MINISTÈRE DE L'ENVIRONNEMENT
ET DE LA LUTTE CONTRE
LES CHANGEMENTS CLIMATIQUES

# Impact on the environment and other users of a transfer of water out of Québec

An analysis of the cumulative impact of water transfers

Votre gouvernement

Québec

**Coordination and drafting**
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Legal Deposit–2021
Bibliothèque et Archives nationales du Québec
ISBN 978-2-550-89614-2 (PDF)

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# 1. BACKGROUND

The City of Ottawa has submitted an application for the withdrawal of surface water from an intake pipe on the Québec side of the Ottawa River. The requested water withdrawal site is within 300 m of the interprovincial boundary and the City of Ottawa's existing water withdrawal site (located in Ontario). The water is intended to supply the City of Ottawa's drinking water aqueduct system, to be used mainly for human consumption,and for other system purposes and involves a transfer of water from Québec to Ontario. The request is based on a frazil ice issue at the existing site that jeopardizes the City's winter water supply.

In order to determine the impact of the transfer of water from Québec on the environment and on other users, the capacity of the Ottawa River to supply the requested water withdrawal while ensuring, among other things, the sustainability of aquatic ecosystems and existing downstream water withdrawals was assessed. This analysis was conducted to ensure that the requested water withdrawal fully complies with section 31.76 of the *Environment Quality Act* (EQA).

The City of Ottawa wishes to withdraw 700 million litres per day (8.1 $m^3/s$) of water, of which 560 million litres per day (6.5 $m^3/s$) would be returned to the river at the Robert-O. Pickard (RP) wastewater treatment plant. Based on information provided by the City of Ottawa, water consumption would be 20% of the total volume withdrawn, or 140 million litres per day (1.6 $m^3/s$). The withdrawal site is located just over 200 m north of Lemieux Island, upstream of Chaudière Falls (CF). The entire volume withdrawn would be consumed in the approximately 14-km stretch between the withdrawal site and the wastewater treatment plant outfall.

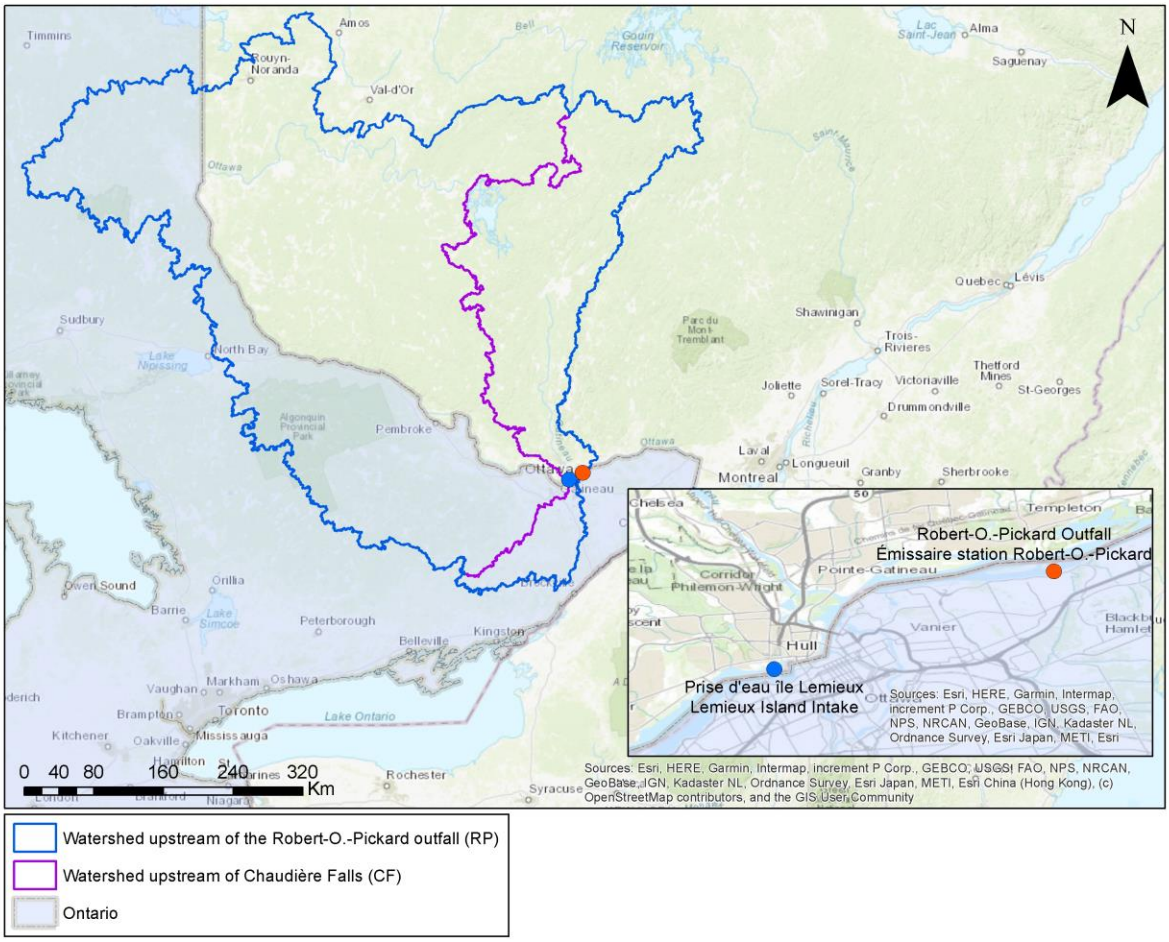
Any potential impact of the withdrawal is likely to be observed in the stretch between the intake (upstream of CF) and the treated wastewater discharge (RP). The cumulative impact of water withdrawals was therefore evaluated by the *ministère de l'Environnement et de la Lutte contre les changements climatiques* (MELCC) at these two sites (Figure 1).

## 1.1 Hydrological context and withdrawals

The Ottawa River drains an area of approximately 146,300 $km^2$. It separates the provinces of Quebec and Ontario between Carillon in the southeast and Lake Timiskaming in the northwest. At the City of Ottawa's proposed withdrawal site, the drainage area is approximately 91,000 $km^2$, 55% of which is in Quebec. The mean discharge at the Britannia Hydrometric Station (02KF005), located approximately 10 km upstream of the withdrawal site, is 1,225 $m^3/s$.

The Gatineau River meets the Ottawa River approximately 5 km downstream from the proposed withdrawal site. Its watershed covers some 23,700 $km^2$ with average flow of 450 $m^3/s$ at its outlet.[1]

[1] *Atlas hydroclimatique du Québec méridional 2018*. Online: https://www.cehq.gouv.qc.ca/atlas-hydroclimatique/EtiagesEstivaux/Q7min2E.htm. Retrieved March 25, 2021.




**<u>Figure 1</u> Location of study sites associated with the City of Ottawa's water withdrawal permit application and wastewater discharge**

In all, 677 *Permits to Take Water* have been authorized within the Ontario portion of the watershed upstream of the RP plant, 362 of which are also upstream of Chaudière Falls. With respect to Québec, 113 sites (not counting agricultural withdrawals) are required to submit an annual water withdrawal declaration[2] and 47 water withdrawal permits have been issued upstream of RP. Upstream of Chaudière Falls, these values are respectively 64 and 22.

Table 1 summarizes this data.

[2] Per the Regulation respecting the declaration of water withdrawals.

**Table 1** **Withdrawals and low-flow data at the test two study sites**

| Characteristics | Chaudière Falls | Robert-O. Pickard plant |
|---|---|---|
| Area ($km^2$) | 91,088 | 119,404 |
| Permits–Ontario | 362 | 677 |
| Permits–Québec | 22 | 47 |
| Reported water use–Québec (not counting agricultural) | 64 | 113 |
| Irrigable crops area–Québec ($km^2$) | 41.9 | 42.3 |
| Number of livestock farms–Québec | 71 | 114 |
| $Q_{2-7}$ median summer/winter (current; $m^3/s$) | 459/923 | 753/1,186 |
| $Q_{2-7}$ median summer/winter (2030; $m^3/s$) | 391/1,103 | 650/1,420 |
| $Q_{2-7}$ median summer/winter (2050; $m^3/s$) | 359/1,205 | 597/1,542 |
| $Q_{2-7}$ median summer/winter 2080; $m^3/s$) | 321/1,282 | 547/1,658 |

# 2. ANALYSIS

The cumulative consumed portion of water withdrawals upstream of the two study sites (CF and RP) was compared to summer low flow on seven consecutive days, with a recurrence period of two years ($Q_{2-7}$). This calculation is the indicator used by the MELCC to assess the level of impact of water withdrawals from a watershed on surface water availability. The threshold value of 15% of $Q_{2-7}$ was used to reflect when water withdrawals are of a significant impact.

The MELCC uses this indicator to assess the impact of cumulative water withdrawals on low flows for the purpose of reconciling surface water uses. The 15% $Q_{2-7}$ indicator is similar to that used by other Canadian provinces such as Alberta and other countries such as the United Kingdom (Locke and Paul, 2011) to identify rivers where water withdrawals exert a greater impact on surface water. As in other provinces and countries where water withdrawals are managed in a manner similar to Quebec, the MELCC can impose operating conditions such as instream flows or monitoring measures, or require additional testing when the 15% threshold of $Q_{2-7}$ is exceeded.

## 2.1 Estimate of $Q_{2-7}$

### 2.1.1 Estimate of $Q_{2-7}$ for the Ottawa River at Chaudière Falls

The applicant has provided an estimate of $Q_{2-7}$ based on daily flows from 1960 to 2019 at the Britannia Hydrometric Station (02KF005), which is operated by Environment and Climate Change Canada. Two calculation methods were used: ranked flow analysis and Log Pearson Type III. The results were respectively 459 $m^3/s$ and 475 $m^3/s$.

Although the methodology is described very succinctly, it appears to be suitable for calculating $Q_{2-7}$ at the intended withdrawal site. A second calculation of $Q_{2-7}$, performed by the MELCC, shows summer $Q_{2-7}$ of 450 $m^3/s$, with lower and upper bounds of 411 $m^3/s$ and 489 $m^3/s$. The latter calculation used data from the same hydrometric station (02KF005) for the 1970 to 2019 period. Any slight differences in $Q_{2-7}$ values are probably due to the range of data that was used.

### 2.1.2 Estimate of $Q_{2-7}$ for the Gatineau River

The low flow Gatineau River values are shown in the *Atlas hydroclimatique du Québec méridional 2018*[3] for the current (reference) and 2030, 2050 and 2080 forecast climate conditions. For current climate conditions, the median summer $Q_{2-7}$ is 269 $m^3/s$, but this value decreases to 228 $m^3/s$ (2030; -15%), 202 $m^3/s$ (2050; -25%) and 171 $m^3/s$ (2080; -36%) for future climate conditions (RCP8.5). In winter, the median $Q_{2-7}$ is 213 $m^3/s$ for current climate conditions, increasing to 257 $m^3/s$ (2030; RCP8.5) and 318 $m^3/s$ (2080; RCP8.5) for future climate conditions.

[3] *Atlas hydroclimatique du Québec méridional 2018*. Online: https://www.cehq.gouv.qc.ca/atlas-hydroclimatique/EtiagesEstivaux/Q7min2E.htm.

### 2.1.3 Estimate of $Q_{2-7}$ for the Ottawa River at the Robert-O. Pickard plant

Flow at RP is directly related to Ottawa River and Gatineau River flows. To estimate low flow at RP, Britannia Hydrometric Station values were adjusted based on the area drained, with low-flow Gatineau River values added.

### 2.1.4 $Q_{2-7}$ Climate change estimates

Section 31.76 of the *Environment Quality Act* requires that any permit authorized under the Act with regard to a water withdrawal must be exercised so as to take the effects of climate change into account. However, Ottawa River values are not shown in the *Atlas hydroclimatique du Québec méridional*, which is the main source of hydro climatology information for Québec. The companion document to the *Atlas*[4] specifies that hydro geological projections are limited to the natural stream flow regime and cannot be generalized to watersheds of less than 250 $km^2$ or major rivers such as the Saguenay, Ottawa, St. Maurice and St. Lawrence. No other data on changes to Ottawa River low flow under future climate conditions were available at the time of this review. The estimated percentage change in $Q_{2-7}$ due to climate change for the Gatineau River was applied to the $Q_{2-7}$ as calculated by the applicant and the MELCC for the Britannia Hydrometric Station.

The projected flow changes that were used for analytical purposes are summarized in Table 2. The summer $Q_{2-7}$ values for current and future climate conditions are shown in Figure 2 for illustrative purposes. Only summer flows are presented since this is when water availability is likely to be most critical.

Several control structures impact the flow of the Ottawa River. It is important to note that the climate change $Q_{2-7}$ estimates described in this section do not take into account the management rules for these structures, or their future evolution.

[4] *Atlas hydroclimatique du Québec méridional 2018* companion document. Online: https://www.cehq.gouv.qc.ca/atlas-hydroclimatique/doc-aCFompagnement.pdf.

**Table 2 Percentage change of Gatineau River flow based on the Atlas hydroclimatique du Québec méridional**

| Year | Scenario | Minimum change | Median change | Maximum change |
|---|---|---|---|---|
| | | **$Q_{2-7}$ (summer)** | | |
| 2030 | RCP4.5 | - 11% | -14% | -16% |
| | RCP8.5 | - 12% | -15% | -17% |
| 2050 | RCP4.5 | - 15% | -18% | -21% |
| | RCP8.5 | - 22% | -25% | -26% |
| 2080 | RCP4.5 | - 18% | -21% | -23% |
| | RCP8.5 | - 31% | -36% | -39% |
| | | **$Q_{2-7}$ (winter)** | | |
| 2030 | RCP4.5 | 15% | 18% | 24% |
| | RCP8.5 | 18% | 21% | 23% |
| 2050 | RCP4.5 | 20% | 25% | 32% |
| | RCP8.5 | 29% | 35% | 41% |
| 2080 | RCP4.5 | 23% | 30% | 41% |
| | RCP8.5 | 38% | 49% | 62% |

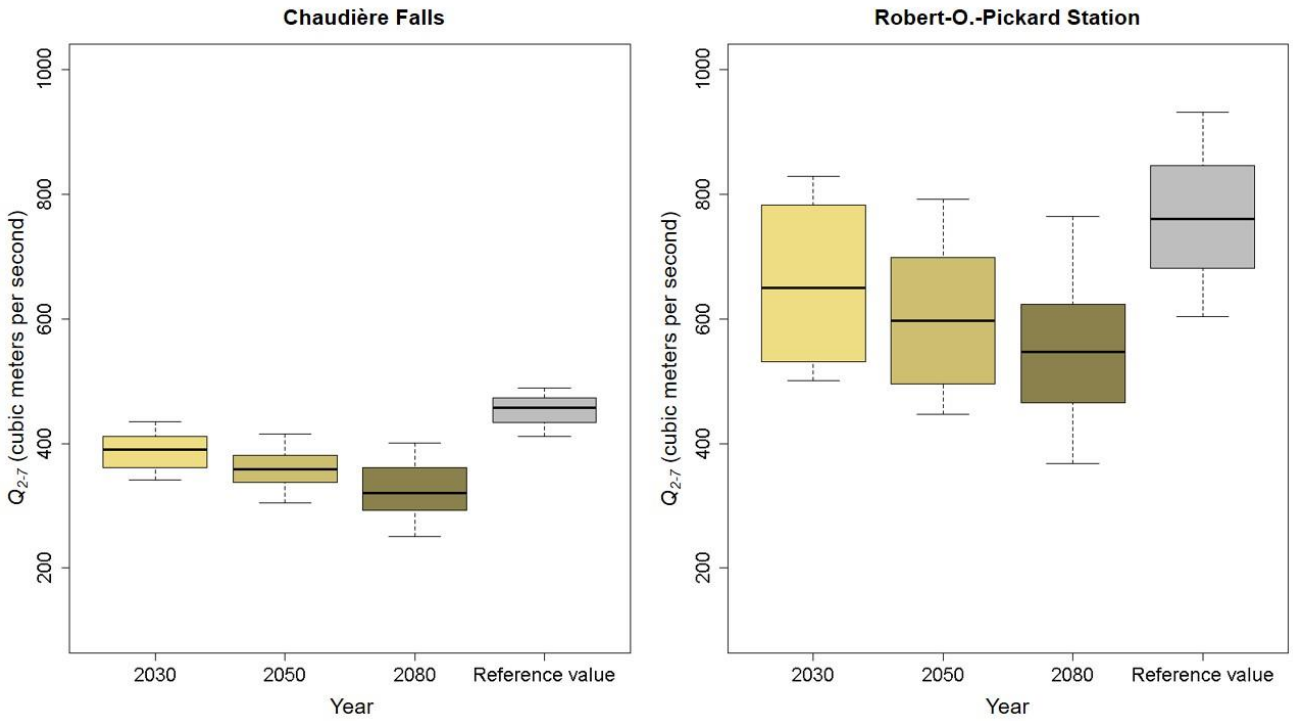



**Figure 2 Estimated summer $Q_{2-7}$ quartiles at the two sites for current (reference) and future climate conditions**

## 2.2 Withdrawal data

### 2.2.1 Québec

Monthly data from the annual reports of water withdrawals for 2015 to 2019 and data from the MELCC water withdrawal permits were used to account for municipal, commercial, institutional and industrial withdrawals for withdrawers of 75 $m^3$/day and more in the Quebec portion of the watershed.

For agricultural withdrawals, which feature less in annual water withdrawal reports, water use was calculated from other databases.

Water requirements for agricultural crops were estimated from the Financière agricole du Québec's database of declared agricultural land and 2016–2020 production.[5] The specific need for each crop was taken from the first report of the Recherche participative d'alternatives durables pour la gestion de l'eau en milieu agricole dans un contexte de changement climatique project (RADEAU; Groupe AGÉCO, 2019[6]). Average input for irrigation, by area, crop type, and percentage of crops irrigated, was calculated

[5] Base de données des parcelles et productions agricoles déclarées en 2019 de la Financière agricole du Québec. Online: https://www.fadq.qc.ca/fr/documents/donnees/base-de-donnees-des-parcelles-et-productions-agricoles-declarees/.

[6] *Recherche participative d'alternatives durables pour la gestion de l'eau en milieu agricole dans un contexte de changement climatique (RADEAU 1)*. Online: https://www.agrireseau.net/agroenvironnement/documents/101346/recherche-participative-d'alternativesdurables-pour-la-gestion-de-l_eau-en-milieu-agricole-dans-un-contexte-de-changement-climatique-radeau-1

on a daily basis and is expressed in cubic meters per second ($m^3/s$). The year with the highest irrigation values was used to calculate total consumption.[7]

Water requirements for livestock production were estimated from the number of animals per species per livestock farm that figure in the farmers' phosphorus report database. The number of animals was calculated from individual water requirements shown in Appendix 5 (livestock consumption charts) of the RADEAU report.

### 2.2.2 Ontario

With respect to the Ontario side of the watershed, only *Permits to Take Water* data was used to calculate cumulative water withdrawal, retrieved online at https://www.ontario.ca/environment-and-energy/map-permits-take-water, which shows maximum authorized daily flow and type of use for each recorded water user.

## 2.3 Consumption coefficient

Analysis of cumulative water withdrawals required that water consumption be estimated. Section 31.89 of the *Environment Quality Act* defines consumption (or consumptive use) as the portion of water withdrawn or impounded from a river basin that is lost or otherwise not returned to the basin due to evaporation, incorporation into a product, or other processes.

For the purposes of our analysis, U.S. Geological Survey coefficients were assigned based on the type of water use, associated with the activity for which the withdrawal is made (https://waterusedata.glc.org/data_about_cuc.php; Shaffer & Runkle, 2007).

[7] *Recherche participative d'alternatives durables pour la gestion de l'eau en milieu agricole dans un contexte de changement climatique (RADEAU 1)*. Online: https://www.agrireseau.net/agroenvironnement/documents/101346/recherche-participative-d'alternativesdurables-pour-la-gestion-de-l'eau-en-milieu-agricole-dans-un-contexte-de-changement-climatique-radeau-1

# 3. RESULTS

The estimated total water consumption upstream of the two study sites is shown in Figure 3. Including the new City of Ottawa withdrawal (8.1 $m^3/s$), total summer consumption is estimated to be 29.9 $m^3/s$ (19.1 $m^3/s$ in winter) at CF and 32.2 $m^3/s$ in summer (20.9 $m^3/s$ in winter) at RP.

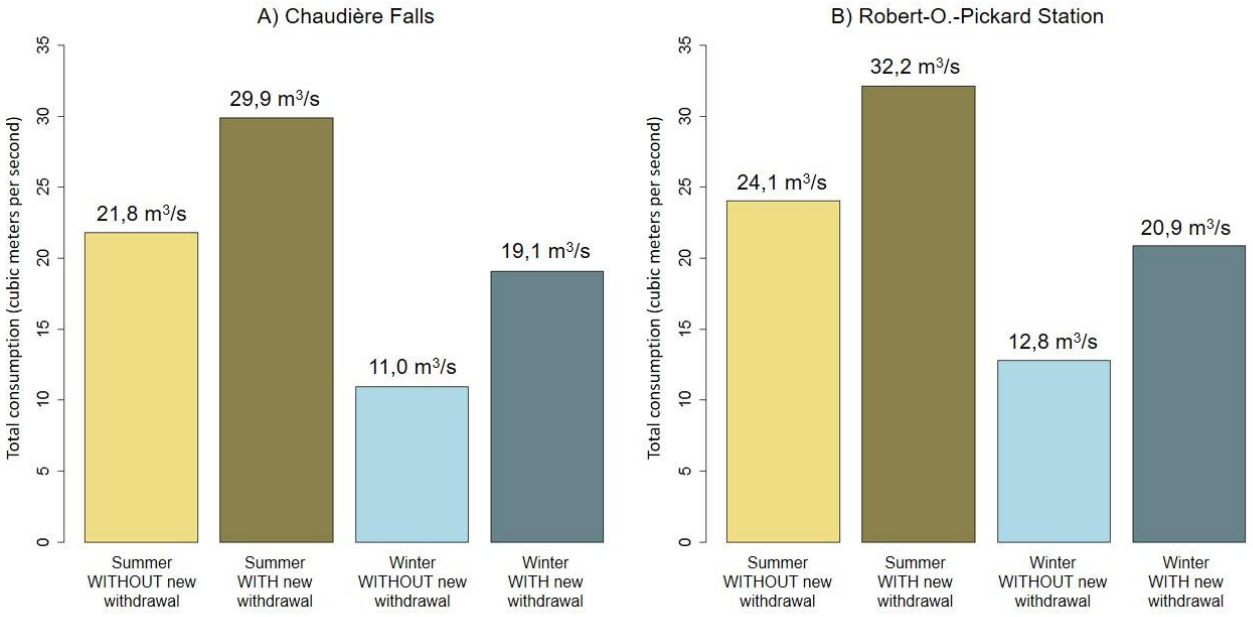


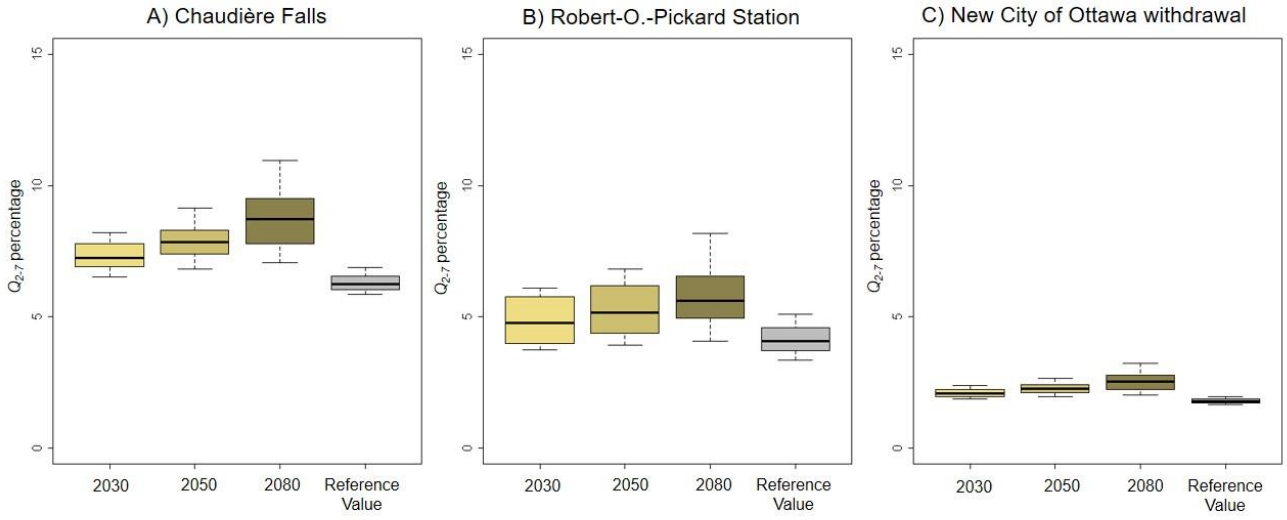

**Figure 3 Total estimated summer and winter water consumption A) at Chaudière Falls and B) at the Robert-O. Pickard station, with and without the new City of Ottawa withdrawal**

These withdrawal values represent percentages of $Q_{2\text{-}7}$ that are below 7% in current (baseline) climate conditions at both sites (CF and RP). Due to a projected decrease in flows, these percentages are expected to increase under future climate conditions, without, exceeding 11% by 2080.

In winter, total consumption represents a percentage of the maximum $Q_{2\text{-}7}$ of 2.2%, at CF in current (reference) climate conditions. Under future climate conditions, the projected low-flow rate tends to increase, resulting in total consumption representing a lower percentage of $Q_{2\text{-}7}$.

The addition of the new City of Ottawa withdrawal results in an increase in total consumption of 37% in summer and 74% in winter at CF. Upstream of the RP station, this increase comes to 34% and 63% in summer and winter respectively and represents approximately 1.8% of $Q_{2\text{-}7}$ at CF and 1% at RP in summer.

All calculated $Q_{2\text{-}7}$ percentages are shown in Figure 4.




**<u>Figure 4</u> Percentage of summer Q2-7 water consumption at A) Chaudière Falls, B) the Robert-O. Pickard station and C) the new City of Ottawa withdrawal**

# 4. CONCLUSIONS

The results show that the additional water withdrawal of 700 million litres per day requested by the City of Ottawa from the Ottawa River will not result in the 15% pressure indicator of $Q_{2-7}$ being exceeded at the two study sites, in summer and winter, under both current and future climate conditions. As such, we conclude that the pressure exerted by these withdrawals does not exceed the availability of surface water in the Ottawa River during the low water period.

The site where the impact of withdrawals on the availability of surface water during low water is the greatest is the section located between Lemieux Island and the confluence of the Ottawa and Gatineau rivers, i.e. site CF.In this stretch, the residual capacity before reaching a $Q_{2-7}$ consumption level of 15% in summer will be about 7.7 $m^3/s$ (666 million l/d) by 2080. This value represents an increase of 26% of current consumption, including the new City of Ottawa withdrawal. Downstream from the confluence with the Gatineau River, at the RP site, residual summer capacity increases to 23 $m^3/s$ (2,000 million l/d) by 2080. This represents a potential increase of 72% of current consumption. In winter, the increase in water withdrawals required to reach the 15% $Q_{2-7}$ indicator is about seven times the current withdrawal amount at the two study sites.

The additional withdrawal requested by the City of Ottawa represents 2% of $Q_{2-7}$ in current climate conditions, 2.4% by 2030 and 3.2% by 2080, in summer. These thresholds are well below the 15% indicator for $Q_{2-7}$. On this basis, the requested withdrawal does not pose a risk to the availability of water for other users, including aquatic ecosystems.

The available margins before reaching total consumption that are equal to or greater than 15% of $Q_{2-7}$ lead us to conclude that there is sufficient water available in the Ottawa River to meet the water needs of the City of Ottawa under present and future climate conditions. This could change, of course, if additional upstream withdrawals are added.

The above analyses are based on the best current knowledge of the status of withdrawals and the severity of low flows to date. It should not be discounted that future analyses based on new information may lead to results different from the ones specified herein.

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*Environnement et Lutte contre les changements climatiques*
Québec