An Interim Joint Action Plan for Lake Erie

An Interim Report[1] of the Great Lakes Commission Lake Erie Nutrient Targets Working Group[2]

A 2014 Great Lakes Commission Lake Erie water pollution resolution committed the Lake Erie states and the province of Ontario to form a working group to develop new and refine existing practices, programs and policies to achieve pollutant reduction targets and/or identify additional remedies to improve water quality in Lake Erie. This report is an interim product of the Lake Erie Nutrient Targets (LENT) Working Group that was formed as a result of that commitment.

It is envisioned that the draft Joint Action Plan will drive further consultation, discussions and actions that the states and the province can advance in the near term as longer term efforts are underway through the GLWQA Nutrients Annex (Annex 4) process, including release of final Lake Erie nutrient targets in 2016 and Domestic Action Plans in 2018.

PREAMBLE

Lake Erie is the eleventh largest lake on Earth by surface area.[3] Of the five Laurentian Great Lakes, Lake Erie is the southernmost, the smallest by volume, the shallowest, and also the warmest. It is the most biologically productive, supporting the largest Great Lakes sport fishery. Lake Erie has three distinct sub-basins: a very shallow western basin and related islands, a deeper central basin, and even deeper eastern basin that drains into the Niagara River and Lake Ontario. The lake provides drinking water to more than 11 million residents, and supports a $1.5 billion sport fishing industry. Lake Erie is a vital resource for the binational Great Lakes region.

---

[1] This interim report is being prepared to inform discussions at a June 2015 Summit of Great Lakes state governors and premiers. It is envisioned that the Joint Action Plan will be refined during summer 2015 and finalized in fall 2015.

[2] A 2014 Great Lakes Commission Lake Erie Water Pollution resolution committed the Lake Erie states and the province of Ontario to form a working group to develop new and refine existing practices, programs and policies to achieve pollutant reduction targets and/or identify additional remedies to improve water quality in Lake Erie. This report is an interim product of the Lake Erie Nutrient Targets Working Group that was formed as a result.

[3] Great Lakes Atlas, 1995, Environment Canada and U.S. Environmental Protection Agency.

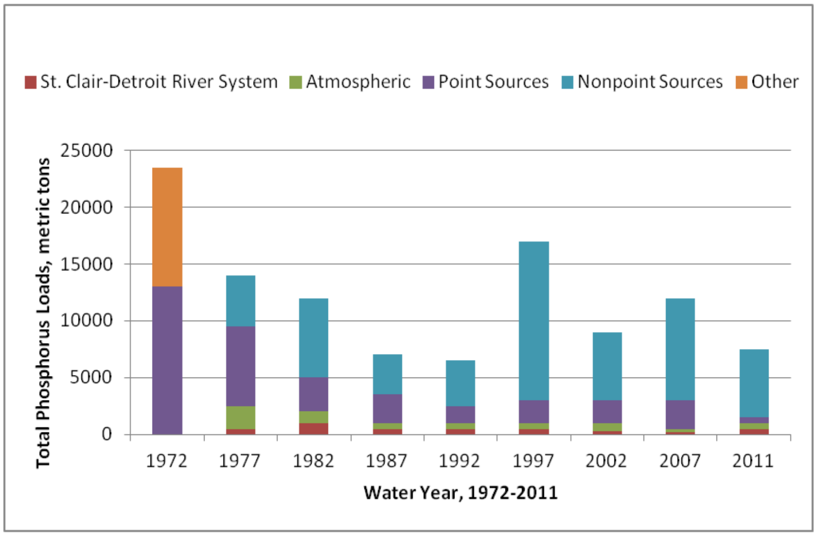

Figure 1: Annual loading of Total Phosphorus to Lake Erie by major sources. Excerpted and modified from Ohio Lake Erie Task Force II Final Report; original data provided by Dr. David Dolan, University of Wisconsin, Green Bay. May 2013.

Eutrophication is a serious global problem that has re-emerged resulting in harmful algal blooms[4] in the western basin of Lake Erie, offshore anoxic also known as dead zones in the central basin, and nuisance levels of *Cladophora* in the eastern basin. All of these problems are linked to excessive loading of nutrients, particularly phosphorus. The primary sources of phosphorus to Lake Erie are urban point and nonpoint sources, and agricultural nonpoint sources. Urban area loadings are associated with municipal and industrial facility point source discharges, combined sewer overflows (CSOs) as well as stormwater runoff containing nutrients from the land including residential fertilizers. Agricultural nonpoint source pollution occurs primarily in the form of farm and field runoff, which results mainly from fertilizer and manure applications.

As shown in Figure 1, point source contributions have dramatically declined over the past several decades while the relative contribution of nonpoint sources to overall loading has increased. The impacts of excessive nutrients are affected by multiple factors, such as climate change, temperature, weather, hydrology and aquatic invasive species. Following extensive phosphorus reduction efforts initiated in the 1970s, algal blooms in Lake Erie were largely absent. However, blue-green algae (cyanobacteria) blooms began to reappear in the western basin of Lake Erie in the mid-1990s.

Monitoring data indicate that since the mid-1990s, total phosphorus has been declining while dissolved reactive phosphorus, or DRP, has been increasing. DRP is the fraction of dissolved phosphorus that is easily absorbed and available to plants and is now widely accepted as the primary nutrient of concern in Lake Erie.[5]

---

[4] Harmful algal blooms are overgrowths of algae or cyanobacteria that can occur in both freshwater and marine systems. Some species can produce dangerous toxins.

[5] *Ohio Lake Erie Phosphorus Task Force II Final Report,* November 2013
http://www.epa.ohio.gov/portals/35/lakeerie/ptaskforce2/Task_Force_Report_October_2013.pdf
International Joint Commission. *A Balanced Diet for Lake Erie: Reducing Phosphorus Loadings and Harmful Algal Blooms* – A Report of the Lake Erie Ecosystem Priority, February 2014
http://www.ijc.org/files/publications/2014%20IJC%20LEEP%20REPORT.pdf
Great Lakes Commission. *A Summary of State and Provincial Programs in the Great Lakes – St. Lawrence River Region.* September 2012. http://glc.org/files/main/news/FINAL-NutrientManagement-Sept2012.pdf
"Detroit River – Western Lake Erie Basin Indicator Project." *EPA.* 2009
http://www.epa.gov/med/grosseile_site/indicators/maumee-p.html

This document aims to address current nutrient loading challenges associated with Total Phosphorus as well as DRP. This interim report is an important milestone toward the development of a Joint Action Plan, which will offer a common roadmap for the Lake Erie states and the province of Ontario to guide shared activities to help solve the nutrient-related problems in Lake Erie. A final Joint Action plan will be published in fall 2015.

Goal for Lake Erie

The citizens of the Lake Erie basin and the governments that represent them share a collective goal of a healthy Lake Erie system that supports biological, social, economic and cultural values of the region and is free from excess nutrients that create harmful algal blooms, toxic water and hypoxia. To achieve this goal, a Lake Erie Nutrient Targets Working Group was formed with representatives from the four states bordering Lake Erie and the province of Ontario to identify a suite of potential joint actions that can be further considered by these jurisdictions.

Figure 2: Lake Erie showing western and central basins.

The LENT Working Group has identified a proposed target of reducing phosphorus loads into western and central Lake Erie by 40 percent (from 2008 levels) by 2025 to achieve this goal. The 40 percent reduction is consistent with the proposed phosphorus reductions identified by the Great Lakes Water Quality Agreement (GLWQA) Nutrients Annex Subcommittee.[6] An interim proposed phosphorus reduction target of 20 percent by 2020 is intended to focus and support early actions by jurisdictions as they work toward the longer term reductions target. The target percent reduction will help reduce cyanobacteria (blue-green) blooms and hopefully the occurrences of harmful toxins produced by cyanobacteria. These proposed reduction targets are intended to set forth a broad framework for actions and discussions by the four Lake Erie states (Michigan, Ohio, Pennsylvania and New York) and the province of Ontario. The 40 percent reduction target was recommended by the Ohio Task Force in 2012[7], the International Joint Commission (IJC) in 2013[8] and the GLWQA. This target does not mean that every source will need to reduce phosphorous by 40 percent; rather it represents an overall reduction target for Lake Erie.

The proposed targets and timelines in this Joint Action Plan are aspirational and are intended to drive action in the near term as longer term efforts are underway through the GLWQA Nutrients Annex (Annex 4) process, including release of final Lake Erie nutrient targets in 2016 and Domestic

---

[6] The Annex 4 Subcommittee presented the recommended phosphorus load reduction target for Lake Erie on May 29, 2015, to the Great Lakes Executive Committee.
[7] *Id.* Ohio Lake Erie Phosphorus Task Force
[8] International Joint Commission, *supra* note 5

Action Plans in 2018. The proposed actions will be developed by working with stakeholders in the Lake Erie basin, leading to significant progress in achieving phosphorus load reduction targets and the goal of a healthy Lake Erie free from problems associated with excessive nutrients. The targets and timelines herein will be pursued using an adaptive management approach whereby they may be revised based on regular monitoring, new information, discussions and knowledge of the system (see Joint Acton number VIII). Importantly, they may be modified and revised to align with the recommendations coming out of the Annex 4 process. Ontario actions would also be aligned with the commitments and actions under the Canada-Ontario Agreement on the Great Lakes Water Quality and Ecosystem Health 2014 (COA).

Joint Actions

To accomplish this goal and proposed associated targets, the following joint actions will be considered collectively by the four states bordering Lake Erie and the province of Ontario. Though not an exhaustive list of all possible actions to address phosphorus, the following recommendations provide a framework for collective action toward solving the nutrient-related problems facing Lake Erie. The actions listed below are known or have shown promise to reduce nutrient loads into receiving waters and contribute to improved water quality. Toward this end, they reflect a shared commitment to solve the problems associated with high nutrient loads in Lake Erie. The Lake Erie states and the province of Ontario would consider these actions to formulate individual total phosphorus loading reduction plans (or other policy or programmatic efforts) to achieve strategic nutrient reductions based on each jurisdiction's needs, authorities, capacities and constraints. If implemented, these actions will make significant progress to achieve phosphorus load reduction targets and the goal of a healthy Lake Erie free from problems associated with excessive nutrients. These actions may be refined and adapted as new information arises about nutrients or the efficacy of various practices and their effects on nutrient-related problems.

I. Manage nutrient applications on frozen or snow covered ground

Description

The action calls for the management of manure, fertilizer and biosolid applications under the following conditions: on frozen or snow-covered ground, on saturated soil, or when the weather forecast calls for a severe rain event.

Rationale

Spreading nutrients, especially liquid manure, on frozen or snow-covered ground can significantly increase the risk of runoff. Frozen soils have virtually no infiltration capability so nutrients are not able to permeate the soil, and there are no growing crops to absorb the nutrients. If applied under any of the above conditions, fertilizer, manure and biosolids can be washed away by spring snow melt and other heavy precipitation events. Not only does this contribute to excessive loadings into nearby receiving waters, it also wastes the nutrients and does not benefit field health.

Benefits and Challenges

Managing or eliminating nutrient applications on frozen ground will reduce or eliminate unabsorbed excess nutrients from running off of fields and polluting nearby waterways. It also has the potential to save producers money by not paying for fertilizer for which there is no real farming benefit. Where necessary, adhering to nutrient management plans, manure application risk assessments and certain application standards will help minimize the risk of nutrient runoff before and during the growing season.

One challenge to this action may be for livestock farms producing more nutrients than may be agronomically required for their fields or for those farms where manure storage capacity is inadequate for the operation. Options for this group would be to install larger storage facilities, which may also involve moving to a liquid manure storage system. The spreading of liquid manure may pose a greater risk for nutrient runoff via field tile during the growing season. Producers need to empty their manure storage facilities in the fall to ensure storage capacity for the coming winter months. However, depending on the timing of harvest and the onset of winter weather, this may not be possible without some spreading on frozen ground or transporting the excess manure offsite, which can be very costly.

Timing and Anticipated Ecosystem Improvements

A phased approach to improving management of nutrients on frozen or snow covered ground is advised. Phasing in this action item will enable the agricultural sector to improve best management practices and adhere to nutrient management requirements prescribed in each jurisdiction. Any new approaches will be developed in consultation with the agricultural sector.

II. Adopt "4Rs Nutrient Stewardship Certification program" or other comprehensive nutrient management programs

Description

The 4Rs Nutrient Stewardship Certification program is a voluntary agricultural retailer certification program focused on nutrient stewardship. The program offers a special designation to retailers and crop advisors who assist producers with the implementation of best management practices (BMPs) that optimize the efficiency of fertilizer use, including:

Right fertilizer: Select fertilizer product based on the nutrients required for optimal plant growth, soil conditions and delivery mechanisms.

Right rate: Determine the correct application rate at which fertilizers should be applied.

Right time: Time the application of fertilizer to optimize fertilizer application rates and plant uptake. Applying fertilizer at times when the plant needs it most can minimize the amount of nutrients lost to runoff or leaching.

Right place: Proper placement of nutrients maximizes plant uptake and can reduce erosive losses.

Rationale

The objective of the 4Rs program is to match nutrient supply with crop requirements and to minimize nutrient losses from fields. These practices support efficient and effective crop production that is more environmentally sound and can improve soil health while controlling costs. This approach allows crop consultants and producers to adapt proper nutrient management to a particular operation or type of cropping system, and supports improved soil health and water quality. Although technology gives producers better control of nutrient delivery, use of any of the 4R's BMPs may not require extensive investments.

Benefits and Challenges
The 4R concept offers enhanced environmental protection and sustainability, as well as increased production and profitability. With better soil and crop management comes higher yields. Coupled with optimized nutrient management, producers are in a position to maximize profits.

To ensure that voluntary approaches are having the desired effect on reducing phosphorus to the Lake Erie basin, 4Rs or other nutrient management and stewardship programs (public and private) should implement appropriate metrics to measure progress and assess effectiveness,. For example, progress can be tracked by measuring phosphorus losses before and after BMP implementation. Edge-of-field monitoring, however, is costly and will likely need to be coupled with other data and/or modeling to assess performance. Soil testing is not required by the program but can help in determining the best fertilizer for a farm.

One challenge to implementing this type of program is targeting education and outreach to agribusinesses in the basin. The Tri-State Western Lake Erie Basin Phosphorus Reduction Initiative project, funded by the U.S. Department of Agriculture's Regional Conservation Partnership Program (Western Lake Erie RCPP), will be promoting the 4R Nutrient Stewardship program in Ohio, Michigan and Indiana between 2015 and 2019. The Western Lake Erie RCPP represents a promising opportunity for overcoming this challenge. Crop consultants and agronomists will play a key role in educating producers about proper nutrient treatment and the application of the 4Rs.

Timing and Anticipated Ecosystem Improvements
The Western Lake Erie RCPP is a five-year program that will begin in 2015 with a focus on cropland and incidental land, which collectively make up 76 percent of agricultural land in the western Lake Erie basin.

III. Reduce total phosphorus from seven key[9] municipal discharges in the western and central Lake Erie basins by phasing in growing season (April-September) average effluent limits of 0.6 milligrams total phosphorus per liter by 2020; conduct optimization and upgrade studies to evaluate costs and compliance options for reducing point source discharge of nutrients

Description
The 0.6 milligram (mg) phosphorus per liter (l) limit by the seven facilities should be in place by 2020, or during the next permit renewal, whichever comes sooner. Optimization and upgrade studies provide facilities with information on the anticipated costs to achieve total phosphorus effluent limits that enable them to evaluate cost-effectiveness of compliance options (e.g., optimizing existing operations, investing in facility upgrades or pursuing alternative compliance options). Optimization and upgrade studies are a priority for the seven key municipal dischargers identified here, but this should not preclude individual jurisdictions or facilities from conducting additional studies to help determine costs and compliance options. In addition, this action should be pursued with ongoing

[9] Key WWTFs to the western and central basins include: the City of Detroit Water and Sewerage Department (MI); the Wayne County-Downriver WWTF (MI); Ypsilanti Community Utility Authority (MI); City of Toledo WWTF (OH); and three WWTFs in the Northeast Ohio Regional Sanitary District (Easterly WWTF, Southerly WWTF, and Westerly WWTF).

implementation of long-term correction programs for CSOs and possible acceleration of long-term CSO control plan implementation schedules for combined collection systems that discharge to Lake Erie or its tributaries.

Rationale

The Nutrients Annex (Annex 4) Subcommittee, convened pursuant to the GLWQA, has determined that these seven key U.S. Wastewater Treatment Facilities (WWTFs) plus the city of Fort Wayne, Ind., deliver a significant portion of the point source total phosphorus load to the western and central basins. Although all point and nonpoint dischargers play a role to improve water quality in Lake Erie, short-term point source reduction efforts at these key WWTFs is a strategic approach that will result in significant load reductions with promising water quality benefits. Optimization at the WWTFs, for example, involves fine-tuning plant operations to minimize total phosphorus in the treated effluent and generally requires only minimal capital expenditures. Upgrades generally require facility expansions or other larger capital investments. Operational changes through optimization can be implemented in a shorter timeframe. However, in some cases, facilities may not be able to meet effluent limits through optimization alone. Studies that assess costs of achieving a reduction target or discharge limit optimization, upgrades and alternative options provide facilities with information to make cost-effective decisions (e.g., compare costs among optimization techniques, capital improvements and upgrades, or offsite conservation investments) and thereby support an adaptive management approach. Short-term investments may focus on optimization, while longer term investments enable cost-effective solutions in light of evolving policies and markets. U.S. and Canadian efforts to reduce untreated CSOs will also further reduce total phosphorus loads into the Lake Erie basin.

Benefits and Challenges

The benefits include potentially significant load reductions at lower costs, because existing WWTFs that contribute the greatest point source loads to the western and central basins will be optimized. In addition, achieving these reduced loading targets could happen in a relatively short timeframe. Currently, federal and state funding is not available to finance optimization and upgrade studies, so WWTFs will need to find new sources of revenue to cover these costs, which may prove difficult. However, armed with information about cost-effectiveness, these studies may build political support for longer-term solutions and help avoid investments in less cost-effective options.

Timing and Anticipated Ecosystem Improvements

As an example, the Detroit WWTF was issued a revised discharge permit[10] in 2013 that called for optimization of total phosphorus removal and compliance with a growing season average of 0.6 mg/l. As a result, the facility is now typically discharging 0.2 – 0.45 mg/l total phosphorus, which has already resulted in reducing the nutrient load by a few hundred metric tons. Determining the timing for ecosystem improvements is difficult due to the variety of factors that affect water quality in Lake Erie (e.g., invasive species and meteorological trends)[11].

---

[10] The permit was issued by the Michigan Department of Environmental Quality, which has authority to administer the National Pollution Discharge Elimination System (NPDES) permit program in the State of Michigan pursuant to the Clean Water Act. The monthly average permit limit for total phosphorus is 0.7 mg/l, year around (each and every month).

[11] Michalak et al. (2013). Record-setting algal bloom in Lake Erie caused by agricultural and meteorological trends consistent with expected future conditions. Proceedings of the National Academy of Sciences of the United States of America. Retrieved from www.pnas.org/cgi/doi/10.1073/pnas.1216006110.

IV. Encourage investments in green infrastructure for urban stormwater and agricultural runoff, including ecological buffers for rivers, streams and wetlands

Description

Green infrastructure can provide multiple ecosystem service benefits, including improved water quality, habitat and flood protection. Ecological buffers are a type of green infrastructure that can be designed to interrupt or slow runoff water and help keep it and associated pollutants from entering nearby waterways.

In contrast to traditional "gray" infrastructure (e.g., storm sewers and stormwater management ponds), where natural ecological processes are replaced with hard structures and engineered systems, green infrastructure is designed, constructed and maintained to enable or enhance certain ecological processes.. A common example of green infrastructure in urban environments is permeable surfaces that allow natural infiltration to occur or where vegetation is planted that can absorb water and nutrients, reducing the volume of water and associated pollutants that enter gray infrastructure. In agricultural and other rural settings, ecological buffers, restored wetlands, and naturally designed stream channels, such as two-stage or multi-staged ditches, are other examples of viable green infrastructure options.

Rationale

Designed properly, green infrastructure delivers superior water quality benefits along with the specific functions for which it is built, such as flood control, water delivery and water treatment. Green infrastructure also provides ancillary ecological and/or societal benefits, such as aesthetic improvements, recreation opportunities and/or other environmental benefits like enhanced wildlife habitat. Over the long term, green infrastructure is more likely to be a cost-effective solution to address multiple ecological and societal challenges related to water quality.

Benefits and Challenges

Creative solutions are needed to finance green infrastructure, which may be costlier, particularly in the short term, when compared with traditional gray infrastructure. Initial capital investment costs can be expected to go down as demand for green infrastructure increases, and marginal costs decrease. Green infrastructure can require additional land or space that may be costly or is not readily available for purchase; or funding may not be available to acquire the land or waterway access needed to create/install the green infrastructure. Consideration of the full life-cycle costs of green infrastructure, including the multiple ecosystem services it can provide compared to gray infrastructure costs, can help leverage investments toward this greener approach.

Timing and Anticipated Ecosystem Improvements

Once it is built or installed, most green infrastructure begins delivering ecosystem benefits within a relatively short time period. Public and private programs to finance, incentivize or otherwise encourage green infrastructure should be available so that these types of stormwater management systems can contribute to water quality improvements quickly.

V. Work with federal partners to develop plans to reduce the open water disposal of dredged material and to advance beneficial reuse of dredge material as an alternative

Description

States are concerned that U.S. Army Corps of Engineers (USACE) policies regarding open water disposal of dredged material may result in altering the movement, cycling, timing, resuspension and recirculation of nutrients in Lake Erie. Ohio has recently adopted legislation (Senate Bill 1 of 2015) that provides for the elimination of open water disposal by 2020, except in limited circumstances, which can include use of sediment as beach nourishment and the creation of in-lake habitat. Pennsylvania law prohibits open lake disposal of dredged material unless it is classified as clean. Michigan effectively prohibits open water disposal in Lake Erie as state law does not allow disposal in waters less than 30 meters deep (the western basin is shallow so open water disposal is not allowed).

Rationale

Operation and maintenance of ports and navigation channels in Lake Erie is vital to the economies of the states and Ontario. However, concern has existed for many years over the practice of open water disposal, especially in the western basin. Legislation adopted in Ohio sends a clear signal to federal agencies of the importance of finding alternatives to the practice in the near future.

Benefits and Challenges

The USACE, which maintains ports and harbors through dredging the federal navigation channel, will need to exercise flexibility in its interpretation of the "federal standard" defining dredge disposal options. States will need to work with the Corps to help identify and promote beneficial reuse of dredged materials, which can include the creation of habitat and use as building or fill material.

VI. Promote and pilot innovative nutrient reduction initiatives in the western Lake Erie basin

Description

Current programs for controlling nonpoint source pollution from agricultural lands largely rely on cost-share programs (e.g., Farm Bill and the Canada-Ontario Farm Stewardship Program) to assist producers with implementing environmental improvement projects. Although these programs are important tools, they do not always encourage farmers to utilize the most cost-effective actions or inspire new and innovative solutions to reduce nutrient runoff from their farming operations.

Other approaches to promoting innovative solutions need to be examined, such as performance-based incentives, or "pay for performance." Performance-based incentives are payments based on the achievement of specified environmental performance targets created by a stakeholder group that may include producers, agency staff, municipalities and researchers in a region or watershed. Payments to producers are based on ecological outcomes and provide flexibility for producers to find the most appropriate and cost-effective solutions for their specific farming operation or resource concern.

A performance-based incentives program is a promising complement to regulatory approaches and other methods to reduce nutrient and sediment pollution from nonpoint sources in western Lake Erie. For example, Ohio is also interested in exploring a water quality trading (WQT) pilot program in the Maumee River watershed. Water quality trading has the potential to offer a cost-effective, flexible option for meeting WWTF permitted nutrient load limits, while encouraging the installation of conservation practices in rural and urban areas. This type of "pay for performance" approach can build parity among rules and processes in each jurisdiction that reflect key trading elements such as eligible participants, quantification of load reductions, trade areas, trade ratios reciprocity, and other necessary checks and balances.

Rationale

A performance-based approach to nutrient reduction provides payments based on the achievement of farm-scale environmental performance outcomes. Producers can earn the largest incentive payments from choosing the most effective actions for their specific fields. Performance-based incentive projects have been and are currently being successfully implemented in portions of the western Lake Erie basin (e.g., The Stewardship Network's Cooling Hotspots: Motivating Farmers to Reduce Nutrient Losses, 2014 Great Lakes Restoration Initiative grant).

Benefits and Challenges

Implementing pilot programs using innovative approaches, like "pay for performance" incentives, can complement and help promote alternatives to traditional cost-share approaches. These alternative programs have proven to reduce phosphorus loss from agricultural land by providing flexible, performance-based outcomes that benefit both the producer and water quality. In the case of WQT, the program requires incentives for WWTF discharge permit holders to want to explore less costly compliance options, which WQT can offer. Strict or stricter discharge limits on existing facilities, TMDLs and other policies can help drive this "demand" for WQT. Without adequate demand, however, WQT is not a reasonable tool for addressing excessive nutrient loads. With adequate demand, WQT can offer more cost-effective approaches that offer ancillary environmental benefits from the installation of conservation practices (i.e., many conservation practices do more than just reduce phosphorus). With any performance-based approach, robust, well-vetted and agreed-upon quantification methods are needed for quantifying reductions in nutrient loadings. Time and resources are also needed to develop and test associated methods and protocols.

Timing and Anticipated Ecosystem Improvements

A pilot nutrient reduction performance-based incentive effort may take approximately 1-3 years to implement. In the case of a WQT program, if the results indicate adequate demand exists and protocols have been agreed to by stakeholders, then a multijurisdictional trading program could be considered to achieve long term reductions.

VII. Phase out residential phosphorus fertilizer application within five years

Description

Residential fertilizer can be over applied or wrongly applied to lawns and can run off into nearby waterbodies contributing to excessive nutrient loadings. Unless turf is being newly established in an area, a fertilizer with high levels of phosphorus is usually not necessary because soils are often nitrogen limited. Thus, established lawns do not typically need extra phosphorus and any extra that is applied may enter a surrounding waterbody.

Rationale
Michigan and New York have laws that prohibit phosphorus fertilizer application unless the lawn is new or has a proven phosphorus deficiency. A Michigan-based study[12] has shown an average 25 percent reduction in phosphorus runoff into a river in southeast Michigan as a result of the phosphorus ban. Some states outside of the Lake Erie basin have more detailed regulations but the underlying principle is the same. Several fertilizer companies in Ohio and Ontario have also voluntarily eliminated phosphorus in commercial brands. However, no restrictions are currently in place in Pennsylvania.

Benefits and Challenges
Fertilizer companies may need to change their chemical ratio for fertilizer mix that is sold for residential use and/or may also need to change their product for specific markets in the Lake Erie basin states and the province of Ontario.

Timing and Anticipated Ecosystem Improvements
A phasing out of virtually all phosphorus in residential fertilizer is recommended by 2020, except under circumstances where compelling information is presented that confirms a need for phosphorus. Water quality benefits will accrue as phosphorus runoff from turf grass and associated pollution loads into receiving waters is drastically reduced.

VIII. Within five years, validate or refine the reduction targets and timelines using an adaptive management approach

Description
An adaptive management approach would be used to track the progress made under this Joint Action Plan and will be used to adjust the targets and actions based on new science and knowledge. The GLWQA Annex 4 Subcommittee process will be an important source of new information and a venue for refining domestic actions using adaptive management. Possible topics warranting further research that could affect the targets, timelines or action items herein include:

- the relative contribution of various sources of nutrients into Lake Erie (including internal cycling of phosphorus once it enters the lake) and targeting actions that are likely to have the greatest impact on reducing the likelihood of nutrient-related ecological problems in Lake Erie, such as harmful algal blooms, nuisance algal blooms and abundance of toxic bacteria
- the role of zebra and quagga mussels and their relationship to algal blooms and their toxicity
- development and testing of mussel management techniques
- measuring the performance of BMPs at increasing nutrient uptake and reducing nutrient runoff, as well as the cost effectiveness of pollution reduction steps
- the impacts of climate change on algal bloom production in Lake Erie

Rationale
New data, tools and technologies will inevitably illuminate our knowledge of excessive nutrients, their sources, relative contributions and impacts on Lake Erie. This information should be periodically assessed and adjustments to the final Joint Action Plan would be made accordingly.

---

[12] Lehman, John T., Douglas, W. Bell, and Kahli E. McDonald. "Reduced River Phosphorus following Implementation of a Lawn Fertilizer Ordinance." *Lake and Reservoir Management* 25.3 (2009): 207-12.

Benefits and Challenges
The collaborative process that created the Joint Action Plan will need to be maintained or re-instated to accommodate new information and make any changes to this document. This requires leadership — an entity to manage that collaborative process — and a commitment of time and resources by the leading entity and all those that need to be engaged in the process.

Timing and Anticipated Ecosystem Improvements
The Lake Erie jurisdictions would continue to collaborate through the GLWQA Annex 4 Subcommittee to meet time-bound commitments set forth in that Agreement to develop a science plan for Lake Erie that can identify science priorities which, when implemented, can be used to validate or refine the reduction targets herein. Updates to the Plan would be aligned with the GLWQA and reporting on related domestic arrangements (e.g. COA).

IX. Collaborate toward an integrated monitoring and modeling network for the Lake Erie basin by 2020

Description
This action calls for multi-sectoral collaboration to build an integrated monitoring and modeling network for Lake Erie by 2020 that can measure nutrient losses at the edge-of-field, as well as load reductions in streams and rivermouths to assess progress toward achieving water quality improvement goals. Edge-of-field and tributary monitoring to assess conservation practice performance should look at both TP and SRP. This includes development and application of consistent methods for quantifying load reductions at edge-of-field as well as refinements to watershed models that are calibrated to incorporate edge-of-field data with other data to assess in-stream loads and water quality trends. This information should be reported to, or be linked from, one central portal.

Rationale
Different tools are needed to analyze effectiveness, impacts of conservation practices and investments at different scales. Information technology tools can complement on-the-ground monitoring to analyze trends and progress toward achieving environmental goals at multiple scales. Coupling of in-stream monitoring with monitoring at rivermouths of Lake Erie tributaries as part of a network allows for tracking and measuring changes in pollution loads and progress toward achieving water quality improvement goals across major sub-watersheds within the Lake Erie basin. Results can be used in an adaptive management approach to refine, adjust or modify actions so that actions are designed and pursued in ways to maximize their ability to solve nutrient-related problems in Lake Erie. Annex 10 (Science Annex) of the Great Lakes Water Quality Agreement calls for similar measures to enhance coordination of science and supporting activities for the entire Great Lakes basin.[13] This action supports the Annex 10 process with a specific focus on Lake Erie.

Benefits and Challenges
Public policy and the public at large increasingly demand to know whether public investments in restoration are resulting in ecological improvements. Answers to questions such as "how many pounds of phosphorus will this restoration project keep from going into nearby waterways?" are

---

[13] Annex 10 to the 2012 Protocol of the Great Lakes Water Quality Agreement calls for "enhancing the coordination, integration, synthesis, and assessment of science activities…. including monitoring, surveillance, observation, research, and modeling…."

expected at multiple scales — ranging from individual farms to the Lake Erie basin at large. There are a multitude of tools and methods for estimating environmental improvements, but most of them were designed to assess specific types of actions or ecosystem components, or at a specific scale and cannot be integrated with others. Monitoring can show whether a stream, river or lake is improving, but only in limited circumstances can monitoring results be linked to specific restoration actions. Monitoring is costly and implementing monitoring of every farm, stream and river is impractical and infeasible. Models can help fill in the gaps. Development of common and accepted protocols for appropriate models that integrate monitoring data and can be adapted over time is foundational to a robust system that can predict and account for ecosystem outcomes and trends. An integrated network leverages existing monitoring and modeling efforts to be mutually supportive in assessing progress toward improved water quality and in making strategic conservation and restoration investments.

Timing and Ecosystem Improvements

A fully integrated monitoring and modeling network for the Lake Erie basin is likely to take many years, even decades, to develop. Interim steps can be taken to enhance collaboration among those agencies and organizations engaged in monitoring and modeling that can improve collective assessment of water quality trends and inform more effective protection and restoration activities. Any monitoring and modeling under the Joint Action Plan would not duplicate efforts being undertaken under the GLWQA.