CANANDAIGUA LAKE WATERSHED NINE ELEMENT PLAN FOR ENHANCED PHOSPHORUS MANAGEMENT

Supplement to the 2014 Canandaigua Lake Watershed Management Plan

PROTECTING THE LIFEBLOOD OF OUR REGION

This Nine Element Plan was prepared with funding provided by the New York State Department of State under Title 11 of the Environmental Protection Fund

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Abbreviations

2014 Plan	Comprehensive Update to the Canandaigua Lake Watershed Management Plan
9E Plan	Nine Element Plan
AEM	Agricultural Environmental Management
BEE	Biological and Environmental Engineering Department, Cornell University
BMP	Best Management Practice
CAST	Chesapeake Assessment Scenario Tool
CCE	Cornell Cooperative Extension
CDBG	Community Development Block Grant
CLWA	Canandaigua Lake Watershed Association
CREP	Conservation Reserve Enhancement Program
CSC	Climate Smart Communities
CSLAP	Citizens Statewide Lake Assessment Program
CSP	Conservation Stewardship Program
CVAP	Clean Vessel Assistance Program
CWIA	Clean Water Infrastructure Act
DWSP2	Drinking Water Source Protection Program
ELAP	Environmental Laboratory Approval Program
EPA	Environmental Protection Agency
EPF	Environmental Protection Fund
EQIP	Environmental Quality Incentives Program
ESF	SUNY College of Environmental Science and Forestry
FEMA	Federal Emergency Management Agency
FLCC	Finger Lakes Community College
FLI	Finger Lakes Institute
FLLOWPA	Finger Lakes – Lake Ontario Watershed Protection Alliance
FSA	Farm Service Agency
GIGP	Green Innovation Grant Program
GIS	Geospatial Information System
GWLF	Generalized Watershed Loading Function
HAB	Harmful Algal Bloom
HRU	Hydrologic Response Units
HUC	Hydrologic Unit Code
LWRP	Local Waterfront Revitalization Program
NLCD	National Land Cover Dataset
NMP	Nutrient Management Plan
NRCS	Natural Resources Conservation Service
NYS	New York State
NYSAGM	New York State Department of Agriculture and Markets
NYSDEC	New York State Department of Environmental Conservation

NYSDOH	New York State Department of Health
NYSDOS	New York State Department of State
NYSDOT	New York State Department of Transportation
NYSEFC	New York State Environmental Facilities Corporation
NYSFOLA	New York State Federation of Lake Associations
NYSOPHRP	New York State Office of Parks, Recreation, and Historic Preservation
ppd	pounds per day
PRISM	Partnership for Regional Invasive Species Management
QAPP	Quality Assurance Project Plan
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plans
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TP	Total phosphorus
TSS	Total suspended solids
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WQIP	Water Quality Improvement Project Program
WRR	Watershed Rules and Regulations
WWTP	Wastewater Treatment Plant

1. Executive Summary

Nine Element Plans have become the emerging standard for waterbodies across New York State. The New York State Department of Environmental Conservation (NYSDEC) has adopted the Environmental Protection Agency's Nine Key Elements of Watershed Planning as a principal component of their Clean Water Framework. Watershed management planning has been a keystone approach to resource protection for decades, and many lakes, including Canandaigua Lake, have benefitted from this collaborative, science-based approach. Community-based watershed planning for the Canandaigua Lake watershed began in the 1980s. The initial Canandaigua Lake Watershed Management Plan was adopted in 2001. In 2014, a Comprehensive Update of the Canandaigua Lake Watershed Management Plan (referenced in this document as the 2014 Watershed Plan) was completed and formally adopted by all 14 watershed and water purveying municipalities. The 2014 Watershed Plan addressed a broad range of pollutants of concern, including nutrients, bacteria, heavy metals, hydrocarbons, sediment, and emerging contaminants. In addition, the 2014 Watershed Plan established a comprehensive set of management categories and strategies designed to reduce the risk of adverse impacts associated with the pollutants of concern.

This 2023 Nine Element Plan supplements the 2014 Watershed Plan with a focused quantitative analysis of phosphorus, a key pollutant affecting water quality. The Nine Element Plan analyzes watershed sources of phosphorus and defines specific targets, actions, and locations for reducing phosphorus inputs to Canandaigua Lake. Recent advances in mathematical modeling of complex watersheds enabled the community to undertake this more quantitative approach to watershed management.

The quantitative analyses summarized in this document are intended to help stakeholders (lake associations, county Soil and Water Conservation Districts, municipal leaders, academic partners, and others) identify and prioritize measures to ensure that Canandaigua Lake and its watershed continue to provide the ecosystem services valued by the community.

Three quantitative tools were applied to inform the recommendations included in this 2022 Nine Element Plan. The first is a landscape model that predicts flux of water and materials to Canandaigua Lake from the watershed. Faculty and graduate students from Cornell University's Department of Biological and Environmental Engineering (BEE) selected the Soil and Water Assessment Tool (SWAT) as the appropriate model for the Canandaigua Lake watershed. The model selection was made in consultation with the NYSDEC and the Canandaigua Lake Watershed Council. The SWAT model has been applied across the Finger Lakes and other regions of NYS in support of Nine Element Plans; the model framework is well suited to agricultural areas.

The SWAT watershed model incorporates environmental data (hydrology, meteorology, topography, soil type, vegetative cover, etc.) and cultural data (land use, settlement patterns, crops, management practices, etc.) to estimate sources and geographical areas contributing phosphorus and other pollutants of concern from the landscape to the waterways. The Cornell BEE modeling team used water quality data collected from multiple tributaries to Canandaigua Lake during years of sampling to set up and test the SWAT model; this process helps ensure that the model adequately captures local conditions. The monitoring program focused on collecting samples over a range of streamflow and meteorological conditions. Monitoring sites were selected to represent the broad range of environmental and cultural characteristics found across the Canandaigua Lake watershed and included in the SWAT watershed modeling framework.

Once the SWAT model was set up and tested, the Cornell BEE modeling team was able to apply the model in a predictive manner to evaluate the relative effectiveness of various management practices on reducing phosphorus export to the lake, given underlying conditions of environmental setting, land cover, and management practices. The SWAT model also helps managers identify priority subwatersheds where implementation of management practices can help achieve reduction targets. While the focus of this Nine Element Plan is phosphorus, the SWAT model also generates estimates for nitrogen and sediment flux from the landscape to the lake; this information can further inform watershed management actions.

A second tool was applied to estimate phosphorus contributions from individual on-site wastewater treatment systems (septic systems) located in proximity to surface waters. The septic system estimation tool provides insights on the relative magnitude of the cumulative contribution of wastewater from on-site systems and identifies priority areas for improved wastewater management. Like the watershed SWAT model, calculations estimate the potential contribution of on-site wastewater treatment systems to the lake's phosphorus budget using site-specific data and information.

The third tool calculates the potential magnitude of point source phosphorus to Canandaigua Lake. This estimate is based on current permit conditions for regulated wastewater treatment plants discharging treated effluent within the watershed.

The SWAT watershed model was also applied to estimate the impact of increased precipitation due to climate change on phosphorus export to Canandaigua Lake. A predicted 5% increase in phosphorus load reinforces the need for improved capacity to prepare for and recover from extreme weather events. Both structural and non-structural approaches are needed. Increased frequency and intensity of precipitation contributes to flood risk, runoff from the landscape, and erosion of streams, gullies, and roadside ditches. A focus on watershed resilience as a guiding principle is reflected in the recommended actions for all categories of land use across the watershed.

Excessive phosphorus inputs and resulting enrichment of lakes and reservoirs can adversely affect local economies through declining property values and tax revenues and reduced tourism. For public water supplies, water quality degradation associated with excessive phosphorus can require additional investment in treatment processes to meet public health standards. The benefits and costs of actions to reduce phosphorus inputs must be balanced across multiple sectors. An important component of all the recommendations is to identify and acquire funding and technical support for their implementation.

Implementing the recommendations will require continued collaboration among the many partners engaged with lake and watershed management issues. The Canandaigua Lake Watershed Program is the hub of effective partnerships and programs. Stakeholders from the agricultural community, water purveyors, academic institutions, NYSDEC, New York State Department of State (NYSDOS), local government, and county and regional agencies remain committed to protecting this vital asset. Progress will be tracked and reported through continued data collection and evaluation led by the Watershed Council. The Watershed Council is committed to ongoing institutional collaboration and communication among all stakeholders.

Canandaigua Lake and its watershed will continue to change. An ongoing commitment to adaptive management, i.e., setting targets, implementing recommendations, monitoring their impact, and adjusting to new conditions, is an essential component of a Nine Element Plan. Data and information used to develop the quantitative tools incorporate recent land cover, management practices, and meteorological conditions. Continued monitoring and tracking will enable the Nine Element Plan to reflect new information and inform management decisions.

2. Purpose and Background

This Nine Element Plan was developed to supplement the 2014 Canandaigua Lake Watershed Management Plan [Canandaigua 2014 Plan] and incorporate all required elements for approval by the New York State Department of Environmental Conservation (NYSDEC). The federal United States Environmental Protection Agency (USEPA, 2008) developed watershed management guidelines for achieving water quality improvements based on nine key elements, as listed in **Table 1**. While many of the nine elements were reflected in the 2014 Watershed Plan, a quantitative analysis of phosphorus sources and required reductions to meet goals and targets was not. The Canandaigua Lake Watershed Council was awarded funding from the NYS Department of State to complete the remaining elements and develop an approvable Nine Element Plan for the Canandaigua Lake Watershed.

Table 1. Nine Key Elements of Watershed Management Planning

Nine Element Criteria	NYS DEC / US EPA Definition	Location in Document (Sections)
Element A	Identify and quantify sources of pollution in the watershed	9
Element B	Identify water quality target or goal and pollutant reductions needed to achieve this goal	3
Element C	Identify the best management practices (BMPs) that will help to achieve the reductions needed to meet water quality goal/target	10
Element D	Describe the financial and technical assistance needed to implement the BMPs identified in Element C	12
Element E	Describe the outreach to stakeholders and how their input was incorporated and the role of stakeholders in implementing the plan	3.1, 11
Element F	Estimate a schedule to implement the BMPs identified in plan	11
Element G	Describe the milestones and estimated time frames for the implementation of BMPs	11
Element H	Identify the criteria that will be used to assess water quality improvement as the plan is implemented	13
Element I	Describe the monitoring plan that will collect water quality data needed to measure water quality improvement (the criteria identified in Element H)	13 Appendix A

The 2014 Watershed Plan will continue to serve as the guiding document for identifying and implementing watershed protection measures using five adaptive management approaches: research, education, restoration/remediation, open space protection, and regulation. The Nine Element Plan explores specific strategies that are amendable to quantitative analysis of their effectiveness in reducing phosphorus input to Canandaigua Lake. With this investment in quantitative analysis, the watershed community can focus their collective resources on areas of the watershed and specific remedial measures that offer greatest potential for long-term water quality benefit. Having a NYS approved Nine Element Plan in place provides access to additional state and federal funding to implement recommendations.

The primary task to build on the existing framework and develop a Nine Element Plan was completion of a mathematical model of the Canandaigua Lake watershed. Faculty and graduate students from Cornell University's Department of Biological and Environmental Engineering (BEE) selected the Soil and Water Assessment Tool (SWAT) as the appropriate model for the Canandaigua Lake watershed in consultation with NYSDEC and the Watershed Council. The SWAT model was deemed appropriate for the Canandaigua Lake watershed due to its capability to simulate agricultural practices and its successful application to other NYS watersheds.

Specific objectives of the Nine Element Planning process include:

- Develop and test a mathematical model of the Canandaigua Lake watershed capable of quantifying phosphorus transport from the landscape to the lake.
- Estimate phosphorus contribution of onsite wastewater treatment systems.
- Apply the quantitative tools, and data from point source discharges, to estimate existing and future phosphorus load both spatially and by land cover/land use classification.
- Review status and trends of Canandaigua Lake water quality, including cyanobacterial blooms (also referred to as Harmful Algal Blooms, or HABs).
- Define measurable targets for long-term water quality protection; targets are defined in terms of both phosphorus export from the landscape and in-lake phosphorus concentrations.
- Identify management practices that are realistic for the stakeholder community and estimate the phosphorus load reduction achieved by their adoption.
- Estimate technical and financial resources required to implement recommendations.
- Define priority actions.
- Outline a monitoring and assessment program to track progress toward achieving targets.

3. Vision, Goals, and Targets

3.1 Vision and Goals: Background

Discussion of community vision and goals for Canandaigua Lake and its watershed have been part of the conversation among stakeholders since watershed planning efforts began in the 1980s. Canandaigua Lake is one of New York's eleven renowned Finger Lakes, which are nestled between the glacially carved rolling hills that are iconic to this region of New York. Long-term monitoring has documented that Canandaigua Lake is a high-quality waterbody capable of supporting a diversity of uses including as a source of drinking water, recreation, aquatic habitat, and aesthetic resource. Residents and visitors enjoy boating, swimming, fishing, canoeing, kayaking, sailing, and sightseeing. The lake is a primary attraction, drawing people to work, live, and visit the area, providing a foundation for the local economy, and bolstering quality of life.

The 2001 Canandaigua Lake Watershed Management Plan states, "**The purpose of this Watershed Management Plan is to maintain and potentially enhance the ecological integrity and the quality of life in this watershed by protecting the lifeblood of this region- the high quality of water produced by the Canandaigua Lake watershed**." More than 20 years later, this vision remains true for the 2023 Nine Element Plan. The watershed's natural capital, also referred to as ecosystem services, is vital to residents and visitors as reconfirmed during public outreach in support of the 2014 Watershed Plan.

Natural capital and ecosystem services refer to the direct and indirect contributions of natural ecosystems to human well-being and quality of life. These contributions are often sorted into four categories: *provisioning* (production of food, fiber, energy, medicinal plants), *regulating* (clean water, flood control, climate moderation, pollination), *supporting* (habitat, soil formation, nutrient cycling), and *cultural* (tourism, recreational, aesthetic, mental and physical health) as documented in the 2005 Millennium Ecosystem Assessment Report Ecosystem Services prepared by the United Nations. Community discussions of specific goals for Canandaigua Lake and watershed include examples drawn from all four categories.

The following goals have been identified:

- Maintain Canandaigua Lake as a reliable source of high-quality drinking water
- Sustain the region as a major recreation and tourism destination
- Maintain the environmental quality that supports a strong tax base
- Sustain the "sense of place" and quality of life built upon a foundation of the beauty and quality of Canandaigua Lake

- Protect and enhance the regulating functions of wetlands, shorelines, streamside/road bank buffer areas, floodplains, forests, and other natural areas that build climate resilience by reducing stormwater runoff and filtering pollutants.
- Maintain productive agricultural lands and forests that provide food and fiber
- Protect and enhance conditions that provide habitat to diverse native species

3.2 Targets: Focus on Phosphorus

A component of a Nine Element Plan is to identify quantifiable targets that will result in water quality conditions that reflect community goals and support the waterbody's designated best uses. For Canandaigua Lake, designated best uses include water supply, aquatic life protection, fishing, and recreation in and on the waters. Since the supply of phosphorus regulates growth of phytoplankton (including algae and cyanobacteria) in Canandaigua Lake, the Watershed Council has defined two phosphorus-related targets. The first is to reduce nonpoint source phosphorus loading from the watershed; the second is to maintain current in-lake ambient phosphorus concentrations into the future, even as climate change affects the region.

As described in **Sections 8 and 9**, the SWAT model and wastewater calculations estimate that approximately 46,000 pounds of phosphorus are exported from the watershed to the lake annually. This estimate is likely biased high, due to conservative assumptions related to performance of the wastewater treatment plants, extent of current nutrient management planning efforts, recent expansion of winter cover crops, and the scale of the modeling (for example, BMPs are not specified at the field scale). After considering these factors, the Watershed Council selected an aggressive and proactive target to reduce loading to the lake by 25% (approximately 11,500 pounds) within a decade.

With the projected increase in both amount and intensity of precipitation due to climate change, nonpoint source phosphorus loading from the watershed is projected to increase by at least 5%. In addition to building in a margin of safety, the Watershed Council selected 25% reduction as an aggressive target to help mitigate the potential impact of climate change on the lake ecosystem. Warming waters increase growth of phytoplankton and provide a competitive advantage to cyanobacteria. Proactive measures to reduce phosphorus supply can help offset this effect. The Watershed Council will work with its partners to track project implementation and estimate the magnitude of phosphorus load reduction.

Canandaigua Lake already benefits from low, relatively stable total phosphorus concentrations; this conclusion is drawn from decades of lake monitoring through the Citizens Statewide Lake Assessment Program (CSLAP) and researchers associated with the Finger Lakes Community College (refer to **Appendix A** for monitoring program details). The Lake meets criteria for total phosphorus, water clarity, and phytoplankton abundance consistent with oligotrophic (nutrientpoor) conditions as detailed in **Section 6.1**. Average phosphorus concentrations may increase or decrease from year to year based on multiple factors. The target is for the Lake's summer average total phosphorus concentration (measured at a mid-lake site) to continue to be 5.5 µg/L, calculated as a three-year rolling average**.** Meeting this target would represent a stable long-term phosphorus concentration despite changes associated with shifting land cover and a changing climate.

4. Project Organization

4.1 Canandaigua Lake Watershed Program

Canandaigua Lake has benefited from an integrated watershed planning approach; all fourteen watershed and water purveyor municipalities recognized the critical need for collaboration across political boundaries to manage Canandaigua Lake for future generations and formally committed to working together on measures to protect the lake and watershed. The Canandaigua Lake Watershed Program has grown and strengthened over the course of three decades with active support of and engagement with county government, resource management agencies, NYS agencies, land trusts, academic institutions, citizen groups, and regional alliances. The first of its kind in New York, the Watershed Program serves as a resource and model to state agencies and other watershed groups striving to develop successful watershed protection programs (see pg. 4-5 of the 2014 Watershed Plan for details).

The Canandaigua Lake Watershed Program encompasses three entities that share the same first three words in their names "Canandaigua Lake Watershed." Although separate entities, the three organizations share similar goals and collaborate on a wide array of projects and programs. Their shared vision is to build on each other's strengths to maximize their collective effectiveness across the watershed as they undertake efforts related to research, education and outreach, restoration, protection, and regulation. Continued cooperation among the organizations (**Figure 1**) is critical to successful implementation of the Nine Element Plan.

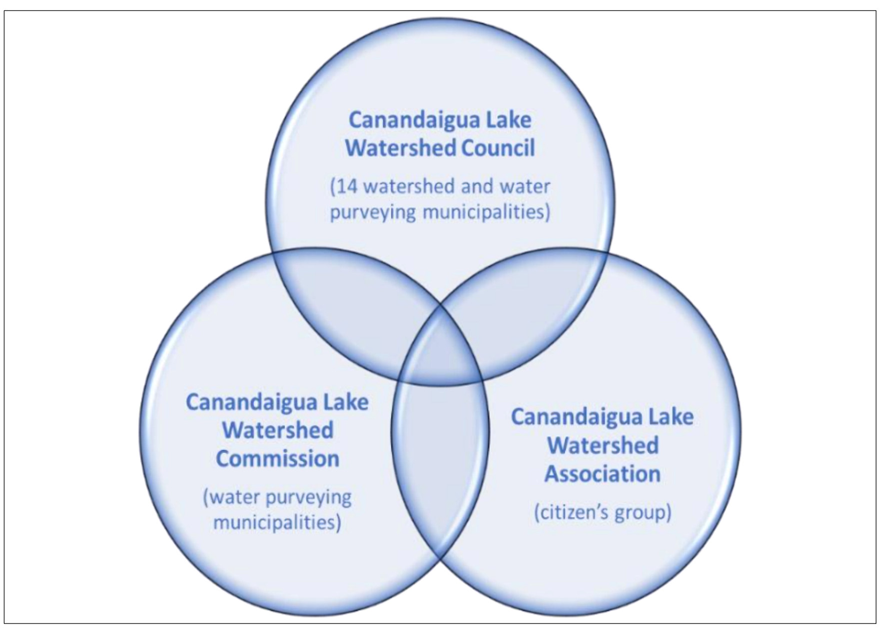

Figure 1. Institutional partnership for lake and watershed management: Canandaigua Lake Watershed Program

4.1.1 Canandaigua Lake Watershed Council

Through the tireless efforts of multiple county agencies, elected officials, and citizen groups during the 1990s, the fourteen watershed and water purveying municipalities officially established the Canandaigua Lake Watershed Council in 1999 by Intermunicipal Agreement. Each of the Watershed Council municipalities officially adopted the 2001 Watershed Management Plan and joined forces through the Watershed Council to lead and coordinate watershed planning and protection efforts. The Watershed Council members include the Towns of Bristol, Canandaigua, Gorham, Hopewell, Italy, Middlesex, Naples, Potter, and South Bristol; the Villages of Naples, Newark, Palmyra, and Rushville; and the City of Canandaigua. Each municipality sends their chief elected official or other elected official to represent their municipality on the Watershed Council.

Since 2000, the Watershed Council has employed a full-time Watershed Program Manager to coordinate the comprehensive watershed management program. The Watershed Program Manager is responsible for recommending and coordinating the implementation of watershed protection measures across the watershed along with organizing these actions with the multiple partners involved. Member municipalities share the costs through a 'fair share' funding formula. In addition to funding the Watershed Council, the municipalities invest in watershed protection projects through both direct budgetary allotments and in-kind services of personnel and construction equipment. In the past 10 years, the Watershed Council has brought in over $3 million in state grants to help implement a wide array of watershed protection efforts, ranging from education, research, restoration projects, and strengthening regulatory protections.

The groundbreaking success of establishing and fostering the intermunicipal and interagency watershed program led both NYSDEC and EPA to formally recognize the effective leadership and strong partnerships exemplified by the Canandaigua Lake Watershed Council. In 2004, the NYSDEC honored the Council with their inaugural Environmental Excellence Award; in 2003, the EPA awarded the organization with designation as a 'Clean Water Partner for the 21st Century'.

In addition to coordinating the watershed management program, the Watershed Council serves as the Steering Committee for completing the Nine Element Plan. More information on the Watershed Council is available on their website www.canandaigualake.org.

4.1.2 Canandaigua Lake Watershed Commission

The Watershed Commission includes the five water purveying municipalities that draw water for public supply from Canandaigua Lake, including the City of Canandaigua, the Town of Gorham, and the Villages of Rushville, Newark, and Palmyra (also on the Watershed Council). The Watershed Commission implements the 1953 Canandaigua Lake Watershed Rules and

Regulations and employs a full time Watershed Inspector through a contract with the Ontario County Soil and Water Conservation District (SWCD).

The Watershed Commission leads the effort to monitor performance of onsite wastewater treatment systems (also known as septic systems). The Watershed Inspector is tasked with inspecting existing systems, helping to site and plan new onsite systems, and dealing with failing systems. In an effort that extended from 2016-2019, the Watershed Council and Watershed Commission collaborated on development and adoption of the Local Onsite Wastewater Law within the larger shoreline communities. This law increases local regulatory control of onsite systems. The Watershed Inspector performs inspection and administrative functions to implement the law. The Watershed Inspector partners with the Watershed Manager and NYSDEC to investigate oil and chemical spills.

The Watershed Inspector supported development of this Nine Element Plan by providing the number of onsite systems located proximate to the waterways. This information was used to develop a quantitative estimate of the combined phosphorus input to Canandaigua Lake from onsite systems and inform realistic scenarios for reducing the overall load from this source.

4.1.3 Canandaigua Lake Watershed Association

The Canandaigua Lake Watershed Association (CLWA) is a member-supported, non-profit organization focused on protection of Canandaigua Lake and its watershed through education, scientific research, and public policy advocacy. The Association operates with the assistance of a Director, small staff, and active volunteer board. In recent years, the Association has evolved into a more complex non-profit organization with an expanded role in lake and watershed protection. With a primary focus on community engagement, CLWA plays a key role in public outreach and education on watershed management. For example, since 2007 the Association co-funds (along with the Watershed Council) the Watershed Education Program, which reaches over 3,000 students each year. The Association coordinates several community science programs including harmful algal bloom (HABs) surveillance along the lake shoreline, Secchi disk water clarity monitoring, and participation in the Citizens Statewide Lake Assessment Program (CSLAP). The CLWA conducts invasive species education and research, co-funds the local match for Watercraft Steward program, and has been integral to the success of the Lake Friendly Lawn Care Program. In addition, the Association directs a portion of their member contributions to support restoration efforts led by the Watershed Council and other organizations. More information on their diverse programming is at https://www.canandaigualakeassoc.org/.

The CLWA has helped promote public awareness of the need to augment the 2014 Watershed Management Plan with the quantitative analyses required for an approvable Nine Element Plan. The organization helped publicize the public outreach meetings and encouraged their members to attend. The Association's Board of Directors received periodic updates throughout the planning process and their members provided valuable input on the plan.

4.2 Ontario and Yates County Soil and Water Conservation Districts

The Ontario and Yates County Soil and Water Conservation Districts (SWCD) play a critical role in long-term protection of Canandaigua Lake and its watershed. Agriculture is a major land use, and the county SWCD managers and technical staff provide essential services to the farming community. SWCD personnel provided information on existing agricultural practices to set up the watershed model. Input from the county SWCDs guided the Nine Element Plan project team as they considered realistic and implementable strategies to reduce phosphorus export from the landscape. The SWCDs will continue as key partners by identifying projects and willing partners, and by providing technical assistance with implementation. In addition, the SWCDs will continue their successful efforts to offer educational opportunities to the agricultural community.

4.3 Cornell University's Department of Biological and Environmental Engineering (BEE)

A primary task of the Nine Element Plan was to develop a mathematical model of the Canandaigua Lake watershed capable of predicting transport of phosphorus from the landscape to the waterways. Cornell University professors Dr. Scott Steinschneider and Dr. M. Todd Walter and doctoral student Mahnaz Sepehrmanesh customized a mathematical watershed model to reflect conditions specific to the Canandaigua Lake watershed. The Cornell BEE team was responsible for model calibration and validation, analysis of model projections, and synthesis of results.

The Cornell BEE team selected the Soil and Water Assessment Tool (SWAT) model as the Canandaigua Lake watershed modeling framework because of its wide application in agricultural watersheds. SWAT is applied to quantify and predict the impacts of land management practices on water, phosphorus, sediment, and other nutrient yields in large complex watersheds with varying soils, land cover, and management conditions. The SWAT model is widely used for Clean Water Plans, which include both Nine Element Plans and Total Daily Maximum Load (TMDL) allocations, across New York State including the Finger Lakes.

The watershed SWAT model was set up using data specific to the Canandaigua Lake watershed. This requirement for site-specific data encompassed both the environmental setting (soils, topography, stream network, and meteorology) and the human impacts on watershed lands (land cover, development patterns, roadways, and management practices). Incorporating detailed information on specific watershed conditions is necessary to ensure that the final model provides realistic projections of the impact of various management actions.

The SWAT model has the capability to simulate transport of phosphorus, nitrogen, and sediment from the landscape to surface waters. While the focus of this Nine Element Plan is total phosphorus, model outputs for nitrogen and sediment are included in the appended model report.

4.4 New York State Agencies

The NYSDEC reviews and approves Nine Element Plans. Staff from NYSDEC's central office and the Finger Lakes Water Quality Hub in Syracuse have provided technical reviews of the SWAT modeling process, reviewed input data sources and quality, and approved the model's Quality Assurance Project Plan (QAPP) (**Appendix B)** and the SWAT Watershed Model Report (**Appendix C)**. Both the Model QAPP and SWAT Watershed Model Report were prepared by Cornell University's BEE modeling team. Drafts of this document were reviewed by NYDEC representatives who provided guidance on supplementing the existing 2014 Watershed Management Plan Update with the information and analysis needed for an approvable Nine Element Plan for Phosphorus Management in the Canandaigua Lake Watershed.

NYSDEC staff coordinated installation of a USGS hydrologic gauge on the West River to fill an important data gap in understanding watershed hydrology. Staff from the Finger Lakes Water Quality Hub collected additional rounds of tributary water quality data for use in the watershed model.

The New York State Department of State (NYSDOS) also provided reviews of the SWAT model along with providing funding for development of this Nine Element Plan under Title 11 of the Environmental Protection Fund. NYSDOS staff reviewed and commented on drafts of the Nine Element Plan. The Watershed Council has a long and successful history of partnering with the NYSDOS to implement high priority projects throughout the watershed.

4.5 Community Engagement

The Canandaigua Lake Watershed is home to a diverse set of stakeholders. Given the mix of regulatory and voluntary water quality protection work, stakeholder involvement is essential to meeting the success of any watershed management plan. Stakeholder groups and the public participated in development of the 2014 Watershed Plan Update through multiple public meetings. To further promote public involvement with the effort to develop a Nine Element Plan, the Watershed Council developed the "*Community Outreach and Participation Plan for the*

Nine Element Addendum to the 2014 Comprehensive Update of the Canandaigua Lake Watershed" which was reviewed and approved by NYSDOS and NYSDEC.

To promote community input as the Nine Element Plan was developed, the Watershed Council:

- Provided updates on the process at Watershed Council meetings, which are open to the public,
- Gave multiple presentations to the Canandaigua Lake Watershed Association Board and had significant communication with Board members and Director,
- Published a Nine Element Plan page on the Watershed Council's website, https://www.canandaigualake.org/9e-plan which features a public comment section to solicit suggestions, concerns, and inquiries related to the Nine Element goals and management priorities, and
- Held two public meetings (details below).

Stakeholders and the public will continue to be involved throughout plan implementation.

Public Meeting #1 – February 18, 2022

Due to the COVID-19 pandemic, the first public meeting was held virtually. Approximately 53 people attended via Zoom (including presenters). Kevin Olvany, Watershed Program Manager reviewed the existing Watershed Plan and described the process to update the plan to a Nine Element Plan. Next, Dr. Scott Steinschneider summarized the interim results from the SWAT model completed by the Cornell BEE team. Kevin Olvany wrapped up the meeting with a summary of best management practices. The public asked questions and provided feedback through the chat feature of Zoom. A recording of this presentation is posted here. The Daily Messenger featured an article on the public meeting and encouraged public feedback (*Biggest threats to the lake? Canandaigua watershed managers want your view.* February 23, 2022).

Public Meeting #2 – February 15th, 2023

The second public meeting will review the goals, targets and implementation strategy that will be used to achieve the goals and targets established in the 9E Plan along with the monitoring plan to document whether we are reaching our targets. Details on the second public meeting to be added.

5. Environmental Setting

5.1 Watershed Characteristics

The Canandaigua Lake covers approximately 109,000 acres (174 square miles) of Central New York's Finger Lakes region and is drained by a network of hundreds of streams and gullies flowing into the lake (**Figure 2**). As detailed in the 2014 Watershed Plan, the tributary stream network totals over 350 miles.

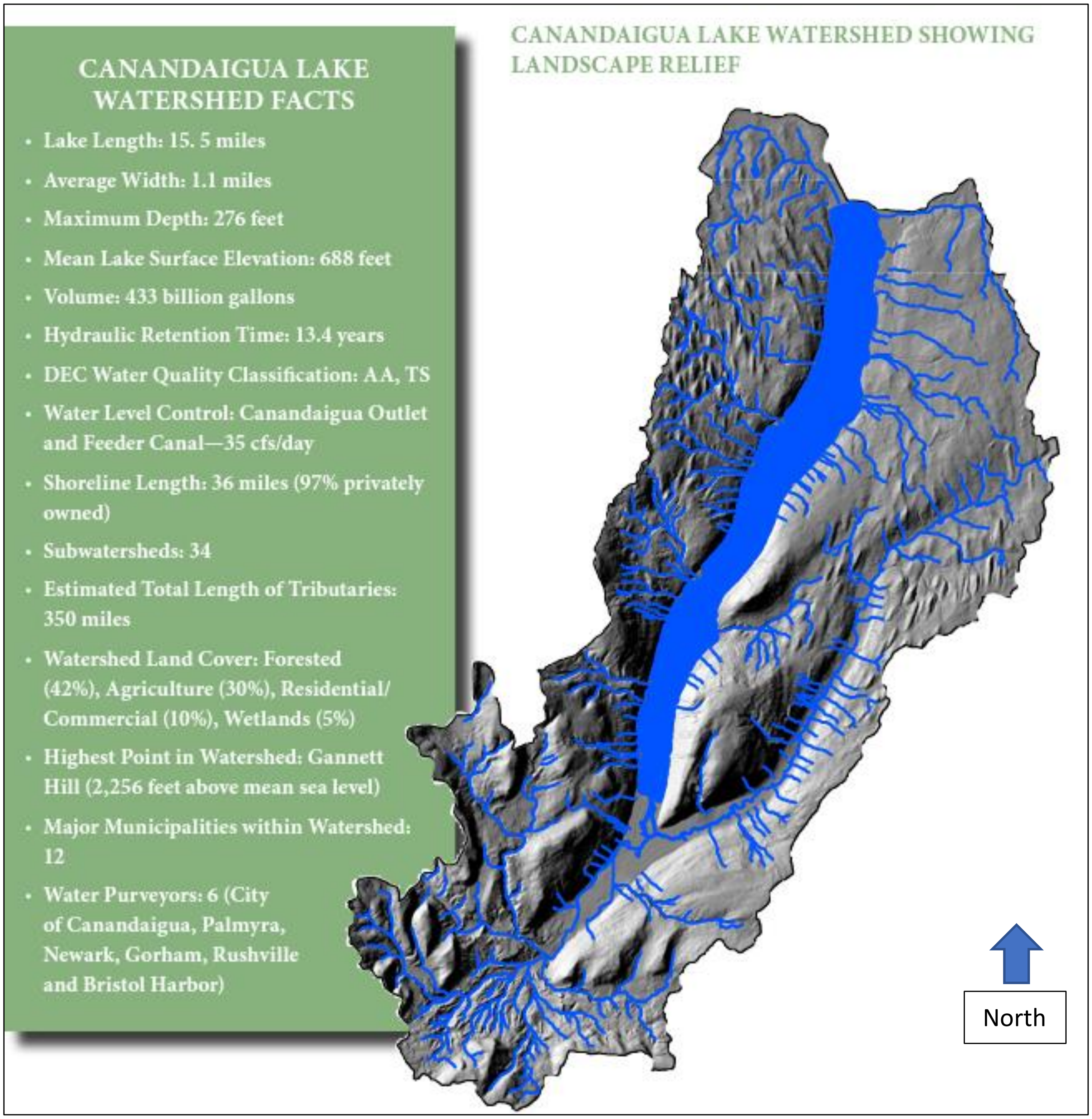

Figure 2. Hydrology of the Canandaigua Lake watershed (Source: Watershed Council, 2014)

The 2014 Watershed Plan includes a comprehensive review of various natural and human influenced characteristics of the watershed. Land cover within the watershed changes over time in response to natural conditions, such as ecological succession, as well as human influences. In 2004, Professor Bruce Gilman inventoried watershed land cover using the New York Natural Heritage Classification System. The NYS Natural Heritage Program is a partnership between NYSDEC and the SUNY College of Environmental Science and Forestry. More than 75 distinct land cover types within the Canandaigua Lake watershed were identified and mapped. This baseline dataset has served as a valuable resource for tracking changes over time.

Watershed program staff updated the inventory in 2018 using 2016 Pictometry imagery. These local experts used recent higher quality aerial imagery and field reconnaissance to refine the land cover dataset and document changes due to development, natural succession, and farming practices. The 2018 detailed land cover breakdown **(Table 2)** summarizes the 75+ landcover types in five primary categories that encompass major cover types. The spatial distribution of watershed land cover is illustrated in **Figure 3**. Note the delineations of 34 subwatersheds/direct drainage basins in both **Table 2** and **Figure 3**. These areas have been utilized since the mid-1990s (including the 2000 and 2014 Watershed Management Plans) to help focus water quality research and management efforts.

Although the 2018 land cover dataset is an integral component of watershed management activities, the format is not compatible with data input requirements for the SWAT modeling. Consequently, the Cornell team used the 2016 National Land Cover Database (NLCD) to characterize the Canandaigua Lake watershed for the model; this approach is widely used across New York State for Nine Element Plans. The NLCD classifies land cover in major groups (e.g., forest, agriculture, development, wetlands) while the Natural Heritage Classification provides much more detail related to the ecological communities. The Watershed Council will continue tracking land cover using the more detailed assessment categories of the Natural Heritage Classification System.

Table 2. 2018 Land Cover by Subwatershed, Summary of the Natural Heritage Classification System

Subwatershed Number	Subwatershed	Agriculture		Development		Successional		Forest		Wetland		Total
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	
1	Sucker Brook	2,591.1	44.8	1,786.1	30.9	422.5	7.3	369.4	6.4	608.6	10.5	5,777.7
2	Tichenor Gully	1,082.2	45.6	408.1	17.2	216.1	9.1	441.8	18.6	226.9	9.6	2,375.1
3	Menteth Gully	1,169.6	28.0	464.8	11.1	553.5	13.3	1,890.5	45.3	94.7	2.3	4,173.2
4	Barnes Gully	208.5	24.6	72.7	8.6	128.5	15.1	434.7	51.2	4.8	0.6	849.1
5	Seneca Point Gully	610.5	22.0	277.0	10.0	185.1	6.7	1,677.1	60.5	23.0	0.8	2,772.8
6	Hick's Point	19.4	4.3	25.7	5.7	45.8	10.2	354.9	79.3	1.7	0.4	447.6
7	Grimes Creek	755.5	7.4	558.0	5.5	827.9	8.1	7,681.3	75.3	374.8	3.7	10,197.5
8	Eelpot Creek	1,514.9	21.5	452.6	6.4	832.8	11.8	4,095.2	58.2	135.6	1.9	7,031.2
9	Reservoir Creek	642.0	16.7	404.3	10.5	476.9	12.4	2,260.2	58.7	68.7	1.8	3,852.1
10	Tannery Creek	357.7	9.2	141.0	3.6	542.6	13.9	2,773.0	71.3	75.6	1.9	3,889.9
11	Parrish Gully	70.0	3.6	23.6	1.2	34.5	1.8	1,805.0	92.5	18.6	1.0	1,951.8
12	Lower Naples Creek	484.8	11.8	449.2	10.9	423.6	10.3	2,581.0	62.9	164.0	4.0	4,102.5
13	Lower West River	1,999.3	19.0	710.0	6.7	1,473.7	14.0	5,654.2	53.6	711.7	6.7	10,548.8
14	Middle West River	4,014.7	58.8	422.0	6.2	667.7	9.8	1,409.6	20.6	318.6	4.7	6,832.6
15	Upper West River	4,358.4	66.1	585.5	8.9	322.9	4.9	589.3	8.9	741.9	11.2	6,597.9
16	Clark Gully	3.0	0.4	4.2	0.5	303.7	36.2	507.3	60.5	19.9	2.4	838.1
17	Vine Valley	943.4	30.7	278.9	9.1	252.6	8.2	1,563.6	50.9	35.8	1.2	3,074.3
18	Fisher Gully	13.2	7.0	43.7	23.2	50.9	27.1	78.6	41.8	1.6	0.9	188.1
19	Gage Gully	575.4	78.3	30.5	4.1	1.3	0.2	125.6	17.1	1.7	0.2	734.5
20	Deep Run	1,493.9	67.6	170.2	7.7	297.4	13.5	219.7	9.9	29.8	1.3	2,210.9
21	Fall Brook	2,024.0	50.5	654.6	16.3	384.2	9.6	404.6	10.1	537.8	13.4	4,005.3
22	Butler Road	291.2	11.6	999.4	40.0	436.3	17.4	674.1	27.0	100.0	4.0	2,500.9
23	Foster Road	58.0	14.9	227.0	58.4	44.7	11.5	51.2	13.2	8.0	2.1	388.9
24	Deuel Road	278.5	29.4	105.9	11.2	97.4	10.3	456.4	48.2	8.9	0.9	947.1
25	Coy Road	312.6	18.8	350.3	21.0	213.4	12.8	753.2	45.2	37.8	2.3	1,667.3
26	Stid Hill	155.0	18.6	90.2	10.8	122.2	14.7	453.6	54.4	12.2	1.5	833.3
27	South Bristol	941.8	14.1	719.1	10.8	819.8	12.3	4,063.7	61.0	121.9	1.8	6,666.3
28	West River- Naples Cree	7.1	0.5	20.2	1.5	85.6	6.5	30.6	2.3	1,183.3	89.2	1,326.8
29	Hi-Tor	34.7	2.2	70.2	4.5	115.5	7.5	1,319.4	85.4	5.9	0.4	1,545.7
30	South Hill	12.0	0.5	124.5	5.6	483.8	21.6	1,608.1	71.8	10.1	0.5	2,238.4
31	Bare Hill	8.0	0.6	174.8	14.0	135.0	10.8	922.6	74.0	5.9	0.5	1,246.4
32	Jones Road	533.7	44.0	158.9	13.1	55.6	4.6	461.1	38.0	4.7	0.4	1,214.0
33	Cottage City	1,451.1	56.0	421.6	16.3	276.4	10.7	428.2	16.5	14.1	0.5	2,591.4
34	Lincoln Hill	1,967.6	47.7	635.4	15.4	652.3	15.8	695.9	16.9	173.9	4.2	4,125.0
	Watershed Total	**30,983.2**	**28.2**	**12,060.2**	**11.0**	**11,981.9**	**10.9**	**48,834.7**	**44.5**	**5,882.4**	**5.4**	**109,742.4**

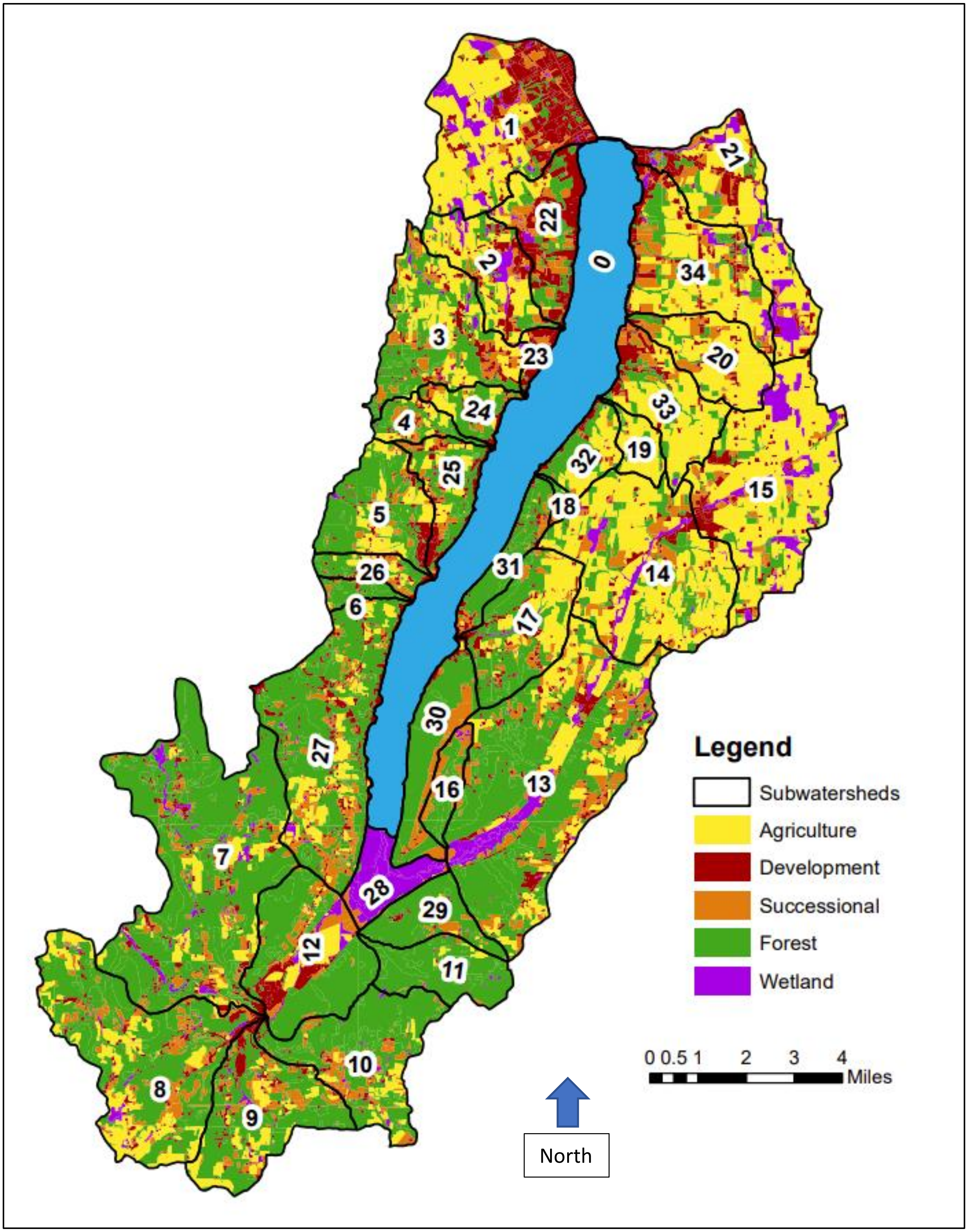

Figure 3. 2018 Land cover classifications for the 34 designated subwatersheds

5.2 Watershed Population

The Genesee/Finger Lakes Regional Planning Council website hosts records of U.S. Census data specific to the region from 2000 onwards. Changes in the population of watershed municipalities are summarized in **Table 3**. In addition, an estimated 70,000 people rely on Canandaigua Lake as their drinking water supply. Through population growth and water line expansion, this water use has increased over the last ten years.

Table 3. Population change reported for 12 watershed municipalities from 2010 to 2020 (source: US Census)

Municipality	Total Population (2010)	Total Population (2020)	Net Change
Bristol	2,315	2,284	-31
Canandaigua City	10,545	10,576	31
Canandaigua Town	10,020	11,109	1,089
Gorham	4,247	4,106	-141
Hopewell	3,747	3,931	184
Italy	2,502	2,403	-99
Middlesex	1,041	931	-110
Naples Town	677	651	-26
Naples Village	1,590	1,641	51
Potter	1,141	1,099	-42
Rushville	1,495	1,377	-118
South Bristol	1,865	1,858	-7
Total	**41,185**	**41,966**	**781**

Overall population within the watershed has remained relatively stable over the last decade. As shown in Table 3, eight smaller municipalities experienced a population decline, with net losses ranging from 7 to 141 people. Growth within the Town of Canandaigua largely accounts for the region's overall net gain. However, the decadal census data recorded higher population increases in certain towns close to the watershed boundary. For example, the Town of Victor increased by 1,585 and the Town of Farmington population grew by 2,345. Given this, and the watershed's proximity to Monroe County, it is likely that the Canandaigua Lake watershed may experience increasing development pressure.

The effort to guide development in an environmentally responsible manner has long been a focus of the Watershed Council. In NYS, municipalities are largely empowered to define regulations on development such as impervious cover, setbacks from waterways, minimum lot sizes, stormwater management, and other factors affecting runoff and phosphorus transport to waterways. The Watershed Council began in the mid-2000s to work with the Town and City of

Canandaigua to incorporate enhanced phosphorus treatment standards as part of their land development review process. The Town of Gorham has also adopted these provisions as part of their review of proposed projects. Enhanced phosphorus removal requirements have been included as a condition on multiple large scale development projects.

6. Water Quality Conditions

6.1 Canandaigua Lake Monitoring Program

Long-term monitoring data are critical for assessing current conditions and trends in lake and watershed health. Canandaigua Lake benefits from an annual lake monitoring program from May to October; samples are collected monthly using protocols and methods discussed in Section 6.2 and analyzed by an ELAP certified laboratory for a suite of parameters, including phosphorus. This monitoring program began in 1996 and is a partnership with Finger Lakes Community College (FLCC). Dr. Bruce Gilman led the effort until his retirement in 2019, when FLCC Professor Patty Rockwell assumed the leadership role.

The monitoring program (**Figure 4**) is designed to collect water quality samples from the main body of Canandaigua Lake at two mid-lake locations (Deep Run and Seneca Point). Four nearshore locations (Fall Brook, Hope Point, Vine Valley, and West River) are used to assess shallow water conditions. These locations have been monitored since program inception, with almost 30 years of data at each site. The Quality Assurance Project Plan for Canandaigua Lake water quality monitoring is included as **Appendix C.**

Monitoring parameters include water clarity, chlorophyll-*a*, total phosphorus, temperature, dissolved oxygen, pH, and conductivity. At the two open water sites, a water quality profile from the surface to a maximum depth of 55 meters is completed for temperature, dissolved oxygen, pH, and conductivity using a sonde. In addition, an integrated water column sample is collected for chlorophyll-*a* analysis and grab samples are collected at three depths (2, 25, and 50 m) for total phosphorus. The four nearshore stations are sampled for chlorophyll *a* (integrated water column) and total phosphorus (2 m).

Annual reports and presentations document lake water quality and update temporal trends. For more information on measured variables and procedures, refer to Section 3.1 (page 21) of the 2014 Watershed Plan.

Since 2017 the NYSDEC Finger Lakes Water Quality Hub has supported participation of all 11 Finger Lakes, including Canandaigua Lake, in the Citizen's Statewide Lake Assessment Program (CSLAP). CSLAP is a joint program between NYSDEC and the NYS Federation of Lake Associations. The program is designed to collect comparable data from lakes across the state using trained volunteers and a central certified laboratory for analysis. Data from the CSLAP program, which has been active for almost three decades, are maintained by NYSDEC in a database. The dataset is invaluable for both tracking changes in individual lakes and statewide trends.

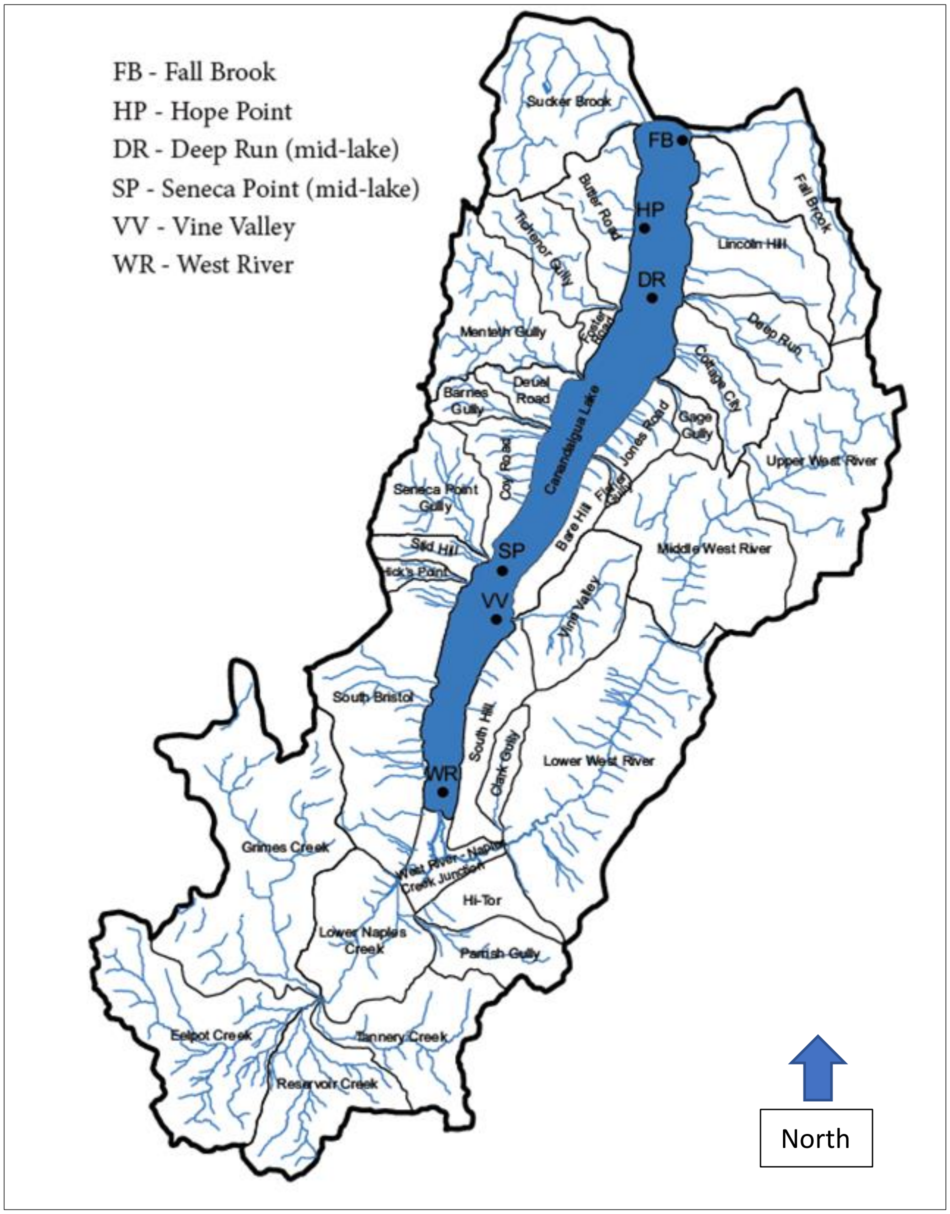

Figure 4. Sampling locations within Canandaigua Lake

6.2 Trophic State Indicator Parameters

6.2.1 Total Phosphorus

Like many other freshwater systems, Canandaigua Lake is phosphorus limited (2018 Finger Lakes Water Quality Report, NYS DEC 2019, page 35), meaning that the abundance of aquatic plants, algae, and cyanobacteria is limited by the supply of phosphorus. The extensive lake monitoring program documents that ambient concentrations of phosphorus in Canandaigua Lake are low and relatively stable. Because nearshore stations may be influenced by localized conditions such as tributary inflows, mid-lake open water sites are typically used when comparing conditions over time within a lake or comparing conditions among lakes. Results of samples collected in the upper waters, where light is available to support photosynthesis, are used to index phosphorus available for primary production. As displayed in **Figure 5**, total phosphorus concentrations measured in the upper waters at the Deep Run (DR) station have remained stable and within the oligotrophic range.

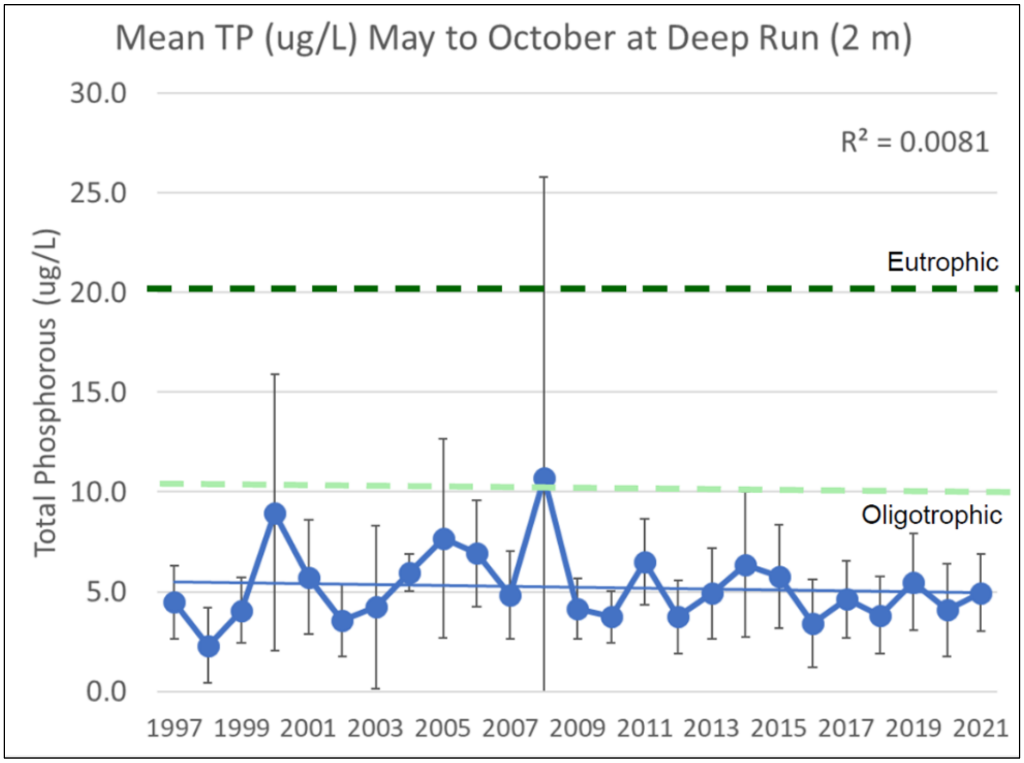

Figure 5. Long term average total phosphorus (TP) concentrations at the Deep Run open water monitoring site. FLCC collected/analyzed data- Dr. Bruce Gilman and Patty Rockwell

6.2.2 Water Clarity

Water clarity is measured at the two open water locations; trained samplers lower a Secchi disk through the water column until it is no longer visible. This simple technique is standard in lake monitoring and used to indicate the depth of light penetration and thus the depth at which photosynthesis is supported. Lake water clarity is influenced by dissolved organic matter as well as particulate matter (sediment and plankton) in the water column. Higher Secchi disk measurements are associated with higher water clarity.

To compare conditions among lakes, the NYSDEC uses summer average (June – Sept.) Secchi disk transparency as a metric of suitability for recreational use. The long-term record of Canandaigua Lake water clarity (**Figure 6**) is consistent with oligotrophic conditions. There is interannual variability and a slight decreasing trend in summer water clarity.

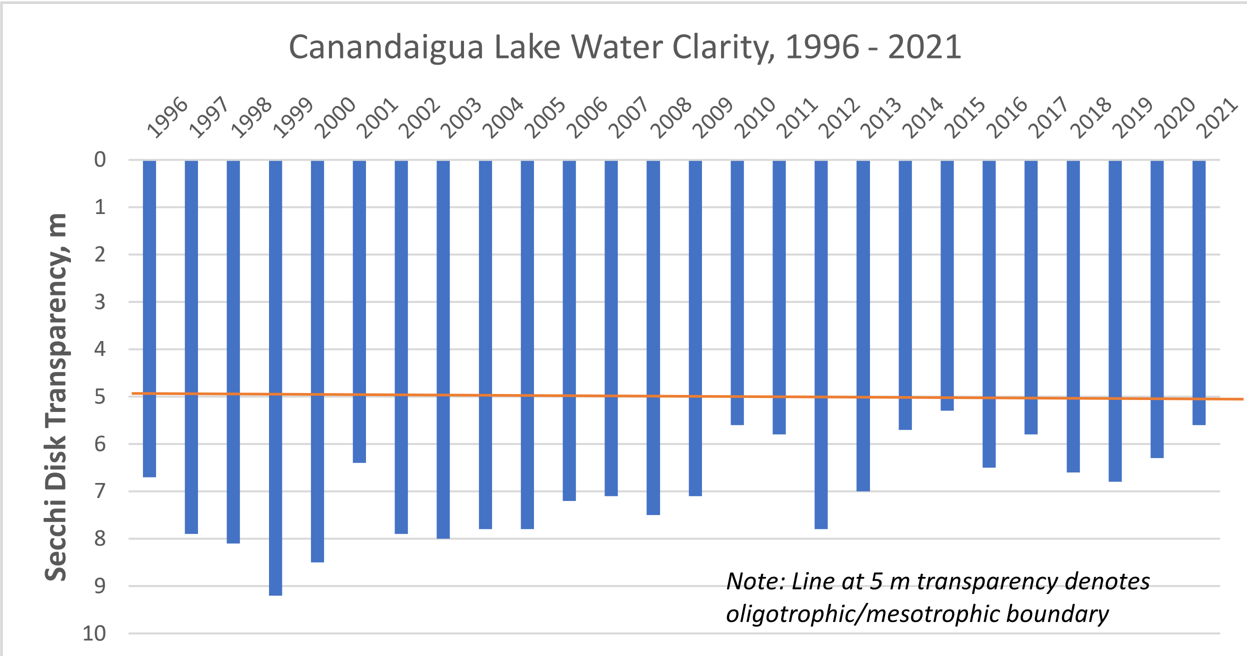

Figure 6. Summer average water clarity (June – Sept.) at the Deep Run and Seneca Point monitoring locations, 1996-2021. FLCC collected/analyzed data- Dr. Bruce Gilman and Patty Rockwell

Canandaigua Lake also benefits from the Canandaigua Lake Watershed Association's Community Science Secchi Disk Program. Volunteers take weekly Secchi disk readings and submit them to a database. These results provide excellent real-time information on lake water clarity throughout the summer and are used as an early warning of increasing algal abundance.

6.2.3 Phytoplankton and HABs

Chlorophyll-*a* is a photosynthetic pigment present in all classes of phytoplankton, including green algae, diatoms, and cyanobacteria. The concentration of this pigment is used as a standard estimate of algal abundance and a trophic state indicator parameter. Data are measured in micrograms per liter (µg/L). In most lakes, including Canandaigua, the phytoplankton community exhibits a predictable seasonal pattern; chlorophyll-a concentrations are low in spring and fall, and higher in July and August. However, algal abundance can change very quickly. The recent proliferation of cyanobacteria may not be captured by the monthly monitoring program and is better assessed by the HABs surveillance program by trained volunteers.

Long-term trend in chlorophyll-*a* concentration is among the key trophic status indicator parameters of lake health. In Canandaigua Lake, summer average chlorophyll-*a* concentrations were relatively low and stable until 2013, when both average concentration and variability increased (**Figure 7**). Overall, there is an increasing trend of summer algal abundance over time.

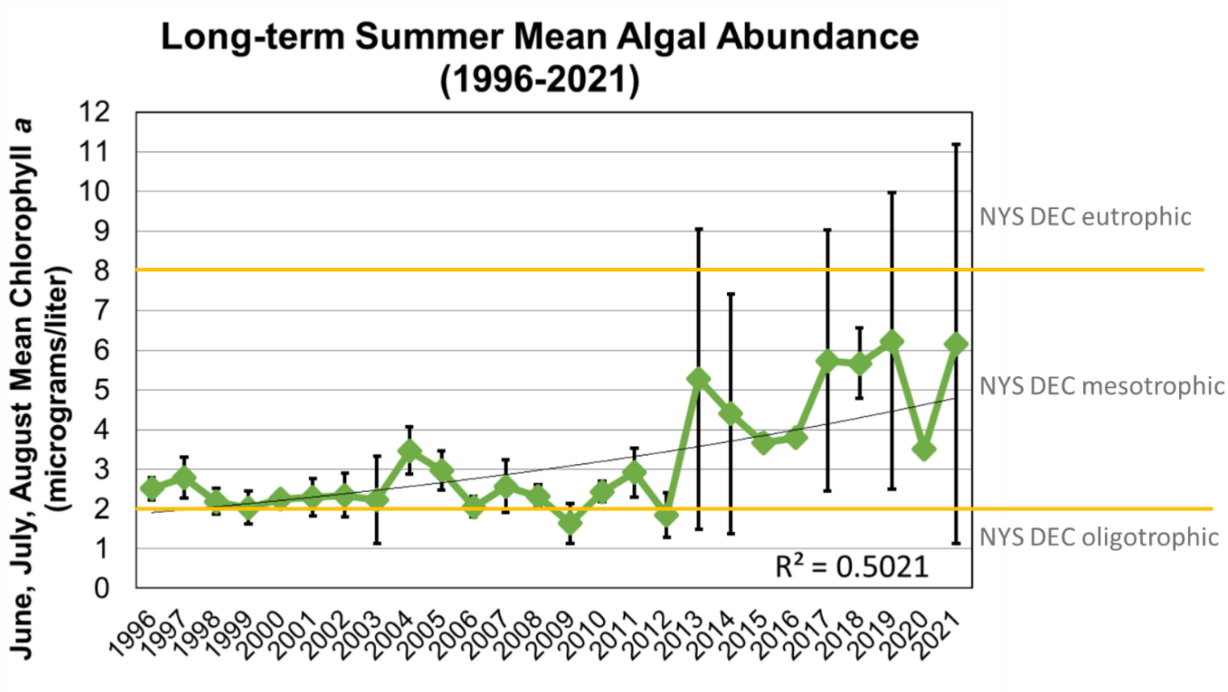

Figure 7. Summer average chlorophyll-a concentration, 1996-2021. FLCC collected/analyzed data- Dr. Bruce Gilman and Patty Rockwell

Population dynamics of invasive dreissenid mussels have affected Canandaigua Lake chlorophyll-*a* concentrations and water clarity. When zebra mussels (*Dreissena polymorpha*) were first introduced to the lake in the late 1990s, water clarity increased as they grazed the plankton community. A presumed crash in population, exhibited by a substantial increase in shells washing up along the shoreline in 2001/2002, led to a rebound in chlorophyll-*a*. A second invasive dreissenid mussel, the quagga mussels (*Dreissena rostiformis bugensis*) was detected in Canandaigua Lake in 2012 (Dr. Bruce Gilman, personal communication). The quagga mussel is adapted to live in deeper waters compared to the zebra mussel and has a higher water filtration rate. There is substantial evidence from the Great Lakes that the dreissenids are selective filter feeders and reject cyanobacteria thus influencing phytoplankton community structure (Vanderploeg et al. 2001[1]). Dreissenid mussels are among the factors related to increased risk of cyanobacterial blooms in NYS lakes (NYSDEC HABs Action Plans, 2018).

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[1] Vanderploeg, H. A., Liebig, J. R., Carmichael, W. W., Agy, M. A., Johengen, T. H., Fahnenstiel, G. L., and Nalepa, T. F. 2001. Zebra mussel (Dreissena polymorpha) selective filtration promoted toxic Microcystis blooms in Saginaw Bay (Lake Huron) and Lake Erie. Canadian Journal of Fisheries and Aquatic Sciences 58: 1208-1221.

Long-term chlorophyll-*a* trends also reflect the emergence of harmful algal blooms in Canandaigua Lake. Cyanobacteria are among the oldest living organisms on Earth and have always been a component of the lake's phytoplankton community. Analyses of Canandaigua Lake's plankton community document the emergence of cyanobacteria late in the summer at low abundance. In 2015, the first documented HAB occurred on the lake; blooms have been experienced to varying degrees each subsequent year. The NYSDEC Statewide HABS tracking and reporting system has improved over the last several years. The Watershed Association and Watershed Council have been utilizing this tracking system- more regularly over the last three years in order to help inform the public through the DEC website. Data from the program are available at NYHABs Blooms reported for Canandaigua Lake are summarized in **Table 4**.

Table 4. Summary of Reported HABs, 2015-2021
Note: In 2019, NYSDEC modified the format of Archived HABs notices. Source: NYSDEC Harmful Algal Blooms Archive

Year	Bloom Period (Date Reported, Date Removed)	# Weeks on Notification Page/ or # of Reports (2019-present)
2015	4/09 – 6/30	12
2016	9/09 – 10/20	6
2017	9/15 – 10/27	6
2018	8/24 – 10/27	9
2019	8/13 -10/28	*67 reports
2020	8/17 – 9/21	*75 reports
2021	7/31 – 10/11	*84 reports

The data reported in Table 4 do not completely reflect the extent of cyanobacterial blooms on the lake; consistent use of this reporting system and standardization of criteria have improved over the years. Since 2015, a combined watershed staff and citizen's surveillance program has been underway to document bloom conditions, understand HABS dynamics, and provide information on public health risks. In 2018, the CLWA formalized a volunteer HABs surveillance program that has become a very robust and critical component to monitoring the extent of HABs on Canandaigua Lake. The number of trained volunteers has substantially increased over the years as summarized in **Table 5**. Watershed Council staff report that 2015, 2018, and 2020 exhibited the most extensive blooms and greatest number of bloom days. Monitoring efforts have expanded to better document bloom dynamics and standardize reporting.

Table 5. Canandaigua Lake HABs Monitoring Program

Volunteer Shoreline HABS Surveillance Program	2018	2019	2020	2021	2022
Number of Volunteers	18	26	42	70	67
Weekly Surveys Performed	218	295	375	560	620
Confirmed Blooms	54	65	79	75	32

The annual HABs surveillance program is a partnership between the Watershed Association and the Watershed Council, along with the Finger Lakes Institute (FLI), SUNY College of Environmental Science and Forestry (ESF), NYS Department of Health (DOH), NYSDEC, and the water purveyors. The Watershed Association coordinates the trained volunteer monitoring program. Volunteers conduct weekly visual inspections of their zone for harmful algae and record their findings. A subset of volunteers also collects bloom samples as needed. Other short-term monitoring and research programs are conducted annually to complement the HABs surveillance program. In addition to the trained volunteers, Watershed Council staff visually monitor the lake and shoreline area and collect samples. Additional information regarding the annual HABs surveillance program and findings is available on the Watershed Association website.

Various research and monitoring efforts continue to explore the factors affecting the occurrence, intensity, and toxicity of cyanobacterial blooms on Canandaigua and other lakes. Since 2017, all eleven Finger Lakes have experienced HABs, regardless of their ambient phosphorus concentration. Canandaigua, Keuka, and Skaneateles Lakes are oligotrophic; total phosphorus levels are low and relatively stable over time. Climate-related factors including warmer waters, changing wind patterns, and higher frequency of intense rainfall events are implicated in the recent HABs proliferation. There is an increasing trend in summer average surface water temperatures (**Figure 8**). The presence and abundance of dreissenid mussels is associated with an increased risk of HABs, as discussed in Section 5.2.3.

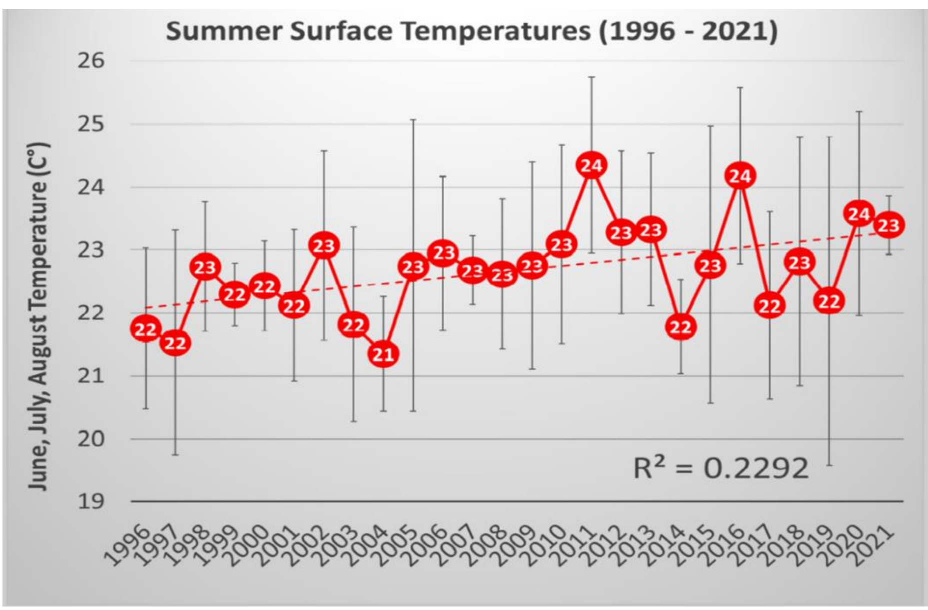

Figure 8. Average summer surface temperatures, mid-lake stations, 1996-2021. FLCC collected/analyzed data- Dr. Bruce Gilman and Patty Rockwell

6.4 Tributary Monitoring

Tributaries transport soil particles and other solid and dissolved materials from the watershed to Canandaigua Lake. The Watershed Council leads a long-term storm and baseline tributary monitoring program that has been in place since 1997. Results of the program document that most of the transport from the landscape to the waterways occurs during storm and melt events. Water quality conditions within the tributary network vary in response to natural conditions (soil erodibility, topography, natural land cover, streambank erosion etc.), settlement patterns (impervious surfaces, wastewater disposal, landscape management, etc.), and the working landscape (cultivated fields, animal density, fertilization practices, animal waste handling, etc.). A long-term record of tributary water quality conditions collected over a range of hydrologic conditions helps inform watershed managers on the overall loading of phosphorus, sediment, nitrogen, bacteria, and other potential pollutants to Canandaigua Lake. The record also helps managers identify geographical areas or land uses that contribute a disproportionate load of these potential pollutants.

The Canandaigua Lake watershed encompasses approximately 174 square miles and has over 350 miles of streams and gullies that direct precipitation and snowmelt to Canandaigua Lake. To better characterize conditions across the large landscape, the watershed is analyzed at a subwatershed level. Thirty-four subwatersheds have been identified, including both stream drainage basins and direct drainage basins (or areas that encompass multiple gullies directing water into Canandaigua Lake). The long-term tributary monitoring program focuses on 17 of these subwatersheds, which represent approximately 79% of the watershed area (**Figure 9**). These 17 tributaries encompass the watershed's diverse land cover, land management practices, topography, and soils. Direct drainage regions are also monitored; frequent visual inspection and photo documentation of conditions in these areas are supplemented with periodic water quality sampling.

The long-term tributary monitoring program collects grab samples from the targeted streams during low flow and high flow (storm/melt) events. Samples are analyzed for total phosphorus, total suspended solids, and nitrate/nitrate. While the goal is to try to capture the peak concentrations during a storm or melt event, this methodology captures a single snapshot in time. However, this robust dataset is less susceptible to the inherent variability of a single set of grab samples, because it includes many samples taken over a long period of time, as described in the 2014 Plan. Additional tributary data were collected by SUNY Brockport during multiple storm events between 1997 and 2000. The Brockport team completed stressed stream analyses on several major tributaries to identify and characterize potential pollutant sources.

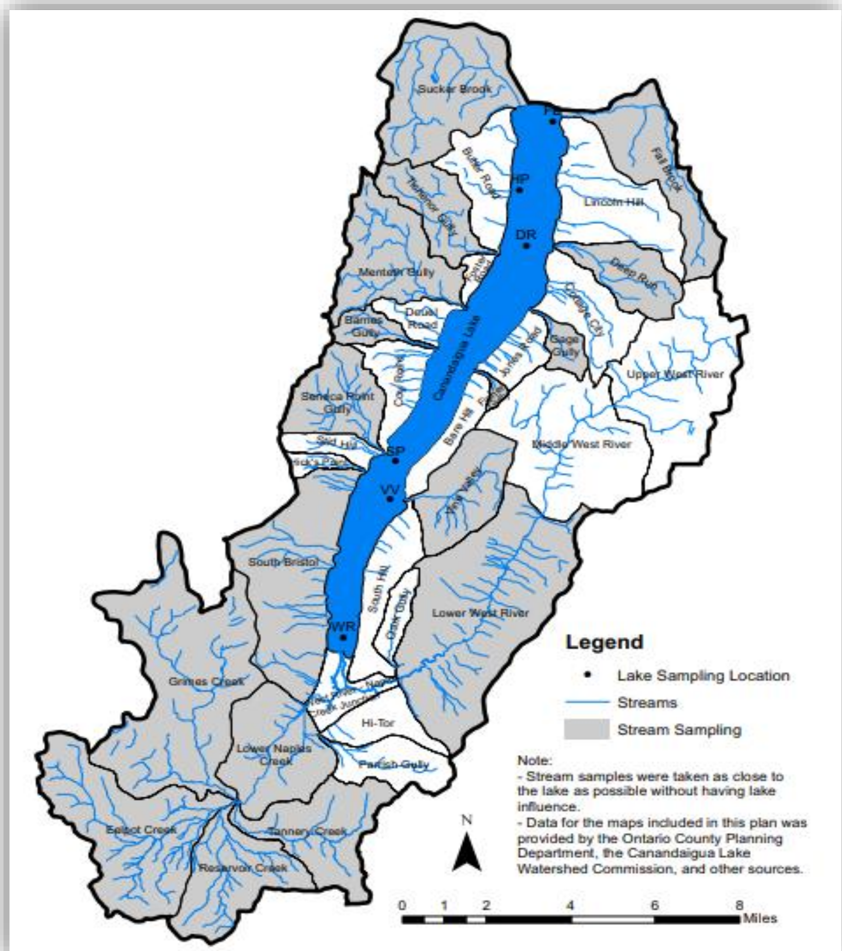

Figure 9. Canandaigua Lake stream and sampling locations with delineated subwatersheds.

From 2001 to February 2022, the Watershed Council collected tributary samples during forty-four storm/melt events; eleven were sampled from 2014-2022. The NYSDEC Finger Lakes HUB sampled water quality of Naples Creek, West River, Fallbrook, and Sucker Brook during three storm events and one baseline event in 2019 and 2020. These datasets were key components to the development of the watershed SWAT model. Watershed Council staff also completed stressed stream/segment analyses of the Fallbrook and Deep Run subwatersheds between 2017 and 2019 to analyze potential sources of nutrients and sediments. Stressed stream/segment analyses on Eelpot Creek were completed as part of a RIT student's master's thesis.

This extensive tributary dataset (**Figure 10**) plays a key role in watershed management. It provides information on long-term trends in water quality and helps identify potential sources and areas of concern. The findings are used to help set priority areas where restoration efforts hold the greatest potential to produce significant benefits. Water quality sampling and analysis also occurs at specific locations of suspected pollution sources, such as failing septic systems and development sites, to document levels of pollutants associated with these land uses. The combination of water quality monitoring, photo documentation during sampling, and visual inspection of erosion and sedimentation have been integral for identifying individual areas and/or drainage pathways for targeted management.

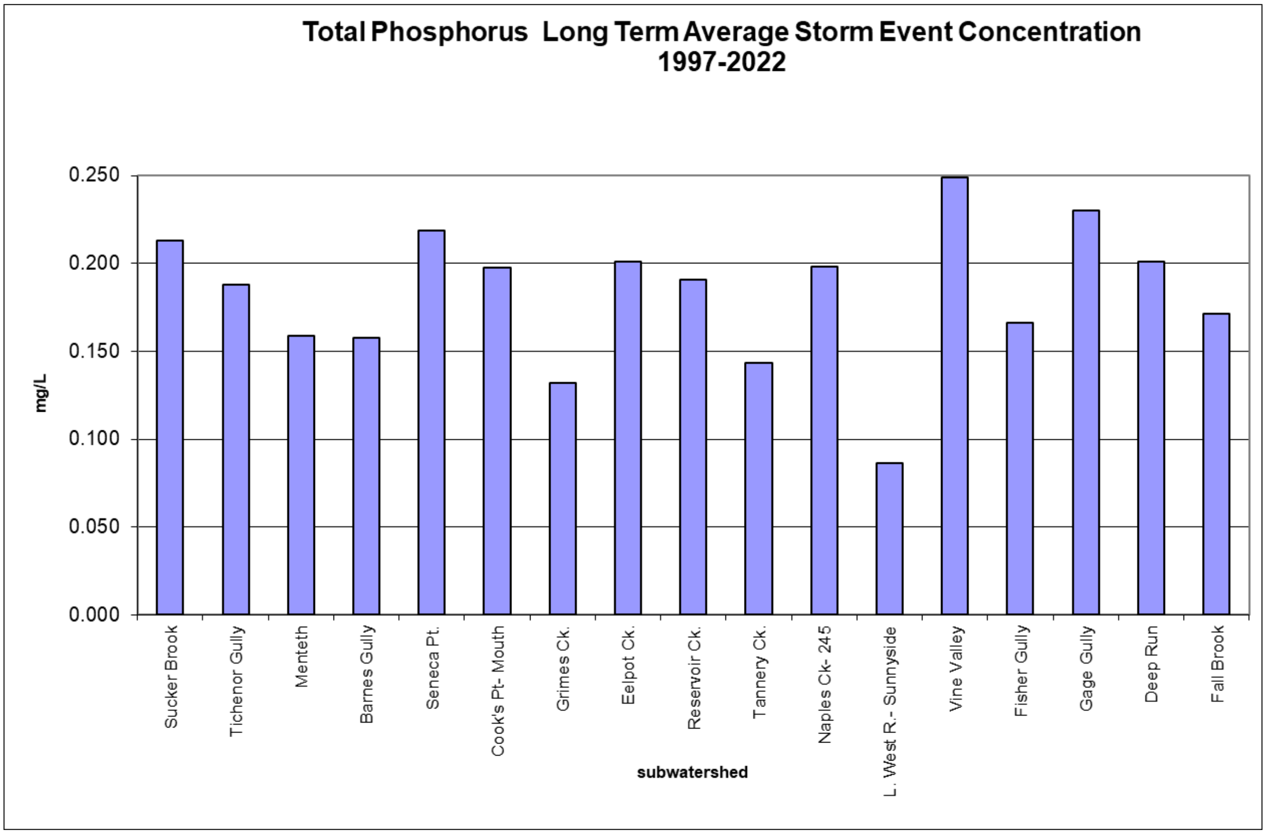

Figure 10. Mean total storm event-based phosphorus concentrations by subwatershed. Each subwatershed has between 50- 65 storm event samples between 1997 – 2022

This long-term storm event-based sampling program spans a broad range of precipitation/snow melt events from minor storms to large runoff events. There can be large variability in small sets of storm event data, especially over a short period of time. As documented on page 35 of the 2014 Watershed Plan, the strength of this dataset lies in its size and diversity. The program has collected storm samples over the range of conditions that affect variability in ambient concentration: time of year, time sampled within the storm event, antecedent moisture conditions, storm intensity, duration and amount, different precipitation amounts/intensities across the watershed (very common), and rotations in land cover and management practices.

Key takeaways from this robust long-term (25 year) storm event-based dataset include the following:

- Subwatersheds dominated by human land uses, including agriculture and urban or suburban areas, have the highest event-based phosphorus concentrations. Priority subwatersheds include Vine Valley, Gage Gully, Sucker Brook, Seneca Point, and Deep Run.
- As Figure 10 indicates; many of the tributary subwatersheds exhibit similar long term average storm event-based phosphorus concentrations (between 150-200ug/L), indicating the importance of managing nonpoint sources across the entire watershed.
- Phosphorus concentrations are lowest in streams draining subwatersheds with extensive forested land cover such as Grimes Creek and Tannery Creek.
- Wetlands and floodplain forests are also effective in maintaining lower overall phosphorus export to the lake; this finding is illustrated by the low phosphorus concentrations measured at the Sunnyside Road monitoring site along West River. There is an extensive floodplain/wetland system upstream of this sample site.

The tributary water quality data set provided a robust and long term dataset to customize the watershed SWAT model to reflect Canandaigua Lake conditions, then subsequently calibrate and validate the model projections using site-specific data. A significant contribution to model development was achieved in 2019 when NYSDEC provided funding to install a United States Geological Survey (USGS) stream gauge on the West River in the Town of Middlesex, site of a previous stream gauge. The location was a joint decision of USGS, NYSDEC, and the Watershed Council. Along with validating stream discharge for the watershed modeling effort, data from this USGS gauge will continue to provide Watershed Council staff with real time information of lake inflows.

7. Watershed Program Accomplishments since 2014

In addition to compiling recent water quality and land cover data, the Nine Element Plan includes a summary of actions implemented by the Watershed Council, the 14 municipalities, and various partners since 2014. Actions are organized by the 13 management categories referenced in the 2014 Watershed Plan. The 2014 Watershed Plan covers a much broader set of issues and pollutants of concern. The Nine Element Plan focuses on recent actions that specifically target phosphorus transport to Canandaigua Lake.

Category 1: New and Existing Development

- Developed and adopted new steep slope ordinances in Towns of Middlesex and Canandaigua
- Continued use of the Enhanced Phosphorus Treatment Standards for residential and commercial development over 1 acre in size- which is substantially stricter than the baseline stormwater standards. These standards were adopted by the Town and City of Canandaigua and Town of Gorham
- Drafted updates to the Docks and Moorings Law
- Continued to implement MS4 requirements within the Town and City of Canandaigua
- Updated Comprehensive Plans for the Town and City of Canandaigua, and Towns of Gorham and South Bristol
- Developed and adopted a Ridgeline Protection Law in Town of Canandaigua
- Modified site plan review requirements to incorporate water resource protection measures in municipalities experiencing growth
- Adopted the on-site wastewater law in four shoreline municipalities: Towns of Middlesex, Gorham, Canandaigua, and South Bristol
- Constructed a 270-foot-long bio-retention project at FLCC campus to manage stormwater runoff/improve water quality from a nine-acre parking lot

Category 2: Lawn and Landscaping Practices

- Provided a Watershed Education Program to over 2,500 students annually within three watershed school districts (Canandaigua, Naples, Marcus Whitman) and a private school. This effort of CLWA/CLWC focused on educating K-12 students on how land use affects water quality.
- Offered community programming in Lake Friendly Living to more than 1,200 residents, businesses, and members of the agricultural community annually. This effort of the CLWA included workshops, mobile lawn signage, and other outreach events.
    - The Lake Friendly Lawncare Pledge and Sign program enlisted 170 residents and businesses committed to reducing use of pesticides and fertilizers and following IPM standards.

- Developed community outreach programming via electronic communication. The CLWA sends monthly E-newsletters, weekly water quality updates during the summer months, and articles of interest throughout the year to over 1800 subscribers.

Category 3: Municipal Roads and Highway Facilities

- Stabilized 1,000s of feet of highly erodible banks on Stid Hill Road, Wolfanger Road, South Lake Road, Jones Road (Gorham), South Lake Road and Old East Lake Road
- Promoted educational programming through Cornell Local Roads Program
- Encouraged Highway Superintendents to attend annual Local Roads training
- Obtained $187,500 in DOS grant funding to support a Pilot program with City of Canandaigua and Town of Gorham to implement a sustainable winter road management program to reduce the use of salt while maintaining/enhancing road safety
- Upgraded culverts in multiple locations to reduce road erosion, protect the driving public and allow for greater fish passage
- Completed drainage and water quality improvements on Sunnyside Road in the Town of Italy

Category 4: Watercourse and Shoreline Management

- Adopted riparian (stream) zone overlay districts and required setback distance of 100 feet in the Town of Canandaigua
- Promoted shoreline management guidelines in the Towns of Canandaigua and Gorham
- Completed a stream bank stabilization/restoration project in the Town of Naples near Highway facility to remediate a massive debris jam and 200 ft. of eroded embankment
- Completed a stream/riparian zone restoration along 190 ft. of Sucker Brook in the Town of Canandaigua
- Implemented measures to stabilize Eelpot Creek in multiple locations along a 2,000-foot stretch of this headwater stream
- Installed multiple berm breaks along Naples Creek (see Category 5 Wetlands and Floodplains for more information)
- Worked with shoreline landowners on natural solutions to shoreline erosion

Category 5: Wetlands and Floodplains

- Completed multiple phases of the Naples Creek Parish Flats water quality and floodplain restoration project
    - 25% of all flow entering Canandaigua Lake passes through the project area
    - More than 13 new berm breaks were created to allow water to enter floodplain
    - 7 new culvert systems added to convey flow into water quality storage areas
    - 110 acres of land were permanently protected- including 6,300 feet of riparian corridor
    - 4 debris jams were removed from the stream and bridge areas

    - Repaired the trail system along the stream and constructed passage for water to reach an adjacent forested floodplain system
    - Naples Creek now has more frequent and greater access to hundreds of acres of additional flood plain that provides major water quality treatment
- Constructed a retention basin on the campus of the Finger Lakes Community College (FLCC) to retain peak flows from Fallbrook; a 20-acre basin can accommodate 50 acre-ft of stored runoff from a 4,000 acre drainage basin.
- Completed a water quality and wetland project at Rtes. 5 and 20 to mitigate storm water runoff from a 1300 acre drainage basin
    - 2017- Obtained donated easements for 23 acres of land across two parcels to implement project
    - Town, Watershed, and City forces worked together to complete project to allow a portion of high flows from Sucker Brook to enter this water quality area
    - Typically functions on at least 6 storm events each year
- Completed a water quality and wetland project on County Road 30 to mitigate stormwater runoff from a 3,500-acre drainage basin
    - 2018- Town/City purchased 18 acres of land north of the Civic Center to complete project
    - Typically functions on at least 6 storm events a year.
- Completed a 3-acre wetland/stormwater basin on County Road 1 (Lake Rd. vicinity) to capture runoff from a 60-acre agricultural area. Project was designed to help alleviate water quality and flooding issues in downstream/lake confluence area
- Completed a 13-acre riparian and wetland buffer at Morrell Rd. along Sucker Brook
- Created a 270 foot bioretention area on the FLCC campus to manage stormwater runoff from a nine acre parking lot

Category 6: Wastewater Management

- The Village of Naples installed a new wastewater treatment plan to serve the business district and portions of their residential area. The Village is in the process of extending the sewer system to other residential areas.
- Expanded adoption of the onsite wastewater local law to include Canandaigua, South Bristol, Middlesex, and Gorham, resulting in inspections of hundreds of systems to date.
- Ontario County received state funding to incentivize upgrade of inadequate onsite systems.

Category 7: Agriculture

- Continued participation in the Agricultural Environmental Management (AEM) programs. SWCD of Yates and Ontario Counites have been implementing AEM in the watershed since 1996; the Canandaigua Lake watershed was among the earliest regions of NYS to embrace this approach.

- Yates and Ontario County SWCD's have completed of AEM assessments on 75% of the farms in the watershed.
- Significant investments in implementation of agricultural Best Management Practices (BMPs). Since 1996, more than $2 million dollars have been invested in implementing 90+ agricultural projects in the watershed. Project implementation has included a wide variety of agricultural BMPs including water and sediment control basins, streambank stabilization, strip cropping, diversion ditches, grassed waterways, buffers, manure storage, barnyard runoff control, and pasture improvement projects.
- Yates and Ontario County SWCD's currently have grants for implementation projects totaling more than $500,000 in value.
- Implemented multiple practices on agricultural lands include WASCOBs, streambank stabilization, strip cropping, diversion ditches, grassed waterways, buffers, manure storage, barnyard runoff control, pasture improvement projects, vineyard mulching, and others.
- Implemented an increased acreage of reduced tillage and winter cover crops on cultivated lands.
- Yates and Ontario County SWCD's along with various partners have organized and held multiple soil health workshops with strong attendance from the agricultural community.

Category 8: In-Lake Issues: Invasive Species, HABS, and Fish Kill Management

- Completed a comprehensive Macrophyte Study of 35 locations in 2018. The investigation was led by Dr. Bruce Gilman of FLCC.
- Supported a Watercraft Steward program at the two primary launch locations in operation since 2014. This program was funded by a combination of state and local grants and was managed under contract with the Finger Lakes Institute at Hobart & William Smith Colleges.
- Installed a boat wash station at Canandaigua Lake Marine State Park
- Developed a citizen science effort to survey shoreline and open water areas for Harmful Algal Blooms (HABs). In 2021, 67 volunteers completed regular surveillance of 61 defined zones for HABs using visual criteria and sampling as warranted.
- CLWA initiated a citizen science program for monitoring water clarity (Secchi disk transparency) and water temperature through the water column at 18 sites on Canandaigua Lake.
- Participated in the CSLAP program at two mid-lake sites since 2017.
- Partnered with Cornell University and the Finger Lakes Institute at Hobart & William Smith Colleges on a HABs DNA research program.
- CLWA collaborated with SUNY ESF on a three-year study of the lake's phytoplankton community. The study is designed to collect weekly samples plus bloom samples at six locations on Canandaigua Lake.
- Participated in citizen science surveys of aquatic macrophyte organized and led by the Finger Lakes Institute.

- Partnered with the NYS Hemlock Initiative to offer Hemlock Woolly Adelgid (HWA) surveys to private landowners in the watershed.
- Treated vulnerable hemlock trees in Grimes Glen (Ontario County) to protect hemlock stands from effects of HWA. This program was completed in partnership with Ontario County SWCD, CLWA, and the Great Lakes Restoration Initiative.
- Continued to work with NYSDEC Region 8 fisheries to monitor fish die off events that occur post spawning (late May/early June).

Category 9: Recreation

- Established the Canandaigua Lake Water Trail and promoted the water trail with signage, pamphlets, and the water trail website.
- Installed an ADA accessible Kayak Launch at Ontario Beach Park.
- Submitted a grant application through the CFA for an ADA accessible Kayak Launch at the north end near Lagoon Park.
- Executed a successful LED Flare Conversion Campaign. Greg Talomie and CLWA played a key role in a promotional campaign to transition lakefront property owners away from more polluting incendiary flares; 6,654 LED flares were sold in 2021.

Category 10: Lake Level Management

- Continued coordination with staff of the City of Canandaigua Wastewater Treatment Plant to monitor inflows and evaluate when to open and close flood control gates.
- Applied for state grant funding to evaluate and modernize the outlet gate system.
- Collaborated with NOAA to have them install a lake level measuring system accessible on-line; provided a link to the real-time data the Watershed Council website.

Category 11: Forestry

- The Towns of South Bristol and Naples adopted a Timber Harvesting Law
- Implemented a practice of reviewing timber harvesting operational plans.

Category 12: Mining and Natural Gas Extraction

- Tracked statewide efforts that resulted in NYS adopting a permanent moratorium on high volume fracking.
- Continued to confer with NYSDEC to monitor mining sites to ensure they are not an erosion risk.

Category 13: Chemical Contamination Prevention

- Promoted the new regulations on petroleum bulk storage facilities.
- In Ontario County, continued to offer a household hazardous waste collection day.
- Continued to support NYSDEC spill response efforts; responded to multiple petroleum and other spills over the last 8 years.

- Worked with NYSDEC and partners on an illegal dump site in the Town of Italy-Sunnyside Road.

8. Classification and Best Use of the Waterways

8.1 Classification and Use Attainment

Canandaigua Lake is designated by NYSDEC as a Class AA- Special (TS) water body. The AA-Special designation signifies that the lake's best use is as a water supply and requires limited treatment. The designation TS signifies that Canandaigua Lake sustains a cold-water fishery (trout and salmon) with suitable spawning habitat.

The federal Clean Water Act requires states and tribes to evaluate water quality and habitat conditions of waterways under their jurisdiction and evaluate whether the best uses (for water supply, recreation, aquatic life protection) are supported. Recent assessments indicate that Canandaigua Lake's habitat and water quality conditions support the designated best uses. No stream or lake segments are included on the December 2021 NYSDEC draft list of impaired waterbodies.

8.2 Quantitative Tools to Estimate Phosphorus Sources and Define Priority Areas

Three quantitative tools were applied to inform the recommendations incorporated into this Nine Element Plan. First, the project team developed a spreadsheet calculation to estimate phosphorus contributions from individual on-site wastewater treatment systems (septic systems) located in proximity to surface waters. The septic system estimation tool provides guidance on the relative magnitude of this source.

A second tool supports analysis of potential contribution of point source phosphorus to Canandaigua Lake by tracking wastewater treatment plants discharging treated effluent within the watershed. The calculation uses regulatory limits for phosphorus concentration and flow. All three wastewater treatment plants operate well below their permit limits; consequently, the estimated phosphorus contribution from this source represents a maximum annual load.

The third tool was development of the watershed model to quantify flux of phosphorus from the watershed lands into the lake. Faculty and graduate students from Cornell University customized the SWAT model to reflect conditions within the Canandaigua Lake watershed. The SWAT model characterizes the nature of the watershed and estimates sources and geographical areas that contribute phosphorus from the landscape. This site-specific watershed model helps evaluate the feasibility of achieving reduction targets given underlying conditions of environmental setting, land cover, and management practices. Moreover, the watershed model provides a tool for testing the relative effectiveness of remedial measures and highlighting priority subwatersheds for implementing such measures. While not the focus of this plan, the SWAT model generated quantitative estimates of nitrogen and sediment loads, in addition to phosphorus.

8.2.1 Estimated Contribution from Septic Systems

Onsite wastewater treatment systems (commonly referred to as septic systems) can be a source of nutrients to the watershed and the lake, especially if sited close to a waterway, poorly designed for the landscape, or improperly maintained. Because the SWAT model does not adequately model subsurface transport of nutrients from septic systems, the Watershed Council developed a simple model to estimate current loading from onsite wastewater systems using local data on the numbers and locations of on-site systems.

Potential septic system phosphorus inputs were calculated using different sets of assumptions for nearshore and upland systems. In general, leachate from shoreline septic systems is more likely to reach Canandaigua Lake for several reasons: proximity (less opportunity for phosphorus adsorption within the soil profile) and the nature of nearshore soils (hydrologic class and soil types). The estimated phosphorus contribution from individual septic systems was calculated using a set of assumptions for wastewater inputs and percent removals (**Table 6** and **Figure 11**).

Table 6. Data and assumptions used to calculate total phosphorus load from onsite wastewater treatment systems (parcel and onsite data from reflect conditions from 2016-2021)

Number of onsite systems	Tax parcels that met the following criteria: • Not served by public sewers • Includes a structure within 250 ft of a drainage feature or the lake; property not classified as agricultural or vacant
Residential wastewater flow	3 bedrooms/property 110 gallons/bedroom (source: Onsite Wastewater Treatment System Law)
Raw sewage concentration	Total phosphorus: 10 mg/L (source: Center for Watershed Protection. 2005)
Onsite system efficiency (removal rate)	Total phosphorus: 57% (sources: Center for Watershed Protection and NYSDEC nonpoint source catalogue)

Soil filtering beyond absorption area (removal rate)	Total phosphorus: 40% for shoreline; 75% elsewhere (Source: Center for Watershed Protection)

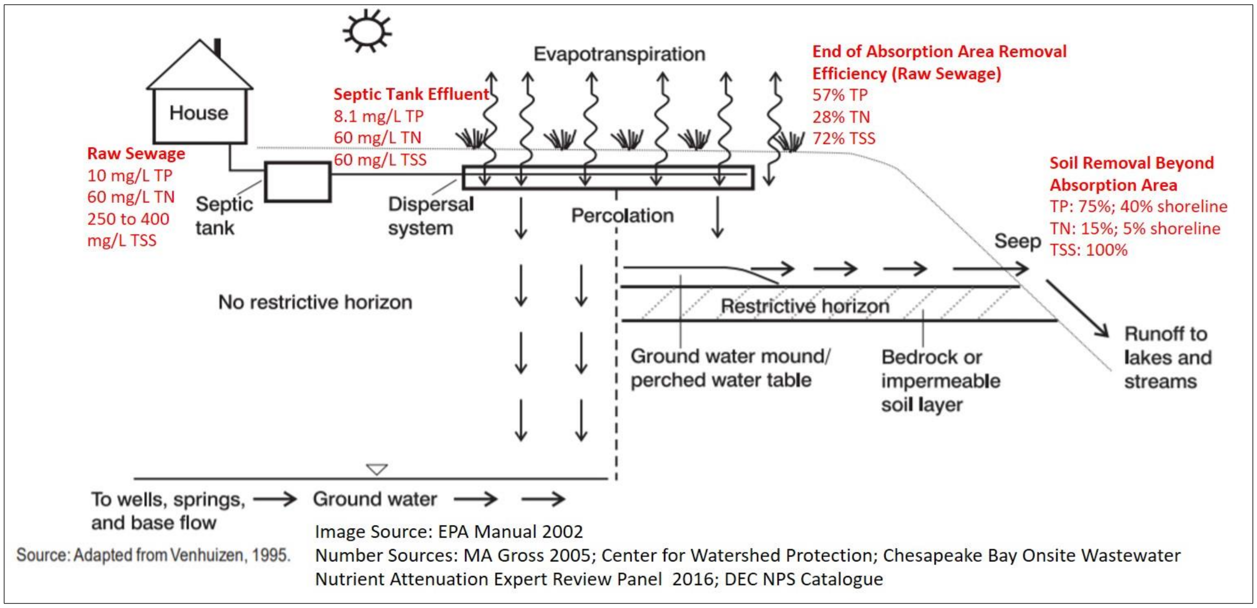

Figure 11. Wastewater concentrations and removal rates through a typical septic system

Results of the calculations are summarized in **Table 7.**

Table 7. Estimated annual total phosphorus load from septic systems proximate to Canandaigua Lake and tributaries

Septic System Location	Septic System Count	Raw Sewage Load	Septic Tank Effluent TP (lb/yr.)[1]	Load at end of absorption area (lb/yr.)[2]	Load after filtering through soil beyond the absorption area TP (lb/yr.)[3]
Riparian stream network (buffer zone)	1,216	12,223	9,901	5,256	1,314
Nearshore lake shoreline	650	6,534	5,292	2,810	1,686
TOTAL	1,866	**18,757**	**15,193**	**8,066**	**3,000**

[1] Loading calculated from count, population, and wastewater characteristics per Table 6.

[2] Phosphorus removal within septic tank per assumptions referenced in Table 6.
[3] Soil adsorption capacity per assumptions referenced in Table 6.

Properly designed and functioning septic systems are essential for protecting Canandaigua Lake. As summarized in **Table 7,** over 18,000 lbs. of phosphorus enter septic systems located proximate to Canandaigua Lake and its tributaries each year. If those systems are functioning at a minimum level (not failing), an estimated 3,000 lbs. of phosphorus may reach the lake. Well maintained and sited septic systems can retain over 80% of phosphorus in domestic wastewater. Since failing and inadequately functioning septic systems may represent a significant input of phosphorus, continued focus on maintenance and inspection is key.

Recognizing the importance of properly designed and functioning septic systems, the Canandaigua Lake Watershed Council worked with partners to develop the Model Onsite Wastewater Treatment System Law. The law includes more realistic flow for calculating design standards, requirements for system inspections, and specifications on when system upgrades are required for inadequately functioning systems. The law has been adopted by the Town of Canandaigua, Town of Gorham, Town of Middlesex, and Town of South Bristol.

The calculations in **Tables 6 and 7** can also support an evaluation of potential change in phosphorus load from on-site wastewater treatment systems such as enhanced removal using upgraded technologies or increased adoption of the model law across the watershed. For example, increased efficiency of phosphorus removal in the absorption field (leach field) from 57% to 80% could capture an additional 1,605 pounds per year, thus lowering the load from septic systems from 3,000 pounds per year to 1,395 pounds per year.

8.2.2 Point Sources

Three publicly owned wastewater treatment plants (WWTPs) are located within the watershed: the Village of Rushville, Bristol Harbor Resorts, and the Village of Naples (**Figure 12**). Watershed Council staff calculated the potential point source phosphorus load from these WWTPs using permit data for flow and effluent total phosphorus limits. Two of the wastewater treatment plants are required to monitor but do not have a permit limit for total phosphorus; an effluent concentration of 3 mg/L was applied based on the level of treatment technology in place and actual data from the Rushville Wastewater Plant. These calculations represent the maximum potential load of wastewater phosphorus to Canandaigua Lake, as the wastewater treatment plants do not typically operate at their maximum permitted flows.

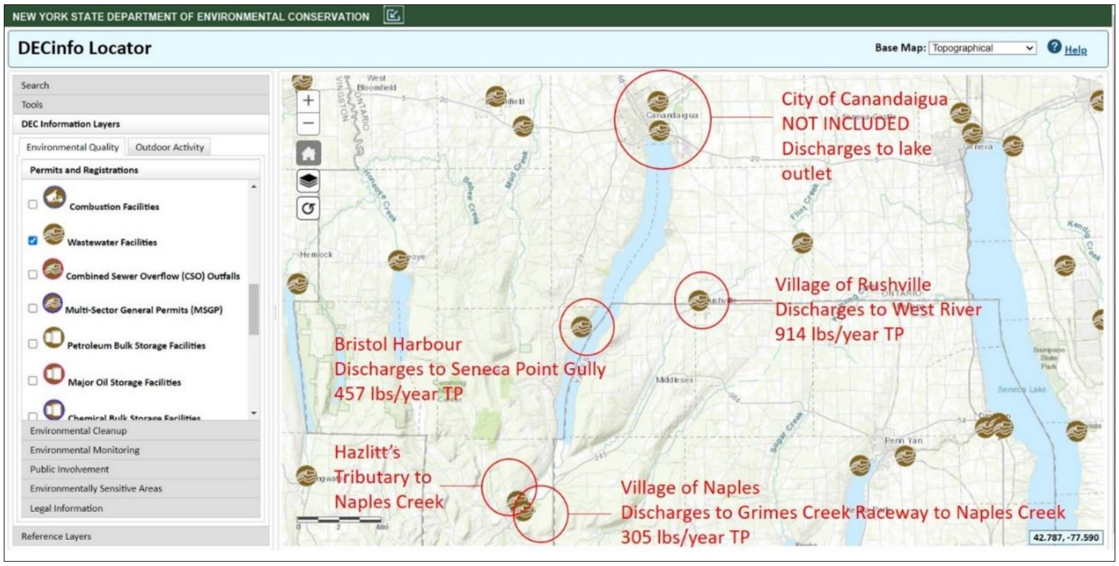

Figure 12. Point Sources of Phosphorus to Canandaigua Lake

Wastewater treatment plants play an essential role in protecting Canandaigua Lake. The maximum potential phosphorus load from the three wastewater treatment plants is 1,676 pounds per year (**Table 8**). Another conservative assumption in the calculation is that all the phosphorus present in the wastewater effluent reaches the lake. Discharge from the WWTPs serving the Villages of Rushville and Naples flows through several miles of tributaries and the southern wetland/floodplain system before reaching Canandaigua Lake. Various processes (physical, chemical, and biological) can reduce phosphorus concentrations within the riparian and wetland ecosystem.

Table 8. Estimated point source phosphorus contribution to Canandaigua Lake

WWTP Name	Discharge Location	Permitted Discharge Monthly Average (million gallons/day)	Permitted Total Phosphorus Daily Maximum (mg/L)	Annual Total Phosphorus Load (lbs.)
Village of Rushville	West River	0.1	Monitor	914
Bristol Harbour Resorts	Seneca Point Creek	0.05	Monitor	457
Village of Naples	Grimes Creek Raceway to Naples Creek	0.05	1 mg/L (seasonal: May 1 to Oct 31)	305
Total Annual Phosphorus Load from Permitted WWTP, lbs.				**1,676**

8.2.3 Landscape Nonpoint Source Phosphorus

As introduced in Section 4.113, the Cornell BEE team completed a SWAT model of the Canandaigua Lake watershed to provide the Watershed Program with a tool to estimate current and future phosphorus export from the watershed. Watershed SWAT models are widely used across Finger Lakes, NYS, and the USA. The model is well suited for applications to agricultural watersheds. SWAT is applied to quantify existing water, phosphorus, sediment, and nitrogen yields in large complex watersheds with varying soils, land use, and management conditions (**Figure 13**). The data files required to set up the SWAT model include:

- Land surface elevation (source: USGS Digital Elevation Model data set, 10 m, 2018)
- Land cover (source: 2016 National Land Cover Database, from the federal Multi-Resolution Land Characteristics Consortium)
- Soil type and hydrologic classification (source: STATSGO, pre-loaded in SWAT)
- Management practices, including fertilization rates (source: County SWCD)

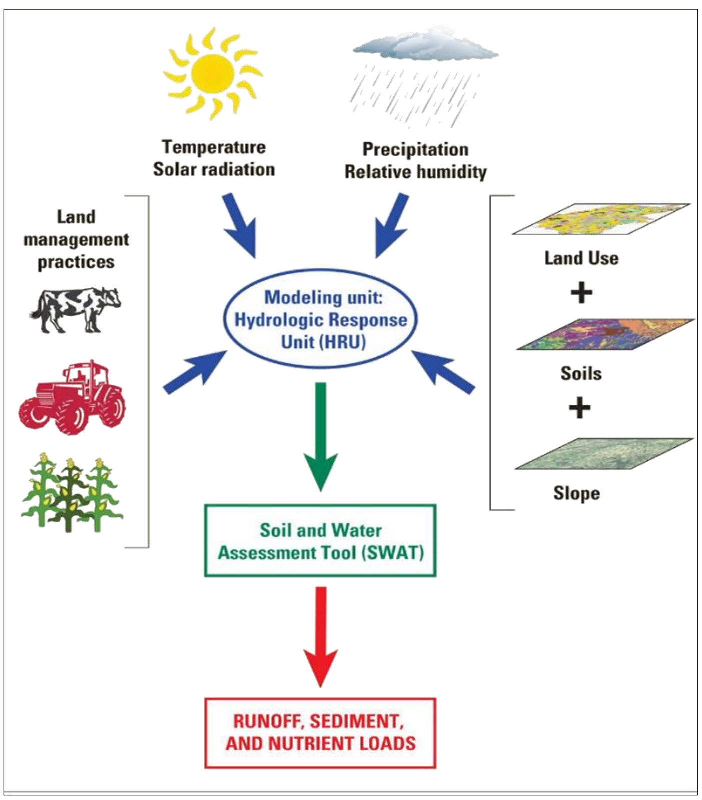

Figure 13. SWAT model schematic

Once developed and tested, the SWAT model can project the potential change in phosphorus export associated with future conditions, including environmental (hydrologic impacts of changing meteorology) and land management (development patterns and Best Management Practices, BMPs).

The modeling team used the extensive record of water quality data from the Watershed Council's long-term tributary monitoring program to achieve the best fit between model predictions and actual measurements (a process known as calibration). Following calibration, modelers run the model for a different period of record and compare predicted responses of streamflow and phosphorus concentrations to a second set of observations not used in calibration (a process known as validation). Data collected within the Canandaigua Lake watershed used to calibrate and validate the SWAT model are summarized in **Table 9** and mapped in **Figure 14.** Additional details on data sources and input files for model set up, calibration and validation are included in **Appendices B and C**.

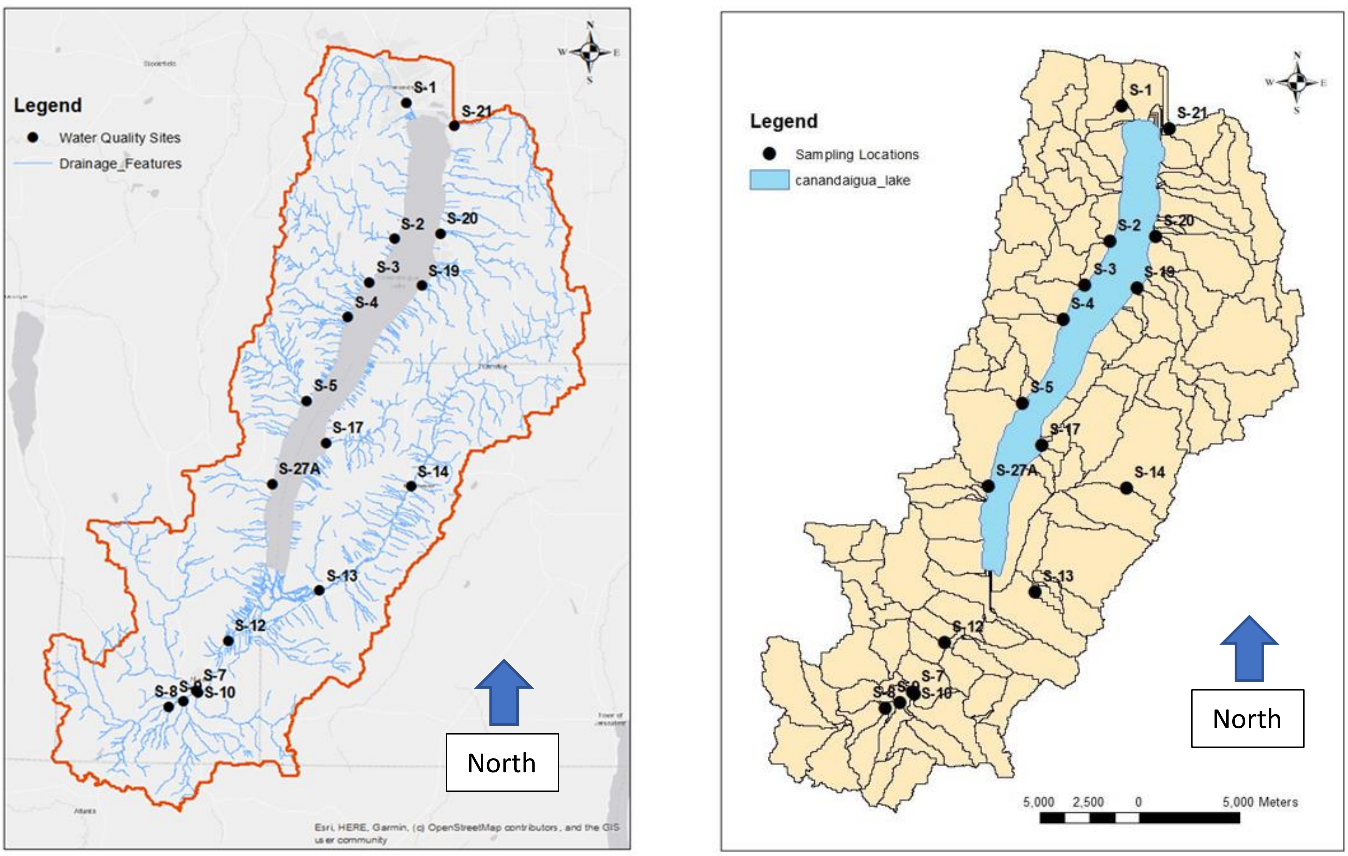

Figure 14 Location of long-term monitoring sites shown with subbasin boundaries and hydrology

Table 9. Summary of tributary data used in the Canandaigua Lake watershed model

Tributary Name	Tributary #	# of Obs. (N)	# of Obs. (P)	# of Obs. (TSS)
Sucker Brook	S-1	59	57	61
Tichenor Gully	S-2	43	45	45
Menteth Gully	S-3	49	52	51
Barnes Gully	S-4	41	43	42
Senes Point Gully	S-5	44	46	46
Grimes Glen	S-7	40	41	40
Eelpot Creek	S-8	42	41	43
Reservoir Creek	S-9	45	45	46
Tannery Creek	S-10	41	41	42
Lower Naples Creek - Rt 245	S-12	57	54	59
Lower West River - Sunnyside	S-13	36	39	31
USGS	S-14	14	9	14
Vine Valley Creek	S-17	42	45	44
Gage Gully	S-19	44	46	46
Deep Run	S-20	43	45	45
Fall Brook	S-A-21	52	50	54
South Bristol Direct Drainage - Cook's Point	27A	37	38	39

The Cornell modeling team applied the calibrated SWAT model to estimate nonpoint sources of phosphorus from the Canandaigua Lake watershed. Note that the watershed wide allocation of land cover used in the model (illustrated in **Figure 15**) reflects the 2016 NLCD available at the onset of the modeling effort. There is interannual variation in agricultural land cover based on many factors, including crop rotation.

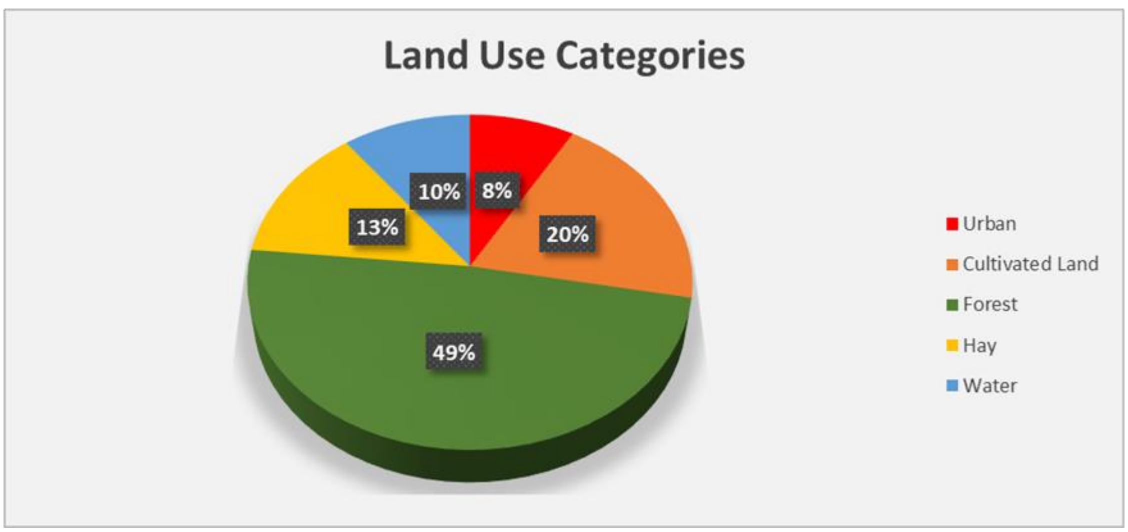

Figure 15. Land use/land cover distribution, watershed wide

Total phosphorus can be transported to the long-term monitoring sites through various processes: sheet flow across the landscape, transport through road ditches and tile drainage outlets, groundwater seepage, any upstream point source discharges, as well as erosion of stream beds and banks and roadside ditches. The SWAT watershed model does not differentiate among these processes. The model estimates material transport from the landscape to the streams. The predicted export coefficients are calibrated/validated to the extensive stream data collected within the Canandaigua Lake watershed. Many water quality samples from tributaries were collected over a range of hydrologic conditions. SWAT results reflect the net transport of sediment and phosphorus to stream monitoring locations. SWAT then allocates these calibrated loads to the land uses it can model; thus, the model attributed load originating from streambank and ditch erosion to the surrounding landscape. The effect of this model limitation is to over-estimate phosphorus loads from land cover classes. This limitation/caveat to this otherwise robust model needs to be understood and taken into context.

Extensive field observations, along with stressed stream analyses, indicate that streambank and road bank erosion is evident in regions of the Canandaigua Lake watershed. Based on this local knowledge, efforts to restore and stabilize eroding sections of stream banks and road banks are among the recommendations of this Nine Element Plan. In addition, a monitoring program to assess the phosphorus reduction associated with these measures is recommended.

The Cornell BEE modeling team solicited input from local SWCDs and other agricultural experts to ensure that the assumed rates of nutrient application used in the SWAT model reflected local practices as of 2016. However, the Canandaigua Lake watershed has recently benefitted from an expansion of nutrient management planning and field based BMPs such as cover crops, WASCOBs, grassed waterways, and other practices. Reductions in phosphorus export to the waterways achieved by these recent BMPs are not reflected in the model estimation of current conditions. This represents another factor contributing to an overestimate of the potential contribution of agricultural land cover and practices to the current phosphorus load.

The Cornell team simulated the impacts of a 15% increase in precipitation on phosphorus transport to the lake and projected a net increase of phosphorus loading to the lake on the order of 5%. This result reinforces the importance of planning for increased phosphorus loading with increased precipitation amounts and intensity. Proactive phosphorus reductions through enhanced watershed management can help build resiliency into the watershed system to buffer impacts of climate change on lake water quality.

9. Summary of Existing Phosphorus Load

Based on estimates generated by the three tools (septic system calculations, point source permit limits, and SWAT model projections) an estimated 45,843 pounds of phosphorus enter Canandaigua Lake annually (**Table 10**). The three models are grounded in monitoring data, background information, and field experience. However, each of the three tools is also based on assumptions; each carries uncertainty and data limitations as described in Section 8. Despite the inherent imprecision of load estimates, the tools collectively provide valuable information to guide efforts to reduce phosphorus load to Canandaigua Lake.

One of the most valuable features of quantitative analysis is the ability for watershed managers to compare relative phosphorus sources across the landscape and estimate load reductions associated with various BMPs. These tools can help define priority actions that offer the greatest value to protecting the ecosystem services offered by the Canandaigua Lake watershed. Selection and implementation of protective measures will be informed by model projections, field observations, water quality monitoring among other key considerations such as willing partners and availability of resources, both financial and technical.

Table 10. Average annual total phosphorus loading from 2000 to 2020 based on the watershed model, septic system calculations, and permitted load from wastewater treatment plants

Land Cover Category and Wastewater Sources	Land Cover (acres)	Annual Total Phosphorus Load (lbs./year)	Percent of Total Phosphorus Load
Residential/Commercial	10,211	4,003	9%
Cultivated Land	23,840	21,899	48%
Forest and Wetlands	59,111	7,901	17%
Hay/Pasture and Successional Old Fields	15,984	7,364	16%
Septic Systems	--	3,000	7%
Wastewater Treatment Plants	--	1,676	4%
Total	**109,145**	**45,843**	**100%**

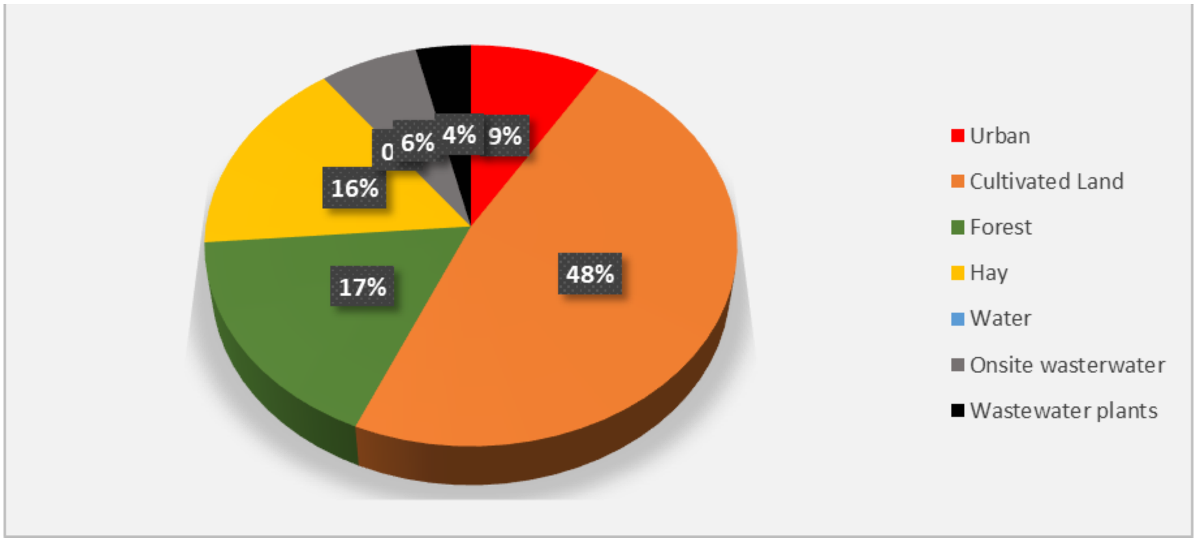

Figure 16. Total Phosphorus loading on a percent basis per major land use and wastewater category

The estimated phosphorus load to Canandaigua Lake is 45,843 pounds distributed among different land cover and management practices, onsite systems, and wastewater plants (**Figure 16**). Agricultural lands, including cultivated row crops, pasture, and hay fields contribute a combined total of 64% of the external phosphorus load to Canandaigua Lake. Recall that the SWAT model is not capable of estimating how much of the measured and modeled phosphorus load originates from eroding streambank and road banks. In addition, the model does not incorporate many of the recent field-based improvements across the watershed. Rather, the model allocates the measured and modeled phosphorus load to export from the watershed lands, thus potentially overestimating their contribution. However, the long-term sampling program has consistently documented the highest concentrations of phosphorus in streams draining agricultural and suburban/urban based subwatersheds. A continued focus on agricultural management practices at the field scale in combination with additional hydrologic resiliency projects will be critical to successful implementation of the Nine Element Plan.

It is also important to acknowledge the importance of non-agricultural sources which contribute an estimated 38% of the annual load to the lake. These sources also need proactive management. Onsite systems that are not failing contribute 7% of the load. It is critical to not only maintain these systems to prevent failure, but also to fully implement wastewater strategies that reduce phosphorus export. Wastewater treatment plants represent approximately 4% of the phosphorus load based on meeting their permit requirements. Urban/residential areas contribute 9% of the load from a relatively small land area; these sources, especially along the lake shoreline and stream systems need to be managed properly. For example, sampling Sucker

Brook upstream and downstream of the City of Canandaigua confirms that phosphorus concentrations increase as the stream flows through urbanized areas.

Forested areas cover 49% of the land area and contribute approximately 17% of the phosphorus load. Protecting forested areas, along with enhancing their hydrologic resilience, is another key component of successful watershed management.

Output of the SWAT model has been compiled and mapped with respect to the sub-basins that have long guided the lake management team. The maps displayed in **Figure 17** display the relative phosphorus load across the landscape by subwatershed, calculated as unit load (pounds per acre) and total load (pounds per year). These maps will be another decision support tool in identifying priority areas for management actions.

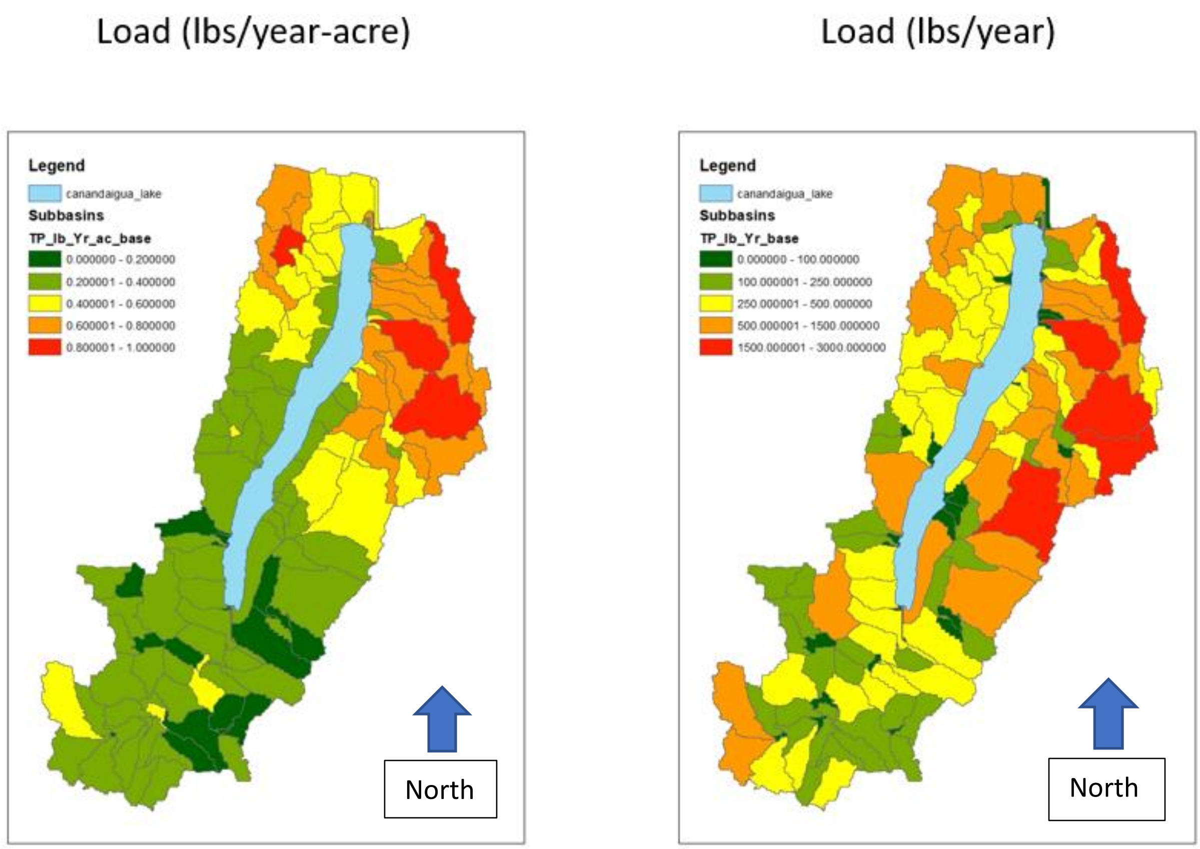

Figure 17. Phosphorus export by SWAT derived subbasins, SWAT model projections

10. Development and Evaluation of Alternatives

10.1 Watershed Wide

The quantitative assessment tools developed for the Nine Element Plan were utilized to evaluate potential phosphorus load reductions achieved by adoption of selected BMPs. The project team first estimated impacts on a watershed-wide basis to assess the potential of feasible practices to contribute toward meeting phosphorus reduction targets. BMP implementation is voluntary and will continue to be so; these model results are intended to guide discussion not to provide a mandate for specific actions.

The SWAT model was applied to demonstrate the estimated phosphorus load reductions from three scenarios:

- Scenario 1: Reduce Fertilizer and Manure Application to Agricultural Lands by Expanding Participation in Nutrient Management Planning
- Scenario 2: Installation of Winter Cover Crops on Agricultural Land
- Scenario 3: Reduced Fertilizer Application to Residential and Urban (Developed) Lands

A fourth scenario was evaluated using the septic system estimation tool:

- Scenario 4: Implementation of the Onsite Wastewater Law

Scenario 1: Nutrient Management Plans

Nutrient management plans are tailored to an individual farm and strive to balance fertilization rates and timing based on crop needs and background soil fertility. To estimate the effectiveness of expanding agricultural nutrient management planning, the model team simulated the impact of reducing application of fertilizer and manure to cultivated lands and hay fields (**Table 11**). A realistic target for reduction of phosphorus application through manure and fertilizer for farms with nutrient management plans is in the range of 20%. Model projections of the impact of 100% reductions are included as a boundary calculation to illustrate that phosphorus export from the landscape will continue.

Table 11. Projected reduction in total phosphorus (TP) loading resulting from nutrient management planning- reduction of fertilizer and manure application to cultivated land and hay land

Land Use Category and Wastewater Sources	Area (acres)	Baseline Total Phosphorus Load (lbs./year)	Reduce fertilizer & manure application by 10% (lbs./year)	Reduce fertilizer & manure application by 20% (lbs./year)	Reduce fertilizer & manure application by 100% (lbs./year)
Residential/Commercial	10,211	4,003	4,003	4,003	4,003
Cultivated Land	**23,840**	**21,899**	**19,588**	**18,565**	**4,902**
Forest and Wetlands	59,111	7,901	7,901	7,901	7,901
Hay/Pasture and Successional Old Field	**15,984**	**7,364**	**7,183**	**7,001**	**5,171**
Septic Systems	--	3,000	3,000	3,000	3,000
Wastewater Treatment Plants	--	1,676	1,676	1,676	1,676
Total	**109,145**	**45,843**	**43,351**	**42,146**	**26,653**

Scenario 2: Expanded Adoption of Winter Cover Crops

Cover crops are an increasingly popular practice for reducing erosion and improving soil health of cultivated lands. The Ontario and Yates County SWCDs are promoting cover crops in Soil Health workshops, field visits and grant funding applications. The use of cover crops has substantially expanded in recent years. The purpose of cover cropping is to retain vegetative cover on the land from post-harvest in the fall through spring planting. Vegetation helps stabilize soils, improve infiltration potential, and thus minimize runoff and erosion. Phosphorus and nitrogen are incorporated into plant biomass, retaining more nutrients on the landscape, and improving soil health. The SWAT model projections summarized in **Table 12** demonstrate the potential for substantial phosphorus load reductions from widespread adoption of cover crops on cultivated fields. Installing cover crops on lands that were getting medium and high levels of nutrient application (approximately 10,000 acres of cultivated land) could result in an annual phosphorus load reduction of approximately 5,000 lb. This reduction equates to a reduction in phosphorus loading rate of about 0.5 lb./acre.

Table 12. Projected reduction in total phosphorus (TP) loading resulting from expanded adoption of winter wheat cover cropping on cultivated lands

Land Use Category and Wastewater Sources	Area (acres)	Baseline Total Phosphorus Load (lbs./yr.)	Cover Crops on medium and high nutrient application cultivated lands- 10,000 acres (lbs./yr.)	Cover Crops on all cultivated land (lb./yr.)
Residential/Commercial	10,211	4,003	4,003	4,003
Cultivated Land	**23,840**	**21,899**	**16,907**	**12,556**
Forest and Wetlands	59,111	7,901	7,901	7,901
Hay/Pasture and Successional Old Field	15,984	7,364	7,364	7,364
Septic Systems	--	3,000	3,000	3,000
Wastewater Treatment Plants	--	1,676	1,676	1,676
Total	**109,145**	**45,843**	**40,850**	**36,449**

Scenario 3: Reduction in fertilizer application to residential and urban landscapes

Although developed lands do not currently comprise a large component of the Canandaigua Lake watershed, the unit export of phosphorus from developed lands can be high. Phosphorus load from developed areas can be elevated because of increased runoff from impervious surfaces coupled with application of phosphorus fertilizers to residential and commercial lawns and gardens. The SWAT model was applied to evaluate the impact of reduced application of fertilizers on watershed phosphorus export, as summarized in **Table 13**.

Table 13. Projected reduction in total phosphorus (TP) loading resulting from developed lands

Land Use Category and Wastewater Sources	Area (acres)	Annual Total Phosphorus Load (lbs./yr)	20% Reduction in Fertilizer application on developed land (lbs./yr.)	100% Reduction in Fertilizer application on developed lands land (lbs./yr.)
Residential/Commercial	**10,211**	**4,003**	**3,767**	**2,823**
Cultivated Land	23,840	21,899	21,889	21,889
Forest and Wetlands	59,111	7,901	7,901	7,901
Hay/Pasture and Successional Old Field	15,984	7,364	7,364	7,364
Septic Systems	--	3,000	3,000	3,000
Wastewater Treatment Plants	--	1,676	1,676	1,676
Total	**109,145**	**45,843**	**45,478**	**44,016**

Scenario 4: Implementation of the Onsite Law

Upgrading septic systems has the potential to further reduce phosphorus loading. To estimate benefits of upgrading septic systems to provide for higher treatment levels, the same equations were run, except the removal efficiency at the end of the absorption area was increased from 57% to 80%. The estimated loading from septic systems was reduced to 1,395 pounds per year from 3,000 pounds per year- a reduction of 1,605 pounds per year.

10.2 Subwatershed Analysis

The quantitative tools developed for the Nine Element Plan also support an analysis of the potential effectiveness of various BMPs at the subwatershed scale. The HUC12 scale is commonly used for Nine Element Planning. HUC is an acronym for Hydrologic Unit Code; this classification system was developed by the United States Geological Survey (USGS) and the USEPA as a means of identifying and tracking nested watersheds. The hydrologic unit hierarchy is indicated by the number of digits in groups of two (such as HUC2, HUC4, and HUC6) within the HUC code. For example, HUC4 represents the subregion level, delineating large river basins. HUC8 maps the subbasin level, analogous to medium-sized river, and HUC12 is a more local sub-watershed level that captures tributary systems. Data and information regarding land uses and management practices are typically available to support a detailed analysis at the HUC12 level. There are five HUC12 tributary subwatersheds to Canandaigua Lake (**Figure 18).**

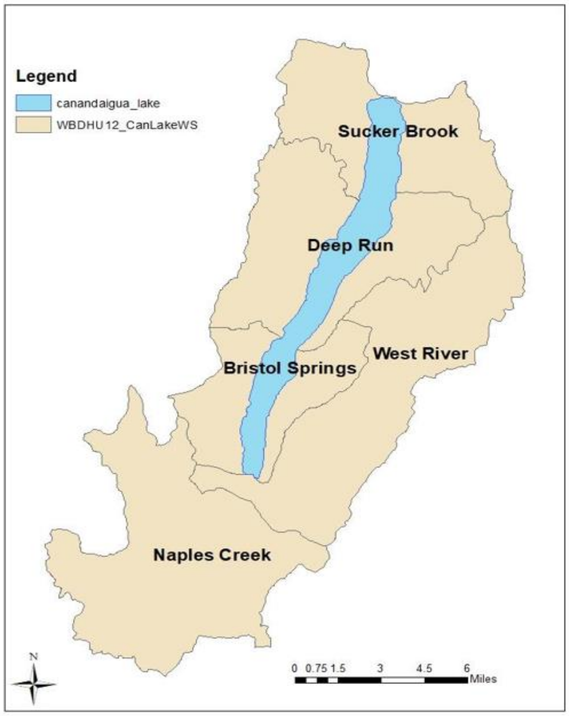

Figure 18. Delineation of HUC12 Subwatersheds

Land cover breakdown within the HUC12 subwatersheds plays an important role in determining the potential effectiveness of phosphorus reduction measures. Note the variability in land cover among the five subwatersheds as summarized in **Table 14** and displayed in **Figure 19.**

Table 14. Phosphorus load and land cover by HUC12 Subwatershed

HUC- 12	Total P Load (lbs/year)	Land Area (acres)	Cultivated Land (acres/%)	Hay, Pasture & Successional Fields (acres/%)	Forest (acres/%)	Residential/ Urban (acres/%)
1-Naples Creek	8,480	31,482	2,800 / 9%	2,539 / 8%	24,428 / 78%	1,716 / 5%
2- West River	13,595	28,205	8,555 / 30%	4,004 / 14%	13,970 / 50%	1,676 / 6%
3- Bristol Springs	3,371	11,957	989 / 8%	1,607 / 13%	8,529 / 71%	832 / 7%
4- Deep Run	9,780	21,143	5,259 / 25%	5,079 / 24%	9,109 / 43%	1,696 / 8%
5- Sucker Brook	10,617	18,035	6,244 / 35%	2,761 / 15%	4,732 / 26%	4,298 / 24%
Total	45,843	110,823	23,847 / 22%	15,990 / 14%	60,768 / 55%	10,217 / 9%

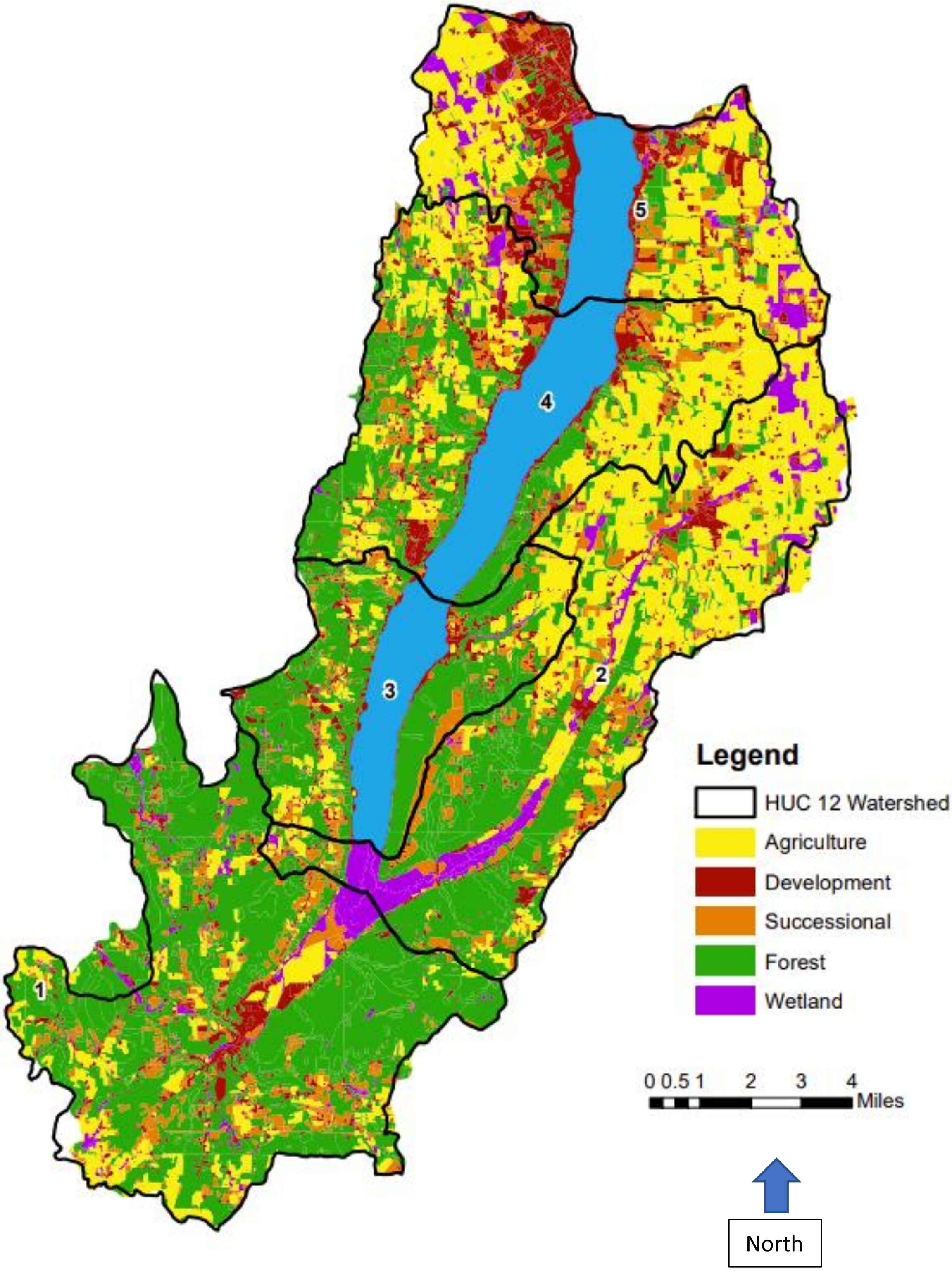

Figure 19. Variation in land cover across Canandaigua Lake watershed

The management scenarios described in Section 10.1 are reported by HUC12 subwatersheds in **Table 15** (nutrient reduction) and **Table 16** (expanded cover crops and reduced fertilizers on residential and commercial properties)

Table 15. BMP Scenario: Reduce agricultural total phosphorus (TP) application rate

HUC- 12	Baseline TP Load (lbs./year)	Projected TP Load with 10% reduction (lbs./year) *(% Reduction)*	Projected TP Load with 20% reduction (lbs./year) *(% Reduction)*	Projected TP Load with 100% reduction (lbs./year) *(% reduction)*
1-Naples Creek	8,480	8,139 *(4%)*	8,024 *(5%)*	6,093 *(28%)*
2- West River	13,595	12,659 *(7%)*	12,273 *(10%)*	6,753 *(50%)*
3- Bristol Springs	3,371	3,253 *(4%)*	3,199 *(5%)*	2,453 *(27%)*
4- Deep Run	9,780	9,289 *(5%)*	8,954 *(8%)*	5,463 *(44%)*
5- Sucker Brook	10,617	10,010 *(6%)*	9,695 *(9%)*	5,891 *(44%)*
Total	45,843	43,351	42,146	26,563

Table 16. BMP Scenario: Increase cover crop on cultivated lands; decrease fertilizer application on developed properties

HUC- 12	Baseline TP Load (lbs./year)	Projected TP Load with 42% cover crops (lbs./year) *(% reduction)*	Projected TP Load with 100% cover crops (lbs./year) *(% reduction)*	Projected TP Load with 20% reduction in Residential/Urban Fertilizer use (lbs./year) *(% reduction)*	Projected TP Load with 100% reduction in Residential/Urban fertilizer use (lbs./year) *(% reduction)*
1-Naples Creek	8,480	7,875 *(7%)*	7,357 *(13%)*	8,404 *(1%)*	8,101 *(4%)*
2- West River	13,595	11,684 *(14%)*	10,073 *(26%)*	13,451 *(1%)*	12,874 *(5%)*
3- Bristol Springs	3,371	3,167 *(6%)*	2,959 *(12%)*	3,345 *(1%)*	3,239 *(4%)*
4- Deep Run	9,780	8,804 *(10%)*	7,848 *(20%)*	9,768 *(0%)*	9,718 *(1%)*
5- Sucker Brook	10,617	9,321 *(12%)*	8,262 *(22%)*	10,510 (1%)	10,084 *(5%)*
Total	45,843	40,850	36,499	45,478	44,016

11. Implementation Strategy

The goal of the Nine Element Plan is to augment and quantify the phosphorus reduction strategies identified in the 2014 Watershed Plan to realize the community's vision of maintaining and enhancing the high water quality of this watershed for future generations. Previous sections of the Nine Element Plan have summarized recent data and trends in lake and tributary water quality and land cover, described the institutional structure for watershed management, and summarized results of applying quantitative tools to identify phosphorus sources. The project team has identified proactive quantitative targets for both watershed phosphorus export and in-lake phosphorus concentrations.

This section details the implementation strategy that will be employed to focus implementation efforts on meeting the defined phosphorus targets. The final section will identify the monitoring and evaluation approaches that will be used to measure the success of these efforts.

A critical feature of the Nine Element planning process is to quantify how recommended actions will advance progress toward achieving phosphorus targets. Phosphorus reduction strategies identified in the following tables include an estimated phosphorus reduction; these estimated reductions are based on model projections and/or literature values.

The strategies also reflect local knowledge and experience, as noted below:

- Strategies identified in the 2014 Watershed Plan and follow the principles of protection and enhancement of natural capital/ecosystem services to build resilience
- Community input received during public presentations, Association meetings and the Nine Element Plan comment section on the Watershed Council website
- Input from resource agency staff reflecting their combined expertise- especially on agricultural lands and practices
- Watershed staff experience with implementing projects over the last 20+ years
- Water quality sampling identifying the need to do landscape scale projects
- Literature Reviews and ESF Master's Thesis (Alison Rickard)
- STEPL, CWP, CAST and other model reduction estimates along with cost per unit of reduction
- Ability to implement these projects on a voluntary basis
- Access to grant funding
- Municipal and overall public support for implementation

Five management focus areas are identified in the Nine Element Plan and recommended strategies are developed for each management category. The categories are broad and thus consolidate many of the categories developed as part of the 2014 Watershed Management Plan.

The tables provide the following information:

- **Geographic focus area**- Many projects can be implemented across the watershed landscape. This column will also highlight geographic and land use areas that should be prioritized. There still needs to be flexibility in this approach as successful projects can be built or implemented in areas that may not be the high geographic focus area.
- **Estimated phosphorus reduction**- As noted above, there are multiple sources for these estimated reductions.
- **Estimated cost**- Some actions will have a broad range of estimated costs, depending on site location, in-house vs contractor, equipment availability, land costs, etc. The cited estimates are based on published guidance documents, case studies, and the project team's combined local experience.
- **Priority and timeframe**- Projects and strategies included in the tables have been developed through multiple sources; all are considered important to implement over the next 10 years. Many are already being implemented. The goal is to accelerate this process and quantify the results. Most, if not all, of the identified projects and strategies will be on-going, as they need to be implemented across the watershed in multiple locations.
    - High Priority strategies should begin to be implemented within the next one-three years.
    - Medium priority strategies should begin to be implemented within the next five years.

11.1 Focus Area 1: Enhance Wetlands, Floodplains and Watershed Resiliency

Watershed wetlands and floodplain systems provide essential ecosystem services to protect the Canandaigua Lake's water quality. The 2014 Watershed Plan placed a high priority on enhancing the resilience of these systems to filter pollutants and reduce flood risk. Over the last few years, the Watershed Council completed multiple wetland/floodplain resiliency projects within the Sucker Brook, Fallbrook, and Naples Creek subwatersheds. The FLCC Fallbrook project, the multiple projects on Naples Creek, and the most recent Sucker Brook projects were completed after development of the SWAT watershed model. Phosphorus reductions from these projects will be credited against the baseline estimated load.

Enhancing wetlands and floodplains collectively offers the greatest potential to reduce phosphorus loads given the watershed's existing land cover and the diffuse phosphorus contributions from across the wide landscape. Other upland projects to enhance hydrologic resiliency are important as well. The general design approach is to slow velocity and enhance infiltration of overland flow that transports phosphorus from the landscape to the waterways. These types of projects can be used across varying land uses. They offer enhanced resilience to the projected changes in hydrology due to climate change.

Focus Area One Project Example: Naples Creek/Parish Flats Water Quality Project

Over the last few years, the Canandaigua Lake Watershed Council, consisting of the fourteen watershed and water purveying municipalities coordinated the project to reconnect Naples Creek to its adjacent natural water quality filtration system in many interdependent locations across the valley floor and over a 1.5 miles of stream length. Naples Creek is an important trout stream that flows north toward Canandaigua Lake through the Village of Naples, and ultimately through the NYS owned High Tor Wildlife Management Area. Naples Creek has a 30,000-acre steep sloped subwatershed, encompassing 25% of the overall 109,000-acre Canandaigua Lake watershed. Extensive storm event sampling over a 20-year period has documented that Naples Creek is a substantial contributor of nutrients and sediment to Canandaigua Lake. Consequently, this tributary subwatershed is a high priority for investing in projects to restore the hydrologic resilience and reduce the risk of pollutant inputs.

Over time, human actions have altered the Naples Creek system as it flows past the Village of Naples and through the Parish Flats/High Tor area. These actions have largely disconnected the stream from its natural floodplain water filtration system. Historic practices, such as the building of berms along the creek to contain flood flows, road systems that act as berms and push flood flows away from natural filtration areas, and widespread ditching of residential and agricultural areas have re-plumbed the drainage network. The result was to route moderate storm flows (which carry most of the nutrients and sediment to the lake each year) directly to the lake. During more extreme storms the berms and road systems exacerbate flooding issues in residential areas and farm fields.

Highway Departments from the Towns of Naples and Canandaigua, along with many partners, listed below, completed a major effort to restore the natural flood plan functionality along Naples Creek. The project included the following:

- Four new large road cross culvert systems on NYS Rt. 245 to allow a portion of these flood waters to flow back into 100+ acres of easement and TNC acquired natural lands for water quality treatment and flood retention. These flood waters were previously flooding homes and closing roads

- Five new large road cross culverts on Parish Cross Road to convey flood flows into the High Tor wetland system for water quality treatment that would otherwise be shunted quickly back into Naples Creek and ultimately the lake.

- Five berm (barrier) breaks on NYS DEC land that allowed moderate storm event flood flows to reconnect with the 100s of acres of floodplain system for water quality treatment.

- 80-acre acquisition by TNC along Naples Creek and 30-acres of critical donated conservation easements to the Town of Naples- 6,300 feet of Naples Creek riparian zone protected

- Seven berm breaks along Naples Creek and its tributaries on the 80-acre land that TNC purchased and the 30 acres in easement areas donated to the project. These berm breaks allow flood flows to once again enter the natural floodplain area for water quality treatment.

- Major storms in 2021 had created significant log jams in a few locations that were causing more harm than benefit. Strategic log jam removals were completed by the Watershed Council/ Town of Canandaigua Highway Department and coordinated with NYS-DEC.

- Fixed ½ mile of DEC trail along Naples Creek damaged during flood events and encouraged flow to enter more of the floodplain area on both sides of the creek for water quality treatment.

These combined efforts have greatly helped to re-establish the natural floodplain connection in the Naples Creek Valley of the Canandaigua Lake watershed. These 22+new (restored) floodplain re-connection points and strategic land protection efforts allow a significant portion of the peak flows in Naples Creek to access more than 300 acres of land that had been largely cut off except in the most extreme events. These 300 acres provide substantial water quality filtering ecosystem services as they are a mixture of floodplain forest, grassland, and wetland systems.

Approximately 25% of the water flowing into Canandaigua Lake each year, or approximately 10 billion gallons, enters through Naples Creek. The benefits of the floodplain reconnection will be evident during storm events that deliver most of the annual load of nutrients, including phosphorus, sediment, and bacteria to Canandaigua Lake. During a typical hydrologic year, Naples Creek is projected to overflow into the project area during six to eight storm events. These storms carry the vast majority of nutrients and sediment to the lake on an annual basis. Access to the floodplain during high flows will provide water quality improvement through enhanced infiltration and pollutant capture. With the anticipated increase in storm intensities and overall increase in precipitation, projects such as implemented on Naples Creek will build resiliency to the impacts of climate change. The Watershed Council and its partners will be monitoring this project during storm events and will continue to look at additional opportunities to enhance the potential of this natural filtration and flood reduction system.

Recommended projects and strategies in support of Focus Area 1 are included in Table 17.

Key partners for project design and implementation include the Watershed Council, municipalities, land trusts, SWCDs, CLWA, NYS-DEC

Table 17. Recommended Actions to Reduce Phosphorus Input. Focus Area 1: Wetland, Floodplain and Watershed Resiliency

Focus Area 1: Enhance Wetlands, Floodplains and Watershed Resiliency				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
Protect, enhance, and restore existing wetlands, riparian corridors and floodplains through easements and land purchase to increase their capability of storing and treating runoff from areas with upstream sources of phosphorus and pollutant loading. Successful projects have been implemented throughout the watershed (Naples, Fallbrook, Sucker Brook) and need to be accelerated throughout other areas of the watershed. These projects provide for critical source water protection	Watershed-wide Naples Creek and West River subwatersheds Downstream of Ag-dominated subwatersheds Use the Natural Capital Model, field investigations and local municipal knowledge to continue to identify critical source water protection areas	Wetlands: 46% removal of TP (TN 51%, TSS 53%)[1]	\$5,000-10,000/acre Plus restoration costs	High priority On-going
Create new wetlands, riparian zones and water quality basins to accept runoff from areas with high phosphorus/pollutant potential	Watershed-wide Ag-dominated subwatersheds	Wetlands: 46% removal of TP (TN 51%, TSS 53%)[1] Floodplain: Site-specific [SK]	\$5,000-10,000/acre Plus restoration costs	High Priority On-going

		Wetland: 20-40% SK		
Protect and/or restore other types of watershed lands that provide a high level of ecosystem services such as meadows, successional old fields and forested lands	Watershed-wide	Site Specific	$5,000-10,000/acre Plus restoration costs	Medium Priority On-going
Source water protection funds through the NYS DEC and other sources of funding will be utilized to acquire land or easements across the watershed to include but not limited to the Naples Creek and West River HUC 12s that were previously deemed ineligible. Shoreline areas, riparian corridors, wetland systems, steep slope lands and other land areas that are deemed to have a high source water quality benefit will be eligible for acquisition. Included in these source water protection areas are lands such as marginal ag lands that could be restored to provide for a substantially higher natural capital ranking as it relates to water quality.	Project areas will continue to be identified and prioritized using the Natural Capital Model methods developed in 2018 along with field reconnaissance and water quality monitoring results. Priority will be given to floodplain systems, riparian corridors, steep slope areas and lands that can be restored to increase their overall natural capital ranking.	Wetlands: 46% removal of TP (TN 51%, TSS 53%)[1] Floodplain: Site-specific SK Wetland: 20-40% SK	$5,000-10,000/acre Plus restoration costs	High Priority and ongoing

11.2 Focus Area 2: Agriculture

Agricultural land encompassing both row crops and hay/pasture lands are vital to the region. The long-term sampling program, field investigations during storm events, and SWAT model projections confirm that agriculture can also be an important contributor of nutrients, sediment, and bacteria to the streams and lake. Model results indicate that agriculture is the most significant contributor of phosphorus to the lake when compared with the other major land uses of forest land, wetlands, residential/urban areas along with onsite systems and wastewater treatment plants.   Agriculture as a significant contributor of phosphorus has long been recognized and has been the focus of many BMP projects over the years.

Many of the strategies identified in the table below are not new. They are time tested strategies that need to be expanded across the watershed, especially in the agriculturally dominated subwatersheds. Some of the strategies are newer and will be piloted across the Canandaigua watershed as well as other Finger Lakes watersheds. Phosphorus reduction estimates are based on a wide array of sources. Local Soil and Water Conservation Districts will continue to play a critical lead role in identifying potential partners and funding sources for implementation.

Recommended projects and strategies in support of Focus Area 2 are included in Table 18.

Key partners for project design and implementation include the Soil and Water Conservation Districts, Natural Resource Conservation Service, NYS-Ag and Markets, Cornell Cooperative Extension, and the Watershed Council. Municipalities, land trusts, CLWA can also play a key role.

Table 18. Recommended Actions to Reduce Phosphorus Input. Focus Area 2: Agriculture

Focus Area 2: Agriculture				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
Increase nutrient planning through soil testing and education programs or the adoption of comprehensive nutrient management plans	Agriculturally dominated subwatersheds, highly erodible land, Watershed-wide	See modeled scenarios Modify phosphorus Placement, timing and rate: 10-20%[2]	Soil testing: \$20/sample, manure testing: \$35/sample CNMP: \$5-\$10/acre	High Priority On-going
Promote and expand the use of cover crops wherever feasible	Agriculturally dominated subwatersheds Watershed-wide	See modeled scenarios Avg: 0.5 lbs. of phosphorus reduction per acre of cover crop	\$100 per acre for seed + installation	High Priority On-going
Implement both on field and off field-based erosion reduction practices (including but not limited to grassed waterways, WASCOBs, strip cropping, etc.)	Agriculturally dominated subwatersheds, highly erodible land, Watershed-wide	Site specific based on type of practice, length of flow path, extent, and severity of erosion problem and land cover	Variable- utilize NRCS cost estimates	High Priority On-going
Enhance and accelerate the use of public and private dollars to compensate agricultural producers for voluntary acquisition/easement of marginal but active agricultural lands with high potential for ecosystem services	Agriculturally dominated subwatersheds Watershed-wide	Site specific	\$4000-\$6000 per acre for marginal farm land	High Priority On-going

Focus Area 2: Agriculture				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
Purchase conservation agricultural equipment (e.g., interseeders) that can be promoted to and shared by watershed farms to enhance capacity to implement cover crops	Watershed-wide	Refer to Table 16	$100,000+	Medium Priority On-going
Where feasible, work with agricultural landowners to develop manure application rate based on a lower phosphorus index - to reduce risk of phosphorus runoff to waterways	Agriculturally dominated subwatersheds Watershed-wide	Use of Phosphorus Index (Phosphorus Placement): 10 to 20%[2]	Variable	Medium Priority On-going
Create water quality basins and/or buffers at the edge of a field to a stream or road side ditch and on fields with long flow paths to filter runoff before it enters streams or roadside ditches	Agriculturally dominated subwatersheds Watershed-wide	Wetland creation, enhancement, rehabilitation, restoration: 22 to 40%[2] Forest or Grass Buffer: 30 to 45%[2]	$5,000 per acre of land Variable installation costs	High Priority On-going
Explore technologies that would reduce overall amount of manure in the watershed such as regional anaerobic digestors	Agriculturally dominated subwatersheds Watershed-wide	Variable; potentially 100% of material Diverted [SK]	$1,000,000+	Medium Priority On-going

Focus Area 2: Agriculture				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
Increase participation in AEM or other agricultural education programs by non-CAFO farms. Continue efforts to engage members of the Mennonite and Amish (Plain Sect) farming community.	Agriculturally dominated subwatersheds Watershed-wide	Site-specific [SK] Manure Incorporation: 12-24% [SK] Tillage Management: 2-71% [SK] Rotational/Prescribed Grazing: 24% [SK]		High Priority On-going
Exclude livestock from streams and other drainage systems.	West River system Agriculturally dominated subwatersheds Watershed-wide	Site-specific exclusionary fencing increases forested/grassed buffer efficiency by 12-37% [SK]	Variable- use NRCS fencing cost estimates	High Priority On-going
Provide funding and/or technical assistance for waste storage and transfer, alternative waste management, precision feed management and barnyard protection.	Animal based farm operations, agriculturally dominated subwatersheds Watershed-wide	Livestock-dependent: Beef: 39% [SK] Dairy: 20% [SK] Hogs: 39% [SK] Poultry: 9% [SK] Sheep/Horses/Goats: 3% [SK]	Variable	Medium Priority On-going

Focus Area 2: Agriculture				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
Work with agricultural property owners to increase the protection of riparian areas	Agriculturally dominated subwatersheds, highly erodible land, Watershed-wide	75% for riparian zones under 25 meters (72% TN, 84% TSS)[1] 91% for riparian zones over 25 meters (88% TN, 94% TSS)[1] Forest Buffer: 30 to 45%[2]	Variable- depends on the quality of ag land	Medium Priority On-going
Encourage crop residue mulching on row crop lands	Watershed-wide	Variable [SK]	Low cost	Medium Priority On-going
Continue to develop, organize, and lead Soil Health Workshops for the farming community to provide technical assistance, establish partnerships, and share information	Agriculturally dominated subwatersheds, highly erodible land, Watershed-wide	Variable [SK]	Variable- depends on the current state of the soil and how best to integrate into the farm operation	High Priority On-going
Enhanced Agri-chemical management of fertilizers and pesticides. Install proper storage and mixing areas of fertilizers and pesticides to reduce the chances of runoff from this potential pollution hot spot	Agriculturally dominated subwatersheds and watershed wide	Highly effective in reducing fertilizer and pesticide runoff potential when installed and maintained properly	$80,000+ per unit installed	High Priority Ongoing

11.3 Focus Area 3: Improved Resilience and Decreased Erosion of Streams, Roadside Ditches, and Shorelines

Efforts to identify measures to reduce the risk of eroding stream beds and banks and road ditches are a continuing focus of watershed management in the Canandaigua Lake watershed. The tools can be used in both preventative and remedial based applications such as stream/road bank stabilization, in-stream measures to slow velocity, design, sizing, and siting of culverts. Although the SWAT model was not capable of estimating phosphorus export from these areas, there is ample field evidence and research indicating that these areas can be substantial contributors of phosphorus to the lake.

Recommended projects and strategies in support of Focus Area 3 are included in Table 19.

Key partners for project design and implementation include State, County, and Municipal Highway Department personnel, the Watershed Council, County Soil and Water Conservation Districts, CLWA, and many educational resources (e.g., Cornell Local Roads Program, Lake Friendly Living initiative, Cornell Cooperative Extension, Finger Lakes Institute, among others).

Table 19. Recommended Projects and Strategies. Focus Area 3: Reduce Risk of Erosion of Streams, Shorelines, and Ditches

Focus Area 3: Stream, Shoreline and Roadbank Erosion and Resiliency				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
Reduce roadside ditch erosion through re-vegetating, stabilization, reduced scraping, check dams, etc.	Steep slope sections of the watershed with road systems. Watershed-wide	<2.2 lbs./year per linear ft. of ditch (Source: CAST narrow grassed buffer) [OW]	Variable	Medium Priority On-going
Where feasible, disconnect roadside ditches from waterways- without causing unintended consequences of new drainage patterns on downslope areas	Watershed-wide	<2.2 lbs./year per linear ft. of ditch (Source: CAST narrow grassed buffer) [OW] Additional treatment from filtering of runoff- variable	Variable	Medium Priority On-going
Where feasible Reduce streambank erosion through bank stabilization and measures to reduce stream velocity	Watershed-wide	Literature review estimates	\$20-\$150/ ft of stabilization	Medium Priority On-going
Increase use of vegetated buffers along streams, roadside ditches, and shoreline areas	Watershed-wide	75% for riparian zones under 25 meter (72% TN, 84% TSS)[1] 91% for riparian zones over 25 meters (88% TN, 94% TSS)[1] 0.35 lbs./acre/year on developed lands (citing CAST forest buffer) [OW]	\$243/acre (citing CAST forest buffer) [OW]	High Priority On-going

Focus Area 3: Stream, Shoreline and Roadbank Erosion and Resiliency				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
Protect shoreline areas by increasing the use of nature-based (soft) erosion control and reducing development in shoreline areas	Shoreline area around lake	Variable	Variable	Medium Priority On-going
Properly size and place new/replacement culverts and bridges to reduce erosion and promote movement of aquatic organisms	Naples Creek watershed Watershed-wide	Reduce erosion rates-Variable	Variable	Medium Priority On-going
Continue surveillance for and treatment of Hemlock Woolly Adelgid in highly erodible steep gullies	Southern watershed areas South Hill	Variable – stream bank erosion can be a substantial contributor to phosphorus load	\$50,000-\$100,000	High Priority Ongoing

Focus Area 3: Stream, Shoreline and Roadbank Erosion and Resiliency				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
Invasive species management • Continue to support the Watercraft Steward and Boat Wash Station Programs at public boat launches • Expand invasive species educational outreach programs with a focus on high-priority invasives, both aquatic and terrestrial • Conduct research and monitoring to improve early detection, rapid response programs for invasive species, both terrestrial and aquatic • Enhance aquatic invasive species removal program	Shoreline areas in-lake and watershed wide	Variable	$200,000+	High Priority

11.4 Focus Area 4: Existing and New Development

Watershed development affects the cycling of water, sediment, and phosphorus from the landscape. Minimizing the risk of adverse impacts while supporting continued multiple uses of the lands and waters is an ongoing challenge. A category of measures designed to minimize impacts of the developed landscape on water quality is referred to as 'green infrastructure'. These measures may include both structural approaches (such as enhanced infiltration) and nonstructural approaches (such as restrictions on phosphorus fertilizers, zoning, and subdivision ordinances). Municipalities within the Canandaigua Lake watershed have made significant progress with both approaches.

Expansion of water resource protection measures in local land use regulations and guidelines is an important metric of progress. Adoption of conservation subdivision codes, steep slope ordinances, and impervious surface guidelines are examples of actions that can help reduce adverse impacts of new development. Although the impact of some preventative measures cannot be directly quantified, continued partnerships and community engagement are key to protecting the watershed for future generations. Measures such as education and outreach, and continued surveillance for impacts of invasive species on landscape stability can help manage nutrient and sediment loading to surface waters. These measures are critically important along the shoreline ring of development since there is no natural buffer of filtration before runoff enters the lake.

Recommended projects and strategies in support of Focus Area 4 are included in Table 20.

Key partners for project design and implementation include the Watershed Council, CLWA, municipalities, SWCDs, educational resources (e.g., Lake Friendly Living initiative, Cornell Cooperative Extension, Finger Lakes Institute, among others).

Table 20. Recommended Actions and Projects. Focus Area 4: Existing and New Development

Focus Area 4: Existing and New Development				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Timeframe**
Reduce fertilizer use on lawns in suburban, urban and commercial areas	Shoreline areas and riparian corridors, Sucker Brook and Watershed-wide	Urban Nutrient Management Plans: 3-10%[2]	Educational work	High Priority On-going
Expand use of green infrastructure	Shoreline areas and riparian corridors, Sucker Brook and Watershed-wide	Dry Extended Detention Pond: 20%[2]	Site and practice specific	High Priority On-going
		Permeable Pavement: 20-80%[2]		
		Bioretention/raingardens45 to 85%[2]		
		Bioswale: 75%[2]		
		Vegetated Filter Strip: 54%[2]		
		Filtering Practice (temporarily store and pass through sand or organic medium): 60%[2]		
		Infiltration Practices: 85%[2]		
		Conservation Landscaping (converting turf to perennial meadows): 25%[2]		
		Install forested buffers in urban areas: 50%[2]		
		Vegetated Open Channels: 10 to 50%[2]		
		Wet Ponds and Wetlands: 45%[2]		

Focus Area 4: Existing and New Development				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Timeframe**
Increase regulatory requirements for shoreline development and re-development to include substantial setbacks and water quality requirements	Shoreline areas	See above for estimates	Site specific	High Priority On-going
Continue to implement enhanced phosphorus treatment standards for stormwater management	Watershed-wide	Increases water quality volume to the 1yr storm event- reduction is dependent on project size	Site specific	High Priority On-going
Protect areas with high potential for pollutant loading such as steep slopes, riparian areas, shorelines	Watershed-wide	Variable	Site specific	High Priority On-going
Where feasible, disconnect direct runoff and outlets from impervious cover to streams and ditches	Watershed-wide	Impervious Disconnection to Amended Soils: 14.6%[2]	Site specific	Medium Priority On-going
Continue to implement and enhance training efforts for governing boards (planning/zoning boards) for stormwater management BMPs for new and existing development highlighting local Canandaigua Lake watershed data and trends	Shoreline and developed areas	Variable- increased effectiveness of existing regulations	$5,000/yr	Medium Priority On-going

11.4 Focus Area 5: Wastewater Management

As watershed population grows, so will the need to manage an increased volume of domestic and commercial wastewater. Most of the watershed population relies on individual on-site wastewater treatment systems. The three small publicly owned wastewater treatment plants that ultimately discharge treated effluent to Canandaigua Lake contribute approximately half of the phosphorus estimated to originate from septic systems, refer to Table 10. Both sources are important and are addressed in the recommended projects and strategies in support of Focus Area 5 (**Table 21).**

Key partners to support implementation of these recommendations include the Watershed Council, local municipalities, state and county Health Departments, and the NYSDEC.

Table 21. Recommended Actions and Projects. Focus Area 5: Wastewater Management

Focus Area 5: Wastewater Management				
Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Timeframe**
Reduce the number of substandard septic systems through implementation of the Local Onsite Wastewater Treatment System Law	Watershed-wide	Modeled scenario		High Priority On-going
Explore expansion of public sewers and implement where feasible	Shoreline areas Watershed-wide			Medium Priority On-going
Increase use of enhanced phosphorus removal technologies on onsite systems	Shoreline properties Watershed-wide			Medium Priority On-going
Increase WWTP phosphorus removal efficiencies before effluent reaches area waterways through the reuse of wastewater, treatment wetlands	3 watershed treatment plants- Rushville, Bristol Harbor and Naples			Medium Priority On-going

12. Financial Resources

The Watershed Council, formed through intermunicipal agreement, provides a base level of funding to support the watershed program through a fair share formula that equitably divides costs of the program among the 14 municipalities. This demonstrates a level of regional coordination and support that is unique across the Finger Lakes region. To date, every municipality has contributed their annual calculated share toward the watershed program.

In 2022, the base funding (the sum of the annual municipal contributions) totaled $137,000. The Watershed Council and its municipal partners then apply for external grants to enhance the local watershed contribution. In the last 20 years, the Watershed Council and municipalities obtained approximately $3 million in grant funding through various agencies, including the NYSDOS and NYSDEC, to help implement priority actions. Many of these grants are matching grants requiring up to 50% local match; NYS provides half of the project cost while requiring a cost match for the remainder. The Watershed Council, municipalities and its partners have cumulatively provided or will provide the approximately $2 million in local match funding/or in-kind assistance (i.e., the machinery needed to implement watershed projects).

Additionally, the Canandaigua Lake Watershed Commission, which includes the five local water purveyors (Canandaigua, Rushville, Gorham, Newark, and Palmyra) contributes toward a watershed inspection program for on-site wastewater systems. The program provides funding for one watershed inspector whose responsibilities include inspecting septic and alternative systems, reviewing building plans for suitability of wastewater treatment, and investigating violations. The five purveyors provide approximately $130,000 per year for the program which is administered through the Ontario County SWCD.

The Council and partners anticipate that most of the implementation projects included in this Nine Element Plan will be partially funded through various state and federal cost-sharing programs. Grants are made available by the launch of each round of the Regional Economic Development Council Initiative. In applying for the grants, the Council utilizes the NYS Consolidated Funding Application (CFA). The CFA process provides applicants expedited and streamlined access to a combined pool of grant funds and tax credits from dozens of existing programs. It enables applicants (such as businesses and other entities) to be considered for multiple sources of funding for a project using a single, web-based application. Regional Councils review projects and score them in accordance with alignment with their regional goals and strategies. Higher scores increase the likelihood of funding.

The following section summarizes the extent of applicable programs, organized by funding source:

STATE:

NYS Dept of Agriculture and Markets (NYSAGM)

- Agricultural Nonpoint Source Abatement and Control Program (ANSACP)
- Agricultural Environmental Management (AEM) Program
- Climate Resiliency Farming (CRF) Program
- Community Resiliency Training Program
- County Agricultural and Farmland Protection Planning Grants
- Source Water Buffer Program

NYS Dept of Environmental Conservation (NYSDEC)

- Climate Smart Communities (CSC) Grants
- Community Forest Conservation Grant Program
- Invasive Species Grant Program
- Trees for Tribs
- NYS Conservation Partnership Program
- Non-Agricultural Nonpoint Source Planning and MS4 Mapping (NPG): funds planning reports for nonpoint source water quality improvement projects and mapping of Municipal Separate Storm Sewer Systems (MS4s)
- Water Quality Improvement Project Program (WQIP): funds projects that reduce runoff, improve water quality, and restore habitat; these include Wastewater Treatment Improvement, Land Acquisition for Source Water Protection, and Aquatic Connectivity Restoration projects
- Water Quality Management Planning Programs: Clean Water Act, Section 604(b) Funding

NYSDEC, NY Sea Grant

- NY's Great Lakes Basin Small Grants

NYSDEC, Land Trust Alliance

- Forest Conservation Easements for Land Trusts Program

NYS Environmental Facilities Corporation (NYSEFC)

- Drinking Water State Revolving Fund
- Clean Water Infrastructure Act (CWIA) Grants
- Integrated Solutions Construction Grant Program
- Septic Replacement Fund
- Wastewater Infrastructure Engineering Planning Grant (EPG)

- Green Innovation Grant (GIGP): funds projects that will implement green practices such as green stormwater infrastructure, energy efficiency, water efficiency, environmental innovation

NYS Environmental Facilities Corporation (NYSEFC) and USFWS

- Clean Vessel Assistance Program (CVAP)

NYS Dept of State (NYSDOS)

- Local Waterfront Revitalization Program (LWRP): funds implementation projects to create more sustainable, accessible, and resilient waterfront communities
- Local Government Efficiency Program (LGE): works with municipal leaders to reduce the cost of operations and modernize the delivery of local services
- Brownfield Area Opportunity Program (BAO): applies a neighborhood-wide approach in the assessment and redevelopment of known/suspected brownfields and other vacant/abandoned properties
- Smart Growth Community Planning and Zoning Program (SGCP): assists communities in preparing land use plans and zoning ordinances that integrate smart growth principles

NYS Dept of Transportation (NYSDOT)

- Transportation Alternatives Program
- Bridge NY Program

NYS Office of Parks, Recreation and Historic Preservation (NYSOPHRP)

- Environmental Protection Fund Municipal Grants Program

NYS Office of Homes and Community Renewal

- Community Development Block Grant (CDBG) Program – Small Cities

New York State Pollution Prevention Institute

- Community Grants

Great Lakes Research Consortium

- Small Grants Program

FEDERAL:

Federal Emergency Management Agency (FEMA)

- Hazard Mitigation Grant Program

US Dept of Agriculture, Farm Service Agency (FSA)

- Conservation Reserve Program (CRP)

US Dept of Agriculture, Farm Service Agency (FSA)

- Conservation Reserve Enhancement Program (CREP)
- Farmable Wetlands Program

US Dept of Agriculture, Natural Resources Conservation Service (USDA-NRCS)

- Agricultural Conservation Easement Program (ACEP)
- Agricultural Management Assistance (AMA) Program
- Conservation Stewardship Program (CSP)
- Environmental Quality Incentives Program (EQIP)
- Conservation Innovation Grants
- Wildlife Habitat Incentive Program (WHIP)

US National Oceanic and Atmospheric Administration

- Environmental Literacy Grants

US Dept of Agriculture, Rural Development

- Water & Waste Disposal Loan & Grant Program
- Community Facilities Direct Loan & Grant Program

US Dept of Agriculture, US Forest Service

- Citizen Science Competitive Funding Program

US Environmental Protection Agency (USEPA) and US Forest Service

- Great Lakes Restoration Initiative Forest Restoration
- Great Lakes Restoration Initiative Cooperative Weed Management

US Fish and Wildlife Service (USFWS)

- Partners for Fish and Wildlife Program
- National Fish Passage Program
- North American Wetlands Conservation Act Grants

US Environmental Protection Agency (USEPA)

- Clean Water Act Section 319 Nonpoint Source Management Program
- EPA Environmental Education Grants
- Water Research Grants

Great Lakes Commission

- Sediment and Nutrient Reduction Program

LOCAL, REGIONAL, AND PRIVATE:

Municipalities

- Municipal Budgets

Ontario County Water Resources Council

- Mini Grants Program

National Fish and Wildlife Foundation

- Five Star and Urban Waters Restoration Grant Program- we have successfully used this grant on two occasions
- Sustain Our Great Lakes Program
-

Great Lakes Basin States

- Great Lakes Protection Fund

13. Monitoring and Evaluation

The Canandaigua Lake Watershed Council will continue to serve as the lead organization to coordinate and track progress toward implementation of the recommended actions and conditions of Canandaigua Lake and watershed. This institutional infrastructure continues to be an effective avenue for collaborative efforts and communication. The Watershed Council will work with various governmental and non-governmental entities to track progress on implementing the Nine Element Plan.

As described in Section 3.2, both an in-lake phosphorus target and a watershed based load reduction target will be used to evaluate success of the watershed implementation efforts. The Watershed Council will continue to utilize an adaptive management framework as they respond to current and emerging issues. The defined targets and metrics of progress described in this Nine Element Plan are evidence of the ongoing commitment to monitoring and assessment.

13.1 Phosphorus target: in-lake concentration

The Watershed Council will continue to partner with FLCC to monitor Canandaigua Lake monthly from May through October at the six long term locations (refer to **Figure 4**). This monitoring program is conducted in accordance with a NYSDEC approved QAPP and is completed with professional staff. All analyses will be performed by an ELAP- certified laboratory. Maintaining a three-year summer (June – Sept.) average mid lake concentration at or below 5.5 ug/L at the Deep Run mid-lake sampling site will be evidence of successful implementation of the 9E Plan.

13.2 Phosphorus target: external load reduction

The second target is a watershed-based load reduction target of 11,461 pounds or 25% of the modeled load of 45,843 pounds per year. Projects will be tracked from 2018- 2033 as determined through a combination of tools to estimate phosphorus reduction success. The implementation tables include quantifiable phosphorus reductions for specific practices. Acceptable tools to estimate phosphorus reductions include:

- SWAT based scenarios for agricultural practices including cover crops and nutrient management plans- acres of cover crops and land covered by nutrient management plans
- NYSDEC non-point source catalog,
- NYSDEC stormwater manual,
- NRCS/SWCD standards for agricultural practices,
- Peer-reviewed literature review on wetland and floodplain improvement projects,

- Tracking success of the onsite law to meet the higher treatment capabilities outlined in the onsite model,
- STEPL, CAST and CWP spreadsheet models.
- Comprehensive educational outreach on residential stormwater and lawncare practices through the various partners to achieve reductions estimated in the SWAT model scenario
- Load reductions from land preservation and natural capital improvements at the landscape scale

The Watershed Council will actively work with the various implementation partners to track these reductions. Achieving the proactive 11,461 pound load reduction (25%) by 2033 will be evidence of successful implementation of the 9E Addendum and overall Watershed Plan.

Since the vast majority of the recommended actions are voluntary and incentive-based, outreach and education coupled with financial and technical support are key. The Watershed Council and its member municipalities along with SWCDs, Watershed Association and other partners have established a long history of collaboration, financial commitments, grant success, and community commitment to fostering watershed success. These entities will need to continue and enhance their efforts to meet the watershed’s latest challenges and opportunities.

14. Conclusions

The Canandaigua Lake watershed provides a multitude of ecosystem services that benefit us all, as reflected in the community's vision statement and goals. The lands and waters support food and fiber production, offer beautiful vistas and diverse recreational opportunities, provide habitat for a diverse assemblage of native species, and are a source of clean and abundant drinking water. In addition, the watershed lands and waters support waste assimilation for development activities. This beautiful region of the New York Finger Lakes has provided a unique sense of place to generations.

Actions are needed to protect and preserve the watershed's ability to support these interrelated ecosystem services. This Nine Element Plan focuses on a key challenge facing many lakes and watersheds: the need to control phosphorus inputs. This document expands the 2014 Watershed Management Plan with a quantitative analysis of phosphorus sources and locations required for approval as a Nine Element Plan. The tools developed as part of this effort support an estimate of current loading, and project the consequences of changing conditions. The findings support a series of recommended actions designed to reduce phosphorus inputs and meet measurable targets that relate to lake water quality and provision of ecosystem services.

Landscape sources are the primary contributors of phosphorus to Canandaigua Lake. Therefore, managing these diffuse sources will require ongoing efforts of many parties: individual landowners, local leaders, farmers, foresters, and resource management agencies. Fortunately, this watershed has a robust and effective institutional structure in place to engage and mobilize the diverse stakeholder community toward their shared vision and goals. Continued collaboration and partnerships are the key to protecting this resource for future generations.

15. References

To be completed

APPENDIX A

Canandaigua Lake Monitoring Program

Quality Assurance Project Plan

APPENDIX B

Canandaigua Lake Watershed SWAT Model

Quality Assurance Project Plan

APPENDIX C

Canandaigua Lake Watershed SWAT Model Report

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