# OSSIPEE LAKE

## Watershed Management Plan

*Phase II: A Watershed Plan for the*
*Ossipee Lake Shoreline and Lovell River Watersheds*

**FINAL** JANUARY 2018

GREEN MOUNTAIN CONSERVATION GROUP

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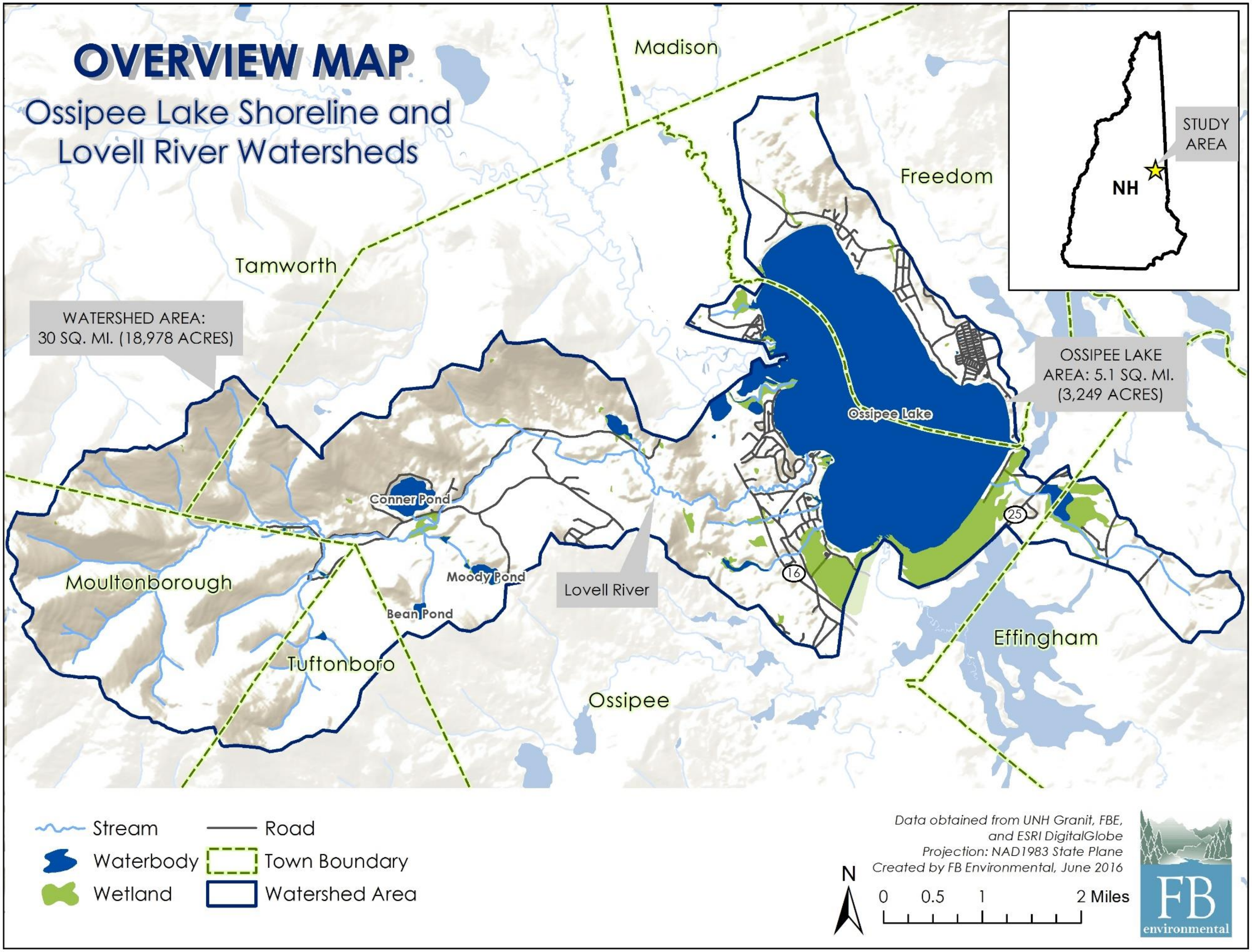
NEW HAMPSHIRE DEPARTMENT OF Environmental Services


OVERVIEW MAP
Ossipee Lake Shoreline and Lovell River Watersheds
Madison
Freedom
Tamworth
STUDY AREA
NH
WATERSHED AREA: 30 SQ. MI. (18,978 ACRES)
OSSIPEE LAKE AREA: 5.1 SQ. MI. (3,249 ACRES)
Ossipee Lake
Conner Pond
Moody Pond
Bean Pond
Lovell River
Moultonborough
Tuftonboro
Ossipee
Effingham
25
16
Stream
Waterbody
Wetland
Road
Town Boundary
Watershed Area
Data obtained from UNH Granit, FBE, and ESRI DigitalGlobe
Projection: NAD1983 State Plane
Created by FB Environmental, June 2016
N
0 0.5 1 2 Miles
FB environmental

# OSSIPEE LAKE

## Watershed Management Plan

*Phase II: A Watershed Plan for the Ossipee Lake Shoreline and Lovell River Watersheds*

Prepared by **FB ENVIRONMENTAL ASSOCIATES**
*in cooperation with Green Mountain Conservation Group and the New Hampshire Department of Environmental Services*

**FINAL** | JANUARY 2018

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# EXECUTIVE SUMMARY

The water quality of Ossipee Lake is threatened by harmful pollutants in nonpoint source (NPS) pollution from developed areas in the watershed. The desirability of Ossipee Lake as a recreational destination, and increasingly as a permanent residence for newcomers, will likely stimulate continued population growth in the future. Thus, taking proactive steps to properly manage and treat NPS pollution in the Ossipee Lake watershed is essential for continued ecosystem health and recreational enjoyment by future generations.

> The **Ossipee Lake Watershed Management Plan** provides a roadmap for preserving the water quality of Ossipee Lake, and provides a mechanism for procuring funding (e.g., Section 319 grants) to secure actions needed to achieve the water quality goal. USEPA requires that a watershed plan (or an acceptable alternative plan) be created so that communities become eligible for watershed assistance implementation grants.

As part of the development of this plan, a build-out analysis, water quality and assimilative capacity analysis, and volunteer shoreline/watershed stormwater surveys were conducted (Section 3). Results of these efforts were used to run a land-use model, or Lake Loading Response Model (LLRM), that estimated the historical, current, and projected amount of total phosphorus being delivered to the lake from the watershed (Section 3.3.2). An Action Plan (Section 5.2) with associated timeframes, responsible parties, and estimated costs was developed based on feedback from community members that attended the public forum in June 2016.

## LAKE QUICK FACTS

*Note: the following watershed-specific facts apply only to the Ossipee Lake Shoreline and Lovell River watersheds*

| | |
|---|---|
| **Town/State:** | Ossipee, NH (52%)<br>Moultonborough, NH (19%)<br>Freedom, NH (15%)<br>Tuftonboro, NH (6%)<br>Effingham, NH (4%) |
| **Total Watershed Area:** | 30 sq. mi. (18,978 ac.) |
| **Lake Area:** | 5.1 sq. mi. (3,249 ac.) |
| **Shore Length:** | 10.6 miles |
| **Max Depth:** | 60.7 ft. |
| **Mean Depth:** | 27.9 ft. |
| **Lake Volume:** | 29.7 billion gallons |
| **Flushing Rate:** | 4.1 times per year |
| **Lake Elevation:** | 410 ft. |
| **Trophic Classification:** | Oligotrophic |
| **Lake Impairments:** | None |

**Invasives:** Milfoil was found in Ossipee Lake near the mouth of Pine River in 2012.

**Tributaries:** Watershed water load (which includes runoff and tributary flow) from the Ossipee Lake Shoreline and Lovell River watersheds accounts for 10% of the total water entering Ossipee Lake on an annual basis.

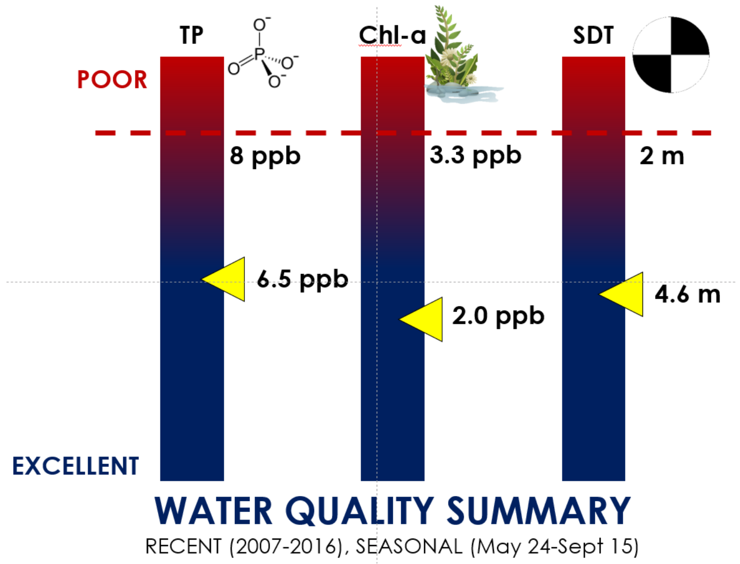
**Other Notes:** The high flushing rate of 4.1 means that the entire volume of the lake is replaced 4 times per year, which allows pollutants less time to settle in lake bottom sediments and/or be taken up by biota. Conservation land in the watershed covers 13.1 square miles (8,414 acres) or approximately 44% of the watershed. This includes the 347-acre Ossipee Natural Area which conserves a two-mile-long stretch of shoreline on the south side of Ossipee Lake.

### WATER QUALITY ASSESSMENT & MODELING

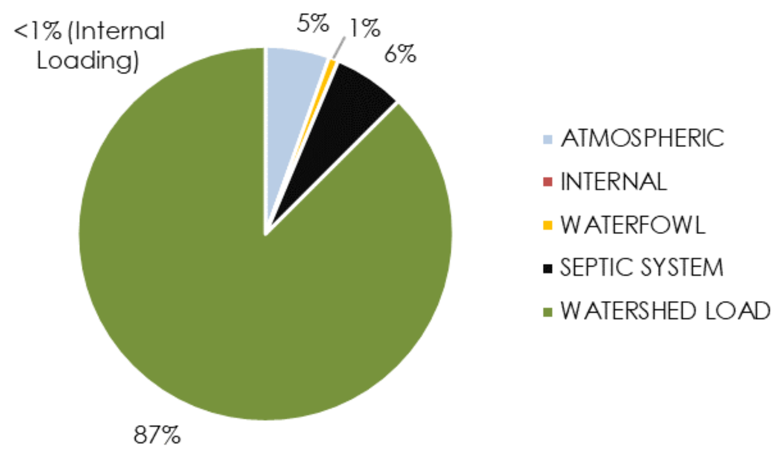
Overall, phosphorus, chlorophyll-a, and water clarity are good in Ossipee Lake and well below the State criteria for oligotrophic lakes. While Ossipee Lake itself is not listed by the State of New Hampshire as impaired for its designated uses, several other waterbodies connected to Ossipee Lake are listed as impaired for aquatic life use or primary contact recreation due to low pH, low dissolved oxygen, poor benthic macroinvertebrate or fish bioassessments, or cyanobacteria (presence of toxic microcystins) (NHDES, 2014b).

For Phase II waterbodies, the Lovell River is listed as impaired for pH and Red and Weetamoe Brooks as impaired for pH and dissolved oxygen. Low pH in New Hampshire surface waters is the result of atmospheric deposition in the form of acid rain (from industrial emissions) and poor buffering capacity from granitic parent material that has delayed or prevented recovery from acid rain in waterbodies of the northeast. Low dissolved oxygen in Red and Weetamoe Brooks, both of which are small direct drainages to Ossipee Lake, is likely the result of enhanced organic matter decomposition following rapid plant and algae growth, stimulated by excess nutrients. Both streams showed elevated levels of total phosphorus and total nitrogen.

In addition, recent analyses showed an increase in the prevalence of low dissolved oxygen (e.g., anoxia) in bottom waters and subsequent increases in hypolimnion phosphorus concentrations at the deep spot of Ossipee Lake. The challenge, like for many other New Hampshire lakes, is to mitigate pollutant nutrient loading to Ossipee Lake from anticipated growth to prevent a decline in water quality or trophic status. As development or other human activities in the watershed increase (e.g., new residential or commercial construction or conversion of small, seasonal properties to large, year-round homes), unmitigated sources of pollution (i.e., phosphorus) will increase and associated algae and plant growth will contribute to oxygen depletion as algal cells and other organic matter sink, die, and decompose in deeper sections of the lake. Low oxygen in bottom waters may lead to a release of phosphorus bound in sediments, refueling algae and plant growth in upper portions of the water column. Enhanced algal blooms and depleted oxygen in bottom waters will lead to water quality degradation and loss of property values along the Ossipee Lake shoreline.

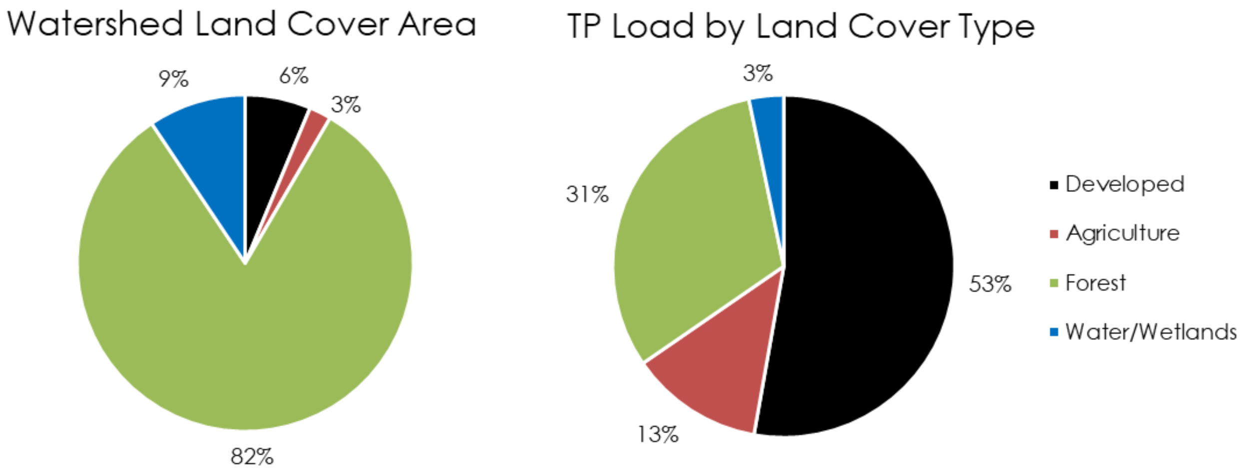



**Visual summary of current water quality in Ossipee Lake. Data represent recent (2007-2016) and seasonal (May 24-Sept 15) median calculations. TP = total phosphorus; Chl-a = chlorophyll-a; SDT = Secchi Disk Transparency. SDT is based on data collected with a scope.**




**Percentage of total phosphorus (TP) loading (kg/yr) by source (atmospheric, internal loading, waterfowl, septic systems, watershed load).**

The land use model results indicate that the greatest phosphorus load comes from watershed runoff, which accounts for 87% of the current total phosphorus loading to Ossipee Lake. Septic systems likely contribute the second largest source of phosphorus to Ossipee Lake at 6%. Old systems (> 25 years old) made up 41% of the 33 Ossipee Lake watershed respondents to the 2016 septic survey.

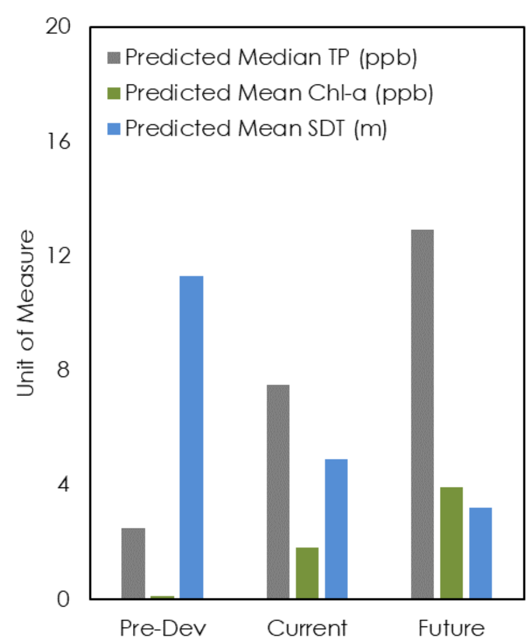



**Watershed land cover area by general type (developed, agriculture, forest, and water/wetlands) and total phosphorus (TP) load by general land cover type. This shows that although developed areas cover only 6% of the Ossipee Lake watershed, these areas are contributing 53% of the TP load to Ossipee Lake.**

Although developed areas cover only 6% of the Ossipee Lake watershed (see Section 2.1.3), developed areas are contributing 53% of the phosphorus load to Ossipee Lake; agriculture covers 3% of the watershed, but contributes 13% of the phosphorus load to Ossipee Lake (FBE, 2017a).

On a per hectare basis, the Red Brook sub-basin had the highest total phosphorus loading, followed by Weetamoe sub-basin (Appendix A, Maps 8 & 9). While Red Brook and Weetamoe Brook are contributing the least phosphorus by mass per year due to their significantly smaller watersheds, phosphorus exported per hectare of land is high compared to the other sub-basins. Red Brook may be impacted by a failing septic system or have significantly different phosphorus export coefficients for developed land cover types than the other sub-basins. Further investigation may be warranted to determine where excess phosphorus to Red Brook and Weetamoe Brook is being sourced from.

The build-out analysis identified an estimated 22,313 acres (51%) of the entire 44,035-acre study area as developable. Up to 13,344 new buildings (a 402% increase from 2016) could be added at full build-out by the year 2107, using the 30-year compound annual growth rate of 1.91% (Appendix A, Map 10). This predicted increase in development was then input to the model for the Ossipee Lake watershed (including build-out results from the Town of Freedom from a previous study); the future phosphorus load was estimated at 7,909 kg/yr, with an in-lake phosphorus concentration of 12.9 ppb (Table 3-8). This future load is 48% more than the current load and represents an estimate of the worst possible water quality for the lake. On a per hectare basis, the Red Brook, Beech River, and Pine River sub-basins are predicted to have the greatest phosphorus mass exported and the greatest increase from current to future conditions in phosphorus mass exported, indicating that these sub-basins are most vulnerable to development and water quality degradation and should be prioritized for watershed implementation work.




**Predicted total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi Disk Transparency (SDT) for pre-development, current, and future loading conditions to Ossipee Lake.**

**Ossipee Lake may experience a 48% increase in phosphorus loading at full build-out by 2107. The Red Brook, Beech River, and Pine River sub-basins are most at risk for increases in phosphorus loading because of anticipated development.**

Results of the build-out analysis reinforce the concept of comprehensive planning at the watershed level to address future development and its effect on the water quality of Ossipee Lake. Future development will increase the amount of polluted runoff that drains to Ossipee Lake. Therefore, it is recommended that town officials revisit zoning ordinances to ensure that existing laws encourage smart, low-impact development. Land-use and zoning ordinances are among the most powerful tools municipalities can use to protect their natural resources.

### WATER QUALITY GOAL & OBJECTIVES

Model results showed that at full buildout, Ossipee Lake would suffer from degraded water clarity and algal blooms, would not support its designated uses, and would be listed as an impaired waterbody. Therefore, a water quality goal and objective were set that will protect the excellent water quality of Ossipee Lake.

**The goal of the Ossipee Lake Watershed Management Plan Phase II: A Watershed Plan for the Ossipee Lake Shoreline and Lovell River Watersheds is to protect the water quality of Ossipee Lake.**

This goal will be achieved through the following objective.

**OBJECTIVE:** Reduce pollutant loading from the Ossipee Lake Shoreline and Lovell River watersheds to Ossipee Lake to help maintain or improve in-lake median total phosphorus concentration.

> The estimated annual total phosphorus load increase from new development at full build-out (based on the 30-year compound annual growth rate) was predicted at 194 and 305 kg/yr by 2107 for the Ossipee Lake Shoreline and Lovell River watersheds, respectively. To maintain current water quality conditions, watershed stakeholders will need to implement low impact development (LID) techniques and/or reduce phosphorus loading from current development to combat the expected increase of 55 kg/yr in phosphorus loading from the Ossipee Lake Shoreline and Lovell River watersheds over the next 10 years (2018-2027). Refer to Section 5.2 for specific action items and recommendations.

### POLLUTANT SOURCE IDENTIFICATION

During the 2015 watershed survey, 31 NPS sites were identified and rated for impact level based on location, slope, amount of soil eroded, and proximity to water. Recommendations ranged from installing buffer plantings to armoring culverts to stabilizing road shoulders.

Select "hotspots" of nonpoint source (NPS) pollution in the Ossipee Lake watershed.


**Camp Cody Drainage Ditch (Site ID 0-13)**

The sandy substrate is causing erosion along the stream channel into Ossipee Lake. Minimal development along the channel allows space for buffer planting along the streambanks. Camp Cody has successfully implemented multiple BMPs that capitalize on the sandy soils, such as the infiltration trenches around their bunkhouses.

**Pine Hill Road and Ossipee Mountain Road (Site ID 0-25)**

Pine Hill Road and Ossipee Mountain Road are the two main gravel roads located along the Lovell River. While these roads are rural in comparison to the roads around Ossipee Lake, they have many residential houses and experience continuous traffic. Pine Hill Road runs east directly along the Lovell River and has several areas of limited buffer between the road shoulder and the river. Along some stretches of road, sandy soils and steep banks are causing severe erosion and culvert failure. Erosion at this site is moderate, but the vast length of the bank failure elevates it to a high priority site.

During the 2015 shoreline survey, 62% of the Ossipee Lake shoreline (or 166 parcels) scored 10 or higher, indicating shoreline conditions that are likely detrimental to lake water quality. These shoreline properties tended to have inadequate buffers, evidence of bare soil, and structures within 75 ft. of the shoreline.

Ossipee Lake parcel receiving a score of 8.

Ossipee Lake parcel receiving a score of 12.

## PLAN IMPLEMENTATION STRATEGY & RECOMMENDATIONS

Management strategies for achieving the water quality goal and objectives involve using a combination of structural and non-structural BMPs, as well as an adaptive management approach (refer to Section 4). The recommendations of this plan should be carried out by a steering committee like the one assembled for development of this plan. A steering committee should include the leadership of GMCG, other conservation groups and land trusts, representatives from the six watershed towns, NHDES, members of conservation commissions and/or planning boards, schools and community groups, local business leaders, and landowners.

The following presents short-term recommendations for achieving the goal and objective:

- SEPTIC SYSTEMS: Host multiple "septic socials" in key neighborhoods near the lake to address link between septic system maintenance and water quality. Target educational campaign in areas with minimally-maintained or aging septic systems.
- WATERSHED & SHORELINE BMPS: Work with shorefront residents to encourage expanded participation in shoreline residential BMP implementation efforts, with initial focus on the 11 high priority shoreline properties. Stakeholders should apply for 319 implementation grant funding in 2018 to address watershed NPS sites and shoreline properties. A funding subcommittee should be created to help find and apply for funding that supports all aspects of the Action Plan.

- ROADS: Create a Lake Coalition Group to bring together neighborhood and road associations. Consider forming additional private road associations in key neighborhoods or heavily-used roads for better management by local stakeholders. Determine if this is a feasible option for the area.
- PLANNING AND LAND CONSERVATION: Work with GMCG to create an aquifer protection committee that evaluates new development, property transfers, and retrofits and makes recommendations to the town planning board and/or regional level planning group (if applicable). Given future development potential, it is critical for municipalities 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.
- WATER QUALITY MONITORING: Add routine bacteria monitoring to public beach areas and tributary sampling sites. Continue to encourage networking between lake associations regarding monitoring occurring at individual waterbodies throughout the watershed. Hold a regional lake association meeting as a collaboration among all area associations for new ideas or actions.

## ESTIMATED COSTS

The cost of successfully implementing this watershed plan is estimated at $576,100 over the next ten years. However, many costs are still unknown and should be incorporated to the Action Plan as information becomes available. A sustainable funding plan should be developed within the first year of this plan and revisited on an annual basis to ensure that the major planning objectives can be achieved over the long-term. This funding strategy would outline the financial responsibilities at all levels of the community (landowners, towns, community groups, and State and federal governments).

**Estimated annual and ten-year costs for protecting Ossipee Lake.**

| Category | Estimated Annual Costs | 10-year Total |
|---|---|---|
| Septic Systems* | $2,850 | $28,500 |
| Watershed and Shorefront BMPs | $37,450 | $374,500 |
| Roads | $1,000 | $10,000 |
| Planning & land Conservation | $4,650 | $46,500 |
| Water Quality Monitoring | $11,660 | $116,600 |
| **Total Cost** | **$57,610** | **$576,100** |

**Septic system recommendations do not include design or replacement costs because these should be covered by private landowners. Recommendations cover assistance to secure grant funding for those individuals who cannot afford these costs.*

## EVALUATING PLAN SUCCESS

The success of this plan is dependent on the continued effort of volunteers, and a strong and diverse steering committee (like the one established for plan development) that meets regularly to coordinate resources for implementation, review progress, and make any necessary adjustments to the plan to maintain relevant action items and interim benchmarks. Measurable milestones (number of BMP sites, volunteers, funding received, etc.) should be tracked by a steering committee and reported to NHDES on a regular basis.

**A reduction in phosphorus loading is no easy task, and because there are many diffuse sources of phosphorus reaching the lake from existing residential development, roads, septic systems, and other land uses in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful.**

# ACKNOWLEDGMENTS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| ACRONYM | DEFINITION |
|---|---|
| ALU | Aquatic Life Use |
| ANC | Acid Neutralizing Capacity |
| BMP | Best Management Practices |
| Chl-a | Chlorophyll-a |
| CWA | Clean Water Act |
| DO | Dissolved Oxygen |
| *E. coli* | *Escherichia coli* |
| FBE | FB Environmental Associates |
| GMCG | Green Mountain Conservation Group |
| LID | Low Impact Development |
| LLRM | Lake Loading Response Model |
| NAIP | National Agriculture Imagery Program |
| NCDC | National Climatic Data Center |
| NH GRANIT | New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GIS Clearinghouse) |
| NHDES | New Hampshire Department of Environmental Services |
| NHDOT | New Hampshire Department of Transportation |
| NHFGD | New Hampshire Fish and Game Department |
| NPS | Nonpoint Source Pollution |
| OLA | Ossipee Lake Alliance |
| ppb, ppm | parts per billion, parts per million |
| PCR | Primary Contact Recreation |
| SCC | State Conservation Commission |
| SDT | Secchi Disk Transparency |
| SSPP | Site Specific Project Plan |
| TP | Total Phosphorus |
| USEPA | United States Environmental Protection Agency |
| USLE | Universal Soil Loss Equation |
| VLAP | Volunteer Lake Assessment Program |

# 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.

**Alkalinity or acid neutralizing capacity (ANC)** is a measure of the buffering capacity of water, or the capacity of water to neutralize acids. It is measured as the concentration of naturally-available bicarbonates, carbonate, other "weak" acids, and hydroxide ions (OH)-). Alkalinity is derived from weathering of soils and rocks, as well as biological processes in the watershed.

**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.

**Benthic Macroinvertebrates** are small organisms that live on bottom substrates, including rocks, logs, sediment, or plants. They are used as a support indicator for aquatic life use attainment.

**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/permanent) 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 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.

***Escherichia coli (E. coli)*** are bacteria present in the intestinal tracts of warm-blooded animals and are used to indicate the presence of fecal contamination in waterbodies.

**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 cover** refers 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 a fuel for 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.

**Microcystins** are toxins produced by cyanobacteria.

**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 algal 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.

**pH** is the standard measure of the acidity or alkalinity of a solution on a scale of 0 (acidic) to 14 (basic).

**Riparian habitat** refers to wildlife habitat found along the banks of a lake, river, or stream. Not only are these areas ecologically diverse, but they are also critical to protecting water quality by preventing erosion and filtering polluted stormwater runoff.

**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. Transparency is an indirect measure of algal productivity and is measured in meters (m).

**Specific conductance** is a measure of water's ability to conduct an electrical current, which varies with the amount of ions present in solution. Though conductance varies with local geology, conductance values exceeding 100 µS/cm generally indicate human disturbance.

**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.

**Thermal stratification** is the process whereby warming surface temperatures in summer create a temperature and density differential that separates the water column into distinct, non-mixable layers.

**Thermocline** or **metalimnion** is the markedly cooler, dynamic middle layer of rapidly changing water temperature. The top of this layer is distinguished by at least a degree Celsius drop per meter of depth.

**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

## 1.1 BACKGROUND AND PURPOSE

Covering 297 square miles across fourteen towns in eastern New Hampshire, the Ossipee Lake watershed features numerous lakes, ponds, and major wetlands that provide critical habitat for a diverse abundance of plants and animals and recharge New Hampshire's largest and deepest stratified-drift aquifer, which serves as the region's primary source of drinking water. Ossipee Lake is connected to five other major waterbodies downstream within the larger Ossipee Watershed (Broad Bay, Leavitt Bay, Berry Bay, Danforth Ponds, and Huckins Pond), all of which are fed by fourteen major tributaries. Ossipee Lake has attracted visitors to its shores for over 100 years. Lake residents, transient boaters, and summer tourists alike enjoy the lake's scenic beauty and quiet, rural character. However, the water quality of Ossipee Lake is threatened by harmful pollutants in **nonpoint source (NPS) pollution** from developed areas in the watershed. Thus, taking proactive steps to properly manage and treat NPS pollution in the Ossipee Lake watershed is essential for continued ecosystem health and recreational enjoyment by future generations.


The Ossipee Lake Watershed Management Plan Phase II for the Ossipee Lake Shoreline and Lovell River Watersheds is the culmination of a major effort by many individuals who care about the long-term protection of water quality in the lake. Established in 1997 with the goal to protect and preserve the Ossipee Lake watershed, the Green Mountain Conservation Group (GMCG) pursued and was awarded funding for a Watershed Assistance Grant from the New Hampshire Department of Environmental Services (NHDES) with Clean Water Act (CWA) Section 319 funds from the United States Environmental Protection Agency (USEPA).

The plan provides a roadmap using USEPA's nine key planning elements for preserving the excellent water quality of Ossipee Lake and a mechanism for acquiring funding for implementation of management actions (e.g., Section 319 grants). USEPA requires that a watershed plan (or an acceptable alternative plan) be created so that communities become eligible for watershed assistance implementation grants. In addition, this plan sets the stage for ongoing dialogue among key stakeholders in the community and promotes coordinated action to address future development in the watershed. Plan success is dependent on the continued effort of volunteers, and a strong and diverse steering committee (like the one established for plan development) that meets regularly to review progress and make any necessary adjustments to the plan.

As part of the development of this plan, a **build-out analysis**, water quality and **assimilative capacity** analysis, and volunteer shoreline/watershed surveys were conducted (Section 3). Results of these efforts were used to run a land-use model, or Lake Loading Response Model (LLRM), that estimated the pre-development, current, and projected future amount of **total phosphorus** being delivered to the lake from the watershed (Section 3.3.2). An Action Plan (Section 5.2) with associated timeframes, responsible parties, and estimated costs was developed based on feedback from community members that attended the public forum. The forum was designed to provide stakeholders with information on the watershed and water quality of Ossipee Lake, to solicit stakeholder input on action items, and to discuss the timing and elements of the plan. The steering committee helped further refine these inputs into relevant action items and recommendations.

Subsequent phases of this watershed management plan will target other major sub-basins to Ossipee Lake (e.g., Bearcamp River, Pine River, and West Branch River). Based on the outcome of this plan, the water quality goals for the Ossipee Lake Watershed Management Plan Phase I for the Danforth Ponds and Lower Bays were revisited to account for the upstream impact from Ossipee Lake.

### 1.2 STATEMENT OF GOAL

Model results showed that at full buildout, Ossipee Lake would suffer from degraded water clarity and algal blooms, would not support its designated uses, and would be listed as an impaired waterbody. Therefore, a water quality goal and objective were set that will protect the excellent water quality of Ossipee Lake.

**The goal of the Ossipee Lake Watershed Management Plan Phase II: A Watershed Plan for the Ossipee Lake Shoreline and Lovell River Watersheds is to protect the water quality of Ossipee Lake.**

This goal will be achieved through the following objective.

**OBJECTIVE:** Reduce pollutant loading from the Ossipee Lake Shoreline and Lovell River watersheds to Ossipee Lake to help maintain or improve in-lake median total phosphorus concentration.

> The estimated annual total phosphorus load increase from new development at full build-out (based on the 30-year compound annual growth rate) was predicted at 194 and 305 kg/yr by 2107 for the Ossipee Lake Shoreline and Lovell River watersheds, respectively. To maintain current water quality conditions, watershed stakeholders will need to implement low impact development (LID) techniques and/or reduce phosphorus loading from current development to combat the expected increase of 55 kg/yr in phosphorus loading from the Ossipee Lake Shoreline and Lovell River watersheds over the next 10 years (2018-2027). Refer to Section 5.2 for specific action items and recommendations.

### 1.3 INCORPORATING EPA'S NINE ELEMENTS

USEPA guidance lists nine components that are required within a watershed plan to restore waters impaired or likely to be impaired by NPS pollution. These guidelines highlight important steps in restoring and protecting water quality for any waterbody affected by human activities. The following locates and describes the nine required elements found within this plan:

A. IDENTIFY CAUSES AND SOURCES: **Section 3.5** highlights known sources of NPS pollution Ossipee Lake Shoreline and Lovell River watersheds and describes the results of the watershed and shoreline surveys conducted in 2015. These sources of pollution must be controlled to achieve load reductions estimated in this plan, as discussed in item (B) below.

B. ESTIMATE PHOSPHORUS LOAD REDUCTIONS EXPECTED FROM MANAGEMENT MEASURES: described under (C) below: **Sections 3.3 and 4.1.1** describe the calculation of pollutant load to Ossipee Lake and the amount of reduction needed to meet the water quality goal. **Section 4** describes how estimated phosphorus load reductions to Ossipee Lake can be met using specific management measures, including structural **Best Management Practices (BMPs)** for existing development, non-structural BMPs for future development, and an adaptive management approach.

C. DESCRIPTION OF MANAGEMENT MEASURES: **Sections 4 and 5.2** identify ways to achieve the estimated phosphorus load reduction and reach water quality targets. The Action Plan focuses on six major topic areas that address NPS pollution, including: septic systems, watershed and shorefront BMPs, roads, planning and land conservation, and water quality monitoring. Management options in the Action Plan focus on non-structural BMPs integral to the implementation of structural BMPs.

D. ESTIMATE OF TECHNICAL AND FINANCIAL ASSISTANCE: **Sections 5.1, 5.2, and 5.4** include a description of the associated costs, sources of funding, and primary authorities responsible for implementation. Sources of funding need to be diverse, and should include State and federal granting agencies (USEPA and NHDES), local groups (watershed towns, GMCG), private donations, and landowner contributions for BMP implementation on private property. GMCG and other core stakeholders, led by a steering committee, should oversee the planning effort by meeting regularly and efficiently coordinating resources to achieve the objectives set forth in this plan.

E. INFORMATION & EDUCATION & OUTREACH: **Sections 1.5 and 5.5** describe how the Education and Outreach component of the plan is already being or will be implemented to enhance public understanding of the project, because of leadership from GMCG.

F. SCHEDULE FOR ADDRESSING PHOSPHORUS REDUCTIONS: **Section 5.2** provides a list of action items and recommendations to reduce stormwater and phosphorus runoff to Ossipee Lake and the Lovell River. Each item has a set schedule that defines when the action should begin. The schedule should be adjusted by a steering committee on an annual basis (see Section 4.3 on Adaptive Management).

G. DESCRIPTION OF INTERIM MEASURABLE MILESTONES: **Section 5.3** outlines indicators of implementation success that should be tracked annually. Using indicators to measure progress makes the plan relevant and helps sustain the action items. The indicators are divided into three different categories: Environmental, Programmatic, and Social Indicators. Environmental indicators are a direct measure of environmental conditions, such as improvement in water clarity or reduced median in-lake phosphorus concentration. Programmatic indicators are indirect measures of restoration activities in the watershed, such as how much funding has been secured or how many BMPs have been installed. Social indicators measure change in social behavior over time, such as the number of new stakeholders on a steering committee or number of new lake monitoring volunteers.

H. SET OF CRITERIA: **Sections 3.4 and 5.3** can be used to determine whether loading reductions are being achieved over time, substantial progress is being made towards water quality objectives, and if not, criteria for determining whether this plan needs to be revised.

I. MONITORING COMPONENT: **Section 5.2.5** and the Action Plan describe the long-term water quality monitoring strategy for Ossipee Lake, the results of which can be used to evaluate the effectiveness of implementation efforts over time as measured against the criteria in (H) above. The goal of this plan is to improve water quality by maintaining or lowering the in-lake phosphorus concentration. The success of this plan cannot be evaluated without ongoing monitoring and assessment and careful tracking of load reductions following successful BMP implementation projects.

### 1.4 PLAN DEVELOPMENT AND COMMUNITY PARTICIPATION PROCESS

The plan was developed through the collaborative efforts of numerous steering committee meetings and conference calls between FB Environmental Associates (FBE) and other technical staff, including GMCG and NHDES (see Acknowledgments).

On May 6, 2015, FBE led a kick-off meeting with key project stakeholders to discuss the project timeline. The first steering committee meeting was held on July 28, 2015 at the Indian Mound Golf Club in Center Ossipee, NH. The meeting included an overview of the watershed plan development process and the role of the steering committee in that process. A second steering committee meeting was held on January 19, 2016 to present on work to date, including the water quality analysis and shoreline and watershed survey results.

A community forum and public presentation of the draft plan took place on June 29, 2016. The forum was designed to provide local stakeholders with information on the watershed and water quality of Ossipee Lake, to solicit stakeholder concerns, identify threats to water quality, and prioritize actions to mitigate identified threats. About a dozen people attended the community forum and provided valuable input to the plan. Attendees were broken out into four focus groups based on areas of concern (septic systems, roads and watershed/shorefront BMPs, municipal planning and conservation, and water quality monitoring). From group discussions and additional actions items provided by FBE, a total of 49 recommendations for achieving action items were identified and prioritized. Recommendations from the forum and additional input from steering committee members following the forum were incorporated to the Action Plan (Section 5.2).

A final steering committee was held on September 27, 2017. FBE presented the draft plan to get final feedback from committee members and discuss strategy for final presentations to the select or planning boards of the four major watershed towns.

### 1.5 WATERSHED PROTECTION GROUPS

GMCG is a community-based charitable organization dedicated to the conservation of natural resources in the Ossipee Lake watershed towns of Eaton, Effingham, Freedom, Madison, Ossipee, Sandwich, and Tamworth, as well as across the border in Maine. Founded in 1997, GMCG's mission is to coordinate and carry out environmental research, education, non-confrontational advocacy, and voluntary land protection. GMCG also works with municipal leaders and residents to foster a commitment to protect their natural resources.

Over the past 17 years, GMCG has developed an extensive water quality monitoring program and public education and outreach campaign for the greater Ossipee Lake watershed area.

- Since 2002, GMCG has developed a water quality monitoring program that includes testing at 30 river and tributary sites and 5 deep water lake stations.
- Beginning in 2006, GMCG teamed up with NHDES to establish a Volunteer Biological Assessment Program (VBAP) to assess the biological health of aquatic systems using macroinvertebrate sampling techniques.
- In conjunction with the VBAP, GMCG teamed up with NHDES to develop a Trout in the Classroom (TIC) program for schools that receive 200 Eastern Brook Trout eggs each year from the NH Fish & Game's Hatchery. The students help to raise the fish to fingerlings before releasing them into nearby rivers.
- GMCG and Ossipee Lake watershed towns also collaborate with schools through a Groundwater Education Through Water Evaluation and Testing (GET WET!) program based out of the University of Maine. Students collect water from their home and test for chloride, nitrate, pH, hardness, iron, and conductivity. This promotes youth awareness of groundwater and drinking water quality and adds to a growing database of regional groundwater well quality.

In concert with GMCG activities, the Ossipee Lake Association (OLA) was founded in 2003 as a volunteer organization dedicated to the long-term protection and preservation of Ossipee Lake and its bays, rivers, and surrounding land. OLA established an Exotic Species Prevention program in cooperation with the State's Weed Watchers program to ensure boaters are properly inspected for invasive species (e.g., milfoil) before entering the lake. OLA also holds public meetings for interested stakeholders as a mode of information transmittal pertaining to area lake issues.

The Ossipee Watershed Coalition (OWC) also worked with GMCG in the mid to late 2000's to host several workshops related to cooperative natural resource-based planning. The OWC was a partnership of municipal officials, community and business leaders, and interested residents who wanted to protect the natural resources of the Ossipee Lake watershed through natural resource-based planning. This cooperative planning ensured natural resource protection and sustainability with development and population growth. The OWC and GMCG published the Ossipee Watershed Natural Resource Based Planning Guide and the Ossipee Watershed Municipal Ordinance Book and distributed copies to town planning boards. A watershed ordinance matrix was also developed to highlight areas of improvement for each watershed town. The OWC also partnered with the Lakes Region Planning Commission (LRPC) to help four towns update or develop their aquifer protection ordinances.

# 2. WATERSHED CHARACTERIZATION

This section provides information on the local climate, demographic history, underlying soil and geographical characteristics, and past and present land cover in the Ossipee Lake Shoreline and Lovell River watersheds. This information helped to guide goal development for protecting the water quality of Ossipee Lake.

## 2.1 POPULATION, GROWTH TRENDS, AND LAND COVER

### 2.1.1 DESCRIPTION, LOCATION, AND CLIMATE

Located in the Lakes Region of east central New Hampshire, just south of the White Mountains, the 30-square-mile (18,978-acre) watershed area of the Ossipee Lake Shoreline and Lovell River watersheds is spread across six towns, with 4% (806.3 acres) in Effingham, 15% (2,882.5 acres) in Freedom, 19% (3,458.8 acres) in Moultonborough, 52% (9,813.2 acres) in Ossipee, 4% (737.4 acres) in Tamworth, and 6% (1,132.5 acres) in Tuftonboro (Appendix A, Map 1). Ossipee Lake itself straddles the boundary between the Towns of Ossipee and Freedom. From the outlet of Ossipee Lake, water flows east via the Ossipee River to the Saco River in Maine.

The Ossipee Lake Shoreline and Lovell River watersheds are situated within a temperate zone of converging weather patterns from the hot, wet southern regions and the cold, dry northern regions, which causes various natural phenomena such as severe thunder and lightning storms, hurricanes, and heavy snowfalls. The area experiences moderate to high rainfall and snowfall, averaging 51.7 inches of precipitation annually (data collected from 1981-2010 at the Tamworth, NH weather station; NOAA NCDC, 2016; Figure 2-1). Temperature generally ranges from 10 °F to 58 °F with an average of 21.5 °F in winter and 65.1 °F in summer (NCDC, 2016).

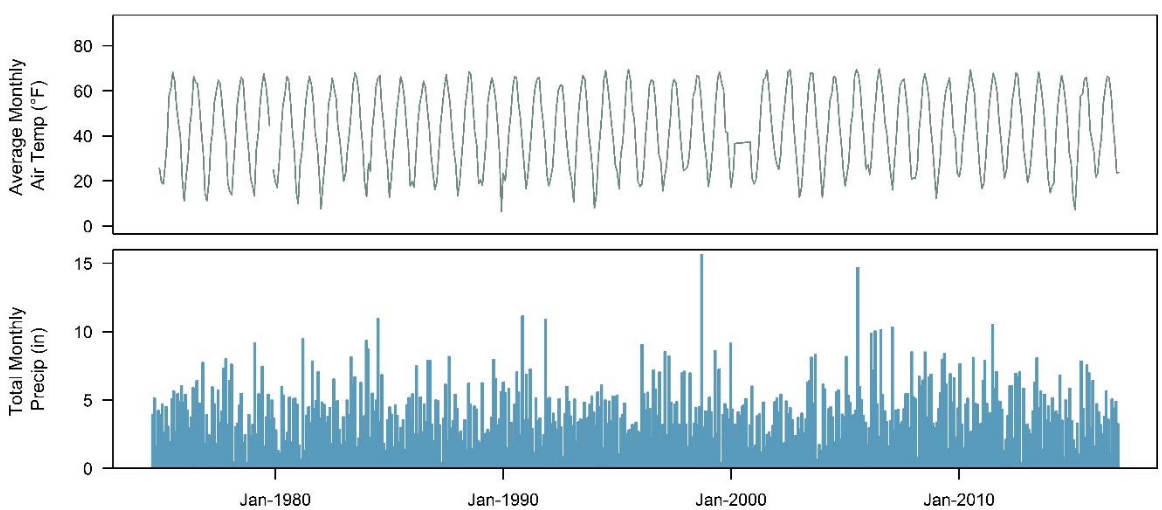



**Figure 2-1. Monthly precipitation and average monthly air temperature from 1974 to present for Tamworth, NH. Station ID (1974-2000): USC00278612. Station ID (2000-2017): USC00278614.**

### 2.1.2 POPULATION AND GROWTH TRENDS

Ossipee Lake has been long treasured as a recreational haven for summer vacationers and year-round residents. The area is one of the oldest summer vacation spots in New Hampshire and offers fishing, hiking, boating, sailing, canoeing, kayaking, swimming, golf, and tennis in the summer, and ice fishing, cross-country skiing, and snowmobiling in the winter. Most lakeshore residents in the watershed are seasonal and enjoy the natural beauty of the landscape from Independence Day to Labor Day. These seasonal residents and visitors utilize various property types around the lakeshore, including private camps, private and group rental camps and cottages, children's camps, and overnight cabins. There is limited public transportation in the area, and most people use personal vehicles in their daily commute.

Understanding population growth and demographics, and ultimately development patterns, provide critical insight to watershed management, particularly as it pertains to lake water quality. According to the U.S. Census Bureau, the population of Carroll County in 2010 was 47,698, representing a 9.4% increase in population since the 2000 census (NHOEP, 2011). From 2000 to 2010, the populations of Effingham, Freedom, Ossipee, Moultonborough, Tamworth, and Tuftonboro increased by 15%, 14%, 3%, -9.8%, 14%, and 11%, respectively (NHOEP, 2011). The Town of Moultonborough experienced a decline in population between 2000 and 2010, while the Town of Effingham experienced the greatest increase at 15%, nearly double the growth rate of Carroll County (Table 2-1, Figure 2-2).

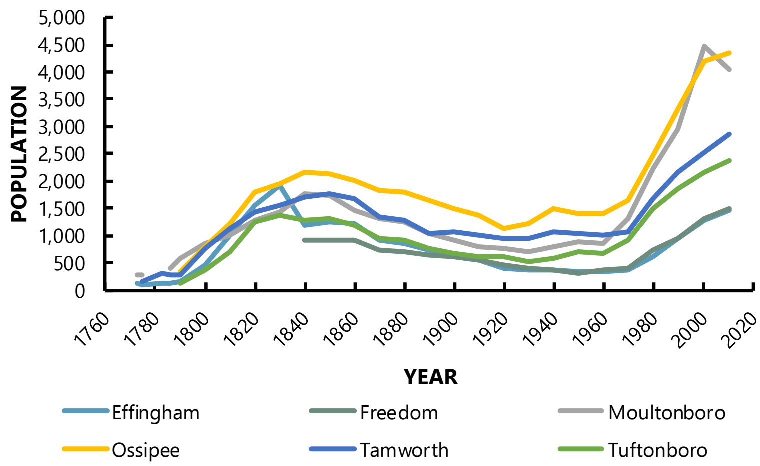



**Figure 2-2. Historical demographic data for towns in the Ossipee Lake Shoreline and Lovell River watersheds. The population of these communities has grown dramatically over the last 50 years.**

**Table 2-1. Population growth rates for watershed communities in the direct shoreline area of Ossipee Lake and the Lovell River watershed.**

| County/Town | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | 50-Yr Annual Growth Rate (1960-2010) | 20-Yr Annual Growth Rate (1990-2010) | 10-Yr Annual Growth Rate (2000-2010) |
|---|---|---|---|---|---|---|---|---|---|
| Carroll County | 15,821 | 18,548 | 27,929 | 35,410 | 43,608 | 47,698 | 4.03% | 1.74% | 0.94% |
| Effingham | 329 | 360 | 599 | 941 | 1,273 | 1,465 | 6.91% | 2.78% | 1.51% |
| Freedom | 363 | 387 | 720 | 935 | 1,303 | 1,489 | 6.20% | 2.96% | 1.43% |
| Ossipee | 1,409 | 1,647 | 2,465 | 3,309 | 4,211 | 4,345 | 4.17% | 1.57% | 0.32% |
| Moultonborough | 840 | 1,310 | 2,206 | 2,956 | 4,484 | 4,044 | 7.63% | 1.84% | -0.98% |
| Tamworth | 1,016 | 1,054 | 1,672 | 2,165 | 2,510 | 2,856 | 3.62% | 1.60% | 1.38% |
| Tuftonboro | 678 | 910 | 1,500 | 1,842 | 2,148 | 2,387 | 5.04% | 1.48% | 1.11% |

Most of the population for all watershed towns fall within the 20-64 age category. Residences in these watershed towns comprise a high percentage of seasonal (25-61%) and renter-occupied (5-16%) homes (Table 2-2). These statistics illustrate the well-known fact that the Lakes Region is an attractive tourist destination for those seeking a tranquil summer retreat, particularly along the shores of Ossipee Lake.

The desirability of Ossipee Lake as a recreational destination will likely stimulate continued population growth in the future. Growth figures and estimates suggest that communities within the watershed should consider the effects of current municipal land-use regulations on local water resources. As the region's watersheds are developed, erosion from disturbed areas increases the potential for water quality decline (refer to Section 3.3.3 for Build-Out Analysis results).

**Table 2-2. 2010 population demographics for watershed communities in the direct shoreline area of Ossipee Lake and the Lovell River watershed.**

| State/County/Town | Total Pop | Aged 0-19 | Aged 20-64 | Aged 65+ | Total Housing Units | Total Occ. Houses[1] | Owner Occ. Houses[1] | Seasonal Houses[1] | Renter Occ. Houses[1] |
|---|---|---|---|---|---|---|---|---|---|
| New Hampshire | 1,316,470 | 325,802 | 812,400 | 178,268 | 614,754 | 84% | 60% | 10% | 25% |
| Carroll County | 47,818 | 9,798 | 28,182 | 9,838 | 39,813 | 53% | 42% | 42% | 11% |
| Effingham | 1,465 | 317 | 925 | 223 | 963 | 64% | 55% | 30% | 9% |
| Freedom | 1,489 | 262 | 827 | 400 | 1,580 | 44% | 38% | 52% | 6% |
| Moultonborough | 4,044 | 828 | 2,311 | 905 | 4,940 | 35% | 30% | 61% | 5% |
| Ossipee | 4,345 | 924 | 2,578 | 843 | 3,057 | 60% | 48% | 34% | 12% |
| Tamworth | 2,856 | 591 | 1,744 | 521 | 1,969 | 66% | 50% | 25% | 16% |
| Tuftonboro | 2,387 | 477 | 1,345 | 565 | 2,435 | 42% | 36% | 53% | 6% |

[1] *Percentage of total housing units*

### 2.1.3 LAND COVER

Characterizing land cover within a watershed on a spatial scale can highlight potential sources of NPS pollution that would otherwise go unnoticed in a field survey of the watershed. For instance, a watershed with large areas of developed land and minimal forestland will likely be more at risk for NPS pollution than a watershed with well-managed development and large tracts of undisturbed forest, particularly along headwater streams. Land cover is also the essential element in determining how much phosphorus is contributing to a lake via stormwater runoff and baseflow (see Section 3.3 on Watershed Modeling).

Current land cover in the Ossipee Lake watershed was determined using a combination of land cover data from NH GRANIT's New Hampshire Land Cover Assessment 2001 [NHLC01], National Wetland Inventory (NWI) wetlands, National Hydrography Dataset (NHD) waterbodies, 2009 National Agriculture Imagery Program (NAIP) aerials, and Google Earth satellite images from September 18, 2013. For more details on methodology, see the Ossipee Lake - Lake Loading Response Model Report (FBE, 2017a).

Today, development accounts for 6% (974 acres) of the watershed, while forested areas dominate at 86% (13,460 acres) (Figure 2-3). Wetlands and open water represent 8% (1,245 acres) of the watershed, not including Ossipee Lake. Agriculture represents <1% (49 acres), and includes row crops and hayfields. Developed areas within the Ossipee Lake Shoreline and Lovell

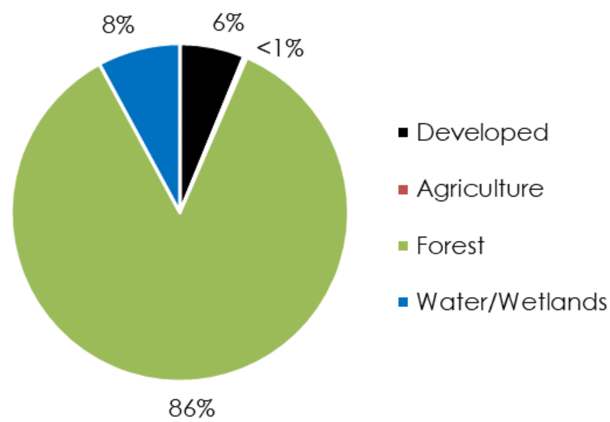
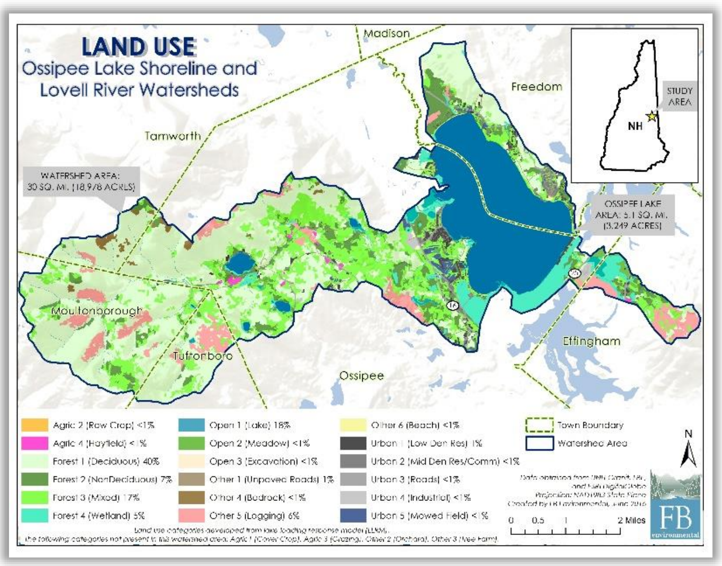



**Figure 2-3. Watershed land cover in the Ossipee Lake Shoreline and Lovell River watersheds. Does not include lake surface area.**

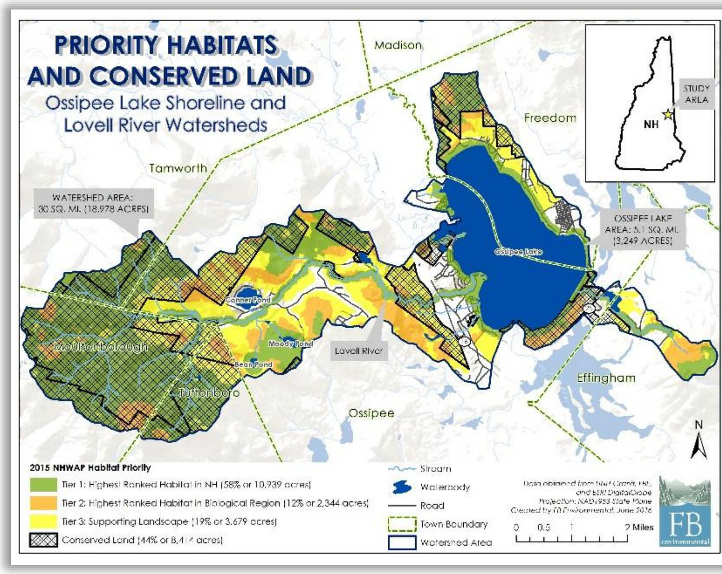



**Land cover within the direct shoreline of Ossipee Lake and the Lovell River watershed is dominated by forest. Refer to Appendix A, Map 2.**

River watersheds, particularly along the shores of Ossipee Lake around Deer Cove and at the Totem Pole Park campground, 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 LID techniques into new development projects. More information on LID strategies and BMP implementation can be found in the Action Plan in Section 5.2.

### 2.1.4 LAND CONSERVATION

Land conservation is essential to the health of a region, particularly for the protection of water resources, enhancement of recreation opportunities, vitality of local economies, and preservation of wildlife habitat. Considerable effort by watershed towns and private individuals has gone into the protection of land within the Ossipee Lake Shoreline and Lovell River watersheds not only to protect critical wildlife habitat and other environmentally-sensitive land and water resources, but also to provide low-impact, public recreational access to these natural resources. Land conservation is one of many tools for protecting lake water quality for future generations. Conservation land in the watershed covers 13.1 square miles (8,414 acres) or approximately 44% of the watershed. This includes the 347-acre Ossipee Natural Area which conserves a two-mile-long stretch of shoreline on the south side of Ossipee Lake. The Ossipee Pine Barrens is another significant piece of conserved land bordering the lake, covering 68.9 acres in the northwest corner of Ossipee Lake. The Bearcamp Memorial Forest is the only other conserved land on the Ossipee Lake shoreline, covering 153.7 acres. Retsof/Chocorua Forestland conserves 2,800 acres in the Lovell River headwaters area through the USDA Forest Service Forest Legacy Program. The area is managed for forest products[1].




**Conservation land (hatched) covers 44% of the Ossipee Lake Shoreline and Lovell River watersheds. Refer to Appendix A, Map 3.**

## 2.2 PHYSICAL FEATURES

### 2.2.1 TOPOGRAPHY

The highest elevation in the watershed (2,986 feet) is located on the summit of Shaw Mountain in Moultonborough, above the headwaters of White Brook, a tributary to the Lovell River. Ossipee Lake and the direct shoreline drainage area are at approximately 410 feet.

[1] *https://www.na.fs.fed.us/legacy/legacy_places/nh/pdfs/nh_ossipee_s.pdf*

## 2.2.2 SOILS AND GEOLOGY

### Surficial Geology

The composition of soils surrounding Ossipee Lake reflects the dynamic geological processes that have shaped the landscape of New Hampshire over millions of years. Some 300 to 400 million years ago, much of the northeastern United States was covered by a shallow sea; layers of mineral deposition compressed to form sedimentary layers of shale, sandstone, and limestone (Goldthwait, 1951). Over time, the Earth's crust then folded under high heat and pressure to change the sedimentary rocks into metamorphic rocks (quartzite, schist, and gneiss parent material). This metamorphic parent material has since been modified by bursts of molten material intrusions to form igneous rock, including granite for which New Hampshire is famous for (Goldthwait, 1951). Erosion has further modified and shaped this parent material over the last 200 million years.

The current landscape formed 12,000 years ago, at the end of the Great Ice Age, as the mile-thick glacier over half of North America melted and retreated, scouring bedrock and depositing glacial till to create the deeply scoured basin of the region's lakes. The retreating action also eroded mountains and left behind remnants of drumlins and eskers from ancient stream deposits. The glacier deposited a layer of glacial till more than three feet deep. Glacial till is composed of unsorted material, with particle sizes ranging from loose and sandy to compact and silty to gravely. This material laid the foundation for invading vegetation and meandering streams as the depression basins throughout the region began to fill with water (Goldthwait, 1951).

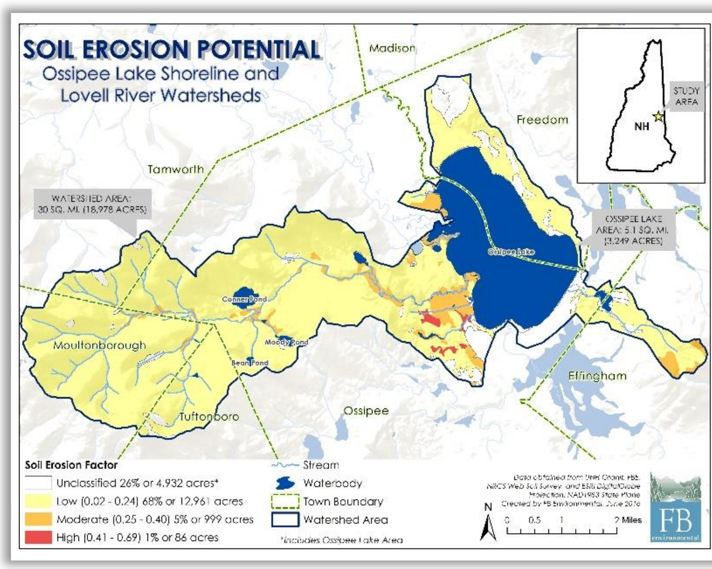
The unique geological formation in this area formed the Ossipee Stratified Drift Aquifer, one of the cleanest and most productive aquifers in the region. The coarse grains in this aquifer allow for easy movement of water while also providing storage and biological filtration of the passing water. The terrain in the Ossipee Lake Shoreline and Lovell River watersheds is a product of these geological processes with an outwash plain north of Ossipee Lake (between Silver Lake and Ossipee Lake) and the Pine River Esker located along the Pine River. Ossipee Lake is a discharge point for the aquifer, meaning that the lake receives water from the aquifer. Any contamination in the aquifer will move quickly due to the high transmissivity of the material and enter Ossipee Lake. Therefore, protection of the aquifer is vital to the protection of the lake.

### Soils

The soils in the Ossipee Lake Shoreline and Lovell River watersheds (Appendix A, Map 4; Appendix B) are a direct result of geologic processes. The most prevalent soil group in the watershed is Becket fine sandy loam very stony (4,006 acres, 21%) closely followed by Lyman-Berkshire-Rock outcrop complex (3,564 acres, 19%), and Berkshire soils, very stony (1,244 acres, 7%). These large grain sizes are responsible for the high transmissivity of the Ossipee Aquifer.

### Soil Erosion Potential

Soil erosion potential is dependent on a combination of factors, including land contours, climate conditions, soil texture, soil composition, permeability, and soil structure (O'Geen et al., 2006). Soil erosion potential should be a primary factor in determining the rate and placement of



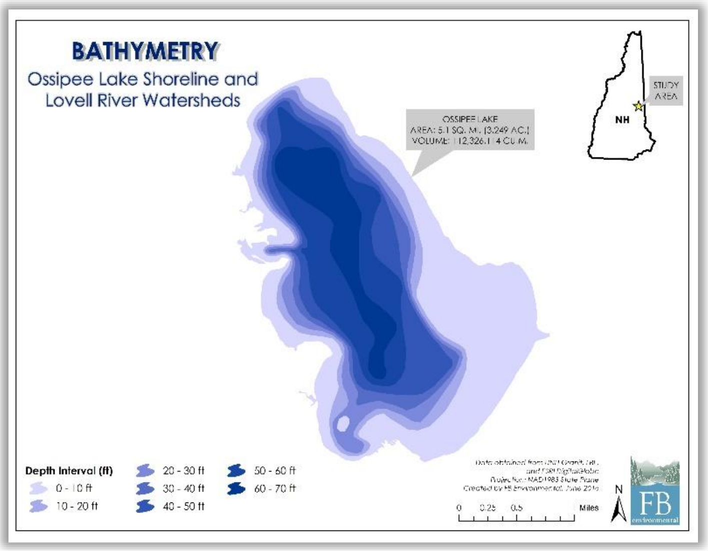

**Moderately-high to high soil erosion potential areas cover 6% of the watershed; these areas are co-located with dense development. Refer to Appendix A, Map 5.**

development within a watershed. Soils with negligible soil erosion potential are primarily low-lying wetland areas near abutting streams. The soil erosion potential for the Ossipee Lake Shoreline and Lovell River watersheds was determined from the associated erosion factor $K_w$[2] used in the Universal Soil Loss Equation (USLE). The USLE predicts the rate of soil loss by sheet or rill erosion in units of tons per acre per year.

Moderately-high and high soil erosion potential areas, which account for 6% of the watershed, are concentrated around the outlets of the Lovell River and Weetamoe Brook (Appendix A, Map 5). Low to moderately-low erosion potential areas, which account for 68% of the watershed, are found throughout much of the watershed. Twenty-six percent (26%) of the watershed is listed as unclassified (including the Ossipee Lake area). Development should be restricted in areas with highly erodible soils due to their inherent tendency to erode at a greater rate than what is considered tolerable soil loss. Since a highly erodible soil can have greater negative impact on water quality, more effort and investment is required to maintain its stability and function within the landscape, particularly from BMPs that protect steep slopes from development and/or prevent stormwater runoff from reaching water resources.

### 2.2.3 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.




**Bathymetry of Ossipee Lake (UNH GRANIT; Appendix A, Map 6).**

The surface area of Ossipee Lake is 5.1 square miles (3,249 acres) with a mean depth of 27.9 feet (8.5 m) and maximum depth of 60.7 feet (18.5 m) at the deep spot (NHDES, 2014c; Appendix A, Map 6). There are 10.6 miles of shoreline and the volume is 112,326,114.4 $m^3$ (this volume calculated from NH GRANIT bathymetry file is slightly larger than the VLAP report, which estimates the volume at 108,421,500 $m^3$). The **areal water load** is 116.8 ft/yr (35.6 m/yr), and the **flushing rate** is 4.1 times each year (VLAP report estimates 4.6) in comparison to 18 and 24 times per year for Danforth Pond and the Lower Bays, respectively. The high flushing rate of 4.1 means that the entire volume of Ossipee Lake is replaced four times every year, which flushes pollutants out quickly, greatly reducing time for settling in lake bottom sediments or being taken up by biota.

### 2.2.4 HABITATS AND WILDLIFE

New Hampshire Fish and Game Department (NHFGD) ranks habitat based on value to the State, biological region (areas with similar climate, geology, and other factors that influence biology), and supporting landscape. These habitat rankings are published in the State's 2015 Wildlife Action Plan, which serves as a blueprint for prioritizing conservation actions to protect Species of Greatest Conservation Need in New Hampshire. More than 10,000 acres (58%) of the Ossipee Lake Shoreline and Lovell River watersheds are considered Tier 1 habitat (highest ranked habitat in NH). Tier 1 habitat includes almost the entire shoreline

[2] *$K_w$ = the whole soil k factor. This factor includes both fine-earth soil fraction and large rock fragments.*

of Ossipee Lake. Most of the Tier 1 habitat overlaps with current conservation parcels. A map of priority habitats for conservation based on the NH Wildlife Action Plan can be found in Appendix A, Map 3.

The watershed is characterized primarily by mixed forest that includes both conifers (e.g., white pine and eastern hemlock) and deciduous (e.g., beech, red oak, and maple) tree species. Fauna that enjoy these rich forested resources include land mammals (moose, deer, black bear, coyote, bobcats, fisher, fox, raccoon, weasel, porcupine, muskrat, mink, chipmunks, squirrels, and bats), water mammals (muskrat, otter, and beaver), land and water reptiles and amphibians (turtles, snakes, frogs, and salamanders), various insects, and birds (herons, loons, gulls, multiple species of ducks, wild turkeys, cormorants, bald eagles, and song birds). Fish are an important natural resource for sustainable ecosystem food webs and provide recreational opportunities. Ossipee Lake supports a diversity of both warmwater and coldwater fish species. These species include rainbow trout, brown trout, lake trout, small and largemouth bass, and white perch. Brook trout are also found in the Lovell River.

### 2.3 DIRECT AND INDIRECT DRAINAGE AREAS

Watershed water load (which includes runoff and tributary flow) from the Ossipee Lake Shoreline and Lovell River watersheds accounts for 10% of the total water entering Ossipee Lake on an annual basis. This fact makes the tributaries and their associated land covers critical to the water quality of Ossipee Lake. Watershed water loads from the other major tributaries to Ossipee Lake (Bearcamp River, Beech River, Pine River, and West Branch River), as well as atmospheric and septic system water loads, make up the additional water load to the lake. The most significant tributary drainage areas to Ossipee Lake are the Bearcamp River and Pine River, which account for 51% and 20% of the watershed water load, respectively. A detailed summary of the water and nutrient loading analysis for Ossipee Lake is provided in Section 3.3.

### 2.4 INVASIVE SPECIES

The introduction of non-indigenous invasive aquatic plant species to New Hampshire's waterbodies has been on the rise. These invasive aquatic plants are responsible for habitat disruption, loss of native plant and animal communities, reduced property values, impaired fishing and degraded recreational experiences, and high removal costs. Once established, invasive species are difficult and costly to remove.

Milfoil was first discovered in Danforth Ponds in the early 1980's and spread to Broad Bay, Phillips Brook, and eventually Leavitt Bay. The Broad-Leavitt Bay Association took immediate action to eradicate the milfoil by hand-pulling the weeds during annual drawdowns. By 2003, the OLA applied chemical treatment to dense milfoil patches in Phillips Brook. A milfoil management plan was developed for the area based on expert recommendations by the NHDES. The plan is managed and carried out by the milfoil subcommittees of the Freedom and Ossipee conservation commissions. The OLA established an Exotic Species Prevention program in cooperation with the State's Weed Watchers program to ensure boaters are properly inspected for invasive species (e.g., milfoil) before entering the lake. Education pamphlets that detail infestation areas in each waterbody are distributed at these public boat launch locations. In 2014, the Town of Freedom established an Aquatic Invasives Species Committee, which obtained funding from state, private, and local sources to help monitor and control milfoil infestation. Milfoil was kept out of the main basin of Ossipee Lake until 2012, when it was first sited near the mouth of the Pine River. The sandy bottoms of Ossipee Lake are not ideal for milfoil attachment, but its presence in the lake shows just how resistant it can be and emphasizes the importance of continued management and prevention.

# 3. ASSESSMENT OF WATER QUALITY

This section provides an overview of the water quality standards that apply to Ossipee Lake, the methodology used to assess water quality, the past, current, and future state of water quality based on the assessment, the established water quality goal and objective, and the potential pollutant sources in the watershed.

While Ossipee Lake itself is not listed by the State of New Hampshire as impaired for its designated uses, several other waterbodies connected to Ossipee Lake are listed as impaired for aquatic life use or primary contact recreation due to low **pH**, low **dissolved oxygen**, poor **benthic macroinvertebrate** or fish bioassessments, or **cyanobacteria** (presence of toxic **microcystins**) (NHDES, 2014b). For Phase II waterbodies, the Lovell River is listed as impaired for pH and Red and Weetamoe Brooks as impaired for pH and dissolved oxygen. Low pH in New Hampshire surface waters is the result of atmospheric deposition in the form of acid rain (from industrial emissions) and poor buffering capacity from granitic parent material that has delayed or prevented recovery from acid rain in waterbodies of the northeast. Low dissolved oxygen in Red and Weetamoe Brooks, both of which are small direct drainages to Ossipee Lake, is likely the result of enhanced organic matter decomposition following rapid plant and algae growth, stimulated by excess nutrients. Both streams showed elevated levels of total phosphorus and total nitrogen.

In addition, the water quality of Ossipee Lake is vulnerable to landscape change from development, which causes degradation in the water quality of incoming tributaries or along the direct shoreline to the lake. Recent analyses showed an increase in the prevalence of low dissolved oxygen (e.g., **anoxia**) in bottom waters and subsequent increases in **hypolimnion** phosphorus concentrations at the deep spot of Ossipee Lake. The challenge, like for many other New Hampshire lakes, is to mitigate pollutant nutrient loading to Ossipee Lake from anticipated growth to prevent a decline in water quality or **trophic status**. As development or other human activities in the watershed increase (e.g., new residential or commercial construction or conversion of small, seasonal properties to large, year-round homes), unmitigated sources of pollution (i.e., phosphorus) will increase and associated algae and plant growth will contribute to oxygen depletion as algal cells and other organic matter sink, die, and decompose in deeper sections of the lake. Low oxygen in bottom waters may lead to a release of phosphorus bound in sediments, refueling algae and plant growth in upper portions of the water column. Enhanced algal blooms and depleted oxygen in bottom waters will lead to water quality degradation and loss of property values along the Ossipee Lake shoreline. As such, phosphorus is the focus of the water quality goal and the target pollutant for management efforts.

### 3.1 APPLICABLE WATER QUALITY STANDARDS AND CRITERIA

The State of New Hampshire is required to follow federal regulations under the **Clean Water Act (CWA)** with some flexibility as to how those regulations are enacted. The main components of water quality regulations include designated uses, water quality criteria, and antidegradation provisions. The Federal CWA, the NH *RSA 485-A Water Pollution and Waste Control*, and the NH Surface Water Quality Regulations (Env-Wq 1700) are the regulatory bases for governing water quality protection in New Hampshire. These regulations form the basis for New Hampshire's regulatory and permitting programs related to surface waters. States are required to submit biennial water quality status reports to Congress via the USEPA. The reports provide an inventory of all waters assessed by the state and indicate which waterbodies exceed the state's water quality standards. These reports are commonly referred to as the "Section 303(d) list" and the "Section 305(b) report."

### 3.1.1 DESIGNATED USES & WATER QUALITY CLASSIFICATION

The CWA requires states to determine designated uses for all surface waters within the state's jurisdiction. 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 (Table 3-1). Surface waters can have multiple designated uses.

In New Hampshire, all surface waters are also legislatively classified as Class A or Class B, most of which are Class B (Env-Wq 1700). A brief description of these classes is provided in Table 3-2 (NHDES, 2014a). Water quality criteria are then developed to protect these designated uses. Depending on the designated use and type of waterbody, water quality criteria can become more or less strict if the waterbody is classified as either Class A or B. Water quality criteria for lakes are discussed in Section 3.1.2. Ossipee Lake is considered a Class B waterbody.

**Table 3-1. Designated uses for New Hampshire surface waters (adapted from NHDES, 2014a).**

| Designated Use | NHDES Definition | Applicable Surface Waters |
|---|---|---|
| Aquatic Life | Waters that provide suitable chemical and physical conditions for supporting a balanced, integrated, and adaptive community of aquatic organisms. | All surface waters |
| Fish Consumption | Waters that support fish free from contamination at levels that pose a human health risk to consumers. | All surface waters |
| Shellfish Consumption | Waters that support a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers. | All tidal surface waters |
| Drinking Water Supply After Adequate Treatment | Waters that with adequate treatment will be suitable for human intake and meet state/federal drinking water regulations. | All surface waters |
| Primary Contact Recreation | Waters suitable for recreational uses that require or are likely to result in full body contact and/or incidental ingestion of water. | All surface waters |
| Secondary Contact Recreation | Waters that support recreational uses that involve minor contact with the water. | All surface waters |
| Wildlife | Waters that provide suitable physical and chemical conditions in the water and the riparian corridor to support wildlife as well as aquatic life. | All surface waters |

**Table 3-2. New Hampshire surface water classifications (adapted from NHDES, 2014a).**

| Classification | Description (RSA 485-A:8) |
|---|---|
| Class A | Class A waters shall be of the highest quality. There shall be no discharge of any sewage or wastes into waters of this classification. The waters of this classification shall be considered as being potentially acceptable for water supply uses after adequate treatment. |
| Class B | Class B waters shall be of the second highest quality. The waters of this classification shall be considered as being acceptable for fishing, swimming and other recreational purposes and, after adequate treatment, for use as water supplies. |

### 3.1.2 LAKE WATER QUALITY CRITERIA

New Hampshire's water quality criteria provide a baseline measure of water quality that surface waters must meet to support their designated uses. These criteria are the "yardstick" for identifying water quality problems and for determining the effectiveness of state regulatory pollution control and prevention programs. If the existing water quality meets or is better than the water quality criteria, the waterbody supports its designated use(s). If the waterbody does not meet water quality criteria, then it is considered impaired for its designated use(s).

Water quality criteria for each classification and designated use in New Hampshire can be found in RSA 485 A:8, IV and in the State's surface water quality regulations. Aquatic Life Use (ALU) and Primary Contact Recreation (PCR) are the two major uses for Ossipee Lake.

**Aquatic Life Use (ALU)**

Criteria for ALU ensure that waters provide suitable habitat for the survival and reproduction of desirable fish, shellfish, and other aquatic organisms. For ALU assessment, the State has narrative nutrient criteria with a numeric translator or threshold, consisting of a "nutrient indicator" or total phosphorus and a "response indicator" or **chlorophyll-a** (Chl-a) (see also: Env-Wq 1703.03, Env-Wq 1703.04, Env-Wq 1703.14, and Env-Wq 1703.19). The nutrient and response indicators are intricately linked since increased phosphorus loading frequently results in greater algal concentrations, which can be estimated by measuring chlorophyll-a levels in the lake. More algae may lead to decreased oxygen at the bottom of the lake, decreased water clarity, and possibly changes in aquatic species composition.

As shown in Table 3-3, ALU criteria vary by lake trophic state, since each trophic state has a certain algal biomass (chlorophyll-a) that represents a balanced, integrated, and adaptive community. Exceedances of the chlorophyll-a criterion suggests that the algal community is out of balance. Since phosphorus is the primary limiting nutrient for growth of freshwater algae (chlorophyll-a), phosphorus is included in this assessment process. For ALU assessment, phosphorus and chlorophyll-a are combined per the decision matrix presented in Table 3-4. 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 B 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 5 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). Lakes that support coldwater fisheries must also meet a 7-day mean of 9.5 ppm and an instantaneous measurement of 8 ppm in the **epilimnion** (if stratified) or in the top 25% of the depth (if not stratified) from October 1 to May 14.

From 1974 through 2010, NHDES conducted trophic surveys of lakes to determine trophic state (**oligotrophic**, **mesotrophic**, or **eutrophic**). The trophic surveys evaluated physical lake features, as well as chemical and biological indicators. For Ossipee Lake, the trophic state was determined to be oligotrophic during all three surveys (1976, 1987, 2003). This means that in-lake water quality (i.e., total phosphorus, chlorophyll-a, and dissolved oxygen) were consistent with the standards for oligotrophic lakes.

**Table 3-3. Aquatic life nutrient criteria by trophic class in New Hampshire. TP = total phosphorus. Chl-a = chlorophyll-a, a surrogate measure for algal concentration.**

| Trophic State | TP (ppb) | Chl-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 3-4. 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 |

**Primary Contact Recreation (PCR)**

For PCR, New Hampshire has a narrative criterion with a numeric translator or threshold for the primary indicator ***E. coli***. The narrative criteria for PCR (Env-Wq 1703.03) states that "*All surface waters shall be free from substances in kind or quantity which float as foam, debris, scum or other visible substances, produce odor, color, taste or turbidity which is not naturally occurring and would render it unsuitable for its designated uses or would interfere with recreation activities*." Nutrient response indicators, chlorophyll-a and cyanobacteria scums, are used as secondary indicators. Elevated chlorophyll-a levels or the presence of cyanobacteria scums interfere with the aesthetic enjoyment of swimming and/or may pose a health hazard. chlorophyll-a levels greater than or equal to 15 ppb or the presence of cyanobacteria scums are considered "not supporting" for PCR. These secondary indicators can provide reasonable evidence to classify PCR as "not supporting," but cannot result in a "fully supporting" designation. Duncan Lake Town Beach and White Lake State Park are both listed as impaired for PCR due to presence of cyanobacteria and toxic microcystins.

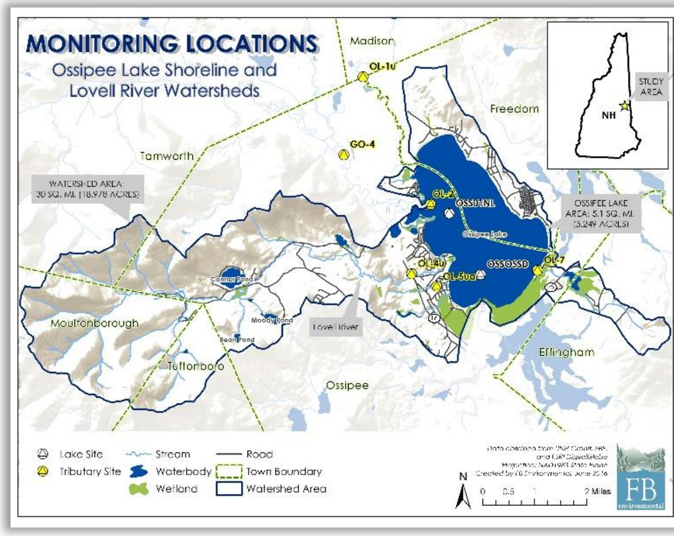
### 3.1.3 ANTIDEGRADATION PROVISIONS

The Antidegradation Provision (Env-Wq 1708) in New Hampshire's water quality regulations serves to protect or improve the quality of the State's waters. The provision outlines limitations or reductions for future pollutant loading. Certain development projects (e.g., projects that require Alteration of Terrain Permit or 401 Water Quality Certification) may be subject to an Antidegradation Review to ensure compliance with the State's water quality regulations. The Antidegradation Provision is often invoked during the permit review process for projects adjacent to waters that are designated impaired, high quality, or outstanding resource waters. While NHDES has not formally designated high-quality waters, unimpaired waters are treated as high quality with respect to issuance of water quality certificates. Antidegradation requires that a permitted activity cannot use more than 20% of the remaining assimilative capacity of a high-quality water. This is on a parameter-by-parameter basis. For impaired waters, antidegradation requires that permitted activities discharge no additional loading of the impaired parameter.

## 3.2 WATER QUALITY SUMMARY

### 3.2.1 STUDY DESIGN AND DATA ACQUISITION

Data acquisition and analysis for Ossipee Lake followed protocols set forth in the Site Specific Project Plan (SSPP) in Appendix C. Water quality monitoring data were accessed from the NHDES OneStop Environmental Monitoring Database (EMD). A detailed summary of all available data, including sources and years of collection, can be found in the Ossipee Lake Water Quality Analysis (FBE, 2017b).




**Monitoring site locations of Ossipee Lake and its tributaries. Refer to Appendix A, Map 7 for larger map.**

FBE completed analysis for several key water quality parameters, including **Secchi disk transparency**, chlorophyll-a, total phosphorus, pH, **specific conductance**, **alkalinity or acid neutralizing capacity**, dissolved oxygen, and temperature. Analysis included a comparison of historical (1976-2006) and recent (2007-2016) seasonal (collected between May 24 and September 15) water quality data, statistical analysis of historical water quality trends, calculation of the median in-lake phosphorus concentration using only epilimnion core samples, and determination of current trophic state and **assimilative capacity**. Detailed descriptions of analysis methods and assessment of all water quality parameters can be found in the Ossipee Lake Water Quality Analysis (FBE, 2017b).

### 3.2.2 TOTAL PHOSPHORUS, CHLOROPHYLL-A, AND SECCHI DISK TRANSPARENCY

Total phosphorus, chlorophyll-a, and water clarity (i.e., Secchi Disk Transparency (SDT)) are inter-related trophic state indicators that dictate water quality impairment determinations. In freshwater systems, phosphorus is the limiting nutrient (i.e., food source) for the growth of algae and plants. Thus, higher amounts of phosphorus in the water column typically leads to increased growth of algae and plants and elevated levels of measured chlorophyll-a. The excess organic material in the water column can cloud water and lead to a decrease in water clarity. **Overall, phosphorus, chlorophyll-a, and water clarity are good in Ossipee Lake and well below the NHDES ALU criteria for oligotrophic lakes** (Figure 3-1).

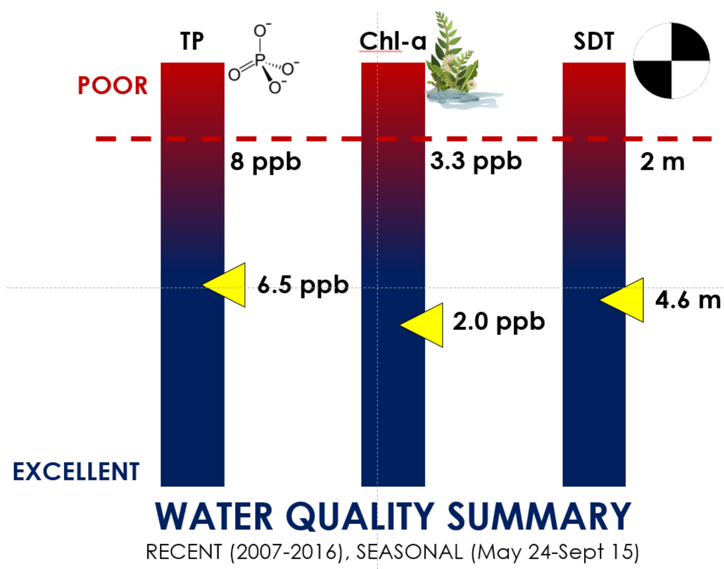



**Figure 3-1. Visual summary of current water quality in Ossipee Lake. Data represent recent (2007-2016) and seasonal (May 24-Sept 15) median calculations. TP = total phosphorus; Chl-a = chlorophyll-a; SDT = Secchi Disk Transparency. SDT is based on data collected with a scope.**

Total phosphorus, chlorophyll-a, and water clarity also show no statistically significant trends in average annual data, indicating that these parameters have remained relatively stable (with some interannual variation due to weather) over the last several decades. For instance, wetter years may deliver more phosphorus-laden sediment to waterbodies and reduce water clarity. Vice versa, drier years typically generate excellent water quality conditions in lakes by reducing the amount of pollutants washing off the landscape and into surface waters. However, while it is difficult to make any strong conclusions about a change in water quality based on limited historical data (prior to 2003), water clarity may have worsened slightly and should be monitored closely in the future.

### 3.2.3 DISSOLVED OXYGEN AND HYPOLIMNION TOTAL PHOSPHORUS

Dissolved oxygen and temperature profiles from the deep spot in Ossipee Lake show typical midsummer **stratification** for New Hampshire lakes, with high oxygen and warm water temperatures near the surface followed by a marked decrease in temperature and oxygen below the metalimnion (i.e., **thermocline**) around 3-8 m below the surface. Dissolved oxygen concentrations can change dramatically with lake depth as a function of water density and biological consumption. Oxygen is produced in the top portion of a lake (where sunlight drives photosynthesis by algae and other plants) and oxygen is consumed near the bottom of a lake (where organic matter accumulates and decomposes). Thus, low oxygen in bottom waters can be a natural phenomenon when thermal stratification in late summer separates oxygenated surface waters from bottom waters. However, an increase in the extent and duration of low oxygen in lakes can be detrimental to aquatic life by reducing their desired habitat (cooler, high-oxygen waters > 5 ppm; NHDES, 2014a). Dissolved oxygen less than 1-2 ppm can release sediment-bound phosphorus back into the water column (a.k.a., **internal phosphorus loading**) where it can re-stimulate algae blooms and plant growth, creating a positive feedback to eutrophication.

Low levels of dissolved oxygen (< 5 ppm) in the hypolimnion (e.g., bottom waters) have become more common since 2008 and on average impact 74% of lake volume each year in Ossipee Lake. Internal phosphorus loading was evident in 2010, 2014, and 2015 when on average > 50% of lake volume was impacted by oxygen < 2 ppm and hypolimnion phosphorus measured above 8 ppm. Though phosphorus measured in the hypolimnion of Ossipee Lake has not been high overall, internal phosphorus loading is a concern for the lake if the recent pattern of low oxygen in bottom waters continues or extends to include earlier parts of the season. When thermal stratification of the lake breaks down in the fall, potentially phosphorus-rich waters in the hypolimnion are mixed and re-distributed throughout the rest of the water column (a.k.a., fall turnover), which can stimulate algae and/or cyanobacteria growth for the next season. As such, it will be important to continue monitoring dissolved oxygen, temperature, and hypolimnion phosphorus on a yearly basis in late summer.

### 3.2.4 PH AND ALKALINITY/ACID NEUTRALIZING CAPACITY

pH is the standard measure of the acidity or alkalinity of a solution on a scale of 0 (acidic) to 14 (basic). Several waterbodies connected to Ossipee Lake, including the Lovell River, Red Brook, and Weetamoe Brook are listed as impaired for aquatic life due to low pH. Low pH in New Hampshire surface waters is the result of atmospheric deposition in the form of acid rain (from industrial emissions) and poor buffering capacity from granitic parent material that has delayed or prevented recovery from acid rain in the northeast. The buffering capacity of water is measured by alkalinity or acid neutralizing capacity (ANC)[3]. A higher alkalinity means that a waterbody has a greater ability to neutralize acidic inputs. A waterbody is considered impaired in New Hampshire when the pH falls below 6.5 or above 8.0. Median pH for Ossipee Lake since 1976 is 6.7, which is suitable for aquatic life (>6.5; NHDES, 2014a). Alkalinity and ANC fall within the "moderately vulnerable" range (NHDES, 2014a), though Ossipee Lake has slightly better buffering

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*[3] NHDES switched from measuring buffering capacity as alkalinity to ANC in 2008. There is a small difference between alkalinity and ANC methodologically, in that alkalinity is measured from filtered water (neutralizing ability of solutes only) and ANC is from unfiltered water (meaning neutralizing ability of solutes + particulates, if present). These are often used interchangeably in the literature, but differences between the two types should be noted when interpreting historical data.*

capacity compared to other lakes in the region and the State. A trend analysis could not be performed, but recent years show a pattern of improving buffering capacity.

### 3.2.5 TRIBUTARY WATER QUALITY ANALYSIS

Many of the tributaries to Ossipee Lake have been monitored by GMCG since 2003 for total phosphorus, pH, specific conductance, chloride, and turbidity (FBE, 2017b). Analysis of tributary water quality can help to identify which tributaries may be adversely impacting the water quality of Ossipee Lake and to prioritize those drainage areas for phosphorus and sediment management. Determination of median phosphorus for these tributaries also helped inform the land use model (Section 3.3).

**In summary, Red Brook and Weetamoe Brook should be prioritized for future monitoring and land use investigations of potential NPS pollution.** Red Brook and Weetamoe Brook showed elevated levels of total phosphorus and total dissolved nitrogen (TDN; Total Kjeldahl Nitrogen (TKN) + $NO_3$-N + $NO_2$-N) (Table 3-5). Based on the land use assessment, the area draining to these tributaries are likely impacted by development and/or logging operations. Local perturbation, such as soil erosion, may be contributing to the increased sediment and nutrient load to these streams.

pH in all tributaries is considered acidic (< 7.0) and of poor quality for aquatic life (< 6.5). Though Ossipee Lake appears to have moderate buffering capacity compared to other lakes in the region, the acidic contributions of these tributaries could further decrease pH in the lake, which is only slightly better than the minimum aquatic life criteria.

Specific conductance and chloride were consistent among the tributaries. Given typical New England geology, specific conductance above 100 µS/cm generally indicates some human disturbance, and was not observed in any of the tributaries. However, the highest mean specific conductance was found in Red Brook, providing additional evidence that this tributary may be a problem source of NPS pollutants. The highest mean chloride was measured in West Branch River, though all chloride concentrations fell far below the chronic exposure limit of 230 ppm.

**Table 3-5. Summary data for Ossipee Lake tributaries. Values represent the mean or median of all available data (FBE, 2017b). Bold and italicized text highlights parameters and sites of concern. TP = total phosphorus.**

| SITE ID | TRIBUTARY | MEDIAN TP (PPB) | MEAN TDN (PPB) | MEAN TURBDITY (NTU) | MEAN PH | MEAN SPCOND (µS/CM) | MEAN CHLORIDE (PPM) |
|---|---|---|---|---|---|---|---|
| GO-4 | Bearcamp River 3 | 6 | 193 | 0.9 | ***5.3*** | 41 | 6 |
| OL-2 | Bearcamp River 4 | 8 | 183 | 0.8 | ***6.1*** | 51 | 7 |
| OL-4u | Lovell River 1 | 3 | 168 | 0.6 | ***5.8*** | 26 | 1 |
| OL-7 | Red Brook 3 | ***57*** | ***517*** | ***1.3*** | ***5.2*** | 56 | 8 |
| OL-5ua | Weetamoe Brook 1 | ***57*** | ***670*** | ***2.3*** | ***5.4*** | 45 | 5 |
| OL-1u | West Branch River 1 | 6 | 248 | 0.6 | ***6.0*** | 45 | 13 |

## 3.3 WATERSHED MODELING

Environmental modeling is the process of using mathematics to represent the natural world. Models are created to explain how a natural system works, to study cause and effect, or to make predictions under various scenarios. Environmental models range from very simple equations that can be solved with pen and paper, to highly complex computer software requiring teams of people to operate. Lake models, such as the Lake Loading Response Model (LLRM), can make predictions about phosphorus concentrations, chlorophyll-a concentrations, and water clarity under different pollutant loading scenarios. These types of models play a key role in the watershed planning process. USEPA guidelines for watershed plans require that both the assimilative capacity of the waterbody and pollutant loads from the watershed be estimated.

### 3.3.1 ASSIMILATIVE CAPACITY

A lake receives natural and human-derived inputs of phosphorus in runoff from its watershed. This phosphorus can be taken up by aquatic life within the lake, settle in the bottom sediments, or flow out of the lake to downstream waterbodies. In this sense, there is a natural balance between the amount of phosphorus flowing in and out of a lake system, also known as the ability of a lake to "assimilate" phosphorus. The assimilative capacity of a lake is its ability to receive and process nutrients (e.g., phosphorus) without impairing water quality or harming aquatic life and is based on factors such as lake volume, watershed area, precipitation, and runoff/baseflow export coefficients. If a lake is receiving more phosphorus from the watershed than it can assimilate, then its water quality will decline over time as algae or cyanobacteria blooms become more frequent. In relation to water quality criteria, the assimilative capacity of a waterbody describes the amount of phosphorus that can be added to a waterbody without causing a violation of the water quality criteria.

For oligotrophic waterbodies, like Ossipee Lake, the water quality criteria are set at 8 ppb for total phosphorus and 3.3 ppb for chlorophyll-a. NHDES requires 10% of the criteria be kept in reserve; therefore, median total phosphorus and chlorophyll-a must be at or below 7.2 ppb and 3.0 ppb, respectively, to achieve Tier 2 High Quality Water status. Support determinations are based on the nutrient stressor (phosphorus) and response indicator (chlorophyll-a), with chlorophyll-a dictating the assessment if both chlorophyll-a and total phosphorus data are available and the assessments differ.

Median total phosphorus at the deep spot of Ossipee Lake over the last ten years (2007-2016) was used to calculate the total, reserve, and remaining assimilative capacity (Table 3-6), using procedures described in the Standard Operating Procedures for Assimilative Capacity Analysis for New Hampshire Waters (NHDES, 2008) and the Consolidated Assessment and Listing Methodology (NHDES, 2014a). Tier 2 waters, or high-quality waterbodies, have one or more water quality parameters that are better than the water quality criteria and that also exhibit a reserve capacity of at least 10% of the waterbody's total assimilative capacity. Tier 2 waters have some assimilative capacity remaining, whereas Tier 1 and Impaired Waters do not. **Based on the assimilative capacity analysis, Ossipee Lake falls in the Tier 2 category for high-quality, oligotrophic lakes (Table 3-6).** This classification holds true, since chlorophyll-a is also better than the water quality criterion for oligotrophic lakes.

**Table 3-6. Summary of total phosphorus (TP) and chlorophyll-a (Chl-a) assimilative capacity (AC) analysis results for Ossipee Lake. Existing data reflects seasonal (May 24 – September 15) and recent (2007-2016) data. NHDES requires 10% of the criteria to be kept in reserve; therefore, median TP and Chl-a must be at or below 7.2 ppb and 3.0 ppb, respectively, to achieve Tier 2 High Quality Water status.**

| Lake and Station | Existing Median TP (ppb) | Remaining TP AC (ppb) | Existing Median Chl-a (ppb) | Remaining Chl-a AC (ppb) | Analysis Results |
|---|---|---|---|---|---|
| **Ossipee Lake** Deep Spot (OSSOSSD) | 6.5 | +0.7 | 2.0 | +1.0 | Tier 2 |

### 3.3.2 LAKE LOADING RESPONSE MODEL (LLRM) RESULTS

A second analysis was used to link watershed loading conditions with in-lake total phosphorus and chlorophyll-a concentrations to predict past, current, and future water quality in Ossipee Lake. An Excel-based model, known as the Lake Loading Response Model (LLRM), was used to develop a water and phosphorus loading budget for the lake and its 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.

Current watershed phosphorus and water loads for sub-basins with terminal discharges to Ossipee Lake are presented in Table 3-7. Phosphorus and water loads from the terminal sub-basins include all sub-basins that route through the terminal sub-basins before reaching Ossipee Lake. The Bearcamp River sub-basin had the highest total phosphorus mass exported to Ossipee Lake at 1,953 kg/yr. This is expected given the large contributing watershed area of the Bearcamp River (8,276 ha) and the resulting large flow volume (232,277,985 cu.m/yr). Tributaries with larger drainage areas will naturally have higher stream flow and will contribute more phosphorus than smaller tributaries.

On a per hectare basis, the Red Brook sub-basin had the highest total phosphorus loading, followed by the Bearcamp River and Weetamoe sub-basins (Appendix A, Maps 8 & 9). While Red Brook and Weetamoe Brook are contributing the least phosphorus by mass per year due to their significantly smaller watersheds, phosphorus exported per hectare of land is high compared to the other sub-basins. The Weetamoe Brook sub-basin may be contributing more phosphorus (and thus have a higher phosphorus mass exported per hectare) than what the model predicted, but insufficient observed data were available to correct phosphorus attenuation factors for Weetamoe Brook (e.g., model predicted roughly half of observed phosphorus concentration (*n* = 6, 2006-2012)). Red Brook had more data (*n* = 35, 2006-2015) to better adjust phosphorus attenuation values so that 2.5 times more phosphorus was exported from Red Brook than what the model predicted. With the highest percent developed area (36%) of all 50 sub-basins, Red Brook may be impacted by a failing septic system or have significantly different phosphorus export coefficients for developed land cover types than the other sub-basins. Further investigation may be warranted to determine where excess phosphorus to Red Brook and Weetamoe Brook is being sourced from[4]. While the Bearcamp River is only 15% developed, most of the developed area is agricultural lands, which have higher phosphorus export coefficients, and are likely driving the higher phosphorus mass exported per hectare. Also of note were the watershed loads in phosphorus mass by area for the Pine River and West Branch River sub-basins, both of which are impacted by large, recreational lakes (i.e., Pine River Pond and Silver Lake) with significant shoreline development.

**Table 3-7. Summary of pre-development, current, and future watershed total phosphorus (TP) and water loads by terminal sub-basin to Ossipee Lake.**

| | | Pre-Dev Watershed Loads | | | Current Watershed Loads | | | Future Watershed Loads | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sub-Basin | Land Area (ha) | Water (cu.m/yr) | P mass (kg/yr) | P mass by area (kg/ha /yr) | Water (cu.m/yr) | P mass (kg/yr) | P mass by area (kg/ha /yr) | Water (cu.m/yr) | P mass (kg/yr) | P mass by area (kg/ha /yr) |
| Bearcamp River | 8,276 | 233,122,319 | 706 | 0.09 | 232,277,985 | 1,953 | 0.24 | 256,844,437 | 2,432 | 0.29 |
| Beech River | 2,476 | 59,012,501 | 176 | 0.07 | 52,099,760 | 451 | 0.18 | 64,522,044 | 1,429 | 0.58 |
| Lovell River | 1,525 | 31,059,408 | 125 | 0.08 | 30,704,616 | 197 | 0.13 | 33,960,415 | 486 | 0.32 |
| Ossipee Lake Direct | 1,406 | 10,019,064 | 45 | 0.03 | 9,995,359 | 232 | 0.17 | 11,017,796 | 410 | 0.29 |
| Pine River | 4,715 | 91,862,717 | 314 | 0.07 | 90,624,331 | 958 | 0.20 | 101,337,854 | 2,595 | 0.55 |
| Red Brook | 403 | 2,831,960 | 12 | 0.03 | 2,678,055 | 125 | 0.31 | 3,026,767 | 235 | 0.58 |
| Weetamoe Brook | 113 | 830,651 | 3 | 0.03 | 833,310 | 23 | 0.21 | 913,816 | 32 | 0.28 |
| West Branch River | 988 | 32,608,144 | 53 | 0.05 | 32,442,716 | 199 | 0.20 | 36,065,666 | 289 | 0.29 |
| **TOTAL** | **19,902** | **461,346,764** | **1,457** | | **451,656,133** | **4,140** | | **507,688,796** | **7,909** | |

[4] Future monitoring should collect samples at Red and Weetamoe Brooks during storm events and spring snowmelt to capture high flow events. The existing data for these streams are skewed to dry weather periods in summer when these small streams run dry.

Overall, watershed load (87%) was the largest loading contribution across all sources, followed by septic systems (6%), atmospheric deposition (5%), waterfowl (1%) and internal loading (<1%) (Figure 3-2). Watershed load was also the dominant source of phosphorus in pre-development and future model predictions. Internal loading will likely remain a relatively insignificant source of phosphorus to Ossipee Lake given the large watershed size, but is predicted to increase 11-fold. Septic systems may increase from 6% to 8% of the total phosphorus loading to Ossipee Lake from current to future conditions; however, this may be underestimated given that voluntary septic system surveys are likely biased to respondents who maintain their systems properly.

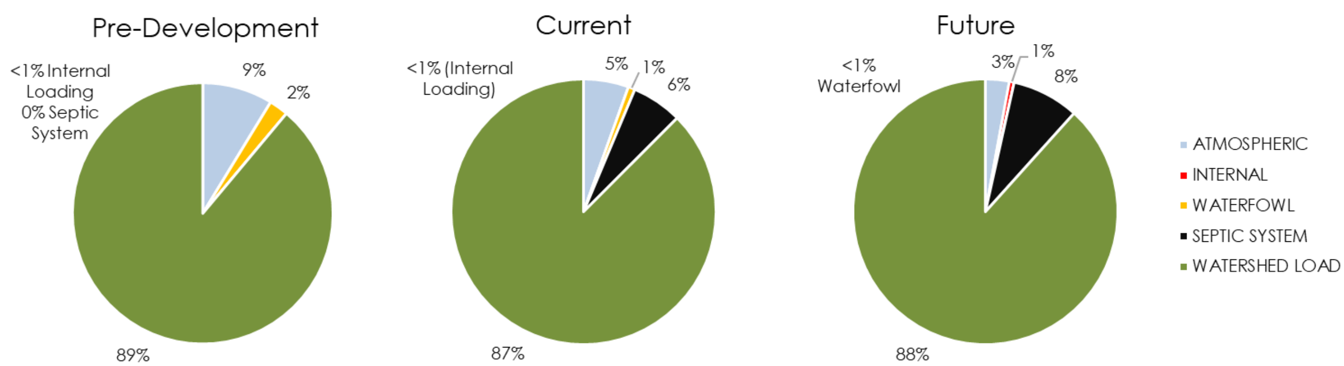


**Figure 3-2. Percentage of pre-development, current, and future total phosphorus (TP) loading (kg/yr) to Ossipee Lake by input category (atmospheric, internal, waterfowl, septic system, and watershed).**

The existing median total phosphorus shown in Table 3-8 reflects the recent, in-lake median total phosphorus concentration multiplied by a factor of 1.2 (assuming actual annual total phosphorus is 20% higher than summer total phosphorus). The model predicted within 4% (relative percent difference) of observed median total phosphorus for the current scenario (Table 3-8). The model also predicted within 11% of observed mean in-lake chlorophyll-a and within 6% of observed mean Secchi disk transparency. Predicted chlorophyll-a and Secchi disk transparency formulas within the model are estimated strictly from phosphorus loading, but other factors strongly affect these parameters, including low light from suspended sediment, grazing by zooplankton, presence of heterotrophic algae, and flushing effects from high flows. The good agreement between predicted and observed chlorophyll-a and Secchi disk transparency suggests that changes in phosphorus load to Ossipee Lake have a direct effect on water quality.

**Table 3-8. In-lake water quality predictions for Ossipee Lake. TP = total phosphorus; Chl-a = chlorophyll-a, SDT = Secchi disk transparency.**

| Condition | Median TP (ppb) | Predicted Median TP (ppb) | Mean Chl-a (ppb) | Predicted Mean Chl-a (ppb) | Mean SDT (m) | Predicted Mean SDT (m) |
|---|---|---|---|---|---|---|
| Pre-Dev | -- | 2.5 | -- | 0.1 | -- | 11.3 |
| Current | 7.8 (6.5)* | 7.5 | 2.0 | 1.8 | 4.6 | 4.9 |
| Future | -- | 12.9 | -- | 3.9 | -- | 3.2 |

**Median TP concentration of 6.5 represents existing in-lake summer epilimnion TP from observed data. Median TP concentration of 7.8 (which was used to calibrate the model) represents 20% greater than the observed median TP of 6.5 to account for year-round variation. Most lake data are collected in summer when TP concentrations are typically lower than annual average concentrations.*

### 3.3.3 HISTORICAL & FUTURE PHOSPHORUS LOADING: BUILD-OUT ANALYSIS

Once the model is calibrated for current in-lake total phosphorus concentration, we can then manipulate land cover and other factor loadings to estimate pre-development and future phosphorus loading (e.g., what in-lake total phosphorus concentration was prior to human development and what in-lake total phosphorus concentration will be following full buildout of the watershed under current zoning constraints). A comparison of pre-development, current, and future in-lake total phosphorus concentrations for Ossipee Lake is shown in Table 3-8 and Figure 3-3.

To predict the pre-development phosphorus load, FBE manipulated the model so that all development was converted back to natural vegetation, septic system inputs were set to zero, and internal loading estimates were smaller (assuming anoxic conditions observed today are the result of excess organic matter and nutrient loading from human activities in the watershed). The phosphorus load for pre-development conditions was estimated at 1,457 kg/yr, with an in-lake phosphorus concentration of 2.5 ppb. This pre-development load is 65% less than the current load and represents an estimate of the best possible water quality for the lake.

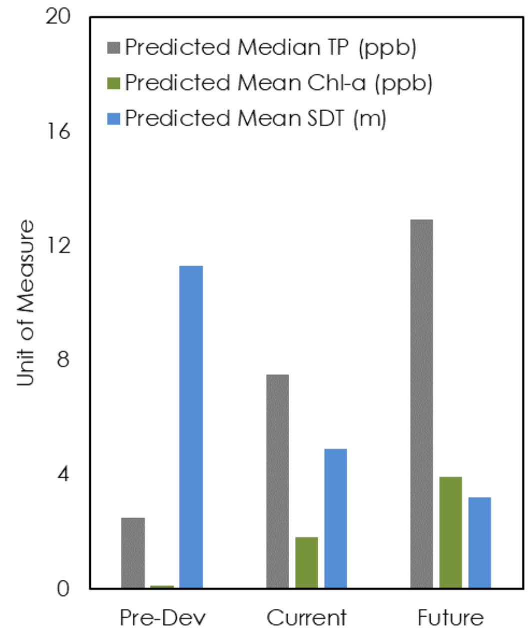


**Figure 3-3. Predicted total phosphorus (TP), chlorophyll-a (Chl-a), and Secchi Disk Transparency (SDT) for pre-development, current, and future loading conditions to Ossipee Lake.**

To predict the future phosphorus load from increased development, FBE first performed a build-out analysis for the Town of Ossipee (FBE, 2017c). The build-out analysis identified an estimated 22,313 acres (51%) of the entire 44,035-acre study area as developable. Up to 13,344 new buildings (a 402% increase from 2016) could be added at full build-out by the year 2107, using the 30-year compound annual growth rate of 1.91% (Appendix A, Map 10). This predicted increase in development was then input to the model for the Ossipee Lake watershed (including build-out results from the Town of Freedom from a previous study); the future phosphorus load was estimated at 7,909 kg/yr, with an in-lake phosphorus concentration of 12.9 ppb (Table 3-8). This future load is 48% more than the current load and represents an estimate of the worst possible water quality for the lake. On a per hectare basis, the Red Brook, Beech River, and Pine River sub-basins are predicted to have the greatest phosphorus mass exported and the greatest increase from current to future conditions in phosphorus mass exported, indicating that these sub-basins are most vulnerable to development and water quality degradation and should be prioritized for watershed implementation work.

Results of the build-out analysis reinforce the concept of comprehensive planning at the watershed level to address future development and its effect on the water quality of Ossipee Lake. Future development will increase the amount of polluted runoff that drains to Ossipee Lake. **Therefore, it is recommended that town officials revisit zoning ordinances to ensure that existing laws encourage smart, low-impact development** (see Section 5.2.4).

### 3.4 ESTABLISHMENT OF WATER QUALITY GOAL

The model results revealed changes in total phosphorus loading and in-lake total phosphorus concentrations over time from pre-development through future conditions. At full build-out, Ossipee Lake would suffer from degraded water clarity and algal blooms, would not support its designated uses, and would be listed as an impaired waterbody. The steering committee used these results to make an informed management decision and set an appropriate water quality goal for Ossipee Lake.

The goal of the *Ossipee Lake Watershed Management Plan Phase II: A Watershed Plan for the Ossipee Lake Shoreline and Lovell River Watersheds* is to protect the water quality of Ossipee Lake. This goal will be achieved through the following objective: **reduce pollutant loading from the Ossipee Lake Shoreline and**

**Lovell River sub-basins to Ossipee Lake to help maintain or improve in-lake median total phosphorus concentration**. The estimated annual total phosphorus load increase from new development at full build-out (based on the 30-year compound annual growth rate) was predicted at 4,258 kg/yr by 2107 or 47 kg/yr cumulatively over the next 91 years (2016-2107). To maintain current water quality conditions, watershed stakeholders will need to implement LID techniques and/or reduce phosphorus loading from current development to combat the expected increase of 470 kg/yr in phosphorus loading over the next 10 years. However, Phase II focuses only on the Ossipee Lake Shoreline and Lovell River sub-basins to Ossipee Lake. The Ossipee Lake Shoreline and Lovell River sub-basins are predicted to increase in watershed and septic system loading by 194 and 305 kg/yr, respectively, by 2107 or 21 and 34 kg/yr, respectively, over the next 10 years (2018-2027). A reduction in phosphorus loading is no easy task, and because there are many diffuse sources of phosphorus reaching the lake from existing residential development, roads, septic systems, and other land uses in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful. Refer to Section 5.2 for specific recommendations.

The interim goals or benchmarks for the water quality objective allow flexibility in re-assessing the water quality objective following more data collection and incorporation of expected increases in phosphorus loading from new development in the watershed over the next 10 or more years (Table 3-9). Understanding where we will be following watershed improvements compared to where we could have been following no action will help guide adaptive changes to interim goals (e.g., goals are on track or goals are falling short). Non-attainment of goals due to lack of funding for implementation projects to reduce existing sources or deal with phosphorus increases from new development may result in different courses of action when adjusting interim goals. For each interim goal year, particularly after 5 and 10 years, the committee should meet to update the water quality data and model and assess why goals are or are not being met. The committee will then decide on how to adjust the next interim goals to better reflect water quality conditions and practical limitations to implementation.

**Table 3-9. Interim benchmarks for the water quality objective. Refer to Action Plan (Section 5.2) for specific recommendations.**

| Objective | Interim Goals/Benchmarks | | |
|---|---|---|---|
| | 2019 | 2022 | 2027 |
| Reduce pollutant loading to Ossipee Lake to maintain or improve in-lake median total phosphorus concentration | Prevent or offset 10 kg/yr in phosphorus loading from new or existing development | Prevent or offset 25 kg/yr in phosphorus loading from new or existing development; reevaluate water quality and track progress | Prevent or offset 55 kg/yr in phosphorus loading from new or existing development; reevaluate water quality and track progress |

## 3.5 POLLUTANT SOURCE IDENTIFICATION

### 3.5.1 SEPTIC SYSTEM SURVEY

Septic systems, outhouses, and even portable toilets help manage our wastewater and prevent harm to human health, aquatic life, and water resources. However, aging, poorly-maintained, and/or improperly-sited systems pose a threat to the health of Ossipee Lake.

Within a septic system, approximately 20% of the phosphorus is removed in the septic tank (due to settling of solid material) and a further 23-99% is removed in the leachfield and surrounding soils (Lombardo, 2006; Lusk et al., 2011). The degree of phosphorus removal efficiency of a septic system depends on site-specific soil and groundwater characteristics, including pH and mineral composition. Depending on the circumstances, older systems may still retain up to 85% of the input phosphorus in the top 30 cm of the soil (Zanini et al., 1998), though a slow, long-term transport of phosphate over long distances in the groundwater table can also occur in older systems (Harman et al., 1996). Phosphorus generally migrates through the soil slower than other dissolved pollutants in groundwater, but studies have shown that this degree of phosphorus reduction and movement is correlated with unsaturated infiltration distance (Weiskel and Howes, 1992), suggesting it is important to have septic systems well above the seasonal high groundwater table.

In 2016, GMCG mailed a septic survey to 1,201 residents within 250 feet of Ossipee Lake, Danforth Ponds, Berry Bay, Leavitt Bay, and Broad Bay. Surveys were either completed online through a Google Survey link on GMCG's website or by mailing a completed paper survey to GMCG. Results of the survey were incorporated to the watershed loading model conducted by FBE (2017a) to estimate the total phosphorus loading to the lake from wastewater systems.

GMCG received 92 responses, approximately 8% of the successfully-mailed recipients. Most responses (67%) came via mailed paper surveys. Most responses (71%) were received from residents with properties close to Broad Bay and Ossipee Lake. Additional survey response information relating to septic age, pump out history, and seasonal use were assessed by watershed (Danforth Ponds and Lower Bays, Ossipee Lake).

**Table 3-10. Summary of septic survey response rates.**

| Watershed | Location | # Responses | Percentage |
|---|---|---|---|
| Danforth Ponds and Lower Bays | Berry Bay | 7 | 8% |
| | Broad Bay | 32 | 35% |
| | Danforth Ponds | 6 | 6% |
| | Leavitt Bay | 12 | 13% |
| Loon Lake | Loon Lake | 2 | 2% |
| Ossipee Lake | Ossipee Lake | 33 | 36% |
| | **TOTAL** | **92** | **100%** |

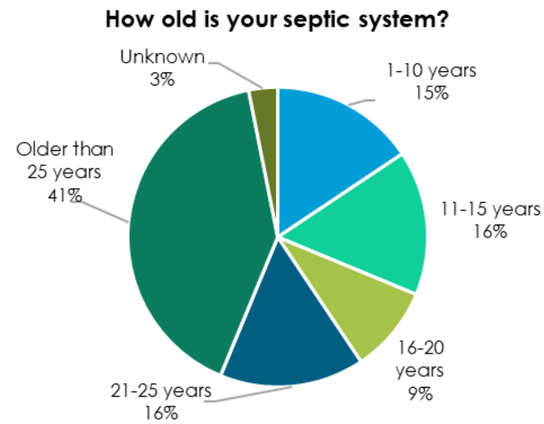


**Figure 3-4. Age of septic systems for 33 respondents in the Ossipee Lake watershed.**

Of the 33 respondents in the Ossipee Lake watershed, 32 had a septic system and one had a holding tank. Most of these septic systems were located >75 feet away from the lake (88%). Approximately 41% of septic systems were more than 25 years old (Figure 3-4). The survey also revealed several patterns among seasonal vs. year-round homes. Year-round homes (> 90 days of use per year) were evenly split between old and young septic systems. Seasonal homes (<90 days of use per year) had a greater number of young systems compared to old systems. However, seasonal homes were pumped less frequently than year-round homes, including approximately 18% of seasonal homes with no known pump out history.

Per the LLRM, **wastewater systems are the second largest source of phosphorus to Ossipee Lake, providing 6% (292 kg/yr) of the total phosphorus load to the lake**. Recommendations for addressing input from wastewater are provided in the Action Plan (Section 5.2.1).

### 3.5.2 WATERSHED AND SHORELINE SURVEYS

Watershed and shoreline surveys are designed to locate potential sources of NPS pollution within areas that drain to a waterbody. During a watershed survey, NPS sites are located by touring the watershed on foot or by car. A shoreline survey is conducted by boat, and assesses visible NPS pollution problems along the shoreline. These surveys are an excellent education and outreach tool, as they raise public awareness by documenting types of problems, engaging volunteers, and providing specific information to landowners about how to reduce NPS pollution on their property. Results of these surveys are essential to the watershed-based planning process because they identify individual NPS sites and prioritize BMP implementation projects throughout the watershed.

A watershed survey of the Ossipee Lake Shoreline and Lovell River watersheds was conducted by FBE staff on November 5, 2015. Documented sites were evaluated for sediment erosion potential using EPA Region 5 Model measurements. These measurements documented the area of observed surface erosion or exposed/bare soil, the average dimensions of gully erosion (depth, width and length), and the height and length of eroded streambanks. Contributing drainage area was also measured from aerial maps or photos, when necessary, for the pollutant load model.

A total of 32 sites were identified during the survey (though one site was removed due to further investigation after the survey) and are estimated to contribute 19.6 kg (43.2 lbs.) of phosphorus to Ossipee Lake and Lovell River annually. The BMPs from the prioritized list of sites (Appendix D) account for >95% of the total estimated phosphorus load per year contributed by all surveyed problem areas. Ideally, if all 31 problem sites were treated with BMPs, annual phosphorus loading to Ossipee Lake would be significantly reduced, nearly meeting half the target objective for off-setting future phosphorus loading from new development at 55 kg/yr by 2027. It is assumed that addressing these 31 sites will reduce all the phosphorus loading coming from those sites (since they tend to be bare soil/erosion gully or bank stabilization sites compared to shoreline buffer sites needing vegetation). Many sites identified in the survey suffered from unstable banks along streams and ditches, causing some culverts to fail due to high sediment loads and eroding banks. Erosional processes at these problem sites are exacerbated by underlying loamy sand soils that enable erosion during large storm events.

**Table 3-11. Select "hotspots" of nonpoint source (NPS) pollution in the Ossipee Lake Shoreline and Lovell River watersheds**


**Camp Cody Drainage Ditch (Site ID 0-13)**

The sandy substrate is causing erosion along the stream channel into Ossipee Lake. Minimal development along the channel allows space for buffer planting along the streambanks. Camp Cody has successfully implemented multiple BMPs that capitalize on the sandy soils, such as the infiltration trenches around their bunkhouses.

**Pine Hill Road and Ossipee Mountain Road (Site ID 0-25)**

Pine Hill Road and Ossipee Mountain Road are the two main gravel roads located along the Lovell River. While these roads are rural in comparison to the roads around Ossipee Lake, they have many residential houses and experience continuous traffic. Pine Hill Road runs east directly along the Lovell River and has several areas of limited buffer between the road shoulder and the river. Along some stretches of road, sandy soils and steep banks are causing severe erosion and culvert failure. Erosion at this site is moderate, but the vast length of the bank failure elevates it to a high priority site.

A shoreline survey was also completed in September 2015 to document the condition of the shoreline for each parcel along the Ossipee Lake shoreline. Parcels were assessed using a scoring system that evaluates vegetated buffer, presence of bare soil, extent of shoreline erosion, distance of structures to the lake, and slope. These scores were summed to generate an overall "Shoreline Disturbance Score" for each parcel, with high scores indicating poor shoreline conditions (maximum possible score = 18). Of the 266 parcels surveyed, 166 (or 62%) scored 10 or greater (Table 3-12; Appendix E). A disturbance score of 10 or greater indicates shoreline conditions that may be detrimental to lake water quality. Around Ossipee Lake, high scores were primarily driven by lots with poor buffers and bare soil**. Eleven (11) parcels with a score of 15 (highest score recorded in the survey) generate an estimated 23.3 kg (51.4 lbs.) of phosphorus load to Ossipee Lake annually.** If shoreline landowners for these parcels were to create adequate buffers and install other shoreline BMPs (at a 50% BMP efficiency rate), phosphorus load would be reduced by 11.7 kg/yr (25.7 lbs./yr). An additional 155 parcels that scored 10-14 are likely contributing 49.3 kg/yr (108.7 lbs./yr) kg of phosphorus. Remediation efforts on these 155 properties using a 50% BMP efficiency rate could result in the reduction of 24.7 kg/yr (54.3 lbs./yr) of phosphorus. Note that the total phosphorus load calculated by the Region 5 model method differs from the LLRM output for direct shoreline drainage. This is due to the large assumptions made in the Region 5 model and the fact that Urban 1 Low Density Residential phosphorus export coefficients are generalized and do not consider specific shoreline condition and proximity to the lake.

**Table 3-12. Average disturbance score for shoreline properties along Ossipee Lake. Lower scores correspond to better shoreline conditions; higher scores correspond to poor conditions and extensive erosion.**

| Average Scores per Parcel | | | | | Total |
|---|---|---|---|---|---|
| **Buffer (1-5)** | **Bare Soil (1-4)** | **Shoreline Erosion (1-3)** | **Distance (1-3)** | **Slope (1-3)** | **Shoreline Disturbance Score (0-18)** |
| 3.1 | 2.0 | 1.1 | 2.4 | 1.4 | **10.0** |

# 4. MANAGEMENT STRATEGIES

The goal of the Ossipee Lake Watershed Management Plan Phase II is to protect both the current and future water quality of Ossipee Lake through treatment of known sources of NPS pollution and prevention of a future water quality decline because of anticipated new development. This goal will be achieved by accomplishing the following objective: reduce or prevent phosphorus loading of 55 kg/yr over the next 10 years (2018-2027). This objective sets a realistic phosphorus reduction target to maintain the excellent water quality of Ossipee Lake. A key component of this effort is the idea that existing and future development can be remediated or conducted in a manner that sustains environmental values. All stakeholder groups have the capacity to be responsible watershed stewards, including citizens, businesses, government, and others. The following section details management strategies for achieving the water quality goal and objective using a combination of **structural and non-structural BMPs**, as well as an **adaptive management approach**. Specific action items are provided in the Action Plan (Section 5.2).

## 4.1 STRUCTURAL NONPOINT SOURCE (NPS) RESTORATION

Consultants and stakeholders documented 31 watershed NPS sites and 166 shoreline properties that directly impact water quality through the delivery of phosphorus-laden sediment (refer to Section 3.5.2). As such, structural BMPs are a necessary and important component for the protection of Ossipee Lake water quality. The best approach to treating these NPS sites is to:

- Address high priority watershed and shoreline survey sites with an emphasis on cost-efficient fixes that have a high impact to low cost per kg of phosphorus treated. The BMP matrix (Appendix D) sorts watershed NPS sites by impact-weighted cost to phosphorus reduction ratio. The shoreline survey results (Appendix E) are sorted from highest to lowest Shoreline Disturbance Scores.
- Work with landowners to get commitments for treating and maintaining sites. Workshops and tours of demonstration sites can help encourage landowners to utilize BMPs on their own property.
- Work with experienced professionals on sites that require a high level of technical knowledge (engineering) to install, and ensure proper functioning of the BMP.
- Measure pollutant load reduction for each BMP installed.

This approach will help guide the proper installation of structural BMPs in the watershed. More specific and additional recommendations (including public outreach) are included in the Action Plan in Section 5.2. For helpful tips on implementing residential BMPs, see the NHDES Homeowner's Guide to Stormwater Management (See Additional Resources).

### 4.1.1 ESTIMATION OF POLLUTANT LOAD REDUCTIONS NEEDED

Remediation of the 31 sites identified in the watershed survey will reduce the phosphorus load to Ossipee Lake and the Lovell River by an estimated 19.6 kg of phosphorus annually[5] and cost an estimated $94,000 to implement. The BMPs from the prioritized list of sites account for >95% of the total estimated phosphorus load per year contributed by all surveyed problem areas (Table 4-1; Appendix D).

[5] Based on EPA Region 5 model.

**Table 4-1. Prioritized (from highest to lowest impact-weighted cost per kg of total phosphorus (TP) removed) BMP matrix of identified NPS sites in the Ossipee Lake watershed. Site 1-03 was omitted because no BMPs were recommended. The 10-year cost is the sum of the estimated BMP installation cost plus ten times the estimated annual cost to maintain the BMP.**

| Site | Land Use | TP (kg/yr)* | BMP Cost Estimate** | Annual Cost** | 10-yr Cost |
|---|---|---|---|---|---|
| 0-25 | Town Road | 3.0 | $940 | $50 | $1,440 |
| 1-02 | Town Road | 3.6 | $938 | $25 | $1,188 |
| 1-06 | Town Road | 2.3 | $1,680 | $25 | $1,930 |
| 0-21 | Private Road | 0.4 | $240 | $50 | $740 |
| 0-11 | Private Road | 0.7 | $500 | $50 | $1,000 |
| 1-05 | Town Road | 0.5 | $432 | $25 | $682 |
| 0-20 | State Road | 1.9 | $1,500 | $50 | $2,000 |
| 0-02 | Private Road | 0.4 | $600 | $25 | $850 |
| 0-22 | Town Road | 0.5 | $480 | $50 | $980 |
| 0-13 | Private Road | 3.1 | $11,760 | $50 | $12,260 |
| 0-06 | Private Road | 0.2 | $1,680 | $50 | $2,180 |
| 1-04 | Town Road | 0.2 | $800 | $25 | $1,050 |
| 0-14 | Private Road | 0.1 | $250 | $50 | $750 |
| 1-01 | Town Road | 0.1 | $480 | $50 | $980 |
| 0-03 | Private Road | 0.0 | $800 | $25 | $1,050 |
| 0-09 | Private Road | 0.4 | $1,940 | $100 | $2,940 |
| 0-05 | Private Road | 0.1 | $736 | $50 | $1,236 |
| 0-24 | Town Road | 0.1 | $1,000 | $25 | $1,250 |
| 1-07 | Town Road | 0.0 | $165 | $50 | $665 |
| 0-15 | Beach Access | 1.0 | $21,408 | $50 | $21,908 |
| 0-18 | Boat Access | 0.5 | $10,985 | $50 | $11,485 |
| 0-04 | Private Road | 0.0 | $1,000 | $50 | $1,500 |
| 0-19 | Private Road | 0.2 | $7,088 | $50 | $7,588 |
| 0-10 | Private Road | 0.0 | $700 | $100 | $1,700 |
| 0-01 | Private Road | 0.0 | $1,760 | $100 | $2,760 |
| 0-08 | Private Lawn | 0.1 | $2,500 | $25 | $2,750 |
| 0-17 | Town Road | 0.0 | $2,798 | $100 | $3,798 |
| 0-23 | Town Road | 0.0 | $2,461 | $50 | $2,961 |
| 0-07 | Private Road | 0.2 | NA | NA | NA |
| 0-12 | Private Road | NA | $700 | $100 | $1,700 |
| 0-16 | Town Road | 0.0 | $300 | $50 | $800 |
| | **TOTAL:** | **19.6** | **$78,621** | **$1,550** | **$94,121** |

** TP reduction estimates based on Region 5 model for bank stabilization or urban runoff.*
*** BMP cost estimates based on CCSWCD (2008) and UNHSWC (2012); assumes volunteer labor*

Using a simple scoring method, the shoreline survey served as an excellent tool for highlighting shoreline properties around the lake that exhibited significant erosion (refer to Section 3.5.2). This method of shoreline survey is a rapid technique to assess the overall condition of the shoreland zone, but it does not allow for making specific BMP recommendations. Therefore, high priority shoreline properties (11 parcels) should be resurveyed in person for specific BMP recommendations and more accurate estimated phosphorus reductions and implementation costs by site. However, we can estimate current impact and potential reduction, along with costs, using a few broad assumptions and the EPA Region 5 model.

Eleven (11) parcels with a score of 15 (high-priority parcels) generate an estimated 23.3 kg of phosphorus load to Ossipee Lake annually[6] (Table 4-2). If shoreline landowners were to create adequate buffers and install other shoreline BMPs on all high-priority parcels (at a 50% BMP efficiency rate), the annual reduction

[6] Based on Region 5 model bank stabilization estimate for sandy soils, using 100 ft (length) by 5 ft (height) and moderate lateral recession rate of 0.2 ft/yr.

would be 11.7 kg of phosphorus. The 155 parcels with scores 10-14 (medium priority parcels) are contributing an estimated 49.3 kg of phosphorus annually[7]. Remediation efforts on all medium priority parcels using a 50% BMP efficiency rate could result in the annual reduction of 24.7 kg of phosphorus. High priority parcels would each cost about $3,000 and medium-priority parcels would each cost about $1,500 to revegetate and mulch with volunteer labor.

**Table 4-2. Summary of properties with high (15) and medium (10-14) shoreline disturbance scores for Ossipee Lake. Refer to Appendix E for full results. Total phosphorus (TP) load with BMPs assumes 50% reduction efficiency.**

| Parcel Priority | # Parcels | TP Load (kg/yr) | TP Load after BMPs (kg/yr) | Cost of BMPs |
|---|---|---|---|---|
| High | 11 | 23.3 | 11.7 | $33,000 |
| Medium | 155 | 49.3 | 24.7 | $232,500 |

If all identified trouble areas were addressed (31 watershed survey sites, 11 high shoreline disturbance score parcels, and 155 medium shoreline disturbance score parcels), total phosphorus load to the lake from the Ossipee Lake Shoreline and Lovell River watersheds could be reduced by 56 kg/yr, meeting the target objective for off-setting future phosphorus loading from new development at 55 kg/yr by 2027. The strategy for reducing pollutant loading to Ossipee Lake will be dependent on available funding and labor resources, but will need to include a combination of approaches (larger watershed BMP sites and smaller residential shoreline BMP sites). Outreach and technical assistance should be provided first to the 11 shoreline properties with a high score of 15. The prevention of additional phosphorus from expected new development over the next 10 years would also be effectively addressed through changes in land use ordinances that better protect water resources.

**Table 4-3. Summary of total phosphorus (TP) reductions and estimated costs of priority BMP implementations in the Ossipee Lake Shoreline and Lovell River watersheds.**

| Identified High Priority BMP Sites | TP Reduction (kg/yr) | Estimated Cost |
|---|---|---|
| Watershed NPS Sites (31) | 19.6 | $94,000 |
| High Priority Shoreline Properties (11) | 11.7 | $33,000 |
| Medium Priority Shoreline Properties (155) | 24.7 | $232,500 |
| **TOTAL** | **56.0** | **$359,500** |

It is important to note that, while the focus of the objective for this plan is on phosphorus, **the treatment of stormwater and sediment erosion will result in the reduction of many other kinds of pollutants that may impact water quality.** These pollutants would likely include:

1) Nutrients (e.g., nitrogen)
2) Petroleum products
3) Bacteria
4) Road salt/sand
5) Heavy metals (cadmium, nickel, zinc, etc.)

Without a monitoring program in place to measure these other pollutants, it will be difficult to track the success of efforts that reduce these other pollutants. However, there are various spreadsheet models available that can estimate reductions in these pollutants depending on the types of BMPs installed. These reductions can be tracked to help assess long-term lake response.

[7] Based on Region 5 model bank stabilization estimate for sandy soils, using 50 ft (length) by 3 ft (height) and moderate lateral recession rate of 0.1 ft/yr.

## 4.2 NON-STRUCTURAL NONPOINT SOURCE (NPS) RESTORATION

Current zoning in the Ossipee Lake watershed presents considerable opportunity for continued development, as an estimated 51% of the Town of Ossipee is still developable (see the build-out analysis in Section 3.3.3). The area's popularity as a permanent residence is growing with seasonal homes being upgraded to year-round single-family dwellings. This may result in a 48% increase in phosphorus loading to Ossipee Lake by 2107, with in-lake phosphorus concentrations climbing to 12.9 ppb (see Section 3.3.3). Given this future development potential, **it is critical for municipalities 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 low impact development 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.** Refer to Section 5.2.4 for specific planning recommendations.

## 4.3 ADAPTIVE MANAGEMENT APPROACH

An **adaptive management approach**, to be employed by a steering committee, is highly recommended for all types and sizes of watershed protection efforts, including for Ossipee Lake. 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.** Because the watershed spans six different municipalities, 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. This group should include representatives from watershed towns, GMCG, local businesses, and other interested groups such as Lakes Region Conservation Trust and Dan Hole Pond Watershed Trust. 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. It is important to place funding priorities in the context of the larger Ossipee River watershed area, which also includes Danforth Ponds and the Lower Bays. 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 must 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, including the Dan Hole Watershed Trust, the Town of Freedom and Ossipee conservation commissions, and GMCG. Several watershed stakeholders participated in the community forum to develop the Action Plan (refer to Section 1.4). 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: Educational Component.
- **Continuing the Long-Term Monitoring Program.** Since the early 2000's, GMCG and volunteers have collected water quality information from 30 river and tributary sites and 5 sites on Ossipee Lake and its lower bays. The streams, rivers, and lakes in the region are regularly monitored for physical and chemical parameters that provide information on water quality and aquatic habitat. An annual water quality monitoring program such as that run by GMCG is necessary to track the health of Ossipee Lake. An expansion of the current program, especially through the incorporation of continuous data loggers, would provide additional insights to the health and functioning of the lake, its tributaries, and adjacent waterbodies. Information from the monitoring program will provide feedback on the effectiveness of management practices at the sub-basin level. Results will help optimize management actions through the adaptive management approach. Refer to Section 5.2.5: 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 3.4: Establishment of Water Quality Goal for interim benchmarks.

# 5. PLAN IMPLEMENTATION

## 5.1 PLAN OVERSIGHT

The recommendations of this plan should be carried out by a steering committee like the one assembled for development of this plan. A steering committee should include the leadership of GMCG, other conservation groups and land trusts, representatives from the six watershed towns, NHDES, members of conservation commissions and/or planning boards, schools and community groups, local business leaders, and landowners. The committee will need to meet regularly and work hard to coordinate resources across municipalities and stakeholder groups to implement management actions. The watershed management plan (especially the Action Plan) will need to be updated periodically (typically every five years) to ensure progress and to incorporate any changes in watershed activities. Measurable milestones (e.g., number of BMP sites, volunteers, funding received, etc.) should be tracked by a steering committee and reported to NHDES on a regular basis.

## 5.2 ACTION PLAN

The Action Plan was developed through the collective efforts of GMCG, FBE, and the current steering committee, as well as the public by way of feedback provided during the community forum held in 2016. The Action Plan outlines responsible parties, approximate costs[8], and an implementation schedule for each recommendation within six major categories: (1) Septic Systems; (2) Watershed and Shorefront BMPs; (3) Roads; (4) Planning and Land Conservation; and (5) Water Quality Monitoring. Accompanying narrative sections also provide "short-term recommendations" or actions to be included in the first, immediate phase of plan implementation.

### 5.2.1 SEPTIC SYSTEMS

Septic systems were identified during the community forum as a significant threat to Ossipee Lake water quality. Watershed modeling indicated that **wastewater systems, including septic systems, outhouses, and cesspools, are the second largest source of phosphorus to the watershed, contributing 6% of the phosphorus load to Ossipee Lake.**

To make significant reductions in phosphorus load from wastewater, landowners will need to take responsibility to check their systems and make necessary upgrades, especially to old systems, cesspools, and outhouses. Code enforcement for each individual town could assist by tracking occupancy loads and have septic system inventories in Master Plans. A comprehensive septic system inventory (or database) could be used to track maintenance and replacement history of systems within the watershed; this would be managed by each individual town, especially if a wastewater inspection and maintenance program was put into effect and enforced by the towns.

The 2016 septic survey completed by GMCG is good first-step in gathering site-specific septic system data (see Section 3.5.1). The database could also be used to help track conversions of seasonal homes to permanent residences and any associated changes (or lack thereof) to wastewater treatment capacity. "Septic socials" are a great outreach tool to spread awareness of proper septic maintenance. Socials are an opportunity for neighbors to come together to socialize, while also learning about keeping healthy septic systems. Socials could be held for willing groups of landowners, such as road or campground associations. Landowner groups can also benefit by coordinating septic system pumping discounts. Refer to Table 5.1.

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[8] Current cost estimates for each recommendation will need to be adjusted based on further research and site design considerations.

#### SHORT-TERM RECOMMENDATIONS

- Host multiple "septic socials" in key neighborhoods near the lake to address link between septic system maintenance and water quality. Target educational campaign in areas with minimally-maintained or aging septic systems.

### 5.2.2 WATERSHED AND SHOREFRONT BMPS

Shorefront residential property was identified during the community forum as a significant threat to Ossipee Lake water quality. Direct shoreline areas are typically among the highest for pollutant loading given their proximity to lakes and desirability for development. The 2015 shoreline survey found that 62% of shoreline parcels showed characteristics detrimental to lake water quality, such as inadequate buffers, evidence of bare soil, and structures within 75 feet of the shoreline. Improvement of shoreline conditions has great potential to protect Ossipee Lake water quality.

Though a subset of 11 (out of 266) shoreline properties with a disturbance score of 15 have been designated as high-priority for remediation, the ubiquity of medium-high disturbance scores (10-14) suggests that efforts should also target implementation of residential BMPs more broadly along the shoreline and throughout the watershed. This could be as simple as planting vegetated buffers, installing gravel driplines along roof edges, and ensuring that path and driveway runoff is filtered into the ground rather than running overland and into the lake. Coordination with landowners will be crucial for successful implementation of the BMPs identified in this Action Plan because many of these mitigation measures will need to be implemented on private land. A well-executed demonstration BMP in one heavily-populated area may inspire friends and neighbors to implement similar practices.

Pollutant load reductions will best be achieved through a combination of the smaller-scale shoreline and larger-scale watershed BMPs, and both will depend on available financial resources and feasibility. A steering committee should develop a long-term strategy to fund these and other action items from the plan. Refer to Table 5.1.

#### SHORT-TERM RECOMMENDATIONS

- Work with shorefront residents to encourage expanded participation in shoreline residential BMP implementation efforts, with initial focus on the 11 high priority shoreline properties. Stakeholders should apply for 319 implementation grant funding in 2018 to address watershed NPS sites and shoreline properties. A funding subcommittee should be created to help find and apply for funding that supports all aspects of the Action Plan.

### 5.2.3 ROADS

Roads pose a threat to Ossipee Lake water quality when they are improperly maintained. The sandy soils in the area are ripe for gully and rill formation along unstable roadsides. These channels act as conduits for sediment, which can result in culvert failure due to high sediment loads and eroding banks. Excess road salt and sand, lack of stormwater control, and a lack of resources to improve and maintain road infrastructure are also concerns. The 2015 watershed survey identified thirteen sites on town or state roads that are delivering nutrients and other pollutants to the lake or its tributaries. However, other private roads comprised the majority of watershed NPS sites and could benefit from improved road maintenance by residents. Stakeholders expressed interest in forming a Lake Coalition Group to bring together the different neighborhood and road associations within the Ossipee Lake watershed. The steering committee should begin reaching out to these groups to facilitate the discussion about formation of a coalition. The coalition can coordinate education on gravel road maintenance for private landowners. Additionally, the steering committee should team up with local road agents and the New Hampshire Department of Transportation (NHDOT) to ensure state and local authorities are working to maintain roads within the watershed. This may include trainings and workshops for relevant staff. Refer to Table 5.1.

### SHORT-TERM RECOMMENDATIONS

- Create a Lake Coalition Group to bring together neighborhood and road associations. Consider forming additional private road associations in key neighborhoods or heavily-used roads for better management by local stakeholders. Determine if this is a feasible option for the area.

### 5.2.4 PLANNING AND LAND CONSERVATION

Municipal land-use regulations are a guiding force for where and what type of development can occur in a watershed, and therefore, how water quality is affected because of this development. The build-out analysis indicates that there is room for improvement in protecting water quality through non-structural BMPs such as municipal ordinance adoption or revisions, especially as it relates to new development.

An important finding of the shoreline survey was that the lowest-scoring (i.e., best condition) parcels were centered on three large undeveloped areas of the lake. These areas are owned by various conservation groups and are pivotal for maintaining high water quality at Ossipee Lake. Efforts to continue to balance development and water quality protection are important to watershed management goals and future water quality.

Stakeholders expressed interest in creating an Aquifer Protection Committee to evaluate new development, property transfers, and retrofits and make recommendations to the town planning board and/or regional level planning group (if applicable). Formation of this group is key to implementing other action items such as incorporating the watershed plan recommendations into town Master Plans and hosting joint informational workshops for new landowners, towns, and developers on local ordinances and watershed goals. Refer to Table 5.1.

### SHORT-TERM RECOMMENDATIONS

- Work with GMCG to create an aquifer protection committee that evaluates new development, property transfers, and retrofits and makes recommendations to the town planning board and/or regional level planning group (if applicable).

### 5.2.5 WATER QUALITY MONITORING

An annual monitoring program is critical to evaluating the effectiveness of watershed restoration activities and determining if the water quality goal and objective are being achieved over time (per interim benchmarks set in Section 3.4). The Action Plan includes recommendations for enhancing current water quality monitoring efforts around Ossipee Lake, the Lovell River, and other tributaries. The recommendations build on GMCG's extensive current monitoring program and collaboration with VLAP. Refer to Table 5.1.

### SHORT-TERM RECOMMENDATIONS

- Add routine bacteria monitoring to public beach areas and tributary sampling sites.
- Continue to encourage networking between lake associations regarding monitoring occurring at individual waterbodies throughout the watershed.
- Hold a regional lake association meeting as a collaboration among all area associations for new ideas or actions.

**Table 5-1. Action Plan for the Ossipee Lake Watershed Management Plan Phase II.**

| ACTION ITEM | DESCRIPTION | Environmental Groups & Land Trusts | Watershed Towns | Conservation Commissions | Landowners & Residents | Consultant | Research University | SCHEDULE | ESTIMATED COST |
|---|---|---|---|---|---|---|---|---|---|
| *The following action table should be considered as a carefully-reviewed and prioritized list of opportunities (not mandated) for improving and protecting water resources; action items can be implemented by stakeholders when resources permit.* | | | | | | | | | |
| **Septic Systems** | | | | | | | | | |
| **Enforce town septic system regulations** | 1) Communicate with town departments to enforce occupancy loads and have septic system inventories in Master Plans. | ✓ | ✓ | ✓ | | | | 2018-27 | TBD |
| | 2) Inspect all home conversions from seasonal to permanent residences and property transfers for proper septic system size and design. | | ✓ | | ✓ | | | 2018-27 | $250/system |
| **Garner funding or discounts that support and encourage septic system maintenance** | 1) Coordinate group septic system pumping discounts. Assumes volunteer labor to coordinate. Pump-out costs responsibility of landowners. | ✓ | ✓ | | ✓ | | | 2018-27 | N/A |
| | 2) Investigate grants and low-interest loans to provide cost-share opportunities for septic system upgrades. Cost estimate based on resources to apply for grant. | ✓ | ✓ | | | | | 2018-18 | $1,500 |
| | 3) Designate a portion of conservation dollars for the watershed that can be used for septic system upgrades. | ✓ | ✓ | ✓ | | | | 2018-27 | N/A |
| **Canine Detection** | 1) Hire canine detection team to investigate shoreline septic systems along Ossipee Lake. | | ✓ | ✓ | | ✓ | | 2018-20 | $5,000 |
| **Enhance awareness of proper septic system maintenance** | 1) Distribute educational pamphlets on septic system function and maintenance in tax bills. | ✓ | ✓ | ✓ | | ✓ | | 2018-19 | $2,000 |
| | 2) Host multiple "septic socials" in key neighborhoods near the lakes to address link between septic system maintenance and water quality. Target educational campaign in areas with minimally-maintained or aging septic systems. | ✓ | | | | | | 2018-27 | $150/yr |
| **Inventory status of septic systems in watershed** | 1) Conduct a comprehensive septic system survey of all properties within 250 ft of a critical waterbody, targeting those that did not respond to the 2016 survey. | ✓ | | | | ✓ | ✓ | 2018-19 | $6,000 |
| | 2) Conduct voluntary dye testing of high impact septic systems. Goal: 20 systems. | ✓ | ✓ | | | | | 2018-19 | $100/system |
| | 3) Develop and maintain a septic system database for the watershed. Towns to maintain. Cost estimate based on initial setup by GMCG or consultants only. | ✓ | ✓ | ✓ | | ✓ | | 2018-27 | $8,000 |
| **Watershed & Shorefront BMPs** | | | | | | | | | |
| **Address priority BMPs identified in surveys** | 1) Implement BMPs at the 31 sites identified in the watershed survey located in the direct drainage of the Lovell River and Ossipee Lake. Cost estimate includes implementation and annual maintenance | ✓ | ✓ | ✓ | ✓ | | | 2018-27 | $94,000 |

| ACTION ITEM | DESCRIPTION | Environmental Groups & Land Trusts | Watershed Towns | Conservation Commissions | Landowners & Residents | Consultant | Research University | SCHEDULE | ESTIMATED COST |
|---|---|---|---|---|---|---|---|---|---|
| *The following action table should be considered as a carefully-reviewed and prioritized list of opportunities (not mandated) for improving and protecting water resources; action items can be implemented by stakeholders when resources permit.* | | | | | | | | | |
| | for all BMPs in a ten year period. Treats 20 kg/yr of phosphorus. | | | | | | | | |
| | 2) Implement BMPs at the 11 high impact sites identified in the shoreline survey with disturbance scores of 15 or greater. Treats 11 kg/yr of phosphorus. Assumes volunteer labor. | ✓ | ✓ | ✓ | ✓ | | | 2018-27 | $33,000 |
| | 2) Implement BMPs at the 155 medium impact sites identified in the shoreline survey with disturbance scores of 10-14. Treats 24 kg/yr of phosphorus. Assumes volunteer labor. | ✓ | ✓ | ✓ | ✓ | | | 2018-27 | $232,500 |
| | 3) Track BMP implementation progress using NPS Site Tracker or similar. | ✓ | | | | | | 2018-27 | $500/yr |
| **Garner funding for action items** | 1) Develop a subcommittee that develops a fundraising strategy and determines how funding is spent. | ✓ | ✓ | ✓ | | | | 2018-19 | N/A |
| | 2) Establish a capital reserve fund for watershed towns to spend on lake protection initiatives. Cost covers labor to setup and maintain fund. | | ✓ | ✓ | | | | 2018-27 | $1,000/yr |
| | 3) Solicit residents for individual donations. | ✓ | | | | | | 2018-27 | N/A |
| **Roads** | | | | | | | | | |
| **Create Lake Coalition Group** | 1) Create a Lake Coalition Group to bring together neighborhood and road associations. | ✓ | ✓ | | | | | 2018-27 | N/A |
| | 2) Consider forming additional private road associations in key neighborhoods or heavily-used roads for better management by local stakeholders. Determine if this is a feasible option for the area. | ✓ | | ✓ | ✓ | | | 2018-27 | TBD |
| | 3) Work with road agents and landowners to create and manage drainage easements on private properties. This will help control salt/sand and stormwater runoff from roads. | ✓ | ✓ | ✓ | ✓ | | | 2018-27 | TBD |
| **Require training of road agents** | 1) Require training for road agents on proper salt, sand, and equipment use. | | ✓ | | | | | 2018-27 | $5,000 |
| **Host road maintenance workshops** | 1) Hold workshops on proper road management. | ✓ | ✓ | ✓ | | | | 2018-27 | $500/yr |
| **Planning & Land Conservation** | | | | | | | | | |
| **Create Aquifer Protection Committee** | 1) Work with GMCG to create an aquifer protection committee that evaluates new development, property transfers, and retrofits and makes recommendations to the town planning board and/or regional level planning group (if applicable). | ✓ | ✓ | ✓ | ✓ | | | 2018-27 | N/A |

| ACTION ITEM | DESCRIPTION | Environmental Groups & Land Trusts | Watershed Towns | Conservation Commissions | Landowners & Residents | Consultant | Research University | SCHEDULE | ESTIMATED COST |
|---|---|---|---|---|---|---|---|---|---|
| *The following action table should be considered as a carefully-reviewed and prioritized list of opportunities (not mandated) for improving and protecting water resources; action items can be implemented by stakeholders when resources permit.* | | | | | | | | | |
| **Adopt plan recommendations** | 1) Incorporate watershed plan recommendations into town master plans. | | ✓ | | | | | 2018-27 | N/A |
| **Enhance enforcement of proper land management practices** | 1) Create better enforcement of forestry rules and regulations. | | ✓ | ✓ | ✓ | | | 2018-27 | TBD |
| | 2) Encourage easement holders to be notified and present at closings. | | ✓ | ✓ | ✓ | | | 2018-27 | N/A |
| **Host workshops for watershed resident education of local land ordinances** | 1) Hold joint informational workshops for new landowners, towns, and developers on local ordinances and watershed goals. Goal: 2-4. | ✓ | ✓ | ✓ | ✓ | | | 2018-27 | $10,000 |
| | 2) Hold educational workshops on conservation easements in the region. Goal: 2. First training is scheduled for July 20, 2016. | ✓ | ✓ | ✓ | ✓ | | | 2018-27 | $5,000 |
| **Host training of code enforcement officers and ZBAs** | 1) Host training for code enforcement officers and ZBAs in watershed towns, where applicable. | | ✓ | | | | | 2018-27 | $5,000 |
| **Improve municipal permitting process** | 1) Create list of BMP descriptions for Town Selectman, ZBA, Planning Boards, and landowners. | ✓ | ✓ | ✓ | | | | 2018-19 | $1,500 |
| | 2) Establish a driveway permitting process, site plan review, and subdivision review by municipal planning boards. Freedom and Effingham currently have these in place. Investigate other watershed towns. | ✓ | ✓ | | | | | 2018-27 | $5,000 |
| **Improve municipal ordinances** | 1) Develop new or improve existing ordinances to address setbacks, buffers, lot coverage, LID, and open space. The Ossipee Watershed Natural Resource Based Planning Guide and Ossipee Watershed Municipal Ordinance Book are scheduled to be updated. | ✓ | ✓ | ✓ | | | | 2018-27 | TBD |
| **Regional level planning** | 1)Work with Lakes Region Planning Commission to standardize conservation practices throughout the watershed and to help with planning and enforcement. | | ✓ | ✓ | ✓ | | | 2018-27 | N/A |
| **Use tools for targeting land for protection** | 1) Fund tools, such as build-out scenario programs, GIS, and natural resource inventories, to help target critical land for protection. Build-out already completed for portions of Freedom, Effingham, and Moultonborough. | ✓ | ✓ | ✓ | | ✓ | | 2018-27 | $20,000 |
| **Water Quality Monitoring** | | | | | | | | | |
| **Add bacteria monitoring** | 1) Add routine bacteria monitoring to public beach areas and tributary sampling sites. Assumes volunteer labor. | ✓ | ✓ | | | ✓ | ✓ | 2018-27 | $3,600 |

| ACTION ITEM | DESCRIPTION | Environmental Groups & Land Trusts | Watershed Towns | Conservation Commissions | Landowners & Residents | Consultant | Research University | SCHEDULE | ESTIMATED COST |
|---|---|---|---|---|---|---|---|---|---|
| *The following action table should be considered as a carefully-reviewed and prioritized list of opportunities (not mandated) for improving and protecting water resources; action items can be implemented by stakeholders when resources permit.* | | | | | | | | | |
| **Network between lake associations** | 1) Continue to encourage networking between lake associations regarding monitoring occurring at individual waterbodies throughout the watershed. | ✓ | | | | | | 2018-27 | N/A |
| **Incorporate the use of continuous loggers in monitoring program** | 1) Add continuous loggers for stage/flow, temperature, dissolved oxygen, conductivity, turbidity, etc. to key sampling locations throughout the watershed. See description in Section 5.2.5. Based on 3 loggers. Two loggers are currently deployed in the streams by Plymouth State University/GMCG. | ✓ | ✓ | | | ✓ | ✓ | 2018-27 | $6,100/yr |
| **Study dam/water level influences** | 1) Conduct study (use UNH or Plymouth State students) to assess the influence of changes in water level on water quality using indicators such as turbidity and aquatic plants. | | | | | | ✓ | 2018-20 | N/A |
| **Continue and/or expand lake/stream monitoring program** | 1) Continue current lake monitoring program, which includes taking regular, annual DO and temperature profile readings and epilimnion and hypolimnion total phosphorus and chlorophyll-a samples at the deep spot of Ossipee Lake. | ✓ | | | | | | 2018-27 | $15,000 |
| | 2) Add more volunteers and equipment to ongoing lake/stream monitoring program (e.g., increase monitoring at Bear Camp River mouth and Mill/Ferrin Brook, add pH probe to profile sampling procedure, and add nitrogen sampling) and increase sampling frequency at 3 stream sites. See description in Section 5.2.5. | ✓ | | | | | | 2018-27 | $10,000 |
| **Obtain more funding** | 1) Obtain funding from sources such as municipal contributions, NHDES grants, lake associations, targeted fundraising, and other grants related to climate change or invasive species studies. | ✓ | ✓ | ✓ | ✓ | | | 2018-27 | $1,500/yr |
| **Maintain and/or improve current invasives management program** | 1) Support State legislation that increases funds for aquatic invasive plant (e.g., milfoil) eradication. | ✓ | ✓ | | | | | 2018-27 | N/A |
| | 2) Increase the number of volunteer inspectors for the Lake Host program. | ✓ | | ✓ | | | | 2018-27 | N/A |
| **Enhance awareness of water quality issues in the watershed** | 1) Hold a regional lake association meeting as a collaboration among all area associations for new ideas or actions. Assumes volunteer labor and donated resources. | ✓ | | | | ✓ | ✓ | 2018 | $5,000 |
| | 2) Contact local representatives and attend selectman meetings to voice concerns and stay informed. | | | | ✓ | | | 2018-27 | N/A |

| ACTION ITEM | DESCRIPTION | Environmental Groups & Land Trusts | Watershed Towns | Conservation Commissions | Landowners & Residents | Consultant | Research University | SCHEDULE | ESTIMATED COST |
|---|---|---|---|---|---|---|---|---|---|
| *The following action table should be considered as a carefully-reviewed and prioritized list of opportunities (not mandated) for improving and protecting water resources; action items can be implemented by stakeholders when resources permit.* | | | | | | | | | |
| | 3) Create flyers/brochures for shorefront homes regarding BMPs, septic systems, no wake zone rules, and fire pit use. | ✓ | | ✓ | | ✓ | | 2018-27 | $2,000 |
| | 4) Contribute interesting articles about water quality and watershed protection efforts to various media sources. Assumes volunteer labor. | ✓ | | ✓ | | | | 2018-27 | N/A |
| | 5) Establish multiple sites as BMP demonstration sites and conduct tours for interested residents. Cost estimate does not include actual BMP implementation. Cost assumes printing, mailing to advertise events. | ✓ | | | | | | 2018-27 | $500/yr |

### 5.3 INDICATORS TO MEASURE PROGRESS

The following environmental, programmatic, and social indicators and associated numeric targets (benchmarks) will help to quantitatively measure the progress of this plan in meeting the established goal and objective for Ossipee Lake. These benchmarks represent short-term (2019), mid-term (2022), and long-term (2027) targets derived directly from actions identified in the Action Plan. Setting benchmarks allows for periodic updates to the plan, maintains and sustains the action items, and makes the plan relevant to ongoing activities. A steering committee should review the benchmarks for each indicator on an ongoing basis to determine if progress is being made, and then determine if the watershed plan needs to be revised because the targets are not being met.

**Environmental Indicators** are a direct 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 maintenance or improvement of median in-lake phosphorus concentration, as well as maintain water clarity (SDT) and reduce the frequency of the low-oxygen in the 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 watersheds.

**Table 5-2. Environmental Indicators for Ossipee Lake.**

| ENVIRONMENTAL INDICATORS | | | |
|---|---|---|---|
| Indicators | Benchmarks* | | |
| | 2019 | 2022 | 2027 |
| Maintain or improve median in-lake total phosphorus in Ossipee Lake. | Prevent or offset 10 kg/yr in phosphorus loading from new or existing development | Prevent or offset 25 kg/yr in phosphorus loading from new or existing development | Prevent or offset 55 kg/yr in phosphorus loading from new or existing development |
| Improve dissolved oxygen conditions in bottom waters by reducing the duration and increasing depth of low DO occurrence. | 5% fewer occurrences | 10% fewer occurrences | 20% fewer occurrences |
| Improve or maintain water clarity at the deep spot of Ossipee Lake. | 0.1 m | 0.2 m | 0.4 m |

**Benchmarks are cumulative starting at year 1.*

**Programmatic indicators** are indirect measures of watershed protection and restoration activities (Table 5-3). Rather than indicating that water quality reductions are being met, these programmatic measurements list actions intended to meet the water quality goal.

**Table 5-3. Programmatic Indicators for Ossipee Lake.**

| PROGRAMMATIC INDICATORS | | | |
|---|---|---|---|
| Indicators | Benchmarks* | | |
| | 2019 | 2022 | 2027 |
| Amount of funding secured for plan implementation (includes contributions from fundraisers, donations, and grants) | $50,000 | $300,000 | $500,000 |
| Number of high priority shoreline sites remediated (11 identified) | 2 | 5 | 11 |
| Number of medium priority shoreline sites remediated (155 identified) | 50 | 100 | 155 |
| Number of watershed survey sites remediated (31 identified) | 5 | 15 | 31 |
| Number of residential BMP demonstration projects completed | 10 | 20 | 30 |
| Linear feet of buffers installed in the shoreland zone | 500 | 1,000 | 3,000 |
| 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) | 1 | 3 | 5 |
| 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" held | 1 | 3 | 5 |
| Number of joint informational workshops for new landowners, towns, and developers on local ordinances and watershed goals. | 1 | 2 | 4 |
| Number of educational workshops on conservation easements in the region | 1 | 2 | 2 |
| Number of parcels with new conservation easements | 1 | 2 | 3 |
| Number of copies of watershed-based educational materials distributed | 50 | 100 | 250 |
| Number of meetings with neighborhoods or road associations (Lake Coalition Group) to discuss road maintenance | 1 | 2 | 3 |

**Benchmarks are cumulative starting at year 1.*

**Social Indicators** measure changes in social or cultural practices and behavior that lead to implementation of management measures and water quality improvement (Table 5-4).

**Table 5-4. Social Indicators for Ossipee Lake.**

| SOCIAL INDICATORS | | | |
|---|---|---|---|
| Indicators | Benchmarks* | | |
| | 2019 | 2022 | 2027 |
| Number of new association, land trust, or conservation group members | 5 | 15 | 25 |
| Number of volunteers participating in educational campaigns | 10 | 15 | 20 |
| Number of people participating in workshops or BMP demonstrations | 20 | 50 | 75 |
| Number of lake hosts | 2 | 5 | 10 |
| Number of newly-trained VLAP volunteers | 1 | 3 | 5 |
| Number of new weed watchers | 2 | 5 | 10 |
| 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% |
| Percentage of shoreline residents installing at least one conservation practice | 10% | 25% | 50% |

**Benchmarks are cumulative starting at year 1.*

### 5.4 ESTIMATED COSTS & TECHNICAL ASSISTANCE NEEDED

The cost of successfully implementing this watershed plan is estimated at $576,100 over the next ten years (Table 5-5). **However, many costs are still unknown and should be incorporated to the Action Plan as information becomes available.** Estimated costs include both structural BMPs, such as fixing eroding roads and planting shoreline buffers, and non-structural BMPs, such as demonstration tours or workshops. Annual BMP costs were estimated based on a ten-year total for the initial BMP installation plus ten years of maintenance (refer to Table 4-1).

**Table 5-5. Estimated annual and 10-year costs for Phase II.**

| Category | Estimated Annual Costs | 10-year Total |
|---|---|---|
| Septic Systems* | $2,850 | $28,500 |
| Watershed and Shorefront BMPs | $37,450 | $374,500 |
| Roads | $1,000 | $10,000 |
| Planning & land Conservation | $4,650 | $46,500 |
| Water Quality Monitoring | $11,660 | $116,600 |
| **Total Cost** | **$57,610** | **$576,100** |

**Septic system recommendations do not include design or replacement costs because these should be covered by private landowners. Recommendations cover assistance to secure grant funding for those individuals who cannot afford these costs.*

Diverse funding sources and strategies will be needed to implement these recommendations. 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, GMCG, and other 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 this watershed management plan:

- **USEPA/NHDES 319 Grants (Watershed Assistance/Restoration Grants)** – This NPS grant is designed to support local initiatives to restore impaired waters (priorities identified in the NPS Management 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. For the 2017 funding year, 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 EDUCATIONAL COMPONENT

As detailed in Section 1.5, much effort is already being done by various groups (e.g., GMCG) in the watershed to enhance public understanding of the project and encourage community participation in watershed restoration and protection activities. GMCG is the primary entity for education and outreach campaigns in the watershed and for development of this plan. GMCG should continue all aspects of their education and outreach programs and consider developing new ones or improving existing ones to reach more watershed residents. Educational campaigns specific to the five Action Plan categories are detailed in their respective tables (Section 5.2).

# ADDITIONAL RESOURCES

*A Shoreland Homeowner's Guide to Stormwater Management.* New Hampshire Department of Environmental Services. NHDES-WD-10-8. Online: https://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/nhdes-wd-10-8.pdf

*Buffers for wetlands and surface waters: a guidebook for New Hampshire municipalities.* Chase, et al. 1997. NH Audubon Society. Online: https://www.nh.gov/oep/planning/resources/documents/buffers.pdf

*Conserving your land: options for NH landowners.* Lind, B. 2005. Center for Land Conservation Assistance / Society for the Protection of N.H. Forests. Online: http://clca.forestsociety.org/publications/

*Gravel road maintenance manual: a guide for landowners on camp and other gravel roads.* Maine Department of Environmental Protection, Bureau of Land and Water Quality. April 2010. Online: http://www.maine.gov/dep/land/watershed/camp/road/gravel_road_manual.pdf

*Gravel roads: maintenance and design manual.* U.S. Department of Transportation, Federal Highway Program. November 2000. South Dakota Local Transportation Assistance Program (SD LTAP). Online: http://www.gravelroadsacademy.com/media/filer_private/2012/02/14/sd_gravel_roads_brochure_1.pdf

*Innovative land use techniques handbook.* New Hampshire Department of Environmental Services. 2008. Online: https://www.nh.gov/oep/resource-library/planning/documents/innovative-land-use-planning-techniques-2008.pdf

*Landscaping at the water's edge: an ecological approach.* University of New Hampshire, Cooperative Extension. 2007. Online: https://extension.unh.edu/resources/files/resource004159_rep5940.pdf

*New Hampshire Homeowner's Guide to Stormwater Management: Do-It-Yourself Stormwater Solutions for Your Home.* New Hampshire Department of Environmental Services, Soak Up the Rain NH. Revised March 2016. Online: https://www.des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-11-11.pdf

*Open space for New Hampshire: a toolbook of techniques for the new millennium.* Taylor, D. 2000. New Hampshire Wildlife Trust. Online: http://clca.forestsociety.org/publications

*Protecting water resources and managing stormwater.* University of New Hampshire, Cooperative Extension & Stormwater Center. March 2010. Online: https://extension.unh.edu/resources/files/Resource002615_Rep3886.pdf

*Stormwater Manual.* New Hampshire Department of Environmental Services. 2008. Online: http://des.nh.gov/organization/divisions/water/stormwater/manual.htm

*University of New Hampshire Stormwater Center 2009 Biannual Report.* University of New Hampshire, Stormwater Center. 2009. Online: https://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/2009_unhsc_report.pdf

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