RESULTS OF THE
COMPREHENSIVE PERFORMANCE EVALUATION
OF THE
MAPLETON WATER POLLUTION CONTROL PLANT

March 2015

Prepared By:

Grand River Conservation Authority

Ontario Ministry of the Environment and Climate Change

Comprehensive Process Optimization Inc.

TABLE OF CONTENTS

NOMENCLATURE

A	Area
AWOP	Area-Wide Optimization Program
BOD_5	Total (5-day) Biochemical Oxygen Demand
CAS	Conventional Activated Sludge
$CBOD_5$	Carbonaceous (5-day) Biochemical Oxygen Demand
CCP	Composite Correction Program
CPE	Comprehensive Performance Evaluation
CSC	Clarifier Sludge Concentration
CTA	Comprehensive Technical Assistance
DO	Dissolved oxygen
EA	Extended Aeration activated sludge process
ECA	Environmental Compliance Approval (formerly Certificate of Approval)
EPA	Environmental Protection Agency
$FeCl_3$	Ferric chloride
FLR	Filter loading rate
F/M ratio	Food-to-Microorganism ratio
GRCA	Grand River Conservation Authority
HP	Horse Power
HRT	Hydraulic Retention Time
I/I	Infiltration/inflow
MOECC	Ontario Ministry of the Environment and Climate Change
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
NH_3-N	Ammonia-Nitrogen
O_2	Oxygen
O&M	Operation & Maintenance
OCWA	Ontario Clean Water Agency
PDC	Process Data Collection (OWCA database)
PE	Primary Effluent
PPG	Performance Potential Graph
Q	Flow
RAS	Return Activated Sludge
SDR	Sludge Distribution Ratio
SOP	Standard Operating Procedure
SOR	Surface Overflow Rate
SPR	Sludge Production Ratio
SRT	Solids Retention Time, also known as sludge age
SWD	Side Water Depth

TAN	Total Ammonia Nitrogen
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WAS	Waste Activated Sludge
WWOP	Watershed-Wide Optimization Program
WWTP	Wastewater Treatment Plant

SITE VISIT INFORMATION

Site Address:

Mapleton WPCP
7101 Sideroad 15, Drayton ON
Mapleton Township
N0G 1P0

Date of Evaluation:

December 16-19, 2014

Municipal Personnel:

Brad McRoberts*	Director of Public Works, Mapleton Township

* to whom any questions or comments about this report should be directed

Evaluators:

Dave Chapman	Comprehensive Process Optimization Inc. (Facilitator)
Mark Anderson	Grand River Conservation Authority (Facilitator)
Kelly Hagan	Grand River Conservation Authority
Martha Weber	Ministry of the Environment and Climate Change
Aaron Law	Ministry of the Environment and Climate Change

EXECUTIVE SUMMARY

From December 16 - 19, 2014, a Comprehensive Performance Evaluation (CPE) was conducted of the Mapleton Water Pollution Control Plant (WPCP) to identify opportunities to improve the performance and provide additional capacity. The Mapleton CPE also provided an opportunity for hands-on training in the evaluation protocol as part of the Grand River Watershed-Wide Optimization Program. The assessment was adapted from the protocol contained in "The Ontario Composite Correction Manual for Optimization of Sewage Treatment Plants" (WTC and PAI, 1996).

The Mapleton WPCP is a seasonal discharge lagoon system with one aerated treatment cell, one facultative treatment cell, and three storage cells. Alum is added for removal of total phosphorus, and the plant has tertiary filters and UV disinfection prior to discharge. The facility has a nominal design flow of 750 m^3/d, services a population of approximately 2,450 and discharges to Conestogo River -- a tributary of the Grand River. In accordance with the Environmental Compliance Approval (ECA), issued April 3, 2013, effluent is discharged in the spring and the fall. The ECA requires that the total volume of effluent discharged each year not exceed the equivalent of 750 m^3/d. The spring discharge period is from March 1 to April 13. In the fall, effluent is discharged during the months of October, November and December.

Reported data were reviewed for the 2013 calendar year in order to incorporate two full discharge periods in the review. Influent flows averaged 714 m^3/d (95% of the nominal design flow) for this period. Concentrations in the final effluent averaged 2.8 mg/L $cBOD_5$, 4.3 mg/L TSS, 1.45 mg/L TAN, and 0.12 mg/L TP. The peak day flow was 2,831 m^3/d in March 2013. The facility met its ECA discharge limit requirements for all 12 months evaluated.

The per capita flow to the Mapleton WPCP was 291 L/person/day, which is slightly lower than the median value of 317 L/person/day for plants in the Grand River (GRCA, 2014). The ratio of peak day flow to annual average flow was approximately 4:1 and the ratio of wastewater to water consumption was 0.74, suggesting that Inflow/Infiltration is not significant. The per capita BOD_5, TSS and TKN loads were lower than typical values for domestic wastewater.

Two studies were conducted to estimate the impact of precipitation on facility capacity. Precipitation adds water to the lagoon, which then must be discharged, thereby reducing the amount of allowable influent wastewater that can be treated. In one approach net precipitation estimates were converted to annual average flows. In the second approach, a water balance was calculated using reported data (influent and effluent flows and liquid levels in the lagoons). The allowable influent flow to maintain the effluent discharge volume and accommodate precipitation was estimated to range from 486 to 592 m^3/d. With the current ECA discharge limits and an influent flow of 714 m^3/d (2013 average), the system is over capacity by 122 to 228 m^3/d.

The removal of ammonia across Cells #2 and #1 was investigated in a special study. The concentrations were compared to model predictions from the existing literature to provide a design basis for ammonia removal in the Mapleton lagoons. The models failed to replicate actual performance, particularly low ammonia concentrations in the summer months.

The capability of major unit processes to meet the effluent requirements at existing flows and loadings was assessed based on available criteria for lagoon processes. The overall plant capability was classified as “not rated” because no design basis for ammonia removal could be determined. Of the processes that were assessed, effluent discharge was the most limiting unit process. All other major unit processes were determined to be “capable” at current flows.

Because the effluent achieved the plant’s ECA requirements over the 12 month period reviewed, no factors were identified as impacting current plant performance. The following factors and recommended follow up activities were identified to provide a focus for future planning:

Administration Factor: Planning

The ECA for the Mapleton WPCP contains limits on effluent volumes and flows that can be discharged seasonally. Due to the accumulation of precipitation, the effective capacity of the Mapleton WPCP to treat influent wastewater flows is less than the allowable effluent discharge rate of 750 m^3/d. As a result, the Mapleton WPCP will likely continue to experience overcapacity issues as the average flow to the plant from raw wastewater is 714 m^3/d and precipitation provides an additional 149 m^3/d. The daily effluent discharge limit in October is 233 m^3/d, which requires a great deal of operator time and attention for a small volume of discharge.

During the CPE, the Director of Public Works was the main contact person within the Township. Due to staff turnover, there was no one else who was responsible for day-to-day management of the wastewater system (e.g. overseeing the operating contract, liaising with the contracted operator and consultants, etc.) Efforts by the Township to recruit for this position, initiated during the CPE, are important to ensure that there is solid municipal understanding of plant performance and capabilities to support proactive planning for future needs.

Maintaining and enhancing communication between Mapleton, OCWA and consultants is also essential for proactive planning. Routine review of current performance, capacities and limitations will help support long-term planning for growth and asset management.

Over time, wastewater lagoons will build-up sludge and require clean-out. A cost for desludging should be included in future budgets.

Design Factor: Design Limitations

Currently, effluent flow is calculated by subtracting an estimate of the filter reject stream from the measured flows going to the filters. Since it is not directly measured, this calculated value has some uncertainty associated with it. A direct measurement of flow following filtration will provide operators with more reliable data to manage effluent discharge volumes and flows. The two HSI turbo blowers that provide aeration to Cell #2 have suffered chronic breakdowns and both units were out of service during the CPE. When the blowers are out-of-service for an extended period, treatment performance is likely impacted.

Fully utilizing the capacity of the existing system is desirable to reduce future costs. The following design related challenges will need to be addressed: accounting for the net accumulation of precipitation; estimating ammonia removal capability at current and future flows (or considering additional technologies to remove ammonia); evaluating the performance of existing units such as filters and UV disinfection system; and investigating potential short circuiting in Cell #2.

Operation Factor: Process Control Testing and Interpretation

Per capita estimates for raw influent loadings were lower than typical for domestic wastewater. Either the population value used in the calculation was not correct and/or the raw influent may need to be better characterized. Improving raw influent data will help with the design of upgrades or future expansion. Similarly, additional process monitoring, including parameters such as pH, T, DO, and NH_3, at key points in the treatment process, will be necessary for future expansion/re-rating work. Information concerning the depth of the sludge in the lagoons will help to determine when the lagoons should be cleaned out. Water levels in each cell are measured on a weekly or bi-weekly basis to estimate the liquid volume in each cell. Collecting this data is important for understanding the storage available in the system. Tracking, trending and jointly reviewing this data will be beneficial for quantifying the impacts of precipitation and identifying the potential for overcapacity.

Operation Factor: O&M Manual/Procedures

The current rationale and procedure for managing the volume in each of the three storage cells should be documented, as it is somewhat different from the procedures described in the O&M manual. This will ensure there is a consistent approach in place in the event of staff turnover, vacation, etc.

Comprehensive Technical Assistance (CTA) is the follow-up step to a CPE. Based on the results of this CPE, the Mapleton WPCP is not a CTA candidate. Recommendations for follow-up include:

- Continue efforts to revise the ECA to include more flexibility for effluent discharge;
- Continue efforts to improve final effluent flow measurement and provide backup power during the seasonal discharge periods;
- Review current process control monitoring to better characterize plant performance and capacity;
- Enhance trending and interpretation of available data;
- Initiate routine review of plant performance and water balance jointly by OCWA, Mapleton and consultants;
- Determine ability of existing facility to provide ammonia removal at higher flows and/or investigate other processes for ammonia removal; and
- Document current operating procedures for cell management.

INTRODUCTION

A Comprehensive Performance Evaluation (CPE) was carried out at the Mapleton Water Pollution Control Plant (WPCP) from December 16th-19th, 2014, with a team of evaluators comprised of staff from the GRCA, MOECC, and CPO Inc. The objectives of the CPE were three-fold:

- on behalf of the Township of Mapleton, to review the performance and capacity of the Mapleton WPCP to identify and prioritize key factors in the areas of administration, operation, design and maintenance;
- on behalf of the Grand River Conservation Authority (GRCA), to provide hands-on training in the CPE protocol as part of the Grand River Watershed-Wide Wastewater Optimization Program; and
- to adapt and apply the concepts of the CPE protocol for mechanical wastewater treatment plants to a lagoon system.

This report summarizes the background, approach, and findings of the CPE conducted at the Mapleton WPCP.

BACKGROUND

The Composite Correction Program

The objective of wastewater treatment is to obtain a good, economical effluent. A “good” effluent is one that meets or is better than the compliance limits and minimizes environmental impacts. An “economical” effluent is achieved by making efficient and effective use of power, chemicals, staff time and available plant infrastructure. Because the goal is effective environmental protection, “good” is placed ahead of “economical” as a focus.

As shown in **Figure 1**, administration, design, maintenance, and operation work together to achieve the goal of producing a good, economical effluent. Administration, design, and maintenance practices establish a plant that is physically capable of achieving the desired performance. By applying process control on a day-to-day basis, operators take a capable plant to the desired level of performance. The requirements of the treatment process, established by process control and testing, help establish priorities for the plant.

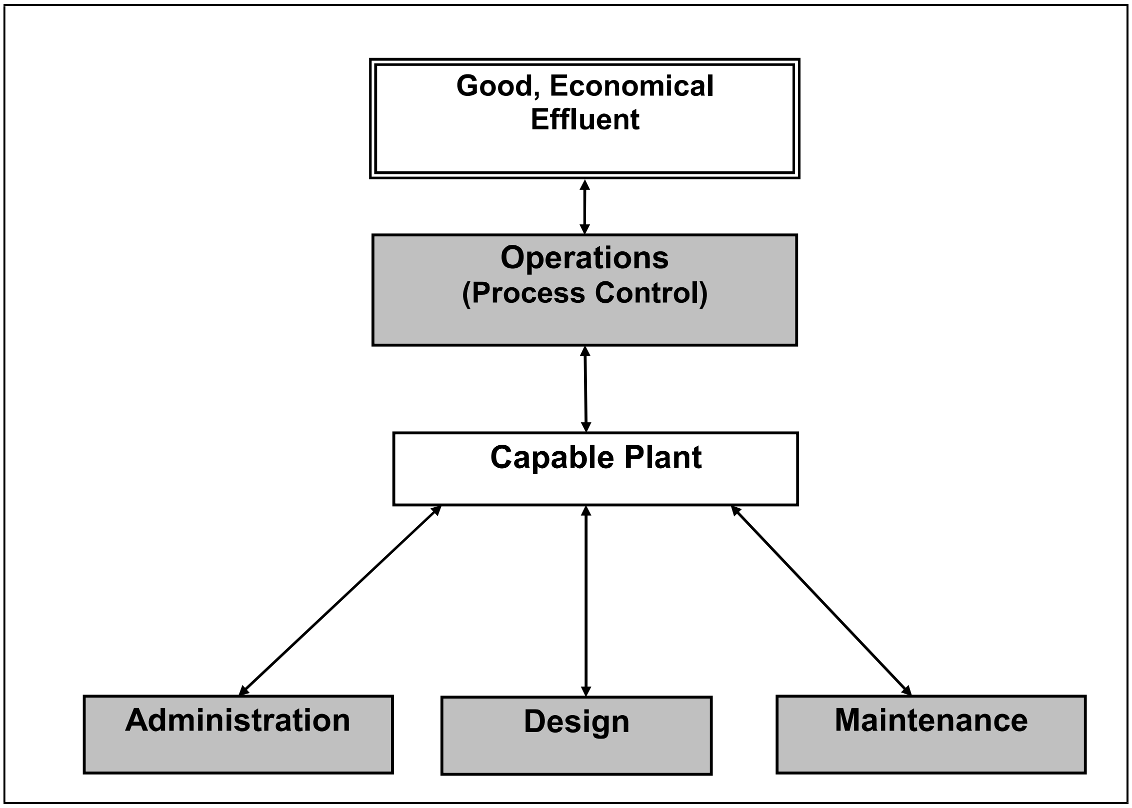


Figure 1: "Performance pyramid" basis of the Composite Correction Program (U.S. EPA, 1989).

Limitations in any of the four shaded areas (**Figure 1**) can lead to poor performance. Experience in Canada has found that the three most commonly occurring factors that impact performance are (XCG, 1992):

- Inadequate sludge wastage and disposal (Design);
- Lack of understanding of wastewater treatment fundamentals and inability to apply wastewater knowledge in controlling a facility (Operations); and
- Inappropriate policies and lack of support for operations (Administration).

The Composite Correction Program is a two-step approach that identifies and resolves the unique combination of design, operational, maintenance, and administrative factors contributing to poor performance or preventing a plant from fully utilizing available capacity. The Office of Research and Development of the U.S. Environmental Protection Agency (EPA) developed the Composite Correction Program (CCP) in response to findings that a significant number of municipal wastewater treatment plants in the U.S. were exceeding their discharge permits (U.S. EPA, 1989). Experience in Canada since 1991 confirms that the CCP is a cost-effective approach for optimizing existing facilities to improve plant performance and identify opportunities to tap additional capacity (MOEE, 1994; MOEE & WTC, 1995; WEAO, et al., 2010; Wheeler 2009; Chapman and Anderson, 2011; Howarth and Chapman, 2012).

The first step of the CCP, the Comprehensive Performance Evaluation (CPE), evaluates the operation, design, maintenance and administration of the WWTP to determine which combination of factors may be impacting performance or capacity. **Table 1** is a summary of the activities that are typically conducted over a one-week period by an evaluation team being trained in the CPE protocol.

If the CPE determines that the facility is “capable” or “marginal”, a Comprehensive Technical Assistance (CTA) program may be recommended to capitalize on opportunities to improve performance or demonstrate increased capacity. The CTA resolves factors preventing the achievement of a good, economical effluent. Minor modifications may be required at “capable” or “marginal” facilities as part of a CTA program. If the WWTP is “not capable” as a result of significant unit process limitations, then a CTA is not appropriate until major design factors are resolved. In this case, a detailed review is required by a professional qualified to address design limitations.

The objective of a CTA is to improve the performance of an existing WWTP by systematically addressing the performance limiting factors identified during the CPE. A CTA facilitation team supports process control activities and transfers skills to the staff and administrators responsible for the facility and assists management to upgrade policies such as those relating to "chain of command", priority setting, workload distribution, plant coverage, etc..

Table 1: Activities typically conducted during a training CPE

Component	Description
CPE Workshop	A half-day workshop to describe the background, objectives, approach and expected results of a CPE.
Plant Tour	A plant tour of the facility to review the process and layout with the plant supervisor or chief operator, followed by an evaluation team debriefing.
Data Collection	Collection of key information in the areas of administration, operations, design, and maintenance using forms in the Appendix of the Ontario CCP Handbook.
Loading Evaluation	In a workshop setting, the evaluation team jointly prepares calculations for per capita flows and loads (BOD_5, TSS, & NH_3) and ratios (TSS: BOD_5, TKN: BOD_5, etc.).
Process Evaluation	Estimates are prepared for key process parameters and compared to recommended guidelines. (for lagoons, HRT, FLR, BOD loading, and disinfection capacity are reviewed)
Sludge Accountability	Calculations are prepared for projected and reported sludge masses for a 12-month period as performance check. Note: this component is not applicable for lagoon systems.
Major Unit Evaluation	A Performance Potential Graph (PPG) is prepared with estimates of rated capacities for each major unit process; the plant is classified as “Capable”, “Marginal” or “Not Capable” at current and nominal design flows.
Special Studies	Additional information on the facility is collected from on-site studies such as a spot check of the flow meter.
Personnel Interviews	A list of key questions is generated. Key operations, maintenance, and administrative staff are interviewed by two-member interview teams and the interviews debriefed with the rest of the evaluation team.
Limiting Factors	Using a schematic of the “performance pyramid”, evaluators identify challenges and opportunities in each of the four areas (operation, design, maintenance and administration). The CPE Facilitators identify and prioritize the limiting factors using a list in the appendix of the Ontario CCP Handbook.
Exit Briefing	A PowerPoint Exit Briefing on the CPE objectives, approach, and findings is prepared and jointly presented.

A period of 12 to 18 months is generally required to complete the CTA in order to:

- progressively transfer new skills and develop staff confidence in new methods,
- implement new policies,
- address a variety of operating conditions (i.e., wet weather flows during the spring),
- allow biological systems to respond to changes,
- enable physical modifications and procedural changes to be completed, and
- provide longer-term exposure to plant policies and practices to allow for the identification and elimination of additional performance limiting factors.

Since skills transfer is the focus of technical assistance, operators must assume responsibility for learning and applying new techniques. The support of managers is therefore crucial to achieving "buy-in" from plant staff. As appropriate, a CTA also develops or upgrades management skills.

The CPE protocol was developed for mechanical treatment facilities. The Evaluation Team adapted the protocol and applied it to a lagoon treatment system for the Mapleton WPCP.

The Grand River Watershed-Wide Wastewater Optimization Program (WWOP)

Within the Grand River watershed, a number of organizations are currently applying the Composite Correction Program to optimize their wastewater treatment plants. Cost-effective improvements in effluent quality from existing facilities and deferred capital expenditures have been achieved at plants in the Grand River watershed through the use of facilitated technical assistance (MOEE and WTC, 1995; Cooke and Anderson, 2010; Wheeler 2009; Baine, 2011; Howarth and Chapman, 2012). Following a pilot project from August 2010 to March 2011, work on a Grand River Watershed-Wide Optimization Program

(WWOP) was initiated. Program activities are directed by a Steering Committee with members from the GRCA, City of Brantford, City of Guelph, Haldimand County and Region of Waterloo. The goals of the program are as follows (Chapman and Anderson, 2011):

- To promote environmental stewardship through optimization of wastewater operations to achieve measurable reductions in total phosphorous and ammonia loadings to the Grand River;
- To enhance collaboration and knowledge sharing within the watershed wastewater community;
- To offer workshops and training opportunities for wastewater operators, supervisors and managers on optimization techniques; and
- To develop facilitation skills through hands-on learning.

Negotiations were conducted with several municipalities in the Grand River watershed to demonstrate the CPE approach at their facilities. The evaluations provided an opportunity for hands-on training to 5-6 team members. Training evaluations were conducted of the Paris WPCP (County of Brant) October 2012, the Galt WWTP (Region of Waterloo) December 2012, the Elmira WWTP (Region of Waterloo) January 2014, the Fergus WWTP (Township of Centre Wellington) January 2014, and the Arthur WWTP (Township of Wellington North) October 2014.

In addition, the following activities are ongoing as part of the Grand River WWOP:

- Development of a forum for sharing of information on the status, issues and lessons learned in conducting optimization. To date six meetings have been held at various locations.
- Establishment of voluntary effluent performance goals for watershed WWTPs based on a performance review of effluent data;

- Development and delivery of optimization training through focused workshops and hands-on site activities to increase staff knowledge and skills;
- Development of a framework for annual reporting of process and performance data by all WWTPs in the Grand River as a means to gauge progress towards the voluntary performance goals and better define the impact of wastewater treatment plant discharges on the river; and
- Development and implementation of a strategy to transfer the successful approach and findings from the Grand River watershed to the larger community in Ontario.

FACILITY DESCRIPTION

General

The Mapleton WPCP is owned by the Township of Mapleton and operated under contract by the Ontario Clean Water Agency (OCWA). The plant currently services the villages of Moorefield and Drayton with a combined population of approximately 2,450. Currently, the plant has a nominal design flow of 750 m^3/d. Raw wastewater enters the WPCP via two forcemains from pumping stations servicing the communities of Moorefield and Drayton. Treated effluent from the Mapleton WPCP is discharged seasonally into the Conestogo River, a tributary of the Grand River. The following sections provide a detailed facility description.

Process Flow

Figure 2 is a schematic of the Mapleton WPCP. Raw wastewater enters the plant and passes through an influent chamber to Cell #2, which is aerated. The aeration system consists of two 40hp HSI turbo blowers (one duty and one standby) and fine bubble diffusers. Effluent from Cell #2 enters Cell #1, which is a facultative cell. Effluent from Cell #1 then discharges via flow control structure A (FCS-A) with valved inlet/outlet pipes to storage, Cell #3, 4A, or 4B. Alum is added for precipitation of total phosphorus at FCS-A via two metering pumps (one on duty).

A secondary gravity flow control structure B (FCS-B) has valved inlet/outlet pipes to Cell #4A and #4B. There is a compressed air distribution system available for Cell #3 consisting of a 25hp compressor/blower and coarse bubble diffusion, however it is not used when effluent is being discharged from this cell.

Flow is stored in the lagoon cells until the seasonal discharge period, when flow from the storage cells (either #3, 4A, or 4B) is discharged to an effluent filter system. This system consists of five Dynasand filters that are continuous backwash, upflow, deep-bed granular modules with a total filtration area of 23.25 m^2. They have a peak flow capacity of 4,000 m^3/d. Reject water from the filter is returned to Cell #2.

Filtered effluent passes through a Trojan UV3000B ultraviolet disinfection system consisting of two banks of UV lamps in series. One bank is operated when the effluent flow is in the 0 - 2,000 m^3/d range; both banks are operated when the flow is greater than 2,000 m^3/d. Each UV bank contains 4 modules with four lamps per module.

Following disinfection treated effluent passes over a concrete cascade aeration system. Final effluent is discharged via a 300mm diameter pipe from the cascade aerator to a final effluent manhole, then through a 600mm diameter effluent pipe to the outfall structure, which discharges onto interlocking concrete blocks within a normally-dry former channel of the Conestogo River (R.J. Burnside & Associates Limited, August 2013). No record of sludge disposal was found during the evaluation.

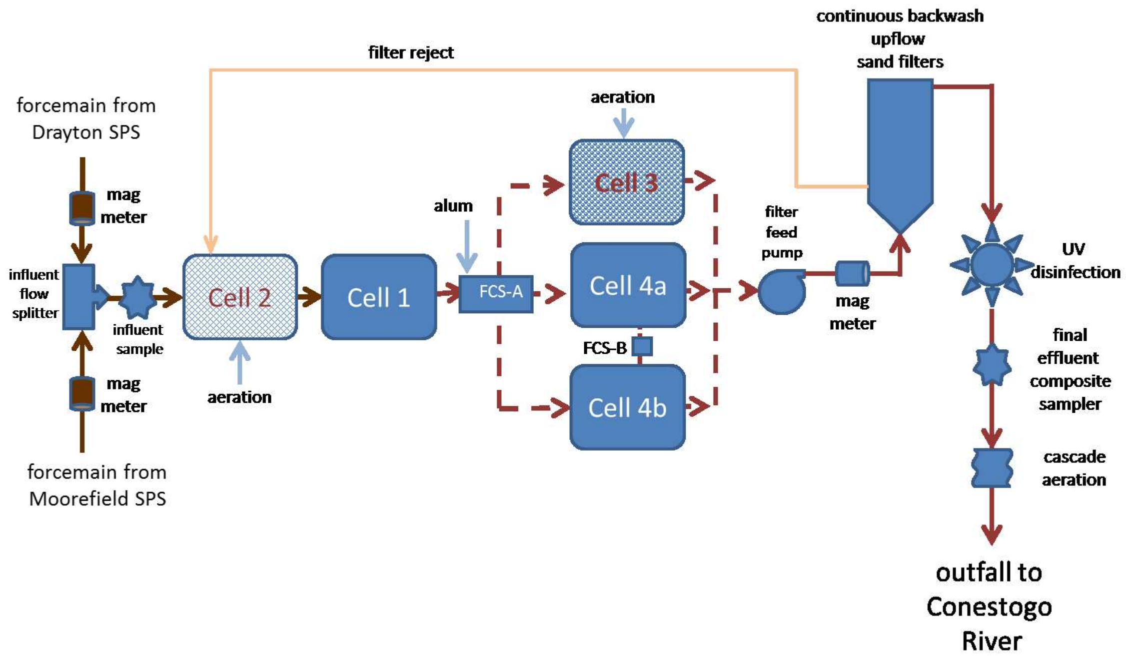


Figure 2: Schematic of the Mapleton WPCP

Sampling and Monitoring

Magnetic flow meters are installed at both the Moorefield and Drayton Pumping Stations, and flow readings are added together to determine the total flow entering the WPCP. A magnetic flow meter is installed on the discharge line to the effluent filters. Filter reject is estimated and subtracted from the effluent meter readings to calculate effluent discharge flows and volumes. A V-notch weir is located on the discharge following UV disinfection but it is not equipped with electronic level measurement.

An automatic sampler collects 24-hour composite samples of final effluent once per week during the discharge period as required by the ECA. The effluent is tested for $cBOD_5$, TSS, TAN, and E. Coli. A grab sample of raw sewage is collected from the influent flow splitter box once per month, and tested for BOD_5, TSS, TP, and TKN.

Process control sampling consists of cell content monitoring, which is a composite grab sample of lagoon contents prior to discharge (to ensure compliance is met). The composite sample is composed of equal volumes of water collected at multiple locations in the cell. More recently the operator has been taking bi-weekly samples of the effluent from Cell #1 for parameters such as BOD_5, TSS, TP, ammonia, etc. The data from this sampling was used in the ammonia removal special study described in **Attachment 3.** In addition, measurements of liquid levels are taken on a weekly or bi-weekly basis to determine lagoon storage volumes.

Plant Staffing and Operation

The Mapleton WPCP is operated under contract by OCWA. One full time operator is dedicated to the Mapleton WPCP and is onsite daily during the seasonal discharge periods. Visits to the site are less frequent during the storage season. The operator has additional duties including maintaining the Moorefield and Drayton wastewater pumping stations, the Moorefield and Drayton water system, as well as on-call duties. This operator reports to a supervisor at OCWA's West Highlands Hub office in Orangeville.

The treatment plant does not have a SCADA system. The Drayton and Moorefield pumping stations have automated alarms for power failure and high levels in the wet well.

Compliance and process data from the facility is managed electronically in PDM (OCWA's internal database for operational data). The data is managed by the Process and Compliance Technician, located at the West Highlands Hub office in Orangeville.

PERFORMANCE ASSESSMENT

Historical Performance

Table 2 summarizes the Mapleton WPCP's effluent limits as set out in the plant's ECA #7875-95DQSC issued April 3, 2013. The ECA allows discharge to the Conestogo River between March 1st and April 13th, and during the months of

October, November, and December. During the discharge period the final effluent must be sampled weekly according to the ECA.

Table 2: Mapleton WPCP Effluent Limits (MOE, 2013)

Month	**Daily Discharge Rate (m^3/d)**	**Monthly Discharge Rate (m^3/mo)**	**cBOD$_5$ (mg/L)**		**TAN (mg/L)**		**TP (mg/L)**		**E.coli (monthly geo-mean)**	
			Limit	**Obj.**	**Limit**	**Obj.**	**Limit**	**Obj.**	**Limit**	**Obj.**
March	1,581	49,015	10.0	5.0	5.0	3.0	0.5	0.3	200 org. per 100mL	100 org. per 100mL
April (1-13)	3,154	40,997	7.5	5.0						
Spring Total		*90,012*								
October	233	7,232	7.5	5.0						
November	1,754	52,618	10.0	5.0						
December	4,000	124,010	10.0	5.0						
Fall Total		*183,860*								
Total		*273,872*								
Sampling Frequency: Weekly 24hour composite samples										

Figure 3 shows monthly average and peak daily flows for influent to the plant for 2013. The annual average plant flow rate for the evaluation period was 714 m^3/d, which is 95% of the capacity set out in the ECA (750m^3/d). The peak day flow was 2,831 m^3/d, which occurred in March 2013 (**Figure 3**).

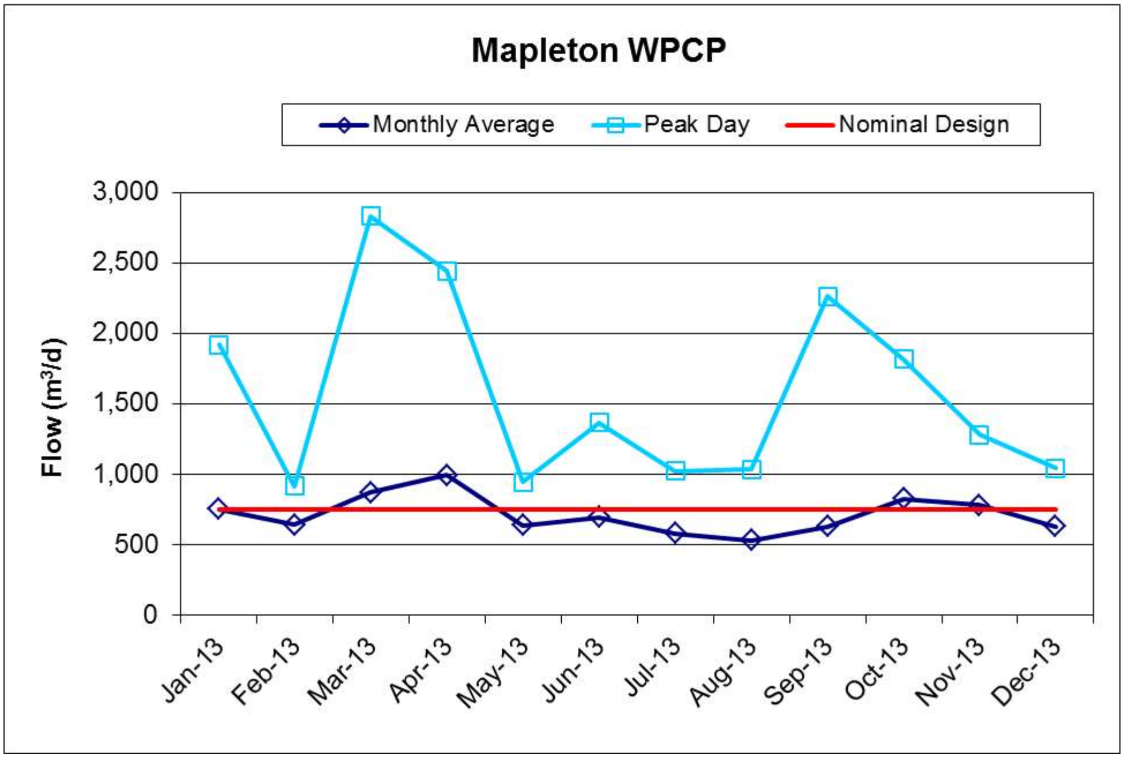


Figure 3: Mapleton WPCP Average Monthly and Peak Daily Flows, Jan. 2013 – Dec. 2013

Figures 4 to 7 display the monthly average concentrations for effluent TSS, BOD_5, TP, TAN and E.coli over the period from January 2013 to November 2014. Two years of effluent quality data were evaluated since effluent discharges only occur twice per year. The graphs in **Figures 4 to 7** show only final effluent concentrations for months when effluent was discharged to the Conestogo River.

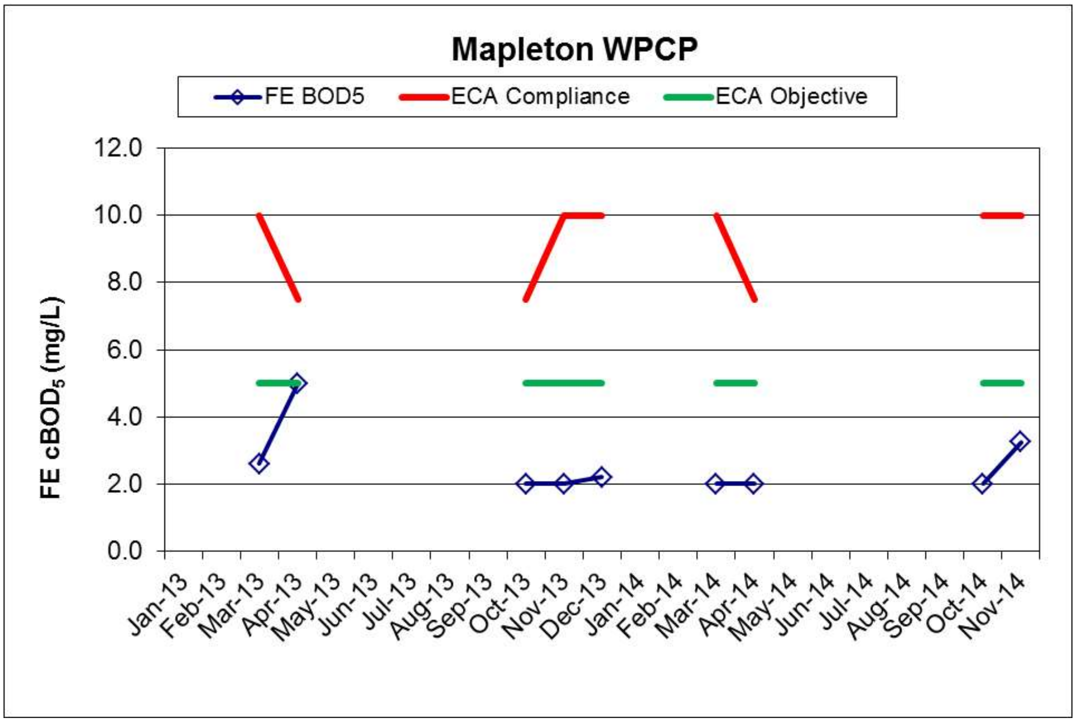


Figure 4 - Monthly average effluent $cBOD_5$ concentrations over the period from January 2013 to November 2014

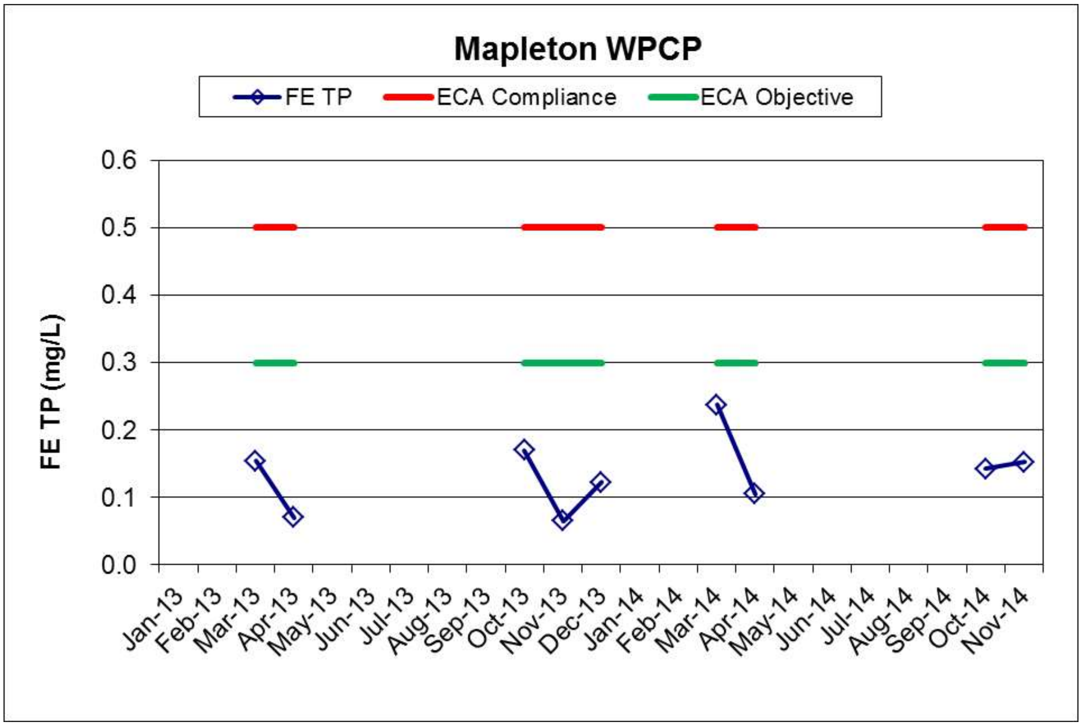


Figure 5 - Monthly average effluent TP concentrations over the period from January 2013 to November 2014

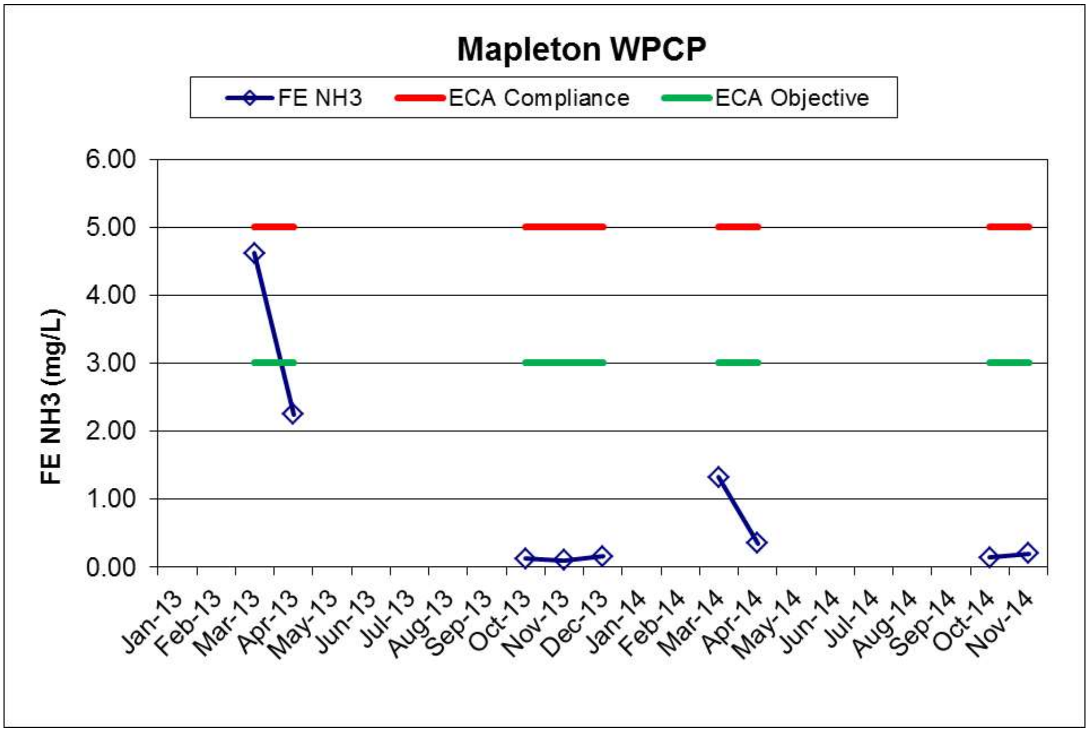


Figure 6 - Monthly average effluent NH_3 concentrations over the period from January 2013 to November 2014

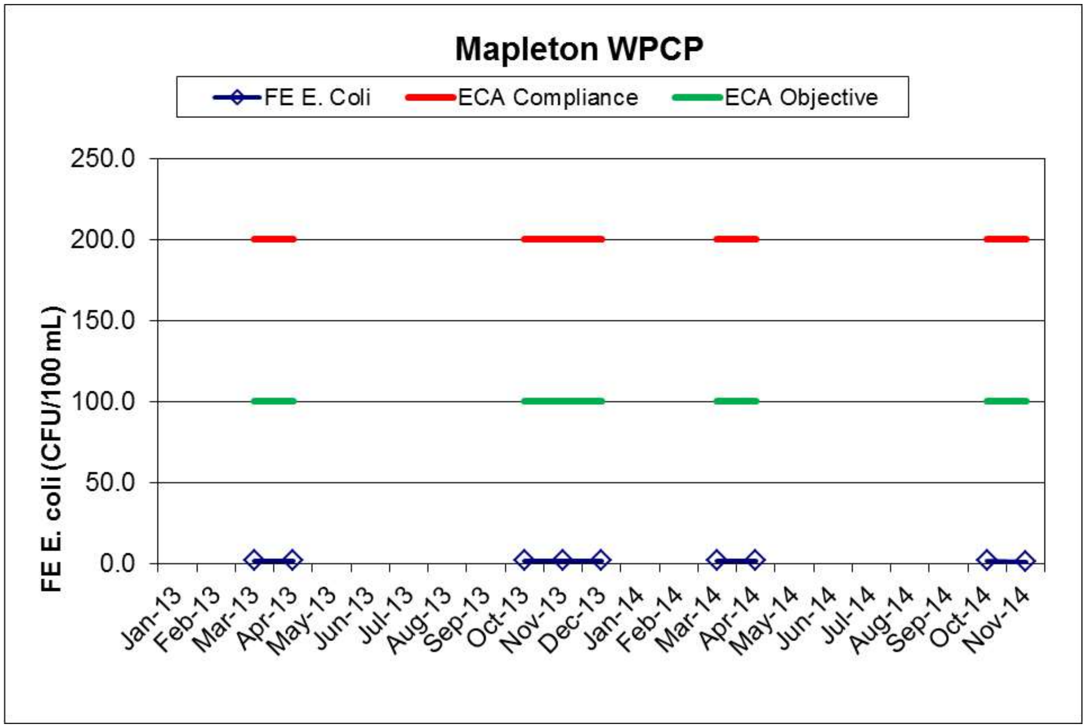


Figure 7 - Monthly average effluent E.coli concentrations over the period from January 2013 to November 2014

Based on the reported data, the Mapleton WPCP met the effluent limits for BOD_5, TSS, TP, TAN and E.coli in the period evaluated (January 2013 to November 2014). The final effluent ammonia concentration appears to be higher during the spring discharge periods and was near the compliance limit in March 2013 shortly after the addition of Cells #4A and #4B to the treatment train.

Load Evaluation

Per capita flows and pollutant loads were calculated and compared to typical ranges for domestic wastewater. Calculations related to process loading were prepared using flows and raw wastewater data for the Mapleton WPCP for the period January 2013 to December 2013. The detailed calculations for the loading evaluation are documented in **Attachment 1** and the results summarized in **Table 3**.

Based on the results reported in **Table 3**, the following comments are provided:

Wastewater flows

The per capita flows and peak day to average day flow ratios were different for Drayton and Moorefield. This difference could be attributed to the collection system in Moorefield, which is newer and utilizes a positive pressure collection system. Both of these differences result in lower inflow and infiltration than in Drayton’s older gravity collection system. Using the combined flow values, the per capita flow to the Mapleton WPCP was at the low end of the typical range. The ratio of peak day flow to annual average flow was at the upper end of typical. In the judgment of the Evaluation Team, the total volume of inflow and infiltration is likely not significant since the ratio of wastewater produced to water consumed is low (0.74). Systems that are heavily impacted by inflow and infiltration typically have a wastewater to water ratio above one, indicating that more wastewater is produced than enters the system from the water supply.

Table 3: Mapleton WPCP flows and loads compared to typical domestic wastewater

Parameter	Units	Value	Typical
Per Capita Flow	L/d per person	312 (D) 200 (M) 291 (overall)	350-500 317 (GRCA)*
Peak Day: Average Day (flows)	--	4.2 (D) 2.3 (M) 4.0 (overall)	2.5->3.5
Wastewater:Water	--	0.74 (same for both)	0.7 – 0.9
Per Capita BOD5	g/d per person	66	80
Per Capita TSS	g/d per person	57	90
Per Capital TKN	g/d per person	10.8	13
Per Capital TP	g/d per person	1.1	3.3
TSS: BOD5	--	0.86	0.80-1.2
TKN: BOD5	--	0.16	0.1-0.2
*Median of 2012 per capita flows from self-reporting in Grand River watershed (GRCA, 2014)			

Pollutant loading

The per capita BOD5, TSS, TKN, and TP loads were all lower than typical for domestic wastewater. One explanation for low loadings is that the population used in the evaluation (i.e. 2,450) could be higher than the actual population. Alternatively, the raw wastewater concentrations may not have been representative of the actual wastewater strength. Currently, a single monthly grab sample is used to characterize incoming wastewater. The ratios of TSS:BOD_5 and TKN:BOD_5 were within typical ranges.

Process Evaluation

Estimates of process parameters for the Mapleton WPCP were prepared using data for the 2013 calendar year and compared to values for facultative or aerated lagoons reported in the literature. The detailed calculations are documented in **Attachment 2** with the results summarized in **Table 4.**

Table 4: Process evaluation results for the Mapleton WPCP for Jan 2013- Dec 2013

Parameter	Units	Mapleton WPCP	Typical*
BOD Loading Rate	$\frac{\text{kg BOD}}{\text{ha*d}}$	For Cells #1 and #2: 25.6 -- For all Cells: 7.6	≤22 kg/ha*d (for facultative lagoons)*
HRT	d	Cell #2 (aerated cell): 84.7 -- Cells #2 & #1 (continuous flow cells): 171.7 (or 5.7 months) -- Cells #3, 4A, 4B (storage Cells): 490 (or 16.3 months) -- All Cells: 662 (or 22 months)	90-120 (facultative flow through)**
Filter Loading Rate	$m^3/(m^2*d)$	172.4	176 to 293***
* From MOE Design Guidelines (2008) to achieve 25 mg/L BOD in final effluent ** Ten States Standard (2004) *** Dynasand manufacturer's recommendation			

Based on the results reported in **Table 4**, the BOD_5 loading rate for Cells #1 and #2 was 25.6 kg/ha*d, which was higher than the typical value of 22 kg/ha*d. However, a direct comparison to the typical value for a facultative lagoon system may not be appropriate since Cell #2 (the first cell in the treatment train) is aerated, thus providing a higher level of treatment than a facultative cell, and flow from Cells #1 and #2 goes to storage cells, which should provide additional treatment. The BOD_5 loading rate to all cells was also calculated, and was much lower than typical at 7.5 kg/ha*d.

The hydraulic residence time for various cell combinations was also calculated, with the total HRT for all cells being 22 months, much higher than the Ten State design standard of 90-120 days. However, Mapleton's required effluent BOD_5 and TAN concentrations are much lower than for a typical lagoon system. The filter loading rate was also calculated and found to be slightly lower than values specified by the manufacturer.

A robust process evaluation of the Mapleton WPCP is challenging since there is a lack of information on typical process parameters for the type of treatment system used in Mapleton. Perhaps most importantly, the Mapleton facility is expected to remove ammonia and there is limited design information for ammonia removal in lagoon systems. As mentioned earlier, the CPE protocol was adapted for lagoon systems for this evaluation. With more experience evaluating lagoon treatment systems with the CPE protocol, more information will be available to enable more robust process evaluations.

Special Study - Water Accountability Analysis

A water accountability calculation (water balance) was conducted to estimate the impact of precipitation on facility capacity. In areas where there is net precipitation (evaporation is less than total precipitation), precipitation will add water to the lagoons. The added volume will have to be discharged, which reduces the amount of wastewater the facility can treat (i.e. inflow) to less than the maximum allowed by the ECA.

The analysis was approached two ways. One way was to use net precipitation estimates and convert those to equivalent daily flows, which is summarized in **Table 5.** Based on these results, the available *allowable* inflow to maintain an annual discharge equivalent to 750 m^3/d (the ECA maximum) is as low as 486 m^3/d. With the current ECA discharge limits and an influent flow of 714 m^3/d (2013 average), the system is over capacity by 122 to 228 m^3/d. Therefore, at the current wastewater inflow and discharge scheme, the facility is accumulating water.

The second method to determine the impact of precipitation employed a mass balance approach. Changes in storage volume, inflow, and effluent released were used to back-calculate the amount of precipitation entering the plant. The results from this approach are depicted in **Figure 8,** which shows a net precipitation rate of 149m^3/d over the period reviewed.

Detailed assumptions and calculations for both of these analyses are presented in **Attachment 3** and summarized in **Table 5.**

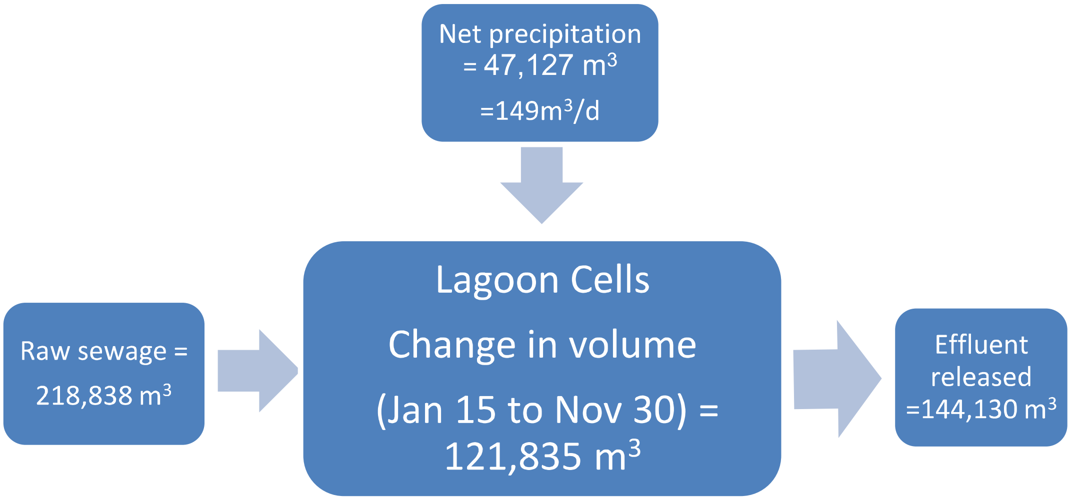


Figure 8 – Water balance of flows entering, accumulating, and leaving the plant

Table 5 – Summary Results of the Water Accountability Analysis

Data Source	Annual Net Precipitation (m)	Precipitation Volume (m^3)	Equivalent Precipitation Flow (m^3/d)	Allowable Discharge ECA (m^3/d)	Net Allowable Inflow (m^3/d)
Net Precipitation					
GRCA*	0.455	96,460	264	750	486
Burnside, 2013	0.257	57,660	158	750	592
Changes in Storage Volume					
Plant data	--	47,127	149	750	601

* from water budget calculations, AquaResource (2009)

Special Study – Ammonia Removal

The Evaluation Team modelled ammonia removal in Cells #1 and #2 to determine if the actual performance of these cells can be predicted by ammonia removal models as documented by the US EPA (US EPA, 2011). The purpose of this special study was to evaluate whether a design basis for ammonia removal at the Mapleton WPCP could be used. A valid design basis would help the team estimate the capability of the facility for ammonia removal at different flows. **Figure 9** shows the results of the study, and a more detailed description of the model is presented in **Attachment 3.**

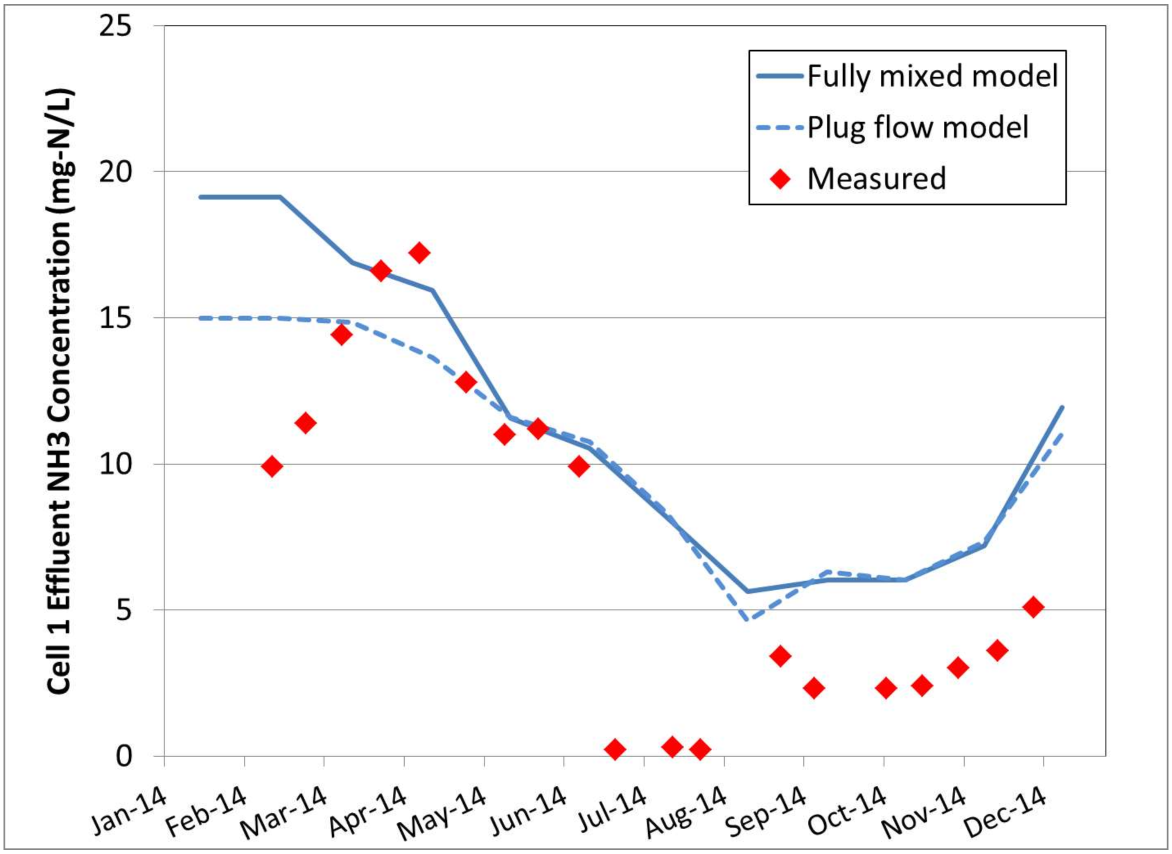


Figure 9 – Estimated NH_3 concentrations compared to measure values from Cell#1

The models were able to follow the general trends in actual performance. However, they failed to replicate actual performance, particularly the low ammonia levels in the summer months. Overall, the models predict higher ammonia effluent concentrations, so the model is considered conservative. A limited amount of parameter fitting improved the fit of the model, but marginally. Ammonia removal was only measured at the outlet of Cell #1 (the second cell in the treatment train). If this approach is considered in the future, ammonia removal data in each cell could help determine the applicability of the USEPA models. Further investigation is warranted before this approach can be used as a design basis for ammonia removal.

Other Studies

During the CPE, the Township of Mapleton was in the process of reviewing RFP submissions for Engineering Consulting Services for a Municipal Class Environmental Assessment for Mapleton Wastewater Servicing. The preferred consultant was selected in January 2015. The environmental assessment will address wastewater servicing capacity in order to handle the anticipated future growth in the community.

The Township also conducted a Municipal Class Environmental Assessment for Effluent Management at the Mapleton WPCP in 2010. This Environmental Assessment (EA) report reviewed and evaluated various effluent management options for the Drayton study area, with a recommended solution to expand the effluent storage, which resulted in the installation of Cell #4A and #4B.

Another recent relevant study is the Village of Drayton Infiltration and Inflow Study Report, 2013, prepared by R.J. Burnside & Associates Limited. This study found that overall the levels of extraneous flows entering the Drayton sanitary sewer system are within the normal ranges expected for a sanitary sewer system. After inspections of 50 manholes it was concluded that the structural integrity of the sanitary sewer system was not a dominant factor contributing to the extraneous flow.

An overcapacity investigation at the Mapleton WPCP was also conducted by R.J. Burnside & Associates Limited in 2012, as a result of instances where failed spring discharges required emergency measures to prevent uncontrolled effluent spills. The report concluded that an underreporting of flows was likely the primary factor in the overcapacity situation.

MAJOR UNIT PROCESS EVALUATION

Background

A major unit process evaluation determines the ability of the main components of an existing system to achieve effluent requirements at current loadings. Results are displayed in the form of a graph, called the "Performance Potential Graph" (PPG). For each process in the PPG, a bar displays the rated capacity in units of flow (i.e. m^3/d). Each bar addresses the question, "In the judgment of the Evaluation Team, how much flow can this unit treat and still achieve the required effluent quality?" Comparing the length of the bar to the line representing current flow, a unit process is classified as being "capable", "marginal" or "not capable" of treating existing flows and loads. The PPG identifies limiting unit processes, as well as the potential to re-rate an existing system to treat higher flows.

Approach

"The Ontario Composite Correction Program Manual for Optimization of Sewage Treatment Plants" provides guidance for setting up a PPG for mechanical systems such as an activated sludge plant (WTC and PAI, 1996). The handbook contains evaluation criteria and sample calculations for rated capacities for unit processes such as surface overflow rate (SOR) for settlers, hydraulic retention time for aeration basins, etc. No reference material was available for developing a Performance Potential Graph for the Mapleton WPCP, which is a seasonal discharge lagoon system with both aerated and facultative lagoons. Based on previous CPEs in the Grand River watershed, the Evaluation Team adapted the existing CPE protocol to Mapleton's lagoon system. Three steps were followed:

- The major unit processes comprising the Mapleton WPCP were identified for achieving the ECA effluent requirements.
- Background design data were collated. **Table 6** summarizes the data pertaining to current loading and the key dimensions or sizes for each unit process.
- Technical references were reviewed to obtain appropriate evaluation criteria to rate each of the unit processes. The US EPA Handbook "Principles of Design and Operation of Wastewater Treatment Pond Systems for Plant Operators, Engineers, and Managers" was particularly helpful (US EPA, 2011).

Table 6: Data and Criteria for Major Unit Process Evaluation of the Mapleton WPCP

Parameter	**Basis**
Type	A seasonal discharge lagoon system with a Nominal Design Flow of 750 m^3/d consisting of one aerated treatment cell, one facultative treatment cell, three effluent storage cells, alum addition for phosphorous removal, tertiary filtration, and UV disinfection.
Receiver	Conestoga River
Loading	Average influent annual flow = 714 m^3/d (Jan.-Dec 2013) Maximum monthly average influent flow = 994 m^3/d (Apr. 2013) Maximum day influent flow = 2,831 m^3/d (Mar. 2013) Influent BOD_5 = 226 mg/L Influent TKN = 37 mg/L
Liquid Treatment System	
Areal BOD5 Loading	Assumed 3 cells for BOD_5 removal (cells #1, #2, & #4a) Total surface area = 9.7 ha
Ammonia removal	Not available
Aeration Systems	No. of blowers = 2 @ 40 HP, assume one on standby for PPG calculations Elevation: 421 m Temperature: 25°C (assumed) Type: Fine Bubble Depth of diffusers = 2.4 m
Tertiary Filtration	Type = upflow Dynasand filters Number = 5 Total surface area = 23 m^2
Disinfection	Type= UV disinfection (Trojan UV lamps) Number = 2 banks Capacity= 2,000 m^3/d per bank (based on manufacturer's specifications)
Effluent Storage and Discharge	
Effluent Storage	Longest storage period = 214 days (from Mar. 1 – Oct. 1) Storage volume: For cells #3 + # 4b = 210,000 m^3 For cells #3+#4a+#4b = 350,000 m^3
Effluent discharge	Allowable effluent discharge volume = 273,872 m^3 (from ECA) Equivalent daily effluent discharge rate = 750 m^3/d Total lagoon area = 21.4 ha Net precipitation accumulation: 257 mm/year (Burnside) – 475 mm (GRCA)

Results

Figure 10 is the PPG that was developed for the Mapleton WPCP. **Attachment 4** provides the detailed calculations for generating the rated capacities for each major unit process.

The following guidance is provided for helping to interpret the PPG:

- A process is classified as “capable” if its rated capacity exceeds the current influent plant flow rate (i.e., the tip of the associated horizontal bar for that unit process is to the right of the current influent flow line of 714 m^3/d).
- A process is classified as “marginal” if the capacity is within 80 to 100 percent of current influent flow, (i.e. 570 to 714 m^3/d).
- A process is classified as “not capable” if its capacity is less than 80% of current flow (i.e. less than 570 m^3/d).
- The shortest bar in the PPG establishes the overall classification (“capable”, “marginal” or “not capable”) for the entire system.
- In some cases, stacked bars are used to indicate a range of rated capacities depending on the number of units in service or a range of evaluation criteria.
- Some processes may appear to have a great deal of excess capacity (e.g. effluent filtration and disinfection) due to the fact that they are designed to handle the maximum daily flow allowed during the discharge period (i.e. 4,000 m^3/d).

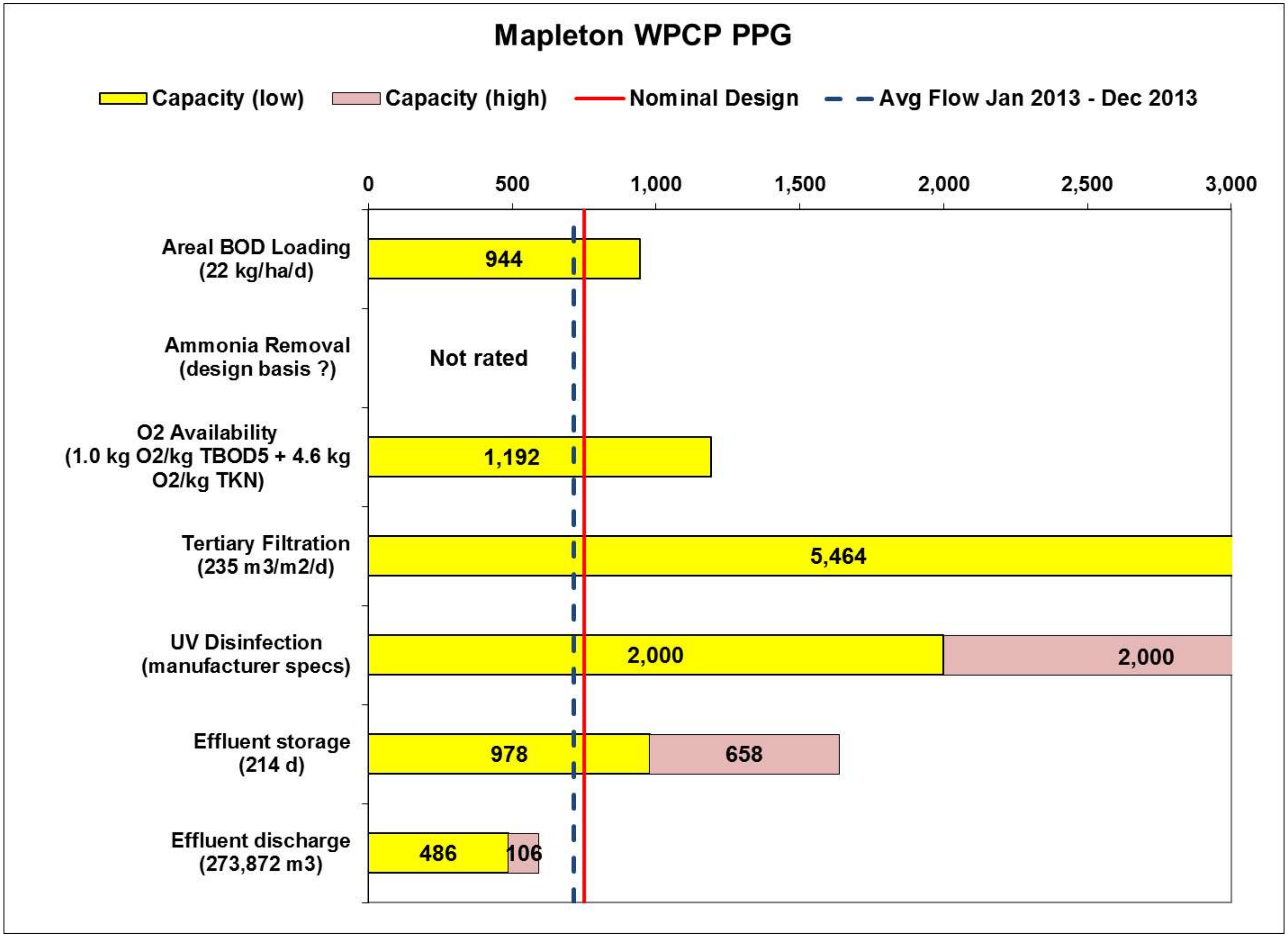


Figure 10: Performance Potential Graph for the Mapleton WPCP

The following sections provide a discussion of the capacity of each major unit process at the Mapleton WPCP.

Discussion

Areal BOD_5 Loading

The capacity of the Mapleton lagoons to remove organic material was rated based on an areal BOD_5 loading rate of 22 kg/d BOD_5 per hectare of surface area. This value is recommended in the MOE Design Guidelines for facultative lagoons to achieve an effluent quality of 25 mg/L BOD_5 or less (MOE, 2008). It was assumed that, at a minimum, three of the five cells would be in operation on a continuous basis with the other two cells providing storage (i.e. no treatment allowance was allocated to them). With Cells #1, #2, and #4a providing treatment, the total surface area was estimated to be 9.7 hectares, resulting in a rated capacity of 944 m^3/d. This rated capacity is somewhat uncertain because the evaluation criteria is not strictly applicable for the Mapleton system for two reasons. First, the Mapleton WPCP has an aerated cell, which should be able to treat a higher BOD loading rate per unit area. However this is counterbalanced by need to achieve a BOD limit of 7.5 to 10 mg/L in the final effluent. Despite these competing sources of uncertainty, the areal BOD_5 loading was classified as “capable” at current flows and this is supported by the fact that the plant consistently achieves the final effluent limits.

Ammonia Removal

Mapleton’s ECA requires monthly average effluent ammonia concentrations that are 5.0 mg/L or less. Assuming that the average raw TKN concentration of 37 mg/L is primary in the form of ammonia in Cell #2, the required ammonia removal across the lagoons is roughly 86%. “Ammonia removal” was accordingly included in the PPG as a unit process to establish the adequacy of the existing lagoon system to treat ammonia to current ECA limits.

The Evaluation Team was unable to accurately model the ammonia concentrations leaving Cell #1 (as previously discussed) nor identify rating criteria for ammonia treatment from the technical literature. The rated capacity for this unit process was therefore listed as “not rated” in the PPG, **Figure 10.**

Tertiary Filters

Mapleton WPCP is equipped with 5 Dynasand upflow filters to reduce effluent TP and TSS during seasonal discharge. The manufacturer’s literature indicates that the units are designed for a filter loading in the range of 176 to 293 m^3/d of flow per square meter of filter surface area. Using the middle of this range and a total filter area of 23 m^2, the rated capacity for tertiary filtration was estimated to be 5,464 m^3/d. In contrast to the preceding major process, this rated capacity for tertiary filters is compared to an effluent discharge rate of 4,000 m^3/d, the current maximum daily effluent discharge rate allowed under Mapleton’s ECA. Tertiary filtration was therefore rated as “capable”.

UV Disinfection

Mapleton WPCP’s effluent disinfection system consists of two banks of Trojan UV lamps. Each bank was designed to treat a design peak flow of 2,000 m^3/d, according to the ECA and documentation from the manufacturer. With both banks in service, the total rated capacity was estimated to be 4,000 m^3/d, the maximum allowable daily effluent discharge rate under the ECA. Therefore, the UV disinfection system was classified as “capable” at current flows.

Effluent Storage

The Mapleton WPCP is required to store effluent for discharge during the spring and fall windows. If it is assumed that effluent from treatment Cells #1 and #2 must be stored from the beginning of the spring discharge period to the first day of the fall discharge period the required storage period is March 1st to October 1st (214 days). For this scenario, the Evaluation Team judged that that the lagoons must store effluent from Cell #1 during the spring discharge period rather than discharge it and risk deteriorated effluent ammonia concentrations. Ignoring the effect of accumulation of precipitation, the rated capacity for available storage for Cells #3 and #4A (with an estimated total volume of 210,000 m^3) was estimated to be 978 m^3/d.

In a second scenario, the assumption was made that the ammonia concentrations out of Cell #1 met the current effluent ammonia requirements. Available storage for Cells #3, #4A and #4B is 350,000 m^3. The rated capacity for this scenario was estimated to be 1,636 m^3/d (neglecting the impact of accumulated precipitation). Effluent storage was classified as "capable" at current flows.

Effluent Discharge

The current ECA specifies that the total volume of effluent discharged in a year by the Mapleton WPCP not exceed 273,872 m^3 (see **Table 2**). This volume equates to a daily discharge rate of 750 m^3/d (from 273,872 m^3/365 d). The CPE special study and previous work by R.J. Burnside & Associates Limited indicated that the lagoons are likely accumulating precipitation over the year (Gendron, 2013). Therefore, the capacity of the lagoons to treat <u>influent</u> flows will be less than 750 m^3/d. To help quantify the magnitude of accumulated precipitation, "effluent discharge" was included as a unit process. Using a total lagoon area of 21.4 hectares and a net accumulation of 257 mm per year (Gendron, 2013), the rated <u>influent</u> capacity was estimated to be 592 m^3/d. Assuming a net accumulation of 475 mm (GRCA 2014) the rated <u>influent</u> capacity was estimated to be 486 m^3/d. Overall, effluent discharge was classified to range from "marginal" to "not capable" depending on the assumed value for annual net precipitation.

Summary of Major Unit Process Evaluation

Based on its PPG, the Mapleton WPCP was classified overall as "not rated" in terms of its ability to treat current flows and loads. The facility is required to remove ammonia to achieve stringent effluent ammonia limits and did so over the period reviewed. However, the Evaluation Team could not identify evaluation criteria from the available technical literature that related ammonia removal to flow in a manner consistent with actual ammonia removals. The PPG also identified that "effluent discharge" was a limiting unit process. To discharge an effluent volume within ECA requirements, the lagoons can only accept <u>influent</u> flows that are roughly in the range of 65% to 80% of the nominal design flow of 750 m^3/d. All other major unit processes were determined to be capable at current flows.

FACTORS

As developed by the U.S. Environmental Protection Agency, the CPE is meant to identify and prioritize causes of poor performance, i.e. factors that cause a plant's effluent concentrations or loadings to exceed limits. The performance of the Mapleton WPCP is acceptable and meets all ECA quality criteria and therefore the focus of this CPE is to identify opportunities to maintain or improve plant performance and fully utilize existing plant capacity.

A checklist of seventy potential factors and their associated definitions is provided in "The Ontario Composite Correction Program Manual for Optimization of Sewage Treatment Plants" in the areas of design, operation, maintenance, and administration (WTC and PAI, 1996). Selection of appropriate factors is based on the results of the historical performance review, the major unit process evaluation, review of plant operation and maintenance practices and interviews with plant staff and administrators.

The identified factors are normally rated based on the severity of impact on performance as a way of establishing priorities for follow up. Factors having a major effect on performance (i.e. causing effluent concentrations to exceed compliance limits) are given an "A" rating under the protocol. An example of an "A" factor might be inadequate sludge wasting resulting in high effluent TSS concentrations on a continuous basis. Factors having a major effect on performance on a periodic basis, or a minor effect on plant performance on a continuous basis are given a "B" rating. An example of a "B" factor might be high levels of infiltration/inflow (I/I) resulting in high effluent TSS concentrations on a seasonal basis. Factors having a minor effect on plant performance are given a "C" rating. Factors that are noteworthy and may affect performance or capacity in future are identified as "not rated" (NR).

Because the effluent produced by the Mapleton WPCP was below the ECA limits over the period reviewed, no “A”, “B” or “C” factors were identified as impacting current plant performance. The factors described below were identified by the Evaluation Team to highlight areas that, if addressed, would help to resolve system capacity issues while preserving effluent quality.

Administration Factor: Planning (not rated)

The ECA for the Mapleton WPCP contains limits on the maximum daily and monthly discharge volume that can be released to the Conestogo River. The annual volume that can be discharged equates to a daily average of 750 m^3/d, which is the nominal design capacity of the lagoon system. Raw wastewater flow to the plant in 2013 was 714 m^3/d. A water balance calculated by the Evaluation Team showed that volume is accumulating in the storage cells at a rate of approximately 149 m^3/d, likely as a result of precipitation. The discharge flow limits do not allow any margin for equipment breakdown or power failure during the discharge periods, nor do they allow for the impact of net precipitation. In this case, the effective capacity of the Mapleton WPCP to receive raw wastewater is less than 750 m^3/d. The plant will likely continue to experience overcapacity issues as the average flow to the plant from raw wastewater and precipitation exceeds the allowable discharge volume. In addition, the daily discharge limit in October is only 233 m^3/d. Maintaining the effluent flow at this limit requires a great deal of operator time and attention for a relatively small volume of discharge. Mapleton has initiated dialogue with the MOECC to investigate options to amend the ECA to allow more flexibility for discharge.

Municipal staff require a solid understanding of the plant performance and capabilities to plan proactively for future needs. Recently, there has been staff reorganization and retirement at Mapleton Township and the Director of Public Works has been the primary point of contact between the municipality, operator and consultants. While it is important for the Director to be well informed of the plant performance and capacity for budgeting and planning purposes, the task of overseeing the operating contract and regular communication with the operators and consultants should be delegated to another staff person. At the time of the CPE, Mapleton was in the process of hiring a manager to fill this role.

Proactive planning for future needs at the Mapleton WPCP will require enhanced communication between Mapleton, OCWA and consultants. Regularly scheduled meetings with all parties will help support long term planning for growth and asset management.

Desludging is required infrequently for lagoon systems but can be very costly. An estimate for desludging should be included in the facility's budget.

Design Factor: Design Limitations (not rated)

Effluent flow is calculated by subtracting an estimate of the filter reject flow from the readings provided by the magnetic meter located before the tertiary filters. This adds uncertainty to the reported final effluent flow volumes which must be maintained below ECA requirements.

A hydraulic bottleneck in Flow Control Structure B may have an impact on operations. The operator noted challenges maintaining a discharge of 4,000 m^3/d in December 2013 when Cell #4A was about half empty. The restriction was operated around by discharging through Flow Control Structure A.

Cell #2 operates as an aerated lagoon for ammonia and BOD removal with two HSI turbo blowers (one duty and one standby) providing aeration to this cell. The turbo blowers have suffered chronic breakdowns and both units were out of service at the time of the CPE.

Reducing the capital and operating costs for future upgrades to service future growth will require the utilization of the full capacity of the existing system. Several design related challenges will need to be considered, including:

- Accounting for net accumulation of precipitation;

- Evaluating the ability of the existing process to remove ammonia to meet current and future ECA limits or considering additional technologies to achieve these limits;
- Identifying the performance of existing units, such as tertiary filters and UV disinfection system, to see if they can be re-rated to accommodate higher flows; and
- Investigating potential short circuiting in Cell #2, which would undermine the treatment capability of the plant.

Operation Factor: Process Control Testing and Interpretation (not rated)

Per capita loadings of BOD_5, TSS, TKN and TP were all lower than typical values for domestic wastewater. Population values that were used in the calculation should be confirmed using the best available information. Alternatively raw influent concentrations may not have been representative due to sampling technique (e.g. grab vs. composite), location, frequency or handling and analysis. Collecting representative raw influent quality data will be necessary to properly design any future expansion or process upgrade.

Process control sampling of lagoons is normally limited. In the case of Mapleton however, additional sampling at key points in the treatment process would be beneficial to better quantify and characterize treatment performance, particularly for ammonia removal in the various treatment and storage cells. Since ammonia removal is largely dependent on water temperature, pH, dissolved oxygen and ammonia concentration, additional sampling should include these parameters.

Sludge accumulation in the treatment cells can impact performance and process control monitoring should include periodic measurements of sludge depth in each lagoon cell. The recommended best practice is to measure sludge depths annually (Federation of Canadian Municipalities and National Research Council, 2004). The current O&M manual recommends measuring the sludge depths once every three years.

The operator currently measures the water level in each cell on a weekly or bi-weekly basis. This information is then entered into a spreadsheet that estimates the volume in each cell. Continuing to track and report on this information routinely is necessary to identify the potential for overcapacity.

Operation Factor: O&M Manual/Procedures (not rated)

The current rationale and procedure for managing the volume in each of the three storage cells should be documented as it is somewhat different from the procedures described in the O&M manual. Maintaining good documentation of the current operating procedure will help to ensure that effluent quality meets the ECA and that there is a consistent approach when there are staff changes due to turnover, vacation, etc.

EVALUATION FOLLOW-UP

Comprehensive Technical Assistance (CTA) is the follow-up step to a CPE according to the Composite Correction Program protocol. Based on the results of this CPE, the Mapleton WPCP is not a candidate for CTA under the Grand River Watershed-Wide Optimization Program because the plant does not currently have performance issues and it is unclear if there are opportunities for additional capacity. The performance of the plant met ECA objectives and limits for all of the months reviewed and there is no design basis to determine the ability of the existing system to remove ammonia at higher flows. Additionally, the Mapleton WPCP is limited by the effluent discharge capacity. This limitation is impacting growth in the communities of Drayton and Moorefield.

Although a CTA is not recommended, there is an opportunity to work within the Grand River WWOP to provide technical support to the Township of Mapleton to address the factors identified above. GRCA staff could work with the municipality, OCWA and consultants to develop a strategy to build understanding of the capacity of existing infrastructure and support proactive planning for future growth. To address the factors previously discussed, the following suggestions are provided for consideration:

1. Continue efforts to revise the ECA to include more flexibility for discharge

Mapleton has already started discussions with the MOECC to determine if there are options to amend the existing ECA to provide additional flexibility for discharge. These negotiations should continue with the objective of addressing overcapacity issues. The municipality has recently initiated an EA to identify options for wastewater servicing and treatment that will accommodate future growth. Through that process there may be opportunities that can be leveraged to utilize assimilative capacity in the Conestogo River (e.g. offsetting phosphorus from agricultural sources, modifying discharge periods or making effluent discharge limits proportional to river flow, having more relaxed ammonia limits for high flow/low temperature conditions, etc.).

2. Continue efforts to improve final effluent flow measurement and provide backup power during the discharge period

Maximizing the volume of effluent discharged from the Mapleton WPCP is critical to mitigate overcapacity issues. To achieve this, it would be beneficial to have an accurate measurement of the final effluent flow as this is an important component of the overall water balance for the lagoon system. Additionally, ensuring reliable operation of plant during the discharge period is also important as the ECA does not allow any margin for equipment shut down for mechanical failure or power outages. Mapleton had already started investigating options for final effluent flow measurement and backup power prior to the CPE and these efforts should continue.

3. Review current process control monitoring to better characterize plant performance and capacity

The raw influent sampling procedures should be reviewed to ensure that the sampling is representative of the raw wastewater entering the Mapleton WPCP. Composite sampling of the raw influent over a 24 hour period is preferable, however this is challenging at the plant. The composite sampler intake line would have to be carefully positioned to avoid drawing settled material from the bottom of the inlet splitter box and clogging of the intake with rags may be an issue. Providing a small insulated heated enclosure for the sampler and heat tracing on the intake line may be required during the winter months. The frequency of sampling should also be reviewed and increased as monthly sampling may be insufficient to fully characterize the influent loadings to the plant. Sample handling procedures should also be reviewed to make sure the samples are refrigerated and sent to the lab as quickly as possible for analysis after collection.

Additional monitoring of key process control variables should be considered including regular measurement of pH, water temperature, dissolved oxygen and ammonia concentration in each cell. These measurements can be done on-site using existing equipment (e.g. for pH, temperature and DO) or an inexpensive test kit (e.g. for ammonia). This data could be supplemented with periodic grab sampling sent to an external lab for more complete analysis and as a quality control check for on-site measurements. A more comprehensive process control monitoring program should be developed in coordination with OCWA operational staff and consultants with the goal of collecting data to determine the capacity of the existing system to remove ammonia, e.g. identifying which cells are contributing to ammonia removal and under what conditions. Increasing process control monitoring will likely require additional resources for operator staff time and laboratory analysis.

4. Enhance trending and interpretation of available data

Regular monitoring of water level and volume in each cell initiated in 2014 should continue. Using this data, along with reported influent and effluent flow measurements, to prepare a water balance around the Mapleton WPCP would provide a richer understanding of potential overcapacity issues. Trending this data will inform the municipality and OCWA of the impact of net precipitation on plant capacity.

5. Initiate routine review of plant performance and water balance by OCWA, Mapleton and consultants

Enhancing communication between the operator, municipality and consultants will facilitate proactive planning for future capacity. Regular meetings to discuss plant performance would increase understanding of the issues and challenges facing the plant by all parties. The focus of these meetings would be to discuss plant performance and identify action items or special studies to investigate plant capability and capacity.

6. Determine ability of existing facility to provide ammonia removal at higher flows or investigate other processes for ammonia removal

The Mapleton WPCP is currently required to meet a stringent effluent limit for ammonia and it is possible that the ECA limits may be lower in the future as flows increase. Servicing anticipated population growth will require expanding the plant and/or re-rating the existing process to accommodate higher influent flows while maintaining ammonia removal to meet ECA limits. Utilizing the existing infrastructure to its maximum capability is economically desirable. It was unclear to the Evaluation Team if ammonia removal could be achieved by the existing lagoons at higher flows (e.g. re-rate the existing process). Determining the capacity of the existing infrastructure to remove ammonia should be an area of focus. This will require enhanced data collection (Recommendation 3) and communication (Recommendation 5). If re-rating the existing infrastructure is not possible, other processes for achieving ammonia removal will have to be investigated.

7. Document current procedure for cell management

The current procedure for filling and discharging from the storage cells varies somewhat from the O&M manual. It would be beneficial to document the differences, for example in a standard operating procedure (SOP) that can be referenced by the operator.

REFERENCES

AquaResource Inc. "Integrated Water Budget Report: Grand River" Prepared for GRCA, June 2009.

Baine, J., "Cleaner future for sewage plants", GRCA Watershed Report, Fall 2011, p. 10-11.

Cooke, S. and M. Anderson, "Water quality in the Grand River: past, present and future", Influents, Winter 2010, p. 30-33.

Federation of Canadian Municipalities and National Research Council, "Optimization of Lagoon Operation", August 2004

Grand River Conservation Authority (GRCA), "Watershed Overview of Wastewater Treatment Plant Performance", May 2014

Gendron, Stephen, "Drayton Wastewater Treatment Plant-Overcapacity Report Comments", R.J. Burnside & Associates Memorandum to Mr. Paul Odom, December 12th, 2013.

Health Research Inc (Ten States Standards), "Recommended Standards for Wastewater Facilities: Policies for the Design, Review, and Approval of Plans and Specifications for Wastewater Collection and Treatment Facilities", A Report of the Wastewater Committee of the Great Lakes--Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, 2004

Howarth, T. and D.T. Chapman, "Troubleshooting Nitrification Issues at the Caledonia WWTP", WEAO Technical Symposium, Ottawa, Ontario, April 22-24, 2012.

Metcalf & Eddy, **Wastewater Engineering: Treatment and Resource Recovery**, fifth edition, McGraw-Hill Inc., New York, 2014.

MOEE, "Assessment of the Comprehensive Performance Evaluation Technique for Ontario Sewage Treatment Plants", Ontario Ministry of Environment and Energy, Jan. 1994.

MOEE & WTC, "Assessment of the Comprehensive Technical Assistance Technique for Ontario Sewage Treatment Plants", Ontario Ministry of Environment and Energy and Wastewater Technology Centre, Jul. 1995.

MOE, “Design Guidelines for Sewage Works”, Ministry of the Environment, 2008.

MOE, “Environmental Compliance Approval Number 7875-95DQSC”, April 3rd, 2013.

R.J. Burnside & Associates Limited, “Village of Drayton Infiltration and Inflow Study Report”, 2013.

R.J. Burnside & Associates Limited, “Overcapacity Investigation at the Drayton Wastewater Treatment Plant”, October 1, 2012.

R.J. Burnside & Associates Limited, “Drayton Wastewater Treatment Plant Operation and Maintenance Manual”, August, 2013.

U.S. EPA, **Handbook: Retrofitting POTWs**, U.S. Environmental Protection Agency, Office of Research and Development, EPA/625/6-89/020, July 1989.

U.S. EPA, **Principles of Design and Operations of Wastewater Treatment Pond Systems for Plant Operators, Engineers, and Managers**, U.S. Environmental Protection Agency, Office of Research and Development, EPA/600/R-11/088, August 2011.

Wellington County, Official Plan May 6, 1999 (Last Revision December 5, 2014)

Wheeler, G.P.,”Optimising Your Wastewater Treatment Facility: Can You Afford to Ignore It?”, Engineers Journal, Vo. 63, Issue 7, Sep. 2009.

WEAO, Ministry of the Environment and Environment Canada, “Optimization Guidance Manual for Sewage Works”, 2010.

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.

XCG “Assessment of Factors Affecting the Performance of Ontario Sewage Treatment Facilities”, report prepared for Ontario Ministry of Environment, Environment Canada, and the Municipal Engineers Association, Nov. 1992.

Attachment 1: Loading Evaluation Calculations

Table A1.1: Summary of Key Information for Loading and Process Evaluation Calculations (2013)

Parameter (units)	**Value**
Total Population • Moorefield • Drayton	2,450 • 450 • 2,000 (from RPF for EA, whereas Drayton Census 2011 = 1,880)
Nominal Design Flow (m^3/d)	750 (ECA)
Current flow (m^3/d) • Moorefield • Drayton	714 • 90 • 624
Peak Day Flow (m^3/d) • Moorefield • Drayton	2,831 • 211 • 2,622
Water Production (m^3/d) • Moorefield • Drayton	968 • 121 • 846
Raw BOD5 (mg/L)	226
Raw TSS (mg/L)	194
Raw TP (mg/L)	3.7
Raw TKN (mg/L)	37

<u>% Nominal Design Flow</u>

$$\frac{714m^3/d}{750m^3/d} \times 100 = \mathbf{95}\%$$

<u>Per Capita Flow</u>

Drayton

$$\frac{624m^3/d}{2000} \times 1000\frac{L}{m^3} = \boldsymbol{312\ L/person * d}$$

Moorefield

$$\frac{90m^3/d}{450} \times 1000\frac{L}{m^3} = \mathbf{200\ L/person * d}$$

Total

$$\frac{714m^3/d}{2{,}450} \times 1000\frac{L}{m^3} = \mathbf{291\ L/person * d}$$

Typical values:
*350-500 L/person*d;*
*GRCA 2012 median: 317 L/person*d*

Per Capita Water Supply

Drayton

$$\frac{846m^3/d}{2000} \times 1000\frac{L}{m^3} = \mathbf{423\ L/person * d}$$

Moorefield

$$\frac{121m^3/d}{450} \times 1000\frac{L}{m^3} = \mathbf{269\ L/person * d}$$

Total

$$\frac{968m^3/d}{2{,}450} \times 1000\frac{L}{m^3} = \mathbf{395\ L/person * d}$$

Ratio Wastewater: water

Drayton

$$\frac{624m^3/d}{846m^3/d} = \mathbf{0.74}$$

Moorefield

$$\frac{90m^3/d}{120m^3/d} = \mathbf{0.74}$$

Total

$$\frac{714m^3/d}{968m^3/d} = \mathbf{0.74}$$

(Typical: 0.7-0.9)

Per Capita BOD Loading (g/person*d)

$$\frac{BOD\ conc.*\ Flow}{Population} = \frac{226\frac{g}{m^3} * \frac{714m^3}{d}}{2{,}450} = \mathbf{65.9\ g/person * d}$$

*(Typical =80 g/person*d)*

Per Capita TSS Loading (g/person*d)

$$\frac{TSS\ conc.*\ Flow}{Population} = \frac{194\frac{g}{m^3} * \frac{714m^3}{d}}{2{,}450} = \mathbf{56.5\ g/person * d}$$

*(Typical = 90 g/person*d)*

Per Capita TKN Loading (g/person*d)

$$\frac{TKN\ conc.*\ Flow}{Population} = \frac{37\frac{g}{m^3} * \frac{714m^3}{d}}{2{,}450} = \mathbf{10.8\ g/person * d}$$

*(Typical = 13 g/person*d)*

Per Capita TP Loading (g/person*d)

$$\frac{TP\ conc.*\ Flow}{Population} = \frac{3.9\frac{g}{m^3} * \frac{714m^3}{d}}{2{,}450} = \mathbf{1.1\ g/person * d}$$

*(Typical = 3.3 g/person*d)*

Population Estimate based on Typical Values

BOD

$$\frac{BOD\ conc.*\ Flow}{Typical} = \frac{226\frac{g}{m^3} * \frac{714m^3}{d}}{80\ {}^{g}/_{person * d}} = \mathbf{2{,}017\ people}$$

TSS

$$\frac{TSS\ conc.*\ Flow}{Typical} = \frac{194\frac{g}{m^3} * \frac{714m^3}{d}}{90\ {}^{g}/_{person * d}} = \mathbf{1{,}539\ people}$$

TKN

$$\frac{TKN\ conc.*\ Flow}{Typical} = \frac{37\frac{g}{m^3} * \frac{714m^3}{d}}{13\ {}^{g}/_{person * d}} = \mathbf{2{,}032\ people}$$

TP

$$\frac{TP\ conc.*\ Flow}{Typical} = \frac{3.9\frac{g}{m^3} * \frac{714m^3}{d}}{3.3\ ^{g}/_{person * d}} = \mathbf{844\ people}$$

Ratios

TSS:BOD
$194\ ^{mg}/_{L} : 226\ ^{mg}/_{L} = \mathbf{0.86}$; (typical = 0.8-0.12)

TKN:BOD
$37\ ^{mg}/_{L} : 226\ ^{mg}/_{L} = \mathbf{0.16}$; (typical = 0.1-0.2)

TP:TSS
$3.9\ ^{mg}/_{L} : 194\ ^{mg}/_{L} = \mathbf{0.02}$;

Peak Day: Average Daily Flow

Drayton
$2{,}622\ ^{m^3}/_{d} : 624\ ^{m^3}/_{d} = \mathbf{4.2}$; (typical = 2.5-3.5)

Moorefield
$211\ ^{m^3}/_{d} : 90\ ^{m^3}/_{d} = \mathbf{2.3}$; (typical = 2.5-3.5)

Total
$2{,}831\ ^{m^3}/_{d} : 714\ ^{m^3}/_{d} = \mathbf{4.0}$; (typical = 2.5-3.5)

*****

Attachment 2: Process Evaluation Calculations

Table A2.1: Summary of Key Information for Process Evaluation Calculations (January 2014 – November 2014)	
Parameter (Units)	**Value**
Flow (m^3/d) Annual Average	 714
Raw BOD_5 (mg/L)	226
Volumes (m^3) Cells #1 and #2 Storage Cells (3, 4a and 4b) Total Areas (m^2) Cells #1 and #2 Storage Cells (3, 4a and 4b) Total	 122,600 350,000 472,600 6.3 14.9 21.2

<u>BOD Loading (kg/d)</u>

$$= BOD\ conc. * Flow$$
$$= \left(0.226\frac{kg}{m^3}\right) * \left(714\frac{m^3}{d}\right)$$
$$= \mathbf{161\frac{kg}{d}}$$

BOD Loading Rate (Cells #1 and #2)

$$= BOD\ Loading/Area$$
$$= \left(161\frac{kg}{d}\right)/(6.3\ ha)$$
$$= \mathbf{25.6\frac{kg}{ha*d}}$$

BOD Loading Rate (for all cells)

$$= BOD\ Loading/Area$$
$$= \left(161\frac{kg}{d}\right)/(21.2\ ha)$$
$$= \mathbf{7.6\frac{kg}{ha*d}}$$

*MOE guidelines suggest ≤ 22 kg/ha*d (for facultative lagoons)*

Hydraulic Residence Time

Cell #2, Partial Mixed Pond

$$\frac{Volume}{Flow} = \frac{60{,}500m^3}{714\frac{m^3}{d}} = \mathbf{84.7d}$$

Treatment Cells (#2 & #1)

$$\frac{Volume}{Flow} = \frac{(122{,}600)m^3}{714\frac{m^3}{d}} = \mathbf{171.7d\ or\ 5.7\ months}$$

Storage Cells (#3, 4A, 4B)

$$\frac{Volume}{Flow} = \frac{350{,}000m^3}{714\frac{m^3}{d}} = \mathbf{490d\ or\ 16.3\ months}$$

All Cells

$$\frac{Volume}{Flow} = \frac{472{,}600m^3}{714\frac{m^3}{d}} = \mathbf{662d\ or\ 22\ months}$$

Filter Loading Rate

$\frac{Flow\ (Q)}{Filter\ area}$, where $Q_{max} = 4{,}000\ m^3/d$

$\frac{4{,}000m^3}{23.25m^2} = \mathbf{172.4}\ {}^{\mathbf{m^3}}/_{\mathbf{m^2 * d}}$ (lower than Dynasand specifications)

Dynasand Specifications: 3-5 USGM/ft^2

3-5 US Gallon	3.785 L	m^3	1440 min	10.76 ft^2
min* ft^2	US Gallon	1000L	d	m^2

= $\mathbf{176}\ {}^{\mathbf{m^3}}/_{\mathbf{m^2 * d}}$ to $\mathbf{293}\ {}^{\mathbf{m^3}}/_{\mathbf{m^2 * d}}$ **(middle value = 235** ${}^{\mathbf{m^3}}/_{\mathbf{m^2 * d}}$**)**

*****

Attachment 3: Special Studies

Water Accountability Analysis

This analysis determines the impact of precipitation on facility capacity using net precipitation estimates, changes in storage volume, inflow, and the amount of effluent discharged. The equivalent daily flow attributed to precipitation is subtracted from the annual average discharge allowed to estimate the total volume of wastewater that can flow into the facility.

Table A3.1: Summary of Key Information for Water Accountability Analysis

Parameter (Units)	Value
Net precipitation (mm):	
GRCA (AquaResource, 2009):	455
RJ Burnside 2013 memo:	257
Total lagoon surface area (m^2)	212,000
Change in storage volume (m^3, January 15 to November 30, 2014)	121,835
Effluent released (m^3, January 15 to November 30, 2014)	144,130
Raw wastewater inflow (m^3, January 15 to November 30, 2014)	218,838

Net Precipitation Calculations

Volume of precipitation = annual net precipitation (m)* pond area (m^2)

GRCA:
= 0.455m * 212,000m^2
= **96,460m^3**
RJ Burnside:
=0.257m*212,000m^2
= **57,660 m^3**

Equivalent daily flow = volume of precipitation (m^3) ÷ 365 days

GRCA:
= 96,460m^3 ÷ 365 d

= **264 m^3/d**
RJ Burnside:
=57,660 m^3 ÷ 365 d
= **158 m^3/d**

Maximum inflow = Average annual ECA maximum discharge flow – equivalent precipitation flow

GRCA:
= 750 m^3/d - 264 m^3/d
= **486 m^3/d**
RJ Burnside:
= 750 m^3/d - 158 m^3/d
= **692 m^3/d**

Change in Storage Volume Calculations

Expected accumulation = Raw wastewater inflow – effluent released
= 218,838 m^3 – 144,130 m^3
= **74,708 m^3**

Unaccounted accumulation* = Actual accumulation – expected accumulation
= 121,835 m^3 – 74,708 m^3
= **47,127m^3**

*unaccounted includes precipitation, but may also include errors in flow metering

Equivalent daily flow = volume of precipitation (m^3) ÷ number of days
= 47,127m^3 ÷ 317 (# days from Jan 15 – Nov 30)
= **149 m^3/d**

Maximum inflow = Average annual ECA maximum discharge flow – equivalent precipitation flow
= 750 m^3/d - 149 m^3/d
= **601 m^3/d**

*****

Ammonia Removal

Wastewater lagoon systems can reliably remove organic loading and suspended solids from typical domestic wastewater, however, removal of other nutrients is not as well-documented. Total phosphorus can be removed with metal salt addition (i.e. alum), but ammonia removal mechanisms are less well known. Ammonia removal could include gaseous NH_3 stripping to the atmosphere, NH_3 assimilation in algal biomass, and biological nitrification (US EPA, 2011).

A special study was conducted to estimate the ammonia removal across the continuous flow Cells (#1 and #2) using ammonia removal models as documented by the USEPA (US EPA, 2011). These removal estimates were then compared to measured performance of ammonia removal. **Figure A4-1** depicts the equations used to estimate the NH_3 concentrations. A first-order, plug flow model is assumed for the ammonia removal across Cell #2, an aerated partial-mix pond. NH_3 removal across Cell #1 was estimated using either a plug flow model or a complete mix model. The plug flow and complete mix models for Cell #1 are empirically derived first-order models that depend on pH, temperature and hydraulic residence time and assume the primary mechanism for ammonia removal is volatilization.

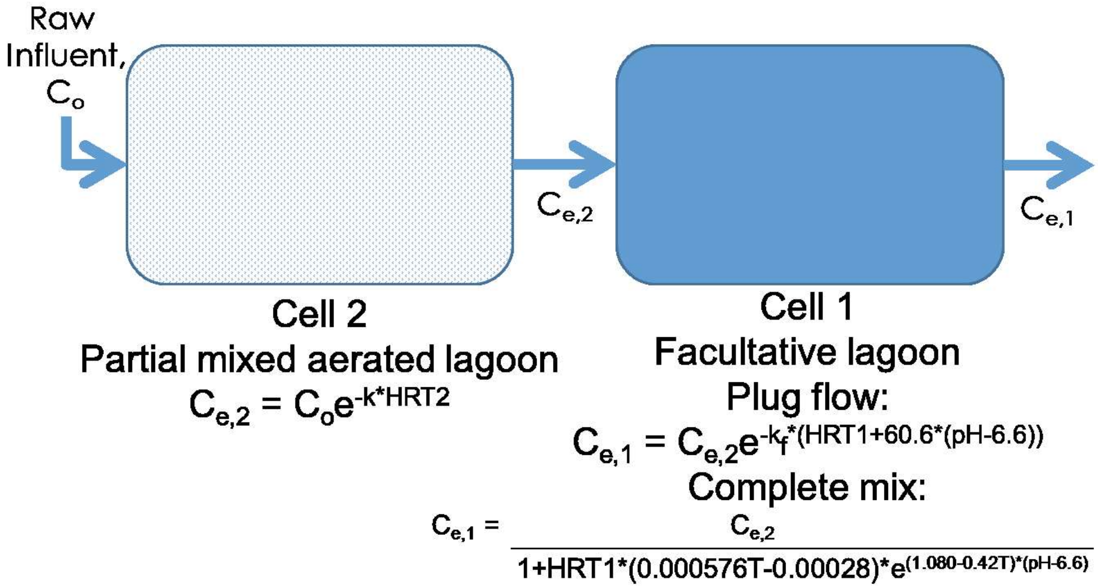


Figure A4-1 – Design equations used for estimating NH_3 concentrations across lagoon treatment cells

Where:
HRT = Hydraulic residence time
$k = 0.0107\ d^{-1}$ (at 20 °C)
$k_f = 0.0064\ d^{-1}$ (at 20 °C)
T = temperature (°C)

The first-order reaction rate constant for the plug flow models can be modified by temperature according to the relationship:

$$k = k_{20}\theta^{t-20}$$

Where:
$\Theta = 1.04$
t = temperature (°C)

The calculations were done using an MS Excel spreadsheet. First, the estimated average monthly ammonia concentration at the outlet of Cell #2 (the first cell in the treatment train) was calculated, then that concentration was used as the input concentration into Cell #1 to arrive at the ammonia concentration at the outlet of Cell #1. The modelled outlet concentrations of Cell #1 were then compared to the measured outlet concentrations. These results are depicted in **Figure 9.**

Attachment 4: Performance Potential Graph Calculations

Plant data and criteria used for the performance potential graph are outlined in the following **Table A5-1**. Detailed calculations follow.

Table A5-1 – Plant data and design criteria for PPG calculations.

Parameter	Basis
Type	A seasonal discharge lagoon system with a Nominal Design Flow of 750 m^3/d consisting of one aerated treatment cell, one facultative treatment cell, three effluent storage cells, alum addition for phosphorous removal, tertiary filtration, and UV disinfection.
Receiver	Conestoga River
Loading	Average influent annual flow = 714 m^3/d (Jan.-Dec 2013) Maximum monthly average influent flow = 994 m^3/d (Apr. 2013) Maximum day influent flow = 2,831 m^3/d (Mar. 2013) Influent BOD_5 = 226 mg/L Influent TKN = 37 mg/L
Liquid Treatment System	
Areal BOD5 Loading	Assumed 3 cells for BOD_5 removal (cells #1, #2, & #4a) Total surface area = 9.7 ha
Ammonia removal	
Aeration Systems	No. of blowers = 2 @ 40 HP, assume one on standby for PPG calculations Elevation: 421 m Temperature: 25°C (assumed) Type: Fine Bubble Depth of diffusers = 2.4 m
Tertiary Filtration	Type = upflow Dynasand filters Number = 5 Total surface area = 23 m^2
Disinfection	Type= UV disinfection (Trojan UV lamps) Number = 2 banks Capacity= 2,000 m^3/d per bank (based on manufacturer's specifications)
Effluent Storage and Discharge	
Effluent Storage	Longest storage period = 214 days (from Mar. 1 – Oct. 1) Storage volume: For cells #3 + # 4b = 210,000 m^3 For cells #3+#4a+#4b = 350,000 m^3
Effluent discharge	Allowable effluent discharge volume = 273,872 m^3 (from ECA) Equivalent daily effluent discharge rate = 750 m^3/d Total lagoon area = 21.4 ha Net precipitation accumulation: 257 mm/year (Burnside) – 475 mm (GRCA)

Performance Potential Graph Calculations:

Areal Organic (BOD) Loading:

$BOD\ Loading = \frac{BOD\ conc.*Q}{Area}$, Where $BOD_{loading,e}$ = 22kg/ha*d

Solve for Q:

$$= \frac{Area*BOD_{\text{loading,e}}}{BOD\ conc.} = \frac{(3.1+3.2+3.4)ha*22^{kg}/_{ha*d}}{0.226^{kg}/_{m^3}} = \mathbf{944}\ \boldsymbol{m^3}/\boldsymbol{d}$$

(Rating: capable)

Ammonia Removal:

Ammonia removal was not rated as there is not a good design basis available.

Tertiary Filters:

$Filter\ Loading\ Rate\ (FLR) = \frac{Q}{A}$, where FLR_e = $\mathbf{2}35\ {m^3}/_{m^2 * d}$

Solve for Q:

$= FLR * A = 235\frac{m^3}{m^2 d} * 23.25m^2 = \mathbf{5,464}\frac{\boldsymbol{m^3}}{\boldsymbol{d}}$ **(Rating: capable)**

UV Disinfection

According to manufacturer's information, the UV disinfection system was designed for peak day flow of 4,000 m^3/d with both banks in operation. It was assumed that each bank has a capacity of 2,000 m^3/d; therefore, with one bank in service and the other on standby

Q = **2,000 m^3/d** **(Rating: capable)**

Effluent Storage

Need storage for at least 214d (March 1- October 1)

Available storage:
Cell 3 & 4A (largest and smallest) = 209,300 m^3

$Q = \frac{V}{t} = \frac{209{,}000m^3}{214d} = \mathbf{978}\boldsymbol{m^3/d}$ **(Rating: capable)**

Cell #3, 4A, 4B (all storage cells) = 350,000 m^3

$Q = \frac{V}{t} = \frac{350{,}000m^3}{214d} = \mathbf{1,636}\boldsymbol{m^3/d}$ **(Rating: capable)**

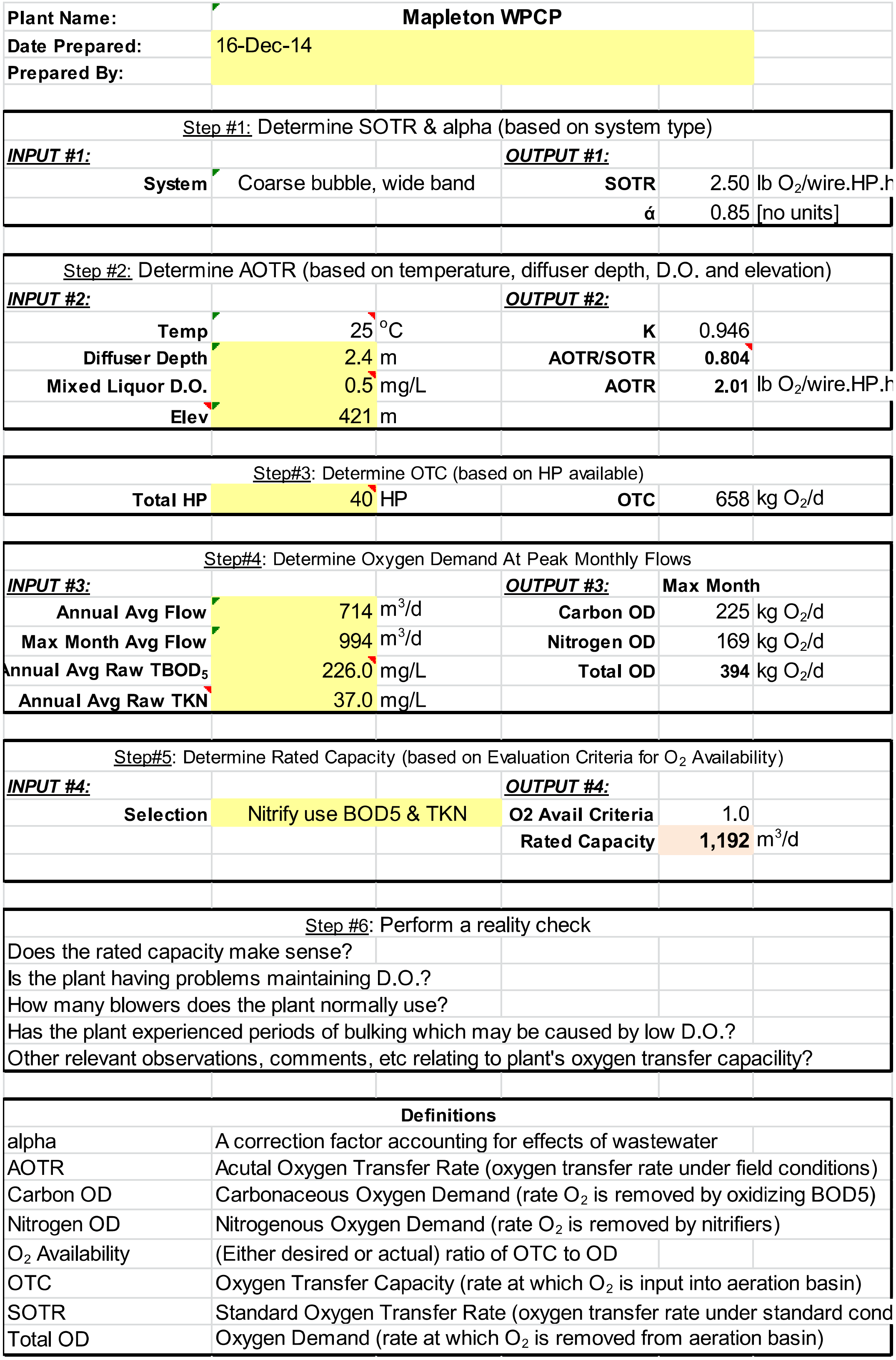
Effluent Discharge

See **Attachment #3** for detailed calculations:
4*86 m³/d - 592 m³/d* **(Rating: not capable - marginal)**

Aerated Cell: Oxygen Availability:

Oxygen availability is calculated using a separate spreadsheet as shown in **Figure A5-1** based on the following assumptions:

- Type of aerator: Fine bubble
- Maximum temperature: 20 ºC
- Diffuser depth: = 2.4 m
- DO target: 2 mg/L target
- Plant elevation: = 421m
- Blower HP: 2 x 40 HP (1 duty, 1 standby)
- Raw BOD_5 = 226 mg/L
- Raw TKN = 37 mg/L



Plant Name:	**Mapleton WPCP**				
Date Prepared:	16-Dec-14				
Prepared By:					

Step #1: Determine SOTR & alpha (based on system type)

INPUT #1:			***OUTPUT #1:***		
System	Coarse bubble, wide band		**SOTR**	2.50	lb O_2/wire.HP.h
			ά	0.85	[no units]

Step #2: Determine AOTR (based on temperature, diffuser depth, D.O. and elevation)

INPUT #2:			***OUTPUT #2:***		
Temp	25	°C	**K**	0.946	
Diffuser Depth	2.4	m	**AOTR/SOTR**	**0.804**	
Mixed Liquor D.O.	0.5	mg/L	**AOTR**	**2.01**	lb O_2/wire.HP.h
Elev	421	m			

Step#3: Determine OTC (based on HP available)

Total HP	40	HP	**OTC**	658	kg O_2/d

Step#4: Determine Oxygen Demand At Peak Monthly Flows

INPUT #3:			***OUTPUT #3:***	**Max Month**	
Annual Avg Flow	714	m^3/d	**Carbon OD**	225	kg O_2/d
Max Month Avg Flow	994	m^3/d	**Nitrogen OD**	169	kg O_2/d
nnual Avg Raw TBOD$_5$	226.0	mg/L	**Total OD**	**394**	kg O_2/d
Annual Avg Raw TKN	37.0	mg/L			

Step#5: Determine Rated Capacity (based on Evaluation Criteria for O_2 Availability)

INPUT #4:			***OUTPUT #4:***		
Selection	Nitrify use BOD5 & TKN		**O2 Avail Criteria**	1.0	
			Rated Capacity	**1,192**	m^3/d

Step #6: Perform a reality check

Does the rated capacity make sense?

Is the plant having problems maintaining D.O.?

How many blowers does the plant normally use?

Has the plant experienced periods of bulking which may be caused by low D.O.?

Other relevant observations, comments, etc relating to plant's oxygen transfer capacity?

Definitions

alpha	A correction factor accounting for effects of wastewater
AOTR	Acutal Oxygen Transfer Rate (oxygen transfer rate under field conditions)
Carbon OD	Carbonaceous Oxygen Demand (rate O_2 is removed by oxidizing BOD5)
Nitrogen OD	Nitrogenous Oxygen Demand (rate O_2 is removed by nitrifiers)
O_2 Availability	(Either desired or actual) ratio of OTC to OD
OTC	Oxygen Transfer Capacity (rate at which O_2 is input into aeration basin)
SOTR	Standard Oxygen Transfer Rate (oxygen transfer rate under standard cond
Total OD	Oxygen Demand (rate at which O_2 is removed from aeration basin)

Figure A5-1 – Mapleton WPCP oxygen availability spreadsheet

Mapleton WPCP PPG:

See Figure on next page.

<u>Overall Rating</u>: Not Rated

<u>Most limiting</u>: effluent discharge.

*****

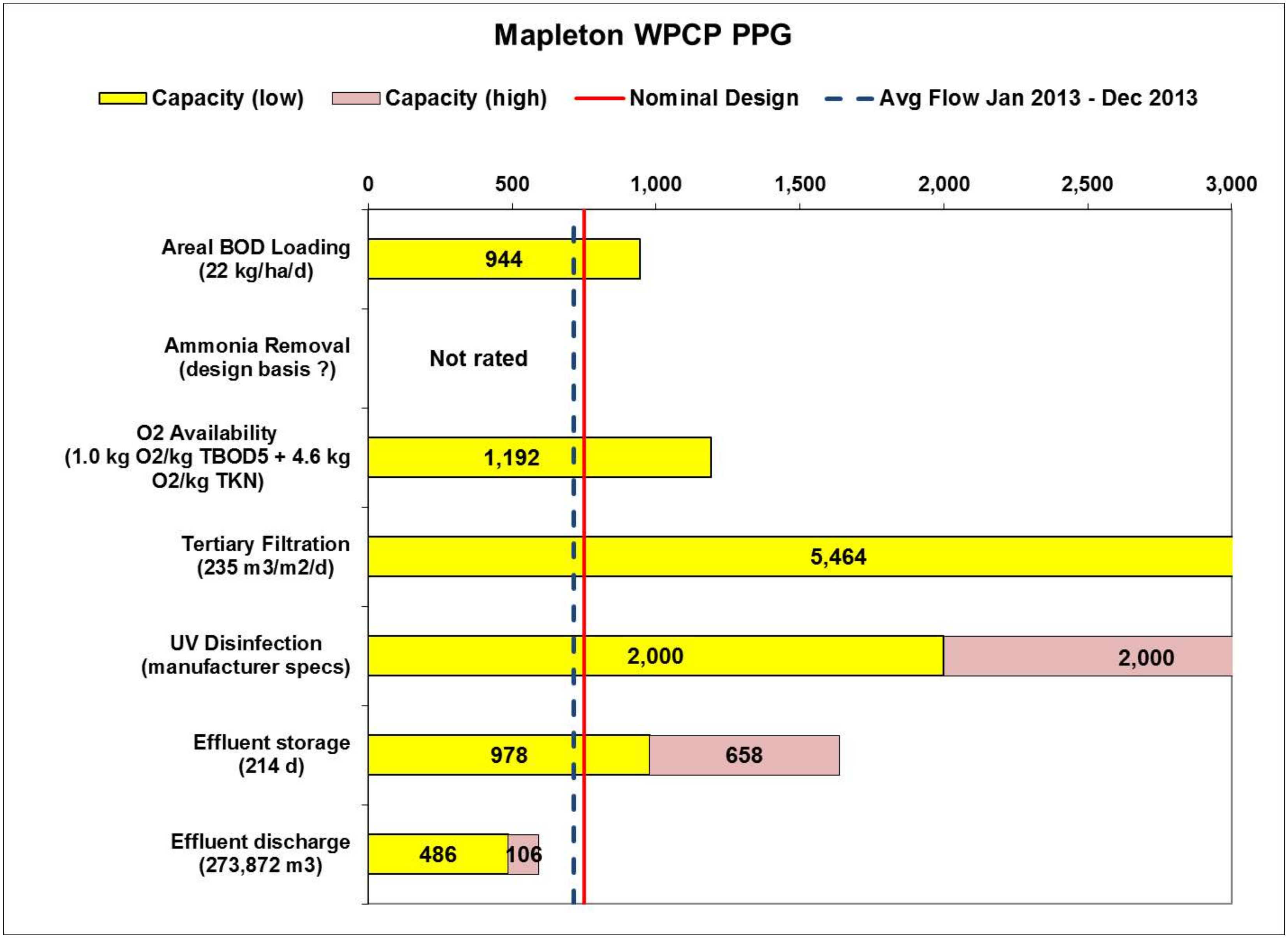


Figure A5-2 – Mapleton WPCP Performance Potential Graph