White Paper

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Onsite Wastewater Management – Critical Issues for Lake George

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EXECUTIVE SUMMARY

The NYS Department of Environmental Conservation (DEC) classification of Lake George as Class AA-Special is to be assiduously preserved. The NYS DEC narrative standard for protection is scientifically insightful for a lake like Lake George:

> "These waters shall contain no phosphorus and nitrogen in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages."

Regrettably, this AA-Special classification has been compromised by a 60% increase in ortho - phosphorus over the past 37 years. The recognition of the magnitude and scientific significance of this increase may be underestimated by the NYS DEC, Department of Health (DOH) and the Lake George Park Commission (LGPC). The significant decline in Lake George water quality merits our attention, understanding, and needs to drive policy.

To date, the regulatory response to these water quality changes has been inadequate. Sources including wastewater, stormwater and stream corridors are not afforded regulatory protections commensurate with the preservation of Lake George's Class AA-special status. Lake protection policies, standards and regulations are assessed in this white paper to better understand the link between observed changes in water quality and protection limits.

In 1999, the LGPC commissioned Stearns and Wheler (2001) to prepare a total phosphorus loading budget for Lake George to estimate the contribution of total phosphorus from point and non-point sources. The amount of nutrients from these sources that are released into the lake are primary determinants of water quality. The non-peer reviewed report has been relied upon for over 20 years for policy decisions.

Questions were raised by this author and others when the report was released, including the Lake George Park Commission. Stearns and Wheler never fully addressed the questions raised – such as the adequacy of the database, data gaps, and how the contribution from septic systems was determined. The validity of the report is evaluated in this white paper. Based on its shortcomings, misrepresentations and unsupported assumptions, the report is considered flawed.

More importantly, for twenty years policy and regulations may have been influenced by the report. The consequences of this reliance are potentially significant. For example, recent

revisions to stormwater and stream corridor regulations may have been based on the report's conclusions as indicated in the LGPC response to public comments thus reducing the regulations' effectiveness in protecting Lake George.

Significant changes in water quality changes in Lake George also include a 42% increase in chlorophyll *a* and tripling of chloride levels. To prevent or reduce any further decline in Lake George water quality the following steps are recommended:

1. Develop and implement a wastewater management plan with policies, regulations and design criteria similar to those already afforded to the New York City Watershed.

2. Update other non-point source water regulations including stormwater and stream corridors, with the goal of protection rather than merely slowing down the decline of water quality.

3. Implement measures to achieve NYS Department of Environmental Conservation's narrative standard for protection. This includes developing a quantitative Antidegradation Plan. Serious consideration should be given to including Lake George on the Clean Water Act 303(d) list for impairment due to the increasing number of algal blooms.

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INTRODUCTION

The purpose of this white paper is to initiate a discussion on critical issues for consideration by the Lake George Park Commission (LGPC) and other stakeholders in order to develop wastewater regulations for the Lake George Park, which are required under Article 43-0110 of the Consolidated Laws of New York. Watershed regulations for septic system management have been vacant (unwritten) since that law was enacted in 1987. It is essential to reduce the nutrient loading of phosphorus and nitrogenous compounds from all non-point sources, including wastewater and to lessen the potential for further eutrophication of Lake George. Support for wastewater management comes from many sources, including the Governors' Harmful Algal Bloom Plan for Lake George, NYS Department of State Task Force for the Future of Lake George, NYS Department of Environmental Conservation, local officials, environmental and business groups.

The classification of Lake George as Class AA-Special is to be assiduously preserved. The NYS DEC narrative standard for protection is scientifically insightful for a lake like Lake George:

> "These waters shall contain no phosphorus and nitrogen in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages."

Regrettably, this AA-Special classification has been compromised by a 60% increase in ortho - phosphorus over the past 37 years. The recognition of the magnitude and scientific significance of this increase may be underestimated by the NYS DEC, NYS Department of Health (DOH), the LGPC and others. The significant decline in Lake George water quality merits our attention, understanding, and need, to drive policy.

The changes in Lake George water quality are limnologically dramatic and indicate significant decline in water quality. Sources including wastewater, stormwater and stream corridors should be afforded regulatory protections commensurate with the preservation of the Class AA-Special status. Declines in water quality are difficult and costly to reverse.

In 1999, the LGPC commissioned Stearns and Wheler (2001) to prepare a total phosphorus loading budget for Lake George to estimate the contribution of total phosphorus from point and non-point sources. The non-peer-reviewed report and its conclusions raised questions when it was released that are even more important today. The validity of the report is objectively evaluated in this white paper. This white paper analyzes the report from a scientific perspective to identify its weaknesses and associated risks in relying on it for lake management purposes. Details related particularly to groundwater nutrient loading and the contribution of wastewater effluent are discussed. Based on its shortcomings, misrepresentations and unsupported assumptions, reliance on the report and its conclusions is not recommended.

This white paper also assesses current regulations and policies and their ability to protect Lake George in regard to public health and water quality. Effective policy formation begins with a scientific understanding of all components of the lake system. This is often achieved with quantitative analysis of lake and watershed dynamics, both internal and external. An

Antidegradation Plan such as a Nine Element Plan would be a valuable step for Lake George to accurately and quantitatively assess nutrient contributions from non-point and point sources.

A. BACKGROUND

1. Need For a Lake George Park Wastewater Management Program

The need for a basin-wide wastewater management program for the Lake George Park has been identified by NYS agencies, local officials, various task forces, watershed coalitions, NGO's, surveys and initiatives since the 1980s.

a. NYS Department of Environmental Conservation (DEC) regulates nutrients in Class AA-Special waters as follows: *"These waters shall contain no phosphorus or nitrogen in amounts that result in the growth of algae, weeds and slimes that will impair the waters for their best usage."* **The NYS DEC specifies inadequate onsite septic systems as a source of nutrient enrichment and eutrophication to lakes and streams.**

b. The 2018 *Harmful Algal Bloom Action Plan for Lake George* considered septic inspection programs as necessary for water quality. It therefore lists, as priority one, the implementation of an inspection and maintenance program for near-shore septic systems within three years.

c. Over 60 members of the Department of State *Task Force for the Future of the Lake George Park* stated in their report of July 1985: "There are serious problems, which if left uncorrected, will ensure the demise of Lake George as we, and those generations who came before us, have known it." The Task Force agreed that there was a direct relationship between the discharge of domestic wastewater and the degradation of water quality. Therefore, "Lake George must be managed to sustain it as a source of drinking water." Toward this end, performance standards for the lake were recommended – including for dissolved oxygen, secchi depth and total phosphorus. Their main recommendation was for a regular and continuing program of sanitary surveys for the Lake George Park. The program should consist of door-to-door interviews of property owners and direct inspection of wastewater treatment systems every five years.

d. The Lake George Watershed Conference, in a report, *Status of Accomplishments and Future Priorities* (NYS Department of State, 2006) stated, "runoff from intensively developed areas and inadequate septic systems have been identified as threats to the lake's water quality." They believed that wastewater treatment had long been a challenge to lake water quality and that failing or improperly maintained onsite wastewater treatment systems were particular threats. They called for an inventory of wastewater treatment systems within the watershed, the implementation of wastewater regulations and the establishment of a program for septic inspections.

e. The *Lake George Watershed Atlas* 2016 estimated that over 9,000 people live in the watershed area and that there are nearly 6,000 onsite wastewater treatment systems (OWTS).

f. The *Town of Lake George Septic Initiative Program* (Navitsky, 2018) stated that the excessive algae growth has been used to identify inadequately functioning septic systems. The report recommended a septic inspection and inventory program. Of the 397 OWTS investigated, at least 33% were more than 30 years old, 39% were newer than 30 years and 28% had no information, 20% of the OWTS were undersized and 50% had no record of maintenance.

g. The FUND for Lake George also cited studies showing a 60% increase in orthophosphate, a 46% increase in chlorophyll-a and a tripling of chloride levels, related to anthropogenic point and non-point sources.

h. The Assembly Point Water Quality Coalition report, written with a grant from the Lake Champlain Basin Program (Collins and Ruffing, 2018), monitored 26 nearshore sites of algal blooms with algal species associated with organic pollution (wastewater).

i. A harmful algal bloom (HAB) was reported on November 7**,** 2020, off of Assembly Point. HABs were also detected in other parts of Harris Bay, Sandy Bay and Warner Bay, as well as near-shore waters off of Lake George Village. Bolton Landing detected a HAB a week earlier. It is likely that the HAB extended over 10 miles and can be described as significant. Additional HAB events was recorded in August 2021 and October 2021. Both non-point and point sources contribute to nutrient loads that feed algal blooms.

In summary, the need for a wastewater management program is a conclusion reached by numerous groups and supported by water quality monitoring results. Recent HABs make wastewater, storm runoff and stream corridor management essential.

2. Prior Efforts to Implement a Wastewater Program

The LGPC was empowered by Environmental Conservation Laws §43-0110 and §17-1709 in 1987 to adopt rules and regulations for the collection, treatment and discharge of wastewater within the Lake George Park. Preliminary regulations were drafted during 1989-1990, and the implementation of revised regulations began in 1991. A lawsuit was brought and overturned the regulations. The Supreme Court ruled in 1994 that the LGPC had not properly followed the SEQRA procedures. It declared that the regulations were null and void and enjoined their enforcement until after the preparation of an Environmental Impact Statement (EIS). By this time, the Commission had conducted over 800 inspections. The Commission decided not to undertake an EIS and dropped the septic inspection program. Thus, this program ended due to the technicality of not preparing an EIS.

Various groups around the Lake have been concerned with declining water quality. The Assembly Point Water Quality Coalition (APWQC) examined the Town of Queensbury's septic system data base. It found that the Town had septic system information for only 29% of the inhabited parcels on Assembly Point; furthermore, it lacked complete information on their type, age and location. It was believed that the majority of systems were installed before 1985. When the APWQC Board of Directors reviewed this report, they decided to make lakewide septic inspections a priority. The Lake Stewardship Group of Cleverdale and the Hague Water Quality Awareness Committee were also concerned with septic system issues. The three groups and others agreed that a town or county septic inspection program would not protect the Lake. The most effective program should be basin-wide and implemented by a state agency.

On December 4, 2020, the Assembly Point Water Quality Coalition, Lake Stewardship Group of Cleverdale and Hague Water Quality Awareness Committee, with the support of the Lake George Village Mayor, five Town Supervisors and other groups such as the Lake George Association, Lake George Land Conservancy, Protect the Adirondacks!, Adirondack Council, Huletts Landing Water Quality Committee and the Dunhams Bay Waste Water Disposal District, wrote to Governor Cuomo to lay out their concerns. They presented data from the Town of Queensbury's inspection program, which found that 60-80% of systems inspected failed inspection to various degrees. With nearly 6,000 on-site wastewater treatment systems in the Lake George Park, the problem of potential pollution could be significant. The Governor's response came from the LGPC, which has the legislative authority to conduct septic inspections. The Commission cited the Stearns and Wheler (2001) non-peer-reviewed study, which claims that septic pollution had zero impact on water quality. Hence, it has become necessary to comprehensively review the methodology and conclusions of this report.

As a result, the groups provided the Lake George Park Commissioners with information about the problems revealed during septic inspections in the Town of Queensbury and other towns, including the costs of repair. The Commissioners were also told by Dave Hatin (Town of Queensbury, Director of Building and Codes) that there was no pushback from residents to the inspections or to repairing their systems. Residents believed that action was necessary to protect their drinking water and water quality.

Because the LGPC operates on a limited budget and with limited staffing, meeting all its jurisdictional responsibilities is a difficult task. Their agenda until January 2021 focused on the passage of the revised stormwater regulations and the new stream corridor regulations. However, the groups and local officials felt that since these mandates had now been at least partially addressed, the LGPC should now begin to focus on concerns over drinking water and water quality. The group also engaged with the NYS DEC in an effort to prompt the agency to develop a Nine Element Watershed Management Plan – an anti-degradation plan that has never been undertaken for Lake George.

B. ROLE OF SCIENTIFIC REVIEW IN POLICY FORMATION

The non-peer-reviewed report prepared by Stearns and Wheler (2001) for the LGPC has generated many questions over the years, by this author and those from the LGPC in 2003. Issues raised include the validity of the field study assumptions used to reach their conclusions. The report has been cited multiple times by the LGPC in reference to key policy decisions. For example, the LGPC cited the report in both stormwater presentations and in response to public comment letters on the proposed stormwater and stream corridor regulations in 2021. These citations signal a reliance on the report that may have far-reaching impacts on management decisions and the water quality of Lake George.

To better understand the potential risks associated with relying on the report and its conclusions, an objective scientific review was undertaken. Objectivity is dependent on a thorough review of data inputs, scientific knowledge of the biological, chemical and physical processes involved and full understanding of the sensitivity of the models involved.

Stearns and Wheler's effort to estimate a total phosphorus budget for Lake George included limited field studies and largely relied on prior investigators' hydrologic models and assumptions. This white paper quotes the report, when necessary, to fully disclose the level of reliability and extent of assumptions. Given the potential impact on policy and water quality, it was essential to validate the field study's design, methodology, findings, data interpretation and analysis, hydrologic assumptions and conclusions. All reports cited by Stearns and Wheler were compiled and reviewed in the process.

In an effort to locate important information missing from the report, the consulting firm Stearns and Wheler was contacted, and a referral was made to another consulting firm, Ecologic, which reportedly worked on the report. On March 2021, the president of Ecologic said she did not have much involvement in the report and had left Stearns and Wheler in 1999. As a result, no opportunity to directly address issues of concern was provided.

C. REVIEW OF STEARNS AND WHELER 2001 REPORT

1. Field Study

A field study was conducted to measure downgradient seepage plumes, from a septic tank effluent to the shoreline of Lake George in order to provide data on phosphorus migration and contribution to the total phosphorus loading budget. The field study was limited in time and scope. Site selection, methodology, scale of study and assumptions are evaluated.

A total of four sites were selected on shallow slopes all in the northern basin of Lake George as representative of the entire lake watershed. The sites were monitored monthly from July to October (four months) and in January 1999 for total phosphorus and other analytes. Samples were taken twice in 2000 for dissolved phosphorus and pH.

The authors claim that the selected sites represent an "overall representative scenario" while ignoring the possible performance characteristics of the soil. And, at the same time, they claim that they represent the most common soil types "whatever they may be."

In review, it is implausible that four sites, all located in the northern basin, could be considered a "representative scenario." The supposition that the sites are "blind to possible performance" indicates that the selection was random, which is highly questionable. To state that there are "relatively few poor performance soil types" in the Lake George watershed is incorrect. The Natural Resources Conservation Service (NRCS) data for the watershed soil types does not support this conclusion. NRCS soil maps in the watershed include for example, very poorly drained soils, excessively drained soils and steep slopes. Town permit applications and site testing will confirm the high variability and often poor performance of the soils.

2. Data Analysis and Interpretation

Data analysis and interpretation are reviewed to better understand how the authors reached their final total phosphorus-loading budget, given the limited information available. The field study was expected to show a decrease in total phosphorus in the effluent plume from the septic system to the lake. Instead, the results showed highly fluctuating levels of total phosphorus in the plume with no conclusive trend downward. The data showed that the septic systems were releasing phosphate into the lake at the four study sites. Stearns and Wheler interpreted the highly fluctuating levels of total phosphorus in the plume to the lake as ambiguous. This led the investigators to reconsider the dataset analysis and interpretation. The investigators pooled the dissolved phosphorus data from all sites, which is uncharacteristic of plume studies, and drew a relationship to pH. This led to the assumption that the phosphorus was tightly bound to the soils even though it was not observed with dissolved phosphorus or total phosphorus. Pooling the data can lead to misinterpretations with the dynamics of plume migration. It would be difficult to draw conclusions based on this information. The fluctuations in the dataset may instead have been related to phosphorus migration.

3. Questions Raised by The Report

When the report was released, several people, including this author, questioned its findings, analytical methods and assumptions. In fact, in 2003 Tom Wardell an engineer with the Lake George Park Commission at the time, wrote a comment letter to Stearns and Wheler requesting additional information. They included:

- What are the causes of major differences in loadings from prior nutrient budgets?
- How do loading rates compare with other authors?
- Is the existing database adequate?
- What are recommendations to fill the “data gaps”?
- How was the contribution of septic systems to the loading budget determined?
- Was total phosphorus or dissolved phosphorus used to prepare the final budget?
- Explain the differences in analytical techniques (total phosphorus and dissolved phosphorus) used by the investigators?

Response to these question by Stearns and Wheler is examined in more detail, as they play a large role in how the authors reach the final Total Phosphorus Loading Budget.

a. Loading Rate Differences

Stearns and Wheler’s response to the major differences in loading rate estimates from those of other authors is compelling and drive the need for a detailed analysis of the Total Phosphorus Loading Budget. The reasons for the differences include:

- Data availability over time,
- Whether or not direct field measurements were made,
- Differences field measurement strategies and techniques;
- Changes in land use over 30 years of multiple studies;
- Changes in understanding of phosphorus cycling over 30 years of study;
- Different underlying assumptions regarding the hydrologic cycle and solute transport.

They conclude that "Various credible combinations of assumptions, estimates, and measurements introduce a degree of variability in the process that generally defies easy explanation." This statement is difficult to understand. Despite the substantial differences in the budget estimates for the 13 reports cited, they claimed their budget to be consistent with the majority of previous investigators. In review, any similarities in the findings are more likely related to the overlap and commonality in the multiple assumptions used in these reports.

b. Adequacy Of Database and "Data Gaps"

Field data was collected from July to October in 1999 and in January 2000; samples were collected in June and Sept in 2000, but only for dissolved phosphorus and pH leaving a significant "data gap" and incomplete annual dataset. The investigators recognized the small sample size of the study, but assumed that the groundwater contribution was insignificant. They also asserted that there would be no value in more widespread groundwater monitoring or sampling program to fill the gap.

When asked if the investigators relied on total phosphorus or dissolved phosphorus in the budget estimate, they claimed to rely on total phosphorus estimates of groundwater loading because it was a more complete dataset. However, this is not what was presented in the report.

c. Contribution of Septic Systems

The contribution of septic systems to the Final Total Phosphorus Loading Budget is one of the hallmarks of the study and important for lake management purposes. The credibility of how this was determined is critical to our level of confidence in the conclusions reached in the report.

The site-specific data from the septic phosphorus plume was intended to be used to estimate the phosphorus export coefficient for septic effluent. However, the investigators did not expect to observe a phosphorus plume that was highly variable and releasing phosphate into groundwater at the four study sites.

This is complicated by the fact that the investigators specified that they relied on total phosphorus estimates of groundwater loading because it was a more complete dataset. This is difficult to understand because they indicated that total phosphorus sampling was changed during the study. After an unknown number of sampling rounds, they decided to filter total phosphorus samples to determine if turbidity might be the cause of the high variability in the total phosphorus data. They claimed that sample turbidity created a "bias" which interfered with "data interpretation." Filtering out the observed turbidity is unusual as phosphorus associated with particulate matter is significant to the total phosphorus measurements and such filtering created uncertainty in the dataset.

The authors' estimate for the septic loading budget is based on the assumption or "notion" that even low levels of carbonate minerals in soils can produce saturated levels of calcium and control the solubility of phosphate at the selected site, probably with the formation of hydroxyapatite. From this they made the following unsupported assumptions:

- Most of the soil in the watershed, regardless of soil type, was saturated with calcium.

- The near-shore area of Lake George as a whole is likely to be saturated and that sandier soils are near saturation with respect to calcium carbonate.

- Dissolved phosphorus would be tightly bound in the watershed a*s* hydroxyapatite precipitation that minimize phosphorus mobility even though field studies showed dissolved phosphorus with as high a degree of variability as total phosphorus.

- Total phosphorus would be tightly bound in the watershed.

The current understanding of phosphate reactivity in the literature is complex (Robertson 1995, Robertson 2020, Lombardo 2006, Zanini 1998). The migration of phosphorus in soils is the subject of numerous reports and ongoing studies. Robertson (2007) explains that, "The mobility of phosphorus in septic system plumes remains a topic of debate because of the considerable reactivity of this constituent. Septic system plumes in Ontario were monitored over a 16-year period in detail that clearly showed the advancing frontal portion of the phosphorus plume. This monitoring record provided insight into the extent of secondary phosphorus attenuation in the ground water zone beyond that available from previous studies." Phosphorus attenuation refers to the reduction in phosphorus concentration in water and soil through chemical and biological processes. Robertson explains that mechanisms of sorbed phosphorus into insoluble metal phosphate minerals such as hydroxyapatite were inactive and that phosphorus in some ground water plumes can remain mobile and persist for decades. This would have important implications for septic systems located in lakeshore environments when long-term usage scenarios are prevalent.

Robertson et al. (2019) long-term study of 24 systems offers a different view from Stearns and Wheler. They conclude that calcareous soils provide fewer opportunities for phosphorus removal than do non-calcareous soils and are dependent on hydraulic conditions. Non-calcareous soils have low levels of $CaCO_3$, generally have lower pH values and more availability of iron and aluminum to precipitate with phosphate. Thus, the most complete removal of phosphorus under septic systems occurs in non-calcareous soils.

It has been suggested that much larger setback distances between septic drainage fields and surface water bodies may be one way of increasing the potential for phosphorus adsorption to soil surfaces. For some sensitive lakes already considered to be "at capacity" for phosphorus loading, a distance of no less than 300 meters is recommended (Robertson 2008). Some factors that may contribute to increased phosphorus concentration in groundwater include (1) high hydraulic loading rate of wastewater, (2) uneven distribution of wastewater in the drainage field, or (3) lack of a clogging zone in the drain field.

4. Total Phosphorus Loading Budget

The NYS Department of Environmental Conservation report by Bloomfield et al (1986) characterizes the validity of prior nutrient budgets as follows, “Several investigators have constructed nutrient budgets of Lake George based on relatively little data or nonexistent data (Aulenbach, 1979, Aulenbach and Clesceri, 1971, 1972, 1973, 1977; Aulenbach et al. 1979; Gibble, 1974; Hetling, 1974; Wood and Fuhs, 1979).

The Stearns and Wheler total phosphorus loading budget is similarly based upon a pyramid of assumptions that compound uncertainties, and are inconsistent with prior reports. Multiple data sets and non-site specific watershed information were used for estimating hydrologic loadings and phosphorus export coefficients.

Using a mass balance approach to determine the hydrologic contribution of groundwater, the sum of the estimated contribution from surface water and atmospheric deposition is subtracted from lake outflow. This approach introduces significant uncertainties into the model. More accurate quantification of the groundwater volume (per time) is an enormous challenge (Burnett et al., 2006) and should be noted.

Stearns and Wheler estimated the hydrologic budget (sources of water flowing into the lake) as:

Groundwater	**4%**
Surface water (streams)	83%
Atmospheric deposition	13%

The quantification of groundwater nutrient loading such as phosphorus for different land uses or sources is even more challenging because of the spatial and temporal variations in groundwater composition in addition to the heterogeneous nature of groundwater fluxes (Levandowski, et al. 2015).

Stearns and Wheler estimated export coefficients to characterize the amount of phosphorus that is exported or released to groundwater by 4 land uses. These land uses include undeveloped, developed, waste water treatment plants and septic systems. An export coefficient is a number that characterizes how much phosphorus is released to the lake from a particular land use type. For example, agricultural land would contribute more phosphorus than a forest. Nutrient budget are mathematically highly dependent on the estimation of these export coefficients.

Critical to the focus of this white paper and future lake management strategies is how septic system phosphorus export coefficient was determined. Based on the unsupported assumption that all total phosphorus was “tightly bound in the soils”, a septic system phosphorus export coefficient of zero (0.0) was selected.

This value means the estimated total contribution of total phosphorus from nearly 6000 septic systems in the Lake George watershed was zero. The field data, number of septic systems, system type, system age, sizing, failures, site conditions, hydraulic loading, soil characteristics, porosity, mineral content of soils, depth to groundwater and distance from shoreline or streams were ignored or assumed to be insignificant and inconsequential in their determination. Hence, when you multiply the groundwater phosphorus loading of septic systems (estimated as 109.8 kg/yr) times an export coefficient of zero (0.0), you get 0.0 kg/yr.

Export coefficients for specific land use types are best determined for a particular subwatershed and are dependent on extensive monitoring studies and site-specific watershed data. Nonpoint sources pose great difficulty in these estimations because few methods have been developed to accurately measure their contributions. Inconsistencies in watershed monitoring (scale, frequencies, yearly differences) may also influence outcomes. Real site specific data for these and other parameters are needed at fine resolution scales (<30 m) within each subwatershed, which was unavailable to Stearns and Wheler.

Unsupported assumptions were also applied in the determination of phosphorus contribution from Bolton Landing and Lake George Village Waste Water Treatment Plants (WWTP) which was estimated to be 1%. This was arrived at by estimating a 60-80% reduction from the sand pits, based on well monitoring reports. They then added an additional 80% phosphorus removal from WWTPs based on the unsupported assumption that phosphorus was largely retained within watershed soils. This resulted in combined phosphorus load reduction from the reported 407.9 kg/yr to 119 kg/yr. The estimated contribution of phosphorus from the WWTPs to be one percent (1%). These unsupported assumptions are problematic to lake management especially since the operation and effectiveness of these WWTP were known to be unreliable.

The contribution of mid-sized wastewater treatment systems that would require a SPDES permit was not included by Stearns and Wheler. NYS DEC presently does not have a complete inventory and therefore has limited oversight of mid-sized wastewater systems in the watershed (Streeter, 2012).

Estimation of surface water phosphorus export coefficients would also benefit from subwatershed site-specific information. Stearns and Wheler estimates were taken from an inconsistent dataset or literature values which were not site specific. Specific details are omitted in this review.

Finally, Stearns and Wheler broke down the groundwater contribution of total phosphorus from four land uses based on estimated export coefficients as:

Undeveloped - forest	2%
Developed land	1%
Waste Water Treatment Plants	1%
Septic systems	**0%**

Although, Stearns and Wheler concluded there was no need for further sampling and investigations, this review would disagree.

5. Implications for Use of the Report in Policy Formation

The risk in using this study in policy formation is best summarized by Stearns and Wheler. They "caution against using loading estimates including their own, for trend analysis because of the various assumptions and methods used to develop the estimates."

The future of Lake George water quality and as a drinking water source depends on the integrity of the data and scientific understanding used to form sound policy for lake management and protection. Inaccuracies and misrepresentation of data or assumptions found in the Stearns and Wheler report may be of consequence.

Undoubtably, stormwater is a major contributor of phosphorus to Lake George. Consequently, its management plays a large role in lake protection strategy. Yet, reliance on the report for stormwater regulations may have compromised the effectiveness of these regulations. For example, the Lake George Park Commission may have relied on the report in response to several public comment letters on stormwater regulations:

> **LGPC Response***:* "As noted above, the limiting nutrient in Lake George is phosphorus, which is relatively insoluble and binds tightly to soils and sediment. Directing all stormwater to infiltration devices will reduce sediment transport to the Lake, and ensure phosphorus is bound to the land. A study by Stearns and Wheeler (*stet*) could not detect phosphorus leaching from wastewater systems; noting that any phosphorus was quickly bound and attenuated by the soils."

HOWEVER, as detailed in this white paper, phosphorus was detected leaching from the septic systems and therefore not tightly bound. **Furthermore, the revised stormwater regulations do not direct all stormwater to infiltration devices, especially for minor projects that are the most prevalent**. Public comment letters on the proposed stormwater regulations recommended treating major and minor projects equally (Navitsky, 2020 and Collins, 2020). Unfortunately, a lesser standard was accepted for minor projects. This is compounded by the fact that stormwater infiltration devices are estimated to mitigate only 30-60% of the phosphorus.

In response to the Adirondack Council's public letter (2020) recommending an increase in stream corridor setbacks, the LGPC also relied on the report:

> LGPC Response: "The vast majority of lakefront parcels are located in an Adirondack Park Agency designated Moderate Intensity land use area, which per APA shoreline restrictions has a 50' structure setback. The proposed 35' setback recognizes the practical reality of this structure setback while respecting existing and proposed shoreline and stream cutting restrictions. As noted above, the majority of projects in the basin are minor projects. At present, aside for (*stet*) parking lots and roads, infiltration devices for minor projects do not have a horizontal setback requirement to waterbodies (including the Lake). The proposed regulations will create a new, minimum 35' setback from these devices to all waterbodies and therefore significantly increase the separation distance for infiltration devices in the basin. The current major project standards have a 100' setback to Lake George and "protected streams". The proposed regulations would create a 35' setback to all waterbodies, including intermittent streams, which currently are not protected under the major project standards. As noted above, the limiting nutrient in Lake George is phosphorus, which is relatively insoluble and binds tightly to soils and sediment. Directing all stormwater to infiltration devices will reduce sediment transport to the Lake, and ensure phosphorus is bound to the land. <u>A study by Stearns and Wheler could not detect phosphorus leaching from wastewater systems; noting that any phosphorus was quickly bound and attenuated by the soils."</u>

A reassessment of both stormwater and stream corridor regulations (see LGPC citations) should be considered in light of the reliance on Stearns and Wheler.

D. STATUTORY AUTHORITY, POLICY, STANDARDS and REGULATIONS for WASTEWATER MANAGEMENT - HOW are DRINKING WATER and WATER QUALITY PROTECTED?

The Lake George Park Commission has the authority to regulate nutrient loading from wastewater, stormwater, and stream corridor to preserve and protect the water quality of Lake George and as a drinking water source. The LGPC has prepared regulations for stormwater and stream corridor regulations.

Authority on wastewater is provided by the NYS Department of Health in Appendix 75-A and local regulations. However, Appendix 75-A is not intended to protect water quality. It is the reason why the Lake George Park Commission was given special authority to promulgate wastewater management regulations. At this time, the need for wastewater regulations is being considered by the LGPC. A management program that includes a septic system inspection, an annual maintenance program and critical design criteria would serve to protect Lake George as a drinking water source as well as protect water quality. Existing policies to demonstrate the need and reason to act in a comprehensive manner to order to protect the lake.

1. Lake George Classification as AA Special - Part 701 Quality and Purity

The Class AA-Special status of Lake George is to be preserved. Lake George's classification and best use according to Article 2, Classifications and Standards is:

> 701.3 Class AA-Special (AA-S) fresh surface waters.(a) The best usages of Class AA-S waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish, shellfish and wildlife propagation and survival. (c) There shall be no discharge or disposal of sewage, industrial wastes or other wastes into these waters. **(d) These waters shall contain no phosphorus and nitrogen in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.**

For a Class AA-S lake, this narrative is particularly incisive. The anthropogenic driven eutrophication process for oligotrophic lakes can present in manners different than other trophic states. Even subtle changes are indicative of a decline and require action. The observed 60% increase in orthophosphate indicates a critical need for basin-wide wastewater management regulatory program and stronger stormwater and stream corridor regulations.

Rather than ignore the implications of Lake George's classification and decline in water quality, a commitment to improve conditions should be paramount to preserve its status.

2. Nutrient Criteria - Part 703 Narrative and Water Quality Standards

NYS DEC lists point and nonpoint sources of nutrient enrichment and eutrophication to lakes and streams to include **inadequate onsite septic systems.**

3. Appendix 75-A **–** New York Title 10. Department Of Health (DOH). Chapter 11. Part 75.

The standards for individual Onsite Water Supply and Individual Onsite Wastewater Treatment Systems (OTWS) is generally referred to as Appendix 75-A. It was developed for NYS as a means to protect public health in the early 1900's. It is the minimum standard for all new residential OWTS's for discharging 1,000 gals per day or less. NYS DEC Design Standards for Wastewater Treatment Works in the Lake George Basin include needs that are not addressed by the large and small systems design standards.

Appendix 75-A was designed to respond to public health concerns with corresponding increases in pollution of water wells and surface waters, but not specifically intended to protect water quality, including nutrient removal from wastewater. Current concerns recognize the need to limit phosphorus and nitrogen to protect both our drinking water source and water quality. Nutrients from point and non-point sources stimulate algal blooms.

Appendix 75-A is also limited in its ability to protect drinking water. Nutrient loading, irrespective of the source, feeds algal blooms. Phosphorus is the primary limiting nutrient for algal productivity in Lake George. The management of Lake George water quality depends on achieving the minimal loading from all possible sources, both point and non-point source. Mitigating the contribution of phosphorus loading from wastewater is complex. Phosphorus assimilation may occur in soils by physio-chemical, geochemical and biological retention. These processes are dependent on a significant number of factors including soil and site conditions.

Appendix 75-A was amended in 2010 to include Enhanced Treatment Units (ETUs) requirements in Appendix 75A-6(ii):

- Compliance with NSF International Standard 40,
- Effluent filtering mechanism in compliance with NSF Standard 46 before discharge to the absorption area,
- ETUs are subject to the jurisdiction of a Responsible Management Entity (RME), or Local sanitary codes or watershed rules or regulations which incorporate the requirement to maintain and service the ETU in accordance with the manufacturer's recommendations.

Appendix 75A-6 (ii) also permits, with conditions:

- A 33% reduction in trench length in absorption fields for septic systems using Enhanced Treatment Units (ETU) and,
- A 25% reduction in trench length for gravelless systems.

These allowances increase the potential phosphorus loading to a watershed and were unacceptable for the NYC Watershed. Therefore, exemptions were made for the New York City Watershed under 75A.6(b)(6)(ii):

- The trench length reduction specified above in clause is **not applicable at properties located within the New York City Watershed** and,
- The gravelless product trench length reductions specified above in paragraph 75A.8(c)(3) are **not applicable at properties located within the New York City Watershed.**

The New York City Watershed restrictions are designed to protect both water quality and public health. **When NYC Watershed became exempt it was recommended that other sensitive watersheds follow suit**. It goes without saying that Lake George should also be exempt to afford Lake George the same protections as the New York City Watershed.

The NYC Watershed is exempt from this clause in order to protect the NYC drinking water source supply and eliminate filtration costs. "In order to ensure that the high quality of New York City's water was maintained, the State of New York negotiated a watershed protection program. In 1997, the Watershed Memorandum of Agreement (MOA), an agreement to protect the watershed, included New York State, the City of New York, the Environmental Protection Agency, the 7 counties, watershed municipalities, and others. It is designed to protect New York's drinking water supply source and maintain high water quality. The New York City Department of Environmental Protection (DEP) partners with the New York State Environmental Facilities Corporation (EFC) in the East-of-Hudson area and Catskill Watershed Corporation (CWC) in the West-of-Hudson area to implement a series of programs designed to protect water quality from septic system contamination. Due to the high volume of water delivered by New York City's water supply system, the cost of retrofitting filtration technology onto the existing water system would have been prohibitively expensive both for rate payers and for government agencies. Because of its high water quality, EPA issued an initial determination granting filtration avoidance to the City of New York (January 1993). In 2003, the Wastewater Treatment Plant Upgrade Program was initiated to upgrade septic systems in the watershed to ensure water quality protection at the source."

Onsite systems are generally divided into two groups, conventional and (ETUs). Enhanced treatment is the biological and physical treatment of wastewater to reduce the amount of biochemical oxygen demand (BOD) and total suspended solids (TSS) of wastewater effluent prior to distribution to a soil absorption area. ETUs are not certified for phosphorus removal and no standards currently exist. Both conventional and ETU's systems depend on the soil absorption field for phosphorus mitigation. Only a few systems are designed for electro-chemical or physio-chemical phosphorus mitigation. Reducing the size of an absorption field may reduce hydraulic retention time which is critical to design sizing, thereby impacting system performance (Hassett, pers. comm. 2021).

There may be some misconception about the efficacy of ETUs that needs clarification in order to protect Lake George water quality. ETU's can reduce BOD and TSS which is important. However, most ETUs including models such as Puraflo, Fugi, Ecoflo, Busse, Clarus Fusion and Presby, do not claim to reduce phosphorus and rely on the soil absorption fields to do this. Likewise, gravelless systems such as Elgen and Presby also do not claim to reduce phosphorus, yet are allotted a 25% reduction in trench length in 75A 8 (c)(3)**.** This has the potential to reduce phosphorus assimilation and increase pollutant loading.

4. NSF/ANSI Certification

NSF/ANSI 40 and 245 are the most recognized and accepted standards for on-site residential wastewater treatment systems. Both standards test residential wastewater treatment systems with rated capacities between 400 and 1,500 gallons per day. NSF/ANSI 40 provides material, design, construction and performance requirements for testing and certifying residential on-site systems. NSF 245 wastewater standard contains minimum requirements for residential wastewater treatment systems having rated treatment capacities of (400 gal/d) to (1500 gal/d) that are designed to provide reduction of nitrogen in residential wastewater. Management methods for the treated effluent discharged from these systems are not addressed by this Standard.

To date, there is no NSF/ANSI certification to address phosphorus. This author and others have, however, been asked to participate in their future development. NSF/ANSI 40 provides material, design, construction and performance requirements for testing residential on-site systems. The NSF/ANSI 245 standard requires a minimum 50% reduction of total nitrogen. This rigorous standard helps wastewater treatment providers meet a growing demand for nutrient reduction in coastal areas and sensitive environments.

According to the NYS Department of Health (2020) the NSF Standard 245 is deficient because it does not address the removal of phosphorus and should not be used for surface water resources of special concern. Stephen Marshall (NYSDOH email Sept. 1, 2020) summaries the public comments and responses:

(Page 11) - ETUs: The proposed revisions will incorporate ETUs as new alternative system options. Several new technologies fall under this category; all provide advanced wastewater treatment prior to dispersal to an absorption area. However, ETUs typically have additional electrical and mechanical components critical to their proper operation and therefore require more vigilant maintenance than conventional septic tanks. As proposed, effective performance of these units must be documented through independent third party testing and certification by a reputable organization such as the National Sanitation Foundation (NSF).

The enhanced treatment provided by ETUs allows for a corresponding reduction in trench lengths for absorption fields. However, because of the increased need for inspection and maintenance of ETUs, trench length reductions will only be allowed in locations with a regulatory program that ensures proper maintenance. These programs can be implemented by agencies with jurisdiction and enforcement authority over OWTSs (e.g., watershed protection agencies, local health departments, and municipal sewer districts), denoted as responsible management entities (RMEs). EPA encourages the establishment of RMEs as an effective means of OWTS management.

(Page 14) - Comment: Multiple comments were received asking why systems located in the New York City Watershed are excluded from the absorption area reduction allowances. Some comments received asked if the exclusion could apply to other watersheds or surface water drinking supplies with filtration avoidance. While some other comments objected to the exclusion because some residents could not get the benefits of using such systems and products that is extended to the rest of the State. This watershed is unique not only from the perspective that it provides almost half on New York States population with drinking water but it is also an unfiltered drinking water supply. New York City's Catskill/Delaware water supply is the largest drinking water supply in the country receiving a Filtration Avoidance Determination. The unique nature of this watershed was recognized by the signing of the historic 1997 New York City Watershed Memorandum of Agreement. This Agreement, was signed by the Governor of New York, the Department of Health, Department of Environmental Conservation, United State Environmental Protection Agency, local communities and environmental groups to protect the watershed. Note however, that many of the technologies and products referenced in Appendix 75-A are used for system replacements and repairs within the watershed.

Response: No change. In Section 75-A.2, ‘‘Regulation by Other Agencies,’’ recognizes that Water Protection Agencies can establish more stringent standards and this exclusion reflects NYC DEP's policy. In regards to the New York City watershed, it is a surface water resource of special concern and oversight. The watershed includes a vast area which provides drinking water to 8 million New York City residents and 1 million people in counties north of the City.

(Page 14) - Comment: A county health department asked to include NSF standard 245 for ETUs because some areas with sensitive watersheds and waterfront properties may need to remove nutrients such as Nitrogen and Phosphorus. **NSF standard 40 does not address nutrient removal.**

Response: No change. NSF Standard 245 units must also pass the NSF Standard 40 testing criteria before it can be listed by NSF, therefore, the NSF Standard 245 units are already acceptable in areas where NSF Standards 40 units can be installed in accordance with the applicable Appendix 75-A standards. **Note that the standard is based upon nitrogen removal and does not include phosphorus reduction testing."**

5. Operation and Performance of Enhanced On-Site Waste Water Treatment Systems (ETUs)

ETUs are now generally recognized as more effective than conventional treatment systems. But as discussed, system performance for nutrient reduction is variable, especially phosphorus. NYC Watershed households were randomly given one of five different types of systems (conventional, raised bed, peat, aerobic, and sand (Hassett et.al. 2008). As reported, sand filters appeared best in total and dissolved phosphorus removal. Hassett said that removal of total phosphorus (30%) by peat systems may be misleading for two reasons 1) the peat used was coated with iron (Fe) and 2) it was determined using pooled data. Other studies cited in the report estimated that total phosphorus removal by peat systems was about 10% and dependent on iron and aluminum concentrations. Hassett also questioned the physical trapping ability of peat. The 10% removal of total phosphorus by peat systems has also been confirmed in discussions with Puraflo and Ecoflo technicians. Each reported that peat systems depend primarily on soil absorption fields for total phosphorus removal.

In preparing the report, Hassett (pers. comm. 2021) found it to be common occurrence that aerobic treatment units (ATU) systems were turned off by homeowners when the properties were transferred or not maintained perhaps because of lack of knowledge or associated costs. Operation and system performance may have significant implications for the ETUs in Lake George without a robust management plan including annual maintenance and inspection.

E. TOOLS TO AID IN WATERSHED PROTECTION AND ANALYSIS

1. Antidegradation Policy

The protection of waters from the lowering of water quality is outlined in the NYYSCEC Organization and Delegation Memorandum No. 85-40 Water Quality Antidegradation Policy (AD Policy) dated September 9, 1985 - Attachment A. The Antidegradation Policy refers to policies that NYS must develop and follow to protect current water quality from deteriorating, unless it is demonstrated that allowing the lowering of water quality is necessary to accommodate significant economic or social development in the affected area and water quality will be adequate to meet the existing use after allowing the lowering of water quality.

An antidegradation plan such as a Nine Element Plan and regulatory action could serve to preserve water quality. Other tools such as the preparation of a Total Maximum Daily Loading (TMDL) to reduce pollutant loading is deemed as moot for Lake George because of the NYS DEC narrative standard for Class AA-S lakes. This limits protection measures for Lake George unless other actions are taken.

The most important issue that an antidegradation program should address is how the assimilative capacity of waters will be allocated, a stipulation that is not explicitly stated in most state policies. Future trends in development, including potential build out, expansion to steeper slopes and an increased intensity of use should be considered, especially with the current intensity of development, redevelopment and proliferation of Airbnb's.

2. NYS DEC Priority Waterbodies List 303(D) for Impaired Waters

NYS DEC is responsible for categorizing all waterbodies that are "use-impaired." The list identifies nonpoint source pollution which cause water quality impairment. The most prevalent contributors listed are agriculture, urban runoff, and septic systems.

NYS DEC placed Oneida Lake on the 303 (d) list for not supporting its beneficial uses and for violating the state's narrative standard for phosphorus, which states that phosphorus cannot exist in amounts that will result in growth of algae, weeds and slimes that will impair waters for their best usages. Consideration should be made to list Lake George given reported near shore algal blooms (Collins and Ruffing, 2018 and Navitsky, 2018) and at least six reported harmful algal blooms (NYS DEC 2020, 2021).

F. CONCLUSIONS and RECOMMENDATIONS

Effective policy for lake protection and management depends on reliable information that is updated frequently as scientific knowledge and data become available. Eutrophication of Lake George, as with other lakes, is a largely an irreversible process that absolutely requires protective measures. The time lost in preventing further decline is often unrecoverable.

The increase in nearshore algal blooms with algae associated with organic waste or excreta (Collins and Ruffing, 2018; Navitsky (2018)) and at least six reported harmful algal blooms (HABs) are important indicators of water quality decline. Phosphorus originating from human excreta in domestic wastewater is mainly present as orthophosphates which are soluble and bioavailable to algae (Doyle and Parsons, 2002).

An increase in orthophosphate (60%), chlorophyll *a* (46% increase), and tripling of chloride are definitive of the need to address management options. Phosphorus from stormwater, septic systems and unprotected stream corridors and other sources fuel algal blooms that imperil our drinking water. Delays in action erode the ability to accomplish the goal or objective. In reviewing the above policies and regulations it is clear that the goal is only to slow down the current rate of decline. Presently, comprehensive protection measures simply do not exist.

Recommendations for Lake George include:

1. Prepare of goals and objectives that meet the need to protect Lake George as a drinking water source as codified by Statute 701.3 and its water quality,

2. Develop and implement a wastewater management plan, that includes inspection, maintenance and design criteria. Policies and regulations similar to that afforded to the New York City Watershed, including exempting 75A-6(ii) (d) and (g) to potentially decrease phosphorus loading from septic systems by 33%,

3. Review and revise prior policy based decisions and references to the Stearns and Wheler report,

4. Develop a quantitative Antidegradation plan similar to the Nine Element Plan,

5. Prepare water quality standards for Lake George and its tributaries,

6. Revise stormwater and stream corridor regulations to include minor projects, contiguous buffers, additions of streams currently unrecognized by DEC,

7. Implement measures to ensure NYS Department of Environmental Conservation's narrative standard for protection – **"There shall be no phosphorus and nitrogen in amounts that will result in the growth of algae, weeds and slimes that will impair the waters for their best usage"**,

8. Update other non-point source water regulations in line with the goal of protection rather than decreasing the rate of decline of water quality,

9. List Lake George on 303 (D) for impairment from an increasing number of nearshore algal blooms.

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