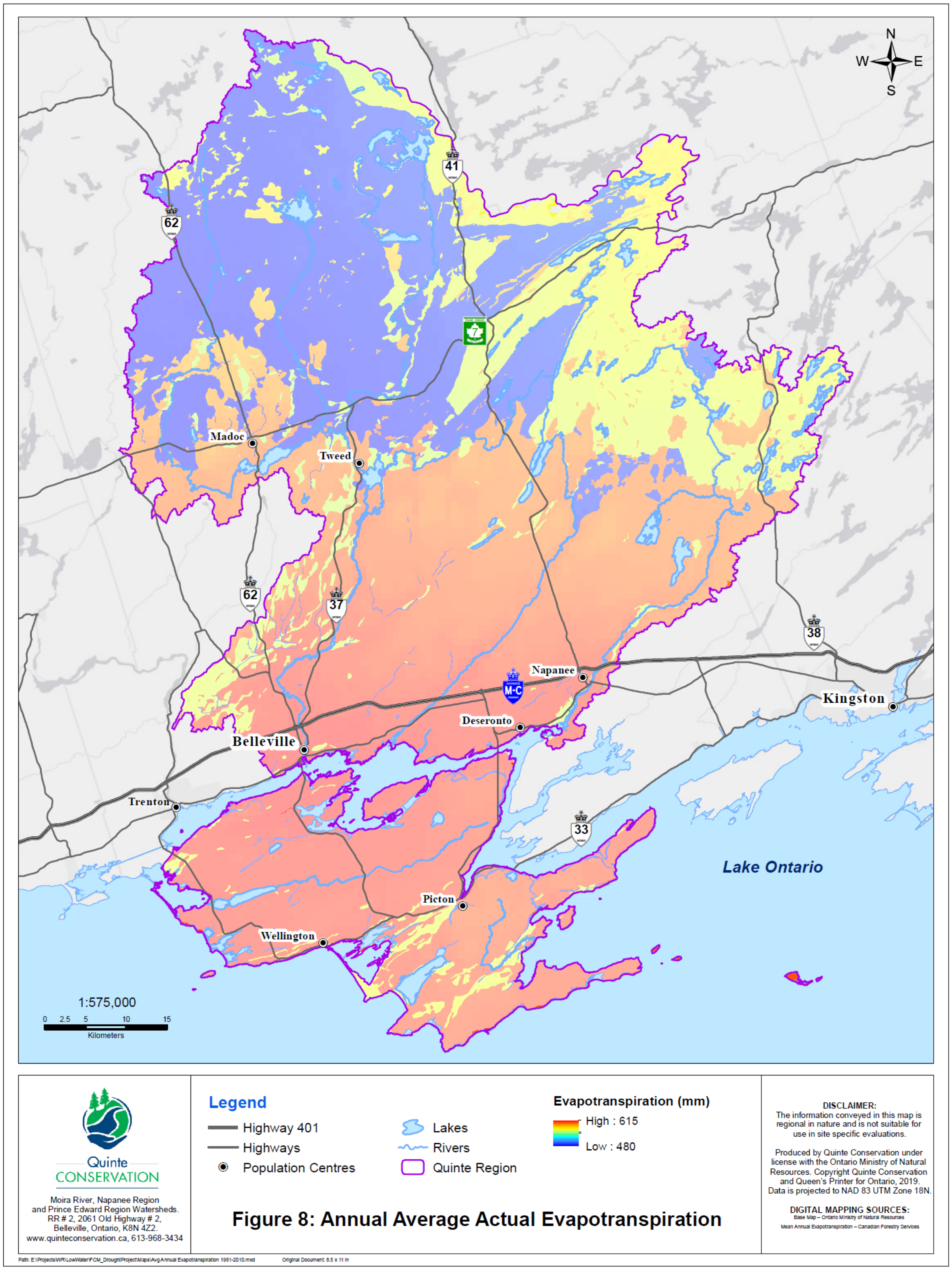


Figure 8: Annual Average Actual Evapotranspiration

The derived ET values may now be calculated by simple subtraction of the annual depths of runoff and precipitation. This has been completed for the four largest gauged catchments of the Quinte Region as listed in Table 3.

Table 3: Water Budget Summary for period 1981 – 2010

Station	Precip mm/yr	Runoff * mm/yr	Derived AET (P –R) mm/yr	Calculated AET (From GIS)** mm/yr	Difference mm/yr
Moira-Foxboro	939	393	**546**	**531**	15
Salmon	959	399	**560**	**566**	6
Napanee	964	399	**565**	**575**	10
Consecon	974	398	**576**	**611**	35

* Runoff as determined from Water Survey Canada Stream Gauge data (Appendix A).

** The GIS model uses the Thornthwaite method of determining AET using soil moisture content

The results of this analysis shows good agreement between the Actual Evapotranspiration (ET) calculated by the GIS model and the values derived from the stream gauged data. Therefore, the GIS methodology is considered to produce reasonably good basin scale average results. Based on the current review the water budget for the Quinte region (1981-2010) can now be expressed as:

Precipitation	– Evapotranspiration	= Runoff (Surplus)
952 mm	– 562 mm	= 390 mm

4.3 Drought Year

To consider the impacts of a drought on the local water budget a review of climate data for the Quinte region over the 2016 calendar year has been completed. During this year the quinte area experienced one of the most severe droughts on record. To determine the climate for this period a review of data from 27 climate stations at the locations illustrated by Figure 9 has been completed. The temperature and precipitation data from these stations has been interpolated in GIS to determine the monthly distribution of these parameters for input to the GIS water budget model. The annual and monthly water budget for the Quinte Region is summarised in Table 4 with the results for the four largest gauged catchments provided in Appendix B.

In comparison to the 1981-2010 climate normal period the main differences of 2016 are higher than normal temperatures with the average annual temperatures 1.7 degrees higher, and reduced annual precipitation by approximately 160 mm. However actual ET was also lower by approximately 111 mm. This was attributed to lower than normal rainfall during the months in which potential ET demand is high. Further review of winter precipitation data indicated that the majority of winter precipitation was in the form of rain as opposed to snow. This in turn resulted in more runoff and reduced storage of snow for recharge of aquifers during the spring months. The lower than normal spring recharge was also compounded by abnormally low precipitation in the month of May and the remaining summer months. Based on the GIS water budget model the water budget for the Quinte Region for 2016 can be written as:

Precipitation	– Evapotranspiration	= Runoff (Surplus)
793 mm	– 451 mm	= 342 mm

A review of the 2016 stream flow data (water Survey Canada) for the four largest catchments as listed above in Table 3 resulted in calculation of derived evapotranspiration in the order of 458 to 478 mm. This comparison provided generally good correlation of most catchment with the exception of the Foxboro catchment which was potentially underestimated due to lack of precipitation data.

Table 4: 2016 Average Temperature, Precip, ET - Quinte Region

Month	Average Temperature (°C)	Average Precipitation (mm)	Avg PET (mm)	Avg AET (mm)
January	-5.0	71	0	0
February	-4.9	110	0	0
March	1.1	98	3	3
April	4.9	40	21	21
May	14.1	28	82	74
June	17.9	59	110	96
July	22.1	31	142	71
August	22.7	71	135	75
September	17.6	54	87	54
October	10.3	107	43	43
November	4.8	40	15	15
December	-1.9	84	0	0
Annual	8.6	793	637	451

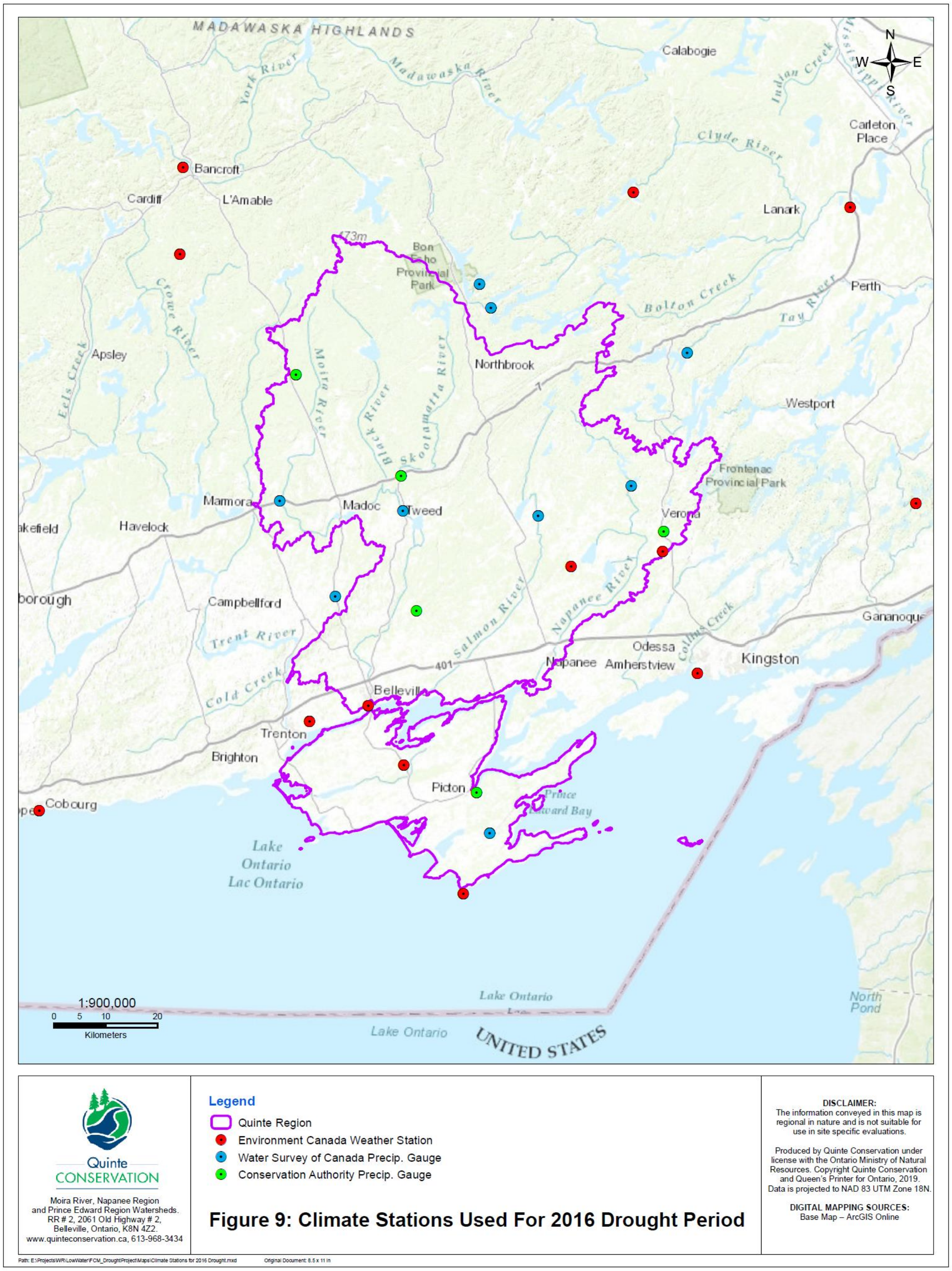


Figure 9: Climate Stations Used For 2016 Drought Period

4.4 Future Climate

Future climate conditions for Canada have been modelled by Natural Resources Canada Canadian Forest Service – (McKenney, D, et al, 2019). These projections represent possible future climate conditions based on assumptions of how the earth's climate operates future world population levels, and economic activity and greenhouse gas emissions. Several scenarios have been interpolated by the Natural Resources Canada group, however to simplify the number of scenarios the results from the CANESM RCP (Canadian Earth System Model – Representative Concentration Pathways) medium or intermediate scenario have been applied. This model is a composite of various models and considers changes to the earth that could affect emissions such as; population and economic growth, energy and oil consumption, emission and atmospheric concentration of pollutants contributing to climate change i.e. carbon dioxide.

Extraction of climate data for the Quinte Region was completed to provide input into the GIS water budget model for assessment of potential changes. A summary of the future water budget for the Quinte Region, as listed in Table 5, indicates a warming trend with the annual average temperature at 1.8 degrees above the 1981-2010 period. Precipitation levels are predicted to be relatively similar to current trends. However, a marked increase in potential evapotranspiration and small increase in actual evapotranspiration is noted. The effects of this change are best illustrated by Figure 10 which shows an increasing water deficit during the warmer summer months. Based on the GIS water budget model the water budget for the Quinte Region for 2016 can be written as:

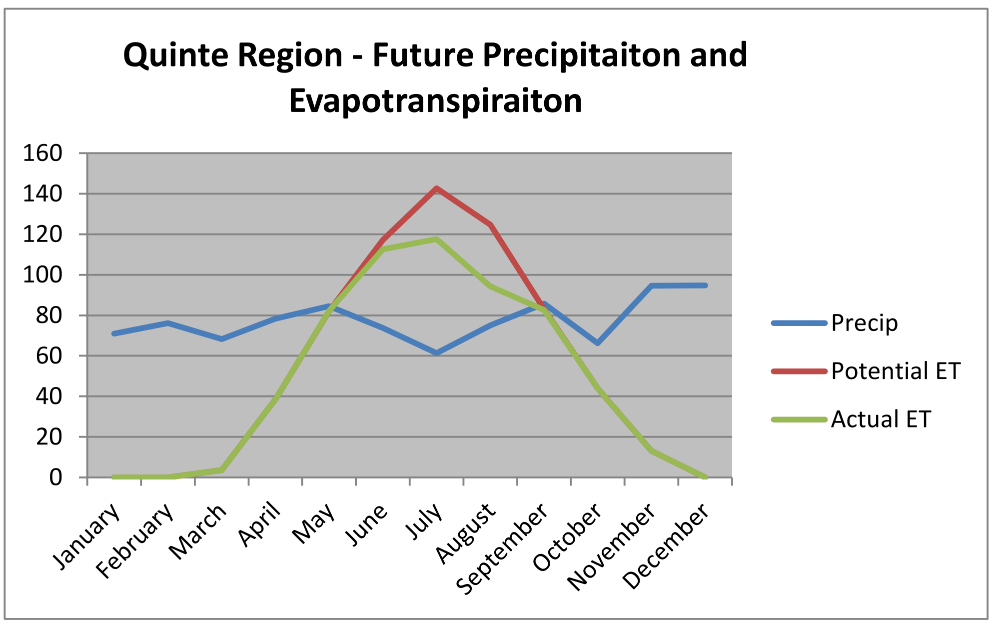
Precipitation	– Evapotranspiration	= Runoff (Surplus)
930 mm	– 588 mm	= 342 mm

The individual water budgets for the 4 largest gauged catchments in the Quinte Region are included in Appendix B. The effects of this potential change on ground and surface water supplies will be discussed later in this report.

Table 5: 2011 – 2040 Average Temperature, Precip, ET - Quinte Region

Month	Average Temperature (°C)	Average Precipitation (mm)	Avg PET (mm)	Avg AET (mm)
January	-5.3	71	0	0
February	-5.0	76	0	0
March	1.2	68	4	4
April	8.3	78	39	39
May	14.2	84	82	82
June	18.9	74	117	113
July	22.2	61	143	118
August	21.2	75	125	94
September	17.0	86	83	83
October	10.7	66	44	44
November	4.4	95	13	13
December	-3.2	95	0	0
Annual	8.7	930	649	588

Figure 10: Quinte Region Precipitation & Evapotranspiration (2011-2040 - Composite)



5. Quinte Region Water Demand

To determine water demand, a variety of sources of information have been reviewed to establish total use of ground and surface water for the various categories itemised below. Sources of information included:

- MECP Permit to Take Water Database (2018),
- Ontario Water Well Record data (2018),
- Canada Census Data (2016) for population, and agricultural statistics,
- Conservation Authority apportionment figures.

In this review the maximum permitted water taking, as specified in the MECP Permit to Take Water (PTTW) data, were applied as one scenario and where possible consumptive factors used to determine the portion of water not returning to the watershed. Permits to take water with the source being from the Great Lakes or connecting channels (i.e. Bay of Quinte) have been reviewed but are not included in further assessment of ground and surface water use.

5.1 Quinte Region Population Distribution

A review of the population figures for the Quinte Region has been completed based on Canada Census data (2016), municipal water servicing information and Conservation Authority apportionment data for percentages of people living within the Quinte Watershed. The results of this review are summarised in Table 6. Of the 127922 people living in the Quinte region approximately 50% of the population rely on water from the Great Lakes and the balance from groundwater. Of those persons relying on groundwater the vast majority rely on private water wells for supply (approximately 64820 people). This fact will be considered later in determination of water use from private wells in the Region.

5.2 Water Demand Categories

The following provides a summary of the various water demand categories that have been considered and how water use was estimated for each category.

Category 1: Domestic and Commercial Use

Domestic and commercial use was determined utilizing Ontario water well record data (2018) and population data from Table 6. The number of wells being utilised for domestic and commercial use were separated out of the water well record database (24000 wells) and compared with the population for the individual municipalities. Based on correlation of the population with the number of water wells a factor of 2.7 persons per well was determined. A water usage of 175 litres per person per day was then applied to calculate the commercial and domestic water use. Points of use were assigned to pixels based on the locations of wells derived from the Ontario Water Well Record database.

Table 6: Municipal Population Distribution on Ground and Surface Water Supplies

Municipality	Total Population	Population Served			% Population Supplied by Groundwater		
		Municipal Groundwater	Surface Water	Private Wells	Total	Municipal Wells	Private wells
Tweed	6044	1539	0	4505	100	25.4	74.5
Belleville	50716	0	40000	10716	21.1	0	21.1
Tyendinaga	4297	0	0	4297	100	0	100
Deseronto	1774	0	1774	0	0	0	0
Stone Mills	7702	0	0	7702	100	0	100
Madoc	2078	0	0	2078	100	0	100
South Frontenac	3916	0	0	3916	100	0	100
Centre Hastings	2673	1730	0	943	100	64.7	35.2
Addington Highlands	1022	0	0	1022	100	0	100
Greater Napanee	8423		7760	663	7.9	0	7.9
North Frontenac	19	0	0	19	100	0	100
Central Frontenac	2012	0	0	2012	100	0	100
Marmora	870	50	0	820	100	5.7	94.2
Quinte West	10022	0	300	9722	100	0	100
Stirling Rawdon	830	0	0	830	100	0	100
Tudor & Cashel	281	0	0	281	100	0	100
Loyalist	509	0	0	509	100	0	100
Prince Edward	24735	50	9901	14784	60.2	0.2	60
Totals	**127922**	**3369**	**59735**	**64820**	**50.7**	**2.6**	**46.7**

Category 2: Industrial and Manufacturing:

MECP permit to take water data was used to determine this usage which includes the dewatering of quarries, aggregate washing and other similar activities.

Category 3: Agricultural

Agricultural water use was determined for livestock watering, irrigation and crop spraying based on PTTW, Canada Census (2016) for livestock numbers and crop areas. The livestock use was determined by applying water requirements of the Ontario Ministry of Agriculture and Rural Affairs (OMAFRA) to census livestock data. The census data indicated negligible irrigation of crops in the Quinte Region which was also supported by the absence of PTTW for agricultural irrigation from wells or inland water sources. However, a review of agricultural trends suggested a decrease in livestock numbers and an increase in acreage of crops that would have spray applied.   The water volume requirements for spray were determined based on recommendations of Ecologisitcs (1993) and local practice. A volume of 168 litres/hectare was determined based on an average of 2.5 applications per year. This combined agricultural demand was distributed to the number of agricultural wells within the respective sub watershed (approximately 1600 individual wells).

Category 4: Irrigation

The MECP permit to take water data was used to determine this usage. This category is predominantly water use for golf courses which exceed 50,000 litres/day.

Category 5: Public supply:

The MECP permit to take water data was used to determine this usage. This includes usage for campground and private developments where total daily demand exceeds 50,000 litres/day.

Category 6: Municipal Water supply

This category is for Municipal drinking water systems. The MECP permit to take water data was used to determine this usage.

Category 7: Remediation

Remediation activities require the taking of water for construction as well as for the treatment of contaminated water to remove impurities. The MECP permit to take water data was used to determine this usage.

5.3 Consumptive Water Use

To refine the actual use of water within the Region consumptive factors were applied to individual takings. The intent of this factor is to consider only the portion of water that is not returned directly to the reservoir or source where it was taken (i.e. municipal well with discharge of sewage to surface water would be 100% consumptive). However, in other cases consumptive use factors as taken from Provincial water budget guidelines (2007) have been applied. These factors are reproduced in Table 7.

Table 7: Consumptive Water Use Factors

Category	Specific Purpose	Consumptive Factor
Groundwater		
Agricultural	Fruit Orchards	0.8
Agricultural	Other - Agricultural	0.8
Commercial	Bottled Water	1
Commercial	Golf Course Irrigation	0.7
Dewatering	Pits and Quarries	0.25
Industrial	Aggregate Washing	0.25
Industrial	Other - Industrial	0.25
Remediation	Groundwater	0.5
Water Supply	Campgrounds	0.2
Water Supply	Communal	0.2
Water Supply	Municipal	0.2
Surface Water		
Agricultural	Other - Agricultural	0.8
Commercial	Golf Course Irrigation	0.7
Dewatering	Pits and Quarries	0.25
Industrial	Aggregate Washing	0.25
Industrial	Manufacturing	0.25
Water Supply	Municipal	0.2
Water Supply	Other - Water Supply	0.2

5.4 Summary of Water Use

Water in the Quinte Region is used for potable supply to municipalities and private homes as well as for irrigation (golf courses), agriculture, industry, public (i.e. campgrounds) and remediation. A review of water use data and population numbers (see Table 9) indicates that drinking water supply for residents of the Quinte Region is essentially divided equally between ground and surface water. Large urban centres are primarily supplied by surface water from the Great lakes whereas the rural population rely on private wells. However the Village of Ameliasburgh obtains supply from a small lake and the backup intake for the Town of Napanee is on the Napanee River.

Permits to Take Water (PTTW) for the Quinte Region were provided by the MECP with records up to the end of 2018. Actual water use data was also provided for those permits for which data was available. Permits that were expired or for short duration takings (i.e. pump tests) as well as for wetland conservation were removed from this review. Wetland conservation activities are now exempt from the PTTW process and in many cases such projects help the local water budget through storage of water. Refinement of PTTW issued for remediation activities at the Deloro mine site was also coordinated with the MECP. This is in recognition of the current status of ongoing activities at the abandoned mine. From the remaining permits there were a total of 62 that allow taking at the locations illustrated by Figure 11. The permits may be broadly grouped as 15 for Great Lakes, 17 for groundwater, 12 surface water, and 18 permits for both ground and surface water. The takings are from 105 individual sources for a total of 210 million cubic metres/year, as summarised in Table 8.

Table 8 Annual Volume of Permitted Water Taking in the Quinte Watershed

Source	**Volume (1000 m3)**	**% of Total**	**Depth (mm) ***
Great Lakes	$40.8 * 10^6$	20	6.6
Surface Water	$120.4 * 10^6$	57	19.4
Groundwater	$49.2 * 10^6$	23	7.9
Total	$210 * 10^6$	100	33.9

*Depths are in reference to the area of the Quinte watershed.

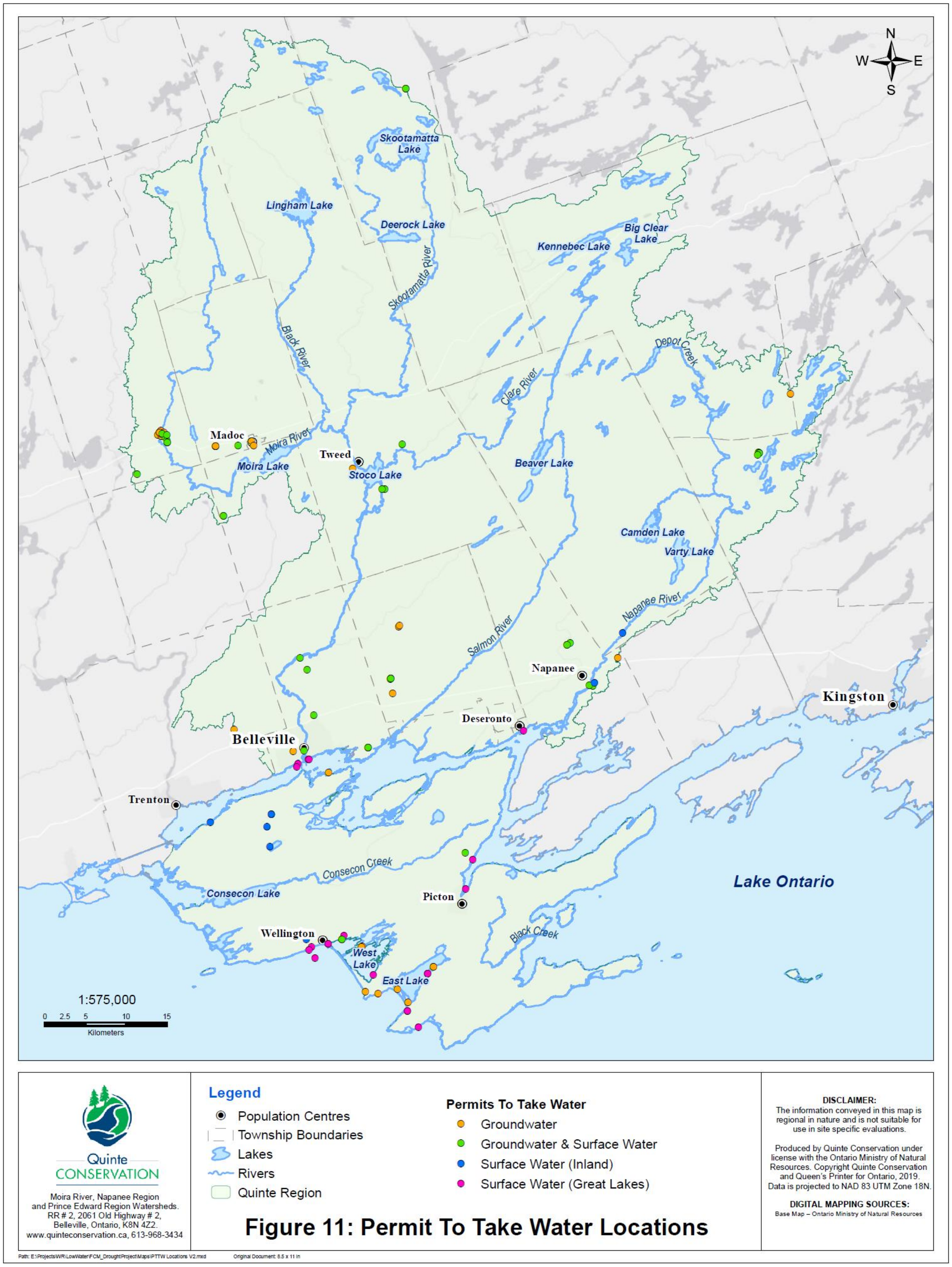


Figure 11: Permit To Take Water Locations

5.5 Groundwater Demand

The total groundwater use for the established categories, as listed in Table 9, was determined, at 42.8 million cubic metres per year. When consumptive factors are considered this use is reduced to 16.4 million cubic metres per year. On a watershed basis this is the equivalent of 7 millimetres for permitted use and 3 millimetres for consumptive use expressed as depth of water equally distributed over the region. The top uses of groundwater are first-Industrial (quarry dewatering), second - private wells, followed by remediation and agriculture. Permitted volume is relatively uniform over the course of the year; however, small increases occur during the spring months as a result of increased water takings at Quarry operations.

Approximately 81% of the permitted volume is for industrial purposes such as dewatering of quarries. In spite of the large permitted volumes, actual water use data for this sector is typically less than 25% of permitted volume. Daily use was noted to be higher than this reduced percentage, however such takings were reported of short duration and sometimes required to maintain dry conditions (i.e. pumping after a large rainfall event). Likewise a review of water takings for municipal purposes indicated average use ranged from 10 to 50 % of permitted volumes. Like other permits, high uses are sometimes required in order to meet peak demands of short duration

Table 9: Monthly Permitted Groundwater Takings (**1000 m^3**)

Month	Agricultural	Domestic	Industrial	Irrigation	Municipal (actual)	Public	Remediation
Jan	60.66	346.82	2714.47	0.00	1.26	34.89	77.38
Feb	60.66	346.82	2300.02	0.00	1.29	34.89	77.38
Mar	60.66	346.82	2762.27	0.00	1.24	34.89	423.93
Apr	60.66	346.82	3001.14	0.00	1.26	54.55	423.93
May	68.49	346.82	3098.64	4.46	1.29	68.19	423.93
Jun	68.49	346.82	3098.64	73.40	1.48	68.19	88.61
Jul	60.66	346.82	3097.44	77.63	1.50	68.19	77.38
Aug	68.49	346.82	3097.44	77.63	1.40	68.19	77.38
Sep	68.49	346.82	3097.44	73.40	1.39	68.19	77.38
Oct	60.66	346.82	3097.44	4.46	1.28	68.19	77.38
Nov	60.66	346.82	2954.94	0.00	1.21	48.53	77.38
Dec	60.66	346.82	2519.13	0.00	1.26	34.89	77.38
Annual	759.26	4161.78	34838.99	310.98	15.85	651.76	1979.46
% of Total	2.19	9.70	81.22	0.72	0.04	1.52	4.61

Surface Water Demand

Surface water extractions were determined based on the Permit to Take Water data following the same categories as above. Maximum permitted volumes were considered in the calculations as well as actual takings where data was provided by the MECP. The permitted takings were assigned to the relevant pixels, however permits for takings from the Great Lakes (Lake Ontario and the Bay of Quinte), and short term pumping tests and construction projects were excluded.

Surface Water Use

Review of the permitted surface water uses indicated that the majority of takings are for remediation (76%) followed by industrial and municipal at 18 and 4 % respectively. The monthly permitted takings are as listed in Table 10 with a total of 120 million cubic metres per year. When consumptive factors are applied this use drops to 26 million cubic metres per year and is further reduction to 3.2 million cubic metres when actual use is considered. Similar to the groundwater permits a review of actual taking for remediation and industrial activities indicated that actual water use was often less than 25% of permitted monthly volumes.

Table 10: Monthly Permitted Surface Water Takings (1000 m^3)

Month	Agricultural	Industrial	Irrigation	Municipal (actual)	Public	Remediation
Jan	15.9	1446.5	0.0	376.0	0.2	7689.3
Feb	15.9	1446.5	0.0	376.0	0.2	7689.3
Mar	15.9	1998.1	0.0	376.0	0.2	7689.3
Apr	15.9	1998.1	0.0	376.0	0.2	7689.3
May	15.9	1958.8	130.8	376.0	1.1	7689.3
Jun	15.9	1958.8	261.6	376.0	1.1	7689.3
Jul	15.9	1957.6	265.9	376.0	1.1	7689.3
Aug	15.9	1957.6	277.2	376.0	1.1	7689.3
Sep	15.9	1951.9	206.6	376.0	1.1	7689.3
Oct	15.9	1951.9	149.0	376.0	1.1	7689.3
Nov	15.9	1951.9	14.9	376.0	1.1	7689.3
Dec	15.9	1578.9	0.0	376.0	0.2	7689.3
Annual	191.3	22156.6	1305.9	4511.4	8.3	92272.0
% total	0.2	18.4	1.1	3.7	0.0	76.6

Groundwater Stress Assessment

Groundwater in the Quinte Region is predominantly found in fractured bedrock aquifers covered by thin soils. Overburden aquifers of limited extent can be found in small isolated areas of thicker soil deposits. Limestone aquifers are found throughout the southern portions of the watershed with Precambrian bedrock aquifers common in the north. In the absence of significant aquitards and soil cover, these aquifers are considered to be unconfined, however in some areas, where the density of fractures in the bedrock is low, confined conditions may exist. A decrease in fracture density occurs with depth in the bedrock as the upper horizons have been subject to weathering and dissolution from the movement of water.

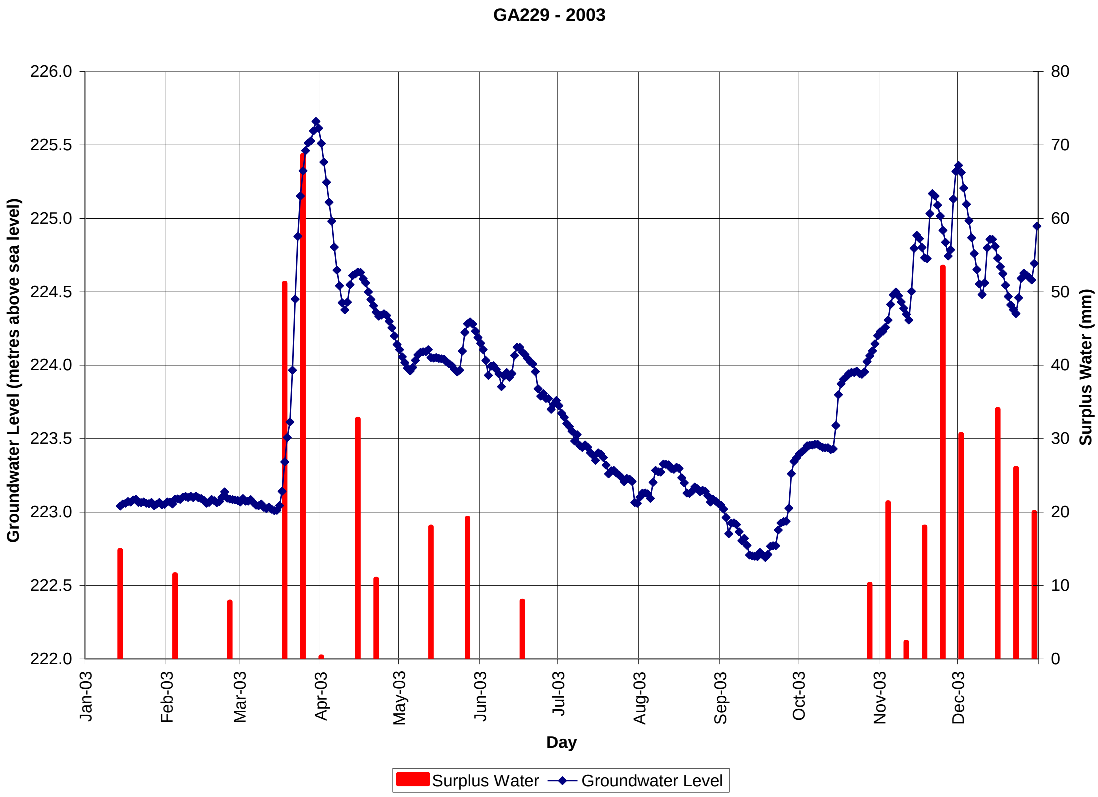
Ontario Water Well records for the Quinte Region confirm the use of aquifers with approximately 95 percent of the wells obtaining supply from fractured bedrock aquifers. The remaining 5 percent of wells obtain supply from overburden aquifers where there is sufficient thickness of sand and gravel. The percentage of wells installed into the major aquifers and/or hydrogeologic units can be simplified as follows:

Precambrian Aquifer(s) –	21 percent of wells
Limestone Aquifer(s) –	74 percent of wells
Overburden Aquifer(s) –	5 percent of wells

Groundwater movement is generally in the top 10 to 30 metres of the fractured bedrock with recharge occurring through infiltrating precipitation throughout the Region. The depth to the water table in the Quinte Region is often shallow at 2 to 3 metres below the ground surface. From mapping of the water table elevation it is evident that greatest depth to the water table is found in topographically high areas and shallow depths are evident in low lands adjacent to water bodies and surface water courses.

Annual recharge to the unconfined aquifers is interpreted to be approximately 10 percent of annual precipitation. The bulk of this recharge occurs in the spring and fall and is a reflection of the water budget when surplus water is available during these periods of low evapotranspiration. A hydrograph for a monitor well installed in a fractured bedrock aquifer in the Quinte watershed is illustrated by Figure 12 showing the annual trend with an increase in water levels during the spring in response to recharge and a decrease in the summer months when more water is leaving the aquifer than entering. This annual trend has been demonstrated to be similar to the discharge in the Quinte Region's local streams and rivers as measured at the many stream gauges throughout the region. Such positive correlation confirms the unconfined conditions of local aquifers.

Figure 12: Groundwater Hydrograph – Quinte Watershed



6.1 Groundwater Recharge Determination

The spatial distribution of groundwater recharge throughout the Quinte Region was determined using the GIS water budget model to calculate infiltration factors as previously described. The volume of infiltration and direct runoff was determined by applying the factor to the amount of precipitation remaining after evapotranspiration has been accounted for. The difference between infiltration and the surplus water is the direct surface runoff. Recharge to the deeper bedrock aquifers was then determined by applying a factor to the volume of infiltration. A summary is provided below.

Infiltration Factor

The infiltration factors were calculated in respect of land slope, soil permeability, and land cover using the GIS water budget model. The sum of the individual factors was calculated for each of 18 different possible combinations and divided into ranges of high medium and low as listed below. This grouping is based on a simple division of the total coefficient into three equal ranges.

Infiltration Factor Range	% of Watershed Area
0.275 – 0.445 (low)	39.6
0.445 – 0.600 (medium)	53.2
0.600 – 0.775 (high)	7.2

For the watershed region the average infiltration factor ranges from 0.45 to 0.49 which resulted in calculation of 183 mm of average annual infiltration. The average direct runoff is the calculated at 207 mm. The combined total of infiltration and direct runoff is 390 mm corresponding with the annual water budget for the region (1981-2010).

Infiltration Results

The infiltration rates for the four largest gauged surface water catchments in the QC watershed is summarised in Table 11. This table also provides the estimated base flows for these watersheds using a base flow index taken from the United States Geological Survey (USGS Base Flow in the Great Lakes Basin – Scientific Investigations Report 2005-5217). These indices allow estimation of the groundwater component of stream flow through consideration of the geology of the watershed in recognition of the fact that groundwater recharge is largely regulated by the capacity of the groundwater system to receive and transmit water.

A comparison of the calculated infiltration rates with estimated base flow for the four watersheds indicates reasonable correlation. The variation between the two methods ranges from a minimum of 2% (4 mm) for the Consecon watershed to a maximum of 14% (27 mm) for the Napanee River watershed. This correlation is considered to be within acceptable range for this type of exercise. The results of the infiltration determinations for the individual catchments in the Region are provided in Appendix C.

Table 11: Groundwater Recharge and Base Flow Summary

Station	Gauged Runoff mm/yr	USGS Groundwater Index BFLOW	USGS Groundwater Base flow mm/yr	Calculated Groundwater Infiltration * mm/yr	Difference mm/yr
Moira	393	0.42	165	179	14
Salmon	399	0.40	160	186	26
Napanee	399	0.40	160	187	27
Consecon	398	0.44	175	179	4

* Determined using the GIS model

6.1.3 Groundwater Recharge

In reference to the local groundwater conditions the volume of water (recharge) entering the ground through infiltration was further refined through application of a recharge coefficient. This coefficient was established through review of water table fluctuations in a network of 30 monitoring wells located throughout the Quinte watershed. This step was necessary as fractured bedrock is the dominant aquifer type throughout the Region and calculation of infiltration in the upper soil layers does not always reflect actual recharge into this type of aquifer. The water table fluctuation method (Healey & Cook, 2002) was applied to calculate recharge from the increase in water levels in an aquifer as measured by monitor wells. The critical assumption is that an increase in water level is in response to recharge received at the water table. This change in water level is then converted to recharge through multiplication by the estimated specific yield for the aquifer. Specific yield for the Quinte Region aquifers was estimated using stream gauge data and groundwater levels during a period of baseflow recession. The recharge factor for the various regions was determined to be 0.32 for Precambrian terrain and 0.53 for the Paleozoic limestone terrain. The annual recharge rates are summarised by Table 12. Further information about the results of this assessment can be found at Quinte Conservation Tier 1 Water Budget, April 14, 2009.

Evaluating Groundwater Stress

The potential hydrologic stress or percent water demand for groundwater was calculated on a monthly and annual basis using the following formula:

$$\% \text{ Water Demand (Stress)} = \frac{Q_{Demand}}{Q_{Supply} - Q_{Reserve}} \text{ X } 100$$

Where:

Q_{Demand} = Monthly & annual demand calculated as consumptive and permitted takings.

Q_{Supply} = Groundwater supply calculated as the average annual recharge rate divided by 12 for monthly volumes.

$Q_{Reserve}$ = Groundwater reserve is estimated as 10% of the recharge.

The stress on the groundwater supply as described above was evaluated for each 1 square kilometre grid of the GIS model. The monthly recharge is summarised by Table 12. The result of this exercise was then compared to prescribed criteria provided in the Provincial Water Budget Guidelines, 2006 as listed in Table 13.

Table 12: Annual and Monthly Groundwater Recharge by Catchment (depth in mm)

Catchment Name	Annual Precipitation	Annual Evapotranspiration	Annual Recharge	Monthly Recharge
Ameliasburgh	952	608	84	6.3
Black	939	495	59	4.4
Milford	987	599	102	7.65
Camden	965	578	74	5.5
Clare	947	549	74	5.5
Consecon	962	611	90	6.75
Deloro	933	503	58	4.3
Depot	964	563	62	4.6
East Lake	937	601	98	7.3
Foxboro	905	574	71	5.3
Hillier	954	610	83	6.2
Moira	947	604	102	7.6
Napanee	958	607	67	5.0
North Marysburgh	970	599	92	6.9
Parks	950	600	92	6.9
Picton	990	599	101	7.6
Salmon	954	612	60	4.5
Shannonville	961	592	90	6.8
Skootamatta	946	503	60	4.5
Sophiasburgh	973	604	96	7.2
South Marysburgh	972	598	100	7.5
Tamworth	957	546	61	4.6
Tweed	921	562	52	3.9
West Lake	974	601	96	7.2

Table 13: Groundwater Stress Thresholds - % Water Demand

Groundwater Quantity Stress Assignment	Average Annual	Monthly Maximum
Significant	> 25%	>50%
Moderate	>10%	>25%
Low	0-10%	0-25%

Groundwater Stress

Using the relevant groundwater recharge rates and demand an assessment of the percent water demand was determined for the 25 individual sub watersheds as illustrated by Figure 3. The results of this exercise with individual groundwater recharge rates, demand, and percent water demand for each catchment are provided in Appendix C.

The percent water demand throughout the Quinte Region is relatively low with monthly and annual stress for the majority of the catchments at less than 10 %. However, moderate annual stress levels were noted for 4 catchments – Picton, Moira, Tweed, and Lower Napanee, as illustrated by Figure 13. A review of the water takings for these areas indicates permits allowing water taking for industrial activities, golf course irrigation, remediation and municipal water supply. These permitted takings represent the majority of the water use in these areas; however these catchments also contain areas of development which contribute to higher water use.

Caution is required in interpretation of these results as some of the permits for these areas indicate the source to be both ground and surface water. For such permits the taking was divided equally between ground and surface water. There is some uncertainty in this assumption especially for water takings at quarries which typically receive significant surface water drainage resulting in high pump volumes during periods of significant precipitation in order to maintain dry conditions. Regardless the potential stress assignments are considered to be as screening tool to indicate the potential for hydrologic stress in these areas.

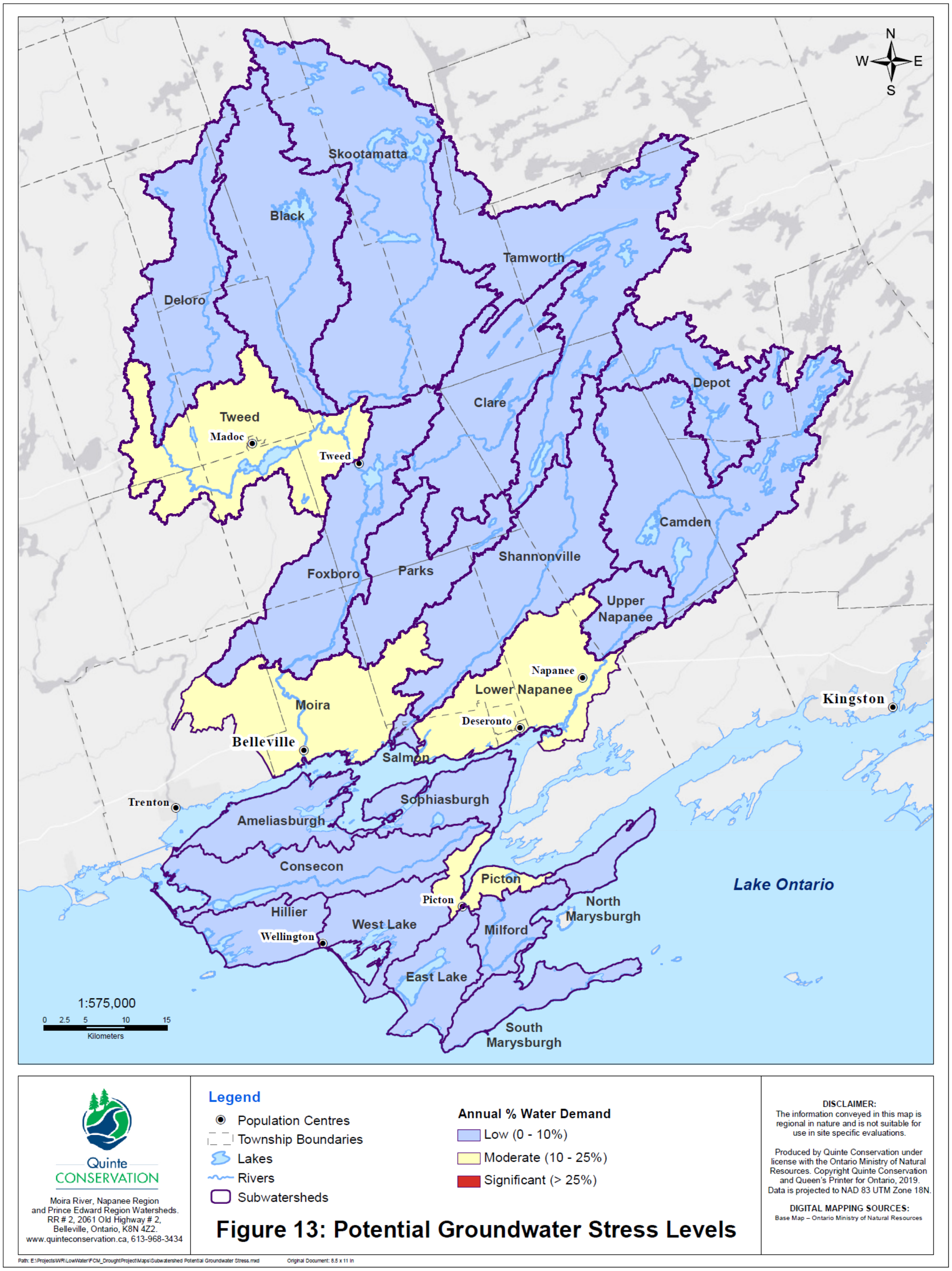


Figure 13: Potential Groundwater Stress Levels

6.3.1 Groundwater Stress Drought Scenario

The stress assessment as described above was repeated using the same water demand but instead with climate conditions for 2016 which represented one of the most severe droughts experienced by the Region. The climate conditions of this year are reported in Section 4 of this report. Low amounts of summer precipitation and high amounts of winter rain combined with higher than normal temperatures contributed to the drought and decreased groundwater recharge.

A review of stress levels determined using the GIS model indicated the level of potential hydrologic stress increased in all catchments. The majority of catchments still remained in low stress level however some of the catchments that were previously identified as exhibiting stress moved up to the next threshold level. The Picton Catchment increased to a significant level of annual stress as well as moderate monthly. The Tweed catchment also increased to a moderate level of monthly stress. The Moira and Lower Napanee catchments remained unchanged at a moderate annual level of stress. The results of this assessment are summarized in Appendix C.

From this exercise it was found that annual groundwater recharge decreased on average by 10% with a water deficit period extended by 1 month to between May and October as opposed to June to October under average conditions. During the deficit period the bulk of precipitation is consumed by evapotranspiration demand with little to no water available for recharge. In the absence of recharge water storage is relied on to meet demand. However the fractured bedrock aquifers of the Quinte Region have low storage capacity and are quickly depleted in the absence of regular rainfall replenishment. This fact is of significance when considering the above percent water demand methodology which requires the equal division of annual recharge into twelve months. In areas of low storage this methodology could underestimate the potential groundwater stress.

Some anecdotal evidence of the impact of the 2016 drought is the records of bulk water sales in Prince Edward County. During the summer of 2016 many private wells went dry and residences were forced to rely on hauled water as reflected in the records provided by Prince Edward County and summarised in Table 14.

Table 14: Picton Bulk Water Station Sales Records

Picton Bulk Station Water Use (m3)			
Year	**Type**	**Estimated Volume**	**Total Volume**
2014	Monthly Users	9829.5	
	Coin Operated	4718.2	14547.7
2015	Monthly Users	8681.9	
	Coin Operated	5742.4	14424.3
2016	Monthly Users	13335.5	
	Coin Operated	14483.6	27819.1
2017	Monthly Users	4853.0	
	Coin Operated	4853.0	9705.9
2018	Monthly Users	7015.4	
	Coin Operated	6097.0	13112.4
2019 (August/September)	Monthly Users	6828.7	
	Coin Operated	4878.9	11707.6

6.3.2 Groundwater Stress Future Climate Conditions

Future climate data for the period of 2011-2040 (see section 4) was processed using the GIS Water Budget model. Under current water demand the levels of potential hydrologic stress were observed to increase. For catchments that were determined to exhibit potential stress under the 1981-2010 period the majority moved to the next stress threshold level. The Picton catchment exhibited moderate monthly and significant annual levels of stress while Moira and Tweed both moved to a moderate monthly level of stress. The Lower Napanee Catchment remained at a moderate level of potential annual hydrologic stress. The results for the four largest gauged catchments are provided in Appendix B.

The model predicts a decrease in average annual recharge by 10 to 17 % (in comparison to 1981-2010) as well as an extended water deficit period which in some cases is from May to November. Such a change could see normal recharge through the early winter and spring months with decreased amounts during the growing months due to increased temperature and evapotranspiration.

In summary it appears that under average climate conditions the level of potential groundwater stress is predominately low across the watershed, exception of some areas of high water use. Under drought and future climate conditions the level of potential stress increases and in some cases move to the significant threshold level. Although water use may be speculative in some of these areas the GIS Water Budget model predicts decreased recharge for the future as a result of warmer temperatures and increased evapotranspiration.

7. Surface Water Stress Assessment

A review of the level of potential hydrologic stress for surface water has been completed for average and drought climate conditions. For this exercise the 1981-2010 data sets for each gauged catchment (see Figure 3) were considered. Using the stream gauge data statistics were calculated to complete the stress assessment. Water Survey Canada Stream Gauge data are included in Appendix A with summary statistics for these catchments shown in Table 15.

Flow statistics were calculated using an Excel spreadsheet function on the gauged data to provide the Median and 10^{th} percentile values. For ungauged catchments Median and 10^{th} percentile statistics were estimated by prorating the catchment to a gauged location or by comparison to a nearby gauged catchment. The following formula, from Hydrology of Floods in Canada by Watt et al., was used to transfer the gauged statistics:

$$Q_1 = Q_2 \left(A_1 / A_2\right)^{0.8}$$

Where:

Q_1 = Flow at location of interest	A_1 = Area at location of interest
Q_2 = Flow at gauged location	A_2 = Area at gauged location

Ungauged catchments include, Lower Moira, Lower Salmon, Lower Napanee, and most of Prince Edward County with the exception of Consecon. Although Black Creek in Prince Edward County is now gauged, the period of record is too short to generate the needed statistics. The two former stations Bloomfield Creek and Demorestville Creek both have short historical records and Bloomfield was noted as having unreliable data (personal communication with Jim Millman, Water Survey of Canada technician).

All statistics for Prince Edward County catchments were derived from the record for the Consecon stream gauge. The estimated statistics for all stations are contained in Appendix D.

7.1 Evaluating Surface Water Stress

The potential for surface water stress was assigned to each catchment through a simple calculation to compare the use to the volume of supply available. Based on the percentage a level of potential stress was assigned to the catchment using thresholds prescribed by the Province of Ontario for water budgeting activities. The methodology is reproduced below:

Table 15: Quinte Region Stream Gauging Stations

Station Name	Drainage Area (km2)	WSC ID	Period of Record	Mean Annual Flow (cms)	Runoff Expressed as mm/yr
Moira River Near Deloro	308	02HL005	1965 - 2018	3.92	401
Black River Near Actinolite	401	02HL003	1955 - 2018	5.35	420
Skootamatta River Near Actinolite	712	02HL004	1955 - 2018	8.47	375
Moira River Near Tweed	1770	02HL007	2002 - 2018	22.1	394
Moira River Near Tweed	1770	02HL101	1968 - 1977	26.9	479
Moira River Near Thomasburg	2210	02HL104	1969 - 1970	25.2	360
Clare River Near Bogart	160	02HL102	1968 - 1977	2.79	550
Parks Creek Near Latta	205	02HL006	1984 - 1992	2.28	351
Parks Creek Near Latta	199	02HL103	1968 - 1977	3.13	496
Moira River Near Foxboro	2620	02HL001	1915 - 2018	30.7	369
Salmon River Near Shannonville	891	02HM003	1958 - 2004	11.1	379
Napanee River at Camden East	694	02HM007	1974 - 2018	9.01	409
Napanee River at Napanee	777	02HM001	1915 - 1974	9.13	371
Depot Creek at Bellrock	189	02HM002	1957 - 2018	2.02	337
Bloomfield Creek at Bloomfield	13.9	02HE001	1970 - 1992	0.168	381
Consecon Creek at Allisonville	114	02HE002	1970 - 2018	1.50	415
Demorestville Creek at Demorestville	29.3	02HE003	1970 - 1977	0.404	435

Surface Water Stress

$$\% \text{ Water Demand (Stress)} = \frac{Q_{Demand}}{Q_{Supply} - Q_{Reserve}} \text{ X } 100$$

Where:

Q_{Demand} = Monthly surface water demand calculated as consumptive takings from streams, ponds, and lakes in the watershed (permitted and actual use).

Q_{Supply} = Monthly surface water supply calculated as monthly median flow within the watershed as measured at a stream gauge.

$Q_{Reserve}$ = Surface water reserve is estimated, at a minimum, as the 10th percentile of monthly median flow.

The percent water demand, once calculated, is compared to the thresholds in Table 16 to assign a stress category to the subwatershed.

Table 16: Surface Water Stress Threshold

Surface Water Quantity Stress Assignment	Monthly Maximum % Water Demand & 25-Year Projection
Significant	>50%
Moderate	20%-50%
Low	<20%

For the 1981-2010 period two scenarios were reviewed for all the catchments to determine the potential for surface water stress. The first scenario considered permitted water usage and the second actual water use where values were available. Both scenarios included consumptive factors.

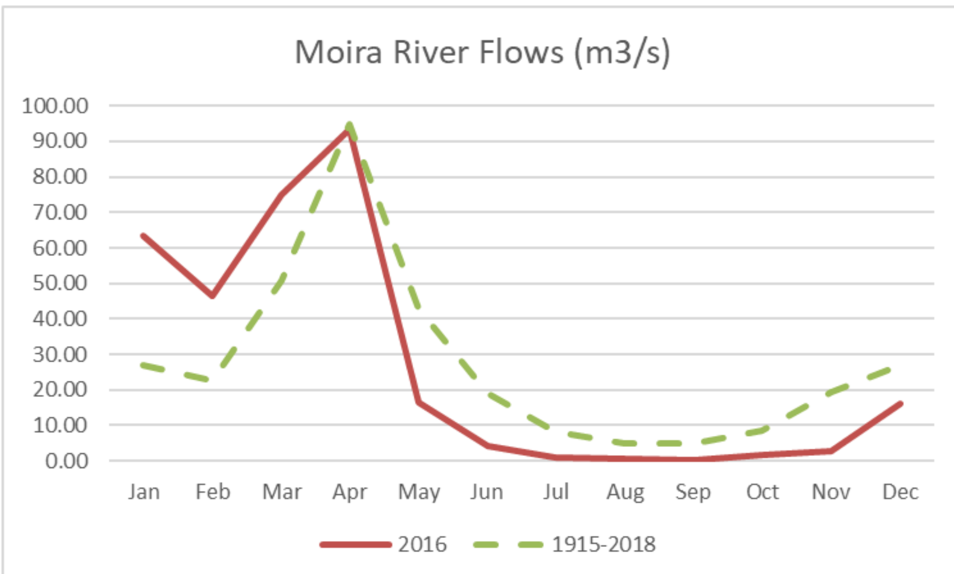
7.2 2016 Drought Scenario

A review of stress conditions during the 2016 drought was also completed for permitted and actual water usage. For the drought period the median and tenth percentile statistics could not be calculated. Instead actual monthly flows were substituted for the median and a 10 percent reserve of the actual monthly flow was used in place of the tenth percentile. These values were substituted in the stress formula.

A review of 2016 flow conditions, indicated annual flows to be below average with the largest decline evident of the Consecon watershed in Prince Edward

County at 14 % below normal. The monthly distribution of flows was also noted as differing from average conditions which is illustrated by Figure 14, a hydrograph of the flows observed in the Moira River at the Foxboro station 02HL001. From this hydrograph it can be seen that higher than normal flows occurred in the winter and lower than normal flows in the summer of 2016. This is a direct reflection of the precipitation patterns of 2016 with more winter rain and less snow followed by a below average summer precipitation. The lack of spring recharge from snow melt also resulted in reduced groundwater storage for maintenance of baseflow during the dry summer months.

Figure 14: Hydrograph of the Moira River Foxboro Gauge-02HL001



7.3 Stress Evaluation Results

This assessment resulted in the identification of 7 catchments exhibiting either moderate or significant levels of potential hydrologic stress. A summary of the results for all of the catchments is provided in Appendix D. Catchments exhibiting greater than 20% potential stress have been bolded in the tables provided to show those catchments that would be at least moderately stressed. It is of note that many catchments show no stress and this is attributed to there being no permitted water takings within these areas.

A map of surface water stress conditions for average climate conditions under permitted and actual water use scenarios is provided by Figure 15. For the permitted water use assessment, a total of 7 catchments were noted as exhibiting moderate to significant levels of potential hydrologic stress. When actual takings are considered this number of catchments exhibiting potential stress drops to 3; all within Prince Edward County.

The catchments showing moderate or higher stress level are as listed in Table 17. This table contains the highest percent water demand values for these catchments which were observed to occur primarily during the months of August or September when stream flows are at their lowest. Of note is that some levels of potential stress are in excess of 100%. While this is not possible these values are provided as a means of illustrating the magnitude of the taking relative to the available supply.

Table 17: Surface Water Catchments with Potential Stress Assignments

Catchment	***1981-2010***		***2016 Drought***	
	Permitted Use	***Actual Use***	***Permitted Use***	***Actual Use***
Deloro	*29%*	*< 1%*	*152%*	*< 1%*
Tweed	*27%*	*2%*	*101%*	*9%*
Ameliasburgh	*376%*	*41%*	*>100%*	*>100 %*
Lower Napanee	*40%*	*7%*	*63%*	*11%*
Hillier	*175%*	*13%*	*>100%*	*>100%*
West Lake	*48%*	*44%*	*>100%*	*>100%*
Picton	*1419%*	*57%*	*>100%*	*>100%*

[red] = Significant Stress level
[yellow] = Moderate Stress level
[white] = Low Stress Level

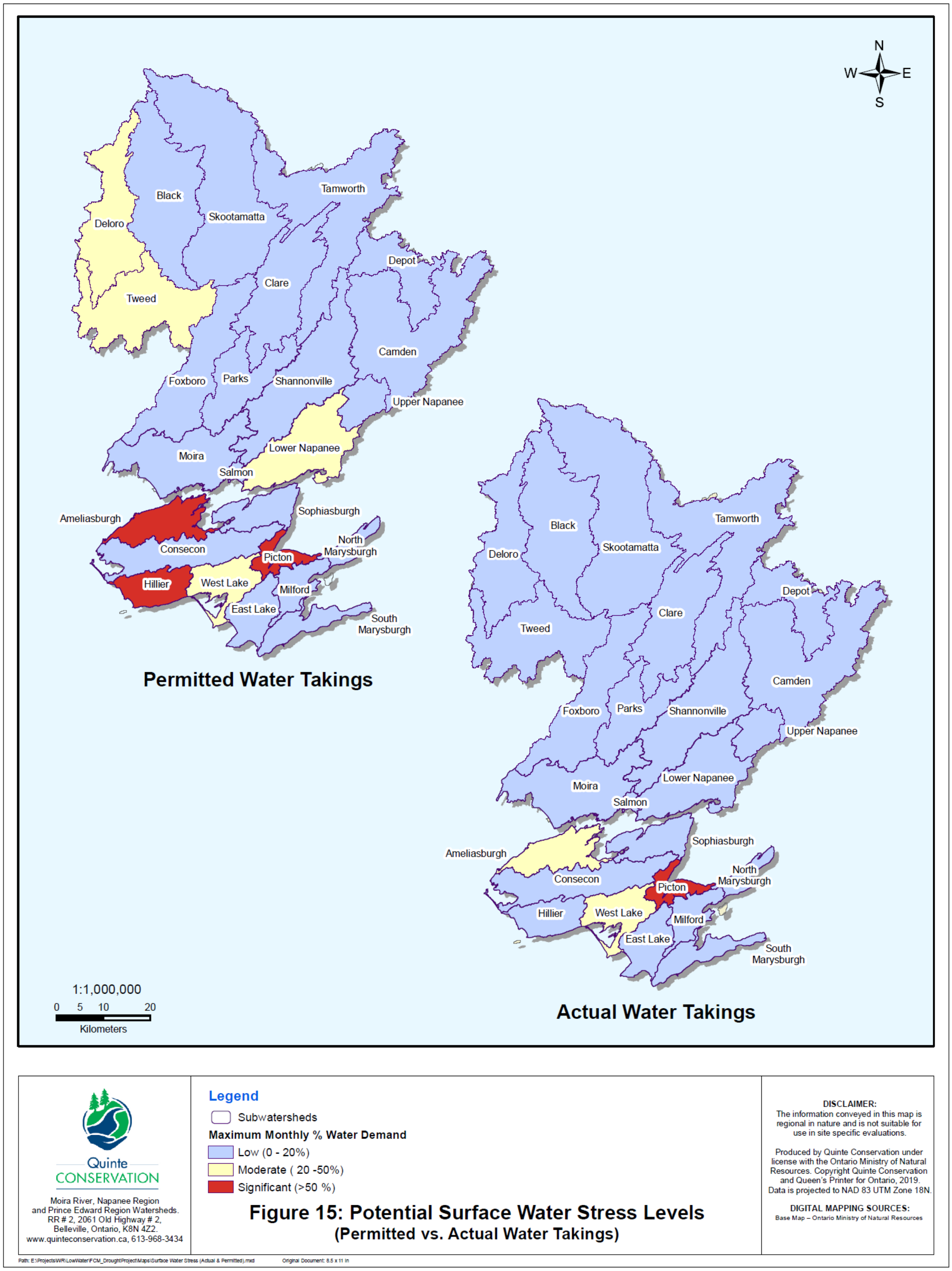


Figure 15: Potential Surface Water Stress Levels
(Permitted vs. Actual Water Takings)

For the drought scenario it was noted that the percent water demand increased on all catchments and those previously evaluated at a moderate level moved to a significant. However no catchments moved from a low to moderate stress level. When considering actual use numbers all of the catchments in the Prince Edward Region, that were noted as exhibiting hydrologic stress under other scenarios, were assessed at the significant hydrologic stress level. This was attributed to the hydrology of Prince Edward County. The catchments are defined by height of land and have many small creeks. These creeks dry up completely in summer months and any taking during that time will appear as a high stress. Also, since the statistics of median and reserve flows are theoretical for most of those catchments, this makes the conclusion of stress less reliable.

A review of the water use in the catchments exhibiting potential hydrologic stress indicated that the water takings in these areas are related to irrigation, remediation, quarry dewatering and municipal supply. Some of these takings are seasonal and time of use corresponds with low flow periods in the dry summer months. During the spring and fall months when flows are at their highest no levels of stress were identified. This seasonal pattern of high flows in the spring and significantly lower flows in the summer can be attributed to the geologic conditions of the watershed as the fractured bedrock aquifers do not have a high storage capacity to provide significant amounts of baseflow. This low storage volume contributes to low flows in the summer months when available precipitation is largely consumed by evapotranspiration demand. This condition is further exaggerated by an increase in water demand during the summer months to meet irrigation and construction activities.

7.4 Future Climate Conditions

Projected climate data for the 2011-2040 period was processed in the GIS Water Budget model to allow prediction of future changes to the long term water budget. Such changes include increased average annual temperatures and a corresponding increase in evapotranspiration. While precipitation levels are predicted to remain stable, the increased evapotranspiration may reduce the amount of available water and warmer winter temperatures may result in increased winter rain and less snow. This occurrence translates to less water storage and an increase in potential for hydrologic stress such as was observed and calculated for 2016. The water budget results for the drought period predict a reduction in long term annual flows by approximately 10 to 18 %. This is similar to the predicted reduction of groundwater recharge and observed annual flows of 2016.

Given that the assessment of potential hydrologic stress indicated higher potential in the low flow summer months, consideration could be given to increasing storage in the watersheds to hold back high spring flows for redistribution in the low flow months. This would help lessen the impact of takings during this period.

The availability of reservoirs for water storage in the Quinte watershed is somewhat limited; however some reservoirs do exist in the upper portions of the Napanee, Salmon and Moira River watersheds. The operation of these reservoirs to augment low flow needs to be reviewed to determine how potential hydrologic stress can be reduced. The availability of reservoirs in the Prince Edward Region is even more restricted; however consideration needs to be given to this need in order to augment low flow summer months.

8. Conclusions & Recommendations

1. A review of water use for the Quinte Region revealed that approximately half of the local population relies on a relatively stable surface water source from the Great Lakes. The remaining population relies on private wells that primarily access water from shallow fractured bedrock aquifers. While domestic use from private wells is ranked as the second highest use of groundwater in the region, use of groundwater for the aggregate industry is ranked as the highest use by far. As regards surface water (excluding Great Lakes use) the highest use is for remediation purposes followed by the aggregate industry, and municipal water supply.

2. Investigation of actual water use for permitted takings revealed that actual use is significantly lower than permitted. On a monthly basis this use is often 25 percent or less of the permitted taking. Consideration to review of how such takings are permitted is recommended as well as a requirement for mandatory implementation of water conservation measures.

3. A GIS model was used to evaluate the water budget for the Quinte Region. When the results of this model are compared with actual stream flow data and derived evapotranspiration the model was found to have reasonable accuracy for the prediction of evapotranspiration and runoff at a watershed and regional scale. Groundwater recharge was predicted by simple means and calibrated based on a review of water level fluctuations for a network of monitor wells in the Quinte Region. The GIS model was deemed adequate for a review of potential groundwater stress at the scale being assessed.

4. The results of this investigation reveal that on an average annual basis (1981-2010) of the 952 mm of precipitation received by the Quinte Region, 562 mm is lost to evapotranspiration. This leaves roughly 390 mm of surplus water available for division between groundwater recharge and direct surface runoff. These two components were calculated in the GIS model at 183 mm of the 390 mm or 47 percent to infiltration and the balance (207 mm) to direct runoff. Recharge into the fractured bedrock aquifers was further reduced to approximately one third to a half of the volume of infiltration.

5. A review of the climate data for 2016 was completed for use as a drought scenario. During this year higher than normal temperatures were experienced with below average precipitation. Higher amounts of winter rain and less snow also contributed to reduced water storage, groundwater recharge and stream flow.

6. Future climate conditions for the 2011 to 2040 period were spatially modelled by Natural Resources Canada. This data was processed by the GIS Water Budget Model to predict impacts on the local water budget. Increased average annual temperatures correspond with increased amounts of evapotranspiration and reduced groundwater recharge and stream flow. The periods of reduced water availability occur in the dry summer months when water demand is increased to meet increased levels of evapotranspiration.

7. Assessment of potential hydrologic stress revealed the majority of the watershed region was evaluated at a low stress level however areas of high water use and development did show some areas as exhibiting both ground and surface water stress. When actual water use data were considered the level of stress diminished but persisted in some watersheds of the Prince Edward County region.

8. Under the drought scenario the level of potential hydrologic stress was observed to increase. However potential groundwater stress was not elevated to the level that was anticipated to reflect the actual conditions observed during this event. This difference is attributed to the methodology of evaluation which entailed the division of annual recharge equally into 12 months. In the case of aquifers with low storage capacity this method is predicted as over estimating the groundwater supply. Further refinement is recommended in order to more accurately represent the monthly distribution of recharge and use of storage.

9. The stress assessment predicted levels of potential surface water stress primarily during the late summer months when the groundwater and stream flow are at their lowest. No levels of stress were detected during the higher flow spring, fall and winter months. This would indicate that increased storage of surface water could help offset low flow months. Given that the future climate predictions are indicating reduced flows it is recommended that action be taken to review current operation of surface water reservoirs as well as the potential for creating new ones.

10. Future climate projections have been used to predict a decrease in groundwater recharge primarily during the dry summer months when evapotranspiration increases. Increased surface water storage will help recharge groundwater in isolated areas near such reservoirs, however increased groundwater storage over the Quinte Region is not feasible. It is recommended that existing groundwater users implement water conservation measures as well as internal storage (i.e. cisterns) to help offset periods of peak demands and allow for the importing of hauled water when necessary.

11. Municipalities should review servicing of future development to focus on areas where long term secure water supplies exist. Such measures may include directing development to existing municipally serviced areas or creating new communal water supply systems.

12. Areas of future development that include an increase in impervious surfaces should consider implementation of low impact development solutions to maintain pre development groundwater recharge conditions and baseflow in local surface water features.

Disclaimer/Notice

The preparation of the Quinte Region Drought Plan, February, 2021 was carried out with assistance from the Government of Canada and the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

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APPENDIX A

Water Survey Canada Stream Gauge Data

Monthly Discharge Data for BLACK RIVER NEAR ACTINOLITE (02HL003) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HL003

Data Type: Monthly

Parameter Type: Flow

Download? Apply

Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	11.1	9.58	8.70	26.5	8.32	1.26	0.387	0.316	0.586	1.41	6.67	13.3	7.34
2017	12.7	9.24	21.1	22.2	24.0	4.59	4.63	2.70	1.03	2.19	12.6	7.22	10.4
2016	10.9	7.51	14.8	17.3	2.78	0.451	0.122	0.588	0.495	0.884	1.89	7.72	5.45
2015	3.98	1.40	1.44	11.8	1.81	4.34	1.43	1.99	1.81	2.52	6.77	7.34	3.89
2014	7.46	5.44	4.78	30.9	11.7	3.26	1.23	1.16	2.10	3.37	4.26	7.46	6.93
2013	6.49	5.25	5.62	17.2	5.15	5.94	4.70	1.42	2.30	3.42	12.6	5.42	6.29
2012	7.42	4.93	14.4	2.50	2.36	1.60	0.259	0.263	0.810	1.24	2.21	5.44	3.62
2011	5.62	3.56	18.4	18.6	10.8	2.46	0.607	0.237	0.152	1.36	1.87	14.3	6.50
2010	7.60	5.34	11.3	4.31	1.35	1.31	0.731	1.03	1.99	3.66	5.88	14.0	4.88
Mean	5.65	4.83	9.50	17.0	7.07	2.85	1.39	1.17	1.43	2.05	4.68	6.57	5.35
Max	16.8	19.7	25.5	35.2	24.0	9.60	4.70	3.27	7.46	14.1	15.8	14.3	15.9
Min	0.184	0.249	1.44	2.50	1.15	0.451	0.122	0.070	0.070	0.106	0.324	0.228	0.575

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	8.75	9.30	13.8	18.7	10.6	2.97	1.72	1.81	0.939	2.41	5.06	7.97	7.00
2008	11.5	7.09	7.22	26.8	8.20	2.89	1.86	1.16	0.649	1.09	2.19	12.3	6.91
2007	11.3	3.91	4.18	11.2	2.21	1.04	0.946	0.502	0.387	0.498	1.49	4.48	3.51
2006	7.40	9.34	13.2	10.6	4.02	2.68	1.27	1.36	2.27	5.78	11.6	14.2	6.98
2005	12.4	4.58	4.28	18.9	3.86	2.30	0.641	0.431	0.472	0.573	1.89	4.85	4.60
2004	7.66	2.56	10.1	10.2	5.70	2.50	1.13	1.06	2.63	1.15	5.55	11.4	5.14
2003	1.80	1.89	8.36	8.92	4.28	1.94	0.486	0.653	1.31	2.92	12.7	13.6	4.90
2002	4.80	4.26	8.25	15.6	10.6	9.60	2.40	0.551	0.516	0.645	1.36	2.31	5.07
2001	5.64	10.3	6.56	17.3	1.86	0.776	0.387	0.316	0.241	0.239	1.34	7.66	4.38
2000	5.55	3.76	6.13	7.44	11.7	9.01	4.63	2.61	1.15	1.31	3.47	7.56	5.36
1999	4.00	5.48	5.88	13.8	1.15	0.795	0.163	0.070	0.266	1.15	7.93	8.13	4.07
1998	8.60	3.59	13.4	15.8	1.42	0.602	0.505	0.351	0.798	0.177	0.665	1.76	3.97
1997	9.33	10.7	12.4	23.2	9.36	2.28	0.987	0.187	0.583	1.07	6.14	4.78	6.75
1996	10.3	12.2	10.3	15.6	11.6	3.44	1.65	1.84	4.74	5.39	8.90	13.7	8.31
1995	16.8	5.48	7.40	2.77	2.83	4.32	0.684	0.946	1.05	1.75	9.48	6.66	5.01
1994	2.44	2.33	4.41	15.6	8.26	3.23	1.36	1.98	1.67	1.81	3.29	5.55	4.33
1993	12.7	3.96	5.01	24.0	4.80	4.15	2.94	0.812	1.51	3.12	5.83	9.43	6.52
1992	2.18	1.66	7.30	23.4	6.12	1.02	0.980	2.34	5.93	4.26	15.8	8.94	6.66
1991	8.90	4.65	16.1	24.3	4.46	1.55	0.595	0.677	0.358	0.505	0.334	2.24	5.39
1990	4.33	4.92	15.2	15.4	5.83	1.99	1.36	0.961	0.481	0.710	2.92	10.1	5.35
1989	2.61	1.88	6.52	13.4	4.79	3.58	1.32	0.604	1.33	4.08	11.1	4.93	4.68
1988	4.27	5.98	9.57	17.0	3.61	1.04	0.418	0.553	0.685	1.04	2.15	2.57	4.07
1987	3.89	2.45	10.3	21.5	2.54	1.44	0.860	0.621	0.713	1.20	4.06	10.4	5.00
1986	4.75	3.91	12.7	12.1	3.68	6.57	2.22	3.27	7.46	14.1	6.61	6.17	6.96

Mean	5.65	4.83	9.50	17.0	7.07	2.85	1.39	1.17	1.43	2.05	4.68	6.57	5.35
Max	16.8	19.7	25.5	35.2	24.0	9.60	4.70	3.27	7.46	14.1	15.8	14.3	15.9
Min	0.184	0.249	1.44	2.50	1.15	0.451	0.122	0.070	0.070	0.106	0.324	0.228	0.575

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1985	5.00	5.80	16.6	20.2	4.31	2.37	1.44	1.24	3.66	2.34	9.79	6.88	6.64
1984	3.61	12.6	10.9	25.7	10.5	2.07	1.23	1.52	1.15	0.282	1.61	3.58	6.23
1983	8.98	7.54	11.4	12.4	15.4	4.36	1.30	1.19	0.398	0.348	1.91	5.02	5.85
1982	3.85	2.01	5.26	24.0	5.73	3.28	1.31	1.83	1.34	0.839	6.34	13.8	5.80
1981	1.79	19.7	10.4	7.37	5.13	4.09	1.54	1.57	5.79	6.23	7.66	6.44	6.48
1980	7.25	3.68	11.8	16.4	7.60	1.56	0.921	0.995	1.91	1.81	4.45	7.24	5.47
1979	6.21	4.58	22.0	22.9	9.30	3.21	0.819	0.628	0.231	1.57	4.10	7.83	6.95
1978	6.61	5.71	8.31	27.8	8.97	1.70	0.987	0.619	0.899	0.856	3.18	3.96	5.80
1977	0.925	1.02	14.8	9.45	2.69	1.12	1.03	0.714	0.612	1.15	3.39	6.65	3.63
1976	1.50	3.58	18.3	22.4	5.75	1.01	1.02	1.22	1.24	1.21	1.24	1.16	4.97
1975	3.56	2.62	13.1	22.8	8.76	2.47	0.570	0.701	0.511	0.106	0.324	2.48	4.83
1974	5.52	5.02	13.8	23.2	14.4	3.56	1.22	1.16	1.31	1.31	3.03	3.26	6.40
1973	9.42	6.69	25.5	15.3	7.25	1.80	0.776	0.937	0.531	0.321	2.01	3.45	6.17
1972	3.38	2.57	3.56	25.5	13.7	4.40	4.04	2.88	1.33	2.26	6.25	6.02	6.32
1971	2.10	1.71	6.04	27.1	7.42	1.77	0.731	0.916	0.745	0.552	0.748	4.31	4.51
1970	1.59	2.34	3.98	16.4	7.99	2.65	1.67	0.745	2.33	1.25	3.13	4.27	4.03
1969	4.00	4.63	8.82	17.1	18.5	4.35	1.90	1.05	0.889	0.688	2.28	3.81	5.67
1968	4.28	5.44	11.8	8.96	3.65	2.74	1.99	1.45	1.39	1.22	2.41	4.19	4.13
1967	4.60	4.87	5.20	15.0	6.13	3.07	3.86	1.58	2.06	6.72	12.3	8.79	6.18
1966	5.18	3.66	12.4	6.63	5.29	2.93	0.869	1.14	0.964	0.272	6.08	12.6	4.83
1965	1.53	4.17	4.22	22.4	6.91	1.33	0.752	0.734	0.928	4.49	7.84	9.03	5.36
1964	2.62	2.05	7.36	12.0	7.13	2.39	0.977	0.802	0.716	0.738	0.790	2.09	3.31
1963	2.02	1.51	7.26	12.6	7.27	1.50	1.06	1.08	1.47	1.08	2.51	2.76	3.51
1962	1.00	0.963	3.59	13.6	3.56	1.32	1.17	1.40	1.76	1.63	4.66	3.86	3.21

Mean	5.65	4.83	9.50	17.0	7.07	2.85	1.39	1.17	1.43	2.05	4.68	6.57	5.35
Max	16.8	19.7	25.5	35.2	24.0	9.60	4.70	3.27	7.46	14.1	15.8	14.3	15.9
Min	0.184	0.249	1.44	2.50	1.15	0.451	0.122	0.070	0.070	0.106	0.324	0.228	0.575

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	0.184	0.249	2.07	9.95	9.20	4.00	0.884	1.34	1.67	1.30	1.29	1.69	2.82
1960	2.63	2.91	2.37	35.2	11.9	5.20	2.46	2.58	0.070	0.124	0.331	0.228	5.50
1959	0.848	1.05	2.64	22.1	6.13	1.61	1.26	1.39	1.29	1.05	3.83	6.14	4.11
1958	4.31	2.48	5.15	11.8	4.07	1.41	1.22	1.56	1.44	0.613	0.761	1.26	3.01
1957	4.00	2.87	7.60	11.5	4.95	2.04	1.67	1.05	0.971	1.51	1.80	9.20	4.10
1956	1.98	1.61	3.20	20.7	14.3	7.42	1.53	2.03	1.51	0.954	1.30	2.41	4.91
1955	-	-	-	-	-	-	-	1.66	0.923	9.47	5.78	2.01	-
Mean	5.65	4.83	9.50	17.0	7.07	2.85	1.39	1.17	1.43	2.05	4.68	6.57	5.35
Max	16.8	19.7	25.5	35.2	24.0	9.60	4.70	3.27	7.46	14.1	15.8	14.3	15.9
Min	0.184	0.249	1.44	2.50	1.15	0.451	0.122	0.070	0.070	0.106	0.324	0.228	0.575

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 32' 22" N	**Longitude:**	77° 22' 10" W
Gross drainage area:	429 km²	**Effective drainage area:**	N/A
Record length:	65 Years	**Period of record:**	1955 - 2019
Regulation type:	Natural	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	No
Type of water body:	River	**RHBN:**	No
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	N/A
Datum of published data:	ASSUMED DATUM		
To convert to:	GEODETIC SURVEY OF CANADA DATUM,add 152.455 m		

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
1955 - 1960	Flow	Continuous	Manual
1961 - 2001	Flow	Continuous	Recorder
2002 - 2019	Flow & Level	Continuous	Recorder

Monthly Discharge Data for CONSECON CREEK AT ALLISONVILLE (02HE002) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HE002

Data Type: Monthly

Parameter Type: Flow

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Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	2.15	4.07	2.72	5.21	1.44	0.649	0.008	0.025	0.006	0.060	1.98	3.27	1.80
2017	3.57	2.88	3.08	4.31	5.75	1.86	0.693	0.039	0.002	0.182	3.27	1.08	2.23
2016	2.00	3.45	4.78	2.79	0.274	0.042	0.00	0.00	0.00	0.002	0.008	0.455	1.15
2015	0.228	0.023	1.40	5.24	0.512	0.962	0.284	0.020	0.015	0.162	1.18	0.936	0.914
2014	2.05	0.866	2.57	11.1	2.79	0.870	0.334	0.033	0.009	0.008	0.047	0.199	1.74
2013	2.71	0.617	4.82	3.38	0.595	1.41	0.116	0.005	0.001	0.006	0.994	0.741	1.28
2012	2.07	2.27	3.24	0.671	0.750	0.082	0.006	0.003	0.117	0.130	0.464	1.25	0.921
2011	0.880	0.410	9.33	3.86	3.01	0.524	0.018	0.013	0.010	0.450	0.802	3.85	1.93
2010	3.59	0.444	5.40	0.961	0.220	0.059	0.066	0.008	0.002	0.009	0.170	2.58	1.13
Mean	1.82	1.68	4.61	4.25	1.43	0.456	0.179	0.082	0.183	0.338	1.18	1.76	1.50
Max	5.74	8.44	9.33	11.2	5.75	2.01	2.99	1.39	2.66	3.90	4.49	5.03	5.24
Min	0.196	0.023	1.40	0.671	0.092	0.010	0.00	0.00	0.00	0.001	0.002	0.063	0.205

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	1.74	3.02	4.72	4.52	1.85	0.864	0.323	0.047	0.087	1.15	2.51	3.24	2.01
2008	3.63	2.16	4.21	7.43	1.34	0.200	0.259	1.00	0.059	0.249	1.38	4.46	2.20
2007	2.33	0.240	4.05	4.46	1.17	0.064	0.003	0.001	0.00	0.001	0.008	0.625	1.08
2006	4.65	2.21	2.59	1.49	1.15	0.208	0.014	0.001	0.007	3.90	4.49	3.58	2.02
2005	3.21	2.07	1.89	5.93	0.864	0.014	0.00	0.00	0.001	0.064	1.01	1.96	1.42
2004	1.56	0.384	4.83	2.92	1.96	0.446	0.105	0.580	2.66	0.087	1.18	3.89	1.72
2003	0.483	0.576	7.64	2.54	1.48	0.731	0.055	0.019	0.001	0.026	2.60	2.97	1.59
2002	2.33	2.55	3.53	2.95	3.68	1.95	0.067	0.005	0.00	0.001	0.128	0.620	1.48
2001	0.905	1.57	5.26	3.38	0.092	0.023	0.002	-	-	0.017	0.043	0.702	-
2000	0.722	1.91	2.82	3.83	1.21	2.01	1.11	1.39	0.686	0.355	1.88	1.94	1.66
1999	1.57	2.57	5.07	2.35	0.170	0.010	0.060	0.009	0.002	0.174	0.595	1.03	1.13
1998	3.66	2.11	5.16	1.50	0.345	0.391	2.99	0.017	0.007	0.014	0.057	0.213	1.37
1997	2.21	2.90	5.40	3.97	1.28	0.147	0.033	0.012	0.019	0.120	1.05	0.919	1.51
1996	3.10	2.78	1.50	3.60	3.27	0.716	0.093	0.004	0.333	1.32	2.33	2.58	1.80
1995	3.36	0.206	2.66	0.870	0.839	0.071	0.00	0.002	0.005	0.995	3.54	1.01	1.13
1994	-	-	-	6.24	1.80	0.154	0.014	0.007	0.001	-	-	1.42	-
1993	5.74	0.736	3.67	7.62	0.751	1.12	0.109	0.001	0.00	0.013	0.606	2.42	1.90
1992	0.363	1.00	4.94	7.96	2.17	0.209	0.006	0.007	0.110	0.160	3.73	1.63	1.86
1991	1.82	2.62	7.22	4.08	1.18	0.029	0.00	0.00	0.00	0.001	0.006	0.063	1.42
1990	2.16	2.34	6.14	4.40	3.76	0.547	0.117	0.014	0.004	0.019	0.169	5.03	2.06
1989	0.307	0.315	3.33	3.93	1.87	0.496	0.036	0.001	0.001	0.025	2.04	0.442	1.07
1988	0.474	0.760	4.95	2.65	0.462	0.040	0.005	0.001	0.002	0.016	0.100	0.085	0.795
1987	1.21	0.608	5.20	5.06	0.413	0.034	0.005	0.00	0.001	0.006	0.176	2.83	1.30
1986	1.95	0.646	5.89	1.90	1.33	0.409	0.031	0.111	1.87	3.29	1.70	4.98	2.01

Mean	1.82	1.68	4.61	4.25	1.43	0.456	0.179	0.082	0.183	0.338	1.18	1.76	1.50
Max	5.74	8.44	9.33	11.2	5.75	2.01	2.99	1.39	2.66	3.90	4.49	5.03	5.24
Min	0.196	0.023	1.40	0.671	0.092	0.010	0.00	0.00	0.00	0.001	0.002	0.063	0.205

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1985	0.196	1.03	5.96	2.28	0.269	0.041	0.008	0.004	0.005	0.009	1.79	0.918	1.04
1984	0.369	3.87	2.46	6.27	1.57	0.352	0.022	0.012	0.006	0.005	0.014	0.166	1.26
1983	1.01	1.05	2.79	3.35	2.96	0.423	0.006	0.001	0.001	0.011	0.853	2.24	1.22
1982	0.618	0.372	7.40	4.78	0.611	1.46	0.416	0.066	0.036	0.304	2.02	2.61	1.72
1981	0.309	8.44	1.45	1.13	0.886	0.224	0.121	0.075	2.58	0.988	1.33	0.541	1.51
1980	0.897	0.128	6.08	3.27	1.25	0.271	0.671	0.165	0.040	0.337	1.09	1.90	1.34
1979	1.65	1.35	8.68	3.76	1.11	0.045	0.005	0.002	0.009	0.095	1.68	3.26	1.80
1978	3.23	1.28	3.12	10.8	0.948	0.068	0.008	0.003	0.004	0.011	0.095	0.715	1.69
1977	0.206	0.201	8.34	2.35	0.515	0.014	0.002	0.002	0.033	0.531	2.26	3.34	1.48
1976	0.612	4.71	7.84	2.59	1.83	0.301	0.168	0.055	0.022	0.129	0.276	0.328	1.57
1975	2.61	2.25	5.67	3.19	0.766	0.293	0.004	0.00	0.005	0.009	0.090	1.20	1.34
1974	3.23	1.05	2.99	5.27	2.62	0.362	0.030	0.003	0.002	0.004	0.098	1.06	1.39
1973	2.58	2.14	6.36	3.37	1.37	0.316	0.017	0.001	0.001	0.007	0.136	0.670	1.41
1972	0.580	0.486	2.15	7.99	1.22	0.535	0.184	0.121	0.017	0.762	2.93	2.75	1.64
1971	0.511	0.544	4.08	11.2	1.10	0.149	0.006	0.00	0.00	0.001	0.002	0.214	1.48
1970	0.224	0.513	5.78	3.71	1.25	0.126	0.143	0.032	0.006	0.021	1.66	1.57	1.25
Mean	1.82	1.68	4.61	4.25	1.43	0.456	0.179	0.082	0.183	0.338	1.18	1.76	1.50
Max	5.74	8.44	9.33	11.2	5.75	2.01	2.99	1.39	2.66	3.90	4.49	5.03	5.24
Min	0.196	0.023	1.40	0.671	0.092	0.010	0.00	0.00	0.00	0.001	0.002	0.063	0.205

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 01' 38" N	**Longitude:**	77° 22' 00" W
Gross drainage area:	119 km^2	**Effective drainage area:**	N/A
Record length:	51 Years	**Period of record:**	1969 - 2019
Regulation type:	Regulated	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	Yes
Type of water body:	River	**RHBN:**	No
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	JAN - DEC
Datum of published data:	ASSUMED DATUM		

Monthly Discharge Data for DEPOT CREEK AT BELLROCK (02HM002) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HM002

Data Type: Monthly

Parameter Type: Flow

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Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	2.70	2.76	2.36	5.45	2.95	0.738	0.508	0.636	0.589	0.810	1.13	2.64	1.94
2017	2.34	2.37	3.60	4.54	7.90	1.47	2.48	1.73	1.51	1.06	2.64	2.62	2.86
2016	3.92	4.59	6.14	6.08	1.44	0.949	0.483	0.300	0.292	0.470	0.526	0.447	2.14
2015	1.29	0.856	1.36	3.29	0.859	1.31	0.910	0.993	1.04	1.30	1.89	2.26	1.45
2014	2.29	1.99	2.76	11.1	4.57	3.37	1.32	1.04	0.750	1.24	1.48	1.67	2.80
2013	2.04	2.88	3.56	4.09	1.26	1.23	1.37	1.48	1.44	1.12	1.97	1.81	2.02
2012	0.972	1.61	2.13	0.364	1.78	0.455	0.507	0.632	0.705	1.32	1.25	0.923	1.05
2011	2.31	1.96	7.50	6.33	6.27	1.75	1.22	0.641	0.641	0.988	0.546	0.640	2.57
2010	2.69	2.01	3.25	1.55	0.957	1.14	0.950	1.06	1.51	2.34	1.93	2.99	1.86
Mean	2.44	2.26	3.14	4.87	2.31	1.26	1.04	0.993	1.04	1.14	1.48	2.29	2.02
Max	5.61	5.35	7.50	12.8	7.90	5.87	2.48	2.06	5.83	4.43	4.67	6.65	5.93
Min	0.192	0.187	0.899	0.364	0.661	0.011	0.483	0.203	0.012	0.006	0.046	0.214	0.273

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	3.77	3.92	3.86	4.21	2.34	0.882	1.33	0.815	0.746	1.32	1.32	2.54	2.25
2008	4.27	3.93	3.79	8.33	1.98	1.28	1.04	1.21	1.12	0.901	1.11	2.83	2.65
2007	4.04	2.11	1.57	2.11	1.42	1.53	0.928	0.821	0.850	0.824	0.710	0.859	1.48
2006	4.91	5.07	3.20	1.87	2.25	1.54	0.960	0.937	1.37	1.76	4.26	6.65	2.90
2005	5.43	2.77	1.44	4.88	1.46	0.871	0.916	0.855	0.854	1.23	1.57	3.18	2.12
2004	4.22	1.88	2.69	4.61	3.02	2.15	0.864	0.899	1.19	0.805	1.22	3.40	2.25
2003	1.03	0.687	2.31	3.92	2.68	1.34	0.678	0.581	0.492	0.660	1.72	5.42	1.79
2002	1.13	1.45	3.53	5.18	4.34	5.87	2.14	1.79	1.80	1.98	1.97	1.90	2.76
2001	1.80	2.35	3.73	4.66	1.23	0.782	0.729	0.726	0.832	0.855	0.435	0.877	1.58
2000	1.60	1.61	1.89	4.67	3.52	1.91	1.63	1.28	1.07	1.26	1.64	2.06	2.01
1999	1.70	2.34	3.15	5.58	0.937	0.706	0.760	0.672	0.635	0.801	0.849	1.68	1.65
1998	2.81	1.99	4.84	4.67	0.845	0.881	0.810	0.788	0.832	1.07	0.885	0.907	1.78
1997	3.70	3.42	4.08	5.61	3.30	0.914	0.873	0.951	1.18	1.44	1.72	2.46	2.47
1996	3.04	3.85	3.91	4.20	4.06	1.35	0.744	0.741	1.12	1.91	3.19	4.03	2.68
1995	2.99	3.42	3.39	1.04	0.828	0.580	0.504	0.439	0.587	0.973	2.23	2.90	1.66
1994	2.78	1.94	1.98	3.66	2.35	1.88	1.11	0.916	0.891	0.955	0.861	0.881	1.68
1993	5.61	4.82	3.27	6.05	2.46	1.45	1.12	1.33	1.25	1.49	1.84	3.35	2.84
1992	0.655	0.542	2.19	5.97	2.87	0.962	0.946	1.01	1.94	2.57	4.61	4.94	2.43
1991	4.44	4.05	4.19	5.46	2.57	1.20	0.950	0.642	0.042	1.30	1.26	0.718	2.24
1990	1.91	2.87	3.48	4.39	3.30	1.49	1.10	0.976	1.04	1.79	1.03	2.58	2.16
1989	0.802	0.976	1.98	3.18	3.08	1.12	1.17	1.20	0.554	0.824	1.23	1.31	1.45
1988	5.13	1.85	2.97	2.70	1.67	0.908	1.07	1.07	1.02	0.828	0.658	0.655	1.71
1987	2.78	1.39	2.63	3.62	1.24	2.08	1.57	1.30	1.04	0.556	1.47	3.36	1.92
1986	3.24	1.76	3.39	1.25	1.19	1.33	1.28	2.06	3.50	4.22	4.15	4.00	2.61

Mean	2.44	2.26	3.14	4.87	2.31	1.26	1.04	0.993	1.04	1.14	1.48	2.29	2.02
Max	5.61	5.35	7.50	12.8	7.90	5.87	2.48	2.06	5.83	4.43	4.67	6.65	5.93
Min	0.192	0.187	0.899	0.364	0.661	0.011	0.483	0.203	0.012	0.006	0.046	0.214	0.273

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1985	1.34	2.27	4.21	3.28	0.708	0.750	1.40	1.08	1.66	1.79	2.72	4.11	2.11
1984	4.02	3.47	4.89	3.81	2.59	1.82	1.66	1.71	1.33	1.06	0.752	0.775	2.32
1983	4.97	2.04	2.45	2.44	5.04	1.81	1.44	1.69	1.22	0.992	1.56	3.73	2.45
1982	1.70	1.40	2.00	5.85	1.94	1.76	1.36	1.38	1.78	1.50	1.50	2.95	2.09
1981	1.28	4.47	3.35	0.782	1.57	2.11	1.37	1.70	5.83	4.43	2.30	3.67	2.74
1980	2.35	2.00	2.29	4.02	3.24	1.31	1.37	1.40	1.27	1.11	1.00	1.61	1.91
1979	0.782	0.644	4.37	4.67	1.64	1.57	1.49	1.47	1.29	1.04	0.891	1.81	1.81
1978	4.27	5.35	1.75	4.68	0.702	1.31	1.31	1.41	1.05	1.58	0.638	0.654	2.06
1977	0.391	0.437	3.09	2.61	1.43	1.57	1.62	1.47	0.908	0.764	0.759	1.26	1.36
1976	1.91	3.00	7.00	4.78	2.10	1.08	1.54	1.43	1.06	0.762	0.551	0.371	2.13
1975	2.79	2.04	3.38	5.35	0.895	0.846	0.939	1.42	1.57	0.702	0.542	1.18	1.80
1974	2.10	2.18	4.95	6.48	3.58	0.777	0.733	0.780	0.774	0.747	0.793	1.20	2.09
1973	4.42	4.06	6.24	4.50	1.59	0.638	0.682	0.658	0.650	0.474	0.541	0.870	2.11
1972	1.72	1.72	1.43	8.85	2.36	1.97	1.60	1.18	0.863	0.776	2.47	4.42	2.45
1971	1.87	1.90	3.41	8.91	1.63	0.660	0.504	0.577	0.509	0.350	0.283	0.505	1.76
1970	1.02	0.683	1.46	5.77	1.86	0.724	0.633	0.551	0.487	0.429	0.758	2.30	1.39
1969	1.79	2.27	2.95	6.92	6.04	0.987	0.710	0.694	0.548	0.684	1.76	1.62	2.25
1968	2.09	1.95	2.42	3.14	0.661	1.31	1.04	1.23	1.47	1.01	1.30	3.39	1.75
1967	2.57	2.37	1.52	4.49	1.43	0.854	0.662	0.645	0.556	1.07	3.64	2.96	1.90
1966	2.86	1.93	4.27	2.25	0.842	0.580	0.632	0.529	0.423	0.338	1.56	6.43	1.89
1965	0.344	3.01	2.59	7.33	1.30	0.367	0.582	0.570	0.443	0.945	4.67	4.71	2.24
1964	1.98	2.72	2.13	4.92	1.69	0.612	0.544	0.616	0.542	0.431	0.292	0.304	1.40
1963	1.15	0.780	2.04	4.42	2.74	1.18	0.808	0.670	0.487	0.646	0.549	1.39	1.41
1962	0.604	0.494	2.35	7.34	0.966	0.495	0.824	0.602	0.417	0.343	0.567	2.40	1.45

Mean	2.44	2.26	3.14	4.87	2.31	1.26	1.04	0.993	1.04	1.14	1.48	2.29	2.02
Max	5.61	5.35	7.50	12.8	7.90	5.87	2.48	2.06	5.83	4.43	4.67	6.65	5.93
Min	0.192	0.187	0.899	0.364	0.661	0.011	0.483	0.203	0.012	0.006	0.046	0.214	0.273

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	0.192	0.187	0.899	4.81	3.77	1.25	0.550	1.26	0.852	0.909	0.596	0.678	1.33
1960	1.98	2.27	1.76	12.8	1.92	0.543	0.609	0.890	0.575	0.360	0.263	0.214	2.02
1959	0.400	0.480	3.04	11.4	0.730	0.011	0.570	0.464	0.551	0.895	3.05	3.90	2.12
1958	2.45	0.806	2.27	5.48	3.32	1.06	1.61	0.795	0.889	1.57	0.210	0.423	1.74
1957	1.47	1.44	4.14	5.12	2.11	0.982	0.605	0.203	0.012	0.006	0.046	2.72	1.57
Mean	2.44	2.26	3.14	4.87	2.31	1.26	1.04	0.993	1.04	1.14	1.48	2.29	2.02
Max	5.61	5.35	7.50	12.8	7.90	5.87	2.48	2.06	5.83	4.43	4.67	6.65	5.93
Min	0.192	0.187	0.899	0.364	0.661	0.011	0.483	0.203	0.012	0.006	0.046	0.214	0.273

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 28' 18" N	**Longitude:**	76° 45' 44" W
Gross drainage area:	181 km^2	**Effective drainage area:**	N/A
Record length:	63 Years	**Period of record:**	1957 - 2019
Regulation type:	Regulated	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	No
Type of water body:	River	**RHBN:**	No
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	N/A
Datum of published data:	ASSUMED DATUM		
To convert to:	GEODETIC SURVEY OF CANADA DATUM,add 129.899 m		

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
1957 - 1969	Flow	Continuous	Manual
1970 - 2001	Flow	Continuous	Recorder
2002 - 2019	Flow & Level	Continuous	Recorder

Click here for further information on remarks.

Date modified:

Monthly Discharge Data for MOIRA RIVER NEAR DELORO (02HL005) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HL005

Data Type: Monthly

Parameter Type: Flow

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Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	5.53	6.94	5.27	18.8	5.79	0.960	0.133	0.131	0.170	1.15	4.54	7.35	4.73
2017	7.26	5.85	12.0	13.8	14.0	3.92	4.52	1.62	0.518	1.72	8.29	3.88	6.45
2016	8.75	6.07	10.8	11.4	1.56	0.154	0.030	0.054	0.080	0.743	1.19	3.75	3.72
2015	1.94	1.30	3.14	16.1	3.28	5.25	1.23	1.37	1.19	3.16	4.21	4.72	3.91
2014	4.03	3.00	3.45	23.6	6.78	2.57	0.921	0.277	0.368	1.65	3.19	3.14	4.41
2013	5.52	3.56	4.67	16.6	4.74	4.77	3.02	0.689	0.582	1.61	9.81	4.17	4.98
2012	4.42	2.87	11.5	2.07	2.12	1.49	0.100	0.147	0.222	0.701	1.66	4.26	2.63
2011	2.77	1.56	15.4	14.0	6.48	1.81	0.437	0.428	0.173	1.46	2.00	11.5	4.83
2010	5.88	3.97	10.4	3.54	1.76	1.77	0.977	1.09	1.62	2.23	4.20	10.3	3.98
Mean	3.97	3.42	7.49	13.7	5.13	2.08	0.810	0.387	0.559	1.31	3.63	4.66	3.92
Max	12.2	16.5	18.0	23.6	14.0	7.47	4.52	1.62	4.10	8.40	11.4	11.5	11.1
Min	0.415	0.367	1.28	2.07	1.04	0.113	0.030	0.006	0.011	0.019	0.149	0.792	0.524

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	6.17	8.04	11.9	15.0	7.32	1.20	2.04	1.58	0.521	1.40	4.08	6.12	5.45
2008	5.44	3.73	4.39	20.1	4.88	2.54	1.44	0.735	0.438	0.728	1.66	6.06	4.35
2007	6.47	2.28	2.09	9.14	2.12	0.507	0.622	0.174	0.054	0.110	0.579	2.18	2.19
2006	5.36	5.75	9.55	8.89	3.39	1.90	0.687	0.075	0.124	4.21	8.80	8.92	4.80
2005	9.33	1.81	1.83	15.8	2.82	3.21	0.347	0.063	0.049	0.430	1.24	2.89	3.32
2004	4.19	1.18	7.27	9.26	6.32	2.04	1.54	1.21	1.90	0.975	3.56	6.93	3.86
2003	0.897	0.965	4.95	8.37	4.83	2.89	0.317	0.226	0.141	2.13	8.61	8.01	3.53
2002	2.73	2.93	7.60	12.3	7.51	7.47	1.82	0.088	0.034	0.132	0.948	1.14	3.73
2001	2.10	5.76	5.73	14.4	1.52	0.740	0.163	0.060	0.016	0.172	1.29	5.44	3.12
2000	2.91	1.82	6.17	8.15	10.8	6.58	3.59	1.24	0.348	0.483	1.91	3.61	3.97
1999	2.23	2.99	3.71	12.1	1.12	0.674	0.068	0.006	0.016	0.567	5.37	5.25	2.84
1998	6.31	1.83	10.3	12.5	1.04	0.676	0.804	0.464	0.495	0.566	1.37	1.93	3.19
1997	6.26	8.28	9.73	17.7	7.49	1.46	0.942	0.248	0.811	1.10	3.98	2.40	5.03
1996	8.04	10.7	8.31	15.2	9.05	3.69	0.732	0.990	3.58	4.32	6.82	9.61	6.75
1995	12.2	2.20	6.98	3.13	3.01	4.01	0.077	0.062	0.018	1.43	8.31	2.63	3.67
1994	1.02	1.04	3.14	14.3	6.73	2.05	0.646	1.02	0.196	0.483	1.54	3.18	2.95
1993	8.07	1.78	3.89	20.5	3.52	3.39	1.33	0.201	0.068	1.54	2.93	5.25	4.37
1992	0.999	1.03	6.71	19.6	5.07	0.530	0.108	0.966	3.41	2.53	11.4	4.20	4.71
1991	4.95	2.51	16.1	19.0	2.81	0.698	0.031	0.019	0.020	0.080	0.177	1.11	3.96
1990	2.66	2.84	11.3	11.9	6.08	1.26	0.507	0.109	0.212	0.916	2.44	6.33	3.88
1989	1.72	1.05	4.30	10.6	5.56	3.95	1.17	0.072	0.230	0.715	7.17	2.14	3.22
1988	2.38	3.92	5.15	12.9	3.23	0.278	0.048	0.014	0.035	0.130	2.08	1.54	2.64
1987	1.64	1.25	6.96	15.8	1.44	0.896	0.282	0.014	0.054	0.499	2.59	7.09	3.21
1986	2.78	2.05	9.58	10.1	3.44	6.02	0.979	1.03	4.10	8.40	3.19	3.04	4.56

Mean	3.97	3.42	7.49	13.7	5.13	2.08	0.810	0.387	0.559	1.31	3.63	4.66	3.92
Max	12.2	16.5	18.0	23.6	14.0	7.47	4.52	1.62	4.10	8.40	11.4	11.5	11.1
Min	0.415	0.367	1.28	2.07	1.04	0.113	0.030	0.006	0.011	0.019	0.149	0.792	0.524

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1985	2.76	3.61	11.4	16.6	3.30	1.42	0.451	0.086	2.21	1.22	7.96	4.65	4.64
1984	1.12	6.90	6.20	19.6	7.22	0.948	0.152	0.209	0.157	0.076	1.06	2.51	3.85
1983	5.11	4.25	8.00	9.92	11.6	2.16	0.139	0.060	0.044	0.075	0.683	2.70	3.73
1982	1.26	0.814	2.54	19.3	3.71	1.72	0.202	0.136	0.118	0.350	4.63	10.6	3.78
1981	1.18	16.5	6.91	6.56	3.13	2.45	0.680	0.285	3.76	4.04	5.32	2.80	4.47
1980	3.83	0.884	10.2	12.9	4.74	0.725	0.314	0.246	0.103	0.915	2.65	3.61	3.43
1979	3.27	1.94	14.3	17.5	5.74	1.64	0.125	0.131	0.061	0.453	2.34	5.53	4.42
1978	5.89	3.64	3.57	21.3	6.68	0.607	0.052	0.026	0.193	0.814	2.46	2.47	3.98
1977	0.415	0.367	10.3	7.77	1.44	0.113	0.050	0.048	0.068	0.664	3.17	5.88	2.52
1976	1.41	2.56	13.0	16.9	3.91	0.543	0.300	0.078	0.089	0.183	0.488	0.792	3.35
1975	3.43	2.59	8.92	17.6	5.80	0.964	0.093	0.041	0.027	0.044	0.149	1.98	3.47
1974	4.56	3.34	5.68	16.8	10.4	2.10	0.440	0.145	0.159	1.10	3.15	2.73	4.22
1973	7.04	4.45	18.0	10.3	3.42	1.20	0.164	0.043	0.011	0.067	1.42	2.88	4.08
1972	2.32	1.72	1.77	18.5	10.5	2.45	2.75	1.37	0.368	1.38	5.34	4.85	4.44
1971	1.60	1.41	2.82	19.8	4.90	0.503	0.097	0.019	0.041	0.138	0.569	3.53	2.95
1970	0.961	1.03	1.28	13.4	5.40	0.962	1.34	0.220	0.045	0.241	2.70	3.47	2.59
1969	2.93	4.12	6.09	14.5	11.4	2.61	1.08	0.414	0.065	0.248	1.61	2.44	3.96
1968	2.39	3.40	8.59	7.87	2.16	2.31	1.04	0.169	0.272	0.280	1.36	2.99	2.74
1967	2.36	2.75	3.17	13.7	4.82	1.92	1.71	0.292	0.288	6.32	8.10	5.79	4.27
1966	3.54	2.11	9.95	6.22	4.20	1.38	0.080	0.017	0.018	0.019	2.74	11.1	3.45
1965	-	-	-	-	-	-	-	-	0.312	3.46	6.75	8.04	-
Mean	3.97	3.42	7.49	13.7	5.13	2.08	0.810	0.387	0.559	1.31	3.63	4.66	3.92
Max	12.2	16.5	18.0	23.6	14.0	7.47	4.52	1.62	4.10	8.40	11.4	11.5	11.1
Min	0.415	0.367	1.28	2.07	1.04	0.113	0.030	0.006	0.011	0.019	0.149	0.792	0.524

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 29' 59" N	**Longitude:**	77° 37' 06" W

Gross drainage area:	297 km^2	**Effective drainage area:**	N/A
Record length:	55 Years	**Period of record:**	1965 - 2019
Regulation type:	Natural	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	No
Type of water body:	River	**RHBN:**	No
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	JAN - DEC
Datum of published data:	ASSUMED DATUM		

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
1965 - 2001	Flow	Continuous	Recorder
2002 - 2019	Flow & Level	Continuous	Recorder

Annual Hydrometric Remarks

DISCHARGES ESTIMATED JUNE 29 -AUGUST 5, 2018 DUE TO BEAVER ACTIVITY.

Click here for further information on remarks.

Date modified:

2019-08-05

Government of Canada / Gouvernement du Canada

Monthly Discharge Data for MOIRA RIVER NEAR FOXBORO (02HL001) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HL001

Data Type: Monthly

Parameter Type: Flow

Download? Apply

Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	42.9	51.0	56.5	116	61.9	10.8	1.90	3.01	2.03	7.65	22.5	52.4	35.7
2017	44.8	35.0	93.3	94.7	117	36.5	35.2	18.4	4.55	8.08	51.0	33.0	47.6
2016	63.5	46.4	74.9	93.5	16.3	4.12	0.997	0.414	0.335	1.57	2.76	16.1	26.7
2015	20.4	8.56	13.0	68.9	19.1	31.3	11.2	9.76	7.84	11.2	34.1	32.2	22.3
2014	34.2	25.9	28.3	179	67.2	33.8	12.0	6.29	6.92	15.5	22.8	29.4	38.4
2013	39.8	30.9	38.5	93.9	33.3	27.8	19.4	6.13	5.06	10.4	52.8	32.2	32.5
2012	36.9	27.7	76.6	21.9	17.8	12.2	2.01	0.737	2.68	5.99	14.0	26.1	20.4
2011	26.4	17.1	113	99.5	65.5	17.6	4.23	1.98	0.678	5.06	6.73	55.4	34.4
2010	43.2	34.7	68.4	30.9	11.9	10.3	12.0	6.09	6.32	14.7	27.4	77.7	28.6
Mean	29.9	25.2	57.7	109	48.7	20.8	8.33	4.60	4.43	8.67	21.3	30.1	30.7
Max	105	106	145	216	156	107	38.9	38.4	43.8	69.7	82.4	86.1	99.5
Min	1.08	1.08	2.78	21.9	10.3	3.66	0.997	0.401	0.335	0.795	1.14	1.05	3.79

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	54.0	41.9	75.3	112	51.0	15.8	10.0	9.80	4.81	11.3	25.4	47.2	38.2
2008	67.8	42.7	43.7	164	53.5	17.7	11.2	8.74	4.20	6.68	14.6	53.7	40.7
2007	59.6	24.3	28.2	71.0	22.8	7.59	4.26	1.61	0.714	1.88	3.51	17.2	20.2
2006	52.8	60.2	69.7	62.5	33.8	24.0	7.19	1.22	3.50	30.3	76.0	82.3	42.0
2005	67.1	28.3	23.5	113	30.8	12.1	4.77	0.797	1.02	5.66	18.4	38.2	28.6
2004	54.2	19.4	54.4	69.6	45.4	21.8	7.26	8.21	19.7	7.83	21.0	60.7	32.5
2003	9.11	9.19	42.6	71.5	35.8	24.6	4.61	2.65	2.10	11.5	61.7	76.9	29.4
2002	29.4	26.0	56.7	87.8	74.4	67.0	21.6	3.03	1.24	2.43	7.86	10.3	32.3
2001	25.4	43.9	44.4	98.7	15.0	6.25	1.23	0.401	0.503	2.14	6.14	37.6	23.5
2000	31.6	19.7	47.3	57.9	67.3	47.1	38.9	15.8	5.80	6.60	14.5	38.3	32.6
1999	24.8	37.9	38.6	97.9	10.3	5.10	2.28	0.435	0.530	4.81	31.6	42.6	24.7
1998	54.1	26.7	73.3	100	10.6	5.17	7.22	2.40	2.76	3.58	6.92	13.3	25.5
1997	54.6	49.4	78.0	133	63.0	14.3	8.27	1.75	4.66	9.75	34.2	28.1	39.9
1996	50.5	72.3	60.2	88.1	80.0	22.7	6.90	5.21	19.8	31.1	53.8	64.4	46.3
1995	84.7	35.6	43.2	24.4	24.8	20.1	2.18	1.69	1.76	7.79	54.6	33.5	27.9
1994	16.1	14.3	28.6	97.8	46.4	22.6	7.66	7.42	3.20	4.67	9.14	23.6	23.5
1993	79.3	27.1	29.6	163	39.2	23.1	12.6	1.71	2.79	13.0	24.0	55.3	39.2
1992	12.6	9.99	44.5	127	48.9	6.87	2.62	3.86	24.3	17.7	73.2	48.6	35.0
1991	63.6	30.0	86.4	141	31.8	8.37	1.43	1.27	0.578	1.80	2.26	10.2	31.6
1990	27.6	35.5	85.3	89.2	46.7	14.2	5.80	3.00	1.13	6.34	15.1	56.1	32.2
1989	18.8	15.9	26.5	84.7	37.0	22.7	7.52	1.53	1.79	9.60	43.2	27.9	24.8
1988	29.1	35.4	54.1	103	26.0	5.09	1.32	1.15	1.92	4.80	12.7	15.0	24.1
1987	26.8	17.0	55.5	140	19.0	9.46	3.80	1.26	2.52	4.98	17.7	58.8	29.7
1986	34.3	28.6	69.0	80.4	26.4	29.9	11.0	13.8	29.1	63.2	30.7	38.4	37.9

Mean	29.9	25.2	57.7	109	48.7	20.8	8.33	4.60	4.43	8.67	21.3	30.1	30.7
Max	105	106	145	216	156	107	38.9	38.4	43.8	69.7	82.4	86.1	99.5
Min	1.08	1.08	2.78	21.9	10.3	3.66	0.997	0.401	0.335	0.795	1.14	1.05	3.79

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1985	32.1	26.1	108	112	31.2	10.4	4.26	2.29	15.8	12.0	63.9	40.6	38.2
1984	20.8	76.7	67.9	149	65.6	17.0	7.38	6.94	5.69	2.66	9.89	18.8	37.4
1983	52.1	39.1	56.9	72.2	78.4	22.5	3.23	2.09	1.25	2.68	9.71	39.1	31.6
1982	19.7	14.1	34.3	149	40.9	21.5	5.99	3.69	4.14	5.25	25.3	68.9	32.7
1981	14.0	106	85.9	42.2	29.4	23.3	12.0	8.70	43.8	27.6	48.0	26.9	39.0
1980	42.8	13.0	82.0	96.8	44.5	13.1	5.55	3.19	3.53	7.47	20.6	34.9	30.6
1979	27.5	20.6	117	131	44.5	16.2	1.93	1.40	1.28	5.06	15.7	41.7	35.3
1978	51.7	41.7	40.9	163	56.5	9.14	2.02	1.75	1.90	2.83	11.6	19.9	33.6
1977	7.93	8.05	93.4	64.7	16.9	3.81	1.66	2.80	2.71	8.88	19.2	48.4	23.2
1976	15.3	32.2	115	144	33.5	9.96	4.01	2.54	2.20	4.24	6.74	7.73	31.5
1975	24.0	19.9	76.4	118	51.4	11.2	1.67	1.54	1.77	1.50	3.04	14.1	27.0
1974	31.3	32.6	73.4	127	82.8	19.7	6.57	2.75	2.49	4.74	11.9	19.9	34.6
1973	54.4	46.0	143	89.6	36.2	12.7	2.89	2.35	1.66	1.89	8.71	19.4	34.9
1972	24.1	18.0	22.0	151	81.7	23.8	21.1	16.8	6.59	13.6	44.8	44.2	39.0
1971	18.7	19.7	32.7	157	50.9	8.32	3.15	2.12	3.47	4.73	6.18	26.6	27.8
1970	10.8	14.1	24.0	103	49.9	14.0	8.24	3.32	3.12	3.66	18.0	27.5	23.3
1969	21.6	32.6	54.4	113	97.9	29.1	10.1	6.88	3.17	3.14	12.3	21.7	33.8
1968	25.4	31.1	65.0	68.1	20.9	24.7	15.6	3.59	3.68	4.56	13.1	26.6	25.2
1967	29.1	29.1	27.9	105	40.1	16.5	16.1	4.33	4.24	27.2	64.4	46.0	34.2
1966	37.3	19.7	80.6	48.7	27.0	16.8	1.99	1.23	1.49	1.52	20.3	86.1	28.6
1965	13.9	28.8	35.9	119	45.4	6.16	3.41	1.93	4.07	22.4	48.7	63.4	32.8
1964	18.6	19.5	44.3	67.7	42.6	11.7	2.70	1.31	1.87	1.62	2.05	8.91	18.6
1963	12.0	8.81	28.7	92.7	45.0	13.4	2.68	2.21	2.13	1.63	7.71	18.1	19.6
1962	7.05	5.32	30.8	102	28.6	8.23	2.70	2.38	2.11	3.86	23.5	23.4	20.0
Mean	29.9	25.2	57.7	109	48.7	20.8	8.33	4.60	4.43	8.67	21.3	30.1	30.7
Max	105	106	145	216	156	107	38.9	38.4	43.8	69.7	82.4	86.1	99.5
Min	1.08	1.08	2.78	21.9	10.3	3.66	0.997	0.401	0.335	0.795	1.14	1.05	3.79

Year ⬆⬇	Jan ⬆⬇	Feb ⬆⬇	Mar ⬆⬇	Apr ⬆⬇	May ⬆⬇	Jun ⬆⬇	Jul ⬆⬇	Aug ⬆⬇	Sep ⬆⬇	Oct ⬆⬇	Nov ⬆⬇	Dec ⬆⬇	Mean ⬆⬇
1961	1.81	4.94	21.3	66.2	61.9	28.9	8.05	4.93	3.76	3.03	3.55	11.2	18.3
1960	14.8	25.2	22.5	216	69.6	19.8	6.31	3.06	0.859	0.795	1.58	2.07	31.9
1959	6.07	8.05	22.6	149	42.5	7.57	4.45	1.76	1.82	3.21	15.2	28.9	24.3
1958	32.3	12.7	34.5	88.7	35.6	9.37	3.35	1.81	3.06	1.96	3.66	7.10	19.5
1957	18.4	22.0	48.4	65.6	33.2	14.0	9.30	2.89	2.93	3.23	7.77	43.4	22.6
1956	13.5	7.22	13.1	141	102	59.1	9.35	5.91	6.91	3.68	4.87	15.6	31.9
1955	24.4	14.0	68.0	137	31.6	11.1	3.55	2.34	2.10	62.7	52.8	16.8	35.5
1954	13.3	25.9	77.8	128	48.4	11.9	3.71	2.67	5.25	21.6	35.1	32.2	33.8
1953	14.2	15.6	51.9	70.4	54.0	23.5	11.2	8.99	4.26	4.07	6.29	21.2	23.8
1952	40.2	45.4	54.9	167	44.0	21.7	4.83	3.20	2.74	2.05	2.20	15.9	33.7
1951	33.9	25.8	82.2	170	57.7	16.5	19.5	5.72	8.11	7.45	36.2	40.3	41.9
1950	84.5	33.0	39.0	157	38.4	13.4	4.53	2.90	2.46	1.90	4.27	20.6	33.5
1949	20.7	29.5	58.8	118	34.3	7.24	3.42	2.21	1.94	2.33	3.61	39.4	26.8
1948	7.68	9.10	111	115	66.9	27.0	9.90	3.60	1.82	1.92	4.89	9.54	30.7
1947	29.1	36.1	43.3	185	76.2	72.5	26.0	20.5	5.37	4.00	4.72	8.49	42.6
1946	24.1	15.3	94.8	41.0	22.2	14.3	4.06	2.08	1.63	1.91	6.69	23.9	21.0
1945	3.15	3.17	75.4	77.2	70.6	50.2	22.4	9.95	8.17	47.3	30.5	20.5	34.9
1944	3.07	3.13	14.4	71.5	62.2	16.0	8.45	2.88	1.94	1.85	1.14	2.82	15.8
1943	18.4	23.3	78.8	149	156	42.3	7.83	3.47	1.37	2.95	8.91	6.45	41.6
1942	29.4	12.2	96.3	73.3	40.9	31.2	6.41	2.05	2.57	3.33	36.7	21.4	29.6
1941	47.6	13.8	15.7	87.2	15.3	3.66	3.06	1.76	1.19	1.97	18.0	29.1	19.9
1940	3.57	1.81	2.78	144	92.0	68.6	13.2	4.59	3.17	2.79	8.45	23.5	30.7
1939	7.85	6.26	10.3	155	75.8	15.5	5.51	5.92	3.52	4.32	5.57	5.60	25.1
1938	12.0	47.6	96.2	87.6	31.1	12.1	4.40	3.60	3.81	5.21	5.33	5.78	26.2

Mean	29.9	25.2	57.7	109	48.7	20.8	8.33	4.60	4.43	8.67	21.3	30.1	30.7
Max	105	106	145	216	156	107	38.9	38.4	43.8	69.7	82.4	86.1	99.5
Min	1.08	1.08	2.78	21.9	10.3	3.66	0.997	0.401	0.335	0.795	1.14	1.05	3.79

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1937	105	48.7	24.4	107	94.3	23.2	6.99	4.08	2.73	3.39	32.5	20.3	39.4
1936	10.9	9.09	145	163	49.2	13.3	3.68	1.73	1.56	5.99	26.1	13.8	36.9
1935	14.7	11.1	71.5	59.4	26.0	30.4	22.1	7.63	2.74	2.07	18.8	27.9	24.5
1934	6.88	4.62	34.9	162	38.0	14.1	5.65	1.99	2.60	2.07	3.48	14.1	24.2
1933	36.5	20.0	20.0	175	56.9	12.3	3.45	1.53	1.11	1.02	1.28	4.67	27.8
1932	78.4	62.0	32.0	147	46.2	11.8	5.11	4.66	2.38	5.38	34.7	44.2	39.5
1931	1.08	1.08	8.56	57.7	36.9	18.5	6.00	3.37	2.77	3.36	10.6	27.2	14.8
1930	42.2	31.4	68.7	97.2	46.3	16.4	6.73	2.75	2.43	2.62	1.89	1.59	26.7
1929	62.7	27.6	121	131	95.5	23.5	7.24	3.90	3.20	2.40	5.33	4.25	40.6
1928	45.9	23.6	71.5	170	51.5	27.2	23.3	38.4	15.5	69.7	70.9	54.3	55.2
1927	16.4	20.1	106	60.9	39.8	32.8	21.5	14.5	5.57	8.57	35.8	81.2	36.9
1926	18.8	13.2	23.3	146	75.8	22.7	7.66	4.58	6.34	15.1	82.4	41.7	38.1
1925	3.31	19.6	94.3	93.2	30.6	15.6	7.00	4.39	4.36	7.78	53.9	42.8	31.4
1924	23.6	25.1	52.2	108	58.4	22.4	5.83	3.47	2.88	10.4	5.63	7.28	27.1
1923	1.14	1.63	6.88	97.2	54.2	42.1	7.63	1.58	1.31	2.12	2.28	22.5	20.0
1922	9.04	6.85	64.7	156	49.1	17.6	5.30	2.64	1.22	0.929	1.14	1.05	26.3
1921	19.2	9.50	110	74.8	31.2	8.60	3.57	1.85	1.87	4.10	9.47	19.8	24.5
1920	5.45	4.80	66.5	75.7	33.4	8.03	6.50	2.79	0.942	1.55	4.47	20.2	19.2
1919	36.3	14.2	78.0	100	101	39.6	8.46	3.49	1.45	1.61	22.0	19.5	35.5
1918	2.05	4.22	66.8	130	37.1	17.4	11.5	4.57	6.38	15.6	38.3	50.4	32.0
1917	9.52	7.53	54.4	133	38.4	21.7	10.5	3.52	1.79	3.89	18.5	6.25	25.8
1916	32.6	56.3	29.0	163	69.3	107	32.5	7.47	3.86	3.07	4.40	10.1	43.2
1915	-	-	-	-	-	-	-	-	-	9.37	11.6	14.2	-
Mean	29.9	25.2	57.7	109	48.7	20.8	8.33	4.60	4.43	8.67	21.3	30.1	30.7
Max	105	106	145	216	156	107	38.9	38.4	43.8	69.7	82.4	86.1	99.5
Min	1.08	1.08	2.78	21.9	10.3	3.66	0.997	0.401	0.335	0.795	1.14	1.05	3.79

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 15' 13" N	**Longitude:**	77° 25' 07" W
Gross drainage area:	2590 km^2	**Effective drainage area:**	N/A
Record length:	105 Years	**Period of record:**	1915 - 2019
Regulation type:	Regulated	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	Yes
Type of water body:	River	**RHBN:**	No
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	JAN - DEC
Datum of published data:	ASSUMED DATUM		
To convert to:	GEODETIC SURVEY OF CANADA DATUM,add 94.488 m		

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
1915 - 1956	Flow	Continuous	Manual
1957 - 2001	Flow	Continuous	Recorder
2002 - 2019	Flow & Level	Continuous	Recorder

Click here for further information on remarks.

Date modified:
2019-08-05

Monthly Discharge Data for MOIRA RIVER NEAR TWEED (02HL007) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HL007

Data Type: Monthly

Parameter Type: Flow

Download? Apply

Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	35.6	33.2	35.6	90.5	40.3	6.06	1.50	1.29	1.54	5.95	19.1	41.7	26.0
2017	35.7	27.7	71.8	72.5	81.5	24.0	22.7	10.9	2.74	7.51	42.0	24.6	35.3
2016	45.4	33.0	57.9	70.9	10.3	2.16	0.656	0.651	0.436	1.06	2.67	14.0	19.9
2015	13.6	5.69	6.76	51.5	10.9	22.5	6.53	6.38	4.95	8.95	23.2	23.6	15.4
2014	21.0	13.2	14.2	130	43.1	14.6	5.49	3.08	3.74	9.74	15.1	19.3	24.4
2013	25.1	21.7	22.0	72.5	21.9	20.4	14.0	3.59	3.67	7.64	43.0	18.4	22.8
2012	26.0	17.1	55.3	11.9	10.5	6.92	1.39	0.848	1.47	2.98	6.12	16.6	13.1
2011	21.4	14.3	72.0	69.3	40.5	9.06	2.26	0.908	0.458	3.29	5.03	46.4	23.7
2010	29.6	22.4	45.9	19.9	7.71	6.50	6.42	3.73	5.21	11.5	21.0	53.4	19.4
Mean	30.6	21.2	37.9	65.4	28.2	12.2	6.32	3.38	2.98	6.68	19.9	30.8	22.1
Max	48.5	39.3	72.0	130	81.5	24.0	22.7	10.9	13.1	21.2	49.8	54.6	47.3
Min	6.08	5.65	6.76	11.9	7.71	2.16	0.656	0.651	0.309	0.806	2.11	7.07	4.32

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	31.9	28.3	51.3	77.7	36.3	9.19	5.74	7.16	3.15	8.31	19.7	33.8	26.0
2008	42.0	29.8	26.5	112	35.0	13.2	6.83	5.77	2.81	4.84	10.4	40.2	27.4
2007	40.3	16.4	13.3	49.2	14.2	5.49	2.81	0.925	0.309	0.806	2.11	12.4	13.2
2006	32.8	39.3	50.7	46.7	23.8	15.5	5.74	1.71	2.96	21.2	49.8	54.6	28.7
2005	48.5	17.9	15.6	79.1	19.2	10.1	3.48	0.944	1.05	2.85	8.49	21.5	19.1
2004	33.9	12.8	37.4	48.0	32.4	14.6	5.40	6.27	13.1	5.92	17.6	42.6	22.5
2003	6.08	5.65	29.4	45.2	23.8	14.8	2.62	1.69	2.05	9.61	47.7	52.8	20.1
2002	-	-	-	-	-	-	13.9	1.68	1.08	1.37	5.01	7.07	-
Mean	30.6	21.2	37.9	65.4	28.2	12.2	6.32	3.38	2.98	6.68	19.9	30.8	22.1
Max	48.5	39.3	72.0	130	81.5	24.0	22.7	10.9	13.1	21.2	49.8	54.6	47.3
Min	6.08	5.65	6.76	11.9	7.71	2.16	0.656	0.651	0.309	0.806	2.11	7.07	4.32

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 29' 18" N	**Longitude:**	77° 19' 11" W
Gross drainage area:	1760 km^2	**Effective drainage area:**	N/A
Record length:	18 Years	**Period of record:**	2002 - 2019
Regulation type:	Regulated	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	No
Type of water body:	River	**RHBN:**	No
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	JAN - DEC
Datum of published data:	ASSUMED DATUM		

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
2002 - 2019	Flow & Level	Continuous	Recorder

Historical Hydrometric Remarks

REGULATED BY DAM DOWNSTREAM IN TWEED.

Monthly Discharge Data for NAPANEE RIVER AT CAMDEN EAST (02HM007) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HM007

Data Type: Monthly

Parameter Type: Flow

Download? Apply

Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	15.3	18.4	21.8	30.8	16.8	3.08	1.31	1.04	0.815	1.05	2.88	9.70	10.2
2017	11.9	13.6	23.1	28.6	34.9	7.61	10.5	12.3	4.80	3.15	16.9	11.6	14.9
2016	16.2	18.2	29.2	25.1	4.58	1.46	0.596	0.388	0.336	1.07	1.39	3.72	8.52
2015	4.43	2.27	4.28	26.0	5.93	6.40	5.09	2.38	2.46	3.02	8.05	9.10	6.62
2014	12.1	8.90	13.8	54.3	23.3	17.9	6.09	3.70	3.86	4.28	5.95	7.19	13.4
2013	11.8	9.50	15.1	23.1	8.16	5.60	4.51	3.21	3.00	3.08	10.2	10.1	8.95
2012	6.71	8.71	20.1	6.30	7.63	2.86	0.794	0.583	0.965	1.34	2.27	4.32	5.22
2011	9.18	8.55	38.2	32.3	30.0	8.38	2.08	0.867	0.801	0.968	0.979	5.28	11.5
2010	12.7	9.52	18.9	10.1	3.64	3.38	2.91	1.60	1.75	3.73	6.66	19.3	7.85
Mean	10.9	9.97	18.4	26.1	11.3	4.92	2.42	1.86	2.45	3.10	6.55	10.1	9.01
Max	21.4	23.6	38.2	54.3	34.9	22.2	10.5	12.3	19.8	14.0	23.0	26.0	25.0
Min	1.16	1.28	4.28	6.30	3.44	1.18	0.596	0.388	0.262	0.798	0.906	1.33	1.83

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	11.9	10.5	21.1	25.3	11.0	3.47	3.11	1.72	1.28	3.05	6.05	11.2	9.14
2008	19.7	13.3	15.9	43.8	10.8	3.06	2.77	2.80	2.42	1.98	3.18	12.3	11.0
2007	16.2	5.72	9.56	19.2	8.32	3.91	2.05	0.987	0.930	1.10	1.84	3.56	6.11
2006	19.7	21.2	16.0	11.5	6.88	5.55	3.24	1.23	1.53	8.88	23.0	26.0	12.1
2005	21.4	14.1	9.74	32.0	9.43	1.73	1.11	0.904	0.905	2.56	9.16	15.2	9.85
2004	16.4	5.66	15.0	20.4	13.0	7.79	2.10	3.39	6.48	2.69	4.47	17.5	9.57
2003	3.48	3.55	13.1	21.5	9.32	6.26	1.98	1.24	1.13	2.72	12.2	23.1	8.30
2002	6.24	7.24	17.5	23.6	19.3	22.2	7.33	1.49	0.596	1.06	2.59	3.12	9.36
2001	7.06	8.37	13.7	25.0	5.10	1.28	0.628	0.543	0.683	0.798	0.906	6.11	5.85
2000	8.48	8.58	16.1	19.5	14.1	7.65	5.15	4.06	3.47	2.79	3.59	7.66	8.43
1999	10.1	14.5	16.5	29.2	4.04	1.18	1.14	0.742	0.910	1.52	3.17	7.83	7.57
1998	15.8	8.82	26.8	22.3	3.44	1.54	1.21	0.908	1.51	1.70	2.49	4.24	7.56
1997	16.3	12.6	23.0	34.9	15.8	4.20	1.85	1.04	2.03	3.18	10.3	10.0	11.3
1996	15.0	17.1	16.0	19.0	18.9	4.96	1.72	1.13	3.04	7.68	16.6	17.4	11.5
1995	18.9	11.6	14.6	6.34	4.25	1.67	0.727	0.619	0.788	2.84	12.7	9.65	7.06
1994	6.37	5.81	9.66	28.9	10.2	5.80	2.23	1.40	1.04	0.935	2.26	4.07	6.56
1993	20.5	12.5	11.4	42.2	12.6	5.37	2.60	1.51	1.47	3.86	6.66	16.3	11.4
1992	3.10	2.36	12.1	32.0	12.3	2.38	1.27	1.49	4.95	7.20	21.0	16.0	9.68
1991	19.5	11.1	24.2	30.8	11.8	2.77	1.02	0.628	0.262	1.15	1.70	2.13	8.92
1990	7.22	11.4	22.3	22.9	13.5	5.49	1.84	1.37	1.07	3.16	4.67	15.4	9.19
1989	3.35	4.04	8.84	23.2	11.1	4.09	1.45	1.17	0.625	1.26	5.59	5.19	5.83
1988	9.81	7.73	14.3	22.0	5.23	1.59	0.802	0.818	0.911	1.32	2.88	2.70	5.84
1987	9.95	5.70	16.4	27.6	4.79	5.18	2.60	1.43	1.98	1.83	5.50	20.5	8.62
1986	8.75	6.58	17.9	16.8	8.15	7.68	2.70	3.06	9.04	14.0	10.7	13.9	9.94

Mean	10.9	9.97	18.4	26.1	11.3	4.92	2.42	1.86	2.45	3.10	6.55	10.1	9.01
Max	21.4	23.6	38.2	54.3	34.9	22.2	10.5	12.3	19.8	14.0	23.0	26.0	25.0
Min	1.16	1.28	4.28	6.30	3.44	1.18	0.596	0.388	0.262	0.798	0.906	1.33	1.83

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1985	4.84	6.29	27.4	20.2	3.84	1.87	1.56	1.18	4.24	4.25	13.9	10.9	8.37
1984	10.3	21.7	17.4	31.1	12.5	5.12	2.90	2.48	2.38	1.72	1.93	3.64	9.43
1983	14.2	11.2	14.5	18.0	20.5	5.44	1.39	1.51	1.30	1.69	6.14	20.3	9.68
1982	5.78	4.45	11.4	37.2	10.6	7.56	2.97	1.60	2.38	3.11	6.71	14.6	9.03
1981	4.35	23.6	24.4	7.64	5.66	6.25	3.13	3.79	19.8	13.7	15.1	9.32	11.4
1980	10.6	4.93	18.2	28.3	15.7	2.64	1.83	2.34	1.95	2.36	4.21	7.64	8.39
1979	5.55	4.59	32.1	30.1	9.23	4.47	1.54	1.62	2.16	2.98	4.24	10.7	9.11
1978	13.0	14.9	11.1	43.7	10.2	2.07	1.22	1.32	1.48	1.79	2.75	4.66	9.02
1977	1.16	1.28	25.8	19.9	5.83	2.31	1.40	1.89	1.66	3.02	5.43	10.1	6.65
1976	5.54	9.71	36.9	36.1	9.99	4.24	2.18	1.81	1.73	1.65	1.63	1.33	9.40
1975	9.45	6.98	21.7	31.5	10.0	2.69	1.22	1.26	2.28	1.31	2.53	6.74	8.14
1974	8.64	11.1	21.0	35.9	17.0	3.12	1.14	1.22	1.14	0.855	1.51	3.96	8.88
Mean	10.9	9.97	18.4	26.1	11.3	4.92	2.42	1.86	2.45	3.10	6.55	10.1	9.01
Max	21.4	23.6	38.2	54.3	34.9	22.2	10.5	12.3	19.8	14.0	23.0	26.0	25.0
Min	1.16	1.28	4.28	6.30	3.44	1.18	0.596	0.388	0.262	0.798	0.906	1.33	1.83

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 20' 04" N	**Longitude:**	76° 50' 20" W
Gross drainage area:	700 km^2	**Effective drainage area:**	N/A
Record length:	46 Years	**Period of record:**	1974 - 2019
Regulation type:	Regulated	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	Yes
Type of water body:	River	**RHBN:**	No
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	JAN - DEC
Datum of published data:	ASSUMED DATUM		

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
1974 - 2001	Flow	Continuous	Recorder
2002 - 2019	Flow & Level	Continuous	Recorder

Click here for further information on remarks.

Date modified:
2019-08-05

Monthly Discharge Data for SALMON RIVER AT TAMWORTH (02HM010) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HM010

Data Type: Monthly

Parameter Type: Flow

Download? Apply

Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	10.5	10.9	13.9	21.9	17.8	2.46	0.341	0.062	0.040	0.214	3.78	12.9	7.90
2017	10.7	8.51	20.7	21.1	23.4	9.26	8.28	6.54	1.67	0.552	11.5	8.78	10.9
2016	15.8	12.2	16.2	22.4	3.61	0.790	0.063	0.031	0.002	0.022	0.055	0.863	6.00
2015	4.89	2.39	2.39	14.0	5.64	6.95	3.16	1.13	1.04	0.754	6.53	7.22	4.67
2014	9.49	6.90	6.38	34.4	16.0	7.54	2.81	0.724	0.638	2.17	3.70	5.56	8.03
2013	11.3	8.05	7.76	18.1	7.92	5.91	7.54	2.44	0.528	0.403	11.0	9.20	7.51
2012	8.14	6.78	15.1	6.59	5.70	2.33	0.425	0.080	0.248	0.485	2.28	6.63	4.57
2011	6.65	2.99	20.4	20.0	18.1	5.62	0.602	0.131	0.098	0.172	0.147	5.94	6.74
2010	9.79	11.0	11.8	8.38	2.98	2.75	2.17	0.720	0.801	1.55	7.16	18.0	6.43
Mean	11.2	7.50	11.1	18.8	10.2	4.84	2.90	1.26	0.826	1.12	5.63	10.3	7.14
Max	18.7	14.5	20.7	34.4	23.4	9.26	8.28	6.54	5.42	6.95	17.9	22.1	15.7
Min	2.80	2.39	2.39	6.59	2.98	0.790	0.063	0.031	0.002	0.022	0.055	0.863	1.58

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	13.2	7.05	13.7	22.2	9.88	3.37	2.12	2.42	1.21	1.09	6.43	12.2	7.91
2008	18.7	10.7	10.3	28.5	11.8	3.89	3.72	2.45	1.18	0.299	2.31	12.0	8.82
2007	14.2	5.39	4.70	15.3	7.15	4.17	1.93	1.63	0.300	0.247	0.243	5.34	5.05
2006	12.0	14.5	13.5	12.5	7.47	5.83	2.81	0.402	0.468	6.95	17.9	19.3	9.47
2005	16.1	6.11	3.93	22.8	7.30	3.60	2.76	0.214	0.185	1.47	5.26	12.0	6.81
2004	14.3	4.00	10.7	14.9	10.4	7.90	1.30	1.08	5.42	2.15	3.64	14.5	7.52
2003	2.80	2.53	6.63	18.2	8.74	5.07	1.62	0.601	0.141	0.386	13.3	22.1	6.84
2002	-	-	-	-	-	-	7.63	0.792	0.079	0.194	0.509	1.79	-
Mean	11.2	7.50	11.1	18.8	10.2	4.84	2.90	1.26	0.826	1.12	5.63	10.3	7.14
Max	18.7	14.5	20.7	34.4	23.4	9.26	8.28	6.54	5.42	6.95	17.9	22.1	15.7
Min	2.80	2.39	2.39	6.59	2.98	0.790	0.063	0.031	0.002	0.022	0.055	0.863	1.58

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 29' 10" N	**Longitude:**	76° 59' 34" W
Gross drainage area:	532 km^2	**Effective drainage area:**	N/A
Record length:	18 Years	**Period of record:**	2002 - 2019
Regulation type:	Natural	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	No
Type of water body:	River	**RHBN:**	No
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	N/A
Datum of published data:	ASSUMED DATUM		

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
2002 - 2019	Flow & Level	Continuous	Recorder

Click here for further information on remarks.

Date modified:

Monthly Discharge Data for SALMON RIVER NEAR SHANNONVILLE (02HM003) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HM003

Data Type: Monthly

Parameter Type: Flow

Download? Apply

Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	16.4	23.9	24.4	43.3	26.0	5.31	0.541	1.78	0.302	0.640	8.63	19.8	14.3
2017	17.1	15.9	31.3	37.6	46.0	13.8	12.1	9.90	3.38	1.82	20.2	10.7	18.3
2016	22.1	19.3	28.4	34.2	6.25	1.67	0.199	0.083	0.037	0.418	0.762	5.56	9.91
2015	5.49	3.45	5.54	28.7	8.25	9.72	4.71	2.09	2.06	3.87	10.9	11.2	8.00
2014	12.3	10.6	12.5	69.0	26.2	18.0	5.83	2.40	1.89	4.15	6.34	8.39	14.8
2013	16.6	11.1	18.5	30.4	12.4	9.30	8.68	3.73	1.66	2.13	15.0	9.54	11.6
2012	12.3	10.7	27.5	10.8	8.91	4.63	0.761	0.091	0.931	1.91	5.21	10.3	7.84
2011	9.21	6.72	48.7	43.5	35.4	9.75	-	-	0.175	0.396	1.08	10.9	-
2010	18.4	15.3	26.2	14.4	5.28	4.81	3.98	1.73	1.37	2.71	11.1	32.2	11.5
Mean	12.4	11.4	22.0	34.7	15.9	6.50	2.74	1.32	1.48	2.53	8.36	13.5	11.1
Max	29.4	36.3	48.7	69.0	46.0	28.4	16.0	9.90	21.5	21.3	31.9	32.2	32.6
Min	0.270	1.40	4.48	9.66	3.72	0.523	0.199	0.038	0.025	0.082	0.139	0.377	1.74

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2009	17.0	15.9	28.5	40.2	17.6	5.87	3.40	2.86	1.48	3.26	11.4	19.4	13.9
2008	27.2	15.6	17.4	52.1	18.1	5.16	4.18	3.24	1.76	1.34	4.25	20.6	14.2
2007	18.5	6.59	11.4	25.7	11.0	5.11	2.10	1.72	0.299	0.216	0.636	6.35	7.47
2006	24.2	23.7	22.0	20.2	11.9	8.35	3.24	0.518	0.524	16.5	31.9	32.0	16.3
2005	24.7	11.4	8.96	41.0	11.7	4.57	3.17	0.303	0.204	2.27	11.5	19.5	11.6
2004	18.3	6.54	21.7	26.6	18.1	11.4	3.55	4.57	10.4	3.67	7.06	23.2	12.9
2003	3.11	2.98	17.6	26.8	14.6	9.34	2.35	1.31	0.334	2.21	20.4	30.2	10.9
2002	12.0	11.8	23.5	31.2	28.8	28.4	9.49	0.925	0.159	0.426	1.69	2.71	12.6
2001	9.39	15.9	19.3	30.5	5.98	1.95	0.367	0.065	0.054	0.454	1.14	13.5	8.22
2000	10.7	8.10	19.9	25.1	21.7	14.8	16.0	7.46	3.73	1.80	5.25	16.2	12.6
1999	9.76	17.5	19.0	32.9	4.58	1.38	0.851	0.224	0.230	0.931	5.30	13.1	8.81
1998	19.9	11.1	29.7	29.3	4.12	1.51	0.999	0.759	0.614	0.539	1.15	3.89	8.63
1997	19.7	19.4	32.9	48.0	27.4	5.97	2.68	1.19	1.43	2.93	15.6	10.3	15.6
1996	18.6	29.2	19.8	28.7	26.3	6.65	1.90	1.12	5.11	10.4	19.2	21.5	15.7
1995	27.4	14.2	14.9	9.66	7.66	3.67	0.789	0.357	0.228	2.41	19.3	12.2	9.40
1994	5.97	4.86	13.9	35.1	16.0	8.45	2.76	0.542	0.554	0.279	1.52	6.44	8.03
1993	29.4	12.0	14.6	53.4	15.5	6.90	2.34	0.537	0.434	2.94	9.51	21.1	14.1
1992	4.65	3.07	19.4	42.2	17.6	2.69	0.574	0.686	3.34	3.72	24.8	17.1	11.7
1991	20.8	11.7	31.9	40.4	13.4	2.73	0.406	0.038	0.025	0.082	0.139	1.87	10.3
1990	10.3	14.9	29.2	31.3	17.8	5.51	1.48	0.492	0.094	2.14	5.46	22.6	11.8
1989	6.86	5.74	12.2	28.0	13.7	5.95	1.47	0.371	0.044	0.238	10.2	8.89	7.81
1988	9.81	10.7	19.0	32.3	7.20	2.01	0.370	0.169	0.085	0.707	5.19	5.29	7.74
1987	8.22	4.51	20.6	41.3	6.23	3.22	1.44	0.294	0.269	0.647	6.22	23.5	9.70
1986	12.4	8.58	21.1	22.2	9.01	9.61	4.44	4.46	8.52	21.3	11.0	15.7	12.4

Mean	12.4	11.4	22.0	34.7	15.9	6.50	2.74	1.32	1.48	2.53	8.36	13.5	11.1
Max	29.4	36.3	48.7	69.0	46.0	28.4	16.0	9.90	21.5	21.3	31.9	32.2	32.6
Min	0.270	1.40	4.48	9.66	3.72	0.523	0.199	0.038	0.025	0.082	0.139	0.377	1.74

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1985	7.93	10.0	35.0	30.0	7.57	2.51	0.657	0.096	2.46	3.71	19.1	11.2	10.9
1984	8.57	27.3	24.0	41.6	18.8	6.06	2.27	1.66	0.923	0.415	1.59	4.86	11.5
1983	19.1	15.3	20.6	29.2	28.3	7.88	1.17	0.490	0.377	2.00	8.62	24.8	13.2
1982	6.12	3.68	18.2	49.8	16.2	8.85	3.07	0.891	0.815	1.71	9.92	25.8	12.1
1981	4.98	36.3	29.1	13.0	9.49	8.78	3.89	2.38	21.5	11.9	18.2	8.08	14.0
1980	17.3	4.20	28.9	35.2	18.6	4.38	3.11	1.40	0.622	1.87	8.97	15.2	11.6
1979	15.3	8.42	43.3	43.2	14.9	5.68	1.11	0.210	0.189	0.790	5.75	17.1	13.0
1978	20.3	14.9	15.7	53.7	17.9	2.44	0.308	0.126	0.197	0.128	1.46	7.20	11.2
1977	2.55	2.59	38.5	23.4	7.16	1.76	0.302	0.244	0.413	2.65	6.77	19.1	8.79
1976	5.58	17.3	46.8	41.8	9.58	3.74	1.21	0.335	0.200	0.593	1.54	3.22	11.0
1975	9.30	9.42	26.9	39.6	21.0	3.76	0.566	0.164	0.129	0.391	0.848	6.78	9.90
1974	15.7	12.7	26.9	42.9	27.4	8.26	2.24	0.385	0.154	0.179	2.16	11.3	12.5
1973	21.7	17.8	43.2	32.0	13.6	5.76	0.993	0.281	0.125	0.158	2.98	8.43	12.3
1972	10.8	7.52	9.24	49.9	25.4	10.5	7.87	5.08	1.36	5.91	17.3	19.0	14.2
1971	8.48	8.18	15.9	52.2	20.0	3.71	0.967	0.266	0.220	0.635	0.665	9.85	10.1
1970	4.56	5.90	12.7	34.3	18.1	6.19	3.21	1.00	0.381	1.08	11.1	14.8	9.44
1969	8.35	12.7	21.1	38.5	31.8	13.4	3.71	2.08	0.465	0.388	4.79	9.75	12.3
1968	8.55	12.1	22.1	21.6	8.36	8.39	4.69	1.22	4.62	4.14	9.80	15.8	10.1
1967	11.1	10.5	11.6	33.1	12.9	4.73	3.02	0.968	0.347	5.12	20.5	15.4	10.8
1966	11.3	5.43	25.8	16.1	6.68	4.54	0.840	0.242	0.181	0.261	7.01	26.0	8.70
1965	4.44	13.5	17.9	36.7	14.4	2.11	0.974	0.307	0.780	6.38	21.1	23.7	11.9
1964	9.23	8.15	16.4	23.4	13.5	3.84	0.919	0.254	0.214	0.317	0.608	2.22	6.59
1963	5.25	3.76	15.9	28.7	14.1	7.98	2.00	0.807	0.292	0.282	1.24	8.37	7.39
1962	1.58	1.40	14.0	26.8	3.72	0.523	0.591	0.424	0.409	0.936	7.21	9.59	5.60

Mean	12.4	11.4	22.0	34.7	15.9	6.50	2.74	1.32	1.48	2.53	8.36	13.5	11.1
Max	29.4	36.3	48.7	69.0	46.0	28.4	16.0	9.90	21.5	21.3	31.9	32.2	32.6
Min	0.270	1.40	4.48	9.66	3.72	0.523	0.199	0.038	0.025	0.082	0.139	0.377	1.74

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	0.270	2.95	11.1	24.0	20.6	9.88	2.82	1.02	0.606	0.315	0.628	2.71	6.41
1960	4.41	7.26	4.48	66.3	21.0	4.89	1.28	0.390	0.143	0.137	0.418	0.377	9.26
1959	3.73	3.88	15.0	50.6	14.2	1.32	0.702	0.171	0.229	2.19	8.46	14.6	9.59
1958	-	-	-	-	-	-	-	0.181	0.280	0.335	2.04	4.10	-
Mean	12.4	11.4	22.0	34.7	15.9	6.50	2.74	1.32	1.48	2.53	8.36	13.5	11.1
Max	29.4	36.3	48.7	69.0	46.0	28.4	16.0	9.90	21.5	21.3	31.9	32.2	32.6
Min	0.270	1.40	4.48	9.66	3.72	0.523	0.199	0.038	0.025	0.082	0.139	0.377	1.74

Station Information

Active or discontinued: Active
Latitude: 44° 12' 26" N
Gross drainage area: 907 km^2
Record length: 62 Years
Regulation type: Regulated
Real-time data available: Yes
Type of water body: River
EC Regional Office: BURLINGTON
Data contributed by: N/A
Datum of published data: ASSUMED DATUM
To convert to: GEODETIC SURVEY OF CANADA DATUM,add 76.2 m

Province / Territory: Ontario
Longitude: 77° 12' 33" W
Effective drainage area: N/A
Period of record: 1958 - 2019
Regulation length: N/A
Sediment data available: Yes
RHBN: No
Current Operation Schedule: Continuous
Operation Period: JAN - DEC

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
1958 - 1964	Flow	Continuous	Manual
1965 - 2001	Flow	Continuous	Recorder
2002 - 2019	Flow & Level	Continuous	Recorder

Click here for further information on remarks.

Date modified:
2019-08-05

Monthly Discharge Data for SKOOTAMATTA RIVER NEAR ACTINOLITE (02HL004) [ON]

All times are specified in Local Standard Time (LST). Add 1 hour to adjust for Daylight Saving Time where and when it is observed.

Graph Table

Station: 02HL004

Data Type: Monthly

Parameter Type: Flow

Download? Apply

Monthly Mean Discharge (m^3/s)

Filter items

This table provides monthly mean value for a station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2018	13.8	14.4	14.0	34.7	14.5	1.92	0.312	0.596	0.517	3.61	9.55	16.6	10.4
2017	14.0	11.8	25.7	26.5	29.7	11.4	10.6	5.41	0.967	3.96	18.1	11.7	14.2
2016	15.6	12.6	20.7	26.5	3.54	0.570	0.201	0.241	0.225	0.413	0.773	6.20	7.30
2015	5.32	2.56	2.84	17.5	3.10	7.72	1.58	2.04	1.18	3.55	9.65	10.4	5.62
2014	9.98	5.93	5.65	51.4	15.6	4.98	1.62	1.04	1.06	3.57	5.83	6.90	9.46
2013	11.5	10.1	10.2	24.6	9.00	9.02	5.59	0.990	0.840	2.86	17.1	10.8	9.38
2012	10.4	6.82	22.4	4.10	3.77	2.38	0.499	0.494	0.621	1.14	2.18	6.82	5.14
2011	8.19	4.66	27.5	28.3	16.8	2.74	0.687	0.257	0.362	0.914	1.46	16.5	9.03
Mean	9.19	7.84	15.2	28.2	11.8	4.27	1.79	1.12	1.41	3.03	7.43	10.3	8.47
Max	29.4	34.3	39.1	58.1	31.6	15.8	10.6	5.41	10.9	22.8	25.8	26.0	25.8
Min	0.405	0.509	2.07	4.10	1.76	0.570	0.201	0.169	0.155	0.168	0.346	0.567	0.918

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
2010	12.9	8.54	18.4	6.14	2.78	2.25	1.73	1.01	1.74	3.90	9.48	22.5	7.61
2009	12.9	11.3	20.4	29.2	12.2	2.36	2.06	2.33	1.27	4.09	8.16	13.9	10.0
2008	20.1	12.1	11.8	43.0	13.0	4.88	2.63	2.49	1.36	2.51	5.02	17.4	11.4
2007	15.0	6.01	7.31	19.3	4.54	2.29	1.20	0.391	0.299	0.498	1.23	5.91	5.33
2006	13.6	15.0	20.4	17.6	10.0	5.26	2.20	0.346	0.438	10.8	21.5	22.5	11.6
2005	18.7	6.59	5.78	31.4	6.86	3.41	1.35	0.440	0.504	1.28	4.12	8.62	7.42
2004	12.4	5.39	14.1	17.0	11.8	3.92	1.39	1.85	5.39	2.30	6.70	16.9	8.26
2003	2.51	2.65	13.4	15.3	8.17	4.31	0.798	0.604	0.645	3.53	20.9	22.4	7.93
2002	7.76	7.23	15.7	25.4	18.8	15.8	4.83	0.820	0.643	0.534	1.65	2.44	8.47
2001	7.80	13.2	10.4	26.2	2.92	1.19	0.214	0.169	0.196	0.931	3.25	13.2	6.64
2000	8.48	5.93	11.2	16.0	17.9	13.0	8.39	5.18	1.32	2.33	5.91	11.6	8.94
1999	7.90	9.02	9.91	25.8	2.40	1.17	0.457	0.226	0.450	1.56	11.0	12.5	6.87
1998	13.9	6.38	19.7	28.1	1.76	0.582	1.25	0.599	0.924	1.09	1.99	3.38	6.64
1997	15.0	15.0	20.3	35.3	17.8	2.42	1.62	0.415	0.867	2.65	9.30	6.88	10.6
1996	15.1	20.5	15.8	27.3	18.6	3.16	1.02	2.09	7.25	8.45	17.2	20.4	13.1
1995	29.4	8.68	12.0	4.51	4.97	5.77	0.454	0.379	0.791	1.83	16.6	8.10	7.79
1994	4.54	3.89	6.77	27.2	11.7	4.32	1.71	3.11	1.37	1.70	3.29	8.58	6.52
1993	19.7	6.52	8.62	42.4	7.40	5.09	2.53	0.656	0.682	3.85	8.71	14.5	10.1
1992	3.73	2.77	11.9	35.9	11.3	1.47	0.529	1.42	7.03	5.99	25.8	13.6	10.1
1991	14.8	7.52	25.3	37.7	5.69	1.19	0.574	0.413	0.213	0.372	0.459	2.91	8.10
1990	7.78	8.26	23.7	24.8	10.2	2.86	1.24	0.668	0.407	1.65	4.05	16.7	8.53
1989	5.14	3.97	9.29	21.8	8.52	5.26	1.54	0.220	0.531	2.83	14.7	7.69	6.79
1988	7.20	11.2	15.9	25.7	5.96	1.14	0.609	0.788	0.715	2.45	3.44	4.45	6.63
1987	6.27	4.53	15.9	36.4	3.71	2.22	1.13	0.497	0.538	2.15	5.41	11.8	7.55

Mean	9.19	7.84	15.2	28.2	11.8	4.27	1.79	1.12	1.41	3.03	7.43	10.3	8.47
Max	29.4	34.3	39.1	58.1	31.6	15.8	10.6	5.41	10.9	22.8	25.8	26.0	25.8
Min	0.405	0.509	2.07	4.10	1.76	0.570	0.201	0.169	0.155	0.168	0.346	0.567	0.918

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1986	8.71	6.45	18.9	18.5	7.53	9.78	2.81	4.44	10.9	22.8	7.75	9.57	10.7
1985	8.84	8.45	27.3	29.3	7.54	1.60	1.02	0.785	3.11	3.05	16.0	9.56	9.71
1984	5.09	22.3	16.5	41.4	17.7	2.95	0.755	0.771	0.611	0.530	2.44	5.37	9.70
1983	13.6	8.97	17.6	21.5	25.4	5.78	0.682	0.618	0.396	0.476	2.96	10.1	9.01
1982	5.62	3.15	8.67	40.0	10.6	4.38	1.48	1.06	0.803	0.936	9.16	24.3	9.18
1981	3.05	34.3	21.4	11.1	7.82	7.32	2.48	1.61	9.71	8.98	13.5	7.67	10.7
1980	11.8	3.30	21.9	28.7	11.6	3.76	1.46	0.955	0.871	2.53	6.57	11.2	8.72
1979	9.49	6.40	33.8	36.4	13.0	4.36	0.889	0.644	0.594	1.92	6.92	16.9	10.9
1978	12.7	8.85	9.90	44.2	16.4	2.08	0.755	0.717	0.655	0.645	3.52	7.18	8.97
1977	2.70	2.79	29.3	17.0	3.44	1.01	0.298	1.47	1.22	1.83	4.08	13.3	6.54
1976	4.04	8.36	32.5	37.0	8.78	2.37	0.895	0.757	0.675	1.09	2.33	2.78	8.46
1975	8.16	5.74	20.8	35.3	13.4	2.41	1.03	0.961	0.359	0.257	0.454	4.31	7.77
1974	11.4	8.58	19.7	37.7	25.2	4.69	1.36	1.14	1.26	1.67	4.83	7.88	10.5
1973	16.5	11.9	39.1	25.1	10.2	3.18	1.40	1.22	0.921	0.669	2.37	7.58	10.0
1972	8.08	6.31	6.29	41.2	25.9	5.44	7.07	3.98	1.60	3.89	14.1	13.0	11.4
1971	4.93	4.70	8.31	44.9	14.5	2.28	1.50	1.41	1.52	1.70	2.42	9.61	8.15
1970	2.46	3.25	5.11	31.7	15.2	3.93	2.98	1.73	0.732	0.604	4.34	6.95	6.58
1969	6.70	10.3	16.3	34.2	31.6	6.85	1.88	0.839	1.65	0.457	2.29	4.67	9.81
1968	7.96	8.08	18.9	18.8	5.06	5.66	3.83	0.676	0.637	0.523	3.21	6.80	6.68
1967	8.26	7.28	7.38	31.1	10.9	4.56	5.46	1.72	1.90	12.2	22.4	14.1	10.6
1966	10.3	4.23	21.2	14.9	10.2	5.43	0.723	0.226	0.471	1.22	10.7	26.0	8.80
1965	3.43	7.58	7.59	35.4	14.4	2.16	0.645	0.401	1.16	8.28	16.6	18.4	9.67
1964	5.29	4.87	12.4	18.5	11.9	3.03	0.462	0.177	1.35	0.515	0.484	3.42	5.20
1963	3.58	2.55	11.7	23.5	11.9	3.18	0.305	0.191	0.155	0.168	4.37	5.94	5.63

Mean	9.19	7.84	15.2	28.2	11.8	4.27	1.79	1.12	1.41	3.03	7.43	10.3	8.47
Max	29.4	34.3	39.1	58.1	31.6	15.8	10.6	5.41	10.9	22.8	25.8	26.0	25.8
Min	0.405	0.509	2.07	4.10	1.76	0.570	0.201	0.169	0.155	0.168	0.346	0.567	0.918

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1962	1.43	0.879	10.7	23.9	7.79	2.16	0.530	0.255	0.330	1.51	9.35	8.51	5.61
1961	0.405	0.509	4.33	17.5	18.9	7.58	2.02	0.550	0.275	1.29	0.346	2.36	4.67
1960	3.92	6.99	5.26	58.1	15.8	3.79	0.757	0.249	0.342	0.766	0.478	0.567	8.08
1959	1.60	2.11	6.07	39.9	11.1	1.52	0.688	0.439	0.343	1.32	5.37	8.27	6.56
1958	-	-	9.20	25.4	9.94	2.09	0.784	-	-	0.418	0.905	1.22	-
1957	5.75	4.62	13.8	18.4	9.50	3.49	1.57	0.490	1.23	-	-	-	-
1956	2.43	1.44	2.07	43.0	27.0	14.1	1.96	1.48	1.46	1.26	1.64	5.40	8.60
1955	-	-	-	-	-	-	-	0.532	0.532	18.2	11.4	2.59	-
Mean	9.19	7.84	15.2	28.2	11.8	4.27	1.79	1.12	1.41	3.03	7.43	10.3	8.47
Max	29.4	34.3	39.1	58.1	31.6	15.8	10.6	5.41	10.9	22.8	25.8	26.0	25.8
Min	0.405	0.509	2.07	4.10	1.76	0.570	0.201	0.169	0.155	0.168	0.346	0.567	0.918

Station Information

Active or discontinued:	Active	**Province / Territory:**	Ontario
Latitude:	44° 32' 58" N	**Longitude:**	77° 19' 41" W
Gross drainage area:	678 km^2	**Effective drainage area:**	N/A
Record length:	65 Years	**Period of record:**	1955 - 2019
Regulation type:	Natural	**Regulation length:**	N/A
Real-time data available:	Yes	**Sediment data available:**	No
Type of water body:	River	**RHBN:**	Yes
EC Regional Office:	BURLINGTON	**Current Operation Schedule:**	Continuous
Data contributed by:	N/A	**Operation Period:**	JAN - DEC
Datum of published data:	ASSUMED DATUM		
To convert to:	GEODETIC SURVEY OF CANADA DATUM,add 158.496 m		

Data Collection History

This table contains information pertaining to the historical changes of defined elements in the operation of a station.

	Type	Operation schedule	Gauge type
1955 - 1956	Flow	Continuous	Manual
1957 - 1957	Flow	Seasonal	Manual

	Type	Operation schedule	Gauge type
1958 - 1961	Flow	Continuous	Manual
1962 - 2001	Flow	Continuous	Recorder
2002 - 2019	Flow & Level	Continuous	Recorder

Click here for further information on remarks.

Date modified:
2019-08-05

APPENDIX B

Water Budgets for Gauged Catchments

Average Climate Conditions

Consecon Creek @ Allisonville (1981-2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-6.1	83	0	0	26	14	27
February	-5.0	69	0	0	33	18	34
March	-0.4	68	0	0	55	29	56
April	6.6	81	32	32	34	18	34
May	12.7	80	76	76	2	1	2
June	18.0	77	113	113	0	0	0
July	20.9	72	135	135	0	0	0
August	20.2	74	120	120	0	0	0
September	16.0	91	80	80	0	0	0
October	9.5	86	41	41	0	0	0
November	3.8	102	13	13	0	0	0
December	-2.3	91	0	0	28	15	28
Annual	**7.8**	**974**	**611**	**611**	**179**	**95**	**182**

Moira River @ Foxboro (1981-2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-8.7	72	0	0	21	7	25
February	-7.3	57	0	0	25	9	31
March	-1.8	64	0	0	47	17	58
April	6.0	76	31	31	28	10	34
May	12.6	84	78	78	3	1	3
June	17.7	86	114	113	0	0	0
July	20.2	72	132	102	0	0	0
August	19.1	76	115	92	0	0	0
September	15.0	96	75	75	0	0	0
October	7.9	85	35	35	11	3	16
November	1.9	93	6	6	24	8	33
December	-5.0	79	0	0	24	8	29
Annual	**6.5**	**939**	**586**	**531**	**182**	**64**	**229**

Napanee River @ Camden (1981-2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-8.2	76	0	0	23	9	25
February	-7.0	61	0	0	28	11	31
March	-1.5	64	0	0	50	19	55
April	6.2	79	32	32	31	12	34
May	12.7	86	78	78	4	1	4
June	17.8	85	114	113	0	0	0
July	20.4	70	133	130	0	0	0
August	19.5	78	116	101	0	0	0
September	14.9	100	76	76	0	0	0
October	8.3	89	37	37	1	0	1
November	2.3	97	8	8	23	9	25
December	-4.4	81	0	0	26	10	28
Annual	**6.8**	**964**	**593**	**575**	**187**	**71**	**204**

Salmon River @ Shannonville (1981-2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-8	75	0	0	23	9	25
February	-7	59	0	0	27	11	30
March	-2	65	0	0	51	20	56
April	6	78	32	32	30	12	34
May	13	85	78	78	3	1	3
June	18	87	114	113	0	0	0
July	20	72	132	121	0	0	0
August	19	77	116	103	0	0	0
September	15	98	75	75	0	0	0
October	8	87	36	36	4	1	6
November	2	95	7	7	22	8	25
December	-5	81	0	0	26	10	28
Annual	**6.6**	**959**	**589**	**566**	**186**	**73**	**209**

2016 Drought Conditions

Consecon Creek @ Allisonville (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-4.1	78	0	0	39	21	39
February	-4.1	121	0	0	61	32	61
March	1.5	92	4	4	44	23	44
April	5.4	45	22	22	11	6	11
May	14.1	27	80	80	0	0	0
June	18.0	43	110	110	0	0	0
July	22.8	18	146	93	0	0	0
August	23.2	76	138	77	0	0	0
September	18.3	57	90	57	0	0	0
October	11.1	100	45	45	0	0	0
November	5.5	48	16	16	0	0	0
December	-1.2	75	0	0	2	1	2
Annual	**9.2**	**782**	**652**	**505**	**157**	**83**	**157**

Moira River @ Foxboro (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-5.4	71	0	0	32	11	39
February	-5.3	105	0	0	47	17	57
March	0.9	105	3	3	45	16	57
April	4.7	39	20	20	8	3	11
May	14.1	28	82	67	0	0	0
June	17.8	63	110	84	0	0	0
July	21.8	40	140	63	0	0	0
August	22.4	64	134	68	0	0	0
September	17.3	56	86	57	0	0	0
October	9.9	99	41	41	8	3	11
November	4.5	37	14	14	5	2	7
December	-2.3	89	0	0	25	8	34
Annual	**8.4**	**795**	**630**	**417**	**171**	**60**	**217**

Napanee River @ Camden (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-5.1	72	0	0	34	13	38
February	-5.0	116	0	0	55	21	61
March	1.1	96	3	3	44	17	49
April	4.8	40	21	21	9	4	10
May	14.1	32	82	81	0	0	0
June	18.0	71	111	109	0	0	0
July	21.9	25	141	69	0	0	0
August	22.6	78	135	87	0	0	0
September	17.6	49	87	50	0	0	0
October	10.3	132	43	43	1	0	2
November	4.8	44	15	15	5	2	6
December	-1.9	83	0	0	29	11	31
Annual	**8.6**	**840**	**636**	**476**	**178**	**67**	**196**

Salmon River @ Shannonville (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-5	71	0	0	34	13	37
February	-5	110	0	0	53	21	58
March	1	99	3	3	45	18	51
April	5	42	20	21	10	4	11
May	14	30	82	77	0	0	0
June	18	57	110	98	0	0	0
July	22	34	141	63	0	0	0
August	23	79	134	82	0	0	0
September	17	54	86	54	0	0	0
October	10	112	42	42	4	1	5
November	5	40	14	14	2	1	3
December	-2	85	0	0	25	9	29
Annual	**8.5**	**813**	**633**	**455**	**172**	**67**	**195**

Future Climate Conditions-Composite

Consecon Creek @ Allisonville (RCP 4.5 2011- 2040,)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-3.3	78	0	0	39	21	39
February	-3.4	83	0	0	41	22	41
March	2.3	70	7	7	31	17	31
April	8.8	83	39	39	22	12	22
May	14.3	85	81	81	2	1	2
June	19.4	73	118	118	0	0	0
July	22.9	58	146	146	0	0	0
August	22.2	69	130	115	0	0	0
September	18.1	85	88	87	0	0	0
October	11.7	69	47	47	0	0	0
November	5.8	99	17	17	0	0	0
December	-1.3	101	0	0	12	7	12
Annual	**9.8**	**953**	**673**	**657**	**149**	**79**	**148**

Moira River @ Foxboro (RCP 4.5 2011- 2040)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-6.3	67	0	0	30	11	37
February	-5.8	72	0	0	33	12	40
March	0.7	68	2	2	30	10	36
April	8.0	75	38	38	17	6	20
May	14.1	82	82	82	0	0	0
June	18.7	74	117	108	0	0	0
July	21.9	63	141	97	0	0	0
August	20.7	77	122	87	0	0	0
September	16.4	85	81	80	0	0	0
October	10.2	64	43	43	1	0	1
November	3.8	90	11	11	17	6	25
December	-4.1	91	0	0	31	11	40
Annual	**8.2**	**908**	**636**	**549**	**158**	**56**	**200**

Napanee River @ Camden (RCP 4.5 2011- 2040)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-5.5	70	0	0	33	13	37
February	-5.2	77	0	0	37	14	41
March	1.2	67	3	3	30	12	33
April	8.5	81	39	39	20	8	22
May	14.3	90	83	83	3	1	4
June	18.9	74	117	116	0	0	0
July	22.3	62	144	128	0	0	0
August	21.3	77	125	93	0	0	0
September	16.8	90	82	82	0	0	0
October	10.6	70	44	44	0	0	0
November	4.4	99	13	13	7	2	8
December	-3.3	96	0	0	37	14	41
Annual	**8.7**	**953**	**650**	**601**	**167**	**64**	**185**

Salmon River @ Shannonville (RCP 4.5 2011- 2040)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)
January	-5.9	70	0	0	33	13	37
February	-5.5	76	0	0	36	14	40
March	0.9	68	3	3	31	12	34
April	8.2	78	39	39	19	7	21
May	14.1	86	82	82	1	1	2
June	18.8	74	117	113	0	0	0
July	22.1	62	142	121	0	0	0
August	21.0	76	124	90	0	0	0
September	16.6	87	82	82	0	0	0
October	10.4	67	43	43	0	0	1
November	4.0	94	12	12	9	3	12
December	-3.7	94	0	0	33	13	38
Annual	**8.4**	**932**	**642**	**585**	**163**	**64**	**184**

APPENDIX C

Groundwater Budgets

Ameliasburgh (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-6.3	78	0	0	23	12	27	0.09	1.49
February	-5.1	65	0	0	29	15	34	0.09	1.49
March	-0.4	66	0	0	50	27	58	0.09	1.49
April	6.7	80	33	33	30	16	35	0.09	1.49
May	13.0	80	77	77	1	1	2	0.10	1.52
June	18.2	78	115	114	0	0	0	0.10	1.52
July	21.1	71	136	134	0	0	0	0.09	1.49
August	20.3	74	120	118	0	0	0	0.10	1.52
September	15.9	91	80	80	0	0	0	0.10	1.52
October	9.4	84	40	40	0	0	0	0.09	1.49
November	3.6	99	12	12	2	1	1	0.09	1.49
December	-2.5	87	0	0	23	12	27	0.09	1.49
Annual	**7.8**	**952**	**613**	**608**	**159**	**84**	**184**	**1.14**	**1.50**

Black (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-9.2	71	0	0	19	6	27	0.01	0.22
February	-7.8	56	0	0	23	7	32	0.01	0.22
March	-2.2	65	0	0	44	14	63	0.01	0.22
April	5.7	75	31	31	26	8	36	0.01	0.22
May	12.3	84	77	77	3	1	4	0.01	0.22
June	17.4	88	112	112	0	0	0	0.01	0.22
July	19.9	74	130	82	0	0	0	0.01	0.22
August	18.8	77	113	81	0	0	0	0.01	0.22
September	14.2	96	73	73	0	0	0	0.01	0.22
October	7.5	85	34	34	17	6	26	0.01	0.22
November	1.4	91	5	5	32	10	46	0.01	0.22
December	-5.5	77	0	0	21	7	30	0.01	0.22
Annual	**6.0**	**939**	**576**	**495**	**184**	**59**	**264**	**0.12**	**0.22**

Camden (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-8.1	76	0	0	**23**	9	25	0.10	1.75
February	-6.9	61	0	0	28	11	31	0.10	1.75
March	-1.5	64	0	0	50	20	55	0.10	1.75
April	6.2	79	32	32	31	12	34	0.10	1.75
May	12.7	85	78	78	4	1	4	0.17	3.02
June	17.8	84	114	113	0	0	0	0.20	3.57
July	20.5	69	133	130	0	0	0	0.20	3.66
August	19.5	78	117	103	0	0	0	0.20	3.67
September	15.0	100	76	76	0	0	0	0.20	3.57
October	8.4	89	37	37	1	0	1	0.17	3.00
November	2.4	98	8	8	22	9	23	0.10	1.75
December	-4.3	81	0	0	26	10	28	0.10	1.75
Annual	**6.8**	**965**	**594**	**578**	**186**	**74**	**202**	**1.72**	**2.58**

Clare (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-8.2	74	0	0	**22**	9	25	0.02	0.34
February	-7.0	59	0	0	26	11	30	0.02	0.34
March	-1.5	64	0	0	49	20	57	0.02	0.34
April	6.3	77	32	32	29	12	33	0.02	0.34
May	12.8	84	79	79	2	1	3	0.02	0.35
June	17.9	86	114	113	0	0	0	0.02	0.35
July	20.5	70	133	112	0	0	0	0.02	0.34
August	19.5	74	116	93	0	0	0	0.02	0.35
September	14.9	98	76	76	0	0	0	0.02	0.35
October	8.2	85	36	36	7	3	10	0.02	0.34
November	2.2	95	7	7	23	9	29	0.02	0.34
December	-4.6	80	0	0	25	10	29	0.02	0.34
Annual	**6.7**	**947**	**594**	**549**	**185**	**74**	**216**	**0.23**	**0.34**

Consecon (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-6.1	81	0	0	**25**	13	27	0.13	1.89
February	-4.9	67	0	0	31	17	34	0.13	1.89
March	-0.4	67	0	0	53	28	57	0.13	1.89
April	6.6	81	33	33	32	17	34	0.13	1.89
May	12.8	80	76	76	2	1	2	0.13	1.95
June	18.0	77	113	113	0	0	0	0.13	1.95
July	21.0	72	135	135	0	0	0	0.13	1.89
August	20.2	74	120	119	0	0	0	0.13	1.95
September	16.0	91	80	80	0	0	0	0.13	1.95
October	9.5	85	41	41	0	0	0	0.13	1.89
November	3.8	100	12	12	1	0	1	0.13	1.89
December	-2.3	89	0	0	26	14	27	0.13	1.89
Annual	**7.8**	**962**	**611**	**609**	**170**	**90**	**182**	**1.55**	**1.91**

Deloro (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-9.1	70	0	0	**19**	6	26	0.09	2.12
February	-7.7	56	0	0	23	7	32	0.09	2.12
March	-2.1	64	0	0	44	14	61	0.38	8.69
April	5.7	75	31	31	26	8	36	0.38	8.69
May	12.4	84	77	77	3	1	4	0.38	8.70
June	17.5	86	113	111	0	0	0	0.10	2.34
July	20.0	73	131	86	0	0	0	0.09	2.12
August	18.8	77	113	84	0	0	0	0.09	2.13
September	14.3	95	74	74	0	0	0	0.09	2.13
October	7.5	85	34	34	15	5	22	0.09	2.12
November	1.5	91	5	5	30	9	42	0.09	2.12
December	-5.4	77	0	0	22	7	30	0.09	2.12
Annual	**6.1**	**933**	**578**	**503**	**181**	**58**	**253**	**1.97**	**3.79**

Depot (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-8.5	75	0	0	23	7	25	0.02	0.47
February	-7.2	60	0	0	28	9	30	0.02	0.47
March	-1.7	64	0	0	51	16	55	0.02	0.47
April	6.1	78	32	32	31	10	34	0.02	0.47
May	12.7	86	78	78	4	1	4	0.02	0.47
June	17.7	86	113	113	0	0	0	0.02	0.48
July	20.3	71	132	128	0	0	0	0.02	0.48
August	19.4	78	116	93	0	0	0	0.02	0.48
September	14.8	100	75	75	0	0	0	0.02	0.48
October	8.2	88	36	36	1	0	2	0.02	0.47
November	2.1	96	7	7	29	9	31	0.02	0.47
December	-4.7	80	0	0	26	8	28	0.02	0.47
Annual	**6.6**	**964**	**590**	**563**	**191**	**62**	**210**	**0.26**	**0.47**

East Lake (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.5	85	0	0	27	14	28	0.11	1.51
February	-4.6	70	0	0	34	18	34	0.11	1.51
March	-0.3	69	0	0	56	30	58	0.11	1.51
April	6.4	81	31	31	34	18	35	0.15	2.03
May	12.3	79	74	74	3	2	3	0.17	2.34
June	17.4	76	110	109	0	0	0	0.17	2.34
July	20.6	73	133	133	0	0	0	0.17	2.27
August	20.2	74	120	115	0	0	0	0.17	2.34
September	16.1	90	81	81	0	0	0	0.17	2.34
October	9.8	86	43	43	0	0	0	0.17	2.27
November	4.2	102	14	14	3	2	3	0.13	1.75
December	-1.8	92	0	0	29	15	30	0.11	1.51
Annual	**7.9**	**885**	**606**	**600**	**157**	**84**	**161**	**1.63**	**1.98**

Foxboro (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-7.6	73	0	0	24	9	22	0.12	2.32
February	-6.3	60	0	0	30	11	28	0.12	2.33
March	-1.1	64	0	0	55	21	50	0.21	4.00
April	6.5	78	33	33	33	12	30	0.21	4.00
May	13.0	82	79	79	2	1	2	0.22	4.21
June	18.2	82	115	115	0	0	0	0.27	4.99
July	20.8	69	135	124	0	0	0	0.27	4.96
August	19.8	74	118	101	0	0	0	0.27	4.99
September	15.3	94	77	77	0	0	0	0.27	4.99
October	8.5	84	37	37	3	1	4	0.22	4.18
November	2.7	95	9	9	13	5	14	0.21	4.00
December	-3.9	81	0	0	28	11	26	0.12	2.32
	7.2	**937**	**602**	**574**	**188**	**71**	**176**	**2.53**	**3.94**

Hillier (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.7	79	0	0	23	12	27	0.09	1.45
February	-4.7	65	0	0	29	15	34	0.09	1.45
March	-0.2	66	0	0	50	26	59	0.09	1.45
April	6.6	80	33	33	30	16	36	0.09	1.45
May	12.7	79	76	76	2	1	2	0.10	1.55
June	17.9	77	113	113	0	0	0	0.10	1.55
July	20.9	72	135	135	0	0	0	0.09	1.45
August	20.2	74	120	119	0	0	0	0.10	1.55
September	16.1	90	80	80	0	0	0	0.10	1.55
October	9.6	84	42	42	0	0	0	0.09	1.45
November	3.9	99	13	13	0	0	0	0.09	1.45
December	-2.0	87	0	0	23	12	27	0.09	1.45
Annual	**7.9**	**954**	**611**	**610**	**157**	**83**	**186**	**1.11**	**1.48**

Lower Napanee (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-7.0	79	0	0	**24**	10	27	0.42	8.36
February	-5.8	64	0	0	30	12	33	0.42	8.36
March	-0.8	65	0	0	51	21	57	0.61	12.15
April	6.6	80	32	32	31	13	35	0.61	12.15
May	13.0	82	78	78	2	1	2	0.62	12.20
June	18.2	80	115	115	0	0	0	0.64	12.77
July	21.0	69	135	135	0	0	0	0.64	12.72
August	20.1	74	120	118	0	0	0	0.64	12.77
September	15.7	94	79	79	0	0	0	0.64	12.77
October	9.1	87	39	39	0	0	0	0.61	12.15
November	3.3	99	11	11	2	1	2	0.61	12.15
December	-3.1	86	0	0	26	11	29	0.61	12.15
Annual	**7.5**	**958**	**609**	**607**	**166**	**67**	**184**	**7.10**	**11.73**

Milford (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.9	87	0	0	28	15	28	0.07	0.89
February	-4.9	72	0	0	35	19	34	0.07	0.89
March	-0.5	70	0	0	58	31	57	0.07	0.89
April	6.3	82	31	31	35	18	34	0.07	0.89
May	12.3	80	74	74	3	2	3	0.07	0.91
June	17.4	76	110	110	0	0	0	0.07	0.91
July	20.6	73	133	132	0	0	0	0.07	0.89
August	20.1	74	120	116	0	0	0	0.07	0.91
September	16.0	90	81	81	0	0	0	0.07	0.91
October	9.7	87	42	42	0	0	0	0.07	0.89
November	4.0	103	13	13	4	2	4	0.07	0.89
December	-2.1	93	0	0	31	16	30	0.07	0.89
Annual	**7.7**	**987**	**604**	**599**	**194**	**102**	**191**	**0.07**	**0.90**

Moira (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-6.9	76	0	0	28	14	21	1.09	14.18
February	-5.6	63	0	0	35	18	27	1.09	14.18
March	-0.7	65	0	0	60	32	46	1.14	14.92
April	6.7	79	33	33	37	19	28	1.29	16.89
May	13.1	81	78	78	2	1	1	1.26	16.42
June	18.3	79	116	116	0	0	0	1.29	16.79
July	21.1	70	136	135	0	0	0	1.28	16.75
August	20.1	74	119	114	0	0	0	1.29	16.79
September	15.7	92	79	79	0	0	0	1.29	16.79
October	9.0	85	39	39	0	0	0	1.25	16.38
November	3.2	97	10	10	4	2	3	1.25	16.38
December	-3.1	85	0	0	29	15	22	1.10	14.41
Annual	**7.6**	**947**	**610**	**604**	**194**	**102**	**149**	**14.61**	**15.91**

North Marysburgh (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-6.3	85	0	0	26	14	29	0.04	0.58
February	-5.2	70	0	0	32	17	36	0.04	0.58
March	-0.6	68	0	0	53	28	60	0.04	0.58
April	6.3	80	31	31	32	17	36	0.04	0.58
May	12.5	79	75	75	2	1	2	0.04	0.60
June	17.6	75	111	111	0	0	0	0.04	0.60
July	20.7	70	134	132	0	0	0	0.04	0.58
August	20.2	74	120	116	0	0	0	0.04	0.60
September	16.0	90	80	80	0	0	0	0.04	0.60
October	9.6	86	42	42	1	0	1	0.04	0.58
November	3.9	101	13	13	3	1	3	0.04	0.58
December	-2.4	91	0	0	26	14	29	0.04	0.58
Annual	**7.7**	**970**	**606**	**599**	**174**	**92**	**194**	**0.49**	**0.59**

Parks (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-7.6	75	0	0	24	13	24	0.23	3.37
February	-6.3	61	0	0	30	16	29	0.23	3.37
March	-1.1	64	0	0	54	28	52	0.23	3.37
April	6.5	79	33	33	33	17	32	0.23	3.37
May	12.9	83	78	78	2	1	2	0.23	3.39
June	18.1	83	115	115	0	0	0	0.23	3.39
July	20.8	69	134	134	0	0	0	0.23	3.37
August	19.8	74	118	116	0	0	0	0.23	3.39
September	15.3	96	77	77	0	0	0	0.23	3.39
October	8.6	86	38	38	0	0	0	0.23	3.37
November	2.7	97	9	9	6	3	6	0.23	3.37
December	-3.9	83	0	0	28	15	27	0.23	3.37
Annual	**7.1**	**950**	**602**	**600**	**177**	**92**	**173**	**2.80**	**3.38**

Picton (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-6.1	87	0	0	27	15	28	1.73	22.79
February	-5.1	72	0	0	34	18	35	1.73	22.79
March	-0.5	69	0	0	56	30	58	1.73	22.79
April	6.4	82	32	32	34	18	35	1.73	22.79
May	12.5	81	75	75	3	2	3	1.73	22.82
June	17.6	77	111	111	0	0	0	1.73	22.82
July	20.7	73	134	131	0	0	0	1.73	22.79
August	20.1	74	120	116	0	0	0	1.73	22.82
September	15.9	91	80	80	0	0	0	1.73	22.82
October	9.6	87	42	42	0	0	0	1.73	22.79
November	3.8	104	13	13	4	2	3	1.73	22.79
December	-2.3	93	0	0	31	16	31	1.73	22.79
Annual	**7.7**	**990**	**606**	**599**	**190**	**101**	**195**	**20.72**	**22.80**

Salmon (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-6.7	79	0	0	22	9	29	0.38	8.37
February	-5.5	65	0	0	27	11	36	0.38	8.37
March	-0.6	65	0	0	46	19	62	0.38	8.37
April	6.7	80	33	33	28	12	38	0.38	8.37
May	13.0	81	78	78	1	1	2	0.38	8.39
June	18.3	78	115	115	0	0	0	0.38	8.39
July	21.1	69	136	136	0	0	0	0.38	8.37
August	20.3	73	120	120	0	0	0	0.38	8.39
September	15.9	92	79	79	0	0	0	0.38	8.39
October	9.2	85	40	40	0	0	0	0.38	8.37
November	3.4	99	11	11	0	0	0	0.38	8.37
December	-2.9	86	0	0	22	9	29	0.38	8.37
Annual	**7.7**	**954**	**613**	**612**	**145**	**60**	**196**	**4.56**	**8.37**

Shannonville (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-7.7	76	0	0	24	12	25	0.07	0.98
February	-6.4	61	0	0	29	15	30	0.07	0.98
March	-1.2	65	0	0	53	26	54	0.07	0.98
April	6.4	79	32	32	32	16	33	0.07	0.98
May	12.9	84	78	78	3	1	3	0.07	1.01
June	18.0	84	114	114	0	0	0	0.07	1.01
July	20.7	69	134	130	0	0	0	0.07	0.98
August	19.7	75	118	114	0	0	0	0.07	1.01
September	15.2	98	77	77	0	0	0	0.07	1.01
October	8.6	88	38	38	1	1	1	0.07	0.98
November	2.7	98	9	9	12	6	12	0.07	0.98
December	-3.9	83	0	0	27	14	28	0.07	0.98
Annual	**7.1**	**961**	**600**	**592**	**182**	**90**	**187**	**0.81**	**0.99**

Skootamatta (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-9.3	72	0	0	19	6	27	0.01	0.22
February	-7.9	57	0	0	23	7	32	0.01	0.22
March	-2.2	65	0	0	45	15	62	0.01	0.22
April	5.7	75	31	31	26	8	36	0.01	0.22
May	12.3	85	77	77	3	1	4	0.01	0.22
June	17.4	89	112	112	0	0	0	0.01	0.22
July	19.8	75	130	88	0	0	0	0.01	0.22
August	18.8	77	113	83	0	0	0	0.01	0.22
September	14.1	97	73	73	0	0	0	0.01	0.22
October	7.4	86	34	34	16	5	23	0.01	0.22
November	1.4	91	5	5	32	10	45	0.01	0.22
December	-5.6	77	0	0	22	7	30	0.01	0.22
Annual	**6.0**	**946**	**575**	**503**	**187**	**60**	**260**	**0.12**	**0.22**

Sophiasburgh (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-6.5	83	0	0	26	14	27	0.05	0.74
February	-5.3	68	0	0	33	17	34	0.05	0.74
March	-0.6	67	0	0	55	29	56	0.05	0.74
April	6.6	81	32	32	33	18	34	0.05	0.74
May	12.8	81	77	76	2	1	2	0.05	0.77
June	18.0	78	114	113	0	0	0	0.05	0.77
July	20.9	71	135	133	0	0	0	0.05	0.74
August	20.2	74	120	118	0	0	0	0.05	0.77
September	15.9	92	80	80	0	0	0	0.05	0.77
October	9.4	86	41	41	1	0	1	0.05	0.74
November	3.6	102	12	12	2	1	3	0.05	0.74
December	-2.7	90	0	0	29	15	29	0.05	0.74
Annual	**7.7**	**973**	**610**	**604**	**181**	**96**	**186**	**0.64**	**0.75**

South Marysburgh (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.5	85	0	0	28	15	27	0.02	0.31
February	-4.6	70	0	0	35	18	33	0.02	0.31
March	-0.2	69	0	0	59	31	56	0.02	0.31
April	6.3	80	31	31	35	18	33	0.02	0.31
May	12.2	79	73	73	3	2	3	0.02	0.32
June	17.3	75	109	109	0	0	0	0.02	0.32
July	20.6	72	133	131	0	0	0	0.02	0.31
August	20.2	74	120	114	0	0	0	0.02	0.32
September	16.1	89	81	81	0	0	0	0.02	0.32
October	9.9	85	44	44	0	0	0	0.02	0.31
November	4.3	101	15	15	3	1	3	0.02	0.31
December	-1.7	92	0	0	28	15	27	0.02	0.31
Annual	**7.9**	**972**	**605**	**598**	**191**	**100**	**181**	**0.28**	**0.31**

Tamworth (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-8.9	74	0	0	22	7	26	0.04	0.85
February	-7.7	58	0	0	26	8	30	0.04	0.85
March	-2.0	66	0	0	50	16	58	0.04	0.85
April	5.9	76	31	31	29	9	34	0.04	0.85
May	12.5	85	78	78	3	1	4	0.04	0.85
June	17.6	89	113	113	0	0	0	0.04	0.85
July	20.1	74	131	114	0	0	0	0.04	0.85
August	19.0	78	114	95	0	0	0	0.04	0.85
September	14.4	99	74	74	0	0	0	0.04	0.85
October	7.7	86	35	35	6	2	9	0.04	0.85
November	1.7	93	6	6	29	9	35	0.04	0.85
December	-5.3	79	0	0	24	8	29	0.04	0.85
Annual	**6.3**	**957**	**582**	**546**	**189**	**61**	**225**	**0.47**	**0.85**

Tweed (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-8.2	70	0	0	20	7	24	0.49	12.36
February	-6.8	57	0	0	25	8	30	0.49	12.36
March	-1.4	63	0	0	47	15	56	0.80	20.28
April	6.3	76	32	32	28	9	33	0.84	21.42
May	12.8	82	78	78	2	0	2	0.84	21.44
June	18.0	83	115	113	0	0	0	0.61	15.48
July	20.5	69	133	116	0	0	0	0.60	15.23
August	19.4	75	116	103	0	0	0	0.60	15.25
September	14.9	94	76	76	0	0	0	0.60	15.26
October	8.1	83	36	36	5	1	7	0.59	14.99
November	2.2	92	7	7	14	4	18	0.59	14.99
December	-4.5	78	0	0	24	8	29	0.49	12.36
Annual	**6.8**	**921**	**594**	**562**	**164**	**52**	**199**	**7.51**	**15.95**

Upper Napanee (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-7.5	77	0	0	24	10	25	0.13	2.39
February	-6.3	62	0	0	30	12	31	0.13	2.39
March	-1.1	64	0	0	52	21	54	0.13	2.39
April	6.4	80	32	32	33	13	34	0.13	2.39
May	12.8	84	78	78	3	1	3	0.13	2.42
June	18.0	82	114	114	0	0	0	0.13	2.42
July	20.7	68	134	134	0	0	0	0.13	2.39
August	19.8	76	118	117	0	0	0	0.13	2.42
September	15.4	98	77	77	0	0	0	0.13	2.42
October	8.8	89	38	38	0	0	0	0.13	2.39
November	2.9	99	10	10	9	4	10	0.13	2.39
December	-3.7	84	0	0	28	11	28	0.13	2.39
Annual	**7.2**	**963**	**601**	**600**	**179**	**72**	**184**	**1.56**	**2.40**

West Lake (1981 - 2010)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.8	84	0	0	26	14	27	0.15	2.12
February	-4.7	69	0	0	33	17	34	0.15	2.12
March	-0.3	68	0	0	55	29	58	0.15	2.12
April	6.5	81	32	32	33	18	35	0.15	2.12
May	12.5	80	75	75	2	1	3	0.16	2.20
June	17.7	77	111	111	0	0	0	0.16	2.20
July	20.8	73	134	134	0	0	0	0.15	2.12
August	20.2	74	120	113	0	0	0	0.16	2.20
September	16.1	90	81	81	0	0	0	0.16	2.20
October	9.7	86	42	42	0	0	0	0.15	2.12
November	4.0	102	13	13	3	2	3	0.15	2.12
December	-2.0	91	0	0	28	15	29	0.15	2.12
Annual	**7.9**	**974**	**609**	**601**	**181**	**96**	**189**	**1.85**	**2.15**

Ameliasburgh (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.22	69	0	0	31	17	37	0.09	1.76
February	-4.11	108	0	0	49	26	59	0.09	1.76
March	1.46	93	4	4	41	22	48	0.09	1.76
April	5.58	38	23	23	7	4	8	0.09	1.76
May	14.08	26	80	78	0	0	0	0.10	1.79
June	18.11	52	110	106	0	0	0	0.10	1.79
July	23.07	22	149	100	0	0	0	0.09	1.76
August	23.19	83	138	87	0	0	0	0.10	1.79
September	18.26	47	90	47	0	0	0	0.10	1.79
October	11.00	99	45	45	1	0	1	0.09	1.76
November	5.40	48	16	16	1	1	1	0.09	1.76
December	-1.31	76	0	0	5	2	5	0.09	1.76
Annual	**9.2**	**761**	**654**	**506**	**135**	**72**	**160**	**1.14**	**1.77**

Black (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.22	69	0	0	30	10	43	0.01	0.22
February	-4.11	108	0	0	41	13	59	0.01	0.22
March	1.46	93	4	4	49	16	69	0.01	0.22
April	5.58	38	23	23	10	3	14	0.01	0.22
May	14.08	26	80	78	0	0	0	0.01	0.22
June	18.11	52	110	106	0	0	0	0.01	0.22
July	23.07	22	149	100	0	0	0	0.01	0.22
August	23.19	83	138	87	0	0	0	0.01	0.22
September	18.26	47	90	47	0	0	0	0.01	0.22
October	11.00	99	45	45	13	4	19	0.01	0.22
November	5.40	48	16	16	8	3	12	0.01	0.22
December	-1.31	76	0	0	34	11	50	0.01	0.22
Annual	**9.2**	**761**	**654**	**506**	**185**	**59**	**266**	**0.12**	**0.22**

Camden (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.05	72	0	0	**34**	14	38	0.10	1.87
February	-4.94	116	0	0	55	22	61	0.10	1.87
March	1.08	95	3	3	44	17	48	0.10	1.87
April	4.82	40	21	21	9	4	10	0.10	1.87
May	14.06	30	82	81	0	0	0	0.17	3.21
June	18.02	72	111	110	0	0	0	0.20	3.81
July	21.95	24	141	75	0	0	0	0.20	3.91
August	22.63	80	135	90	0	0	0	0.20	3.92
September	17.62	49	87	50	0	0	0	0.20	3.81
October	10.36	133	43	43	1	0	1	0.17	3.20
November	4.82	44	15	15	4	2	4	0.10	1.87
December	-1.88	83	0	0	26	10	28	0.10	1.87
Annual	**8.6**	**839**	**637**	**486**	**174**	**70**	**191**	**1.72**	**2.76**

Clare (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.10	71	0	0	**33**	13	38	0.02	0.38
February	-5.02	111	0	0	52	21	59	0.02	0.38
March	1.08	94	3	3	42	17	49	0.02	0.38
April	4.93	40	21	21	9	3	10	0.02	0.38
May	14.07	30	82	73	0	0	0	0.02	0.38
June	17.89	61	110	94	0	0	0	0.02	0.38
July	21.99	30	141	55	0	0	0	0.02	0.38
August	22.58	67	134	70	0	0	0	0.02	0.38
September	17.54	49	87	49	0	0	0	0.02	0.38
October	10.17	107	42	42	6	2	8	0.02	0.38
November	4.69	38	14	14	3	1	4	0.02	0.38
December	-2.00	84	0	0	25	10	30	0.02	0.38
Annual	**8.6**	**781**	**636**	**423**	**169**	**67**	**198**	**0.23**	**0.38**

Consecon (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.10	74	0	0	**36**	19	39	0.13	2.20
February	-4.02	116	0	0	56	30	60	0.13	2.20
March	1.47	91	4	4	42	22	45	0.13	2.20
April	5.44	42	23	23	9	5	10	0.13	2.20
May	14.07	26	80	80	0	0	0	0.13	2.26
June	18.00	46	109	108	0	0	0	0.13	2.26
July	22.80	20	147	94	0	0	0	0.13	2.20
August	23.17	78	138	79	0	0	0	0.13	2.26
September	18.28	52	90	53	0	0	0	0.13	2.26
October	11.08	99	45	45	0	0	0	0.13	2.20
November	5.48	48	16	16	0	0	0	0.13	2.20
December	-1.23	76	0	0	3	2	3	0.13	2.20
Annual	**9.2**	**768**	**652**	**502**	**146**	**77**	**157**	**1.55**	**2.22**

Deloro (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.66	73	0	0	**31**	10	42	0.09	2.09
February	-5.49	99	0	0	41	13	57	0.09	2.09
March	0.75	125	2	2	51	16	71	0.38	8.57
April	4.32	42	19	19	9	3	13	0.38	8.57
May	14.05	26	83	57	0	0	0	0.38	8.57
June	17.70	65	110	74	0	0	0	0.10	2.31
July	21.52	43	138	56	0	0	0	0.09	2.09
August	22.21	47	132	52	0	0	0	0.09	2.10
September	17.12	69	85	68	0	0	0	0.09	2.10
October	9.66	103	40	41	13	4	18	0.09	2.09
November	4.25	34	13	13	6	2	9	0.09	2.09
December	-2.45	94	0	0	32	10	46	0.09	2.09
Annual	**8.2**	**818**	**624**	**383**	**184**	**59**	**258**	**1.97**	**3.73**

Depot (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.2	71	0	0	33	11	37	0.02	0.47
February	-5.2	114	0	0	54	17	60	0.02	0.47
March	1.0	99	3	3	46	15	51	0.02	0.47
April	4.7	42	20	20	10	3	12	0.02	0.47
May	14.1	37	82	80	0	0	0	0.02	0.48
June	17.9	67	111	107	0	0	0	0.02	0.49
July	21.8	29	140	51	0	0	0	0.02	0.48
August	22.5	74	134	80	0	0	0	0.02	0.49
September	17.5	49	86	49	0	0	0	0.02	0.49
October	10.2	132	42	42	2	1	3	0.02	0.47
November	4.6	45	14	14	8	3	9	0.02	0.47
December	-2.1	84	0	0	36	12	39	0.02	0.47
Annual	**8.5**	**843**	**633**	**447**	**189**	**61**	**211**	**0.26**	**0.48**

East Lake (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-3.8	74	0	0	35	19	39	0.11	1.79
February	-3.8	131	0	0	62	33	68	0.11	1.79
March	1.5	81	5	5	36	19	40	0.11	1.79
April	5.0	45	21	21	11	6	12	0.15	2.41
May	14.1	28	81	81	0	0	0	0.17	2.78
June	17.7	41	107	105	0	0	0	0.17	2.78
July	22.2	12	142	50	0	0	0	0.17	2.70
August	23.1	71	138	69	0	0	0	0.17	2.78
September	18.4	53	91	54	0	0	0	0.17	2.78
October	11.3	114	46	46	0	0	0	0.17	2.70
November	5.7	44	17	17	0	0	0	0.13	2.08
December	-1.0	79	0	0	12	6	12	0.11	1.79
Annual	9.2	**773**	**648**	**448**	**156**	**83**	**171**	**1.74**	**2.35**

Foxboro (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.8	69	0	0	36	14	33	0.12	2.88
February	-4.7	108	0	0	57	21	52	0.12	2.88
March	1.2	78	4	4	39	15	36	0.21	4.95
April	5.3	31	23	23	4	2	4	0.21	4.95
May	14.1	23	81	76	0	0	0	0.22	5.21
June	18.0	61	110	100	0	0	0	0.27	6.18
July	22.6	26	145	63	0	0	0	0.27	6.14
August	22.8	54	136	57	0	0	0	0.27	6.18
September	17.8	42	88	42	0	0	0	0.27	6.17
October	10.5	90	43	43	2	1	3	0.22	5.17
November	5.0	35	15	15	1	1	2	0.21	4.95
December	-1.8	83	0	0	13	5	14	0.12	2.88
Annual	**8.8**	**699**	**644**	**423**	**153**	**58**	**144**	**2.53**	**4.88**

Hillier (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-3.9	72	0	0	34	18	38	0.09	1.68
February	-3.9	115	0	0	54	28	61	0.09	1.68
March	1.5	87	5	5	39	20	44	0.09	1.68
April	5.5	39	23	23	8	4	9	0.09	1.68
May	14.1	26	80	80	0	0	0	0.10	1.80
June	17.9	47	109	108	0	0	0	0.10	1.80
July	22.7	20	146	107	0	0	0	0.09	1.68
August	23.2	77	138	79	0	0	0	0.10	1.80
September	18.3	49	90	50	0	0	0	0.10	1.80
October	11.2	100	45	45	0	0	0	0.09	1.68
November	5.6	47	17	17	0	0	0	0.09	1.68
December	-1.1	77	0	0	1	0	1	0.09	1.68
Annual	**9.2**	**757**	**652**	**513**	**135**	**72**	**153**	**1.11**	**1.72**

Lower Napanee (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.5	70	0	0	**33**	13	37	0.42	9.92
February	-4.4	115	0	0	55	22	60	0.42	9.92
March	1.3	87	4	4	40	16	44	0.61	14.41
April	5.4	38	22	22	7	3	8	0.61	14.41
May	14.1	26	81	80	0	0	0	0.62	14.46
June	18.1	58	110	110	0	0	0	0.64	15.14
July	22.9	18	147	111	0	0	0	0.64	15.08
August	23.1	73	138	80	0	0	0	0.64	15.14
September	18.1	51	89	51	0	0	0	0.64	15.14
October	10.9	114	44	44	0	0	0	0.61	14.41
November	5.2	41	16	16	0	0	0	0.61	14.41
December	-1.5	79	0	0	6	2	6	0.61	14.41
Annual	**9.0**	**769**	**650**	**519**	**141**	**57**	**154**	**7.10**	**13.90**

Milford (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.0	72	0	0	35	19	37	0.07	1.09
February	-4.0	124	0	0	60	32	63	0.07	1.09
March	1.4	82	4	4	38	20	40	0.07	1.09
April	4.9	45	20	20	12	6	12	0.07	1.09
May	14.1	28	81	80	0	0	0	0.07	1.12
June	17.7	40	108	105	0	0	0	0.07	1.12
July	22.2	10	142	52	0	0	0	0.07	1.09
August	23.1	58	138	59	0	0	0	0.07	1.12
September	18.3	59	90	59	0	0	0	0.07	1.12
October	11.2	118	46	46	1	0	1	0.07	1.09
November	5.6	40	17	17	0	0	0	0.07	1.09
December	-1.2	78	0	0	11	6	12	0.07	1.09
Annual	**9.1**	**753**	**646**	**442**	**157**	**83**	**165**	**0.07**	**1.10**

Moira (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.5	66	0	0	38	20	29	1.09	17.47
February	-4.4	107	0	0	61	32	46	1.09	17.47
March	1.4	88	4	4	47	25	36	1.14	18.38
April	5.5	35	23	23	7	3	5	1.29	20.81
May	14.1	25	80	80	0	0	0	1.26	20.23
June	18.1	55	110	109	0	0	0	1.29	20.69
July	23.1	21	149	98	0	0	0	1.28	20.64
August	23.1	75	137	78	0	0	0	1.29	20.69
September	18.1	44	89	44	0	0	0	1.29	20.69
October	10.8	98	44	44	0	0	0	1.25	20.18
November	5.2	42	15	15	0	0	0	1.25	20.18
December	-1.5	78	0	0	5	3	4	1.10	17.76
Annual	**9.1**	**731**	**652**	**496**	**157**	**83**	**119**	**14.61**	**19.60**

North Marysburgh (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.2	69	0	0	32	17	37	0.04	0.73
February	-4.2	118	0	0	54	29	64	0.04	0.73
March	1.4	84	4	4	37	20	43	0.04	0.73
April	5.0	40	21	21	9	5	10	0.04	0.73
May	14.1	26	80	80	0	0	0	0.04	0.75
June	17.8	49	108	107	0	0	0	0.04	0.75
July	22.4	15	144	95	0	0	0	0.04	0.73
August	23.2	76	138	80	0	0	0	0.04	0.75
September	18.3	55	90	55	0	0	0	0.04	0.75
October	11.2	118	46	46	0	0	0	0.04	0.73
November	5.5	42	17	17	0	0	0	0.04	0.73
December	-1.3	76	0	0	4	3	4	0.04	0.73
Annual	**9.1**	**769**	**648**	**505**	**136**	**74**	**159**	**0.49**	**0.73**

Parks (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.8	70	0	0	36	19	34	0.23	3.97
February	-4.7	111	0	0	58	30	54	0.23	3.97
March	1.2	85	4	4	42	22	39	0.23	3.97
April	5.2	35	22	22	7	4	6	0.23	3.97
May	14.1	26	81	81	0	0	0	0.23	3.99
June	18.0	61	110	110	0	0	0	0.23	3.99
July	22.5	22	144	76	0	0	0	0.23	3.97
August	22.8	62	136	64	0	0	0	0.23	3.99
September	17.8	46	88	46	0	0	0	0.23	3.99
October	10.5	101	43	43	0	0	0	0.23	3.97
November	5.0	38	15	15	0	0	0	0.23	3.97
December	-1.7	83	0	0	7	4	6	0.23	3.97
Annual	**8.8**	**739**	**643**	**461**	**150**	**78**	**139**	**2.80**	**3.98**

Picton (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.1	72	0	0	37	20	35	1.73	27.13
February	-4.1	120	0	0	62	33	58	1.73	27.13
March	1.4	85	4	4	42	22	39	1.73	27.13
April	5.1	43	21	21	11	6	10	1.73	27.13
May	14.1	27	81	79	0	0	0	1.73	27.16
June	17.9	31	109	104	0	0	0	1.73	27.16
July	22.4	15	143	52	0	0	0	1.73	27.13
August	23.1	81	138	81	0	0	0	1.73	27.16
September	18.3	70	90	69	0	0	0	1.73	27.16
October	11.1	116	46	46	1	0	1	1.73	27.13
November	5.5	37	17	17	0	0	0	1.73	27.13
December	-1.2	77	0	0	9	4	8	1.73	27.13
Annual	**9.1**	**773**	**648**	**473**	**161**	**85**	**152**	**20.72**	**27.14**

Salmon (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.4	69	0	0	32	13	38	0.38	9.22
February	-4.3	112	0	0	51	22	61	0.38	9.22
March	1.4	88	4	4	38	16	45	0.38	9.22
April	5.6	37	23	23	6	3	8	0.38	9.22
May	14.1	25	80	80	0	0	0	0.38	9.24
June	18.1	52	110	110	0	0	0	0.38	9.24
July	23.2	19	149	98	0	0	0	0.38	9.22
August	23.2	74	138	77	0	0	0	0.38	9.24
September	18.2	48	89	48	0	0	0	0.38	9.24
October	10.9	101	44	44	0	0	0	0.38	9.22
November	5.3	42	16	16	0	0	0	0.38	9.22
December	-1.4	78	0	0	3	1	3	0.38	9.22
Annual	**9.2**	**745**	**654**	**501**	**130**	**55**	**154**	**4.56**	**9.23**

Shannonville (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.8	72	0	0	35	18	36	0.07	1.14
February	-4.7	114	0	0	56	28	58	0.07	1.14
March	1.2	89	4	4	42	21	43	0.07	1.14
April	5.1	39	22	22	9	4	9	0.07	1.14
May	14.1	27	81	80	0	0	0	0.07	1.16
June	18.0	58	111	107	0	0	0	0.07	1.16
July	22.3	18	143	72	0	0	0	0.07	1.14
August	22.8	68	136	71	0	0	0	0.07	1.16
September	17.8	47	88	47	0	0	0	0.07	1.16
October	10.5	113	43	43	1	1	2	0.07	1.14
November	5.0	40	15	15	1	0	1	0.07	1.14
December	-1.7	81	0	0	13	7	14	0.07	1.14
Annual	**8.8**	**766**	**642**	**460**	**158**	**78**	**163**	**0.81**	**1.15**

Skootamatta (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.8	71	0	0	30	10	41	0.01	0.23
February	-5.7	104	0	0	44	14	60	0.01	0.23
March	0.6	114	2	2	48	15	65	0.01	0.23
April	4.3	43	19	19	10	3	14	0.01	0.23
May	14.1	31	83	62	0	0	0	0.01	0.23
June	17.7	60	110	71	0	0	0	0.01	0.23
July	21.5	53	138	60	0	0	0	0.01	0.23
August	22.2	84	132	88	0	0	0	0.01	0.23
September	17.0	64	85	65	0	0	0	0.01	0.23
October	9.6	100	40	40	11	4	16	0.01	0.23
November	4.2	38	13	13	8	3	12	0.01	0.23
December	-2.7	92	0	0	34	11	47	0.01	0.23
Annual	**8.1**	**854**	**622**	**420**	**185**	**59**	**254**	**0.12**	**0.23**

Sophiasburgh (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.3	72	0	0	35	18	37	0.05	0.91
February	-4.2	116	0	0	56	30	60	0.05	0.91
March	1.4	88	4	4	41	22	43	0.05	0.91
April	5.3	41	22	22	9	5	9	0.05	0.91
May	14.1	26	80	79	0	0	0	0.05	0.94
June	18.1	46	110	108	0	0	0	0.05	0.94
July	22.8	18	146	90	0	0	0	0.05	0.91
August	23.2	76	138	78	0	0	0	0.05	0.94
September	18.2	54	90	54	0	0	0	0.05	0.94
October	11.0	105	45	45	1	0	1	0.05	0.91
November	5.4	43	16	16	0	0	0	0.05	0.91
December	-1.4	76	0	0	5	2	5	0.05	0.91
Annual	**9.1**	**763**	**651**	**496**	**147**	**78**	**155**	**0.64**	**0.92**

South Marysburgh (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-3.8	72	0	0	37	20	35	0.02	0.34
February	-3.8	132	0	0	68	36	65	0.02	0.34
March	1.5	80	5	5	38	20	37	0.02	0.34
April	5.0	44	20	21	12	6	12	0.02	0.34
May	14.1	28	81	80	0	0	0	0.02	0.36
June	17.6	45	107	104	0	0	0	0.02	0.36
July	22.1	11	141	51	0	0	0	0.02	0.34
August	23.2	66	138	64	0	0	0	0.02	0.36
September	18.4	49	91	49	0	0	0	0.02	0.36
October	11.4	116	47	47	0	0	0	0.02	0.34
November	5.8	45	18	18	0	0	0	0.02	0.34
December	-1.0	79	0	0	15	8	15	0.02	0.34
Annual	**9.2**	**766**	**647**	**437**	**170**	**90**	**163**	**0.28**	**0.34**

Tamworth (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.5	71	0	0	33	11	38	0.04	0.88
February	-5.5	108	0	0	50	16	58	0.04	0.88
March	0.8	107	3	3	48	15	56	0.04	0.88
April	4.5	44	20	20	11	4	13	0.04	0.88
May	14.1	32	83	75	0	0	0	0.04	0.88
June	17.8	56	110	92	0	0	0	0.04	0.88
July	21.6	45	139	57	0	0	0	0.04	0.88
August	22.3	87	133	91	0	0	0	0.04	0.88
September	17.2	59	85	60	0	0	0	0.04	0.88
October	9.8	110	41	41	5	2	8	0.04	0.88
November	4.4	39	14	14	3	1	5	0.04	0.88
December	-2.4	87	0	0	33	11	39	0.04	0.88
Annual	**8.3**	**845**	**627**	**451**	**182**	**59**	**217**	**0.47**	**0.88**

Tweed (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-5.1	70	0	0	32	10	38	0.49	14.14
February	-4.9	105	0	0	48	15	58	0.49	14.14
March	1.1	96	3	3	42	13	51	0.80	23.21
April	5.0	33	21	22	5	2	7	0.84	24.51
May	14.1	25	82	74	0	0	0	0.84	24.54
June	17.8	72	110	101	0	0	0	0.61	17.72
July	22.1	36	142	82	0	0	0	0.60	17.43
August	22.6	49	134	56	0	0	0	0.60	17.46
September	17.6	45	87	45	0	0	0	0.60	17.46
October	10.1	90	42	42	3	1	4	0.59	17.16
November	4.7	36	14	14	2	1	3	0.59	17.15
December	-2.0	86	0	0	12	4	16	0.49	14.14
Annual	**8.6**	**743**	**636**	**440**	**143**	**46**	**176**	**7.51**	**18.25**

Upper Napanee (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-4.8	73	0	0	36	14	37	0.13	2.60
February	-4.7	116	0	0	58	23	59	0.13	2.60
March	1.2	92	4	4	44	18	45	0.13	2.60
April	5.1	37	21	22	8	3	8	0.13	2.60
May	14.1	23	81	81	0	0	0	0.13	2.64
June	18.1	69	111	111	0	0	0	0.13	2.64
July	22.3	19	143	81	0	0	0	0.13	2.60
August	22.9	75	136	80	0	0	0	0.13	2.64
September	17.9	52	88	52	0	0	0	0.13	2.64
October	10.6	130	44	44	0	0	0	0.13	2.60
November	5.1	44	15	15	0	0	0	0.13	2.60
December	-1.7	80	0	0	20	8	20	0.13	2.60
Annual	**8.8**	**813**	**644**	**489**	**165**	**66**	**168**	**1.56**	**2.61**

West Lake (2016)

Month	Avg Temp (°C)	Precip (mm)	APE (mm)	AE (mm)	Infiltration (mm)	Recharge (mm)	Runoff (mm)	Demand (mm)	% Demand
January	-3.9	75	0	0	37	19	38	0.15	2.47
February	-3.9	122	0	0	60	32	63	0.15	2.47
March	1.5	87	4	4	40	21	43	0.15	2.47
April	5.3	44	22	22	11	6	11	0.15	2.47
May	14.1	27	80	80	0	0	0	0.16	2.57
June	17.9	41	109	105	0	0	0	0.16	2.57
July	22.5	16	144	86	0	0	0	0.15	2.47
August	23.2	76	138	77	0	0	0	0.16	2.57
September	18.3	57	90	58	0	0	0	0.16	2.57
October	11.2	106	46	46	0	0	0	0.15	2.47
November	5.6	45	17	17	0	0	0	0.15	2.47
December	-1.1	76	0	0	7	4	7	0.15	2.47
Annual	**9.2**	**774**	**651**	**495**	**155**	**82**	**162**	**1.85**	**2.50**

APPENDIX D

Surface Water Stress Evaluation

Surface Water Potential Stress: Permitted Takings (1981 - 2010)

Catchment	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Moira River												
Deloro	2%	3%	1%	1%	1%	4%	11%	**28%**	**29%**	7%	2%	2%
Black	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Skootamatta	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tweed	2%	8%	1%	1%	2%	9%	11%	**27%**	**21%**	15%	6%	4%
Clare	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Parks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Foxboro	0%	0%	0%	0%	0%	0%	1%	3%	2%	1%	0%	0%
Lower Moira	0%	0%	0%	0%	0%	1%	1%	5%	3%	1%	0%	0%
Salmon River												
Tamworth	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Shannonville	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Lower Salmon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Napanee River												
Depot	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Camden	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%
Upper Napanee	1%	1%	0%	0%	0%	1%	4%	5%	4%	3%	1%	1%
Lower Napanee	4%	5%	2%	1%	4%	9%	**33%**	**40%**	**36%**	**27%**	10%	5%
Prince Edward County												
Ameliasburgh	0%	0%	0%	0%	0%	3%	**23%**	**376%**	**133%**	17%	0%	0%
Sophiasburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Consecon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Hiller	0%	0%	0%	0%	1%	3%	**30%**	**124%**	**175%**	**22%**	0%	0%
West Lake	0%	0%	0%	0%	0%	1%	8%	**34%**	**48%**	6%	0%	0%
Picton	5%	9%	3%	4%	8%	**27%**	**241%**	**1000%**	**1419%**	**181%**	8%	7%
East Lake	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Black Creek	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
North Marysburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
South Marysburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Surface Water Potential Stress: Actual Takings (1981 - 2010)

Catchment	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Moira River												
Deloro	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Black	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Skootamatta	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tweed	0%	1%	0%	0%	0%	1%	1%	2%	2%	1%	1%	0%
Clare	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Parks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Foxboro	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Lower Moira	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Salmon River												
Tamworth	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Shannonville	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Lower Salmon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Napanee River												
Depot	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Camden	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%
Upper Napanee	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	0%
Lower Napanee	0%	0%	0%	0%	1%	1%	6%	7%	6%	5%	1%	0%
Prince Edward County												
Ameliasburgh	0%	0%	0%	0%	0%	0%	6%	**41%**	9%	1%	0%	0%
Sophiasburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Consecon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Hiller	0%	0%	0%	0%	0%	2%	8%	13%	0%	0%	0%	0%
West Lake	0%	0%	0%	0%	0%	1%	8%	**34%**	**44%**	6%	0%	0%
Picton	1%	2%	0%	1%	2%	5%	**25%**	**26%**	**57%**	8%	0%	1%
East Lake	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Black Creek	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
North Marysburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
South Marysburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Surface Water Potential Stress: Permitted Takings (2016)

Catchment	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Moira River												
Deloro	1%	1%	0%	0%	3%	**31%**	**152%**	**84%**	**59%**	6%	4%	1%
Black	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Skootamatta	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tweed	1%	1%	1%	1%	4%	**20%**	**65%**	**65%**	**101%**	**40%**	16%	3%
Clare	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Parks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Foxboro	0%	0%	0%	0%	0%	1%	4%	10%	12%	3%	0%	0%
Lower Moira	0%	0%	0%	0%	0%	1%	6%	14%	18%	4%	2%	0%
Salmon River												
Tamworth	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Shannonville	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Lower Salmon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Napanee River												
Depot	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Camden	0%	0%	0%	0%	0%	0%	1%	2%	2%	1%	0%	0%
Upper Napanee	0%	0%	0%	0%	1%	2%	4%	6%	7%	2%	2%	1%
Lower Napanee	1%	1%	1%	1%	4%	14%	**34%**	**52%**	**63%**	18%	15%	5%
Prince Edward County												
Ameliasburgh	0%	0%	0%	0%	1%	18%	**>100%**	**>100%**	**>100%**	**>100%**	**42%**	1%
Sophiasburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Consecon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Hiller	0%	0%	0%	0%	4%	**24%**	**>100%**	**>100%**	**>100%**	**481%**	0%	0%
West Lake	0%	0%	0%	0%	1%	6%	**>100%**	**>100%**	**>100%**	**131%**	**34%**	1%
Picton	4%	2%	2%	3%	**28%**	**191%**	**>100%**	**>100%**	**>100%**	**3890%**	**1005%**	17%
East Lake	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Black Creek	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
North Marysburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
South Marysburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Surface Water Potential Stress: Actual Takings (2016)

Catchment	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Moira River												
Deloro	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Black	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Skootamatta	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Tweed	0%	0%	0%	0%	1%	3%	7%	6%	9%	3%	2%	0%
Clare	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Parks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Foxboro	0%	0%	0%	0%	0%	0%	2%	1%	2%	0%	0%	0%
Lower Moira	0%	0%	0%	0%	0%	0%	0%	1%	2%	1%	0%	0%
Salmon River												
Tamworth	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Shannonville	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Lower Salmon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Napanee River												
Depot	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Camden	0%	0%	0%	0%	0%	0%	1%	2%	2%	1%	0%	0%
Upper Napanee	0%	0%	0%	0%	0%	0%	1%	2%	2%	1%	0%	0%
Lower Napanee	0%	0%	0%	0%	1%	2%	6%	9%	11%	3%	2%	0%
Prince Edward County												
Ameliasburgh	0%	0%	0%	0%	0%	1%	**>100%**	**>100%**	**>100%**	**27%**	7%	0%
Sophiasburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Consecon	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Hiller	0%	0%	0%	0%	1%	13%	**>100%**	**>100%**	**>100%**	0%	0%	0%
West Lake	0%	0%	0%	0%	1%	6%	**>100%**	**>100%**	**>100%**	**131%**	**34%**	1%
Picton	1%	0%	0%	1%	7%	**35%**	**>100%**	**>100%**	**>100%**	**180%**	**64%**	2%
East Lake	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Black Creek	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
North Marysburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
South Marysburgh	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%