SQUAM LAKES

Watershed Management Plan

February 2020

SQUAM LAKES ASSOCIATION

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Prepared by the **SQUAM LAKES ASSOCIATION**
In cooperation with FB Environmental Associates
and the New Hampshire Department of Environmental Services

February 2020

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Steering Committee

- Bob Snelling (Holderness Planning Board, SLA water quality monitoring volunteer)
- Dave Martin (SLA water quality monitoring volunteer, shorefront property owner)
- Andrea LaMoreaux (NH Lakes Association)
- Jeff Hayes (Lakes Region Planning Commission)
- Tiffany Grade (Loon Preservation Committee)
- June Hammond Rowan (Plymouth State University)
- Peter Webster (shorefront property owner)
- Cindy O'Leary (SLA board member, shorefront property owner)

Water Quality Advisory Committee

- Bob Snelling (Holderness Planning Board, SLA water quality monitoring volunteer)
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ACRONYM	DEFINITION
ALU	Aquatic Life Use
BMP	Best Management Practices
CHL-A	Chlorophyll-a
CWA	Clean Water Act
DO	Dissolved Oxygen
EMD	Environmental Monitoring Database
FBE	FB Environmental Associates
LID	Low Impact Development
LLMP	UNH Lakes Lay Monitoring Program
LLRM	Lake Loading Response Model
LRPC	Lakes Region Planning Commission
NCEI	National Centers for Environmental Information
NH GRANIT	New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GIS Clearinghouse)
NHD	National Hydrography Dataset
NHDES	New Hampshire Department of Environmental Services
NHDOT	New Hampshire Department of Transportation
NHFGD	New Hampshire Fish and Game Department
NPS	Nonpoint Source Pollution
NWI	National Wetlands Inventory
PCR	Primary Contact Recreation
ppb, ppm	parts per billion, parts per million
SDT	Secchi Disk Transparency
SLA	Squam Lakes Association
TP	Total Phosphorus
USEPA	United States Environmental Protection Agency

Definitions

Adaptive management approach recognizes that the entire watershed cannot be restored with a single restoration action or within a short time frame. The approach provides an iterative process to evaluate restoration successes and challenges to inform the next set of restoration actions.

Anoxia is a condition of low dissolved oxygen.

Areal water load is a term used to describe the amount of water entering a lake on an annual basis divided by the lake's surface area.

Assimilative Capacity is a lake's capacity to receive and process nutrients (phosphorus) without impairing water quality or harming aquatic life.

Best Management Practices (BMPs) are conservation practices designed to minimize discharge of NPS pollution from developed land to lakes and streams. Management plans should include both non-structural (non-engineered) and structural (engineered) BMPs for existing and new development to ensure long-term restoration success.

Build-out analysis combines projected population estimates, current zoning restrictions, and a host of additional development constraints (conservation lands, steep slope and wetland regulations, existing buildings, soils with low development suitability, and unbuildable parcels) to determine the extent of buildable areas in the watershed.

Chlorophyll-a (Chl-a) is a measurement of the green pigment found in all plants, including microscopic plants such as algae. Measured in parts per billion or ppb, it is used as an estimate of algal biomass; the higher the Chl-a value, the higher the amount of algae in the lake.

Clean Water Act (CWA) requires states to establish water quality standards and conduct assessments to ensure that surface waters are clean enough to support human and ecological needs.

Cyanobacteria are photosynthetic, nitrogen-fixing bacteria that can grow prolifically as blooms when enough nutrients are available. Some cyanobacteria can produce microcystin, which is highly toxic to humans and other life forms.

Dissolved Oxygen (DO) is a measure of the amount of oxygen dissolved in water. Low oxygen can directly kill or stress organisms and stimulate release phosphorus from bottom sediments.

Epilimnion is the top layer of lake water directly affected by seasonal air temperature and wind. This layer is well-oxygenated by wind and wave action.

Flushing rate (also called retention time) is the amount of time water spends in a waterbody. It is calculated by dividing the flow in or out by the volume of the waterbody.

Full build-out refers to the time and circumstances in which, based on a set of restrictions (e.g., environmental constraints and current zoning), no more building growth can occur, or the point at which lots have been subdivided to the minimum size allowed.

Hypolimnion is the bottom-most layer of the lake that experiences periods of low oxygen during stratification and is devoid of sunlight for photosynthesis.

Impervious surfaces refer to any surface that will not allow water to soak into the ground. Examples include paved roads, driveways, parking lots, and roofs.

Internal Phosphorus Loading is the process whereby phosphorus bound to lake bottom sediments is released back into the water column during periods of anoxia. The phosphorus can be used as fuel for plant and algae growth, creating a positive feedback to eutrophication.

Low Impact Development (LID) is an alternative approach to conventional site planning, design, and development that reduces the impacts of stormwater by working with natural hydrology and minimizing land disturbance by treating stormwater close to the source, and preserving natural drainage systems and open space, among other techniques.

Nonpoint Source (NPS) Pollution comes from diffuse sources throughout a watershed, such as stormwater runoff, seepage from septic systems, and gravel road erosion. One of the major constituents of NPS pollution is sediment, which contains a mixture of nutrients (like phosphorus) and inorganic and organic material that stimulate plant and algae growth.

Non-structural BMPs, which do not require extensive engineering or construction efforts, can help reduce stormwater runoff and associated pollutants through operational actions, such as land use planning strategies, municipal maintenance practices, and targeted education and training.

Oligotrophic lakes are less productive or have less nutrients (i.e., low levels of phosphorus and chlorophyll-a), deep **Secchi Disk Transparency** readings (8.0 m or greater), and high dissolved oxygen levels throughout the water column. In contrast, **eutrophic** lakes have more nutrients and are therefore more productive and exhibit algal blooms more frequently than oligotrophic lakes. **Mesotrophic** lakes fall in-between with an intermediate level of productivity.

Secchi Disk Transparency (SDT) is a vertical measure of the transparency of water (ability of light to penetrate water) obtained by lowering a black and white disk into the water until it is no longer visible.

Structural BMPs, or engineered Best Management Practices, are often at the forefront of most watershed restoration projects and help reduce stormwater runoff and associated pollutants.

Total Phosphorus (TP) is one of the major nutrients needed for plant growth. It is generally present in small amounts (measured in parts per billion (ppb)) and limits plant growth in lakes. In general, as the amount of TP increases, the amount of algae also increases.

Trophic State is the degree of eutrophication of a lake and is designated as oligotrophic, mesotrophic, or eutrophic.

1. Introduction & Vision

1.1 Background and Purpose

The Squam Lakes in central New Hampshire are an important part of the culture, economy, and environment of the neighboring communities of Ashland, Center Harbor, Holderness, Moultonborough, and Sandwich. The Lakes are renowned for their quiet beauty and clean waters by residents and visitors alike. With increasing pressure from development, especially the subdivision of large parcels of land, increased tourism, and threats from climate change, it is imperative to plan and manage for the future.

The Squam Lakes Watershed faces a number of concerns today. Nutrient loading from the watershed, increased recreation activity, and invasive species all threaten to change the quality of water—and the quality of life in the lakes. Recent evidence identifying legacy contaminants in select areas in the watershed also may pose a concern for the health of the lakes. These issues can all be compounded by increasing development throughout the watershed and by climate change.

A watershed management plan examines the factors affecting watershed health. It incorporates data on water quality and creates goals to maintain or improve watershed-wide standards. It acts as a guiding document for towns to support watershed and community health across municipal boundaries.

Guided by the Squam Lakes Association (SLA), whose mission is to conserve and protect the Squam Watershed, the watershed planning process has been grounded in community collaboration. Conservation and protection work at the watershed scale requires productive collaboration across all aspects of a community; town governments, state agencies, conservation partners, universities, and local businesses, as well as the greater Squam community. All stakeholders are needed to ensure a healthy watershed into the future.

A comprehensive watershed management plan for the Squam Lakes provides a strategy for protecting water quality into the future. The United States Environmental Protection Agency (EPA) requires an approved watershed-based plan to become eligible for Clean Water Act (CWA) Section 319 funds. Fund can be used for water quality improvement projects identified by watershed-based plans. The Squam Lakes Watershed Management Plan follows EPA guidelines and requirements that incorporate the nine key elements (a – i) for watershed-based plans.

1.2 Vision

The watershed management plan development process was guided by a steering committee. Established in 2016, the steering committee comprised a diverse group of Squam stakeholders (Table 1-1). In the early stages of plan development, the steering committee was first tasked with developing a vision statement.

Although the 1991 Squam Watershed Plan plan did not have a vision statement, the recommendations focused on maintaining the quality of the water in the lakes and encouraging watershed development in a manner that supports local communities without damaging the overall ecosystem. By spring 2016, interviews were conducted with a variety of watershed stakeholders, who provided major “themes” that the vision statement needed to address. The themes remained similar to the 1991 plan and centered on protecting the watershed, maintaining ecological integrity, preserving the character of the region, balancing high environmental quality with the benefits that humans derive from the watershed, and supporting and upholding the social and economic components of the Squam Lakes community. From this, a vision statement was drafted and presented to the public through an online forum where people could post comments about the statement. Additional comments were gathered from attendees at the 2016 Squam Lakes Association Annual Meeting. With this input, the following vision statement was created:

The Squam Lakes Watershed is a unique and special place with clean water; a healthy ecosystem; a vibrant and supportive economy; sustainable land uses and development; and access for all in a manner that respects the carrying capacity of the watershed.

Table 1-1: Watershed management plan steering committee members and affiliations.

Committee Member	Affiliation
Bob Snelling	Holderness Planning Board, SLA water quality monitoring volunteer
Dave Martin	SLA water quality monitoring volunteer, shorefront property owner
Andrea LaMoreaux	NH Lakes Association
Jeff Hayes	Lakes Region Planning Commission
Tiffany Grade	Loon Preservation Committee
June Hammond Rowan	Plymouth State University
Peter Webster	Shorefront property owner
Cindy O'Leary	SLA board member, shorefront property owner

1.3 Statement of Goal

After establishing a vision statement, the steering committee recommended that a more focused group of water quality experts convene to establish the water quality goals and guide the completion of the watershed management plan. A Water Quality Advisory Committee was created in 2018 with representative stakeholders across the watershed (Table 1-2). Utilizing current and historic water quality data, future development projections, and current and future nutrient modelling results, the Water Quality Advisory Committee set the following water quality goals and required nutrient load prevention, reduction, and/or offset needed to achieve the goals for the Squam Lakes over the next ten years. See Section 3.3.2 for more information on this process.

The goal of the Squam Lakes Watershed Management Plan is to maintain current in-lake median total phosphorus concentrations (6.5 ppb in Squam Lake and 6.4 ppb in Little Squam Lake). Based on development growth projections, this will require the prevention, reduction, and/or offset of 113 kg/year in phosphorus loading to the Squam Lakes over the next ten years.

Table 1-2: Water quality advisory committee members and affiliations.

Committee Member	Affiliation
Bob Snelling	Holderness Planning Board, SLA water quality monitoring volunteer
Dave Martin	SLA water quality monitoring volunteer, shorefront property owner
David Cutright	SLA water quality monitoring volunteer, shorefront property owner
Wendy Waskin	NHDES
Matt Wood	NHDES
Mark Green	Plymouth State University
Bob Craycraft	University of New Hampshire Lakes Lay Monitoring Program
Leigh Sharps	Ashland Select Board, shorefront property owner
Susan McLeod	Ashland Planning Board
Charley Hanson	Center Harbor Planning Board

1.4 Incorporating EPA's Nine Elements

The EPA requires that watershed plans incorporate nine key elements. These nine elements are described below, along with the section locations for each of the elements in the Squam Lakes Watershed Management Plan.

a. Identify pollution causes and sources: Section 3.5 describes the results of the watershed survey and summarizes the erosion hotspots that contribute sediment and nutrients to the lake.
b. Estimate pollution reductions needed: Sections 3.4.1 and 3.4.2 describe the pollutant load reductions necessary to reach the water quality goal of maintaining current water quality in the Squam Lakes.
c. Management measures that will achieve load reductions and targeted critical areas: Sections 4 and 5.2 describe the actions to be undertaken to meet the water quality goal established by the watershed management plan.
d. Estimate amounts of technical and financial assistance and the relevant authorities needed to implement the watershed management plan: Sections 5.1, 5.2, and 5.4 describe costs, technical assistance needed, and those groups or individuals that will be responsible for completing action items.
e. Develop an information/education component: Education, outreach, and communication are discussed in Sections 1.5, 5.2, and 5.5
f. Develop a project schedule: The project schedule is established in the Action Plan (Section 5.2). Each action item has a timeline of when completion should be expected.
g. Describe the interim, measurable milestones: Section 5.3 describes the interim as well as final milestones indicating successful watershed management plan implementation.
h. Identify indicators to measure progress: Sections 3.4 and 5.3 can be used to determine if loading reductions are being met over time indicating watershed management plan implementation is successful or on-track.
i. Develop a monitoring component: Long-term monitoring in the Squam Lakes is an important aspect of ensuring the watershed management plan's success. Monitoring goals are established in the Action Plan in Section 5.2

1.5 Public Engagement and Community Involvement

Kick-off Meeting

On January 20, 2016, more than 50 individuals gathered to celebrate the Squam Lakes watershed and kick-off the update of the Squam Lakes Watershed Management Plan. After a brief presentation about the Squam Lakes watershed and the planning process, participants divided into small groups to discuss the following topics:

- How do we enhance the public's understanding of the Squam watershed project and how do we encourage people to be involved?
- What are your thoughts about a new Squam Watershed Management Plan? What do we need to address?
- What do you think are the issues and priorities around the economy, environment, and culture of the Squam Lakes watershed?

At the end of the meeting, the entire group came back together to summarize the breakout sessions.

Speaker Series and Science Pub Events

The SLA worked with local partners to host public programs that pertain to the watershed management planning process. Three programs were held:

- 3/27/2019: Speaker Series (landscape and design to protect water quality)
- 9/11/2019: Science Pub (climate change)
- 10/16/2019: Science Pub (land conservation, stream restoration)

Meetings with Town Officials

The Lakes Region Planning Commission (LRPC) was responsible for reaching out to town officials and board members (selectboards, planning boards, and conservation commissions) and including them in the watershed management planning process.

On February 13, 2019, the LRPC introduced the results of the buildout analysis to town officials and the public. LRPC followed up on this meeting in September 2019 through November 2019 at meetings with the planning board for each watershed town: Ashland, Center Harbor, Holderness, Moultonborough, and Sandwich.

SLA Annual Meetings

The Squam Lakes Watershed Management Plan has been a major point of discussion at every SLA annual meeting since 2016.

Weed Watcher Trainings

The SLA trains individuals to be the first line of defense against new aquatic invasive species and new patches of variable milfoil (an aquatic invasive species already present in the Squam Lakes). Weed Watcher trainings were held every other Saturday between June and August 2018 and on three dates in 2019: 6/22, 7/20, and 8/23.

Stakeholder Interviews

During spring 2016, interviews were conducted with stakeholders to determine watershed users' knowledge about watershed issues, identify key issues in the Squam Watershed, and engage stakeholders in the watershed management planning process. Qualitative analysis techniques were applied to determine key issues and themes which should be incorporated to the new Squam Lakes Watershed Management Plan. Interview highlights:

- Water quality is a primary concern. Tributaries and upland areas are important. Management should focus on the watershed as a whole.
- The use of the watershed is important, and the frequency and intensity of use are issues.
- The development of land for residential and business uses needs to be considered. It is important to improve the economic well-being and quality of life through job creation and growing income.
- All five towns in the watershed need to be involved. Need dialog between communities.
- Need to engage lots of people; the new plan should be everyone's plan.
- Complete the plan in a timely manner and implement the new plan soon thereafter.
- The Watershed Management Plan will help with finding a balance for the use and development of the watershed.

Survey of Recreational Visitors

A survey of recreational visitors was conducted over two days in July 2016 at the West Rattlesnake trailhead, the Holderness boat launch, campsites, and the SLA headquarters in Holderness. The survey was designed to gather demographic and qualitative data about the visitors, their purpose for coming to the Squam Lakes Watershed, their opinion about water quality, and what they identify as threats to the watershed. A summary of the survey findings is presented below:

- 226 people participated in the survey that was evenly distributed over each day.
- 83% of respondents do not live in the Squam Lakes watershed, of which 23% had not visited the Squam region before, and 80% were staying one week or less.
- During their visit to the Squam Lakes watershed, 39% of all respondents planned to spend less than $100, and 29% planned to spend greater than $500.
- Hiking, swimming, and boating were the most popular activities that respondents engaged in.
- People come for the recreational opportunities, visiting family and friends, clean water, undeveloped landscape, and fewer people engaged in similar pursuits.

- 57% of respondents expressed that they are concerned, very concerned, or extremely concerned about water quality in the lakes.
- People cited development of land, roads, and climate change as the top three potential threats to the watershed.

1.6 Current and Historic Efforts in the Squam Watershed

Lakes Lay Monitoring Program (1979-present):

The SLA has been collecting water quality data from Squam Lakes since 1979, in partnership with the University of New Hampshire Cooperative Extension's Lakes Lay Monitoring Program (LLMP). This volunteer program runs June through August and collects several parameters at thirteen sites across the Squam Lakes. In addition to the volunteer monitoring portion of this program, biologists from the LLMP visit the Squam Lakes once per month in June, July, and August. Parameters measured include water clarity, chlorophyll-a, total phosphorus, total color, alkalinity, pH, and dissolved oxygen.

Septic System Survey Data for Shoreland Properties (1998-1999)

In 1992-1993 and again in 1998-1999, the SLA conducted a septic system survey for shoreland properties around the lake. The earlier survey had a 66% response rate, and the later study collected data from 88% of shorefront properties. The two studies resulted in the following summary and conclusions:

The initial and subsequent review of town files may have led to an incentive to improve record keeping because in almost all cases, record accuracy and completeness had improved significantly over the project period. The data were mapped based on two survey criteria deemed to be of primary significance: age of system and distance of subsurface sanitary, septic system, or other waste management system from lake. The graphical depiction of these criteria did not reveal any clear patterns in the potential failure risk of septic systems. The graphical representation of tax lots necessary for the mapping of the septic data did lead to an evaluation of the density of shoreland development.

Tributary Monitoring study (1999-2001)

In late 1998, the SLA and UNH LLMP developed a monitoring program to assess each of the subwatersheds in the Squam Lakes Watershed. The program was an intensive study of the major tributaries entering the Squam Lakes with the goal of determining the water budget and nutrient contributions of each of the subwatersheds. This tributary monitoring program was conducted from July 1999 through June 2000 and provided baseline hydrologic and phosphorus budgets for the Squam Lakes.

Bioinventory (2001-2002)

A biological inventory of the Squam Lakes Watershed was performed between July 2001 and July 2002. The purpose of the inventory was to establish representative monitoring plots and to collect baseline biological data from these locations. During the baseline bioinventory study, a total of 827 distinct species were identified and confirmed to be present in the Squam Lakes watershed.

LoVoTECs (2012-2016)

From 2012-2016, the SLA participated in a statewide stream monitoring program that measured stream depth, temperature, and specific conductance in streams throughout New Hampshire. One site was located at an unnamed brook running through Belknap Woods into Dog Cove, and the other sensors were deployed in Mill Brook. The sensors recorded measurements every 4-15 minutes from 2012-2016. The results from 2014 show Mill Brook falls within normal healthy limits. The water coming out of Belknap Woods fluctuates between the normal and low-impact categories. Results also show that the higher conductivity readings at Belknap Woods are likely related to impact from road salt.

Watershed Reports (2012-present)

In 2012, the SLA began publishing the Squam Watershed Report. This annual publication is a compilation of all the data collected in the Squam Lakes Watershed each year. While the reports vary from year to year, they generally include data and analysis about water quality, land protection, fisheries, invasive species (both aquatic and terrestrial), loons, and land conservation.

Aquatic Invasive Species

Variable milfoil is the primary aquatic invasive species in the Squam Lakes Watershed, and the SLA has been successfully managing it since 2000, resulting in a reduction in both the amount and spread of milfoil. The Chinese mystery snail, an invasive aquatic invertebrate animal, is also present in the Squam Lakes. Control of both variable milfoil and the Chinese mystery snail and prevention of the introduction of other aquatic invasives is a focus of the Squam Lakes Watershed Management Plan.

Investigation of Contaminants in the Squam Lakes Watershed (2018-2019)

In 2018, the SLA received funding to investigate various contaminants identified in the Squam Lakes Watershed. The SLA began working with Geosyntec, an environmental consulting firm, to create a preliminary plan to widen the geographic scope of contaminant sampling in the Squam Lakes Watershed. The short-term sampling effort will inform a longer-term investigation.

Staff at the SLA conducted sediment sampling in seven Squam Lakes tributaries in early November 2018. Sediment samples were tested for DDT (dichlorodiphenyltrichloroethane), PCBs (polychlorinated biphenyls), and dioxins/furans. These chemicals are persistent and ubiquitous in the environment, meaning they are very slow to break down in nature and can be found in all environments due to high levels of wide-spread historic use.

Generally, the contaminants of concern - DDT, dioxins/furans, and PCBs - tend to stick to sediment, which is why the SLA have tested tributary sediment and not water samples. These contaminants are insoluble in water and therefore less of a hazard to swimmers. Concentrations of these contaminants were compared to EPA Regional Screening Levels for recreational exposure to sediment (i.e., swimming, wading, etc.). Results indicated that concentrations of these compounds in sediment do not pose a risk to human health through recreational exposure. As these compounds do accumulate in fish, the exposure to humans is primarily through fish consumption. Levels of these contaminants are known to accumulate up the food chain and can impact both aquatic invertebrates and vertebrates, including apex predators such as loons (the Loon Preservation Committee has also performed sediment analysis and continues to test loon eggs for DDT and PCBs, and other contaminants). Further study is recommended. Sediment mitigation projects, such as those recommended in this plan to reduce nutrient loading, are also beneficial to reduce potential legacy contaminants from entering the Squam Lakes.

2. The Squam Lakes Watershed

2.1 Watershed description

The Squam Lakes Watershed, located in central New Hampshire, covers 36,644 acres. At the heart of the watershed is Squam Lake (6,762 acres) and Little Squam Lake (408 acres). The watershed is 20% open water with 85% of the surrounding watershed landscape as forest. There is minimal development in the Squam Lakes Watershed; less than 3% of the watershed is considered low density development, while high and medium density development are less than 0.1% of the total watershed area. There are 34 tributaries contributing flows to the Squam River and Squam Lakes. Water flows generally from east to west from Squam Lake through the Squam Channel into Little Squam Lake and through two miles of the Squam River until the lake impoundment in Ashland. Ultimately, the Squam River drains into the Pemigewasset River in Ashland. The watershed is divided among multiple political boundaries: three counties (Belknap, Carroll, and Grafton) and seven towns (Ashland, Campton, Center Harbor, Holderness, Meredith, Moultonborough, and Sandwich). Elevations range from 2,212 feet on Mount Percival in the Squam Range, which forms the northern boundary of the watershed, to 561 feet at the outlet dam in Ashland. Twenty-six percent (26%) of the Squam Lakes Watershed is permanently protected through conservation easements.

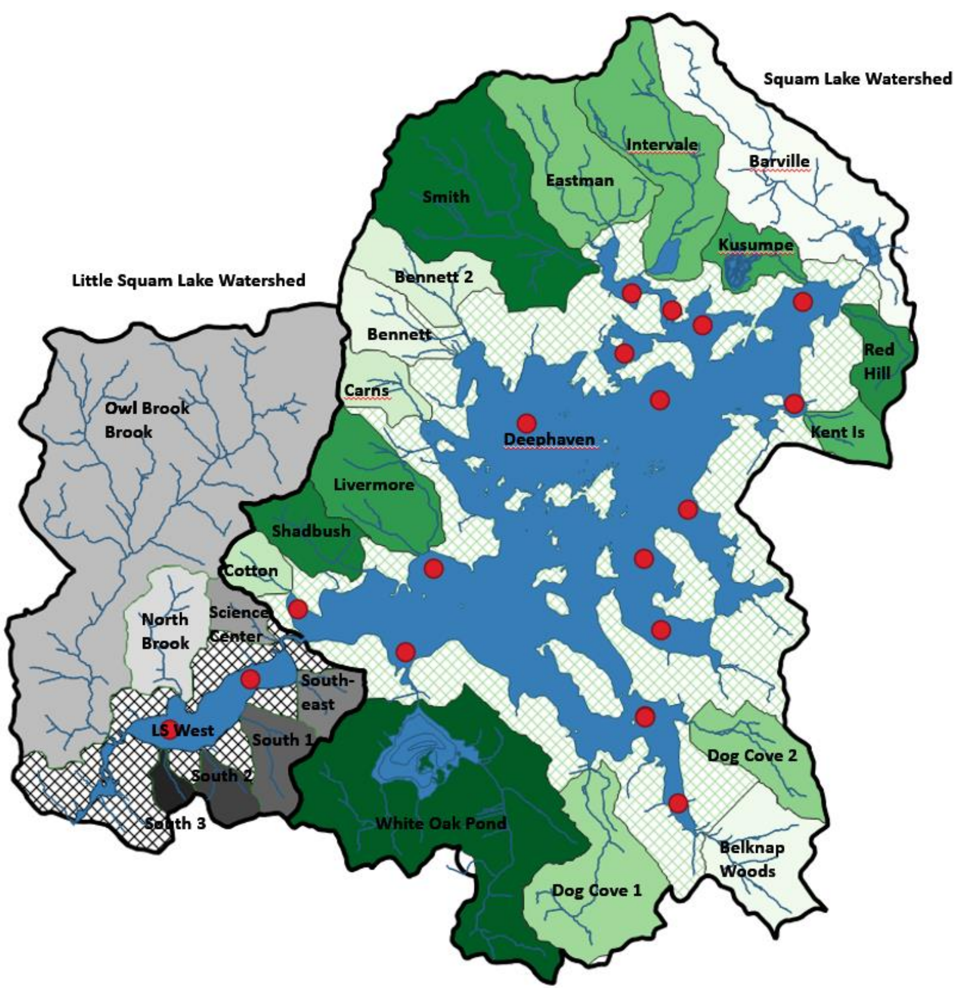


Figure 2-1: Map of the Squam Lake and Little Squam Lake Watersheds and their sub-basins. Cross-hatched areas are direct shoreline input. Red dots indicate water quality monitoring sites. LS West (in Little Squam Lake) and Deephaven (in Squam Lake) are the deepest points in each lake.

2.2 Physical Characteristics

2.2.1 Surficial Geology

Surficial earth materials include unconsolidated sediments (sand, gravel, etc.) of glacial and nonglacial origin. Most of these deposits formed during and after the latest episode of glaciation within the last 25,000 years. Surficial sediments cover bedrock over much of the watershed.

Till is the most widespread surficial deposit in the Squam Lakes watershed. It blankets the hills and sides of mountains, although parts of it have been disturbed by mass movements and surface water runoff on the steeper slopes. There are many shallow areas and islands on Squam Lake where large boulders are present. These boulders resulted from extensive capture and movement of the Winnipesaukee Tonalite bedrock as glacial ice flowed over the area.

Glacial sand and gravel were emplaced in the Squam Lakes watershed, most commonly in lowland areas by waters flowing out of melting ice during recession of the Laurentide Ice Sheet.

Ice-contact deposits formed where water laid glacial sediments upon or beside melting ice in the marginal zone of the retreating ice sheet. The resulting sand and gravel deposits may show hummock topography, including locally steep slopes where the ice once stood and depressions (kettles) left by melting of stray buried ice blocks. Ice-contact sand and gravel deposits occur in the upper Owl Brook valley in Holderness (Thompson, 2015).

Outwash consists of sand and gravel laid down by glacial meltwater streams on valley bottoms as the ice sheet retreated from the study area. Small outwash deposits occur on the northwest side of Squam Lake and along Owl Brook in Holderness (Thompson, 2015).

Terraces of sand and gravel are scattered along the shorelines of Squam Lake and Little Squam Lake in Holderness and Ashland. These deposits were formed when both lakes were slightly higher than today, and the lake surfaces probably stood at an elevation of about 580 ft. The higher lake system may have been dammed by a temporary plug of glacial till in a narrow part of the Squam River valley, just upstream from the modern dam that now regulates the lake levels. Sand and gravel in the lower Owl Brook valley are thought to be glacial outwash that the brook carried into ancestral Little Squam Lake.

Stream terraces are remnants of past floodplains that have been left as streams eroded down to their modern levels. These flat-topped deposits consist mostly of sand and gravel that were reworked from older glacial sediments. They occur along parts of Owl Brook in Holderness (Thompson, 2015).

Fine-grained and organic-rich sediments of postglacial age have been deposited in low, flat, poorly drained areas. This unit occurs in upland areas and in some poorly drained valley environments associated with flood plains.

Alluvial sand, gravel, silt, and organic material have been deposited by late glacial to modern streams. Sediment coarseness varies depending on the depositional environment, but in general there is a higher percentage of coarse gravel along steep streams in mountainous areas around the periphery of the watershed, while silty-sandy sediments are associated with more sluggish streams in gently sloping valley bottoms.

2.2.2 Soil Erosion Potential

Soil type and soil erosion potential are important considerations when planning for development. Soils with lower infiltration rates and higher runoff potential can contribute greater amounts of nonpoint source pollution (nutrients, sediments, bacteria, etc.) to surface water. Soil erosion potential is determined from the soil hydrologic group, where soils are ranked from A-D, with A as the highest soil erosion potential and D as the lowest. Most soils in the Squam Lakes Watershed are ranked as B (24%) with moderately low runoff potential and C (57%) with moderately high runoff potential.

2.3 Population

According to the United States Census Bureau, most towns in the Squam Lakes watershed have experienced steady population growth over the last 30 years. The populations of watershed towns combined have grown from 7,312 people in 1980 to 10,650 people in 2010 – a 46% increase. During that same time span, housing units in the target communities grew from 5,952 to 9,657 – a 62% increase. In most cases the rate of housing growth has been higher than the population growth rate. Note that the population and housing data account for each entire town, not just that town's population and housing within the watershed. A more extensive breakdown of population in watershed towns was included in the Squam Lakes Watershed Build-Out Analysis (Lakes Region Planning Commission, 2018).

2.4 Land Cover

Land cover in a watershed helps identify areas that contribute nonpoint source pollution, such as phosphorus, to surface waters. For example, residential and urbanized areas contribute more nutrients to surface waters than undeveloped forest lands. Details on the land cover assessment are provided in Section 3.2.

Today, in the Squam Lake Watershed, development accounts for 6% (476 acres), while forested areas dominate at 81% (7002 acres). Wetlands and open water represent 8% (696 acres) of the watershed, not including Squam Lake. Agriculture represents 4% (306 acres) and includes hayfields, and grazing pastures.

In the Little Squam Lake Watershed, development accounts for 7% (258 acres), while forested areas cover at 84% (2890 acres). Wetlands and open water represent 2% (93 acres) of the watershed, not including Little Squam Lake. Agriculture represents 4% (142 acres) of the land cover.

Developed areas within the Squam Lakes watershed are characterized by impervious surfaces, including areas with asphalt, concrete, and rooftops that force rain and snow that would otherwise soak into the ground to runoff as stormwater. Stormwater runoff carries pollutants to waterbodies that may be harmful to aquatic life, including sediments, nutrients, pathogens, pesticides, hydrocarbons, and metals. The build-out analysis conducted for the watershed, coupled with projected population growth trends, indicates that the percentage of developed area will continue to increase. Therefore, it is imperative that watershed communities incorporate low impact development (LID) techniques into new development projects. More information on BMP implementation can be found in the Action Plan in Section 5.2.

2.5 Lake Morphology and Morphometry

The morphology (shape) and bathymetry (depth) of lakes are considered reliable predictors of water clarity and lake ecology. Large, deep lakes are typically clearer than small, shallow lakes as the differences in lake area, number and volume of upstream lakes, and flushing rate affect lake function and health. The surface area of Squam Lake (6,762 acres) and Little Squam Lake (408 acres) is characterized by complex morphology with numerous coves and bays that generate an extensive shoreline length and distinct basins that may limit water and nutrient movement at certain times of the year. Squam Lake has a mean depth of 7 m, a maximum depth of 27 m, and a volume of 187,047,000 m^3. Squam Lake's areal water load is 2.8 m/yr, and its flushing rate is 0.4 times per year. The low areal water load and flushing rate means that the entire volume of the Squam Lakes is replaced every 2.4 years, which increases time for pollutants to settle in lake bottom sediments or be taken up by biota. Little Squam Lake has a mean depth of 10 m, a maximum depth of 21 m, and a volume of 17,431,112 m^3. Little Squam Lake's areal water load is 59.5 m/yr, and its flushing rate is 5.8 times per year. The moderately-high areal water load and flushing rate means that the entire volume of Little Squam Lake is replaced multiple times every year, which decreases time for pollutants to settle in lake bottom sediments or be taken up by biota. The statistics presented here were derived from (or cited in) LLRM documentation (see Section 3.2).

3. Water Quality Assessment

3.1 Water Quality and Assimilative Capacity Analysis

3.1.1 Analysis Design and Methods

Data acquisition and analysis followed the protocol established in the April 18, 2018 Site Specific Project Plan (SSPP). As established in the SSPP, the parameters assessed for the Squam Lakes Watershed Management Plan included Secchi disk transparency (SDT), as well as chlorophyll-a and total phosphorus from epilimnetic composite samples from the summer season (May 24th through September 15th). Water quality data were accessed from the NHDES Environmental Monitoring Database (EMD). EMD data were available from 1979-2017. Using these data, we ran summary statistics and trend analyses on historic data (1979-2007), recent data (2008-2017), and all data (1979-2017). Trends in water quality for each parameter were analyzed by the Mann-Kendall test (*rkt*, R statistical program; Marchetto, 2015).

3.1.2 Water Quality Criteria

According to the NH Consolidated Assessment and Listing Methodology (CALM), New Hampshire's water quality criteria set the baseline quality that all surface waters of the state must meet in order to protect their designated uses and are the measure for identifying where water quality violations exist and for determining the effectiveness of regulatory pollution control and prevention programs. Designated uses are the desirable activities and services that surface waters should be able to support, and include uses for aquatic life, fish consumption, shellfish consumption, drinking water supply, primary contact recreation (swimming), secondary contact recreation (boating and fishing), and wildlife. Water quality criteria may be found in RSA 485-A:8, I-V and in the state's surface water quality regulations Env-Wq 1700.

For lakes, water quality criteria vary depending on the lake's trophic status, since each trophic state has a certain algal biomass (chlorophyll-a) that represents a balanced, integrated, and adaptive community (Table 3-1). To determine if a waterbody is meeting its designated uses, water quality criteria for various water quality parameters (e.g., chlorophyll-a, total phosphorus, dissolved oxygen, pH, and toxics) are applied to the water quality data. If a waterbody meets or is better than the water quality criteria, the designated use is supported. If the waterbody does not meet or is worse than the water quality criteria, it is considered impaired for the designated use. Aquatic Life Use (ALU) and Primary Contact Recreation (PCR) are the two major uses for New Hampshire lakes, with ALU being the focus of watershed management plans.

For ALU assessment, phosphorus and chlorophyll-a are combined per the decision matrix presented in Table 3-2. The chlorophyll-a concentration will dictate the assessment if both chlorophyll-a and phosphorus data are available and the assessments differ.

Dissolved oxygen is also used as an indicator for ALU assessment and is critical to the balanced, integrative, and adaptive community of organisms (see Env-Wq 1703.19). For Class A waters, non-support use determinations are based on a daily average measurement of 75% dissolved oxygen saturation or less and an instantaneous dissolved oxygen measurement of 6 ppm or less, which apply to any depth in a vertical profile (except within 1 meter of lake bottom) collected from June 1 to September 30 (see Env-Wq 1703.07).

Table 3-1: Trophic state water quality criteria in New Hampshire.

Trophic State	Total Phosphorus (ppb)	Chlorophyll-a (ppb)
Oligotrophic	<8.0	<3.3
Mesotrophic	8.0-12.0	3.3-5.0
Eutrophic	>12.0-28.0	>5.0-11.0

Table 3-2. Decision matrix for aquatic life use (ALU) assessment in New Hampshire. TP = total phosphorus. Chl-a = chlorophyll-a, a surrogate measure for algae concentration.

Nutrient Assessments	TP Threshold Exceeded	TP Threshold NOT Exceeded	Insufficient Info for TP
Chl-a Threshold Exceeded	Impaired	Impaired	Impaired
Chl-a Threshold NOT Exceeded	Potential Non-support	Fully Supporting	Fully Supporting
Insufficient Info for Chl-a	Insufficient Info	Insufficient Info	Insufficient Info

3.1.3 Squam Lake Water Quality

Total Phosphorus, Chlorophyll-a, Secchi Disk Transparency

Water quality in Squam Lake is stable and meets water quality criteria for oligotrophic lakes. Table 3-3 shows the summary data for Squam Lake's deep spot near Deephaven Reef. Epilimnetic total phosphorus exhibits no annual trends since 1982, when TP data was first collected (Figure 3-1). The historic (1982-2007) record showed a trend toward increasing (worsening) chlorophyll-a that leveled off after 2008 (Figure 3-2). For water clarity measured by Secchi disk, the entire data set and the most recent ten years of data show a trend toward increasing water clarity, indicating a possible improvement in water clarity (Figure 3-3).

Table 3-3: Squam Lake summary statistics for epilimnetic total phosphorus, epilimnetic chlorophyll-a, and Secchi disk transparency during the summer season (May 24-September 15). Trends were determined using the Mann-Kendall trend analysis test.

Squam Lake Total Phosphorus	n	Mean (ppb)	Median (ppb)	Min (ppb)	Max (ppb)	Trend	MK p-value	MK slope
All years (1982-2017, y=31)	87	6.2	6	1.5	6.2	no trend	0.683	0.021
Historic (1982-2007, y=21)	51	6.1	5.6	1.5	18.3	no trend	1	-0.008
Recent (2008-2017, y=10)	36	6.4	6.5	3.4	13.3	no trend	0.788	-0.02
Squam Lake Chlorophyll-a	**n**	**Mean (ppb)**	**Median (ppb)**	**Min (ppb)**	**Max (ppb)**	**Trend**	**MK p-value**	**MK slope**
All years (1982-2017, y=36)	93	2	1.9	0.5	6	no trend	0.185	0.015
Historic (1982-2007, y=26)	58	2	1.9	0.5	6	declining	0.015	0.05
Recent (2008-2017, y=10)	35	1.9	1.7	1.1	3.4	no trend	0.857	-0.008
Squam Lake Secchi Disk Transparency	**n**	**Mean (m)**	**Median (m)**	**Min (m)**	**Max (m)**	**Trend**	**MK p-value**	**MK slope**
All years (1982-2017, y=34)	92	8.7	8.8	6.3	11.4	improving	0.048	0.03
Historic (1982-2007, y=24)	55	8.5	8.6	6.5	11.4	no trend	0.766	0.009
Recent (2008-2017, y=10)	37	9	9.2	6.3	11.4	improving	0.025	0.225

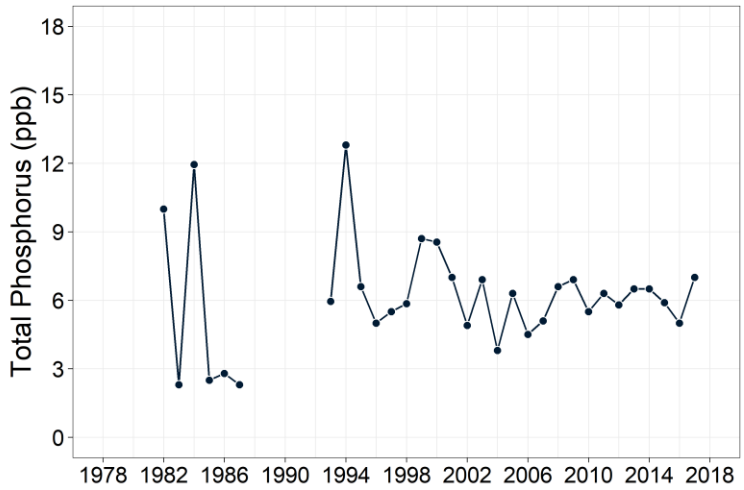


Figure 3-1: Annual median epilimnetic total phosphorus for the deep spot of Squam Lake, 1982-2017. Gaps reflect years with no data.

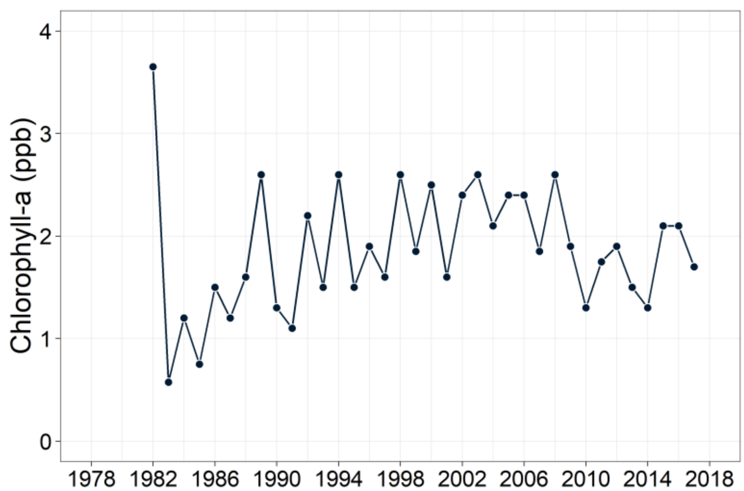


Figure 3-2: Annual median epilimnetic chlorophyll-a for the deep spot of Squam Lake, 1982-2017

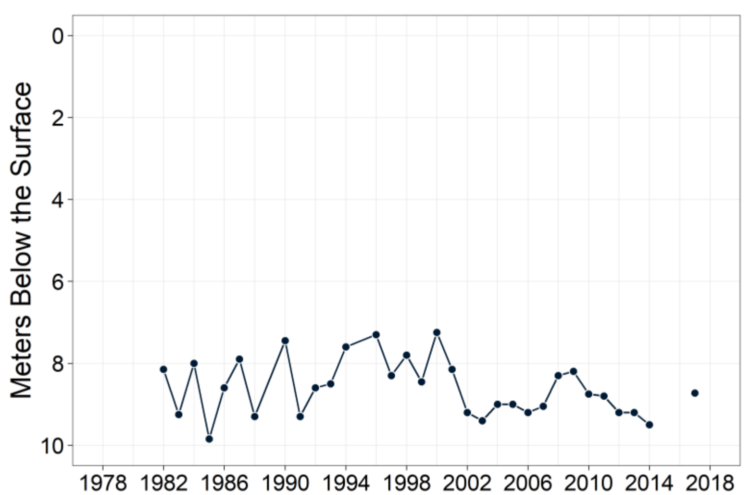


Figure 3-3: Annual average Secchi disk transparency for the deep spot of Squam Lake, 1982-2017. Gaps reflect years with no data.

3.1.4 Little Squam Lake Water Quality

Total Phosphorus, Chlorophyll-a, Secchi Disk Transparency

Water quality in Little Squam Lake is stable and meets water quality criteria for oligotrophic lakes. Table 3-4 shows the summary data for Little Squam Lake's deep spot at the western edge of the lake. Epilimnetic total phosphorus exhibits no annual trends since 1980, when TP data was first collected (Figure 3-4). The historic (1979-2007) record showed no trend in chlorophyll-a concentrations (Figure 3-5). For water clarity measured by Secchi disk, the entire data set and the most recent ten years of data also show no trend (Figure 3-6).

Table 3-4: Little Squam Lake summary statistics for epilimnetic total phosphorus, epilimnetic chlorophyll-a, and Secchi disk transparency during the summer season (May 24-September 15). Trends were determined using the Mann-Kendall trend analysis test.

Little Squam Lake Total Phosphorus	n	Mean (ppb)	Median (ppb)	Min (ppb)	Max (ppb)	Trend	MK p-value	MK slope
All years (1980-2017, y=33)	191	7	6.4	1.5	29.4	no trend	0.336	-0.021
Historic (1980-2007, y=23)	101	7.3	6.3	1.5	29.4	no trend	0.161	-0.056
Recent (2008-2017, y=10)	90	6.5	6.4	4.2	9.8	no trend	0.474	0.181
Little Squam Lake Chlorophyll-a	**n**	**Mean (ppb)**	**Median (ppb)**	**Min (ppb)**	**Max (ppb)**	**Trend**	**MK p-value**	**MK slope**
All years (1979-2017, y=39)	463	1.9	1.9	0.4	4.3	no trend	0.37	0.008
Historic (1979-2007, y=29)	362	1.9	2	0.4	4.3	no trend	0.053	0.03
Recent (2008-2017, y=10)	101	1.9	1.8	1	3	no trend	0.474	0.054
Little Squam Lake Secchi Disk Transparency	**n**	**Mean (m)**	**Median (m)**	**Min (m)**	**Max (m)**	**Mean (m)**	**Median (m)**	**Min (m)**
All years (1979-2017, y=39)	571	7.3	7.3	5	9.6	no trend	0.468	-0.006
Historic (1979-2007, y=29)	406	7.1	7.3	5	9.6	no trend	0.75	0.01
Recent (2008-2017, y=10)	165	7.3	7.4	5.9	8.9	no trend	0.589	0.075

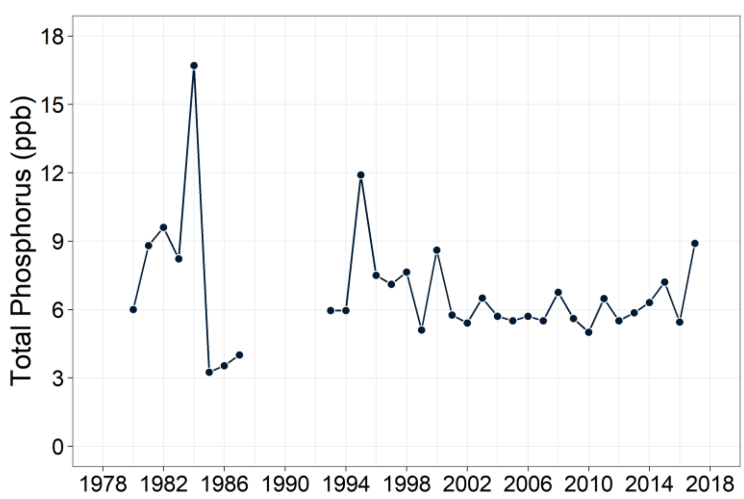


Figure 3-4: Annual median epilimnetic total phosphorus for the deep spot of Little Squam Lake, 1980-2017. Gaps reflect years with no data.

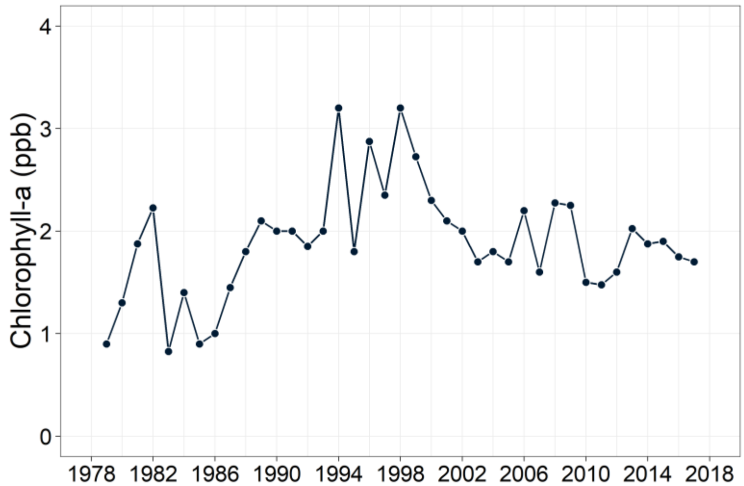


Figure 3-5: Annual median epilimnetic chlorophyll-a for the deep spot of Little Squam Lake, 1979-2017.

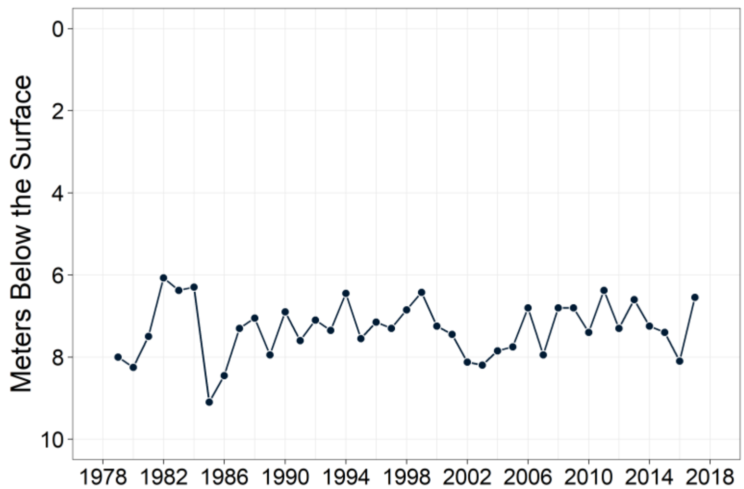


Figure 3-6: Annual average Secchi disk transparency for the deep spot of Little Squam Lake, 1979-2017.

3.1.5 Assimilative Capacity

The assimilative capacity of a waterbody describes the amount of pollutant that can be added to that waterbody without exceeding water quality criteria. For New Hampshire lakes, the water quality criteria for phosphorus and chlorophyll-a are based on the lake's trophic status. The NHDES has determined that the trophic status of Squam Lakes is categorized as oligotrophic. For oligotrophic lakes, the water quality criteria for phosphorus and chlorophyll-a is 8.0 ppb and 3.3 ppb, respectively. Total assimilative capacity is the difference between zero and the water quality criteria and thus is set by the water quality criteria. The NH Surface Water Quality Standards (ENV-Wq-1708) require that 10% of the assimilative capacity for a waterbody must be held in reserve. For Squam Lake and Little Squam Lake, the reserve assimilative capacity for total phosphorus and chlorophyll-a is 7.2 ppb and 3.0 ppb, respectively. The remaining assimilative capacity is the calculated difference between the water quality criteria and the existing median water quality value. Epilimnetic total phosphorus and chlorophyll-a levels should remain below 7.2 ppb and 3.0 ppb, respectively, to be in the Tier 2 High Quality Water category for an oligotrophic lake. Tier 2 waters in New Hampshire are of the highest quality—water quality is better than 10% of the criteria (Table 3-5). Tier 1 waters are within 10% of the water quality criteria, and impaired waters exhibit water quality that exceeds the state criteria.

Table 3-5: NH surface water classification assessment criteria.

Water Quality Classification	Description	Total Phosphorus (ppb)	Chlorophyll-a (ppb)
Tier 2	Water quality is better than 10% of the water quality criteria	<7.2	<3.3
Tier 1	Water quality is within 10% of the water quality criteria	7.2-8.0	3.3-5.0
Impaired	Water quality exceeds the criteria	>8.0	>5.0

Recent (2008-2017) median epilimnetic total phosphorus and chlorophyll-a for the deepest spots of both Squam Lakes were used to calculate the total, reserve, and remaining assimilative capacity. For Squam Lake and Little Squam Lake, the existing median for both total phosphorus and chlorophyll-a is better than the reserve assimilative capacity threshold and thus meet the classification of Tier 2 for high quality waters (

Table 3-6).

Table 3-6: Assimilative capacity, reserve assimilative capacity, remaining assimilative capacity, and waterbody classification for total phosphorus and chlorophyll-a in Squam Lake and Little Squam Lake.

Squam Lake Assimilative Capacity	**Existing Median TP (ppb)**	**Assimilative Capacity (ppb)**	**Reserve Assimilative Capacity (ppb)**	**Remaining assimilative capacity (ppb)**	**Waterbody classification**
Total Phosphorus	6.5	8.0	7.2	0.7	Tier 2
Chlorophyll-a	1.7	3.3	3.0	1.3	Tier 2
Little Squam Lake Assimilative Capacity	**Existing Median TP (ppb)**	**Assimilative Capacity (ppb)**	**Reserve Assimilative Capacity (ppb)**	**Remaining assimilative capacity (ppb)**	**Waterbody classification**
Total Phosphorus	6.4	8.0	7.2	0.8	Tier 2
Chlorophyll-a	1.8	3.3	3.0	1.2	Tier 2

3.1.6 Dissolved Oxygen and Hypolimnion Total Phosphorus

Dissolved oxygen concentrations from the most recent ten years were also examined to understand the depth at which each lake experiences anoxia and how many days anoxia occurs. These data were used to calculate internal loading in the watershed model. Also, for the internal load calculation, the difference between epilimnetic and hypolimnetic total phosphorus levels was calculated. For Squam Lake, the difference in TP levels was calculated at the Lake's deepest point, Deephaven Reef. Multiple sites were used to calculate the anoxic zone of the lake since there are so many distinct deep basins that experience anoxia (Table 3-7). When the dissolved oxygen concentration is less than 1.0 mg/L, the conditions are considered anoxia and oxygen deprived.

Table 3-7: Date and depth of anoxic conditions in Squam Lake water quality testing sites.

SITE	DATE	DEPTH (m)	TEMP (C)	DO (mg/L)	Station Max Depth (m)
5 Livermore Cove	8/18/2010	8	22.2	0	9.1
10 Sandwich Bay	8/18/2016	21	6.5	0.47	22.9
10 Sandwich Bay	8/15/2017	19.958	6.923	0.99	22.9
10 Sandwich Bay	8/16/2018	20.693	6.482	0.98	22.9
12 Moultonboro Bay	9/28/2016	13.5	15.6	0.15	18.6
14 Sturtevant Bay	7/20/2011	13	9.5	0.47	18
14 Sturtevant Bay	8/12/2014	15	9.7	0.98	18
14 Sturtevant Bay	7/16/2015	16.5	8.5	0.66	18
14 Sturtevant Bay	8/12/2015	13.5	10.1	0.94	18
14 Sturtevant Bay	7/12/2016	16	11.1	0.89	18
14 Sturtevant Bay	9/28/2016	12	16.7	0.17	18
14 Sturtevant Bay	7/12/2017	17	9.8	0.94	18
14 Sturtevant Bay	8/15/2017	12.5	12.2	0.68	18
14 Sturtevant Bay	8/16/2018	13.5	9.6	0.26	18
16 Dog Cove	7/20/2011	12	16.4	0.02	18.2
16 Dog Cove	8/20/2013	9	21.3	0.08	18.2
18 Piper Cove	9/24/2010	13.5	17.9	0	12.2
18 Piper Cove	7/20/2011	13	12.9	0.59	12.2
18 Piper Cove	8/20/2013	10.5	17.5	0.85	12.2
18 Piper Cove	8/18/2016	11.5	17.5	0.52	12.2
18 Piper Cove	7/12/2017	13.98	13.667	0.92	12.2
18 Piper Cove	8/15/2017	11.183	15.99	0.93	12.2
18 Piper Cove	8/16/2018	11.436	14.012	0.91	12.2
Deep Haven	8/15/2017	29.398	7.727	0.97	30
Loon Reef	8/18/2016	23	10.6	0.93	27.7
Loon Reef	8/15/2017	24.028	9.806	0.98	27.7

For Little Squam Lake, only one site was used when looking at anoxic conditions to calculate internal loading and there were only three days where anoxia was measured in the recent data (Table 3-8).

Table 3-8: Date and depth of anoxic conditions in Little Squam Lake water quality testing sites.

SITE	DATE	DEPTH (m)	TEMP (C)	DO (mg/L)	Station Max Depth (m)
Little Squam West	9/24/2010	16.0	8.2	0.65	21.9
Little Squam West	8/15/2017	19.329	6.946	0.97	21.9
Little Squam West	8/16/2018	18.865	5.605	0.98	21.9

3.1.7 Cyanobacteria

Cyanobacteria are actually a group of bacteria that are closely related to algae; however, they are not considered algae. They are the only group of bacteria that photosynthesize, or use light and carbon dioxide to create their own food the same way that plants do. Different types of cyanobacteria may be green, blue, red, or brown, but the one thing they have in common is their tendency to float on the surface in a layer that is often described as “oily” or “scummy” looking.

A “bloom” is a generic term used for rapidly reproducing colonies of bacteria or algae in bodies of water. These blooms tend to occur in bodies of water that have received a high input of nutrients, either by being disturbed from a sediment bed where it previously laid dormant, or from some external input of nutrients, such as from fertilizer runoff.

In September 2017, a sample from Squam contained at least two types of the bacteria *Anabaena* and *Aphanocapsa*. It was a small, isolated event that did not cause any known incidents or issues for those on the lake. In October 2018, a cyanobacteria bloom was reported on White Oak Pond. The bloom cleared within several days.

3.2 Buildout analysis

The build-out analysis for the Squam Lakes Watershed area provides estimates about the potential for new development, including the amount of land area in the watershed that could be developed and the number of new buildings, based on current zoning standards. The build-out also presents information about where the development has the potential to occur. The build-out analysis provides a full build-out scenario based on current zoning standards, and should be viewed as an estimate only. It is a planning tool that communities can utilize for guiding future land use activities in the watershed as well as for exploring conservation actions. The greatest amount of existing development is concentrated around the western and southern shores of Squam Lake and around the shores of Little Squam Lake. Large portions of the watershed are in permanent conservation. Nearly 13,000 acres of land in the study area (46%) are constrained in some manner. The build-out analysis shows that there is room for potential development in each of the five communities, the amount depends upon the land available in the community and the applicable restrictions. For the entire study area the analysis estimates that 5,175 new buildings could be added in the watershed. Projections as to when build-out levels are reached can vary based on several factors, some of which are subject to decisions made by landowners and towns, including the amount of land available for development, the local zoning regulations, and the rate at which development occurs. The projected time frame for full build-out for the entire watershed is 2148.

The full buildout analysis, including all maps and figures, is available on the SLA website (squamlakes.org).

3.3 Watershed Modeling

The LLRM is a spreadsheet-based tool that estimates the water and phosphorus loading budget for the lakes and their tributaries. Water and phosphorus loads (in the form of mass and concentration) are traced from various sources in the watershed, through tributary basins, and into the lake. The model incorporates data about land cover, watershed boundaries, point sources, septic systems, waterfowl, rainfall, and internal phosphorus loading, combined with many coefficients and equations from scientific literature on lakes and nutrient cycling. The outcome of this model can be used to identify current and future pollution sources, estimate pollution limits and water quality goals, and guide watershed improvement projects. Squam and Little Squam lakes were modeled separately.

3.3.1 Watershed and Sub-basin Delineation

Both Squam and Little Squam lake watersheds were broken out into sub-basins. The U.S. Geological Society StreamStats was used to delineate 17 sub-basins in the Squam Lake Watershed and 7 in the Little Squam Lake Watershed. All other land areas were considered direct shoreline input to the lakes.

3.3.2 Land Cover Update

Land cover is the primary input to the LLRM since it determines the quantity and quality of water that flows into the Squam Lakes. The LLRM uses water and phosphorus loading coefficients for different land cover types to estimate how much water and phosphorus reaches the Squam Lakes. Providing an adequate representation of current land cover contributes to a more accurate model. The 2001 New Hampshire Land Cover Assessment (NHLCA) from NH GRANIT was used as a starting point for determining current land cover in the Squam Lakes Watershed. Land cover types from the NHLCA from 2001 were translated to the land cover types used by the LLRM. Using Google Earth satellite images from 6/2/2018, as well as local knowledge and ground-truthing in the field, major land cover changes were noted and changed within the working land cover file. The following assumptions were made during the land cover correction process:

- Forest 3: Mixed was the default category for any land determined to be forest.
- Athletic fields and cemeteries were labeled as Urban 5: Open Space.
- Residential lawns were labeled as Urban 1: Low Density Residential.
- Unpaved roads from the NHDOT roads layer from NH GRANIT were labeled as Other 2: Unpaved Roads.
- Wetlands from the National Wetlands Inventory were labeled as Forest 4: Wetlands.

Final land cover data is shown in Figure 3-7.

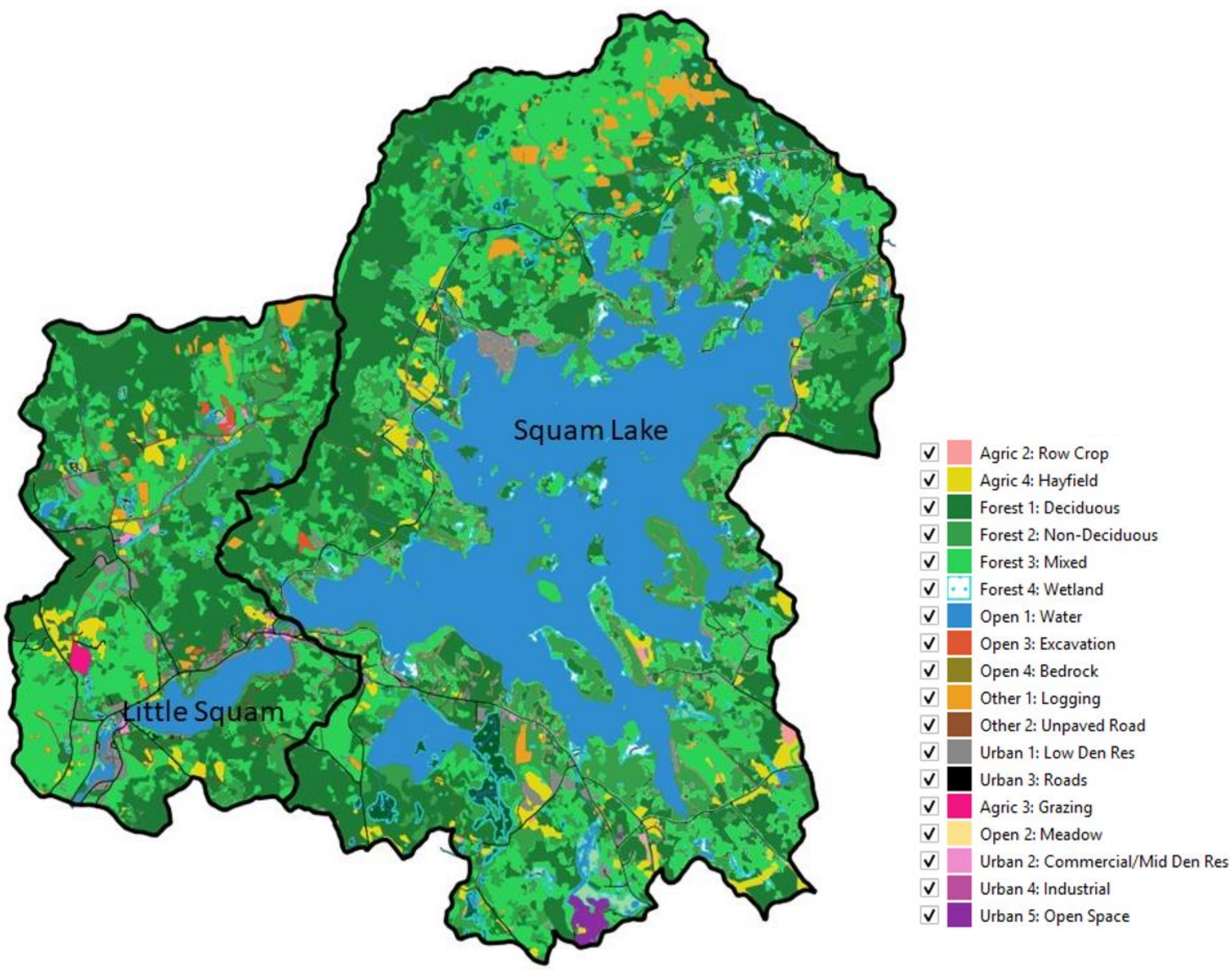


Figure 3-7: Land cover in the Squam Lakes Watershed after correcting existing land cover files.

3.3.3 Other LLRM Inputs

- **Precipitation**: Monthly precipitation data were obtained from NOAA NCEI for the MEREDITH 2.9 SSW, NH US (Station ID: US1NHBK0009) weather station with 2008-9 data gaps not included in the 10-year average. Average annual precipitation totals from 2010-2017 were input to the model (49.4 in or 1.25 m).
- **Septic system** data was an estimate based on a number of sources including 2010 Census information for the state of New Hampshire, buildout analysis results from the Lakes Region Planning Commission, QGIS area calculations, Patricia Tarpey's 2013 Plymouth State University master's thesis, and Lake Waukewan (Meredith and Center Harbor, NH) and Winona (Center Harbor, NH) septic survey results. (A septic system survey was completed for lakeshore residents around Lake Waukewan and Lake Winona in 2014 as part of development of a watershed management plan. It was assumed that the relative break-out of seasonal or year-round and old or new systems would be similar to other lake watersheds in the area.)
- Assumed 133 **waterfowl** (0.3 per hectare of lake area) were contributing to the phosphorus loading for half the year.
- **Lake area** was calculated based on a clip from the NH GRANIT NHD Waterbody shapefile.
- **Bathymetry** data was based on extensive lake depth data gathered by Brad Washburn (1962). The Squam Lake bathymetry data produced a lake volume that was 20% greater than the NHDES 1989 trophic survey for Squam Lake, and 7% greater than the 2009 NHDES trophic survey for Little Squam Lake. Trophic survey volume estimates were used.
- **Water quality** data were obtained from the NHDES Environmental Monitoring Database. Both the Squam Lake and Little Squam Lake models were calibrated using data from each lake's deepest point between 2008 and 2017. Data collection is summarized in the Water Quality and Assimilative Capacity Analysis Report. The most recent tributary water quality data was collected in 1999-2000. These data were used general guides but were not used to calibrate the model. Lake water quality data was also used to determine and calculate internal loading. Anoxia calculations to determine internal loading included dissolved oxygen data from other water quality sites for Squam Lake (Livermore Cove, Sandwich Bay, Moultonborough Bay, Sturtevant Bay, Dog Cove, Piper Cove, and Loon Reef).
- **Atmospheric phosphorus** deposits were incorporated primarily as dry deposition calculations—dust that gets blown up into the air and settles down somewhere else contains phosphorus. As development increases, so will atmospheric phosphorus. The atmospheric phosphorus export was set at 0.11 kg/ha/year, a value determined from existing scientific literature.

3.3.4 Model limitations

There were several limitations to the model; literature values and best professional judgement were used in place of measured data, wherever appropriate. Acknowledging and understanding these model limitations is critical to interpreting model results and applying any derived conclusions to management decisions. The model should be viewed as one of many tools available for lake management. The model results should be updated regularly as new information is collected. Because the LLRM incorporates specific waterbody information and is flexible in applying new data inputs, it is a powerful tool that predicts in-lake total phosphorus concentrations with a high degree of confidence; however, model confidence can be increased with more data. The following lists specific limitations to the model:

- Minimal water quality data were available for tributaries.
- Septic information was based on regional estimates.
- Waterfowl estimates were based on default assumptions.

- Due to its morphometric complexity, Squam Lake would greatly benefit from a more advanced modeling approach, such as the BATHTUB model that could allow for hydrologic segmentation of distinct basins.
- Minimal water quality data were available for internal load estimates in all distinct basins and thus internal load may be underestimated for Squam Lake.

3.3.5 Calculating Pre-Development Phosphorus Loads

To estimate phosphorus loading to the Squam Lakes before development occurred, all human development related land cover categories—including all urban, agriculture, excavation, timber harvesting, and unpaved roads—were changed to forest land cover. The estimate for pre-development loading was calculated without breaking each watershed into sub-basins.

Other assumptions and changes for calculating pre-development phosphorus loads:

- Removed septic input.
- Removed internal loading input.
- Reduced atmospheric loading coefficient to 0.07 kg/ha/year.
- All other parameters were kept the same to the original model.

3.3.6 Calculating Future Phosphorus Loads

The Squam Lakes Watershed build-out analysis from the LRPC was used to generate an estimate of changes in land cover at full build-out by 2148. We assumed that for every new building added to the watershed, some amount of developed land (residential, commercial, roads, etc.) will increase. To determine the amount and type of developed land added per new building, we used the number of existing buildings in the watershed to calculate how much of each developed land cover category is associated with each existing building in the watershed. These factors for developed land cover categories were multiplied by the number of new buildings possible and added to the current water and phosphorus load in the model. It was assumed that the new developed land at build-out will occur on current forest and agricultural land, so the area of developed land was subtracted proportionally from current forest and agricultural land.

Other assumptions and changes for calculating future phosphorus loads:

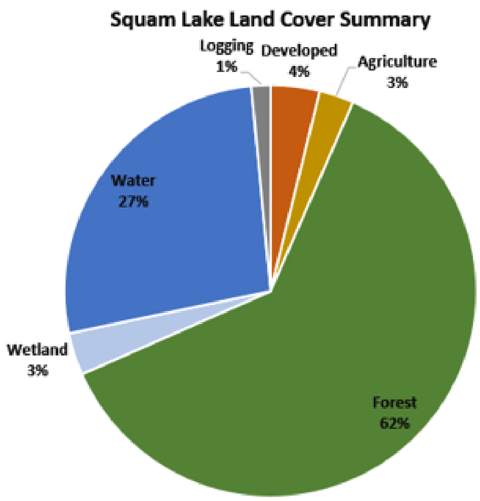
- Did not change the precipitation input, even though precipitation will likely change in the future.
- Septic input was estimated using building numbers at full build-out using same proportion of seasonal and occupied homes.
- Internal loading was estimated to be the same proportion of the total phosphorus load at full build-out as it is currently.
- Increased atmospheric loading coefficient to 0.25 kg/ha/year.
- All other parameters were kept the same to the original model.

3.3.7 Results (Current, Pre-Development, and Future Load Estimates)

Squam Lake Watershed

In Squam Lake, the Dog Cove 1 sub-basin contributes the greatest annual phosphorus load followed by the direct shoreline area (Table 3-9). At full build-out, the amount of phosphorus entering Squam Lake will more than double (from 1,121 kg/ha/year to 2,805 kg/ha/year; Table 3-10). In Squam Lake, phosphorus load from the watershed (runoff and baseflow) contributes the greatest amount of phosphorus to the lake (Table 3-10, Figure 3-9). Septic input is estimated at 15% and internal loading is 1%. Septic and internal loading are rough estimates and will need further study to refine. At full build-out, the LLRM estimated that there will be an increase in relative impact from septic systems. This is based on a series of assumptions and should be refined to understand further, possibly by estimating building locations and limiting septic influence on the lake from only buildings within 250 feet from surface waters.

Predicted in-lake phosphorus concentrations for Squam Lake were 7.9 ppb, compared to measured values for the lake's deepest spot (Deephaven site) at 7.8 ppb (Table 3-11). Table 3-11 also includes mean total phosphorus concentrations for other lake sites for comparison. Measured values were increased by 20% as an estimate for year-round total phosphorus concentrations. There is limited year-round data for the Squam Lakes. Generally, total phosphorus concentrations are higher when the lake is not stratified. The Squam Lakes Association is currently conducting water quality monitoring during all months of the year, though only two seasons of data have been collected. Soon, the actual difference between phosphorus concentrations in the summer season and other seasons can be calculated. At full build-out, the LLRM predicts in-lake total phosphorus concentration will be 16.9 ppb, which would classify Squam Lake as eutrophic.



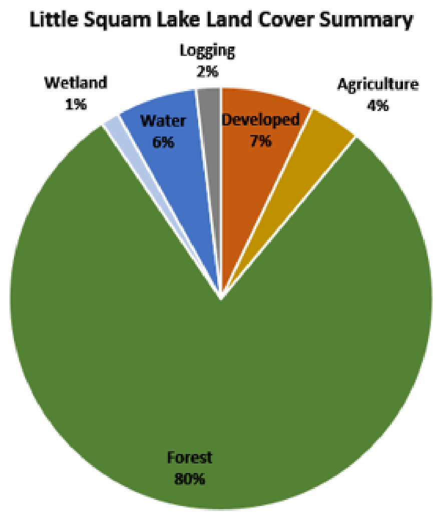


Figure 3-8: Land cover summary for the Squam Lake and Little Squam Lake.

Table 3-9: Summary of land area, water flow, and total phosphorus (TP) loading by sub-basin the Squam Lake watershed.

Squam Lake Sub-Basin	Basin Area (ha)	Water Flow (cu.m./yr)	TP Load (kg/yr)	Calculated TP (mg/L)	TP Load Per Hectare (kg/ha/yr)
Cotton Cove	91.73	620184.95	4.27	0.01	0.05
Shadbush	179.47	1227840.21	13.75	0.01	0.08
Livermore Cove	316.80	2143906.80	17.18	0.01	0.05
Carns Cove	123.92	838694.72	7.25	0.01	0.06
Bennett	160.94	1090437.96	6.85	0.01	0.04
Bennett 2	204.44	1383554.87	10.57	0.01	0.05
Smith Brook	708.59	4751332.44	23.73	0.00	0.03
Eastman Brook	405.55	2739561.98	17.21	0.01	0.04
Intervale Pond	517.70	3450198.93	21.98	0.01	0.04
Kusumpe	130.64	817217.47	5.15	0.01	0.04
Barville	721.12	4261605.27	39.01	0.01	0.05
Red Hill (Eagle Cliff)	128.27	865781.96	4.91	0.01	0.04
Kent Island	98.06	662990.98	3.96	0.01	0.04
Dog Cove 2	217.99	1457089.06	17.88	0.01	0.08
Belknap Woods	295.44	1990034.23	20.05	0.01	0.07
Dog Cove 1 (Laurel Is.)	437.78	2837726.39	47.32	0.02	0.11
White Oak Pond	1189.11	7207100.58	70.81	0.01	0.06
Direct Shoreline	2681.63	18948539.09	269.03	0.01	0.10
Total	**8609.2**	**57293797.9**	**600.9**		**1.0**

Table 3-10: Phosphorus load estimates from the Lake Loading Response Model (kg/ha/yr) for Squam Lake.

Source	Pre-Development	Current	Future
Atmospheric	192.2	302.0	686.5
Internal	0.0	13.2	33.0
Waterfowl	36.6	36.6	36.6
Septic	0.0	168.6	678.9
Watershed Load	250.4	600.9	1370.0
total	**479.2**	**1121.3**	**2805.0**

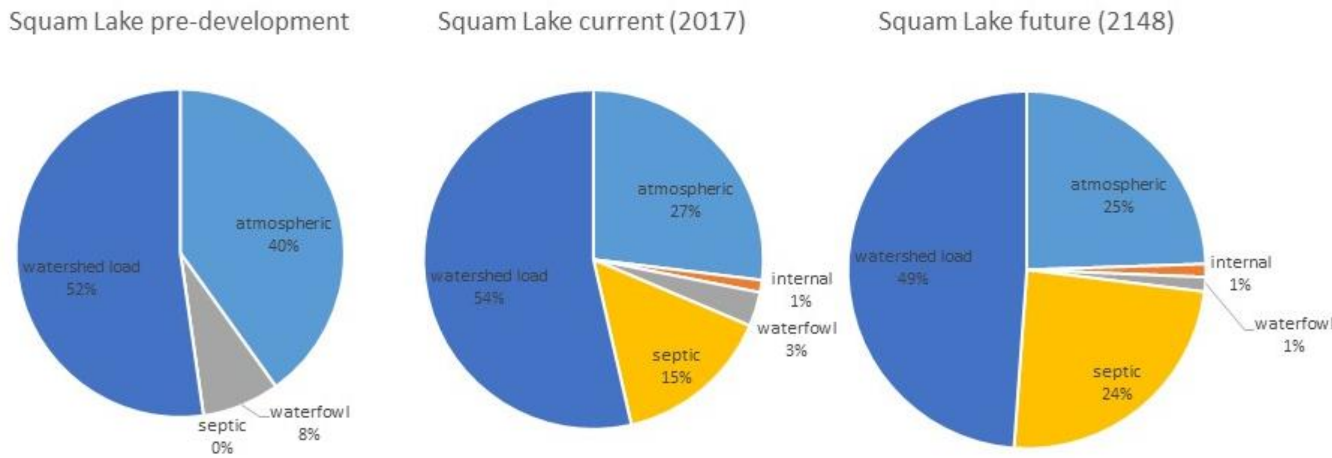


Figure 3-9: Phosphorus load summary from the Lake Loading Response Model for Squam Lake. The relative contribution of septic systems greatly increases in the future model scenario (due to the large number of potential new buildings) and thus lowers the proportional loads from the watershed, atmospheric deposition, and waterfowl, but all loads (except waterfowl) greatly increase in load from the current model scenario.

Table 3-11: Predicted and Measured in-lake total phosphorus (TP) concentrations for Squam Lake. Measured values are increased by 20% as an estimate for year-round in-lake phosphorus concentrations

Scenario/Site	Median TP (ppb)
Predicted Squam Lake pre-development	2.9
Predicted Squam Lake current (2017)	7.9
Predicted Squam Lake future (2148)	16.9
Deephaven (measured +20%)	7.8
Dog Cove (measured +20%)	8.6
Piper Cove (measured +20%)	9.0
Sandwich Bay (measured +20%)	6.9

Little Squam Lake Watershed

The direct shoreline area contributes the greatest annual phosphorus load to Little Squam Lake (Table 3-12). Most of the loading to Little Squam Lake comes from Squam Lake (Table 3-13). At full build-out, the amount of phosphorus entering Little Squam Lake will more than double (from 1,031 kg/ha/yr to 2,548 kg/ha/yr). At full build-out, the impact from the watershed (runoff and baseflow) and septic loading will increase proportionally (Figure 3-10). Septic and internal loading are rough estimates and will need further study to refine.

Predicted in-lake phosphorus concentrations for Little Squam Lake were 7.6 ppb, and measured values for the lake's deepest spot were 7.7 ppb (Table 3-14). Measured values were increased by 20% as an estimate for year-round total phosphorus concentrations. At full build-out, the LLRM predicts in-lake total phosphorus concentrations will be 18.7 ppb, which would put Little Squam Lake in the eutrophic trophic status.

Table 3-12: Summary of land area, water flow, and total phosphorus (TP) loading by sub-basin the Little Squam Lake watershed.

Little Squam Lake Sub-Basins	Basin Area (ha)	Water flow (cu.m./yr)	TP Load (kg/yr)	Calculated TP (mg/L)	TP Load Per Hectare (kg/ha/yr)
North Brook	229.3	1,462,371	13.4	0.009	0.06
Owl Brook	2172.4	13,805,256	160.3	0.012	0.07
Science Center Brook	75.8	513,024	5.4	0.010	0.07
SE Little Squam	95.4	644,947	6.3	0.010	0.07
South Little Squam 1	139.4	944,279	5.7	0.006	0.04
South Little Squam 2	78.4	531,589	5.5	0.010	0.07
South Little Squam 3	42.5	288,764	3.1	0.011	0.07
Direct Shoreline	549.3	3,681,088	72.3	0.020	0.13
Total	3382.55	21871317.92	272.05		0.58

Table 3-13: Load estimates from the Lake Loading Response Model (kg/ha/year) for Little Squam Lake.

Source	Pre-Development	Current	Future
Atmospheric	11.9	18.7	42.5
Internal	0.0	2.2	5.4
Waterfowl	6.8	6.8	6.8
Septic	0.0	116.9	510.9
Watershed Load	98.2	272.0	657.7
Load From Big Squam Lake	225.0	614.7	1323.4
Total	**341.9**	**1031.3**	**2546.7**

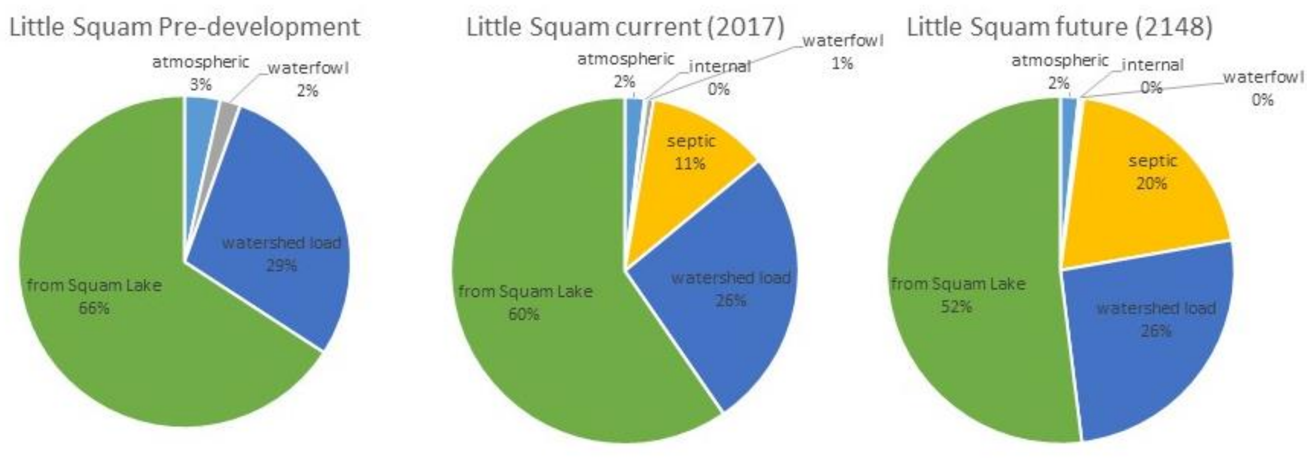


Figure 3-10: Phosphorus load summary from the Lake Loading Response Model for Little Squam Lake. The relative contribution of septic systems greatly increases in the future model scenario (due to the large number of potential new buildings) and thus lowers the proportional loads from Squam Lake and waterfowl, but all loads (except waterfowl) greatly increase in load from the current model scenario.

Table 3-14: Predicted and measured in-lake total phosphorus concentrations. Measured values are increased by 20% as an estimate for year-round in-lake phosphorus concentrations

Scenario/Site	median TP (ppb)
Predicted Little Squam Lake pre-development	2.9
Predicted Little Squam Lake current (2017)	7.6
Predicted Little Squam Lake future (2148)	18.7
Little Squam Lake West (measured +20%)	7.7

3.4 Water Quality Goal

The LLRM demonstrated changes in water quality as land cover changes with continued development of the watershed. Using the model results, we can make management decisions that will protect water quality in the Squam Lakes. Both Squam Lake and Little Squam Lake have in-lake phosphorus conditions that are within the State of New Hampshire's oligotrophic criteria, and there is enough reserve capacity to assimilate the input of additional phosphorus as development increases; however, the build-out analysis and the results from the LLRM demonstrate that Squam Lakes are extremely vulnerable to new development. Thus, establishing a water quality goal that maintains current water quality better than the oligotrophic criteria is recommended to protect water quality into the future.

The goal of the Squam Lakes Watershed Management Plan is to maintain current water quality in the Squam Lakes by reducing new or offsetting existing pollutant loading to Squam Lake and Little Squam Lake. To maintain current in-lake total phosphorus concentrations in the Squam Lakes, a total of 113.1 kg/yr of phosphorus load must be prevented, reduced, and/or offset in the Squam Lakes watershed (Table 3-15). This reduction is based on estimating the rate of development using the build-out analysis and using a compound annual growth rate to determine how much the projected phosphorus load will increase during the next ten years.

Table 3-15: Total phosphorus loading (kg/yr) reductions necessary to achieve water quality goal.

Lake	Projected load increase from new dev in next 10 yrs [A]	Reductions possible from sites identified by watershed survey [B]	Further reductions needed [A-B]	Fix high impact shoreline properties	Fix medium impact shoreline properties	Upgrade year-round shoreline septic systems	Upgrade seasonal shoreline septic systems
Squam Lake	78.7	26.6	52.1	33.4	17.9	0.7	0.2
Little Squam Lake	34.4	6.8	27.6	19.1	8.1	0.4	0.1
Total	**113.1**	**33.4**	**79.7**	**52.5**	**25.9**	**1.1**	**0.3**

3.4.1 Pollutant Load Reductions Needed

A variety of strategies will be required to meet the water quality objective in the next 10 years. Implementing structural BMPs from the watershed survey, future shoreline survey, and possible septic system upgrades will meet the water quality objective; however, achieving the water quality objective solely through structural BMPs will be resource intensive and will be more successful if non-structural BMPs are also used to address changes to zoning ordinances and to increase land conservation in the watershed. It is also important to note that, while the focus of the water quality objective is on phosphorus, the treatment of stormwater and sediment erosion will result in the reduction of many other kinds of pollutants (such as nitrogen, bacteria, road salt/sand, heavy metals, toxics, etc.) that may impact water quality.

Watershed Survey

A watershed survey conducted in May 2018 identified erosion hotspots in locations around the watershed. Erosion brings sediment and nutrients, including phosphorus, into surface waters. The watershed survey identified 53 practices around the watershed that will reduce phosphorus loading by 33.4 kg/yr into the lakes.

Shoreline Phosphorus Impact

A shoreline survey was not a part of the watershed planning process. Conducting a shoreline survey is recommended in the future to further understand the impact shoreline properties have on the water quality of Squam Lake and Little Squam Lake. Using the EPA Region 5 model, we can estimate the reduction in phosphorus loading from implementing best management practices (BMPs) along the shoreline (Table 3-16). We estimated that there are 35 shoreline properties on Squam Lake and 20 on Little Squam Lake that are high impact, requiring larger projects to reduce phosphorus loading. We estimated that there are 124 properties on Squam Lake and 56 on Little Squam Lake that are medium impact properties, needing smaller projects to reduce phosphorus loading, such as a rain garden or infiltration steps, which can be completed by the homeowner.

Table 3-16: Shoreline property total phosphorus (TP) reductions. Based on Region 5 model bank stabilization estimate for silt loams, using 100 ft (length) by 5 ft (height) and moderate lateral recession rate of 0.2 ft/yr and assuming a 50% BMP efficiency for high impact properties and using 50 ft (length) by 3 ft (height) and moderate lateral recession rate of 0.1 ft/yr and assuming a 50% BMP efficiency for medium impact properties.

	High Impact properties (0.9538 kg/yr TP reduction per property)			Medium impact properties (0.144 kg/yr TP reduction per property)		
Lake	Number of shoreline properties	% of shoreline properties	TP reduction (kg/yr)	Number of shoreline properties	% of shoreline properties	TP reduction (kg/yr)
Squam Lake	35	10%	33.38	124	35%	17.86
Little Squam Lake	20	11%	19.08	56	30%	8.06
Total	**55**	**10%**	**52.50**	**180**	**33%**	**25.90**

Septic System Impact

A septic survey was conducted for the Squam Lakes Watershed between 1999 and 2000. This study was determined to be too outdated to understand current septic system impact in the Squam Lakes Watershed. It is recommended to conduct a septic system survey in the future to further understand septic influence on water quality. We can still estimate the impact of upgrading septic systems in the watershed without a septic survey based on default values used in the LLRM for converting year-round or seasonal old systems to new systems (Table 3-17). Upgrading septic systems changes how much phosphorus is released from the system. With newer, upgraded septic systems, the phosphorus attenuation factor decreases from 0.2 to 0.1 (meaning that the system will treat 90% instead of only 80% of the effluent).

Table 3-17: Total phosphorus (TP) loading reductions from septic system improvements.

	Year-round upgrades		Seasonal upgrades	
Lake	Number of shoreline properties	TP reduction (kg/yr)	Number of shoreline properties	TP reduction (kg/yr)
Squam Lake	10	0.73	10	0.18
Little Squam Lake	5	0.37	5	0.09
Total	15	1.10	15	0.30

Non-Structural Practices (Ordinance Revisions)

The most effective approach to reducing phosphorus loading from anticipated new development will be to complete a thorough review of existing ordinances and regulations that govern land development in the watershed and make necessary updates or additions to those ordinances to better protect water quality. Zoning ordinance changes are not reflected in the load reduction calculation. A matrix study of existing regulations and zoning across watershed communities would be beneficial. We should also consider watershed-specific ordinances for Squam Lakes.

Land Conservation

Land conservation is an effective method of protecting water quality. Currently 26% of the watershed is protected, primarily by conservation easements. Local (Squam Lakes Conservation Society) and regional (Lakes Region Conservation Trust, Society for the Protection of New Hampshire Forest) are actively adding to the roster of conserved land within the Squam Lakes Watershed, with a goal of ultimately protecting one-third of the watershed. Future land conservation was not reflected in the load reduction calculation or the build-out analysis.

3.4.2 Finalizing the Water Quality Goal

The Water Quality Advisory Committee was tasked with determining the in-lake nutrient goal for the Squam Lakes Watershed Plan. The goal was finalized by the committee on September 25, 2019. It was noted that the load reductions are based on several assumptions, including assumptions from the build-out analysis and the modeling process. As part of the plan, the committee recommends further study to understand the impacts of shoreline development, septic systems, and waterfowl inputs to the lake. The committee also acknowledged the value of tributary monitoring in the future.

Taking the build-out analysis, water quality analysis, and the Lake Loading Response Model results into consideration, the committee has set the following in-lake goal for the Squam Lakes Watershed Plan:

The goal of the Squam Lakes Watershed Management Plan is to maintain current in-lake median total phosphorus concentrations (6.5 ppb in Squam Lake and 6.4 ppb in Little Squam Lake). Based on development growth projections, this will require the prevention, reduction, and/or offset of 113 kg/year in phosphorus loading to the Squam Lakes over the next ten years.

The committee has also agreed upon interim goals/benchmarks to track progress in meeting the water quality goal over the next 10 years (Table 3-18). These benchmarks also provide for water quality monitoring to check success in meeting in-lake total phosphorus concentration targets and allow for reassessing objectives and interim benchmarks as necessary.

Table 3-18: Proposed timeline for total phosphorus (TP) loading reduction.

	Interim Goals/Benchmarks		
	2022	**2025**	**2030**
Goal: ***Maintain current in-lake median total phosphorus concentrations (6.5 ppb in Squam Lake and 6.4 ppb in Little Squam Lake) by preventing, reducing, and/or offsetting phosphorus loading to Squam and Little Squam Lake by 113 kg/yr.***			
	Prevent or offset 15 kg/yr in TP loading from new development; re-evaluate water quality and track progress.	Prevent or offset 52 kg/yr in TP loading from new development; re-evaluate water quality and track progress.	Prevent or offset 113 kg/yr in TP loading from new development; re-evaluate water quality and track progress.

3.5 Pollutant Source Identification—Watershed Survey

FB Environmental Associates (FBE) was contracted by the Squam Lakes Association (SLA) to complete a watershed survey that identified and documented evidence of sediment erosion or "hotspots" of nutrient loading to surface waters in the Squam Lakes watershed. On 5/31/2018, FBE technical staff surveyed the watershed and documented 53 erosion "hotspot" sites that may be detrimental to the lake's water quality. Documentation included describing the problem, estimating the impact/treatment area, making recommendations for fixing the problem, rating the site's impact to water quality, logging the site's geoposition, and taking photographs.

Using the NHDES Simple Method Pollutant Loading Spreadsheet Model, FBE estimated the pollutant loading (total suspended solids, total phosphorus, and total nitrogen) likely generated from each erosion "hotspot" site (see model spreadsheets for metadata, references, and assumptions). A general cost estimate was also assigned to each site based on the scale of recommended fixes. We strongly recommend that a thorough engineered design and cost estimate be completed for each site prior to implementation.

Based on each site's impact rating, estimated cost, and potential pollutant load reduction, the 53 erosion "hotspot" sites were ranked 1-53 from highest to lowest priority for implementation, described in Squam Lakes Watershed Survey Results (Task 24) and Pollutant Load Reduction Estimates and Costs (Task 25). Implementing recommendations at all 53 erosion "hotspot" sites would potentially reduce the phosphorus load to Squam Lakes by 33 kg/yr (11 kg/yr for the top 10 sites) and cost an estimated $1.09-$2.29 million ($300,000-$600,000 for the top 10 sites), including annual maintenance costs for 10 years.

4. Watershed Management

The goal of the Squam Lakes Watershed Management Plan is to maintain the water quality of the Squam Lakes, as new projected development will have a marked impact on phosphorus levels in the lakes. To maintain water quality in the Squam Lakes, both structural and non-structural strategies are necessary to achieve the goals established for each lake within the context of this watershed management plan.

4.1 Structural Strategies

Structural strategies are also known as best management practices (BMPs). BMPs are an engineered approach aimed at reducing the amount of sediment and nutrients (which are often affixed to sediment) that erode or are transported from the watershed to surface waters.

The watershed survey, conducted in May 2018, identified 53 sites throughout the watershed that impact water quality through erosion and sedimentation. Although a shoreline survey was not completed, there are likely several high and medium impact shoreline properties that could use attention (a formal survey is recommended to help identify these properties). Structural BMPs are necessary to remediate these sites and reduce the amount of sediment and nutrients that are sources from these sites and impact the lakes' water quality. To address these erosion sites:

- Work with the priority list of nonpoint source "hotspots" pollution established through the watershed survey process (and shoreline survey process once it is conducted).
- Work with property owners for each of the identified sites to ensure participation in the process to improve these sites and to commit to long-term maintenance of BMPs.
- Work with professional staff including consultants, engineers, and town road agents to design and implement the specific BMP(s) at each site.
- Estimate the pollutant load reduction(s) for each installed practice.

Septic system upgrades could also fall under structural BMPs. It is recommended that a watershed-wide inventory of septic systems be completed so that at-risk septic systems (older, improperly maintained) can be prioritized for follow-up outreach and voluntary system evaluations. The towns should consider setting up low-interest loans or other funding mechanisms to support homeowners with costly upgrades.

4.2 Non-Structural Strategies

Current zoning in the Squam Lakes Watershed presents considerable opportunity for continued development and future water quality degradation. Given this future development potential, it is critical for watershed communities to develop and enforce stormwater management measures that prevent an increase in pollutant loadings from new and re-development projects, particularly as future development may offset reduced loads from other plan implementation actions. The impact of future development can be mitigated with the implementation of non-structural BMPs, such as land use planning, zoning ordinances, and LID requirements. Though non-structural BMPs often receive little emphasis in watershed planning, it can be argued that local land use planning and zoning ordinances are the most critical components of watershed protection. Working with planning commissions to complete a matrix study of existing regulations and zoning across watershed communities would be beneficial. We should also consider watershed-specific ordinances for Squam Lakes. Refer to Section 5.2 for specific planning recommendations.

4.3 Adaptive Management Approach

An **adaptive management approach**, to be employed by a steering committee, is highly recommended for protecting the Squam Lakes Watershed. Adaptive management enables stakeholders to conduct restoration actions in an iterative manner. Through this management process, restoration actions are taken based on the best available information. Assessment of the outcomes following restoration action, through continued watershed and water quality monitoring, allows stakeholders to evaluate the effectiveness of one set of restoration actions and either adopt or modify them before implementing effective measures in the next round of restoration actions. This process enables efficient utilization of available resources through the combination of BMP performance testing and watershed monitoring activities. Adaptive management features establishing an ongoing program that provides adequate funding, stakeholder guidance, and an efficient coordination of restoration actions. Implementation of this approach ensures that restoration actions are implemented and that surface waters are monitored to document restoration over an extended time.

The adaptive management components for implementation efforts should include:

Maintaining an Organizational Structure for Implementation. Communication and a centralized organizational structure are imperative to successfully implementing the actions outlined in this plan. A diverse group of stakeholders (an expansion of the current steering committee overseeing plan development) should be assembled to coordinate watershed management actions. Refer to Section 5.1: Plan Oversight.

Establishing a Funding Mechanism. A long-term funding mechanism to be guided by a steering committee should be established to provide financial resources for management actions. A sub-committee of the steering committee can be dedicated to prioritizing and seeking out funding opportunities. In addition to initial implementation costs, consideration should also be given to the type and extent of technical assistance needed to inspect and maintain structural BMPs. Funding is a key element of sustaining the management process, and, once it is established, the management plan can be fully vetted and restoration actions can move forward. A combination of grant funding, private donations, and municipal funding should be used to ensure implementation of the plan. Refer to Section 5.4 for a list of potential funding sources.

Determining Management Actions. This plan provides a unified watershed management strategy with prioritized recommendations for restoration using a variety of methods, including structural and non-structural restoration actions. The proposed actions in this plan should be used as a starting point for grant proposals. Once a funding mechanism is established, detailed designs for priority restoration actions on a project-area basis can be completed and their implementation scheduled. Refer to Section 5.2: Action Plan.

Continuing and Expanding the Community Participation Process. Plan development has included active involvement of a diversity of watershed stakeholders. Plan implementation will require continued and ongoing participation of stakeholders, as well as additional outreach efforts to expand the circle of participation. Long-term community support and engagement is vital to successfully implement this plan. Continued public awareness and outreach campaigns will aid in securing this engagement. Refer to Section 5.2: Action Plan and Section 5.5: Education.

Continuing the Long-Term Monitoring Program. An annual water quality monitoring program (including ongoing monitoring of watershed tributaries) is necessary to track the health of the lake. Information from the monitoring program will provide feedback on the effectiveness of management practices at the sub-basin level and help optimize management actions through the adaptive management approach. Refer to Section 5.2 on Water Quality Monitoring.

Establishing Measurable Milestones. A restoration schedule that includes milestones for measuring restoration actions and monitoring activities in the watershed is critical to the success of the plan. In addition to monitoring, several environmental, social, and programmatic indicators have been identified to measure plan progress. Refer to Section 5.3: Indicators to Measure Progress and Section 3.3: Water Quality Goal for interim benchmarks.

5. Plan Implementation

5.1 Plan oversight

A Squam Lakes Watershed Management Plan Steering Committee, led by the SLA, will be responsible for guiding the plan implementation. The Steering Committee will be led by SLA staff and will include representatives from watershed towns, land trust partners, Plymouth State University, University of New Hampshire, and NHDES. The steering committee will meet regularly to track implementation progress and will update the Action Plan as needed.

5.2 Action Plan

The Action Plan (Table 5-2) provides specific recommendations for watershed management plan implementation. Action items were developed by SLA staff, FBE, and the Water Quality Advisory Committee. In the Action Plan, the groups responsible for completion of each action are assigned. A timeline for completion and estimated costs are also documented. Action items fall under seven different categories:

1. General
2. Education and Communication
3. Water Quality
4. Shorefront and Watershed BMPs
5. Road Maintenance and Training
6. Municipal Planning & Land Conservation/Management
7. Septic Systems

Table 5-1: Action Plan for the Squam Lakes Watershed Management Plan.

ACTION ITEM	#	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SLA	Watershed Towns	NHDOT/DES/SOAK NH/NRCS	Landowners & Residents	Conservation group partners	Consultant	University Partners	SCHEDULE	ESTIMATED COST
		General Implementation									
Watershed Plan Steering Committee	**1**	Create a Watershed Plan Committee to coordinate, evaluate, and adapt implementation efforts.	✓	✓		✓	✓		✓	2020	N/A
		Education and Communication									
Enhance awareness of water quality issues in the watershed	**2**	Contact local representatives and attend selectman meetings to voice concerns and stay informed.	✓	✓		✓	✓			2020-2029	N/A
	3	Create a website for the Squam Watershed Plan that contains the entire plan, a summary, maps, data, and progress report. Include links to resources such as the runoff reduction model for homeowners, NHDES links, UNH links, etc.	✓							2020-2029	TBD
	4	Host an annual meeting to discuss the progress and challenges of implementing the watershed plan. The first conference will provide an overview of the watershed plan upon its completion.	✓							2020-2029	TBD
	5	Create a compelling and engaging summary of the watershed plan. Include success stories for residential BMP installation with photos and pollutant load reductions. Highlight areas that are critical and have room for improvement. Regularly create updates to the summary that include progress updates on water quality goals.	✓							2020-2029	TBD
	6	Update the SLA's 50 ways to care for the Squam Lakes to a watershed wide document. Include recommendations for the following groups: realtors, marina owners, tour operators, fishing guide outfits, septic haulers, septic designers and installers, developers/builders, homeowners, renters, educators, road maintenance professionals, recreationists (boaters, hikers, etc.), landscapers	✓							2020-2029	TBD
	7	Ensure the Watershed Plan process and implementation progress is on regular communication lists, presented and displayed at conferences and meetings, and displayed at watershed kiosks.	✓							2020-2029	TBD
	8	Continue to publish the Squam Watershed Report summarizing the health of the Squam Watershed and the efforts underway to protect it. Ensure that Squam Watershed monitoring data and analysis and results are easily accessible.	✓							2020-2029	N/A
	9	Brainstorm and implement other ways to ensure that the plan's message reaches a variety of target groups through different media and encourages action and why and how to get involved.	✓	✓					✓	2020-2029	N/A

ACTION ITEM	#	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SLA	Watershed Towns	NHDOT/DES/SOAK NH/NRCS	Landowners & Residents	Conservation group partners	Consultant	University Partners	SCHEDULE	ESTIMATED COST
Stormwater and BMP education	10	Create a Squam Smart program for shorefront properties owners to reduce stormwater impact to lakes. Based on NH Lakes Lake Smart program.	✓		✓		✓			2020-2029	TBD
	11	Give tours of demonstration sites at SLA headquarters that display BMPs at work.	✓							2020-2029	N/A
	12	Offer lake-friendly landscaping training and certification program for landscapers that work in the watershed.	✓		✓	✓	✓			2020-2029	TBD
		Water Quality									
Maintain and/or improve current invasives and/or weed management program	13	Continue to work with conservation partners, including NH LAKES and the Lake Host Program, to educate stakeholders about invasive species in the watershed.	✓				✓			2020-2029	N/A
	14	Provide aquatic invasive species information to Squam marinas, boat launches, campgrounds, and property rental agencies.	✓	✓	✓		✓			2020-2029	N/A
Maintain and expand lake water quality monitoring program	15	June through September: Continue regular lake monitoring including weekly secchi disk readings, bi-weekly phosphorus, chlorophyll, and color samples, and monthly oxygen/temp profiles.	✓						✓	2020-2029	$27,000
	16	Other ice free months: monthly monitoring visits to each lake site to capture secchi disk readings, oxygen/temp profiles, phosphorus, chlorophyll, and color samples.	✓						✓	2020-2029	$4,000
	17	Winter lake monitoring: Continue monitoring lake sites in the winter for phosphorus, color, chlorophyll, oxygen/temp, and ice depth.	✓						✓	2020-2029	$2,000
	18	Consider adding nitrogen monitoring to all monitoring seasons.	✓						✓	2020-2029	TBD
	19	Conduct near-shore water quality monitoring to understand if/how water quality is different away from deep points and to track the influence of shoreline development on water quality.	✓						✓	2020-2029	TBD
Data Analysis	20	Squam and Little Squam Lakes have 18 distinct basins with unique hydrology and material fluxes. Because of this, water quality and assimilative capacity analysis should be performed for each of these basins.	✓						✓	2020-2029	TBD
	21	Examine year-round trends for water quality to determine how winter water quality conditions contribute to summer conditions.	✓						✓	2020-2029	TBD
Establish regular tributary monitoring program	22	Sample major tributary and mainstem river sites for at least total phosphorus, and also consider turbidity, pH, total nitrogen, total carbon, and chloride 3-4 times per year from June-September. Cost assumes 10 sites. Consider adding stream gages to monitor flow.	✓						✓	2020-2029	$36,000

ACTION ITEM	#	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SLA	Watershed Towns	NHDOT/DES/SOAK NH/NRCS	Landowners & Residents	Conservation group partners	Consultant	University Partners	SCHEDULE	ESTIMATED COST
Sediment Contaminants	23	Continue to keep contaminants issue on the SLA agenda. Take more samples as needed.	✓	✓	✓			✓	✓	2020-2029	TBD
Cyanobacteria	24	Develop a cyanobacteria monitoring program on the Squam Lakes.	✓		✓				✓	2020-2023	TBD
		Shorefront and Watershed BMPs									
Shoreline survey	25	Complete a shoreline survey of lake shoreline properties to prioritize shorefront properties for follow-up technical assistance.	✓	✓			✓	✓		2020-2026	$6,000
Promote healthy vegetated buffers for shoreline properties	26	Create a program for shorefront properties owners to reduce stormwater impact to lakes. Based on NH Lakes Lake Smart program.	✓			✓	✓			2020-2023	N/A
	27	Work with SOAK Up the Rain NH to implement small scale example BMPs and host concurrent residential stormwater workshops. Cost estimate does not include actual BMP implementation. Cost assumes printing, mailing to advertise events.	✓		✓					2020-2023	$1,000
	28	Work with shoreline residents to implement 55 high impact and 180 medium conservation practices based on shoreline survey (Action Item #25). Estimated TP reduction: 78 kg/yr.	✓			✓				2020-25	$435,000
Address priority pollutant sites identified in watershed survey	29	Implement BMPs at 53 sites identified in the watershed survey. Estimated TP reduction: 33 kg/yr	✓	✓		✓		✓		2020-2030	$1,690,000
	30	Develop a method of tracking and monitoring BMP implementation progress (e.g., NPS Site Tracker).	✓							2020-2029	TBD
BMP demonstration sites	31	Create demonstration sites at SLA headquarters that display BMPs at work.	✓				✓	✓			TBD
		Road Maintenance & Training									
Coordinate road and culvert improvements	32	Develop a complete inventory and assessment of all public road cross culverts. Maintain a prioritized database to direct available annual funding through the culvert upgrade program more efficiently and effectively.	✓	✓	✓		✓	✓		2020-2026	$20,000
	33	Summarize NPS sites identified on state-maintained roads and send to NHDOT for review and remediation.	✓		✓					2020-2021	TBD
Require winter and spring maintenance training of road agents for the town	34	If not already in place, require training for road agents on proper road BMPs for salt, sand, and equipment use (such as the New Hampshire Green SnowPro Program). Use only treated salt, and no sand on paved surfaces, and reduce application rate by 40-50%, sweep the roadways in the spring. Review locations of snow pile areas to avoid nearby surface waters. Training should include best practices for salt storage within the watershed according to NHDES guidelines and recommended practices.	✓	✓						2020-2029	$5,000

ACTION ITEM	#	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SLA	Watershed Towns	NHDOT/DES/SOAK NH/NRCS	Landowners & Residents	Conservation group partners	Consultant	University Partners	SCHEDULE	ESTIMATED COST
Update town BMP road installation and maintenance practices to better protect water quality	35	Review BMP road installation and maintenance practices currently used for each town and determine areas for improvement. Develop and/or update a written protocol for BMP road installation and maintenance practices.	✓	✓				✓		2020-2029	$20,000
Create and manage drainage easements on roads	36	Work with road agents and landowners to create and manage drainage easements on private properties. This will help ensure that culverts and other drainage structures that cross private property are being properly maintained to control salt/sand and stormwater runoff from roads.	✓	✓		✓				2020-2029	N/A
Host road maintenance workshops for private landowners	37	Hold workshops on proper road management, winter maintenance, and provide educational material for homeowners about winter maintenance and sand/salt application for driveways and walkways.	✓	✓		✓			✓	2020-2029	$5,000
Municipal Planning & Land Conservation/Management											
Work with land conservation partners	38	Work with land trust partners (Lakes Region Conservation Trust and Squam Lakes Conservation Society) so these organizations can incorporate watershed plan into their land conservation strategies.	✓				✓			2020-2029	N/A
Enhance watershed resident education and communication of local land ordinances, best management practices, and actions	39	Hold informational workshops for new landowners, towns, and developers on relevant town ordinances, conservation easements, and watershed goals. Goal: Host 1-2 workshops.	✓	✓		✓				2020, 2026	$2,000
	40	Utilize online points of contact to provide information on ordinances, LID, and BMPs for landowners (e.g., fact sheets). Assumes consultant design of fact sheets. Does not include printing costs.	✓	✓				✓		2020	$3,000
	41	Reach out to residents converting camp properties to year-round single family homes to educate on watershed issues, LID, and BMPs. Includes cost of printing materials made in other action items.	✓	✓						2021	$1,000
Adopt plan recommendations	42	Present the watershed plan to the BOS/planning board of Squam Watershed towns.	✓	✓						2020	N/A
	43	Incorporate watershed plan recommendations into town master plan.	✓	✓						2020-2025	N/A
Improve municipal permitting process	44	Create list of BMP and LID descriptions for Town Selectman, ZBA, Planning Boards, and landowners.	✓	✓				✓		2020-2026	$2,000

ACTION ITEM	#	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SLA	Watershed Towns	NHDOT/DES/SOAK NH/NRCS	Landowners & Residents	Conservation group partners	Consultant	University Partners	SCHEDULE	ESTIMATED COST
Improve municipal ordinances	**45**	Meet with town staff to review recommendations to improve or develop ordinances addressing setbacks, buffers, lot coverage, LID, steep slopes, stormwater regulations, and open space.	✓	✓				✓		2020-2026	N/A
		a) Lot Coverage: adopt requirements on Stormwater Management Plans for subdivisions, commercial, and multi-family development, and redevelopment disturbing 20,000 sq. feet or more.	✓	✓				✓		2020-2026	N/A
		b) Setbacks (Shoreland Zoning): increase the setback distance to 100 feet within the shoreland zone. Expand the coverage of the Shoreland Protection Overlay District to smaller lakes and ponds, streams and rivers, and surface waters of local significance, as defined by a natural resource inventory.	✓	✓				✓		2020-2026	N/A
		c) Wetland Buffers: increase the setback distance from all wetlands (not just prime wetlands) to 100 feet. Develop and approve a Wetland Conservation Overlay District that encompasses all wetlands and establishes higher levels of protection for wetlands of local significance, wetlands contiguous to lakes or ponds, and vernal pools.	✓	✓				✓		2020-2026	N/A
		d) Steep Slopes: require design and implementation of BMPs on all development on slopes >15%.	✓	✓				✓		2020-2026	N/A
		e) Conservation/Cluster Subdivisions: encourage conservation subdivisions and increase the amount of land set aside in conservation subdivisions to min. 50% of the development area.	✓	✓				✓		2020-2026	N/A
		f) LID: Amend Stormwater Management ordinances to state that the use of LID techniques is preferred and shall be implemented to the maximum extent possible.	✓	✓				✓		2020-2026	N/A
Investigate additional municipal ordinances for protecting water quality	**46**	Assess if more stringent wake restrictions may have a positive impact on the lake shoreline. Currently, the lake is governed by state law (RSA 270-D:2 - boats shall maintain headway (no wake) speed within 150 ft of the shoreline, docks, and mooring fields. http://www.gencourt.state.nh.us/rsa/html/XXII/270-D/270-D-2.htm). Request more involvement of Marine Patrol on Squam Lakes. Follow up with 2019 Session results for HB137 which established a commission to examine the effects of wake boats in NH (http://gencourt.state.nh.us/bill_status/billText.aspx?sy=2019&id=65&txtFormat=html).	✓	✓						2020-2021	N/A
	47	Complete a full-scale ordinance review that includes working with the planning board to recommend changes, such as site plan review regulations, road and right of way standards, minimum lot sizes, minimum shore frontage per lot, and others.	✓	✓				✓		2020	$20,000

ACTION ITEM	#	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SLA	Watershed Towns	NHDOT/DES/SOAK NH/NRCS	Landowners & Residents	Conservation group partners	Consultant	University Partners	SCHEDULE	ESTIMATED COST
		Septic Systems									
Watershed-wide septic survey	48	Complete a voluntary septic survey for shorefront property owners and incorporate results into model.	✓							2020-2026	TBD
	49	Present results of septic survey at SLA annual meeting and other forums as appropriate	✓	✓				✓		2020-2026	N/A
Enforce town septic system regulations	50	Communicate with town departments to enforce occupancy loads and have septic system inventories in Master Plans.	✓	✓						2020-2029	TBD
	51	Inspect all home conversions from seasonal to permanent residences, sold properties, and property transfers for proper septic system size and design. Cost responsibility of property owner.		✓		✓				2020-2029	TBD
	52	Consider septic system ordinances (similar to the Town of Meredith, NH, that require regular pump-outs and inspections to ensure proper functioning. Require a septic system to be fixed before the property is sold, and require full evaluations, not brief assessments. Cost responsibility of property owner.	✓	✓		✓				2020-2026	TBD
Garner funding or discounts that support and encourage septic system maintenance	53	Coordinate group septic system pumping discounts. Pump-out costs responsibility of landowners.	✓			✓				2020-2029	N/A
	54	Investigate grants and low-interest loans (e.g., NHDES Clean Water State Revolving Fund, Section 319 Implementation Grant) to provide cost-share opportunities for septic system upgrades. Cost estimate based on resources to apply for grant.	✓	✓		✓		✓		2020-2021	$3,000
	55	Encourage towns, conservation commissions, or local conservation partners to reserve a portion of conservation dollars for the watershed that can be used for septic system upgrades.	✓	✓						2020-2029	N/A
Enhance awareness of proper septic system maintenance and regulations	56	Distribute educational pamphlets on septic system function and maintenance in tax bills, and have the materials available in the library (to include recommended pumping schedules, proper leach field maintenance/planting, new/alternative septic system designs such as community septic or site-limited homes, etc.). Cost covers printing.	✓	✓						2019-20	$2,000
	57	Create and distribute a list of septic service providers (designers v. pumpers)	✓	✓						2019-20	$1,000
	58	Host multiple "septic socials" to address link between septic system maintenance and water quality. Target educational campaign in areas with minimally-maintained or aging septic systems near the lake.	✓	✓		✓				2020-2029	$1,500

ACTION ITEM	#	RECOMMENDATIONS TO ACHIEVE ACTION ITEM	SLA	Watershed Towns	NHDOT/DES/SOAK NH/NRCS	Landowners & Residents	Conservation group partners	Consultant	University Partners	SCHEDULE	ESTIMATED COST
Inventory status of septic and greywater systems in watershed	**59**	Develop and maintain a septic system database for the watershed. Code Enforcement Office for towns to maintain database.	✓	✓						2020-2021	$500
	60	Complete in-person, mail-in, or online survey of septic systems to fill in any missing information in the database. Assumes volunteer labor.	✓	✓						2020-2029	TBD
	61	Conduct voluntary dye testing of any suspected septic systems. Goal: 5 systems.	✓	✓		✓				2020-2021	$1,250
	62	Hire canine scent detection team to investigate shoreline septic systems.	✓	✓				✓		2020-2026	$20,000
		Total cost of action items with determined values								TOTAL	$2,308,250

5.3 Indicators to Measure Progress and Success

To quantify and track progress of watershed management plan implementation, we established environmental, programmatic, and social indicators. These indicators are benchmarks that set short-term (2022), mid-term (2025) and long-term (2030) measures of success derived from action items in Section 5.2. The Steering Committee will review the indicators and track the success of plan implementation.

5.3.1 Environmental Indicators

Environmental indicators are a measure of environmental conditions (Table 5-2). They are measurable quantities used to evaluate the relationship between pollutant sources and environmental conditions. They assume that BMP recommendations outlined in the Action Plan will be implemented accordingly and will result in the improvement of median in-lake phosphorus concentration, as well as improve water clarity and reduce the frequency of the low-oxygen in bottom waters of the lake. Note that the benchmarks for environmental indicators also reflect protection of water quality from any potential impacts from future development in the watershed. To reach these environmental indicators, both structural and non-structural strategies must be implemented.

Table 5-2: Environmental indicators for the Squam Lakes. Benchmarks are cumulative across years.

ENVIRONMENTAL INDICATORS

Indicators	Benchmarks 2022	2025	2030
Maintain current in-lake median total phosphorus concentrations (6.5 ppb in Squam Lake and 6.4 ppb in Little Squam Lake) reducing pollutant loading to Squam and Little Squam Lake by 113 kg/year.	Prevent or offset **15 kg/yr** in phosphorus loading from new or existing development	Prevent or offset **52 kg/yr** in phosphorus loading from new or existing development	Prevent or offset **113 kg/yr** in phosphorus loading from new or existing development
Improve dissolved oxygen conditions in bottom waters by reducing the extent and duration of anoxia.	5% fewer occurrences in the water column (excluding within one meter of bottom)	10% fewer occurrences (excluding within one meter of bottom)	20% fewer occurrences (excluding within one meter of bottom)
Reduce and/or prevent the occurrence of cyanobacteria blooms	Absence of cyanobacteria blooms where they currently have not occurred; 5% fewer occurrences at known locations	Absence of cyanobacteria blooms where they currently have not occurred; 10% fewer occurrences at known locations	Absence of cyanobacteria blooms where they currently have not occurred; 20% fewer occurrences at known locations
Prevent and/or control the introduction of invasive aquatic species to surface waters.	Absence of invasive aquatic species where they currently do not exist; 5% less coverage where they currently do exist	Absence of invasive aquatic species where they currently do not exist; 10% less coverage where they currently do exist	Absence of invasive aquatic species where they currently do not exist; 20% less coverage where they currently do exist

5.3.2 Programmatic Indicators

Programmatic indicators measure watershed protection and restoration activities (Table 5-2). These indicators track the success of the different programs recommended to start or continue.

Table 5-3: Programmatic indicators for the Squam Lakes. Benchmarks are cumulative across years.

PROGRAMMATIC INDICATORS

Indicators	Benchmarks 2022	2025	2030
Amount of funding secured from municipal/private work, fundraisers, donations, and grants	$200,000	$800,000	$2,000,000
Number of high priority shoreline sites remediated	2	8	13
Number of medium priority shoreline sites remediated	6	12	24
Number of watershed survey sites remediated (53 identified)	3	21	53
Number of BMP demonstration projects completed	2	3	5
Linear feet of buffers installed in the shoreland zone	500	1,000	2,000
Percentage of shorefront properties with at least one installed conservation practice	25%	50%	75%
Percentage of culverts assessed and prioritized	50%	100%	100%
Percentage of culverts remediated	5%	25%	50%
Percentage of septic system database complete for watershed	25%	50%	100%
Number of updated or new ordinances that target water quality protection	1	2	3
Number of voluntary septic system inspections (seasonal conversion and property transfer)	3	5	10
Number of voluntary septic system dye tests and inspections (watershed residents)	5	10	20
Number of septic system upgrades	1	3	5
Number of septic/stormwater "socials" or workshops held	3	5	10
Number of informational workshops and/or trainings for landowners, town staff, and/or developers/landscapers on local ordinances, watershed goals, and/or best management practices	2	5	10
Number of parcels with new conservation easements	1	2	3
Number of copies of watershed-based educational materials distributed or articles published	100	500	1,000
Percentage of shoreline parcels assessed for prioritizing technical assistance	50%	100%	100%
Number of best management practices used in road BMPs	1	3	5
Number of new parcels put into permanent conservation	1	3	5
Percentage of mapped and properly managed drainage easements	25%	75%	100%

5.3.3 Social Indicators

Social indicators measure the change in social and cultural practices and behavior that lead to implementation of best management practices for watershed protection (Table 5-4).

Table 5-4: Social indicators for the Squam Lakes. Benchmarks are cumulative across years.

SOCIAL INDICATORS

Indicators	Benchmarks		
	2022	2025	2030
Number of volunteers participating in educational campaigns	10	15	20
Number of people participating in workshops, trainings, or BMP demonstrations	20	50	75
Percentage of shorefront residents installing conservation practices on their property	25%	50%	75%
Number of new weed watcher neighborhood groups	5	10	20
Percentage of residents making voluntary upgrades or maintenance to their septic systems (with or without free technical assistance), particularly those identified as needing upgrades or maintenance	10%	25%	50%

5.4 Estimated Technical Assistance and Costs Needed

The estimated cost for implementing the Squam Lakes Watershed Management Plan is over $2.3 million (Table 5-5). Many of these costs are unknown and should be incorporated into the Action Plan as information becomes available.

Table 5-5: Estimate of costs for implementing the Squam Lakes Watershed Management Plan.

Category	Cost
General Implementation	$ -
Education and Communication	$ -
Water Quality	$ 69,000
Shorefront and Watershed BMPs	$ 2,132,000
Road Maintenance & Training	$ 50,000
Municipal Planning & Land Conservation/Management	$ 28,000
Septic Systems	$ 29,250
Total	**$ 2,308,250**

Funding from diverse sources is necessary to reach full implementation of the watershed management plan. State and federal grants, municipal funding, SLA contributions, and grants from other foundations will be required to achieve the action items. Funding to cover ordinance revisions and third-party review could be supported by municipalities through tax collection (as approved by majority vote by town residents). Monitoring and assessment funding could come from a variety of sources, including state and federal grants (Section 319, ARM, Moose Plate, etc.), municipalities, SLA, or donations. Funding to improve septic systems, roads, and shoreland zone buffers would likely come from property owners. As the plan evolves into the future, the formation of a funding subcommittee, as well as a steering committee, will be a key part in how funds are raised, tracked, and spent to implement and support the plan. The following list summarizes several possible outside funding options available to implement the watershed management plan:

- **USEPA/NHDES 319 Grants (Watershed Assistance Grants)** – This NPS grant is designed to support local initiatives to restore impaired waters (priorities identified in the NPS Management Program Plan, updated 2014) and protect high-quality waters. 319 grants are available for the implementation of watershed-based management plans. http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm
- **NH State Conservation Committee (SCC) Grant Program (Moose Plate Grants)** – County Conservation Districts, municipalities (including commissions engaged in conservation programs), and qualified nonprofit organizations are eligible to apply for the SCC grant program. Projects must qualify in one of the following categories: Water Quality and Quantity; Wildlife Habitat; Soil Conservation and Flooding; Best Management Practices; Conservation Planning; and Land Conservation. The total SCC grant request per application cannot exceed $24,000. http://agriculture.nh.gov/divisions/scc/grant-program.htm
- **Milfoil and Other Exotic Plant Prevention Grants (NHDES)** – Funds are available each year for projects that prevent new infestations of exotic plants, including outreach, education, Lake Host Programs, and other activities. http://des.nh.gov/organization/divisions/water/wmb/exoticspecies/categories/grants.htm
- **Clean Water State Revolving Loan Fund (NHDES)** – "This fund provides low-interest loans to communities, nonprofits, and other local government entities to improve and replace wastewater collection systems with the goal of protecting public health and improving water quality. A portion of the CWSRF program is used to fund nonpoint source, watershed protection and restoration, and estuary management projects that help improve and protect water quality in New Hampshire." http://des.nh.gov/organization/divisions/water/wweb/grants.htm

5.5 Education

The Squam Lakes Watershed Management Plan includes an outreach and education component that complements the structural and non-structural recommendations of the watershed management plan through stakeholder action, community engagement and educational events. Outreach activities provide general communication and updates about the watershed management plan implementation, educate landowners and watershed residents about the connection of land practices to the health of the lakes and encourage stakeholders to participate in actions to improve water quality. Successful outreach depends upon many conservation, municipal, and community partners. Actions and recommendations for outreach, communication, and education are detailed in the Action Plan in Section 5.2.

6. References

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Marchetto, Aldo. 2015. Mann-Kendall Test, Seasonal and Regional Kendall Tests. R statistical program.

Squam Lakes Association. 2001. Wastewater Management Needs Assessment: Squam Lakes Watershed, New Hampshire.

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Tarpey, Patricia E. 2013. "Linking Watershed and Sub-basin Characteristics to In-lake TP Concentrations in the Lake Winnipesaukee Watershed, New Hampshire." M.S. Thesis. Plymouth State University.

Thompson, W. B., 2015, Surficial geologic map of the Squam Mountains 7.5-minute Quadrangle, Grafton, Carroll, and Belknap Counties, New Hampshire: New Hampshire Geological Survey, Geo-085-024000-SMOF, 1:24,000-scale map.

WATERSHED SURVEY RESULTS | MEMORANDUM

TO: Rebecca Hanson, Squam Lakes Association

FROM: Laura Diemer, FB Environmental Associates

SUBJECT: Squam Lakes Watershed Survey Results (Task 24) and Pollutant Load Reduction Estimates and Costs (Task 25)

DATE: September 10, 2018

CC: Forrest Bell, FB Environmental Associates

FB Environmental Associates (FBE) was contracted by the Squam Lakes Association (SLA) to complete a watershed survey that identified and documented evidence of sediment erosion or "hotspots" of nutrient loading to surface waters in the Squam Lakes watershed. On 5/31/2018, FBE technical staff (Forrest Bell, Laura Diemer, Margaret Burns, Richard Brereton, and Christine Bunyon), along with SLA Director of Conservation Rebecca Hanson, surveyed the watershed and documented 53 erosion "hotspot" sites that may be detrimental to the lake's water quality. Documentation included describing the problem, estimating the impact/treatment area, making recommendations for fixing the problem, rating the site's impact to water quality, logging the site's geoposition, and taking photographs.

Using the NHDES Simple Method Pollutant Loading Spreadsheet Model, we estimated the pollutant loading (total suspended solids, total phosphorus, and total nitrogen) likely generated from each erosion "hotspot" site (see model spreadsheet for metadata, references, and assumptions). A general cost estimate was also assigned to each site based on the scale of recommended fixes. We strongly recommend that a thorough engineered design and cost estimate be completed for each site prior to implementation.

Based on each site's impact rating, estimated cost, and potential pollutant load reduction, the 53 erosion "hotspot" sites were ranked 1-53 from highest to lowest priority for implementation. The top 10 sites are described in greater detail below. All 53 sites are documented in Figures 1-3, Table 1, and Attachment 1 (photos for #11-53 only).

Implementing recommendations at all 53 erosion "hotspot" sites would potentially reduce the phosphorus load to Squam Lakes by 33 kg/yr (11 kg/yr for the top 10 sites) and cost an estimated $1.09-$2.29 million ($300,000-$600,000 for the top 10 sites), including annual maintenance costs for 10 years.

TOP 10 EROSION "HOTSPOT" SITES

#1: Public access area across from Squam Lakeside Farm (Site 1-06)

Observations: Minimal shoreline buffer and large areas of exposed sand and gravel were observed at a public access area (with picnic area, dock, and parking) across the street from the Squam Lakeside Farm.

Recommendations: Install runoff diverters, bioretention cells, and erosion controls. Plant a vegetated buffer with bank stabilizers (e.g., staked coir logs).

Minimal shoreline buffer at public access spot.

#2: Agricultural field between Moo Corners and Winterberry Ln (Site 1-10)

Observations: An agricultural field between Moo Corners and Winterberry Ln runs adjacent to Owl Brook with minimal buffer and no fencing. Cows have direct access to the stream. Fecal matter was observed on the floodplain and lateral channel bar. This represents a significant pollutant loading source to the stream and downstream waterbodies.

Recommendations: Work with the farm owners to extend the paddock's electric fence and restrict cattle access to Owl Brook. Enhance the riparian buffer with vegetation.

Cows in field have unrestricted access to Owl Brook (pictured left).

#3 Rt. 113 along Cotton Cove (Site 1-18)

Observations: Cotton Cove is located at the southwestern end of Squam Lake. Rt. 113, running parallel to the shoreline of the cove between Goss Rd and Marden Point Rd, suffers from road shoulder and ditch erosion and minimal buffer.

Recommendations: A roadside ditch, turnout, and runoff diverter could be installed, along with a vegetated buffer. Further investigation is needed to formulate a specific design plan because the site has complex runoff issues from Rt. 113 with minimal space to work with between the water and the road.

Rt. 113 along Cotton Cove suffers from complex runoff issues.

#4, #5, #6 Coolidge Farm Rd (Sites 2-21, 2-22, 2-23)

Observations: Coolidge Farm Rd is a gravel road with steep grades that run stormwater to several major stream crossings. Road shoulders and ditches are poorly formed with lots of loose sediment being deposited directly to the streams. Perched culvert outlets at the stream crossings also prevent fish passage.

Recommendations: Armor ditches with vegetation, riprap, and/or check dams. Install turn-outs or other runoff diverters to carry water from the road surface to vegetated areas for infiltration.

Coolidge Farm Rd steep grades transport significant amounts of eroded ditch sediment to streams.

#7 Squam Lake Rd east of Sandwich-Harbor line (Site 3-06)

Observations: Roadside shore access point is steep, unbuffered, and eroding. Lack of shoreline vegetation sends eroded sediment from the roadside slope directly to the lake. An unstable stormwater outlet was also found.

Recommendations: Define and build-up the parking/pull-off area, install a curb to divert stormwater flow away from the steep slope and channel flow to an infiltration basin. Armor the stormwater outlet and enhance the shoreline buffer.

Erosion and poor buffer at Squam Lake Rd pull-off area.

#8 Camp Hale (Site 2-01)

Observations: Heavily trampled areas along the shoreline and around buildings were observed at Camp Hale. Compacted ground with minimal vegetation leads to concentrated stormwater flowpaths and sheet flow runoff in many areas leading directly to the lake.

Recommendations: Define a smaller footpath using infiltration steps and mulch from the upper parking area down to the shoreline. Install runoff diverters (e.g., waterbars), enhance the shoreline buffer, and reseed bare soil and thinning grass. This site has great demonstration potential due to its high use and visibility.

High use impact generating uncontrolled stormwater runoff at Camp Hale.

#9 Squam Lakes Association crew cabin driveway (Site 3-01)

Observations: Three gullies are forming on the steep gravel driveway of the Squam Lakes Association's crew cabin from concentrated road runoff. Sand build-up in front of the cabin may be from runoff or a plow berm.

Recommendations: Install open top culvert to divert sheet flow, grade gully, build up driveway grade and reshape crown, install French drain below parking area where driveway continues past barn and cabin, and extend current gravel trench for roof dripline.

Steep gravel driveway of Squam Lakes Association's crew cabin causing significant gully formation.

#10 Sandwich Town Beach (Site 3-07)

Observations: Significant shoreline bank undercutting, lack of shoreline vegetation or buffer, and bare soil erosion were observed at the Sandwich Town Beach.

Recommendations: Enhance vegetated buffer around beach and boat ramp. May require bioretention cells and bank stabilization practices for complete fix.

Significant undercutting and erosion at Sandwich Town Beach.

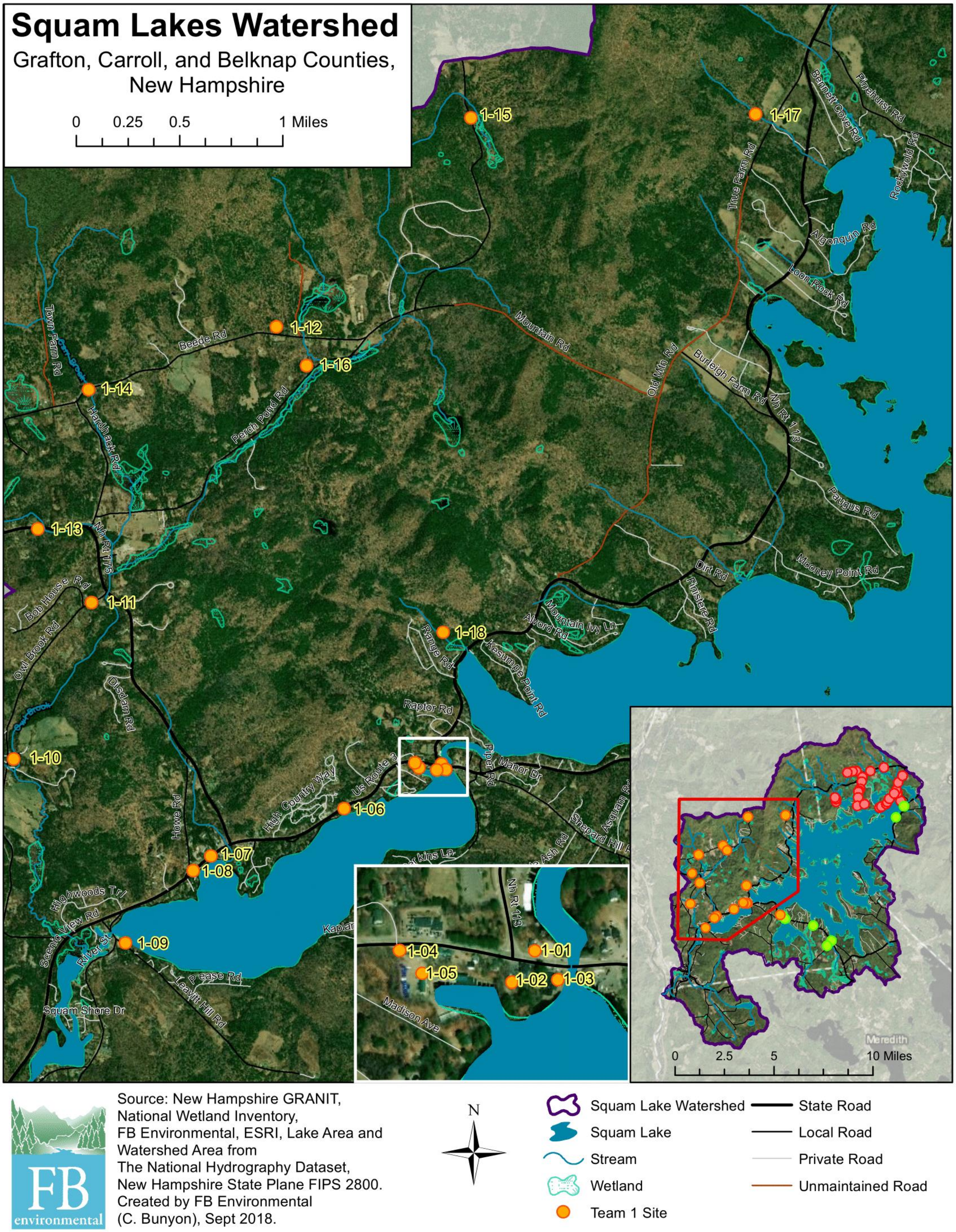


Figure 1. Location of identified erosion “hotspot” sites (1 of 3).

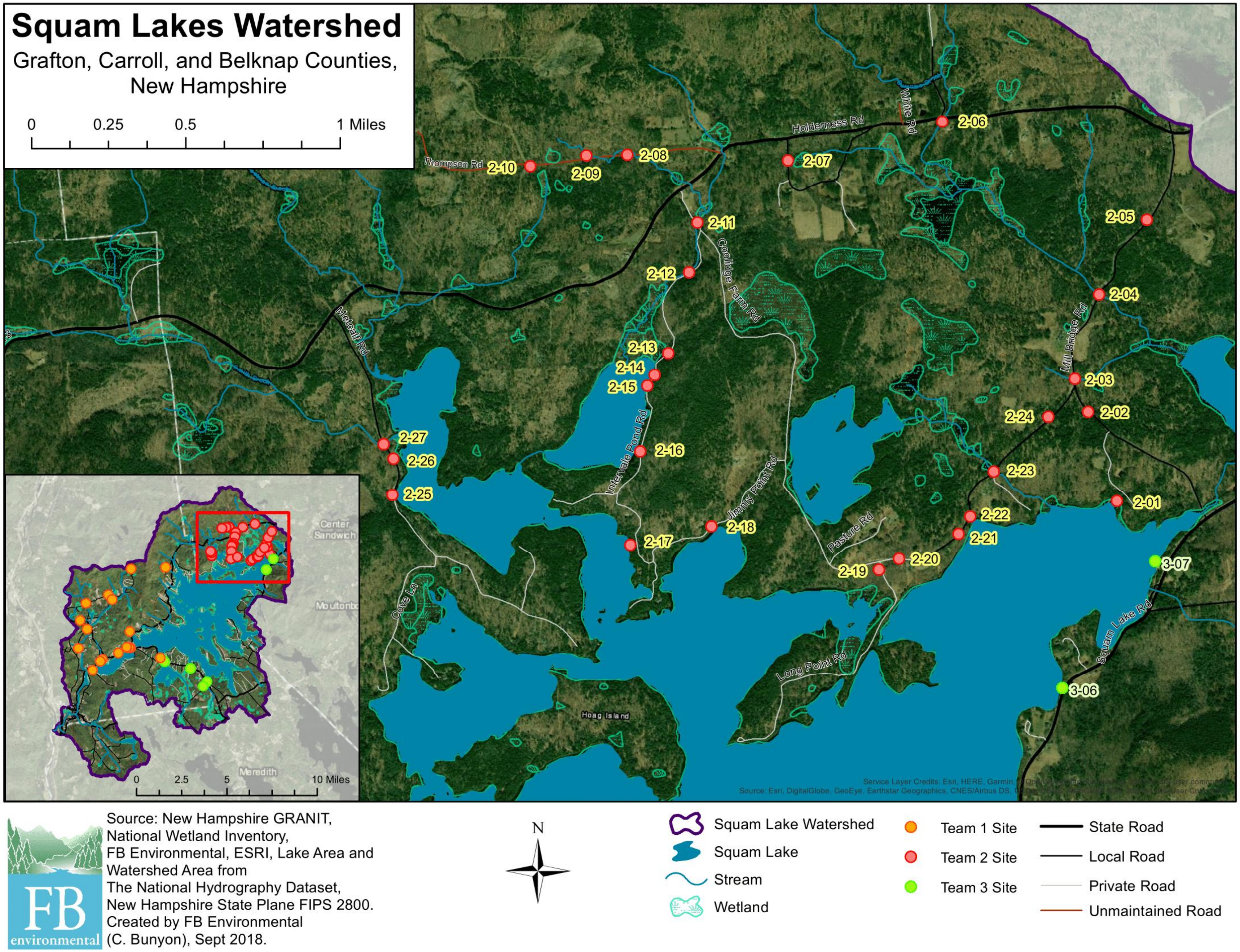


Figure 2. Location of identified erosion “hotspot” sites (2 of 3).

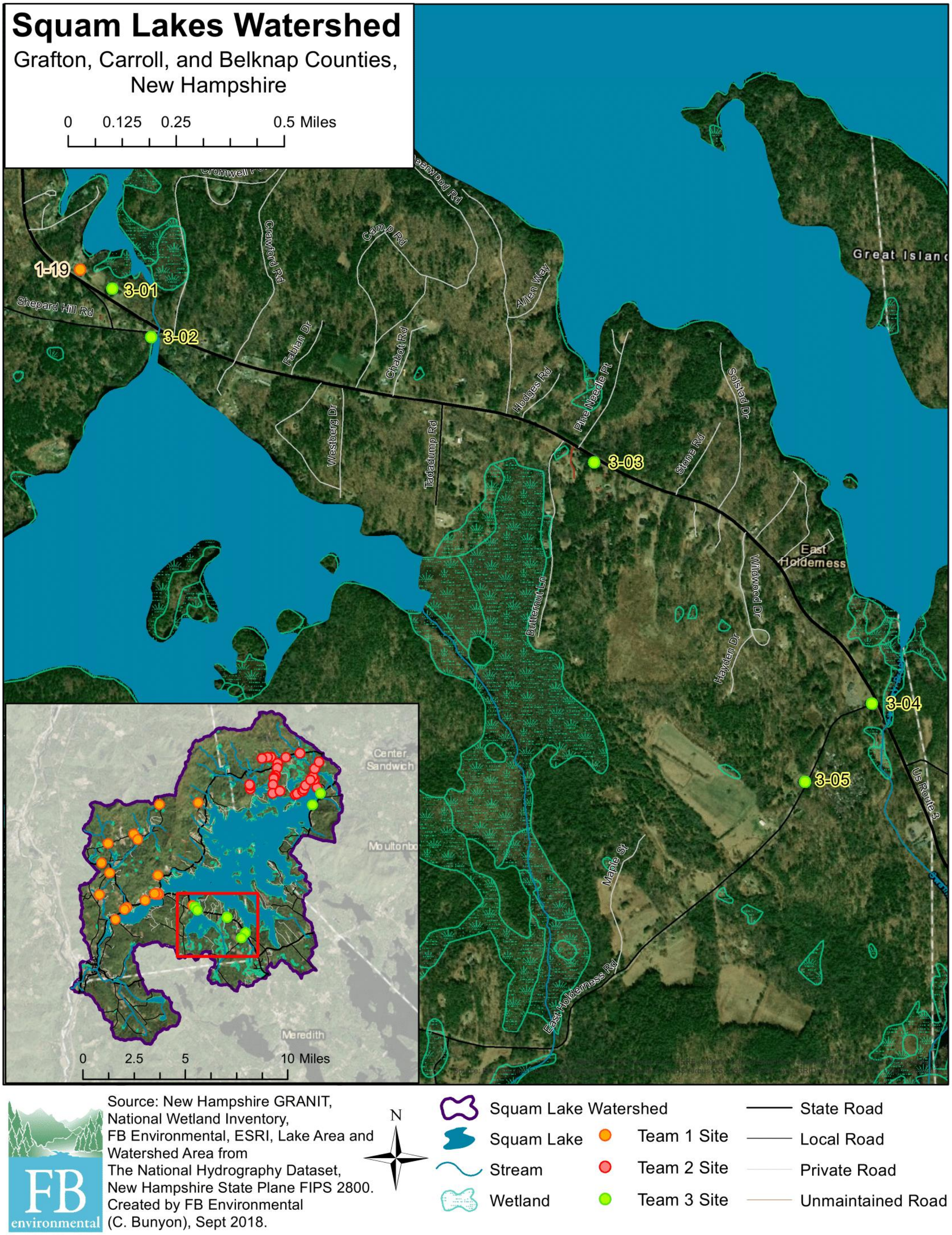


Figure 3. Location of identified erosion “hotspot” sites (3 of 3).

Table 1. Priority ranking, site ID, description of location, problem, and recommendations, impact rating, estimated pollutant load reductions, and estimated implementation costs for 53 erosion “hotspot” sites identified during the May 2018 watershed survey of the Squam Lakes watershed.

Rank	Site #	Description	Problem	Recommendations	Impact Rating	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Est. Cost Range
1	1-06	Squam Lakeside Farm public access area	Road surface erosion, road shoulder/ditch erosion, buffer not wide enough, poor/degraded buffer	Armor ditch with stone or grass, install erosion controls (silt fence, etc.), install runoff diverter/bioretention cells	High	1305.6	2.5	19.3	$25,000-$75,000
2	1-10	Agricultural field between Moo Corners and Winterberry Ln	Livestock access to Owl Brook; poor manure storage, poor/degraded buffer	Fence out livestock from stream, extend/improve buffer	High	69.3	1.5	1.5	$10,000-$20,000
3	1-18	Rt. 113 along Cotton Cove	Road shoulder/ditch erosion, buffer not wide enough, poor/degraded buffer, multiple-site design needed, complex runoff issues with little space for diversion/infiltration	Install ditch, install turnout, reshape ditch, reshape/veg. shoulder, install runoff diverter, establish buffer	High	643.4	1.4	5.3	$75,000-$125,000
4	2-22	Coolidge Farm Rd, steep grade to stream crossing	Unstable inlet/outlet, road shoulder/ditch erosion, steep rd grade on both sides draining to culvert to lake (access spot with minimal buffer), lots of loose sediment, high PCB site	Armor/vegetate inlet/outlet, armor w/stone or grass, install check dams, reshape ditch, add to buffer	High	1058.4	1.3	3.6	$25,000-$35,000
5	2-23	Coolidge Farm Rd, steep grade to stream crossing (Outflow from Kusumpe Pond)	Unstable inlet/outlet, hanging (no fish passage), road shoulder/ditch erosion, PCB site, culvert replaced in 2015 after beaver dam blowout, steep rd grade washing to unstable ditch (recent ditch clean out)	Armor/vegetate inlet; Armor w/stone or grass, install check dams, install turnouts, vegetate	High	164.7	0.2	0.5	$15,000-$25,000
6	2-21	Coolidge Farm Rd, steep grade	Undersized, unstable inlet/outlet, hanging (no fish passage), road shoulder/ditch erosion, steep rd grade washing to unstable ditch (recent ditch clean out), evidence of significant water flow	Armor/vegetate inlet/outlet, enlarge, install plunge pool, armor w/stone or grass, install check dams, vegetate	Medium	1153.6	1.6	5.6	$20,000-$30,000
7	3-06	Squam Lake Rd east of Sandwich-Center Harbor line	Unstable outlet, erosion, lack of shoreline vegetation, concentrated flow path	Armor outlet, vegetate shoulder, add to buffer, define parking area/add pavement and curbing, install infiltration basin	High	512.3	1.0	4.1	$25,000-$75,000
8	2-01	Camp Hale	Unstable path/trail access, poor/lack of shoreline vegetation/buffer, concentrated stormwater flowpath, heavily trampled area with compact ground	Define foot path, infiltration steps, install runoff diverters (waterbar), stabilize footpath, add to buffer, reseed bare soil & thinning grass; great demonstration site potential	High	287.0	0.5	1.9	$50,000-$100,000
9	3-01	Squam Lakes Association crew cabin driveway	Three gullies forming on steep gravel road slope, flow originates from road and concentrates in driveway, small pile of sand in front of bathroom cottage (runoff or plow berm), driveway receiving sheet flow from road	Install open top culvert to divert sheet flow, grade gully, build up driveway grade and crown, install French drain below parking area where driveway continues past barn and cottage, extend current gravel trench for roof dripline	High	353.7	0.5	5.8	$30,000-$40,000

Rank	Site #	Description	Problem	Recommendations	Impact Rating	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Est. Cost Range
10	3-07	Sandwich Town Beach	Erosion, inadequate shoreline vegetation, undercut shoreline	Enhance buffer around beach and boat ramp	High	304.6	0.6	2.2	$25,000-$75,000
11	1-08	Beach area across from Cottage Place On Squam Lake (right)	Road shoulder/ditch erosion, poor/degraded buffer; sand dumped right at shoreline	Install runoff diverter, plant/improve buffer, establish buffer, install bioretention cells	High	612.1	0.9	8.5	$25,000-$75,000
14	2-25	Metcalf Rd, Lake Access parking area	Road shoulder/ditch erosion, roadside plow/grader berm, poor/lack of shoreline vegetation/buffer, concentrated stormwater flowpath, lake access parking area, minimal buffer between rd and lake, plow berm area with lots of loose sediment	Armor w/stone or grass, install turnouts, vegetate, add to buffer, stabilize stream bank	Medium	488.2	2.2	8.1	$25,000-$75,000
12	2-24	Coolidge Farm Rd cross-culvert	Undersized, unstable inlet/outlet, hanging (no fish passage), road shoulder/ditch erosion, roadside plow/grader berm, recent soil gravel moving work, hayed and grassed along rd side banks, lots of loose sediment	Armor/vegetate inlet/outlet, enlarge, install plunge pool, armor w/stone or grass, install check dams, vegetate, install turnouts	Medium	106.4	0.1	0.4	$10,000-$20,000
13	3-02	White Oak Pond Boat Access	Unstable access, concentrated flow path, gully formation, road shoulder erosion above boat access, erosion control sock along boat access washed out	Install turnouts, vegetate shoulder, define foot path, install infiltration steps to water (large, broad steps for easy portage), divert road shoulder runoff to forest area east of launch	Medium	166.1	0.1	1.1	$10,000-$20,000
15	2-14	Intervale Pond Rd cross-culvert	Crushed/broken, undersized, unstable inlet/outlet, road shoulder/ditch erosion, severe culvert inlet erosion, sheet flow erosion of road shoulder to culvert outlet	Armor/vegetate inlet/outlet, enlarge, replace, vegetate shoulder	Medium	200.3	0.2	0.9	$10,000-$20,000
16	2-15	Intervale Pond Rd, Pond Access	Winter sand, unstable path/trail access, road surface erosion, road shoulder/ditch erosion, roadside plow/grader berm, concentrated stormwater flowpath, public access spot with pull-off parking and steep trail to water (minimum soil, tree roots showing)	Vegetate, add new gravel, install runoff diverters (waterbar), stabilize foot path, add to buffer	Medium	197.3	0.2	0.8	$20,000-$30,000
17	1-07	Beach area across from Cottage Place On Squam Lake (left)	Road shoulder/ditch erosion, poor/degraded buffer	Install runoff diverter, plant/improve buffer, establish buffer, install bioretention cells	Medium	183.7	0.3	2.8	$25,000-$75,000
18	2-08	Thompson Rd	Unstable inlet/outlet, winter sand, road shoulder/ditch erosion, roadside plow/grader berm, possible winter logging rd, very steep rd grade draining to pull-off area by stream	Armor/vegetate inlet/outlet, vegetate, remove grader/plow berms, remove winter sand, vegetate shoulder	Medium	342.9	0.4	1.3	$25,000-$75,000
19	1-02	Squam Lake Market Place Dock	Road surface erosion, road shoulder/ditch erosion, buffer not wide enough, poor/degraded buffer	Reshape/veg. shoulder, reshape or crown road, establish buffer, extend/improve buffer	Medium	64.1	0.1	0.5	$20,000-$30,000

Rank	Site #	Description	Problem	Recommendations	Impact Rating	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Est. Cost Range
20	2-03	Road crossing on Mill Bridge Rd (Trib. to Burrows Brook)	Unstable inlet/outlet, winter sand, road shoulder/ditch erosion, steep road ditch to turnout to stream, recent ditch cleanout, evidence of sediment flowpath from road runoff around culvert	Armor/vegetate inlet/outlet, realign, armor w/stone or grass, install check dams, install sediment pools	Medium	84.5	0.1	0.4	$10,000-$20,000
21	2-11	Coolidge Farm Rd	Winter sand, road surface erosion, road shoulder/ditch erosion, representative road condition, hard packed, pot holes, surface washout to stream	Install turnouts, add new gravel, grade, remove grader/plow berms, remove winter sand, reshape (crown)	Medium	777.6	1.1	4.2	$50,000-$100,000
22	3-03	Rt. 3 driveway before Owls Landing Campground	Large gully formations in private driveway	Install turnouts, build up, grade, install open top culvert, reshape (crown)	Medium	421.2	0.4	3.4	$10,000-$20,000
23	2-04	Road crossing on Mill Bridge Rd (Burrows Brook)	Road shoulder/ditch erosion, steep grade on both sides with ditch draining to stream, winter sand berm pile areas on upstream side	Armor w/stone or grass, install check dams, install sediment pools, install turnouts	Medium	555.5	0.7	1.8	$20,000-$30,000
24	2-12	Buffer between Trib. to Intervale Pond and Intervale Pond Rd	Road shoulder/ditch erosion, roadside plow/grader berm, poor/lack of shoreline vegetation/buffer, minimal buffer and no rd shoulder (visible rd surface runoff) between stream and rd	Remove grader/plow berms, vegetate shoulder, add to buffer, stabilize stream bank	Medium	395.3	0.8	2.5	$25,000-$35,000
25	2-09	Thompson Rd	Clogged, undersized, misaligned culvert, road shoulder/ditch erosion, roadside plow/grader berm, poor/lack of shoreline vegetation/buffer, channel straightening causing severe undercutting and bank erosion along road to culvert crossing	Armor/vegetate inlet/outlet, enlarge, remove clog/clean out, vegetate, remove grader/plow berms, remove winter sand, vegetate shoulder	Medium	881.0	1.1	2.6	$25,000-$75,000
26	2-20	Coolidge Farm Rd, road shoulder to cross-culvert	Unstable inlet/outlet, hanging (no fish passage), road shoulder/ditch erosion, steep bank along rd eroding with bare soil, lots of loose sediment at inlet and outlet, evidence of significant water flow	Armor/vegetate inlet/outlet, enlarge, install plunge pool, armor w/stone or grass, install check dams, vegetate	Medium	198.2	0.3	1.3	$10,000-$20,000
27	2-16	Intervale Pond Rd, road wash-out	Road surface erosion, road shoulder/ditch erosion, significant sediment deposits found off road side near pond	Armor w/stone or grass, install sediment pools, install turnouts, vegetate, reshape(crown)	Medium	1536.3	1.8	5.1	$20,000-$30,000
28	2-26	Metcalf Rd, cross-culvert	Clogged, undersized, unstable inlet/outlet, winter sand, road shoulder/ditch erosion, concentrated flow path from culvert drainage to lake through some vegetation	Armor/vegetate inlet/outlet, enlarge, clean out, armor w/stone or grass, install sediment pools, install turnouts	Medium	237.0	0.3	1.0	$10,000-$20,000
29	2-17	Intervale Pond Rd, wash-out/access point	Bare soil/fields, winter sand, road surface erosion, road shoulder/ditch erosion, poor/lack of shoreline vegetation/buffer, concentrated stormwater flowpath, direct stormwater/sediment flow path from road to pond	Armor w/stone or grass, install sediment pools, install turnouts, vegetate, add to buffer	Medium	119.8	0.1	0.4	$10,000-$20,000

Rank	Site #	Description	Problem	Recommendations	Impact Rating	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Est. Cost Range
30	1-01	Holderness Library parking lot	Road surface erosion, buffer not wide enough, concentrated flowpath of stormwater through buffer	Install erosion controls (e.g., mulch berm), add surface material, plant/improve buffer, extend/improve buffer; good demonstration site	Medium	79.3	0.2	1.8	$20,000-$30,000
31	1-04	Rt. 3 from Holderness Fire Depart. to bridge	Staining around storm drain/spills, significant vehicle traffic, drainage from large paved area	Stencil storm drains, install stormwater controls; needs further investigation	Medium	583.8	0.5	3.8	$50,000-$100,000
32	1-05	Asquam Marina at Holderness Harbor	Heavy vehicle traffic, poor/degraded buffer	Improve/install stormwater controls, establish buffer	Medium	204.5	0.4	4.0	$50,000-$100,000
33	1-16	Road crossing on Perch Pond Rd (Trib. to Owl Brook)	Road shoulder/ditch erosion, culvert misaligned	Stabilize inlet/outlet, re-align, repair, or upgrade culvert	Medium	64.3	0.1	0.2	$25,000-$75,000
34	1-11	Stormwater outfall pipe from Owl Brook Rd	Road shoulder/ditch erosion at outfall pipe	Install plunge pool, armor ditch with stone or grass	Low	565.1	1.2	0.5	$20,000-$30,000
35	1-19	Squam Lakes Association (SLA) boat launch	Road surface erosion, poor/degraded buffer	Install turnout, reshape/veg. shoulder, reshape or crown road, install runoff diverter, extend/improve buffer, seed and mulch (esp. near launch pad, existing wood chips may wash out)	Low	575.1	1.0	6.1	$20,000-$30,000
36	1-17	Road crossing on Rt. 113 (West Brook)	Road shoulder/ditch erosion	Install plunge pool, install turnout, reshape/veg. shoulder	Low	440.4	1.0	0.6	$20,000-$30,000
37	1-14	Road crossing on Beede Rd (Carr Brook)	Bare soil/fields, road shoulder/ditch erosion, hanging culvert (limited fish passage)	Replace culvert, stabilize inlet/outlet	Low	809.5	1.0	2.0	$25,000-$75,000
38	1-13	Road crossing on Rt. 175 by house #421	Road shoulder/ditch erosion to crossing at tributary to Carr Brook	Stabilize inlet/outlet, reshape/veg. shoulder, install runoff diverter	Low	568.6	0.7	1.8	$10,000-$20,000
39	1-15	Road crossing on Perch Pond Rd (Owl Brook)	Road shoulder/ditch erosion	Install turnout/reshape/veg. shoulder	Low	502.2	0.6	1.4	$10,000-$20,000
40	1-12	Road shoulder by house #296 Beede Rd	Road shoulder/ditch erosion	Armor ditch with stone or grass, install turnout	Low	776.0	0.9	3.3	$20,000-$30,000
41	1-09	Ashland Town Beach	Possible septic system problem due to heavy use and proximity to lake	Evaluate septic systems; replace/upgrade, if necessary	Low	0.0	0.9	0.0	$20,000-$30,000
42	3-04	Intersection of East Holderness Rd and Rt. 3	Excessive sand likely from winter application	Install turnouts, reshape ditch, vegetate shoulder	Low	192.2	0.3	2.3	$10,000-$20,000

Rank	Site #	Description	Problem	Recommendations	Impact Rating	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)	Est. Cost Range
43	2-10	Thompson Rd	Bare soil/fields, winter sand, road surface erosion, road shoulder/ditch erosion, roadside plow/grader berm, staging area with excess sand and gravel from plow berms, poor/eroded turnout	Armor w/stone or grass, reshape ditch, vegetate, remove grader/plow berms, remove winter sand, reshape (crown), vegetate shoulder	Low	225.4	0.3	0.8	$10,000-$20,000
44	2-05	Road crossing on Mill Bridge Rd (Trib. to Burrows Brook)	Undersized, unstable inlet/outlet, road shoulder/ditch erosion, steep road ditch to culvert to vegetated area, evidence of significant stormwater runoff/scouring	Armor/vegetate inlet/outlet, enlarge, install plunge pool, armor w/stone or grass, install check dams, install sediment pools, install turnouts	Low	351.8	0.4	1.4	$20,000-$30,000
45	1-03	Walter's Basin Restaurant + Bar	Road surface erosion, dumpster runoff	Install runoff diverter, clean up garbage/dumpster area (e.g., install concrete containment pad and grease bin), extend/improve buffer	Low	116.6	0.2	1.0	$10,000-$20,000
46	2-06	Rt. 113 at Transfer Station Rd (Burrows Brook)	Unstable outlet with minimal buffer or road shoulder, evidence of slumping as guard posts falling over, stream straightened and at sharp bend with culvert	Armor/vegetate inlet/outlet, vegetate shoulder	Low	164.4	0.2	0.4	$10,000-$20,000
47	2-18	Jimmy Point Rd, stone culvert	Unstable outlet, road shoulder/ditch erosion, no rd shoulder (visible rd surface runoff over culvert) between culvert top and rd	Armor/vegetate outlet, vegetate, build out rd/culvert	Low	286.9	0.3	1.1	$25,000-$75,000
48	2-02	Road crossing on Mill Bridge Rd (drainage)	Undersized, hanging (no fish passage), road shoulder/ditch erosion, stagnant water pooling above culvert, evidence of high flow scours downstream, road runoff to turnout (to downstream of culvert)	Armor/vegetate inlet/outlet, enlarge, armor w/stone or grass, install check dams, install sediment pools	Low	79.1	0.1	0.3	$10,000-$20,000
49	2-27	Metcalf Rd, cross-culvert	Crushed/broken, unstable inlet, misaligned, road shoulder/ditch erosion, smaller side culvert connected to main stream after large flow, chute, rd surface runoff over culvert top, culvert bottom rusted and broken up	Armor/vegetate inlet/outlet, replace, install sediment pools, install turnouts	Low	76.3	0.1	0.3	$10,000-$20,000
50	2-07	Taylor Rd	Road surface erosion, road shoulder/ditch erosion, straightened, good example of other similar issues along rd	Vegetate shoulder	Low	71.1	0.1	0.3	$25,000-$75,000
51	2-13	Intervale Pond Rd, cross-culvert	Crushed/Broken, undersized, misaligned, hanging (no fish passage)	Enlarge, replace, armor w/stone or grass, vegetate, vegetate shoulder	Low	406.3	0.5	1.5	$5,000-$15,000
52	2-19	Long Point Rd	Unstable inlet, recent pink wetland flagging	Armor/vegetate inlet	Low	0.8	0.01	0.01	$5,000-$15,000
53	3-05	Royea's Auto Wrecking	Metals, oil, grease, fluids on pervious surface	Needs site assessment	Medium	0.0	0.0	0.0	TBD

ATTACHMENT 1. PHOTOGRAPHS (#11-53)

Site 1-08: Beach area across from Cottage Place on Squam Lake (right beach).

Site 2-25: Metcalf Rd, lake access parking area.

Site 2-24: Coolidge Farm cross-culvert.

Site 3-02: White Oak Pond boat access.

Site 2-14: Intervale Pond Rd cross-culvert.

Site 2-15: Intervale Pond Rd, pond access.

Site 1-07: Beach area across from Cottage Place on Squam Lake (left beach).

Site 2-08: Thompson Rd (steep logging rd).

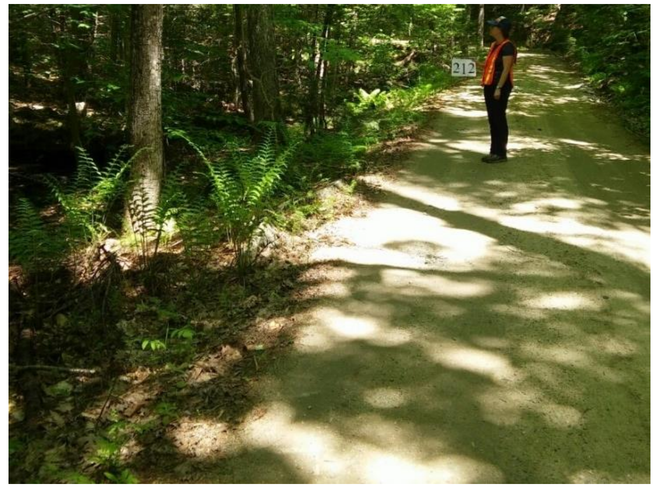
Site 1-02: Squam Lake Market Place dock.

Site 2-03: Road crossing on Mill Bridge Rd (Trib. to Burrows Brook).

Site 2-11: Coolidge Farm Rd.

Site 3-03: Rt. 3 driveway before Owl's Landing Campground.

Site 2-04: Road crossing on Mill Bridge Rd (Burrows Brook).



Site 2-12: Buffer between trib. to Intervale Pond and Intervale Pond Rd.

Site 2-09: Thompson Rd.

Site 2-20: Coolidge Farm Rd, road shoulder to cross-culvert.

Site 2-16: Intervale Pond Rd, road wash-out.

Site 2-26: Metcalf Rd, cross-culvert (note incorrect site label in photo).

Site 2-17: Intervale Pond Rd, wash-out/access point.

Site 1-01: Holderness Library parking lot.

Site 1-04: Rt. 3 from Holderness Fire Depart. to bridge.

Site 1-05: Asquam Marina at Holderness Harbor.

Site 1-16: Road crossing on Perch Pond Rd (Trib. to Owl Brook).

Site 1-11: Stormwater outfall pipe from Owl Brook Rd.

Site 1-19: Squam Lakes Association (SLA) boat launch.

Site 1-17: Road crossing on Rt. 113 (West Brook).

Site 1-14: Road crossing on Beede Rd (Carr Brook).

Site 1-13: Road crossing on Rt. 175 by house #421.

Site 1-15: Road crossing on Perch Pond Rd (Owl Brook).

Site 1-12: Road shoulder by house #296 Beede Rd.

Site 1-09: Ashland Town Beach.

Site 3-04: Intersection of East Holderness Rd and Rt. 3

Site 2-10: Thompson Rd.

Site 2-05: Road crossing on Mill Bridge Rd (Trib. to Burrows Brook).

Site 1-03: Walter's Basin Restaurant & Bar.

Site 2-06: Rt. 113 at Transfer Station Rd (Burrows Brook).

Site 2-18: Jimmy Point Rd, stone culvert.

Site 2-02: Road crossing on Mill Bridge Rd (drainage).

Site 2-27: Metcalf Rd, cross-culvert.

Site 2-07: Taylor Rd.

Site 2-13: Intervale Pond Rd, cross-culvert.

Site 2-19: Long Point Rd.