NORTH POND

SMITHFIELD, MERCER,
& ROME, MAINE

WATERSHED-BASED MANAGEMENT PLAN

(2024-2033)

OCTOBER 2023

NORTH POND WATERSHED-BASED MANAGEMENT PLAN

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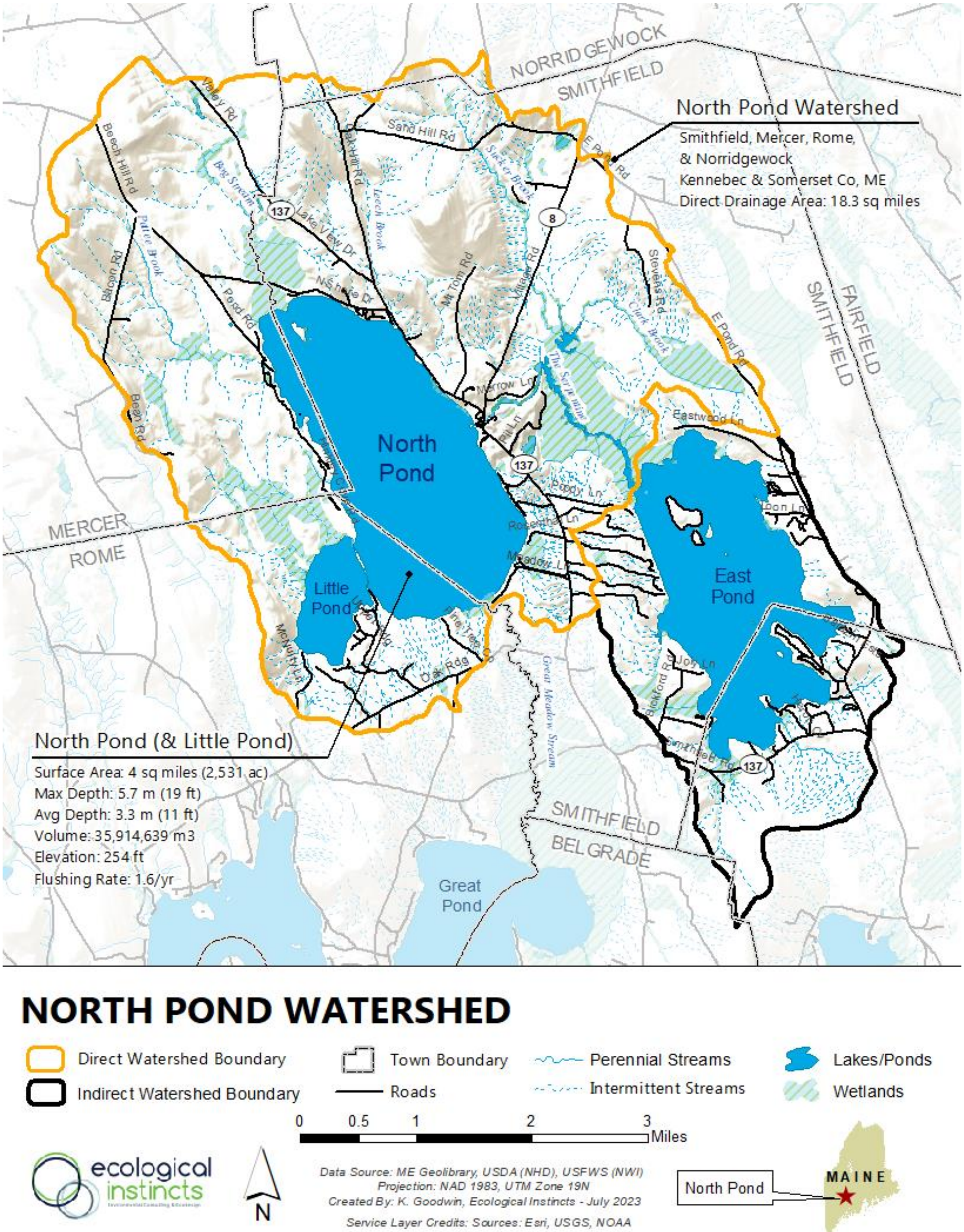
NORRIDGEWOCK
SMITHFIELD
North Pond Watershed
Smithfield, Mercer, Rome, & Norridgewock
Kennebec & Somerset Co, ME
Direct Drainage Area: 18.3 sq miles
FAIRFIELD
SMITHFIELD
MERCER
ROME
North Pond
Little Pond
East Pond
Great Pond
SMITHFIELD
BELGRADE
North Pond (& Little Pond)
Surface Area: 4 sq miles (2,531 ac)
Max Depth: 5.7 m (19 ft)
Avg Depth: 3.3 m (11 ft)
Volume: 35,914,639 m3
Elevation: 254 ft
Flushing Rate: 1.6/yr
Sand Hill Rd
Beech Hill Rd
Valley Rd
Lake View Dr
Pond Rd
E Pond Rd
Stevens Rd
Eastwood Ln
Bean Rd
Oak Rdg
Great Meadow Stream
NORTH POND WATERSHED
Direct Watershed Boundary
Indirect Watershed Boundary
Town Boundary
Roads
Perennial Streams
Intermittent Streams
Lakes/Ponds
Wetlands
0 0.5 1 2 3 Miles
N
Data Source: ME Geolibrary, USDA (NHD), USFWS (NWI)
Projection: NAD 1983, UTM Zone 19N
Created By: K. Goodwin, Ecological Instincts - July 2023
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North Pond
MAINE

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North Pond WBMP Steering Committee

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Jennifer Jespersen	Ecological Instincts (Watershed Modeling & Project Management)

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Commonly Used Acronyms

The following are used throughout this document:

7 LAKES	7 Lakes Alliance
BMP	Best Management Practice
Chl-a	Chlorophyll a
DO	Dissolved Oxygen
HAB	Harmful Algal Bloom
KCSWCD	Kennebec County Soil and Water Conservation District
KVCOG	Kennebec Valley Council of Governments
LLRM	Lake Loading Response Model
LSM VLMP	Lake Stewards of Maine Volunteer Lake Monitoring Program
Maine DEP	Maine Department of Environmental Protection
NPA	North Pond Association
NPS	Nonpoint Source (Pollution)
ppb	Parts Per Billion
ppm	Parts Per Million
SDT	Secchi Disk Transparency
SCSWCD	Somerset County Soil and Water Conservation District
TP/P	Total Phosphorus/Phosphorus
USDA/NRCS	U.S. Department of Agriculture/Natural Resources Conservation Service
US EPA	United States Environmental Protection Agency
WBMP	Watershed-Based Management Plan

NORTH POND WATERSHED-BASED MANAGEMENT PLAN (2023-2032)

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Executive Summary

Purpose

Photo Credit: Jodie Mosher-Towle

The North Pond Watershed-Based Management Plan (WBMP) provides details about current water quality conditions, watershed characteristics, and steps that can be taken to restore water quality in North Pond over the next 10 years. This WBMP supersedes the 2017 North Pond Watershed-Based Protection Plan (WBPP). Implementation is estimated to cost $3.17 million through state, federal and local contributions over the 10-year time frame. The plan outlines management strategies and an activity schedule (2024 – 2033), establishes water quality goals and objectives, and describes actions needed to achieve these goals. This includes strategies to:

A. **Reduce the external phosphorus load** by addressing existing nonpoint source (NPS) pollution in the North Pond watershed and upgrading septic systems in the shoreland zone in order to reduce the amount of phosphorus available for algae in the lake;

B. **Reduce the internal phosphorus load** by stripping phosphorus (P) from the water column and inactivating P in bottom sediments to improve the lake's trophic state and prevent future blue-green algal blooms;

C. **Prevent new sources** of NPS pollution from getting into North Pond by strengthening and enforcing municipal ordinances to prevent any increase in P loading from existing and future development, improving municipal standards and practices for roadways, investing in land conservation, and focusing on climate change adaptation planning;

D. **Raise public awareness** about the connection between land use, phosphorus, and algal blooms, as well as water quality restoration goals and strategies, by increasing local education, outreach, and communication efforts to increase participation among municipalities and watershed residents;

E. **Build local capacity** through partnership building across multiple community groups, engaging steering committee members, and developing a robust fundraising strategy;

F. **Monitor and assess improvements** in North Pond's water quality over time. This includes monitoring in-lake water quality, streams, NPS pollution, and invasive aquatic plants.

THE GOAL

A team of scientists and local stakeholders worked collaboratively over two years with input from the public to set a water quality goal for North Pond that would restore water quality and reduce the probability of nuisance algal blooms. Findings from this evaluation indicate that reducing P loading from the direct watershed of North Pond alone will not achieve desired water quality conditions. Therefore, additional actions are needed to inactivate P in the lake's sediments (internal load).

WATER QUALITY GOAL

North Pond exhibits improving water quality trends & reduced frequency of algal blooms

Current In-Lake Concentration= 19 ppb
In-Lake Phosphorus Goal= 10 ppb
Reduction In-Lake Concentration= 9 ppb

What P load reductions are needed to meet the goal?

"P" REDUCTIONS NEEDED

Direct Watershed: - 90 kg/yr
- 58 kg/yr direct watershed
- 32 kg/yr septic systems

Internal Load: - 872kg/yr
90% reduction of internal load

Timeframe: 2024- 2033

Projects: Erosion Control BMPs, LakeSmart, Septic Upgrades, Aluminum Treatment

A total P load reduction of 962 kg/yr is needed to achieve the water quality goal of 10 ppb set for this plan. This includes reducing the P load by 58 kg/yr from the watershed of North Pond, 32 kg/yr from septic systems, and 872 kg/yr by addressing the internal P load. These reductions are expected to **reduce the average in-lake total P concentration in North Pond by 9 ppb (currently at 19 ppb), reduce bloom probability by 30% to just 1%, and increase water clarity by more than 5 ft.** Achieving this goal will be a challenge and requires that the two primary P reduction strategies described above are completed simultaneously to be successful.

What actions are needed to achieve the goal?

The North Pond WBMP outlines 115 individual action items within six core planning categories to achieve the water quality goal. Planning recommendations, developed with input from the project's steering committee, are outlined in the plan. The action plan provides current, science-based solutions for restoring the water quality in North Pond while simultaneously promoting communication between watershed groups, municipalities, residents, business owners, and agricultural landowners. The action plan outlines pollution reduction targets, responsible parties, potential funding sources, approximate costs, and an implementation schedule for each task within each of the six categories.

How will the plan be funded?

The 2023 North Pond WBMP is expected to cost **$3.17M over a 10-year period.** Therefore, a sustainable funding strategy is needed within the first year that includes diverse funding sources. The majority of fundraising will be completed by NPA with support from watershed partners. The combined resources of state, federal, and local grants and contributions from and participation by municipalities, private landowners, and lake association members will be needed to support this monumental restoration effort.[1] The funding strategy will be revisited on at least an annual basis by an engaged steering committee. The action plan (Sections 7 & 8) is divided into the following six major planning objectives along with estimated load reductions and estimated costs to complete the work:

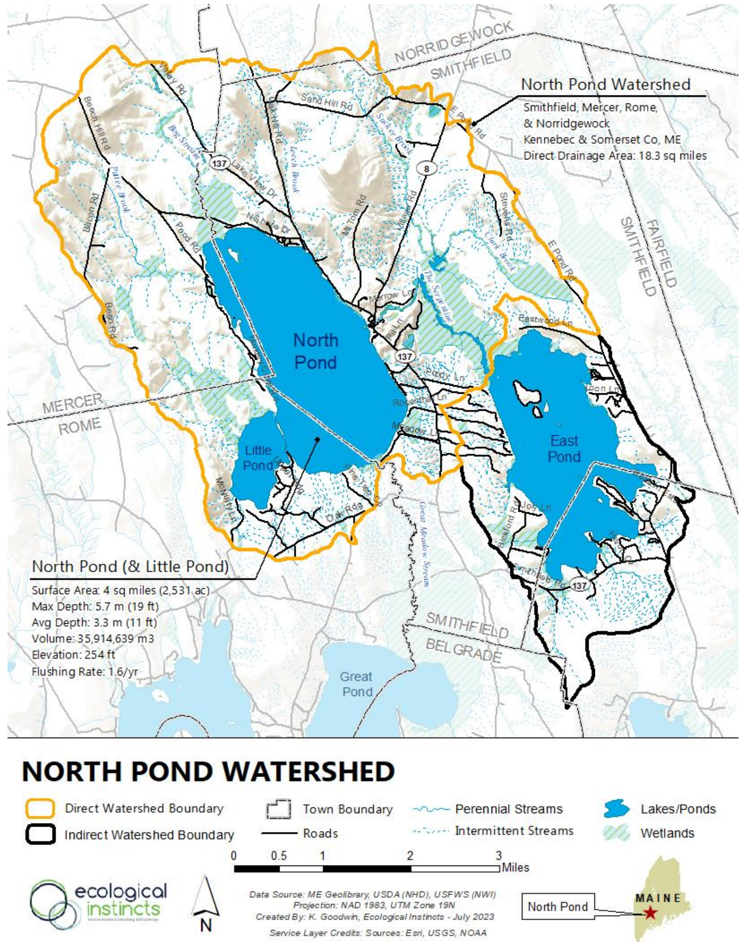
Planning Objective	Planning Action (2022-2032)	P Load Reduction Target	Cost
A	**Reduce the External P Load** (NPS sites, septic systems, LakeSmart, buffer campaign, upstream watersheds)	90 kg/yr	$1,180,500
B	**Reduce the Internal P Load** (Sediment testing, permitting, aluminum treatment)	872 kg/yr	$1,323,900
C	**Reduce New Sources of NPS Pollution** (NPS sites, land conservation, ordinances, enforcement, climate change adaptation)	n/a	$331,000
D	**Education, Outreach & Communications** (Public meetings, town meetings, online videos, aluminum treatment outreach, targeted outreach, workshops)	n/a	$81,600
E	**Build Local Capacity** (Funding plan, steering committee, grant writing, relationship building- including town government, contractors and scientists)	n/a	$74,000
F	**Long-Term Monitoring & Assessment** (Baseline monitoring, NPS pollution, streams/dam monitoring, invasive plants, etc.)	n/a	$178,500
	TOTAL	**962 kg/yr**	**$3,169,500**

How will success be measured?

Environmental, social, and programmatic milestones were developed to reflect how well implementation activities are working and provide a means by which to track progress toward the established goals (Section 9). The steering committee will review the milestones on an annual basis, at a minimum, to determine if progress is being made, and will then determine if the watershed plan needs to be revised if the targets, including decreasing P concentration or reduction in algal blooms, are not being met.

[1] Preliminary estimates suggest that approximately 40% of the cost of implementing the action plan will come from outside grant sources, 50% from local sources, and 10% from in-kind volunteer efforts.

THE LAKE & WATERSHED



North Pond (MIDAS 5344)[2], including Little Pond, is a 2,531-acre lake (Class GPA)[3] located in Kennebec and Somerset Counties in the central Maine towns of Rome (Kennebec County), Mercer and Smithfield (Somerset County). North Pond is the second lake in the seven-lake Belgrade China of Lakes. Little Pond (aka Little North Pond) is located on the southwest end of the lake, connected by a shallow channel known as "the Narrows". The watershed is located in four towns including Smithfield (57%), Mercer (28%), Rome (14%) and Norridgewock (1%)

North Pond is relatively shallow with a maximum depth of 5.7 m (19 ft), an average depth of 3.6 m (12 ft). The flushing rate of 1.6 flushes/year is slightly higher than the average for Maine lakes of 1-1.5 flushes/yr. The deepest location in the lake is offshore of the outlet of the Serpentine near downtown Smithfield on the eastern shore.

Major tributaries in the North Pond include Pattee Brook, Bog Stream, Leech Brook, and Bog Stream on the north end of the lake, as well as the Serpentine Stream to the east, which drains Sucker Brook and Clark Brook on the east side of the watershed. In addition to the major tributaries, numerous unnamed perennial and intermittent streams flow into the lake across the watershed. East Pond, an indirect watershed, drains into North Pond through the Serpentine. The direct North Pond watershed includes 123 miles of streams, 1,415 acres of wetlands, and 3,328 acres of riparian habitat bordering lakes, ponds, streams, and wetlands.

Water level in North Pond is controlled by natural precipitation and evaporation, and through management of the dam on Mill Stream (between the Serpentine and North Pond controlling flow from East Pond) and a dam at the outlet of North Pond on Great Meadow Stream which flows to Great Pond. Great Pond flows into Long Pond, then to Messalonskee Lake and to the Kennebec River via Messalonskee Stream, eventually

[2] The unique 4-digit code assigned to a lake.

[3] Defined by MRSA Title 38 §465-A, Maine Standards for Classification of Lakes and Ponds: Class GPA is the sole classification of Great Ponds (>10 acres) and natural lakes and ponds <10 acres in size.

flowing into the Gulf of Maine. Elevation in the watershed ranges from 254 ft above sea level (lake level) to 743 ft in the north end of the watershed (Mt. Tom).

What is the current status of development in the watershed?

Out of the 465 shoreline lots on North Pond, an estimated 351 are developed. Of these, 90% are estimated to be within 100 feet of the lake and a third are estimated to be used seasonally (<90 days/year), although this number is predicted to have risen since 2020 due to the global pandemic.

An updated land cover analysis for the North Pond watershed shows that forestland makes up the majority of the watershed area (71%), followed by wetlands and open water (not including the surface area of North Pond) at 15%. Developed land (e.g., residential, commercial, roads) accounts for approximately 7% of the land area in the watershed, while agriculture accounts for another 7%.

The lake is surrounded by a network of roads including 24 miles of state, town, and private roads including two major state roads numerous town roads, and many unpaved gravel roads that service high-density residential development along the shoreline. Paved town and state roads in the watershed include Lake View Drive (Rt. 137) that provides access to the northeastern shore, Village Road (Rt. 8/137) to the southeast, as well as Pond Road and North Pond Road that provide access to private roads along the western and southern shoreline respectively, along with several other paved roads that cross the upper watershed. Commercial development in the watershed includes a narrow band of development in downtown Smithfield including a large gravel operation. A large commercial summer camp is located on the south shore near the outlet in Rome.

Public access to North Pond is available at the state-owned boat launch in Smithfield. There are three small areas of conserved land in the watershed (including the public boat launch). The other two properties are under private easements.

The Problem

North Pond is listed on the **Maine DEP's NPS Priority Watersheds List as Threatened ("Watch List")**, due to development threats in the watershed and the sudden change in water quality that the lake has experienced over the past five years, placing the lake on the threshold of impairment. In addition to North Pond being listed on the State's NPS Priority watersheds list as threatened Lake, North Pond is also listed as "Most at Risk from New Development" under Chapter 502 of the Maine Stormwater Law because of its sensitivity to eutrophication, and potential for internal recycling of phosphorus.

An aerial image view of North Pond (left) and Little North Pond (right) during an algal bloom on North Pond in 2022. (Photo Credit: Alex Wall)

North Pond has has been experiencing occasional algal blooms since the 1990s, but has experienced a **steep**

decline in water quality beginning in 2018. Between 2018-2022, the lake experienced severe algal blooms each summer despite not having a bloom since 2010 indicating that the lake had reached its “tipping point”, meaning there is too much phosphorus in the lake. Water quality data collected in North Pond indicates that the potential for recurring annual nuisance algal blooms is high and is driven by both external sources of phosphorus from the watershed, and by internal phosphorus loading from the sediments in the summer during short periods of thermal stratification leading to low levels of dissolved oxygen (anoxia) at the sediment-water interface, and the ensuing release of P from the sediments that fuels algae growth.

The North Pond watershed has historically included large areas of agricultural, residential, and commercial development delivering nonpoint source (NPS) pollution including soil erosion, fertilizer, and animal waste into the lake over many decades. Though some historical sources of pollution have been minimized, including a decline in large agricultural operations, legacy pollutants that have built up in the lake’s bottom sediments combined with current sources of NPS pollution on hobby farms, forestry activities, residential shoreline development, commercial development, and roads remain a threat to water quality.

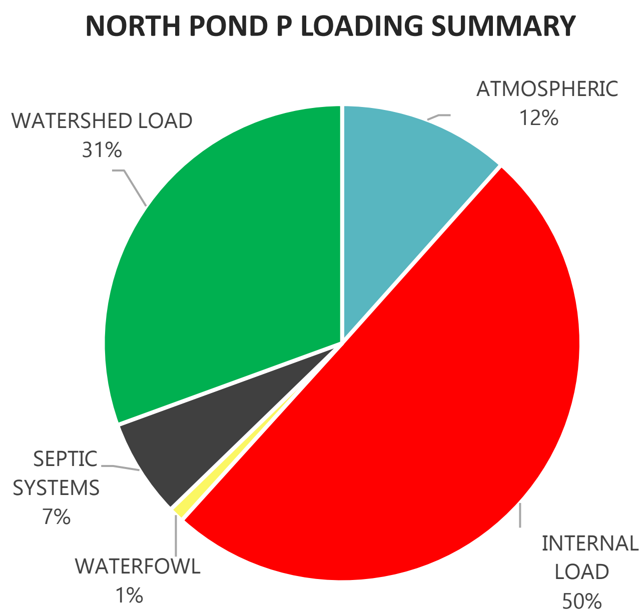
Water quality data have been collected consistently at the deepest location in the lake since 1970. In 2022, intensive monitoring was completed for the WBMP update by 7 Lakes Alliance and Colby College. Both recent and historical data were used to conduct a water quality trend analysis for North Pond including long-term (1970 – 2020), and short-term (10-year trend- 2013-2022) trends. Data collected over the last five years (2018-2022) and pre-2018 data were compared to examine differences in water quality conditions since the shift in water quality conditions in 2018. Results of this analysis indicate:

- ☐ **Current average annual water clarity, Chl-a and TP classify as eutrophic, with huge shifts in all three parameters since 2018** which will continue unless actions are taken to prevent P loading in the lake.
- ☐ **Minimum water clarity readings were less than 2 m** (depth threshold indicating a nuisance algal bloom is occurring) in 9 of the last 42 years of data collection (21%). Of the nine years with readings below 2 m, four occurred within the last 5 years (since 2018). Water clarity readings <2 m typically begin in mid-July to early August, with the lowest readings in mid-August corresponding with warmer water temperature and low dissolved oxygen levels at the bottom of the lake. Average water clarity has shifted from 4.1 m prior to 2018 when algal blooms began occurring regularly to 3.2 m since 2018, representing close to a 1 m decrease in clarity since 2018. Despite this observation, no significant trends were observed over either the full-time period or the past 10 years. However, decadal medians show the worst readings in the 2020s.
- ☐ **Chlorophyll-a concentrations have been increasing** in North Pond since 1978 with a weak increasing trend since 1978, and a strong increasing trend over the past 10 years. Chl-a provides a relative estimate of algal biomass in the lake (higher Chl-a equates to more algae) meaning that there is more algae in North Pond now than ever before. Average annual Chl-a over the past five years has increased by more than 6 ppb compared to the pre-2018 average.

- ☐ **Total phosphorus concentrations have increased** by an average of 5 ppb over the past five years (from 17 ppb to 22.2 ppb) compared to the pre-2018 annual average with a weak significant increasing trend in epilimnetic TP over the long-term, but no trend over the last 10 years.
- ☐ **Water temperature data signals a weak but significant increase in surface water temperatures** driven by an increase in August surface water temperature, coinciding with a trend of warmer summer temperatures across Maine. `
- ☐ **Low levels of dissolved oxygen have been documented for short periods at depths of 4 m and deeper in July and August** resulting in the release of stored P in bottom sediments into the water column and providing food for bottom-dwelling cyanobacteria that carry P up into the water column resulting in cycles of algal growth caused by internal P loading. North Pond does not strongly stratify which means that both oxygen and water temperature remain fairly stable from the surface to the bottom for most of the open water season depending on weather conditions.
- ☐ **Of particular concern are the potential effects to public health from toxins produced by cyanobacteria** (blue-green algae) that have been documented in North Pond. To date however, the cyanobacteria driving algal blooms in the lake are not currently producing microcystin at a level that could pose a risk to the health of watershed residents.

What are the primary sources of P?

Watershed modeling was used to estimate current sources of P in North Pond. The model estimates a total P load of 1,933 kg to North Pond annually. P loading from the watershed accounts for 31% of the total P load. Internal loading is estimated to be the largest source of P in North Pond at 50% of the load (right). Atmospheric deposition, waterfowl, and septic systems account for the remaining 20% of the P load.[4]



Watershed modeling was also used to estimate pre-development water quality conditions in North Pond. The results of this analysis indicate that North Pond is a naturally oligotrophic lake (low productivity) with an estimated in-lake TP concentration of 4 ppb. Changes in the landscape for agriculture, forestry, and residential and commercial development in the watershed and on the shoreline have resulted in a reduction in the lake's natural flushing rate, a doubling of the watershed's natural P load, and an increase in the concentration of P in the lake by more than triple background conditions (10-year average TP is 19 ppb). Setting a realistic water quality target that is closer to pre-development conditions will be a

[4] P loading estimates could vary by plus or minus 10-20% among years as a function of weather and measurement limitations.

challenge that will require significant effort to address all sources of P given the present level of development in the watershed.

Why do we need to address nonpoint source pollution?

NPS pollution stemming from developed land in the watershed including active agriculture and forestry, residential development and commercial development (shoreline and non-shoreline development) and the roads, driveways, and septic systems that serve them, are the most significant threat to the water quality of North Pond. Combined, these sources of P account for 38% of the current P load to the lake. Addressing NPS pollution from watershed sources is an important part of a multi-step, multi-year process to restore the current state of water quality in North Pond.

The 2022 watershed survey update completed by 7 Lakes Alliance identified:

- ☐ **91 sites** across the watershed that are current sources of P to the lake across nine different land uses.
- ☐ Only seven sites were ranked **high impact**, with six of the seven on residential properties (86%).
- ☐ **Residential NPS sites** also accounted for the greatest number of sites, accounting for 49% of all sites, including 27% of medium and 62% of low-impact sites.
- ☐ **Private roads** account for the greatest number of sites behind residential sites making up 29% of all NPS sites and 36% of medium impact sites. Town roads and driveways account for an additional 15% of all NPS sites.

The action plan includes strategies for **reducing the watershed load by 10%** which includes addressing seven high impact, 37 medium impact, and 47 low impact NPS sites over the next 10 years. The plan also targets **P reductions on agricultural land and active timber harvests as well as taking steps to mitigate impacts from "at-risk" septic systems**- specifically the 166 parcels likely to have a septic system on sensitive soils within the shoreland zone of North Pond that could result in short-circuiting of the leach field and may be contributing excess P to the lake via groundwater. The action plan recommends continuing to encourage shorefront property owners to participate in the LakeSmart program, with a **goal of 50 new LakeSmart evaluations completed** by 2033.

Lack of shoreline buffers and fertilizer use results in delivery of phosphorus to North Pond.

Why do we need to address internal P loading?

Addressing watershed sources alone will not be enough to prevent recurring nuisance algal blooms in the lake but is one part of a larger effort to meet water quality goals to improve water quality. The plan must also include actions to address internal loading from sediments exposed to low oxygen; estimated at 50% of the P load, and a key factor in the dynamics causing elevated P in the lake during the summer. Importantly, decreasing P concentrations in North Pond will help reduce the probability of toxic blue-green algal blooms by providing less food for these P loving species. Adequate P reductions to significantly reduce the probability of algal blooms can't be achieved without also addressing the internal P load. An aluminum treatment will provide immediate relief from recurring nuisance algal blooms while ongoing watershed work is underway. **The action plan includes strategies for reducing the internal P load by 90%.**

What about future development & climate change?

Between 2010-2020 two of the four towns in the watershed (Rome and Mercer) experienced population growth that far exceeded the growth rates for Kennebec and Somerset Counties and the State of Maine. In fact, Mercer's population grew by more than twice the state rate and triple the rate for Somerset County, while Rome's population growth was 4.5 times the state rate and 14 times the rate for Kennebec County. As water quality in the lake improves, North Pond will continue to be an even more desirable place to live and to visit, resulting in new development on the shoreline and throughout the watershed.

Preventing new sources of P from getting into the lake is imperative to the success of the WBMP. Future development is estimated to increase the in-lake P concentration by 0.5 ppb. Climate change will only exacerbate the problem by increasing P loading by another 0.5 ppb. Combined, climate change and future development scenarios are expected to result in as much new P being added to the lake as needs to be reduced in the watershed. In other words, **if nothing is done to adapt to climate change and prevent new sources of P from getting into the lake, then much of the effort to reduce existing sources of P may be offset, and goals may not be achieved**. Prevention strategies will need to include more robust municipal planning and enforcement, ongoing public education, land conservation, and climate mitigation strategies.

Administering The Plan

The North Pond WBMP provides a framework for restoring water quality and preventing further water quality declines in North Pond so that the lake meets state water quality standards. The plan will be led by NPA with guidance and support from a watershed steering committee comprised of NPA, 7 Lakes Alliance, Maine DEP, KCSWCD and SCSWCD, USDA/NRCS, the towns of Smithfield, Rome, and Mercer, local businesses, and landowners. The formation of subcommittees that focus on the six main watershed action categories will result in more efficient implementation of the plan.

Incorporating US EPA's 9 Elements

The US EPA has identified nine key elements that are critical for achieving improvements in water quality. An approved nine-element plan is a prerequisite for future federally funded work in impaired watersheds. The nine elements are designed to provide a robust framework by which to restore waters impaired by NPS pollution through characterization of the watershed, partnership building, development of an implementation plan (actions, schedule, costs), goal setting, and monitoring. The nine elements can be found in the following locations within the North Pond WBMP.

Planning Element	WBMP Section	Description
a) Identify Causes & Sources	Section 1	Highlights current programs and research that have helped frame the water quality problem.
	Section 2	Describes the characteristics of the lake and watershed that have contributed to the changes in water quality.
	Section 3	Provides an analysis of water quality data to describe changes in water quality.
	Section 4	Provides an estimate of watershed loading including current and future sources of NPS pollution.
	Section 7 & Appx. E	Summarizes current NPS sites in the North Pond watershed.
b) Estimated P Load Reductions expected from Planned Management Measures	Sections 4 & 6 & Appx. D	Provides an overview of water quality and phosphorus (P) reduction targets to reduce annual P loading to North Pond from both external loading (watershed sources) and internal loading (in-lake sources) over the next ten years and methods used to estimate P reductions.
c) Description of Management Measures	Sections 6, 7 and 8	Identifies ways to achieve the estimated P load reduction and reach water quality targets described in (g) below. The action plan covers six major topic areas that focus on NPS pollution, including: reducing the watershed load, addressing the internal load, preventing new sources of P, education and outreach, building local capacity, and conducting long-term monitoring and assessment.
d) Estimate of Technical and Financial Assistance	Sections 7 - 10	Provides a description of the associated costs, sources of funding, and organizations responsible for plan implementation. The estimated cost to address NPS pollution and reduce P in North Pond is estimated at $3.17M over the next ten years.
e) Information & Education & Outreach	Section 7	Describes how the education and outreach component of the plan should be implemented to enhance public understanding of the project. This includes leadership from watershed partners to promote lake/watershed stewardship.
f) Schedule for Addressing the NPS Management Measures	Sections 7 & 8	Provides a list of strategies and a set schedule that defines the timeline for each action. The schedule should be reviewed and adjusted by the steering committee on at least an annual basis.
g) Description of Interim Measurable Milestones	Section 9 (Tables 15 & 16)	Lists milestones that measure implementation success that will be tracked annually, makes the plan relevant, and helps promote implementation of action items. The milestones are broken down into two different categories: programmatic and social.

Planning Element	WBMP Section	Description
h) Set of criteria	Section 9 (Table 14)	Provides a list of criteria and benchmarks for determining whether load reductions are being achieved over time, and if substantial progress is being made towards water quality objectives. Environmental milestones are a direct measure of environmental conditions, such as improvement a decrease in phosphorus concentrations to help determine whether this plan needs to be revised.
i) Monitoring Component	Section 8	Provides a description of planned monitoring activities for North Pond to evaluate the effectiveness of implementation efforts over time as measured against the criteria in (h) above.

1. Background

A blue-green algae bloom on the shoreline of North Pond. Photo Credit: Jodie Mosher-Towle

North Pond, located in Smithfield, Mercer, and Rome, Maine (Figure 1) has been experiencing occasional algal blooms since the 1990s, but experienced a steep decline in water quality beginning in 2018. Between 2018-2022, the lake experienced severe algal blooms each summer. North Pond is on the **Maine DEP NPS Priority Watersheds List as Threatened ("Watch List")**, due to development threats in the watershed and the sudden change in water quality that the lake has experienced over the past five years, placing the lake on the threshold of impairment. In addition to North Pond being listed on the State's NPS Priority watersheds list as threatened, North Pond is also listed as **"Most at Risk from New Development"** under Chapter 502 of the Maine Stormwater Law because of its sensitivity to eutrophication, and potential for internal recycling of phosphorus. East Pond,[5] which flows into North Pond as part of its greater watershed, is listed as impaired, along with downstream lakes including Great Pond and Long Pond.

The North Pond watershed has historically included large areas of agricultural, residential, and commercial development, providing sources of nonpoint source (NPS) pollutants stemming from stormwater runoff, soil erosion, fertilizers, and animal waste, among other pollutants. Phosphorus (P) (and other pollutants) from NPS pollution has washed into the lake, which has resulted in a build-up of P in lake sediments over time, increasing the concentration of P in the lake, and providing a healthy food supply for algae in the lake. North Pond is currently threatened by NPS pollution from development, including agriculture, timber harvesting, residential and commercial development, and roads, and is subject to internal P loading from the sediments.

In 2016, a watershed survey was conducted to identify high-priority NPS pollution sites in the watershed (Ecological Instincts, 2017a). This survey was followed by the development of a Watershed-Based Protection Plan for North Pond which set goals for addressing the identified NPS sites and protecting water quality in the lake from 2017-2026 (Ecological Instincts, 2017b). Between 2017- 2023, 7 Lakes Alliance (7 Lakes) has worked collaboratively with the North Pond Association (NPA) Maine Department of Environmental Protection (DEP), Maine Department of Transportation (DOT), United States Department of Agriculture's Natural Resources Conservation Service (USDA/NRCS), and other partners to complete three phases of watershed improvement projects, funded partly by the United States Environmental Protection Agency's (US EPA) Clean Water Act (CWA) Section 319 funding. Along with installing best management

[5] East Pond received an aluminum treatment in 2018 after decades of algae blooms triggered by internal phosphorus loading.

practices (BMPs) at NPS sites throughout the watershed, these projects aimed to build local support for protecting North Pond through education and outreach. A fourth phase of watershed restoration work is planned for 2024-2025.

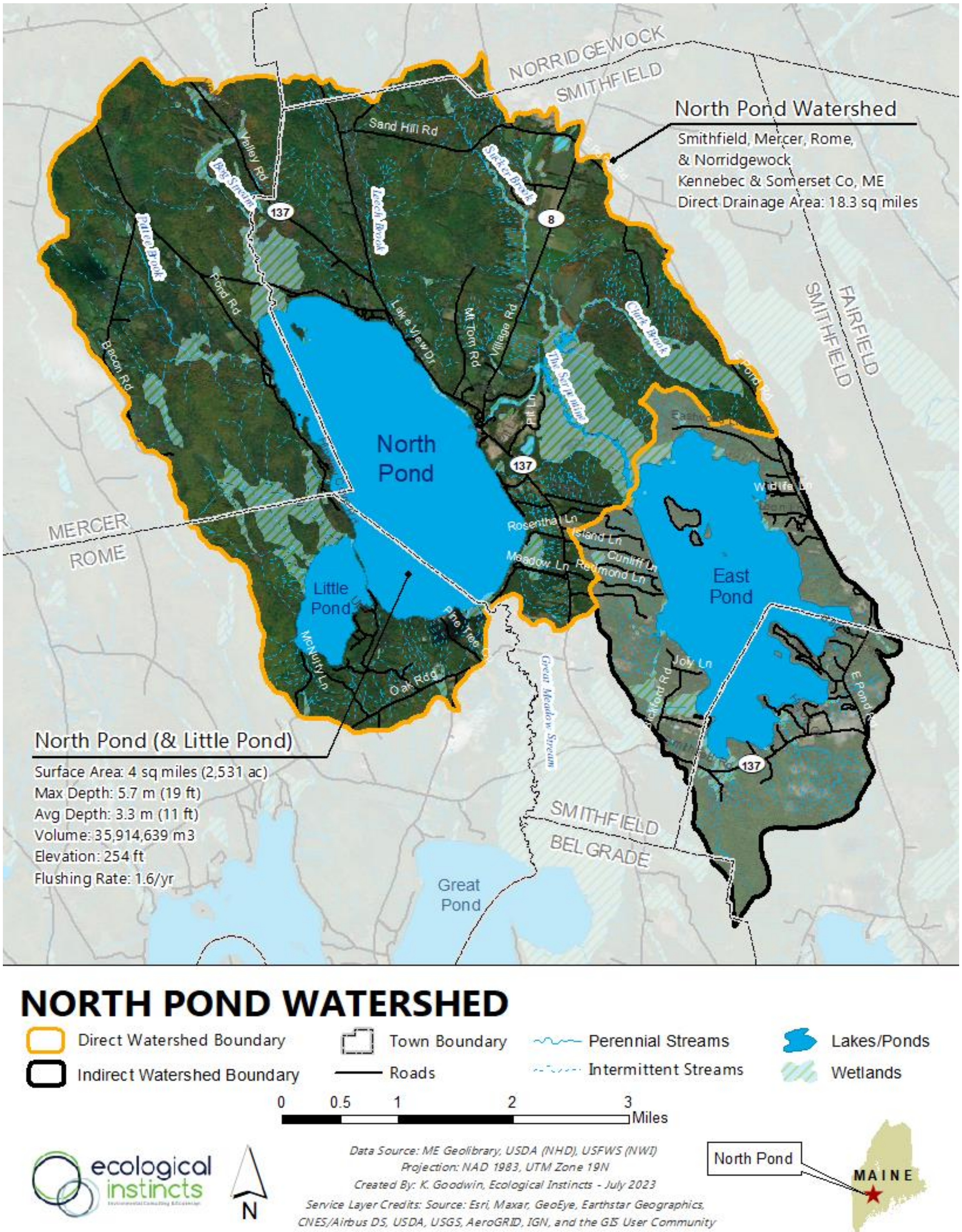


Figure 1. *Map of the North Pond direct and indirect (East Pond) watershed.*

The sharp decline in water quality beginning in 2018 spurred the need for a more in-depth analysis of current watershed and in-lake conditions. Development of the North Pond Watershed-Based Management Plan (WBMP) in 2022-2023 included a water quality trend analysis utilizing the most current data available, watershed modeling (including an internal loading analysis), bathymetric mapping, sediment analysis, a watershed survey update, septic system survey, septic vulnerability analysis, development of updated watershed maps, multiple steering committee and technical advisory committee meetings to develop an updated action plan, and a public meeting to inform the community about the state of water quality and actions needed to restore water quality over the next 10 years. Since P is the nutrient driving poor water quality in the lake, it was used as the primary parameter for setting the water quality goal.

PURPOSE

The North Pond WBMP provides details about current water quality conditions, watershed characteristics, and steps that can be taken to restore water quality in the lake over the next 10 years and is estimated to cost $3.17 million to complete through a combination of state, federal and local contributions over this time period. The plan outlines management strategies and an activity schedule (2024 – 2033), establishes water quality goals and objectives, and describes actions needed to achieve these goals. This includes strategies to:

1. **Reduce the external phosphorus load** by addressing NPS pollution from soil erosion and stormwater runoff on developed land, agriculture, and forestry, and improving septic systems;
2. **Reduce the internal phosphorus load** through inactivation of P in bottom sediments;
3. **Reduce new sources** of NPS pollution from getting into North Pond by improving and enforcing municipal ordinances, increasing land conservation efforts, conducting regular road maintenance, and offsetting the effects of future development and climate change;
4. **Raise public awareness** about lake restoration strategies by increasing local education, outreach, and communication efforts through targeted outreach and workshops to increase participation among municipalities and watershed residents;
5. **Build local capacity** through partnership building across multiple community groups, engaging steering committee members, and developing a robust fundraising strategy;
6. **Monitor and assess improvements** in North Pond's water quality over time. This includes annual baseline monitoring, plankton and cyanobacteria monitoring, tracking NPS pollution, stream monitoring, and monitoring for invasive aquatic plants.

WATERSHED PLANNING GOALS

(2024-2033)

1. **REDUCE P INPUTS FROM DEVELOPED LAND IN THE WATERSHED**
2. **REDUCE P FROM INTERNAL LOADING IN THE LAKE**
3. **REDUCE THE PROBABILITY OF ALGAL BLOOMS**
4. **IMPROVING WATER QUALITY TRENDS**

STATEMENT OF GOAL

The goal of this plan is to restore water quality in North Pond by reducing phosphorus inputs to the lake from the direct watershed (external load) and in-lake sources (internal load). Planning recommendations include reducing the phosphorus load by 962 kg/yr thereby reducing the average annual in-lake phosphorus concentration by 9 ppb over the next 10 years.

PLAN DEVELOPMENT & COMMUNITY PARTICIPATION

The North Pond WBMP was developed with input from a diverse group of local stakeholders and scientists over a period of two years (2022-2023). Plan recommendations are the result of multiple steering committee meetings, technical advisory committee meetings and numerous subcommittee meetings (outreach, septic systems, and water quality). The plan update was led by Ecological Instincts (project manager) in partnership with KCSWCD (grantee), 7 Lakes, Colby College, KVCOG, SCSWCD, the towns of Smithfield, Rome, and Mercer, and Maine DEP. Technical support was provided by Ecological Instincts and Water Resource Services (WRS, Inc.).

Community participation included two public presentations at NPA annual meetings (August 2022 & 2023) and a hybrid public meeting on July 24, 2023 to present the North Pond WBMP viewed by 125 attendees including 75 in-person attendees at the Smithfield town office, and 50 online attendees via Zoom webinar. NPA members were notified of the meeting by email in addition to Facebook and newspaper announcements. The meeting highlighted the history of water quality and watershed planning efforts in the watershed as well current water quality trends and recommended actions needed to restore water quality. The public meeting Q&A was emailed to meeting participants, posted on the NPA website, and is also provided in Appendix A.

WATERSHED PROJECTS, PROGRAMS & RESEARCH

North Pond is at the center of ongoing scientific research and monitoring as a result of many years of private/public partnerships involving numerous watershed partners effectively working together to document and understand the changes in the lake's water quality and to identify the best ways to protect it. A list of recent and/or relevant watershed projects is presented below.

PLANNING/RESEARCH

(2016) North Pond Watershed NPS Survey – NPA conducted a watershed survey to document current sources of NPS pollution in the North Pond watershed. The survey identified 135 erosion sites on ten different land-use types throughout the watershed.

(2017) North Pond Watershed-Based Protection Plan- Using information gathered during the 2016 watershed survey, NPA developed a Watershed-Based Protection Plan (WBPP) for North Pond which set a goal of remediating 113 sites identified during the watershed survey. The plan did not include in-depth estimates of sources of P to North Pond and did not quantify internal loading or septic system inputs.

CLEAN WATER ACT SECTION 319 FUNDS

Since 2018, three CWA Section 319 implementation grants (Phases I, II, and III) have supported town road, private road, public access, and residential shoreline improvement projects in the North Pond watershed. These projects were estimated to have reduced annual pollutant loading to the lake by more than 542 tons of sediment and 460 pounds (207 kg) of P. Education and outreach to watershed residents and local stakeholders was also completed as part of these restoration projects, including hosting a buffer and gravel road workshops.

LAKESMART

A LakeSmart program was initiated by NPA in 2013 to provide technical assistance to landowners looking to reduce their lakeshore properties' impact on water quality. The program is currently run by 7 Lakes Alliance and continues to provide regular technical assistance with support from Maine Lakes. Since 2020, 13 awards and 24 commendations have been issued in the North Pond watershed. Property owners that make improvements to their property are helping reduce stormwater runoff (and resulting phosphorus) into the lake as well as improving wildlife habitat.

YOUTH CONSERVATION CORPS (YCC)

7 Lakes runs a Youth Conservation Corps (YCC) program that has been active in the North Pond watershed since 1996. The program provides low-cost installation for landowners looking to install BMPs on their properties. Since 2017, a total of 25 YCC projects have been completed in the North Pond watershed.

PUBLIC OUTREACH

NPA and 7 Lakes are the primary entities conducting public outreach in the watershed. NPA hosts an annual meeting each summer for all interested watershed residents, provides watershed updates on its website and Facebook page (1,500 followers), and distributes two annual newsletters to 476 watershed residents through direct mailings and emails as well as distribution of the newsletter at local establishments. 7 Lakes serves as the regional coordinator for the LakeSmart program and the Courtesy Boat Inspection (CBI) program, with support from NPA and the towns of Mercer, Rome, and Smithfield. The CBI program began in 2000 and operates with paid staff conducting approximately 900 inspections annually at the public boat launch from Memorial Day to Labor Day. General and targeted outreach and education activities recommended for the next 10 years are presented in Section 7.

WATER QUALITY MONITORING

Water quality data have been collected at North Pond by Maine DEP and Lake Stewards of Maine Volunteer Lake Monitoring Program since 1970 in the deepest part of the lake (Station 1). Additional data has been collected by Colby College and 7 Lakes starting in 2015 as part of a three-year intensive water quality monitoring initiative in the Belgrade Lakes, and ongoing from 2018-present. Data was collected by 7 Lakes and Colby College at Little North Pond beginning in 2020. Water quality will be discussed in Section 3.

2. Lake & Watershed Characteristics

Photo Credit: Jodie Mosher-Towle

LAKE & WATERSHED FACTS

Watershed Towns:	**Rome, Mercer, Smithfield, & Norridgewock, ME**
Watershed Area:	**18.3 mi^2**
Surface Area:	**4 mi^2 (2,531 acres)**
Max Depth:	**19 ft (5.7 m)**
Mean Depth:	**12 ft (3.6 m)**
Flushing Rate:	**1.63 flushes/yr[8]**
Lake Elevation:	**254 ft**
Peak Elevation:	**742 ft**
Avg. Clarity:	**3.2 m**

North Pond (MIDAS 5344)[6], is a 2,531-acre lake (Class GPA)[7] located in Kennebec and Somerset Counties, in the central Maine towns of Rome (Kennebec County), Mercer and Smithfield (Somerset County) (Figure 2). North Pond is the second lake in the seven-lake Belgrade Chain of Lakes. Little Pond (aka Little North Pond) is located on the southwest end of the lake, connected by a shallow area known as "the Narrows". The watershed is located in four towns including Smithfield (57%), Mercer (28%), Rome (14%), and Norridgewock (1%).

North Pond is relatively shallow with a maximum depth of 5.7 m (19 ft), and an average depth of 3.6 m (12 ft). The flushing rate of 1.6 flushes/year is slightly higher than the average for Maine lakes of 1-1.5 flushes/yr. The deepest location in the lake is offshore of the outlet of the Serpentine near downtown Smithfield on the eastern shore.

Major tributaries in the North Pond watershed include Pattee Brook, Bog Stream, Leech Brook, and Bog Stream on the north end of the lake, as well as the Serpentine Stream to the east, which drains Sucker Brook and Clark Brook on the east side of the watershed. In addition to the major tributaries, numerous unnamed perennial and intermittent streams flow into the lake across the watershed. East Pond, an indirect watershed, drains into North Pond through the Serpentine.

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[6] The unique 4-digit code assigned to a lake.

[7] Defined by MRSA Title 38 §465-A, Maine Standards for Classification of Lakes and Ponds: Class GPA is the sole classification of Great Ponds (>10 acres) and natural lakes and ponds <10 acres in size.

[8] As calculated by the Lake Loading Response Model (LLRM) in 2023, described in Section 4.

The watershed at 18.3 square miles includes 123 miles of streams, 1,415 acres of wetlands, and 3,328 acres of riparian habitat bordering lakes, ponds, streams, and wetlands.

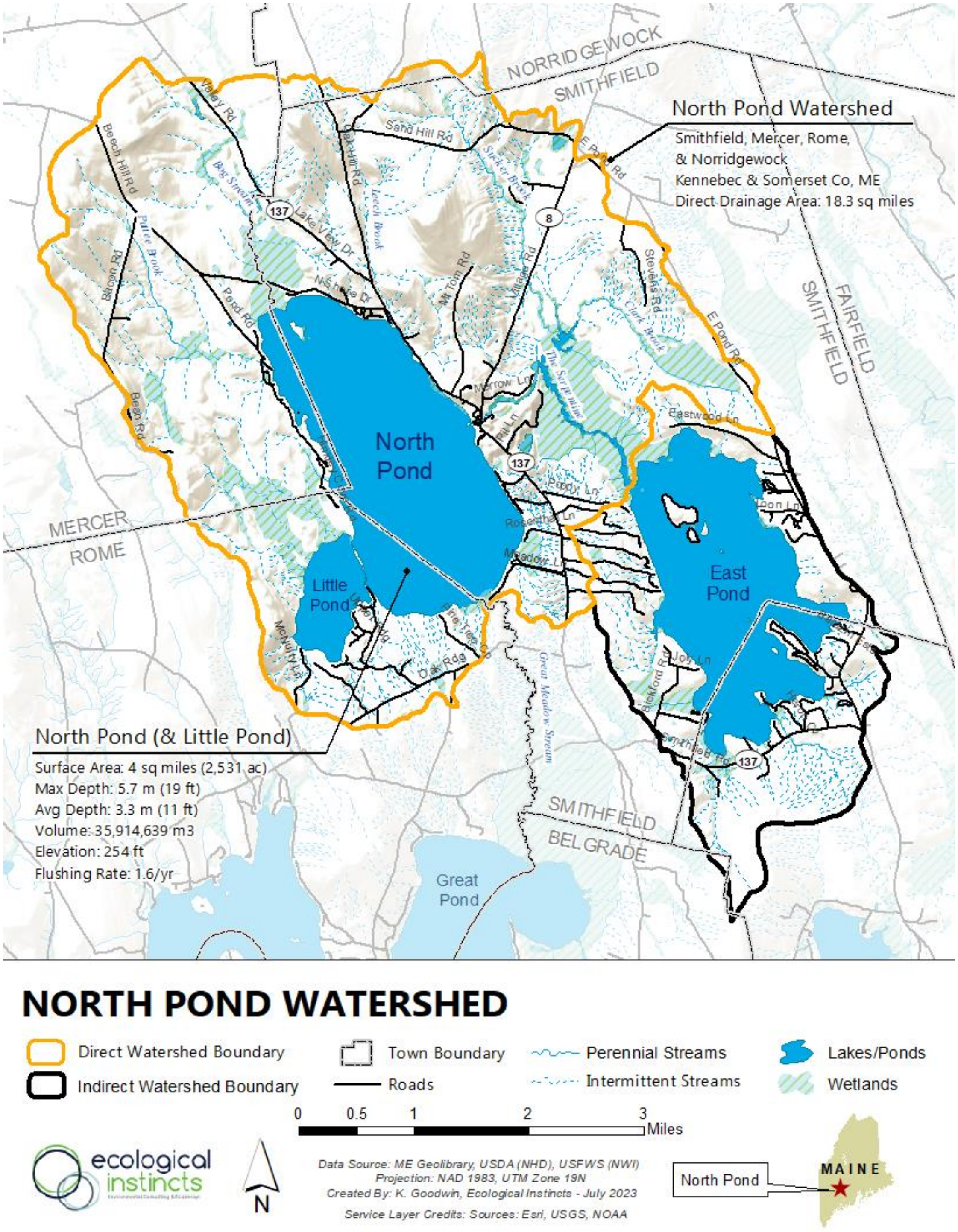


Figure 2. *Map of the North Pond direct and indirect watersheds.*

Water level in North Pond is controlled by natural fluctuations in precipitation and evaporation, and through management of the dam on Mill Stream (between the Serpentine and North Pond controlling flow from East Pond) and a dam at the outlet of North Pond on Great Meadow Stream which flows to Great

Pond. Great Pond flows into Long Pond, then to Messalonskee Lake and to the Kennebec River via Messalonskee Stream, eventually flowing into the Gulf of Maine. Elevation in the watershed ranges from 254 ft above sea level (lake level) to 743 ft in the north end of the watershed (Mt. Tom).

North Pond is listed on the state's 303(d) list of threatened lakes due to development threats and recent declines in water clarity making it likely to be listed as impaired in the future. Upstream East Pond is listed as impaired, along with downstream lakes including Great Pond and Long Pond. Of the 465 shoreline lots on North Pond, an estimated 351 are developed. Of these, 90% are estimated to be within 100 feet of the lake and a third are estimated to be used seasonally (<90 days/year), although this number is predicted to have risen since 2020 due to the global pandemic.

Residential development on North Pond's shoreline (Photo Credit: Jodie Mosher-Towle)

An updated land cover analysis for the North Pond watershed shows that forestland makes up the majority of the watershed area (71%), followed by wetlands and open water (not including the surface area of North Pond) at 15%. Developed land (e.g., residential, commercial, roads) accounts for approximately 7% of the land area in the watershed, while agriculture accounts for another 7%. There are 24 miles of roads in the watershed, many of which are unpaved gravel roads that service high-density residential development along the shoreline. Paved town and state roads in the watershed include Lake View Drive (Rt. 137) that provides access to the northeastern shore, Village Road (Rt. 8/137) to the southeast, Pond Road and North Pond Road that provide access to private roads along the western and southern shoreline respectively, along with several other paved roads that cross the upper watershed. Commercial development in the watershed includes a narrow band of development in downtown Smithfield including a large gravel operation. A large commercial summer camp is located on the south shore near the outlet in Rome.

Public access to North Pond is available at the state-owned boat launch in Smithfield. There are three small areas of conserved land in the watershed (including the public boat launch). The other two properties are under private easements.

POPULATION, GROWTH, & MUNICIPAL ORDINANCES

POPULATION

North Pond provides excellent recreational opportunities including swimming, fishing, and boating in the summer. Landowners, businesses, and watershed towns will likely see a monetary benefit from improved water quality over time as more seasonal and year-round residents are attracted to the lake. Factors such as increased property values will also improve the town's tax base. A study on 36 Maine lakes found that lakes with 1 m greater clarities have higher property values on the order of 2.6% - 6.5%. Similarly, lakes with a 1 m decrease in minimum transparencies cause property values to decrease anywhere from 3.1% to 8.5% (Boyle and Bouchard, 2003).

Population and demographics are important factors in watershed planning because large increases in unplanned population growth, and consequently development, could negatively affect water quality. Conversion of seasonal or second homes to year-round homes would result in a significant change in use on the shoreline, increasing the potential for more stormwater runoff and impacts from septic systems among other factors.

Paddleboarders on North Pond. (Photo Credit: Jodie Mosher-Towle)

According to the Maine Office of the State Economist, the population of Kennebec and Somerset Counties in 2020 was 123,642 and 152,199 respectively, representing a net increase in population by 2% in Kennebec County, and a 3% decrease in population in Somerset County since 2010 (Table 1). This is a lower rate of growth than the total population of the State of Maine, which increased by 3% between 2010 and 2020. The Maine State economist predicts that population growth for Kennebec County will continue into the future, predicting continued growth for Rome into 2025. Somerset County's population growth appears tumultuous as reflected in the array of growth rates across the three towns found in North Ponds watershed. These predictions consider 2020 census numbers and effects of the COVID-19 pandemic, which has changed patterns of migration throughout the US, enabling some people to work remotely and driving movement to more rural areas (O'Hara, 2020).

Between 2010 and 2020, the population in the towns of Rome and Mercer increased slightly, with the highest growth rate (14%) in Rome, while Smithfield and Norridgewock saw decreases in population with the lowest growth rate (-10%) in Smithfield (Maine State Economist, 2020b). The populations of the towns of Mercer and Norridgewock changed by just 7% and -3%, respectively. The populations of Mercer and Rome have grown faster than the State as a whole and faster than their respective counties –Kennebec and Somerset (Table 1).

Table 1. *Population demographics and 2023 projections for the towns of Mercer, Smithfield, Rome, and Norridgewock, Kennebec and Somerset Counties, and the State of Maine. (Source: Maine State Economist, 2020a)*

Town	Population				
	2010	2015	2020	Projected 2025	% Change 2010-2020
Mercer	664	686	709	738	7%
Smithfield	1,033	964	925	890	-10%
Rome	1,010	1,068	1,148	1,236	14%
Norridgewock	3,367	3,314	3,278	3,263	-3%
Kennebec County	122,151	121,483	123,642	126,211	1%
Somerset County	52,228	50,654	50,477	49,889	-3%
State of Maine	1,332,361	1,328,009	1,362,359	1,374,728	3%

These trends indicate that some towns in the watershed may develop more rapidly while others may experience decline. Population growth in some watershed towns (Rome and Mercer) is outpacing population decline, indicating an expected increase in watershed development as population growth continues. The amount of additional development may vary depending on the exact levels of population growth, the amount of land protected as open space, zoning and other regulations, and other socioeconomic factors.

MUNICIPAL ORDINANCES

Protecting natural resources starts with good municipal ordinances that meet or exceed the minimum state requirements. Ordinances that are up to date, provide clear consistent criteria and guidelines for development, and are adequately enforced provide the means by which to protect lake water quality through responsible development. As the watershed continues to develop over time, erosion from disturbed areas will deliver new and previously unaccounted for P into the lake, thereby affecting the success of planned management strategies to restore water quality.

Probably the most important ordinance for lake protection is administration and enforcement of local shoreland zoning regulations, required through the Mandatory Shoreland Zoning Act (MSZA). The State created Chapter 1000 Guidelines for Municipal Shoreland Zoning Ordinances[9] to provide guidance that towns can choose to use for their own ordinances, or as guidance for adopting more stringent ordinances- as long as they are equally or more effective in achieving the purposes of the MSZA.

***The shoreland zone** is defined as all land areas within 250 feet, horizontal distance, of the normal high-water line of any great pond or river, upland edge of a coastal wetland, including all areas affected by tidal action, upland edge of defined freshwater wetlands, and all land areas within 75 feet, horizontal distance, of the normal high-water line of certain streams.*

A review of municipal ordinances in Smithfield, Mercer and Rome was completed in September 2022 by the Kennebec Valley Council of Governments to determine if local ordinances were meeting the mininum requirements of the MSZA and to identify areas where towns could improve ordinances to be more protective of water quality (KVCOG, 2022). Follow-up presentations were made to each town between December 2022 and July 2023 to present the outcomes of the review.

- **Smithfield**, which makes up the largest area of the watershed and the largest lake area, has an up-to-date SLZ ordinance (2022) as well as several other ordinances that help protect water quality and were reviewed by KVCOG (Subdivision, Commercial- Industrial Site Review, Minimum Lot Size, Mobile Home Park, House Trailer Ordinances, Flood Plain). KVCOG made several recommendations to strengthen Smithfield's ordinances including addressing inconsistencies between ordinances, considering LID design criteria to the Subdivision and Commercial-Industrial Site Review ordinances, referencing the Maine Stormwater Management Design Manuals and Maine Erosion and Sediment

[9] A model regulation adopted in January 1988 and amended through January 2015.

Control Best Management Practices Manuals for all ordinances, digitizing all ordinances, maps, and related information and making them available online, digitizing and maintaining all permiting information (building and plumbing), and adding information about NPA on the town website as well as updating the town's Comprehensive Plan (last updated in 2004).

- **Mercer**, with the second highest population growth in the watershed over the last 10-year period has not adopted the State's most recently amended Model Shoreland Zoning Ordinance and should prioritize updating their ordinance to, at the very least, reflect the minimum requirements of the State's most recently amended SLZ Ordinance to ensure the utmost protection of the North Pond Watershed. Mercer also does not have construction or building guidelines or site plan review criteria of any kind to set parameters and encourage Best Managmeent Practices (BMPs) or Low Impact Development (LID) design for new construction. Other recommendations include updating the Mobile Home Park Ordinance, adding information on the town's website about NPA and watershed protection, and digitizing and maintaining all permitting information such as building and septic system permits.
- **Rome**, with highest population growth rate in the watershed over the last 10 year period, performed well in the ordinance review with an up-to-date SLZ Ordinance (2022) that met requirements of the State's model ordianance. Rome also had a Minimum Lot Size Ordinance (2021) that restricts building on land with slopes >20% within the SLZ, and a Commercial Development Review Ordinance (2003), a Subdivision Ordinance (2004), and a Floodplains Management Ordinance. KVOG provided several recommendations for improving Rome's ordinances including incorporating references to the Maine Stormwater Managment Design Manual, the addition of LID design standards to the Commercial Development and Subdivision Ordinances, addressing inconsistencies amongst ordinances, adding links on the town's website for NPA and 7 Lakes Alliance, and digitizing tax parcels, ordinances, maps, and permitting documents (building & plumbing).

Two of the four towns in the watershed have current shoreland zoning ordinances that meet the State's Chapter 1000 guidelines in 2015, while only Rome has a current Comprehensive Plan (Table 2).

Table 2*. Status of shoreland zoning and comprehensive plans in the four towns in the North Pond watershed, and percentage of the lake and watershed area in each town.*[10]

Town	% of Watershed Area	% of Lake Area	Current SLZ Ordinance?	Current Comprehensive Plan
Smithfield	57%	70%	Yes, March 2022	No
Mercer	28%	6%	No, March 2011	No
Rome	14%	24%	Yes, March 2022	In Progress, expected 2023
Norridgewock	1%	0%	No, March 2008	No

[10] Norridgewock was not included in the KVCOG municipal ordinance review due to the small amount of land located in the watershed.

Towns should consider working collaboratively to develop consistent ordinance language across the watershed.

Some examples of recommended municipal ordinance improvements recommended in this review include:

- Develop a standards manual detailing **Low Impact Development (LID)** requirements and options for all new construction projects, and add LID standards to the new and existing ordinances where acceptable.
- Include greater P controls required for all projects in the shoreland zone of impaired waterbodies such as the Maine DEP **per acre P allocations**.
- Develop a **watershed-wide P control ordinance** for all new development (including single family residential units, roads, and seasonal to year-round conversions).
- Incorporate/update references to the Maine Stormwater Management Design Manual Best Management Practices (Vol I & II) in existing development standards (Maine DEP 2016 & 2016a).
- **Digitize ordinances and related maps (tax parcels)** to make available to the public on town websites in a downloadable, printable format.
- Review whether current **staffing is adequate for enforcing existing ordinances** in all towns, and consider provisions for third party review and long-term maintenance as a requirement for all building permits.
- Develop a **Unified North Pond Watershed Regulation** that would result in a shared Code Enforcement Officer to consistently adminster and enforce regulations.

As described above, only one of the four towns in the watershed has a current Comprehensive Plan. Comprehensive Plans outline a municipalities' goals, priorities, and vision for natural and cultural resource conservation, transportation, and land use patterns. While not state-mandated, towns with current Comprehensive Plans have a leg up when applying for state and federal grants and have among other benefits. Comprehensive Plans can be helpful in bringing the community together for a common goal, creating a current inventory of natural resources, and providing the basis for making sound management decisions at the town level.

Example of shoreline development on North Pond. (Photo Credit: NPA)

As shown in Table 2, only Rome has a current Comprehensive Plan. Comprehensive Plans that are current and consistent with Maine's Growth Management Act[11] are listed on the Maine Department of Agriculture, Conservation & Forestry website.[12] Smithfield and Mercer

[11] 30-A MRSA, Chapter 187. Online: https://legislature.maine.gov/statutes/30-a/title30-Ach187sec0.html

[12] MDACF, Municipal Planning Assistance Program, https://www.maine.gov/dacf/municipalplanning/comp_plans/index.shtml

should consider updating and/or developing current Comprehensive Plans that incorporate actions needed to restore water quality in North Pond.

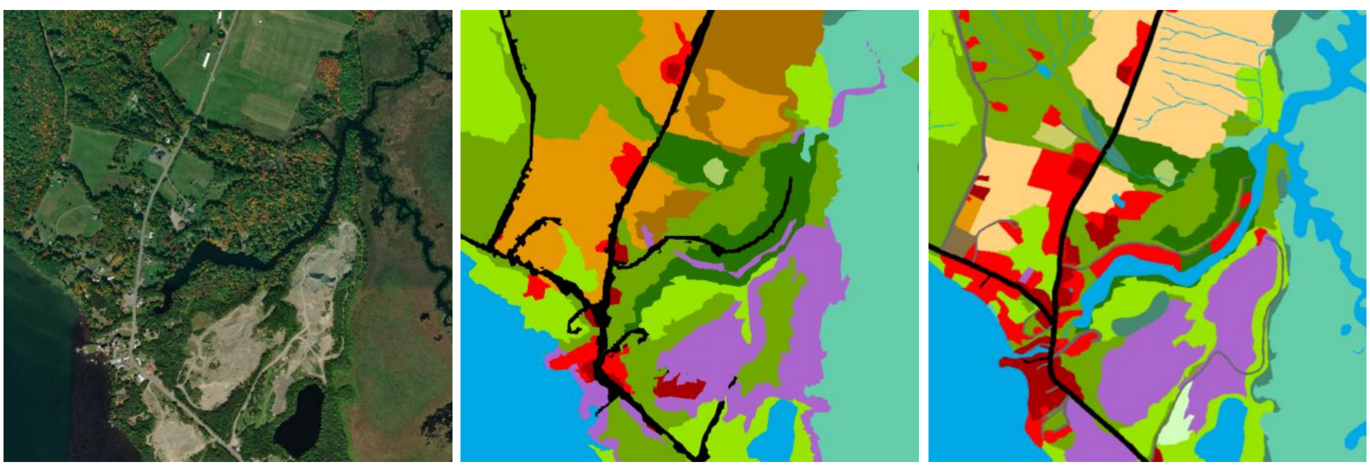
Given the large areas of buildable land in the watershed and the potential increase in P from new development, there is an immediate need to reduce the amount of P getting to the lake from both existing development and future development. As the watershed continues to develop over time, erosion from disturbed areas will deliver new and previously unaccounted for P into the lake, thereby affecting the success of planned management strategies to restore water quality.

Proactive Planning- *North Pond <u>needs strong leadership at the municipal level to ensure that all new development is protective of water quality</u>, any modifications in the shoreland zone are strictly reviewed and rules are enforced, planning board members are educated on shoreland zoning requirements, code enforcement is adequately funded to minimize impacts from current and future development in the watershed, and mechanisms are in place to protect and conserve sensitive land in the watershed.*

LAND COVER

To get a more accurate picture of the land cover in the North Pond watershed, an updated land cover layer was created by comparing 2004 Maine Land Cover Dataset (MeLCD) data with Google Earth and ArcMap aerial imagery taken in 2018. Polygons were manually edited to match the more recent aerial images, and assigned one of 20 different land cover types. Examples of how some areas were re-categorized are presented in Figure 3, below.

Figure 3. *Example of aerial imagery (left), original MELCD land cover layer (middle), and updated land cover layer (right) for the North Pond land cover update..*



Forestland (including recent timber harvesting at 2.6%) dominates the landscape, accounting for 71% of the land in the watershed (Figure 4 & Figure 5). The watershed also includes a of open water and wetlands (15% of the watershed, not including the area of the lake), much of which consists of forested wetlands around the north end of the lake and in the north end of the watershed. Agriculture, including row crops, grazing, and hayfield, makes up 7% of the watershed. Development, which makes up 6% of the watershed, is primarily located along major roadways and around the shoreline, with the highest concentration of commercial development located at the eastern tip of the watershed in downtown Smithfield. Much of the development in the watershed is low-density residential development. Roads, including state (Rt. 137 & 8), town, and private roads (including numerous gravel roads that provide access the shoreline) encircle the lake.

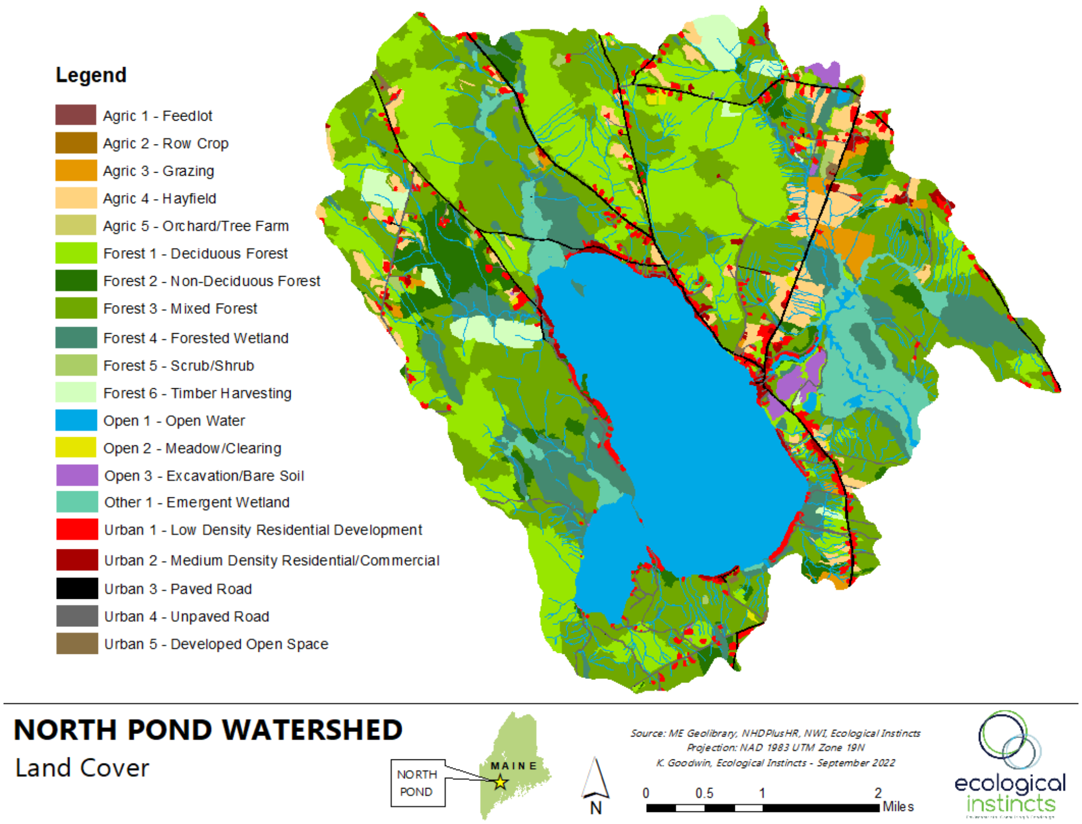


Figure 4*. Land cover map for the North Pond direct watershed.*

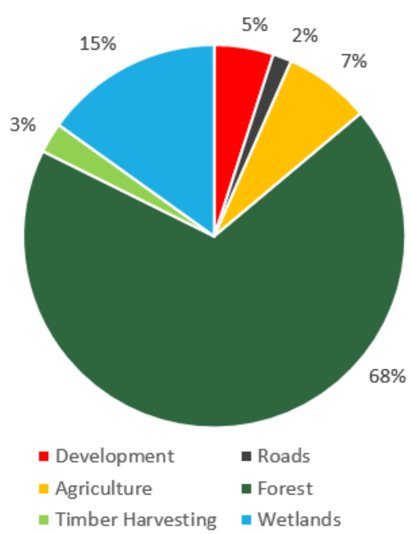


Figure 5. *Land cover by percent cover in the North Pond direct watershed.*

SOILS

Factors such as topography, soil type, erosive potential, and land alteration all influence the degree to which soil erosion occurs. The topography of the North Pond watershed is mostly hills to the north and west with a maximum elevation of 743 feet (Mt. Tom) and extensive low wetland areas to the southeast.

Soils in the watershed are primarily derived from glacial till, a result of the glaciers that covered Maine more than 12,500 years ago. Soil associations are groups of soils with similar characteristics. The North Pond watershed is characterized by the Berkshire-Peru general soil association which consists of loam and sandy soils formed in glacial till. This soil association comprises the northern and western portions of the watershed. Soils in the eastern watershed are typified by the Scantic-Bangor-Peat and Muck general soil association, which consist of silty loamy soils formed in glaciomarine deposits, glacial meltout till, and organic matter (Ferwerda et. al., 1997). The composition of each soil type dictates the amount of phosphorus, iron, and aluminum exported to the lake from the watershed soils, and therefore define the chemical makeup of sediment that has settled at the bottom of the lake.

AT-RISK SOILS AND SUBSURFACE WASTEWATER SYSTEMS

Soil type also affects the suitability for infrastructure, specifically for septic systems. Septic systems that are located on unsuitable soil types may also be at risk of failure due to outside factors, such as age of the systems, maintenance, and changes in use. Coarse, sandy, and shallow to bedrock soils are considered "at-risk soils", due to the rapid permeability of these soils that may result in septic system leach field effluent "short-circuiting" to groundwater. Short-circuiting occurs when septic tank effluent is not properly treated in the leach field because the soils are coarse and porous, which allows the effluent to move through them too quickly. Additionally, soils with shallow water tables and shallow-to-bedrock soils that abut or are hydrologically connected to the lake are also considered at-risk due to lack of treatment area where the leach field might rest on fractured bedrock resulting in no treatment of effluent before reaching groundwater which might then flow into the lake.

Maine DEP (2022a) conducted a septic risk analysis of soils in the North Pond watershed. Soils that met the characteristics of "at-risk" were cross-referenced with tax maps to identify developed properties located within the shoreland zone of North Pond or its tributaries. At-risk soils were found to encompass 786 acres, or about 15% of the watershed area.[13] Of the soils of concern, 89% are considered coarse and at high or very high risk for short circuiting[14] and only 9% by area are shallow-to-bedrock (represented as red and gold in Figure 6, respectively).A total of 259 unique parcels were identified as being located on an either at-risk or shallow to bedrock soils within the watershed (Table 3). Approximately 64%, or 166 parcels with a likelihood of containing a septic system in at-risk soil. Of the four watershed towns, **Smithfield contained the most at-risk parcels**. No at-risk parcels were identified in Rome.

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[13] Calculated as 4,750 acres, inclusive of waterbodies other than North Pond.

[14] Course soils considered high and very-high risk include Adams, Colton, Skowhegan, and Stetson soil series, formed in glacio-fluvial outwash and/or glaciolacustrine sand.

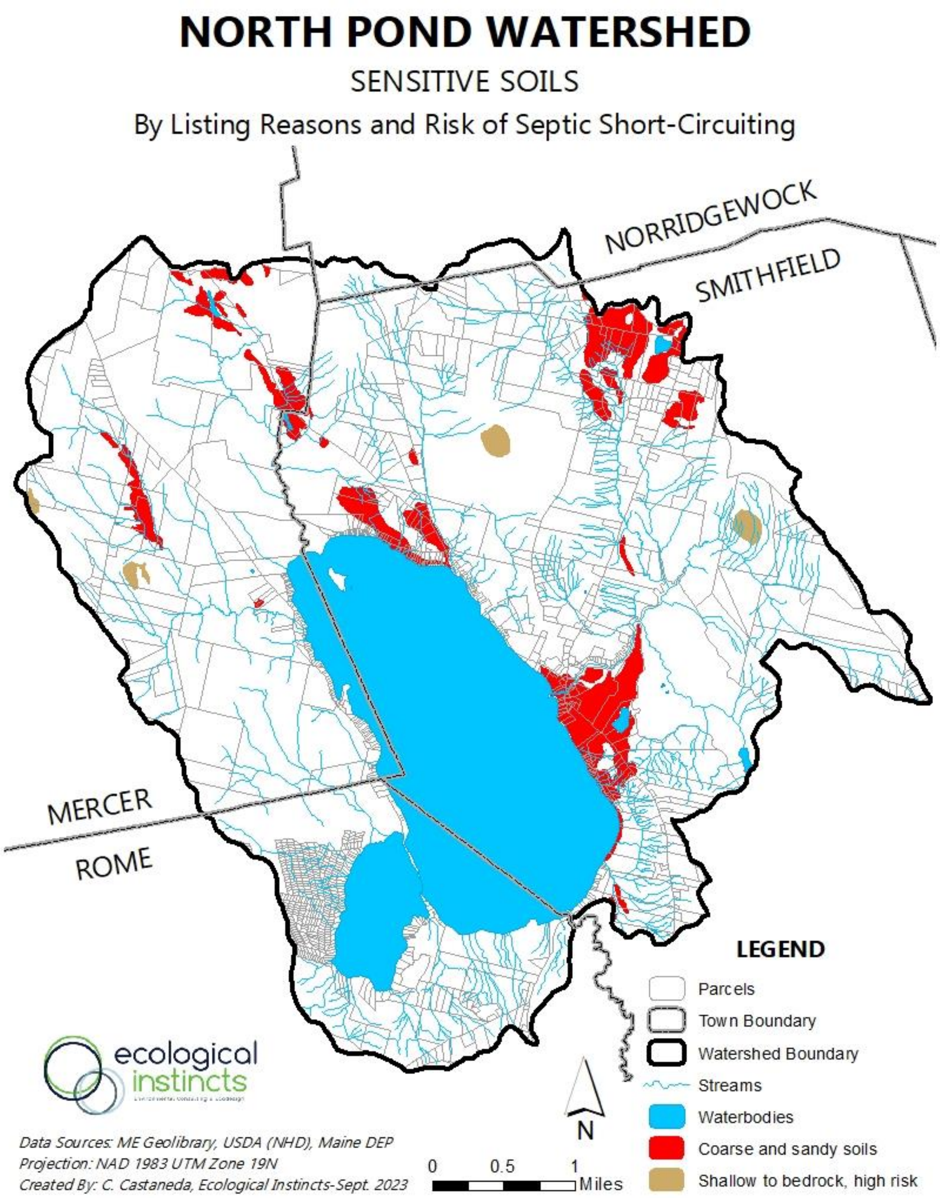


Figure 6. *At-risk soils and associated parcels in the North Pond direct watershed.*

Table 3. *Number of high priority parcels by town and likelihood of development in the North Pond watershed. (Source: Maine DEP, 2022)*

Town	Developed	Undeveloped	Total
Smithfield	158	75	233
Mercer	7	18	25
Norridgewock	1	0	1
Rome	0	0	0
Total	**166**	**93**	**259**

Future assessment of septic systems in the North Pond watershed should focus on developed shoreline parcels on at-risk soils. A septic system database was developed for North Pond by 7 Lakes and Colby College in 2022 which focused on parcels located on at-risk soils on the shoreline of North Pond in Smithfield where septic records were more complete/accessible. In addition, a Septic System Survey was completed by NPA to help estimate P loading from septic systems for the watershed model (Ecological Instincts, 2023a) that could be used to help fill in gaps in the 7 Lakes septic database. Follow-up work is needed to finalize the septic database to get a complete picture of the status of septic systems in the watershed. This includes combining information from the database, septic vulnerability analysis, and septic survey to create a list of high-priority septic systems.

Priority for Septic System Evaluations in the North Pond Watershed

1. Old systems (pre-1974) within the watershed, with priority to systems located on at-risk soils;
2. Systems (pre-1995) located on at-risk soils located within 250 feet of the lake; and
3. Systems (pre-1995) located on other at-risk soils in other areas of the watershed, especially near tributary streams and/or wetlands draining to North Pond.
4. Septic systems located in areas with a high groundwater table or in areas prone to flooding.

While town septic system permit records can sometimes be used to identify the location and age of septic systems (when data is available), on-the-ground inspections will be needed to confirm these findings.

BATHYMETRY

The morphology (shape) and morphometry (measurement of shape) of lakes have been shown to be good predictors of water clarity and lake ecology, where large, deep lakes are typically clearer than small shallow lakes. Bathymetric data is useful for estimating the mass of P within each basin by depth, for assessing internal loading, and examining changes in the Anoxic Factor in the lake which requires a reliable bathymetric map. The most recent bathymetric map for North Pond was created by Lakes Environmental Association (Figure 7). The deepest areas of the lake are located northeast of the lake's center between the inlets of Leech Brook and Serpentine Stream. The deepest area of Little Pond is located at its southern end. Both deep holes reach a depth of over 5 m. North Pond is a fairly shallow lake, with roughly three-quarters of the total volume of the lake in water shallower than 3 m. In comparison, roughly 24% of the lake area and 2% of the lake volume is in water deeper than 5 m, vs. 48% of the lake area and 12% of the lake volume in water deeper than 4m.

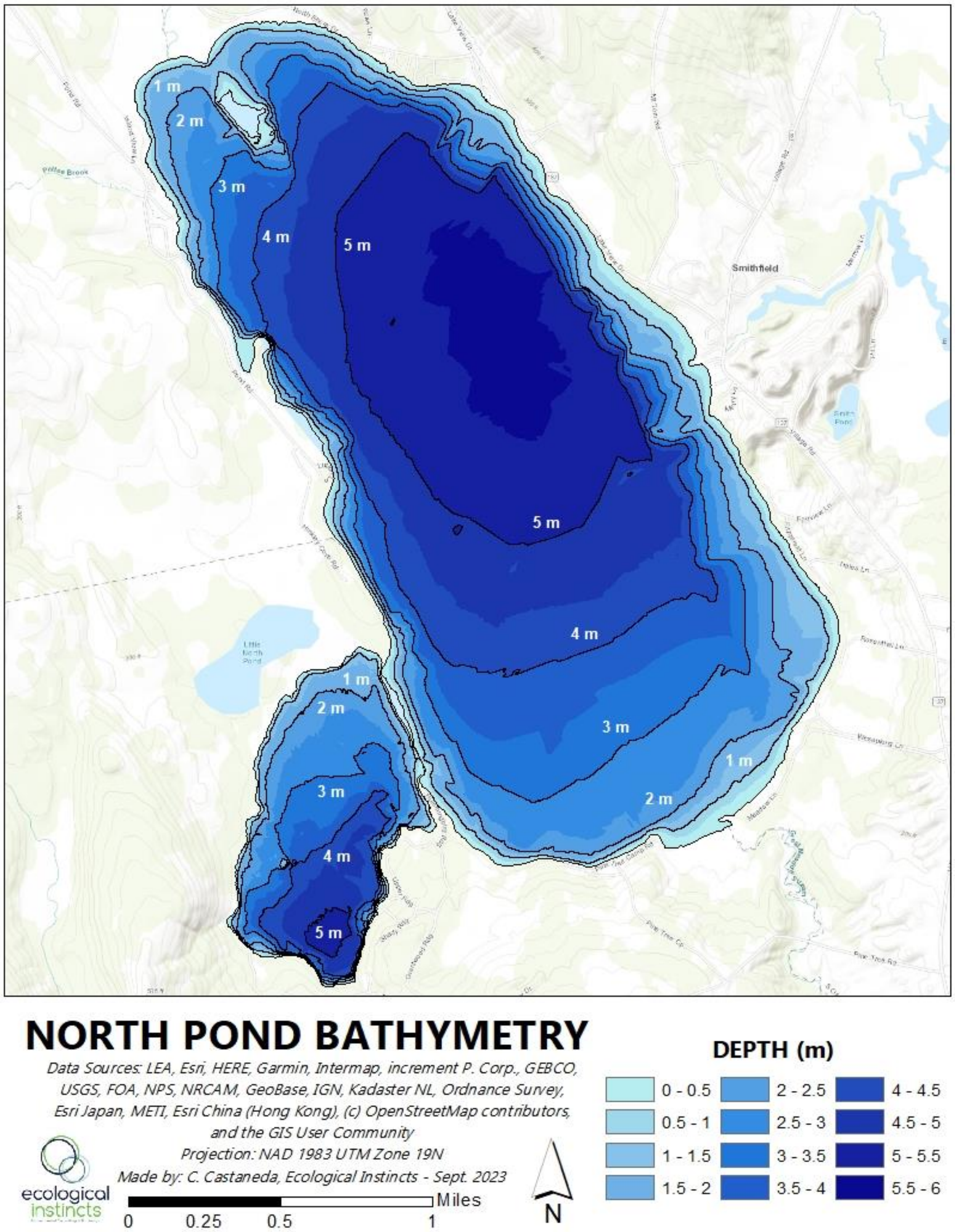


Figure 7. *Bathymetric map for North Pond. (Source: LEA)*

WATER RESOURCES AND WILDLIFE HABITAT

Fish and wildlife require suitable upland habitat, as well as healthy riparian buffers, wetlands, and large undeveloped habitat blocks strategically linked to provide movement of wildlife. An assessment of water resources and wildlife habitat was completed for the North Pond watershed (Figure 8 & Figure 9) using Beginning with Habitat (BwH) data.[15]

[15] https://www.maine.gov/ifw/fish-wildlife/wildlife/beginning-with-habitat/index.html

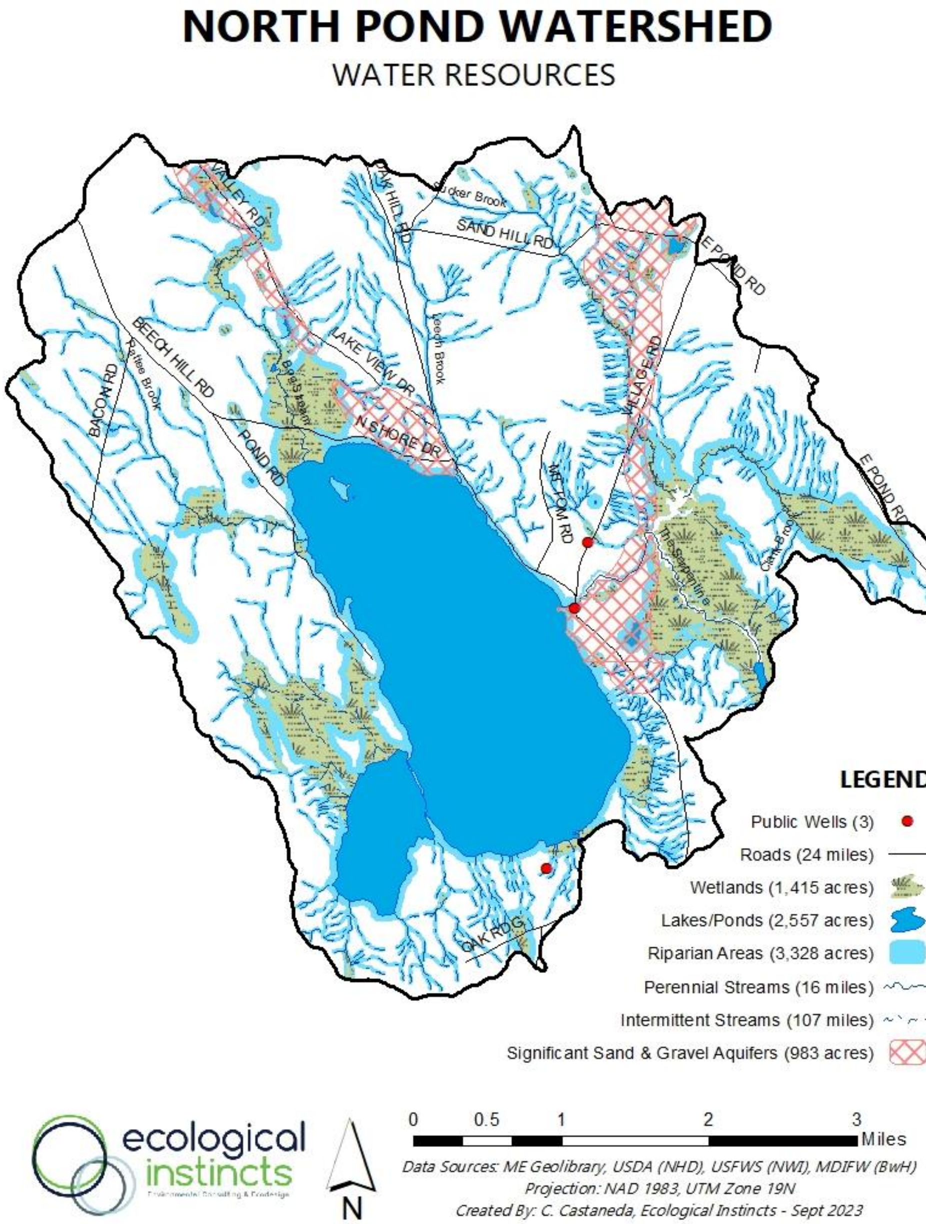


Figure 8. *Water resources in the North Pond watershed.*

Riparian habitat is the transitional area between aquatic habitats and dry, upland areas.

Results of the assessment highlight the wealth of water resources in the watershed, including 1,415 acres of wetlands, 123 miles of streams, 2,557 acres of open water (including the surface area of North Pond), and 3,328 acres of riparian habitat including the large area of freshwater wetlands of statewide significance associated with the Serpentine. Healthy riparian zones are not only important for water quality but are essential for more than 60 species of Maine wildlife. More animals live in riparian zones than in any other habitat type in Maine, with hundreds of species depending on riparian zones for survival (ME Audubon, 2006). Sections of the riparian habitat in the watershed have been impacted by development and roads, especially along the shoreline. As development continues, this valuable habitat will diminish - underlining the need for strong protection of the shoreland zone and conservation of undeveloped land within the watershed.

The watershed provides habitat for rare plant and animal species of special concern. MDIFW documented four occurrences of threatened, endangered, or species of special concern in the watershed, including the great blue heron and eastern ribbon snake in wetlands surrounding the watershed, and the upland sandpiper in the northeastern tributaries of the watershed (Figure 9).

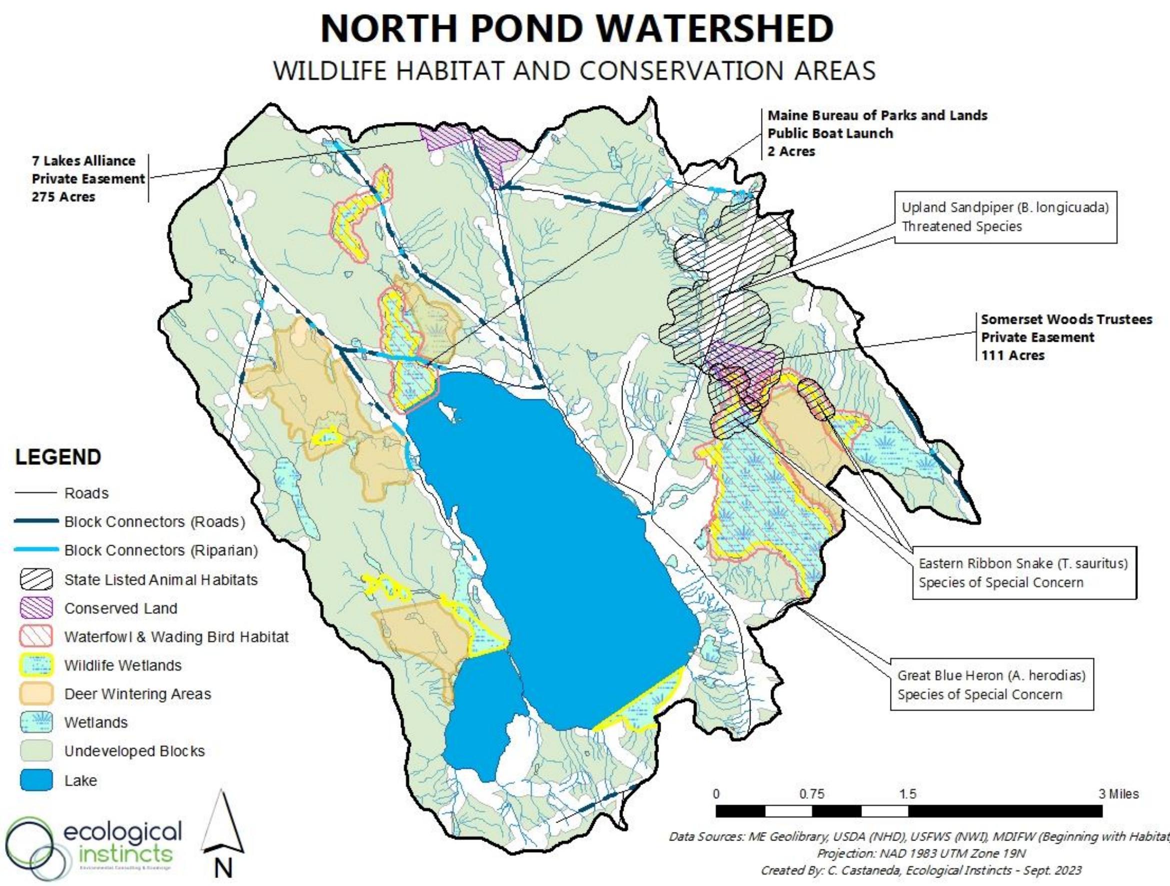


Figure 9. *Wildlife habitat and conservation land in the North Pond watershed.*

Other locally important wildlife species present in North Pond include the American eel (*Anguilla rostrata*) and the common loon (*Gavia immer*). A symbol of summertime on Maine lakes, loons are regularly present on North Pond, with 18 adult loons counted on the lake in 2022 (Maine Audubon, 2022).

According to Beginning with Habitat, large undeveloped forest blocks cover 60% or 8,580 acres of the watershed. There are three areas of inland wading bird and waterfowl habitat (IWWH) in the watershed, the largest being the Serpentine wetland connecting North Pond to East Pond.[16] Areas of deer wintering habitat are located throughout the watershed, primarily associated with large wetland complexes in the

[16]The Serpentine Marsh is classified by MDIFW as Inland Wading Bird & Waterfowl Habitat and is considered a Wetland of Special Significance. The marsh is believed to be the original statewide location of the first nesting pair of Sand Hill Cranes (Grus canadensis) with 14 birds documented in 2013.

Serpentine Marsh, wetlands north of Little Pond, and wetlands associated with Pattee Brook and Bog Brook on the north end of the lake. Protecting the land and water resources in the watershed is vital for maintaining this high-value wildlife habitat.

FISHERIES

North Pond contains 19 species of fish including both native and introduced species (Table 4). The lake provides an excellent warm water fishery due to its abundant shallow weedy areas. Primary fisheries include robust populations of largemouth and smallmouth bass, white perch, and pickerel. Although Maine IF&W does not stock North Pond, East Pond is occasionally stocked with brown trout which may occasionally make it to North Pond through the serpentine.

Table 4. *Fish species in North Pond. (Source: Lakes of Maine)*

Species	Scientific Name	Introduced
Alewife, landlocked	*Alosa pseudoharengus*	X
Brown bullhead	*Ameiurus nebulosus*	
American eel	*Anguilla rostrata*	
Fourspine stickleback	*Apeltes quadracus*	
White sucker	*Catostomus commersoni*	
Slimy sculpin	*Cottus cognatus*	
Northern pike	*Esox lucius*	X
Chain pickerel	*Esox niger*	
Banded killifish	*Fundulus diaphanus*	
Redbreast sunfish	*Lepomis auritus*	
Pumpkinseed	*Lepomis gibbosus*	
Smallmouth bass	*Micropterus dolomieu*	X
Largemouth bass	*Micropterus salmoides*	X
White perch	*Morone americana*	
Golden shiner	*Notemigonus crysoleucas*	
Yellow perch	*Perca flavescens*	
Black crappie	*Pomoxis nigromaculatus*	X
Brown trout	*Salmo trutta*	X
Fallfish	*Semotilus corporalis*	

In the summer of 2020, a fish-kill was documented in North Pond corresponding with warm water temperature, and a substantial drop in DO in the water column as the algal bloom died off. In 2022, North a mussel die-off occurred, when a sudden mortality event caused mussels to wash up on the shoreline. Officials from 7 Lakes and other agencies are still working to discover the cause of the mussel deaths.[17]

[17] The mussel die-off is believed to be a result of a virus. Unexplained mussel die-offs have become more common in the US and Europe (personal communication, MDIFW, December 2022), but further testing is needed to confirm this theory.

Thirteen stream crossings were identified within the North Pond watershed by the Maine Stream Habitat Viewer.[18] Seven crossings are identified as barriers to fish passage, six of which are culverts and the last being the East Pond Dam on the Serpentine in Smithfield. Six stream crossings are identified as potential barriers for fish passage. All stream crossings identified in the Stream Habitat Viewer in the North Pond watershed are considered barriers or potential barriers to fish passage. Fish passage between North Pond and Great Pond is also restricted by the North Pond Dam, located at the outlet on Great Meadow Stream.

FISH CONSUMPTION ADVISORY (MERCURY & PFAS)

The Maine Center for Disease Control and Prevention (CDC) has posted a fish consumption advisory for all freshwater fish in inland waters in Maine due to mercury contamination. The advisory warns pregnant and nursing women, women who may get pregnant and children under age 8 not to east any freshwater fish from Maine's inland water except brook trout and landlocked salmon (one meal/month is safe). All other adults and children older than eight years old can eat two freshwater fish meals/month and for brook trout and landlocked salmon the limit is one meal/week.

(Photo Credit: Jodie Mosher Towle)

An emerging issue for Maine lakes is PFAS (per- and polyfluoroalkyl substances). PFAS are a group of chemicals that have been used in household and industrial products since the 1940's to repel water and resist stains and grease. These chemicals have been found to persist for a very long time once released into the environment, and they can build up in the bodies of people and animals over time. Current research suggests that high levels of exposure to PFAS can have negative effects on human health, including increased risk of some cancers, lower infant birth rates, and reduction of the immune system's capacity to fight infections (Maine DHHS, 2017). More research is underway to better understand these health effects and how they are affected by different levels of exposure (USEPA, 2022). Sources of PFAS in the environment include historical use of firefighting foams, industrial sites that used or processed PFAS, and fields with a history of land-spreading materials used for fertilizer that likely contained PFAS (Maine DHHS, 2017).

Fish that live in waterbodies contaminated with PFAS can accumulate the chemicals in their bodies. An advisory may be issued for a waterbody if fish cannot be safely consumed at a rate of at least one meal per week, which corresponds to a fish tissue action level (FTAL) of 3.5 nanograms per gram (ng/g). However, mercury consumption guidelines for inland waters in Maine recommend no more than one meal/week of brook trout and landlocked salmon and two meals/month of all other freshwater fish. These guidelines generally protect against PFAS contamination up to 7.5 ng/g and advisories are therefore usually not issued until PFAS levels in fish tissues exceed these levels. Currently, no PFAS advisories have been placed on North Pond, and there is little evidence of large-scale sludge dumping or other known PFAS sources in the

[18] https://webapps2.cgis-solutions.com/MaineStreamViewer/

watershed (Maine DEP, 2023a). Warmwater fish samples were collected in the summer of 2023 to test for PFAS, and results are expected to be available in early 2024.[19]

INVASIVE AQUATIC PLANTS

7 Lakes has extensive prevention and detection programming on all the Belgrade lakes, prompted by an invasive variable milfoil infestation in Great Pond in 2009. Since then, 7 Lakes leads Adopt-a-Shoreline trainings, Invasive Plant Paddles, and conducts more than 10,000 Courtesy Boat Inspections across the 7 Lakes region.

In June 2021, curly-leaf pondweed (CLP) was documented in North Pond, believed to have been introduced via the East Pond side of the Serpentine Stream. CLP is originally from Europe and Asia and lacks natural checks and balances here in the Northeastern U.S. which would limit excess growth. The plant propagates through turions (buds that can remain periodically dormant at the bottom of the lake) and stolons (horizontal roots) and can only be eradicated via removing buried turions and all new CLP growth before maturation.

Curly-Leaf Pondweed. (Source: Dennis Roberge)

Once invasive plant species become established in a new lake, they can be very difficult or impossible to eradicate. However, because of the regular monitoring and prevention practices of 7 Lakes, remediation plans were quickly developed in conjunction with Maine DEP. Since 2021, Maine DEP has funded remediation efforts in the effected waterbodies as part of their emergency response management plan. 7 Lakes dive crews spend a minimum of 20 hours a week (12-15 weeks/year) surveying and physically removing CLP plants. Two fragment barriers have been installed on the upstream side of the East Pond Dam to prevent further spread of CLP into North Pond. Rigorous eradication efforts have kept the CLP infestation confined to the same section of The Serpentine and Old Mill Stream with dwindling numbers of CLP patches. Continuous maintenance and monitoring on the affected waterbodies must be upkept as turions can remain dormant for up to five years, meaning it would take five years to exhaust the cache of turions in the sediments (7 Lakes Alliance, 2023a).

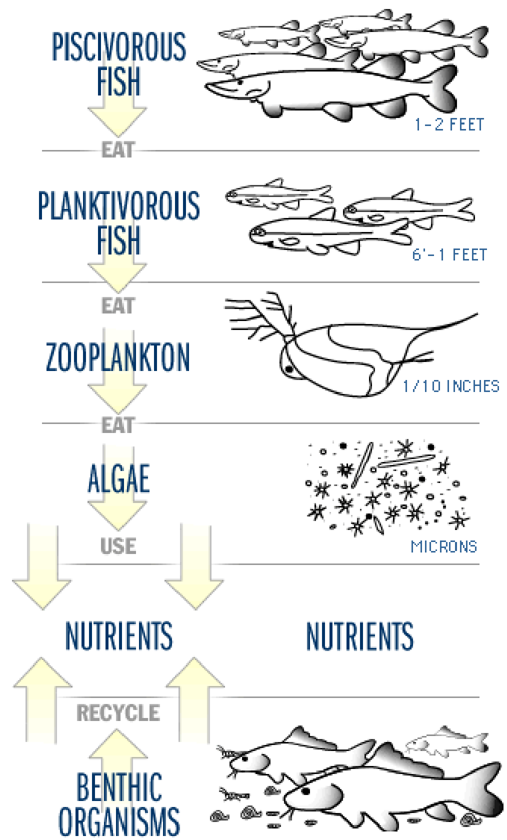
PLANKTON AND CYANOBACTERIA

Tiny aquatic plants (algae, aka phytoplankton) and animals (zooplankton) are the primary and secondary source of food and energy in a lake food web and play a key role in lake ecosystems. Because plankton float in the water column, they influence the transparency of the water throughout the season and from year-to-year as these communities undergo both seasonal and annual growth cycles. These growth cycles vary over the course of the year as a result of changes in temperature, light and nutrient availability.

[19] Personal communication. Tom Danielson, Maine DEP. October 2023.

PHYTOPLANKTON

Phytoplankton are microscopic algae and bacteria that photosynthesize using the sun's energy to turn carbon dioxide, nutrients and water into food for organisms higher in the food web such as zooplankton and small fish. Phytoplankton are sensitive to changes in lake ecosystems. The effects of environmental and watershed impacts can often be detected in changes in the plankton community species composition, abundance, and biomass.



A typical food web. (Source: www.waterontheweb.com)

Monthly phytoplankton samples were collected between May and December 2022 and analyzed by 7 Lakes using a Flowcam (7 Lakes Alliance, 2023b). Diatoms dominated the biovolume in May, but by late June cyanobacteria had become the dominant taxa in terms of both biovolume and particle count. Biovolume was relatively low in May and June, but increased dramatically in late July, heavily dominated by cyanobacteria. Cyanobacteria dominance continued through August as total biovolume dropped back down. More green algae was observed in September, and golden algae in October. Total biovolume was low in the winter months, with a higher amount of smaller unidentifiable (unknown) particles (Figure 10).

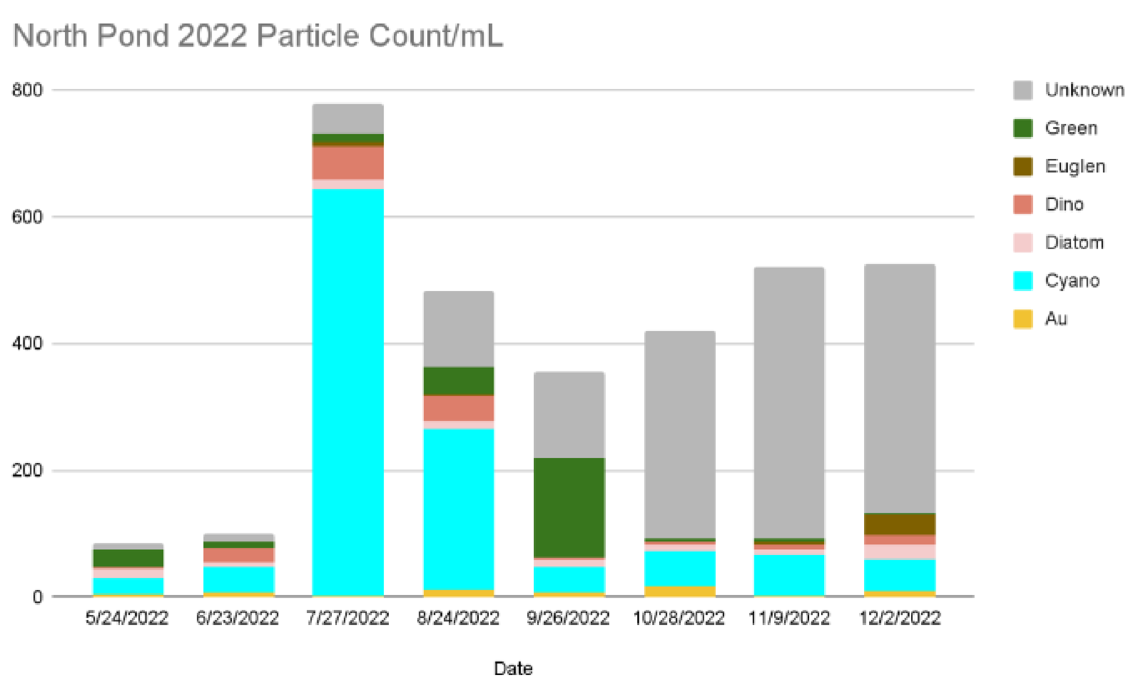


***Figure 10**. 2022 Flowcam (phytoplankton) results in North Pond. (Source: 7 Lakes Alliance, 2023b)*

Ongoing sampling of plankton species composition and abundance (including zooplankton) will improve our understanding of water quality changes, and track the successes of aluminum treatments and watershed improvement activities.

CYANOBACTERIA

Cyanobacteria are a type of phytoplankton present in North Pond and in lakes all around the world. Their presence, species composition, and abundance can be used as an indicator of water quality. Cyanobacteria are not like other algae but are actually photosynthetic bacteria that can form dense growths (blooms) in lakes when nutrients are plentiful, water temperature is warm, and sunlight is abundant. These blooms are an indication that the ecology of the lake is out of balance.

Some forms of cyanobacteria initiate growth on the bottom, then form gas pockets in their cells and rise to the surface almost synchronously. Those cells tend to carry excess P, and once in the upper waters, they can grow with adequate light. When cells die, some portion of the P is released into the upper waters that can support other algae growth. Blooms that start on the bottom and move to the surface are therefore not just symptoms of increasing fertility, but vectors of it. Areas of fertile sediment subject to low oxygen that also recieve adequate light can be "nurseries" for cyanobacteria blooms. Consequently, release of P from sediment exposed to low oxygen can fuel blooms without dissolved P ever moving into the water column. The cyanobacteria rising in the water column will cause an increase in measured P by virtue of what they bring with them from the bottom.

The effects of toxins produced by cyanobacteria (cyanotoxins) on humans, domestic animals, and wildlife, are closely associated with the occurrence of Harmful Algal Blooms (HABs) (US EPA, 2019). The effects are well documented, and can affect kidney, brain, and liver function. Not all blue-green algae blooms are toxic. However, Microcystis is one of the most common bloom-forming genus, and is almost always toxic (US EPA, 2017). *Dolichospermum* (formerly *Anabaena*), the most common blooming cyanobacteria in Maine, is also capable of producing toxic blooms.

Microcystin (the cyanotoxin produced by *Microcystis, Dolichospermum* and other common blooming cyanobacteria species) was studied in lakes throughout the state from 2014-2020. Nine open water and scum samples were collected from North Pond, as one of 12 lakes due to its more recent algal blooms. Results of cyanotoxin testing from samples collected in North Pond during this time showed that maximum microcystin concentrations met the US EPA's acceptable cyanotoxin levels for recreation in all samples, including downwind scum samples. Cyanotoxin levels also met the drinking water standard for non-school

The US EPA 10-day health advisory value for microcystin in **Drinking Water** is 0.3 µg/L for non-school-age children and 1.6 µg/L for school-age children and adults. US EPA criteria for microcystin in **Recreational Water** is 8 µg/L for all ages. These recommendations stem from studies that consider magnitude, duration and frequency of exposure that are considered protective of human health. For more information on how to avoid exposure, visit the following pages at the Maine DEP website:

https://www.maine.gov/dep/water/lakes/cyanobacteria.html

https://www.maine.gov/dep/water/lakes/algalbloom.html age children, school-age children, and adults at all stations. This indicates that the cyanobacteria driving blooms in North Pond are not currently producing microcystin at a level that could pose a risk to the health of watershed residents (Maine DEP, 2023b).

Dolichospermum was observed in North Pond in 2022, although not at levels that would be indicative of a bloom due to the fact that targeted sampling of algal blooms was not completed.[20] However, a bloom was observed (SDT <2m) between July 24 and August 24, which appears to have been driven by cyanobacteria, specifically *Dolichospermum*, based on 7 Lakes Flowcam results. *Dolichospermum* had by far the greatest density and biomass in late July, and was not observed in August, after the peak of the bloom had likely already occurred.

Follow-up monitoring for cyanotoxins should be a public health priority at North Pond during the summer when the lake is experiencing an algal bloom. This allows public officials to post an advisory at public locations if cyanotoxins exceed US EPA guidelines. **Rapid tests conducted by 7 Lakes and NPA for microcystin going back to 2020 have not detected the presence of the this most common toxin found in Maine lakes.** Studies conducted by the Maine DEP in conjunction with Bigelow Laboratory indicate that the cyanobacteria that are the worse bloomers in North Pond do not have the gene to produce this toxin.[21]

ZOOPLANKTON

Zooplankton are microscopic animals that feed on phytoplankton, helping keep the algae biomass in balance (clearer lakes), and providing food for newly hatched fish each year. Zooplankton species can be grazers (feeding on phytoplankton) or predatory (feeding on smaller zooplankton). The species of zooplankton present in a lake generally remain stable over time, however, the appearance of new species or sudden changes in quantities of existing species can indicate changes in nutrient input, dominant fish species, aquatic invaders, or a pollution source.

Keratella sp. (Rotifera) (Source: CFB.UNH.edu)

An analysis of the zooplankton community in North Pond in 2022 was completed by WRS, Inc. Results of five monthly samples collected between June and October indicate an overall decreasing biomass as the year progresses, although zooplankton density peaked in August, dominated heavily by *Rotifera*. In June the community had a high total biomass (368.6 ug/L) and rich biodiversity of *Rotifera, Copepoda*, and *Cladocera*. By the start of August, there was a moderate biomass (109.5 ug/L) community being dominated by rotifers and juvenile copepods. In October there was a significantly lower biomass (37.6 ug/L). While this progression may be linked to fish predation, cyanobacteria blooms, or a combination of both, the small sample size only provides a glimpse into the world of zooplankton in North

[20] Personal communication. Ken Wagner, WRS, Inc. January 2023.
[21] Personal communication. Danielle Wain, 7 Lakes Alliance. July 2023.

Pond. More consistent sampling methods are required to gain a better understanding of what is causing the shift in zooplankton communities.

GLOEOTRICHIA

Gloeotrichia *echinulata (magnified) (Source: Jonathan Dufresne, UNH)*

A type of cyanobacterium common in lakes across Maine is *Gloeotrichia echinulata* or *"Gloeo*", which forms small spheres and are big enough to be seen by the naked eye. *Gloeo* grows at the sediment-water interface and then rises through the water column to the surface waters where it completes its life cycle, dies, and sinks back down to the bottom of the lake where it will stay through the winter months until conditions are again suitable for growth (King & Laliberte, 2005). *Gloeo* grows in relatively shallow areas where lake sediments have abundant available P and there is also adequate light for photosynthesis. It has been observed in Maine lakes for many years, but blooms have increased in lakes throughout the northeast in recent decades. *Gloeo* blooms have been observed in lakes all over the world with a wide range of trophic states and conditions. **To date, there have not been any reports of *Gloeo* in North Pond**, though there has been no formal survey to document its presence.

METAPHYTON

Metaphyton mass. (Source: LSM, Betsy & Dick Enright)

Metaphyton is filamentous algae typically found in wetlands, floodplains, and the littoral zones of lakes and ponds. It forms loosely aggregated masses or mats that are either attached to benthic substrates or suspended in the water column. Mats can rise to the water surface when oxygen bubbles form within the mass as a result of photosynthesis. Metaphyton begins to form within the littoral zone of a lake shortly after ice-out, persists through the summer months, and begins to degrade in late summer when they sink to the bottom to decompose. The species that make up metaphyton are not cyanobacteria and do not produce toxins.

Maine DEP and LSM have received observational data and reports over the past decade from volunteer monitors and watershed associations suggesting a significant increase in metaphyton in Maine lakes. Though common throughout the state, implications of an increasing trend are not well understood. There is also limited understanding of the physical, chemical, and biological role these algae play in aquatic ecosystem (Shute & Wilson, 2013). LSM has developed a standardized monitoring protocol to help lake associations identify and document the location and density of metaphyton growth in their lake, but **to date, this monitoring protocol has not been implemented in North Pond. The presence and extent of metaphyton in North Pond is currently unknown.** A volunteer led survey of the littoral zone could be conducted in the future to document whether metaphyton is present in North Pond and to what extent, as well as to document changes in metaphyton in shallow areas of the lake over time.

3. Water Quality Assessment

Water quality data has been collected in North Pond at Station 1 beginning in 1970 (Figure 11). There are nine years in which no data is available, with the largest gap in data occurring from 1985-1989. Data for Stations 2 and 3 is limited to 10 years between 2004 and 2015. Due to limited data available for Stations 2 and 3, these stations were not included in the water quality trend analysis for the WBMP, nor was data collected at a new station in Little Pond between 2020-2022, though both datasets provide valuable information for comparing to Station 1 results.

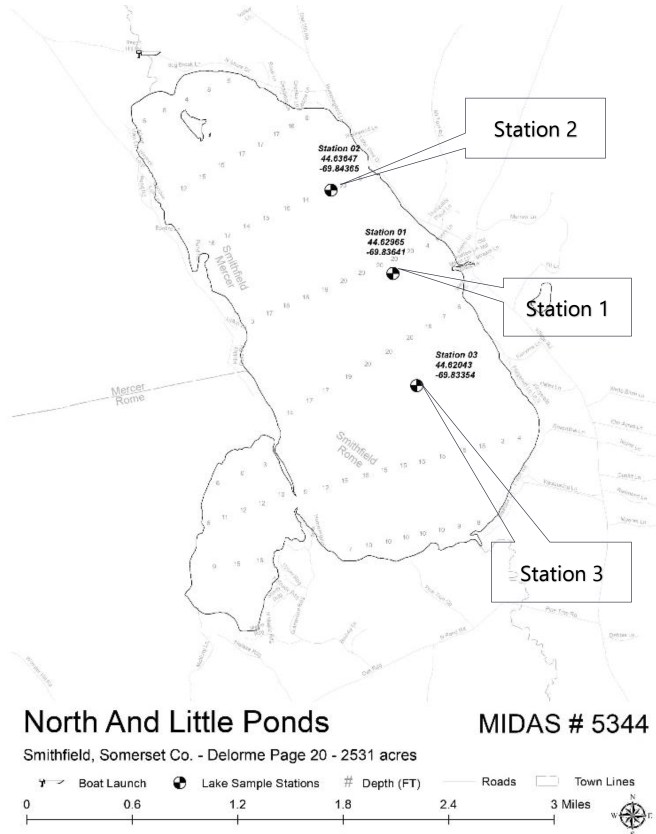


***Figure 11**. Water quality monitoring stations in North Pond (Source: LakesofMaine.org).*

A water quality trend analysis was conducted for Station 1, which included analysis of the long-term (1970-2022) and short-term (last 10 years) dataset using data collected by certified monitors from Lake Stewards of Maine, the 7-Lakes-Colby Water Quality Initiative, and Maine DEP (7 Lakes Alliance, 2023b). These results were also compared to water quality results from the past five years to compare pre-2018 monitoring results with 2018-2022- the period when the lake experienced severe algal blooms.

WATER QUALITY TRENDS

WATER CLARITY

Water clarity readings in North Pond have been collected at Station 1 since 1970, with 42 years of data collected over the sampling period.[22] The lowest water clarity on record was 0.8 m, recorded in July 2020, and there are several years where SDT reached the bottom of the lake. Average clarity over the entire sampling period is 4 m. There was no significant trend observed over either the full time series or the past

[22] Changes in water clarity are measured by slowly lowering a black and white Secchi disk into the water until it is no longer visible and recording the depth. Changes in clarity may be due to increased or decreased algal growth or the amount of dissolved or particulate materials in the lake, which makes it an important parameter to track in order to determine if water quality is improving or getting worse over time.

10 years. However, mean SDT has shifted from 4.1 m prior to 2018 when algal blooms began occurring regularly, to 3.2 m since 2018 (Figure 12). Decadal medians also show that the worst SDT was observed in the 2020s. Long-term monitoring of SDT is an easy and reliable method for tracking changes in water quality over time.

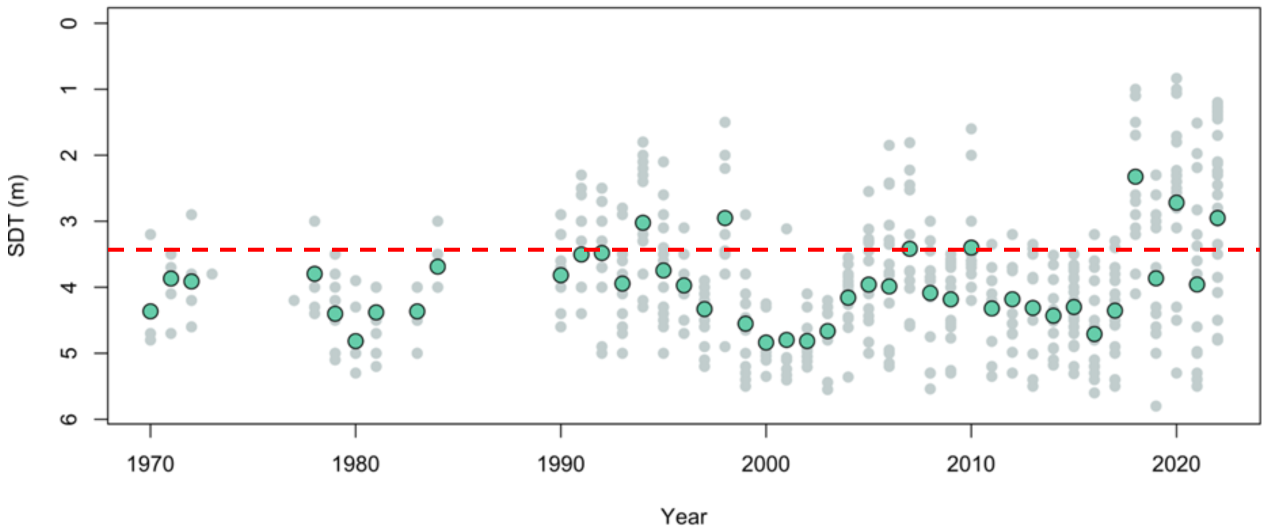


Figure 12. *Historical water clarity readings in North Pond 1970 – 2022. (Green circles indicate the average SDT reading for each year and gray circles represent the range in actual readings collected each year. SDT readings above the red line indicate algal bloom conditions.*

Water clarity readings of 2 m or less indicate that an algal bloom is actively occurring in a lake. Water clarity readings in North Pond have fallen below 2 m in 9 of the 42 years on record (21%). Of the nine years with readings below 2 m, four occurred within the last 5 years (since 2018). Bloom periods have varied over the last 5 years, but SDT readings <2 m typically begin in mid-July to early August, and SDT readings begin to rise in late August or early September with the lowest SDT readings in mid-August when water temperatures are high, increasing the potential for low dissolved oxygen at the lake bottom of the lake.

Aerial view of a recent algal bloom on North Pond. (Photo credit: Pine Tree Camp)

CHLOROPHYLL A

Chlorophyll-a (Chl-a) data has been collected since 1978 at Station 1, with 28 years of data collected over this period.[23] The lowest Chl-a on record was 1.4 ppb, observed in May 2012. The highest Chl-a on record

[23] Chlorophyll-a (Chl-a) is a measure of the green pigment found in all plants including microscopic plants such as algae. Chl-a provides a relative estimate of algal biomass where higher Chl-a equates with a higher concentration of algae in the lake. Chl-a

was 24 ppb, observed in August 2007. **There is a weak significant increasing trend in Chl-a over the long-term dataset, and a strong significant increasing trend over the past 10 years.** Average Chl-a over the past 10 years is 7.6 ppb (Table 5).

Table 5. *Long and short-term (10-years) trend analysis results for the three primary trophic state parameters for North Pond, Station 1.*

Water Quality Parameter	Average Annual Water Quality	Trend (Long-Term)	Trend (10-Year)
Water Clarity (m) Long-term Average 10-year Average	**4.0** **3.8**	No trend	No trend
Chlorophyll A (ppb) Long-term Average 10-year Average	**5.5** **7.6**	**Weak increasing trend over long-term**	**Strong increasing trend over the past 10 years**
Total Phosphorus (Epilimnetic core) (ppb) Long-term Average 10-year Average	**17.2** **19.0**	**Weak increasing trend over long-term**	No trend

TOTAL PHOSPHORUS

Total phosphorus (TP) is the total concentration of phosphorus including organic and inorganic forms. Humans add phosphorus (P) to a lake through stormwater runoff, lawn or garden fertilizers, agricultural runoff and leaky or poorly maintained septic systems. P can also be released from the lake's bottom sediments when there is no oxygen at the sediment water interface (internal loading); it can eventually reach the upper layers of the lake profile through mixing or diffusion, where it fuels algal growth.

Phosphorus (P) is one of the major nutrients needed for plant growth and is generally present in small amounts in freshwater, thereby limiting plant (and algae) growth. As TP increases in a lake, generally the amount of algae also

The water quality analysis utilized epilimnetic core samples collected in North Pond between 1977 – 2022.[24] Epilimnetic TP has ranged from 9 ppb (September 2006) – 52 ppb (August 2020) with a long-term annual average (median) of 17.2 ppb and a 10-year annual average of 19 ppb. **There is a weak significant increasing trend in epilimnetic TP over the long-term**, and no trend over the last 10 years.[25]

and water clarity often track closely since water clarity is an indirect measure of algal abundance. Chl-a is typically collected as an integrated core from the epilimnion as this is typically where temperatures are warmest, light penetration strongest, and where plants, including algae, grow.

[24] The epilimnion is the upper layer of a thermally stratified lake. The epilimnion is typically warm as a result of the sun penetrating the water's surface and high in oxygen due to mixing from wind.

[25] Surface TP grabs were collected in five years between 1978-2022, and three bottom grabs were collected from 1981-2021. Data for surface and bottom grabs were insufficient for the trend analysis. However, both showed notable increases in 2022.

TROPHIC SHIFT

Though water quality in North Pond has historically been below average, **a significant shift in water quality was observed beginning in 2018**. Prior to 2018, the lake fell within the range for mesotrophic lakes for all three parameters when compared to the numerical guidelines for evaluation of trophic state in Maine (Table 6). However, when looking at data from the past five years, **North Pond has degraded to a eutrophic classification for all three parameters including close to a 1 m decrease in water clarity, a 6 ppb increase in Chl-a, and a 5 ppb increase in TP.** Eutrophic lakes have elevated nutrient levels and are highly productive. They tend to be murky, with elevated plant and algae growth. This data matches the observed shift in North Pond to a highly productive lake and experiencing algae blooms annually in 2018.

Table 6. *Comparison of 5-year and pre-2018 averages for primary trophic state parameters in North Pond compared to numerical guidelines for evaluation of trophic status in Maine.*

	5-Yr Average (2018-2022)	Pre-2018 Average	ME DEP Trophic Status Indicators			North Pond Classification (2018-2022)
			Oligotrophic	Mesotrophic	Eutrophic	
Water Clarity (m)	3.2	4.1	> 8	4 – 8	< 4	Eutrophic
Chlorophyll-a (ppb)	10.7	4.5	< 1.5	1.5 – 7	> 7	Eutrophic
Total Phosphorus (ppb)	22.2	17.0	< 4.5	4.5 – 20	> 20	Eutrophic

Despite the clear shift in trophic state in North Pond in 2018, it is evident that water quality is very different in Little North Pond than in the larger lake. Little North Pond often remains clear even while North Pond is experiencing severe algae blooms, indicating that Little North Pond is not experiencing the same water quality problems as North Pond, based on observational difference and the little amount available data for Little North Pond since a monitoring station was established there by 7 Lakes in 2020.[26] Regular water quality sampling should be initiated on Little North Pond to develop an understanding of existing water quality patterns and allow for comparison of conditions in the two basins.

OTHER CHEMISTRY TRENDS

In addition to the three trophic state parameters described above, pH, color, conductivity, alkalinity, surface temperature, and dissolved oxygen (presented below) were also evaluated for long and short-term water quality trends. **A strong, significant, increasing conductivity trend was observed over the full time series and over the last 10 years** (7 Lakes Alliance, 2023b)**.** The long-term increase in conductivity matches a statewide trend of increased conductivity in lakes, likely related to the use of road salts since the 1990s.

[26] Average TP in Little North Pond in 2022 was 13 ppb and SDT was 3.9 m. Note that Little North Pond is shallower than North Pond, and the Secchi disk hit bottom on 6 of 8 sampling dates indicating water is clear to the bottom in most instances.

A weak but significant increase in the surface water temperature of North Pond was also observed (driven by an increase in August surface water temperatures), coinciding with a trend of warmer summer temperatures across Maine.

DISSOLVED OXYGEN & TEMPERATURE

Dissolved oxygen (DO) refers to the concentration of oxygen dissolved in the water, which is vital to fish, zooplankton, vertebrates, and chemical reactions that support lake functioning. DO levels below 5 ppm can stress some species of coldwater fish, and over time reduce habitat for sensitive coldwater species. DO concentrations in lake water are influenced by several factors, including water temperature, stratification, concentration of algae and other plants in the water, decomposition, and the amount of nutrients and organic matter flowing into the lake as runoff from the watershed.

Summer DO concentrations can change dramatically with lake depth, as oxygen is produced in the top portion of the lake where sunlight drives photosynthesis and winds continuously mix water and air. Oxygen consumption dominates near the bottom of the lake where organic matter accumulates and decomposes. In seasonally stratified lakes, the DO concentrations from top to bottom can be very different, with high levels of oxygen near the surface and little to no oxygen near the bottom, especially during the summer when water temperature and decomposition are at their highest. Even in un-stratified or weakly-stratified lakes like North Pond, DO levels can drop in the narrow layer of water at the sediment-water interface due to microbial activity in the sediments. Microbial respiration (microbes breaking down decaying plant and animal matter) at the bottom of the lake consumes oxygen, the combination of which results in loss of DO in these deep areas of the lake (anoxia).

Thermal stratification, anoxia, and sediment chemistry can result in the release of P from the sediments (internal loading) which can fuel algal growth and lead to persistent, recurring nuisance algal blooms.

Dissolved oxygen and temperature profiles have been collected at Station 1 since 1978, with 35 years of data over the historical monitoring period. Based on these data:

- Although DO rarely drops below 2 ppm, DO of 5 ppm or lower does occur in the deepest part of the lake in July and August.
- North Pond does not strongly stratify. Temperature remains fairly stable throughout the water column, with only slight variations from surface to depth occurring in the summer months.

A full summer series of DO and temperature profiles were collected at Station 1 in 2021 (Figure 13). This dataset provides information about the current onset and extent of anoxia across the open water sampling season and throughout the water column.

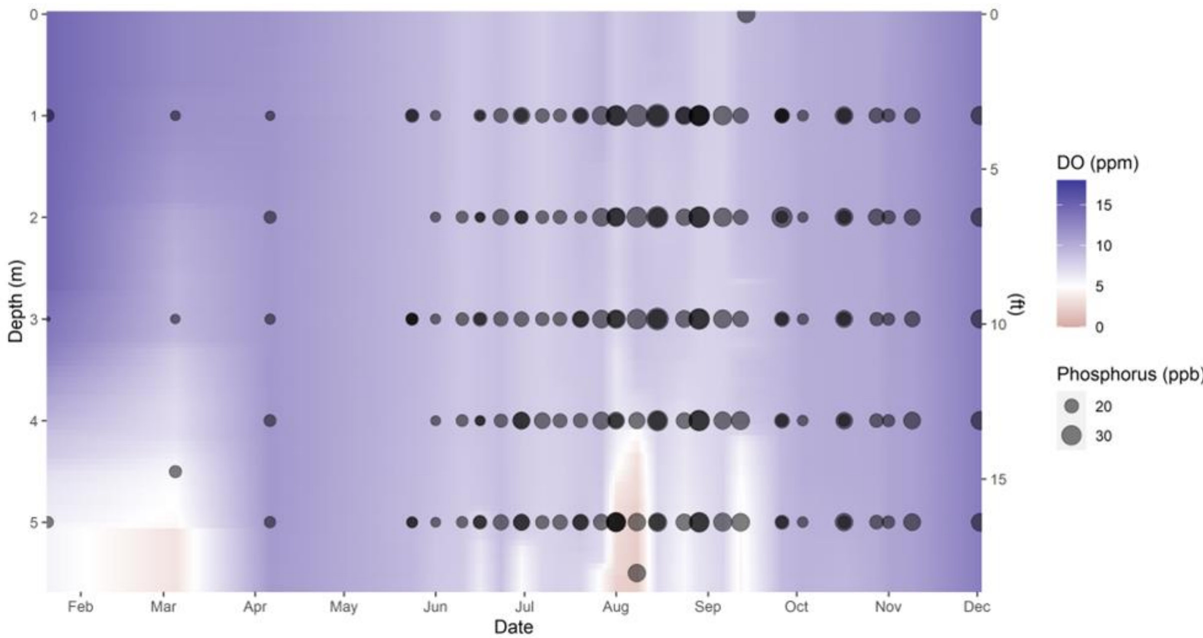


Figure 13. *2022 DO and TP concentrations by depth in North Pond, Station 1. (Gray circles represent the concentration of TP at each depth in the water column) (Source: 7 Lakes, 2023b)*

Based on DO and TP data collected in North Pond in 2022:

- The greatest extent of low DO (<5 ppm) occurred on August 1 and August 8, 2022, with DO dropping below 5 ppm at 4.5 m and reaching 2.1 ppm and 2 ppm at the bottom of the lake on August 1 and August 8, respectively.
- The highest TP concentration was recorded on August 15, 2022, with a reading of 39 ppb at 1 m and 28 ppb at the bottom of the lake, just after the lowest DO readings were recorded the week prior indicating that internal P loading is being driven by low oxygen conditions in the lake.

STREAM MONITORING

From 2021-2023, 7 Lakes conducted stream sampling across the entire Belgrade Lakes watershed to measure phosphorus levels in the water entering the lakes through their tributary streams. As part of this initiative, 10 sites were monitored on eight streams that feed North Pond, including The Serpentine, Bog Stream, Leech Brook, Sucker Brook, Pattee Brook, and unnamed tributaries.

The highest mean and maximum TP values were recorded at two unnamed tributaries in the southeastern watershed and one unnamed tributary flowing into The Serpentine. The high TP levels measured in tributaries in the southeastern watershed matches with the watershed loading estimates described in Section 4, which show the highest P load by area coming from the eastern shoreline.

4. Watershed Modeling

The Lake Loading Response Model (LLRM) is an Excel-based model that uses environmental data to develop a water and P loading budget for lakes. Water and P loads (in the form of mass and concentration) are traced from various sources in the watershed to the lake. The model requires detailed and accurate information about the waterbody, including the type and area of land cover, water quality data, lake volume, septic systems, and internal loading estimates, among other important information. Additional LLRM inputs and limitations are provided in Appendix B.

The following section provides an overview of the process by which these critical inputs were determined and utilized for the North Pond LLRM using available resources and presents predicted outputs including how much and where P is coming from in the watershed, as well as in-lake annual average predictions of TP, Chl-a, and SDT. The outcome of this model can be used to identify current and future pollution sources, estimate pollution limits, set water quality goals, provide insight on where future monitoring is needed, and guide prioritization of on-the-ground watershed improvement projects (Ecological Instincts, 2023b).

WATERSHED AND SUB-BASIN DELINEATIONS

Ten major basins were included in the model to estimate P loading at different scales within the North Pond watershed (Figure 14). The basin approach helps watershed managers prioritize on-the-ground conservation planning and target education and outreach in the basins that contribute the greatest amounts of P.

Sub-basin delineations were completed in ArcMap by Ecological Instincts (2023b). Larger drainage basins were divided into smaller sub-basins where one sub-basin passes through another sub-basin to help guide prioritization of areas with higher nutrient loads within a drainage basin. For North Pond, Basin 7 (Sucker Brook), Basin 8 (Clark Brook), and Basin 10 (East Pond) were set up to pass through Basin 9 (The Serpentine). The East Pond watershed is an indirect drainage to North Pond. East Pond is a 1,720-acre lake with a maximum depth of 8.2 m. East Pond has a low flushing rate at 0.37 flushes/year.

LAND COVER

The drainage basins layer was combined with the updated land cover layer (Section 2) to create a land cover breakdown for each basin for use in the watershed model. Table 7 presents land cover types and their associated P export coefficients for the North Pond watershed model while Figure 15 presents the percentage each landcover type in the direct watershed and its corresponding P load.

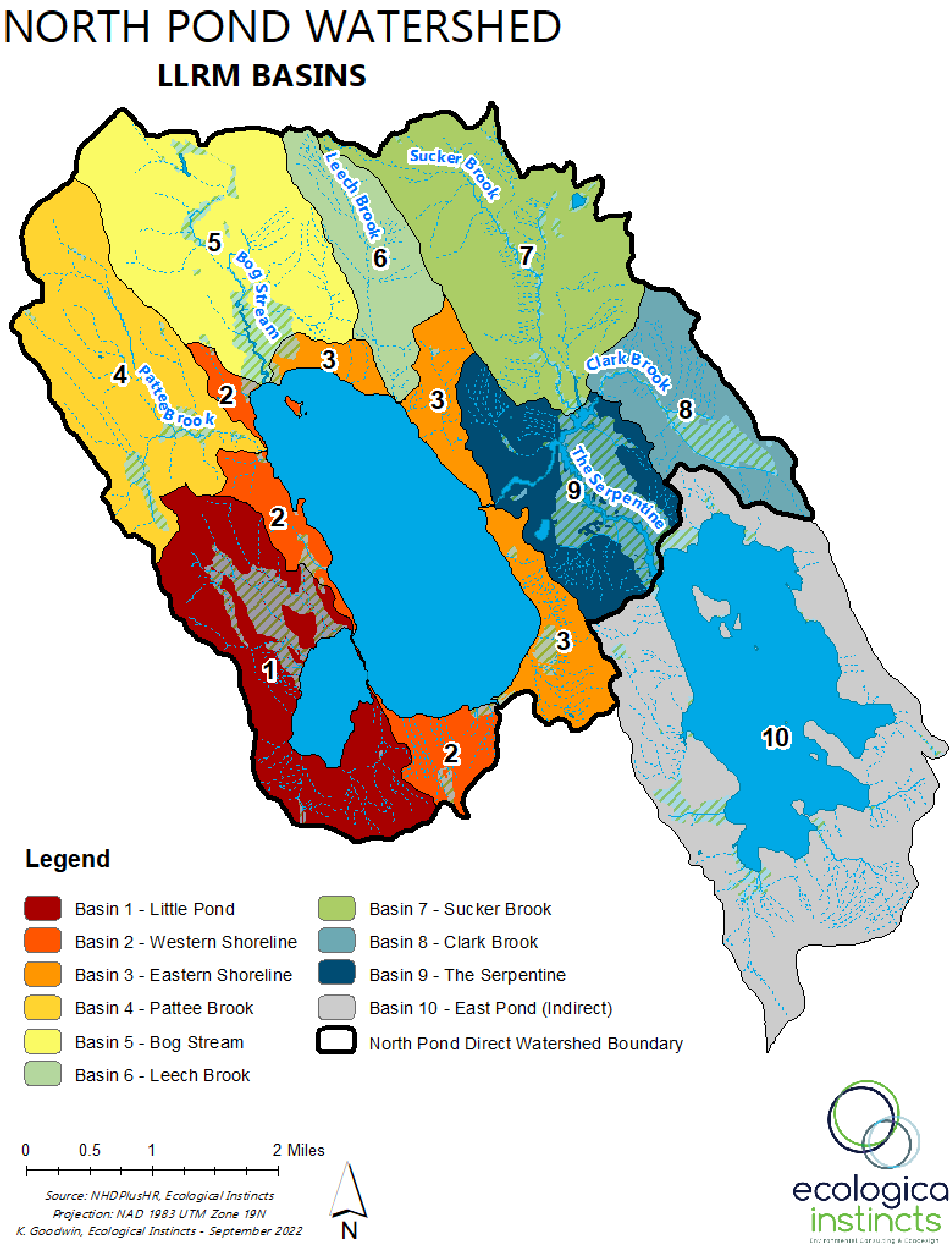
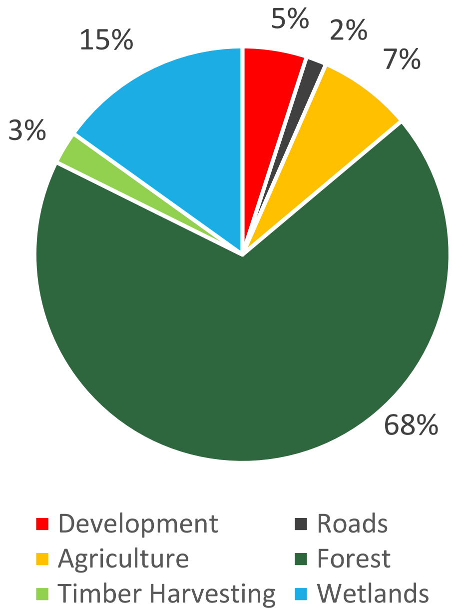


Figure 14. *Drainage basins used in the North Pond LLRM.*

***Table 7**. P coefficients and total land area by land cover type for the North Pond LLRM.*

LAND COVER TYPE	Runoff P export coefficient	Baseflow P export coefficient	Area (hectares) North Pond Direct & East Pond Indirect Watershed
Forest 1 (Upland Forest)	0.08	0.005	4099.3
Forest 4 (Forested Wetland)	0.10	0.005	498.0
Forest 5 (Scrub-Shrub)	0.10	0.005	21.2
Forest 6 (Timber Harvesting)	0.40	0.005	121.6
Agric 1 (Feedlot)	224.00	0.010	0.5
Agric 2 (Row Crops)	1.00	0.010	2.8
Agric 3 (Grazing)	0.60	0.010	72.9
Agric 4 (Hayfield)	0.50	0.010	272.3
Agric 5 (Orchard/Tree Farm)	0.35	0.010	2.7
Open 1 (Open Water)	0.10	0.005	774.7
Open 2 (Meadow/Clearing)	0.20	0.005	13.1
Open 3 (Excavation/Bare Soil)	0.80	0.010	36.6
Other 1 (Freshwater Emergent Wetland)	0.15	0.005	207.7
Urban 1 (LDR/Residential)	0.70	0.010	224.2
Urban 2 (MDR/Commercial)	0.90	0.010	96.5
Urban 3 (Paved Roads)	1.00	0.010	51.2
Urban 4 (Gravel Roads)	1.40	0.010	54.3
Urban 5 (Developed Open Space)	0.60	0.010	6.5
TOTAL			**6,556**

Notably, developed land (development and roads) accounts for 7% of the land area in the direct watershed but accounts for about a quarter (27%) of the total watershed P load (runoff and baseflow). Similarly, agricultural land accounts for 7% of the watershed and approximately 31% of the watershed P load. Estimates of timber harvesting in the watershed are relatively low, accounting for just 3% of the watershed land area, but making up 5% of the watershed P load. On the other hand, undeveloped land, including forests and wetlands, cumulatively covers 83% of the watershed but only 37% of the watershed P load (Figure 15).



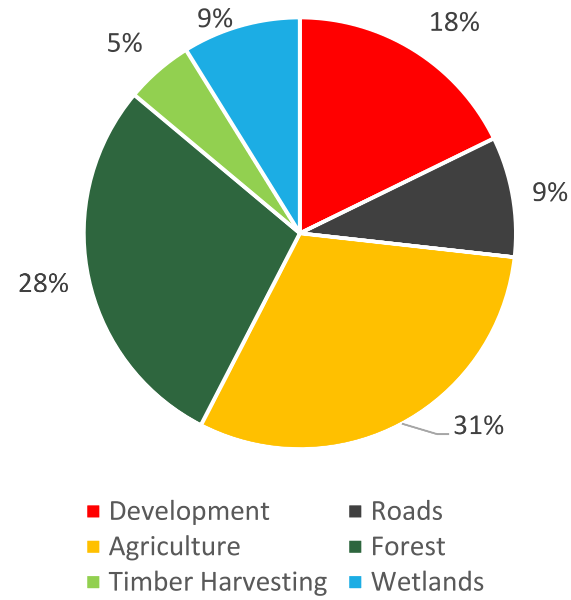


Figure 15. *Watershed land cover area by category as a % of total (left) and corresponding TP load by land cover type (baseflow and runoff P) (right) for the North Pond direct watershed.*

MODEL RESULTS

The current P load to North Pond is estimated at 1,933 kg/yr. The internal load is the greatest source of P to North Pond, representing approximately 50% of the total P load to the lake, followed by P loading from the watershed, which contributes approximately 31% of the total P load (28% direct watershed, 2% indirect watersheds). Septic systems make up an estimated 7% of the total P load, while waterfowl are estimated to make up just 1% of the total load. The remaining 12% of the load is from atmospheric deposition (Figure 16).

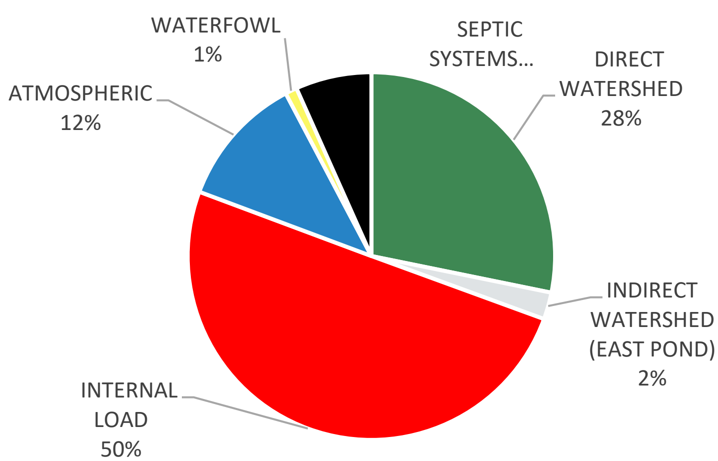


Figure 16. *Percent of the total P load by category for North Pond.*

SUB-BASIN PHOSPHORUS LOADING

The Pattee Brook watershed, which encompasses the northwestern area of the watershed, is estimated to contribute the largest total P load (110 kg/yr) to North Pond, followed by the Sucker Brook drainage and the Eastern Shoreline (96 kg/yr and 90 kg/yr respectively). The East Pond indirect watershed is the largest sub-basin (including the area of East Pond), followed by the Bog Stream watershed. Clark Brook, Leech Brook, and Little Pond are estimated to have the lowest overall P load (Table 8, Figure 17).

***Table 8**. Summary of land area and total phosphorus by sub-basin for North Pond.*

Sub-Basin	Basin Area (ha)	Total P Load (kg/yr)	P Load by Area (kg/ha/yr)
Basin 1- Little Pond	641	34	0.05
Basin 2- Western Shoreline	284	45	0.16
Basin 3- Eastern Shoreline	405	90	0.22
Basin 4- Pattee Brook	676	110	0.16
Basin 5- Bog Stream	766	64	0.08
Basin 6- Leech Brook	299	32	0.11
Basin 7- Sucker Brook	793	96	0.12
Basin 8- Clark Brook	358	17	0.05
Basin 9- The Serpentine	529	56	0.11
Basin 10- East Pond	1,806	46	0.03

On an areal basis, the sub-basins with the greatest P load per hectare are the more developed Eastern Shoreline (Basin 3) and Western Shoreline (Basin 2), followed by Pattee Brook (Basin 4) (Figure 18). While Pattee Brook doesn't contain large amounts of urban development, it contains the largest area of recent timber harvests and the second largest area of hayland in the watershed. In respect to the Eastern and Western Shoreline, drainage areas directly adjacent to waterbodies do not have adequate treatment time and are often most desired for development in a lake watershed, which increases the possibility for greater P export now and in the future. Land cover in Basin 3 includes 63 ha of development (26% of the total developed area in the watershed), including residential and commercial development, as well as 17 ha of paved and gravel roads (22% of the total area of roads in the watershed).

Basins with the highest annual P export in the North Pond watershed also have more development (i.e., shoreline development, roads, agriculture, timber harvests). This reinforces the fact that developed land, and other human-related impacts, can result in an increased export of P to the lake. These are also the areas with the greatest number of documented NPS sites from the 2016 & 2022 watershed surveys. Maps showing phosphorus loading results are presented in Appendix C.

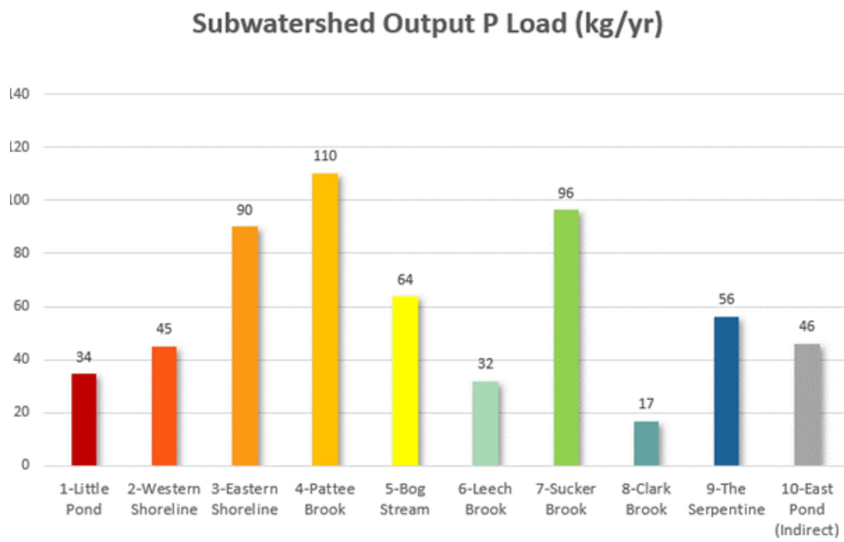


Figure 17. *Phosphorus load by sub-basin in the North Pond watershed.*

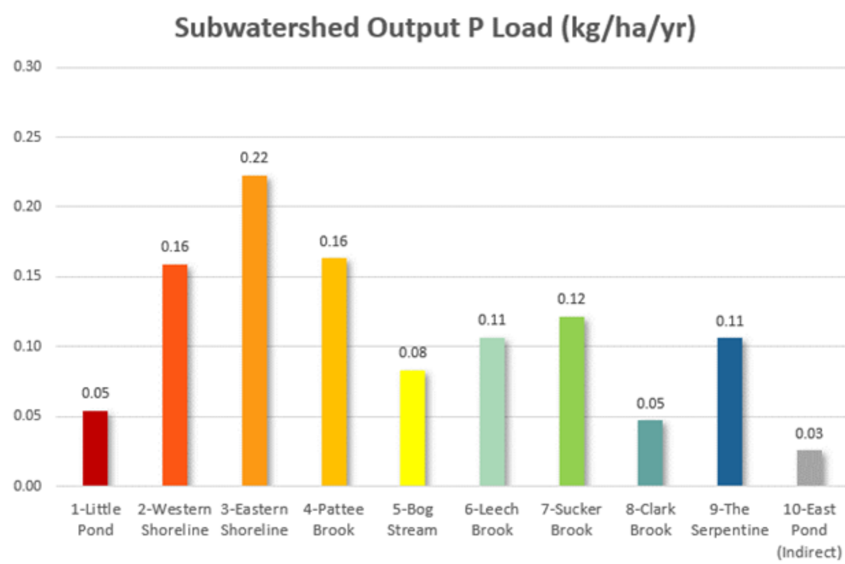


***Figure 18**. Phosphorus load by sub-basin and area in the North Pond watershed.*

Addressing erosion and nutrient management in sub-basins with the highest estimated phosphorus loading and adding effective natural buffers to disturbed shorelines on North Pond will help reduce the amount of sediment and P entering the lake.

PRE-DEVELOPMENT (BACKGROUND CONDITIONS)

Once the model was calibrated for the current in-lake P concentration in North Pond (19 ppb), land cover and other factors that affect model estimates were manipulated to estimate pre-development (background conditions), representing the best possible water quality for the lake before the watershed was developed. The pre-development watershed P load to North Pond is estimated at 273 kg/yr, representing about half of the current watershed load to the lake (Table 9, Figure 19), with a predicted in-lake TP concentration of 4 ppb.

Table 9. *Total phosphorus and water loading summary by source for North Pond for pre-development, current, and future watershed conditions.*

SOURCE CATEGORY	PRE-DEVELOPMENT			CURRENT			FUTURE		
	TP (kg/yr)	%	Water (m^3/yr)	TP (kg/yr)	%	Water (m^3/yr)	TP (kg/yr)	%	Water (m^3/yr)
ATMOSPHERIC	112	26%	24,265,959	224	12%	24,265,959	224	11%	26,617,140
INTERNAL	24	6%	0	969	50%	0	989	47%	0
WATERFOWL	20	5%	0	20	1%	0	20	1%	0
SEPTIC SYSTEM	0	0%	0	129	7%	40,399	138	7%	43,133
WATERSHED LOAD	273	64%	28,922,359	591	31%	29,256,650	744	35%	32,091,389
TOTAL LOAD TO LAKE	**429**	**100%**	**53,188,318**	**1,933**	**100%**	**53,563,008**	**2,115**	**100%**	**58,751,662**

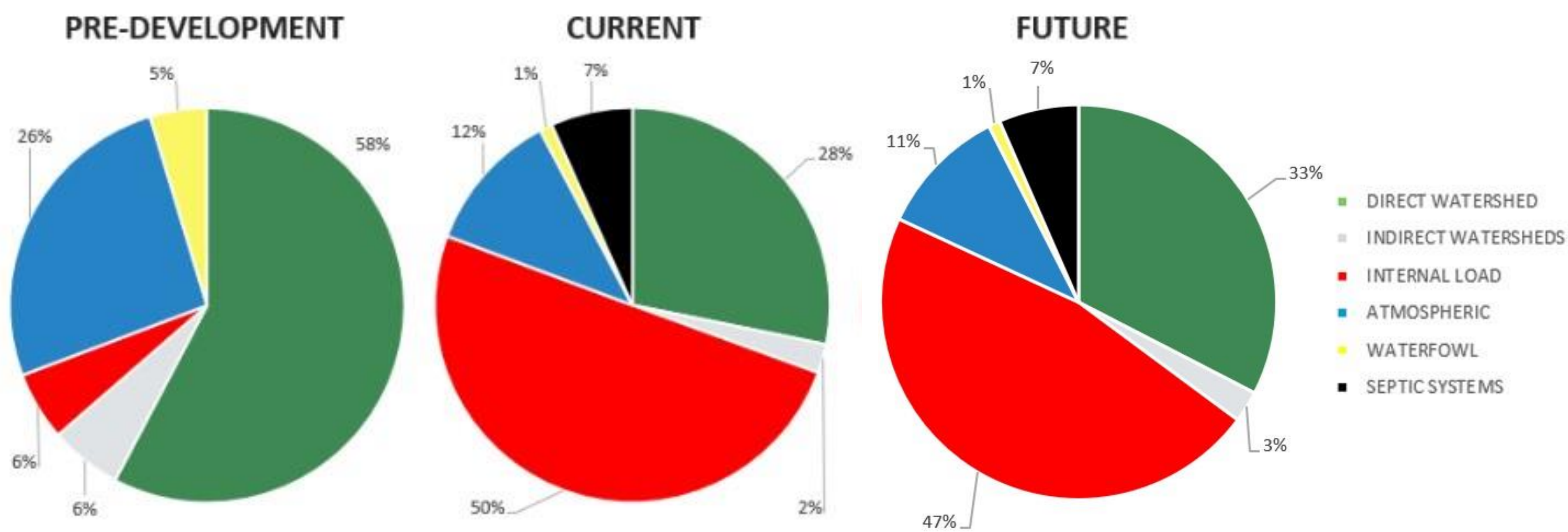


Figure 19. *Percentage of total phosphorus loading (kg/yr) by source to North Pond under pre-development conditions (left), current conditions (center), and future conditions (development & climate change) (right).*

This exercise indicates a significant increase in not only the watershed P load to North Pond from pre-development to present, but also a significant increase in the internal P load from just 6% of the total load to 50% under current conditions.

FUTURE DEVELOPMENT & CLIMATE CHANGE

Primary climate change impacts to lakes include variation in both precipitation and temperature. Higher precipitation periods, usually involving more intense storms, lead to more runoff and greater nutrient loading. Higher (air and water) temperatures lead to increased algal growth, greater oxygen demand due to decomposition, lower oxygen near the lake bottom, and increased P release from surficial sediments where iron is a major P binder (internal loading).The approximate influence of climate change can be evaluated in the LLRM by varying the inputs in accordance with projected climate change effects, generally set at a 10-20% increase based on long-term trends of lakes in the northeast. Climate change's influence on internal loading can be similarly evaluated by increasing the LLRM inputs in accordance with expected oxygen depletion rates, affected areas, and the period of release.

The predicted P increase in North Pond from climate change is based on a 10% increase across the board for precipitation, runoff coefficients for all developed land cover types, the overall watershed load, and the affected area of the internal load. An increase of 120 kg P/yr is estimated based on these conditions. This includes 100 kg/year from the watershed, and 20 kg/yr from internal loading.

Additional loading includes a conservative estimate of 53 kg/yr (or a 0.5 ppb in-lake concentration increase) to reflect loading from future development, and 9 kg/yr from septic systems.[27] In addition to new development on the shoreline, population growth (and an increase in the developed land area in watershed) is expected in the form of conversion of small seasonal camps to larger year-round homes on the shoreline and residential and commercial development outside of the shoreland zone, all of which will ultimately lead to new sources of P to North Pond. Combined, climate change and future development are estimated to increase the in-lake P concentration in North Pond by 1 ppb, and the probability of experiencing an algal bloom under future development and climate change scenarios is estimated to increase by 3% from current conditions (Table 12).

MODEL PREDICTIONS

There was little difference within the model between the observed mean TP in North Pond and the predicted mean TP (Table 10), though annual average TP over the last 10 years has been quite variable with a range of close to 6 ppb between the 5 and 10-year averages. The model predicted a lower average chlorophyll-a concentration than the observed 5-year average value (10.7 ppb) but was closer to the 10-year average (7.6 ppb). The model predicted slightly lower water clarity compared to the mean clarity for the last 5-years (3.2 m) but was closer to the median SDT over the same period (2.5 m). With a high amount

[27] For modeling purposes, an increase of 13 new properties was used in the septic module (9 year-round and 4 seasonal systems).

of variability in water quality over the past 10 years, the median may be the best value to compare to model predictions.

The general empirical equations used in the LLRM do not fully account for all biogeochemical processes occurring within North Pond that contribute to the overall water quality. In particular, processing of nutrients within the lake may vary substantially depending on biological components such as zooplankton and the fish community, neither of which are addressed in the model. Production of algae at the sediment-water interface could allow for greater Chl-a than average upper water column P concentrations would suggest through the model.

For pre-development conditions, the model predicted substantially lower P and chlorophyll-a concentrations and deeper mean water clarity (SDT reaching the bottom of North Pond) compared to current conditions (Table 10). These values fall within the bounds of the classification for a naturally oligotrophic lake.[28] The model predicted an increase in TP by 0.5 ppb and a 0.3 ppb increase in chlorophyll-a, but no change in water clarity as a result of future development and climate change.

Table 10. *In-lake water quality predictions for North Pond.*

LLRM Water Quality Predictions	***Average TP (ppb)***	***Predicted Average TP (ppb)***	***Average Chl-a (ppb)***	***Predicted Average Chl-a (ppb)***	***Average SDT (m)***	***Predicted Average SDT (m)***
PRE-DEVELOPMENT	-	4.3	-	0.8	-	7.5*
*CURRENT ** *	17.5 - 23.4	19.3	7.6 - 10.7	7.1	3.2***	2.4
FUTURE	-	19.8	-	7.3	-	2.3

**Predicted average SDT exceeded the depth of North Pond (5.7 m max depth). Therefore, a value of 5.7 m was used in Table 12.*

***A range of values were used to account for variability in the data over the past 10 years. The high end of the range represents the 5-year average, and the low end of the range represents the 10-year average. Values represent median TP and mean Chl-a.*

****Represents mean SDT between 2018-2022. Median SDT over the same period is 2.5 m, closer to the model prediction.*

ASSESSMENT OF THE INTERNAL LOAD

An analysis of potential internal loading of P to North Pond was conducted by WRS, Inc. (2023) using all available water quality data collected between 1977 and 2022. The analysis revealed that the oxygen demand at the sediment-water interface is likely large enough to allow ongoing release of P from the sediments even though the lake does not stratify strongly enough to experience large areas of anoxia. P that is released from the sediments may immediately be taken up by algae, especially cyanobacteria that later form gas pockets in cells and rise into the water column, and which can be difficult to quantify.

[28] Numerical guidelines for evaluation of trophic status in Maine lists oligotrophic lakes as having average SDT readings of >8 m, Chl-a from <1.5 ppb, and TP of < 4.5 ppb. Current conditions in North Pond fall within the mesotrophic classification due to elevated levels of TP >4.5 ppb, and Chl-a >1.5 ppb.

P MASS IN NORTH POND IN 2022

The mass of P at discrete depth intervals (0-1 m, 1-3 m, 3-5+ m) within North Pond was plotted using data collected in May and October 2022 (Figure 20). In typical stratified lakes there is an accumulation of P in the deeper layers over the summer as internal loading proceeds, generally increasing oxygen is lost from the bottom up, with anoxia sometimes occurring near the thermocline. North Pond does not have a distinct thermocline and does not strongly stratify. Because of this, mixing throughout the water column is extensive and there was only a slight accumulation of P in the deepest layers of the lake in 2022. The overall P concentration in the water column did rise from mid-June through mid-August. The increasing P may be largely a function of uptake by algae[29] at the sediment-water interface which then rise in the water column, bringing excess P with them.

From the low point of P mass in mid-June (471 kg), the P mass increased over the next two months to a peak (1,160 kg) that represented a net increase of 691 kg. Though some of this may be attributed to watershed runoff with a few significant storms occurring during the period of P mass increase, most of the P increase is believed to have been released from sediments exposed to low oxygen.

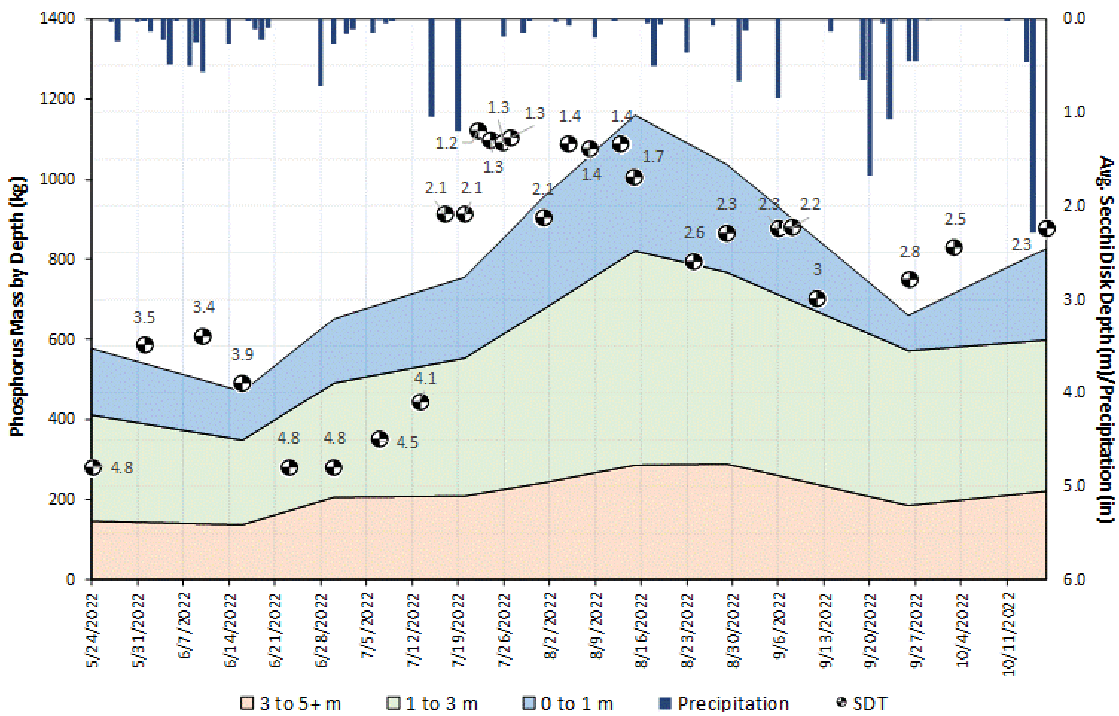


Figure 20. *P Mass at different depths in North Pond between May- October 2022.*

While there are multiple ways by which internal loading of P can occur, the dominant one in New England is for P bound by iron (Fe) to be released under low oxygen conditions. Redox reactions result in both Fe and P being released into the overlying water. If a lake is stratified, much of the released P is trapped in the deeper water. If the distance between the point of anoxia (defined as DO<2 ppm) and the point of light

[29] Notably cyanobacteria, but other algae use this mechanism as well.

penetration into the lake is far enough apart (at least 3 m), available P may not move upward and be used by algae. However, mixing events, algae that move in the water column, and algae that grow at the sediment-water interface with just enough light to grow can all result in internally loaded P reaching the upper waters. Weather patterns can create substantial variation among years, so the portion of internally loaded P that becomes part of the "effective" P load to the lake will vary.

In North Pond:

- Mixing of water in the water column is ongoing and substantial, and the shallow depth may allow adequate light to promote algae growth even in the deepest areas of the lake.
- Although substantial areas of anoxia rarely develop due to mixing, what little oxygen loss is occurring at the sediment-water interface is likely enough to release significant amounts of P from the sediments, feeding algae growth.
- There is adequate oxygen in most of the water column to allow P to be inactivated and re-precipitated to the sediment, meaning that the measured net P mass increase likely underestimates the actual release of P from the sediment.
- Patterns in SDT and overall P mass throughout the summer also support the idea that algae rising from the bottom with excess P then growing in the surface water is a likely mechanism of the observed P increase. This is a common but understudied mechanism of eutrophication.
- The period of increase in P in the water column is at least 60 days and probably closer to 75 days in the deepest areas of the lake.
- Contributing area of P release will vary over time and among years as stratification is weak and transient and oxygen conditions at the sediment-water interface will be highly weather dependent. However, areas of the lake <4 m may not contribute at all to P release, and if they do, it is probably for only a few days compared to areas >4 m which experience low oxygen for an extended period each year going back to at least 2018.

CHANGES OVER TIME

A pronounced shift toward higher P in North Pond in recent years is evident when comparing 1977-2017 data with those from 2018-2022, however, that shift may not be abrupt as it seems given that maximum P from 2013-2017 is similar to 2018-2022, and cyanobacteria blooms were reported in 2011.

- The pronounced increase in P over the last five years clearly signals a productivity problem, and cyanobacteria blooms have become more common with severe blooms in 2018, 2020, and 2022.
- Peak P concentrations appear to coincide with cyanobacteria blooms, consistent with those cyanobacteria being agents for bringing P from the bottom of the lake to the top. While increasing P will tend to lead to increasing algae abundance, the mechanism of growth at the sediment-water interface and rising of cyanobacteria into the water column can actually reverse that relationship; the cyanobacteria may be a cause of increased P concentration, not just a result of it.
- The size of the watershed has not changed over the period of record, and while land use changes have occurred, they are not large enough to represent a likely cause of the shift in water quality.

- Internal loading of P that has accumulated over a long period of time in North Pond appears to be the major driving force behind increased P concentrations.
- Given the shallow nature of North Pond and climate change that causes higher variation in weather conditions, variability among years can be expected to be substantial and **the role of cyanobacteria in the lake's condition can be expected to remain high if that internal load is not addressed.**

SEDIMENT PHOSPHORUS EVALUATION

An evaluation of the redox sensitive P in a 20 cm sediment core sample and 11 box cores collected by 7 Lakes and Colby College across North Pond at various depths were used to estimate potentially available P in the sediments (Figure 21).

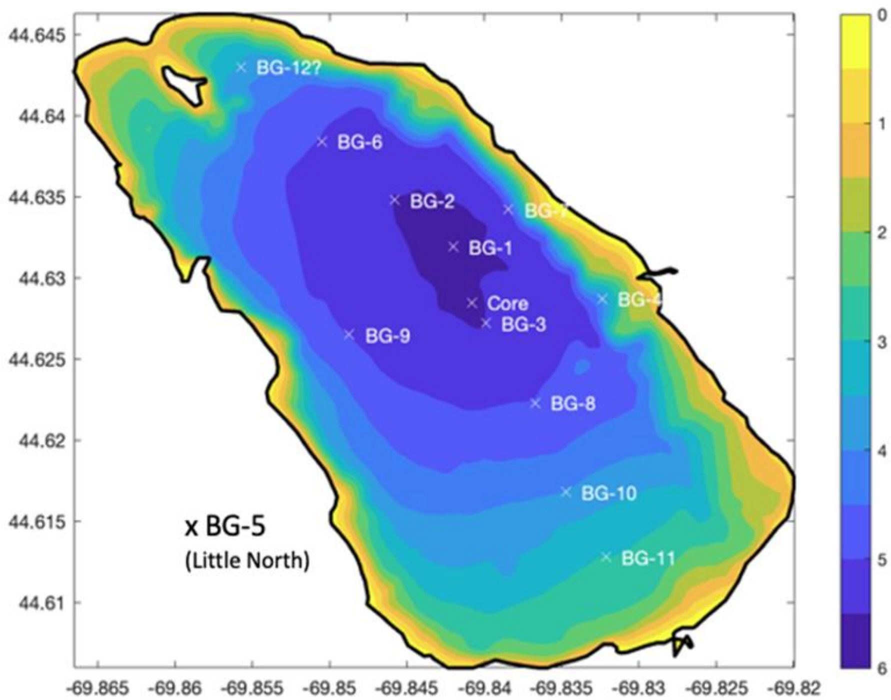


***Figure 21**. Sediment sampling locations in North Pond. Source: Colby College.*

Results of this analysis indicate:

- A distinct decline in the concentration of reducible P in the upper 20 cm of the sediment core, especially between 0 and 6 cm with P mass leveling off with depth (Figure 22).
- Sediments with more organic matter content and sediments associated with deeper water depth also correlated with increased P release that could be expected to release substantial P when exposed to low oxygen.
- The mass of P is highest at the sediment surface, declines gradually to 7 cm, with the 6-7 cm slice having about 1/3 the P mass of the 0-1 cm slice.

- Inactivation of sediment P to reduce internal loading might only need to address the upper 2-3 cm to get a major reduction and might only need to treat the upper 6 cm which includes 76% of the mass of P in the upper 10 cm).[30]
- The largest P mass is in the 5 – 5.5 m depth increment which also represents the largest area (Table 11). However, on an arial basis, the deepest area of the lake >5.5 m has the highest mass by area despite representing the smallest area.
- Based on sediment data, the total internal load based is estimated at 867 – 1064 kg P/yr, making it the dominant P source to North Pond. The sediment-based estimate is slightly higher than the estimate from the 2022 P mass data.

Table 11. *Reducible P mass associated with North Pond areas. (Source: WRS, Inc., 2023)*

Water Depth Increment (m)	***Area (ac)***	***P Mass (kg)***	***Mass/Area (kg/ac)***
>5.5	64	367	5.7
5 – 5.5	431	2130	4.9
4.5 - 5	317	1168	3.7
4 – 4.5	263	672	2.6
3 - 4	411	583	1.4

Typically, lakes with Al:Fe ratios <3 are more susceptible to internal P release (Fitzgibbon, 2017 and Amirbahman, et al., 2022). The 2022 North Pond sediment analysis (Colby, 2023) showed surface Al:Fe ratios ranging from 1.0 and 2.7 with the higher ratios associated with samples collected in shallower water. The Al:Fe ratios for North Pond sediments are well below the ratios that indicate susceptibility to internal P release. North Pond sediments were also collected and analyzed by Fitzgibbon (2017) and Amirbahman, et al. (2022) and found to have similar Al:Fe ratios (1.4 and 2.67, respectively).

A third method for estimating internal loading is to model it based on assigned release rates and duration of release based using the available empirical data. WRS utilized the Lake Loading Response Model (LLRM), setting duration of anoxia at 60-75 days for the deepest areas, 45 days for the intermediate area, and 30 days for the shallowest area. Release rates of 3 to 6 $mg/m^2/day$ were used for the shallowest to the deepest areas of the lake, respectively. Using this method, the LLRM estimates an **internal load of 969 kg/yr**, which aligns with the range estimated based on the sediment chemistry but slightly higher than the 2022 P mass estimates described above.

Based on the analysis of P mass, sediment chemistry, and watershed modeling, **internal loading is considered the dominant component of overall P loading to North Pond at 50% of the total load.** That cyanobacteria are likely utilizing the P released by sediment before it ever enters the water column makes the transfer into the water column very efficient.

[30] Based on a single core sample.

An evaluation of remediation options and costs for addressing the internal load and preventing algal blooms from occurring was provided by WRS (2023). Options that were considered included dredging, oxygenation, P inactivation, selective withdrawal, and biomanipulation. **The recommendation for North Pond is to treat the sediment area subject to low oxygen (>4 m) with aluminum to bind P in surficial sediments and make P reserves less susceptible to release.** The effects should be immediate, with the uppermost sediment P inactivated first and P in the water column reduced. A single treatment for all areas >4 m (Figure 22) is estimated to cost $1.3M, effectively reducing the internal load by 90%, reducing the overall P load to North Pond by 45%, and providing water quality benefits for 10-20 years while watershed work is conducted to reduce external loading.

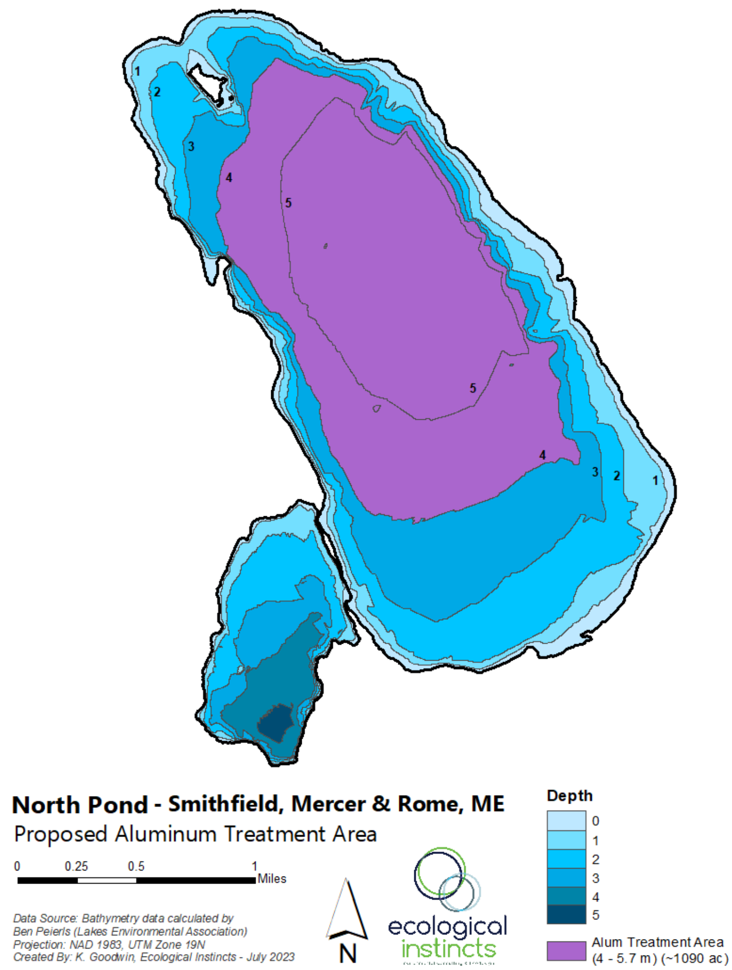


***Figure 22**. Map of proposed aluminum treatment areas for North Pond (purple).*

Additional sediment testing is recommended prior to conducting an aluminum treatment to finalize treatment area and dosing recommendations.[31]

[31] Colby, 7 Lakes, NPA, Maine DEP, WRS, and Ecological Instincts will finalize a follow-up sediment sampling and testing plan in mid-October 2023. Samples are expected to be collected by 7 Lakes in October 2023 and analyzed by Colby in January 2023. Follow-up analysis is expected to include sediment assays, or "jar tests".

WATER QUALITY TARGET SELECTION

The LLRM was used to evaluate possible water quality targets for the North Pond WBMP. This required calculating practical watershed P reductions (and resulting in-lake P concentrations) that will result in meaningful water quality improvements. The approach was guided by watershed partners including members of the project's Technical Advisory Committee. Load reduction estimates were calculated for 2022 watershed survey sites, and the DEP relational method for P reductions was used to derive estimated load reductions for developed land in the direct and indirect watershed (East Pond). The methods for estimating P load reductions for the North Pond WBMP is provided in Appendix D.

For North Pond, with an estimated pre-development P concentration of 4 ppb, and current P concentration of 19 ppb, the difference is quite large. However, moving the lake substantially toward pre-development conditions will be an exceedingly difficult challenge given the present level of development in the watershed. The LLRM was used to set an in-lake phosphorus target for North Pond based on achievable P load reductions over the next 10 years (Table 12). **An in-lake TP concentration of 10 ppb is recommended for North Pond, which will require a 50% P reduction (-9 ppb) over the next 10 years.** Achieving this goal will require a reduction in the watershed load by 10% (58 kg/yr), a 25% reduction in the septic system load (32 kg/yr) and reducing the internal P load by 90% (872 kg/yr). However, these reductions come with a cost. Addressing the internal load alone is estimated to cost $650,000- $1.27M[32] with an expected longevity of up to 10 years.

Addressing the internal load, which accounts for an estimated 50% of the total phosphorus load, will help break the cycle of annual nuisance algal blooms while efforts continue to reduce the watershed load. This goal cannot be achieved without addressing both the internal and external watershed load and does not account for the 1 ppb increase in P due to future development and climate change.

[32] Water Resources Services, Inc. Internal loading to North Pond. July 7, 2023.

Table 12. *Modeled water quality and P loading predictions under future development and climate change scenarios, current conditions, various target load reduction conditions, and pre-development (background conditions) for North Pond.*

In-lake P concentration	**20**	**19**	**18**	**11**	**10**	**4**
Reduction (kg/yr) from Current Total P Load	*+182*	*0*	-90	*-872*	*-962*	*-1504*
	Future Development & 10% Climate Change Scenario	**Current**	**External Load Reduction (5%)**	**Internal Load Reduction (45%)**	**External & Internal load (50%)**	**Background Conditions***
Atmospheric	224	**224**	224	224	224	112
Internal Load	989	**969**	969	97	97	24
Waterfowl	20	**20**	20	20	20	20
Septic Systems	138	**129**	97	129	97	0
Watershed Load	744	**591**	533	591	533	273
TOTAL LOAD TO LAKE	**2115**	**1933**	**1843**	**1061**	**971**	**429**
SDT Avg	2.3	**2.4**	2.5	3.8	3.9	5.7
SDT Max	4.2	**4.3**	4.3	5.0	5.1	5.7
Chl-a Avg	7.3	**7.1**	6.7	3.2	3.0	0.8
Chl-a Max	25	**25**	23	12	11	4
Bloom Probability	34%	**31%**	27%	2%	1%	0%
Flushing Rate	**1.8**	**1.6**	1.6	1.6	1.6	**1.6**

5. Climate Change Adaptation

Current Maine DEP guidance calls for developing watershed management plans that incorporate climate change considerations. This guidance would be addressed to a large extent by any plan that focuses on stormwater inputs and minimzing the internal P load. The primary climate change impacts on lakes are variation in precipitation and temperature. Higher precipitation periods, usually involving more intense storms, lead to more runoff and greater nutrient loading.

Higher (air and water) temperatures lead to earlier ice-out and later ice-in, resulting in longer and stronger stratification periods, which leads to increased algal growth, greater oxygen demand due to decomposition on the lake bottom, lower oxygen near the lake bottom, and increased P release from surficial sediments where iron is a major P binder (internal loading). Warmer water temperatures and increased P also favor invasive species, cyanobacteria, and harmful algal blooms (HABs) that produce toxins harmful to humans and wildlife. Increasing temperature and dissolved organic carbon (DOC) in lakes has a direct effect on thermal and biological dynamics, ultimately favoring nutrient-loving species (like toxin-producing cyanobacteria) over species adapted to cooler water temperatures.

Photo Credit: Jodie-Mosher Towle

Between 2015 – 2020, the Gulf of Maine experienced its warmest 5-year period on record (Pershing, et. al., 2021), warming at a rate seven times faster than the rest of the ocean. A 2020 report from the Maine Climate Council confirms that over the last several decades, air and surface water temperatures have been increasing in Maine. Surface water temperatures in northern New England increased 1.4 °F per decade from 1984-2014, which is faster than the worldwide average, with Maine lakes warming on average by nearly 5.5 °F during this time. Data also show that smaller lakes and ponds are warming more rapidly than larger lakes. The statistical analysis of water quality data in North Pond indicates a significant increase in the surface water temperatures of North Pond since 1978, which appears to be largely driven by the increase in August surface temperatures (7 Lakes Alliance, 2023c).

Movement toward bigger and more frequent storms presents another challenge for watershed management and exacerbates the internal loading problem as more intense rainfall will increase the amount of nutrient transport to the lake from the watershed via stormwater runoff that will be available for algal growth. P loading is very strongly connected to precipitation, and disrupting that relationship is not an easy task.

These climate-related changes are likely to exacerbate water quality issues in North Pond, necessitating additional P load reductions from watershed sources to offset the anticipated increases due to climate change. Though water quality in many Maine lakes has improved as a result of laws and regulations that protect water quality by mitigating the effects of human development, the effects of climate change threaten the effectiveness of these dated laws that may need adjusting to adequately protect natural resources in the future (MCC, 2020).

Watershed modeling estimates **an additional 120 kg P/yr could be delivered to North Pond due to climate change.**[33] It is important to remember that the watershed is not a static system, and the P load will continue increasing over time without taking actions to address these changes. The estimated increase above could be exceeded with just a few unforeseen large-scale climatic events that deliver a lot of sediment to the lake in a single pulse. Climate change adaptation planning, such as upgrading infrastructure on roads (i.e., undersized culverts), infiltrating stormwater runoff on commercial and residential properties, planting buffers, and conserving undeveloped land, can help to counteract the effects of the anticipated increase in precipitation. Infiltration of stormwater runoff reduces runoff volume, decreases P through filtration and adsorption, and importantly, decreases the temperature of the runoff water.

Current and future generations of lake users should expect to see warming air and water temperatures, longer ice-free periods, and an increase in precipitation and runoff in the watershed. Photo Credit: Jodie Mosher-Towle

A good starting point for adaptation planning includes ensuring that all watershed towns are enrolled in the State's Climate Resiliency Partnership (CRP), formation of a Community Climate Change Committee, and development of a Climate Change Action Plan that incorporates a regional watershed climate model. The plan would include a prioritized list of community actions using guidance from the Maine Climate Council and the Maine DEP's Adaptation Toolkit. A more detailed list of planning actions to mitigate the effects of climate change is presented in Section 7.

[33] Model inputs included a 10% increase in precipitation, 10% increase in runoff coefficients for developed land uses, an overall watershed load increase of 10% and a 10% increase in the affected area of internal loading. This includes an additional 20 kg/yr from internal loading.

6. Establishment of Water Quality Goals

Findings from the current evaluation of water quality data and watershed modeling indicate that reducing P loading from the watershed is an important component of the long-term strategy to restore water quality. However, **internal P loading was identified as <u>the major source of P loading in North Pond making it a necessity to also reduce internal loading</u> in order to successfully restore water quality**.

A team of scientists and local stakeholders worked collaboratively over two years to set a revised water quality goal for North Pond that would help stabilize and improve water quality trends in North Pond. Specifically, the committee reviewed the results of the water quality analysis (7 Lakes, 2023c), watershed modeling and future loading scenarios (Ecological Instincts, 2023b), and internal loading analysis (WRS, 2023) to set the goal. Watershed assessment work, including the 2022 NPS Assessment (7 Lakes, 2023d), the Ag/Forestry Survey (SCSWCD, 2022) and past NPS implementation projects, were evaluated to determine if revised water quality goals could be met based on past performance and proposed load reduction estimates.

WATER QUALITY GOAL

North Pond exhibits improving water quality trends & reduced frequency of algal blooms

Current In-Lake Concentration= 19 ppb
In-Lake Phosphorus Goal= 10 ppb
Reduction In-Lake Concentration= 9 ppb

"P" REDUCTIONS <u>NEEDED</u>

Direct Watershed: - 90 kg/yr
- 58 kg/yr direct watershed
- 32 kg/yr septic systems

Internal Load: - 872kg/yr
90% reduction of internal load

Timeframe: 2024- 2033

Projects: Erosion Control BMPs, LakeSmart, Septic Upgrades, Aluminum Treatment

The goal of this plan is to reduce the current P load by approximately 50% resulting in a reduction in the average annual in-lake TP concentration by 9 ppb (from 19 ppb to 10 ppb), which equates to a P reduction of 962 kg/yr. This can be achieved by:

- Reducing the external load in the <u>direct watershed</u> by 58 kg/yr (18 kg/yr agriculture, 32 kg/yr urban development, 8 kg/yr timber harvesting);
- Reduce P loading from <u>septic systems</u> by 32 kg/yr; and
- Reducing the <u>internal load</u> by 872 kg/yr.

7. Watershed Action Plan & Management Measures

The North Pond WBMP provides strategies for achieving the water quality goal. These recommendations are outlined in detail in the plan and were presented to the steering committee and the public for review and feedback. The action plan represents solutions for improving water quality in North Pond based on the best available science. The plan is divided into six major objectives (A-F), along with a schedule for completion, description of potential funding sources, and a list of project partners assigned to each task. The objectives focus on:

- **A) Restoration - Reduce the External P Load**
- **B) Internal P Load in North Pond**
- **C) Prevention – Reduce new Sources of NPs Pollution**
- **D) Education, Outreach & Communications**
- **E) Build Local Capacity**
- **F) Science – Conduct Long-Term Monitoring & Assessment**

REDUCING THE EXTERNAL LOAD

Addressing NPS pollution from watershed sources is an important part of a multi-step, multi-year process to make a significant difference to restore the current state of water quality in North Pond. Addressing the external load will require ongoing work annually over the ten-year period and beyond, both in the direct and indirect watersheds. Success of this work will depend on cooperation from landowners, towns, and businesses to reduce the watershed load by 58 kg P/yr.

Load reductions were estimated for North Pond using three different models to develop the best estimates. A summary of methods for calculating load reductions is provided in Appendix D. A combination of the three models was used to set the water quality goal. While the DEP Relational Method estimated a slightly smaller load reduction, the method itself shines some light on the challenge ahead. This includes:

- **Agriculture**- Address 5% of row crops and 25% of hay/grazing land
- **Urban Development-** Address 50% of low and medium-intensity residential and commercial development, and 30% of roads
- **Non-developed land-** Address 25% of recent timber harvests
- **Septic Systems-** Address 50% of septic systems on the shoreline

WATERSHED NPS SITES

In 2016, volunteers and technical staff completed a survey of the North Pond watershed to identify sites in the watershed that contribute nonpoint source (NPS) pollution to North Pond (Ecological Instincts, 2017a). In 2022, 7 Lakes revisited the sites identified in the 2016 watershed survey to update the status of those sites, resulting in a list of 91 sites that are currently sources of NPS pollution to the lake (Appendix E). NPS sites were documented across nine different land uses (Table 13). The number of residential properties far outweighed the other land use types. The impact that documented NPS sites may have on the water quality of North Pond was determined during the survey based on the proximity to a waterbody and the magnitude of the problem. Factors such as slope, amount of eroding soil, and buffer size were also considered. While there were a total of 91 sites documented, only seven ranked high impact compared to 37 medium, and 47 low impact sites (Table 13). The majority of high impact sites were located on residential properties, with one beach access site. Residential NPS sites make up the greatest number of high and medium impact sites, 62% of all low-impact sites, and 49% of all NPS sites. The majority of medium impact sites were located on private roads and residential properties (Table 13). An additional eight medium impact sites are located on driveways and town roads.

Table 13. *Summary of NPS sites in the North Pond watershed by land use and impact. (Source: 7 Lakes, 2023d)*

Land Use	High Impact	Medium Impact	Low Impact	Total
Residential	6	10	29	**45**
Private Road		17	9	**26**
Driveway		4	3	**7**
Town Road		4	3	**7**
Beach Access	1		1	**2**
Boat Access			1	**1**
Commercial		1		**1**
Municipal/ Public			1	**1**
Trail/ Path		1		**1**
Total	**7**	**37**	**47**	**91**

BUFFERS

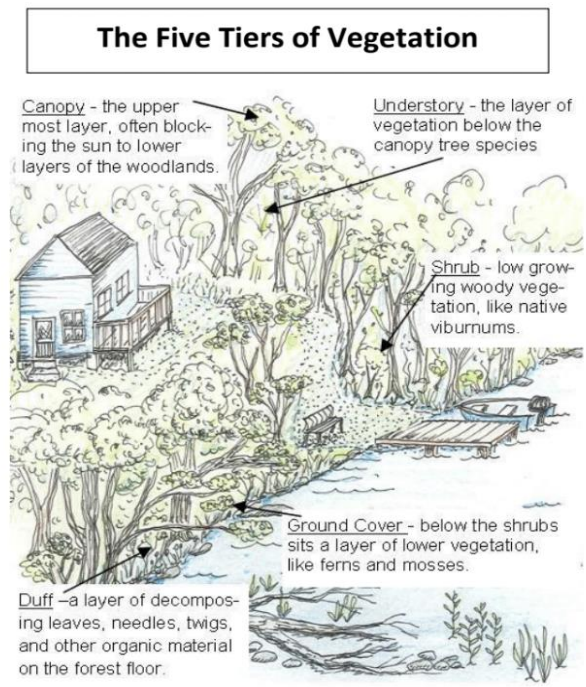
Installing an effective shoreline buffer can be one of the easiest ways to help improve water quality. Natural vegetated shorelines are often the "last line of defense" for trapping and treating polluted stormwater runoff before it gets to the lake. A healthy, vegetated shoreline will not only act as a buffer between the lake and adjacent shoreline development but will also provide great benefit to wildlife as more species live in (and rely on) shoreline riparian zones than any other habitat type (Maine Audubon, 2006). Increasing development pressure throughout the watershed, and especially within the shoreland zone of North Pond, and the effects of climate change (more frequent and more intense precipitation and increased

Shoreline buffer installation on a lakefront property. (Source: https://www.uwp.edu) volume and velocity of stormwater runoff) means that healthy, vegetated shoreline buffers will be even more important for achieving water quality goals and maintaining a healthy lake ecosystem.

The 2016 watershed survey documented a general lack of adequate buffers on developed shoreline properties. 7 Lakes currently runs a LakeSmart program that has certified 13 properties and awarded commendations for 24 properties between 2020-2022. This plan recommends continuing to encourage shorefront property owners to participate in the program, with the **goal of completing 50 new LakeSmart evaluations by 2032**. LakeSmart currently requires a vegetative buffer zone that is at least 10-feet deep (on average) comprised of all three of the vegetation stand types (ground cover: <2 ft, small trees and shrubs: <6 ft, and trees and large shrubs: >6 ft) to ensure that stormwater runoff is captured and infiltrated within the buffer, raindrops are interrupted by overstory vegetation, and the overall function of the shoreline is maximized.

Outreach efforts will include a buffer campaign with easy-to-follow guidance for installing effective shoreline buffers highlighting the importance of **buffer quality**- as a healthy and functioning shoreline buffer includes more than just the installation of native plantings. The quality of the soil and a healthy duff layer is just as important when constructing an effective vegetated shoreline.

In addition to encouraging participation in the LakeSmart program, several phases of federal grants (particularly Clean Water Act Section 319 grants awarded by the US EPA to Maine DEP) will be sought to address high and medium impact sites on commercial properties, driveways, and residential properties on the shoreline, with a goal of addressing 7 high impact sites, 37 medium impact sites, and 47 low impact sites over the next 10 years.



Example of an effective shoreline buffer with five tiers of vegetation. (Source: Maine Lakes)

AGRICULTURE AND FORESTRY

An assessment of active forestry and agriculture operations in the watershed was completed in 2022 by the SCSWCD in partnership with KCSWCD and USDA/NRCS. Over the years, NRCS staff have worked with several foresters and farmers in the watershed to implement conservation practices that are protective of water quality through USDA programs. These programs provide financial support to farmers for the implementation of conservation practices through the Environmental Quality Incentives Program (EQIP), among other initiatives. Specific information was gathered for approximately 1,369 acres of forest and agricultural land in the watershed, identifying specific conservation practices that have been implemented on these land units through work with NRCS.

Additional information was collected through field observations and landowner meetings from spring site visits conducted by SCSWCD personnel. Based on recommendations from a local watershed resident and project Steering Committee member, District personnel met with five different property owners to discuss current agricultural practices. The assessment also included a review of the 2022 land cover update completed by Ecological Instincts.

FORESTRY

The land cover map for the North Pond watershed includes six distinct forest types in the watershed including: deciduous forest, non-deciduous forest, mixed forest, forested wetland, scrub shrub, and timber harvesting. The land cover survey estimates a total of 9,425 acres of land in forest production, representing 66% of the total land area in the watershed. The area of recent timber harvests (within last 5 years) is estimated to cover 300 acres, or 2.1% of the forested area in the watershed. According to NRCS records, a total of 18 NRCS conservation forestry practices have been applied since 2005 in the North Pond watershed including practices such as access road, brush management, forest management plans, forest stand improvement, forest trails and landings, land clearing, and upland wildlife habitat management.

AGRICULTURE

In spring and summer of 2022 SCSWCD personnel met with NRCS District Conservationists from Kennebec and Somerset County to review active agricultural operations in the watershed. Only one agricultural conservation practice has been applied to farmland in the watershed through the NRCS since 2005, consisting of nutrient management on two acres of pasture in 2009. Based on the land cover map, there are very few current active agricultural operations in the watershed. Existing agricultural operations in the watershed include small alpaca, horse, goat, chicken, and hay operations. The land cover survey estimates a total of 858 acres of land in agricultural production including 7 acres of row crops, 172 acres of pasture/grazing, 1 acre in feedlot, 671 acres of hayfield, and 7 acres of orchard/tree farm, all together representing 6% of the total land area in the watershed.

The following actions are recommended for reducing the external load by reducing P loading in the watershed. A detailed planning schedule, potential funding sources, and estimated costs for 17 related actions is provided below.

ADDRESS DOCUMENTED NPS SITES ACTION ITEMS & MANAGEMENT MEASURES					
Action Plan & Management Measures		**Schedule**	**Who**	**Potential Funding Sources**	**Estimated Cost** (10 years)
A. Reduce External Phosphorus Load (NPS Sites)					
A1	Reduce P export from agricultural land in the watershed (focus on manure management/row crops)	Years 1-10	Farmers, USDA/NRCS, KCSWCD/SCSWCD	USDA/NRCS, US EPA (319), Maine DEP	$500,000
A2	Provide outreach to landowners regarding proper use of timber harvesting BMPs and conduct follow-up site visits for large harvests	Years 1-10	Maine Forest Service	MFS	n/a

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
A3	Review list of **44 high and medium impact sites from the 2022 watershed survey** and develop a **candidate site list** for future 319 grant applications	Year 1	7 Lakes, NPA, Steering Committee	NPA, 7 Lakes	$500
Address High Impact NPS Sites (7 sites)					
A4	Address NPS sites on residential properties ***Goal: 6 residential sites***	Years 1-3	7 Lakes, NPA, private property owners	US EPA (319), Maine DEP, landowners	$24,000
A5	Address NPS sites on beach access sites ***Goal: 1 beach access site***	Years 1-3	7 Lakes, NPA, private property owners	US EPA (319), Maine DEP, landowners	$5,000
Address Medium Impact NPS Sites (37 sites)					
A6	Address NPS sites on private roads ***Goal: 17 sites***	Years 1-10	7 Lakes, NPA, landowners, road associations	US EPA (319), Maine DEP, landowners, road associations	$221,000
A7	Address NPS sites on residential properties ***Goal: 10 sites***	Years 1-5	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$20,000
A8	Address NPS sites on driveways ***Goal: 4 sites***	Years 1-5	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$16,000
A9	Address NPS sites on town roads ***Goal: 4 sites***	Years 1-5	Towns, 7 Lakes	US EPA (319), Maine DEP, watershed towns	$32,000
A10	Address NPS sites on trails or paths ***Goal: 1 site***	Years 1-3	7 Lakes, NPA, landowner	US EPA (319), Maine DEP, Maine DOT	$1,000
A11	Address NPS sites on commercial sites ***Goal: 1 site***	Years 1-3	7 Lakes, NPA, landowner	US EPA (319), Maine DEP, landowners	$5,000
Address Low Impact Sites (47 sites)					
A12	Work with residential property owners to address low-impact residential NPS sites ***Goal: 29 sites***	Years 1-10	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$43,500
A13	Encourage shorefront properties to get a LakeSmart evaluation ***Goal: 50 new evaluations completed***	Years 1-10	NPA, 7 Lakes, Landowners	NPA, Maine Lakes, landowners, US EPA (319), Maine DEP	$37,500
A14	Work with road associations and homeowners to address low-impact private road sites ***Goal: 9 sites***	Years 3-7	7 Lakes, NPA, landowners	Road associations, private landowners	$27,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
A15	Address low-impact sites on town road and municipal/public sites ***Goal: 4 sites***	Years 1-5	Towns, 7 Lakes, NPA	Watershed towns, US EPA (319), Maine DEP	$20,000
A16	Address low-impact sites on driveways ***Goal: 3 sites***	Years 1-3	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$12,000
A17	Address low-impact sites on beach and boat access sites ***Goal: 2 sites***	Years 1-2	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$4,000
External Phosphorus Load (NPS Sites) Subtotal					**$968,500**

SEPTIC SYSTEMS

Septic systems are estimated to contribute 7% of the total P load to North Pond. However, there are still many unknowns about their impact and the total load could actually be larger, depending on the state of these systems. Just one or two failing septic systems leaching nutrient-rich wastewater into the lake could result in localized water quality problems. With 259 parcels located on sensitive soils in the watershed, it is likely that some of the septic systems in the watershed are short-circuiting and contributing P and Nitrogen (N) among other pollutants, directly to the lake.

The following actions are recommended for reducing the external load from septic systems. The goal is to reduce P by 32 kg/yr through septic system inspections and upgrades. A detailed planning schedule, potential funding sources, and estimated costs for ten related septic system actions is provided below.

REDUCE NPS FROM SEPTIC SYSTEMS
ACTION ITEMS & MANAGEMENT MEASURES

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
Reduce NPS from Septic Systems (Upgrade 50% of old systems)					
A18	**Finalize the 2022 septic system database** by combining with septic vulnerability analysis and NPA septic system survey and incorporating records from Mercer and Rome	Years 1-2	NPA, 7 Lakes, Colby, Consultant	Grants, NPA	$5,000
A19	**Prioritize list of systems** based on risk to water quality and **offer technical assistance to landowners with high risk systems**.	Years 1-2	NPA, 7 Lakes, Colby	Grants, NPA	$5,000
A20	Offer landowners free septic evaluations & septic designs for high priority systems ***Goal: 20 free evaluations, 10 system designs***	Years 2-5	NPA, 7 Lakes, Site Evaluators	Grants, NPA, watershed towns	$25,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
A21	Provide cost-share grants to assist landowners with replacing problem septic systems **Goal: 10 systems (targeted outreach to landowners with systems >20 years old and/or failing or malfunctioning systems)**	Years 3-10	NPA, 7 Lakes, KCSWCD/SCSWCD, DHHS, watershed towns	Grants, landowners, NPA, watershed towns	$80,000
A22	Develop a long-term **septic inspection and pumping rebate program** to encourage timely septic maintenance	Years 1-3	NPA	NPA	$50,000
A23	Conduct community outreach regarding **DEP Small Community Septic System grants** for malfunctioning systems to eligible landowners with high priority systems	Years 1-10	NPA, Watershed Towns	Watershed towns	$500
A24	Require **proof that septic systems have been installed to code** when properties change from seasonal to year-round status, and require replacement if proof is not available	Years 1-10	Watershed Towns	Watershed towns	$1,500
A25	Create a system for adequately **tracking septic inspections** conducted for all real estate transactions in the shoreland zone; this may include an ordinance that requires new homeowners to submit a copy of their inspection report to the town	Years 1-2	Watershed Towns	Watershed towns	$5,000
A26	Create a permitting system and **registration requirement for rental properties on the shoreline** to minimize impacts from undersized septic systems	Years 2-4	Watershed Towns	Watershed towns	$10,000
A27	**Improve town administration** to digitize existing septic records and maintain records	Years 3 - 10	Watershed Towns	Watershed towns, infrastructure grants	$30,000
External Phosphorus Load (Septic Systems) Subtotal					**$212,000**
Reducing the External Load Total					**$1,180,500**

ADDRESSING THE INTERNAL LOAD

Addressing watershed sources alone will not be enough to prevent nuisance algal blooms in North Pond. Internal loading from sediments exposed to low oxygen is estimated to make up 50% of the P load in North Pond and is a key factor in the dynamics causing elevated P in the lake which fuels recurring nuisance algal blooms. **The internal load will need to be reduced to meet desired water quality targets and conditions in the lake.**

PRELIMINARY EVALUATION OF REMEDIATION OPTIONS

There are several ways to directly address algal blooms caused by internal P loading, but the focus of remediation should be on preventing blooms from occurring. P inactivation was recommended as the most cost effective and immediate method for reducing the internal load,[34] minimizing algal blooms, and setting the P concentrations back to pre-2018 conditions (WRS, 2023).

A large barge is used to conduct an aluminum treatment at upstream East Pond to address chronic internal P loading. (Photo credit, 7 Lakes) Alliance)

Phosphorus inactivation can be used three ways: to treat incoming water high in P, to strip P from the water column in a lake, or to bind P in surficial sediments and make reserves less susceptible to release under anoxia. The most advantageous approach for North Pond would be a treatment of the sediment area subject to anoxia with a P binder such as aluminum. The track record for such treatments is favorable, including past efforts in Maine, and the empirical evidence that higher Al:Fe ratios in the sediment prevents phosphorus release also favors this approach.

In North Pond, successful P inactivation of sediment under water >4 m deep could result in a reduction of at least 90% of the internal load would be expected, reducing the internal P load from the projected value of 969 kg/yr to a level near 97 kg/yr. Successful P inactivation of all sediment under water >4 m deep could reduce the average P concentration in the lake by about 45%. This would set North Pond back to P concentration levels observed prior to 2018.

The sediment analysis conducted by Colby College (Colby, 2023) examined the iron and aluminum content of the sediment and was used to determine the potential for P release from anoxic sediments. Samples with low Al:Fe and Al:P ratios indicated the potential for significant P release into the water. Sediment with higher organic matter content as well as deeper water depth also correlated with increase P release. These results support the recommendation for increasing the aluminum concentration in bottom sediments to prevent P release into the water column. However, while a total of 12 samples were analyzed from various depths across the lake (at half meter intervals in water >4m) clearly show increasing P release as a function

[34] Other management options considered for North Pond include dredging, oxygenation, selective withdrawal, and biomanipulation.

of depth, organic matter content, and Al:Fe ratio, preliminary aluminum treatment dosing recommendations and costs are based on sediment density. Additional sediment testing should be completed to finalize dosing recommendations which may include collecting additional sediment samples from all depths >4 m and conducting sediment assays.[35]

Aluminum is used extensively in water treatments worldwide. When applied in a lake, it is buffered to remain pH neutral and will not harm fish when applied properly. Fish and aquatic life surveys will be conducted before, during and after the treatment, as well as in-plume monitoring of pH, and floc evaluation during treatment to ensure that pH remains neutral, and coverage is as intended.

To reiterate, watershed management by itself will not achieve desired water quality conditions in North Pond but will provide protection for the future and increase the efficacy of an in-lake treatment which is necessary to meet the objective of restoring water quality and minimizing algal blooms. The following actions are recommended for reducing the internal loading in North Pond. A detailed planning schedule, potential funding sources, and estimated costs for six related actions is provided below.

REDUCE THE INTERNAL LOAD
ACTION ITEMS & MANAGEMENT MEASURES

	Action Plan & Management Measures	Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
B. Internal Phosphorus Load in North Pond					
Conduct an Aluminum Treatment					
B1	Conduct additional sediment analysis (jar tests) before finalizing an aluminum treatment plan	Year 1	Colby, 7 Lakes, DEP	NPA, grants, private donors	$2,500
B2	Develop final **treatment options and a funding plan** for inactivating P in the sediment	Year 1	NPA, 7 Lakes, consultant	NPA	$1,500
B3	Complete required permitting for aluminum treatment(s)	Year 1	7 Lakes, NPA, consultant, contractor	NPA, consultant, US EPA (319), Maine DEP	$6,500 *(plus $793 annual permit fee)*
B4	Develop Request for Proposals (RFP) and **select contractor** for aluminum application(s)	Year 1-2	7 Lakes, NPA, consultant	NPA	$1,000
B5	Conduct an **aluminum treatment**	Year 2	NPA, 7 Lakes, consultants	NPA, watershed towns, US EPA (319), Maine DEP,	$1,300,000

[35] Sediment assays or "jar tests" involve adding a known dose of alum to sediment samples to determine the most effective dose of alum for a given depth in the lake.

	Action Plan & Management Measures	Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
				private donors, landowners	
B6	Implement an aluminum treatment monitoring plan before and during treatment(s)	Years 2-3	NPA, 7 Lakes, Colby, LSM, Maine DEP, consultants	NPA, grants, private donors	$10,000
				Internal Phosphorus Load Total	**$1,323,900**

PREVENTING NEW SOURCES OF NPS POLLUTION

Preventing new sources of P from getting into the lake is imperative to the success of the management strategies described above. Future development is estimated to increase the total P load from the watershed (53 kg/yr) and septic systems (9 kg/yr) resulting in an increase in the in-lake P concentration by 0.5 ppb. Climate changes will only exacerbate the problem by increasing P loading by an additional 120 kg P/yr. Combined, climate change and future development scenarios result in almost more new P being added to the lake than the P load reduction goals for in the direct and indirect watersheds. In other words, **if nothing is done to adapt to climate change and prevent new sources of P from getting into the lake, then much of the effort to reduce existing sources of P may be offset and goals may not be achieved.** As the water quality in the lake improves, North Pond will continue to be an even more desirable place to live and to visit, resulting in new development in the watershed. Prevention strategies will need to include more robust municipal planning and enforcement, ongoing public education, and land conservation.

FUTURE DEVELOPMENT, MUNICIPAL PLANNING & CONSERVATION

While towns in the watershed have taken steps to help protect lake water quality, **only two of the four towns in the watershed have shoreland zoning ordinances that meet the State's minimum standards, and three of the four towns in the watershed are lacking a current comprehensive plan**. Even in towns where ordinances are up to date it is likely that many older structures do not meet the current standards set by these ordinances. Along with new construction on the remaining undeveloped shoreline parcels, conversion of seasonal or second homes to year-round homes is the most likely shift in usage along the shoreline, thereby increasing the potential for additional stormwater runoff to the lake as a result of increased use (e.g., fertilizing, clearing vegetation, raking, compacted soil areas from vehicles and foot traffic), and related impacts from septic systems.

Ensuring that regulations are in place to address runoff from conversions of structures in the shoreland zone will be important for preventing new sources of P from getting into the lake. Protecting high-value riparian habitat through land conservation in order to safeguard small headwater streams and large areas of undeveloped forests and high-value habitat should be a priority, as should land conservation.

Below are the major recommendations applicable to reducing impacts from future development. A detailed planning schedule, potential funding sources, and estimated costs for 18 related actions is provided below.

PREVENT NEW SOURCES OF NPS (FUTURE DEVELOPMENT) ACTION ITEMS & MANAGEMENT MEASURES					
Action Plan & Management Measures		**Schedule**	**Who**	**Potential Funding Sources**	**Estimated Cost** (10 years)
C. Prevention – Reduce New Sources of NPS Pollution					
General Tasks					
C1	Attend regular Select Board meetings to update towns about watershed activities and needs ***Goal: Minimum 2 meetings/town/year***	Years 1-10	7 Lakes, NPA	NPA	$500
C2	Work with town officials on **winter sand and salt** issues including cleanup and ongoing road maintenance	Years 1-10	7 Lakes, NPA	7 Lakes	$2,000
C3	Work with landowners/road associations to conduct regular road maintenance on private **gravel roads**	Years 1-10	7 Lakes, NPA	7 Lakes	$1,000
C4	Work with local landscape nurseries to provide discounts for buffer plantings ***Goal: 1-2 local nurseries participating***	Years 1-10	7 Lakes, NPA	7 Lakes	$1,000
Future Development & Conservation					
C5	Work with landowners to **protect undeveloped forest and agricultural land** throughout the watershed, especially in tributary drainages having with highest estimated P loading	Years 1-10	7 Lakes, NPA, landowners, watershed towns	Grants, donors	$3,000
C6	Conduct a **build-out analysis** to quantify future development patterns and long-term P loading	Years 3-4	NPA, 7 Lakes, watershed towns, KVCOG	Grants, donors	$3,000
C7	Prepare up-to-date **Comprehensive Plans** to guide future development so that it is protective of water quality	Years 1-3	Watershed towns, KVCOG	Watershed towns, grants	$10,000
Municipal Planning/Ordinances					
C8	**Digitize tax parcels** for all towns in the watershed	Years 1-3	KVCOG, 7 Lakes, watershed towns	NPA, grants, donors	$7,500
C10	Encourage towns to **expand hours for code enforcement** to adequately enforce current ordinances	Years 1-10	7 Lakes	NPA, 7 Lakes	$2,000
C9	Ensure that all municipal **ordinances, tax maps, and permitting information are available online** for each watershed town	Years 1-3	KVCOG, watershed towns	Watershed towns	$500

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
C11	Follow-up with watershed towns to **begin implementing ordinance recommendations** from the 2022 Municipal Ordinance Review	Years 2-5	KVCOG, 7 Lakes, NPA, watershed towns	KVCOG, watershed towns	$5,000
C12	Develop a **standards manual detailing Low Impact Development (LID)** requirements and options for all new construction projects, and add LID design standards to new and existing ordinances where applicable (commercial, subdivision ordinances, etc.)	Years 1-3	Watershed towns, KVCOG	Watershed towns, grants	$10,000
C13	Incorporate/update references to the Maine Stormwater Management Design Manual Best Management Practices (Vol I & II) in existing development standards	Years 1-3	KVCOG, watershed towns	Watershed towns, KVCOG	$10,000
C14	Add language detailing the state mandated inspection requirements for subsurface waste disposal systems on properties in the Shoreland Zone (SLZ) by a certified inspector upon transfer of property **and require submission of septic inspection reports for town records**.	Years 1-3	Watershed towns	Watershed towns, KVCOG	$10,000
C15	Include **greater phosphorus controls for all projects in the Shoreland Zone (SLZ)** of impaired waterbodies such as the Maine DEP per acre phosphorus allocations	Years 3-5	Watershed towns	7 Lakes, towns	$10,000
C16	Consider developing a **watershed-wide P control ordinance** for all new development (including single family residential units, roads, and seasonal to year-round conversions)- see C15	Years 3-5	Watershed towns	KVCOG, 7 Lakes, watershed towns	$10,000
C17	Consider development of a **Unified North Pond Watershed Regulation** that would result in a shared Code Enforcement Officer to consistently administer and enforce regulations	Year 5	KVCOG, NPA, 7 Lakes, watershed towns	Watershed towns, grants	$2,500
C18	Consider provisions for **3rd party site review**, and long-term maintenance as a requirement for building permits	Years 3-5	7 Lakes, watershed towns, consultant	7 Lakes, watershed towns	$2,000
Reduce New Sources of NPS (Future Development) Subtotal					**$90,000**

CLIMATE CHANGE

Watershed modeling estimates **an increase of 120 kg P/yr from the watershed and internal loading as a result of climate change.** Climate change adaptation planning, such as upgrading infrastructure on roads (i.e., undersized culverts), infiltrating stormwater runoff on commercial and residential properties, planting buffers, and conserving undeveloped land are a few ways to counteract the effects of the anticipated increase in precipitation. The following climate change activities should be factored into all future watershed planning activities. A detailed planning schedule, potential funding sources, and estimated costs for the five actions is provided below.

PREVENT NEW SOURCES OF NPS (CLIMATE CHANGE)					
Action Plan & Management Measures		**Schedule**	**Who**	**Potential Funding Sources**	**Estimated Cost** (10 years)
Climate Change					
C19	Set up **automated precipitation monitoring** (e.g., automated rain gauges) to document occurrence and intensity of rainfall in the watershed	Years 2-10	7 Lakes, Colby, NPA	Grants	$6,000
C20	Utilize a **climate model for larger Belgrade Lakes watershed** to anticipate effects of extreme events on lake water quality (e.g., heat, ice out, rainfall, drought)	Years 5-7	Colby, 7 Lakes, consultant	Grants	$30,000
C21	Host **climate change workshops** or webinars to provide information about ways landowners can adapt to climate change and help protect water quality	Years 2, 4, 6, 8	7 Lakes, Colby, consultant	Grants	$2,500
C22	Conduct a **stream-crossing survey** to assess whether culverts at road/stream crossings require upgrades	Year 1-2	7 Lakes, consultant, TNC	7 Lakes, Grants	$2,500
C23	Work with watershed towns and the state to apply for grants to **fund and implement culvert upgrade projects**	Years 3-8	7 Lakes, KCSWCD/SCSWCD, towns, consultant	Grants, watershed towns, Maine DEP, Maine DOT	$200,000
Reduce New Sources of NPS (Climate Change) Subtotal					**$241,000**
Prevent New Sources of NPS Pollution Total					**$331,000**

EDUCATION, OUTREACH & COMMUNICATIONS

Public education and outreach is an important and necessary component of meeting the water quality goals for the North Pond WBMP. Development of a comprehensive outreach strategy led by a steering committee consisting of watershed partners that are actively conducting outreach will streamline outreach messaging and increase participation in watershed planning activities.

7 Lakes works to provide education and outreach to residents of the Belgrade Lakes watersheds, while NPA conducts outreach for North Pond specifically. NPA hosts an annual meeting every August for all interested watershed residents, provides watershed updates on its website, and distributes two newsletters each year. 7 Lakes provides community outreach through administering the LakeSmart program and Courtesy Boat Inspection (CBI) program, along with the YCC program. Coordination with watershed towns will help expand these existing coordinated outreach efforts through NPA and 7 Lakes so that all watershed residents are aware and involved in the process.

A detailed planning schedule, potential funding sources, and estimated costs for each of the 22 education and outreach actions is provided below.

EDUCATION, OUTREACH & COMMUNICATIONS ACTION ITEMS & MANAGEMENT MEASURES					
Action Plan & Management Measures		**Schedule**	**Who**	**Potential Funding Sources**	**Estimated Cost** (10 years)
D. Education, Outreach & Communications					
General Outreach					
D1	Develop an outreach strategy/**communications committee** to get the word out to the community; meet annually to discuss plan objectives	Year 1 and ongoing	7 Lakes, NPA, interested stakeholders	7 Lakes, NPA	n/a
D2	Develop and maintain a North Pond WBMP **web page** for the public to access information about restoration strategies and progress	Years 1-10	NPA	NPA	$5,000
D3	Keep partner **websites** updated regarding on-going restoration efforts and NPS pollution projects	Years 1-10	NPA, 7 Lakes, watershed towns	NPA, watershed towns	$2,500
D4	Prepare and distribute **press releases** and **newsletter articles** about watershed improvement activities, grant projects, and successful projects **(Goal 2/year)**	Years 1-10	7 Lakes, NPA	NPA	$5,000
D5	Provide **welcome packets** to new property owners with water quality educational materials	Year 2	NPA, 7 Lakes, watershed towns	NPA, grants	$5,000
D6	Develop an **online video series** of short educational clips that can be viewed by the public (including climate change)	Years 2-4	NPA, Colby, 7 Lakes	Grants, 7 Lakes, NPA	$5,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
D7	Work with **local realtors and towns** to track property transfers and subdivisions	Years 1-10	NPA	NPA	$2,500
Alum Treatment Outreach					
D8	**Distribute Frequently Asked Questions (FAQ)** about alum treatments to project partners and the make it publicly available through partner websites	Year 1	NPA, 7 Lakes, watershed towns	NPA	$500
D9	Develop an **online educational video** pertaining to the need for an aluminum treatment that can be viewed by the public and help with fundraising efforts	Year 1-2	Outreach Committee, Colby, 7 Lakes	Grants, 7 Lakes, NPA	$5,000
D10	Host a **public workshop** specific to the aluminum treatment to provide opportunity for public feedback	Year 1-2	NPA, 7 Lakes	NPA	$1,500
Targeted Outreach					
D11	Send **educational materials to landowners with high-impact sites** (7 sites) **and medium-impact sites** (37 sites) to gauge interest in cost-sharing opportunities for a future 319 grant	Year 1-2	NPA, 7 Lakes	NPA, Grants	$1,600
D12	Prepare a list of NPS sites on **town-owned properties (8 sites)** and work with towns on their annual budget planning (municipal sites and roads) to fund the projects	Years 1-2	7 Lakes, NPA, Towns	7 Lakes, NPA	$2,500
D13	Prepare educational materials for the NPA **LakeSmart** program	Years 1-2	NPA, 7 Lakes	NPA, Maine Lakes, grants	$5,000
D14	Meet with **road associations** with documented NPS problems on private roads (26 sites) to determine interest in future 319 grant cost-sharing opportunities	Years 1-2	NPA, 7 Lakes, road associations	7 Lakes	$2,000
D15	Design a **Buffer Campaign** with easy to follow guidance/recipes for installing effective shoreline buffers	Years 2-3	NPA, 7 Lakes, Maine Lakes, Towns	NPA, grants	$5,000
D16	**Increase participation in NRCS agricultural programs** through newspaper articles, NRCS sponsored workshops, and targeted outreach (e.g. small-scale or hobby farms) throughout the watershed (goal 5 new participating landowners)	Years 1 - 3	USDA/NRCS	USDA/NRCS	$6,000
D17	Conduct outreach to landowners/road associations to **promote use of bluestone surface gravel** for use on driveways and	Years 1 - 10	7 Lakes, road associations, landowners	7 Lakes, grants	$5,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
	roads; identify roads where bluestone is not currently used and provide **incentives** to switch over to new material				
Workshops					
D18	Host annual **gravel road workshops** in the watershed working directly with road associations (goal 1 every other year)	Years 1 - 10	7 Lakes, NPA	7 Lakes, US EPA (319), Maine DEP	$5,000
D19	Host annual **"Buff Enough" workshops in coordination with sister lake associations** (goal 1/year)	Years 1 - 10	NPA, 7 Lakes	NPA, grants	$5,000
D20	Host **LakeSmart workshops** (goal 1/odd years)	Years 1, 3, 5, 7, 9	NPA, 7 Lakes	NPA	$5,000
D21	Host **septic workshops** or **webinars** (goal 1/even years)	Years 2, 4, 6, 8	NPA, 7 Lakes	NPA, grants	$5,000
D22	Host **ordinance workshops** for landowners, developers, and realtors (goal 1)	Years 2 - 4	NPA, 7 Lakes, watershed towns	NPA, grants, watershed towns	$2,500
Education, Outreach & Communications Total					**$81,600**

BUILDING LOCAL CAPACITY

NPA, in cooperation with watershed partners, will oversee plan implementation, which will require funding the plan, meeting annually with project partners, and strengthening relationships within the community among other tasks described below. A detailed planning schedule, potential funding sources, and estimated costs for each of the 14 capacity building actions is provided below.

BUILD LOCAL CAPACITY
ACTION ITEMS & MANAGEMENT MEASURES

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
E. Build Local Capacity					
Fundraising					
E1	Develop and maintain a **fundraising committee** to help implement the plan	Year 1 and ongoing	NPA, 7 Lakes, watershed towns	NPA	$2,500
E2	Apply for US EPA Clean Water Act Section 319 watershed implementation grants to address internal loading and NPS sites ***Goal: 4 phases of 319 implementation projects***	Years 2-9	7 Lakes, NPA	NPA	$15,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
E3	Create a **sustainable funding plan** to pay for the cost of an aluminum treatment, watershed implementation projects, erosion control program management, outreach and education, and long-term science and monitoring ***Goal: $1,750,000 raised by 2027***	Years 1-3	NPA, 7 Lakes, consultant	NPA, towns, private donors	$5,000
E4	Apply for other state, federal or private foundation **grants** that support planning recommendations	Years 2-10	NPA, 7 Lakes, consultant	7 Lakes, NPA	$5,000
E5	Work with watershed towns to **enroll in the State's Climate Resiliency Partnership (CRP)**	Years 1-2	KVCOG, 7 Lakes, NPA	Towns, KVCOG	$7,500
E6	Fundraise for **septic system cost-sharing grants** & septic rebate program	Years 1-3	NPA	NPA, 7 Lakes, watershed towns	$1,000
Steering Committee & Partnerships					
E7	Steering Committee to **meet annually** to discuss action items and goals	Years 1-10	7 Lakes, NPA	7 Lakes NPA	$5,000
E8	Reach out to **new potential Steering Committee members** including town officials, local businesses, realtors, and septic inspectors	Years 1-10	7 Lakes, NPA	7 Lakes, NPA	$1,000
E9	Convene annual meetings with watershed towns to strengthen **stakeholder relationships** and bolster community support for restoration efforts	Years 1-10	7 Lakes, NPA, watershed towns	7 Lakes, NPA, watershed towns	$5,000
E10	Consider formation of a more diverse **Dam Committee** to review dam management procedures; meet at least annually to review and update procedures as needed	Years 1-3	NPA, EPA, watershed towns, 7 Lakes	NPA, watershed towns	$5,000
E11	Coordinate with Colby, Bates, and other academic institutions regarding ongoing **scientific research projects** (e.g., NASA study, Gloeotrichia, eDNA, etc.)	Years 1-10	7 Lakes, NPA, Colby, Bates, UMaine	7 Lakes	$5,000
E12	Develop a comprehensive list of projects and an accessible **database** to track activities conducted by the numerous project partners that work in the watershed	Year 2 and ongoing	7 Lakes, NPA	7 Lakes, NPA, grants	$5,000
E13	Meet with area **landscaping companies** to increase their capacity to do more erosion control work in the watershed and to educate them on LakeSmart practices	Years 2-4	7 Lakes, NPA	7 Lakes	$2,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
E14	Continue **Lake Trust meetings** with area lake associations in upstream and downstream watersheds (East Pond, Great Pond) to strategize about ways to reduce P inputs and share outreach BMPs	Ongoing (Years 1-10)	NPA, 7 Lakes, BLA, EPA	7 Lakes	$10,000
			Build Local Capacity Total		**$74,000**

8. Monitoring Activity, Frequency and Parameters

Maine water quality standards require North Pond to have a stable or improving trophic state and be free of culturally induced algal blooms. Measuring the water quality of the lake is a necessary component of successful watershed planning because results can be used to evaluate the effectiveness of watershed management measures. If improvements in water clarity, P, or other parameters are evident or if water quality is stable, then planning objectives are being met. If water quality gets worse, then additional management strategies may be needed.

FUTURE BASELINE MONITORING

An assessment of existing water quality monitoring data in North Pond was completed as part of the water quality analysis (1970-2022). The steering committee and 7 Lakes determined that ongoing annual monitoring efforts conducted by 7 Lakes should continue over the next 10 years in order to assess and track annual changes in water quality and the effects of actions to reduce P loading in the lake. Future monitoring should include the following 13 measures detailed below.

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
F. Conduct Long-Term Monitoring & Assessment					
Baseline Lake Monitoring					
F1	Continue collecting annual **water quality data** to inform long-term management actions (April-October), including regular sampling on Little North Pond	Ongoing (Years 1-10)	7 Lakes, Colby, Maine DEP	7 Lakes, NPA, watershed towns, private donors, grants	$50,000
F2	Expand lake monitoring program to include **nitrate, silicate, and chlorophyll** concentrations	Ongoing (Years 1-10)	7 Lakes, Colby, Maine DEP	7 Lakes, NPA, watershed towns, private donors, grants	$5,000
F3	Monitor **zooplankton**, **phytoplankton** and **cyanobacteria** throughout the year through the Colby "Algae Tracker", and 7 Lakes FlowCam	Ongoing (Years 1-10)	7 Lakes, Colby, volunteer monitors	7 lakes, NPA	$16,000

	Action Plan & Management Measures	Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
F4	Create an **inventory of all plankton species** documented in North Pond for easy ID on future FlowCam runs	Years 1-2	7 Lakes, Colby	7 Lakes	$1,500
F5	**Monitor anoxia**, both at the bottom of the lake throughout the year, and from shallower areas of the lake to determine the true maximum extent of anoxia	Year 1 and ongoing	7 Lakes, Colby	7 Lakes, Colby	$10,000
F6	Conduct **winter sampling** for DO/Temp and P samples during ice-on to collect under ice profiles	Ongoing (Years 1-10)	7 Lakes, Colby	7 Lakes, Colby	$10,000
F7	Continue sending split TP samples to HETL and **develop a TP correction curve** using Colby TP data and HETL duplicate samples.	Years 1-5 or until curve complete	7 Lakes, Colby, Maine DEP	7 Lakes, Colby	$3,000
F8	Continue collecting **annual conductivity data** to examine long-term trends	Ongoing (Years 1-10)	7 Lakes, Colby, Maine DEP	7 Lakes, Colby, Maine DEP	$3,000
				Baseline Monitoring Subtotal	**$98,500**

7 Lakes will continue to work with project partners including Colby College and Maine DEP to conduct long-term water quality monitoring at North Pond, and to analyze the results of this data to inform future watershed management planning and assessment, and in-lake treatments.

NPS POLLUTION

Additional NPS assessments following the 2017 Watershed Survey and 2022 update will be beneficial for preventing new sources of NPS from getting into the lake, for protecting water quality, and protecting the investments made to address current sources of P in the lake. The following five actions will track NPS pollution in the watershed over the next 10 years.

NPS ASSESSMENTS

ACTION ITEMS & MANAGEMENT MEASURES

	Action Plan & Management Measures	Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
NPS Pollution					
F9	Revise **NPS Site Tracker** & update annually	Ongoing (Years 1-10)	7 Lakes	US EPA (319), 7 Lakes	$5,000

	Action Plan & Management Measures	Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
F10	Conduct **site visits to logging sites** to better understand their impact on water quality; meet with District Forester to strategize on ways to reduce P runoff from timber harvests	Years 1, 3, 5, 7, 9	7 Lakes, landowners, MFS	7 Lakes, NPA	$1,500
F11	Investigate manure management in the watershed including the extent of spreading on hay fields, inputs from horse farms near the lake, and manure washing of roads	Years 1-3	NPA, 7 Lakes, SCSWCD, USDA/NRCS	NPA, USDA/NRCS	$2,500
F12	Conduct an informal watershed survey for **new NPS sites** 5 and 10 years after last survey	Years 5 and 10	7 Lakes	NPA, 7 Lakes, watershed towns	$10,000
F13	Update 2010/2011 GIS-based **shoreline photos** and share with towns to assist with compliance in the shoreland zone; include documentation of buffer quality	Years 2 & 7	Colby, 7 Lakes	7 Lakes, Colby, watershed towns	$10,000
				NPS Pollution Subtotal	**$29,000**

STREAM MONITORING

There are only a few years of phosphorus data currently available for streams in the North Pond Watershed. The available data provides a look at which streams may be contributing the most P to the lake. Ongoing monitoring at these same stations, along with expanded stream monitoring over the next 10 years will improve our understanding of P loading from streams in the North Pond watershed. Monitoring the water level at the dam is also important to document water level in the lake. Future stream and dam monitoring actions include:

STREAM MONITORING
ACTION ITEMS & MANAGEMENT MEASURES

	Action Plan & Management Measures	Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
Stream Monitoring					
F14	Install in-situ water-level loggers at the dam to document changes in water level over the course of the year	Year 1-2	7 Lakes, Colby, NPA,	7 Lakes, NPA, grants	$7,500

	Action Plan & Management Measures	Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
F15	Collect **water quality data at targeted stream outlets** (ISCO samplers) to quantify P load from streams under different conditions throughout the year	Years 1-10 (Create 3-year baseline)	7 Lakes, Colby, Maine DEP, volunteers	Grants, NPA, 7 Lakes	$15,000
F16	Train volunteer **"stream watchers"** to take pictures during storms or install game cameras; set up online repository for uploading photos; work with Maine DEP to train volunteers on how to collect storm samples	Years 1-4	Maine DEP, NPA, volunteers	Grants, NPA	$3,000
				Stream Monitoring Subtotal	**$25,500**

AQUATIC INVASIVE PLANTS & HABs

In a eutrophic lake with a large littoral zone like North Pond, keeping aquatic invasive plants (AIP) out of the lake is a high priority, especially with the presence of at least one invasive species already in the lake. The following seven actions should be taken to prevent the introduction of AIP, and to monitor the presence of Harmful Algal Blooms (HABs):

AQUATIC INVASIVE PLANTS ACTION ITEMS & MANAGEMENT MEASURES:					
	Action Plan & Management Measures	**Schedule**	**Who**	**Potential Funding Sources**	**Estimated Cost** (10 years)
Invasive Plant Monitoring					
F17	Participate in fundraising activities that support programs that prevent the spread of invasive aquatic plants in North Pond (e.g., CBI, volunteer invasive plant surveys, etc.)	Years 1-10	NPA, 7 lakes, volunteers, LSM	NPA, 7 Lakes, watershed towns, state funding	$10,000
F18	Continue the NPA/7 Lakes volunteer cyanotoxin monitoring program and coordinate with the Maine Cyanobacteria Collective for ongoing testing	Ongoing (Years 1-10)	NPA, 7 Lakes, Maine DEP	NPA, 7 Lakes, Maine DEP	$5,000
F19	Distribute educational materials about management tools/best practices for identifying and removing invasive terrestrial plants on the shoreline	Years 5-10	NPA, Maine Natural Areas Program	NPA	$2,500
				Invasive Aquatic Plants Monitoring Subtotal	**$17,500**

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Cost (10 years)
Other					
F20	Consider developing a subcommittee to look at the **economic value of North Pond** that can be used for public outreach	Year 2	NPA 7 Lakes, watershed towns, Colby	7 Lakes, Colby	$2,500
F21	Follow-up with MDIFW regarding the November 2022 mussel die-off, and continue monitoring for **mussel mortality**	Year 1 and ongoing	7 Lakes, NPA	NPA, 7 Lakes	$500
F22	Look into the costs and **logistics of dredging** as an option for addressing internal loading	Years 1-2	7 Lakes, interested stakeholders	NPA, 7 Lakes	$2,500
F23	Test lake water and sediments for **PFAS**	Years 1-2	Maine DEP, 7 Lakes	Maine DEP, 7 Lakes, NPA	$2,500
All Long-Term Monitoring & Assessment Total					**$178,500**

9. Measurable Milestones, Indicators & Benchmarks

The following section provides a list of interim, measurable milestones to document progress in implementing management strategies outlined in the action plan (Section 8). These milestones are designed to help keep project partners on schedule. Additional criteria are outlined to measure the effectiveness of the plan by documenting loading reductions and changes in water quality over time thus providing the means by which the steering committee can reflect on how well implementation efforts are working to reach established goals.

Photo Credit: 7 Lakes Alliance

Environmental, social, and programmatic indicators and proposed benchmarks represent short-term (1-2 years), mid-term (3-5 years), and long-term (6-10 years) targets for restoring the water quality in North Pond. The steering committee will review the criteria for each milestone annually to determine if progress is being made, and then determine if the watershed plan needs to be revised if targets are not being met. This may include updating proposed management practices and the loading analysis, and/or reassessing the time it takes for phosphorus concentrations to respond to watershed and in-lake management strategies. The large P reductions anticipated as a result of **addressing the internal P is expected to result in an immediate observable change in lake trophic state** following the aluminum treatment. However, actions to reduce the watershed load will result in smaller and less noticeable changes in lake trophic state; helping protect the benefits of the aluminum treatment and supporting the long-term stabilization of the trophic state in the face of threats from existing and future development in the watershed and climate change.

Environmental Milestones are a direct measure of environmental conditions. They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions. Table 14 outlines the water quality benchmarks, and interim targets for improving the water quality of North Pond over the next 10 years.

Social Milestones measure changes in social or cultural practices and behavior that lead to implementation of management measures and water quality improvements. Table 15 outlines the social indicators, benchmarks, and interim targets for the North Pond WBMP.

Programmatic Milestones are indirect measures of watershed protection and restoration activities. Rather than indicating that water quality reductions are being met, these programmatic measurements list actions intended to meet the water quality goal. Table 16 outlines the programmatic indicators, benchmarks, and interim targets for the North Pond WBMP.

Table 14. *Water quality benchmarks and interim targets for North Pond.*

Environmental Milestones			
Water Quality Benchmarks	***Interim Targets****		
	Years 1-2	*Years 3-5*	*Years 6-10*
a) P loading reductions from external sources (58 direct watershed, 32 kg septic systems) **Current:** 964 kg/yr **Goal:** 874 kg P/yr (reduce by 90 kg P/yr)	939 kg/yr *(▼25 kg/yr)*	901 kg/yr *(▼38 kg/yr)*	874 kg/yr *(▼27 kg/yr)*
b) P loading reductions from internal P sources **Current:** 969 kg/yr **Goal:** 97 kg P/yr (reduce by 872 kg/yr)	97 kg/yr *(▼872 kg/yr)*	0 kg/yr	0 kg/yr
c) Decrease in average in-lake TP concentration **Current:** 19 ppb **Goal:** 10 ppb	11 ppb *(▼8 ppb)*	10.5 ppb *(▼0.5 ppb)*	10.0 ppb *(▼0.5 ppb)*
d) Increase in average water clarity **Current:** 2.4 ppb **Goal:** 4.0 ppb (increase by 1.7 m)	3.8 m *(▲1.4 m)*	3.9 m *(▲0.1 m)*	4.0 m *(▲0.1 m)*
e) Decrease in Chl-a **Current:** 7.1 ppb **Goal:** 2.8 ppb (reduce by 4.3 ppb)	3.2 ppb *(▼3.9 ppb)*	3.0 ppb *(▼0.2 ppb)*	2.8 ppb *(▼0.2 ppb)*
f) Decrease algal bloom probability **Current:** 31% **Goal:** 1% (reduce by 30%)	2% *(▼29%)*	1.5% *(▼0.5%)*	1% *(▼0.5%)*

** Benchmarks are cumulative unless otherwise noted. Years 1-2 (2024-2025); Years 3-5 (2026-2029); Years 6-10 (2029-2034). (▲▼) arrows indicate a change in water quality up or down over the planning period.*

Table 15. Social indicators, benchmarks, and interim targets for North Pond.

Social Milestones			
Indicators	***Benchmarks & Interim Targets****		
	Years 1-2	*Years 3-5*	*Years 6-10*
a) Number of community meetings organized (alum, realtors, homeowner associations, etc.)	2 meetings	3 meetings *(5 total)*	5 meetings (10 *total)*
b) Number of people viewing online video series	50 views	250 views	1,000 views
c) Number of educational workshops held (gravel roads, buffers, LakeSmart, septic, ordinance)	5 workshops	6 workshops *(11 total)*	5 workshops *(16 total)*
d) Number of "welcome packets" distributed to new property owners in the watershed	10 packets	20 packets	30 packets
e) Number of LakeSmart site visits and new landowners participating (cumulative) **Goal:** 50 new evaluations completed	15 visits	30 visits	50 visits
f) Number of landowners participating in septic system incentive program **Goal:** 20 evaluations, 10 septic designs, 10 upgrades	5 evaluations	15 evaluations, 10 designs, 5 upgrades	5 upgrades

Social Milestones			
Indicators	***Benchmarks & Interim Targets****		
	Years 1-2	*Years 3-5*	*Years 6-10*
g) Number of planning board/selectman meetings attended to strengthen town ordinances and relationships with town officials **Goal:** 2 meetings/town/yr	12 meetings	18 meetings *(30 total)*	30 meetings *(60 total)*
h) Number of press releases and newsletter articles distributed **Goal:** 2/year	2	7	13

** Benchmarks are cumulative unless otherwise noted. Years 1-2 (2024-2025); Years 3-5 (2026-2029); Years 6-10 (2029-2034).*

Programmatic Milestones are indirect measures of watershed protection and restoration activities. Rather than indicating that water quality reductions are being met, these programmatic measurements list actions intended to meet the water quality goal. Table 16 (below) outlines the programmatic indicators, benchmarks and interim targets for the North Pond WBMP.

Table 16. *Programmatic indicators, benchmarks, and interim targets for North Pond.*

Programmatic Milestones			
Indicators	***Benchmarks & Interim Targets****		
	(Years 1-2)	*(Years 3-5)*	*(Years 6-10)*
a) Number of new landowners enrolled in NRCS programs	1	3 *(4 total)*	5 *(9 total)*
b) Number of NPS sites addressed **Goal:** 7 high impact, 37 medium impact, and 47 low impact NPS sites (91 total)	25 sites	30 sites *(55 total)*	36 sites *(91 total)*
c) Number of steering committee meetings **Goal:** 1 meeting/year	2 meetings (2 total)	3 meetings *(5 total)*	5 meetings *(10 total)*
d) Amount of funding spent on water quality projects. **Goal:** $3,156,000	$1.8M	$800K *($2.6M total)*	$600K *($3.2M total)*
e) Number of 319 grants awarded **Goal:** Four 319 grants	1 grant	1 grant	2 grants
f) Number of new or revised ordinances passed that help protect water quality **Goal:** 5 ordinance updates	2 ordinances	4 ordinances	5 ordinances

** Benchmarks are cumulative unless otherwise noted. Years 1-2 (2024-2025); Years 3-5 (2026-2029); Years 6-10 (2029-2034).*

POLLUTANT LOAD REDUCTIONS & COST ESTIMATES

The following pollutant load reductions and costs were estimated for the next 10-year planning cycle based on five primary planning objectives outlined in the action plan:

Table 17. North Pond planning objectives, P load reduction targets & cost.

Planning Objective	Planning Action (2022-2032)	P Load Reduction Target	Cost
A	**Reduce the External P Load** (NPS sites, septic systems, LakeSmart, buffer campaign, upstream watersheds)	90 kg/yr	$1,180,500
B	**Reduce the Internal P Load** (Sediment testing, permitting, aluminum treatment)	872 kg/yr	$1,323,900
C	**Reduce New Sources of NPS Pollution** (NPS sites, land conservation, ordinances, enforcement, climate change adaptation)	n/a	$331,000
D	**Education, Outreach & Communications** (Public meetings, town meetings, online videos, aluminum treatment outreach, targeted outreach, workshops)	n/a	$81,600
E	**Build Local Capacity** (Funding plan, steering committee, grant writing, relationship building- including town government, contractors and scientists)	n/a	$74,000
F	**Long-Term Monitoring & Assessment** (Baseline monitoring, NPS pollution, streams/dam monitoring, invasive plants, etc.)	n/a	$178,500
	TOTAL	**962 kg/yr**	**$3,169,500**

Actual pollutant load reductions will be documented as work is completed as outlined in this plan. This includes reductions for the proposed aluminum treatment and for completed NPS sites to help demonstrate phosphorus and sediment load reductions as the result of BMP implementation. Pollutant loading reductions will be calculated using methods approved and recommended by Maine DEP and the US EPA and reported to Maine DEP for any work funded by 319 grants using an NPS site tracker.

10. Plan Oversight, Partner Roles, and Funding

PLAN OVERSIGHT

Implementation of a 10-year watershed plan cannot be accomplished without the help of a central organization to oversee the plan, and a diverse and dedicated group of project partners and the public to support the various aspects of the plan. The following organizations will be critical to the plan's success and are excellent candidates for the watershed plan steering committee. The committee will need to meet at least annually to update the action plan, to evaluate the plan's success, and to determine if the water quality goal is being met.

PARTNER ROLES

North Pond Association (NPA) will oversee plan implementation and plan updates and coordinate a fundraising campaign to raise funds from outside sources to support the plan. NPA will serve on the steering committee, provide ongoing education and outreach throughout the watershed, provide volunteers LakeSmart, CBI and stream and lake monitoring programs, and serve as a liaison between watershed partners and technical advisors.

7 Lakes Alliance (7 Lakes) will provide 319 grant management and administration, manage the YCC, CBI and curly-leaf pondweed removal programs, provide ongoing water quality monitoring, support watershed education and outreach efforts, provide support to help reduce internal loading, support land conservation initiatives in the watershed, and serve on the steering committee and outreach committee.

Colby College will continue as an important project partner proving ongoing research and lab support related to water quality in the watershed.

Kennebec Valley Council of Governments (KVCOG) will support planning initiatives that result in improvements or updates to existing municipal ordinances or Comprehensive Plans, digitizing tax parcels, and provide municipal assistance for enrollment in the State's Climate Resiliency Partnership.

Kennebec County Soil & Water Conservation District (KCSWCD) will serve on the steering committee and support education and outreach efforts to landowners and agricultural producers in coordination with SCSWCD, USDA/NRCS and other watershed partners.

Maine Lakes may provide support to the NPA and 7 Lakes' LakeSmart Program Coordinators to evaluate and certify properties and provide LakeSmart signs for landowners meeting certification requirements.

Somerset County Soil & Water Conservation District (SCSWCD) will support education and outreach efforts to landowners and agricultural producers in coordination with KCSWCD, USDA/NRCS and other watershed partners.

USDA/Natural Resources Conservation Service (NRCS) will provide education and outreach including hosting workshops for small-scale agricultural producers and provide technical and financial assistance to agricultural producers in the watershed.

Landowners and Road Associations will address documented NPS sites on their properties and provide a private source of matching funds by contributing to fundraising efforts and participating in watershed projects and LakeSmart.

Maine Department of Environmental Protection will provide watershed partners with ongoing guidance, technical assistance and resources, and the opportunity for financial assistance through grants including the US EPA's 319 grant program. Maine DEP will also serve on the steering committee.

Towns of Smithfield, Rome, and Mercer will serve on the watershed steering committee, and may provide funding for water quality monitoring, match for watershed restoration projects, and support for the CBI and LakeSmart programs. The towns will also play a key role in addressing any documented NPS sites on town roads and municipal/public property, providing training and education for municipal employees, supporting initiatives to reduce inputs from septic systems, and improving ordinances to be more protective of water quality locally and regionally.

US Environmental Protection Agency will provide guidance on grant programs particularly Clean Water Act Section 319, work plan guidance, and selected project funding, pending acceptability of grant proposals, final workplans and availability of federal funds.

ACTION PLAN IMPLEMENTATION & FUNDING

NPA will develop and coordinate a public-private fundraising plan and will coordinate and implement the proposed action plan. Expected partners are 7 Lakes, Pine Tree Camp, local towns, Maine DEP, landowners, businesses, road associations, and private donors. Many of these partners have worked together for over 20 years. Accomplishments include completing a watershed survey (2016) and developing and implementing the North Pond Watershed Protection Plan (2017). 7 Lakes, Pine Tree Camp, Maine DEP, and local towns also have a long track record of working together on other large, successful programs including four 319 implementation grants (2018- present), curly-leaf pondweed removal efforts (2021-present), the Youth Conservation Corps (1996-present), Courtesy Boat Inspections (2007-present), the annual loon count, and volunteer water quality monitoring.

There are a number of opportunities for acquiring funding to support implementation of the watershed management plan. The list below contains a few of the better-known State and Federal funding options. Additional support from private foundation grants, local fundraising efforts, monetary contributions by participating landowners, and financial support from municipal partners will be needed to adequately fund this plan.

- **Land for Maine's Future Program** – Funding for land conservation that provides multiple public and natural resource benefits: https://www.maine.gov/dacf/lmf/

- **Maine DEP Courtesy Boat Inspection (CBI) Program Grants** – A cost-share program to help fund locally-supported CBI program: https://www.maine.gov/dep/water/grants/invasive/index.html
- **Maine DEP Invasive Aquatic Plant Removal Grants** – Administered by Maine DEP to assist communities planning and managing removal of invasive aquatic plant infestations: https://www.maine.gov/dep/water/grants/invasive/index.html
- **Maine DEP Small Community Grant Program (SCG)** – Administered by Maine DEP, this program provides grants to Municipalities to help replace malfunctioning septic systems that are polluting a waterbody or causing a public nuisance: https://www.maine.gov/dep/water/grants/scgp.html
- **Maine DEP Stream Crossing Upgrade Grant Program** – A competitive grant program for the upgrade of municipal culverts and stream crossings that improve fish and wildlife habitats and improve community safety: https://www.maine.gov/dep/land/grants/stream-crossing-upgrade.html
- **Maine DOT's Municipal Partnership Initiative (MPI)** – This program funds projects of municipal interest on state infrastructure working with Maine DOT as a partner to develop, fund, and build the project: https://www.maine.gov/mdot/pga/
- **Maine Governor's Office of Policy Innovation and the Future (GOPIF)** – Two types of grants are offered including Community Action Grants to support projects that reduce energy use and costs and/or make their community more resilient to climate change effects, such as flooding, extreme weather, drought, and public health impacts: https://www.maine.gov/future/climate/community-resilience-partnership/grants
- **Maine Natural Resource Conservation Program (MNRCP)** – A cooperative program between Maine DEP and US Army Corps of Engineers, administered by The Nature Conservancy, funding the restoration, enhancement, preservation, and creation of wetland habitat: https://www.maine.gov/dep/land/nrpa/ILF_and_NRCP/index.html
- **US EPA Clean Water Act (Section 319) Watershed Nonpoint Source (NPS) Grant Program** – Administered by Maine DEP, 319 grants assist communities implementing a watershed-based management plan for waters named on Maine DEP's NPS Priority Watershed List: https://www.maine.gov/dep/water/grants/319.html
- **US EPA/Maine Clean Water State Revolving Fund (CWSRF)** – Provides financial assistance for a wide range of water infrastructure projects including control of nonpoint sources of pollution, and other water quality projects: https://www.epa.gov/cwsrf/learn-about-clean-water-state-revolving-fund-cwsrf
- **USDA/NRCS Financial Assistance** – NRCS offers voluntary programs to eligible landowners and agricultural producers to provide financial and technical assistance to help manage natural resources including financial assistance to help plan and implement conservation practices that address natural resource concerns or opportunities to help save energy, improve soil, water, plant, air, animal and related resources on agricultural lands and non-industrial private forest land: https://www.nrcs.usda.gov/wps/portal/nrcs/main/me/programs/financial/

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APPENDIX A. PUBLIC MEETING Q&A

North Pond Public Meeting – July 24, 2023
Questions from the Audience

Lake Science Questions

Q: What is the watershed to the south of North Pond?
A: Great Pond

Q: Can you define what you mean that a lake can no longer handle the amount of phosphorus entering the lake?
A: Lakes have an assimilative capacity, an amount of phosphorus that the lake can process while still functioning properly. When the phosphorus level exceeds the lake's capacity, it can result in a shift in the lake's ecosystem and make it difficult to control the algae.

Q: How do lakes assimilate phosphorus?
A: It can be consumed physically or chemically, by settling out into the sediments, getting used by plants, or being flushed downstream.

Q: Which lake was it that is perfect now, can we do that?
A: Georges Pond was the lake referenced earlier in the presentation that completed an aluminum treatment in 2020-2021. It isn't perfect, but the water quality is much better – they were able to meet the goal set in their 10-year plan. North Pond will be able to get there if we work together.

Q: How do pH levels and temperature affect phosphorus in the lake?
A: The pH and temperature affect microbial processes, which in turn affect P recycling in the lake. Very low or very high pH reduces the microbial community, while increased temperature accelerates decay and oxygen demand. The pH tends to be between 6 and 8 unless a severe bloom is in progress, in which case the removal of carbon dioxide during photosynthesis raises pH. The pH fluctuations seen in the lake aren't a major influence on microbial activity. A temperature increase of as little as 4 degrees C (7 degrees F) can double oxygen uptake, meaning areas with low oxygen will develop faster and be more expansive, leading to greater P release.

Q: When algae die and they provide food for the next blooms, should we pick up metaphyton so they don't feed the next bloom?
A: It would be difficult to remove a significant amount of metaphyton, but it wouldn't hurt if it was practical. Metaphyton are mostly green algae, and while unsightly at times, these do not present human health issues like cyanobacteria (blue-green algae). Metaphyton tend to grow in shallow water, whereas cyanobacteria often get their start in deeper water. Metaphyton can also bloom without excess phosphorus in the system, as seen in Lake Tahoe, and aren't the real culprits in the phosphorus recycling.

Q: When testing the sediment, have you analyzed where in the lake the sediment is more intense [concerning]?
A: The sediment of concern has high organic content and high P content. There is not much organic content and not much potential for significant P release in water <10 ft deep, with a transition to a high probability of release at 13 ft of water depth. The sediment with the greatest P content and potential for release is in the deepest water in North Pond, which is typical of most lakes with significant internal P loading.

Q: There are PFAS areas in the watershed. Does it affect the algae?

A: PFAS is not a nutrient for algae and is unrelated to the phosphorus problem in North Pond. If there are PFAS in the lake sediments, then dredging would become even more costly, as the sediment would need to be disposed of properly to contain the PFAS.

Q: How close are we to getting an algae bloom?

A: That is mostly a weather related question, the answer to which is hard to predict, but the warm temperatures say that a bloom in the next month is probable, while the higher than average rain suggests some control over blooms, so maybe there will be a less intense bloom. The weather this year has been very weird, making it hard to predict.

Q: What is the effect of wind and temperature on blooming?

A: Warmer temperatures encourage cyanobacteria blooms, both because cyanos prefer warmer water and warmer water increases oxygen demand (decomposition) and P release. Wind can keep the lake mixed (aerated) and reduce P availability if consistent over time, but that rarely happens. Usually the wind comes and goes, allowing low oxygen areas to develop then mixing released P into the water column. Years with stagnant summers tend to have worse blooms.

Phosphorus Questions – External Sources

Q: What is the effect of sump pumps emptying into the lake?

A: Sump pumps and foundation drains should drain into a vegetated swale away from the lake, or a dry well so the water can get filtered before it enters the lake. Even if it's not a major source of phosphorus, the water can carry contaminants and basement molds. The actual amount of P is unknown and may be hard to quantify but will not be a major factor in any one year. Over time it will contribute to loading and wind up fueling internal load, so it is best to avoid.

Q: Is there a way to detect where P levels are higher by measuring shoreline soils?

A: Yes, we can measure P levels in the sediment, but those tests are expensive. There are soil maps that describe the kind of soil present in the watershed which may give us clues to the local P level, but human activity can drastically change that baseline.

Q: Have we been able to quantify the ratio of the impact of the camp lot runoff, vs P coming in via streams/brooks?

A: The watershed model shows that the largest P load by area stems from the highly developed eastern shoreline and western shorelines, and the Pattee Brook drainage. The 7 Lakes Alliance is looking into sampling stream water to verify the model's results.

Q: Why did Pattee Brook have a large contribution to the phosphorus load in the watershed model?

A: The thought is that Pattee Brook has quite a bit of development and is missing the wetlands that several of the other sub-basins have. Wetlands have the ability to treat the water and remove some of the nutrients before it enters the lake. The Pattee Brook land cover data shows the greatest amount of hayland and greatest amount of recent timber harvesting of all the sub-basins in the watershed.

Q: The watershed has some of Norridgewock, does anything come from waste management?

A: No, Waste Management is not located in the North Pond watershed.

Q: About organic matter to feeding the algae - what contribution does leaf litter have?

A: Leaf litter can be a source of P in the fall when the leaves come off the deciduous trees and decay. To some extent this is a natural phenomenon, but controlling leaf litter has been found to improve the quality of urban runoff in the autumn (leaves that land in the streets are washed directly into the water via storm drains, instead of remaining on land to build up as duff). It is not an overriding factor in any year for North Pond but does contribute to internal loading over time. Keeping leaf litter (duff) in place in a vegetated buffer is beneficial to the environment, it slows down runoff and can protect the shoreline. Dumping leaf litter directly into the lake is not a good idea.

Q: A significant number of trees have ended up in the lake from blow downs. What effect does that have on water quality?

A: This is similar to the question about leaf litter. It is a natural part of a lake ecosystem; fallen trees provide habitat for aquatic life. An increase in decaying matter can deplete dissolved oxygen, but in shallow areas (where most fallen trees land) there is enough mixing from wind and waves to reoxygenate the water.

Phosphorus Questions – Internal Load

Q: What are the characteristics of salt and sand from winter plowing, and how does that affect P in the lake?

A: While added salt and sand are not good for the lake, they are not discernibly bad, certainly not like fertilizers or other high P sources. Conductivity, often indicative of salt inputs, has risen in North Pond, but is not extreme at this point. The issue is more that winter sand builds up in ditches and clogs drainageways, eventually making its way into the lake. When the capacity of the drainageways is decreased, large storms can blow out culverts and roads and lead to major erosion events.

Q: What happened in 2018 that put North Pond over the edge? What effect did the dredging in Smithfield have?

A: North Pond has been hovering on the edge of poor water quality for a while, and there is no single event that could have caused the amount of phosphorus present in the sediment. Before 2018, the internal loading was not a major contributor to the phosphorus load, but the gradual accumulation of P in bottom sediments and warming climate (which affects oxygen demand which in turn affects P release) has increased the probability of algal blooms. The key trigger that pushed water quality over the edge is hotter summer weather.

Q: Does internal loading have anything to do with the dredging in Smithfield?

A: The internal load is large enough that the phosphorus could not have come from a single event. It has been accumulating for a long time. The dredging in Smithfield could have removed some of the P reserves, but it was mostly conducted in shallow water where oxygen is high enough to limit release. It is unlikely that the dredging is a factor in the lake's current condition.

Q: What is it in the sediment that creates the unique issue in North Pond? Is it the WMA [Waste Management in Norridgewock]? Where did it really come from?

A: It is the combination of organic matter that lowers oxygen through decay and a high phosphorus content from the materials that have settled on the bottom of the lake. It comes from leaves, lawns, incoming sediment, aquatic plants, algae, and other sources over a long period of time. The WM plant is not in the North Pond watershed - that area drains to the Kennebec via Mill Stream.

Alternatives to Alum for Treating the Internal Load

Q: There are different options for addressing P, can we do a combination? Like dredge in some areas and Alum in others?

A: No options are mutually exclusive. It is unlikely that a thorough dredging job would require additional effort for P inactivation or oxygenation, but either could be conducted. If oxygenation was done properly, adding iron could control P and adding aluminum would not be necessary, but either could be added. The problem of multiple in-lake approaches is mostly cost; using one method over a logical target area is likely to be least costly. Any of the in-lake options will be done in conjunction with the watershed remediation efforts.

Q: If poor oxygenation contributes, why won't aeration help?

A: The depleted oxygen is at the water / sediment interface where decomposition is occurring. Aeration would help in theory, but it will be very difficult to keep the oxygenated water at the bottom of the lake, especially since North Pond doesn't stratify. Any bubbler system set up close to sediment will stir up sediment and only works in a small area; a very large network of piping and diffusers would be needed and represents a permitting problem in ME. Side-stream saturation or oxygen saturation technology could work but will be more expensive, and the operational costs of any oxygenation system are substantial over time. It is a great idea in stratified lakes, but much less efficient and effective in shallow systems.

Q: Would aeration cost less if we used solar power with it?

A: Using solar power will increase the initial costs greatly. It may or may not end up saving money when averaged over 20 years or so, given reduced operating costs. The cost overall would still be very high.

Q: What about binding phosphorus with ocher?

A: Ocher has not been used for phosphorus inactivation in a lake setting before. Experimental use of ocher for treating municipal wastewater is a very different application, as they are able control dissolved oxygen levels and pH, then discard the spent material in a landfill once the ocher has absorbed the P. In a lake setting, once the oxygen is consumed by biological activity the added iron from the ocher will simply release the phosphorus again. A paper was provided by an attendee that was from a wastewater application; interesting but not at all applicable to lake management, based on the tests conducted, the pH of the solution, and being completely a lab exercise. And it was actually calcium, not iron, that did most of the P binding, from cement that was added. Just imagine trying to get a permit to put enough cement in North Pond to make a difference!

Q: The dredging was expensive but looked like a long term 100-year solution. Is it off the table based on cost?

A: Nothing is off the table at this point. Given the cost of dredging (and the associated permitting required), trying P inactivation or oxygenation first would be a logical choice. If a $1M phosphorus inactivation completely failed, having to resort to a $50+ M dredging program would not have a significantly different total cost. The probability of better conditions from phosphorus inactivation is very high, making it much more attractive based on cost alone.

Dams and Water Levels

Q: A popular contention point is whether or not the dam is the end-all solution. Can you touch on this?

A: Flushing lake water by lowering the dam will help with in-lake P levels, but 50% of the P load is coming from the sediment. Trying to lower the P concentration in the lake only using drawdown will only work, if at all, over many decades.

The short version of the math on this goes as follows: the water level could be lowered by 2 feet if the lake is at full pool at the time it is lowered (most times it will be less); P is roughly evenly distributed in the water column, even with a bloom at the surface; given the max amount of water one could discharge and the P concentration, only 2-3% of the internal P reserves could be discharged each summer; ignoring that 2-3% will be a declining portion of the total over time (2-3% of what is left after the previous year's discharge is less than what left the previous year), it would take 15-25 years to get rid of about half the internal reserves, and no benefit is likely until that level of reduction is reached.

To get a 90% reduction as desired, it would take at least 30 years. In reality, it would take much longer: there are diminishing returns on each year's discharge and more P entering every year. Selective discharge efforts to reduce P concentration in lakes have achieved some benefits after 20+ years but never reached P goals by themselves. There is also the issue of getting a permit to send high P water downstream to Great Pond, which is very unlikely to be granted.

Q: Talk about the depth of the lake, would it help to make it deeper or shallower?

A: North Pond is 13 feet deep on average with maximum depth of 20 feet. North Pond has a lot of its depth in a range that allows temporary stratification and low oxygen but not deep enough to stay stratified all summer. As a result, released P can be mixed into the upper waters and can fuel cyanobacteria growth anywhere in the lake. To make the lake substantially less susceptible, the depth would have to be >25 ft or <10 ft, both unlikely to be permitted and extremely costly.

Q: To what extent do high water levels increase erosion/phosphorus in the lake and are guidelines for management of the dam included in a plan?

A: The plan has not been drafted yet. Keeping the water level stable will help with erosion, but it is not the main cause for phosphorus entering the lake. Internal loading and runoff are more important contributors.

Q: In 1985 the lake level was raised and beaches disappeared by 6-10 ft. This caused erosion of the shores. Is this a contributor to the P? Is there a way to get the lake back to the level it was in 1985 and reduce erosion?

A: When the water level was initially increased, yes, it would have had an effect on increasing the erosion and phosphorus in the lake. Since the dam has been in place since 1985, the old lawns that are underwater have already leeched their phosphorus into the lake and the existing shorelines should be reaching a new equilibrium. Putting the lake to its original level will have little or no effect on P. The original shorelines don't have vegetation anymore and will be highly erodible until stabilized. This approach will only make the lake shallower.

Alum Questions

Q: Who would pay for the Alum Treatment?

A: It is possible to get grants from the state or federal government, but they will not cover the whole cost of the treatment. Grants require local buy-in. The North Pond community will need to raise the majority of the funds. Look to East Pond as an example.

Q: How much will we be able to get for grants for the Alum plan?

A: It is too early to know. Getting funding from the 319 grants depends on the reviewers and politics during a particular funding cycle. Talk to your state representatives to support ear-marking funds for lake restoration and Alum treatments.

Q: Are there aquatic toxicity concerns associated with adding Alum to the water? Does the Alum treatment have any negative side effects?

A: When done properly there is limited effect on aquatic life. There is a potential toxicity when the pH is outside the range of 6 - 8 with Alum concentrations over 5 mg/L. The floc that forms may smother invertebrates, but with such low oxygen levels, the treatment area does not support a desirable fauna. Any impacts are temporary and the long-term condition of the biota of treated lakes has invariably improved. There have been no fishkills during Alum treatments in New England in over two decades.

Q: The Alum treatment in East Pond. What is the estimate of how long before they might have to do it again?

A: The treatment is estimated to last 10 years or more. It will depend on how much effort is put into stopping external P from entering the lake and how much P is below the inactivated zone in the sediment. Many treatments have provided in excess of 20 years of benefit, but shallow lakes tend to be more impacted by their watersheds, decreasing the period of benefit.

Q: When is the earliest we could get the Alum treatment? How long did it take East Pond to get there (after the action plan was finalized)?

A: Permitting will take about 6 months. The amount of time it takes to raise funds depends on the community. Alum treatments are typically applied in the spring or early summer. The East Pond community had done a lot of the fundraising before the action plan was actually finalized, but it was about two years between the decision to treat and actual treatment.

Q: There is a big range between $650k and $1.3M, what is the process for deciding what dose or area you go with for the Alum treatment?

A: The primary difference in the cost is the depth of sediment treated. In most cases, the dose is calculated to treat the top 10 cm of sediment. In the case of North Pond, the top 6 cm have the majority of the phosphorus, so a lower dosage may be sufficient to provide the desired outcome. If the action plan does call for an Alum treatment, additional sediment testing will be conducted to decide on the final dosage.

Q: Do we need a certain percent of LakeSmart participation to get federal money for an Alum treatment?

A: There is no LakeSmart requirement for getting federal funds, but funding agencies look at what else is being done in the watershed when evaluating grant applications. Having a large number of LakeSmart properties will help make the application more favorable.

Q: What is the required permitting for Alum Treatments?

A: There is a permit from the state subject to local input. It is regulated as a discharge to the aquatic environment. DEP has been both efficient and open about the process on other lakes treated in ME. It is about $700 to permit and takes about 3 to 6 months.

Q: What is the effect of wind on an Alum treatment in a shallow lake like North Pond?

A: Below 15 feet, the wind driven waves and boat wakes do not affect the sediment.

Miscellaneous

Q: East Pond vs North Pond participation in lake associations?

A: 130 members in East Pond Association. North Pond Association has 250 members.

Q: How many LakeSmart properties on East vs North Pond?

A: East Pond has over 50 LakeSmart properties. North Pond has between 20-25.

APPENDIX B. OTHER MAJOR LLRM INPUTS

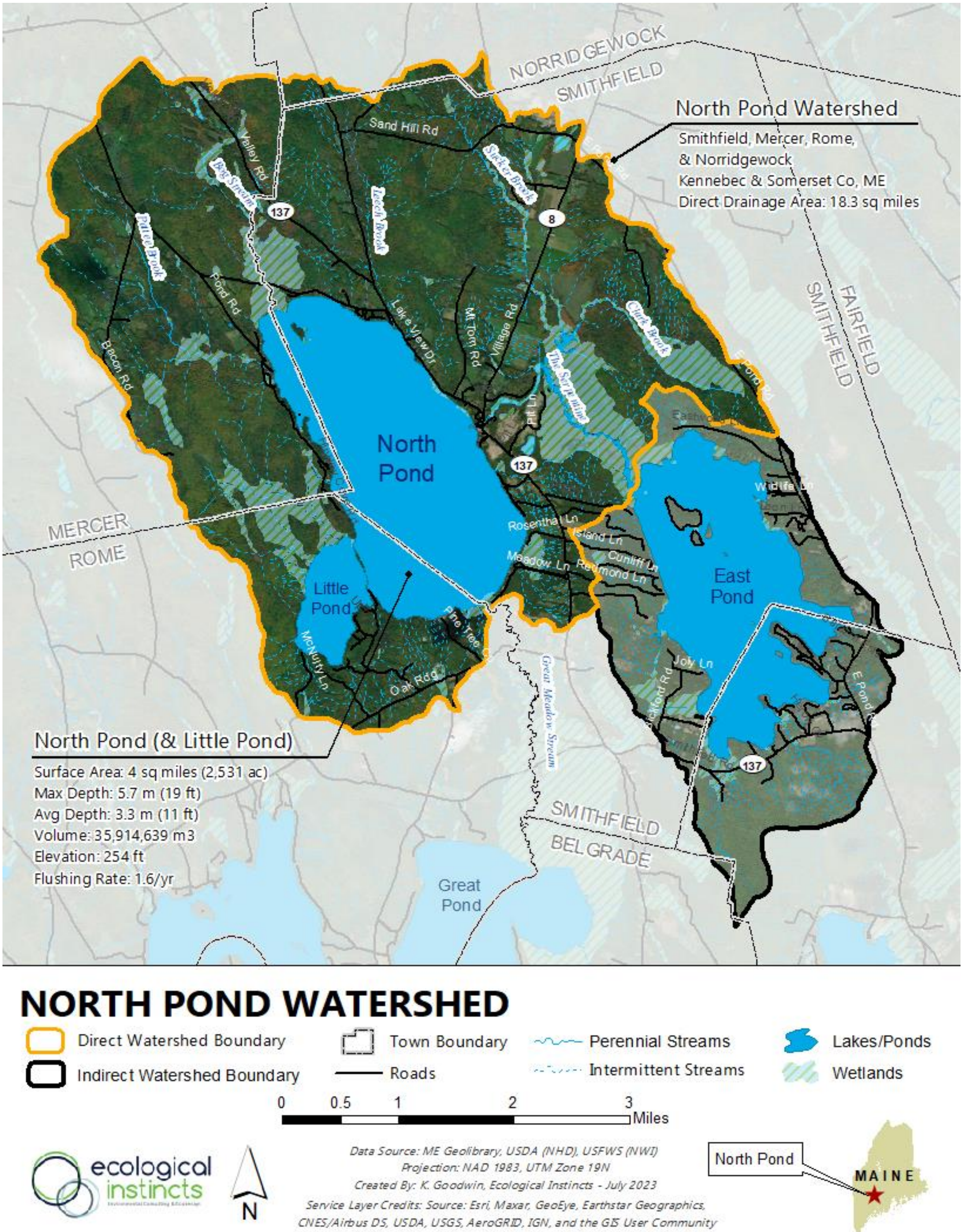
- *Annual precipitation* data were obtained from NOAA National Climatic Data Center (NCDC) Waterville, ME station (Station ID: USC00179151) for the ten-year period 2013 - 2022 (annual average of 42.6 in or 1.1 m).
- *Atmospheric deposition* a P export coefficient of 0.1 kg/ha/yr was used in the model, which aligns with coefficients being used in current LLRM models for other Maine lakes with mainly forested watersheds.
- *Lake area* and volume estimates were obtained from bathymetry data collected in partnership by 7 Lakes Alliance, Colby College, and North Pond Association volunteers in 2022, and processed by Lakes Environmental Association (LEA) in 2023. For modeling purposes, the area and volume of Little North Pond was separated from North Pond based on the 2022 bathymetry. Water quality in Little North Pond is significantly different than North Pond, and while North Pond has been experiencing annual algal blooms since 2018, Little North has not. Therefore, Little North Pond was treated as a separate sub-basin with its own watershed area.
- *Routing Pattern* is a feature within the LLRM that allows larger drainage basins to be divided into smaller sub-basins where one sub-basin passes through another sub-basin. This guides prioritization of areas with higher nutrient loads within a drainage basin. For North Pond, Basin 7 (Sucker Brook), Basin 8 (Clark Brook), and Basin 10 (East Pond) were all set up to pass through Basin 9 (The Serpentine).
- *Septic system data* estimates were extrapolated from the North Pond Association's 2022 Septic System Survey mailed to shoreline property owners, the septic database created by 7 Lakes in 2022, and input from local members of the Technical Advisory Committee. Information used for the model included the days of occupancy (seasonal vs. year-round) distance of the system from the shoreline (<100' or >100') and number of people per dwelling (3 was used as a default across all categories).
- *Water quality data* were obtained from Maine DEP and 7 Lakes Alliance. Because of the significant shift in water quality starting in 2018, both the 5-year (2018-2022) and 10-year in-lake phosphorus concentration (2013-2022) were considered and used for calibrating the model. Measured values during these time periods range from 17.5 ppb (10-year average) to 23.4 ppb (5-year average) representing the median annual average TP concentration from epilimnetic core samples collected at Station 1 between April 15 – October 15.[36]
- *Waterfowl counts* are based on a conservative estimate of 100 birds on the lake annually. Waterfowl can be a direct source of nutrients to lakes. However, if they are eating from the lake, and their waste returns to the lake, the net change may be less than might otherwise be assumed. Despite the fact

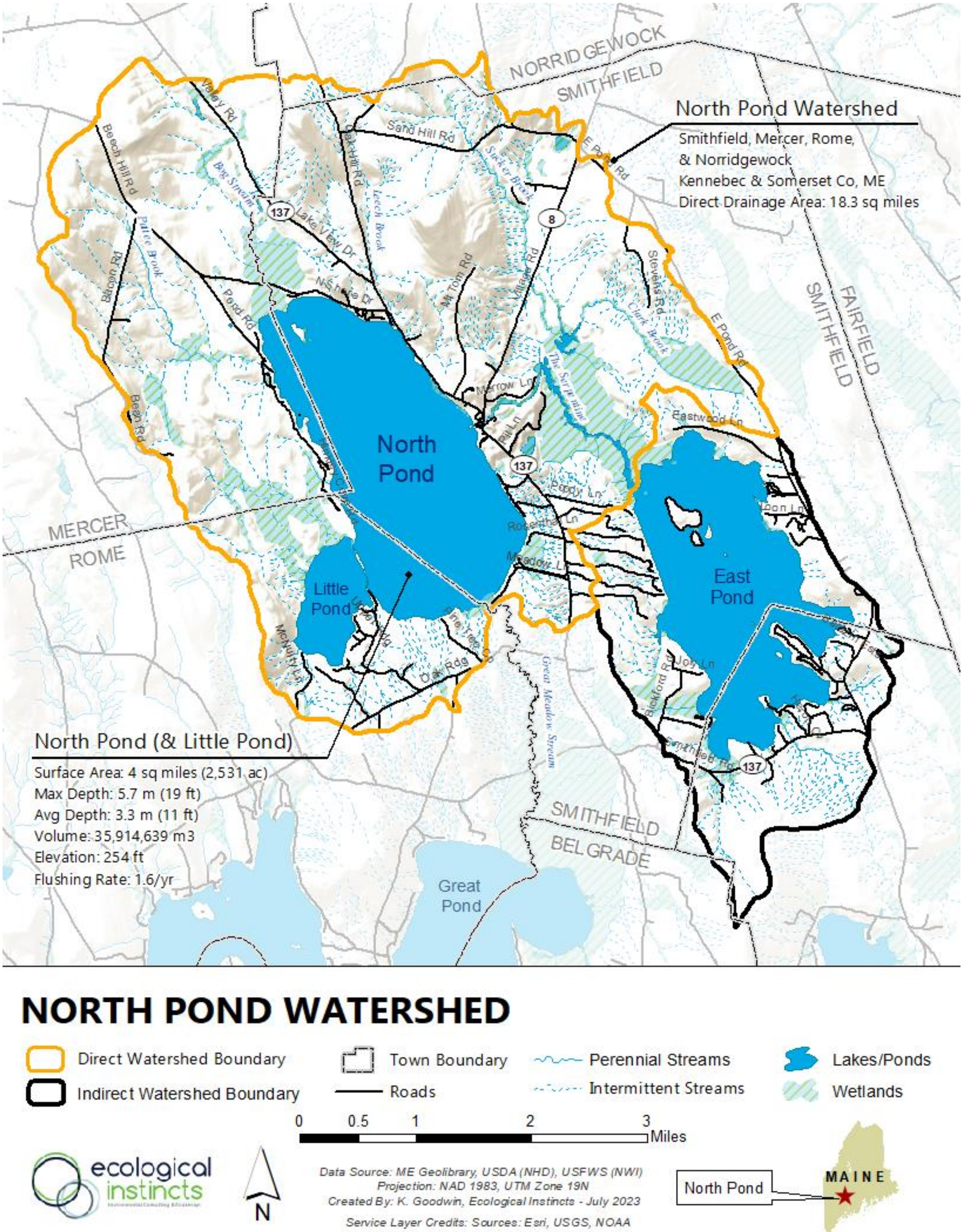
[36] Due to lack of epilimnetic core samples in 2022, grab samples were used to compute a volume weighted average TP for each sampling day. Measurements from the same day were averaged together. For each year, a weighted mean was calculated that accounts for irregular data intervals.

that waterfowl may also be removing some phosphorus from the lake, the phosphorus excreted may be in a form that can readily be used by algae.

- *Internal phosphorus loading* was calculated by WRS, Inc. based on 2023 bathymetry data, 2013-2022 water quality data, 2022 P profile data collected by 7 Lakes, P mass calculations provided by Ecological Instincts, and sediment data provided by Colby College.

APPENDIX C. WATERSHED MAPS


NORRIDGEWOCK
SMITHFIELD
North Pond Watershed
Smithfield, Mercer, Rome,
& Norridgewock
Kennebec & Somerset Co, ME
Direct Drainage Area: 18.3 sq miles
Sand Hill Rd
Valley Rd
Bog Stream
Leech Brook
Sucker Brook
Pattee Brook
Pond Rd
Lake View Dr
Mt Tom Rd
Village Rd
Clark Brook
The Serpentine
Pit Ln
Bacon Rd
FAIRFIELD
SMITHFIELD
North
Pond
MERCER
ROME
Rosenthal Ln
Island Ln
Cunliff Ln
Meadow Ln
Redmond Ln
East
Pond
Little
Pond
McNutty Ln
Oak Rdg
Joly Ln
Great Meadow Stream
North Pond (& Little Pond)
Surface Area: 4 sq miles (2,531 ac)
Max Depth: 5.7 m (19 ft)
Avg Depth: 3.3 m (11 ft)
Volume: 35,914,639 m3
Elevation: 254 ft
Flushing Rate: 1.6/yr
SMITHFIELD
BELGRADE
Great
Pond
NORTH POND WATERSHED
Direct Watershed Boundary
Indirect Watershed Boundary
Town Boundary
Roads
Perennial Streams
Intermittent Streams
Lakes/Ponds
Wetlands
0 0.5 1 2 3 Miles
N
Data Source: ME Geolibrary, USDA (NHD), USFWS (NWI)
Projection: NAD 1983, UTM Zone 19N
Created By: K. Goodwin, Ecological Instincts - July 2023
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
North Pond
MAINE


NORRIDGEWOCK
SMITHFIELD
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SMITHFIELD
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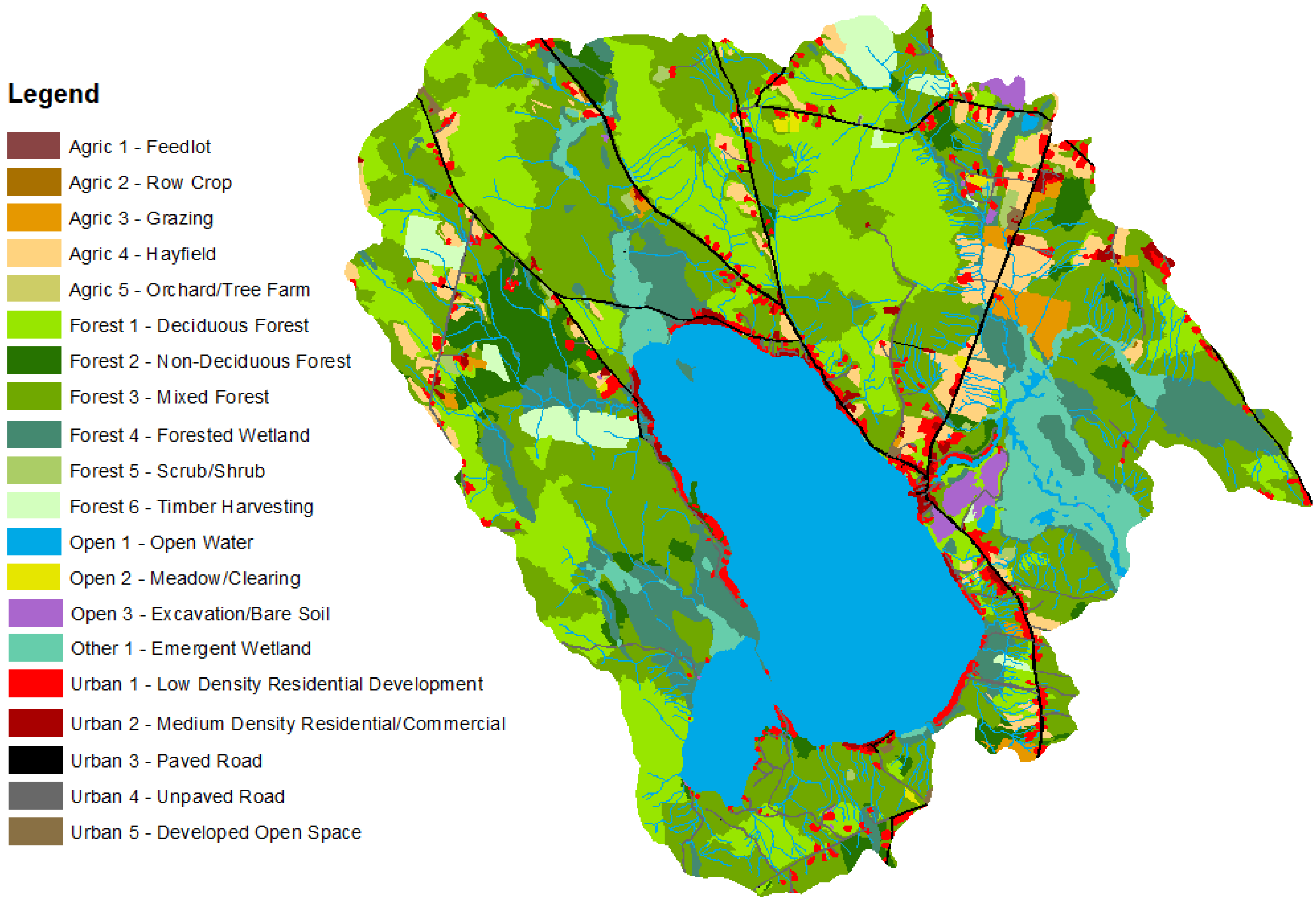
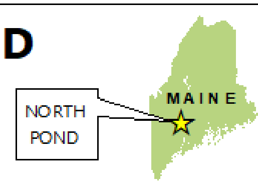
NORTH POND WATERSHED
Direct Watershed Boundary
Indirect Watershed Boundary
Town Boundary
Roads
Perennial Streams
Intermittent Streams
Lakes/Ponds
Wetlands
0 0.5 1 2 3 Miles
ecological instincts
N
Data Source: ME Geolibrary, USDA (NHD), USFWS (NWI)
Projection: NAD 1983, UTM Zone 19N
Created By: K. Goodwin, Ecological Instincts - July 2023
Service Layer Credits: Sources: Esri, USGS, NOAA
North Pond
MAINE



NORTH POND WATERSHED

Land Cover



N

Source: ME Geolibrary, NHDPlusHR, NWI, Ecological Instincts
Projection: NAD 1983 UTM Zone 19N
K. Goodwin, Ecological Instincts - September 2022

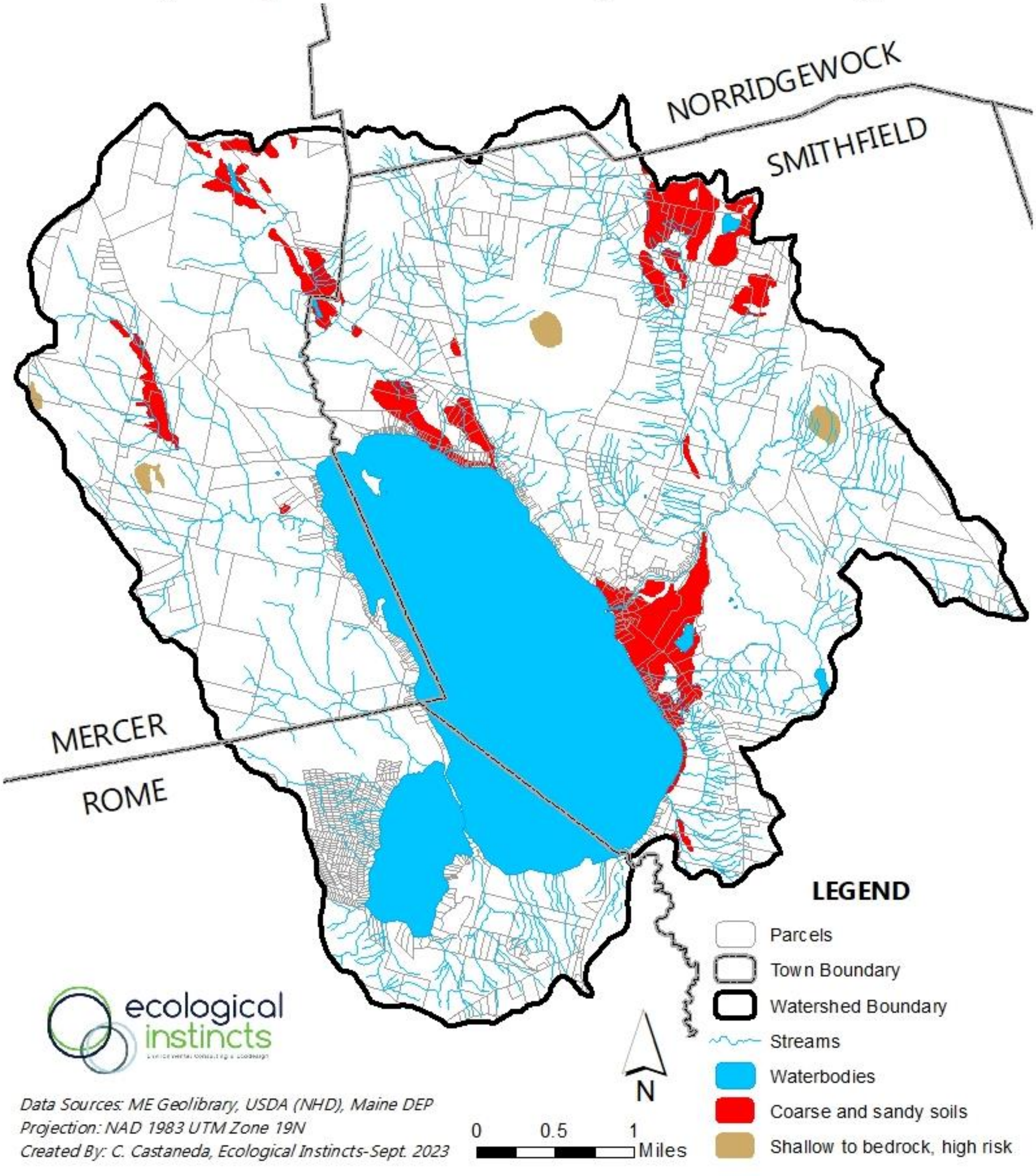
0 0.5 1 2 Miles

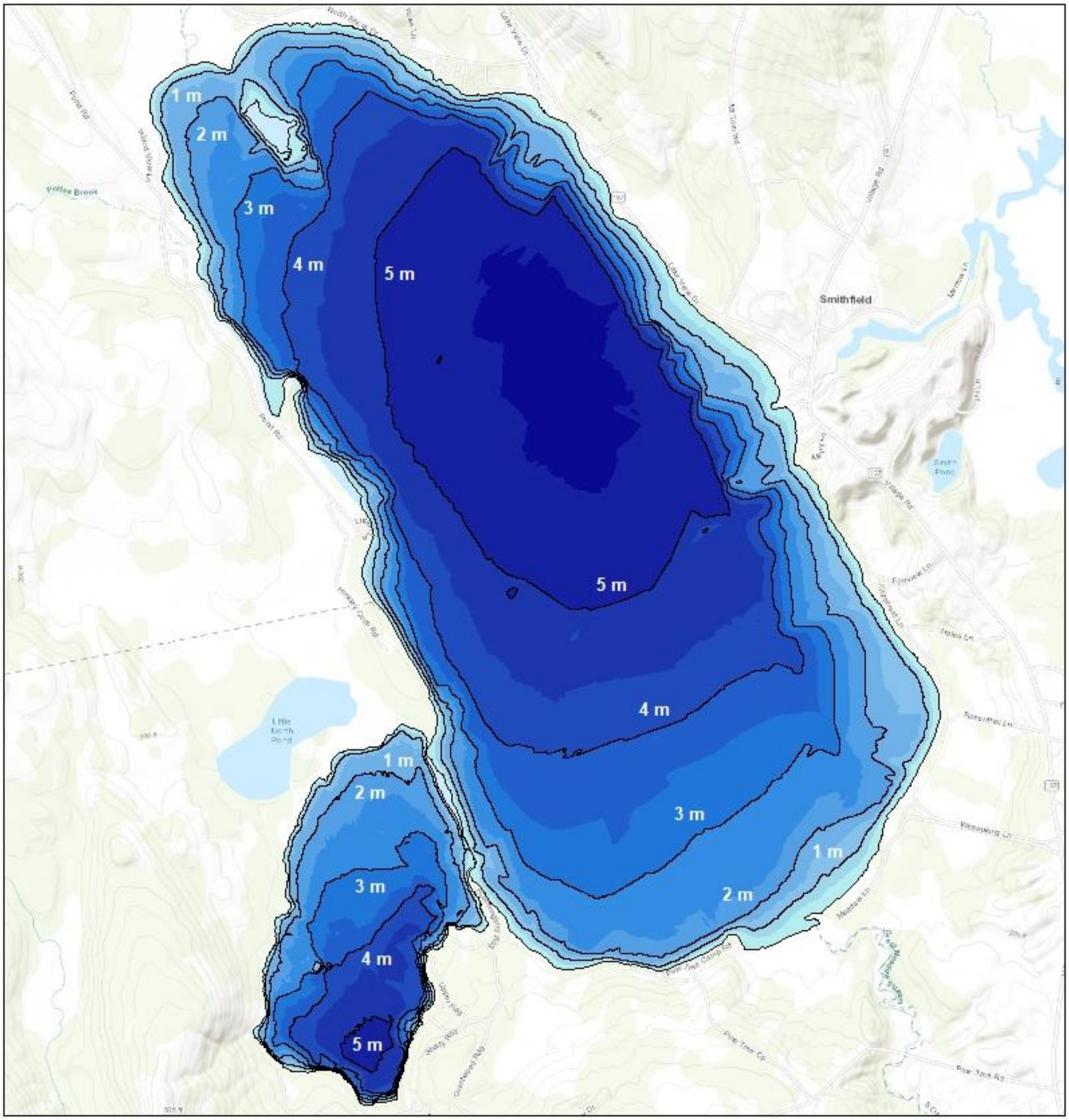
ecological instincts

NORTH POND WATERSHED

SENSITIVE SOILS

By Listing Reasons and Risk of Septic Short-Circuiting





NORTH POND BATHYMETRY

Data Sources: LEA, Esri, HERE, Garmin, Intermap, increment P. Corp., GEBCO, USGS, FOA, NPS, NRCAM, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Projection: NAD 1983 UTM Zone 19N

Made by: C. Castaneda, Ecological Instincts - Sept. 2023

ecological instincts

0 0.25 0.5 1 Miles

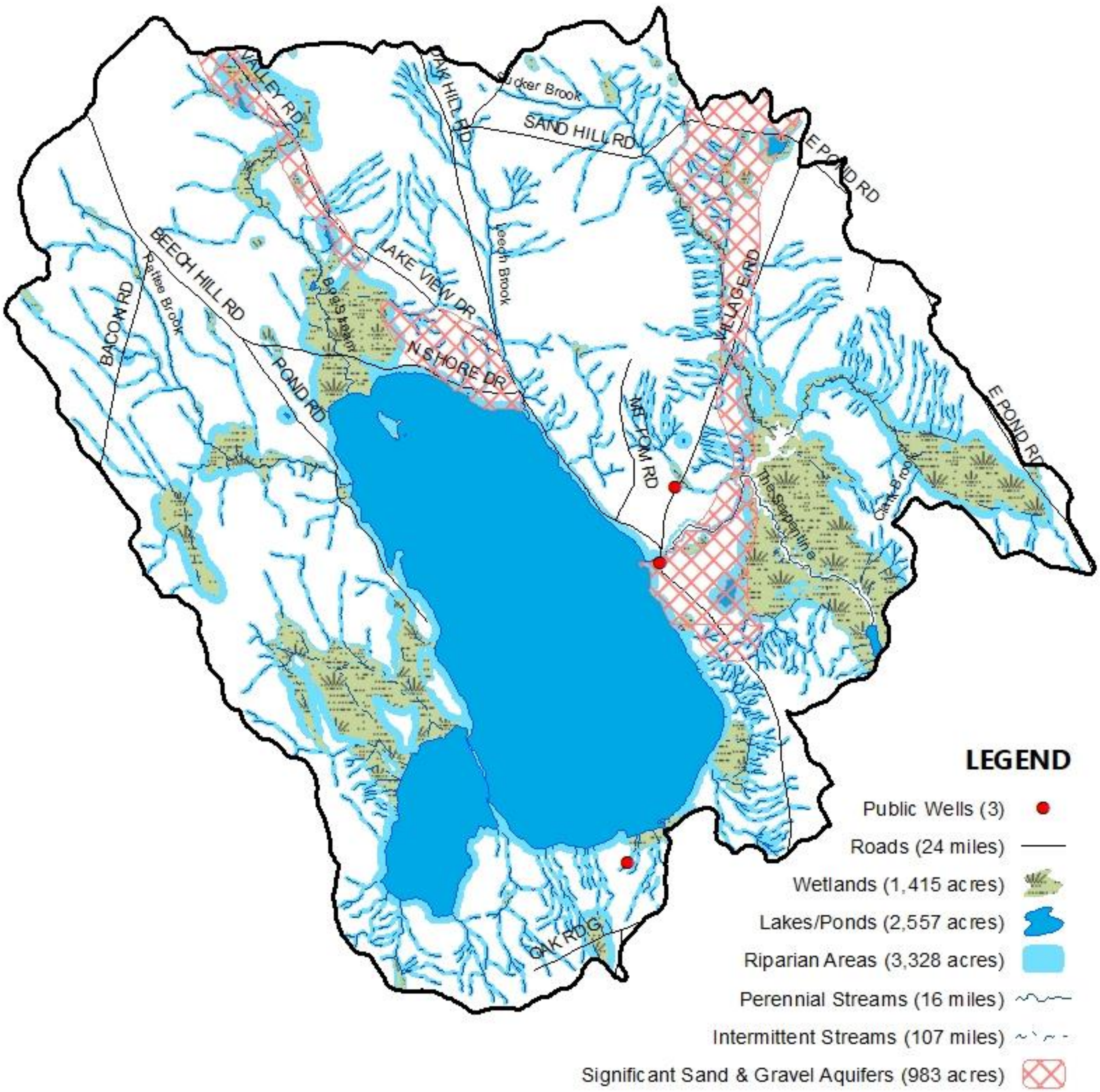
N

DEPTH (m)

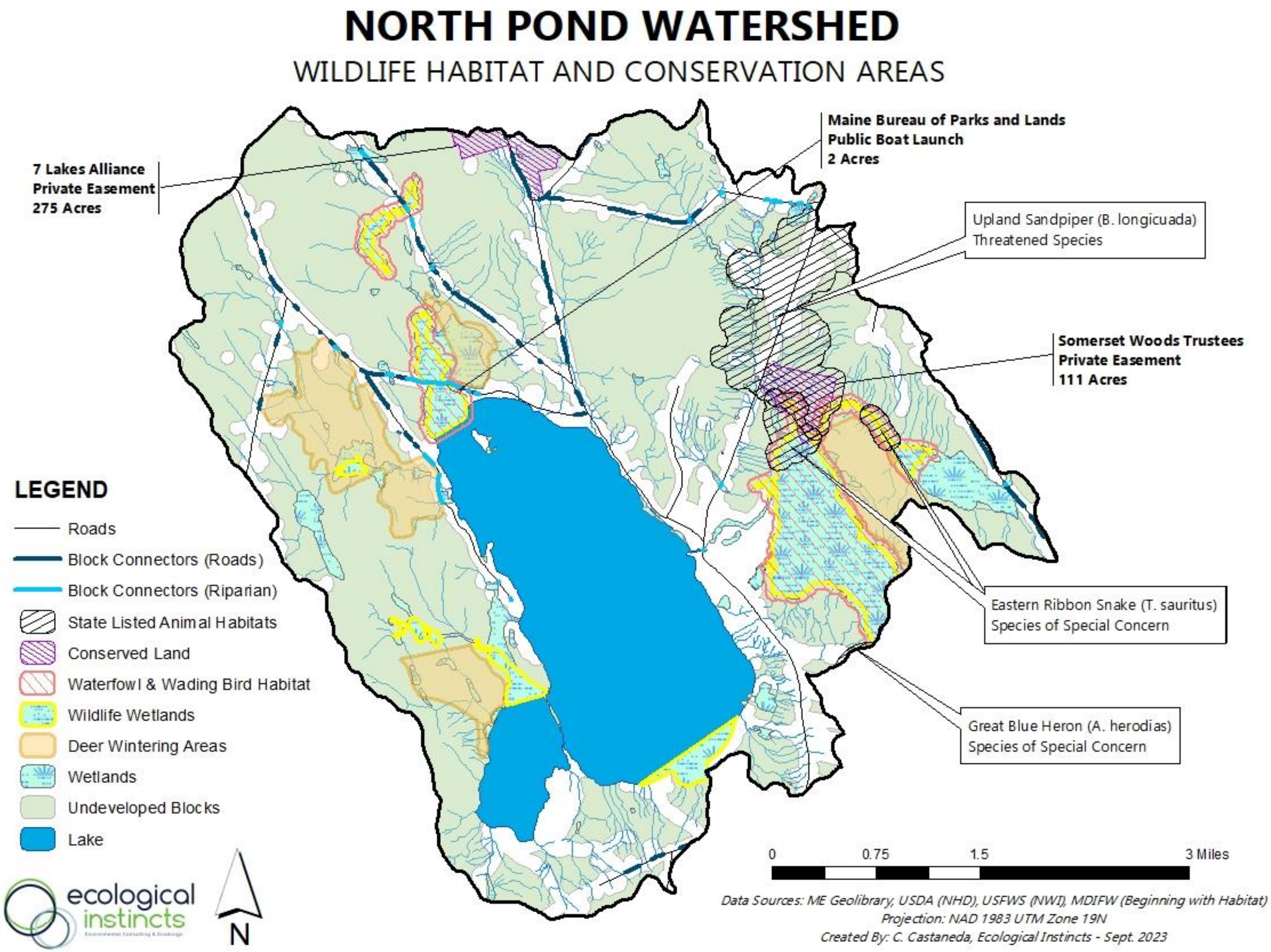
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 3.5
3.5 - 4
4 - 4.5
4.5 - 5
5 - 5.5
5.5 - 6

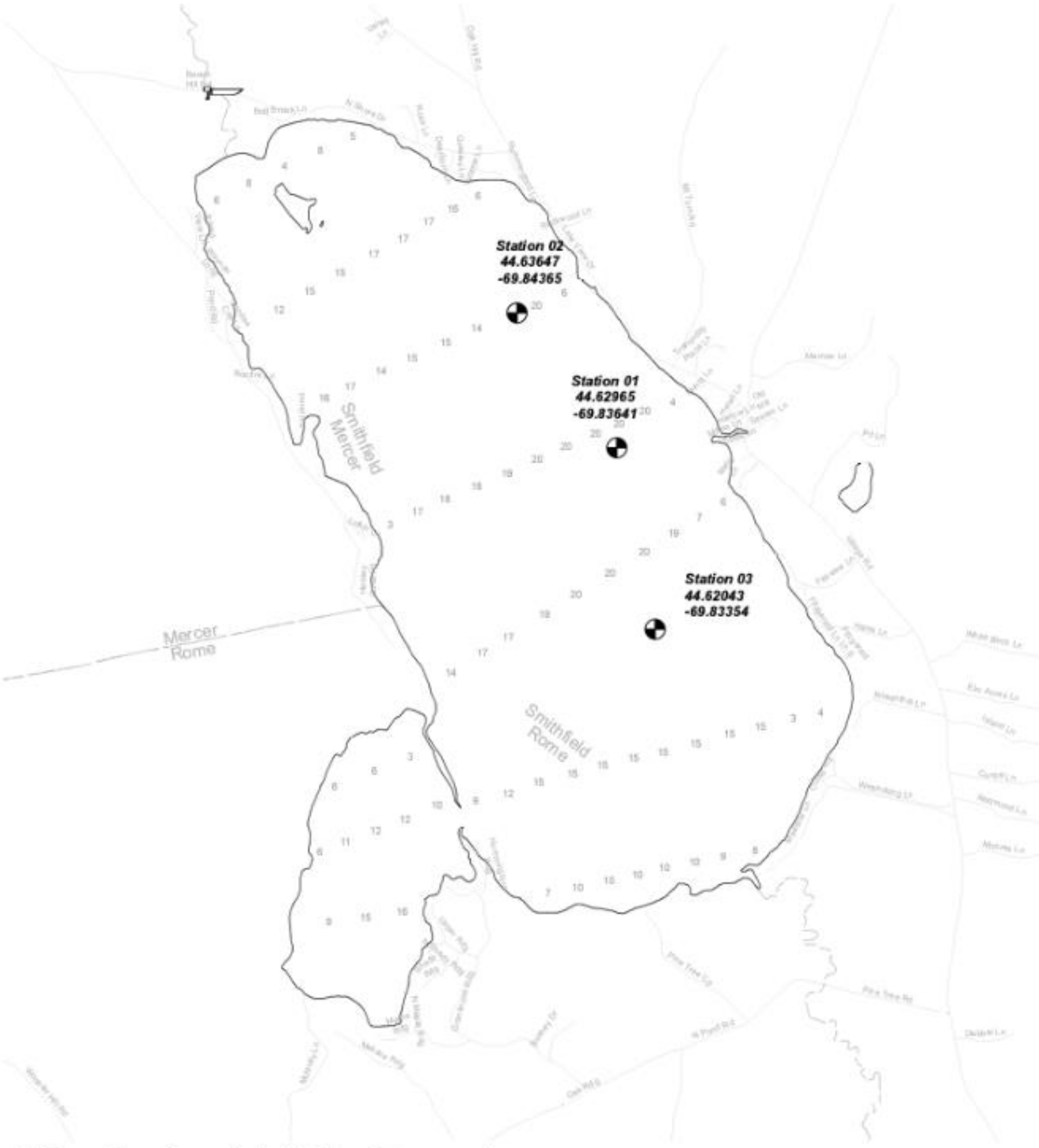
NORTH POND WATERSHED

WATER RESOURCES



Data Sources: ME Geolibrary, USDA (NHD), USFWS (NWI), MDIFW (BwH)
Projection: NAD 1983, UTM Zone 19N
Created By: C. Castaneda, Ecological Instincts - Sept 2023


NORTH POND WATERSHED
WILDLIFE HABITAT AND CONSERVATION AREAS
7 Lakes Alliance
Private Easement
275 Acres
Maine Bureau of Parks and Lands
Public Boat Launch
2 Acres
Upland Sandpiper (B. longicuada)
Threatened Species
Somerset Woods Trustees
Private Easement
111 Acres
Eastern Ribbon Snake (T. sauritus)
Species of Special Concern
Great Blue Heron (A. herodias)
Species of Special Concern
LEGEND
Roads
Block Connectors (Roads)
Block Connectors (Riparian)
State Listed Animal Habitats
Conserved Land
Waterfowl & Wading Bird Habitat
Wildlife Wetlands
Deer Wintering Areas
Wetlands
Undeveloped Blocks
Lake
0
0.75
1.5
3 Miles
N
ecological instincts
Data Sources: ME Geolibrary, USDA (NHD), USFWS (NWI), MDIFW (Beginning with Habitat)
Projection: NAD 1983 UTM Zone 19N
Created By: C. Castaneda, Ecological Instincts - Sept. 2023



North And Little Ponds

MIDAS # 5344

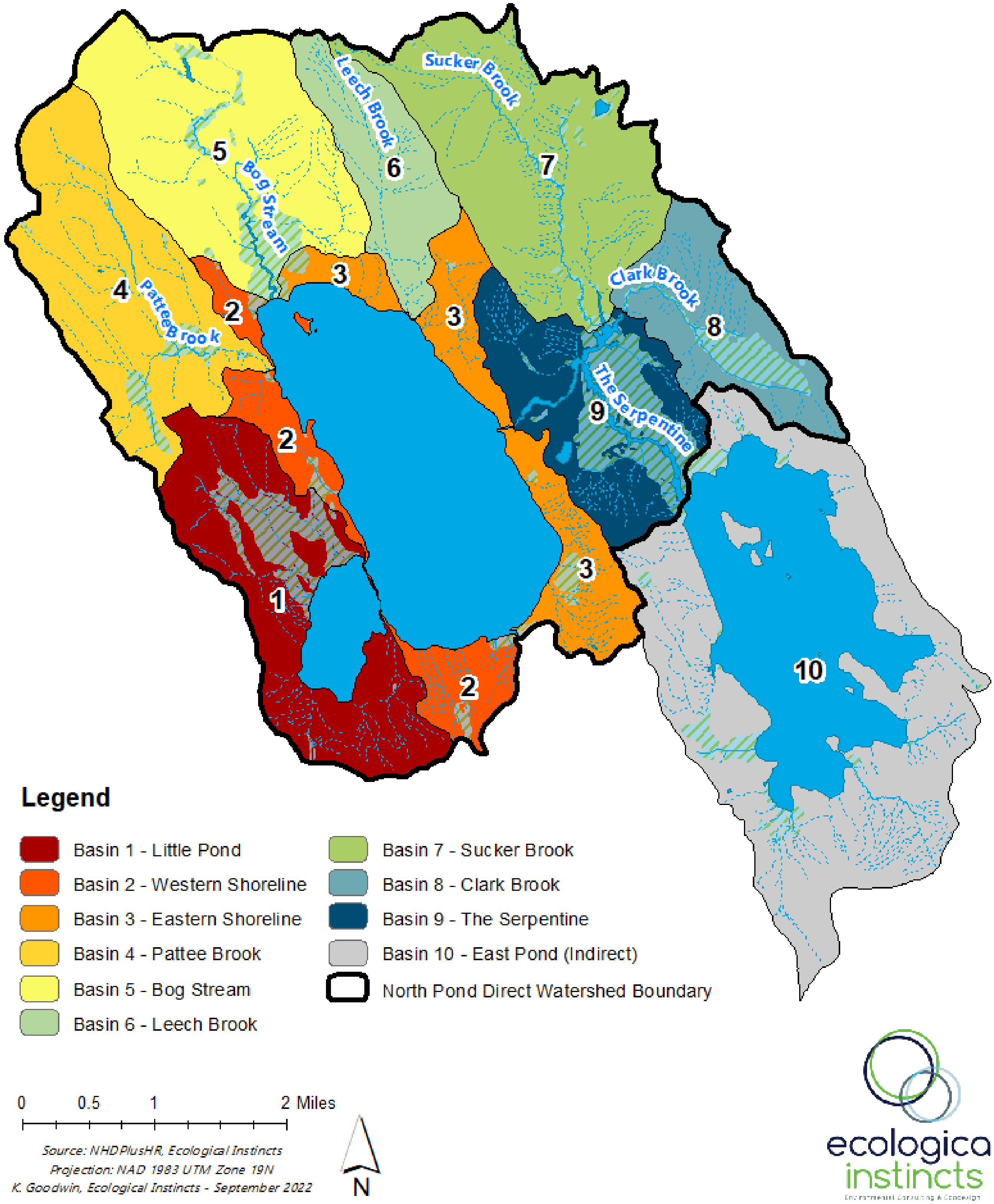
Smithfield, Somerset Co. - Delorme Page 20 - 2531 acres

Boat Launch | Lake Sample Stations | # Depth (FT) | Roads | Town Lines

0 | 0.6 | 1.2 | 1.8 | 2.4 | 3 Miles

NORTH POND WATERSHED

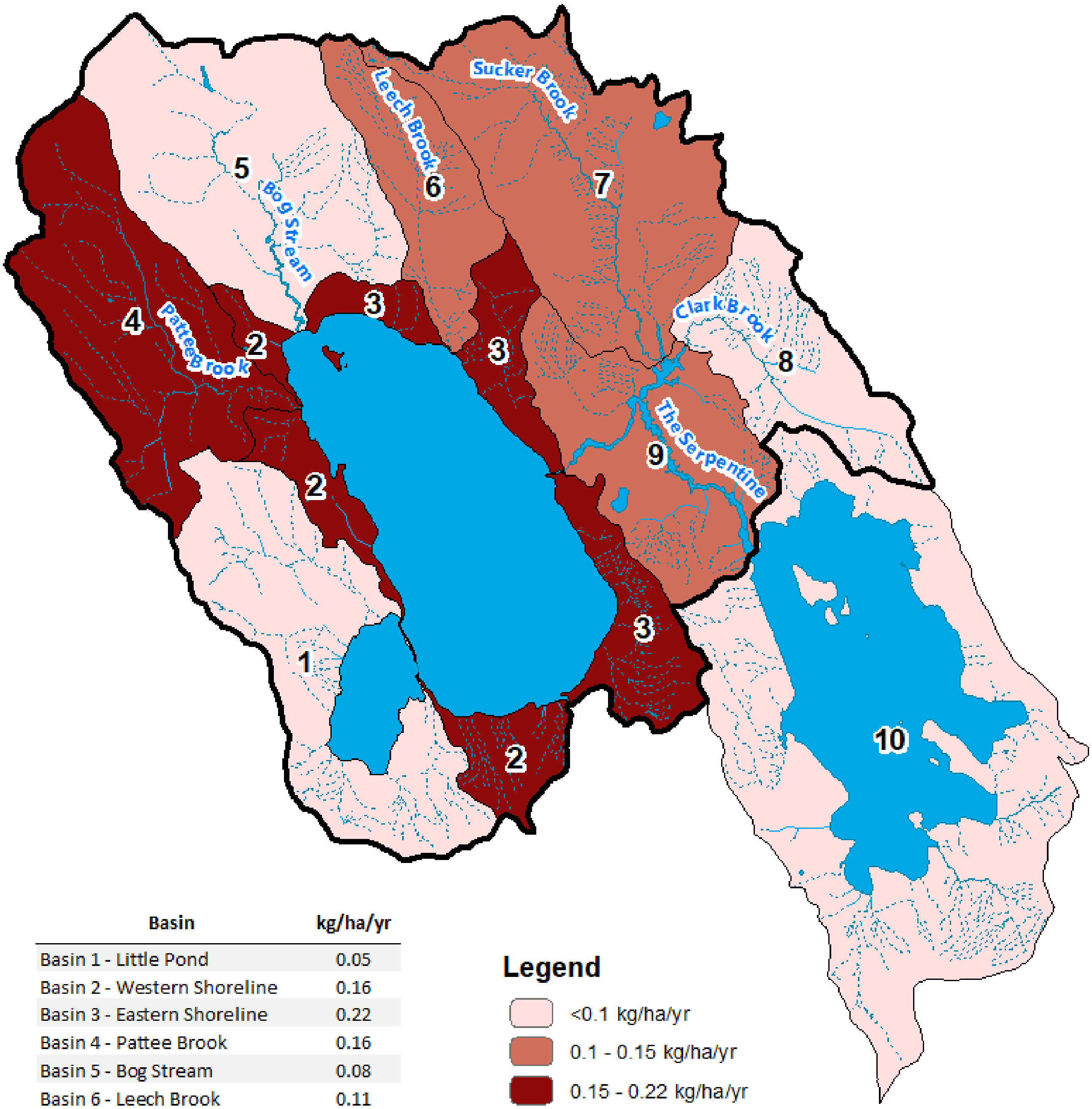
LLRM BASINS



ecological instincts

NORTH POND LLRM

P-load by area (kg/ha/yr) - All Sub-Basins



Basin	kg/ha/yr
Basin 1 - Little Pond	0.05
Basin 2 - Western Shoreline	0.16
Basin 3 - Eastern Shoreline	0.22
Basin 4 - Pattee Brook	0.16
Basin 5 - Bog Stream	0.08
Basin 6 - Leech Brook	0.11
Basin 7 - Sucker Brook	0.12
Basin 8 - Clark Brook	0.05
Basin 9 - The Serpentine	0.11
Basin 10 - East Pond (Indirect)	0.03

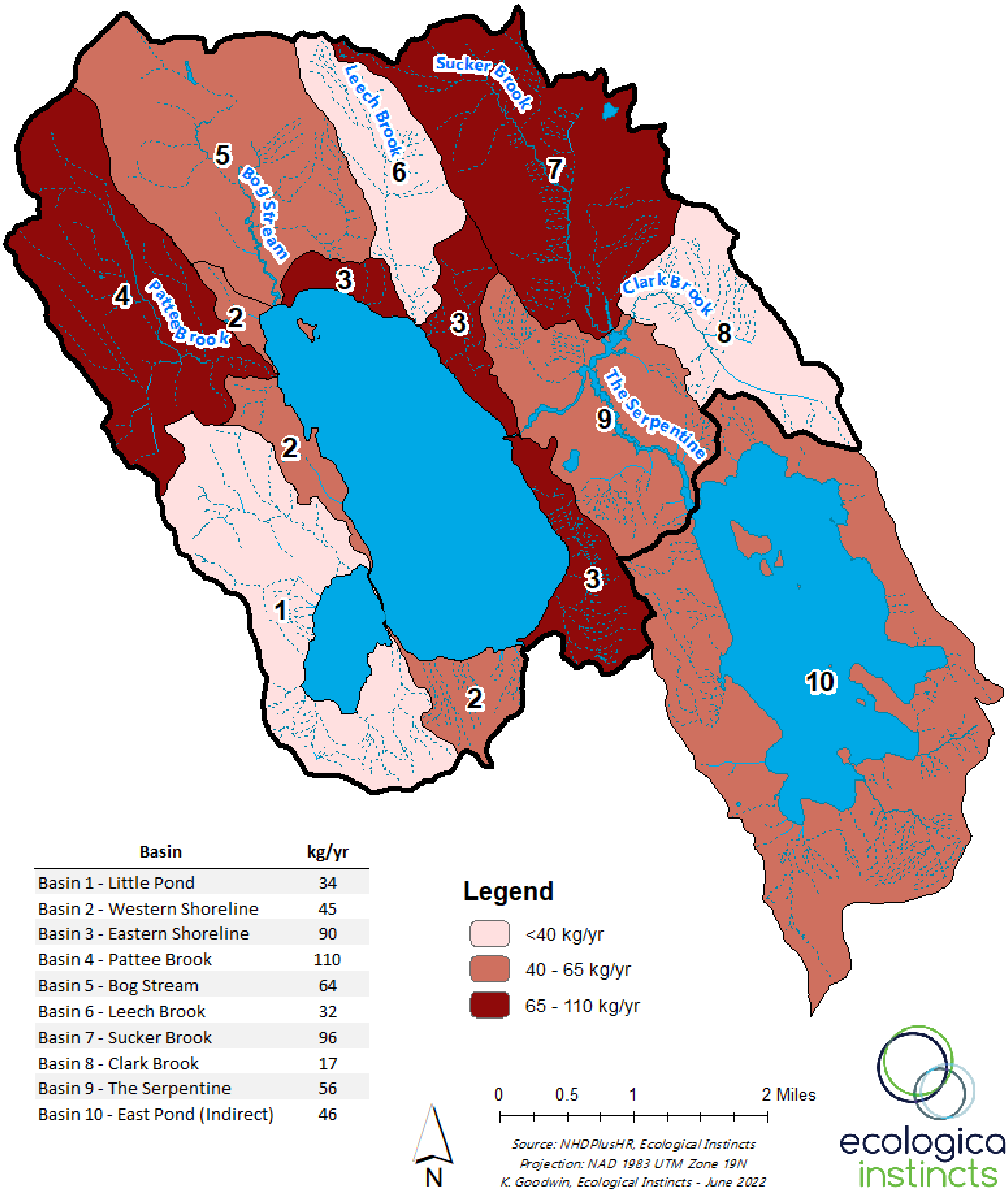
N

0 0.5 1 2 Miles

Source: NHDPlusHR, Ecological Instincts
Projection: NAD 1983 UTM Zone 19N
K. Goodwin, Ecological Instincts - June 2023

NORTH POND LLRM

P-load (kg/yr) - All Sub-Basins



Basin	kg/yr
Basin 1 - Little Pond	34
Basin 2 - Western Shoreline	45
Basin 3 - Eastern Shoreline	90
Basin 4 - Pattee Brook	110
Basin 5 - Bog Stream	64
Basin 6 - Leech Brook	32
Basin 7 - Sucker Brook	96
Basin 8 - Clark Brook	17
Basin 9 - The Serpentine	56
Basin 10 - East Pond (Indirect)	46

Source: NHDPlusHR, Ecological Instincts
Projection: NAD 1983 UTM Zone 19N
K. Goodwin, Ecological Instincts - June 2022

ecological instincts

APPENDIX D. Phosphorus Reduction Estimates Methods

Load reduction estimates for the 2023 North Pond WBMP were developed by Ecological Instincts based on three methods including: **1)** the US EPA Pollutant Load Estimation Tool (PLET) model to estimate P reductions that can be achieved by addressing NPS sites from the 2022 watershed survey update, **2)** Maine DEP Relational Method to provide a rough estimate of load reductions across developed land cover types in the watershed as a percent of the total for each cover type, and **3)** use of an empirical watershed model (Lake Loading Response Model) to finalize load reduction estimates, predict in-lake water quality conditions under different load reduction scenarios, and provide water quality target scenarios for Steering Committee and Technical Advisory Committee members. Each step used to calculate load reductions was useful for preparing final load reduction estimates to help set the in-lake water quality target for North Pond over the next 10 years. A brief summary of each method is provided below.

1) <u>Pollution Load Estimation Tool (PLET)</u>

The US EPA Pollutant Load Estimation Tool (PLET) Model[37] is an online model that provides estimates of sediment and nutrient load reductions from the implementation of Best Management Practices (BMPs). The PLET is the recommended method and is used extensively for developing Pollutants Controlled Reports (PCR) for US EPA 319 grant projects and incorporates local weather data that was not accounted for in the US EPA's Region 5 Model that was used for past WBMP projects.

Data used in the PLET model was compiled using a desktop assessment of available watershed survey data (site description, land use type, problems/solutions, area of exposed soil, and photos of the sites). Rather than calculating soil loss estimates for 91 individual sites identified during the 2022 update of the 2016 watershed survey, a subset of representative sites was selected based on the total number of sites (or percentage of sites) by land use type within each of the three impact categories (high, medium, or low). This includes calculations for 100% of all high impact sites (7 sites), 25% of medium impact sites (10 sites), and 20% of low impact sites (10 sites).

The PLET Gullies and Streambanks tool was used for all sites. Soil nutrient concentrations are estimated in the model based on soil types, which were entered based on the soil type for each location as mapped by the USDA Soil Survey Geographic Database (SSURGO). Lateral Recession Rates (LRR) were entered using the PLET categories of slight, moderate, severe, or very severe, and were based on the site description and photographs for each site. BMP efficiency was set at 0.85 for all sites for simplicity. A spreadsheet was prepared that includes variables used for each site sorted by impact. The average of each parameter (sediment, P, N) was multiplied by the total number of sites by impact and then summed to develop final pollutant reduction estimates (49 tons/yr sediment, 13.8 kg/yr P, and 41.4 kg/yr N) for the NPS sites (Table 1).

[37] https://www.epa.gov/nps/plet

Table 1. *PLET soil loss estimates for 2022 North Pond watershed survey sites.*

Total: High Impact Sites (7 sites)		
Sediment (t/yr)	P (lbs/yr)	N (lbs/yr)
10.1	6.0	15.5
Total: Medium Impact Sites (37 sites)		
Sediment (t/yr)	P (lbs/yr)	N (lbs/yr)
25.9	14.0	36.1
Total: Low Impact Sites (47 Sites)		
Sediment (t/yr)	P (lbs/yr)	N (lbs/yr)
13.0	10.4	39.6

Total (P & N= lbs/yr)		
Sediment (t/yr)	P (lbs/yr)	N (lbs/yr)
49.0	30.3	91.2
Total (P & N= kg/yr)		
Sediment (t/yr)	P (kg/yr)	N (kg/yr)
49.0	**13.8**	**41.4**

2) <u>DEP Relational Method</u>

The *Relational Method for Estimating Required and Projected Load Reductions*[38] was used to estimate potential phosphorus load reductions that could be achieved in the North Pond watershed. This model estimates the percentage of various sources of phosphorus in the watershed by land use type expressed as a fraction of the total contributing P sources times the fraction to be addressed times a BMP efficiency. The result is an estimate of the fraction of the load reduced for each land use type.

A land cover analysis was completed to calculate the area of each land cover type within the North Pond direct watershed using the MELCD (2004) land cover layer modified by Ecological Instincts (2022) by comparing the layer to aerial imagery and manually editing polygons. To estimate load reductions, the P export coefficient assigned to each land cover type in the empirical model was used to estimate the P load from each land cover type, and the fraction of the total P load for each land cover category was calculated (Table 2).[39] "Fraction addressed" was applied to the P load for each land cover type (ranging from 25% for hay/grazing and timber harvesting, to 50% for row crops, low and medium intensity development, and septic systems, and 100% for the internal load). BMP efficiencies were applied for each category based on various literature sources and values used for past WBMP projects. A BMP efficiency of 0.9 was applied for the internal load, representing a 90% reduction in the internal load. Other BMP efficiencies ranged from 0.37 (row crops) to 0.78 (timber harvesting). The fractions addressed were multiplied by the BMP efficiencies to calculate the P load reduction by category (Table 3). The total fraction that could be reduced based on the conditions above was estimated at 962 kg P/yr, or 50% of the total phosphorus load.

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[38] Jeff Dennis, Division of Watershed Management, MEDEP, n.d.

[39] The total load in the Relational Method is slightly higher than the total load in the empirical model because the model accounts for attenuation of P, where the Relational Method does not.

Table 2. *Values used for the DEP Relational Method for the North Pond watershed.*

Land Cover Type	P Export Coefficient (kg/ha/yr)	Total area (ha)	P Load (kg/yr)	Fraction of Load
Hay/Grazing	0.55	341	188	0.080
Feedlot	224.00	1	114	0.049
Row Crop	1.00	3	3	0.001
Orchard/Tree Farm	0.35	3	1	0.000
Developed, Low Intensity	0.70	140	98	0.042
Developed, Medium Intensity	0.90	43	39	0.017
Developed Open Space	0.60	7	4	0.002
Roads	1.20	75	90	0.038
Upland Forest	0.08	3230	258	0.110
Open Water	0.10	68	7	0.003
Scrub/Shrub	0.10	21	2	0.001
Meadow/Clearing	0.20	11	2	0.001
Barren Land (Rock/Sand/Clay)	0.80	37	29	0.012
Forested Wetlands	0.10	442	44	0.019
Emergent Herbaceous Wetlands	0.15	208	31	0.013
Recent Timber Harvesting	0.40	122	49	0.021
East Pond (Indirect)			46	0.020
Septic Systems			129	0.055
Waterfowl			20	0.009
Atmospheric			224	0.095
Internal			969	0.413
TOTAL		**4750**	**2347**	**1.0**

3) <u>**Empirical Model Application**</u>

The Relational Method helped guide relative load reduction estimates for use in the empirical model. Within the empirical model, the following reductions were applied: direct watershed load (58 kg/yr), internal loading (872 kg/yr), and septic systems (32 kg/yr). For reductions from the direct watershed, 18 kg/yr is estimated to come from agriculture (largely reductions from hay/grazing), 32 kg/yr from urban development (largely low intensity shoreline development, roads, and medium intensity development), and 8 kg/yr from timber harvesting. Additional P reductions from upstream lakes (East Pond) were not factored into the calculations.

Table 3. *DEP Relational Method for estimating phosphorus reductions in the North Pond watershed.*

Source Type	Sub-type	Fraction of total load	Fraction Addressed	Expected BMP Efficiency	Load Fraction Reduced	Total P Reduced (kg/yr)
Agriculture						
	Row Crop	0.001	0.5	0.37	0.0%	0.4
	Hay/Grazing	0.080	0.25	0.45	0.9%	17
	Feedlot	0.049	0		0.0%	0
	Orchard/Tree Farm	0.000	0		0.0%	0
	Subtotal					**18**
Urban Development						
	Low Intensity Development	0.042	0.5	0.42	0.9%	17
	Medium Intensity Dev/Commercial	0.017	0.5	0.40	0.3%	6
	Developed Open Space	0.002	0	0.40	0.0%	0
	Roads	0.038	0.3	0.40	0.5%	9
	Barren Land (Rock/Sand/Clay)	0.012	0	0.40	0.0%	0
	Meadow/Clearing	0.001	0	0	0.0%	0
	Subtotal					**32**
Non-Developed Land						
	Unmanaged Forest	0.110	0	0	0.0%	0
	Timber Harvesting	0.021	0.25	0.78	0.4%	8
	Open Water	0.003	0	0	0.0%	0
	Scrub/Shrub	0.001	0	0	0.0%	0
	Emergent Wetlands	0.013	0	0	0.0%	0
	Forested Wetlands	0.019	0	0	0.0%	0
	Subtotal					**8**
Other Load Types						
	Atmospheric	0.095	0	0	0.0%	
	Waterfowl	0.009	0	0	0.0%	
	Septic Systems	0.055	0.5	0.6	1.6%	**32**
	Internal	0.413	1	0.9	45.1%	**872**
	East Pond	0.020	0	0.4	0.0%	**0**
	Total	**1.00**			**49.7%**	**962**

Load Reduction	kg/yr
TP Export Load kg TP (current)	1933
TP Export Loading Target	971
TP Reduction Needed	**962**
% Reduction Possible	**50%**

The total estimated P load reduction for North Pond is 962 kg/yr, a reduction of approximately 50% from the current estimated load of 1,933 kg/yr. This reduction is estimated to result in an 8 ppb decrease in the annual average in-lake TP concentration (from 18 ppb to 10 ppb). Based on these assumptions, the probability of North Pond experiencing an algal bloom would decrease from 31% to 1%, average annual Secchi disk transparency is expected to improve by 1.5 m, and average Chl-a concentrations are expected to decrease by 4.1 ppb. An overview of the empirical modeling outputs under different management scenarios is provided in Table 4.

Table 4. *Empirical Method for estimating phosphorus reductions in the North Pond watershed.*[15]

In-lake P Concentration	**20**	**19**	**18**	**11**	**10**	**4**
Reduction (kg/yr) from Current Total P Load	*+182*	*0*	-90	*-872*	*-962*	*-1504*
	Future Development & 10% Climate Change Scenario	**Current**	**External Load Reduction (5%)**	**Internal Load Reduction (45%)**	**External & Internal Load (50%)**	**Background Conditions**
Atmospheric	224	**224**	224	224	224	112
Internal Load	989	**969**	969	97	97	24
Waterfowl	20	**20**	20	20	20	20
Septic Systems	138	**129**	97	129	97	0
Watershed Load	744	**591**	533	591	533	273
TOTAL LOAD TO LAKE	**2115**	**1933**	**1843**	**1061**	**971**	**429**
SDT Avg	2.3	**2.4**	2.5	3.8	4.0	5.7
SDT Max	4.2	**4.3**	4.3	5.0	5.2	5.7
Chl-a Avg	7.3	**7.1**	6.7	3.2	2.8	0.8
Chl-a Max	25	**25**	23	12	11	4
Bloom Probability	34%	**31%**	27%	2%	1%	0%
Flushing Rate	**1.8**	**1.6**	1.6	1.6	1.6	**1.6**

One of the greatest challenges with P reduction efforts preventing new sources of P from entering the lake. A 1 ppb increase (182 kg/yr) is anticipated a result of future development and climate change. Proactive efforts to mitigate the effects of climate change and future development are essential for meeting the water quality goal of 10 ppb.

APPENDIX E. NORTH POND NPS SITES

NORTH POND NPS SITES (7 Lakes Alliance, 2023d)

A nonpoint source (NPS) assessment of the North Pond watershed was completed by 7 Lakes Alliance over a period of seven days in the fall of 2022. All roads in the watershed were surveyed along with all high & medium impact NPS sites identified in the 2016 North Pond Watershed Survey (Ecological Instincts, 2017a).

Impact of NPS Sites: The impact rating is an indicator of how much soil and phosphorus erodes into the lake from a given site. Factors such as slope, soil type, amount and severity of eroding soil, and buffer size are considered. Generally, low impact sites are those with limited transport of soil off-site, medium impact sites exhibit sediment transportation off-site, but the erosion does not reach high magnitude, and high impact sites are those with large areas of significant erosion and direct flow to water.

Site ID	Land Use	Impact	Erosion Type	Notes	Road	Town
22-002	Town Road	Low	Sheet	Culvert is too small. Road needs ditching and would benefit from bluestone.	Bacon Road	Mercer
22-003	Private Road	Medium	Rill, Sheet	Road is channeling water and sending it out to Bacon Rd. Needs ditching.	Bean Road	Mercer
22-005	Driveway	Low	Rill, Sheet	Resurface and grade. Probably be part of Bean Rd project.	Trista Lane	Mercer
22-006	Town Road	Low	Culvert inlet/outlet	Low priority culvert. Extensive 319 work has been done on Pond Road.	Pond Road	Mercer
22-009	Residential	Low	Shoreline	Could use a little riprap and driplines	Island View Lane	Mercer
22-010	Private Road	Medium	Sheet	Road needs resurfacing. Ask residents about redoing driveways at same time.	Brookside Lane	Mercer
22-012	Private Road	Medium	Rill, Sheet	Culvert is too high and rotted out. Replace w/ upsized HDP culvert. Road can also be resurfaced.	Candee Cott Lane	Mercer
22-013	Residential	Low	Shoreline	Lack of buffer and could use some riprap	Brookside Lane	Mercer
22-014	Private Road	Medium	Sheet	Road needs elevation, resurfacing, and grading. Driveways need the same. Culverts are also too high. Driveway is Barker Lane, road is the continuation of Candee Cott Ln.	Candee Cott Lane	Mercer
22-015	Residential	Low	Sheet, Shoreline	Needs a buffer.	Pond Road	Mercer
22-016	Residential	Low	Sheet	A little bit of bare soil but for a house that's 25 feet from the water it looks pretty good. Definitely something to keep on the radar but not a top priority.	Bonfire Lane	Mercer
22-017	Residential	High	Bank, Rill, Sheet	Runoff from driveway is causing damage to the house. Needs lots of work. Infiltration trenches, French drains, and regrading to start.	Pond Road	Mercer
22-018	Residential	Low	Bank, Sheet	Encourage planting. Plenty of canopy, needs midstory and groundcover along with a better shoreline buffer.	Pond Road	Mercer
22-019	Residential	Medium	Rill, Sheet, Shoreline	New owner. Already had LakeSmart survey done. Going to work with YCC. Runoff from driveway, steep slope to lake,	Pond Road	Mercer

Site ID	Land Use	Impact	Erosion Type	Notes	Road	Town
22-020	Private Road	Medium	Sheet	Need resurfacing and puddles filled. Low impact other than proximity to lake.	Bog Brook Lane	Smithfield
22-021	Driveway	Medium	Rill, Sheet	Regrade and resurface. Fix issues caused by water being channeled in the 320 driveway.	Pond Rd	Mercer
22-023	Residential	Low	Road Sand, Sheet	Stabilize roads, driveways and parking areas	Pond Road	Mercer
22-024	Residential	Low	Shoreline	Could use a little riprap. Could also use driveway and parking area definition	Bog Brook Lane	Smithfield
22-025	Residential	Low	Water flow through woods	New culvert is letting a lot more water through and washing out owner's yard. Possible YCC project.	Pond Road	Mercer
22-028	Residential	Low	Road Sand, Sheet, Shoreline	Could use some angular riprap. Encourage planting a buffer.	Pond Road	Mercer
22-029	Driveway	Medium	Bank, Rill	Surface improvements and stabilization by culvert.	Pond Road	Mercer
22-031	Residential	Low	Sheet, Shoreline	Shoreline looks stable. Large parking area close to water. Could use bigger buffer.	McNulty Lane	Rome
22-032	Private Road	Low	Sheet	Road could use improvements but because of the topography it has little impact on water quality.	McNulty Lane	Rome
22-033	Driveway	Low	Sheet	Resurface and grade	Pond Road	Mercer
22-034	Residential	Low	Bank	Shoreline looks stable. Could use larger buffer.	North Shore Drive	Smithfield
22-035	Driveway	Medium	Sheet	Resurface and grade	Pond Road	Mercer
22-036	Residential	Low		Large sand beach. Plantings at end of driveway. Improve buffer.	North Shore Drive	Smithfield
22-037	Driveway	Medium	Rill, Sheet	Resurface and grade	Pond Road	Mercer
22-038	Residential	Low	Sheet	Looks like an old boat launch that is no longer being used. Sandy Beach. Yard could use a buffer garden and mulch. Encourage planting. Driveway has an old metal culvert that needs replacing.	Pond Road	Mercer

Site ID	Land Use	Impact	Erosion Type	Notes	Road	Town
22-039	Driveway	Low	Rill, Sheet	Resurface driveway with bluestone	North Shore Drive	Smithfield
22-040	Residential	Low	Rill, Sheet	Driveway needs defined parking area. Needs bigger buffer and riprap.	North Shore Drive	Smithfield
22-041	Residential	High	Rill, Sheet	Driveway improvement needed.	North Shore Drive	Smithfield
22-042	Private Road	Medium	Sheet	Resurface and grade.	Hinkley Cove Road	Mercer
22-043	Residential	Low		Shoreline was repacked by YCC. Needs a more robust buffer.	North Shore Drive	Smithfield
22-044	Residential	Medium	Bank, Sheet, Shoreline	Wants help with riprap.	Lufkin Lane	Mercer
22-045	Residential	Low	Bank, Pathway, Shoreline	Repack shoreline with what's there. Possible infiltration steps. Old septic from 1974 just replaced with new 1000-gallon tank.	Lufkin Lane	Mercer
22-046	Beach Access	High	Bank, Shoreline	Riprap shoreline and stabilize bank with plantings. Preferably creeping juniper.	North Shore Drive	Smithfield
22-047	Residential	Low	Shoreline	Inadequate shoreline vegetation.	Pond	Mercer
22-049	Residential	Medium	Bank	Banks need planting for stabilization.	North Shore Drive	Smithfield
22-050	Town Road	Low	Undersized and Filled in Culvert	Riprap and check dams have been added to ditches but culverts are too small. One culvert is filled with sand and silt, the other is rusting out.	Oak Hill Road	Smithfield
22-051	Private Road	Medium	Rill	Culvert is going to fail soon and needs to be longer but has not failed yet. Signs of erosion on sides of culvert. Replace w/ HDP of the same size. Med/low impact.	Maple Ridge	Rome
22-052	Private Road	Low	Sheet	Low impact.	Shady Ridge	Rome
22-053	Residential	Low	Sheet	Lawn to lake. Needs better buffer and a little driveway work.	North Shore Drive	Smithfield
22-054	Residential	Medium	Sheet, Shoreline	Add more riprap to shoreline, resurface and grade driveway, possibly loam and reseed lawn.	North Shore Drive	Smithfield
22-056	Private Road	Medium	Road Sand, Sheet	Water flows across driveway and into lake	Witham Lane	Smithfield
22-057	Town Road	Medium	Rill, Sheet	Culvert is too short. Could use riprap and plunge pool.	Sand Hill Road	Smithfield

Site ID	Land Use	Impact	Erosion Type	Notes	Road	Town
22-058	Private Road	Medium	Gully, Rill, Sheet	Road needs resurfacing. Old boat launch could use work. Add material in driveway “turn around” and make ditch bigger. Clean out uphill side of ditch all the way down.	Bull Moose Ridge	Rome
22-059	Private Road	Low	Sheet	Add new surface material	Dearborn Lane	Smithfield
22-060	Private Road	Medium	Rill, Sheet	Upsize culverts. Armor ditches. Add plunge pools. Could use crowning in areas. Road is low impact.	Upper Ridge	Rome
22-061	Private Road	Low	Sheet	Check out in spring. Water is channeling on road. No signs of real erosion.	Shady Ridge	Rome
22-062	Beach Access	Low	Sheet, Shoreline	Slight surface erosion; bare soil	Grantwood Ridge	Rome
22-063	Private Road	Medium	Rill, Sheet	Road is very rough. Has one rubber razor that appears to still work. Resurface, knock berms down and add turnouts.	Greeley Lane	Smithfield
22-066	Town Road	Medium	Rill, Sheet	Medium impact until end which is high impact. Road needs resurfacing, some ditching, and increased elevation in areas.	North Pond Estates	Rome
22-067	Private Road	Medium	Sheet	Resurface with bluestone	Greeley Lane	Smithfield
22-068	Residential	Low	Sheet, Shoreline	Define pathway, loam & seed, and shoreline plantings. Retaining wall needs work.	Yvonne Lane	Smithfield
22-069	Residential	Low	Sheet	Ditch has been riprapped. Seed and straw over exposed areas. Shoreline plantings.	Mitchell Lane	Smithfield
22-071	Private Road	Medium	Rill, Sheet	Could use ditching in areas. Resurface with bluestone.	Grantwood Ridge	Rome
22-072	Residential	Medium	Sheet	Plantings on steep bank, replace steps with infiltration steps, and add drip line trenches. New septic installed.	Mitchell Lane	Smithfield
22-074	Private Road	Low	Rill, Sheet	Rode pretty good. Could use crown and blue stone.	Mitchell Lane	Smithfield
22-075	Residential	Medium	Rill	Lawn leading up to shoreline could use some loam seed and straw. Area by old well has eroded. Fix fallen piece of granite.	Mitchell Lane	Smithfield

Site ID	Land Use	Impact	Erosion Type	Notes	Road	Town
22-076	Residential	High	Sheet	Exposed soil in front of house and on steep banks. Seed and straw. Replace old wooden steps with infiltration steps.	Mitchell Lane	Smithfield
22-077	Town Road	Medium		Replace rotten culvert	Lake View Drive	Smithfield
22-078	Residential	High	Gully	Major erosion in ditch to left of house when looking at lake. Riprap the ditch.	Mitchell Lane	Smithfield
22-079	Private Road	Low	Sheet	Needs more gravel	Hummingbird Lane	Smithfield
22-084	Residential	Low	Shoreline	Add angular granite riprap to shoreline. Geotextile and crushed stone under house. Replace old timbers and add planting on lakeside left of house.	Lake View Drive	Smithfield
22-085	Residential	High	Bank, Road Sand, Shoreline	Very steep eroding bank. Good candidate for boulders.	Lake View Drive	Smithfield
22-090	Residential	Low	Shoreline	Could use a little riprap but what's there isn't bad	Lake View Drive	Smithfield
22-093	Trail or Path	Medium	Bank, Gully	Path could use ECM. Banks are not an issue worth pursuing.	Lake View Drive	Smithfield
22-094	Commercial	Medium	Road Sand, Sheet, Shoreline	Road and parking lot issues remediated in 2022. Still things to work at on the shoreline. 319 work was done on road in 2022 and 15(+) YCC projects since 2016. Most remaining issues have to do with buffers and LakeSmart issues.	Pine Tree Camp Road	Rome
22-096	Residential	Low	Rill, Sheet	Seed and straw areas of exposed soil.	Lake View Drive	Smithfield
22-097	Town Road	Medium	Sheet	Bluestone, knock berms down, a little ditching.	Mt Tom Road	Smithfield
22-098	Residential	Low	Shoreline	Could use some riprap in a few small undercut sections. Add to shoreline buffer.	Helen Lane	Smithfield
22-099	Private Road	Medium	Bank, Rill, Road Sand	Bridge made of old tires and what looks like a recycled culvert. Culvert is too high. Road surface material is less than optimal. Large culvert under road is also starting to rust.	Sand Hill Road	Smithfield

Site ID	Land Use	Impact	Erosion Type	Notes	Road	Town
22-100	Residential	High	Rill, Sheet, Shoreline	Resurface driveways, define and resurface parking areas, add a vegetative buffer along entire shoreline. Driplines on most cabins; stop mowing close to water.	Village Road	Smithfield
22-102	Municipal	Low	Bank, Shoreline	Had riprap and infiltration steps installed.	Village Road	Smithfield
22-103	Residential	Low	Shoreline	Moderate surface erosion; undercut shoreline; inadequate shoreline vegetation; shoreline erosion. Riprap was added on shoreline since 2016 survey.	Knotty Pine Lane	Smithfield
22-104	Residential	Medium	Sheet	Surface erosion; bare soil! Seed and straw.	Knotty Pine Lane	Smithfield
22-105	Residential	Low	Bank, Shoreline	Medium risk. Actual erosion is low. Encourage more planting	Village Road	Smithfield
22-106	Private Road	Medium	Rill, Sheet	Bluestone	Harlow Lane	Smithfield
22-108	Residential	Low	Shoreline	Encourage more planting. Consider re-seeding lawn.	Fairview Lane	Smithfield
22-109	Boat Access	Low	Sheet	Add more crushed stone	Fairview Lane	Smithfield
22-110	Private Road	Low	Sheet	Build up road. Ditch on lakeside, culvert and flow over to inland side.	Meadow Lane	Smithfield
22-111	Residential	Low	Shoreline	Add riprap	Meadow Lane	Smithfield
22-112	Residential	Low	Sheet	YCC referral?	Fitzgerald Lane	Smithfield
22-113	Residential	Medium	Bank, Sheet, Shoreline	Shoreline erosion and bare soil. Encourage planting and possible riprap. Add driplines trenches around house.	Cross Road	Smithfield

Site ID	Land Use	Impact	Erosion Type	Notes	Road	Town
22-114	Residential	Medium	Bank, Rill, Sheet, Shoreline	Bare soil. Either get new grass or some other type of plants that will survive better. Shoreline is good but owner should stop cutting so much. Install dripline trenches around house.	Cross Road	Smithfield
22-115	Residential	Medium	Rill, Sheet, Shoreline	Bare soil, seed it or replant with something other than grass. Add roof dripline trenches.	Cross Road	Smithfield
22-117	Private Road	Medium	Bank, Road Sand, Sheet	2016: Unstable inlet / outlet culvert- 48" in size - riprap has fallen into streambed; NRPA stream. 2022: Culvert could be replaced and road could use bluestone and grading.	Cross Road	Smithfield
22-119	Private Road	Medium	Gully	Unstable inlet / outlet culvert (perched); 12-20' above stream bed.	Meadow Lane	Smithfield
22-121	Private Road	Low	Sheet	Road gets little use. Could use a new culvert and grading.	Rosenthal Lane	Smithfield
22-122	Private Road	Low	Ditch, Sheet	Moderate ditch erosion; roof runoff erosion; outlet to wooded area but large catchment connectivity?	Wesauking Lane	Smithfield

APPENDIX F. NORTH POND WBMP 10-YEAR ACTION PLAN

The following action strategies are outlined in Section 7 of the WBMP. Estimated costs are for the 10-year planning period unless otherwise noted. Below is a list of Commonly Used Acronyms in the Action Plan:

319- Section 319(h) of the Clean Water Act- a federal grant program through the US EPA

7 Lakes- 7 Lakes Alliance

Colby- Colby College

DO- Dissolved oxygen

CBI- Courtesy Boat Inspections

KVCOG- Kennebec Valley Council of Governments

LID- Low Impact Development

KCSWCD- Kennebec County Soil & Water Conservation District

Maine DEP- Maine Dept. of Environmental Protection

Maine DOT- Maine Dept. of Transportation

MFS- Maine Forest Service

NPA- North Pond Association

NPS- Nonpoint source pollution

P- Phosphorus

SCSWCD- Somerset County Soil & Water Conservation District

SLZ- Shoreland zone

USDA/NRCS- United States Dept. of Agriculture/Natural Resources Conservation Service

US EPA- United States Environmental Protection Agency

Watershed Towns- Smithfield, Mercer and Rome

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
A. Restoration - Reduce External Phosphorus Load					
A1	Reduce P export from agricultural land in the watershed (focus on manure management/row crops)	Years 1-10	Farmers, USDA/NRCS, KCSWCD/SCSWCD	USDA/NRCS, US EPA (319), Maine DEP	$500,000
A2	Provide outreach to landowners regarding proper use of timber harvesting BMPs and conduct follow-up site visits for large harvests	Years 1-10	Maine Forest Service	MFS	n/a
A3	Review list of **44 high and medium impact sites from the 2022 watershed survey** and develop a **candidate site list** for future 319 grant applications	Year 1	7 Lakes, NPA, Steering Committee	NPA, 7 Lakes	$500
Address High Impact NPS Sites (7 sites)					
A4	Address NPS sites on residential properties ***Goal: 6 residential sites***	Years 1-3	7 Lakes, NPA, private property owners	US EPA (319), Maine DEP, landowners	$24,000
A5	Address NPS sites on beach access sites ***Goal: 1 beach access site***	Years 1-3	7 Lakes, NPA, private property owners	US EPA (319), Maine DEP, landowners	$5,000
Address Medium Impact NPS Sites (37 sites)					
A6	Address NPS sites on private roads ***Goal: 17 sites***	Years 1-10	7 Lakes, NPA, landowners, road associations	US EPA (319), Maine DEP, landowners, road associations	$221,000
A7	Address NPS sites on residential properties ***Goal: 10 sites***	Years 1-5	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$20,000
A8	Address NPS sites on driveways ***Goal: 4 sites***	Years 1-5	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$16,000
A9	Address NPS sites on town roads ***Goal: 4 sites***	Years 1-5	Towns, 7 Lakes	US EPA (319), Maine DEP, watershed towns	$32,000
A10	Address NPS sites on trails or paths ***Goal: 1 site***	Years 1-3	7 Lakes, NPA, landowner	US EPA (319), Maine DEP, Maine DOT	$1,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
A11	Address NPS sites on commercial sites ***Goal: 1 site***	Years 1-3	7 Lakes, NPA, landowner	US EPA (319), Maine DEP, landowners	$5,000
Address Low Impact NPS Sites (47 sites)					
A12	Work with residential property owners to address low-impact residential NPS sites ***Goal: 29 sites***	Years 1-10	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$43,500
A13	Encourage shorefront properties to get a LakeSmart evaluation ***Goal: 50 new evaluations completed***	Years 1-10	NPA, 7 Lakes, Landowners	NPA, Maine Lakes, landowners, US EPA (319), Maine DEP	$37,500
A14	Work with road associations and homeowners to address low-impact private road sites ***Goal: 9 sites***	Years 3-7	7 Lakes, NPA, landowners	Road associations, private landowners	$27,000
A15	Address low-impact sites on town road and municipal/public sites ***Goal: 4 sites***	Years 1-5	Towns, 7 Lakes, NPA	Watershed towns, US EPA (319), Maine DEP	$20,000
A16	Address low-impact sites on driveways ***Goal: 3 sites***	Years 1-3	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$12,000
A17	Address low-impact sites on beach and boat access sites ***Goal: 2 sites***	Years 1-2	7 Lakes, NPA, landowners	US EPA (319), Maine DEP, landowners	$4,000
Reduce NPS from Septic Systems (Upgrade 50% of old systems)					
A18	**Finalize the 2022 septic system database** by combining with septic vulnerability analysis and NPA septic system survey and incorporating records from Mercer and Rome	Years 1-2	NPA, 7 Lakes, Colby, Consultant	Grants, NPA	$5,000
A19	**Prioritize list of systems** based on risk to water quality and **offer technical assistance to landowners with high-risk systems**.	Years 1-2	NPA, 7 Lakes, Colby	Grants, NPA	$5,000
A20	Offer landowners free septic evaluations & septic designs for high priority systems ***Goal: 20 free evaluations, 10 system designs***	Years 2-5	NPA, 7 Lakes, Site Evaluators	Grants, NPA, watershed towns	$25,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
A21	Provide cost-share grants to assist landowners with replacing problem septic systems **Goal: 10 systems (targeted outreach to landowners with systems >20 years old and/or failing or malfunctioning systems)**	Years 3-10	NPA, 7 Lakes, KCSWCD/SCSWCD, DHHS, watershed towns	Grants, landowners, NPA, watershed towns	$80,000
A22	Develop a long-term **septic inspection and pumping rebate program** to encourage timely septic maintenance	Years 1-3	NPA	NPA	$50,000
A23	Conduct community outreach regarding **DEP Small Community Septic System grants** for malfunctioning systems to eligible landowners with high priority systems	Years 1-10	NPA, Watershed Towns	Watershed towns	$500
A24	Require **proof that septic systems have been installed to code** when properties change from seasonal to year-round status, and require replacement if proof is not available	Years 1-10	Watershed Towns	Watershed towns	$1,500
A25	Create a system for adequately **tracking septic inspections** conducted for all real estate transactions in the shoreland zone; this may include an ordinance that requires new homeowners to submit a copy of their inspection report to the town	Years 1-2	Watershed Towns	Watershed towns	$5,000
A26	Create a permitting system and **registration requirement for rental properties on the shoreline** to minimize impacts from undersized septic systems	Years 2-4	Watershed Towns	Watershed towns	$10,000
A27	**Improve town administration** to digitize existing septic records and maintain records	Years 3 -10	Watershed Towns	Watershed towns, infrastructure grants	$30,000
				External Phosphorus Load Total	**$1,180,500**
B. Internal Phosphorus Load in North Pond					
Conduct an Aluminum Treatment					

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
B1	Conduct additional sediment analysis (jar tests) before finalizing an aluminum treatment plan	Year 1	Colby, 7 Lakes, DEP	NPA, grants, private donors	$2,500
B2	Develop final **treatment options and a funding plan** for inactivating P in the sediment	Year 1	NPA, 7 Lakes, consultant	NPA	$1,500
B3	Complete required permitting for aluminum treatment(s)	Year 1	7 Lakes, NPA, consultant, contractor	NPA, consultant, US EPA (319), Maine DEP	$6,500 *(plus $793 annual permit fee)*
B4	Develop Request for Proposals (RFP) and **select contractor** for aluminum application(s)	Year 1-2	7 Lakes, NPA, consultant	NPA	$1,000
B5	Conduct an **aluminum treatment**	Year 2	NPA, 7 Lakes, consultants	NPA, watershed towns, US EPA (319), Maine DEP, private donors, landowners	$1,300,000
B6	Implement an aluminum treatment monitoring plan before and during treatment(s)	Years 2-3	NPA, 7 Lakes, Colby, LSM, Maine DEP, consultants	NPA, grants, private donors	$10,000
				Internal Phosphorus Load Total	**$1,323,900**
C. Prevention - Reduce New Sources of NPS Pollution					
General Tasks					
C1	Attend regular Select Board meetings to update towns about watershed activities and needs ***Goal: Minimum 2 meetings/town/year***	Years 1-10	7 Lakes, NPA	NPA	$500
C2	Work with town officials on **winter sand and salt** issues including cleanup and ongoing road maintenance	Years 1-10	7 Lakes, NPA	7 Lakes	$2,000
C3	Work with landowners/road associations to conduct regular road maintenance on private **gravel roads**	Years 1-10	7 Lakes, NPA	7 Lakes	$1,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
C4	Work with local landscape nurseries to provide discounts for buffer plantings ***Goal: 1-2 local nurseries participating***	Years 1-10	7 Lakes, NPA	7 Lakes	$1,000
Future Development & Conservation					
C5	Work with landowners to **protect undeveloped forest and agricultural land** throughout the watershed, especially in tributary drainages having with highest estimated P loading	Years 1-10	7 Lakes, NPA, landowners, watershed towns	Grants, donors	$3,000
C6	Conduct a **build-out analysis** to quantify future development patterns and long-term P loading	Years 3-4	NPA, 7 Lakes, watershed towns, KVCOG	Grants, donors	$3,000
C7	Prepare up-to-date **Comprehensive Plans** to guide future development so that it is protective of water quality	Years 1-3	Watershed towns, KVCOG	Watershed towns, grants	$10,000
Municipal Planning/Ordinances					
C8	**Digitize tax parcels** for all towns in the watershed	Years 1-3	KVCOG, 7 Lakes, watershed towns	NPA, grants, donors	$7,500
C10	Encourage towns to **expand hours for code enforcement** to adequately enforce current ordinances	Years 1-10	7 Lakes	NPA, 7 Lakes	$2,000
C9	Ensure that all municipal **ordinances, tax maps, and permitting information are available online** for each watershed town	Years 1-3	KVCOG, watershed towns	Watershed towns	$500
C11	Follow-up with watershed towns to **begin implementing ordinance recommendations** from the 2022 Municipal Ordinance Review	Years 2-5	KVCOG, 7 Lakes, NPA, watershed towns	KVCOG, watershed towns	$5,000
C12	Develop a **standards manual detailing Low Impact Development (LID)** requirements and options for all new construction projects, and add LID design	Years 1-3	Watershed towns, KVCOG	Watershed towns, grants	$10,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
	standards to new and existing ordinances where applicable (commercial, subdivision ordinances, etc.)				
C13	Incorporate/update references to the Maine Stormwater Management Design Manual Best Management Practices (Vol I & II) in existing development standards	Years 1-3	KVCOG, watershed towns	Watershed towns, KVCOG	$10,000
C14	Add language detailing the state mandated inspection requirements for subsurface waste disposal systems on properties in the Shoreland Zone (SLZ) by a certified inspector upon transfer of property **and require submission of septic inspection reports for town records**.	Years 1-3	Watershed towns	Watershed towns, KVCOG	$10,000
C15	Include **greater phosphorus controls for all projects in the Shoreland Zone (SLZ)** of impaired waterbodies such as the Maine DEP per acre phosphorus allocations	Years 3-5	Watershed towns	7 Lakes, towns	$10,000
C16	Consider developing a **watershed-wide P control ordinance** for all new development (including single family residential units, roads, and seasonal to year-round conversions)- see C15	Years 3-5	Watershed towns	KVCOG, 7 Lakes, watershed towns	$10,000
C17	Consider development of a **Unified North Pond Watershed Regulation** that would result in a shared Code Enforcement Officer to consistently administer and enforce regulations	Year 5	KVCOG, NPA, 7 Lakes, watershed towns	Watershed towns, grants	$2,500
C18	Consider provisions for **3rd party site review**, and long-term maintenance as a requirement for building permits	Years 3-5	7 Lakes, watershed towns, consultant	7 Lakes, watershed towns	$2,000
Climate Change					
C19	Set up **automated precipitation monitoring** (e.g., automated rain gauges) to document occurrence and intensity of rainfall in the watershed	Years 2-10	7 Lakes, Colby, NPA	Grants	$6,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
C20	Utilize a **climate model for larger Belgrade Lakes watershed** to anticipate effects of extreme events on lake water quality (e.g., heat, ice out, rainfall, drought)	Years 5-7	Colby, 7 Lakes, consultant	Grants	$30,000
C21	Host **climate change workshops** or webinars to provide information about ways landowners can adapt to climate change and help protect water quality	Years 2, 4, 6, 8	7 Lakes, Colby, consultant	Grants	$2,500
C22	Conduct a **stream-crossing survey** to assess whether culverts at road/stream crossings require upgrades	Year 1-2	7 Lakes, consultant, TNC	7 Lakes, Grants	$2,500
C23	Work with watershed towns and the state to apply for grants to **fund and implement culvert upgrade projects**	Years 3-8	7 Lakes, KCSWCD/SCSWCD, towns, consultant	Grants, watershed towns, Maine DEP, Maine DOT	$200,000
				Prevent New Sources of NPS Pollution Total	**$331,000**
D. Education, Outreach & Communications					
General Outreach					
D1	Develop an outreach strategy/**communications committee** to get the word out to the community; meet annually to discuss plan objectives	Year 1 and ongoing	7 Lakes, NPA, interested stakeholders	7 Lakes, NPA	n/a
D2	Develop and maintain a North Pond WBMP **web page** for the public to access information about restoration strategies and progress	Years 1-10	NPA	NPA	$5,000
D3	Keep partner **websites** updated regarding on-going restoration efforts and NPS pollution projects	Years 1-10	NPA, 7 Lakes, watershed towns	NPA, watershed towns	$2,500
D4	Prepare and distribute **press releases** and **newsletter articles** about watershed improvement activities, grant projects, and successful projects **(Goal 2/year)**	Years 1-10	7 Lakes, NPA	NPA	$5,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
D5	Provide **welcome packets** to new property owners with water quality educational materials	Year 2	NPA, 7 Lakes, watershed towns	NPA, grants	$5,000
D6	Develop an **online video series** of short educational clips that can be viewed by the public (including climate change)	Years 2-4	NPA, Colby, 7 Lakes	Grants, 7 Lakes, NPA	$5,000
D7	Work with **local realtors and towns** to track property transfers and subdivisions	Years 1-10	NPA	NPA	$2,500
Alum Treatment Outreach					
D8	**Distribute Frequently Asked Questions (FAQ)** about alum treatments to project partners and the make it publicly available through partner websites	Year 1	NPA, 7 Lakes, watershed towns	NPA	$500
D9	Develop an **online educational video** pertaining to the need for an aluminum treatment that can be viewed by the public and help with fundraising efforts	Year 1-2	Outreach Committee, Colby, 7 Lakes	Grants, 7 Lakes, NPA	$5,000
D10	Host a **public workshop** specific to the aluminum treatment to provide opportunity for public feedback	Year 1-2	NPA, 7 Lakes	NPA	$1,500
Targeted Outreach					
D11	Send **educational materials to landowners with high-impact sites** (7 sites) **and medium-impact sites** (37 sites) to gauge interest in cost-sharing opportunities for a future 319 grant	Year 1-2	NPA, 7 Lakes	NPA, Grants	$1,600
D12	Prepare a list of NPS sites on **town-owned properties (8 sites)** and work with towns on their annual budget planning (municipal sites and roads) to fund the projects	Years 1-2	7 Lakes, NPA, Towns	7 Lakes, NPA	$2,500
D13	Prepare educational materials for the NPA **LakeSmart** program	Years 1-2	NPA, 7 Lakes	NPA, Maine Lakes, grants	$5,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
D14	Meet with **road associations** with documented NPS problems on private roads (26 sites) to determine interest in future 319 grant cost-sharing opportunities	Years 1-2	NPA, 7 Lakes, road associations	7 Lakes	$2,000
D15	Design a **Buffer Campaign** with easy-to-follow guidance/recipes for installing effective shoreline buffers	Years 2-3	NPA, 7 Lakes, Maine Lakes, Towns	NPA, grants	$5,000
D16	**Increase participation in NRCS agricultural programs** through newspaper articles, NRCS sponsored workshops, and targeted outreach (e.g. small-scale or hobby farms) throughout the watershed (goal 5 new participating landowners)	Years 1 - 3	USDA/NRCS	USDA/NRCS	$6,000
D17	Conduct outreach to landowners/road associations to **promote use of bluestone surface gravel** for use on driveways and roads; identify roads where bluestone is not currently used and provide **incentives** to switch over to new material	Years 1 - 10	7 Lakes, road associations, landowners	7 Lakes, grants	$5,000
Workshops					
D18	Host annual **gravel road workshops** in the watershed working directly with road associations (goal 1 every other year)	Years 1 - 10	7 Lakes, NPA	7 Lakes, US EPA (319), Maine DEP	$5,000
D19	Host annual **"Buff Enough" workshops in coordination with sister lake associations** (goal 1/year)	Years 1 - 10	NPA, 7 Lakes	NPA, grants	$5,000
D20	Host **LakeSmart workshops** (goal 1/odd years)	Years 1, 3, 5, 7, 9	NPA, 7 Lakes	NPA	$5,000
D21	Host **septic workshops** or **webinars** (goal 1/even years)	Years 2, 4, 6, 8	NPA, 7 Lakes	NPA, grants	$5,000
D22	Host **ordinance workshops** for landowners, developers, and realtors (goal 1)	Years 2 - 4	NPA, 7 Lakes, watershed towns	NPA, grants, watershed towns	$2,500

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
				Education, Outreach & Communications Total	**$81,600**
E. Build Local Capacity					
Fundraising					
E1	Develop and maintain a **fundraising committee** to help implement the plan	Year 1 and ongoing	NPA, 7 Lakes, watershed towns	NPA	$2,500
E2	Apply for US EPA Clean Water Act Section 319 watershed implementation grants to address internal loading and NPS sites ***Goal: 4 phases of 319 implementation projects***	Years 2-10	7 Lakes, NPA	NPA	$15,000
E3	Create a **sustainable funding plan** to pay for the cost of an aluminum treatment, watershed implementation projects, erosion control program management, outreach and education, and long-term science and monitoring ***Goal: $1,750,000 raised by 2027***	Years 1-3	NPA, 7 Lakes, consultant	NPA, towns, private donors	$5,000
E4	Apply for other state, federal or private foundation **grants** that support planning recommendations	Years 2-10	NPA, 7 Lakes, consultant	7 Lakes, NPA	$5,000
E5	Work with watershed towns to **enroll in the State's Climate Resiliency Partnership (CRP)**	Years 1-2	KVCOG, 7 Lakes, NPA	Towns, KVCOG	$7,500
E6	Fundraise for **septic system cost-sharing grants** & septic rebate program	Years 1-3	NPA	NPA, 7 Lakes, watershed towns	$1,000
Steering Committee & Partnerships					
E7	Steering Committee to **meet annually** to discuss action items and goals	Years 1-10	7 Lakes, NPA	7 Lakes NPA	$5,000
E8	Reach out to **new potential Steering Committee members** including town officials, local businesses, realtors, and septic inspectors	Years 1-10	7 Lakes, NPA	7 Lakes, NPA	$1,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
E9	Convene annual meetings with watershed towns to strengthen **stakeholder relationships** and bolster community support for restoration efforts	Years 1-10	7 Lakes, NPA, watershed towns	7 Lakes, NPA, watershed towns	$5,000
E10	Consider formation of a more diverse **Dam Committee** to review dam management procedures; meet at least annually to review and update procedures as needed	Years 1-3	NPA, EPA, watershed towns, 7 Lakes	NPA, watershed towns	$5,000
E11	Coordinate with Colby, Bates, and other academic institutions regarding ongoing **scientific research projects** (e.g., NASA study, Gloeotrichia, eDNA, etc.)	Years 1-10	7 Lakes, NPA, Colby, Bates, UMaine	7 Lakes	$5,000
E12	Develop a comprehensive list of projects and an accessible **database** to track activities conducted by the numerous project partners that work in the watershed	Year 2 and ongoing	7 Lakes, NPA	7 Lakes, NPA, grants	$5,000
E13	Meet with area **landscaping companies** to increase their capacity to do more erosion control work in the watershed and to educate them on LakeSmart practices	Years 2-4	7 Lakes, NPA	7 Lakes	$2,000
E14	Continue **Lake Trust meetings** with area lake associations in upstream and downstream watersheds (East Pond, Great Pond) to strategize about ways to reduce P inputs and share outreach BMPs	Ongoing (Years 1-10)	NPA, 7 Lakes, BLA, EPA	7 Lakes	$10,000
				Build Local Capacity Total	**$74,000**
F. Science - Conduct Long-Term Monitoring & Assessment					
Baseline Lake Monitoring					
F1	Continue collecting annual **water quality data** to inform long-term management actions (April-October) including regular sampling on Little North Pond	Ongoing (Years 1-10)	7 Lakes, Colby, Maine DEP	7 Lakes, NPA, watershed towns, private donors, grants	$50,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
F2	Expand lake monitoring program to include **nitrate, silicate, and chlorophyll** concentrations	Ongoing (Years 1-10)	7 Lakes, Colby, Maine DEP	7 Lakes, NPA, watershed towns, private donors, grants	$5,000
F3	Monitor **zooplankton**, **phytoplankton** and **cyanobacteria** throughout the year through the Colby "Algae Tracker", and 7 Lakes FlowCam	Ongoing (Years 1-10)	7 Lakes, Colby, volunteer monitors	7 lakes, NPA	$16,000
F4	Create an **inventory of all plankton species** documented in North Pond for easy ID on future FlowCam runs	Years 1-2	7 Lakes, Colby	7 Lakes	$1,500
F5	**Monitor anoxia**, both at the bottom of the lake throughout the year, and from shallower areas of the lake to determine the true maximum extent of anoxia	Year 1 and ongoing	7 Lakes, Colby	7 Lakes, Colby	$10,000
F6	Conduct **winter sampling** for DO/Temp and P samples during ice-on to collect under ice profiles	Ongoing (Years 1-10)	7 Lakes, Colby	7 Lakes, Colby	$10,000
F7	Continue sending split TP samples to HETL and **develop a TP correction curve** using Colby TP data and HETL duplicate samples.	Years 1-5 or until curve complete	7 Lakes, Colby, Maine DEP	7 Lakes, Colby	$3,000
F8	Continue collecting **annual conductivity data** to examine long-term trends	Ongoing (Years 1-10)	7 Lakes, Colby, Maine DEP	7 Lakes, Colby, Maine DEP	$3,000
NPS Pollution					
F9	Revise **NPS Site Tracker** & update annually	Ongoing (Years 1-10)	7 Lakes	US EPA (319), 7 Lakes	$5,000
F10	Conduct **site visits to logging sites** to better understand their impact on water quality; meet with District Forester to strategize on ways to reduce P runoff from timber harvests	Years 1, 3, 5, 7, 9	7 Lakes, landowners, MFS	7 Lakes, NPA	$1,500

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
F11	Investigate manure management in the watershed including the extent of spreading on hay fields, inputs from horse farms near the lake, and manure washing of roads	Years 1-3	NPA, 7 Lakes, SCSWCD, USDA/NRCS	NPA, USDA/NRCS	$2,500
F12	Conduct an informal watershed survey for **new NPS sites** 5 and 10 years after last survey	Years 5 and 10	7 Lakes	NPA, 7 Lakes, watershed towns	$10,000
F13	Update 2010/2011 GIS-based **shoreline photos** and share with towns to assist with compliance in the shoreland zone; include documentation of buffer quality	Years 2 & 7	Colby, 7 Lakes	7 Lakes, Colby, watershed towns	$10,000
Streams/Dam					
F14	Install in-situ water-level loggers at the dam to document changes in water level over the course of the year	Year 1-2	7 Lakes, Colby, NPA,	7 Lakes, NPA, grants	$7,500
F15	Collect **water quality data at targeted stream outlets** (ISCO samplers) to quantify P load from streams under different conditions throughout the year	Years 1-10 (Create 3-year baseline)	7 Lakes, Colby, Maine DEP, volunteers	Grants, NPA, 7 Lakes	$15,000
F16	Train volunteer **"stream watchers"** to take pictures during storms or install game cameras; set up online repository for uploading photos; work with Maine DEP to train volunteers on how to collect storm samples	Years 1-4	Maine DEP, NPA, volunteers	Grants, NPA	$3,000
Invasive Plants & HABs					
F17	Participate in fundraising activities that support programs that prevent the spread of invasive aquatic plants in North Pond (e.g., CBI, volunteer invasive plant surveys, etc.)	Years 1-10	NPA, 7 lakes, volunteers, LSM	NPA, 7 Lakes, watershed towns, state funding	$10,000

Action Plan & Management Measures		Schedule	Who	Potential Funding Sources	Estimated Total Cost (10 years)
F18	Continue the NPA/7 Lakes volunteer cyanotoxin monitoring program and coordinate with the Maine Cyanobacteria Collective for ongoing testing	Ongoing (Years 1-10)	NPA, 7 Lakes, Maine DEP	NPA, 7 Lakes, Maine DEP	$5,000
F19	Distribute educational materials about management tools/best practices for identifying and removing invasive terrestrial plants on the shoreline	Years 5-10	NPA, Maine Natural Areas Program	NPA	$2,500
Other					
F20	Consider developing a subcommittee to look at the **economic value of North Pond** that can be used for public outreach	Year 2	NPA 7 Lakes, watershed towns, Colby	7 Lakes, Colby	$2,500
F21	Follow-up with MDIFW regarding the November 2022 mussel die-off, and continue monitoring for **mussel mortality**	Year 1 and ongoing	7 Lakes, NPA	NPA, 7 Lakes	$500
F22	Look into the costs and **logistics of dredging** as an option for addressing internal loading	Years 1-2	7 Lakes, interested stakeholders	NPA, 7 Lakes	$2,500
F23	Test lake water and sediments for PFAS	Years 1-2	Maine DEP, 7 Lakes	Maine DEP, 7 Lakes, NPA	$2,500
				Conduct Long-Term Monitoring & Assessment Total	**$178,500**
				North Pond WBMP Project 10-Year Grand Total	**$3,169,500**