Glen Lake Watershed Plan

Prepared for: Town of Queensbury
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Acknowledgements

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They would like to recognize all of the Lake's Residents who participated in the Glen Lake Septic Survey and the Glen Lake- User Survey which helped inform this plan.

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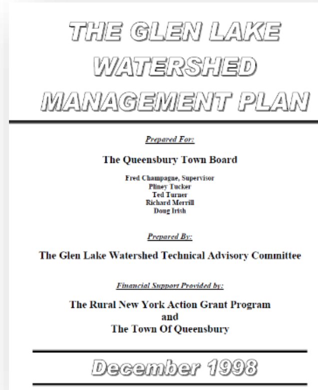
1 INTRODUCTION

This document is an update to the "*Glen Lake Watershed Management Plan*" completed in 1998 ("1998 Plan"). The Town of Queensbury, with the assistance of the Warren County Soil and Water Conservation District (WCSWCD), prepared the 1998 Plan establishing a baseline understanding of the lake and the issues impacting the watershed, water quality and the health of the lake. The 1998 Plan also established a series of goals and implementing actions to protect the lake and water quality.


THE GLEN LAKE WATERSHED MANAGEMENT PLAN

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Financial Support Provided by:

The Rural New York Action Grant Program
and
The Town Of Queensbury

December 1998

Image 1: Glen Lake Watershed Management Plan, 1998

The Town and representatives of the Glen Lake Protective Association (GLPA) desired to update the plan with particular attention to how land-based activities may have impacted the lake and influenced the continued presence of aquatic invasives.

Included in this report is information on the overall watershed characteristics, the results of water quality sampling and testing, a modeling analysis of the watershed and potential nutrient sources. The project also included a qualitative assessment of the large wetland complex at the headwaters of the lake ("the Fen"), an inventory of residential subsurface wastewater disposal systems (septic systems) and a survey of resident's perceptions of the lake and its health.

The Plan concludes with a series of recommended actions to further protect the lake's water quality.

2 PHYSICAL AND ENVIRONMENTAL SETTING

Glen Lake is located in Queensbury, Warren County, New York. The lake is approximately 320 acres in area with a watershed (defined as the land area that drains into the lake) is approximately 7500 acres in area. Classified as a glacial lake, the surficial geology of the watershed area is characterized by kame deposits; well drained sandy and gravel soils deposited as glaciers melted and retreated. A site location map is presented as Figure 1. (Figures are located at the end of the document)

Glen Lake is in the southernmost reach of the Lake Champlain watershed and the Poultney-Mettawee sub basin and Halfway Creek sub watershed (HUC-12 041504010103). The Glen Lake Watershed Regional Context map is provided as Figure 2.

Glen Lake is fed by Glen Lake Inlet Brook and a series of unnamed tributaries which generally flow west to east. Figure 3 Streams and Water Resources Map provides a depiction of the lake and other significant water resources in the Glen Lake basin/watershed.

The lake elevation is controlled with a dam located at the north/east end of the lake.

Image 2 NYSDEC Lake Depth

The majority of the lake's watershed stems from the land west of the lake and is located entirely in the Town of Queensbury. Watersheds are natural units of land defined by a landscape's topography, that are unconstrained by political boundaries. Glen Lake's global drainage basin can be broken down into 12 subcatchments, each in most instance centered around a well-defined stream channel. These stream channels all flow down gradient and drain into either the neighboring fen or the lake itself. Some subcatchments may not have a defined channel, but topographically trend to the lake.

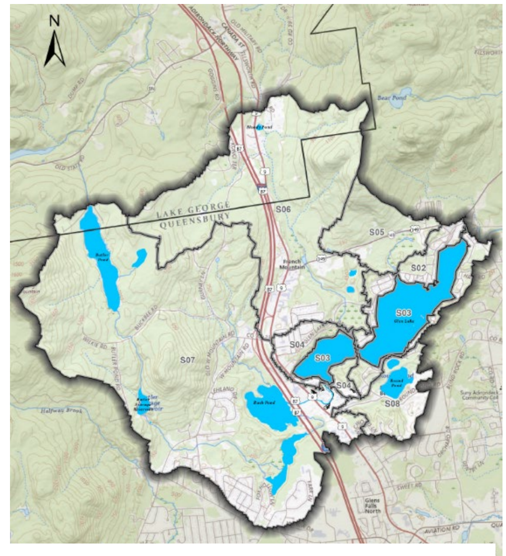


Image 3 Glen Lake Watershed/Subcatchments

A more detailed description of the watershed, its subcatchments and tributaries to the lake is provide in Section 6.

2.1 Zoning

The entirety of the lake's shoreline is zoned Waterfront Residential (WR). The WR district allows Single Family dwellings and Class B Marinas as permitted uses. A variety of other uses are allowed with Site Plan Review (SPR) or Special Use Permit (SUP) including Boathouses (SPR), Class B Marinas (SPR) and Food Services (SUP).

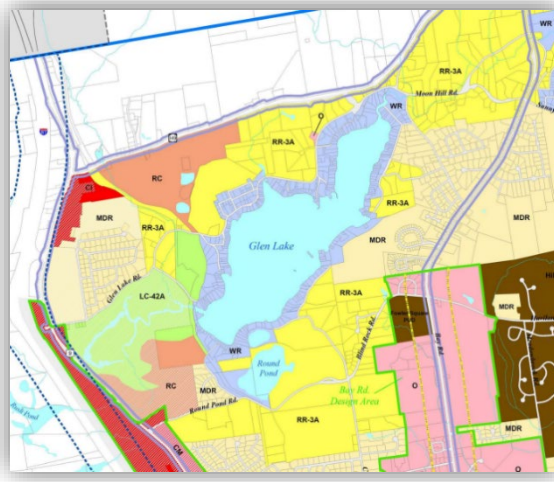


Image 3 Zoning Districts Around Glen Lake

The WR district does not allow Class A Marinas (commercial marinas) multi-family residential and other uses inconsistent with the Town's goals. The area surrounding the WR District, and the lake is primarily zone large lot residential including Rural Residential 3 acre (RR-3A), Land Conservation 42 acre (LC-42), recreation Commercial (RC) and Moderate Density Residential (MDR). These zoning districts introduce a modest number of uses not allowed in the WR District and include multi-family dwellings, duplexes, outdoor recreation and limited non-residential uses. :

2.2 Shoreline Regulations

The Town regulates land clearing activities adjacent to lakes, wetlands and streams under 179-6-050 of the zoning ordinance. Generally stated, the removal of vegetation is prohibited within 35 feet of the mean high-water mark of the lake, except for maintenance purposes or for provision of access to the lake. Additional provisions regulate the alteration of the shoreline, filling, dredging, hard surfacing and the placement of retaining wall.

The stated purpose of the regulation is "to *promote and protect the public health, welfare and safety and to protect economic property values, aesthetic and recreational values and other."*

2.3 Land Use

Glen lake has approximately 5.1 miles of shoreline, and residential land use predominates the shoreline. Approximately 266 residential lots front on the lake with an additional 39 lots providing shared access or other uses.

The upland portions of the watershed west of the lake are sparsely developed, with a substantial land area largely forested and controlled by the City of Glens Falls. Rush Pond and the Glen Lake Fen (NYSDEC Class 1 wetland) are notable surface water features located west of the lake and which water flows through before arriving at the lake. The lake is on average approximately 25-30 feet in depth with the deepest portions approximately 50 feet in depth.

The Land Cover map developed from USGS land cover data shows the predominant land cover to be deciduous, evergreen and mixed forests. Residential and commercial development follow the transportation routes with moderate to high density development noted along NYS Route 9. The southern reach of the watershed extends to the Town of Queensbury residential neighborhoods that are located just north of Potter Road and the City of Glens Falls lower Halfway Brook watershed. A Land Cover Map is presented as Figure 4.

The Land Use map (Figure 5) is depicted from the Town's real property data and shows land use by tax parcel basis. Predominant land uses west to east include the City of Glens Falls watershed lands (including Butler Pond reservoir), residential land uses west of US Interstate 87 (the Northway), and the previously mentioned commercial uses straddling NYS Route 9. In closer proximity to the lake itself, residential land uses encircle the lake and a mix of land uses radiating away from the lake. Notable land uses within 0.5 to 1 mile of the lake include Six Flags/Great Escape, the Glen Falls Country Club, and Courthouse Estates residential subdivision.

The major roadways within the watershed have great influence on the watershed given the extent of impermeable surfaces, related stormwater runoff (containing road salt and other contaminants) and proximate to the lake and its tributaries.

Four major transportation routes bisect the Glen Lake watershed:

- Interstate 87 travels north to south and spans approximately 38,497 linear feet within the watershed.
- County Rt 149 travels east to west and runs for approximately 8,600 linear feet within the watershed.
- County Rt 58 travels northeast to southwest, and spans approximately 5,353 linear feet span within the watershed.
- State Rt 9 travels north to south, 19,784 linear feet of which run through the watershed.

2.4 Glen Lake Critical Environmental Area

Critical Environmental Areas (CEAs) are areas which have been recognized and designated by a state or local agency because one or more of the following attributes:

- A feature that is a benefit or threat to human health;
- An exceptional or unique natural setting;
- An exceptional or unique social, historic, archaeological, recreational, or educational value; or
- An inherent ecological, geological, or hydrological sensitivity to change that may be adversely affected by any physical disturbance.

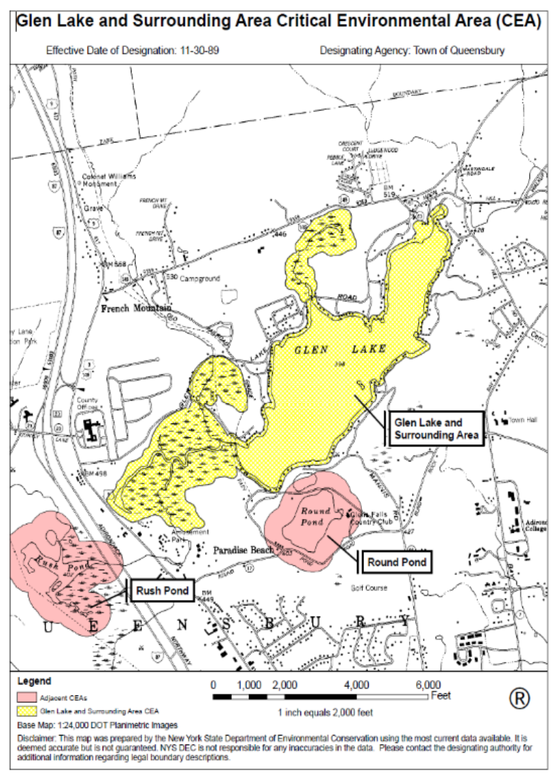


Image 4: Glen Lake CEA

The Town of Queensbury designated Glen Lake and the surrounding area as a CEA in 1989 based on its benefit to human health and the unique natural setting. This designation is to heighten the Town's awareness (including the Town Planning Board) of the importance of this resource and to consider actions that could impact the resource when conducting the State Environmental Quality Review (SEQR) process.

3 INVASIVE AND NUISANCE SPECIES

3.1 Introduction

Invasive species are non-native plants, animals, or other organisms that can cause harm to the ecosystem, economy or human health. Generally, they thrive in their new environment (unchecked by natural predators) and alter the natural balance of the ecosystem. Regionally/locally much effort is focused on the prevention, control and elimination of several species of concern including the Zebra Mussel (Dreissena polymorpha), Eurasian Watermilfoil (Myriophyllum spicatum), Curly-leaf Pondweed (Potamogeton crispus), and Water Chestnut (Trapa natans).

Nuisance species may be a locally occurring native species (or an invasive) but when the density/prevalence of the local population surges it can interfere with navigation and recreational uses of a waterbody. Managing these invasives/nuisance species often involves coordinated efforts between local organizations, government agencies, and community groups to prevent their spread and mitigate their impacts.

3.2 Glen Lake Invasives

Eurasian Water Milfoil was observed in the lake as early as the late 1980's. Subsequent aquatic plant surveys conducted in 1991, 1998 and 1999 further documented its presence and distribution.

The Glen Lake Protective Association (GLPA) engaged Allied Biological to prepare an Aquatic Vegetation Management Plan in 2004. The plan included an aquatic plant inventory documenting the presence of aquatic plants including several nuisance and/or invasive species including Curyleaf Pondweed, Illinois Pondweed, Eurasian Watermilfoil, as well as others.

The Plan explored various methods to manage aquatic plant including mechanical harvesting, biological control (i.e., grass carp), benthic barriers (mats), and chemical treatment (herbicides/algaecides). A chemical treatment

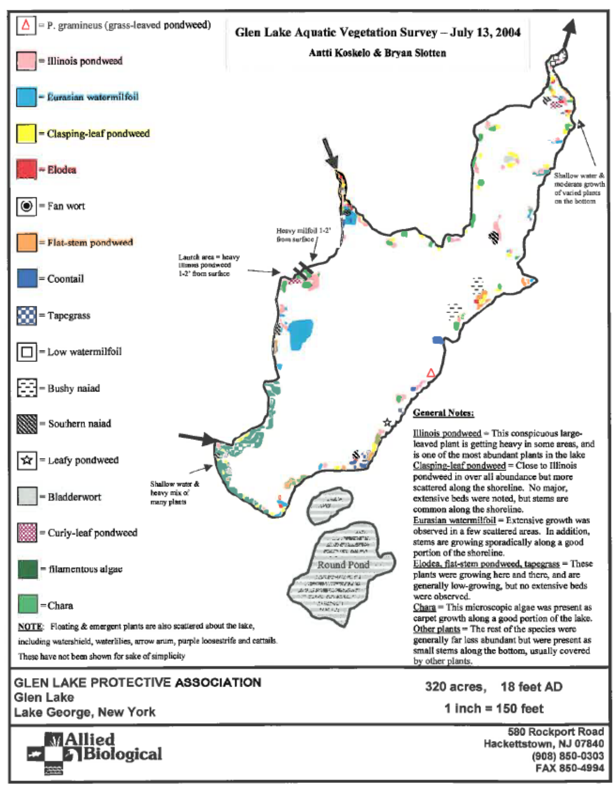


Image 5: Glen Lake Vegetative Survey

(Aquathol) was identified as the preferred means to control invasive/nuisance aquatic plants at that time. In 2005 Allied Biological secured a NYS DEC permit, and the first application of Aquathol was made to the lake treating approximately 45 acres of the shoreline. Herbicides and hand harvesting has been used to manage invasive/nuisance aquatic plants in subsequent years.

3.3 Aquatic Plan Control District

The Town of Queensbury and the GLPA sought a long term means to fund the management of aquatic invasives. The Town established the Glen Lake Aquatic Plant Control District ("District") in 2011 for the purposes of raising revenues to fund the long-term management and control of aquatic invasive species. NYS Town Law Section 190 authorizes Towns to establish special assessment districts including water quality treatment, aquatic growth control and watershed protection.

The District boundaries encompass all lakefront parcels and some adjacent properties with lake access that benefit from the district's activities. Revenues from the special district go to a dedicated/controlled fund to pay for the expense of hand harvesting, application of aquatic herbicides and supporting activities focused on control of Eurasian milfoil and other invasive aquatic species.

The Town Board manages the district and consults with the Glen Lake Advisory Committee (which includes members from various parts of the lake) and the Glen Lake Protective Association on the most effective means to control aquatics. A copy of the Map Plan and Report for the establishment of the district is included as Appendix A.

The Town of Queensbury is authorized by the NYSDEC to conduct aquatic vegetation management practices. The NYSDEC Freshwater Wetlands Permit (Permit ID 5-5234-0521/00018) authorizes the Town to use aquatic herbicides to control Eurasian watermilfoil and other invasive and nuisance species in high-use areas of the lake.

A NYSDEC permit is required for aquatic herbicide applications in Glen Lake. The Bureau of Pesticides Management is responsible for the administration of the Aquatic Pesticide Permit Program in New York, under the authority granted by Article 15-0313(4) of the Environmental Conservation Law (ECL) and Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York (6 NYCRR) Parts 327, 328 and 329.

The Town/GLPA have annually contracted with consulting firms which specialize in the harvesting and application of herbicides. The Town currently contracts with Ready

Scout, which holds an aquatic pesticide permit for the application of herbicides. A copy of the most recent permit is included as Appendix B.

Permits regulate the timing of the management activities and require an annual assessment of vegetation present post treatment. The Vegetation Assessment Surveys identify plant species present, the relative density of individual plant species within the treatment area as well as a control area to allow assessment of the effectiveness of treatment.

3.4 Solitude Lake Management

Lake management firms have targeted the management of Eurasian watermilfoil (*Myriophyllum spicatum*), Illinois pondweed (*Potamogeton illinoensis*) and Curlyleraf Pondweed (*Potamogeton crispis*). Recently, brittle naiad (*Najas minor*) has become a species of concern. Allied Biological managed the lake's vegetation from 2004 through 2017 when SŌLitude Lake Management (SLM) took over having purchased Allied.

In 2022, SLM provided treatment of a 34-acre portion of the lake using Aquathol® Super K for curly-leaf pondweed and brittle naiad. SLM reported that based on monitoring conducted 2009-2022 and relative management programs, the overall frequency of vegetation occurrence has remained fairly consistent year-over-year; while fluctuations may occur for individual species, and regardless of management (treatment, harvesting, planting), overall littoral zone cover has remained generally consistent. Maintaining plant cover is important for lake biota and the health of the system as a whole.

3.5 Ready Scout

Ready Scout was most recently engaged by the Town or Queensbury and the GLPA to manage aquatic invasives, and they also conducted the most recent plant survey on Glen Lake on August 27, 2024. The following information is summarized from the "Glen Lake 2024 Aquatic Plant Survey Report" which is included as Appendix C.

Sampling was conducted to evaluate areas treated with herbicides. Treatment areas 1-5 were treated with ProcellaCOR EC for control of Eurasian watermilfoil. Eurasian watermilfoil was not observed in the post-treatment plant survey. Only a small portion of Treatment area 6 was treated with Aquathol k to control Brittle naiad. No brittle naiad was found in this site in the post-treatment survey.

Ready Scout reported most of the native plant biomass consists of three species, Illinois Pondweed, Common Waterweed and Muskgrass. Eurasian watermilfoil historically has been managed through regular spot applications of aquatic herbicides including Aquathol k, Renovate and more recently ProcellaCOR EC. Aquathol k (and its granular form Aquathol Super k) has also been used to target curlyleaf pondweed, and brittle naiad, both invasive species.

Periodically, Illinois Pondweed creates nuisance conditions throughout the littoral zone. Historically, when Illinois Pondweed growth has become a nuisance, spot treatment with Aquathol has provided effective control reducing their presence to non-nuisance abundance the following season. Growth of Illinois Pondweed during the 2024 survey was more extensive than has been seen in the past 25 years, with the plant reaching the water surface in almost all shoreline areas restricting swimming and boat movement for most of the shoreline residents.

Ready Scout reports, "Based *on the survey observations and data, the 2024 Eurasian watermilfoil and Brittle naiad treatment areas were successful, and plant management in 2025 will target Illinois Pondweed, herbicide application will need to occur in late June or early July when plants are present*."

3.6 NYS Invasive Species Comprehensive Management Plan

In response to the increased prevalence of both terrestrial and aquatic invasive species, New York State's Invasive Species Task Force was charged with the preparation of a comprehensive approach to address this growing threat to the state's natural resources and economy. The Invasive Species Comprehensive Management Plan completed in 2018 focuses on building partnerships improving the sharing of information, early detection and response and the overall response to invasives. This plan established a framework for leveraging resources and guiding state policy and funding mechanism. One of the outcomes was the establishment of eight Partnerships for Regional Invasive Species Management (PRISM). Queensbury and Glen Lake are in the Capital Region PRISM.

3.7 Adirondack Research Aquatic Invasive Species Survey

The Capital Region PRISM is hosted by the Cornell Corporation Extension of Saratoga County. The Capital Region PRISM contracted Adirondack Research during the 2021 field season to conduct Aquatic Invasive Species (AIS) early detection surveys.

Glen Lake was one of several lakes selected for evaluation. Adirondack Research surveyed the littoral zone utilizing high-resolution sonar, GPA and Lidar technologies for the purpose of detecting plant beds and the hardness of the lake bottom. When plant beds were detected, they were sampled for the presence of invasive plant species.

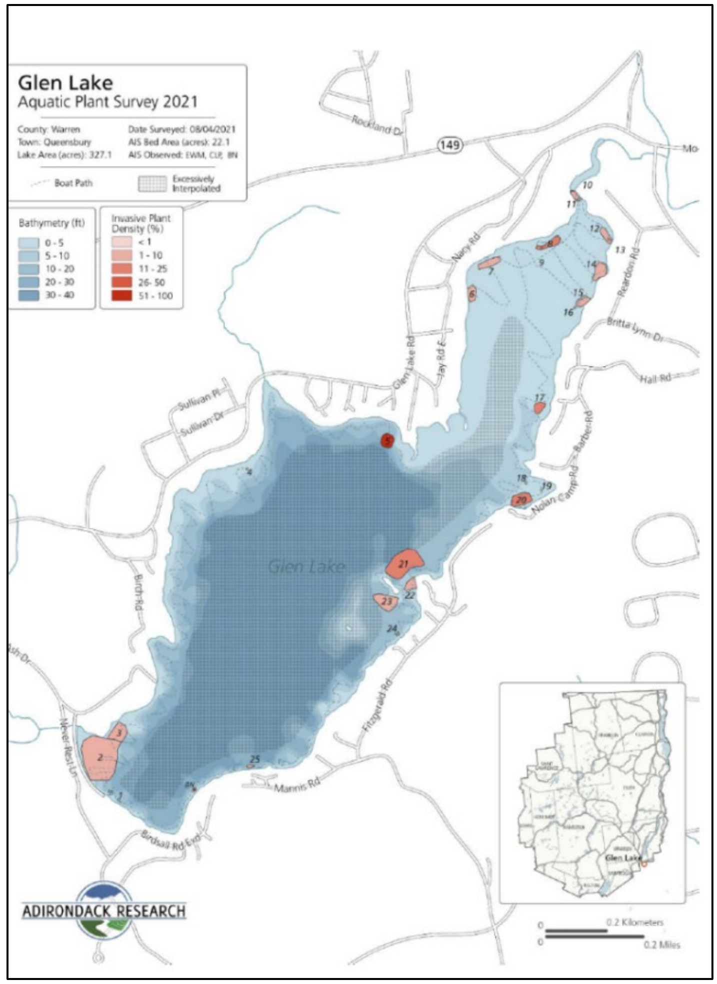


Image 6: ADK Research Aquatic Plant Survey

Adirondack Research conducted survey of Glen Lake on August 4, 2021. The presence of aquatic invasive plants was noted at 25 sampling locations. *Myriophyllum spicatum* (Eurasian watermilfoil), *Najas minor* (brittle naiad), and *Potamogeton crispus* (curly-leaf pondweed) were detected. Sediment samples were also collected to assess for the presence of Asian clams and Zebra Mussels. While this study did not detect Zebra Mussells, they have reportedly been present for many years. A copy of the 2021 Capital Region Prism – Early Detection Team Report is included as Appendix D.

3.8 Other Issues of Concern

3.8.1 Algae and Harmful Algal Blooms

There are many types of algae in a lake's ecosystem. Most algae are harmless. Common to Glen Lake are Green Algae (*Chlorophta)* and Diatoms. Blue Green Algae (*Cyanobacteria*) are more correctly identified as bacteria. The presence and abundance of algae can be influenced by a number of factors including the presence of nutrients, water temperatures, oxygen and other factors,

Harmful Algae Blooms (HABs) have not been observed in Glen Lake. Not all blue-green algae or algal blooms are toxic. The reasons algae produce toxins at any given time are not well understood. Standard monitoring techniques cannot predict when a bloom has toxins in it.

> *Algae*
>
> *"Hundreds of species of algae are found in New York State lakes, from little green dots, to bubbling masses, to stringy filaments that look a lot like weeds. Algae can be classified by growth habitat. Phytoplankton are the free-floating forms (the little green dots). Periphyton attach to surfaces, such as stones, dock pilings and macrophytes. Periphytons that attach to macrophytes are referred to as epiphytes. In highly productive lakes, stringy masses of filamentous algae attach to boats and submerged objects. Within these main categories, there are many different varieties of algae. There is a general progression from one type of algae to another through the seasons. Three major varieties dominate most New York State lakes: diatoms, green algae, and blue-green algae. The rapid growth of algae on the surface of lakes, streams, or ponds, which is generally stimulated by nutrient enrichment, is referred to as an algal bloom."*
>
> From: Diet for a Small Lake

3.8.2 Road Salt

Road salt can be present in stormwater runoff. It makes its way into tributaries and eventually in the lake.

The Adirondack Watershed Institute (AWI) conducted several studies focused on understanding the concentration of salt in road runoff and the effect of paved roads on sodium and chloride concentration within the Adirondack Park. One of the findings of their research is road density and proximity of roadways to surface water, which contributes to higher concentrations of sodium chloride in surface waters.

NYS established the Adirondack Road Salt Reduction Task Force (Task Force). The Task Force conducted a comprehensive review of road salt contamination and established a series of recommendations to reduce salt in roadside runoff.

Road salt finding its way into the natural environment can negatively impact aquatic and terrestrial ecosystems. The Task Force noted that species composition that tend towards salt tolerant species may reduce the diversity, abundance and productivity of freshwater ecosystems.

The water quality sampling program conducted as a component of Glen Lake Watershed Plan did not specifically focus on sodium or chloride concentrations. Given the Lake's proximity to major transportation thoroughfares (NYS Route 9 and US I87) and roadways that encircle the lake, future water quality sampling should include monitoring for road salts.

The Road Salt Reduction Task Force recommendations have been provided to NYSDOT and County Highway Departments. The Town of Queensbury's Highway Department may want to consider these recommendations.

4 LAKE USER SURVEY

A survey of lake residents/users was conducted in the fall of 2023 to gain input on the current state of Glen Lake. Residents were provided with a web link and a QR code to the survey to be conducted online, with the option to request a paper copy of the survey to fill out and return. The survey was advertised through the GLPA website, public informational postings and a mailing. A similar survey was conducted during the completion of the 1998 Plan, and the 2023 survey results are compared to the 1998 survey results where questions allow.

4.1 2023 Lake User Survey Results

The Town/GLPA received 160 completed surveys, and the analysis below is intended to summarize the range of perspectives shared by the community. A complete copy of the survey results is provided as Appendix E.

Question 1-4. Residency at Glen Lake

In the first four questions, respondents were asked about their residency around Glen Lake. First, they were asked about their proximity to the lake. 91 percent of residents have direct waterfront access to Glen Lake, eight percent have deeded access, and one percent have no shorefront access. Of the 160 respondents, 158 own their residence while 2 rent. Most respondents - 73 percent - live at their Glen Lake residence year-round, while 27 percent are there seasonally.

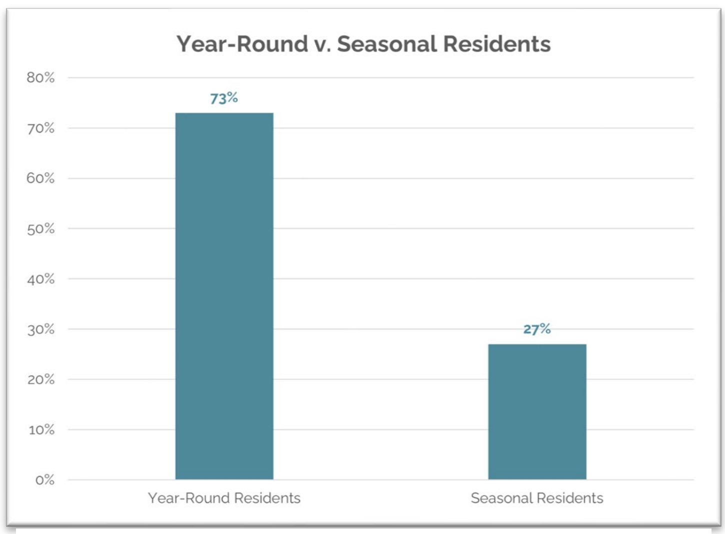


Chart 4.1: Residency at Glen Lake

Finally, residents were asked how long they've lived on Glen Lake. About one quarter of Glen Lake residents have lived in their residence for less than 10 years. 19 percent have been there between 10 and 20 years, 26 percent have lived there between 20 and 40 years, and 29 percent have lived there for more than 40 years.

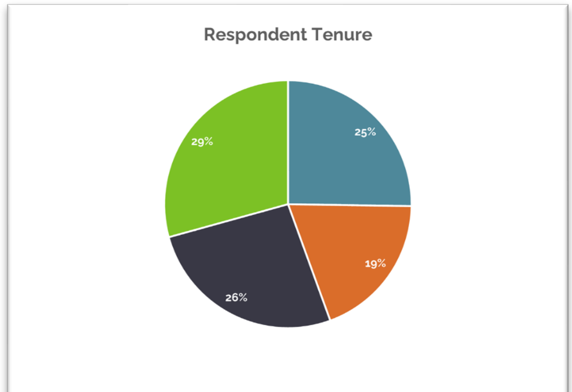


Chart 4.2: Survey Respondent Tenure

Question 5. What do you enjoy most about Glen Lake?

Residents were asked in an open format what they enjoy most about Glen Lake. In the responses, many described their love of the quiet peacefulness and serenity of life on Glen Lake. Most noted their appreciation of the natural beauty of the lake, the wildlife, the water, and its surroundings. Many others discussed how much they enjoy the activities that the lake has to offer including boating, swimming, fishing, water sports, and even bird watching. Others noted how much they value spending time with their family on the lake and the friendly small community feel of the area. Residents also appreciate the cleanliness and private feel of the lake.

Image 7: What Survey Respondents Enjoy Most about Glen Lake

Question 6. How do you use Glen Lake?

Respondents were asked to identify all the ways they utilize the lake. Responses included a variety of activities; most selected that they use the lake for boating (86 percent), kayaking (80 percent), fishing (58 percent), swimming (87 percent), water sports (51 percent), winter sports (43 percent), and enjoying the scenery (9 percent). There was also an "other" category where residents could explain what else they use the lake for. Other highlighted uses included jet skiing, irrigation, bird watching, biking to nearby areas, stargazing, tubing, aquatic ecology, relaxing and gathering with family.

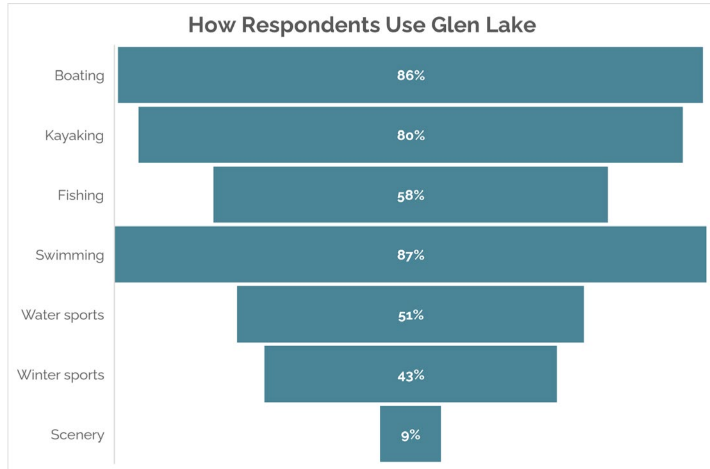


Chart 4.3: How Respondents Use Glen Lake

Question 7-8. Boats on Glen Lake

Residents were asked about their use of boats on Glen Lake, including whether they own boats and whether they rent out any dock space. 91 percent of respondents own at least one boat at Glen Lake, while 9 percent reported not owning any. Most own only one boat, while others report owning several kayaks, canoes, or jet skis in addition to their motorized or pontoon boats. Two respondents reported renting out dock space while the remainder of residents do not.

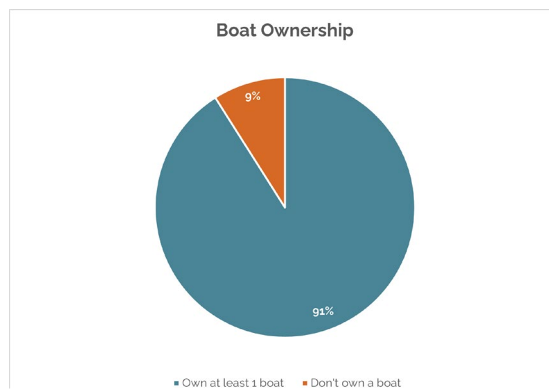


Chart 4.4: Boat Ownership Around Glen Lake

Question 9. Do you Obtain Drinking Water from the Lake?

Residents were asked whether they obtain drinking water from Glen Lake to which 16 respondents (10 percent) said that they do, while 90 percent do not.

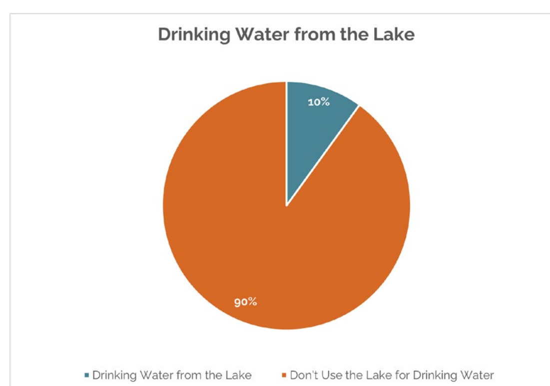


Chart 4.5: Percentage of Respondents that Get Drinking Water from Glen Lake

Question 10. What do you think are the Greatest Threats to the Water Quality of Glen Lake?

Residents were provided a list of potential threats to the water quality of Glen Lake and asked to identify their top three concerns on the list. They were also provided the option to select none of the above and list other potential threats. The top three identified threats by the survey were aquatic invasives (90 percent), septic system failures (56 percent), and algae blooms (45 percent). Other identified threats to water quality and quality of life issues include the population of waterfowl, aquatic plant overgrowth and muck, boat and wake size, light and sound pollution, roadway runoff, herbicides, and people not following lake signage and buoys.

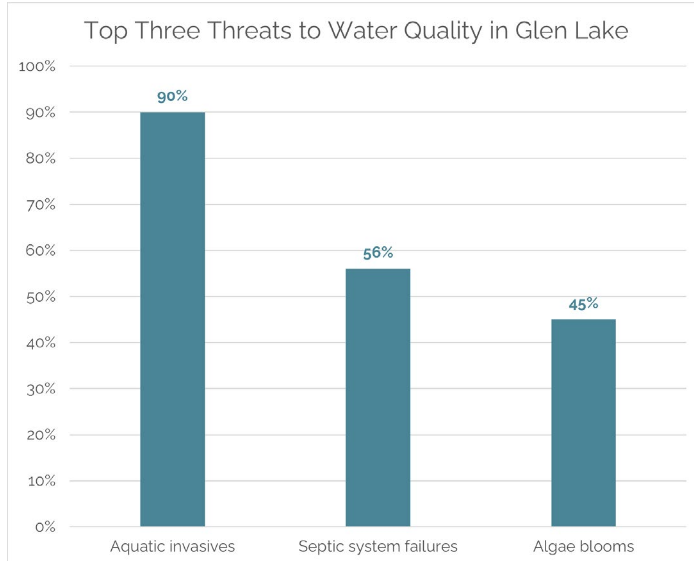


Chart 4.6: Top Threats to Water Quality in Glen Lake

Question 11. Do you perceive any of the following as problems at Glen Lake?

Respondents were asked if they perceive any of the following as problems at Glen Lake and to identify their top three concerns. Residents seem to prioritize safety concerns and protection of water quality in identifying problems and threats to the lake. The top three problems identified by the survey were unsafe watercraft operation (50 percent), boats and wakes becoming too large (36 percent), and problems caused by off-lakers like noise or a lack of public restrooms (26 percent). **51 percent of respondents chose "other."** Other problems identified included development at Great Escape and its impact on the lake and water, a lack of a sewer system and the faulty septic systems, unsafe operation of and overuse of motorized crafts, too little regulation and patrol on the lake, invasive species, and the safety of swimmers and kayakers.

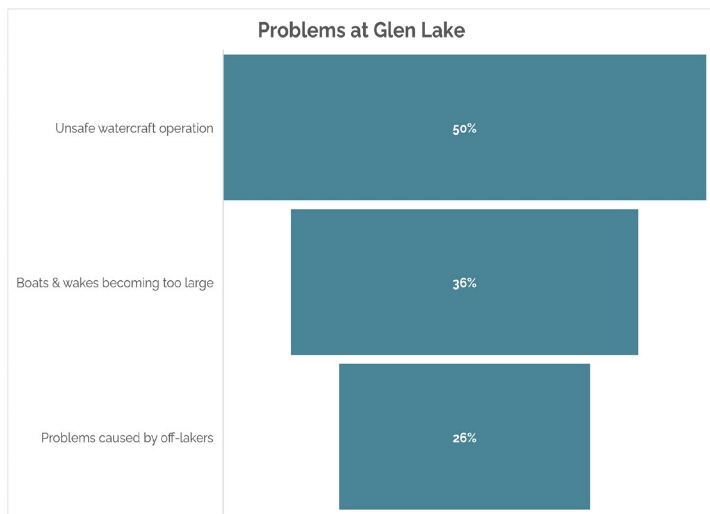


Chart 4.7: Perception of Problems at Glen Lake

Question 12: Would you like to see any of the following at Glen Lake?

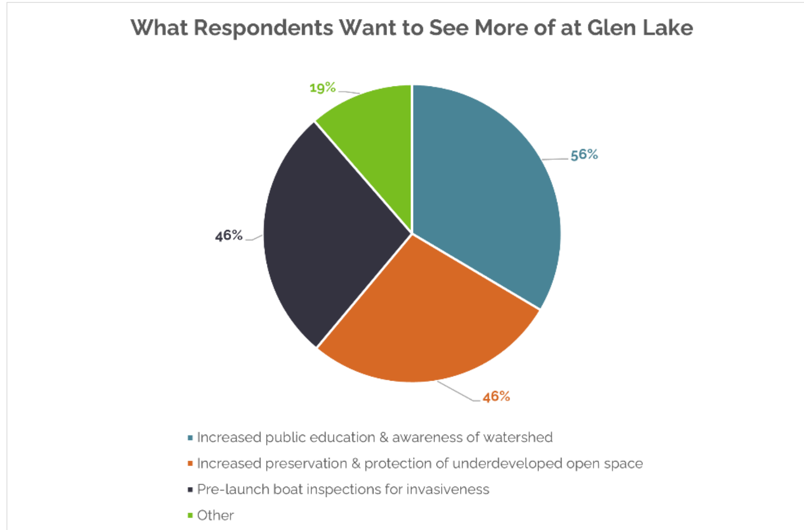


Chart 4.8: What Respondents Want to See More of at Glen Lake

Respondents were provided a list and asked to identify what else they would like to see more of at Glen Lake. Again, respondents tended to highlight their desire to see increased education, preservation, and protection of the lake, its water quality, and the safety of all users of the lake. The top three selections that residents would like to see were increased public education and awareness of the watershed (56 percent), increased preservation and protection of underdeveloped open spaced (46 percent), and a pre-launch boat inspections for invasiveness (46 percent). 19 percent of respondents identified other additions they'd like to see. These included wanting to see education on lawn care and fertilizer use, septic inspections, limits on the use of ice bubblers in the winter, enforcement of lake rules, limits on boat usage and outdoor lighting, clean up related to Great Escape development, and attention for vacant homes and properties.

Question 13 – 14: The Glen Lake Protective Association.

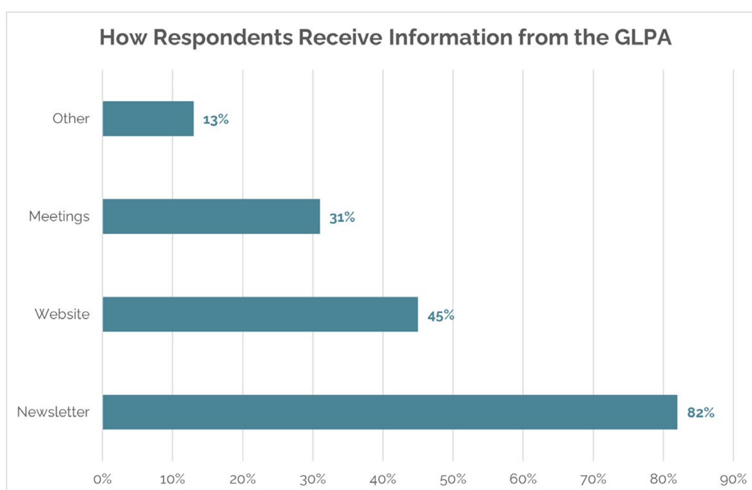


Chart 4.9: How Respondents Receive Information from the GLPA

The mission of the Glen Lake Protective Association (GLPA) is to protect, enhance and restore the ecological health of the natural and human communities of Glen Lake and its watershed. Respondents were asked to identify how well they feel that the GLPA fulfills this mission. 46 percent of respondents said the GLPA does an excellent job, 36 percent said it is satisfactory, 10 percent felt neutral on the question, and 1 percent feel the GLPA does an unsatisfactory job meeting its mission.

Respondents were also asked to report how they receive information from the GLPA. 82 percent of respondents receive information from the GLPA through the newsletter, 45 percent use the website, 31 percent receive information through meetings, and less than one percent do not receive any information from the GLPA. 13 percent identified other sources they use to receive information from the GLPA, most of which were via email, Facebook, or word of mouth.

Question 15: Other questions and Comments?

Finally, residents were left space to provide any additional questions or comments that they had on the state of the Glen Lake Watershed. Overall, residents seem to love living on Glen Lake and appreciate what it provides them in terms of peace and serenity, access to nature, and recreation on the water. However, many raised concerns throughout the survey on the need to better protect their natural resource and its longevity.

Some expressed the need for support in replacing or updating septic systems and a desire to better identify and address the impact of Great Escape's development to preserve the lake. Many residents also want to see increased education for residents and visitors alike to maintain the quality and health of the lake, as well as increased enforcement and patrol to maintain the peaceful nature of life in the community. Most residents seem engaged with the work of the GLPA and some asked for the ability to join meetings on Zoom when they cannot attend in person to ensure their involvement.

4.2 Comparisons with the 1998 Glen Lake Survey.

Like the 2023 Lake User Survey, Glen Lake residents were surveyed in 1998 to evaluate the state of Glen Lake. In that version of the survey, participants were also asked to identify their perception of problems facing the watershed related to water quality, conflicting recreational uses, and land use issues.

In 1998, the top three issues identified by residents as serious problems were aquatic weed growth (61.6 percent), septic

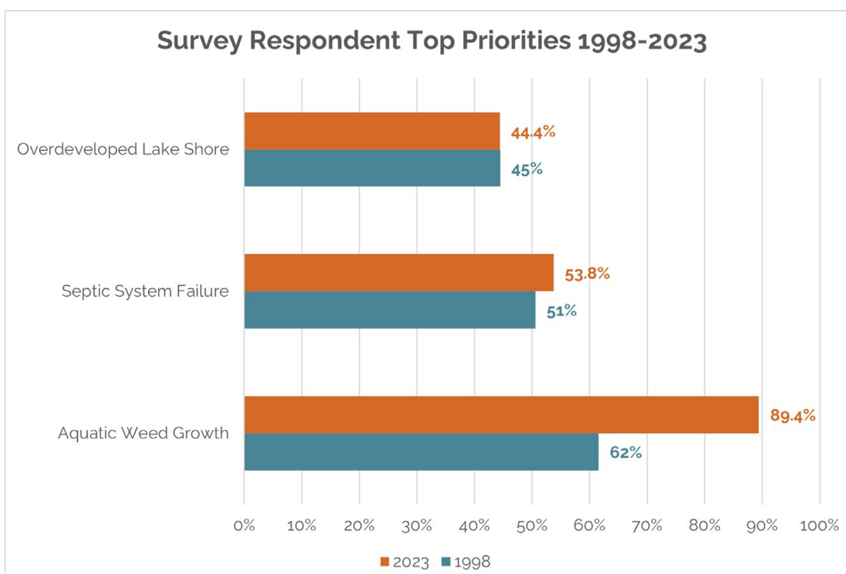


Chart 4.10: Survey Respondent Top Priorities, 1998-2023

system failures (50.6 percent), and an overdeveloped lake shore (44.5 percent).

In 2023, the top three threats to Glen Lake identified by residents were Aquatic invasives (89.4 percent), septic system failures (53.8 percent), and algae blooms (44.4 percent). This comparison shows that, over time, residents continue to prioritize protection and preservation of the lake and show increasing concern regarding aquatic weed growth.

In the 1998 survey, respondents were asked about the severity of problems facing the watershed related to water quality. 62 percent of respondents identified aquatic weed growth as a serious problem in the watershed and 33 percent identified algae blooms as a serious problem. Lack of water clarity and unpleasant water odor were seen as more minor concerns.

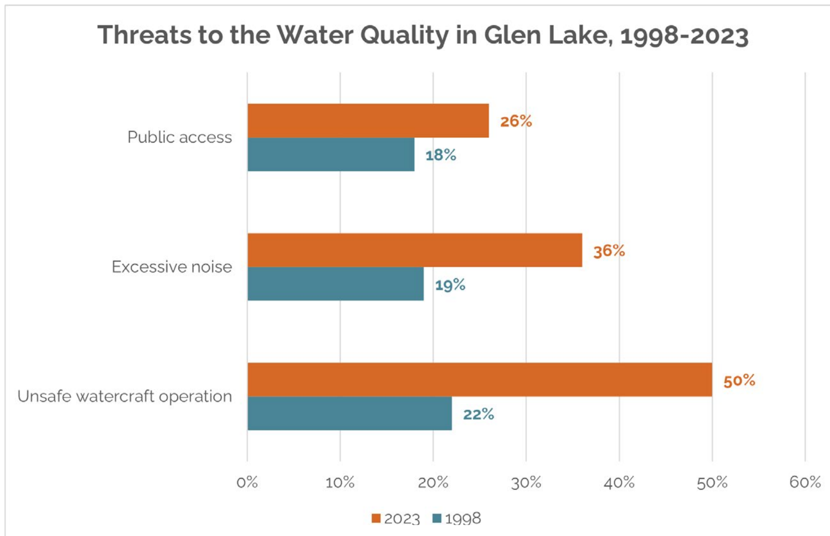


Chart 4.11: Perceived Threats to Water Quality at Glen Lake, 1998-2023

Conflicting recreational uses such as boater and fishing or swimming conflicts, excessive noise, unsafe watercraft operation, lack of adequate public access and swimmer's itch were viewed more as minor problems in 1998. 22 percent identified unsafe watercraft operation as a serious problem, 19 percent viewed excessive noise on the lake as a serious issue, and 18 percent viewed public access as a major problem.

Land use issues like an overdeveloped lake shore, an overdeveloped watershed, septic system failures and excessive use of lawn fertilizers were all identified by at least a third of respondents as serious problems in all categories. 51 percent said septic system failures were a significant problem. Each of these results trend alongside what was identified in the 2023 survey as significant environmental threats to the Glen Lake watershed. In comparing the results of both surveys, it seems most of the identified priorities in the 1998 survey remain true of the residents of Glen Lake today as the community develops over time.

5 NEAR SHORE SEPTIC SYSTEMS

As noted, there are approximately 266 homes on the lake with additional near shore lots with some form of access to the lake. All homes rely on on-site subsurface sewage disposal/treatment. The efficacy of conventional on-site wastewater treatment systems (OWTS) is highly variable depending on system maintenance, design, and local environmental factors such as soil type and proximity to groundwater or vadose zone depth. The risk of groundwater contamination from onsite disposal of domestic sanitary waste is largely dependent on system size, soil composition, and vadose zone depth or a system's proximity to shallow groundwater (Chazen 2020).

The life expectancy of a properly sited and constructed septic system is approximately 30 years. Systems may continue to function properly, but their overall effectiveness diminishes with age.

5.1 Phosphorus & Septic Systems

The Lake George Park Commission prepared an evaluation of phosphorus in the Lake George Watershed entitled "The Total Phosphorous Budget Analysis, Lake George" which suggested that OWTS's contribution to annual phosphorus load is minor when compared to surface runoff (Stearns & Wheler, 2001). However, the main threat to phosphorus loading of surface waters from septic systems is from system failures where overloaded or saturated drain fields, or short circuiting via drainage ditches and pipes results in surface breakout of untreated wastewater (Robertson et al., 2019).

Research on phosphorus loading finds that while phosphorus loading from septic systems is generally a small component of the total phosphorus load to waterbodies such as lakes, impacts can be substantial since the phosphorus is in a soluble form and readily available to algae (Green, 2002). Because near-lake systems are often seasonal, this phosphorus is added to lakes at the height of the algal growing season.

Failure rates of septic systems are also highly variable. The USEPA has collected information on system failures as reported by states, with failure rates ranging from 10 to 20 percent (USEPA 2002). A system has failed when the system, or component of the system, threatens the public health by inadequately treating sewage. Most common failures cause sewage to rise to the surface of the ground, back up into the residence it serves, or discharge to surface waters.

5.2 Septic System Inventory

An inventory of the Glen Lake's septic systems was undertaken in an effort to identify antiquated septic systems with the theory that these represent the greatest potential for failure and therefore release of phosphorus (and other constituents) into the Lake. The septic system inventory occurred in phases and included a review of the Town's building permit data, a homeowner survey, and compilation of inspection data compiled by the Town's Building Department. It was noted previously that the average life of septic systems is 30 years, and this was used in the evaluation.

The Town's building permit records were reviewed for information on the age of the residence, the number of bedrooms, and the age of the septic system. The Town requires a building permit for the replacement or modification of a septic system. If a record of a septic system replacement was identified that was recorded as the age of the septic system. If no age/construction date was reported, the age of the home construction was reported as the age of the septic system.

A septic survey was distributed to homeowners on the lake via direct mail, the GLPA newsletter and website. A QR code was provided to link users to the online survey website. A copy of the survey form is provided in Appendix F. Homeowners were asked to provide information regarding their home and septic system including bedroom count and age of septic. A total of 88 surveys were returned. However, only 44 surveys contained all key parameters requested (i.e. age of septic). This information was compiled into the database.

The Town requires the inspection of septic systems at the time of property transfer in areas zoned Waterfront Residential (WR). The WR District generally corresponds with the shoreline areas of Glen Lake. Chapter 137 Septic Systems identifies the inspection process and requires that the owner/seller obtain certification for the Town that the septic system is functioning properly. If the system is not functioning properly, the code provides guidance on addressing the deficiencies. The inspection records were reviewed and included in the inventory.

The data sources were combined and the age of the systems was reported. A total of 270 records were collected, and they are summarized below.

Table 5.1: Age of Septic Systems on Glen Lake

Age (Years)	Number of systems
<10	50
10-20	28
20-30	26
>30	166

Based on this evaluation just over 60% of all septic systems are in excess of 30 years old or exceeding their typical life expectancy.

The results of this evaluation are presented on Figure 6A. System ages were presented as a "heat" map with the greatest concentration of older systems appearing as "hotspots" on the map. This information is used in exploring the relationship between aging septic systems and water quality sampling results presented in Section 6.

5.3 NYSEFC Septic Replacement Program

The NYS Environmental Facilities Corporation (EFC) provides funds to counties to partially fund replacement of failing or inadequate septic systems through their Septic Replacement Program. The NYSDEC and NYSDOH identify areas where property owners are eligible to participate based on the presence of a sole-source aquifer used for drinking water, known water quality impairment linked to failing septic systems, and/or the ability for septic system upgrades to mitigate water quality impairments.

The DEC and DOH periodically re-evaluate priority geographic areas which could impact future rounds of funding. NYSDEC does not routinely perform water quality testing. A list of eligible counties and priority geographic areas within those counties is available on EFC's website at https://efc.ny.gov/septic-replacement.

Water bodies that have a water quality impairment are listed on the NYSDECs 303(d) list of Impaired waterbodies. NYSDEC updates this list every 2 years and provides this to USEPA. A water body is determined to be impaired when a water quality parameter triggers a threshold as established by the NYSDEC.

Water quality standards are tied to NYS Water Classifications and Best Uses. NYSDEC Classifies Glen Lake as a Class B (T) waterbody. The Best Use designation for Class B is primary and secondary contact recreation, and fishing. The 'T' denotes Trout Waters. Glen Lake's fact sheet from NYSDEC is available at https://extapps.dec.ny.gov/data/WQP/PWL/1005-0009.html.

The New York State Department of Environmental Conservation (NYSDEC) Division of Water (DOW) published the Consolidated Assessment and Listing Methodology (CALM) in May 2023, which establishes water quality assessment procedures. CALM assigns an impairment status and establishes the minimum quality and quantity requirements for water quality monitoring data to satisfy NYSDEC Water Quality standards.

6 WATER QUALITY

Glen Lake has been the subject of much study and a variety of water quality monitoring efforts over time. Water quality monitoring has been performed by the GLPA and citizen scientists under the Citizens Statewide Lake Assessment Program (CSLAP), by scientists at SUNY Adirondack, and most recently as a component of this plan. A compendium of past efforts can be found on the GLPA/Town website.

This section provides data on the most recent CSLAP monitoring and SUNY Adirondack near shore sampling and presents the findings of water quality sampling prepared as a part of this plan (2022 Water Quality Sampling).

6.1 Regulatory Standards

As noted previously. NYSDEC assigns water bodies a letter classification based on their anticipated "best use." Letters A through D are assigned to freshwater bodies. These uses include source of drinking water, primary contact recreation (i.e. swimming), secondary contact recreation (i.e. boating), fishing, and shell fishing. Certain waters in the Lake George/Adirondack regions include a (T) to denote trout populations. Glen Lake is classified as B(T) meaning its best use is primary contact recreation and it hosts a trout population.

NYSDEC, NYSDOH and the USEPA develop water quality standards depending on the use of the water. The table below depicts the water quality standard for key parameters. Drinking water standards are typically the most stringent and protective of human health. A standard is a legally enforceable value. In some instanced no standard exists and a guidance value is presented.

Table 6.1: Water Quality Parameters

Parameter	Type	Allowable Concentrations	Uses Protected	Description
Dissolved Oxygen	Standard	4 ppm	All	To protect aquatic life. At no time shall the concentration be less than 4 ppm for non-trout waters.
		5 ppm	Coldwater fish (Class T)	To protect fish survival. At no time shall the DO concentration be less than 5 ppm for Class T.
		6 ppm	Coldwater fish (Class TA)	To protect fish spawning. 6 ppm is the minimum daily average

Total Phosphorus	Guidance Value	20ppb	Swimming	To evaluate whether tertiary treatment is required for wastewater discharge to lake
Nitrate	Standard	10 ppm	Drinking Water	
Ammonia	Standard	2 ppm	Drinking Water	Separate standard for ammonium only
pH	Standard	<6.5; >8.5	All	Developed for regulating wastewater discharges to streams and lakes
Fecal Coliform	Standard	1 colony/100mL	Drinking Water	
Fecal Coliform		200 colonies/100mL	Swimming	Average of minimum of 5 measurements in one month
Total Coliform	Standard	2400 colonies/100mL	All	Median of minimum of 5 measurements in one month
E. Coli	Standard	126 colonies/100mL	All	The geometric mean over a 30-day consecutive period shall not exceed 126 colonies/100 mL

6.2 CSLAP Monitoring

The GLPA has been a participant in the Citizens Statewide Lake Assessment Program (CSLAP) for nearly four decades. CSLAP is a volunteer lake monitoring and education program that is managed cooperatively by NYSDEC and New York State Federation of Lake Associations (NYSFOLA). Citizen volunteers across the state monitor and report water quality to inform individuals (and the state) about local lake conditions.

This program was established in 1985 and has had great influence in helping citizens and the broader community understand the water quality of the state's 7500 lakes and ponds. It has also helped citizens and communities monitor lake eutrophication (lake nourishment).

Lake eutrophication is a measure of a lake's age and its relative nutrient loading process. Over time, lakes move from a nutrient poor (oligotrophic) state to an intermediate (mesotrophic) state, to a nutrient rich or highly biologically productive (eutrophic) state.

The trophic state can be thought of as the productivity of a waterbody representing the biological, physical, and chemical characteristics of the lake. Several measures affect this, and the most important are phosphorus levels, chlorophyll *a*, and Secchi disk transparency. Using these parameters (and a few more), a trophic state can be determined for a lake. Table 6.2 below identifies and explains those parameters that affect trophic state.

Table 6.2: CSLAP Water Quality Parameters

Parameter	Importance
Water Temperature (˚C)	Water temperature affects the growth of plants and animals, the amount of oxygen in the water, and the length of the recreation season.
Water Clarity (m)	Water clarity is determined with a secchi disk to measure how far down into the water column you can see.
Conductivity (µmho/cm)	Conductivity measurers the amount of dissolved and suspended materials in the water, including salts and organic material. Conductivity may be related to geology or land use practices.
pH	pH means water acidity. A pH value between 6 and 9 supports most types of plant and animal life.
Color (true) (platinum color units)	Water color is affected by organic matter (decaying plants). The color of water can affect water clarity and impact plant growth by limiting the amount of sunlight that can pass through the water.
Phosphorus (total, mg/l)	Phosphorus is an important nutrient for the growth of aquatic plants and animals in lakes. Too much phosphorus can harm aquatic life, water supplies, and recreational uses
Nitrogen (nitrate, ammonia, and total dissolved, mg/l)	Nitrogen is also an important nutrient for the growth of aquatic plants and animals in lakes. Too much nitrogen can harm aquatic life, water supplies and recreational uses.
Chlorophyll a (µg/l)	Chlorophyll a is the primary pigment in green plants and estimates the amount of algae in a lake. The amount of chlorophyll a may be influenced by phosphorus and can affect the water clarity.
Calcium (mg/l)	Calcium is an important nutrient for most aquatic organisms and is required for mussel shell growth. Calcium enters lakes through natural limestone deposits. Calcium concentration is related to lake conductivity and improves the lake's buffering capacity to acid rain.
Use Perception Surveys	Four question survey on the Field Observations Form that capture the user's observations of the quality of the lake for recreational use.

High lake clarity and low productivity are associated with oligotrophic (nutrient poor) lakes, whereas low clarity and high productivity are associated with eutrophic (nutrient rich) lakes. Glen Lake is considered an oligotrophic lake, meaning that there are relatively low levels of nutrients in the water.

The most recent CSLAP report (2023) reports that the median concentration of Chlorophyll A has not changed significantly and is declining over the 37 years of sampling. Similarly, Total Phosphorus has not changed over the last decade and is modestly declining. A copy of the CSLAP Report is included as Appendix G. (We note that the NYSDEC/NYFOLA have transitioned CSLAP reporting to online only and no longer issues a physical 'report card")

While the trophic state of a lake will naturally change over time, the change can be accelerated by human activity. Using trophic states as a reference for changing conditions can help show use (e.g. drinking water, recreation) impairments. Of primary interest to Glen Lake's water quality are nutrients (primarily phosphorus), pathogens, possible toxic substances, and sediments

Table 6.3: Thresholds that distinguish different trophic states.

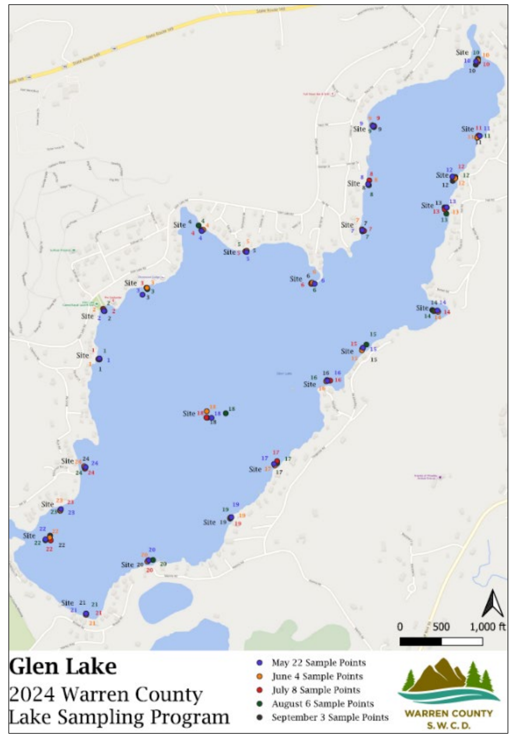
Parameter	Trophic State		
	Oligotrophic	**Mesotrophic**	**Eutrophic**
Total Phosphorus (Mg/L)	<10	10-20	>20
Chlorophyl a (Mg/L)	<2	2-8	>8
Secchi Disk Transparency	>5 meters	2-5 meters	<2 meters

Phosphorus has historically been found in lawn fertilizers, and when it finds its way into surface waters, it can increase the growth of algae, reduce oxygen in water, cause harmful algal blooms, and reduce water clarity. Excess phosphorus is also often associated with agricultural practices. The NYS Nutrient Runoff Law limits the amount of phosphorus in lawn fertilizers and restricts the time of year when fertilizers can be used. The law is meant to reduce the amount of phosphorus entering the state's waters. Excess nitrogen has a very similar impact on aquatic ecosystems to phosphorus. However, of the two, phosphorus is the limiting nutrient, since many algal blooms need one mol of phosphorus for every 16 mols of nitrogen.

6.3 SUNY Adirondack Water Quality Monitoring

Since 2015, the Environmental Studies Collaborative (ESC) at SUNY Adirondack has collaborated with the Warren County Soil and Water Conservation District (WCSWCD) in the collection of water quality samples on Glen Lake to detect septic system-derived non-point source pollution (NPSP).

SUNY ADK historically has collected water quality samples at 23 locations adjacent to the shoreline as well as a 'control' sample located in the middle of the lake (location No.: 18). Additional sampling has occurred at locations withing the Fen. The most recent sampling was performed during 2024, and a summary of the results presented here. A copy of the 2024 report is included in Appendix H which includes a sampling location map.



During the most recent round of sampling ESC collected water samples at locations around the lake's shoreline over a six-month period (May – October 2024), on average once per month. All water samples were screened in the field for pH, temperature and dissolved oxygen using a YSI PRO DSS instrument. Samples were also collected and analyzed for TEC and HOCl at the SUNY Adirondack laboratory.

TEC is a bacterium that is widely used as an indicator of fecal contamination, the challenge in the use of TEC as an indicator is that these bacteria are present in both humans and other animals (including birds).

Free chlorine (HOCl) is found in bleach, cleaning products, as well as a drinking water purifying agent. There are no natural sources of HOCl and therefore detection in lake water may be attributed to human-associated activity. SUNY Adirondack ESC indicates that "*the concurrent detection of thermotolerant Escherichia coli (TEC) and the ionic form of chlorine (HOCl) found in bleach and other cleaning agents in lake water samples*" may indicate the release of human derived from near shore septic systems.

TEC were identified using the R-Card E. coli system from Roth Biosciences This test is a quantitative measure of *E. coli* cells (colony forming unit or cfu), which are indicated by the formation of visible and discreet bacterial colonies on the test card surface. TEC ≥ 2 cfu/mL is considered positive for thermotolerant *E. coli*. HOCl (free chlorine) was measured using chemical reagent where a color change indicates its presence. HOCl ≥ 0.02 mg/L was considered significant.

A total of 11 of the 24 lake testing sites were positive for NPSP indicators at least once in 2024. Site 9 was NPSP positive 3 of the 5 testing dates. Site 18 (the control site located at the center of the lake) was negative across all testing dates.

Based on a review of SUNY ADK's NPS sampling for the years 2019 - 2022 nearly all sampling locations reported TEC and HOCL detections during those years. Sampling locations 8 and 11 reported detections over 50% of the sampling events and locations 2 and 9 approximately 40% of the events. No detections were reported for sampling location 18.

The SUNY ADK testing results were plotted on a map of the lake (Figure 6B) which Identifies the location of septic system and their relative age. The oldest septic systems are depicted 'thematically', a prevalence of older systems (.30 years in age and older) appear as yellow or bright spots on the figure.

Examination of the map reveals a strong relationship between the location of older septic systems (yellow hot spots) and the NSPS detections as noted above.

6.4 2022 Water Quality Sampling

6.4.1 The Watershed and Sampling Locations

The Glen Lake drainage basin can be broken down into 12 subcatchments (or smaller drainage areas), each typically centered around a stream channel/drainage course. These channels all flow down gradient and drain into either the neighboring fen or the lake itself. The subcatchments are identified as S01 through S12 and are identified on Image 8 (as well as Figure 7 in the attachments). A brief description of the characteristics of each subcatchment is as follows:

- **S01 –** Glen Lake itself.
- **S02 –** The near shore area around the perimeter of Glen Lake. Residential land use and near shore septic systems are the predominant land use.
- **S03** – The Glen Lake Fen, a significant wetland complex located immediately to the west of Glen Lake. Much of the global Glen Lake watershed enters Glen Lake through the Fen.
- **S04** – The near-shore area around the Fen. This includes portions of the Warren County Municipal Center, Courthouse Estates subdivision, and the Great Escape.
- **S05** – Tributary area entering Glen Lake from the north. Mostly undeveloped but includes a significant stretch of Route 149.
- **S06** – Tributary area to Glen Lake from the south. Includes Round Pond and a portion of the Glens Falls Country Club. No surface discharge/connection (ie. stream) to Glen Lake was observed during a filed investigation
- **S07** –Tributary area entering the Fen from the west. Includes a portion of the Great Escape, commercial development along NYS Rote 9, and a significant stretch of the Adirondack Northway and Route 9.

- **S08** – Southern-most subcatchment within the watershed. Includes mostly single-family residential homes north of Aviation Road, and a stream tributary to the Glen Lake Fen.
- **S09** - Tributary area west of I-87 including the City of Glens Falls watershed lands,. Includes mostly woodland areas and consists of a stream that drains from Butler Pond.
- **S10** - Major tributary the lake and includes the Warren County Annex, Glens Falls watershed lands, and streams converging within Rush Pond.
- **S11** – Upper most reach of the Glen Lake watershed includes Butler Pond, mostly woodlands and a small pond to the east.
- **S12** - Major tributary area entering the Fen from the north. Includes the outlet mall, a portion of the Warren County Municipal Center, and a significant stretch of the Adirondack Northway and Route 9.

Amongst the 12 subcatchments, the area immediately adjacent to the lakeshore (S02) plays an outsized role in water quality because of its proximity to the lake. Any pollutants picked up by runoff from this area have less chance of being absorbed or mitigated by natural processes before reaching the lake, and they are more likely to be transported into the lake.

Water quality samples were collected at key locations in the watershed to understand water quality and how it may change as it travels through the watershed and exits the lake. Water quality sample locations were identified as SL-01 through SL-08 and are also shown on Image 8 and are briefly described below.

SL-01: Glen Lake outlet brook

Glen Lake outlet brook (unnamed tributary to Halfway Creek), location immediately upstream of the Tee Hill Road Bridge/Culvert.

SL-02: St Mary's Bay inlet brook

Upstream of Glen Lake Rd culvert. Drains south side of French Mountain (S05).

SL-03: Rocky Brook

Stream crossing under Ash Drive, drains all of So 12 including Goggins Rd beaver dam, west side of French Mountain and area beside Warren County Bike Trail.

SL-04: Glen Lake Fen outlet/ Glen Lake inlet brook

The western inlet into Glen Lake is adjacent to the western perimeter of the Fen. Downstream from Warren County Bike Trail bridge. Collects all subcatchments from the north and west into Glen Lake.

SL-05: Great Escape outlet brook

Unnamed tributary to Glen Lake downstream from culvert exiting Great Escape property. Captures all of Rush Pond (S06) and any runoff from the Park.

SL-06: Rush Pond outlet brook

Unnamed tributary to Glen Lake as it enters the Great Escape property, Downstream from western bridge in Great Escape parking lot. Captures subcatchments So8,9,10 and 11.

SL-07: Rush Pond Way trail, southernmost bridge

Downstream from bridge in large wetland located south of the Rush Pond. This wetland is fed by a brook originating in Butler Pond near Buckbee Rd. Captures S09 and S011and most of the western side of S08.

SL-08: West Mtn Rd/ Schermerhorn Apartments Brook

Sample taken from an unnamed stream Downstream from West Mtn Rd culvert. Captures northern 2/3 of subcatchment S10. Many small streams flowing down beside Gurney Lane.

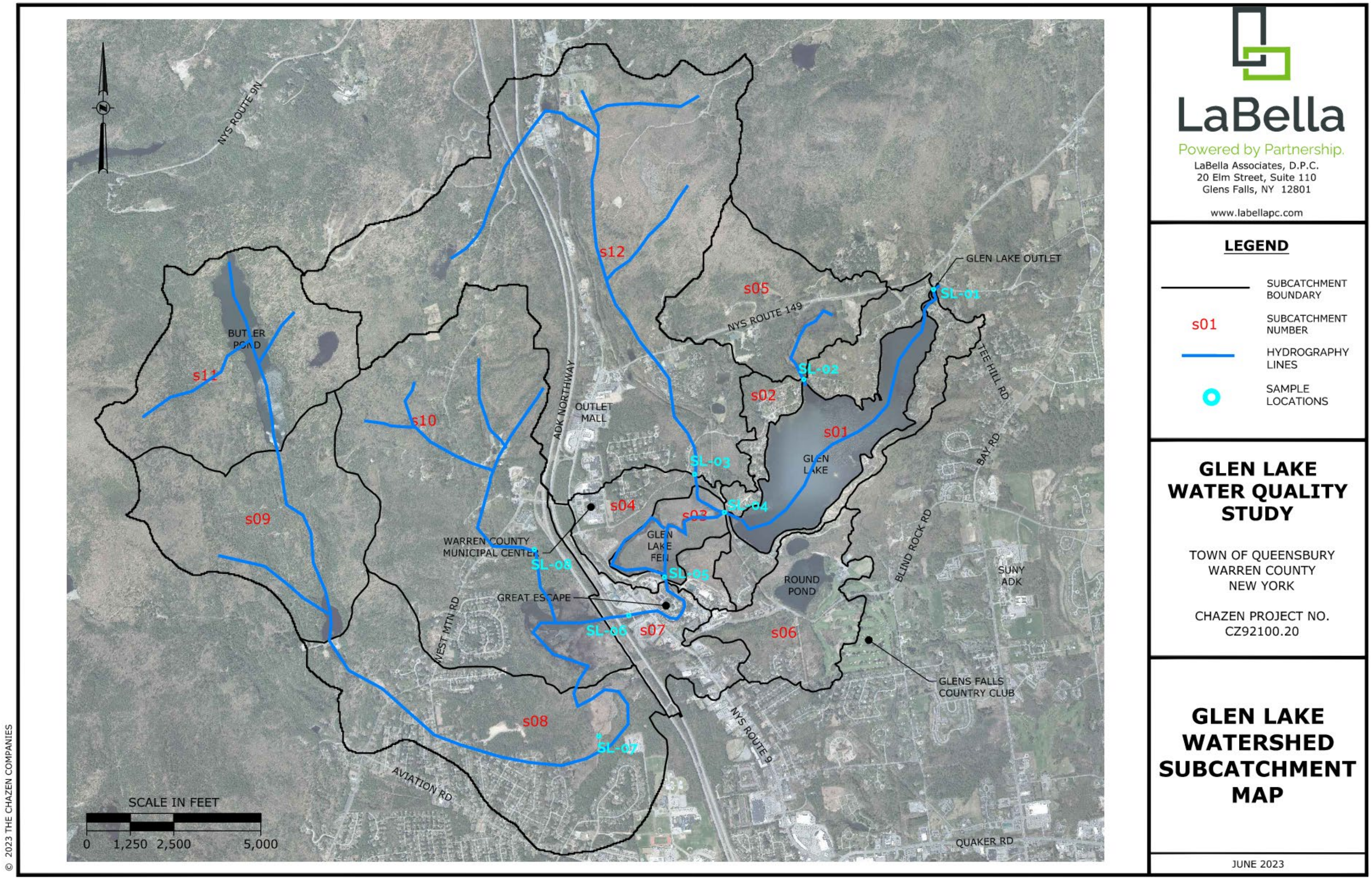


Image 8:: This map shows the locations of each sampling location. Note that SL-07 dried in the summer and was moved to SL-08.

Water quality samples were collected at seven locations within the watershed, shown in Image 8/Figure 7. Note that sample location 7 (SL-0) ran dry in the summer and was only sampled in the spring, so the sample collection was moved upgradient to SL-08. While these two locations have different upland drainage areas and pollutant concentrations, and are not directly comparable, they help illustrate the relative changes from upstream of Rush Pond, to the Great Escape downstream of Rush Pond, to the Fen downstream of the Great Escape. With that said, the data collected at SL-07 is treated as if it was collected at SL-08, and that was done to compare the relative change in pollutant concentrations from upstream to downstream in Glen Lake's subcatchments.

Samples were collected at each location three different times in 2022: Spring (April), Summer (July), and Fall (early November). These dates were selected to understand potential variation in water quality throughout the seasons. The following pollutants, bacteria, and pathogens were measured at each location:

- Total Coliform
- E. Coli
- Total Kjeldahl Nitrogen (TKN)
- Nitrate
- Free Chlorine
- Total Phosphorus
- Soluble Phosphorus
- Temperature
- Dissolved Oxygen
- pH
- Conductivity

Water quality monitoring often focuses on those pollutants that are carried in stormwater runoff or that may emanate from adjacent land uses and include nutrients (especially phosphorus.), pathogens,; possible toxic substances, and sediments.

Total Phophorus is a measure of the particulate and dissolved phosphorus, while Soluble Phosphorus is what plants, including algae, directly uptake and is what contributes to algal blooms. Total Phosphorus is indivicative of a lake's trophic state, but Soluble Phophorus is a more reliable indicator. Phosphorus was historically present In lawn fertilizers (and detergents) but (as noted) has been removed from many products.

Total Coliform is a group of bacteria commonly found in soils and animal intestines. Most Total Coliform are harmless and naturally present in the environment, but their presence in water samples indicates that more harmful fecal bacteria, such as E. Coli, are present in the water. If a lab determines that a sample has Total Coliform in it, the lab must test for E. Coli as well, which is commonly responsible for causing diseases in humans.

Total Kjeldahl Nitrogen describes the total organic nitrogen and ammonia in a water sample. This, in addition to any nitrate in the water, describes how much nitrogen is in the ecosystem and can give a sense of Glen Lake's trophic state.

Total Coliform & E. coli

Generally, coliforms are bacteria that are not harmful and are naturally present in the environment. They are used as an indicator that other, potentially harmful, fecal bacteria (indicated by the E. coli species) could be present.

Total coliforms are a group of bacteria that are widespread in nature. All members of the total coliform group can occur in human feces, but some can also be present in animal manure, soil, and submerged wood and in other places outside the human body. E. coli is a species of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals.

If total coliform is detected in a water quality sample it must further analyzed to determine if *E. coli* are present. *E.* coli is a more specific indicator of fecal contamination and is a potentially more harmful pathogen. It is difficult to distinguish between E coli from humans versus other sources.

EPA recommends E. coli as the best indicator of health risk from water contact in recreational waters; some states have changed their water quality standards and are monitoring accordingly.

6.4.2 2022 Water Quality Results

The charts that follow show the sampling results of parameters of interest, including Total Coliform, E. Coli, Total Phosphorus, TKN, free chlorine, and Soluble Phosphorus. The order of the samples on each horizontal axis shows the relative location of the samples in Glen Lake's watershed. The samples are located upstream to downstream, from left to right on the horizontal axis. SL-08 is upstream of Rush Pond, so it is the leftmost sample. SL-08 is upstream of SL-06, SL-06 is upstream of SL-05, and so on. Since this study is concerned with the source of pollutants in the watershed and the relative changes in pollutant concentrations, this order helps visualize the change in concentration from upstream to downstream.

Total Coliform and E.Coli

Charts 6.1 and 6.2 show the Total Coliform and E. Coli concentrations in each sample. Total Coliform inidicates the presence of pathogens, including E. Coli. Throughout the summer and fall, E. Coli accounted for most, if not all, of the Total Coliform at each sample location. For example, the summer sample at SL-05 had 78 MPN/100 mL in Total Coliform, and 78 MPN/100 mL in E. Col. E. Coli concentrations in the spring were below the Reporting/Practical Quantitation Level (RL/PQL) of the instruments at Environmental Laboritories, Inc. This does not mean that there were zero E. Coli in the water in the spring, but that the number of colonies was too low to be detected. This was the case at each sample location in the spring, and at two locations in the fall. The E. Coli concentration in the summer samples, however, exceeded the number of colonies collected in the spring and the fall at each location.

The absence of E. Coli in the spring and fall could have been the result of many factors. The average water temperature in the spring was 42.2˚F. According to the World Health Organization, E. Coli's optimum growth occurs at 98.6˚F, though it can grow in temperatures from 44.6˚F to 120˚F. The water's frigid temperatures likely contributed to fewer E. Coli colonies in the spring. Other coliform besides E. Coli could have been present in the spring water samples, since the water was too cold for E. Coli to grow. Water temperature was not recorded in the fall.

E. Coli accounted for most of the Total Coliform in the summer and fall samples. The summer samples collected from SL-08 and SL-03 far exceeded the US Standard for E. Coli of 126 colonies/100mL for all water uses. The upland drainage areas of SL-08 and SL-03 are S10 and S12, respectively, as shown in Image 8. Both subcatchments, however, are mostly wooded, so they have high infiltration capacity and little capacity for pollutant transport. S12 has more agricultural land in its headwaters than any other watershed, though only 1.5% of it is agricultural land. The E. Coli, then, is not attributable to the agricultural land alone. It likely has other sources.

Based on the available data, it would seem that there is a significant amount of E. Coli in Glen Lake's tributaries that could impact the lake's best use. However, bacteria samples are incredibly variable. Sample results can span several orders of magnitude, so having a large enough sample size and summarizing the data appropriately are critical. NYS DEC requires that the geometric mean of samples collected over a 30-day period not exceed 126 MPN/100 mL. The geometric mean of the samples collected at Glen Lake is 18 MPN/100 mL, well below the limit, but samples were only collected every few months. Based on this data E. Coli is not a concern at this time and may not threaten Glen Lake's best use, based on DEC's requirements.

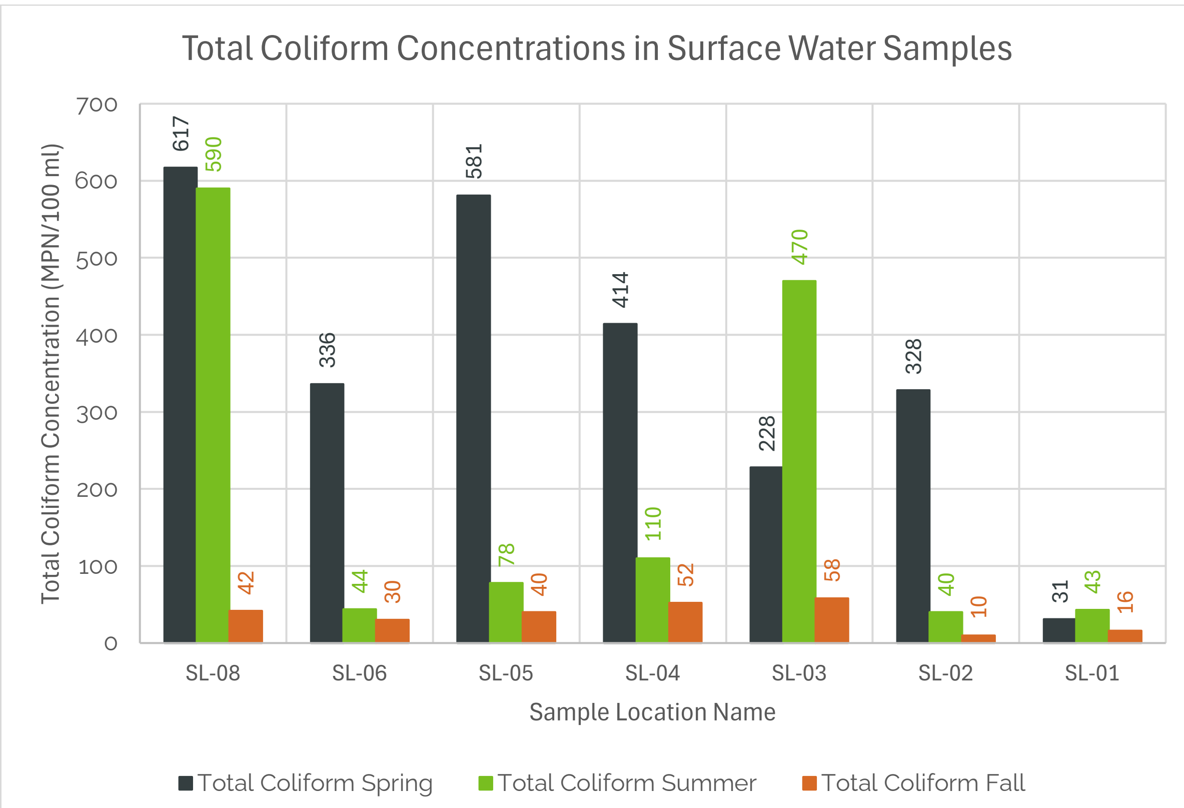


Chart 6.1: Total Coliform concentration at each sample location over seasonal changes.

Sampling locations are organized from left to right on the horizontal axis, from upstream (SL08) to downstream (SL-01). All of the following charts are presented in this fashion..

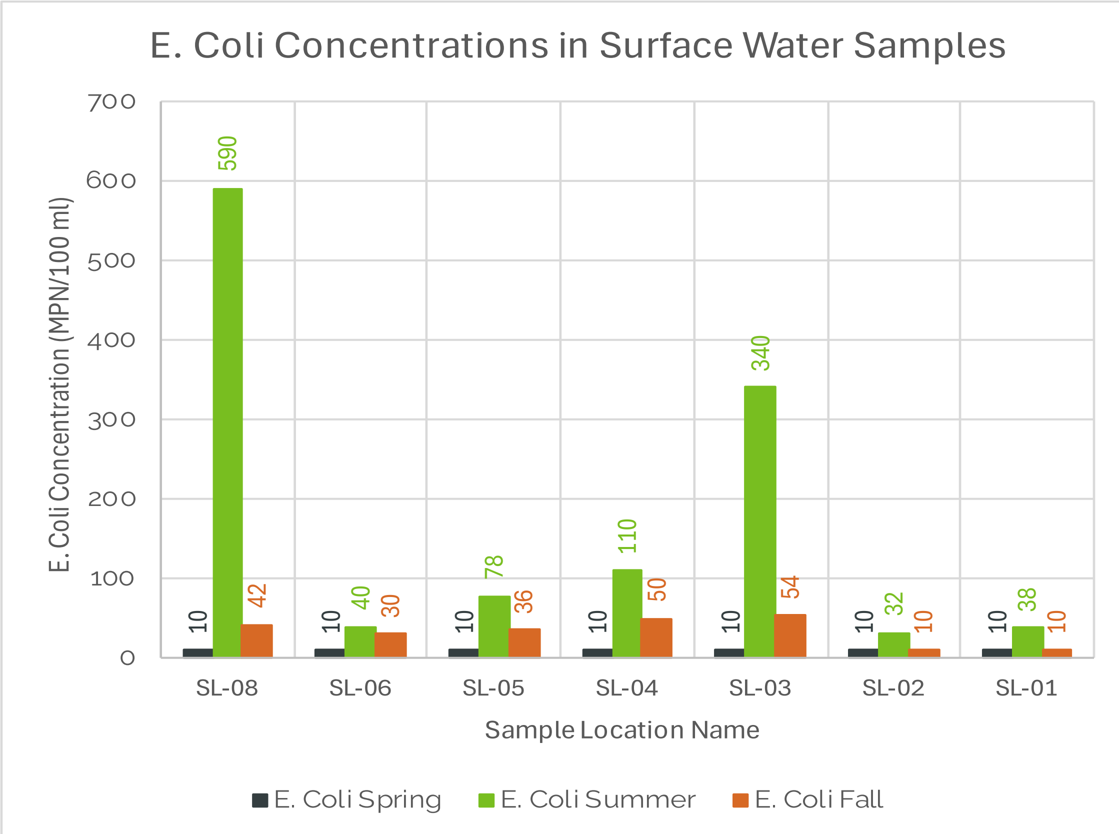


Chart 6.2: E. Coli concentrations at each sample location over seasonal changes.

Total Kjeldahl Nitrogen *(TKN)*

Chart 6.3 shows the Total Kjeldahl Nitrogen (TKN) concentrations in each sample. TKN is equal to the sum of total organic nitrogen and ammonia in a sample. Organic compounds are derived from carbon, hydrogen, and oxygen, and organic nitrogen has those three elements in it, in addition to nitrogen. Organic nitrogen is used in natural gas treatments, pharmaceuticals, plastics, rubber, and herbicides. Ammonia, meanwhile, is a natural piece of the nitrogen cycle, but it is synthesized for use in cheap fertilizer.

Without measuring the ammonia or organic nitrogen in the water samples separately, it is difficult to discern what the TKN came from and where it came from at each sampling location in Glen Lake's watersheds. If the TKN is mostly ammonia, its source may be fertilizer in residential areas. If it is mostly organic nitrogen, it may be from an industrial sector or an area with a large amount of impervious surface, such as S04, S07, or S10.

It is notable that the highest TKN concentration during the summer was just downstream of the Great Escape, and the concentration declines going upstream from SL-06 to SL-08. The land use in the same subcatchment, S07, is 43.4% industrial, commercial, and multi-family residences.

These areas, including the Great Escape, could contribute to the 20% increase in TKN from SL-06 to SL-05. It is tempting to conclude that I87 is responsible for the 50% increase in TKN from SL-08 to SL-06, but, with limited data, it is difficult to make such a conclusion.

There is a confluence downstream of SL-08 that merges the flow from S08, S09, and S11 (a combined 2216 acres) with the flow upstream of SL-08. The subcatchments S09 and S11 have no impervious surfaces that could produce pollutants such as nitrogen; they are completely forrested. The land use in S08, however, is 38.7% single-family residential and may contribute a significant ammount of nitrogen pollutants to Rush Pond and Glen Lake from lawn fertilizers and pollutants from vehicles. With limited data, a reliable conclusion cannot be drawn regarding the source of nitrogen pollutants. Additional sample locations and rounds of sampling may offer insight on the sources of TKN, whether it is a point source or a non-point source and what type of land use may be responsible.

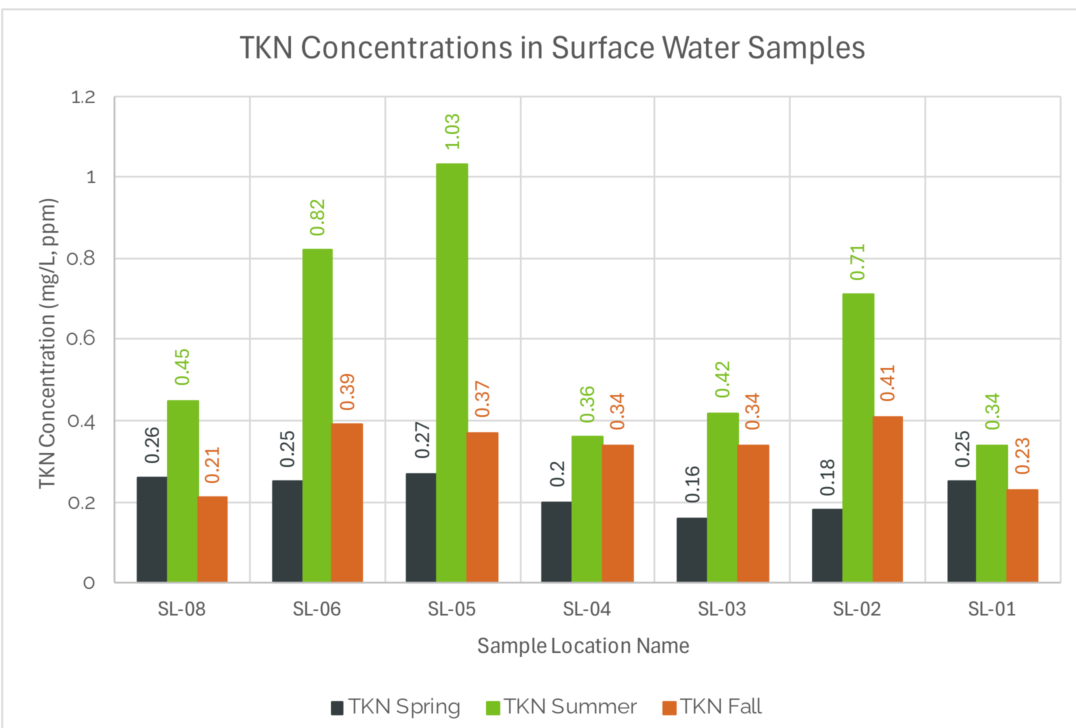


Chart 6.3: TKN concentrations at each sample locations over seasonal changes.

Free Chlorine

Chart 6.4 shows the free chlorine concentrations in each round of sampling. The measuring instrument's RL/PQL was 0.02 mg/L, and every sample, except one, had a free chlorine concentration less than the RL/PQL. This does not mean that the samples' free chlorine concentration was 0 mg/L. Instead, RL/PQL describes a laboratory's confidence to quantify a compound of interest. RL is the reporting limit. Below this concentration, a laboratory is not confident enough to accurately quantify the compound. The concentration of free chlorine in these samples is less than 0.02 mg/L, but not 0 mg/L. Based on the available data, there is not a significant presence of free chlorine in Glen Lake.

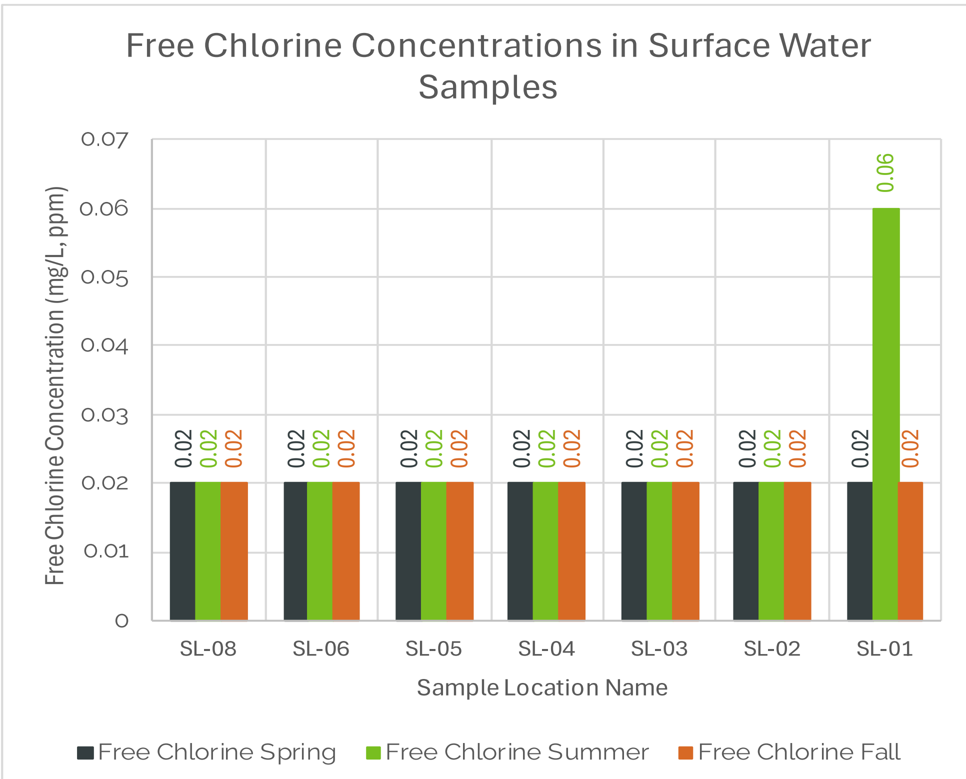


Chart 6.4: Free chlorine concentrations at each sample location over seasonal changes. *Concentrations are below Reporting/Practical Quantitation Level (RL/PQL) and are not measurable below 0.02 mg/L with available instrumentation.*

Total/Soluble Phosphorus

Of all the pollutants and parameters measured, total phosphorus is the only parameter that exceeded the NYS DEC standard and guidance values. NYS DEC requires that total phosphorus be less than 0.02 ppm to support its best use. Based on this standard, total phosphorus is the only measured pollutant that may inhibit Glen Lake's best use. However, algae uses soluble phosphorus, which is part of total phosphorus, to bloom and grow. Soluble phosphorus was below the lab's RL/PQL of 0.01 mg/L in every sample taken, as shown in Chart 6.5, meaning that most of the phosphorus in these samples was particulate phosphorus, which still reduces water quality.

Ahern and Hare (2020) suggest that septic tanks on lakefront properties are the most probable source of non-point source pollution (NPS pollution). Section 7 further discusses possible sources of phosphorus and locations for additional sampling.

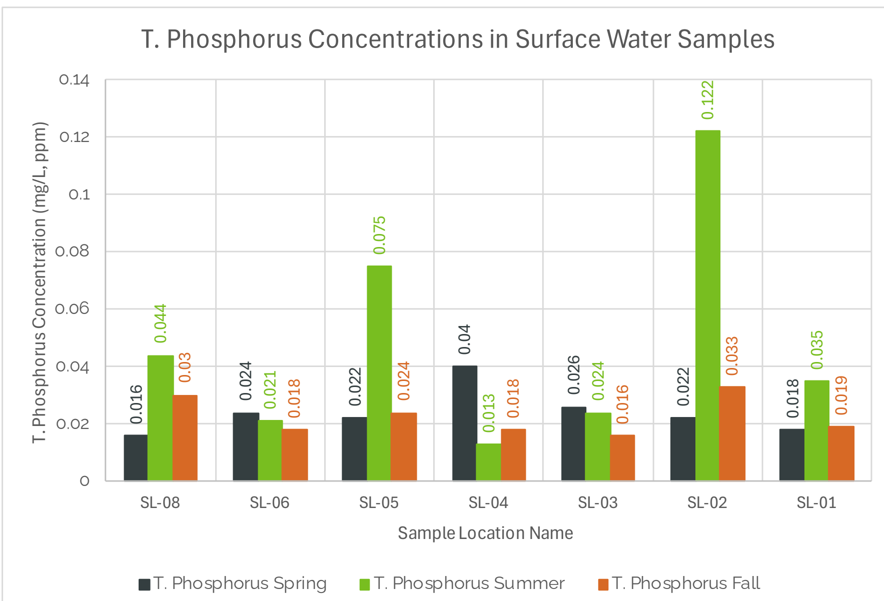


Chart 6.5: Total phosphorus concentrations at each sample location over seasonal changes.

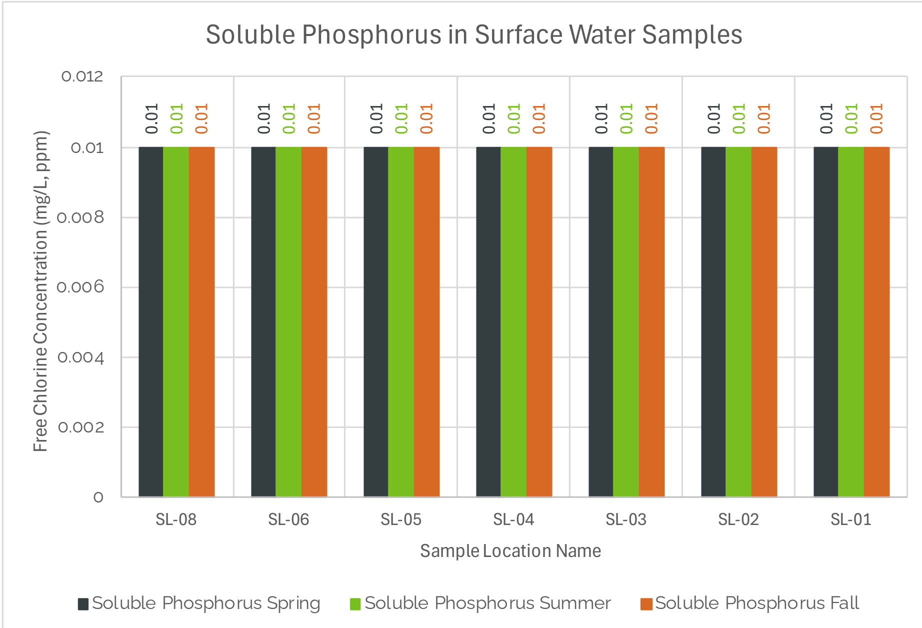


Chart 6.6: Soluble Phosphorus concentrations at each sample location over seasonal changes.

Table 6.4 summarizes the results for the most relevant parameters of interest, namely E. Coli, Total Phosphorus, TKN, free chlorine, and Soluble Phosphorus. A copy of the full report prepared by Phoenix Environmental Laboratories Inc. for each round of testing can be found in Appendix C.

Table 6.4;Water Quality Sampling Results

Water Quality Sampling Lab Results					
Parameter	Sampling Location	Spring*	Summer**	Fall***	Average
					Geometric Mean
E. Coli (MPN/100 mls) (MPN=Most Probable #)	SL-01	< 10	38	10	7.2
	SL-02	< 10	32	10	6.8
	SL-03	< 10	340	54	26.4
	SL-04	< 10	110	50	17.7
	SL-05	< 10	78	36	14.1
	SL-06	< 10	40	30	10.6
	SL-07	< 10	-	-	N/A
	SL-08	-	590	42	29.2
	Geometric Mean	< 10	175.4	33.1	18.0
					Arithmetic Mean
TKN* (mg/L)	SL-01	0.25	0.34	0.23	0.27
	SL-02	0.18	0.71	0.41	0.43
	SL-03	0.16	0.42	0.34	0.31
	SL-04	0.2	0.36	0.34	0.30
	SL-05	0.27	1.03	0.37	0.56
	SL-06	0.25	0.82	0.39	0.49
	SL-07	0.26	DRY	-	0.26
	SL-08	-	0.45	0.21	0.33
	Arithmetic Mean	0.22	0.59	0.33	0.38
					Arithmetic Mean
T. Phosphorus (mg/L)	SL-01	0.018	0.035	0.019	0.024
	SL-02	0.022	0.122	0.033	0.059
	SL-03	0.026	0.024	0.016	0.022
	SL-04	0.04	0.013	0.018	0.024
	SL-05	0.022	0.075	0.024	0.040
	SL-06	0.024	0.021	0.018	0.021
	SL-07	0.016	DRY	-	0.016
	SL-08	-	0.044	0.03	0.037
	Arithmetic Mean	0.0240	0.0477	0.0226	0.031
					Arithmetic Mean
Nitrate (mg/L)	SL-01	0.16	<0.02	<.02	0.07
	SL-02	0.05	<.020	<.02	0.03
	SL-03	0.25	0.23	0.16	0.21
	SL-04	0.16	0.03	0.18	0.12
	SL-05	0.23	0.04	0.12	0.13
	SL-06	0.22	0.02	0.15	0.13
	SL-07	2.28	DRY	-	0.76
	SL-08	-	0.09	<.02	0.06
	Arithmetic Mean	0.48	0.08	0.15	0.24
					Arithmetic Mean
Free Chlorine (mg/L)	SL-01	< 0.02	0.06	<0.02	0.03
	SL-02	< 0.02	< 0.02	<0.02	0.02
	SL-03	< 0.02	< 0.02	<0.02	0.02
	SL-04	< 0.02	< 0.02	<0.02	0.02
	SL-05	< 0.02	< 0.02	<0.02	0.02
	SL-06	< 0.02	< 0.02	<0.02	0.02
	SL-07	< 0.02	DRY	-	0.02
	SL-08	-	< 0.02	<0.02	0.02
	Arithmetic Mean	0.02	0.02	0.02	0.02
					Arithmetic Mean
Sol. Rec. Phosphorus** (mg/L)	SL-01	< 0.010	< 0.010	<0.010	0.01
	SL-02	< 0.010	< 0.010	< 0.010	0.01
	SL-03	< 0.010	< 0.010	< 0.010	0.01
	SL-04	< 0.010	< 0.010	< 0.010	0.01
	SL-05	< 0.010	< 0.010	< 0.010	0.01
	SL-06	< 0.010	< 0.010	< 0.010	0.01
	SL-07	< 0.010	DRY	-	0.01
	SL-08	-	< 0.010	< 0.010	0.01
	Arithmetic Mean	0.01	0.01	0.01	0.01

*Spring labs taken on 4/11/12022

**Summer labs taken 7/19 /2022 except total coliform and E. Coli, taken on 8/24/2022

***Fall labs taken on 11/7/2023

Limitations of Water Quality Sampling

Nutrient uptake and deposition are cyclical processes, and if a pollutant source is constantly leaching phosphorus and nitrogen into Glen Lake and its tributaries, that may not appear as an obvious trend in sample data due to the natural cycles. For example, nutrient loading tends to peak in the spring from fertilizer, and it peaks in both the spring and fall from decaying plant matter. One is a natural peak, the other is artificial, and it is difficult to distinguish between the two without adequate data.

6.5 Glen Lake Fen Assessment

The New York State Department of Environmental Conservation (NYSDEC) maps the fen as freshwater wetland GF-15, a Class 1 wetland. NYSDEC also has the fen mapped as a Class B(T) waterbody (NSYSDEC segments 830-500 and 830-509). New York Natural Heritage Program (NYNHP) has the fen and immediate area mapped as significant natural communities, including sedge meadow, red maple-tamarack peat swamp, and medium fen.

Image 9: A view of the Fen

The Glen Lake Fen was evaluated by a wetland's scientist on July 7, 2022, using a personal watercraft. Observations focused on the overall health of the resource based on visual observation of plant species, vegetation health assessments based on current conditions, and general observations made during the visit.

Water levels within the fen appear to fluctuate 4 to 6 inches as evident by the exposed vegetation root systems. Water fluctuations are expected during the summer months especially during periods with reduced rainfall.

The stream between Rush Pond (west of the Northway) and Glen Lake fen flows directly through the Great Escape Park. While driving south along Route 9, several pipes were observed to discharge into the stream and eventually into the fen. Direct discharge from these pipes could be a potential point source for contaminants. A second tributary (identified by NYSDEC as segment 830-590) flows into fen from the north from a subdivision north of Glen Lake Road. The tributary connection was reviewed during the site visit and there were no apparent contamination issues visible during the site visit, though pollution discharges from the adjacent subdivision could be a potential point source for contamination.

An area of debris within and along the southwest shoreline of the fen, adjacent to the Great Escape, was observed during the site visit. Plastic drums were observed within the water of the fen. The drums were not labeled and there was no apparent residue, and the area immediately surrounding the debris did not appear to indicate toxicity to the vegetation or aquatic fauna.

A complete plant inventory was not conducted during the field review but observed plant species were generally recorded during the site visit. Herbaceous species observations include coontail (*Ceratophyllum demersum*), muskgrass (*Chara vulgaris*), white water lily (*Nymphaea odorata),* yellow water lily (*Nuphar variegata*), arrowhead (*Sagittaria latifolia*), tussock sedge (*Carex stricta*), soft rush (Juncus effusus), and broad leaf cattail (Typha latifolia). Please note this is not and extensive list of plant species. Observed shrub species include blueberry (*Vaccinium formosum*), steeplebush (*Spiraea tomentosa*), speckled alder (*Alnus incana*), buttonbush (*Cephalanthus occidentalis*), arrowwood (*Viburnum recognitum*), nannyberry (*Viburnum lentago)*, and bog rosemary (*Andromeda polifolia*). Tree species include red maple (*Acer rubrum*), tamarack (*Larix laricina*), and eastern hemlock (*Tsuga canadensis*). It is important to note that the tamarack tree density appears to be declining as several dead tamarack trees were observed dead.

Several invasive species were also observed, including curly pondweed (*Potamogeton crispus*), and Eurasian watermilfoil (*Myriophyllum spicatum*), were observed in Glen Lake, while bitttersweet nightshade (*Solanum dulcamara)* was observed within the fen portion itself.

Overall, the wetland vegetation health appeared to be consistent with other bodies of water within the area (for example Rush Pond west of I-87). There was an area observed along the southwest edge of the fen where trees appeared to be stressed, particularly the white pine and maples appeared to be brown and dying. Upon additional investigation, it appears the trees have been impacted by the recent tent caterpillar (*Malacosoma disstria*) infestation.

The Glen Lake fen provides a wide variety of habitat uses for various species of insects, birds, fish, and mammals. The following species were observed during the field visit: bald eagle (*Haliaeetus leucocephalus*), green-backed heron (*Butorides virescens*), wood duck (*Aix sponsa*), mallard duck (*Anas platyrhynchos*), great blue heron (*Ardea herodias*), common crow (*Corvus brachyrhynchos),* red-winged blackbird (*Agelaius phoeniceus*), belted kingfisher (*Megaceryle alcyon*), song sparrow (*Melospiza melodia*), goldfinch (*Spinus tristis*), eastern kingbird (*Tyrannus tyrannus*), black duck (*Anas rubripes*), great horned owl (*Bubo virginianus*), and Canada goose (*Branta canadensis*). Common loon (*Gavia immer*) was observed within Glen Lake. Several fish species were observed as well, including bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomus gibbosus*), largemouth bass (*Micropterus salmoides*), and chain pickerel (*Esox nigra*). Waterfowl nest boxes were observed and well as waterfowl hunting blinds.

At the time of the site visit in 2022, the fen appeared overall healthy and as expected during midsummer. There were wildlife species utilizing the area and vegetation appeared to be normal for the time of year. Further investigation of potential point sources from the stream between Rush Pond and the subdivision to the north may indicate potential pollution sources. The other potential point source is the storage area located in the southwest corner of the fen. The storage of equipment and drums and materials may create an additional pollutant source. The potential introduction of further invasive species may also be of concern in relation to the overall fen health, along with the high Canada goose populations in the fen. Geese consume herbaceous and shrub plants while fecal matter can have an impact on the water quality, which could pose human health and safety risks.

7 THE WATERSHED AND STORMWATER MODEL

7.1 Overall Watershed Description

As noted, the Glen Lake watershed has a total area of approximately 7,500 acres. The area's combined runoff flows into a body of water with a total surface area of 320 acres. The majority of the lake's watershed stems from the land west of the lake and is located entirely in the town of Queensbury.

Watersheds are natural units of land, defined by a landscape's topography, that are unconstrained by political boundaries. Watershed designations are classified into hydrological units. Each unit is uniquely identified by a series of numbers. This allows smaller watersheds to be identified within the larger watersheds. Classifying watersheds into hydrological units is useful for watershed planning and management.

Image 10: View of the Glen Lake Dam

The Lake Champlain Basin Program commonly uses several groupings of watersheds in its research. The 8-digit hydrological unit is used in modeling the influence of major river systems, particularly in terms of land use and phosphorus loads. Smaller watershed (12 and 16 units hydrological units) are used for research, which benefits from a more detailed examination of the landscape.

7.2 Subcatchment Delineation

As noted in Section 6 the Glen Lake watershed was broken down into 12 subcatchments for purpose of characterizing land use and hydrologic modeling. A map of the delineated subcatchments within the Glen Lake watershed is included as Figure 7.

7.3 Watershed Pollutant Loading and Transport Modeling

An EPA SWMM model of the Glen Lake watershed was created for the purpose of analyzing pollutant loading and transport. EPA SWMM is a hydrologic and hydraulic modeling software package that can calculate rainfall-runoff relationships. In addition, the software can track the deposition, mobilization, transport, and absorption/removal of pollutants in stormwater runoff over time given appropriate input parameters.

The EPA SWMM software is pollutant agnostic in that any pollutant can theoretically be modeled.

- Total Coliform
- E Coli
- Total Kjeldahl Nitrogen
- Nitrate
- Total Phosphorus
- Soluble Phosphorus
- Dissolved Oxygen

The model for Glen Lake places particular focus on total phosphorus and soluble phosphorus, since phosphorus is the limiting factor for freshwater eutrophication. The model was designed to analyze a few different precipitation patterns:

- Extreme 24-hour precipitation events, with depths and hydrograph distributions obtained from the Northeast Regional Climate Center (NRCC) website. These storms were used to hydraulically calibrate the model to reproduce the runoff predicted by USGS Stream Stats.

- 3 years of rainfall data were observed and recorded locally during April of 2019 and 2023 (provided by the GLPA). This rainfall data was used to calibrate the model for a full simulated year to calculate the annual pollutant loading from the global watershed. The simulation with this data was named “Normal Rain Year” in the analysis.

Calibrating the EPA SWMM model means making meaningful changes to the model’s parameters that improve the accuracy and reliability of the model’s predictions. The predicted values include pollutant concentrations at the sampling locations, runoff volumes from each subcatchment, infiltration volumes, and so on. Many of these predicted values can be calibrated independently.

One of the goals of the EPA SWMM model is to better understand where the sources are for the pollutants listed, namely which subcatchment and type of land cover are the largest contributors of each pollutant. The model was calibrated with the observed rainfall data recorded along the lake by a resident between April 2019 and 2023. This helped us create a “normal rain year” in Glen Lake watershed that could be tied to observed data, and we used that to calibrate the annual runoff volume in the EPA SWMM model.

Using the arithmetic mean of each of the seven pollutants listed, and the annual runoff volume from each subcatchment, we normalized the total pollutant loading with the acreage of the upland drainage area of each sampling location. Table 7.1 shows the total acreage and runoff discharge from each subcatchment. Tables 7.2 and 7.3 show the normalized pollutant loadings in lbs/yr/ac and in oz/yr/ac.

7.4 Pollutant Loading Analysis - Phosphorus

Of all the pollutants and parameters measured, total phosphorus is the only pollutant that exceeded the NYS DEC standard and guidance values. NYS DEC requires that total phosphorus be less than 0.02 ppm to support a waterbody’s best use. For this reason, this section focuses on pollutant loading of phosphorus.

Table 7.1 shows each subcatchment and the subcatchments’ respective areas (acres) and annual discharge due to runoff (mega-gallons/yr) during a normal rain year. This is based on the data observed and collected by a resident from April 2019 to 2023. Table 7.2 shows each sampling location’s total upstream drainage area and annual soluble phosphorus loading, normalized with the discharge due to runoff and total upstream acreage.

Note that the soluble phosphorus concentration in each sample was less than the lab’s minimum measurable concentration of soluble phosphorus, which is 0.01 mg/L. To calculate annual loading for soluble phosphorus, it was assumed that the mean concentration of soluble phosphorus in the water samples was 0.01 mg/L. In reality, the loading was less than the values shown in Table 7.2. Table 7.3 shows the same parameters for total phosphorus. Figure 6.1 facilitates finding the drainage areas upstream of each sampling location, as shown in Tables 7.2 and 7.3.

Table 7.1: Rainfall Data by Subcatchment. All twelve subcatchments and their respective acreage and discharge due to runoff modeled during a normal rain year.

Normal Rain Year		
Subcatchment	Area (acres)	Discharge (10^6 gal/year)
S1	325	272.78
S2	370	49.34
S3	113	98.26
S4	196	53.55
S5	388	6.86
S6	312	31.28
S7	235	106.27
S8	905	21.98
S9	625	20.55
S10	1301	67.00
S11	687	135.90
S12	2045	68.74

Table 7.2: Phosphorus Loading

Normal Rain Year							
				Soluble Phosphorus			
Sampling Location	Upstream Drainage Areas	Total Drainage Area (acres)	Discharge (10^6 gal/year)	Avg. Sample Concentration (mg/L)	Annual Loading (lbs/yr)	Normalized Annual Loading (lbs/yr/acre)	Normalized Annual Loading (oz/yr/acre)
SL-01	All	7502	932.51	0.01	77.8	0.010	0.166
SL-02	S05	388	6.86	0.01	0.6	0.001	0.024
SL-03	S12	2045	68.74	0.01	5.7	0.003	0.045
SL-04	S03, S04, S07, S08, S09, S10, S11, S12	6107	572.25	0.01	47.7	0.008	0.125
SL-05	S04, S07, S08, S09, S10, S11	3949	405.25	0.01	33.8	0.009	0.137
SL-06	S08, S09, S10, S11	3518	245.43	0.01	20.5	0.006	0.093
SL-08	S10	1301	67	0.01	5.6	0.004	0.069

This table shows the annual soluble phosphorus loading normalized with annual discharge due to runoff and total upstream acreage. Note that annual loading for soluble phosphorus was calculated by assuming that the mean concentration of soluble phosphorus in the water samples was 0.01 mg/L, which is the lab's minimum detectable concentration. In reality, the loading was less than the values shown in the table. The values shown are for a normal rain year.

Table 7.3: Total Phosphorus

Normal Rain Year							
				Total Phosphorus			
Sampling Location	Upstream Drainage Areas	Total Drainage Area (acres)	Discharge (10^6 gal/year)	Avg. Sample Concentration (mg/L)	Annual Loading (lbs/yr)	Normalized Annual Loading (lbs/yr/acre)	Normalized Annual Loading (oz/yr/acre)
SL-01	All	7502	932.51	0.024	186.7	0.025	0.398
SL-02	S05	388	6.86	0.059	3.4	0.009	0.139
SL-03	S12	2045	68.74	0.022	12.6	0.006	0.099
SL-04	S03, S04, S07, S08, S09, S10, S11, S12	6107	572.25	0.024	114.5	0.019	0.300
SL-05	S04, S07, S08, S09, S10, S11	3949	405.25	0.04	135.2	0.034	0.548
SL-06	S08, S09, S10, S11	3518	245.43	0.021	43.0	0.012	0.195
SL-08	S10	1301	67	0.03	16.8	0.013	0.206

Each sampling location has an upland drainage area. This table shows the annual total phosphorus loading normalized with annual discharge due to runoff and total upland acreage. The values shown are for a normal rain year.

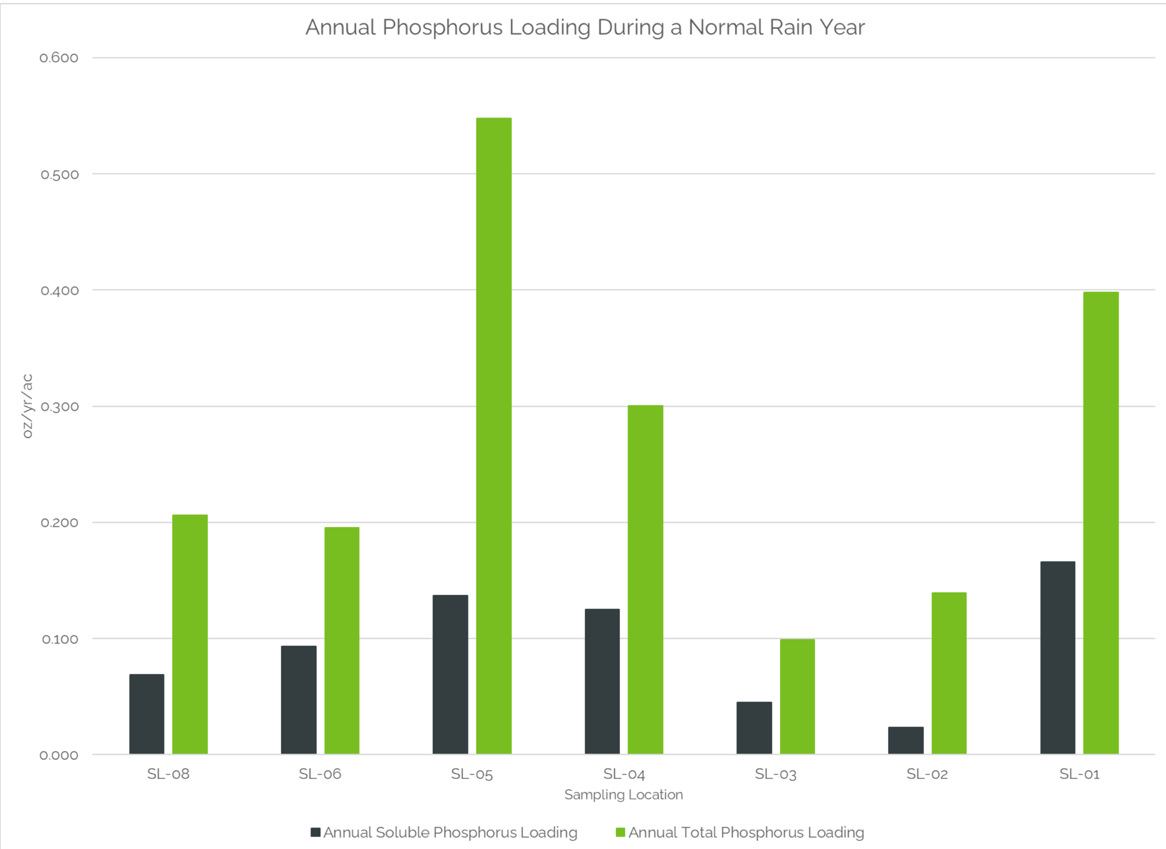


Chart 7.1: Soluble and total phosphorus normalized by annual volume of runoff and total acreage of upstream drainage area. (*Sampling locations are organized from left to right on the horizontal axis, from upstream (SL08) to downstream (SL-01). The values shown are for a normal rain year.)*

Calculating the annual phosphorus loading and normalizing that with the total upstream acreage shows where efforts in reducing phosphorus loading may have the greatest impact. Total phosphorus and soluble phosphorus are both included in this analysis due to the impact that they can have on water quality and nutrient levels in Glen Lake.

Total phosphorus and soluble phosphorus work in tandem. They can indicate Glen Lake's potential for eutrophication, but they are unique pollutants. Total phosphorus is equal to the sum of soluble phosphorus and particulate phosphorus. Soluble phosphorus is immediately available for biological uptake by plants or algae, and it is the main cause of lake eutrophication. Particulate phosphorus, meanwhile, is organic matter or phosphorus bound to soil particles, and it is not immediately available for plant uptake. However, particulate phosphorus can become available through a few different processes, such as mineralization, weathering, or dissolution. Particulate phosphorus can come in organic and inorganic forms, and it can contribute to eutrophication if it becomes available as soluble phosphorus through one of the aforementioned processes.

In Chart 7.1, note the difference between total phosphorus and soluble phosphorus. The difference is particulate phosphorus. For example, SL-08 had an annual total phosphorus loading of 0.206 oz/yr/ac during a normal rain year, and a soluble phosphorus loading of 0.069 oz/yr/ac. It is important to keep in mind the assumption that the average concentration of soluble phosphorus was 0.01 mg/L, which is an overestimate of the actual concentration. At least 0.137 oz/yr/ac (0.206 – 0.069 = 0.137, or 67%) of the phosphorus loading at SL-08 was particulate phosphorus. Particulate phosphorus is not immediately available for plant uptake

Chart 7.1 shows that soluble phosphorus rises slightly between SL-08 and SL-06, while total phosphorus is nearly constant. Total phosphorus increases over 150% from SL-06 to SL-05, while soluble phosphorus increases by 47% from SL-06 to SL-05, as shown in Chart 7.2. Both values are significantly high. SL-05 is just downstream of the Great Escape and Queensbury. This increase in total phosphorus is likely due to the increased runoff volume from S07 and S04. See Figure 6.1. From SL-06 to SL-05, the total upland drainage area increases by 12%, but the annual discharge increases by 65% based on Tables 7.2 and 7.3, which would be caused by the increase in impervious surfaces and urbanization in S07 and S04. With the addition of S04 and S07 at SL-05 (see Figure 6.1), the percent impervious increases by 77%.

Chart 7.2 shows the percent change in total phosphorus and soluble phosphorus from upstream sampling locations to downstream sampling locations. Figure 6.1 is particularly helpful in visualizing which locations are downstream of each other, and in understanding how Figure 7.3 was made. Note that SL-04 and SL-02-mark subcatchment outlets to Glen Lake, so they are considered upstream of SL-01.

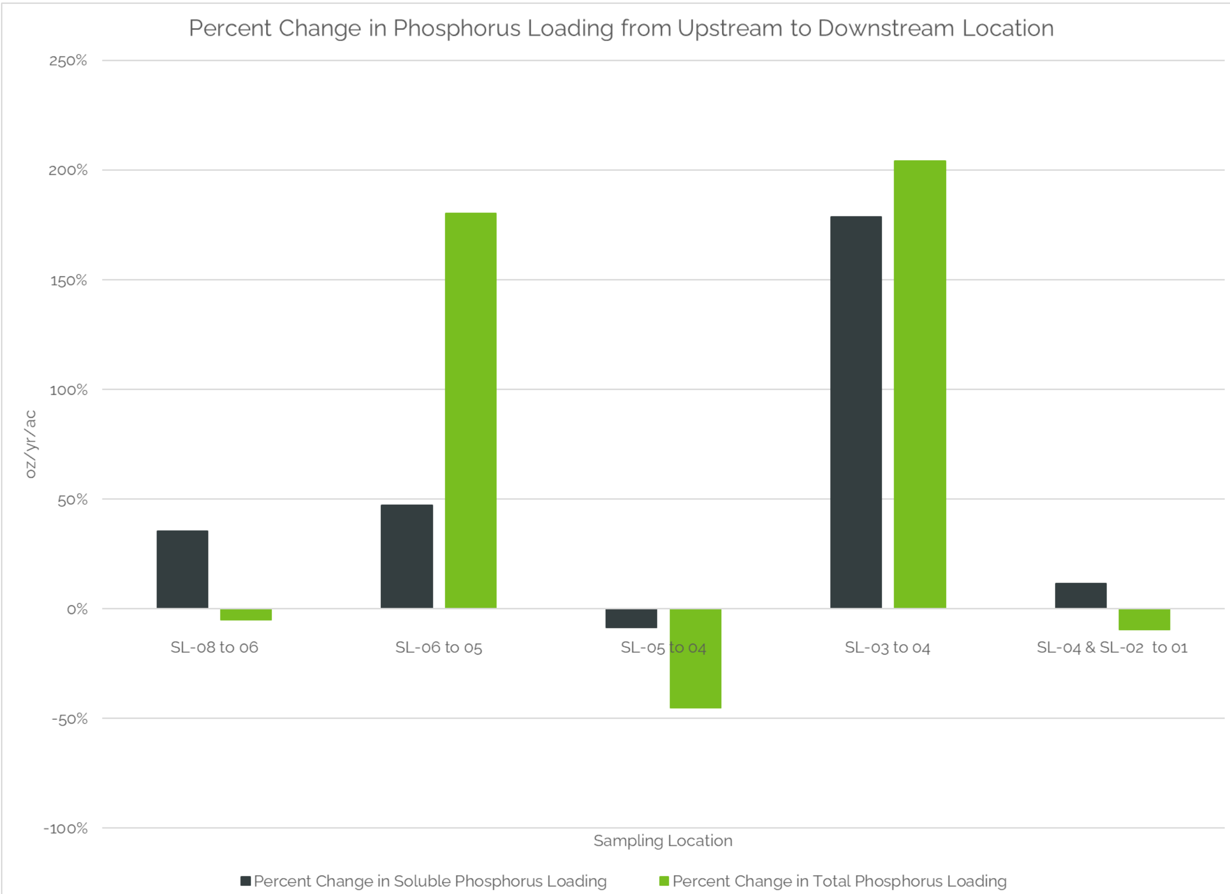


Chart 7.2: This chart shows the percent change in total phosphorus and soluble phosphorus from upstream sampling locations to downstream sampling locations.

Total phosphorus decreases at SL-04. The percent change in soluble phosphorus and total phosphorus from SL-05 to SL-04 is -9% and -45%, respectively, which may mean that the Glen Lake Fen acts as a sink for phosphorus. To flow from SL-03 to SL-04, runoff must flow through S04 and the Glen Lake Fen. Total phosphorus increases over 200% from SL-03 to SL-04. The huge increase in total phosphorus eliminates S12 as being a significant contributor of phosphorus in Glen Lake.

Glen Lake is not at immediate risk of eutrophication due to the low levels of soluble phosphorus in the lake. However, most of the available phosphorus is particulate phosphorus, which can be made available as soluble phosphorus and negatively impact the lake. The total amount of phosphorus transported into the lake, based on the sampling and runoff volumes, is 0.439 oz/yr/ac (sum of loading at SL-02 and SL-04). This is slightly higher than the amount leaving the lake, 0.4 oz/yr/ac (SL-01). There is some build-up of soluble phosphorus in Glen Lake.

Chart 7.2 shows that total phosphorus decreases 9% from the Glen Lake inlets to the lake's outlets, and that soluble phosphorus increases by 12%. Glen Lake may act as a sink for total phosphorus as well. However, this analysis and its calibration do not account for plant life cycles, natural phosphorus uptake, or phosphorus release from decaying organic matter in the lake.

Since soluble phosphorus increases from upstream to downstream in Glen Lake, there are several possible sources. The model and analytical data don't necessarily identify a single source. As noted previously, one potential source is the release from septic systems. Phosphorus in urine is typically soluble. Particulate phosphorus (such as that from fertilizers) could also be made available as soluble phosphorus in Glen Lake. Other processes are likely at work as well, but it is difficult to pinpoint which ones are the greatest contributors. Figure 6.6 shows a similar trend, in that the cumulative phosphorus flowing into Glen Lake from SL-04 and SL-02 is greater than the cumulative phosphorus in the lake's outflow.

Based on the sampling done and the runoff volumes calculated, most of the measured phosphorus is transported to Glen Lake by runoff from S04 and S07.

8 SUMMARY & RECOMMENDATIONS

8.1 Summary

CSLAP data (collected for nearly 40 years) indicates that water quality has been consistent over time. Glen Lake is considered an oligotrophic lake but is trending toward mesotrophic. The most recent CSLAP report (2023) indicates that the median concentration of Chlorophyll A has not changed significantly and is declining. Similarly, Total Phosphorus has not changed over the last decade and is modestly declining.

However, Glen Lake's water quality may be threatened by the presence of aging residential septic systems located near the lake shore. A full 60 percent of all septic systems (or 166 systems) located on the Lake's waterfront are in excess of 30 years old. The detection of both thermotolerant Escherichia coli (TEC) and Free chlorine (HOCl) has been documented over several years and these detections coincide with the location of the older septic systems.

The SUNY ADK Near shore sampling results have detected the presence of thermotolerant Escherichia coli (TEC) coincident with Free chlorine (HOCl). SUNY Adirondack ESC indicates that "*the concurrent detection of thermotolerant Escherichia coli (TEC) and the ionic form of chlorine (HOCl) found in bleach and other cleaning agents in lake water samples*" may indicate the release of human derived from near shore septic systems Based on a review of SUNY ADK's NPS sampling for the years 2019 - 2022 nearly all sampling locations reported TEC and HOCL detections during those years.

The survey of residential septic systems documents that 60 percent (166 /270) of septic systems are in excess of 30 years old. The location of the TEC/HOCl detections align with the location of older systems. This presents a strong indication that the older septic systems are the possible source of the E.Coli.

The 2022 WQ sampling conducted as a component of the watershed plan show some upstream to downstream variation in water quality. The detection of E Coli peaks during the summer sampling events. This coincides with increased occupation and usage of the lake shore residences.

8.2 Recommendations

1. Continue to pursue funding from EFC/DEC Septic Replacement Program, acknowledging that Glen Lake is not currently included in the Program. Collaborate with Warren County Planning to secure Glen Lake's inclusion into approved water bodies. Also, seek other sources of funding to incentivize septic system upgrades.
2. Educate lake residents about on-site septic systems. Promote voluntary annual inspections of their septic systems and encourage proper maintenance and record keeping. Explore the development of a septic management district for Glen Lake. A septic management district could be charged with inspecting septic systems, facilitating regular/routine pump out of septic tanks, negotiating possible reduced pump out rates, public education and other measures.
3. Consider requesting the Town of Queensbury to implement a mandatory septic inspection program for Glen Lake, similar to the Lake George Park Commission's (LGPC) program that requires (and conducts) inspection of all septic systems withing 500 feet of Lake George once every five years. The LGPC 2024 report noted that 59% of systems inspected required repairs (21%), failed (23%) or were noted as substandard (15%).
4. Identify and expand opportunities to collaborate with the Lake Champlain Lake George Regional Planning Board (LCLGRPB) as well as the Warren County Soil and Water Conservation District (WCSWCD). LCLGRPB is the regional contact/collaborator for the Lake Champlain Basin Program (LCBP) and recently updated the *Lake Champlain Nonpoint Source Pollution Subwatershed Assessment and Management Plan.* The LCBP provides local funding and the referenced plan identifies opportunities for phosphorus reduction.
5. Continue to participate in the WCSWCD's Water Quality Strategy Committee. This committee provides technical assistance and opportunities for collaboration with similar lake management entities.
6. Explore and pursue New York State DEC invasive species grant program. The most recent solicitation of the program announced $2.9 million in grant funding for January 2024. Seek other sources of funds to supplement the special assessment district actions.
7. Continue to fund early detection of invasives and nuisance aquatic plants through annual aquatic plant surveys.

8. Continue to participate in the annual CSLAP water quality data collection program, which also includes monitoring HABs and recording lake user perceptions of water quality.
9. Explore the development of a mandatory boat inspection program, similar to that of Lake George and Schroon Lake. Boats are inspected prior to launch and tagged/certified as free of invasives. This could be done at the local launch or by the use of current inspection and wash stations at the Lake George and I-87 inspection sites.
10. Explore developing measures to monitor and regulate boat and personal watercraft speeds, and explore regulations on maximum boat size and horsepower. These could come in the form of local laws. Consider inviting Warren County Sherrif to have a stronger presence on the lake.
11. Explore measures to address noise issues emanating from watercraft and other sources.
12. Explore measures to mitigate light pollution.
13. Provide means of educating residents and lake users to address appropriate handling of pharmaceuticals, yard waste, fertilizer use, pet waste, and other potential contaminants that may get introduced into the lake.
14. Developing a program to inform lake residents and landscape contractors and related service providers about the regulations of fertilizer use and tree removal (clear cutting restrictions).
15. Provide education to lake residents about bubbler or ice eater use during the winter. Consider requesting the Town, County, and/or State to regulate the use of bubblers and ice eaters.
16. Monitor usage of the Town's cartop launch and educate off-lake users of watercraft rules and lake etiquette issues. Request that Warren County monitor and prohibit the launching or removal of any watercraft from the Bike Path.
17. Establish a long-term water quality monitoring program and establish nutrient loading goals for Glen Lake and its tributaries. This should include establishing new locations for continuous water sampling. This could include engaging the WCSWCD or other agency to perform the samplings. Explore the use of special assessment district funds for this purpose.
18. Future water sampling could include a variety of different strategies. Explore sample collection as far upstream as possible – at Butler Pond, for example – to collect samples that have minimal human impact. This set of samples

would act as a control and provide a “background value” for pollutants. Sampling farther upstream would facilitate parsing out what is from manmade and controllable sources, and what is not. A background value, since it is so similar to the natural nutrient loading of the watershed, could be used to establish nutrient loading goals.

19. Explore expanding water quality monitoring to include sampling for salts/chlorides.
20. Update the Watershed Management Plan every 10 years to provide longitudinal data, identify current watershed and lake issues, and stay up to date with available resources and regulations.

Terminology

Aquathol: Broad-spectrum aquatic herbicide used to control a wide variety of submerged aquatic weeds in lakes, ponds, and other water bodies. Its primary active ingredient is the dispotassium salt of endothall, typically at a concentration of 40.3%.

C Slap Data: The Citizen Statewide Lake Assessment Program (CSLAP) is a volunteer-driven initiative in New York State that collects water quality data to evaluate the health of lakes. Managed by the Department of Environmental Conservation (DEC) and the NYS Federation of Lake Associations (FOLA), it focuses on parameters linked to eutrophication, invasive species, and recreational suitability.

Deciduous: Plants that shed their leaves at the end of each growing season, typically in response to changes in climate such as colder temperature or dry periods.

E. Coli: Escherichia coli is a type of bacteria typically found in the intestines of humans and warm-blooded animals. Most strains are harmless and play a role in digestion. However, some strains can cause serious illnesses. E. Coli enters a water system primarily through fecal contamination such as through sewage leaks or overflows, agricultural runoff, surface water infiltration or storm events.

Eutrophic: Describes water systems with excessive nutrient concentrations (primarily nitrogen and phosphorus), leading to dense plant/agal growth and ecological imbalance.

Free Chlorine: Refers to the active, unreacted form of chlorine in water that is available to disinfect and neutralize pathogens. It is critical for maintaining water safety in treatment and distribution systems.

Hydrologic Soil Groups (HSGs): Classification systems for soil based on their runoff potential when saturated, influencing water infiltration and flood risk. It was developed by the USDA Natural Resources Conservation Service (NRCS), they are critical for modeling behavior and managing water resources.

Littoral Zone: The nearshore area of a sea, lake or river that is close to the shore and influenced by wave action, tides, or water-level fluctuations. It serves as a critical ecological interface between aquatic and terrestrial environments.

Macrophyte: A large aquatic plant that grows in or near water bodies, playing critical roles in freshwater and marine ecosystems. They are categorized by growth form and serve as key indicators of water quality and ecosystem health.

Mesotrophic: Refers to a moderate level of biological productivity in water bodies, positioned between oligotrophic (low-nutrient) and eutrophic (high-nutrient) systems. It describes lakes, ponds, or other aquatic environments with balanced nutrient levels that sustain diverse plant and animal life without severe algal overgrowth or oxygen depletion.

Oligotrophic: Described aquatic ecosystems with low nutrient levels, particularly nitrogen and phosphorus, resulting in minimal plant/agal growth and high water clarity. These systems are characterized by their low biological productivity and pristine water quality.

ProcellaCOR EC: A selective systemic herbicide designed to manage invasive aquatic vegetation in freshwater systems. It targets specific submerged, floating, and emergent plants while minimizing harm to non-target species and ecosystems.

Renovate: A group of systemic aquatic herbicides used to control invasive and nuisance aquatic vegetation in freshwater systems. It targets broadleaf plants while sparing most grasses and monocots, making it a selective tool for managing weeds in ponds, lakes, and wetlands,

Secchi Disk: A device used to measure water clarity in lakes, rivers, and other water bodies by determining the depth at which sunlight penetrates. It serves as a critical tool for assessing water quality, particularly in relation to suspended particles and turbidity.

Soluble Phosphorus: Refers to phosphorus forms in water that pass through a 0.45-micron filter, primarily consisting of dissolved reactive phosphorus (DRP) and dissolved organic phosphorus (DOP). It is the most bioavailable form, directly influencing algal growth and eutrophication in water systems.

Subcatchments: Hydrologically defined land areas within a larger catchment that drain surface runoff to a specific point in a water system, such as a storm drain, pipe, stream, or another subcatchment. They are essential for modeling stormwater flow, managing drainage, and implementing water quality controls.

Total Coliform: Refers to a group of bacteria commonly found in the environment, including soil, vegetation, and the intestines of warm-blooded animals. While most total coliform bacteria are not harmful themselves, their presence in water serves as an indicator or potential contamination and possible health risks from pathogens.

Total Kjeldahl Nitrogen (TKN): A measurement of organic nitrogen and ammonia/ammonium in water, wastewater, soil, or organic materials. It does not include nitrate or nitrite nitrogen. TKN is critical for assessing nutrient loads, designing wastewater treatment processes, and monitoring environmental pollution.

Total Phosphorus: A measurement of all forms of phosphorus in a water sample, including dissolved and particulate phosphorus across organic and inorganic compounds. It is a critical parameter for assessing nutrient pollution and managing water quality to prevent eutrophication.

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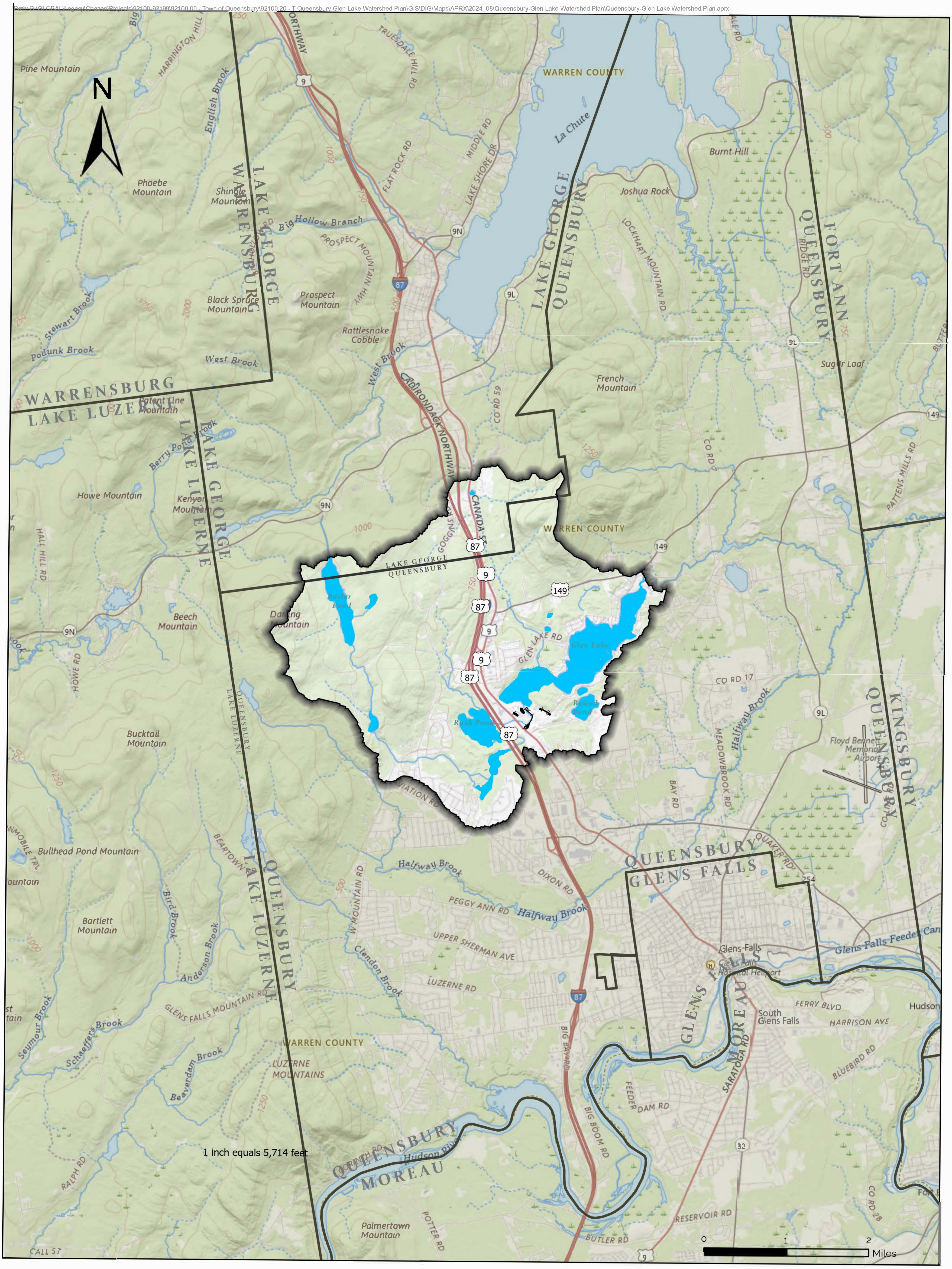
FIGURES



Map Key:

- Municipal Border
- Railroad
- Waterbody

Glen Lake Watershed Plan Location Map

Town of Queensbury
Warren County, NY

Figure 1

Map Creation Date: 08/22/2024

SOURCES:

Municipal Border: NYS GIS Clearinghouse, 2024;
Railroad: NYS GIS Clearinghouse, 2020;
Waterbody: Geofabrik, 2022;

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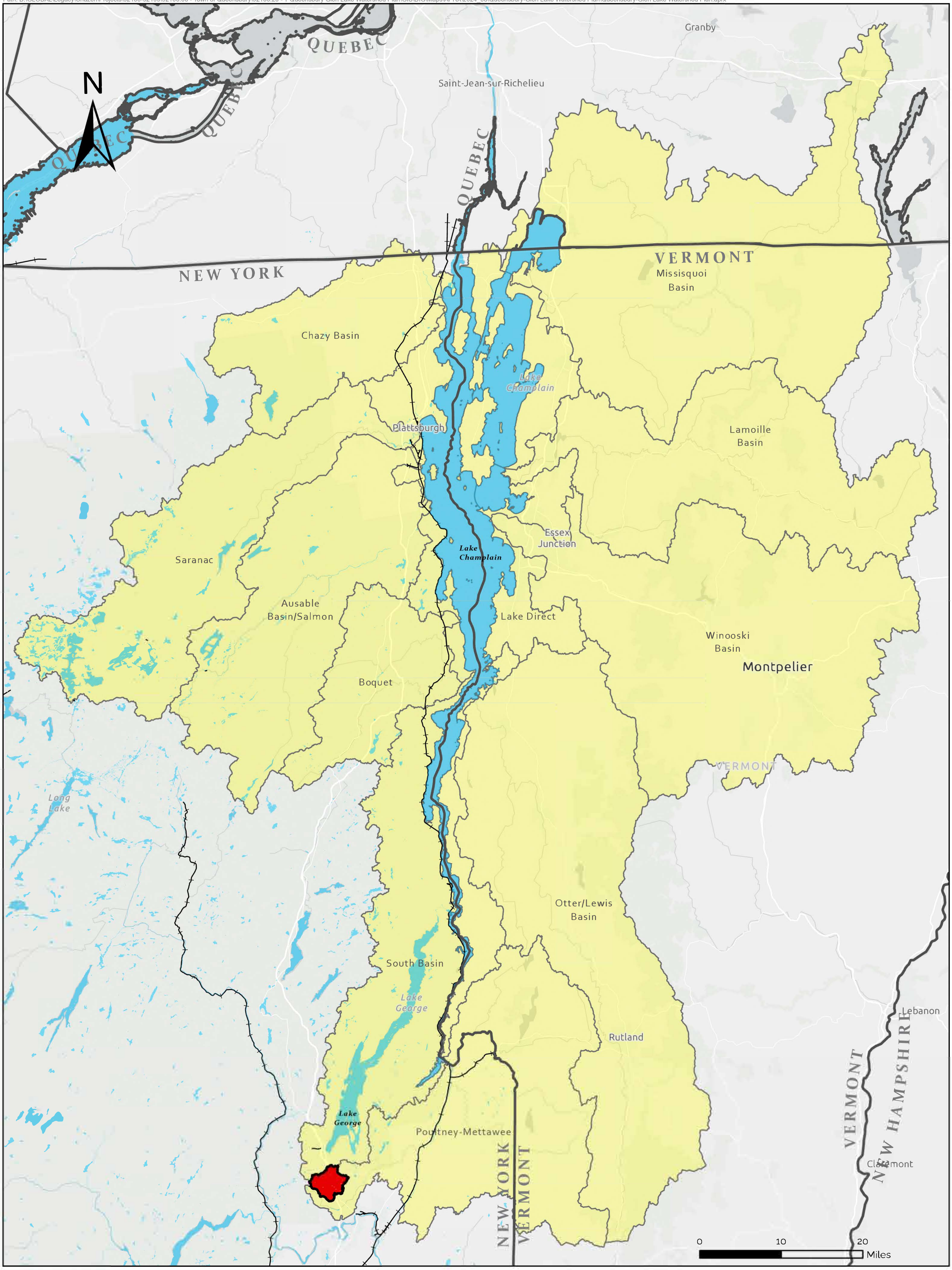

Map Key:

- Glen Lake Watershed
- Water Bodies
- Railroad
- Lake Champlain Watershed

Glen Lake Watershed Plan Glen Lake Watershed Regional Context Map

Town of Queensbury
Warren County, NY

Figure 2

Map Creation Date: 08/22/2024

SOURCES:

Glen Lake Watershed: USGS, 2023;
Lake Champlain Watershed: Lake Champlain Basin Atlas, 2013;
Municipal Border: NYS GIS Clearinghouse, 2024;
Railroad: NYS GIS Clearinghouse, 2020;
Waterbody: Geofabrik, 2022;

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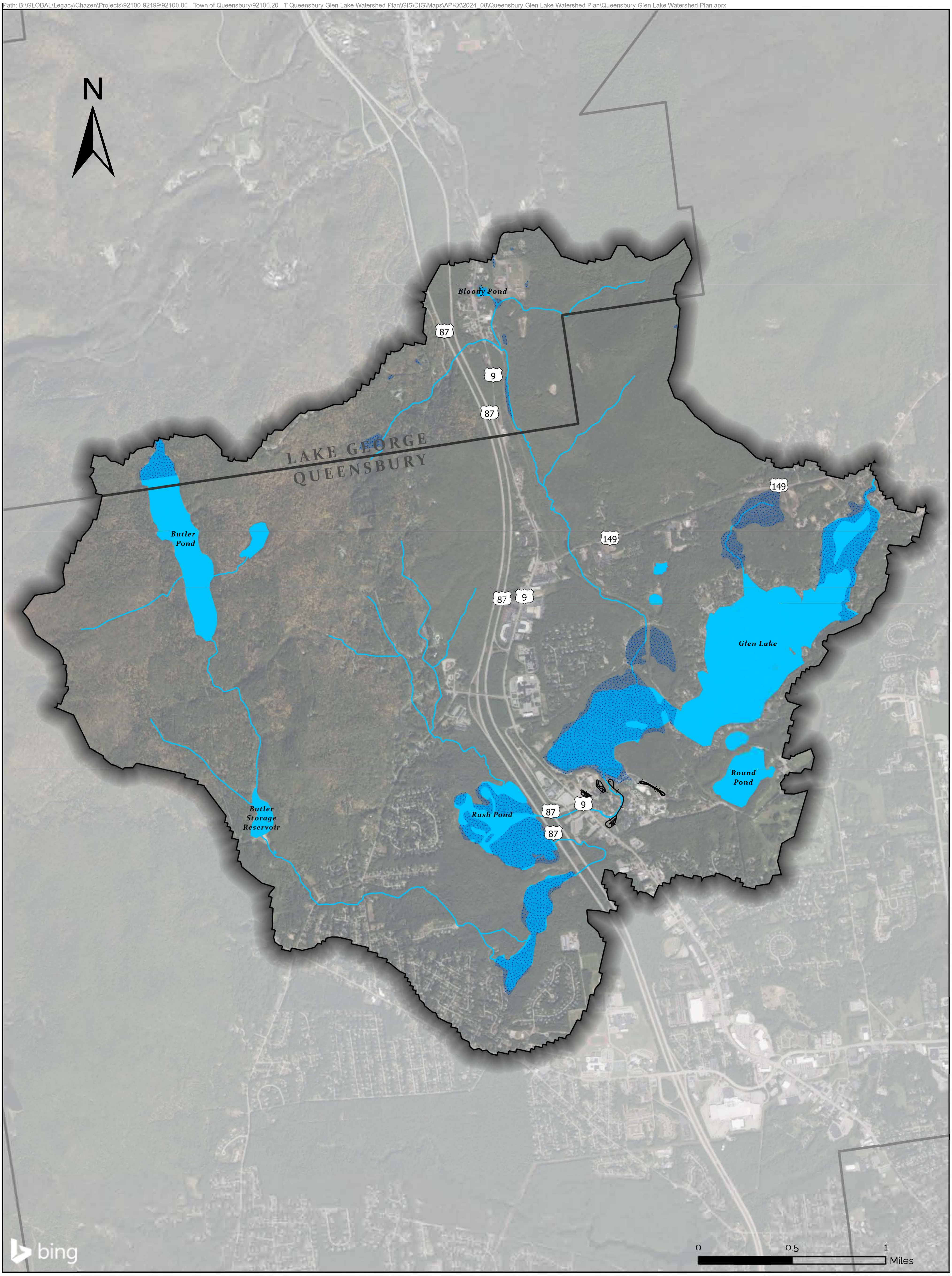

Map Key:

- Municipal Border
- Wetlands
- Railroad
- Streams
- Water Bodies

Glen Lake Watershed Plan Streams and Water Resources Map

Town of Queensbury
Warren County, NY

Figure 3

Map Creation Date: 08/22/2024

SOURCES:

Wetlands: DEC, 2024; NYS APA, 2016;
Streams: USGS, 2023;
Municipal Border: NYS GIS Clearinghouse, 2024;
Railroad: NYS GIS Clearinghouse, 2020;
Waterbody: Geofabrik, 2022;

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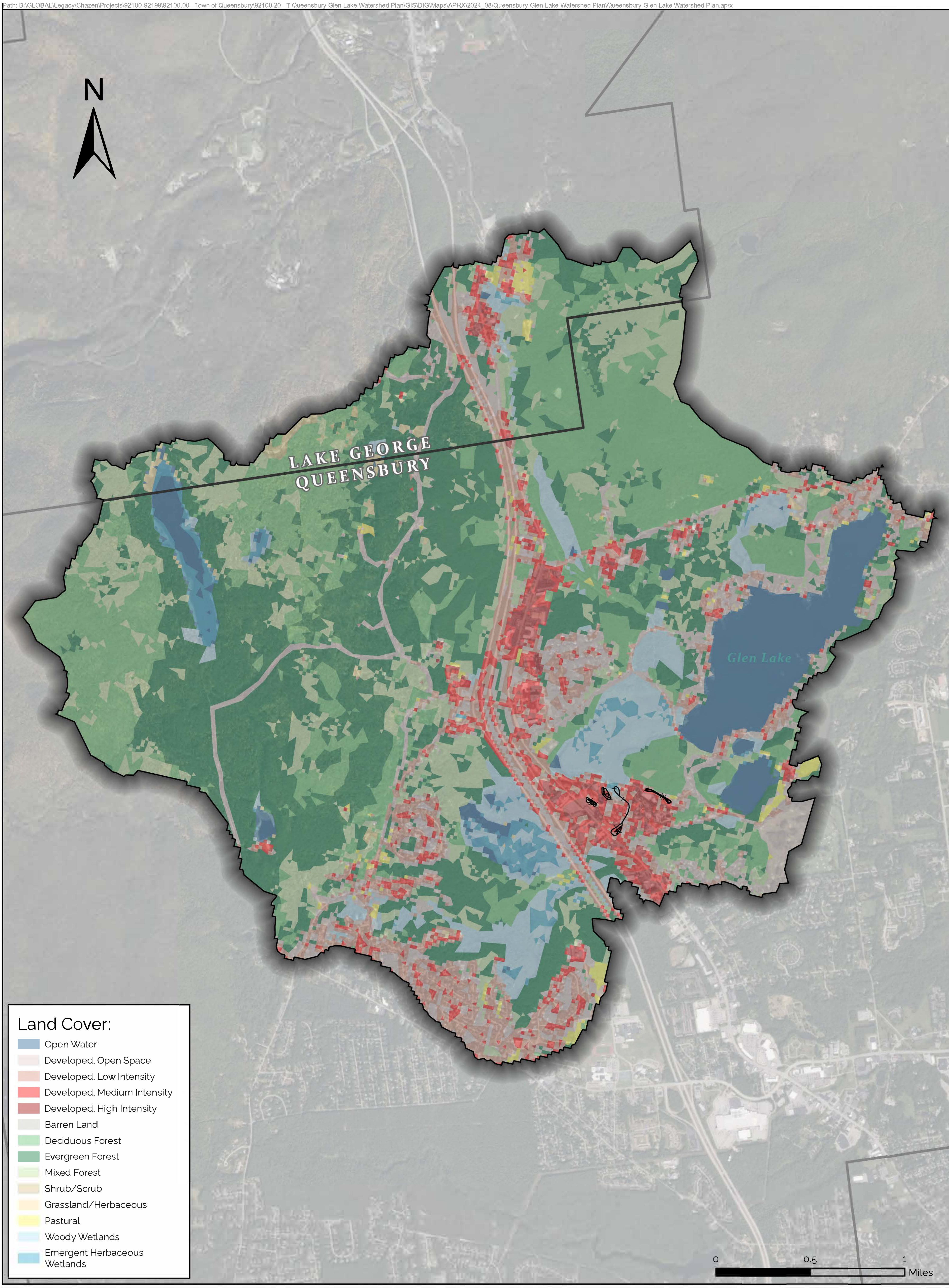

Map Key:
Municipal Border
Railroad

Glen Lake Watershed Plan Land Cover Map

Town of Queensbury
Warren County, NY

Figure 4

Map Creation Date: 08/22/2024

SOURCES:

Land Cover: USGS, 2021;
Municipal Border: NYS GIS Clearinghouse, 2024
Railroad: NYS GIS Clearinghouse, 2020;
Waterbody: Geofabrik, 2022;

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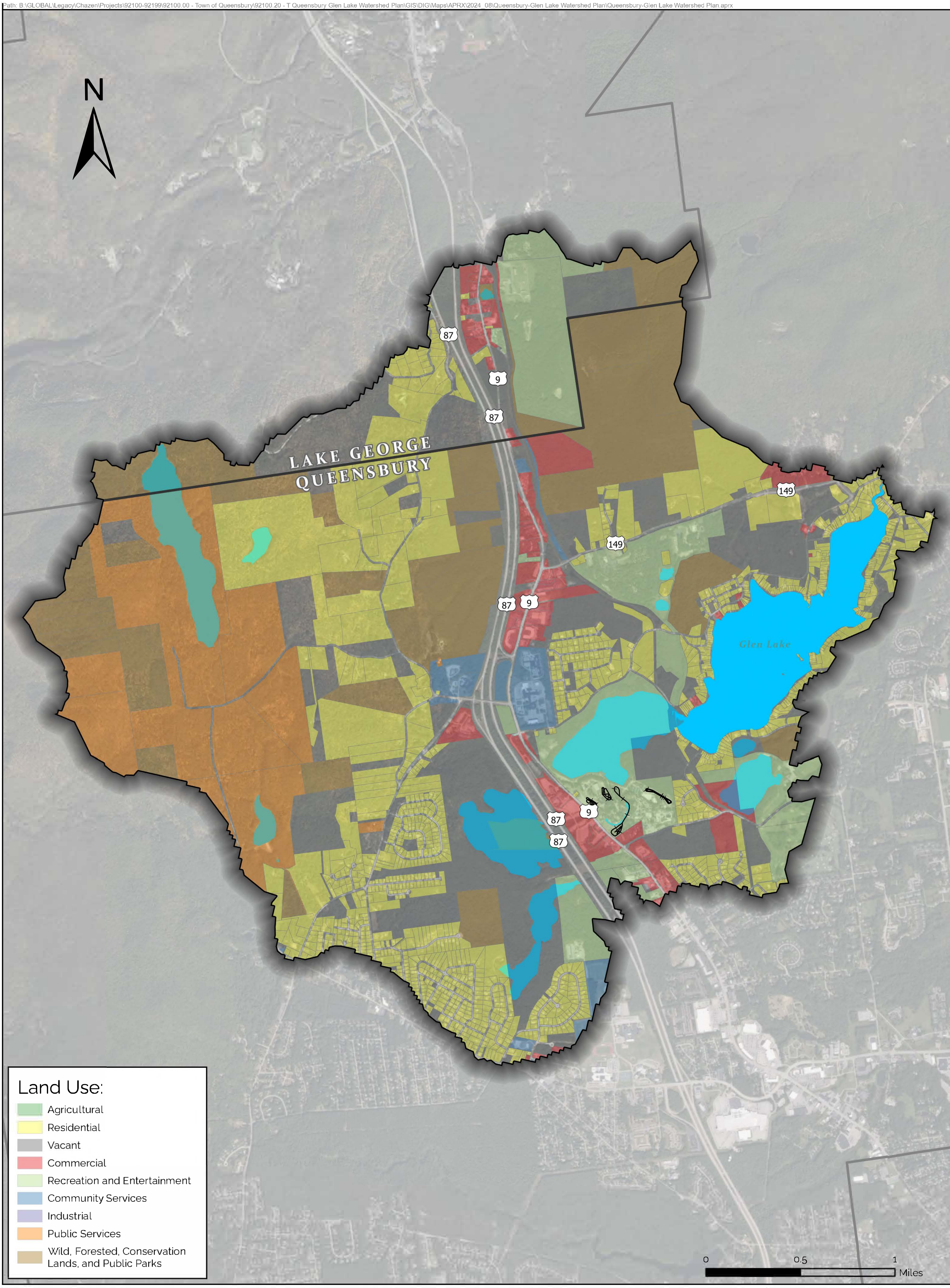


Map Key:
Municipal Border
Waterbody
Railroad

Glen Lake Watershed Plan Land Use Map

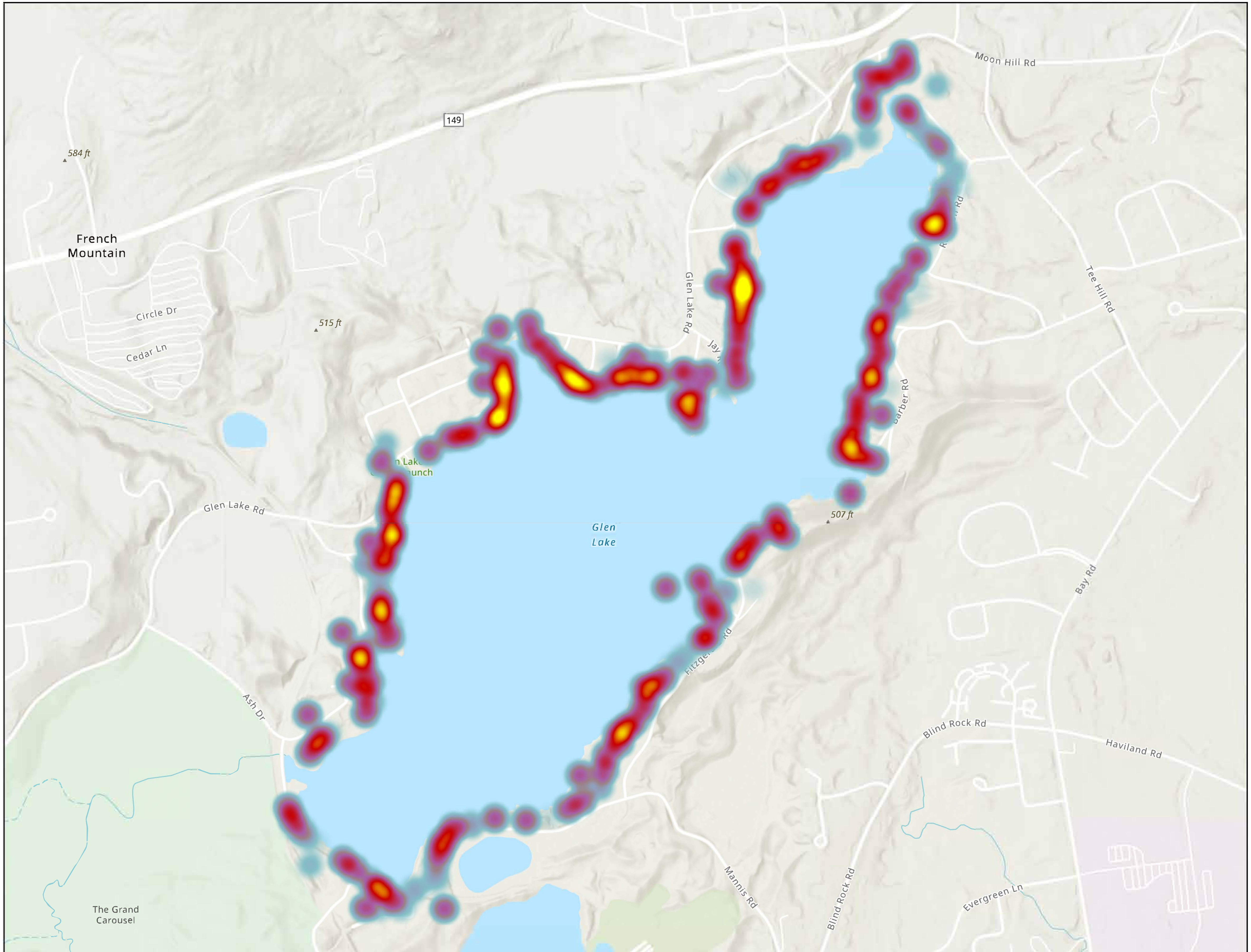
Town of Queensbury
Warren County, NY

Figure 5

Map Creation Date: 08/22/2024

SOURCES:

Land Use: Regrid, 2024;
Municipal Border: NYS GIS Clearinghouse, 2024;
Railroad: NYS GIS Clearinghouse, 2020;
Waterbody: Geofabrik, 2022;



Glen Lake Watershed Plan

Septic System Age

Glen Lake, NY

Figure 6A

Septic System Age
Newer
Older

Age (Years)	Number of Systems
<10	50
10 - 20	28
20 - 30	26
>30	166

N

0 500 1,000 Feet

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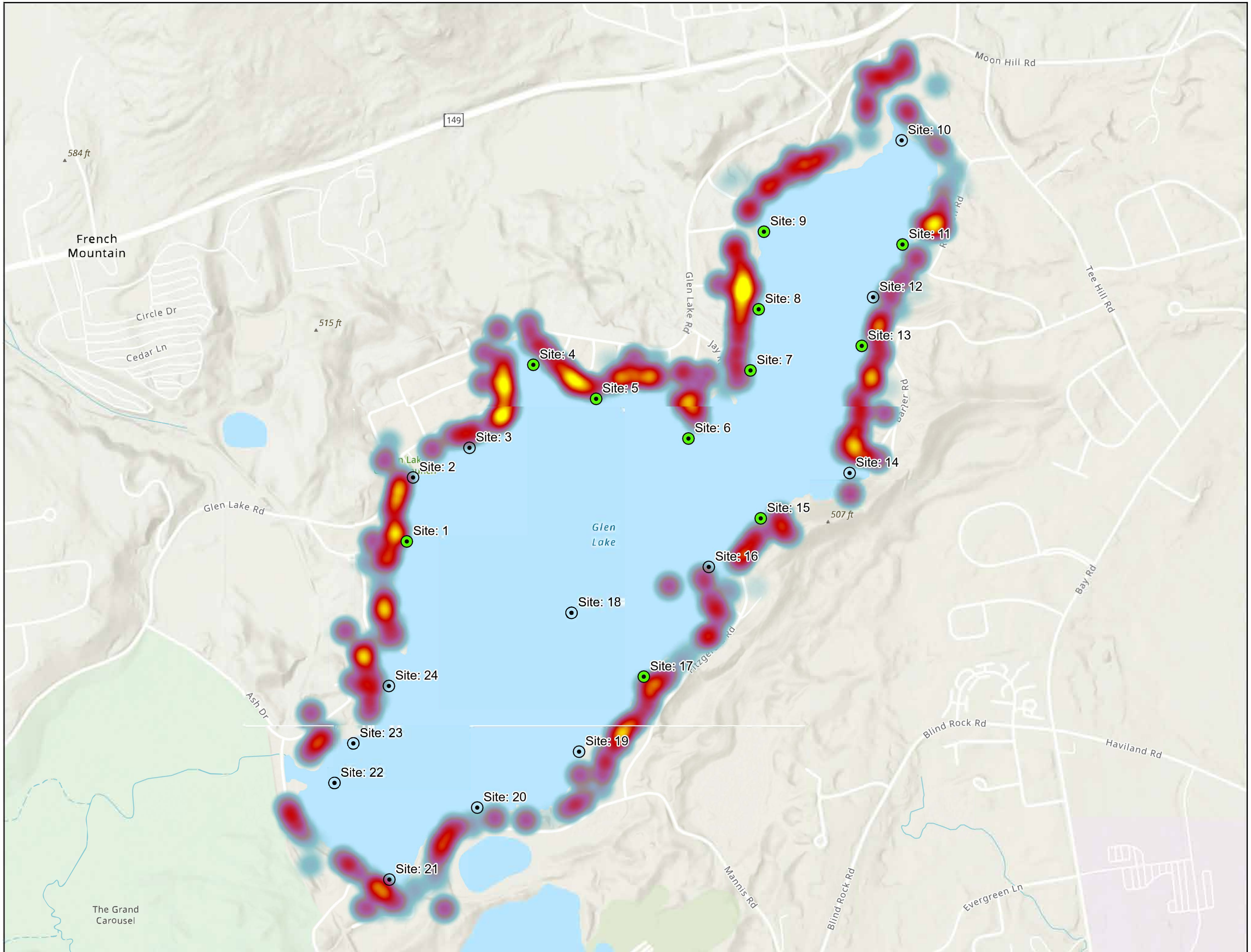

Glen Lake Watershed

Septic System Age

& NPS Detections

Glen Lake, NY

Figure 6B

Septic System Age

Newer

Older

NPS Positive

NPS Negative

Age (Years)	Number of Systems
<10	50
10 - 20	28
20 - 30	26
>30	166

N

0 500 1,000 Feet

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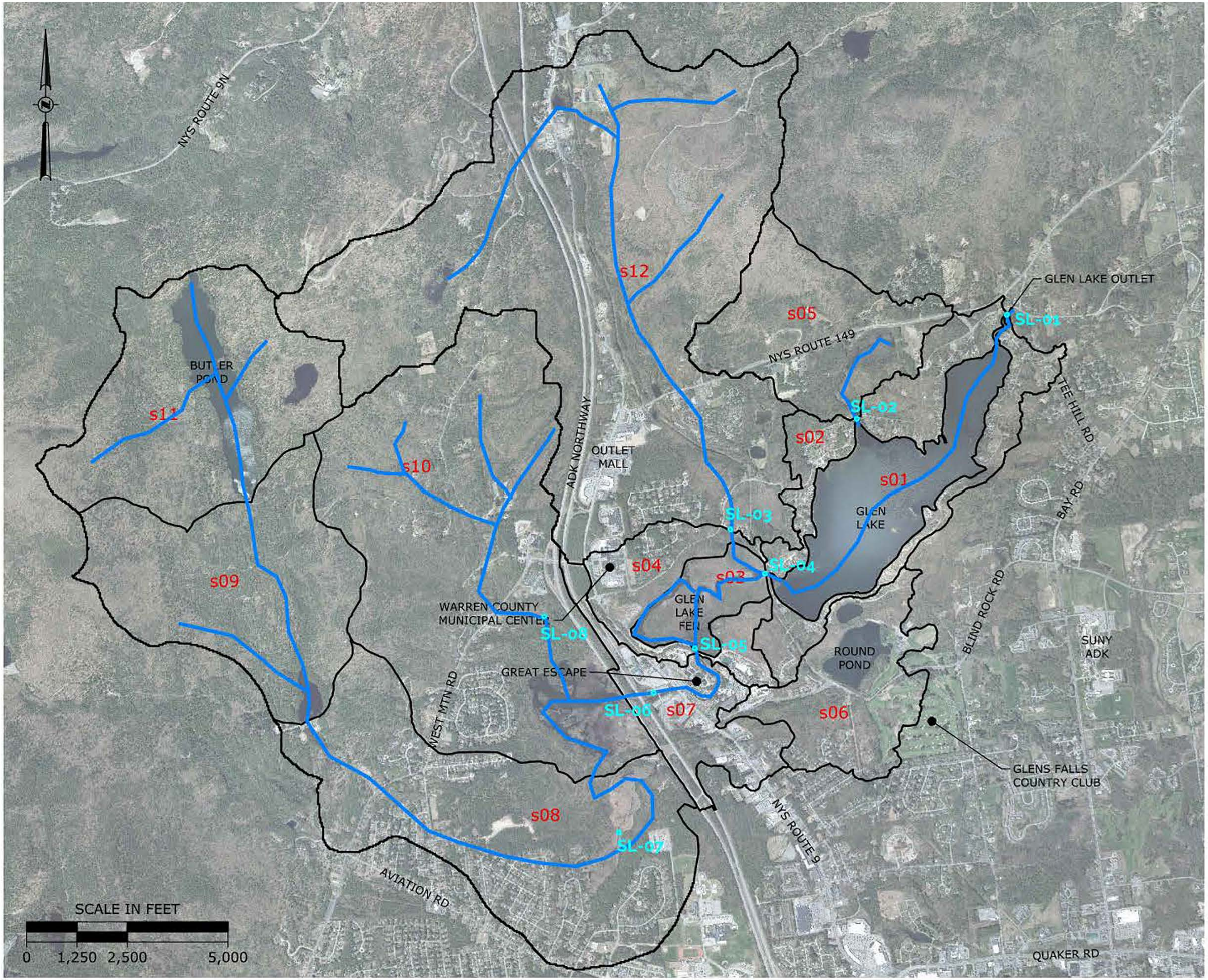

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LEGEND

(black line)	SUBCATCHMENT BOUNDARY
s01	SUBCATCHMENT NUMBER
(blue line)	HYDROGRAPHY LINES
(cyan circle)	SAMPLE LOCATIONS

GLEN LAKE WATERSHED PLAN

TOWN OF QUEENSBURY
WARREN COUNTY
NEW YORK

Figure 7

GLEN LAKE WATERSHED SUBCATCHMENT MAP

JUNE 2023

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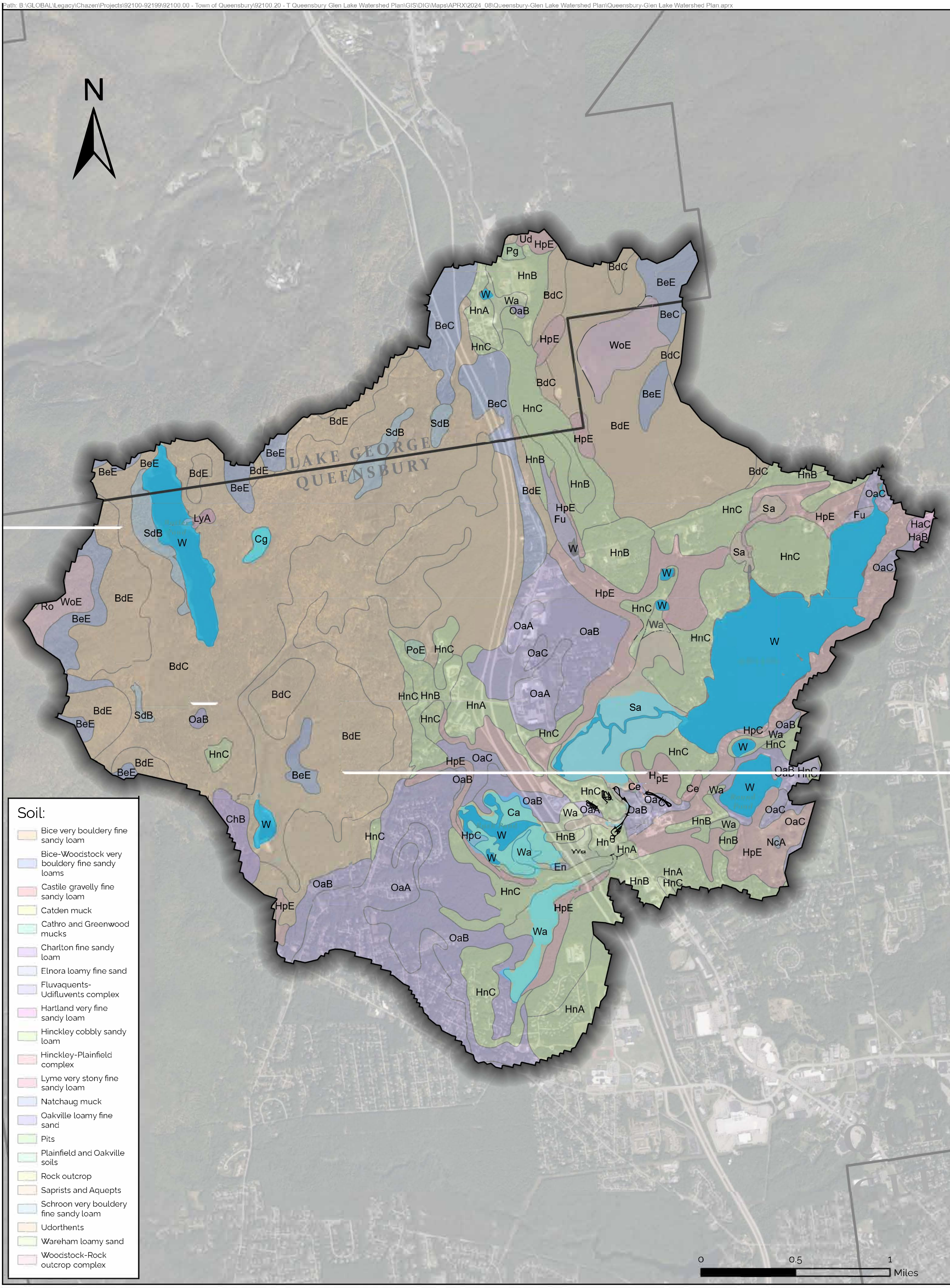

Map Key:

Municipal Border

Railroad

Waterbody

Glen Lake Watershed Plan
Soils Map

Town of Queensbury
Warren County, NY

Map Creation Date: 08/22/2024

Figure 8

SOURCES:

Soils: USGS SSURGO, 2023;
Municipal Border: NYS GIS Clearinghouse, 2024;
Railroad: NYS GIS Clearinghouse, 2020;
Waterbody: Geofabrik, 2022;

APPENDICES

Appendix A:

Map Plan and Report, Aquatic Control District, August 2, 2011

Appendix B:

NYSDEC Freshwater Wetlands Permit

Appendix C.

Ready Scout – Glen Lake 2024 Aquatic Plant Survey Report

Appendix D:

ADK Research Invasives – Report/Map

Appendix E:

Glen Lake User Survey

Appendix F:

Glen Lake Septic Survey

Appendix G:

Glen Lake 2023 CSLAP Report Card

Appendix H:

Detection of Septic Derived Non-Point Source Pollution in Residential Lakes

Appendix I:

Water Quality Sampling Locations

Appendix J:

PACE Water Quality Testing Results

Appendix I-Water Quality Sampling Locations

SL-01: Glen Lake outlet brook Sample taken from Glen Lake outlet brook (unnamed tributary to Halfway Creek), taken immediately upstream of the Tee Hill Road Bridge/Culvert.	
SL-02: St Mary's Bay inlet brook Just upstream of Glen Lake Rd culvert. Drains south side of French Mountain (Subcatchment 05)	
SL-03: Rocky Brook Sample taken from the stream crossing under Ash Drive, Drains all of Subcatchment 12 including Goggins Rd beaver dam, west side of French Mountain and area beside Warren County Bike Trail.	

SL-04: Glen Lake Fen outlet/ Glen Lake inlet brook Sample collected from the Western inlet into Glen Lake, from the western perimeter of the Fen. Down stream from Bike Trail bridge. Collects all subcatchments from the north and west into Glen Lake.	
SL-05: Great Escape outlet brook Sample taken from an unnamed tributary to Glen Lake Downstream from culvert exiting Great Escape property. Captures all of Rush Pond (SL 06) and any runoff from the Park..	
SL-06: Rush Pond outlet brook Sample taken from an unnamed tributary to Glen Lake as it enters the Great Escape property, Down stream from western bridge in Great Escape parking lot. Captures subcatchments 8,9,10 and 11.	

SL-07: Rush Pond Way trail, southernmost bridge Downstream from bridge in large wetland located south of the Rush Pond. This wetland is fed by a brook originating in Butler Pond near Buckbee Rd. Captures subcatchments 11,9 and most of the western side of 8.	
SL-08: West Mtn Rd/ Schermerhorn Apartments Brook Sample taken from an unnamed stream Down stream from West Mtn Rd culvert. Captures northern 2/3 of subcatchment 10. Many small streams flowing down beside Gurney Lane..	