Analysis of Gatineau River Water Quality Data

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Surface water quality measures and guidelines

Water quality measures and guidelines generally target contaminants or naturally-occurring substances that pose a risk to human health or natural biological communities, or which can cause aesthetic or maintenance issues in drinking water systems. Regulatory agencies – such as Health Canada, Environnement Québec, or the U.S. Environmental Protection Agency – normally set their guidelines for such substances on the basis of a risk assessment process. In this process, regulatory agencies use existing or new scientific research to determine the risks that substances pose to human or animal health at different concentrations. The agencies then establish guidelines for those substances based upon acceptable health risks – with "acceptable" risk usually defined as statistically indistinguishable from normal ("background") risk.

Some naturally occurring substances (for example, nitrogen and phosphorous) may pose no direct risk to human health, yet may pose a threat to natural communities (such as fish or bird populations) at elevated concentrations. In such cases, regulatory agencies may establish "reference levels" based upon studies of natural, unpolluted or "pristine" environments. These standards often vary between regions, depending upon differences in geology, soils, climate and land uses. The U.S. Environmental Protection Agency, for example, has taken a regional approach to setting reference levels for nutrients and water clarity in streams, rivers and lakes: we have used these regional reference standards in the assessment.

Sites on the Gatineau River (Table 1) were monitored by volunteers from the Friends of the Gatineau River and tested for fecal coliforms, nutrients and physical parameter as described below. Results for each parameter were then compared to the identified guidelines or reference standards applicable to that parameter.

Fecal coliforms

Fecal coliform bacteria come almost exclusively from human and animal fecal matter, and they include the bacteria most often responsible for water-related diseases, especially *E. coli*. Laboratories identify fecal coliforms by their ability to grow under conditions found in human and animal digestive systems. While not all fecal coliforms cause disease, their presence indicates that water have been exposed to fecal contamination, and therefore have an increased risk of pathogenic fecal bacteria and other pathogenic microorganisms. Fecal coliforms are measured as the number of colonies forming on a filter after it has strained 100 ml of water (colonies per 100ml)

Reference standards for fecal coliforms were the Health Canada established guideline values of 200 colonies per 100ml for recreational waters and 100 colonies per 100 ml for irrigation water. These values represent the level above which there may be a significant risk to human health. The guidelines, however, refer specifically to a single fecal coliform, *E. coli*. Laboratory analyses done for this report do not distinguish between *E. coli* and other fecal bacteria. The Health Canada guidelines can apply to total fecal coliforms where *E.coli* makes up at least 90% of fecal coliforms in water. In general, *E. coli* makes up over 90% of fecal coliforms in humans and most domestic animals (Federal-Provincial Advisory Committee on Environmental and Occupational

Health, 1992). Fecal coliforms, therefore, are generally an acceptable indicator, except for waters which receive pulp and paper effluent or non-fecal bacterial contamination from industrial sources.

The Province of Québec has also adopted a guideline of 200 fecal coliforms colonies per 100 ml for recreational waters. Le Ministère du Développement durable, de l'Environnement et des Parcs and has developed a recreational water quality rating system with associated recreational use guidance, based on fecal coliform levels (Table 2), available via the internet at www.mddep.gouv.qc.ca/eau/recreative/qualite.htm.

Nutrients

All living organisms require nitrogen and phosphorus (as well as many other nutrients) to survive. In streams, rivers and lakes, however, excessive amounts of these nutrients can cause overproduction of bacteria and algae. This, in turn, can lead to depletion of dissolved oxygen in the water – with negative or potentially fatal consequences to fish and other wildlife. Depleted oxygen or "anoxic" zones cannot support fish or aquatic life. Anoxic zones also increase nutrient loading from the sediment. Nutrients enter streams, rivers and lakes from a variety of sources: some sources are natural, others of human origin, in particular septic and sewage systems, livestock manure and crop fertilization.

This study measured two parameters; Total Phosphorous (TP) and Total Kjedahl Nitrogen (TKN). Total phosphorous includes both phosphorous tied up in organic matter and that in an inorganic, water-soluble, biologically-available forms. Nitrogen also occurs in rivers in both organic and inorganic forms. Total Kjedahl Nitrogen measures nitrogen stored as part of organic matter and as ammonia. It does not include inorganic nitrogen in the form of nitrites or nitrates, and therefore differs from Total Nitrogen reported in H20 Chelsea's Year 2005 report.

Reference standards for nutrients were taken from the Regional Nutrient Criteria published by the United States Environmental Protection Agency (US EPA). Regional Nutrient Criteria are recommended levels for lakes, rivers and streams, which represent "minimally impacted" or "relatively natural" surface waters Criteria are given separately for lakes and rivers/streams within different Ecoregions, in recognition that different geographic areas will naturally have different nutrient levels. This criterion (reference standard) are calculated by taking the nutrient concentration below which 25% of all measured lakes or streams in that Ecoregion fall, as a measure of a "natural" concentration. Reference standards are calculated for each Ecoregion as a whole, and then for different sub-regions to provide a range of values for the Ecoregion. These reference values are relatively conservative, and should be interpreted accordingly. Readers should keep in mind that these standards represent the levels that one would expect to find in areas of similar geology and hydrology, for water bodies subject to no significant human stresses.

Establishing a single reference level for Gatineau River may be difficult as it flows through multiple Ecoregions. In the H20 Chelsea 2004 report, two Ecoregions were identified in the Chelsea area: Region VII, the "Mostly Glaciated Dairy Region" was chosen as being appropriate for Chelsea Creek, Hayworth Creek and Beamish Lake, while Region VIII, the "Nutrient poor, largely glaciated upper midwest and northeast" was chosen as the reference standard for Meech Creek and Meech and Kingsmere lakes.

Québec also has a provincial guideline (0.03 mg/L) for total phosphorous for the protection of aquatic life.

Water Quality Results

Fecal Coliforms

Fecal Coliform levels were measured at 29 stations between 2000 and 2005 (Table 2). Samples were taken in June, July and August, although not all stations were measured in all months and years. In total, 188 Fecal Coliform measures were obtained for stations on the Gatineau River or creeks flowing into the Gatineau River. Using the Quebec Recreational Water Quality Guidelines, most of the samples indicated excellent (62%) or good (24%) water quality. Only a small number of samples indicated mediocre (7%) or poor (6%) water quality. Fecal coliform levels at sites with poor water quality exceed both Health Canada and Provincial guidelines for recreational water quality and swimming and other direct contact with water should be avoided. Mediocre water quality exceeds Health Canada guidelines for irrigation water.

Analysis by station shows highly variable water quality along the Gatineau River (Figure 1). At most sites in the Gatineau River mean and maximum fecal coliform values were within the excellent to good water quality range. At four sites – GR030, GR040 (both on La Pêche Creek), GR061 (Meech Creek) and GR131 (Le Grande Gulley, Cantley) – mean values indicated mediocre water quality, and maximum levels exceeded the Provincial Recreational Water Quality Guideline of 200 colonies per 100 ml.

Samples taken in 2003 at an additional three sites – GR171, GR172, GR173- exceeded the Recreational Water Guidelines but the small sample size (only one or two samples per site) did not allow any measure of the variation at the stations. All three sites were on Hellard Stream at Allen, Nielsen and Hwy 5 respectively, and had values much higher than those recorded farther upstream at Reid (GR174) or Minney Red House (GR175), suggesting that contamination occurred at or downstream of Hwy 5. Water quality in Wilson Bay (GR160) into which Hellard Stream empties was generally good to excellent. Further sampling would be required to determine if there was continually poor water quality at these sites.

Nutrients

Total Phosphorous (TP) and total Kjedahl Nitrogen (TKN) data were collected in 2005 at two sites on the Gatineau River; Wakefield Bay Hole (GR022) and Baie de fer à cheval (GR151). Samples were taken in June, July and August at 1, 2, 5, 10 and 15m depths. Analysis did not show significant differences between stations, date or depth for TKN. For TP, there was slight increase with depth at GR022 and increase in July compared to the other two months at GR151. The differences were not large, however, and for the purposes of this analysis, all samples were pooled at each station to get overall mean TP and TKN values for summer of 2005

For TP, all samples taken were below the provincial guideline for the protection of aquatic health (0.03mg/L) (Figure 2). Mean TP and TKN values were most similar to those for US EPA Ecoregion VIII (i.e. Meech Creek) and well below those for Ecoregion VII (i.e. Chelsea Creek) (Figure 2 and 3). Mean TP and TKN values for the Gatineau River were generally lower than those recorded at the mouth of both Meech and Chelsea Creek where they enter Gatineau River (Figure 2 and 3). Nutrient levels were most

similar to the head waters of Meech Creek, in the relatively undisturbed area of Gatineau Park (Figure 2 and 3).

The other physical parameters were well within normal ranges (Table 3). Dissolved Oxygen levels are all depths were well above anoxic levels (<1 mg/L) and pH values were all in the normal range of 6.5 – 8.5. Total dissolved solids and conductivity were highest on the La Pêche Creek (GR030, GR040) and Blackburn creek (GR050) than in the river itself (Table 3), likely indicative of decreased water quality.

Conclusions

Water quality in Gatineau River was generally good, meeting provincial guidelines for both Fecal Coliforms and Total Phosphorous. Overall nutrient levels were within the natural range for Ecoregion VIII, "Nutrient poor, mostly glaciated" and similar to the more natural portions of Meech Creek. All sites with samples that exceeded the recreational water guidelines appeared to be on creeks or streams that fed into the Gatineau River, rather than in the river itself.

Fecal coliforms in some feeder streams - La Pêche, Meech Creek, Hellard Creek and La Grande Gulley, Cantley - were considerably higher than in Gatineau River itself, often exceeding the provincial guidelines. Recreational use of these waters should, therefore, be avoided. Fecal coliform levels at the mouths of Meech and Chelsea Creek also exceeded recreational guidelines in H20 Chelsea sampling conducted in 2005, likely due to agricultural and urban runoff (*see H20 Chelsea 2005 Annual Report*). Nutrient levels in Meech and Chelsea were also significantly higher than in the Gatineau River.

These results suggest that there was some fecal and nutrient contamination of the Gatineau River. It was, however, diluted by the larger volume of Gatineau River and/or swept away by the rivers currents, so that the risks to health and environment were low. The sampling conducted, however, was relatively limited and fecal coliforms in particular may vary considerably, influenced by periodic events such as rainfall and temperature. Areas near the poorer quality streams may, for example, show spikes in fecal coliform immediately following heavy rains. Reducing run-off would improve water quality in streams, and reduce the contamination of Gatineau River, thereby further reducing risks to health and the environment.

Table 1. Sampling site codes and descriptions

SiteCode	Site description
GR010	Wakefield Covered Bridge - swimming area directly S of covered bridge on east side of river
GR020	Turntable Park beach - Narrow strip of grass-shored adjacent to water tower and Wakefield General Store
GR021	Burnside Ck mouth
GR022	Wakefield Bay Hole
GR030	La Peche Ck. mouth, in a shallow bay about 30 m upstream from confluence with Gatineau R.
GR040	La Peche Ck. upstream by Wakefield Mill Inn
GR050	Wakefield Public Dock - Dock and swimming area at N end of Veterans Park
GR060	River area infront of Cohen family farm.
GR061	Meech Ck mouth
GR062	half mile S of Wakefield
GR070	Farm Point Public dock and swimming area infront of baseball diamond
GR071	Farm Point Picnic rocks
GR080	Cascades Club - Dock and swimming beach
GR090	Burnett - Beach at boat ramp at end of Burnett road
GR100	Gatineau River Yacht Club - Pool, swimming rocks, club and boat docks
GR110	Tenaga - Dock and swimming area
GR111	Tenaga culvert
GR130	Mary Anne Phillips Park - Swimming area at narrow beach
GR131	Le grand gulley (cantley)
GR140	Romaniuk Ck. mouth
GR150	Blackburn Ck. - Wide section of creek roughly 200m upcreek from Gatineau R.
GR151	Baie de fer à cheval
GR160	Wilson bay
GR171	Hellard stream @ allen
GR172	Hellard stream @ nielsen
GR173	Hellard stream @ hwy 105
GR174	Hellard stream @ reid
GR175	Hellard stream @ minney red house

Table 2. Recreational water quality ratings developed by Le ministère du Développement durable, de l'Environnement et des Parcs, based on fecal coliform levels (colonies per 100ml)

Water Quality	Fecal Coliforms	Advisory
Excellent	0-20	All recreational uses permitted
Good	21-100	All recreational uses permitted
Mediocre	101-200	All recreational uses permitted
Poor	200 +	Swimming, direct contact with water to be avoided
Very Poor	1000+	All recreational uses to be avoided

Table 3. Mean ± SD temperature (°C), dissolved Oxygen (mg/L), Conductivity (µS), Total Dissolved Solids (TDS in ppm) and pH recorded at stations in and near Gatineau River, May – August 2005.

	Temperature		Dissolved Oxygen		Conductivity		TDS		pH	
SiteCode	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
GR_010	22.17	1.60	7.74	0.23	29.50	4.95	14.00	2.83	7.11	0.02
GR_020	22.23	1.12	7.86	0.55	27.33	1.15	13.33	1.53	7.06	0.09
GR_022	22.13	1.51	7.57	0.38	31.07	2.79	15.50	1.99	7.11	0.05
GR_030	24.43	2.66	7.97	1.07	168.33	100.03	86.00	49.43	7.11	0.02
GR_040	26.70		8.52		124.00		61.00		7.11	
GR_050	22.33	1.53	7.49	0.12	29.00	5.00	15.00	2.65	7.17	0.21
GR_060	21.90	0.71	8.07	0.30	25.50	0.71	14.50	0.71	7.08	0.02
GR_070	22.90	1.31	7.44	0.12	29.33	3.51	15.00	1.73	7.11	0.06
GR_080	23.40	0.56	7.64	0.26	29.33	4.16	16.00	2.65	7.08	0.07
GR_090	24.05	0.78	7.43	0.11	30.50	7.78	15.00	4.24	7.12	0.01
GR_100	24.00	1.08	7.53	0.10	30.00	5.66	15.50	3.54	7.02	0.16
GR_110	24.13	0.90	8.05	1.53	31.50	6.36	13.50	0.71	7.00	0.18
GR_130	25.20	0.95	7.60	0.42	32.50	7.78	16.00	4.24	7.2	0.17
GR_140	25.60		8.66		49.00		23.00		7.12	
GR_150	24.43	0.93	7.91	0.21	95.00	39.60	44.00	15.56	7.43	0.54
GR_151	23.18	1.49	7.26	0.24	34.60	4.97	16.90	2.69	6.99	0.22

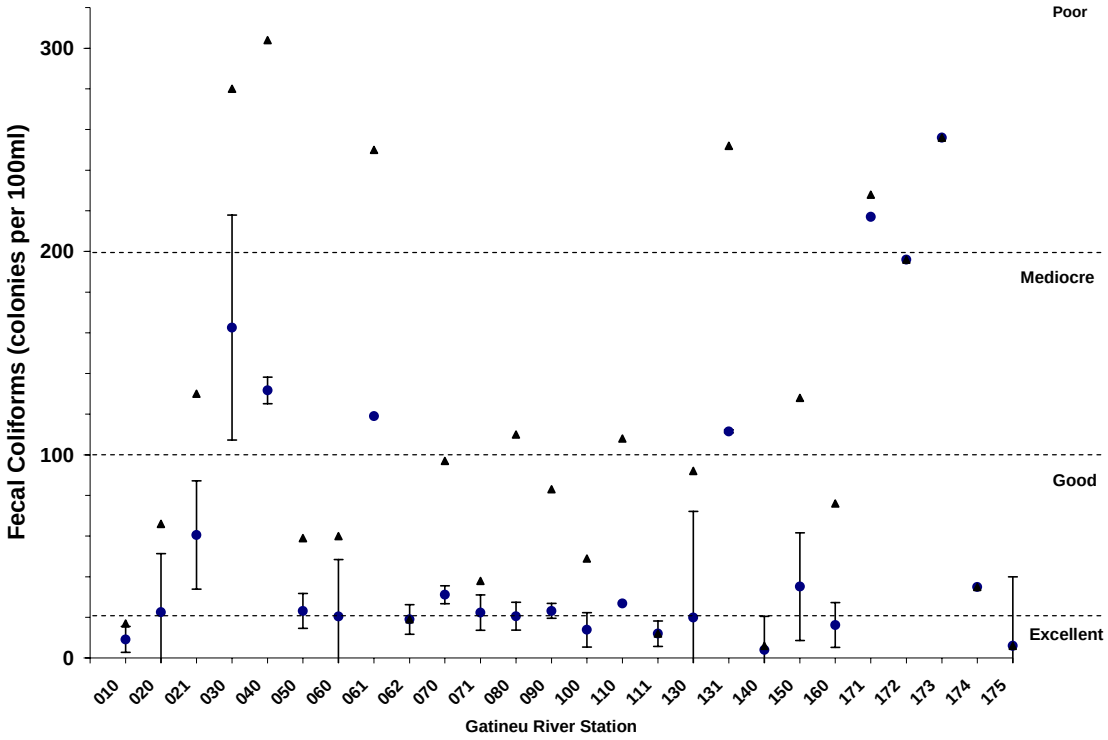

Figure 1. Mean ± standard error (●) and maximum (▲) fecal coliform values (colonies per 100 mL) recorded at stations in and flowing into Gatineau River between 2000 and 2005. Dotted lines indicate the Recreational water quality categories developed by Le ministère du Développement durable, de l'Environnement et des Parcs.

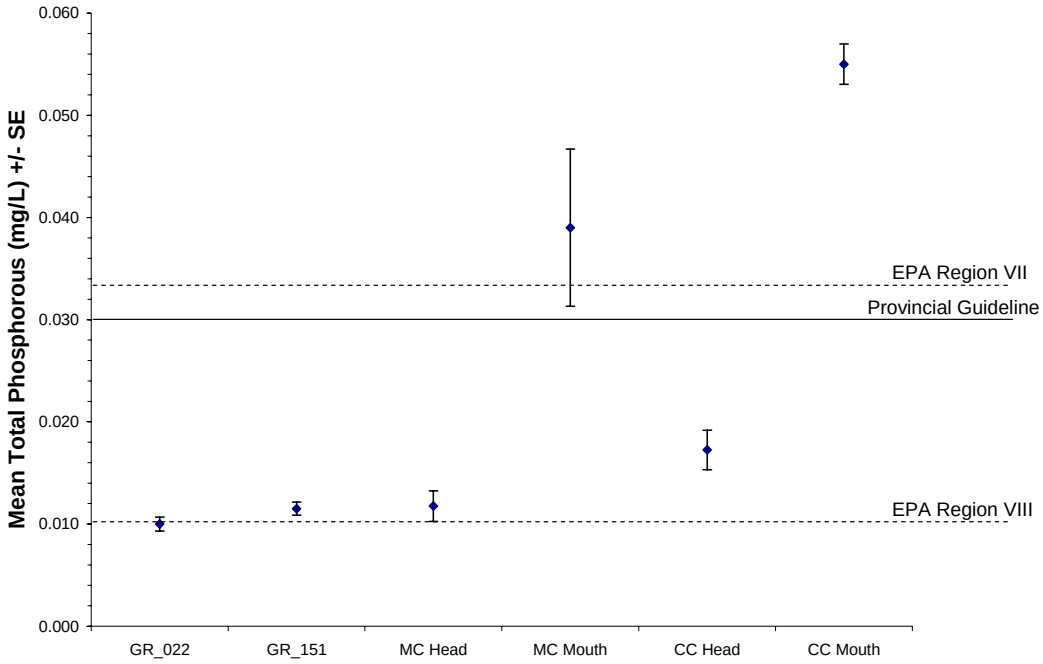

Figure 2. Mean (± SE) total phosphorous at stations on Gatineau River (GR022, GR151) and at the head and mouth of Meech Creek (MC) and Chelsea Creek (CC), in 2005.

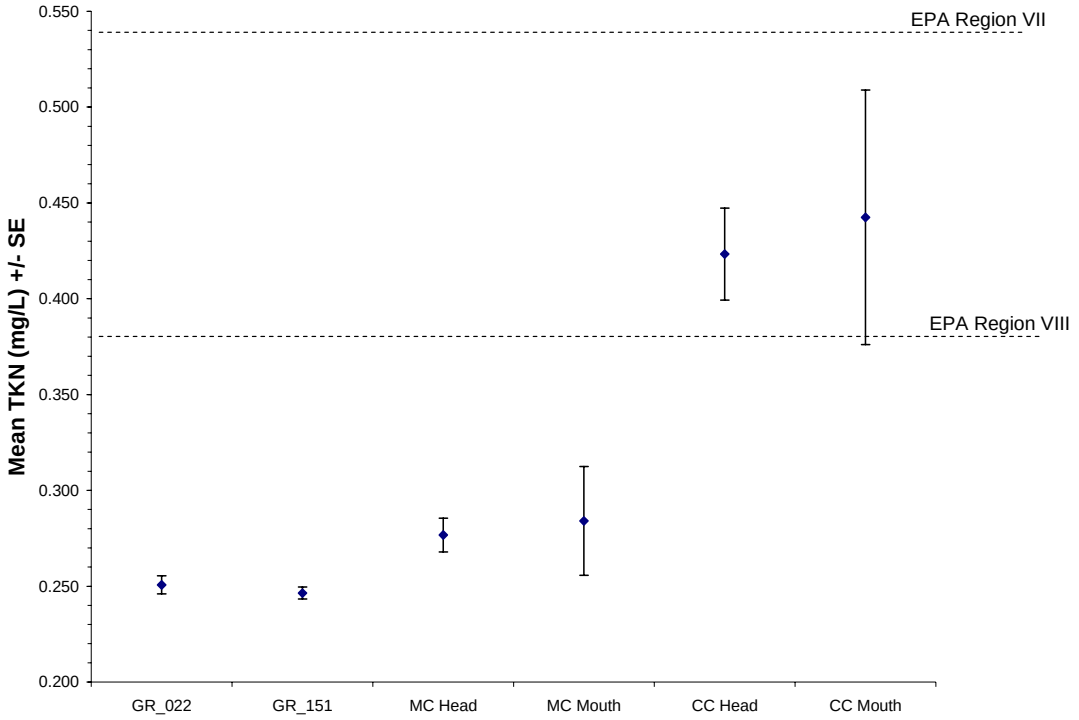

Figure 3. Mean (± SE) total Kjeldahl nitrogen at stations on Gatineau River (GR022, GR151) and at the head and mouth of Meech Creek (MC) and Chelsea Creek (CC), in 2005.