GRAND RIVER WATERSHED
Water Management Plan

Watershed Overview of Wastewater Treatment Plant Performance

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Acronyms and Abbreviations

ADF	Average daily flow
cBOD	Carbonaceous 5 day biochemical oxygen demand
CCP	Composite Correction Program
ECA	Environmental Compliance Approval (formerly called Certificate of Approval)
EPA	US Environmental Protection Agency
GRCA	Grand River Conservation Authority
MOE	Ontario Ministry of the Environment
OCWA	Ontario Clean Water Agency
TAN	Total ammonia nitrogen
TBOD	Total 5 day biochemical oxygen demand
TKN	Total Kjeldahl nitrogen
TP	Total phosphorus
TSS	Total suspended solids
WWOP	Watershed-wide Wastewater Optimization Program
WWTP	Wastewater treatment plant

Introduction

The Grand River Watershed-wide Wastewater Optimization Program (WWOP) was initiated to promote optimization across the watershed by encouraging the adoption of the Composite Correction Program (CCP). The US Environmental Protection Agency (EPA) developed the CCP as a structured approach to identify and correct performance limitations with the goal of producing high quality effluent. The watershed municipalities of Guelph, Haldimand County and Brantford have applied the CCP approach and have demonstrated its benefits including improved effluent quality. Adopting the CCP at WWTPs across the watershed is being recommended in the Grand River Water Management Plan as a potential means to reduce overall loading of total phosphorus to the Grand River and, ultimately, to Lake Erie.

During the initial development of the WWOP, several workshops were held in 2010/2011 to bring wastewater operators, supervisors and managers together from communities within the watershed. These workshops focused on providing information on optimization using the CCP and training on some of the tools used to evaluate wastewater performance. The tools were demonstrated in a workshop format and the participants were encouraged to gain hands-on experience by carrying out the calculations using real data from their own facilities. Peer facilitators, who had some experience with the CCP, provided follow up support to the workshop participants and helped them complete the calculations. As an outcome of these workshops, performance data was compiled for 14 WWTPs in the Grand River watershed.

A workshop was held in November 2012 to review some of the metrics that were taught during the initial phase of the WWOP. These metrics included:

- ADF as a percentage of rated capacity;
- Per capita influent flow;
- Ratio of peak day flow to annual average flow;
- Per capita TBOD, TSS and TKN loading to the plant; and
- The ratios of TSS to TBOD and TKN to TBOD in the raw influent

Workshop participants were asked to calculate these metrics for all of the WWTPs in the watershed using data from January to December, 2012 and provide the information back to the GRCA using a standard spreadsheet template. The participants were also encouraged to start including these simple metrics in their annual performance reports to the MOE.

Compiling this information for all plants allows WWTP performance to be compared on a watershed basis, which can be tracked over time. It also enables an assessment of the status of plants to determine suitability for follow-up optimization activities.

This report provides an overview of WWTP performance based on the data that was provided to the GRCA following the November 2012 workshop.

Data Collection Methodology

Each municipality or the contract operator compiled WWTP performance data and entered it into a spreadsheet template. Once the data was input into the spreadsheet, the participants calculated a number of metrics based on the data. The completed spreadsheets were submitted to GRCA. GRCA checked the calculations and confirmed using external sources of information, where available.

Information was provided by the following participants:

- Township of Southgate;
- Township of Centre Wellington;
- Region of Waterloo;
- City of Guelph;
- Oxford County;
- County of Brant;
- OCWA on behalf of City of Brantford; and
- Haldimand County.

The municipalities listed above are responsible for 25 of the 28 municipally-owned WWTPs discharging directly to the Grand River or one of its tributaries. All available performance data submitted to GRCA has been compiled and is summarized in graphical form in the following section.

Wastewater Treatment Plant Performance

Influent flow

Figure 1 shows a summary of the ADF to each plant (shown in blue) compared to the rated capacity of the plant as stated in the ECA (shown in red). Plants A to E are plotted on a separate vertical scale as these facilities are considerably larger than the rest of the WWTPs in the watershed. As expected, ADF is less than the rated capacity and this is demonstrated in Figure 2, which shows the ADF as a percentage of the rated capacity. Based on Figure 2, most plants are operating between 40 and 75% of their rated capacity.

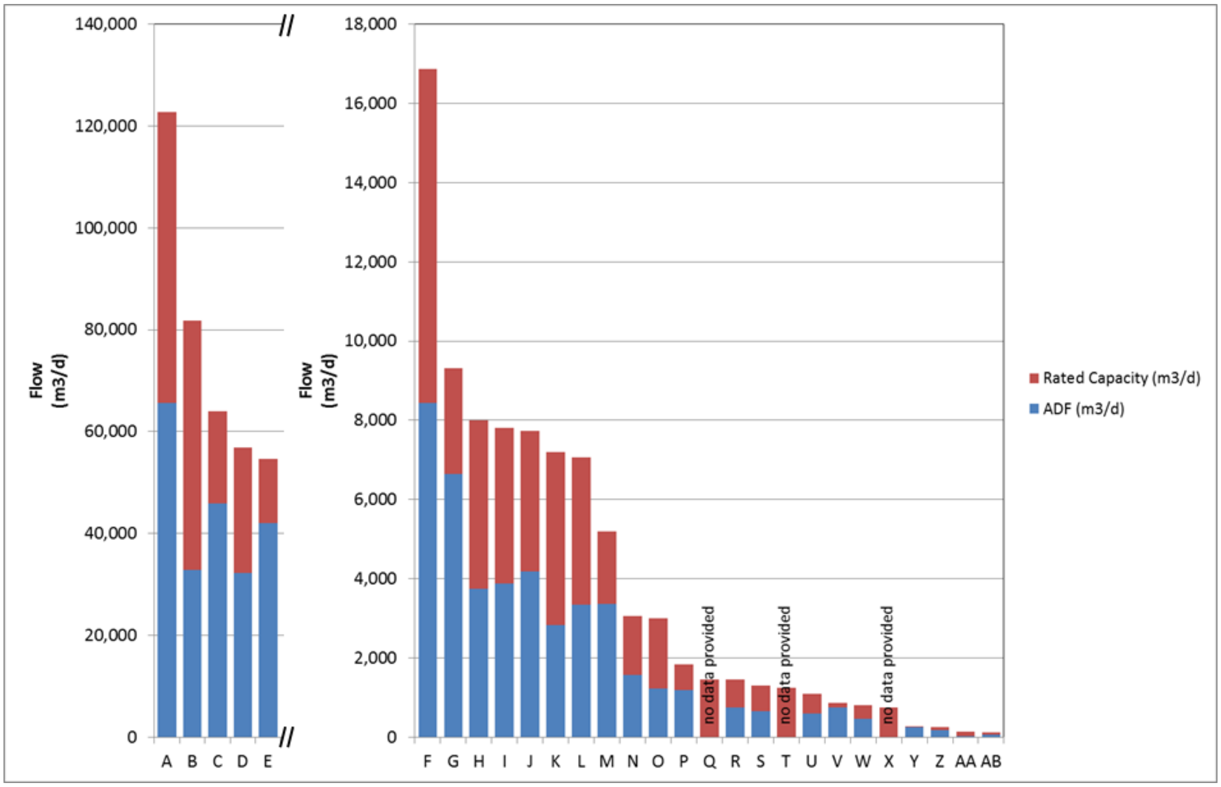

Figure 1: ADF and rated capacity for each WWTP

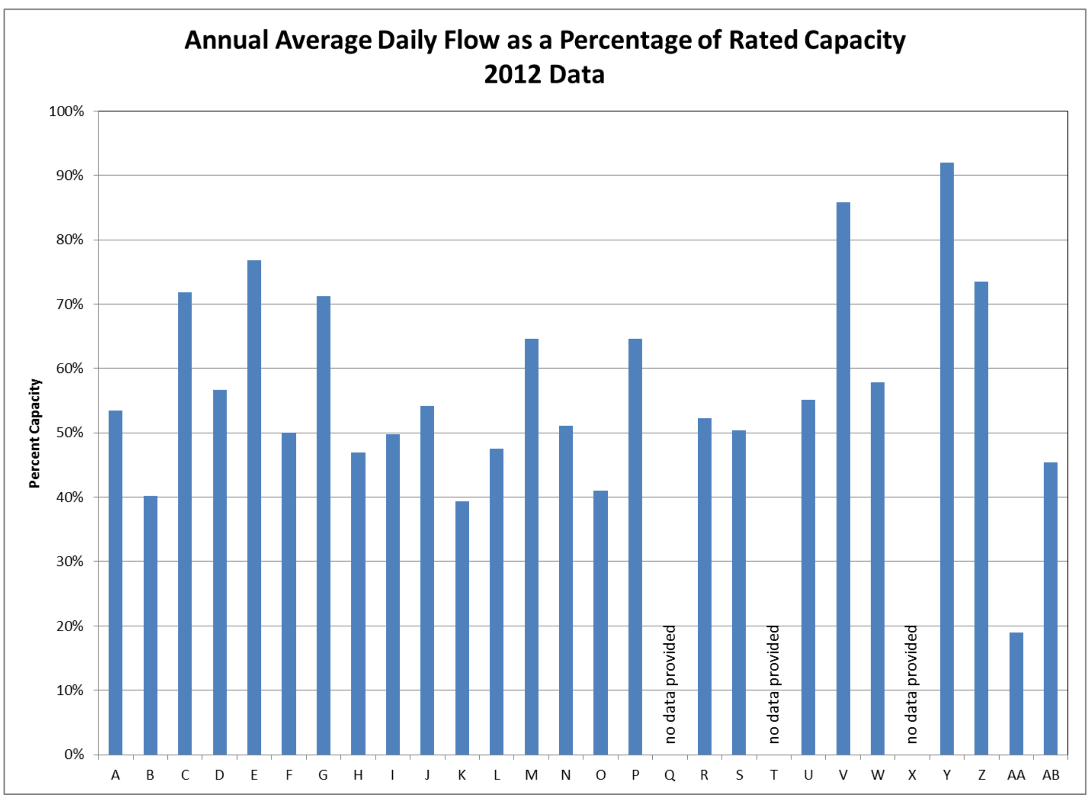

Figure 2: Annual average daily flow as a percentage of rated capacity

Another way to look at influent flow is to normalize it based on the serviced population and express it as per capita flow. Per capita wastewater flow vary from location to location but typical values used in the CCP are from 350 to 500 L/person/d. Figure 3 shows per capita flows for WWTPs in the watershed. From this figure, it appears that plants in the Grand River watershed are generally at or below the low end of the typical range. The median value, based on reported data from 2012, was 317 L/person/d.

The low per capita flows in the Grand River watershed may be related to water conservation efforts that have been promoted by local municipalities in recent years. Climate may also be a factor as 2012 was much drier than normal and this may have resulted in less extraneous flow into collection systems.

There are three notable exceptions that had much higher per capita flows than expected. Plant "Z" services primarily industrial users, which explains why the per capita flows are high. In another case, high per capita flow at Plant "P" has been attributed to I/I and possibly some issues with a flow meter that was reading high. The flow meter issue has been addressed and historical flow data is being reviewed to see if it can be adjusted to give a more realistic picture of flow to the plant. This community, like many in the watershed, has an active I/I control program and is implementing measures to limit extraneous flows.

Two plants show very low per capita flows and the data used to derive these numbers may be questionable. A review of the information for Plant "S" suggested that the original calculations were based on erroneous population data. The data shown in the graphs in this report are based on a more reasonable population estimate for Plant "S".

Figure 4 shows the ratio of peak day flow to ADF, which is another indicator of I/I or periodic industrial flows. This figure also suggests that 2012 was a particularly dry year as many of the plants had a peak day:ADF ratio of about 1.5 or less. Several plants are known to experience I/I (e.g. Plants K, P and V) and this is reflected in Figure 4. Plant AA has a very high peak day:ADF and a very low per capita flow which brings into question the veracity of this data.

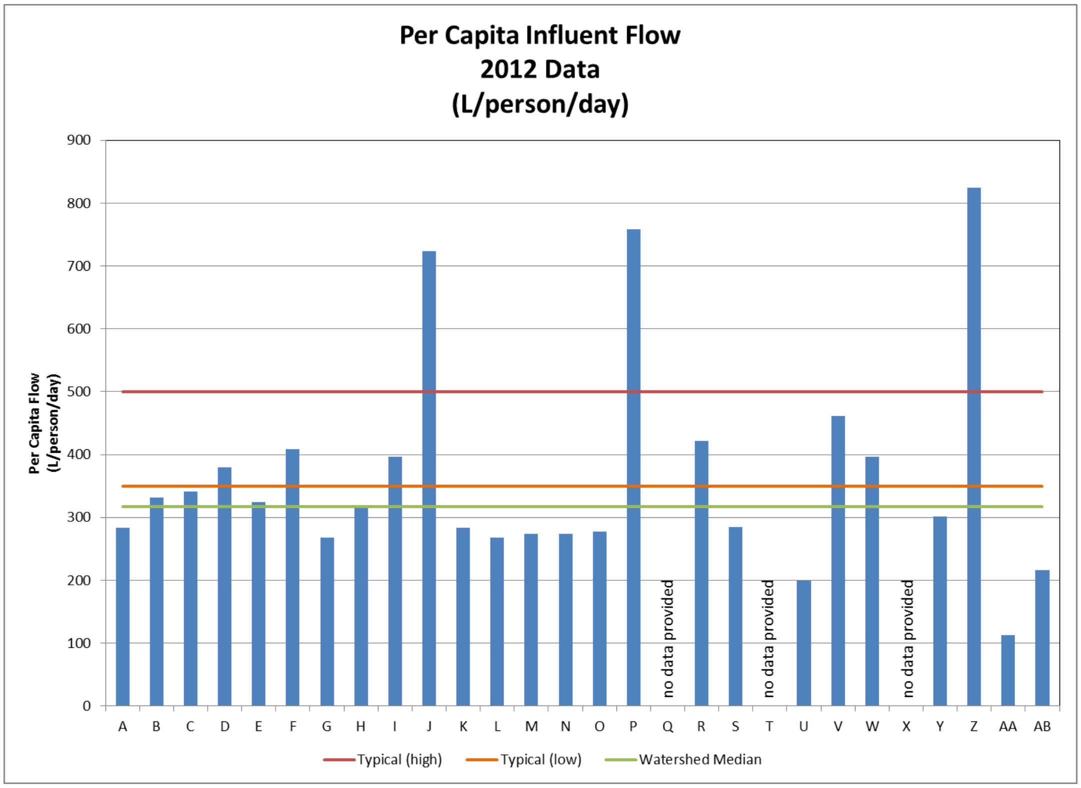

Figure 3: Per capita influent flow

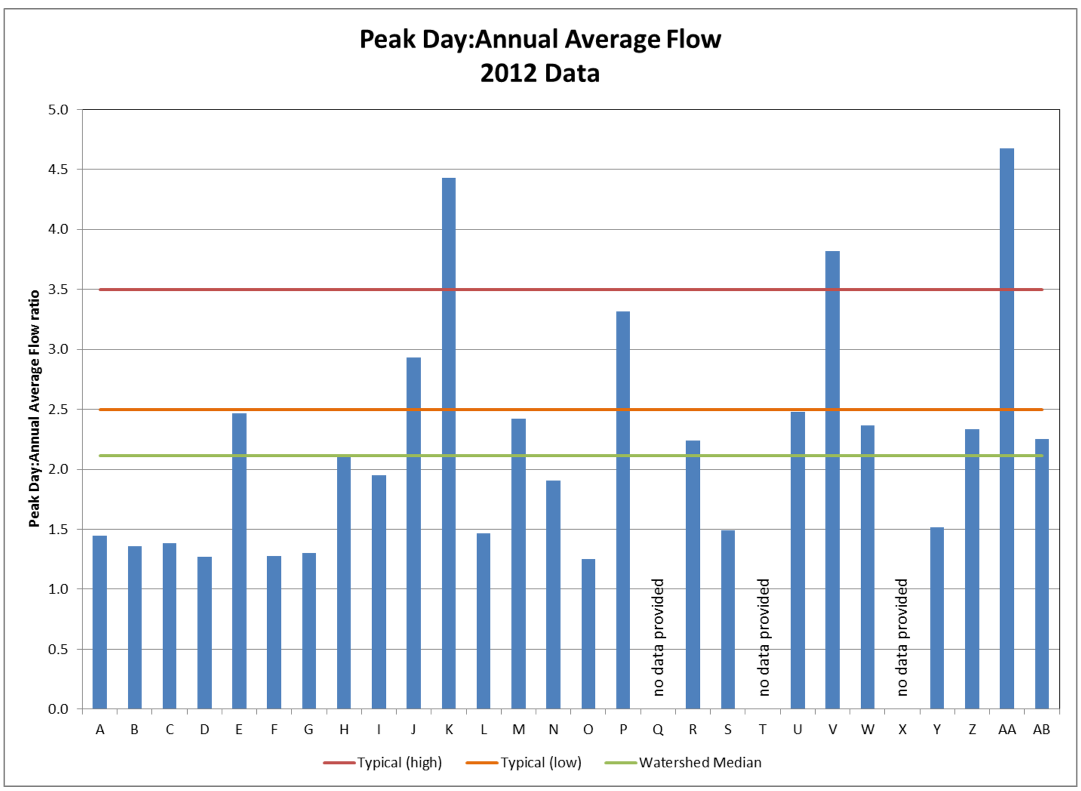

Figure 4: Ratio of peak day flow to annual average flow

Raw Influent Loads

Raw influent loads of TBOD, TSS and TKN can be calculated by multiplying raw influent concentrations by flow. These loads can be expressed on a per capita basis and compared to values that are typical of systems that are primarily treating domestic sewage.

Figure 5 shows estimated per capita TBOD loads for plants in the Grand River watershed. A typical value for domestic wastewater is 80 g/person/d. Many of the plants in the watershed have reported values that are much lower than the typical value. The reason for this is unknown but could be partly related to the fact that most of the plants in the watershed do not measure TBOD in the raw influent on a routine basis. This stems from the fact that most of the ECAs have a requirement to measure cBOD in the raw influent. A paper by Albertson (2005) stated that the cBOD test underestimates the strength of raw wastewater by 20 to 40%. In the absence of measured TBOD data, TBOD loads were estimated based on cBOD concentrations multiplied by a factor of 1.2. The scaling factor of 1.2 is an assumption based on the data presented by Albertson (2005) and it introduces significant uncertainty in the estimate of TBOD loads.

There are a couple of WWTPs that have TBOD loads that are much higher than typical and this is attributed to industrial discharges.

TSS loads in raw influent are summarized in Figure 6. Several plants have reported per capita TSS loads that are lower than typical and some are higher. Where the loads are less than expected based on the typical value, it brings into question the adequacy of raw influent sampling to accurately characterize the influent. Higher than expected loads may be attributed to industrial inputs and/or internal recycle streams that may be influencing the raw influent sample (e.g. this has been observed at some local WWTPs).

Figure 7 shows per capita TKN loads to plants in the watershed. Several plants were reported to have TKN loads that are higher than expected and in most cases, the per capita TSS and/or TBOD loads are also high. This suggests industrial loads to the plant or internal recycle streams that may be influencing raw influent samples. A small number of plants had TKN, TSS and TBOD loads that were less than the typical values and this may be indicative of insufficient sampling to characterize the raw influent. Other sources of error in the calculation of these metrics are the population estimates and raw influent flows. For example, there are some questions about the accuracy of influent flows and/or population estimates, e.g. Plants “U”, “Y” and “AA”.

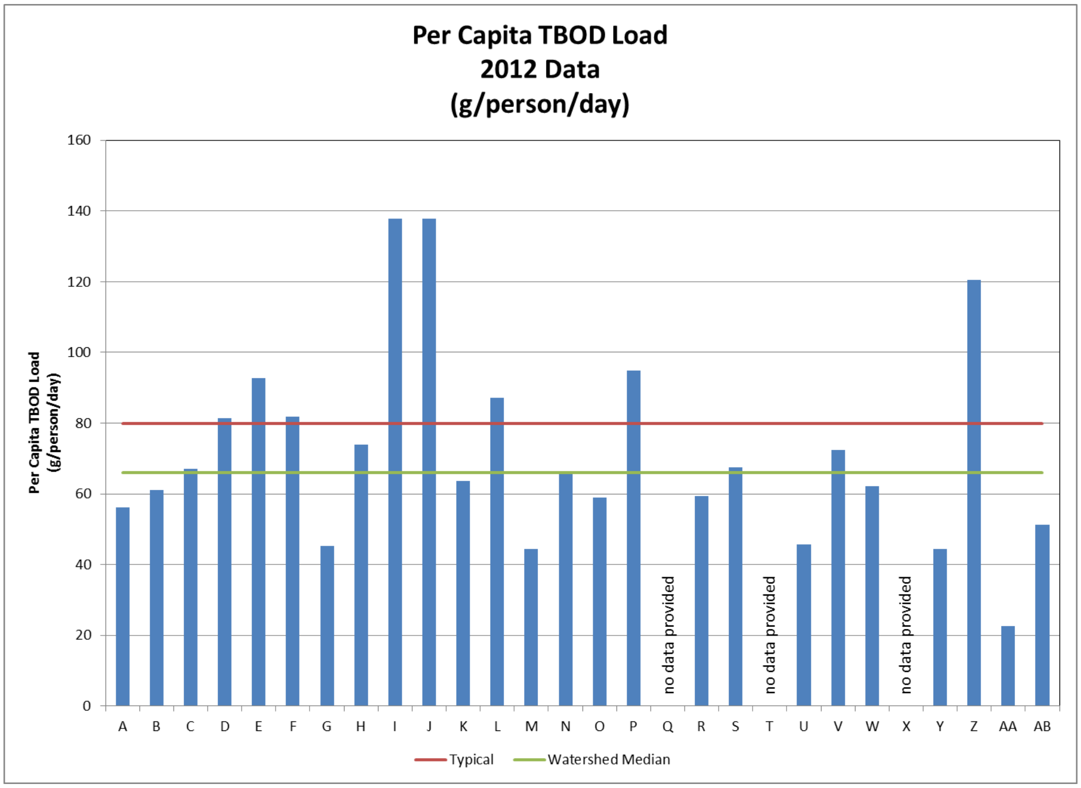

Figure 5: Per capita TBOD load

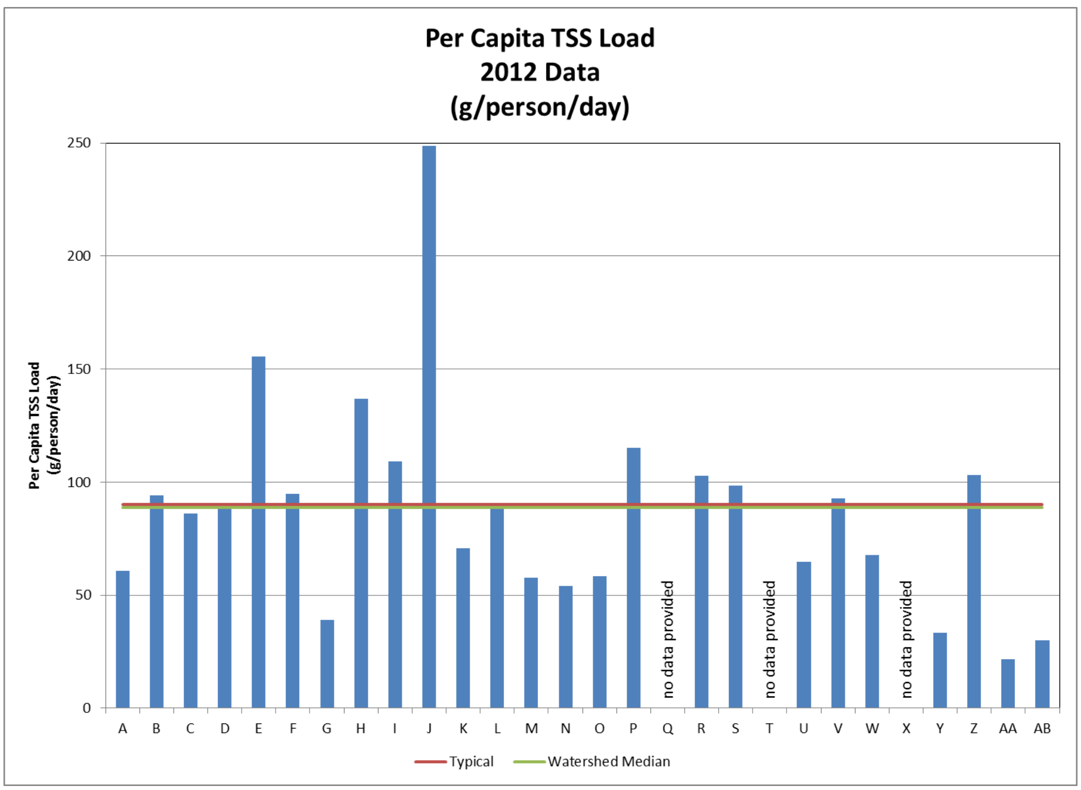

Figure 6: Per capita TSS load

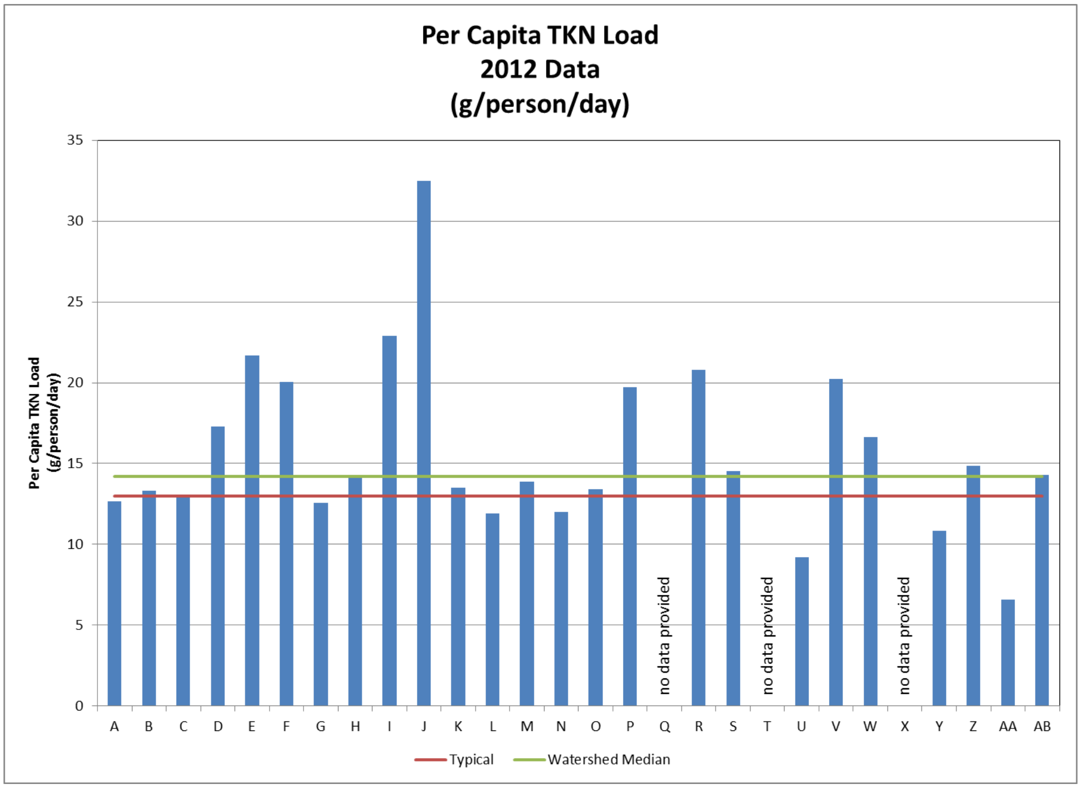

Figure 7: Per capita TKN load

It should be noted that per capita TBOD, TSS and TKN loads for Plant “E” are consistently higher than expected and this may be due to construction activities at this plant. Waste sludge from the secondary clarifiers at Plant “E” was temporarily redirected to a point upstream of the raw influent sampler during construction.

Figure 8 shows the ratio of raw influent TSS to TBOD concentrations. For a typical domestic sewage system, this value would typically be between 0.8 and 1.2. Figure 9 shows a similar graph for the ratio of raw TKN to TBOD, which is typically 0.1 to 0.2.

Many of the plants are within the typical range for TSS:TBOD ratio with some plants higher than the typical. The TKN:TBOD ratio, on the other hand, is generally higher than the typical range for most of the plants with reported data.

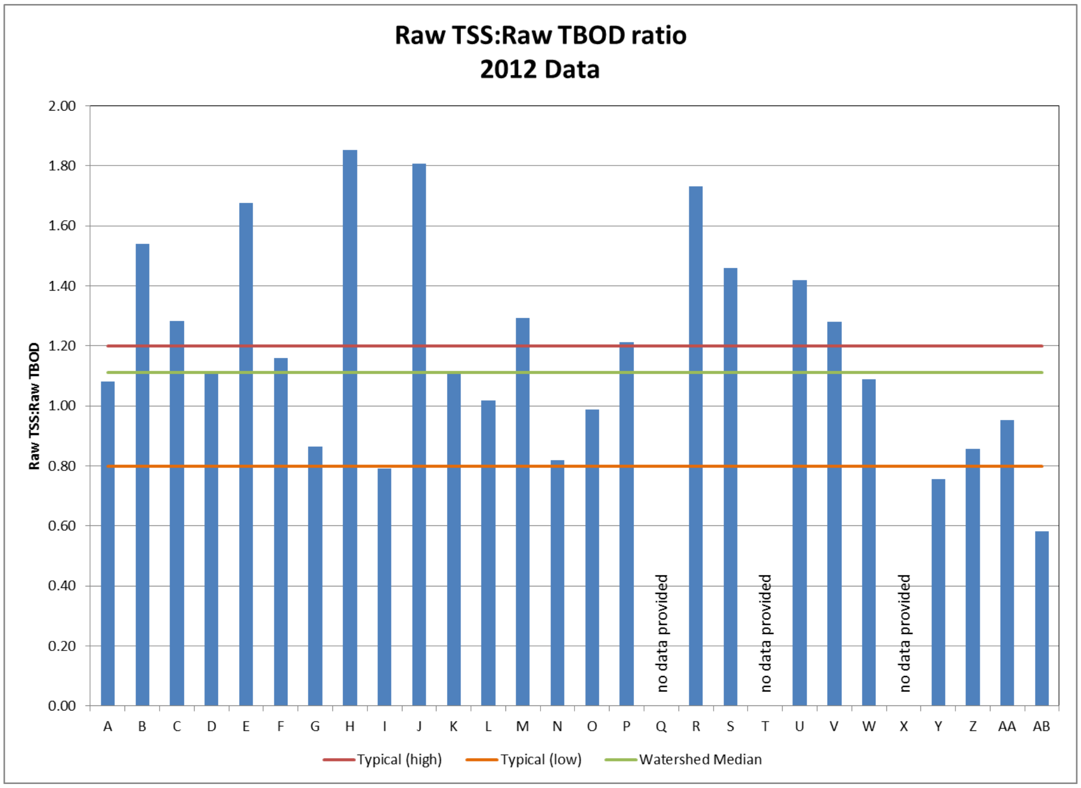

Figure 8: Ratio of raw TSS to TBOD concentration

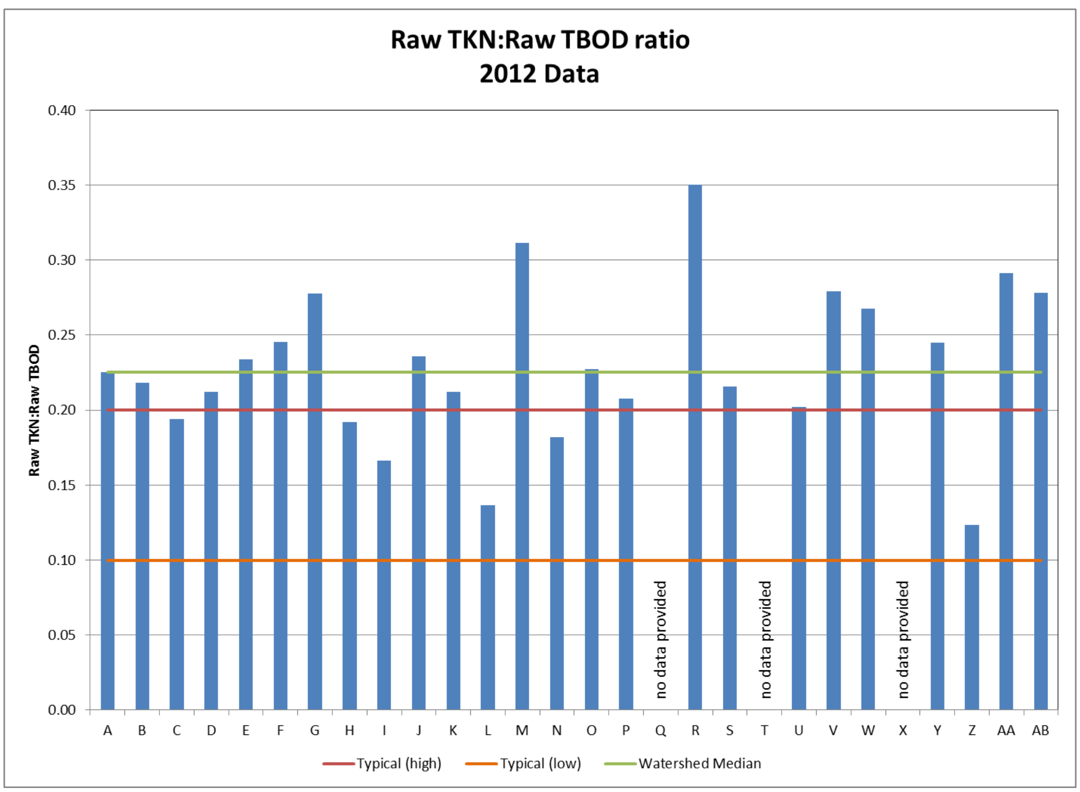

Figure 9: Ratio of raw TKN to TBOD concentration

Final Effluent Quality

Figure 10 shows final effluent TP reported for each WWTP in blue with the ECA limit shown in red. The maximum and minimum monthly average values reported for 2012 are also shown on this figure as the blue error bars. The graph shows that plants generally perform well and meet their ECA criteria.

Data for TAN in final effluent has been separated by season. Figure 11 shows the data for the “summer” period which is defined as May through October, inclusive. The “winter” period is considered to be November to April and this data is shown in Figure 12. Each graph shows the annual average TAN concentration as a blue bar and the ECA limit, where there is one, in red. It is common to have different ECA criteria for TAN in “summer” and “winter”. For some plants, the definition of “summer” and “winter” in their ECA is slightly different from the definition used in this report. These graphs show that plants in the watershed are meeting their ECA criteria for TAN in summer and winter. Generally, effluent concentrations are somewhat higher in winter due to the fact that nitrification is less effective under cold conditions.

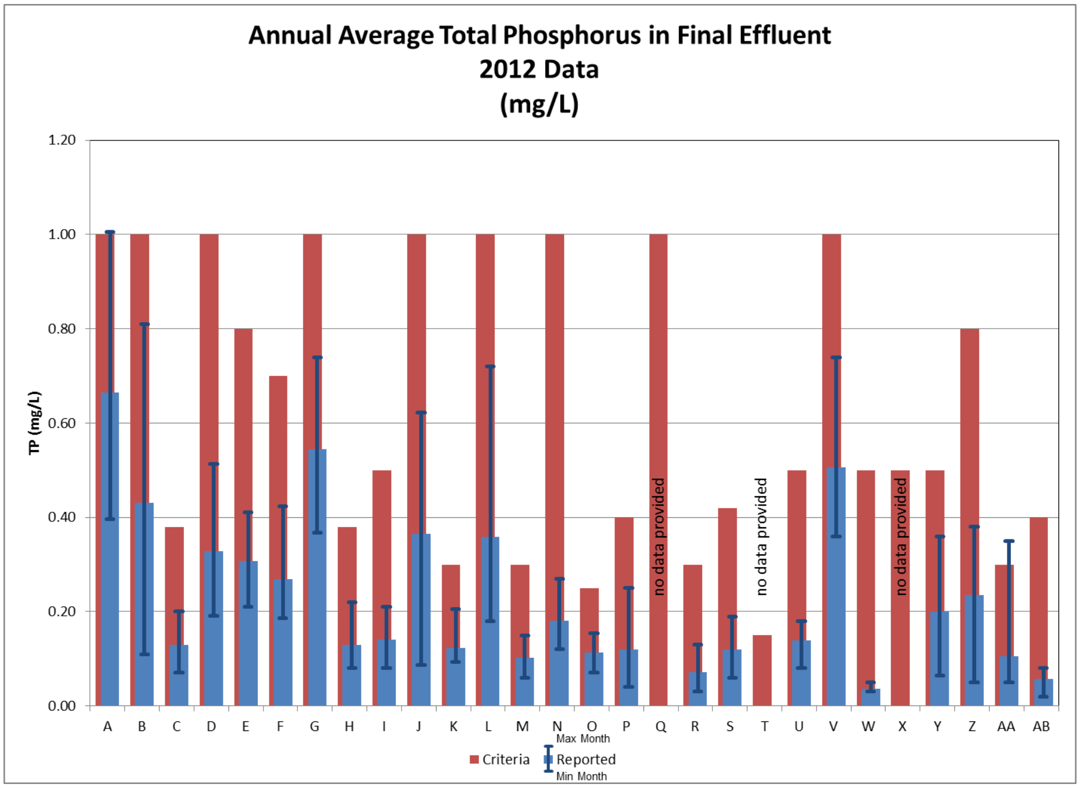

Figure 10: Annual average TP in final effluent

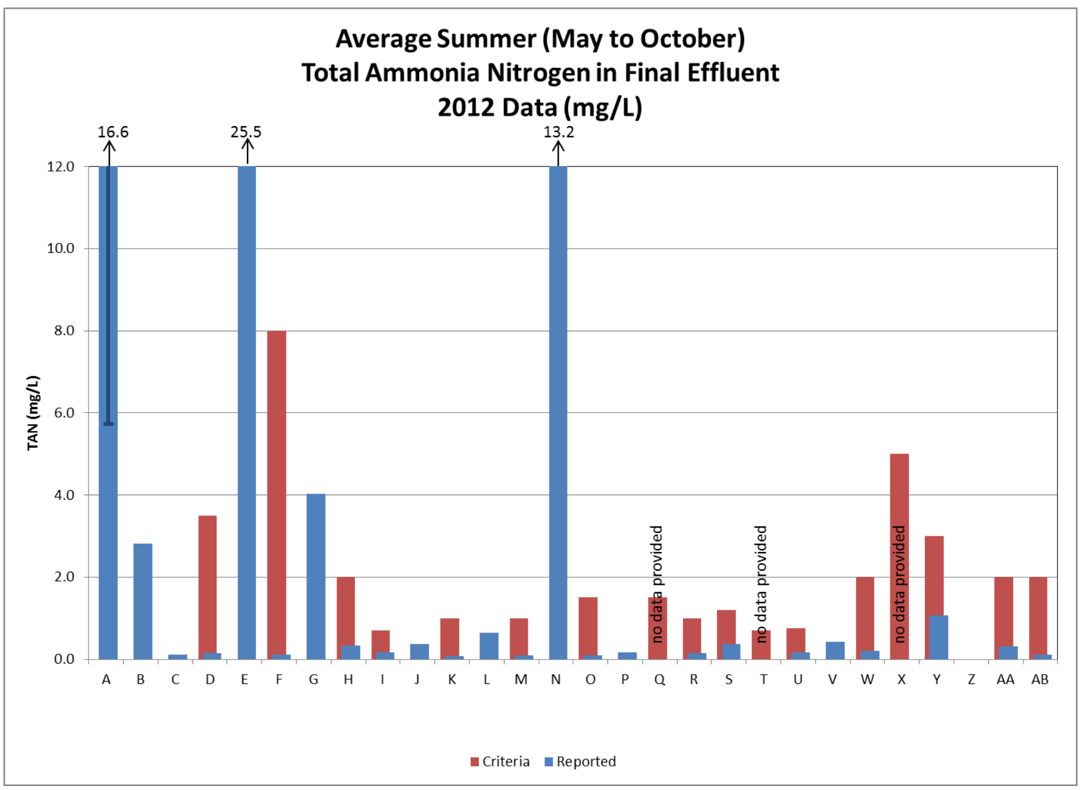

Figure 11: Average TAN in final effluent – May to October

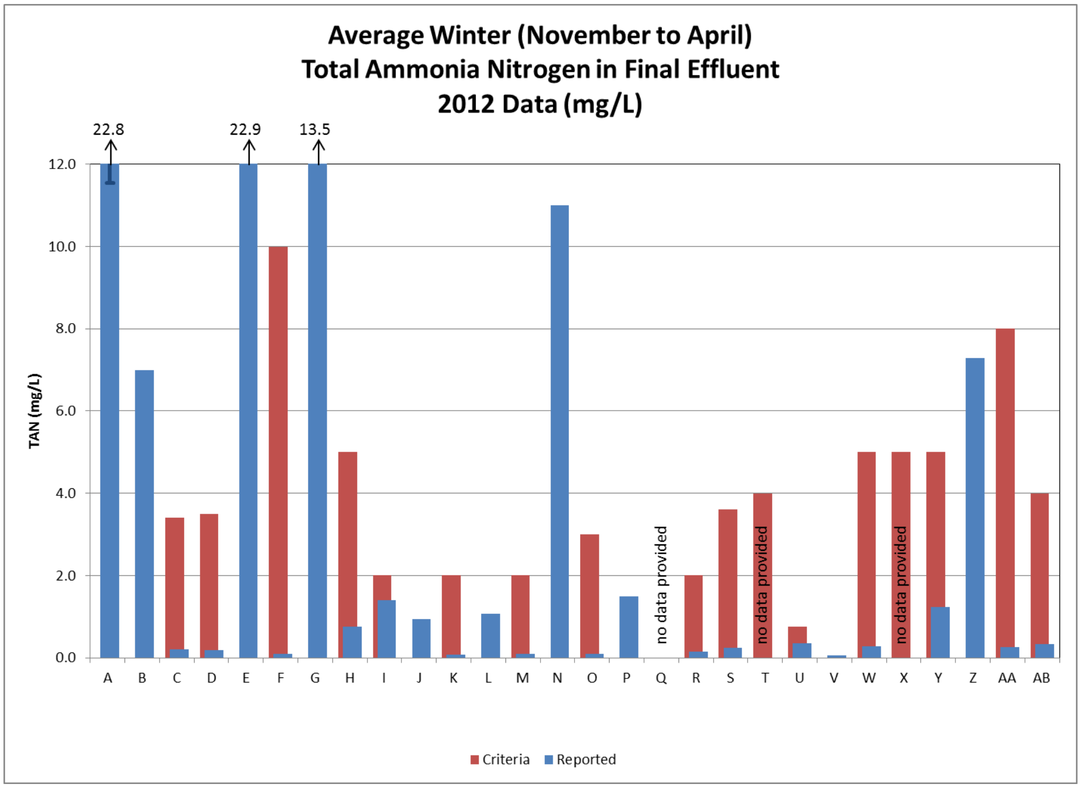

Figure 12: Annual average TAN in final effluent – November to April

Summary

Per capita wastewater flows to plants in the Grand River watershed in 2012 were generally below the typical range. The primary reason for this has been attributed to water conservation efforts. Dry weather conditions in 2012 were reflected in relatively low peak day:ADF ratios for most plants.

TBOD, TSS and TKN loads were generally not within the typical range, which suggests that there may be some opportunities to improve the characterization of raw influent at many plants. Most, if not all, plants in the watershed are required by their ECA to measure cBOD in raw influent. This is likely resulting in significant underestimation of the TBOD loadings. Other challenges include raw influent sampling locations that are not representative of sewage entering the plant due to internal recycle streams.

Table 1 provides a summary of performance measures based on data from 25 plants across the Grand River watershed. The GRCA will continue to encourage local municipalities to report on these performance measures on an annual basis. Tracking these measures over time can be used to demonstrate improved performance and help to identify candidates that may benefit from further optimization.

Table 1: Summary of Performance Measures based on 2012 Data

Performance Measure	Watershed Median	Typical Value
Per capita flow (L/person/d)	317	350 – 500
Peak day:ADF ratio	2.1	2.5 – 3.5
Per capita TBOD load (g/person/d)	66	80
Per capita TSS load (g/person/d)	89	90
Per capita TKN load (g/person/d)	14	13
TSS:TBOD ratio	1.1	0.8 - 1.2
TKN:TBOD ratio	0.23	0.1 - 0.2

References

Albertson, O.E., “Is $CBOD_5$ Test Viable for Raw and Settled Wastewater?”, Journal of Environmental Engineering, July 1995, p. 515-520.

WTC and PAI, “The Ontario Composite Correction Program Manual for Optimization of Sewage Treatment Plants”, prepared for Ontario Ministry of Environment and Energy, Environment Canada and the Municipal Engineers Association, last revised October 1996.