

Appendix J

TM9A - Phosphorus Offsetting: Review of Existing Ontario Programs and Opportunities



Region of Waterloo

Wastewater Treatment Master Plan Update

**TM-9A: Phosphorus Offsetting:
Review of Existing Ontario Programs and
Opportunities**

Final



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1. Introduction and Background

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, 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 to 40 years, as consistent with the Region's Strategic Plan.

Total phosphorus is the key water quality parameter for the Grand River watershed and the focus of Lake Erie remedial efforts (i.e., the proposed Canada-Ontario Action Plan for Lake Erie 2017, [Section 1.1]; IJC 2014). Although watershed management is outside of the scope of the WWTMP, the MP strategy will affect watershed management activities over the long term. Since the costs for controlling non-point source phosphorus loads may be seven to ten times less expensive than those for controlling point source pollution such as wastewater treatment plant (WWTP) effluent quality (Conservation Ontario 2003), the Region would like to understand the opportunities to control phosphorus loadings to the watershed through investments in non-point source controls. As such, under the WWTMP update project, Hutchinson Environmental Sciences Limited (HESL), was retained to complete a review of existing phosphorus offsetting programs in Ontario, identify watershed management opportunities that may be further explored within the Region, and recommend next steps for developing and implementing a phosphorus offsetting program.

The Region is responsible for 13 WWTPs, 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 WWTPs that discharge to a surface water body, either discharge 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 that concentrations consistently exceed the Provincial Water Quality Objective (PWQO; MOE 1994a) of 0.03 mg/L (GRCA 2011). The Ministry of Environment and Climate Change (MOECC) 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

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).

The following sections of this memorandum present background on water quality trading or phosphorus offsetting (Section 2), case studies/examples of offsetting programs (Sections 3 and 4), a summary of the Region of Waterloo’s Rural Water Quality Program (Section 5), applicability of a phosphorus offsetting program within the Region of Waterloo (Section 6), and recommended next steps in developing a phosphorus offsetting program (Sections 7 through 9).

1.1 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 that will outline strategies to meet the targets will be developed by 2018. 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 Basin – 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 have been 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. Some specific actions include:

- + Point sources (which contribute 10% to 15% of total load to Lake Erie) - Establish legal effluent discharge limit of 0.5 mg/L total phosphorus for all municipal WWTPs that have an average daily flow of 3.78 ML/d or more; and upgrade plants with >3.78 ML/d flows to tertiary treatment.
- + Urban non-point sources (which contribute 5% to 10% of total load to Lake Erie) – Promote and support the use of green infrastructure and low impact development (LID); enhanced requirements for mandatory pump-out and inspections of septic systems; and review of hauled sewage policy and program.
- + Agricultural sources (which contribute 75% of total load to Lake Erie) – Education within the agricultural sector to promote application of nutrients at the right time (i.e., less application during high runoff, non-growing season); implementation of the “4Rs” program (i.e., right time, rate, source and placement of nutrients); work with agricultural sector to enhance and promote environmentally sustainable best practices including the use of cover crops during the non-growing season to reduce soil loss and field runoff; develop an Agricultural Soil Health and Conservation Strategy; and develop a digital elevation model of the Lake Erie watershed to assist with environmental stewardship planning (Canada-Ontario Agreement Partners 2017).

2. Introduction to Phosphorus Offsetting

Phosphorus offsetting is a flexible watershed based program that ultimately improves and protects water quality. It allows for a limited increase in pollutant discharge to be “offset” by greater reductions elsewhere in the same watershed. The reduction is achieved through an offsetting ratio that is applied to the discharge. Phosphorus offsetting is often more economical than point-source control because more cost-effective controls can be constructed to achieve the required phosphorus reductions (LSRCA 2014).

Phosphorus offsetting can either occur as “one-offs” or as a formal Water Quality Trading (WQT) program. These are based on site-specific conditions for municipal and/or industrial WWTPs, and are determined on a case-by-case basis. They are generally seen as a measure of “last resort” after evaluation of potential point-source solutions. Water quality offsets can be explored as part of sewage treatment plant design or as part of the Class EA planning process (Tovilla, 2015).

Since the passing of the Lake Simcoe Protection Act in 2008, Section 75 of the Ontario Water Resources Act (OWRA) was amended to allow for WQT regulations to be made in Ontario (Water Resources Act, Section 75). This includes prescribing areas, parameters, and persons to which the regulation applies, the requirements for monitoring and reporting, designating an administrative body, and determining the creation, trading and retirement of credits or offsets. It is important to note that the provision is not yet proclaimed, and may be automatically repealed in 2018 if the proclamation is not issued (Legislation Act, 2006 Section 10.1 (2)).

3. Phosphorus Offsetting Programs in Ontario

South Nation Conservation (SNC) has pioneered phosphorus offset trading for credits in Ontario and developed a Total Phosphorus Management (TPM) program using economic instruments to improve water quality. Phosphorus offsetting programs are also in place in the Nottawasaga watershed and are being developed for Lake Simcoe Region and Halton Region. A phosphorus offsetting program is not currently active in the Grand River watershed, and as such, a program would need to be established. Details of the phosphorus offsetting programs for SNC Authority, Nottawasaga, Lake Simcoe Region and Halton Region are provided in the following subsections.

3.1 South Nation River Watershed

South Nation River Watershed was the first region in Canada to establish a formal phosphorus trading program to protect and improve water quality. In 1999, the provincial MOECC created a TPM program for the watershed to address levels of phosphorus in the South Nation River and its tributaries, which were two to four times above PWQOs (Conservation Ontario undated). The TPM program prohibits all new WWTPs, as well as existing WWTPs undergoing expansion, from increasing phosphorus loadings to receiving waters in the watershed. To achieve a zero-net increase in phosphorus loadings, WWTPs must either treat and remove phosphorus at the source or offset any increased phosphorus load in their discharges through controls at non-point source locations elsewhere in the watershed (Conservation Ontario undated).

The TPM program is administered by SNC, which acts as a broker for phosphorus credits by finding projects in the watershed for WWTPs to fund. SNC hires local farmers as field representatives who conduct site visits to view potential projects for funding and present their findings to a multi-stakeholder committee (the Clean Water Committee), which chooses the projects to fund. The committee is comprised of farmers and members of farmer organizations, industry, municipalities and SNC. Grants fund 50% of project capital costs. Grant funding sources include municipal levies, industry donations, TPM project funding, and provincial and federal funding (Conservation Ontario, 2003). As part of the program, SNC is required to conduct ongoing monitoring to document and evaluate phosphorus loading reductions. SNC monitors the water quality of the South Nation River and prepares an annual report

summarizing the amount of phosphorus controlled and the allocation to WWTP dischargers.

A variety of best management practices (BMPs) offering long-term phosphorus reduction benefits are recognized under the program as eligible for phosphorus credits. The following categories summarize BMPs included in the program:

- + Manure storage (Storing manure in properly constructed facilities [concrete or steel structures, tanks or buildings] during periods when land application is not suitable);
- + Milkhouse washwater (Various methods of treatment of milkhouse washwater);
- + Clean water diversion (Diversion of clean water [from roofs, treated wastewater, upland drainage, etc.] away from manure, thus reducing phosphorus loading through runoff);
- + Livestock access (Restricting livestock access to a watercourse, thereby reducing manure deposited directly into the watercourse);
- + Buffer strips (Areas of planted or naturally occurring vegetation that filter nutrients and sediments from agricultural runoff before reaching surface waters);
- + Nutrient management (Using crop nutrients [i.e., fertilizers, manure, biosolids, legumes or irrigation water] as efficiently as possible by, for example, following a yearly plan and conducting soil tests to determine the nutrient needs of crops);
- + Fragile land retirement (Fragile agricultural lands are tilled or pastured lands that are prone to water, tillage or wind erosion, such as steeply sloped lands, flood plains, lands prone to standing water); and
- + Septic systems (Improvement or upgrade of septic system).

SNC-calculated algorithms determine the amount of phosphorus reduction provided by each BMP based on a literature review covering provincial, national and international studies. The initial formulas were primarily derived from calculations used by the Grand River Conservation Authority's (GRCA) Rural Water Quality Program. These algorithms were subsequently updated in 2003 by a University of Ottawa study (South Nation Conservation Clean Water Committee 2003). The updated values are summarized in Table 2.

Calculating the amount of phosphorus diverted from watercourses from BMPs is complicated due to high variability among individual practices and the influence of a wide variety of factors. In recognition of this complexity and uncertainty, MOECC (Eastern Region) requires an offsetting ratio of 4:1 or greater (i.e., for every 1 kg increase of phosphorus produced by a WWTP above the existing load, 4 kg must be removed from the watershed).

Community support for the South Nation River Watershed phosphorus offsetting program was not immediate. Rural landowners were often resistant to participate in the offsetting arrangement because they felt that industry was being given a green light to pollute, while farmers were doing all the work to solve the problem. Landowners worried that the public perception might be that the agricultural community was the root of the problem (O’Grady and Wilson undated). This barrier to community buy-in was eventually overcome through three years of extensive consultations with partners of the program spearheaded by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). These consultations led to a “Statement of Roles and Responsibilities” which clearly identified the nature of each group’s involvement in the program, and which absolved suppliers of phosphorus credits (e.g., the farmers) from any legal liability if phosphorus targets were not met by their projects. Instead, full responsibility for achieving required phosphorus reductions laid entirely with the WWTPs buying the credits. Community support for the program was further enhanced by the decision to hire local farmers as field representatives to monitor projects, rather than agency staff (Marcano 2015).

Table 2 Phosphorus Loading Algorithms used for South Nation River Watershed (SNC Clean Water Committee 2003).

Best Management Practice	Calculation of kg phosphorus controlled
Manure Storage	# animals x days x phosphorus excreted x 0.30 (beef cattle) # animals x days x P excreted x 0.07 (dairy cattle)
Milkhouse Washwater	# cows x 0.69 kg/cow/yr (excluding manure) # cows x 2.76 kg/cow/yr (including manure)
Clean Water Diversion	# animals x days x phosphorus excreted x 0.30 x (reduced feedlot runoff volume/ original feedlot runoff volume) (phosphorus leached = 0.30 for beef cattle manure and 0.07 for dairy cattle manure)
Livestock Access	# animals x days x phosphorus excreted x 0.03 (multiply by 0.5 if animals have half day access to watercourse)
Cropping Practices	0.5 kg x hectares (no-till) 0.4 kg x hectares (cover cropping)
Buffer Strips	0.67 kg x hectares buffered (for 6-10 m wide buffer)
Nutrient Management	25 kg x hectares x 0.1
Fragile Land Retirement	0.7 kg x hectares
Septic Systems	phosphorus loading of failed system – phosphorus loading of improved system where phosphorus loading = 0.6 kg total phosphorus x # persons x (1-A) and A = attenuation in vadose zone (the unsaturated zone between the land surface and the water table), where 0 = failed, 0.4 = functional-sand, and 0.7 = functional-sand mixed with either silt, clay or red mud)

The TPM program is now widely accepted by farmers in the South Nation River watershed. A recent survey of participants found high levels of satisfaction and SNC consistently receives more applications than there is funding available (Rafanan *et al.* 2013; Marcano 2015). WWTPs are also overwhelmingly supportive of the system. Although dischargers have the choice of either implementing traditional wastewater treatment methods on site or offsetting through phosphorus trading credits, all have elected to go with the latter (O’Grady and Wilson undated). As of 2015, 287 trades had been completed in the program and more than 12,144 kg of phosphorus are estimated to have been removed from the watershed (Marcano 2015). SNC estimates

that the average cost to remove 1 kg of phosphorus under the program is \$300, which includes staffing and administration, water sampling, grant promotion and annual reporting. A cost-benefit analysis for the watershed revealed that the cost of removing phosphorus via traditional wastewater treatment methods would cost approximately \$2000 per kg phosphorus removed. Applying the 4:1 ratio, the cost through the TPM program is \$1200/kg (O’Grady and Wilson, undated).

3.2 Nottawasaga Valley Conservation Authority

Nottawasaga Valley Conservation Authority (NVCA) initiated a small-scale phosphorus offsetting strategy in partnership with the Town of New Tecumseth in 2013. The program was developed as a condition of MOECC approving the Town of New Tecumseth’s plans to upgrade the Tottenham WWTP. Under the agreement, the expanded WWTP has a phosphorus discharge objective of 0.07 mg/L (equivalent to 104 kg/yr), providing that the net phosphorus loading to Beeton Creek is decreased by 39 kg/yr to a total of 65 kg/yr through offsetting projects (NVCA 2012). NVCA manages the program, which is funded through the Town of New Tecumseth’s development charges. NVCA prepares annual reports summarizing projects implemented under the program.

NVCA proposed two levels of projects eligible for funding under its work plan for the program. Tier 1 projects would cover manure and nutrient management systems, while Tier 2 projects would cover structural initiatives, such as livestock exclusion from watercourse with fencing, stream buffer strips, improved cropping practices, clean water diversions, stream bank stabilization, fragile land retirement and septic system upgrades (within 30 m of a watercourse). Tier 2 projects were subject to MOECC approval as offsets, and NVCA recommended that they only be used if Tier 1 projects were unsuccessful, or if Tier 2 projects were found to be more cost-effective (NVCA 2012).

NVCA and the Town of New Tecumseth used estimates of phosphorus load reductions for BMPs based on SNC algorithms. They calculated that approximately 70-135 kg/yr of phosphorus loading to the Beeton Creek watershed could be reduced through agricultural BMPs, such as manure storage facilities, milkhouse wastewater treatment and livestock fencing around local creeks. Additionally, they calculated that upgrades to the urban stormwater management system could remove a further 30 kg/yr from Beeton Creek (Rafanan et al. 2013).

A 4:1 offsetting ratio was chosen for the program to account for variability among BMPs in their ability to reduce phosphorus loading, and because this ratio has been used for more than a decade in the South Nation River watershed. NVCA estimated that the program would cost approximately \$950,000 to run over a three year period (2013-2015), which included \$210,000 for program delivery (including monitoring, reporting and staffing) and \$740,000 for program costs (e.g., material and equipment) during this period (NVCA 2012). In comparison, NVCA estimated that it would have cost the Town of New Tecumseth \$10 million to undertake the necessary wastewater treatment upgrades to remove the required amount of phosphorus loadings from the Tottenham WWTP discharge (Marcano 2015).

3.3 Halton Region

A Class Environmental Assessment (EA) for the Acton WWTP expansion was completed in 2011 by the Regional Municipality of Halton (Halton Region). The Acton WWTP discharges to Black Creek, a Policy 2 receiver for total phosphorus. Based on Black Creek's Policy 2 status for TP, the MOECC has required that the current loads (not loads permitted in the ECA) be maintained. Halton Region, therefore, developed a strategy to offset the additional loadings (approximately 150 kg/yr) from the new WWTP. A total phosphorus offsetting strategy was proposed by Halton Region, and approved in principle by MOECC, to offset additional loads from the plant upgrades (Magda Bielawski, Halton Region, pers. comm).

The total phosphorus strategy identified measures to offset the increased phosphorus loadings from the expansion of the WWTP. The strategy reviewed the feasibility of several different urban stormwater management measures (e.g. wet ponds, wetlands, permeable pavement, Oil Grit Separators [OGS] and Jellyfish filters) to reduce total phosphorus loadings throughout the urban area of Acton and recommended a combination (OGS and Jellyfish filters) be installed. MOECC approved the Total Offset Strategy, but require Halton Region to undertake a verification monitoring program of an OGS and a Jellyfish filter to confirm the total phosphorus removal efficiency used in the strategy. Halton Region is also working with the Town of Acton to identify potential candidate sites for implementation (Magda Bielawski, pers. comm).

3.4 Lake Simcoe Region Conservation Authority

In December 2008, the Lake Simcoe Protection Act, 2008 was passed in Ontario. The purpose of the Act is to protect and restore the ecological health of the Lake Simcoe watershed. The Act required the Government of Ontario to establish a protection plan for the Lake and surrounding areas. The Lake Simcoe Protection Plan came into effect in 2009. The plan outlines actions to protect and restore the ecological health of the Lake Simcoe Watershed (XCG 2010). The Lake Simcoe Protection Plan calls for total phosphorus inputs to Lake Simcoe to be lowered to ~ 44 tonnes/yr, approximately 40% less than the current average loadings at the time. The Plan committed the MOECC working with Lake Simcoe Region Conservation Authority (LSRCA), local stakeholders, municipalities and other partners to develop a comprehensive Phosphorus Reduction Strategy (PRS) as a long-term framework to meet the target (MOE 2010).

With funding from MOECC's Showcasing Water Innovation program, LSRCA developed a Lake Simcoe Phosphorus Offset Program (LSPOP) to reduce phosphorus loadings to Lake Simcoe. Phase 1 of LSPOP is proposed to start in 2017, and LSRCA is seeking provincial requirements that need to be met to administer the program (e.g., credit definition and verification, trade facilitation and documentation, compliance, water quality monitoring and reporting). Phase 1 of LSPOP (4 year program) is limited to stormwater retrofits in existing areas. Retrofits will include conventional stormwater controls and low impact development practices (LSRCA 2014). For new developments that cannot meet the "zero runoff" requirement, the developer may purchase an offset at a multiplier of 2.5:1 from an existing development within the watershed. The offset would be in the form of a retrofit to an existing stormwater management works (LSRCA 2014). The program focus is on stormwater management infrastructure (with like-to-like trading), as it is well-defined, easily quantifiable and verifiable, with benefits beyond phosphorus reduction. The full details of the program are still under development.

4. Phosphorus Reduction from Non-Point Sources Outside Canada

4.1 Chesapeake Bay

Chesapeake Bay is the largest estuary in the United States; its watershed includes parts of the states of Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia. Nitrogen and phosphorus loadings to Chesapeake Bay from point and non-point sources have resulted in diminished water quality, including hypoxia and algal blooms (U.S. Environmental Protection Agency [EPA], 2010a). From an Executive Order issued in May 2009, the U.S. EPA published *Guidance for Federal Land Management in the Chesapeake Bay Watershed* in May 2010. This guidance document focuses on non-point source pollution and includes BMPs to address nutrient sources originating from agriculture, urban and suburban sources, forestry, decentralized wastewater treatment systems, and hydromodification. The document also addresses measures to restore wetlands and riparian areas (U.S. EPA, 2010b). As part of the restoration, the U.S. EPA and Chesapeake Bay state jurisdictions set pollution reduction targets for over 700 federal facilities throughout the watershed. As of 2015, \$513 million has been spent on the Chesapeake Bay restoration (Federal Leadership Committee for the Chesapeake Bay 2016).

4.2 Mississippi River Basin

The Mississippi River Basin drains 41% (by area) of the U.S., including all or part of 31 states. Similar to Chesapeake Bay, excess loads of nitrogen and phosphorus in the Mississippi River Basin have resulted in diminished water quality in the Gulf of Mexico. In 2009, the U.S. Department of Agriculture launched a large scale initiative to implement conservation practices in the river basin called the Mississippi River Basin Initiative (MRBI), with \$320 million in funding over 5 years (U.S. Department of Agriculture 2016). The focus of the initiative is to implement voluntary conservation projects within targeted watersheds. One unique aspect of this program has been the provision of financial incentives to farmers to conduct edge of field monitoring to quantify the effectiveness of conservation practices to reduce nutrient runoff (Sharpley 2016).

4.3 Europe

There is no general European phosphorus legislation or directive toward non-point source control; however, phosphorus controls and other agricultural (non-point) nutrient sources are discussed in the Water Framework Directive (2000/60/IEC), and as part of this, the Nitrates Directive (91/676/EEC) (Amery 2014). Some European Union (EU) Member States address agricultural phosphorus losses via national or regional legislation, which restricts the application of phosphorus on crops. Details of the restrictions vary between Member States, and may include maximum application standards, crop type standards, and acceptable types of fertilizer (Amery 2014).

5. Grand River Rural Water Quality Program

The GRCA does not have an existing phosphorus offsetting/trading policy or program; however, since 1998 it administers the Rural Water Quality Program (RWQP) on behalf of participating watershed municipalities to work with farmers to implement BMPs to improve water quality and mitigate phosphorus loadings. The program is considered to be very successful: since its inception, over 5,000 projects have been implemented throughout the Grand River watershed, with an estimation of 98% of enrolled farmers continuing in the program. The overall success of the program has been attributed to the relationships built with the farming community (GRCA, Pers. Communication).

The program provides technical and financial assistance to off-set the costs of implementing BMPs; however, the eligible projects, guidelines, grant rates and funding models vary among municipalities. These program components, including program budget, are set by each municipality; therefore there are some areas within the watershed, including the headwaters of the Nith River, where farmers do not have access to RWQP grants. However, farmers may access funding from federal-provincial cost-share programs (e.g., Canada-Ontario Farm Stewardship Plan), which can also be combined with the RWQP grants.

Local steering and review committees review and approve funding applications in accordance with their municipality's Council-approved program guidelines and grant rates. There is a need to develop a watershed-wide RWQP that provides technical and financial assistance to priority farms in all municipalities in the watershed (GRCA 2013a).

The program specifics vary depending on the municipality, but generally it provides incentives for capital projects such as fencing, buffer strips, and windbreaks, and incentives for practices such as cover cropping, crop rotation, and strip cropping that require more than a one-time investment. Again, funding eligibility varies across municipalities; however, with few exceptions, funds are generally only available for farmers, leaving non-farm rural property owners not eligible for support through existing programs. It has been identified that funding for non-farm rural landowners would provide water quality benefits as well.

The GRCA uses phosphorus-loading algorithms to calculate the amount of phosphorus kept out of a watercourse by various BMPs. The algorithms are based

on research throughout Ontario and have been accepted as reasonable estimates of the phosphorus reduction from individual projects (from GRCA 1999). Table 3 provides a summary of phosphorus loading algorithms used by the GRCA for their RWQP for different BMPs to reduce phosphorus loading.

Table 3 Phosphorus Loading Algorithms (from GRCA 1999)

Best Management Practice	Calculation of kg phosphorus controlled per year
Manure storage (calculated by livestock commodity group)	Animal phosphorus factor*total head of livestock* days of manure production*0.04
Clean Water Diversion	# animals x animal phosphorus factor x days x 0.02
Milkhouse waste	Number of milking cows*1.26 kg P/cow/year
Stream fencing (calculated by livestock commodity group)	Head of livestock*animal P factor*days on pasture*0.03
Nutrient management planning	Hectares*25 kg P/ha*.1
Conservation tillage (Cropping practice)	Hectares*0.75 kg P/ha
Cover crops	Hectares*0.4 kg P/ha
Riparian buffer strips	Hectares*0.7 kg P/ha
Fragile land retirement	Hectares*0.7 kg P/ha

In addition to the BMPs identified in Table 3, other techniques in the RWQP BMP toolkit include (GRCA 2013):

- + Streambank stabilization structures (Such as bioengineering techniques, ditchbank seeding, spillway drop structures, or culvert or tile outlet protection);
- + Machinery crossings (A structure built to allow machinery to safely cross a watercourse without causing damage to the streambed or bank);
- + Windbreaks (Rows of trees planted on field borders to reduce wind speeds, protect crops and reduce the risk of soil erosion by wind);
- + Water and sediment control basins (An earthen berm that intercepts and ponds runoff, then releases it slowly into a subsurface drainpipe in less than 24 hours);

- + Drop structures (A structure to control erosion in an area of concentrated flow by directing water from a higher level to a lower level (e.g., rock chute spillways, drop pipe inlets);
- + Strip cropping (System of crop strips across a slope to control soil erosion, typically alternate strips of forage crops and cereal/row crops);
- + Terraces (Earthen berms that intercept runoff and divert it to a subsurface drainage system); and
- + Tile outlet stabilization (The use of erosion resistant material [i.e., rock riprap on top of a filter cloth] to protect the stream or ditchbank area from erosion where water exits a tile drain.

Currently, there is no funding for monitoring of BMP performance, once implemented; however, the Region of Waterloo conducted a Nith River Watershed Review in 2009 to assess the status of funded projects. The GRCA has identified that on-going monitoring programs should be in place to measure the effectiveness of the BMPs at the subwatershed scale, to understand and quantify the relationship between BMP and water quality.

There has been discussion regarding implementing a phosphorus offsetting program within the GRCA. In February 2016, GRCA convened a meeting with the MOECC, Region of Waterloo, OMAFRA, Agriculture and Agri-Food Canada (AAFC) and Greenland Consulting to identify actions over the next five to ten years for managing non-point sources of nutrients in priority subwatersheds. It was identified that although most of the WWTPs in the watershed will have advanced phosphorus and nitrogen treatment within the next 10 years, there will still be a need to decrease nutrient concentrations in receivers to meet phosphorus targets for Lake Erie (GRCA 2016, Canada-Ontario Agreement Partners 2017). Some of the identified challenges to implementing a program include: the lack of provincial framework; the need for a long-term commitment to characterize baseline conditions, determine reduction target, and detect load reductions; and the lack of economic analysis to determine the cost/benefit of BMP implementation (GRCA 2016).

6. Applicability of a Phosphorus Offsetting Program within the Region of Waterloo

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 2012-2016]) and Lake Erie; and impairment of water uses by high nitrate concentrations (GRCA 2014c). The causes of these issues have been identified as excess inputs of suspended sediment and nutrients (GRCA 2013b). 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 2013b). 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 2013b). Impacts to Lake Erie are largely influenced by total seasonal loads; in the spring, phosphorus loading to Lake Erie is estimated to be 300 kg/d, while in the summer it is typically less than 100 kg/day (Stantec, 2014).

Potential areas to focus phosphorus offsetting efforts:

+ The Nith, Conestogo and Canagagigue Subwatersheds

Through the work that the GRCA has completed, the Nith, Conestogo and Canagagigue subwatersheds were identified as good candidate watersheds where phosphorus offsetting can be implemented since they are key sources of phosphorus due to runoff of nutrients in the spring from livestock manure and fertilizer application (GRCA 2013b). Further, total phosphorus concentrations in the WWTP effluent on these subwatersheds (e.g., at the St. Jacobs, New Hamburg, Elmira and Ayr WWTPs) are low and current treatment technology limits a substantial reduction in these effluent total phosphorus concentrations at this point in time (St. Jacobs ECA 1047-94FHWA dated March 22, 2013; New Hamburg ECA 9330-6G9K5B dated November 22, 2015; Elmira ECA 6698-8QGJ8E dated January 27, 2012; and Ayr ECA 4800-6GMFXG dated October 20, 2005). As such, phosphorus offsetting for WWTPs in these watersheds could

focus on implementing agricultural and rural non-farm BMPs to reduce phosphorus loads in spring runoff.

- + Areas of substantial soil loss/erosion, as identified by GIS, digital elevation and soil erosion modelling

With funding from the MOECC's Showcasing Water Innovation Program, the GRCA has been using GIS tools to identify nutrient and sediment sources in the watershed. This approach uses high resolution digital elevation model (DEM), advanced GIS techniques, and soil erosion models to identify source areas at the local farm/field scale (GRCA 2014a). Firella Creek, a small subwatershed within the Nith basin, was identified to pilot the use of GIS tools and soil erosion models to determine nutrient and sediment source areas in the subwatershed (GRCA 2014b). Local farmers confirmed the accuracy of the mapping, and requested assistance in designing BMPs to mitigate soil loss. It is envisioned that maps created through this technique can be used to identify and implement BMPs and water quality monitoring at priority areas throughout the watershed (GRCA 2014b).

- + Phosphorus offsets currently under the RWQP umbrella

The Region developed the first RWQP in 1998 and has been funding the GRCA to administer the program since that time; therefore phosphorus offsetting within the Region may include rural non-farm/agricultural BMPs that are already part of the existing RWQP. This may require some modifications to the RWQP guidelines, eligibility criteria and/or grant rates, all of which would be need to be approved by Regional Council.

- + Urban Stormwater Controls

Waterloo Region includes the Cities of Cambridge, Kitchener, and Waterloo, and the Townships of North Dumfries, Wellesley, Wilmot and Woolwich. The local municipalities own many stormwater facilities and provide opportunities for phosphorous offsetting through urban stormwater management. Phosphorus offsetting using stormwater controls (as per the LSRCA offsetting program and the Halton Region strategy) as a mechanism for mitigation from Region owned WWTPs would require acceptance and collaboration with the local municipalities, which may be challenging. Another challenge may be in the lack of data available

for estimating urban stormwater impacts (McElmurry, 2014); however, this phosphorus offsetting opportunity could be further evaluated, as it has the potential to provide phosphorus offsets at a lower offsetting ratio (e.g. 2:1 for stormwater vs 4:1 for rural/agriculture).

Correspondence with the GRCA noted that offsetting may not be a fit for every WWTP. Further, although loadings to Lake Erie may be considered on an annual basis, loadings to receivers in the Grand River watershed may need to consider seasonal trends that may affect water quality and aquatic habitat. For example, total phosphorus loadings in the Grand and Speed Rivers during the spring (2007 to 2011 data) are comprised of 60% upstream non-point (i.e., agricultural) sources and 5 to 10% from point-sources (i.e., WWTPs) (Stantec, 2014). At Glen Morris, spring loadings are substantially higher than summer loadings (316 kg/d in spring compared to 75 kg/d in summer) indicating that non-point source reductions in phosphorus would have the largest impact in reducing the overall annual load. However, improving phosphorus conditions in the watershed may also need to focus on reducing phosphorus concentrations under summer low flow conditions. In the summer months, it is estimated that the Kitchener WWTP, Waterloo WWTP, Preston WWTP, and Galt WWTP comprise approximately 70% of the total phosphorus load in the central portion of the Central Grand River watershed (GRCA 2013b). It can be noted that recent and on-going upgrades to the Kitchener and Waterloo WWTP have resulted in improved treatment efficiency and effluent quality (total ammonia nitrogen, biochemical oxygen demand and total suspended solids) (Hicks et al. 2016). Further reductions in phosphorus are anticipated after the commissioning of tertiary filtration at the Kitchener WWTP.

7. Implementing a Phosphorus Offsetting Program

From the phosphorus offsetting programs currently existing in Ontario (e.g., SNCA, NVCA, Halton Region, and LSRCA), the following program elements are recommended for consideration within the Region of Waterloo, whether developing a new program or enhancing an existing program:

- + Program is administered by the GRCA;
- + A committee (made up of representatives from the Region, GRCA, local area municipalities, OMAFRA, and local farmer organizations at a minimum) to evaluate potential projects;
- + Funding eligibility should consider the inclusion of projects within defined areas (which may extend upstream into other municipalities) that benefit the Region of Waterloo's WWTPs;
- + Consider both urban and rural offsetting projects when evaluating potential means to meet phosphorus loading reductions. Urban stormwater projects typically have a lower offsetting ratio (e.g. 2 or 2.5 to 1 compared to 4:1 for agricultural) and may be easier to implement and monitor than rural offsets;
- + Project evaluation based on a decision matrix with a heavily weighted economic component (for example, SNCA estimated that the average cost to remove 1 kg of phosphorus at a 4:1 ratio is \$1200 under the offsetting program in comparison to \$2000/kg using traditional wastewater treatment methods. NVCA estimated about \$1M to run the offsetting program in comparison to \$10M in WWTP upgrades that would have been needed);
- + Confirmation of an offsetting ratio with MOECC (typically a 4:1 ratio has been used for agricultural projects and 2 or 2.5:1 for urban stormwater projects);
- + Ongoing monitoring of the project by the Region, GRCA, local area municipalities, or a local field representative (e.g., farmers). The monitoring program should be developed by the Region, GRCA, and approved by MOECC. Funding for the monitoring and re-imburement/payment to farmers or other second parties can be obtained through the TPM program funding;
- + Retaining OMAFRA and GRCA for a role in engaging and educating the agricultural community. Reviewing the benefit of separating potential offsetting

projects into two tiers, with Tier 1 projects requiring fewer MOECC approvals and therefore being easier to implement.

Funding for these elements can be obtained from the TPM program funding which may include municipal levies, industry donations, TPM project funding, and provincial and federal funding.

The document *Watershed Economic Incentives Through Phosphorus Trading and Water Quality* (Conservation Ontario, 2003) provides a framework for implementing a phosphorus trading program in Ontario watersheds by using experiences of TPM programs in South Nation and Lake Simcoe watersheds. The approach provided in the document is for the use of conservation authorities, environmental consultants, wastewater managers, and provincial and municipal government staff when establishing water quality trading programs (Conservation Ontario 2003).

The steps to follow when implementing a TPM/offsetting program are provided in Figure 1. They have varying degrees of applicability depending on the type (point vs non-point source) of phosphorus trade, and are not in order of importance; however all are considered pre-requisites when implementing TPM.

GRCA has already completed the first step of documenting watershed conditions and phosphorus levels (e.g., GRCA 2011 and GRCA 2013b). It is now well understood that the Grand River is Policy 2 for total phosphorus in its central and lower reaches, in that concentrations are above the PWQO of 0.03 mg/L.

A next step would be for the West Central Region of MOECC to adopt a TPM/offsetting program. In 1998, the MOECC Eastern Region adopted phosphorus offsetting or credit trading instead of only considering enhanced treatment as a means to mitigate additional phosphorus loadings from WWTPs. The TPM program is regulated by the MOECC by granting an ECA for sewage works on condition that the TPM program is implemented. The ECA identifies that a Director's Deviation from Policy 2 requirements would be granted by MOECC provided that the TPM/offsetting program was implemented to achieve the necessary offset. MOECC would need to establish an offsetting ratio to be applied to projects. Typically ratios of 4:1 for agricultural offsets and 2 to 2.5:1 for urban stormwater offsets are used to account for the uncertainty in the BMPs efficiency.

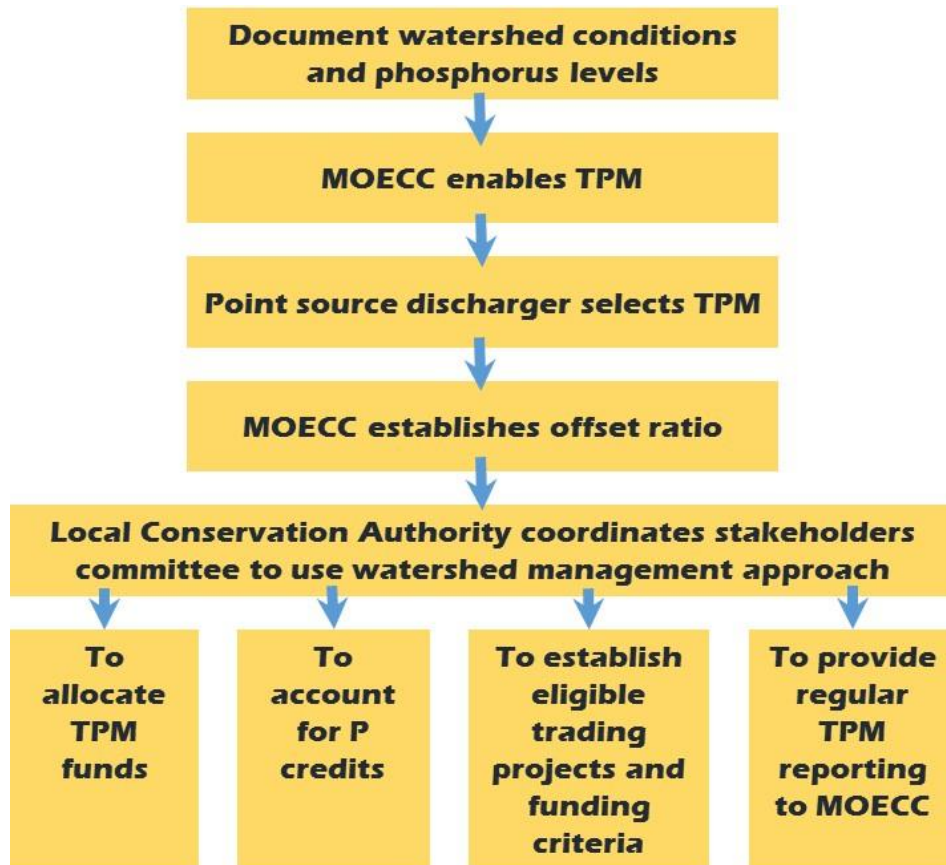


Figure 1 Generic Framework to Implement TPM (Conservation Ontario, 2003)

After the MOECC has formally approved a program, the next step is for a multi-stakeholder group to be developed. The stakeholder group would be developed and coordinated by the local conservation authority (in this case GRCA) and would likely comprise the MOECC, GRCA, OMAFRA, Region of Waterloo, local municipalities (e.g. Cambridge, Waterloo, Kitchener) and local farm organizations, at a minimum. The purpose of the multi-stakeholder group is to develop a set of guidelines which will govern the TPM/offsetting program for the watershed. In the South Nation watershed, two years of discussions were needed to develop a set of guidelines for their TPM program. Since GRCA does not have a TPM program in place, a similar period of time would be expected to develop the program and guidelines. Once the guidelines have been established, then the process of selecting offsetting opportunities (which have been already identified) may be initiated.

8. Potential Funding Source (Agricultural Phosphorus Sources): ALUS Canada

ALUS Canada (ALUS) is a not-for-profit organization that provides funding to farmers for agricultural stewardship projects. ALUS program is intended to complement existing conservation programs, including federal and provincial government policy frameworks (ALUS 2017).

ALUS was founded in 2005, and by the end of 2015, had completed or was in the process of completing 15,500 projects. Funding for ALUS projects comes from the W. Garfield Weston Foundation, federal government programs (e.g., National Conservation Plan), provincial government programs (e.g., Ontario Trillium Foundation), municipal governments, individual philanthropists, corporate social responsibility programs, interested partner organizations and agricultural and environmental groups (ALUS 2017).

ALUS is currently active in six provinces in Canada, including PEI, Quebec, Ontario, Manitoba, Saskatchewan, and Alberta. ALUS communities in Ontario include locations in Norfolk County, Grey Bruce, Lambton, Ontario East (Cornwall), and Elgin (ALUS 2017). There are currently two initiatives that have been completed in Norfolk County and the ALUS program has been very well received there by the community (Bob Fields, pers. comm.).

Each ALUS community is managed by a local ALUS Coordinator and a Partnership Advisory Committee (PAC), which determine how the local ALUS program will be run. The PAC is comprised of agricultural producers and local stakeholders (i.e., municipalities, conservation authorities, farm associations, government agencies). Approximately 50% of each local PAC membership are farmers. Further, the farmers (landowners) themselves are responsible for carrying out the environmental initiative/project. All programs are independently monitored, verified and audited, in a process decided on by the local ALUS Coordinator and PAC (ALUS 2017).

The program focuses on marginal and ecologically sensitive parcels of agricultural land that can be managed in a different manner to produce ecosystem services that benefit all Canadians. Some current and past project examples include:

- + Erosion control (windbreak planting, riparian buffers);
- + Flood mitigation through management of sustainable drainage systems;

- + Pollinator support through habitat creation;
- + Increasing wildlife habitat through habitat naturalization;
- + Wetland restoration; and
- + Reforestation (ALUS 2017).

Given the success of the ALUS program in Ontario, it is recommended that the Norfolk ALUS Coordinator be contacted to determine the suitability of the program to key identified agricultural properties within the Region of Waterloo.

9. Next Steps

For the master planning process, phosphorus offsetting represents one option that can be considered to reduce expansion costs associated with enhanced point-source treatment technologies. Phosphorus offsetting may not be appropriate for all plants, and potential candidates can be identified through consultation with the MOECC and GRCA.

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