CONNECTICUT SOURCE WATER PROTECTION PROJECT (CSWPP)

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Little River Watershed Based Plan Update

The Little River Watershed Based Plan Update was funded in part by a USDA Natural Resources Conservation Service National Water Quality Initiative (NWQI) Planning Grant through the Connecticut Council on Soil and Water Conservation.

https://conservect.org/eastern/

Prepared by the
Eastern Connecticut Conservation District
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US EPA CWA §319 NPS Grant Supported Agriculture Best Management Practices 2010 – 2022

New silage bunker and leachate collection system for a dairy farm (2012)

Refurbish silage bunkers and install silage leachate collection system (2012)

Roof gutters on dairy barns with sub-surface drainage pipes (2012)

Aerway equipment purchase (2013)

Small farm manure management, tarp distribution and outreach (2015)

Aerated composting facility for heifer manure and dairy mortality (2016)

Precision planter equipment purchase (2017)

Denitrifying woodchip bioreactor (2017)

Denitrifying woodchip bioreactor monitoring (2019)

Silage bunker sub-surface drainage/new concrete floor with an asphalt cap (2019)

High/low flow separator for leachate collection (2019)

Two concrete manure storage receiving pits constructed (2019)

Pumphouse (2019)

Manure liquid/solid separator for dairy bedding (2019)

Pumping system for liquid manure to SlurryStore storage tanks (2019)

Manure injector equipment purchase (2020)

Design free-stall barn with ag waste storage and management facilities (2020)

Second precision planter purchase (2020)

New free-stall barn with ag waste storage & management (2022)

Silage Bunker with high/low flow separator (2022)

Figure 1.

Little River Watershed Based Plan Update Introduction

In 2009, CT Department of Energy and Environmental Protection (DEEP) and US Environmental Protection Agency (EPA) approved *Muddy Brook and Little River Water Quality Improvement Plan*. The 2009 watershed-based plan, written by Eastern CT Conservation District (ECCD), outlined an action plan for implementation efforts needed to restore the water quality in impaired segments of the Little River watershed basin (CT 3708). The Little River watershed is located primarily in Woodstock, CT, but also includes drainage from Pomfret, Thompson and Putnam, CT and Southbridge, MA.

At the time the 2009 plan was developed, five different waterbodies within the Little River watershed were classified as not meeting water quality standards of the State of Connecticut. These waterbodies were the primary focus of the 2009 plan. They included Muddy Brook (between the Moss Brook convergence and CT Route 197) and North Running Brook (between a farm ditch and Muddy Brook). Both of these segments were listed as impaired for aquatic life use support. Muddy Brook (below Route 197 to Roseland Lake) and Little River between Shepherds Pond Dam and Quinebaug River were listed as impaired for recreation due to elevated levels of *E. coli* bacteria, indicating fecal contamination. Roseland Lake was also listed as impaired for recreation based on nutrient/eutrophication and biological indicators.

Muddy Brook and Little River Water Quality Improvement Plan focused on addressing sources of nutrient and fecal contamination from potential non-point sources (NPS), including agricultural sources. In 2013, following the publication of the plan, USDA Natural Resources Conservation Service (NRCS), CT DEEP and US EPA designated the Little River watershed as a National Water Quality Initiative (NWQI) implementation watershed and NRCS set aside a special pool of Environmental Quality Incentive Program (EQIP) funding for agricultural projects in the Little River watershed. At times, this funding was combined with US EPA Section 319 non-point source grant funds to successfully complete projects that cost significantly more than the cost-share allowance permitted under the USDA Farm Bill producer EQIP allotment. A list of conservation projects subsidized by US EPA Clean Water Act (CWA) §319 grant-funded projects are noted in the sidebar (Figure 1). Many of these projects were planned in coordination with NRCS.

In 2018, the requirements for supporting a NWQI watershed designation were updated, and the 2009 *Muddy Brook and Little River Water Quality Improvement Plan* no longer met the requirements for supporting a NWQI designation. In 2020, CT NRCS designated the Little River as a NWQI Planning Watershed and provided funding to ECCD through Connecticut Council on Soil and Water Conservation (CSWC) for updating the *Muddy Brook and Little River Water Quality Improvement Plan*. This updated plan focuses on agricultural NPS pollution and is now known as *Little River Watershed Based Plan Update*.

In the years since the 2009 *Muddy Brook and Little River Water Quality Improvement Plan* was developed, various changes in the watershed have occurred.

- Several large-scale multi-partner projects addressing non-point source runoff from dairy farms have been implemented.
- The number of active dairy farms in the watershed decreased. The size of some remaining active dairy farms has increased and may have more than one farmstead.
- The amount of preserved agricultural land through Connecticut Department of Agriculture or Connecticut Farmland Trust agricultural easements increased.
- The types of farming in the watershed have diversified.
- The water quality in the two streams listed as not meeting aquatic life use support improved and are now both meeting the CT Water Quality Standards for supporting aquatic life.
- One additional stream was listed as impaired for recreation due to exceedances in pathogen concentrations.

When the 2009 *Muddy Brook and Little River Water Quality Improvement Plan* was developed, dairy farms were the dominant type of farm in the watershed. At that time, there were eight active dairy farms in operation that managed at least 150 cows each. By 2022, the number of dairy farms had decreased to four in the watershed and one dairy farm operates outside the watershed but cultivates land in the watershed.

I. Overview of the Source Water Protection Area and At-Risk Public Water System

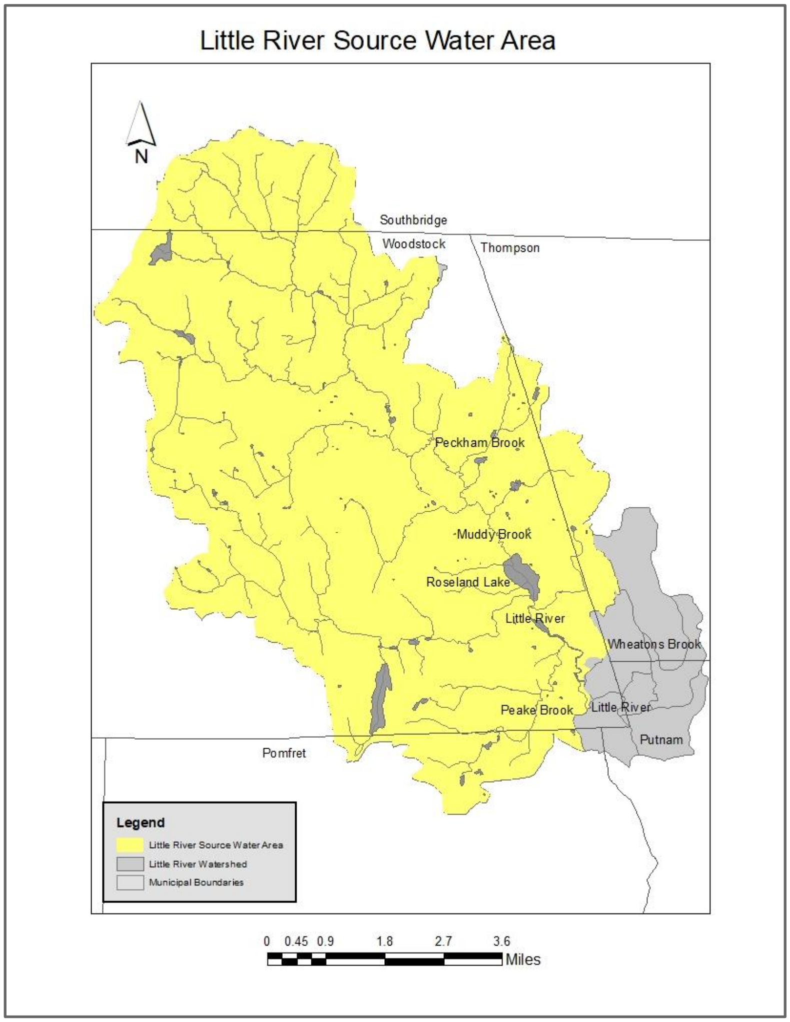


Figure 2. Little River source water

The primary focus of this watershed plan update is on the source water protection area for the watershed upstream of the Little River bypass to the Putnam Water Treatment Plant located in southeastern Woodstock, CT. The area is highlighted in yellow in Figure 2. This plan will also include land in agricultural use within the Little River watershed but outside the source water watershed area when the home farmstead for that land is within the source water protection area. The plan, funded in part by a USDA Natural Resources Conservation Service as a National Water Quality Initiative Planning Grant[1], includes a more in-depth review of potential agricultural influences on water quality

[1] *Little River Watershed Based Plan Update* was funded by a USDA Natural Resources Conservation Service National Water Quality Initiative (NWQI) Planning Grant through the Connecticut Soil and Water Council. Additional funding for this project was provided through a TLGV Regional Conservation Partnership Program, *Improving Soil Health and Water Quality In the Thames River Watershed,* as well as through funding from UCONN's Regional Conservation Partnership Program, *Path to Reduce Pathogens in CT Agricultural Runoff (PATH).*

and recommendations to address those influences. Other potential non-agricultural sources of water quality degradation may be noted but are not the focus of this plan.

The Town of Putnam, CT uses water diverted from Little River as part of its municipal water supply. ECCD calculated the area of the source water drainage basin upstream of the Little River Bypass as 34.9 square miles[2]. Source water lands in the watershed are predominantly in Woodstock, CT but also include lands in Pomfret and Thompson, CT, as well as Southbridge, MA.

Between 20 - 25% of the annual municipal water supply for the Town of Putnam is drawn from Little River. Businesses and residents outside of the source water protection area consume most of the water from the Little River surface water supply. Upstream of the Putnam Water Pollution Control Authority (WPCA) Little River diversion, nearly all homes and businesses rely on groundwater for their drinking water and a focus on any impacts on downstream water quality may not exist.

a. Description of the drinking water system at risk from impaired source water quality.

The Putnam WPCA oversees the Town of Putnam municipal water supply (Putnam Water) and wastewater treatment plant (Putnam Wastewater). In its 2019 Annual Water Quality Report, Putnam WPCA reported that Putnam Water produced 296,210,300 gallons of water from the following sources: 72,603,300 gallons from Little River, 205,203,800 gallons from the Park Street Well Field and 18,403,200 gallons were sourced from the CT Water Company. These numbers indicate that 25% of the total municipal water supply was obtained from Little River in 2019.

According to the 2020 annual water quality report, Putnam Water produced 313,846,900 gallons of water from the following sources: 62,618,700 gallons from Little River, 220,477,800 gallons from the Park Street Well Field and 30,750,400 gallons were sourced from the CT Water Company. These numbers indicate that 20% of the total municipal water supply was obtained from Little River in 2020.

Putnam Water provides drinking water for approximately 7,300 people, including hookups to 1,996 residential properties, 201 commercial properties and 33 industrial properties in Putnam and parts of Thompson and Woodstock, CT. (*Connecticut Department of Public Health Drinking Water Section Water Quality Monitoring and Compliance Schedule*, n.d.) Four schools obtain their water from the Putnam municipal water supply including Putnam Elementary School, Putnam Middle School, Putnam High School and Putnam Science Academy. The Putnam Water System also supplies water to Day Kimball Hospital.

[2] USGS StreamStats v4.4.0 was used to estimate the watershed area.

The US EPA has enacted environmental regulations to protect the quality of public drinking water. “The 1996 Amendments to the Safe Drinking Water Act (SDWA) emphasized the importance of pollution prevention to protect the safety of drinking water supplies and required states to create a Source Water Assessment Program (SWAP) for all public drinking water systems. State drinking water programs were required to:

- identify the land area(s) which provide water to each public drinking water source in the state;
- complete an inventory of existing and potential sources of contamination in those areas;
- determine the susceptibility of each drinking water system to contamination; and
- distribute the results of the assessment to water users and other interested entities” (US EPA, 2020).

In 2006, Atlantic States Water and Wastewater Association developed *Little River Sourcewater Protection Plan* for Putnam WPCA.

In Connecticut, surface waters used as source water and their contributing watersheds are categorized as Class AA. The designated uses for Class AA[3] waters are:

(A) existing or proposed drinking water supplies;
(B) habitat for fish and other aquatic life and wildlife;
(C) recreation[4]; and
(D) water supply for industry and agriculture.

Class AA Restricted and Allowable Discharges include:

- an absolute restriction on the discharge of wastewater to Class AA reservoirs and their tributaries;
- discharges to Class AA surface waters may be permitted from public or private drinking water treatment systems, dredging activity and dredge material dewatering operations, including the discharge of dredged or fill material and clean water discharges. Such discharges shall be subject to the approval of the Commissioner of Public Health.

[3] Connecticut Water Quality Standards and Classification rev 2013. Connecticut General Statutes section 22a-426 subsections (d) through (g).
[4] Certain recreational activities are restricted within two miles of a surface water intake including public bathing beaches and landing aircraft on water (CT General Statutes Sec. 25-43).

For Class AA drinking water supply sourcewater areas, water quality criteria at the drinking water supply intake is based on a number of different parameters, including Total Coliform. A monthly moving average of Total Coliform of less than 100 MPN/100 ml and a single sample maximum of 500 MPN/100 ml are the standards for drinking water. This criteria only applies at the drinking water supply intake structure (Connecticut Water Quality Standards and Classifications. Revised 2015-11-21. Pg 38).

While the above environmental regulations were enacted to protect drinking water quality from defined point source discharges, non-point source pollution, including many agricultural operations, are often exempt from local regulations enabled under the CT Inland Wetlands and Watercourses Act of 1972.

i. Source water quality.

The Putnam Water Pollution Control Authority 2019 Annual Water Quality Report describes the water treatment process for water withdrawn from Little River before it is distributed for public consumption.

> “The water treatment process from the surface water supply [from the Little River] consists of a series of five key steps. Initially the water is drawn from the river and pre-disinfected with chlorine dioxide and chlorine. This step allows for oxidation of iron, manganese and total organic carbon that are present in the raw water. This pretreated water enters a mixing tank where poly aluminum chloride is added allowing small particles to adhere to one another (called "floc") making them heavy enough to settle out of the water. The water is then processed through a filtering unit where any remaining smaller floc particles are removed, turbidity disappears, and clean water emerges. Chlorine is added in the final disinfection step as a precaution against any bacteria that may still be present. We closely monitor the amount of chlorine, adding the lowest quantity necessary to protect the safety of your water without compromising taste. The final chemical injection steps are taken by adding Potassium Hydroxide to adjust the pH of the water and an Ortho Polyphosphate (corrosion inhibitor) to protect the pipes. The water is then pumped to our two, one-million-gallon water storage tanks from which it is distributed into your home.” (Putnam WPCA, 2019)

According to Putnam’s Annual Water Quality Report, “The raw water from Little River is tested for Nitrate-N And Nitrite-N (NOX) once per year, Pesticides, Herbicides and PCBs - Phase II & V (SOCs) twice every three years and Organic Chemicals (VOCs) once per year. Total Alkalinity and Total Organic Carbon are monitored on a monthly basis. Total Coliform, Surface Water Inorganic Chemicals, Surface Water Color and Turbidity must be monitored four times per year.” Their treated water is compatible with the thresholds for safe drinking water.

Putnam WPCA supplied water quality data obtained from its raw water samples collected at the Little River bypass to the treatment plant. The data set including pathogen and nitrate-nitrogen concentrations, collected from 2017 - 2022, were reviewed as potential impacts from agricultural runoff. The complete data set is available in Appendix A.

ii. General characteristics, source water facilities, plans developed.

The majority of residents and businesses upstream of the Little River Diversion obtain their drinking water from onsite wells. This includes private residential wells on private property that serve less than 25 residents, or public community water supply wells that serve more than 25 individuals. There are no major public water supply wells in sand and gravel aquifers with a required wellhead protection area in the Little River Watershed.

There are twenty-seven smaller community wells in the Little River watershed that are required to submit annual water quality reports to CT Department of Public Health Drinking Water Division. There are 3 types of public drinking water systems:

- "Community Water Systems" which serve at least 25 residents throughout the year,
- "non-transient, Non-Community Systems" which are not community systems and regularly serve at least 25 of the same people over six months of the year at places like schools and office buildings; and
- "transient Non-Community Systems" which do not meet the definition of a non-transient, non-community water system such as restaurants, parks, etc. (*Public Water System Lists*, n.d.)

Within the Little River watershed there are 8 Community Water Systems, 7 Non-transient, Non-Community Systems and 12 Transient Non-Community Systems (DPH website). The reports do not indicate if the wells are drilled groundwater wells or more shallow wells in stratified drift deposits. A shallow well is more vulnerable to contamination from above-ground land use.

Municipalities with public supply wells are required to test their wells annually and report to the CT Department of Public Health. Parameters tested include, but are not limited to, Nitrite/Nitrate once annually; Pesticides, Herbicides, PCBs once every three years and Total Coliform (1x/month for Cs, 1x/quarter for NCs and 2x/month for NTNCs).

In Connecticut, water quality testing of private wells serving less than 25 people is voluntary. CT DPH recommends testing private wells annually for Total Coliform, Nitrite/Nitrate Nitrogen, pH, odor, Chlorine, Hardness, Apparent Color, Sulfate, Turbidity, Iron and Manganese. CT DPH also recommends testing private wells at least once for Lead, Arsenic, Uranium, Radon and Volatile Organic Compounds.

b. Population that will benefit from source water protection.

The Town of Putnam includes a Special Services District (Figure 3), which receives water and sewer service supplied by Putnam Water Pollution Control Authority. Approximately 20 – 25% of its water is supplied by Little River. The Putnam Special Services District has the highest density of people and multi-family residences within the Town of Putnam. The remainder of town residents rely on private wells for water and septic systems for household waste disposal. Residents and businesses in the Special Services District would benefit the most from water quality improvements impacting the surface water supply.

Figure 3. Map outlining the Putnam special services district.

In Woodstock, upstream of the Little River diversion, and in parts of Pomfret and Thompson that are within the Little River watershed, the majority of homes and businesses derive their drinking water and waste disposal services from onsite wells and septic systems. Excess soluble nutrients, especially Nitrate-nitrogen, applied to the surface of the land or discharging from failing septic systems can lead to elevated concentrations of Nitrate-nitrogen in groundwater. Nitrate-nitrogen found in concentrations more than 10 mg/l is a human health risk. The homes and businesses served by shallow wells in stratified drift deposits near land managed for agriculture are at highest risk for elevated nitrate contamination. Water quality testing of private wells is voluntary and the responsibility of the property owner. Annual testing is recommended, but not always practiced.

A request was made to the Northeast District Department of Health for water quality information from private wells that have reported excesses of pathogens or Nitrate-nitrogen. During the process of drafting *Little River Watershed Based Plan Update*, the State Legislature passed Public Act 22-58, which amended CGS Sec. 19a-37, making any water quality samples received by local health departments on or after 10/1/22 confidential. Although ECCD staff requested the information prior to 10/1/22, we were unable to obtain this information from NDDH.

Community well data collected between 2017 – 2021 at Woodstock Elementary School and Woodstock Middle School indicated only background levels of Nitrate-nitrogen in the test samples. Woodstock Academy reported background levels of Nitrate-nitrogen in 4 of the 5 samples. The 2021 sample exceeded 3 mg/L Nitrate-nitrogen but was well under 10 mg/l. The drinking water supply at all three schools in Woodstock was compatible with the safe drinking water standards established by CT DPH.

c. Contaminants / conditions of concern that pose a risk to drinking water.

Elevated levels of toxins and nitrate-nitrogen are potential contaminants of concern. Toxins include pesticide in runoff and cyanotoxins produced by seasonal cyanobacteria blooms. Elevated phosphorus levels in stormwater runoff and other sources, combined with elevated summer temperatures over an increasing time span, fuel the cyanobacteria blooms. Cyanobacteria blooms may produce cyanotoxins that pose a human health risk.

Elevated nitrogen, specifically nitrate-nitrogen, is a pollutant of concern in the watershed. Nitrate-nitrogen in concentrations greater than 10 mg/l in drinking water is a human health hazard. The raw surface water at the Little River diversion to the Putnam water treatment plant is tested for nitrate-nitrogen on an annual basis, typically in January. This may not be the season of the year when nutrients, including manure, are typically applied to agricultural fields for farms with adequate manure storage. Those without adequate manure storage may need to apply manure throughout the year, including on frozen ground or prior to a rainfall.

In winter months, when Roseland Lake has open water, a significant population of overwintering Canada geese roost on the lake overnight. Their waste, deposited on the ice along the fringe of the lake or upon take off, is a source of nutrients and pathogens. Testing the raw water once seasonally may not capture the true concentration of nitrate-nitrogen in the Little River raw water samples. Despite the sources of potential nutrient contamination, or the season when the samples were obtained, there have not been any safe drinking water exceedances for Nitrate-nitrogen reported in the last 5 years at the water treatment plant intake.

Another challenge for the Putnam WPCA water treatment system is that it is not equipped to remove high levels of cyanotoxins. Little River begins at the outlet of Roseland Lake. The Roseland Lake outlet into Little River is located approximately two miles upstream of the Little River bypass to the Putnam Water Treatment Plant. Due to seasonal algal blooms, including cyanobacteria, CT DEEP has listed Roseland Lake as impaired for recreation. Roseland Lake has been on the list of impaired waters of the State of Connecticut since the list was initiated in 1992.

From US EPA: "Conventional water treatment (consisting of coagulation, sedimentation, filtration and chlorination) can generally remove cyanobacterial cells and low levels of toxins. However, water systems may face challenges providing drinking water during a severe bloom event, when there are high levels of cyanobacteria and cyanotoxins in drinking water sources.

Once cyanobacteria and/or their cyanotoxins are detected in the surface water supplying the water system, it is possible for the treatment system operators to remove or inactivate them in a number of ways. Some treatment options are effective for some cyanotoxins, but not for others. Effective management strategies depend on understanding the growth patterns and species of cyanobacteria that dominate the bloom, the properties of the cyanotoxins (i.e., intracellular or extracellular), and appropriate treatment processes. For example, oxidation of microcystin depends on the chlorine dose, pH and the temperature of the water. Applying the wrong treatment process at a specific state in treatment could damage cells and result in the release rather than removal of cyanotoxins."

The US EPA has guidance available regarding the effectiveness of different types of water treatment to remove intact cyanobacteria cells and treatment processes that are effective in removing extracellular dissolved toxins of several of the most important cyanobacteria. "Drinking water operators are encouraged to monitor the treated water to confirm the removal of cyanotoxins." (*Summary of Cyanotoxins Treatment in Drinking Water | US EPA*, 2022) Monitoring for cyanotoxins in drinking water, however, is expensive.

Cyanotoxins are a natural by-product of cell metabolism in many types of cyanobacteria. These toxins can be released into the water by cyanobacteria cells when the cells lyse (break open) or die. In 2018, water sampled at both the Putnam intake at the water treatment plant and from Roseland Lake did not indicate a level of cyanotoxins in the water that exceeded the EPA threshold for safe drinking water. Research is ongoing to determine under what conditions cyanobacteria develop toxic by-products from their cellular metabolism and if it is locally or seasonally influenced. (*Cyanobacteria Monitoring Collaborative*, n.d.)

Aside from concerns for the potential development of cyanotoxins, cyanobacteria, along with other types of phytoplankton, can create bad taste and odors in drinking water even after it has been treated and sanitized.

Pathogens in raw river water are another threat to drinking water quality. Fecal contamination of drinking water is a risk to the general population. While certain pathogens are inactivated by chlorination during the water treatment process, certain other pathogens, such as *Cryptosporidium*, are not. According to the Center for Disease Control, people who are in poor health or who have weakened immune systems are at higher risk for more severe and prolonged illness from a *Cryptosporidium* infection. *Cryptosporidium* is a type of pathogen potentially spread via cow manure.

There is no simple test for *Cryptosporidium* contamination. Although *E. coli* is a naturally occurring bacterium of the gut of warm blooded animals, the assumption is that any sample contaminated by fecal material as indicated by elevated *E. coli* may also be contaminated with other more lethal pathogens that are spread by fecal matter, including *Cryptosporidium* and more harmful variants of *E. coli*.

A final challenge for the Little River source water supply is maintaining stream flow downstream of the treatment plant. CT DEEP enacted streamflow regulations on December 12, 2011. The Town of Putnam is required to monitor the flow of Little River downstream of the bypass to the water treatment facility. Its current permit allows the town to withdraw up to 1.47 million gallons per day (MGD). It is also required that the minimum downstream flow be at least 12.33 cubic feet per second (cfs). (CT DEEP, 2009) During seasonal droughts, the diversion to the Little River treatment plant may periodically need to be shut down to maintain minimal flows downstream of the Little River bypass. In 2011, a streamflow gauge was installed to monitor flow in the Little River downstream of the water treatment plant intake. The Town of Putnam has a drought management plan for periods of low flow. The Town of Woodstock does not.

The raw water to the treatment plant is monitored at the point of entry in accordance with a schedule required by the Connecticut Department of Public Health Drinking Water Division. (*Connecticut Department of Public Health Drinking Water Section Water Quality Monitoring and Compliance Schedule*, n.d.)

Non-drinking Water Concerns Related to Water Quality in the Little River Watershed

Harmful Algae Blooms (HABs) are a growing concern on a global basis. Certain cyanobacteria have the potential to produce cyanotoxins as a byproduct of their metabolism. In Roseland Lake and Shepherd's Pond, cyanobacteria blooms occur annually and are supported by elevated concentrations of phosphorus in combination with warmer surface water temperatures in summer. With the increased number of days exceeding 90° F, there is potential for periods of prolonged cyanobacteria blooms. There is limited data on the algal toxin concentrations in the raw water at the water treatment plant intake. In June 2015, US EPA published drinking water health advisories (HA) for microcystins and cylindrospermopsin. "The EPA recommends HA levels at or below 0.3 μg/L for microcystins and 0.7 μg/L for cylindrospermopsin in drinking water for children preschool age and younger (less than six years old). For school-age children through adults, the recommended HA levels for drinking water are at or below 1.6 μg/L for microcystins and 3.0 μg/L for cylindrospermopsin. Young children are more susceptible to the toxic effects of cyanotoxins than older children and adults as they consume more water relative to their body weight."

Roseland Lake is used recreationally for fishing and boating. CT general statutes Sec. 25-43a, *Bathing in and pollution of reservoirs*, restricts swimming. A former bathing beach at Roseland Park was closed following the passage of the law. Though considered moderate risks, exposure to cyanotoxins during recreational activities, such as canoeing and kayaking, can occur through skin contact and inhalation. Catch and release fishing is considered a low to no risk activity. (*Guidance to Local Health Departments For Blue–Green Algae Blooms in Recreational Freshwaters*, n.d.) Based on US EPA recreational criteria, CT DPH recommends a toxin threshold of 8 ug/l microcystin in the water column.

Roseland Lake experiences cyanobacteria blooms annually during the summer. Algal scum blown toward the shoreline may have higher algal toxin concentrations compared to water samples from the middle of the lake. These shoreline algal scums are a high risk to dogs that enjoy lake swimming. Nutrient enrichment of Roseland Lake from agricultural runoff is an ongoing concern.

Putnam WPCA has the authority to manage Roseland Lake for cyanobacteria blooms. It has hired a contractor to maintain a continuous water quality monitoring buoy in order to better time Copper sulfate treatments in the lake for more effective control. Copper sulfate is an effective herbicide for reducing the intensity of algal blooms in lakes but only for a short duration. Copper may also negatively impact non-target species of invertebrates, including snails and freshwater mussels.

d. Source water protection goals and objectives.

USDA Natural Resources Conservation Service (NRCS) supports many conservation practices that focus on reducing nutrient and pathogen contamination of surface and groundwater from agricultural sources. In addition, it also has programs for preserving environmentally sensitive land from development. NRCS programs range from education and outreach to BMP design and implementation, as well as financial support to conserve lands through conservation easements. NRCS also funds a Conservation Innovation Grants program that supports the development of new technologies to further natural resource conservation on private lands. Additionally, NRCS has developed strategies for water quality improvement, which are listed as practices under Source Water Protection, High Priority and Climate Smart Agriculture and Forestry Mitigation Practices. Since nutrients and pathogens from agricultural sources contribute significantly to water quality concerns in the Little River watershed, all of these NRCS programs are critical to protecting and restoring the water quality of the Little River source water protection area.

According to the Woodstock Land Records, approximately 1500 acres of farmland have been preserved in the Little River watershed by agricultural easements under the State of Connecticut Purchase of Development Rights Program and other land conservation programs. Similarly, NRCS supports the acquisition of agricultural easements through the Farm and Ranch Lands Protection Program, another means to protect important agricultural land from potential development. Additionally, in the Woodstock part of the watershed, a local Open Space fund is sometimes applied to supplement the payment per acre for high-value farmland. By supplementing landowners with financial incentives to place conservation easements on their land, regional agriculture is supported to ensure enough local land is available to grow livestock feed as well as distribute livestock waste to be recycled back into the system. Various studies have determined the estimated amount of land required to support a single dairy cow. “A rule of thumb for dairy operations is 1.5 to 2.0 acres per cow, which includes the youngstock.” For pasture raised beef, NRCS recommends roughly 1.8 acres/cow. Higher densities of animals can be supplemented by importing feed from outside the watershed but that would result in increased manure waste to distribute on the land, potentially causing overfertilization of the land contributing to nutrient and pathogen-enriched runoff. Protecting farmland from development by supporting the purchase of agricultural easements is an important tool to protect farmland in the watershed. When accomplished through NRCS programs, such as the agency's Agricultural Conservation Easement Program-Agricultural Land Easements (ACEP-ALE), conservation plans are required for Highly Erodible Lands (HELs), providing additional protections to agricultural lands and receiving waterbodies.

NRCS also manages a Healthy Forests Reserve Program. Through the program, landowners are subsidized for placing a conservation easement on their land. Forest conservation in the healthier, less developed parts of the watershed upstream of the agricultural valley is important for diluting agricultural runoff with water filtered naturally through the forested system. Based on a model developed by Becker and Dunbar of CT DEEP, for every acre of forest converted to developed land there is the potential to increase phosphorus runoff by 13.4mg/m^2/yr, and even more so if the land is converted from forest to agriculture fields. Conserving well-managed forests through forest management plans and conservation easements is a cost-effective means to protect downstream water quality. NRCS is well-positioned through its various land conservation and easement programs to assist landowners in the watershed to preserve farm and forest land, which will positively impact source water quality.

There are additional means NRCS can use to encourage forest landowners to maintain their land as forests. For example, NRCS can encourage and subsidize Forest Farming or support sustainable Silvopasture management. Both of these sustainable practices are a means to extract income from a forested property while maintaining healthy forest canopy and soils. Maintaining the forest canopy decreases the velocity of rainwater and helps to prevent erosion, while intact forest soils filter rainwater. Examples of other non-timber forest products include maple and other tree syrups, nuts, fruits and cultivated understory herbs.

The shift in farming from dairy to smaller livestock operations in the Little River watershed may require NRCS staff to manage multiple smaller projects, each with its own requisite paperwork, placing a burden on NRCS staff. For NRCS to effectively assist the increased number of small farms in the watershed, it may need to hire additional staff to manage its caseload.

USDA NRCS Environmental Quality Incentives Program (EQIP) provides technical and financial assistance to agricultural producers and forest landowners to address natural resource concerns, such as:

- improved water and air quality;
- conserved ground and surface water;
- increased soil health;
- reduced soil erosion and sedimentation;
- improved or created wildlife habitat; and

- mitigation against drought and increasing weather volatility.

USDA NRCS offers technical assistance at no cost. Producers can use NRCS' personalized advice and information, based on the latest science and research, to make informed decisions about their land.

USDA NRCS Conservation Stewardship Program (CSP) For farms looking to improve grazing conditions, increase crop resiliency, or develop wildlife habitat, NRCS staff can custom design a CSP plan to help them meet those goals. NRSC professionals can assist to identify natural resource problems in agricultural operations and provide technical and financial assistance to solve those problems or attain higher stewardship levels in an environmentally beneficial and cost-effective manner.

USDA NRCS Conservation Innovation Grants (CIG) is a competitive program that supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands.

USDA NRCS Agricultural Conservation Easement Program (ACEP) helps landowners, land trusts, and other entities protect, restore, and enhance wetlands or protect working farms and ranches through conservation easements.

USDA NRCS Agricultural Management Assistance (AMA) assists producers to construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming. AMA provides financial assistance up to 75 percent of the cost of installing conservation practices up to $50,000.

II. Characterization of the Area(s) of Influence

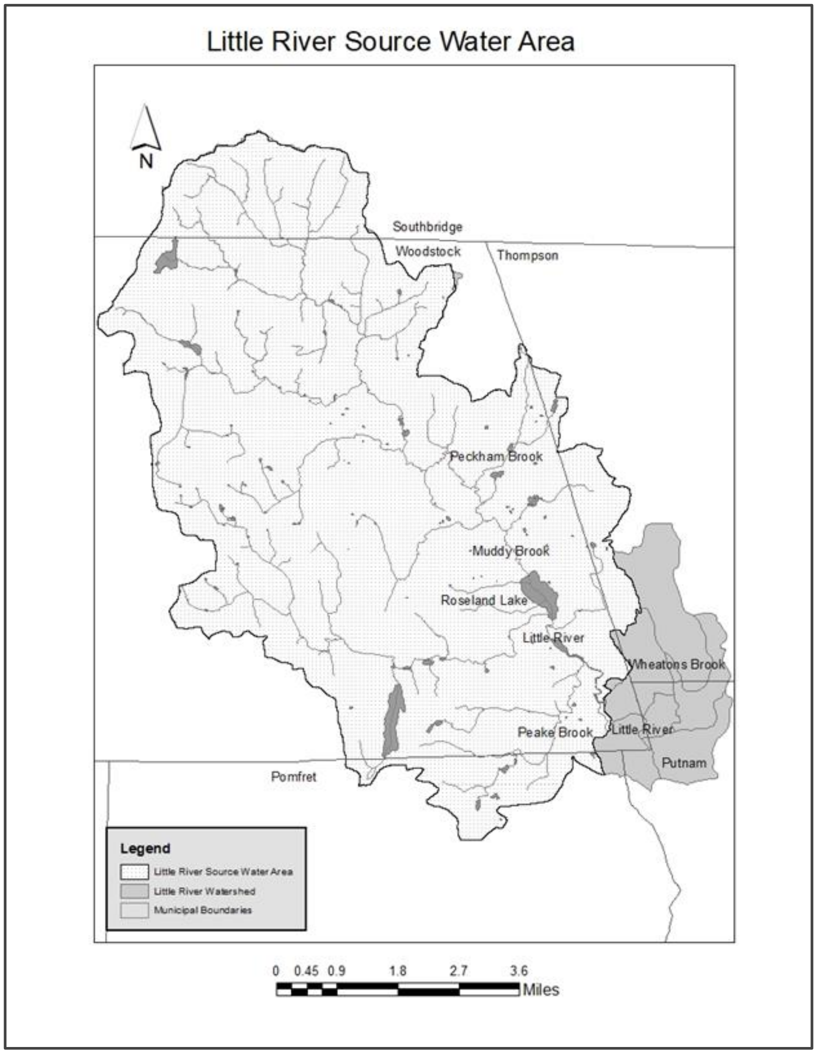


Figure 4. Little River Source Water Protection Area of Influence upstream of the Little River diversion.

a. Location of surface or groundwater protection area/area of influence.

The map of the source water protection area upstream of the Little River diversion was created using the USGS StreamStats Application version 1.2.22. (Figure 4). The area of the drainage basin upstream of the Little River diversion is 35.5 square miles. The entire Little River HUC 12 watershed, including the drainage areas below the source water inlet, is 39.2 square miles. Little River discharges into Quinebaug River in Putnam, CT.

b. Characteristics of the MLRA/ecoregion.

Little River is in EPA Ecoregion 59c, described as the Southern New England Coastal Plains and Hills by the Native Plant Trust (Figure 5). Ecoregions are areas where ecosystems (and the type, quality, and quantity of environmental resources) are generally similar. Historically, the land in Ecoregion 59c was predominantly forested with a mix of oaks, American chestnut, hickories, other hardwoods, and some hemlock and white pine. These primeval forests were cleared either for agriculture or grazing, or for charcoal production. As the less valuable farmland was abandoned, forest regrowth took place. A variety of dry to mesic successional oak and pine forests covers the region today, mixed with elm and ash. Red maple is typical in the southern New England forested wetlands. Much of the more productive farm soils in the

Muddy Brook/Little River valley that supported farms 100 years ago are still managed as farmland today.

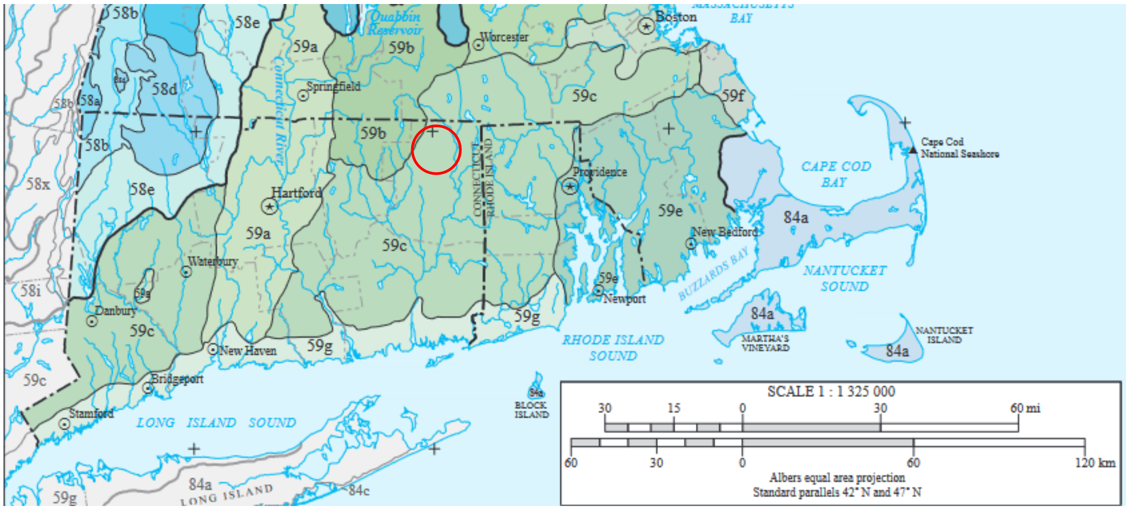


Figure 5. Level III and IV Ecoregions of New England. Location of Little River watershed shown with a red circle.

c. Geology.

“The bedrock of the area consists primarily of igneous and metamorphic rocks of early Paleozoic age. Granite is the most common igneous rock, and gneiss, schist and slate are the most common metamorphic rocks” (USDA NRCS 2008).

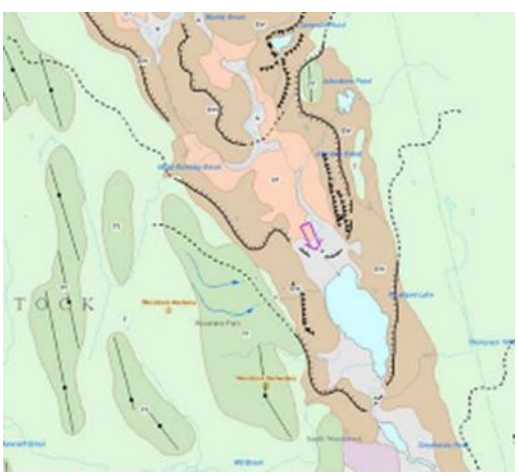


Figure 6. Roseland Lake and Shepherds Pond in Woodstock are located within the East Woodstock stratified drift deposits.

d. Geomorphology and soils/soil interpretations.

At the end of the most recent ice age, approximately 12,000 years ago, the East Woodstock Glacial Deposits were laid down in what is now known as the Little River/Muddy Brook valley in Woodstock. These deposits were formed under an upper extension of Glacial Lake Quinebaug. In areas, the coarse-grained stratified drift deposits are estimated to be between 50 – 100 feet deep and could serve as a potential new future source of public drinking water.

As the glacier retreated in a general northward direction, different ice margins formed and held back meltwater. When a breach would form through an ice margin, the spillway would concentrate water with great force through the valley below. Immediately below the spillway, a scour pool would develop. Roseland Lake and Shepherds Pond were created at different times as the result of breaches in an ice margin during the melting of the glacier (Email communication with Margaret Thomas, CT DEEP, 11/21/2012). Both of these waterbodies in the Little River watershed are natural lakes with no dams associated with them.

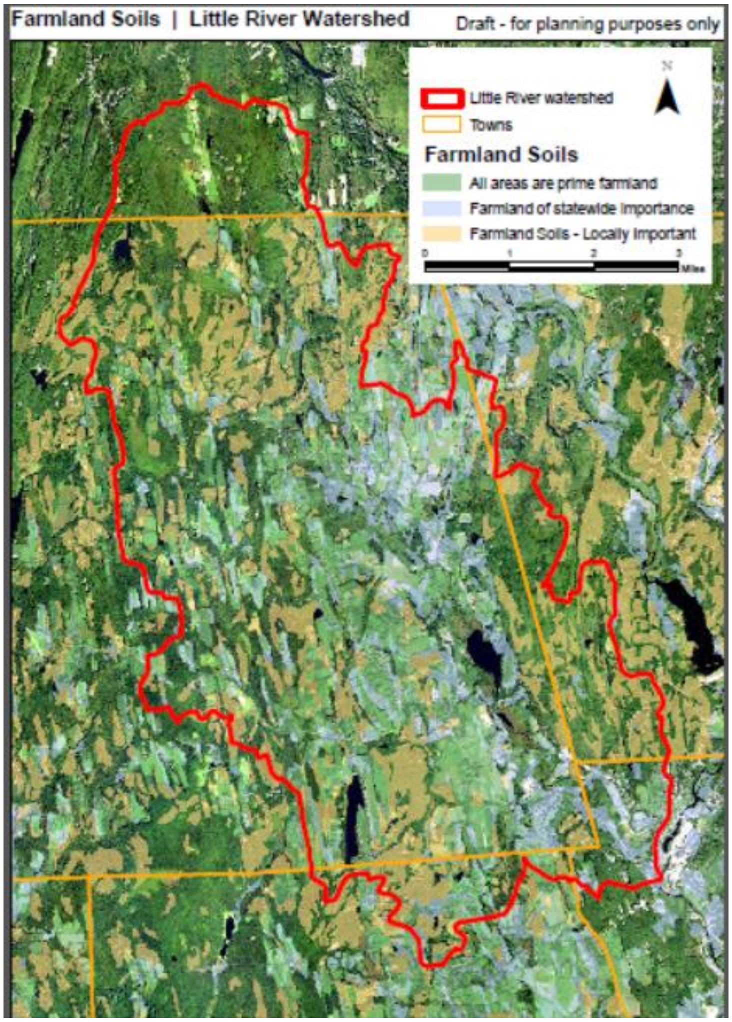


Figure 7. Farmland soils of importance.

<u>Soils</u>

"The dominant soil orders in this MLRA are Entisols, Histosols and Inceptisols. The soils in the area dominantly have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed mineralogy. They generally are very deep, somewhat excessively drained to poorly drained, and loamy or sandy. Udorthents (Hinckley series) and Udipsamments (Windsor series) formed in outwash deposits on outwash plains, terraces, kames, and eskers. Haplosaprists (Freetown series) formed in organic material in depressions on uplands and outwash plains. Dystrudepts formed in till, loamy sediments over till, and dense till on till plains, hills, and ridges (Canton, Charlton, Chatfield, Gloucester, Hollis, Montauk, Paxton, Scituate, Sutton, and Woodbridge series) and in outwash deposits on outwash plains and terraces (Merrimac series). Endoaquepts (Leicester and Ridgebury series) and Epiaquepts (Ridgebury series) formed in till in depressions on hills and in drainageways. Fragiudults (Rockaway series) formed in till on hills" (USDA NRCS, 2008).

The farm soils of the East Woodstock/Muddy Brook and Little River valley were used for productive agriculture by Native Americans prior to European migration and settlement.

While the land in the watershed is currently about 60% forested, the stone walls dividing the contemporary forested areas indicate the land was cleared for agricultural use during the American colonial period. Through natural succession, abandoned farmland was restored to forest cover following the opening of farmable land in the Midwest (A Plan of Open Space and Conservation, Woodstock Conservation Commission, revised 12/3/2003).

Agriculture in Woodstock is supported by soils categorized as Prime Farmland Soil, Statewide Important Farmland Soil and Locally Important Farmland Soil. Each of these soil categories are further described in the table below (Figure 8).

Prime Farmland Soils:
Soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oil seed crops, and are also available for these uses (the land could be cropland, pastureland, range-land, forestland, or other land, but not urban built-up land or water). It has the soil quality, growing season and moisture supply needed to economically produce sustained high yields or crops when treated and managed, including water management, according to acceptable farming practices.
Statewide Important Farmland Soils:
Soils that fail to meet one or more of the requirements of prime farmland, but are important for the production of food, feed, fiber, or forage crops. They include those soils that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods.
Locally Important Farmland Soils:
Soils that are not prime or statewide importance but are used for the production of high value food, fiber or horticultural crops. This land may be important to the local economy due to its productivity or value.

Figure 8. Farm soil categories.

CT NRCS State Soil Scientist, Jason Islieb, informed ECCD that CT NRCS is in the process of updating its criteria used for *Farmland of Statewide Importance*, allowing for *very stony* map units that meet the other existing criteria to be added to the designation (Jacob Islieb, Email, August 22, 2023). Therefore, some of the soil map units currently designated as *Farmland of Local Importance* in select towns will become *Farmland of Statewide Important* for the entire state. The proposed change will not result in all locally-important farmland map units becoming of statewide importance. These changes will influence funding for farm preservation efforts based on agricultural soil classifications. This change will take effect on October 1, 2023, after this plan has been completed. For a list of all farm soils that will be impacted by this change, refer to Appendix C.

Climate Projections for the Next Century
(NPCC 2009)

Temperatures

- Temperatures may increase by 4 to 7.5°F by the end of the century.
- There may be more days over 90 and 100° F.
- Heatwaves may increase in frequency, duration and intensity.
- Extreme cold events may become less frequent.

Precipitation

- Precipitation may increase by 5 to 10% by the end of the century.
- More precipitation may fall in the winter.
- More of the winter precipitation may fall as rain.
- There may be more severe storm events causing flooding.
- Droughts may increase in frequency, duration and intensity.

Figure 9. Climate Projections

e. Climate.

"In MRLA 144A, the average annual precipitation is 45 to 54 inches (1,145 to 1,370 millimeters) in the south end of the western part of the area and in most of the eastern part of the area. The precipitation generally is evenly distributed throughout the year. It is slightly higher in spring and fall in inland areas.

Rainfall may occur as high-intensity, convective thunderstorms during the summer. During the winter, most of the precipitation occurs as moderate-intensity storms (northeasters) that produce large amounts of rain or snow. The average annual temperature is 44 to 54 degrees F (6 to 12 degrees C), increasing from north to south. The freeze-free period averages 190 days and ranges from 145 to 240 days."

"Temperatures in Connecticut have risen almost 3.5°F since the beginning of the 20th century. The greatest number of hot days occurred during the last two multi-year periods (2010–2014 and 2015–2020). The number of warm nights has been consistently above the long-term (1895–2020) average since 1995; the most recent multi-year period had the second-highest average. The number of very cold nights has been below average since the mid-1980s, with the lowest multi-year average occurring during the 2010–2014 period.

Precipitation in Connecticut is abundant but highly variable from year to year. Generally, annual precipitation has been above average since the 1970s. The driest multi-year periods were in the 1960s and the wettest in the late 1970s and late 2000s. The wettest consecutive 5-year interval on record (2007–2011) averaged 53.6 inches per year, while the driest (1962–1966) averaged about 36 inches per year. The single driest year was 1965, with a statewide average of 30.7 inches, while the wettest year was 2011, with 63.7 inches. The highest number of 2-inch extreme precipitation events was recorded between 2005 and 2014. Summer precipitation was generally above average in the 2000s and early 2010s. Connecticut experienced extreme drought in 2016–2017 and again in 2020, straining water supplies" (USDA NRCS, 2008).

Potential impacts on agriculture from climate change include a longer growing season, increased runoff from high-intensity rain events, increased number of days over 90°F, increased energy usage on dairy farms as more fans are needed to keep the cows cool, and decreased milk production (USDA NRCS, 2008). Earlier spring warming encourages fruit trees to flower earlier and increase the risk from frost kill (Poizner, 2022).

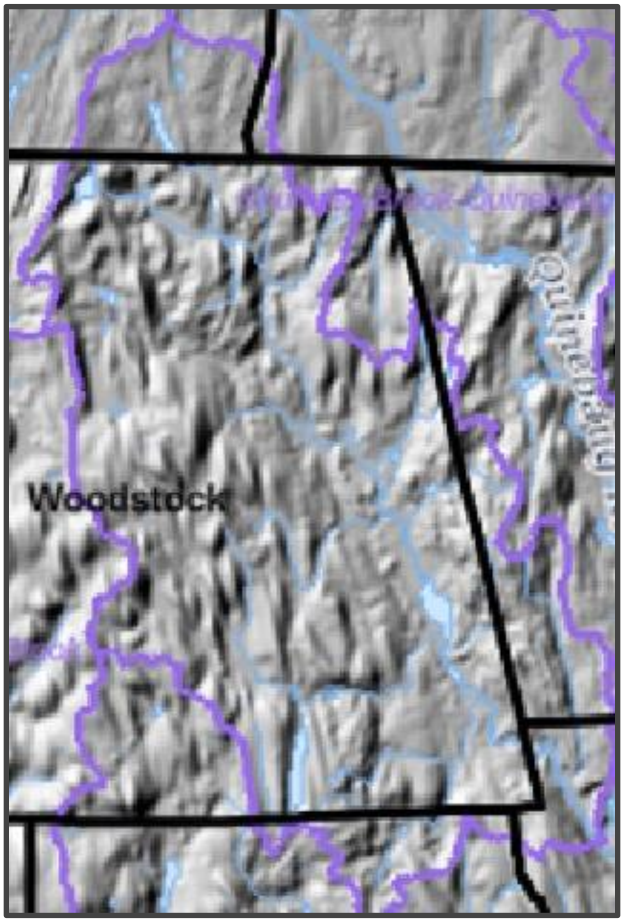


Figure 10. Topography and drainage system hillshade map with stream channels.

f. Topography and drainage system.

The Little River watershed is in the Eastern Uplands of Connecticut. The area is described as having smooth bedrock knobs and drumlins. The area has long been an area of agricultural importance, with rich soils and adequate rainfall. The source of the agricultural productivity is the cover of glacial till that has buried the infertile bedrock. (*The Face of Connecticut*, 1985 pgs 44 – 48)

A Little River Drainage System Map (Figure 8) overlying a shaded relief LiDAR view of the watershed was created using The Last Green Valley Conservation Map Viewer.

g. Land cover/land and water uses.

The University of Connecticut Center for Land Use Education and Research developed land cover layers for GIS applications using satellite-derived, 12 class, 30 meter pixels land cover datasets. Using the land cover data clipped using an outline of the Little River source water area, it was possible to estimate the land cover types in acres based on the most recent (2015) remote sensing information (Figure 11). The land cover was grouped into categories. Forested land included Coniferous Forest, Deciduous Forest and Forested Wetlands. Impervious Cover, Turf Grass and Barren Land were combined into a general Developed Land Category. Non- Forested Wetlands and Open Water were categorized as Wetlands and Watercourses.

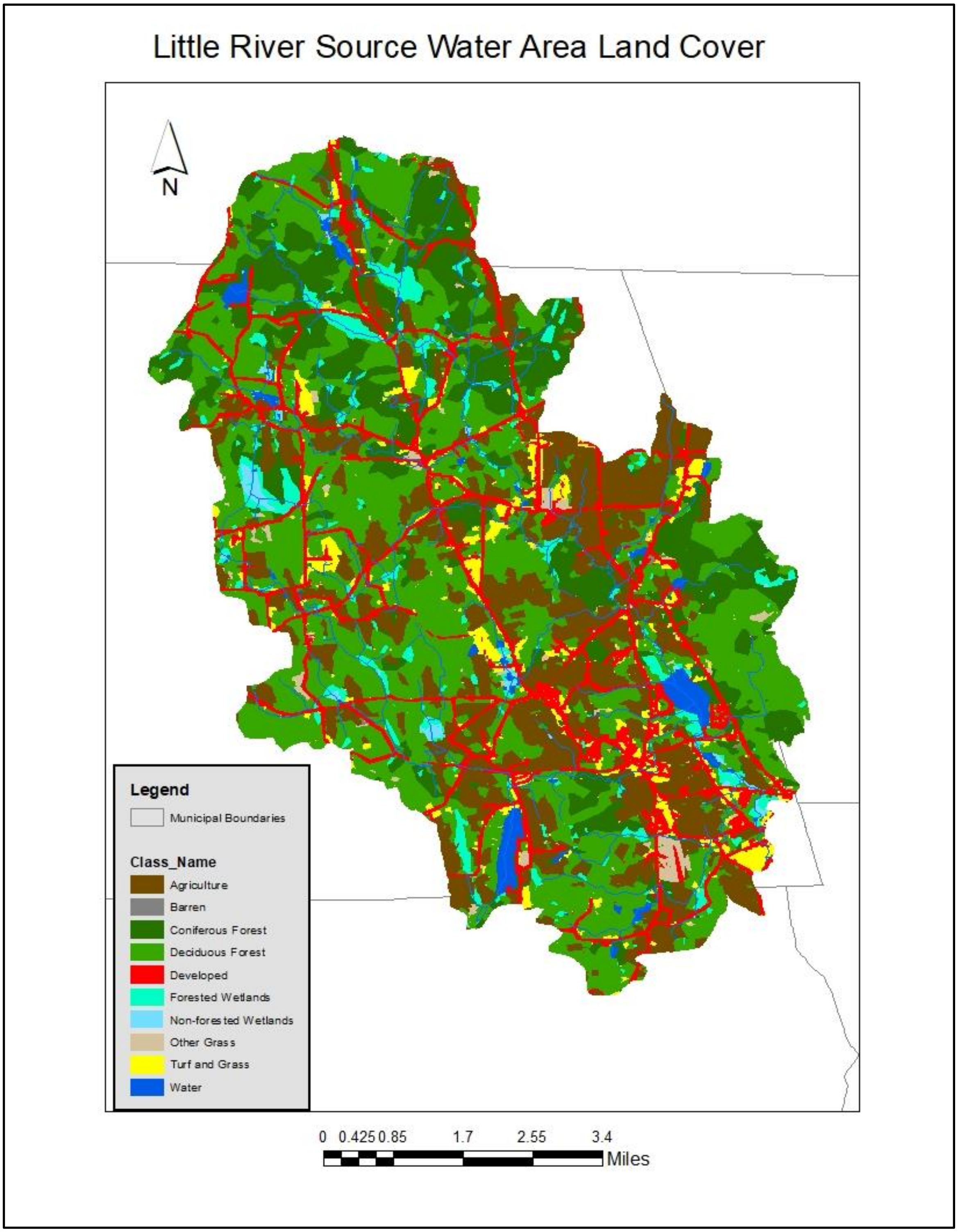


Figure 11. Little River source water area land cover.

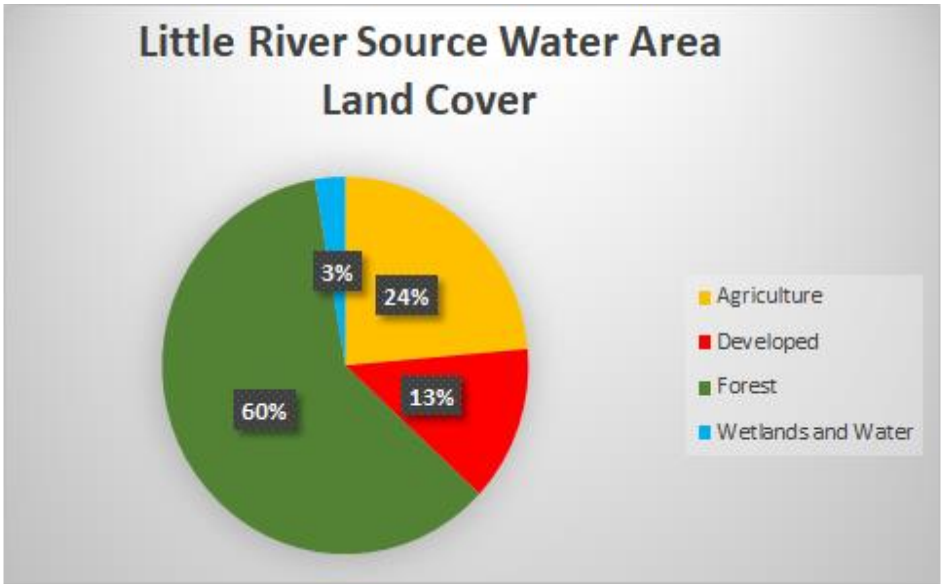


Figure 12. Little River sourcewate land cover.

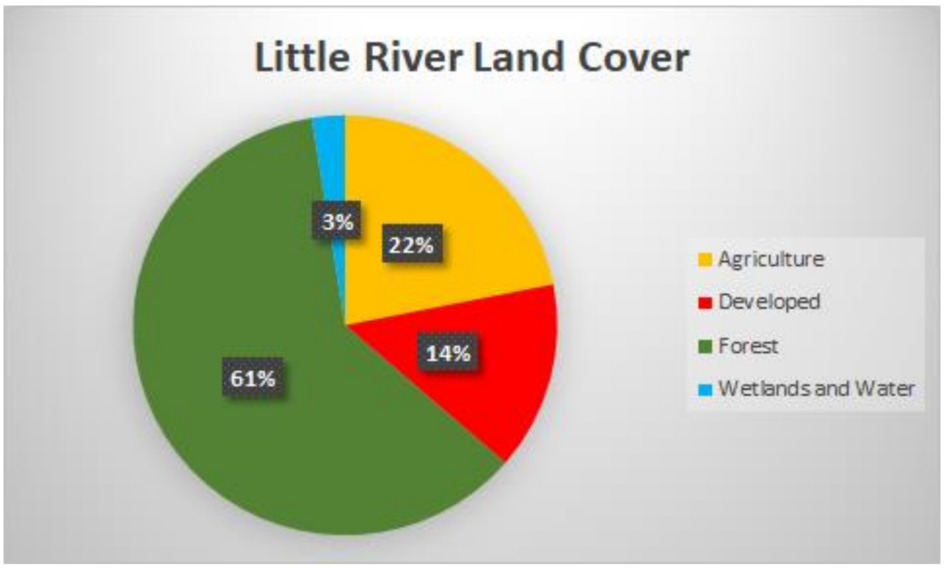


Figure 13. Little River Land Cover HUC 12 watershed.

Little River Source Water Area Land Cover does not include watershed downstream of the bypass to the Putnam Water Treatment Plant.

Phosphorus is a nutrient of concern in the watershed, especially above Roseland Lake and Shepherds Pond. Excess phosphorus combined with an increasing number of days greater than 90 °C during the summer growing season create conditions that support excessive growth of cyanobacteria. Runoff from agricultural land in the Muddy Brook and Little River valleys, without field breaks or vegetative streamside buffers, does not have the opportunity to filter naturally. The dominant location of the forested land is on the outer fringe of the watershed.

Elevated nitrogen levels, especially soluble nitrate-nitrogen, supports other types of phytoplankton growth in spring and fall, including green algae and diatoms. Excess cyanobacteria and other types of phytoplankton are negatively buoyant and sink to the bottom of the lake when they die, adding to the high nutrient stores in the lake sediments.

Of the 35.5 square mile watershed upstream of the water treatment plant inlet, approximately 23.6% is managed for agricultural purposes and slightly over 60% is forested land. There is approximately an additional 127 acres of land in agricultural use in the Little River watershed downstream of the water treatment plant in Putnam at the Putnam, Pomfret, Woodstock municipal border. This includes land that supports the dairy industry and is subject to nutrient enrichment from dairy manure.

Groundwater recharge impacts surface water flow throughout the watershed. Using the CLEAR 2015 landcover data, the Little River watershed above the Putnam water treatment plant includes approximately 8.6% impervious cover. Due to the rural nature of the community, the impervious cover is scattered throughout the watershed. Forest cover, which comprises over 60% of the landscape above the water treatment plant, promotes infiltration of stormwater. The forest cover is predominantly on the outer fringe of the watershed at higher elevations. The higher capacity for groundwater recharge in the forested fringe is important for providing baseflow to downstream locations.

The Town of Putnam maintains a permit to withdraw water from Little River to use as a source of drinking water. As previously stated, Putnam Water Pollution Control Authority is permitted to withdraw a maximum of 1.47 million gallons per day from the river contingent upon maintaining a minimum flow based on the bio period for fish downstream of the treatment plant. As part of its permit requirements, the Town of Putnam installed a flow gauge in Little River which came online in June 2011. The gauge is located downstream of the water diversion in the Harrisville section of Woodstock.

There are no permits for non-consumptive surface water withdrawal exceeding 50,000 gallons in any 24-hour period issued in the Little River watershed. Smaller volume non-consumptive surface water withdrawals to water the Roseland Park Golf Course and a vegetable farm have been documented.

Below the water treatment plant in the section of the Little River watershed in Putnam, there is considerably more impervious cover in a more concentrated pattern. Impervious cover comprises about 19.2% of the landscape in the lower section of the watershed. Based on various water quality models including Schuller's Impervious Cover Model (1994), once impervious cover is greater than 10% of the watershed, water quality is impacted by stormwater runoff. Connecticut DEEP used a 12% impervious cover target attainment for the Eagleville Brook Total Maximum Daily Load determination (2007). While not a focus of this watershed-based plan, efforts to address runoff from impervious surfaces in the lower reach of Little River needs to be further investigated.

h. Socioeconomic conditions.

The majority of water users supplied by Little River live in Putnam. In 2021, Putnam ranked #21 out of 169 on the list of the state's most fiscally and economically distressed municipalities in Connecticut. Putnam has been included on the list of top 25 distressed municipalities since at least 2010. (CT Department of Economic and Community Development, n.d.) The percentage of Putnam Elementary School students on free and reduced lunch assistance (69.5%) is higher than the state average of 41.1%, indicating that Putnam has a higher level of poverty than the state average. (Elementary Schools.org, 2016)

In 2011, the Town of Thompson was included temporarily on the list of the state's most fiscally and economically distressed municipalities, but was removed in 2012. The portion of Thompson in the Little River watershed is mostly forested, sparsely populated and includes the majority of the 1000+ acre Wyndham Land Trust Bull Hill Preserve.

The Town of Southbridge, MA is also an economically disadvantaged community. However, the urban center where the most disadvantaged population live is outside of the Little River watershed. The Southbridge land in the watershed is sparsely populated and predominantly undeveloped forested land.

The northeastern corner of the Town of Pomfret is also in the Little River watershed. The sparsely populated land within the watershed is mostly forested and agricultural land.

The Town of Woodstock has the most land drainage with the potential to impact water quality in the Little River watershed. Land use is a mixture of rural residential and forested land surrounding an agricultural valley. According to the 2020 US Census, Woodstock's poverty rate was 4.1%. In 2016, 17% of elementary school students qualified for free or reduced meals, which is lower than the statewide average, yet indicative of some level of economic distress in the community. The demographics of all the communities in the Little River Watershed are outlined in Figure 14.

Municipality	Population	Median Household income	Poverty Rate	Owner occupied housing units
Putnam	9,224	$64,320	6.4%	58.7%
Woodstock	8,221	$92,165	4.1%	84%
Thompson	9,361	$75,168	7.2%	78%
Pomfret	4,178	$91,788	8.5%	79%
Southbridge	17,740	$52,900	19.6%	46.8%

Figure 14. US Census 2020 data (www.census.gov)

i. Other relevant information to characterize the protection area.

On average, residents living in municipalities that have the greatest influence on Putnam's drinking water quality are more affluent than downstream residents who are the primary users of the water. Those who live downstream are likely less able to afford bottled water if their drinking water has poor taste and odor. Property owners upstream of the Little River diversion that rely on private wells may be unaware of water quality concerns if they do not voluntarily have their well water tested annually. There may be clusters of undisclosed issues which are less likely to be noted due to new regulations regarding access to private well drinking water information.

III. Hydrology and Water Quality Characterization

Little River begins at the outflow of Roseland Lake in Woodstock and flows five miles until it converges with Quinebaug River in Putnam, CT.

Roseland Lake has two main tributaries flowing into it. Muddy Brook is the main tributary, flowing into the lake at its northern end. Mill Brook is the second main tributary, flowing into Roseland Lake at the southwestern end of the lake close to the Little River outlet. English Neighborhood Brook is a tributary of Muddy Brook.

Two miles downstream of Roseland Lake, the Town of Putnam has a permitted bypass that flows into a water treatment plant. The water is processed and added to the town's municipal water distribution system.

a. Available data and resources.

i. Muddy Brook, Roseland Lake studies.

The most current study of water quality in the Little River watershed was conducted by Kenneth P. Kulp of USGS in 1991 (*Suspended-Sediment Characteristics of Muddy Brook at Woodstock, CT* , US Geological Survey, CT DEP Connecticut Water Resources Bulletin No. 43). Analysis of the Roseland Lake watershed was based on water quality data collected between May 1980 through September 1983. During the period of this water quality evaluation, high quantities of sediment in Muddy Brook was documented following runoff-inducing events. From the Kulp study, it was calculated that 427 tons of sediment were being deposited into Roseland Lake annually via Muddy Brook.

ii. DEEP, NGO, ECCD data.

When developing the *Roseland Lake Management Plan* in 2018, Eastern Connecticut Conservation District researched previous water quality studies involving water quality in and upstream of Roseland Lake. The *2018 Management Plan* included a report of previous studies, including available water quality data from USGS, CT DEP and other agencies. A copy of the report, *Review of Previous Studies of Roseland Lake, Woodstock, CT*, can be downloaded from the ECCD website.[5]

iii. Surface and Groundwater monitoring data; water level and quality.

Pathogen Data

Coliform bacteria are rod-shaped Gram-negative non-spore forming bacteria. The total coliform group is a large collection of different kinds of bacteria. There are three different categories of coliform bacteria: total coliform, fecal coliform and *E. coli*, each having a different level of risk. These organisms can be found both in the environment and in the feces of all warm-blooded animals, including humans. Total coliform, fecal coliform, and *E. coli* are all indicators of drinking water quality. Fecal coliforms are types of total coliform that mostly exist in feces. *E.coli* is a sub-group of fecal coliform. Coliform bacteria may not cause illness, but their presence in drinking water indicates that other disease-causing organisms (pathogens) could be in the water system. Most pathogens that can contaminate water supplies come from the feces of humans or other animals. Testing drinking water for all possible pathogens is complex, time-consuming and expensive. It is relatively easy and inexpensive to test for coliform bacteria. If coliform bacteria are found in a water sample, water system operators are required to find the source of contamination and restore safe drinking water. (*GUIDANCE DOCUMENT Presence of Total Coliform or Fecal Coliform/ E. Coli Bacteria in the Water Supply At Food Service Establishments*, n.d.)

Roseland Lake Data

While developing the *Roseland Lake Management Plan*, Eastern Connecticut Conservation District and volunteers from The Last Green Valley Water Quality Monitoring Program sampled Roseland Lake and its tributaries in 2015 and 2016. The water quality data is available in *Roseland Lake Management Plan*, Appendix D – Tributary Water Quality Monitoring Results.

Putnam WPCA sponsored a Roseland Lake water quality study in 2020, 2021 and 2022. The sample method included monthly in-situ physical data collection and nutrient samples. Continuous monitoring probes suspended from a buoy near the surface and the bottom of the lake were also deployed in the deep hole of the lake. Data from 2021 and 2022 was provided by WPCA's consultant, Pond and Lake Connections. The full report is located in Appendix A.

[5] https://conservect.org/eastern/wp-content/uploads/2018/01/13-01e-Task-1e-Review-of-Previous-Studies-of-Roseland-Lake-final-draft.1.pdf

Ground Water Data

USGS does not maintain wells for monitoring groundwater quality in the Little River watershed. Community well data from 27 wells was obtained from the CT Department of Public Health as an alternate source of groundwater data.

Private wells

The remainder of the businesses and residential homes located within the source water watershed area are served by private wells. Private well testing is the responsibility of the property owner with oversight by Northeast District Department of Health, if there are drinking water quality issues that need to be addressed. ECCD requested addresses from Northeast District Department of Health for the past 5 years of wells that tested above the safe drinking water limits for Nitrate-nitrogen and *E. coli* bacteria. Recently passed legislation has made that data unavailable.

While there is a potential medium-yield stratified drift aquifer within the Little River valley, there are currently no regulated aquifer protection areas for public water supply wells that draw water from stratified drift deposits in the Little River watershed.

iv. Source water quality data from the water quality treatment intake area.

Putnam WPCA provided water quality data from raw (pre-treatment) water samples from 2017 - 2022. These data were reviewed for nitrate-nitrogen and Total Coliform Bacteria, two of the required tests that may be influenced by agricultural runoff. The complete data set is located in Appendix A.

v. Sources of contamination/pollutants.

Legacy Phosphorus in Roseland Lake

As part of the research for preparing the Roseland *Lake Management Plan*, sediment samples from the bottom or Roseland Lake were collected and analyzed for iron-bound phosphorus concentration by Solitude Lake Management. According to the report, internal loading of phosphorus from the lake sediments is significant, especially in the summer months when the lake is stratified and flushing is at its lowest. The sample results indicate the concentration of Iron-bound phosphorus, which is the form that is released under anoxic conditions, is in the high end of the typical range at 570-949 mg/kg (Solitude Lake Management, 2017).

In 2019, volunteers with The Last Green Valley Water Quality Monitoring Program, following protocols developed by the Cyanobacteria Monitoring Collaborative, collected water samples from Roseland Lake. Water samples collected with a 3 M integrated tube sampler from the center of the lake were collected and frozen to lyse any cyanobacteria cells in the sample. The samples were thawed and analyzed using a Fluor*Quik Fluorometer to measure the relative concentration of phycocyanin, a pigment found in cyanobacteria, as an indicator of the cyanobacteria abundance in Roseland Lake. The data showed that a correlation between water surface temperature and dissolved oxygen concentration at the bottom of the lake is the best predictor for when a cyanobacteria bloom is going to begin in Roseland Lake. Anoxic conditions at the bottom of the lake permit nutrients to be released from the bottom sediments and influence the severity of cyanobacteria blooms in Roseland Lake.

"Harmful Algal Blooms (HABs) are a rising concern for water quality in freshwater lakes. Microcystis and other cyanobacteria are microscopic organisms found naturally at low concentrations in freshwater systems. Under optimal conditions (such as high light and calm weather, usually in summer), these algae occasionally form blooms, or dense aggregation of cells, that float on the surface of the water forming a thick layer or "mat." At higher concentrations, blooms may be so dense that they resemble bright green paint that has been spilled in the water. These blooms potentially affect water quality as well as human health (Microcystis produces microcystin, a potent liver toxin) and natural resources. Decomposition of large blooms can lower the concentration of DO in the water, resulting in hypoxia (low oxygen) or anoxia (no oxygen). Sometimes, this results in fish kills. The blooms can also be unsightly, often floating at the surface in a layer of decaying, odiferous, gelatinous scum.

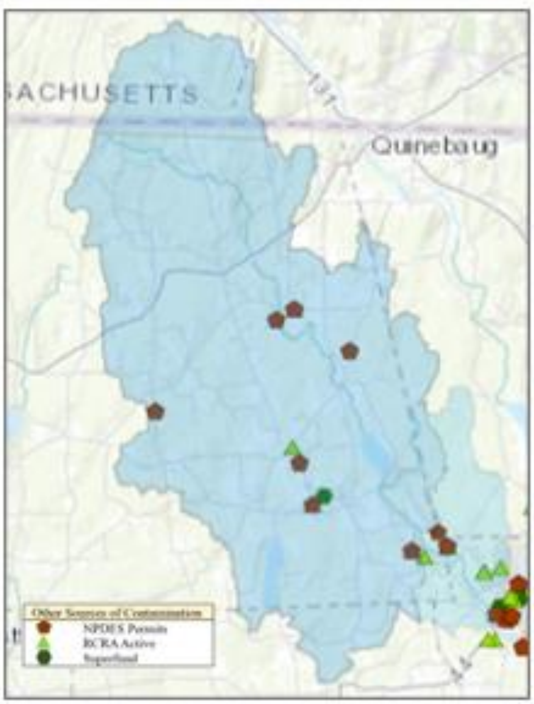


Figure 15. US EPA Drinking Water Mapping Application Potential Sources of Water Pollution Source Waters.

Although the likelihood of people being affected by a cyanobacteria bloom is low, minor skin irritation can occur with contact, and gastrointestinal discomfort can also occur if water from a bloom is ingested. People recreationally exposed (e.g., personal watercraft operators) to cyanobacteria blooms have also reported minor skin irritation. Health problems may occur in animals if they are chronically exposed to fresh water with Microcystis or other cyanotoxins present. Livestock and domestic animals can be poisoned by drinking contaminated water, fish and bird mortalities have been reported in water bodies with persistent cyanobacteria blooms". (US EPA, 2012)

<u>Other potential sources of water pollution</u>

Using the US EPA Drinking Water Mapping Application to Protect Source Waters (DWMAPS) app (https://geopub.epa.gov/DWWidgetApp), other potential sources of water pollution in the sourcewater watershed area were mapped. The following list of regulated activities are shown on the map in Figure 15.

NPDES - National Pollutant Discharge Elimination System Permitted Facilities that Discharge Point Source Pollution to Water.

RCRA Active sites - Resource Conservation and Recovery Act is the public law that creates the framework for the proper management of hazardous and non-hazardous solid waste.

Superfund Site - locations polluted with hazardous materials.

The USGS StreamStats for the Little River sourcewater watershed area shows there are 95.7 local roads and 21.4 local connecting roads upstream of the Putnam Water Treatment Plant. These local roads intersect with streams in 97 locations. The local connecting roads intersect with streams in 26 locations. The road network intersects with sand and gravel deposits for 18.9 road miles.

The majority of residences and commercial businesses dispose of their household waste into septic systems. Septic systems that are not well maintained or over 30 years old are potential sources of nutrient and pathogen pollution.

Turf grass is also a potential source of nutrient and pesticide runoff, especially if there is no vegetated buffer between the lawn and nearby water resources. Chemically maintained turf grass that drains to a storm water conveyance system that discharges to a wetland or watercourse is also a source of water pollution. There are two golf courses in the Little River source water area.

b. Hydrogeology of the source water protection area.

Surface water and groundwater are interrelated. During dry periods, stream and river flow is dependent on groundwater.

i. Major and minor aquifers providing domestic and public water supplies.

A potential aquifer associated with stratified drift deposits has been identified in the Little River watershed. The surface water within Roseland Lake and Little River overlay this potential aquifer and are interconnected through the stratified drift deposit. Sources of contamination above the aquifer recharge areas can potentially impact surface water quality if the contamination plume discharges into the surface water through a spring or groundwater seep.

ii. Ground water (aquifer) depths, potentiometric levels, and flow directions.

The depth of the stratified drift aquifer under the Little River channel is estimated to be 50 – 100 feet of coarse grain deposits. Surrounding the deeper deposits are additional coarse grain deposits estimated to be between 0 – 50 feet deep. The aquifer under the Little River Watershed (Figure 16) is an extension of more extensive sand and gravel deposits underlying the Quinebaug River.

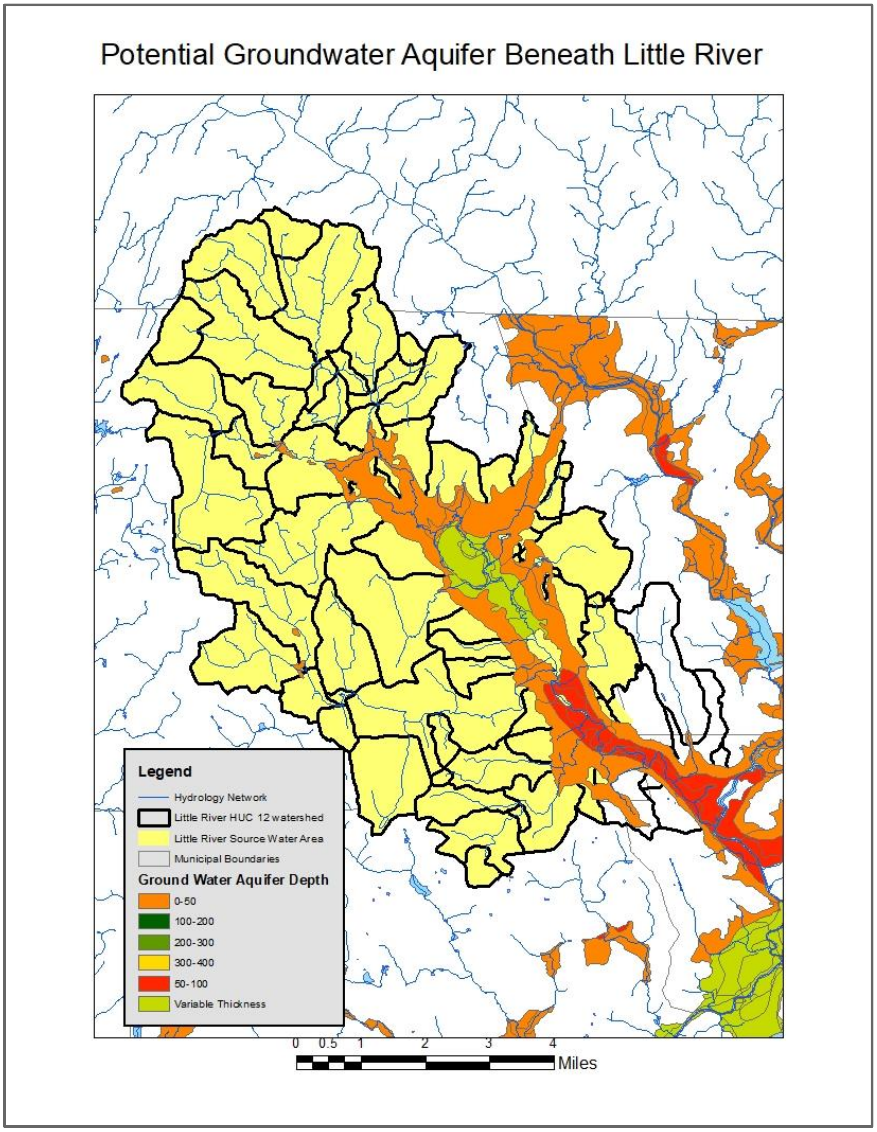


Figure 16. Depth of Stratified Drift Deposits in Little River SWA.

The flow direction of the surface water is generally toward the southeast in the northern section of the watershed, and to the east in the southern part of the watershed.

iii. Surface and Groundwater withdrawals.

The Town of Putnam, CT surface water intake from Little River is within the primary recharge area of the stratified drift aquifer. The exact location of the bypass to the water treatment plant is not depicted on the map due to Department of Homeland Security guidelines. Water quality and quantity in the aquifer within the stratified drift deposits can directly impact water quality and stream flow in Little River.

This aquifer is not currently utilized as a public water supply.

iv. Characterization of aquifer water chemistry.

USGS does not maintain any testing wells in Woodstock. The chemistry of the water in the aquifer is unknown.

c. Recharge and discharge areas; surface water-groundwater interconnections.

Groundwater is the source of surface water during dry periods. Water quantity and quality in Little River is impacted by land use over the primary recharge area of this aquifer. The proximity of the primary recharge area for this stratified drift deposits to the source water surface intake makes protection policies recommended in this plan important for both ground and surface drinking water source protection.

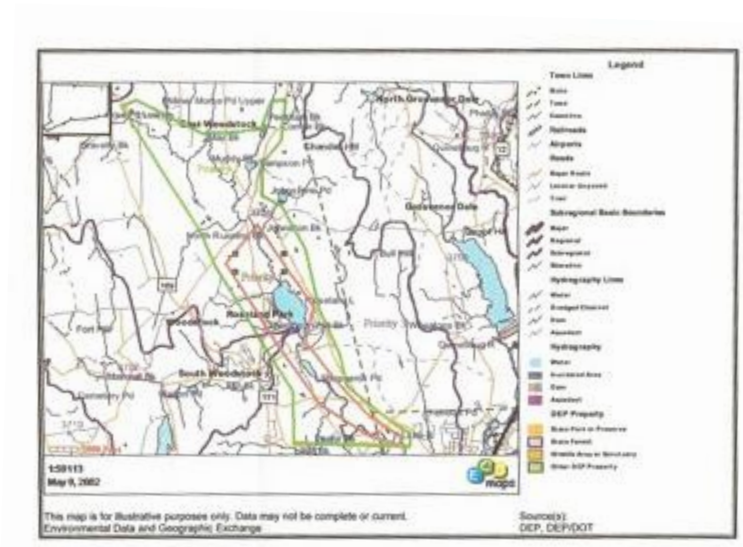


Figure 17. Preliminary Priority Recharge Areas for Little River Aquifer.

In 2002, at the request of Woodstock Conservation Commission, Rob Hust of CT Department of Environmental Protection created a preliminary Primary and Secondary recharge area map for the potential medium yield sand and gravel aquifer that underlies the Muddy Brook and Little River valleys. This hard copy map data was digitized and is deployed in Figure 17. This aquifer is vulnerable to certain types of land uses, if a spill were to occur. The red outline corresponds to the primary recharge area of this aquifer. The yellow outline corresponds to the secondary recharge area to this aquifer.

d. Runoff and streamflow hydrology.

According to USGS the flow between storms is an indicator of long-term stream conditions. Although expansion of a river or stream channel onto its floodplain is a normal, natural occurrence, human interference can cause higher than normal and more frequent flooding. The higher the water level remaining in streams and rivers before a storm, the more likely there will be dangerous conditions, streambed scouring, and other detrimental effects of high water.

Rainfall statistics (Figure 18) and peak flow statistics (Figure 19) were available from the USGS StreamStats report for the Little River watershed. The 24 hour two year precipitation is 3.22 inches, ranging from 2.05 to 3.82 inches.

Parameter Name	Value	Units	Min limit	Max Limit
24 Hour 10 Year Precipitation	4.552	inches	4.15	5.53
24 Hour 25 Year Precipitation	5.557	inches	4.93	7.00
24 Hour 50 Year Precipitation	6.455	inches	5.62	8.36
24 Hour 100 Year Precipitation	7.495	inches	6.41	9.99

Figure 18. Rainfall statistics for Little River watershed.

Statistic	Value	Unit	SE	SEp	Equiv. Yrs.
50_percent_AEP_flood	1080	Ft^3/s	35.5	35.5	2.9
10_percent_AEP_flood	2420	Ft^3/s	36.8	36.8	6.6
4_percent_AEP_flood	3300	Ft^3/s	38.2	38.2	9.2
2_percent_AEP_flood	4050	Ft^3/s	39.3	39.3	11
1_percent_AEP_flood	4840	Ft^3/s	40.7	40.7	12.5
O_2_percent_AEP_flood	7030	Ft^3/s	45.2	45.2	15.1

Figure 19. USGS Peak Flow Statistics Report for Little River watershed.

When water levels are low, portions of the streambed become too dry to support the aquatic life that usually colonizes those areas. Groundwater seeping from the stream banks can help organisms survive for short times. As a result, Little River downstream of the Putnam Little River diversion is monitored for streamflow and withdrawals from the river can be discontinued when the streamflow is below specified seasonal flow rates based on fish spawning requirements.

Impervious cover reduces the ability of water to infiltrate into the ground and increases overground runoff. Runoff that crosses contaminated surfaces will pick up those contaminants and mobilize them to receiving wetlands and waterbodies.

i. Runoff and streamflow generation processes.

A streamflow gauge for monitoring flow in Little River is in the Harrisville section of Woodstock downstream of the drinking water plant intake. This gauge was installed and came online in 2011.

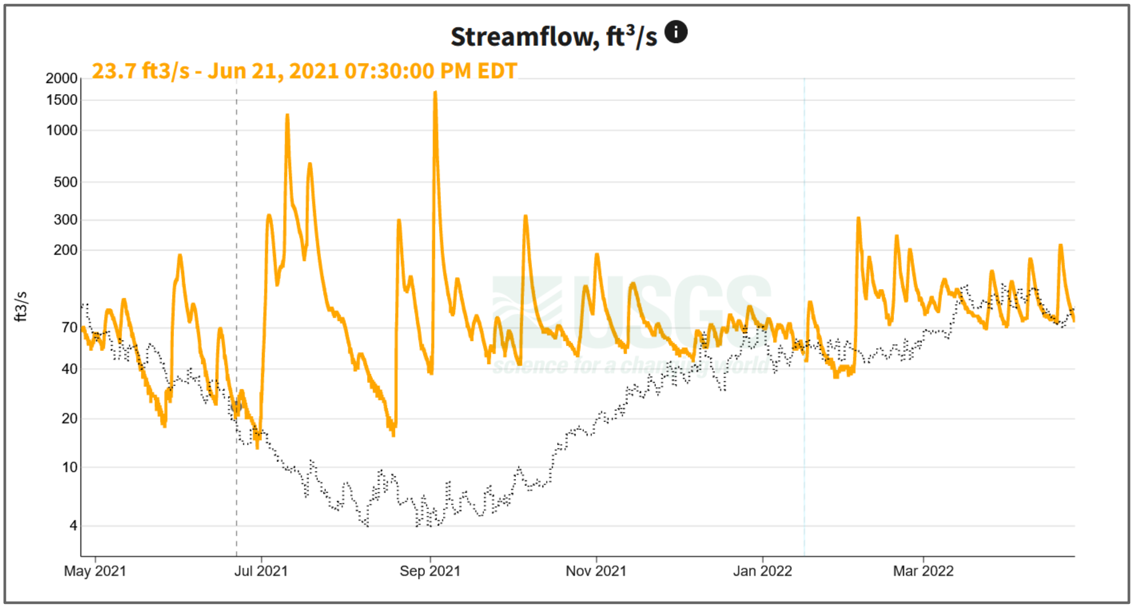


Figure 20. Streamflow downstream of the Little River bypass to the water treatment plant.

Little River flow in cubic feet per second from May 2021 to April 2022 is shown as the orange line on the graph in Figure 20. Median streamflow levels are shown as the black perforated line on the graph. The gauge is located downstream of the Putnam surface water intake and the values would be influenced by how much is withdrawn on a daily basis.

ii. Precipitation-runoff budget.

USGS has not calculated a specific precipitation-runoff budget for the Little River watershed.

From the Connecticut Highlands Technical Report - Documentation of the Regional Rainfall-Runoff Model, a generalized precipitation-runoff budget for Windham County is displayed in figure 21.

State /County Name	Precipitation (inches)	Rain Days	USGS Runoff (inches)
Connecticut/ Windham County	45.09	112.5	25.5

Figure 21. Regional Precipitation-runoff budget for Windham County.

iii. Spatial and temporal distribution of runoff.

This analysis has not been completed for the Little River watershed.

iv. Surface water drainage networks – GIS-derived flow network.

A GIS-derived flow network in the Little River Sourcewater Area is shown in Figure 22. The land drainage in general flows from the northwest to the southeast.

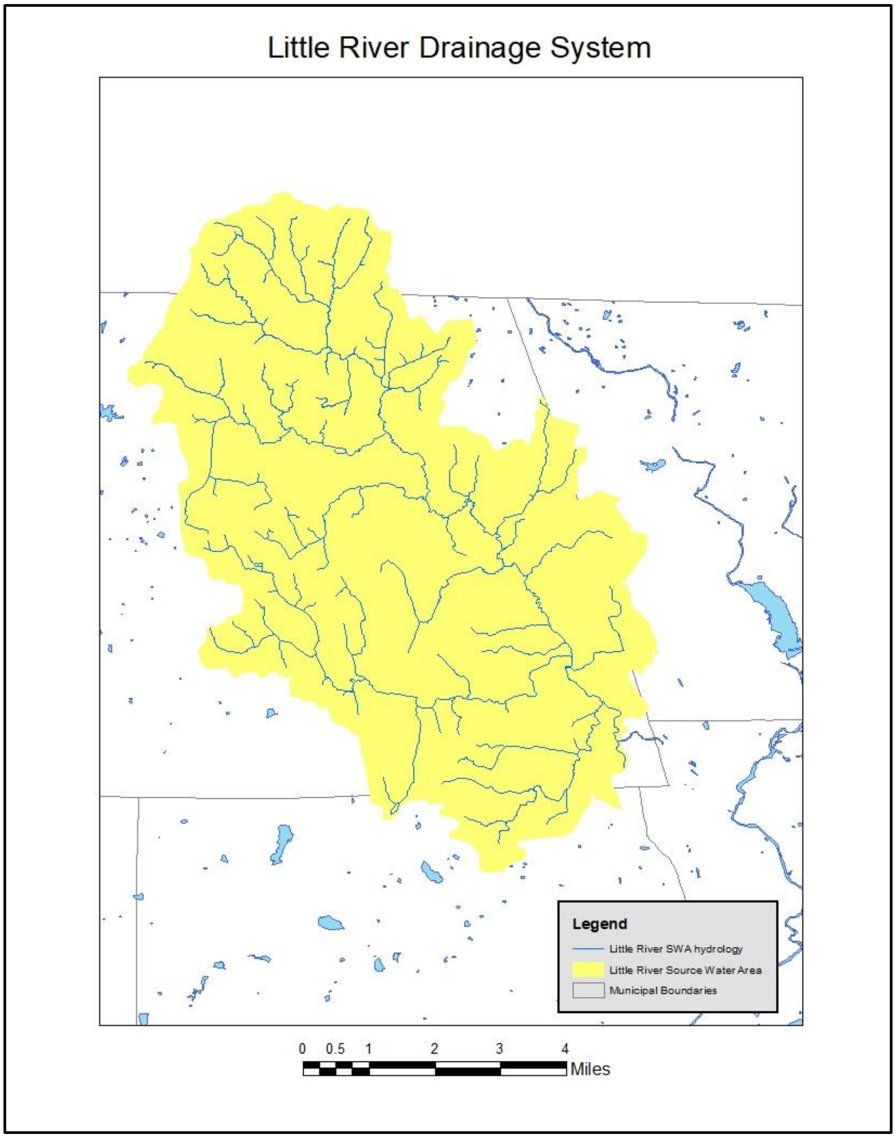


Figure 22. Little River Sourcewater Drainage Network.

e. Potential contaminants of concern and sources.

i. Agricultural sources of concern.

1. <u>Crop growing operations</u>

Type in acres	Corn	Hay + Forage	Pasture	Ag land (unknown use)	
CT - 2021*	1,134	2,738	134		
CT - 2015**				1,483	
MA - 2015**				1,075	
Watershed Total	**1,134**	**2,738**	**134**	**2,558**	**6,564**

Figure 23. Table of crop types and acreage.

Acres of crops with the potential to contribute nutrients in the watershed were compiled using available data. The CT 2021 breakdown by crop types was obtained by CT FSA from 2021 producer voluntary acreage reporting. A FOIA request was submitted in reasonable time to obtain MA FSA 2021 producer voluntary acreage reporting, but the finding was that they couldn't reasonably comply. The 2015 amounts were calculated from CLEAR land use data. Three (3) known plant nurseries, 1 orchard and 1 organic vegetable business are also located in the watershed. (Figure 23)

2. Farm animals

Type	# animals	comments
Dairy cows	3,188	at least 4 farms
Beef cows	165	at least 7 farms
Swine	113	identified 3 properties
Horses	67	at least 26 properties identified/2 boarding
sheep	55	identified 5 properties
goats	unknown	identified 3 properties
alpacas	1	
chickens/ ducks	62	identified 4 properties, but definitely more

Figure 24. Table of animal types and estimated numbers.

Farm animal numbers with the potential to contribute nutrients and pathogens in the watershed were compiled from NRCS sources, ECCD windshield surveys and from the EPA STEPL model. (Figure 24)

3. Animal feeding operations

EPA defines Animal Feeding Operations (AFOs) as agricultural operations where animals are kept and raised in confined situations. An AFO is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

AFOs that meet the regulatory definition of a concentrated animal feeding operation (CAFO) are regulated under the NPDES permitting program. The NPDES program regulates the discharge of pollutants from point sources to waters of the United States. CAFOs are point sources, as defined by the CWA [Section 502(14)].

Under the authority of section 22a-430b of the Connecticut General Statutes, CT DEEP developed a General Permit for Concentrated Animal Feeding Operations (CAFO GP) that went into effect on January 1, 2023. A final determination for APOs that will be qualified as CAPOs under this permit has not been completed. Farms that are designated to be CAFOs and subject to regulations under the CAFO General Permit may not be eligible to receive EPA Section 319 NPS funding for implementing required environmental improvements under the CAFO General Permit going forward (email communication with Eric Thomas, CT DEEP, August 2023). USDA NRCS cost share conservation programs will not be impacted by CAFO General Permit regulations (email communication with Nancy Ferlow). A copy of the General Permit for CAFO is located in Appendix B.

ii. Other potential sources (which may confound agricultural conservation solutions).

1. <u>Urban and industrial wastewater lagoons</u>

   Rogers Corporation in East Woodstock has a NPDES permit (CT0021504) for discharging fire pump test wastewater into the fire pond located at the southeast end of the site. Rogers Corporation is in the May Brook watershed.

2. <u>Septic systems</u>

   The majority of businesses and residents in the towns of Woodstock and Pomfret, as well as a section of Thompson in the Little River watershed, have individual onsite wastewater disposal systems. Woodstock Academy, Woodstock Middle School and Woodstock Elementary School are connected to a sewer line extension from the Putnam wastewater treatment plant. Woodstock Water Pollution Control Authority maintains a sewer avoidance policy and, based on that policy, new subdivision lot sizes are required to be large enough to include a private well, a septic system and a reserve area in the event the existing system should fail in the future. Septic system maintenance is the responsibility of property owners. The Northeast District Department of Health has oversight for permitting and can mandate repairs.

3. <u>Active and non-active landfills</u>

   The former Woodstock Town Landfill is located on Paine District Road, within the Peckham Brook watershed. The unlined landfill has been capped. The town waste transfer station is located adjacent to the closed landfill. Household waste is compacted and stored in a covered dumpster. Larger open dumpsters are situated for collection of recyclable materials such as waste paper, cardboard and scrap metal.

4. <u>Mining (active/abandoned), petroleum operations, and underground injection</u>

   There are no gas stations or underground injection sites in the Little River SWPA. Mining, which is limited to sand and gravel, is regulated by the local Planning and Zoning Commission.

iii. Contaminant physical and chemical properties - modes of transport.

The contaminants of concern in the Little River watershed include excess nutrients, sediment, pathogens and pesticides.

1. Nitrogen

   Nitrogen is an essential nutrient for plant growth. Failing septic systems, agricultural sources and atmospheric deposition are three types of non-point sources of nitrogen.

   Crop-ready nitrogen-based fertilizers over applied or applied at the wrong time to the land can be configured into water soluble ions including nitrate-N, nitrite-N and ammonia-N. These forms of nitrogen, as well as organic nitrogen containing particulate matter, can be exported off treated fields by surface stormwater runoff.

   Soluble forms of nitrogen can also be transported into groundwater and released into surface water at groundwater upwellings (springs). Soluble nitrogen interacting with soil microbes can denitrify it into inert nitrogen gas through natural processes in the nitrogen cycle. If an agricultural field is underlaid with tile drains to facilitate field drainage, the interface with soil microorganisms is reduced, allowing the surplus soluble nitrogen to drain from the fields without being treated through natural processes.

   Soluble forms of nitrogen introduced to groundwater may take years to flush out after the source of the contamination is removed or reduced. Multiple studies provide evidence demonstrating that slow release of nitrogen to streams can accumulate in groundwater and other storage areas. The United States Geological Survey refers to the slow release of nitrogen to streams from varied sources, such as an accumulation in groundwater and other storage areas, as *legacy nitrogen*. (Johnson & Stets, n.d.) While it is well known that nitrogen pollution has negative environmental impacts, the amount and role of legacy nitrogen in the Little River watershed is currently unknown. In some areas of the country, despite best efforts to reduce runoff contaminated with nitrogen, nitrogen pollution persists at elevated levels. The lag between efforts to reduce the load of nitrogen and improved water quality is under review. Currently, models for nutrient load reductions do not adequately address legacy nitrogen.

2. Phosphorus

   Phosphorus is a pollutant of concern both in surface runoff and potentially from groundwater sources. Phosphorus is present in both organic and inorganic forms. The inorganic forms of phosphorus are divided into three general categories:

   - plant available phosphorus that is dissolved in water in a form ready to be used by plants,
   - sorbed phosphorus attached to clay surfaces, iron (Fe), aluminum (Al), and calcium (Ca) oxides in soil released slowly for plant uptake,
   - Mineral phosphorus is composed of primary and secondary phosphate minerals present in soil. Primary phosphorus minerals include apatite, strengite, and variscite. Secondary phosphorus minerals include calcium (Ca), iron (Fe), and

aluminum (Al) phosphates that release extremely slowly and occurs when the mineral weathers and dissolves in soil water.

In freshwater ecosystems, plant available phosphorus is typically the limiting factor for supporting plant growth. Roseland Lake has been receiving both plant soluble and mineral sorbed phosphorus for hundreds of years. The sediments at the bottom of the lake have been a sink for phosphorus stored over time. In 2016, Roseland Lake sediment samples were analyzed for their phosphorus content. Nutrient modeling conducted as part of the *Roseland Lake Management Plan* indicated that legacy phosphorus deposits stored in lake sediments are released during the growing season when the lake is temperature stratified and the bottom region becomes anoxic. During the summer, this source of phosphorus provides up to an estimated 40% of the available phosphorus, fueling cyanobacteria blooms in the lake (*Roseland Lake Management Plan revised March 8, 2022 , page 57*).

The risk of phosphorus loss in the watershed is related to the degree of phosphorus saturation in agricultural soils. Farm fields over-fertilized with animal waste can potentially reach a stage when the clay and mineral oxide binding sites are exhausted. The soluble phosphorus can then leach into groundwater. Also, tile-drained fields allow groundwater to bypass potential binding sites, discharging phosphorus-rich water into local waterbodies.

Phosphorus sorbed on the clay and mineral oxides at the soil surface can be transported off the field if the field is not properly managed to prevent erosion.

3. Sediments

Loss of topsoil to water and wind erosion is the main cause of sediment pollution. Disturbed soils from construction sites and agricultural operations are susceptible to erosion. Suspended sediment in high concentrations can dislodge or smother plants, invertebrates and insects in a streambed, affecting the food source of fish which can result in smaller and fewer fish. When sediments settle they can bury and suffocate fish eggs and other aquatic life. Iron-rich sediment particles that have sorbed phosphorus to them are a major transport mechanism for phosphorus into waterbodies. Sediment particles can carry toxic agricultural, residential and industrial compounds, including herbicides and pesticides. As sediment-laden water slows upon entering still waters, including Roseland Lake, it contributes to the eutrophication of the lake and succession towards marshland. Inadequate riparian vegetation permits soil from destabilized bank sediments to be more easily eroded during storm events.

4. <u>Pathogens</u>

   Pathogens contained in animal waste are introduced to the watershed by field-grazing livestock or field application of manure. While there are multiple types of pathogens present in animal manure, the commonly used indicator species is *Escherichia coli (E. coli)* bacteria. As a gut-dwelling organism in warm blooded animals, *E. coli* have cytoplasmic extensions called pili that extend through the cell wall. One of the functions of the pili is to help the bacteria cling onto the surface of intestinal walls. When live *E. coli* is shed into the environment, those that survive can be suspended in stormwater runoff or cling to sediment particles or organic debris. *E. coli* is negatively buoyant and will sink to the bottom in calm water.

   In 2018, as part of a tile drain outlet study to determine the effectiveness of a woodchip bioreactor in South Woodstock, ECCD demonstrated that a tile drain outlet contained elevated *E. coli* concentrations after liquified manure was applied to a hayfield. The study indicated that *E. coli* is able to pass through the soil into groundwater. The level of *E. coli* in the tile drain outlet decreased to near zero once the groundwater temperature decreased in winter, but increased in spring when the groundwater temperature increased, indicating that *E. coli* remained viable in the soil or as a biofilm coating the tile drainage pipes (Project # 14-03m Little River Water Quality Improvements - Valleyside Farm Bioreactor Monitoring Project Final Report to CT DEEP).

f. Ambient water quality conditions and problems/threats.

The most recent Connecticut Integrated Water Quality Assessment Report, published in 2022, lists Roseland Lake as impaired for recreation. The reason for the impairment is listed as nutrients.

Lake trophic classifications in Connecticut are based on Total Nitrogen, Total Phosphorus, Chlorophyll A concentrations and the depth at which you can see a submerged secchi disk. Based on monitoring data obtained from Roseland Lake and published in the *Roseland Lake Management Plan*, the parameters that define the lake trophic status in Roseland Lake often fluctuate between the mesotrophic to hypereutrophic range during the summer. Roseland Lake has been on the list of impaired waters in Connecticut since the inception of the list in 1992. Cyanobacteria blooms have been documented on the lake during the summer.

Figure 25 lists the waterbody segments in the Little River watershed that have been assessed and are not meeting one or more water quality goals based on the CT Water Quality Standards and Classifications.

Waterbody Segment ID	Waterbody Name	Location	Stream Miles	Aquatic Life	Recreation
CT3706-00_01	English Neighborhood Brook (Woodstock)-01	Mouth at confluence Muddy Brook parallel along south side of Route 197, US to HW 2 miles US of northern most English Neighborhood Road crossing, Woodstock.	4	Fully Supporting	Not Assessed
CT3707-00_01	Mill Brook (Woodstock)-01	Mouth Roseland Lake above Little River parallel Stone Bridge Road (near Putnam Fish and Game Club property), US to Norwich Worchester [*sic*] Turnpike (Route 171/Route 169) crossing, Woodstock.	1.09	Fully Supporting	Not Assessed
CT3707-00_02	Mill Brook (Woodstock)-02	Norwich Worchester [*sic*]Tpke (Route 171/Route 169) crossing, US to OUTLET of Cemetery Pond, just US of Quasset Road crossing, Woodstock.	1.48	Fully Supporting	Not Assessed
CT3708-00_01	Little River (Putnam/Woodstock)-01	Mouth Quinebaug River (just DS of Route 44 crossing), Putnam, US to drinking water watershed boundary (outlet of marsh, parallel to Peake Brook Road, DS of Shepherds Pond), Woodstock (southeast corner).	2.64	Not Supporting	Not Supporting
CT3708-01_01	Muddy Brook (Woodstock)-01	From mouth at inlet to Roseland Lake, US to Route 197 crossing, Woodstock.	5.44	Not Assessed	Not Supporting
CT3708-01_02	Muddy Brook (Woodstock)-02	Route 197 crossing, US to confluence with Moss Brook (just DS of Route 169 crossing, Sherman corner area), Woodstock.	1.98	Fully Supporting	Insufficient Information
CT3708-06_01	Gravelly Brook (Woodstock)-01	Mouth Muddy Brook DS to Cady Lane crossing, US to HW US County Road crossing, Woodstock.	2.05	Fully Supporting	Not Assessed
CT3708-08_01	Peckham Brook (Woodstock)-01	Mouth at confluence with Muddy Brook just DS of Dugg Hill Road crossing, US to confluence with Coman Brook, just US of Morses Pond outlet stream and parallel to Paine District Road, Woodstock	0.89	Fully Supporting	Not Supporting
CT3708-10_01	North Running Brook (Woodstock)-01	Mouth at confluence Muddy Brook, US to runoff ditch from farm field (300Ft US of farm road crossing) (farm road crossing is 900Ft US of Muddy Brook confluence, farm road is off of Child Hill Road), Woodstock.	0.19	Fully Supporting	Not Assessed
CT3708-14_01	Peake Brook (Woodstock/Pomfret)-01	Mouth Little River DS Route 171 crossing, US to HW east of	3.66	Insufficient Information	Insufficient Information

		Quasset Rd and Wappaquasset Pond, Woodstock/Pomfret.			
CT3708-18_01	**Wheatons Brook (Putnam/Thompson)-01**	**Mouth Little River DS Wicker St crossing, Putnam, US to HW parallel to Ravenelle Rd, Thompson.**	**3.27**	**Not Assessed**	**Not Supporting**
Waterbody Segment ID	**Waterbody Name**	**Location**	**Lake acres**	**Aquatic Life**	**Recreation**
CT3708-00-1-L1_01	**Roseland Lake (Woodstock)**	**Southeast section of Woodstock.**	**96.38**	**Fully Supporting**	**Not Supporting**
CT3708-01-1-L1_01	**Muddy Pond (Woodstock)**	**headwaters of Muddy Brook, near MA border, Woodstock**	**38.42**	**Not Assessed**	**Insufficient Information**

Figure 25. Assessed streams in the Little River Watershed.

In the 2018/2020 Massachusetts Water Quality Assessment Report, Morse Pond in Massachusetts remained listed as an impaired lake segment for the 2018 cycle. It was noted, however, that the lake is very shallow (1.8 m at deepest part of lake) and likely should not be represented as a lake segment.

Cyanobacteria were formerly known as blue green algae. While considered a type of phytoplankton, cyanobacteria are structurally more like photosynthetic bacteria. When present in high concentrations, cyanobacteria can cause water to taste and smell badly, and be aesthetically displeasing. Under certain conditions yet to be defined, cyanobacteria may also create by-products of their cellular metabolism that are toxic to mammals. Exposure to cyanobacteria and their toxins could occur by ingestion of drinking water contaminated with cyanotoxins and through direct contact, inhalation and/or ingestion during recreational activities. Cyanotoxins, if present in the water, can be a threat to a significant source of Putnam’s drinking water. Because most cyanobacteria can use atmospheric nitrogen as a nutrient source, the limiting factors for promoting cyanobacteria blooms are available phosphorus and temperature influences. Water temperatures above 25° C (77° F) favor cyanobacteria over other forms of phytoplankton growth. With the average number of days with greater than 90° F increasing due to climate change, a critical focus for NRCS programs in the Little River watershed is to reduce sources of phosphorus entering Roseland Lake. Phosphorus can be transported to surface water attached to sediments. A focus on reducing soil erosion or filtering sediment laden runoff is critical.

Surplus soluble nitrogen applied to the land has the potential to contaminate groundwater sources or be transported to downslope waterbodies with stormwater runoff. Nitrogen discharging from the watershed contributes to eutrophication in the Thames River estuary and Long Island Sound.

Pathogen contamination is another concern for water quality in the Little River watershed. Muddy Brook, Muddy Pond and Peckham Brook upstream of Roseland Lake were assessed for pathogen concentrations using *Escherichia coli (E. coli)* as the indicator organism. *E coli* is a bacterium found in the gut of all warm-blooded animals and its presence in high concentrations indicates the water has been contaminated by fecal material. Muddy Pond in the headwaters of the watershed is a bathing beach and is assessed weekly each summer. There were no reported water quality issues related to pathogens in Muddy Pond for the past several years. Muddy Brook, between Route 197 and Roseland Lake, and Peckham Brook both exceed the Connecticut Water Quality Standards for *E. coli* concentration. Peake Brook was assessed in 2014 and, based on a limited sample set, the data implies a recreation impairment. The baseline low flow geometric mean (average) of 8 samples was calculated to be 348 MPN/100 ml. This is higher than the threshold target of 126 MPN/100 ml. Little River downstream of the water treatment plant intake is also impaired for recreation due to elevated *E. coli* concentrations. The remainder of the stream segments in the watershed were not fully assessed and their status for pathogen concentrations is unknown. Roseland Lake has not been assessed for pathogens to any significant degree.

Nitrogen, phosphorus, pathogens and sediment are common components of stormwater runoff from agricultural areas. In addition, these contaminants may also be found in higher concentrations in groundwater near agricultural operations. Dissolved nitrogen in concentrations higher than 10 mg/l is a human health concern. The presence of *E. coli* in water indicates fecal contamination that may also include pathogens that present human health risks, such as cholera or cryptosporidium. Excess phosphorus fuels aquatic plant or phytoplankton growth, which not only alters the aquatic ecology of the receiving water but may lead to cyanotoxin production.

i. Water quality data (physical, chemical and biological indicators) - impacts.

ECCD staff obtained and reviewed water quality data from multiple sources. Data obtained from Putnam Water Pollution Control Authority is located in Appendix A. Data associated with the Roseland Lake Management Plan is available in Appendix D of that document. Bacteria data for Muddy Brook and Peckham Brook were obtained from the CT Statewide Bacteria TMDL for the Little River. Peake Brook and other data collected by The Last Green Valley Volunteer Water Quality Monitoring Program was obtained from the Program Coordinator, Jean Pillo. Dr. John Clausen provided data from UCONN's Conservation Partnership Program, *Path to Reduce Pathogens in CT Agricultural Runoff*.

Nutrients

At the time of this Plan, there is no TMDL assessment for nutrients specifically in the Little River watershed. The Connecticut Water Quality Standards and Classifications do not include specific nutrient threshold values for non-waste receiving streams.

In the *Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound* assessment for Long Island Sound, there is an across the board recommendation to 10% reduction in nitrogen entering Long Island Sound, leading to seasonal hypoxia.

Nutrient thresholds have been established for stormwater runoff for MS4 communities. Those thresholds are for Total Nitrogen and Total Phosphorus. Assuming that stormwater runoff is expected to meet these concentration thresholds, it can be assumed that river water should be more dilute than concentrated stormwater runoff from outfalls.

Nitrogen is an important nutrient in marine and estuarine waters such as Long Island Sound, as well as a concern in freshwater lakes and rivers. High amounts of nitrogen can lead to excessive growth of aquatic plants and algae, which then reduces the amount of oxygen available to living organisms in receiving waters. Under current MS4 permitting guidelines, last updated on July 1, 2017, any Tier 1 MS4 community with a result for total nitrogen greater than 2.5 mg/L from a stormwater outfall sample is required to conduct a follow-up investigation.

Phosphorus is an important nutrient necessary for growth in plants and animals in freshwater. Too much phosphorus in the water can disrupt the balance of aquatic ecosystems, causing excessive growth of water plants and algae blooms, which reduces oxygen levels in the water potentially harming fish. At times, algal blooms contain toxic forms of algae which, upon contact or consumption, are harmful to people and animals. Under the current MS4 permit, any Tier 1 MS4 community with a stormwater outfall sample with a total phosphorus result greater than 0.3 mg/L is required to conduct a follow-up investigation.

Muddy Brook Nutrient Data Summary

In 2015/2016, Muddy Brook was assessed for Total Nitrogen and Total Phosphorus. A summary of that data is available in Figure 26. Muddy Brook is one of the two main tributaries that flow into Roseland Lake. The baseflow nutrient values represent groundwater-influenced values.

STREAM	BASE FLOW TN	RANGE	BASEFLOW TP	RANGE
	mg/l	mg/l	mg/l	mg/l
Muddy Brook	1.249 (4)	0.998 - 1.911	0.051(4)	0.017 - 0.144

Figure 26. Baseflow Concentration of Nitrogen and Phosphorus in Muddy Brook 2015 and 2016.

The baseflow concentrations, as determined by the 4 samples obtained from Muddy Brook, facilitate eutrophic and highly eutrophic conditions in Roseland Lake.

Peckham Brook Nutrient Data Summary

Figure 27 summarizes the baseflow nutrient concentrations in Peckham Brook. Baseflow concentrations of Total Nitrogen in Peckham Brook would fail the allowable MS4 stormwater outflow limit for an MS4 regulated municipality. Source tracking of this high nitrogen load is recommended.

Peckham Brook Weather prior to sampling	10/27/15 Dry	4/25/16 Dry	11/14/16 Dry	Geomean
Total Nitrogen	2.948 mg/l	3.766 mg/l	3.435 mg/l	3.336 mg/l
Total Phosphorus	0.014 mg/l	0.018 mg/l	0.014 mg/l	0.015 mg/l

Figure 27. Baseflow Concentration of Nitrogen and Phosphorus in Peckham Brook 2015 and 2016.

Peckham Brook is upstream of the Muddy Brook monitoring station. The high Total Nitrogen values in Peckham Brook contribute to the highTotal Nitrogen values in Muddy Brook.

Baseflow concentrations of Total Phosphorus are low and would support a healthy diversity of stream diatoms using the Becker Model. During baseflow conditions, Peckham Brook does not appear to be a major influence on the Total Phosphorus concentration in Muddy Brook.

May Brook

Data collected from May Brook for *Roseland Lake Management Plan* tributary monitoring implicated May Brook as a significant source of nutrients and sediment into Muddy Brook. In 2022, ECCD, in partnership with CT DEEP, US EPA and USDA NRCS completed the construction of a free-stall barn with manure storage and management facilities. Subsequent to the completion of the project, no follow-up data was collected from May Brook. Therefore, it is unknown whether the water quality in the brook or downstream locations was improved by the completion of the project.

Mill Brook

Mill Brook is a tributary of Roseland Lake. The brook converges with the lake near the southwestern end, not far above the outlet of the lake into Little River. Baseflow data obtained from Mill Brook in 2015-2016 are displayed in Figure 28.

STREAM	BASE FLOW TN	RANGE	BASEFLOW TP	RANGE
	mg/l	mg/l	mg/l	mg/l
Mill Brook	0.339 (3)	287 - 382	0.030 (3)	0.020 - 0.044

Figure 28. Baseflow Concentration of Nitrogen and Phosphorus in Peckham Brook 2015 and 2016.

The nutrient values obtained from Mill Brook influence the nutrient concentrations in Roseland Lake. They fall within the mesotrophic range for lake classifications.

Roseland Lake

In 2015/2016, ECCD staff completed a water quality investigation of the Roseland Lake watershed. Data from Roseland Lake was collected monthly during the growing season. Four times during the study, water quality data from the lake's tributaries and the outlet into Little River was collected, including pre-storm, first flush and post-storm monitoring. The Roseland Lake tributary data was assessed to determine areas of concern that were contributing high concentrations of nutrients to the lake. The lake data, along with tributary data, were used to determine nutrient cycling in the lake, and the quantity of nutrients from external versus in-lake sources. The analysis determined that up to 40% of the nutrients supporting summer algal blooms in Roseland Lake was derived from legacy sources stored in the lake's sediments. The remaining 60% of nutrients during the growing season originated from upland sources. Prior to spring turnover of the lake, the nutrient concentration in the lake surface samples was nearly equal to the tributary contributions, indicating the baseline levels of nutrients in the lake before the lake bottom became anoxic.

Data obtained from Pond and Lake Connections, the lake consultant retained by Putnam WPCA, included continuous monitoring of several parameters in Roseland Lake. Its full report on its monitoring is available in Appendix A. Figure 29 shows the dissolved oxygen values in Roseland Lake in 2022. Anoxic conditions at the lake bottom began in early June and extended to late September with one lake mixing event. Under anoxic conditions, legacy nutrients stored in the lake sediments are released into the water. These nutrients, especially Phosphorus, become available to support cyanobacteria blooms, especially when the temperature of the surface water is >25℃.

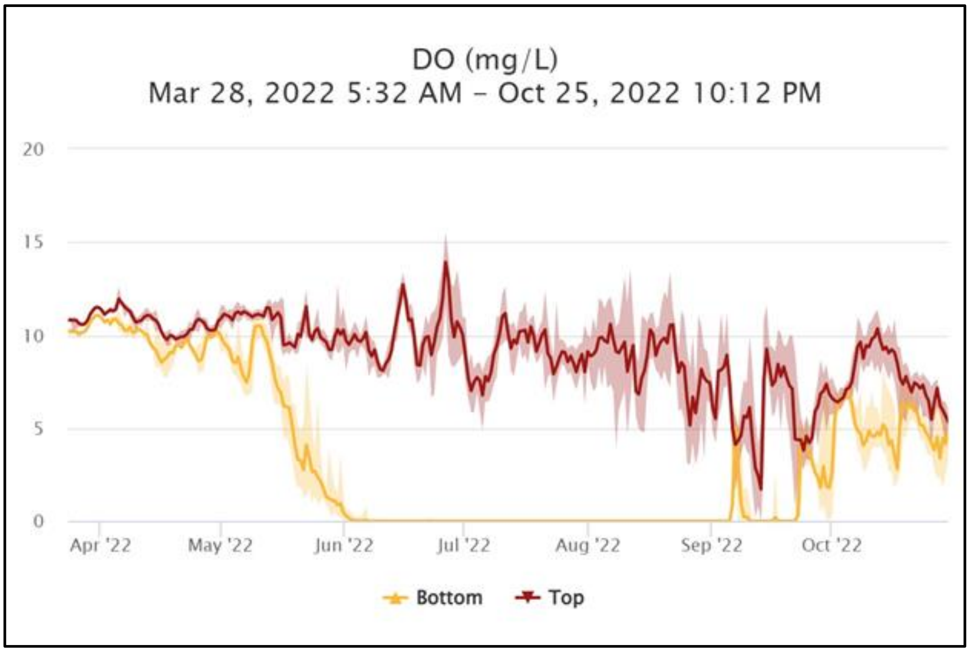


Figure 29. Dissolved oxygen in Roseland Lake from April to November 2022.

<u>Roseland Lake TMDL for Nutrients</u>

CT DEEP is in the process of gathering data for the development of a Phosphorus TMDL for Roseland Lake. Roseland Lake experiences seasonal cyanobacteria blooms. A TMDL for Phosphorus may impact Comprehensive Nutrient Management Plan requirements for agricultural businesses identified as Concentrated Animal Feeding Operations (CAFO). At least one existing agricultural business in the watershed meets the criteria to be defined as a large CAFO where the main farmstead of this farm is located downstream of Roseland Lake, but the farm manages some cropland upstream of Roseland Lake.

The trophic state of Roseland Lake varies seasonally. Data collected in 2015 - 2016 demonstrated that in early spring, prior to the lake stratifying with temperature/density layers, Roseland Lake surface nutrient concentrations measured in the Mesotrophic range. By early summer, legacy phosphorus stored in the lake sediments are released, adding to the surface concentration of total phosphorus. Monthly lake monitoring during summer months documented that the Total Phosphorus concentration at the surface of the lake exceeded 50 µg on three occasions. As the lake began to stratify by temperature in late spring and summer, the lake bottom became anoxic and the TP concentrations increased at both the bottom and the surface. This internal loading of phosphorus from lake sediments contributes to highly eutrophic conditions which support potentially Harmful Algae Blooms in Roseland Lake. Nutrient modeling completed by Dr. Rick Canavan estimated that up to 40% of the total phosphorus in Roseland Lake in summer is derived from internal loading.

Little River Nutrient Data Summary

The two available data sets were reviewed and interpreted regarding Nitrogen concentrations in Little River.

ECCD collected water samples from Little River below the Roseland Lake outlet upstream of Stonebridge Road in Woodstock. A summary of the nutrient concentrations of samples collected in Little River are shown in Figure 30. Nine samples were collected between 2015 and 2016 in both wet and dry weather. The samples were assessed for nutrients including Total Nitrogen, Nitrate-Nitrogen and Total Phosphorus.

Little River Upstream of Stone Bridge Road				
Date	TN mg/l	NO3 mg/l	TP mg/ml	wet or dry
9/10/2015	0.457	0.017	0.037	dry
9/11/2015	0.469	0.011	0.043	wet
9/30/2015	0.712	0.278	0.041	wet
10/27/2015	0.731	0.129	0.040	dry
10/29/2015	0.741	0.145	0.120	wet
4/25/2016	0.676	0.311	0.038	dry
4/27/2016	0.676	0.329	0.030	wet
11/14/2016	0.968	0.271	0.049	dry
11/16/2016	1.166	0.311	0.070	wet
geomean	0.704	0.127	0.047	

Figure 30. Summary of Little River Nutrient Data from 2015 and 2016.

Putnam WPCA is required to collect and analyze raw water samples prior to water entering the water treatment plant. These requirements include an annual nitrate-nitrogen sample. The results of the sampling from 2017–2022 are listed in Figure 31. It is unknown whether these samples were collected in wet or dry conditions.

Putnam WPCA Raw Water Samples at the Intake	
date	NO3-nitrogen mg/l
Jan-17	0.600
Apr-18	0.058
Jan-19	0.690
Jan-20	0.700
Jan-21	0.820

Dec-22	0.450
geomean	0.429

Figure 31. Putnam Nitrate-Nitrogen Raw Water Data 2017 – 2022.

The raw water concentration for nitrate-nitrogen is well within the acceptable range for drinking water quality.

While the sampling dates and analytical methods may be different, the data suggests there are additional sources of nitrate-nitrogen between the outlet of Roseland Lake and the intake for the water treatment plant in South Woodstock. Potential sources may include agricultural runoff and failed septic systems.

<u>Pathogens</u>

Connecticut Water Quality Standards and Classifications use indicator bacteria to detect the presence of contamination by human or animal wastes. Due to the inherent uncertainty involved in sampling and analytically determining bacteria levels, exceedances of water quality criteria for indicator bacteria does not always indicate a water quality problem and therefore should be investigated by means of a sanitary survey or other appropriate means to determine sources of elevated indicator bacteria levels. The Water Quality Standards for Indicator bacteria are shown in Figure 32.

Water Quality Standards for Indicator Bacteria for Freshwater in Connecticut			
Designated use	Indicator	Criteria By Classification	
Drinking Water	Total Coliform	Monthly Moving Average less than 100 MPN/100 ml	
		Single Sample Maximum 500 MPN/100 ml	
Recreation Designated Swimming Area	E. coli	Geometric Mean Sample Maximum	126 MPN/100 ml 235 MPN/100 ml
Recreation Non-designated Swimming Area	E. coli	Geometric Mean Sample Maximum	126 MPN/100 ml 410 MPN/100 ml
Recreation All Other Uses	E. coli	Geometric Mean Sample Maximum	126 MPN/100 ml 576 MPN/100 ml

Figure 32. CT Water Quality Standards for Indicator Bacteria in Freshwater.

While the indicator organisms used to determine recreational water quality may not themselves increase risks to the drinking water supply, their presence in high concentration may indicate the presence of other more harmful pathogens in the water that could pose a risk, including Cryptosporidium and Cholera.

Muddy Pond Pathogen Data

Muddy Pond in Woodstock has a designated swimming area owned and managed by the Town of Woodstock. The water is tested weekly for *E coli* from Memorial Day through Labor Day. Data obtained from Northeast District Department of Health indicate the water quality in the lake meets recreational standards for a designated swimming area.[6] This information is not reflected in the DEEP assessed waters list.

Muddy Brook Pathogen Data Summary

From 2006 - 2009, Muddy Brook was assessed by CT DEEP as part of its probabilistic monitoring program. Muddy Brook was found not to be in compliance with the CT Water Quality Standards. A Total Daily Maximum Load analysis was calculated. The data on which this assessment was made are available in Little River TMDL Report, pages 24 - 26.

Peckham Brook Pathogen Data Summary

Peckham Brook was assessed by The Last Green Valley Volunteer Water Quality monitoring Program in 2011 and found not to be in compliance with the CT Water Quality Standards. A Total Daily Maximum Load analysis was calculated. The data on which this assessment was made are available in Little River TMDL Report, pages 27 - 28.

University of Connecticut Source Tracking Data using *E. coli* biomarkers

To determine the sources of the fecal material, Peckham Brook and Muddy Brook were assessed through a pathogen trackdown survey using DNA biomarkers. This study was led by Dr. John Clausen of University of Connected and funded through a USDA Natural Resources Conservation Service Regional Conservation Partnership Program (Project ID: 1283). Water samples were collected at Muddy Brook at Roseland Park Road and Peckham Brook at Dugg Hill Road in Woodstock. Sterilized passive stormwater samplers were set up prior to an expected storm event. Samples were obtained as the water level rose. Samplers were collected the following day after the water level receded. Samples were assessed at UCONN for *E. coli* bacteria concentrations and filtered through a sterile filter pad using a vacuum filtration kit. The filter pads were freeze-dried, bagged, labeled and stored below 0°C. At the end of the sampling period, one filter pad from each sample site with the highest measured *E. coli* concentration was shipped to Source Molecular, a specialty lab in Florida. The samples were tested for DNA biomarkers specific to ruminate animals or human sources. If the sample

[6] Weekly data from NDDH is obtained and reviewed by ECCD staff.

tested positive for ruminant biomarkers, it was further tested for cattle biomarkers. The results are presented in Figure 33.

Stream Name	Date	Human	Ruminant	Cattle
Muddy Brook	6/7/2017	ND	6.81E+04 copies/ml	1.03E+03 copies/ml
Peckham Brook	5/15/2017	Detected - low concentration	6.51E+05 copies/ml	6.54E+03 copies/ml

Figure 33. Concentration of Biomarkers in Muddy Brook and Peckham Brook.

In 2017, *E. coli* associated with cattle were confirmed to be present in both Muddy Brook and Peckham Brook. This does not imply that cattle manure to be the only source of *E. coli* found in the brooks. A low concentration of *E. coli* biomarkers was also detected in Peckham Brook.

Peake Brook Pathogen Data Summary

Peake Brook was monitored in 2014 as part of a Little River trackdown survey. The results of that survey are shown in Figure 34.

The Last Green Valley *E. coli* Results 2014				
Date	Little River	Wheaton Brook	Peake Brook	
	MPN/100 ml	MPN/100 ml	MPN/100 ml	
08/12/14	180	1700	160	dry
08/14/14	14000	2400	13000	wet
08/19/14	20	110	340	dry
08/21/14	41	111	240	dry
08/26/14	110	240	420	dry
08/28/14	110	112	460	dry
09/02/14	120	460	20	dry
09/04/14	190	210	330	dry
Geomean	165.76	326.57	348.27	

Figure 34. 2014 Pathogen Results from Little River, Wheaton Brook and Peake Brook.

The geometric mean of the sample set exceeded the CT Water Quality Standards. A single sample exceedance of 13,000 following a rain event also suggests that Peake Brook may be impaired for recreational contact. Due to a small sample set, CT DEEP has classified Peake Brook water quality for recreation as inconclusive.

Little River Pathogen Data Summary

Little River at Murphy Park in Putnam was formerly a designated swimming area. The water adjacent to the beach was assessed weekly through 2005 after the dam breached during a flood. The water in Little River adjacent to the beach failed to meet the water quality standards frequently, especially after a rain event.

In 2014, following the removal of the dam and some significant potential upstream sources, The Last Green Valley Volunteer Water Quality Monitoring Program assessed Little River for *E. coli*. Figure 32 displays the correlation of *E. coli* concentration of Little River at Murphy Park in Putnam and upstream in Peake Brook, as measured in 2014.

The Last Green Valley Volunteer Water Quality Monitoring Program assessed Little River for *E. coli* again in 2022. The ten-sample data set shown in Figure 35 did not indicate any single sample exceedances for *E. coli*, but the geomean of the sample set remains higher than the standard.

Little River at Murphy Park		
Date	MPN/100 ML	runoff
6/7/2022	98	dry
6/14/2022	130	dry
6/21/2022	160	dry
6/28/2022	540	wet
7/5/2022	170	dry
7/12/2022	170	dry
7/19/2022	120	wet
7/26/2022	120	dry
8/2/2022	140	dry
8/9/2022	130	dry
Geomean	155.6	

Figure 35. E. coli results for Little River at Murphy Park in 2022.

Little River Pre-treatment Raw Water Samples from the Water Treatment Plant.

Data received from Putnam WPCA for raw water samples collected at the intake from 2017 - 2022 tested high in Total Coliform bacteria. WPCA is required to sample for pathogens (Total Coliform and *E. coli*) four times per year. In accordance with the CT Water Quality Standards and Classifications (last revised in 2015), the goal for Total Coliform concentrations at a drinking water intake should have a monthly moving average of 100/100ml and a single sample maximum of 500/100 ml. These criteria apply only at the drinking water supply intake structure. The complete raw water data set is available in Appendix A.

The actual range of Total Coliform was 275.5 - >2419.6 MPN/100 ml (2017 – 2022). Only 2 of 22 samples were <500 MPN/100 ml. Eleven of the samples were reported as >2419.6, meaning the actual value could be higher. The geometric average of the sample set could not be determined, but no samples measured below 275.5 MPN/100 ml. Therefore, it can be concluded that the average exceeded the goal of 100 MPN/100. This data indicate a need to reduce pathogen contamination in Little River

E. coli values in the concurrent reported Total Coliform data ranged from 7.5 to 161.6 MPN/100 ml with a geomean of all samples = 35.5 MPN/100 ml. *E. coli* concentrations determined from the same samples measuring the Total Coliform concentration were well within the safe recreational contact range for river water.

Altered Flow Regime

CT DEEP adopted Stream Flow Standards and Regulations on December 12, 2011.The regulations were enacted to balance river and stream ecology, wildlife and recreation while providing for public health, flood control, industry, public utilities, water supply, public safety, agriculture and other lawful uses of water. Little River downstream of the Putnam Water Treatment Plant is classified as a Class 3 stream. This class requires the most balancing of human and ecological needs for water use. Baseline seasonal flow standards were influenced by the fish spawning bioperiods as shown in Figure 36.

Bioperiod	Effective Dates	Minimum Required Release	
		Antecedent Period Dry	Antecedent Period Wet
Overwinter	Dec 1- Feb 28/29	Bioperiod Q99*	
Habitat Forming	Mar 1 – Apr 30	Bioperiod Q99	
Clupeid Spawning	May 1 – May 31	Bioperiod Q95	
Resident Spawning	June 1 – June 30	Bioperiod Q90	
Rearing and Growth	July 1- Oct 31	Bioperiod Q80	Bioperiod Q50
Salmonid Spawning	Nov 1 – Nov 30	Bioperiod Q90	

* These are established by DEEP stream statistics (Stream Stats)

Figure 36. Fish Spawning Bioperiods

There are

various operational flexibilities to the Class 3 release rule for public water supplies, as follows:

- drought relief - progressive triggers to reduce required releases based on drought conditions,
- may reduce spring releases up to 85% to preserve water storage for summer use,
- may reduce releases, subject to certain conditions, to maintain required margin of safety:
    - up to 50% for ten years, with DEEP approval
    - reduce more than 50% or greater than 10 years.

Downstream of the water treatment plant intake, Little River in Putnam is listed as impaired for Habitat for Fish, Other Aquatic Life and Wildlife caused by FLOW REGIME MODIFICATION. Since this determination was made, the Town of Putnam instituted many new practices including the installation of a river flow gauge downstream of the bypass to the water treatment plant for monitoring downstream river flow. Additionally, Putnam created a drought management plan with restrictions for water uses during a severe drought. Putnam also installed a two-way connection to the Connecticut Water Company for supplemental water when the local supplies are less available.

Agricultural uses of water are exempted under the streamflow regulations. Water conservation both upstream and downstream of the Putnam Water Treatment Plant is an important consideration for maintaining streamflow downstream of the Plant.

IV. Resource Analysis/Source Assessment

Below is an overview of the Town of Putnam Little River Diversion Source Water Assessment self-assessment from the town's 2020 Annual Report:

> "The Overall Susceptibility
>
> Rating: HIGH
>
> This rating indicates susceptibility to potential sources of contamination that may be in the source water area and does not necessarily imply poor water quality.
>
> Strengths:
>
> There are no point source pollution discharge points present in the watershed area."
>
> Potential Risk Factors:
>
> This source carries a high-risk factor specifically for environmental sensitivity. The reservoir [Roseland Lake] is able to support excessive growth of algae and plankton. Potential contaminant sources are present in the watershed and homeowners are encouraged to adopt residential best management practices that minimize the use of hazardous wastes or generation of waste in the watershed.
>
> Potential Risk Factors: This source carries a moderate risk factor as major state and interstate roadways are present in the watershed and there are known contaminant release points present in the watershed. There should be monitoring for road salt and herbicides as well as addressing the potential for hazardous spills from vehicular accidents. More than 50% of land for this source water is underdeveloped, which could present a risk if inappropriately developed.
>
> Source Protection Needs: This source carries a high rating as less than 1% of the land is owned by the public water system and less than 5% exists as open space. It is advisable to increase ownership or control of watershed area whenever land becomes available for purchase. It is also recommended to establish local watershed protection regulations to protect public drinking water sources."

The threat assessment by Putnam Water Pollution Control Authority (WPCA) does not address concerns with runoff from agriculture fields or improperly managed animal waste. However, a study of the watershed completed in 2018 for the development of *Roseland Lake Management Plan* implicated agricultural runoff as the primary source of nutrient contamination in Roseland Lake, located 2 miles upstream of the intake to the water treatment plant. The estimated land use watershed load of total phosphorus from agricultural sources flowing into Roseland Lake was estimated to be 3,211 lbs./yr. This shows agricultural runoff as the main source of phosphorus from external sources compared to developed land (397 lbs./yr.) or forested land (474 lbs./year). Phosphorus is typically the nutrient in limited supply to support aquatic plant and algae growth in freshwater ecosystems and a key nutrient to fuel potentially harmful algae blooms.

a. Source causes of the surface contamination problem.

In 2015/16, prior to drafting *Roseland Lake Management Plan*, ECCD staff, with assistance from volunteers from The Last Green Valley Volunteer Water Quality Monitoring Program, conducted sampling to assess water quality conditions in Roseland Lake, its tributaries and the lake outlet into Little River. The lake was assessed monthly representing the period between spring and fall turnover. Streams were sampled to gather information on baseflow conditions, first flush and after a return to near normal flow levels following a runoff event.

ECCD monitored Roseland Lake at its deepest part from the surface to the bottom at 0.5 meter intervals. Using a multiparameter sonde, the parameters monitored included depth, temperature, dissolved oxygen, pH, specific conductance and turbidity. In addition, grab samples were collected at the surface, thermocline and bottom and assessed for total nitrogen, Nitrate-nitrogen, Nitrite-nitrogen, organic nitrogen, total phosphorus, ortho-phosphorus and alkalinity. The chlorophyll A concentration of the lake surface sample was also determined. Stream samples were monitored for the same nutrient parameters above as well as Total Suspended Solids (TSS). A pre-storm and post-storm analysis of temperature, dissolved oxygen, pH, conductivity and turbidity using the multiprobe was also conducted. Muddy Brook, the main tributary to Roseland Lake, was sampled in multiple locations to bracket several smaller tributaries. The study concluded that nutrient levels in Muddy Brook increased below Woodstock Road after flowing through the East Woodstock farm valley. The study also determined that May Brook, Peckham Brook and North Running Brook were contributing to the increase in nutrient concentrations in Muddy Brook above Roseland Lake. Nitrate-nitrogen levels in May Brook and Peckham Brook contained high background levels of Nitrate-nitrogen in dry weather samples, suggesting that area groundwater, the source of flow during the study, may have elevated Nitrate-nitrogen levels.

The Roseland Lake monitoring results, based on monthly sampling, indicated lower phosphorus concentrations in spring before the lake was thermally stratified, but following the loss of dissolved oxygen at the bottom of the lake, phosphorus levels increased at the surface. This indicates that the *legacy phosphorus* stored in lake bottom sediments are contributing significantly to the eutrophic conditions in Roseland Lake in summer.

b. Treatment analysis of critical areas.

i. Surface water impacted or at risk.

Figure 37 delineates the Little River Source water watershed. The red areas on the map demonstrate the waterbodies that do not meet the Connecticut Water Quality Standards.

Streams shown in blue have demonstrated they meet the water quality standards for their designated uses.

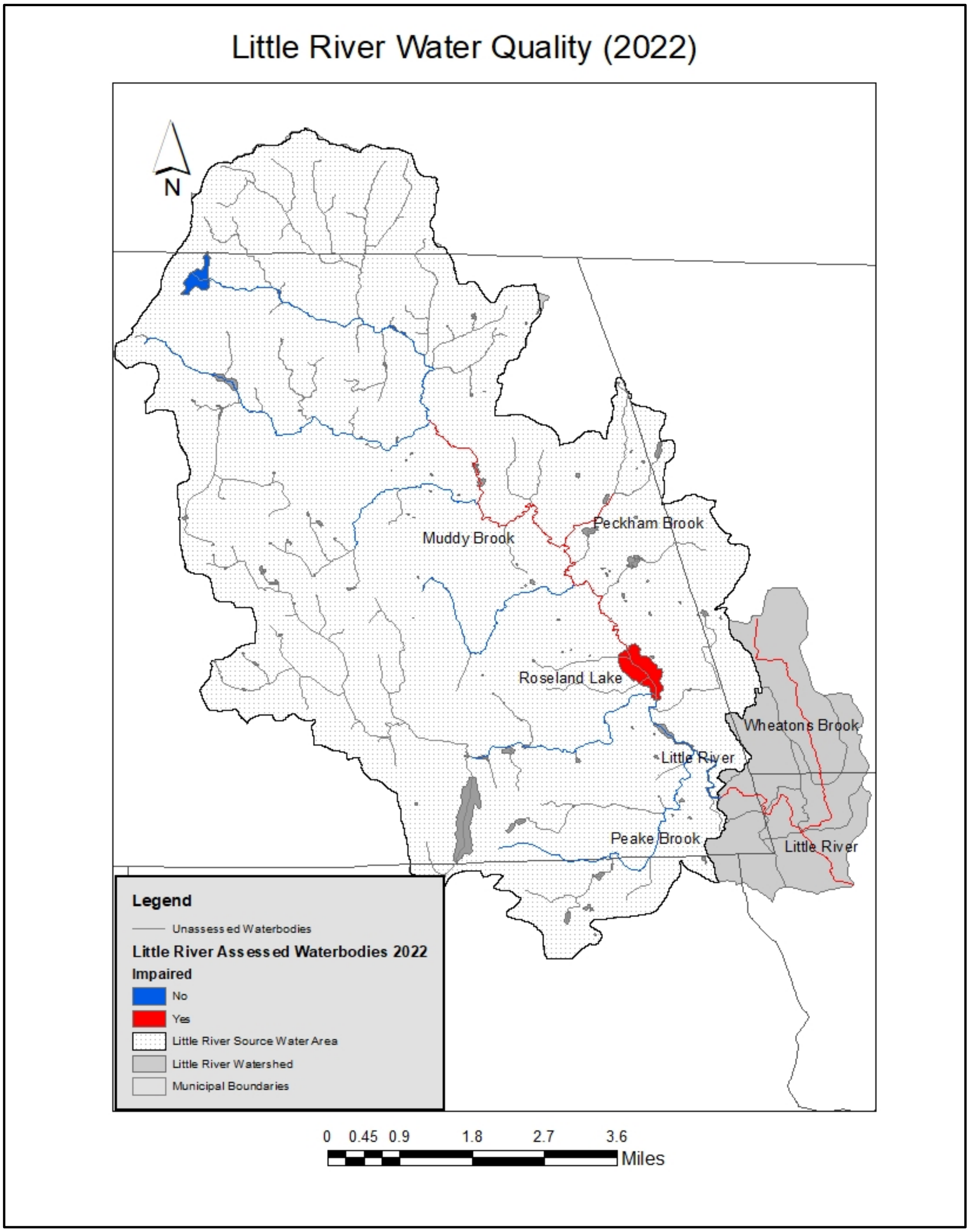


Figure 37. Little River Source Water Impaired Waterbodies.

ii. Ground water quality impacts or at risk.

There are no Aquifer Protection Areas in the Little River watershed. As previously discussed in Section II.3.c, there is a potential medium yield sand and gravel aquifer located in the Muddy Brook and Little River valleys.

For potential contamination sources of concern over a stratified drift aquifer primary recharge area, follow this link. https://portal.ct.gov/-/media/DEEP/aquifer_protection/principlegwcontaminantspdf.pdf

Current "hot spots" for elevated Nitrate-nitrogen levels in the Little River watershed are unknown. As previously discussed, the baseline concentration of Total Nitrogen exceeds the upper threshold for stormwater runoff is MS4 communities. Expected contaminant transport, direction and rates are unknown. Current public groundwater wells exist for condominium associations, Woodstock Academy and the Roseland Heights neighborhood. There are 27 community wells located within the Little River watershed. Risks to groundwater contamination include unsecured (lined) manure lagoons or secured manure lagoon overflows, septic systems, chemical spills and silage leachate.

Alternate Groundwater Data

All public drinking water systems are required to submit an annual report to the CT Department of Public Health Drinking Water Division. To assess potential issues with groundwater quality in the watershed, ECCD requested the annual reports from 2017 - 2021 for the public drinking water systems in the Little River watershed. The data from these reports were reviewed for exceedances for Total Coliform and Nitrate-nitrogen concentration as potential indicators of agricultural influences on groundwater quality.

The safe drinking water standard and action level for Nitrate-nitrogen is 10 mg/l as determined by US Environmental Protection Agency. CT Department of Public Health Drinking Water Division notes that Nitrate-nitrogen concentrations above 3.0 mg/l indicate potential land use impacts to water quality. Figure 38 summarizes the Nitrate-nitrogen concentrations in samples assessed in 26 of the 27 public supply wells in the Little River watershed. During the review of data from the 5-year sampling period, most of the wells contained normal background levels of Nitrate-nitrogen. Wells that include Nitrate-nitrogen values >3 mg/l suggest a human-influenced contamination source in the aquifer recharge area. None of the samples exceeded the upper limit of 10 mg/l. Agricultural sources and failing septic systems are two common sources of concern in rural areas for nitrate and pathogen contamination in groundwater. (*#16 Nitrogen Contamination in PDWW*, n.d.)

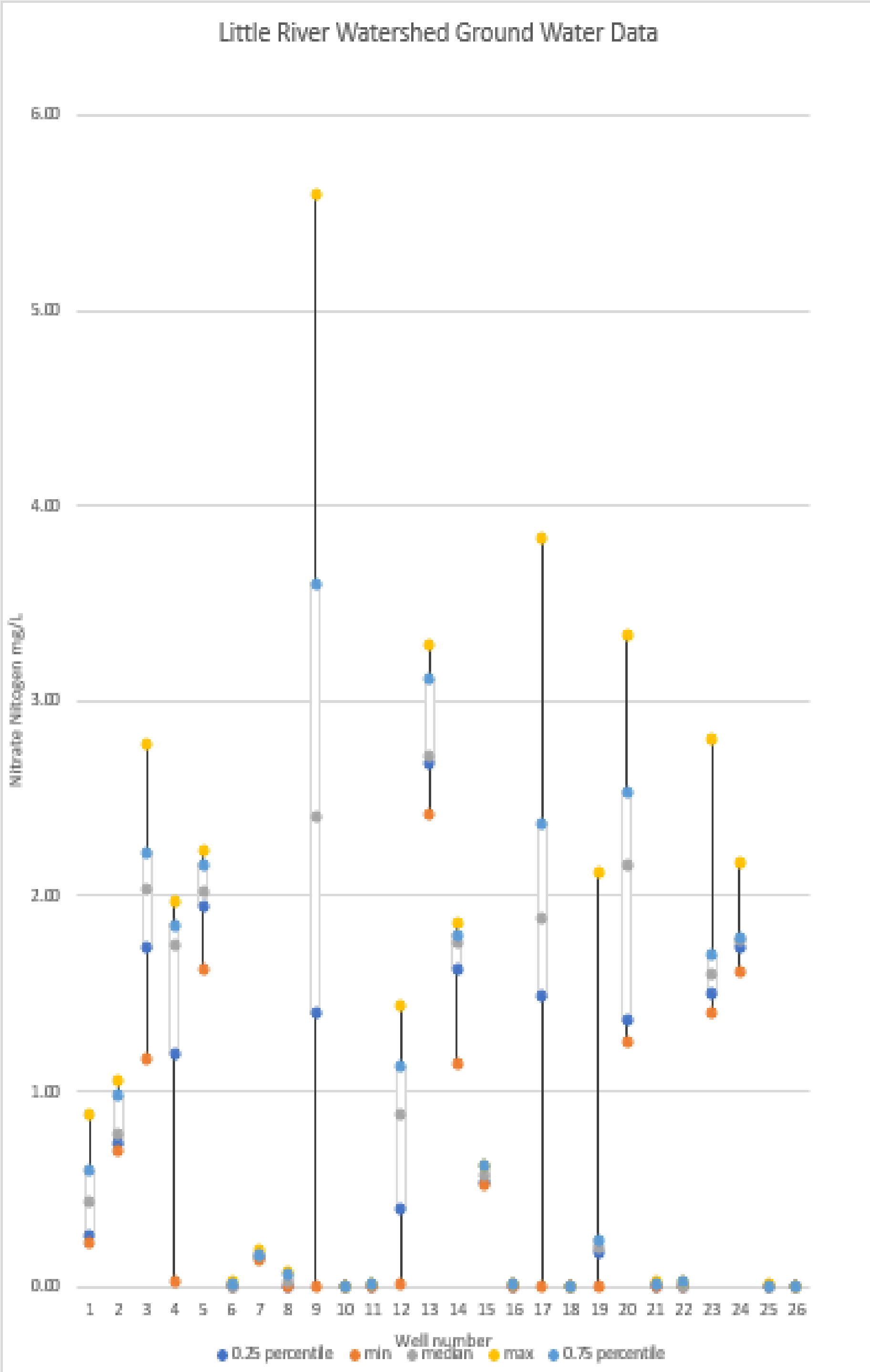


Figure 38. Nitrate- nitrogen concentrations in Community Wells

ECCD staff also reviewed Coliform and *E. coli* bacteria levels in public well supplies. Any amount above 0 colony forming units (cfu)/100 ml is an exceedance of the drinking water standard. Alternate data on groundwater quality was obtained from CT Department of Public Health Drinking Water Division. For public water systems that submit a required annual report to DPH, the last 5 years of reports were requested for the twenty-six public water systems in the watershed. The data was reviewed for water quality parameters, Nitrate-nitrogen and *E.Coli* bacteria, that may be influenced by agricultural activity within the recharge areas of these public water systems.

The data provided by CT DPH indicates many results of Total Coliform >0 cfu/100 ml in the Little River well water samples. None of the positive Total Coliform results were correlated with a positive *E. coli* result in the well samples analyzed between 2017 and 2021. A review of the data set also demonstrated no correlation between elevated Nitrate-nitrogen values and positive Coliform samples.

c. Analysis of treatment and opportunities

i. Level of treatment in the watershed

Existing & Planned practices implementation

Figure 39 lists practices that were planned to be implemented from 2019 to 2022, some which were implemented and others that still need to be implemented. It is a snapshot of data obtained in August 2020. Analysis of load reductions was not possible because data provided by NRCS used in the table did not include Personally Identifiable Information (PII) for specific farms and load reduction analysis requires input of data on a ‘farm by farm’ basis.

As noted in the table, soil health practices such as no till, cover crops and forest harvest management comprise the highest number of acres planned for implementation It also cites a significant number of acres for nutrient management, a small number of acres for forest stand improvement and no, or very little, acres planned for vegetated treatment areas or field border practices. These recently implemented and planned practices should be considered when establishing practice implementation goals for the watershed. It is also important to account for the nutrient management and soil health practices implemented, the agricultural infrastructure facilities constructed and the equipment purchases facilitated through ECCD and its partners using multiple funding sources, as noted in Fig. 1 at the beginning of this document. Many opportunities exist to implement practices that will improve water quality.

Land use	Practice Code	Practice Name	Practice Unit	Total Planned Amount	Total Practices
		NRCS Practices planned in the Little River Watershed 2019-2022			
Associated Ag Land	327	Conservation Cover	Ac	0.5	1
Crop	314	Brush Management	Ac	1.4	1
	327	Conservation Cover	Ac	0.8	1
	328	Conservation Crop Rotation	Ac	6.6	13
	329	Residue and Tillage Management, No Till	Ac	118.9	22
	330	Contour Farming	Ac	10.3	1
	340	Cover Crop	Ac	4.9	4
	362	Diversion	Ft	60	1
	386	Field Border	Ac	0.5	1
	441	Irrigation System, Microirrigation	Ac	0.4	1
	449	Irrigation Water Management	Ac	13.4	8
	511	Forage Harvest Management	Ac	211.8	38
	512	Forage and Biomass Planting	Ac	10.3	1
	590	Nutrient Management	Ac	835.5	173
	AIR04	Use drift reducing nozzles, low pressures, lower boom height & adjuvants to reduce pesticide drift	Ac	251.4	39
	E329106Z	No till system to increase soil health and soil organic matter content	Ac	93.9	22
	E340106Z2	Use of multi-species cover crops to improve soil health and increase soil organic matter	Ac	8.9	7
	E484106Z	Mulching to improve soil health	Ac	0.1	1
	PLT20	High residue cover crop or mixtures of high residue cover crop for weed suppression & soil health	Ac	251.4	39
	SQL01	Controlled traffic system	Ac	105.1	11
	SQL04	Use of Cover Crop Mixes	Ac	105.1	11
	SQL05	Use deep rooted crops to breakup soil compaction	Ac	105.1	11
	WQL10	Plant an annual grass-type cover crop that will scavenge residual nitrogen	Ac	64	6
Farmstead	103	Comprehensive Nutrient Management Plan - Applied	No	1	1
	590	Nutrient Management	Ac	38.5	1
Forest	314	Brush Management	Ac	33.4	7
	649	Structures for Wildlife	No	30	6
	666	Forest Stand Improvement	Ac	12.8	4
	666	Forest Stand Improvement	Ac	49	1
Pasture	329	Residue and Tillage Management, No Till	Ac	6.9	1
	397	Aquaculture Pond	Ac	0.7	1
	464	Irrigation Land Leveling	Ac	0.6	1

* includes CTA & EQIP programs

Figure 39. Practices Planned for Implementation in the Little River Watershed, as of 8/2020

1. <u>Potential</u>

NRCS' Conservation Practice Physical Effects (CPPE) matrix can be used to describe the environmental effects of its conservation practices. It provides a qualitative description of a conservation practice's impact on soil, water, air, plants and animals. It is a valuable tool for recommending NRCS practices that have the highest potential to improve water quality or to address other resource concerns in a watershed. Because practices can have either a positive or negative effect on a resource concern, they are assigned ratings between -5 to 5. A "0" (zero) rating represents "no effect". The negative side of the scale represents varying degrees of worsening impacts on natural resources, with -5 representing "substantial worsening". At the other end of the scale, a 5 represents "substantial improvement". When applying the CPPE matrix to the category, "Pathogens and Chemicals from Manure, Bio-solids or Compost Applications Transported to Surface Water" and screening for practices that rate either 4 or 5, representing "Moderate to Substantial Improvement" or "Substantial

Improvement", respectively, the matrix generates the following list of recommendations: 590-Nutrient Management, 393-Filter Strip, 635-Vegetated Treatment Area and 656-Constructed Wetland. To achieve similar positive impacts to groundwater, the matrix recommends 590-Nutrient Management and 656-Constructed Wetland.

For the category, "Nutrients Transported to Surface & Groundwater", 590-Nutrient Management, 390-Riparian Herbaceous Cover, 391-Riparian Forest Buffer, 327-Conservation Cover and 313-Waste Storage Facility all rank very high. Ranking on the higher end to achieve moderate to substantial improvement for "Sediments & Pesticides Transported to Surface Water", the matrix recommends 393-Filter Strip, 390-Riparian Herbaceous Cover, 391-Riparian Forest Buffer and 656-Constructed Wetland.

Later in this plan (see section V.e.), waste storage facility, nutrient management and conservation cover are recommended as planned practices. A more in-depth description of the type and size of vegetated buffers and their benefits is provided in Figure 38. Combining these practices with soil health practices, nutrient management and forestry practices present potential treatments to implement in the watershed.

Figure 40. Buffer composition and water-quality benefits when applied in agriculture.

BUFFER SIZE AND VEGETATIVE MIX	BENEFITS*	COMMENTS
• Woody veg. along bank • Dense stiff grasses 35'-50'	• Traps 75% sediment from runoff • Traps 25% of nitrates & phosphorus from surface runoff	• Allows most nutrients to pass into water body
• Woody veg. along bank • Shrubs 37'-75' • Dense stiff grasses 25'	• Traps 75% of sediment from runoff • Shrubs trap more nitrates & phosphorus than grass alone	• Additional root complexity and depth improves soil porosity and promotes more infiltration
• Woody veg. along bank • Trees & shrubs 50'-75' • Dense stiff grasses 25'	• Traps 95% sediment • Traps 75-80% nitrogen • Traps 80% phosphorus	• Maximum canopy breaks force of storms • Root complexity and depth provides maximum porosity and infiltration • Root complexity and depth provide maximum nutrient "sink" through plant uptake and storage

The MA Buffer Manual, Berkshire Regional Planning Commission, 2003. Adapted from CRJC, 2000, "Buffers for Agriculture," Fact Sheet #5. Source: http://www.crjc.org/buffers/Buffers%20for%20Agriculture.pdf

* Note: General removal rates are from agricultural lands, where surface runoff and subsurface flow often contain high nutrient concentrations.

ii. Analysis of producers and participation.

Currently, NRCS does not have a backlog of producers in the watershed eligible for EQIP funding. Most of the producers in the watershed have fully expended their EQIP allotments and are waiting for a new Farm Bill.

Producers are eligible to re-apply for cover crop funding every 5 years if there is a higher level of conservation achieved with a different and/or more complex cover crop mix. Under EQIP, many farms in the watershed planted an initial cover crop mix and are planting more diverse mixes under NRCS' Conservation Stewardship Program (CSP).

Without financial assistance, many producers cannot afford to implement conservation practices. With funding available through the Farm Bill, USDA NRCS offers a variety of cost-share programs and other funding programs to assist farmers with these expenses. Under the Farm Bill, which is reauthorized every 5 years, producers are eligible to receive from NRCS up to $450,000 of EQIP funding.

Some agricultural conservation practices require a much larger investment than is available through Farm Bill programs. Also, NRCS does not fund the purchase of innovative equipment such as no-till technology. In the Little River watershed, however, ECCD has employed a partnership approach using multiple funding sources to fund large, expensive projects. In East Woodstock for example, ECCD administered the construction of a free-stall barn with manure storage. For the project, ECCD combined the producer's EQIP funding from NRCS with a US EPA Clean Water Act Section 319 non-point source grant provided by CT DEEP.

With the redesignation of Little River as a National Water Quality Initiative watershed, additional funding and technical assistance from NRCS will help to address the critical needs in the watershed, enabling more farms to reduce their water quality impacts while improving the productivity of their farms. Various other federal and state agencies, as well as foundations, administer programs that provide funding to support agricultural conservation practices including USDA Forest Service, Long Island Sound Futures Fund, EPA, CT DEEP, MA DEP and CT Department of Agriculture.

Some other funding and technical support include:

- USDA Forest Service Inflation Reduction Act Forest Landowner Support for underserved and small-acreage forest landowners in emerging private markets for climate mitigation and forest resilience;
- Long Island Sound Futures Fund (LISFF) for projects that will result in a significant reduction in nitrogen pollution from the Long Island Sound watershed;
- CT DEEP/EPA Clean Water Act §319 non-point source (NPS) pollution grant addresses NPS water pollution. CT DEEP administers funds from US Environmental Protection Agency (EPA) that are passed on to communities, local conservation

groups, and other organizations for NPS implementation projects, plans and statewide NPS management efforts;

- MA DEP/EPA Clean Water Act §319 non-point source grant program is authorized under Section 319 of the federal Clean Water Act for implementation projects that address the prevention, control and abatement of nonpoint source (NPS) pollution.;
- CT DEEP Open Space and Watershed Land Acquisition Grant Program (OSWA) provides financial assistance to municipalities and nonprofit land conservation organizations to acquire land for open space, and for water companies to acquire land to be classified as Class I or Class II water supply lands;
- CT Department of Agriculture Farmland Preservation Program (FPP) is a voluntary program for placing an agricultural easement and preserving larger (>30 acres) farms that have a significant quantity of cropland and prime and important soils as defined by United State Department of Agriculture;
- CT Department of Agriculture Community Farms Preservation Program is suited for farms that do not meet the criteria of the traditional Farmland Preservation Program for reasons of size, soil quality, or location, but may contribute to local economic activity through agricultural production. Such farms typically have fewer than 30 acres of cropland, are active farms in food or fiber production, contain prime farmland soils and/or additional farmland of statewide and local importance, and have a demonstrated level of community support.

Outreach Conducted

Education and Outreach Completed During Plan Development

During the process of developing this plan, ECCD staff conducted multiple outreach initiatives including farm visits, social media campaigns, direct mailings, farmer surveys "Farm Talks" workshops and tabling at local events focused on agriculture. ECCD staff organized several stakeholder meetings, inviting local agricultural businesses to participate alongside conservation professionals. Both in person and remote meetings were scheduled. The goal of this outreach was to emphasize the need for reducing runoff from agribusinesses and to gauge the willingness of local farmers to adopt new conservation practices. Figure 41 summarizes the Education and Outreach strategies conducted during the development of this plan.

Completed Outreach	
Date	**Activity**
September 2021	Project Outreach table at Celebrating Agriculture Day at Woodstock Fairgrounds
3/21/2022	Day Without Water – Little River NWQI Planning presentation

August 2021	Project Outreach table Woodstock Locally Grown Day
9/30/2021	Farm Talk #1 at the Senexet Grange – Manure and Nutrient Management for Small Farms & Farmer Survey
10/13/2021	Farm Talk #2 at the Senexet Grange - Forest Management
10/27/2021	Farm Talk #3 at the Senexet Grange – Grazing Animals 101
11/16/2021	Farm Talk #4 at the Senexet Grange – Soil Health for Small Farms
4/19/2021	Presentation at the Woodstock Agriculture Commission Meeting
	Presentation at the Woodstock Conservation Commission Meeting
	Direct mailing of postcards to list of agribusinesses in the watershed
	Direct Phone calls and emails to target audience
	Putnam Water Pollution Control Authority communications
February 23, 2021	Little River WS Collaborative meeting Project introduction
March 16, 2022	Little River WS Collaborative meeting Project update
August 31, 2022	Little River WS Collaborative meeting at Elm Farm Project Update and tour of the new free-stall barn with manure storage
	Postings on ECCD website and social media
2021 - 2023	Project updates at Thames River Basin Partnership Quarterly Meetings and newsletter
2021 - 2023	Project updates at The Last Green Valley Water Advisory Committee quarterly meetings

Figure 41. Education & Outreach Strategies Conducted to date.

On February 23, 2021, ECCD staff held the Little River stakeholder kick-off ZOOM meeting with 25 participants representing local farmers, state and federal agencies, and town committees and officials. In order to reach a wider audience of stakeholders, ECCD presented a panel of 3 speakers representing farms currently collaborating with NRCS. To attract additional stakeholders, ECCD conducted outreach through social media, ECCD's website, flyers, email and a press release. At the kick-off meeting, producers presented about their experiences with NRCS, the benefits of participating in NRCS programs and the impacts to their operations and productivity that resulted from implementing NRCS conservation practices. At the stakeholder meeting, ECCD recruited producers to engage with ECCD and NRCS, particularly to encourage them to participate in NRCS programs to protect the drinking water supply for Putnam.

To obtain producer feedback, ECCD conducted four workshops facilitated by experts. From September through November 2021, in partnership with Woodstock's Senexet Grange and the Town of Woodstock Agriculture Commission, the following workshops were conducted: Manure and Nutrient Management, Forest Management, Grazing Animals 101 and Soil Health. To advertise the workshops, ECCD staff created and distributed flyers, posted on social media, posted the workshops on ECCD's website and issued press releases to local newspapers. The Agriculture Commission paid for and advertised workshops in the local Shopper's Guide. Workshops were well-attended; 28 people attended the Soil Health workshop and the remaining workshops averaged 12-16 people per session. In September 2021, ECCD staff tabled at Celebrating Ag, presenting a tri-fold display about the project and soil health. The display also included a replica of a miniature farm with NRCS conservation practices and interpretive signs.

ECCD staff distributed educational handouts and an online producer survey with QR code access. In addition, ECCD staffed an outreach table at a day-long 'buy local' event planned by the Woodstock Grange where we received contact information for local animal owners. ECCD received 8 responses to the online producer survey. Respondents included hobby farms and homesteaders with woodlots, horses, livestock and poultry. It is unknown if the farms of all respondents are located within the Little River watershed. The purpose of the survey was to gain insights into which practices producers are interested in, potential barriers to implementing the practices, their awareness of water quality issues and to offer a free farm site assessment. Two out of the eight respondents provided their contact information to schedule a site assessment.

Seventy-five percent (75%) of respondents to the survey replied that they might be or were concerned that "manure draining from barnyards, manure stacks or manure spreading could be affecting water quality by way of disease-causing bacteria or pathogens getting into nearby waterways or groundwater."

As Fig. 42 shows, five out of the eight respondents to the survey were most interested in learning about conservation practices to improve manure management, plant health and productivity and soil health. Two were interested in learning more about practices to improve animal health and erosion issues. Responses to the survey provide valuable information for planning future workshops.

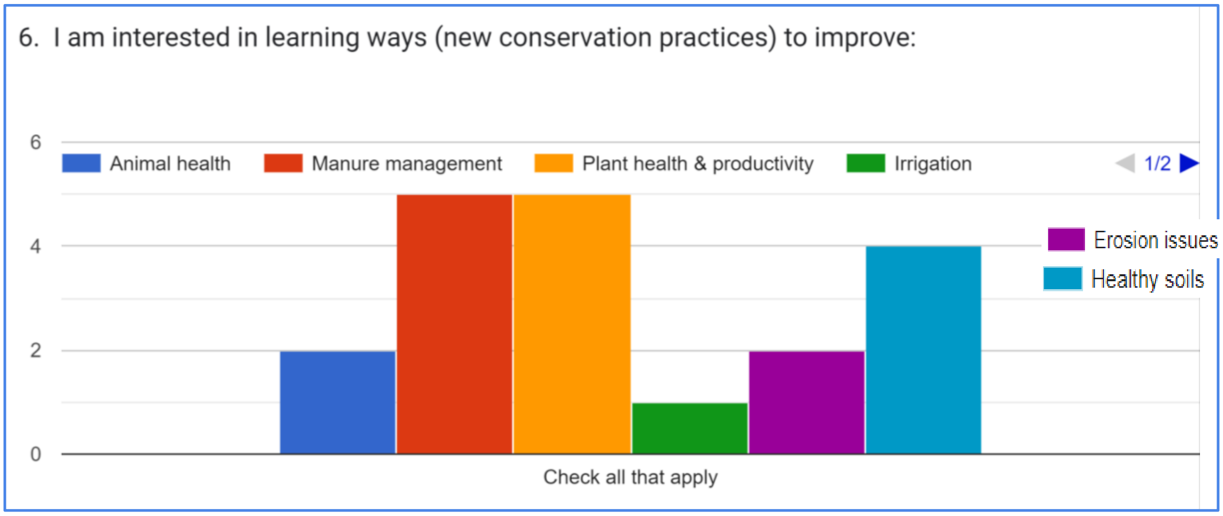


Fig. 42. Example of survey results - Small farms, homesteaders areas of interest

Fig. 43 reviews farmer responses regarding obstacles farmers have to adopting conservation practices. 50% (four) of respondents cited financial reasons and 25% (two) cited lack of knowledge of practices.

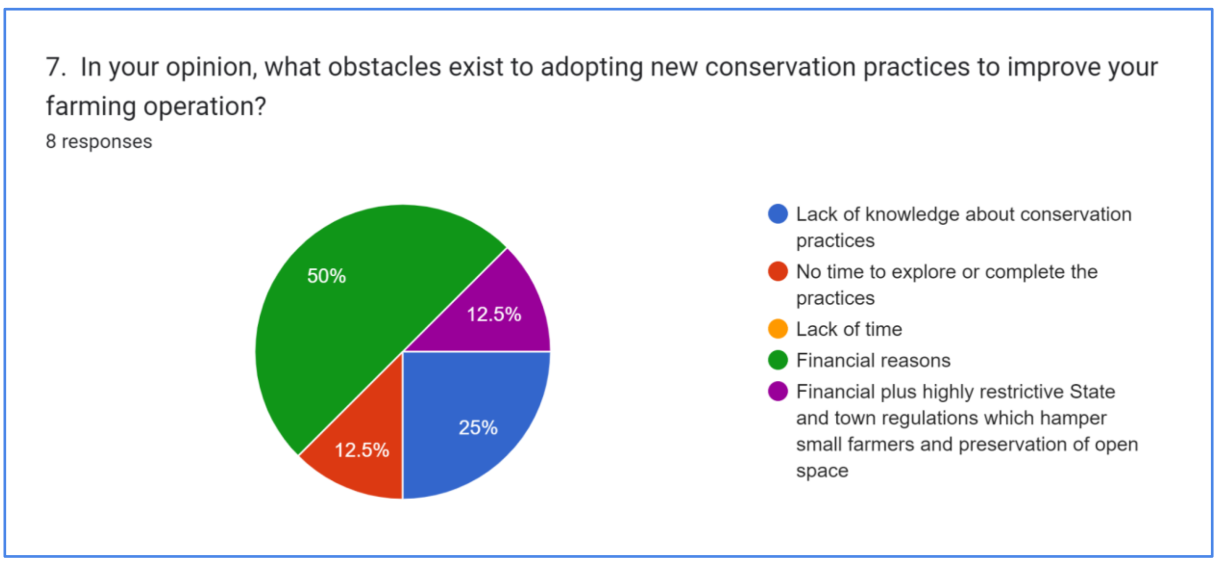


Fig. 43. Survey results - Small farms, homesteaders areas of interest

When asked, "what method(s) would you prefer to hear about new conservation practices that can benefit your farming operation?", all respondents selected field demonstrations at a local farm and seven out of eight selected both in-person workshops and online forums, such as virtual workshops. Two respondents preferred to receive information by mail.

ECCD also sent postcard surveys to producers to determine in which practices farmers are most interested, and to determine potential barriers to implementation, awareness of water quality issues and to offer free farm assessments. On March 24, 2023, 66 property owners including livestock owners, homesteaders and hobby farmers, who were deemed unlikely to be aware of NRCS programs, were sent postcards. They were selected based on "windshield surveys" and aerial map observations of erosion or manure management issues. Thirty-four additional postcards were distributed at post offices and farm businesses in the watershed. To date, no responses have been received. A future option to consider is to hold more farmer workshops on topics such as forestry and wetlands regulations, switchgrass streamside buffers and funding for climate change practices.

ECCD conducted additional outreach by publishing an article in ECCD's Spring Newsletter and attending the Town of Woodstock Agriculture Commission and Conservation Commission meetings to inform members about the project and to request assistance reaching producers.

On March 16, 2022 and August 31, 2022, ECCD conducted two additional Little River project planning meetings. The March meeting was held virtually. The August meeting was hosted by Elm Farm and included a tour of the farm's new free stall barn. Both meetings provided stakeholders with updates on the progress of the watershed plan. At the meetings, ECCD continued to seek feedback on the best ways to reach producers.

Visual Field Assessment and Data Compilation

In May 2021, ECCD staff conducted windshield surveys in the watershed to visually assess conservation concerns and collect data on the types of farms operating in the watershed. Consequently, ECCD updated its database of producers. ECCD staff also conferred with an Alpaca farmer about BMPs and the availability of NRCS assistance. Additionally, ECCD staff provided a report with recommendations to the owner of a small hobby farm with cattle.

During an NRCS webinar, Kevin King of USDA-Agricultural Research Service cited producer perception about practice efficacy and financial burdens as barriers to adopting conservation practices (Wilson et al., 2019: 45:4-11). The information King presented was based on a survey of about 750 farmers in the western Lake Erie Basin watersheds (Figure 44). ECCD's survey indicated similar results; the top two barriers to adopting conservation practices were financial burden and lack of knowledge of practice effectiveness.

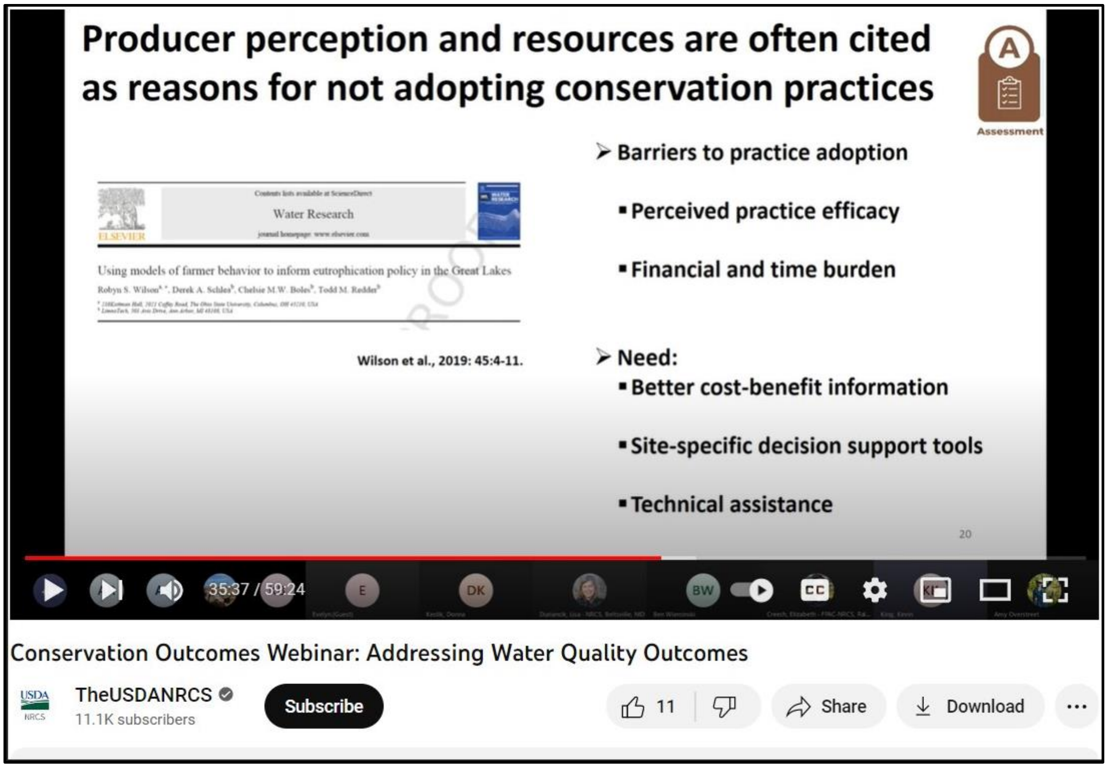


Fig. 44. Example of survey results - Small farms, homesteaders areas of interest

Through a workshop series and conversations at the Woodstock Grange, ECCD engaged producers, homesteaders, hobby harmers and horse owners. According to a study about cover crop adoption done by Purdue University with online focus groups from three midwest states, providing knowledge about conservation practices (e.g. cover crops), while not enough by itself to lead to adoption by larger producers, may be very beneficial to adoption by small operations (12/16/21, SWCS Hoosier chapter zoom meeting: *Culture of Adoption*).

To the extent feasible while still meeting production goals, dairy producers in the watershed have taken action and have expressed a willingness to address watershed health concerns. With grant funding, ECCD has provided financial and technical assistance to producers, assisting farmers to meet their goals while improving water quality in the watershed. ECCD will continue to do so.

With an outreach plan, a sustainable and comprehensive approach to building relationships with producers will be developed. Through the outreach plan, technology will be transferred, knowledge shared, NRCS conservation practices promoted and efforts increased to improve water quality in the watershed.

Create & Implement Communications & Outreach Plan

As studies and experience have demonstrated, providing knowledge about conservation practices, while not enough to encourage large producers, is beneficial to encourage smaller producers to adopt them. A survey conducted by Anita Morzillo of University of Connecticut indicated that 14 of 26 producers prefer to hear about conservation practices through mail, 11 of 26 preferred field demonstrations at local farms and 9 of 26 respondents preferred online resources (Path to Reduce Pathogens in CT Agricultural Runoff - Survey Summary, Anita Morzillo, p. 2). From the survey, it is apparent that producers prefer a variety of forums through which to hear about conservation practices. Therefore, outreach efforts in the watershed should be tailored to meet the needs of producers, whether farmers with large operations or those with small hobby farms.

Although recommendations to implement the outreach plan should be viewed independently and implementable by stakeholders, initially Little River Healthy Watershed Coalition (LRHWC) will be the primary instrument through which stakeholders will engage producers in the Little River watershed. The coalition was established in October 2018, so is well-poised to implement the outreach plan. The long-term sustainability of LRHWC, however, warrants a cautious approach to relying upon the *Coalition* in the future.

Prior to implementing the outreach plan, LRHWC will adopt *Muddy Brook and Little River Water Quality Improvement Plan* (2009), *Roseland Lake Management Plan* (2018) and the current *Little River Watershed Plan Update*. Then LRHWC will develop an action plan to promote NRCS conservation practices and programs, research and provide information about funding assistance and engage producers through a sustained outreach effort.

Based on producer needs and interests, the outreach plan is detailed in Section V.g. and will involve conducting Farm Talk Workshops, facilitating farm tours and demonstrations to showcase completed projects and successful best management practices, conducting mailings and posting on social media to promote best management practices, as well as promoting soil health and manure management practices to small hobby farms.

iii. Assessment of critical area treatment, participation and prioritization.

In the following section, a preliminary analysis of priority areas to address, in the order of high, medium and low, is described. In the implementation stage, additional assessments are proposed to be carried out, with further outreach and education to producers. Anyone meeting NRCS requirements in the watershed can apply for funding at any time but consideration is given on a first come, first serve basis and through NRCS ranking protocols.

Since they do not represent accurate depictions of drainage features in the watershed, the following maps should be used for planning purposes only. Site visits should be conducted to ground-truth drainage features. To protect PII, views of maps are zoomed out. ECCD will provide GIS layer files for more detailed analysis of field scale maps by NRCS. Using available GIS data layers, it will be possible to overlay multiple areas of concern with the watershed priority map (located in Section 5d) to conduct a co-occurring resource analysis for implementation prioritization purposes.

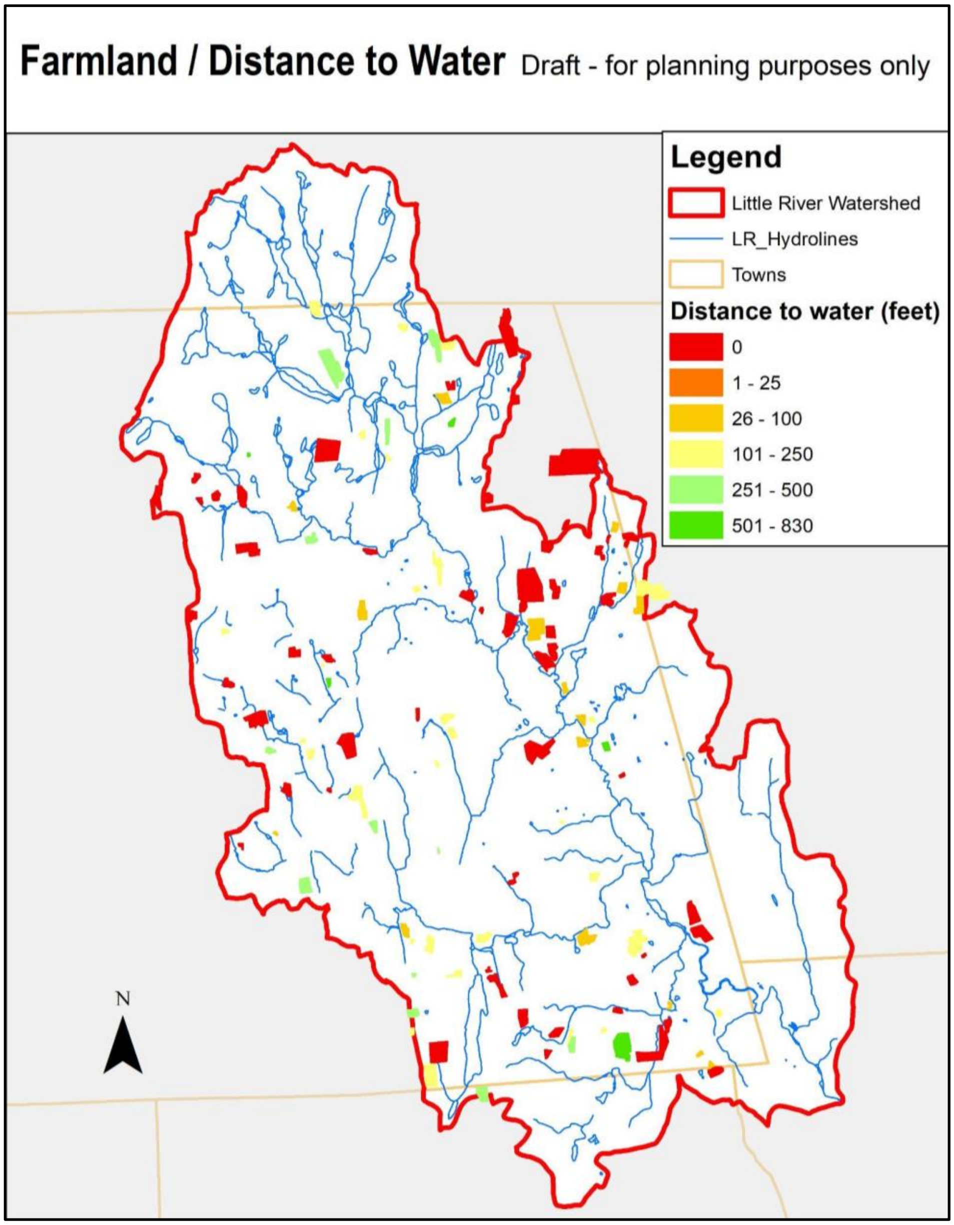


Figure 45.

Farmland – Distance to water

There are a number of farmsteads or farmland within close proximity to water sources as evidenced by red in Figure 45. Due to the higher potential for these farmsteads and lands to contribute nutrients and bacteria to waterways, they should be prioritized for evaluation and treatment. The map was created using visual analysis and tools in Google Earth.

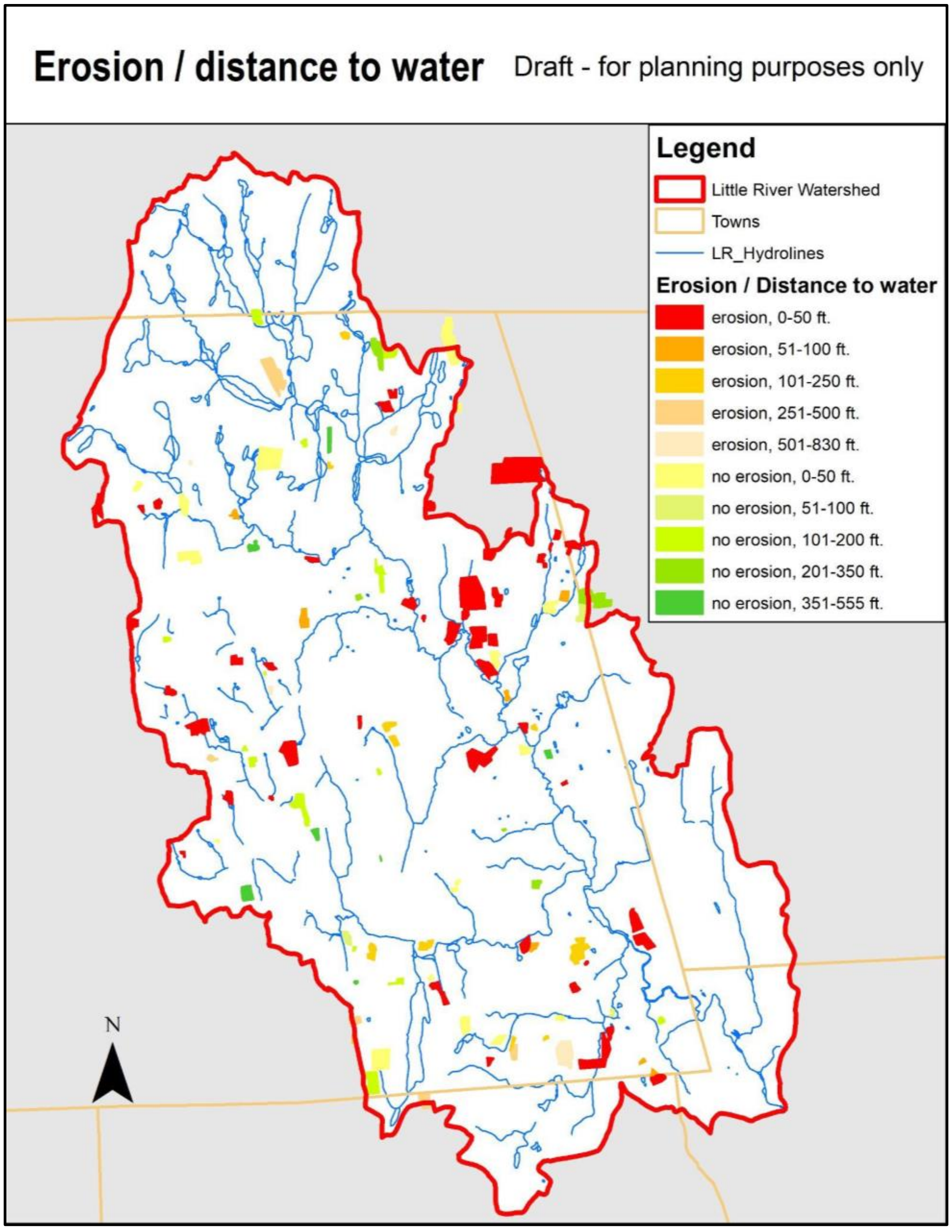


Figure 46.

Areas of erosion / Distance to water

In addition to identifying a number of farms and farmland in close proximity to waterways, Figure 46 depicts areas within 500 feet or more of a waterway with erosion issues, as identified from aerial maps, windshield surveys or onsite visits. This signifies properties vulnerable to significant resource concerns. As mentioned, on-the-ground observations are needed to verify the accuracy of these areas. The map was created using visual analysis and tools in Google Earth.

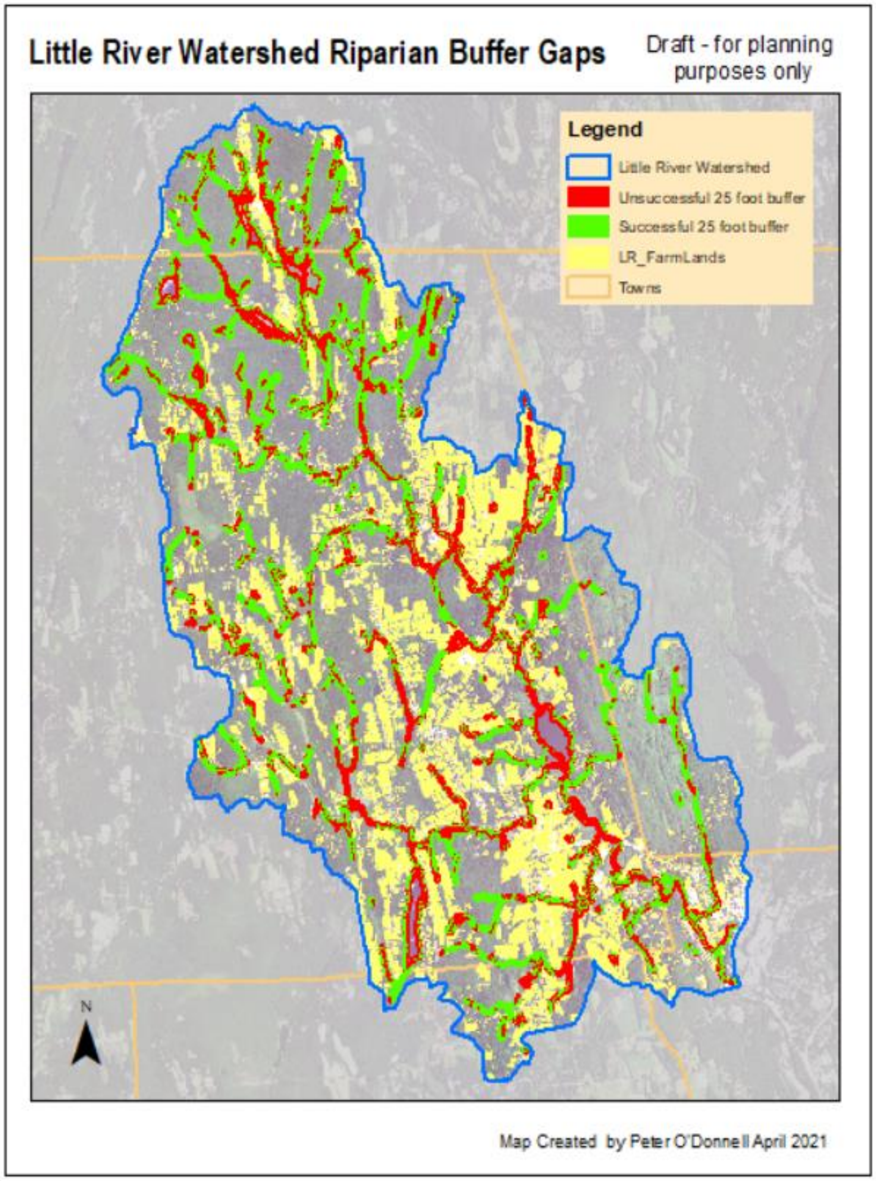


Figure 47.

Riparian Buffer Gaps

Riparian corridors were evaluated in the Little River watershed as either effective or ineffective buffers (Figure 47). The goal was to identify buffers that need the most improvement. The identification of these gaps in the riparian buffer was based on land cover data and buffering the Little River vector water lines by 25 feet.

Riparian zones were evaluated to determine if at least a 25-foot wide vegetated buffer was present, either herbaceous or mixed forest as defined by the 2016 land cover layer. Twenty-five feet was used as the minimum requirement since the NRCS practice standard for Filter Strip requires a minimum of 25 feet and the practice standard for Riparian Forest Buffer requires a minimum of 35 feet. A total of 107 miles of streambank (both sides of the stream) was evaluated. Out of 10.4 square miles of buffers, 4.6 sq. mi. of buffers are adequate (at least 25 feet). However, it is estimated that approximately 245 acres of pasture, hay and crop land in the watershed do not have adequate vegetated riparian buffers. It may be useful to overlay the Riparian Buffer Map data with cropland and/or erosion and

runoff risk potential data. These areas exhibit greater rates of erosion and runoff and should be prioritized for the installation of well-vegetated riparian buffers.

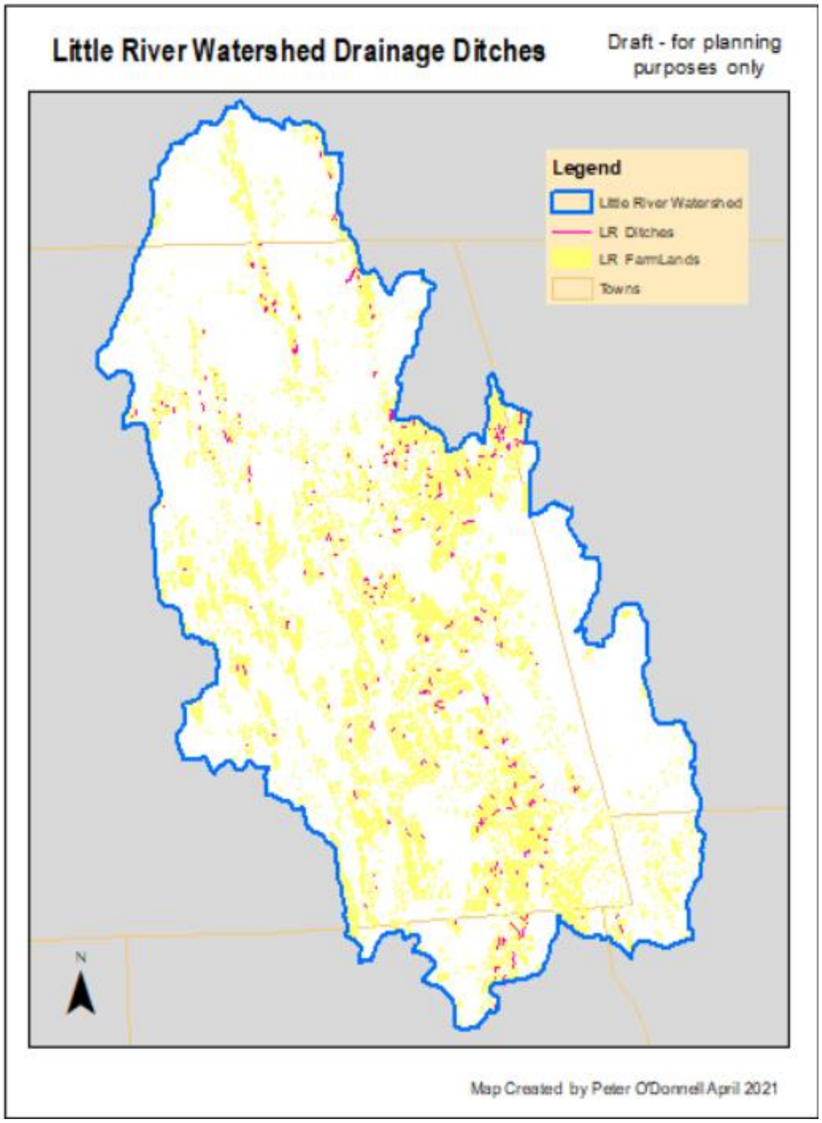


Figure 48.

Drainage Ditches

Field ditches are common on agricultural land throughout the Little River watershed and have the potential to readily transport both sediment and nutrients to streams and rivers. One way to mitigate this potential source of sediment and nutrients is to install a 10 ft.wide vegetated buffer adjacent to the ditches.

This GIS analysis highlights the location of possible ditches and other drainage features in the watershed. Its goal is to identify where ditches on agricultural land are most likely to be present.

Figure 48 was created using visual interpretation of orthophotos, including a Hillshade raster. The process was focused only on identifying possible ditches on agricultural land. No interpretation was done on any other type of land cover. The Little River watershed has approximately 16 miles of likely ditches on agricultural land.

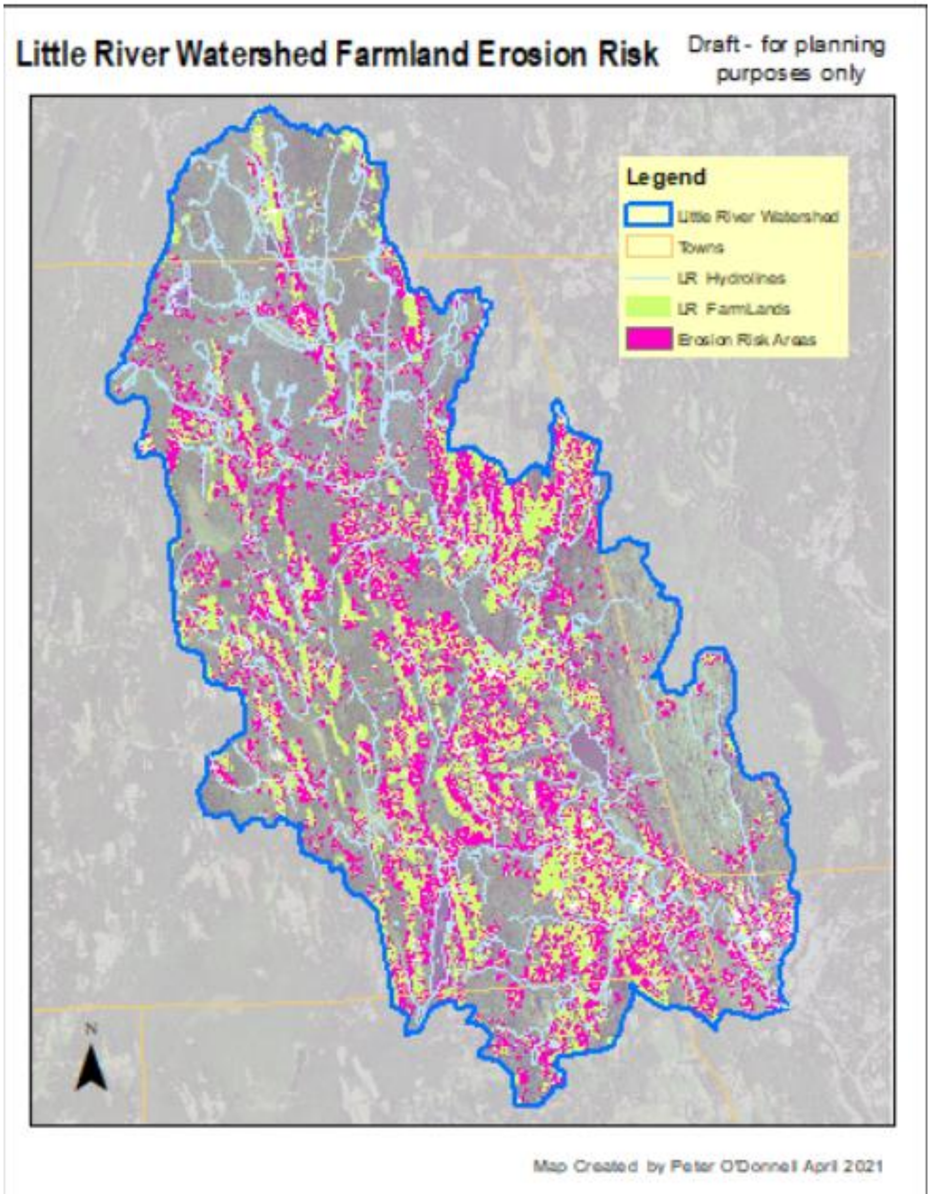


Figure 49.

<u>Farmland slopes-erosion risk</u>

Figure 49 highlights areas in pink that have a slope of greater than or equal to 8%, are within 100 feet of an area of a calculated accumulated flow and are on agricultural land. Its goal is to identify critical areas in the Little River watershed on agricultural land where the risk of erosion is highest. There are a number of such areas scattered throughout the watershed. Identifying these areas in close proximity to the waterways shown, along with other high risk factors such as animal high use areas, will assist in the prioritization and ranking process of resource concerns.

Agricultural Land Use

To show the extent and types of land cover in the watershed, the annual acreage of Cropland and Hayland is an important factor needed for agricultural watershed planning. Figure 50 depicts the 2016 land cover layer, which is a "snapshot in time". Land uses, however, may have changed since 2016. The 'Grassland – herbaceous' category is graminoid or herbaceous vegetation greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling but can be utilized for grazing. From NRCS' 2021 voluntary producer acreage reporting for Connecticut, there was a total of 4,006 ac. of annual corn, hayland (includes grass/mixed forage) and pasture in the Little River watershed. Since reporting acreage to NRCS is voluntary, the amount of farmland provided here is incomplete. As of 2015, there was an additional 1,483 ac. of agricultural land in the watershed. This comprises a total of 5,489 acres of the 22,720 acre watershed.

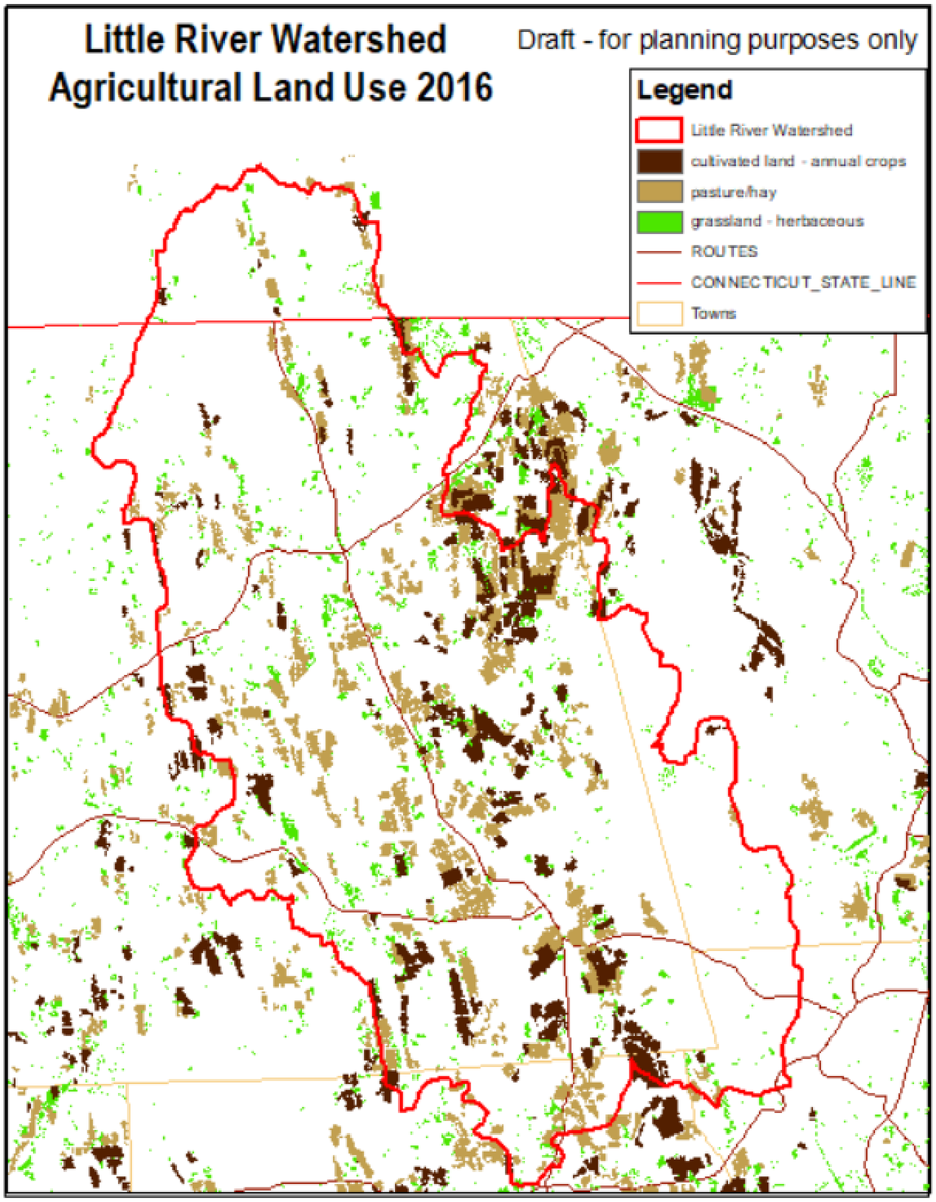


Figure 50. CLEAR CT High Resolution land cover (NOAA CCAP)

iv. Preferred conservation systems descriptions.

Conservation management systems (CMS) include any combination of conservation practices and management that achieves a level of treatment of the five natural resources (i.e., soil, water, air, plants, and animals) that satisfies criteria contained in the Soil Conservation Service (SCS) Field Office Technical Guide (FOTG), such as a resource management system (RMS) or an acceptable management system (AMS).

Some agricultural operations in the watershed have animal grazing areas through which intermittent streams or drainage ditches flow. If possible, exclusionary fencing should be installed to keep animals out of streams and waterways, then vegetated buffers or filter strips can be added in order to protect water quality, reduce soil erosion and reduce sedimentation. Where a stream or pond serves as a source of drinking water for livestock, providing an alternative water supply for livestock (groundwater well) may be necessary.

Erosion & Sediment control management measure - The first, and most desirable, strategy would be to implement practices on farm fields that would prevent erosion and the transport of sediment from fields. Practices that could be used to accomplish this are conservation tillage, contour strip-cropping, terraces and critical area planting.

The second strategy is to route runoff from fields through practices that remove sediment. Practices that could be used to accomplish this are filter strips, field borders, grade stabilization structures, sediment retention ponds, water and sediment control basins, and terraces. Site conditions will dictate the appropriate combination of practices for any given situation. National Management Measures for the Control of Nonpoint Pollution from Agriculture (epa.gov). Figure 51 shows the effectiveness of some of these control measures for reducing both nutrients and sediment.

Table 2-1. Relative Gross Effectiveness[a] of Sediment[b] Control Measures (Pennsylvania State University, 1992a)

Practice Category[c]	Runoff[d] Volume	Total[e] Phosphorus (%)	Total[e] Nitrogen (%)	Sediment (%)
Reduced Tillage Systems[f]	—	45	55	75
Diversion Systems[g]	—	30	10	35
Terrace Systems[h]	—	70	20	85
Filter Strips[i]	—	75	70	65

[a] Actual effectiveness depends on site-specific conditions. Values are not cumulative between practice categories.
[b] Includes data where land application of manure has occurred.
[c] Each category includes several specific types of practices.
[d] - indicates reduction; + increase; 0 no change in surface runoff.
[e] Total phosphorus includes total and dissolved phosphorus; total nitrogen includes organic-N, ammonia-N, and nitrate-N.
[f] Includes practices such as conservation tillage, no-till, and crop residue use.
[g] Includes practices such as grassed waterways and grade stabilization structures.
[h] Includes several types of terraces with safe outlet structures where appropriate.
[i] Includes all practices that reduce contaminant losses using vegetative control methods.

Figure 51. "Chapter 2: Management Measures for Agriculture Sources from Guidance Specifying Management Measures For Sources Of Nonpoint Pollution"

In areas identified as Conservation Priority using the Local Watershed Assessment Map, establishment and maintenance of the riparian vegetation is a top priority.

From the [draft] Connecticut Stormwater Quality Manual and Soil Erosion and Sediment Control Guidelines (2022):

"Vegetated buffers are naturally vegetated areas between developed land and surface waterbodies and wetlands. Vegetated buffers protect water quality by providing shade for cooling, stabilizing banks, mitigating flow rates, and providing for pollutant removal by filtering runoff and promoting infiltration. Vegetated buffers also provide flood storage and wildlife habitat.

Preservation of vegetated buffers involves delineating and preserving naturally vegetated buffers and implementing measures to ensure that buffers and native vegetation are protected throughout planning, design, construction and occupancy. General guidelines and standards for vegetated buffers include:

A minimum buffer width of 100 feet as measured from the edge of a resource (wetland, top bank elevation of a stream, etc.) is recommended to preserve most buffer functions. Larger buffer widths (up to 300 feet or more) may be necessary for critical resources such as public drinking water supplies or based on site characteristics such as slope, soils, land use, vegetation type, and other factors.

The minimum recommended buffer width may not be achievable on existing developed sites.

The greatest buffer width that is practical should be maintained and restored and should not be reduced to less than 25 feet or below local or state regulatory requirements.

Other environmental features important to water quality preservation and enhancement should be included within the buffer, such as the 100-year floodplain and steep slopes."

In addition, the recommendation continues to emphasize the importance of maintaining vegetated buffers when clearing land for new development. This is especially critical for land currently in forest cover in the Conservation Priority areas of the watershed.

Figure 52 shows conserved farmland in the Little River Watershed. To date, approximately 1500 acres of farmland have been conserved. Maps of conserved farmland are useful for identifying lands for future conservation, as well as for directing funds and efforts to conserving these lands.

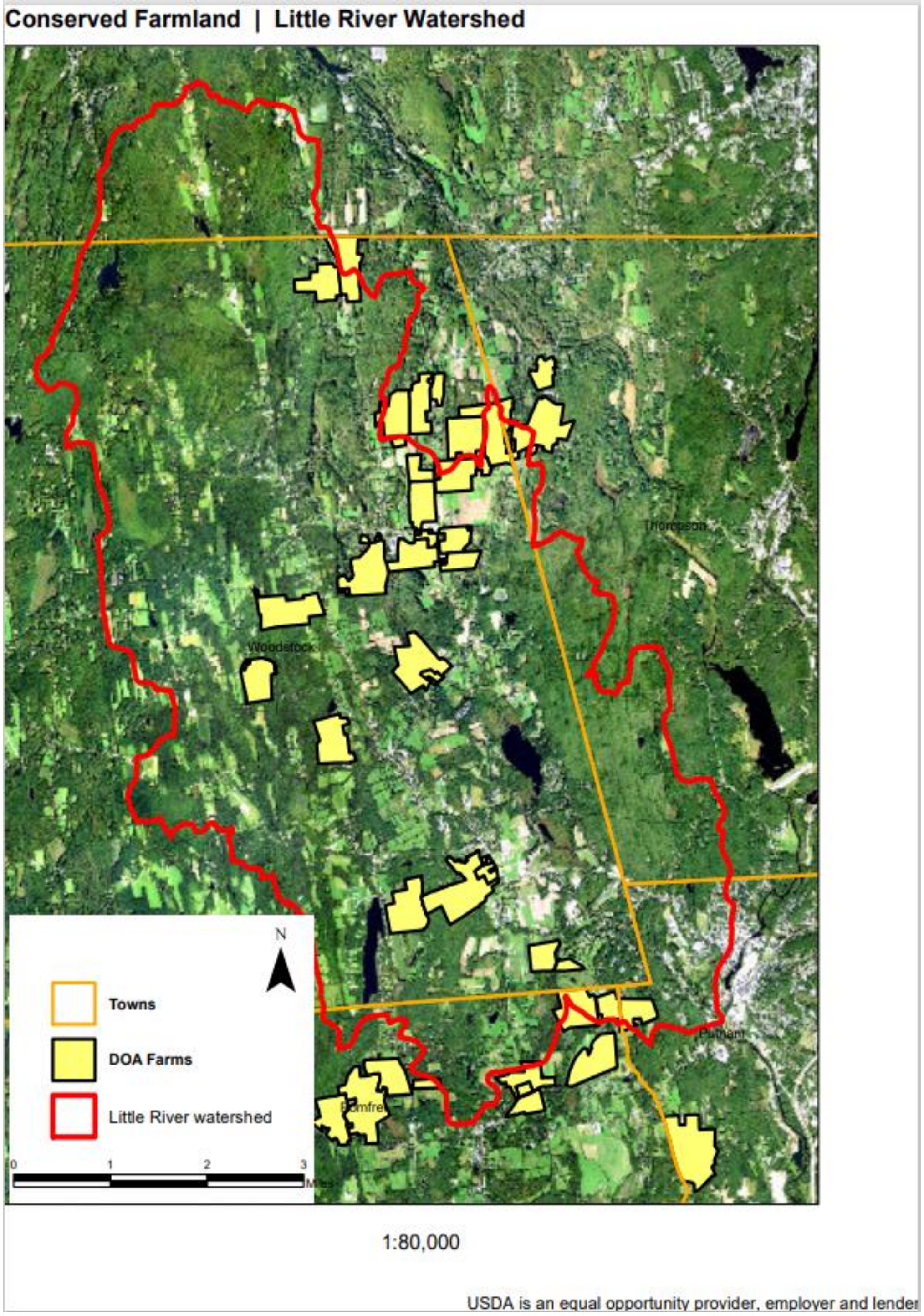


Figure 52. Conserved Farmland in the Little River Watershed

V. Summary and Recommendations

a. Water quality impairments/concerns and treatments needed.

Water quality concerns in the Little River watershed are from non-point source pollution. The principal impairments as presented in CT's Water Quality Assessment Report are based primarily on pathogen concentrations that exceed the safe recreational contact and drinking water quality standards. Excess nutrients and sediment are the primary concerns for Roseland Lake.

Pathogens

Peckham Brook and Muddy Brook are both cited in the Connecticut Statewide TMDL for Bacteria-Impaired Waters. Peckham Brook data is based on samples collected in 2011 by ECCD and volunteers from The Last Green Valley Volunteer Water Quality Monitoring Program. Muddy Brook data is based on CT DEEP Probabilistic Monitoring Data. The geomean exceedance is based on water samples collected in 2006. The single sample exceedance is based on water quality data collected in 2008.

Within the Little River watershed, "any facilities that discharge non-MS4 regulated stormwater should update their Pollution Prevention Plan to reflect BMPs that can reduce bacteria loading to the receiving waterway. These BMPs could include nuisance wildlife control programs and any installations that increase surface infiltration to reduce overall stormwater volumes."

Muddy Brook

Muddy Brook is the main tributary to Roseland Lake. It drains through the heart of the East Woodstock agricultural valley. Figure 53 identifies the load reduction required for *E. coli* bacteria in Muddy Brook to meet CT's Water Quality Standards.

Figure 53. Required load reductions for Muddy Brook

Statewide Bacteria TMDL Muddy Brook Assessment						
Stream Name	Single Sample Limit (MPN/100ml)	Actual high reading (MPN/100ml)	Required % reduction	Geomean of sample set limit (MPN/100 ml)	Actual Geomean	Require % reduction
Muddy Brook	410	5000	92%	126	482	74%

Peckham Brook

Figure 54 identifies the load reduction required for *E. coli* bacteria in Peckham Brook to meet CT's Water Quality Standards.

Figure 54. Required load reductions for Peckham Brook

Statewide Bacteria TMDL Peckham Brook Assessment						
Stream Name	Single Sample Limit (MPN/100ml)	Actual high reading (MPN/100ml)	Required % reduction	Geomean of sample set limit (MPN/100 ml)	Actual Geomean	Require % reduction
Peckham Brook	410	4400	91%	126	254	50%

High *E. coli* values in Peckham Brook and high Total Nitrogen values during dry weather indicate Peckham Brook contamination is not solely derived from stormwater runoff. Further water quality monitoring for *E. coli* and Total Nitrogen, bracketing potential sources, is recommended including potential agricultural and residential sources.

Pathogen DNA Source Tracking

Pathogen source tracking conducted by UCONN verifies that some of the pathogen contamination in Muddy Brook and Peckham Brook comes from cattle feces.

Available Sources of Nutrients and Pathogens

Another means to estimate nutrient contributions from stormwater runoff from agricultural land is to use export estimates compiled by the US EPA in 2007. For its study, *Estimated Animal Agriculture Nitrogen and Phosphorus from Manure*, EPA calculated the available amount of Nitrogen and Phosphorus per farm land area. Figure 55 reveals the Connecticut statewide estimate for both Nitrogen and Phosphorus. Using land cover estimates from Section II for land in agricultural use in the Little River sourewater area, 24% of the 35.5 square miles source water area equals 8.52 square miles.

Figure 55. Estimated Animal Agriculture Nitrogen and Phosphorus

State	**Estimated animal manure (1000 kg of N)**	**Estimated animal manure (1000 kg of P)**	**Estimated animal manure per farm land area (kg of N/km^2)**	**Estimated animal manure per farm land area (kg of P/km^2)**
Connecticut	3,493	749	2,105	451

Based on this model, there are 9,953.57 kg (21,943.9 lbs) of Phosphorus and 46,457 kg (102,420.2 lbs) of Nitrogen available annually from agricultural manure in the Little River

Source Water area. Nutrients applied to the soil, not taken up by plant growth and reintegrated into crops potentially contribute to surface water and/or groundwater contamination.

Harmful Algae Blooms

Cyanotoxin Data

Roseland Lake is one of the lakes studied by US EPA for its National Lakes Assessment (NLA) project. For the study, Roseland Lake was assessed on July 31, 2007 and July 11, 2012. Mid-lake water samples were assessed for Microcystin. Microcystin is one of multiple cyanotoxins produced as a by-product of cyanobacteria metabolism.

In 2018, water samples collected by The Last Green Valley water quality monitoring volunteers, following protocols developed by the US EPA Cyanobacteria Monitoring Collaborative, were assessed by lab staff at University of New Hampshire. Two water surface samples and a third sample collected at the boundary of the hypolimnion and thermocline, where elevated phycocyanin were measured, were assessed for microcystin.

In 2020 and 2022, additional samples were collected from shoreline surface scums and assessed at the US EPA lab in Chelmsford, MA as part of the Cyanobacteria Monitoring Collaborative cyanotoxin study.

The following table 56 presents a summary of available data on Microcystin Concentrations from water samples collected in Roseland Lake.

Figure 56. Microcystin Sampling Results in the Little River Sourcewater Area

Date	Source	Results µg/l	Location	Sample method
July 31, 2007	EPA NLA	0.05	Mid-lake	2 M water column
July 11, 2012	EPA NLA	0.05	Mid-lake	2 M water column
July 18, 2018	CMC UNH lab	0.05	Mid-lake	3 M water column
August 17, 2018	CMC UNH lab	0.03	Mid-lake	3 M water column
August 17, 2018	CMC UNH lab	0.04	Mid-lake	3.5 M Discrete sample
August 6, 2020	CMC EPA lab	Non detect	Shoreline	Surface grab
August 16, 2022	CMC EPA lab	pending	Shoreline	Surface grab
August 31, 2022	CMC EPA lab	pending	Shoreline	Surface grab
September 15, 2022	CMC EPA lab	pending		

b. Description of the SWP goals, objectives and practice efficiencies.

Pathogen Reduction Goals

The CT Water Quality Standards include upper limits for pathogen contamination based on the concentration of the pathogen indicator species, *E. coli*. In the Connecticut Statewide

Bacteria TMDL published in September 2012, a TMDL for bacteria was developed for Muddy Brook and Peckham Brook. Figure 57, with data extracted from Table 8-2 from that report shows the percent reduction required for each stream to meet the CT Water Quality Standards.

Figure 57.

Waterbody ID	Waterbody Name	WQ Class	Towns	Endpoint Target MPN/100 ml		% Reduction to meet TMDL	
				single sample limit	geometric mean limit		
CT3708-01-01	Muddy Brook	AA	Woodstock	410	126	92	74
CT3708-08-01	Peckham Brook	AA	Woodstock	410	126	91	50

Little River

Although Little River downstream of the Shepherds Pond Dam is listed as impaired for recreation, a TMDL has not been determined for that reach of the river.

Peake Brook

Water quality data was collected from Peake Brook in 2014 by The Last Green Valley Volunteer Water Quality Monitoring Program. The data was reviewed by CT DEEP staff. They concluded that based on the limited four week, twice a week sampling period with only a single exceedance of the single sample limit, the results were not sufficient to declare an impairment of Peake Brook. Although the geomean of the sample set indicated a high baseline concentration of *E. coli* in the brook, the official status of Peake Brook for recreation is undetermined. Based on the available water quality data and using the template for load reduction requirements as presented in the Statewide Bacteria TMDL, the unofficial load reduction for pathogens needed for Peake Brook are represented in Figure 58. The single sample limit for all other uses for streams is 576 MPN/100 ml. The higher threshold is for waterbodies not utilized as a bathing area, or for areas that may be used for bathing though not designated as a bathing area.

Figure 58. E. coli load reductions necessary for Peake Brook

Stream Name	Single Sample Limit (MPN/100ml)	Actual high reading (MPN/100ml)	Required % reduction	Geomean of sample set limit (MPN/100 ml)	Actual Geomean	Require % reduction
Peake Brook	576	13000	95.6	126	348	63.8

Nutrient Reduction Goals

The Connecticut Water Quality Standards and Classifications Surface Water Criteria For Class AA (source water) state that the loading of nutrients, principally phosphorus and nitrogen, to any surface waterbody shall not exceed that which supports maintenance or attainment of designated uses. There are no numeric nutrient thresholds for water quality in freshwater streams in Connecticut. CT DEEP has adopted a Biological Condition Gradient Model approach to surface water conditions. The Biological Condition Gradient is a model that describes how ecological attributes change in response to increasing levels of stressors. According to the Biological Condition Gradient Model, as the level of stress gets progressively greater, the biological communities, which start out in a natural condition, begin to change as they respond to the stress. It is difficult to directly develop nutrient goals for the individual waterbodies in Little River.

Nitrogen Reduction Goals

In December 2020, a Total Maximum Daily Load (TMDL) was developed for Long Island Sound. A TMDL is the calculation of the maximum amount of a pollutant a waterbody can accept so that the waterbody will meet and continue to meet water quality standards for that particular pollutant and an assessment of how much of a pollutant load reduction is necessary to meet that goal. (*Overview of Total Maximum Daily Loads (TMDLs) | US EPA*, 2022) The Long Island Sound TMDL focuses on excess nitrogen and total organic compounds that support hypoxia in the western part of Long Island Sound. The sources of these pollutants include nonpoint sources, or runoff from land use activities, which includes stormwater from urban areas, and runoff and groundwater transport from all land covers. The goals in the TMDL are based upon achieving a 10 percent reduction in the total nonpoint source load of nitrogen from urban and agricultural land covers within a management zone. The Little River watershed is in the upper Thames Management Zone 1-3 (Long Island Sound TMDL, 2020). Limited data is available to assess whether the 10% reduction goal for Little River has been met.

Phosphorus Reduction Goals

CT DEEP is in the planning and information gathering stage to initiate a Phosphorus based Total Maximum Daily Load (TMDL) for Roseland Lake.

The Causes of Algae Growth in Roseland Lake, Woodstock, CT assessed the lake trophic status based on the ratio of the watershed area to lake surface area of the lake. This 1978 study predicted Roseland Lake to be naturally eutrophic based solely on the watershed to lake surface ratio. (CT DEEP, 1978) Water quality data collected from Roseland Lake indicates the lake frequently crosses the threshold for highly eutrophic conditions during summer months. Roseland Lake has been on the Connecticut List of impaired waters since the list was initiated in 1992. The goal for Roseland Lake is to enact treatments in the upstream drainage area or to inactivate the legacy phosphorus deposits on the lake bottom to maintain the lake in the high mesotrophic/low eutrophic range.

Aquatic Life Support Use Goals

Many of CT Water Quality Standards are based on the Biological Condition Gradient Model. The model describes how ecological attributes change in response to increasing levels of stressors. According to the Biological Condition Gradient Model, as the level of stress gets progressively greater, the biological communities, which start out in a natural condition, begin to change as they respond to the stressors as defined by the biological metrics for determining water quality. The water quality goal for all freshwater environments is to meet the metrics that determine minimal water quality health standards for aquatic life support.

At the time of this report, all streams above the water treatment plant intake and Roseland Lake that have been monitored are meeting water quality standards for aquatic life support. However, many streams have not been assessed for Aquatic Life Support Use. The water quality goals for all streams in the Little River watershed are to maintain good stream health where it has been documented and to focus on assessing streams not previously assessed.

Little River below the Shepherds Pond Dam is not meeting water quality standards due to a modified flow regime. The goal is to ensure enough water flows over the dam to support aquatic life downstream. In order to meet the minimum flow standards for supporting downstream fish populations, water must be conserved upstream of the dam and by Putnam Water subscribers.

c. Interim metrics to track progress.

Metrics to track progress on water quality improvement effectiveness

To determine if conservation practices are effective at reducing pathogen contamination in the watershed, stakeholders will need to coordinate periodic assessments of water quality for *E. coli* in Peckham Brook, Muddy Brook, Peake Brook and Little River above the bypass to the water treatment plant. Summer *E. coli* monitoring should be coordinated with CT DEEP, the CT Department of Public Health, Putnam Water Pollution Control Authority and/or The Last Green Valley Volunteer Water Quality Monitoring Program. For freshwater sampling in a non-bathing stream, the goal is to not have any single sample exceed 576 MPN/100 ml *E. coli*, and the geomean of the sample set should be below 126 MNP/100 ml.

In order to bracket potential sources and better design remediation strategies, stakeholders should conduct a trackdown survey for *E. coli* in Muddy Brook and Peckham Brook. To specify the types of animals contributing *E. coli* to the brooks, stakeholders should consider additional monitoring for pathogens using DNA markers as part of the trackdown survey.

Stakeholders should also prioritize assessing streams for Aquatic Life Use Support. Smaller high-gradient headwater streams can be assessed by using CT DEEP's Volunteer Water Quality Monitoring Program, using its method known as Riffle Bioassessment By Volunteers (RBV). Through RBV, volunteers assess streams for the presence of macroinvertebrates that are sensitive to different pollutants. The macroinvertebrates are used as water quality indicators. The RBV method is a tool to verify stream health, though is not a means to quantify stream degradation.

CT DEEP may also conduct a Total Phosphorus trackdown survey in the watershed. This method, under development by CT DEEP, uses freshwater diatoms as water quality indicators in streams. Diatoms are a type of single cell algae that make a shell wall out of silica. Certain diatom species only live in water with low concentrations of phosphorus. Higher levels of phosphorus cause ecological changes in streams that impact aquatic life, including diatom diversity. The results will not be equivalent to an actual assessment of Total Phosphorus concentration, but the ranges of nutrients represented by the actual diatom diversity may be useful to target streams with the highest concentration of Total Phosphorus.

To support development by CT DEEP of the Roseland Lake TMDL, ECCD also recommends nutrient monitoring in Roseland Lake, and its major tributaries, Muddy Brook and Mill Brook, as well as Little River. As part of its TMDL assessment, CT DEEP will determine the need for additional monitoring in Roseland Lake. Potential monitoring partners include CT DEEP, USGS, Putnam Water Pollution Control Authority, CT Department of Public Health, Northeast District Department of Health, US EPA, ECCD and The Last Green Valley Volunteer Water Quality Monitoring Program. Figure 59 is an outline of metrics that can be used to evaluate the effectiveness of Agriculture BMP implementations.

Figure 59. Metrics to evaluate Agriculture BMP implementations

BMP	**# of BMP units required**	**# of BMP units completed**
Comprehensive Nutrient Management Plan (CNMP) development	# of acres managed under a CNMP	Increased # of acres managed under CNMP
Riparian buffer improvements	Linear feet of degraded buffer	Linear feet of linear buffer improved
Mortality composting facilities	# of mortality composting facilities planned	# of mortality composting facilities completed
Woodchip bioreactor/iron enriched sand filter treatment train	# of untreated tile drain effluent sites	# of woodchip bioreactors/iron enriched sand filters installed
Anaerobic Digester with wastewater treatment plant to separate nutrients	# of anaerobic digesters with wastewater treatment planned	# of anaerobic digesters with wastewater treatment installed

Sediment phosphorus treatment to address legacy phosphorus load in Roseland Lake/Shepherds Pond	# acres of lake bottom subjected to anaerobic conditions in summer	# acres of lake bottom treated
Increase # of acres of farmland using healthy soil practices	# of acres not using healthy soil practices	# of acres being brought into healthy soil practices
Cover crops and multispecies cover crops	# acres not using cover crops	# of acres introduced to cover crops
Adopt Haney soil test for better assessment of healthy soil practices	# of farms not using Haney test	# of farms that adopted the Haney soil test
Incorporate innovative conservation practices (biochar, value added riparian buffer plantings, shared equipment to bag composted manure)	# acres not using innovative conservation practices	# of acres benefiting from innovative conservation practices
Constructed treatment wetland	Current # acres intercepted by a constructed treatment wetland	# acres of runoff intercepted by a constructed treatment wetland
Forest conservation easements with Forest management Plan (FMP)	Current # of acres with a forest easement and FMP	Increased # of acres with a forest easement and FMP
Conservation Crop Rotation (includes pasture and hay planting)	# acres recommended for conservation cover crop rotation	# of acres where conservation cover crop rotation was achieved
Filter strip using switch grass or another grass species	# of linear feet of existing filter strips	Increased # of linear feet of filter strips installed
Exclusionary Fencing	# of linear feet of exclusionary fencing along wetland/water resources	Increased # of linear feet of exclusionary fencing along wetland/water resources
Heavy use area protection supports	# areas where heavy use area supports are needed	# of heavy use area supports installed
Waste storage facilities	# of inadequate waste storage facilities	# of improved waste storage facilities installed
Compost facilities (manure)	# of compost facilities recommended	# of compost facilities installed
Prescribed grazing plans	# of recommended prescribed grazing plans needed	# of prescribed grazing plans developed and implemented
Free-stall barn with ag waste storage	# of recommended free-stall barns recommended	# of recommended free-stall barns completed

Metrics for tracking water quality improvements	**Activity**	**# of waterbodies assessed for compliance with CT Water Quality Standards**
Baseline trackdown survey for pathogens in Muddy Brook and Peckham Brook	# of unassessed stream miles	# of stream miles with assessment completed
BMP completion follow-up monitoring in Muddy Brook and Peckham Brook	baseline pathogen concentration	% reduction in pathogen concentrations

Baseline trackdown survey for nutrient sources in Muddy and Peckham Brooks	# of unassessed stream miles	# of stream miles with assessment completed
BMP completion follow up monitoring in Peckham Brook	baseline TN concentration	% reduction of nitrogen pollution
Assessment of watershed health in Conservation focus areas	# of unassessed streams	# of assessments in streams previously unassessed

d. Locations of critical source areas and vulnerable acres needing treatment.

While developing the *Roseland Lake Management Plan*, ECCD staff determined critical source areas upstream of Roseland Lake. The determination was based on an analysis of measured nutrient concentrations compared to a variety of recommended thresholds for nutrients in Ecoregion 59. These thresholds were not developed by CT DEEP and are not official CT-approved nutrient thresholds. These critical areas were assigned High (pink) and Medium (orange) priorities as seen in Figure 60.

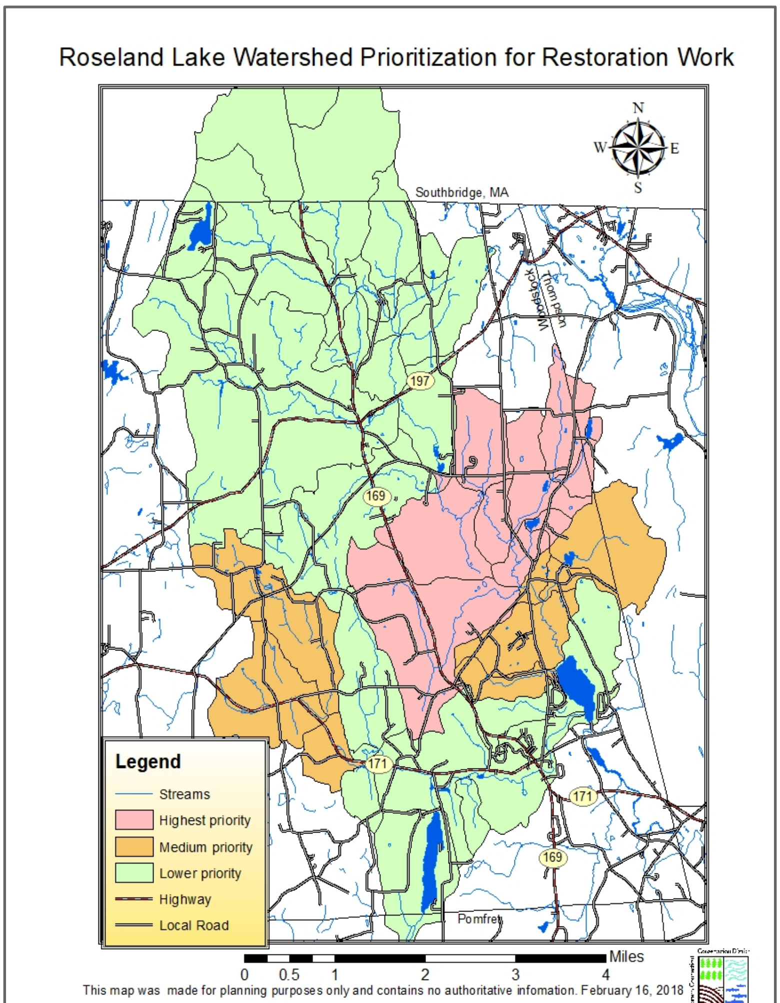


Figure 60. Roseland Lake Management Plan Critical source areas.

Little River and Peake Brook were not assessed as part of the Roseland Lake watershed evaluation. UCONN's Center for Land Use Education and Research (CLEAR), in partnership with Footprints on the Water, LLC, developed an alternate model to assess critical water quality areas in Connecticut watersheds. This web-based tool was used by ECCD staff to assess watershed health in the Little River watershed. By using high resolution landcover data provided by NOAA, the watershed assessment tool is able to develop different indexes to estimate watershed health. The tool is valid only for watersheds in Connecticut. Therefore, it does not score watersheds in Massachusetts which are located in the Little River watershed.

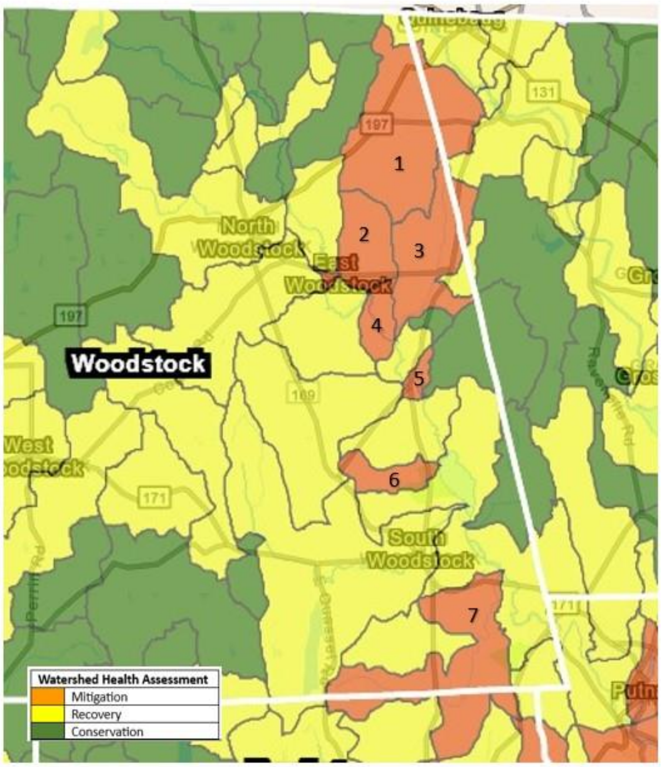


Figure 61. Local Watershed Assessment of Little River watershed area.

Figure 61 depicts a clip of the Little River watershed scored using the Local Watershed Assessment Tool.

The Local Watershed Assessment Tool uses an index, known as the Combined Condition Index (CCI). It describes the probable health of a watershed. Based on the C-CAP High Resolution Land Cover dataset for 100-ft riparian zone and upland area within the watershed, CCI of a watershed is calculated by determining the ratios of natural, impervious and agriculture-like land cover. CCI ranges between 0 and 1. A CCI of 0.75 or above indicates a healthy watershed.

UCONN CLEAR Local Watershed Assessment Tool © 2022

Enrichment Factor (EF) is a ratio of the estimated N export of a particular basin compared to the export we would expect from a pristine, forested watershed. A basin with a higher EF is more likely to have higher total nitrogen export.

The tool also assessed agriculture-like vegetation within a 100 foot riparian zone.

Using this model, watersheds were evaluated and assessed as Mitigation, Remediation or Conservation status based on the metrics used for the analysis. Figure 62 summarizes the scores for the local watersheds determined to be the highest priority Mitigation areas.

	Local Watershed Priority Map Key				
	Local WS Name	Comment	EF	CCI	% Ag-like vegetation in riparian zone
1	Jordan Brook	Not in Little River watershed			
2	May Brook	Mitigation	9.95	0.07	44.0

3	Peckham Brook	Mitigation	7.99	0.23	40.3
4	Muddy Brook	Mitigation	6.25	0.34	37.6
5	Muddy Brook	Mitigation	6.42	0.33	17.3
6	Unnamed "golf course" brook	Mitigation	6.42	0.33	21.3
7	Peake Brook	Mitigation	5.3	0.40	13.8

Figure 62. Local Watershed Assessment Scores

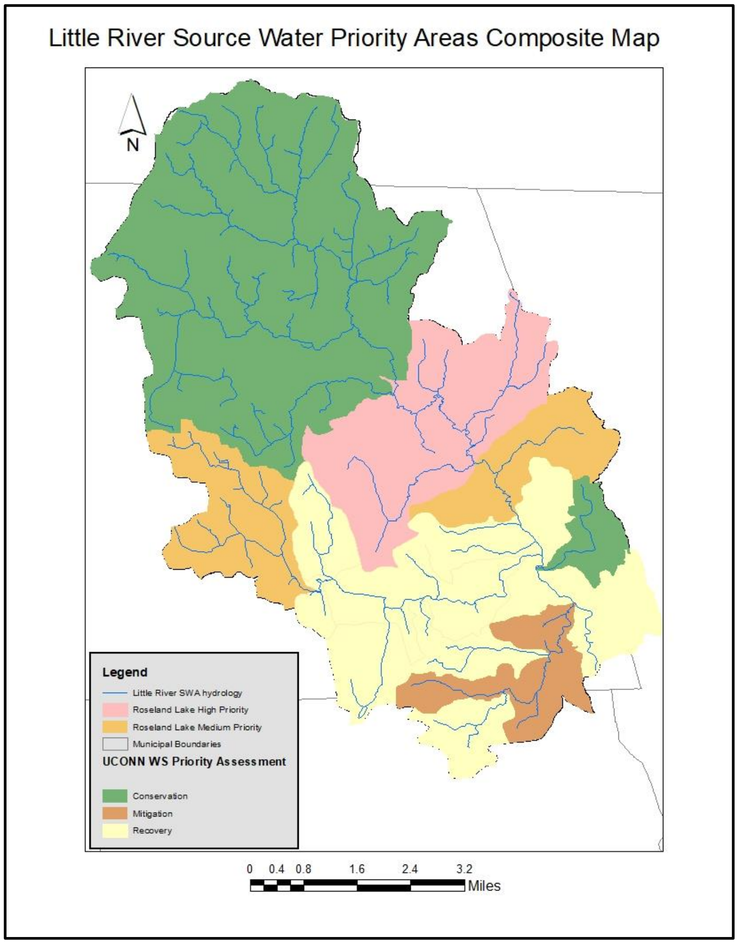


Figure 63. Little River Source Water Priority Area Composite Map

Designated Mitigation basins, depicted in orange, have a low CCI score indicating the likelihood of significant pollution problems and the need for restoration measures, particularly in the riparian zone. Designated Recovery basins, depicted in yellow, have a moderate CCI score indicating some impairment. Conserving and reforesting key riparian and watershed lands are the best strategies to implement in these areas. Designated Conservation basins, depicted in green, have a high CCI score indicating that the health of the watershed is likely to be good and should be protected.

A composite map of the Little River watershed priorities was created by combining the Roseland Lake priority analysis with the Local Watershed Priority Areas. The Little River Source Water Priorities Areas Composite map visually identifies the watersheds with the highest priority needs (mitigation), medium priority needs (recovery) and areas where conservation needs are the highest priority, as shown in Figure 63.

e. Description, evaluation & costs of planned practice scenarios.

"NWQI emphasizes a 'systems approach' to address priority natural resource concerns. A cornerstone of this approach is to encourage producers to implement a system of practices that has been determined to address specific high-priority resource concerns in selected watersheds and incorporate practices that address the concepts of avoiding, controlling, or trapping pollutants, also known as ACT".

"Contracts developed under NWQI must include at least one of the applicable core practices or must be completing a conservation system that supports core practices that are documented as already applied on the land under contract" (307.28 National Water Quality Initiative, Amended Oct. 2021).

In 2022, NRCS developed a strategic operational plan to address a recent report by CEAP (Conservation Effects Assessment Project), which found an increase in soluble nitrogen and phosphorus lost to the environment nationally over a ten-year period. In response to changing trends in climate, technology and production, NRCS introduced SMART nutrient management planning.

SMART Nutrient Management includes the 4Rs of nutrient stewardship – the right **Source**, right **Method**, right **Rate**, and right **Timing** – and reduces nutrient loss by **Assessment** of comprehensive, site-specific conditions. Nutrient management planning or NRCS practice 490, includes many types of testing including soil, organic nutrient source and plant tissue, and applying nutrients according to the soil or crop needs. It often saves money on fertilizer and improves water quality (https://www.nrcs.usda.gov/getting-assistance/other-topics/nutrient-management).

NRCS Soil health research has determined how to manage soil in a way that improves soil function, which includes Five Principles to Manage Soil for Health:

- ❖ Maximize Presence of Living Roots - Keep plants (or cover crops) growing throughout the year to feed the soil and reduce erosion
- ❖ Minimize Disturbance - Minimize physical, chemical, and biological disturbance as much as possible to keep soil structure healthy
- ❖ Maximize Soil Cover - Keep plant residues on the soil surface to reduce weeds, water evaporation and erosion
- ❖ Maximize Biodiversity - Grassland and cropland plant diversity increases soil and animal health

- Integrating livestock - Well managed grazing livestock help reduce weeds, provide natural fertilizer, increase nutrition and nutrient cycling

In the Little River watershed, most livestock farmers assisted by NRCS are practicing no-till corn and some form of cover crop, whether a single species or a diverse mix. They also have Comprehensive Nutrient Management Plans (CNMP) and should be following the NRCS nutrient management standard. Many farmers have been able to receive payments for cover crops and no-till in the past and have continued to implement both on their own. However, as bigger corn crop varieties are used, the farmers' harvest date around Labor Day is now mid-September, which means the cover crops are planted later than recommended and have less time to grow and provide benefits. NRCS recommends using a shorter season corn, allowing more time for cover crops to be in the ground, thereby providing the greatest soil health benefits – especially water quality protection. Under its Conservation Stewardship Program, NRCS provides additional funding to producers to implement soil health practices at a higher level. In 2022, two farmers in the watershed signed up for CSP enhancements including no-till, multiple species cover crops and nutrient management enhancements (conversation with Bill Purcell, 2022).

For many reasons, most hay fields exhibit poor soil health. Many fields have not had either manure or lime applied. Others have not been re-seeded in a long time, so any legumes have died out. Some recommendations are to till, re-seed, add lime and do multi-species planting with practices such as forage & biomass planting, nutrient management and soil testing. If there are compaction or stormwater runoff issues, combine additional forage crops and interseed with a no-till drill. Most horse farm fields can use an addition of tillage or daikon radish (conversation with Sally Timmons, NRCS, 2019).

It is recommended in Figure 62 that at least 6 identified horse farms in the watershed receive funding for manure compost facilities. In the past, horse owners have resisted this avenue as too expensive in CT to meet the standards of the NRCS practice when they are unable to sell or otherwise remove all the composted manure anyway. They are reluctant to confine the animals to small heavy use areas in order to keep pastures from being overgrazed. It appears to give the impression that NRCS programs are not for them. With so many horse owners in the watershed, this issue that would do well for solutions to be sought so they may participate fully in NRCS programs.
There are suites of practices that could benefit soil and water health in the Little River watershed, including:

● Residue & tillage management (329) with no-till and strip-till combined with Cover crop (340)
● Waste Storage Facility (313) or Compost facility (317), Roofs and covers (367), Roof runoff structure (558) and Underground outlet (620)
● Exclusionary Fencing (382), Filter Strip (393) or Riparian Herbaceous Cover (390), Water well (642), Livestock Pipeline (516), Watering facility (614) and prescribed grazing (528)
● Forest Management Plan (106), Forest stand improvement (666), Forest Trails and Landings (655) and Brush Management (314)
● Filter Strip (393) or Riparian Herbaceous Cover (390), Nutrient Management (590), Conservation Cover (327), Cover Crop (340) and Pasture and Hay Planting (512)

The following table (Figure 64) summarizes areas of resource concerns using previously mentioned priority areas, by practices, with estimated costs and load reductions. Sites were selected based on aerial map evaluations along with NRCS staff input and would need to be verified for accuracy. Costs change yearly, so amounts are not definitive.

Practice scenarios	**# Units Estimated**	**Units**	**Estimation of treatment costs per unit**	**Estimation of treatment costs total ($)**	**Total N Reduction Treated Acres (lbs/yr)**	**Total P Reduction Treated Acres (lbs/yr)**
Cover crops (340)	most larger farms already doing, but potential for improvement	Ac	$74 - basic $93 - mult. sp. $507 - <= 1 Ac		3.31/acre*****	0.31/acre*****
Conservation cover (327)	potential	Ac	$195 native species $211-847 all other			
Conservation crop rotation (328)	potential	Ac kSqFt	$14 - Basic $37 - Specialty Crops $35 small scale specialty crop		1.7/acre*	0.4/acre*
Filter Strip (393) using switchgrass or another grass species	40	Ac	$245 native species $602 native sp. forgone income $211 introduced sp	9,800 - 24,080	1811	130
Residue & tillage management (329)	most larger farms already doing no-till, potential on smaller farms	Ac kSqFt	$20 No-Till/Strip-Till $41 Small Scale No Till		4.49/acre*	3.0/acre*

Practice scenarios	# Units Estimated	Units	Estimation of treatment costs per unit	Estimation of treatment costs total ($)	Total N Reduction Treated Acres (lbs/yr)	Total P Reduction Treated Acres (lbs/yr)
Pasture and Hay Planting (512)	Potential	Ac	$105-934 depends on type and area			
CNMP Activity (101) DIA (102) CPA supports waste storage	14	No	$5,000 - 7,975 depends on AU's	70,000 - 111,650		
Nutrient Management Design and Implementation Activity (157) CPA	5	No	$4,867 < or = 100 Acres Fertilizer and Manure	24,335		
Nutrient Management (590)	6	No	$2,910 Adaptive NM	17,460	2.5/acre*	1.7/acre*
Exclusionary Fencing (382)	10,000	Ft	$1-12	10,000 - 120,000	14.9	1.9
Water well (642) Alternate water source	4-7 sites (typical well depth = 400-600 ft.)	No Ft LnFt	$8,689 typical well $20 4"limited casing $28-46 typical 6-8" or >	34,756 - 60,823		
Pumping Plant (533) supports 642	4-7 1	BHP No	$2,797 Electric pump 2 HP with Adequate Pump Controls $1387 Livestock Nose Pump	11,188 - 19,579 1,387		
Livestock Pipeline (516) supports 642	4-6 sites 2,000 1.5"	Ft	$5.50 PE pipe >1 in Dia., Buried 4ft Deep	44,000-66,000		
Irrigation Pipeline (430) supports 642	1 site 2,000 2"	LnFt	$6 PVC <= 4 inch, Small Scale System	12,000		
Watering facility (614)	4-6	No	Frost Free Trough $839	3,356 - 5,034		

Practice scenarios	# Units Estimated	Units	Estimation of treatment costs per unit	Estimation of treatment costs total ($)	Total N Reduction Treated Acres (lbs/yr)	Total P Reduction Treated Acres (lbs/yr)
Heavy use area protection (561) supports 642, 614, 313, 317	4-6 24 sf 6 sites (350 sf = 6 horses)	SqFt	$3.59 - Gravel pad for water facility $9 - Concrete /Asphalt without Curb up to 1000 SF	1,000 18,900	59	12.5
Critical Area Planting (342) supports 561	potential	Ac kSqFt	$446 - any vegetation, normal tillage $940-1343 - w/grading & shrubs $1629-2329 - hydroseeding $20 small scale perm. cover			
Mulching (484) supports 561	potential	kSqFt Ac	$223-441 - Erosion Control Blanket or aggregate $47-534 - natural or synthetic mat'l, straw or hay			
Waste Storage Facility (313)	size & types: 1558k -2 5328 -1, 48,000 - 2 1672 - 2 4800 -1	SqFt CuFt	$31 Bedded Pack, Concrete Wall, Concrete Floor $10 Concrete, Rectangular, With Concrete Top	261,764 1,041,440	5449.3	1006
Waste Transfer (634)	624 sf - 2	SqFt	$15 Concrete Scrape Alley	19,260		
Compost Facility (317)	6 sites 1K sf	SqFt	$20-30 depending on bin type	120,000 - 180,000	4079.9	1260.7
Roofs and covers (367) supports 313, 317	6 compost facility - 1k sf 6528-1 3886-2	SqFt	$21 Timber Framed Roof with Timber Foundation	344,694		
Roof Gutter (558) supports 313, 317	6 compost fac. 100 ft, 5 stor. facil. = 1100 ft	Ft Ft	$8 small $19 large	4,800 20,900		

Practice scenarios	# Units Estimated	Units	Estimation of treatment costs per unit	Estimation of treatment costs total ($)	Total N Reduction Treated Acres (lbs/yr)	Total P Reduction Treated Acres (lbs/yr)
Underground outlet (620) supports 313, 317	6 compost fac. & 4 stor. fac. 400 ft	Ft	$12 6-inch Corrugated Plastic Pipe (CPP) only	48,000		
Prescribed grazing (528)	75	Ac	$42-230	3,150 - 17,250	258.5	12.5
Animal Mortality Facility (316)	2 concrete pad 5,763 sf.	SqFt	$8 static pile, concrete pad	92,208		
Riparian Forest Buffer (391)	potential	Ac	$250 seeding $2203-7646 bareroot, cont, cuttings			
Riparian Herbaceous cover (390)	potential	Ac	$1064 Warm or cool Season Grass w/Forbs			
Forest Stand Improvement (666)	570	Ac	$745 HU-Thinning for Wildlife and Forest Health	424,650		
Forest Trails and Landings (655) supports 666	TBD	varied units	HU - wide range			
Forest Management Plan (106) CPA	12 12	No	$1436 HU <= 20 ac $2117 HU 21-100 ac	17,232 25,404		
Brush Management (314) supports 666	TBD	Ac	$40-1,520 depending on type			
Field Border (386) using switchgrass or another grass species	potential	Ac	$170 native sp. $526 native sp. forgone income			
Waste Facility Closure (360)	3 (208x208x8)	CuFt	$.20 -.26	69,225 - 89,989		

Alternate Practices

Practice scenarios	**# Units Estimated**	**Units**	**Estimation of treatment costs per unit**	**Estimation of treatment costs total ($)**	**Total N Reduction Treated Acres (lbs/yr)**	**Total P Reduction Treated Acres (lbs/yr)**
Manure injection (under nutrient mgmt)	potential		TBD			
Precision planting	potential		TBD			
Denitrifying bioreactor for Nitrogen in ground water (605)	potential	CuYd	$82			
Anaerobic digester (366)	potential		$400,000 - $5,000,000 (source: EPA)			
Waste Treatment (629) supports 366	potential		$1417-11,763 Aerators $.61 - 15 (sqft) or $23 -93 (gallons/day) Various Milkhouse Wastewater Treatments			
Soil Carbon amendment (808)	potential	CuYd or CuFt	$11-331 HU depends on type			
Forest Farming (379)	potential	Ac	$1161 HU-canopy treatment $1419 HU-Native Forb Planting $1945 HU-Native Forb Planting $1030 HU-Tree and Shrub Planting			
Total			**NRCS funding**	**2,750,909 - 3,069,839**	**minimum of 11,673 lbs/yr**	**minimum of 2,424 lbs/yr**
New free-stall barn with ag waste storage (estimate)	1 site		TBD funding	915,655	2096	387

Sitework/removal of old barn (estimate)	1 site		TBD funding	132,000		
Total			**TBD funding**	**1,047,655**		

Figure 64.

* **STEPL/Acre using Total Cropland = 5100 acres**

- ★ Used costs for PR & WP (Priority & Sourcewater Protection practices)
- ★ All costs from CT EQIP payments schedule dated 3-17-23 and rounded up to nearest dollar
- ★ Not all supporting practices to core practices may be listed here
- ★ Pollutant Load Reductions for N and P were calculated using EPA's Spreadsheet Tool for Estimating Pollutant Load (STEPL)

The NRCS Conservation Stewardship Program (CSP) encourages producers to address priority resource concerns and improve and conserve the quality and condition of natural resources in a comprehensive manner by adding additional conservation activities (practices) and improving, maintaining and managing existing conservation (even if not an NRCS practice standard).

Examples of CSP to look at for future contracts in the watershed (not a complete list):

E328F Modifications to improve soil health and increase soil organic matter
E340G Cover crop to reduce water quality degradation by utilizing excess soil nutrients
E390A Increase riparian herbaceous cover width for sediment and nutrient reduction
E590A Improving nutrient uptake efficiency and reducing risk of nutrient losses
E612A Cropland conversion to trees or shrubs for long term improvement of water quality

<u>Alternate Conservation Practices (NRCS and Non-NRCS supported)</u>

Switch grass riparian buffers: Field border (386) or Riparian Herbaceous cover (390)

A grass buffer has the potential to reduce up to 60% of sediment and captures sediment-attached phosphorus within the first 15 feet of the buffer. Harvesting grass buffers provides producers more flexibility in their management options and allows for the removal of excess nutrients so that more can be taken up as the plants regrow. Grass from the buffers can be harvested for hay to feed livestock, and the harvest season is after a hard frost so it would not compete with a farmer's focus at corn-chopping time. The grass can also be harvested for use as a biofuel. Big Bluestem and Switchgrass are native, warm-season perennial grasses that produce well during hot, dry weather on soils with low moisture or pH, and can do well with low fertility. Switchgrass is more tolerant than big bluestem for seeding in poorly drained sites. The limited nutrient input requirements make them ideal for a buffer location where nutrient applications could be harmful, and deep-rooted plants allow for nutrient scavenging. Although they are typically used in pasture settings, warm-season perennials in riparian areas can be harvested and stored as hay and still maintain their filtering capacity provided the remaining grass stems are not mowed lower than 4 – 6 inches. Warm-season grasses should be seeded alone, as management techniques with mixed stands typically end in failure of one species or another. They can be difficult and expensive to establish so they should be planted as a permanent sod in pastures or hayfields.

Soil testing to include a review of available legacy nitrogen (Conservation and Evaluation Monitoring Activities or CEMA - code 216)

Retesting for soil health indicators is recommended at least every 3 years during management transition periods and at least every 5 years once all new management practices have stabilized, or more frequently if management is significantly changed. Healthy soil biota includes microbes that can utilize water insoluble organic nitrogen and release water soluble nitrate and nitrite-nitrogen into the soil in the root zone of the crops, reducing the need for synthetic fertilizer. Traditional soil testing focuses on available nitrogen levels in the inorganic form. Relying on a traditional soil test to calculate nutrient needs may lead to an unnecessary over-application of water-soluble nitrogen. Any excess soluble nitrogen will likely be transported off the field either through surface runoff, or through groundwater transport. The Haney Test provides a more comprehensive evaluation of soil health. It uses unique soil extracts in the lab to determine what quantity of soil nutrients are available to soil microbes. The test also evaluates soil health indicators such as soil respiration (Solvita CO2 burst test), water-soluble organic carbon and organic nitrogen and their ratio. (non-structural)

Soil Carbon Amendment (Practice Code 808)

In November of 2022, Soil Carbon Amendment became a national (non-interim) practice with the code 336.

A means to achieve that goal is to increase soil carbon with biochar. Biochar is a stable solid, rich in carbon that is made from organic waste material or biomass that is partially combusted in the presence of limited oxygen. The qualities that make up biochar vary depending upon the material from which it comes (feedstocks; i.e., timber slash, corn stalks, manure, etc.) and the temperature at which combustion occurs. Benefits of biochar include improving soil health, raising soil pH, remediating polluted soils, sequestering carbon, lowering greenhouse gas emissions and improving soil moisture.

Dairy manure is utilized as a soil amendment on a large scale, mostly in a slurry form. Several larger farms including active dairy farms have a Comprehensive Nutrient Management Plan.

This plan is part of the conservation management system (CMS) Animal Feeding Operations (AFO). An important part of this program is manure management. (non-structural)

Numerous residents in the watershed have small-scale livestock operations, including horses. There is at least one horse boarding operation in the watershed. Horse manure management or minimum acreage for large animals is not regulated in the Little River watershed, and the process of manure management varies from the ever-growing large pile at the edge of the property, to dumpster waste hauling, to advertising "free horse manure compost – you haul". Horse owners struggle to find places for the manure and don't have the advantage of spreading the manure on their pastureland as horses will reject feeding on the grasses (horseowner conversation, 2023). Small scale biochar production could be explored as a feasible alternative to convert horse manure waste into biochar, a value-added product. (non-structural)

Anaerobic Manure Digester (Conservation Practice Standard 366)

"Farm-based anaerobic digestion (AD) of manure presents an opportunity to increase renewable energy production, improve the economics of Connecticut's agricultural sector, reduce nutrient loading and associated water quality impairments, and address climate change" (https://portal.ct.gov/-/media/DEEP/Permits_and_Licenses/Factsheets_General/Farm-Anaerobic-Digester-Factsheet.pdf). An AD is a system in which bacteria biologically digest and break down organic material in the absence of oxygen (or "anaerobically"). ADs typically process animal manure, food scraps, and wastewater biosolids or a combination thereof. ADs produce heat as a bioproduct of the digestion process. This heat is very effective in killing pathogens in the manure (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7112049/; Is anaerobic digestion a reliable barrier for deactivation of pathogens in biosludge? Sci Total Environ. 2020 June 25; 723: 138016). AD's produce biogas digestate with residual solid and liquids as byproducts. Biogas is mainly made up of methane gas (CH4) which can be stored and used as a sustainable energy source. Biogas collected from ADs is often used to generate electricity on-site or the biogas is further processed to produce renewable natural gas (RNG) and fed by injection directly into natural gas pipelines converting manure into a value-added product that will increase revenue diversity for agriculture producers. The byproducts of this process heat up during the anaerobic digestive process, deactivating potential pathogens as a side effect of the process. (Structural)

Waste Treatment (Code 629)

To use manure and waste treatment facilities to improve water quality and air quality by:

- reducing the nutrient content, organic strength, and/or pathogen levels of manure and agricultural waste,

- reducing odors and gaseous emissions,
- facilitating desirable waste handling and storage,
- producing value added byproducts that facilitate manure and waste utilization.

The end product of anaerobic manure digestion (AD biogas digestate), after the carbon is sequestered, is rich in nutrients, including nitrogen and phosphorus. Treatment of this wastewater using available technology can segregate the nutrient fractions and process them into value-added products that can be used as an agricultural fertilizer better proportioned to soil needs. It also would allow for nutrients traditionally applied to fields in excess, such as phosphorus, to be packaged for export out of the watershed to areas that have a higher demand and value. (structural)

Inactivation of legacy sediment phosphorus in Roseland Lake

Eutrophication and the resulting proliferation of cyanobacteria and cyanotoxins are the greatest causes of water quality deterioration in aquatic systems worldwide (Barry Husk, President, BlueLeaf Inc. Cyanobacteria, Cyanotoxins & Aquatic Eutrophication News google group email, June 29, 2023). Roseland Lake and Shepherds Pond are two natural lakes within the Little River source water watershed. Both waterbodies experience seasonal cyanobacteria blooms. These waterbodies have been receiving and storing nutrients from the watershed for centuries. The legacy phosphorus in the bottom sediments of Roseland Lake has been documented to contribute to summer cyanobacteria blooms.

A recommendation of *Roseland Lake Management Plan* is to immobilize the legacy phosphorus stored in the lake sediments that are seasonally available during summer when the lake bottom becomes anoxic. This recommendation was mirrored by Pond and Lake Solutions, the lake management consultant hired by the Town of Putnam Water Pollution Control Authority (see Roseland Lake Water Quality Report in appendix A). A treatment of the lake bottom sediments where legacy phosphorus has built up in Roseland Lake and Shepherds Pond would reset the summertime phosphorus availability to surface flow sources. During summer months, this type of treatment will reduce up to 40% of the phosphorus at the surface of Roseland Lake that is available to intensify potential harmful algal blooms. An estimate of the duration of the treatment success is up to 10 years, after which less costly maintenance treatments could be implemented. (non-structural)

Denitrifying bioreactor (Practice Code 605)

A woodchip bioreactor has been locally demonstrated as an effective means of reducing dissolved nitrate-nitrogen from tile drain effluent by passing the effluent through a bed of hardwood chips under anaerobic conditions. The water quality results from the monitoring that took place for a year beginning in 2017 demonstrated that the woodchip bioreactor installed in a hay field in South Woodstock CT showed the system was very effective at removing nitrogen from the tile drain discharge. Total Nitrogen, composed of NO2-N, NO3-

N, NH3-N and Organic N, was reduced by a range of 30 – 97%, averaging 76% over the 20 samples. NO3-N, which is the dominant form of nitrogen in the inflow samples, was reduced by an average of 94% with a range of 41.3% to 100%. (Structural)

There is a need to document locations of existing tile drain networks for the potential to intercept and treat tile drain effluent to remove nutrients. Once the location of a tile drain outlet is located, the site can be evaluated for suitability based on available land and the slope of the field. It is just as important to avoid conversion of tile drained farmland to residential land with onsite septic systems. If the underground plumbing network is left undisturbed during residential construction, the tile drain systems may potentially facilitate the household wastewater effluent to bypass the natural soil microbe treatment of nutrients and pathogens and discharge untreated household waste into nearby wetlands and/or water resources. (non-structural)

Phosphorus Removal System (Practice Code 782)

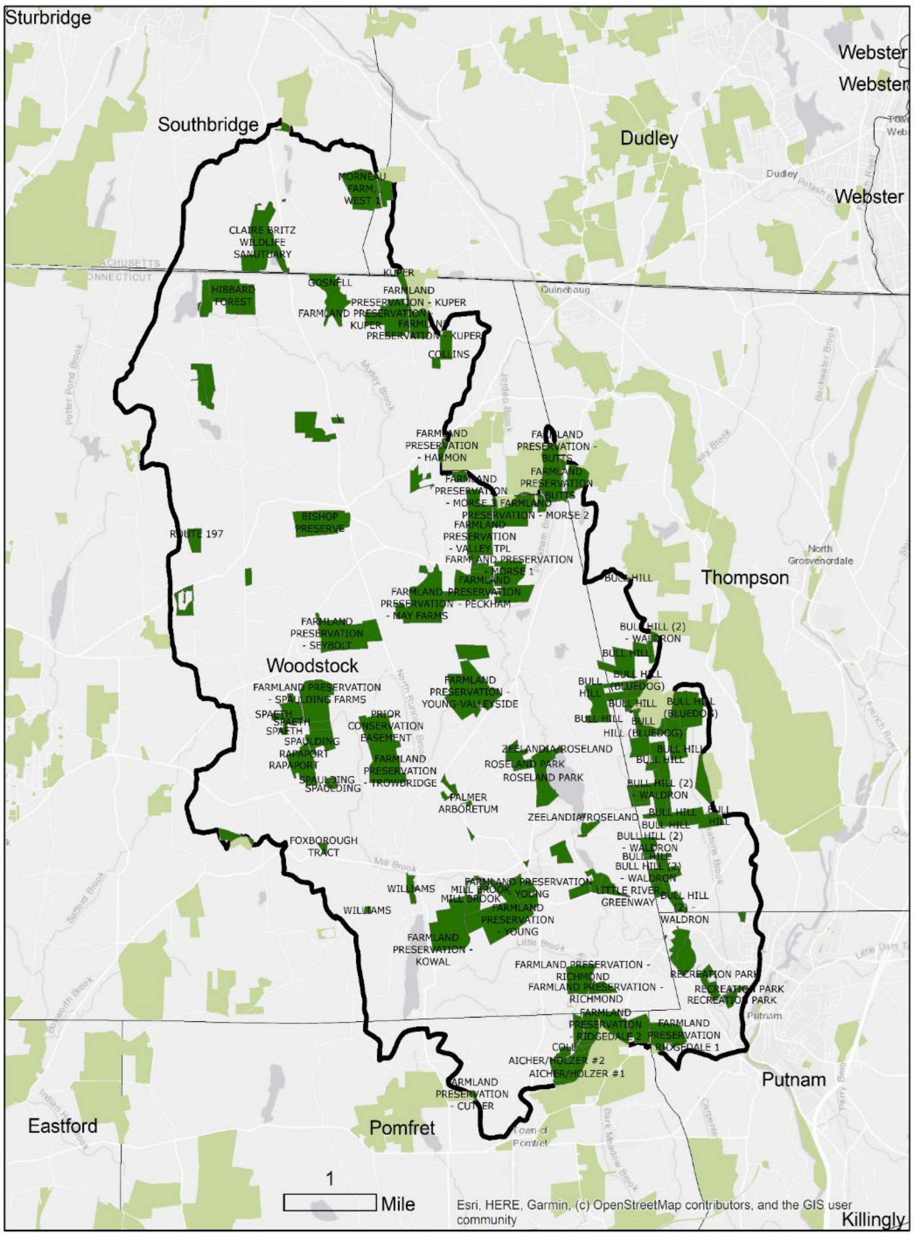
The woodchip bioreactor installed to intercept and treat tile drain effluent in South Woodstock was highly effective at removing nitrate-nitrogen from the effluent. The system was not effective at removing phosphorus and shed low amounts of phosphorus during the summer months. A phosphorus removal system is designed to remove dissolved phosphorus (P) from surface runoff, subsurface flow, or groundwater. A phosphorus removal system usually consists of a sorption media with a high affinity for dissolved phosphorus. This system includes a containment structure that allows phosphorus-rich water to flow through the media. The containment structure is designed to retain the media so that it does not move downstream. It also includes a means to remove and replace the media after its absorptive properties are expired. This practice is used to improve water quality by reducing dissolved phosphorus loading to surface water through the sorption of phosphate (dissolved) P from drainage and runoff water and can be installed independently, or in a treatment train system with nitrogen removing technology. Properly designed P Removal Structures can result in reductions of 16-71% of dissolved phosphorus concentration and loading. (structural)

Forest Easements

This plan identifies areas of the watershed that have the highest need for remediation in the watershed, the Little River watershed is fringed with many areas with blocks of forested land. Anti-degradation practices, with a focus on limited disturbance in riparian areas, are recommended for these areas.

Figure 65 is a map showing the open space parcels in the watershed. Brian Hall, a GIS consultant for The Last Green Valley developed a map displaying the location of the conserved open land in the Little River watershed (Figure 63). He calculated that 3,780 acres of the watershed (or 15%) were protected from development. Of those protected acres, approximately 1,500 acres are in agricultural land protection programs. Protected Open Space Layer Metadata and

Background Information shown on the map were current up to 9/28/2021; minor updates 5/2/2022.



Brian Hall, Date Saved 5/3/2023; LittleRiverCalcPOSStats.mxd

Figure 65. Conservation Land in the Little River Watershed.

The Bull Hill ridgeline on the Woodstock/Thompson border has been an area of focus for the Wyndham Land Trust. Since the publication of *Muddy Brook and Little River Water Quality Improvement Plan* (2009), the Wyndham Land Trust has acquired over 1000 acres of land in this area. The Trust's collective Bull Hill Preserve straddles the ridgeline, with some of the land draining towards the Little River source water area. The east side of the ridgeline drains towards Wheaton Brook, a Little River tributary that flows into Little River downstream of the drinking water bypass.

The northern part of the Little River wooded landscape includes protected land owned by Opacum Land Trust, New Roxbury Land Trust, Connecticut Forest and Parks Association and the Town of Woodstock.

The benefits of forested land are many, but in terms of reducing impacts from agricultural runoff, forested land upstream of the land in agricultural use helps to maintain base stream flow and dilute the elevated load of nitrogen and phosphorus shed from agricultural land. The USDA NRCS Healthy Forests Reserve Program (HFRP) can assist landowners to promote the recovery of endangered or threatened species, improve plant and animal biodiversity and enhance carbon sequestration. Based on the Becker/Dunbar model Figure 66, a square meter of forested land sheds approximately 18.8 times less phosphorus per year than a square meter of agricultural land. (non-structural)

Figure 66. Runoff coefficients for Urban, Forested and Agricultural Land

Land Use	Phosphorus lbs/ac/day	Phosphorus mg/m^2/yr
Urban (developed land)	$4.33*10^{-4}$	17.7
Forest	$1.04*10^{-4}$	4.3
Agriculture	$1.98*10^{-3}$	80.8

(Becker and Dunbar, 2009)

It is not always possible to protect an entire forest from development. The next best recommendation is to protect the streamside vegetation.

Value-added Riparian Buffer Plantings

The increased stormwater runoff and nutrient reduction benefits from riparian buffer plantings has been emphasized repeatedly throughout this plan. An alternate riparian buffer strategy suggested by Cadie Pruss of CT USDA NRCS is to plant value-added perennial shrub borders along stream channels that, when strategically pruned, have a market value to the floral decorating industry. Examples of suitable plantings include pussy willow, red osier dogwood, and winterberry. Another option would be to lease the riparian buffer region to a grower to grow shrubs whose clippings would have a cash value on the floral market. (non-structural)

Constructed Treatment Wetlands

Constructed treatment wetlands have been found to remove fecal coliform (FC) through a variety of mechanisms. This type of wetland was installed and monitored in Nova Scotia and evaluated for removal of FC in both warm and cold seasons from surface flow treatment wetlands. Two wetlands (100 m 2), of differing depths were monitored over a 17 month period. The wetlands were loaded with dairy wastewater and sampled weekly at both the wetland inlet and outlet. Removal rates and mass reductions ranged from 96.8 to 99.7% over the entire monitoring period. While an effective treatment system for removal of FC in agricultural runoff, it may be difficult to find a suitable location that doesn't reduce valuable cropland. (Structural)

Centrifugal Separation of Manure Solids

Through information provided by UCONN, an NPS Workgroup found that Connecticut produces excess phosphorus in the form of animal manure, feed and fertilizer. Centrifugal separation of solids from manure can concentrate phosphorus in the solids, allowing liquid manure to be land-applied with less impact to water quality. Anaerobic digestion, paired with solid separation, can further reduce the volume of waste and can produce energy and value-added products like farm animal bedding, soil conditioners and peat for potting. The Workgroup recommends for this priority to:

- enhance agriculture animal waste management and technologies that concentrate phosphorus in separated solids,
- assist with capital costs and organize cooperative agreements to pool resources for centralized/regionalized anaerobic digestion for dairy and food wastes,
- incentivize or capitalize private companies to coordinate manure transfer from areas of nutrient excess to areas of soil nutrient need,
- identify and incentivize manure management strategies on fields,
- provide capital funding for pilot projects to evaluate new technologies for managing manures and agricultural waste such as pelletizing, gasification and phosphorus recovery.

Shared Equipment to Bag Compost

Multiple farms have composting systems for their manure, after which it is advertised as a soil amendment to the landscaping industry and home gardeners. The manure is only available for bulk sale by the yard and requires a truck to transport it. To encourage more transportation of these nutrients out of the watershed, a better distribution system would involve bagging the manure in sealed bags and selling it at local farm stores, or by the pallet load to garden centers.

f. Documentation of NEPA Concerns.

The National Environmental Policy Act (NEPA) requires that all branches of government consider environmental impacts from government funded projects. A partial listing of impacts subject to NEPA include potential impacts on wilderness areas, wildlife preserves, endangered species, wetlands, floodplains, historical and archeological resources, cultural resources, and other environmental, cultural and socioeconomic impacts.

Figure 67 depicts hatched geometric shapes indicating locations at which species listed on the Federal Endangered Species list and/or the CT List of Endangered, Threatened and Species of Special Concern have been documented. The map represents the most current data set, last updated in June, 2023. ECCD obtained the Natural Diversity Data Base information from the Connecticut Environmental Conditions Online Map Viewer maintained by University of Connecticut's Center for Land Use Education and Research (CLEAR). This NDDB data layer is updated every 6 months in coordination with CT DEEP.

The pink on the map downstream of Roseland Lake corresponds to Connecticut Critical Habitat. These areas are Floodplain Forests - Mesic forests and associated open, alluvial wetlands influenced by seasonal inundation, with flood deposited sandy or nutrient-rich silty soils. This map data was last updated in 2009.

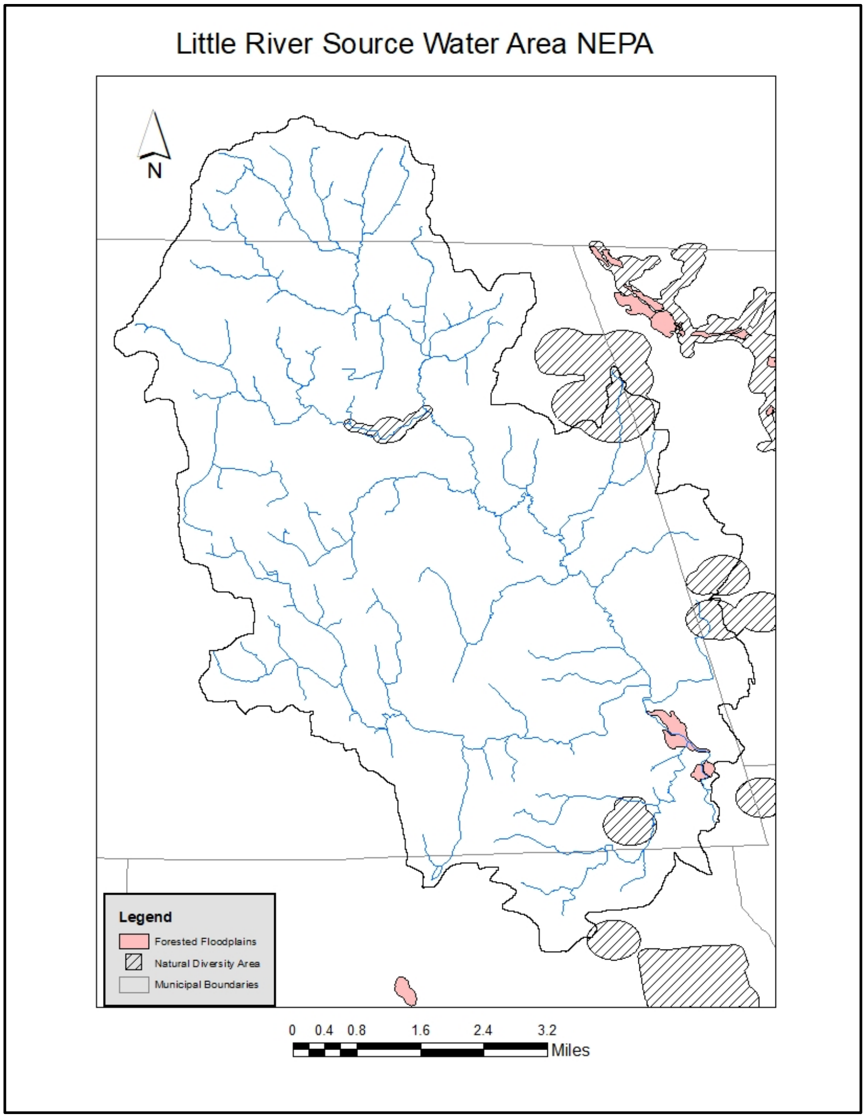


Figure 67. National Environmental Policy Act Areas of Concern

Not represented on this map is a known location for a species of freshwater snail, the Disc Gyro snail *Gyraulus circumstriatus*. This snail species has been documented in Roseland Lake as recently as 2018 and is currently listed as a species of special concern in Connecticut. Recent review by the CT DEEP species advisory committee has determined that this snail should be considered for delisting as it is not considered rare or at risk and there are no management recommendations for it. For the purposes of this report, the Disc Gyro snail is still technically state listed as a special concern species and is still in the lake (email communication with Shannon B. Kearney, DEEP Wildlife Division, April 8, 2022).

Little River Wetlands Map – wetlands in Connecticut are determined by soil type (Figure 68). Some soils that are listed as prime agriculture soils and other statewide important farm soils are also listed as wetland soils. Certain wetland soil can be economically important for producing food, feed, forage, fiber and oil seed crops when treated and managed, including water management, according to acceptable farming practices. As an example, an accepted farming practice allows for the installation of tile drainage systems to expedite drainage.

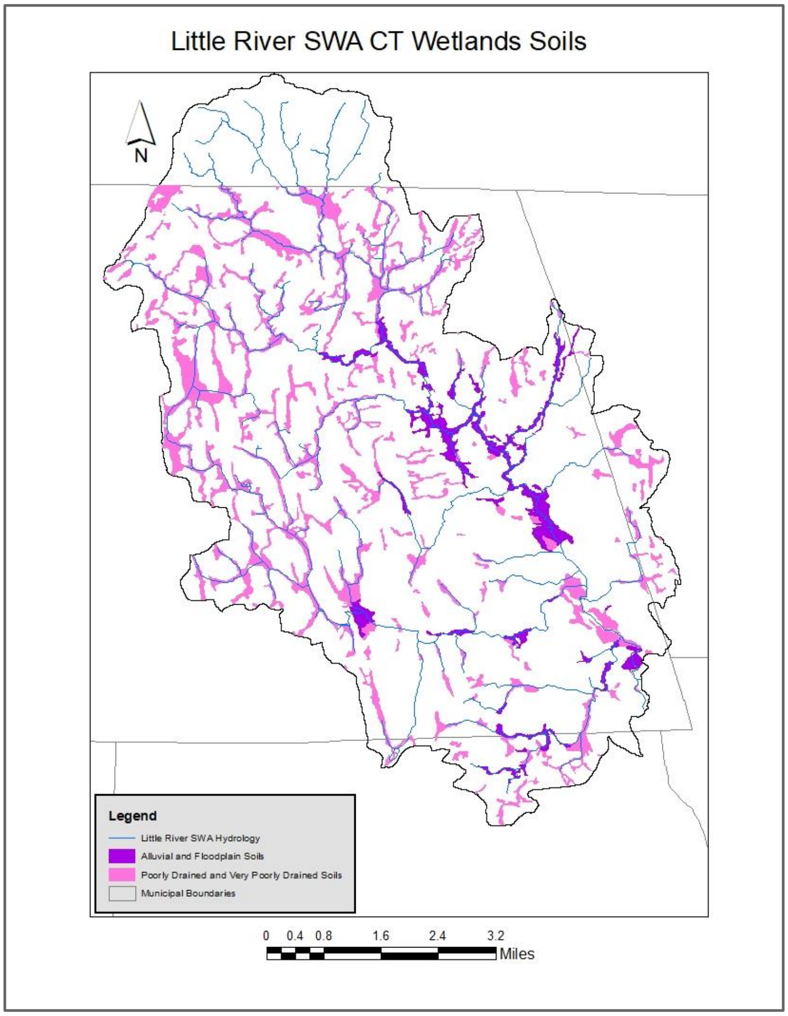


Figure 68. Little River Wetlands Map (Connecticut)

Little River Floodplain Map

Soil susceptibility to flooding is defined as the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding, rather than flooding. The frequency classes are expressed as none, very rare, rare, occasional, frequent, and very frequent. (CT Ecomap metadata) The Little River Sourcewater Flood Areas for Connecticut are shown in Figure 69.

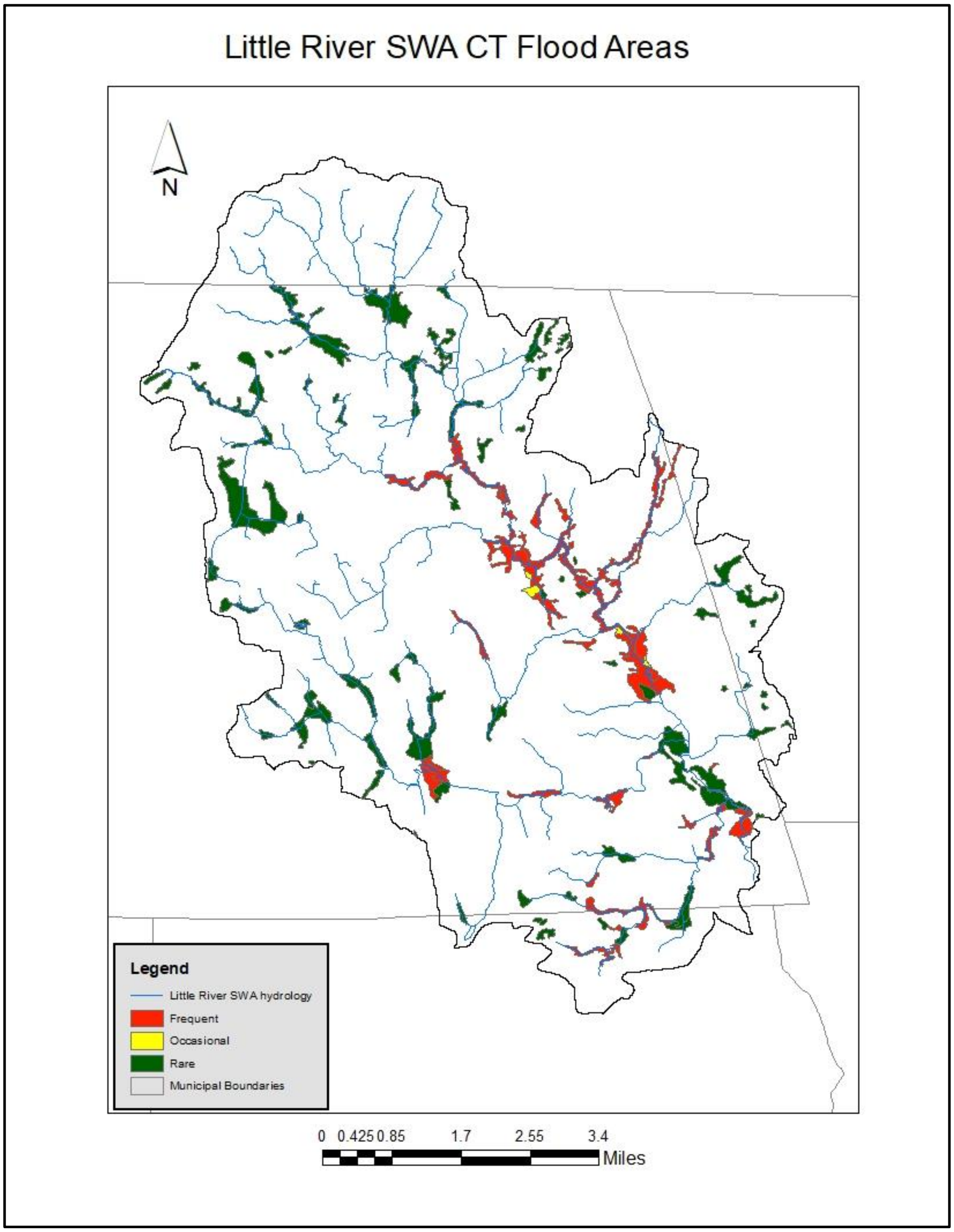


Figure 69. Little River SWA Flood Areas

Riparian floodplains have many important roles. These areas are a transitional zone between terrestrial and aquatic systems that exhibit characteristics of both systems. They are typically vegetated with lush growth of grasses, forbs, shrubs and trees that are tolerant of periodic flooding. The vegetation helps to dissipate the energy of flood water and filter from the water suspended sediments that are rich in nutrients and organic matter. Riparian floodplains play a role in aquifer recharge. They also serve as an important habitat for animals.

Woodstock Cultural Resources

A complete and current inventory of important cultural sites is not available.

g. Outreach Strategy/Plan

Little River Healthy Watershed Collaborative (LRHWC) was formed based on recommendations in the Roseland *Lake Management Plan* (2018) and *Muddy Brook and Little River Water Quality Improvement Plan* (2009). LRHWC comprises stakeholders in the Little River watershed (Woodstock/Putnam). The Collaborative is focused upon implementing recommendations in the two plans..The primary goals of LRHWC are to improve water quality of impaired waters and prevent water quality degradation of healthy waters. ECCD recommends that the Collaborative be the primary entity to promote and conduct outreach for the current watershed plan, *Little River Watershed Based Plan Update* (2023).

Ongoing, concerted outreach efforts, as detailed in Figure 70, are critical to the successful implementation of recommendations in *Little River Watershed Based Plan Update*.

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs
Soil Health Stewards Program Grant – Inventory of agricultural conservation land, soil health practices and outreach.	Town of Woodstock Conservation Commission and Agricultural Commission	0-2 years	Two town commission members trained on soil health, promote soil health practices to the community.	$10,000 awarded
Continue Little River Healthy Watershed Collaborative meetings 2-4 x/year	ECCD, DEEP, NRCS, EPA, Putnam WPCA, local stakeholders	0-5 years	# of coalition meetings held	$ = $0 to $5,000 per year
Coordinate farm tours to showcase conservation practices	LRHWC	annually	Completed farm tours/ number of attendees	$ = $0 to $5,000
Expand social media outreach	LRHWC	ongoing	# of social media posts	$ = $0 to $5,000
Continue the Farm Talk Series @ 4x/ year	Woodstock Agricultural Commission, ECCD	annually	# of workshops/number of attendees	$ = $0 to $5,000
Continue presence at Celebrating Agriculture to promote NRCS conservation practices	ECCD, NRCS	annually	# of events	$ = $0 to $5,000
Develop and publish a StoryMap about water quality issues in the watershed including examples of practices that will reduce polluted runoff	LRHWC, ECCD	Year 1	StoryMap posted to ECCD website	$ = $0 to $5,000
Paid commercial or interview to air on local community radio station (WINY) promoting water quality BMPs and contact info where to get more information	LRHWC, ECCD	Year 2	Commercial or interview aired, # of people contacting LRHWC, ECCD or NRCS	$ = $0 to $5,000

Actions & Milestones	Who	Timeframe	Products & Evaluation Criteria	Estimated Costs
Revise WPCA annual report to include agricultural runoff as a concern for water quality	Putnam WPCA	Year 1	WPCA report revision	$ = $0 to $5,000
Publicize the development of nutrient TMDL for Roseland Lake to further define nutrient reduction loads/strategies	LRHWC, CT DEEP	2-4 years	Number of social media posts, # website posts, # articles published	$ = $0 to $5,000
Reach more smaller farms that have livestock animals with nutrient runoff issues	NRCS, ECCD	Year 1 - 5	Number of small farms reached	$ = $0 to $5,000
Follow up with 66 postcard recipients	ECCD, Woodstock, Pomfret, Thompson Agricultural Commissions	Year 1 & 2	Track progress and successes for outreach and NRCS contracts	$ = $0 to $5,000
Contact the local chapter of National Beef Association, Farm Bureau and CT RC&D for successful outreach strategies to farmers	LRHWC, ECCD	Year 1	Number of successful outreach strategies developed	$ = $0 to $5,000
Implement NRCS 'Soil Your Undies' campaign geared toward small farms, homesteaders, livestock owners in the watershed to teach about the importance of microbes and soil health	Agricultural Commissions, LRHWC, NRCS, ECCD	Year 2	Number of target audience reached	$ = $0 to $5,000

Figure 70. Outreach strategy plan

$ = $0 to $5,000 $$ = $5,000 to $10,000 $$$ = $10,000 to $50,000 $$$$ = Greater than $50,000
USDA-NRCS = U.S. Department of Agriculture, Natural Resources Conservation Service
ECCD = Eastern CT Conservation District
LRHWC = Little River Healthy Watershed Collaborative

VI. Appendix: Follow-Up

a. Plan Evaluation Process

The successful implementation of a watershed plan includes the periodic review of management measures that have been completed. This evaluation process will help watershed managers determine if watershed goals are being achieved. The plan evaluation process also allows watershed managers to assess and improve not only implementation measures, but the implementation process. The implementation of a watershed management plan is necessarily an iterative process as seen in Figure 71. As management measures are undertaken and completed, they should be evaluated to determine if the desired outcome is being achieved. If the desired outcome is not being achieved (e.g., no reduction in nitrogen concentration has been observed), the measure should be re-evaluated, adjusted, reimplemented, evaluated and so on until the desired outcome (water quality goals) is reached. Many goals were stated and conservation practices were implemented following the original *Muddy Brook and Little River Water Quality Improvement Plan* (2009), yet the water quality goals have not been achieved. The revisions to this *Little River Watershed-Based Plan Update* are the result of an evaluation of the original plan in the context of management measures that have been implemented.[DM1]

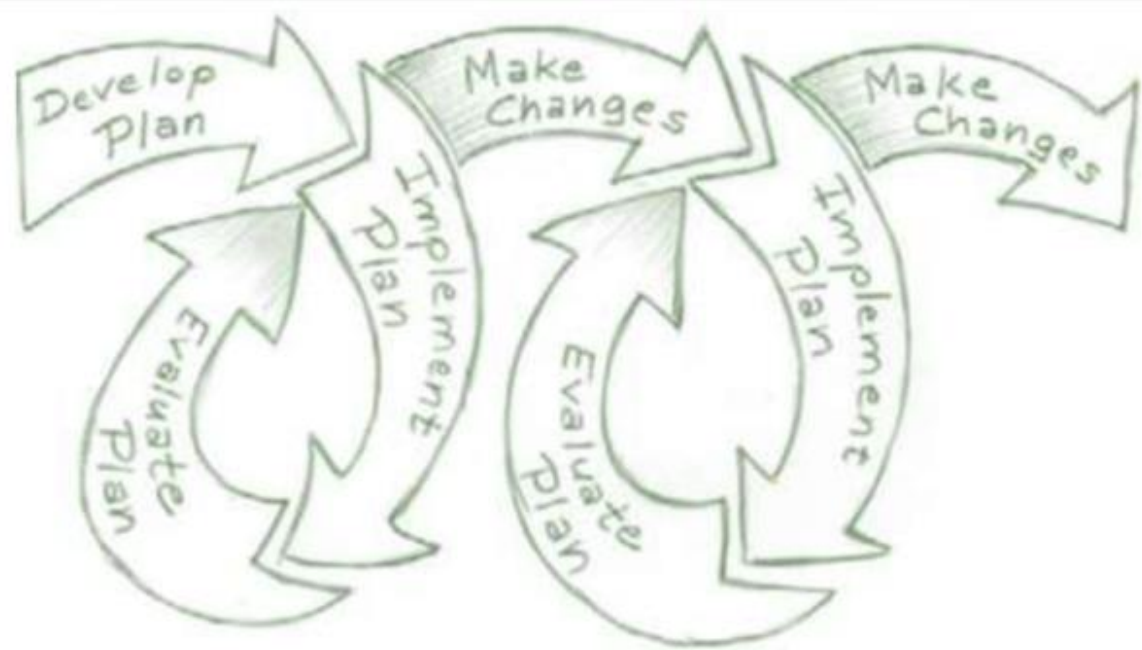


Figure 71. Graphic from the US EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters depicts the iterative nature of the watershed planning process (USEPA 2008).

To evaluate watershed plan implementation outcomes, the watershed team should develop a method to track progress. This tracking methodology should document evaluation criteria such as whether management measures are being implemented, if implementation milestones are being met, if water quality improvements are being documented, and if intended outcomes are being achieved. If the watershed team determines that intended outcomes are not being achieved, the implementation process will need to be adjusted. The team will need to evaluate why outcomes are not being achieved. This could be due to an overly ambitious work plan, the lack of funding, the need for additional or different management measures to target a particular pollutant, or new conditions in the watershed, such as a large development in a sensitive area that has altered pollutant loads and load reduction targets, in which case the Plan itself may need to be revised to reflect altered watershed conditions. Finally, the watershed team should conduct the Plan evaluation on a regular (e.g., annual or biennial) basis. This regular evaluation will allow managers to closely track implementations and affect any course corrections necessary.

b. Watershed Plan Implementation

A watershed plan is only as good as its successful implementation. While this Plan provides a roadmap for watershed managers to conduct actions that are intended to improve the water quality and aquatic habitat of Little River, including the Muddy Brook, Roseland Lake and Mill Brook watersheds and their tributaries, without a workplan to initiate its implementation, these watershed goals will not be achieved. Further, watershed managers need to understand how they will prioritize, schedule and evaluate actions, measure success, evaluate the overall effectiveness of the Plan implementation, and provide corrective actions if the goals of the Plan are not being realized. The following section provides guidance to stakeholders to begin the implementation of this Plan.

Guidance for this section was drawn from *A Quick Guide to Developing Watershed Plans to Restore and Protect Our Waters* (USEPA, 2013), a resource we strongly suggest the watershed team review and revisit as the Plan is implemented.

<u>Step 1. Convene the Watershed Team</u>

The first, and most important, step in implementing this Plan is to convene the watershed management team. The watershed team will tackle critical decisions that will determine how the Plan will be implemented, how actions will be prioritized, when and in what order actions will be implemented, how the effectiveness of the actions will be evaluated, whether the overall implementation of the Plan is having the desired effect, and, if not, what steps to take to correct the course of action. In addition to determining how the watershed plan will be implemented, the watershed team will be responsible for assigning roles such as project manager or implementation teams, to facilitate the implementation of projects. It will also be the responsibility of the team to share information, including water quality problems and success stories, with the general public.

The Little River Heathy Watershed Collaborative was established in 2018 during the development of *Roseland Lake Management Plan*. The Collaborative includes representation from ECCD, CT DEEP, CT Department of Public Health Drinking Water Division, USDA NRCS, Putnam Water Pollution Control Authority, Woodstock Conservation Commission, Woodstock Agriculture Commission, members of the local agriculture community, Wyndham Land Trust and other local stakeholders. While the team has had an active role in the development of this Plan, a more formalized structure focused on implementing this Plan will need to be developed.

Step 2. Prepare a Workplan

Little River Watershed Plan Update is a long-term document that is intended to guide the actions of the watershed team over a 10- year timeframe and beyond. In order to implement the management measures recommended in the Plan, the watershed team should develop a watershed workplan. A workplan is a short-term strategic "to-do" list, usually spanning a 1 to 3-year timeframe, that identifies actions the team intends to conduct within that timeframe. Elements of the workplan are drawn from the Watershed Plan, with workplan activities based on the Plan recommendations and the timeframes provided in the Plan.

Step 3. Implement the Management Strategies

With the workplan in place, the watershed team should begin to implement the management strategies provided in this Plan. The management strategies include a variety of short -, medium- and long-term non-structural and structural controls that vary in complexity from easily implemented practices like rain gardens to more complex structural practices that will need to be installed by experienced practitioners. As the management strategies are implemented, the team should be sure to track progress to ensure targets in the workplan are being met and evaluate the effectiveness of the implementations to ensure that the overarching goals of the Plan are being attained.

Step 4. Conduct Monitoring and Analyze Data

Water quality monitoring and data analysis provide valuable information to the watershed team. Routine data analysis "…tracks progress, assesses the quality of data relative to measurement quality objectives (i.e., whether the data are of adequate quality to answer the monitoring questions), and provides early feedback on trends, changes, and problems in the watershed," while intensive analysis can be used by the watershed team to "…determine status, changes, trends, or other issues that measure the response to watershed plan implementation" (USEPA, 2013).

As management measures are being implemented, their effectiveness should be monitored and the results analyzed relative to the management practice objectives. The type of monitoring conducted and the data collected will be specific to the practice or activity being implemented and should be tied to water quality standards or other criteria established in earlier sections of this Plan. For example, the installation of a riparian buffer alongside an agricultural field might document the linear feet of buffer installed, and/or the *E. coli* concentrations upstream and downstream of the installation. The effectiveness of sediment phosphorus inactivation from a Phosloc application can be monitored by lake monitoring both before and after the application.

Whatever the methodology used, monitoring is a means to document and demonstrate that positive gains are being achieved through the implementation of the Plan management measures, and inform partners and the public that the goals of the Watershed Plan are being attained.

Step 5. Conduct Information/Education Activities

It will be the responsibility of the watershed team to raise awareness among watershed residents about water quality issues in the Little River watershed and to share results and success stories. As outlined in Section 5g, the watershed team should undertake a series of outreach actions to raise public awareness, educate the public about water quality problems in the watershed, and conduct educational programs so that members of the public can learn what actions they can take to help protect and improve water quality.

The watershed team should develop a means to communicate with the broader watershed community and to highlight key activities and success stories or assign that role to a team member. This could include the establishment of social media sites such as Facebook and Instagram accounts to publicize implementation actions, workshops, and other community events.

Step 6. Measure Progress and Make Adjustments

As discussed in Section VI a, the successful implementation of a watershed plan requires the periodic review and evaluation of the implementation activities, a comparison to interim milestones and water quality criteria, and a review of feedback from project partners, watershed residents and others. As suggested in Section Step 1, the watershed team should conduct the Plan evaluation on a regular (e.g., annual or biennial) basis, which will allow managers to closely track implementations and affect any course corrections necessary.

Figure 72. Little River Watershed-based Plan Implementation Schedule.

Activity	Timeline	Responsible parties
Assemble /recruit to the Little River Healthy Watershed Collaborative (LRHWC) to review the completed plan	Short term. The basic structure of LRHWC exists. Long time participants will need to be replaced due to staff turnover/retirements.	LRHWC
Develop a Workplan	Short term	LRHWC
Implement outreach strategy	Short term but will need to be continuous	LRHWC
Conduct monitoring and analyze data	Short term but will need to be continuous	The Last Green Valley Vol Water Monitoring Program, CT DEEP, Putnam WPCA
Conduct information/education activities	Short term but will need to be continuous	LRHWC
Implement BMP recommendations in the WBP	Medium/Long term Will depend on available funding	Local agribusinesses, Putnam WPCA
Measure progress and make adjustments	Long term	LRHWC

Short term project – can be completed in less than 2 years
Medium term project – can be completed in 5 -10 years
Long term project – may take more than 10 years to implement

c. Summary and Conclusion

Little River provides up to a quarter of the drinking water for residents in the town of Putnam. Putnam is one of Connecticut's most economically distressed communities.

There are healthy streams in the source water watershed area, but there are also streams and lakes upstream of the intake to the water treatment plant that do not meet the Connecticut Water Quality Standards. Agricultural runoff contributes to the degraded water quality in these streams. The impacted streams are concentrated close to the drinking water diversion from Little River.

Different watershed assessment models were employed to evaluate the drainage basins in the watershed. Assessments of the watershed through watershed modeling, along with water quality data, have identified the sub-watersheds with the highest need for water quality improvements. To effect water quality improvements in these sub-watersheds, investment in Best Management Practices is critical.

Millions of dollars invested previously has improved but not corrected water quality impairments, so additional funding is needed to address stormwater runoff from agricultural operations. To that end, NRCS cost-share programs are a very important part of the solution. Although NRCS will fund up to 90% of the cost to implement its approved conservation practices, many practices exceed the $450,000 EQIP cap allotted under the Farm Bill, so many producers cannot afford to implement them. Additionally, EQIP does not fund the purchase of farm equipment which is needed to implement certain conservation practices.

As demonstrated throughout the Little River watershed, combining funding from EQIP and EPA§319 NPS grants has achieved some success at controlling nonpoint source pollution from agricultural runoff. Combining funding from multiple sources is a model that should be emulated and supported by state and federal agencies.

Redesignation of the Little River watershed under NRCS' National Water Quality Initiative will inject additional funding into efforts to improve the water quality of the drinking water for Putnam, CT, an economically distressed community. Upon adoption of Little River Water Quality Plan Update, project partners should engage in a concerted effort to reach watershed stakeholders and to educate landowners, producers and animal owners to implement conservation practices that will improve water quality in Little River.

Glossary of Terms

Term	Definition
Aerobic composting	principle at work in aboveground composting environments that provide air circulation
Algastatic	inhibits the growth of algae
Alkalinity	the quantitative capacity of an aqueous solution to neutralize an acid
Alluvium	a deposit of clay, silt, sand, and gravel left by flowing streams in a river valley
Ammonia nitrogen	(NH_3-N) a form of plant nutrient that can be used by plants or oxidized by bacteria into nitrate nitrogen
Anaerobic digestion	a series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen.
Anoxia	an absence of oxygen
Anoxic water	water with dissolved oxygen concentration of less than 0.5 mg/l
Anthropogenic inputs	the direct or indirect results of human activities
Aquatic macrophytes	aquatic plants large enough to be seen without magnification
Base flow	The portion of stream flow that is not runoff and results from seepage of water from the ground into a channel

Benthic	ecological region associated with the bottom of a body of water
Best management practices (BMP)	a practice that is determined to be an effective and practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources
Biomanipulation	the deliberate manipulation of an ecosystem, especially by adding or removing species
Biomass	the amount of living matter in a given habitat, expressed either as the weight of organisms per unit area or as the volume of organisms per unit volume of habitat
Bioswale	a landscape element designed to remove silt and pollution out of surface runoff water, consisting of a swaled drainage course with sloped sides filled with vegetation, compost or riprap
CAFO	concentrated animal feeding operation, as defined by the United States Department of Agriculture (USDA) is an animal feeding operation (AFO)that has over 1000 "animal units" confined for over 45 days a year.
Chlorophyll a	Chlorophyll a is a specific form of chlorophyll used in oxygenic photosynthesis
Comprehensive Nutrient Management Plan	a conservation plan for an animal feeding operation
Conductivity	a measure of water's capability to pass electrical flow; it is related to the concentration of ions in the water

Constructed wetland	a treatment system that uses natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality
Cyanobacteria	a phylum of bacteria that obtain their energy through photosynthesis (formerly known as blue green algae)
Cyanotoxins	toxins produced by cyanobacteria
Dissolved oxygen	microscopic bubbles of gaseous oxygen that are mixed in water and available to aquatic organisms for respiration
Diurnal vertical phytoplankton migration	a pattern of movement in which phytoplankton remain beneath the photic zone during the day, moving toward the surface after dusk and returning to the depths before dawn
Epilimnion	the upper layer of water in a stratified lake
Eutrophic	description of a lake when the water is highly enriched with plant nutrients and with high biological productivity characterized by occasional blooms of algae or extensive areas of dense macrophyte beds
Eutrophication	the natural aging process in which a lake transitions to a shallow pond to a wetland and eventually to dry land
Farmland soils of statewide importance	Category of soils that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods.

"First Flush" Stormwater	Initial surface runoff after a rain event
Gastropods	mollusks of the class Gastropoda, as snails, whelks, and slugs, having a single shell, often coiled, reduced, or undeveloped, and moving by means of a wide muscular foot
Geometric mean	special type of average where numbers are multiplied together and then take a square root (for two numbers), cube root (for three numbers) etc.
Glyphosate	a synthetic herbicide that is particularly effective against perennial weeds
Healthy soil practices	practices that support the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans
Hydraulic residence time	a measure of the average length of time that water remains in a lake or pond
Hydroponically	the process of growing plants in sand, gravel, or liquid without soil
Hypereutrophic	description of a lake that is extremely rich in nutrients and minerals
Hypolimnion	the lower layer of water in a stratified lake, typically cooler than the water above and relatively stagnant
Impervious cover	any surface in the landscape that cannot effectively absorb or infiltrate rainfall, such as driveways, roads, parking lots, rooftops, and sidewalks

Intermittent stream	streams which normally cease flowing for weeks or months each year
Internal loading of phosphorus	phosphorus released from stored accumulations in the bottom of a lake in an anoxic environment
Kjeldahl nitrogen	(TKN) total concentration of organic nitrogen and ammonia
Iron bound phosphorus	(Fe-P) an inorganic molecule containing iron and phosphorus
Legacy phosphorus	phosphorus that has accumulated in soil over time
Limnologist	a scientist who studies the physics, chemistry, geology, and biology of lakes and other inland waters
Littoral zone	The littoral zone is the near shore area where sunlight penetrates all the way to the sediment and allows aquatic plants to grow
Loosely sorbed phosphorus	(Org-P)Phosphorus bound with organic molecules
Lysing	the disintegration of a cell by rupture of the cell wall or membrane
Macropores	Cavities that are larger than 75 µm. Functionally, soil pores of this size host preferential soil solution flow and rapid transport of solutes and colloids
Median value	The median is the middle point of a number set, in which half the numbers are above the median and half are below.

Mesotrophic	description of a lake that has a moderate amount of dissolved nutrients
Metalimnion	The layer of water in a stratified lake which lies beneath the epilimnion and above the hypolimnion, in which the temperature decreases rapidly with depth.
Microcystin	a toxin produced naturally by cyanobacteria
Mollusk	any invertebrate of the phylum Mollusca, typically having a calcareous shell of one, two, or more pieces that wholly or partly enclose the soft, unsegmented body
Morphometric	mathematical analysis of the configuration of the earth's surface, shape and dimension of its landforms
MS4	acronym for municipal separate storm sewer system
Natural succession	the process of change in the species structure of an ecological community over time
Nitrate nitrogen	(NO_3-N) an inorganic form of nitrogen readily used as a plant nutrient
Nitrite nitrogen	(NO_2-N) an inorganic form of nitrogen in the nitrogen cycle
No-till farming	a way of growing crops or pasture from year to year without disturbing the soil

Oligotrophic	description of a lake that is relatively low in plant nutrients and containing abundant oxygen in the deeper parts
Organic molecules	molecules that contain carbon, oxygen and hydrogen. May be combined with other types of atoms.
Organic nitrogen	(Org-N) nitrogen associated with organic compounds
Ortho phosphorus	(ortho-P) soluble reactive phosphorus and is the form directly taken up by plant cells
Passive stormwater sampler	samplers that rely on the physical flow of stormwater to obtain a sample
pH	a measure of the acidity or alkalinity of a solution
Photosynthesis	the process by which green plants use sunlight to synthesize foods from carbon dioxide and water
Phycocyanin	a pigment-protein complex, mainly found in freshwater cyanobacteria, that biologically functions cooperatively with chlorophyll in photosynthesis
Phytoplankton	plankton consisting of microscopic plants
PII	Personally Identifiable Information

PPM	Parts per million which is equivalent to 1 mg/l or 1000 µg/l
Prime farmland soils	Soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oil seed crops
Rain garden	a planted depression that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots, and compacted lawn areas, the opportunity to infiltrate and be filtered of non-point source pollution
Secchi disk	an opaque disk, typically white and black, used to gauge the transparency of water by measuring the depth (Secchi depth) at which the disk ceases to be visible from the surface
Subaqueous soil	soils formed in sediment found in shallow, permanently flooded environments or soils in any areas permanently covered by water too deep for the growth of rooted plants
Suspended solids	small solid particles which remain in suspension in water
SWPA	source water protection area
Thermal resistance to mixing	

	a measure of the amount of energy that is needed for water from two different temperatures layers to mix together
Thermocline	where the water temperature changes rapidly and can act as a barrier to mixing the layers above and below this zone
Tile drain system	a network of below-ground pipes installed below the surface of agricultural fields, that allow subsurface water to move out from between soil particles and into the tile line
Total Coliform	total coliform is a large collection of different kinds of bacteria. Fecal coliforms are types of total coliform. *E. coli* is a sub-group of fecal coliform
Total Nitrogen	the sum of total Kjeldahl nitrogen (ammonia, organic and reduced nitrogen) and nitrate-nitrite and nitrite-nitrogen.
Total Phosphorus	the sum of all phosphorus compounds that occur in various forms
Total suspended solids	(TSS) the dry-weight of particles trapped by a filter; it is a water quality parameter used assess water quality; includes both sediments and organic material
Tributary	

	a river or stream flowing into a larger river or lake
Trophic state	the total weight of biomass in a given water body at the time of measurement
Turbidity	Turbidity is the measure of relative clarity of a liquid; material that causes water to be turbid include clay, silt, finely divided inorganic and organic matter, algae, soluble colored organic compounds, plankton and other microscopic organism
Wet weather sampling	Water sampling after a rainfall event greater than 0.1”
Woodchip bioreactor	subsurface trenches filled with a carbon source, mainly wood chips, through which water is allowed to flow just before leaving the drain to enter a surface water body; the carbon source in the trench serves as a substrate for bacteria that break down the nitrate through denitrification or other biochemical processes
Zooplankton	plankton consisting of small animals and the immature stages of larger animals

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Appendix A - Putnam Water Pollution Control Authority Water Quality Data

PUTNAM W.P.C.A - WATER TREATMENT PLANT

Raw Water Sample Record

Location	Little River In-Take					Sample ID # 2201					
	Parameters										
Date (Mo / Yr)	pH	Turb	Temp	Color	Odor	Cl2	Fe	Mn	PO4	TOC	Alkalinity
Jan-17	7.00	0.950	5.4	50	1	0.00	0.17	0.044	0.08	6.5	22.0
Feb-17	6.98	1.040	8.1	45	1	0.00	0.19	0.024	0.03	4.8	20.3
Mar-17	7.19	1.390	7.0	35	1	0.00	0.18	0.033	0.04	4.9	20.8
Apr-17	6.94	1.030	12.4	35	1	0.00	0.11	0.014	0.05	5.7	20.1
May-17	7.11	1.280	18	60	1	0.00	0.06	0.038	0.06	6.2	22.5
Jun-17	7.15	1.890	22.5	65	1	0.00	0.43	0.042	0.06	7.7	26.4
Jul-17	7.09	0.950	24.5	40	1	0.00	0.36	0.078	0.28	6.3	33.0
Aug-17	7.28	0.860	23.7	50	1	0.00	0.34	0.038	0.05	6.9	36.9
Sep-17	7.29	1.500	22.3	30	1	0.00	0.73	0.135	0.08	6.3	34.2
Oct-17	7.16	1.190	19.8	25	1	0.00	0.24	0.119	0.08	5.7	56.7
Nov-17	7.40	1.950	10.9	60	1	0.00	0.16	0.086	0.19	9.4	23.3
Dec-17	7.03	2.810	8.0	45	1	0.00	0.17	0.039	0.12	7.6	24.0
Jan-18	6.87	2.000	6.9	40	1	0.00	0.33	0.032	0.14	4.5	26.6
Feb-18	6.89	1.980	8.0	50	1	0.00	0.23	0.019	0.11	4.1	17.4
Mar-18	7.15	1.330	7.7	35	1	0.00	0.22	0.021	0.06	4.2	11.4
Apr-18	7.12	1.270	11.1	35	1	0.00	0.18	0.009	0.01	3.1	20.7
May-18	6.95	2.870	18.4	50	1	0.00	0.26	0.043	0.06	4.9	21.7
Jun-18	7.10	2.100	20.7	50	1	0.00	0.42	0.071	0.41	6.4	29.0
Jul-18	7.08	1.190	25.2	30	1	0.00	0.14	0.038	0.17	4.9	36.9
Aug-18	6.93	1.530	26.6	50	1	0.00	0.41	0.105	0.09	6.2	39.7
Sep-18	6.85	0.760	24.9	35	1	0.00	0.19	0.087	0.06	9.3	26.1
Oct-18	6.82	1.210	14.1	55	1	0.00	0.37	0.033	0.10	7.9	28.4
Nov-18	6.75	2.170	13.6	60	1	0.00	0.18	0.025	0.22	6.7	37.0
Dec-18	6.98	1.450	7.9	35	1	0.00	0.19	0.042	0.08	3.5	22.0
Jan-19	6.93	2.320	7.3	30	1	0.00	0.22	0.019	0.00	3.7	16.4
Feb-19	6.92	2.090	7.2	35	1	0.00	0.23	0.036	0.08	2.5	22.1
Mar-19	6.97	1.670	4.7	34	1	0.00	0.23	0.033	0.03	3.4	23.8
Apr-19	7.11	1.620	10.8	20	1	0.00	0.20	0.039	0.03	3.5	20.0
May-19	6.80	3.880	13.0	110	1	0.00	0.34	0.065	0.05	4.2	23.0
Jun-19	7.11	2.100	22.5	92	1	0.00	0.31	0.039	0.06	4.2	30.5
Jul-19	7.06	1.440	24.0	73	1	0.00	0.47	0.093	0.08	4.4	35.6
Aug-19	6.67	1.600	24.3	58	1	0.00	0.2	0.055	0.05	5.3	32.9
Sep-19	6.89	1.080	20.5	79	1	0.00	0.31	0.035	0.05	5.8	36.4
Oct-19	6.98	1.810	19.8	91	1	0.00	0.42	0.113	0.02	5.5	35.6
Nov-19	7.00	1.820	9.0	99	1	0.00	0.54	0.049	0.00	6.2	29.7
Dec-19	7.50	2.000	5.0	93	1	0.00	0.39	0.058	0.02	6.7	24.3
Jan-20	6.76	1.150	4.9	60	1	0.00	0.19	0.016	0.01	3.9	21.1
Feb-20	7.02	1.950	7.6	64	1	0.00	0.23	0.012	0.00	3.9	15.9

Mar-20	7.10	1.410	8.5	60	1	0.00	0.18	0.030	0.21	3.4	21.4
Apr-20	7.06	1.320	9.7	58	1	0.00	0.22	0.034	0.01	4.2	21.8
May-20	7.06	2.110	11.4	82	1	0.00	0.30	0.260	0.00	4.9	29.6
Jun-20	7.26	2.390	21.0	84	1	0.00	0.46	0.050	0.00	5.1	40.3
Jul-20	7.13	1.510	24.4	64	0	0.00	0.25	0.042	0.01	4.3	32.7
Aug-20	7.02	1.720	25.6	60	1	0.00	0.22	0.063	0.01	7.3	47.0
Sep-20	7.21	0.500	21.5	48	1	0.00	0.25	0.067	0.01	4.2	46.8
Oct-20	7.10	0.670	16.8	49	1	0.00	0.29	0.047	0.01	5.5	47.6
Nov-20	6.97	2.200	12.0	92	0	0.00	0.47	0.010	0.00	5.4	31.3
Dec-20	6.81	2.560	8.7	141	1	0.00	0.29	0.023	0.00	8.6	15.8
Jan-21	6.93	1.400	5.8	69	1	0.00	0.16	0.023	0.01	4.1	16.4
Feb-21	6.89	1.660	4.9	67	1	0.00	0.19	0.036	0.00	3.9	17.0
Mar-21	6.94	1.360	7.5	64	0	0.00	0.02	0.030	0.01	3.1	14.6
Apr-21	7.09	1.340	11.0	89	1	0.00	0.20	0.023	0.00	4.3	21.3
May-21	7.05	2.400	14.8	126	1	0.00	0.40	0.032	0.01	8.3	16.4
Jun-21	6.93	1.890	20.4	139	1	0.00	0.53	0.049	0.02	7.0	21.9
Jul-21	6.78	1.390	20.6	162	1	0.00	0.65	0.064	0.01	9.2	16.0
Aug-21	7.20	1.030	24.0	86	2	0.00	0.24	0.024	0.01	4.4	32.9
Sep-21	7.02	1.060	20.0	135	0	0.00	0.21	0.020	0.00	5.6	25.6
Oct-21	7.00	0.950	18.8	135	1	0.00	0.23	0.031	0.00	5.9	26.7
Nov-21	7.06	1.100	12.0	122	1	0.00	0.37	0.030	0.00	5.9	25.2
Dec-21	7.22	1.670	9.2	90	1	0.00	0.31	0.032	0.00	3.9	26.9
Jan-22	7.14	2.300	4.8	76	0	0.00	0.24	0.028	0.00	3.4	28.6
Feb-22	7.03	1.910	6.0	70	0	0.00	0.01	0.010	0.00	3.4	13.4
Mar-22	7.07	1.420	10.0	60	0	0.00	0.01	0.001	0.00	3.6	20.9
Apr-22	7.21	1.610	11.2	75	1	0.00	0.08	0.008	0.02	4.2	21.2
May-22	7.25	1.920	14.8	73	2	0.00	0.19	0.027	0.00	5.2	23.2
Jun-22	7.46	3.510	22.8	104	1	0.00	0.19	0.015	0.00	5.6	36.2
Jul-22	7.17	1.160	22.6	58	1	0.00	0.26	0.020	0.04	5.4	34.1
Aug-22	7.26	0.879	25.3	59	1	0.00	0.25	0.049	0.00	6.2	46.7
Sep-22	7.14	0.750	18.6	69	0	0.00	0.27	0.022	0.00	5.9	29.9
Oct-22	6.75	2.190	15.6	169	1	0.00	0.23	0.025	0.03	5.7	30.1
Nov-22	6.92	1.760	9.1	116	1	0.00	0.13	0.092	0.14	7.3	23.7
Dec-22	6.90	1.500	6.8	93	0	0.00	0.21	0.019	0.00	6.4	16.0

PUTNAM W.P.C.A - WATER TREATMENT PLANT

Raw Water Sample Record

Little River In-Take				Sample ID # 2201
Date	Parameters			
	Total Coliforms	E-coli	Nitrate	Nitrite
Jan-17	Present	Present	0.60	<0.004
Apr-17	579.4	16.1		
Jul-17	1986.3	9.7		
Oct-17	>2419.6	52.9		
Jan-18	517.2	33.6		
Apr-18	547.5	7.5	0.058	<0.004
Jul-18	>2419.6	65.0		
Oct-18	>2419.6	52.9		
Jan-19	>2419.6	73	0.69	0.007
Apr-19	461.1	16.1		
Jul-19	>2419.6	52		
Oct-19	980.4	18.7		
Jan-20	1046.2	23.3	0.70	<0.010
Apr-20	275.5	9.6		
Jul-20	>2419.6	40.2		
Oct-20	1203.3	18.7		
Jan-21	>2419.6	78.2	0.82	<0.010
Apr-21	1986.3	7.2		
Jul-21	>2419.6	135.4		
Oct-21	>2419.6	95.9		
Jan-22	980.4	56.3		
Apr-22	1203.3	84.2		
Jul-22	>2419.6	57.3		
Oct-22	>2419.6	161.6		
Dec-22			0.45	<0.004

Notes: Total Coliform Testing is Required Quarterly

Nitrate and Nitrite Testing is Required Annually

THE POND AND LAKE
CONNECTION

Putnam Water Pollution Control Authority
Peake Brook Rd. Woodstock, CT

Roseland Lake Treatment Summary 2022

Roseland lake and Shepherds Pond are approximately 98 and 8 acres respectively. Two half lake treatments were performed on each waterbody, 7/21 and 8/30. A total of 250g of SeClear was used for each treatment with 96% of it being used in Roseland Lake and the remainder used in Shepherds Pond. This was applied at a rate of a full gallon per acre/ft in both waterbodies. A hand-held nozzle was used with the aid of a sticker adjuvant to target floating mats and submerged drop hoses were used to target subsurface algae.

The first treatment showed some algae present and levels on the rise but not in full bloom. The second treatment had more algae present due to how rapidly this bloom came on. With such a prolonged drought this Summer, Phosphorus levels shot up over 150% of baseline here which makes algae blooms very flashy when conditions are right. Following each treatment, there was a fast and substantial visual decrease in the amount of algae present.

Last year's addition of highly sophisticated and accurate continuous monitoring equipment has again provided real-time data on the algae density and type as well as other key parameters in the middle of the lake both at the surface and down below the thermocline. This has proven to be a great early warning system in the management of Algae at Roseland Lake. When we see changes on the buoy data, that helps us determine the best timing of algae ID lab testing and has helped reduced the overall cost and frequency of lab testing. Between the buoy data, lab testing and regular visual inspections, reactive algae treatment timing can be optimized to provide the best results with the minimum required number of treatments. Historically since we have started collecting data here, that has been 2-3 treatments per season.

The last options left unexplored currently are oriented towards more long-term results and help push algae species more towards beneficial Green Algae rather than toxic Blue-Green species. This would involve the sequestration of nutrients that are responsible for causing the algae in the first place (mainly Phosphorus). Phosphorus can come from runoff/upstream sources and from the release of lake sediment under low Dissolved Oxygen (DO) conditions commonly found during the summer. If Phosphorus is removed from the system, the lake would realize two key benefits; A reduction in overall algae, and a shift away from toxic Blue-Green algae towards the beneficial Green Algae species. In a system with such abundant Phosphorus, Blue-Green Algae (BGA) can quickly increase in the spring and dominate most of the season because they can "fix" or create the

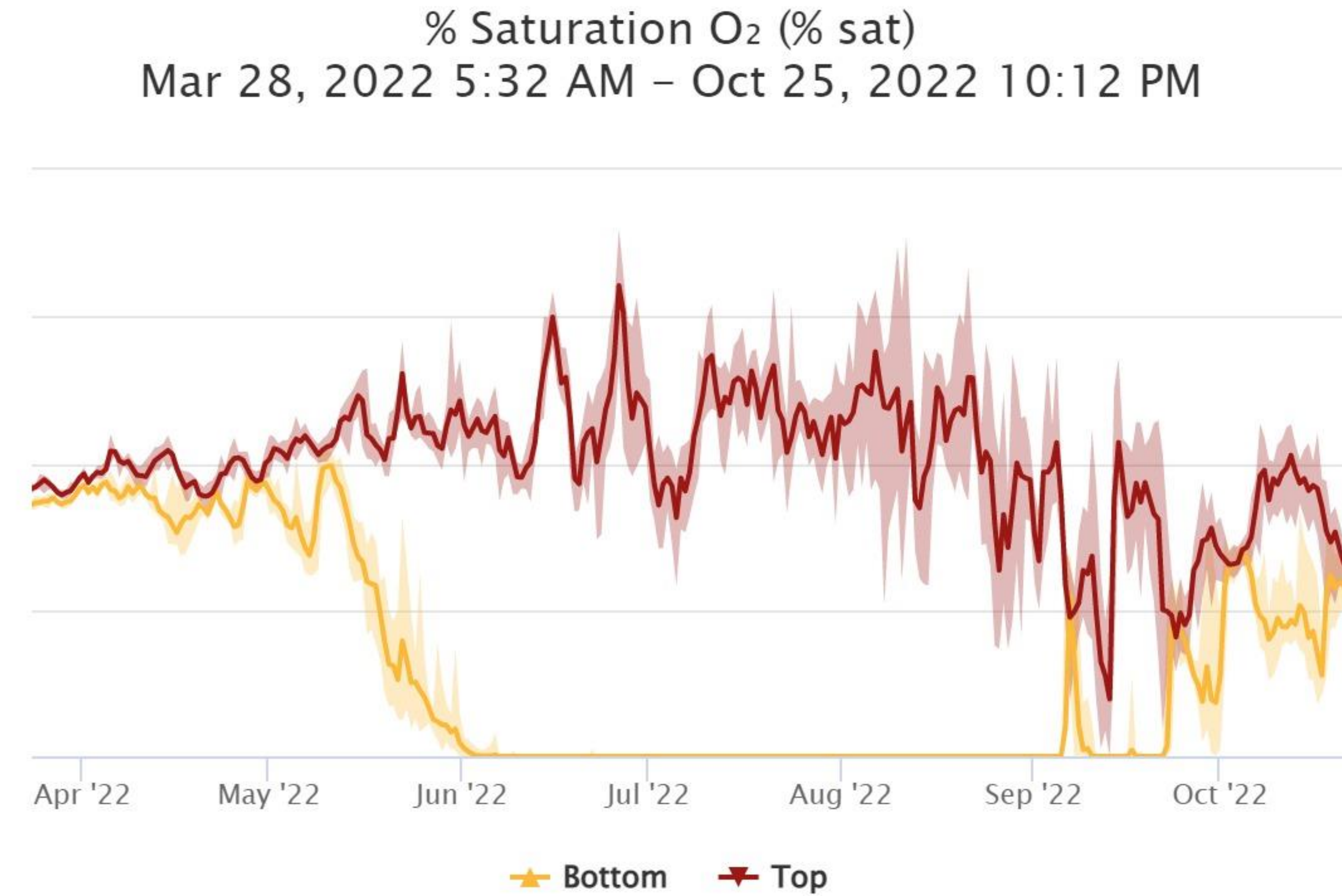
THE POND AND LAKE CONNECTION

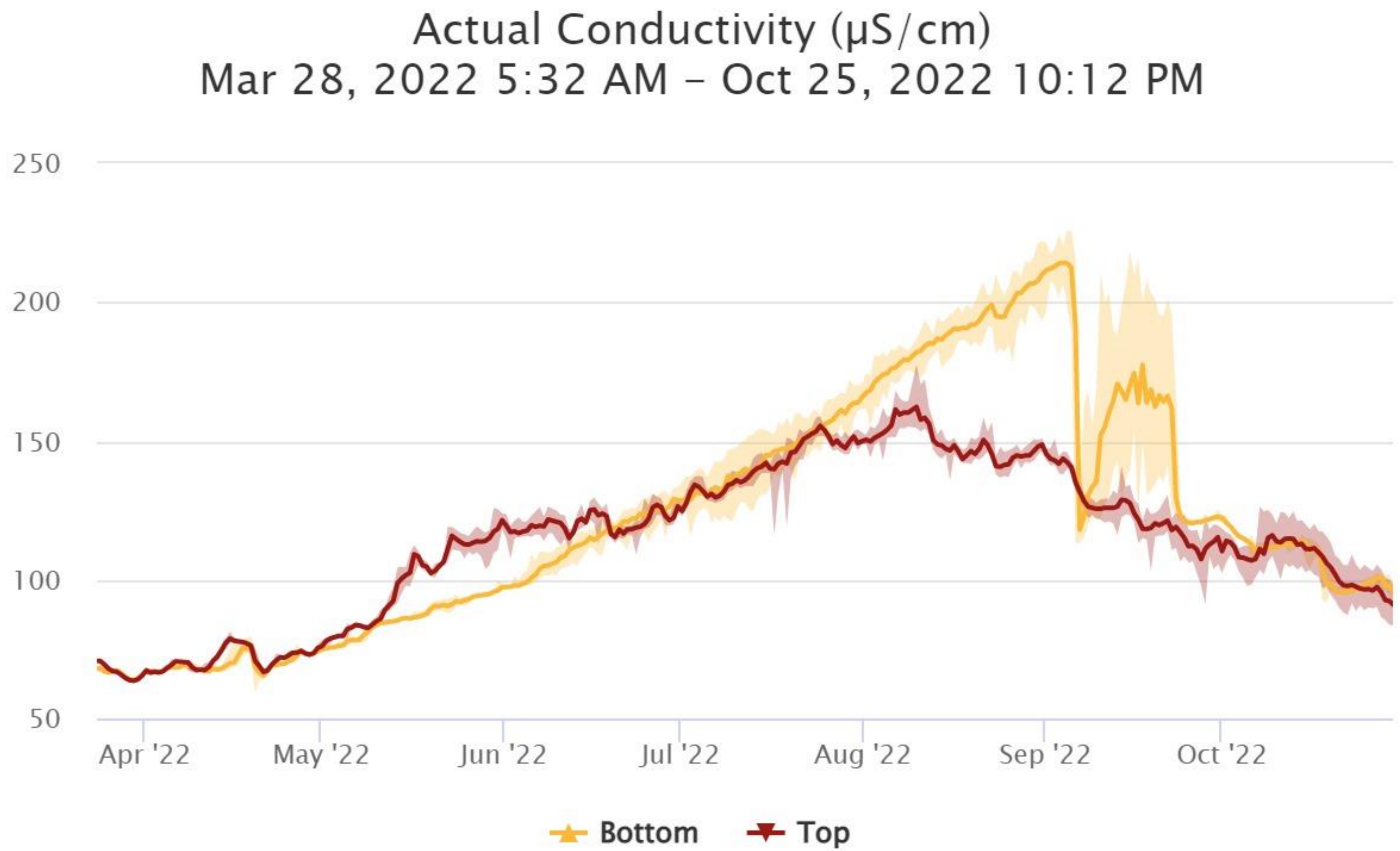
other required nutrient Nitrogen. This gives BGA the competitive advantage in a high Phosphorus environment. When the ratio of Phosphorus:Nitrogen is brought more into line, Green Algae can proliferate and help block BGA growth. A product like Phoslock/Eutrosorb G is designed to target sediment bound Phosphorus and bind to it permanently so it can no longer be used by any plant or algae. Phoslock is NSF/ANSI 60 Certified safe for use in drinking water reservoirs and can be applied as either a one-time large reset application, or annually in smaller doses to slowly bring down the Phosphorus levels. A full sediment reset dose would be about $125,00-140,000 or could be split up over multiple years. This would require some sediment samples to be lab tested to dial in the dose completely. Eutrosorb WC is a newer liquid formulation of the same product designed to target Phosphorus is the water column rather than in the sediment and has drastically reduced the cost of water column phosphorus stripping. This could be done to Roseland Lake for about $25,000-35,000 where the older formulations would have cost more than double that amount. If you are interested in exploring any of these phosphorus mitigation measures, please let me know and I will work up a formal estimate.

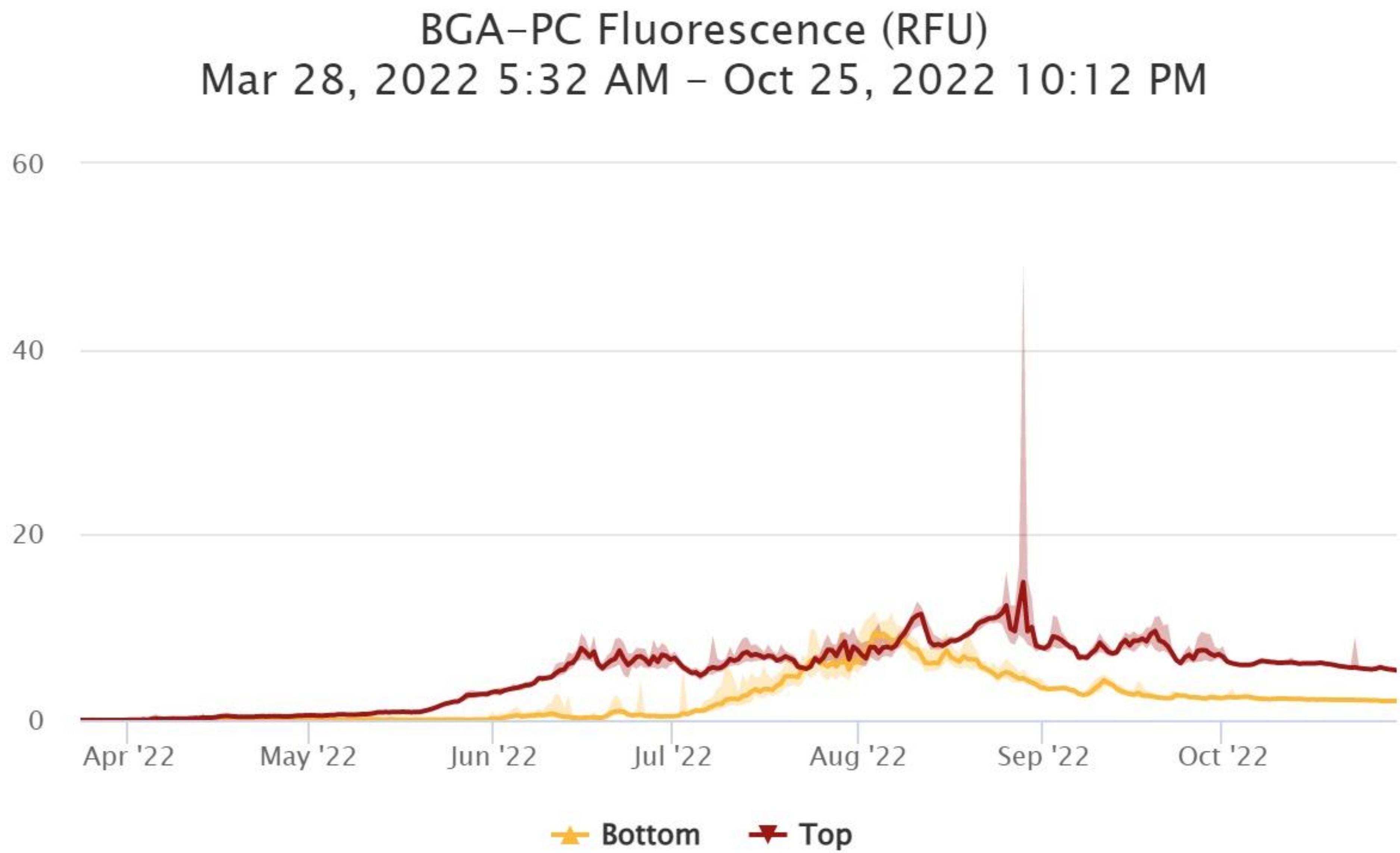
If you have any questions regarding last season's treatments or my recommendations for 2023, please feel free to reach out to me. It was a pleasure to work on this lake again and I hope to see you all in the Spring.

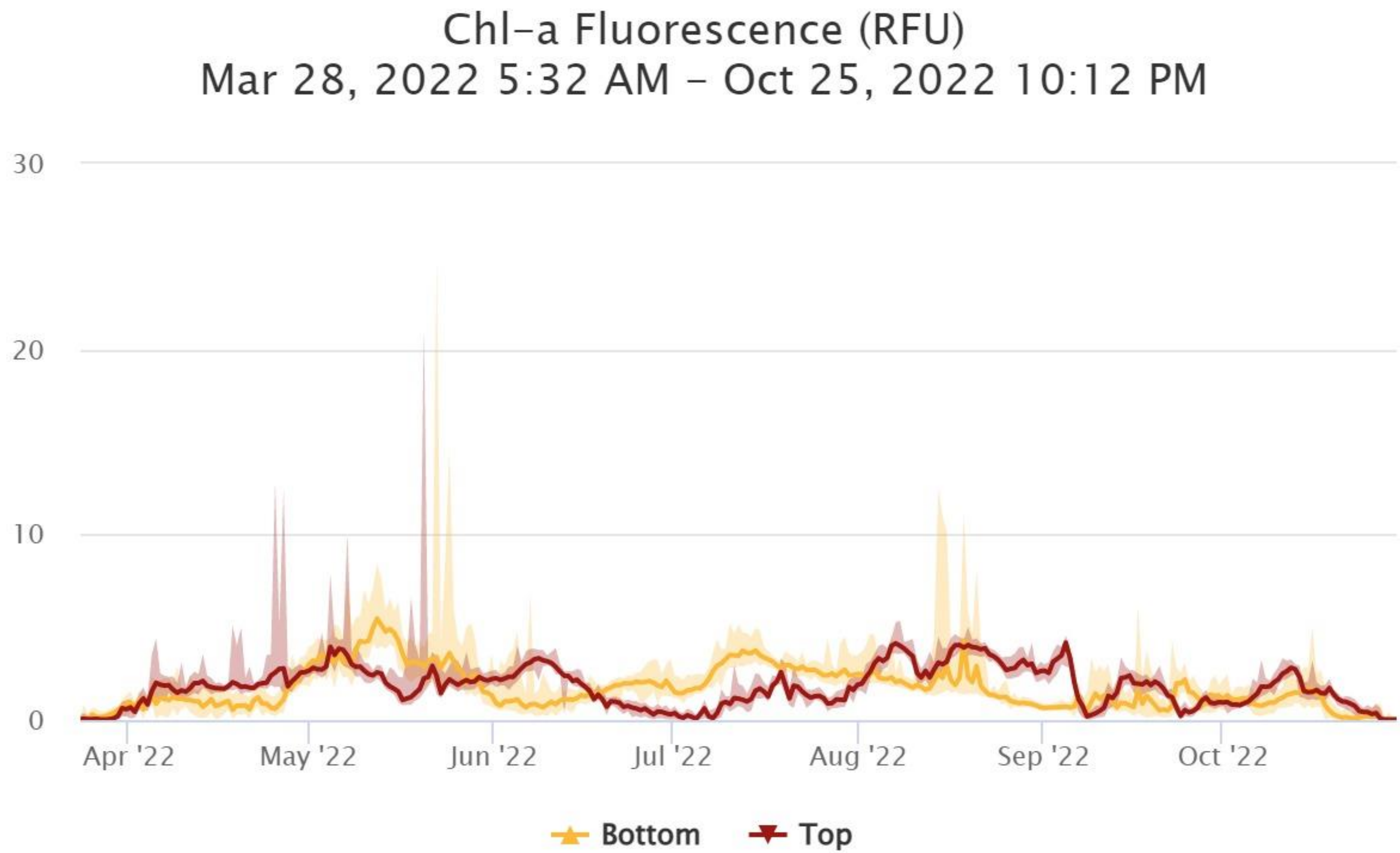
Nicholas McMahon

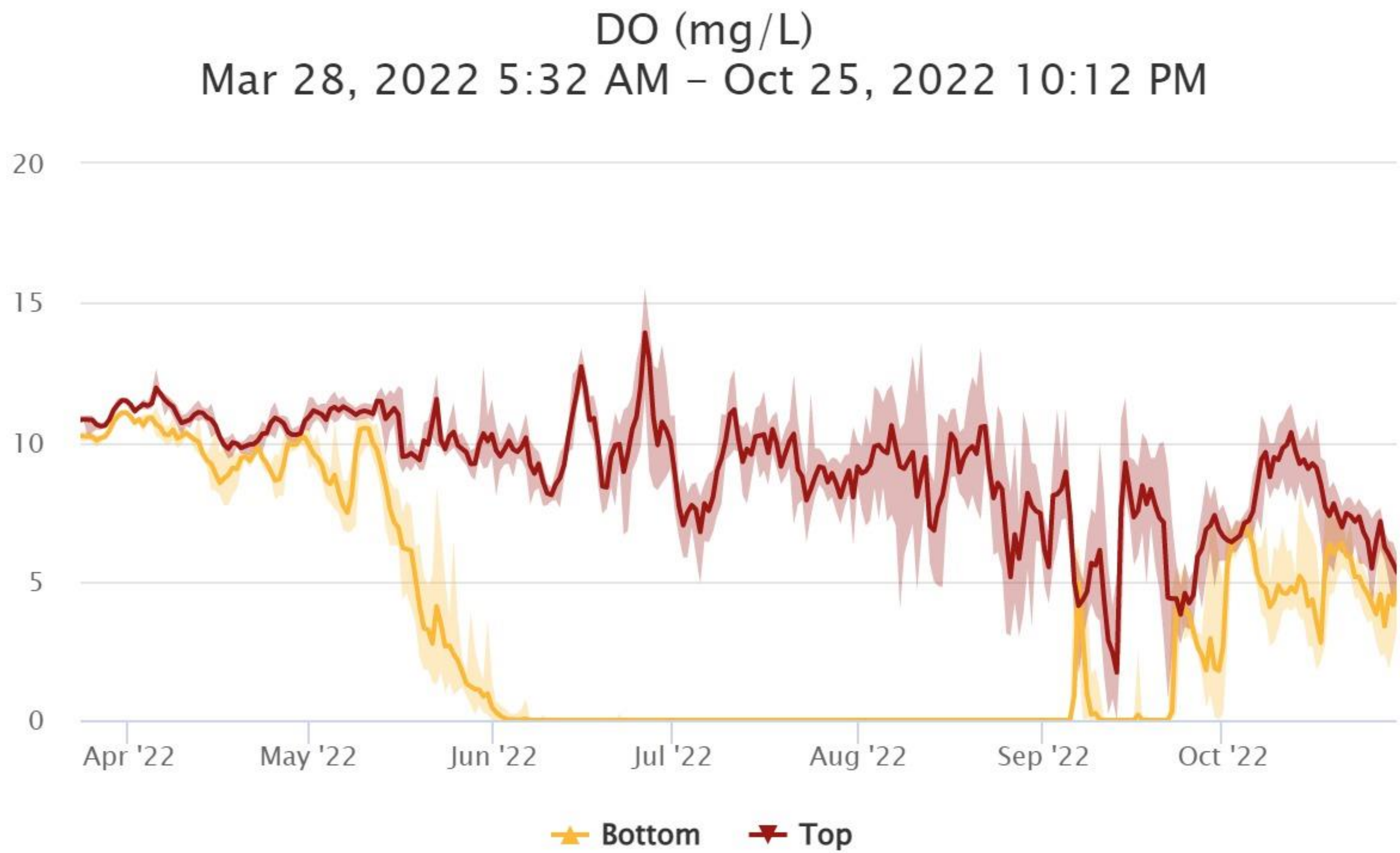
The Pond and Lake Connection
Aquatic & Fisheries Biologist
1(860)389-5519 cell
1(203)885-0184 office
nick@thepondandlake.com

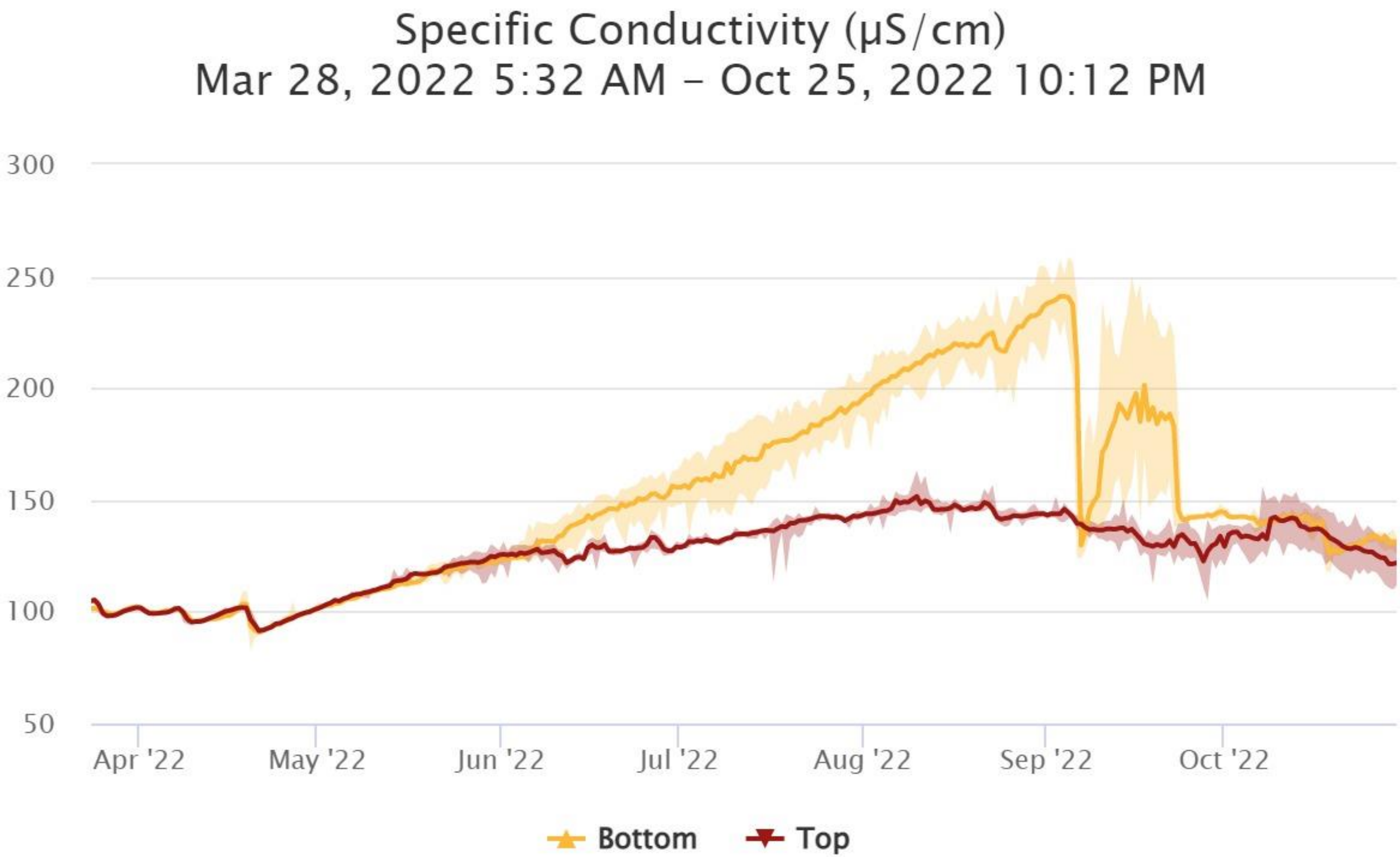

% Saturation O2 (% sat)
Mar 28, 2022 5:32 AM - Oct 25, 2022 10:12 PM
Apr '22
May '22
Jun '22
Jul '22
Aug '22
Sep '22
Oct '22
Bottom
Top

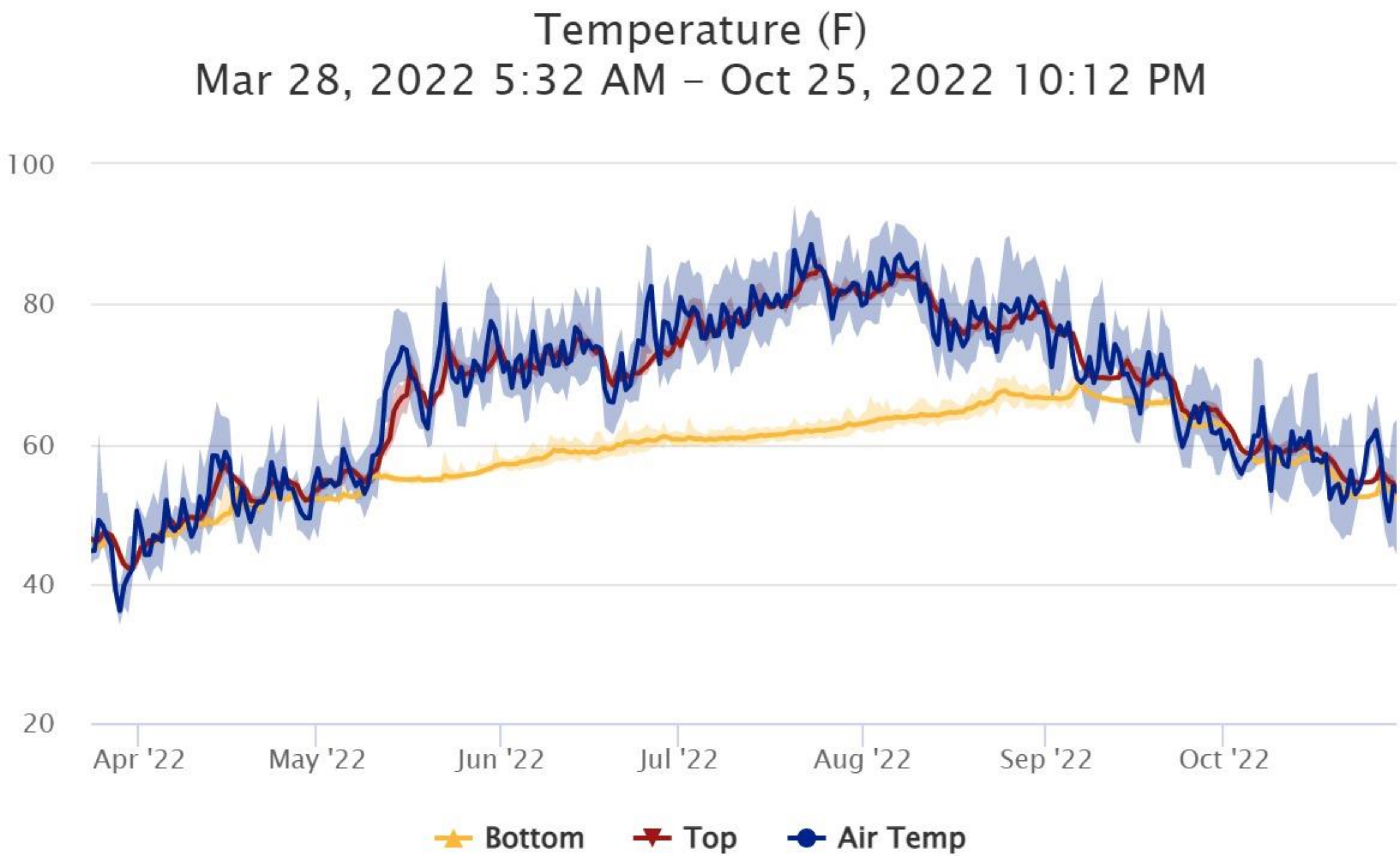

Actual Conductivity (µS/cm)
Mar 28, 2022 5:32 AM – Oct 25, 2022 10:12 PM
250
200
150
100
50
Apr '22
May '22
Jun '22
Jul '22
Aug '22
Sep '22
Oct '22
Bottom
Top


BGA-PC Fluorescence (RFU)
Mar 28, 2022 5:32 AM - Oct 25, 2022 10:12 PM
60
40
20
0
Apr '22
May '22
Jun '22
Jul '22
Aug '22
Sep '22
Oct '22
Bottom
Top


Chl-a Fluorescence (RFU)
Mar 28, 2022 5:32 AM - Oct 25, 2022 10:12 PM
30
20
10
0
Apr '22
May '22
Jun '22
Jul '22
Aug '22
Sep '22
Oct '22
Bottom
Top


DO (mg/L)
Mar 28, 2022 5:32 AM – Oct 25, 2022 10:12 PM
20
15
10
5
0
Apr '22
May '22
Jun '22
Jul '22
Aug '22
Sep '22
Oct '22
Bottom
Top


Specific Conductivity (µS/cm)
Mar 28, 2022 5:32 AM - Oct 25, 2022 10:12 PM
300
250
200
150
100
50
Apr '22
May '22
Jun '22
Jul '22
Aug '22
Sep '22
Oct '22
Bottom
Top



Temperature (F)
Mar 28, 2022 5:32 AM - Oct 25, 2022 10:12 PM
100
80
60
40
20
Apr '22
May '22
Jun '22
Jul '22
Aug '22
Sep '22
Oct '22
Bottom
Top
Air Temp

Water Quality Results
Roseland Lake

Analysis	Measurements	Description
Site A-Center Surface		
pH (SU)	7.1	Near neutral
Dissolved Oxygen (mg/L)	9.1	Acceptable for freshwaters
Conductivity (µS/cm)	85.9	Acceptable for freshwaters
Alkalinity (mg/L as $CaCO_3$)	20	Low buffered
Hardness (mg/L as $CaCO_3$)	20.2	Soft
Turbidity (NTU)	3.3	Low

Nutrient Results
Roseland Lake

Analysis	Measurements	Description
Site A-Center Surface		
Total Phosphorus (µg/L)	19.1	Moderate amount: Mesotrophic
Free Reactive Phosphorus (µg/L)	< 5	Low
Total Kjeldahl Nitrogen (mg/L)	0.2	Low
Nitrates & Nitrites (mg/L)	0.5	High
Total Nitrogen (mg/L)	0.7	Low
Chlorophyll a (µg/L)	< 10	Low

SeSCRIPT Discussion

The algae and water sample collected from **Roseland Lake** was received on **04/15/2022**. Based on results from the water quality and algae analyses, proposed treatment recommendations for algae and nutrient management at **Roseland Lake** were determined (see below).

Follow all product label instructions. Check with local and state agencies for product restrictions and permit regulations prior to use.

SeSCRIPT Treatment Guidance **Roseland Lake**

ALGAE MANAGEMENT

In order to control the targeted algae at this site, apply:

SeClear algaecide and water quality enhancer at 0.64-1.3 gallons/AF (0.1-0.2 mg Cu/L).

Contact your SePRO Aquatic Specialist for further guidance on final application rate selection, technique and frequency based on project objectives, site conditions, algae location and density at treatment time.

PHOSPHORUS MANAGEMENT

Analysis of the water quality parameters in this pond revealed this system is **mesotrophic**. Based on these site-specific water parameters, consider implementing one of the following Phoslock phosphorus removal solutions to restore water quality in your water body.

Recovery Solution: Improve water quality by incorporating strategic applications of Phoslock to remove free reactive phosphorus from the water column. Integrate with SePRO algaecide applications as needed to control algae and achieve desired water quality objectives.

Reset Solution: A more comprehensive solution to water quality restoration. Reset the ecological clock and restore water quality in your pond by implementing a Reset application strategy customized by water body. This Phoslock solution targets and permanently removes free reactive phosphorus in the water column and accumulated in water body sediments over time. A sediment sample is ideal for this prescription.

Contact your SePRO Aquatic Specialist for additional guidance on development of a custom Phoslock prescription based on site conditions and water quality management objectives.

Jon Gosselin, SePRO Technical Specialist
Phone: 603-494-5966 Email: jong@sepro.com

Water Quality Analysis Explanation

These water quality parameters are essential to document the condition of a water body and design custom treatment prescriptions to achieve desired management objectives.

pH: Measure of how acidic or basic the water is (pH 7 is considered neutral).

<6 notably acidic *6 - 9 standard for typical freshwaters* *>9 notably basic*

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Hardness: Measure of the concentration of divalent cations, primarily consisting of calcium and magnesium in typical freshwaters. *0-60 mg/L as $CaCO_3$ soft; 61-120 moderately hard; 121-180 hard; > 181 very hard*

Alkalinity- Measure of the buffering capacity of water, primarily consisting of carbonate, bicarbonate and hydroxide in typical freshwaters. Waters with lower levels are more susceptible to pH shifts.
≤ 50 mg/L as $CaCO_3$ low buffered; 51-100 moderately buffered; 101-200 buffered; > 200 high buffered

Conductivity- Measure of the waters ability to transfer an electrical current, increases with more dissolved ions.
< 50 uS/cm relatively low concentration may not provide sufficient dissolved ions for ecosystem health; 50-1500 typical freshwaters; > 1500 may be stressful to some freshwater organisms, though not uncommon in many areas

Dissolved Oxygen- amount of diatomic oxygen dissolved in the water.
< 2 mg/L likely toxicity with sufficient exposure duration; < 5 stressful to many aquatic organisms; ≥ 5 able to support most fish and invertebrates

Phosphorus: Essential nutrient often correlating to growth of algae in freshwaters.

Total Phosphorus (TP) is the measure of all phosphorus in a sample as measured by persulfate strong digestion and includes: inorganic, oxidizable organic and polyphosphates. This includes what is readily available, potential to become available and stable forms.
<12 µg/L oligotrophic; 12-24 µg/L mesotrophic; 25-96 µg/L eutrophic; > 96 µg/L hypereutrophic

Free Reactive Phosphorus (FRP) is the measure of inorganic dissolved reactive phosphorus (PO_4^{-3}, HPO_4^{-2}, etc.). This form is readily available in the water column for algae growth.

Nitrogen: Essential nutrient that can enhance growth of algae.

Total N is all nitrogen in the sample (organic N^+ and Ammonia) determined by the sum of the measurements for Total Kjeldahl Nitrogen (TKN) and ionic forms.

Nitrites and Nitrates are the sum of total oxidized nitrogen, often readily free for algae uptake.
< 1 mg/L typical freshwater; 1-10 potentially harmful; >10 possible toxicity, above many regulated guidelines

Chlorophyll *a*: primary light-harvesting pigment found in algae and a measure of the algal productivity and water quality in a system.
0-2.6µg/L oligotrophic; 2.7-20 µg/L mesotrophic; 21-56 µg/L eutrophic; > 56 µg/L hypereutrophic

Turbidity- Measurement of water clarity. Suspended particulates (algae, clay, silt, dead organic matter) are the common constituents impacting turbidity.
< 10 NTU drinking water standards and typical trout waters; 10-50 NTU moderate; > 50 NTU potential impact to aquatic life.

Water Quality Results
Roseland Lake

Analysis	Measurements	Description
Site A-Center Surface		
pH (SU)	9.2	Slightly basic
Dissolved Oxygen (mg/L)	9.2	Acceptable for freshwaters
Conductivity (µS/cm)	570.0	Acceptable for freshwaters
Alkalinity (mg/L as $CaCO_3$)	23.4	Low buffered
Hardness (mg/L as $CaCO_3$)	25.5	Soft
Turbidity (NTU)	2.9	Low

Nutrient Results
Roseland Lake

Analysis	Measurements	Description
Site A-Center Surface		
Total Phosphorus (µg/L)	18.8	Moderate amount: Mesotrophic
Free Reactive Phosphorus (µg/L)	6.8	Low
Total Kjeldahl Nitrogen (mg/L)	0.5	Low
Nitrates & Nitrites (mg/L)	0.5	High
Total Nitrogen (mg/L)	1.0	Moderate
Chlorophyll a (µg/L)	24.6	Moderate

SeSCRIPT Discussion

The algae and water sample collected from **Roseland Lake** was received on **05/04/2022**. Based on results from the water quality and algae analyses, proposed treatment recommendations for algae and nutrient management at **Roseland Lake** were determined (see below).

Follow all product label instructions. Check with local and state agencies for product restrictions and permit regulations prior to use.

SeSCRIPT Treatment Guidance **Roseland Lake**

ALGAE MANAGEMENT

In order to control the targeted algae at this site, apply:

SeClear algaecide and water quality enhancer at 0.64-1.3 gallons/AF (0.1-0.2 mg Cu/L).

Contact your SePRO Aquatic Specialist for further guidance on final application rate selection, technique and frequency based on project objectives, site conditions, algae location and density at treatment time.

PHOSPHORUS MANAGEMENT

Analysis of the water quality parameters in this pond revealed this system is **mesotrophic**. Based on these site-specific water parameters, consider implementing one of the following EutroSORB phosphorus removal solutions to restore water quality in your water body.

Recovery Solution: Improve water quality by incorporating strategic applications of EutroSORB to remove free reactive phosphorus from the water column. Integrate with SePRO algaecide applications as needed to control algae and achieve desired water quality objectives.

Reset Solution: A more comprehensive solution to water quality restoration. Reset the ecological clock and restore water quality in your pond by implementing a Reset application strategy customized by water body. This EutroSORB solution targets and permanently removes free reactive phosphorus in the water column and accumulated in water body sediments over time. A sediment sample is ideal for this prescription.

Contact your SePRO Aquatic Specialist for additional guidance on development of a custom EutroSORB prescription based on site conditions and water quality management objectives.

Jon Gosselin, SePRO Technical Specialist
Phone: 603-494-5966 Email: jong@sepro.com

Water Quality Analysis Explanation

These water quality parameters are essential to document the condition of a water body and design custom treatment prescriptions to achieve desired management objectives.

pH: Measure of how acidic or basic the water is (pH 7 is considered neutral).

<6 notably acidic | *6 - 9 standard for typical freshwaters* | *>9 notably basic*

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Hardness: Measure of the concentration of divalent cations, primarily consisting of calcium and magnesium in typical freshwaters. *0-60 mg/L as $CaCO_3$ soft; 61-120 moderately hard; 121-180 hard; > 181 very hard*

Alkalinity- Measure of the buffering capacity of water, primarily consisting of carbonate, bicarbonate and hydroxide in typical freshwaters. Waters with lower levels are more susceptible to pH shifts.
≤ 50 mg/L as $CaCO_3$ low buffered; 51-100 moderately buffered; 101-200 buffered; > 200 high buffered

Conductivity- Measure of the waters ability to transfer an electrical current, increases with more dissolved ions.
< 50 uS/cm relatively low concentration may not provide sufficient dissolved ions for ecosystem health; 50-1500 typical freshwaters; > 1500 may be stressful to some freshwater organisms, though not uncommon in many areas

Dissolved Oxygen- amount of diatomic oxygen dissolved in the water.
< 2 mg/L likely toxicity with sufficient exposure duration; < 5 stressful to many aquatic organisms; ≥ 5 able to support most fish and invertebrates

Phosphorus: Essential nutrient often correlating to growth of algae in freshwaters.

Total Phosphorus (TP) is the measure of all phosphorus in a sample as measured by persulfate strong digestion and includes: inorganic, oxidizable organic and polyphosphates. This includes what is readily available, potential to become available and stable forms.
<12 µg/L oligotrophic; 12-24 µg/L mesotrophic; 25-96 µg/L eutrophic; > 96 µg/L hypereutrophic

Free Reactive Phosphorus (FRP) is the measure of inorganic dissolved reactive phosphorus (PO_4^{-3}, HPO_4^{-2}, etc.). This form is readily available in the water column for algae growth.

Nitrogen: Essential nutrient that can enhance growth of algae.

Total N is all nitrogen in the sample (organic N^+ and Ammonia) determined by the sum of the measurements for Total Kjeldahl Nitrogen (TKN) and ionic forms.

Nitrites and Nitrates are the sum of total oxidized nitrogen, often readily free for algae uptake.
< 1 mg/L typical freshwater; 1-10 potentially harmful; >10 possible toxicity, above many regulated guidelines

Chlorophyll *a*: primary light-harvesting pigment found in algae and a measure of the algal productivity and water quality in a system.
0-2.6µg/L oligotrophic; 2.7-20 µg/L mesotrophic; 21-56 µg/L eutrophic; > 56 µg/L hypereutrophic

Turbidity- Measurement of water clarity. Suspended particulates (algae, clay, silt, dead organic matter) are the common constituents impacting turbidity.
< 10 NTU drinking water standards and typical trout waters; 10-50 NTU moderate; > 50 NTU potential impact to aquatic life.

Water Quality Results
Roseland Lake

Analysis	Measurements	Description
Site A-Center Surface		
pH (SU)	8.7	Near neutral
Dissolved Oxygen (mg/L)	8.1	Acceptable for freshwaters
Conductivity (µS/cm)	103.6	Acceptable for freshwaters
Alkalinity (mg/L as $CaCO_3$)	28.8	Low buffered
Hardness (mg/L as $CaCO_3$)	34.3	Soft
Turbidity (NTU)	2.4	Low

Nutrient Results
Roseland Lake

Analysis	Measurements	Description
Site A-Center Surface		
Total Phosphorus (µg/L)	16.9	Moderate amount: Mesotrophic
Free Reactive Phosphorus (µg/L)	< 5	Low
Total Kjeldahl Nitrogen (mg/L)	0.5	Low
Nitrates & Nitrites (mg/L)	0.2	Moderate
Total Nitrogen (mg/L)	0.7	Low
Chlorophyll a (µg/L)	< 10	Low

SeSCRIPT Discussion

The algae and water sample collected from **Roseland Lake** was received on **06/01/2022**. Based on results from the water quality and algae analyses, proposed treatment recommendations for algae and nutrient management at **Roseland Lake** were determined (see below).

Follow all product label instructions. Check with local and state agencies for product restrictions and permit regulations prior to use.

SeSCRIPT Treatment Guidance **Roseland Lake**

ALGAE MANAGEMENT

In order to control the targeted algae at this site, apply:

SeClear algaecide and water quality enhancer at 0.64-1.3 gallons/AF (0.1-0.2 mg Cu/L).

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Jon Gosselin, SePRO Technical Specialist
Phone: 603-494-5966 Email: jong@sepro.com

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<6 notably acidic | *6 - 9 standard for typical freshwaters* | *>9 notably basic*

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Hardness: Measure of the concentration of divalent cations, primarily consisting of calcium and magnesium in typical freshwaters. *0-60 mg/L as $CaCO_3$ soft; 61-120 moderately hard; 121-180 hard; > 181 very hard*

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≤ 50 mg/L as $CaCO_3$ low buffered; 51-100 moderately buffered; 101-200 buffered; > 200 high buffered

Conductivity- Measure of the waters ability to transfer an electrical current, increases with more dissolved ions.
< 50 uS/cm relatively low concentration may not provide sufficient dissolved ions for ecosystem health; 50-1500 typical freshwaters; > 1500 may be stressful to some freshwater organisms, though not uncommon in many areas

Dissolved Oxygen- amount of diatomic oxygen dissolved in the water.
< 2 mg/L likely toxicity with sufficient exposure duration; < 5 stressful to many aquatic organisms; ≥ 5 able to support most fish and invertebrates

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<12 µg/L oligotrophic; 12-24 µg/L mesotrophic; 25-96 µg/L eutrophic; > 96 µg/L hypereutrophic

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Nitrites and Nitrates are the sum of total oxidized nitrogen, often readily free for algae uptake.
< 1 mg/L typical freshwater; 1-10 potentially harmful; >10 possible toxicity, above many regulated guidelines

Chlorophyll *a*: primary light-harvesting pigment found in algae and a measure of the algal productivity and water quality in a system.
0-2.6µg/L oligotrophic; 2.7-20 µg/L mesotrophic; 21-56 µg/L eutrophic; > 56 µg/L hypereutrophic

Turbidity- Measurement of water clarity. Suspended particulates (algae, clay, silt, dead organic matter) are the common constituents impacting turbidity.
< 10 NTU drinking water standards and typical trout waters; 10-50 NTU moderate; > 50 NTU potential impact to aquatic life.

Algae ID Results (cont.)
Roseland Lake

Identification	Classification	Description	Density/Biomass (cells/mL)
Site 4			
Dolichospermum sp.	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	11,500
Aphanizomenon sp.	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	5,000

Other algae in the sample at densities below 100 cells/mL, include: *Fragilaria* (Bacillariophyta)

Identification	Classification	Description	Density/Biomass (cells/mL)
Site 5			
Dolichospermum sp.	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	3,000
Aphanizomenon sp.	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	700

Water Quality Results
Roseland Lake

Analysis	Measurements	Description
pH (SU)	8.7	Near neutral
Dissolved Oxygen (mg/L)	8.9	Typical for freshwaters
Conductivity (µS/cm)	696.0	Typical for freshwaters
Alkalinity (mg/L as $CaCO_3$)	38.1	Low buffered
Hardness (mg/L as $CaCO_3$)	39.5	Soft
Turbidity (NTU)	4.3	Low

Nutrient Results
Roseland Lake

Analysis	Measurements	Description
Total Phosphorus (µg/L)	19.7	Moderate amount: Mesotrophic
Free Reactive Phosphorus (µg/L)	5.0	Low
Total Kjeldahl Nitrogen (mg/L)	0.9	Low
Nitrates & Nitrites (mg/L)	0.1	Low
Total Nitrogen (mg/L)	1.0	Low
Chlorophyll a (µg/L)	14.5	Moderate amount: Mesotrophic

SeSCRIPT Discussion

The algae and water sample collected from **Roseland Lake** was received on **07/01/2022**. Based on results from the water quality and algae analyses, proposed treatment recommendations for algae and nutrient management at **Roseland Lake** were determined (see below).

Follow all product label instructions. Check with local and state agencies for product restrictions and permit regulations prior to use.

SeSCRIPT Treatment Guidance **Roseland Lake**

ALGAE MANAGEMENT

In order to control the targeted algae at this site, apply:

SeClear algaecide and water quality enhancer at 0.64-1.3 gallons/AF (0.1-0.2 mg Cu/L).

Contact your SePRO Aquatic Specialist for further guidance on final application rate selection, technique and frequency based on project objectives, site conditions, algae location and density at treatment time.

PHOSPHORUS MANAGEMENT

Analysis of the water quality parameters in this pond revealed this system is **mesotrophic**. Based on these site-specific water parameters, consider implementing one of the following EutroSORB phosphorus removal solutions to restore water quality in your water body.

Recovery Solution: Improve water quality by incorporating strategic applications of EutroSORB to remove free reactive phosphorus from the water column. Integrate with SePRO algaecide applications as needed to control algae and achieve desired water quality objectives.

Reset Solution: A more comprehensive solution to water quality restoration. Reset the ecological clock and restore water quality in your pond by implementing a Reset application strategy customized by water body. This EutroSORB solution targets and permanently removes free reactive phosphorus in the water column and accumulated in water body sediments over time. A sediment sample is ideal for this prescription.

Contact your SePRO Aquatic Specialist for additional guidance on development of a custom EutroSORB prescription based on site conditions and water quality management objectives.

Jon Gosselin, SePRO Technical Specialist
Phone: 603-494-5966 Email: jong@sepro.com

Water Quality Analysis Explanation

These water quality parameters are essential to document the condition of a water body and design custom treatment prescriptions to achieve desired management objectives.

pH: Measure of how acidic or basic the water is (pH 7 is considered neutral).

<6 notably acidic ***6 - 9 standard for typical freshwaters*** ***>9 notably basic***

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Hardness: Measure of the concentration of divalent cations, primarily consisting of calcium and magnesium in typical freshwaters. *0-60 mg/L as $CaCO_3$ soft; 61-120 moderately hard; 121-180 hard; > 181 very hard*

Alkalinity- Measure of the buffering capacity of water, primarily consisting of carbonate, bicarbonate and hydroxide in typical freshwaters. Waters with lower levels are more susceptible to pH shifts.
≤ 50 mg/L as $CaCO_3$ low buffered; 51-100 moderately buffered; 101-200 buffered; > 200 high buffered

Conductivity- Measure of the waters ability to transfer an electrical current, increases with more dissolved ions.
< 50 uS/cm relatively low concentration may not provide sufficient dissolved ions for ecosystem health; 50-1500 typical freshwaters; > 1500 may be stressful to some freshwater organisms, though not uncommon in many areas

Dissolved Oxygen- amount of diatomic oxygen dissolved in the water.
< 2 mg/L likely toxicity with sufficient exposure duration; < 5 stressful to many aquatic organisms; ≥ 5 able to support most fish and invertebrates

Phosphorus: Essential nutrient often correlating to growth of algae in freshwaters.

Total Phosphorus (TP) is the measure of all phosphorus in a sample as measured by persulfate strong digestion and includes: inorganic, oxidizable organic and polyphosphates. This includes what is readily available, potential to become available and stable forms.
<12 µg/L oligotrophic; 12-24 µg/L mesotrophic; 25-96 µg/L eutrophic; > 96 µg/L hypereutrophic

Free Reactive Phosphorus (FRP) is the measure of inorganic dissolved reactive phosphorus (PO_4^{-3}, HPO_4^{-2}, etc.). This form is readily available in the water column for algae growth.

Nitrogen: Essential nutrient that can enhance growth of algae.

Total N is all nitrogen in the sample (organic N^+ and Ammonia) determined by the sum of the measurements for Total Kjeldahl Nitrogen (TKN) and ionic forms.

Nitrites and Nitrates are the sum of total oxidized nitrogen, often readily free for algae uptake.
< 1 mg/L typical freshwater; 1-10 potentially harmful; >10 possible toxicity, above many regulated guidelines

Chlorophyll *a*: primary light-harvesting pigment found in algae and a measure of the algal productivity and water quality in a system.
0-2.6µg/L oligotrophic; 2.7-20 µg/L mesotrophic; 21-56 µg/L eutrophic; > 56 µg/L hypereutrophic

Turbidity- Measurement of water clarity. Suspended particulates (algae, clay, silt, dead organic matter) are the common constituents impacting turbidity.
< 10 NTU drinking water standards and typical trout waters; 10-50 NTU moderate; > 50 NTU potential impact to aquatic life.

SRTC SePRO Research & Technology Campus SePRO

SeSCRIPT Analysis Report: *Roseland Lake*

Company: The Pond and Lake Connection

Address: 1112 Federal Rd, Brookfield, CT 06804

Contact Person: Nick McMahon

Phone: 860-389-5519

Email: nick@thepondandlake.com

Project Name: Roseland Lake

Surface Area: 95 acres

Average depth: 5 feet

Date Sample Received: 08/11/2022

SeSCRIPT Analysis Performed: 1x Algae and WQ Baseline Plus; 3x Algae ID

Algae ID Results
Roseland Lake

Identification	Classification	Description	Density/Biomass (cells/mL)
Site A- Center Surface			★★★★
Aphanizomenon sp.	Cyanophyta-Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	216,000

Other algae in the sample at densities below 100 cells/mL, include: *Dictyosphaerium, Pandorina* (Chlorophyta); *Cryptomonas* (Cryptophyta); *Microcystis* (Cyanophyta); *Gymnodinium* (Dinophyta)

Identification	Classification	Description	Density/Biomass (cells/mL)
Site A- Center Subsurface			
Pandorina sp.	Chlorophyta-Green algae	Colonial, flagellated, planktonic	32,400
Aphanizomenon sp.	Cyanophyta-Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	28,800

Other algae in the sample at densities below 100 cells/mL, include: *Synedra* (Bacillariophyta); *Cryptomonas* (Cryptophyta); *Microcystis* (Cyanophyta); *Gymnodinium* (Dinophyta)

Algae ID Results (cont.)
Roseland Lake

Identification	Classification	Description	Density/Biomass (cells/mL)
Site B- Shore Surface			★★★★
Aphanizomenon sp.	Cyanophyta-Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	272,000

Other algae in the sample at densities below 100 cells/mL, include: *Urosolenia* (Bacillariophyta); *Chlamydomonas, Dictyosphaerium, Pandorina* (Chlorophyta); *Cryptomonas* (Cryptophyta); *Dolichospermum, Microcystis* (Cyanophyta); *Gymnodinium* (Dinophyta); *Trachelomonas* (Euglenophyta); *Staurastrum* (Streptophyta)

Identification	Classification	Description	Density/Biomass (cells/mL)
Site C- Shore Surface			★★★★
Aphanizomenon sp.	Cyanophyta-Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	265,000

Other algae in the sample at densities below 100 cells/mL, include: *Fragilaria* (Bacillariophyta); *Pandorina* (Chlorophyta); *Cryptomonas* (Cryptophyta); *Dolichospermum* (Cyanophyta); *Gymnodinium* (Dinophyta)

SeSCRIPT* ALERT INDEX	EXPOSURE RISK	CYANOBACTERIA LEVELS (cells/mL)
★	Low	<20,000
★★	Moderate	20,000 to 100,000
★★★	High	>100,000
★★★★	Extreme	>100,000 with scums/mats
See the following Cyanobacteria Alert Guide for additional information		

Water Quality Results
Roseland Lake

Analysis	Measurements	Description
Site A-Center Surface		
pH (SU)	9.3	Notably basic
Dissolved Oxygen (mg/L)	8.4	Acceptable for freshwaters
Conductivity (µS/cm)	149.3	Acceptable for freshwaters
Alkalinity (mg/L as $CaCO_3$)	35.9	Low buffered
Hardness (mg/L as $CaCO_3$)	32.7	Soft
Turbidity (NTU)	5.8	Low

Nutrient Results
Roseland Lake

Analysis	Measurements	Description
Site A-Center Surface		
Total Phosphorus (µg/L)	51.3	High amount: Eutrophic
Free Reactive Phosphorus (µg/L)	5.6	Low
Total Kjeldahl Nitrogen (mg/L)	1.4	Moderate
Nitrates & Nitrites (mg/L)	<0.02	Low
Total Nitrogen (mg/L)	1.4	Moderate
Chlorophyll a (µg/L)	92.2	Very high

SeSCRIPT Discussion

The algae and water sample collected from **Roseland Lake** was received on **08/11/2022**. Based on results from the water quality and algae analyses, proposed treatment recommendations for algae and nutrient management at **Roseland Lake** were determined (see below).

Follow all product label instructions. Check with local and state agencies for product restrictions and permit regulations prior to use.

SeSCRIPT Treatment Guidance **Roseland Lake**

ALGAE MANAGEMENT

In order to control the targeted algae at this site, apply:

SeClear algaecide and water quality enhancer at 1.3-2.6 gallons/AF (0.2-0.4 mg Cu/L).

Contact your SePRO Aquatic Specialist for further guidance on final application rate selection, technique and frequency based on project objectives, site conditions, algae location and density at treatment time.

PHOSPHORUS MANAGEMENT

Analysis of the water quality parameters in this pond revealed this system is **eutrophic**. Based on these site-specific water parameters, consider implementing one of the following EutroSORB phosphorus removal solutions to restore water quality in your water body.

Recovery Solution: Improve water quality by incorporating strategic applications of EutroSORB to remove free reactive phosphorus from the water column. Integrate with SePRO algaecide applications as needed to control algae and achieve desired water quality objectives.

Reset Solution: A more comprehensive solution to water quality restoration. Reset the ecological clock and restore water quality in your pond by implementing a Reset application strategy customized by water body. This EutroSORB solution targets and permanently removes free reactive phosphorus in the water column and accumulated in water body sediments over time. A sediment sample is ideal for this prescription.

Contact your SePRO Aquatic Specialist for additional guidance on development of a custom EutroSORB prescription based on site conditions and water quality management objectives.

Jon Gosselin, SePRO Technical Specialist
Phone: 603-494-5966 Email: jong@sepro.com

Water Quality Analysis Explanation

These water quality parameters are essential to document the condition of a water body and design custom treatment prescriptions to achieve desired management objectives.

pH: Measure of how acidic or basic the water is (pH 7 is considered neutral).

<6 notably acidic ***6 - 9 standard for typical freshwaters*** ***>9 notably basic***

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

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Alkalinity- Measure of the buffering capacity of water, primarily consisting of carbonate, bicarbonate and hydroxide in typical freshwaters. Waters with lower levels are more susceptible to pH shifts.
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Conductivity- Measure of the waters ability to transfer an electrical current, increases with more dissolved ions.
< 50 uS/cm relatively low concentration may not provide sufficient dissolved ions for ecosystem health; 50-1500 typical freshwaters; > 1500 may be stressful to some freshwater organisms, though not uncommon in many areas

Dissolved Oxygen- amount of diatomic oxygen dissolved in the water.
< 2 mg/L likely toxicity with sufficient exposure duration; < 5 stressful to many aquatic organisms; ≥ 5 able to support most fish and invertebrates

Phosphorus: Essential nutrient often correlating to growth of algae in freshwaters.

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<12 µg/L oligotrophic; 12-24 µg/L mesotrophic; 25-96 µg/L eutrophic; > 96 µg/L hypereutrophic

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Nitrites and Nitrates are the sum of total oxidized nitrogen, often readily free for algae uptake.
< 1 mg/L typical freshwater; 1-10 potentially harmful; >10 possible toxicity, above many regulated guidelines

Chlorophyll *a*: primary light-harvesting pigment found in algae and a measure of the algal productivity and water quality in a system.
0-2.6µg/L oligotrophic; 2.7-20 µg/L mesotrophic; 21-56 µg/L eutrophic; > 56 µg/L hypereutrophic

Turbidity- Measurement of water clarity. Suspended particulates (algae, clay, silt, dead organic matter) are the common constituents impacting turbidity.
< 10 NTU drinking water standards and typical trout waters; 10-50 NTU moderate; > 50 NTU potential impact to aquatic life.

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CONNECTION

Putnam Water Pollution Control Authority
Peake Brook Rd. Woodstock, CT

Roseland Lake Treatment Summary 2021

Roseland lake and Shepherds Pond are approximately 98 and 8 acres respectively. Two half lake treatments were performed on each waterbody, 6/29 and 8/24. A total of 250g of SeClear was used for each treatment with 96% of it being used in Roseland Lake and the remainder used in Shepherds Pond. This was applied at a rate of a full gallon per acre/ft in both waterbodies. A hand held nozzle was used with the aid of a sticker adjuvant to target floating mats and submerged drop hoses were used to target subsurface algae.

Both treatments were timed well with some algae present and levels on the rise but not in full bloom. Each treatment showed a fast and substantial visual decrease in the amount of algae present.

The addition of highly sophisticated and accurate continuous monitoring equipment has provided real-time data on the algae density and type as well as other key parameters in the middle of the lake both at the surface and down near the thermocline. This has proven to be a great early warning system in the management of Algae at Roseland Lake. When we see changes on the buoy data, that helps us determine the best timing of algae ID lab testing and has helped reduced the overall cost of lab testing. Between the buoy data, lab testing and regular visual inspections, treatment timing can be optimized to provide the best results with the minimum required number of treatments.

The last options left unexplored currently are oriented towards more long term results and reduce the need for frequent algae treatments. This would involve the sequestration of nutrients that are responsible for causing the algae in the first place (mainly Phosphorus). Phosphorus can come from runoff/upstream sources and from the release of lake sediment under low Dissolved Oxygen (DO) conditions commonly found during the summer. If Phosphorus is removed from the system, the lake would realize two key benefits; A reduction in overall algae, and a shift away from Toxic Blue-Green algae towards the beneficial Green Algae species. In a system with such abundant Phosphorus, Blue-Green Algae (BGA) can quickly increase in the spring and dominate most of the season because they can "fix" or create the other required nutrient Nitrogen. This gives BGA the competitive advantage in a high Phosphorus environment. When the ratio of Phosphorus:Nitrogen is brought more into line, Green Algae can proliferate and help block BGA growth. A product like Phoslock is designed to target Phosphorus and bind to it permanently so it can no longer be used by any plant or algae. Phoslock is NSF/ANSI 60 Certified safe for use in drinking water reservoirs

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and can be applied as either a one time large reset application, or annually in smaller doses to slowly bring down the Phosphorus levels. To explore this option further, some sediment testing would need to be done to dial in the required dose needed to reset the lakes nutrients.

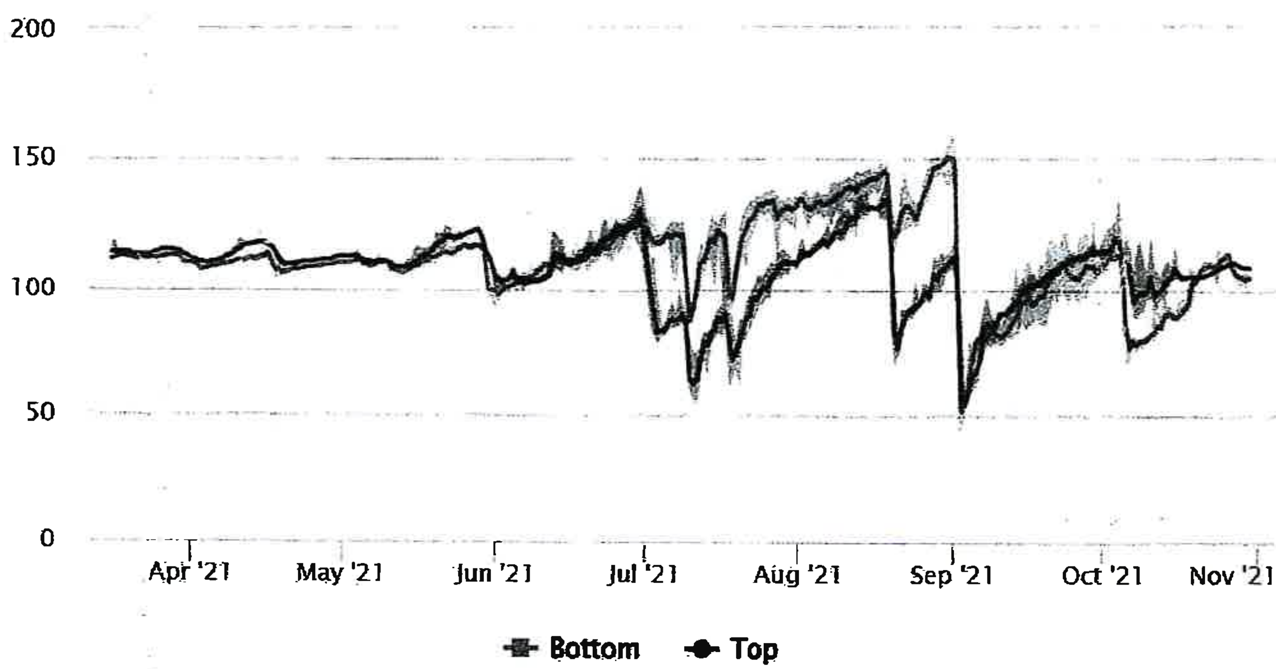
If you have any questions regarding last seasons treatments or my recommendations for 2022, please feel free to reach out to me. It was a pleasure to work on this lake and I hope to see you all in the Spring.

Nicholas McMahon

The Pond and Lake Connection
Aquatic & Fisheries Biologist
1(860)389-5519 cell
1(203)885-0184 office
nick@thepondandlake.com

THE POND AND LAKE CONNECTION

Specific Conductivity (µS/cm)
Mar 16, 2021 1:52 AM - Oct 31, 2021 12:32 PM



1112 Federal Road, Brookfield, Ct 06804
Telephone (203) 885-0184 Fax (203) 885-0873
www.ThePondConnection.com
NY 15201 / CT 2764 / NJ 99972A

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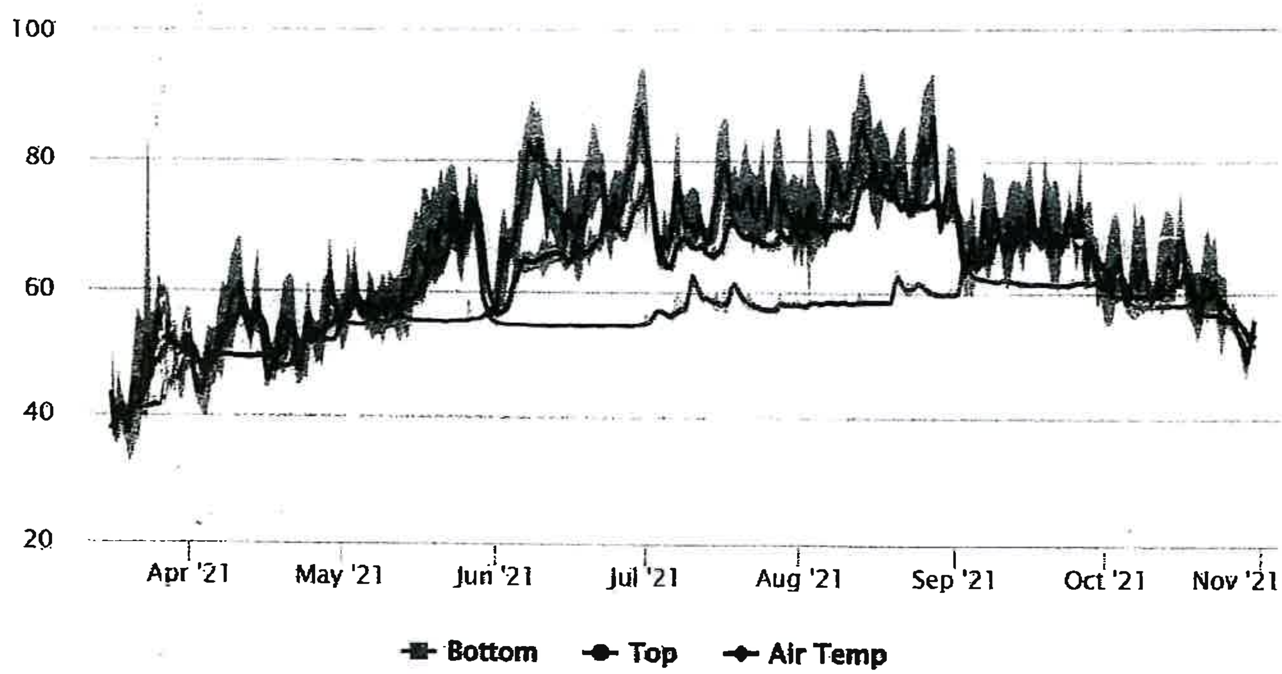
Temperature (F)
Mar 16, 2021 1:52 AM - Oct 31, 2021 12:32 PM



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NY 15201 / CT 2764 / NJ 99972A

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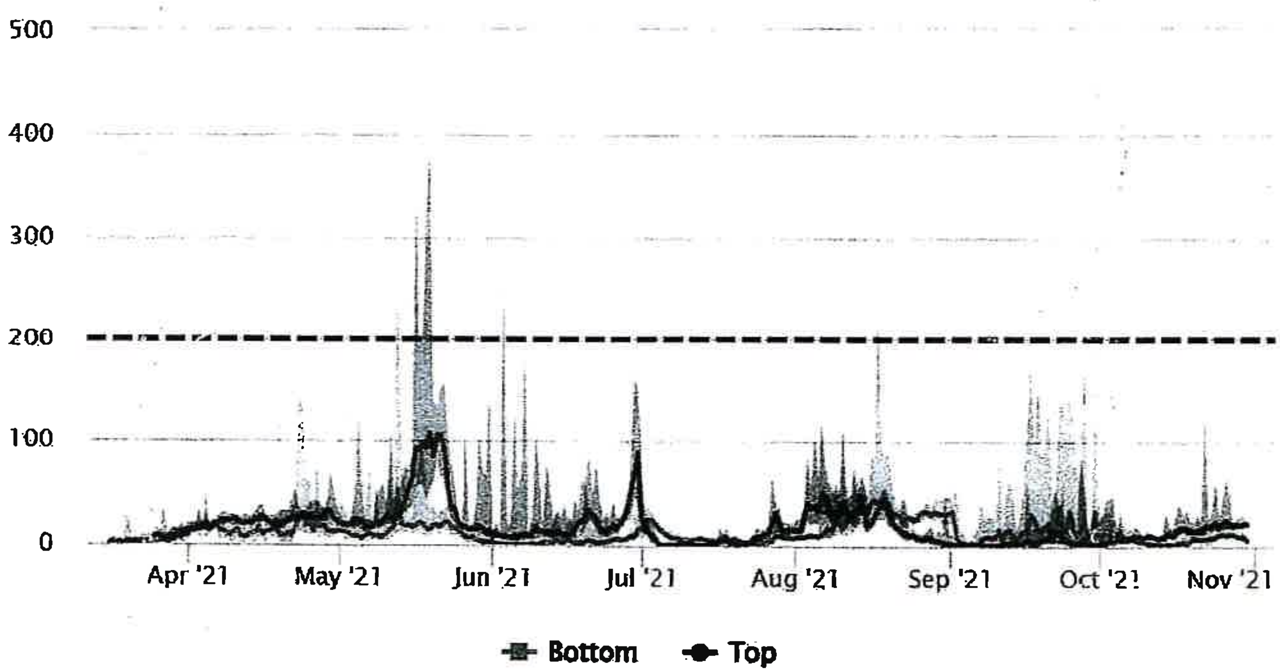
Chl-a Concentration (µg/L)
Mar 16, 2021 1:52 AM – Oct 31, 2021 12:32 PM



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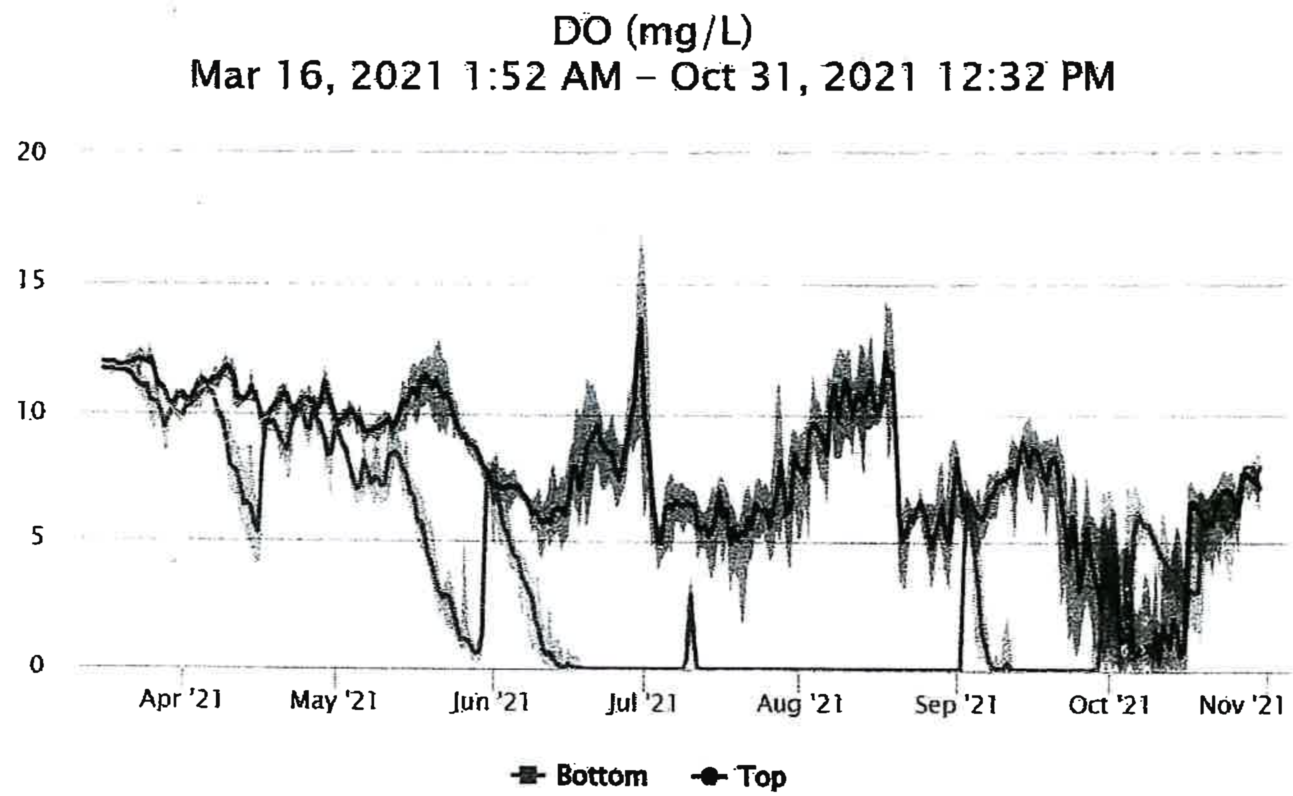

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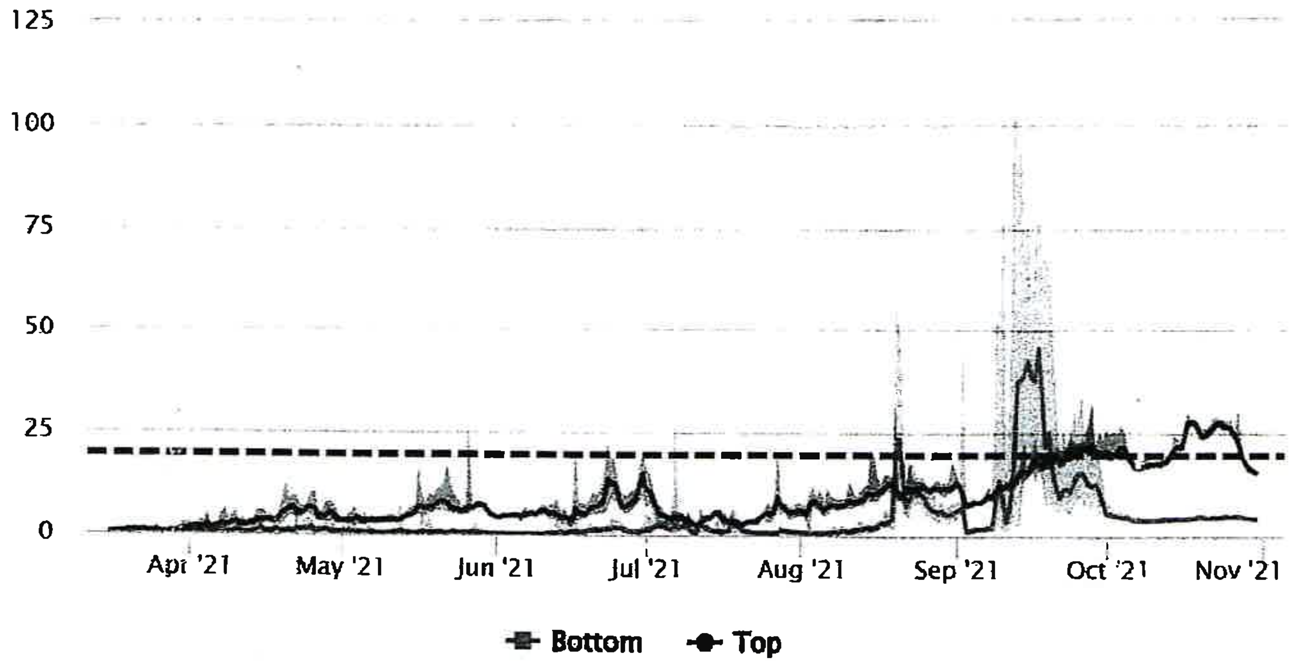
BGA-PC Concentration (µg/L)
Mar 16, 2021 1:52 AM - Oct 31, 2021 12:32 PM



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www.ThePondConnection.com
NY 15201 / CT 2764 / NJ 99972A

SRTC SePRO Research & Technology Campus SePRO

SeSCRIPT Analysis Report: *Roseland Lake*

Company: The Pond and Lake Connection

Address: 1112 Federal Rd, Brookfield, CT 06804

Contact Person: Lisa Mariakakis

Phone: 203-885-0184

Email: lisa@thepondandlake.com

Project Name: Roseland Lake

Surface Area: 95 acres

Average depth: 5 feet

Date Sample Received: 07/08/2020

SeSCRIPT Analysis Performed: 1x Algae and WQ Baseline Plus; 3x Algae ID

Algae ID Results
Roseland Lake

Identification	Classification	Description	Density/Biomass (cells/mL)
Site A- Surface			
Dolichospermum sp.	Cyanophyta-Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	900
Staurastrum sp.	Streptophyta-Desmids	Single-celled, planktonic	360

Other algae in the sample at densities below 60 cells/mL, include: *Fragilaria* (Bacillariophyta); *Planktosphaeria* (Chlorophyta)

Identification	Classification	Description	Density/Biomass (cells/mL)
Site A- Subsurface			
Dolichospermum sp.	Cyanophyta-Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	1,900
Coelosphaerium sp.	Cyanophyta-Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	900
Staurastrum sp.	Streptophyta-Desmids	Single-celled, planktonic	240

Other algae in the sample at densities below 60 cells/mL, include: *Fragilaria* (Bacillariophyta); *Gloeocystis* (Chlorophyta)

Algae ID Results
Roseland Lake

Identification	Classification	Description	Density/Biomass (cells/mL)
Site B- Surface			
Eunotia sp.	Bacillariophyta- Diatoms	Colonial, planktonic	1,800
Dolichospermum sp.	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	1,000

Other algae in the sample at densities below 60 cells/mL, include: *Aulacoseira, Meridion, Navicula, Synedra* (Bacillariophyta); *Pandorina* (Chlorophyta); *Coelosphaerium, Microcystis* (Cryptophyta); *Trachelomonas* (Euglenophyta); *Cosmarium, Staurastrum* (Streptophyta)

Identification	Classification	Description	Density/Biomass (cells/mL)
Site C- Surface			
Dolichospermum sp.	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	2,200

Other algae in the sample at densities below 60 cells/mL, include: *Eunotia, Fragilaria, Meridion* (Bacillariophyta); *Oocystis, Pandorina* (Chlorophyta); *Trachelomonas* (Euglenophyta); *Staurastrum* (Streptophyta)

Water Quality Results
Roseland Lake

Analysis	Measurements	Description
Site A-Surface		
pH (SU)	7.7	Near neutral
Dissolved Oxygen (mg/L)	8.7	Acceptable for freshwaters
Conductivity (µS/cm)	137.6	Acceptable for freshwaters
Alkalinity (mg/L as $CaCO_3$)	20.1	Low buffered
Hardness (mg/L as $CaCO_3$)	13.1	Soft
Turbidity (NTU)	3.7	Low

Nutrient Results
Roseland Lake

Analysis	Measurements	Description
Site A-Surface		
Total Phosphorus (µg/L)	10.9	Low amount: Oligotrophic
Free Reactive Phosphorus (µg/L)	5	Low
Total Kjeldahl Nitrogen (mg/L)	0.7	Low
Nitrates & Nitrites (mg/L)	0.1	Moderate
Total Nitrogen (mg/L)	0.8	Low
Chlorophyll a (µg/L)	< 10	Low

SeSCRIPT Discussion

The algae and water sample collected from **Roseland Lake** was received on **07/08/2020**. Based on results from the water quality and algae analyses, proposed treatment recommendations for algae and nutrient management at **Roseland Lake** were determined (see below).

Follow all product label instructions. Check with local and state agencies for product restrictions and permit regulations prior to use.

SeSCRIPT Treatment Guidance **Roseland Lake**

ALGAE MANAGEMENT

In order to control the targeted algae at this site, apply:

Captain algaecide at 0.3-0.6 gallons/AF (0.1-0.2 mg Cu/L).

Contact your SePRO Aquatic Specialist for further guidance on final application rate selection, technique and frequency based on project objectives, site conditions, algae location and density at treatment time.

PHOSPHORUS MANAGEMENT

Analysis of the water quality parameters in this pond revealed this system is **oligotrophic**. Based on these site-specific water parameters, consider implementing one of the following Phoslock phosphorus removal solutions to restore water quality in your water body.

Recovery Solution: Improve water quality by incorporating strategic applications of Phoslock to remove free reactive phosphorus from the water column. Integrate with SePRO algaecide applications as needed to control algae and achieve desired water quality objectives.

Reset Solution: A more comprehensive solution to water quality restoration. Reset the ecological clock and restore water quality in your pond by implementing a Reset application strategy customized by water body. This Phoslock solution targets and permanently removes free reactive phosphorus in the water column and accumulated in water body sediments over time. A sediment sample is ideal for this prescription.

Contact your SePRO Aquatic Specialist for additional guidance on development of a custom Phoslock prescription based on site conditions and water quality management objectives.

Jon Gosselin, SePRO Technical Specialist
Phone: 603-494-5966 Email: jong@sepro.com

Water Quality Analysis Explanation

These water quality parameters are essential to document the condition of a water body and design custom treatment prescriptions to achieve desired management objectives.

pH: Measure of how acidic or basic the water is (pH 7 is considered neutral).

<6 notably acidic	*6 - 9 standard for typical freshwaters*	*>9 notably basic*

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Hardness: Measure of the concentration of divalent cations, primarily consisting of calcium and magnesium in typical freshwaters. *0-60 mg/L as $CaCO_3$ soft; 61-120 moderately hard; 121-180 hard; > 181 very hard*

Alkalinity- Measure of the buffering capacity of water, primarily consisting of carbonate, bicarbonate and hydroxide in typical freshwaters. Waters with lower levels are more susceptible to pH shifts.
≤ 50 mg/L as $CaCO_3$ low buffered; 51-100 moderately buffered; 101-200 buffered; > 200 high buffered

Conductivity- Measure of the waters ability to transfer an electrical current, increases with more dissolved ions.
< 50 uS/cm relatively low concentration may not provide sufficient dissolved ions for ecosystem health; 50-1500 typical freshwaters; > 1500 may be stressful to some freshwater organisms, though not uncommon in many areas

Dissolved Oxygen- amount of diatomic oxygen dissolved in the water.
< 2 mg/L likely toxicity with sufficient exposure duration; < 5 stressful to many aquatic organisms; ≥ 5 able to support most fish and invertebrates

Phosphorus: Essential nutrient often correlating to growth of algae in freshwaters.

Total Phosphorus (TP) is the measure of all phosphorus in a sample as measured by persulfate strong digestion and includes: inorganic, oxidizable organic and polyphosphates. This includes what is readily available, potential to become available and stable forms.
<12 µg/L oligotrophic; 12-24 µg/L mesotrophic; 25-96 µg/L eutrophic; > 96 µg/L hypereutrophic

Free Reactive Phosphorus (FRP) is the measure of inorganic dissolved reactive phosphorus (PO_4^{-3}, HPO_4^{-2}, etc.). This form is readily available in the water column for algae growth.

Nitrogen: Essential nutrient that can enhance growth of algae.

Total N is all nitrogen in the sample (organic N^+ and Ammonia) determined by the sum of the measurements for Total Kjeldahl Nitrogen (TKN) and ionic forms.

Nitrites and Nitrates are the sum of total oxidized nitrogen, often readily free for algae uptake.
< 1 mg/L typical freshwater; 1-10 potentially harmful; >10 possible toxicity, above many regulated guidelines

Chlorophyll *a*: primary light-harvesting pigment found in algae and a measure of the algal productivity and water quality in a system.
0-2.6µg/L oligotrophic; 2.7-20 µg/L mesotrophic; 21-56 µg/L eutrophic; > 56 µg/L hypereutrophic

Turbidity- Measurement of water clarity. Suspended particulates (algae, clay, silt, dead organic matter) are the common constituents impacting turbidity.
< 10 NTU drinking water standards and typical trout waters; 10-50 NTU moderate; > 50 NTU potential impact to aquatic life.

THE POND AND LAKE
CONNECTION

Jeff Livernoche
Putnam Water Pollution Control Authority
Peake Brook Rd. Woodstock, CT

Roseland Lake Treatment Summary

Roseland lake is approximately 98 acres with an average depth of 7' and Shepherds Pond is about 8 acres with an average dept of 2'. Two half lake treatments were performed on each waterbody, 6/12 and 8/5. A total of 250g of SeClear was used each time with 96% of it being used in Roseland Lake and the remainder used in Shepherds Pond. This was applied at a rate of a full gallon per acre/ft in both waterbodies. A hand held nozzle was used with the aid of a sticker adjuvant to target floating mats and submerged drop hoses were used to target subsurface algae.

The first treatment on 6/12 was timed well with some algae present but not in full bloom. The second treatment on 8/5 was likely needed a few weeks earlier because when we arrived, the algae was in full bloom and required much more attention than we had anticipated.

For next season, I would recommend someone at least get eyes on the pond weekly and if any signs of algae are visible, then let me know. If you would like us to take over the full weekly testing, that can also be arranged. I also would have you guys consider looking back into some Phosphorus sequestering with the product Phoslock. This product is safer to apply than Alum, offers a permanent bond locking up Phosphorus, and its price has come down substantially to the point where it is less expensive than Alum. Phoslock can also be applied in a much smaller annual dose which makes it much easier to afford if a full lake re-set application is too expensive.

If you have any questions regarding last seasons treatments or my recommendations for 2020, please feel free to reach out to me. It was a pleasure to work on this lake and I hope to see you all in the Spring.

Nicholas McMahon

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Fax # (860) 486-5488
Telephone # (860) 486-4015
Email: cesecustserv@uconn.edu
Analyst: A. Provatas

Putnam Water
Order# 190330
Matrix: Water
Contact: Thomas Goillemette
Report Date: 9/6/19
Reported by: C. Perkins

CESE ID	Field ID	Collected	Recieved	cylindrospermopsin	anatoxin A	microcystin RR	microcystin YR	microcystin LR	microcystin LA
Instrument				UPLC-MS/MS	UPLC-MS/MS	UPLC-MS/MS	UPLC-MS/MS	UPLC-MS/MS	UPLC-MS/MS
Units	WET WEIGHT			ng/mL	ng/mL	ng/mL	ng/mL	ng/mL	ng/mL
Prep date				8/30/19	8/30/19	8/30/19	8/30/19	8/30/19	8/30/19
Analysis date				9/5/19	9/5/19	9/5/19	9/5/19	9/5/19	9/5/19
190330-001	2201 surface	08/30/19	08/30/19	ND	ND	ND	ND	ND	ND
190330-002	2201 3 feet	08/30/19	08/30/19	ND	ND	ND	ND	ND	ND
190330-003	00700	08/30/19	08/30/19	ND	ND	ND	ND	ND	ND
			Reporting Limit	0.005	0.020	0.050	0.040	0.050	0.040

Note:

Appendix B - Concentrated Animal Feeding Operations General Permit

The Connecticut Department of Environmental Protection issued a draft General Permit for Concentrated Animal Feeding Operations on February 16, 2022. The CAFO GP authorizes new and existing discharges from Large or Medium CAFOs and facilities designated as CAFOs (see Table below for definitions).

Under the CAFO General Permit, only one farm meets the Large CAFO category and 2 – 3 farms are medium-sized CAFO operations.

Method of Discharge Criteria for medium CAFOs

1. Pollutants are discharged into waters of the state through a man-made ditch, flushing system, or other similar man-made device, or
2. Pollutants are discharged directly into waters of the state, or otherwise come into direct contact with the animals confined in the operation.

"*Facility designated as a CAFO*" means that the Commissioner has determined that an AFO is a significant contributor of pollutants to waters of the state. In making this determination to designate a CAFO, the Commissioner shall consider the following factors:
(1) The size of the AFO (i.e., number of animals), the amount of agricultural wastes or agricultural wastewaters which may be generated or which is discharging or which can reasonably be expected to discharge to the waters of the state;
(2) The location of the AFO relative to waters of the state;
(3) The means of conveyance of agricultural waste and agricultural wastewaters into the waters of the state;
(4) The slope, vegetation, rainfall, and other factors affecting the likelihood or frequency of discharge of agricultural waste, manure and agricultural wastewaters into the waters of the state; and
(5) Other relevant factors.

More info in draft summary and draft permit language.

Animal Sector	**Size Thresholds (number of animals)**			
		Authorized Under This General Permit		
	Large CAFOs (per Federal Regulation)	**Large CAFOs** (per this General Permit)	**Medium CAFOs**[1]	**Small CAFOs**[2]
cattle or cow/calf pairs	1,000 or more		300 - 999	less than 300
mature dairy cattle	700 or more	700 or more	200 - 699	less than 200
veal calves	1,000 or more		300 - 999	less than 300

swine (weighing over 55 pounds)	2,500 or more		750 - 2,499	less than 750
swine (weighing less than 55 pounds)	10,000 or more		3,000 - 9,999	less than 3,000
horses	500 or more		150 - 499	less than 150
sheep or lambs	10,000 or more		3,000 - 9,999	less than 3,000
turkeys	55,000 or more		16,500 - 54,999	less than 16,500
laying hens or broilers (liquid manure handling systems)	30,000 or more			
chickens other than laying hens (other than liquid manure handling systems)	125,000 or more		37,500 - 124,999	less than 37,500
laying hens (other than liquid manure handling systems)	82,000 or more	82,000 or more	25,000 - 81,999	less than 25,000
ducks (other than liquid manure handling systems	30,000 or more		10,000 - 29,999	less than 10,000
ducks (liquid manure handling systems)	5,000 or more			less than 300

[1]Must also meet one of two “method of discharge” criteria cited in the paragraph below to be defined as a CAFO, or may be designated as a CAFO on a case-by-case basis.
[2]May only be designated as a CAFO on a case-by-case basis.

Appendix C - NRCS Local Farm Soil Recategorization

Appendix C

Effective October 1, 2023, the following changes to Farm Soil Classification will be in effect.

Table 1. Connecticut soil map units that are reclassified in this proposal. All affected map units are currently locally-important farmland in select towns, as listed at far right.

Mapunit Symbol	National Mapunit Symbol	Mapunit Name	Mapunit Type	Status	Total Acres	Farm Class Name	Proposed New Farm Class Name	Local Important towns
427B	9lt2	Ashfield fine sandy loam, 2 to 8 percent slopes, very stony		correlated	1535	Not prime farmland	Farmland of statewide importance	Colebrook, Cornwall, Goshen, Norfolk, North Canaan, Winchester
427C	9lt3	Ashfield fine sandy loam, 8 to 15 percent slopes, very stony		correlated	3928	Not prime farmland	Farmland of statewide importance	Colebrook, Cornwall, Goshen, Norfolk, North Canaan, Torrington, Winchester
417B	9lst	Bice fine sandy loam, 3 to 8 percent slopes, very stony		correlated	1499	Not prime farmland	Farmland of statewide importance	Colebrook, Cornwall, Goshen, Norfolk, Winchester
417C	9lsv	Bice fine sandy loam, 8 to 15 percent slopes, very stony		correlated	4744	Not prime farmland	Farmland of statewide importance	Colebrook, Cornwall, Goshen, Norfolk, Winchester
83B	9lr6	Broadbrook silt loam, 3 to 8 percent slopes, very stony		correlated	1423	Not prime farmland	Farmland of statewide importance	Ellington, Enfield, Granby, Suffield
83C	9lr7	Broadbrook silt loam, 8 to 15 percent slopes, very stony		correlated	698	Not prime farmland	Farmland of statewide importance	Granby, Shelton, Suffield
61B	2w81v	Canton and Charlton fine sandy loams, 0 to 8 percent slopes, very stony	mlra map unit	correlated	69311	Not prime farmland	Farmland of statewide importance	Ashford, Barkhamsted, Bethany, Bethlehem, Bolton, Bozrah, Brooklyn, Canterbury, Canton, Chaplin, Chester, Clinton, Colchester, Colebrook, Columbia, Cornwall, Coventry, Deep River, Durham, East Haddam, East Hampton, East Lyme, Eastford, Easton, Ellington, Essex, Franklin, Goshen, Granby, Griswold, Haddam, Hampton, Hebron, Kent, Killingly, killingworth, Lebanon, Ledyard, Lisbon, Litchfield, Madison, Mansfield, Middlefield, Middletown, Milford, Morris, New Hartford, New Milford, Newtown, North Canaan, North Stonington, Old Lyme, Old Saybrook, Orange, Plainfield, Pomfret, Portland, Preston, Roxbury, Salisbury, Scotland, Sharon, Shelton, Southbury, Sprague, Sterling, Stonington, Thompson, Tolland, Torrington, Vernon, Voluntown, Warren, Washington, Watertown, Westbrook, Westport, Willington, Woodbridge, Woodbury, Woodstock
61C	2w820	Canton and Charlton fine sandy loams, 8 to 15 percent slopes, very stony	mlra map unit	correlated	58062	Not prime farmland	Farmland of statewide importance	Ashford, Barkhamsted, Bethany, Bethlehem, Bolton, Bozrah, Bridgewater, Brooklyn, Canterbury, Canton, Chaplin, Chester, Clinton, Colchester, Columbia, Cornwall, Coventry, Deep River, East Haddam, East Hampton, East Lyme, Eastford, Easton, Ellington, Essex, Franklin, Goshen, Granby, Griswold, Haddam, Hampton, Hebron, Kent, Killingly, killingworth, Lebanon, Ledyard, Lisbon, Litchfield, Madison, Mansfield, Middletown, Milford, Morris, New Hartford, New Milford,

								Newtown, Norfolk, North Canaan, North Stonington, Old Lyme, Old Saybrook, Orange, Plainfield, Pomfret, Portland, Preston, Roxbury, Salisbury, Scotland, Sharon, Shelton, Southbury, Sprague, Sterling, Stonington, Thompson, Tolland, Torrington, Vernon, Voluntown, Warren, Washington, Watertown, Westbrook, Westport, Willington, Winchester, Woodbridge, Woodbury, Woodstock
64B	9lpz	Cheshire fine sandy loam, 3 to 8 percent slopes, very stony		correlated	3996	Not prime farmland	Farmland of statewide importance	Bethany, East Windsor, Ellington, North Branford, South Windsor, Southbury, Suffield, Vernon
64C	9lq0	Cheshire fine sandy loam, 8 to 15 percent slopes, very stony		correlated	1748	Not prime farmland	Farmland of statewide importance	Bolton, East Windsor, Ellington, Granby, North Branford, South Windsor, Suffield, Vernon, Woodbury
405C	9lt9	Dummerston gravelly loam, 3 to 15 percent slopes, very stony		correlated	396	Not prime farmland	Farmland of statewide importance	Salisbury
408C	9lsk	Fullam silt loam, 3 to 15 percent slopes, very stony		correlated	1029	Not prime farmland	Farmland of statewide importance	Salisbury
49B	9lnz	Georgia and Amenia silt loams, 3 to 8 percent slopes, very stony		correlated	720	Not prime farmland	Farmland of statewide importance	Cornwall, Kent, North Canaan, Salisbury, Sharon
49C	9lp0	Georgia and Amenia silt loams, 8 to 15 percent slopes, very stony		correlated	1374	Not prime farmland	Farmland of statewide importance	Cornwall, Kent, North Canaan, Salisbury, Sharon
58B	9lph	Gloucester gravelly sandy loam, 3 to 8 percent slopes, very stony		correlated	2873	Not prime farmland	Farmland of statewide importance	Barkhamsted, Bethlehem, Brooklyn, Canterbury, Canton, Chaplin, Colebrook, Cornwall, Coventry, East Haddam, East Hampton, Eastford, Ellington, Goshen, Granby, Hampton, Kent, Killingly, Litchfield, Mansfield, Morris, New Hartford, Norfolk, Plainfield, Pomfret, Roxbury, Scotland, Sharon, Sterling, Thompson, Tolland, Torrington, Warren, Washington, Watertown, Willington, Winchester, Woodbury, Woodstock
58C	9lpj	Gloucester gravelly sandy loam, 8 to 15 percent slopes, very stony		correlated	3537	Not prime farmland	Farmland of statewide importance	Barkhamsted, Bethlehem, Bridgewater, Brooklyn, Canterbury, Canton, Chaplin, Colebrook, Cornwall, Coventry, East Hampton, Eastford, Goshen, Granby, Hampton, Hebron, Kent, Killingly, Litchfield, Mansfield, Morris, New Hartford, Norfolk, Plainfield, Pomfret, Roxbury, Scotland, Sharon, Sterling, Thompson, Tolland, Torrington, Washington,

								Watertown, Willington, Winchester, Woodbury, Woodstock
449B	2wrch	Hogansburg loam, 0 to 8 percent slopes, very stony	mlra map unit	correlated	66	Not prime farmland	Farmland of statewide importance	Goshen
449C	2wrck	Hogansburg loam, 8 to 15 percent slopes, very stony	mlra map unit	correlated	190	Not prime farmland	Farmland of statewide importance	Goshen
407C	9lsh	Lanesboro loam, 3 to 15 percent slopes, very stony		correlated	343	Not prime farmland	Farmland of statewide importance	Salisbury
41B	9lnk	Ludlow silt loam, 2 to 8 percent slopes, very stony		correlated	2273	Not prime farmland	Farmland of statewide importance	Cromwell, Durham, Granby, Haddam, Meriden, Middlefield, Middletown, North Branford, Rocky Hill, Suffield
67B	9lq5	Narragansett silt loam, 3 to 8 percent slopes, very stony		correlated	2970	Not prime farmland	Farmland of statewide importance	Colchester, East Haddam, East Lyme, Ellington, Enfield, Ledyard, North Stonington, Preston, South Windsor, Stonington, Suffield, Vernon
67C	9lq6	Narragansett silt loam, 8 to 15 percent slopes, very stony		correlated	663	Not prime farmland	Farmland of statewide importance	Ellington, Enfield, Granby, South Windsor, Suffield, Vernon
93C	9ls0	Nellis fine sandy loam, 3 to 15 percent slopes, very stony		correlated	531	Not prime farmland	Farmland of statewide importance	Cornwall, Kent, New Milford, North Canaan, Salisbury
85B	2w679	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes, very stony	mlra map unit	correlated	44575	Not prime farmland	Farmland of statewide importance	Ashford, Barkhamsted, Bethany, Bethlehem, Bolton, Bozrah, Bridgewater, Brooklyn, Canterbury, Canton, Chaplin, Chester, Clinton, Colchester, Columbia, Cornwall, Coventry, Deep River, Durham, East Haddam, East Hampton, East Lyme, Eastford, Easton, Ellington, Essex, Franklin, Goshen, Granby, Griswold, Haddam, Hampton, Hebron, Kent, Killingly, killingworth, Lebanon, Ledyard, Lisbon, Litchfield, Madison, Mansfield, Middletown, Morris, New Hartford, New Milford, Newtown, Norfolk, North Canaan, North Stonington, Old Lyme, Old Saybrook, Plainfield, Pomfret, Portland, Preston, Roxbury, Scotland, Sharon, Shelton, Southbury, Sprague, Sterling, Stonington, Thompson, Tolland, Torrington, Vernon, Voluntown, Warren, Washington, Watertown, Westbrook, Westport, Willington, Winchester, Woodbridge, Woodbury, Woodstock
85C	2w67f	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes, very stony	mlra map unit	correlated	27079	Not prime farmland	Farmland of statewide importance	Ashford, Barkhamsted, Bethany, Bethlehem, Bolton, Bozrah, Bridgewater, Brooklyn, Canterbury, Canton, Chaplin, Chester, Clinton, Colchester, Columbia, Cornwall, Coventry, Deep River, Durham, East Haddam, East Hampton, East Lyme,

								Eastford, Easton, Ellington, Essex, Franklin, Goshen, Granby, Griswold, Haddam, Hampton, Hebron, Kent, Killingly, killingworth, Lebanon, Ledyard, Lisbon, Litchfield, Madison, Mansfield, Middletown, Morris, New Hartford, New Milford, Newtown, Norfolk, North Canaan, North Stonington, Old Lyme, Old Saybrook, Plainfield, Pomfret, Portland, Preston, Roxbury, Scotland, Sharon, Shelton, Southbury, Sprague, Sterling, Stonington, Thompson, Tolland, Torrington, Voluntown, Warren, Washington, Watertown, Westbrook, Willington, Woodbridge, Woodbury, Woodstock
451B	qwzq	Pyrities loam, 3 to 8 percent slopes, very stony		correlated	18	Not prime farmland	Farmland of statewide importance	Goshen
451C	qwzb	Pyrities loam, 8 to 15 percent slopes, very stony		correlated	93	Not prime farmland	Farmland of statewide importance	Goshen
44B	9lnp	Rainbow silt loam, 2 to 8 percent slopes, very stony		correlated	1391	Not prime farmland	Farmland of statewide importance	Bozrah, Ellington, Enfield, Granby, Ledyard, North Stonington, Old Lyme, Preston, Sprague, Stonington, Suffield
418C	9lsx	Schroon fine sandy loam, 2 to 15 percent slopes, very stony		correlated	2413	Not prime farmland	Farmland of statewide importance	Colebrook, Cornwall, Goshen, Norfolk, North Canaan, Torrington, Winchester
425B	9lsz	Shelburne fine sandy loam, 3 to 8 percent slopes, very stony		correlated	1383	Not prime farmland	Farmland of statewide importance	Colebrook, Cornwall, Goshen, Norfolk, North Canaan, Winchester
425C	9lt0	Shelburne fine sandy loam, 8 to 15 percent slopes, very stony		correlated	3542	Not prime farmland	Farmland of statewide importance	Colebrook, Cornwall, Goshen, Norfolk, North Canaan, Torrington, Winchester
91B	9lrv	Stockbridge loam, 3 to 8 percent slopes, very stony		correlated	184	Not prime farmland	Farmland of statewide importance	Cornwall, Salisbury, Sharon
91C	9lrw	Stockbridge loam, 8 to 15 percent slopes, very stony		correlated	1495	Not prime farmland	Farmland of statewide importance	Cornwall, Goshen, Kent, North Canaan, Salisbury, Sharon
51B	2xfff	Sutton fine sandy loam, 0 to 8 percent slopes, very stony	mlra map unit	correlated	22821	Not prime farmland	Farmland of statewide importance	Ashford, Barkhamsted, Bethlehem, Bolton, Bozrah, Bridgewater, Brooklyn, Canterbury, Canton, Chaplin, Chester, Colchester, Colebrook, Columbia, Cornwall, Coventry, Durham, East Haddam, East Hampton, East Lyme, Eastford, Easton, Ellington, Franklin, Goshen, Granby, Griswold, Haddam, Hampton, Hebron, Kent, Killingly, killingworth, Lebanon, Ledyard, Lisbon, Litchfield, Mansfield, Middletown, Milford, Morris, New Hartford, New Milford, Newtown, North Canaan, North Stonington,

								Old Lyme, Plainfield, Pomfret, Portland, Preston, Roxbury, Salisbury, Scotland, Sharon, Shelton, Sprague, Sterling, Stonington, Thompson, Tolland, Torrington, Vernon, Voluntown, Warren, Washington, Watertown, Westport, Willington, Woodbury, Woodstock
54B	9lp8	Wapping very fine sandy loam, 2 to 8 percent slopes, very stony		correlated	705	Not prime farmland	Farmland of statewide importance	Ellington, South Windsor, Suffield, Washington
56B	9lpc	Watchaug fine sandy loam, 2 to 8 percent slopes, very stony		correlated	489	Not prime farmland	Farmland of statewide importance	Canton, Rocky Hill, South Windsor, Suffield
88B	9lrl	Wethersfield loam, 3 to 8 percent slopes, very stony		correlated	3840	Not prime farmland	Farmland of statewide importance	Canton, Cromwell, Durham, Ellington, Granby, Middlefield, Middletown, North Branford, Rocky Hill, Shelton, Suffield
88C	9lrm	Wethersfield loam, 8 to 15 percent slopes, very stony		correlated	2441	Not prime farmland	Farmland of statewide importance	Canton, Cromwell, Durham, Ellington, Haddam, Middlefield, Middletown, North Branford, Rocky Hill, Suffield
46B	2t2qr	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	mlra map unit	correlated	56170	Not prime farmland	Farmland of statewide importance	Ashford, Barkhamsted, Bethany, Bethlehem, Bolton, Bozrah, Bridgewater, Brooklyn, Canterbury, Canton, Chaplin, Chester, Clinton, Colchester, Colebrook, Columbia, Cornwall, Coventry, Deep River, East Haddam, East Hampton, East Lyme, Eastford, Easton, Ellington, Essex, Franklin, Goshen, Granby, Griswold, Haddam, Hampton, Hebron, Kent, Killingly, killingworth, Lebanon, Ledyard, Lisbon, Litchfield, Madison, Mansfield, Middletown, Milford, Morris, New Hartford, New Milford, Newtown, Norfolk, North Canaan, North Stonington, Old Lyme, Old Saybrook, Orange, Plainfield, Pomfret, Portland, Preston, Roxbury, Salisbury, Scotland, Sharon, Shelton, Southbury, Sprague, Sterling, Stonington, Thompson, Tolland, Torrington, Vernon, Voluntown, Warren, Washington, Watertown, Westbrook, Westport, Willington, Winchester, Woodbridge, Woodbury, Woodstock
46C	2w687	Woodbridge fine sandy loam, 8 to 15 percent slopes, very stony	mlra map unit	correlated	6605	Not prime farmland	Farmland of statewide importance	Ashford, Bethlehem, Bolton, Bozrah, Bridgewater, Brooklyn, Canterbury, Canton, Chaplin, Colchester, Colebrook, Columbia, Cornwall, Coventry, East Haddam, East Hampton, East Lyme, Eastford,

								Franklin, Goshen, Granby, Griswold, Hampton, Hebron, Kent, Lebanon, Ledyard, Lisbon, Mansfield, Morris, New Hartford, New Milford, Newtown, Norfolk, North Canaan, Plainfield, Pomfret, Preston, Roxbury, Salisbury, Scotland, Sharon, Shelton, Sprague, Sterling, Stonington, Thompson, Tolland, Warren, Washington, Watertown, Willington, Winchester, Woodbury, Woodstock

Table 2. Locally Important Farmland map units that are *not* reclassified in this proposal.

Mapunit Symbol	National Mapunit Symbol	Mapunit Name	Mapunit Type	Status	Total Acres	Farm Class Name	Proposed New Farm Class Name	Local Important towns
413C	9lsm	Bice-Millsite complex, 3 to 15 percent slopes, very rocky		correlated	9997	Not prime farmland		Colebrook, Cornwall, Goshen, Norfolk, North Canaan, Winchester
70C	9lqd	Branford-Holyoke complex, 3 to 15 percent slopes, very rocky		correlated	567	Not prime farmland		Meriden
409B	9lsl	Brayton mucky silt loam, 0 to 8 percent slopes, very stony		correlated	400	Not prime farmland		Salisbury, Norfolk
73C	2w698	Charlton-Chatfield complex, 0 to 15 percent slopes, very rocky	mlra map unit	correlated	264790	Not prime farmland		Ashford, Barkhamsted, Bethany, Bethlehem, Bolton, Bozrah, Bridgewater, Brooklyn, Canterbury, Canton, Chaplin, Chester, Clinton, Colchester, Columbia, Cornwall, Coventry, Cromwell, Deep River, Durham, East Haddam, East Hampton, East Lyme, East Windsor, Eastford, Easton, Ellington, Essex, Franklin, Goshen, Granby, Griswold, Haddam, Hampton, Hebron, Kent, Killingly, Killingworth, Lebanon, Ledyard, Lisbon, Litchfield, Madison, Mansfield, Middletown, Milford, Morris, New Hartford, New Milford, Newtown, Norfolk, North Canaan, North Stonington, Old Lyme, Old Saybrook, Orange, Plainfield, Pomfret, Portland, Preston, Roxbury, Salisbury, Scotland, Sharon, Shelton, Southbury, Sprague, Sterling, Stonington, Thompson, Tolland, Torrington, Vernon, Voluntown, Warren, Washington, Watertown, Westbrook, Westport, Willington, Winchester, Woodbridge, Woodbury, Woodstock
77C	9lqs	Cheshire-Holyoke complex, 3 to 15 percent slopes, very rocky		correlated	13417	Not prime farmland		Bethany, Bolton, Canton, Cromwell, Durham, Enfield, Granby, Haddam, Meriden, Middlefield, Middletown, North Branford, Portland, Rocky Hill, South Windsor, Suffield
401C	9lsc	Macomber-Taconic complex, 3 to 15 percent slopes, very rocky		correlated	2203	Not prime farmland		Salisbury

74C	9lqm	Narragansett-Hollis complex, 3 to 15 percent slopes, very rocky		correlated	2977	Not prime farmland		Bozrah, Griswold, Ledyard, Lisbon, North Stonington, Old Lyme, Preston, Stonington, Voluntown
72C	2svjw	Nipmuck-Brookfield complex, 3 to 15 percent slopes, very rocky		correlated	25718	Not prime farmland		Ashford, Colchester, Coventry, East Haddam, East Lyme, Eastford, Lebanon, Mansfield, Tolland, Woodstock

GIS Map Sources

CT Data Sources

CT DEEP Data: CT Hydrolines

CT DEEP Data: CT Town Boundaries

CRCOG 2016 CRCOG Lidar DEM: Connecticut Statewide

- Projection: State Plane 1983
- Datum: NAD83
- File Format: GeoTIFF
- Output Resolution: 1.00 meters = 3.28 feet
- Vertical Units:U.S. Feet
- Vertical Datum:NAVD88

2016 High Res Land Cover: Connecticut Statewide

- Projection: State Plane 1983
- Datum: NAD83
- File Format: GeoTIFF
- Output Resolution: 1.00 meters = 3.28 feet

MA Data Sources

MassGIS Data: Networked Hydro Centerlines

MassGIS Data: Town Boundaries

MassGIS Data: Digital Elevation Model (1:5,000)

2016 High Res Land Cover: Massachusetts Statewide

- Projection: State Plane 1983
- Datum: NAD83
- File Format: GeoTIFF
- Output Resolution: 1.00 meters = 3.28 feet

Attachment 1:

Proposed Best Management Practices and Load Reductions for the Little River Watershed

Farm #	Watershed Priority [3]	Proposed acres treated or No.	Proposed BMPs (practice code)	Estimated 100% cost per unit (based on size)	Estimated 90% NRCS cost share [1]
1	Recovery (medium)	1	Freestall barn²	915,655	
		1	Sitework/removal of old barn²	132,000	
			Farm 1 Totals	**1,047,655**	
2	Mitigation (high)	1	Waste Storage Facility (313) 4,800 sf	53,333	48,000
		1	Waste Storage Facility (313) bedded pack 5,328 sf	183,520	165,168
		supporting practices	Roofs and covers (367) 6,528 sf	152,320	137088
		supporting practices	Roof Gutter (558)	6,333	5,700
		supporting practices	Underground outlet (620)	5,333	4,800
			Farm 2 Totals	**400,839**	**360,756**
3	Mitigation (high)	1	Waste Storage Facility (313) 48,000 sf	533,333	480,000
			Farm 3 Totals	**533,333**	**480,000**
4	High	1	Waste Storage Facility (313) 1,672 sf	18,578	16,720
		1	Waste Storage Facility (313) bedded pack 1,558 sf	53,664	48,298
		supporting practices	Roofs and covers (367) 2,214 sf	52,222	47000
		supporting practices	Roof Gutter (558)	3,167	2,850
		supporting practices	Underground outlet (620)	5,333	4,800
		supporting practices	Waste Transfer (634) 624 sf	10,400	9,360
			Farm 4 Totals	**143,364**	**129,028**
5	Medium	1	Waste Storage Facility (313) 48,000 sf	533,333	480,000
			Farm 5 Totals	**533,333**	**480,000**
6	High	1	Waste Storage Facility (313) 1,672 sf	18,578	16720
		1	Waste Storage Facility (313) bedded pack 1,558 sf	53,664	48298
		supporting practices	Roofs and covers (367) 2,214 sf	52,222	47000
		supporting practices	Roof Gutter (558)	3,167	2,850
		supporting practices	Underground outlet (620)	5,333	4,800
		supporting practices	Waste Transfer (634) 624 sf	10,400	9,360
			Farm 6 Totals	**143,364**	**129,028**
			GRAND TOTALS	**2,801,888**	**1,578,812**

[1] all NRCS costs are from CT EQIP unit costs per scenario as of 3-17-23

² Freestall barn and removal of old barn costs from similar farm project cost in 2022

³ Watershed Priority is based on maps pp. 92-94 of the Little River WBP update

BMPs may not include every supporting practice needed

Attachment 2:
US EPA Nine Elements of Watershed Based Plan
Little River Watershed Based Plan Update

	EPA Nine Elements	Location in Plan
1. Impairment	Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and other goals identified in the watershed plan.	Pages 41, 46, 49, 61, 86
2. Load Reduction	An estimate of the load reductions expected from management measures.	Pages 88, 91
3. Management Measures	A description of the nonpoint source management measures that will need to be implemented to achieve load reductions, and a description of the critical areas in which those measures will be needed to implement this plan.	Attachment 1, Page 143
4. Technical and Financial Assistance	An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.	Pages 16, 66, 97, 116
5. Public Information and Education	An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures.	Page 116
6. Schedule	A schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	Page 119
7. Milestones	A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Page 91
8. Performance Criteria	A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standard.	Pages 91, 116-119
9. Monitoring	A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.	Pages 91, 116