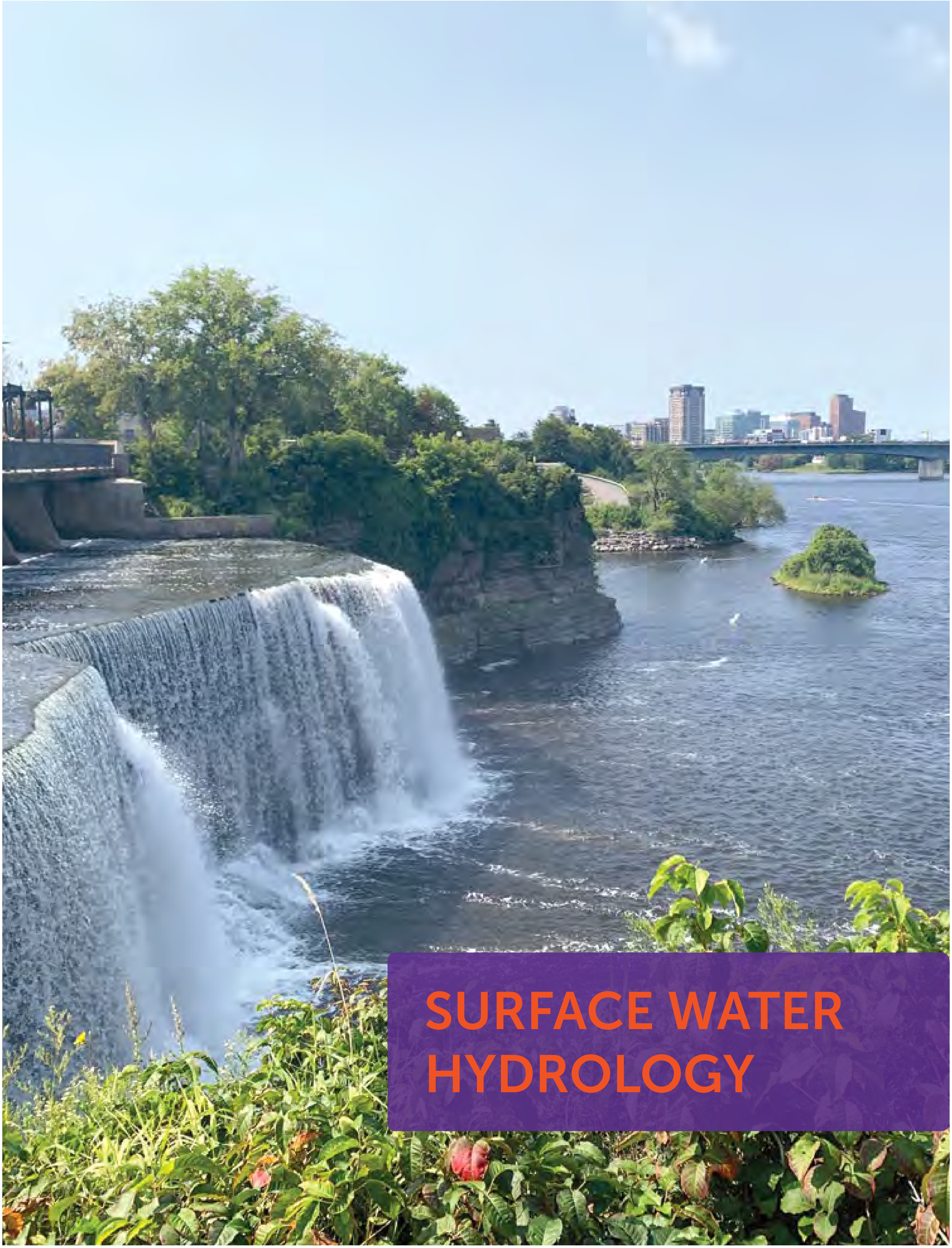
Watershed Conditions:

Water



SURFACE WATER HYDROLOGY

Our surface water hydrologic system encompasses all water found in our lakes, rivers and wetlands – basically any water that exists above ground. It's intricately connected to the larger hydrologic system including the atmosphere, land, and groundwater systems that continuously cycle our water.

▲ Neighbourhoods along the Ottawa River experienced historic flooding in 2017 and 2019.

It's not a static system, and the Rideau River Watershed's surface water hydrology is under increasing pressure from a host of changes occurring across the watershed, including increased development, loss of natural land cover, and a changing climate. Impacts are already noticeable: analysis of our long-term data suggests a departure from normal climate baselines as well as an increase in the frequency and severity of droughts.

In the past decade there has been more volatility in average temperatures, storms and peak flows in general, as well as higher risk of drought in the warmer seasons. At the same time, preliminary analysis suggests average annual flows are on the rise – a symptom of historic and ongoing wetland storage loss and hardening of surfaces in developed areas. Increasing flow conveyance is not only contributing to the increase in low water events in the driest months (as water moves more quickly through the system, leaving less in reserve), but could also put communities at higher risk of flooding as there is reduced room in our waterways to hold back major storm events.

Indeed, the region experienced historic floods along the Ottawa River in 2017 and 2019, with 2019's catastrophic flooding approaching 1-in-100 year levels. Four years later, moderate high water (reaching the 25-year flood level in some areas) once again threatened Ottawa River properties.

The potential consequences of such trends is still unclear. But if they continue we could see long-lasting and potentially permanent impacts on the watershed and all who live here. It is critical that we understand the baseline hydrologic conditions of our region as a means of tracking change. In the immediate sense, this helps us more accurately predict and respond to extreme flood and low water events for the protection of people and property. In the long term, tracking our local climate conditions, water levels and the frequency of flood and drought conditions can reveal patterns that will help us develop and implement new strategies to continue to protect our watershed resources into the future.

Ideal conditions

Floods and droughts are driven by weather and climate conditions and are largely out of human control. However, when natural features like wetlands and headwaters are preserved, watersheds are more capable of reducing the extent, severity and duration of these events.

Ideal surface water hydrology conditions protect natural landscapes and allow them to do their work within the ebb and flow of the watershed.

The best way to do this is to give our lakes and rivers the space they need to expand and contract naturally. This means directing development away from floodplains and wetlands where excess water is most likely to go. We can also soak up excess stormwater – and store it for dry periods – by protecting green infrastructure like wetlands, forests and natural shorelines. Wetlands especially act as natural stormwater management systems, absorbing excess water and slowly releasing it over time. Forests and shorelines, meanwhile, reduce runoff by slowing and removing stormwater before it can swell our lakes and rivers. The ideal surface water hydrology conditions protect these natural landscapes and allow them to do their work within the ebb and flow of the watershed – as they have done for thousands of years.


▲ Flooding on the Ottawa River near Britannia Beach.

But as the climate changes, our natural infrastructure may not be enough. Ideally we will also continue to protect communities by using climate and weather data, water level gauges and other monitoring tools to help us accurately predict floods and droughts with enough time for residents to react. Being prepared also means using long-term data to plan and prepare for changes to the watershed as a result of climate change, and to alter the RVCA's development and watershed management policies to continue to direct people and property out of flood-vulnerable areas.

How do we measure it?

RVCA routinely monitors climate conditions and flow characteristics. Temperature, precipitation and evapotranspiration are the primary drivers of the surface water hydrologic cycle, and are key to understanding regional climate conditions. Real-time water levels and streamflows can help us predict the severity of potential floods and droughts.

The RVCA uses stream gauges, weather stations, snowpack surveys, meteorological forecasts and computer models to predict and prepare for floods and droughts, track long-term hydrometric trends and assess for local climate change impacts.

Climate data is collected from a network of local weather monitoring stations across the watershed. Most are operated by the RVCA, while others are maintained by the Meteorological Services division of Environment and Climate Change Canada (ECCC) (Figure 2.1).

▲ One of RVCA's 11 weather stations installed across the watershed.

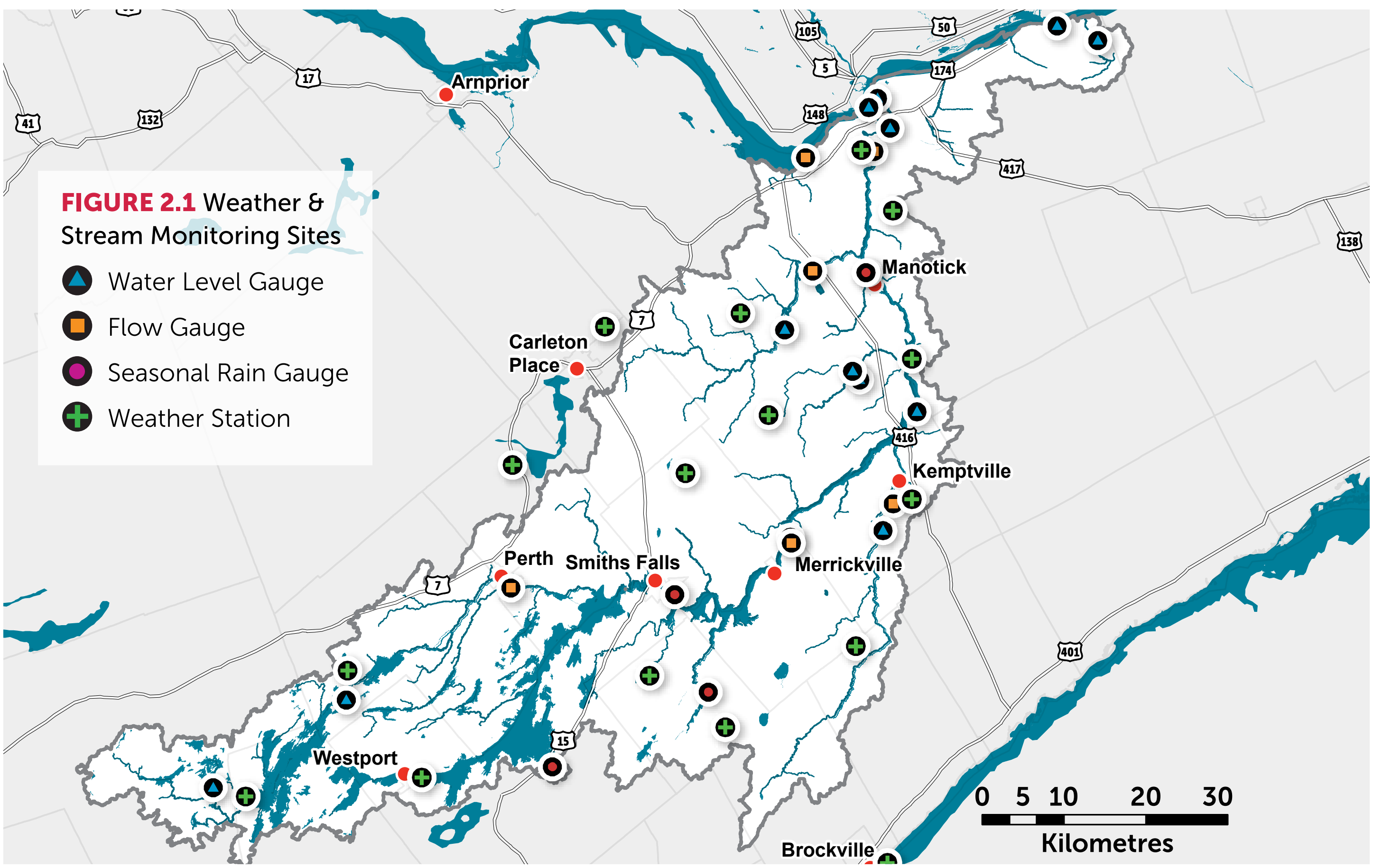
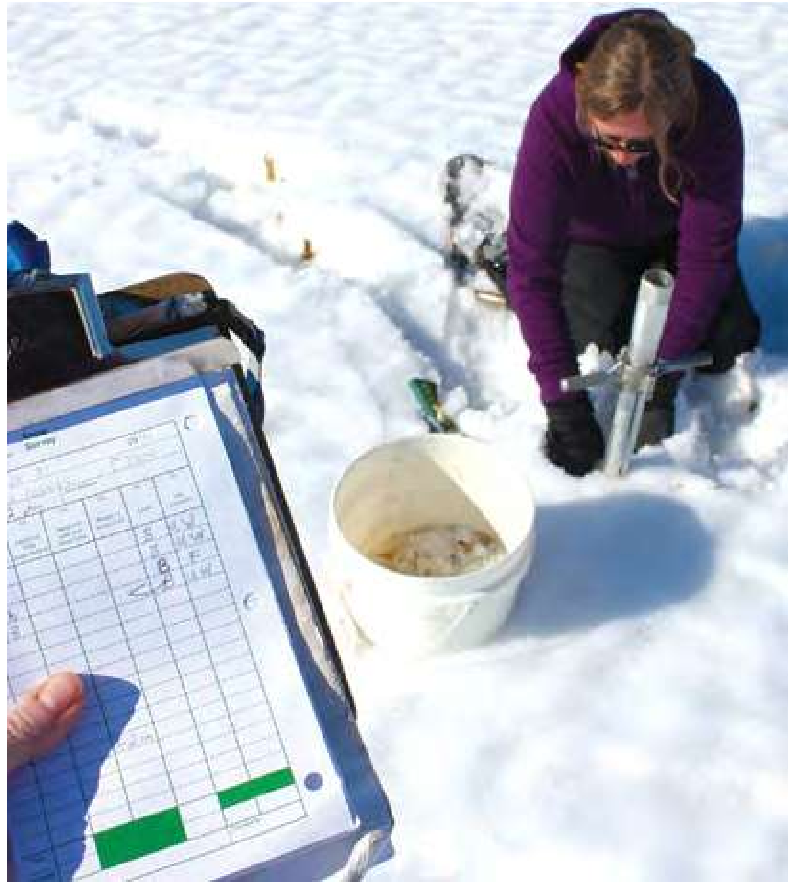


FIGURE 2.1 Weather & Stream Monitoring Sites

Many of the ECCC stations have been in operation for upwards of 80 years and are used in the determination of regional climate normals. The RVCA and its partners also maintain a widespread complementary network of real-time water level and stream flow monitoring stations (Figure 2.1). Additionally, the RVCA conducts biweekly snow surveys during the winter months to predict spring runoff volumes and subsequent flood risk (Figure 2.2).

The RVCA primarily utilizes this information for flood forecasting purposes, but it is also used for low flow/drought monitoring, floodplain mapping and hydrological/hydraulic modelling.



Staff routinely monitor the snow pack to determine how much water it holds - and how that could contribute to flood conditions when it melts in the spring.

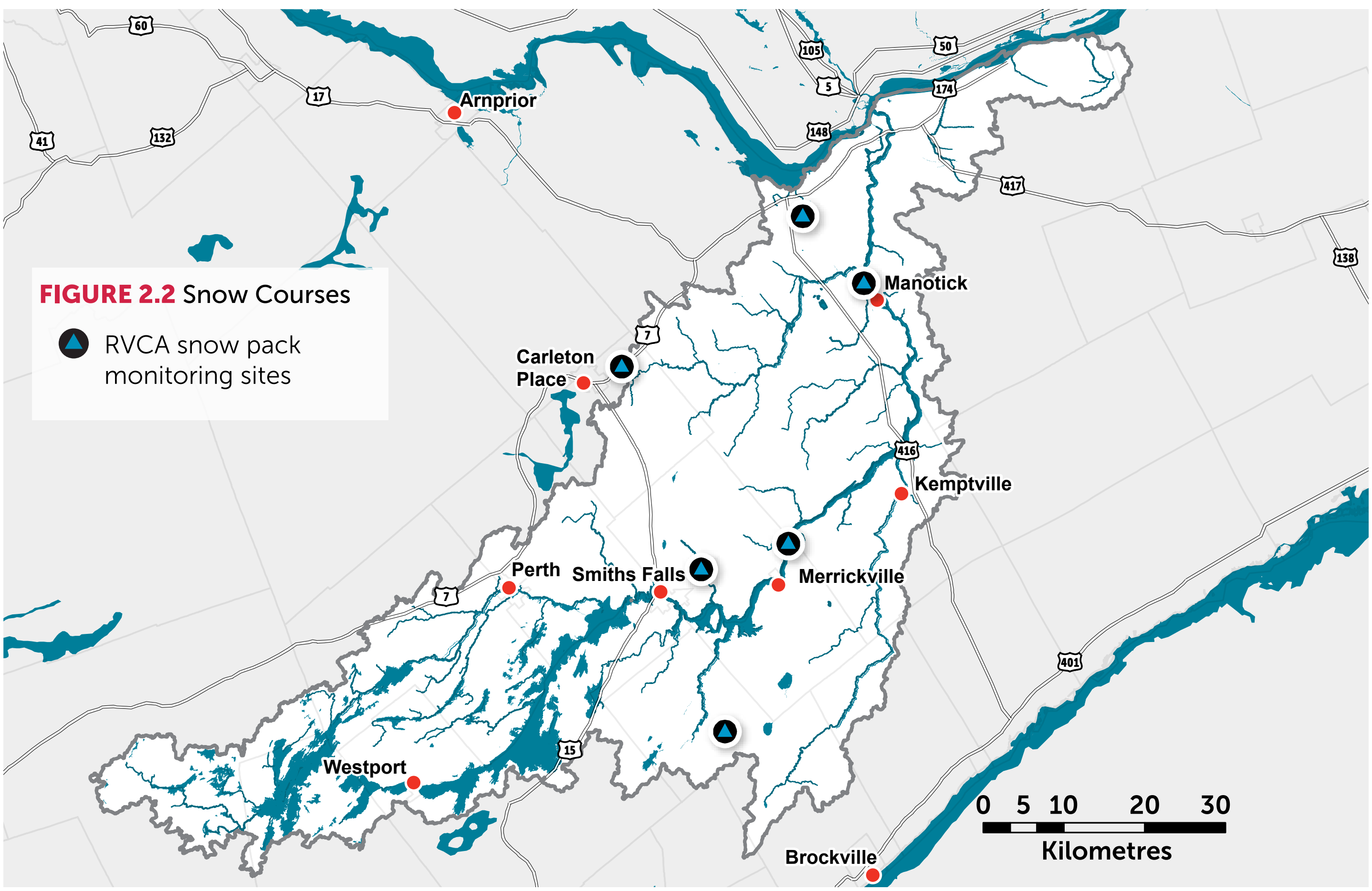


FIGURE 2.2 Snow Courses

WATERSHED HYDROLOGY

The Rideau River Watershed is approximately 4,000 km^2 in size[1]. It starts upstream at Burridge Lake in South Frontenac and flows downstream until it plunges over Rideau Falls in downtown Ottawa.

The RVCA's jurisdiction can be divided into five regions: the Upper Rideau, Middle Rideau, Lower Rideau, Ottawa River East & Ottawa River West, which are further subdivided into several subwatersheds.

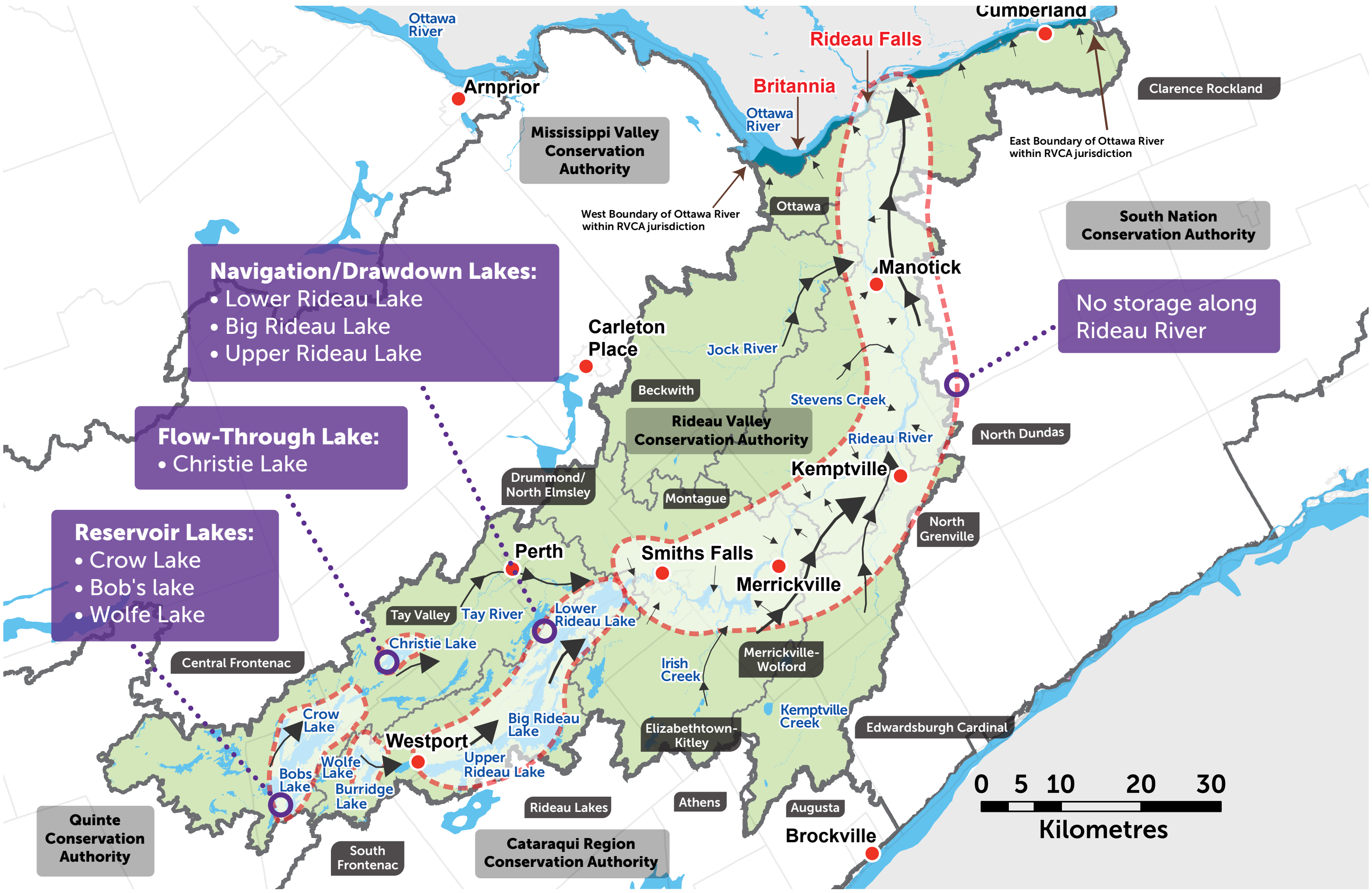


FIGURE 2.3 Rideau River Watershed - Parks Canada Operation Summary

Fall: Water levels in lakes and rivers are lowered

Winter: Water levels adjusted up or down based on snow depth

Spring: Lakes are filled. Multiple dam operations completed to mitigate flooding

Summer: Maintain 'navigation' water levels

Legend

- Municipal Boundary
- Water flow direction
- Ottawa River
- RVCA jurisdiction Waterbody
- RVCA Subwatershed

1 The noted drainage area for the Rideau River does not include the Ottawa River catchments contained within the RVCA jurisdiction.

Lakes

Wolfe Lake and Bobs Lake are the watershed's main reservoir lakes. Bobs Lake receives flow from the Tay River, Eagle Lake and Crow Lake. Wolfe and Bobs lakes are both controlled to augment flows downstream. Christie Lake is located downstream of Bobs Lake, and has a significant surface area with no control structure. The outflow of the Tay River from Christie Lake is regulated by the flow within the Tay River / Tay Canal.

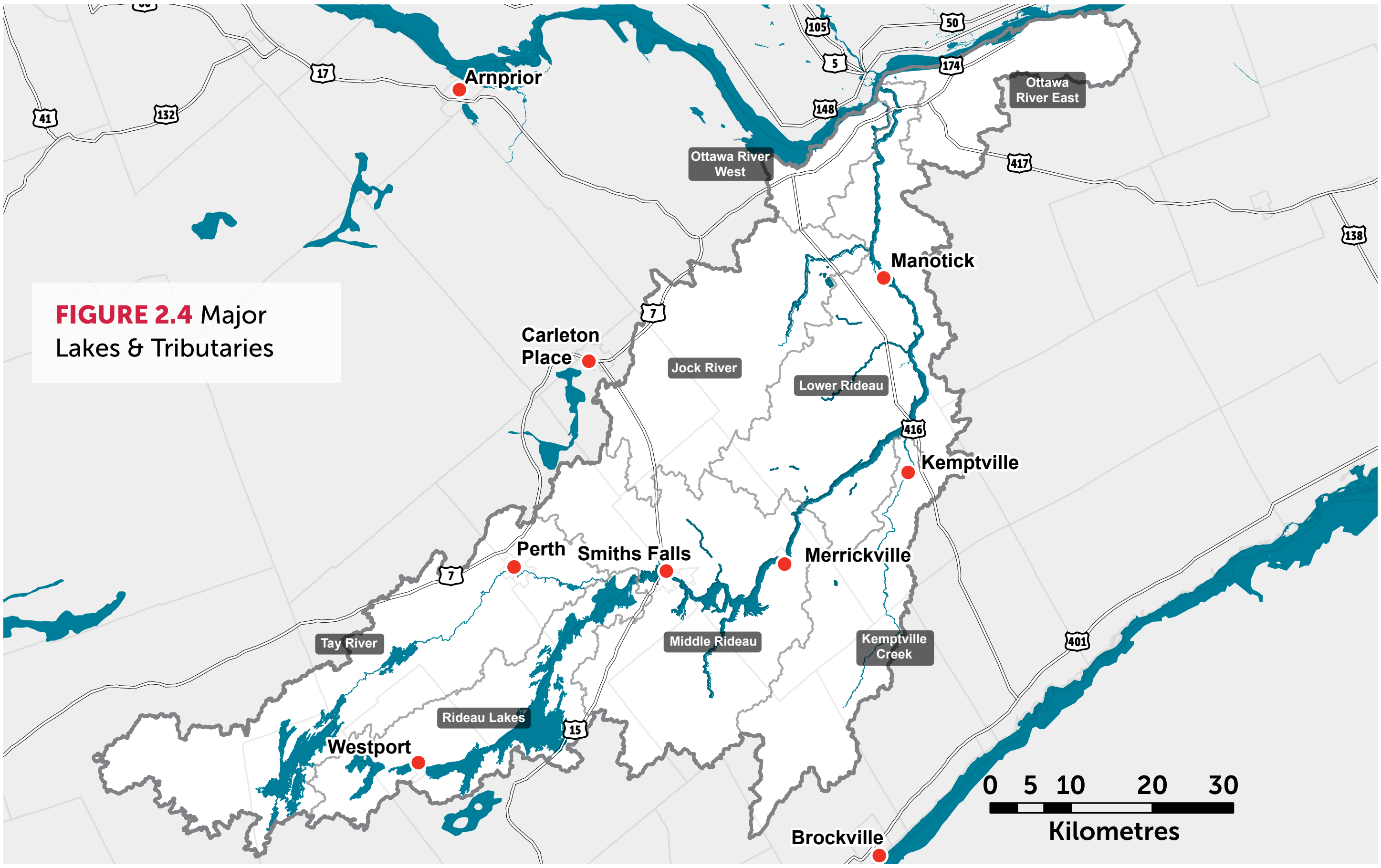


FIGURE 2.4 Major Lakes & Tributaries

Rivers

The major rivers that are tributaries to the Rideau River include (from upstream to downstream): the Tay River, Irish Creek, Kemptville Creek, Stevens Creek and the Jock River.

- The Tay River drains the western portion of the Rideau Watershed. It flows from its headwaters at Carnahan Lake through Long Lake via Fish Creek into Bobs Lake, a major storage reservoir on the Rideau Canal. From Bobs Lake, the Tay River flows northeasterly through Christie Lake till the confluence with Grants Creek at Perth. Grants Creek flows through Pike Lake and Crosby Lake upstream. Below Perth, the Tay River flows easterly into Lower Rideau Lake.

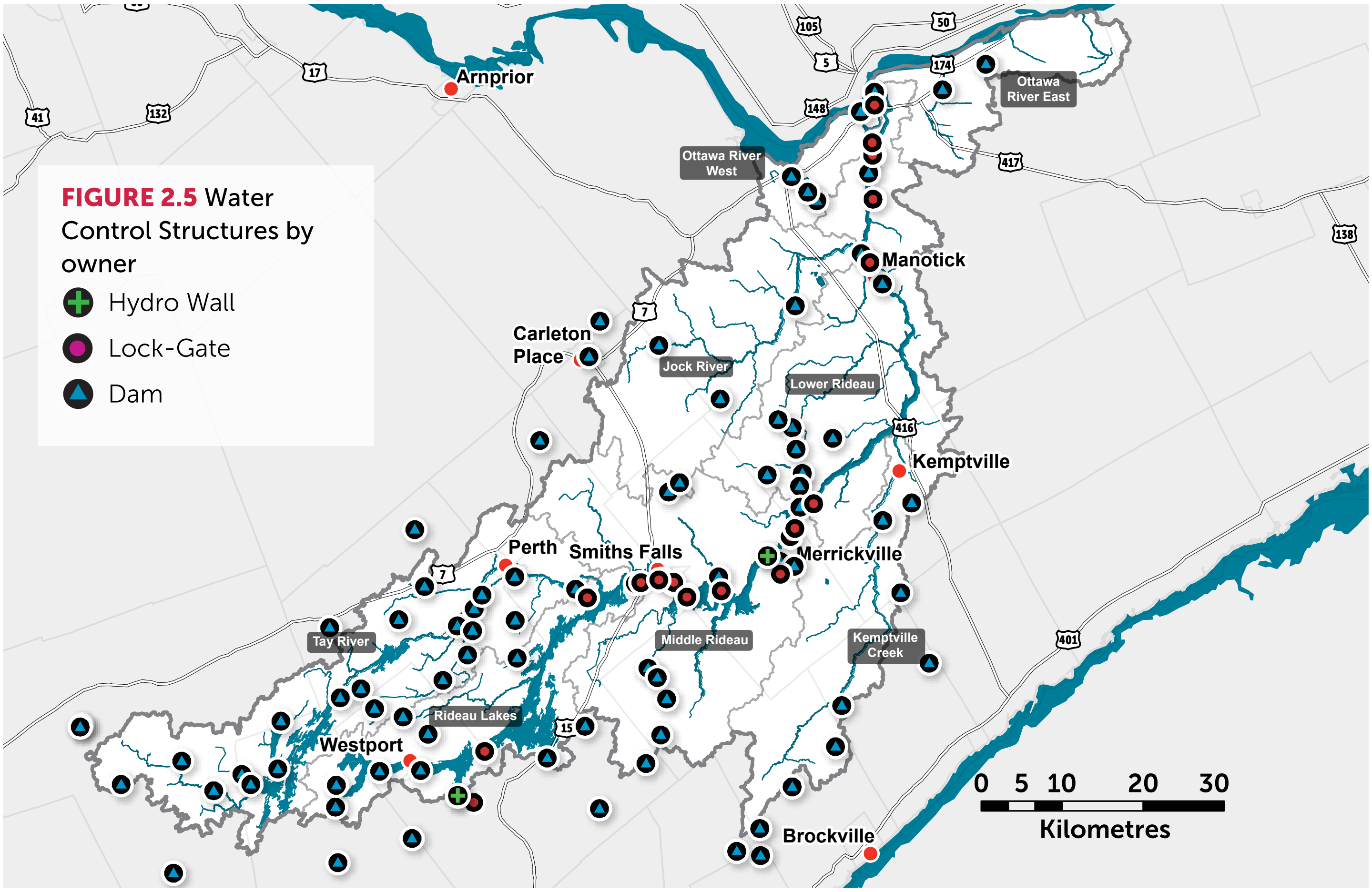
- Irish Creek drains an area south of the Rideau River between Merrickville and Kilmarnock. It starts at Bellamy Pond and flows into Irish Lake and then northerly into the Rideau River at the Village of Jasper.

- Kemptville Creek is located in the eastern portion of the watershed. It has two main branches: the south branch runs from Mud Lake to the hamlet of Garretton, while the north branch originates at Atkin Lake, and flows through Cranberry Lake toward the confluence with the south branch between the hamlets of Bishop's Mills and Patterson's Corners. From here it runs in one unified channel northerly through Oxford Mills where it has been dammed. From the Oxford Mills Dam, Kemptville Creek flows northerly through the former Town of Kemptville and ultimately discharges into the Rideau River just downstream of Beckett's Landing.

- Stevens Creek drains an area west of the Rideau River between Burritts Rapids and Manotick. It starts approximately 6 km north of Burritts Rapids and flows through North Gower and then east into the Rideau River at the Village of Kars.

- Jock River's headwaters are located in a swampy area near the hamlet of Franktown. It flows northerly to Ashton and then easterly to south of Richmond. Along this reach, Kings Creek and Nichols Creek flow into the Jock River. It then flows northeasterly through Richmond and bends east before discharging into the Rideau River at Jockvale just downstream from Manotick.

▲ A swollen Jock River joins the Rideau River in Barrhaven during the spring freshet.



Source: Ontario Dam Inventory (Ontario Ministry of Natural Resources and Forestry).

Water Regulation on the Rideau River

The Rideau system is primarily managed for recreational navigation. Secondary uses include hydroelectric power generation, lake and river recreation, flood abatement and the control of flows and water levels.

There are approximately 46 control structures in the Rideau River watershed including 24 dams, 19 locks (on the Rideau Canal), and three power generating stations. These structures are primarily operated by Parks Canada (PC) and The Ministry of Natural Resources and Forestry (MNRF; previously MNRF).

RVCA operates two dams and three storage weirs in the Rideau River basin.

The principal flow control point on the Rideau system is at Poonamalie (Smiths Falls), which regulates levels in the Big Rideau and Lower Rideau Lakes and regulates flow to the downstream reaches. Upstream of Poonamalie, the canal system is formed by a series of large navigation lakes, joined by short canal sections. Big Rideau and Upper Rideau Lakes are the main navigation lakes.

Although Parks Canada has some degree of control over how much water is released at the Poonamalie Dam to mitigate downstream flooding, the capacity to do so is limited and water has to be released when that capacity is exceeded. The dams on the Rideau system are also not designed for flood control purposes; they are meant to maintain water levels for navigation purposes.

Control structures operated by MNRF and RVCA do not have a significant effect on the overall management of the Rideau Canal system.

CLIMATE DATA

The Rideau River Watershed is located within the Great Lakes and St. Lawrence climate region. It has moderately cold winters and warm summers, with four distinct seasons. Prevailing winds tend to bring storms in from the west and southern movement up from the Gulf of Mexico. Precipitation occurs year-round and is typically driven by frontal interactions (ie. lighter, warm, moist air lifting over more dense, cold air), however, thunderstorms are also common. The Rideau River Watershed is primarily influenced by continental factors and, to a lesser extent, Maritime-like effects from Lake Ontario.

Temperature and Precipitation

Climate data from five of Environment Canada's regional stations was tabulated to assess for geographic variability across the watershed, while recent conditions (2010-2020) were compared against the established historic normals to determine if climate conditions over the last 10 years were comparable to the historic range (Table 2.1).

Winter temperatures in the southern part of the watershed are generally milder with more winter precipitation than all other comparative regions.

A degree of geographic variability is evident across the region. Winter temperatures in the southern part of the watershed are generally milder with more winter precipitation than all other comparative regions. This can likely be attributed to lake-effect influences from Lake Ontario. Some temperature variability is also evident outside the major urban centers, with the Kemptville and Drummond Centre regions showing slightly cooler summer temperatures on average. When comparing recent conditions (2010-2020) to the established historic normals (1981-2010), a consistent warming trend is evident.

There is also some indication of reduced annual precipitation over the last 10 years, however this trend is not consistent between regions. In addition to the warming trend noted, monthly temperature variability has also increased when compared to the historic range. Monthly average variability over the historic record ranges from 1-4°C, while recent trends suggest a greater degree of variability ranging from 3-7°C on average. For instance, when comparing average conditions for January, the temperatures varied by a greater degree year-to-year over the last 10-years, compared to the previous 30-year record.

Table 2.1 Average annual temperature & precipitation trends from 1981-2020

ECCC Weather Station	Ottawa Intl Airport	↑↓	Kemptville	↑↓	Drummond Centre	↑↓	Brockville PCC	↑↓
Subwatershed	Lower Rideau River		Kemptville Creek		Tay River		---	
Elevation (mASL)	114		99.4		145		96.0	
Winter Precipitation [Jan-Mar, mm] (1981-2010)*	184.1	-4.8	185.7	-11.7	174.1	+22.0	205.6	+13.3
Winter Precipitation [Jan-Mar, mm] (2010-2020)	179.3		174		196.1		218.9	
Summer Precipitation [Jul-Sep, mm] (1981-2010)*	267.5	-19.0	273.7	-42.4	250.6	+27.4	266.2	-1.6
Summer Precipitation [Jul-Sep, mm] (2010-2020)	248.5		231.3		278		264.6	
Mean Annual Precipitation [mm] (1981-2010)*	943.6	-22.9	954.5	-125.7	876.3	+106.1	986.8	+30.3
Mean Annual Precipitation [mm] (2010-2020)	920.7		828.8		982.4		1017.1	
Coldest Month [January, °C] (1981-2010)*	-10.3	+1.4	-10.0	+1.7	-9.8	+1.2	-7.8	+1.1
Coldest Month [January, °C] (2010-2020)	-8.9		-8.3		-8.6		-6.7	
Warmest Month [July, °C] (1981-2010)*	21.0	+1.0	20.5	+1.1	20.3	+1.0	21.2	+0.5
Warmest Month [July, °C] (2010-2020)	22.0		21.6		21.3		21.7	
Mean Annual Temp [°C] (1981-2010)*	6.4	+0.6	6.1	+1.0	6.1	+0.7	7.5	+0.4
Mean Annual Temp [°C] (2010-2020)	7.0		7.1		6.8		7.9	

* Published Environment Canada Climate Normals from 1981-2010

Snowpack measurement

RVCA staff have manually surveyed snowpack accumulation in the region for more than 45 years. These measurements help to quantify the amount of water in storage on the landscape prior to the spring melt. Snow water volumes from four distinct regions were tabulated to assess for geographic variability across the watershed. Furthermore, a comparative assessment was prepared to determine if snowpack accumulation over the last 10 years (2010-2020) was comparable to the conditions observed over the historic record (Table 2.2).

Table 2.2 **Annual peak snow water equivalent (SWE) trends from 1981-2020**

RVCA Snow Courses	Ashton	↑↓	Bells Corners	↑↓	Nolans Corners	↑↓	Pierces Corners	↑↓
Subwatershed	Jock River		Ottawa River West		Middle Rideau		Lower Rideau	
Historic Max SWE [mm]	208.3		202.5		150		190	
Median Peak SWE [mm] (1981-2010)	96.5	+14.5	86.0	+24.0	70.0	+4.0	81.0	+10.0
Median Peak SWE [mm] (2010-2020)	111.0		110.0		74.0		91.0	

In general, snow sites located within the northern half of the watershed (Ashton & Bells Corners) tend to exhibit higher average peak snow water volumes compared to the southern sites (Nolans Corners, Pierces Corners). In comparison between the recent and historic records, an overall increase in the median peak snow water volume is evident across all sites. Given that snow accumulation is a product of a variety of climate factors (ie. temperature, precipitation, solar radiation, soil moisture, etc.) it is difficult to speculate as to whether this represents a trend towards increased flood risk. In contrast, most regional climate projections suggest an overall reduction in snow accumulation as winter precipitation is expected to transition towards more rainfall over the long term.

STREAM FLOWS

Stream flow (or discharge) is defined as the volume of water that moves over a designated point over a fixed period of time. In this way, stream flows relate to the amount of water moving through a channel and are critical to understanding how water levels will respond/fluctuate in any given region. These volumes are generally expressed in cubic meters per second (m^3/sec).

Table 2.3 Average seasonal flows trends from 1981-2020

Sub watershed	Average Annual Flow (m3/sec)	↑↓	Average Seasonal Flows (m3/sec)								Seasonal Flows relative to Average Annual Flow	
			Winter	↑↓	Spring	↑↓	Summer	↑↓	Fall	↑↓	Spring	Summer
Lower Rideau (1981 - 2010)	44.3	**+4.5**	53.5	**+10.2**	69.3	**+7.7**	14.6	**+3.9**	40.0	**-3.7**	157%	33%
Lower Rideau (2010 - 2020)	48.7		63.6		77.0		18.5		36.4		158%	38%
Jock River (1981 - 2010)	6.3	**+1.2**	7.0	**+2.2**	12.0	**+1.7**	1.4	**+0.9**	4.7	-0.0	191%	23%
Jock River (2010 - 2020)	7.5		9.3		13.7		2.4		4.7		183%	32%
Kemptville Creek (1981 - 2010)	4.9	**+0.5**	6.3	**+1.8**	8.4	**+0.4**	1.0	**+0.2**	4.1	**-0.4**	170%	21%
Kemptville Creek (2010 - 2020)	5.4		8.0		8.8		1.2		3.8		162%	22%
Tay River (1996-2020)*	8.9		10.5		13.7		5.0		6.2		154%	56%

* Comparative statistics were not generated due to the limited period of record (1996-2019)

Stream flow data from four of the regional Water Survey Canada (WSC) stations was tabulated to illustrate the relative flow contributions from each of the primary subwatersheds (i.e. Lower Rideau, Jock River, Kemptville Creek & Tay River). Furthermore, recent conditions (2010-2020) were compared against the historic range (1981-2010) to determine if the average annual & seasonal flows over the last 10 years were comparable (Table 2.3).

The effects of water level regulation are evident when comparing the relative seasonal flows to the annual average. Flows within the Lower Rideau and Tay River (both regulated) show a lesser degree of seasonal variability when compared to the unregulated systems (ie. Jock River & Kemptville Creek).

Average annual flows for the Lower Rideau subwatershed are the most significant, as this region receives flow contribution from all other noted subwatersheds.

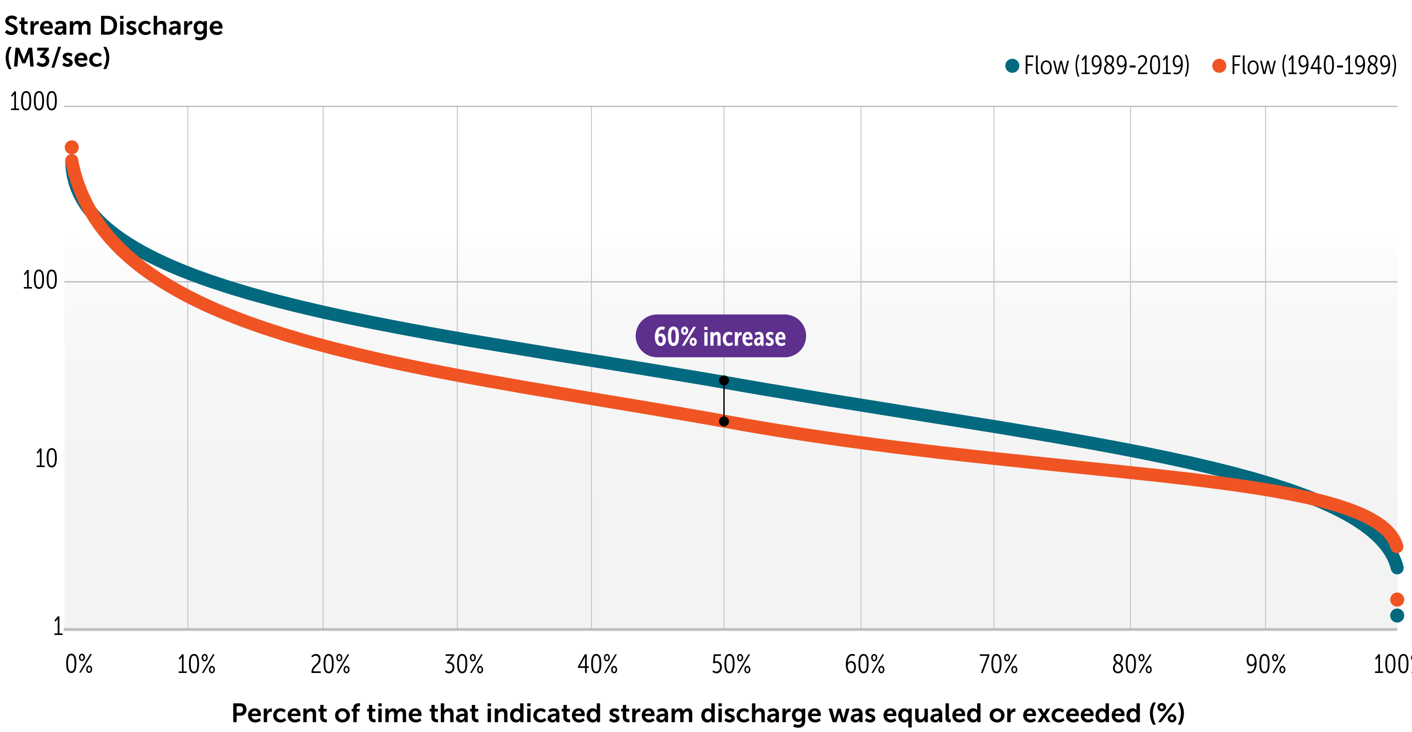
In general, an increase in the average annual flow is evident for most subwatershed regions when comparing the recent record to the historic range. Average seasonal flows during the winter, spring and summer all appear to have increased, with a minimal to slight decrease noted in the fall. These trends might indicate changes in drainage characteristics, regional climate factors, storage capacity or water regulation over the last decade.

To further evaluate the noted recent increases in flow conveyance, a flow duration analysis (FDA) was completed for the Lower Rideau region (Figure 2.6). Flow duration analyses convey the percentage of time that flow in a river/stream is likely to equal or exceed a given value. In this way, the typical hydrological characteristics of a stream/river can be illustrated and tracked over time. Flow conditions were plotted over two time periods (ie. 1940-1989 & 1989-2019) for the Rideau at Ottawa stream gauge (02LA004).

In general, the magnitude of mid-range flows has increased over time. For example, median flow during the 1980s to present has increased by approximately 60% compared to the period between 1940 and 1980. The degree of increase is even more significant comparing the 1940s to the 2010s: an approximate 165% increase at the median/50th percentile flow.

At the same time, the magnitude of peak flows (left side of the curve) appears to have decreased slightly between the two time periods, while the lower range (right side of the curve) indicates a trend towards more extreme summer low flow conditions.

FIGURE 2.6 Flow Duration Curve for the Lower Rideau River (02LA004)



The noted trends indicate that the incoming source water (whether it be from precipitation, snowmelt or groundwater) is not being held in storage to the same degree as it was, likely due to loss of natural storage such as wetlands. This is resulting in more outgoing flow through the systems, which is depleting the reservoirs sooner and leading to more severe/frequent low water conditions.

These changes in flow may be attributed to a variety of influences and/or impacts, including:

- Cumulative loss of natural storage reservoirs (i.e. wetlands)
- Enhanced or increased runoff (ie agricultural drainage, urban stormwater runoff, etc.)
- Climate variability (ie changes in precipitation patterns or rates of evapotranspiration)
- Water regulation practices (ie. changes to operational strategies)

Trends indicate that the incoming source water is not being held in storage to the same degree as it was, likely due to loss of natural storage such as wetlands.

Further statistical analysis based on 10-year increments reveals a continuous and consistent upward trend over the mid-range flows from the 1940's to present. Although it is challenging to draw any direct correlations; these observed changes can likely be attributed to cumulative impacts, as identified above.

Flood Forecasting and Warning – Annual Peak Flow Conditions

The RVCA uses stream gauges, weather stations, surveys of snow conditions, meteorological forecasts and computer models to determine the potential for flooding. When spring melt or severe storms are anticipated, the Conservation Authority estimates the severity, location, and timing of possible flooding and informs the public.

The 2023 spring freshet created moderate flooding conditions in several neighbourhoods along the Ottawa River.

▲ **While the RVCA directs new development away from floodplains and other natural hazards, existing buildings are sometimes grandfathered into hazard areas and are at higher risk of impacts.**

Most flooding within the RVCA's jurisdiction is due to heavy continuous rainfall in combination with snow melt. Flooding on the Rideau River typically occurs in the early spring (with a median date of April 3) as a result of a combination of snowmelt and precipitation runoff, with about 48 hours between increasing flows and the flood peak.

The severity and likelihood of a flood is described as a "return period": basically, how frequently a given high water level is likely to return. A 1:20-year flood return does not mean those water levels will occur every 20 years; rather, they have a 5% probability of occurring in any given year. A more extreme 1:100-year flood return period refers to a 1% probability of severe flooding in any given year.

Annual peak flows from the primary subwatersheds (i.e. Lower Rideau, Jock River, Kemptville Creek and Tay River) were tabulated and compared against the estimated flood return periods for these regions. Return periods from the 1:2-year event up to the 1:100-year event were plotted relative to the annual peak flows measured at each of the corresponding stream gauges (Figures 2.7 to 2.10).

Over the available 80+ year record, no peak flows in exceedance of the 1:50 year return period (ie. 2% probability event) have been observed on the Rideau River or within the primary subwatersheds[2]. A period of elevated freshet conditions is evident throughout the 1970s for all regions, with most historic maximums having occurred during this period.

2 Events approaching or exceeding the 1:100 flood event have been observed within smaller catchments and tributaries, but not within the larger subwatersheds.

FIGURE 2.7 Stream Flows: Rideau at Ottawa (02LA004); 1971-2022

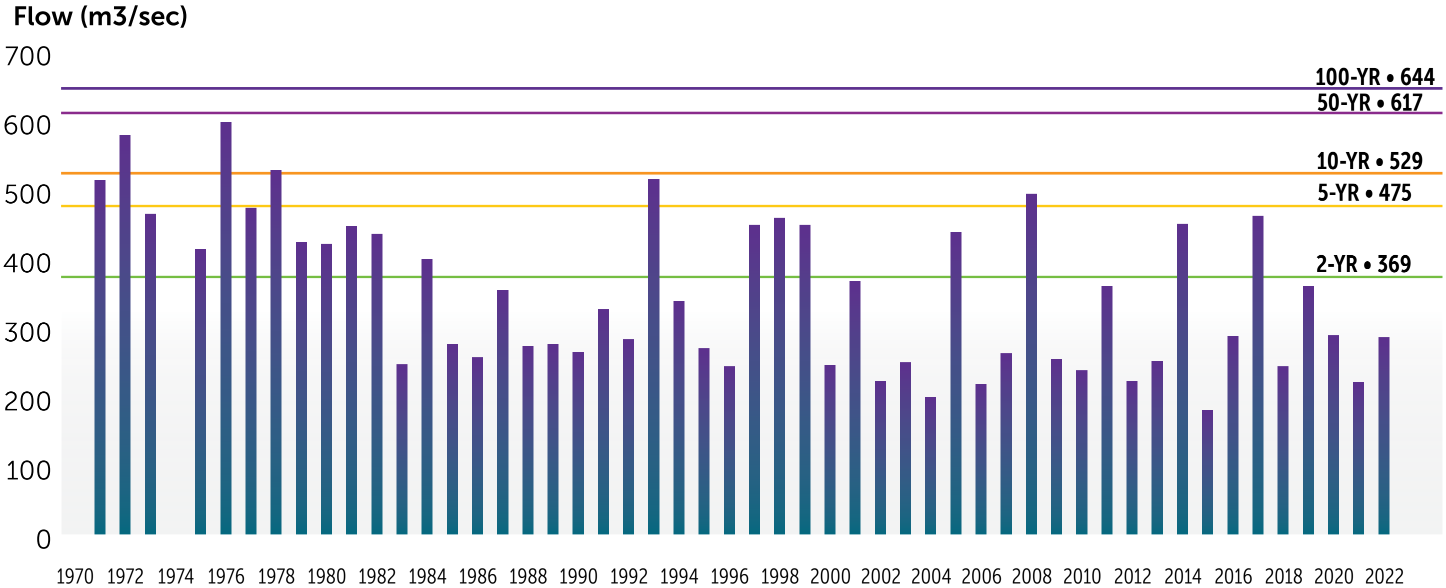


FIGURE 2.8 Stream Flows: Jock River at Moodie Dr (02LA007); 1986-2022

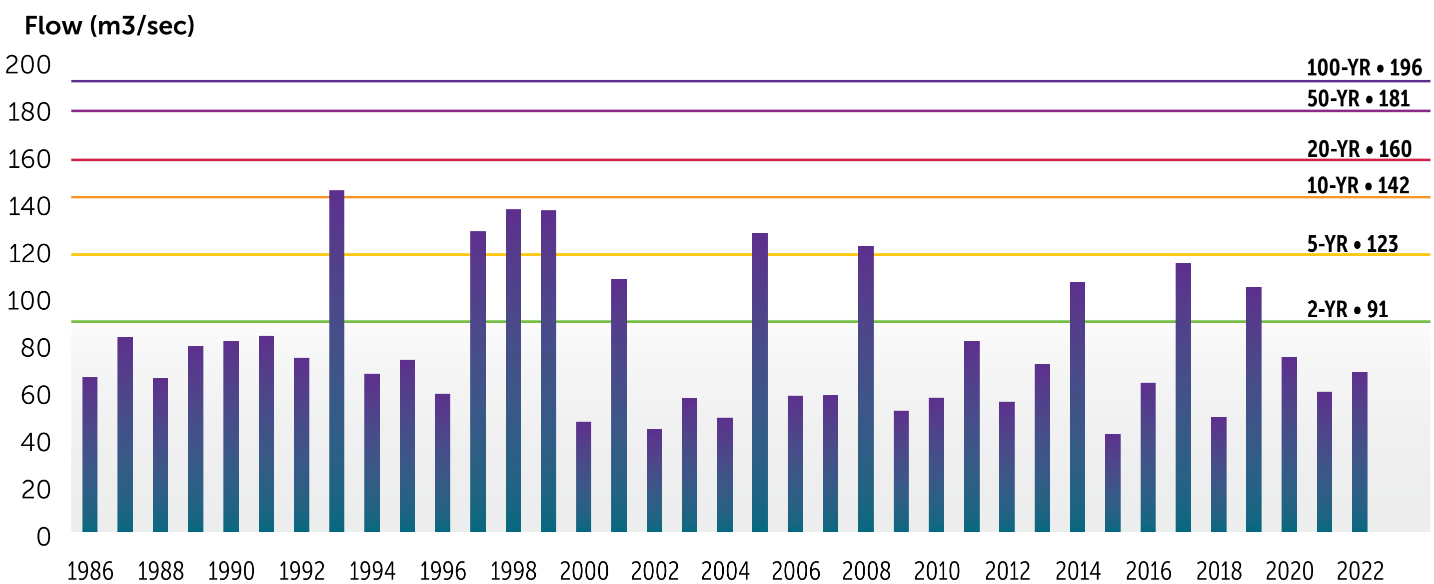


FIGURE 2.9 Stream Flows: Kemptville Creek at Kemptville (02LA006); 1988-2022

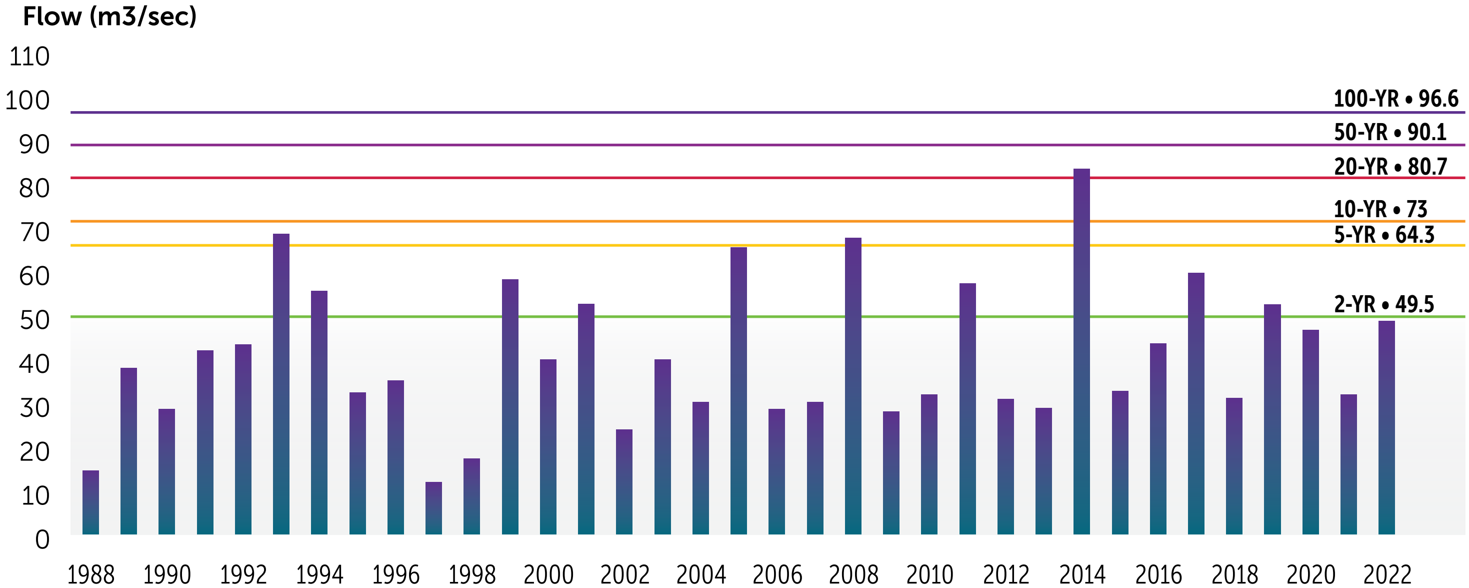
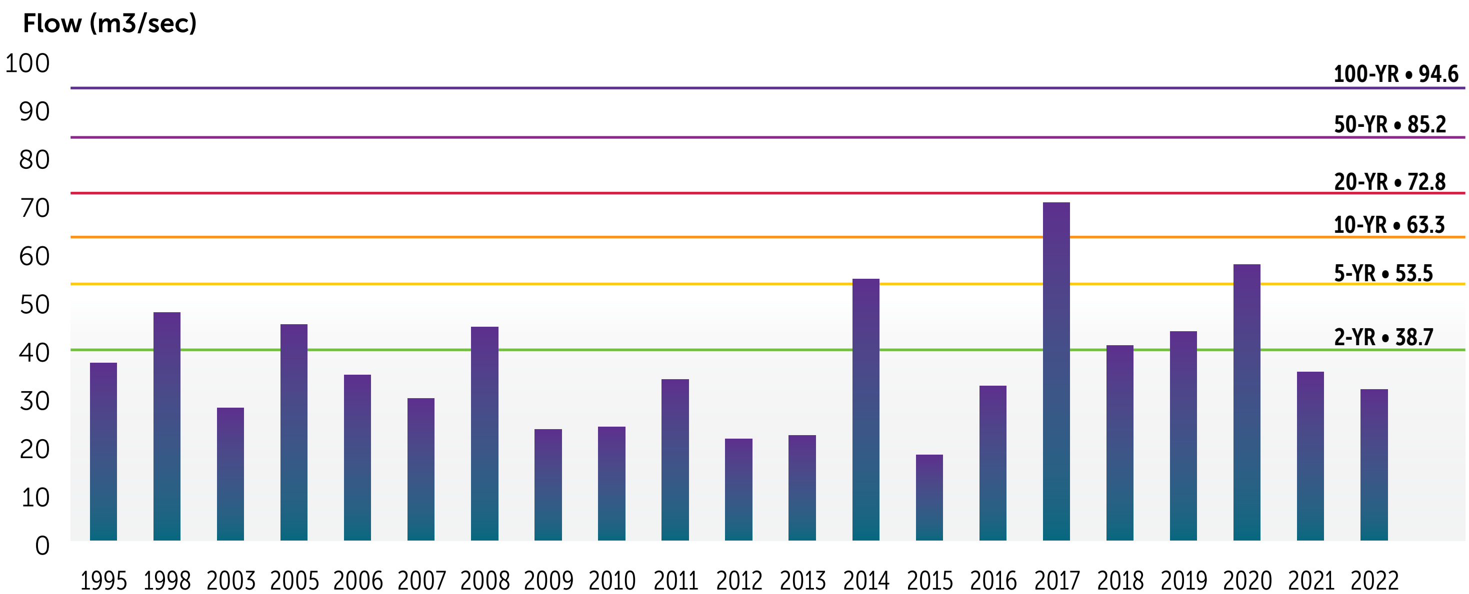


FIGURE 2.10 Stream Flows: Tay River at Perth (02LA024); 1995-2022

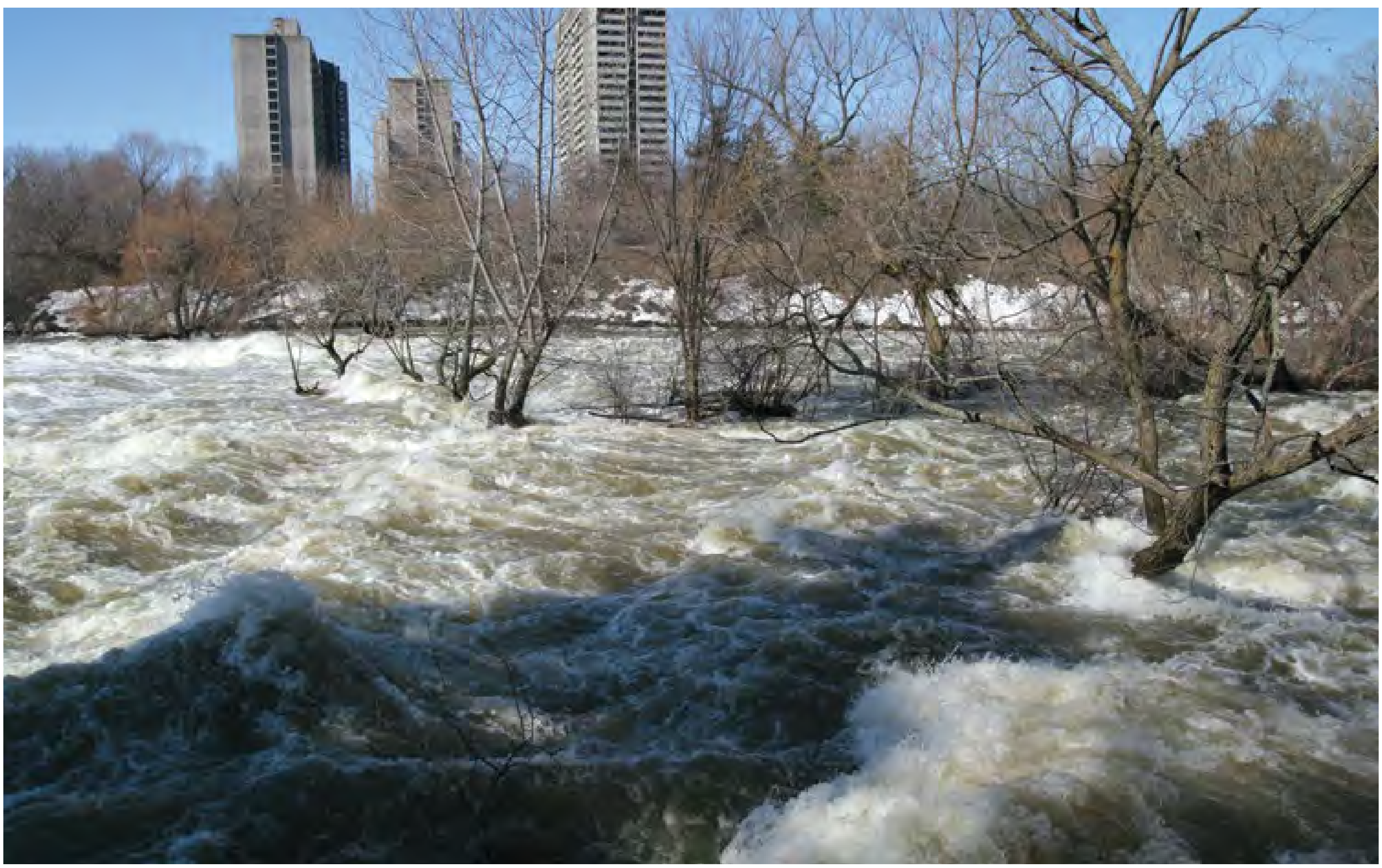


The maximum instantaneous flow measured in the Lower Rideau region over the available record occurred in 1976 and peaked at approximately 597 m^3/sec (i.e. between the 1:20 and 1:50 return period flow). Since this event, there have been no peak flows which have exceeded the 1:10 year return period (i.e. 10% probability event).

The maximum instantaneous flow measured in the Jock River over the available record occurred in 1978 and peaked at approximately 148 m3/sec (ie. between the 1:10 and 1:20 return period flow). A comparable event was also observed more recently, with a peak flow of 145 m^3/sec measured in April of 1993. To date, no peak flows in exceedance of the 1:20 year return period have been observed (i.e. 5% probability event) over the available record.

The maximum instantaneous flow measured in Kemptville Creek over the available record occurred in 2014 and peaked at approximately 83 m^3/sec (i.e. between the 1:20 and 1:50 return period flow). Prior to this event, most elevated flows on record occurred in the 1970s, with the second highest peak having occurred in 1972 at 81 m^3/sec.

The maximum instantaneous flow measured in the Tay River over the available record occurred in 2017 and peaked at approximately 70 m^3/sec (i.e. between the 1:10 and 1:20 return period flows).



▲ **During the spring freshet, stream flows tend to peak in early April on the Rideau River. This photo was captured in the City of Ottawa.**

◀ Low flow conditions can have severe impacts on local aquatic ecosystems when connections between water bodies dry up. Low water can also affect agricultural activities.

Low Flow and Drought – Annual Low Flow Conditions

In 2001, the MNRF established the Ontario Low Water Response Program to assist with the coordination and support of local response in the event of a drought. Under the program, local drought response is managed through a Water Response Team (WRT) coordinated by the RVCA and local municipal representatives. When warranted, the RVCA will issue low water conditions statements to inform residents, municipalities and other stakeholders of current or projected drought severity.

Similarly to flood monitoring, low flow events can also be categorized relative to their severity and likelihood (i.e. return periods). The thresholds referenced below (7Q5, 7Q10 and 7Q20) are stream flow indicators associated with the estimated 20%, 10% and 5% probability low water events, respectively.

Annual low flow conditions from three of the primary subwatersheds (i.e. Lower Rideau, Jock River, Kemptville Creek) were tabulated and compared against the estimated low water return periods for these regions. Thresholds from the 7Q5 to the 7Q20 year event were plotted relative to the annual 7-day minimum flows measured at each of the corresponding stream gauges (Figures 2.11 to 2.13).

FIGURE 2.11 Low Flow: Rideau at Ottawa: 7-Day average minimum flow (02LA004); 1940-2022

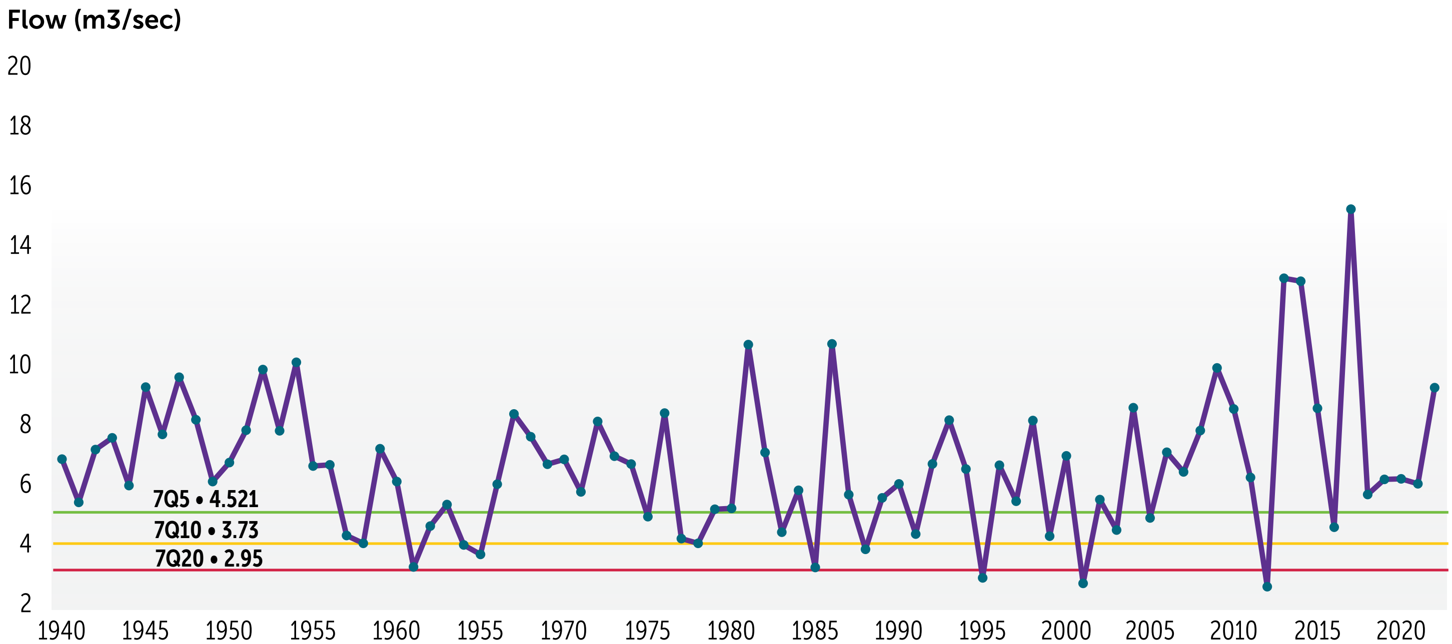


FIGURE 2.12 Low Flow: Jock River at Moodie Dr: 7-Day average minimum flow (02LA007); 1969-2022

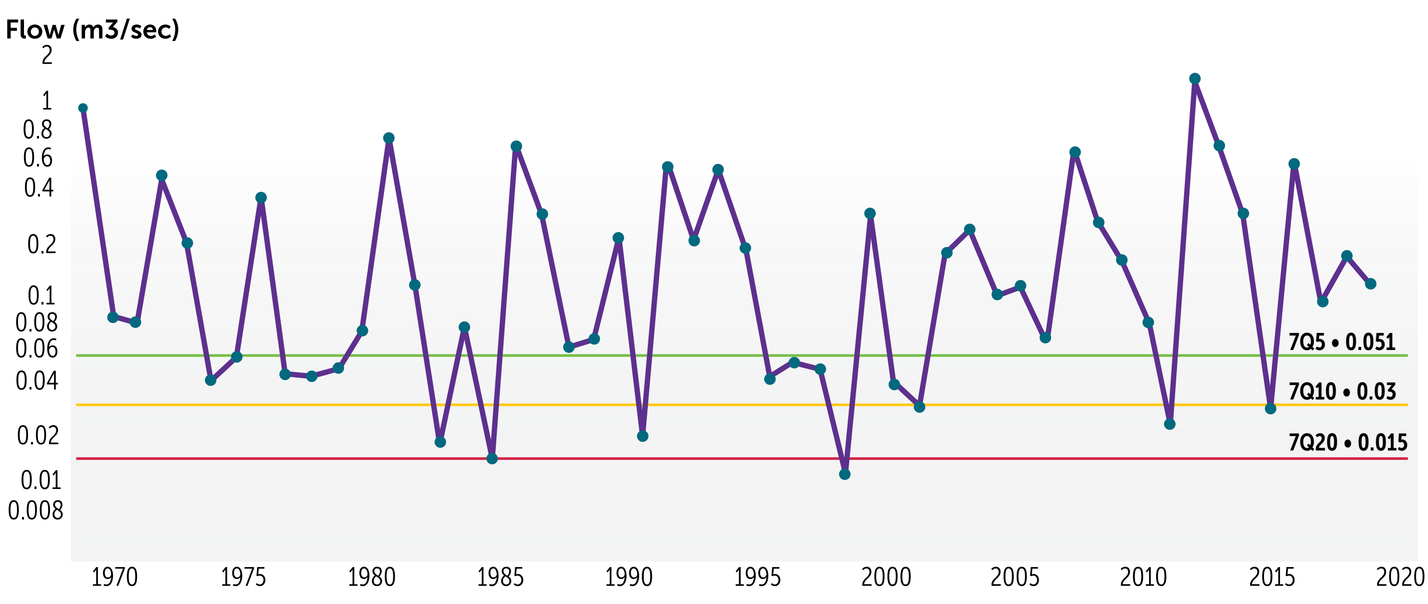
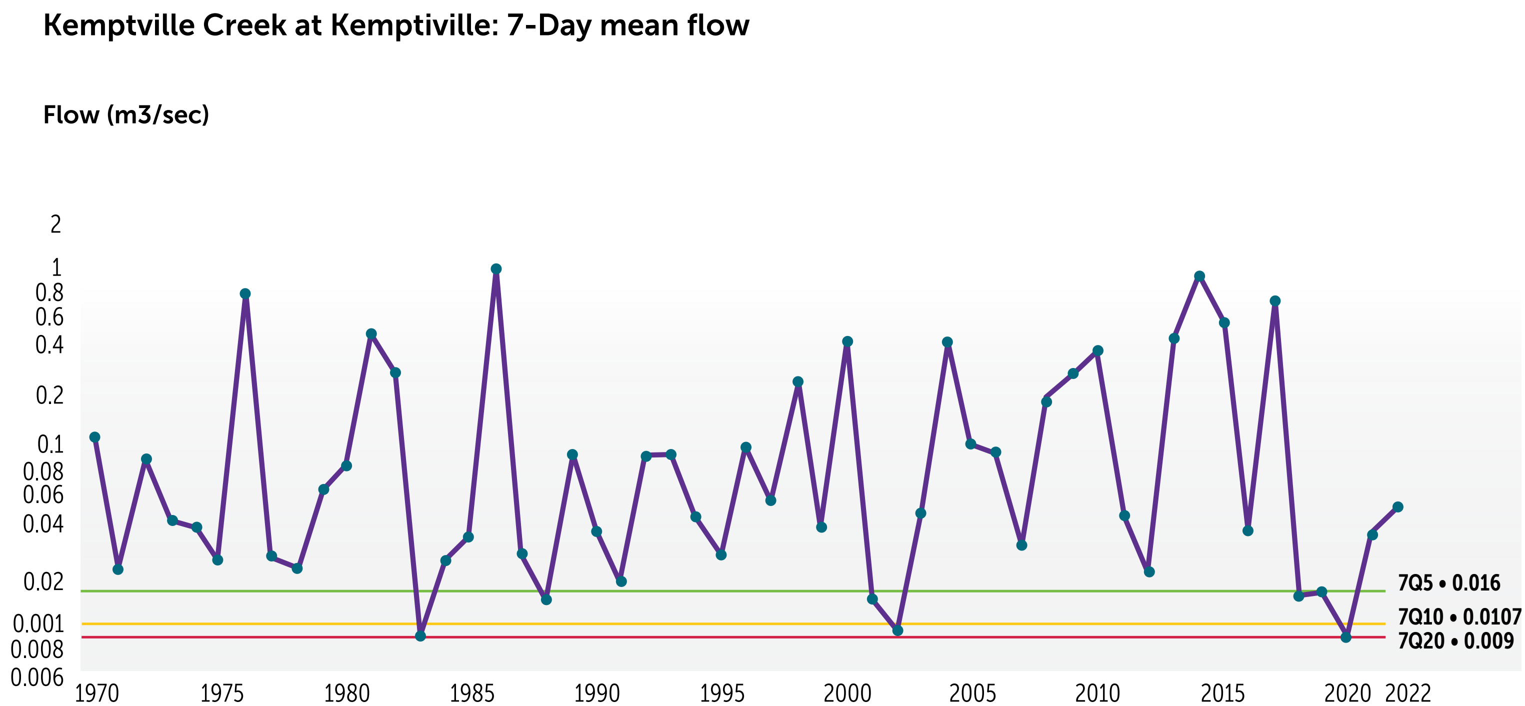


FIGURE 2.13 **Low Flow: Kemptville Creek at Kemptville: 7-Day average minimum flow (02LA006); 1969-2022**



During the summer months, flows in the Rideau River are augmented for navigational purposes. The incidence of low flow conditions during this time period therefore reflects both natural variability and operational influences. For details regarding Rideau River operations, refer to Watershed Hydrology above. Conversely, stream flows within the Jock River and Kemptville Creek subwatersheds are unregulated and reflect natural variability year to year.

Since the establishment of the Ontario Low Water Response Program (2001), the RVCA has issued low water declarations in 11 of the last 20 years.

The most severe low water declaration was issued in 2016, with the RVCA having maintained a Level 3 status for approximately 17 weeks. A similar event was observed in 2012, when a considerable rainfall deficit in the spring resulted in low water conditions in both the Lower Rideau and Jock River regions. Reported impacts from these events included: highly fragmented/pooled streams, agricultural crop losses and low lake, reservoir and private well levels.

In the Lower Rideau region, flows have dropped to or below the 7Q20 (5% probability event) on three occasions over the available record. Instances of these “severe” conditions were observed in 1995, 2001 and most recently, 2012. Over the last decade, low water conditions ranging from “severe” to “minor” have been observed in two instances (2012 and 2016).

In the Jock River subwatershed, flows have dropped to or below the 7Q20 (5% probability event) on two occasions over the available record. Instances of these "severe" conditions were observed in 1985 and 1999. In parallel with the Lower Rideau region, low water conditions were also observed in 2012 and 2016, at or below the 7Q10 threshold (10% probability event, or a "moderate" low water status).

In the Kemptville Creek subwatershed, flows have dropped to or below the 7Q20 (5% probability event) on two occasions over the available record. Instances of these "severe" conditions were observed in 1983 and, mostly recently, in 2020. Over the last decade, low water conditions ranging from "minor" to "severe" were observed in 2018, 2019 and 2020.

The declaration of a low water status is informed by the use of established stream flow and precipitation thresholds.

More recently, the Kemptville Creek region experienced a significant series of low water events beginning in 2018, with the most severe conditions observed in 2020 during a 3-month rainfall deficit that led to a 5% (7Q20) probability low flow event.

The declaration of low water status is informed by the use of established stream flow and precipitation thresholds. Additional factors such as drinking water quantity and quality, reservoir conditions and aquatic health are also considered in the determination of low water status.

Table 2.4 RVCA Low Water Declarations by Year (2001-2021)

Year	Low Water Status
2001	Normal
2002	Normal
2003	Normal
2004	Normal
2005	Level 1 (Minor)
2006	Normal
2007	Normal
2008	Normal
2009	Normal
2010	Normal
2011	Level 1 (Minor)
2012	Level 2 (Moderate)
2013	Level 1 (Minor)
2014	Normal
2015	Level 1 (Minor)
2016	Level 3 (Severe)
2017	Level 1 (Minor)
2018	Level 2 (Moderate)
2019	Level 1 (Minor)
2020	Level 2 (Moderate)
2021	Level 1 (Minor)

IMPACTS AND IMPLICATIONS

Recent climate conditions suggest a warming trend over the past decade, with higher volatility in average temperatures compared to the baseline. We've seen a greater risk of low water and drought conditions in the warmer seasons, and a general increase in the average annual flows and peak snow volumes.

We have partnered with other local climate data managers for a more comprehensive analysis of local climate trends and projections. The National Capital Commission, in partnership with the City of Ottawa and local conservation authorities, commissioned a comprehensive climate change projection study for the National Capital Region (June 2020).

The study focused on the use of climate science and modelling to predict future changes in temperature, precipitation, wind and extreme events under a range of global emissions scenarios. These projections were compared against established baselines (i.e. ECCC Canadian Climate Normals, 1981-2010 Climate Normals and Averages) for either moderate or high emissions scenarios and predicted over three time periods (i.e. 2030s, 2050s and 2080s). The results for the predicted temperature, precipitation and snow fall conditions are summarized below (Table 2.5).

Warming is anticipated for all seasons, with a greater degree of increase noted under the high emissions scenario.

In general, it is projected that temperatures and precipitation will increase in the National Capital Region. Warming is anticipated for all seasons, with a greater degree of increase noted under the high emissions scenario. Increased precipitation is also anticipated for most seasons, with only marginal differences (from baseline) projected for the summer months.

Rainfall in the region is expected to increase in both volume and intensity while total annual snowfall is projected to decrease. Winter duration is also anticipated to decrease, in addition to an earlier spring onset of 2-4 weeks by 2080. Although the duration and volume of snowfall are anticipated to decrease, the model predictions suggest that more precipitation is expected to fall as rain rather than snow. Overall, it is still unknown how these conditions will affect the duration or magnitude of the spring melt and subsequent flood risk.

Table 2.5 Projected annual & seasonal climate trends in the National Capital Region from 2021 to 2100

Period	Temperature (°C)							
	Baseline	2030s		2050s		2080s		↑↓
		MOD	HIGH	MOD	HIGH	MOD	HIGH	
Annual Average	6.1	7.5	7.9	8.2	9.3	8.8	11.4	↑
Fall (Oct-Dec)	8.2	9.9	10.2	10.5	11.5	11	13.6	↑
Winter (Jan-Mar)	-8.9	-6.8	-6.6	-5.8	-4.7	-5.2	-2.4	↑
Spring (Apr-Jun)	5.2	6.4	6.7	6.8	7.9	7.5	9.6	↑
Summer (July-Sep)	19.2	20.7	21.1	21.6	22.5	2.1	24.8	↑

Period	Precipitation (mm)							
	Baseline	2030s		2050s		2080s		↑↓
		MOD	HIGH	MOD	HIGH	MOD	HIGH	
Annual Average	921	949	968	979	933	983	1028	↑
Fall (Oct-Dec)	232	238	242	247	252	247	252	↑
Winter (Jan-Mar)	186	200	198	209	217	210	231	↑
Spring (Apr-Jun)	223	236	231	234	239	239	239	↑
Summer (July-Sep)	238	240	235	241	235	238	252	---

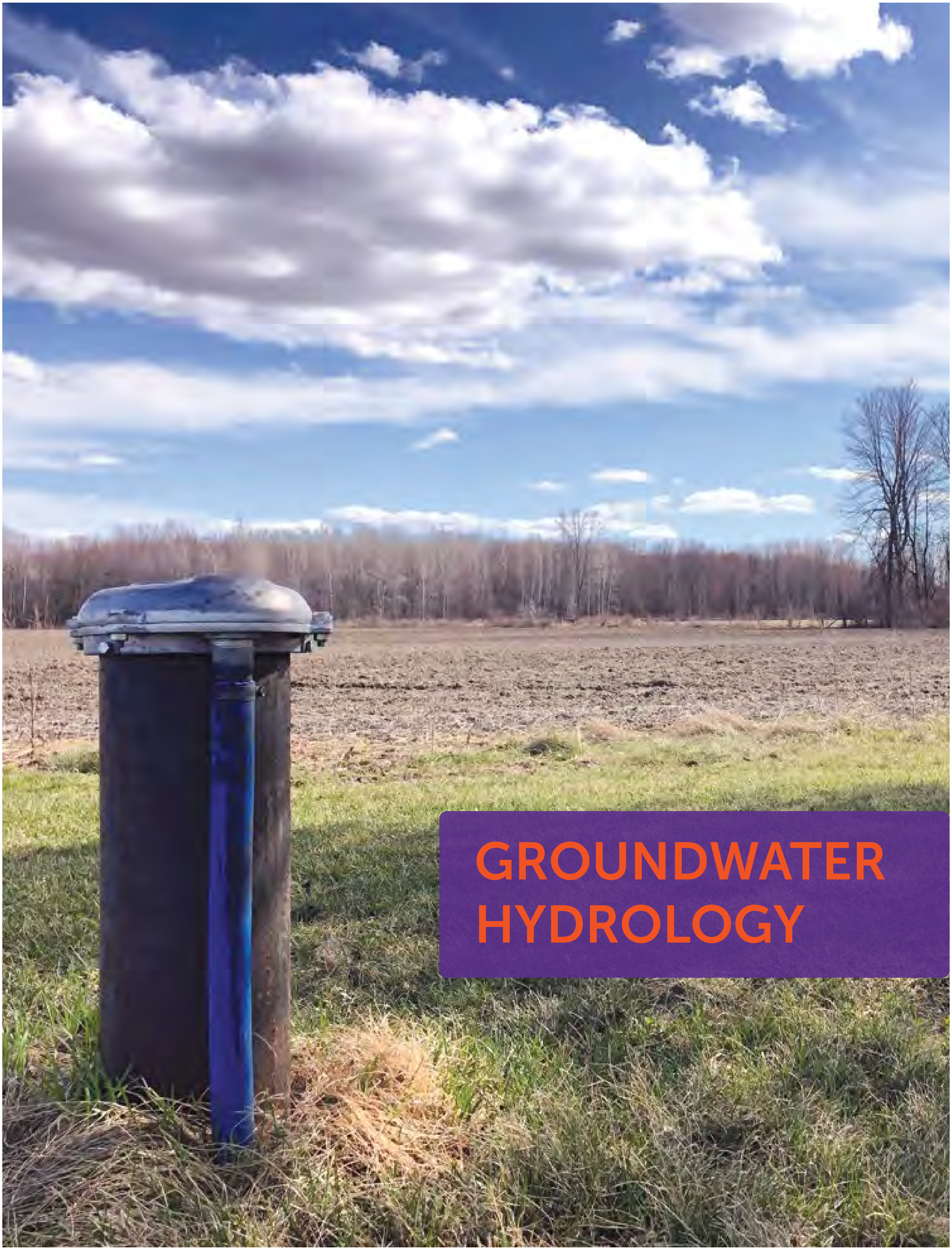
Period	Snow Fall (mm)							
	Baseline	2030s		2050s		2080s		↑↓
		MOD	HIGH	MOD	HIGH	MOD	HIGH	
Annual Average	223	193	201	184	179	154	124	↓
Fall (Oct-Dec)	65	53	49	47	42	38	21	↓
Winter (Jan-Mar)	124	109	109	94	97	86	49	↓
Spring (Apr-Jun)	8	4	5	3	3	2	0	↓
Summer (July-Sep)	0	0	0	0	0	0	0	---

Source: Climate Projections for the National Capital Region; Vol 2: Plots and Tabular Data for all Climate Indices, June 2020

References

National Capital Commision (NCC). Climate Projections for the National Capital Region. Volume 2: Plots and Tabular Data for all the Climate Indices (June 2020). https://ncc-website-2.s3.amazonaws.com/documents/Climate-Projections-for-the-NCR_Volume-2_Final.pdf

Environment and Climate Change Canada (ECCC). Canadian Climate Normals, 1981-2010 Climate Normals & Averages (Ottawa Internation Airport, Ottawa CDA RCS, Kemptville CS & Brockville PCC). https://climate.weather.gc.ca/climate_normals/



GROUNDWATER HYDROLOGY

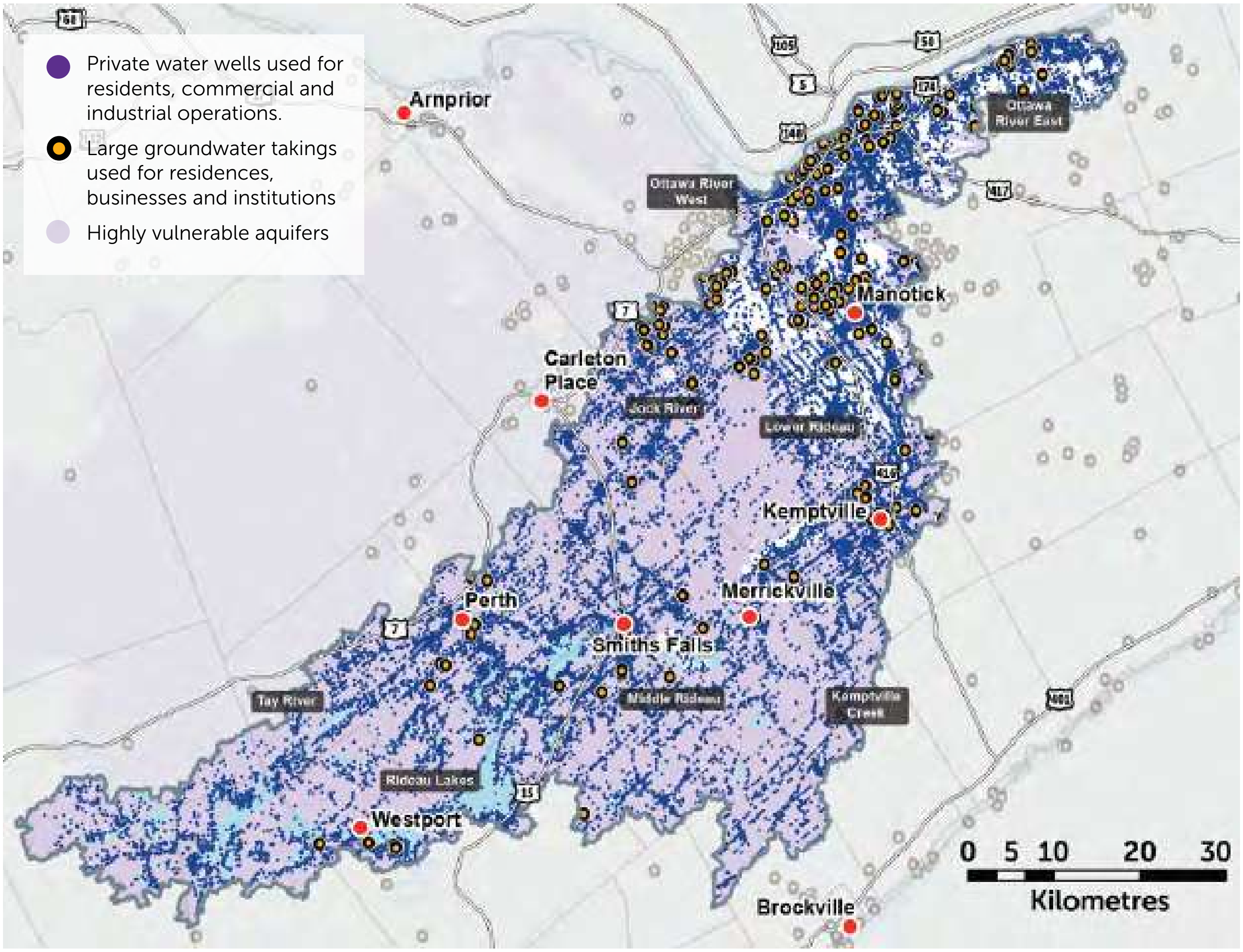
Across the watershed, as throughout many parts of the world, groundwater is the largest part of the hydrological cycle and forms the supportive circulatory system of the Rideau River system. The importance of our groundwater aquifers to the communities and natural heritage of the Rideau River Watershed cannot be overstated.

The groundwater table in the upper parts of our aquifers is generally close to the surface. Further, there is generally not enough overlying sediments to protect our shallow aquifers from the variety of land uses that we engage in. Therefore, about 90% of the watershed has been formally designated by the Mississippi-Rideau Drinking Water Source Protection program as Highly Vulnerable Aquifer (HVA).

The water quality in our aquifers is known to be widely impacted to varying levels from many of our land use activities. This is problematic as our aquifers also store an invaluable drinking water reserve. They are used throughout the watershed for several large municipal and many small private drinking water supply systems, many tens of thousands of private wells, and some larger industrial water supplies. The extent of our groundwater use across the watershed can be seen in Figure 2.12.

Our groundwater feeds all of our permanently flowing surface water bodies as baseflow. Our groundwater also swells after the annual snowmelt to exacerbate spring flooding, and at any time can cause erosion when it seeps out of slopes. Our groundwater is also the vehicle which creates our karst, which in our watershed are networks of wide dissolved cracks throughout our limestone aquifers.

FIGURE 2.14 Use of Underground Drinking Water Reserves and Highly Vulnerable Aquifers Across the Rideau River Watershed: Private and Public Groundwater Takings



Source: Provincial Water Well Records and Permit To Take Water database

Our Groundwater Systems

Contrary to some beliefs, local groundwater aquifers are not underground rivers. Instead, our groundwater flows slowly through vast networks of natural cracks and partings in our bedrock and between the grains of the overlying sediments. In the Rideau River Watershed, most of our groundwater resources are found within bedrock aquifers, with a smaller but important portion found within overlying sands and gravels.

Our bedrock aquifers include the Precambrian Shield in the southwest part of the watershed and the layered Paleozoic-aged and Cambrian-aged sedimentary rock units in the northeast. These are mapped and drawn in Figures 2.15 and 2.16 below. Photographs of these systems are presented in the physiography section of this report.

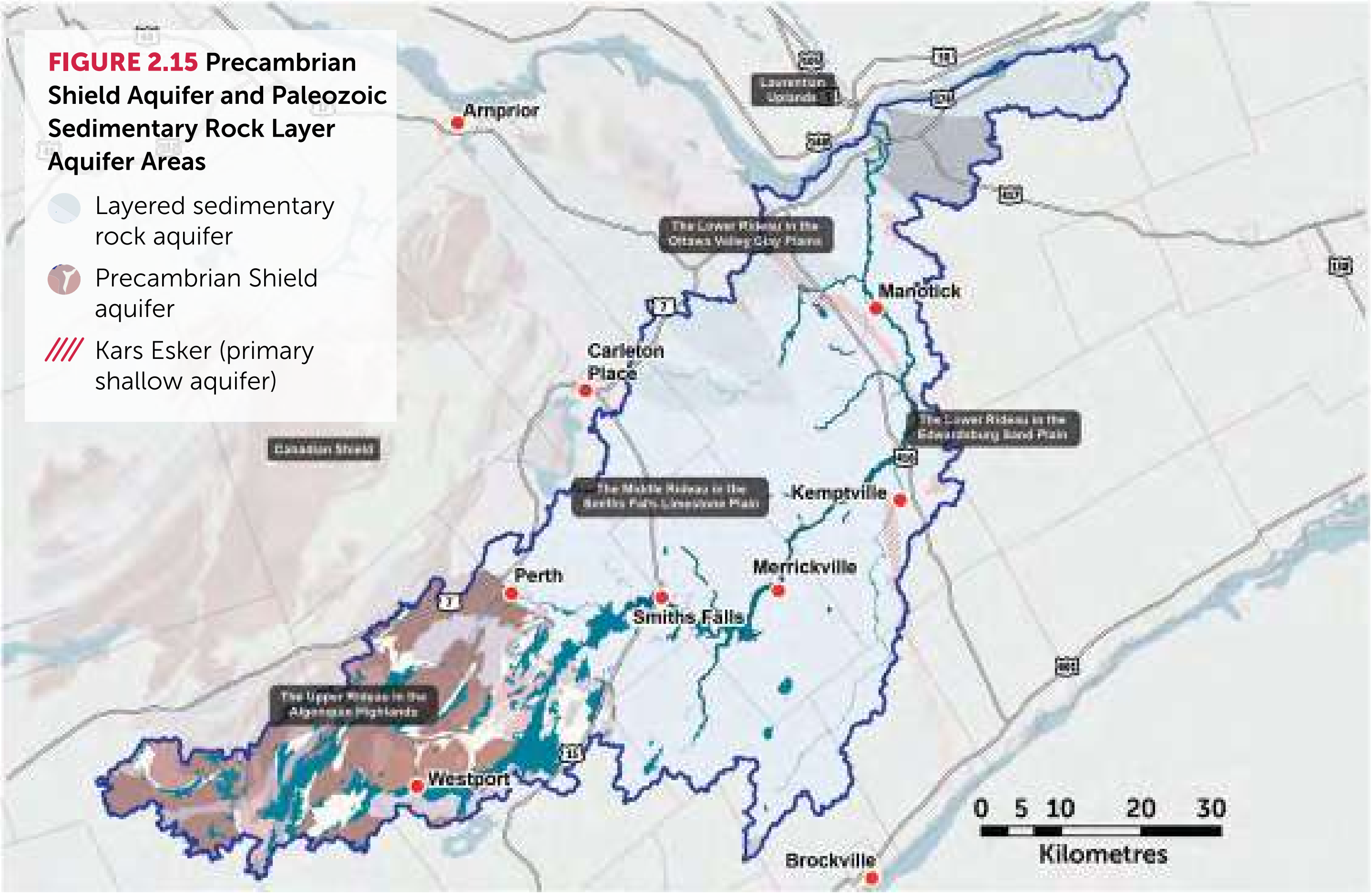


FIGURE 2.15 Precambrian Shield Aquifer and Paleozoic Sedimentary Rock Layer Aquifer Areas

Source: Ontario Geological Survey Bedrock and Paleozoic Maps

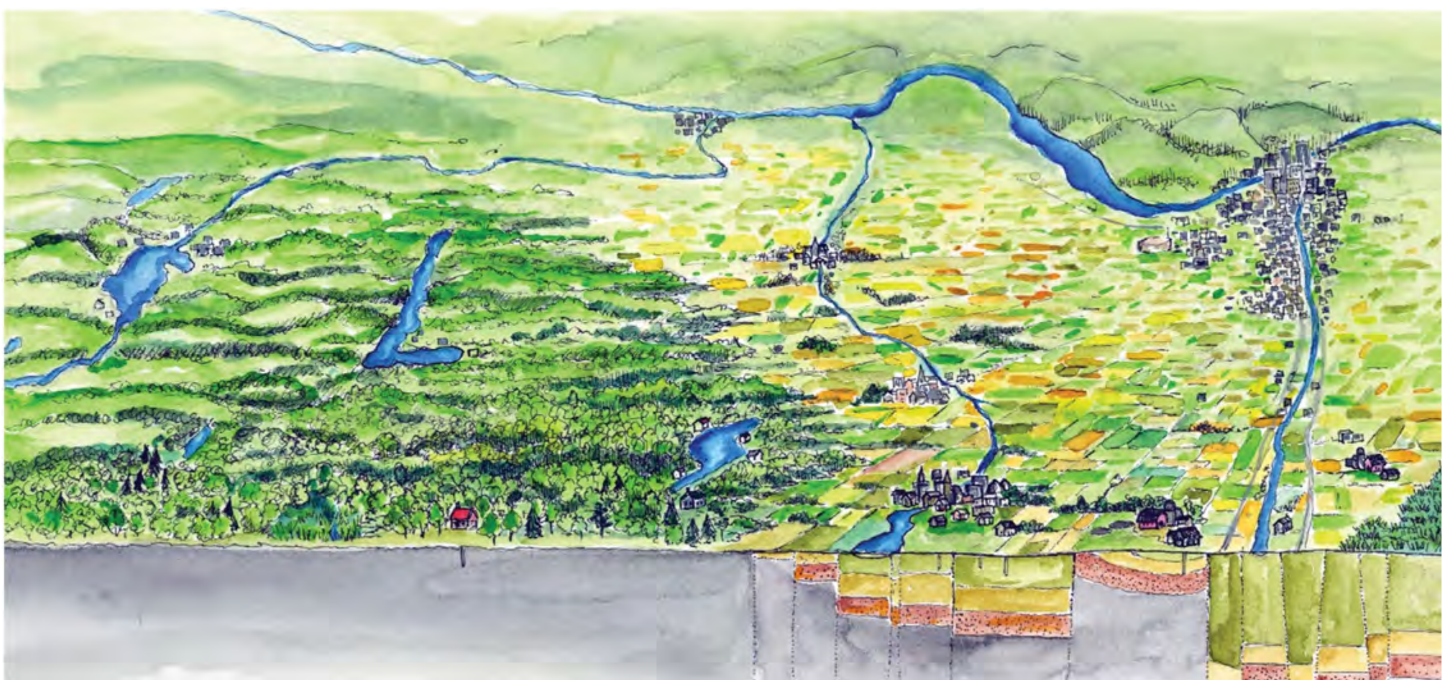


FIGURE 2.16 Artist's portrayal, from west to east, of the Precambrian Shield Aquifer and Paleozoic Sedimentary Rock Layer Aquifer underlying the Mississippi – Rideau Source Protection Region.

Our main overlying sand and gravel aquifer is known as the Kars Esker. Eskers are long, partially buried, and roughly cylindrical geological features deposited during the last glaciation. The Kars Esker runs from the Ottawa River in Mississippi River Watershed southeast to the village of Kars in the Rideau River Watershed. The esker is made up of sand, gravel and boulders.

▲ Boulders amongst sand and gravel in an esker aquifer.

Both the shallow bedrock and the sandy aquifers described above are known to be Highly Vulnerable Aquifers (HVA). Many of these areas are also formally designated by the Mississippi-Rideau Drinking Water Source Protection program as Significant Groundwater Recharge Areas, which demonstrates their importance to the local hydrological cycle.

Ideal Groundwater System Conditions

There are no specific targets for groundwater levels in aquifers and overlying sediments, other than for these to be sustained as per historic levels to preserve fundamental baseflows to our surface water bodies and preserve aquifer levels for drinking, agricultural, commercial, and industrial water supplies. Ideally, our aquifers would therefore be seasonally replenished with clean snowmelt and rain, and aquifer withdrawals (pumping) would never exceed the rate of replenishment.

Ideally, our aquifers would also optimally provide cold and suitably mineralized water for human and ecological needs, which naturally meets all Ontario and federal drinking water, ecosystem, and recreational water quality standards. Ontario's drinking water standards, guidelines, and objectives are discussed in the *Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines* [34]; whereas health-related maximums are listed in *Ontario Regulation 169/03: Ontario Drinking Water Quality Standards*[35]. Details of some standards for private wells are further presented in Ontario's Procedure D-5-5 Private Wells: Water Supply Assessment[36].

Also, Canada's drinking water standards are available in the *Guidelines for Canadian Drinking Water Quality - Summary Tables*[37]. Ecological and recreational standards for surface water, meanwhile, are discussed in the Surface Water Quality section of this report.

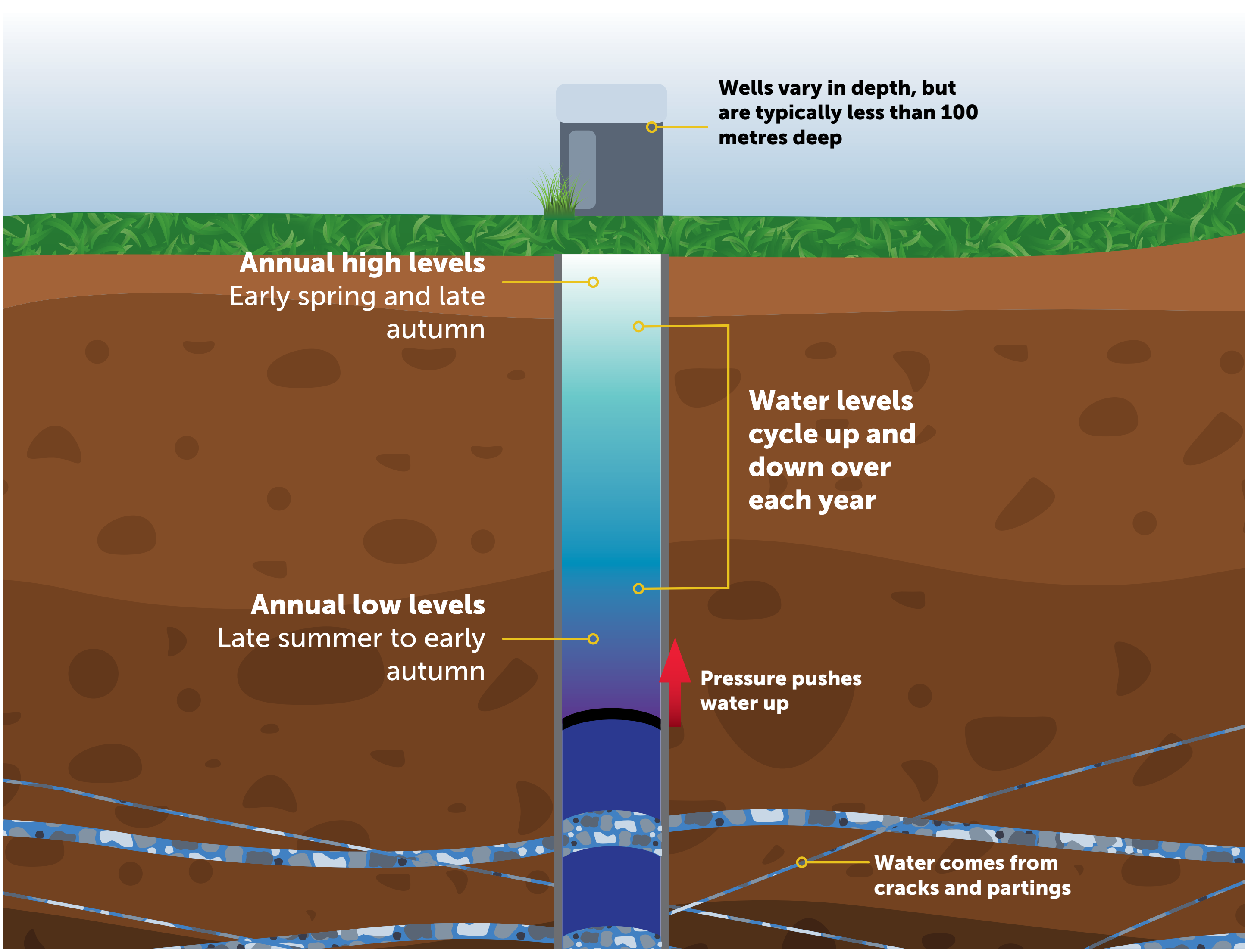
CHARACTERIZING OUR GROUNDWATER SYSTEMS

Groundwater systems in and of themselves are extremely expensive to characterize. Historically, the wide range of important societal and individual benefits associated with understanding groundwater systems have been poorly understood at all levels of society, including government agencies. As a result, groundwater is generally not sufficiently characterized in the Rideau River Watershed, as elsewhere. However, there is better quality information available now than there was even ten years ago for our watershed, and below is a summary of the information we have gathered about our watershed's groundwater systems.

Groundwater Levels and Flow

The groundwater table generally exists just a few metres below the ground surface, across the watershed. It can be pictured as being not much deeper than the water levels in the closest lake, stream, river, or wetland since the groundwater table is naturally at the ground surface around those features.

FIGURE 2.17 Average seasonal well water levels in the Rideau River Watershed



The shallow groundwater table and the water levels (pressures) in our deeper aquifers move up and down throughout each year in similar cycles. However, the height of the groundwater table is different than the height to which water levels rise in a well from a deeper aquifer.

Groundwater levels in our aquifers are normally highest in the spring, just after the snow melts and just before the growing season kicks-off for another year. Groundwater levels are often also high in the late autumn, just after the growing season winds down for the year but before the ground freezes. Our aquifers are replenished mainly during these shoulder seasons. High water tables notably can contribute to the seasonally high water levels in our floodplains.

Our groundwater levels are generally lowest in the early autumn just prior to the end of that year's growing season. During the growing season, the vegetation across the watershed drinks up the rain that would otherwise seep down into the aquifers. However, since our aquifers mostly lie exposed at the ground surface, large summer storms can often provide enough rain to get past thirsty vegetation to reach the groundwater table.

Groundwater levels are normally highest in the spring, just after the snow melts and right before the growing season. Levels are also high in the late autumn after the growing season winds down but before the ground freezes.

Since about 2001, groundwater levels have been recorded continuously in 17 monitoring wells at 14 different locations across the watershed, as part of the Provincial Groundwater Monitoring Network (PGMN) Program. Continuous groundwater level charts have been produced from this data. In addition to some very old quarries where groundwater is monitored, these will be the longest records of groundwater levels in the Rideau River Watershed. Individual groundwater level charts are available at the province's interactive mapping portal.[38]

The approximate median groundwater levels from each monitoring well, as depths below ground, are shown in Figure 2.17. This is a simple way to see typical groundwater levels across the watershed over the past 20+ years. These levels are not necessarily the water table but rather the height to which pressurized groundwater will rise in a well.

More generalized groundwater levels from across the watershed are also seen in Figure 2.18, as elevation contours at 25 metre intervals. These were included in the *Mississippi-Rideau Source Protection Region Watershed Characterization Report*. These levels are reported as metres above mean sea level rather than as depth below ground so that one can see where the groundwater is flowing, which is from higher elevations to lower elevations, and which is irrespective of the depth of water below ground at any given point.

The data comes from one-time measurements at the tens of thousands of private wells that have been drilled across the watershed over the past approximately hundred years. So, the data is from different years that have occurred during somewhat different climate regimes and may represent the water level at any point in its annual cycle of changing levels.

However, for an entire watershed, the dataset is still useful to consider since the water level in each of those private wells would change throughout any given year within the mapped 25-metre interval. Further, in our watershed there are no known increasing or decreasing groundwater level trends across the past hundred years, beyond the annual cycle.

Under the southern and central parts of the watershed, the groundwater appears to be flowing very slowly from the southwest to the northeast after which some of it may flow towards the St. Lawrence River and some to the Ottawa River. Where that path diverges, however, is undefined.

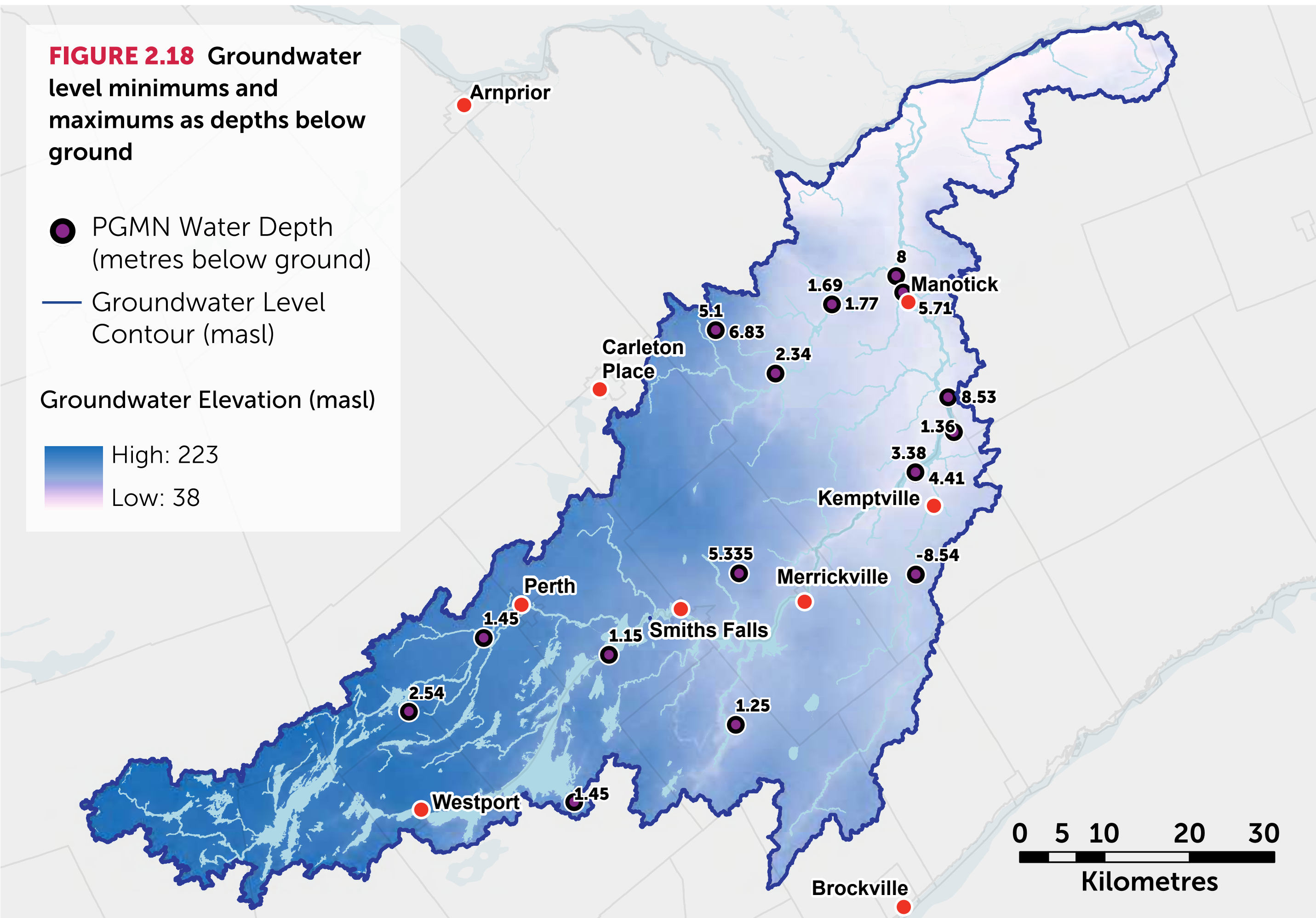
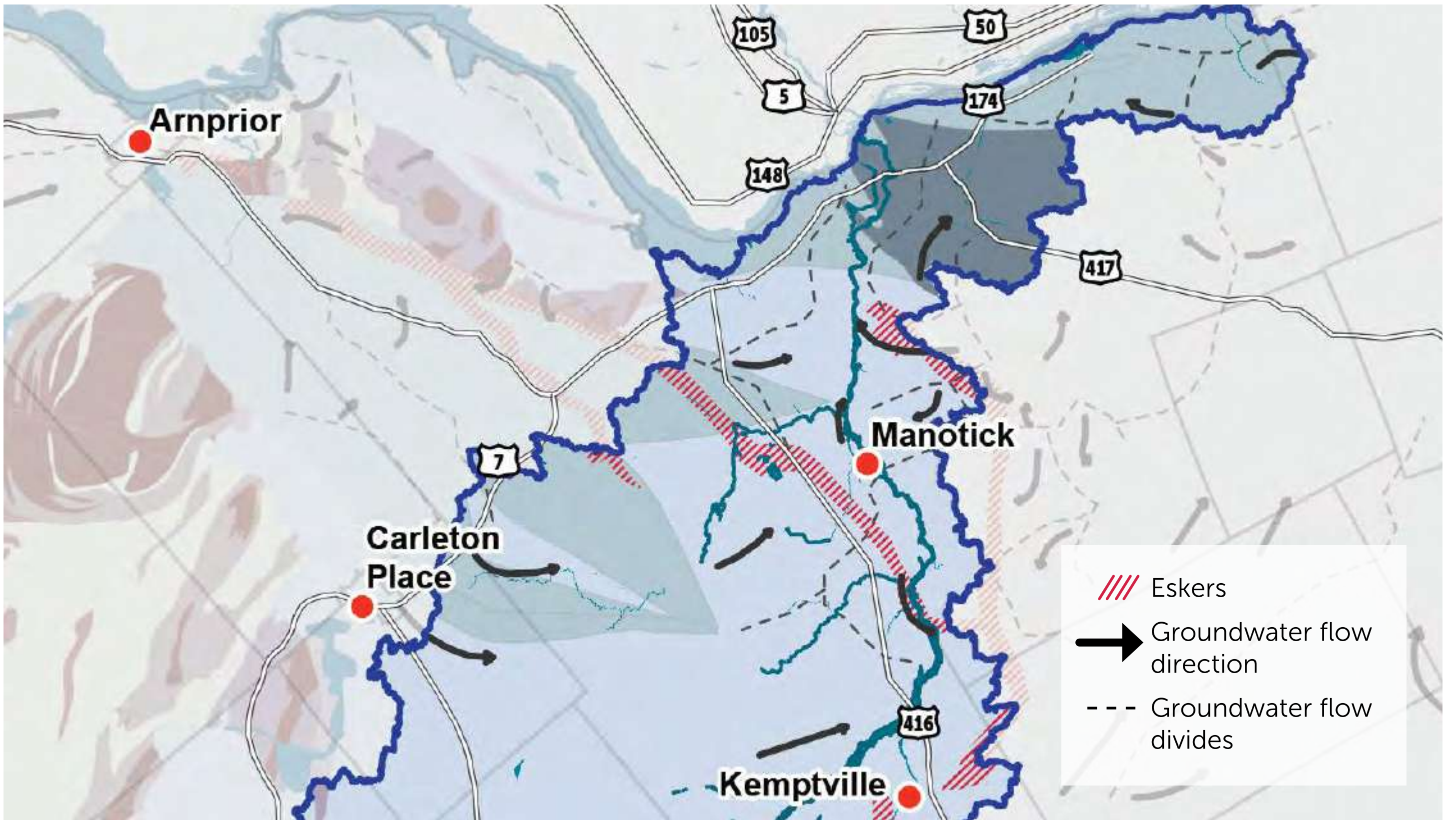


FIGURE 2.18 Groundwater level minimums and maximums as depths below ground

For the northern parts of the watershed (and the Ottawa River subwatersheds within the City of Ottawa), digital groundwater level data is also available from the City of Ottawa's 2019 hydrogeological information geodatabase. That data establishes that bedrock groundwater flow directions are more complicated than previously thought.

Indeed, we also can see the complexity of understanding groundwater flow directions from the *Urban Geology of the National Capital Region* project by the Geological Survey of Canada[39] (2000). In the following figure, the GSC estimated that bedrock groundwater diverges at the illustrated flow divides.

FIGURE 2.19 Bedrock groundwater flow divides and direction from the Urban Geology of the National Capital Region



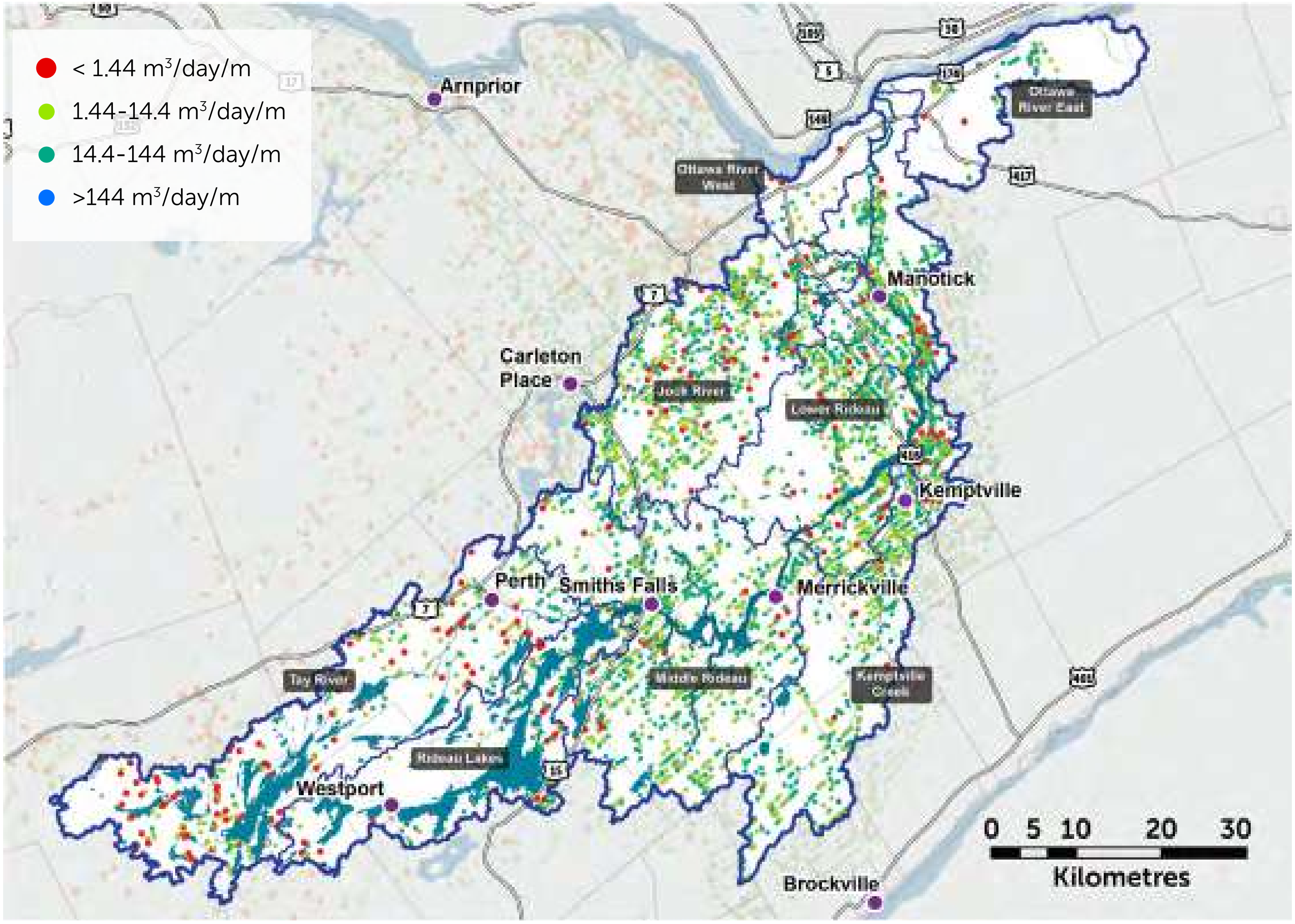
Based on the knowledge we have already, it can be assumed that if even more data was obtained from both across the region and from different depths, that the actual groundwater flow conditions would become clearer but also show an even greater complexity. A main take-away from this is to assume we cannot predict groundwater flow directions to any great accuracy, so conservative approaches to site specific studies and preventing contamination are essential.

Groundwater yield

An aquifer's potential yield largely depends on how much can be stored in the bedrock fracture network or between sediment grains and how well the fractures or pore spaces are connected to each other so that they can deliver the groundwater to a well. The yields of bedrock aquifers in the Rideau River Watershed are generally sufficient to excellent for residential use at low to medium densities, with few exceptions, and poor to sufficient for large commercial or industrial water usage. The yields of sandy sediment aquifers are generally known to be good to excellent. However, shallow dug wells are prone to going dry in late summer and under low water conditions since they do not reach down to tap the majority of the sediment aquifer's water.

A simple and long-standing way to look at an aquifer's ability to provide water is to consider the specific capacity of wells across an area. Specific capacities tell us how much water we can get from a well for each metre that the water level drops while it is being pumped. Therefore, a well is a better producer if it provides more water for every metre it drops.

FIGURE 2.20 Distribution of specific capacity across the watershed



Source: Mississippi-Rideau Source Protection Region

▲ **More than 90 percent of the Rideau River Watershed's aquifers are considered highly vulnerable due to exposed, cracked bedrock.**

GROUNDWATER QUALITY

Across the watershed, our natural groundwater almost always looks fresh and clean as it comes out of our water wells. It is typically cool, clear, colourless, and odourless. It often looks thirst quenching and enticing. In many locations, our groundwater is naturally safe and aesthetically pleasing to drink and suitable for use. In some locations, however, our groundwater requires treatment for it to be pleasing and suitable for use in our homes, offices, and businesses. In some locations, our groundwater can even be naturally unsafe to consume to varying degrees.

Our groundwater exhibits this variability in quality since it contains many dissolved substances in it that we cannot see, taste, or smell. This is because our groundwater circulates very slowly through our watershed's massive basement of rock. Over the decades, centuries, and millennia, our groundwater has a lot of time to interact with a variety of host sediments and rock, all with different compositions. During its long journey under our watershed, it dissolves many minerals from these hosts.

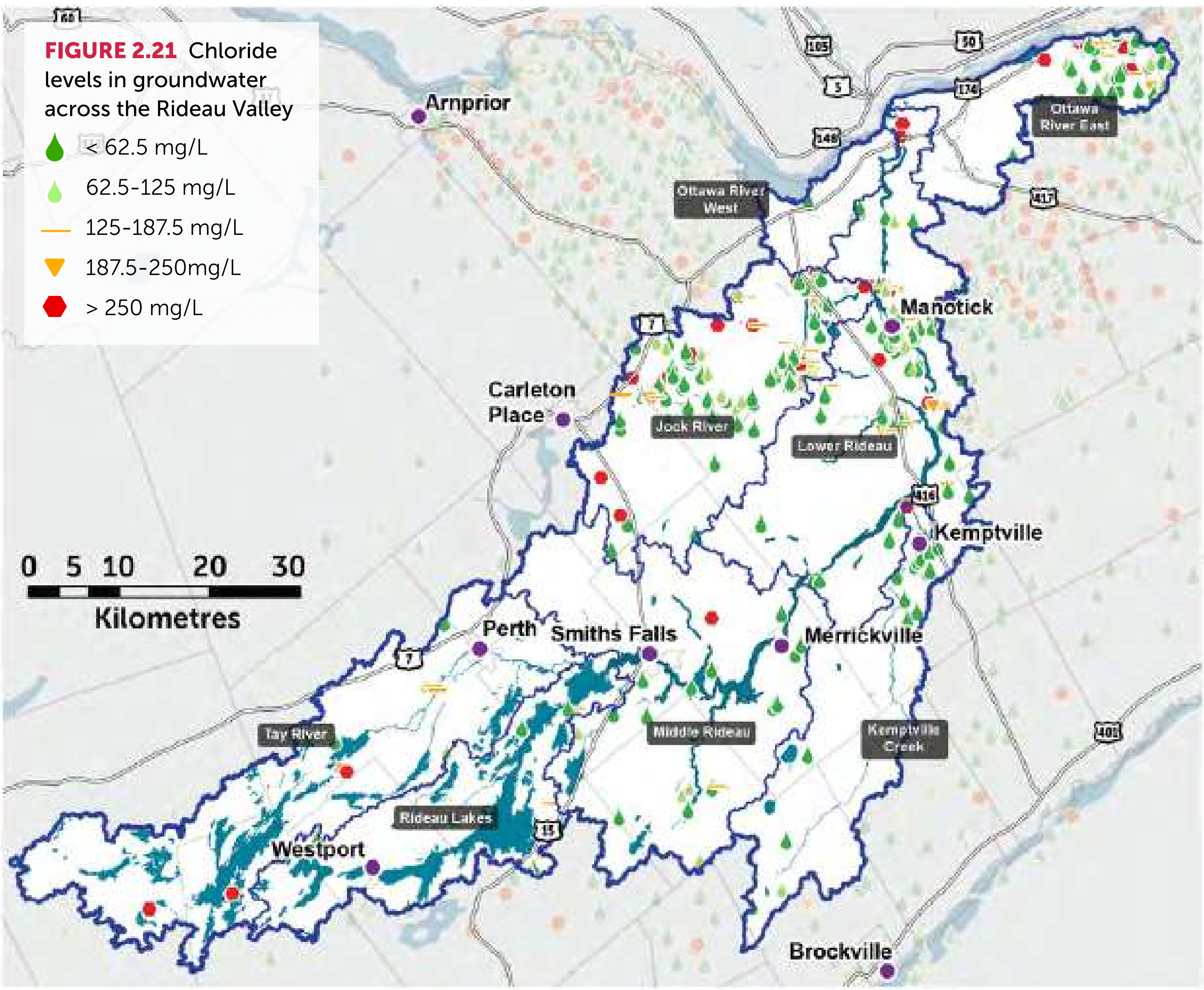
Given that our aquifers are by and large highly vulnerable, our groundwater also has time to receive both short-lived and "forever" contaminants that can seep down from the ground surface.

To better understand the quality of the watershed's groundwater, several organizations have sampled it, at various times and locations for different purposes and using somewhat different methods, for the analysis of hundreds of dissolved substances. For this report, we have chosen to focus on select substances that are commonly used to describe groundwater quality when it is used for drinking water. Depending on the substance, its presence may cause concern for human health or may require treatment to avoid damage to pipes and plumbing fixtures or other personal property.

Chloride

Chloride[40] can taste bad in drinking water between 210 mg/L to 310 mg/L, and it may cause corrosion in pipes and equipment above 250 mg/L. The drinking water guideline* has therefore been set at 250 mg/L by Health Canada and Ontario's Ministry of the Environment, Conservation and Parks (MECP).

Figure 2.21 illustrates the readily available data about chloride in our groundwater. In the watershed, both naturally occurring and human-introduced chloride is variably found above the provincial guideline in groundwater. In the Rideau River Watershed, naturally occurring chloride comes from the ancient marine clay which blankets the lower part of the watershed to variable depths. In our watershed, human-introduced chloride is found mainly along transportation corridors and near municipal works yards, as it comes largely from road salting activities.



Sources: Ontario Geological Survey Ambient Groundwater Geochemistry Database, Provincial Groundwater Monitoring Network Program database

Nitrate

Nitrate[41] (N) in high concentrations has the potential to cause Methemoglobinemia (commonly referred to as "blue baby syndrome"), thyroid dysfunction, and cancer, according to Health Canada. Nitrate is considered unsafe for consumption by infants at or above 10 mg/L and therefore Health Canada and MECP have set the health-related maximum concentration in drinking water at 10 mg/L.

Figure 2.22 illustrates the available data about nitrate in our groundwater, which in the Rideau River Watershed is human introduced. It can enter our groundwater through the watershed's many private septic systems, or through the application of fertilizers or livestock manure at agricultural sites, golf courses, etc. Any level of nitrate is an indicator that sewage may be contaminating a drinking water supply. The presence of nitrate also means that many different types of pathogens, pharmaceuticals, food additives, and chemicals from personal and home care products may also be found in that drinking water, although these substances are essentially never tested.

The available nitrate data doesn't adequately show impacts in privately serviced settlement areas like villages, hamlets, and estate lot subdivisions, where most impacts would be expected. To understand if there are nitrate related problems in those areas, additional focused sampling would have to occur.

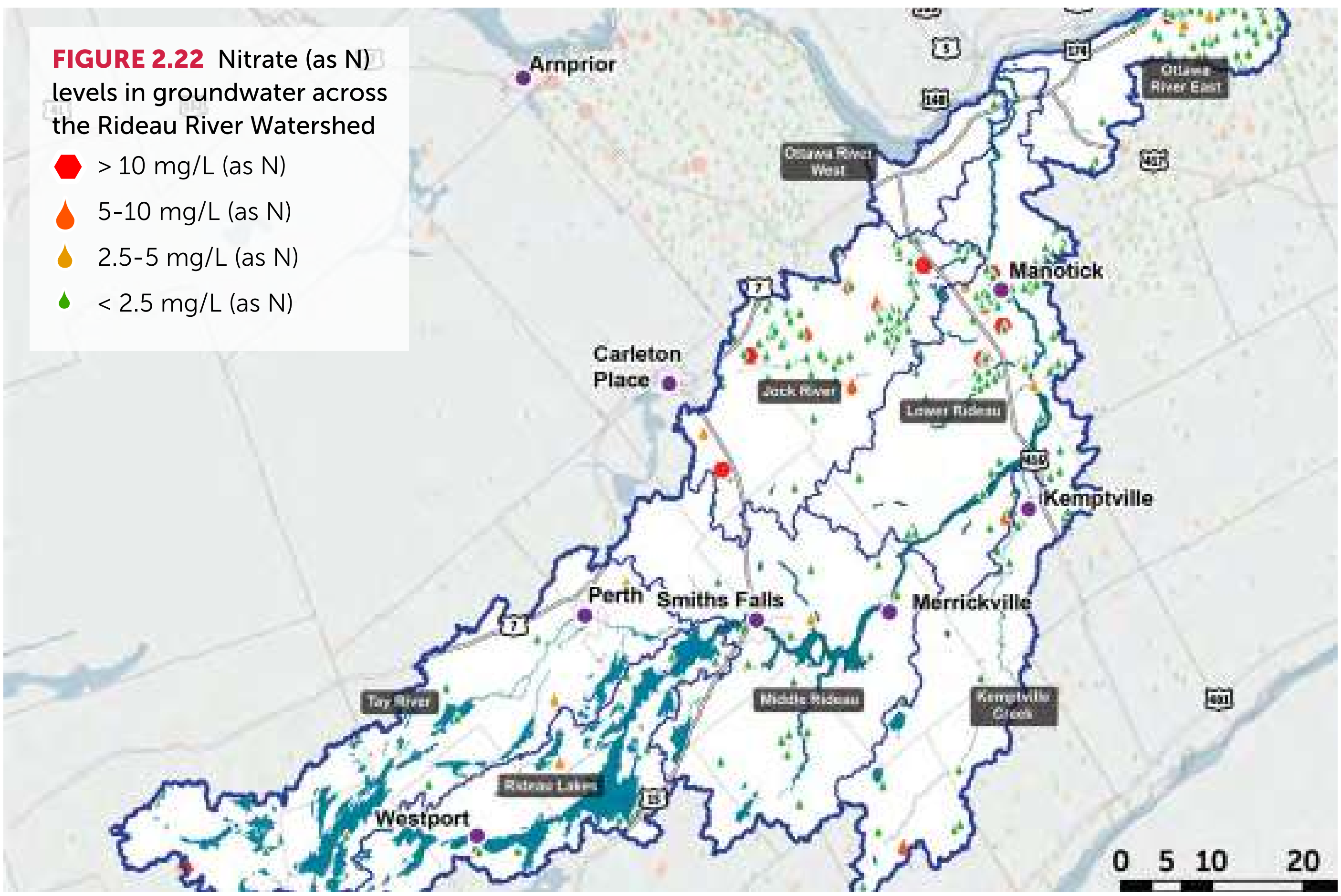


FIGURE 2.22 Nitrate (as N) levels in groundwater across the Rideau River Watershed

Sources: Ontario Geological Survey Ambient Groundwater Geochemistry Database, Provincial Groundwater Monitoring Network Program database

Hardness

Hardness[42] in groundwater is generally natural. In high concentrations, it causes telltale crusty deposits (scale) in pipes and equipment. Whereas hardness in low concentrations is “soft” and slowly eats away at (dissolves) pipes and equipment. When hardness exceeds 200 mg/L, most people consider it of poor but tolerable quality. When hardness is below 80 mg/L or above 500 mg/L, it is generally considered unsuitable or unreasonable to use. The ideal balance between scaling and corrosion occurs when hardness is between 80 and 100 mg/L, and this is therefore the drinking water guideline* set by Health Canada and MECP. As per the provincial guidance in MECP Procedure D-5-5, hardness levels up to 500 mg/L can be reasonably treated with accessible equipment and supplies.

Figure 2.23 illustrates the readily available data about hardness in our groundwater. In the Rideau River Watershed as elsewhere, groundwater hardness is mainly caused by the presence of dissolved calcium and magnesium, which comes from the host rocks. Our groundwaters are generally very hard to excessively hard and should be conditioned before use.

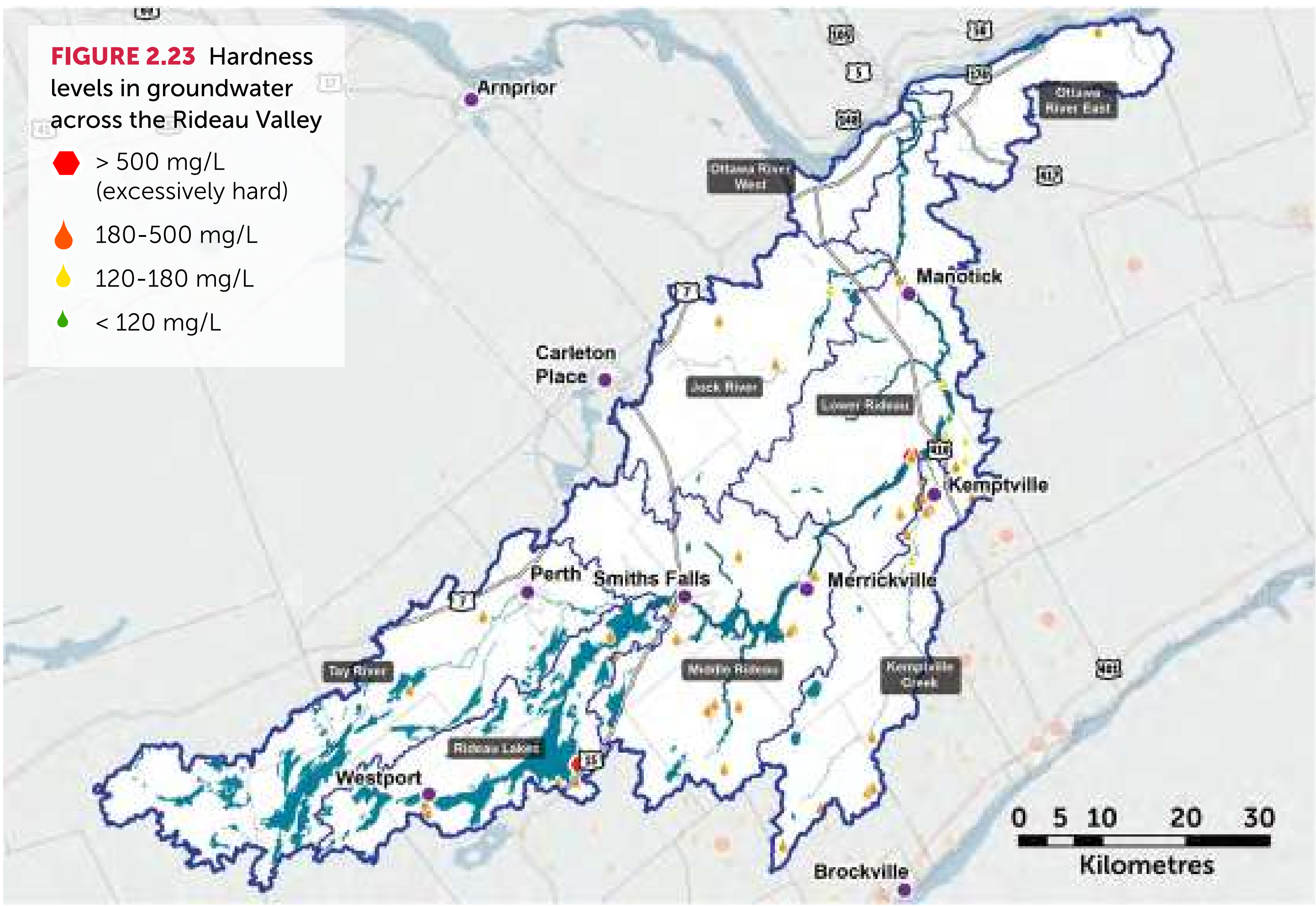


FIGURE 2.23 Hardness levels in groundwater across the Rideau Valley

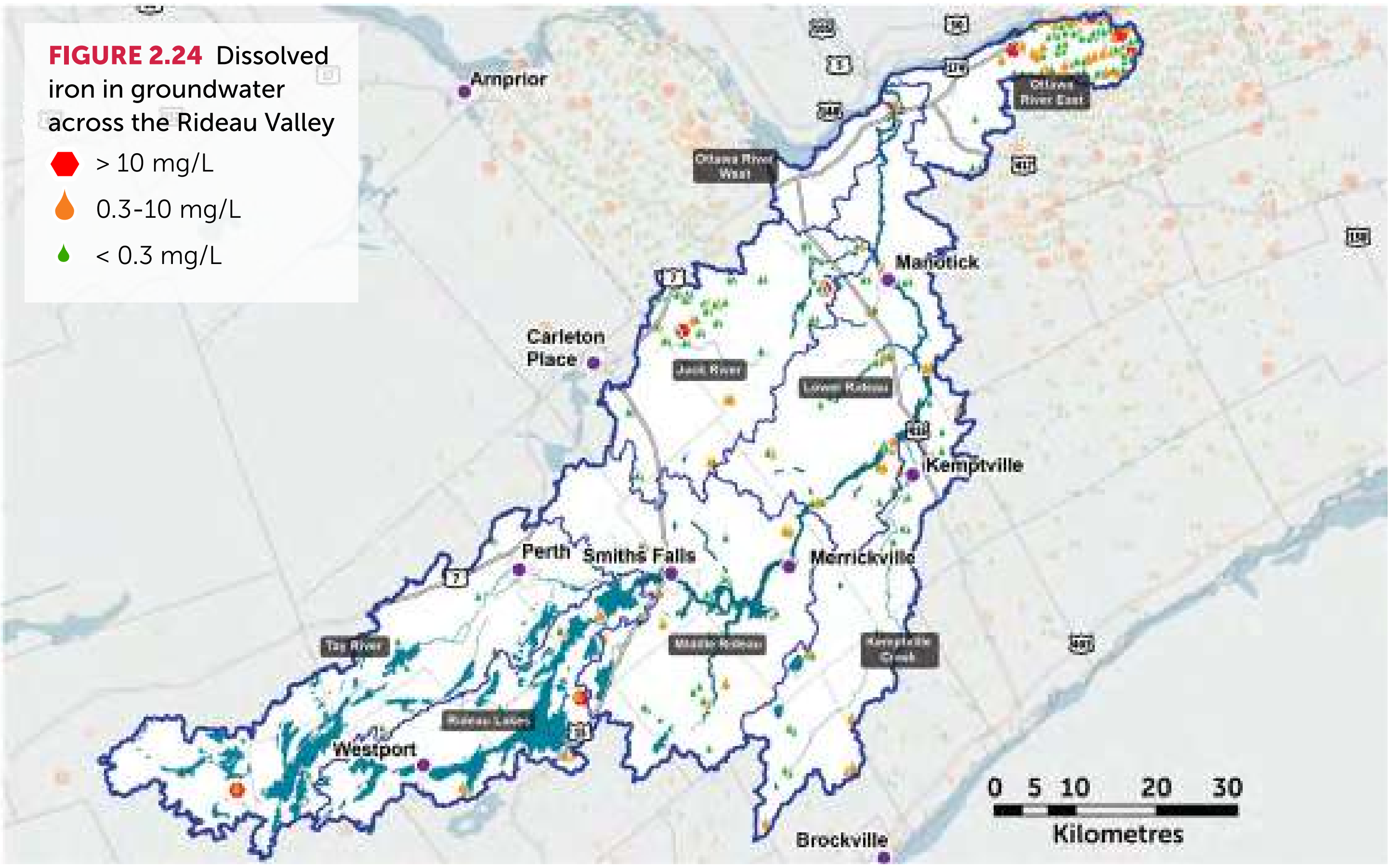
Sources: Ontario Geological Survey Ambient Groundwater Geochemistry Database, Provincial Groundwater Monitoring Network Program database

Iron

Iron[43] dissolved in groundwater is generally natural but can affect the taste of water and stain clothes, sheets, sinks and tubs. It can also cause iron-loving bacteria to create slime in pipes and wells. The drinking water guideline for dissolved iron has been set by HC and MECP at 0.3 mg/L. Below this level, unwanted aesthetic effects should not be of concern. As per the provincial guidance in MECP Procedure D-5-5, levels of dissolved iron up to 10 mg/L can be reasonably treated with accessible equipment and supplies.

Figure 2.24 illustrates the available data about iron in our groundwater. In many areas of the watershed, groundwater has enough dissolved iron in it that it should be conditioned before use.

FIGURE 2.24 Dissolved iron in groundwater across the Rideau Valley



Sources: Ontario Geological Survey Ambient Groundwater Geochemistry Database, Provincial Groundwater Monitoring Network Program database

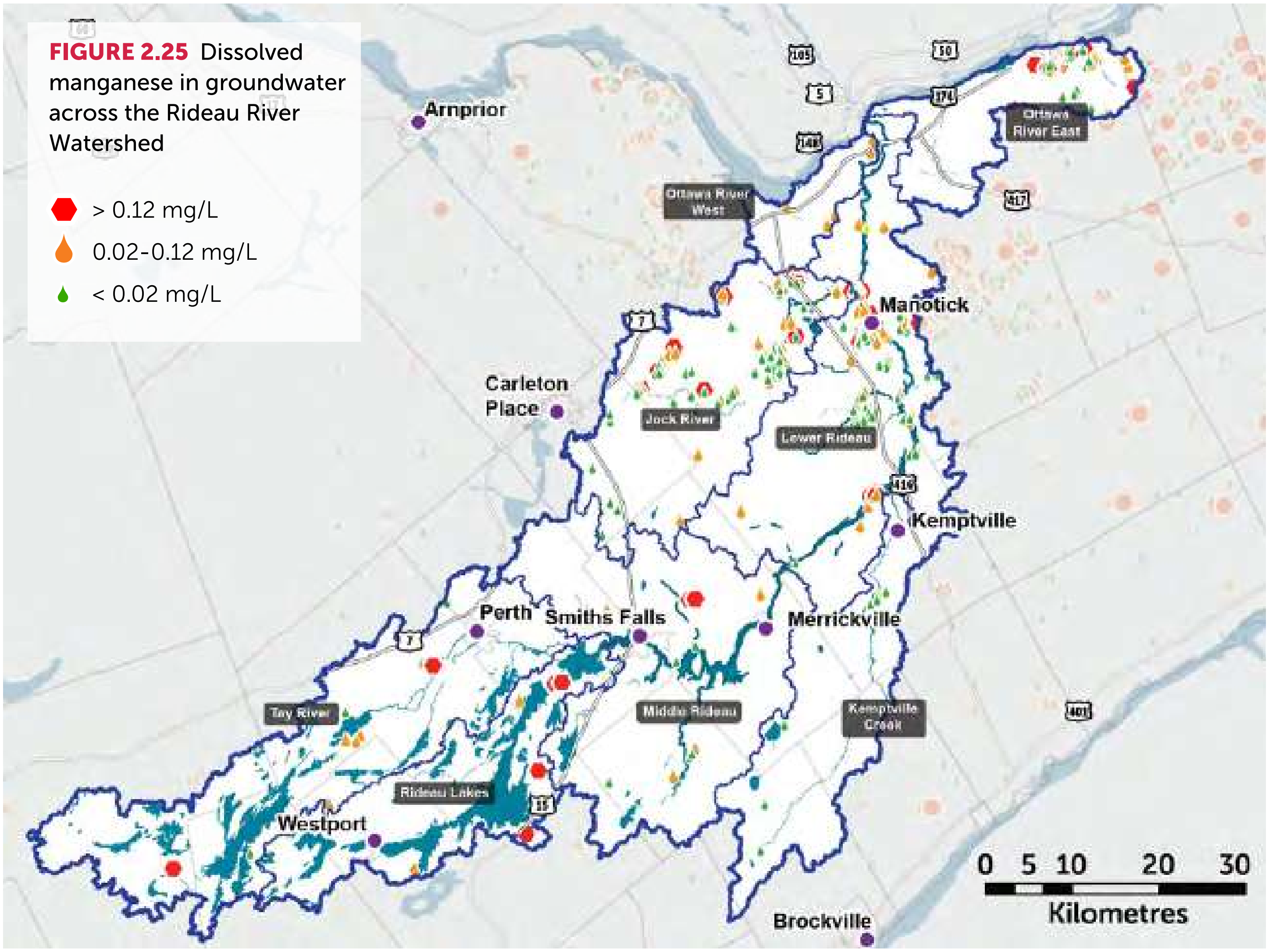
Manganese

Manganese[44] dissolved in groundwater is generally natural, but in high enough concentrations may produce neurological effects in children, according to Health Canda. The maximum acceptable concentration (MAC) has been set at 0.12 mg/L, based on Health Canada's safe consumption limit for infants. Apart from health impacts, manganese also can cause water to stain clothes, sheets, sinks, and tubs. Therefore, Health Canada has set the aesthetic guideline to 0.02 mg/L. In Ontario, the aesthetic drinking water guideline has been set by MECP at 0.05 mg/L. Below these levels, unwanted aesthetic effects should not be of concern.

As per the provincial guidance in MECP Procedure D-5-5, levels of dissolved manganese up to 1 mg/L can be reasonably treated / conditioned with accessible equipment and supplies.

Figure 2.25 illustrates the readily available data about manganese in our groundwater. In some areas of the Rideau River Watershed, groundwater has enough dissolved manganese that it should be treated / conditions before use.

FIGURE 2.25 Dissolved manganese in groundwater across the Rideau River Watershed



Sources: Ontario Geological Survey Ambient Groundwater Geochemistry Database, Provincial Groundwater Monitoring Network Program database

Other common metals

In addition to iron, manganese, calcium, and magnesium, several other common metals, with drinking water (health) standards, (aesthetic) objectives, or (operational) guidelines, are naturally present to varying levels at different locations in the groundwater of the Rideau River Watershed. These include but are not limited to aluminium, arsenic, barium, chromium, sodium and strontium. These dissolved metals can cause various health, aesthetic, or operational concerns if consumed or used at high levels.

Figure 2.26 illustrates the readily available data that we have about where these metals are found in our groundwater. Each data point represents a water well where at least one of the metals has been found at or above its respective standard, objective, or guideline. This data is shown to illustrate that no matter where you are in the watershed, dissolved metals are natural in groundwater and may be found at problematic levels. Note that each substance in Figure 2.24 may have more than one type of quality level. Each one may have a health standard, an aesthetic objective, and / or an operational guideline. Readers are directed to Health Canadas's information about each substance for more information.

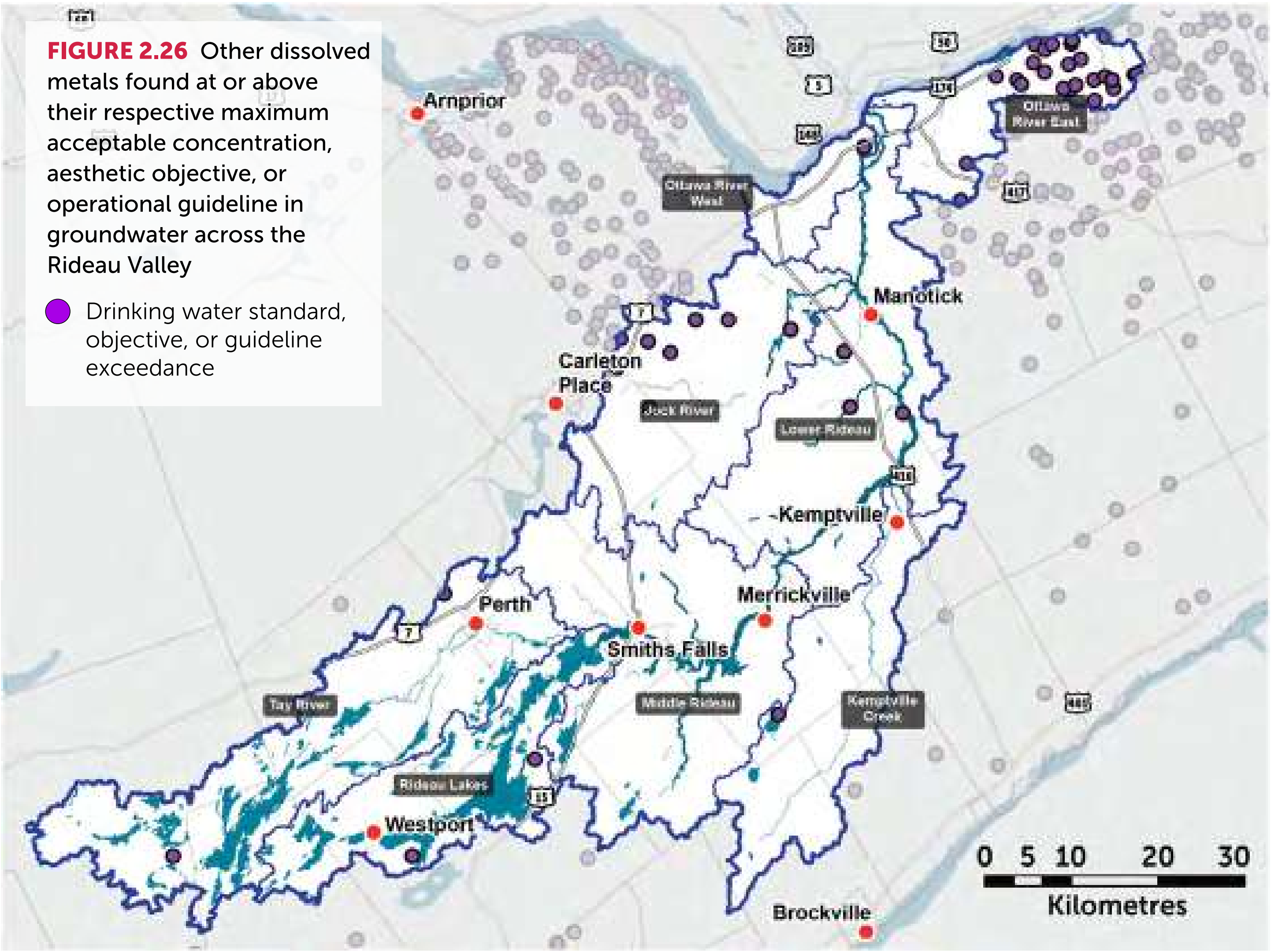


FIGURE 2.26 Other dissolved metals found at or above their respective maximum acceptable concentration, aesthetic objective, or operational guideline in groundwater across the Rideau Valley

IMPACTS AND IMPLICATIONS

Our groundwater systems are invaluable for the health and wellbeing of our families and communities today, and for countless future generations. While we know groundwater is critically important – and that it is under constant threat – we don't know as much about our groundwater as we should. More attention to the quality of groundwater, how it interacts with surface water and how contaminants impact these systems is required if we are to safeguard this vital natural resource for the future.

Renewed interest must be paid to the impacts of growth and development near or overtop of our vulnerable aquifers. Private servicing studies required by the province for all development planning decisions are unevenly applied at the local level, leaving some sites more vulnerable to invisible risks.

The *Ontario Building Code*'s minimum design and construction standards for sewage disposal systems should be treated as such – minimums – particularly in our watershed's large expanses of Highly Vulnerable Aquifers (HVA). In addition, provincial guidance about hydrogeologically sensitive terrain should be better heeded to protect the health and investments of watershed communities, residents, and business owners.

New or growing privately serviced developments must now, more than ever, always be supported by robust terrain and groundwater investigations.

Many municipalities in the Rideau River Watershed require site-specific private servicing studies for subdivision development. However, it is important that the current guidance requiring these studies is also followed for all new, changing, or expanding private services, without exception. This would pertain to any number or size of lots and to any type of development, including residential, commercial, institutional, and industrial. Further, all privately-serviced settlement areas should be supported by the long-term impact assessments that are required by provincial planning policy to justify continued reliance on private servicing for growth.

Renewed interest must also be paid to the health of growing communities that rely on groundwater with all its variability in quality. New or growing privately serviced developments must now, more than ever, always be supported by robust terrain and groundwater investigations. Further, the analysis should include all common trace metals and parameters needed to understand potential impacts from adjacent land uses.

In addition, all new or growing municipally serviced development should, now more than ever, use robust mitigation measures to keep contaminants from slipping through the cracks. Intensive agriculture, industrial land uses, and winter maintenance also all require more scrutiny regarding the potential for groundwater contamination. Stewardship programs, partnerships, and grants will go some way to help individual landowners in the watershed embrace best practices for groundwater protection. However, it is large developers and regulators - be them private, municipal, provincial, or national - that must do the lion's share of protection, since they are responsible for the land use and oversight that either creates most related impacts or prevents and mitigates potential impacts.

In the end, robust government policy, technical innovation, the implementation of long-standing provincial regulations and guidance, and a broad community commitment to protecting local drinking water reserves will be paramount to ensuring our groundwater is protected in perpetuity for the benefit of all.

RESOURCES AND REFERENCES

In the Rideau River Watershed, aquifers and their groundwater have been characterized through the following programs:

The provincial water well information system, from which we get the breadth of our aquifer's knowledge: https://www.ontario.ca/page/map-well-records

The following studies, amongst a handful of others, produced the preliminary understandings of our aquifer systems on a regional basis: Ground Water Survey of The Regional Municipality of Ottawa-Carleton (1970); the Tay River Watershed Groundwater Study (2000); The Renfrew-Mississippi-Rideau Groundwater Study (2003); and the Leeds and Grenville Groundwater Study (2003). These studies are available upon request.

- The Mississippi-Rideau Source Protection Program, under Ontario's Clean Water Acts and Conservation Authority Acts, has characterized the region's water supply aquifers and surface waters that are used for municipal drinking water supplies. The program has produced detailed wellhead protection studies for each municipal well; and has also identified the areas of obvious aquifer vulnerability and areas where groundwater recharge likely occurs preferentially. Further, it works to manage threats to municipal sources of water in partnership with local municipalities.

- The Ministry of the Environment, Conservation, and Park's (MECP) Provincial Groundwater Monitoring Network (PGMN) Program is implemented by local conservation authorities within their area of jurisdiction, as per Ontario Regulation 686/21: Mandatory Programs and Services and MECP standards. The PGMN Program monitors long-term aquifer water levels and annually tests groundwater chemistry at select monitoring wells. Findings from this program are available in the next section.

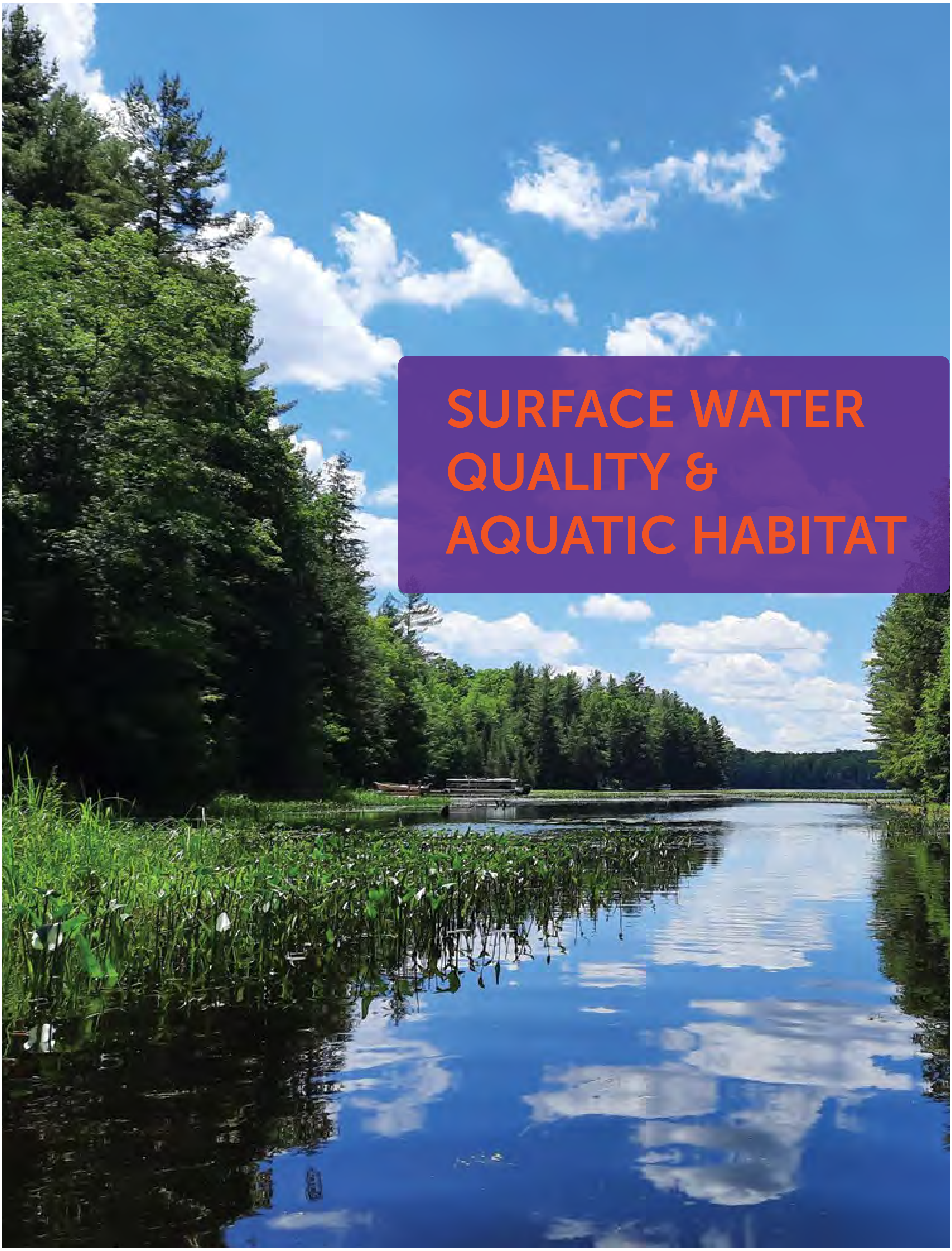
- The Ontario Geological Survey's detailed ambient groundwater geochemistry survey has recently provided a wealth of information about natural groundwater quality, which has proved very relevant to our collective understanding of regional geohazards, like karst, and potential risks to public health, such as from naturally high and problematic levels of some dissolved substances.

- The Ontario Geological Survey's bedrock and surficial geological mapping products, amongst others, have provided the foundational aquifer information for our region.

- Private professional geoscience and engineering consultant projects are also produced over short periods for municipal and conservation authority groundwater studies, contaminated site monitoring and remediation projects, and for the development industry. These mainly provide site specific information necessary to make planning and development decisions.

In addition, in select areas, we may also have information from the following sources:

- Some aspects of municipal well water quality monitoring programs may provide some information about natural groundwater quality/chemistry;
- Several federal government ministries are located within Canada's National Capital Region and undertake select high quality groundwater related research projects for their own purposes;
- Universities, over the decades, occasionally also undertake high quality groundwater research projects in the region. A list of theses pertaining to local areas is available upon request.


SURFACE WATER
QUALITY &
AQUATIC HABITAT

The Rideau River Watershed is rich with many lakes and rivers, as well as hundreds of streams, creeks and other smaller headwater tributaries. These water bodies support both the local ecosystem and the local economy, while providing exceptional recreational opportunities for residents and visitors alike. But across the watershed, this abundant surface water is not always what it seems: its health and quality ranges from very poor to very good, with a span of reasons just as wide.

Generally, excessive nutrient levels are the main driver of low water quality scores. In turn, those high nutrient levels usually correlate with natural sources like wetlands or human-influenced sources like increased urbanization, hardened landscapes or high-intensity agriculture.

While the data shows our lake conditions are generally unchanging on a broad scale, some signs of change are emerging, including increased harmful algae bloom occurrences and anecdotal evidence of warming water temperatures that hint at the impacts of human activity and climate change.

Our rivers, streams and other smaller tributaries are also showing signs of stress, particularly in developed areas, although trends are a mixed bag of success stories and concern. In most catchments, statistically significant trends were not present. But when they were, most trends pointed to an improvement in water quality.

Overall, urban areas demonstrate more issues. Chloride (Cl) is on the rise across the entire watershed but particularly in developed areas. This is likely tied to use of road salt in winter maintenance activities. Ammonia (NH_3) consistently exceeds provincial guidelines in developed areas, although it's now on a downward trend; total phosphorous is also higher in urbanized areas and often exceeds provincial guidelines, with a mix of upward and downward trends across the watershed.

In short: surface water quality across the watershed is a mix of good and bad news stories. Conditions are often hyper-local and directly correlate to activities nearby. Solutions are just as varied.

Surface water quality across the watershed is a mix of good and bad news stories. Conditions are often hyper-local and directly correlate to activities nearby.

Why should we care?

Under ideal conditions, healthy waterbodies – as part of a broader healthy watershed – support and create diverse ecosystems. Healthy rivers and lakes provide clean, safe habitats for the many species that depend on them. Clean and healthy waterways also buoy up the economy by supporting industries and providing resources for nearby communities. Whether the water is used by residents, farmers, tourist attractions, municipalities, fisheries, or a healthy ecosystem, it's clear that clean surface water has wide-reaching benefits for all. Therefore, understanding the overall quality and conditions of local waterbodies can help us better support them into the future.

How do we measure it?

Our knowledge of water quality and aquatic conditions across the watershed is informed by many different data collection methods and assessments. Water chemistry in our lakes and streams is assessed through several sampling programs that analyze parameters like clarity, temperature, conductivity, pH, dissolved oxygen levels, and levels of limiting nutrients such as Total Phosphorus (TP) and Total Kjeldahl Nitrogen (TKN). Samples also look for the presence of metals, chloride (Cl) and ammonia (NH_3).

Aquatic conditions can also tell us a lot about water quality. The presence of benthic invertebrates, the health of certain fish communities, the state of shoreline and headwater features and ongoing thermal sampling can all offer important insights into current water quality conditions and highlight areas of concern. Combined, these monitoring programs provide a holistic view of surface water quality and its impact on the aquatic environment across the Rideau River Watershed.

SURFACE WATER CHEMISTRY: LAKE CONDITIONS

The Rideau River Watershed contains hundreds of lakes, most of them located in the Upper Watershed. Some lakes are highly developed, with many seasonal and year-round properties along their waterfronts. Others are quieter, with cottages and homes spread out around a more undisturbed shoreline. Others are virtually undeveloped.

To assess surface water chemistry in our lakes, RVCA staff sample 39 lakes four times a year between May and October. At each lake, staff profile the water chemistry of a designated deep point, while also using a Secchi disc to assess clarity. Collected samples are analyzed for nutrients like phosphorus and nitrogen, as well as other supplemental nutrients.

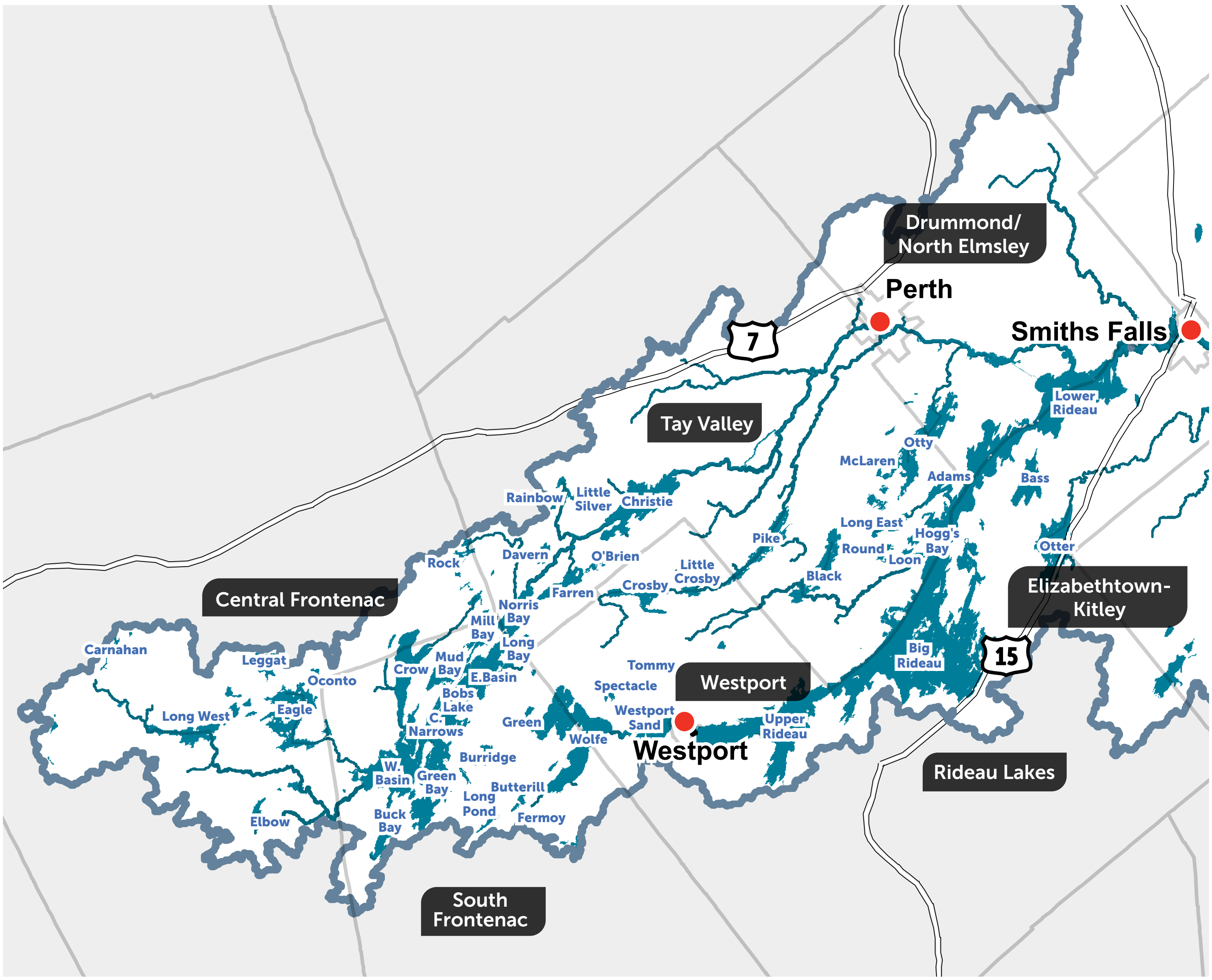


FIGURE 2.27 **Monitored lakes in the Rideau River Watershed.**

Ideal Conditions

Under ideal conditions, a pristine lake is resilient to external impacts, demonstrates healthy shorelines, adequate land cover, and provides valuable ecosystem services (i.e. habitat). Across the watershed, each lake is considered unique. Although some similarities may be found, each lake's position and natural influences within the watershed can impact its appearance and response to outside factors.

Trophic Status

The trophic status of a lake shows its position within geological time. All lakes age naturally and move through geological time; however, outside impacts can influence and accelerate this process. Monitoring results for nutrient concentrations can be used to infer a lake's trophic status[12]. Young lakes are classified as ultraoligotrophic or oligotrophic lakes, while older or aged lakes are classified as eutrophic or hypereutrophic. This aging occurs over centuries as lakes are slowly infilled through erosion and sedimentation, while aquatic plants and vegetation also begin to dominate the substrate. During this process, a lake is moving towards a state of nutrient enrichment which can trigger nuisance algal blooms and a change in fish habitat. Although no trophic status is better than another, understanding a lake's trophic status can help to improve our understanding of a lake's baseline conditions, sensitivities, and predicted response to outside impacts.

Table 2.6 Lake Trophic Status Ranges

Trophic Status	Total Phosphorus Concentration
Ultraoligotrophic	0 - 0.004 mg/L
Oligotrophic	0.004 - 0.01 mg/L
Mesotrophic	0.01 - 0.02 mg/L
Mesoeutrophic	0.02 - 0.035 mg/L
Eutrophic	0.035 - 0.1 mg/L
Hyper-eutrophic	> 0.1 mg/L

In the Rideau River Watershed, lake trophic statuses range from oligotrophic to mesoeutrophic, outlined in Table 2.6. Younger, colder, and deeper oligotrophic lakes lend themselves to clearer waters with fewer nutrients and aquatic plant growth, while aged eutrophic lakes demonstrate diverse and productive habitats with higher nutrient concentrations and clouded waters[13].

In all lakes, the outer limits of the data set (Figures 2.28 and 2.29) suggest there are also instances of excessive or unusual nutrient loading within the watershed. The smaller, shallower, headwater lakes (Carnahan, Elbow, Long (West), and Butterill Lakes) lend themselves to greater influence by wetlands and as such demonstrate higher nutrient concentrations and greater sedimentation. These lakes are often Mesoeutrophic/Eutrophic lakes and accelerated changes as a result of outside impacts are more commonly observed. Similarly, some of these headwater lakes also demonstrate characteristics of a Dystrophic or tea-stained lake as they contain higher carbon contents than others (e.g., Elbow, Carnahan, and Maclaren Lake)[14]. This can also impact nutrient cycling within the lake and may influence aquatic conditions.

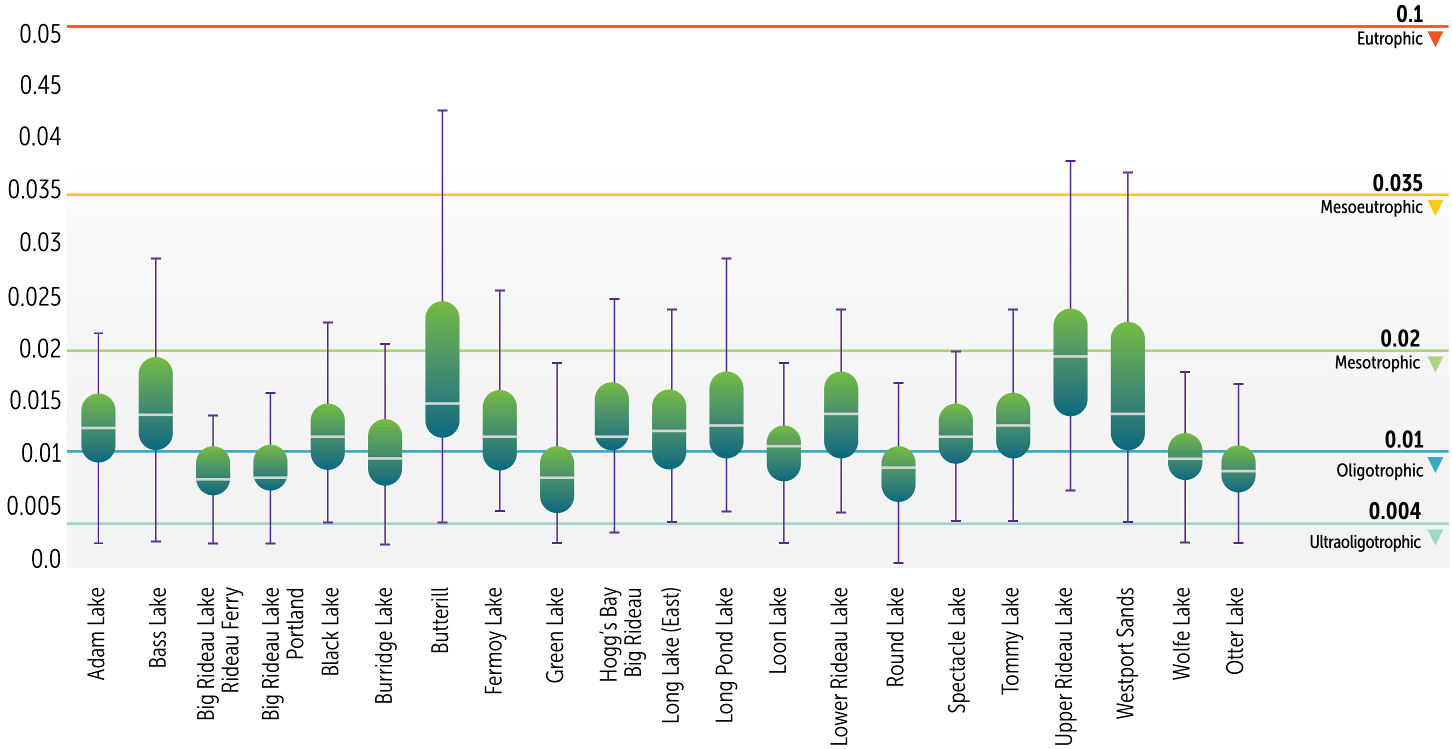


FIGURE 2.28 **Trophic status in the Rideau Lakes and Middle Rideau Subwatersheds as determined by euphotic zone Total Phosphorus concentrations results between 2001 and 2021**

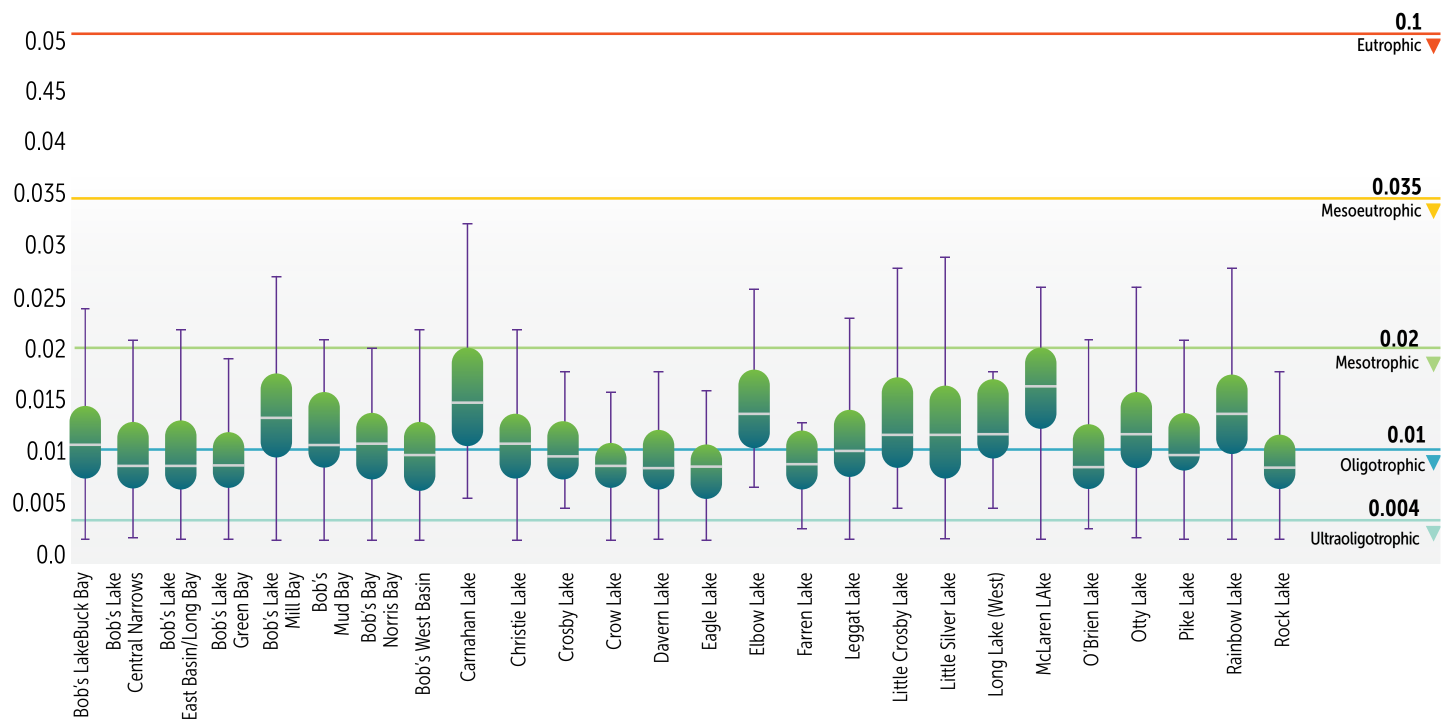


FIGURE 2.29 **Trophic status in the Tay River Subwatershed as determined by euphotic zone Total Phosphorus concentrations results between 2001 and 2021**

Water Quality Index

WQI scores for lakes within the watershed range from Poor to Very Good (Table 2.8). These scores are calculated based on collected data for five parameters (TP, TKN, secchi depth, dissolved oxygen and temperature and pH) from each lake's designated deep point compared against their associated guidelines. Scores are calculated at 3-year intervals[15].

Although a valuable tool, the WQI index for lakes may not accurately account for all the lake's natural conditions and in some cases, may unfairly represent them. Across all monitored lakes, WQI scores range from Poor to Very Good with little movement. In calculating WQI scores, nutrient levels were the main driver in lower WQI scores. In many cases, the nutrient rich and lower scoring lakes are in wetland dominant regions, with naturally higher nutrient levels. These lakes also tend to be shallower in depth and as a result lean towards warmer temperatures and depleted oxygen levels during the late summer months.

Table 2.7 CCME Water Quality Index Score Categories and Descriptions

WQI Ranking	WQI Scores	Water Body Description
Very Good (Excellent)	95 - 100	Water Quality is protected with virtual absence of threat or impairment. Conditions are very close to natural or pristine. This value is received when all guidelines fall within the appropriate range all of the time.
Good	80 - 94.9	Water Quality is protected with only a minor degree of threat or impairment. This value is received when conditions rarely depart from natural or desirable levels
Fair	65 - 79.9	Water Quality is usually protected but occasionally threatened or impaired. This value is received when conditions sometimes depart from natural or desirable levels.
Poor (Marginal)	45 - 64.9	Water Quality is frequently threatened or impaired. The value is received when conditions often depart from natural or desirable levels.
Very Poor	0 - 44.9	Water Quality is almost always threatened or impaired. This value is received when conditions usually depart fron the natural or desirable levels.

Adapted from the Canadian Council of Ministers of the Environment's CCME Water Quality Index User's Manual 2017 update

Table 2.8 Lake WQI score ranges and WQI score trends on collected data from 2010-2021

Lake	2010-2012	2013-2015	2016-2018	2019-2021	Trend
Tay River Subwatershed					
Bob's Lake - Buck Bay	53.5	88.4	88.4	88.2	↔
Bob's Lake - Central Narrows	88.3	76.8	88.4	88.4	↔
Bob's Lake - East Basin/Long Bay*	76.9	76.8	76.7	88.3	↔
Bob's Lake - Green Bay	88.4	88.4	88.4	88.3	↔
Bob's Lake - Mill Bay	65.2	88	75.8	76.5	↔
Bob's Lake - Mud Bay	65	76.7	100	76.8	↔
Bob's Lake - Norris Bay	88.4	65.1	65.1	88.4	↔
Bob's Lake - West Basin	88.4	88.3	88.4	88.4	↔
Carnahan Lake	53.4	75.5	76.8	64.7	↔
Christie Lake	100	100	76.5	88.2	↔
Crosby Lake	88.4	76.8	76.7	76.2	↓
Crow Lake	64.8	100	100	76.7	↔
Davern Lake	74.3	100	88.4	88.2	↔
Eagle Lake	76.8	100	76.7	88.1	↔
Elbow Lake*	53.3	64.2	41.3	53	↔
Farren Lake	88.4	100	88.4	88.4	↔
Leggatt Lake	86.7	76.7	76.8	76.5	↔
Little Crosby Lake	65.1	88.2	76.7	87.6	↑
Little Silver Lake*	76.8	76.5	76.9	65.1	↔
Long Lake West	64.9	41.9	76.5	64.5	↔
McLaren Lake	61.7	59.4	51.2	60.6	↓
O'Brien Lake	76.8	76.5	88.4	100	↔
Otty Lake	88.3	88.4	76.3	88.4	↔
Pike Lake	76.8	100	100	100	↑
Rainbow Lake	76.6	74.9	75.7	76.1	↑
Rock Lake	76.8	76.8	100	100	↔
Rideau Lakes Subwatershed					
Adam Lake	64.4	88.3	76.3	65.1	↔
Bass Lake	65	88.3	76.7	73.6	↔
Big Rideau Lake - Portland*	76.9	88.4	87.9	88.4	↔
Big Rideau Lake - Rideau Ferry	76.4	100	88.4	76.7	↔
Black Lake	65.2	100	76.7	88.4	↔
Burridge Lake	100	76.8	76.8	76.1	↔
Butterill Lake	53.5	70.9	50.4	52.8	↔
Fermoy Lake	76.7	65	76.6	76.5	↔
Green Lake	88.4	76.8	76.8	100	↔

Very Good (Excellent) · Good · Fair · Poor (Marginal) · Very Poor

Table 2.8 Lake WQI score ranges and WQI score trends on collected data from 2010-2021

Hogg's Bay - Big Rideau	52.9	64	76.6	100	←→
Long Lake East	76.6	76.8	76.4	65.1	←→
Long Pond Lake	50.1	76.7	75.8	76.5	←→
Loon Lake	64.3	75.6	64.8	76.4	↑
Lower Rideau Lake	76.5	64.7	76.8	75.5	←→
Round Lake	88.4	88.4	100	100	←→
Spectacle Lake	76.8	76.8	88.4	88.4	←→
Tommy Lake	64.1	76.5	88.2	76.4	←→
Upper Rideau Lake*	64.3	63.9	64.9	76	↑
Westport Sand Lake	52.7	76.7	87.9	88	↑
Wolfe Lake*	76.9	88.4	76.9	88.4	←→
Middle Rideau Subwatershed					
Otter Lake*	76.9	76.8	88.3	88.4	←→

* Denotes a waterbody with multiple monitored deep points ↑ Indicates a statistically significant improving trend
↓ Indicates a statistically significant delcining trend ←→ Indicates no statistically significant trends

Very Good (Excellent) | Good | Fair | Poor (Marginal) | Very Poor

▲ Deeper, cooler lakes tend to score higher on the WQI.

The higher scoring lakes tend to be deeper, cooler lakes, including Pike, Eagle, and Rock Lake in the Tay River Subwatershed, and the Rideau Ferry catchment in Big Rideau Lake in the Rideau Lakes Subwatershed. In many cases, these lakes also demonstrated isolated occurrences of elevated nutrients and fluctuations outside of the guidelines. Across all lakes, WQI scores have fluctuated over the sampling period on record. In some cases, climate factors (i.e. reduced precipitation, warmer temperatures) may be a driving factor in scores. Understanding how each parameter is changing with time can better inform how localized impacts may be driving fluctuating conditions on each individual lake.

Parameter Trends

To understand how lakes are changing with time, statistical trends analyses[16] on collected data were completed. Few significant and consistent trends were identified. Most prominently, within the watershed secchi depth presented a declining trend, along with pH, and for some lakes chemical parameters presented declining trends (Table 2.9).

- Nutrients (TP, TKN):
  Across all lakes, nutrient trends varied. In some cases, improvements were seen, while in other cases declines. The lack of consistency indicates variability across the watershed and suggests the presence of localized impacts from years past and present. Although many lakes demonstrated a declining trend in nutrients, a closer examination of more recent years shows increasing nutrients trends on select lakes (Bass, Burridge, Butterill, Crow, Elbow, Green, Little Silver and Rainbow Lake).

- **Secchi Depth:**
  As a measure of water clarity, declining trends suggest a change in biomass, organic matter, or turbidity within our lakes. In some cases, reduced water clarity could be a result of increased algal biomass within the water column, while in others it may be a signal of changing species populations (e.g. changing invasive Zebra Mussels populations)[17].

- **Calcium (Ca):**
  Naturally derived from the weathering of rock, calcium is a key nutrient for certain aquatic life (e.g. invertebrates)[18]. Within the Tay River subwatershed, calcium levels are on the decline in several major lakes (Bob's, Christie, Crow, etc.), while in the Rideau Lakes subwatershed calcium levels appear to be on the rise in some (Bass, Black, Burridge, and Hogg's Bay) and on the decline in others (Big Rideau – Portland). Changes to calcium concentrations may be a result of historical impacts, however they may influence plankton populations potentially altering food webs.

> **Understanding how each parameter is changing with time can better inform how localized impacts may be driving fluctuating conditions on each individual lake.**

- **Dissolved Organic Carbon (DOC):**
  Originating from the breakdown of organic material, DOC levels vary lake to lake. In regions dominated by wetlands, DOC levels in lakes tend to be higher (e.g., Maclaren, Elbow, Carnahan Lake). In many cases, DOC levels are on the rise. This correlates with declining secchi depths indicating decreasing water clarity. This could suggest that the breakdown and storage of organic matter within our lakes is changing[19].

- **pH:**
  In many of our lakes, pH values collected from the surface appear to be declining. Although pH levels decline naturally as a lake ages, these declines may also result from increased organic matter and plant decomposition. These two variables can increase the presence of carbon within the system, which can slowly decrease lake pH through the production of carbonic acid.

Table 2.9 Lake parameter concentration 75th percentiles and/or median values and trends (p value<0.1) on collected data from 2001-2021

Lake	Total Phosphorus (TP, mg/L)		Total Kjeldahl Nitrogen (TKN, mg/L)		Dissolved Organic Carbon (DOC, mg/L)		Calcium (Ca, mg/L)		Secchi (m)		pH	
	75th Percentile	Trend	75th Percentile	Trend	Median	Trend	Median	Trend	75th Percentile	Trend	75th Percentile	Trend
Tay River Subwatershed												
Bob's Lake - Buck Bay	0.014	↔	0.41	↓	5.7	↔	14.9	↔	3.5	↓	8.2	↔
Bob's Lake - Central Narrows	0.013	↓	0.40	↓	5.7	↔	16.1	↔	3.8	↔	8.2	↓
Bob's Lake - East Basin/ Long Bay*	0.013	↓	0.40	↓	5.5	↑	16.4	↔	4.0	↓	8.2	↔
Bob's Lake - Green Bay	0.012	↔	0.37	↔	4.4	↑	27.2	↓	4.1	↓	8.4	↓
Bob's Lake - Mill Bay	0.017	↓	0.52	↓	6.1	↑	16.3	↓	2.6	↔	8.5	↓
Bob's Lake - Mud Bay	0.016	↓	0.41	↓	4.8	↔	16.2	↓	3.4	↔	8.4	↓
Bob's Lake - Norris Bay	0.014	↔	0.41	↔	5.5	↔	16.0	↔	3.3	↓	8.1	↓
Bob's Lake - West Basin	0.013	↔	0.41	↔	5.9	↔	15.7	↓	3.3	↓	8.2	↓
Carnahan Lake	0.020	↔	0.53	↓	9.2	↔	14.6	↔	2.5	↓	7.9	↓
Christie Lake	0.013	↔	0.38	↓	5.3	↔	18.2	↓	4.5	↔	8.1	↔
Crosby Lake	0.013	↔	0.43	↔	6.7	↔	14.5	↔	4.0	↓	8.1	↔
Crow Lake	0.011	↔	0.32	↔	4.4	↑	17.7	↓	4.5	↓	8.4	↓
Davern Lake	0.012	↔	0.43	↔	5.7	↑	30.5	↔	3.5	↓	8.6	↔
Eagle Lake	0.011	↔	0.36	↔	4.6	↔	14.5	↔	4.5	↓	8.5	↓
Elbow Lake*	0.018	↔	0.50	↔	7.8	↑	7.3	↔	2.0	↓	7.9	↓
Farren Lake	0.010	↔	0.37	↔	4.7	↔	26.8	↔	4.6	↓	8.5	↓
Leggatt Lake	0.014	↔	0.38	↔	4.1	↑	8.3	↔	4.2	↓	8.1	↔
Little Crosby Lake	0.017	↓	0.44	↔	6.8	↔	15.8	↓	3.0	↓	8.1	↔
Little Silver Lake*	0.016	↓	0.45	↔	5.3	↑	17.4	↔	3.5	↓	8.1	↓

Table 2.9 Lake parameter concentration 75th percentiles and/or median values and trends (p value<0.1) on collected data from 2001-2021

Long Lake West	0.017	↔	0.47	↔	6.6	↔	10.4	↔	2.5	↓	8.1	↔
McLaren Lake	0.020	↓	0.67	↔	10.1	↔	20.8	↔	2.5	↓	8.3	↔
O'Brien Lake	0.012	↔	0.44	↓	6.5	↑	22.0	↔	4.0	↓	8.1	↔
Otty Lake	0.016	↔	0.47	↔	6.5	↔	27.8	↔	4.4	↓	8.4	↓
Pike Lake	0.014	↔	0.43	↓	5.7	↔	17.5	↔	3.5	↓	8.3	↔
Rainbow Lake	0.017	↓	0.55	↔	7.0	↔	19.3	↔	2.6	↔	8.0	↔
Rock Lake	0.011	↔	0.40	↔	6.8	↔	5.0	↔	3.4	↓	7.8	↔
Rideau Lakes Subwatershed												
Adam Lake	0.016	↓	0.48	↔	5.7	↑	30.0	↔	3.9	↔	8.4	↔
Bass Lake	0.019	↑	0.47		4.9	↔	14.2	↑	4.2	↔	8.4	↓
Big Rideau Lake - Portland*	0.011	↔	0.35	↔	4.6	↑	24.1	↓	6.0	↓	8.4	↔
Big Rideau Lake - Rideau Ferry	0.011	↔	0.37	↔	4.4	↔	24.5	↔	5.3	↓	8.3	↓
Black Lake	0.015	↓	0.47	↓	6.6	↓	19.5	↑	4.0	↔	8.3	↔
Burridge Lake	0.013	↔	0.43	↔	6.5	↑	18.5	↑	4.5	↔	8.4	↔
Butterill Lake	0.024	↑	0.62	↔	6.2	↑	15.5	↔	3.0	↔	8.2	↔
Fermoy Lake	0.016	↔	0.41	↔	5.2	↔	20.0	↔	3.4	↓	8.1	↔
Green Lake	0.011	↔	0.31	↔	4.2	↔	4.1	↔	5.0	↓	8.1	↓
Hogg's Bay - Big Rideau	0.017	↔	0.50	↔	6.5	↑	23.0	↑	3.3	↔	8.2	↔
Long Lake East	0.016	↔	0.46	↔	5.4	↔	20.4	↔	4.5	↓	8.4	↓
Long Pond Lake	0.018	↔	0.50	↔	6.9	↑	25.0	↔	3.5	↓	8.1	↔
Loon Lake	0.013	↓	0.55	↓	6.2	↑	14.3	↔	3.8	↔	8.3	↔
Lower Rideau Lake	0.018	↔	0.45	↔	5.2	↔	23.4	↔	3.9	↓	8.3	↓
Round Lake	0.011	↔	0.38	↔	5.2	↑	21.6	↔	4.2	↓	8.5	↔
Spectacle Lake	0.015	↔	0.43	↔	5.5	↔	10.9	↔	3.5	↓	8.2	↔
Tommy Lake	0.016	↔	0.47	↔	5.6	↑	8.8	↔	3.4	↓	8.2	↔

Table 2.9 Lake parameter concentration 75th percentiles and/or median values and trends (p value<0.1) on collected data from 2001-2021

Upper Rideau Lake*	0.024	↓	0.45	↓	4.5	←→	23.9	←→	3.5	←→	8.5	↓
Westport Sand Lake	0.022	↓	0.45	↓	4.8	←→	26.8	←→	4.0	←→	8.5	←→
Wolfe Lake*	0.012	↓	0.38	↓	4.7	←→	25.5	←→	5.0	↓	8.5	↓
Middle Rideau Subwatershed												
Otter Lake*	0.010	↓	0.44	↓	6.2	←→	31	←→	5.0	←→	8.5	↓

* Denotes a waterbody with multiple monitored deep points ↑ Indicates a significant increasing trend
↓ indicates a significant decreasing trend ←→ indicates no significant trend

▲ Staff revisit the same locations on 39 lakes multiple times throughout the sampling season to sample near-shore lakewater as well as designated deep points.

SURFACE WATER CHEMISTRY: STREAM CONDITIONS

Standing anywhere within the RVCA's jurisdiction, you don't have to go far to find a creek, stream or minor river flowing merrily toward our larger waterbodies. These tributaries are critical to the watershed's hydrologic network, feeding flows on our larger rivers and lakes and providing habitat connections. If water quality suffers in our streams, it doesn't take long for the downstream impacts to appear elsewhere in the watershed. Our staff therefore monitor spots across the watershed for signs of stress, using a range of data collection techniques, protocols, and methods.

Ideal Conditions

When evaluating water chemistry, ideal conditions exist where the water body has natural and balanced levels of nutrients, metals and bacteria, and few suspended solids. Using provincial and federal guidelines, RVCA considers 12 chemical, biological, and physical parameters when assessing conditions. These guidelines include certain metals, nutrients and bacteria in the water as well as general physical and chemical parameters. These parameters and guidelines are used to assess water quality conditions using the Canadian Council for the Ministry of Environment's (CCME) Water Quality Index (WQI)[20].

Current Conditions

Results vary widely across the watershed, from very good to poor. In nearly all cases, poor results correlate directly with historically channelized streams, loss of wetlands or headwater features, lack of shoreline vegetation, and increased runoff and pollution from nearby agriculture, hardened landscapes or industry.

When evaluating stream water quality using the CCME's WQI, we consider 12 parameters: aluminium, chloride, copper, iron, zinc, total suspended solids, pH, E.Coli, ammonia, nitrate, TKN and TP. Conditions for rivers, streams, and tributaries range from Very Poor to Very Good (Table 2.10). Systems reporting lower scores were generally found in historically and increasingly developed areas, or nutrient-rich wetland systems. The highest scores across the watershed were typically observed at lake outlets and/or larger systems (e.g. Tay River-Christie Lake, Westport Dam, Irish Creek).

In most systems, statistically significant overall trends weren't identified – but when they were, they tended to be positive. In many cases, declining or low water quality trends were due to the stream exceeding guidelines parameters for nutrients such as TP, TKN, and NH_3, or occasionally exceeding parameters for metal contamination (Al, Cu, Zn).

Table 2.10 Catchment level stream and tributary Water Quality Index (WQI) scores and trends on collected data from 2010-2021

Catchment	2010-2012	2013-2015	2016-2018	2019-2021	Trend
Tay River Subwatershed					
Blueberry Creek	64.5	70.9	53.7	58.4	↔
Christie Lake	94.7	95.2	90.4	85.5	↔
Eagle Creek	72.5	69.9	63.6	63.1	↔
Fish Creek*	57	74.6	61.5	61.3	↔
Grants Creek*	49.8	52.6	56.5	52.1	↔
Long Lake*	53.3	63.3	61.8	53.4	↓
Otty Lake - Jebbs Creek	71.1	79.6	76.3	75.7	↔
Rudsdale	58.6	69.5	53.9	59.6	↔
Tay River - Glen Tay*	73.5	70.9	75.9	75.6	↔
Tay River - Perth*	60.4	65.2	70	69.9	↔
Tay River - Port Elmsley*	67.6	62.7	73.4	70.6	↔
Rideau Lakes Subwatershed					
Adrains Creek	40.8	52.3	51	47.9	↔
Black Creek - Rideau Lakes	51.7	73.7	71.8	75.4	↔
Sheldon's Creek	47.8	73	54.7	70.4	↔
Upper Rideau Lake	82.7	90.2	89.7	80.1	↔
Middle Rideau Subwatershed					
Barbers Creek	50.9	58.8	51.4	44.9	↔
Black Creek (Cockburn)	60.3	59.9	62	60	↔
Dales Creek	69.1	73.9	76.9	52.4	↔
Hutton Creek	65.3	77.3	73.9	55.4	↔
Irish Creek	87.3	89.3	78.4	83.1	↔
Otter Creek	68.6	77.7	74.7	55.6	↔
Rideau Creek	71.3	79.4	79.3	78.9	↔
Rideau River - Merrickville*	60.7	67.7	78.2	86.9	↔
Rideau River - Smith Falls*			82.6	79.1	↔
Rosedale Creek*	58.3	72.9	62	66.6	↑
Kemptville Creek Subwatershed					
Barnes Creek	35.6	58.8	42	42.4	↔
Kemptville*◊	59.5	57.5	60.1	63.1	↔
Mud Creek - Kemptville*	55.5	84.4	72.8	56.1	↔
North Branch*	66.6	59.6	66.9	59.8	↔
Oxford Mills*	61.3	83.6	65	72.4	↔
South Branch*	59.2	74.2	64.8	64.9	↔

Very Good (Excellent) · Good · Fair · Poor (Marginal) · Very Poor

Table 2.10 Catchment level stream and tributary Water Quality Index (WQI) scores and trends on collected data from 2010-2021

Lower Rideau Subwatershed					
Arcand◊	44.9	53.4	62.2	48.6	↔
Barrhaven Creek◊	32.3	32.5	39.8	33.9	↔
Black Rapids Creek*◊	43.1	50.9	40	38.4	↔
Brassils Creek*◊	53.8	65.6	67.1	57.2	↔
Cranberry Creek◊	50.5	56.4	54.7	46.6	↔
Hunt Club Creek*◊	34	35.6	40.8	40.1	↔
McDermott Drain*◊	43.5	35.7	48.1	43	↔
Mosquito Creek*◊	39.2	40.4	38.3	34.9	↔
Mud Creek - Lower Rideau◊	44.2	47.9	53.2	41.2	↔
Murphy Drain◊	58.9	61.3	66.9	67.7	↔
Nepean Creek◊	36.3	37.9	43.2	37.7	↑
Rideau River - Hogs Back*◊	56.7	53	51.6	72.5	↔
Rideau River - Kars*◊	69.6	64.9	69.9	79.6	↔
Rideau River - Long Island*◊	68.4	58.7	53.8	39.4	↔
Rideau River - Rideau Falls*◊	57.7	57.8	59	63.7	↔
Sawmill Creek*◊	31	38.2	35.9	38.8	↑
Stevens Creek*◊	49.1	56.1	54.2	43.3	↔
Taylor Creek (Stevens)*◊	40.7	51.8	38.5	36.2	↔
Jock River Subwatershed					
Ashton-Dwyer Hill*◊	52.6	63.3	65.7	54	↔
Flowing Creek*◊	43.6	34.1	41.7	46.5	↑
Hobbs Drain*◊	61.1	62	56.7	58	↔
Jock River - Barrhaven*◊	56.9	62.9	59	55.2	↔
Jock River - Leamy Creek*◊	52.6	57.3	49.7	52.3	↔
Jock River - Richmond*◊	65.5	64.1	73.8	54.3	↔
Kings Creek◊	74.5	84.6	64.6	69.9	↔
Monahan Drain*◊	33.4	34.8	28.1	29.2	↔
Nichols Creek◊	63.6	79.1	63	59.5	↔
Richmond Fen			33.2	51.2	↔
Ottawa River West					
Graham Creek*◊	35	38.7	32.3	33.9	↔
Pinecrest Creek◊	35.6	36.4	37.3	27.5	↔
Rideau Canal*◊	53.8	62.8	67	75.6	↑
Stillwater*◊	38.3	42.9	52.7	38.4	↑

Very Good (Excellent) Good Fair Poor (Marginal) Very Poor

Table 2.10 **Catchment level stream and tributary Water Quality Index (WQI) scores and trends on collected data from 2010-2021**

Ottawa River East					
Becketts Creek*◊	27	35.3	29.3	28.8	←→
Bilberry Creek◊	25.3	23.9	24.7		←→
Black Creek - Ottawa East◊	37.2	38.9	39.8	45.6	↑
Cardinal Creek*◊	26.2	38.8	31.1	31.2	←→
Greens Creek*◊	24.7	27.9	28.1	30.3	↑
McEwan Creek◊	31	27.5	32.1	35.6	←→
Mud Creek (Greens)◊	25.4	26.3	24	22.1	←→
Ottawa East Trib◊	32.1	29.4	23.3	24.8	↓
Ramsay Creek◊	45.3				←→
Taylor Creek◊	29.8				←→
Voyager Creek◊	26.9	33.4	32.7	35.9	↑

* Denotes a catchment with multiple monitored sites ◊ Indicates a catchment with sites monitored and/or data collected by an external organization ↑ Indicates a statistically significant improving trend ↓ Indicates a statistically significant delcining trend ←→ Indicates no statistically significant trends.

Very Good (Excellent) | Good | Fair | Poor (Marginal) | Very Poor

▲ RVCA staff conduct a stream assessment on Cardinal Creek near Orleans.

Parameter Trends

When assessing individual parameters, trends in parameter concentrations across the watershed were variable. In some regions of the watershed conditions were heavily influenced by natural sources, while in others human impacts may have played a role.

A. Nutrients

As a limiting nutrient in freshwater systems, Total Phosphorus concentrations are extensively used to determine levels of nutrient enrichment. In our rivers, streams, and tributaries, TP values exceeded the guidelines in the many of the urbanized reaches of the watershed (Table 2.11). In both the Tay River and Kemptville Creek subwatersheds, TP values only exceeded the PWQO (Provincial Water Quality Objective[21]) in select areas. Subwatersheds with more urbanized centers, including Lower Rideau, Ottawa East and Ottawa West Subwatersheds, demonstrated more consistent values exceeding the PWQO; however, trends across these regions suggested both increasing and decreasing trends across the subwatersheds.

In the case of nitrogen forms and concentrations, the upper reaches of the watershed (Tay, Rideau Lakes, and Middle Rideau subwatersheds), demonstrated increasing ammonia concentrations, but in most cases, these did not exceed the PWQO[22] (Table 2.11). In the more urbanized reaches of the watershed, this trend was the opposite: NH_3 concentrations consistently exceeded the PWQO[23], however most systems showed a decreasing trend. In the case of Nitrates (NO_3)[24], concentrations were declining across the watershed, with select instances of increasing trends in the lower watersheds (Ottawa East and Jock River). Similarly, TKN[25] concentrations across the watershed were also found to increase, with select declines in both the upper and lower watersheds.

Table 2.11 Calculated catchment level stream and tributary nutrient parameter concentration 75th percentiles and trends (p value<0.1) on collected data from 1998-2021

Catchment	Ammonia (mg/L)		Nitrate (mg/L)		Total Kjeldahl Nitrogen (TKN, mg/L)		Total Phosphorus (TP, mg/L)	
Parameter guidelines & Objectives	< 0.02 mg/L (PWQO)		< 0.02 mg/L (PWQO)		<0.5 mg/L (CWQG)		<0.03 mg/L (PWQO)	
	75th Percentile	Trend	75th Percentile	Trend	75th Percentile	Trend	75th Percentile	**Trend**
Tay River Subwatershed								
Blueberry Creek	0.017	↑	0.04	↓	1.19	↑	0.045	↔
Christie Lake	0.014	↑	0.02	↓	0.41	↓	0.013	↓
Eagle Creek	0.018	↔	0.02	↓	0.68	↔	0.034	↔
Fish Creek*	0.014	↔	0.02	↓	0.72	↔	0.040	↔
Grants Creek*	0.020	↔	0.03	↓	0.59	↔	0.037	↔
Long Lake*	0.015	↑	0.02	↓	0.87	↑	0.041	↑
Otty Lake - Jebbs Creek	0.022	↔	0.02	↓	0.77	↑	0.025	↑
Rudsdale	0.017	↑	0.06	↔	1.02	↔	0.037	↔
Tay River - Glen Tay*	0.009	↔	0.02	↓	0.45	↓	0.016	↓
Tay River - Perth*	0.015	↓	0.02	↓	0.52	↓	0.023	↓
Tay River - Port Elmsley*	0.026	↔	0.04	↓	0.60	↓	0.025	↓
Rideau Lakes Subwatershed								
Adrains Creek	0.020	↑	0.03	↓	1.37	↔	0.156	↔
Black Creek - Rideau Lakes	0.028	↔	0.04	↓	0.83	↔	0.041	↔
Sheldon's Creek	0.060	↔	0.04	↓	1.15	↓	0.052	↔
Upper Rideau Lake	0.019	↔	0.02	↓	0.53	↔	0.025	↔
Middle Rideau Subwatershed								
Barbers Creek	0.026	↔	0.71	↔	1.26	↑	0.059	↑
Black Creek (Cockburn)	0.039	↑	0.13	↔	1.37	↔	0.050	↔
Dales Creek	0.016	↑	0.12	↓	0.78	↔	0.027	↔
Hutton Creek	0.017	↑	0.05	↓	1.01	↔	0.038	↔
Irish Creek	0.013	↑	0.05	↓	0.75	↔	0.019	↔
Otter Creek	0.019	↔	0.10	↔	0.78	↔	0.044	↓
Rideau River - Smith Falls*	0.025	↓	0.09	↔	0.58	↔	0.025	↑

Table 2.11 **Calculated catchment level stream and tributary nutrient parameter concentration 75th percentiles and trends (p value<0.1) on collected data from 1998-2021**

Rideau Creek	0.011	↓	0.03	↓	0.71	↔	0.025	↔
Rideau River - Merrickville*	--	--	0.18	↑	0.60	↓	0.025	↓
Rosedale Creek*	0.018	↔	0.05	↓	0.67	↔	0.036	↓
Kemptville Creek Subwatershed								
Barnes Creek	0.052	↔	1.41	↔	1.02	↓	0.204	↔
Kemptville*◊	0.021	↑	0.17	↔	0.83	↔	0.027	↔
Mud Creek - Kemptville*	0.011	↑	0.03	↔	0.95	↔	0.030	↑
North Branch*	0.028	↔	0.02	↓	0.94	↔	0.021	↑
Oxford Mills*	0.015	↑	0.05	↓	0.91	↔	0.024	↔
South Branch*	0.013	↔	0.05	↓	0.97	↑	0.040	↑
Lower Rideau Subwatershed								
Arcand◊	0.022	↑	0.84	↔	1.03	↑	0.194	↔
Barrhaven Creek◊	0.300	↔	1.85	↔	1.06	↔	0.084	↔
Black Rapids Creek*◊	0.062	↔	4.50	↓	0.77	↔	0.095	↔
Brassils Creek*◊	0.014	↔	0.05	↓	0.73	↑	0.019	↑
Cranberry Creek◊	0.037	↔	0.25	↔	1.91	↔	0.161	↔
Hunt Club Creek*◊	0.064	↔	1.00	↓	0.58	↑	0.050	↑
McDermott Drain*◊	0.045	↑	3.05	↔	1.24	↔	0.240	↔
Mosquito Creek*◊	0.045	↔	0.30	↓	0.79	↔	0.075	↓
Mud Creek - Lower Rideau◊	0.058	↑	1.72	↔	0.74	↔	0.050	↑
Murphy Drain◊	0.026	↓	0.80	↔	0.69	↓	0.043	↔
Nepean Creek◊	0.115	↑	1.00	↓	0.73	↔	0.068	↓
Rideau River - Hogs Back*◊	0.049	↔	0.15	↔	0.71	↔	0.047	↓
Rideau River - Kars*◊	0.031	↔	0.13	↔	0.68	↔	0.031	↔
Rideau River - Long Island*◊	0.045	↔	0.33	↔	0.67	↔	0.038	↔
Rideau River - Rideau Falls*◊	0.042	↑	0.40	↔	0.66	↔	0.042	↓
Sawmill Creek*◊	0.080	↓	0.60	↓	0.75	↑	0.059	↔
Stevens Creek*◊	0.033	↑	0.93	↔	0.91	↑	0.074	↑
Taylor Creek (Stevens)*◊	0.050	↓	1.74	↓	1.26	↑	0.127	↔

Table 2.11 Calculated catchment level stream and tributary nutrient parameter concentration 75th percentiles and trends (p value<0.1) on collected data from 1998-2021

Jock River Subwatershed								
Ashton-Dwyer Hill*◊	0.019	←→	0.28	←→	1.02	←→	0.038	↓
Flowing Creek*◊	0.059	↓	1.30	↓	0.81	↓	0.062	↓
Hobbs Drain*◊	0.028	←→	0.33	↑	0.67	←→	0.026	←→
Jock River - Barrhaven*◊	0.036	↑	0.70	←→	0.79	↓	0.042	←→
Jock River - Leamy Creek*◊	0.052	↑	0.63	←→	0.91	←→	0.056	←→
Jock River - Richmond*◊	0.011	←→	0.18	↑	0.93	←→	0.035	←→
Kings Creek◊	0.005	↓	0.05	←→	0.75	←→	0.021	↑
Monahan Drain*◊	0.283	↑	3.00	←→	1.04	←→	0.137	←→
Nichols Creek◊	0.016	←→	0.03	←→	0.72	←→	0.017	↑
Richmond Fen	0.060	↓	0.10	←→	0.95	↓	0.068	↓
Ottawa River West Subwatershed								
Graham Creek*◊	0.062	←→	1.80	↓	0.68	↑	0.064	↑
Pinecrest Creek◊	0.052	↑	2.40	↓	0.52	←→	0.044	←→
Rideau Canal*◊	0.043	←→	0.10	←→	0.82	↑	0.049	↑
Stillwater*◊	0.042	↓	0.70	↓	0.69	↓	0.056	↓
Ottawa River East Subwatershed								
Becketts Creek*◊	0.083	↑	1.80	↑	0.95	↑	0.160	↑
Bilberry Creek◊	0.080	↓	1.84	←→	0.69	←→	0.098	←→
Black Creek - Ottawa East◊	0.029	←→	0.02	↓	1.56	←→	0.084	↓
Cardinal Creek*◊	0.052	←→	2.00	←→	0.69	←→	0.095	↓
Greens Creek*◊	0.094	←→	0.90	←→	1.06	↓	0.092	←→
McEwan Creek◊	0.170	←→	1.00	↓	0.78	↑	0.088	↑
Mud Creek (Greens)◊	0.061	←→	1.04	↓	1.06	←→	0.091	←→
Ottawa East Tributary◊	0.062	←→	0.90	↑	0.78	↑	0.117	↑
Ramsay Creek◊	0.108	←→	0.99	↑	1.61	↓	0.130	←→
Taylor Creek◊	0.068	↓	2.10	←→	0.68	↓	0.074	↓
Voyager Creek◊	0.046	↑	2.40	←→	0.59	↓	0.050	↓

* Denotes a catchment with multiple monitored sites
◊ Indicates a catchment with sites monitored and/or data collected by an external organization
↑ Indicates a significant increasing trend
↓ Indicates a significant declining trend
←→ Indicates no significant trend

▲ Staff collect data on basic parameters such as dissolved oxygen, as well as sampling streams for more detailed chemical compounds such as metals, nutrients and bacteria.

B. Metals

Although often essential in trace amounts, metal contaminants within the water can have impacts on aquatic life. In many cases, these contaminants can have varying concentrations solely as a result of the landscape and regions' geology. In the eastern reaches of the watershed, aluminum and iron concentrations often exceeded guideline concentrations[26], suggesting that high natural concentrations may be present within the region due to natural rock and soil formations[27]. In select waterbodies, these collected values demonstrated decreasing trends over the monitored period on record. Within the Tay River and Kemptville Creek subwatershed, aluminum concentrations were often found to increase with sources being unclear.

Although regularly reported below the guideline[28], zinc is another key metal contaminant impacting aquatic life. Across the watershed, zinc concentrations were often found to increase with select catchments demonstrating declining trends. The increasing trends may highlight changes in soil structures and increased weathering within the watershed[29].

In the case of copper, this naturally occurring metal showed increasing and decreasing trends across the watershed. In many cases, changes in copper concentrations are often associated with stormwater runoff and road waste[30]. In systems where stormwater impacts are more predominantly observed, these increases are often present.

Table 2.12 Calculated catchment level stream and tributary metal parameter concentration 75th percentiles and trends (p value<0.1) on collected data from 1998-2021

Catchment	Aluminum (mg/L)		Copper (mg/L)		Iron (mg/L)		Zinc (mg/L)	
Parameter guidelines & Objectives	< 0.02 mg/L (PWQO)		< 0.02 mg/L (PWQO)		<0.5 mg/L (CWQG)		<0.03 mg/L (PWQO)	
	75th Percentile	Trend	75th Percentile	Trend	75th Percentile	Trend	75th Percentile	Trend
Tay River Subwatershed								
Blueberry Creek	0.092	↔	0.002	↔	0.37	↔	0.008	↔
Christie Lake	0.013	↑	0.002	↑	0.05	↔	0.004	↔
Eagle Creek	0.031	↔	0.002	↔	0.25	↔	0.004	↔
Fish Creek*	0.026	↔	0.002	↔	0.39	↔	0.004	↑
Grants Creek*	0.045	↑	0.003	↓	0.19	↑	0.005	↑
Long Lake*	0.035	↑	0.002	↔	0.84	↔	0.004	↑
Otty Lake - Jebbs Creek	0.015	↑	0.002	↔	0.05	↑	0.005	↑
Rudsdale	0.033	↔	0.003	↓	0.79	↓	0.004	↑
Tay River - Glen Tay*	0.025	↔	0.002	↓	0.09	↔	0.004	↑
Tay River - Perth*	0.072	↓	0.002	↓	0.15	↓	0.005	↔
Tay River - Port Elmsley*	0.063	↓	0.001	↑	0.12	↔	0.005	↑
Rideau Lakes Subwatershed								
Adrains Creek	0.418	↓	0.003	↔	1.43	↔	0.010	↓
Black Creek - Rideau Lakes	0.035	↔	0.002	↔	0.27	↔	0.008	↑
Sheldon's Creek	0.023	↔	0.002	↓	0.15	↔	0.005	↔
Upper Rideau Lake	0.016	↔	0.002	↓	0.06	↔	0.004	↔
Middle Rideau Subwatershed								
Barbers Creek	0.114	↔	0.003	↔	0.31	↔	0.010	↓
Black Creek (Cockburn)	0.157	↔	0.004	↔	0.40	↔	0.006	↔
Dales Creek	0.030	↔	0.003	↓	0.20	↓	0.007	↔
Hutton Creek	0.053	↓	0.003	↓	0.25	↔	0.005	↔
Irish Creek	0.011	↔	0.002	↓	0.06	↔	0.003	↔
Otter Creek	0.072	↓	0.003	↔	0.24	↓	0.006	↔
Rideau River - Smith Falls*	0.031	↔	0.001	↔	0.09	↑	0.003	↔
Rosedale Creek*	0.465	↓	0.004	↓	0.61	↓	0.007	↓

Kemptville Creek Subwatershed								
Barnes Creek	0.121	↔	0.004	↔	0.47	↓	0.010	↑
Kemptville*◊	0.037	↑	0.002	↓	0.19	↓	0.006	↑
Mud Creek - Kemptville*	0.017	↑	0.002	↔	0.18	↔	0.004	↔
North Branch*	0.016	↑	0.002	↓	0.22	↔	0.005	↑
Oxford Mills*	0.020	↑	0.002	↓	0.17	↔	0.004	↑
South Branch*	0.016	↑	0.002	↓	0.21	↔	0.005	↑
Lower Rideau Subwatershed								
Arcand◊	0.057	↑	0.003	↔	0.37	↔	0.009	↑
Barrhaven Creek◊	0.293	↔	0.005	↔	0.33	↔	0.012	↑
Black Rapids Creek*◊	0.359	↓	0.004	↔	0.47	↓	0.007	↑
Brassils Creek*◊	0.029	↑	0.002	↓	0.24	↑	0.003	↔
Cranberry Creek◊	0.061	↔	0.003	↓	1.29	↔	0.005	↔
Hunt Club Creek*◊	0.163	↔	0.005	↑	0.47	↓	0.011	↑
McDermott Drain*◊	0.155	↔	0.004	↓	0.42	↔	0.005	↑
Mosquito Creek*◊	0.472	↑	0.004	↑	0.60	↔	0.008	↑
Mud Creek - Lower Rideau◊	0.193	↔	0.004	↔	0.28	↔	0.006	↑
Murphy Drain◊	0.168	↔	0.004	↔	0.26	↔	0.010	↑
Nepean Creek◊	0.410	↓	0.007	↔	0.55	↓	0.019	↔
Rideau River - Hogs Back*◊	0.086	↑	0.002	↓	0.13	↔	0.004	↓
Rideau River - Kars*◊	0.061	↓	0.002	↓	0.10	↓	0.004	↓
Rideau River - Long Island*◊	0.071	↔	0.003	↑	0.13	↔	0.004	↔
Rideau River - Rideau Falls*◊	0.117	↑	0.003	↔	0.19	↔	0.006	↔
Sawmill Creek*◊	0.425	↓	0.006	↑	0.80	↓	0.017	↓
Stevens Creek*◊	0.250	↓	0.003	↓	0.35	↓	0.005	↔
Taylor Creek (Stevens)*◊	0.356	↓	0.004	↓	0.54	↓	0.006	↔
Jock River Subwatershed								
Ashton-Dwyer Hill*◊	0.061	↓	0.003	↓	0.27	↓	0.004	↔
Flowing Creek*◊	0.595	↓	0.004	↓	0.71	↓	0.006	↓
Hobbs Drain*◊	0.120	↔	0.003	↔	0.22	↔	0.005	↑
Jock River - Barrhaven*◊	0.100	↔	0.003	↔	0.21	↔	0.004	↓

Jock River - Leamy Creek*◊	0.093	←→	0.003	↑	0.21	←→	0.006	←→
Jock River - Richmond*◊	0.059	↑	0.003	←→	0.20	↑	0.004	↑
Kings Creek◊	0.021	←→	0.001	↓	0.13	←→	0.003	←→
Monahan Drain*◊	0.503	↑	0.005	←→	0.57	↑	0.009	↑
Nichols Creek◊	0.023	←→	0.001	↓	0.28	←→	0.002	←→
Richmond Fen	0.139	←→	0.003	←→	0.47	←→	0.017	←→
Ottawa River West Subwatershed								
Graham Creek*◊	0.738	↓	0.006	↑	0.78	↓	0.011	←→
Pinecrest Creek◊	0.236	←→	0.007	←→	0.36	←→	0.016	←→
Rideau Canal*◊	0.063	↓	0.003	↓	0.10	↓	0.006	↓
Stillwater*◊	0.423	↓	0.005	↓	0.59	↓	0.009	↓
Ottawa River East Subwatershed								
Becketts Creek*◊	2.098	←→	0.006	↓	1.78	←→	0.011	↑
Bilberry Creek◊	1.427	←→	0.009	↑	1.42	←→	0.017	←→
Black Creek - Ottawa East◊	0.680	↓	0.004	↓	2.74	←→	0.010	↓
Cardinal Creek*◊	1.840	↓	0.006	↓	1.52	↓	0.010	←→
Greens Creek*◊	1.510	↓	0.008	←→	1.69	↓	0.020	←→
McEwan Creek◊	0.522	←→	0.008	←→	0.83	←→	0.017	↑
Mud Creek (Greens)◊	1.577	←→	0.007	↓	2.00	↓	0.012	↑
Ottawa East Trib◊	1.705	←→	0.007	↓	1.68	←→	0.011	←→
Ramsay Creek◊	2.300	←→	0.009	↑	2.51	←→	0.013	←→
Taylor Creek◊	0.681	↓	0.007	↑	0.67	↓	0.013	←→
Voyager Creek◊	0.954	↓	0.007	←→	1.04	↓	0.013	←→

* Denotes a catchment with multiple monitored sites ◊ Indicates a catchment with sites monitored and/or data collected by an external organization ↑ Indicates a significant increasing trend ↓ Indicates a significant declining trend ←→ Indicates no significant trend

Physical and Biological Conditions

Chloride demonstrated consistent increasing trends across the watershed, with most increases observed in urbanized areas (Lower Rideau, Kemptville Creek, Jock River, Ottawa East and Ottawa West subwatersheds), although in most areas 75th percentile concentrations still did not exceed the water quality guidelines[31]. This trend is consistent with other identified trends across the province[32]. Chlorides are closely tied with road salt for winter maintenance, fertilizers, and other industrial and wastewater effluents.

When evaluating total suspended solids (TSS), TSS concentrations did not demonstrate consistent exceedances or trends. Total suspended solids changes are often closely associated with stormwater or overland runoff impacts. Within the watershed, observed exceedances or increasing trends may be a result of the increased presence of these impacts and are hereby hindering water quality[33].

Chlorides are closely tied with road salt for winter maintenance, fertilizers, and other industrial and wastewater effluents.

Across the watershed, pH values have demonstrated declining trends. Although linked with natural conditions, a changing pH may have long term implications on aquatic life. Although not currently outside ideal conditions, long term changes could have lasting impacts.

When evaluating biological contaminants, such as *E.coli*, the eastern reaches of the watershed (Ottawa East), demonstrated consistently elevated concentrations. In all other subwatersheds the PWQO for *E. Coli* contamination was only exceeded in select waterbodies. In many cases, trends suggest increasing values in many catchments with sources unknown.

Table 2.13 Calculated catchment level stream and tributary physical and biological parameter concentration 75th percentiles and trends (p value<0.1) on collected data from 1998-2021

Catchment	Chloride (mg/L)		*E.Coli* (CFUs/100mL)		pH		Total Suspended Solids (mg/L)	
Parameter guidelines & Objectives	<120mg/L (CWQG)		<100 CFUs/100mL (PWQO)		>6.5, <9.5 (PWQO)		>6.5, <9.5 (PWQO)	
	75th Percentile	**Trend**	75th Percentile	**Trend**	75th Percentile	**Trend**	75th Percentile	**Trend**
Tay River Subwatershed								
Blueberry Creek	48.91	↔	190	↔	8.2	↓	4	↔
Christie Lake	5.10	↑	10	↔	8.2	↔	2	↓
Eagle Creek	10.35	↔	90	↔	7.9	↔	4	↓
Fish Creek*	6.00	↑	150	↔	7.8	↓	5	↓
Grants Creek*	13.08	↓	160	↔	8.0	↓	5	↓
Long Lake*	6.10	↔	100	↔	7.9	↓	5	↓
Otty Lake - Jebbs Creek	10.93	↑	80	↑	8.1	↔	3	↓
Rudsdale	37.00	↑	127	↔	8.2	↓	4	↔
Tay River - Glen Tay*	5.99	↑	63	↔	8.1	↓	3	↓
Tay River - Perth*	9.10	↔	155	↔	8.0	↔	3	↓
Tay River - Port Elmsley*	12.70	↓	100	↑	8.1	↔	4	↔
Rideau Lakes Subwatershed								
Adrains Creek	16.84	↔	290	↔	8.0	↓	15	↔
Black Creek - Rideau Lakes	8.00	↔	70	↔	8.0	↓	5	↔
Sheldon's Creek	17.83	↔	93	↔	8.1	↓	7	↔
Upper Rideau Lake	12.56	↔	10	↔	8.4	↔	3	↔
Middle Rideau Subwatershed								
Barbers Creek	16.38	↑	275	↓	8.3	↔	19	↑
Black Creek (Cockburn)	10.93	↑	190	↔	8.1	↔	6	↑
Dales Creek	16.97	↔	200	↔	8.3	↑	3	↔
Hutton Creek	8.90	↑	298	↔	8.3	↔	5	↔
Irish Creek	14.51	↔	50	↓	8.2	↓	2	↓
Otter Creek	31.00	↔	420	↓	8.3	↔	4	↔
Rideau River - Smith Falls*	11.86	↑	60	↔	8.2	↔	3	↔
Rideau Creek	8.03	↑	110	↔	8.2	↔	4	↓
Rideau River - Merrickville*	13.10	↔	4	↔	8.4	↑	4	↔
Rosedale Creek*	21.00	↑	268	↓	8.2	↓	10	↓
Kemptville Creek Subwatershed								
Barnes Creek	68.52	↑	440	↔	8.3	↓	8	↔
Kemptville* ◊	18.40	↑	118	↑	8.4	↓	3	↓
Mud Creek - Kemptville*	11.20	↑	116	↓	8.1	↔	5	↑
North Branch*	5.65	↑	120	↔	8.2	↓	4	↓
Oxford Mills*	10.44	↑	40	↓	8.3	↓	3	↓
South Branch*	12.42	↑	90	↑	8.2	↓	4	↓

Table 2.13 Calculated catchment level stream and tributary physical and biological parameter concentration 75th percentiles and trends (p value<0.1) on collected data from 1998-2021

Lower Rideau Subwatershed								
Arcand ◊	63.88	↑	132	↔	8.1	↓	9	↔
Barrhaven Creek ◊	361.15	↔	430	↔	8.3	↔	14	↔
Black Rapids Creek* ◊	162.10	↑	250	↔	8.2	↓	12	↓
Brassils Creek* ◊	16.17	↓	106	↑	8.4	↔	3	↓
Cranberry Creek ◊	51.77	↑	105	↔	8.0	↓	9	↔
Hunt Club Creek* ◊	146.00	↓	400	↑	8.2	↓	9	↑
McDermott Drain* ◊	39.35	↑	250	↔	8.3	↓	19	↔
Mosquito Creek* ◊	107.40	↑	310	↑	8.3	↓	13	↑
Mud Creek - Lower Rideau ◊	111.90	↑	250	↑	8.2	↔	7	↔
Murphy Drain ◊	41.93	↑	101	↓	8.2	↑	8	↔
Nepean Creek ◊	394.00	↑	220	↔	8.1	↓	13	↓
Rideau River - Hogs Back* ◊	29.73	↑	28	↑	8.3	↓	4	↓
Rideau River - Kars* ◊	15.70	↑	12	↓	8.3	↓	3	↓
Rideau River - Long Island*◊	21.40	↑	38	↑	8.3	↓	3	↓
Rideau River - Rideau Falls ◊*	37.55	↑	80	↑	8.3	↓	5	↑
Sawmill Creek*◊	274.00	↑	570	↑	8.2	↓	19	↓
Stevens Creek*◊	40.60	↑	164	↑	8.2	↓	8	↔
Taylor Creek (Stevens)*◊	28.00	↔	280	↔	8.2	↔	11	↓
Jock River Subwatershed								
Ashton-Dwyer Hill* ◊	65.29	↑	189	↑	8.3	↔	4	↔
Flowing Creek* ◊	113.80	↔	520	↓	8.3	↓	18	↓
Hobbs Drain* ◊	65.70	↑	420	↔	8.3	↔	6	↔
Jock River - Barrhaven* ◊	77.40	↑	80	↑	8.3	↓	4	↔
Jock River - Leamy Creek* ◊	63.00	↑	98	↑	8.3	↓	6	↔
Jock River - Richmond* ◊	32.00	↑	146	↑	8.4	↓	4	↑
Kings Creek ◊	12.23	↑	109	↔	8.3	↔	3	↓
Monahan Drain* ◊	190.50	↑	320	↑	8.2	↓	19	↑
Nichols Creek ◊	9.21	↑	120	↑	8.2	↓	2	↔
Richmond Fen	90.25	↔	210	↓	8.2	↔	11	↓
Ottawa River West Subwatershed								
Graham Creek* ◊	240.00	↔	540	↑	8.3	↓	23	↓
Pinecrest Creek ◊	420.00	↑	1030	↑	8.4	↔	8	↔
Rideau Canal* ◊	69.61	↑	64	↔	8.6	↓	5	↔
Stillwater* ◊	260.00	↓	500	↓	8.2	↑	12	↓
Ottawa River East Subwatershed								
Becketts Creek* ◊	60.75	↑	260	↑	8.4	↔	24	↔
Bilberry Creek ◊	488.25	↔	1140	↑	8.3	↓	33	↔
Black Creek - Ottawa East ◊	37.00	↓	167	↑	7.1	↓	8	↑
Cardinal Creek* ◊	93.85	↑	313	↑	8.4	↔	27	↓
Greens Creek* ◊	320.00	↔	563	↑	8.2	↓	28	↓

Table 2.13 Calculated catchment level stream and tributary physical and biological parameter concentration 75th percentiles and trends (p value<0.1) on collected data from 1998-2021

McEwan Creek ◊	310.50	←→	588	←→	8.3	↓	19	↑
Mud Creek (Greens)◊	156.15	↑	780	↓	8.2	↓	30	←→
Ottawa East Tributary ◊	134.70	↑	365	←→	8.3	←→	30	←→
Ramsay Creek ◊	159.50	↓	330	↑	7.8	↓	22	←→
Taylor Creek ◊	385.00	↑	460	←→	8.4	↓	13	←→
Voyager Creek ◊	310.68	↑	660	↑	8.4	↓	24	↓

* Denotes a catchment with multiple monitored sites ◊ Indicates a catchment with sites monitored and/or data collected by an external organization ↑ Indicates a significant increasing trend ↓ Indicates a significant declining trend ←→ Indicates no significant trend

AQUATIC HABITAT CONDITIONS – STREAMS

Good water quality goes hand in hand with streams that are as natural as possible: ideally, no channelization or piping, at least 30 metres of natural shoreline vegetation on either side, and strong connections to the broader hydrological system for natural surface water circulation and recharge.

In Environment and Climate Change Canada's document *How Much Habitat is Enough?* targets are set for riparian conditions and the recommended percentage of hardened landscapes within a watershed, which both have big impacts on ecosystem diversity and water quality:

Table 2.14 How Much Habitat Is Enough Version 3.0 (ECCC, 2011)

Parameter	Guideline
Width of natural vegetation adjacent to a stream	Both sides of streams should have a minimum 30-metre-wide naturally vegetated riparian area to provide and protect aquatic habitat. The provision of highly functional wildlife habitat may require total vegetated riparian widths greater than 30 meters.
Percent of stream length naturally vegetated	75% of stream length should be naturally vegetated.
Percent of an urbanizing watershed that is impervious	Urbanizing watersheds should maintain less than 10% impervious land cover to preserve the abundance and biodiversity of aquatic species. Significant impairment in stream water quality and quantity is highly likely above 10% impervious land cover and can often begin before this threshold is reached. In urban systems that are already degraded, a second threshold is likely reached at the 25 to 30% level.

Aquatic Habitat Score

When aquatic ecosystems are removed or modified through human alterations, their functions can be damaged or destroyed, negatively impacting overall watershed health. Staff calculate aquatic habitat scores by assessing shoreline conditions, in-stream conditions and channel conditions.

An overall aquatic health evaluation score was calculated for each catchment area by averaging the shoreline condition, instream condition, and channel condition along the main drainage features in each catchment. These conditions are summarized by surveying the stream for habitat complexity features such as riffles, vegetation and the presence of wood structure. A higher score would derive from a more complex habitat, a shoreline with minimal anthropogenic modifications and low erosion rates.

▲ A white sucker is measured during fish community sampling in the City of Ottawa. Tracking fish communities in our creeks and streams can tell us a lot about the health of our water systems.

A huge range of scores are found across the watershed. The best scores are consistently found in areas with naturally meandering systems, natural shoreline conditions and high instream habitat complexity – generally areas with lower levels of urbanization and agricultural land uses.

Catchment areas where excellent conditions were observed include:

- Nichols Creek
- Jock River – Richmond Fen
- Jock River - Ashton Dwyer Hill
- Brassils Creek
- Hutton Creek
- Otter Creek
- Tay River – Glen Tay
- Tay River – Port Elmsley

The poorest scores were found in catchments areas that are dominated by high urbanization and agricultural land uses, as their watercourses are highly channelized, lack habitat complexity, and have altered shoreline conditions.

These catchments include:

- Monahan Drain
- Murphy Drain
- McDermott Drain
- Arcand Drain
- Cyrville Drain

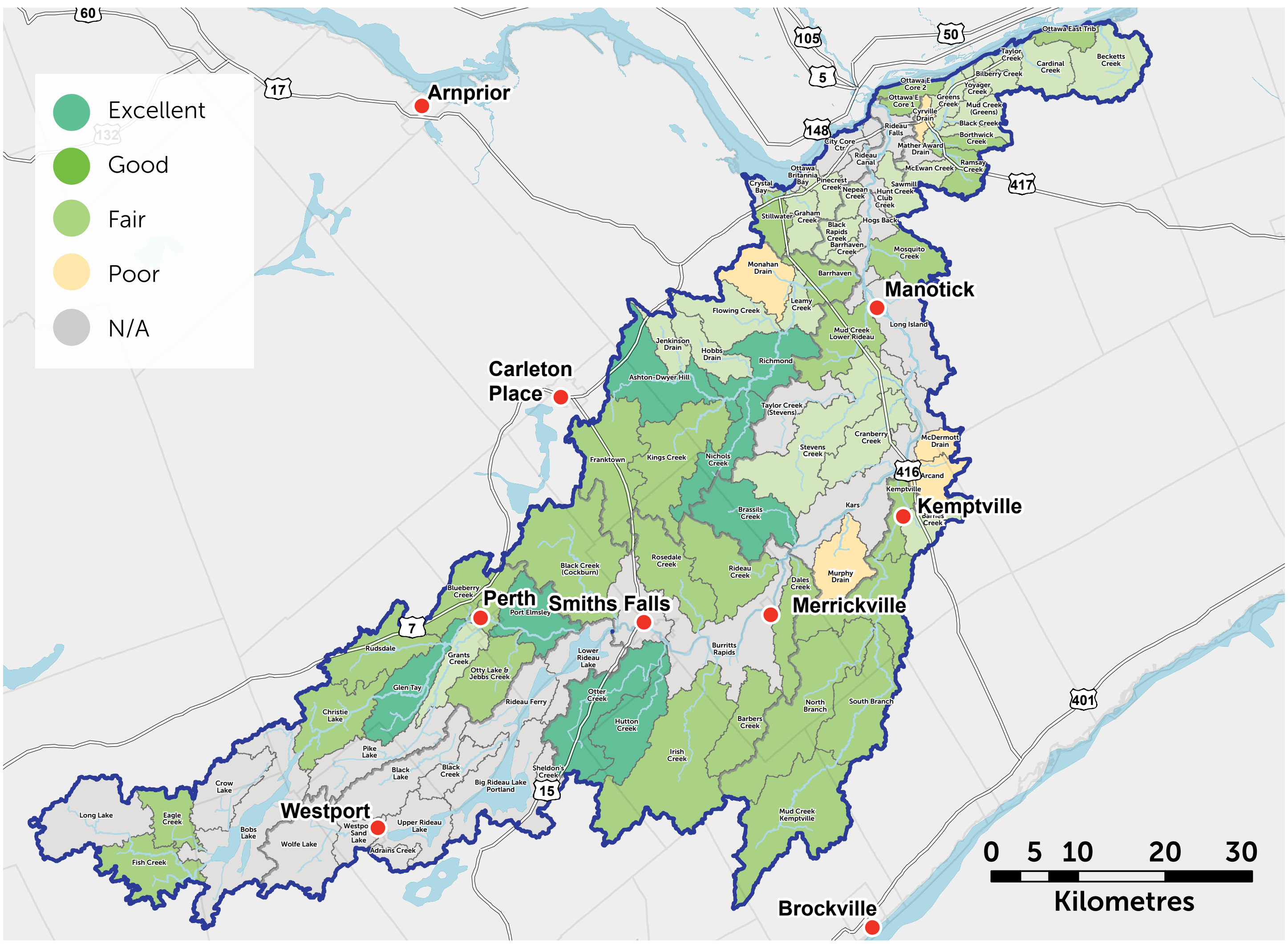


FIGURE 2.30 Overall Aquatic Score by Catchment

Biotic Communities

The presence or absence of aquatic species can tell us a lot about local stream conditions, water quality and changes in thermal regime. Fish and benthic invertebrate sampling are especially telling, as some species are sensitive to even the slightest changes in their environment.

▲ The presence or absence of pollution-intolerant benthic invertebrates in a stream says a lot about local water quality conditions.

A. Benthic Invertebrates Community

Benthic invertebrates can be used as indicators of water quality and instream habitat conditions because they are sensitive to pollution and water quality changes in the local ecosystem. The Family Biotic Index (FBI) assigns pollution tolerance values to each family based on its ability to survive and thrive in areas with varying amounts of organic pollution. Put simply, the presence of pollution-intolerant benthic invertebrates can indicate better water quality.

Conditions range from excellent to very poor across the watershed. Excellent to good conditions tend to be consistent with catchment areas that are in a natural state, such as the Tay River-Glen Tay catchment, versus poor conditions being observed in highly altered catchment areas, like that of Bilberry Creek catchment area, which has lost many of its headwater systems through historical development.

Trend Analysis:

Benthic trends across the watershed are generally stable or improving. RVCA's benthic invertebrate scores were summarized into two time periods (2007-2013 and 2014-2021) and compared to determine changes or trends (+/-10% change in condition).

Eleven catchment areas were classified as improving in condition between the two time periods:

- Kings Creek - Jock River
- Jock River – Ashton Dwyer Hill
- Kemptville Creek - South Branch
- Kemptville Creek - North Branch
- Kemptville Creek – Oxford Mills
- Murphy Drain – Lower Rideau
- Dales Creek – Middle Rideau
- Rideau Creek – Middle Rideau
- Rosedale Creek – Middle Rideau
- Otter Creek – Middle Rideau
- Rudsdale Creek – Tay River

The remaining catchment areas had no significant change in condition, and none were classified as declining.

Note: Tributaries of the Ottawa River in the Ottawa East and Ottawa West subwatersheds were evaluated through the City of Ottawa baseline program, which RVCA administers on behalf of the City of Ottawa. Data from 2019 and 2020 was used to prepare the results for each catchment area where data is available, therefore no trend analysis is available for these sample locations.

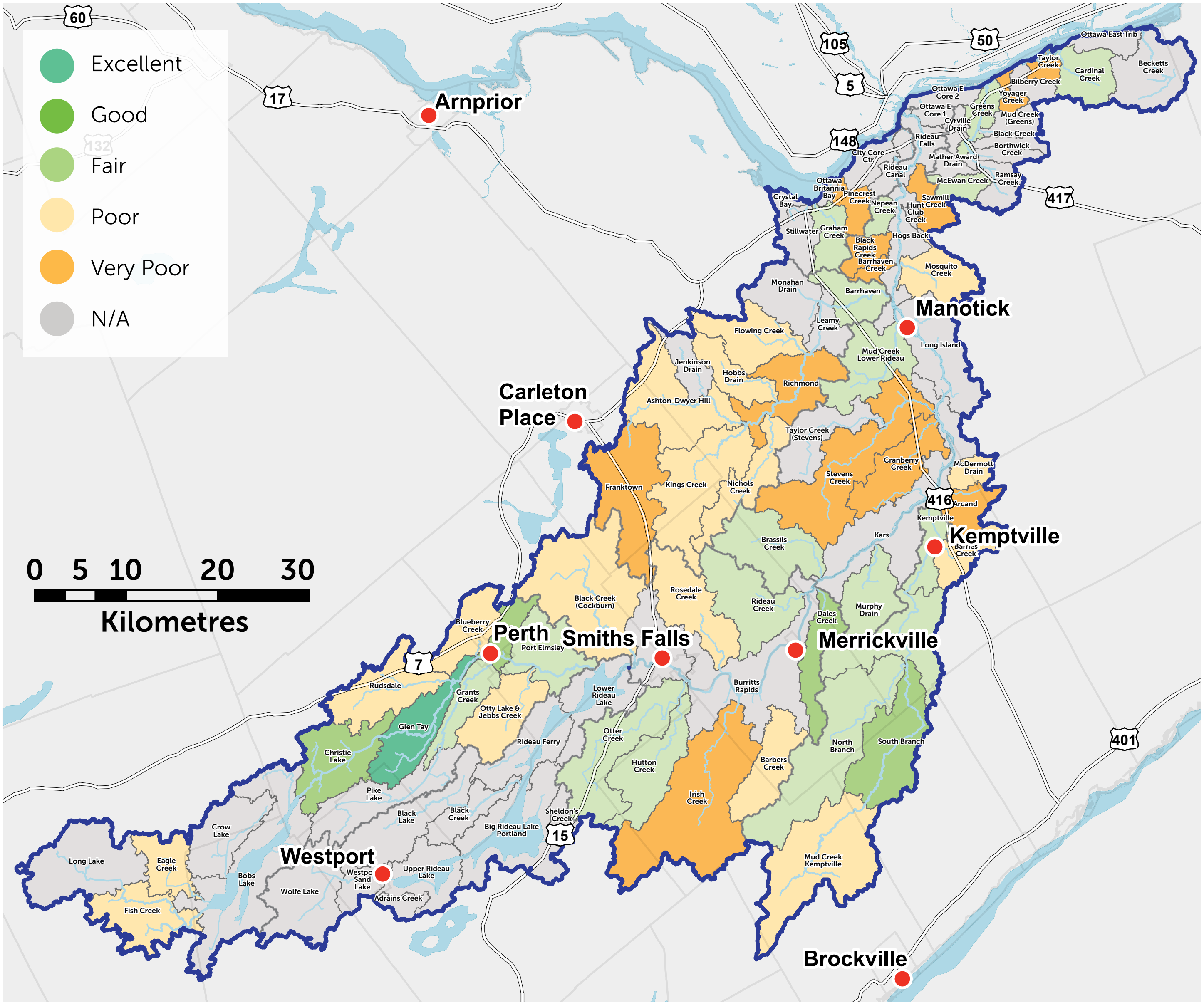


FIGURE 2.31 Benthic Invertebrates Communities Score by Catchment

B. Fish Community

Fish are often used as indicators of aquatic health, since individual species have preferred habitat characteristics, thermal regime requirements, and sensitivities to disturbance and ecological conditions (i.e., coldwater species being indicative of groundwater discharge). The presence or absence of species or change in community structure within a site can provide a measure of aquatic health and identify potential opportunities for enhancement or stewardship. In addition to habitat conditions, fragmentation of habitat is another important factor that can influence the distribution of fish species.

Table 2.15 City of Ottawa Fish Community Data Results

Subwatershed	Catchment Name	Fish Species Diversity	Sensitive Species	Indicator Species
Lower Rideau River	Rideau River - Rideau Falls	25	1	1
	Rideau River - Hogs Back	33	1	1
	Sawmill Creek	26	1	1
	Nepean Creek	21	1	4
	Black Rapids Creek	29	1	1
	Barrhaven Creek	26	1	4
	Rideau River - Long Island	23	1	1
	Mud Creek - Lower Rideau	34	1	1
	Stevens Creek	33	1	4
	Cranberry Creek	21	1	4
	Murphy Drain	12	4	4
	Brassils Creek	30	1	1
	Arcand	6	4	4
	McDermott Drain	7	4	4
	Rideau River - Kars	31	1	1
	Mosquito Creek	37	1	1
Ottawa River East	Ramsay Creek	25	1	1
	Borthwick Creek	15	1	1
	Mud Creek (GCk)	19	1	4
	McEwan Creek	16	1	4
	Cyrville Drain	3	4	4
	Greens Creek	44	1	4
	Becketts Creek	31	1	1
	Taylor Creek	8	1	4
	Ottawa East Tributary	3	4	4
	Cardinal Creek	40	1	1
	East Bilberry Creek	33	1	1
	West Bilberry Creek (Voyager)	2	4	4
	Black Creek	13	4	4
Ottawa River West	Stillwater	41	1	1
	Graham Creek	31	1	1
	Pinecrest Creek	3	4	4

RVCA monitors fish communities in creeks within the City of Ottawa on six-year cycle. Table 2.15 shows the results of fish community diversity, along with the presence of sensitive and indicator species within the City of Ottawa.

Poor conditions exist in several Ottawa catchment areas with a high degree of channelization and low-quality instream conditions. These include:

- Arcand Drain
- Ottawa East
- Voyageur Creek
- Black Creek
- Pinecrest Creek
- Cyrville Drain

In Pinecrest and Voyageur Creek, significant sections of the stream network are piped, resulting in fragmentation, low diversity and lack of sensitive species.

In the rural watershed, fish community data is based on historical data from 2011-2018 and are therefore excluded from the map below. However, fish communities in most of the rural watershed have been classified as good or excellent.

Larger rivers and streams tend to have higher fish community diversity. Surface water features that have good connectivity with minimal migration barriers also tend to have increased diversity.

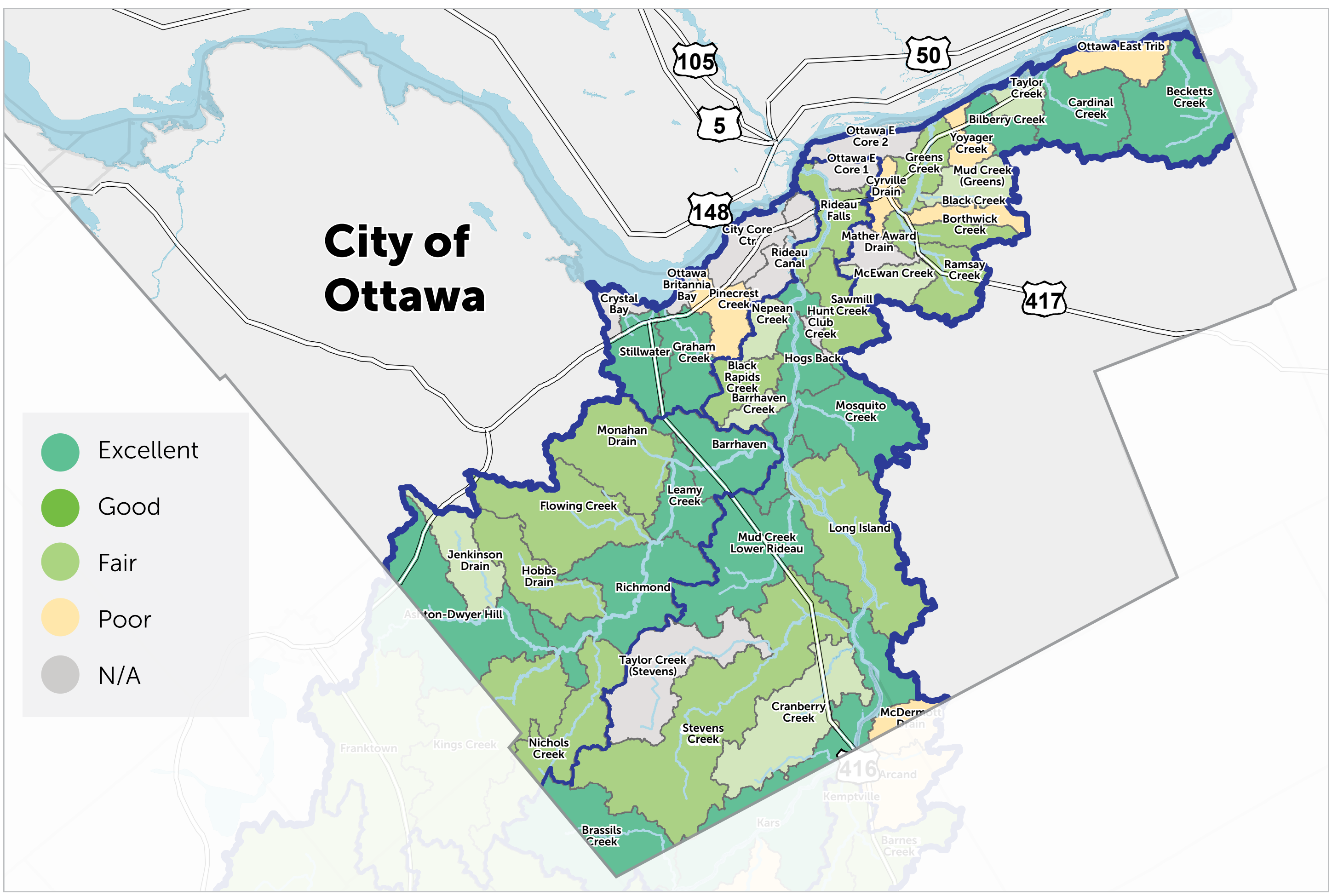


FIGURE 2.32 **Fish Communities Score by Catchment in the City of Ottawa**

Excellent to good conditions have been observed anecdotally and through sampling on several of the larger systems in the watershed, including:

- Rideau River
- Jock River
- Tay River
- Kemptville Creek

Thermal Regime

Temperature is an important factor in determining the composition of aquatic communities. Knowledge of aquatic thermal regimes is important for predicting species composition, activity levels, behaviors, and life process events. Species that rely on cold water with high oxygen levels are typically less tolerant than species with the ability to withstand thermal stress and low oxygen levels. Stream temperature is influenced by many factors which include water velocity, climate, elevation, stream order, riparian vegetation conditions, water source, groundwater, adjacent land use, and human impacts. As a result, thermal monitoring provides insight into the health and stressors within an aquatic community. RVCA installs temperature monitoring probes at 151 sites within the City of Ottawa on a six-year cycle to classify systems into five thermal regimes:

- Warm
- Warm/Cool
- Cool
- Cold/Cool
- Cold

The data collected outside of the City of Ottawa is baseline data from 2011-2018. This shows us what the conditions are currently. This data will be helpful to determine which systems are warming in the future.

Systems with cold and cool water thermal classifications are more sensitive than systems that are classified as warm water. The Jock River – Richmond Fen catchment is classified as cold/cool as the baseflow conditions have a

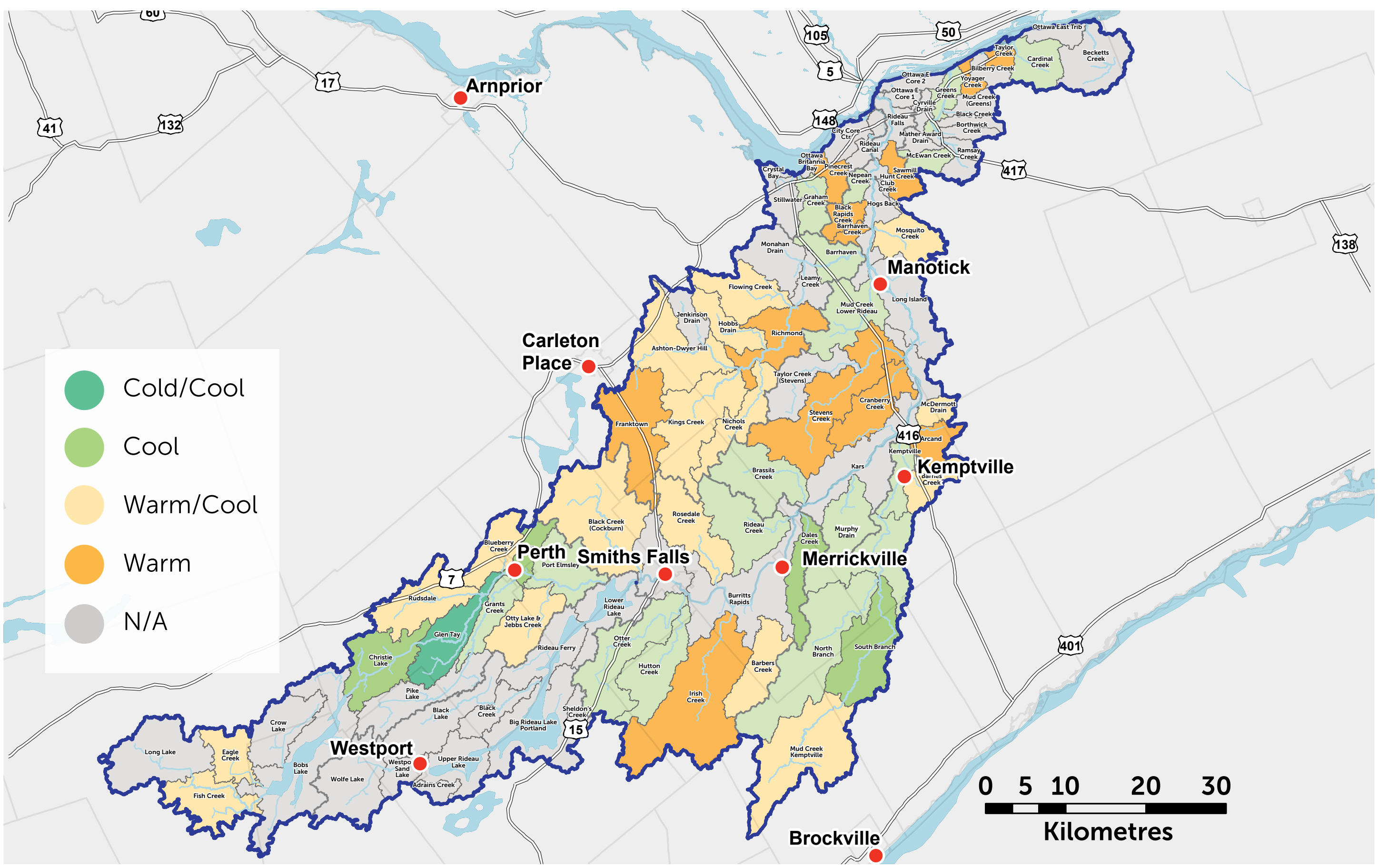


FIGURE 2.33 Thermal Regime by Catchment

significant groundwater influence, which is critical for the Richmond Fen. The other catchment area that is classified as a cold/cool water system is Pinecrest Creek, which is more of a result of the system being primarily fed by closed surface water features.

Many catchments have been classified as cool water systems, which are important features that provide cooler baseflows to the larger rivers and lakes. A large number of systems are classified as warm/cool or warm water systems. While these systems are less sensitive to change, as climate change and warming trends continue, it will be important to track any changes and mitigate if necessary.

▲ A yellow perch is processed during fish community sampling in the City of Ottawa.

IMPACTS AND IMPLICATIONS

The surface water found in our lakes and streams is critical to the Rideau River Watershed's overall health, both for the plants and animals that call it home and the communities we've built within it.

▲ **Staff sample lake water for water quality parameters such as total phosphorus.**

But these waterbodies are under stress: widespread development, agriculture and industry all impact the integrity and health of these systems, resulting in reduced water quality and habitat diversity in some areas – and the predicable downstream impacts. With a rapidly changing climate, increasing development and changing land uses, surface water and aquatic ecosystems will continue to exist under stressful conditions, sometimes with severe impairments, unless governments, communities and individuals take action to protect them.

Taking a "protection first" approach while maintaining robust monitoring programs can go a long way to ensure our waterbodies and the ecosystems they support are protected into the future. It's clear that waterbodies with robust natural shorelines, good hydrological function and low levels of development or industry nearby enjoy much better water quality. In these areas aquatic ecosystems thrive, lakes are clean and clear, and algae blooms are few and far between. The RVCA and its partners can replicate those conditions through targeted shoreline naturalization and clean water projects, wetland restoration, reforestation and other stewardship activities.

Data from our monitoring programs can also point us toward priority catchments for targeted initiatives. For instance, we can target increasing chloride concentrations in urban areas by promoting better or alternative road salt usage, including improved buffer zones between roadways and aquatic systems to reduce the risk of chloride toxicity. Or when implementing new stormwater management systems, RVCA can work with developers and municipalities to manage both dissolved and sediment-bound nutrients to help reduce nutrient loading into aquatic systems. By improving these parameters, aquatic habitats will be more naturally balanced, subsequently improving their long-term health and their resilience to the long-term effects of climate change.

As climate change accelerates, bringing warmer air and water temperatures, more severe floods and droughts and more toxic algae blooms, it is imperative that we protect and support our lakes and streams as a buffer against these changes for the benefit of all.

Endnotes

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