

Appendix K

TM-9B - Receiving Water Assessment



Region of Waterloo

Wastewater Treatment Master Plan Update

**Technical Memorandum No. 9B:
Receiving Water Assessment**



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June 2018

T000478A

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Preparation and Review Log

Version	Date	Prepared by (Deliverable Lead)	QC Reviewer	Project Manager Sign-off
Draft v1	January 2018	K. Hadley, D. Sinclair	T. Briggs, E. Longworth	T. Briggs
Draft v2	March 2018	K. Hadley, D. Sinclair	T. Briggs, E. Longworth	T. Briggs
Draft v3	May 2018	K. Hadley, D. Sinclair	T. Briggs	T. Briggs
Final	June 2018	S. Dong	E. Longworth	T. Briggs

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1. Introduction

1.1 Overview

On behalf of the Region of Waterloo (Region), CIMA Canada Inc. (CIMA) are currently updating the Region's Wastewater Treatment Master Plan (WWTMP) to reflect the predicted increase in population, increase in wastewater flows, and changing regulations. The main goal of the Master Plan update is to develop a current, comprehensive, cost-effective and feasible strategy to address the anticipated wastewater treatment and disposal needs of the Region over the next 35 years, as consistent with the Region's Strategic Plan. Accordingly – this exercise addresses a planning timeframe and assumed effluent flows for the year 2051.

The Region is responsible for 13 wastewater treatment plants (WWTP), as summarized in Table 1. Twelve of these plants discharge to watercourses and rivers, and one (Foxboro Green) discharges to a subsurface disposal system. All of the other WWTPs discharge to a surface water body, which either discharges directly to the Grand River or to a tributary of the Grand River (i.e. Speed, Nith, Conestogo, and Canagagigue). The Grand River is Policy 2 for total phosphorus in the Central Basin throughout the Region, in that concentrations consistently exceed the Provincial Water Quality Objective (PWQO; MOE 1994a) of 0.03 mg/L (GRCA 2011a). MOE's Procedure B-1-5, Deriving Receiving-Water based, Point-Source Effluent Requirements for Ontario Waters (MOE 1994b) states:

In areas with water quality not meeting the PWQO for a specific contaminant (Policy 2), no further degradation of water quality will be allowed for that contaminant. All reasonable and practical measures to improve water quality shall be undertaken...Expansion of existing discharges to Policy 2 receivers will only be permitted if the concentration and total load of the Policy 2 contaminant to the receiving stream is not increased.

Table 1 Receiving Watercourses in the Region of Waterloo

Receiver	WWTP
Grand River	<ul style="list-style-type: none"> • Kitchener • Waterloo • Galt • Preston • Conestogo
Nith River	<ul style="list-style-type: none"> • New Hamburg • Ayr • Wellesley
Speed River	<ul style="list-style-type: none"> • Hespeler
Canagagigue Creek	<ul style="list-style-type: none"> • Elmira
Conestogo River	<ul style="list-style-type: none"> • St Jacobs
Heidelberg Creek (to Conestogo)	<ul style="list-style-type: none"> • Heidelberg
Subsurface disposal	<ul style="list-style-type: none"> • Foxboro Green

Several key water quality issues have been identified for the Grand River basin. These include: eutrophication of the river system; elevated sediment and turbidity in river reaches; phosphorus loading of the reservoirs, causing potentially toxic algal blooms (TreeFrog Environmental 2012-2015) in Lake Erie; and impairment of water uses by high nitrate concentrations (GRCA 2014). The causes of these issues have been identified as excess inputs of suspended sediment and nutrients (GRCA 2013). Since the watershed is so large and complex, no single point source or area prevails as being the most important or the largest contributor to water quality impairment (GRCA 2013). The export of low-solubility parameters (i.e., suspended sediment/solids, total phosphorus) is driven largely by non-point sources during hydrologic events, with loads peaking during high flows in the spring. In the central portion of the watershed, point sources from wastewater treatment plants contribute almost 75% of the phosphorus loading during summer low flow conditions (GRCA 2013).

In 1998, the MOECC Eastern Region agreed that a broader interpretation of “all reasonable and practical measures to improve water quality shall be undertaken” would include phosphorus offsetting or credit trading instead of the previous interpretation, which only considered enhanced treatment. Through the broader interpretation of this policy, municipal and industrial dischargers were provided

another potentially less costly alternative for phosphorus control (Conservation Ontario 2003).

Modelling of the Grand River, to explore the feasibility of employing a phosphorus trading program to manage water quality, was completed to support the development of the 2018 WWTMP Update. Hutchinson Environmental Sciences Limited (HESL) was retained by CIMA to work in cooperation with the Grand River Conservation Authority (GRCA) to explore the effects of a potential phosphorus trading scenario between wastewater treatment plants on water quality in the river using the Grand River Simulation Model (GRSM). The phosphorus trading scenario modelled involved enhancing the treatment to achieve lower effluent limits for TP at one WWTP facility to offset relaxed TP limits (i.e. higher TP effluent concentration) at another.

In addition, a review of the recent data from the Region's ongoing Surface Water Quality Monitoring Program (SWQMP) on the Grand and Nith Rivers was conducted to determine if the current river water quality is in line with the assumptions made in past assimilative capacity studies (ACS). Assumptions made for the river water quality influence recommended treatment objectives, which are key assumptions for the 2018 WWTMP Update.

1.2 Objectives of TM 9B

The objectives of TM 9B are to:

- + Review background information related to recent river water quality monitoring data, changes in infrastructure and conditions, and previous ACS studies to identify if the previously recommended treatment objectives are still valid for the 2018 WWTMP Update
- + Anticipate future effluent objectives for the Region's WWTPs that will ensure protection of the receiving water environment and are consistent with current and expected future regulatory trends
- + Investigate the feasibility of employing a phosphorus trading program to manage water quality based on modeling of the Grand River
- + Recommend appropriate level of treatment for the Region's WWTPs based on available infrastructure and the relative impact to the receiving water.

2. Background

2.1 Grand River Simulation Model

The Grand River Simulation Model (GRSM) is a one-dimensional, dynamic water quality model aimed at assessing the impacts of water management strategies on nutrient and oxygen concentrations in the Grand River. The calibrated GRSM can simulate the effects of up to 30 point sources (e.g., wastewater treatment plants) on 7 water quality parameters (dissolved oxygen (DO), carbonaceous biochemical oxygen demand (cBOD), nitrogenous oxygen demand (NOD), nitrate (NO₃), suspended solids (TSS), and total phosphorus (TP)) and the growth and processes of photosynthesis and respiration for three aquatic plant species (*Cladophora glomerata*, *Potamogeton pectinatus* and *Myriophyllum spicatum*; GRCA, 2011b). The model consists of 71 reaches, beginning in the Grand River downstream of Belwood Lake and at Victoria Road in the Speed River and extends downstream beyond the confluence of the two rivers to the intake for the Six Nations drinking water plant at Chiefswood Road (Figure 1).

The GRSM model has a complex set of input parameters, which are documented in the model's user manual (GRCA, 2011b). The 2012 and 2013 calibrated models include Boundary inflows (i.e., tributary rivers and streams), consisting of water quality and flows for the Shand Dam (Belwood), Irvine Creek, Carrol Creek, Swan Creek, Cox Creek, Canagagigue River, Conestogo River, Laurel River, Schneiders River, Speed River, Eramosa River, Nith River, Whitemans River and Fairchild River.

The calibrated models also include existing WWTP effluent quality and flows for Fergus, Elora, Waterloo, Kitchener, Guelph, Hespeler, Preston, Galt, Paris and Brantford WWTPs. Baseline effluent quality in 2016 from Kitchener, Waterloo, Galt, Preston and Hespeler WWTP were updated for this simulation exercise. However, the model does not include WWTP inputs for New Hamburg, Ayr, Wellesley, St Jacobs, or Elmira as they discharge to tributary receivers. Those receivers are included as boundary inputs to the model but WWTP inputs cannot be manipulated directly. As a result, the data for these WWTPs were based on the existing values in the calibrated model from the GRCA.

The updated GRSM model consists of 71 reaches of the Grand and Speed Rivers, which are delineated based upon uniform physical, hydraulic and waste assimilative characteristics (Figure 1; GRCA, 2011b).

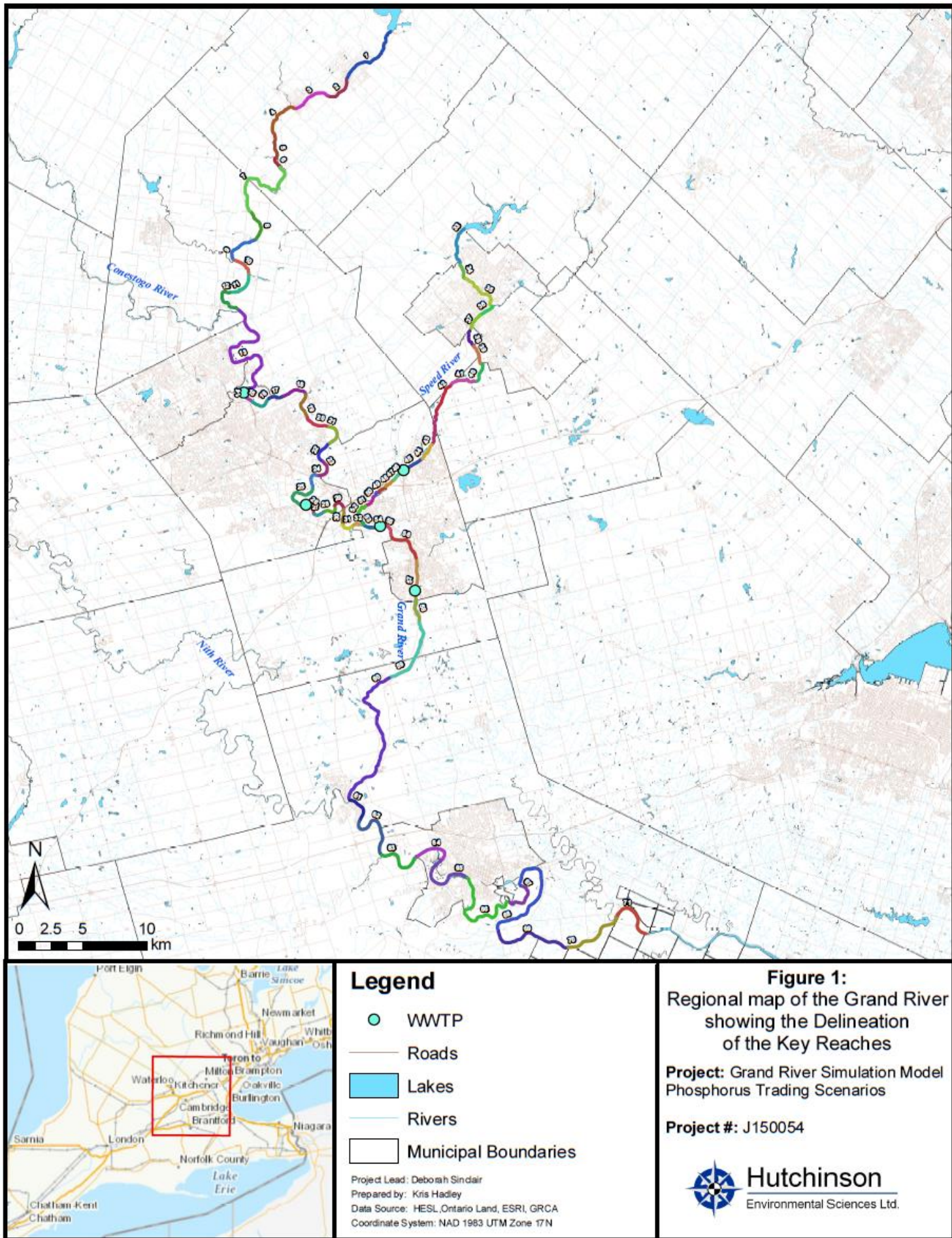


Figure 1 Regional Map of the Grand River Showing the Delineation of the Key Reaches

2.2 Surface Water Monitoring Program

The Region initiated a Surface Water Quality Monitoring Program (SWQMP) in summer 2007 as part of the 2007 WWTMP. The program was initially managed by the Grand River Conservation Authority (GRCA), until early 2009. Since 2009, the Region has retained LGL to continue the monitoring program. The program monitors the receiving water near ten of the Region's WWTPs (Kitchener, Waterloo, Galt, Preston, Hespeler, Ayr, New Hamburg, Wellesley, St Jacobs and Elmira WWTPs). The goals of the program include:

- + To determine the impact of ten of the Region's WWTPs on the water quality of the receiving water bodies (Grand River, Nith River, Speed River, Conestogo River, and Canagagigue Creek), and
- + To create a water quality database to track changes in water quality over time and allow the Region to continuously monitor and assess the impacts of planned wastewater treatment upgrades on these rivers.

Figure 2 presents the current water quality monitoring program. Water quality sampling is conducted six times per season at most stations. The seasons are classified as follows:

- + Winter – January and February – coldest water temperatures, under ice;
- + Spring – March and April – spring melt, rain events;
- + Summer – July and August, but can extend to September – low flow; and
- + Fall – October and November.

In addition to the water quality monitoring program, fish and benthic community surveys and longitudinal surveys are carried out periodically within the Grand, Nith and Speed Rivers in the vicinity of the WWTPs. Since the river monitoring program's inception in 2007, a benthic invertebrate community survey and fish survey were conducted in 2009, 2012, and 2015. Longitudinal surveys were carried out in 2010, 2012, 2014 and 2016.

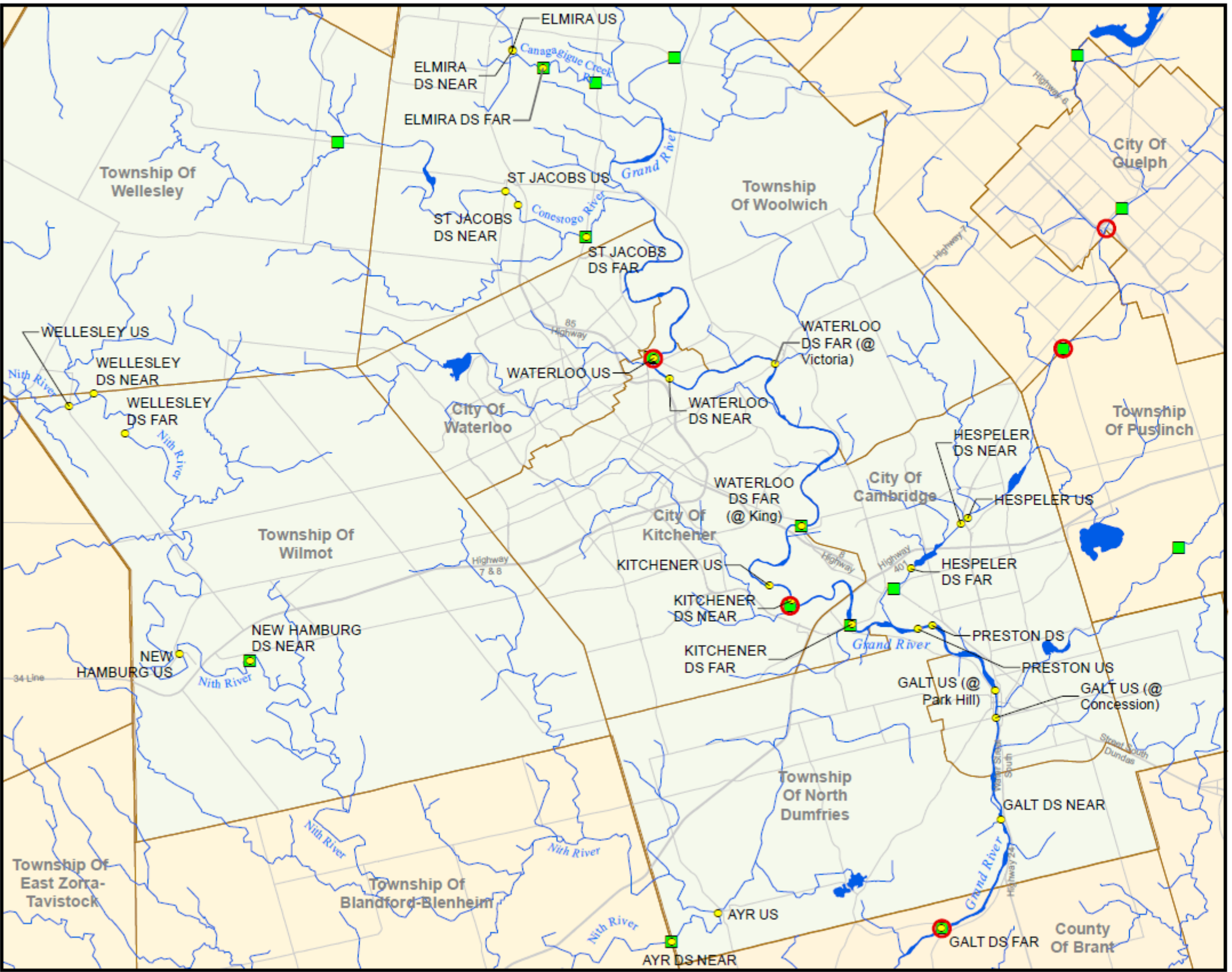


Figure 2:
Region of Waterloo River
Monitoring Stations and
PWQMN Stations

- Region of Waterloo River Monitoring Program Station - Water Quality
- Provincial Water Quality Monitoring Network Station
- GRCA Continuous Monitoring Station
- Arterial
- Highway
- Stream
- Waterbody
- ▭ Regional Municipality of Waterloo
- ▭ Other Municipality

Canada
United States

0 1 2 4 6 8 km

Prepared by: Eric Dilligeard
Data Source: LIO, PWQMN.
Coordinate System: NAD 1983 UTM Zone 17N

Project Lead: Tara Roumeliotis
Project: Region of Waterloo Wastewater Treatment
Master Plan Update, River Monitoring Program
Review
Project#: 150054

June 30, 2016

Figure 2 Region of Waterloo River Monitoring Stations and PWQMN Stations

2.3 Assimilative Capacity Studies

Following the completion of the 2007 Wastewater Treatment Master Plan, ACSs were completed in support of the upgrades/expansions that were identified in the short-term. This included the following:

- + Kitchener WWTP Upgrades, Middle-Grand River ACS: The ACS was completed in 2010 with an outcome including the recommended effluent design criteria for the on-going Kitchener WWTP Upgrades (Stantec, 2010).
- + Waterloo and Hespeler WWTPs ACS: This study was completed in 2014 with recommended effluent criteria for both the Waterloo and Hespeler WWTPs for the 2051 horizon year (Stantec, 2014).

As noted in Section 2.1, the GRCA maintains the GRSM for use in reviewing and evaluating impacts on the Grand River due to changes in infrastructure and conditions. As part of the ACSs for the Kitchener, Waterloo and Hespeler WWTPs, the GRSM was used to develop recommendations for the level of treatment required at the plants. One of the key inputs of this model is the baseline WWTP effluent quality, which was assumed the same as the rated average day design flow and objectives identified in the Environmental Compliance Approval (ECA) for the Region's WWTPs at the time of the ACS. For the 2010 Kitchener WWTP ACS, the 2007 plant effluent flows were used for the baseline flows and the projected future effluent flows of 123,000 m³/d (i.e. the ECA rated capacity of the plant) were used for future model run scenarios for the Kitchener WWTP. For the 2014 Waterloo and Hespeler ACS, the 2011 WWTP effluent flows were used for the baseline flows and the projected 2051 effluent flows of 73,200 and 13,200 m³/d were used for future model run scenarios for the Waterloo and Hespeler WWTPs in the 2014 ACS.

Following the completion of the ACS, upgrades have been implemented at these WWTPs, and the impacts of these upgrades on the river water quality have been monitored and assessed through the Region's SWQMP within the Grand and Nith Rivers. A review of the recent data from the Region's ongoing SWQMP on the Grand and Nith Rivers was conducted to determine if the current river water quality is in line with what was used for the past ACSs, as the ACS recommended treatment objectives are key assumptions for the 2018 WWTMP Update.

2.4 The Canada-Ontario Draft Action Plan for Lake Erie

To assist in reducing toxic and nuisance algal blooms in Lake Erie, the Great Lakes Water Quality Agreement (GLWQA, adopted in 2014) proposed a binational (i.e., Canada and the United States) load reduction target of 40% (from 2008 loads) of total phosphorus entering the Western and Central Basin of Lake Erie by 2025, with an “aspirational” interim goal of 20% by 2020 (Canada-Ontario Agreement Partners 2017). Domestic action plans will be developed by 2018 to outline strategies for meeting the targets. To this end, the proposed Canada-Ontario Draft Action Plan (Action Plan) for Lake Erie was posted for comment in February 2017 and meets all of Ontario’s binational and domestic commitments related to phosphorus reductions.

The Action Plan applies to tributaries, point and non-point sources entering Lake Erie. A phosphorus reduction target has been proposed for the Western and Central Basins of Lake Erie, however, a target for the Eastern Basin (into which the Grand River discharges) has not been established and requires further scientific assessment. The phosphorus loading to the Eastern Basin is notably lower than to the Western and Central Basins – 12% of the loading is to the Eastern Basin, while the remaining 88% discharges to the Western and Central Basin (Canada-Ontario Agreement Partners 2017). However, the phosphorus load from the Grand River is potentially a factor in nuisance *Cladophora* blooms in the nearshore zone of the Eastern Basin, since Canadian sources and specifically, the Grand River watershed, are the largest phosphorus contributor to the Eastern Basin. The mean load of total phosphorus from the Grand River between 2003 and 2013 was 340 tonnes per year. Canadian sources contribute 54% of the total phosphorus load to the Eastern Basin (Canada-Ontario Agreement Partners 2017). The finalization of the Action Plan will be based on comments on the draft Action Plan and engagement of key stakeholders, including First Nations and Metis communities, and the public.

Although the GLWQA targets do not apply to the Grand River watershed at this time, targets for the Eastern Basin are likely to follow. Similarly, it is reasonable to assume many of the proposed actions in the Action Plan (for the Western and Central Basins) will likely carry over as proposed actions for the Eastern Basin.

The proposed actions are organized into five categories: Reduce Phosphorus Loadings; Ensure Effective Policies, Programs and Legislation; Improve the Knowledge Base; Educate and Build Awareness; and Strengthen Leadership and Coordination.

The key impact on the levels of treatment required for the Region of Waterloo WWTPs is that point sources (which contribute 10% to 15% of total load to Lake Erie) establish a legal effluent discharge limit of 0.5 mg/L total phosphorus monthly average for all municipal WWTPs that have an average daily flow of 3.78 ML/d or more. The Draft Action Plan recognizes that these limits can be achieved using new technology retrofits and/or process modifications which can be made to existing secondary sewage treatment plants that can approach or match the effluent phosphorus concentrations attainable through conventional tertiary treatment (i.e., chemically-assisted filtration), but at a lower cost.

3. Wastewater Treatment Master Plan Alternatives

Alternatives for the 2018 WWTMP Update that are potentially impacting the receiving waters were developed in Tech Memo 6 - Liquid Treatment Alternatives. Considerations were made as part of this process for the expected future effluent quality requirements. The following plants are expected to have changes for effluent quality requirements based on accommodating growth or the Lake Erie targets:

- + Waterloo
- + Preston
- + Hespeler
- + Wellesley
- + St Jacobs
- + Elmira

It can be noted that the Galt WWTP effluent requirements are also expected to be impacted by the Lake Erie targets (i.e., Effluent TP objective and compliance of 0.4 mg/L and 0.5 mg/L, respectively). However, the suggested targets could easily be accommodated by the existing tertiary filters and chemical dosing equipment. The expected impact will primarily be an update to the Environmental Compliance Approval (ECA) for the plant with no additional capital improvements.

In support of the evaluation of alternatives, a receiving water assessment was done for each of the WWTPs above. This included reviewing previously completed ACSs, recent water quality data from the SWQMP, and other available studies related to the receiving waters (refer to Section 4 for details).

Specific to the Waterloo WWTP, an opportunity was identified for phosphorus trading with the Kitchener WWTP. In this alternative, a higher level of treatment would be provided at the Kitchener WWTP to allow a lower level of treatment at the Waterloo WWTP. To investigate this alternative, GRSM modeling was conducted to evaluate the impacts of the proposed trading between WWTPs on the receiving waters (refer to Section 5 for details).

4. Receiving Water Considerations

As discussed in Sections 2.2 and 2.3, the Region has previously completed several ACSs and/or receiving water impact studies for a number of the Region's receiving streams, and the Region carries out significant river monitoring in all of the receiving streams. The following sections provide a review of the available information to suggest realistic and appropriate future effluent objectives and make recommendations on level of treatment for the facilities. The goal is to ensure protection of the receiving water environment and be consistent with current and expected future regulatory trends.

4.1 Waterloo WWTP

The Waterloo WWTP is a conventional activated sludge plant, with an existing ECA approved hydraulic capacity of 72,730 m³/d and a rated average day (ADF) capacity of 57,500 m³/d. The treated water is discharged to the Grand River, with a current Environmental Compliance Approval (ECA) effluent objective and compliance limit of 0.4 and 0.6 mg/L respectively for TP.

The Waterloo WWTP is expected to have changes to current effluent quality limits, as an expansion to a minimum design ADF of approximately 63,600 m³/d (based on growth projections developed through the 2018 WWTMP Update) will be required during the planning period to accommodate the projected 2051 flows, and the plant will also need to meet the Lake Erie Basin targets.

An ACS was completed for the Grand River for the Waterloo WWTP in 2014. The following sections provide a review of the 2014 ACS and proposed TP effluent objectives.

Review of ACS

The ACS proposed an effluent TP objective of 0.2 mg/L with a calculated average daily loading of 14.6 kg/d at a design ADF of 72,730 m³/d which is consistent with the ECA approved hydraulic capacity of the Waterloo WWTP (Stantec, 2014). The background data used for the ACS was based on the 2006-2011 Grand River quality data.

Following the completion of the ACS, the Waterloo WWTP has been undergoing upgrades to provide year-round nitrification. A portion of the upgrades to provide

increased oxygenation capacity were completed in 2014. The interim upgrades allow the plant to achieve partial nitrification (mostly in the warmer summer months). The remainder of the upgrades have recently been completed and commissioned which allow the plant to meet the year-round effluent objectives for TAN identified in the ECA. The impacts of these upgrades on the river water quality have been monitored and assessed through the Region's Surface Water Quality Monitoring Program (SWQMP).

A review of the river quality monitoring data (2014) shows a statistically significant reduction in total ammonia levels during the summer months in the Grand River downstream of the Waterloo WWTP, compared to previous years (2007-2013) (LGL, 2015). It is expected that water quality will be further improved with the completion of the ongoing upgrades.

The Waterloo WWTP continues to provide secondary treatment with chemical phosphorus removal. TP concentrations in the river downstream of the plant remain similar to or slightly lower than the concentrations over the period from 2006 to 2011 used to develop the ACS recommended effluent limits.

The background TP concentration changes at the upstream of the Waterloo WWTP in the Grand River were also evaluated. No statistically significant difference was found between the historical and the ongoing water quality monitoring results for all seasons except summer. For summer season, the TP concentrations upstream of the Waterloo WWTP in 2014 were higher than they were in previous years (2009-2013), due to the low flow conditions compared to the previous years.

Overall, the only statistically significant change in water quality in the vicinity of the Waterloo WWTP since completion of the 2014 ACS, is the positive impact of partial nitrification during warmer summer months. Accordingly, the 2014 ACS proposed TP treatment objectives and limits for the plant are still considered appropriate for the 2018 WWTMP Update.

Suggested Effluent Objectives

As mentioned previously, the Waterloo WWTP discharges treated water to the Grand River. The Grand River is a MOECC Policy 2 receiver for TP as the background TP concentrations consistently exceed the Provincial Water Quality Objective (PWQO) of 0.03 mg/L (GRCA 2011). This means that no further degradation of water quality

will be allowed and all practical measures should be taken to improve the water quality to meet the PWQO requirements (MOECC, 1994).

Per Policy 2 requirements, to maintain the ACS allowable loadings of 14.6 kg/d at a reduced 2051 design ADF of 63,600 m³/d due to lower than expected population growth rate in the plant service areas, the suggested future TP effluent objective would be 0.23 mg/L. The suggested objectives represent a reduction in TP concentrations and loadings to the receiving water compared to the current ECA. A comparison of the suggested and the current ECA approved effluent TP objectives is shown in Table 2 for the Waterloo WWTP.

Table 2 Waterloo WWTP Current and Suggested Effluent TP Objectives

Parameter	Effluent Flow (m ³ /d)	Concentration (mg/L)	Allowable Loading (kg/d)
Current ECA	57,500	0.4	23.0
2014 ACS	73,200	0.2	14.6
Updated Future Projections	63,600	0.23	14.6

To achieve the suggested TP effluent objective of 0.23 mg/L at the Waterloo WWTP, one of the options is phosphorus trading with the Kitchener WWTP as identified in Tech Memo No. 6. Detailed review of the phosphorus trading option will be discussed in Section 5, based on the Grand River Simulation Model. Other treatment options include tertiary filtration.

Table 3 summarizes anticipated effluent objectives for the Waterloo WWTP at a rated capacity of 63,600 m³/d. The suggested limits are consistent with levels associated with a conventional single-stage tertiary treatment facility with chemical dosing. These objectives will need to be confirmed as part of the Class EA for a plant expansion to 63,600 m³/d.

As part of the 2007 WWTMP and subsequent St Jacobs and Elmira WWTMP recommendations, a diversion of flows from the St Jacobs WWTP service area to the Waterloo WWTP was identified as an option that may be beneficial. It is important to note that if the St Jacobs WWTP flows were diverted to the Waterloo WWTP, the total future flow would be approximately 65,200 m³/d for the Waterloo WWTP. With the slightly higher future flow (approximately 2.5% increase), the suggested effluent TP objective would need to be reduced slightly from 0.23 mg/L to 0.22 mg/L to maintain

the 2014 ACS TP loading. As a result, the impact of the diversion of St Jacobs flow on the effluent TP objectives of the Waterloo WWTP is considered minor.

Table 3 Waterloo WWTP Current and Future Planning Effluent Objectives

Parameter	Existing ECA Objectives	ACS Recommended Objectives at 73,200 m ³ /d	Suggested Effluent Objectives at 63,600 m ³ /d
cBOD ₅	10 mg/L	10 mg/L	10 mg/L
TSS	10 mg/L	10 mg/L	10 mg/L
Ammonia-Nitrogen	1.5 mg/L	1.5 mg/L	1.5 mg/L
TP	0.4 mg/L	0.2 mg/L	0.23 mg/L
<i>E. Coli</i>	100 cfu/100 mL	100 cfu/100 mL	100 cfu/100 mL

4.2 Preston WWTP

The Preston WWTP is a conventional activated sludge plant that provides full nitrification and a high level of phosphorus removal through chemical addition, with a rated ADF capacity of 16,800 m³/d. The treated water is discharged to the Grand River (a Policy 2 receiver for TP), with a current ECA effluent objective and compliance limit of 0.6 and 0.7 mg/L, respectively, for TP. The plant already provides a high level of year-round nitrification consistent with a non-toxic effluent and similar to the recently approved effluent objectives for the Kitchener WWTP Upgrades.

As noted in Tech Memo No. 6, the Preston WWTP does not require an expansion within the planning period, therefore no significant changes are expected for most effluent quality parameters. However, the 2017 Canada-Ontario Phosphorus Reductions Action Plan for Lake Erie, has proposed a legal effluent discharge limit of 0.5 mg/L total phosphorus for all municipal WWTPs in the Lake Erie basin that have an average daily flow of 3,780 m³/d (refer to Section 2.4). As a result, the Preston WWTP future TP effluent objective will be reduced to meet the Lake Erie targets (i.e. 0.5 mg/L). For the purposes of this Master Plan, we have conservatively assumed the effluent TP concentration compliance limits would be 0.5 mg/L (consistent with Lake Erie recommendations) with an effluent objective concentration of 0.4 mg/L.

A review of the existing treatment process at the Preston WWTP indicates the plant is already routinely achieving the expected TP objective of 0.4 mg/L (e.g., the average effluent TP concentration was 0.23 mg/L between 2012 and 2014). As the proposed

effluent TP objectives are already being achieved, further upgrades are not expected. A comparison of the suggested and the current ECA approved effluent TP objectives is provided in Table 4 for the Preston WWTP.

Table 4 Preston WWTP Current and Future Planning Effluent TP Objectives

Parameter	Effluent Flow (m ³ /d)	Concentration (mg/L)	Allowable Loading (kg/d)
Current ECA	16,800	0.6	10.0
Expected with Lake Erie Targets	16,800	0.4	6.7

Table 5 summarizes current and suggested future effluent objectives for the Preston WWTP. The future effluent objectives are consistent with the performance of a secondary treatment facility with optimized chemical addition.

Table 5 Preston WWTP Current and Future Planning Effluent Objectives

Parameter	Existing ECA Objectives	Suggested Effluent Objectives at 16,800 m ³ /d
cBOD ₅	10 mg/L	10 mg/L
TSS	10 mg/L	10 mg/L
Ammonia-Nitrogen		
May 1 – September 30	3 mg/L	3 mg/L
October 1 – April 30	5 mg/L	5 mg/L
TP	0.6 mg/L	0.4 mg/L
<i>E. Coli</i>	200 cfu/100 mL	200 cfu/100 mL

4.3 Hespeler WWTP

The Hespeler WWTP is an extended aeration plant, with a rated ADF capacity of 9,320 m³/d. The treated water is discharged to the Speed River, with a current ECA effluent objective and compliance limit of 0.75 and 1.0 mg/L, respectively, for TP.

The Hespeler WWTP is expected to have changes to current effluent quality limits, as an expansion to a minimum design ADF of approximately 10,400 m³/d (based on growth projections developed through the 2018 WWTMP Update) will be required during the planning period to accommodate the projected 2051 flows, and the plant will also need to meet the Lake Erie Basin targets. As noted in Section 2.3, an ACS was completed for the Hespeler WWTP in 2014.

Review of ACS

The ACS proposed an effluent TP objective of 0.4 mg/L with a calculated average daily loading of 5.3 kg/d at a 2051 design ADF of 13,200 m³/d based on the expected plant capacity identified in the 2007 WWTMP (Stantec, 2014). The background data used for the Hespeler WWTP ACS was based on the 2006-2011 Speed River quality data.

Similar to the Waterloo WWTP, a comparison between the background data and the recent Speed River water quality monitoring data was conducted to determine if the past ACS recommended effluent objectives and limits are still appropriate.

The Hespeler WWTP has been able to partially nitrify during warmer months. The recent river monitoring data (2013) shows a statistically significant reduction in total ammonia levels in the river downstream of the plant, compared to previous years (2007-2012) (LGL, 2014); even though nitrification was inconsistent during the warmer months of 2014 due to planned maintenance activities at the plant.

The Hespeler WWTP continues to provide secondary treatment with chemical phosphorus removal. TP concentrations in the river downstream of the plant remain similar to the concentrations over the period from 2006 to 2011 used to develop the ACS recommended limits.

The background TP concentration changes upstream of the Hespeler WWTP in the Speed River were also evaluated. No statistically significant difference was found between the historical and current water quality monitoring results for all seasons, except the fall season. For the fall season, the TP concentration in 2014 was slightly higher than in 2009-2013 at the upstream of the Hespeler WWTP.

In summary, there are minimal statistically significant changes in water quality in the vicinity of the Hespeler WWTP, with the exception of the positive impact of partial nitrification during warmer summer months.

Suggested TP Effluent Objectives

The Hespeler WWTP discharges treated water to the Speed River. The Speed River is a MOECC Policy 2 receiver for TP as the background TP concentrations consistently exceed the Provincial Water Quality Objective (PWQO) of 0.03 mg/L (GRCA 2011).

The 2014 ACS for the Hespeler WWTP indicated a future TP effluent objective of 0.4 mg/L based on a design ADF of 13,200 m³/day, which equates to an allowable loading of 5.3 kg/d. Per Policy 2 requirements, to maintain the ACS allowable loadings of 5.3 kg/d at a reduced 2051 design ADF of 10,400 m³/d (due to lower than expected population growth rate in the plant service areas) the future TP effluent objective would be 0.5 mg/L.

As mentioned previously, phosphorus removal is expected to be required as part of the plant expansion and the Lake Erie effluent phosphorus target requirements. However, the primary driver for the phosphorus removal for Hespeler WWTP will be the Lake Erie targets as this is expected to be required prior to the need for additional plant capacity. As a result, the future effluent TP objective is expected to remain at 0.4 mg/L, based on the anticipated Lake Erie basin loading recommendations. Since the changes based on the Lake Erie targets will re-define the baseline conditions for the Policy 2 Speed River, an updated ACS will be required for expansion of the Hespeler WWTP.

A comparison of the future suggested TP effluent objectives and the current ECA approved objectives is shown in Table 6 for the Hespeler WWTP. The proposed TP effluent objectives represent a reduction in TP concentrations and loadings to the receiving water compared to the current ECA.

Table 6 Hespeler WWTP Current and Suggested Effluent TP Objectives

Scenarios	Effluent Flow (m³/d)	Concentration (mg/L)	Allowable Loading (kg/d)
Current ECA	9,320	0.75	7.0
2014 ACS	13,200	0.40	5.3
Updated Future Projections	10,400	0.40	4.2

Table 7 summarizes current and anticipated future effluent objectives for the Hespeler WWTP. The future objectives are consistent with the performance of a secondary treatment facility with optimized chemical addition. Effluent objectives will need to be confirmed through a new ACS to be completed during a Schedule C Class EA for the Hespeler WWTP expansion.

Table 7 Hespeler WWTP Current and Future Planning Effluent Objectives

Parameter	Existing ECA Objectives	Suggested Effluent Objectives at 10,400 m ³ /d
cBOD ₅	15 mg/L	10 mg/L
TSS	15 mg/L	10 mg/L
Ammonia-Nitrogen May 1 – November 30 December 1 – April 30	N/A N/A	2 mg/L 5 mg/L
TP	0.75 mg/L	0.40 mg/L
<i>E. Coli</i>	150 cfu/100 mL	150 cfu/100 mL

4.4 Wellesley WWTP

The Wellesley WWTP is an extended aeration plant, with a rated ADF capacity of 1,100 m³/d. The treated water is discharged to the Nith River, with a current ECA effluent objective and compliance limit of 0.5 mg/L for TP. The Wellesley WWTP is currently completing upgrades to the tertiary filtration process to improve effluent quality by replacing the existing sand filters with cloth media disk filters.

The Wellesley WWTP is expected to have changes to current effluent quality limits, with an expansion to a minimum design ADF of approximately 1,320 m³/d required during the planning period to accommodate the projected 2051 flows. A recent ACS specific to the Wellesley WWTP is not available.

The Nith River is a Policy 2 receiver for TP, as background TP concentrations consistently exceed the PWQO of 0.03 mg/L (GRCA 2011). Previous studies identified the high level of background phosphorus concentrations in the Nith River watershed to be primarily from non-point source (e.g. agricultural sources), compared to the relatively smaller loadings from point sources such as Region’s WWTPs (AECOM, 2011). As a result, WWTP discharge flows have a low impact on the water quality of the Nith River. However, per Policy 2 requirements, the TP loading of the plant effluent cannot be increased beyond the current ECA approved loading objectives (MOECC, 1994b).

Consistent with a Policy 2 receiver, an effluent TP objective of 0.42 mg/L is required to maintain the existing loadings at an expanded Wellesley WWTP capacity of 1,320 m³/d. The specific TP required objective will need to be determined as part of an

ACS in support of the plant expansion. A comparison of the suggested and the current ECA approved TP effluent objectives is provided in Table 8.

Table 8 Wellesley WWTP Current and Suggested Effluent TP Objectives

Parameter	Effluent Flow (m ³ /d)	Concentration (mg/L)	Allowable Loading (kg/d)
Current ECA	1,100	0.5	0.55
ACS ⁽¹⁾	-	-	-
Future	1,320	0.42 ⁽²⁾	0.55

Notes:

1. A recent ACS specific to the Wellesley WWTP is not available.
2. Concentration to maintain existing loadings consistent with a Policy 2 receiver. A specific TP Objective will be determined through an ACS.

Table 9 summarizes current and anticipated future effluent objectives for the Wellesley WWTP. Overall, the suggested effluent TP objectives are consistent with the performance of an optimized single stage tertiary treatment facility. Effluent objectives will need to be confirmed through an ACS to be completed during a Schedule C Class EA for the Wellesley WWTP expansion.

Table 9 Wellesley WWTP Current and Future Planning Effluent Objectives

Parameter	Existing ECA Objectives	Suggested Effluent Objectives at 1,320 m ³ /d
cBOD ₅	10 mg/L	5 mg/L
TSS	10 mg/L	5 mg/L
Ammonia-Nitrogen	0.5 mg/L	0.35 mg/L
TP	0.5 mg/L	0.42 mg/L
<i>E. Coli</i>	200 cfu/100 mL	100 cfu/100 mL

4.5 St Jacobs WWTP

The St Jacobs WWTP is an oxidation ditch extended aeration plant that provides a high level of nitrification and tertiary phosphorus removal, with a rated ADF capacity of 1,450 m³/d. The treated water is discharged to the Conestogo River, with a current ECA effluent objective and compliance limit of 0.2 and 0.3 mg/L, respectively, for TP.

If expanded as discussed in Tech Memo No.6, the St Jacobs WWTP is expected to have changes to current effluent quality limits. The expansion would be to a minimum design ADF of approximately 1,600 m³/d to accommodate the projected 2051 flows.

A Receiving Water Quality Impact Study (RWQIS) was completed for the Conestogo River in 2011. The study proposed an effluent TP objective of 0.15 mg/L, resulting in a daily loading of 0.32 kg/d at an expanded plant capacity of 2,100 m³/d (XCG, 2011).

The Conestogo River is a MOECC Policy 2 receiver for TP as the background TP concentrations consistently exceed the PWQO of 0.03 mg/L (GRCA 2011). Per Policy 2 requirements, to be conservative and to maintain the existing allowable loading of 0.30 kg/d rather than the loading of 0.32 kg/d identified in the RWQIS at a design ADF of 1,600 m³/d, the suggested future TP effluent objective would be 0.18 mg/L. A comparison of the suggested and the current ECA approved TP objectives is shown in Table 10.

Table 10 St Jacobs WWTP Current and Suggested Effluent TP Objectives

Parameter	Effluent Flow (m³/d)	Concentration (mg/L)	Allowable Loading (kg/d)
Current ECA	1,450	0.20	0.30
RWQIS ⁽¹⁾	2,100	0.15	0.32
Future	1,600	0.18	0.30

Notes:

1. Based on the allowable loading identified in the Receiving Water Quality Impact Study (RWQIS) (XCG, 2011).

Table 11 summarizes current and anticipated future effluent objectives for the St Jacobs WWTP. Overall, the suggested effluent objectives are consistent with the performance of an optimized single stage tertiary treatment facility. Effluent objectives will need to be confirmed through an ACS to be completed during a Schedule C Class EA for the St Jacobs WWTP expansion.

Table 11 St Jacobs WWTP Current and Future Planning Effluent Objectives

Parameter	Existing ECA Objectives	Suggested Effluent Objectives at 1,600 m ³ /d
cBOD ₅	5 mg/L	5 mg/L
TSS	5 mg/L	5 mg/L
Ammonia-Nitrogen May 1 – October 31 November 1 – September 30	0.7 mg/L 1.0 mg/L	0.5 mg/L 1.0 mg/L
TP	0.2 mg/L	0.18 mg/L
<i>E. Coli</i>	100 cfu/100 mL	100 cfu/100 mL

4.6 Elmira WWTP

The Elmira WWTP is a biological nutrient removal (BNR) plant, with a rated ADF capacity of 7,800 m³/d. The treated water is discharged to the Canagagigue Creek, with a current ECA effluent objective and compliance limit of 0.20 and 0.5 mg/L, respectively, for TP.

The Elmira WWTP is expected to have changes to current effluent quality limits, as an expansion to a minimum design ADF of approximately 10,000 m³/d will be required during the planning period to accommodate the projected 2051 flows. A recent ACS specific to the Elmira WWTP is not available.

The Canagagigue Creek is a MOECC Policy 2 receiver for TP as the background TP concentrations consistently exceed the PWQO of 0.03 mg/L (GRCA 2011). Per Policy 2 requirements, the TP loading of the plant effluent cannot be increased beyond the current ECA approved loading.

For the purpose of this evaluation, it has been assumed that an effluent TP objective of 0.15 mg/L would be required for a plant expansion to 10,000 m³/d. This would maintain the current ECA TP loading objectives of 1.56 kg/d (i.e., 0.2 mg/L at 7,800 m³/d). The suggested TP effluent objective of 0.15 mg/L is achievable with a single stage tertiary filtration system similar to the existing system and optimized BNR performance with supplemental chemical addition. A comparison of the suggested and the current ECA approved effluent TP objectives is shown in Table 12.

Table 12 Elmira WWTP Current and Suggested Effluent TP Objectives

Parameter	Effluent Flow (m ³ /d)	Concentration (mg/L)	Allowable Loading (kg/d)
Current ECA	7,800	0.2	1.56
Future	10,000	0.15	1.56

Notes:

1. There is no current ACS specific to the Elmira WWTP available.

Table 13 summarizes current and anticipated future effluent objectives for the Elmira WWTP. Overall, the suggested effluent objectives are consistent with the performance of an optimized single stage tertiary treatment facility. Effluent objectives will need to be confirmed through an ACS to be completed during a Schedule C Class EA for the Elmira WWTP expansion.

Table 13 Elmira WWTP Current and Future Planning Effluent Objectives

Parameter	Existing ECA Objectives	Suggested Effluent Objectives at 10,000 m ³ /d
cBOD ₅	5 mg/L	5 mg/L
TSS	5 mg/L	5 mg/L
Ammonia-Nitrogen May 1 – October 31	0.4 mg/L	0.4 mg/L
November 1 – September 30	1.0 mg/L	1.0 mg/L
TP	0.2 mg/L	0.15 mg/L
<i>E. Coli</i>	-	100 cfu/100 mL

5. Phosphorus Trading

Specific to the Waterloo WWTP, an opportunity was identified for phosphorus trading with the Kitchener WWTP. In this alternative, a higher level of treatment would be provided at the Kitchener WWTP to allow a lower level of treatment at the Waterloo WWTP. To investigate this alternative, GRSM modeling was conducted to evaluate the impacts of the proposed trading between WWTPs on the receiving waters. The following sections describe the approach and results of the GRSM modeling.

5.1 Methodology

5.1.1 Receiver Flow and Calibrated Model Selection

Multiple calibrated versions of the GRSM were provided by the GRCA representing various flow and climate conditions. These included recent models for 2012 and 2013, as well as three models from 2005, 2007 and 2008. The 2005, 2007 and 2008 models were calibrated prior to the addition of 11 reaches during the Waterloo and Hespeler assimilative capacity studies and therefore are not easily comparable with the 2012 and 2013 models which include the additional 11 reaches.

The 2012 calibrated model was selected for this study, which includes the additional 11 reaches. The rationale for this selection is described below.

The mean annual flow estimates provided by the GRCA from the Grand and Speed Rivers were used to characterize the flow regime in the two recent calibrated model years, 2012 and 2013. Flows in 2012 were amongst the lowest in the 39 year record (21.6 m³/s). The mean annual 2012 flow is equivalent to the 5th percentile of the data set, suggesting that the 2012 flow are most similar to the 7Q20 statistic that is used for assimilation modeling. Under these conditions, WWTP effluent would have the greatest effect on water quality in the model simulations. Therefore, for the purpose of this study, the 2012 calibrated model was selected over the 2013 model, where flows were significantly higher (60.1 m³/s). More details about the Grand and Speed Rivers flow data is referred to Appendix A.

5.1.2 Inputs

Key reaches in determining the impact of the proposed P-trading scenario on the Grand River included those affected by the Waterloo (Reach 14-25) and Kitchener (Reach 26-32) wastewater treatment plants (Figure 1).

Water Quality Parameters

For the baseline scenario, each point source discharge to the system is represented in the GRSM by a suite of water chemistry variables including dissolved oxygen (DO), carbonaceous biochemical oxygen demand (cBOD), nitrogenous oxygen demand (NOD), nitrate (NO₃), suspended solids (TSS), and total phosphorus (TP), as shown in Table 14.

Table 14 Baseline Wastewater Effluent Quality

WWTP	TP (mg/L)	cBOD (mg/L)	TSS (mg/L)	DO (mg/L)	NO ₃ (mg/L)	NH ₃ -N (mg/L)	NOD (mg/L)
Kitchener	0.2	10.0	10.0	2.0	25.1	2.0	9.1
Waterloo	0.23	11.5	11.5	2.0	37.5	1.7	7.9

Data for BOD, TSS, and NO₃ were based on objectives identified in the existing Environmental Compliance Approval (ECA) for Kitchener WWTP (AECOM, 2012) and on a recent ACS for Waterloo WWTP (Table 15; Stantec, 2014). As no information was available for DO concentrations, a conservative effluent value of 2 mg/L was assumed for all plants. NOD was calculated based on available NH₃-N data following:

$$(1) \text{ NOD} = 4.57 * \text{NH}_3\text{-N.}$$

Total phosphorus concentrations were the only input parameter manipulated as a part of the phosphorus trading scenario. In the baseline scenario, TP concentrations were based on objectives developed during ACS studies (Table 15; AECOM, 2012, Stantec, 2014). The phosphorus trading scenario modelled involved enhancing the treatment to achieve lower effluent limits for TP at one WWTP facility to offset higher P limits at another (Table 15). Overall, the net phosphorus loading to the receiver remains unchanged.

Table 15 Proposed Phosphorus Trading Scenarios for the 2018 WWTMP Update

WWTP	Baseline TP (mg/L)	Scenario 1: Trading Between Kitchener and Waterloo TP (mg/L)
Kitchener	0.2	0.11
Waterloo	0.23	0.4

Flow

Projected WWTP flows for 2051 were developed as part of the 2018 WWTMP Update and incorporated into the calibrated GRSM model for the Kitchener, Galt, Waterloo and Preston WWTP discharges (Table 16). For simplicity, flows were divided into 12 equal, 2-hour for the model simulations. The GRSM accepts daily flows from each point source as input to the model, as a result, the WWTP effluent flows in Table 16 were used for all calibrated model run scenarios. These flows were kept constant throughout the simulations, no hourly or daily variation.

Table 16 WWTP Effluent Flow Projections for 2051

WWTP	Flow (m ³ /d)
Kitchener	122,700
Waterloo	63,600

5.1.3 Outputs

The GRSM produces outputs for each modelled reach of the Grand and Speed River consisting of daily average flow, a suite of water chemistry variables including cBOD, NOD, NO₃, TSS, UIA, DO and water temperature, and aquatic plant growth data on *Cladophora*, *Potamogeton* and *Myriophyllum*. As our goal was to assess the general viability of P-trading options, we have focussed our analysis on the water chemistry changes.

Numerical Analysis

The GRSM water quality data set was downloaded to an Excel spreadsheet, before being analyzed and graphed using the R Statistical Computing Environment (R Core Team 2015) and the R packages “igraph v. 1.0.1” (Csardi, 2015), “dunn.test” (Dinno, 2017) and “WGCNA” (Langfelder and Horvath, 2008).

Data collected from the GRSM for all 71 reaches and eight parameters was formatted for analysis. Summary statistical analyses were performed to allow for comparison between the two modelled scenarios (Baseline and P-trading Scenario) and have been presented as boxplots. Boxplots allow for efficient visualization of five key summary statistics, the median, two hinges (the 75th and 25th percentiles) and the whiskers which extend from the hinge to the largest and smallest value no further away than 1.5 * the Interquartile Range (IQR).

The significance of water quality differences between sites within each Reach was tested using the non-parametric Kruskal Wallis test. Where statistically significant ($p < 0.05$) differences were identified, we performed pairwise post-hoc Dunn's tests to identify the sites which differed significantly. Kruskal Wallis and Dunn's tests were performed in R using the core "kruskal.test" function and the "dunn.test" function of the "dunn.test" v. 1.3.4 package. Results were corrected following the Benjamini–Hochberg procedure (Benjamini and Hochberg 1995) to adjust p-values to account for Type I error of multiple comparisons.

5.2 Results

Water chemistry data output from the GRSM includes biological oxygen demand (BOD), nitrogenous oxygen demand (NOD), water temperature, and concentrations of total phosphorus (TP), dissolved oxygen (DO), nitrate+nitrite (NO_3+NO_2), total suspended solids (TSS), and un-ionized ammonia (UIA). The following section presents the water chemistry results from the proposed phosphorus trading scenario relative to a baseline (no P-trading) scenario, focusing on significant differences in water quality ($p < 0.05$). No differences in WWTP performance were proposed for BOD, NO_3+NO_2 , DO, TSS or water temperature in any scenario, therefore, no significant differences were observed for these parameters and they are not discussed below.

Scenario 1 - Trading Between Kitchener and Waterloo

In this scenario, effluent TP was increased to 0.4 mg/L (considered to be a reasonable effluent objective for a well-run secondary treatment plant with chemical phosphorus removal) at the Waterloo WWTP and decreased to 0.11 mg/L at the Kitchener WWTP.

Total phosphorus concentrations in Reach 14 of the Grand River, the location of the outfall of the Waterloo WWTP, increased significantly (median TP = 0.057 mg/L) relative to the baseline calibrated model run (median TP = 0.046 mg/L) and persisted downstream to Reach 25 immediately upstream of the Kitchener WWTP (Figure 3). Reduced TP concentrations at the Kitchener WWTP compensated for the elevated upstream loads and a reduction in total phosphorus was noted in Reach 26 (outfall of Kitchener WWTP) where total phosphorus concentrations fell (median TP = 0.057 mg/L) significantly below those modelled in the baseline scenario (median TP = 0.060 mg/L) suggesting a potential improvement in water quality downstream of the

Kitchener WWTP. The overall reduction in TP continued until Reach 60, south of the Galt WWTP, by which point the response of the river to TP trading between the Waterloo and Kitchener WWTPs was undetectable, with no significant difference between P concentrations.

Increased total phosphorus concentrations in the reaches downstream of the Waterloo WWTP pose a concern as water quality in the Grand River in these Reaches is Policy 2 for TP (Figure 4), and there is a water treatment plant intake within this segment of the Grand River. The 75th percentile total phosphorus concentration exceeds the PWQO (0.03 mg/L). In addition, total phosphorus reduction downstream of Kitchener (0.003 mg/L) was significantly smaller than the degradation downstream of the Waterloo WWTP (0.011 mg/L).

5.3 Conclusions and Recommendations

The phosphorus trading scenario investigated results in increased total phosphorus concentrations in specific reaches of the Grand River, downstream of the Waterloo WWTP. Given that the Grand River is a Policy 2 receiver for total phosphorus in these regions, it is unlikely that approval of these scenarios would be possible and therefore suggest that other alternatives be considered.

Based on modelling data in the GRSM, any additional trading scenarios should focus exclusively on shifting phosphorus loading downstream (i.e. a higher level of treatment should be provided at the upstream plant). Increased loading upstream will consistently result in degradation of water quality and therefore is not viable unless accompanied by additional P mitigation to ensure no net phosphorus increase.

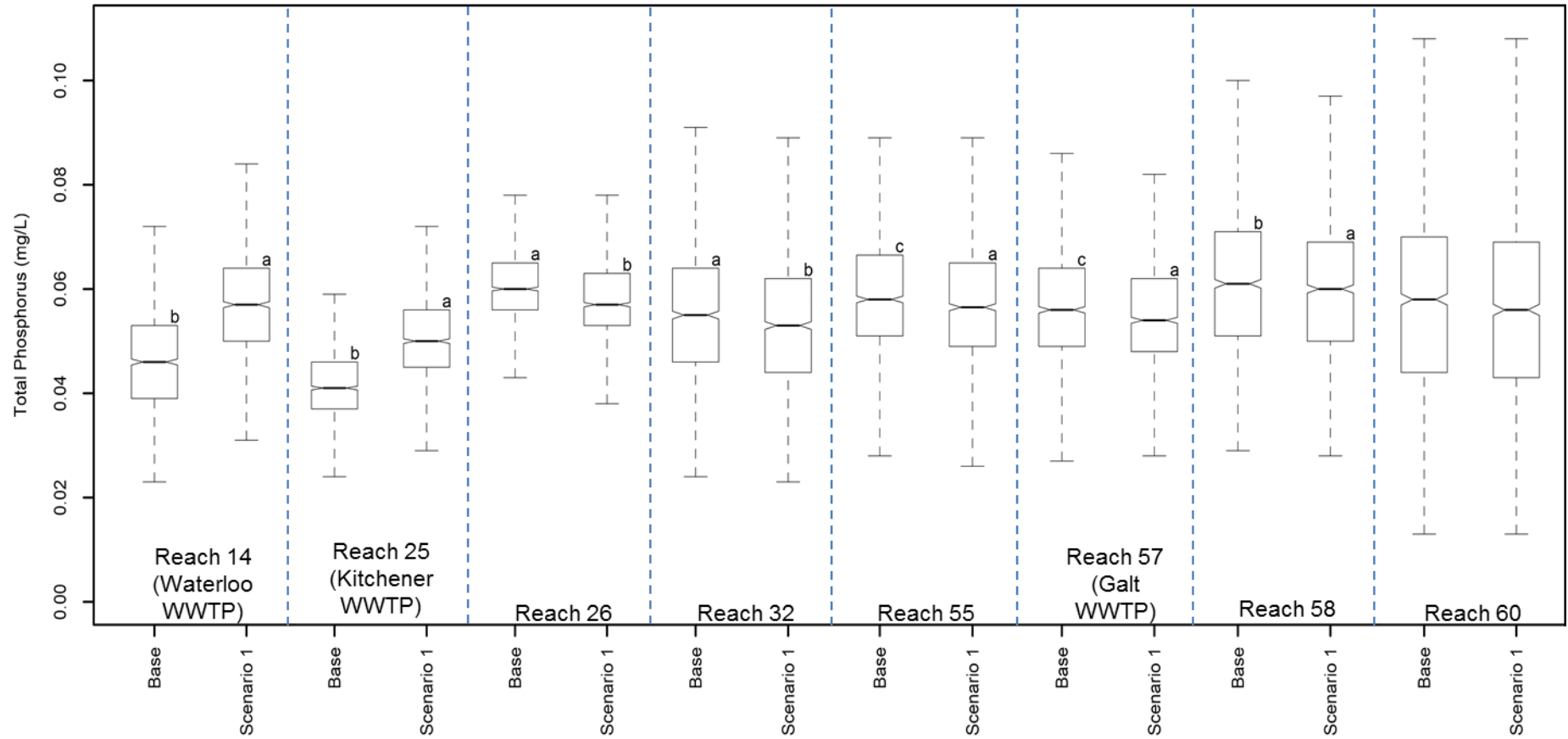


Figure 3 Total Phosphorus Concentrations for Selected Reaches of the Grand River based on Scenario 1 P-Trading between Kitchener and Waterloo WWTP

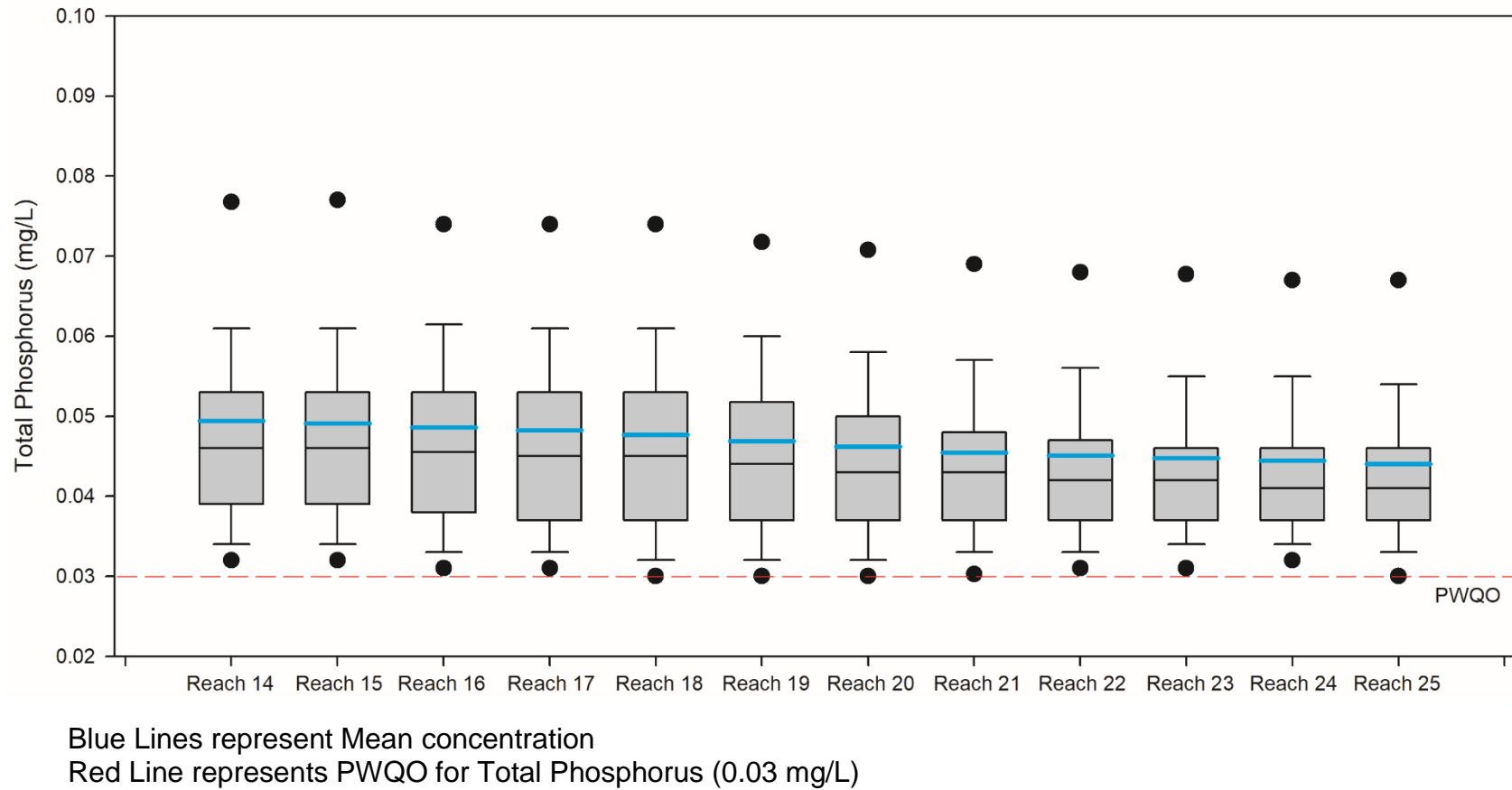


Figure 4 Baseline Total Phosphorus Concentrations Downstream of the Waterloo WWTP

6. Summary of Expected Level of Treatment

Future TP effluent objectives were developed for the Region's WWTPs which require expansion or will be affected by proposed Lake Erie targets, based on the results of ACS and MOECC Guidelines. Where ACSs are not completed, the suggested effluent objectives were determined based on maintaining future loadings at or below the current ECA objectives. It is recommended that updated ACSs be completed to firmly establish the future effluent objectives for any expansion of the existing WWTPs where recent ACSs are not available (i.e. Wellesley, St Jacobs and Elmira WWTPs).

A summary of suggested TP effluent objectives and anticipated level of treatment is provided in Table 17. It is important to note that only treatment objectives where a change is expected are summarized in this table.

Based on GRSM modeling, the phosphorus trading between the Kitchener and Waterloo WWTP would result in increased total phosphorus concentrations in specific reaches of the Grand River, downstream of the Waterloo WWTP. Therefore, phosphorus trading is not recommended for this scenario.

Table 17 Suggested Effluent Objectives and Anticipated Level of Treatment for WWTPs

WWTP	Future CBOD ₅ Objective (mg/L)	Future TSS Objective (mg/L)	Future Ammonia-N Objective (mg/L)	<i>E. coli</i> (cfu/100 mL)	Future TP Treatment Objectives		Required Level of Treatment	Basis
					Concentration (mg/L)	Loading (kg/d)		
Waterloo	No Change from Existing	No Change from Existing	No Change from Existing	No Change from Existing	0.23	14.6	Tertiary filtration	2014 ACS and Lake Erie targets
Preston	No Change from Existing	No Change from Existing	No Change from Existing	No Change from Existing	0.40	6.7	Secondary treatment with chemical phosphorus removal	Lake Erie Target
Hespeler	10	10	2 (non- freezing) ⁽¹⁾ 5 (freezing) ⁽²⁾	No Change from Existing	0.40	4.2	Secondary treatment with chemical phosphorus removal	2014 ACS and Lake Erie targets
Wellesley	5	5	0.35	100	0.42	0.55	Tertiary filtration	Effluent TP Objective to maintain existing allowable loadings
St Jacobs	No Change from Existing	No Change from Existing	0.5 (non- freezing) ⁽¹⁾ 1.0 (freezing) ⁽²⁾	No Change from Existing	0.18	0.30	Tertiary filtration	Maintain existing Loadings

WWTP	Future CBOD ₅ Objective (mg/L)	Future TSS Objective (mg/L)	Future Ammonia-N Objective (mg/L)	<i>E. coli</i> (cfu/100 mL)	Future TP Treatment Objectives		Required Level of Treatment	Basis
					Concentration (mg/L)	Loading (kg/d)		
Elmira	No Change from Existing	No Change from Existing	No Change from Existing	100	0.15	1.56	Tertiary filtration	Maintain existing Loadings

Notes:

1. Non-freezing: May 1 to October 31.
2. Freezing: November 1 to September 30.

7. References

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Appendix A

Grand and Speed River Flow Data (1978-2016)