CANANDAIGUA LAKE WATERSHED NINE ELEMENT PLAN FOR ENHANCED PHOSPHORUS MANAGEMENT

November 2023

PROTECTING THE LIFEBLOOD OF OUR REGION

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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

Watershed management planning has been a keystone approach to resource protection for decades, and many lakes, including Canandaigua Lake, have benefitted from a 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 and included as **Appendix A**) 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.

The 2023 Nine Element Plan for Enhanced Phosphorus Management (9E Watershed Plan) expands the 2014 Watershed Plan with a focused quantitative analysis of phosphorus, a key pollutant affecting water quality of Canandaigua Lake. The 9E Watershed Plan analyzes existing sources of phosphorus and projects how meteorology, land cover, and management practices affect phosphorus loading. The Watershed Council selected a target to reduce phosphorus load by 25% over the next decade to build water quality resiliency into the watershed system. A comprehensive suite of actions will be required to meet the target.

The overarching goal of both the 2014 Watershed Plan and this 2023 9E Watershed Plan is to protect the existing high quality of Canandaigua Lake and its watershed. Managing phosphorus inputs to the Lake will help advance the following related goals:

- Maintain Canandaigua Lake as a reliable source of high-quality drinking water source for 70,000+ people.
- 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 providing habitat for a diverse assemblage of native flora and fauna.
- Continue to maintain in-lake phosphorus concentrations consistent with an oligotrophic ecosystem.

This 9E Watershed Plan describes a series of quantitative analyses designed to identify current sources of phosphorus entering Canandaigua Lake from the watershed; the analyses encompass both sources of phosphorus (landscape and wastewater) and locations (tributary subwatersheds). Three quantitative tools specific to the Canandaigua Lake watershed were applied. The first is a spreadsheet calculation to estimate phosphorus input from nearshore on-site wastewater treatment systems (septic systems). The second tool calculates phosphorus input from municipal wastewater treatment facilities if each facility discharges at its maximum permitted capacity. Taken together, these tools estimate phosphorus input to Canandaigua Lake from domestic and commercial wastewater.

The third tool estimates nonpoint phosphorus from the landscape using the geographic information system (GIS) based mathematical watershed model: Soil and Water Assessment Tool (SWAT). Faculty and graduate students from Cornell University's Department of Biological and Environmental Engineering (BEE) selected SWAT as an appropriate model for the Canandaigua Lake watershed. Model selection was made in consultation with the New York State Department of Environmental Conservation (NYSDEC) and the Canandaigua Lake Watershed Council. The SWAT model has been applied across NYS in development of 9E Plans and other Clean Water Plans (such as Total Maximum Daily Loads); the model framework is well suited to agricultural landscapes and other watersheds with extensive nonpoint sources of sediment and nutrients.

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 influence on the landscape (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.

Once the current phosphorus load from landscape and wastewater sources was developed, the tools were applied to project the impact of changing conditions and practices on the future phosphorus load. For example, the SWAT watershed model was applied to estimate how increased precipitation due to climate change could affect phosphorus export to Canandaigua Lake. These model projections were used to help inform the Watershed Council's reduction targets. Additional model simulations were run 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. SWAT model output also helps managers identify priority subwatersheds where implementation of management practices can help achieve reduction targets. While the focus of this 9E 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.

The SWAT model estimated current annual phosphorus loading to Canandaigua Lake at 45,843 pounds. Based on stakeholder input, the Watershed Council selected an aggressive reduction target of 25% (11,461 pounds) in phosphorus load over the next decade. This reduction target is proactive and reflects the need to build enhanced water quality resiliency into the watershed system to offset the impacts of invasive species and climate change and incorporate a substantial margin of safety. Model projections indicate that this target can be achieved by a suite of actions on the landscape designed to enhance water quality resiliency and improve 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. Based on current conditions and trends, proactive actions will be required to maintain the desired state of Canandaigua Lake. 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.

Reducing phosphorus load by 25% is an aggressive, but achievable, target. Meeting this target over the next decade will require voluntary actions across the watershed by multiple sectors. A combination of agricultural best management practices (BMPs) offer potential to improve hydrologic resilience and reduce export of phosphorus and sediment from the landscape. Key agricultural recommendations include increased adoption of cover crops, expanded comprehensive nutrient management planning, and landscape measures such as grassed waterways and installation of water and sediment control basins (WASCOBs) downgradient of cultivated areas. On the developed landscape, implementation of green infrastructural practices to enhance stormwater infiltration and improved septic management will contribute to meeting the 25% target. Across the watershed, efforts to reduce erosion from road banks and streambanks can help retain sediment and nutrients on the landscape. Finally, a major focus area will continue to be the restoration, creation, and enhancement of the water quality functional value of wetlands and floodplains. These systems can offer substantial benefits in phosphorus capture. Specific priority actions are described in Section 11.

Implementing the recommendations of the 9E Watershed Plan 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 toward the plan's goals will be tracked and reported through a coordinated effort led by the Watershed Council in partnership with the major implementation entities. 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. Funding opportunities will likely change over the next decade as well, which could affect prioritization of recommended projects. Continued monitoring and tracking will enable the Watershed 9 Plan to reflect new information and inform management decisions.

2. Purpose and Background

This 9E Watershed Plan was developed to supplement the 2014 Canandaigua Lake Watershed Management Plan and incorporates 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 (**Appendix A**), 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 B

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 9E Watershed Plan explores specific strategies that are amenable to quantitative analysis of their effectiveness in reducing phosphorus input to Canandaigua Lake. With this investment in quantitative analysis, the watershed community can use the 9E plan as another tool to focus their collective resources on areas of the watershed and specific remedial measures that offer greatest potential for long-term water quality benefit. Moreover, recommended projects included in a NYS-approved 9E Watershed Plan may be prioritized for funding through multiple state and federal grant programs.

The primary task to build on the existing framework and develop a 9E Watershed Plan was completing 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 an 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 nonpoint 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

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 9E Watershed Plan. The watershed's natural capital, also referred to as ecosystem services, is vital to residents and visitors as reconfirmed during public outreach efforts.

3.2 Goals

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. At the local level, the Watershed Council and its partners analyzed the Natural Capital value of the ecosystem services provided by the lake and its surrounding watershed (www.canandaigualake.org). 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 source for 70,000+ people.
- 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.
- Continue to maintain in-lake phosphorus concentrations consistent with an oligotrophic ecosystem. For Canandaigua Lake, the goal is to maintain a three-year average summer Total Phosphorus concentration of 5.5 ug/L. Meeting this goal would represent stable conditions in response to changing land use, land cover, management practices, invasive species, and a warming climate.

3.3 Targets

A central component of a Nine Element Plan is identification of 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 phosphorus is the limiting nutrient that largely regulates growth of phytoplankton (including algae and cyanobacteria) along with macrophytes in Canandaigua Lake, defining limits on phosphorus inflows is key to long-term protection.

As detailed in Sections 8 and 9, the quantitative tools employed to develop the 9E Watershed Plan estimate that 45,843 pounds of phosphorus reach Canandaigua Lake each year under current conditions. The sources include runoff from the landscape, septic systems, and effluent from wastewater treatment plants. An important finding of the SWAT modeling is that climate change impact on the amount and intensity of precipitation could increase total phosphorus loading to the lake by an additional 5% in the absence of source reductions.

The Watershed Council considered the multitude of current conditions and trends that could adversely affect Canandaigua Lake including:

- Annual cyanobacteria blooms (present since 2015).
- Increasing frequency and intensity of storms generating substantial runoff issues especially from agricultural fields, developed areas and their conveyance systems (streams and road ditches).
- Continued residential development along the shoreline and upland areas, notably in the northern half of the watershed.

- Invasive species such as dreissenid (quagga and zebra) mussels; presence of these benthic mussels is implicated in the increased risk of cyanobacterial blooms.
- Increasing lake water temperature provides a more favorable growing environment for cyanobacteria.

Based on these emerging issues and threats, the watershed community has coalesced around an aggressive and proactive **target to reduce external phosphorus loading to the lake by 25% (approximately 11,461 pounds) by 2033**. The 25% reduction target goes beyond offsetting the projected increase in phosphorus load that could occur due to climate change. Selection of the proactive reduction target is intended to build water quality resiliency measures against the multiple human and natural stressors on the lake ecosystem referenced above and include a substantial margin of safety. The model scenario BMP outputs and the comprehensive list of phosphorus reduction projects identified in Section 11 indicate that this is an achievable target.

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 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 9E Watershed Plan.

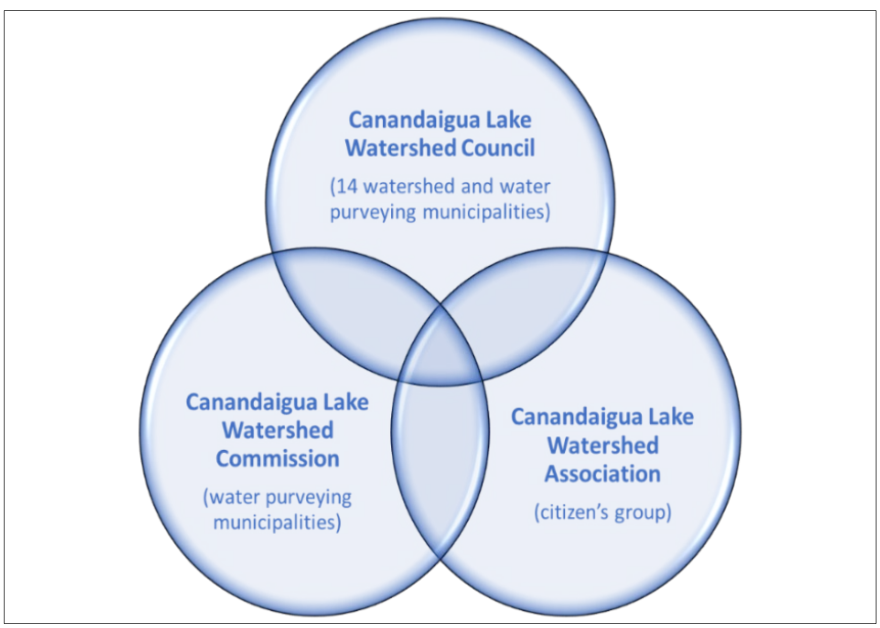

Figure 1. Institutional partnership for lake and watershed management: Canandaigua Lake Watershed Program

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 the 2014 comprehensive update to the plan- Appendix A) and joined forces through the Watershed Council to lead and coordinate watershed planning and protection efforts. The Watershed Council utilizes five main areas to focus their work: education, research, restoration, open space protection and regulation. The Watershed Council leads the stream sampling program and contracts with FLCC to complete the monthly lake monitoring program (Appendix B- QAPP). Members of the Watershed Council include chief elected official or their designee of 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.

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 15 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 9E Watershed 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 (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 9E Watershed Plan by documenting 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 9E Watershed 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.

4.4 New York State Agencies

The NYSDEC reviews and approves Nine Element Plans. Staff from NYSDEC's Central Office and the Finger Lakes Watershed 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) and Data Usability Assessment Report (DUAR) (**Appendix C)** and the SWAT Watershed Model Report (**Appendix D)**. 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 NYSDEC 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 funded and coordinated installation of a USGS gauging station on the West River to fill an important data gap in understanding watershed hydrology. Staff from the Finger Lakes Watershed 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 9E Watershed 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.

To promote community input as the 9E Watershed 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 2014 Watershed Plan and described the rationale and process for updating the plan to a Nine Element Plan. Next, Cornell University Professor Scott

Steinschneider summarized the interim findings of the SWAT model completed by the Cornell BEE team. Kevin Olvany wrapped up the meeting with a summary of best management practices. Audience members submitted questions and provided feedback using the chat feature of Zoom. A recording of the 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 – April 13, 2023

The second public meeting was held April 13, 2023, using the Zoom platform. Kevin Olvany, Watershed Program Manager, provided an overview of the 9E Plan with a focus on targets and recommended actions. The Naples Creek/Parish Flats project (described in Section 11.1) was highlighted as an example of an effective approach to phosphorus reduction through enhanced hydrologic resilience. The commitment to an adaptive management approach was described in context of ongoing monitoring and assessment to track watershed projects, phosphorus transport in storm water, and the quality of Canandaigua Lake. Details of the meeting and presentation are available here

Continued Community Engagement During Implementation

As detailed in the 2014 Watershed Plan and this 9E Watershed Plan, community partnerships and engagement are critical to protecting Canandaigua Lake. There is a long history of the watershed program engaging with the community and key stakeholder groups. The Watershed Council will continue to serve as the lead coordinating entity among the many agencies and interest groups involved in the watershed program. Lake and tributary monitoring will continue and be guided by Quality Assurance Project Plans; data and information from the ambient monitoring programs will guide the adaptive management process.

The Council will track progress toward the 25% reduction target. Watershed staff will periodically meet with key implementation partners to understand the status of current projects, plans for additional measures, and the need for financial and technical support. The Watershed Council will facilitate an annual meeting of the stakeholder groups to discuss progress toward meeting the landscape reduction target and opportunities to accelerate implementation. Projects and accomplishments will be tracked and, where appropriate, published on digital media platforms (websites) to document progress.

5. Environmental Setting

5.1 Watershed Characteristics

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

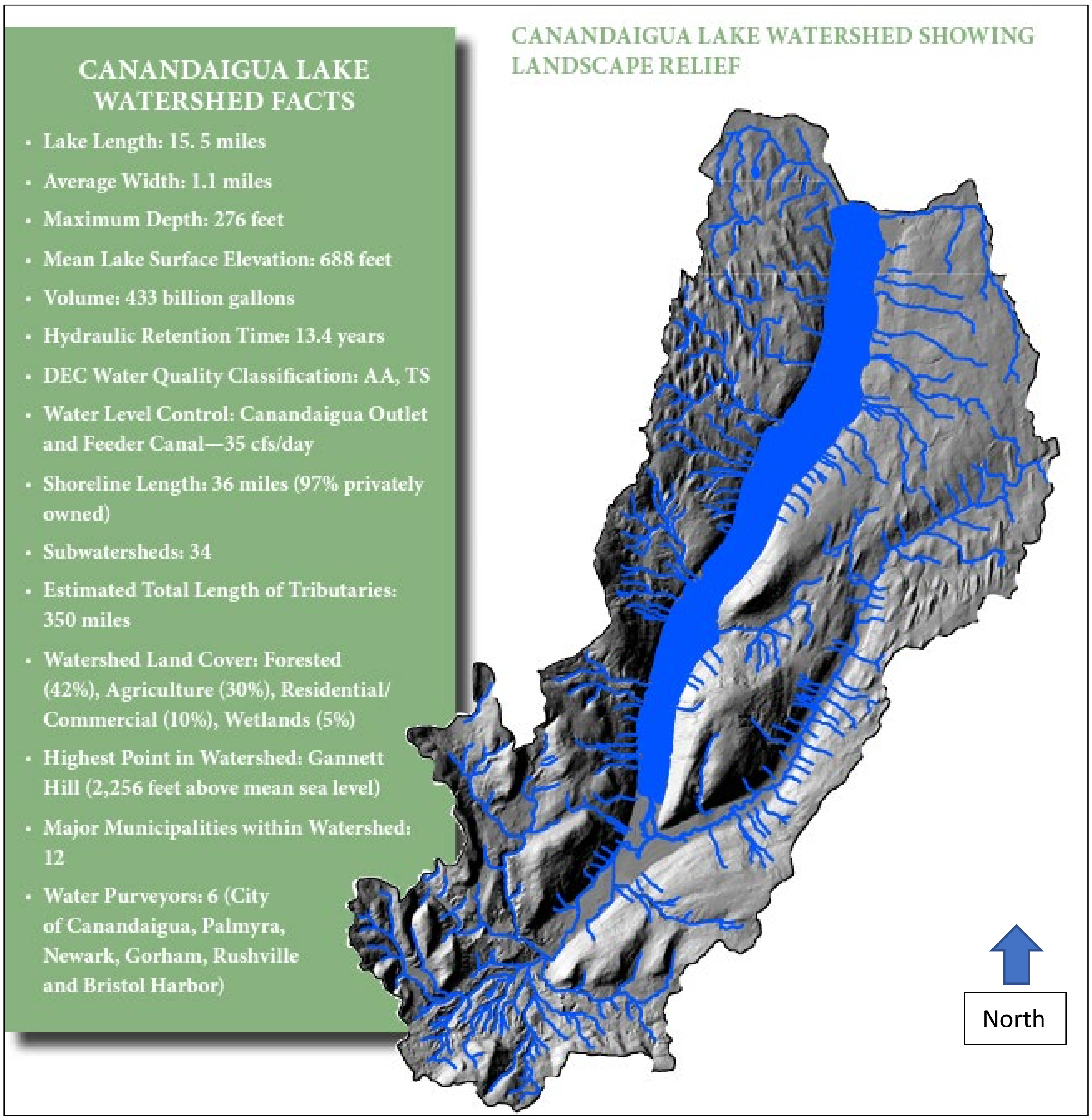

Figure 2. Hydrology of the Canandaigua Lake watershed *(Source: Watershed Council, 2014)*

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 the more 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**

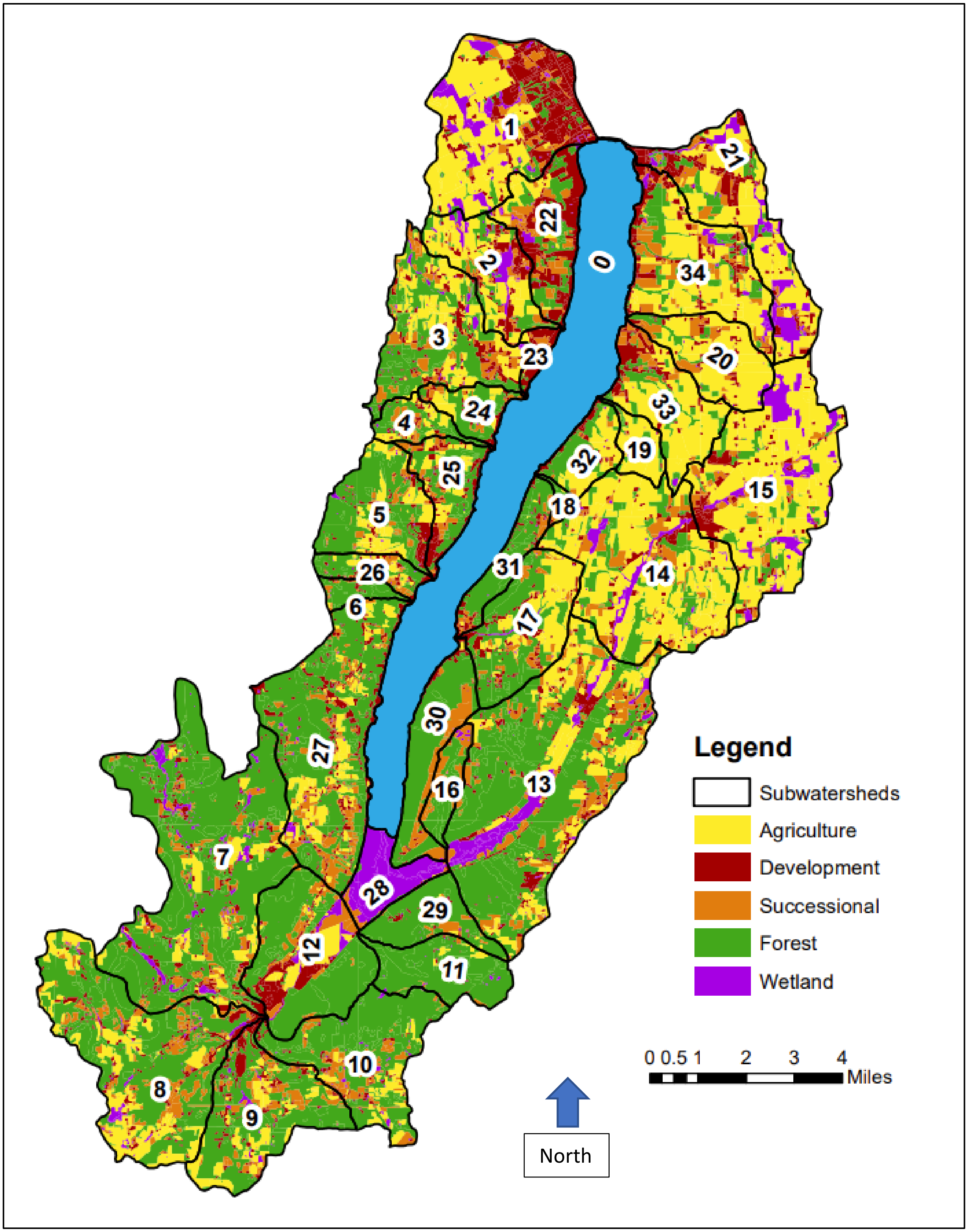

Figure 3. 2018 Land cover classifications for the 34 designated subwatersheds.

Source: Watershed Council staff completed heads-up digitizing and field surveys of land cover types to update the 2004 Natural Heritage Classification System Landcover survey completed by Dr. Bruce Gilman

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 extensions, reliance on the lake as a primary drinking water source 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

Availability of long-term monitoring data is critical for assessing current condition 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 described in Section 6.2. Samples are 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 from each site. The NYSDEC-approved Quality Assurance Project Plan for water quality monitoring was formalized in 2019 and is included as **Appendix B**. These data were screened though a Data Usability Assessment Report (DUAR) process, as summarized in the SWAT model QAPP (**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 has supported participation of all 11 Finger Lakes, including Canandaigua Lake, in the Citizen's Statewide Lake Assessment Program (CSLAP). CSLAP, as codified in ECL § 17-0305, is a program to monitor water quality by private citizens under the direction of the DEC and serves as a source of data and information used by the Department in the assessment of lake condition and other water quality management functions. The program has collected comparable data from lakes across the state using trained volunteers and a central certified laboratory for analysis for almost three decades. The NYSDEC maintains the CSLAP database, which provides invaluable information for tracking changes in individual lakes as well as regional and statewide trends.

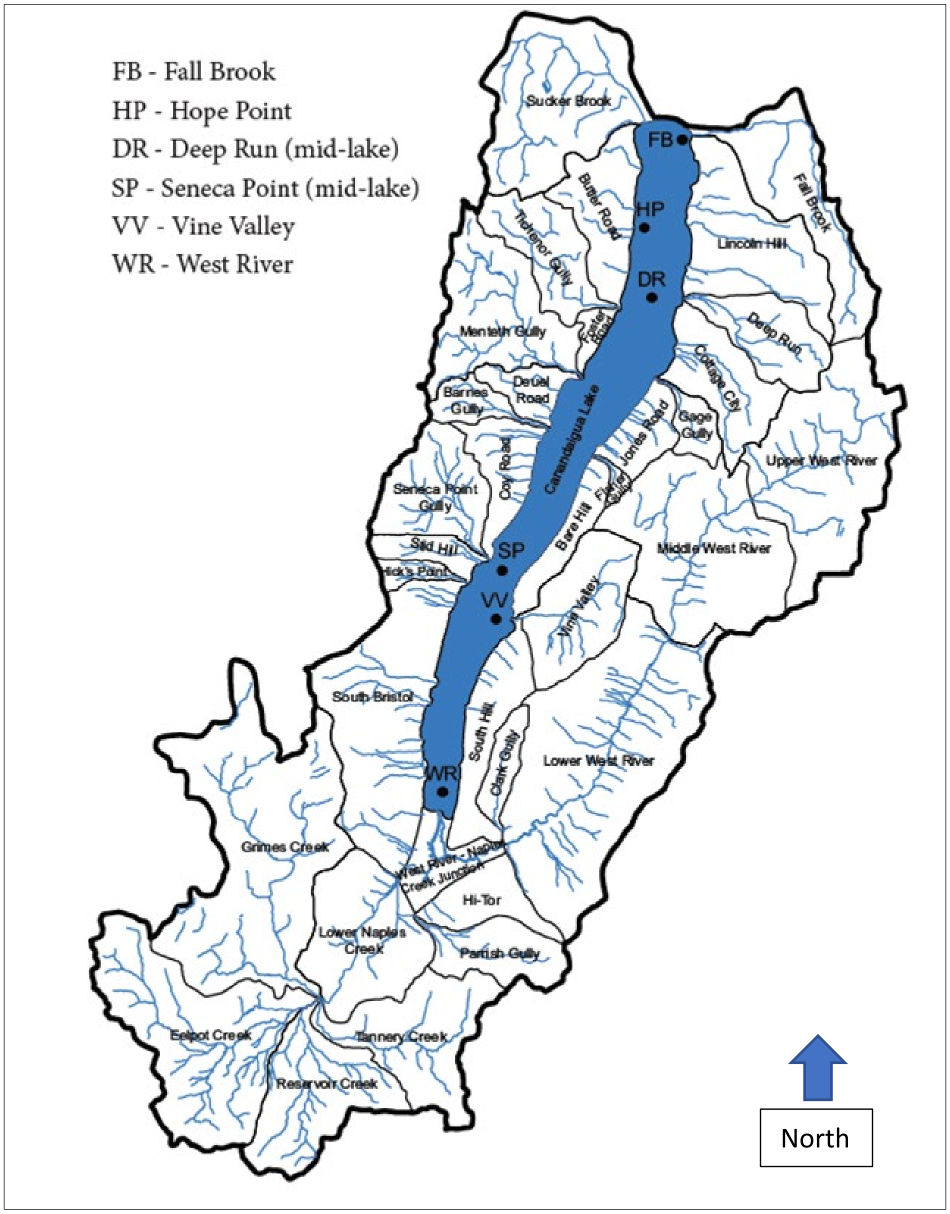

Figure 4. Sampling locations within Canandaigua Lake

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.

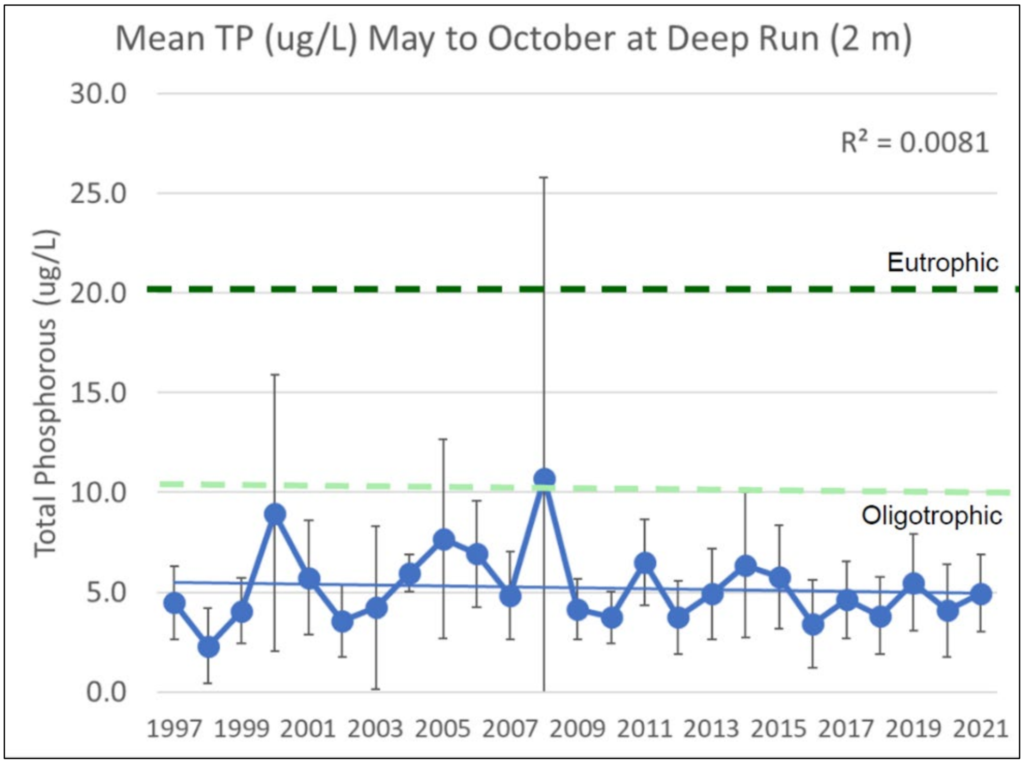

Figure 5. Long term average total phosphorus (TP) concentrations at the Deep Run open water monitoring site. *FLCC collected/analyzed data- Dr. Bruce Gilman and Patty Rockwell. Trophic state boundaries are referenced in NYSFOLA (2009)*

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.

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.

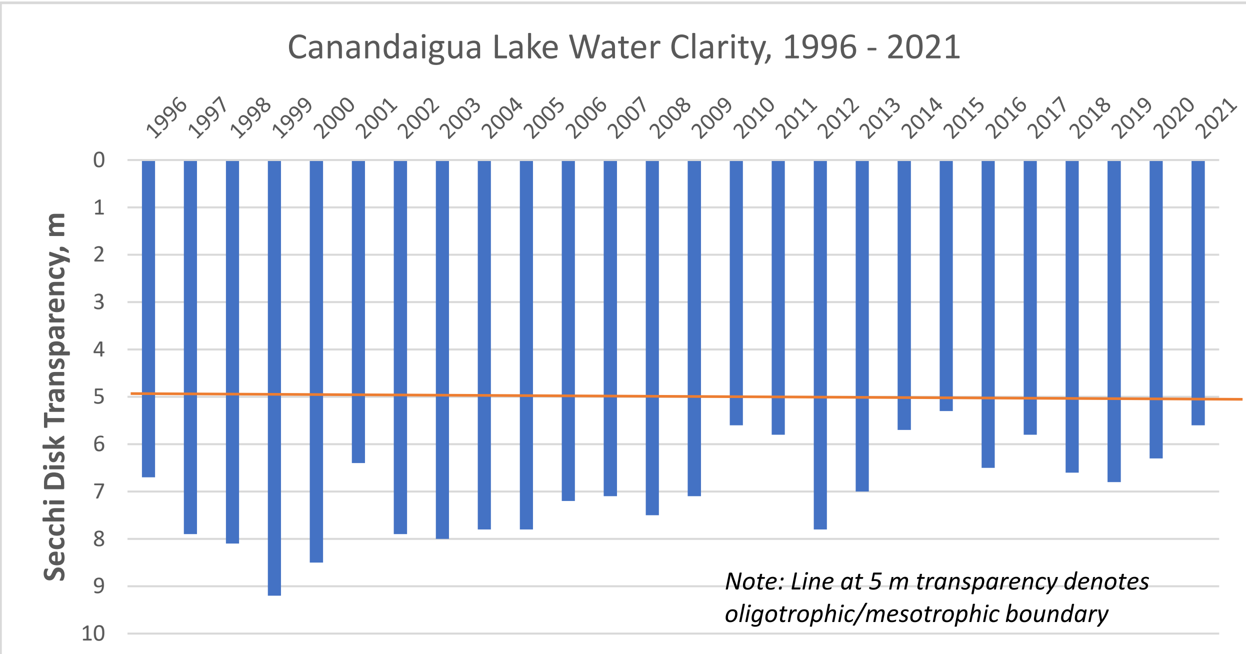

Figure 6. Summer average water clarity (June – Sept.) at the Deep Run and Seneca Point monitoring locations, 1996-2021. *FLCC collected/analyzed data- Dr. Bruce Gilman and Patty Rockwell. Trophic state boundaries are referenced in NYSFOLA (2009)*

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.

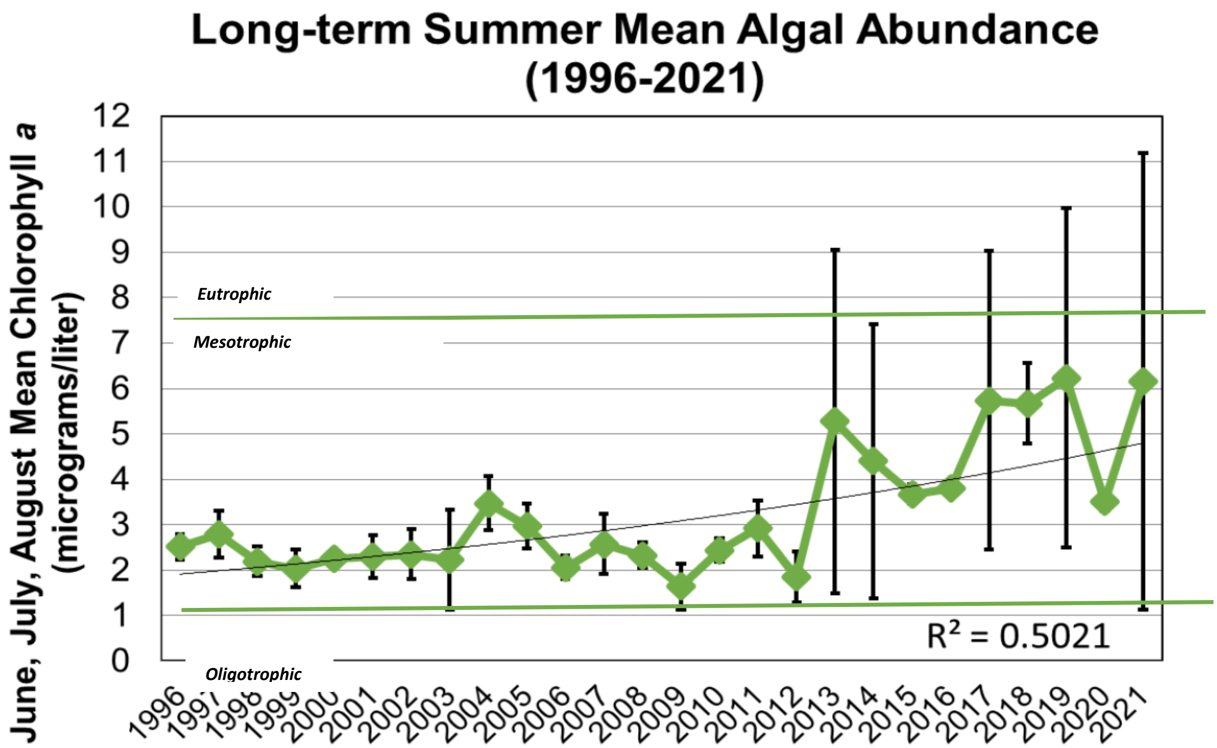

Figure 7. Summer average chlorophyll-a concentration, 1996-2021. *FLCC collected/analyzed data-Dr. Bruce Gilman and Patty Rockwell. Trophic state boundaries NYSFOLA (2009)*

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 temporary 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 the phytoplankton community structure and promoting HABs (Vanderploeg et al. 2001). Dreissenid mussels are among the factors related to increased risk of cyanobacterial blooms in NYS lakes (NYSDEC HABs Action Plans, 2018).

Long-term chlorophyll-*a* trends also reflect the emergence of harmful algal blooms (HABs) 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 typical emergence of cyanobacteria late in the summer and typically at low abundance. However, in 2015, the first documented HAB occurred on the lake; blooms have been experienced to varying degrees each subsequent year.

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. From 2015-2017, Watershed staff were documenting the extent of HAB occurrences and reports with an informal group of volunteers helping to understand the extent of the blooms. In 2018, the CLWA formalized a volunteer HABs surveillance program that has evolved into 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 4**. 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 4. 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 as needed. Additional information regarding the annual HABs surveillance program and findings is available on the Watershed Association website.

Since 2020, the Watershed Association and Watershed Council have been utilizing NYHABs, the statewide notification system maintained by NYSDEC, to report bloom conditions and increase public awareness of potential risks. Data from the NYSHABs website for Canandaigua Lake cyanobacterial blooms are summarized in **Table 5**. These data may not reflect the total extent of cyanobacterial blooms, especially in the first few years of observations. Consistent use of this reporting system and standardization of criteria have evolved over the years.

Table 5. Summary of Reported HABs, 2015-2021

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

*Note: In 2019, NYSDEC modified the format of Archived HABs notices. Source: NYSDEC Harmful Algal Blooms Archive

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 with low ambient phosphorus concentrations. Climate-related factors including warmer waters, changing wind patterns, and higher frequency of intense rainfall events are implicated in the recent HABs proliferation as is the proliferation of dreissenid mussels. There is an increasing trend in summer average surface water temperatures (**Figure 8**).

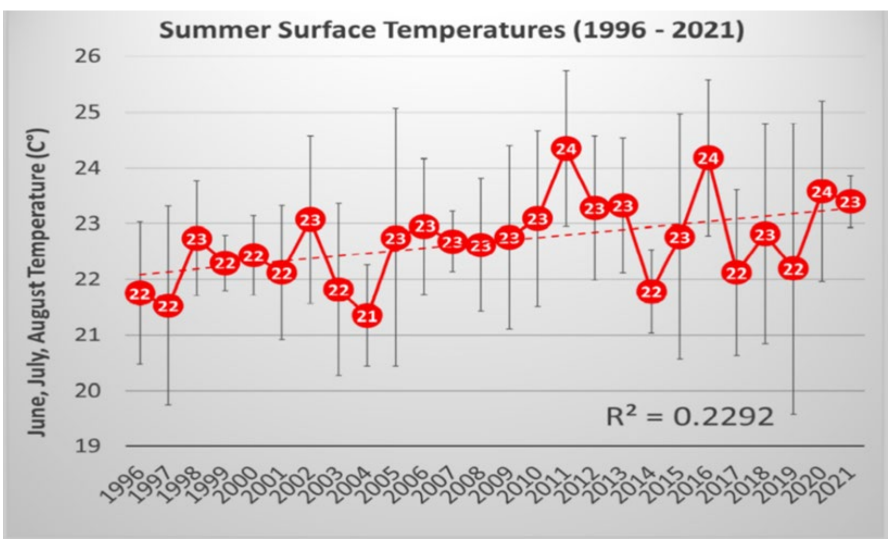

Figure 8. Summer average surface water temperature, open water sites,1996-2021. *Source: FLCC*

6.3 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.

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 full watershed's diverse land cover, land management practices, topography, and soils and are representative of conditions in the unmonitored 21% of the lake's watershed. The SWAT model utilized the extensive water quality dataset from these 17 diverse tributaries to calibrate and validate the model to the whole watershed. The direct drainage regions, which encompass the remaining 21% of the watershed, are also periodically monitored. Watershed program staff conduct frequent visual inspection of the direct drainage subwatersheds and photograph conditions during storm events.

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 snowmelt 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.

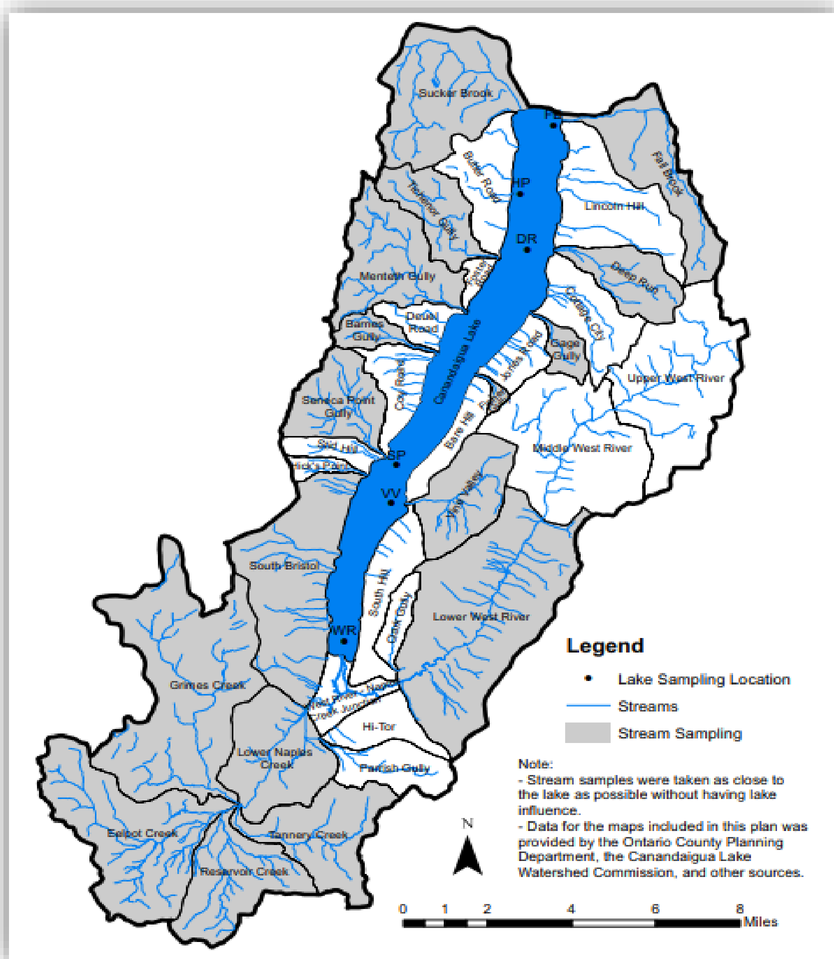

Figure 9. Canandaigua Lake stream and sampling locations with delineated subwatersheds.

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 Watershed 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 for development of the watershed SWAT model. Segment analyses to identify reaches exhibiting streambank erosion or other evidence of degradation have been completed in addition to the downstream water quality sampling. Watershed Council staff completed stressed stream/segment analyses of the Fallbrook and Deep Run subwatersheds between 2017 and 2019; Valerie George completed a similar evaluation of Eelpot Creek in 2009 (George 2009).

Stream data collected during high flow events (**Figure 10**) provided an important source of information to the watershed model and the overall Nine Element Planning effort. For watersheds dominated by nonpoint (landscape) sources of phosphorus, the majority of load occurs during periods of storm runoff and snowmelt. The number of sample locations and multiple years of observations helped the Cornell modeling team set up and calibrate the SWAT model to reflect local conditions, as described in Section 8 below and the SWAT model report (**Appendix D**). The spatial data help identify potential sources and areas of concern and support analysis of 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. As this is an ongoing monitoring program, these data will also support efforts to evaluate the effectiveness of control measures over the next decade.

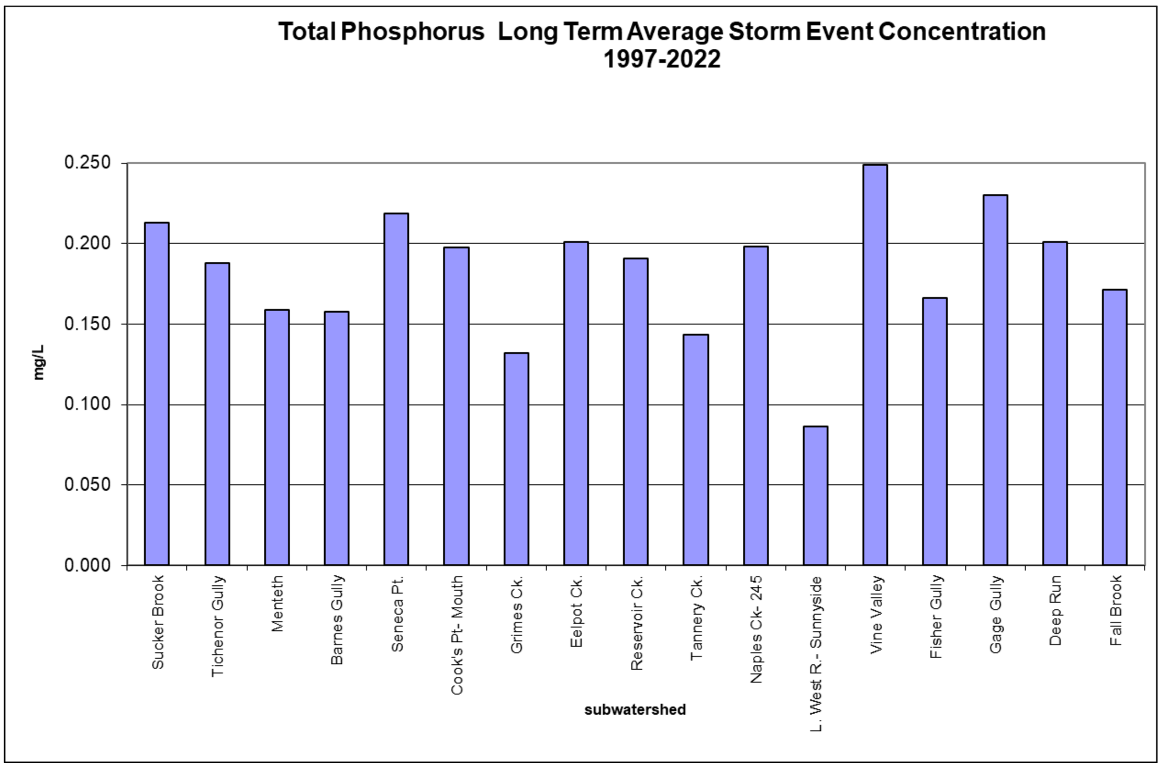

Figure 10. Mean total storm event-based phosphorus concentrations by subwatershed. *Each subwatershed has between 50- 65 storm event samples between 1997 – 2022*

The long-term storm event-based sampling program spans a broad range of precipitation/snowmelt 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. 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 that includes data from 50-65 storm event samples at each of the 17 locations 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 150-200 ug/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 (USGS 04234398). 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 9E Watershed 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

- Construction of a new wastewater treatment plan to serve the business district and some residential areas of the Village of Naples. The Village is in the process of extending the collection system to serve additional 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 funding to incentivize upgrade of inadequate onsite systems.

Category 7: Agriculture

- Continued participation in the Agricultural Environmental Management (AEM) program. SWCDs of Yates and Ontario Counties 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 SWCDs have completed AEM assessments of 75% of farms in the watershed.

- Significant investments in implementing agricultural Best Management Practices (BMPs). Since 1996, over two million dollars have been invested in implementing 90+ agricultural BMPs within the watershed. Projects encompass a wide variety of agricultural BMPs including water and sediment control basins (WASCOBs), streambank stabilization, strip cropping, diversion ditches, grassed waterways, buffers, manure storage, barnyard runoff control, pasture improvement, vineyard mulching, and other projects.
- Successful applications by the Yates and Ontario County Soil & Water Conservation Districts to implement over $500,000 of improvements.
- Implementation of winter cover crops on cultivated lands and expanded adoption of reduced tillage practices.
- Yates and Ontario County SWCDs 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 water quality conditions do not support all designated best uses. In 2018, Canandaigua Lake was added to the List of Integrated Report (IR) Category 4a/b/c Waters for impairment of secondary contact recreation (boating) due to algae and weed growth. See the DEC's Info Locator from more information (https://www.dec.ny.gov/data/WQP/PWL/0704-0001.html?req=13389).

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**; **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 meeting 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)

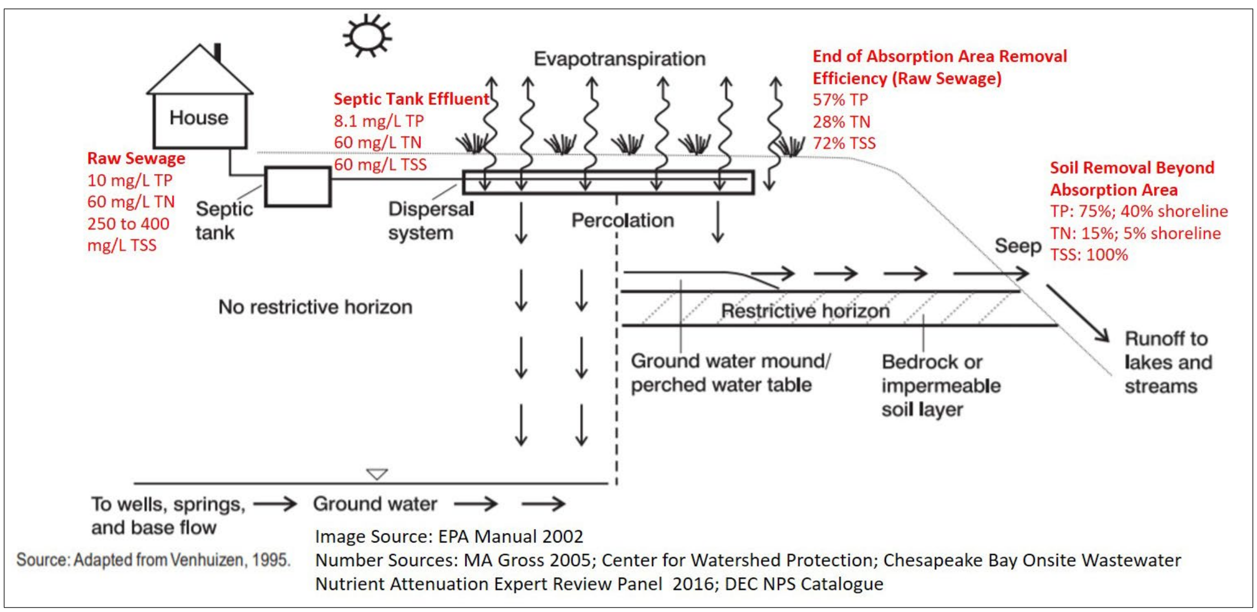

Figure 11. Wastewater concentrations and removal rates through a typical septic system

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.

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.

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**). Hazlitt's WWTP is small, has no regulatory limit on phosphorus loading, and is not required to monitor for phosphorus. Consequently, this discharge was not included in the analysis. Watershed Council staff calculated the potential point source phosphorus load 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.

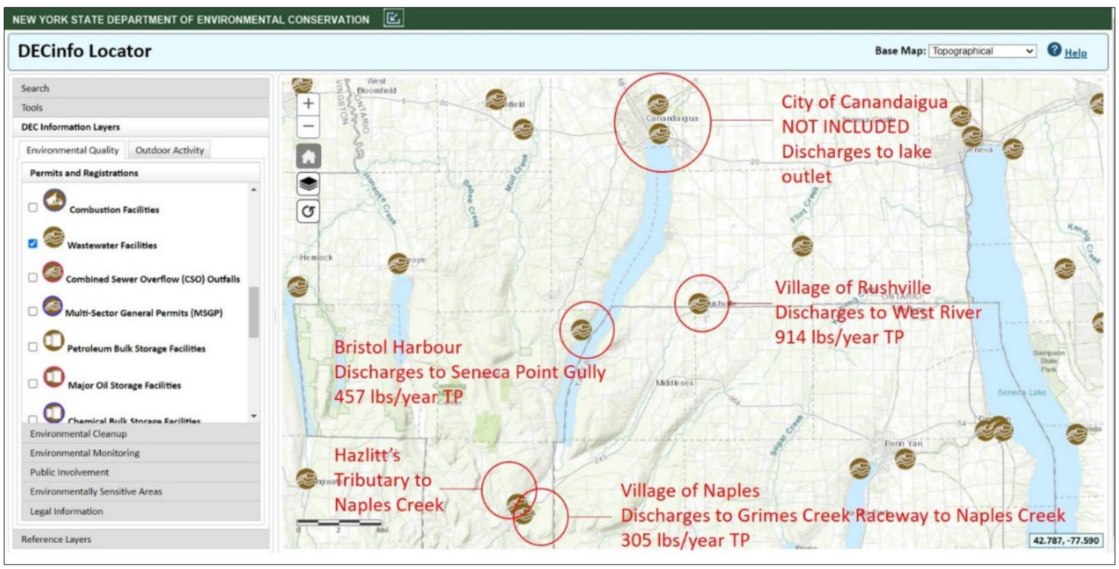

Figure 12. Point Sources of Phosphorus to Canandaigua Lake

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 (NY0161071)	West River	0.1	Monitor	914
Bristol Harbour Resorts (NY0063584)	Seneca Point Creek	0.05	Monitor	457
Village of Naples (NY0272060)	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 in watershed management plans. In the New York Finger Lakes, the Owasco Lake and Seneca-Keuka Lakes watersheds were recently modeled using SWAT as part of their approved 9E Watershed Plans. 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)

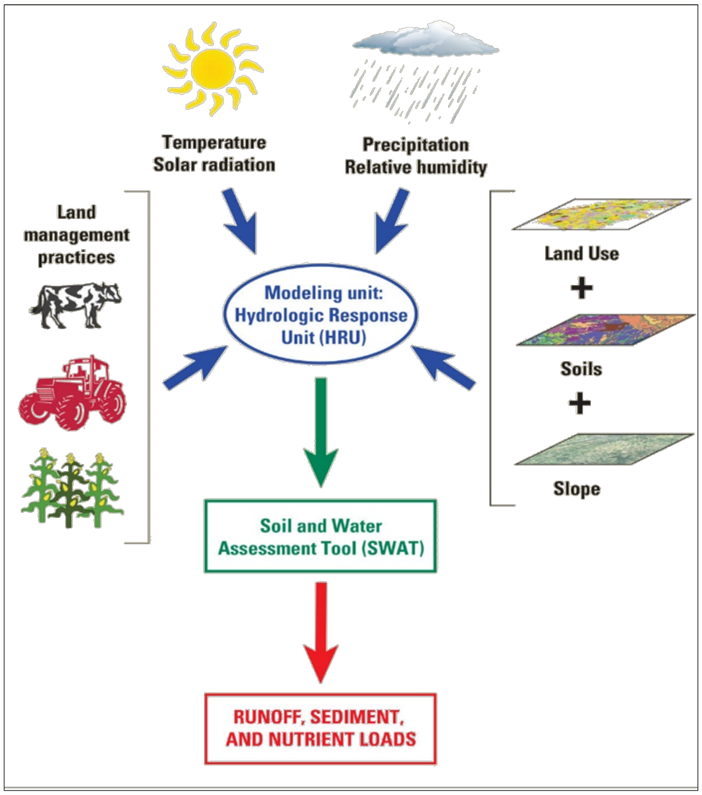

Figure 13. SWAT model schematic

Once developed, calibrated, and tested, the SWAT model can be used to 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 simulate conditions 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 C and D.**

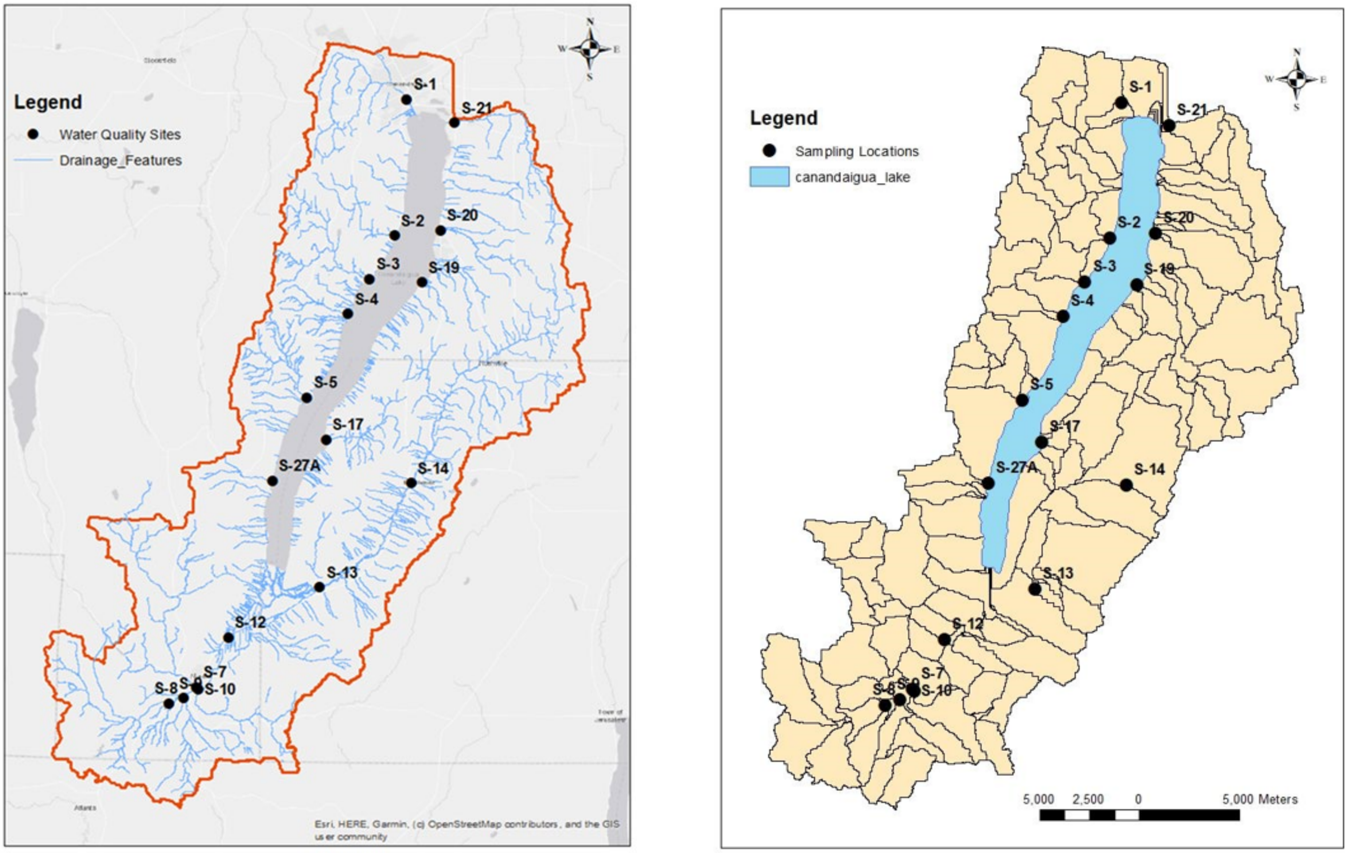

Figure 14 Location of long-term monitoring sites shown with subbasin boundaries and hydrology

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 current 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 United States Geological Survey National Landcover Dataset (NLCD), available at the onset of the modeling effort. Although there is some interannual variation in agricultural land cover based on factors such as crop rotation, most recent land cover data are largely unchanged since the 2016 compilation.

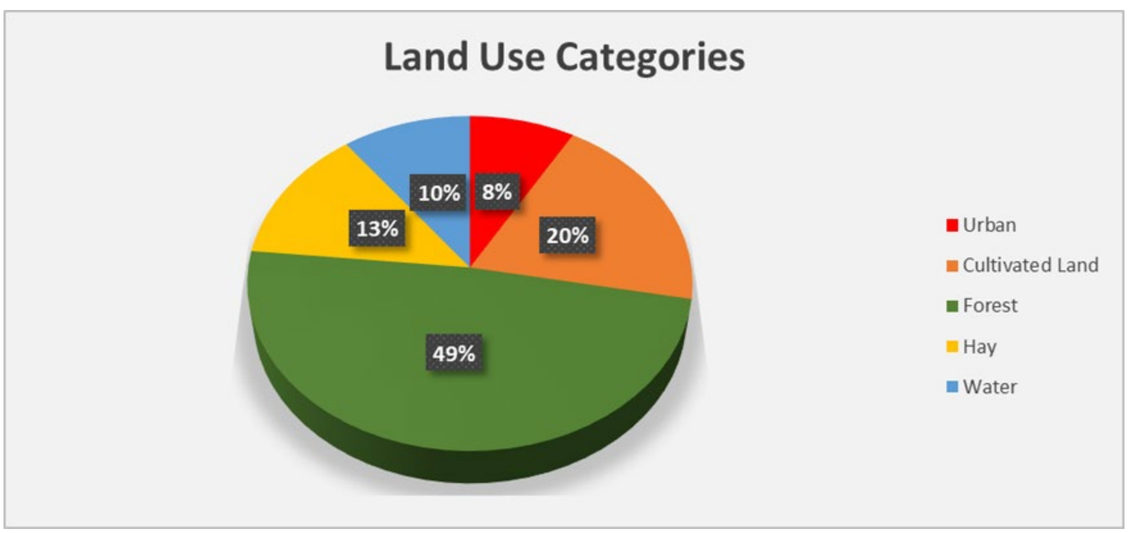

Figure 15. 2016 USGS- NLCD Land use/land cover distribution, watershed wide

SWAT results reflect the net transport of phosphorus from the tributaries to the lake. Two caveats are noted.

First, although the SWAT model is calibrated to existing conditions measured in the Canandaigua Lake tributaries, water quality analyses cannot differentiate between landscape and instream sources of phosphorus. In addition, SWAT is unable to allocate a portion of the load to stream and road ditch erosion and thus allocates the load of phosphorus and other tracked pollutants (sediment and nitrogen) to the land cover and management practices in the tributary subwatershed. For example, phosphorus loads from streambank erosion from a stream through a forested area would be included in the forested land loading. Additional details are included in the SWAT model report **(Appendix D)**. 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, continued efforts to restore and stabilize eroding sections of stream banks and road banks are among the recommendations of this 9E Watershed Plan.

Second, the Cornell BEE modeling team and Watershed Council staff 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. However, the most recent investments in agricultural BMPs, including nutrient management plans, expansion of winter cover crops, WASCOBs, grassed waterways, etc. are not fully reflected in the land cover/practice data layers within the SWAT model. Thus, reductions in phosphorus export to the waterways achieved by these recent BMPs are not reflected in the model estimation of current conditions, contributing to the potential overestimation of phosphorus load from agriculture.

As both local data and extensive literature document, climate change has affected the meteorology and hydrology of the Finger Lakes region. Annual average precipitation has increased 0.37 inches per decade since 1900 and rainfall intensity (the annual number of events greater than one inch) has increased as well, most notably in the northeast (NYSERDA https://www.nyserda.ny.gov/climaid). Increased volume and intensity of rainfall directly affect transport of nutrients and solids from the landscape to the lake. Even with no change in the watershed, these altered rainfall patterns are projected to increase erosion and phosphorus transport to Canandaigua Lake.

The Cornell team ran a SWAT simulation to estimate the impact of climate-related changes to watershed hydrology on phosphorus export. Using data and information from the Northeast Regional Climate Center NRCC and the US Forest Service Rustad et al 2012, the researchers selected a 15% increase in precipitation as the basis for their simulation. An increase in precipitation of that magnitude was projected to increase phosphorus loading to the lake by

5%. This result reinforces the importance of planning for increased phosphorus loading due to increased precipitation volume and intensity. Proactive phosphorus reductions through enhanced watershed management can help build resiliency into the system to help mitigate impacts of climate change on lake water quality. This projected increase in phosphorus load among the considerations that led to the Watershed Council’s commitment to an aggressive phosphorus reduction target to enhance water quality resilience for the Canandaigua Lake watershed.

9. Summary of Existing Phosphorus Load

Based on estimates generated by the three tools (onsite wastewater system calculations, wastewater plant discharges, and SWAT landscape model projections) an estimated 45,843 pounds of phosphorus enter Canandaigua Lake annually (**Table 10**). The phosphorus load estimate incorporates data from an extensive long-term monitoring program and reflects a wealth of local knowledge. The quantitative tools developed for the 9E Watershed Plan provide the watershed community with information to help direct efforts toward long-term protection of the lake and watershed from excessive phosphorus inputs.

One of the most valuable features of quantitative analysis is the ability for watershed managers to predict how the watershed would respond to interventions. The SWAT model and other calculations provide a basis for comparing the relative magnitude of phosphorus sources across the landscape, estimate load reductions associated with various BMPs, and set priorities. The tools can also assess the potential consequences from increasing the frequency and intensity of precipitation events due to climate change.

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 Source Type	Land Cover (acres) and Percent of Watershed Area	Annual Total Phosphorus Load (lbs./year)	Percent of Total Annual Total Phosphorus Load to Canandaigua Lake
Residential/Commercial	10,211/ 9%	4,003	9%
Cultivated Land	23,840 / 22%	21,899	48%
Forest and Wetlands	59,111/ 54%	7,901	17%
Hay/Pasture and Successional Old Fields	15,984 / 15%	7,364	16%
Septic Systems	--	3,000	7%
Wastewater Treatment Plants	--	1,676	4%
Total	**109,145**	**45,843**	**100%**

The estimated phosphorus load to Canandaigua Lake is distributed among different land cover and management practices, onsite systems, and wastewater plants (**Table 10**). 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 subwatersheds. A continued focus on agricultural management practices at the field scale in combination with additional watershed resiliency projects will be critical to successful implementation of the Nine Element Plan.

It is important to acknowledge the importance of non-agricultural sources which contribute a substantial portion 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 and wetland areas cover 54% of the land area and contribute approximately 17% of the phosphorus load. Protecting forested and wetland areas, along with enhancing their hydrologic and phosphorus 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 16** 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.

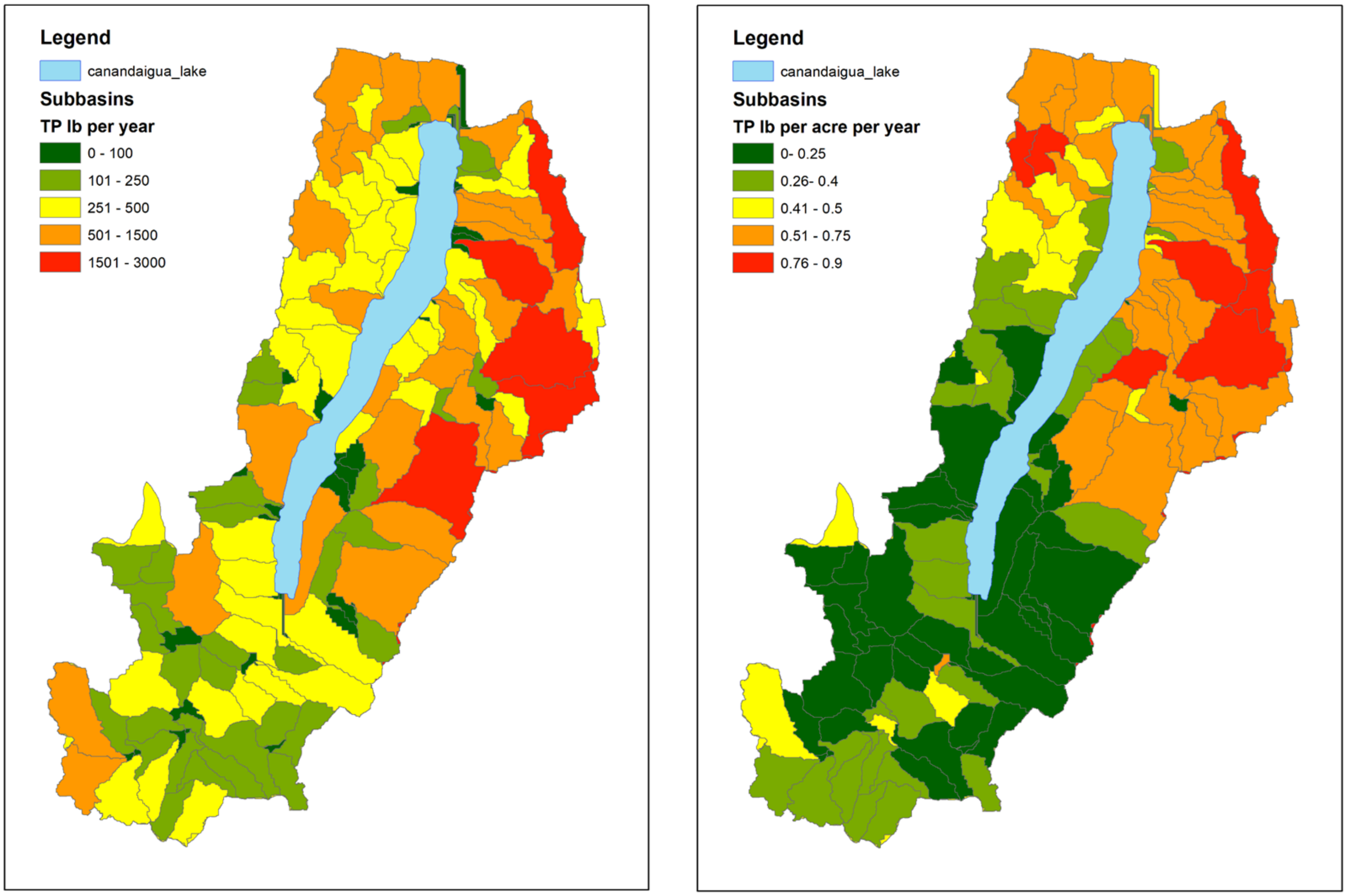

Figure 16. Phosphorus export by subwatersheds, SWAT model projections

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. Currently, BMP implementation strategies are voluntary for most of the action items in this 9E Plan; 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 (NMP) 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 Cornell BBE 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 estimated to be 20%. This figure comes from other SWAT model scenarios such as the Owasco 9E Plan.

Over the last two decades, SWCDs have worked with 75% of the farms in the watershed through the Agricultural Environmental Management Program to assess overall farm conditions and potential water quality threats and opportunity areas. Within the last 10 years. SWCDs estimate that they have developed nutrient management plans for approximately 50% of the farmland in the watershed. Moving forward, the strategy is to try to develop nutrient management plans for an additional 25% of the farmland (7,500 acres) over the next 10 years. The goal of this model scenario was to evaluate the water quality impact of developing and implementing nutrient management plans for all agricultural lands in the watershed. Model projections of the impact of 100% reductions are included as a boundary calculation to illustrate that phosphorus export from the landscape will continue. The model results will be used to calculate the benefits of increasing nutrient management planning in the watershed. The model results indicate that there is a 0.14 lb/acre of phosphorus reduction when implementing the most likely 20% nutrient application reduction scenario (second to last column). When applying that to the estimated nutrient plans developed over the last five years (7,500 acres) and the next 10 years (7,500 acres) the anticipated phosphorus load reduction on 15,000 acres is 2,100 lbs. The acres under NMPs will continue to be tracked and used to calculate progress toward our phosphorus reduction target.

Table 11. Modeled reduction in total phosphorus (TP) loading resulting from nutrient management planning on agricultural land

Land Use Category and Wastewater Sources	Area (acres)	Baseline Total Phosphorus Load (lbs./year)	Reduce fertilizer & manure application by 10% on all agricultural parcels (lbs./year)	Reduce fertilizer & manure application by 20% on all agricultural parcels (lbs./year)	Reduce fertilizer & manure application by 100% on all agricultural parcels (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 (-5%)**	**42,146 (-8%)**	**26,653 (-42%)**

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 through 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 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 approximately 0.5 lb./acre.

However, discussions with the SWCDs indicate that realistically about 30% of the total cropland in the Canandaigua watershed is suitable for planting winter cover crops in any given year. This equates to about 7,152 acres a year. Weather conditions, soil moisture levels, and short planting windows can substantially alter the success of cover cropping. The consensus from watershed SWCDs is that a realistic target for enhancing cover cropping on a sustainable basis is an additional 3,500 acres. Using the model scenario of 0.5 lbs./acre phosphorus reduction, this would equate to a 1,750 lb reduction in phosphorus loading. The adaptive management targets for the watershed reflect the SWCD assessment of feasibility of adoption: 3,500 additional acres and a sustainable reduction of 1,750 pounds in phosphorus load.

Table 12. SWAT Projected reduction in total phosphorus (TP) loading resulting from expanded adoption of 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 an additional 3,500 acres of cultivated lands (lb./yr.)
Residential/Commercial	10,211	4,003	4,003	4,003
Cultivated Land	**23,840**	**21,899**	**16,907**	**20,149**
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 -11%**	**44,093 -3.8%**

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, numerous studies suggest that the unit export of phosphorus from developed lands can be high due to 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**. The total phosphorus load is reduced by 236 pounds in this scenario.

Table 13. Projected reduction in total phosphorus (TP) loading resulting from modified practices on 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** **-0.5%**	**44,016** **-4%**

Scenario 4: Implementation of the Onsite Septic 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% (DEC Non-Point Source Catalogue and Center for Watershed Protection). 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 (**Table 14)**.

Table 14. Potential reduction in phosphorus Load from increased phosphorus removal requirements in the Onsite Wastewater Law

Land Use Category and Wastewater Sources	Area (acres)	Annual Total Phosphorus Load (lbs./yr)	Onsite Law implementation that improves removal efficiency from 57% to 80%
Residential/Commercial	10,211	4,003	3,767
Cultivated Land	23,840	21,899	21,889
Forest and Wetlands	59,111	7,901	7,901
Hay/Pasture and Successional Old Field	15,984	7,364	7,364
Septic Systems	--	**3,000**	**1,395**
Wastewater Treatment Plants	--	1,676	1,676
Total	**109,145**	**45,843**	**44,238** **-3.5%**

Summary: Modeled Scenario Results Showing Total Load and Percent Load Reduction

These scenario results illustrate the relative effectiveness of management practices on reducing phosphorus export at the watershed scale. The first two scenarios address agricultural BMPs; these are voluntary, incentive-based and rely on willing landowners and availability of funding and technical support. The objective of these model scenarios was to explore the impact of nutrient management planning and implementation on all farms across the watershed in addition to expanding cover crops to all cultivated fields classified as using high or medium phosphorus application rates. Expanding these BMPs to all eligible parcels would enable significant progress toward reaching the reduction target. It is far more likely that adoption will be incremental. For example, with increased nutrient management plans and cover crops implemented on 50% of the identified parcels, models project an annual reduction of 6,185 pounds of phosphorus. While below the target, expansion of these practices offers an increased resilience to impacts of a changing climate.

The third scenario (reduced fertilizer applications on residential parcels) projects only minor reductions overall. This finding, while consistent with the current NYS restrictions on residential application of phosphorus fertilizers, may not accurately capture the runoff from the high-density development patterns around the shoreline of Canandaigua Lake, the City of Canandaigua, and the residential growth nodes in the Town of Canandaigua. Section 11 will look at phosphorus reduction opportunities associated with use of green infrastructure practices. The Watershed Council will continue to promote the phosphorus reduction benefits of low impact development practices consistent with the NYS Stormwater Manual.

The fourth scenario- expanded implementation of the onsite law- builds on a well-established foundation of local understanding and acceptance across the Canandaigua Lake watershed. The target expansion is achievable; the Watershed Council will continue to implement and enforce the law through the partnership between the Watershed Inspector and the municipal Code Officers.

The four modeled scenarios provide a good understanding of the potential magnitude of reduction in both the unit load of phosphorus (lbs./acre/yr.) and the total export to the lake (lbs./yr.) When coupled with realistic predictions of what can be accomplished by 2033, the four modeled scenarios could account for 5,691 lbs/yr (or approximately half of the 11,461 lb. reduction target (**Table 15)).** Additional measures will be required to meet the aggressive reduction target by 2033. Section 11 details a comprehensive set of management strategies with estimated phosphorus reductions that will be utilized in combination to reach the full 25% phosphorus load reduction target of 11,461 lbs.

Table 15. Summary of Anticipated Phosphorus Reduction from the four Modeled Scenarios to be Implemented by 2033.

Scenario Category	Current Phosphorus Load, lbs./yr.	Total P Load Reduction with scenario, lbs./yr.	Percent reduction in TP load from recommended practice
Nutrient management plans on 15,000 acres	29,263	2,100	4.6%
Cover Crops on cultivated lands- 3,500 acres	21,899	1,750	3.8%
20% Reduction in Fertilizer application on developed land	4,003	236	0.5%
Onsite Law implementation that improves removal efficiency from 57% to 80%	3,000	1,605	3.5%
Total (including wastewater plants)	**45,843**	**5,691**	**12.4%**

10.2 HUC 12 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 17).**

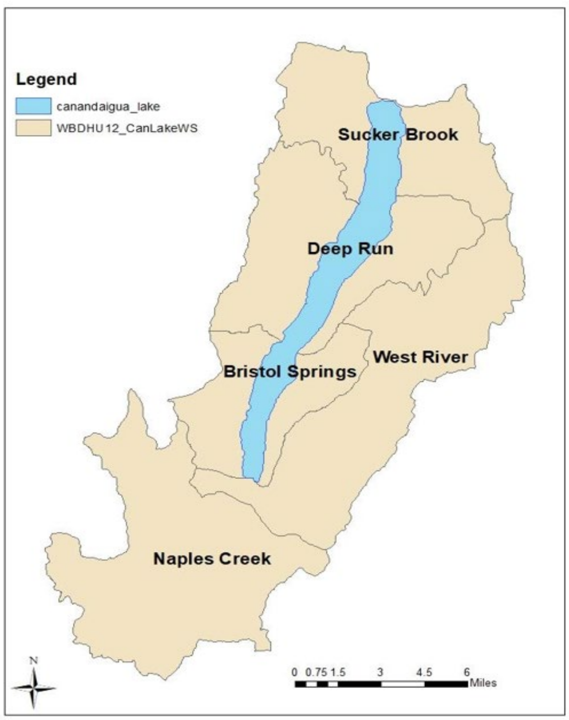

Figure 17. Delineation of HUC12 Subwatersheds

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 16** and displayed in **Figure 18.**

Table 16. Phosphorus load and land cover by HUC12 Subwatershed

HUC- 12	Total P Load (lbs./yr.)	Land Area (acres)	Cultivated Land (acres/%)	Hay, Pasture & Successional Fields (acres/%)	Forest (acres/%)	Residential/ Urban (acres/%)
1-Naples Creek 041402010201	8,480	31,482	2,800 / 9%	2,539 / 8%	24,428 / 78%	1,716 / 5%
2- West River 041402010202	13,595	28,205	8,555 / 30%	4,004 / 14%	13,970 / 50%	1,676 / 6%
3- Bristol Springs 041402010203	3,371	11,957	989 / 8%	1,607 / 13%	8,529 / 71%	832 / 7%
4- Deep Run 041402010204	9,780	21,143	5,259 / 25%	5,079 / 24%	9,109 / 43%	1,696 / 8%
5- Sucker Brook 041402010205	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%

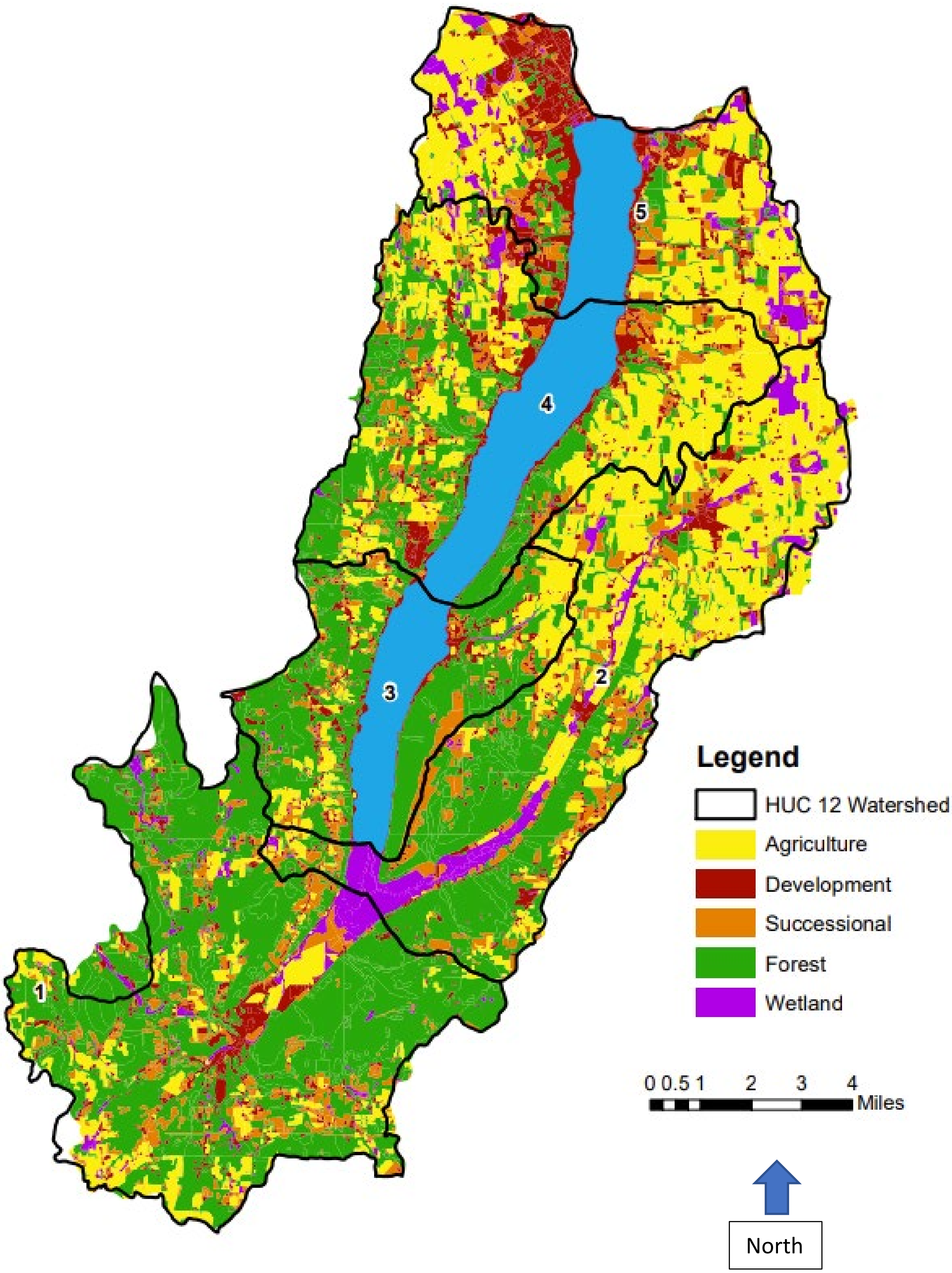

Figure 18. Variation in land cover across Canandaigua Lake watershed

Phosphorus load reductions for three of the four management scenarios described in Section 10.1 are reported by HUC12 subwatersheds in **Table 17** (nutrient management plans on agricultural lands) and **Table 18** (expanded cover crops on cultivated lands and reduced fertilizer application to residential and commercial properties). The onsite systems in the watershed are not georeferenced to enable assignment to a HUC-12 and are therefore not reflected in the loading analyses. The watershed program is currently working on geo-referencing these systems and will be able to track them by subwatershed in the future.

Table 17. Phosphorus reduction projections by subwatershed: expansion of nutrient management plans (NMP). *

HUC- 12	Current Estimated TP Load (lbs./yr.)	Projected TP Load with 10% expansion of NMP (lbs./yr.) *(% Reduction)*	Projected TP Load with 20% expansion of NMP (lbs./yr.) *(% Reduction)*	Projected TP Load with 100% adoption of NMP (lbs./yr.) *(% 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 (5%)	42,146 (8%)	26,563 (42%)

*Note that a 20% expansion of NMP across the watershed is considered realistic

Table 18. Phosphorus reduction projections by subwatershed: increased cover crops on cultivated lands; decreased fertilizer application on developed properties

HUC-12	Baseline Annual TP Load (lbs.)	Projected Annual TP Load with 42% adoption of cover crops, lbs. *(% reduction)*	Projected Annual TP Load with 100% adoption of cover crops, lbs. *(% reduction)*	Projected Annual TP Load with 20% reduction in Residential Fertilizer use, lbs. *(% reduction)*	Projected Annual TP Load with 100% reduction in Residential Fertilizer use *(% 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 (11%)	36,499 (20%)	45,478 (1%)	44,016 (4%)

11. Implementation Strategy

The objective of developing this 9E Watershed Plan is to quantify and augment the phosphorus reduction strategies identified in the 2014 Watershed Plan to realize the community's vision for Canandaigua Lake and its watershed. Previous sections of the 2023 9E Watershed 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 and project the effectiveness of management scenarios. The project team identified a proactive quantitative target to reduce watershed phosphorus export by 25% by 2033 along with a quantitative goal of not exceeding an in-lake phosphorus concentration of 5.5 ug/L.

Sections 8-9 detailed that the estimated annual load of phosphorus to Canandaigua Lake is modeled to be 45,843 pounds. The established target is to reduce the annual load by 25% (11,461 pounds) in order to build enhanced water quality resiliency into the watershed system. Section 10 evaluated four management alternatives for phosphorus reduction and demonstrated the potential to achieve the reduction target based on general assumptions related to the extent of adoption of the management actions across the watershed.

With additional site-specific input from local agencies, the scenarios were refined to reflect more realistic projections of the extent to which management practices will be implemented over the next decade (refer to **Table 15)**. The phosphorus reductions achieve approximately half (12.4%) of the 25% phosphorus load reduction target. Consequently, additional projects and practices will be necessary to reach the phosphorus load reduction target.

Section 11 details the implementation strategy that will be utilized by the watershed program and its partners to focus implementation efforts on meeting the 25% phosphorus load reduction target. Phosphorus reduction strategies are categorized in five Focus Areas and include an estimated phosphorus reduction. The combined projected phosphorus load reductions indicate that meeting the overall 25% target reduction is aggressive but achievable over the next decade.

The Watershed Council received input and guidance from many stakeholder groups on the specific strategies included in this section. These groups will also be actively involved in the implementation of the 9E Watershed Plan.

Strategies were selected after consideration multiple factors:

- Strategies identified in the 2014 Watershed Plan that follow the principles of protection and enhancement of natural capital/ecosystem services to build resilience.
- Community and stakeholder 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 SUNY-ESF Master of Science Thesis (Rickard 2021).
- PLET (replaced STEPL), CWP, CAST and other model reduction estimates and unit costs.
- Ability to implement these projects on a voluntary basis.
- Potential to access grant funding.
- Municipal and 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.

1. Enhance Wetlands, Floodplains and Watershed Resiliency
2. Agriculture
3. Stream, Shoreline and Road bank Erosion and Resiliency
4. Existing and New Development
5. Wastewater Management

The tables provide the following information:

- **Geographic focus area**- Many projects can be implemented across the watershed landscape. This column notes priority geographic and land use areas projects; however, landowner willingness and funding opportunities can vary, and recommendations are not limited to noted focus areas.
- **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 will be implemented across the watershed in multiple locations.
  - High Priority strategies: initiate within one to three years
  - Medium priority strategies: initiate within 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 The Nature Conservancy (TNC) completed a major effort to restore the natural flood plan functionality along Naples Creek. The project included the following:

- Installation of four 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
- Installation of five 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.
- Construction of five berm (barrier) breaks on NYSDEC land to allow moderate storm event flood flows to reconnect with the hundreds of acres of floodplain 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 enter the natural floodplain area for water quality treatment.

- Major storms in 2021 created log jams in a few locations that were creating local impairments. Strategic log jam removals were completed by the Watershed Council/ Town of Canandaigua Highway Department and coordinated with NYSDEC.

- Repaired ½ mile of NYSDEC trail along Naples Creek that was damaged during flood events and reconfigured berms to allow more flow to reach floodplain area on both sides of the creek and enhance capture of phosphorus and sediment.

These combined efforts have helped 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 flow onto more than 300 acres of land that had been mostly isolated. These 300 acres of forest, wetland, and grassland provide substantial potential for infiltration and capture of phosphorus and sediment.

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 pollutants 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 deliver the majority of the annual load of nutrients and sediment to the lake. 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 seek opportunities to enhance the potential of this natural filtration and flood reduction system.

Recent research indicates that wetlands and floodplain areas can achieve an average phosphorus removal rate of 46% (Rickard 2021). The Watershed Program's long-term storm event sampling program documents that Naples Creek has an average total phosphorus concentration of 198 ug/L during storm events. The effective storage area created from this floodplain reconfiguration was estimated using GIS and LiDAR, at 300 acres, and the storage volume at 600 acre-feet. This project is estimated to capture 1,136 pounds of phosphorus annually; representing or a 2.5% reduction in external load to Canandaigua Lake. When combined with the other modeled scenarios this project increases the phosphorus load reduction to 16.9% or 6,827 lbs. of the 11,461 lbs. needed to achieve the 25% reduction target. The actions detailed in the five focus areas showcase the projects that will be implemented over the next decade to achieve the additional 4,634 lbs. of phosphorus reduction.

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

Table 19. Recommended Actions and Projects 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**
1.1	Protect, enhance, and restore existing wetlands, riparian corridors and floodplains through easements and land purchase to increase their water quality resiliency to store and treat 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. **Described in narrative – Section 11.1**	Watershed-wide Naples Creek and West River subwatersheds Downstream of Ag-dominated subwatersheds	Wetlands: 46% removal of TP (TN 51%, TSS 53%) **Naples Creek project = 1,136 lbs. of phosphorus reduction annually- see description above**	$5,000-10,000/acre And restoration costs	High priority On-going

Focus Area 1: Enhance Wetlands, Floodplains and Watershed Resiliency					
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable) ***	**Estimated Cost**	**Priority Timeframe**
1.2	**Implement 5 additional projects in priority subwatersheds to treat runoff from an additional 20,000 acres of land either as a flow through filtering system or closed basin system. Goal is to construct 500-acre feet of storage**	Use the Natural Capital Model for Canandaigua, field investigations, GIS mapping and/or local municipal knowledge to continue to identify critical source water protection areas	**500-acre feet of storage will result in 1,200 lbs. of phosphorus reduction- estimate based on the Naples Creek project and Rickard 2021**	$5,000-10,000/acre plus, restoration costs	High priority On-going
1.3	Create new wetlands, riparian zones, and water quality basins to accept runoff from areas with high phosphorus/pollutant potential **Implement riparian buffers, wetlands, and water quality basins to treat 2,000 acres of upland agricultural land**	Watershed-wide Ag-dominated subwatersheds	**Capture runoff from 2,000 acres of upland agricultural land (42% reduction in unit TP export from upland agricultural lands) = 773 lbs. of phosphorus reduction- 42% is for riparian buffers- based on CAST model and Owasco Plan**	$5,000-10,000/acre plus, restoration costs	High Priority On-going

Focus Area 1: Enhance Wetlands, Floodplains and Watershed Resiliency					
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable) ***	**Estimated Cost**	**Priority Timeframe**
			Rickard 2021: Wetlands: 46% removal of TP (TN 51%, TSS 53%) Floodplain: Site-specific Wetland: 20-40%		
1.4	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
1.5	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	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	Wetlands: 46% removal of TP (TN 51%, TSS 53%) Floodplain: Site-specific Wetland: 20-40%	$5,000-10,000/acre Plus, restoration costs	High Priority and ongoing

Focus Area 1: Enhance Wetlands, Floodplains and Watershed Resiliency					
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable) ***	**Estimated Cost**	**Priority Timeframe**
	restored to provide for a substantially higher natural capital ranking as it relates to water quality. **Goal: Implement 10 new floodplain/wetland projects over the next decade**	corridors, steep slope areas and lands that can be restored to increase their overall natural capital ranking.	Calculated load reductions will be site/project specific		

* Note that estimated reduction in total phosphorus load is based on full implementation of the recommended practice (target 2033)

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 phosphorus, nitrogen and sediment 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 forests, wetlands, and developed areas as well as domestic wastewater. 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 20.

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.

Field Based gully erosion can contribute tons of soil loss and substantial phosphorus loads to the lake. This is especially true during high intensity rain events on row crops. A major priority will be to partner with ag landowners to reduce these impacts.

Table 20. Recommended Actions and Projects 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**
2.1	Increase nutrient planning through soil testing and education programs or the adoption of AEM Tier III nutrient management plans Modeled scenario: 15,000 additional acres under NMP (see Table 15)	Agriculturally dominated subwatersheds, highly erodible land, Watershed-wide	**SWAT model 2,100 lbs. phosphorus reduction from 15,000 acres NMP** Average of 0.14 lbs./acre reduction from nutrient management plans on cultivated lands 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
2.2	Promote and expand the use of cover crops wherever feasible Modeled scenario: 3,500 additional acres with cover crops (see Table 15)	Agriculturally dominated subwatersheds Watershed-wide	**SWAT Model** Avg: 0.5 lbs. of phosphorus reduction per acre of cover crop **3,500 acres = 1,750 lb reduction (2018-2033)**	$100 per acre for seed + installation	High Priority On-going
References: NYSDEC Nonpoint Source Guidance and Technical Assistance https://www.dec.ny.gov/chemical/96777.html CAST (Chesapeake Area Scenario Tool) https://cast.chesapeakebay.net/					

	Focus Area 2: Agriculture				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
2.3	Implement both on field and off field-based erosion reduction practices (including but not limited to grassed waterways, WASCOBs, conservation tiling, strip cropping, etc.) **Target: implement measures to reduce gully type field erosion and capture 3,000 tons of soil by 2033- this target is based on extensive field work and reconnaissance by the Watershed Council and SWCD staff identifying many agriculture-based field erosion sites throughout the watershed.**	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 Average of 1 ton (2000 lbs) of soil erosion reduction equals 1 lb of phosphorus reduction (Soil resources of phosphorus | Integrated Crop Management (iastate.edu)) and Virginia Tech Report. Based on over 650 storm event samples. the average TSS to TP ratio is 273 mg/L of TSS to 0.210 mg/L (1,300 to 1), The assumed ration (2,000 to 1) may underestimate the potential reduction. The project team used this as a conservative estimate. **Reduce gully type field erosion with the use of grass waterways, and WASCOBS by 3,000 tons = 3,000 lbs of phosphorus reduction**	Variable- utilize NRCS cost estimates	High Priority On-going

	Focus Area 2: Agriculture				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
2.4	Enhance and accelerate public and private investment to compensate agricultural producers for voluntary acquisition/easement of agricultural lands with high potential for water quality improvement and other ecosystem services	Agriculturally dominated subwatersheds Watershed-wide	Site and practice specific- will use the literature and modeled phosphorus reduction estimates identified in these tables along with the latest research	$4000-$6000 per acre for marginal farmland	High Priority On-going
References: NYSDEC Nonpoint Source Guidance and Technical Assistance https://www.dec.ny.gov/chemical/96777.html CAST (Chesapeake Area Scenario Tool) https://cast.chesapeakebay.net/					
2.5	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	**(See 2.2) For estimates**	$100,000+	Medium Priority On-going
2.6	Where feasible, work with agricultural landowners to develop manure application rate based on a lower acceptable phosphorus index - to reduce risk of phosphorus runoff to waterways	Agriculturally dominated subwatersheds Watershed-wide	(**See 2.1**) Use of Phosphorus Index (Phosphorus Placement): 10 to 20%	Variable	Medium Priority On-going

	Focus Area 2: Agriculture				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
2.7	Create water quality basins and/or buffers at the edge of a field to a stream or roadside ditch and on fields with long flow paths to filter runoff before it enters streams or roadside ditches	Agriculturally dominated subwatersheds Watershed-wide	**See 1.3 for estimates** Wetland creation, enhancement, rehabilitation, restoration: 22 to 40% Forest or Grass Buffer: 30 to 45%	$5,000 per acre of land Variable installation costs	High Priority On-going
References: NYSDEC Nonpoint Source Guidance and Technical Assistance https://www.dec.ny.gov/chemical/96777.html CAST (Chesapeake Area Scenario Tool) https://cast.chesapeakebay.net/					
2.8	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	$1,000,000+	Medium Priority On-going
2.9	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 Manure Incorporation: 12-24% Tillage Management: 2-71% Rotational/Prescribed Grazing: 24%		High Priority On-going
2.10	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%	Variable- use NRCS fencing cost estimates	High Priority On-going

	Focus Area 2: Agriculture				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
2.11	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% Dairy: 20% Hogs: 39% Poultry: 9% Sheep/Horses/Goats: 3%	Variable	Medium Priority On-going
References: NYSDEC Nonpoint Source Guidance and Technical Assistance https://www.dec.ny.gov/chemical/96777.html CAST (Chesapeake Area Scenario Tool) https://cast.chesapeakebay.net/					
2.12	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) 91% for riparian zones over 25 meters (88% TN, 94% TSS) Forest Buffer: 30 to 45%	Variable- depends on the quality of ag land	Medium Priority On-going
2.13	Encourage crop residue mulching on row crop lands	Watershed-wide	Variable	Low cost	Medium Priority On-going
2.14	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	Variable- depends on the current state of the soil and how best to integrate into the farm operation	High Priority On-going

	Focus Area 2: Agriculture				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
2.15	Enhanced Agri-chemical management of fertilizers and pesticides. Install proper storage and mixing areas of fertilizers and pesticides to reduce risk of runoff	Agriculturally dominated subwatersheds and watershed wide	Qualitative- Highly effective in reducing fertilizer and pesticide runoff potential when installed and maintained properly	$80,000+ per unit installed	High Priority Ongoing
References: NYSDEC Nonpoint Source Guidance and Technical Assistance https://www.dec.ny.gov/chemical/96777.html CAST (Chesapeake Area Scenario Tool) https://cast.chesapeakebay.net/					

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 21.

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, Finger Lakes PRISM, and many educational resources (e.g., Cornell Local Roads Program, Lake Friendly Living initiative, Cornell Cooperative Extension, Finger Lakes Institute, among others).

Table 21. Recommended Actions and Projects to Reduce Phosphorus Input. 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**
3.1	Reduce roadside ditch erosion through re-vegetating, stabilization, reduced scraping, check dams, etc. **Stabilize 2,000 feet of highly eroding road ditches**	Steep slope sections of the watershed with road systems. Watershed-wide	Load reductions will be site specific and reflect level of erosion reduction. Estimates will be based on the 1 ton of soil loss to 1 lb of phosphorus loss ratio that has been documented previously. CAST and PLET and other models will also be used to estimate phosphorus load reductions	Variable	Medium Priority On-going
3.2	Where feasible, disconnect roadside ditches from waterways- without causing unintended consequences of new drainage patterns on downslope areas	Watershed-wide	Additional treatment from filtering of runoff- variable	Variable	Medium Priority On-going
Reference: CAST, Stream Restoration Protocols https://cast.chesapeakebay.net/Documentation/BMPs					

	Focus Area 3: Stream, Shoreline and Roadbank Erosion and Resiliency				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
3.3	Where feasible reduce streambank erosion through bank stabilization and measures to reduce stream velocity **Stabilize 3,000 ft of eroding stream banks-; estimate reflects extensive evaluations of potential stream bank erosion areas by Watershed staff and SWCD. It is a conservative estimate of capacity to complete bank stabilization/restoration projects over the next 10 years.**	Watershed-wide Highly erodible streams that are accessible by equipment	Load reductions will be site specific and will be based level of erosion reduction. Estimates will be based on the 1 ton of soil loss to 1 lb of phosphorus loss ratio that has been documented previously. CAST and PLET and other models will also be used to estimate phosphorus load reductions	$20-$150/ ft of stabilization	Medium Priority On-going
3.4	Increase use of vegetated buffers along streams, roadside ditches, and shoreline areas	Watershed-wide	(Refer to section 2.7) 75% for riparian zones under 25-meter (72% TN, 84% TSS) 91% for riparian zones over 25 meters (88% TN, 94% TSS) 0.35 lbs./acre/year on developed lands (reference CAST forest buffer)	$243/acre (citing CAST forest buffer) OW	High Priority On-going
Reference: Chesapeake Assessment Scenario Tool (CAST) https://cast.chesapeakebay.net/Documentation/BMPs					
3.5	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

	Focus Area 3: Stream, Shoreline and Roadbank Erosion and Resiliency				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Priority Timeframe**
3.6	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
3.7	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
3.8	Invasive Species Management Actions • Continue boat steward program and wash stations at public launches • Expand educational programming with focus on high priority aquatic and terrestrial species • Research effective early detection/rapid response approaches • Enhance aquatic invasive species removal program	Shoreline areas in-lake and watershed wide	**Qualitative**	$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 22.

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 22. Recommended Actions and Projects to Reduce Phosphorus Input. 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**
4.1	Reduce fertilizer use on lawns in suburban, urban, and commercial areas Modeled scenario	Shoreline areas and riparian corridors,	Urban Nutrient Management Plans: 3-10% **SWAT Modeled scenario: 236 lb. reduction**	Educational effort	High Priority On-going
4.2	Expand use of green infrastructure	Shoreline areas and riparian corridors, Sucker Brook and Watershed-wide	Dry Extended Detention Pond: 20% Permeable Pavement: 20-80% Bioretention/raingardens45 to 85% Bioswale: 75% Vegetated Filter Strip: 54% Filtering Practice (temporarily store and pass through sand or organic medium): 60% Infiltration Practices: 85% Conservation Landscaping (converting turf to perennial meadows): 25% Install forested buffers in urban areas: 50% Vegetated Open Channels: 10 to 50% Wet Ponds and Wetlands: 45%	Site and practice specific	High Priority On-going

	Focus Area 4: Existing and New Development				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Timeframe**
Reference: Chesapeake Assessment Scenario Tool (CAST) https://cast.chesapeakebay.net/Documentation/BMPs NYSDEC Nonpoint Source Guidance and Technical Assistance https://www.dec.ny.gov/chemical/96777.html					
4.3	Local governments consider regulatory requirements for shoreline development and re-development including buffers and water quality requirements	Shoreline areas	See above for estimates	Site specific	High Priority On-going
4.4	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
4.5	Protect areas with high potential for pollutant loading such as steep slopes, riparian areas, shorelines	Watershed-wide	Variable	Site specific	High Priority On-going
4.6	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
4.7	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
Reference: NYSDEC Storm Water Design Manual (review draft December 2022) https://www.dec.ny.gov/fs/docs/pdf/stormwaterdesignmanual.pdf					

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 23).**

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

Table 23. Recommended Actions and Projects to Reduce Phosphorus Input. Focus Area 5: Wastewater Management

	Focus Area 5: Wastewater Management				
	Recommended Action	**Geographic area**	**Estimated Phosphorus Load Reduction (if quantifiable)**	**Estimated Cost**	**Timeframe**
5.1	Reduce the number of substandard onsite wastewater systems through implementation of the Local Onsite Wastewater Treatment System Law **Modeled scenario** (**Table 14)** Increase TP removal from 57% to 80% from onsite system effluent	Watershed-wide	**Onsite Model scenario: 1,605 lbs. per year**	Existing Watershed Inspection program- low regulatory cost	High Priority On-going
5.2	Explore expansion of public sewers and implement where feasible	Shoreline areas Watershed-wide	Variable- depends on failure rate of onsite systems and proximity to lake	$1,000,000+	Medium Priority On-going
5.3	Increase use of enhanced phosphorus removal technologies on onsite systems	Shoreline properties Watershed-wide	**See 5.1 for reduction**	$5,000 per system	Medium Priority On-going
5.4	Consider the implementation of treatment wetlands and/or wastewater reuse/recycling of permitted wastewater effluent to reduce phosphorus loadings to surface waters	Watershed wide	Variable- site specific	$100,000+	Medium Priority On-going

11.5 Summary of Recommended Actions to Reach Target

As presented in **Tables 19-23**, each of the five focus areas include a range of recommended actions. A quantitative estimate of the number of projects/land area impacted and the resulting amount of phosphorus captured is available for many, but not all, of the recommendations. The Watershed Council and its partners will continue their efforts to track progress toward implementation, monitor the quality of the watershed tributary streams, engage landowners, and support efforts to direct funding toward these priority projects. The projected benefit in phosphorus reduction achieved by projects within the focus areas associated with a quantitative reduction estimate is presented in **Table 24**. There are many critical projects and concepts identified in Tables 19-23 that do not have a specific estimate listed. When individual projects are implemented, the literature-based estimates and modeling tools listed in the table will be used to provide a quantitative phosphorus reduction.

Note that the summed estimate of phosphorus reduction in Table 24 meets and exceeds the 25% target. This is a conservative estimate since there are many additional projects listed in the 5 focus area tables that are site specific and will have phosphorus load reductions based on the exact scope of the project.

Table 24. Projected Progress toward Phosphorus Reduction Targets when fully implemented

Focus Area Item #	Implementation action items with specific objectives and resulting phosphorus reduction estimates	Annual Phosphorus Load Reduction (lbs/yr)	Percent Reduction in Total Phosphorus load (45,843 lbs.)
1.1, 1.2, 1.3	Naples Creek Restoration project- completed in 2021 and 2022	1,136 lbs.	2.5%
1.1, 1.2, 1.3	Implement 5 projects in priority subwatersheds to treat runoff from an additional 20,000 acres of land either as a flow through filtering system or closed basin system. **Goal is to construct 500-acre feet of storage**	1,200 lbs.	2.6%
1.3, 2.7	Implement riparian buffers, wetlands, and water quality basins to treat 2,000 acres of upland agricultural land	773 lbs.	1.7%
2.1	Nutrient management plans on 15,000 acres	2,100 lbs.	4.6%
2.2	Cover Crops on cultivated lands- 3,500 acres	1,750 lbs.	3.8%
2.3	Reduce Gully type field erosion by 3,000 tons with the use of grass waterways and WASCOBS	3,000 lbs.	6.5%
4.1	20% Reduction in Fertilizer application to developed landscapes (lbs./yr.)	236 lbs.	0.5%

Focus Area Item #	Implementation action items with specific objectives and resulting phosphorus reduction estimates	Annual Phosphorus Load Reduction (lbs/yr)	Percent Reduction in Total Phosphorus load (45,843 lbs.)
5.1, 5.3	Modify provisions of the Onsite Law to improve phosphorus removal efficiency from 57% to 80%	1,605 lbs.	3.5%
	Total Phosphorus Load Reduction	**11,800 lbs.**	**25.7%**

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 2023, the base funding (the sum of the annual municipal contributions) totaled $144,000. 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

- Watershed Council- $145,000 per year total contributions from fourteen watershed and water purveying municipalities
- Watershed Commission- $120,000 per year total contributions from water purveying municipalities
- Municipal Budgets- municipalities have open space funds, and contribute well beyond their Watershed Council contribution

Finger Lakes Lake Ontario Watershed Protection Alliance

- *Funding is routed through Ontario County Planning Department- each year we get contributions to implement both research and in the field water quality projects*

Canandaigua Lake Watershed Association

- *Partner on research, education programs and help fund projects*

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 meeting the target and goals of the 9E Plan. There are long standing partnerships among the various agencies and entities that will be implementing recommendations. The Watershed Council will develop a tracking system and host annual meetings with the implementation partners and other stakeholders to track progress and scope out partnerships and opportunity areas to implement key projects to achieve the target.

As described in Section 3.2, both the in-lake phosphorus goal of 5.5 ug/L at the Deep Run mid lake station (see Section 6.1 for FLCC program details) and the watershed-based load reduction target of 25% will be used to evaluate success of implementing the recommended projects to reduce watershed phosphorus load. 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 Watershed 9E Plan necessitate continuation of monitoring and assessment. If the FLCC lake sampling results indicate that lake phosphorus concentrations are increasing, watershed BMPs will be re-evaluated and expanded/accelerated to the extent possible. If the number of watershed projects is not on track, the Watershed Council and partners will review whether technical support, equipment, and/or funding is the primary impediment and respond accordingly.

The established 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:

- Use existing SWAT based scenario results 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,

- PELT, 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 restoration 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 11,461-pound load reduction (25%) by 2033 along with maintaining a summer average Total Phosphorus concentration at or below 5.5ug/L will be evidence of successful implementation of the 9E Watershed Plan.

Since most 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.

As described above, the Watershed Council will host annual meetings and periodic sessions with the implementation partners to track and report progress and identify opportunity areas to further implement critical watershed strategies. The Council will provide progress updates via their website (www.canandaigualake.org) and at their meetings which are open to the public. Watershed Council staff will continue their long-standing commitment to make presentations to other organizations, notably the Canandaigua Lake Watershed Association, when requested.

14. Conclusions

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

Actions are needed to protect and preserve the watershed's ability to support these interrelated ecosystem services. The 9E Watershed Plan focuses on a key challenge facing many lakes and watersheds: the need to increase water quality resilience and manage loss of nutrients and sediment from the landscape. This document builds on the 2014 Watershed Management Plan with a quantitative analysis of phosphorus sources and locations. The tools developed as part of this effort support an estimate of current loading and project the potential for phosphorus load reduction under different management alternatives.

The target of the 9E Watershed Plan is to reduce the phosphorus load to Canandaigua Lake by 25% in order to build additional water quality resiliency into the watershed system and help mitigate the adverse impacts of a changing climate. Analysis of current sources of phosphorus, both by category and location, offers guidance on measures to achieve this substantial reduction. As phosphorus export from agricultural lands represent a significant proportion of the annual load to Canandaigua Lake, measures to reduce stormwater runoff from cultivated fields are among the priority recommendations. Management practices designed to enhance infiltration and minimize bare soils are key; recommendations include expanded use of winter cover crops, grassed waterways, edge of field projects, infiltration basins, and WASCOBs. Development and implementation of nutrient management plans on farms of all sizes is another recommended action. Adoption of these voluntary measures will require continued financial and technical support for the farming community.

However, the watershed model predicts that agricultural BMPs are necessary but not sufficient to reach the 25% reduction goal. Managing phosphorus export will require ongoing efforts of the entire watershed community: individual landowners, local leaders, farmers, foresters, and resource management agencies. Focus area 1 provides key recommendations to build water quality resiliency at the landscape scale and includes reconnecting tributary streams with their floodplains and constructing new wetlands or increasing the water quality functional value of existing wetland systems are critical to reducing the phosphorus load. The Naples Creek/Parish Flats project is an excellent example of the potential for natural systems to mitigate the adverse effects of storm events on receiving waters. Riparian buffers, streambank stabilization, and road ditch improvements will contribute to reaching the 25% reduction target over the next decade. Finally, enhanced phosphorus removal by on-site wastewater treatment systems located proximate to surface waters has potential to reduce the annual phosphorus seepage into Canandaigua Lake. Each of these initiatives will advance the watershed community toward reducing phosphorus export to Canandaigua Lake. Taken together, the actions outlined in this 9E Watershed Plan are projected to meet the 25% reduction target over the next decade.

The target phosphorus reduction is achievable but challenging. 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. The Watershed Council and partners are committed to an adaptive management approach, tracking progress toward implementation of recommended projects, and continued monitoring and modeling of the effectiveness of actions on stream water quality. In addition, the watershed stakeholders will continue to focus on Canandaigua Lake water quality; the goal of an in-lake summer average total phosphorus concentration of 5.5 ug/L (as a three-year rolling average) will be a key metric of success.

Funding to implement the recommendations will be sought from a range of state and federal programs designed to support sustainable agricultural practices, climate adaptation, improved wastewater management, and support to local government and highway departments. Watershed municipalities and water purveyors will be asked to maintain their strong support to the Watershed Council to ensure effective collaboration and communication. Local volunteers will continue to be recruited to support monitoring and surveillance of water quality conditions.

Progress toward reaching the 25% reduction target will be tracked and reported annually to the stakeholder community, along with updates on Canandaigua Lake water quality conditions. The adaptive management approach enables the Watershed Council and partners to respond to monitoring results, new funding opportunities, and findings from other watershed projects.

15. References

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APPENDIX A

2014 Canandaigua Lake Watershed Management Plan

APPENDIX B

Canandaigua Lake Monitoring Program Quality Assurance Project Plan

APPENDIX C

Canandaigua Lake Watershed SWAT Model

Quality Assurance Project Plan (QAPP)

and Data Usability Assessment Report (DUAR)

APPENDIX D

Canandaigua Lake Watershed SWAT Model Report

Cornell University

Department of Biological and Environmental Engineering