2018 Watershed Overview of Wastewater Treatment Plant Performance

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Glossary of Terms

ADF

Average daily flow

cBOD

Carbonaceous 5 day biochemical oxygen demand

GRCA

Grand River Conservation Authority

MECP

Ontario Ministry of the Environment, Conservation and Parks

TAN

Total ammonia nitrogen

TBOD

Total 5 day biochemical oxygen demand

TKN

Total Kjeldahl nitrogen

TP

Total phosphorus

TSS

Total suspended solids

UIA

Un-ionized Ammonia

WWOP

Watershed-wide Wastewater Optimization Program

WWTP

Wastewater treatment plant

Executive Summary

Since 2010, the Grand River Conservation Authority (GRCA) has been working collaboratively with municipal partners and the Ministry of the Environment, Conservation and Parks (MECP) to develop a Watershed-wide Wastewater Optimization Program (WWOP). A key program activity is monitoring performance and plant loading, which are used to evaluate the success of the program and track WWTP impacts on the Grand River over time. Available performance and loading data for 28 of 30 municipal wastewater treatment plants were voluntarily reported in 2018. These results were summarized and compared to results from previous years.

Treatment Performance

Table 1 shows the average final effluent TP flow-weighted concentrations, targets and the total loading from 2012 to 2018.

Table 1: TP Flow-weighted concentrations, total loading and targets

Year	TP flow-weighted concentration (mg/L)	Total Loading (tonnes per year)	TP flow-weighted concentration target (mg/L)
2012	0.37	35.9	0.24
2013	0.35	37.6	0.24
2014	0.33	36.8	0.24
2015	0.37	36.5	0.24
2016	0.33	33.8	0.24
2017	0.30	32.5	0.24
2018	0.30	30.6	0.24

With respect to the TP concentrations and loads in Table 1, the following observations can be made:

- From 2017 to 2018, the TP flow-weighted concentration did not change but the TP load decreased by 6%
- From 2012 to 2018, the TP flow-weighted concentration decreased by 19% and the TP load by 15%

Table 2 shows the average final effluent TAN flow-weighted concentrations (for both summer and winter), targets and the total loading from 2012 to 2018.

Table 2: Flow-weighted summer and winter TAN concentrations, total loading and targets

Year	Winter TAN flow-weighted concentration (mg/L)	Summer TAN flow-weighted concentration (mg/L)	Summer Target (mg/L)	Winter Target (mg/L)	Total Loading (tonnes per year)
2012	5.5	4.3	1	2	951
2013	3.9	3.2	1	2	773
2014	4.6	3.1	1	2	855
2015	3.6	2.1	1	2	560
2016	2.2	1.3	1	2	347
2017	1.7	0.7	1	2	259
2018	0.9	0.5	1	2	146

With respect to Table 2 showing the TAN loads and concentrations, the following comments are applicable:

- From 2017 to 2018 the summer TAN decreased by 34% and winter by 45%. TAN total loading decreased by 44% compared to previous year.
- From 2012 to 2018, overall the TAN flow-weighted concentration decreased by 86% and the total loading by 85%.

Sludge Accountability and Water Balance

A sludge accountability analysis compares the annual amount of sludge reported by a mechanical plant to the amount of sludge projected based on plant loadings and removal. Conducting this analysis can help to determine if monitoring is truly representative. In 2018, sludge accountabilities were reported for 23 plants in the watershed. For eight of the plants, the accountability "closed" within ± 15%. In 2017, 22 plants reported sludge accountability and 10 plants "closed" within ± 15%.

A water balance analysis compares the annual amount of measured net precipitation on the surface area of a lagoon system to the annual amount of projected net precipitation using lagoon level measurements, total influent and total effluent flows of a lagoon system. This analysis can help to determine if the flow measurement devices at a lagoon are accurate. In 2018, water balances were reported for 3 lagoon systems in the watershed. Two of these analyses did close within ±15%.

Grand River Impacts

Table 3 summarizes the impact of wastewater effluent discharges on the Grand River.

Table 3: WWTP Effluent flow as a percentage of Grand River total flow

Parameter	2012	2013	2014	2015	2016	2017	2018
% Annual Average Flow	7%	3%	3%	5%	5%	4%	4%
% August Average Flow	14%	5%	9%	12%	9%	8%	9%

The values in Table 3 are largely a function of precipitation and weather in any given year. The percent of flows in August is shown, as August is typically a low river flow month when treated wastewater makes up a larger portion of river flow. In 2018, precipitation was at the long-term average. In 2017, precipitation was above average. In 2016, precipitation was close to (but lower than) the long-term average. In 2015, precipitation was near the lower end of typical. In 2014, precipitation was close to the long-term average. In 2013, the watershed generally experienced higher than normal precipitation across its central and northern portions. Precipitation in 2012 was near the low end of typical.

Some improvements have been noted due to recent upgrades and optimization efforts, for example upgrades at the Kitchener and Waterloo WWTPs have allowed the plants to nitrify, resulting in lower concentrations of TAN, UIA and nitrite in the Grand River. Data from 2018 demonstrated a statistically significant reduction in these parameters compared to previous years. Dissolved oxygen conditions have also improved downstream of the Kitchener WWTP as a result of lower loadings of TAN. The concentration of TAN in the lower Speed River were also lower in the winter and summer of 2018 as a result of optimization at the Hespeler WWTP.

Plant Loading

Table ES-2 summarizes key process loading metrics for 2018 as well as typical values and the range of median reported values from 2012 to 2017. The results in the table enable municipalities to compare loadings at their facilities to those at other plants in the watershed, which can be used to determine the impact of industrial discharges and may highlight concerns with unrepresentative sampling of raw influent. For plants that do not measure TBOD in the raw influent it was assumed to be 20% higher than the cBOD measurement.

Table 4: Summary of 2012 to 2018 watershed WWTP loading measures

Performance Measure	Watershed Median 2012-2017 (min-max)	2018	Typical Value
Per capita flow (L/person/day)	294 - 351	**317**	350 - 500
ADF as % of Nominal Design	51% - 66%	**58%**	N/A
Peak day: Annual average flow	2.25 - 2.75	**3.06**	2.5 – 3.5
Per capita TBOD loading (g/person/day)	65 - 77	**72**	80
Per capita TSS loading (g/person/day)	69 - 93	**82**	90
Per capita TKN loading (g/person/day)	13 - 14	**13.5**	13
Per Capita TP loading (g/person/day)	1.7 – 2.0	**1.7**	2.1
Raw TSS:TBOD ratio	1.01 - 1.17	**1.25**	0.8 - 1.2
Raw TKN:TBOD ratio	0.17 - 0.22	**0.21**	0.1 - 0.2

Year-to-year variations in per capita flow, %ADF and peak to average flow from Table 4 are largely due to differences in inflow and infiltration (I&I) related to precipitation.

By embracing an optimization approach to reduce the impacts of wastewater effluents on the Grand River, including nutrients, municipal wastewater managers and operators can help to ensure a healthy and sustainable watershed that supports prosperous and growing communities into the future.

Bypasses and Overflows

Bypasses/overflows can be classified as low, medium or high according to the level of risk to downstream users. Overall the total number of bypasses decreased 30% from 66 in 2013 to 46 in 2018. Alternatively the total volume of bypasses has decreased 86% from 1,156,707 m^3 in 2013 to 164,686 m^3 in 2018. A number of moderate risk bypass in 2018 occurred in February and April and were related to weather conditions generating high peak day flows to the WWTP.

Contact

Further information on the Grand River Watershed-wide Optimization Program can be obtained from the Grand River wastewater optimization web page, or by contacting Kelly Hagan, Optimization Extension Specialist at 519-621-2761 Ext. 2295 or Mark Anderson, Water Quality Engineer at 519-621-2761 Ext. 2226.