Case Study: City of Brantford

Controlling Industrial Discharges to Improve Plant Performance

Tim Howarth – City of Brantford, Gerry Wheeler – Global Facilitation Inc., Dave Chapman – CPO Inc.

Introduction:

In November of 2011, the City of Brantford initiated an optimization program to improve performance of its wastewater treatment plant with a view to achieving voluntary targets for effluent ammonia established under the Grand River Watershed-wide Wastewater Optimization Program. Achievement of the voluntary targets by all plants in the watershed will result in improved effluent quality in the Grand River.

This case study describes the background, approach, outcomes and "lessons learned" to date from optimizing the Brantford Wastewater Treatment Plant (WWTP) to achieve consistent nitrification. A major issue which was addressed in the optimization program was the impact of industrial loads on plant operation.

Background:

The City of Brantford has a population of about 95,000 and owns a conventional activated sludge wastewater treatment plant with a nominal design flow of 81,800 m^3/d. The plant has two parallel treatment trains (primary and secondary) designated as Process Modules (PM #1 and PM #2). In January 2016, the City assumed day-to-day responsibility for operating the wastewater treatment plant from a contract operator. Figure 1 is an aerial photograph of the Brantford WWTP.

Figure 1 – Aerial Photograph of the Brantford WWTP

Treated effluent from the plant is discharged to the Grand River. The effluent requirements, objectives and targets for the WWTP are identified in Table 1.

Table 1 – Brantford WWTP Effluent Requirements, Objectives, and Targets				
Parameter	GRCA Voluntary Target (mg/L)	ECA Objective (mg/L)	ECA Limit (mg/L)	ECA Loading Limit (kg/d)
$cBOD_5$	--	15.0	25.0	2,045
TSS	--	15.0	25.0	2,045
TP	0.4	0.8	1.0	81.8
TAN	4.0 (Nov. – Apr.) 2.0 (May – Oct.)	--	--	--

In 2011, an optimization program was initiated by the City with third party facilitation to improve treatment performance to achieve voluntary targets for effluent ammonia (see Table 1) which have been set as part of the Grand River Watershed-wide Wastewater Optimization Program. Modelling of the Grand River by the Grand River Conservation Authority has indicated that achieving voluntary effluent TP and ammonia targets by all plants in the watershed will significantly improve water quality in the river (Anderson *et al*., 2014).

Optimization Approach:

Composite Correction Program:

The City of Brantford utilized the Composite Correction Program (CCP) to evaluate and optimize its WWTP. The CCP is a two-step protocol that was developed by the U.S. Environmental Protection Agency and successfully demonstrated in Ontario in the 1990's (MOEE, 1994; MOEE and WTC, 1995). Guidance for conducting CCPs can be found in several existing manuals (US EPA, 1989; WTC & PAI, 1996).

Using the first step of the CCP, City of Brantford staff and a third-party facilitator assessed the plant's operation, design, maintenance and administration to determine the unique combination of factors limiting performance. The design evaluation concluded that the unit processes could treat current and future wastewater flow rates to achieve consistent nitrification. As a result, the WWTP was considered a candidate for Comprehensive Technical Assistance, the second step of the CCP.

Following the kick-off of technical assistance, the facilitator supported operations staff with implementation of total mass control on both liquid trains (PM #1 and PM #2). In total mass control, the activated sludge process is controlled to maintain a target mass and to maximize the activated sludge mass in the aeration basins, while minimizing the mass in the secondary clarifiers.

Industrial Discharge Impacts:

Total mass control was achieved during the winter of 2012 based on a target Solids Residence Time (SRT) of 10 days. However, the nitrification performance was variable. Low levels of effluent ammonia were achieved in June 2012 but deteriorated in September 2012. In response to the unexpected increase in effluent ammonia, the total mass was increased to a target SRT of 15 days. Despite this change, nitrification performance remained variable.

In early 2013, operators initiated daily raw sewage sampling and analysis which revealed significantly high organic loading indicating potential industrial discharges to the system. To effectively communicate the impacts of organic loading on the plant within the City, the loading results were expressed as a population equivalence using a conversion of 80 g/person/day. Figure 2 is a graphical representation of the monthly average organic loading converted to an equivalent population.

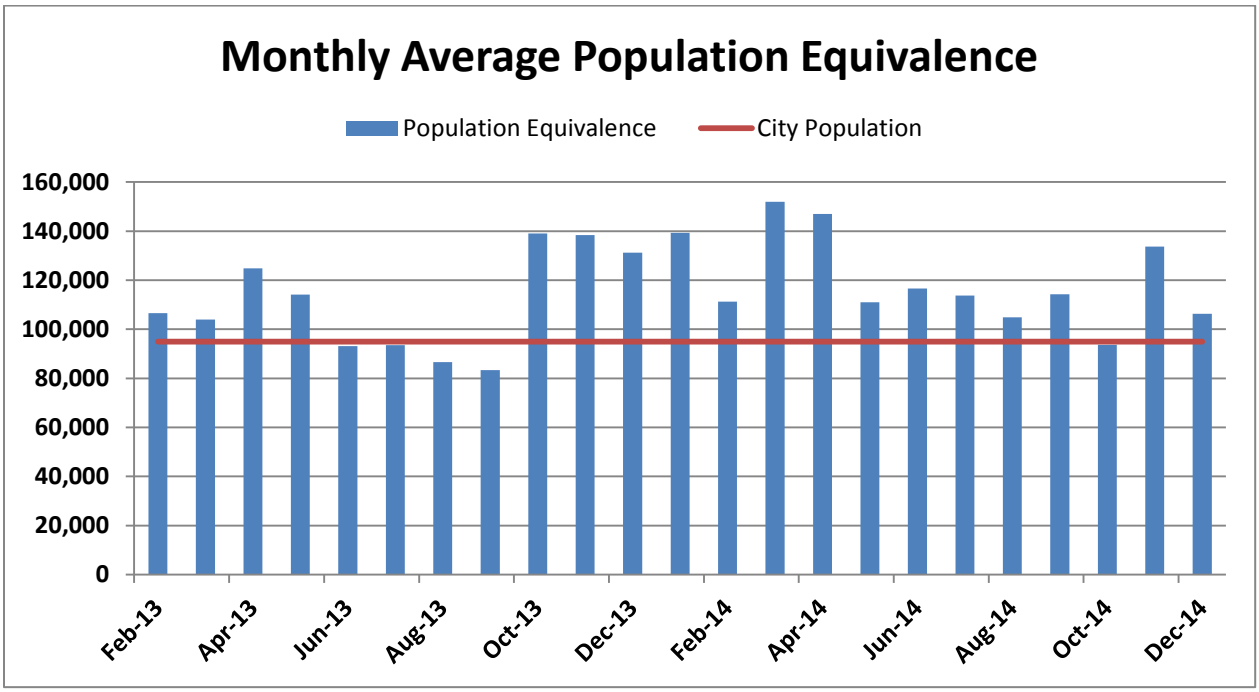

Figure 2 - Monthly Average Population Equivalence Based on WWTP Organic Loading

The monthly average population equivalence, which ranged from a low of 80,000 people to a high of 150,000 people, was then compared to the actual City population of 95,000. Trend charts of population equivalence on a daily basis showed an even greater variability with population equivalence up to 300,000. These results, confirmed that highly variable organic loading from industrial discharges created unfavourable conditions for achieving nitrification despite improved control. Subsequently, the loading of major industries within the City were evaluated in terms of population equivalence based on their sewage discharge data.

During this time, the City's Pollution Control Division received training to conduct bench-scale testing for nitrification inhibition. This new training enabled staff to quickly determine the impact of individual industrial dischargers on the plant.

<u>Reducing Industrial Impacts:</u>

In May of 2013, the City employed the in-house test to identify that an industry was discharging inhibitory waste and determined that the industry was also a source of high organic loading. Over the next several months, City staff were in constant communication with the industry to improve their discharge practices. In November 2013, the industry failed another nitrification inhibition test and discharged a high organic load to the WWTP. As the blowers were unable to provide sufficient air, inadequate dissolved oxygen (D.O.) residuals persisted for for one week and effluent $cBOD_5$ concentrations reached 80 mg/L. The City followed up with the industry and

requested that it cease discharging altogether. By the next day the D.O. residuals had recovered and performance began improving.

Based on this information and experience, the City of Brantford passed a new Sewer-use Bylaw which placed importance on achieving compliance rather than paying over-strength fees. Also, there was a complete ban placed on the discharge of inhibitory substances in April 2014.

As part of enforcing the Sewer-use Bylaw, Pollution Control staff could conduct the inhibition testing which involves spiking waste to samples of mixed liquor and measuring the rate of nitrification. Using the inhibition test method, another industry was found to be discharging an inhibitory substance, which was quickly resolved by staff in January 2015.

In July 2016, the largest industrial discharger in the City started their biological pre-treatment system resulting in a drop of about 35% in organic loading to the WWTP. It is anticipated that all major industrial dischargers will be compliant with the new Sewer-use Bylaw by 2018.

Outcomes:

As a result of improved mass control, coupled with reduced organic loading from industries and the elimination of inhibitory discharges, consistent nitrification was achieved by the WWTP in June 2015. Subsequently, the plant has demonstrated improved nitrification and has achieved the GRCA voluntary effluent ammonia targets since July 2016. Figure 3 is a graph of the monthly average effluent ammonia concentrations compared to the GRCA voluntary effluent ammonia targets.

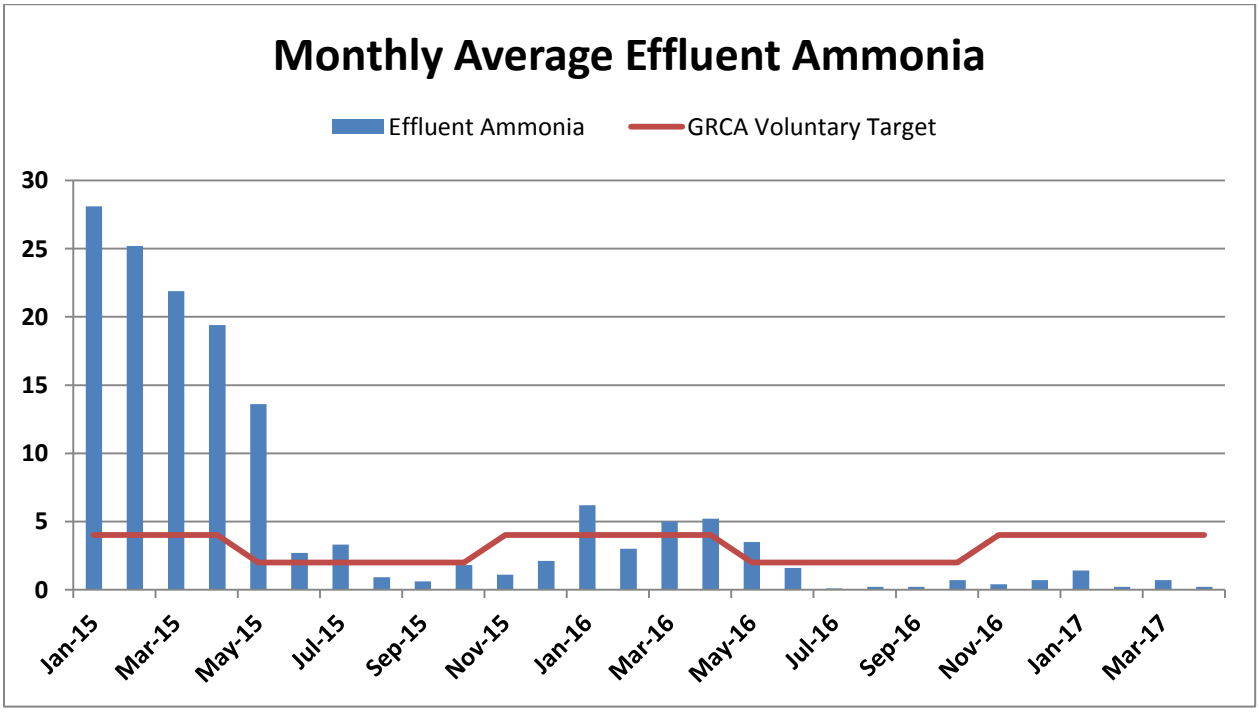

Figure 3 – Monthly Average effluent ammonia concentrations from January 2015 to April 2017

For a two-month period, the plant also has demonstrated that it can achieve a TP concentration of 0.15 mg/L. With support from the MOECC's "Draw the Graph Funding", optimization activities are continuing to further

reduce effluent total phosphorous concentrations. This will be completed by dialing in the total mass target and improving the dosage of ferric chloride. The optimization goal is to consistently achieve 0.1 mg/L. The results from this demonstration will help promote the achievement of voluntary effluent TP limits by conventional activated sludge plants discharging to Lake Erie.

"Lessons Learned":

Optimization:

- The Composite Correction Program is an effective protocol for assessing and resolving performance limiting factors.
- The optimization program was initiated in 2011 and continues to present. Patience and tenacity are therefore an essential component of any optimization program.
- On 16-December 2015, the City of Brantford assumed control of the WWTP from a contract operator. Because of the work done to establish total mass control, this strategy became the routine "way of doing business" for the new hires.
- Stable process control was required before detecting industrial discharge impacts. Establishing mass control helped to uncover the influence of high organic loading and the discharge of inhibitory substances, prior to further investigations.

Industrial Discharges:

- Expressing organic loading in population equivalence was a very effective tool for communicating the impact of organic loads from industries.
- The issues identified at the plant drove investigations back into the sewer system and necessitated the City to upgrade its Sewer-use Bylaw.
- More than one company had to be addressed to resolve the discharge problems impacting plant performance.
- The use of inhibition testing by the City's Pollution Control staff is a direct and effective way of linking industrial discharges to impacts on nitrification at the WWTP.

Further information:

Further information about the City of Brantford's wastewater optimization program can be obtained by e-mailing Tim Howarth at: thowarth@brantford.ca.

References:

Anderson, Mark, Trevor Brown, David Chapman, Sandra Cooke, Jim Matthews, Geoff Rae and Kiran Suresh, "Development of the Grand River Watershed-Wide Wastewater Optimization Program: Demonstrating the Environmental Benefits of Optimization", paper presented at the WEAO Technical Conference, London, Ontario, 2014.

MOEE (1994), "Assessment of the Comprehensive Performance Evaluation Technique for Ontario Sewage Treatment Plants", Queen's Printer for Ontario, ISBN 0-7778-1293-2.

MOEE and WTC (1995), "Assessment of the Comprehensive Technical Assistance Techniques for Ontario Sewage Treatment Plants", report prepared for Ontario Ministry of Environment and Energy, Environment Canada and the Municipal Engineers Association, Queen's Printer for Ontario, ISBN 0-7778-3833-8.

US Environmental Protection Agency (1989), Handbook: Retrofitting POTWs, Center for Environmental Research Information, Cincinnati OH, EPA/625/6-89/020.

Wastewater Technology Centre and Process Applications Inc. (1996), "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.